

ESTTA Tracking number: **ESTTA1216679**

Filing date: **06/21/2022**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD

Proceeding no.	91227510
Party	Plaintiff Vision Research, Inc.
Correspondence address	JOHN MCGLYNN CHRISTOPHER BLASZKOWSKI RATNERPRESTIA 2200 RENAISSANCE BLVD SUITE 350 KING OF PRUSSIA, PA 19406 UNITED STATES Primary email: tmde@ratnerprestia.com Secondary email(s): electronicservice@ratnerprestia.com, jwm-cglynn@ratnerprestia.com, cblaszkowski@ratnerprestia.com, kpop-pel@ratnerprestia.com 610-407-0700
Submission	Testimony For Plaintiff
Filer's name	Christopher Blaszkowski
Filer's email	cblaszkowski@ratnerprestia.com
Signature	/Christopher Blaszkowski/
Date	06/21/2022
Attachments	Carter NonCon Ex P342 - P358.pdf(5909513 bytes) Carter NonCon Ex P359 - P373.pdf(5701723 bytes) Carter NonCon Ex P374 - P390.pdf(5597121 bytes) Carter NonCon Ex P391 - P397.pdf(5598258 bytes) Carter NonCon Ex P398 - P403.pdf(4579363 bytes) Carter NonCon Ex P404.pdf(5546853 bytes) Carter NonCon Ex P405 - P417.pdf(3802089 bytes)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE TRADEMARK TRIAL AND APPEAL BOARD**

Vision Research, Inc.,

Defendant, Opposer/Counterclaim

v.

DJI GmbH,

Applicant/Counterclaim Plaintiff.

Opposition No. 91227510

Serial No. 79/163,070

Mark:  | PHANTOM

**APPENDIX TO TESTIMONIAL DECLARATION OF
DEANNA CARTER ON BEHALF OF
OPPOSER VISION RESEARCH, INC.**

NONCONFIDENTIAL EXHIBITS

P342 to P417

Date: June 21, 2022

Respectfully submitted,

/s/ Christopher H. Blaszkowski

Christopher H. Blaszkowski

RatnerPrestia

2200 Renaissance Boulevard

Suite 350

King of Prussia, PA 19406

cblaszkowski@ratnerprestia.com

*Attorneys for Opposer,
Vision Research, Inc.*

CERTIFICATE OF SERVICE

It is hereby certified that a true and correct copy of the foregoing document was served on June 21, 2022 by email to the correspondence address of record at the USPTO:

Parties Served:

B. Brett Heavner
Douglas A. Rettew
Katie W. McKnight
Yinfei Wu
Finnegan Henderson Farabow Garrett & Dunner, LLP
901 New York Avenue, NW
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yinfei.wu@finnegan.com
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/JaneFrankland/

Jane Frankland

EXHIBIT P342

Trademark/Service Mark Application, Principal Register

Serial Number: 78665261

Filing Date: 07/07/2005

The table below presents the data as entered.

Input Field	Entered
MARK SECTION	
MARK	PHANTOM
STANDARD CHARACTERS	YES
USPTO-GENERATED IMAGE	YES
LITERAL ELEMENT	PHANTOM
MARK STATEMENT	The mark consists of standard characters, without claim to any particular font, style, size, or color.
OWNER SECTION	
NAME	Vision Research Incorporated
STREET	100 Dey Road
CITY	Wayne
STATE	New Jersey
ZIP/POSTAL CODE	07470
COUNTRY	United States
AUTHORIZED EMAIL COMMUNICATION	No
LEGAL ENTITY SECTION	
TYPE	CORPORATION
STATE/COUNTRY OF INCORPORATION	New Jersey
GOODS AND/OR SERVICES SECTION	
INTERNATIONAL CLASS	009
DESCRIPTION	digital cameras; computer software for motion analysis, namely, software for image and data acquisition, digital image playback, image processing, image storage, quantitative measurements, and file management, of high-speed, still, and time-lapse events such as airbag deployment, chemical spray patterns, aircraft icing patterns, materials development, medical-surgical procedures, ballistics and weapons testing, and machine processes; user manuals sold therewith and parts for all the aforesaid goods
FILING BASIS	Section 1(a)
FIRST USE ANYWHERE DATE	At least as early as 07/12/1993
FIRST USE IN COMMERCE DATE	At least as early as 09/22/1994
	\VTICRS\EXPORT10\IMAGEOUT

SPECIMEN FILE NAME(S)	10\786\652\78665261\xml1\ APP0003.JPG
SPECIMEN DESCRIPTION	a photograph of the mark as it appears on one of the Applicant's digital cameras
ADDITIONAL STATEMENTS SECTION	
MISCELLANEOUS STATEMENT	The Applicant originally registered the PHANTOM [and design] mark (Registration No. 2053892). However, the registration was cancelled due to the inadvertent failure to file the Section 8 Affidavit.
SIGNATURE SECTION	
SIGNATURE	/dana o. lynch/
SIGNATORY NAME	Dana O. Lynch
SIGNATORY DATE	07/07/2005
SIGNATORY POSITION	Attorney
PAYMENT SECTION	
NUMBER OF CLASSES	1
NUMBER OF CLASSES PAID	1
SUBTOTAL AMOUNT	325
TOTAL AMOUNT	325
ATTORNEY	
NAME	Dana O. Lynch
FIRM NAME	Whiteford, Taylor & Preston L.L.P.
STREET	Seven Saint Paul Street
CITY	Baltimore
STATE	Maryland
ZIP/POSTAL CODE	20202
COUNTRY	United States
PHONE	410-347-8700
FAX	410-347-9414
EMAIL	dlynch@wtplaw.com
AUTHORIZED EMAIL COMMUNICATION	No
ATTORNEY DOCKET NUMBER	9080-100
OTHER APPOINTED ATTORNEY(S)	Frank S. Jones, Jr., S. Keith Mouldsdale, Gregory M. Stone, Jeffrey C. Maynard, Antoinette A. McRae, J. Bradley Aaron
CORRESPONDENCE SECTION	
NAME	Dana O. Lynch
FIRM NAME	Whiteford, Taylor & Preston L.L.P.
STREET	Seven Saint Paul Street
CITY	Baltimore
STATE	Maryland

ZIP/POSTAL CODE	20202
COUNTRY	United States
PHONE	410-347-8700
FAX	410-347-9414
EMAIL	dlynch@wtplaw.com
AUTHORIZED EMAIL COMMUNICATION	No
FILING INFORMATION	
SUBMIT DATE	Thu Jul 07 10:54:26 EDT 2005
TEAS STAMP	USPTO/BAS-XXXXXXXXXX-2005 0707105426237106-78665261 -200c723ec311b6cb7e89f476 8aea4c638-DA-1094-2005070 7105330444718

Trademark/Service Mark Application, Principal Register

Serial Number: 78665261
Filing Date: 07/07/2005

To the Commissioner for Trademarks:

MARK: (Standard Characters, see [mark](#))

The mark consists of standard characters, without claim to any particular font, style, size, or color.

The literal element of the mark consists of PHANTOM.

The applicant, Vision Research Incorporated, a corporation of New Jersey, residing at 100 Dey Road, Wayne, New Jersey, United States, 07470, requests registration of the trademark/service mark identified above in the United States Patent and Trademark Office on the Principal Register established by the Act of July 5, 1946 (15 U.S.C. Section 1051 et seq.), as amended.

The applicant, or the applicant's related company or licensee, is using the mark in commerce, and lists below the dates of use by the applicant, or the applicant's related company, licensee, or predecessor in interest, of the mark on or in connection with the identified goods and/or services. 15 U.S.C. Section 1051(a), as amended.

International Class 009: digital cameras; computer software for motion analysis, namely, software for image and data acquisition, digital image playback, image processing, image storage, quantitative measurements, and file management, of high-speed, still, and time-lapse events such as airbag deployment, chemical spray patterns, aircraft icing patterns, materials development, medical-surgical procedures, ballistics and weapons testing, and machine processes; user manuals sold therewith and parts for all the aforesaid goods

In International Class 009, the mark was first used at least as early as 07/12/1993, and first used in commerce at least as early as 09/22/1994, and is now in use in such commerce. The applicant is submitting or will submit one specimen for *each class* showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) a photograph of the mark as it appears on one of the Applicant's digital cameras.

[Specimen - 1](#)

The Applicant originally registered the PHANTOM [and design] mark (Registration No. 2053892). However, the registration was cancelled due to the inadvertent failure to file the Section 8 Affidavit.

The applicant hereby appoints Dana O. Lynch and Frank S. Jones, Jr., S. Keith Mouldale, Gregory M. Stone, Jeffrey C. Maynard, Antoinette A. McRae, J. Bradley Aaron of Whiteford, Taylor & Preston L.L.P., Seven Saint Paul Street, Baltimore, Maryland, United States, 20202 to submit this application on behalf of the applicant. The attorney docket/reference number is 9080-100.

A fee payment in the amount of \$325 will be submitted with the application, representing payment for 1 class(es).

Declaration

The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. Section 1001, and that such willful false statements, and the like, may jeopardize the validity of the application or any resulting registration, declares that he/she is properly authorized to execute this application on behalf of the applicant; he/she believes the applicant to be the owner of the trademark/service mark sought to be registered, or, if the application is being filed under 15 U.S.C. Section 1051(b), he/she believes applicant to be entitled to use such mark in commerce; to the best of his/her knowledge and belief no other person, firm, corporation, or association has the right to use the mark in commerce, either in the identical form thereof or in such near resemblance thereto as to be likely, when used on or in connection with the goods/services of such other person, to cause confusion, or to cause mistake, or to deceive; and that all statements made of his/her own knowledge are true; and that all statements made on information and belief are believed to be true.

Signature: /dana o. lynch/ Date: 07/07/2005
Signatory's Name: Dana O. Lynch

Signatory's Position: Attorney

Mailing Address:

Dana O. Lynch
Seven Saint Paul Street
Baltimore, Maryland 20202

RAM Sale Number: 1094

RAM Accounting Date: 07/07/2005

Serial Number: 78665261

Internet Transmission Date: Thu Jul 07 10:54:26 EDT 2005

TEAS Stamp: USPTO/BAS-XXXXXXXXXX-2005070710542623710

6-78665261-200c723ec311b6cb7e89f4768aea4

c638-DA-1094-20050707105330444718

PHANTOM



EXHIBIT P343

Trademark/Service Mark Application, Principal Register

Serial Number: 85771138

Filing Date: 11/05/2012

The table below presents the data as entered.

Input Field	Entered
SERIAL NUMBER	85771138
MARK INFORMATION	
*MARK	PHANTOM
STANDARD CHARACTERS	YES
USPTO-GENERATED IMAGE	YES
LITERAL ELEMENT	PHANTOM
MARK STATEMENT	The mark consists of standard characters, without claim to any particular font, style, size, or color.
REGISTER	Principal
APPLICANT INFORMATION	
*OWNER OF MARK	Vision Research, Inc.
*STREET	100 Dey Road
*CITY	Wayne
*STATE (Required for U.S. applicants)	New Jersey
*COUNTRY	United States
*ZIP/POSTAL CODE (Required for U.S. applicants only)	07470
LEGAL ENTITY INFORMATION	
TYPE	corporation
STATE/COUNTRY OF INCORPORATION	New Jersey
GOODS AND/OR SERVICES AND BASIS INFORMATION	
INTERNATIONAL CLASS	009
*IDENTIFICATION	Cameras; remote controls for cameras; communication, digital media, network and power hubs for cameras; solid state memory drives; blank flash memory drives; electronic storage device in the nature of memory media for storing raw image files containing minimally processed data from an image sensor; electronic docking station; computer hardware and peripherals; computer hardware, peripherals and software for connecting solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media to a computer; computer hardware, peripherals and software for reading solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media; computer hardware, peripherals and software for transferring video data to a computer; software for managing and editing video and video files
FILING BASIS	SECTION 1(a)

FIRST USE ANYWHERE DATE	At least as early as 06/00/2007
FIRST USE IN COMMERCE DATE	At least as early as 06/00/2007
SPECIMEN FILE NAME(S)	
ORIGINAL PDF FILE	SPE0-6320917811-102557232 . Specimen for the PHANTOM MAN Logo.pdf
CONVERTED PDF FILE(S) (1 page)	\\TICRS\EXPORT16\IMAGEOUT16\857\711\85771138\xml1\APP0003.JPG
SPECIMEN DESCRIPTION	Image of the goods bearing the mark
INTERNATIONAL CLASS	041
*IDENTIFICATION	Training in the use and operation of cameras and camera accessories; consulting services in the fields of photography and video; camera rental
FILING BASIS	SECTION 1(a)
FIRST USE ANYWHERE DATE	At least as early as 06/00/2007
FIRST USE IN COMMERCE DATE	At least as early as 06/00/2007
SPECIMEN FILE NAME(S)	
ORIGINAL PDF FILE	SPE0-1-6320917811-102557232 . Specimen for the PHANTOM MAN Logo.pdf
CONVERTED PDF FILE(S) (1 page)	\\TICRS\EXPORT16\IMAGEOUT16\857\711\85771138\xml1\APP0004.JPG
SPECIMEN DESCRIPTION	Image of the goods bearing the mark
ATTORNEY INFORMATION	
NAME	John W. McGlynn
ATTORNEY DOCKET NUMBER	AMT-8005US1
FIRM NAME	RatnerPrestia
INTERNAL ADDRESS	P.O. Box 1596
STREET	1007 Orange Street, Suite 1100
CITY	Wilmington
STATE	Delaware
COUNTRY	United States
ZIP/POSTAL CODE	19899
PHONE	302-778-2500
FAX	302-778-2600
EMAIL ADDRESS	tmde@ratnerprestia.com
AUTHORIZED TO COMMUNICATE VIA EMAIL	Yes
OTHER APPOINTED ATTORNEY	Lawrence E. Ashery, Antranig Baronian, Christopher H. Blaszkowski, Joshua L. Cohen, Rex A. Donnelly, IV, Jacques L. Etkowicz, Stephen Harper, Richard A. Howe, Jack J. Jankovitz, Andrew J. Koopman, Benjamin E. Leace, Christopher R. Lewis, Lisa Mead, John W. McGlynn, Glenn E.J. Murphy, Brian L. Mutschler, Kenneth N. Nigon, Michael P.F. Phelps, Paul F. Prestia, Derek Richmond, Brett J. Rosen, Christopher A. Rothe, Jonathan H. Spadt, Stephen J. Weed, Tom Southard Ling Zhong
CORRESPONDENCE INFORMATION	
NAME	John W. McGlynn

FIRM NAME	RatnerPrestia
INTERNAL ADDRESS	P.O. Box 1596
STREET	1007 Orange Street, Suite 1100
CITY	Wilmington
STATE	Delaware
COUNTRY	United States
ZIP/POSTAL CODE	19899
PHONE	302-778-2500
FAX	302-778-2600
EMAIL ADDRESS	tmde@ratnerprestia.com
AUTHORIZED TO COMMUNICATE VIA EMAIL	Yes
FEE INFORMATION	
NUMBER OF CLASSES	2
FEE PER CLASS	325
*TOTAL FEE DUE	650
*TOTAL FEE PAID	650
SIGNATURE INFORMATION	
ORIGINAL PDF FILE	hw_6320917811-092703472_._Signed_Declaration_AMT-8005US1.pdf
CONVERTED PDF FILE(S) (3 pages)	\\TICRS\EXPORT16\IMAGEOUT16\857\711\85771138\xml1\APP0005.JPG
	\\TICRS\EXPORT16\IMAGEOUT16\857\711\85771138\xml1\APP0006.JPG
	\\TICRS\EXPORT16\IMAGEOUT16\857\711\85771138\xml1\APP0007.JPG
SIGNATORY'S NAME	Rick Robinson
SIGNATORY'S POSITION	VP Marketing, Vision Research, Inc.

Trademark/Service Mark Application, Principal Register

Serial Number: 85771138

Filing Date: 11/05/2012

To the Commissioner for Trademarks:

MARK: PHANTOM (Standard Characters, see [mark](#))

The literal element of the mark consists of PHANTOM.

The mark consists of standard characters, without claim to any particular font, style, size, or color.

The applicant, Vision Research, Inc., a corporation of New Jersey, having an address of
100 Dey Road
Wayne, New Jersey 07470
United States

requests registration of the trademark/service mark identified above in the United States Patent and Trademark Office on the Principal Register established by the Act of July 5, 1946 (15 U.S.C. Section 1051 et seq.), as amended, for the following:

International Class 009: Cameras; remote controls for cameras; communication, digital media, network and power hubs for cameras; solid state memory drives; blank flash memory drives; electronic storage device in the nature of memory media for storing raw image files containing minimally processed data from an image sensor; electronic docking station; computer hardware and peripherals; computer hardware, peripherals and software for connecting solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media to a computer; computer hardware, peripherals and software for reading solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media; computer hardware, peripherals and software for transferring video data to a computer; software for managing and editing video and video files

In International Class 009, the mark was first used by the applicant or the applicant's related company or licensee or predecessor in interest at least as early as 06/00/2007, and first used in commerce at least as early as 06/00/2007, and is now in use in such commerce. The applicant is submitting one(or more) specimen(s) showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Image of the goods bearing the mark.

Original PDF file:

[SPE0-6320917811-102557232 . Specimen for the PHANTOM MAN Logo.pdf](#)

Converted PDF file(s) (1 page)

[Specimen File1](#)

International Class 041: Training in the use and operation of cameras and camera accessories; consulting services in the fields of photography and video; camera rental

In International Class 041, the mark was first used by the applicant or the applicant's related company or licensee or predecessor in interest at least as early as 06/00/2007, and first used in commerce at least as early as 06/00/2007, and is now in use in such commerce. The applicant is submitting one(or more) specimen(s) showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Image of the goods bearing the mark.

Original PDF file:

[SPE0-1-6320917811-102557232 . Specimen for the PHANTOM MAN Logo.pdf](#)

Converted PDF file(s) (1 page)

[Specimen File1](#)

The applicant's current Attorney Information:

John W. McGlynn and Lawrence E. Ashery, Antranig Baronian, Christopher H. Blaszkowski, Joshua L. Cohen, Rex A. Donnelly, IV, Jacques L. Etkowicz, Stephen Harper, Richard A. Howe, Jack J. Jankovitz, Andrew J. Koopman, Benjamin E. Leace, Christopher R. Lewis, Lisa Mead, John W. McGlynn, Glenn E.J. Murphy, Brian L. Mutschler, Kenneth N. Nigon, Michael P.F. Phelps, Paul F. Prestia, Derek Richmond, Brett J. Rosen, Christopher A. Rothe, Jonathan H. Spadt, Stephen J. Weed, Tom Southard Ling Zhong of RatnerPrestia

P.O. Box 1596
1007 Orange Street, Suite 1100
Wilmington, Delaware 19899
United States

The attorney docket/reference number is AMT-8005US1.

The applicant's current Correspondence Information:

John W. McGlynn
RatnerPrestia
P.O. Box 1596
1007 Orange Street, Suite 1100
Wilmington, Delaware 19899
302-778-2500(phone)
302-778-2600(fax)
tmde@ratnerprestia.com (authorized)

A fee payment in the amount of \$650 has been submitted with the application, representing payment for 2 class(es).

Declaration

The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. Section 1001, and that such willful false statements, and the like, may jeopardize the validity of the application or any resulting registration, declares that he/she is properly authorized to execute this application on behalf of the applicant; he/she believes the applicant to be the owner of the trademark/service mark sought to be registered, or, if the application is being filed under 15 U.S.C. Section 1051(b), he/she believes applicant to be entitled to use such mark in commerce; to the best of his/her knowledge and belief no other person, firm, corporation, or association has the right to use the mark in commerce, either in the identical form thereof or in such near resemblance thereto as to be likely, when used on or in connection with the goods/services of such other person, to cause confusion, or to cause mistake, or to deceive; and that all statements made of his/her own knowledge are true; and that all statements made on information and belief are believed to be true.

Declaration Signature

Signature: Not Provided Date: Not Provided
Signatory's Name: Rick Robinson
Signatory's Position: VP Marketing, Vision Research, Inc.
RAM Sale Number: 8628
RAM Accounting Date: 11/05/2012

Serial Number: 85771138
Internet Transmission Date: Mon Nov 05 09:32:10 EST 2012
TEAS Stamp: USPTO/BAS-XX.XXX.XXX.XX-2012110509321036
3892-85771138-490691994f17fac3903412ae28
12cbc96-CC-8628-20121105092703472967

PHANTOM





PTO Form 1478 (Rev 9/2006)

OMB No. 0651-0009 (Exp 12/31/2011)

**Trademark/Service Mark Application, Principal Register
Handwritten Signature**

To the Commissioner for Trademarks:

MARK: PHANTOM (Standard Characters, see mark)

The literal element of the mark consists of PHANTOM.

The mark consists of standard characters, without claim to any particular font, style, size, or color.

The applicant, Vision Research, Inc., a corporation of New Jersey, having an address of
100 Dey Road
Wayne, New Jersey 07470
United States

requests registration of the trademark/service mark identified above in the United States Patent and Trademark Office on the Principal Register established by the Act of July 5, 1946 (15 U.S.C. Section 1051 et seq.), as amended, for the following:

International Class 009: Cameras; remote controls for cameras; communication, digital media, network and power hubs for cameras; solid state memory drives; blank flash memory drives; electronic storage device in the nature of memory media for storing raw image files containing minimally processed data from an image sensor; electronic docking station; computer hardware and peripherals; computer hardware, peripherals and software for connecting solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media to a computer; computer hardware, peripherals and software for reading solid state memory drives, flash memory drives and electronic storage devices in the nature of memory media; computer hardware, peripherals and software for transferring video data to a computer; software for managing and editing video and video files

In International Class 009, the mark was first used by the applicant or the applicant's related company or licensee at least as early as 06/00/2007, and first used in commerce at least as early as 06/00/2007, and is now in use in such commerce. The applicant is submitting one specimen(s) showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Image of the goods bearing the mark.
Specimen-1 [SPE0-1-6320917811-102557232_._Specimen_for_the_PHANTOM_MAN_Logo.pdf]

International Class 041: Training in the use and operation of cameras and camera accessories; consulting services in the fields of photography and video; camera rental

In International Class 041, the mark was first used by the applicant or the applicant's related company or licensee at least as early as 06/00/2007, and first used in commerce at least as early as 06/00/2007, and is now in use in such commerce. The applicant is submitting one specimen(s) showing the mark as used in commerce on or in connection with any item in the class of listed goods and/or services, consisting of a(n) Copy of webpage advertising the services and showing the mark.
Specimen-1 [SPE0-6320917811-131222151_._VR_RENTAL-Matrix2012-P3.pdf]

The applicant's current Attorney Information:

John W. McGlynn and Lawrence E. Ashery, Antranig Baronian, Christopher H. Blaszkowski, Joshua L. Cohen, Rex A. Donnelly, IV, Jacques L. Etkowicz, Stephen Harper, Richard A. Howe, Jack J. Jankovitz, Andrew J. Koopman, Benjamin E. Leace, Christopher R. Lewis, Lisa Mead, John W. McGlynn, Glenn E.J. Murphy, Brian L. Mutschler, Kenneth N. Nigon, Michael P.F. Phelps, Paul F. Prestia, Derek Richmond, Brett J. Rosen, Christopher A. Rothe, Jonathan H. Spadt, Stephen J. Weed, Tom Southard Ling Zhong of RatnerPrestia

P.O. Box 1596

<http://teas.uspto.gov/forms/xslt.service?xsl=hsign&stamp=USPTO/BAS-63.209.178.11-20121102...> 11/2/2012

1007 Orange Street, Suite 1100
Wilmington, Delaware 19899
United States

The attorney docket/reference number is AMT-8005US1.

The applicant's current Correspondence Information:

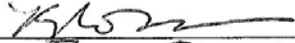
John W. McGlynn
RatnerPrestia
P.O. Box 1596
1007 Orange Street, Suite 1100
Wilmington, Delaware 19899
302-778-2500(phone)
302-778-2600(fax)
tmde@ratnerprestia.com (authorized)

A fee payment in the amount of \$650 will be submitted with the application, representing payment for 2 class(es).

Declaration

The undersigned, being hereby warned that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. Section 1001, and that such willful false statements, and the like, may jeopardize the validity of the application or any resulting registration, declares that he/she is properly authorized to execute this application on behalf of the applicant; he/she believes the applicant to be the owner of the trademark/service mark sought to be registered, or, if the application is being filed under 15 U.S.C. Section 1051(b), he/she believes applicant to be entitled to use such mark in commerce; to the best of his/her knowledge and belief no other person, firm, corporation, or association has the right to use the mark in commerce, either in the identical form thereof or in such near resemblance thereto as to be likely, when used on or in connection with the goods/services of such other person, to cause confusion, or to cause mistake, or to deceive; and that all statements made of his/her own knowledge are true; and that all statements made on information and belief are believed to be true.

Signature Section:

Signature: 
Signatory's Name: RICK ROBINSON
Signatory's Position: VP MARKETING, USLOW RESEARCH, INC.
Signatory's Phone Number: 973-692-4070

Date Signed: 10/5/2012

NOTE TO APPLICANT: When filed as part of the electronic form (i.e., scanned and attached as an image file), the signature page **must** include both the signature information and the boilerplate declaration language. Do **not** include the entire application, but do ensure that the boilerplate declaration language actually appears; *a signature by itself will not be acceptable*. If, due to browser limitations, the boilerplate declaration language appears on a previous page when printed, you must "merge" the declaration and signature block onto a single page prior to signing, so that the *one complete page* can be scanned to create an acceptable image file. It is recommended that you copy-and-paste the entire text form into another document, manipulate the spacing there to move the declaration and signature section to a separate page, and then print this new version of the text form to send to the signatory.

EXHIBIT P344

Int. Cl.: 9

Prior U.S. Cls.: 21, 23, 26, 36 and 38

Reg. No. 2,053,892

United States Patent and Trademark Office

Registered Apr. 22, 1997

**TRADEMARK
PRINCIPAL REGISTER**

Phantom

VISION RESEARCH INCORPORATED (NEW
JERSEY CORPORATION)
190 PARISH DRIVE
WAYNE, NJ 07470

FOR: DIGITAL CAMERAS; COMPUTER
SOFTWARE FOR MOTION ANALYSIS,
NAMELY, SOFTWARE FOR IMAGE AND
DATA ACQUISITION, DIGITAL IMAGE PLAY-
BACK, IMAGE PROCESSING, IMAGE STOR-
AGE, QUANTITATIVE MEASUREMENTS,
AND FILE MANAGEMENT, OF HIGH-SPEED,
STILL, AND TIME-LAPSE EVENTS SUCH AS
AIRBAG DEPLOYMENT, CHEMICAL SPRAY

PATTERNS, AIRCRAFT ICING PATTERNS,
MATERIALS DEVELOPMENT, MEDICAL-
SURGICAL PROCEDURES, BALLISTICS AND
WEAPONS TESTING, AND MACHINE PROC-
ESSES; USER MANUALS SOLD THEREWITH
AND PARTS FOR ALL THE AFORESAID
GOODS, IN CLASS 9 (U.S. CLS. 21, 23, 26, 36
AND 38).

FIRST USE 7-12-1993; IN COMMERCE
9-22-1994.

SER. NO. 74-661,711, FILED 4-17-1995.

RUSS HERMAN, EXAMINING ATTORNEY

EXHIBIT P345

REDACTED AS CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT P346

REDACTED AS CONFIDENTIAL

EXHIBIT P347

REDACTED AS CONFIDENTIAL

ATTORNEYS' EYES ONLY

EXHIBIT P348

DATA SHEET

For the most current version visit www.visionresearch.com
Subject to change Preliminary File October 2014

Phantom[®] Miro[®] C210J & C210 Digital High-Speed Cameras

The Compact & Flexible Solution
for the most difficult applications

Key Features:

- 12-bit 1.3 Megapixel CMOS sensor
- 2,000 fps @ 1280 x 1024
- ISO Monochrome 5,000 (T), 2,500 (D)
Color 640 (T), 640 (D), adjustable
- Compact, rugged design
- Hi-G: 170G, IAW MIL-STD 810G,
17Grms, IAW MIL-STD-202G
- Reversible mount for C & CS lenses
- Internal battery to protect data
- Phantom RCU compatible
- HD-SDI output
- Internal CineFlash

AMETEK[®]
MATERIALS ANALYSIS DIVISION



Miro JBox



Miro C210J & Miro C210

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO[®]

- Small, light & rugged, to meet the most demanding applications
- Modular: Systems can be as simple or complex as needed
- 2,000 fps at full 1280 x 1024 resolution

The Miro C210J & C210 digital high-speed cameras are each smaller than 3-inch cubes (73 mm x 73 mm x 73 mm) and weigh just over 1 lb. (.5 kg), but are rugged enough to withstand shocks of 170G and vibration of 17 grms. With strategically placed mounting holes, these cameras can fit in the most difficult places. An internal battery and internal, non-removable **Phantom CineFlash[®]** are standard with each camera. In the event of AC power loss, the battery provides up to 30 minutes of backup power to protect the data as it saves to the **CineFlash**.

The Miro C210J & C210 are built on the same platform, each with distinguishing features to maximize their utility. Miro C-Series cameras can be used individually or grouped together with a Miro Junction Box to create almost any multi-camera configuration imaginable. They are complimentary to the Phantom Miro camera family and accessories, further expanding the configuration possibilities.

Both cameras achieve up-to 2,000 frames-per-second (fps) at the maximum resolution of 1280 x 1024, with very low noise to capture critical details. The cameras have a 1/2" image sensor format, and can take advantage of a large selection of C and CS lenses. Comprehensive motion analysis tools come standard in the camera software included with each camera.

Miro® C210J & C210

Protecting the Images

3 reasons images are safe with the C210J & C210 if a cable is severed during an experiment:

1. Memory is local, directly on the cameras
2. Every camera has battery backup
3. Cameras can immediately store images to non-volatile CineFlash

**JBox Connections
(Each with status indicator LED):**

Ethernet	Ruggedized RJ45 connector
Power In	20-28VDC, protected for reverse polarity, overcurrent (10A), undervoltage and overvoltage to 50V. Independent power is required for each Junction Box
Ready BNC	"Closed" for ready, "open" for not ready; covers all cameras connected to this JBox and any JBox up-chain of this one
Trigger BNC	Contact closure causes trigger. There is also Trigger on System connector: isolated, <1V deassert, 3 to 24V assert
Camera Ports	Each JBox has Six Camera ports with Fischer connectors, which carry Ethernet, power, serial, and Miro camera signals on capture connector. There are two status LEDs for each camera port – Ethernet and camera status. One port can be used to daisy chain or branch to another JBox's System port
System	Same Fischer connector as Camera port. Connects to a Camera Port on second JBox to daisy chain or branch the system for additional cameras.

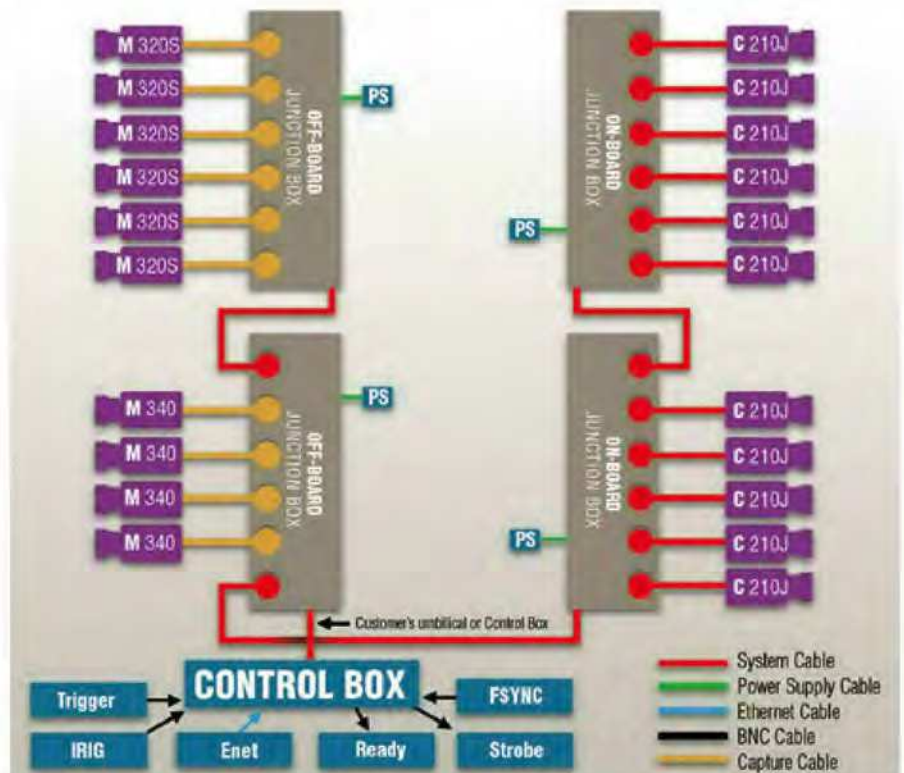
Miro C210J Camera and Junction Box

Small, light, and rugged, the Miro C210J is **designed for tough and difficult situations**, such as automotive on-board applications. It uses just a single cable to connect to the Miro Junction Box (JBox). The Miro C210J is also versatile. It can be connected to a Remote Control Unit (RCU), and also has a DIN 1.0/2.3 connector for HD video.



Phantom Miro C210J and Junction box

The Miro Junction Box (JBox) is **flexible**: With six camera ports, it can host six cameras or dedicate any port to uplink to another JBox in a daisy chain or tree branch, expanding the number of cameras in a configuration. It is compatible with all Miro cameras, including the M and R series. Each JBox provides power to the cameras via customer supplied power source. It connects the cameras to either a central control system to manage Trigger, IRIG, Strobe, FSYNC, Ready control, and Ethernet, or directly to a computer with PCC or MultiCam software via Gb Ethernet.

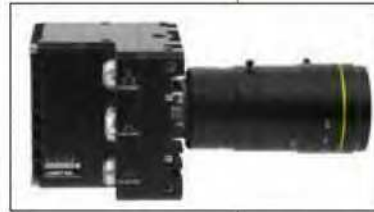


Complex Configuration Example

Miro C210 camera

The Miro C210 is **ideal for single camera applications** requiring a small, light, and rugged camera. With three connections for Ethernet, Power, and Capture, it is compatible with all cables for Miro cameras.

Additionally, the Miro C210 has a DIN 1.0/2.3 connector on the camera front for HD video. It comes with a power supply and MiniBoB to connect to the Capture connector. The MiniBoB is a simple and reliable way to control the Miro C210 with Trigger, Video, IRIG in, IRIG out, F-Sync, Ready, Strobe, Event and Memgate signals, greatly enhancing the Miro C210's capability. Alternatively, the camera may also connect directly to a computer via Ethernet.



Phantom Miro C210

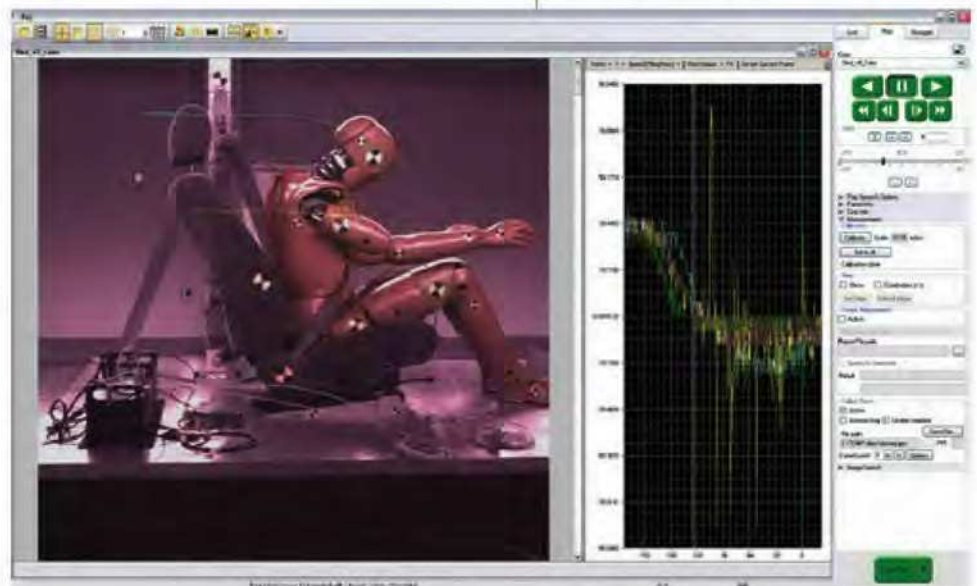
Motion Analysis Capability

The Miro C210J & C210 use Phantom Camera Control (PCC) software, and take advantage of the **robust Motion Analysis features built into the software**. PCC can perform timing, position, distance, velocity, angle and angular speed measurements, and track multiple points or objects to compute and graph their XY-coordinates, speed, or acceleration. The software has several proven edge detection algorithms and image processing tools to enhance motion analysis. PCC also provides a Collect Point (tracking) tool to compute the position, speed, acceleration, and/or generate motion graphs of a point (or object) or multiple points (up to 99), with respect to the image plane, over time.

PCC Motion Analysis capabilities

Specifications

The Miro C210J & C210 are based on a 1.3 Mpx sensor with 2.6 Gpx throughput. This provides 2,000 fps at 1280 x 1084, and higher frame rates at lower resolutions. These cameras utilize a 12-bit pixel depth, CMOS sensor, with 5.6 μm pixel size.



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Phantom® Miro® C210J & C210 Digital High-Speed Cameras

Additional Features:

- Continuous Recording
- Auto-Exposure
- Multi-cine Acquisition
- Gb Ethernet
- Rechargeable Battery
- Size and Weight: 1.0 lb, 0.5 kg; 2.9 x 2.9 x 2.8 inches
73 x 73 x 72 mm (W x H x D)
- Operating Temperature:
0° C to 35° C
- Tiered Service Contracts to protect your investment

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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Maximum Frame Rates

Resolution	FPS
1280 x 1024	2,000
1280 x 720	2,700
512 x 512	3,800
640 x 480	4,000
256 x 256	7,400
64 x 8	74,400

Enhance your workflow with Phantom Accessories Remote Control Unit (RCU)

Both the Miro C210J & C210 are compatible with the Phantom Remote Control Unit (RCU). The RCU is a valuable accessory, offering simple local set-up and complete control when the camera is mounted remotely.

Control Breakout Box (Control BoB)

The Control Breakout Box (Control BoB) offers a sleek and simple way to connect the required signaling to a Junction Box configuration without splicing cables. With ports for IRIG, Ethernet, Ready, Strobe, and FSYNC, the Control BoB is a clean and convenient solution to manage signaling.

Vision Research Global Support - for wherever you are

Our Miro C-Series Digital High-speed camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera by learning more about our service and support options at www.visionresearch.com/Service--Support/

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

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subject to change Rev February 2016

Phantom® Miro® N-Series Digital High-Speed Camera

Tiny, Hi-G camera gives
big Impact

Environmental Specifications:

Miro N5 HEAD:

Size and Weight:

0.2lb, 0.09kg
1.25 x 1.25 x 1.1 inches
32 x 32 x 28 mm (H x W x D)

Power:

16 - 32 VDC, 2.5 W, typical

Miro N-JB or N-B Base:

Size and Weight:

1.4lb, 0.64kg
2.9 x 2.1 x 7.3 inches
75 x 53.5 x 187 mm (H x W x D)

Power:

16 - 32 VDC, 10 W typical,
18W during battery charge.

Miro N5 Head & Base:

Hi-G: 150G Shock, IAW MIL-STD 202G
24 Grms Vibe, IAW MIL-STD 202G

Operating Temperature:

0°C to 50°C

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Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

- 👁 Small camera head fits in hard to reach places
- 👁 Ultimate data protection through the CXP cable
- 👁 Hi-G, for demanding applications

The Phantom Miro N-Series high-speed camera brings maximum flexibility in accessing hard to reach places. The system has **three simple, interchangeable components**.

Miro N5 Camera head: A small **cube camera head** measuring just 32mm x 32mm x 28mm, **this tiny camera head can do big things**. The 0.5Mpx sensor achieves over 1,000 fps at 512 x 472. Heads can be purchased separately, a cost-effective solution for destructive applications.

CXP cable: All images are transferred instantaneously through the CXP cable. **Every last image is safe** if the head or cable is damaged. The 3 Meter cable is strain relieved, field-replaceable, and provides ample length to position the camera head.

Miro N Base: The Base has 8GB of RAM, 128GB internal CineFlash, battery for back-up, and an HD-SDI port. It comes in 2 versions:

JB-Base, for a single cable connection to the Miro J-Box 2.0

B-Base, to use either stand-alone or connected to the J-Box via adapter cable. Both bases have an SDI connector to easily connect to a monitor.

All components are interchangeable for maximum convenience and flexibility.

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Phantom® Miro® N-Series Digital High-Speed Camera

Camera Specifications		Special Features:
Sensor Resolution	768 x 600	
Pixel Size	4.8 µm	
Sensor Size	3.6 x 2.8mm	
Bit Depth	10-bit	
Max fps at Max Res	560 fps	
Max fps at Min Res	9,055 fps	
CAR	128 x 32	
Minimum fps	30 fps	
Minimum Exposure	30 µs	
ISO	Mono: 2,000D Color: 400D	
Adjustable E.I.	Mono: 2,000 - 10,000 Color: 400 - 2,000	



Resolution	Maximum fps
768 x 600	560
640 x 480	815
512 x 512	930
256 x 256	2325
256 x 128	3570
128 x 64	4870
128 x 32	9055

Resolutions Providing 1000 fps

Resolution	Maximum fps
480 x 480	1040
512 x 450	1045
512 x 472	1000



2 versions: Junction Box-ready N-JB Base and stand-alone Miro N-B Base

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Vision Research Global Support - for wherever you are

Our Miro Digital High-speed cameras are supported by Vision Research's Global Support network from multiple sites around the globe. Maximize the value of your Phantom camera by learning more at www.phantomhighspeed.com/Support/

Focused

Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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For the most current information visit www.phantomhighspeed.com
or call 1-800-451-7115

Phantom®
Miro® C110

The Cost Effective and Easy to Use camera, perfect for many applications

Key Features:

- 12-bit 1.3 Megapixel CMOS sensor
- 800 fps @ 1280 x 1024
- 1125 fps at 1280 x 720
- Available in Monochrome or Color
- ISO Mono 5,000 (T), 2,500 (D)*
- Color 640 (T)*, 640 (D)*, adjustable
- Compact and sturdy
- Standard BNC and Ethernet connections
- Reversible mount for C & CS lenses
- 8GB of RAM included
- Easy-to-use signals:
 - Trigger
 - I/O 1:
 - FSYNC
 - Strobe
 - Event
 - Mergate
 - I/O 2:
 - Strobe
 - Ready

* Measured according to ISO 12232:2006 method



Miro C110
Side view



Miro C110 Rear view of connectors

Key Benefits:

When it's too fast to see, and too important not to®

The **Phantom Miro C110** is the **perfect go-to camera** for many applications that benefit from high quality, high speed analysis. Its ideal mix of **speed, image quality and ease of use** makes it one of the most flexible analytical tools in the lab.

- 800 frames per second (fps) at full 1.3 Mpx resolution, 1125 fps @ 1280 x 720, and up to 29,800 fps at smaller resolutions
- Sturdy and small, easy to connect and use, with common BNC and Ethernet connectors
- Phantom quality image and features, in a cost effective camera

The smart companion for a **wide range of applications** such as industrial trouble-shooting, mechanical analysis and motion analysis, the Miro C110 is **easy to work with**. Its sturdy, small body connects to signaling with common BNC cables, and uses a standard Ethernet cable for camera control and data downloading. Its accessible Trigger BNC and two programmable I/O BNC's make it easily controlled in any situation.

Specifications

The Miro C110 is based on a 1.3 Mpx sensor with 1.0 Gpx throughput. This provides 800 fps at 1280 x 1024, and up to 29,840 fps at lower resolutions, with very low noise to capture critical details. Also, the Miro C110's exposure times can be set as low as 5 microseconds, to further help **eliminate motion blur** and freeze objects in motion. The minimum frame rate at all resolutions is 100 fps.

The camera uses a 12-bit pixel depth, CMOS sensor, with 5.6 µm pixel size. Its image sensor format is slightly larger than 1/2", and takes advantage of a large selection of C and CS lenses. Available in either Color or Monochrome, it **makes the most out of available light**, with light sensitivity ISO ratings measured according to ISO 12232:2006 method:

	D (Daylight)	T (Tungsten)
Monochrome	2500	5000
Color	640	640

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Phantom[®] Miro[®] C110

Additional Features:

- Image-Based Auto-Trigger (IBAT)
- Continuous Recording
- Auto-Exposure
- Multi-cine Acquisition
- Gb Ethernet
- Motion Analysis software included
- Size and Weight:
1.2 lb, 0.54 kg; 2.9 x 3.65 x 3.25 inches
73 x 93 x 82.5 mm (H x W x D)
- Operating Temperature: 0° C to 50° C
- Tiered Service Contracts to protect your investment

Complete with Easy-to-Use Phantom Features

The Miro C110 comes equipped with 8GB of memory, providing 5.0 seconds of record time at maximum frame rate and resolution, and longer at reduced rates and resolutions. It uses powerful Phantom Camera Control (PCC) software. PCC makes an easy job out of capturing the event and then adjusting image characteristics like color and brightness. Flexible triggering options **easily capture the images of a specific event**. Images are automatically recorded into a circular buffer, and the trigger option determines which of those images are saved to RAM – images before, after, or on either side of the trigger, depending on the actual experiment set-up. There is also a suite of advanced features to support your analysis, including:



Phantom Miro C110

- **Image-Based Auto-Trigger:** Trigger the camera (or even a number of connected cameras) from motion detected within the live image. This makes it easier to catch events that are not predictable and may occur infrequently.
- **Multi-Cine:** Partition internal memory into up to 63 segments and make shorter recordings back-to-back without missing any action.
- **Continuous Recording:** Perfect to record many occurrences of an event, especially an event that happens rarely or is unpredictable. Continuous recording mode automatically saves a cine to a connected PC immediately after it is recorded then re-arms the camera, waiting for the next cine. A recording can be triggered manually, from an event detection system, or even by our Image-Based Auto-Trigger. The number of recordings is limited only by the amount of available disk storage.

Trim Save the Cine in either its raw format, or convert it **popular formats such as Quicktime or AVI** or save frames in JPEG or TIFF, to easily email the analysis to colleagues.

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Maximum Frame Rates		
Horizontal	Vertical	FPS
1280	1024	800
1280	720	1125
768	768	1060
640	480	1670
512	512	1570
384	288	2710
256	256	3025
128	128	5645
128	8	29,840

Focused

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Miro M310 shown with optional Remote Control Unit (RCU)

Phantom® Miro® M-Series Digital High-Speed Cameras

Advanced features in a compact camera at an affordable price

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

You will wonder how we packed so much capability in such a small package! The Phantom Miro M-Series cameras contain all the **high-performance** features you've come to expect from Vision Research in a **compact, rugged camera**.

The Miro M110 and M310 are based on a 1 Megapixel (Mpx), 1280 x 800, custom-designed CMOS sensor from Vision Research. The M110 has 1.6 Gigapixel/second (Gpx/s) throughput, yielding over **1600 frames-per-second (fps)** at full resolution. The M310 doubles that for 3.2 Gpx/s throughput and over **3200 fps at full resolution**. With a 20 micron (µm) pixel size and 12-bit depth, these cameras feature **high-light sensitivity** and **great dynamic range**. Maximum frame rates at reduced resolution are 400,000 fps for the M110 and 650,000 for the M310.

Key Features:

- 1 Megapixel and 2 Megapixel custom-designed CMOS sensors
- Up to 3.2 Gigapixels/second throughput
- High light sensitivity
- Compact, rugged design
- Rechargeable battery
- Phantom CineFlash™ storage system
 - 60GB, 120GB and 240GB CineFlash
 - CineFlash Dock
 - eSATA Connectivity

Miro® M-Series



Miro M120 shown with optional BP-U60 battery

Advanced Features:

CineFlash Storage System
 Image-Based Auto-Trigger
 Burst Mode
 Extreme Dynamic Range
 Continuous Recording
 Auto-Exposure
 Measurements
 Multi-cine Acquisition
 Internal Mechanical Shutter
 AutoSet

Miro M-Series Rear View
shown with optional BP-U60 battery

The M120 is based on a >2Mpx sensor and 1.6 Gpx/s throughput. That translates to **730 fps at 1920 x 1200**, or **over 1200 fps at 1152 x 1152**. **The M320S has 3.2 Gpx/s throughput. That's 1380 fps at 1920 x 1200.** These cameras use microlenses on their custom-designed CMOS sensors with 10 μm pixel pitch to achieve high light sensitivity. With 12-bit pixel depth, they also sport high dynamic range for excellent image quality. Maximum frame rate at reduced resolution is 250,000 for the M120 and 325,000 for the M320S.

Depending on model, the minimum digital exposure time is either 1 μs or 2 μs for **sharp, blur-free images** using a global electronic shutter. Vision Research's unique **Extreme Dynamic Range (EDR)** feature is standard on all models. With EDR enabled, each pixel in a frame will receive one of two exposure times – a short exposure for potentially overexposed pixels and a longer exposure for pixels receiving normal light levels. This dramatically increases dynamic range and gets you results even under the most demanding shooting conditions.

For PIV applications, using the Shutter Off mode allows for a **straddle time of 500 ns** on the M110 and M310 and **1.4 μs** on the M120 and M320S.

An integrated internal mechanical shutter for remote and automatic black references is another unique innovation from Vision Research that comes standard on all models. This means **each shot is properly referenced** for maximum image quality. And, there is no need to manually cap the lens or even touch the camera since the black reference can be done remotely or automatically before each shot.

A **Nikon F-mount is standard on the cameras**. Or, you can choose a C-mount, PL-mount or EOS-mount. The EOS mount enables the use of compatible EF and EF-S lenses. Focus and aperture can be adjusted via our Phantom Remote Control Unit (RCU), Phantom Camera Control software (PCC), or using an adjustment ring on the lens mount. Remote control of focus and aperture is a **huge benefit when cameras are remotely located and/or difficult to reach**.

Each camera model comes in three memory configurations: 3 Gigabytes (GB), 6 GB or 12 GB. The high-speed internal **memory can be segmented** into as many as 16 partitions for cine storage. (A *cine* is Vision Research's raw image format that stores all image data in a compact file.)

At the end of any shot, save your cine to the removable Phantom CineFlash storage media at about 4GB/minute. CineFlash allows you to **save a copy of your cine to non-volatile memory** for later retrieval, and **avoid costly downtime** while you download from camera memory to a computer hard disk. When done with an experiment, just remove the CineFlash from the camera, insert it into its docking station connected to a PC, and drag-and-drop cines from the CineFlash onto your computer disk.



	Phantom Miro M110	Phantom Miro M310	Phantom Miro M120	Phantom Miro M320S
Maximum Resolution	1280 x 800	1280 x 800	1920 x 1200	1920 x 1200
Maximum Frame Rate at Maximum Resolution	1600 fps	3200 fps	730 fps	1380 fps
Throughput (Gpx/s)	1.6 Gpx/s	3.2 Gpx/s	1.6 Gpx/s	3.2 Gpx/s
Sensor Size	25.6mm x 16.0mm	25.6mm x 16.0mm	19.2mm x 12.0mm	19.2mm x 12.0mm
Pixel Pitch	20 µm	20 µm	10µm	10µm
Minimum Exposure	2 µs	1 µs	1 µs	1 µs
ISO (12232 SAT Method)	13,000 T Mono 3900 T Color	13,000 T Mono 3900 T Color	8600 T Mono 1100 T Color	8600 T Mono 1100 T Color



	Phantom Miro M110		Phantom Miro M310		Phantom Miro M120		Phantom Miro M320S	
	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*
1920 x 1200	N/A	-	N/A	-	730	4.7	1,380	2.5
1920 x 1080	N/A	-	N/A	-	800	4.8	1,540	2.5
1152 x 1152	N/A	-	N/A	-	1,220	4.9	2,250	2.6
1024 x 1024	N/A	-	N/A	-	1,530	4.9	2,780	2.7
1280 x 800	1,630	4.7	3,260	2.3	1,600	4.8	2,960	2.6
1280 x 720	1,810	4.7	3,630	2.3	1,780	4.8	3,280	2.6
896 x 720	2,520	4.9	5,040	2.4	2,450	5.0	4,400	2.8
640 x 480	5,090	5.1	10,100	2.5	4,910	5.3	8,490	3.0
512 x 512	5,790	5.2	11,500	2.6	5,540	5.5	9,330	3.2
384 x 288	12,900	5.6	25,900	2.7	12,200	5.9	19,600	3.6
256 x 256	19,800	6.1	39,700	3.0	18,300	6.6	27,600	4.4
128 x 128	60,400	8.0	120,700	4.0	52,400	9.3	69,000	7.0
128 x 64	113,200	8.6	226,300	4.3	95,300	10.2	121,900	8.0
64 x 8	400,000	19.5	650,000	12.0	250,000	31.0	325,000	25.0

* Record time into maximum memory of 12GB.

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Phantom[®] Miro[®] M-Series Digital High-Speed Cameras

Additional Features:

- Gb Ethernet
- Rechargeable Battery (Sony BP-U30 or BP-U60)
- Dimensions: 7.5 x 3.5 x 4 inches, 19 x 9 x 10 cm
(L, W, H without handle or lens)
- Weight: 3.0 lbs, 1.4 kg (without CineFlash, battery or lens)
- Operating Temperature and Humidity: 0° C to 40° C @
8% to 80% relative humidity, non-condensing
- Tiered Service Contracts to protect your investment



ViSiON
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4

Using PCC, you can then **view, edit, enhance and analyze** cine files. Easily extract still shots, or convert cines into web- and presentation-compatible formats for sharing with colleagues and documenting experiments. Use PCC's measurement tools to **determine distances, angles and speed**. Advanced tools let you **crop, scale, rotate and enhance** cine files to get to the information and insight you seek in images that have never before been seen.

Control your camera with an extensive suite of tools in PCC via a Gb Ethernet connection, or use the Phantom RCU and its **easy-to-learn and easy-to-use touchscreen interface**.

Advanced control signals are available including a Trigger input and Frame Synchronization signal (FSYNC) on the camera back panel. Trigger, Ready, IRIG In, Video Out, IRIG Out and an Auxiliary signal connection are all available on the standard capture cable. The Auxiliary signal can be assigned to Event, Strobe or Memgate.

Video Out is either **NTSC or PAL on the M110, M310 and M120. An HD-SDI port is available on the M320S**. And, a live image is always available in PCC. You can adjust the video to fill the available monitor space for framing a shot, and then switch to a 1:1 pixel representation (center-cropped) for focusing.

Applications for the Phantom Miro M-Series cameras are as broad as your imagination. Study flow dynamics in PIV applications; improve micro- and nano-designs through small object imaging; diagnose and troubleshoot problems with high-speed machinery; improve product designs by characterizing materials and products under stress; any application that demands high-speed image capture at one- to two-megapixel resolution with high light sensitivity is a candidate for the Miro M-Series cameras.

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

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DATA SHEET

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 or call 1-800-451-0099



Miro M-Series High-Speed Digital Cameras

**Phantom[®]
Miro M140
& M340
High-Speed
Cameras**

Advanced features in a compact, rugged camera

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO[®]

Phantom Miro cameras have all the high-performance features you've come to expect from Vision Research in a compact, rugged camera. Now, we've introduced two new models — the Miro M140 and M340.

These new models differ from the Miro M120 and M320S in two significant ways. First, they have twice the resolution at 2560 x 1600 on a 35mm sized sensor. Second, neither comes with a video output. Images are only available over Gb Ethernet using our Phantom Camera Control (PCC) software or custom written 3rd party software using our SDK.

These cameras are best used in a tethered environment for measurement applications such as Tomographic PIV. An SDK is available for use in embedded or custom applications. LabView drivers are also available, as is the ability to

Key Features:

- 4 Megapixel custom-designed CMOS sensor
- Up to 3.2 Gigapixels/second throughput
- High light sensitivity
- Compact, rugged design
- Rechargeable Battery (Sony BP-U30 or BP-U60)
- Phantom CineFlash[™] storage system
 - 60GB, 120GB and 240GB CineFlash
 - CineFlash Dock
 - eSATA Connectivity

DATA SHEET

Phantom® Miro M140 & M340 High-Speed Cameras

Additional Features:

- Gb Ethernet
- Dimensions: 7.5 x 3.5 x 4 Inches, 19 x 9 x 10 cm
(L, W, H without handle or lens)
- Weight: 3.0 lbs, 1.4 kg (without CineFlash, battery or lens)
- Operating Temperature and Humidity: 0° C to 40° C @
8% to 80% relative humidity, non-condensing
- Tiered Service Contracts to protect your investment

acquire data from National Instrument's data acquisition modules synchronized to the camera.

The M140 has 1.6 gigapixels-per-second (Gpx/s) throughput while the M340 is twice that fast. That means a maximum frame rate of 410 fps on the M140 at full resolution and 800 fps on the M340 at full resolution. Both cameras have a straddle time of 1.4 μ s. Minimum exposure on both models is 1 μ s.

Both cameras are available with color or monochrome sensors. And, both come with our revolutionary CineFlash® non-volatile storage system (including a docking station) and rechargeable battery packs.

When ordering your camera, you can select from a variety of lensing alternatives including Nikon F/G mount, Canon EF / EF-S mount, 1" c-mount or a PL mount.

Cameras come with 3GB, 6GB or 12GB internal volatile high-speed memory. And, include other advanced features like: internal mechanical shutter for remote/automatic black referencing; advanced control signals (ready, strobe, sync, IRIG, trigger, event & memgate.)



Miro M-Series Rear View with optional BP-U60 battery

Phantom Miro M340	
Resolution	Max FPS
2560 x 1600	800
2048 x 1600	980
1920 x 1080	1540
1152 x 1152	2240
1280 x 1024	2310
1280 x 800	2950
896 x 720	4390
640 x 480	8450
512 x 512	9290
256 x 256	27200
128 x 128	66600
128 x 64	114700
64 x 8	320000

Phantom Miro M140	
Resolution	Max FPS
2560 x 1600	410
2048 x 1600	510
1920 x 1080	810
1152 x 1152	1220
1280 x 1024	1250
1280 x 800	1600
896 x 720	2450
640 x 480	4900
512 x 512	5530
256 x 256	18100
128 x 128	51000
128 x 64	90800
64 x 8	250000

ISO SAT			
Mono		Color	
ISO SAT T	ISO SAT D	ISO SAT T	ISO SAT D
12,500	5000	1600	1250



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Shown with optional high-g lens mount.

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Compact. Lightweight. Rugged. The perfect balance of resolution, speed, and light-sensitivity. Flexible triggering. Secure, removable, non-volatile CompactFlash memory. Everything you need in a high-speed digital imaging system for airborne applications.

With a variety of image sizes up to 800 x 600 and a maximum full-resolution frame rate of **over 1250 frames-per-second** (fps), you will find a setting that matches your need. (Maximum frame rates at reduced resolutions are as high as 111,000 fps!)

The Phantom Miro Airborne's custom-designed CMOS active-pixel sensor has an ISO 12232 rating of 4800 (monochrome) ensuring the **light-sensitivity** required in high-speed imaging applications. And, it comes in color or monochrome versions. With access to all 12-bits of grayscale information, you can bring out the detail in shadows that result from uncontrollable and constantly changing lighting situations.

With shutter speeds as low as 2 microseconds, you can **freeze objects in motion**, eliminate blur, and bring out the detail you need for successful motion analysis.

Miro Airborne

Your Ideal Solution for
Airborne Applications

Key Features:

Resolution (Pixels): 800 x 600¹

Continuously Adjustable Resolution (CAR): 32 x 8

Frames-per-second (fps) at full resolution:
10-1265 (2252 at 512 x 512)

Maximum Frame Rate: 111,110 fps at 32 x 16

Exposure Time (shutter speed): 2µs to 1/frame-rate

Built in Memory: 2 GiB

ISO (ISO-12232 Standard): 4800 Mono, 1200 Color

Non-volatile Memory: Removable CompactFlash

Memory Segmentation: 1 to 4

Pixel Bit-depth: 12-bits

Camera Trigger and Signals:

- Trigger (TTL or +28VDC)
- Aux (IRIG-out or Strobe)
- Ready
- FSync
- IRIG-in
- Video

10/100 Ethernet

¹ Very short focal-length lenses may exhibit some vignetting in the extreme corners at maximum resolution.

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Miro A0



EDR and AutoExposure help deal with subjects moving from sunlight to shadow

Connect your Phantom Miro Airborne camera to a PC using 10/100 Ethernet for camera programming and control and to retrieve your test images in our efficient cine format for later analysis and processing. Set up the camera with the Phantom Software, and those settings will be retained, even after power down. You can then deploy the camera untethered from the PC if you choose.

The Miro Airborne camera has **two types of memory**: volatile for high-speed image capture, and removable CompactFlash non-volatile memory. After the camera is triggered, the captured images can

automatically be copied to the non-volatile memory for safe storage. If the mission requires multiple stores releases or has the possibility of false triggers, the camera can be automatically rearmed for the next trigger, and the process repeats.

Using the Phantom Software you can **save slow-motion movies in popular formats** such as QuickTime or AVI, or you can save frames as JPEG or TIFF images. Easily email movies or frames to colleagues.

Take advantage of our **flexible triggering**. When you power-up the camera, it begins taking images at the programmed settings and stores them in a circular buffer in internal memory. Set up the camera so that a trigger (from external hardware or software on a connected PC) starts your recording, stops your recording, or records a selectable number of frames before and after the trigger.

The Phantom Miro Airborne can be connected to a standard analog video monitor (PAL or NTSC) for real-time monitoring of the camera image or for playback of images stored in the camera's memory. This provides a great way to check camera status prior to a mission. Camera live video can even be fed into the aircraft's telemetry system for ground station monitoring.

Lens mounting holes provide anchorage for additional lens support and flange mount High-g and vibration resistant lenses. Mounting plates with standard 1/4-20 holes on two sides of the camera give you plenty of mounting options. Or, you can remove these plates and replace them with custom plates that meet your specific requirements.

The Miro Airborne camera has passed the following qualification tests

	Miro Airborne Test Conditions	Test Method
Operating Temperature	-30°C to +50°C	Mil-Std-810G Method 502.5, Proc III Mil-Std-810G Method 501.5, Proc II-III
Storage Temperature	-50°C to +70°C	Mil-Std-810G Method 502.5, Proc I Mil-Std-810G Method 501.5, Proc I
Altitude, Operating	Sea level to 40,000 feet	Mil-Std-810G Method 500.0, Proc III
Altitude, Non-operating	-500 to 50,000 feet	Mil-Std-810G Method 500.0, Proc III
Humidity	95% non-condensing	Mil-Std-810G Method 507.5, Proc I, II
Random Vibration	Functional: 0.20g ² /Hz for 1 hour in each of the three orthogonal axes Endurance: 0.83g ² /Hz for 1 hour in each of the three orthogonal axes	Mil-Std-810G Method 514.6, Proc I
EMI/RFI	Passed	EN-55033A, IEC-61000-3-2 and 3-3, EN-55024, EN-50082, IEC-61000-4-2
Acceleration	6g for 1 minute on all axes	RTCA/DO-160E Section 7.3.3 Crash Safety Sustained
Shock	40g, 10ms in all three axes, saw tooth	Mil-Std-810G Method 516.6, Proc I, III
Magnetic Field Immunity	500A/m	Mil-Std-1399-70-1
Regulatory	Passed	EN-60950-1, UL-60950-1
ESD	8kV air discharge	IEC-61000-4-2

H	V	FPS
800	600	1,265
640	480	1,949
512	512	2,252
512	384	2,985
512	256	4,429
320	240	7,155
256	512	4,192
256	256	8,146
256	128	15,325
128	128	25,477
128	64	43,010
64	64	58,823
32	32	95,238
32	16	111,111



DATA SHEET

Miro A0

Additional Features:

Analog video out: PAL & NTSC

Lensing: 1-inch C-mount

Size (without lens): 11 x 6.5 x 8 cm (W x D x H)
4.3 x 2.56 x 3.15 in

Weight (without lens): 2 lbs (0.9 kg)

Standard Accessories:

- AC power supply with power cord
- Capture cable with 5 BNCs - 18"
- Ethernet cable - 5m
- Single-user software license
- Software CD

External Power: 12-30 VDC, 12W

Recording time at full resolution, 200 fps,
maximum built-in memory and 8-bit depth: 44 seconds

The Miro Airborne is a **High-g camera**, ensuring you will get great pictures, even when subjected to 40gs of shock. All internal electrical components are conformally coated to protect against damp/humid environments and condensation.

IRIG-B input gives you a GPS-derived time reference input to the camera. This allows you to time stamp each image if running asynchronous to IRIG timing. Or, phase-locking to IRIG allows frame synchronization to the GPS timing at **key frame rates such as 100, 200, 400, 500, 800 and 1000 fps**. This permits synchronization of the camera to a time standard or to other cameras without additional wiring.

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Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

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For the most current version visit www.visionresearch.com
 Contact us at sales@visionresearch.com (Rev. Mar. 2012)

Miro® eX-Series

eXplore your world.

eXciting new features.

eXtraordinary value.

Introducing the compact, lightweight, untethered Phantom Miro eX-Series. The world's first "point and shoot" high-speed cameras just got better.

Key Features:

Resolution (Pixels): 640 x 480, 800 x 600*

Maximum full-resolution frame rates of up to 1260 fps

Maximum frame rates at reduced resolutions are as high as 111,100 fps

CMOS active-pixel sensor

Exposure time (shutter speed) as low as 2 microseconds (1/500,000 second)

Built-in LCD touch screen display

ISO (ISO-12232 standard): 4800 Mono, 1200 Color

Ethernet connectivity

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Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

A compact, lightweight and rugged point-and-shoot digital high-speed camera that is as familiar in your hand as a digital SLR. This revolutionary, self-contained, portable high-speed camera leverages over 50 years of Vision Research's legendary high-speed video capture expertise.

The Phantom Miro eX-Series provides the perfect balance of resolution, speed, and light-sensitivity in a self-contained solution enabling anyone to capture high quality, slow-motion movies. A built-in touch screen display is used to set up the camera as well as immediately view results. Battery power means freedom from power cords. Flexible triggering helps you capture even the most challenging events. Removable CompactFlash™ memory provides safe, secure and portable storage for valuable slow-motion content.

Miro® eX-Series

On most Phantom cameras, as you decrease the resolution in increments defined by the Continuously Adjustable Resolution (CAR) specification, you will see an increase in the maximum frame rate that is available to you.

Resolution/Speed Miro eX2

H	V	FPS
640	480	1,240
512	480	1,540
512	384	1,920
512	256	2,860
512	128	5,610
512	64	10,700
320	240	4,710
256	480	2,940
256	256	5,420
256	192	7,130
256	128	10,400
256	64	19,400
128	128	18,200
128	64	32,200
64	64	48,100
32	32	86,900
32	16	105,200

The Phantom Miro eX has everything you need in a digital high-speed imaging system. Whether you are researching the flight of a bumble bee, troubleshooting the fill/seal step of your packaging process, analyzing a golf swing, or drop-testing mobile appliances, there is a Phantom Miro camera that can help you explore your world.

With a variety of image sizes (640 x 480, 800 x 600) and maximum full-resolution frame rates **up to 1,200 fps**, you will find a model that matches your need. (Maximum frame rates at reduced resolutions are as high as 111,100 fps!)

Exposure times as low as 2 microseconds (1/500,000 second), allow you to **freeze objects in motion**, eliminate blur, and bring out the detail you need for successful motion analysis.

The custom-designed CMOS active-pixel sensors have an ISO-12232 rating of 4800 (monochrome) ensuring the **light-sensitivity** required in high-speed imaging applications and come in color or monochrome versions.

Point-and-shoot, review and edit – all from the built-in LCD touch screen which also provides **immediate feedback** on the results of your test or experiment. You can play and rewind the slow-motion movie in normal or fast mode or step through your movie one frame at a time. Trimming the movie is as easy as setting in-points and out-points prior to saving. With the Miro eX2 and Miro eX4, you can also **control multi-cine setups** and even program our new **Image-Based Auto-Trigger** feature with the LCD interface.

Take advantage of our **flexible triggering**. When you start recording on the camera, it begins taking images at the programmed settings and stores them in a circular buffer in internal memory. Change a setting, and see the impact of the change on the built-in LCD or external monitor immediately. Set up the camera where a trigger starts your recording, stops your recording, or records a selectable number of frames before and after the trigger. You can supply a trigger from external hardware, an on-camera trigger button, or software on a connected PC. You can even set some cameras to **trigger on motion** that occurs within the image.

Connect your Phantom Miro eX camera to a PC using Ethernet for additional camera programming and control, and to retrieve your test images in our efficient cine format for later analysis and processing using motion analysis software.

Using the Phantom Software you can also **save movies in popular formats** such as Quicktime or AVI, or you can save frames as JPEG or TIFF images. Easily email movies or frames to colleagues.

SPECIFICATIONS	Miro eX2	Miro eX4
Resolution (pixels)	640 x 480	800 x 600 ¹
Continuously Adjustable Resolution (CAR)	32 x 8	32 x 8
Frames-per-second (fps) at full resolution	10 – 1,246	10 – 1,265
Maximum frame rate	105,263 @ 32 x 16 resolution	111,100 @ 32 x 16 resolution
Exposure time (shutter speed)	5µs to 1/frame-rate	2µs to 1/frame-rate
Built-in memory	2 GB or 4 GB	2 GB or 4 GB
Memory segmentation	1-4	1-4
LCD touch screen interface	Yes, 3-1/2" 640 x 480	Yes, 3-1/2" 640 x 480 with 800 x 600 zoom
Image-based auto-trigger	Yes	Yes
ISO (ISO-12232 standard)	4800 Mono, 1200 Color	4800 Mono, 1200 Color
High-g rated	No	No
Non-volatile memory	Type 1 CompactFlash	Type 1 CompactFlash
Pixel bit-depth	8-, 10-bits	8-, 10-, 12-bits
Camera trigger and signals	<ul style="list-style-type: none"> • Trigger • Strobe • Video out 	<ul style="list-style-type: none"> • Trigger • IRIG-out/Strobe • Ready • FSync • IRIG-in • Video
10/100 Ethernet	Yes	Yes
Analog video out	PAL & NTSC	PAL & NTSC
Lensing	1" C-mount	1" C-mount, C- to F-mount adapter included
Size (without lens)	11.2 x 8 x 7.9 cm (W x D x H), 4.4 x 3.4 3.1 in	11.2 x 8 x 7.9 cm (W x D x H), 4.4 x 3.4 3.1 in
Weight (without lens)	1.5 lbs / 0.7 kg	1.5 lbs / 0.7 kg
Standard accessories	<ul style="list-style-type: none"> • Rechargeable, removable Li-ion battery • AC power supply with power cord • 18" Capture cable with 3 BNCs <ul style="list-style-type: none"> • 5m Ethernet cable • Single-user software license <ul style="list-style-type: none"> • Software CD • 2 GB CF card • USB CF card reader 	<ul style="list-style-type: none"> • Rechargeable, removable Li-ion battery • AC power supply with power cord • 18" Capture cable with 5 BNCs <ul style="list-style-type: none"> • 5m Ethernet cable • Single-user software license <ul style="list-style-type: none"> • Software CD • 2, 4, or 8 GB CF card • USB CF card reader
Camera power requirements	12 - 30 VDC, 12 W	12 - 30 VDC, 12 W
Operating temperature	0° C - 50° C	0° C - 50° C
Storage temperature	-20° C - 70° C	20° C - 70° C
Battery	Removable, replaceable Li-Ion, 7.4V, BP-511	Removable, replaceable Li-Ion, 7.4V, BP-511
Typical battery use time ²	30 minutes	30 minutes
Recording time (500 fps, full resolution, minimum bit-depth, 1GB memory)	7 seconds	4.47 seconds

¹ Very short focal-length lenses may exhibit some vignetting in the extreme corners at maximum resolution. An F-mount adapter is included to be used in these situations.

² Highly dependent upon frame-rate, idle time, installed memory and battery AH rating.



Resolution/Speed Miro eX4:

H	V	FPS
800	600	1,260
640	480	1,940
512	480	2,400
512	384	2,980
512	256	4,430
512	128	8,580
512	64	16,100
320	240	7,150
256	480	4,460
256	256	8,140
256	192	10,600
256	128	15,300
256	64	27,500
128	128	25,400
128	64	43,000
64	64	58,800
32	32	95,200
32	16	111,100

DATA SHEET

Miro® eX-Series



Both models can be connected to a standard analog video monitor (PAL or NTSC) for real-time monitoring of the camera image or for playback of images stored in the camera's memory.

Use any 1" C-mount lens, or attach your Phantom Miro eX camera to a microscope or borescope. An F-mount adapter allows the use of standard 35mm lenses. Battery power allows you to take shots completely **untethered** from a power source. Field use for animal studies, for example, is now practical. Carry multiple batteries with you for field replacement. Store images onto removable non-volatile CompactFlash memory. A wide variety of Miro-compatible accessories are available in our online store.

Mounting plates on two sides of the camera give you plenty of options whether using a tripod, boom, or custom mount.

The Phantom Miro family extends beyond the eX-Series. We also have the Phantom Miro 3, a high-g rated camera without an LCD screen and removable battery for use in the harshest environments. And, the Phantom Miro Airborne is ideal for airborne applications which require a small camera that meets the rigorous requirements for in-flight use.



Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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DATA SHEET

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Subject to change Rev. May 2012

Phantom[®] Miro[®] M320S Digital High-Speed Camera

The Ultimate Compact Solution
for Production and Digital Media
Applications, Now Featuring
HD-SDI

Key Features:

- 12 bit, 2 Megapixel CMOS sensor
- 1920 x 1080 @ 1540 FPS
- 35mm depth of field
- 1100T ISO, Color
- Compact, rugged design
- PL, Nikon F, and Canon EOS lens mounts
- Phantom RCU compatible
- Rechargeable battery
- Phantom CineFlash storage system
 - CineFlash modules up to 240GB
 - CineFlash Dock
 - eSATA connectivity

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Phantom Miro M320S with PL Mount and Phantom RCU Kit

Key Benefits:

The **Phantom[®] Miro[®] M320S** takes portable high-speed imaging to the next level by combining the compact design of our latest Miro family with the resolution, speed and workflow possibilities of more robust camera systems.

Capable of recording at resolutions **beyond HD** at speeds up to 1320 frames-per-second (FPS), the M320S now includes a single **HD-SDI output** for improved

Miro® M320S



Based on the
award-winning
 technology of the
 Phantom Flex,
 the M320S takes
 quality, portability
 and performance
 to the next level.

monitoring and alternate workflow possibilities. The M320S ships standard with a rechargeable battery and our powerful CineFlash system. When used together with the Phantom RCU all recording becomes conveniently self-contained.

Versatility

The Miro M-series family follows the Phantom tradition in versatility by adapting to several imaging applications, and the M320S is no exception. With precise control over resolution, frame rate, exposure time and trigger point, this camera is ideal for applications ranging from industrial & scientific, to new media and TV production.

The M320S is available with a variety of lens mounts, including Canon EOS, 35mm PL, Nikon-F, and C. Optical low-pass filters are also available for applications where image



Phantom M320S with Canon EOS Mount

quality is key. The EOS mount enables the use of Canon's EF and EF-S lenses, which can be controlled from the RCU, Phantom PCC software, or an aperture ring on the mount itself. Remote control of aperture and focus is a huge benefit when cameras are remotely located and/or difficult to reach.



Phantom CineFlash Module & CineFlash Dock

Workflow & Phantom CineFlash Storage Solution

Directly record to up-to 12 Gigabytes of internal memory and preview the shot immediately by playing back over HD-SDI, or Gb Ethernet. Save your shot by editing the clip, and quickly save to a Phantom CineFlash drive, via Ethernet or record the video playback to a separate device. Re-arm the camera and you're ready for the next shot.

CineFlash drives are available in sizes **up to 240 Gigabytes**, and offer write speeds of 4GB/minute. A full 12 GB cine will save in less than 3 minutes.

At the end of the day, or once the drive is full, simply remove it from the camera and download Cine raw files via the CineFlash Dock or over the camera's Ethernet. The CineFlash Dock connects to your computer via eSATA for speedy downloads.

Phantom Cine Raw files can then be processed using Phantom PCC to take further advantage of the Miro M-series' advanced color processing, which includes user-defined **color matrices, color temperature settings and tone curves.**

Specifications

The M320S is based on a >2Mpx sensor with 3.2 Gpx/s throughput. This means frame rates of approximately 1380 fps at 1920 x1200, with higher frame rates at lower resolutions. This camera has 12-bit pixel depth, and uses micro-lenses on its custom-designed CMOS sensor to achieve exceptional light sensitivity.

The Phantom Miro M320S is available with 3GB, 6GB or 12GB of internal RAM Memory. Expected record times and maximum frame rates per resolution can be found in the tables to the right.



Phantom Miro M320S

Record Time: M320S w/ 12GB Ram		
Resolution	FPS	Seconds
1920 x 1200	1,380	2.5
1920 x 1200	1,000	3.2
1920 x 1080	1,540	2.5
1920 x 1080	1,000	3.5
1920 x 1080	500	6.9
1920 x 1080	24	144.4
1152 x 1152	2,250	2.6
1152 x 1152	1,000	6.0
1024 x 1024	2,780	2.7
1280 x 720	3,280	2.6
1280 x 720	1,000	8.6
1280 x 720	60	144.4
640 x 480	8,490	3.0
640 x 480	1,000	26.0

Maximum Frame Rates	
Resolution	FPS
1920 x 1200	1,380
1920 x 1080	1,540
1152 x 1152	2,250
1024 x 1024	2,780
1280 x 800	2,960
1280 x 720	3,280
896 x 720	4,400
640 x 480	8,490
512 x 512	9,330
384 x 288	19,600
256 x 256	27,600
128 x 128	69,000
128 x 64	121,900
64 x 8	325,000

Enhance your workflow with Phantom Accessories



RCU-Miro Kit. Includes Phantom RCU, Mounting Bracket and Cables

When paired with the Phantom RCU, the Miro M320S becomes a fully portable high-speed camera system. The RCU doubles as an HD-SDI monitor, allowing you to frame and focus, set up your basic and advanced capture parameters, trigger,

PRELIMINARY

DATA SHEET

Phantom[®] Miro[®] M320S Digital High-Speed Camera

Additional Features:

- Image-based Auto Trigger
- Continuous Recording
- Auto-Exposure
- Multi-cine Acquisition
- Internal Mechanical Shutter
- Gb Ethernet
- Rechargeable Battery (Sony BP-U30 or BP-U60)
- Size and Weight: 3.0 lbs, 1.4 kg; 7.5 x 3.5 x 4 inches,
19 x 19 x 10 cm (L, W, H)
- Operating Temperature and Humidity:
0° C to 40 C @ 8% to 80% relative humidity,
non-condensing
- Tiered Service Contracts to protect your investment

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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immediately watch the playback, edit the shot and save to a Phantom CineFlash device.

Vision Research will be offering a variety of standard and cinema-style accessories for mounting, power, handling and monitoring. Ask your Phantom sales rep for more details.

Accessibility

The advanced features and small, lightweight form factor makes the Miro M320S the **most accessible Phantom high speed camera** available today.

Compatible with a vast array of applications, the M320S can be used for scientific research, as a creative storytelling tool, and anywhere in between. The possibilities are endless with the M320S at your fingertips.



Phantom M320S, right side view

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

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DATA SHEET

For the most up-to-date version visit www.visionresearch.com
or contact your account manager.



Vision Research's Phantom Miro 3 digital high-speed video camera.

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Rated to survive 100g acceleration, this rugged camera can take 800 x 600 pixel images at up to 1,200 frames-per-second (or 2,200 fps at 512 x 512). Reduce the resolution to 32 x 16 and achieve frame rates greater than 111,100 fps. With an ISO rating of 4800 (monochrome, saturation-based ISO12232), the camera has the light sensitivity for the most demanding applications.

With shutter speeds as low as 2 microseconds, the user can freeze objects in motion, eliminate blur, and bring out the image detail needed for successful motion analysis.

As with all Phantom cameras, the Miro 3 provides a number of advanced features that help you get the high-speed shots you need for your application.

Phantom® Miro® 3

Compact

Rugged

Hi-G

Key Features:

Great for crash test or other harsh environments

800 x 600 at 1,200 fps

Minimum exposure time (shutter speed) as low as 2 microseconds (1/500,000 second)

CAR (Continuous Adjustable Resolution) in 32 x 8 pixel increments

Electronic Global Shutter

Non-volatile memory -Internal Flash, 2GB standard; 4GB and 8GB optional

ISO (ISO-12232 standard): 4800 Mono, 1200 Color

10/100BASE-T Ethernet

DATA SHEET

Phantom[®] Miro[®] 3

Additional Features:

Analog video out: PAL & NTSC

SVGA Computer Monitor, Continuous Video Out

Lensing: Inter-changeable C-mount standard

Size (without lens): 11 x 6.5 x 8 cm (W x D x H)
4.3 x 2.56 x 3.15 in

Weight (without lens): 2 lbs (0.9 kg)

External Power: 15-28 VDC, 12W

DC Power/Battery - Internal Li-polymer, 11.1V

Triggering - fully adjustable within recordable frames
software or hardware trigger (TTL)

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



AMETEK[®]
MATERIALS ANALYSIS DIVISION

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The Miro 3 offers flexible triggering options allowing the user to trigger the camera anywhere in the recording buffer. Synchronization to other cameras or to an external trigger or time base (such as IRIG) is standard. Segment the built-in memory into up to 4 segments to take multiple shots back-to-back.

The camera can even be set up to automatically store cines to non-volatile memory for safe storage in case of loss of power (a real risk in harsh environments.) But, even a temporary loss of power is not a problem for the Miro 3 because it can run off an internal battery for up to 30 minutes giving you time to retrieve any critical data.

H	V	FPS
800	600	1,200
640	480	1,949
512	512	2,252
320	240	7,155
256	256	8,146
128	128	25,477
128	64	43,010
32	32	95,238
32	16	111,111

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File: <http://ftp.research.phantom.com>
 Subject: K0151400
 Date: July 2015



Phantom Miro LAB-, LC- and R-Series Cameras

Phantom® Miro® LAB-, LC- and R-Series Cameras

Setup, capture, view, save, analyze. Powerful, high-speed imaging in the package of your choice.

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

See the previously unseen. Study and characterize phenomena that are too fast for human observation. Improve quality and reliability of products and processes. Share results with colleagues and clients.

Phantom Miro cameras come in a variety of models and a range of performance levels. There are three body styles. The **LAB-Series** is designed for laboratory/ office-environment applications where computer control is preferred – for example, a fixed installation where high-speed cines¹ are immediately saved to a computer for viewing and analysis. The **LC-Series** has an integrated flip-out LCD touchscreen for on-camera control and viewing of recorded cines. It is best employed where the camera will be used in a variety of applications, often requiring portability. The **R-Series** is also designed for applications where computer control is used, and is packaged in a robust, shock-tolerant, all-metal body for applications in outdoor and harsh environments.

¹ Phantom cameras record into a file format called a *cine* file.
 This is a raw file that holds all sensor data and camera metadata in an efficient format.

Key Features:

- Choose the resolution, performance level, and body style that best fits your application
- 1, 2 and 4 megapixel versions available
- Choose the throughput you need: 1.6 Gpx/s or 3.2 Gpx/s
- 12-bit pixel depth
- 6GB or 12GB memory
- Flexible tools for qualitative and quantitative analysis
- Nikon F/G, Canon EOS, 1" C, PL lens mounts
- Phantom CineFlash storage system
 - CineFlash modules up to 240GB
 - CineFlash Dock
 - USB and eSATA connectivity
- Standard on the LC- and R-Series
- Optional on the LAB-Series

Miro® LAB-Series, LC-Series, R-Series

And, there are a **variety of performance levels** in each series. This table shows the various performance levels:

Performance Levels and Key Specifications	LAB110 LC111 R111	LAB310 LC311 R311	LAB3a10	LAB120 LC121 R121	LAB320 LC321S R321S	LAB140 R141	LAB340 R341
Maximum Resolution	1280x800	1280x800	1280x1280	1920x1200	1920x1200	2560x1600	2560x1600
Sensor Mpx	1Mpx	1Mpx	1.6Mpx	2.3Mpx	2.3Mpx	4Mpx	4Mpx
Maximum FPS at Maximum Resolution	1600 fps	3200 fps	1850 fps	730 fps	1380 fps	410 fps	800 fps
Throughput (Gpx/s)	1.6 Gpx/s	3.2 Gpx/s	3.2 Gpx/s	1.6 Gpx/s	3.2 Gpx/s	1.6 Gpx/s	3.2 Gpx/s
Sensor Size	25.6mm x 16.0mm	25.6mm x 16.0mm	12.8mm x 12.8mm	19.2mm x 10.8mm	19.2mm x 10.8mm	25.6mm x 16mm	25.6mm x 16mm
Pixel Pitch	20 µm	20 µm	10µm	10µm	10µm	10µm	10µm
Minimum Exposure	2 µs	1 µs	1µs	1 µs	1 µs	1 µs	1 µs
Native *(ISO 12232 SAT Method)	2000 D* Color 2000 T* Color 6400 D* Mono 16,000 T Mono	2000 D* Color 2000 T* Color 6400 D* Mono 16,000 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono	1250 D* Color 1600 T* Color 5000 D* Mono 12,500 T Mono

Not all **performance levels** are available in all body styles. Here is a table showing what is available.

Body Style	LAB-Series	LC-Series	R-Series
Miro 11x	✓	✓	✓
Miro 31x	✓	✓	✓
Miro 3a1x	✓		
Miro 12x	✓	✓	✓
Miro 32x	✓		
Miro 32xS		✓	✓
Miro 14x	✓		✓
Miro 34x	✓		✓

This table shows what **video system** is available on each model.

Video	LAB-Series	LC-Series	R-Series
Miro 11x	None	NTSC/PAL	NTSC/PAL
Miro 31x	None	NTSC/PAL	NTSC/PAL
Miro 3a1x	None	-	-
Miro 12x	None	NTSC/PAL	NTSC/PAL
Miro 32x	None	-	-
Miro 32xS	-	HD-SDI	HD-SDI
Miro 14x	None	-	None
Miro 34x	None	-	None

Resolution/speed charts

Resolution	LAB110 LC111 R111		LAB310 LC311 R311		LAB3a10	
	FPS	Secs*	FPS	Secs*	FPS	Secs*
1280 x 1280	-	-	-	-	1850	2.7
1280 x 1024	-	-	-	-	2310	2.7
1024 x 1024	-	-	-	-	2780	2.7
1280 x 800	1630	4.7	3260	2.3	2950	2.7
1280 x 720	1810	4.7	3630	2.3	3280	2.6
896 x 720	2520	4.9	5040	2.4	4390	2.9
640 x 480	5090	5.1	10100	2.5	8450	3.2
512 x 512	5790	5.2	11500	2.6	9290	3.4
384 x 288	12900	5.6	25900	2.7	19400	3.9
256 x 256	19800	6.1	39700	3.0	27200	4.7
128 x 128	60400	8.0	120700	4.0	66600	7.7
128 x 64	113200	8.6	226300	4.3	114700	8.9
128 x 8	400000	19.5	650000	12.0	311000	26.0

Resolution	LAB120 LC121 R121		R321S LC321S Mono		R321S LC321S Color		LAB320	
	FPS	Secs*	FPS	Secs*	FPS	Secs*	FPS	Secs*
1920 x 1200	730	4.7	1380	2.5	1380	2.5	1380	2.5
1920 x 1080	800	4.8	1540	2.5	1530	2.6	1540	2.5
1152 x 1152	1220	4.9	2250	2.6	2240	2.6	2250	2.6
1024 x 1024	1530	4.9	2780	2.7	2770	2.9	2780	2.7
1280 x 800	1600	4.8	2960	2.6	2940	2.7	2960	2.6
1280 x 720	1780	4.8	3280	2.6	3200	2.7	3280	2.6
896 x 720	2450	5.0	4400	2.8	4300	2.9	4400	2.8
640 x 480	4910	5.3	8490	3.0	8300	3.3	8490	3.0
512 x 512	5540	5.5	9330	3.2	9200	3.4	9330	3.2
384 x 288	12200	5.9	19600	3.6	19000	3.9	19600	3.6
256 x 256	18300	6.6	27600	4.4	26400	4.8	27600	4.4
128 x 128	52400	9.3	69000	7.0	62000	8.1	69000	7.0
128 x 64	95300	10.2	121900	8.0	102000	9.7	121900	8.0
128 x 8	250000	31.0	325000	25.0	240000	45.0	325000	25.0

Resolution	LAB140 R141		LAB340 R341	
	FPS	Secs*	FPS	Secs*
2560 x 1600	410	4.7	800	2.5
1600 x 1600	650	4.7	1220	2.5
1920 x 1200	730	4.7	1380	2.5
1920 x 1080	800	4.8	1530	2.6
1280 x 1280	1000	6.3	1850	2.7
1024 x 1024	1530	5.2	2780	2.7
1280 x 800	1600	4.9	2960	2.6
1280 x 720	1750	4.8	3280	2.6
640 x 480	4900	4.8	8450	3.0
512 x 512	5540	5.5	9280	3.2
256 x 256	18300	6.6	27200	4.4
128 x 128	52400	9.3	66600	7.0
128 x 64	95300	10.2	114700	8.0
128 x 8	250000	31.0	311000	25.0

* Record time into maximum memory of 12GB

Miro® LAB-Series, LC-Series, R-Series

Camera throughput specifies the number of pixels the camera can acquire each second. So, for example, a Miro LAB310 with 3.2Gpx/s, can acquire and save up to 3200 one-megapixel frames each second! Another way to specify speed is in frames-per-second (fps) at a given resolution.

Let's explore these cameras in more detail by following a typical workflow of setup, capture, viewing, saving and analyzing the results.

Setup

Phantom Miro cameras are **easy to set up and control**. Use our Phantom Camera Control (PCC) software over a Gb Ethernet connection, a hand-held Phantom RCU, or the on-board LCD touchscreen (on the LC-Series only) to access and control the camera's features. (An SDK enabling custom software interfaces and LabView drivers are also popular ways to set up and control Phantom cameras.)

Change **resolution, frame-rate and exposure** and see the results immediately on a live image. As you decrease resolution, you have access to higher and higher frame rates.

A short exposure time will help **freeze motion and eliminate blurry images** (but, also requires more light.) Exposure times as short as 1 microsecond (μ s) are available on most models.

Optionally, **segment memory** into as many as 63 segments to capture multiple shots back-to-back – tailored to your record time and shot sequencing needs.

The native **light sensitivity** of a camera is specified by its ISO rating – the higher the rating, the greater the light gathering capability of the sensor. Greater light sensitivity means you can achieve shorter exposure times with a given amount of light, or you need less supplemental light at very short exposures. You have more flexibility to adapt to various shooting conditions and greater depth-of-field with higher ISO ratings. The ISO 12232 standard specifies several ways to determine light sensitivity. We use the S_{SAT} method to determine the minimum native rating for our cameras. You can boost the camera's apparent sensitivity using the **Exposure Index** function and straight-forward image processing settings.

Select a **triggering strategy** appropriate to your application – you can trigger at the beginning of an event, after an event, or anywhere in between. Select your trigger source from among many alternatives: on-camera button, remote hardware trigger, soft trigger via software, or even automatically trigger based on changes in the live image using our unique **Image-Based Auto-Trigger** technology.

Timing is critical in most high-speed applications. Choose a timing reference from the internal camera clock, external IRIG, external Frame Sync signal, or even from another camera for multi-camera setups. All Miro cameras have 20 ns timing accuracy with resolution dependent upon the source.

For the ultimate in image quality from a CMOS sensor, it is important to black reference the sensor any time the camera setup changes or if temperatures change over time. Most cameras require you to manually cap the lens to provide a black reference. This is inconvenient since you need to have physical access to the camera, find the right lens cap, and manually cap the lens while taking the black reference. Phantom Miro cameras have an **internal mechanical shutter** mechanism that closes off all light to the sensor

Setup is easy.

There are even several common setups pre-installed on the LC-Series. Just select the one you want with a tap on the screen.



Phantom Miro LC321S with Canon EOS Mount

Miro® LAB-Series, LC-Series, R-Series



Combining
award-winning
technology from
Phantom cinema
cameras and Phantom
industrial/scientific
cameras, the
Miro LAB-Series,
Miro LC-Series, and
Miro R-Series cameras
take quality, portability
and performance to
the next level.

for automatic/remote black referencing. (The internal mechanical shutter in the R-Series can be removed with an option at the time you order the camera. Removing the shutter allows the camera to be used in more extreme environments.)

Other setup controls are available including hardware signals for Strobe (active during frame exposure), Ready (indicates camera is ready for trigger), Event (mark events during recording), Memgate (temporarily stop image acquisition during recording.) (Not all control signals are available simultaneously.) These signals make it possible to integrate a Miro camera with popular data acquisition hardware, for example.

On cameras equipped with a Canon EF/EFS lens mount, lens aperture and focus can be remotely controlled. Other **lens mounts** available include: 1" C-mount; Nikon F-mount that supports F and most G style lenses; PL mount.

Finally, select **end-of-recording actions** that include automatically saving an acquired cine to the CineFlash non-volatile memory module; playback of the recorded cine; and, rearming the camera for the next shot.

Capture

Once set up, **image acquisition is really quite easy**. Just trigger the camera.

When armed, the camera will start acquiring images into its high-speed RAM memory buffer. When memory is full, the oldest image will be dropped and replaced with a new image. We call this a "**circular buffer**" and it helps ensure you will get the shot you need. It enables you to place the trigger frame anywhere in the buffer. This makes it easier to capture unpredictable events—just trigger somewhere in the middle of the buffer. Frames in memory prior to the trigger (pre-trigger frames) will be retained and the remainder of the buffer will store frames acquired after the trigger (post-trigger frames.)

When all post-trigger frames are in memory, the camera will execute any end-of-recording actions you have programmed, such as AutoSave.

View

Immediately view the slow-motion cine on a video monitor, Phantom Remote Control Unit (RCU)², computer screen, or the LCD touchscreen on the LC-Series. You have video controls available to view the cine forward or backward, sped-up or slowed-down, even single-step through your cine! You can mark in- and out-points to surround only those frames with content of interest.

Once you are sure you have the shot you need and have optionally trimmed the cine to include only the frames of interest, you are ready to save the cine.

Save

Of course, if you set up an end-of-recording action to automatically save the cine, it will be saved to **CineFlash** at about 4GB per minute. If not, then you can manually save the cine to CineFlash after viewing and optionally trimming it.

Once on the CineFlash module, the cine file is safely stored in non-volatile memory and

² Not all camera models support video output. And, the RCU is not supported on models without video output. See Video System table on a page 2.

Miro® LAB-Series, LC-Series, R-Series

you are free to re-arm the camera and take your next shot.

A cine file can be viewed in Phantom Camera Control (PCC) software or in our free Phantom Cine Viewer. You can convert the cine file to a number of common file formats from either software package making it easy to archive and share your slow-motion content. Save your file as a raw cine, or stack of TIFF, JPG or DNG files. Supported movie formats include h.264, .mov, AVI, and Apple ProRes.

CineFlash modules can be removed from a camera and inserted into the included **CineFlash Dock** connected to a computer with a USB or eSata connection. Third party drivers required to access the cines are included. The CineFlash module then mounts on your computer as an external disk drive and you can easily "drag and drop" cine files from the CineFlash to local storage.

CineFlash modules currently come in 120GB and 240GB sizes. Not only can you conveniently save multiple cine files on-camera in non-volatile memory for later retrieval, CineFlash modules are specially designed for high throughput which translates into save and retrieval times far better than what you get with commercial solutions designed for slow-speed cameras. The ability to save data at rates up to 70 megabytes per second translates into less downtime due to long file save times and higher camera productivity. This means higher productivity because you don't have to wait for a lengthy download between shots.

Alternatively, for computer-connected cameras, you can download the cine file from high-speed memory to a local disk drive over Gb Ethernet, typically around 50 MB/s.

Analyze

Now what? You have an amazing slow-motion movie of phenomena that cannot be seen by the human eye. Of course, the ability to play a slow-motion movie, stop it, rewind, fast-forward and single step gives you the ability to tap into the human brain for qualitative insights and analysis. You will find yourself saying "I didn't know that!" Or, "I would never have believed it!"

But, you are not limited to qualitative analysis of your movies. When performing your experiment or test, you can **simultaneously acquire data about your subject using data acquisition (DAQ)** modules from National Instruments. PCC natively supports camera synchronization to NI M- and X-Series DAQ modules and the data acquired is saved with the cine file. Use PCC to view quantitative data synchronized to the playback of a cine file.

And, **PCC supports a suite of measurement tools** that allows you to track points, estimate distance, velocity, acceleration and angles based on points in the cine file. These tools are in both the PCC and the Cine Viewer software packages.

Vision Research Global Support - for wherever you are

Our Miro camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera by learning more about our service and support options at <https://www.phantomhighspeed.com/Service-Support/Technical-Support>.



Phantom Miro LAB3a10



Phantom CineFlash Drive & CineFlash Dock

DATA SHEET

Phantom[®] Miro[®] LAB-, LC- and R-Series Cameras

	LC-Series	R-Series	LAB-Series
On-Camera Controls	Yes, LCD touchscreen	Trigger	Trigger
Battery Power Option	Yes	Yes	No
CineFlash Compatible	Yes	Yes	Yes
Shock Rating	Not specified	100G, sawtooth wave, 11ms, 10 pulses, all axes, no lens, no internal shutter 30G rating with internal shutter installed and BP30 battery	30G, sawtooth wave, 11ms, 10 pulses, all axes, no lens
Operating Temperature	0°C to +40°C @ 8% to 80% RH	-10°C to +50°C @ 10% to 95% RH	0°C to +40°C @ 8% to 80% RH
Storage Temperature	-20°C to 70°C	-20°C to 70°C	-20°C to 70°C
Size*	7.4 x 3.85 x 4 in 19 x 9.8 x 10 cm without battery	7.5 x 3.5 x 4 in 19 x 8.8 x 10 cm without battery	7.5 x 3.5 x 4 in 19 x 8.8 x 10 cm
Weight*	3.0 lbs, 1.4 kg, without CineFlash, battery or lens	3.5 lbs, 1.6 kg, without CineFlash, battery or lens	3.0 lbs, 1.4 kg, without CineFlash or lens
Battery Power	Sony BP-U30 or BP-U60 rechargeable, external charger required	Sony BP-U30 or BP-U60 rechargeable, external charger required	None
Internal Mechanical Shutter	Standard	Standard, option to remove for increased shock ratings	Standard
Junction Box Compatibility	Yes	Yes	No
Data Acquisition	Native Support in PCC for National Instruments X- and M-Series	Native Support in PCC for National Instruments X- and M-Series	Native Support in PCC for National Instruments X- and M-Series

* Size and weight can vary with lens mount selection.

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Additional Features:

- Image-Based Auto-Trigger (IBAT)
- Burst Mode
- Continuous Recording
- Auto-Exposure
- Multi-cine Acquisition
- Internal Mechanical Shutter (optional on the R-Series)
- Gb Ethernet
- Rechargeable Battery (Sony BP-U30 or BP-U60)
Not available on the LAB-Series
- Tiered Service Contracts to protect your investment

Focused

Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

VISION
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AMETEK[®]
MATERIALS ANALYSIS DIVISION

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EXHIBIT P358

PHANTOM[®] Miro Family

All specifications subject to change

Rev October 2008



VISION
RESEARCH

Key Features:

Resolution (Pixels): 640x480,
800x600¹

Maximum full-resolution frame
rates of 500fps to 1200fps.
(Maximum frame rates at
reduced resolutions are as
high as 111,000fps)

CMOS active-pixel sensor

Exposure time (shutter speed)
as low as 2 microseconds
(1/500,000 second)

Built-in LCD touch screen display
(on most models)

ISO (ISO-12232 standard):
4800 Mono, 1200 Color

10/100 Ethernet

¹ Very short focal-length lenses may exhibit some vignetting in
the extreme corners at maximum resolution.

**Compact, lightweight, untethered. The world's first
"point and shoot" high-speed cameras.**

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO™

Compact. Lightweight. Rugged. The perfect balance of resolution, speed, and light-sensitivity. A built-in touch screen display. Battery powered. Flexible triggering. PC connectivity. Removable CompactFlash memory. Everything you need in a high-speed digital imaging system. Whether for product drop testing, biometrics research, automotive crash testing, airborne applications, manufacturing line troubleshooting, or scientific experimentation, our new line of cameras has a model just for you.

Every member of the Phantom Miro family is compact, lightweight, and rugged. Each accepts any standard 1" C-mount lens. Each is packed with the technology and innovation you've come to expect from Vision Research.

With a variety of image sizes (640x480, 800x600) and maximum full-resolution frame rates of **500fps to 1200fps**, you will find a model that matches your need. (Maximum frame rates at reduced resolutions are as high as 111,000fps!)

PHANTOM[®] Miro Family

All specifications subject to change Rev October 2006

On most Phantom cameras, as you decrease the resolution in increments defined by the Continuously Adjustable Resolution (CAR) specification, you will see an increase in the maximum frame rate that is available to you. This is true on the Phantom Miro cameras with the exception of the Miro 1. The Miro 1 has a fixed resolution of 640x480 pixels and a maximum frame rate of 500 fps. Here are some example frame rates for the rest of the Miro line.

Resolution	Miro 2
640 x 480	1258
512 x 480	1558
512 x 384	1941
512 x 256	2892
512 x 128	5665
512 x 64	10869
320 x 240	4756
256 x 480	2969
256 x 256	5471
256 x 192	7194
256 x 128	10526
256 x 64	19607
128 x 128	18433
128 x 64	32520
64 x 64	48192
32 x 32	86956
32 x 16	105263

Resolution	Miro 3 & 4
800 x 600	1265
640 x 480	1949
512 x 512	2252
512 x 384	2985
512 x 256	4429
512 x 128	8583
512 x 64	16194
320 x 240	7155
256 x 512	4192
256 x 256	8146
256 x 128	15325
256 x 64	27586
128 x 128	25477
128 x 64	43010
64 x 64	58823
32 x 32	95238
32 x 16	111111

The Phantom Miro's custom-designed CMOS active-pixel sensors have an ISO rating of 4800 (monochrome) ensuring the **light-sensitivity** required in high-speed imaging applications, come in color or monochrome versions.

With shutter speeds as low as 2 microseconds (1/500,000 second), you can **freeze objects in motion**, eliminate blur, and bring out the detail you need for successful motion analysis.

A built-in LCD touch screen display (on most models) allows you to program the camera easily, frame your shot perfectly, and gives you **immediate feedback** on the results of your test or experiment. You can play and rewind in normal or fast mode or step through your movie one frame at a time. Trimming the movie is as easy as setting in-points and out-points prior to saving.

Connect your Phantom Miro camera to a PC using 10/100 Ethernet for camera programming and control, and to retrieve your test images in our efficient cine format for later analysis and processing using the bundled TEMA Starter for Phantom motion analysis software.

Using the Phantom Software you can also **save movies in popular formats** such as Quicktime or AVI, or you can save frames as JPEG or TIFF images. Easily email movies or frames to colleagues.

Take advantage of our **flexible triggering**. When you power-up the camera, it begins taking images at the programmed settings and stores them in a circular buffer in internal memory. Change a setting, and see the impact of the change on the built-in LCD or external monitor immediately. Set up the camera so that a trigger (from external hardware, an on-camera trigger button or software on a connected PC) starts your recording, stops your recording, or records a selectable number of frames before and after the trigger.

Apply the bundled TEMA Starter for Phantom software from Image Systems AB, and you get a **quantitative analysis** as well as a qualitative view of your test results.

All models can be connected to a standard analog video monitor (PAL or NTSC) for real-time monitoring of the camera image or for playback of images stored in the camera's memory.

Use any 1" C-mount lens, or attach your Phantom Miro camera to a microscope or borescope.

Battery power allows you to take shots completely **untethered** from a power source. Field use for animal studies, for example, is now practical. Carry multiple batteries with you for field replacement.

Store images onto removable non-volatile CompactFlash memory (not removable on the Miro 3).

PHANTOM[®] Miro Family

All specifications subject to change Rev October 2008

Mounting plates on two sides of the camera give you plenty of options whether using a tripod, boom, or custom mount. There are standard 1/4-20 mounting holes.

The **Hi-G model** (Miro 3) ensures the camera will get great pictures, even when subjected to 100Gs of acceleration.

KEY SPECIFICATIONS	Miro 1.0	Miro 2.0	Miro 3.0	Miro 4.0
Resolution (pixels)	640 x 480	640 x 480	800 x 600 ¹	800 x 600 ¹
Continuously Adjustable Resolution (CAR)	No	Yes (32 x 8)	Yes (32 x 8)	Yes (32 x 8)
Frames-per-second at full resolution	50, 60, 100, 120, 240, 250, 480, 500	10-1200	10-1200 (2252 fps at 512 x 512)	10-1200 (2252 fps at 512 x 512)
Maximum Frame Rate	500 fps	105,200 fps at 32 x 15	111,110 fps at 32 x 16	111,110 fps at 32 x 16
Exposure Time (Shutter Speed)	10%, 25%, 50%, or 100% of maximum (1/frame-rate)	5 µs to 1/frame-rate	2 µs to 1/frame-rate	2 µs to 1/frame-rate
Built-in Memory	512 MB	1 GB or 2 GB	1 GB or 2 GB	1 GB, 2 GB, or 4 GB
LCD Touchscreen Interface	Yes, 3-1/2" 640 x 480	Yes, 3-1/2" 640 x 480	No	Yes, 3-1/2" 640 x 480 with 800 x 600 zoom
ISO (ISO-12232 Standard)	4800 Mono, 1200 Color	4800 Mono, 1200 Color	4800 Mono, 1200 Color	4800 Mono, 1200 Color
Hi-G Rated	No	No	Yes to 100Gs for 13 ms on all axis	No
Non-volatile memory	Type 1 CompactFlash	Type 1 CompactFlash	2 GB Internal flash standard, not removable. 4 GB option	Type 1 CompactFlash
Memory Segmentation	No	1-4	1-4	1-4
Pixel bit-depth	8-bits	8-bits 10-bit option	8-bits 12-bit option	8-bits 12-bit option
Camera trigger and signals	<ul style="list-style-type: none"> • Trigger • Video out 	<ul style="list-style-type: none"> • Trigger • Strobe (Aux) • Video out 	<ul style="list-style-type: none"> • Trigger • Aux (IRIG-out or Strobe) • Ready • FSync • IRIG-in • Video 	<ul style="list-style-type: none"> • Trigger • Aux (IRIG-out or Strobe) • Ready • FSync • IRIG-in • Video
10/100 Ethernet	Yes	Yes	Yes	Yes
Analog Video Out	PAL & NTSC	PAL & NTSC	PAL & NTSC	PAL & NTSC
Lensing	1-inch C-mount	1-inch C-mount	1-inch C-mount, C- to F-mount adapter included	1-inch C-mount, C- to F-mount adapter included
Size (without lens)	11.2 x 8 x 7.9 cm (WxDxH) 4.4 x 3.4 x 3.1 in	11.2 x 8 x 7.9 cm (WxDxH) 4.4 x 3.4 x 3.1 in	11 x 6.5 x 8 cm (WxDxH) 4.3 x 2.56 x 3.15 in	11.2 x 8 x 7.9 cm (WxDxH) 4.4 x 3.4 x 3.1 in
Weight	2.5 lbs / 1.1 kg	2.5 lbs / 1.1 kg	2 lbs / 0.9 kg	2.5 lbs / 1.1 kg
Standard Accessories	<ul style="list-style-type: none"> • Rechargeable, removable Li-ion battery • AC power supply with power cord • Trigger cable - 18" • Ethernet cable - 5m • Single-user software license • Software CD • 2 GB CF card • USB CF card reader 	<ul style="list-style-type: none"> • Rechargeable, removable Li-ion battery • AC power supply with power cord • Capture cable with 2 BNCs - 18" • Ethernet cable - 5m • Single-user software license • Software CD • 2 GB CF card • USB CF card reader 	<ul style="list-style-type: none"> • AC power supply with power cord • Capture cable with 5 BNCs - 18" • Ethernet cable - 5m • Single-user software license • Software CD 	<ul style="list-style-type: none"> • Rechargeable, removable Li-ion battery • AC power supply with power cord • Capture cable with 5 BNCs - 18" • Ethernet cable - 5m • Single-user software license • Software CD • 8 GB CF card • USB CF card reader

PHANTOM[®] Miro Family

All specifications subject to change Rev October 2008

ADDITIONAL SPECIFICATIONS	Miro 1.0	Miro 2.0	Miro 3.0	Miro 4.0
External Power	12 - 30 VDC 12W	12 - 30 VDC 12W	15 - 30 VDC 12W	12 - 30 VDC 12W
Operating Temperature	10°C to 40°C	10°C to 40°C	0°C to 50°C	10°C to 40°C
Storage Temperature	-20°C to 35°C with battery -25°C to 80°C without battery	-20°C to 35°C with battery -25°C to 80°C without battery	-20°C to 35°C	-20°C to 35°C with battery -25°C to 80°C without battery
Battery	Removable, replaceable LI-ion 7.4V BP-511	Removable, replaceable LI-ion 7.4V BP-511	Internal Li-polymer, 11.1V	Removable, replaceable LI-ion 7.4V BP-511
Typical battery use time between charges	30 minutes ²	30 minutes ²	45 minutes ²	30 minutes ²
Recording time at full resolution, 500 fps, maximum built-in memory and 8-bit depth	3.4 seconds	13.9 seconds	8.9 seconds	17.8 seconds

MIRO.

² Highly dependent upon frame-rate, idle time, installed memory and battery Ah rating.



Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing **high-speed cameras**. Our single focus is to invent, build, and support the most advanced cameras possible.

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An **AMETEK** Company



EXHIBIT P359

DATA SHEET

For the most current version visit www.phantomhighspeed.com
Subject to standard S&B legal notices Rev/April 2016



Phantom® Flex4K

- 4K at up to 1000 fps
- Excellent image performance
- Records 2K and 4K at ultra high-speed and standard frame rates
- Choose between RAW and Apple ProRes recording formats

Key Features:

Full resolution: 4096 x 2304 @ 938 fps

4096 x 2160 @ 1000 fps

2048 x 1080 @ 1975 fps

1° to 360° adjustable electronic shutter

3G HD-SDI video outputs

Dual-link 3G SDI for 4K video per SMPTE ST 425-3

Audio: AES/EBU and S/PDIF standards

Recording media:

Phantom CineMag IV available in 1TB and 2TB sizes

CineMag IV recording formats:

- Phantom Cine Raw

- Apple ProRes 422 HQ at full 4K resolution only

ProRes

The Industry's Most Flexible Digital Cinema Camera

The Phantom Flex4K is a full-featured digital cinema camera, capable of speeds that range from standard frame rates up to 1,000 frames-per-second (fps) at 4K and almost 2,000 fps at 2K resolution. Building upon the award winning technology of Phantom digital cinema products, the Flex4K combines features found in the latest cinema cameras with those otherwise found only in specialty cameras.

New for Summer 2015: The Flex4K now supports both uncompressed raw and Apple ProRes 422 HQ as recording format options. In-camera AES/EBU audio support is included as well. Audio can be enabled for sync-sound recording and higher frame rates, and is intended for use as a high quality scratch track.

Flex4K

Features (continued):

- Advanced on-camera control interface
- Playback and save controls on both sides of the camera
- Memory can be partitioned for multi-cine
- GenLock for simplified 3D shooting and synchronizing video playback
- Phantom RCU compatible

Optional Battery Back

Choose a battery back at the time of purchase - or later as an accessory. Three mounts are currently available:

- Hawk-Woods mount supports 26v Reel Power batteries
- Anton Bauer Gold mount supports 14.4v Hytron and Dionic-HC batteries
- V-Lock mount supports high-capacity 14.4v V-Lock batteries

Viewfinder

A Phantom-branded HD OLED viewfinder is recommended for the camera. This EVF, manufactured by Astro Design, is powered from the camera and works with the front SDI port. It has full HD resolution, high quality optics and an extremely crisp and bright display. It comes with the bracket and cables needed for the Flex4K.

The camera will also support common component based HD viewfinders, and can be configured with a Fischer or optional Hirose viewfinder port.



Cinematic Design, 35mm Depth of Field, Exceptional Image Quality

Designed with the cinematographer in mind, the form factor of the Phantom Flex4K adapts to a variety of shooting environments. From the studio to extreme conditions, the Flex4K is built to perform.

At 4K resolution the Flex4K offers super 35mm depth of field. The custom 9.4 megapixel sensor captures intricate detail with impressive dynamic range and low noise. This means excellent image quality and low-light performance. The camera's streamlined design and thermal architecture makes the camera quick-to-shoot with an ultra-stable image.

Sensitivity & Exposure Index

The low noise performance of the Flex4K sensor allows for the effective ISO to be dialed in with the camera's Exposure Index function

Exposure Index (EI) range: from 250 to 1250 (color)

Convenient and Intuitive Camera Controls

Controlling the Phantom Flex4K is easier than ever with a full-featured on-camera control interface for both basic and advanced camera operation. Set up universal capture and recording parameters before the shoot, while retaining access to the more commonly adjusted parameters like frame rate and exposure settings at the push of a button.

Capture, trigger, playback and save controls can be found on both sides of the camera in order to provide a seamless workflow for different shooting environments. Remote control is also possible with a handheld Phantom RCU.

Expanded Recording Options for Different Production Styles

The Phantom Flex4K is available with 32, 64 or 128 Gigabytes of internal RAM. More RAM allows longer recording times at high frame rates. Loop mode records into the RAM buffer at the camera's top speeds, and once the camera is triggered the files can be previewed immediately, then quickly offloaded to an installed Phantom CineMag IV.

For longer record times use run/stop (R/S) mode and record directly to the CineMag IV for several minutes. This is an excellent option when high-speed is not required. In fact, at 24 fps two hours of raw 4K footage can be recorded directly to a 2TB CineMag IV.



Phantom cameras have always generated .Cine raw files, and the Flex4K is no exception. These files include the maximum information for post processing. They are compatible with many of the industry's top color grading software packages, or they can be converted to common file formats using software provided with the camera.

Maximum Record Times *recording times vary based on memory size, frame rate and resolution

Resolution	Frame Rate (fps)	64GB RAM (seconds)	128GB RAM (seconds)	2TB CineMag IV R/S Mode
4096 x 2304 (max res)	938 (max loop)	5.0	10	N/A
4096 x 2304	30	2.7 min.	5.3 min.	100 min. (raw) 4 hrs. (ProRes HQ)
4096 x 2160	1000 (max loop)	5.0	10	N/A
4096 x 2160	120	42	84	20 min.
4096 x 2160	24	3.5 min.	7 min.	130 min.
2048 x 1080	1975 (max loop)	9.8	19.6	N/A
2048 x 1080	500	39	78	25 min.

Working with Apple ProRes

Set the camera to record ProRes 422 HQ and the files become 2.5X smaller compared to an equivalent Cine Raw. ProRes recording works at up to 938 fps in loop mode, and up to 30 fps in R/S mode. A 2TB CineMag IV will hold more than 4 hours of footage at 30p.

The camera will allow video playback of the ProRes files at all 4K and 1080p video modes. 1080i ProRes playback is not supported at this time.

PC & Mac Based Workflow Solutions

Download files from the CineMag IV with the Phantom CineStation® IV, a simple download device that saves files via Gb or 10Gb Ethernet using software on a PC or Mac. One license of the popular Glue Tools Cine Toolkit, and Séance download software for the Mac is included with camera purchase. This provides the ability to download Flex4K raw files in Mac OSX, and allows for direct compatibility with most Quicktime-based edit and color grading software.



The camera also ships standard with our updated (PC-only) Phantom PCC controller software, for downloading, file conversion and full camera control. Phantom PCC software includes both h.264 and Apple ProRes transcoding for Phantom Cine raw files.

Resolution / Maximum Frame Rates

Resolution	Max fps Loop Mode
4096 x 2304 (max res)	938 fps
4096 x 2160 (4K standard)	1000 fps
3840 x 2160 (16 x 9)	1000 fps
1920 x 1080 (16 x 9)	1975 fps
1280 x 720 (16 x 9)	2930 fps

Inputs / Outputs

Power input	1x 3-pin Fischer (+12 - 28V DC)
Battery mount (optional)	Selectable Hawk Woods RP mount, Anton Bauer Gold mount & V-Lock battery backs
12V Power aux outputs	1x 2-pin Lemo, 1x 4-pin Hirose for viewfinder
24V Power aux outputs	2x 3-pin Fischer with R/S (24V is unregulated)
Ethernet	8-pin Fischer for software operation & file download
Remote	5-pin Fischer for RS232 & 24V DC; works with BT-Dongle and Phantom RCU
HD-SDI	3x main 3G HD-SDI outputs, 1 additional SDI output at front for viewfinder. 1 SDI return (includes Genlock support)
Sync	12-pin Fischer for Mini-BOB. Provides access to F-Sync, AES/EBU Audio in & out, Timecode in & out, strobe, ready, trigger
Audio out	3.5mm headphone-jack (for monitoring only)
Viewfinder	1 Fischer (standard) or Hirose (optional) for component video, and 1x BNC for SDI-based viewfinders, including the Phantom OLED HD EVF

CineStation IV

Power input	+12 - 28V DC
Gb Ethernet	RJ45 port
10Gb Ethernet	RJ45 port, for the fastest CineMag IV offload

DATA SHEET

Phantom Flex4K

Imaging Specifications:

Pixel size:	6.75 micron
Ultra-fast rolling shutter (<1 millisecond scan time)	
ISO Color:	250T (EI Range 250-1250)
ISO Mono:	2000T (EI Range 2000-10,000)
Sensor size:	27.7 x 15.5mm
Sensor @ 1080p:	13 x 7.3mm
Lens mount:	PL (standard), Nikon F/G & Canon EF

Additional Specifications:

Internal RAM:	32GB, 64GB or 128GB
Recording media:	Phantom CineMag IV (up to 2TB)
Environmental:	-20° - +50° C temperature range
Camera size:	11.5 x 5.0 x 7.9 in (LxWxH); 29.2 x 14 x 20 cm
Camera weight:	14 lbs (6.3 kg) without lens, viewfinder or battery
CineStation IV size:	6.5 x 5.75 x 1.5 in (LxWxH); 16.5 x 14.6 x 3.8 cm
CineStation IV weight:	1 lb (0.45kg)

Focused

Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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Audio Recording

The camera accepts a stereo AES/EBU input compatible with both professional and consumer standards. It is intended for use as a reference or scratch track for sync-sound recording, and can be recorded at frame rates at or above 23.98 fps.

The signal is fed through the AES input on the Mini-BOB, via the camera's Sync port. It will accept 2 channels at variable rates which are normalized in camera to 48KHz with up to 24-bit full scale. The signal can be monitored via the AES output (recommended) or the headphone jack on top of the camera. On-camera meters are included to keep an eye on the audio levels during recording and playback. Files are saved from RAM or CineMag as separate tracks in the uncompressed .wav format, which can then be easily synchronized with the video.

Image Monitoring & Video Outputs

The multi-channel video system is customizable for monitoring with adjustable frame guides, and/or a clean output for use with field recorders. Supported video formats include: 720p (50, 59.94, 60Hz), 1080p (23.98, 24, 25, 29.97, 30, 50, 59.94, 60Hz); 1080i (25, 29.97, 30Hz); 1080psf (23.98, 24, 25, 29.97, 30Hz), 3160p (23.98, 24, 25, 29.97, 30Hz)

The outputs can be switched between displaying Rec709 and a pre-set Log curve. The viewfinder and monitor feeds can also be set to always show a live feed, so the operator can follow the action while the last shot is still being saved or played from the other outputs.



AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

EXHIBIT P360



Phantom Flex (equipped with optional accessories)

DATA SHEET

For the most current version visit www.visionresearch.com
Or email info@vision.com or call 1-800-451-7273

Phantom® Flex

Shoot 10 - 1455 fps at 2560 x 1600

Shoot 10 - 2570 fps at 1920 x 1080

HQ Mode for ultimate image quality

Raw digital and/or video workflow solutions

Flexible lens options

Key Features:

- Up to 2570 fps at 1920 x 1080 in Standard Mode
- 12-bit pixel depth
- ISO (ISO-12232 SAT method):
Color: 1250 T; 1600 D
- HQ Mode provides ultimate in image stability under changing shooting conditions
- Phantom CineMag compatible, CineMag interface has field-replaceable pin array
- 2 x 4:2:2 HD-SDI video ports, can be configured as dual-link 4:4:4 video (4:4:4 not available at 60fps video formats)
- Global, electronic shutter to 1 us (shutter angles in HQ mode dependent upon frame rate)
- Multi-cine capable via segmented memory
- Internal mechanical shutter for hands-free and remote Current Session References
- On-camera controls for camera modes, settings, playback, edit & save
- Frame synchronization to external signal, allows multiple cameras to be synchronized – essential for stereo 3D recording
- Two 12VDC auxiliary power outputs for powering external devices
- External trigger signal on camera connector panel
- GenLock for synchronizing video playback

AMETEK®
MATERIALS ANALYSIS DIVISION

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The Phantom Flex is a second-generation high-speed camera designed for the digital cinema industry. It extends the legacy of the groundbreaking Phantom HD – a camera that changed the world of high-speed imaging for television and motion picture production forever. The Phantom Flex provides exceptional flexibility in frame rate, workflow, lens format and overall storytelling ability. It goes **beyond HD** and supports 4 megapixel imaging when the ultimate in image resolution is required.

Flex your creative muscle with a camera that can shoot from **10 frames-per-second to over 10,000 frames-per-second** depending upon shooting mode and resolution.

Phantom® Flex

Key Features continued:

- Timecode in/out
- Remote port for connecting a Phantom Remote Control Unit
- Component video viewfinder port
- Two 24VDC power inputs to allow for "hot swapping" power
- PL mount standard, Canon EOS, manual Nikon optional Adapter for 2/3" lenses available
- Ultra-quiet dual-fan cooling with low-fan mode for silent shooting
- 16 GB and 32 GB models

ISO SAT	
Color	
ISO SAT T	ISO SAT D
1250	1600

Flexible lens options let you choose between 35mm (PL, Canon EOS, Nikon F Panavision), Super 16mm, and 2/3" lens alternatives.

Select a **raw digital workflow, a video workflow**, or combine workflows for maximum control and flexibility.

User selectable shooting modes allow you to adapt the camera to the shooting environment. In Standard Mode, the Phantom Flex is just like any other Phantom digital high-speed camera. Shoot at resolutions up to 2560 x 1600 pixels at anywhere from **10 frames-per-second** up to **1455 frames-per-second (fps)**. As you reduce the resolution, the maximum speed increases – **up to 2570 fps at 1920 x 1080, 5385 fps at 1280 x 720, and 10,900 fps at 640 x 480.**

In **Phantom HQ Mode** Vision Research's proprietary multi-sampling image enhancement technology is employed. This results in electronic image stability unprecedented in digital high-speed cameras: stable blacks, low noise, higher dynamic range and repeatable shots over the full range of supported resolutions, frame rates, and temperatures without the need for pre-shot black references. Maximum frame rates in HQ mode are approximately half those in Standard mode. That means the ultimate in image quality at speeds up to **1275 fps** at 1920 x 1080 or **2660 fps** at 1280 x 720 can be achieved.

If you are using **a video workflow** or you want the best possible video available on set, the Phantom Flex is for you. The video format available on the dual-link HD-SDI ports is independent of the camera resolution. Set the camera resolution to 2650 x 1440 (16:9) and the camera will automatically scale the oversampled

	STANDARD	HQ
Benefit	Standard Phantom camera use model, shoot at resolutions up to 2560 x 1600 with highest frames rates at any resolution.	Proprietary multi-sampling technology provides unprecedented image stability under changing shooting conditions.
Min Resolution	256 x 8	256 x 8
Max Resolution	2560 x 1600	2560 x 1600
Min FPS	10 fps	10 fps
Max FPS @ max resolution	1455	725
Max FPS @ 1920 x 1080	2570	1275
Max FPS @ 1280 x 720	5385	2660
Max FPS @ 640 x 480	10,900	5345
Max FPS @ 256 x 8	280,000	90,300

image when rendering the video signal. This technique increases the dynamic range in the video signal and virtually eliminates edge artifacts sometimes seen in other Bayer pattern cameras. The greater the oversample resolution, the better the image! It is up to you. And, this is something those "square" sensor cameras simply can't do without sacrificing pixels.

If you choose to oversample when you are using a raw digital workflow, you can still get the benefits of increased dynamic range and fewer edge artifacts in a saved RGB file because the Phantom Camera Control software (and compatible 3rd party solutions) know your intentions and can apply appropriate scaling technology!

New for 2013:

Vision Research is now offering bundles of the Phantom Flex and related accessories at a discounted rate, and with a guaranteed quick delivery.

Bundle configurations are as follows:

- Flex Lite Bundle: 16GB Flex + 1x 144GB CineMag & CineStation
- Flex Medium Bundle: 32GB Flex + 1x 256GB CineMag & CineStation
- Flex Complete Bundle: 32GB Flex + 2x 256GB CineMags & CineStation
- Flex Ultra Bundle: 32GB Flex + 2x 512GB CineMags & CineStation-X2SR

Service Protection:

With the purchase of a new Phantom Flex, you will receive at no additional cost, 3 years of camera service protection. If anything goes wrong with your camera within three years of purchase, we will repair it free-of-charge at one of our service locations. Your camera will receive expedited service for fast turn-around-time. You will be entitled to web-based support at no charge. And, any software and firmware updates are also available at no charge.

Standard warranty terms and conditions apply. Major upgrades that add new functionality are not included.
The 3-year warranty is implemented as a 2-year service contract extension to the standard 1-year warranty. The special 3-year warranty does not apply to the new Phantom Flex4K.



*Flex-Front View



*Flex-Top View



*Flex-Back View

DATA SHEET

Phantom[®] Flex

Additional Features:

12-bit CMOS sensor with Bayer color filter array

Quantum efficiency: 60% peak

Noise Equivalent Power (NEP) 0.011 fJ

10 micron pixel size with microlens technology for improved sensitivity

Size (without lens, CineMag or handle):

11.5 x 5.5 x 5.0 in (L x W x H)

29.2 x 14 x 12.7 cm

Weight (without lens, CineMag or handle):

11.75 lbs. (5.33 kg)

Mounting: Two ¼-20 and three 3/8-16 mounting holes on the bottom of the camera body, with additional mounting points on left side panel, right side panel and on the top camera handle

Temperature: 0°C to 40°C @ 8% to 80% relative humidity

Shock: 30G, half sine wave, 11 ms, 10 times all axes (without CineMag or lens)

Vibration: 25G, 5-500 Hz, all axes without CineMag

Focused

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MATERIALS ANALYSIS DIVISION

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Typical recording times for various configurations:

Recording Times into Camera RAM	16 GB Flex Standard (1)	16 GB Flex HQ (1)	144 GB CineMag II (2)
2560 x 1600			
1450 fps	1.8 sec	n/a	n/a
727 fps	3.7 sec	1.8 sec	n/a
195 fps	14 sec	7 sec	2.2 min
60 fps	45 sec	22 sec	7.4 min
24 fps	114 sec	57 sec	18.6 min
2560 x 1440			
1600 fps	1.8 sec	n/a	n/a
800 fps	3.7 sec	1.8 sec	n/a
217 fps	14 sec	7 sec	2.2 min
60 fps	51 sec	25 sec	8 min
24 fps	125 sec	64 sec	20 min
1920 x 1080			
2570 fps	1.9 sec	n/a	n/a
1275 fps	3.9 sec	1.9 sec	n/a
361 fps	14 sec	7 sec	2.2 min
60 fps	86 sec	43 sec	13.5 min
24 fps	211 sec	105 sec	33 min
1280 x 720			
5385 fps	2.2 sec	n/a	n/a
2660 fps	4 sec	2 sec	n/a
868 fps	14 sec	7 sec	2.2 min
60 fps	207 sec	103 sec	33 min
24 fps	8.6 min	4.3 min	82 min

(1) Double record times for 32 GB configuration, (2) Valid for both Std and HQ modes, double for 256 GB

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

EXHIBIT P361

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EXHIBIT P362



Home ▶ PRODUCTS ▶ 4K and Media Production ▶ VEO4K-PL



**Carter Exhibit
25 (2-28-22)**
WWW.DIGITALEVIDENCEGROUP.COM

VEO4K-PL

The Phantom VEO4K-PL produces highly detailed 4K imaging at 1,000 fps in a rugged and compact housing. Features include access to CFast 2.0

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- 938 fps at 4096 x 2304
- Super 35mm sensor with ISO Ratings:
 - Color 320 T (rolling shutter)
 - Exposure Index: 800 – 1000 color
- 36 or 72GB RAM
- Rolling Shutter

[DOWNLOAD DATASHEET](#) 

OVERVIEW

SPECIFICATIONS

ACCESSORIES

FAQs

MEDIA

VIDEOS

VEO4K-PL and PL-RLS cameras bring the high imaging standards of the Phantom Flex4K to a portable and rugged body style. The compact body increases the flexibility of use including such applications as robotic arms and drone flight.

The 35mm 9.4 Mpx sensor produces sharp highly-detailed images at high frame rates and upholds the low noise requirements of the industry, particularly in rolling shutter mode.

While the VEO4K-PL does come with a standard PL mount there is user flexibility through the optional and interchangeable lens mounts. Nikon and Canon EF (with electronic control) mounts are also available to increase workflow needs.

The VEO4K-PL housing comes standard in the VEO S-style body with full features for maximum portability. The body is made from milled aluminum, has sealed electronics (to protect from air and dust), is lightweight (6 lbs/2.8 kg), and is ruggedized to increase the durability in harsh environments.

- SDI and HDMI video outputs
- Includes S-Model features:
 - CFast 2.0 media
 - 12V battery input
 - On-camera controls
- PL Mount Included
- Optical Low Pass Filter (OLPF) included
- Programmable I/O
- 10Gb Ethernet Option
- Cine Raw file format

What's in the box?

- Power supply with XLR extender
- Ethernet Cable
- Mini-SDI video cable
- Printed manual
- Phantom PCC software

Downloads

 [VEO Manual](#)

 [S-Model Mechanical Drawing](#)

 [Spectral Response Curve](#)

GET MORE INFORMATION ABOUT PHANTOM PRODUCTS

CONTACT US

When it is too fast to see, and too important not to [®].



TMX

Ultrahigh-Speed

T-Series

VEO

Miro C and N

Machine Vision

4K and Media Production

Compare Cameras

Miro Junction Box 2.0 (JB 2.0)

CineMag V and CineStation

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Automotive

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Industrial

Media Production

Science Research

APPLICATIONS

Combustion

Microfluidics

Particle Image Velocimetry

Cytometry Single-Cell Imaging

Digital Image Correlation

Schlieren Imaging

Workflow

RESOURCES

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Phantom Features

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[Frame Rate and Exposure](#)

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EXHIBIT P363



PHANTOM VEO 1310 VEO 1010

HIGH-SPEED CAMERA

1.2 Megapixels, 1280 x 960
Up-to 10,860 fps (1310);
8,420 (1010)
L and S body styles

FEATURES & BENEFITS

PHANTOM VEO PRODUCT FAMILY

Designed to perform in a wide array of scientific and industrial applications, Phantom VEO high-speed cameras provide valuable insight into events that are otherwise too fast to be seen.

VEO 1310 and 1010 models incorporate recent advancements in image technology to deliver exceptional image quality with **2.5X greater light sensitivity** and at the **highest frame rates** available in the VEO platform. Binning mode is included for a boost to the throughput and sensitivity at 640 x 480 and below.

EXTREME CONFIGURABILITY

VEO cameras are available in color or monochrome, up to 72GB RAM, with a variety of lens mounts and two body styles to allow users to **choose the best configuration** in terms of features and budget:

- **L-model** is for basic, software based imaging in a lab or office environment
- **S-model** provides additional signals, on-camera controls for untethered and remote recording, ruggedized connectors and compatibility with removable CFast 2.0 storage media.

FRAME RATES & EXPOSURE		
Top FPS at Max Resolution	1310: 10,860	1010: 8,420
1 Megapixel FPS	1310: 12,900	1010: 10,010
Maximum FPS	1310: 423,350*	1010: 328,460
Minimum FPS	50	
CAR Increments	640 x 12	
Minimum Exposure	1 μ s Standard	706 ns with Fast Option** <i>(1310 only)</i>
Electronic Shutter	Global	
PIV Features	Shutter-off mode with straddle time of 726 ns, Supports Burst Mode	
Exposure Features	Auto-Exposure, Overexposure Indication over video and in PCC	

IMAGING		
Sensor Type	CMOS with Correlated Double Sampling	
Maximum Resolution	1280 x 960	
Bit Depth	12-bit	
Pixel Size	18 μ m	
Sensor Size	23 x 17.2; 28.7 mm diagonal	
ISO Daylight (12232 STD)	Standard: Mono 25,000; Color 6,400	Binned: Mono 50,000; Color 8,000
ISO Tungsten (12232 STD)	Standard: Mono 80,000; Color 8,000	Binned: Mono 125,000; Color 10,000
Exposure Index	Standard: Mono 25,000 - 125,000; Color 6,400 - 32,000	Binned: Mono 50,000 - 250,000; Color 8,000 - 40,000
Dynamic Range	Standard: 60.3 dB	Binned: 59.4 dB
Readout Noise	Standard: 10 e-	Binned: 24 e-

FRAME RATE CHART

Table provides examples of common resolutions and frame rates. The record times shown are for 72GB RAM at the frame rate shown. Duration will be 1/2 the time for 36GB and 1/4 the time for 18GB RAM.

Maximum Frame Rate - FPS; [72GB Record Time - Sec]				
Resolution (H x V)	VEO 1310	VEO 1310 Binned Mode	VEO 1010	VEO 1010 Binned Mode
1280 x 960	10,860 [3.60]	-	8,420 [4.40]	-
1280 x 804	12,900 [3.60]	-	10,010 [4.40]	-
1280 x 720	14,350 [3.60]	-	11,140 [4.40]	-
1280 x 240	40,300 [3.90]	-	31,270 [4.80]	-
960 x 960	13,330 [3.90]	-	10,340 [4.80]	-
640 x 480	30,030 [5.10]	40,300 [3.90]	23,300 [6.40]	31,270 [4.80]
640 x 240	57,360 [5.30]	73,510 [4.20]	44,510 [6.80]	57,030 [5.20]
640 x 120	105,260 [5.70]	125,000 [4.90]	81,660 [7.20]	96,980 [6.40]
640 x 96	126,360 [5.90]	145,360 [5.20]	98,030 [7.60]	112,780 [6.80]
640 x 72	158,030 [6.30]	173,650 [5.80]	122,610 [8.00]	134,730 [7.20]
640 x 48	210,900 [6.90]	215,610 [6.90]	163,630 [8.80]	167,280 [8.80]
320 x 240	57,360 [10.30]	105,260 [5.70]	44,510 [13.20]	81,660 [7.20]
320 x 72	158,030 [11.90]	253,270 [7.60]	122,610 [15.20]	196,500 [9.60]
320 x 24	316,930 [15.30]	423,350 [11.90]	245,900 [19.60]	328,460 [15.20]

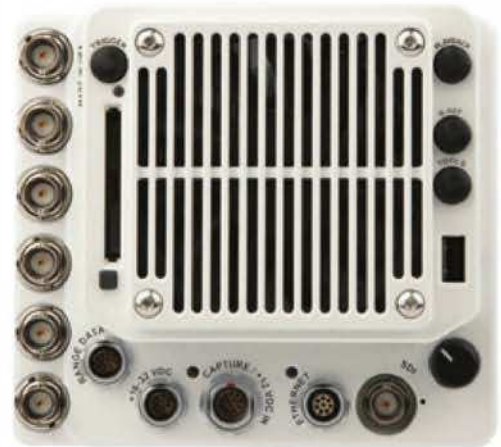
* VEO 1310 has increased frame rate in PIV (shutter-off) mode:
560K fps (600K fps with Fast option) at 640 x 12 std or 320 x 24 binned.

**Certain Phantom cameras are held to export licensing standards.
Details available at: www.phantomhighspeed.com/export



CONNECTIVITY & SIGNALS

Ethernet	Gigabit Standard, 10Gb Optional		
Timecode	IRIG-B Modulated and Un-modulated		
Port Descriptions		S-model	L-model
	Ethernet	Fischer 8-pin	RJ45
	Power	Fischer 6-pin	Fischer 6-pin
	Range Data	Fischer 8-pin	N/A
	USB	Yes for WiFi dongle	N/A
	Video output	3G-SDI (2 ports), HDMI	3G-SDI (1 port), HDMI
	Dedicated BNC	Trigger, Timecode-in, 3G-SDI	Trigger, Timecode-in
	Programmable I/O BNC	4 ports	2 ports
I/O Signals	Programmable I/O for Fsync, Strobe, Ready, Timecode-out, Event, Memgate, Pretrigger. Assign and define signals in PCC		
Hardware Trigger	Dedicated BNC		
Software Trigger	Trigger button (S-model); via Ethernet; via Image-based auto trigger (IBAT)		
Synchronization	External Sync via FSync or IRIG Timecode		
Recording Features	Burst mode; Image-based auto trigger, Continuous recording & AutoSave to CFAST (S-model)		
Video Output	3G-SDI via BNC (rear-S-model only), Din and Micro HDMI type D port (front). <i>Cameras prior to 2021 had HDMI type A port.</i>		
Accessory Power	4-pin Hirose (front) for 12V monitors up to 1 Amp		



VEO S-model (Top),
L-model (Bottom)

CONTROL

Software & OS	Phantom PCC (Windows); SDK also available with MatLab and LabView drivers
On-camera Controls	S-models only. Access menu system with encoder, viewed on video monitor. Buttons for trigger, play and save - Color indicates current camera state
Primary File Format	Phantom Cine RAW (.cine)
Alternative File Formats	Easily convert to formats including .mp4, Apple ProRes .mov, .avi, Tiff, JPG, DNG and many more using PCC. Cine files are directly compatible with many major video editing and motion analysis programs
Software Feature Highlights	Continuous Recording for automated workflows, Integrated Data Acquisition (NI-DAQ), support for D/C Calibration with Sync-Snapshot menu, advanced Image Tools including Crop & Resample, Tone Curves, Filters and more

MEMORY & STORAGE

RAM Buffer	18GB, 36GB, 72GB RAM options
Multi-Cine	Up-to 64 Partitions
Non-Volatile Media	VEO S-model supports CFAST 2.0 (NTFS format) 80 MB/s Cine Raw file transfer rate from RAM

MECHANICAL

Housing Variants	L-model and S-model variants
Size	L-model: 5 x 5 x 5" (12.7 x 12.7 x 12.7 cm); S-model: 5 x 5.5 x 5" (12.7 x 14 x 12.7 cm)
Weight	L-model: 5.0 lbs (2.3 kg); S-model: 5.6 lbs (2.5 kg)
Lens Mounts	Choose lens mount at time of purchase: F-mount (with aperture support for Nikon G-style lenses), Canon EF mount (with electronic focus and iris control), PL, C-mount
Mounting Points	Standard 1/4 x 20" mounting points on bottom. Top, bottom and side are compatible with Cameo cheese plate for added mounting points, riser, and custom handle
Internal Shutter	Standard, for remote black references
Cooling	Active cooling. Quiet mode disables fans during capture

GLOBAL SUPPORT NETWORK

The Phantom VEO product line is supported by Vision Research's Global Service and Support network, offering PhantomCare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera with a selection of professional services from which to choose.

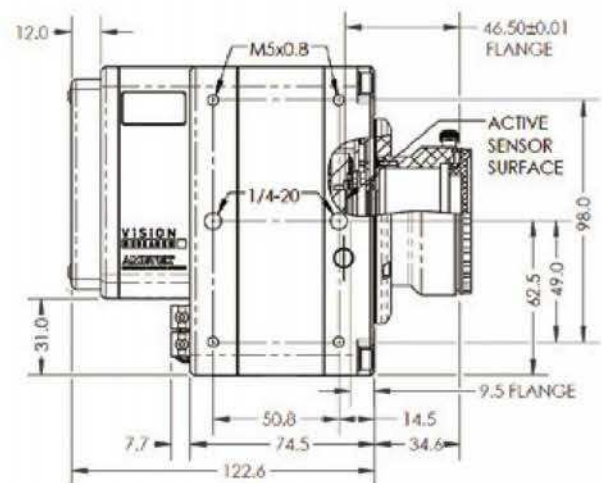
Learn more about our service offering at www.phantomhighspeed.com/Service-Support

POWER

AC Power	100-240 VAC, 80W power supply included
Voltage Range	16-32VDC Primary; Secondary Power down to 12VDC via 12-pin capture port (S-models only)
Power Consumption	65W typical
Battery Options	S-model includes 12V input for compatibility with common 14.4V batteries. V-Lock and Gold-mount VEO side-mounts are available for VEO-S cameras

ENVIRONMENTAL

Operating Temperature	-10 to +50°C
Storage Temperature	-20 to +70°C
Operational Shock	MIL-STD-202G Method 213-B. Rated 30G with shutter; 100G without; sawtooth wave, 11ms, +/- 10 pulses all axes
Operational Vibration	MIL-STD-202G Method 214-A. Rated 12Grms; Figure 2A-1, Test Condition D, 15 min per axis
Regulatory	CE Emissions - CE Compliant EN 61326-1 CE Immunity - CE Compliant EN 61326-1 FCC - CFR 47, Part 15, Subpart B & ICES-0003, Class A


ABOUT VISION RESEARCH

Focused. Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

ViSiON
RESEARCH

AMETEK
MATERIALS ANALYSIS DIVISION

100 Dey Road
Wayne, NJ 07470 USA
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EXHIBIT P364



DATA SHEET

File: \\pcprod.scs.corp.vision.com\www\vision\camera\docs\phantom_v2511_data_sheet.pdf
Rev: August 2010

Phantom® v2511 Phantom® v2011 Phantom® v1611 Phantom® v1211

The world's fastest 1 Mpx ultrahigh-speed digital camera line is also the most light sensitive.

Key Benefits:

The Phantom ultrahigh-speed digital camera line offers ultra high throughputs with improved sensitivity.

- The Phantom line's new member, the **Phantom v2511**, achieves over 25 Gpx/s and more than 25,000 frames-per-second (fps) at its full megapixel resolution of 1280 x 800.
- The **Phantom v2011** performs at over 22 Gpx/s and greater than 22,000 fps at full resolution
- The **Phantom v1611** offers 16 Gpx/s throughput and 16,000 fps at full resolution
- The **Phantom v1211** can capture 12,000 fps at full resolution

The entire line has improved sensitivity, providing better picture quality and more lighting flexibility. Using the ISO 12232 SAT method, these cameras are measured at:

v2511 - v2011 - v1611 - v1211 ISO		
	T (Tungsten)	D (Daylight)
Monochrome	100,000	32,000
Color	10,000	6,400

And, these cameras are **built on the proven Phantom v2010/v1610/v1210 Ultrahigh-speed Camera Platform**, with the full array of **unique features** that let you take full advantage of their speed and flexibility. The cameras are supported by Vision Research's **Global service and support network**, offering a full menu of professional support services so that you can maximize your Phantom camera experience.

Key Features:

- 1 Megapixel sensor (1280 x 800)
- 25Gpx/s throughput (v2511)
- 22Gpx/s throughput (v2011)
- 16Gpx/s throughput (v1611)
- 12Gpx/s throughput (v1211)
- 1µs minimum exposure
- 500ns minimum exposure with FAST option*
* Export controlled feature
- ISO (ISO 12232 SAT method):
Mono: 100,000 T and 32,000 D
Color: 10,000 T and 6,400 D
- Up to 96GB memory
- Phantom CineMag® compatible
- Weight (without lens): 16 lbs, 14 oz. (7.7 Kg)



v2511, v2011, v1611 & v1211

The standard Capture Cable, which attaches to the Capture Port, provides the following signals:

- Ready (is high when camera is in capture mode, can be combined with other cameras to provide a "system ready" signal)
- Strobe (is low during frame exposure time)
- Auto-Trigger (a hardware trigger signal supplied by Image-Based Auto-Trigger)
- Pre-trigger/Memgate (a falling edge causes the camera to start acquiring pre-trigger frames and wait for a trigger – the camera goes into "capture" mode; or, if used in Memgate mode, frames acquired while low are discarded and not saved to memory allowing for selective recording)
- Video Out (NTSC or PAL composite video signal)

Or, use the optional Break-out-Box (BoB) connected to the Capture Port and have access to the following signals on the BoB.

- IRIG-In
- IRIG-Out
- Video Out
- Trigger
- Event (if low when Strobe goes high, the frame is marked with an event marker)
- Strobe
- Auto-Trigger (goes low when this camera is triggered by Image-Based Auto-Trigger allowing one camera to trigger other cameras based on an event detected in the live image)
- Pre-trigger/Memgate
- Ready



Phantom v1211- Right Side View

Image Storage:

At ultrahigh-speeds, memory can become a limitation to recording duration. The **cameras can be equipped with 24GB, 48GB or 96GB** of high-speed memory. A camera with 96GB of memory, recording at 10,000 fps at 1280 x 800 can record a single high-speed shot (called a *cine*) for up to 6.2 seconds. Or, **segment memory** into up to 63 segments and record shorter cines into each segment.

Minimize cine save times with the Phantom CineMag feature that is standard on all ultrahigh-speed models. With the ability to save 1GB/s of data to an attached CineMag, a 96GB shot can be saved in about 1.5 minutes. The resulting **cine is securely stored in non-volatile memory**.

The contents of a CineMag can later be viewed on a PC, trimmed, played to video, and saved either by placing the CineMag back on the camera, or using our offline Phantom CineStation® – a simple CineMag reader that connects to your PC with Gb or 10Gb Ethernet.

Sensor Characteristics:

Phantom UltraHigh-Speed Cameras are based on a Vision Research designed **custom CMOS sensor**. The **28 micron pixel size means high light sensitivity** and Vision Research's innovative design increases the sensitivity even more. Each pixel has a **bit depth of 12 bits** yielding 4,096 gray levels with high dynamic range. Each camera comes in monochrome and color versions.

Sensor resolution is 1280 x 800 "widescreen" format. The rectangular shape of the 1 Mpx sensor allows the user to keep moving objects in the frame longer and is compatible in aspect ratio with modern display technology. The physical size of the sensor is 35.8mm x 22.4mm.

These cameras have a **global electronic shutter** capable of exposures as fast as 1 μ s on a standard camera, or, 500 ns with the export controlled FAST option, to truly **"freeze motion" and eliminate motion blur** in the most demanding of applications.

Connectivity:

The Phantom v2511, v2011, v1611 & v1211 are **our most "connected" cameras ever!**

On the back panel of the camera you will find:

- 1 Trigger BNC**
(trigger the camera on either a rising or falling TTL signal)
- 2 F-SYNC BNC**
(as an output, this provides a frame sync signal to slave cameras, as an input, the camera is slaved to an external frame sync signal)

- 3 Timecode In BNC (IRIG, SMPTE)**
- 4 Timecode Out BNC (IRIG, SMPTE)**
- 5 Power Switch**
- 6 HD-SDI 1 BNC**
- 7 HD-SDI 2 BNC**
- 8 10Gb Ethernet** (UTP copper interface, RJ45 connector)
- 9 1Gb Ethernet**
- 10 Primary DC Power** (20 - 28VDC)
- 11 Backup DC Power**
- 12 GPS** (input GPS time, location from an external GPS receiver)
- 13 Range Data** (input azimuth and elevation data from a tracker)
- 14 Remote Control Port**
- 15 Capture Port**

The two HD-SDI ports can be configured in several ways. The two ports can act as identical 4:2:2 HD-SDI ports where one port can be set up to provide an (optional) on-screen display for monitoring the on-camera controls and camera operation. Or, they can be configured as a "single" 4:4:4 Dual-Link HD-SDI port.



Command & Control:

You can set up and control your Phantom camera using several different tools.

A convenient way to use your Phantom ultrahigh-speed camera is with the standard **on-camera controls**. Simply connect a video monitor to the camera and use the intuitive user interface to control most common camera settings.

Our **Phantom Camera Control (PCC) software** is full-featured and easy to use. Set up and control one or many cameras from a single interface with easy access to even the most complex camera features. PCC even has a basic motion analysis and measurements package built-in.

PCC also connects to our Phantom CineStation for offline work with our popular CineMag storage devices. View, trim, and save slow-motion movies based on Phantom cine raw files into a variety of formats.

The **Phantom Remote Control Unit (RCU)** is a small full-featured camera controller that connects to the Remote port on the camera (or connects via Bluetooth to using a Bluetooth adapter on the camera for wireless control). The bright LCD touchscreen gives you access to all popular camera features with the tap of a finger. Connect the RCU to one of the HD-SDI video ports and use it as a monitor, too!

LabView and Matlab development environments are also available.

Environmental Specs:

Operating Temperature:	-10 to +50 C
Storage temperature:	-20 to +70 C
Humidity:	95% non-condensing
Altitude:	
Operational	0 to 10 k feet above sea level
Non-Operational	-500 to 50 k feet above sea level
Magnetic Field Immunity:	500 amp-meter
Regulatory:	EMI/RFI
Emissions	EN 55022, FCC part 15
Conducted	EN 55022
Immunity	EN 55024
ESD	IEC 61000-4-2
Random Vibration:	
Operational	0.25G, 5 –500 – 5Hz, 1.0 Octave/min 10 Sweeps (5 Cycles).
Non-Operational	1.2G, 5 –500Hz, 1.0 Octave/min 10 Sweeps
Shock:	
Operational	5.5G, 11mSec half-sine with 10 shocks in all axis.
Non-Operational	33G, 11mSec half-sine with 10 shocks in all axis
Natural Frequency:	Operational 5-200 Hz
Safety:	IEC 60950

Advanced Features:

- **Image-Based Auto-Trigger:** trigger the camera (or even a number of connected cameras) from motion detected within the live image. This makes it easier to catch events that are not predictable and may occur infrequently.
- **Internal Mechanical Shutter:** all digital high-speed cameras require an occasional black reference if they are to provide the highest quality images. A black reference is obtained by sampling a perfectly black image. With an internal mechanical shutter, the black frame can be obtained by simply closing the shutter. No physical access to the camera is needed.
- **Multi-Cine:** partition internal memory into segments and make shorter recordings back-to-back without missing any action.
- **Continuous Recording:** Do you need to record many occurrences of an event, especially an event that happens rarely or is unpredictable? Continuous recording is a mode that automatically saves a recorded cine to a disk drive on a connected PC immediately after it is recorded then re-arms the camera and waits for the next cine to be recorded. A recording can be triggered manually, electronically from an event detection system, or even by our Image-Based Auto-Trigger. The number of recordings is limited only by the amount of disk storage you have available.
- **PIV features:** Particle Image Velocimetry and similar measurement techniques like Particle Tracking Velocimetry (PTV), Laser Induced Florescence (LIF), and Digital Image Correlation (DIC) require extremely accurate timing and the ability to take images is a very stable and predictable way. The straddle time on the v2511 and v2011 is 500 ns, on the v1611 is 525ns, and on the v1211 is 725ns.
- **Burst Mode:** Many experiments require taking images at precisely the same time during the experiment. For example, combustion studies may require images at each 1° turn in a crankshaft. Our unique burst mode allows you to trigger the camera at 0° and then take a burst of images at precise time delays.
- **Quiet Fans:** During recording, turns the fans off to eliminate vibration which might interfere with some applications, especially when image magnification is required.

Vision Research Global Support - for wherever you are

Our ultrahigh-speed camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera by learning more about our service and support options at www.visionresearch.com/PhantomZone

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Phantom v2511, v2011, v1611 & v1211

		RESOLUTION			
		v2511*	v2011*	v1611*	v1211*
H	V	Max FPS	Max FPS	Max FPS	Max FPS
1280	800	25,600	22,500	16,600	12,600
1280	720	28,500	25,100	18,400	14,000
1024	800	30,500	26,900	19,700	15,000
1024	512	47,300	41,800	30,700	23,400
896	800	33,600	29,800	21,800	16,600
768	768	39,100	34,700	25,300	19,300
640	480	69,900	62,400	45,500	34,700
512	512	75,400	67,700	49,100	37,500
512	384	99,500	89,000	65,000	49,600
384	256	170,600	154,200	112,300	85,700
256	256	205,000	187,200	135,400	103,600
256	128	375,700	343,500	253,000	193,900
128	64	764,700	708,800	538,400	415,500
128	32	1,000,000	1,000,000	840,000	653,000
128	16	1,000,000	1,000,000	1,000,000	820,000

*Assumes FAST option is installed

Maximum v2511 standard: 677,000 fps

Maximum v2011 standard: 666,000 fps

Maximum v1611 standard: 646,000 fps

Maximum v1211 standard: 570,000 fps

v2511 - v2011 - v1611 - v1211 ISO		
	T (Tungsten)	D (Daylight)
Monochrome	100,000	32,000
Color	10,000	6,400

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

VISION
RESEARCH

AMETEK
MATERIALS ANALYSIS DIVISION

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EXHIBIT P365

DATA SHEET

File: 1101_101011 phantom v1212 www.visionresearch.com
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Phantom v2512

Phantom[®] v2512
Phantom[®] v2012
Phantom[®] v1612
Phantom[®] v1212

The world's fastest 1 Mpx ultrahigh-speed digital camera line now has the most memory.

Key Features:

1 Megapixel sensor (1280 x 800)

25Gpx/s throughput (v2512)

22Gpx/s throughput (v2012)

16Gpx/s throughput (v1612)

12Gpx/s throughput (v1212)

ISO (ISO 12232 SAT method):

Mono: 32,000* ; 100,000*

Color: 6,400* ; 10,000*

* Measured according to ISO 12232:2006 method

1μs minimum exposure standard

Camera	Minimum exposure with FAST option
v2512	265 ns
v2012	290 ns
v1612	500 ns
v1212	500 ns

The FAST option is an export controlled feature

Up to 228GB memory

Phantom CineMag[®] IV 1TB and 2TB compatible

AMETEK[®]
MATERIALS ANALYSIS DIVISION

Key Benefits:

The **Phantom ultrahigh-speed UHS-12 digital camera line** offers ultra high throughputs, superb sensitivity, and the most memory available on the market.

- 👁️ **72GB, 144GB, and 288GB memory** options are available on all UHS-12 Series models. 288GB of memory provides over 7.6 seconds of recording time for a v2512 capturing images at 25Gpx/s.
- 👁️ Like their predecessor UHS-11 Series, the UHS-12 Series offer **ultra high throughputs**. At full megapixel resolution of 1280 x 800:
The **Phantom v2512** achieves over 25 Gpx/s and over 25,000 frames per second (fps)
The **Phantom v2012** achieves over 20 Gpx/s and over 20,000 fps
The **Phantom v1612** achieves over 16 Gpx/s and over 16,000 fps
The **Phantom v1212** achieves over 12 Gpx/s and over 12,000 fps
- 👁️ The UHS-12 Series also have **superb sensitivity** for better picture quality and more lighting flexibility. Using the ISO 12232 SAT method, all models are measured at:

v2512 - v2012 - v1612 - v1212 ISO		
	D (Daylight)	T (Tungsten)
Monochrome	32,000*	100,000
Color	6,400*	10,000*

And, these cameras are **built on the proven Phantom Ultrahigh-speed UHS-11 Series Camera Platform**, with the full array of **unique features** that let you take full advantage of their speed and flexibility.

v2512, v2012 v1612 & v1212

The standard Capture Cable, which attaches to the Capture Port, provides the following signals:

- Ready (is high when camera is in capture mode, can be combined with other cameras to provide a "system ready" signal)
- Strobe (is low during frame exposure time)
- Auto-Trigger (a hardware trigger signal supplied by Image-Based Auto-Trigger)
- Pre-trigger/Memgate (a falling edge causes the camera to start acquiring pre-trigger frames and wait for a trigger – the camera goes into "capture" mode; or, if used in Memgate mode, frames acquired while low are discarded and not saved to memory allowing for selective recording)
- Video Out (NTSC or PAL composite video signal)

Or, use the optional Break-out-Box (BoB) connected to the Capture Port and have access to the following signals on the BoB.

- IRIG-In
- IRIG-Out
- Video Out
- Trigger
- Event (if low when Strobe goes high, the frame is marked with an event marker)
- Strobe
- Auto-Trigger (goes low when this camera is triggered by Image-Based Auto-Trigger allowing one camera to trigger other cameras based on an event detected in the live image)
- Pre-trigger/Memgate
- Ready



Phantom v1212 with CineMag™

Image Storage:

At ultrahigh-speeds, memory can become a limitation to recording duration. The **cameras can be equipped with 72GB, 144GB, or 288GB** of high-speed memory. A camera with 288GB of memory, recording at 10,000 fps at 1280 x 800 can record a single high-speed shot (called a *cine*) for up to **almost 20 seconds**. Or, **segment memory** into up to 63 segments and record shorter cines into each segment.

Minimize cine save times with the Phantom CineMag option. With the ability to save 1GB/s of data to an attached CineMag IV, a 288GB shot can be saved in under 5 minutes. The cine is **securely stored in non-volatile memory**.

The contents of a CineMag can later be viewed on a PC, trimmed, played to video, and saved either by placing the CineMag back on the camera, or using our offline Phantom CineStation® – a simple CineMag reader that connects to your PC with 1Gb or 10Gb Ethernet.

Sensor Characteristics:

Phantom Ultrahigh-Speed Cameras are based on a Vision Research designed **custom CMOS sensor**. The **28 micron pixel size means high light sensitivity** and Vision Research's innovative design increases the sensitivity even more. Each pixel has a **bit depth of 12 bits** yielding 4,096 gray levels with high dynamic range. Each camera comes in monochrome or color versions.

Sensor resolution is 1280 x 800 "widescreen" format. The rectangular shape of the 1 Mpx sensor allows the user to keep moving objects in the frame longer and is compatible in aspect ratio with modern display technology. The physical size of the sensor is 35.8mm x 22.4mm.

These cameras have a **global electronic shutter** capable of exposures as fast as 1 μ s on a standard camera, or up to 265 ns with the export controlled FAST option depending on the camera model. This truly "freezes motion" and eliminates **motion blur** in the most demanding of applications.

Command & Control:

You can set up and control your Phantom camera using several different tools.

A convenient way to use your Phantom ultrahigh-speed camera is with the standard **on-camera controls**. Simply connect a video monitor to the camera and use the intuitive user interface to control most common camera settings.

Our **Phantom Camera Control (PCC) software** is full-featured and easy to use. Set up and control one or many cameras from a single interface with easy access to even the most complex camera features. PCC even has a basic motion analysis and measurements package built-in. PCC also connects to our Phantom CineStation for offline work with our popular CineMag storage devices.

The **Phantom Remote Control Unit (RCU)** is a small full-featured camera controller that connects to the Remote port on the camera (or via Bluetooth using a Bluetooth adapter on the camera for wireless control). The LCD touchscreen gives access to all popular camera features with the tap of a finger. Connect the RCU to an HD-SDI video port and use it as a monitor, too!

Connectivity:

The Phantom v2512, v2012, v1612 & v1212 are **our most “connected” cameras ever!** On the back panel of the camera you will find:

BNC Connectors		9	Power Switch
1	Trigger	10	Range Data (input azimuth and elevation data from a tracker)
2	Time Code In (IRIG, SMPTE)	11	GPS (input time, location from an external GPS receiver)
3	I/O 1: Ready	12	Remote Control Port
4	I/O 2: F-SYNC	13	1 Gb Ethernet
5	I/O 3: Time Code Out (IRIG, SMPTE)	14	10 Gb Ethernet (UTP copper interface, RJ45 connector)
6	I/O 4: Strobe	15	Primary DC Input (20-28VDC)
7	HD-SDI 2	16	Backup DC Power
8	HD-SDI 1	17	Capture Port

The two HD-SDI ports can act as identical 4:2:2 HD-SDI ports with one port set up to provide an (optional) on-screen display to monitor the on-camera controls and camera operation. Or, they can be configured as a “single” 4:4:4 Dual-Link HD-SDI port.

LabView and Matlab development environments are also available.

Advanced Features:

- **10G Ethernet:** Download cines from the camera super fast. The 10G Ethernet transfers data at up to 600 MB/second on optimized systems, saving time and getting to your critical data faster.
- **Image-Based Auto-Trigger:** Trigger the camera (or even a number of connected cameras) from motion detected within the live image. This makes it easier to catch events that are not predictable and may occur infrequently.
- **Internal Mechanical Shutter:** All digital high-speed cameras require an occasional black reference to provide the highest quality images. A black reference is obtained by sampling a perfectly black image. With an internal mechanical shutter, no physical access to the camera is needed.



Environmental Specs:

Power:	100 - 240 VAC, 280 Watt power supply included
Weight (without lens):	17 lbs, 8 oz. (8.1 Kg)
Operating Temperature:	-10 to +50 C
10G operating temperature:	+5 to +50 C
Storage temperature:	-20 to +70 C
Humidity:	95% non-condensing
Altitude:	
Operational	0 to 10 k feet above sea level
Non-Operational	-500 to 50 k feet above sea level
Magnetic Field Immunity:	500 amp-meter
Regulatory:	EMI/RFI
Emissions Conducted	EN 55022, FCC part 15
Immunity	EN 55022
ESD	EN 55024
	IEC 61000-4-2
Random Vibration:	
Operational	0.25G, 5 - 500 - 5Hz, 1.0 Octave/min 10 Sweeps (5 Cycles)
Non-Operational	1.2G, 5 - 500Hz, 1.0 Octave/min 10 Sweeps
Shock:	
Operational	5.5G, 11mSec half-sine with 10 shocks in all axis.
Non-Operational	33G, 11mSec half-sine with 10 shocks in all axis
Natural Frequency:	Operational 5-200 Hz
Safety:	IEC 60950

- **Multi-Cine:** Partition internal memory into segments and make shorter recordings back-to-back without missing any action.
- **Continuous Recording:** Do you need to record many occurrences of an event, especially an event that happens rarely or is unpredictable? Continuous recording mode automatically saves a recorded cine to a disk drive on a connected PC immediately after it is recorded then re-arms the camera and waiting for the next cine. A recording can be triggered manually, from an event detection system, or even by our Image-Based Auto-Trigger. The number of recordings is limited only by the amount of available disk storage.
- **PIV features:** Particle Image Velocimetry and similar measurement techniques like Particle Tracking Velocimetry (PTV), Laser Induced Florescence (LIF), and Digital Image Correlation (DIC) require extremely accurate timing and the ability to take images in a very stable and predictable way. The straddle time on the v2512 is 375ns, on the v2012 is 400ns, on the v1612 is 425ns, and on the v1212 is 550ns.
- **Burst Mode:** Many experiments require taking images at precisely the same time during the experiment. For example, combustion studies may require images at each 1° turn in a crankshaft. Our unique burst mode allows you to trigger the camera at 0° and then take a burst of images at precise time delays.
- **Quiet Fans:** Turns the fans off to eliminate vibration which might interfere with some applications, especially when image magnification is required.



v1612 with 2TB CineMag

Vision Research Global Support - for wherever you are

Our ultrahigh-speed camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera with a full menu of professional support services. Learn more about our service and support options at www.visionresearch.com/Service--Support

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

Phantom v2512, v2012, v1612 & v1212

		RESOLUTION			
		v2512	v2012	v1612	v1212
H	V	Max FPS	Max FPS	Max FPS	Max FPS
1280	800	25,600	22,500	16,600	12,600
1280	720	28,500	25,100	18,400	14,000
1024	800	30,500	26,900	19,700	15,000
1024	512	47,300	41,800	30,700	23,400
896	800	33,600	29,800	21,800	16,600
768	768	39,100	34,700	25,300	19,300
640	480	69,900	62,400	45,500	34,700
512	512	75,400	67,700	49,100	37,500
512	384	99,500	89,000	65,000	49,600
384	256	170,600	154,200	112,300	85,700
256	256	205,000	187,200	135,400	103,600
256	128	375,700	343,500	253,000	193,900
128	64	764,700*	708,800*	538,400	415,500
128	32	1,000,000*	1,000,000*	840,000*	653,000*
128	16	1,000,000*	1,000,000*	1,000,000*	820,000*

*Assumes FAST option is installed

Maximum v2512 standard: 677,000 fps

Maximum v2012 standard: 666,000 fps

Maximum v1612 standard: 646,000 fps

Maximum v1212 standard: 570,000 fps

Learn more at:



Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

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EXHIBIT P366



Phantom V5.2

One Megapixel, 1000 fps, 12-bit pixel depth:
A new entry-level standard from VRI

THE ULTIMATE IN PRICE/ PERFORMANCE

The Phantom V5.1 has been an indispensable member of the Phantom high-speed digital camera family for many years. Now, the V5.1 passes that role to the new Phantom V5.2.

Featuring a full megapixel--1152x896 resolution--in a widescreen format with a full-resolution frame rate of up to 1000 pictures-per-second! At lower resolutions, you can go faster, up to 148,000 pictures-per-second at 96x8. Adjust the resolution in any combination of 96x8 pixels to get the field-of-view and the speed you need.

Available in both monochrome and color models the V5.2 gives you sensitivity rated at 2400 ISO (mono) or 600 ISO (color). Our sensitivity ratings are based on the ISO 12232 standard and are measured without the benefit of any noise reduction filtering which can alter the data in the image. With up to 12 bits of greyscale information for each pixel, you can pull details out of the images that were previously unseen.

With an electronic shutter speed down to 2 μ s, you can get crisp images free of motion blur on fast-moving objects.

The features you've come to expect on a Phantom V-series camera are all there: Extreme Dynamic Range (dual-slope integration within a single frame), Continuously Adjustable Resolution (in 96x8 increments), Automatic Exposure, multi-cine recording, IRIG timing, and more.



The camera is controlled via Gigabit Ethernet from a PC or laptop. Our Phantom software application, used to setup and control the camera as well as review, edit and save your high-speed images, runs on Windows XP or Vista.

The camera features a video-out port that supports NTSC, PAL, SD-SDI and 720p HD-SDI formats.

Trigger the camera from software, or from external sources. Synchronize multiple cameras to a master camera or external time base.

F-mount lensing allows you to use many popular Nikon format lenses. And, the 16.5mm sensor fits under most C-mount lenses, too. Many lens choices are available from Vision Research. Check out our online store.

Available in 1.5GB, 3GB, 6GB and 12GB versions, there is a model to meet your needs. And, of course, memory upgrades are always available (the 1.5GB version cannot be upgraded.)

The 1.5GB version of the V5.2 is built for hi-g applications and runs cool enough that it does not

require active cooling, the other versions feature active cooling to maintain constant operating temperature and ensure highest picture quality.

Phantom camera training is available at many locations around the world.

Performance, features, price, and risk reduction. What more could you ask for from the leader in digital high-speed imaging? Check out the Phantom V5.2 today!

RESOLUTION	FRAME RATE (FPS)
1152x896	1000
1152x720	1244
1024x512	1885
768x768	1667
768x512	2489
768x384	3305
640x480	2971
512x512	3164
512x384	4197
512x256	6220
256x256	10362
256x128	19704
256x32	59701
128x128	25000
96x64	57971
96x32	88888
96x16	121212
96x8	148148

SPECIFICATION	V5.2
SENSOR SIZE	1,032,192 pixels
RESOLUTION (PIXELS)	1152x896
CONTINUOUSLY ADJUSTABLE RESOLUTION (CAR)	Yes, 96x8
FRAMES-PER-SECOND AT FULL RESOLUTION	1,000 fps
MAXIMUM FRAME RATE	~148,000 fps
EXPOSURE TIME (SHUTTER SPEED)	Minimum: 2µs
BUILT-IN MEMORY	1.5GB, 3GB, 6GB, 12GB
ISO (ISO-12232 STANDARD)	2400 Mono 600 Color
MEMORY SEGMENTATION	Yes, up to 16 segments
PIXEL BIT-DEPTH	8, 10, 12 bits
CAMERA TRIGGER AND SIGNALS	Trigger, Pretrigger (or, MemGate), Sync, IRIG-In & Analog Video are standard. IRIG-Out, Ready, and Event are available.
GB ETHERNET	Yes
VIDEO OUT	PAL, NTSC & HD Component (720p), SD-SDI and 720p HD-SDI
LENSING	F-mount with optional C-mount
OPERATING TEMPERATURE	10°C to 40°C



All specifications are subject to change. (Mar 25, 2008)

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VRI-0000200

EXHIBIT P367



Phantom v10

Provides 14-bit image depth, and 480 frames per second at a full resolution of 2400 x 1800 pixels

INSTRUMENTATION OR CINEMATOGRAPHY? IT'S YOUR CHOICE

The Phantom v10's CMOS sensor, offers 480 frames per second at its full resolution of 2,400 x 1,800 active pixels. At the HD resolution of 1920 x 1080 the v10 records 978 fps (standard mode), or 519 fps (enhanced mode).

While continuing the feature rich tradition, sensitivity and "ease-of-use" offered in previous Phantom camera models, the Phantom v10 offers new features such as an HD-SDI interface, Gigabit Ethernet, 14-bit depth, and larger DRAM image memory optioning to record more images over a longer record time.



- *Full frame 4:3 aspect ratio CMOS sensor composed of 2,400 x 1,800 pixels*
- *14-bit image depth (standard)*
- *481 frames per second (standard mode), 252 fps (enhanced mode), full resolution, up to 153,846 fps (standard mode), 148,148 fps (enhanced mode) "CAR" (Continuously Adjustable Resolution) in 96 x 8 pixel increments*
- *2400 ISO/ASA monochrome, 600 ISO/ASA color sensitivity equivalency*
- *Global (snap-shot) on-chip shuttering to 2 microseconds*
- *"EDR" Extreme Dynamic Range™ exposure control*
- *Auto Exposure control*
- *Up to 24 Gigabytes DRAM, 24 Gigabytes Flash memory (optional)*
- *IRIG-B timing capture, modulated or unmodulated, IRIG lock w/phase shift*
- *Continuous video output; NTSC, PAL, multiple HD-SDI output formats available*
- *Optional continuous data streaming up to 275 fps (8-bits) 175 fps (12-bits)*
- *Automated multiple session recording for remote unmanned operation*
- *Gigabit Ethernet or RS232 control*



V10 Specifications

FEATURES

Auto Exposure

"EDR" Extreme Dynamic Range™

Continuous data streaming (optional)

Continuous recording

Pre-trigger recording

On chip global shuttering

Strobe sync

Segmented image memory

Continuous color HD-SDI video output

IRIG-B timing capture with phase shift

10/100/Gigabit Ethernet

Sensor: 2400 x 1800 pixel CMOS sensor.

Image Bit Depth: 14-bit (standard)

Sensitivity: 2400 ISO/ASA mono-chrome, 600 ISO/ASA color

Frames per second (FPS): Full sensor; to 480 fps maximum; (standard mode), or 250 fps (enhanced mode)

Exposure Time: Variable, independent of sample rate (fps), to 2 microseconds

Trigger: Continuously variable pre/post

Imager Control: 10/100/Gigabit Ethernet, or RS232 serial interface

Preview and Focusing: Via computer monitor or continuous video out

Lens Mounts: Nikon mount standard. Many other lens mounts available, including C-mount

INPUTS/OUTPUTS: via integrated quick-release connector:

Trigger: Rising/falling TTL pulse w/filter, or switch closure

Sync Image: TTL pulse

Event Marker: TTL pulse or switch closure

Ready Signal: TTL pulse

IRIG-B Timing: IRIG-B code, modulated or unmodulated input, with IRIG-B output, lock, and variable phase shift

Continuous Data Streaming: Up to 275 fps (8-bits), 175 fps (12-bits)

Strobe Sync: TTL Pulse

RS232

Network: 10/100/Gigabit Ethernet

Video out: NTSC, PAL, and HD-SDI (720p, 1080p, 1080i, or 1080pfs at 24, 25, 59.9, and 60 fps)

Power: 20-36VDC/50W

MEMORY

Standard: 6 Gigabytes integral image memory records 1,422 images for 2.96 sec of continuous recording at 480 fps, full format (8-bits) or 813 images for 1.69 sec of continuous recording at 480 fps, full format (14-bits). Longer recording times for lower sample rates and allocated formats.

Optional: 12 Gigabytes integral image memory continuously records 2,890 images for 6.0 sec. (8-bits) or 1,651 images for 3.43 sec (14-bits) at 480 fps full frame, and 24 Gigabytes will record 5,825 images for 12.1 sec (8-bits) or 3,329 images for 6.92 sec (14-bits) at 480 fps full frame.

Optional: Non-Volatile Flash Memory, up to 24Gigabytes.

ENVIRONMENTAL

Ambient Temperature
32°F and 104°F (0°C and 40°C)

Maximum humidity: 80%, non-condensing, at 5°C

SOFTWARE

Phantom® operates in Windows XP Pro or Vista environments with familiar commands found in familiar places. Standard functions include:

Acquisition: Image capture, IRIG-B timing capture & standard time annotation. Field of view & focus. Sample rate & aspect ratio selection. Shutter speed. Histogram. Brightness, contrast, & gamma adjust. Trigger modes. Continuous record. Save & recall setups.

Analytical playback: Immediate playback of cine. Variable playback speed in forward or reverse, including freeze frame & endless loop. Random Go-to-Image. View single images at random from any cine. Tile/cascade multiple images on one screen. Timing data displayed with each image. Cine editor. Multi Cine Viewer.

Measurements: Linear or angular measurements. English and metric units. Generate Velocity, RPM, or 100 data points per measurement reports. Report files & images are compatible with Phantom, TEMA Starter Software or any spread-

sheet software, and image analysis software such as TrackEye®, Image Express®, or Falcon®.

Image processing: Smooth, sharpen, psuedocolor, negative image, and edge detection. Brightness, contrast & gamma adjust. 3x3 and 5x5 filter matrix for custom image processing.

File management: Organize, save, compress and export cines, or single images. File formats are compatible with most word processing, desktop, publishing, and presentation software.

DIMENSIONS

Size: 4.3 x 4.0 x 9.5 inch (HWD)
(10.9 x 10.16 x 24.13 cm) (HWD)

Weight: 7 lbs (3.18kg)

Power: 24VDC/1.5 Amp

Mounting: 1/4-20 inch and four 10-32 threaded hole pattern in base and top

Mounting Axis: Any position

Country of Origin: The United States of America

STANDARD ACCESSORIES

Phantom® software, Single user license*

6 Gigabyte integral image memory

Ethernet, Sync output pulse, trigger, pretrigger, video out, and IRIG-B

110/220VAC -24VDC International Power Adapter, 12 foot (3.7 m) power cord

One year service contract included

QUESTIONS?

For technical assistance, systems integration, custom options, or information on imaging techniques or training please call us toll free:

1.800.RESOLUTION

(US & Canada 1.800.737.6588)

For the most up-to-date information, specifications and options, please visit our website:

www.visionresearch.com

VISION RESEARCH

All specifications are subject to change. (May-08)

Phantom v10 Maximum Recording Speed vs. Image Size

The Phantom v10 camera system can record up to 480 frames per second using the full 2400 x 1800 pixel CMOS imaging sensor array. The operator may also specify other aspect ratios to increase speeds or extend recording times.

The chart below details the Phantom v10 aspect ratio choices available in the setup screen pull down menu. Using the CAR (Continuous Adjustable Resolution) feature, speeds between these values are continuously adjustable in 96 x 8 pixel increments.

STANDARD MODE		ENHANCED MODE	
RESOLUTION	RATE	RESOLUTION	RATE
2400 x 1800	480	2400 x 1800	252
1600 x 1200	1,016	1600 x 1200	544
1920 x 1080	978	1920 x 1080	519
1440 x 1440	943	1440 x 1440	509
1280 x 720	1,992	1280 x 720	1,082
1152 x 1152	1,419	1152 x 1152	779
960 x 720	2,619	960 x 720	1,464
960 x 480	3,902	960 x 480	2,188
768 x 768	2,919	768 x 768	1,667
768 x 576	3,872	768 x 576	2,216
576 x 576	4,756	576 x 576	2,818
576 x 288	9,280	576 x 288	5,555
480 x 480	6,420	480 x 480	3,902
192 x 192	24,242	192 x 192	17,391
96 x 96	51,282	96 x 96	43,010
96 x 8	153,846	96 x 8	148,148



All specifications are subject to change. (May-08)

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EXHIBIT P368



Phantom v9.1

Provides 14-bit image depth, and 1,000 frames per second at a full resolution of 1,632 x 1,200 pixels

HIGH RESOLUTION, HIGH SPEED, HIGH SENSITIVITY

With its CMOS sensor, the Phantom v9.1 offers 1,000, 14-bit, frames per second at a full resolution of 1,632 x 1,200 active pixels. Like its predecessor, the Phantom v9.0, the v9.1 preserves such feature as Gigabit Ethernet for camera control and file transfer, and the ability to segment a significantly larger DRAM image memory for multiple cine recording. In addition to these features, the v9.1 has added an HD-SDI interface, and the ability to continuously data stream 8-bit or 12-bit images.



- *Full frame 4:3 aspect ratio CMOS sensor composed of 1,632 x 1,200 pixels*
- *14-bit image depth (standard)*
- *1,000 frames per second full resolution, up to 153,846 fps maximum*
- *“CAR” (Continuously Adjustable Resolution) in 96 x 8 pixel increments*
- *2400 ISO/ASA monochrome, 600 ISO/ASA color sensitivity equivalency*
- *Global on-chip shuttering to 2 microseconds*
- *“EDR” Extreme Dynamic Range™ exposure control*
- *Auto Exposure control*
- *Up to 24 Gigabytes DRAM, 24 Gigabytes non-volatile flash memory (optional)*
- *IRIG-B timing capture, modulated or unmodulated, IRIG lock w/phase shift*
- *Continuous video output (NTSC, PAL, HD/SDI 720p, 1080p, 1080i, 1080psf)*
- *Optional continuous data streaming up to 500 fps (8-bits), 350 fps (12-bits)*
- *Automated multiple session recording for remote unmanned operation*
- *Gigabit Ethernet or RS232 control*



V9.1 Specifications

FEATURES

Auto Exposure

"EDR" Extreme Dynamic Range™

Continuous data streaming (optional)

Continuous recording

Pre-trigger recording

On chip global shuttering

Strobe sync

Segmented image memory

Continuous color HD-SDI video output

IRIG-B timing capture with phase shift

10/100/Gigabit Ethernet

Sensor: 1,632 x 1,200 pixel SR-CMOS sensor.

Image Bit Depth: 14-bit (standard)

Sensitivity: 2400 ISO/ASA mono-chrome, 600 ISO/ASA color

Frames per Second (FPS): Full sensor; to 1,000 fps

Allocated formats: to 153,846 fps with "CAR" (Continuous Adjustable Resolution) feature

Exposure Time: Variable, independent of sample rate (fps), to 2 microseconds

Trigger: Continuously variable pre/post

Imager Control: 10/100/Gigabit Ethernet, or RS232 serial interface

Preview and Focusing: Via computer monitor or continuous video out

Lens Mounts: Nikon mount standard. Many other lens mounts available, including C-mount

INPUTS/OUTPUTS: via integrated quick-release connector:

Trigger: Rising/falling TTL pulse w/filter, or switch closure

Sync Image: TTL pulse

Event Marker: TTL pulse or switch closure

Ready Signal: TTL pulse

IRIG-B Timing: IRIG-B code, modulated or unmodulated input, with IRIG-B output, lock, and variable phase shift

Continuous Data Streaming: Up to 500 fps (8-bits), 350 fps (12-bits)

Strobe Sync: TTL Pulse

RS232

Network: 10/100/Gigabit Ethernet

Video out: NTSC, PAL, and HD-SDI (720p, 1080p, 1080i, 1080psf at 24, 25, 59.9, and 60 fps)

Power: 24VDC/1.5 Amp

MEMORY

Standard: 6 Gigabytes integral image memory records 3,192 images for 3.19 sec of continuous recording at 1,000 fps, full format (8-bits) or 1,824 images for 1.82 sec of continuous recording at 1,000 fps, full format (14-bits). Longer recording times for lower sample rates and allocated formats.

Optional: 12 Gigabytes integral image memory continuously records 6,427 images for 6.43 sec. (8-bits) or 3,762 images for 3.67 sec (14-bits) at 1,000 fps full frame, and 24 Gigabytes will record 12,899 images for 12.9 sec (8-bits) or 7,370 images for 7.37 sec (14-bits) at 1,000 fps full frame.

Optional: Non-Volatile Flash Memory, up to 24Gigabytes.

ENVIRONMENTAL

Ambient Temperature

-14°F to +122°F (-10°C to + 50°C)

Maximum humidity: 80%, non-condensing, at 5°C

SOFTWARE

Phantom® operates in Windows XP Pro or Vista environments with familiar commands found in familiar places. Standard functions include:

Acquisition: Image capture, IRIG-B timing capture & standard time annotation. Field of view & focus. Sample rate & aspect ratio selection. Shutter speed. Histogram. Brightness, contrast, & gamma adjust. Trigger modes. Continuous record. Save & recall setups.

Analytical playback: Immediate playback of cine. Variable playback speed in forward or reverse, including freeze frame & endless loop. Random Go-to-Image. View single images at random from any cine. Tile/cascade multiple images on one screen. Timing data displayed with each image. Cine editor. Multi Cine Viewer.

Measurements: Linear or angular measurements. English and metric units. Generate Velocity, RPM, or 100 data points per measurement reports. Report files & images are compatible with Phantom, TEMA Starter Software or any spreadsheet software, and image analysis software such as TrackEye®, Image Express®, or Falcon®.

Image processing: Smooth, sharpen, psuedocolor, negative image, and edge detection. Brightness, contrast & gamma adjust. 3x3 and 5x5 filter matrix for custom image processing.

File management: Organize, save, compress and export cines, or single images. File formats are compatible with most word processing, desktop, publishing, and presentation software.

DIMENSIONS

Size: 4.3 x 4.0 x 9.5 inch (HWD) (10.9 x 10.16 x 24.13 cm) (HWD)

Weight: 7 lbs (3.18kg)

Power: 24VDC/1.5 Amp

Mounting: 1/4-20 inch and four 10-32 threaded hole pattern in base and top

Mounting Axis: Any position

Country of Origin: The United States of America

STANDARD ACCESSORIES

Phantom® software, Single user license*

6 Gigabyte integral image memory

Ethernet, Sync output pulse, trigger, pretrigger, video out, and IRIG-B

110/220VAC -28VDC International Power Adapter, 12 foot (3.7 m) power cord

One year service contract included

QUESTIONS?

For technical assistance, systems integration, custom options, or information on imaging techniques or training please call us toll free:

1.800.RESOLUTION

(US & Canada 1.800.737.6588)

For the most up-to-date information, specifications and options, please visit our website:

www.visionresearch.com

VISION RESEARCH

All specifications are subject to change. (Oct-07)

Phantom v9.1 Maximum Recording Speed vs. Image Size

The Phantom v9.1 camera system records up to 1,016 frames per second using the full 1632 x 1200 pixel CMOS imaging sensor array. The operator may specify other aspect ratios to increase recording speeds or extend recording times.

The chart below details some of the Phantom v9.1 aspect ratio choices available from a resolution and sample rates pull down menu. Using the CAR (Continuous Adjustable Resolution) feature, resolution/speed settings between these values are continuously adjustable in 96 x 8 pixel increments.

RESOLUTION	RATE
1632 x 1200	1,016
1632 x 960	1,268
1632 x 480	2,520
1632 x 240	4,975
960 x 960	1,972
960 x 480	3,906
960 x 240	7,648
480 x 480	6,420
480 x 240	12,422
480 x 120	23,391
480 x 64	36,603
96 x 96	51,948
96 x 48	81,632
96 x 32	100,000
96 x 16	129,032
96 x 8	153,846



All specifications are subject to change. (Oct-07)

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EXHIBIT P369

DATA SHEET

For the most current version visit www.visionresearch.com
or sales@visionresearch.com Rev. Mar 2012



Phantom ir300

Phantom® ir300

Extend response beyond visible light spectrum

800 x 600 at up to 6688 fps

Familiar Phantom camera use model

Key Features:

- Extended-range CMOS sensor
- 800 x 600 full-frame resolution
- 14-bit image depth
- 6,688 fps at full resolution
- 190,000 fps at reduced resolution
- Continuously adjustable resolution in 32/8 increments
- 4800 ISO monochrome
- Global on-chip shuttling to 1 microsecond
- Extreme Dynamic Range (EDR) and Auto Exposure
- 8GB or 16GB versions
- IRIG-B timing capture, modulated or unmodulated, IRIG lock with phase shift
- Video output (NTSC, PAL, HD-SDI)
- Gb Ethernet control

Additional Features:

- PIV features (shutter off)
- Automated continuous recording for remote, unmanned operation
- Optional external mechanical shutter for hands-off black references
- Optional Canon EOS lens mount for remote lens control
- Nikon f-mount standard, PL, C-, and Canon EOS available
- 0°C to 40°C operating temperature, 80% non-condensing humidity
- Power: 24VDC with AC adapter included

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Using a proprietary sensor design and existing Phantom v7.3 camera electronics, the Phantom ir300 provides extended spectral response beyond visible light into the infrared spectrum. The extended IR response allows you to image events not previously visible to CMOS-based digital high-speed cameras. (The ir300 is not a thermal imaging camera.)

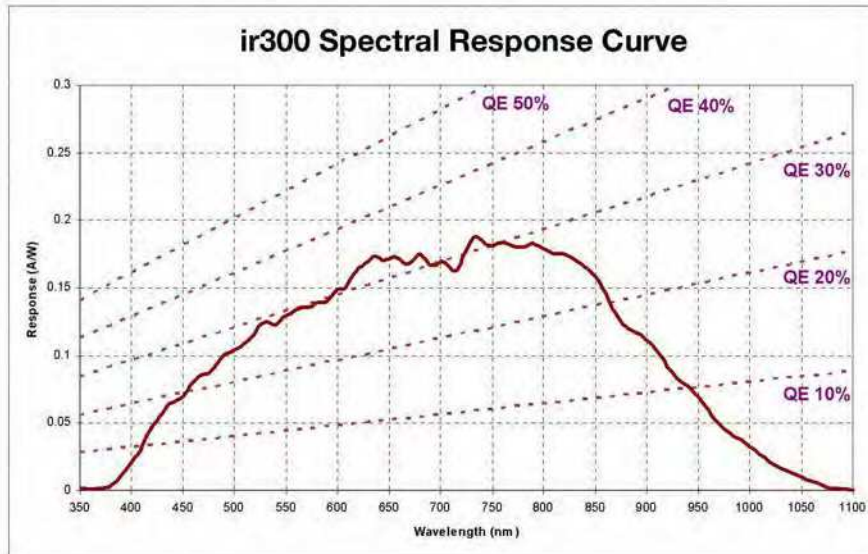
The Phantom ir300 is ideal for nocturnal animal studies, security applications, pulsed laser targeting applications, PIV, combustion and other uses where light sources in the 600nm to 1100nm spectrum are used. While most CMOS sensors start losing sensitivity rapidly above 600nm, the Phantom ir300 extends that point to 800nm giving it a usable range to about 1100nm.

DATA SHEET

Phantom® ir300

With the new ir300, you can use IR LEDs or lasers to illuminate events or capture 'self illuminating' phenomenon in the 600nm -1100nm range.

The Phantom ir300 behaves just like a v7.3 at wavelengths up to 600nm, so it is a general-purpose monochrome digital high-speed camera also!



The Phantom ir300 has a 4:3 aspect ratio and uses a proprietary 800 x 600 pixel CMOS sensor with 14-bit depth. At full resolution the ir300 can take over 6,500 frames-per-second (fps). At reduced resolutions, the camera can shoot up to 190,000 fps.

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users. Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

ir300 FRAME RATES	
RESOLUTION	RATE
800 x 600	6,688
640 x 480	10,101
320 x 240	33,057
512 x 512	11,527
512 x 384	15,151
512 x 256	21,978
512 x 128	40,000
512 x 64	67,796
256 x 512	20,000
256 x 256	36,697
256 x 128	63,492
256 x 64	100,000
128 x 128	88,888
128 x 64	129,032
64 x 64	148,148
32 x 32	190,476

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



AMETEK
MATERIALS ANALYSIS DIVISION

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EXHIBIT P370

DATA SHEET

For the most current version visit www.visionresearch.com
Subject to change Rev. Mar 2012



Phantom® v12.1 High-Speed Digital Camera (with CineMag® interface)

v12.1

High-Definition

1280 x 800

1 million fps

sub- μ s shutter

Phantom CineMag® compatible

Key Features:

Up to 6242 frames-per-second (fps) at full resolution.
Maximum fps: 680,000 standard, 1,000,000 optional

1280 x 800 CMOS sensor

Exposure Time (shutter speed): 1 μ s standard
Sub-microsecond shuttering: 300 ns, programmable in
18 ns increments (optional)

High-resolution timing system: Better than 20 ns resolution

Extreme Dynamic Range (EDR): Two different exposures
within a single frame

Internal Shutter: Hands-free/remote current session
reference (CSR)

Memory Segmentation: Up to 63 segments

Non-volatile, hot-swappable Phantom CineMag
memory magazines (128 GiB, 256 GiB & 512 GiB)

CineMag to CineStation®

Range Data input

Built-in Memory: 8 GiB, 16 GiB, 32 GiB

ISO (ISO-12232 SAT): 7000 Mono, 2100 Color

Pixel Bit-depth: 8- and 12-bit

Gb Ethernet

View recordings immediately via video-out port

Versatile Dual HD-SDI ports configured to meet your needs

AMETEK
MATERIALS ANALYSIS DIVISION

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

One million fps is the new benchmark in high-speed imaging. Introducing the Phantom v12.1 – a megapixel camera capable of taking 1,000,000 pictures-per-second.

With the Phantom v12 camera, Vision Research broke the high-speed digital imaging speed barrier. With the v12.1, the fastest camera now adds remote/automatic black referencing, versatile dual HD-SDI outputs, a component viewfinder port, high-speed synchronization and range data input.

Take the wide view with our custom-designed 1280 x 800 CMOS sensor. The wide aspect ratio of the v12.1 allows you to see more of the event you are recording with a "widescreen" view. The v12.1's widescreen aspect ratio also provides the unique ability to shoot 1280 x 720 HD with a one megapixel camera.

v12.1

Phantom v12.1
a megapixel
camera
capable
of taking
1,000,000
pictures-
per-
second...

Get 6,242 frames-per-second (fps) at full resolution. At lower resolutions, you will get even higher frame rates, up to 1,000,000 fps (optional).

With an active pixel size of 20 microns and improved quantum efficiency, the Phantom v12.1 camera has **sensitivity** superior to our acclaimed v7.3. So, even if you are using our sub-microsecond shuttering, you'll get the highest sensitivity with the lowest noise possible.

That's right. You can eliminate blur and see the most minute detail by using our optional **sub-microsecond shuttering**. Down to 300 nanoseconds, programmable in 18 ns increments.

Each camera supports **8- and 12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12-bits, you can pull more detail out of the image.

The v12.1's **high-resolution timing** system yields a timing resolution of better than 20 ns. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, a frame synchronization signal is now available via a dedicated BNC for easier cabling and increased signal integrity. This makes the camera perfect for **PIV applications** with a 500 nanosecond straddle time and no image lag.

Of course, the v12.1 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an optional **internal shutter** for shading the sensor when doing a session-specific black reference (CSR). Whenever you do a CSR from the Phantom Software, the shutter closes automatically. You no longer have to manually shade the sensor with a lens cap! With the optional **Canon EOS** lens mount installed you get remote control over lens aperture and focus, too. This enables **complete remote control** in environments where you cannot easily access the camera.

The v12.1 comes with 8 GiB of high-speed dynamic RAM standard, but you can order 16 GiB or 32 GiB versions. Our **segmented memory** allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

Or, record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. Continuously record full resolution cines into non-volatile memory at up to 800 fps. That's just over 2 minutes into the 128 GiB CineMag, 4.25 minutes into the 256 GiB CineMag, or 8.5 minutes into the 512 GiB CineMag. Or, record at even higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera. Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via Gb Ethernet, dual HD-SDI, or Component Video outputs. (A 10Gb Ethernet interface is available.)

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique **Range Data** input.

View your recording immediately in a variety of formats. Our Versatile **Dual HD-SDI** ports can be configured to meet your monitoring and playback needs. Use them together for 4:4:4 video out; or, use them independently – one for playback while the other is always live. A component video viewfinder port has been added so any viewfinder compatible with our Phantom HD camera can now be used with the v12.1.

	128	256	512	768	1024	1280
8	1,000,000	980,392	763,941	632,511	534,759	463,177
16	852,514	683,994	490,196	381,970	312,891	264,970
32	560,224	423,190	284,171	214,684	172,503	143,472
64	330,469	240,096	155,207	114,220	90,637	74,934
96	236,239	168,067	106,371	77,911	61,402	50,709
128	183,250	128,998	81,024	59,059	46,464	38,296
256	96,749	66,997	41,483	30,042	23,548	19,362
512	49,724	34,140	20,978	15,156	11,854	9,735
768	33,479	22,906	14,042	10,134	7,921	6,501
800	32,161	22,006	13,485	9,730	7,605	6,242

H	V	FPS*
1280	800	6,242
1280	720	6,933
1024	768	7,921
1024	512	11,854
800	600	11,364
720	576	13,485
640	480	18,769
512	512	20,978
512	384	27,865
512	256	41,483
512	128	81,024
512	64	155,207
512	32	284,171
320	240	54,516
256	256	66,997
256	128	128,998
256	64	240,096
256	32	423,190
256	16	683,994
256	8	980,392
128	128	183,250
128	96	236,239
128	64	330,469
128	32	560,224
128	16	852,514
128	8	1,000,000

**Typical results; frame rates > 680,000 assume the FAST option is installed.*

DATA SHEET

v12.1

Additional Features:

Analog Viewfinder Out: PAL, NTSC & HD Component (720p)

Lensing: F-mount, C-mount, PL-mount, Canon EOS

Size (without lens): 12.25 x 5.5 x 5.0 in. (L,W,H)
31.1 x 14 x 12.7 cm

Weight (without lens): 12 lbs (5.4 Kg)

Power: 90 Watts @ 24 VDC, without CineMag

Operating Temperature: 0°C to 40°C @ 8% to 80% RH

Storage Temperature: -10°C to 55°C

Non-operational Shock: 33G, half sine wave, 11ms,
all axes without lens

Operational Shock: 30G, half sine wave, 11ms, 10 times all
axes (without CineMag or lens) to
Mil-Std-810 G

Operational Vibration: 25G, 5-500 Hz, all axes



Phantom® v12.1, sideview (with CineMag® interface)

The v12.1 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v12.1. And, we'll ship you a trial version of Image System's TEMA Starter for Phantom for motion analysis applications.

The v12.1 comes in two base models, either with or without a CineMag interface. The base models operate at up to 680,000 fps and 1µs exposure.

An option is available to enable 1,000,000 fps and 300 ns exposure. All models come in either color or monochrome configurations.



Phantom® v12.1, rearview (with CineMag® interface)

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Focused

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www.visionresearch.com

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PRELIMINARY

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For the most current version visit www.visionresearch.com
 Contact us at info@visionresearch.com or call 1-800-451-7272



Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

You asked for it – the Phantom v210. A **one megapixel digital high-speed camera capable of taking more than 2000 frames-per-second (fps)** at full 1280 x 800 resolution. And, up to 300,000 fps at reduced resolution.

Take the wide view with our custom-designed 1280 x 800 CMOS sensor. The wide aspect ratio of the v210 – 25% wider than square cameras – allows you to keep moving targets in-frame longer and see more of the event you are recording. The v210's widescreen aspect ratio also provides the unique ability to shoot 1280 x 720 HD with a one megapixel camera.

With an active pixel size of 20 microns and improved quantum efficiency, the Phantom v210 camera has **sensitivity you need** for even the most challenging lighting conditions.

v210

1 Megapixel at over 2000 fps

Widescreen 1280 x 800 resolution

Maximum speed 300,000 fps

Minimum shutter 2 μ s

Phantom CineMag® compatible

Key Features:

Custom-designed 1280 x 800 CMOS sensor

Over 2000 frames-per-second (fps) at full-resolution

High-resolution timing system: Better than 40ns resolution

Extreme Dynamic Range (EDR): two different exposures within a single frame

Optional Internal Shutter: hands-free/remote current session reference (CSR)

Memory Segmentation: Up to 63 segments

Non-volatile, hot-swappable Phantom CineMag memory magazines (128 GiB, 256 GiB & 512 GiB)

CineMag to CineStation®

Range Data Input

Built-in Memory: 8 GiB, 16 GiB, 32 GiB

ISO (ISO-12232 SAT method): 13,000 T Mono, 3,900 T Color

Pixel Bit-depth: 8- and 12-bit

Gb Ethernet

View recordings immediately via video-out port

4:2:2 HD-SDI output

AMETEK®
MATERIALS ANALYSIS DIVISION

v210

Phantom v210,
a 1 megapixel
digital high-
speed camera
that shoots
over 2000 fps
at 1280 x 800
resolution.

You can eliminate blur and see the most minute detail by using **short exposure times**. On the v210, you can set the exposure to as little as 2 microseconds.

The camera supports **8- and 12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12-bits, you can pull more detail out of the image.

The v210's **high-resolution timing system** yields a timing resolution of better than 40 ns. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, a frame synchronization signal is now available via a dedicated BNC for easier cabling and increased signal integrity.

Of course, the v210 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with auto exposure, the camera adjusts to changing lighting conditions automatically.

There is an **optional internal shutter** that can cut off all light to the sensor when doing a session-specific black reference (CSR). You can now do remote CSRs through software control without the need to manually cover the lens! With the optional **Canon EOS** lens mount installed you get remote control over lens aperture and focus, too. This enables **complete remote control** in environments where you cannot easily access the camera.

The v210 comes with 8 GiB of high-speed dynamic RAM standard, but you can order 16 GiB or 32 GiB versions. Our segmented memory allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

Or, record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. Continuously record full resolution cines into non-volatile memory at up to 800 fps. That's just over 2 minutes into the 128 GiB CineMag, 4.25 minutes into the 256 GiB CineMag, or 8.5 minutes into the 512 GiB CineMag. Or, record at even higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a CineStation connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera. Keep them in their original cine raw format, or convert them

to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10Gb Ethernet, 4:4:4 HD-SDI, or Component Video outputs.

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique Range Data input.

View your recordings immediately in a variety of formats either through the HD-SDI ports on the camera, or through the component video viewfinder port. There are two HD-SDI ports each with 4:2:2 video out. And, any viewfinder compatible with our Phantom HD camera can now be used with the v210. The v210 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v210.

The v210 comes in two base models, either with or without a CineMag interface.

All models come in either color or monochrome configurations.

H	V	FPS*
1280	800	2,190
1280	720	2,430
1024	800	2,700
1024	512	4,200
800	800	3,050
800	600	4,060
720	480	5,820
600	480	6,850
512	512	7,810
480	360	11,000
360	240	20,600
256	256	26,500
256	128	50,000
128	128	76,100
128	64	129,800
128	32	200,000
128	8	300,000

**Typical results*



PRELIMINARY

DATA SHEET

v210

Additional Features:

Analog Viewfinder Out: PAL, NTSC & HD Component (720p)

4:2:2 HD-SDI out

Lensing: F-mount, C-mount, PL-mount, Canon EOS

Size (without lens): 12.25 x 5.5 x 5.0 in. (L,W,H)
31.1 x 14 x 12.7 cm

Weight (without lens): 12 lbs (5.4 Kg)

Power: 60 Watts @ 24 VDC, without CineMag

Operating Temperature: 0°C to 40°C @ 8% to 80% RH

Storage Temperature: -10°C to 55°C

Non-operational Shock: 33G, half sine wave, 11ms,
all axes without CineMag

Operational Shock: 30G, half sine wave, 11ms,
10 times all axes (without CineMag
or lens) to Mil-Std-810 G

Operational Vibration: 25G, 5-500 Hz, all axes without
CineMag



Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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EXHIBIT P372

DATA SHEET

For the most current version visit www.visionresearch.com
Go by the name: Phantom v310



v310

1 Megapixel at 3250 fps

Widescreen 1280 x 800 resolution

Maximum speed 500,000 fps

Minimum shutter 1 μ s

Phantom CineMag[®] compatible

Key Features:

Custom-designed 1280 x 800 CMOS sensor

3250 frames-per-second (fps) at full-resolution

High-resolution timing system: Better than 40 ns resolution

Extreme Dynamic Range (EDR): two different exposures within a single frame

Optional Internal Shutter: hands-free/remote current session reference (CSR)

Memory Segmentation: Up to 63 segments

Non-volatile, hot-swappable Phantom CineMag memory magazines (128 GiB, 256 GiB & 512 GiB)

CineMag to CineStation[®]

Range Data Input

Built-in Memory: 8 GiB, 16 GiB, 32 GiB

ISO (ISO-12232 SAT method): 13,000 T Mono, 3,900 T Color

Pixel Bit-depth: 8- and 12-bit

Gb Ethernet

View recordings immediately via video-out port

4:2:2 HD-SDI output

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO[®]

Vision Research sets a new standard for affordable, high-performance 1 megapixel digital high-speed cameras with the new Phantom v310.

Take the wide view with our custom-designed 1280 x 800 CMOS sensor. The wide aspect ratio of the v310 allows you to keep moving targets in-frame longer and see more of the event you are recording. The v310's widescreen aspect ratio also provides the unique ability to shoot 1280 x 720 HD with a one megapixel camera.

Get 3,250 frames-per-second (fps) at full resolution. At lower resolutions, you will get even higher frame rates, up to 500,000 fps.

v310

Phantom v310,
setting a
new price/
performance
standard for
1 megapixel
digital
high-speed
cameras.

With an active pixel size of 20 microns and improved quantum efficiency, the Phantom v310 camera has **sensitivity** you need for even the most challenging lighting conditions.

You can eliminate blur and see the most minute detail by using **short exposure times**. On the v310, you can set the exposure to as little as 1 microsecond.

The camera supports **8- and 12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image.

The v310's **high-resolution timing system** yields a timing resolution of better than 40 ns. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, a frame synchronization signal is now available via a dedicated BNC for easier cabling and increased signal integrity. This makes the camera perfect for **PIV applications** with a 700 nanosecond straddle time and no image lag.

Of course, the v310 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an optional **internal shutter** that can cut off all light to the sensor when doing a session-specific black reference (CSR). You can now do **remote CSRs** through software control without the need to manually cover the lens! With the optional **Canon EOS** lens mount installed you get remote control over lens aperture and focus, too. This enables **complete remote control** in environments where you cannot easily access the camera.

The v310 comes with 8 GiB of high-speed dynamic RAM standard, but you can order 16 GiB or 32 GiB versions. Our **segmented memory** allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

Or, record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. Continuously record full resolution cines into non-volatile memory at up to 800 fps. That's just over 2 minutes into the 128 GiB CineMag, 4.25 minutes into the 256 GiB CineMag, or 8.5 minutes into the 512 GiB CineMag. Or, record at

even higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera. Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10Gb Ethernet, HD-SDI, or Component Video outputs.

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique **Range Data** input.

View your recordings immediately in a variety of formats either through the HD-SDI ports on the camera, or through the component video viewfinder port. There are **two HD-SDI ports** each with 4:2:2 video out. And, any viewfinder compatible with our Phantom HD camera can now be used with the v310.

The v310 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v310.

The v310 comes in two base models, either with or without a CineMag interface. All models come in either color or monochrome configurations.

H	V	FPS*
1280	800	3,250
1280	720	3,650
1024	800	4,040
1024	512	6,300
720	480	8,750
640	480	10,300
512	512	11,700
256	256	40,500
128	128	123,650
128	64	228,680
128	32	397,500
128	8	500,000

**Typical results*



DATA SHEET

v310

Additional Features:

Analog Viewfinder Out: PAL, NTSC & HD Component (720p)

4:2:2 HD-SDI out

Lensing: F-mount, C-mount, PL-mount, Canon EOS

Size (without lens): 12.25 x 5.5 x 5.0 in. (L,W,H)
31.1 x 14 x 12.7 cm

Weight (without lens): 12 lbs (5.4 Kg)

Power: 60 Watts @ 24 VDC, without CineMag

Operating Temperature: 0°C to 40°C @ 8% to 80% RH

Storage Temperature: -10°C to 55°C

Non-operational Shock: 33G, half sine wave, 11ms,
all axes without CineMag

Operational Shock: 30G, half sine wave, 11ms, 10 times
all axes (without CineMag or lens) to
Mil-Std-810 G

Operational Vibration: 25G, 5-500 Hz, all axes without
CineMag

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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EXHIBIT P373

DATA SHEET

For the most current version visit www.visionresearch.com
or email info@visionresearch.com



v710

Ultra-fast – 1.4 million fps

1280 x 800 at 7500 fps

300 ns digital exposure

Phantom CineMag® compatible

Key Features:

Over 7500 frames-per-second (fps) at full resolution.

Maximum fps (128 x 8): 680,000 standard, 1,400,000 (optional & export controlled)

1280 x 800 CMOS sensor

Exposure Time (shutter speed): 1 μs standard

Sub-microsecond shuttering: 300 ns (optional & export controlled)

High-resolution timing system: Better than 20 ns resolution

Extreme Dynamic Range (EDR): Two different exposures within a single frame

Internal Shutter: Hands-free/remote current session reference (CSR)

Memory Segmentation: Up to 63 segments

Non-volatile, hot-swappable Phantom CineMag memory magazines (128 GiB, 256 GiB & 512 GiB)

Range Data Input

Built-in Memory: 8 GiB, 16 GiB, 32 GiB

ISO (ISO-12232 SAT method): 13,000 T Mono, 3,900 T Color

Pixel Bit-depth: 8- and 12-bit

Gb Ethernet

View recordings immediately via video-out port

Versatile Dual HD-SDI ports configured to meet your needs

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Introducing the Phantom v710 – a megapixel camera capable of taking 1,400,000 pictures-per-second.

Building on the architecture of the award winning Phantom v12.1 digital high-speed camera, the Phantom v710 goes beyond ultra-high-speeds and delivers the user-convenience features you need: remote/automatic black referencing, Versatile Dual HD-SDI outputs, a component viewfinder port, high-speed synchronization, range data input and Phantom CineMag support.

Take the wide view with our custom-designed 1280 x 800 CMOS sensor. The wide aspect ratio of the v710 – 25% wider than square cameras – allows you to keep moving targets in-frame longer and see more of the event you are recording. The v710's widescreen aspect ratio also provides the unique ability to shoot 1280 x 720 HD with a one megapixel camera.

v710

Phantom v710
a megapixel
camera
capable
of taking
1,400,000
pictures-
per-
second...

Get over 7500 frames-per-second (fps) at full megapixel resolution. At lower resolutions, you will get even higher frame rates, up to **1,400,000 fps** (optional).

With an active pixel size of 20 microns and improved quantum efficiency, the Phantom v710 camera has unsurpassed **sensitivity**. So, even if you are using our sub-microsecond shuttering, you'll get the highest sensitivity with the lowest noise possible.

That's right. You can eliminate blur and see the most minute detail by using our optional **sub-microsecond shuttering**. Down to 300 nanoseconds, programmable in 18 ns increments.

Each camera supports **8- and 12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12-bits, you can pull more detail out of the image.

The v710's **high-resolution timing** system yields a timing resolution of better than 20 ns. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, a frame synchronization signal is now available via a dedicated BNC for easier cabling and increased signal integrity. This makes the camera perfect for **PIV applications** with a 500 nanosecond straddle time and no image lag. Another PIV-specific feature is the v710's unique shutter-off setting which keeps the electronic global shutter open throughout the entire frame acquisition time allowing external strobe lights or pulsed lasers to control the exposure for each frame.

Of course, the v710 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an **internal shutter** for shading the sensor when doing a session-specific black reference (CSR). Whenever you do a CSR from the Phantom Software, the shutter closes automatically. You no longer have to manually shade the sensor with a lens cap! With the optional **Canon EOS** lens mount installed you get remote control over lens aperture and focus, too. This enables **complete remote control** in environments where you cannot easily access the camera.

The v710 comes with 8 GiB of high-speed dynamic RAM standard, but you can order 16 GiB or 32 GiB versions. Our **segmented memory** allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

Or, record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. Continuously record full resolution cines into non-volatile memory at up to 800 fps. That's just over 2 minutes into the 128 GiB CineMag, 4.25 minutes into the 256 GiB CineMag, or 8.5 minutes into the 512 GiB CineMag. Or, record at even higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera. Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10Gb Ethernet, 4:4:4 HD-SDI, or Component Video outputs.

H	V	FPS
1280	800	7,500
1280	720 (720p)	8,360
1024	768	9,520
896	480 (DVD)	17,000
768	576 (PAL)	16,100
768	480 (NTSC)	19,300
640	480	22,400
512	512	25,000
512	256	49,500
512	128	97,200
384	256	60,900
256	256	79,000
256	128	153,200
256	64	288,800
128	128	215,600
128	64	397,100
128	32	685,800
128	16*	1,077,500
128	8*	1,400,000

**Assumes FAST option installed, option is export controlled*



DATA SHEET

v710



Additional Features:

- Analog Viewfinder Out: PAL, NTSC & HD Component (720p)
- Lensing: F-mount, C-mount, PL-mount, Canon EOS
- Size (without lens): 12.25 x 5.5 x 5.0 in. (L,W,H)
31.1 x 14 x 12.7 cm
- Weight (without lens): 12 lbs (5.4 Kg)
- Power: 90 Watts @ 24 VDC, without CineMag
- Operating Temperature: 0°C to 40°C @ 8% to 80% RH
- Storage Temperature: -10°C to 55°C
- Non-operational Shock: 33G, half sine wave, 11ms, all axes without lens
- Operational Shock: 30G, half sine wave, 11ms, 10 times all axes (without CineMag or lens) to Mil-Std-810 G
- Operational Vibration: 25G, 5-500 Hz, all axes

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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EXHIBIT P374

DATA SHEET

For the most current version visit www.visionresearch.com
Subject to change. Rev. Mar. 2012

Phantom® v-Series Family of Digital High- Speed Cameras

Key Features:

In 2009, we introduced several exciting new members of the v-Series family that bring a new level of price/performance to the high-speed imaging marketplace:

Phantom v210: Ideal for megapixel applications requiring around 2,000 fps. Attractively priced, yet packed with powerful features. A wide variety of options let you configure a camera that exactly meets your needs and budget.

Phantom v310: Unrivaled performance in its price range, the v310 is quickly becoming our most popular camera ever. It has the performance and features to adapt to a wide variety of applications. Get over 3,000 fps at megapixel resolution.

Phantom v640: Four megapixels with unsurpassed sensitivity. When you need maximum spatial resolution, but can't afford to give up speed or sensitivity, the v640 is the camera for you.

Phantom v12.1: The original speed demon. The award winning v12.1 camera was the first CMOS camera to break the 1,000,000 fps barrier. With a new price point, this speedster is the obvious choice for applications demanding speed, versatility, and proven performance.

Phantom v710: The newest speed demon, the v710 is capable of taking 1,400,000 pictures each second (at reduced resolution). This is the ultimate high-performance digital high-speed camera that will allow you to see things that no one has ever seen before.

AMETEK®
MATERIALS ANALYSIS DIVISION



Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Whether you are studying crack propagation in a metal alloy, aerosol spray patterns, air flow around a side-view mirror, the biomechanics of an Olympian athlete, the efficacy of shaped explosive charges, or the effects of a bird strike on a jet engine, when you need a **high-speed imaging system** you can rely on, turn to Vision Research.

Our v-Series family of digital high-speed cameras has been around for over 15 years. The v2.0 was introduced in 1993. And, the v4.0 – in 1999 – was the first ever **CMOS-based digital high speed camera** introduced to replace film-based technology. We've been improving the state-of-the-art in high-speed imaging with each new family member introduced since then – whether the first-ever megapixel camera capable of taking 1000 frames-per-second (v5.0), the first-ever 4-megapixel camera (v10), the first digital camera to break the 1,000,000 frames-per-second (fps) barrier (v12), or the first high-speed imaging system qualified to fly on board a NASA space launch vehicle.

DATA SHEET

v-Series



when it's too fast to see, and too important not to.

These cameras all have a common set of breakthrough features that propel them ahead of any competition:

Widescreen Aspect Ratio: Take the wide view with a **1.6:1** aspect ratio – 25% wider than traditional square cameras. Keep more of your moving target in-frame longer.

CineMag Compatibility: Each camera has an optional Phantom CineMag interface. CineMags are non-volatile, hot-swappable, removable storage for Phantom cameras. **Now you can take multiple shots back-to-back**, saving each shot to the CineMag without the need for timely downloads between shots. Or, at recording speeds up to about 800 megapixels/second, record directly to the CineMag and achieve very long record times.

Internal Mechanical Shutter (optional on some models): All digital high-speed cameras require a periodic calibration to correct for differences in the analog characteristics of each photo site. Poor calibration results in pesky imaging artifacts that can both look bad and interfere with motion analysis software. This calibration requires that the sensor be completely shaded from light so a "black reference" can be established. This used to mean placing a lens cap on the camera during calibration. With Vision Research's unique internal mechanical shutter, this lens shading can be automatically and/or remotely.

HD-SDI video ports: Each v-Series camera has two HD-SDI ports. On the v210 and v310, these ports output identical 4:2:2 HD-SDI signals (with an on-screen display available on one of them.) On the other members of the v-Series family, these Versatile Dual HD-SDI ports are configurable. They can be two identical 4:2:2 signals, a single dual-link 4:4:4 signal, or one can be configured for a 4:2:2 live feed, while the other is available for 4:2:2 slow-motion playback – ideal for use in sports broadcast.

Image-Based Auto-Trigger: Set up the camera to trigger based on changes to the live image. Trigger from hard-to-catch intermittent events, and even trigger multiple cameras simultaneously based on changes in the image.

Extreme Dynamic Range (EDR): By taking two exposures in a single frame, Vision Research's unique Extreme Dynamic Range feature actually allows you to see detail in what otherwise might be overexposed areas of the image. Imaging "looking through" flames, or getting equally stunning detail out of both the dark areas and bright areas of a high contrast subject.

Automatic Exposure (AE): An essential feature when shooting outdoors, the camera exposure adjusts to lighting conditions. No more underexposed images when a cloud passes over, for example.

Camera	Resolution	FPS at Full Resolution	Maximum FPS	Minimum Exposure	Sensitivity (ISO-12232)	EDR / AE	Versatile Dual HD-SDI	Image-Based Auto-Trigger	Internal Mechanical Shutter	CineMag Compatible
v210	1280 x 800	> 2,000	300,000	2 µs	7000 Mono 2100 Color	Yes	No, 2 xHD-SDI ports	Optional	Optional	Optional
v310	1280 x 800	> 3,000	500,000	1 µs	7000 Mono 2100 Color	Yes	No, 2 xHD-SDI ports	Optional	Optional	Optional
v640	2560 x 1600	> 1,500	300,000	1 µs	4000 Mono 1000 Color	Yes	Yes	Standard	Standard	Optional
v12.1	1280 x 800	> 6,000	1,000,000 optional 680,000 standard	300 ns optional 1 µs standard	7000 Mono 2100 Color	Yes	Yes	Optional	Optional	Optional
v710	1280 x 800	> 7,500	1,400,000 optional 723,000 standard	300 ns optional 1 µs standard	7000 Mono 2100 Color	Yes	Yes	Standard	Standard	Optional

Focused

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EXHIBIT P375

DATA SHEET

For the most current version visit www.visionresearch.com
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Phantom® 1 Megapixel v-Series Cameras

Choose the model that best fits your performance requirements and budget

Advanced features are standard on these models

Each model is available with or without CineMag compatibility and On-Camera Controls

Key Features:

- Custom-designed 1280 x 800 CMOS sensor
 - Extreme Dynamic Range (EDR): two exposures per frame
 - Internal Mechanical Shutter mechanism for hands-free/remote CSRs
 - Memory Segmentation: up to 63 segments
 - Non-volatile, hot-swappable Phantom CineMag memory magazines
 - CineMag interface is optional on all models
 - Range Data Input: embed tracker data into recorded cine file
 - 8GB, 16GB or 32GB of internal high-speed memory
 - ISO (ISO-12232 SAT method):
 Mono: 20,000 T and 6400 D
 Color: 2500 T and 2000 D
 - Pixel Bit-Depth: 8-, 12-bit
 - Gb Ethernet
- The v711 and v611 support a FAST option that provides frame rates of 1,000,000 fps or more as well as sub-microsecond exposure times (export controlled)

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Our line of 1 megapixel cameras has several members. This data sheet covers the Phantom v411, v611, and v711. Be sure to check out our ultrahigh-speed line of 1 megapixel cameras also – including the new v2512.

All models feature a widescreen 1280 x 800 CMOS sensor – 25% wider than most competitive models – allowing you to **keep moving targets in-frame longer and see more of the event you are recording.** The wide sensor also allows you to get true 1280 x 720 HD images from a 1Mpx camera.

With a pixel size of 20 microns and improved quantum efficiency, **these cameras have the sensitivity you need** for even the most challenging lighting conditions.

Minimum exposure time of 1 microsecond (300 nanoseconds on the v711 with the FAST option) allows you to **eliminate blur and allow you to see the smallest of details.**

Phantom 1 Mpx Cameras



Phantom v411

Throughput:

v411 - 4Gpx/s

v611 - 6Gpx/s

v711 - 7Gpx/s

**MAXIMUM SPEEDS AT
VARIOUS RESOLUTIONS**

Resolution		
v411	v611	v711
1280 x 800		
4200	6240	7530
1280 x 720		
4670	6930	8360
512 x 512		
13,900	20,970	25,000
256 x 256		
44,100	66,990	79,000
128 x 8		
600,000	1,000,000*	1,400,000*

*With FAST option installed

With throughput specifications ranging from 4 gigapixels-per-sec (Gpx/s) to 7Gpx/s, **there is a model to meet your frame-rate requirements.**

At 4Gpx/s, the v411 can take over 4000 frames-per-second (fps) at full resolution. With 6Gpx/s the v611 tops out at over 6000 fps. A 7Gpx/s camera (the v711) can take over 7000 fps at full resolution (7530 fps, actually!) Top speeds at reduced resolution range from 300,000 fps to 1,400,000 fps depending on camera model.

These cameras support both 8- and 12-bit pixel depth. **Smaller bit-depth gives you more recording time** and smaller files. **Greater bit-depth gives you more gray levels** and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image, an essential requirement for most motion analysis applications.

Phantom's high-accuracy timing system means improved frame rate, frame synchronization and exposure accuracy. And a frame-synchronization (F-SYNC) signal is now available on a dedicated BNC connector on the camera connector panel for **easier cabling and increased signal integrity.**

The camera models offer the Extreme Dynamic Range feature – pioneered by Vision Research. This gives you the ability to **get two different exposures within a single frame** so areas that would otherwise be overexposed contain image detail. And, with Auto Exposure, **the camera adjusts to changing lighting conditions** automatically.

There is an internal mechanical shutter that can cut off all light to the sensor when doing a session-specific black reference (CSR). **You can now do remote CSRs through software control without the need to manually cover the lens!** With the optional Canon EOS lens mount installed you get remote control over lens aperture and focus, too. **This enables complete remote control in environments where you cannot easily access the camera.**

These models come with 8GB, 16GB or 32GB internal high-speed memory. Segmenting memory allows you to divide this into up to 63 segments so you can **take multiple shots back-to-back** without the need to download data from the camera.

Or, record directly to our Phantom CineMag non-volatile, hot-swappable memory magazines. They mount on the CineMag interface of compatible cameras. Continuously record full resolution cines into a CineMag at up to 780 fps. That's just over 2 minutes into the 128GB CineMag, 4.25 minutes into the 256GB, or 8.5 minutes into the 512GB version. Or, record at even higher speeds into camera RAM, then manually or automatically move your recording to the CineMag. With CineMag storage you **get maximum data protection and an ideal storage medium for secure environments.** The CineMag interface is an option on all models.

	Phantom v411	Phantom v611	Phantom v711
Throughput / Speed	> 4 Gpx/second Max speed at full resolution of 1280 x 800 is 4200 fps Max speed at reduced resolution of 128 x 8 is 600,000 fps Record direct to CineMag at up to 800 Mpx/second Minimum frame rate of 24 fps	> 6 Gpx/sec Max speed at full resolution of 1280 x 800 is 6242 fps Max speed at reduced resolution of 128 x 8 is 680,000 fps (standard), 1,000,000 fps (optional) Record direct to CineMag at up to 800 Mpx/second Minimum frame rate of 24 fps Some features are export controlled	> 7 Gpx/sec Max speed at full resolution of 1280 x 800 is 7530 fps Max speed at reduced resolution of 128 x 8 is 680,000 fps (standard), 1,400,000 fps (optional) Record direct to CineMag at up to 800 Mpx/second Minimum frame rate of 24 fps Some features are export controlled
Exposure	1 μ s minimum exposure Global electronic shutter Extreme Dynamic Range (EDR) Auto Exposure Shutter Off mode for PIV	1 μ s minimum exposure (standard), 300 ns (optional) Global electronic shutter Extreme Dynamic Range (EDR) Auto Exposure Shutter Off mode for PIV Some features are export controlled	1 μ s minimum exposure (standard), 300 ns (optional) Global electronic shutter Extreme Dynamic Range (EDR) Auto Exposure Shutter Off mode for PIV Some features are export controlled
Record Times	5.2 seconds at maximum frame rate, maximum bit depth, largest resolution and into maximum internal memory. Longer record times are available when recording directly to a CineMag.	3.58 seconds at maximum frame rate, maximum bit depth, largest resolution and into maximum internal memory. Longer record times are available when recording directly to a CineMag	2.97 seconds at maximum frame rate, maximum bit depth, largest resolution and into maximum internal memory. Longer record times are available when recording directly to a CineMag
Image-Based Auto-Trigger	Standard		
Internal Mechanical Shutter	Standard		
Timing & Synchronization	20 ns timing resolution Frame synchronization to internal or external clock (FSYNC) IRIG in/out (modulated or unmodulated) SMPT E timecode at support frame rates Ready output Strobe output Genlock		
Signaling	Dedicated FSYNC, Trigger, Genlock, Timecode In and Timecode Out (SMPT E & IRIG) BNCs on camera body, Range Data input on camera body Capture cable with Ready, Strobe, IBAT-Trigger, Pre-Trigger, Analog Video, Additional signals available with use of optional Break-Out-Box (BoB)		
Ethernet Connection	Gb Ethernet for both control and data		
Camera Control	Optional On-Camera Controls (OCC), Phantom Camera Control (PCC) Remote Control Unit (RCU), connects to Remote port, LabView and Matlab drivers available		
Video Out	Analog video (NTSC or PAL) available on Capture Cable Component viewfinder port Versatile Dual HD-SDI can provide 4:4:4 video (except at 60 fps), or can be two single 4:2:2 HD-SDI ports, one for playback and one always live		
Lensing	Nikon F-mount standard, Canon EOS mount optional, PL-mount optional, C-mount optional, (lens not included)		



Phantom v711

ISO SAT			
Mono		Color	
ISO SAT T	ISO SAT D	ISO SAT T	ISO SAT D
20,000	6400	2500	2000

DATA SHEET

Phantom® 1 Megapixel v-Series Cameras

Additional Features:

Size (without lens, CineMag or handle):

11.5 x 5.5 x 5.0 inches (L x W x H);

29.2 x 14 x 12.7 cm

Weight (without lens or CineMag): 11.75 lb; 5.33 kg

Temperature and Humidity: 0°C - 40°C @ 8% to 80% RH

Shock: 30g, half sine wave, 11 ms, 10 times all axes
(without CineMag or lens)

Vibration: 25g, 5-500 Hz, all axes without CineMag

Focused

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Move the CineMag to a CineStation connected to a PC and **view, edit, and save your recordings using the Phantom Camera Control software** included with the camera. Keep the recordings in their original raw cine format, or convert them to TIFF, QuickTime, AVI, or other popular formats. Move files from the CineStation to a disk or video recorder via 10Gb Ethernet; 4:4:4 HD-SDI, or Component Video outputs.

When using the camera on a tracking mount, **elevation and azimuth data can be transferred to the camera** and associated with image frames through our unique Range Data interface.

View your recordings immediately in a variety of formats either through the HD-SDI ports on the camera, or through the component video port. There are two HD-SDI ports on the camera which can be configured in a variety of ways including 4:4:4 dual-link and simultaneous play/record (on some models).

The cameras can be controlled with the feature-rich PCC software, the Phantom RCU, or the new (optional) on-camera controls.

Vision Research Global Support - for wherever you are

Our ultrahigh-speed camera line is supported by Vision Research's Global Service and Support network offering AMECare Performance Services from multiple sites around the globe. Maximize the value of your Phantom camera by learning more about our service and support options at www.visionresearch.com/PhantomZone

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

EXHIBIT P376

DATA SHEET

For the most current version visit www.visionresearch.com
 or sales@visionresearch.com Rev. Mar. 2012

Phantom® 65

4K resolution & 65mm

format is now a digital

cinema reality

Key Features:

4K (4096 x 2440) resolution, active-pixel CMOS sensor

1 to 140 frames-per-second (fps) at full resolution

Frame rate adjustable in 1 fps increments

Shutter speeds as fast as two microseconds
 (shutter angle from 1-360°)

14-bit sensor depth (42-bit color)

65mm depth-of-field and aspect ratio,
 11-stop tonal range

Hot-swappable Phantom CineMag® compatible

AMETEK®
 MATERIALS ANALYSIS DIVISION



Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The world's first 65mm digital cinema camera

With Vision Research's unique sensor design and today's powerful digital technologies, the coveted 65mm format is now within every filmmaker's reach.

The Phantom 65 features 10 megapixel resolution, and with frame rates up to 140 frames-per-second and shutter angle from 1 to 360, you now have all the tools you need to tell your story in new and dramatic ways.

Maximum creative control

Shoot at 20 fps to get faster, sharper action. Try 28 fps to subtly smooth fast action. Or, shoot 140 fps to create slow-motion effects. You have the ability to control frame rates in increments of 1 frame-per-second.

Use the adjustable shutter control to stop fast action for a sharp image, or to create motion blur to soften an image and create a sense of movement. Shutter speed can be adjusted in increments of one microsecond. That's 1 millionth of a second!

DATA SHEET

Phantom[®] 65

Additional Features:

- Component video output to viewfinder
- Video out: 4:2:2 HD-SDI (all standard formats)
- Up to 32 GiB in-camera memory
- Weight: 12.1 lb (5.5 Kg)
- Size: (W x H x D) 13.97 cm x 19.4 cm x 30.8 cm
(5.47 in x 7.62 in x 12.13 in)
- Power: 100-240VAC, 150 Watts
- Compatible w/ 35mm film accessories
- Lensing: Mamiya 645 standard;
Super PL & Hasselblad available

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



AMETEK[®]
MATERIALS ANALYSIS DIVISION

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+1.973.696.4500
phantom@visionresearch.com

www.visionresearch.com

Superior image quality & usability

The CMOS sensor's 14-bit depth provides a dynamic range and color rendition that gives you images rivaling film.

Unlike film, you can immediately see the results of a shot while you still have the scene set up and talent ready.



The Phantom 65 has preset formats for classic 65mm (2.28:1) as well as 2.35:1, 2.21:1 and 1.85:1 aspect ratios. User-selectable aspect ratios can be set in 8 pixel vertical increments.

Images can be stored to RAM or to a removable flash memory pack. Our 512 GiB Phantom CineMag memory magazine can hold about 30 minutes of images at 24 fps. Think of it like a roll of 65mm film, without the costs.

Stored images can then be downloaded from the Phantom CineStation[®] to a disk array, or directly from the camera using Gigabit Ethernet. Images can be stored in Phantom RAW format, or converted to TIFF stacks, DPX, DNG, Quicktime, AVI and many other popular formats.

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EXHIBIT P377

DATA SHEET

For the most current version visit www.visionresearch.com
Contact your account manager for more information. Rev. Mar. 2007



Phantom® HD GOLD

The Gold standard,
for high-speed, HD Imaging

Key Benefits:

Experience ultimate creative control with the Phantom HD

The Phantom HD Gold is not just a high-speed camera, but an instrument that gives the cinematographer 35mm depth of field at HD or 2K resolutions.

At 2K or HD resolution, the ability to take thousands of pictures-per-second, Shutter speeds as fast as two microseconds, and 42-bit color, you now have all the tools you need to tell your story in new and dramatic ways.

Supreme Creative Flexibility

With its 35mm depth of field, you no longer have to compromise the composition of a scene or your story-telling art with the infinite depth-of-field you get from tape-based, small sensor cameras.

At only 12.1 pounds, the camera is truly portable and can be easily mounted on booms or sleds. Optional battery power is available.

Regardless of your HD application, you'll appreciate the flexibility and performance of the Phantom HD.

Key Features:

HD (1920 x 1080) and 2K (2048 x 1536) resolution under a PL-mount lens & 2048 x 2048 under an F-mount lens

Up to 1000 frames-per-second (fps) at 1920 x 1080 or 1500 fps at 1280 x 720. Even higher frame rates at decreased resolution

Adjust frame rate in 1 fps increments

Shutter speeds as fast as two microseconds (shutter angle from 1-360 degree)

14-bit sensor depth (42-bit color), active-pixel CMOS sensor

35mm depth-of-field 11 stop tonal range

Hot-swappable Phantom CineMag® compatible

On-camera control buttons for complete control

Circular buffer to internal RAM, or run/stop recording to CineMag

DATA SHEET

Phantom® HD Gold

Additional Features:

Component video output to viewfinder

Video out: 4:2:2 HD-SDI (all standard formats)

Up to 32 GiB in-camera memory

Weight: 12.1 lb (5.5 Kg)

Size: (W x H x D) 13.97 cm x 19.4 cm x 30.8 cm
(5.47 in x 7.62 in x 12.13 in)

Power: 100-240VAC, 150 Watts

Compatible w/ 35mm film accessories

Lensing: 35mm PL-mount, Nikon F-mount available

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



AMETEK®
MATERIALS ANALYSIS DIVISION

100 Dey Road
Wayne, NJ 07470 USA
+1.973.696.4500
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www.visionresearch.com

The Sense of Time

The Phantom HD Gold combines the visual quality of high-definition imaging with the high frame rates of specialty cameras.



Select any frame rate from 1 to 1,000 fps in increments of one frame-per-second at HD resolution. With the Phantom camera's shutter, variable to 1/500,000 second, and radically adjustable frame rates, you have seamless control of the duration, speed and time of a story element.

Because the Phantom HD is capable of creating breathtaking special effects by controlling frame rate and exposure times in fine increments, you can use a single camera for all of your shooting needs.

Versatility

Depending on the nature of your shoot, employ a raw-data or video workflow direct from the camera. Our Phantom CineMag is the perfect complement, allowing you to maximize your recording time, or quickly secure high-speed shots without worrying about download time, and without compromising image quality.

The HD can also be configured for "live" broadcast or studio production and has a continuous video output that includes HD (720p, 1080p, 1080i) standards. Multiple triggering and recording modes can also be tailored to your application.

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EXHIBIT P378

DATA SHEET

For the most current version visit www.visionresearch.com
Subject to change Rev. 08/10/07



HD

35mm depth of field
in a high-speed
digital camera

Key Features:

HD (1920 x 1080) and 2K (2048 x 1536) resolution under a PL-mount lens & 2048 x 2048 under an F-mount lens

Up to 1000 frames-per-second (fps) at 1920 x 1080 or 1500 fps at 1280 x 720. Even higher frame rates at decreased resolution

Adjust frame rate in 1 fps increments

Shutter speeds as fast as six microseconds (shutter angle from 1-360 degree)

14-bit sensor depth (42-bit color), active-pixel CMOS sensor

35mm depth-of-field 11 stop tonal range

Hot-swappable Phantom CineMag® compatible

On-camera control buttons for complete control

Circular buffer to internal RAM, or run/stop recording to CineMag

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The Phantom HD is not just a high-speed camera, but an instrument that gives the cinematographer 35mm depth of field at HD or 2K resolutions.

At 2K or HD resolution, the ability to take thousands of pictures-per-second, Shutter speeds as fast as six microseconds, and 42-bit color, you now have all the tools you need to tell your story in new and dramatic ways.

Supreme Creative Flexibility

With its 35mm depth of field, you no longer have to compromise the composition of a scene or your story-telling art with the infinite depth-of-field you get from tape-based, small sensor cameras.

At only 12.1 pounds, the camera is truly portable and can be easily mounted on booms or sleds. Optional battery power is available.

Regardless of your HD application, you'll appreciate the flexibility and performance of the Phantom HD.

DATA SHEET

HD

Additional Features:

- Component video output to viewfinder
- Video out: 4:2:2 HD-SDI (all standard formats)
- Up to 32 GB in-camera memory
- Weight: 12.1 lb (5.5 Kg)
- Size: (W x H x D) 13.97 cm x 19.4 cm x 30.8 cm
(5.47 in x 7.62 in x 12.13in)
- Power: 100-240VAC, 150 Watts
- Compatible w/ 35mm film accessories
- Lensing: 35mm PL-mount, Nikon F-mount available

Focused

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The Sense of Time

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The HD can also be configured for "live" broadcast or studio production and has a continuous video output that includes HD (720p, 1080p, 1080i) standards. Multiple triggering and recording modes can also be tailored to your application.

Experience ultimate creative control with the Phantom HD



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EXHIBIT P379



Phantom v7.3

800 x 600 at 6,688 frames-per-second,
and up to 500,000 fps with the new
Turbo Mode.

THE UNDISPUTED KING OF SPEED

VRI expands the capabilities of its Phantom v7 Series cameras with the Phantom v7.3. Its full frame 4:3 aspect ratio 14-bit image depth (standard) 800 x 600 active pixel CMOS sensor the camera sports an exception recording rate of 6,688 frames per second at full resolution, and over 190,000 fps (standard mode) or an astounding 500,000 fps (Turbo Mode) at a reduced resolution adjustable in 32 x 8 pixel increments.

With all the features Phantom camera users have become accustomed to the v7.3 has added a larger memory module option for longer recording times, and a continuous video output HD/SDI interface.



- *Full frame 4:3 aspect ratio CMOS sensor composed of 800 x 600 pixels*
- *14-bit image depth (standard)*
- *6,688 frames per second full resolution, up to 190,000 fps (standard mode), 500,000 fps (Turbo Mode)*
- *“CAR” (Continuously Adjustable Resolution) in 32 x 8 pixel increments*
- *4800 ISO/ASA monochrome, 1200 ISO/ASA color sensitivity equivalency*
- *Global on-chip shuttering to 1 μ s (fixed at 1 μ s in Turbo Mode)*
- *“EDR” Extreme Dynamic Range TM and Auto Exposure control*
- *PIV - Particle Image Velocimetry (standard)*
- *Up to 16 Gigabytes DRAM, 24 Gigabytes non-volatile flash memory (optional)*
- *IRIG-B timing capture, modulated or unmodulated, IRIG lock w/phase shift*
- *Continuous video output (NTSC, PAL, HD/SDI 720p, 1080p, 1080i, 1080psf)*
- *Optional continuous data streaming up to 2000 fps (8-bits)*
- *Automated multiple session recording for remote unmanned operation*
- *Gigabit Ethernet or RS232 control*



v7.3 Specifications

FEATURES

Auto Exposure

"EDR" Extreme Dynamic Range™

Continuous data streaming (optional)

Continuous recording

PIV (Particle Image Velocimetry)

Pre-trigger recording

On chip global shuttering

Strobe sync

Segmented image memory

Continuous color HD-SDI video output

IRIG-B timing capture with phase shift

10/100/Gigabit Ethernet

Sensor: 800 x 600 pixel CMOS sensor.

Image Bit Depth: 14-bit (standard)

Sensitivity: 4800 ISO/ASA mono-chrome, 1200 ISO/ASA color

Frames per Second (FPS): Full sensor, to 6,688 fps

Allocated formats: to 190,476 fps (standard mode), 500,000 fps (Turbo Mode) with "CAR" (Continuous Adjustable Resolution) feature

Exposure Time: Variable, independent of sample rate (fps), to 2 microseconds, optional 1 μ s (standard mode), fixed 1 μ s (Turbo Mode)

Trigger: Continuously variable pre/post

Imager Control: 10/100/Gigabit Ethernet, RS232 serial interface, or HD-SDI

Preview and Focusing: Via computer monitor or continuous video out

Lens Mounts: Nikon mount standard. Many other lens mounts available, including C-mount

INPUTS/OUTPUTS: via integrated quick-release connector:

Trigger: Rising/falling TTL pulse w/filter, or switch closure

Sync Image: TTL pulse

Event Marker: TTL pulse or switch closure

Ready Signal: TTL pulse

IRIG-B Timing: IRIG-B code, modulated or unmodulated input, with IRIG-B output, lock, and variable phase shift

Continuous Data Streaming:

Up to 2000 fps (8-bits), 1300 fps (12-bit)

Strobe Sync: TTL Pulse

RS232

Network: 10/100/Gigabit Ethernet

Video out: NTSC, PAL, and HD-SDI (720p, 1080p, 1080i, 1080psf at 24, 25, 59.9, or 60 fps)

Power: 24VDC/1.5 Amp

MEMORY

Standard: 2 Gigabytes integral image memory records 4,266 images for 0.6 seconds of continuous recording at 6,688 fps, full format (8-bits) or 2,133 images for 0.3 seconds of continuous recording at 6,688 fps, full format (14-bits). Longer recording times for lower sample rates and allocated formats.

Optional: 4 Gigabyte integral image memory continuously records 8,533 images for 1.3 sec (8-bits) or 4267 images for 0.6 sec (14-bits) at 6,688 fps full frame, 8 Gigabyte option will record 17,066 images for 2.6 sec (8-bits) or 8,533 images for 1.3 sec (14-bits) at 6,688 fps full frame, and the 16 Gigabyte option will record 34,133 images for 5.1 sec (8-bits) or 17,066 images for 2.6 sec (14-bits) at 6,688 fps full frame.

Optional: Non-Volatile Flash Memory, up to 24Gigabytes.

ENVIRONMENTAL

Ambient Temperature

32°F and 104°F (0°C and 40°C)

Maximum humidity: 80%, non-condensing, at 5°C

SOFTWARE

Phantom® operates in Windows XP Pro or Vista environments with familiar commands found in familiar places. Standard functions include

Acquisition: Image capture, IRIG-B timing capture & standard time annotation. Field of view & focus. Sample rate & aspect ratio selection. Shutter speed. Histogram. Brightness, contrast, & gamma adjust. Trigger modes. Continuous record. Save & recall setups.

Analytical playback: Immediate playback of cine. Variable playback speed in forward or reverse, including freeze frame & endless loop. Random Go-to-Image. View single images at random from any cine. Tile/cascade multiple images on one screen. Timing data displayed with each image. Cine editor. Multi Cine Viewer.

Measurements: Linear or angular measurements. English and metric units. Generate Velocity, RPM, or 100 data points per measurement reports. Report files & images are compatible with Phantom, TEMA Starter Software or any spread-sheet software, and image analysis software such as TrackEye®, Image Express®, or Falcon®.

Image processing: Smooth, sharpen, psuedocolor, negative image, and edge detection. Brightness, contrast & gamma adjust. 3x3 and 5x5 filter matrix for custom image processing.

File management: Organize, save, compress and export cines, or single images. File formats are compatible with most word processing, desktop, publishing, and presentation software.

DIMENSIONS

Size: 4.3 x 4.0 x 9.5 inch (HWD) (10.9 x 10.16 x 24.13 cm) (HWD)

Weight: 7 lbs (3.18kg)

Power: 24VDC/1.5 Amp

Mounting: 1/4-20 inch and four 10-32 threaded hole pattern in base and top

Mounting Axis: Any position

Country of Origin: The United States of America

STANDARD ACCESSORIES

Phantom® software, Single user license*

2 Gigabyte integral image memory

Ethernet, Sync output pulse, trigger,

pretrigger, video out, and IRIG-B

110/220VAC -24VDC International Power Adapter, 12 foot (3.7 m) power cord

One year service contract included

QUESTIONS?

For technical assistance, systems integration, custom options, or information on imaging techniques or training please call us toll free:

1.800.RESOLUTION

(US & Canada 1.800.737.6588)

For the most up-to-date information, specifications and options, please visit our website:

www.visionresearch.com

VISION RESEARCH

All specifications are subject to change. (Jul-13)

Phantom v7.3 Maximum Recording Speed vs. Image Size

The Phantom v7.3 camera system can record up to 6,688 frames per second using the full 800 x 600 pixel CMOS imaging sensor array. The operator may also specify other aspect ratios to increase speeds or extend recording times.

The chart below details the Phantom v7.3 aspect ratio choices available in the setup screen pull down menu. Using the CAR (Continuous Adjustable Resolution) feature, speeds between these values are continuously adjustable in 32 x 8 pixel increments.

STANDARD MODE	
RESOLUTION	RATE
800 x 600	6,688
640 x 480	10,101
320 x 240	33,057
512 x 512	11,527
512 x 384	15,151
512 x 256	21,978
512 x 128	40,000
512 x 64	67,796
256 x 512	20,000
256 x 256	36,697
256 x 128	63,492
256 x 64	100,000
128 x 128	88,888
128 x 64	129,032
64 x 64	148,148
32 x 32	190,476

TURBO MODE	
RESOLUTION	RATE
800 x 600	6,814
640 x 480	10,389
320 x 240	36,697
512 x 512	11,869
512 x 384	15,810
512 x 256	23,391
512 x 128	44,943
512 x 64	83,333
256 x 512	21,052
256 x 256	40,816
256 x 128	76,923
256 x 64	137,931
128 x 128	117,647
128 x 64	200,000
64 x 64	250,000
32 x 16	500,000



All specifications are subject to change. (Jul-13)

Vision Research, Inc.
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EXHIBIT P380

DATA SHEET

For the most current version visit www.visionresearch.com
 02/2012 10-13-2012



Phantom v341
Shown with optional CineMag interface
and On-Camera Controls

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The Phantom v341 provides a 4 megapixel sensor and almost 3 gigapixels/second throughput. That means full-resolution frame rates of 800 frames-per-second (fps), and 2 megapixel 1920 x 1080 HD-resolution frame rates of 1440 fps. The minimum frame rate is 10 fps.

Take the wide view with our custom-designed 2560 x 1600 pixel CMOS sensor. The aspect ratio of the v341 allows you to keep moving targets in-frame longer and see more of the event you are recording.

Shutter speeds down to 1 microsecond and a **global electronic shutter** allow for crisp, sharp images with little or no image blur or motion artifacts.

v341

2560 x 1600 resolution

10-800 fps at full resolution

Breakthrough sensitivity

Phantom CineMag® compatible

Key Features:

10-800 frames-per-second (fps) at full resolution.

Maximum FPS: 129,500 @ 256 x 8

2560 x 1600 CMOS sensor

Minimum Exposure (shutter speed): 1 μ s

High-resolution timing system: Better than 20 ns resolution

Extreme Dynamic Range (EDR): two different exposures within a single frame

Internal Shutter Mechanism: hands-free/remote current session reference (CSR)

Memory Segmentation: Up to 63 segments

Non-volatile, hot-swappable Phantom CineMag memory magazines (128 GB, 256 GB & 512 GB)

CineMag to CineStation®

Range Data input

Built-in Memory: 8 GB, 16 GB, 32 GB

Breakthrough Sensitivity, ISO (ISO-12232 SAT method):

Mono: 16,000 T; 6400 D

Color: 1600 T; 1600 D (without OLPF)

Color: 1250 T; 1600 D (with OLPF)

QE 60% peak; NEP 0.011 fJ

Pixel Bit-depth: 12-bit

Gb Ethernet, 10 Gb Ethernet with optional CineStream X2SR module

Image-Based Auto-Trigger

Burst Mode

IRIG & SMPTE Time Code

Genlock

v341

Phantom v341
provides a
4 megapixel
sensor and
almost
3 gigapixels/
second
throughput.

With a peak quantum efficiency (QE) of 60% – greatly improved over current sensor designs – and a significant reduction in readout noise, along with the addition of microlens technology, the v341's **four megapixel resolution can be used to full advantage** at speeds that normally called for large-pixel, lower resolution cameras.

That makes the v341 ideal for applications where **high sensitivity and high resolution** are needed. Coupled with a 1.4 microsecond straddle time the v341 is ideal for **PIV applications**, for example. And, our new **burst acquisition mode** can take a user-set number of frames with a programmed interframe time upon receiving a single frame synchronization (FSYNC) pulse. This greatly simplifies timing setups for repetitive events such as combustion studies, where bursts can be captured at a specific/precise position in the operating cycle.

Each camera supports **12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image.

The v341's **high-resolution timing system** yields a timing resolution of better than 20 nanoseconds. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, an external frame synchronization signal is available via a dedicated BNC for easier cabling and increased signal integrity.

Of course, the v341 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an **internal shutter mechanism** for cutting off all light to the sensor when doing a session-specific black reference (CSR). You now can do **remote CSRs** through software control without the need to manually cover the lens! With the optional **Canon EOS** lens mount installed you get remote control over lens aperture and focus, too. This enables **complete remote control** in environments where you cannot easily access the camera.

The v341 comes standard with 8 GB of high-speed dynamic RAM, but you can order 16 GB or 32 GB versions. Our **segmented memory** allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

You are able to record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. **Continuously record** full-resolution cines into non-volatile memory at up to 195 fps (360 fps for 1920 x 1080). That is over 4 minutes of continuous recording into the 256 GB CineMag or over 8 minutes into the 512 GB CineMag.

Or, record at higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. If you need to **take multiple shots back-to-back**, you don't have to wait for a time-consuming download of camera memory over Ethernet. Instead, just upload the camera memory to a CineMag at about 800 megapixels/second, then take your next shot!

With CineMag storage you get maximum data protection and an ideal storage medium for secure environments. Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera. Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10 Gb Ethernet, HD-SDI, or Component Video outputs.

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique **Range Data** input. Signals available directly on the camera back panel include: FSYNC; Range Data; HD-SDI, two power inputs for hot swapping power or providing battery backup while on AC power; IRIG-In and IRIG-Out; Trigger; Gb Ethernet; Remote; and Genlock.

View your recordings immediately. There are two identical **4:2:2 HD-SDI ports** for previewing a shot or viewing recorded cines. One can optionally be configured with an on-screen display (OSD) of key camera information. And, a component viewfinder port supports a variety of viewfinders and monitors.

The v341 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v341. As an option, you can add **On-Camera Controls** (OCC) to get full control of the camera without the need to connect to a PC. We also provide a full-featured **Remote Control Unit** (RCU) for wired or wireless control.

The v341 comes in two base models, either with or without a CineMag interface. An optical low-pass filter is available as an option.

H	V	FPS*
256	8	129,500
256	64	61,800
256	128	38,700
256	256	22,100
512	384	10,900
512	512	8,390
640	480	6,880
800	600	4,510
1280	720	3,180
1280	800	2,870
1280	1024	2,250
1920	1080	1,440
2048	1024	1,520
2048	1600	980
2560	1600	800

*Typical results

ISO SAT			
Mono		Color	
ISO SAT T	ISO SAT D	ISO SAT T	ISO SAT D
16,000	6400	1600	1600

DATA SHEET

v341

Additional Features:

- View recordings immediately via video-out ports
- Analog video out: PAL, NTSC & HD Component (720p)
- HD-SDI: All standard formats
- Lensing: F-mount, C-mount, PL-mount, Canon EOS
- Optional optical low-pass filter
- Size (without lens, CineMag or handle):
11.5 x 5.5 x 5.0 inches (L x W x H);
29.2 x 14 x 12.7 cm
- Weight (without lens or CineMag): 11.75 lb; 5.33 kg
- Power: 90 Watts @ 24 VDC, without CineMag
- Operating Temperature: 0°C to 40°C @ 8% to 80% RH
- Storage Temperature: -10°C to 55°C
- Non-operational Shock: 33G, half sine wave, 11ms,
all axes without CineMag
- Operational Shock: 30G, half sine wave, 11ms,
10 times all axes (without CineMag
or lens) to Mil-Std-810 G
- Operational Vibration: 0.25G, 5-500 Hz, all axes without
CineMag

Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



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Phantom v341
Back View



Phantom v341

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

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EXHIBIT P381

DATA SHEET

For the most current version visit www.visionresearch.com
 Or visit us on LinkedIn <https://www.linkedin.com/company/vision-research> or Facebook <https://www.facebook.com/visionresearch>



*Phantom v641
Shown with optional CineMag interface
and On-Camera Controls*

Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The Phantom v641 is the second generation v640 camera. It's smaller and lighter than its predecessor and has a number of new convenience features requested by users.

The v641 provides a 4 megapixel sensor and greater than 6 gigapixels/second throughput. That means full-resolution frame rates of 1450 frames-per-second (fps), and 1920 x 1080 HD-resolution frame rates of 2560 fps. The minimum frame rate is 10 fps.

Take the wide view with our custom-designed 2560 x 1600 pixel CMOS sensor. The aspect ratio of the v641 allows you to keep moving targets in-frame longer and see more of the event you are recording.

v641

2560 x 1600 resolution

10-1450 fps at full resolution

Breakthrough sensitivity

Phantom CineMag® compatible

Key Features:

- 10-1450 frames-per-second (fps) at full resolution.
Maximum FPS: 219,000 @ 256 x 8
- 2560 x 1600 CMOS sensor
- Minimum Exposure (shutter speed): 1 μ s
- High-resolution timing system: Better than 20 ns resolution
- Extreme Dynamic Range (EDR): two different exposures within a single frame
- Internal Shutter Mechanism: hands-free/remote current session reference (CSR)
- Memory Segmentation: Up to 63 segments
- Non-volatile, hot-swappable Phantom CineMag memory magazines (128 GB, 256 GB & 512 GB)
- CineMag to CineStation®
- Range Data input
- Built-in Memory: 8 GB, 16 GB, 32 GB
 - Breakthrough Sensitivity: ISO (ISO-12232 SAT Method)
 - Mono: 16,000 T; 6400 D
 - Color: 1600 T; 1600 D (without OLPF)
 - Color: 1250 T; 1600 D (with OLPF)
- Pixel Bit-depth: 12-bit
- Gb Ethernet, 10 Gb Ethernet with optional CineStream X2SR module
- Image-Based Auto-Trigger
- Burst Mode
- IRIG & SMPTE Time Code
- Genlock

v641

Phantom v641
provides a
4 megapixel
sensor and
greater than
6 gigapixels/
second
throughput.

Shutter speeds down to 1 microsecond and a **global electronic shutter** allow for crisp, sharp images with little or no image blur or motion artifacts.

With a peak quantum efficiency (QE) of 60% – greatly improved over current sensor designs – and a significant reduction in readout noise, along with the addition of microlens technology, the v641's **four megapixel resolution can be used to full advantage** at speeds that normally called for large-pixel, lower resolution cameras.

That makes the v641 ideal for applications where **high sensitivity and high resolution** are needed. Coupled with a 1.4 microseconds straddle time the v641 is ideal for **PIV applications**, for example.

Each camera supports **12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image.

The v641's **high-resolution timing system** yields a timing resolution of better than 20 nanoseconds. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, an external frame synchronization signal is available via a dedicated BNC for easier cabling and increased signal integrity. A GenLock input is available for synchronizing the playback of recorded cines to other video gear.

Of course, the v641 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an **internal shutter** for cutting off all light to the sensor when doing a session-specific black reference (CSR). You now can do **remote CSRs** through software control without the need to manually cover the lens!

The v641 comes standard with 8 GB of high-speed dynamic RAM, but you can order 16 GB or 32 GB versions. Our **segmented memory** allows you to divide this into up to 63 segments so you can take multiple shots back-to-back without the need to download data from the camera.

You are able to record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. **Continuously record** full-resolution cines into

non-volatile memory at up to 195 fps (360 fps for 1920 x 1080). That's about 4.5 minutes of continuous recording into the 256 GB CineMag or 9 minutes into the 512 GB CineMag.

Or, record at higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. If you need to **take multiple shots back-to-back**, you don't have to wait for a time-consuming download of camera memory over Ethernet. Instead, just upload the camera memory to a CineMag at about 800 megapixels/second, then take your next shot!

With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera.

Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10 Gb Ethernet, dual HD-SDI, or Component Video outputs.

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique **Range Data** input.

View your recordings immediately. There are two **Versatile Dual HD-SDI ports** that can be used in one of four different modes: 2 identical 4:2:2 outputs; 1 dual HD-SDI 4:4:4 output; independent 4:2:2 outputs where one is live and one is playback; or 4:4:4 playback on the dual HD-SDI while you have a live image on the component viewfinder. Yes, a component video viewfinder port has been added so any viewfinder compatible with our Phantom HD camera can now be used with the v641.

The v641 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v641. As an option, you can add **On-Camera Controls** (OCC) to get full control of the camera without the need to connect to a PC. We also provide a full-featured **Remote Control Unit** (RCU) for wired or wireless control.

The v641 comes in two base models, either with or without a CineMag interface. An optical low-pass filter is available as an option.

H	V	FPS*
256	8	219,200
256	64	90,200
256	128	53,900
256	256	29,800
512	384	16,200
512	512	12,300
640	480	10,700
800	600	7,370
1280	720	5,350
1280	800	4,820
1280	1024	3,780
1920	1080	2,560
2048	1024	2,700
2048	1600	1,730
2560	1600	1,450

*Typical results

ISO SAT			
Mono		Color	
ISO SAT T	ISO SAT D	ISO SAT T	ISO SAT D
16,000	6400	1600	1600

DATA SHEET

v641

Additional Features:

- Analog video out: PAL, NTSC & HD Component (720p)
- HD-SDI: All standard formats, Versatile Dual HD-SDI outputs
- Lensing: F-mount, C-mount, PL-mount
- Optional optical low-pass filter
- Size (without lens, CineMag or handle):
11.5 x 5.5 x 5.0 inches (L x W x H);
29.2 x 14 x 12.7 cm
- Weight (without lens or CineMag): 11.75 lb; 5.33 kg
- Power: 90 Watts @ 24 VDC, without CineMag
- Operating Temperature: 0°C to 40°C @ 8% to 80% RH
- Storage Temperature: -10°C to 55°C
- Non-operational Shock: 33G, half sine wave, 11ms,
all axes without CineMag
- Operational Shock: 30G, half sine wave, 11ms,
10 times all axes (without CineMag
or lens) to Mil-Std-810 G
- Operational Vibration: 0.25G, 5-500 Hz, all axes without
CineMag

Focused

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Phantom v641
Back View



Phantom v641

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DATA SHEET

For the most current version visit www.visionresearch.com
Product literature: Ray.Gibson@VR.com

Phantom® v-Series Family of Digital High- Speed Cameras

Key Features:

In 2009, we introduced several exciting new members of the v-Series family that bring a new level of price/performance to the high-speed imaging marketplace:

Phantom v210: Ideal for megapixel applications requiring around 2,000 fps. Attractively priced, yet packed with powerful features. A wide variety of options let you configure a camera that exactly meets your needs and budget.

Phantom v310: Unrivaled performance in its price range, the v310 is quickly becoming our most popular camera ever. It has the performance and features to adapt to a wide variety of applications. Get over 3,000 fps at megapixel resolution.

Phantom v640: Four megapixels with unsurpassed sensitivity. When you need maximum spatial resolution, but can't afford to give up speed or sensitivity, the v640 is the camera for you.

Phantom v12.1: The original speed demon. The award winning v12.1 camera was the first CMOS camera to break the 1,000,000 fps barrier. With a new price point, this speedster is the obvious choice for applications demanding speed, versatility, and proven performance.

Phantom v710: The newest speed demon, the v710 is capable of taking 1,400,000 pictures each second (at reduced resolution). This is the ultimate high-performance digital high-speed camera that will allow you to see things that no one has ever seen before.

AMETEK®
MATERIALS ANALYSIS DIVISION



Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Whether you are studying crack propagation in a metal alloy, aerosol spray patterns, air flow around a side-view mirror, the biomechanics of an Olympian athlete, the efficacy of shaped explosive charges, or the effects of a bird strike on a jet engine, when you need a **high-speed imaging system** you can rely on, turn to Vision Research.

Our v-Series family of digital high-speed cameras has been around for over 15 years. The v2.0 was introduced in 1993. And, the v4.0 – in 1999 – was the first ever **CMOS-based digital high speed camera** introduced to replace film-based technology. We've been improving the state-of-the-art in high-speed imaging with each new family member introduced since then – whether the first-ever megapixel camera capable of taking 1000 frames-per-second (v5.0), the first-ever 4-megapixel camera (v10), the first digital camera to break the 1,000,000 frames-per-second (fps) barrier (v12), or the first high-speed imaging system qualified to fly on board a NASA space launch vehicle.

DATA SHEET

v-Series



when it's too fast to see, and too important not to.

These cameras all have a common set of breakthrough features that propel them ahead of any competition:

Widescreen Aspect Ratio: Take the wide view with a **1.6:1** aspect ratio – 25% wider than traditional square cameras. Keep more of your moving target in-frame longer.

CineMag Compatibility: Each camera has an optional Phantom CineMag interface. CineMags are non-volatile, hot-swappable, removable storage for Phantom cameras. **Now you can take multiple shots back-to-back**, saving each shot to the CineMag without the need for timely downloads between shots. Or, at recording speeds up to about 800 megapixels/second, record directly to the CineMag and achieve very low record times.

Internal Mechanical Shutter (optional on some models): All digital high-speed cameras require a periodic calibration to correct for differences in the analog characteristics of each photo site. Poor calibration results in pesky imaging artifacts that can both look bad and interfere with motion analysis software. This calibration requires that the sensor be completely shaded from light so a "black reference" can be established. This used to mean placing a lens cap on the camera during calibration. With Vision Research's unique internal mechanical shutter, this lens shading can be automatically and/or remotely.

HD-SDI video ports: Each v-Series camera has two HD-SDI ports. On the v210 and v310, these ports output identical 4:2:2 HD-SDI signals (with an on-screen display available on one of them.) On the other members of the v-Series family, these Versatile Dual HD-SDI ports are configurable. They can be two identical 4:2:2 signals, a single dual-link 4:4:4 signal, or one can be configured for a 4:2:2 live feed, while the other is available for 4:2:2 slow-motion playback – ideal for use in sports broadcast.

Image-Based Auto-Trigger: Set up the camera to trigger based on changes to the live image. Trigger from hard-to-catch intermittent events, and even trigger multiple cameras simultaneously based on changes in the image.

Extreme Dynamic Range (EDR): By taking two exposures in a single frame, Vision Research's unique Extreme Dynamic Range feature actually allows you to see detail in what otherwise might be overexposed areas of the image. Imaging "looking through" flames, or getting equally stunning detail out of both the dark areas and bright areas of a high contrast subject.

Automatic Exposure (AE): An essential feature when shooting outdoors, the camera exposure adjusts to lighting conditions. No more underexposed images when a cloud passes over, for example.

Camera	Resolution	FPS at Full Resolution	Maximum FPS	Minimum Exposure	Sensitivity (ISO-12232)		EDR / AE	Versatile Dual HD-SDI	Image-Based Auto-Trigger	Internal Mechanical Shutter	CineMag Compatible
					Mono	Color					
v210	1280 x 800	> 2,000	300,000	2 µs	20,000 T 6400 D	2500 T 2000 D	Yes	No, 2 xHD-SDI ports	Optional	Optional	Optional
v310	1280 x 800	> 3,000	500,000	1 µs	20,000 T 25,00 D	2500 T 5000 D	Yes	No, 2 xHD-SDI ports	Optional	Optional	Optional
v640	2560 x 1600	> 1,500	300,000	1 µs	16,000 T 6400 D	1600 T 1600 D	Yes	Yes	Standard	Standard	Optional
v12.1	1280 x 800	> 6,000	1,000,000 optional 680,000 standard	300 ns optional 1 µs standard	20,000 T 6400 D	2500 T 2000 D	Yes	Yes	Optional	Optional	Optional
v710	1280 x 800	> 7,500	1,400,000 optional 723,000 standard	300 ns optional 1 µs standard	20,000 T 6400 D	2500 T 2000 D	Yes	Yes	Standard	Standard	Optional

Focused

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Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Our line of 1 megapixel cameras has several members. This data sheet covers the Phantom v411 and v711. Be sure to check out our ultra high-speed line of 1 megapixel cameras also – including the new v2010.

Both models feature a widescreen 1280 x 800 CMOS sensor – 25% wider than most competitive models – allowing you to **keep moving targets in-frame longer and see more of the event you are recording**. The wide sensor also allows you to get true 1280 x 720 HD images from a 1Mpx camera.

With a pixel size of 20 microns and improved quantum efficiency, **these cameras have the sensitivity you need** for even the most challenging lighting conditions.

Minimum exposure time of 1 microsecond (300 nanoseconds on the v711 with the FAST option) allows you to **eliminate blur and allow you to see the smallest of details**.

DATA SHEET

File: 1116.mpxd, 12/18/07, v411.vision, visit: www.visionresearch.com
Color: v411.vision, visit: www.visionresearch.com
File: 1117.mpxd, 12/18/07, v711.vision, visit: www.visionresearch.com
Color: v711.vision, visit: www.visionresearch.com

Phantom® 1 Megapixel v-Series Cameras

Choose the model that best fits your performance requirements and budget

Advanced features are standard on these models

Each model is available with or without CineMag compatibility and On-Camera Controls

Key Features:

- Custom-designed 1280 x 800 CMOS sensor
 - Extreme Dynamic Range (EDR): two exposures per frame
 - Internal Mechanical Shutter mechanism for hands-free/remote CSRs
 - Memory Segmentation: up to 63 segments
 - Non-volatile, hot-swappable Phantom CineMag memory magazines
 - CineMag interface is optional on all models
 - Range Data Input: embed tracker data into recorded cine file
 - 8GB, 16GB or 32GB of internal high-speed memory
 - ISO (ISO-12232 SAT method):
 - Mono: 20,000 T and 6400 D
 - Color: 2500 T and 2000 D
 - Pixel Bit-Depth: 8-, 12-bit
 - Gb Ethernet
- The v711 supports a FAST option that provides frame rates of 1,000,000 fps or more as well as sub-microsecond exposure times (export controlled)

Phantom 1 Mpx Cameras



Phantom v411

Throughput:

v411 - 4Gpx/s

v711 - 7Gpx/s

MAXIMUM SPEEDS AT
VARIOUS RESOLUTIONS

Resolution	
v411	v711
1280 x 800	
4200	7530
1280 x 720	
4670	8360
512 x 512	
13,900	25,000
256 x 256	
44,100	79,000
128 x 8	
600,000	1,400,000*

* With FAST option installed

With throughput specifications ranging from 4 gigapixels-per-sec (Gpx/s) to 7Gpx/s, **there is a model to meet your frame-rate requirements.**

At 4Gpx/s, the v411 can take over 4000 frames-per-second (fps) at full resolution. A 7Gpx/s camera (the v711) can take over 7000 fps at full resolution (7530 fps, actually!) Top speeds at reduced resolution range from 300,000 fps to 1,400,000 fps depending on camera model.

These cameras support both 8- and 12-bit pixel depth. **Smaller bit-depth gives you more recording time** and smaller files. **Greater bit-depth gives you more gray levels** and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image, an essential requirement for most motion analysis applications.

Phantom's high-accuracy timing system means improved frame rate, frame synchronization and exposure accuracy. And a frame-synchronization (F-SYNC) signal is now available on a dedicated BNC connector on the camera connector panel for **easier cabling and increased signal integrity.**

Both camera models offer the Extreme Dynamic Range feature – pioneered by Vision Research. This gives you the ability to **get two different exposures within a single frame** so areas that would otherwise be overexposed contain image detail. And, with Auto Exposure, **the camera adjusts to changing lighting conditions** automatically.

There is an internal mechanical shutter that can cut off all light to the sensor when doing a session-specific black reference (CSR). **You can now do remote CSRs through software control without the need to manually cover the lens!** With the optional Canon EOS lens mount installed you get remote control over lens aperture and focus, too. **This enables complete remote control in environments where you cannot easily access the camera.**

These models come with 8GB, 16GB or 32GB internal high-speed memory. Segmenting memory allows you to divide this into up to 63 segments so you can **take multiple shots back-to-back** without the need to download data from the camera.

Or, record directly to our Phantom CineMag non-volatile, hot-swappable memory magazines. They mount on the CineMag interface of compatible cameras. Continuously record full resolution cines into a CineMag at up to 780 fps. That's just over 2 minutes into the 128GB CineMag, 4.25 minutes into the 256GB, or 8.5 minutes into the 512GB version. Or, record at even higher speeds into camera RAM, then manually or automatically move your recording to the CineMag. With CineMag storage you **get maximum data protection and an ideal storage medium for secure environments.** The CineMag interface is an option on all models.

	Phantom v411	Phantom v711
Throughput / Speed	> 4 Gpx/second Max speed at full resolution of 1280 x 800 is 4200 fps Max speed at reduced resolution of 128 x 8 is 600,000 fps Record direct to CineMag at up to 800 Mpx/second Minimum frame rate of 24 fps	> 7 Gpx/sec Max speed at full resolution of 1280 x 800 is 7530 fps Max speed at reduced resolution of 128 x 8 is 680,000 fps (standard), 1,400,000 fps (optional) Record direct to CineMag at up to 800 Mpx/second Minimum frame rate of 24 fps Some features are export controlled
Exposure	1 μ s minimum exposure Global electronic shutter Extreme Dynamic Range (EDR) Auto Exposure Shutter Off mode for PIV	1 μ s minimum exposure (standard), 300 ns (optional) Global electronic shutter Extreme Dynamic Range (EDR) Auto Exposure Shutter Off mode for PIV Some features are export controlled
Record Times	5.2 seconds at maximum frame rate, maximum bit depth, largest resolution and into maximum internal memory. Longer record times are available when recording directly to a CineMag.	2.97 seconds at maximum frame rate, maximum bit depth, largest resolution and into maximum internal memory Longer record times are available when recording directly to a CineMag
Image-Based Auto-Trigger	Standard	
Internal Mechanical Shutter	Standard	
Timing & Synchronization	20 ns timing resolution Frame synchronization to internal or external clock (FSYNC) IRIG in/out (modulated or unmodulated) SMPTE timecode at support frame rates Ready output Strobe output Genlock	
Signaling	Dedicated FSYNC, Trigger, Genlock, Timecode In and Timecode Out (SMPTE & IRIG) BNCs on camera body, Range Data input on camera body Capture cable with Ready, Strobe, IBAT-Trigger, Pre-Trigger, Analog Video, Additional signals available with use of optional Break-Out-Box (BoB)	
Ethernet Connection	Gb Ethernet for both control and data	
Camera Control	Optional On-Camera Controls (OCC), Phantom Camera Control (PCC) Remote Control Unit (RCU), connects to Remote port, LabView and Matlab drivers available	
Video Out	Analog video (NTSC or PAL) available on Capture Cable Component viewfinder port Versatile Dual HD-SDI can provide 4:4:4 video (except at 60 fps), or can be two single 4:2:2 HD-SDI ports, one for playback and one always live	
Lensing	Nikon F-mount standard, Canon EOS mount optional, PL-mount optional, C-mount optional, (lens not included)	



Phantom v711

ISO SAT			
Mono		Color	
ISO SAT T	ISO SAT D	ISO SAT T	ISO SAT D
20,000	6400	2500	2000

DATA SHEET

Phantom®

1 Megapixel

v-Series Cameras

Additional Features:

Size (without lens, CineMag or handle):

11.5 x 5.5 x 5.0 inches (L x W x H);

29.2 x 14 x 12.7 cm

Weight (without lens or CineMag): 11.75 lb; 5.33 kg

Temperature and Humidity: 0°C - 40°C @ 8% to 80% RH

Shock: 30g, half sine wave, 11 ms, 10 times all axes
(without CineMag or lens)

Vibration: 25g, 5-500 Hz, all axes without CineMag

Focused

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Move the CineMag to a CineStation connected to a PC and **view, edit, and save your recordings using the Phantom Camera Control software** included with the camera. Keep the recordings in their original raw cine format, or convert them to TIFF, QuickTime, AVI, or other popular formats. Move files from the CineStation to a disk or video recorder via 10Gb Ethernet; 4:4:4 HD-SDI, or Component Video outputs.

When using the camera on a tracking mount, **elevation and azimuth data can be transferred to the camera** and associated with image frames through our unique Range Data interface.

View your recordings immediately in a variety of formats either through the HD-SDI ports on the camera, or through the component video port. There are two HD-SDI ports on the camera which can be configured in a variety of ways including 4:4:4 dual-link and simultaneous play/record (on some models).

The cameras can be controlled with the feature-rich PCC software, the Phantom RCU, or the new (optional) on-camera controls.

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DATA SHEET

For the most current version visit www.visionresearch.com
subject to change. Rev. 06/19/11



Phantom® v640 Broadcast

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

The Vision Research Phantom v640 camera is the **ultra-slow motion camera-of-choice of broadcast solution providers worldwide**. Its unique feature set, tailored for sports replay applications and other live events, sets it apart from other slow-motion cameras. Don't settle for only 3X or 4X slow motion.

Leading slow-motion Solution Providers around the world have chosen Phantom cameras as the core of their broadcast-ready solutions.

The v640 has been used for ultra-slow motion at the **2010 FIFA World Cup**, the **Super Bowl**, the **2010 Olympics**, and baseball's **World Series**.

What makes the v640 so unique and so perfect for ultra-slow motion replay?

Extremely high frame rates at HD resolutions enables playback speeds as much as 90X times slower than live action. (For example, at 1280 x 720, the maximum recording speed is 5850 fps. Play that back at 60 fps to achieve a slow-down of 97 times.) Catch what the eye cannot see in live action. Marvel at the amazing skills of an athlete, watch muscles ripple, eyes focus, intense concentration. Ultra-slow motion playback evokes a deep visceral, emotional reaction in viewers.

Excellent control of HD-SDI image quality. The Phantom v640 image lends itself perfectly to the high-standards of the industry. Working with video matrix, hue, gamma

v640 Broadcast

Ultra-slow motion for
live sports and events

Key Features:

Frame rates for up to 90X ultra-slow motion at
1920 x 1080 or 1280 x 720 resolution

Breakthrough light sensitivity, ISO 1200 color
(ISO 12232 SAT method)

Versatile Dual HD-SDI, two HD-SDI ports for dual-link 4:4:4
or 2x 4:2:2 independent video outputs

Video matrix and advanced color control over the
HD-SDI video

Multi-cine recording capability

EVS integration for camera control and playback

1 μ s minimum exposure times for sharp images of
fast moving events

Internal mechanical shutter for hands-free /
remote black referencing

8 GB, 16 GB or 32 GB built-in high-speed memory

8-bit or 12-bit pixel depth

Gb Ethernet for camera control

DATA SHEET

v640 Broadcast

and chroma adjustments enables the Phantom v640 to match the HD broadcast cameras shooting an event at normal speeds.

An electronic global shutter capable of microsecond exposure times. It is highly unlikely you need such short exposures to freeze motion and prevent blur in sporting activities. But, the roots of the v640 technology come from scientific, academic and industrial uses where short exposures are often required. We've brought industry leading performance required by those extreme applications to the v640 for the ultimate in flexibility.

High light sensitivity. Rated at 1200 ISO (color) using the ISO 12232 SAT method, the v640 has enough light-gathering capability to deal with high frame rates, short exposure times and unpredictable lighting conditions. Enabled by a custom-designed sensor with high quantum efficiency and a unique microlens technology, the v640 will produce well exposed images which lessens the need to introduce gain and possible noise.

Multi-cine support. Not only can you segment the internal memory into a maximum of 63 segments, you can record into one segment while playing back a slow-motion clip from another. One segment is always continuously recording the live action. When an important event takes place, trigger that segment to save the recording. The live recording automatically moves to the next segment. Meantime, you can view, trim, and playback the just-recorded clip from camera memory.

Versatile Dual HD-SDI. The multi-cine capability is supported with a dual independent video port architecture. The "live" image is always played through one of the two HD-SDI ports on the camera (and the viewfinder port), while the second port can simultaneously be used for playback of a saved clip. Either or both of these outputs can be fed to an external recorder or clip server. The camera operator never loses sight of the live action while waiting for a playback to finish. Alternatively, combine the two HD-SDI ports into a dual-link configuration to create a single 4:4:4 output for ultimate quality playback/recording.

EVS support via UltraMotion. EVS software supports the v640 natively, enabling all these features from an OB truck. An operator in the truck can segment memory, start recording live images, trigger the camera, view any saved clip, scrub through the clip, trim it and queue it for playback – all without the need to first download the clip.

Custom fit B4 adapter. While the v640 comes standard with a Nikon F-mount allowing for full sensor coverage (2560 x 1600 pixels), for sports broadcast applications there is a B4 adapter that allows a B4 broadcast lens to exactly cover 1920 x 1080 for minimum light loss.

If you are looking for the ultimate in ultra-slow motion playback solutions for sports broadcast, consider the Phantom v640. Contact your local Vision Research representative today.

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Focused

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DATA SHEET

v640

2560 x 1600

10-1500 fps at full resolution

Breakthrough sensitivity

Phantom CineMag® compatible

Key Features:

10-1500 frames-per-second (fps) at full resolution.
Maximum FPS: 300,000 @ 256 x 16

2560 x 1600 CMOS sensor

Minimum Exposure (shutter speed): 1 μ s

High-resolution timing system: Better than 20 ns resolution

Extreme Dynamic Range (EDR): two different exposures
within a single frame

Internal Shutter: hands-free/remote current session
reference (CSR)

Memory Segmentation: Up to 64 segments

Non-volatile, hot-swappable Phantom CineMag
memory magazines (128 GiB, 256 GiB & 512 GiB)

CineMag to CineStation®

Range Data input

Built-in Memory: 8 GiB, 16 GiB, 32 GiB

Breakthrough Sensitivity: ISO (12232 SAT) 1000 Color,
4000 Mono; QE 60% peak; NEP 0.011 fJ

Pixel Bit-depth: 8- and 12-bit

Gb Ethernet

View recordings immediately via video-out ports

Versatile Dual HD-SDI ports configured to meet your needs



Key Benefits:

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

In 2006, Vision Research introduced the world's first 4 megapixel digital high-speed camera – the Phantom v10. Look how far we've come since then!

Based on a camera architecture first introduced with the Phantom v12.1, the v640 provides a 4 megapixel sensor and greater than 6 gigapixels/second throughput. That means full-resolution frame rates of 1500 frames-per-second (fps), and 1920 x 1080 HD-resolution frame rates of 2700 fps. The minimum frame rate is 10 fps.

Take the wide view with our custom-designed 2560 x 1600 pixel CMOS sensor. The aspect ratio of the v640 allows you to keep moving targets in-frame longer and see more of the event you are recording.

Shutter speeds down to 1 microsecond and a **global electronic shutter** allow for crisp, sharp images with little or no image blur or motion artifacts.

With a peak quantum efficiency (QE) of 60% – greatly improved over current sensor designs – and a significant reduction in readout noise, along with the addition of microlens technology, the v640's **four megapixel resolution can be used to full advantage** at speeds that normally called for large-pixel, lower resolution cameras.

Phantom v640
provides a
4 megapixel
sensor and
greater than
6 gigapixels/
second
throughput.

That makes the v640 ideal for applications where **high sensitivity and high resolution** are needed. Coupled with a 1.2 microseconds straddle time the v640 is ideal for **PIV applications**, for example.

Each camera supports **8- and 12-bit pixel depth**. Smaller bit-depth gives you more recording time and smaller files. Greater bit-depth gives you more gray levels and finer detail. With the greater latitude of 12 bits, you can pull more detail out of the image.

The v640's **high-resolution timing system** yields a timing resolution of better than 20 nanoseconds. Frame rate, frame synchronization and exposure accuracy are all improved over previous generations of high-speed cameras. And, an external frame synchronization signal is available via a dedicated BNC for easier cabling and increased signal integrity. A GenLock input is available for synchronizing the playback of recorded cines to other video gear.

Of course, the v640 offers our unique **Extreme Dynamic Range (EDR)** feature giving you the ability to get two different exposures within a single frame. And, with **auto exposure**, the camera adjusts to changing lighting conditions automatically.

There is an **internal shutter** for cutting off all light to the sensor when doing a session-specific black reference (CSR). You now can do **remote CSRs** through software control without the need to manually cover the lens!

The v640 comes standard with 8 GiB of high-speed dynamic RAM, but you can order 16 GiB or 32 GiB versions. Our **segmented memory** allows you to divide this into up to 64 segments so you can take multiple shots back-to-back without the need to download data from the camera.

Or, record directly to our **Phantom CineMag** non-volatile, hot-swappable memory magazines. They mount on the CineMag compatible version of the camera. **Continuously record** full resolution cines into non-volatile memory at up to 240 fps (445 fps at 1920 x 1080). That's about 3.5 minutes of continuous recording into the 256 GiB CineMag or 7 minutes into the 512 GiB CineMag.

Or, record at higher speeds into camera RAM, then manually or automatically move your cine to the CineMag. If you need to **take multiple shots back-to-back**, you don't have to wait for a time-consuming download of camera memory over Ethernet. Instead, just upload the camera memory to a CineMag at about 1 GiB/second, then take your next shot!

With CineMag storage you get maximum data protection and an ideal storage medium for secure environments.

Move the CineMag from the camera to a **CineStation** connected to a PC and view, edit, and save your cines using the Phantom Software supplied with the camera.

Keep them in their original cine raw format, or convert them to TIFF, QuickTime, AVI, or a number of other formats. Move the files from the CineStation to a disk or tape deck via 10 Gb Ethernet, dual HD-SDI, or Component Video outputs.

When used on a tracking mount, elevation and azimuth data can be transferred to the camera and associated with image frames through our unique **Range Data** input.

View your recordings immediately. There are two **Versatile Dual HD-SDI ports** that can be used in one of four different modes: 2 identical 4:2:2 outputs; 1 dual HD-SDI 4:4:4 output; independent 4:2:2 outputs where one is live and one is playback; or 4:4:4 playback on the dual HD-SDI while you have a live image on the component viewfinder. Yes, a component video viewfinder port has been added so any viewfinder compatible with our Phantom HD camera can now be used with the v640.

The v640 is controlled by the feature-rich Phantom Software. If you've used any Phantom camera before, you will know how to run the v640.

The v640 comes in two base models, either with or without a CineMag interface. An optical low-pass filter is available as an option.

H	V	FPS*
2560	1600	1,500
2048	1600	1,800
2048	1024	2,800
1920	1080	2,700
1280	800	5,250
1280	720	5,850
800	600	8,250
640	480	12,500
512	512	15,000
512	384	19,800
256	256	39,500
128	128	72,000
128	64	125,000
128	8	300,000

*Typical results

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v640



Additional Features:

- Analog video out: PAL, NTSC & HD Component (720p)
- HD-SDI: All standard formats, Versatile Dual HD-SDI outputs
- Lensing: F-mount, C-mount, PL-mount
- Optional optical low-pass filter
- Size (without lens): 12.25 x 5.5 x 5.0 in. (L,W,H)
31.1 x 14 x 12.7 cm
- Weight (without lens): 12 lbs (5.4 Kg)
- Power: 90 Watts @ 24 VDC, without CineMag
- Operating Temperature: 0°C to 40°C @ 8% to 80% RH
- Storage Temperature: -10°C to 55°C
- Non-operational Shock: 33G, half sine wave, 11ms, all axes without CineMag
- Operational Shock: 30G, half sine wave, 11ms, 10 times all axes (without CineMag or lens) to Mil-Std-810 G
- Operational Vibration: 0.25G, 5-500 Hz, all axes without CineMag

Focused

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All specifications are subject to change without notice. Rev Nov, 2009

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For the most current information visit www.visionresearch.com
 Product Code: 0123 Rev: Mar 2012



CineMag shown is the new, smaller 128 GiB version.

Phantom® CineMag®

Hot-swappable, non-volatile memory for Phantom Digital Cameras

Key Benefits:

HIGH-SPEED IMAGING IS MEMORY HUNGRY

Shoot 1000 frames-per-second with the Phantom HD at 1920 x 1080 and 14-bits-per-pixel and you will need 3.6 GiB of memory for each second of recording! A 4-second recording could take up to 15 minutes to save using standard Gb Ethernet. Equip the Phantom HD with a CineMag, and save the shot to non-volatile memory in about 10 seconds.

Need to shoot 4 minutes of 1 megapixel footage at 425 fps for later analysis? Put a 128 GiB CineMag on a v210 and you are good to go.

Do you have a recurring event that you want to safely save multiple recordings of? Unattended? Using a CineMag equipped camera set up for automatic saves after each shot, and you'll never miss an important event again.

Introducing the Phantom CineMag hot-swappable, non-volatile memory for Phantom high-speed cameras.

Record directly to a CineMag using compatible Phantom cameras at speeds up to 800 megapixels-per-second. That's 450 fps at 1920 x 1080 on the Phantom HD, 95 fps at full resolution on the Phantom 65, 800 fps at full resolution on the v210, v310, v12.1 or v710, and up to 200 fps at 2560 x 1600 on the v640. If you need higher speeds, record into camera RAM and "upload" the recording to a CineMag in seconds.

Key Features:

Hot-swappable, non-volatile memory for Phantom HD, 65, v12.1, v210, v310, v710, v640

Three sizes – 128 GiB, 256 GiB, 512 GiB

Direct recording to a CineMag at up to 700 megapixels/second for long record time applications

Immediately save high-speed recordings to non-volatile memory and free the camera for the next event

Efficient cine raw format packs a lot of information into the available memory

Swap the CineMag onto a CineStation® for the ultimate digital imaging workflow

Access the data in the CineMag from the Phantom Software, just as if you were accessing recordings stored in camera RAM

CineMag®

Introducing
the Phantom
CineMag
hot-swappable,
non-volatile
memory for
Phantom
high-speed
cameras.

Once saved in the CineMag, your data are secure and you can move on to your next shot.

When a CineMag gets full, or when you are done with a series of shots, pop the CineMag off the camera and snap another one on. You can later use the same camera, or Phantom CineStation as a docking station to view and download the raw cine files.

Use the Phantom CineStation connected to a PC and keep your camera free for doing its job – shooting high-speed events. The CineStation supports both raw digital and video workflows by providing a fast file download capability as well as the ability to play the cine files stored on the CineMag over dual HD-SDI video outputs or component video. The 10Gb Ethernet version of the CineStation accelerates your workflow even more.

Access the data in the CineMag from the Phantom Software, just as if you were accessing recordings stored in a camera. All the familiar tools are available. You can view stored cines, trim them, and save them onto a hard disk for later processing and conversion. Or, trim them, make image enhancements and “play” them out over HD-SDI (dual-link HD-SDI or component video if using the CineStation).



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CineMag®

Maximum recording times at various resolutions

PHANTOM HD

RESOLUTION	FRAME RATE	128 GiB	256 GiB	512 GiB
2048 x 2048	230 max	1.8 min.	3.7 min.	7.4 min.
2048 x 1536	310 max	1.8 min.	3.7 min.	7.4 min.
1920 x 1080	450 max	1.8 min.	3.6 min.	7.2 min.
1920 x 1080	24	33.5 min.	67 min.	135 min.
1280 x 720	670 max	1.8 min.	3.6 min.	7.3 min.

PHANTOM 65

RESOLUTION	FRAME RATE	128 GiB	256 GiB	512 GiB
4096 x 2440	95 max	1.9 min.	3.8 min.	7.6 min.
4096 x 2440	24	7.5 min.	15 min.	30 min.
1920 x 1080	224 max	1.8 min.	3.6 min.	7.25 min.

PHANTOM v210, v310, v12.1, v710

RESOLUTION	FRAME RATE	128 GiB	256 GiB	512 GiB
1280 x 800	800 max	2.2 min.	4.4 min.	8.8 min.
1280 x 720	300	6.5 min.	13 min.	26 min.
1024 x 768	1020 max	2.2 min.	4.5 min.	9 min.
640 x 480	2660 max	2.2 min.	4.4 min.	8.8 min.

PHANTOM v640

RESOLUTION	FRAME RATE	128 GiB	256 GiB	512 GiB
2560 x 1600	200 max	2.2 min.	4.4 min.	8.8 min.
2560 x 1600	24	18.3 min.	36.5 min.	73 min.
2048 x 1600	250 max	2.2 min.	4.4 min.	8.8 min.
2048 x 1080	370 max	2.2 min.	4.4 min.	8.8 min.
1024 x 1024	780 max	2.2 min.	4.4 min.	8.8 min.

The Phantom CineMag – your workflow solution for high-speed imaging.



CineMag shown is the new, smaller 128 GiB version.

Additional Features:

Weight: 0.9 kg (2 lb.), less for the 128 GiB version

Size: 5.5" x 4.9" x 1.5" (L x W x H); 192 x 126 x 40 mm, the new 128 GiB version is 1/2 this height

LED display: On-board display includes: memory remaining, write activity, write protect, magazine enabled, and power

Operating temperature: 0°C to +40°C (+32°F to +104°F)

Operating humidity: 80% non-condensing at +5°C

Recording: Fully uncompressed 12-bit or 14-bit sensor data, saved internally as 10-bit log

Power Consumption: 1.5 amp supplied by camera or CineStation

Focused

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AMETEK®
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For the most current version visit www.phantomcameras.com
or contact your distributor



Phantom CineMag installed on a Phantom CineStation

Phantom[®] CineMag[®] and CineStation[®]

Hot-swappable, non-volatile memory solutions for Phantom High-Speed Cameras

Key Features:

Available in three sizes: 144GB, 256GB, 512GB

Supports direct recording up to 800 Mpx/second for applications that require long record times of up to several minutes

Quickly save high-speed recordings from RAM to the CineMag and free up the camera to capture the next event

Files are stored in CineMag in the efficient & high quality Cine raw format

Download files from CineMag using the Phantom CineStation via standard Gigabit Ethernet or optional 10-Gigabit Ethernet for the fastest file transfer

Access the data in the CineMag from Phantom PCC software, just as you were accessing recordings stored in camera RAM

Key Benefits:

High-Speed Imaging is Memory Hungry

Each second of HD 1,000 frame-per-second (fps) recording takes up about 4 Gigabytes of memory. A 4-second recording could then take up to 15 minutes to save using the camera's standard Gigabit Ethernet. That's a lot of downtime between shots! As technology improves, and available resolutions and frame rates increase, the fact is that more memory is needed for each second of ultra-high speed recording.

By equipping the camera with a Phantom CineMag[®], that same shot can now be saved to non-volatile memory in about 15 seconds. The file is secure, and stored in Phantom's native uncompressed raw format to ensure the highest quality footage. Re-arm the camera and you're ready to move on to the next shot right away. The amount of time saved on set, or in between experiments is invaluable.

CineMags are small, compact and completely hot-swappable. Once they are full they can be removed from the camera and replaced with an empty one so the shoot remains uninterrupted. The full CineMag can now be moved to a Phantom CineStation[®] for off-camera download and file management.

The CineStation is a simple device that connects to a PC using standard Gb Ethernet or optional fiber-based 10Gb Ethernet for the fastest file download

DATA SHEET

Phantom® CineMag® and CineStation®



CineMag installed on a Phantom v1210 camera

CineMag Specifications:

- Weight: <1 lb (.4 kg)
- Size: 5.5" x 4.9" x 0.5" (192 x 126 x 13 mm)
- Environmental: Operating temperature 0°C to +40°C; Humidity: 80% non-condensing at +5°C
- Power Consumption: 1.5 amp supplied by camera or CineStation
- LED display: Built-in display shows memory remaining, write activity, write protect, status and power

CineStation Specifications:

- Weight: 5 lbs (2.3 kg)
- Size: 10.25" x 6" x 3" (26 x 15.25 x 7.7 cm)
- Inputs: CineMag, AC power, Tri-level genlock
- Outputs: Gb Ethernet, Dual-link HD-SDI (4:4:4), Component Video (YPrPb), Optional 10Gb Ethernet Standard Gb Ethernet – RJ45 Copper interface Optional 10Gb Ethernet – X2SR Fiber interface



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possible. Mount a CineMag to the CineStation and use the supplied software to view each file stored on the CineMag, play them over the dual HD-SDI or component video ports, set in- and out-points to trim, and save the files to a connected hard drive. The save process can also be fully automated.

Applications that require a longer duration recording than what is available in the camera's built in memory will benefit from the CineMag's Run/Stop workflow. In this mode data can be streamed at a throughput of roughly 800 Mpx/sec directly to the CineMag, which is available in sizes up to 512 GB. Several minutes of high-speed recording are possible at limited frame rates. Maximum record speed and times can be found in the chart below.

CineMags are now compatible with most modern Phantom v-Series and Digital Cinema cameras. Whether in a studio environment, in the lab or on a test range, save time and file security is critical. The Phantom CineMag and CineStation provides the ideal solution for a fast, streamlined and high quality workflow.

Maximum Direct-to-CineMag Record Times at Select Resolutions

Phantom Flex, v341, v641, v642

Resolution	Frame Rate (fps)	144 GB	256 GB	512 GB
2560 x 1600	175 max	2.4 minutes	4.3 minutes	8.5 minutes
2560 x 1440	200 max	2.4 minutes	4.3 minutes	8.5 minutes
2048 x 1080	360 max	2.4 minutes	4.3 minutes	8.5 minutes
2048 x 1080	24	36 minutes	64 minutes	128 minutes
1024 x 1024	750 max	4.3 minutes	4.3 minutes	8.5 minutes
1280 x 720	850 max	2.4 minutes	4.3 minutes	8.5 minutes

Phantom v711, v611, v411, v311, v211

Resolution	Frame Rate (fps)	144 GB	256 GB	512 GB
1280 x 800	780 max	2.4 minutes	4.2 minutes	8.5 minutes
1280 x 720	860 max	2.4 minutes	4.2 minutes	8.5 minutes
1280 x 720	300	7 minutes	12 minutes	24.5 minutes
640 x 480	2600 max	2.4 minutes	4.2 minutes	8.5 minutes

Phantom v1610, v1210

Resolution	Frame Rate (fps)	144 GB	256 GB	512 GB
1280 x 800	970 max	2 minutes	3.4 minutes	6.8 minutes
1280 x 720	1050 max	2 minutes	3.4 minutes	6.8 minutes
1280 x 720	300	7 minutes	12 minutes	24.5 minutes
640 x 480	3260 max	2 minutes	3.4 minutes	6.8 minutes

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Phantom CineMag IV and CineStation IV

DATA SHEET

For the most current version visit www.phantomhighspeed.com
Product Code: 01918 Rev. April 19/18

Phantom® CineMag IV® and CineStation IV®

Hot-swappable, non-volatile
workflow solutions for Phantom
High-Speed Cameras

Key Benefits:

Streamline the Phantom Flex4K and UHS-12 high-speed camera workflow

The Phantom CineMag IV is the third-generation CineMag model from Vision Research. While the physical size of the device has decreased, the capacities and throughputs have increased in order to keep up with the size of data, which is ever increasing alongside advances in camera resolution and frame rate.

For example, a 72GB Phantom UHS v2512 records for less than 2 seconds of real time at the camera's top frame rate. That 72GB of data has to be downloaded before moving on to the next shot. The fastest and easiest way to do this is by using a CineMag IV, which will save all of the data in less than a minute.

CineMag IVs are secure, compact, and completely hot-swappable. Once they are full they can be removed from the camera and replaced with an empty one so the shoot remains uninterrupted. A full CineMag IV can now be moved to a Phantom CineStation IV for off-camera download and file management.

The CineStation IV is a simple device that connects to a PC using either 1Gb or ideally 10Gb Ethernet, which comes standard in the CineStation IV. Connect a

Key Features:

Available in two sizes: 1TB and 2TB

Compatible with: Flex4K and all UHS-12 models (v1212, v1612, v2012, v2512)

Recording formats: Cine raw (all cameras), or Apple ProRes 422 HQ (Flex4K only)

Operational modes: Supports Loop-mode and Run/Stop mode for longer record times at lower frame rates

CineStation IV: Download the CineMag IV over Gb Ethernet or 10Gb Ethernet (included)

Access the data in the CineMag from Phantom PCC software, just as you were accessing recordings stored in camera RAM

DATA SHEET

Phantom® CineMag IV® and CineStation IV®

CineMag IV Specifications:

- Weight: 0.6 lb (0.3 kg)
- Size: 3.5 x 4.5 x 0.4 (88 x 113 x 11mm)
- Power Consumption: 1.5 amp supplied by camera or CineStation
- LED display: Built-in display shows memory remaining, write activity, write protect, status and power

CineStation IV Specifications:

- Weight: 1 lb (0.45 kg)
- Size: 6.5 x 5.7 x 1.5" (16.5 x 14.6 x 3.8 cm)
- Power: 40W power supply included
- Inputs: CineMag IV, AC power
- Outputs: Gb Ethernet, 10Gbse-T Ethernet (both via RJ45 Copper interface)

Note: SDI video outputs and buttons are not active



CineMag IV mounted in Phantom UHS-12 (left) and Flex4K (right)

CineMag IV and use the supplied software to view each file, set in- and out-points to trim, and save the files to a connected hard drive. The save process can also be fully automated.

The CineMag IV supports Loop mode, taking advantage of the camera's top frame rates, and Run/Stop (R/S) mode for applications that require long record times of up to several minutes at reduced frame rates. In this mode raw image data can be streamed at a throughput of up to 1 Gpx/sec directly to the CineMag IV, which is available in sizes up to 2TB. Several minutes of high-speed recording are possible at limited frame rates. Maximum record speed and durations can be found in the chart below.

Run/Stop Record Times at Select Resolutions

(note: max frame rates to 1TB CineMag IV are slightly reduced)

Phantom UHS-12 (v1212, v1612, v2012, v2512)

Resolution	Frame Rate (fps)	2 TB CineMag IV
1280 x 800	1000 max	26 minutes
1280 x 720	1110 max	26 minutes
1280 x 720	300	88 minutes
640 x 480	3330 max	26 minutes

Phantom Flex4K

Resolution	Frame Rate (fps)	2 TB CineMag IV
4096 x 2304	120 max	25 minutes
4096 x 2160	128 max	25 minutes
4096 x 2160	24	134 minutes
2048 x 1080	512 max	25 minutes
2048 x 1080	24	538 minutes

*Note: Max fps indicated for raw recording only. ProRes recording in R/S mode is up to 30 fps at full 4K resolution



CineStation IV (rear)

Focused

Since 1950, Vision Research has been designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.



100 Dey Road
Wayne, NJ 07470 USA
+1.973.696.4500

www.phantomhighspeed.com

AMETEK Vision Research's digital high-speed cameras are subject to the export licensing jurisdiction of the Export Administration Regulations. As a result, the export, transfer, or re-export of these cameras to a country embargoed by the United States is strictly prohibited. Likewise, it is prohibited under the Export Administration Regulations to export, transfer, or re-export AMETEK Vision Research's digital high-speed cameras to certain buyers and/or end users.

Customers are also advised that some models of AMETEK Vision Research's digital high-speed cameras may require a license from the U.S. Department of Commerce to be: (1) exported from the United States; (2) transferred to a foreign person in the United States; or (3) re-exported to a third country. Interested parties should contact the U.S. Department of Commerce to determine if an export or a re-export license is required for their specific transaction.

EXHIBIT P389

PRELIMINARY

DATA SHEET

For the most current version visit www.visionresearch.com
Additional features: For More Info

Phantom® CineStream®

New Connectivity Solutions
for Phantom Cameras



Phantom CineStream-RTO (left) and CineStream-X2SR (right)

WHEN IT'S TOO FAST TO SEE, AND TOO IMPORTANT NOT TO®

Phantom CineStream

Introducing new connectivity solutions for Phantom digital high-speed cameras. The Phantom CineStream family of products provides new ways to manage the massive amounts of data that today's digital high-speed cameras generate. The CineStream module plugs onto the CineMag® interface of any CineMag capable v-Series¹ Phantom camera.

CineStream® X2SR

The X2SR model of the Phantom CineStream provides 10Gb Ethernet connectivity. With this module mounted onto a Phantom camera, you can control the camera and download cine files over 10Gb Ethernet – at speeds that are up to 7 times faster² than the standard 1Gb Ethernet port on the camera. The package comes complete with everything you need: the CineStream module, the X2SR transceiver, 10 meters of fiber, and a PCIe card and associated transceiver for installation in a compatible PC. (The 10m distance can be extended to 26m using FDDI grade multi-mode fiber. For greater distances contact Vision Research for alternatives.)

Key Features:

All CineStream modules plug onto the camera's CineMag interface

CineStream X2SR

Control and data download over 10Gb Ethernet

Comes with everything you need including CineStream module, 10Gb Ethernet transceivers, 10m fiber and PCIe card

By replacing the supplied transceivers with other industry standard transceivers, you can achieve greater separation distances:

X2-10GB-SR: 26M over FDDI grade MMF; 300m over 50-micron 2000 MHz*km MMF

X2-10GB-LR: 10km over SMF

X2-10GB-ER: 40km over SMF

CineStream RTO

Stream camera data at up to 800 Mpx/sec over fiber to frame grabber

CineStream SAFE

Remote a CineMag on a CineSafe located at up to 100 meters away

PRELIMINARY

DATA SHEET

CineStream® RTO

The RTO model of the Phantom CineStream provides an ultra-fast streaming interface from Phantom v-Series¹ cameras. The "real time output" is a fiber interface with an 800 megapixel-per-second bandwidth. It provides 10-bit-per-pixel corrected data in a well-documented format which can be connected to a high-bandwidth frame grabber³. The frame grabber can be located up to 100m away from the camera.

With the initial purchase of a CineStream RTO, an installation package will be required. Packages are available that include comprehensive documentation and engineering support, and will be determined based on the specific application.

CineStream® SAFE⁴

While not yet available as a shipping product, the Phantom CineStream SAFE module will allow you to record and read from Phantom CineMags that are remotely located. The use-model is identical to having a CineMag mounted on the camera. You can record directly to a CineMag, save high-speed cines from camera RAM to a CineMag, and play back cines stored on a CineMag. However, the CineMag can be remotely located on a Phantom CineSafe – a new product, soon to be available, up to 100 meters away! This is ideal for situations where the camera cannot be easily accessed for removal of the CineMag, or when the camera may be located in a hazardous position and securely storing the image data at a remote location in real-time is required. The Phantom CineSafe™ is simply a device that allows you to "remote" a CineMag at a safe distance from the camera.

¹ Not compatible with the Phantom FLEX, Phantom HD, Phantom HD GOLD or Phantom 65.

² Speeds are heavily dependent upon the performance of the controlling PC and disk storage.

³ A commercial frame grabber will soon be available, or we will provide you with the interface specifications so you can build your own.

⁴ Not yet available.

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Phantom CineStream

Phantom CineStream X2SR

Control camera and download cine files over 10Gb Ethernet



Phantom CineStream RTO

Stream data in real time at 800 Mpx/sec to frame grabber



Phantom CineStream Safe

Remotely locate a CineMag for safe storage of cine files



Focused

Since 1950, Vision Research has been shooting, designing, and manufacturing high-speed cameras. Our single focus is to invent, build, and support the most advanced cameras possible.

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An **AMETEK** Company

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phantom@visionresearch.com

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EXHIBIT P390

DATA SHEET

For the most current version visit www.phantomhighspeed.com
Subject to change Rev./April 2016

Remote Control Unit

Small, lightweight, handheld controller even doubles as a video monitor.



Key Benefits:

The Phantom Remote Control Unit (RCU) is an ideal companion to your Phantom digital high-speed camera. The **small, lightweight, handheld controller** allows you to control most settings on Phantom cameras, as well as view and save recorded cines to a CineMag®— it even doubles as a video monitor.

Available in **wired and wireless models**, the RCU supports the entire high-speed imaging workflow. Set up the camera, trigger the shot, view the cine on the LCD screen, trim to the frames of interest, and save the result to a CineMag. (The wireless mode does not provide a video display on the RCU.)

The **ergonomic design** of the Phantom RCU allows you to hold it in one hand while using your other hand to manipulate settings; you can set it on a horizontal surface; or, you can mount it to any available mounting point using the 1/4-20 tap in the bottom of the unit.

Key Features:

- Extensive control over Phantom cameras without the need to tether the camera to a PC
- Lightweight and handheld for mobility and flexibility
- Intuitive/simple user interface minimizes learning curve
- Easy control over hard-to-access camera installations
- Compatible with PCC Software

RCU

Available in
wired and
wireless
models, the
RCU supports
the entire
high-speed
imaging
workflow.



The 5" active TFT display is **easy to see – even outdoors**. The sensitive touch screen allows you to completely control a camera with just the **tap of your finger**. A **scroll/jog dial** gives you an alternate (and fast!) way to change many settings or to scrub through a recorded cine.

Just 7" wide, 4" tall and 3-1/2" deep at the hand-grip/battery compartment, and weighing only 26 ounces, the RCU is big enough to use as a video monitor, and small enough to be truly hand-held. (17.75 cm by 10.2 cm by 8.9 cm, 740 gm.)

The RCU connects to Phantom v-Series cameras via our new **Break-out-Box**. Not only do you get convenient RCU connectivity, but the Break-out-Box also makes **all camera signals easily accessible**. The RCU gets power and a video signal from the camera (NTSC or PAL from a v-Series camera). It can display SDI signals by using a separate SDI cable connection. The RCU can also be powered by battery. This is needed if you want to use the RCU to set up several cameras without the need to restart the RCU each time, or if you are working in a wireless use model.

If you have a Phantom HD, or 65 model, the RCU **connects directly to the Remote port** on the camera – no need for the Break-out-Box – or connect wirelessly using a Bluetooth™ dongle that plugs into the camera. (The RCU is not compatible with the Miro or Miro eX line.)

The optional industrial Bluetooth* connectivity gives you the freedom to **control the camera wirelessly**. (You will likely still want a wired monitor on which to preview shots.)

Simply connect the RCU to the Break-out-Box or camera, press the **Menu** button to power up, and within a few seconds you are ready to setup and control the camera. On the home screen, you have four menu choices: **Status, Setup, Capture, Play**.

Select **Status** by tapping it, and you will see a screen that shows the current camera setup and status. This is a great way to quickly view key information about the camera.

Setup is where you control camera settings and prepare your high-speed shot.

Tap on **Capture** to arm the camera and begin acquiring pretrigger frames. When ready, trigger the shot. You can use the trigger button on the RCU, a trigger wired through the Break-out-Box, or our unique Image-Based Auto-Trigger on compatible cameras.

Play gives you access to the recorded cine(s). View a cine on the RCU screen, trim it to contain only relevant frames, and save it to a CineMag (if your camera has a CineMag attached.)

You can hide the on-screen menu system entirely at any time and view the video image on the LCD screen by tapping on the close icon "X" button on the LCD display. Or, simply minimize the menu system and share the display with both video and control menus.

Easily accessible buttons on the RCU allow you to move through the menu system and execute common commands with the push of a button. The **Menu** button will restore the menu system view if it is hidden, or, take you back to the Home screen if the menu is already visible. The **Video** button allows you to sequence through several useful views of the live image to help you prepare your shot. Tap it once to see a full-screen live image, tap it again to get a zoomed image, a third tap will display an image where any saturated pixels are shown in false color. In three taps you can judge framing, focus and exposure easily!

Two **user-programmable buttons*** are available. You can assign any of several common functions to a button, including the ability to load a saved camera setup. If you have a suite of camera settings that you use frequently, save those settings into user-defined camera profiles and apply a profile to any compatible camera with just the press of a button.

With the Phantom Remote Control Unit, you get a small, lightweight, hand-held camera control unit as well as a video monitor in one package. To learn more, contact your Vision Research sales representative today, or visit our web site.

The RCU is
big enough to
use as a
video monitor,
and small
enough to be
truly hand-held.

* Some features not enabled at initial release.

DATA SHEET

Remote Control Unit

Additional Features:

- Size: 7" x 4" x 3.5" max (W, H, D)
17.75 cm x 10.2 cm x 8.9 cm
- Weight: 26 oz (740 gm)
- 5" (diagonal), 800 x 480 Active TFT Touchscreen Display
- Connectivity: Phantom v-Series via Break-out-Box
Phantom Flex, HD or 65 direct to Remote Port
- Wireless Control: Optional Industrial Bluetooth Connectivity
- Up to 1.75 hours of battery operation with backlight at 70%
- Easily Accessible Buttons including Two User-programmable Buttons
- Battery charge time: 2.75 hours
- Voltage: 12-36VDC, AC adapter included
- Power: 7 W, 12.6 W when charging battery
- Temperature range: Operational -10°C to 40°C,
Storage -20°C to 50°C
- Humidity: 85% non-condensing
- Shock: 5.5G 11 ms half sine wave, 10 times all axes
- Vibration: 0.25G, 0.5-500 Hz, 1.0 Octave/min, 10 sweeps
- Natural Frequencies: no natural frequencies between
5 and 200 Hz
- EMI: Passes Class A

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EXHIBIT P391

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Phantom Academy On-Site Courses ▶ Phantom Essentials Training Course



Phantom Essentials Training Course

The hands-on coursework will help participants better understand challenges they may face in their applications and how to address them.

- Determining the Optimal System Setup
- Addressing Optical and Lighting Challenges
- Investigating Applications
- Phantom Camera Setup
- Analyzing Image Data



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Vision Research has designed this Phantom Academy course to introduce new operators to the essentials of camera operation.

Participants will gain an understanding of basic optic and illumination concepts, lighting techniques, key camera components, and the processes necessary to

Event Details

- **Location:** Wayne Township, New Jersey
- **Duration:** 3 days
- **Max Attendance:** 8
- **Next Course Date:** TBD
- **Pricing:** \$2000.00 (USD), includes lunches. *Attendees will be responsible for lodging and travel expenses (i.e.,*

**Carter Exhibit
52 (2-28-22)**

WWW.DIGITALEVIDENCEGROUP.COM

produce quality image data for analysis. The Knowledge of Phantom Essentials is fundamental for producing reliable, quality image data employed by Vision Research's Phantom Camera Control (PCC) software.

The beginning of the course will be focused on lecture, and the latter part will deal with hands-on learning and problem solving. Upon completion, the participant will be recognized as a Factory Authorized and Trained Phantom Technician, added to the Vision Research Global List of available Phantom technicians, granted access to Rental Technical Support opportunities within their region, and the Refurbished and Rental Camera Discount Program.

Concepts Covered:

This 3-day course allow participants to learn essential concepts with over 20 hands-on exercises:

- Photography Principles
- Introduction to High-Speed Imaging
- Phantom Camera Operation

Please note: All course materials, lectures, and hands-on exercises are open to modification to meet

your needs (e.g., travel, airfare, taxis, etc.)

- **Who Should Attend:**
Anyone with little or no experience in photographic principles, digital high-speed imaging, and technicians required to install or operate Phantom cameras.
- **Required Course Materials:**
 - **Textbook (provided by Vision Research):** Each participant will be provided copy the Phantom Essentials manual.
 - **Technology (provided by student):** Attendees are required to bring a laptop computer with one of the following Operating Systems installed; Microsoft Windows 10 (32 or 64 Bit), Microsoft Windows 8.1 (32 or 64 Bit), or Microsoft Windows 7 (32 or 64 Bit); Administrative Privileges enabled, and the latest release of PCC (Phantom Camera Control) software installed. [Download the latest version of PCC online.](#)

Questions:

specific client requirements.

Questions:

Email: phantom.academy@ametek.com

On-Site Training Option:

This course can also be conducted at the customer site. Cost \$10,000 US (USA domestic site). For an International or on-site training quote, please contact us by e-mail at:

phantom.academy@ametek.com

[Registration Form](#)

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- 4K and Media

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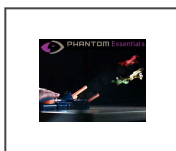


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Phantom Essentials Training Course

The hands-on coursework will help participants better understand challenges they may face in their applications and how to address them.

- Determining the Optimal System Setup
- Addressing Optical and Lighting Challenges
- Investigating Applications
- Phantom Camera Setup
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Key Concepts in High-Speed Imaging

This is a three-day course where attendees will experience 2 days of hands-on training:

Module 1: Photography Principles

- Understanding Photography Terms and

- Their Effects on Imaging
- Lensing and Optic Basics
- Lighting Basics

Module 2: Introduction to High-Speed Imaging

- Benefits of High-speed Imaging
- Workflow
- The Image Sensor
- Digital Processing Components
- Other Considerations

Module 3: Phantom Camera Operation (over 20 hands-on exercises)

- PCC Installation and IP Address Assignment
- Phantom Camera Restore Factory Settings
- PCC Application Preferences (Exercise)
- Capturing, Editing and Saving a Cine
- EDR (Extreme Dynamic Range™)
- Low Light / Bit Depth
- Tone Curve / Exposure Index
- Partitions
- Image-Based Auto Trigger (IBAT)
- Continuous Recording
- Post Processing File Conversion
- Flash Memory
- Sensor Modes
- Camera and Cine Information
- Exposure in PIV (Particle Image Velocimetry) Mode
- Burst Mode
- DAQ (Data Acquisition)

Signals

- Dual HD-SDI
- 10Gb Ethernet
- Assign IP Address
- DHCP (Dynamic Host Configuration Protocol)
Wireless / Wired
- Measurements & Point Tracking

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Kyle D. Gilroy, PhD is a Field Applications Engineer for Vision Research, Ametek. He travels internationally orchestrating and consulting on high-speed experiments for a range of academic, government, and industrial high-speed applications. His expertise is in ballistics and explosion characterization, and



(Kyle D. Gilroy, PhD)

digital image correlation, and biomedical microfluidics. Kyle conducts group trainings on VRI hardware and software. Previously, he was a research fellow at the Georgia Institute of Technology where he conducted investigations centered on the synthesis, application, and characterization of inorganic nanomaterials in the Wallace H. Coulter Department of Biomedical Engineering. At Temple University, he assisted in teaching undergraduate and graduate level thermodynamics, while carrying out research at Temple University's Renewable Energy Laboratory.

[View Kyle D. Gilroy, PhD Curriculum Vitae](#)

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- Can I bring my own experimental materials to test?

Absolutely! As long as they are safe to transport, inform the instructor prior to the course, and follow all local and federal laws and regulations.

+ What are the travel and lodging details?

+ Can I bring my own camera to learn on?

+ Will I receive a certification for this course?

+ What is the best way to contact you for more information?

+ Are there group awards for the best video data and analysis?

+ Will this course involve the harm of LEGO based life forms and structures?

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+ Can I bring my own experimental materials to test?

- What are the travel and lodging details?

An info packet will be provided to you regarding lodging. The best airport to fly into is Newark International (EWR).

+ Can I bring my own camera to learn on?

+ Will I receive a certification for this course?

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+ Can I bring my own experimental materials to test?

+ What are the travel and lodging details?

- Can I bring my own camera to learn on?

Yes, it is best to have it shipped the week previous to ensure a timely arrival.

+ Will I receive a certification for this course?

+ What is the best way to contact you for more information?

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+ Can I bring my own experimental materials to test?

+ What are the travel and lodging details?

+ Can I bring my own camera to learn on?

- Will I receive a certification for this course?

Yes, you will receive an application-specific certification after attendance and instructor approval.

+ What is the best way to contact you for more information?

+ Are there group awards for the best video data and analysis?

+ Will this course involve the harm of LEGO based life forms and structures?

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+ Will I receive a certification for this course?

- What is the best way to contact you for more information?

You can email us directly at phantom.academy@ametek.com.

+ Are there group awards for the best video data and analysis?

+ Will this course involve the harm of LEGO based life forms and structures?

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Why yes, of course!

+ Will this course involve the harm of LEGO based life forms and structures?

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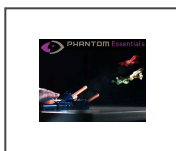
- Will this course involve the harm of LEGO based life forms and structures?

It may happen, but rest assured they have great worker's compensation plans and property insurance.

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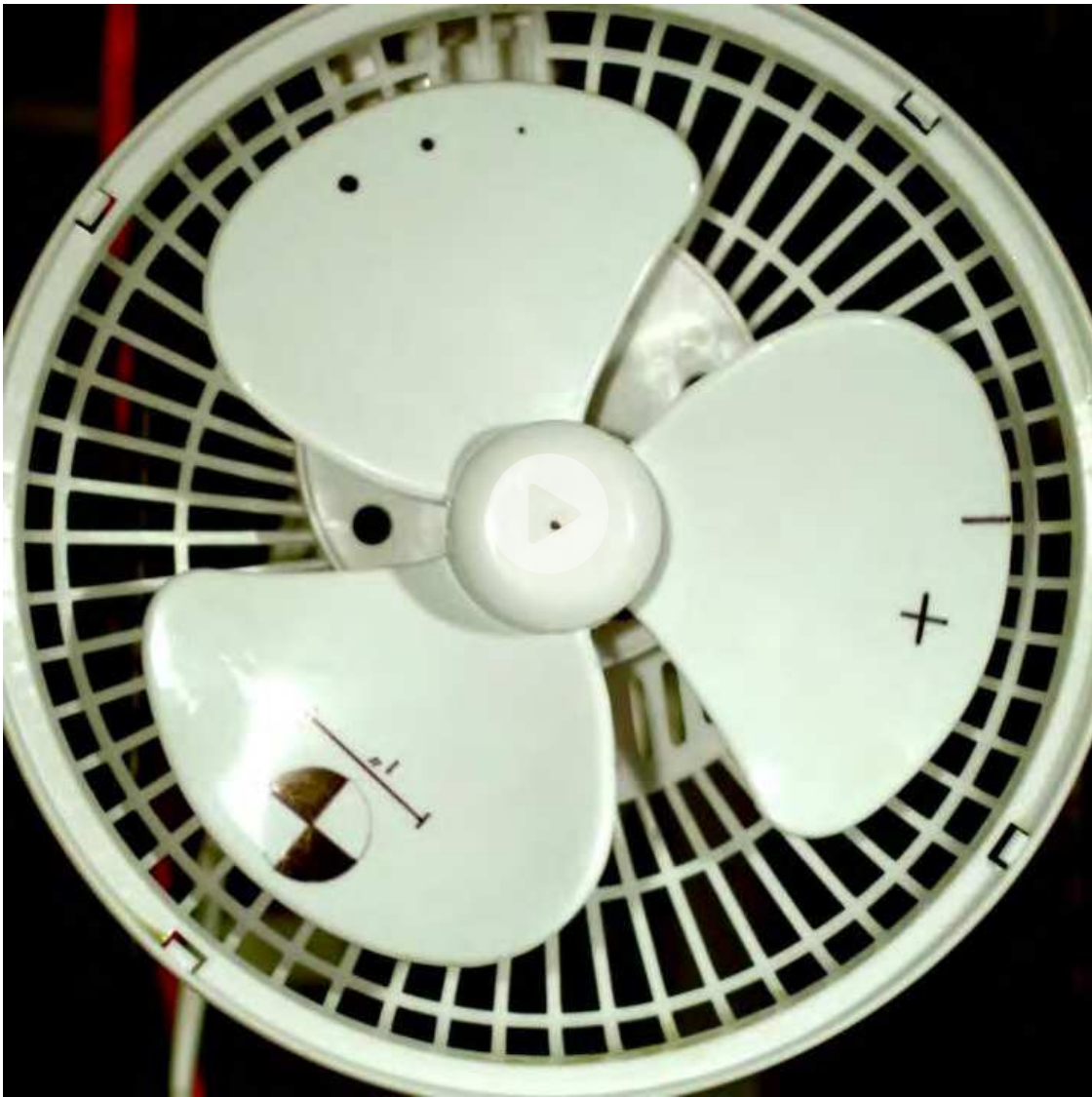
Home ▶ RESOURCES ▶ Phantom Academy of High-Speed Imaging ▶
Phantom Academy On-Site Courses ▶ **Phantom Essentials Training Course**



Phantom Essentials Training Course

The hands-on coursework will help participants better understand challenges they may face in their applications and how to address them.

- Determining the Optimal System Setup
- Addressing Optical and Lighting Challenges
- Investigating Applications
- Phantom Camera Setup
- Analyzing Image Data

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Fan

Rotating fan blades recorded with a Phantom VEO 640S color high-speed camera. Shot was recorded during a Phantom Essentials Course at 1024 x 1024 at 4,700 fps.



Jets

Phantom Essentials Course student captures images of toy jets flying off into the abyss at 5,000 fps using Phantom VEO 640S camera.



Vapor Trail Ignition

Vapor trail ignition was recorded at 1280 x 720 at 3,200 fps with a Phantom Miro 320S by a Timber Creek High School student for a school science project.

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Miro Junction Box 2.0 (JB 2.0)

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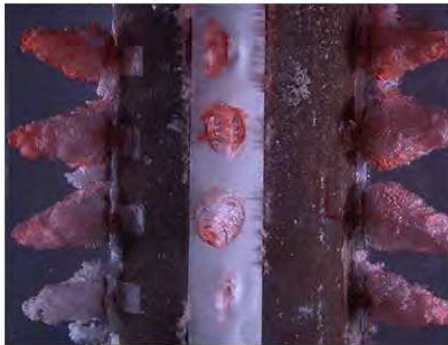
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Home ▸ APPLICATIONS

APPLICATIONS

Specific applications require specific consideration and the proper tool to capture a high-speed event. The application pages below demonstrate the use of Phantom cameras in a variety of testing methods and situations. Case studies provide Phantom camera customers with the knowledge necessary to make an informed decision.

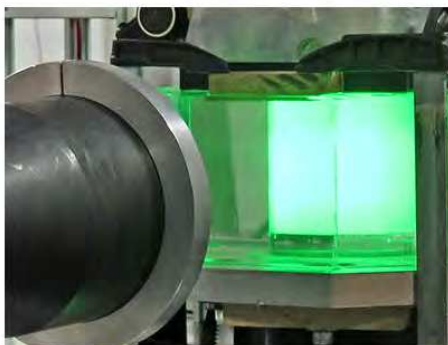
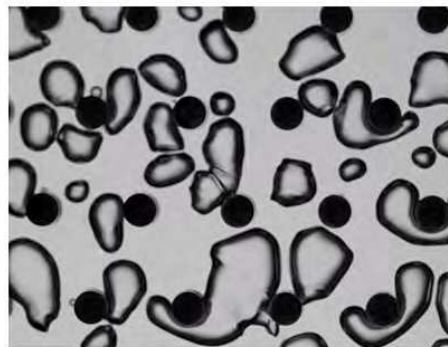


Combustion

Combustion applications often have unique difficulties that need to be overcome. Aside from being exceptionally fast events they often have lighting issues as they quickly fluctuate between being very dark and very bright. Phantom cameras have features that aid researchers in dealing with these issues.

Microfluidics

Microfluidics research is a growing field of research as more industries advance technology into the microscope realms. Whether in a laboratory or studying spray behavior for industrial applications Phantom cameras can be found nearby.



Particle Image Velocimetry

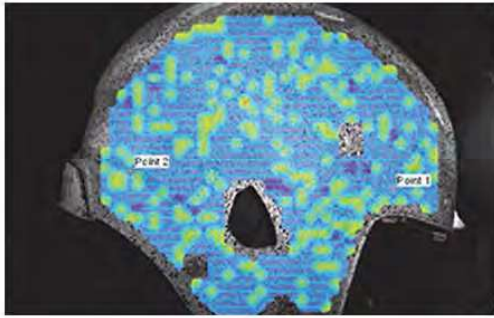
Particle Image Velocimetry (PIV) is a research method that allows scientists to observe the flow of air, water, and other invisible elements. Phantom cameras are equipped with high-resolution sensors to make particle tracking simple.

Cytometry Single-Cell Imaging

<https://www.phantomhighspeed.com/applications>

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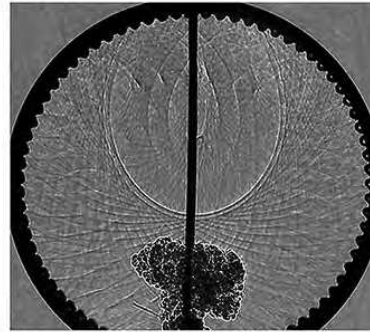


Digital Image Correlation

Digital Image Correlation is a non-contact method of observing how an object is affected by impact and vibration. It can also be used to create 3D imaging of the object to help researchers take exact measurements.

Schlieren Imaging

Schlieren imaging is a special technique that utilizes mirrors and filters to allow researcher to view invisible events such as shock waves. Phantom cameras have high-sensitivity and low noise settings that help increase contrast and make these occurrences visible.



Workflow

Understanding workflow and how it can enhance your high-speed imaging experience is very helpful when planning one-time or time sensitive events. Phantom cameras have a variety of options that can increase portability, connections, and data management to ensure operators are getting the best shots possible.

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FIRST EVER PHANTOM FLEX4K DRONE FOOTAGE

What happens when you combine the ultra high definition ultra slow motion image of a Phantom Flex4k with the Aerial perspective of a specialty Heavy-Lift Aerigon Drone System? You change the game.

Brain Farm unveils the latest weapon in their already impressive arsenal of cinematic technology. Capable of shooting at 1000 frames per second at a resolution of 4K, The Phantom Flex4K is one of the worlds most dynamic slow motion cameras. Until now the images captured by the Phantom Flex 4K have been limited by the camera's weight. Simply put: It's too heavy for most drones to carry. For 5 years, Brain Farm's CEO, Curt Morgan, dreamt of ways he could capture the same super slow motion images from the sky. The solution came when Brain Farm and Swedish drone manufacturers Intuitive Aerial joined forces to create the first UAV capable of carrying the heavy weight of the PhantomFlex4k.

Watch as the team creates the first ever Phantom Flex4K drone footage using Intuitive Aerial's Heavy-Lift Aerigon Drone System. Simply getting this rig airborne wasn't enough, the Brain Farm crew had to put it to the test Wyoming style with some heavy machinery and a whole bunch of mud. True to their action sports heritage, here is a cinematic experience that is one step ahead of the game.



MORE NEWS



CREATORS PROJECT ON BRAIN FARM AND CURT MORGAN



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Greg Wheeler, Director of Photography, mounting the Phantom Flex4k to Intuitive Aerial's Heavy-Lift Aerigon Drone System- Photo @Andy_Bardon





In the world of filmmaking there is no such thing as the perfect tool, there is just the right tool for that particular situation. - Photo @Andy_Bardon





All photos above by [@Andy_Bardon](#)

Thank you to:

Danny Holland

Greg Wheeler

Nel Boshoff

John Rodosky

Melissa Larsen

Justin Smith

Hilary Byrne

Brendan Zipfel

Stephen Scherba

6 RESPONSES TO "FIRST EVER PHANTOM FLEX4K DRONE FOOTAGE"



April 2, 2016 at 5:07 am

Nice! That is one big rig!

Reply

GARY

MUCKLAUY



April 2, 2016 at 10:04 am

Terrific filming using the Aerigon drone. Takes a lot of work to get a big camera into the air for any length of time.

FINTAN CORRIGAN

Reply



April 3, 2016 at 11:07 am

Looks really fantastic on my 27" iMac 5K. I do assume that you did a test flight of the drone with a load equal to that of the camera plus 10%.

MIKE KLAENE

Thanks for posting this.

Reply



April 6, 2016 at 10:42 pm

Hey Mike! That wasnt the exact test before the flight but good Ideal

Reply

BRAIN FARM



April 4, 2016 at 1:43 am

I have a 4k TV and a lot of friends that fly drones - very interested in seeing this in ultra high quality. How can I see it in full resolution on my TV?

DARREN HIGHFILL

Reply



April 6, 2016 at 10:40 am

Hi Darren, You should be able to adjust through YouTube and adjusting the HD setting.

Reply

BRAIN FARM

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Email *

Website

SUBMIT COMMENT



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AERIGON, the aerial remote camera head manufactured by Intuitive Aerial, is powered by...

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Most people film skate videos with a single camera...


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By Alexander George Apr 3, 2015

358



The camera attached to this drone is a Phantom Flex 4K, over 15 pounds of camera that costs \$110,00 and up. Yes, \$100,000-plus worth of hardware floating above the hard ground.

To get that camera in the air, Brain Farm Cinema of Jackson, Wyoming, worked with Swedish drone-builder Intuitive Ariel to create a craft that could handle what ended up being about 30 pounds of gear, including a cradle to steady the camera. Compare that to a housing-clad GoPro weighing 0.3 pounds, or 88 grams.

The final design is a 40 percent more powerful version of the Aerigon drone (\$50,000). That means six carbon fiber arms and twelve counter-rotating carbon fiber propellers.

Not everyone has six figures to spend on drone video, but those that do now have the means to shoot insane aerial footage beyond anything *Planet Earth* producers or Peter Jackson could imagine. For now, gawk at this mud-spraying pickup truck.





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We removed all the logos from our new car and asked people to guess what it is.

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1. Important Information: Prototype shown with options.

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2020 NAB Show

Company Listing as of 2/10/21

Company Name

[E³] Engstler Elektronik Entwicklung GmbH

16x9, Inc. known as Band Pro Film & Digital, Inc.

1CapApp

1SourceVideo

24i

25 Seven known as Telos Alliance

2wcom Systems GmbH known as ALC NetworX GmbH

360 Systems

3Play Media

3Way Solutions SA

4 Color Light

5th Kind

7Mountains

A.C. Lighting Inc.

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DISH
Disk Archive Corp
Diversified
DJB Software Inc dba DJBRadio
DJI
DM Broadcast
Dolby Laboratories
Dongguan Film spider cultural communications co., LTD
Dongguan Lanparte Television Equipment Technology Co., LTD.
DONGGUAN ZEAPON TECHNOLOGY CO., LTD
Doteck
dotstudioPRO
DPA Microphones
Dream Chip Technologies GmbH
Dreamwall
DS Broadcast, Inc
DTC
DTV Innovations

DVB
DVBControl (RTSS)
DVEO
Dynacore Technology Co.,Ltd
Dynamic Drive Pool/Ardis Technologies
DynaMount
Dynatron Corporation
DZ Solutions Enterprises, Inc.
DZOFILM/Shenzhen Dongzheng Optical Technology Co., Ltd
Eartec
Easy Tools
EasyBroadcast
Easyrig known as Band Pro Film & Digital, Inc.
EchoStar Satellite Services L.L.C.
EchoStreams
Ecodigital
ECONCO known as CPI
edelkrone
Edgeware
EditShare
EEG Enterprises, Inc.
Egatel
Eisele Connectors, Inc.
EIZO Inc.
EKT
ELBER SRL
Elec card
Electro-Voice
ELEMENTS
Elenos Group
eluvio
EMAM, Inc.

Embrionix Design Inc
Emergent Vision Technologies
Emotion Broadcast Systems Limited
ENCO Systems, Inc.
Encoding.com
Encompass Digital Media
ENENSYS TeamCast Inc
Enhanced Digital
Enping Baikaler Audio Equipment Co., Ltd.
Ensemble Designs
Entertainment Services and Technology Association
envision ai
Epiphan Video
EQUINIX
Ereca
Erector Sets, Inc.
ERI-Electronics Research, Inc.
ESE
ETC
Etere Pte Ltd
ETL Systems LTD
Eurofins Digital Testing
Eurotek S.r.l.
Eutelsat
Eventide, Inc.
Everlumi Shenzhen Co., Ltd
Evertz
Evolphin Software
EVS
Exascend
Exir Broadcasting
Explorer Inc.

Extreme Cases
Extreme Reach, Inc.
Extron
EZDRM
F&V
Facilis Technology, Inc.
Falcon Eyes Ltd.
farmerswife
Fastly
FEMA Integrated Public Alert and Warning Systems (IPAWS)
Fidus Systems, Inc.
FieldCast
Fiilex
FileCatalyst
Film and Digital Times
Film Devices
Film Gear (International) Ltd.
Filmfabriek
FiLMiC Inc
FilmLight
FilmTrack
Fincons Group
FingerWorks Telestrators
Fireco US
FirstCom Music
FIS Blue Inc.
FLANDERS INVESTMENT
Flanders Scientific, Inc.
Flash Technology
Fletcher Consulting
Flex Rental Solutions
FlipFlop Systems

Florical Systems
Flowcine known as Band Pro Film & Digital, Inc.
Flowics
FLUOTEC / GTM INC
Focusrite
Focusrite Pro
FOR-A
Ford Commercial Vehicles
Forecast Consoles
Formerica Optoelectronics
Fortium Technologies
Fotodiox Pro.
Foundry
Frame.io
Fraunhofer-Gesellschaft
Frezzi Energy Systems, Div of Frezzolini
Friend MTS
Frontline Communications
ftrack
FUJIFILM North America Corporation - Optical Devices
FURUKAWA SANGYO NORTH AMERICA,INC
Future US
Futures Park Welcome Booth
Futuri Media
Fuzhou Boling Photographic Equipment Co., Ltd.
FX Design Group
FXhome/MAGIX
Fxlion Electronic Co.,Ltd
G&D North America Inc.
G.L Optics
GaD Electronics, LLC.
Gaian Solutions

GatesAir
Gator Cases
GB Labs
GECKO-CAM GmbH
GEN ENERGY
Genelec, Inc.
Gerling & Associates, Inc.
GIEC DIGITAL (HONG KONG) COMPANY LIMITED
GIGABYTE TECHNOLOGY CO., LTD.
GlenSound (UK)
GLIC LED Displays INC
GlobalLogic
Globecast
GLOOKAST
Glyph Production Technologies
GNARBOX
GODOX Photo Equipment Co., Ltd
GoMax Electronics Inc.
Google LLC
GoPro Inc.
Gracenote, Inc.
Graphics Outfitters
Grass Valley
GraVue Co./Gefei Tech.Co.,Ltd
Gray Television
GrayMeta
GREAT Britain & Northern Ireland Pavilion
Green GO/JAC Specialty Dist
Grip Gear Ltd
GroundLinx Technologies
Gsertel - Sistemas Integrados de Servicios de Telecontrol S.L
GTI America, Inc

Guangzhou BOSMA Technology Co., Ltd
GuangZhou Harmonic Electronic Company Ltd
Guilin Feiyu Technology Incorporated Company
Gyro-Stabilized Systems
H3 Platform
Haivision
Hakutatz Photographic Equipment Co., Ltd
Halter Technical
Hamilton Metalcraft, Inc
Hangzhou Chingan Tech Co.,Ltd
Hangzhou Justtong Network Technology Co.,Ltd (SEEDER)
Hangzhou Xingxi Technology Co., Ltd
HARDATA
Harmonic Inc.
HD&P, Inc
HDPlus Tech Co., Ltd
HEDBOX
Hedge
Hedley Standwell
Heil Sound
Hewlett Packard Enterprise
High Sight
HighPoint Technologies, Inc.
Hindenburg Systems
Hirose Electric U.S.A.
Hiscala GmbH
HISPASAT
Hitachi Kokusai Electric America, Ltd.
Hitomi Ltd
Hive Lighting
Hongkong Mcoplus Technology Co.,Ltd
Hoodman Corporation

HP
HPRC Cases Plaber srl
HUBER+SUHNER, Inc.
Huizhou City LATU Photographic Equipment Co.,Ltd / GVM Photographic Equipment Inc.
Hypertec
HYUNDAI FOMEX Co., Ltd
IABM
IAC Acoustics
IBC
IBM
iBusiness Magazine
Icom America
IDEA
IDenTV LLC
IDX System Technology, Inc.
IEEE Broadcast Technology Society
IFeelSmart
IFOOTAGE INTERNATIONAL(HK) LIMITED
IHSEusa, LLC
Ikan
Ikegami
Image Matters
Image Video
Imagen
Imagine Communications
Imagine Products, Inc.
IML Co. Ltd.
Immersive Ways
INA/Institut National de l'Audiovisuel
InBroadcast
Independent Audio Inc.
Indipro Tools Corp

Inetsat
Infomedia Technologies Corp.
Infomir
INOVATIV
Inovonics, Inc.
Inspired Energy, LLC
Insta360
In-Sync Publications
InSync Technology
Integrated Media Technologies, Inc.
Intelligent Wave Inc.
Intellimedia Networks
Intelsat Corporation
Inter BEE 2020
International Datacasting Corporation
International Supplies
INTERNATIONAL TOWER LIGHTING, LLC (ITL, LLC)
International Towers, LLC (ITL)
Interra Systems
Intertrust
Intinor
intoPIX
IO Industries
IONTAC
IP Showcase
IPtec, Inc.
IPV
Irdeto USA Inc.
iSize
Israel Pavilion
iStarUSA Group
Italtelec S.p.a.

Ittiam Systems
ivitec GmbH
IW Microwave Products Division
iZotope
J.L. Fisher
Jampro Antennas, Inc.
JBL Professional by HARMAN known as Studer by HARMAN
JLCooper Electronics
JM Broadcast
Joseph Electronics
Journey
JUMP - Data-Driven Video
JVC Professional Video
JW Player
JW Winco
K5600, Inc.
KAI MEDIA Co., Ltd.
Kaltura
Katapy
KATHREIN Broadcast USA, Inc.
Kazuhm
KB Covers
KBTA
KenCast, Inc.
Keywall
Kiloview Electronics Co., Ltd.
Kinfinity Inc
Kingston Technology Company Inc.
Kino Flo Lighting Systems
Kintronic Laboratories, Inc.
KOBA 2020 (Korea E&Ex Inc.)
Kondor Blue

kontron
Konvision
KOONSOLATEC
Korea UHD On Air
KOTRA
Kron Technologies INC.
kvm-tec GmbH
KXWELL
LAKE-VIEW ELECTRONIC CO., LTD
Lamar Systems
LAON Technology Co., Ltd
Lasergraphics, Inc.
Iatakoo, Inc.
Lawo AG
Leader Instruments Corp.
Lectrosonics, Inc.
LEDGO/NANLITE
Ledman Optoelectronic Co Ltd
Legrand AV
Leica Geosystems
Leitz
LEMO USA, Inc.
LEN Limited
Lenovo
LensRentals.com
Levels Beyond
Lexar
Libec Sales of America
Libsyn
Light & Motion
Lightcast.com
Lightstar (Beijing) Electronic Corporation

Lilliput Electronics (USA) Inc.
Limecraft
Limelight Networks
Lindsey Optics
Linear Acoustic known as Telos Alliance
LINEDOCK
Link Electronics
LinkUp Communications
LiteGear Inc.
Litepanels
Litra
Live X, Inc.
Live365
LiveU INC
Logickeyboard
Logitek Electronic Systems
LTN Global Communications, Inc.
LTO PROGRAM
Luma Touch, LLC
LUMANTEK
Lume Cube
Lumen Technologies, Inc.
Lumens Integration, Inc.
Lumos Lighting
LundHalsey known as Legrand AV
Lupo SRL
LYNX Technik AG
M2A Media Ltd
MAC Group
Macnica Inc
MaestroVision
Magewell Electronics Co., Ltd..

Magnum Towers Inc
MagStor Inc
MainConcept
Mainstream Network
Mandozzi Elettronica SA
Manios Digital & Film
MAP known as Legrand AV
Markertek
Marketron
Marquis Broadcast
Marquise Technologies
Marshall Electronics Inc
Martin International Enclosures
Masstech Innovations Inc.
Masterclock, Inc.
MATRIX LIGHT
MATRIX MEDIA
Matrox
Matthews Studio Equipment
MAXICRANE LLC
Maxon
MaxxKonnect / Bohn Broadcast Services
MAY 24
MEDIA 5 S.R.L.
Media Access Services
Media Excel
Media Links
Media Services Group
MEDIAEDGE Corporation
MEDIAGENIX Corporation
Media-IO
MediaKind

MediaMelon, Inc.
Mediamorph known as Whip Media Group
Mediapro
Mediaproxy/ XDT Catapult
MEDIAWEN INTERNATIONAL
Megaphone TV
Megatrax Production Music
MEIDIKE PHOTO&VIDEO CO.,LTD
Meinberg Funkhrehn GmbH & co. KG
Mellanox Technologies
Mercedes-Benz USA
Merging Technologies
Microsoft Corporation
Miller Camera Support, LLC
Minerva Networks
Minnetonka Audio known as Telos Alliance
MiraVid
Mistserver
Mitsubishi Electric US, Inc.
Mjoll
MNC Software Inc
mn-nh
Mobile Viewpoint
MoEngage
Mog Technologies
Mole-Richardson Co.
Monogram
Monoprice
Moseley Associates, Inc.
Mo-Sys Engineering Ltd
Movcam known as Band Pro Film & Digital, Inc.
Movicom

MTI Film, LLC
Multicam Systems
MulticoreWare
MultiDyne Video & Fiber Optic Systems
Museum of Broadcast Technology
MusicMaster
Muvi
Mux
MwareIPTV
Myat Inc.
MyCaseBuilder
Myers
NAB Leadership Foundation
NAB Public Service
NAGRA
Nanjing Nagasoft Corporation
Nanjing Yingchen Pro-Video Equipment Co., Ltd
nanocosmos
Nanuk by Plasticase Inc.
Nasuni
NATE: The Communications Infrastructure Contractors Association
National Engineering Laboratory for DTV (Beijing)
National Fleet Products
Nautel
NCAM TECHNOLOGIES LTD
NDI Central
NEC Display Solutions
Nelson Case Corporation
Nemal Electronics Intl. Inc.
Neocortext, Inc.
Neoti
NEP Group

NEP Inc.
Net Insight AB
NET MEDIA
NetApp
Netflix Studios LLC
NETGEAR
NETINT
Neuro Media Software
Neutrik USA, Inc.
Never.No UK Limited
Nevion AS
NewBlue Inc.
NewsMaker Systems, LLC
NewTek, Inc
NexPlayer
Nexsan
Nextera Video Inc.
NextGen Broadcasting dba Cast.era
Nextologies Limited
NHK
NicomUSA Inc.
Nielsen Global Media
Nila LED lighting
Nimbus, Inc.
Ningbo Eimage Studio Equipment Co. Ltd.
NKK Switches of America
Nordija A/S
Norsat International Inc.
Novastar
Novella SatComs Ltd.
NovelSat
NPAW - Nice People At Work

NPR Distribution Services
NS1
NTP Technology A/S
NTT Electronics Corporation
NTT Group
NUGEN Audio
Nutanix Xi Frame
Nutanix, Inc.
NVerzion, Inc.
O.C.White
Object Matrix
OConnor
OCTOPUS Newsroom Americas Inc.
ODU-USA, Inc.
OMB Sistemas Electrónicos S.A.
Omega Broadcast & Cinema
OMNI Technologies
Omnia known as Telos Alliance
Omnirax Furniture Company
Omniscien Technologies
On Set Headsets
One Stop Systems
On-Hertz
Open Broadcast Systems Ltd
Open Stack
OpenDrives
Operative
Ophit USA
Optical Cable Corporation
Opticis USA
Optima Stantron, an Elma Company
OptoMedia Technology Inc.

Orban Labs, Inc.
Orca Bags
Ortana Media Group Limited
Oslo
Osprey Video
OSRAM
OTRS AG
Otter Video Inc.
Overline Systems
Ovide Smart
OWC
OZEN Camera Support Equipment
P+S Technik GmbH
Pacer Air Freight
PacketFabric
Padcaster
PAG Ltd
Panasonic
Panther GmbH
Paravel Systems
Patchamp
Patrick Communications
PCCW Global, Inc.
Pebble Beach Systems
Peer5
Pelican Products, Inc.
PERFECT MEMORY
PERU TV RADIOS
PESA
PHABRIX
Phasetek Inc.
Phenix Real Time Solutions, Inc.

Phoenix 7 Ltd
Phonak Communications AG
PILOT
Pilotfly Technology Co.,Ltd
Pixel Power
Pixellot Ltd.
Pixit Media Ltd
Pixit Media Ltd known as NetApp
Pixop
PIXTREE, Inc.
Planar
Planetcast Media Services Limited
Platinum Tools
PlayBox Neo LLC
Playlist Software Solutions INC
Pliant Technologies, LLC
Plisch GmbH
Plura Broadcast, Inc
Podbean
Podcast Engineering School
Podcast Studio
Point Lighting Corporation
Point Source Audio / Wider Pro
PolarPro Filters
Polpo AI
Pomfort GmbH
Porta Brace Inc.
Portable Electric Ltd.
Porta-Jib
Portrait Displays
POST & CGW Magazine
Postium Korea

postPerspective
Premier Mounts
Preston Cinema Systems
Prime Focus Technologies Inc.
Primestream
Priority Capital Partners
Pro Cyc
Pro Video Instruments
Proaim
Proco Sound
ProConsultant Informatique
ProductionHUB, Inc.
Professional Wireless Systems
ProFound by Jillite
Program Productions, Inc.
Promax Electronica SL
Promise Technology
Prompter People
Pronology
Propagation Systems, Inc. (PSI)
PROVYS
PSSI Global Services
PTZOptics
Puget Systems
Q5X (Quantum5X Systems Inc.)
Qarva
Qencode
Qligent Corp.
QNAP Inc.
QPC Fiber Optic, LLC
QSAN Technology Inc.
QTAKE known as Ovide Smart

Qualstar Corporation
Quantum Corporation
Quasar Science
Quicklink
Qumulo
Quortex
Qvest Media GmbH
Radio Act
Radio Active Designs (RAD) known as Q5X (Quantum5X Systems Inc.)
Radio Design Labs
Radio Frequency Systems (RFS)
RadioDNS
Ram Commercial
Raritan
RBC Capital Markets
RCS
RE:Vision Effects
Really Right Stuff
Reckeen
Red Bee Media
RED Digital Cinema
Red Giant
Redding Audio, LLC
Reflecmmedia Ltd
Remote Camera Technology
Renewed Vision
Research Concepts, Inc.
Rev
RF Specialties
RFALV Services
Rhino Camera Gear
Riedel Communications

Rip-Tie, Inc.
RIST
RME
Rochester Institute of Technology
Rocosoft
ROE Visual US Inc
Rohde & Schwarz and Pixel Power
Rokinon Xeen
Roland
Rose Electronics
Ross Video
Rotolight
Royal Case Company
RST Visions In Color
RStor
RT Software
RTS Intercom Systems
RTW
RUIGE
RUSHWORKS
RVR / Broadcast Depot
RYMSA RF
Sabre Towers & Poles
Sachtler
SAF Tehnika
Sam Woo Electronics Co., Ltd.
Samsung Electronics
Samtec
Sanken Microphones and Brainstorm Electronics
SAPEC
Satellite Markets and Research
Sat-Lite Technologies

SatNews Publishers
Scale Logic
Scality Inc.
Scenarist
Schill GmbH & Co. KG
Schulze-Brakel GmbH
Scoops
SD Card Association
SDVI Corporation
SeaChange International
Seagate Technology
SECUREDATA, Inc.
Semtech Canada Corporation
Sencore | WellAV
Sennheiser Electronic Corporation
Servicevision Bis SL
SET - Brazilian Society of Television Engineering
Setplex
SGO
Shandong Prosperous Star Optoelectronics Co.
Shanghai Moki Tech LLC
SHAPE WLB Inc.
Shattuc Cord Specialties
SheerID
Shenyang Powerange Co., Ltd
Shenzhen Chromatech Lighting Co.,Ltd
Shenzhen Commlite Technology Co., Ltd.
Shenzhen Define Technology Co., Ltd
Shenzhen Eastar Electronic Co; Ltd
Shenzhen Gloshine Technology Co.,Ltd
Shenzhen GLU Lighting Co.,Ltd.
Shenzhen Gudsen Technology Co., LTD

Shenzhen Hollyland Technology Co., Ltd
Shenzhen JinJiutianshi Industry Co.,Ltd
Shenzhen Konka Information Network Co., Ltd
Shenzhen MINE Technology Co., Ltd.
Shenzhen NUMBER KING TECH Co., Ltd
Shenzhen Pisoftware Technology Co., Ltd.
Shenzhen Portkeys Electronic Technology Co., Ltd
Shenzhen PUAS Industrial Co., Ltd
Shenzhen Skywise Photo Equipment Co.,Ltd
Shenzhen Ulanzi Technology Co.,Ltd
Shenzhen XTAR Electronics Co., Ltd
Shenzhen Yingzhiqi Technology Co.,Ltd
SHIFT
Shively Labs
Shoflo - Rundown Software
Shotoku Broadcast Systems
Shotover Systems Limited
Shoulderpod S.L.
Shure Incorporated
Shutterstock, Inc.
SI Media
Sierra Automated Systems & Eng. Corp.
SIF Codec LLC
Sigma corp of America
Signiant
Silicon Power
Silverdraft Supercomputing
Simplylive LTD
Sinclair/ONE Media
singular.live
Sintech Sistemas Eletronicos Ltda
SIRUI USA, LLC

SixArms
SKAARHOJ
SKB Corporation
Skyline Communications
Slatercom- WCD
SLOMO TV, Inc.
SmallHD
SMALLRIG
SMPTE-Society of Motion Picture & Television Engineers
SnapStream
Society Of Broadcast Engineers
Socionext
SoftLab-NSK
SoftNI Corporation
SOFTRON
Sohonet
Sojitz – DEV
Solid State Logic Inc.
Soliton Systems, Inc.
Sommer Cable GmbH
SONAD, Inc.
Sonifex Ltd.
Sonnet Technologies, Inc.
Sony Electronics Inc.
Soonwell Tech Co.,ltd
Sound Devices, LLC
Sound Ideas Music & Sound Effects
Soundcraft by HARMAN known as Studer by HARMAN
SoundExchange
SoundID
Soundproof Windows, Inc.
Soundstripe

Soundwhale
Spectee Inc.
Spectra Logic
Spectrum Co.
Speedcast
SPINNER
SPL - Podcast Studio Integration
SPORTZCAST
Spreaker powered by Voxnest
SPROCKIT Lounge
SQD Technologies LLC
SRI International
SSIMWAVE Inc.
ST Engineering iDirect
ST Video-Film Technology Ltd
StabiLens
Staco Energy Products Company
Stage Tec GmbH
Stainless
Stanton Video Services
Stardom
Starfish Technologies Limited
Staubli Corporation
Steadygum S.L.
Stellus
Stereo Tool
Stirlitz Media
Storage Made Easy
StorageDNA
Stream Circle, a. s.
Stream Monkey
Stream Station, Inc.

StreamGear, Inc.
Streaming Video Alliance
StreamShark
Streann Media
STRYME Inc.
Studer by HARMAN
Studio Network Solutions
Studio Suite by Adatasol
Studio Technologies, Inc.
StudioXperience
STYPE
SUBLAB PRODUCTION
SuiteLife Systems/NFB Consulting
Suitest
Sumavision Technologies Co.,Ltd
Sunmulon
Superior Access Solutions
Superior Electric
SWIT Electronics Co., Ltd.
Switch
Switchcraft, Inc.
SWR, LP
SYES
SYMPLY (Global Distribution)
Synamedia
Syncbak, Inc.
Synchronized
Syncwords
System-on-Chip Technologies
TAG V.S.
Talamoos
TASCAM

Tata Communications
TBC Consoles
TC TEK INC.
Teamium Inc.
Tech Emmy Awards
Techflex, Inc.
Technalogix
Techno Mathematical Co., Ltd.
Technocrane, Ltd.
Technostrobe
Tecla System
TecNec Distributing
TEDIAL
Teledyne LeCroy
Telemetry, Inc.
Telescript International
Telestream
TELEVES
TELIKOU Technologies Co., Ltd
Telos known as Telos Alliance
Telos Alliance
Telsat srl
Telstra
Tentacle Sync
Teradek
TerraMaster System Limited
TetaVi Ltd
The Broadcast Bridge
The Eizo Shimbun
The Future Group
The Light Source
The Rag Place, Inc.

The Switch
The Team Companies
The Tiffen Company
The Video Call Center
The Wire Guyz
Theatrixx Technologies Inc
THEO Technologies
Thermo Bond Buildings, LLC
Thermodyne Cases
ThinkAnalytics
Thinklogical, A Belden Brand
Thomson Broadcast
Three Media
Tianjin Zhonghuan Ascend Technologies Co., Ltd
Tico Alliance
Tieline
Tiger Technology
Tilta Inc.
TimeLapseCameras.com
TimeLink USA
TitanTV, Inc
TKT International Awards
T-Mobile
TO THE NEW
Tokina Cinema
Tolifo (Dongguan) Photographic Equipment Co., Ltd
Toner Cable Equipment, Inc.
ToolsOnAir Broadcast Engineering Gmbh
TopEndVideo
Torque Video Systems
Total Technologies, Ltd.
Touchstream International Pty Ltd

Tower Engineering Company
TownNews
Traffic Sim Co., Ltd
TransPerfect
TRedess
TRIAD-ORBIT
Trint
Tripleplay
Triveni Digital
True Lens Services (TLS)
TRYO Communications
TSL Products
Tulix Systems
TV Pro Gear
TVLogic
tvONE
tvsetdesigns.com
TVU Networks
TWR Lighting, Inc.
U.S. Captioning Company
Ultra HD Forum
Unified Streaming
Unilumin USA
Unique Business Systems
UNISSET
UniSoft Corporation
Unitex Corporation
UNITRON GROUP NV
Unity Intercom
UnlimitedIRL
UPCOM Technologies Inc.
Utah Scientific, Inc.

Vaddio known as Legrand AV
ValueHD Corporation
Variant Systems Group
Varnish-Software
Vast Data
vCreative
VdoCipher Media Solutions
Vecima Networks
Veetronix, Inc.
Vela
Velocix
VELVET LIGHT
Venera Technologies
Verbit Software Ltd.
Verimatrix, Inc.
Veritone, Inc.
Verizon Business
Verizon Media
Versatile Distribution Services
Vertical Bridge
VerticalXchange
Viaccess-Orca
ViacomCBS
ViaLite Communications
VIAVI Solutions
Vicuesoft
VidCAD LLC
Videa
Video Clarity
Video Solutions Group
VideoBrokers
VideoFlow

Videolabs
Videon
VIDEOSWITCH
Videstra
Vidispine
VidOvation - Moving Video Forward
Vidpro Corp.
ViewLift
ViewSonic Corp.
Viking Satcom
Vimeo
Vimmi Communications Ltd.
Vimond Media Solutions
Vimsoft
Vine Resources
Vintage King Audio
Vinten
Vision Research
Vislink Technologies
Vistex, Inc.
VisualOn Inc
VITAC
VITEC
Vitec Group
Vizrt
vMix
V-Nova Ltd.
VocalBooth.com, Inc.
VoiceInteraction
Vortex Communications Ltd
VSN
V-SOFT Communications, LLC

Vubble Inc.
Vuwr Entertainment Media Inc
Vyusync Design Solutions
W. B. Walton Enterprises Inc
Wallonia Export and Investment Office
Wasabi
Waterbird Systems
Wave Central / DTC Broadcast
Waves and DiGiGrid
WAVSTAR, LLC
Weather Metrics, Inc.
WebCheckout, Inc.
Wedel Software
Welch Media, Inc
Well Buying Industrial Co., Ltd.
WeMeet
WESCO Broadcast & AV
Westcott (F.J. Westcott Company)
Wheatstone Corporation
Whip Media Group
Whirltech Electronic Co. Ltd
Whirlwind
WhisperRoom, Inc.
WideOrbit
WidePath
Wildmoka
Williams AV
Win-OMT Software
WireCAD
WISI
WISYCOM SRL
Witbe

WNM
Wohler Technologies, Inc.
Wolftech Broadcast Solutions
Women in Media
Wooden Camera
Woody Technologies
WordPress.com VIP
WorldCast Systems
Worldwide Communications Consultants
Wowza Media Systems
wTVision
X2X Media Group
XenData, Inc.
XIAMEN CAME TECHNOLOGY CO., LTD.
X-JIB
X-Keys
XPERI / HD RADIO / DTS
Xytech Systems Corporation
YEGRIN
Yelangu
Yella Umbrella
Yellowtec GmbH
YNM Systems
Yospace Technologies Ltd
You.i TV
YoYotta
YUAN High-Tech Development Co., Ltd.
Z CAM / Shenzhen ImagineVision Technology Limited
Z3 Technology, LLC
Zacuto USA
Zaxcom Inc.
Zayo

ZEPLAY

Zero Density

Zhangzhou Seetec Optoelectronics Technology Co., Ltd

ZHIYUN

ZIPPY TECHNOLOGY CORP.

Zixi

ZOO Digital

ZOOM

ZT Logistics Inc.

Zylight

Zype

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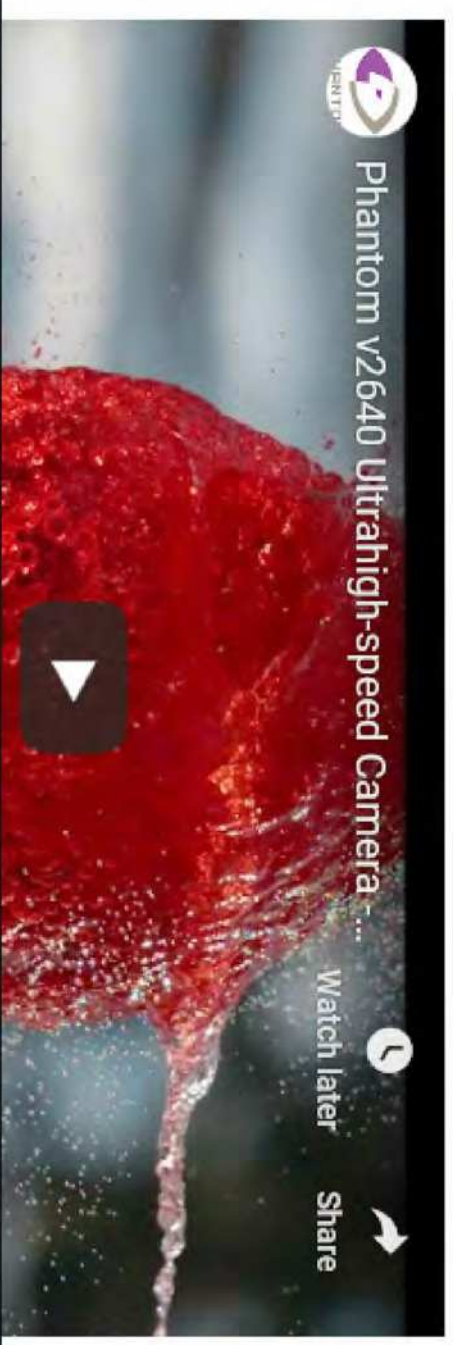
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The 4MP Phantom v2640 can shoot 6,600fps at full resolution, 11,750fps at 1920x1080

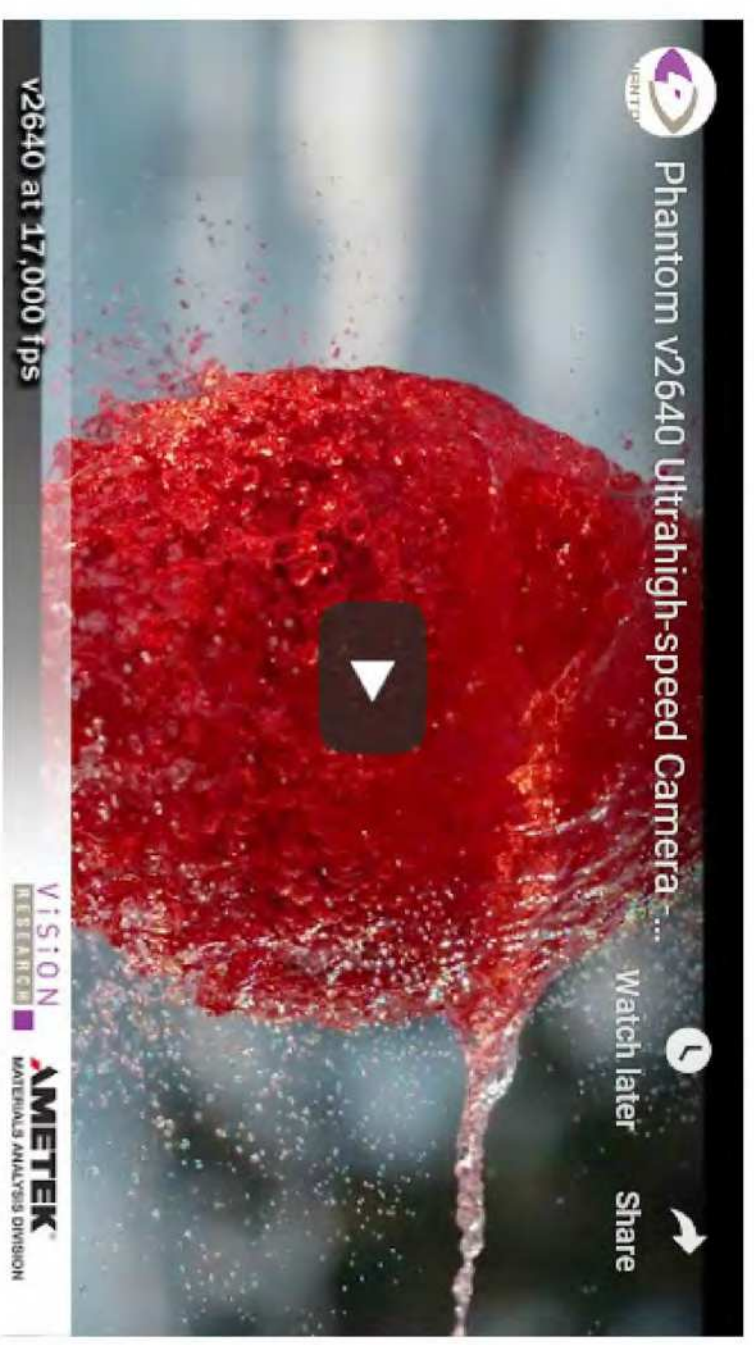
105

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FEATURED VIDEOS



If you thought you had a pretty good high-speed photography set-up, [the new Phantom v2640](#) from Vision Research might make you think again. Using a 4-million-pixel sensor and a shortest 'shutter speed' of 142 nanoseconds, this new model from the scientific and industrial manufacturer can reach speeds of up to 6,600fps at full resolution, and can go even faster when the pixel-count is reduced.

The latest in a line of high-speed cameras aimed at researchers and engineers, the v2640 comes in color and monochrome versions, and with internal memory of up to 288GB to store the data collected. Vision Research claims the camera has a dynamic range of 64dB (over 10 stops) and that the monochrome model has ISO settings of 16,000, so it can work in very low light.



FEATURED VIDEOS



Fun with Bokeh! Visual experiments you can do at home



Chris: the gear that CHANGED MY LIFE (the humble wrist strap)

store the data collected. Vision Research claims the camera has a dynamic range of 64dB (over 10 stops) and that the monochrome model has ISO settings of 16,000, so it can work in very low light.



The black and white model can be switched to 1-million-pixel mode and will then record at up to 25,030fps, while the color model can 'only' manage a best of 11,750fps when dropped to 1920x1080 2MP quality. We've reached out to the company for a price, and are waiting for a reply, but don't expect this puppy to come cheap.



The Camera Gear that Changed my Life (the humble wrist strap)



Sigma 24-70mm F2.8 DG DN Art Hands-on Review

FINISHED CHALLENGES





https://www.dpreview.com/news/4514783704/the-4mp-phantom-v2640-can-shoot-6-600fps-at-full-resolution-11-750fps-at-1920x1080

The 4MP Phantom v2640 c... X

File Edit View Favorites Tools Help

researchers to better understand and quantify the phenomena they are observing."

The v2640 has multiple operating modes for increased flexibility. Standard mode uses correlated double sampling for the clearest image, while high-speed (HS) mode provides 34% higher throughput to achieve 6,600 fps. Monochrome cameras can incorporate "binning," which converts the v2640 into a 1-Mpx camera that can reach 25,030 fps at full resolution, with very high sensitivity. "The various operating modes also allow users to have just one camera to cover multiple applications," adds Doreen Clark, Product Manager for the Phantom Ultrahigh-Speed family.

To help users manage the amount of data inherent in high-speed imaging, the v2640 is available with up to 288GB of memory, and is compatible with Phantom 1TB and 2TB CineMag[®] for fast data saves. Alternatively, 10Gb Ethernet is standard, saving significant download time.

Key Specifications of the Phantom v2640

- 4-Mpx sensor (2048 x 1952), 26Gpx/sec throughput
- Dynamic range: 64 dB
- Noise level: 7.2 e-
- ISO measurement: 16,000D (Mono), 3,200D (Color)
- 1 μs minimum exposure standard, 499ns / 142ns minimum exposure with export-controlled FAST option
- 4 available modes: Standard, HS and Binning (in Standard and HS)
- Standard modes feature Correlated Double Sampling (CDS) performed directly on the sensor to provide the lowest noise possible
- Up to 288 GB of memory
- 10-Gb Ethernet standard
- Compatible with CineMag[®] IV (up to 2 TB)

Via: Image Sensors World

Tags: camera-news, high-speed, phantom, slow-mo, slow-motion, vision-research

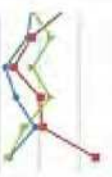


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SLR cameras and can be used with dedicated back covers designed for the most popular camera models.

Apr 13, 2020

51



BCN data shows mirrorless camera sales have dropped 50% YoY in Japan for March amidst COVID-19 pandemic

Year-over-year, sales of mirrorless interchangeable-lens cameras decreased by 50.5 percent, according to BCN Retail's latest data.

Apr 13, 2020

99



'Accurate autofocus on any subject in any environment': Olympus engineer talks OM-D E-M1 Mark III AF

In this interview, Tetsuo Kikuchi, manager of Imaging System Development at Olympus Corp explains how the E-M1 Mark III's autofocus system was developed, and what it means to design a camera for demanding professionals.

Apr 13, 2020

SPONSORED



Nine things working photographers can do for their business during isolation

Like so many, self-employed photographer Suzi Pratt found herself at home with lots of time to kill. Here are the steps she recommends for those in the same position, both to fill time during

Via: Image Sensors World

Tags: camera-news, high-speed, phantom, slow-mo, slow-motion, vision-research

HIDE COMMENTS (105) ^

Comments

- All (105)
- Most popular (9)
- Editors' picks (0)
- DPR staff (0)
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CrazySwiss The question everybody wants to know was not answered. Does it come with face detection?

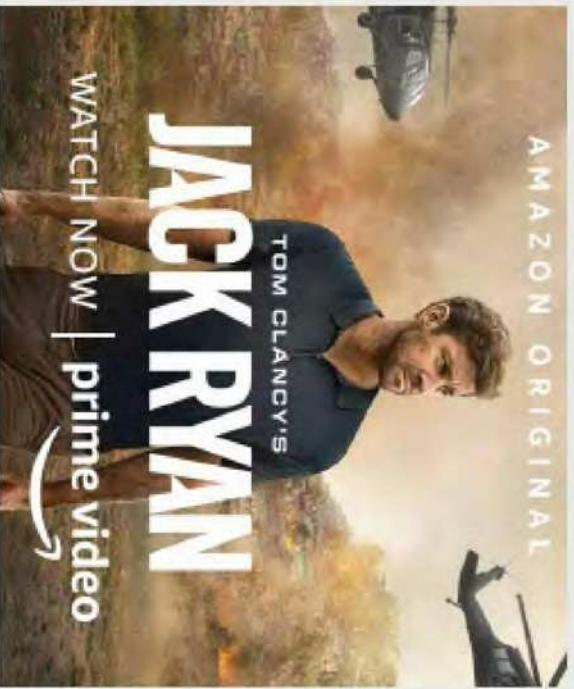
Reply Like Feb 6, 2018 permalink



M Chambers What a shoddy video to promote their product. This reminds me of the Lonely Island music video 'Threw It On the Ground.'

Reply Like Feb 5, 2018 permalink

Pratt found herself at home with lots of time to kill. Here are the steps she recommends for those in the same position, both to fill time during isolation and to prepare for what's next.
Apr 13, 2020 | 17



Video: How a video production company turned an ambulance into the ultimate grip truck

The two-minute video shares a behind-the-scenes look at how commercial film production company Threefold made an old ambulance the ultimate all-in-one film truck.
Apr 12, 2020 | 8 VIDEO



Affordable anamorphic: hands-on with the Sirui 50mm F1.8 1.33x

All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first



M Chambers What a shoddy video to promote their product. This reminds me of the Lonely Island music video 'Threw It On the Ground.'

Reply

Like

Feb 5, 2018 permalink



diglit Great for shooting weddings!

Reply

Like

Feb 5, 2018 permalink



crashpc Now that took some overclocking skills. :-D Reminds me of dr.Manhattan. "I have witnessed events so fast that can hardly be said they occurred at all" :-D

Reply

Like

Feb 4, 2018 permalink



(unknown member) We've used Phantoms with great success in recording the impact of bullets fired at test coating materials, specifically coatings for powerplant transformers. They are quite the tools.

Reply

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Feb 4, 2018 permalink

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look at how commercial film production company Threefold made an old ambulance the ultimate all-in-one film truck.

Apr 12, 2020

8

VIDEO



Affordable anamorphic: hands-on with the Sirui 50mm F1.8 1.33x

Compact and affordable, the new Sirui 50mm anamorphic lens comes in options for three camera mounts - so we tried it on each of them. See the lens in more detail and read about the benefits of using it on each system.

Apr 12, 2020

73



Updated: Fujifilm X100V sample gallery

The Fujifilm X100V is a camera designed to tag along on adventures large and small. We brought it along on plenty of excursions during the course of testing - back when we were able to do that sort of thing - from trips to the coast to walks around the block.

Apr 12, 2020

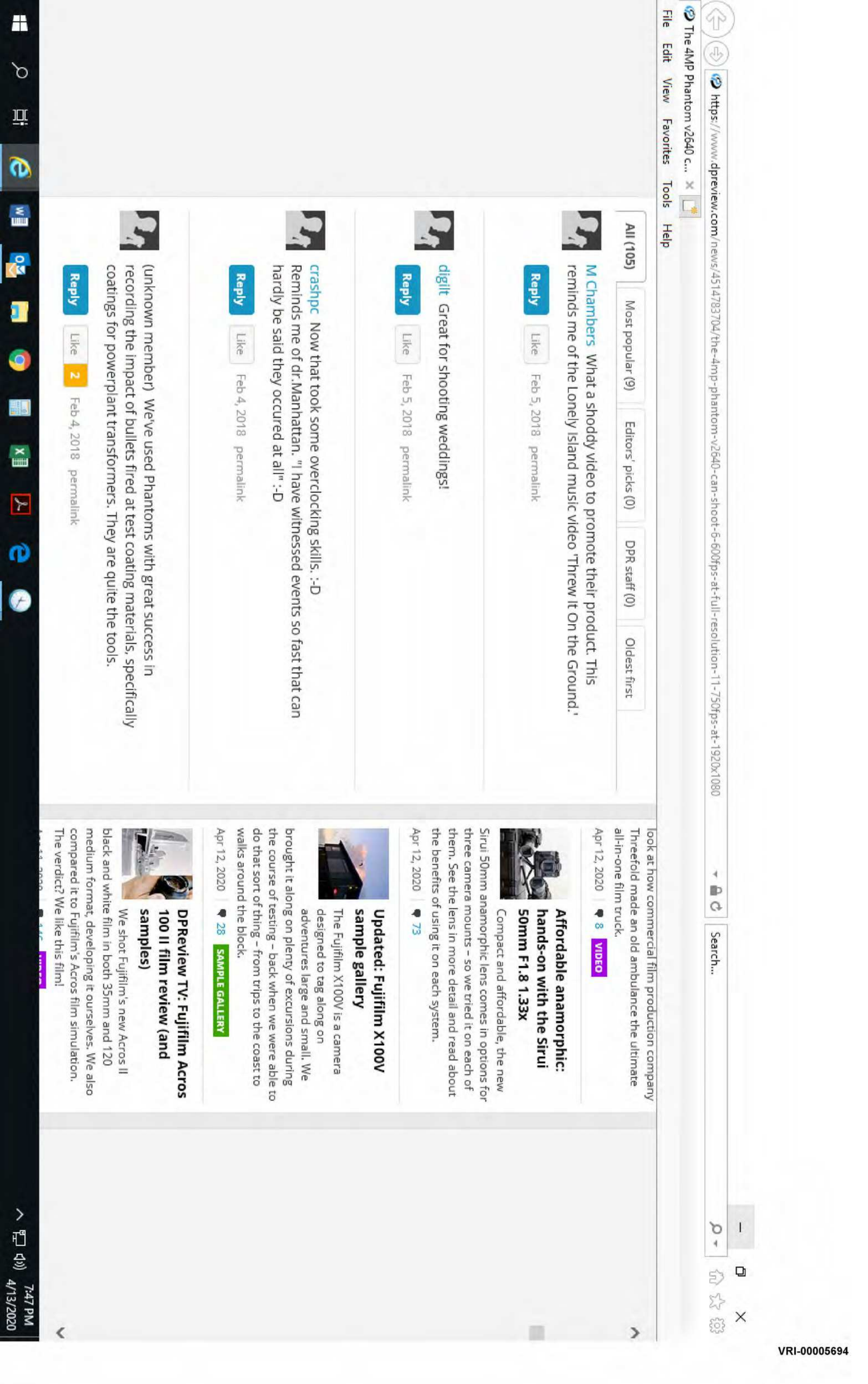
28

SAMPLE GALLERY



DPReview TV: Fujifilm Acros 100 II film review (and samples)

We shot Fujifilm's new Acros II black and white film in both 35mm and 120 medium format, developing it ourselves. We also compared it to Fujifilm's Acros film simulation. The verdict? We like this film!



All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first

(unknown member) We've used Phantoms with great success in recording the impact of bullets fired at test coating materials, specifically coatings for powerplant transformers. They are quite the tools.

Like **2** Feb 4, 2018 [permalink](#)

walker2000 280W power supply. I'm sure this beast uses battery much faster than infamous Sony A7R2 and Sigma DP-1M. :-)

Like Feb 3, 2018 [permalink](#)

doctor digi Need this for the Pitch Drop Experiment. https://en.wikipedia.org/wiki/Pitch_drop_experiment

Like **3** Feb 3, 2018 [permalink](#)

stevo23 And just when I was going to give up on getting sharp photos of a two-toed sloth in motion...

Like **4** Feb 2, 2018 [permalink](#)

DPreview TV: Fujifilm Acros 100 II film review (and samples)

We shot Fujifilm's new Acros II black and white film in both 35mm and 120 medium format, developing it ourselves. We also compared it to Fujifilm's Acros film simulation. The verdict? We like this film!
 Apr 11, 2020 **146** VIDEO

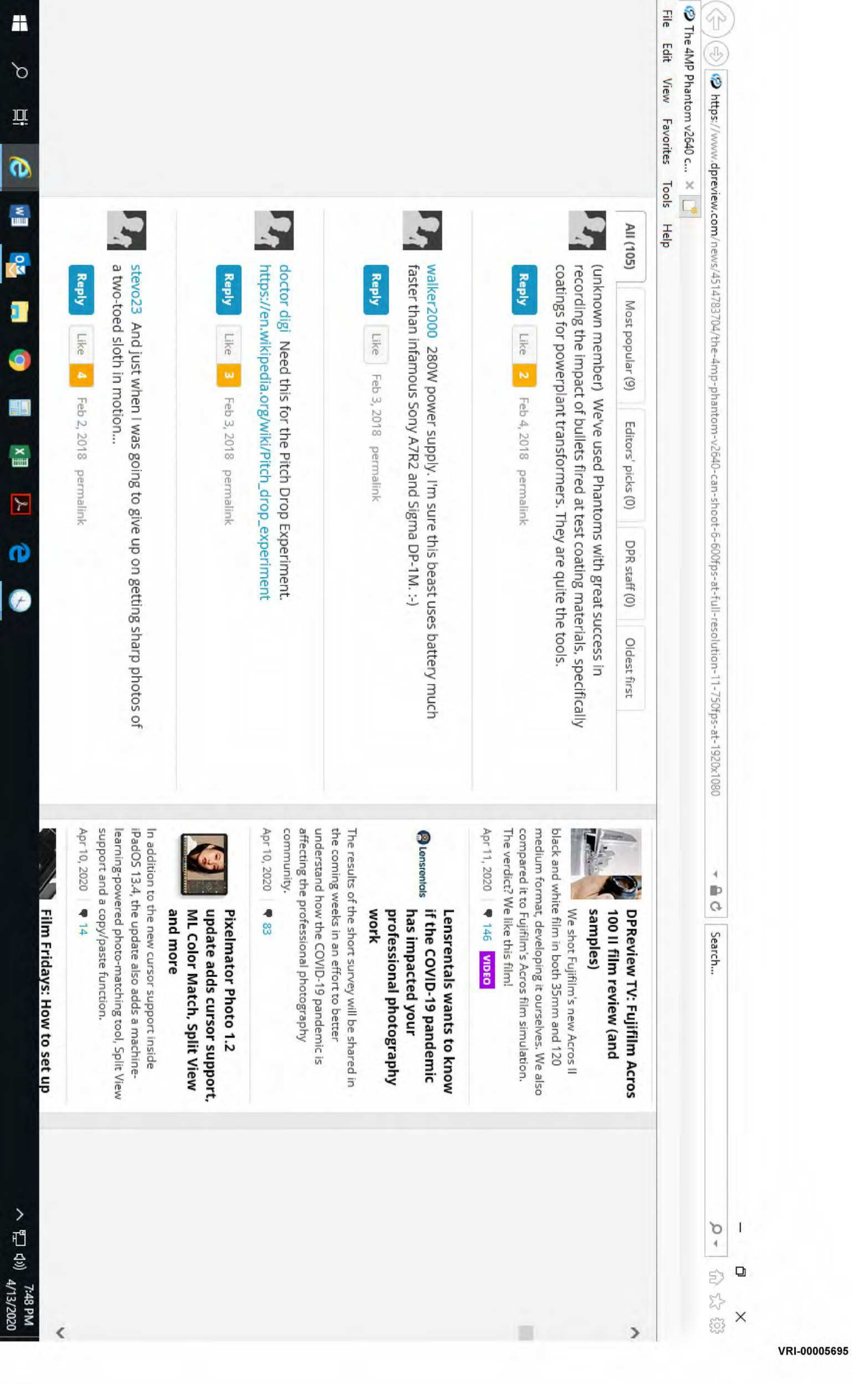
Lensrentals wants to know if the COVID-19 pandemic has impacted your professional photography work

The results of the short survey will be shared in the coming weeks in an effort to better understand how the COVID-19 pandemic is affecting the professional photography community.
 Apr 10, 2020 **83**


Pixelmator Photo 1.2 update adds cursor support, ML Color Match, Split View and more

In addition to the new cursor support inside iPadOS 13.4, the update also adds a machine-learning-powered photo-matching tool, Split View support and a copy/paste function.
 Apr 10, 2020 **14**


Film Fridays: How to set up



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 stevo23 And just when I was going to give up on getting sharp photos of a two-toed sloth in motion...


[Reply](#) [Like](#) 4 Feb 2, 2018 [permalink](#)

 stevo23 That's really cool. If you look at their website and the alternator belt footage, you can actually detect when the pistons fire. Incredibly useful tool for research and analysis. And fun too.


[Reply](#) [Like](#) 2 Feb 2, 2018 [permalink](#)

 lylejk Man; using image stacking, you can really get hirez low noise captures. lolol

[Reply](#) [Like](#) 1 Feb 2, 2018 [permalink](#)

 rbach44 I wouldn't lol too hard... I'm sure at least one DPRreview reader was seriously thinking that.


[Like](#) 2 Feb 2, 2018 [permalink](#)


ML Color Match, Split View and more

In addition to the new cursor support inside iPadOS 13.4, the update also adds a machine-learning-powered photo-matching tool, Split View support and a copy/paste function.


Apr 10, 2020 [14](#)

Film Fridays: How to set up a darkroom and get printing for cheap

 Setting up a fully-functional B&W darkroom is way easier and cheaper than you may think. Our pals over at 35mmcc.com show you how to get printing for under \$100.


Apr 10, 2020 [61](#)

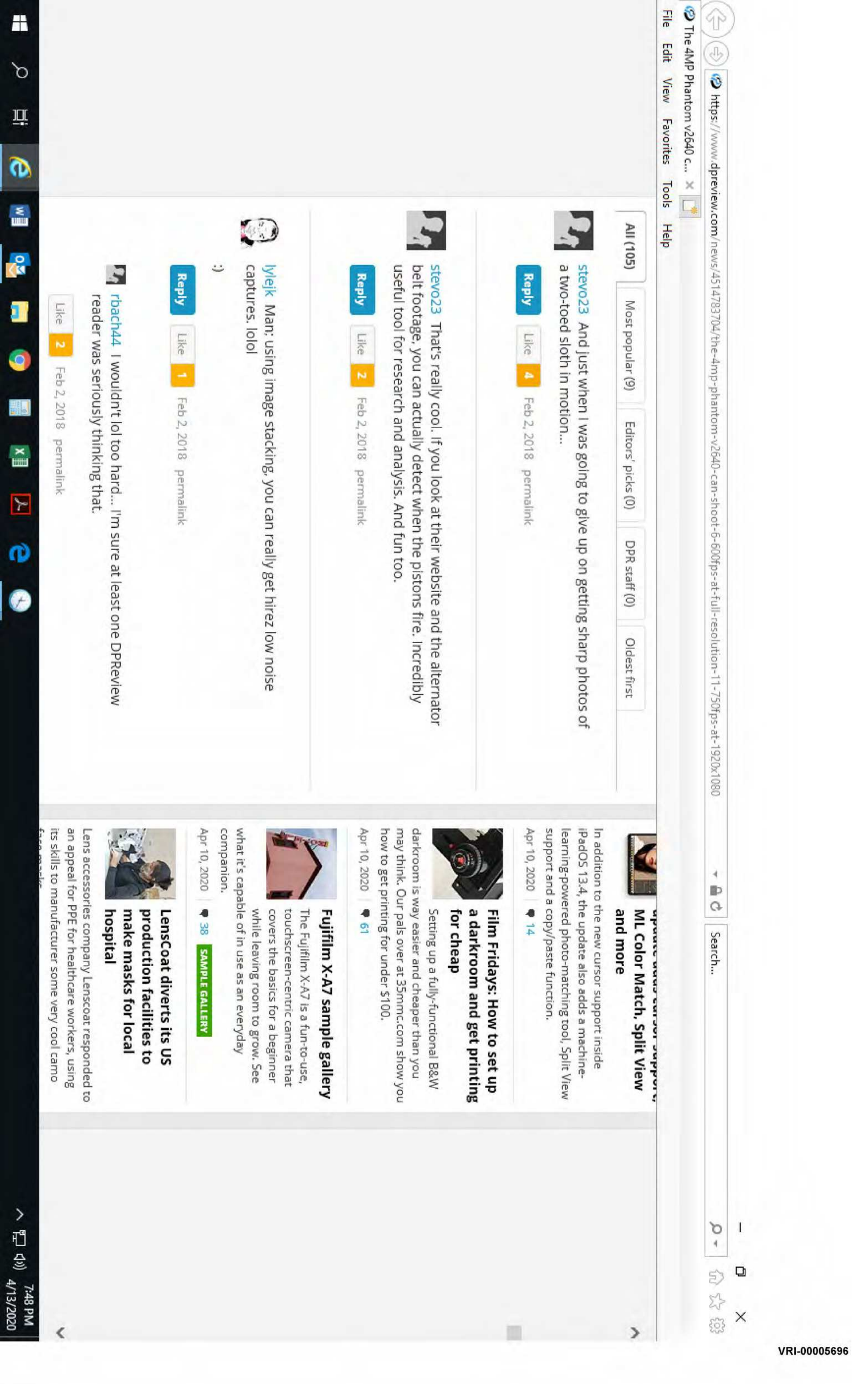
Fujifilm X-A7 sample gallery

 The Fujifilm X-A7 is a fun-to-use, touchscreen-centric camera that covers the basics for a beginner while leaving room to grow. See what it's capable of in use as an everyday companion.

Apr 10, 2020 [38](#) [SAMPLE GALLERY](#)

LensCoat diverts its US production facilities to make masks for local hospital

 Lens accessories company Lenscoat responded to an appeal for PPE for healthcare workers, using its skills to manufacturer some very cool camo face masks.



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rbach44 I wouldn't lol too hard... I'm sure at least one DPreview reader was seriously thinking that.

Like 2 Feb 2, 2018 permalink

Jochen's Yes, too bad we need to raise iso by 15 stops to get a correct exposure.

Like Feb 3, 2018 permalink

Hide replies Reply

fredmason Just what I needed for my selfie stick.

Reply Like 2 Feb 2, 2018 permalink

Slapstick Noir Whaaaaat? No 4K ?????????? And no flipping screen for vlogging? Can it share to Hipstagram?

Reply Like 2 Feb 2, 2018 permalink

LenzCoat diverts its US production facilities to make masks for local hospital

Lenz accessories company LenzCoat responded to an appeal for PPE for healthcare workers, using its skills to manufacture some very cool camo face masks

Apr 9, 2020 | 71

Slideshow: PDNedu Student Photo Contest 2020 winners and finalists

Here are the Grand Prize Winners and Honorable Mentions for the 9th Annual PDNedu Student Photo Contest.

Apr 9, 2020 | 53

The ins and outs of ISO: What is ISO?

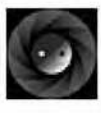
We look into what the ISO setting on your camera does and doesn't mean - why it can't necessarily be measured, and why your sensor's sensitivity never changes.

Apr 9, 2020 | 507

Sony releases 2.00 firmware update for its a9 II mirrorless camera

The firmware update adds a new 'Hi-Frequency Flicker' function, adds a new Face/Eye Priority autofocus function and more.

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Slapstick Noir Whaaaat? No 4K ???!!!!????? And no flipping screen for vlogging? Can it share to Hipstagram?

Reply Like 2 Feb 2, 2018 permalink



Flashback I guess somebody here is going to say they can achieve that with their iphone!

Reply Like 2 Feb 2, 2018 permalink

badi Unlikely. Most DPR commenters doubt that smartphones even take pictures.

Like 5 Feb 2, 2018* permalink

Hide replies Reply



(unknown member) Looks great. I'll take two.

Reply Like Feb 2, 2018 permalink

mean - why it can't necessarily be measured, and why your sensor's sensitivity never changes.

Apr 9, 2020 | 507



Sony releases 2.00 firmware update for its a9 II mirrorless camera

The firmware update adds a new 'Hi-Frequency Flicker' function, adds a new Face/Eye Priority autofocus function and more.

Apr 9, 2020 | 195



DPreview TV: Fun with bokeh

Photographers throw the word 'bokeh' around a lot, but what exactly is it? Our resident mad scientist, Don Komarechka, takes us on a ride through a bokeh-rific world of creative possibilities.

Apr 9, 2020 | 51 VIDEO



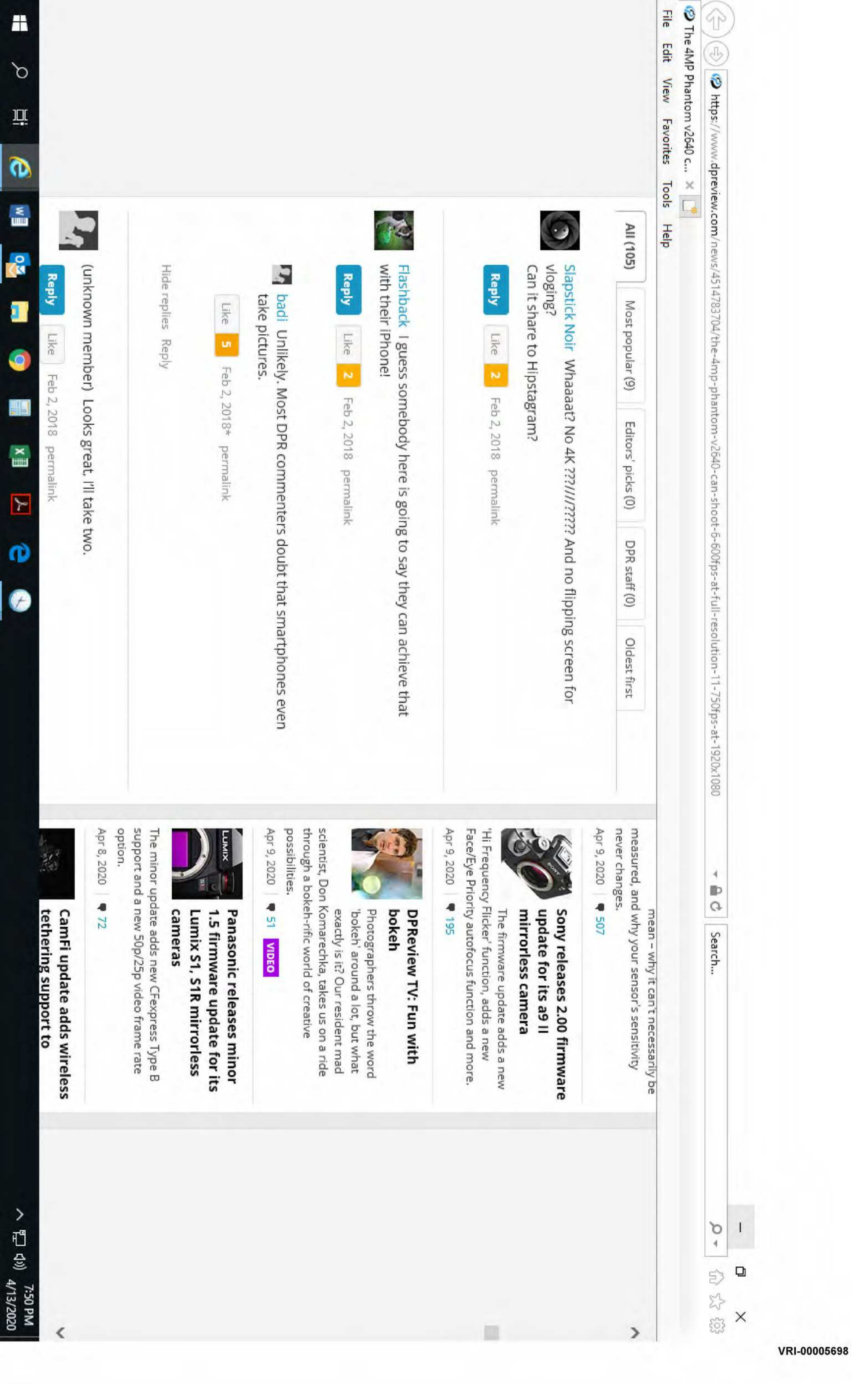
Panasonic releases minor 1.5 firmware update for its Lumix S1, S1R mirrorless cameras

The minor update adds new CFexpress Type B support and a new 50p/25p video frame rate option.

Apr 8, 2020 | 72



CamFi update adds wireless tethering support to



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(unknown member) Looks great, I'll take two.

[Reply](#) Like Feb 2, 2018 [permalink](#)

[Johannes Zander](#) Just looked up the specs: Nikon F-Mount is the standard lens mount. Interesting!

[Reply](#) Like 4 Feb 2, 2018 [permalink](#)

[Chaitanya S](#) There is a large selection of Nikon F mount lenses and older lenses also have mechanical aperture which further simplifies the lens mount unlike electronic lens mounts. It's quite common to find Nikon F mount on these high speed video cameras.

Like 1 Feb 3, 2018 [permalink](#)

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[overengloves](#) But does it have IBIS?

[Reply](#) Like 4 Feb 2, 2018 [permalink](#)

The minor update adds new CFexpress Type B support and a new 50p/25p video frame rate option.

Apr 8, 2020 | [72](#)

CamFi update adds wireless tethering support to Fujifilm's most popular cameras



The update will add wireless tethering support and more for the Fujifilm X-T2, X-T3, X-H1, GFX 50R, GFX 50S and GFX 100.

Apr 8, 2020 | [6](#)

Fujifilm X100V review: The most capable prime-lens compact camera, ever



We think Fujifilm's X100V is the best choice for a photographer's carry-everywhere camera in 2020. Provided you can find somewhere safe to take pictures, of course. Take a look through our full review to find out more.

Apr 8, 2020 | [1495](#) **REVIEW**

DPreview TV: The gear that changed my life



We all have some piece of photo gear that changed the way we work. In this video, DPreview TV host Chris Niccolls tells us what product rocked his world. The answer may surprise you.

Apr 8, 2020 | [142](#) **VIDEO**

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ovengloves But does it have IBIS?

[Reply](#) Like **4** Feb 2, 2018 [permalink](#)



Paul_B Midlands UK incredible - nice work guys.

[Reply](#) Like **1** Feb 2, 2018 [permalink](#)



dr.noise (in a shop) ... Is that price or framerate?

[Reply](#) Like **8** Feb 2, 2018 [permalink](#)

[BLongborough](#) If you think that's the price, I think you're being a bit optimistic. I suspect we're talking, like, USD 50K here.

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DPreview TV: The gear that changed my life

We all have some piece of photo gear that changed the way we

work. In this video, DPreview TV host Chris Niccolls tells us what product rocked his world. The answer may surprise you.

Apr 8, 2020 | **142** [VIDEO](#)



5 stay-at-home challenges for photographers and videographers in quarantine

Who says you can't be creative while confined to your home? Top camera companies and creatives are challenging photographers and videographers to submit their best work while in quarantine.

Apr 8, 2020 | **14**



Skyllaney unveils its forthcoming 50mm F2 'Bertele' Sonnar lens for Leica M-mount cameras

The Leica M-mount lens is the first from Skyllaney, a British company which designs and constructs its lenses in the British Isles.

Apr 7, 2020 | **124**



Wet plate photographer shoots portrait of subject 4000 miles away via Zoom

Marrying technologies invented over 150 years apart, U.S. photographer Shane Ralkowitsch used the wet collodion process to

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Blongborough If you think that's the price, I think you're being a bit optimistic. I suspect we're talking, like, USD 50K here.

Like Feb 2, 2018 permalink

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Dirk Nuary I think this gear is the gear that used by youtuber "The Slow Mo Guy", now named "the super slow show". But I wonder, can this gear catch up the bullet out of the gun?

Reply

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Roland Karlsson A bullet from a gun might be 1000 m/s, depending on gun. And this thingie bursts away at approx 1000 FPS. So, there will be a meter between the bullets in the pictures. So, I think it is more than possible to catch a bullet in a picture.

Default exposure time is 1 microsecond. That will make the blur 1 mm. That is OK, and it can be improved with a factor of 7.

Like 1 Feb 2, 2018 permalink

Berteire's sonnar lens for Leica M-mount cameras

The Leica M-mount lens is the first from Skyllaney, a British company which designs and constructs its lenses in the British Isles.
Apr 7, 2020 | 124



Wet plate photographer shoots portrait of subject 4000 miles away via Zoom

Marrying technologies invented over 150 years apart, U.S. photographer Shane Balkowitsch used the wet collodion process to photograph a sitter in London as she posed in front of her phone camera
Apr 7, 2020 | 83 VIDEO



Canon releases 1D X Mark III firmware update to fix lock-up issue, add 23.98p video capture

The update addresses a lock-up issue multiple 1D X Mark III camera owners were experiencing when shooting with the electronic level was on in the viewfinder display.
Apr 7, 2020 | 93



How HDR display could change your photography forever

HDR isn't always a popular term in photography circles, but the latest high-DR TVs could free your photos from the standard DR constraints you didn't even know you were

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Old Cameras Using a slow bullet like a .45ACP at about 650 feet per sec. at 11750 frames per second, that's a frame every 5/8" or so of bullet travel, 16 inches per second at 24fps. You'd definitely see it coming but I guess it would just be a blur. Metric system is confusing, I have to use feet and inches.

Like 1 Feb 2, 2018 [permalink](#)

Roland Karlsson Ah, but your slower bullet will be perfectly sharp. That is 200 m/s. Then the bullet will just move 1/5 m = 200 mm. And the sharpness will be 1/5 mm. Or even less if you use the high speed mode. Nema problema.

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III firmware update to fix lock-up issue, add 23.98p video capture

The update addresses a lock-up issue multiple 1D X Mark III camera owners were experiencing when shooting with the electronic level was on in the viewfinder display.
Apr 7, 2020 | 93

How HDR display could change your photography forever

HDR isn't always a popular term in photography circles, but the latest high-DR TVs could free your photos from the standard DR constraints you didn't even know you were working to.
Apr 7, 2020 | 209

Tamron's 70-180mm F2.8 lens should ship in mid-May for \$1,199

Tamron first teased the 70-180mm F2.8 Di III VXD for Sony E-mount last October. Now, we have confirmation of its price and the expected shipping date, pending any further interference from the COVID-19 pandemic.
Apr 7, 2020 | 270 [LENS NEWS](#)

Video: How to capture abstract macro photographs using little more than paper and lights

The 15-minute tutorial shows how with a few

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- Editors' picks (0)
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Roland Karlsson Ah, but your slower bullet will be perfectly sharp. That is 200 m/s. Then the bullet will just move 1/5 m = 200 mm. And the sharpness will be 1/5 mm. Or even less if you use the high speed mode. Nema problema.

Like 1 Feb 2, 2018 [permalink](#)

John ruciak It does 28,760 FPS at 640 x 480

Like Feb 6, 2018 [permalink](#)

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malcolm moy Check out the Slow Mo Guys on YouTube, excellent examples and there is also a good technical explanation of what the camera can do and how it works.

Reply Like 1 Feb 2, 2018 [permalink](#)

adengappasami I need 3. 1 for letting it sit idle in the dry box. 1 for in the car hoping i will take some slow mo shots and 1 for shooting two balloon burst shots..

Tamron first teased the 70-180mm F2.8 Di III VXD for Sony E-mount last October. Now, we have confirmation of its price and the expected shipping date, pending any further interference from the COVID-19 pandemic.

Apr 7, 2020 | 270 [LENS NEWS](#)

Video: How to capture abstract macro photographs using little more than paper and lights

The 15-minute tutorial shows how with a few sheets of printer paper and a light source or two, you can create abstract macro photographs.

Apr 6, 2020 | 15 [VIDEO](#)

Fotodiox's new EF to L-mount adapter features AF, aperture and image stabilization support

The new EF to L-Mount 'Fusion' adapter offers full EXIF data support, as well as communication protocols to support autofocus, aperture control and image stabilization on supported lenses.

Apr 6, 2020 | 34

Tips or suggestions? [Contact us!](#)

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adengappasami I need 3. 1 for letting it sit idle in the dry box. 1 for in the car hoping I will take some slow mo shots and 1 for shooting two balloon burst shots..

Ready to pay 100K for 3

Reply

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Feb 2, 2018 permalink



Ebrahim Saadawi Their cameras are so damn expensive! We could truly use such a high resolution feed at 6000fps to document the propelling speed of a stabilized dental hand-piece we're working on, all the previous HS cameras never cut it, but the phantoms go to the top US research facilities first I'm afraid. One would need it for about a minute no longer so I hope they offer a generous amount of bodies.

Reply

Like

Feb 2, 2018 permalink



(unknown member) Yeah seems like something that a lot of people would be happy to rent rather than buy. Not many people need something like this all the time, but there are plenty of folks who could probably make use of one occasionally.

Like

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https://www.dpreview.com/news/4514783704/the-4mp-phantom-v2640-can-shoot-6-600fps-at-full-resolution-11-750fps-at-1920x1080



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The 4MP Phantom v2640 c... X

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Like Feb 2, 2018 permalink

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technotic DJI are really stepping out up.

Reply Like Feb 2, 2018 permalink

technotic it

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Franz Weber Finally the new Phantom many of us have been waiting for. I like the new design without the distracting clutter of the propellers.





https://www.dpreview.com/news/4514783704/the-4mp-phantom-v2640-can-shoot-6-600fps-at-full-resolution-11-750fps-at-1920x1080



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The 4MP Phantom v2640 c... X

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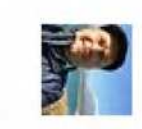
DPR staff (0)

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 **technotic** it

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Franz Weber Finally the new Phantom many of us have been waiting for. I like the new design without the distracting clutter of the propellers. Cudos to Dji

Reply Like 5 Feb 2, 2018 [permalink](#)



Kabalyero I need one for my cat photos

Reply Like 12 Feb 2, 2018 [permalink](#)



rialcnis I just want one to use as a streaming live webcam in a slime factory

Reply Like 5 Feb 2, 2018* [permalink](#)

Windows taskbar with icons for Start, Search, Task View, Edge, Word, Outlook, File Explorer, Chrome, Calendar, Excel, PowerPoint, and a system tray showing network, volume, and the time 8:00 PM on 4/13/2020.



https://www.dpreview.com/news/4514783704/the-4mp-phantom-v2640-can-shoot-6-600fps-at-full-resolution-11-750fps-at-1920x1080



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The 4MP Phantom v2640 c... X

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rialcnis I just want one to use as a streaming live webcam in a slime factory

Reply

Like 5

Feb 2, 2018* [permalink](#)



chriskcats best laugh I had today!

Like 1

Feb 2, 2018 [permalink](#)



Franz Weber How is the slime business doing lately? I have heard of some entrepreneurs who became very rich

Like 1

Feb 2, 2018* [permalink](#)



rialcnis Some youngish blonde lady named Nicole Skyes has a youtube channel with 100's of slime videos. I stumbled onto it the other night. Each video has at least half a million views. She looks like she's doing well. Then saw many other Slime channels. All very preposterous.

There are slime videos with 15-20 million views. Brave new world of Slime.

Like 2

Feb 3, 2018* [permalink](#)

Windows taskbar with icons for Start, Search, Task View, Edge, Word, Outlook, File Explorer, Chrome, Teams, OneDrive, Excel, PowerPoint, and system tray showing time 8:00 PM and date 4/13/2020.



https://www.dpreview.com/news/4514783704/the-4mp-phantom-v2640-can-shoot-6-600fps-at-full-resolution-11-750fps-at-1920x1080



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There are slime videos with 15-20 million views. Brave new world of Slime.

Like 2 Feb 3, 2018* permalink

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Internet Enzyme With a shutter speed of 142 nano seconds, I wonder how much light you would need to use the lowest ISO.

Reply Like 1 Feb 2, 2018 permalink

Mike CH I think the technical term is "lots and lots of light" 😊

Like 12 Feb 2, 2018 permalink

Jochenls You need to raise iso by 17 stops to get equivalent exposure to 1/100 shutter speed.

Like Feb 3, 2018 permalink

nickolas84 On a bright sunny day on a place like Greece, you could get to base ISO with a fast lens. Assuming ISO 100 and f/1.0 or f/1.4

Windows taskbar with icons for Start, Search, File Explorer, Microsoft Word, Outlook, Chrome, Task View, Edge, and a clock showing 8:01 PM on 4/13/2020.



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The 4MP Phantom v2640 c... X

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DPR staff (0)

Oldest first



nickolas84 On a bright sunny day on a place like Greece, you could get to base ISO with a fast lens. Assuming ISO 100 and f/1.0 or f/1.4 lens.

In these cases its the flashes the problem that are often too weak to be used to "fill in" the shadows.

Like 1

Feb 6, 2018 [permalink](#)

Hide replies Reply



Max Iso It's even better if you play it at 1/4 speed !!!!!

Reply

Like 3

Feb 2, 2018 [permalink](#)



stevenbrantley Sony, Nikon and Canon DSLR owners will dump all their gear just to have this and claim bragging rights to the blazing frames per second.

Reply

Like 1

Feb 2, 2018 [permalink](#)

ZeBebito I would love to shoot a turtle race at 11750 frames per second.

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ZEBebito I would love to shoot a turtle race at 11750 frames per second.

Reply

Like 14

Feb 2, 2018 permalink



Jesse_Just_Him now watching paint dry have never been so exciting as before~!!!

Reply

Like 2

Feb 2, 2018 permalink



Ian I can see it now - a 2 hour film of the final second of a bullet hitting the target...

Reply

Like 2

Feb 2, 2018 permalink



PLShutterbug How far from the target are you standing that it takes longer than 2 seconds for the bullet to reach the target?

Like

Feb 2, 2018 permalink



Kondamin Depends on the weapon and bullet, for something like a .50 using sniper rifle that would be about 1600m



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DPR staff (0)

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Kondamin Depends on the weapon and bullet, for something like a .50 using sniper rifle that would be about 1600m

For a hand gun like a 44 magnum in theory about 600m

Like 2 Feb 2, 2018 [permalink](#)

technotic Can you hit something with a 44 magnum from 600m??

Like Feb 2, 2018 [permalink](#)

Scoobaru "Can you hit something with a 44 magnum from 600m??" Absolutely not. I struggled to hit an A2 paper target at 6m with a 44mag when I was visiting Orlando. It was my first session with a firearm though.

Like Feb 2, 2018 [permalink](#)

otto k I can hit something, no problem, just not sure in advance what I would hit.

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otto k I can hit something, no problem, just not sure in advance what I would hit.

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Biowizard Gonna need a bigger drone ...

Reply

Like 1 Feb 2, 2018 permalink

photomedium Gonna need a better joke ...

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doctor digi Does it blend?





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RUCRAZ 1. How long will it take to fill my (typical) 16GB "400x speed" SD chips?
2. Does in come in blue color?

Reply

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Feb 2, 2018 permalink



AiryDiscus 11750fps * 1920 * 1089px * 12bpp / 8bit/byte = 36.5GB/s. So 1/2 second, if the card could keep up.

FWIW, this is faster than your average RAM can even go. Half of phantom's expertise is in very very fast sensors, the other half is in moving data around exceptionally quickly without losing it to noise or corruption.





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FWIW, this is faster than your average RAM can even go. Half of phantom's expertise is in very very fast sensors, the other half is in moving data around exceptionally quickly without losing it to noise or corruption.

Like 12 Feb 2, 2018 permalink

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Heytjsjoel Yeah, but can it make pancakes? That's the real question.

Reply Like 1 Feb 2, 2018 permalink

chrisno oh yeai a lot of them.

Like Feb 2, 2018* permalink



Franz Weber No, but you can attach pancake lenses and produce footage where pure water will look like maple sirup, if you like. But thats about it regarding pancakes

Like Feb 2, 2018* permalink





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Franz Weber No, but you can attach pancake lenses and produce footage where pure water will look like maple sirup, if you like. But thats about it regarding pancakes

Like

Feb 2, 2018* [permalink](#)



dr.noise It can, but very slowly

Like

Feb 2, 2018 [permalink](#)

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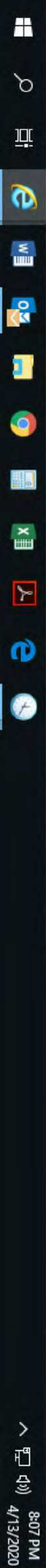
xiao_xiang But is it ISO-invariant?

Does it recover the shadows?

Does the lens have edge to edge sharpness?

And of course.... Shutter speed doesn't, it's all about lighting, composition, and the artistic beauty of the shot. How did it make the viewer think and feel?

It's all about the photographer. A great photographer could achieve better shots with an iPhone 5, a broken flash, and an old battery.





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better shots with an iPhone 5, a broken flash, and an old battery.

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xiao_xiang This is an incredible piece of our. I used to run a research lab and we salvated over 2,500 fps, black and white, 230*160 resolution.

This will offer researchers incredible observation powers! Great work!

Like 21 Feb 2, 2018 [permalink](#)

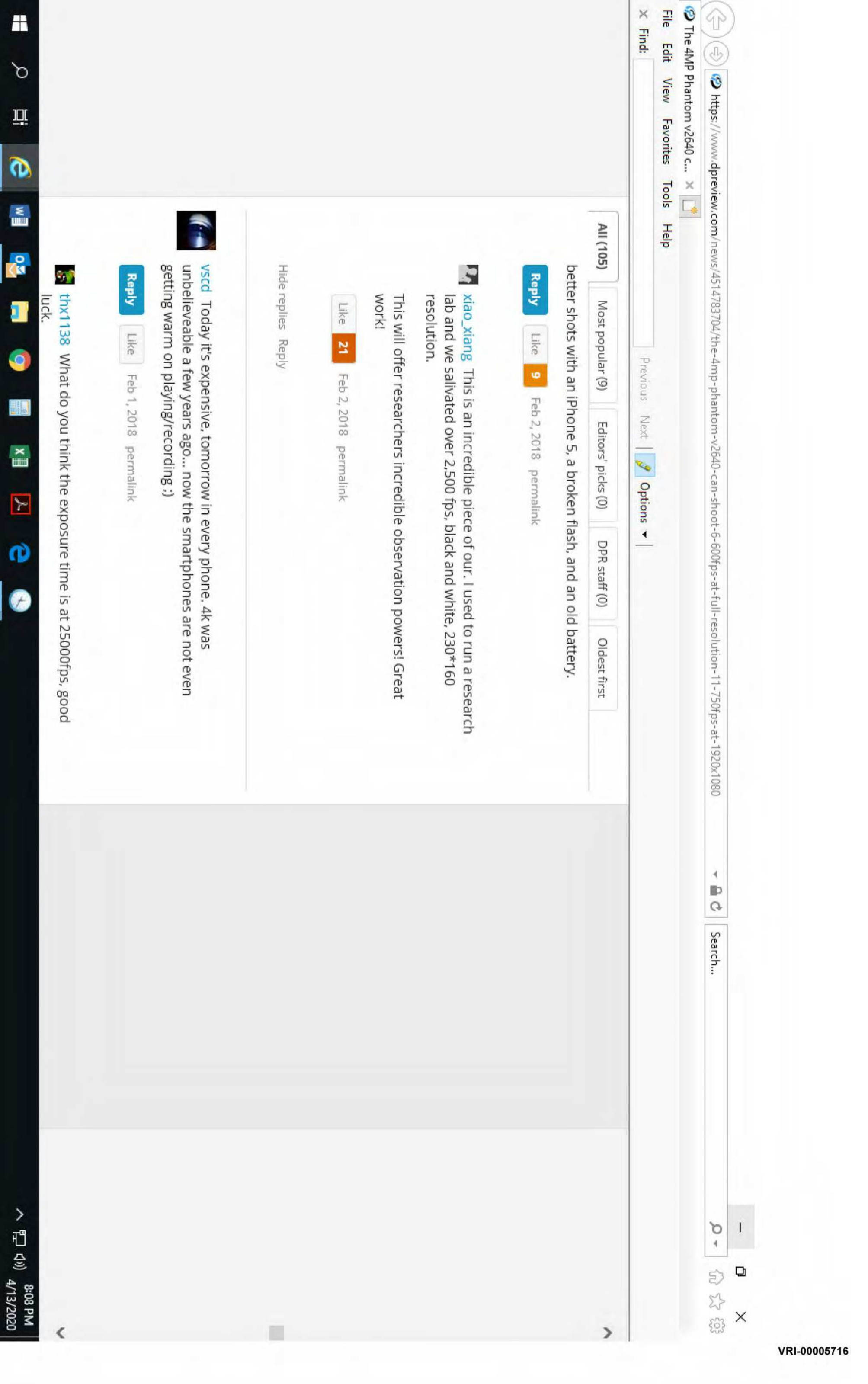
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vsccd Today it's expensive, tomorrow in every phone. 4k was unbelievable a few years ago... now the smartphones are not even getting warm on playing/recording ;)

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thx1138 What do you think the exposure time is at 25000fps, good luck.





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thx1138 What do you think the exposure time is at 25000fps, good luck.

Like 1 Feb 2, 2018 permalink

vsacd The same exposure time as the cam above (exposure time depends heavily on thod fast fps-sensors). Sensortechnology will grow, you know. We startet on Film with ISO 1 or 2 equivalent (or less). Now we are at 4 million.

Like Feb 2, 2018 permalink

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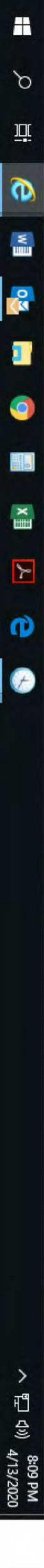


jhinkey I'll get one to take on my next vacation

Reply Like Feb 1, 2018 permalink

Photoman just don't use it in the bedroom...;P

Like 4 Feb 1, 2018 permalink





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Photoman just don't use it in the bedroom...;P

Like 4 Feb 1, 2018 permalink

jhinkey I'm sure there's a self deprecating joke I can make up here somewhere. /:>)

Like 2 Feb 1, 2018 permalink

Photoman You don't want your partner to analyse your performance mabye?!

Like 2 Feb 2, 2018 permalink

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cosinaphile ummmm... one please

Reply Like Feb 1, 2018 permalink





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cosinaphile ummmm... one please

Reply Like Feb 1, 2018 permalink



Kamox I wonder if the Slo Mo Guys have already ordered one... Here's a "how it's made"-style video:
<https://www.youtube.com/watch?v=LaqeLrLXYOg>

Reply Like 3 Feb 1, 2018* permalink



Rensol I would buy one should it be around 10k. But unfortunately....

Reply Like 1 Feb 1, 2018 permalink



oliver77 This is a very specific purpose camera, like a scientific imaging device. I don't understand why it gets a dpreview front page. Please, keep me informed of the latest 500k\$ Siemens Medical Magnetic Resonance Imaging Machine. I'm very interested. (Pun intended)



8:10 PM 4/13/2020

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the most interesting of the latest DVX cameras is the new 4MP Phantom v2640 Imaging Machine, I'm very interested. (Pun intended)

Reply Like 4 Feb 1, 2018* permalink

chrisno true, however some people are very rich to just buy this as a gadget in this planet anyway lol

Like Feb 1, 2018 permalink

its_a_knife Nooooooooooooo..... This camera is used for more than scientific imaging. Plenty of people like using super slow motion as an aesthetic. Of course no one's going to buy it but they might rent it out.

This music video was shot on the phantom flex. The take was 5 seconds long in real time but it was slowed down to fit the song. Nothing about science hurr. https://vimeo.com/118738368

Like 1 Feb 1, 2018 permalink

techiedi I found this article newsworthy and interesting, even if I will never use it. I would love to see more articles about interesting applications of photographic technology beyond the bland and



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applications of photographic technology beyond the bland and repetitive consumer form factors.

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cosinaphile careful with that sarcasm or you'll get much hate for suggesting dpr review medical equipment ... lol

Like 3 Feb 1, 2018 permalink

Merida What's wrong with medical equipment? Those CT scans are beautiful too. Sharp as hell, Paper thin depth of field.

Like 3 Feb 2, 2018 permalink

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Androole What is the lens mount on that, anyway? Does it use a C-mount given that it is generally for industrial applications?

And a small sensor for maximum readout speed, I would expect?

Reply Like Feb 1, 2018 permalink



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And a small sensor for maximum readout speed, I would expect?

Reply

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Mssimo Looks like its a Zeiss 85mm f1.4 ZF.2 (Nikon mount). I bet the mount can be changed out. They use nikon because it has an aperture ring on it no need for electronics.

Like

Feb 1, 2018* permalink



cosinaphile aperture ring aperture ring

[just wanted to say it twice]

Like

Feb 1, 2018 permalink

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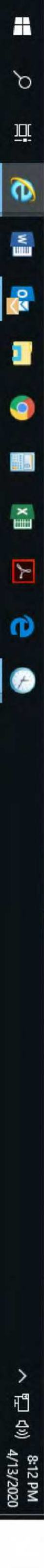


matt1941 Cheaper options Chronos, edgertronic, fps4000 https://www.slomcamco.com/

Reply

Like 1

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matt1941 Cheaper options Chronos, edgertronic, fps4000
<https://www.slomocamco.com/>

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Feb 1, 2018 permalink



mgblack74 Cool. So hybrid wedding videographers can just pull stills from this all day long. :-)

Reply

Like

Feb 1, 2018 permalink



christno I predict it will take another 10-12 years for smartphones to match this speed if they can solve the heat issues, from current 1080p 240fps to over 2000fps in 2024, and over 10000 fps in 2028-2030.

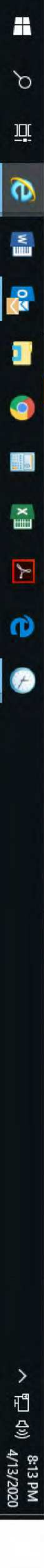
However, it's gonna take forever for APS-C/FF cameras to achieve that performances because of heat.

Reply

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kreislauf who cares?





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kreislauf who cares?

Like 3 Feb 1, 2018 permalink

MikeFairbanks If you didn't care you wouldn't take the time to write "who cares".

Like 7 Feb 1, 2018 permalink

photophile Maybe he only closet cares.

Like Feb 2, 2018 permalink

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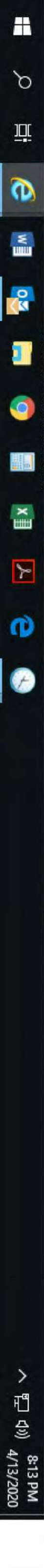


tinternaut Hmmmm... Whatever the price, I'm betting it will be an awful lot of money to spend and discover I'm still crap at shooting sports.

Reply Like 1 Feb 1, 2018 permalink

chrisno One can pick up a RX10 II for under \$1000 for a rather

decent slow mo effect





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chrisno One can pick up a RX10 II for under \$1000 for a rather decent slow mo effect.

Like Feb 1, 2018 permalink

graybalanced Yeah...instead of taking one perfectly composed, perfectly timed, but slightly misfocused frame of a fast-moving player, now i'll have taken 11,000 slightly misfocused frames of a fast-moving player. :(

Like 1 Feb 2, 2018 permalink

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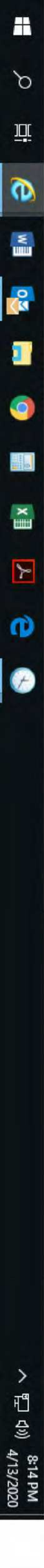


Missimo This is the type of camera that is rented and not purchased. The phantom flex4k went for around \$110K. Anyone have better numbers and do they come with a lens and camera strap?

Reply

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kreislauf disagree. mostly, these cameras are deployed in research laboratories.





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kreislauf disagree. mostly, these cameras are deployed in research laboratories.
like ours.
not your neighbor mike, who happens to have a youtube channel on which he destroys stuff...

Like **2** Feb 1, 2018 [permalink](#)

MikeFairbanks Did someone ask for Mike?

Like **13** Feb 1, 2018 [permalink](#)

cosinaphile lol i love dpr

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Magnar W There is no price information, and I can't find the camera at B&H or other large camera stores ... :-D

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Magnar W There is no price information, and I can't find the camera at B&H or other large camera stores ... :-D

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Best cameras and lenses

The 4MP Phantom v2640 can shoot 6,600fps at full resolution, 11,750fps at 1920x1080

Published Feb 1, 2018 | [Damien Demolder](#)

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If you thought you had a pretty good high-speed photography set-up, the new Phantom v2640 from Vision Research might make you think again. Using a 4-million-pixel sensor and a shortest 'shutter speed' of 142 nanoseconds, this new model from the scientific and industrial manufacturer can reach speeds of up to 6,600fps at full resolution, and can go even faster when the pixel-count is reduced.

The latest in a line of high-speed cameras aimed at researchers and engineers, the v2640 comes in color and monochrome versions, and with internal memory of up to 288GB to store the data collected. Vision Research claims the camera has a dynamic range of 64dB (over 10 stops) and that the monochrome model has ISO settings of 16,000, so it can work in very low light.



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Fun with Bokeh! Visual experiments you can do at home



The Camera Gear that Changed my Life (the humble wrist strap)



Sigma 24-70mm F2.8 DG DN Art Hands-on Review



The black and white model can be switched to 1-million-pixel mode and will then record at up to 25,030fps, while the color model can 'only' manage a best of 11,750fps when dropped to 1920x1080 2MP quality. We've reached out to the company for a price, and are waiting for a reply, but don't expect this puppy to come cheap.

In the meantime, if you fancy one yourself you'll find more information and instructions for ordering on the [Vision Research website](#).

Press Release

New Phantom v2640 Ultrahigh-Speed Camera Achieves Unmatched 4-Mpx Resolution

Vision Research, a leading manufacturer of digital high-speed imaging systems, has introduced the Phantom® v2640, the fastest 4-Megapixel (MPx) camera available. It features a new proprietary 4-Megapixel (Mpx) CMOS image sensor (2048 x 1952) that delivers unprecedented image quality at up to 26 Gpx/sec, while reaching 6,600 frames per second (fps) at full 2048 x 1952 resolution, and 11,750 fps at 1920 x 1080.

The v2640 features very high dynamic range (64 dB) and the lowest noise floor of any Phantom camera (7.2 e-)—making it an excellent tool for researchers, scientists and engineers who need to capture clean, high-resolution images at ultra-high speeds. The high dynamic range shows significant detail, especially in high-contrast environments, while the low noise is particularly beneficial when analyzing the dark regions of an image. It also has exceptional light sensitivity, with an ISO measurement of 16,000D for monochrome cameras and 3,200D for color cameras.

"We're excited to bring this extremely high image quality to the high-speed camera market," says Jay Stepleton, Vice President and General Manager of Vision Research. "In designing this new, cutting-edge sensor, we focused on capturing the best image in addition to meeting the speed and sensitivity requirements of the market. The 4-Mpx design significantly increases the information contained in an image allowing researchers to better understand and quantify the phenomena they are observing."

The v2640 has multiple operating modes for increased flexibility. Standard mode uses correlated double sampling for the clearest image, while high-speed (HS) mode provides 34% higher throughput to achieve 6,600 fps. Monochrome cameras can incorporate "binning," which converts the v2640 into a 1-Mpx camera that can reach 25,030 fps at full resolution, with very high sensitivity. "The various operating modes also allow users to have just one camera to cover multiple applications," adds Doreen Clark, Product Manager for the Phantom Ultrahigh-Speed family.

FINISHED CHALLENGES



Pantry Still Life by SkipRD
from Still Life from your Pantry

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Japan offers \$2.2B to help domestic companies move production from China, but will it help the imaging industry?

Last week, it was reported that \$2.2 billion of Japan's COVID-19 emergency stimulus package will be allocated to companies willing to move production out of China. We asked two executives of Japanese imaging companies whether or not this incentive could help their operations.

Apr 13, 2020 | 30



I'm Back returns to Kickstarter with updated I'm Back 35 digital back for old 35mm SLRs

The new model supports nearly all 35mm analog SLR cameras and can be used with dedicated back covers designed for the most popular camera models.

Apr 13, 2020 | 51



BCN data shows mirrorless camera sales have dropped 50% YoY in Japan for March amidst COVID-19 pandemic

Year-over-year, sales of mirrorless interchangeable-lens cameras decreased by 50.5 percent, according to BCN Retail's latest data.

Apr 13, 2020 | 99



'Accurate autofocus on any subject in any environment': Olympus engineer talks OM-D E-M1 Mark III AF

In this interview, Tetsuo Kikuchi, manager of Imaging System Development at Olympus Corp explains how the E-M1 Mark III's autofocus system was developed, and what it means to design a camera for demanding professionals.

Apr 13, 2020 | SPONSORED

To help users manage the amount of data inherent in high-speed imaging, the Phantom v2640 is available with up to 288GB of memory, and is compatible with Phantom 1TB and 2TB CineMags® for fast data saves. Alternatively, 10Gb Ethernet is standard, saving significant download time.

Key Specifications of the Phantom v2640

- 4-Mpx sensor (2048 x 1952), 26Gpx/sec throughput
- Dynamic range: 64 dB
- Noise level: 7.2 e-
- ISO measurement: 16,000D (Mono), 3,200D (Color)
- 1 µs minimum exposure standard, 499ns / 142ns minimum exposure with export-controlled FAST option
- 4 available modes: Standard, HS and Binning (in Standard and HS)
- Standard modes feature Correlated Double Sampling (CDS) performed directly on the sensor to provide the lowest noise possible
- Up to 288 GB of memory
- 10-Gb Ethernet standard
- Compatible with CineMag® IV (up to 2 TB)

Via: [Image Sensors World](#)

Tags: [camera-news](#), [high-speed](#), [phantom](#), [slow-mo](#), [slow-motion](#), [vision-research](#)

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CrazySwiss The question everybody wants to know was not answered. Does it come with face detection?

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M Chambers What a shoddy video to promote their product. This reminds me of the Lonely Island music video 'Threw It On the Ground.'

Reply

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diglit Great for shooting weddings!

Reply

Like

Feb 5, 2018 [permalink](#)

crashpc Now that took some overclocking skills. :-D Reminds me of dr.Manhattan, "I have witnessed events so fast that can hardly be said they occurred at all" :-D



Nine things working photographers can do for their business during isolation

Like so many, self-employed photographer Suzi Pratt found herself at home with lots of time to kill. Here are the steps she recommends for those in the same position, both to fill time during isolation and to prepare for what's next.

Apr 13, 2020 | 17



Video: How a video production company turned an ambulance into the ultimate grip truck

The two-minute video shares a behind-the-scenes look at how commercial film production company Threefold made an old ambulance the ultimate all-in-one film truck.

Apr 12, 2020 | 8 VIDEO



Affordable anamorphic: hands-on with the Sirui 50mm F1.8 1.33x

Compact and affordable, the new Sirui 50mm anamorphic lens comes in options for three camera mounts - so we tried it on each of them. See the lens in more detail and read about the benefits of using it on each system.

Apr 12, 2020 | 73



Updated: Fujifilm X100V sample gallery

The Fujifilm X100V is a camera designed to tag along on adventures large and small. We brought it along on plenty of excursions during the course of testing - back when we were able to do that sort of thing - from trips to the coast to walks around the block.

Apr 12, 2020 | 28 SAMPLE GALLERY



DPReview TV: Fujifilm Acros 100 II film review (and samples)

We shot Fujifilm's new Acros II black and white film in both 35mm and 120 medium format, developing it ourselves. We also compared it to Fujifilm's Acros film simulation. The verdict? We like this film!

Apr 11, 2020 | 146 VIDEO

Lensrentals wants to know if the COVID-19 pandemic has impacted your

[Reply](#) [Like](#) Feb 4, 2018 [permalink](#)
[All \(105\)](#) [Most popular \(9\)](#) [Editors' picks \(0\)](#) [DPR staff \(0\)](#) [Oldest first](#)

(unknown member) We've used Phantoms with great success in recording the impact of bullets fired at test coating materials, specifically coatings for powerplant transformers. They are quite the tools.

[Reply](#) [Like](#) 2 Feb 4, 2018 [permalink](#)

walker2000 280W power supply. I'm sure this beast uses battery much faster than infamous Sony A7R2 and Sigma DP-1M. :-)

[Reply](#) [Like](#) Feb 3, 2018 [permalink](#)

doctor digl Need this for the Pitch Drop Experiment.
https://en.wikipedia.org/wiki/Pitch_drop_experiment


[Reply](#) [Like](#) 3 Feb 3, 2018 [permalink](#)

stevo23 And just when I was going to give up on getting sharp photos of a two-toed sloth in motion...

[Reply](#) [Like](#) 4 Feb 2, 2018 [permalink](#)

stevo23 That's really cool. If you look at their website and the alternator belt footage, you can actually detect when the pistons fire. Incredibly useful tool for research and analysis. And fun too.

[Reply](#) [Like](#) 2 Feb 2, 2018 [permalink](#)


 lylejk Man; using image stacking, you can really get hirez low noise captures. lolol

;))

[Reply](#) [Like](#) 1 Feb 2, 2018 [permalink](#)

rbach44 I wouldn't lol too hard... I'm sure at least one DPRReview reader was seriously thinking that.

[Like](#) 2 Feb 2, 2018 [permalink](#)

jochenls Yes, too bad we need to raise iso by 15 stops to get a correct exposure.

[Like](#) Feb 3, 2018 [permalink](#)

Hide replies [Reply](#)

professional photography work



The results of the short survey will be shared in the coming weeks in an effort to better understand how the COVID-19 pandemic is affecting the professional photography community.

Apr 10, 2020 83



Pixelmator Photo 1.2 update adds cursor support, ML Color Match, Split View and more

In addition to the new cursor support inside iPadOS 13.4, the update also adds a machine-learning-powered photo-matching tool, Split View support and a copy/paste function.

Apr 10, 2020 14



Film Fridays: How to set up a darkroom and get printing for cheap

Setting up a fully-functional B&W darkroom is way easier and cheaper than you may think. Our pals over at 35mmc.com show you how to get printing for under \$100.

Apr 10, 2020 61



Fujifilm X-A7 sample gallery

The Fujifilm X-A7 is a fun-to-use, touchscreen-centric camera that covers the basics for a beginner while leaving room to grow. See what it's capable of in use as an everyday companion.

Apr 10, 2020 38 [SAMPLE GALLERY](#)



LensCoat diverts its US production facilities to make masks for local hospital

Lens accessories company Lenscoat responded to an appeal for PPE for healthcare workers, using its skills to manufacturer some very cool camo face masks

Apr 9, 2020 71



Slideshow: PDNedu Student Photo Contest 2020 winners and finalists

Here are the Grand Prize Winners and Honorable Mentions for the 9th Annual PDNedu Student Photo Contest.

Apr 9, 2020 53



The ins and outs of ISO: What is ISO?

We look into what the ISO setting on your camera does and doesn't mean - why it can't necessarily be measured, and why your sensor's sensitivity never changes.

Apr 9, 2020 507



Sony releases 2.00 firmware update for its a9 II mirrorless camera

The firmware update adds a new 'Hi Frequency Flicker' function, adds a new Face/Eye Priority autofocus function and more.

All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first

[fredmason](#) Just what I needed for my selfie stick.

[Reply](#) [Like](#) 2 Feb 2, 2018 [permalink](#)



[Slapstick Noir](#) Whaaaat? No 4K ?????/????? And no flipping screen for vlogging?
Can it share to Hipstagram?

[Reply](#) [Like](#) 2 Feb 2, 2018 [permalink](#)



[Flashback](#) I guess somebody here is going to say they can achieve that with their iPhone!

[Reply](#) [Like](#) 2 Feb 2, 2018 [permalink](#)

[badf](#) Unlikely. Most DPR commenters doubt that smartphones even take pictures.

[Like](#) 5 Feb 2, 2018* [permalink](#)

[Hide replies](#) [Reply](#)

(unknown member) Looks great, I'll take two.

[Reply](#) [Like](#) Feb 2, 2018 [permalink](#)

[Johannes Zander](#) Just looked up the specs: Nikon F-Mount is the standard lens mount. Interesting!

[Reply](#) [Like](#) 4 Feb 2, 2018 [permalink](#)

[Chaitanya S](#) There is a large selection of Nikon F mount lenses and older lenses also have mechanical aperture which further simplifies the lens mount unlike electronic lens mounts. It's quite common to find Nikon F mount on these high speed video cameras.

[Like](#) 1 Feb 3, 2018 [permalink](#)

[Hide replies](#) [Reply](#)

[ovengloves](#) But does it have IBIS?

[Reply](#) [Like](#) 4 Feb 2, 2018 [permalink](#)

Apr 9, 2020 195



DPReview TV: Fun with bokeh

Photographers throw the word 'bokeh' around a lot, but what exactly is it? Our resident mad scientist, Don Komarechka, takes us on a ride through a bokeh-rific world of creative possibilities.

Apr 9, 2020 51 VIDEO



Panasonic releases minor 1.5 firmware update for its Lumix S1, S1R mirrorless cameras

The minor update adds new CFexpress Type B support and a new 50p/25p video frame rate option.

Apr 9, 2020 72



CamFi update adds wireless tethering support to Fujifilm's most popular cameras

The update will add wireless tethering support and more for the Fujifilm X-T2, X-T3, X-H1, GFX 50R, GFX 50S and GFX 100.

Apr 8, 2020 6



Fujifilm X100V review: The most capable prime-lens compact camera, ever

We think Fujifilm's X100V is the best choice for a photographer's carry-everywhere camera in 2020. Provided you can find somewhere safe to take pictures, of course. Take a look through our full review to find out more.

Apr 8, 2020 1495 REVIEW



DPReview TV: The gear that changed my life

We all have some piece of photo gear that changed the way we work. In this video, DPReview TV host Chris Nicolls tells us what product rocked his world. The answer may surprise you.

Apr 8, 2020 142 VIDEO



5 stay-at-home challenges for photographers and videographers in quarantine

Who says you can't be creative while confined to your home? Top camera companies and creatives are challenging photographers and videographers to submit their best work while in quarantine.


Apr 8, 2020 14



Skylaney unveils its forthcoming 50mm F2 'Bertele' Sonnar lens for Leica M-mount cameras

The Leica M-mount lens is the first from Skylaney, a British company which designs and constructs its lenses in the British Isles.

Apr 7, 2020 124

 **Paul_B Midlands UK** Incredible - nice work guys.
 (05) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first
[Reply](#) [Like](#) **1** Feb 2, 2018 [permalink](#)

 **dr.noise** (in a shop)
 ... Is that price or framerate?
[Reply](#) [Like](#) **8** Feb 2, 2018 [permalink](#)

BLongborough If you think that's the price, I think you're being a bit optimistic. I suspect we're talking, like, USD 50K here.

[Like](#) Feb 2, 2018 [permalink](#)

[Hide replies](#) [Reply](#)

Dirk Nuary I think this gear is the gear that used by youtuber "The Slow Mo Guy", now named "the super slow show". But I wonder, can this gear catch up the bullet out of the gun?

[Reply](#) [Like](#) **2** Feb 2, 2018 [permalink](#)

Roland Karlsson A bullet from a gun might be 1000 m/s, depending on gun. And this thingie bursts away at approx 1000 FPS. So, there will be a meter between the bullets in the pictures. So, I think it is more than possible to catch a bullet in a picture.

Default exposure time is 1 microsecond. That will make the blur 1 mm. That is OK, and it can be improved with a factor of 7.

[Like](#) **1** Feb 2, 2018 [permalink](#)

Old Cameras Using a slow bullet like a .45ACP at about 650 feet per sec. at 11750 frames per second, that's a frame every 5/8" or so of bullet travel, 16 inches per second at 24fps. You'd definitely see it coming but I guess it would just be a blur.
 Metric system is confusing, I have to use feet and inches.

[Like](#) **1** Feb 2, 2018 [permalink](#)


Roland Karlsson Ah, but your slower bullet will be perfectly sharp. That is 200 m/s. Then the bullet will just move 1/5 m = 200 mm. And the sharpness will be 1/5 mm. Or even less if you use the high speed mode. Nema problema.

[Like](#) **1** Feb 2, 2018 [permalink](#)

john ruciak It does 28,760 FPS at 640 x 480


[Like](#) Feb 6, 2018 [permalink](#)

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 **Wet plate photographer shoots portrait of subject 4000 miles away via Zoom**


Marrying technologies invented over 150 years apart, U.S. photographer Shane Balkowitsch used the wet collodion process to photograph a sitter in London as she posed in front of her phone camera

Apr 7, 2020 [83](#) VIDEO

 **Canon releases 1D X Mark III firmware update to fix lock-up issue, add 23.98p video capture**


The update addresses a lock-up issue multiple 1D X Mark III camera owners were experiencing when shooting with the electronic level was on in the viewfinder display.

Apr 7, 2020 [93](#)

 **How HDR display could change your photography forever**


HDR isn't always a popular term in photography circles, but the latest high-DR TVs could free your photos from the standard DR constraints you didn't even know you were working to.

Apr 7, 2020 [209](#)

 **Tamron's 70-180mm F2.8 lens should ship in mid-May for \$1,199**


Tamron first teased the 70-180mm F2.8 Di III VXD for Sony E-mount last October. Now, we have confirmation of its price and the expected shipping date, pending any further interference from the COVID-19 pandemic.

Apr 7, 2020 [270](#) LENS NEWS

 **Video: How to capture abstract macro photographs using little more than paper and lights**

The 15-minute tutorial shows how with a few sheets of printer paper and a light source or two, you can create abstract macro photographs.

Apr 6, 2020 [15](#) VIDEO


 **Fotodiox's new EF to L-mount adapter features AF, aperture and image stabilization support**

The new EF to L-Mount 'Fusion' adapter offers full EXIF data support, as well as communication protocols to support autofocus, aperture control and image stabilization on supported lenses.


Apr 6, 2020 [34](#)

Tips or suggestions? [Contact us!](#)

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 **malcolm moy** Check out the Slow Mo Guys on YouTube, excellent examples and there is also a good technical explanation of what the camera can do and how it works.

[Reply](#) [Like](#) **1** Feb 2, 2018 [permalink](#)

 **adengappasami** I need 3. 1 for letting it sit idle in the dry box, 1 for in the car hoping i will take some slow mo shots and 1 for shooting two balloon burst shots..

Ready to pay 100K for 3

[Reply](#) [Like](#) **1** Feb 2, 2018 [permalink](#)


 **Ebrahim Saadawi** Their cameras are so damn expensive! We could truly use such a high resolution feed at 6000fps to document the propelling speed of a stabilized dental hand-piece we're working on, all the previous HS cameras never cut it, but the phantoms go to the top US research facilities first I'm afraid. One would need it for about a minute no longer so I hope they offer a generous amount of bodies.

[Reply](#) [Like](#) Feb 2, 2018 [permalink](#)

(unknown member) Yeah seems like something that a lot of people would be happy to rent rather than buy. Not many people need something like this all the time, but there are plenty of folks who could probably make use of one occasionally.

[Like](#) Feb 2, 2018 [permalink](#)

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 **technotic** DJI are really stepping out up.

[Reply](#) [Like](#) Feb 2, 2018 [permalink](#)


 **technotic** It

[Like](#) Feb 2, 2018 [permalink](#)

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 **Franz Weber** Finally the new Phantom many of us have been waiting for. I like the new design without the distracting clutter of the propellers. Cudos to Dji


[Reply](#) [Like](#) **5** Feb 2, 2018 [permalink](#)

 **Kabalyero** I need one for my cat photos


[Reply](#) Like **12** Feb 2, 2018 · [permalink](#)
All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first

[rialcnis](#) I just want one to use as a streaming live webcam in a slime factory

[Reply](#) Like **5** Feb 2, 2018* · [permalink](#)

 [chriskeats](#) best laugh I had today!

Like **1** Feb 2, 2018 · [permalink](#)

 [Franz Weber](#) How is the slime business doing lately? I have heard of some entrepreneurs who became very rich


Like **1** Feb 2, 2018* · [permalink](#)

[rialcnis](#) Some youngish blonde lady named Nicole Skyes has a youtube channel with 100's of slime videos. I stumbled onto it the other night. Each video has at least half a million views. She looks like she's doing well. Then saw many other Slime channels. All very preposterous.

There are slime videos with 15-20 million views. Brave new world of Slime.

Like **2** Feb 3, 2018* · [permalink](#)

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 [Internet Enzyme](#) With a shutter speed of 142 nano seconds, I wonder how much light you would need to use the lowest ISO.

[Reply](#) Like **1** Feb 2, 2018 · [permalink](#)

[Mike CH](#) I think the technical term is "lots and lots of light" 😊

Like **12** Feb 2, 2018 · [permalink](#)

[Jochenls](#) You need to raise iso by 17 stops to get equivalent exposure to 1/100 shutter speed.

Like Feb 3, 2018 · [permalink](#)


[nickolas84](#) On a bright sunny day on a place like Greece, you could get to base ISO with a fast lens. Assuming ISO 100 and f/1.0 or f/1.4 lens.


In these cases its the flashes the problem that are often too weak to be used to "fill in" the shadows.


Like **1** Feb 6, 2018 · [permalink](#)


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All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first

 **Max Iso** It's even better if you play it at 1/4 speed !!!!!
[Reply](#) Like **3** Feb 2, 2018 [permalink](#)

 **stevenbrantley** Sony, Nikon and Canon DSLR owners will dump all their gear just to have this and claim bragging rights to the blazing frames per second.
[Reply](#) Like **1** Feb 2, 2018 [permalink](#)

 **ZeBebito** I would love to shoot a turtle race at 11750 frames per second.
[Reply](#) Like **14** Feb 2, 2018 [permalink](#)

 **Jesse Just Him** now watching paint dry have never been so exciting as before~!!!
[Reply](#) Like **2** Feb 2, 2018 [permalink](#)

 **Ian** I can see it now - a 2 hour film of the final second of a bullet hitting the target...
[Reply](#) Like **2** Feb 2, 2018 [permalink](#)

PLShutterbug How far from the target are you standing that it takes longer than 2 seconds for the bullet to reach the target?
[Like](#) Feb 2, 2018 [permalink](#)

Kondamin Depends on the weapon and bullet, for something like a .50 using sniper rifle that would be about 1600m
For a hand gun like a 44 magnum in theory about 600m
[Like](#) **2** Feb 2, 2018 [permalink](#)

technotic Can you hit something with a 44 magnum from 600m??
[Like](#) Feb 2, 2018 [permalink](#)

Scoobaru "Can you hit something with a 44 magnum from 600m??" Absolutely not. I struggled to hit an A2 paper target at 6m with a 44mag when I was visiting Orlando. It was my first session with a firearm though.
[Like](#) Feb 2, 2018 [permalink](#)

otto k

All (105) I can hit something, no problem, just not sure in advance what I would hit!
Worth it! (9) Editors' picks (0) DPR staff (0) Oldest first

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Blowizard Gonna need a bigger drone ...

Brian

Reply Like 1 Feb 2, 2018 permalink

photomedium Gonna need a better joke ...

Like 1 Feb 2, 2018 permalink

Hide replies Reply

doctor digi Does it blend?

Reply Like Feb 2, 2018 permalink

photomedium Like a vitamix?

Like Feb 2, 2018 permalink

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RUcrAZ 1. How long will it take to fill my (typical) 16GB "400x speed" SD chips?
2. Does it come in blue color?

Reply Like Feb 2, 2018 permalink

AiryDiscus $11750\text{fps} * 1920 * 1089\text{px} * 12\text{bpp} / 8\text{bit/byte} = 36.5\text{GB/s}$. So 1/2 second, if the card could keep up.

FWIW, this is faster than your average RAM can even go. Half of phantom's expertise is in very very fast sensors, the other half is in moving data around exceptionally quickly without losing it to noise or corruption.

Like 12 Feb 2, 2018 permalink


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HeytsJoel Yeah, but can it make pancakes? That's the real question.

Reply Like 1 Feb 2, 2018 permalink

All (105) [chrisno](#) oh yea! a lot of them.
Most popular (9) Editors' picks (0) DPR staff (0) Oldest first
Like Feb 2, 2018* permalink

 [Franz Weber](#) No, but you can attach pancake lenses and produce footage where pure water will look like maple sirup, if you like. But thats about it regarding pancakes
Like Feb 2, 2018* permalink


 [dr.noise](#) It can, but very slowly
Like Feb 2, 2018 permalink


Hide replies Reply


[xiao_xiang](#) But is it ISO-invariant?
Does it recover the shadows?
Does the lens have edge to edge sharpness?
And of course.... Shutter speed doesn't, it's all about lighting, composition, and the artistic beauty of the shot. How did it make the viewer think and feel?
It's all about the photographer. A great photographer could achieve better shots with an iPhone 5, a broken flash, and an old battery.
Reply Like 9 Feb 2, 2018 permalink

[xiao_xiang](#) This is an incredible piece of our. I used to run a research lab and we salivated over 2,500 fps, black and white, 230*160 resolution.
This will offer researchers incredible observation powers! Great work!
Like 21 Feb 2, 2018 permalink

Hide replies Reply

 [vscd](#) Today it's expensive, tomorrow in every phone. 4k was unbelievable a few years ago... now the smartphones are not even getting warm on playing/recording ;)
Reply Like Feb 1, 2018 permalink

 [thx1138](#) What do you think the exposure time is at 25000fps, good luck.
Like 1 Feb 2, 2018 permalink

 [vscd](#) The same exposure time as the cam above (exposure time depends heavily on thod fast fps-sensors). Sensortechnology will

All (105) grow, you know. We start on Film with ISO 1 or 2 equivalent (or less). Now we are at 4K resolution. 4 replies 0 DPR staff (0) Oldest first

Like Feb 2, 2018 [permalink](#)

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jhinkey I'll get one to take on my next vacation

Reply Like Feb 1, 2018 [permalink](#)



Photoman just don't use it in the bedroom... ;P

Like 4 Feb 1, 2018 [permalink](#)



jhinkey I'm sure there's a self deprecating joke I can make up here somewhere. /;>)

Like 2 Feb 1, 2018 [permalink](#)



Photoman You don't want your partner to analyse your performance mabye?!

Like 2 Feb 2, 2018 [permalink](#)

[Hide replies](#) [Reply](#)



cosinaphile ummmm... one please

Reply Like Feb 1, 2018 [permalink](#)

Kamox I wonder if the Slo Mo Guys have already ordered one... Here's a "how it's made"-style video:
<https://www.youtube.com/watch?v=LaqeLrLxYOg>

Reply Like 3 Feb 1, 2018* [permalink](#)

Rensol I would buy one should it be around 10k. But unfortunately....

Reply Like 1 Feb 1, 2018 [permalink](#)

oliver77 This is a very specific purpose camera, like a scientific imaging device. I don't understand why it gets a dpreview front page. Please, keep me informed of the latest 500k\$ Siemens Medical Magnetic Resonance Imaging Machine, I'm very interested. (Pun intended)

Reply Like 4 Feb 1, 2018* [permalink](#)

All (105) [chrisno](#) true, however some people are very rich to just buy this as a gadget on this planet anyway. [Follow](#) [DPR staff \(0\)](#) [Oldest first](#)

[Like](#) Feb 1, 2018 [permalink](#)

[its_a_knife](#) Nooooooooooooo..... This camera is used for more than scientific imaging. Plenty of people like using super slow motion as an aesthetic. Of course no one's going to buy it but they might rent it out.

This music video was shot on the phantom flex. The take was 5 seconds long in real time but it was slowed down to fit the song. Nothing about science hurr.
<https://vimeo.com/118738368>

[Like](#) **1** Feb 1, 2018 [permalink](#)

[techjedl](#) I found this article newsworthy and interesting, even if I will never use it. I would love to see more articles about interesting applications of photographic technology beyond the bland and repetitive consumer form factors.

[Like](#) Feb 1, 2018 [permalink](#)

[cosinaphile](#) careful with that sarcasm or you'll get much hate for suggesting dpr review medical equipment ... lol

[Like](#) **3** Feb 1, 2018 [permalink](#)

[Merida](#) What's wrong with medical equipment? Those CT scans are beautiful too. Sharp as hell, Paper thin depth of field.

[Like](#) **3** Feb 2, 2018 [permalink](#)

Show more replies (4) [Reply](#)

[Androole](#) What is the lens mount on that, anyway? Does it use a C-mount given that it is generally for industrial applications?

And a small sensor for maximum readout speed, I would expect?

[Reply](#) [Like](#) Feb 1, 2018 [permalink](#)

[Mssimo](#) Looks like its a Zeiss 85mm f1.4 ZF.2 (Nikon mount). I bet the mount can be changed out. They use nikon because it has an aperture ring on it no need for electronics.

[Like](#) Feb 1, 2018* [permalink](#)

[cosinaphile](#) aperture ring aperture ring

[just wanted to say it twice]

[Like](#) Feb 1, 2018 [permalink](#)

Hide replies [Reply](#)

All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first

matt1941 Cheaper options Chronos, edgertronic, fps4000
<https://www.slomocamco.com/>

Reply Like 1 Feb 1, 2018 permalink

mgblack74 Cool. So hybrid wedding videographers can just pull stills from this all day long. :-)

Reply Like Feb 1, 2018 permalink

chrisno I predict it will take another 10-12 years for smartphones to match this speed if they can solve the heat issues, from current 1080p 240fps to over 2000fps in 2024, and over 10000 fps in 2028-2030.

However, it's gonna take forever for APS-C/FF cameras to achieve that performances because of heat.

Reply Like 1 Feb 1, 2018 permalink

kreislauf who cares?

Like 3 Feb 1, 2018 permalink

MikeFairbanks If you didn't care you wouldn't take the time to write "who cares".

Like 7 Feb 1, 2018 permalink

photophile Maybe he only closet cares.

Like Feb 2, 2018 permalink

Hide replies Reply

tinternaut Hmm... Whatever the price, I'm betting it will be an awful lot of money to spend and discover I'm still crap at shooting sports.

Reply Like 1 Feb 1, 2018 permalink

chrisno One can pick up a RX10 II for under \$1000 for a rather decent slow mo effect.

Like Feb 1, 2018 permalink

graybalanced Yeah...instead of taking one perfectly composed, perfectly timed, but slightly misfocused frame of a fast-moving player, now I'll have taken 11,000 slightly misfocused frames of a fast-moving player. :(

Like 1 Feb 2, 2018 permalink

All (105) Most popular (9) Editors' picks (0) DPR staff (0) Oldest first



Mssimo This is the type of camera that is rented and not purchased. The phantom flex4k went for around \$110K. Anyone have better numbers and do they come with a lens and camera strap?

Reply Like 2 Feb 1, 2018 permalink



kreislauf disagree. mostly, these cameras are deployed in research laboratories. like ours. not your neighbor mike, who happens to have a youtube channel on which he destroys stuff...

Like 2 Feb 1, 2018 permalink

MikeFairbanks Did someone ask for Mike?

Like 13 Feb 1, 2018 permalink



cosinaphile lol i love dpr

Like 1 Feb 1, 2018 permalink

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Magnar W There is no price information, and I can't find the camera at B&H or other large camera stores ... :-D

Reply Like Feb 1, 2018 permalink

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Fujifilm X-A7 review

259

REVIEW Apr 1, 2020 at 13:00

The X-A7 is Fujifilm's latest, and most polished, entry-level APS-C mirrorless camera. With improved autofocus and a large touchscreen interface, we found ourselves really enjoying it.



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343

REVIEW Mar 18, 2020 at 13:00

With a fast lens, GPS and useful tracking features, and Raw support, Olympus's flagship rugged compact continues to be the best waterproof camera on the market.



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REVIEW Mar 16, 2020 at 13:00
While improvements like HyperSmooth 2.0 stabilization are truly impressive, the latest GoPro generation really only offers incremental upgrades - and that's looking like a trend we can count on in the foreseeable future.



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The Lume Cube 2.0 is much improved on its predecessor, but we do have concerns about its smartphone app. It's also pretty pricey among its competitors, but its feature set and quality of light may win you over. Find out more in our full review.

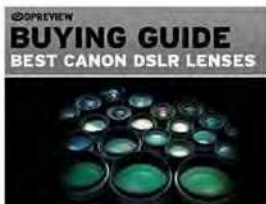
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Apr 10, 2020 at 17:16
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Best fixed prime lens cameras in 2020

Mar 2, 2020 at 22:41
The fixed lens camera market may be a bit niche, but it's here that you'll find some of the best cameras you can buy. Sensors ranging from APS-C to full-frame are designed to match their lenses, which cover ranges from 28-75mm equivalent, so image quality is top-notch.

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Mar 2, 2020 at 22:23



Although a lot of people only upload images to Instagram from their smartphones, the app is definitely more than just a mobile photography platform. In this guide we've chosen a selection of cameras that make it easy to shoot compelling lifestyle images, ideal for sharing on social media.

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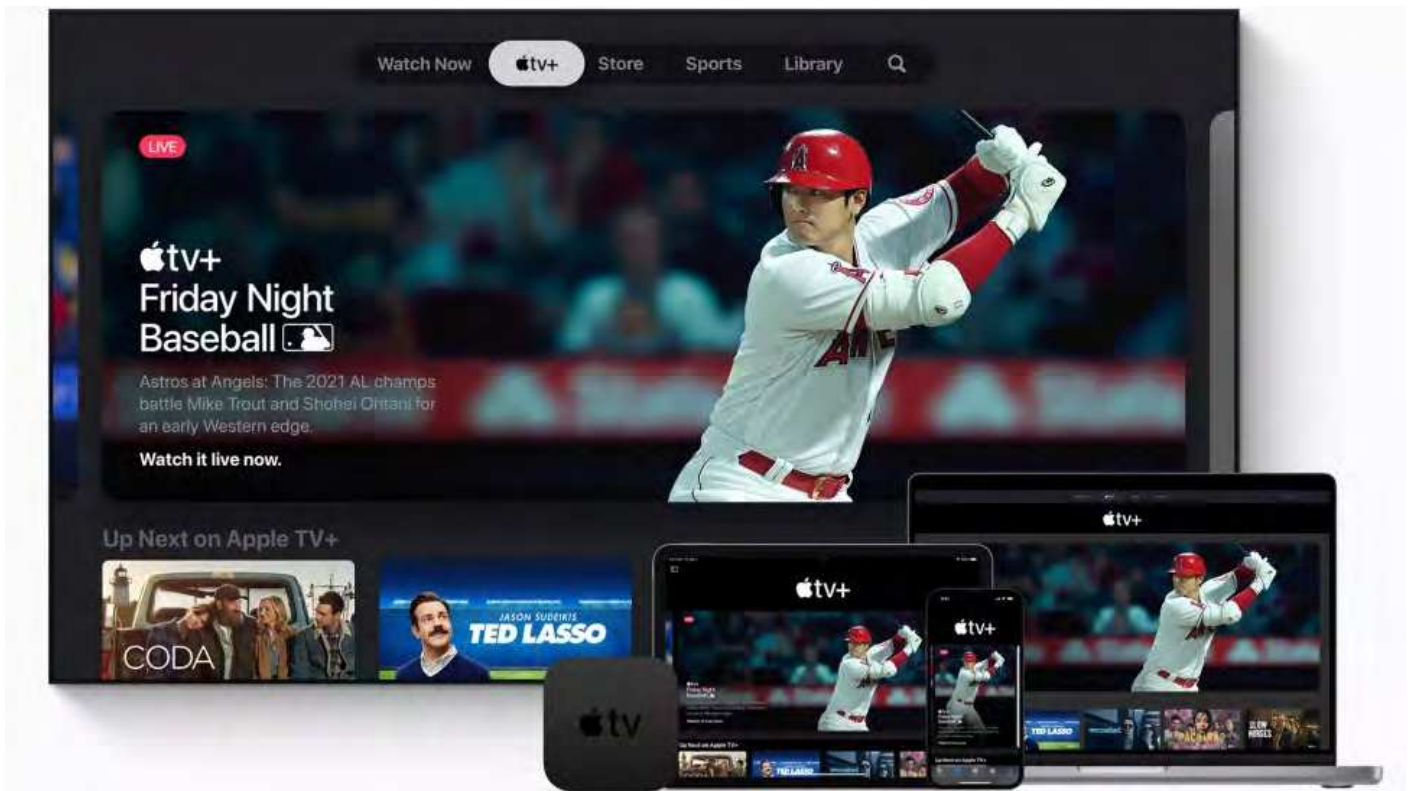
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Apple TV Plus Friday Night Baseball curveball start could still lead to a home run

By Lance Ulanoff last updated May 15, 2022

Apple's first Friday Baseball Night was called foul, but it's in for all nine innings



(Image credit: Apple)



Audio player loading...



said about the Friday Night Baseball debut.

At least the evening had everything a baseball fan could hope for. In the first game (there are two per night for a total of 50 games this season), the Mets played the Washington Nationals and endured non-working stadium lights, a 9th inning rain delay, and a bench-clearing near brawl when [Francisco Lindor was beamed](#) by Nationals pitcher Steve Cishek.

That last moment should have been (and still mostly was) the story of that game but all people could talk about on social media was Apple TV Plus and how it handled the game.

Apple announced the [MLB partnership in March](#) and, perhaps, set itself up with the first streamed game between two eagerly-watched teams with, at least in the Mets' case, intensely devoted fan bases.

Fans, industry watchers, and other play-by-play pros [tore into the Apple TV Plus team](#) hired to cover the game: Melanie Newman (play-by-play), Chris Young (analyst), Hannah Keyser (analyst), and Brooke Fletcher (reporter). Hernandez quipped during the next Mets game broadcast covered by him and Gary Cohen, that Mets fans had already had one horrible broadcast experience this season. Granted, this is the same slightly tech-phobic fellow who a week later recounted on air how he was [almost taken in](#) by a phone phishing scam.

Comments that complained about how the play-by-play didn't seem to know how to emphasize the importance of the right plays and how they talked over some of them, and sometimes around topics unrelated to the game or baseball.

The thing is, though, this may all be part of the plan.





Mets player Francisco Lindor after being hit by a pitch during the first Apple TV+ Friday Night Baseball game
(Image credit: Getty / Mitchell Layton)

Will Apple's changeup work?

Apple is purposely not doing things exactly as they've been done for decades of game broadcasts. It's intentionally widening the diversity and perspective of the typical game announcers. It purposely pulled together teams that offer new faces demographics and fresh perspectives.

That can take some getting used to but Apple, which appears to have grander baseball plans than just this Friday night slot (though we're guessing here), not only wants the traditional baseball fan to enjoy these games but is also hoping to build the audience beyond the endemic.

Perhaps that's why, despite the strong criticism, Apple is sticking with these game-calling teams. As it listens to and learns from the critical feedback, it will make adjustments but all the while Apple will still try to manage a difficult balance of satisfying the old (some of which had never tried out Apple TV) and welcoming the new. It knows it can't afford to alienate existing fans, but as a tech company, it can't help but innovate America's favorite pastime (by the way, Apple Friday Night Baseball is also streaming to Canada, Mexico, Australia, South Korea, and Japan - all hubs for baseball fanaticism).

The tech hurdles were real for those who have grown up watching games on broadcast TV where pressing a single number on a remote was enough to bring up the day's game. Apple TV and the original content platform TV Plus was a new frontier for them and Apple didn't spend any time teaching longtime baseball fans how to access the game.

At least these Friday night games are free for now (no word on when that ends), and if you have an Apple ID you can log into TV Plus through Apple TV or a variety of other third-party platforms to watch the games. And really, Mets fans had no choice because, aside from radio, there was no place else to watch that Nationals game (that broadcast blackout will carry through for all 50 Apple TV Plus Friday baseball games).

Home run tech

Leaving aside the criticisms and tech frustration, there were some notable Apple touches. Yes, the company splashed its proprietary SF Pro font all over everything to give the proceedings a very Apple feel.



Megalodon, which is not a new camera but a collection of technologies (a [Sony a7R IV](#) camera mounted on a [DJI Ronin-S](#) gimbal, a 6-inch field monitor, and a backpack to carry external batteries and a 1080p wireless transmitter), creates a recognizable cinematic effect. Players, usually walking on or off the field, are in share focus while the rest of the scenery is out of focus. It's a cinematic effect that instantly raises the drama. One could wonder, though, why Apple isn't using its own iPhone 13 Pro, which also shoots Cinematic video.

Apple is also employing a Phantom camera to shoot super-high-speed frame rate footage that can then slow down a slider to show what's really happening when the pitcher throws it, the ball bends down and in, and a player swings past it.

Plus, if you noticed that the overall game looked just a bit crisper, it could be because Apple is broadcasting in 1080p 60fps. That's above what you'd get from a typical broadcast or cable game. Sadly, no one is delivering these games in 4K, yet.

It's early days in Apple's made scramble from home to first, as it attempts to promote the heck out of these games on Apple TV (the app), TV Plus, and even in Apple News. It might garner more eyeballs this way, but ultimately, it has to win over baseball fans. It failed to reach first this inning, but there are 50 more this season and, potentially, a long MLB partnership ahead of it to work out a run.



Lance Ulanoff

US Editor in Chief



A 35-year industry veteran and [award-winning journalist](#), Lance has covered technology since PCs were the size of suitcases and “on line” meant “waiting.” He’s a former Lifewire Editor-in-Chief, Mashable Editor-in-Chief, and, before that, Editor in Chief of PCMag.com and Senior Vice President of Content for Ziff Davis, Inc. He also wrote a popular, weekly tech column for Medium called The Upgrade.

[Lance Ulanoff](#) makes frequent appearances on national, international, and local news programs including Live with Kelly and Ryan, Fox News, Fox Business, the [Today Show](#), Good Morning America, CNBC, CNN, and the BBC.



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NEWS

YES Network Enhances 1080p Yankees Coverage With Phantom Slo-Mo, Augmented Reality

Amazon Prime deal powers enhancements that make a difference for talent and viewers

By Ken Kerschbaumer, Editorial Director (<https://www.sportsvideo.org/author/kkersch/>)

Thursday, June 2, 2022 - 7:30 am

Print This Story (<https://www.sportsvideo.org/2022/06/02/yes-network-enhances-yankee-1080p-coverage-with-phantom-slo-mo-augmented-reality/?print=1>) | Subscribe (<https://us1.list-manage.com/subscribe?u=74255ab74f2837b1232c567e2&id=5ccb082d23>)

The YES Network is enjoying some solid play from the New York Yankees, but it is also enjoying some production enhancements resulting from a deal with Amazon Prime, which this year is streaming 21 Yankees games, including 19 on Friday nights.

"This is a real credit to Amazon because Amazon really wanted to drive their productions in a unique way this year," says **Jared Boshnack, VP, production, YES Network**. "They challenged us and said, 'Look, we know you put on one of the best productions and that is a separator. But what can be the differentiator?'"



(https://www.sportsvideo.org/new/wp-content/uploads/2022/05/AR_PrimeTimePlayer.png)

AR graphics are giving a lift to YES Network Yankees broadcasts.

Efforts to differentiate began with enhancements to Game Creek Video Yogi truck.

“Yogi’s still a high-end truck in the fleet, even after a few years,” says **Mike Webb, VP, broadcast operations and engineering, YES Network**. “But Game Creek went ahead with an investment to upgrade all the cameras on the truck to the new Sony HDC-5500, and we upgraded the EVS network to XT-VIAs. And then Fletcher upgraded our robos, two of which are also super-slo-mo. We’re now able to do a full 1080p show, which can be seen on Amazon Prime. And, while I haven’t compared 1080p to 720p side-by-side, I watched it the other night on a Roku on my big TV and noticed the difference.”

YES has increased its use of RF handheld cameras and also expanded deployment of Phantom high-speed cameras. According to Boshnack, that has already made a difference, and not just for viewers.

“Our talent gets a lot out of [the Phantom camera],” he says. “They’re seeing images now that are so much more descriptive and can show things that we weren’t able to truly appreciate before. It’s not just a player sliding but also the ability to see the torque that goes into throwing a 99-mph fastball. The way the camera slows everything down in such crystal-clear images is a game-changer and makes our broadcast feel really big. I can see it being used more and more on bigger shows, but, for now, it has to be used judiciously and in the right way.”

Using those cameras in the right way depends on three things: the camera operator’s skills, the proper location for the camera, and an EVS operator who can quickly build the right clips. Because the camera is used for replays and not live coverage, Boshnack says, the best spots for positioning the camera are low first or third.



(<https://www.sportsvideo.org/new/wp-content/uploads/2022/05/Sure-Shot-Phantom-Cam.jpg>)

Phantom cameras are giving YES announcers more insight into the game.

“It depends on if you have a right or a lefty pitcher on the mound or how the lineup is loaded,” he adds. “We’ve learned that not only do you have to have the technology but you also need an excellent camera operator and someone who’s really adept on the EVS in the truck to turn these images around. A lot of it is about understanding the game to be in the right place at the right time and get shots that have a depth.”

The graphics side has also been enhanced. Created by third-party graphics house Girraphic, and supported by their technology partner Vizrt, augmented reality is bringing a new level of information to viewers at home.

“[AR graphics] bring depth and value to the broadcast,” says Boshnack. “We can do a nice wide shot and have the graphic seemingly come up from the middle of the field, and it looks magnificent and makes the broadcast bigger. We had the Girraphic team work with **Game Creek Video EIC Gavin Hornick** and with **Rick Deutschman**, who heads up our graphics group and is director of our design group, to make sure it was launched successfully.”

As with the Phantom cameras, the team is experimenting with different locations for the dedicated camera head and lens that powers the AR graphics.

“We had it on a low camera the first couple of games,” he notes, “and we had it at tight center yesterday. We’re trying to figure out the best angle for introducing these graphics, but they are really, really cool.”

As for the future, Webb says HDR is in the roadmap but some issues are still to be worked out, including the ability to have an HDR-capable truck available for both home and away games.

“When we started digging in for this year,” he explains, “handling media from an HDR truck to an SDR truck and back and forth still seems to be a little much, especially for the production team. But we still wanted to get to an internal 1080p workflow.”

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EXHIBIT P415



'Black Adam' Will Feature Dwayne Johnson Filmed At 960 Frames Per Second, As The Movie Gods Intended



BY JEREMY MATHAI / JULY 13, 2021 1:53 PM EDT

You probably tend to think of directors like **George Lucas** or **James Cameron** or **Peter Jackson** as technical innovators. These titans are responsible for almost singlehandedly changing the filmmaking frontier with their industry-shaking contributions — all ranging from advancements in visual effects to 3D formats to a valiant (if [short-lived](#)) experiment with high frame-rates. Well, forget everything you thought you knew, because here comes *Black Adam* director **Jaume Collet-Serra** and he's not messing around.

And honestly, this sounds cool enough that I'm not even joking.



If star **Dwayne Johnson's** [latest Instagram post](#) is any indication, the ***Run All Night***, ***The Shallows***, and ***Jungle Cruise*** director is pulling out all the stops for this DCEU movie. Take it straight from Black Adam himself:

"In our final week of shooting BLACK ADAM?? our director, Jaume Collet Serra designed very cutting edge, intricate, bad ass and cool shots. This advanced robot arm called a BOLT is the fastest in the world with a high speed PHANTOM camera that shoots me at an insane 960 frames per second (normally movies are shot at 24 frames per second)."

In short: this sounds like it'll be the ultimate form of slow-motion.

Who says celebrities can't offer some free education while they're showing off their ridiculously toned bodies on social media? With his trademark enthusiasm, Johnson sheds some intriguing light on just how differently this WB/DC film is being filmed compared to other projects in the superhero universe. At 960 frames per second, we're left with nothing but anticipation over what larger-than-life scenes are in store for us with *Black Adam*.

In ***Thor: Ragnarok***, director **Taika Waititi** also utilized the Phantom high speed camera for certain flashback sequences involving **Tessa Thompson** and **Cate Blanchett**, creating an operatic stuttering effect [at a staggering 1200 frames per second](#). Collet-Saume's camera doesn't quite reach that speed, but we won't hold that against him.

And because we can't resist stuff like this, Johnson also goes on to throw just the barest hint of good-natured shade at his competition. In an apparent reference to the recent ***Avengers*** movie, Johnson adds another remark in his post:

"If you know the comic mythology of BLACK ADAM, then you know/



His pain comes from the loss of his wife and children.

He is now the most unstoppable force in the DC Universe or ANY endgame universe???"

It's not exactly the cleverest example of wit but, again, we'll let it slide. As the star alludes to in his post, *Black Adam* has just about wrapped filming (it's been in various stages of planning for over a decade, no big deal) and is slated for a theatrical release on **July 29, 2022**.

RECOMMENDED

EXHIBIT P416



Phantom camera, Sci-Tech winner

POSTED BY IAN FAILES ON FEBRUARY 12, 2012

We've all seen incredible high impact sports replays, slow motion film scenes and poetic balloon bursts. Now, the team behind the digital high-speed camera responsible for many of those types of shots – the Phantom came from Vision Research – has been recognized by the Academy of Motion Picture Arts and Sciences at the Scientific and Engineering Academy Awards, which fxguide recently attended.

With the Phantom 65, HD Gold and Flex being Vision Research's most recent models for the motion picture industry, the cameras have found high profile use on such films as *Sherlock Holmes: A Game of Shadows* (for a scene of the main actors dodging bullets through a forest), *Inception*, *Green Hornet*, *Zombieland*, *Captain America: The First Avenger* and *TRON: Legacy*. Phantom cameras are also prevalent in academic research, medical work, military use and sports broadcasting.

Below, fxguide's Mike Seymour speaks to Vision Research Chief Scientist Radu Corlan and Chief Technology Officer Andy Jantzen, both Sci-Tech award recipients, walking through the various parts of the camera that make up the Phantom tech. And stay tuned to fxguide for our continued coverage of the Sci-Tech Awards winners and a fxguidetv from the ceremony itself.

fxg: Firstly, congratulations on being recognized by the Academy.

Andy Jantzen: Thanks, it's gratifying to be the first digital camera to be recognized by AMPAS.

fxg: We're not just talking about a digital camera and high speed here, we're also talking about the camera as a general camera, too, aren't we?

Jantzen: The Phantom camera product line's claim to fame is a high speed camera, but the cameras are equally capable and happy at shooting 24P as well.

fxg: What does it take to make a high end, high speed camera? Why is a high speed camera hard to make?

Radu Corlan: One of the difficult points is that you have to advance the field of sensors and processing. Most of the development that has been done elsewhere is towards making normal speed cameras. Many of those components, be it sensors or converters, memory systems – don't really apply to high speed. So you have to re-build every block of the camera, customized to high speed. That's why you don't benefit from a lot of other work.

fxg: You've got to be able to get frames running quickly and deal with the sensitivity issues, as well?

Corlan: The first and foremost thing is just reading the pixels out of the sensors. You have to start with a sensor that has to be designed specifically, a long and expensive process. In many cases in electronics, if you increase your bandwidth, you increase your noise as well. From one side your sensitivity and noise are more critical, and then on the other side you have to do it at high speed which makes it much more difficult.

fxg: There's also the rolling shutter.

Corlan: The Phantom HD Gold has a rolling shutter, and the Flex has a synchronous shutter. On a high speed camera, when the shutter rolls it rolls very fast regardless of



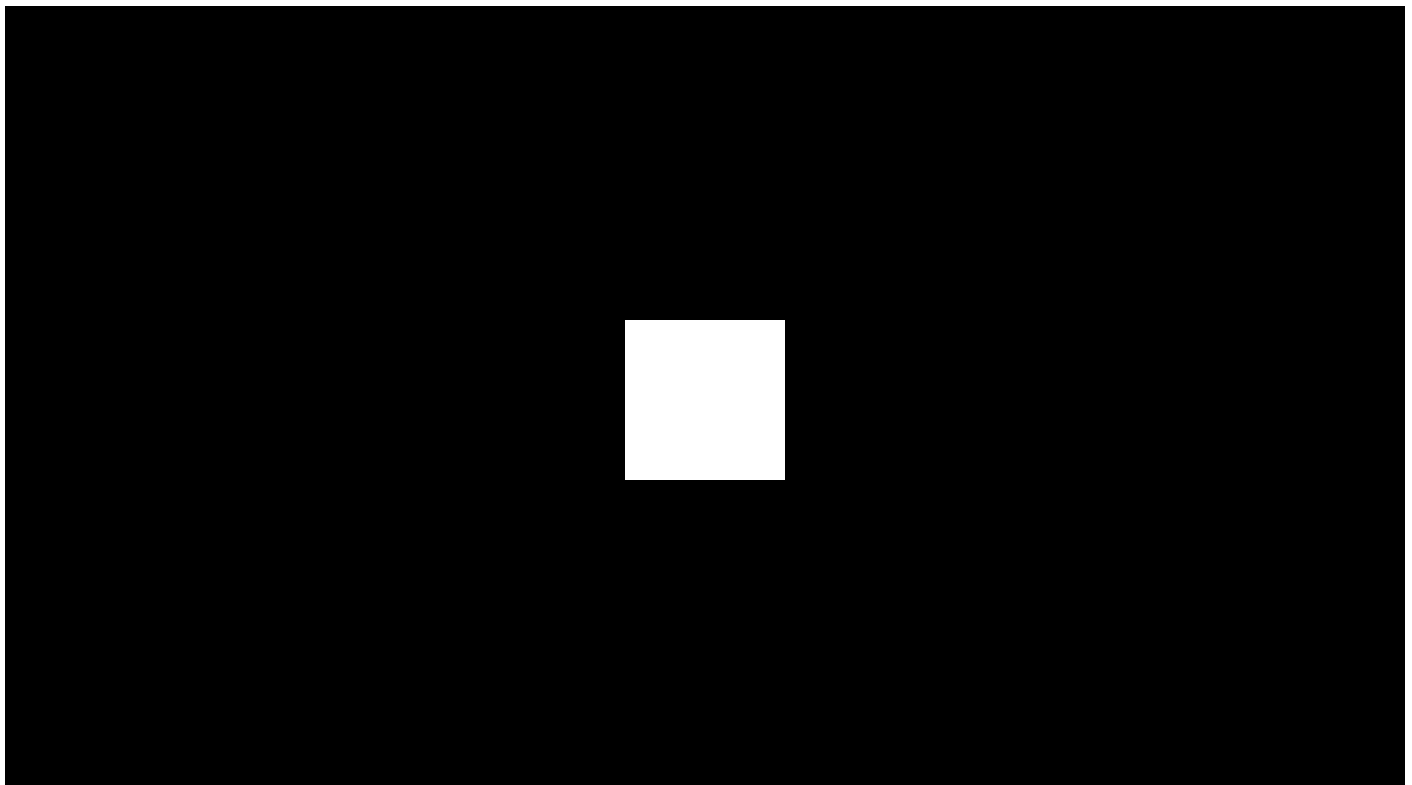
Vision Research's Andy Jantzen (left), Petru Pop (left center), Radu Corlan (right center) and Richard Toftness prior to the Scientific and Technical Achievement Awards. Photo credit: Todd Wawrychuk / © A.M.P.A.S.

whether you are shooting at a high speed or a low speed. From that perspective having a roller shutter is not that much of a problem.

Jantzen: When you think about it, every motion picture camera has a rolling shutter.

fxg: Yes, even a film camera has a rolling shutter from the blade.

Jantzen: Correct, the top of your frame is exposed at a different time than the bottom of your frame.



00:00

00:25

A balloon burst shot on a Phantom camera

fxg: Yes it's just a matter of getting it where it's acceptable – especially when you're doing imaging that needs to be accurate. Is the sensor technology in the Gold and the Flex – is it the same sensor tech or different versions?

Jantzen: Actually they're quite different. The HD Gold and the 65 are a family of sensors – a 2K sensor and a 4K sensor that have rolling shutters. That sensor we began developing that in 2003. The sensor that's in the Flex is a global shutter or a synchronous shutter – we

produced that in 2008 or 2009. They're all CMOS sensors and made with different technologies. We try to take advantage of the general state of the art at the time.

fxg: So we've got our sensor running fast enough and we're dealing with the noise, but you're going to have to put the data somewhere. How have you approached that?

Corlan: This is really the difference between the way a high speed camera is operated and the way a normal camera is operated. Sometimes for the high speed camera you cannot afford to record everything until an event happens, because sometimes an event can be unpredictable or the exact point of it is not known.

So the way most high speed cameras operate – it started with scientific ones – but even on the newer ones, is to record inside RAM inside the camera and just loop over continuously until the thing you want to record happens. When that happens you trigger or stop the camera.

fxg: So in this model you've got a bunch of RAM acting as a buffer and you're looping through the buffer, and at some point I say, 'That was the thing I wanted,' and then I can record that off to some other medium.

Corlan: And in some cases, especially in production, you look at it and you may not even like the take. So you can loop it into the buffer, see if you like it, and then you can save it later. Also being RAM inside the camera, it allows the full speed of the sensor to be taken advantage of.

fxg: Right so because the RAM is so fast it – one of the reasons you can get astronomically higher frame rates is because you go to much smaller frame sizes – it's all about that bandwidth.

Corlan: RAM is fast, but bandwidth is always a limitation. You need to put a lot of modules on just to keep up. After you have recorded into RAM you will download your images into a



Vision Research's Phantom Flex digital high speed camera

computer. That's where the CineMag, a custom non-volatile recorder that we have designed, is useful.

fxg: In addition to the high speed buffer, you're going from your RAW format to whatever I want to look at on monitor. How much coding needs to go into the RAW files from the CMOS chips – how much do you have to deal with the files?

Corlan: There is actually very little done, normally just black referencing and calibrating the camera.

fxg: Is there any gain in the pipeline?

Corlan: Going to the RAW file there is no gain. Essentially it's being black referenced and calibrated.

Jantzen: The files are RAW and the fit into post-processing environment – it is that real RAW data that everybody wants. It's never cooked and it's always RAW.

fxg: One of the good things these days is having access to options for dealing with the files – there are quite a few apps for dealing with them with these days. How have you found this?

Corlan: When we create the RAW file we tell people what's in the file, in terms of metadata and describing the file structures.

fxg: What are some of the performance specs of these Phantom cameras, in terms of frame rates that they are capable of shooting?

Jantzen: On the 65 you can do a full 4K by 2400 high at about 140 frames per second. The Flex which is 4MP has two different modes – it has a normal mode that will do over 2500 fps and a high quality mode that does 1300-1400 fps at 4MP which is 2500 by 1600 resolution.

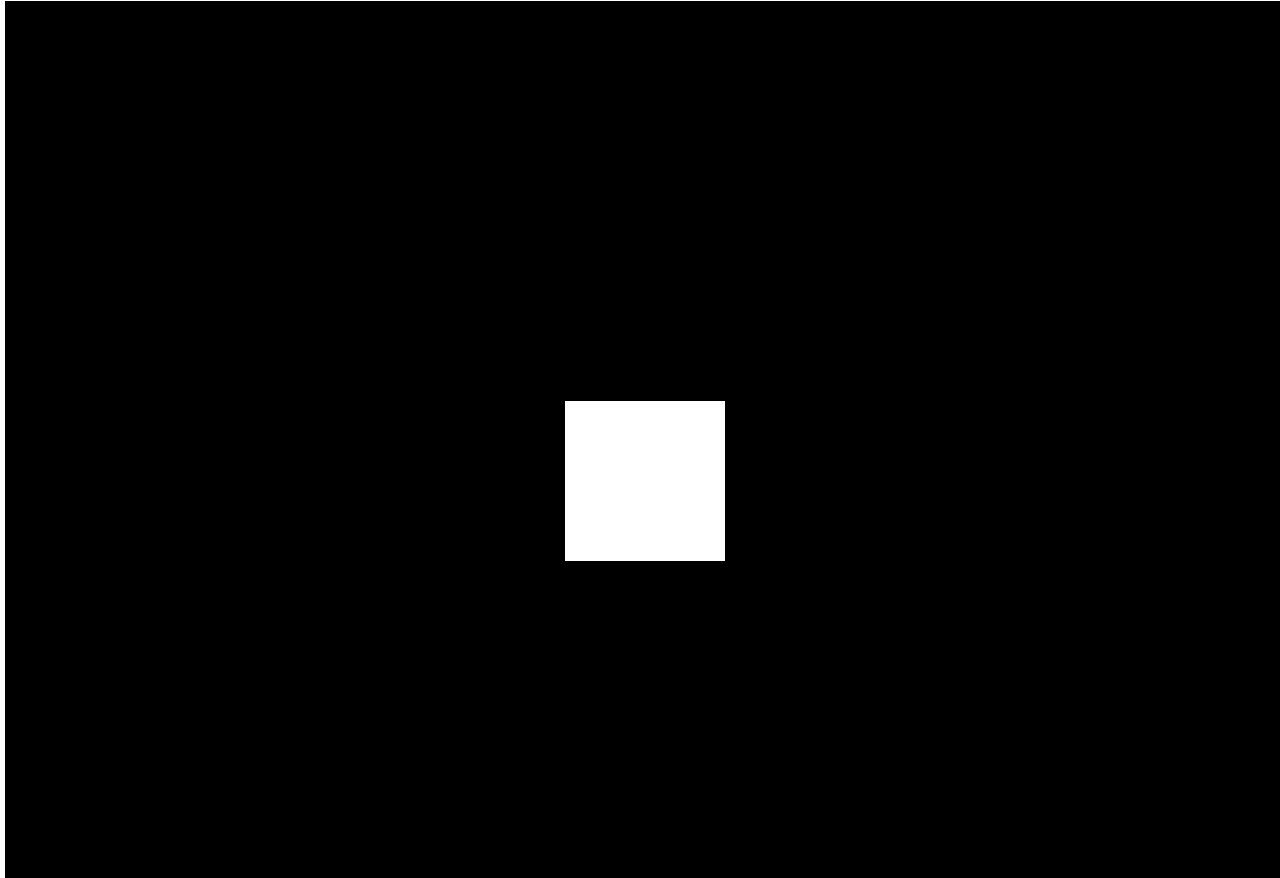
We measure our cameras by throughput and the horizontal / vertical resolution times the frames per second – and when you think about it the Flex camera is six billion pixels per second – that's the speed of it.

fxg: At 1200 ISO.

Jantzen: Yes, and the 6 billion pixels per second is the constant – and you divide different resolutions into that to get your different frame rates.

fxg: It must really open up the possibilities in terms of options for filmmakers.

Jantzen: The cinematographers and directors out there are very creative people, and we try to give them a well-engineered tool and let them do their thing. At Vision Research we can be creative with cameras, but when it comes to filmmaking, that we're not.



00:00

01:02

The Kato fight from Green Hornet, which was partially shot on Phantom Flex (vfx by CIS Hollywood, now Method Studios)

fxg: What about mounts – what are the main preferences in the filmmaking industry?

Jantzen: Overwhelmingly for that industry it's the PL mounts. The PL lenses – the people in the industry have the lenses, have the motor drivers for them, have the focus pulls and matte boxes.

fxg: There are different industries too which shoot at even vastly higher frames. Can you talk about these other specialist areas?

Jantzen: Probably the next highest profile past motion pictures is what we do for live sports broadcast, whether it be soccer, NFL, baseball – every day in almost every sports broadcast you will see slow motion replays and they come to you courtesy of the Phantom camera line. We won an Emmy award for it last year. We do car crashes and bombs and bullets for military applications, packaging machinery, for putting pills in bottles. Anything that's too fast for the eye to see – and there's a lot of it out there – our cameras are used for. They're used on microscopes, airplanes, tripods and in buildings.

fxg: I saw a demo once of stills flashes going off – they wanted to see the rise and fall of the decay. You could see enough frames around a single flash.

Jantzen: The flash bulbs being used today – which is actually pretty old technology going back to the 50s – they take about 30 milliseconds to go through – 30 milliseconds is 30 thousandths of a second. In 30 thousandths of a second, we can give a customer several hundred thousands pictures of that.

fxg: So what's next from the Phantom cameras and what things still need to be solved?

Jantzen: Resolution, how many pixels, speed, frames per second, and sensitivity – do I have enough light to take pictures at that speed. So we have these three things that we constantly bump into and constantly trade off against. Sometimes you'll see us going faster, sometimes higher resolution, sometimes you'll see us going with higher sensitivity. Generally we're pushing those boundaries.



Vision Research's lens mount for Canon EOS

fxg: You mentioned the development of the chips in 2003 and then 2009. Is there a cyclical timeline to the generation of sensors?

Jantzen: It's true that our two offerings for the entertainment and broadcast industries were about five years apart – we developed other sensors between 2003 and 2009 and also since then but for industries other than the filmmaking industries. There's a very strong relationship between the film business and our other markets, and they feed each other. The entertainment industry is concerned with frame speed but also image quality. Our academic customers are less concerned with image quality but more with features and frame rates.

fxg: With the Sci-Tech award, does it seem like a long road to gain acceptance?

Jantzen: Our first foray into the entertainment industry was 2003, and we first got noticed around the 2005-2006 time frame when the HD first came out. But the market has grown. What digital photography has done for our traditional markets – which by the way used to be film – used to be 16mm rotating prism film cameras – what digital has done to broaden our academic markets, the same thing is true in the entertainment market.

The Scientific and Engineering Academy Award recipients from Vision Research were:

– Radu Corlan, Chief Scientist, who was responsible for the sensor specification and design, camera architecture, firmware, CineMag and CineStation mass storage devices.

– Petru Pop, Software Architect, who was responsible for software design and tools to realize the image processing pipeline as well as the CineMag and CineStation mass storage devices.

– Andy Jantzen, Chief Technology Officer, who contributed to the sensor specification, camera and workflow requirements, and system integration.

– Richard Toftness, Vice President, Research and Development, who was responsible for the system product realization, production and engineering support, and product fine tuning.

1 thought on “Phantom camera, Sci-Tech winner”

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EXHIBIT P417

2020: The Year of the Affordable Ultra High-Speed Cameras - Y.M.Cinema

by Yossy Mendelovich

4-5 minutes

In 2020, like in any other year, the efforts to develop affordable ultra-high-speed cameras, have led to the born of two major models: The Kron Technologies Chronos 2.1-HD, and the Freely Wave. Both of them are considered affordable, allow the privilege of ultra-high-speed frame rates, and were designed for consumer use. Also, they share similarities, but on the other hand, are very much different cameras. Check out a high-level comparison below.



Wave: Freely high-speed camera: 420 FPS at 4K. Picture: Freely

The main camera company that specializes in ultra-high frame rate (FPS) imagery is Vision Research with their flagship, the Phantom Flex 4K. This camera is being extensively used in high-end Hollywood productions. Their “low cost” [options](#) are in the range of \$100,000. Yes, this is the price range for purchasing a Phantom, and I know personally filmmakers that bought them for consumer use. It has to be noted that the utilization of those cameras was primarily designed for scientific research mainly for physics and weaponry development. However, filmmakers (which are very smart people :-)) have discovered the vast advantages and epicness of 1000 fps in their movies, which made a lot of camera companies make some R&D efforts to try and provide these capabilities to the masses. Two major companies that did this are Freely and Kron Technologies.



Chronos 2.1-HD

Actually, the Chronos 2.1-HD was **announced** in 2019, but now they are ready for pre-order. Kron is a Canadian high-speed imaging system design and manufacturing company, with a focus on providing a solid, fully-featured product, at an affordable price. Chronos 2.1-HD is a 1080p, 2.1 gigapixel-per-second handheld high-speed camera. It records 1080p video at 1000fps and can record at up to 24,046fps at lower resolutions. Video is saved to removable media in compressed H.264 or uncompressed DNG format.



The **Wave** has been developed by the company which specializes in camera motion, Freefly. “We designed Wave to be the most efficient high-speed camera. It’s small, light, and insanely fast” stated Freefly. The camera allows shooting more than 400 FPS in 4K, with a sensor that is capable of producing pixel data at up to 37.75Gb/s. According to the company, the Wave is selling like hotcakes, and that’s the sign that there is a demand for affordable HFR cameras.



Although there's a decent similarity between those two cameras, these are very different products.

Explore the slide below which compares these cameras based on their highlights and specs. By judging from the image quality (see videos above), the results are on the same level (excluding the fact that the Wave shoots 4K).

M Y.M.Cinema Magazine
Affordable Ultra-High-Speed Cameras



Freefly WAVE

- **Sensor:** Super 35 4K Global shutter
- **Resolution and FPS:** 4K (17:9) in 422fps
- **Max resolution:** 9,259 FPS at 2048x128
- **Recording format:** 10 bit Compressed RGB
- **Capture time:** Only limited by storage size. records direct to internal SSD (1TB or 2TB).
- **Internal battery:** 1.5 hr runtime
- **Lens mount:** Locking E mount
- **Built-in LCD screen:** No
- **Dynamic range:** 10-11 stops
- **Weight:** 716g
- **Structure:** Aluminum chassis
- **Price:** \$10,000



CHRONOS 2.1-HD

- **Sensor:** 19.2 x 10.8mm (4/3" format) Global shutter
- **Resolution and FPS:** 1920x1080 - 1,000fps
- **Max resolution:** 24,046 FPS at 640 x 96
- **Recording format:** H.264 and CinemaDNG
- **Capture time:** 2.7s(8GB), 5.5s(16GB), 11s(32GB)
- **Internal battery:** 1 hour runtime
- **Lens mount:** Nikon F, Canon EF and C mounts available as field-swappable options
- **Built-in LCD screen:** Yes
- **Dynamic range:** 10.3 stops
- **Weight:** 1Kg
- **Structure:** Aluminum chassis
- **Price:** \$5,000

Affordable high speed cameras: The Freefly WAVE vs. CHRONOS 2.1-HD

06/20/2022

As explained, there is a valid need in the market for ultra-high-speed consumer cameras. The passion for shooting 1000 FPS and beyond for storytelling is among us, and thus, more R&D efforts being made by major manufacturers and startup companies are welcomed.

Let's know your insights about those two high-speed affordable cameras. Would you use them in your production? Comment below.

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