

http://qprox.com/downloads/index.php?datasheets=1

Go

JAN FEB APR

24

2001 2002 2003



25 captures

24 Feb 2002 - 9 Sep 2006

About this capture



PRODUCTS | SUPPORT | ABOUT | APPLICATIONS

SEARCH

PRODUCT FINDER

### Downloads

DOWNLOADS

[Datasheets](#) | [User Guides](#) | [Software](#) | [Schematics](#) | [Articles](#) | [Press Coverage](#) | [Miscellaneous Files](#)

ORDER ONLINE

#### DATASHEETS

REQUEST INFO

SEND A LINK

File	Format	Size	Last Updated
<a href="#">QTM1001 DATASHEET</a>	PDF	548 KB	05 Feb 2002
<a href="#">QTM2000 DATASHEET</a>	PDF	203 KB	07 Feb 2002
<a href="#">QT9701B DATASHEET</a>	PDF	566 KB	05 Feb 2002
<a href="#">QT110 DATASHEET</a>	PDF	292 KB	05 Feb 2002
<a href="#">QT113 DATASHEET</a>	PDF	175 KB	05 Feb 2002
<a href="#">QT114 DATASHEET</a>	PDF	309 KB	05 Feb 2002
<a href="#">QT11X DATASHEET</a>	PDF	71 KB	05 Feb 2002
<a href="#">QT118H DATASHEET</a>	PDF	356 KB	05 Feb 2002
<a href="#">E2SR DATASHEET</a>	PDF	792 KB	05 Feb 2002
<a href="#">E6S2 DATASHEET</a>	PDF	308 KB	05 Feb 2002
<a href="#">QT9701B2 DATASHEET</a>	PDF	604 KB	05 Feb 2002
<a href="#">QTM1001AS DATASHEET</a>	PDF	334 KB	05 Feb 2002
<a href="#">QT60645 DATASHEET</a>	PDF	644 KB	11 Feb 2002
<a href="#">QT60320 DATASHEET</a>	PDF	235 KB	05 Feb 2002
<a href="#">QT60040 DATASHEET</a>	PDF	214 KB	05 Feb 2002
<a href="#">QT60161 DATASHEET</a>	PDF	605 KB	12 Feb 2002

[Home](#) / [Support](#) /

[Downloads](#)

[FAQ](#)

[Support Forum](#)

- NEWS** | [ARCHIVE](#)
- [» New QStamp™ Embeddable Sensor Module](#)
  - [» QTouch™ QT3xx Programmable Touch Sensor ICs](#)
  - [» New Datasheet for QT60645 QMatrix™ IC](#)
  - [» New Datasheet for QT60161 QMatrix™ IC](#)
  - [» Giesting & Associates Is New US Representative](#)
  - [» New Datasheet for QT118H QTouch™ IC](#)
  - [» Braemac Is New Distributor for Australia and NZ](#)
  - [» Award-Winning Xerox PARC Application](#)

ENTER YOUR EMAIL ADDRESS HERE TO SUBSCRIBE TO OUR NEWSLETTER

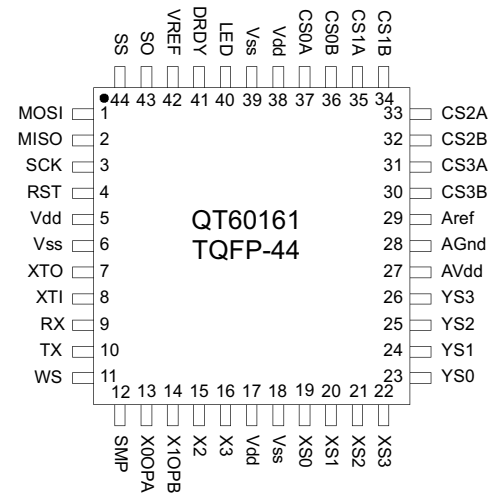
[Australia](#), [Austria](#), [Canada](#), [France](#), [Germany](#), [Ireland](#), [Italy](#), [New Zealand](#), [Switzerland](#), [Taiwan](#), [United Kingdom](#), [United States](#)

Enter offer code here to claim your free sample

Copyright © 2002 QRG Ltd



- Advanced second generation QMatrix controller
- 16 touch keys through any dielectric
- 100% autocal for life - no adjustments required
- SPI Slave or Master/Slave interface to a host controller
- Parallel scan interface for electromechanical compatibility
- Keys individually adjustable for sensitivity, response time, and many other critical parameters
- Sleep mode with wake pin
- Synchronous noise suppression
- Mix and match key sizes & shapes in one panel
- Adjacent key suppression feature
- Panel thicknesses to 5 cm or more
- Low overhead communications protocol
- 44-pin TQFP package



**APPLICATIONS -**

- Security keypanels
- Industrial keyboards
- Appliance controls
- Outdoor keypads
- ATM machines
- Touch-screens
- Automotive panels
- Machine tools

The QT60161 digital charge-transfer (“QT”) QMatrix™ IC is designed to detect human touch on up to 16 keys when used in conjunction with a scanned, passive X-Y matrix. It will project the keys through almost any dielectric, e.g. glass, plastic, stone, ceramic, and even wood, up to thicknesses of 5 cm or more. The touch areas are defined as simple 2-part interdigitated electrodes of conductive material, like copper or screened silver or carbon deposited on the rear of a control panel. Key sizes, shapes and placement are almost entirely arbitrary; sizes and shapes of keys can be mixed within a single panel of keys and can vary by a factor of 20:1 in surface area. The sensitivity of each key can be set individually via simple functions over the SPI or UART port, for example via Quantum’s QmBtn program, or from a host microcontroller. Key setups are stored in an onboard eeprom and do not need to be reloaded with each powerup.

The device is designed specifically for appliances, electronic kiosks, security panels, portable instruments, machine tools, or similar products that are subject to environmental influences or even vandalism. It can permit the construction of 100% sealed, watertight control panels that are immune to humidity, temperature, dirt accumulation, or the physical deterioration of the panel surface from abrasion, chemicals, or abuse. To this end the device contains Quantum-pioneered adaptive auto self-calibration, drift compensation, and digital filtering algorithms that make the sensing function robust and survivable.

The part can scan matrix touch keys over LCD panels or other displays when used with clear ITO electrodes arranged in a matrix. It does not require 'chip on glass' or other exotic fabrication techniques, thus allowing the OEM to source the matrix from multiple vendors. Materials such as such common PCB materials or flex circuits can be used.

External circuitry consists of a resonator and a few capacitors and resistors, all of which can fit into a footprint of less than 6 sq. cm (1 sq. in). Control and data transfer is via either a SPI or UART port; a parallel scan port provides backwards compatibility with scanned electromechanical keys.

The QT60161 makes use of an important new variant of charge-transfer sensing, transverse charge-transfer, in a matrix format that minimizes the number of required scan lines. Unlike some older technologies it does not require one sensing IC per key.

**AVAILABLE OPTIONS**

T <sub>A</sub>	TQFP Part Number
0°C to +70°C	QT60161-S
-40°C to +105°C	QT60161-AS



Copyright © 2001 Quantum Research Group Ltd  
Pat Pend. R1.01/02.02

# Contents

<b>1 Overview</b>	4	<i>y</i> 0x79 - Column Keys Scope	18
1.1 Field Flows	4	<b>5.3 Status Commands</b>	18
1.2 Circuit Overview	4	<i>0</i> 0x30 - Signal for Single Key	18
1.3 Communications	4	1 0x31 - Delta Signal for Single Key	18
<b>2 Signal Processing</b>	5	2 0x32 - Reference Value	18
2.1 Negative Threshold	5	5 0x35 - Detection Integrator Counts	18
2.2 Positive Threshold	5	6 0x36 - Eeprom Checksum	18
2.3 Hysteresis	5	7 0x37 - General Device Status	19
2.4 Drift Compensation	5	<sp> 0x20 - Signal Levels for Group	19
2.5 Negative Recalibration Delay	6	! 0x21 - Delta Signals for Group	19
2.6 Detection Integrator	6	" 0x22 - Reference Levels for Group	19
2.7 Positive Recalibration Delay	6	% 0x25 - Detect Integrator Counts for Group	19
2.8 Signal and Reference Guardbanding	6	<i>e</i> 0x65 - Error Code for Selected Key	19
2.9 Adjacent Key Suppression	7	<i>E</i> 0x45 - Error Codes for Group	20
2.10 Full Recalibration	7	<i>k</i> 0x6B - Reporting of First Touched Key	20
2.11 Device Status & Reporting	7	<b>5.4 Setup Commands</b>	21
<b>3 Circuit Operation</b>	7	^A 0x01 - Negative Detect Threshold	21
3.1 Matrix Scan Sequence	7	^B 0x02 - Positive Detect Threshold	21
3.2 Signal Path	8	^C 0x03 - Negative Threshold Hysteresis	21
3.3 'X' Electrode Drives	8	^D 0x04 - Positive Threshold Hysteresis	21
3.3.1 RFI From X Lines	8	^F 0x06 - Burst Length	21
3.3.2 Noise Coupling Into X Lines	8	^G 0x07 - Burst Spacing	22
3.4 'Y' Gate Drives	8	^H 0x08 - Negative Drift Compensation Rate 5	22
3.4.1 RFI From Y Lines	8	^I 0x09 - Positive Drift Compensation Rate	22
3.4.2 Noise Coupling Into Y Lines	8	^J 0x0A - Negative Detect Integrator Limit	22
3.5 Burst Length & Sensitivity	8	^K 0x0B - Positive Recalibration Delay	23
3.6 Burst Acquisition Duration	9	^L 0x0C - Negative Recalibration Delay	23
3.7 Intra-Burst Spacing	9	^M 0x0D - Intra-Burst Pulse Spacing	23
3.8 Burst Spacing	9	^N 0x0E - Positive Reference Error Band	23
3.9 Sample Capacitors	9	^O 0x0F - Negative Reference Error Band	23
3.10 Water Film Suppression	9	^P 0x10 - Adjacent Key Suppression	24
3.11 Reset Input	9	<b>5.5 Supervisory / System Functions</b>	24
3.12 Oscillator	9	<i>6</i> 0x36 - Eeprom Checksum	24
3.13 Startup / Calibration Times	9	<i>L</i> 0x4C - Lock Reference Levels	24
3.14 Sleep_Wake / Noise Sync Pin (WS)	10	<i>b</i> 0x62 - Recalibrate Keys	24
3.15 LED / Alert Output	11	<i>l</i> 0x6C - Return Last Command Character	25
3.16 Oscilloscope Sync	11	<i>r</i> 0x72 - Reset Device	25
3.17 Power Supply & PCB Layout	11	<i>V</i> 0x56 - Return Part Version	25
3.18 ESD / Noise Considerations	11	<i>W</i> 0x57 - Return Part Signature	25
<b>4 Communications Interfaces</b>	12	<i>Z</i> 0x5A - Enter Sleep	25
4.1 Serial Protocol Overview	12	^Q 0x11 - Data Rate Selection	25
4.2 SPI Port Specifications	12	^R 0x12 - Oscilloscope Sync	26
4.3 SPI Slave-Only Mode	12	^W 0x17 - Noise Sync	26
4.4 SPI Master-Slave Mode	13	<b>5.6 Function Summary Table</b>	27
4.5 UART Interface	15	<b>5.7 Timing Limitations</b>	30
4.6 Sensor Echo and Data Response	15	<b>6 Electrical Specifications</b>	31
4.7 Parallel Scan Port	15	6.1 Absolute Maximum Specifications	31
4.8 Eeprom Corruption	16	6.2 Recommended operating conditions	31
<b>5 Commands &amp; Functions</b>	17	6.3 DC Specifications	31
5.1 Direction Commands	17	6.4 Protocol Timing	31
<i>g</i> 0x67 - Get Command	17	6.5 Maximum Drdy Response Delays	32
<i>p</i> 0x70 - Put Command	17	<b>7 Mechanical</b>	33
5.2 Scope Commands	18	7.1 Dimensions	33
<i>s</i> 0x73 - Specific Key Scope	18	7.2 Marking	33
<i>S</i> 0x53 - All Keys Scope	18	<b>8 Index</b>	34
<i>x</i> 0x78 - Row Keys Scope	18		

**Table 1.1 Device Pin List**

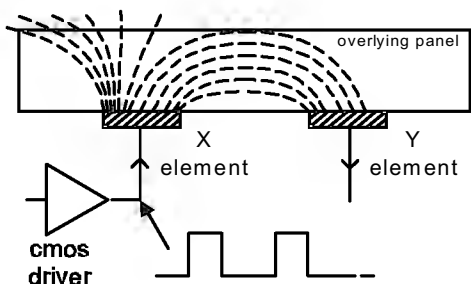
Pin	Name	Type	Description
1	MOSI	I/O PP	Master-Out / Slave In SPI line. In Master/Slave SPI mode is used for both communication directions. In Slave SPI mode is the data input (in only).
2	MISO	I/O PP	Master-In / Slave Out SPI line. Not used in Master/Slave SPI mode. In Slave mode outputs data to host (out only).
3	SCK	I/O PP	SPI Clock. In Master mode is an output; in Slave mode is an input
4	RST	I	Reset input, active low reset
5	Vdd	Pwr	+5V supply
6	Vss	Pwr	Ground
7	XTO	O PP	Oscillator drive output. Connect to resonator or crystal.ply
8	XTI	I	Oscillator drive input. Connect to resonator or crystal, or external clock source.
9	RX	I	UART receive input
10	TX	O PP	UART transmit output
11	WS	I	Wake from Sleep / Sync to noise source
12	SMP	O PP	Sample output control
13	X0OPA	I/O PP	X0 Drive matrix scan / Communications option A input
14	X1OPB	I/O PP	X1 Drive matrix scan / Communications option B input
15	X2	O PP	X2 Drive matrix scan
16	X3	O PP	X3 Drive matrix scan
17	Vdd	Pwr	+5V supply
18	Vss	Pwr	Ground
19	XS0	I	XS0 Scan input line
20	XS1	I	XS1 Scan input line
21	XS2	I	XS2 Scan input line
22	XS3	I	XS3 Scan input line
23	YS0	O PP	YS0 Scan output line
24	YS1	O PP	YS1 Scan output line
25	YS2	O PP	YS2 Scan output line
26	YS3	O PP	YS3 Scan output line
27	AVdd	Pwr	+5 supply for analog sections
28	AGnd	Pwr	Analog ground
29	Aref	Pwr	+5 supply for analog sections
30	CS3B	I/O PP	Cs3 control B
31	CS3A	I/O PP	Cs3 control A
32	CS2B	I/O PP	Cs2 control B
33	CS2A	I/O PP	Cs2 control A
34	CS1B	I/O PP	Cs1 control B
35	CS1A	I/O PP	Cs1 control A
36	CS0B	I/O PP	Cs0 control B
37	CS0A	I/O PP	Cs0 control A
38	Vdd	Pwr	+5 supply
39	Vss	Pwr	Ground
40	LED	O PP	Active low LED status drive / Activity indicator
41	DRDY	O OD	Data ready output for Slave SPI mode; active low
42	Vref	I	Vref input for conversion reference
43	SO	O PP	Oscilloscope sync output
44	SS	I/O OD	Slave select for SPI direction control; active low

I/O: I = Input  
O = Output  
Pwr = Power pin  
I/O = Bidirectional line  
PP = Push Pull output drive  
OD = Open drain output drive

# 1 Overview

QMatrix devices are digital burst mode charge-transfer (QT) sensors designed specifically for matrix geometry touch controls; they include all signal processing functions necessary to provide stable sensing under a wide variety of changing conditions. Only a few low cost external parts are required for operation. The entire circuit can be built in under 6 square centimeters of PCB area.

Figure 1-1 Field flow between X and Y elements



The device has a wide dynamic range that allows for a wide variety of key sizes and shapes to be mixed together in a single touch panel. These features permit new types of keypad features such as touch-sliders, back-illuminated keys, and complex warped panels.

The devices use an SPI interface running at up to 3MHz rates to allow key data to be extracted and to permit individual key parameter setup, or, a UART port which can run at rates to 57.6 Kbaud. The serial interface protocol uses simple commands; the command structure is designed to minimize the amount of data traffic while maximizing the amount of information conveyed.

In addition to normal operating and setup functions the device can also report back actual signal strengths and error codes over the serial interfaces.

QmBtn software for the PC can be used to program the IC as well as read back key status and signal levels in real time.

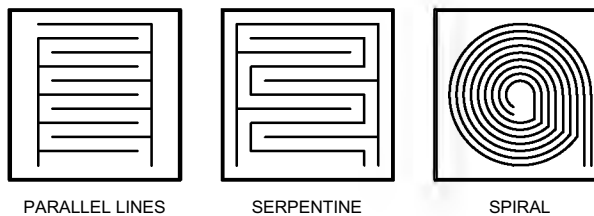
A parallel scan port is also provided that can be used to directly replace membrane type keypads.

QMatrix technology employs transverse charge-transfer ('QT') sensing, a new technology that senses the changes in an electrical charge forced across an electrode set.

## 1.1 Field Flows

Figure 1-1 shows how charge is transferred across an electrode set to permeate the overlying panel material; this charge flow exhibits a high  $dQ/dt$  during the edge transitions of the X drive pulse. The

Figure 1-4 Sample Electrode Geometries



charge driven by the X electrode is partly received onto the corresponding Y electrode which is then processed. The part uses 4 'X' edge-driven rows and 4 'Y' sense columns to sense up to 16 keys.

The charge flows are absorbed by the touch of a human finger (Figure 1-1) resulting in a decrease in coupling from X to Y. Thus, received signals decrease or go negative with respect to the reference level during a touch.

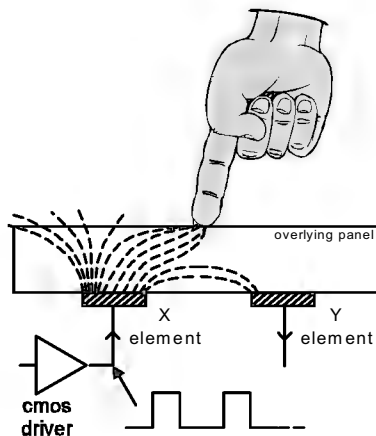
As shown in Figure 1-3, water films cause the coupled fields to increase slightly, making them easy to distinguish from touch.

## 1.2 Circuit Overview

A basic circuit diagram is shown in Figure 1-5. The 'X' drives are sequentially pulsed in groupings of bursts. At the intersection of each 'X' and 'Y' line in the matrix itself, where a key is desired, should be an interdigitated electrode set similar to those shown in Figure 1-4. Consult Quantum for assistance on key design.

The device uses fixed external capacitors to acquire charge from the matrix during a burst of charge-transfer cycles; the burst length can be varied to permit digitally variable key signal gains. The charge is converted to digital using a single-slope conversion process.

Figure 1-2 Field Flows When Touched



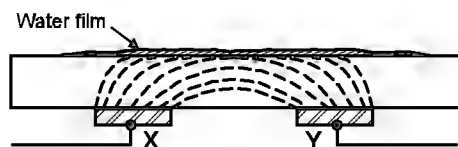
Burst mode operation permits the use of a passive matrix, reduces RF emissions, and provides excellent response times.

Refer to Section 3 for more details on circuit operation.

## 1.3 Communications

The device uses two variants of SPI communications, Slave-only and Master-Slave, a UART interface, plus a parallel scan interface. Over the serial interfaces are used a command and data transfer structure designed for high levels of flexibility using minimal numbers of bytes. For more information see Sections 4 and 5.

Figure 1-3 Fields With a Conductive Film



The parallel scan port permits the replacement of electromechanical keypads that would be scanned by a microcontroller; the scan interface mimics an electromechanical keyboard's response.

# Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

## Real-Time Litigation Alerts



Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

## Advanced Docket Research



With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

## Analytics At Your Fingertips



Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

## API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

## LAW FIRMS

Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

## FINANCIAL INSTITUTIONS

Litigation and bankruptcy checks for companies and debtors.

## E-DISCOVERY AND LEGAL VENDORS

Sync your system to PACER to automate legal marketing.