



How Fax Machines Work

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BY MARSHALL BRAIN TECH | FAX MACHINES

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Modern Fax Machines

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Panasonic KX-FB421 Fax/Copier machine
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A modern fax machine does not have the rotating drums and is a lot faster, but it uses the same basic mechanics to get the job done:



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- At the sending end, there is some sort of sensor to read the paper. Usually, a modern fax machine also has a paper-feed mechanism so that it is easy to send multi-page faxes.
- There is some standard way to encode the white and black spots that the fax machine sees on the paper so that they can travel through a phone line.
- At the receiving end, there is a mechanism that marks the paper with black dots.

A typical fax machine that you find in an office is officially known as a CCITT (ITU-T) Group 3 Facsimile machine. The Group 3 designation tells you four things about the fax machine:

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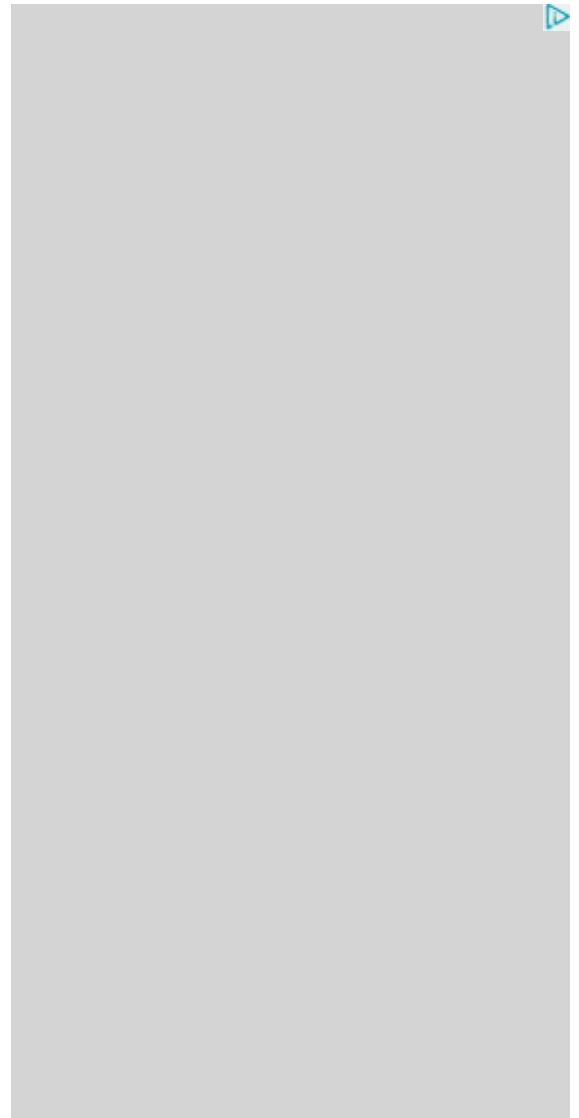
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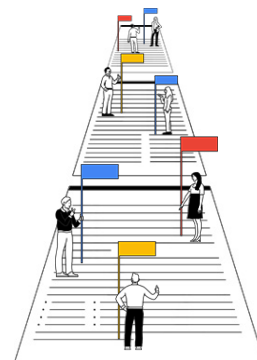
The scanning process: The scanner in a fax machine looks at one line of the sheet of paper. The scan line is shown here in red. It sees a group of black and white spots, shown blown up in the red rectangle at the bottom of the figure. It encodes the pattern of spots and sends them through the phone line.

- It will be able to communicate with any other Group 3 machine.
- It has a horizontal resolution of 203 pixels per inch (8 pixels/mm).
- It has three different vertical resolutions: Standard: 98 lines per inch (3.85 lines/mm) Fine: 196 lines per inch (7.7 lines/mm) Super fine (not officially a Group 3 standard, but fairly common): 391 lines per inch (15.4 lines/mm)
- It can transmit at a maximum data rate of 14,400 bits per second (bps), and will usually fall back to 12,000 bps, 9,600 bps, 7,200 bps, 4,800 bps or 2,400 bps if there is a lot of noise on the

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line.

The fax machine typically has a [CCD](#) or photo-diode sensing array. It contains 1,728 sensors (203 pixels per inch), so it can scan an entire line of the document at one time. The paper is lit by a small [fluorescent tube](#) so that the sensor has a clear view.

The image sensor looks for black or white. Therefore, a single line of the document can be represented in 1,728 [bits](#). In standard mode, there are 1,145 lines to the document. The total document size is:

1,728 pixels per line * 1,145 lines = approximately 2,000,000 bits of information

To reduce the number of bits that have to be transmitted, Group 3 fax machines use three different compression techniques:

- Modified Huffman (MH)
- Modified Read (MR)
- Modified Modified Read (MMR)

See [Electronics Plus: Facsimile Theory](#) for a discussion of these compression types. The basic idea in these schemes is to look for "runs" of same-color bits. For example, if a line on the page is all white, the [modem](#) can transmit a dozen

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