Don Lancaster's
Tech Musings

February, 2000

Let the megapixel wars begin. Digital cameras are getting quite good, and soon should blast their way right on past traditional film photography. But I'm wondering if an obvious product is not being missed out on big time.

One we might call a *scamera*.

We have seen in previous columns and in IMAGIMAG.PDF how a better grade scanner can take digital photos up to 170 megapixel and even higher resolutions. Observe that 1200 DPI x 1200 DPI x 8.5 inches x 14 inches = 171.36 megapixels. All done by using only 10,200 actual light sensor cells! Why? Because a scanner needs only a *line* array of *n* cells, while a digital camera needs an *n* x *m array*.

The only tiny problems with my scanner techniques are the "straight on" format, the limited depth of field, subject restrictions, and that dropoff of sharpness, brightness, and contrast with glass distance. But, given any suitable subject, your results totally blow digital cams away. Especially on product lettering.

See *www.tinaja.com/barg01.html* for dozens of examples.

What I am wondering is why we can't have the best of both worlds.

Put a lightweight line sensor and a tiltable mirror on the back of a larger camera. Presto. Low cost megapixels which have few subject limitations. At least for subjects that are willing to sit still for a second or so.

With a cheaper light sensor, there is no reason why a scamera should not cost a lot *less* than conventional consumer digital cams. While giving ridiculously better results.

Another thing many cams miss out on: They seem to blindly insist upon immediately JPEG compressing (and thus trashing up) your images. JPEG seems especially adept at making any small lettering illegibly ugly. It also seems to want to create blotches. A raw bitmap output option should be provided for those who'll demand the best quality. Even if you could only store one pix at a time. JPEG or other compression is best done only *after*

you have gotten your image precisely the way you want it.

Hanging a new scanner on a litho camera's ground glass might lead to some interesting possibilities. If the lighting levels and depth of field can be worked out.

Be sure to watch out for JPEG-2000 which *includes* wavelets and should dramatically ease artifacts. This new scheme promises better images and denser compression. Brought about in part by exploiting unviewable color differences that were ignored in the original JPEG spec. From 3X to 5X denser compression is expected.

Let's have your thoughts on routes to effective digital photography.

Some More Digimatic Info

We started to look at machine tool to PC computer interfaces on back in MUSE142.PDF Apparently the crucial spec for the most popular interface is found in a *Manual Number 4330* from

Mitutoyo. And titled as the *Digimatic Code Output I/F Specifications*.

This code sends measurement info from a micrometer or height gauge or caliper or whatever to a host display, CAM *computer aided manufacturing*, for SPC *statistical process control*, or other interface needs.

The pinouts of the 2x5 header-style rectangular 0.1 inch connector are shown in figure one. This connector is directly compatible with a stock ten conductor flat cable.

Only the first five pins are used in the basic interface. Inputs sent *to* the measuring instrument are all CMOS compatible and are forced normally high by a 20K resistor. There's also a second series 20K resistor and a 100 picofarad capacitor which acts as an input noise filter. The high frequency input impedance is thus around 10K or so. Outputs *from* your instrument are open-collector NPN transistors or open-source N-channel FET's.

connector is viewed from male pins

The gauge outputs an active low **READY** several times a second when measurement is available.

If data is wanted, the host outputs an active low **REQUEST** following the Gauge ready signal.

When requested, 52 bits of **DATA** are provided by the gauge. Format is thirteen bytes of four bits each.

A **CLOCK** is provided by the gauge to indicate data valid times. Data is valid on the rising clock edge.
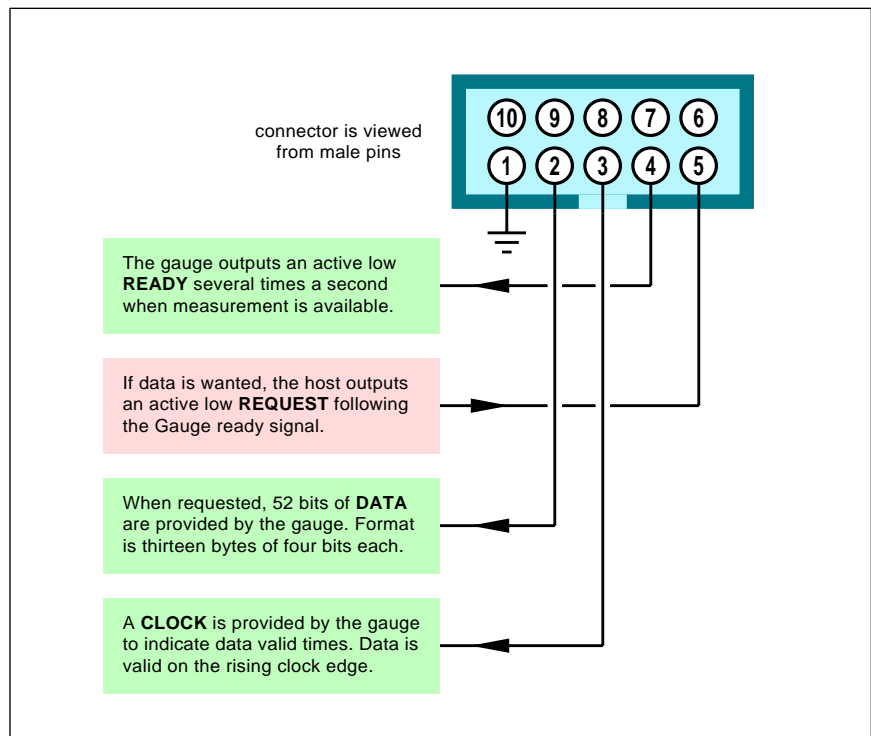
Fig. 1 – CONNECTOR PINOUTS and handshaking sequence for the Mitutoyo Digimatic machine tool gauge interface. A standard 2x5 pin header can be used with ten conductor flat cable.
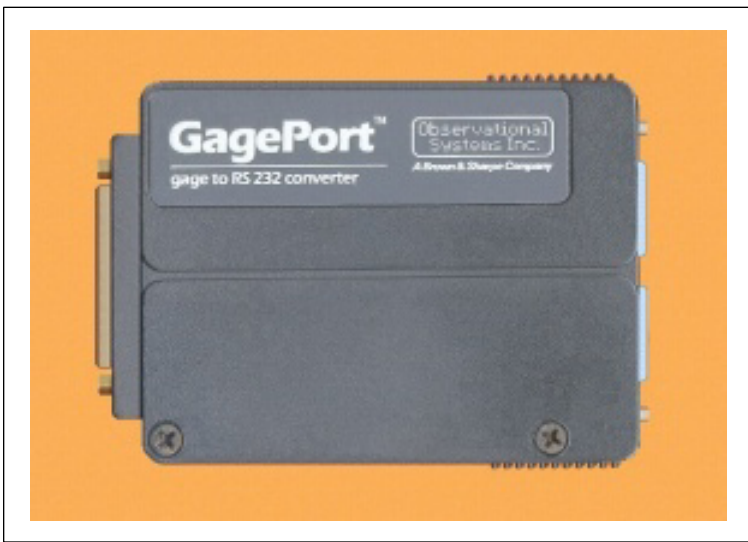
Fig. 2 – A TYPICAL OLDER Digimatic to computer interface.

Note that signals at the connector are *active low*.

Your handshaking works like this: Several times each second, the gauge sends out a low *ready* signal. If the computer host wishes to see data, it can respond at any time within eighty milliseconds by pulling the *request* line low. Your gauge then answers by outputting a 52 bit data sequence.

Each clock pulse stays a minimum of 100 microseconds high and then has to remain 100 microseconds low.

For a 5 kHz max clock rate.

While the data is valid during the entire clock low time, it should get entered into an interface on the *rising edge* of the clock. Clocking continues until all 52 data bits are output.

Figure two shows us a traditional commercial interface. Pairs of gauge instrument cables are combined and converted to a RS232C serial comm. Timesharing games can be played to multiplex eight or more instruments on one RS232 port. I sometimes have a few surplus interfaces available at *www.tinaja.com/barg01.html*

It seems reasonable to expect any newer interfaces to go the USB route instead of RS232.

You will find their Digimatic data format shown in figure three. Data is grouped into thirteen sequential bytes of four 0-F hex bits each. All the data bits in each byte will arrive LSB first. Because of the seperate clocking line, there are no start, stop, formatting, or framing bits in use.

The first byte tells you which type of data you are about to receive. The choices include data *to* the gauge, the data number (if an instrument can output multiple values), max, min, x-bar, sigma, max hold, min hold, or normal data. Most often, this byte will be all ones or hex "F" for *normal* data output.

Bytes two through four are used as 0-999 data entry numbers. These are binary coded decimal BCD with the *most* significant bit MSB as byte two. A plain old micrometer might output only one data entry number, while a fancier system can apparently deliver many different measurements on its sequential bit streams.

Byte five is their *sign* bit with its MSB low meaning *positive* and a high ending up *negative*.

Bytes six through eleven should be the BCD numeric data with byte six being the *most* significant digit MSD.

Byte twelve sets the decimal point for you with zero an integer and five giving you five digits to the right of the decimal point. Thus, the interface can deliver six decade accuracy over the plus or minus 9.99999 to 99999 range interval.

Byte thirteen tells you the units in use, with zero being millimeters and one being inches. Other options here are metric or inch go or no-go, high or low. Or "none of the above".

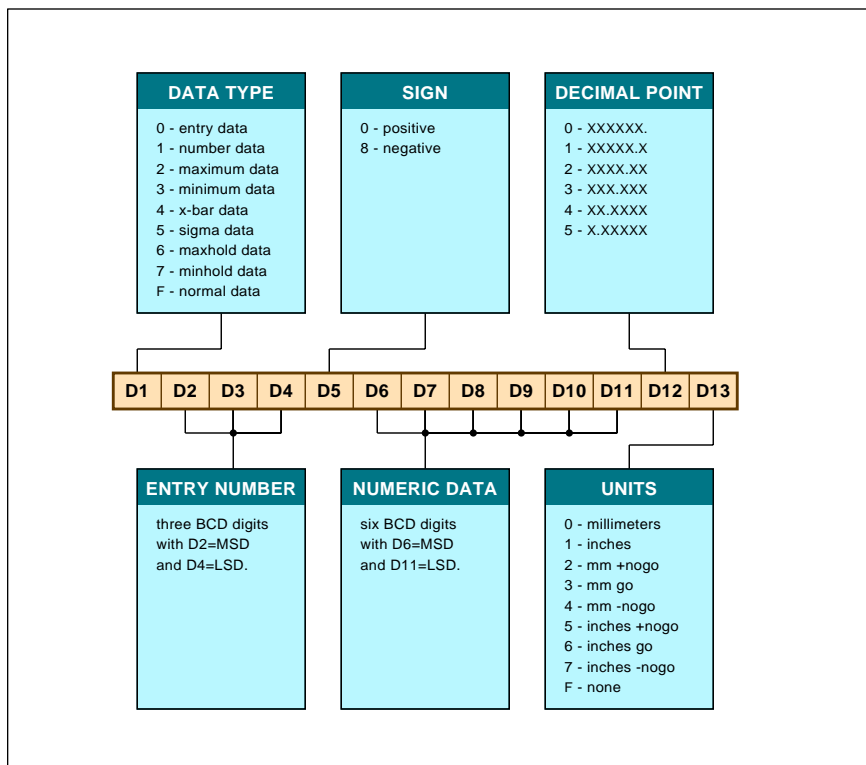Be sure to have the actual spec on hand when developing any serious applications.

A PIC Digimatic Interface

The PIC seems an obvious choice

Fig. 3 – DIGIMATIC DATA FORMAT. Thirteen bytes of four bits each are used to pass one measurement from gauge to host.

to build your own low cost Digimatic interface. A single channel PIC-based Digimatic to RS232 interface that was submitted by *Carl Huben Consulting* is shown in figure five.

The complete sourcecode is found at *www.tinaja.com/picup01.html* as file DIGI232.ASM.

The "A" side of the PIC interfaces with your host computer's serial port, accepting simple control commands and returning your choice of the raw BCD or formatted data. The "B" side of the PIC does the needed Digimatic handshaking and uses the incoming clock and data signals to extract the needed info.

A *Visual Basic or similar program could interact with your interface. The* ASCII serial commands include F for data *format*, M for *mode*, R for your *return* data, and P to set your *periodic* data interval.

Some PIC Books

Speaking of PIC's, I have updated our recommended PIC books listing. This appears as our resource sidebar for this month. Also included are a few *Parallax* Basic Stamp titles and two new books on the alternate *Atmel* AVR microcontroller. Further details on all of these titles can be gotten at *www.tinaja.com/amlink01.html*

I've also done a major update and overhaul of our PIC links page found at *www.tinaja.com/pic500.html*

Four Point Curve Fitting

One better way to create smooth curves for animation, typography, or machine tool paths involves strange math beasties called *cubic splines*. A *Bezier Curve* is one version of cubic spline that is very popular.

We saw a tutorial on these back in HACK62.PDF And more of the gory insider Bezier Curve secrets than you could possibly ever want to know is at *www.tinaja.com/cubic01.html*

The PostScript computer language is especially adept when creating and using cubic splines. Figure four has example code that lets you fit a cubic spline to four on-the-curve points.

As usual, you bring the code up in an editor, change your data values, and then send it to Acrobat *Distiller* or GhostScript.

More PostScript-as-language info in *www.tinaja.com/post01.html* and
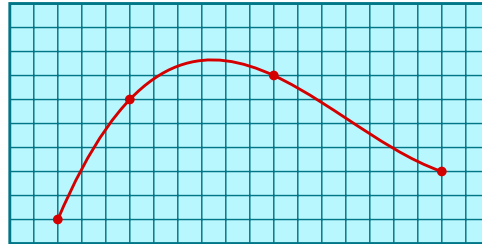

```
%!
% BEZIER CURVE THROUGH FOUR POINTS
% =================================

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% Consulting services available per http://www.tinaja.com/info01.html

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% This utility demo shows how to use PostScript to draw a smooth Bezier
% curve through four points. It is based on the Jim Fitzsimmons tutorial
% and derivation in BEZ4PTS.PDF

% /bez4pts is a modified Jim Fitzsimmons utility. This version draws
% a straight line from the currentpoint, then appends a Bezier curve
% through the next four points, presented as an eight element matrix.

% Data format is [ix0 iy0 ix1 iy1 ix2 iy2 ix3 iy3 ] bez4pts

/bez4pts {aload pop                          % unpack array

    /y3 exch store /x3 exch store            % stash data. Strange
    /y5 exch store /x5 exch store            % numbering is in use
    /y4 exch store /x4 exch store
    /y0 exch store /x0 exch store

/x1 x0 dup add x3 add 3 div def              % solve for x1
/x2 x3 dup add x0 add 3 div def              % solve for x2
/u4 x4 dup add x0 sub x3 sub x3 x0 sub div def   % solve for u4
/u5 x5 dup add x0 sub x3 sub x3 x0 sub div def   % solve for u5
/u0 -1 def /u3 1 def                         % define u0 and u3

/y04 y0 y4 sub u0 u4 sub div def             % define y04
/y45 y4 y5 sub u4 u5 sub div def             % define y45
/y53 y5 y3 sub u5 u3 sub div def             % define y53

/y05 y04 y45 sub u0 u5 sub div def           % define y05
/y43 y45 y53 sub u4 u3 sub div def           % define y43

/b3 y43 y05 sub 2 div def                    % solve for b3
/b2 y05 u4 u5 add 1 sub b3 mul sub def       % solve for b2

% Solve for y1.
/y1 y0 dup add y3 add b2 b3 sub dup add dup add sub 3 div def
% Solve for y2.
/y2 y3 dup add y0 add b2 b3 add dup add dup add sub 3 div def

x0 y0 lineto x1 y1 x2 y2 x3 y3 curveto       % draw the cubic
} def

%%  100 300 moveto                           % demo - comment before use
%%  [100 100 200 120 300 190 400 300]
%%  bez4pts 0.1 setlinewidth stroke showpage
```

Fig. 4 – POSTSCRIPT CODE to draw a Bezier cubic spline curve through four slected data points.

www.tinaja.com/acrob01.html

The Jim Fitzsimmons math behind the four point Bezier fitting can be picked up in BEZ4PTS.PDF

More on PostScript fundamentals are in the Adobe red and blue books.

You can find lots more about these at *www.tinaja.com/amlink01.html*

Two useful newsgroups are…

comp.lang.postscript
comp.text.pdf

PIC AND BASIC STAMP BOOKS

Design With PIC Microcontrollers (John Peatman)
Easy PIC'n, A Beginners guide to the PIC (Dave Benson)
Intermediate Guide to Using PIC Microcontrollers (Dave Benson)
Microcontroller Beginner's Handbook (Lawrence Duarte)
PIC Microcontroller Applications (Harvey Weinberg)
PIC Microcontroller Handbook (Harvey Weinberg)
PIC Microcontroller Serial Communications   (Roger Stevens)
PIC'n up the Pace PIC 16/17 Applications (Dave Benson)
PIC: Your Personal Introductory Course (John Morton)
Programming & Customizing the PIC Micro (M. Predko)

Basic Stamp (Claus Kuhnel and Klaus Zahnert)
Basic Stamp II - Tutorial and Applications (Peter Anderson)
Programming &Customizing the Basic Stamp (Scott Edwards)

AVR RISC Microcontroller Handbook (Claus Kuhnel)
Programming & Customizing the Avr Microcontroller (D. Gadre)

For more book details, see *www.tinaja.com/amlink01.html*

This code always creates the finest cubic spline it can *exactly* through your four points. If the points happen to get wrongly chosen, though, you might get some unexpected behavior between them. One cubic spline can be used for a straight line, a smooth curve, or shapes with one inflection point, cusp, or loop.

More splines could get connected together for fancier results. Further consulting services are available per *www.tinaja.com/info01.html*

New Tech Lit

Carbon nanotubes are starting to show promise as a dense and highly cost effective way to store hydrogen. Catch the latest advance in *Hydrogen Storage in Single Walled Carbon Nanotubes at Room Temperature* by C. Liu and others in *Science* for Nov 5, 1999, pages 1127-1129.

Five percent storage by weight is reported. Reprints are available for $5 from *www.sciencemag.org* More on hydrogen in general can be found at my *www.tinaja.com/h2gas01.html* or at *sci.energy.hydrogen*

As I strongly suspected on back in MUSE143.PDF, there was a secret and utterly inexcusable defect in existing recordable CD-R technology. A flaw which makes it trivially easy to trash disks. This is called the *BURN* buffer underrun problem. And I sure have been burned by it.

The problem and its solution are detailed in *E.E. Times* for Nov 22, 1999 on page 41. Basically, when an open buffer underflows because of another program's activity, your disk trashes. A still-open disk might also trash during routine reboots if it gets interrogated by anti-virus code. New *Sanyo* chips which may resolve this issue should be shortly available.

The real secret insider stuff on old Tektronix oscilloscopes is newly up at *www.reprise.com* Hosted by Bill Den Beste and Stan Griffiths, the site supplies Tek vacuum tube, transistor and CRT cross references, probe data, a repair forum, and even classic Tek cartoons. Stan wrote *Oscilloscopes: Restoring a Classic*. More details at *www.tinaja.com/amlink01.html*

I have got a very rare 6R1A Nixie tube digital data plugin and other Tek collectibles available. You can email

NEED HELP?

Phone or email all your US Tech Musings questions to:

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me via *don@tinaja.com* for details.

From *Setra*, a freebie *Capacitance Pressure Transducer Handbook*. For other sources of similar info, check out the *Sensors* and the *Measurement and Control* trade journals. Bargain prices of capacitive accelerometers, mass flowmeters, and lots of similar laboratory goodies are picked up at *www.tinaja.com/bargsn01.html*

A new access site for technical or scientific papers and abstracts can be found at *pubsci.osti.gov*

The Nudist on the Late Shift is one highly readable collection of Silicon Valley stories and anecdotes. A book that appears to give a true flavor of what is actually coming down in this greed-driven and idealist-exploiting fantasy microcosm.

The author is Po Bronson.

Here at my *Synergetics*, we don't often draw all that fine a distinction between our casual dress days and the clothing optional ones. I can not imagine anyone working very long or very hard for any employer that does.

You will find more book details at *www.tinaja.com/amlink01.html*

A directory of local building codes is found at *www.buildingteam.com* Along with the names and numbers of those who enforce them.

Custom solutions to unique mobile autonomous robotics projects can be found up at *www.zagrosrobotics.com* They also have great buys on unusual robotic sensor components. One mag here is *Robot Science & Technology*.

A free "gee-whiz" demo on their *Rheonetic Magnetic Fluids* is offered by *Lord*. Magnetic fluids behave like a medium viscosity grease when they are unmagnetized but freeze up in the presence of a strong magnetic field. Obvious uses include speaker airgap eliminators or robotic clutches.

This unique demo consists of two back-to-back plastic syringes. Thumb pressure easily moves their fluid until it gets locked up by a nearby magnet. This demo is also a "magic trick" and an instant Science Fair project.

For all the fundamentals of Active Filters, check into my *Active Filter Cookbook*. In my nearby *Synergetics* ad or on my website. This is by far the best selling book on active filters of all time. And to get instant custom research solutions, please be sure to visit *www.tinaja.com/info01.html*

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www.mrfluid.com

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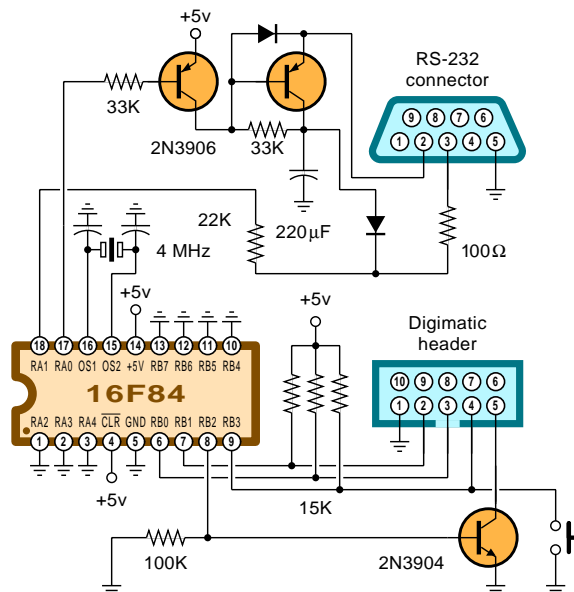
Fig. 5 – A PIC BASED Digimatic interface.

Our latest website additions up at *www.tinaja.com* include new sensor and lab equipment pages, along with three newly uploaded archives of the full *Hardware Hacker* column series. At *www.tinaja.com/hack01.html* Be sure to check our live *eBay* auctions by clicking on my AUCTION button.

Visit *www.tinaja.com/advt01.html* if you want to join the other industry leaders who are superb *Guru's Lair* sponsors. You click on the homepage STATS button for the latest info.

As usual, most of our referenced items are in the *Names & Numbers* or *PIC Books* sidebars. These have all been hotlinked in the online version of this column MUSE145.PDF found up at *www.tinaja.com/muse01.html*. Always be sure to check these links before calling our no-charge US tech helpline you will find in the nearby assistance box.

Let's hear from you. ❖

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