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http://www.nutsvolts.com/toc_Pages/jul04toc.htm

Selecting an inexpensive logic analyzer

"You can tell the difference between a professional and an amateur by the tools they use", or so the saying goes. But even pros have a limited budget. So we only buy tools as we need them. Sometimes you only need a tool for a short period of time or just for one project. So, when you need a specialty tool, do you rent, borrow, or buy? If you need a full set of features it might be cheaper to lease the equipment. Alternatively, you might want to buy an inexpensive device if it satisfies your immediate requirements.

The Problem

I'm more of a software person, but I work on embedded systems, so I do get to work with hardware. I am working on a project that required the use of a logic analyzer. I've never used a logic analyzer before, so I had to do a bit of research to understand what I would need before making the lease versus buy decision. I'll first briefly introduce the project so you know the scope of the requirements. Then, I'll consider leasing as an option. Finally, I'll give a brief overview of the products that I considered, and ultimately, the product that was purchased.

The Project

The project involves the conversion of 3-phase power, with variable voltage and frequency, to 60 Hz 3-phase power, (the grid). A piece of the hardware involves all digital signals for input and output. I won't go into the details of the project, but the hardware consists of eight switches, six phase polarity detector circuits, and a current zero crossing detector circuit for a total of fifteen, 0-5 volt logic signals. Since I am developing the switching algorithm, I need to examine and record all these signals to determine if the device is performing properly.

The Requirements

Before looking for a logic analyzer, I need to determine my data acquisition requirements. From the fifteen logic signals, eight switches and the current zero crossing signal never change faster that 50kHz. Also, the six phase signals change much more slowly; less than 200 Hz. I want to monitor these signals while the amplitude and phase of the input power changes. Thus, I need to be able to look at an entire switching sequence for several seconds. Assuming a sample rate of 50kHz for all 15 signals for 4sec, my worse case data buffer calculation is:

$$50{,}000*15*4.0 = 3{,}000{,}000 \text{ samples}$$

I'm currently working with a fixed input amplitude and frequency, so my immediate needs are only for one full 60Hz cycle, or about 16.7 milliseconds worth of data:

$$50{,}000*15*0.167 = 12525 \text{ samples}$$

The above estimates assume that all the signals are sampled at the same rate, which might not be the case, but the estimates define a lower and upper bounds for the data buffer size. So my minimum requirements are a buffer size of at least 12525 samples and a sampling rate of at least 50kHz. Additionally, I want to be able to get digital copies of the images from the logic analyzer so I can include them in reports. I needed any software to run on both Windows 2000 and XP Pro. My bench is already covered with equipment, so a small footprint is preferred. Oh, and I'm not working on this project by myself, so it would be great if I could save the recorded data and email it to someone else so that they could look at the entire recorded stream without being limited to just screen shots and without having the email large files (tens of megabytes). I will

need this piece of equipment for at least a month, but 6 months is a more realistic time period. Also, I don't want to spend a lot of time looking and pricing this piece of equipment because I want to use it as soon as possible. So, vendors with prices on their website and next day shipping are preferred. Lastly, I wanted to keep the total cost under $1000 and ideally under $700.

Lease vs Purchase

There are a lot of equipment leasing companies out there. Unfortunately, they rarely list the details of their equipment or prices on their websites. Also, most of the logic analyzers for lease are the big expensive monsters with lease prices on the order of $500/month. My requirements were only for 15 channels, possible 12 months, and under $1500. This pretty much ruled out the lease option, at least for the full-featured logic analyzer. So, ruled out leasing and I went shopping.

Shopping

Where do you do your shopping? When I'm looking for electronic, I typically look in past issues of Nuts & Volts magazine, before doing a search on Google.com. Once I have a product name, I'll look in Google's Groups to see if anyone has made comments (good or bad) about the equipment. I have seen a number of ads for PC based electronic equipment that uses USB for communication. In fact, I have been involved with the development of such equipment using the IC's from FTDIchip.com. From ads in Nuts & Volts, I knew that USB based logic analyzers existed, so I started my Google search with the keywords, "USB Logic Analyzer". This immediately brings up a number of items, which I have summarized in the table below:

Table 1 Summary of USB Logic Analyzer Search

Name	# of Chs	Buffer Size	Sample Rate/ch	Comments	Price
Ant8/Ant16	16	2048 samples/ch	500 MSa/s	500MHz Async, 100MHz sync	$299
TechTools DigiView	18	132,000 samples	100 MSa/s	w/data compression	$495.95
Link Instruments LA-4540	16 24	8 @512k, 8@256k 16 @256k, 8@128k	500 MSa/s 250 MSa/s	various models	$2200
Janatek Lu LA-USB	16	1048000 samples/ch	200 MSa/s		$750-$1100
USBee (a number of different models)	8	1 million samples up to available PC memory	24 MSa/s	USB 2.0 for max. rate	$395-$895

Product Selection

All of the above product would probably work for my application. From a software point of view, USBee looks neat because it has an application programmer's interface, which could be used to expand its functionality. However it only had 8 channels and I needed 15. Also, it uses USB 2.0, which my PCs support, but I've not yet used. The equipment from Link Instrument was pricey when compared to the other devices. I ruled out the Ant16 because I thought the buffer size at 2048 samples/channel wouldn't support my requirement of collecting data for several seconds. I ended up selecting the DigiView DV1-100 device over the Janatek Lu LA-USB device because of the price and also because I hoped that the DigiView's hardware data compression would allow me to look at long time sequences of the switching data. Also, TechTools was the vendor for the DigiView equipment and I've done business with them in the past.

TechTools DigiView DV1-100 Logic Analyzer

I won't repeat the device specifications here. You can find the details of the device on the TechTools website. I'll just give a brief overview of my use of the equipment. I received the hardware within 24-hours of ordering it and it came nicely packed with all the pieces, CDROM and a printed user's manual, (see Figure 1). The product comes with micro-clip leads, but I have been using the raw connectors that fit 0.025-inch square posts (stackable on 0.1 inch centers).

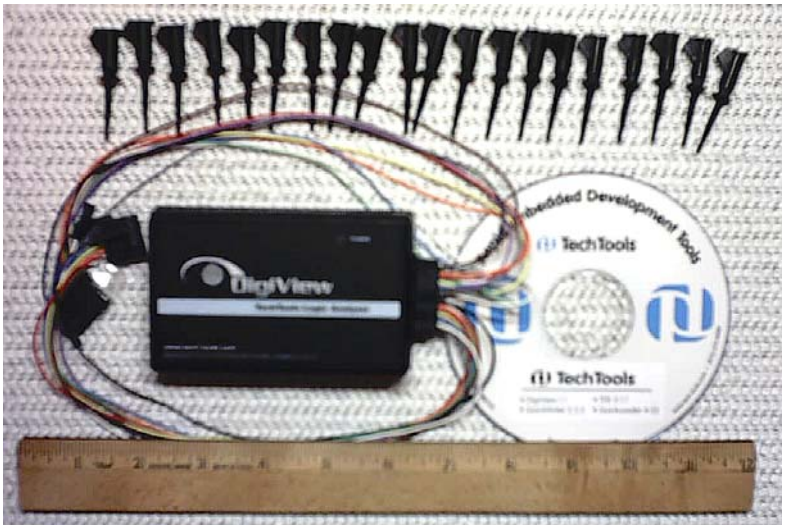

Figure 1 DigiView DV1-100 Logic Analyzer Equipment

The DV1-100 has a screw panel on the back. I couldn't resist looking inside. The device consists of the FTDI FT245BM USB IC, a Samsung K7A403600A SRAM, and a Quicklogic QL3025 ASIC, (Figure 2).

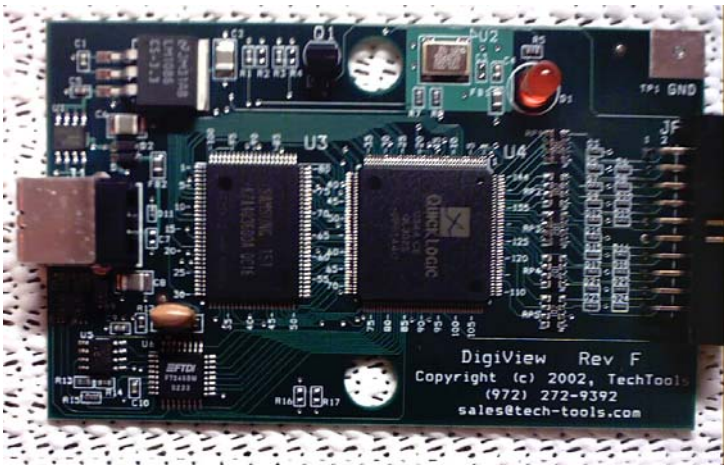

Figure 2 Inside the DV1-100

You can download the software from the TechTools website. It uses an InstallShield installation procedure and the download includes the USB drivers. The printed manual appears to be identical to the online help, so if you do download the software, you pretty much have everything except for the hardware. The software includes some test data so you can examine the capabilities of the display.

The GUI

The main window shows the recorded data. There are pushbuttons for File, Help, Configure, Run/Stop, and Time, which is displayed in seconds, milliseconds, microseconds, and nanoseconds. The "File" menu allows the user to open, save, print and exit. The open/save option allows the user to save data and email it to someone else. The RUN button is disabled unless the hardware is detected.

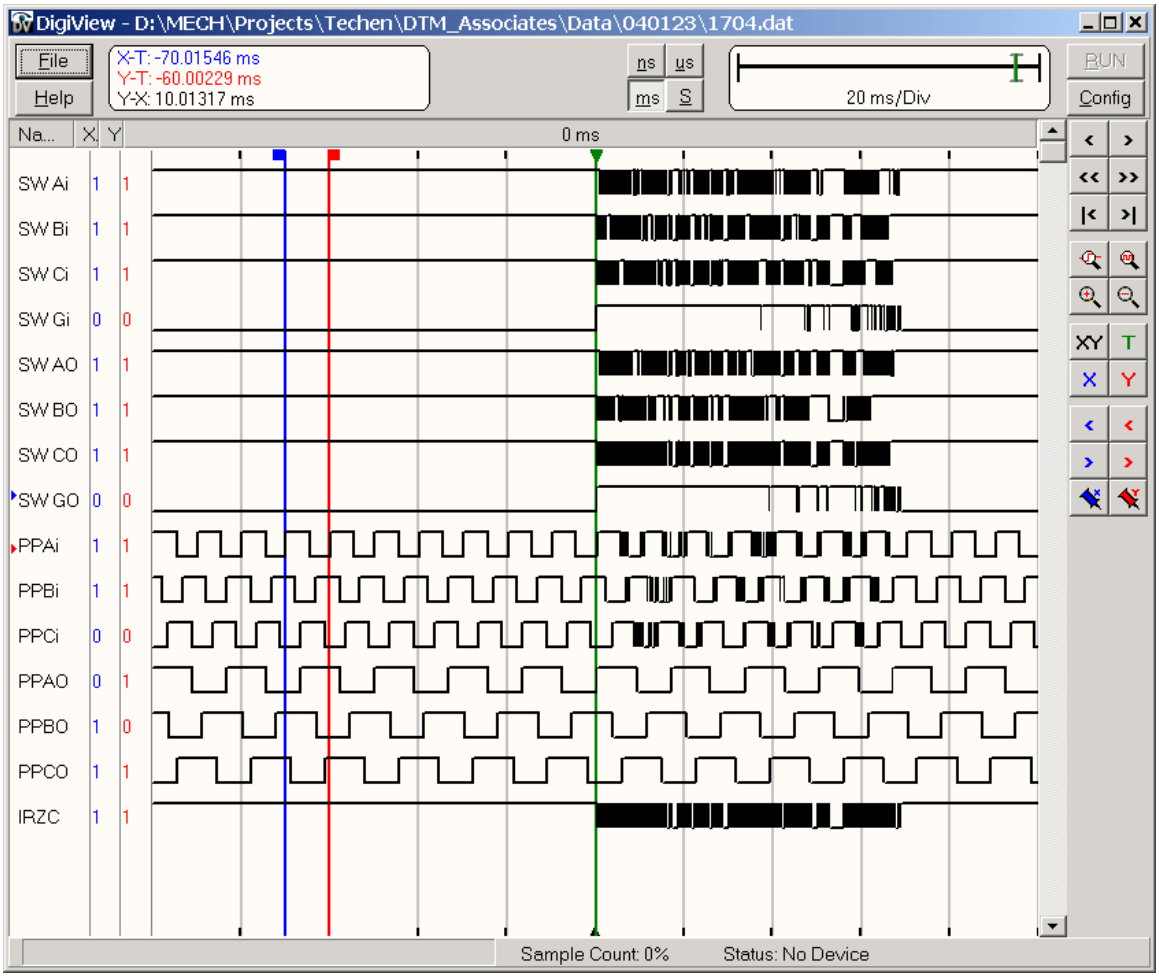

Figure 3 Main Screen and Data Display

An example of a test sequence is shown in Figure 3. In this display, I have zoomed out to show the change of the slower signals, (3-phases at 100Hz and 3-phases at 60Hz). I'm working out some noise issues with the hardware, so there is some signal switching where it shouldn't be. The software allows the user to zoom in and out on the data, center on the trigger, and set two snap lines that provide a measure of time between the two snap lines. Data files that I recorded were approximately 700kbytes and compressing with ZIP reduced the file size by about 50%. So this resulted in a file size that was easy to email. This feature has been very useful for discussing results with the other team members that are working on the project.

The Configure pushbutton brings up a configuration window (Figure 4) that allows signals and triggers to be defined. A trigger can be assigned to any channel or combination of channels and can be level or edge triggered or both, so you can trigger on multiple events. The wire color code is the same as the color code for resistors. This configure screen also allows auto save/restore and prefill to be enabled.

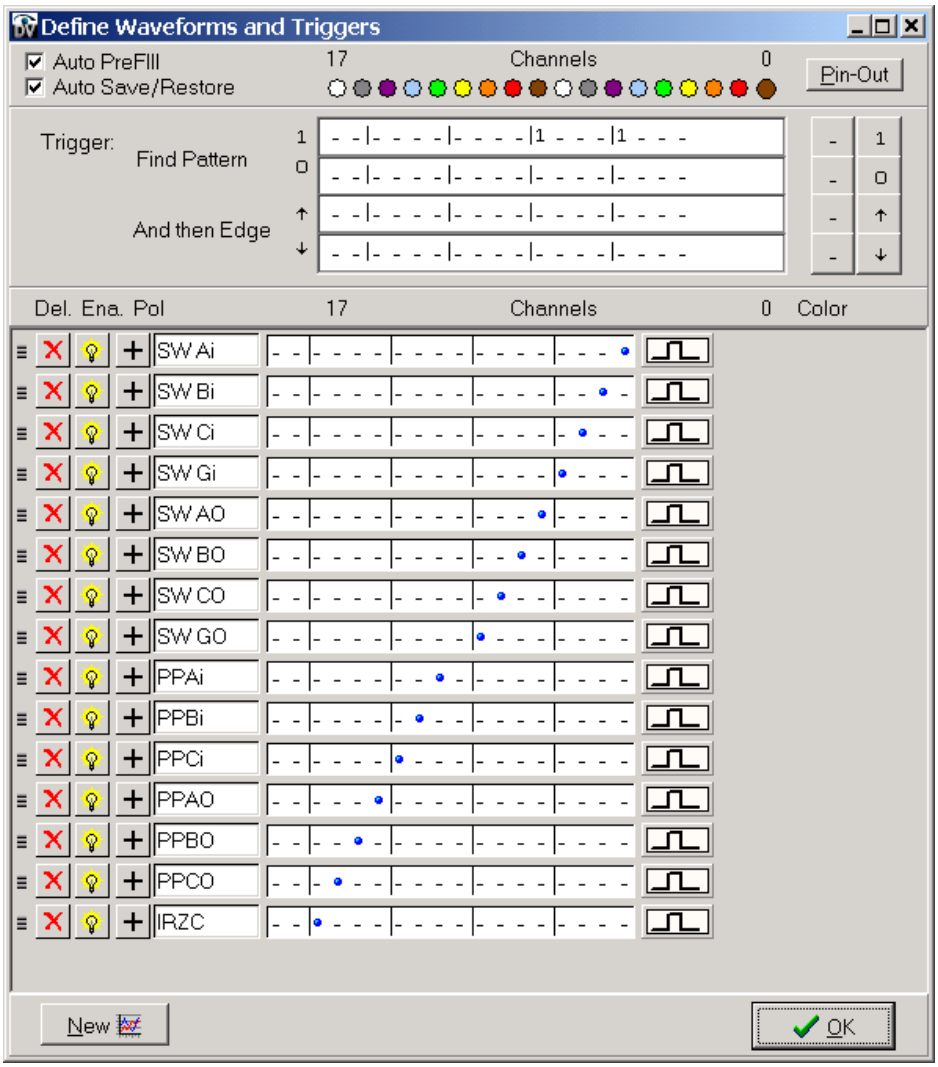

Figure 4 Configuration Screen

The DigiView is always sampling and storing data in circular buffer. This uses ½ of the capacity. When a trigger event occurs, DigiView fills the other ½ of the buffer or runs until the "Stop" pushbutton is pressed. Thus the "trigger" event occurs at the midway point in the data. Time before the trigger event is shown as negative. Depending on how fast the data is changing, sometimes you have to press "Stop", because with compression, it can take several seconds to fill the remaining buffer. I found the software ease to use and intuitive.

Summary

I've been able to record several seconds worth of data, which makes it much easier to examine what is going on. Once I get to the part of the project where I'm changing input voltage amplitude and frequency, this feature will come in very handy. All and all, I'm pretty happy with the procurement. It would have been heck trying to acquire all this data with a multi-channel scope.

References

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The author may be contacted via Email with any questions thorough d.mattern@ieee.org

BIO

Duane Mattern is a freelance engineer with a background
in instrumentation, controls, and real-time and embedded software.