Plotting Spectrum Analyzer Data without a Plotter

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1. Introduction

This article describes using a PC to upload and plot measurements from older test sets that do not support USB or Ethernet but do have an IEEE-488 interface. The test set also must support HP-GL/2. IEEE-488 is the short name for IEEE-Std-488.1, which is a standardized interface bus. IEEE-488 originally was developed by Hewlett-Packard as the HP-IB (Hewlett-Packard Interface Bus) for use with automatic test equipment (ATE). It is called GPIB (General Purpose Interface Bus) by other manufacturers and was standardized by IEEE [IEEE488]. In a basic IEEE-488 setup up to 15 devices can be interconnected and the data rate is around 1 Mb/s but it is possible to expand both the devices and data rate. For most purposes, the terms HP-IB, GPIB and IEEE-488 are used interchangeably. HP-GL/2 is a graphics language also developed by HP and supported by almost all plotters and many printers. Many test sets inherently or optionally support both IEEE-488 and HP-GL/2. A tutorial on the GPIB is here: http://www.hit.bme.hu/~papay/edu/GPIB/tutor.htm

For purposes of this article I used the Hewlett-Packard 8590A spectrum analyzer but the methods apply to many other test sets including those by other companies. The setup described here requires in addition to the test equipment a compatible interface controller, appropriate drivers and software and a personal computer (PC) with Windows operating system. I needed only about 5 minutes to hook everything up, install the software and obtain my first plot (figure 1).
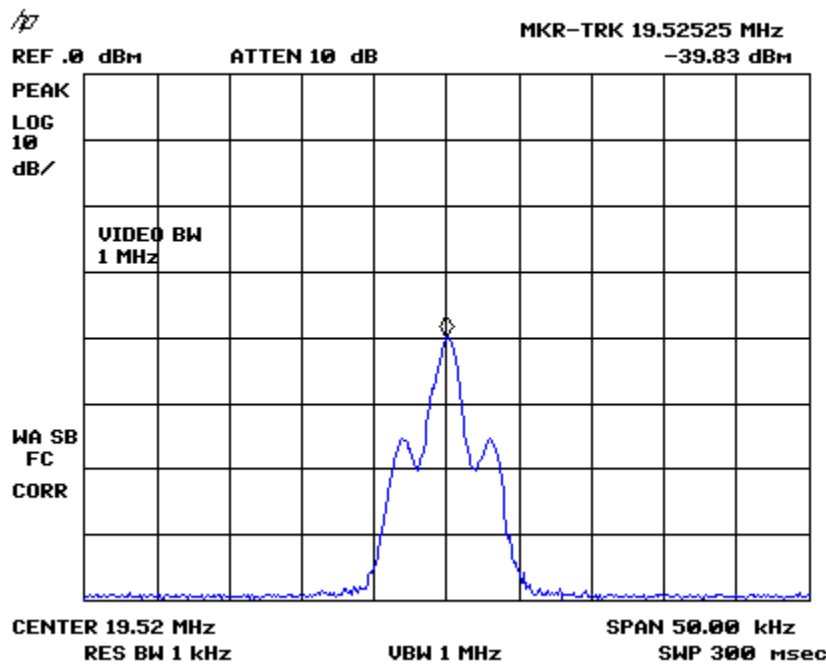

Figure 1 ~ First plot obtained from an HP 8590A spectrum analyzer after spending 5 minutes installing the setup described in this article. The image is 512x384 pixels and one of many sizes available. The spectrum is a 3 kHz amplitude modulated carrier at 19.52 MHz.

2. Hardware and software requirements

The IEEE-488 interface is equipped on many, but not all, Hewlett-Packard analyzers. The IEEE-488 interface uses an easily recognizable 24-pin micro-ribbon connector (figure 2). It may be labeled HP-IB, GPIB, 488 or something similar. The original interface was designed to use stackable cables so that several test sets could be interconnected and controlled from a single computer or ATE. In such a setup, each node would have a different address. Depending on how you decide to connect the test set to the PC, you may need one or more cables (figure 3). However, if the test set is near the PC or near a local area network (LAN) switch, and you use the controllers described here, an IEEE-488/GPIB cable is not needed.

Figure 2 ~ IEEE-488 interface connector on the HP 8590A rear panel at top-left marked "HP-IB". The interface controllers described in this article can be mounted directly on the test set connector or connected through an IEEE-488/GPIB cable.

Figure 3 ~ IEEE-488/GPIB interface cable, 0.5 m long. The maximum total cable length is 20 m. New cables are quite expensive but used ones are easy to find for US$10 to US100 depending on length and condition.

The next consideration is the interface controller. The controller connects between the test set and the PC and handles the necessary protocols and electrical signals. Controllers have been made to support many data communications technologies including the ubiquitous EIA-232 serial interface, universal serial bus (USB) and Ethernet. I will describe two controllers, one for USB and another for Ethernet, both made by Prologix (http://prologix.biz/) (figure 4). Other manufacturers such as National Instruments make suitable controllers but all others that I know of are much more expensive than the Prologix devices. A big plus is the Prologix devices worked for me out of the box without any problems whatsoever. The controllers are not limited to plotting; they can be used for any GPIB function but, of course, the user must have supporting software.

Figure 4 ~ Ethernet (left) and USB controllers for the IEE-488/GPIB interface. The new price for the USB controller is about US$150 and for the Ethernet controller is about US$200, but both occasionally appear online at slightly reduced prices. The Ethernet controller requires an external ac power adapter (not shown), and the USB controller is powered through the USB port.

Software packages have been developed specifically for plotting with IEEE-488 and HP-GL/2 (table 1). A review of these programs is beyond the scope of this article. I use the free 7470.exe software. 7470 is the model name of an HP desktop plotter, long out of production, and the 7470.exe program emulates it. When you download and install the software from the KE5FX website, you also get a number of other useful programs including a very easy-to-use configurator for the Prologix controllers mentioned above (it also can be used with a National Instruments controller). 7470.exe is a 32 bit Windows application. I use it on Windows XP with all service packs and updates. I have not tried to use it on a Windows 7 or 8 PC.

Table 1 ~ IEEE-488 and HP-GL/2 compatible software. This is not an all-inclusive list; other programs probably exist

Program	Website	Approx. Cost US$
7470.exe	http://www.ke5fx.com/gpib/7470.htm	Free
PrintCapture	http://www.printcapture.com/	100
Plottergeist	http://www.aphena.com/pltgeist/pltgeist.htm	500

3. Hardware and software installation

Two setups are described based on the Prologix controllers (figure 5). These controllers may be connected directly to the test set or through an IEEE-488 cable. The USB controller uses the FTDI FT245B chipset and associated virtual comport (VCP) driver. Even though some FTDI VCP drivers may be already installed on your PC, you must download and install the latest available driver before using the controller (this is customary with all new USB device installations and is a step you should never skip): http://www.ftdichip.com/Drivers/VCP.htm.
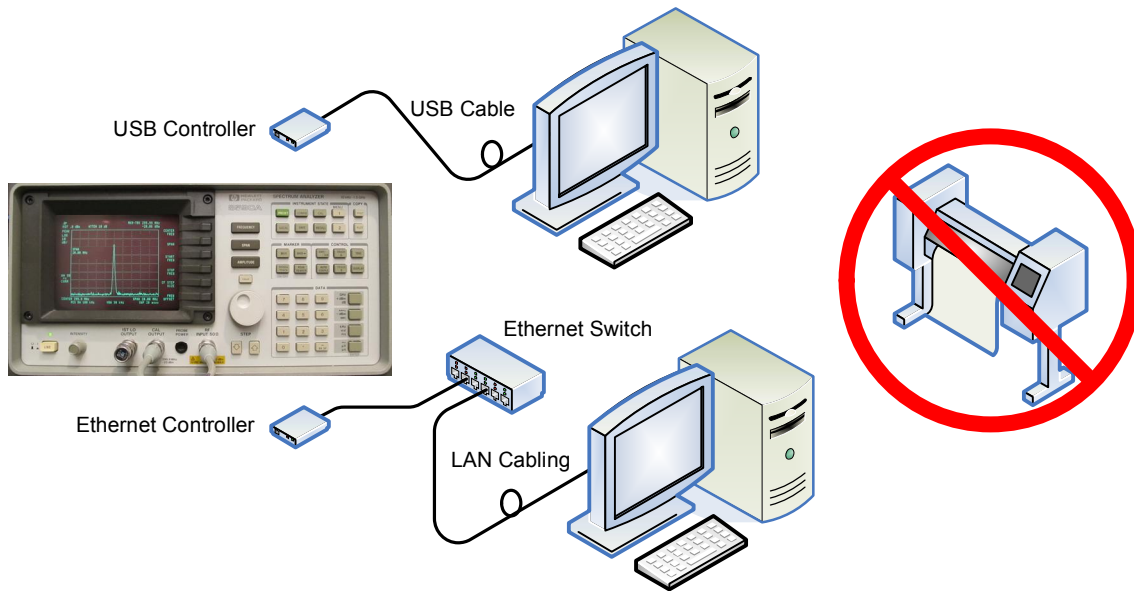

Figure 5 ~ Block diagram of USB and Ethernet setups. The USB setup is slightly cheaper but the maximum cable length between the controller and the PC is approximately 3 m unless a hub or special adapters are used.

The USB controller installation procedure is routine, but USB device installations are problematic for many users. Most problems can be resolved by removing old USB drivers from the PC before installing new ones as described in [Reeve].The Ethernet controller is not nearly as restrictive in terms of location with respect to the PC and almost always will be connected through a LAN switch. No driver installation is required for the Ethernet controller if the PC already supports Ethernet interfaces (all modern PCs do).

The 7470.exe program is provided as part of a self-installing executable file simply called *setup.exe*. When the executable is run, it installs several useful programs, not just 7470.exe. The developer's website has plenty of helpful information, including test equipment compatibility, and it is unlikely you will have any problems. After software installation is done, the next task is to configure the controller. One of the installed programs is called GPIB Configurator. It will automatically find the type of controller you are using (figure 6).
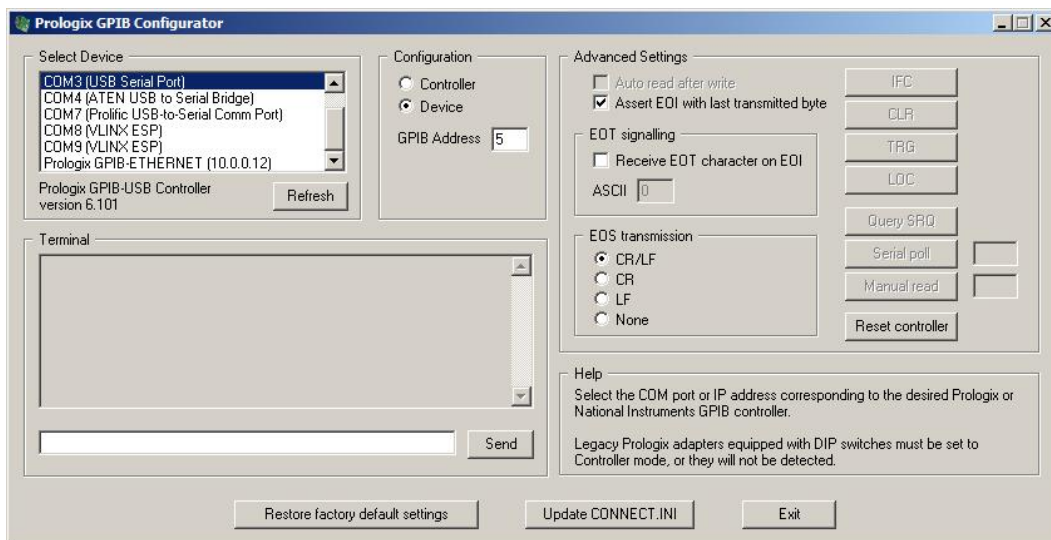
Figure 6 ~ KE5FX provides a configurator that automatically finds the Prologix controllers. In the screenshot shown here, both the USB (highlighted at top-left of window and labeled "COM3 (USB Serial Port)") and Ethernet controllers were found. It also shows other devices unrelated to the controllers. To configure the desired controller, it is selected and the 7470.exe initialization (connect.ini) file is updated by clicking the button at bottom-middle.

Now it is time to run 7470.exe using the Start menu or the desktop shortcut. The program opens with a blank window and will do nothing until told to wait for a plot to be sent by the test set (figure 7). The "wait" state can be commanded from the Acquire drop-down menu or by simply pressing the "W" key on the PC keyboard. Once the program is waiting, the test set has to be commanded to send the plot. To obtain a plot from the HP 8590A spectrum analyzer, it is only necessary to press the Plot button (figure 8) and the HP-GL/2 commands are sent over the controller to the PC and software. A moment later a plot will appear (figure 9). The plot then may be saved in several image formats and pixel dimensions.

I found that the software default settings were fine, and I did not do anything but place the program in the wait state and press Plot on the analyzer to obtain my first plot. The program can be forced to listen on a specific address and has options for specific test sets. The 7470.exe program has remarkable flexibility including ability to save and recall raw plot data. I found it to be foolproof and very well supported by the developer John Miles.
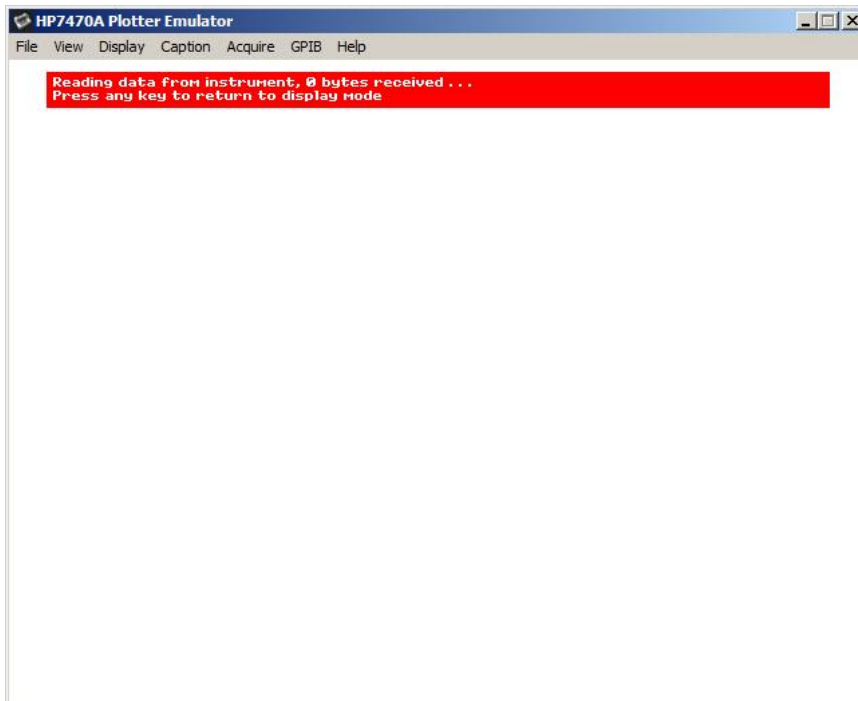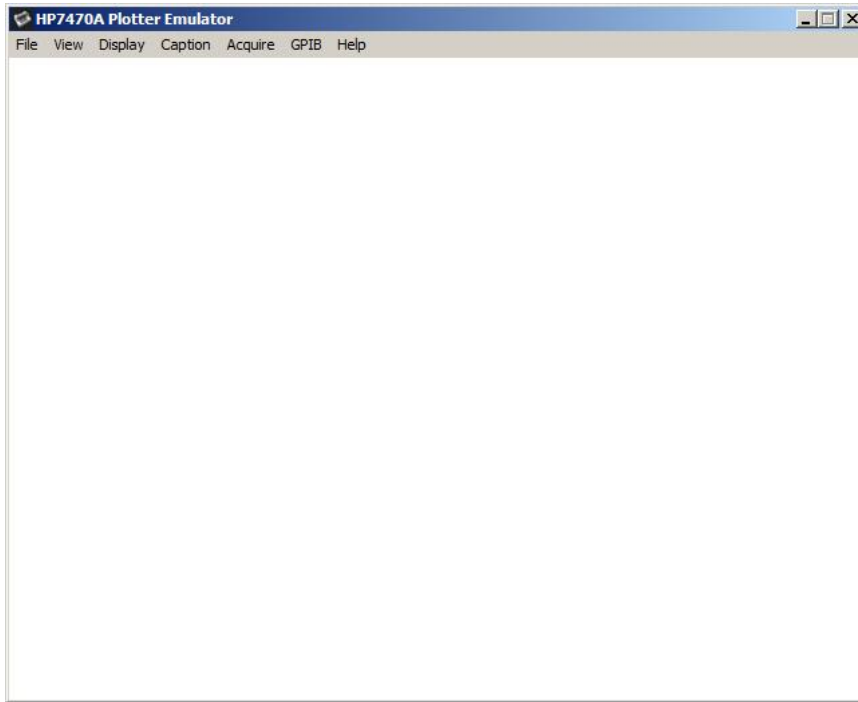
Figure 7 ~ Screenshots of 7470.exe when first opened (top) and when commanded to wait for a plot to arrive.
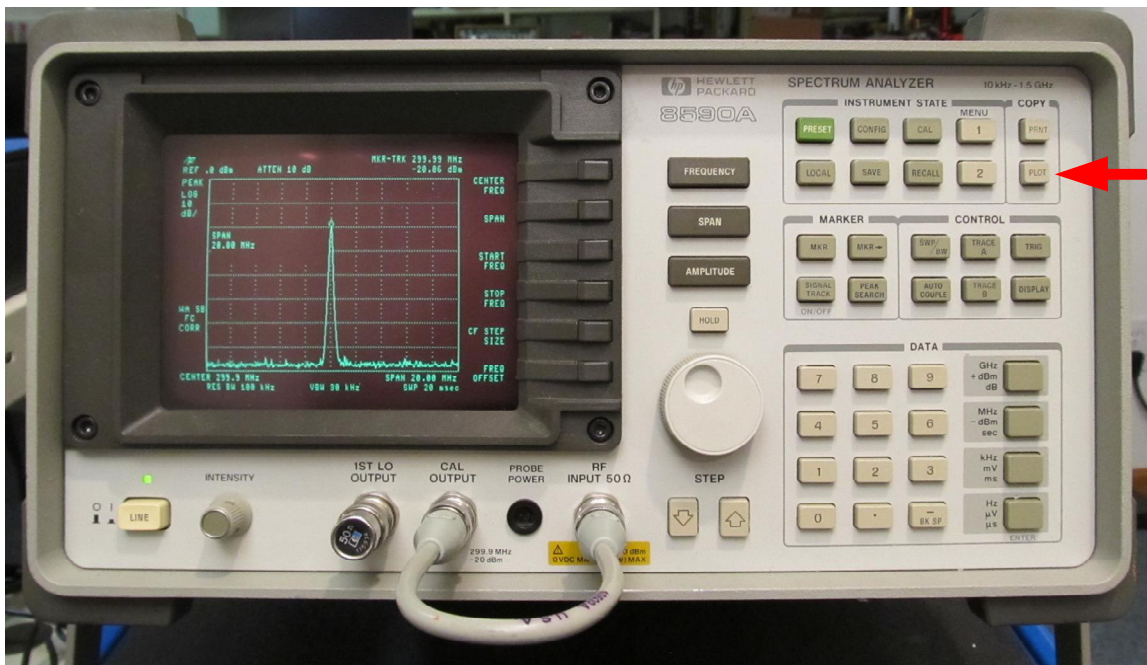
Figure 8 ~ Test sets that support plot printing generally have a dedicated button as shown here on the HP 8590A spectrum analyzer front panel (arrow).
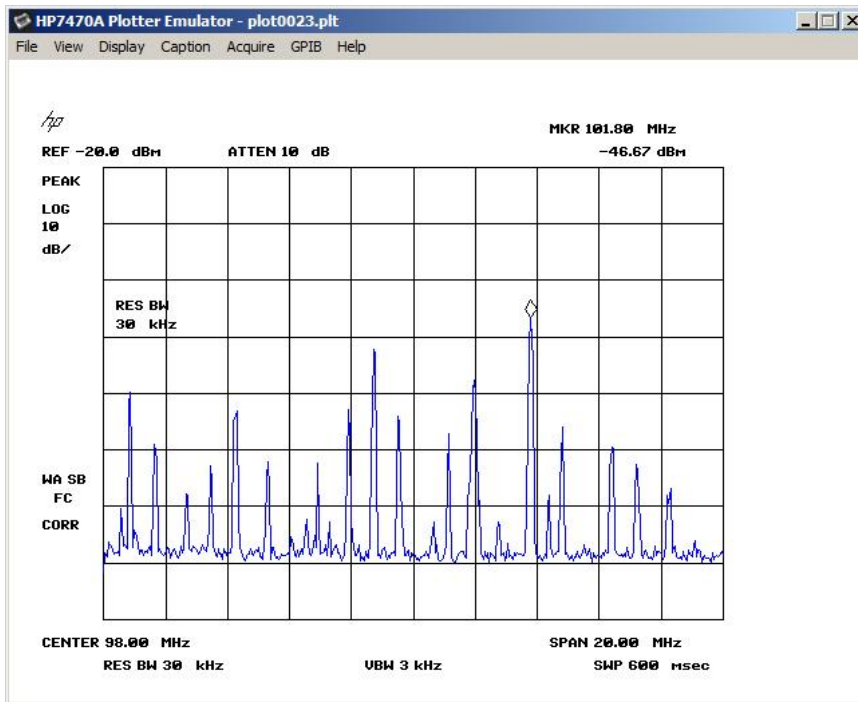

Figure 9 ~ Plot of the FM broadcast station spectrum from 88 to 108 MHz received on a 0.6 m whip antenna connected to the RF Input jack on the spectrum analyzer. This is a screenshot of the program window, which includes the plot and menu bar. When the plot is saved as an image file, only the plot itself is saved. It may be saved in different sizes and includes all data shown on the test equipment screen as shown here.

4. Conclusions

Using plotter emulation software, screen plots may be readily and inexpensively captured from almost any test set that has an IEEE-488/GPIB interface and supports the HP-GL/2 graphics language. The 7470.exe program used here allows the plots to be viewed on a PC display and saved in many image file formats for use in reports and documentation. The 7470.exe program is remarkably flexible and costs nothing.

5. References

[IEEE488]   IEEE-Std-488.1-1987, IEEE Standard Digital Interface for Programmable Instrumentation, Institute of Electrical and Electronics Engineers, 1987
[Reeve]   Reeve, W., USB Port Management, 2012, http://www.reeve.com/Documents/Articles%20Papers/USBPortManagement_Reeve.pdf