TIMS-301C Instrument and the PicoScope

A Telecommunications Instructional Modeling System (TIMS) is shown in Figure 1. This instrument includes a PicoScope card. Each TIMS instrument in our laboratory is connected to a computer containing software that supports the PicoScope interface. The PicoScope display appears on the computer monitor, and the PicoScope configuration is set with the mouse and monitor.

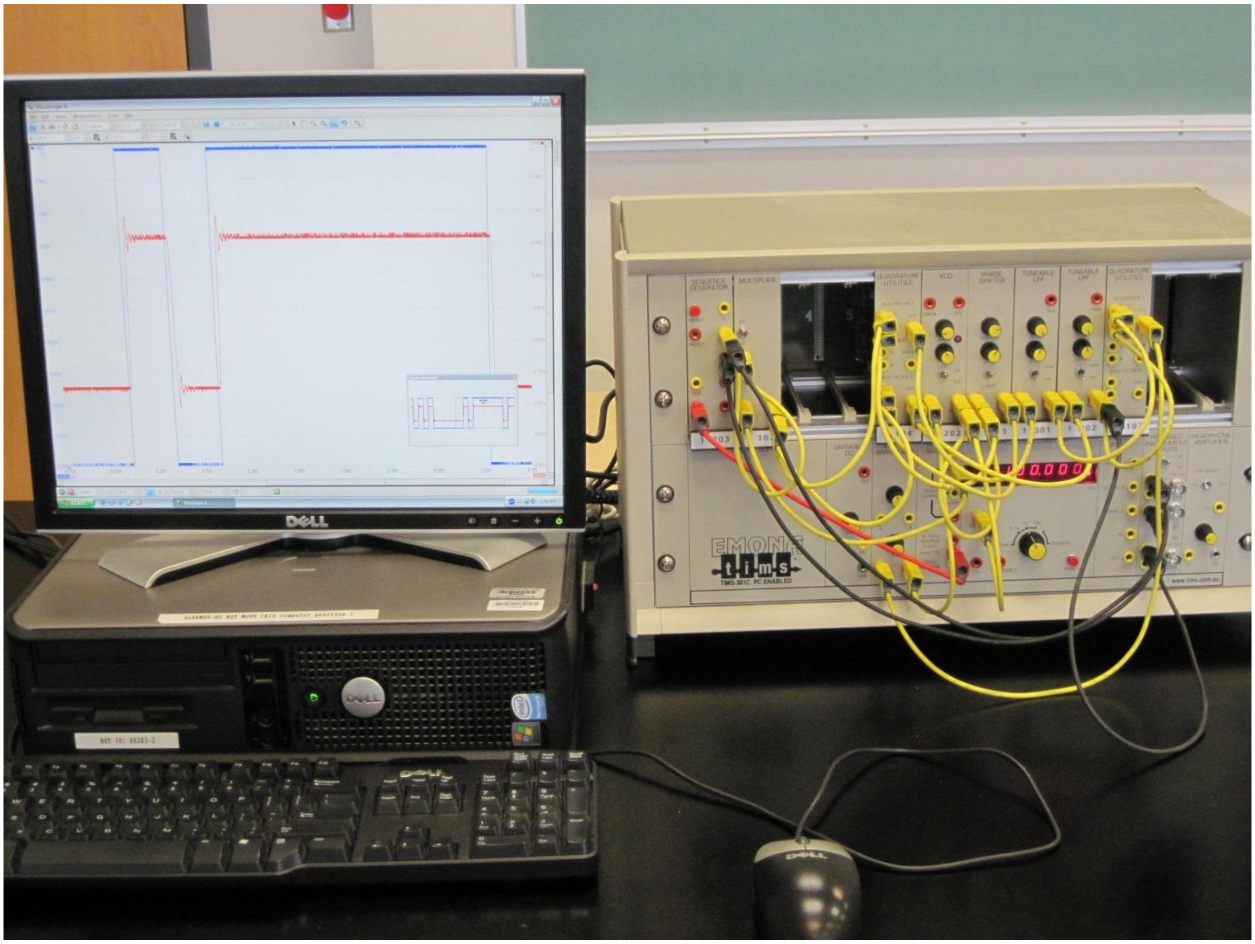


Figure 1: TIMS-301C instrument connected to a computer

The PicoScope can be used as an oscilloscope (Scope Mode) and as a sampling spectrum analyzer (Spectrum Mode). Signals are input to the PicoScope by making connections to the PC-Based Instrument Inputs panel on the TIMS instrument. There are two channel A input ports. You select one or the other with a toggle switch on the panel. There are also two channel B input ports, and you can toggle between them. In addition, there is an input port for providing an external trigger source.

TIMS employs the following color scheme:

Yellow	Analog
Red	TTL (binary)

A signal with TTL (Transistor-to-Transistor Logic) levels is a binary signal for which high is about 5 V and low is near 0 V.

PicoScope

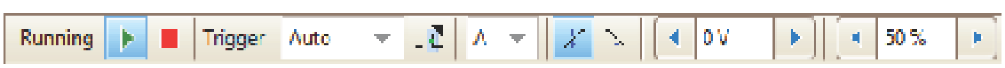
You will start the PicoScope program on the computer like this:

`Start > All Programs > Pico Technology > PicoScope 6`

When the PicoScope program starts, it is in Scope Mode. Figure 2 shows the display in Scope Mode when there is a 100-kHz sinusoid on the Channel A input.

The Trigger Toolbar is at the bottom of the display. Proper use of this toolbar is necessary in order to achieve stable displays on the oscilloscope. When PicoScope first starts, the trigger mode on the Trigger Toolbar is set to *None*. You will normally want to change this to *Auto*.

Trigger Toolbar:



The Trigger toolbar also permits you to select a trigger source. If there is a sinusoid on channel A, you will likely want your trigger source to be set to *A*. Similarly, you can set the trigger source to *B*, if there is a sinusoid on Channel B. Often when you are looking at a signal that is more complicated than a simple sinusoid, you will want to use an external source for triggering; in such a case, the trigger source should be set to *Ext*. If you set the trigger source to *Ext*, you must supply a suitable triggering signal to the E input of the PC-Based Instrument Inputs panel.

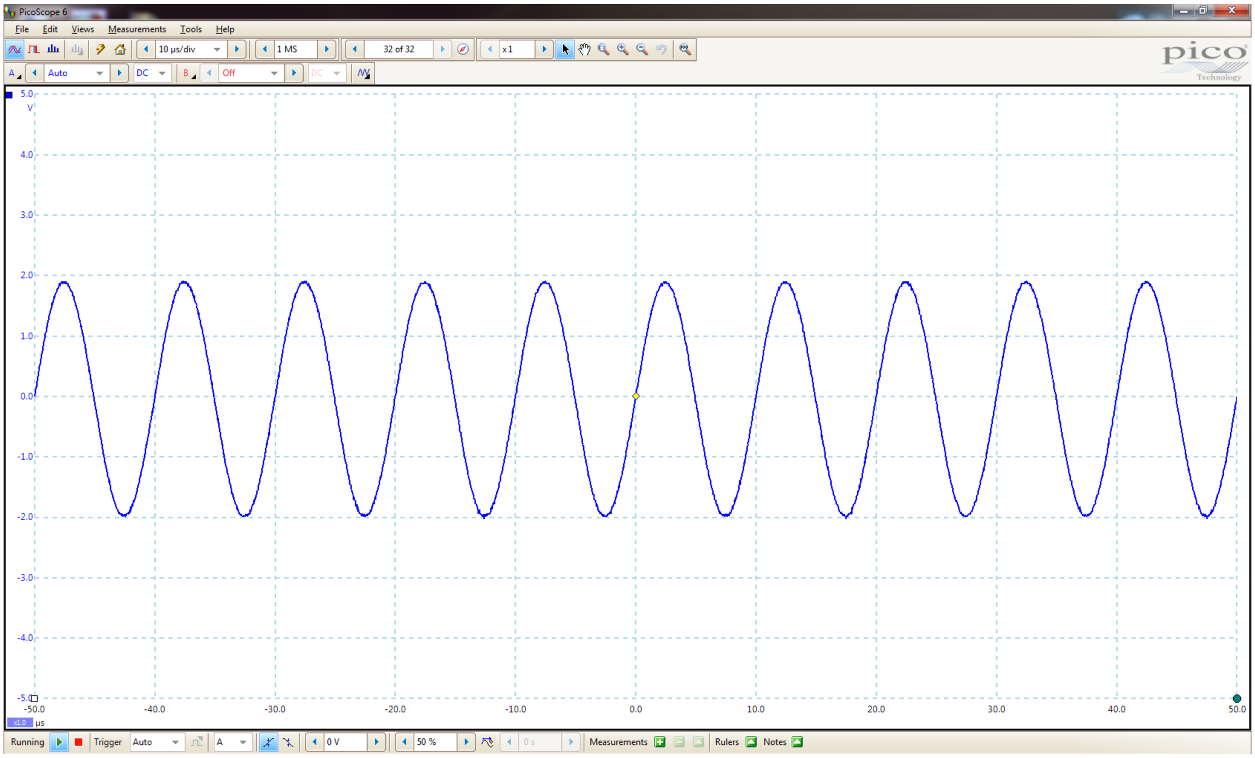
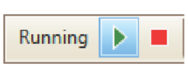


Figure 2: Scope Mode display with a 100-kHz sinusoid on Channel A

Also on the Trigger Toolbar is a place for specifying the trigger level. If the triggering signal is periodic with zero-crossings, than a trigger level of 0 V (the default) will usually work well. However, if a TTL signal serves as the trigger, the trigger level must be set to a nonzero and positive voltage. (A TTL signal does not have zero-crossings.) A trigger level of 2 V is a good choice for a TTL signal.

In the bottom left corner of the oscilloscope display, there are start and stop icons. When the oscilloscope is sampling the signal, the start icon is highlighted; otherwise, the stop icon is highlighted. Normally, you will want the oscilloscope to be sampling the signal. You can start or stop the sampling by clicking on the appropriate icon.



The Channel Setup Toolbar is located just above the data display area. In this toolbar are a range control and coupling control for each of Channels A and B. When PicoScope is first started, Channel A range control is set to *Auto* and Channel B range control is set to *Off*. This means that the vertical scale will be automatically adjusted for Channel A and that the Channel B signal will not be displayed. This is why Figure 2 contains only one trace (the Channel A trace).

Channel Setup Toolbar:

When Channel A is not turned off, it displays as a blue trace, and its vertical scale appears on the left. When Channel B is not turned off, it displays as a red trace, and its vertical scale appears on the right.

Coupling control for each channel is set to either *DC* or *AC*. If set to *AC*, the direct-current component of the input signal is blocked. Normally, you will want to operate with DC coupling.

The Capture Setup Toolbar is above the Channel Setup Toolbar. The icon at the left end of the Capture Setup Toolbar represents the Scope Mode. The third icon from the left represents the Spectrum Mode. You can move back and forth between the Scope and Spectrum Modes by clicking on these icons.

Scope Mode: 

Spectrum Mode: 

When in Scope Mode, there is a place on the Capture Toolbar to select the timebase. This adjusts the horizontal scale of the display.

Capture Setup Toolbar (Scope Mode):

You will want to save some of your PicoScope plots for later inclusion in your laboratory report. This is easily accomplished. On the File menu, you will find “Save As”:

`File > Save As`

In the dialog window that opens, you will want to select **`"Current waveform only"`** and save the plot to a graphics file. It is recommended that you use PNG (Portable Network Graphics) files.

You can place PicoScope in the Spectrum Mode by clicking on the Spectrum Mode icon in the Capture Setup Toolbar. In Spectrum Mode on the Capture Setup Toolbar, there is a place to select the frequency range. This is a sampling spectrum analyzer. The sampling rate equals twice the frequency range. These two (related) parameters are of great importance in a sampling spectrum analyzer, because they define how aliasing will happen.

Spectrum Mode: sampling rate = 2 × (frequency range)

Capture Setup Toolbar (Spectrum Mode):

Figure 3 shows the PicoScope display in Spectrum Mode. In this case, the frequency range is set to 195 kHz. The horizontal axis ranges from 0 to 195 kHz. The sampling rate is 390 kHz in this case.

On the Capture Setup Toolbar (Spectrum Mode), there is an icon that you can select in order to set spectrum options.

Spectrum Options: 

When you click on the spectrum options icon, a dialog box will appear from which you can adjust display parameters. Figure 4 shows this dialog box with typical parameter values. If you increase the number of frequency bins, you will get better frequency resolution; but the price paid for this is a slower response, as this requires the PicoScope to compute larger discrete Fourier transforms.

It will sometimes be beneficial to use a linear and sometimes a logarithmic scale. The linear scale shows the rms voltage of individual frequency components. The logarithmic scale permits a larger dynamic range to be viewed. The default scale is logarithmic with units dBu. This unit is defined as

$$\text{signal level} = 20\log_{10}\left(\frac{V_{\text{rms}}}{0.775}\right)\ \text{dBu}$$

where V_{rms} is the rms voltage and 0.775 V rms is a common reference voltage in audio electronics.

There is a lot more detail to PicoScope operation than discussed in these notes. However, you now have enough information to get started; and the best way to learn to use the PicoScope is by playing with it. Documentation is available on the Help menu.

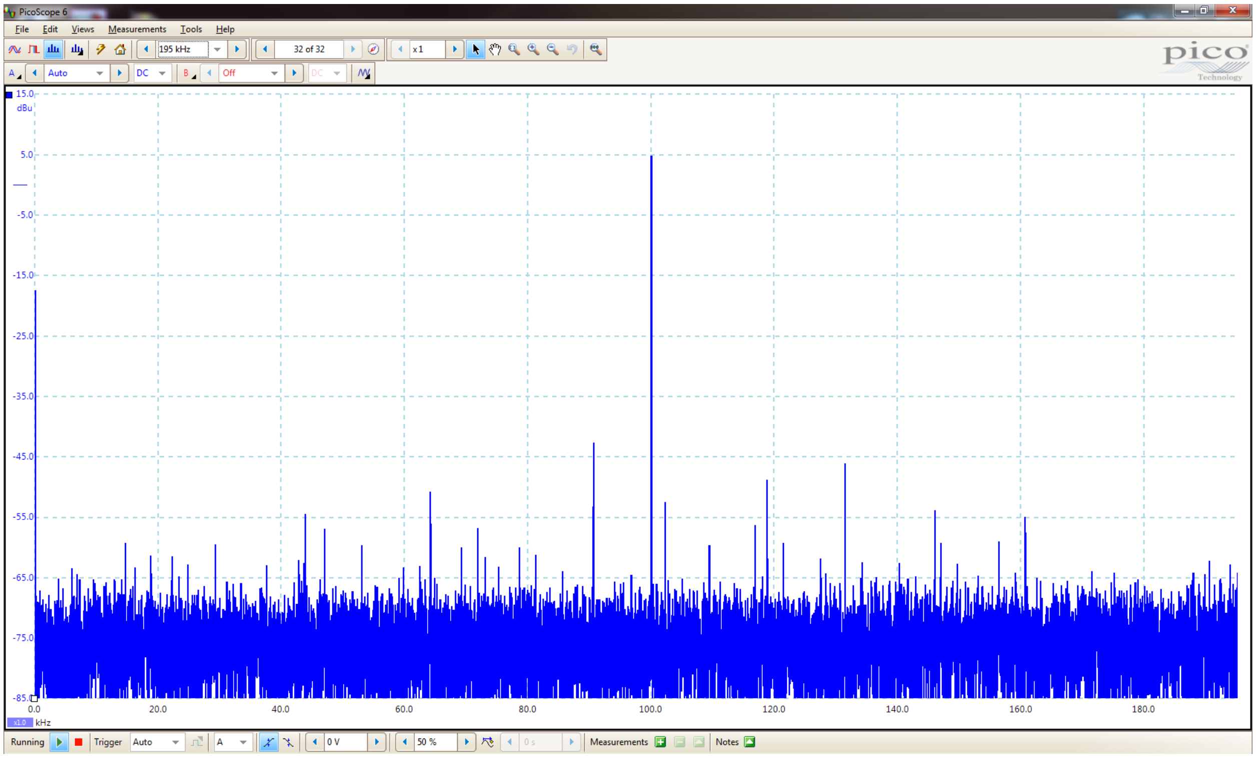


Figure 3: Spectrum Mode display with a 100-kHz sinusoid on Channel A

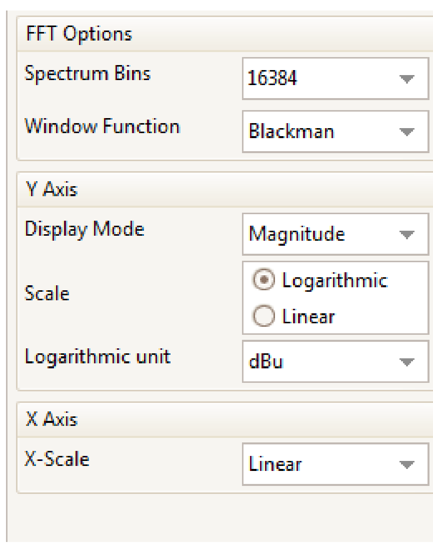


Figure 4: Spectrum options dialog box

Troubleshooting Tips

Most ports on the TIMS instrument and its modules are not labeled as either input or output, but you should be able to identify input and output ports based on your understanding of the function of each module. When in doubt, you can consult the manual pages. In general, a module's input ports will be on the left side of the module, and the output ports will be on the right.

On the computer desktop there is a folder called **`PicoScope & TIMS Manual Pages`**. Get to know it!

If you are experiencing problems, consider the following.

Perhaps you have mistakenly connected an output port to another output port.

Perhaps you have mistakenly connected more than one output signal to the same input port.

You must bear in mind the distinction between analog and TTL (binary) signals. Perhaps you are misusing one of these signal types. For example, a red input port expects a TTL signal, so don't give it an analog signal.

If you have unnecessary connections, remove them. Reducing clutter can make it easier to troubleshoot.

If you don't see your data displayed on the PicoScope, check on the Channel Setup Toolbar to make sure that range control is not off for that channel. If that doesn't fix the problem, check the PC-Based Instrument Inputs panel to make sure your signal is applied to the intended channel and the toggle switch is in the right position.

In the Scope Mode, make sure that you have an appropriate value selected for the timebase.

What if you can't get a stable oscilloscope display? Check the following. The trigger mode should be set to something other than *None*. (*Auto* is a good choice.) The trigger source should have an appropriate setting. (If you want to trigger on an external signal, for example, the trigger source must be set to *Ext*.) If the triggering signal has no zero-crossings (such as a TTL signal) than you can't use a trigger level of 0 V. (For a TTL triggering signal, use a nonzero, positive voltage for the trigger level.) If you intend to use an external triggering signal, make sure that you supply one to the E input port on the PC-Based Instrument Inputs panel. Finally, the triggering signal and the signal whose display you wish to stabilize must have periods that are related in a special way. (Triggering will work, for example, if the triggering and display signals have equal periods.)