Using the Transmille 3000 Series Oscilloscope Calibration Option

Introduction

Oscilloscopes have always been an important measurement tool for the engineer. The design of oscilloscopes has evolved slowly from early instruments which were used to simply view a waveform, to oscilloscopes with calibrated ranges and graticules (grid) on the display to enable measurements to be made, up to the modern digital storage oscilloscope (DSO) which have many advanced measurement functions built in as standard.

The latest designs now use digital LCD displays instead of the tradition CRT (cathode ray tube) and are putting even more measurement power in the hands of the engineer in ever more portable instruments. The oscilloscope is still evolving, the latest step is the scope meter which combines the functions of an oscilloscope with those of the DMM in one instrument. Each evolutionary step has added to the measurement capability of the oscilloscope, making the calibration of these instruments even more important.

The large number of ranges, channels and functions of oscilloscopes can make the calibration process time consuming and hence expensive which has lead to, in some cases, the oscilloscope being marked 'DISPLAY USE ONLY' calibration not required - this limits the usage of an otherwise very power measurement tool. The solution is more efficient calibration which is provided by the 3000 series calibration option and ProCal software.

Oscilloscope Types

There are three basic types of oscilloscope in common usage which the calibration laboratory may need to calibrate.

1) *Simple oscilloscopes* - usually dual channel with direct display on CRT.

2) *Digital storage scope* (DSO) with readout

3) *Hand held* Scope meters

All types are available with different bandwidths, but the bulk of oscilloscopes have bandwidths less than 200MHz with very few having bandwidth above 600MHz.

The bandwidth rating is a measure of the oscilloscopes ability to display high frequency, and as a guide the higher the bandwidth the more features a scope will have.

All types of oscilloscopes require calibration of three main functions.

Vertical Deflection / Amplitude

Typical ranges from 2mV/Div to 50V/Div

Ranges are normally in a 1,2,5 sequence, calibration is carried out using a 1kHz square wave positive going from ground, 6 graticules high. As it is impossible to read the error accurately from the scope display the calibrators output is slewed (Increased or Decreased) to align the trace with the graticules. On some scopes, especially if fitted with readout a DC voltage is needed for calibration which can also be provided by the 3000 series calibrator.

Notes

1) Parallax errors

It is important to view the display straight on to avoid any parallax errors. This only applies to the older scopes, many modern digital scopes also display the graticules digitally on the screen.

2) Calibrate Each range

Even the high ranges as any range could have been damaged by the user applying excessive voltage to the input.

3) Shock Risk

The 3000 Series option produces voltages up to 300Volts needed for the calibration of the high ranges (50V/Div x 6 = 300Volts) found on some scopes.

4) Noise On Low Ranges

This can be reduced by using the scopes bandwidth limit function if fitted.

5) Ground Loops

An oscilloscope's input is almost always at power line earth - if the 3000 series also has the output grounded then noise / offsets could be caused by ground loop currents flowing between the power ground of the scope and that of the calibrator.

To calibrate amplitude with the 3000 series select 'Scope' from the soft menu keys, then amplitude. Use the range keys, stepping up or down through the ranges to match that of the scopes. Slew the calibrator using the digital pot to align waveform.

The Horizontal Deflection / Time Base Calibration.

Typical ranges from 5s to 2ns

Calibration is performed using a comb type wave form which can easily be aligned to the graticule scale. This works well up to 100ns where bandwidth limits the use of very short pulses, so a sine wave is used instead. Like amplitude, the calibrators output is slewed to accurately align the first and ninth pulse up on the graticule scale. The error can then be read from the deviation applied by the calibrator. The linearity of the horizontal sweep can also be checked by looking at the alignment of every pulse.

Notes

1) To help get the scope set to the correct settings for amplitude/trigger etc. use a midrange marker first, 1ms for example, auto-scale on DSO's will, in particular, find this waveform easily and set trigger and amplitude range for you.

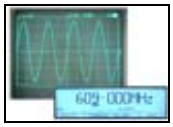
2) Set the coupling to DC and the trigger mode to 'NORM' to capture slow time markers. Auto trigger may start the sweep before the first pulse.

3) Using a 50 Ohms input will improve the shape of the waveform but makes no difference to the accuracy of calibration.

To calibrate timebase with the 3000 series select 'Scope' from the soft menu keys, then Timebase. Use the range keys, stepping up or down through the ranges to match that of the scopes, slew the calibrator using the digital pot to align waveform.

Bandwidth / Leveled Sweep

From 5MHz upwards



Calibration of bandwidth requires a constant amplitude sine wave of variable frequency up to and above that of the oscilloscopes specification. Many calibration procedures also call for a 50kHz reference level to set the start amplitude.

Calibration involves setting the scope to display the 50kHz ref level at 6 graticules high then increasing the frequency until the waveform is only 5.4 graticules high (the 3db point). The frequency at this point is the bandwidth. On increasing the frequency the display should also be checked for any 'highs' or flat spots to ensure a level response. Bandwidth can also be obtained by using a fast rising edge (formula Bandwidth MHz = 0.35 / Fast Rise)

Notes

Bandwidth must be measured with either the oscilloscope's 50 Ohm input selected or an external feed through line terminator fitted to the oscilloscope's input.

To calibrate bandwidth with the 3000 series select 'Scope' from the soft menu keys, then bandwidth. Ensure the oscilloscope input is 50 ohms. Set the oscilloscope amplitude to show the waveform at 6 divisions high using the 50 kHz ref level selected from the soft keys, then return to the leveled sweep output increase the frequency until the 3db point (5.4 div high) is reached.

Trigger Level & Sensitivity

Trigger level can be tested by using a sinusoidal signal at 6 divisions high and adjusting the trigger level control to produce a stable trace starting at any point on either the positive or negative slope depending on scope selection. Sensitivity is tested by applying a much smaller signal (typically 10% of FS) and checking a stable trace can be obtained even when the position controls are used to move the trace to the top or bottom of the display. Bandwidth of the triggering and operation of the HF noise filters on some scopes can be tested by using the leveled sweep output and increasing the frequency or until stable triggering is lost. See oscilloscope manual for method and levels.

Other Parameters

There are many other functions on oscilloscope's which may require testing are listed below, The scopes manual will give the manufactures recommend methods for testing other features which can be tested as required.

Display Geometry

Mainly for older scopes with separate graticules screens which require mechanical alignment with the CRT which may also need trace rotation to be adjusted.

Display & Controls

Operation of brightness, focus, astigmatism and position controls.

Selection of vertical channel operation

Chopped/Alternate/channel 1,2 etc.

DC balance

The change in DC level between ranges.

Input Coupling Selection

AC/DC/50 ohm/Gnd

Pulse Response

Leading edge Aberration.

X Input operation and bandwidth

For scopes with 'X' inputs

Vertical & Horizontal XIO function:

Trigger mode selection

Ch1, Ch2, Int, Ext, DC couple, noise reject, +/-ve edge etc

Time base mode selection

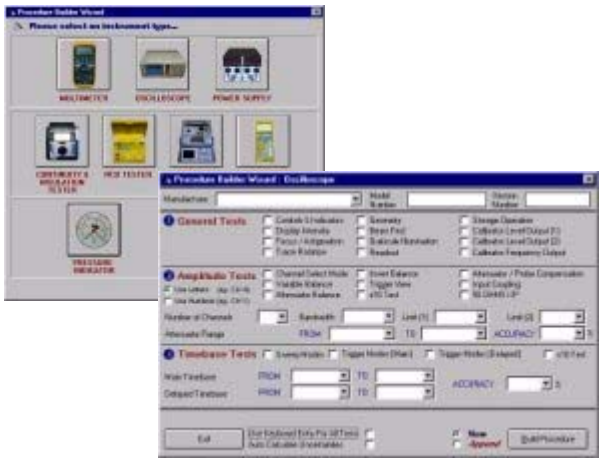
Auto, norm, hold off etc

Delay Time base operation and accuracy.

Cursor Readouts

Frequency, period, pk-pk amp, etc.

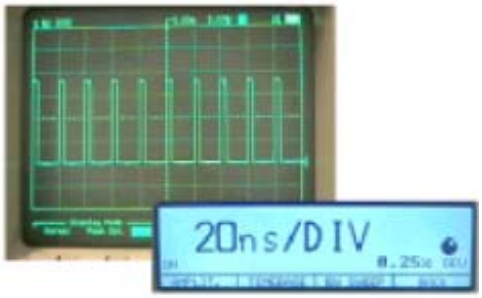
The 3000 series calibrator combines all the functions found in many standalone scope calibrators with the technical and economic advantage's of a full multi product calibrator, combine this with Transmille's powerful ProCal calibration software, with an auto create procedure builder wizard for many generic instrument types including oscilloscopes and you have a easy to use system to produce consistence calibration results with documented procedures and results, reducing errors and increasing the calibration throughput of the calibration engineer.



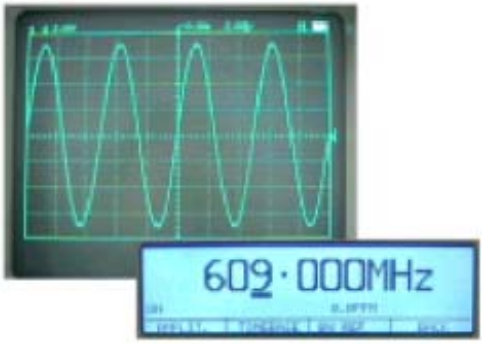
ProCal oscilloscope calibration *procedure wizard*

3000 Series Oscilloscope Calibration Option - Display Examples

3000 Series *amplitude* output display



3000 Series *timebase* output display



3000 Series *bandwidth (leveled sweep)* output display

Additional Documents

- 3000 Series Oscilloscope Option Extended Specifications
- 3000 Main Brochure

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