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DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR DIGITIZING OSCILLOSCOPE, TEKTRONIX, MODEL TDS540B

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REPORTING OF ERRORS AND RECOMMENDING IMPROVEMENTS

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CHANGE 1

SECTION I IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Digitizing Oscilloscope, Tektronix, Model TDS540B. The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

a. Model Variations. None.

b. Time and Technique. The time required for this calibration is approximately 8 hours, using the dc and low frequency technique.

2. Forms, Records, and Reports

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25.

b. Adjustments to be reported are designated (R) at the end of the sentence in which they appear. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
DC Gain	Range: 1 mV/div to 10 V/div Accuracy: $\pm 1\%$
DC Voltage ¹	
Average of ≥ 16 waveforms	Accuracy: $\pm((1.0\% \times \text{reading} - \text{Net Offset}^1) + \text{Offset Accuracy} + (0.6 \text{ div} \times \text{V/div}))$
Delta volts between any two averages of ≥ 16 waveforms acquired under the same setup and ambient conditions	Accuracy: $\pm((1.0\% \times \text{reading}) + (0.1 \text{ div} \times \text{V/div}) + 0.3 \text{ mV})$
Bandwidth ²	
DC to 500 MHz	Range: 10 mV/div to 1V/div 5 mv/div to 9.95 mV/div 2 mv/div to 4.98 mV/div DC to 500 MHz
DC to 450 MHz	Range: 1 mv/div to 1.99 mV/div

See footnotes at end of table.

Table 1. Calibration Description - Continued

Test instrument parameters	Performance specifications
Offset	Range: 1 mV/div to 100mV/div Accuracy: $\pm((0.2\% \times \text{Net Offset}^1) + 1.5 \text{ mV} + (0.1 \text{ div} \times \text{V/div}))$ Range: 101 mV/div to 1 V/div Accuracy: $\pm((0.25\% \times \text{Net Offset}^1) + 15 \text{ mV} + (0.1 \text{ div} \times \text{V/div}))$ Range: 1.01 V/div to 10 V/div Accuracy: $\pm((0.25\% \times \text{Net Offset}^1) + 150 \text{ mV} + (0.1 \text{ div} \times \text{V/div}))$
Delay	$\leq 50 \text{ ps}$ for any two channels with equal volts/div and coupling settings
Time Base	$\pm 100 \text{ ppm}$ over any $\geq 1 \text{ ms}$ interval ³
Input Impedance	Range: Dc to 1 M Ω Coupled Accuracy: 1 M $\Omega \pm 0.5\%$ in parallel with 10 pF $\pm 3 \text{ pF}$ Range: DC to 50 M Ω Coupled Accuracy: 50 $\Omega \pm 1\%$ with VSWR $\leq 1.3:1$ from Dc to 500 MHz, $\leq 1.5:1$ from 500 MHz to 1 GHz
Input Voltage	Range: DC - 1 M Ω , AC - 1 M Ω , or GND Coupled Accuracy: $\pm 300 \text{ V}$ (DC + peak AC), 400 V peak; derate at 20 dB/decade above 1 MHz, CAT II Range: Dc - 50 Ω or ac - 50 Ω coupled Accuracy: 5 V _{RMS} , with peaks $\leq +30 \text{ V}$
Long Term Sample Rate and Delay Time	Accuracy: $\pm 25 \text{ ppm}$ over any $\geq 1 \text{ ms}$ interval
Sensitivity and Edge Trigger	Any Channel: 0.35 div from dc to 50 MHz, increasing to 1 div at 500 MHz Auxiliary: 400 mV from dc to 50 MHz, increasing to 750 mV at 100 MHz
Pulse-Width Triggering	Range: 1 ns to 1 μs Accuracy: $\pm(20\%$ of setting $+0.5 \text{ ns})$ Range: 1.02 μs to 1 s Accuracy: $\pm(100 \text{ ns} + 0.01\%$ of setting)
Trigger Output V _{OUT} (HI) V _{out} (LO)	Accuracy: ≥ 2.5 open circuit; $\geq 1.0 \text{ V}$ into a 50 Ω load to ground Accuracy: $\leq 0.7 \text{ V}$ into a load of $\leq 4 \text{ mA}$; $\leq 0.25 \text{ V}$ into a 50 Ω load to ground

¹Net Offset = Offset - (Position x Volts/Div). Net Offset is the nominal voltage level at the oscilloscope input that corresponds to the center of the A-D converter dynamic range. Offset Accuracy is the accuracy of this voltage level

²The limits given are for the ambient temperature range of 0°C to +30°C. Reduce the upper bandwidth frequencies by 2.5 MHz for each °C above +30°C

³Due to STANDARDS limitations, this specification does not agree with manufacturer's stated accuracies.

SECTION II EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286. Alternate items may be used by the calibrating activity. The items selected must be verified to perform satisfactorily prior to use and must bear

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evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI. Where the four-to-one ratio cannot be met, the four-to-one accuracy will be listed, and the actual accuracy of the equipment selected is shown in parenthesis.

5. Accessories Required. The accessories required for this calibration are common usage accessories issued as indicated in paragraph 4 above and are not listed in this calibration procedure.

Table 2. Minimum Specifications of Equipment Required

Common name	Minimum use specifications	Manufacturer and model (part number)
CALIBRATOR	Dc voltage: Range: 0 V to 18 V Accuracy: .11%	John Fluke, Model 5700A/CT (p/o MIS-35947); w/power amplifier, John Fluke, Model 5215A/CT (5215A/CT) w/transconductance amplifier, John Fluke, Model 5220A/CT (5220A/CT); w/ac divider, John Fluke, Model 7405A-4207 (7405A-4207)
OSCILLOSCOPE CALIBRATION WORKSTATION	Frequency: Range: 100 kHz to 500 MHz (12 mV to 12 V p-p) Accuracy: $\pm 2\%$ Time markers: Range: 10 ms to 10 ns Accuracy: $\pm 0.005\%$ of reading ± 10 ps (8 ppm) Square Wave: Range: 500 mV Accuracy: $\pm 0.25\%$ of reading $+1 \mu\text{V}$	(MIS-38938)consisting of: Tektronix, Type I (F7529A1)(MIS-38938 TYPE I); Tektronix, Type II (F7529A2)(MIS-38938 Type II); calibration generator, Tektronix, Type CG 5011 calibration generator, Tektronix, Type CG 5011 (CG 5011), pulse head, Tektronix, Type 015-0611-00 (015-0611-00); leveled sine wave generator, Tektronix, Type SG5030 (SG5030); w/leveling head, Tektronix, Type 015-2350-01 (015-2350-01)
MULTIMETER	Range: 1.0 to 10.0 V Accuracy: Nominal	John Fluke, Model 8840A/AF-05/09 (AN/GSM-64D)

SECTION III CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name as listed in table 2.

c. Unless otherwise specified, verify the results of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.