TM 500 / 5000

MODULAR TEST INSTRUMENTS

• DC 5010

Digital Counter

A Counter for Every Purpose

The 350 MHz DC5010 Universal Counter/Timer features reciprocal frequency measurements and an especially wide range of other measurement functions; plus auto-trigger, auto-averaging, arming, probe compensation, the flexibility of IEEE Standard 488 compatibility; and more.

Microprocessor-Based High Performance

The DC 5010 is microprocessor-based, and contains features available only in high-performance, microprocessor-based instruments. It uses a powerful dual-register architecture to obtain high-resolution counting of low-frequency signals. The DC 5010 provides eight digits of resolution in about a third of a second. It provides 3.125 ns single shot resolution for time interval measurements. With averaging, the DC 5010 provides ps resolution on time-interval measurements, the best available today.

Other features include auto-trigger, auto-averaging, probe compensation, and diagnostic self-test. At the push of a button, the auto-trigger feature senses the top and bottom of the applied signal and automatically sets the trigger point midway between the two. Auto-averaging provides the optimum combination of resolution and measurement time, regardless of the frequency of the signal. Both auto-trigger and auto-averaging can be overridden to allow manual or programmable control of averaging, measurement time and triggering levels.

The probe compensation feature allows the user to quickly and accurately compensate a high-impedance probe to the instrument input impedance directly. Improperly compensated probes are a common source of timing errors when using counters without this feature.

The DC 5010 includes arming inputs and shaped outputs for added versatility when measuring selected parts of complex waveforms. It features a phase-modulated time base to eliminate clock-synchronous errors in all time averaging modes.

In addition, the DC 5010 permits direct measurement and display of rise time and fall time.

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THE GLOBAL SOURCE FOR PROVEN TEST AND MEASUREMENT TECHNOLOGY.

Prices and specifications subject to change without notice.

DC 5010

- **350 MHz both A and B Channels**
- **3.125 ns Single Shot Resolution**
- **9 Digit LED Display**
- **Measurement Functions:**
  Reciprocal Frequency
  Period and Period Average
  Width and Width Average
  Time A → B and Time A → B Average
  Events B During A and
  Events B During A Average
  Totalize (A, A + B, A - B)
  Time Manual
  Ratio B/A and Ratio B/A Average
  Rise time A/Fall time A (With Averaging)
- **Duty Cycle Independent Auto-Trigger from 10 Hz to 350 MHz in <2.5 Seconds**
- **DVM Mode for Displaying Trigger Level Setting**
- **Shaped A and B Channel Outputs**
- **Auto or Selected Averaging from 1 to 10^9**
- **Hysteresis Compensation**
- **Probe Compensation Mode for Probe Compatibility**
- **Arming for Added Measurement Capability with Complex Waveforms**
- **IEEE Standard 488.1-1987 compatibility**

The DC 5010 Universal Counter/Timer features reciprocal frequency, period, ratio and events B During A measurements to 350 MHz. The powerful reciprocal technique provides high resolution of low frequency signals much faster than conventional counting techniques. A 3.125 ns, single-shot resolution is featured for the rise time and fall time functions and for the timing, time interval and width measurements. For all of these measurements, identical A and B channels and averaging provide increased accuracy. The averaging feature allows measurements to be averaged from 1 to 10^9 times with usable time interval resolution to 1 picosecond. A pseudo-random, phase modulated time base in the DC 5010 provides increased accuracy by eliminating clock synchronous errors in the Time Interval and Width Averaging modes. Also included is a Time Manual mode, as well as three 350 MHz Totalize modes: A, A+B and A - B.

The DC 5010 also has an auto-trigger feature for ease of setup. Auto-trigger, at the push of a button, senses the applied signal and sets both trigger levels to the optimum trigger points. The trigger voltage setting can be displayed. Such trigger level information is essential for accurate time interval measurements, especially when the rise time and falltime of the signal accounts for a sizable portion of the time interval to be measured. Hysteresis compensation is automatic in the DC 5010. The outputs of the signal shaping circuits can also be monitored. These outputs are useful for setting the trigger points on complex waveforms.

The microprocessor-based DC 5010 executes an extensive self-test routine when powered up. The test modes and signature analysis contribute to a reduced life-cycle cost of ownership. A unique feature, Probe Compensation, permits quick and accurate compensation of signal probes. An arming input allows measurement of selected events within complex waveforms. The DC 5010 uses proprietary amplifiers and Schmitt trigger circuitry to provide flat sensitivity and low distortion signal acquisition.

The DC 5010 is equipped with a temperature-controlled 10 MHz crystal oscillator to obtain an accurate, highly stable time base.

DC 5010 Characteristics

Display — Nine-digit LED display, automatic decimal point positioning, LED indicators for units and measurement gate. Overflow is indicated by a blinking display.

Channel A and B Input Characteristics

Frequency Range —
50 Ω Termination: 0 to 350 MHz dc coupled. 100 kHz to 350 MHz ac coupled.

1 MΩ Termination: 0 to 300 MHz dc coupled. 16 Hz to 300 MHz ac coupled.

Sensitivity —
50 Ω Termination: 25 mV RMS sine wave to 350 MHz. 70 mV peak-to-peak pulse.

1 MΩ Termination: 25 mV RMS to 200 MHz, 42 MV rms to 300 MHz.

Attenuation — Selectable 1X, 5X.

Impedance — 1 MΩ paralleled by 23 pF ± 2 pF or 50 Ω.

Trigger Level Range — +2V to -2V (X1). +10V to -10 V (X5).

Trigger Level Accuracy — ± 2% of reading for a dc input V, ±40 mV x attenuator.

Dynamic Range — 4 V peak-to-peak x attenuation.

Auto-Trigger Frequency Range —
10 Hz to 350 MHz.

Independent Controls — Slope +/-, attenuation 1X/5X, Coupling ac/dc., impedance 1 MΩ/50.

Maximum Input Voltage — 1 MΩ input impedance.

1X: ± 42 V (dc + peak ac) to 200 kHz;
± 2 V (dc + peak ac) to 300 MHz.

5X: ± 42 V (dc + peak ac) to 1 MHz;
± 10 V (dc + peak ac) to 300 MHz.

In 50 Ω input impedance, signals > ±2V x attenuator will cause input protection circuitry to switch input to 1 MΩ.

Shaped Out — Shaped replica of signal being measured, aids proper triggering on complex waveforms (≥100 mV typically to 350 MHz into 50 Ω load).

Arming Input — Permits measurements of complex waveforms. A TTL high allows averaging of selected events within a measurement.

Frequency A

Range — 36 µHz to 350 MHz.

Resolution =

$$\pm \text{LSD} \pm 1.4 \times \frac{\text{A Trigger Jitter Error}}{N} \times (\text{Frequency A})^2$$

Accuracy — Resolution ± (Time Base Error x Frequency A).

Period A

Range — 3.125 ns to 7.6 hours.

Resolution =

$$\pm \text{LSD} \pm \frac{1.4 \times \text{A Trigger Jitter Error}}{N}$$

Accuracy — Resolution ± (Time Base Error) x Period A.

Ratio B/A

Range — 10^{-8} to 10^{9} (Frequency range 36 µHz to 350 MHz).

Resolution =

$$\pm \text{LSD} \pm \frac{1.4 \times \text{B Trigger Jitter Error} \times \text{Frequency B}}{N}$$

Accuracy — Same as Resolution.

Time A → B

Range — 2.0 ns to 7.6 hours.

Resolution =

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} \times (\pm \text{CH A Trig Jitter Error} \pm \text{CH B Trig Jitter Error})$$

Accuracy — Resolution
± (Time Base Error x Time A → B)
+ (B Trigger Slew Error)
– (A Trigger Slew Error)
± (Channel Delay Mismatch*).

Resolution — Best time A → B Avg resolution = ± 1 ps.

Minimum Dead Time — 12.5 ns (stop to start).
Rep Rate — <70 MHz.

*Can be removed with "Null."

Events B During A

Range — 10^{-8} to 10^{9}.

Maximum B Frequency — 350 MHz.

Maximum A Frequency — 80 MHz

Minimum A Pulse Width — 4.0 ns (and 8.5 ns minimum time between pulses).

Resolution =

$$\pm \text{LSD} + \frac{\text{Frequency B}}{\sqrt{N}} \pm (\text{Trig Jitter Error CH A start edge} \pm \text{Trig Jitter Error CH A stop edge}).$$

Accuracy — Resolution + Freq B (Stop Slew Rate Error - Start Slew Rate Error) + Freq B x (5 ± 2 ns).

Width A

Range — 4 ns to 7.6 hours.

Resolution =

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error}).$$

Accuracy — Resolution
± (Time Base Error x Width A)
+ (Stop Slew Rate Error - Start Slew Rate Error) ± 2 ns.

Minimum Dead Time Between Pulses — ≤8.5 ns.

Repetition Rate — 50 MHz maximum.

Time Manual

Range — 0 to 3.125 x 10^{4} s (≈ 8 hours).

Resolution — ± LSD (100 ms).

Accuracy — ± Resolution ± (Time Base Error x Time).

Totalize A

Range — 0 to 10^{9} counts.

Repetition Rate — 0 to 350 MHz.

Totalize A + B

Range — 0 to 10^{9} counts (A+B ≤ 10^{9}).

Repetition Rate — 0 to 350 MHz.

Totalize A - B

Range — -1 x 10^{8} to +1 x 10^{9} (either A >10^{12} or B >10^{12} will cause overflow).

Repetition Rate — 0 to 350 MHz.

Rise/Fall A

Range — 4 ns to 10^{4} s (50 Ω) 5 ns to 10^{4} s (1 mΩ).

Repetition Rate — Minimum time between rising (falling) edges is 12.5 ns (80 MHz).

Input Amplitude — (1.4 V to 8 V) x Attenuation (50 Ω), (0.7 V to 4 V) x Attenuation (1 MΩ).

Resolution =

$$\pm \text{LSD} + \frac{1}{\sqrt{N}} (\pm \text{Start Trig Jitter Error} \pm \text{Stop Trig Jitter Error})$$

Accuracy — Resolution ±
(Time Base Error x Risetime/Fall time)
± 2 ns ± 4 mV x Slew Rate A Error (near 10%) ± 4 mV Slew Rate A Error (near 90%).

Resolution and Accuracy Definitions

Trigger Jitter Error (seconds RMS) =

$$\frac{\sqrt{(en_1)^2 + (en_2)^2} \text{ (Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: en_1 = *140 µV RMS typical counter input noise for 1 MΩ filter on; 250 µV RMS typical for 1 MΩ filter off and 340 µV RMS typical for 50 Ω.*

en_2 = *RMS Noise Voltage of input signal at trigger point measured with 150 MHz bandwidth.*

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Slew Rate Error (seconds) =

$$\frac{\text{*trigger level error (V)}}{\text{Input slew rate at trigger point (V/s)}}$$

*Trigger level error =

All functions except Width and Events B During A	Positive Slope	Trigger accuracy times ATTN factor
	Negative Slope	(trigger accuracy ± 10 mV) times ATTN factor
Width A (positive pulse)	start edge	trigger accuracy times ATTN factor
	stop edge	(trigger accuracy + hyst) times ATTN factor
(negative pulse)	start edge	(trigger accuracy + hyst) times ATTN factor
	stop edge	trigger accuracy times ATTN factor
Events B During A	Same as Width, except each number is multiplied by (Frequency B)	

Note: Input hysteresis is typically 50 mV peak-to-peak x attenuation.

N = Number of Averages

The minimum number of averages is selected by the Averages button and the ↑↓ buttons in decade steps from 1 to 10^9. At Channel A repetition rates above ≈250 Hz the actual number of averages will be:

N = [Frequency A (Hz) x 4 ms] + Averages.
N = Averages setting (below 250 Hz).

This calculation typically leads to better than expected resolution in the displayed answer for small N with only minimal impact on measurement time. It does mean, however, that Arming must be used where only N = 1 is desired for signals ≥250 Hz.

In the Auto mode the counter measures with a fixed measurement time of about 300 ms (or the time for one event, whichever is greater).

N = Frequency A (Hz) x 0.3 s (N always ≥1).

Probe Comp display indicates 1 for over comp, 0 for under comp. Accuracy = (A x 0.300)%. A = Probe Attenuation times counter attenuator setting.

Time Base Error — The sum of all errors specified for the time base used.

High Stability Time Base

Crystal Frequency — 10 MHz.

Temperature Stability — ±2 x 10^{-7} of final frequency in < 10 minutes when cold started at 25˚C.

Aging Rate — ≤1 x 10^{-8}/day at time of shipment, 4 x 10^{-8}/week after 30 days of continuous operation, 4 x 10^{-6}/year after 60 days of continuous operation.

Setability — Adjustable to within +2 x 10^{-8}.

Rear Interface

Inputs — Arming; reset; external time base (1.5, or 10 MHz).

Outputs — 1 MHz clock.

Included Accessory

Shaped output cable (012-0532-00).

Ordering Information

DC 5010	Prgm. Universal Digital Counter

Includes:
Instruction Manual (070-3897-02),
Instrument Interfacing Guide (070-4611-00),
Reference Guide (070-3553-01),
Shaped Output Cable (012-0532-00)

TM 502A	2 Wide Power Module Mainframe
TM 502A/TB	TM 502A w/Tool Box Plug-In
TM 503B	3 Wide Power Module Mainframe
TM 5003	3 Wide Power Module Mainframe, GPIB
TM 5003/RI	TM 5003 w/Rear Interface
TM 5006A	6 Wide Power Module Mainframe, GPIB
TM 5006A/R	TM 5006A w/Rack Mount
TM 5006A/RI	TM 5006A w/Rear Interface
TM 5006A/R/RI	TM 5006A w/Rack Mt & Rear Interface
TM 5006A/EMC	TM 5006A w/EMC Shielding

Mainframe Power Plug Options

Standard	120V North American
UE220	220V Universal Euro & Switzerland
UK240	240V United Kingdom
A240	240V Australian
NA240	240V North American
S220	220V Switzerland

Warranty

One year on materials and workmanship.

Calibration Documentation

Contact TEGAM for OPTION Z540 NIST Traceable Compliance Certificate and Test Data.

Calibration & Technical Services

For warranty and remedial repair, calibration services and spare parts, or for additional information on TEGAM sales and service offices around the world, contact us at 440-466-6100 (ph) or 440-466-6110 (fx).

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