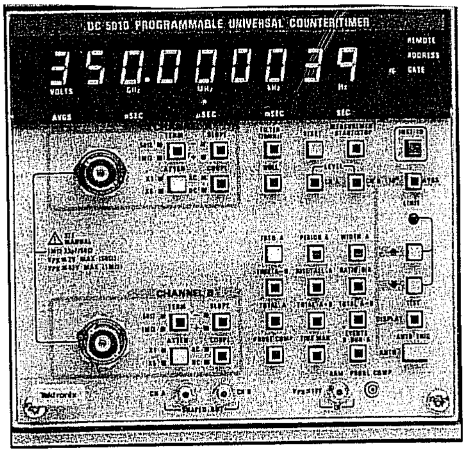


DC 5010 Programmable Counter/Timer

DC 5010/DC 510

GPIB IEEE-488 — The DC 5010 complies with IEEE Standard 488.1-1987, and with Tektronix *Standard Codes and Formats.*

- **350 MHz both A and B Channels**
- **3.125-ns Single-Shot Resolution**
- **9-Digit Display**
- **1-ps Resolution, with Averaging**
- **Reciprocal Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize A, A+B, A−B; Ratio; Rise/Fall; Time Manual; Arming; Null**
- **Auto or Selected Averaging to 10^9 in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **DVM Mode for Displaying Trigger-Level Setting**
- **Shaped A and B Channel Outputs**
- **Hysteresis Compensation**
- **Probe Compensation**
- **High Stability Oven Time Base**

The DC 5010/DC 510 Universal Counter/Timers feature reciprocal frequency to 350 MHz, period, ratio, events B during A measurements, and time A to B. The powerful reciprocal technique provides high resolution of low frequency signals much faster than conventional counting techniques.

Timing measurements include time interval, width, and rise and fall time features to 3.125 ns single-shot resolution. Measurements can be averaged up to 1 billion times with usable resolution to 1 picosecond. The pseudo-random, phase-modulated time base provides increased accuracy by eliminating synchronous errors in the time interval and width averaging modes.

Auto trigger senses the applied signal and sets trigger levels to the optimum points. In the DC 5010, trigger levels, the minimum and maximum signal voltage and the trigger voltage are available over the GPIB, and can be viewed on the 9-digit display.

Other features include an arming input that allows measurement of selected inputs from complex waveforms, hysteresis compensation and probe compensation for attenuator type probes.

The DC 510 is upgradeable to the GPIB compatible DC 5010 with a modification kit that can be installed in the field.

CHARACTERISTICS

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

CHANNEL A AND CHANNEL B INPUT

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 dc: ≤25 mV RMS sinewave to 350 MHz. ≤70 mV p-p pulse. 1 MΩ termination. DC/AC ≤25 mV RMS to 200 MHz. 42 mV RMS to 300 MHz.
Attenuation—Selectable 1X, 5X.
Impedance—1 MΩ paralleled by 23 pf ±2.2 pF (10%) or 50 Ω ±3% dc.
Dynamic Range—70 mV p-p to 4 V p-p (x attenuation).
Trigger Level Range—≥ +2 V to ≤ −2 V with 4 mV resolution (X1). ≥ ±10 V to ≤ −10 V with 20 mV resolution (X5).
Trigger Level Accuracy—±1% of F.S. trigger level range, plus ±2% of reading for a dc input V, ±40 mV x attenuator.
Autotrigger Frequency Range—10 Hz to ≥350 MHz.
Independent Controls—Slope ±, Attenuation 1X/5X, Couple ac/dc, Impedance 1 MΩ/50 Ω.
Maximum Input Voltage (1 MΩ input impedance)—1X: ±42 V (dc + peak ac) to 200 kHz; ±2 V (dc + peak ac) 2 to 250 MHz. 5X: ±42 V (dc + peak ac) to 1 MHz; ±10 V (dc + peak ac) 1 to 250 MHz.
In 50 Ω Input Impedance: Signals > ±2 V ×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—

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

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

PERIOD A

Range—3.125 ns to 7.6 hrs.
Resolution—

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

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

RATIO B/A

Range—10^{-8} to 10^9 (Frequency Range: ≤36 μHz to ≥350 MHz).
Resolution—

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

Accuracy—Same as Resolution.

TIME A→B

Range—2.0 ns to 7.6 hrs.
Minimum Dead Time—12.5 ns (stop to start).
Resolution—

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

Accuracy—Resolution ± (Time Base Error ×TI) ±Channel Delay Mismatch + B Trigger slew error-A Trigger slew error.
Channel Delay Mismatch—<2 ns between front panel inputs.
Resolution—Best time A→B Avg resolution = ±1 ps.
Repetition Rate—≥70 MHz.
[1] 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.
Maximum A Pulse Width—≤4.0 ns.
Minimum Time Between A Pulses—≤8.5 ns.
Minimum Dead Time Between Pulses—≤8.5 ns.
Resolution—

$$\pm LSD + \frac{\text{Frequency B}}{\sqrt{N}}$$

±(Trigger Jitter Error CH A start edge ±Trigger Jitter Error CH A stop edge).
Accuracy—Resolution +Frequency B (Stop Slew Rate Error−Start Slew Rate Error) + Frequency B×(5±2 ns).

WIDTH A

Range—≤4 ns to 7.6 hrs.
Minimum Dead Time Between Pulses—1.6 ns.
Resolution—

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

Accuracy—Resolution ± (Time Base Error ×Width A) + (Stop Slew Rate Error−Start Slew Rate Error) ±2 ns.
Repetition Rate—≥80 MHz.

TIME MANUAL

Range—3.125×10^4 s (≈ 8 hrs).
Resolution—±LSD 100 ms.
Accuracy—±Resolution ±(Time Base Error ×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— -1×10^8 to $+1\times10^9$ (either A>10^{12} or B>10^{12} will cause overflow).
Repetition Rate—0 to ≥350 MHz.

RISE/FALL A

Range—5 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 to 8 V) 1.4 V p-p min, +4 to −4 V Dc + peak AC max (50 Ω), (0.7 to 4 V) 700 mV p-p min, +2 to −2 V DC + peak AC max (1 MΩ).
Resolution—

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

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

PROBE COMPENSATION

Display—1 or 0 in each channel.
Accuracy—Probe Attenuation×Counter Attenuation×0.300 (%).

RESOLUTION AND ACCURACY DEFINITIONS

Trigger Jitter Error (Seconds RMS)—

$$\frac{\sqrt{(e_{n1})^2+(e_{n2})^2}\ \text{(Volts RMS)}}{\text{Input Slew Rate at trigger point (V/s)}}$$

Where: e_{n1} = 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.
e_{n2} = RMS Noise Voltage of input signal to trigger point measured with 350 MHz bandwidth.

Slew Rate Error (Seconds)—

$$\frac{\text{Trigger Level Error (V)}^{*1}}{\text{Input Slew Rate at Trigger Point (V/s)}}$$

*1 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	Start Edge	Trigger accuracy times ATTN factor
	Stop Edge	(Trigger accuracy+hyst) times ATTN factor
	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 p-p x attenuation.
N=Number of events averaged.

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)×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 nean, however, that Arming must be used where only N=1 is 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)×0.3 s
(N always ≥1).

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

STANDARD HIGH STABILITY TIME BASE

Crystal Frequency—10 MHz.
Temperature Stability—$\pm 2\times10^{-7}$ 0 to +50 °C after warm-up.
Warn-Up Time—$\pm 2\times10^{-7}$ of final frequency in <10 minutes when cold started at 25 °C.
Aging Rate—$\leq 1\times10^{-8}$/day at time of shipment, 4×10^{-8}/week after 30 days of continuous operation, 4×10^{-8}/year after 60 days of continuous operation.
Setability—Adjustable to within $\pm 2\times10^{-8}$.

REAR INTERFACE

Inputs—Arming; reset; external time base (1, 5, or 10 MHz), prescale.
Outputs—1 MHz clock.

OTHER CHARACTERISTICS

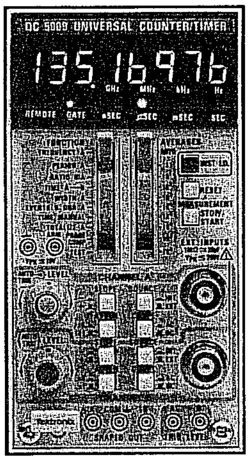
Power Consumption—19.3 W.
GPIB Data Output Rate—≈10 readings/s maximum (DC 5010 only).
TM 5000 Power Module Compatibility—The DC 5010 is not compatible with TM 500 Series mainframes; the DC 510 is compatible with both.

ORDERING INFORMATION

DC 5010 Programmable Universal Counter/Timer. **$3,600**
Includes: Shaped output cable (012-0532-00); instruction manual (070-3897-02); instrument interfacing guide (070-4611-00); reference guide (070-3553-00).
DC 510 Universal Counter/Timer **$3,300**

RECOMMENDED PROBE

P6125—5X Passive Probe $80



DC 5009 Programmable Counter/Timer

DC 5009/DC 509

GPIB IEEE-488

The DC 5009 complies with IEEE Standard 488.1-1987 and with Tektronix *Standard Codes and Formats.*

- **135 MHz Both A and B Channels**
- **10-ns Single-Shot Resolution**
- **8-Digit Display**
- **5-ps Resolution, with Averaging**
- **Reciprocal-Frequency Measurement; Period; Width; Time A→B; Events B During A; Totalize; Ratio; Time Manual; Arming**
- **Auto or Selected Averaging to 10^8 in All Modes**
- **Duty-Cycle Independent Autotrigger**
- **Shaped A and B Channel Outputs**
- **Probe Compensation**
- **High Stability Oven Time Base**

The DC 5009/DC 509 single-width Universal Counter/Timers provide all of the measurement functions of the higher performance DC 5010/DC 510 except rise time/fall time, null, and totalize A±B.

The powerful reciprocal-frequency measurement technique allows up to eight digits of resolution of low-frequency signals in one second or less of measurement time. The DC5009/DC509 has the same automatic averaging feature as the DC 5010/DC 510; selected averaging of up to 10^8 events provides usable time-interval resolution of 5 ps.

The TM 5000 rear-interfacing capability allows the operation of the DP 501 to be controlled over the GPIB through the DC 5009 frequencies to 1.3 GHz.

A field-installable modification kit is available to upgrade a manual DC 509 Universal Counter/Timer to a GPIB programmable DC 5009 Universal Counter/Timer.

CHARACTERISTICS

Display—Eight-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

Frequency Range—>0 to ≥135 MHz dc coupled; ≤10 Hz to ≥135 MHz ac coupled.
Sensitivity—≤20 mV RMS (56.6 mV p-p) to ≥100 MHz, 40 mV RMS (113 mV p-p) to ≥135 MHz, 115 mV p-p at minimum, pulse width of 3 ns.
Attenuation—Selectable 1X, 5X.
Impedance—1 MΩ ±2% paralleled by ≤30 pF.
Trigger Level Range—+3.200 to −3.175 V with 25 mV resolution (X1), +16 to −15.875 V with 125 mV resolution (X5).
Trigger Level Accuracy—±15 mV ±40 μV/°C referenced to 25 °C.
Dynamic Range—−3.2 ≤input voltage ≤+3.2. X1: V_{in} p-p ≤3 V; X5: V_{in} p-p ≤15 V (for input signal risetimes ≤5 ns).
Autotrigger Frequency Range—Sensitivity: ≤125 mV p-p × attenuation; ≤20 Hz to ≥100 MHz. Range: ±3.2 V × attenuation. Resolution: 25 mV × attenuation.
Independent Controls—Slope±, attenuation 1X/5X, Couple ac/dc, Source Internal/External.