



THURLBY THANDAR INSTRUMENTS

TG500 & TG2000 series



5MHz & 20MHz function generators

*including sweep/function and pulse/function generators*

# TG500 and TG2000 series function generators

## 5MHz & 20MHz function, sweep/function & pulse/function

### Classic analogue generators

The function generator is one of the most versatile pieces of test & measurement instrumentation available.

It can generate a variety of precision waveshapes over a range of frequencies from mHz to MHz. It can provide a wide range of controlled amplitudes from a low-impedance source, and maintain constant amplitude as the frequency is varied.

The TG500 and TG2000 series from TTI represent the state of the art in pure analogue function generators and incorporate features not included on lower cost generators, such as triggering, gating and variable start/stop phase.

### Exceptional waveform quality

These generators provides exceptionally high waveform quality under all conditions. That means low sinewave distortion, low aberration triangle waves and fast-edged square waves with low overshoot.

This waveform quality is maintained throughout the frequency range, and at low output levels as well as high.

### Triggered and gated modes with variable start/stop phase

As well as continuous operation the TG500/2000 series can operate in triggered or gated modes.

In Triggered mode the generator is quiescent until triggered by an external input or by pressing Manual. One complete cycle is then generated.

In Gated mode the generator is quiescent until gated by an external signal or by pressing Manual. It then runs continuously for the duration of the gate signal.

The Start/Stop Phase control varies the triggered and gated signal start/stop point between  $-90^\circ$  to  $+90^\circ$ .

### Extended sweep range

The TG500/2000 series generators offer a frequency sweep range of more than 1000:1 using either the vernier or an external sweep voltage. Sweep linearity (voltage to frequency) is excellent.

The TG502 has a logarithmic mode which offers a sweep range of more than 10,000:1.

## Four different generators

### TG501

- 0.005Hz to 5MHz frequency range
- Continuous, triggered or gated modes
- Very high waveform quality at all frequencies & levels
- Sine, square, triangle, ramp, pulse and haversine outputs
- Variable start/stop phase
- 1000:1 frequency change by vernier or external voltage
- Variable DC offset with disable switch
- 19:1 symmetry range
- 20mV to 20V pk-pk from 50  $\Omega$ , plus TTL output

### TG2001 - as TG501 except:

- 0.002Hz to 20MHz frequency range
- Digital display of frequency, amplitude and offset
- Amplitude modulation input

### TG502 - as TG501 plus:

- Built-in sweep generator
- 1000:1 linear or 10,000:1 log sweep with marker
- Precise dial-and-enter setting of sweep limits
- Variable sweep rate and marker duration
- Single sweep mode
- Sweep reset and hold
- Sweep and pen-lift outputs

### TG503 - as TG501 plus:

- Built-in pulse generator
- Normal, double or delayed pulse modes
- 10MHz in double pulse mode
- Variable pulse width and delay
- Symmetrical, positive-going or negative-going outputs with adjustable baseline level

# Technical specifications

## Wide range variable symmetry

The TG500/2000 series provide switchable bi-directional variable symmetry at constant frequency from 1:19 to 19:1. This enables pulse and ramp waveforms to be generated over a wide duty cycle range.

## Full range level control

The TG500/2000 series provides a main output with a maximum emf of 20V pk-pk from a 50Ω source.

An amplitude vernier with a range of more than 20dB is combined with two -20dB switched attenuators to provide levels down to 20mV pk-pk. Variable DC offset of ±10V can be selected via a front panel switch.

An auxiliary output provides a fixed TTL level signal suitable for driving up to 20 standard TTL loads.

## Digital display for precision and convenience (TG2001)

The TG2001 has the added convenience of a digital display. This display provides a readout not just of frequency, but of amplitude and offset as well.

## Sophisticated internal sweep (TG502)

The TG502 incorporates a highly sophisticated internal sweep generator capable of providing linear or logarithmic frequency sweeps. In logarithmic mode sweep ranges of over 10,000:1 are possible.

The sweep generator is of much higher performance than those incorporated into some lower cost function generators.

The upper and lower sweep limits are set with the main vernier dial and maintained with digital sample/hold amplifiers. This gives excellent setability and high sweep stability - essential when large sweep ranges are needed.

The sweep time is settable from about 20ms up to 120 seconds. A variable duration Marker is provided at the frequency of the vernier.

Continuous or single sweep modes are available. Sweep reset and hold can be controlled by external signals. A set of front panel LEDs indicates the sweep status.

The sweep generator is suitable for use with any X-Y display such as an oscilloscope or chart recorder. Output sockets are provided for the sweep ramp signal and for a pen-lift signal.

## High performance pulse generator (TG503)

The TG503 incorporates a full-performance pulse generator with pulse widths variable between 50ns and 50ms at repetition rates from 0.005Hz up to 5MHz.

Pulses can be gated or triggered with fully variable delay between trigger and pulse (100ns to 50ms). A double pulse mode is also available with variable delay between pulses. Pulse repetition rates up to 10MHz can be generated in this way.

Pulses are available over the amplitude range of the main function generator (20mV to 20V). Pulses can be symmetrical about 0V or uni-directional, positive or negative going.

## FREQUENCY RANGE (TG501/502/503)

Frequency Range:	0.005Hz to 5MHz in 7 overlapping decade ranges with fine adjustment by calibrated vernier.
Vernier Range:	1000:1 within each range; (10,000:1 in Log mode - TG502 only).
Vernier Accuracy:	Better than ±5% of full scale.

## FREQUENCY RANGE (TG2001)

Frequency Range:	0.002Hz to 20MHz in 8 overlapping decade ranges with adjustment by coarse and fine verniers.
Vernier Range:	1000:1 within each range.
Frequency Display:	By 3.5 digit meter, accuracy better than 1% of full scale up to 2MHz, better than 3% up to 20MHz.

## EXTERNAL SWEEP

Sweep Range:	1000:1 within each range (10,000:1 in Log mode TG502).
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## FUNCTIONS

(Specifications apply for the top decade of each range and output level of 10V peak-to-peak into 50Ω termination).

### Sine

Distortion:	Less than 0.5% to 50kHz; less than 1% to 500kHz; all harmonics >30dB below fundamental above 500kHz.
Amplitude Flatness:	0.2dB to 500kHz; ± 1dB to 5MHz, (± 1.5dB to 20MHz TG2001 only)

### Triangle

Linearity:	Better than 99% to 500kHz.
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### Squarewave

Rise and Fall Times:	<45ns TG501/2/3; <15ns TG2001.
Mark : Space Ratio:	1:1 ± 1% to 100kHz; 1:1 ±5% to 5MHz.

### DC

Range:	± 10V from 50Ω.
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## OPERATING MODES

Run:	Generator runs continuously at selected frequency.
Triggered:	Generator is quiescent until triggered by an external input at TRIG IN or by pressing MANUAL. One complete cycle is then generated at the selected frequency, starting and stopping at the phase set by the START/STOP PHASE control.
Gated:	Generator is quiescent until gated by an external signal at TRIG IN or by pressing MANUAL. Generator then runs continuously at the selected frequency for duration of gate signal, starting and stopping at the phase set by the START/STOP PHASE control. Last waveform started is completed.
Manual:	Manually operates generator as described in Triggered and Gated sections.
Start/Stop Phase:	The START/STOP PHASE control varies the triggered and gated signal start/stop point from approximately -90° to +90° up to 500kHz (TG501/2/3) or 2MHz (TG2001).
Symmetry:	When SYM is selected the SYMMETRY control varies the duty cycle from typically 1:19 to 19:1 to produce sawtooth and variable pulse-width waveforms. The indicated frequency is divided by 10 with SYM selected.

## INPUTS

### Sweep Input

Input Impedance:	10kΩ.
Input Sensitivity:	0 to 4V for 1000:1 sweep (TG501/2/3). 0 to 3V for 1000:1 sweep (TG2001).
Maximum Allowable Input Voltage:	±10V.
Sweep Linearity:	Better than 1%.
Maximum Slew Rate of Input Voltage:	0.1 V/us.

# Specifications (continued)

## Trigger Input

Frequency Range: DC - 5MHz (TG501/2/3); DC - 20MHz (TG2001).  
Signal Range: TTL compatible levels; maximum input 20V.  
Minimum Pulse Width: 50ns (TG501/2/3); 25ns (TG2001).  
Input Impedance: Typically 2k $\Omega$

## AM Input (TG2001 only)

Frequency Range: DC to 50kHz  
Input Sensitivity: 2V peak to peak for 50% amplitude modulation  
Input Impedance: 3k9 $\Omega$

## OUTPUTS

### 50 $\Omega$

Amplitude Control: >20dB vernier control within each attenuator range. Maximum output 20V peak-to-peak from 50 $\Omega$  (10V into 50 $\Omega$ ).  
Attenuator: Additional switch-selectable attenuation of 0dB, -20dB or -40dB. Minimum output <20mV peak-to-peak from 50 $\Omega$  (10mV into 50 $\Omega$ ).  
DC Offset Range:  $\pm 10V$  from 50 $\Omega$ . DC offset plus signal peak limited to  $\pm 10V$  ( $\pm 5V$  into 50 $\Omega$ ). DC offset plus waveform attenuated proportionally in -20dB and -40dB positions.  
Meter accuracy (TG2001 only): Amplitude - 0dB,  $\pm 5\%$  of full scale up to 2MHz, -20dB,  $\pm 6\%$  of full scale up to 2MHz, -40dB,  $\pm 7\%$  of full scale up to 2MHz.  
DC Offset - 0dB,  $\pm 1\%$  of reading  $\pm 10mV$ , -20dB,  $\pm 3\%$  of reading  $\pm 1mV$ , -40dB,  $\pm 5\%$  of reading.

### TTL

Amplitude: Fixed TTL level output at frequency and symmetry of main output. Capable of driving 20 standard TTL loads.

## INTERNAL SWEEP GENERATOR (TG502 only)

### Operating Modes

Sweep: Repetitive low to high to low frequency change. Mode, limits and rate selectable, see SWEEP CONTROL section.  
Single Sweep: One sweep and hold at STOP frequency.

### Operating Range

Sweep Range: 1000: 1 within each range in LIN mode, 10,000: 1 within each range in LOG mode.

### Sweep Control

ON/CFF: Sets main generator under control of sweep section.  
Sweep Mode: LOG/LIN see logarithmic or linear sweep mode for both internal and external sweep.  
Sweep Limits: START and STOP set lower and upper limits of sweep to frequency dial setting.  
Reset: RST holds sweep at START frequency until released.  
Single Sweep: SNGL selects single sweep mode. Releasing RST initiates a single sweep between the set limits.  
Hold: The sweep is halted at its instantaneous position whilst HOLD is selected.  
Drift in Hold Mode: Typically 0.25%/minute of full scale.  
Sweep Rate: The TIME control varies the sweep time from approximately 20ms to 120s.

### Marker

When the marker is selected the sweep ramp is halted for the set duration. If the sweep output is used to drive the X-axis of an oscilloscope then the electron beam is also halted for the marker duration and the display will have a bright "mark" on the trace at that point.

Marker Duration: The MARKER DURATION control switches the marker on and sets the duration for which the sweep is halted between 1ms and 10s.

Marker Frequency: When marker is selected the frequency dial sets the marker frequency.

### Sweep Annunciators

Reset: Lit whilst sweep is reset (held at start).  
Hold: Lit whilst sweep is halted by HOLD button.  
End: Lit when sweep is held at the end of a single sweep.  
Marker Off Scale: Lit when marker position (set by frequency dial) is outside sweep limits.

## Sweep Inputs

External Sweep Reset: TTL low or switch closure returns sweep to start frequency and holds until TTL high or switch opens.  
External Sweep Hold: TTL low or switch closure halts sweep at its instantaneous position until TTL high or switch opens.

## Sweep Outputs

Sweep Out: 0 to 4V ramp from internal sweep generator. Zero slope for duration of marker. Output impedance 600 $\Omega$ .  
Pen Lift: TTL high at end of single sweep and momentary TTL high at reset.  
(rear panel)

## PULSE GENERATOR SECTION (TG503 only)

### Operating Modes

Normal, double or delayed pulse with independently variable pulse width and delay, see PULSE section.

### Pulse Modes

Off: With no pulse mode selected the generator output is defined by the FUNCTION buttons.  
Normal: Pulse frequency determined by main dial, pulse width set by WIDTH control.  
Square Wave: 50% duty cycle squarewave at frequency of main dial.  
Double Pulse: WIDTH control sets width of both pulses; DELAY adjusts time between leading edges. Second pulse not generated until DELAY > WIDTH  
Delayed Pulse: DELAY control delays pulse with respect to TRIGGER INPUT.

### Pulse Operating Ranges

Period: 200ns to 200s (5MHz to 0.005Hz) in 7 overlapping decade ranges set by main generator controls. 100ns (10MHz) minimum period in double pulse mode.  
Width: 50ns to 50ms in 3 overlapping ranges with separate vernier providing continuously variable control within each range.  
Delay: 100ns to 50ms in 3 overlapping ranges with separate vernier providing continuously variable control within each range.

### Pulse Output

Complement: Inverts the 50 $\Omega$  output.  
Symmetrical: Pulse LOW and HIGH levels symmetrical about baseline. Max. output level 20V pk to pk (10V into 50 $\Omega$ ).  
Positive going: Pulse LOW level clamped to baseline. Maximum output level + 10V from baseline (5V into 50 $\Omega$ ).  
Negative going: Pulse HIGH level clamped to baseline. Pulse LOW level - 10V maximum from baseline (-5V into 50 $\Omega$ ).  
Base line: Adjustable  $\pm 10V$  using DC offset control.

## GENERAL

### Power Requirements

Input Voltage: TG501/502/503 - 220/240V or 110/120V AC nominal 50/60Hz, adjustable internally.  
TG2001 - 220V or 230V or 240V, or 110V or 120V AC nominal at 50/60Hz adjustable internally.  
Power Consumption: Typically 30VA max (TG501/2/3); 50VA max (TG2001).

### Environmental

Operating Range: +5°C to +40°C, 20% to 80% RH, indoor use at altitudes to 2000m, Pollution Degree 1.  
Storage Range: -40°C to +70°C.  
Electrical Safety: Complies with EN61010-1.  
EMC: Complies with EN55011 and EN50082-1.

### Mechanical

Size: 300 x 100mm x 230mm (WxHxD) - TG501/TG2001.  
300 x 145mm x 230mm (WxHxD) - TG502/TG503.  
Weight: 3.4kg (TG501); 4.2kg (TG502/3); 3.5kg (TG2001).

All specifications apply after warm-up in an ambient temperature range of 18°C to 28°C.

*Thurlby Thandar Instruments Ltd. operates a policy of continuous development and reserves the right to alter specifications without prior notice.*

Designed and built in the U.K. by:



Thurlby Thandar Instruments Ltd. Glebe Road, Huntingdon. Cambs.  
PE18 7DX England Tel: 01480 412451 Fax: 01480 450409  
Email: sales@ttinst.co.uk Web: www.ttinst.co.uk