



THURLBY THANDAR INSTRUMENTS

TG1010A



10MHz programmable DDS function generator

Arbitrary Waveform Capability, Extensive Modulation Modes

*Direct Digital Synthesis*

# All the versatility of a function generator

## with the precision of Direct Digital Synthesis

### A DDS generator at a non-DDS price

The TG1010A breaks new ground by offering a DDS function generator at a similar price to that of a conventional generator of comparable functionality.

It can generate a wide variety of waveforms between 0.1MHz and 10MHz with a resolution of 7 digits and an accuracy better than 10ppm.

### Direct digital synthesis for accuracy & stability

Direct digital synthesis (DDS) is a technique for generating waveforms digitally using a phase accumulator, a look-up table and a DAC. The accuracy and stability of the resulting waveforms is related to that of the crystal master clock.

The DDS generator offers not only exceptional accuracy and stability but also high spectral purity, low phase noise and excellent frequency agility.

### A wide range of waveforms

The TG1010A generates high quality sine, square and pulse waveforms over the full frequency range of 0.1MHz to 10MHz.

Triangle waveforms, ramp waveforms and multi-level squarewaves can also be generated subject to some limitations in the maximum useable frequencies.

Variable symmetry/duty-cycle is available for all waveforms.

### Fully bus programmable

#### Addressable RS-232 standard, GPIB optional

The TG1010A has an RS-232 interface as standard which can be used for remote control of all of the instrument functions or for the down-loading of arbitrary waveforms.

As well as operating as a conventional RS-232 interface, it can also be used in addressable mode whereby up to 32 instruments can be linked to one PC serial port as part of a TTI "ARC" system.

Alternatively, a GPIB interface conforming to IEEE-488.2 is available as an option.

### Powerful modulation modes

#### Sweep

All waveforms can be swept over their full frequency range at a rate variable between 10 milliseconds and 15 minutes. The sweep is fully phase continuous.

Sweep can be linear or logarithmic, single or continuous. Single sweeps can be triggered from the front panel, the trigger input, or the digital interfaces.

Two sweep markers are provided which are adjustable whilst sweep is running. The markers can provide a visual indication of frequency points on a 'scope or chart recorder.

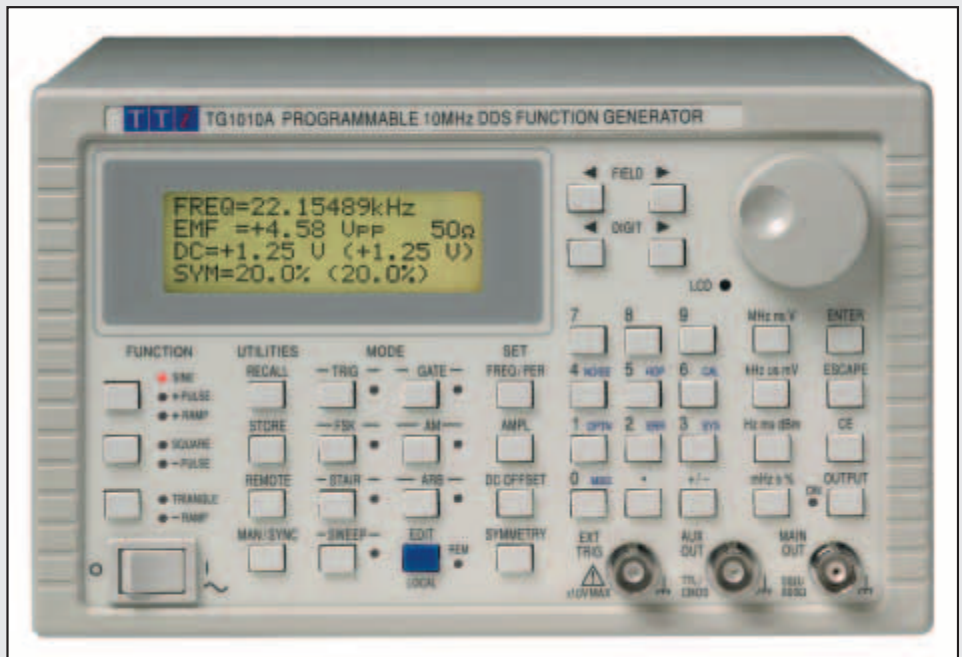
#### AM

Amplitude Modulation is available for all waveforms and is variable in 1% steps up to 100%. An internal AM source is incorporated. Alternatively modulation can be controlled from an external generator.

#### FSK

Frequency Shift Keying provides phase coherent switching between two selected frequencies at a rate defined by the switching signal source.

The rate can be set from dc to 50kHz internally, or dc to 1MHz externally.



- ▶ 0.1MHz to 10MHz frequency range, 7 digit resolution.
- ▶ Eight standard waveforms, plus multiple "complex" waveforms, true arbitrary waveforms and noise.
- ▶ Powerful modulation modes including Sweep, AM, Gating, Trigger/Burst, FSK and Hop.
- ▶ Variable symmetry, variable start/stop phase.
- ▶ 20V pk-pk output from 50 Ω or 600 Ω (switchable).
- ▶ Storage for five Arbitrary waveforms (1024 x 10-bits).
- ▶ Fully programmable via RS-232 or GPIB interfaces.

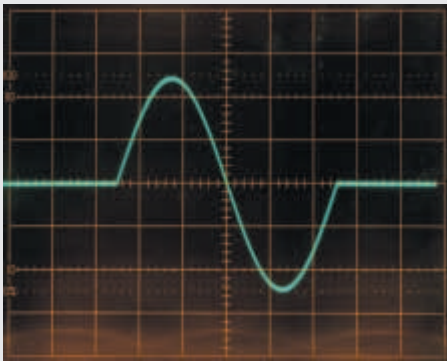
# Powerfull modulation facilities

## Arbitrary waveform capability

### Trigger/Burst

All waveforms are available as a triggered burst whereby each positive edge of the Trigger signal will produce one burst of the carrier, starting and stopping at the phase angle specified by the start-stop phase setting.

The number of cycles in the burst can be set between 0.5 and 1023.



Single cycle burst, start-stop phase =  $0^\circ$

### Gated

The Gated mode turns the output signal On when the gating signal is high and Off when it is low.

Both Triggered and Gated modes can be operated from the internal Trigger Generator (0.005Hz to 50kHz) or from an external source (dc to 1MHz).

### Waveform hop

The generator can be set up to 'hop' between a number of different waveform set-ups either at a pre-determined rate or in response to a manual or bus trigger.

Up to 16 different hop waveforms can be defined in terms of frequency, amplitude, function, offset and duration, which is variable in 1ms steps up to 60 seconds.

### Noise generation

The TG1010 can be set to simulate wide band random noise with adjustable amplitude and offset.

### Locked generators

The signals from the Clock In/Out socket and the Sync Out socket can be used to phase lock two or more generators.

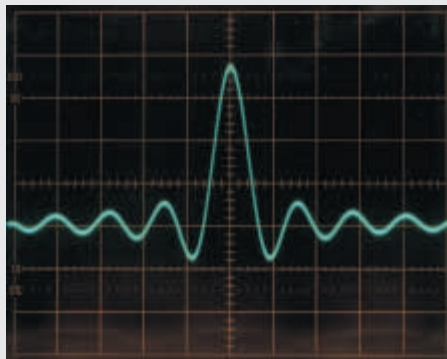
This can be used to generate multi-phase waveforms or locked waveforms of different frequencies.

### Easy and convenient to use

The TG1010A is particularly easy to use. All of the main information is clearly displayed on a backlit LCD with 4 rows of 20 characters. Sub menus are used for the modulation modes and other complex functions.

```
SOURCE=TGEN [FREE]
TGEN=0.24ms 4.167kHz
BURST COUNT=0015
PHASE=+145° (+145°)
```

All parameters can be entered directly from the numeric keypad. Alternatively most parameters can be incremented or decremented using the rotary encoder.



Pre-programmed 'complex' waveform.

### Arbitrary waveform capability

Arbitrary waveforms can be loaded via the digital interfaces and then used in a similar way to the standard waveforms.

Up to five arbitrary waveforms of 1024 10-bit words can be stored in non-volatile memory. The waveform clock is 27.48MHz maximum.

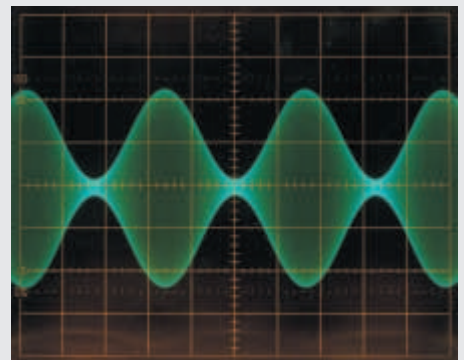
This facility considerably expands the versatility of the TG1010A making it suitable for the generation of highly complex waveform patterns.

In addition, the TG1010A offers numerous "complex" waveforms pre-defined in ROM. These include commonly used waveshapes such as sine x/x, decaying sinewave, exponential rise and fall etc.

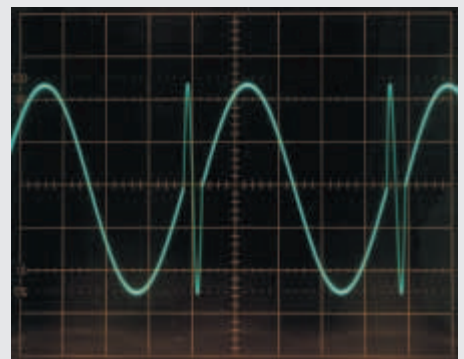
Optional software is available for the creation and editing of arbitrary waveforms on a personal computer.



Phase continuous frequency sweep.



Amplitude modulation using the internal sine wave modulation source.



Frequency shifting on alternate cycles.



Arbitrary waveform - simulated contact bounce.



# Technical Specifications

## FREQUENCY

All waveforms are available up to 10MHz. However, the purity of triangle, ramp, and multi-level squarewave waveforms is not specified above the frequencies indicated in the following section.

Range: 0.1mHz to 10MHz  
Resolution: 7 digits or 0.1mHz  
Accuracy:  $\pm 10$ ppm for 1 year, 18°C to 28°C  
Tempco.: Typically  $<1$ ppm/°C outside of 18°C to 28°C

## WAVEFORMS

### Sinewave

Distortion:  $<0.3\%$  THD to 500kHz, -60dBc to 20kHz,  $<-50$ dBc to 1MHz,  $<-35$ dBc to 10MHz (typically  $<-40$ dBc)

Spurii: Non harmonically related spurii  $<-65$ dBc to 1MHz,  $<-65$ dBc + 6dB/octave) 1MHz to 10MHz

### Squarewave

Rise & Fall Times:  $<22$ ns

### Triangle

Linearity error:  $<0.5\%$  to 30kHz

### Positive and Negative Ramp

Linearity error:  $<0.5\%$  to 30kHz

### Positive and Negative Pulse

Rise & Fall Times:  $<22$ ns

### Multi-Level Squarewave

Up to 16 steps available per cycle, each step selectable for amplitude (10 bit resolution) and duration (1 to 1024 samples). Above 27kHz a 36ns edge uncertainty is introduced.

Rise & Fall Times:  $<22$ ns

### Arbitrary (and Complex)

A number of "complex" waveforms are pre-programmed in ROM. A further 5, user defined, waveforms may be loaded via the digital interfaces and stored in non-volatile RAM.

Frequency range: All waveform points can be continuously output up to 27kHz, beyond which they are sampled

No. of Samples: 1024 10 bit samples

### Noise

Wideband white noise with variable amplitude and offset. Typical 3dB bandwidth 0.03Hz to 700kHz.

## SYMMETRY

Range: Sine, Triangle, Ramp - 1% to 99% at all frequencies; Other waveforms - 1% to 99% to 30kHz, 20% to 80% to 10MHz  
Resolution: 0.1%

## MAIN OUTPUT

Output Impedance: 50Ω or 600Ω switchable  
Amplitude: 5mV to 20V pk-pk open circuit (2.5mV to 10V into 50Ω/600Ω).

Output can be specified as V-HiZ (open circuit value) or V (potential difference) in pk-pk, RMS or dBm. Note that in positive or negative Pulse modes the amplitude range is 2.5mV to 10V pk-pk O/C.

Accuracy:  $\pm 3\% \pm 1$ mV at 1kHz into 50Ω/600Ω

Flatness:  $\pm 0.2$ dB to 500kHz;  $\pm 1$ dB to 10MHz

Pulse Aberrations:  $<5\% + 2$ mV

DC Offset:  $\pm 10$ V from 50Ω/600Ω. DC offset plus signal peak limited to  $\pm 10$ V from 50Ω/600Ω

Resolution: 3 digits for both amplitude and offset

## MODULATION MODES

### Trigger/Burst

Phase coherent signal keying - each positive edge of the Trigger signal will produce one burst of the carrier, starting and stopping at the phase angle specified by the Start/Stop phase setting.

Carrier frequency: 0.1mHz to 10MHz  
Carrier waveforms: All  
Number of cycles: 1 to 1023 (resolution 1 cycle) or 0.5 to 511.5 (resolution 1/2 cycle)

Trigger rep. rate: dc to 50kHz internal, dc to 1MHz external

Source: Internal from keyboard or trigger generator. External from EXT TRIG input or remote interface

### Gated

Non phase-coherent signal keying - output is On while Gate signal is high and Off while low.

Carrier frequency: From 0.1mHz to 10MHz  
Carrier waveforms: All

Trigger rep. rate: dc to 50kHz internal dc to 1MHz external

Gate source: Internal from keyboard or trigger generator. External from EXT TRIG input or remote interface

### Sweep

Carrier waveforms: All

Sweep Mode: Linear or logarithmic, single or continuous  
Sweep Width: 0.1mHz to 10MHz. Phase continuous. Independent setting of the start and stop frequency.

Sweep Time: 10ms to 999s (3 digit resolution)  
Markers: Two markers variable during sweep. Available at the TRIG/SWEEP OUT socket

Sweep Trigger source: The sweep may be free run or triggered from: keyboard, EXT TRIG input, remote interface

### Amplitude Modulation

Carrier frequency: 0.1mHz to 10MHz

Carrier waveforms: All

Depth: 0 to 100% typical, resolution 1%.  
Internal source: 1kHz fixed sinewave or 0.005Hz to 50kHz square wave

External: See "VCA In" section

### Frequency Shift Keying (FSK)

Phase coherent switching between two frequencies at a rate defined by the switching signal source.

Carrier frequency: 0.1mHz to 10MHz

Carrier waveforms: All

Switch repetition rate: dc to 50kHz internal, dc to 1MHz external

Switching signal source: Internal from keyboard or trigger generator. External from EXT TRIG input or remote interface

### Hop

Up to 16 different "hop" waveforms can be defined in terms of function, frequency, amplitude, offset and duration. Duration settable per step 1ms to 60s.

### Start/Stop Phase

Carrier frequency: 0.1mHz to 10MHz

Carrier waveforms: All

Range: -360 to +360 degrees

Resolution: 1 degree

Accuracy: 1 degree up to 20kHz

### Trigger Generator

Internal source 0.005Hz to 50kHz squarewave adjustable in 20us steps. 3 digit resolution. Available for external use from TRIG/SWEEP OUT socket

## AUXILIARY OUTPUTS

### AUX OUT

CMOS/TTL levels with symmetry and frequency of main output and phase of Start-Stop phase setting.

### TRIG/SWEEP OUT

Multi-function output depending upon mode. Except in Sweep mode, the output is that of the Trigger Generator at CMOS/TTL levels from 1kΩ.

In Sweep mode the output is a 3-level waveform, changing from high (+4V) to low (0V) at the start of sweep, with narrow 1V pulses at each marker point.

## INPUTS

### Ext Trig

Frequency Range: DC to 1MHz

Signal Range: TTL (1.5V) threshold; maximum input  $\pm 10$ V

Min. Pulse Width: 50ns

### VCA In

Frequency Range: DC - 100kHz

Signal Range: 2.5V for 100% level change at maximum output

Input Impedance: Typically 6kΩ

## PHASE LOCKING

### Clock In/Out

TTL/CMOS threshold levels; output impedance typically 50Ω as an output

Sync Out TTL/CMOS logic levels from typically 50Ω

The signals from these sockets are used to phase lock two or more generators.

## INTERFACES

Full remote control facilities are available through the RS232 (standard) or optional GPIB interfaces.

RS232: Variable Baud rate, 9600 Baud maximum. 9-pin D-connector. Fully compatible with Thurlby-Thandar ARC (Addressable RS232 Chain) system

GPIB (IEEE-488): Conforming with IEEE488.1 and IEEE488.2

## GENERAL

Display: 20 character x 4 row alphanumeric LCD

Data Entry: Keyboard selection of mode, waveform etc.; value entry direct by numeric keys or by rotary control.

Stored Settings: Up to 9 complete instrument set-ups may be stored in battery-backed memory.

Size: 3U (130mm) height; half-rack (212mm) width, 330mm long  
Weight: 4.1kg (9lb)

Power: 100V, 110-120V or 220-240V  $\pm 10\%$  50/60Hz, adjustable internally. 40VA max. Installation Category II.

Operating Range: +5°C to 40°C, 20-80% RH

Storage Range: -20°C to +60°C

Environmental: Indoor use at altitudes up to 2000m, Pollution Degree 2

Safety: Complies with EN6010-1

EMC: Complies with EN61326

### Options:

GPIB (IEEE-488) interface.  
19 inch rack mounting kit.  
PC-based waveform creation and editing software - Waveform Manager Plus

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

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