THURLBY THANDAR INSTRUMENTS

TGA1200 Series



Single and Multi-channel Universal ARB Generators

One, two or four independent or inter-linked channels

40MS/s or 100MS/s, 64K or 256K words per channel

Function generator and pulse generator features

TGA1200 series universal ARB waveform generators

Changing technology

The expansion of electronics within every engineering discipline is requiring today's engineers to generate ever more diverse and complex signals. The TGA1200 series is designed to meet that challenge.

Expanding model range

The TGA1200 series currently comprises four models:

TGA1241 - 40MS/s single channel waveform generator in 3U half rack size case.

TGA1242 - 40MS/s two channel waveform generator in 3U rack size case.

TGA1244 - 40MS/s four channel waveform generator in 3U rack size case.

TGA12101 - 100MS/s single channel waveform generator in 3U half rack size case.

On multi-channel units each channel can be operated fully independently, or multiple channels can be linked using simple or complex relationships.

N.B. Two and Four channel 100MS/s models will be introduced in 2005.

An Arbitrary Generator unmatched at this price

The TGA1200 series are highly sophisticated 12-bit arbitrary generators capable of recreating virtually any waveform.

True variable clock architecture is used with clock speeds between 0.1Hz and 40MHz (100MHz on TGA12101). This architecture avoids the clock jitter associated with DDS arbitrary generators and permits waveform linking, looping and sequencing.

Waveforms may be defined with up to 4096 vertical points and from 4 to 65,536 horizontal points (8 to 262,144 on TGA12101). Arbitrary waveforms may be replayed at a specified waveform frequency, period or sample rate.

On TGA124x units, up to 100 user-defined waveforms can be stored within the instrument's 256K of non-volatile memory.

On the TGA12101 waveform storage is on removeable Compact Flash memory cards. Up to 500 waveforms can be stored on each card.

Function Generator

Each channel can operate as a full DDS function generator. High quality sine, cosine, haversine, havercosine and square waves are available between 1mHz and 16MHz (40MHz on TGA12101).

Triangle, ramp and sine(x)/x waveforms are available from 0.1mHz up to 100kHz.

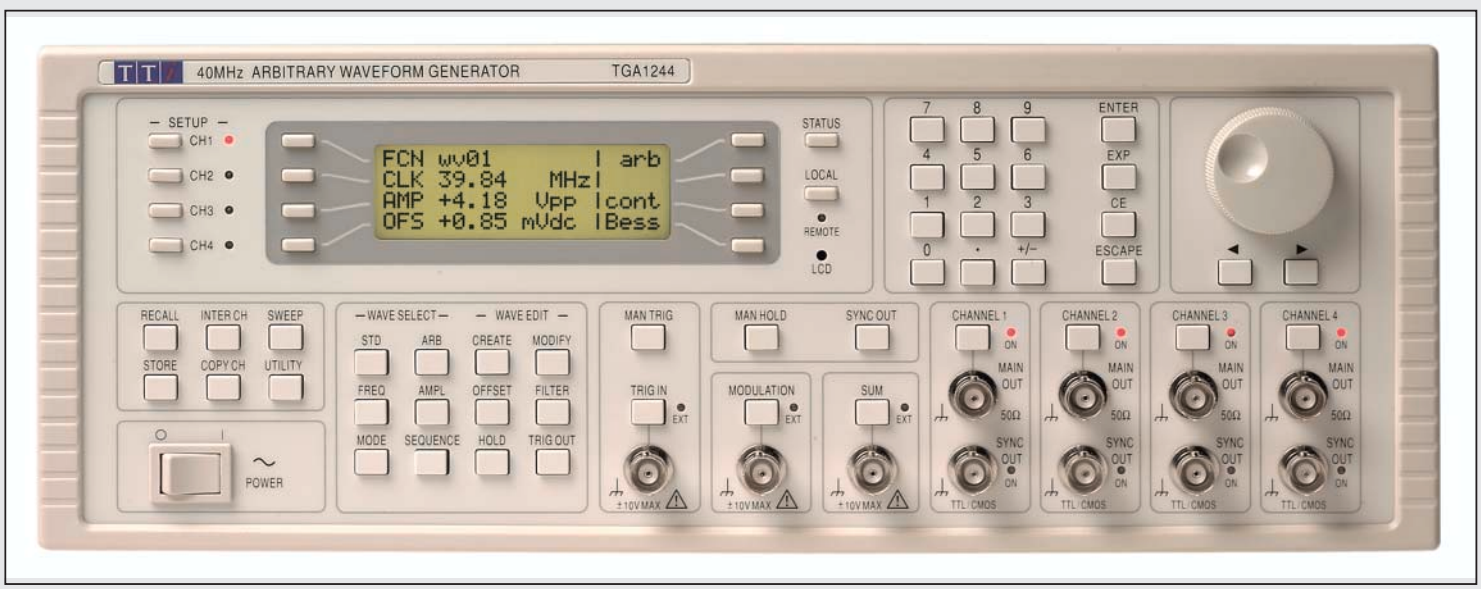
Pulse Generator

Each channel can generate not just pulses but complex pulse trains.

A pattern of up to 10 pulses can be quickly defined with each pulse having its own amplitude, width and delay. The whole pulse train pattern can then be replayed at a user defined repetition rate.



Where variable rise time pulses are required, the full arbitrary function can be used.



TGA1240 Series - Main Features

- *1, 2 or 4 waveform channels, independent or linked.*
- *40MS/s 12-bit arbitrary waveform capability.*
- *65,536 point waveform memory per channel.*
- *16MHz function generator capabilities using DDS.*
- *Multiple 'standard' waveforms including sine, square, triangle, haversine, ramp, pulse and sin(x)/x.*
- *Pulse train pattern generation for up to 10 pulses.*
- *Complex waveform sequencing and looping capability using up to sixteen waveform segments.*
- *Wide range sweep, AM, tone switching, signal summing.*
- *Tone switching facilitates precision DTMF generation.*
- *Built-in trigger generator, gated & triggered burst modes.*
- *Inter-channel triggering, summing and phase control.*
- *Multiple generators can be easily phase locked.*
- *Waveform creation/editing tools built-in; sophisticated external Windows based software included.*
- *GPIB (IEEE-488.2) and RS-232 interfaces.*

TGA12101 - Additional Features

- *100MS/s 12-bit arbitrary waveform capability.*
- *256K point waveform memory.*
- *40MHz function generator capabilities using DDS (50MHz for square waves).*
- *Waveform sequencing with up to 1024 segments.*
- *Unlimited waveform storage using CF memory cards.*
- *USB interface in addition to RS232 and GPIB.*

40MS/s or 100MS/s - one, two or four channels

Wide range sweep

All waveforms can be swept over their full frequency range at a rate variable between milliseconds and minutes.

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.

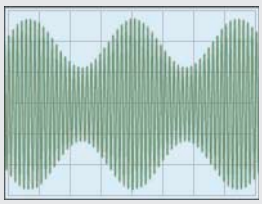
Multiple channels can be swept simultaneously.

Amplitude modulation

Amplitude Modulation and Suppressed Carrier Modulation are available for all waveforms.

Any channel can be used to modulate another channel.

Alternatively all channels can be modulated simultaneously via the modulation input.



Amplitude modulation

Built-in trigger generator

All waveforms are available as a triggered burst whereby each trigger edge will produce one burst of the carrier. Start and stop phase is fully variable.

Both Triggered and Gated modes can be operated from the internal trigger generator, from an adjacent channel, an external source or a key press or remote command.

The trigger generator signal is available as a separate output if required.

Tone switching

The TGA1200 series can provide triggered switching between up to 16 frequencies of standard or arbitrary waveforms.

Tone switching modes can be gated, triggered or FSK using any trigger source.

By summing two channels together it is possible to generate precise DTMF test signals.



Simple tone switching

GPIB, RS-232, USB

The TGA1200 series incorporates both RS-232 and GPIB (IEEE-488) interfaces as standard. The TGA12101 also has a USB interface.

These can be used for loading arbitrary waveforms and for remote control of all the instrument functions.

On the TGA12101, waveform data can also be transferred using the memory card.

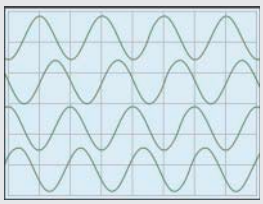
Multi-channel operation

(TGA1242 and 1244)

Multi-channel phase locking

Any number of channels can be phase locked with offsets defined to a resolution of 0.1 (or 360/waveform points for arbitrary waveforms).

For applications requiring more than four channels, multiple generators can be phase locked.



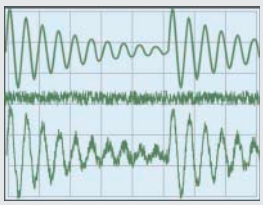
N.B.
All models including the TGA1241 and TGA12101 have the facility for phase locking to another generator.

Multi-channel summing

Waveform Summing sums the waveform from any channel into the next channel.

Alternatively any number of channels can be summed with an external signal.

This permits complex modulations to be created such as noise superimposition.



Arbitrary waveform summed with noise

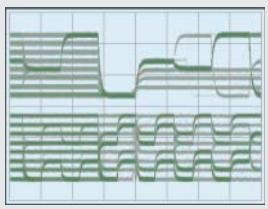
Inter-channel triggering and modulation

Because any channel can be triggered by the previous or next channel, waveforms on different channels can be 'daisy chained' and looped. By summing the channel outputs, up to 64 segments can be used (32 segments for TGA1242).

A channel can be used to AM modulate or SCM modulate another channel.

Digital modulation

Inter-channel modulation and summing allows the simulation of various telecom digital modulation systems.



IQ Modulation signals (Quadrature Amplitude Modulation)

Generating more voltage

For applications requiring more than 20V pk-pk emf, an external wideband amplifier is available. The WA301 can provide up to 30V pk-pk from 50 .

Fast and easy to use

All of the main information is clearly displayed on a backlit 80 character LCD. Eight "soft" keys provide fast data editing.

On the 2 and 4 channel models, a Copy Channel key enables similar setups to be created across multiple channels with ease.

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

Waveform creation and editing

Waveform creation and editing features are incorporated within the instrument. These include waveform insert, point edit, line draw, amplitude adjust and invert.

Start and end points and data values are defined using the keypad or the rotary control.

A wide range of standard waveforms is available for insertion within an arbitrary waveform. These include sine, triangle, ramp and square. Sections of existing arbitrary waveforms can also be inserted.

For more sophisticated waveform creation and editing, **Waveform Manager Plus** software for Windows is provided (see the next page for more detail).

Waveforms created on a PC can be downloaded to the instrument via the digital interfaces.

Linked-sequence operation

Up to 16 arbitrary waveforms may be linked in a sequence (1024 waveforms on TGA12101). Each waveform can have a loop count of up to 32,768 and the whole sequence can be run continuously or repeated more than a million times.

For multi-channel models, waveforms on different channels can be 'daisy chained' and looped.

By summing the channel outputs, up to 64 segments can be used to create highly complex waveforms.



Simple waveform sequence

Waveform Manager Plus - included with all TGA1200 series generators

Advanced waveform creation, editing and management software



- *Full waveform building tools including standard waveforms, mathematical expressions, and freehand drawing.*
- *Operates under Windows 95, 98, Millennium, NT, 2000 and XP.*
- *Supports vertical resolutions up to 16 bits (65536 points).*
- *Supports horizontal resolutions to over one million points.*
- *Provides waveform import and export via clipboard functions.*
- *Directly supports waveform upload from some Tektronix DSOs.*
- *Supports download and upload via RS-232, GPIB and USB.*

WAVEFORM BUILDING TOOLS

TOOLKIT

Waveforms can be built in any number of sections using any combination of the following: Standard waveforms, mathematical expressions, drawn waveforms, uploaded waveforms, imported waveforms (using clipboard), existing stored waveforms.

Note: Waveform section limits can be defined via moveable cursors which can be dragged or positioned numerically.

STANDARD WAVEFORMS

The following waveforms are available directly from the Waveforms dialogue box: Sine, square, triangle, pulse, ramp, sinc [sin(x)/x], gaussian, exponent, noise.

Note: The mathematical expression for any standard waveform can be examined by opening the expression editor window.

EXPRESSION EDITOR FUNCTIONS

The following mathematical operators are available within the expression editor: Add, subtract, multiply, divide, x^n, sin, cos, arcsin, arccos, abs, $\log_{10}$, $\log_e$, e^n, square root, floor, ceiling, random, pulse, in conjunction with constants and waveforms.

Note: The expressions used for each section of a waveform are retained and can be displayed in a drop-down window.

EXPRESSION LIBRARIES

The mathematical expressions used for waveform creation can be stored in libraries. A default library is created for each project which includes a number of useful examples including waveshapes and modulations.

WAVEFORM DRAWING FUNCTIONS

Waveforms can be created or edited using freehand drawing and/or point to point line drawing.

SMOOTH

Waveforms can be smoothed using a running average filter. Start and end points can be specified as well as the number of points to average.

WAVEFORM EDITING/CONVERSION

TOOLKIT

All of the waveform building tools previously mentioned can be used to edit existing waveforms. In addition waveforms can be manipulated directly using the following functions:

RESIZE WAVEFORM

Allows a waveform to be resized horizontally to any length between 4 and 65536 horizontal points.

Note: The vertical resolution of a waveform is automatically adjusted when it is downloaded to the generator. Thus an 8-bit waveform from a DSO will be expanded to 12-bits if it is downloaded to a 12-bit generator (and vice versa).

WAVEFORM MATHEMATICS

The Waveforms Maths function allows waveforms to be combined and manipulated independently of the expression editor. Waveforms can be scaled, offset, added, subtracted or multiplied using dialogue boxes.

Note: Waveforms can also be combined and manipulated within the expression editor giving access to the full range of mathematical functions.

INPUT/OUTPUT FUNCTIONS

FILE FORMATS

Waveforms can be read from and saved as any of the following formats: WFM(binary), NRM (normalised data in ASCII), WAV (WaveCAD), ASC (WaveCAD), DSF (Tektronix DSO).

WAVEFORM DOWNLOAD/UPLOAD

Waveforms can be downloaded/uploaded to/from TTi arbitrary generators (or certain Tektronix DSOs) using either an RS232 or GPIB (IEEE-488) interface or, for the TGA1210x, a USB interface.

CLIPBOARD FUNCTIONS

Waveforms can be imported to the program and exported from the program using the Windows Clipboard.

Waveform import uses the "Text" clipboard format (i.e. numeric lists). This enables waveforms to be imported from spreadsheets such as Excel and from mathematical programs such as MathCad. Values are automatically normalised and re-scaled.

Waveform export creates multiple clipboard formats of Text (normalised numeric values between ±1), Bitmap (as per on-screen display) and Picture (metafile retaining waveform vector properties).

Note: Pictures or bitmaps can be pasted into programs such as Word for documentation purposes.

DISPLAY AREA AND PRINTING

Multiple waveform windows can be open simultaneously. Each window is fully scaleable. Variable zoom is provided with panning from a "navigator" sub-window.

Waveform section limits can be defined via moveable cursors which can be dragged or positioned numerically.

Waveforms can be printed with automatic annotation and scaling.

MANAGEMENT AND UTILITIES

PROJECTS

To maintain good housekeeping, waveforms can be organised into "projects" with separate directory structures. Each project maintains its own library of expressions. Waveforms and expressions can be imported and exported from other projects.

INSTRUMENT SETUP

The instrument setup screen enables options for the waveform generator to be set from the program. Examples of settable options are output amplitude, clock frequency and trigger source.

HELP

Full on-screen Help is available with a hyper linked contents table.

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

TGA1200 Series ARB Generators - Technical Specifications

TGA1241, TGA1242, TGA1244

ARBITRARY WAVEFORMS

Arbitrary

Maximum waveform size is 65,536 points, minimum waveform size is 4 points. Up to 100 user defined waveforms may be stored in the 256K point nonvolatile RAM. Waveforms can be defined by front panel editing controls or by downloading of waveform data via RS232 or GPIB.

Waveform Memory:	64k points per channel.
Vertical Resolution:	12 bits
Sample Clock:	100mHz to 40MHz
Resolution:	4 digits
Accuracy:	± 1 digit of setting

Sequence

Up to 16 waveforms may be linked. Each waveform can have a loop count of up to 32,768. A sequence of waveforms can be looped up to 1,048,575 times or run continuously.

Output Filter

Selectable between 16MHz Elliptic, 10MHz Elliptic, 10MHz Bessel or None.

STANDARD WAVEFORMS

Sine, square, triangle, DC, positive ramp, negative ramp, sin(x)/x, pulse, pulse train, cosine, haversine and havercosine.

All Waveforms

Accuracy:	10 ppm for 1 year
Temp. Stability:	Typically <1 ppm/ºC.
Output Level:	2.5mV to 10Vpp into 50Ω

Sine, Cosine, Haversine, Havercosine

Range:	0·1mHz to 16 MHz
Resolution:	0·1mHz or 7 digits
Harmonic Distortion:	<0.1% THD to 100kHz; <–65dBc to 20kHz, <–50dBc to 1MHz, <-35dBc to 10MHz <-30dBc to 16MHz
Nonharmonic Spurii:	<–65dBc to 1MHz, <–65dBc + 6dB/octave 1MHz to 16MHz

Square

Range:	1mHz to 16MHz
Resolution:	1mHz (4 digits)
Accuracy:	± 1 digit of setting
Rise/Fall Times:	<25ns

Pulse and Pulse Train

Rise/Fall Times:	<25ns
Period Range:	100ns to 100s
Period Resolution:	4digit
Accuracy:	±1 digit of setting
Delay Range:	-99·99s to + 99·99s
Delay Resolution:	0·002% of period or 25ns, whichever is greater
Width Range:	25ns to 99·99s
Width Resolution:	0·002% of period or 25ns, whichever is greater

Note that the pulse width and absolute value of the delay may not exceed the pulse period at any time.

Pulse trains of up to 10 pulses may be specified, each pulse having independently defined width, delay and level. The baseline voltage is separately defined and the sequence repetition rate is set by the pulse train period.

Triangle

Range:	0.1mHz to 100kHz
Resolution:	0.1mHz or 7 digits
Linearity Error:	<0.1% to 30 kHz

Ramps and Sin(x)/x

Range:	0.1mHz to 100kHz
Resolution:	0.1mHz (7 digits)
Linearity Error:	<0.1% to 30 kHz

OPERATING MODES

Continuous

Waveform runs continuously.

Triggered Burst

Each active edge of the trigger signal will produce one burst of the waveform.

Carrier Waveforms: All standard and arbitrary

Max. Carrier Frequency:
40Msamples/s for ARB and Sequence. 1MHz or the maximum for the selected waveform.

Number of Cycles: 1 to 1,048,575

Trigger Repetition: 0.005Hz to 100kHz internal dc to 1MHz external.

Trigger Signal Source:
Internal from keyboard, previous channel, next channel or trigger generator. External from TRIG IN or remote interface.

Trigger Start/Stop Phase:
± 360 settable with 0.1 resolution, subject to waveform frequency and type.

Gated

Waveform will run while the Gate signal is true and stop while false.

Carrier Waveforms: All standard and arbitrary.

Max. Carrier Frequency:
40Msamples/s for ARB and Sequence. 1MHz or the maximum for the selected waveform.

Number of Cycles: 1 to 1,048,575

Trigger Repetition: 0.005Hz to 100kHz internal dc to 1MHz external.

Gate Signal Source:
Internal from keyboard, previous channel, next channel or trigger generator. External from TRIG IN or remote interface.

Gate Start/Stop Phase:
± 360 settable with 0.1 resolution, subject to waveform frequency and type.

Sweep

Frequency sweep capability is provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques are used to perform the sweep.

Carrier Waveforms: All standard and arbitrary except pulse, pulse train and sequence.

Sweep Mode:
Linear or logarithmic, triggered or continuous.

Sweep Direction:
Up, down, up/down or down/up.

Sweep Range:
From 1mHz to 16 MHz in one range. Phase continuous. Independent setting of the start and stop frequency.

Sweep Time: 30ms to 999s .

Marker: Variable during sweep.

Sweep Trigger Source:
The sweep may be free run or triggered from the following sources: Manually from keyboard. Externally from TRIG IN input or remote interface.

Sweep Hold: Sweep can be held and restarted by the HOLD key.

Multi Channel Sweep

Any number of channels may be swept simultaneously but the sweep parameters will be the same for all channels. Amplitude, Offset and Waveform can be set independently for each channel.

Tone Switching

Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques are used to allow instantaneous frequency switching.

Carrier Waveforms:
All except pulse, pulse train and sequence.

Frequency List:
Up to 16 frequencies from 1mHz to 10MHz.

Trigger Repetition Rate:
0.005Hz to 100kHz internal. dc to 1MHz external. Usable repetition rate and waveform frequency depend on the tone switching mode.

Source:
Internal from keyboard, previous channel, next channel or trigger generator. External from TRIG IN or remote interface.

Tone Switching Modes:
Gated: The tone is output while the trigger signal is true and stopped, at the end of the current waveform cycle, while the trigger signal is false. The next tone is output when the trigger signal is true again.
Triggered: The tone is output when the trigger signal goes true and the next tone is output, at the end of the current waveform cycle, when the trigger signal goes true again.
FSK: The tone is output when the trigger signal goes true and the next tone is output, immediately, when the trigger signal goes true again.
Using 2 channels with their outputs summed together it is possible to generate DTMF test signals.

Trigger Generator

Internal source 0.005 Hz to 100kHz square wave adjustable in 10us steps. 3 digit resolution. Available for external use from any SYNC OUT socket.

OUTPUTS

Main Output - One for each channel

Output Impedance: 50Ω

Amplitude:
5mV to 20Vpp open circuit (2.5mV to 10Vpp into 50Ω). Amplitude can be specified open circuit (hi Z) or into an assumed load of 50Ω or 600Ω in Vpkpk, Vrms or dBm.

Amplitude Accuracy:	2% ±1mV at 1kHz into 50Ω.
Amplitude Flatness:	±0.2dB to 200 kHz; ±1dB to 10 MHz; ±2.5dB to 16MHz.
DC Offset Range:	±10V from 50Ω. Offset plus signal peak limited to ±10V.
DC Offset Accuracy:	Typically 3% ±10mV, unattenuated.
Resolution:	3 digits or 1mV for both Amplitude and DC Offset.

Sync Out - One for each channel

Multifunction output user definable or automatically selected to be any of the following:

Waveform Sync (all waveforms):
A square wave with 50% duty cycle at the main waveform frequency, or a pulse coincident with the first few points of an arbitrary waveform.

Position Markers (Arbitrary only):
Any point(s) on the waveform may have associated marker bit(s) set high or low.

Burst Done:
Produces a pulse coincident with the last cycle of a burst.

Sequence Sync:
Produces a pulse coincident with the end of a waveform sequence.

Trigger:
Selects the current trigger signal. Useful for synchronizing burst or gated signals.

Sweep Sync:
Outputs a pulse at the start of sweep to synchronize an oscilloscope or recorder.

Phase Lock Out:
Used to phase lock two generators. Produces a positive edge at the 0° phase point.

Output Signal Level:
TTL/CMOS logic levels from typically 50Ω.

Cursor/Marker Out

Adjustable output pulse for use as a marker in sweep mode or as a cursor in arbitrary waveform editing mode. Can be used to modulate the Z axis of an oscilloscope or be displayed on a second 'scope channel.

Output Signal Level:
Adjustable from nominally 2V to 14V, normal or inverted; adjustable width as a cursor.

Output Impedance: 600Ω typical

INPUTS

Trig In

Frequency Range: DC to 1MHz.
Signal Range: Threshold nominally TTL level; maximum input ±10V.
Min. Pulse Width: 50ns, for Trigger/Gate; 50us for Sweep mode.
Polarity: Selectable as high/rising edge or low/falling edge.
Input Impedance: 10kΩ

Modulation In

Frequency Range: DC to 100kHz.
VCA Signal Range: Approximately 1V pkpk for 100% level change at maximum output.
SCM Signal Range: Approximately ± 1Vpk for maximum output.
Input Impedance: Typically 1 kΩ.

Sum In

Frequency Range: DC to 8MHz.
Signal Range: Approximately 2 Vpk-pk input for 20Vpk-pk output.
Input Impedance: Typically 1kΩ.

Hold

Holds an arbitrary waveform at its current position. A TTL low level or switch closure causes the waveform to stop at the current position and wait until a TTL high level or switch opening which allows the waveform to continue. The front panel MAN HOLD key or remote command may also be used to control the Hold function. While held the front panel MAN TRIG key or remote command may be used to return the waveform to the start. The Hold input may be enabled independently for each channel.

Input Impedance: 10kΩ

Ref Clock In/Out

Set to Input: Input for an external 10MHz reference clock. TTL/CMOS threshold level.
Set to Output: Buffered version of the internal 10MHz clock. Output levels nominally 1V and 4V from 50Ω.
Set to Phase Lock: Used together with SYNC OUT on a master and TRIG IN on a slave to synchronise (phase lock) two separate generators.

INTER-CHANNEL OPERATION

Inter-channel Modulation:

The waveform from any channel may be used to Amplitude Modulate (AM) or Suppressed Carrier Modulate (SCM) the next channel. Alternatively any number of channels may be Modulated (AM or SCM) with the signal at the MODULATION input socket.

Carrier frequency: Entire range for selected waveform.
Carrier waveforms: All standard and arbitrary waveforms.
Modulation Types:
AM: Double sideband with carrier.
SCM: Double sideband suppressed carrier.
Modulation source:
Internal from the previous channel. External from Modulation input socket. The external modulation signal may be applied to any number of channels simultaneously.
Frequency Range: DC to >100 kHz.
Internal AM Depth: 0% to 105%.
Internal AM Resolution: 1%.
Carrier Suppression (SCM): > 40dB.
External Modulation Signal Range:
VCA: Approximately 1V pk-pk for 100% level change at maximum output.
SCM: Approximately ± 1Vpk for max. output.

Inter-channel Analogue Summing:

Waveform Summing sums the waveform from any channel into the next channel.

Alternatively any number of channels may be summed with the signal at the SUM input socket.

Carrier frequency:
Entire range for selected waveform.
Carrier waveforms:
All standard and arbitrary waveforms.
Sum source:
Internal from the previous channel. External from SUM IN socket.
Frequency Range: DC to >8MHz.
Ext. Signal Range:
Approx. 5Vpk-pk input for 20Vpk-pk output.

Inter-channel Phase locking:

Two or more channels may be phase locked together. Each locked channel may be assigned a phase angle relative to the other locked channels. Arbitrary waveforms and waveform sequences may be phase locked but certain constraints apply to waveform lengths and clock frequency ratios. With one channel assigned as the Master and other channels as Slaves a frequency change on the master will be repeated on each slave thus allowing multiphase waveforms at the same frequency to be easily generated. DDS waveforms are those with 7 digits of frequency setting resolution, while Non-DDS waveforms have 4 digits.

Phase Resolution:
DDS waveforms: 0.1 degree
Non-DDS waveforms: 0.1 degree or 360 degrees/number of points whichever is the greater
Phase Error: <±10ns all waveforms.

The signals from the REF IN/OUT socket and the SYNC OUT socket can be used to phase lock two instruments where more than 4 channels are required.

Inter-channel Triggering:

Any channel can be triggered by the previous or next channel.

The previous/next connections can be used to 'daisy chain' a trigger signal from a 'start' channel, through a number of channels in the 'chain' to an 'end' channel. Each channel receives the trigger out signal from the previous (or next) channel, and drives its selected trigger out to the next (or previous) channel. The 'end' channel trigger out can be set up to drive the 'start' channel, closing the loop.

In this way, complex and versatile interchannel trigger schemes may be set up. Each channel can have its trigger out and its output waveform set up independently. Trigger out may be selected from Waveform End, Position Markers, Sequence Sync or Burst Done.

Using the scheme above it is possible to create a sequence of up to 64 waveform segments, each channel producing up to 16 segments and all channels being summed to produce the complete waveform at the output of channel 4.

INTERFACES

Full remote control and waveform download facilities are available through the RS232 or GPIB interfaces.

RS232: Variable Baud rate, 9600 Baud maximum.
IEEE488: Conforms with IEEE488.1 and IEEE488.2

ARBITRARY WAVEFORM EDITING

Basic arbitrary waveform creation and editing tools are built into the instrument. Arbitrary waveforms can be built-up using insertion of standard waveforms between points, point by point value setting, and straight line drawing between points.

"Waveform Manager Plus" Software

The TGA124x generators are supplied with Waveform Manager Plus software for Windows which provides full PC based waveform creation, editing and management. See the main TGA1200 series brochure for full details.

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 setups may be stored and recalled from battery-backed memory. Up to 100 arbitrary waveforms can also be stored independent of the instrument settings.

Size:

130mm (3U) height; 335mm long; width 350mm (TGA1242/1244), 212mm (TGA1241).

Weight:

7.2 kg. (16 lb), TGA1242/1244;
4.1kg (9lb) TGA1241.

Power:

220 - 240V, 110 - 120V or 100V nominal 50/60Hz, adjustable internally; operating range ±10% of nominal; 100VA max. for 4 channels, 75VA max. for 2 channel, 40VA max. for 1 channel. Installation Category II.

Compliance

Operating Range: +5°C to 40°C, 20-80% RH.
Storage Range: -20°C to + 60°C.
Environmental: Indoor use at altitudes to 2000m, Pollution Degree 2.
Safety: Complies with EN61010-1.
EMC: Complies with EN61326.

N.B. Specifications apply at 18-28 C after 30 minutes warm-up, at maximum output into 50 Ω

Instrument Drivers

Labview and LabWindows CVI drivers are either supplied with the instrument or are available for download without charge from the TTi website.

Supplied Items:

IEC Mains Lead
Printed Manual (partly multi-language)
Multi-language manual on CD
Waveform Manager Plus software

Options:

19 inch rack mounting kit.

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ARBITRARY WAVEFORMS

The maximum arbitrary waveform size is 262,144 points. Up to 500 user defined waveforms may be stored on the removable memory card. Arbitrary waveforms can be defined by front panel editing controls, by downloading of waveform data via RS232, USB or GPIB, or by writing directly to the removable memory card using the USB card reader/writer connected to a PC.

Waveform Memory:	256K points. Minimum waveform size is 8 points.
Vertical Resolution:	12 bits
Sample Clock Range:	100mHz to 100MHz
Resolution:	4 digits
Accuracy:	±1 digit of setting.
Output Filter:	Selectable between 40MHz Elliptic, 20MHz Bessel or none.

Sequence:

Up to 1024 waveforms may be linked. Each waveform can have a loop count of up to 32,768. A sequence of waveforms can be looped up to 1,048,575 times or run continuously.

Noise Function:

Digital noise generated by a 35-bit linear feedback register clocked at 100MHz. User's external filter defines bandwidth and response.

STANDARD WAVEFORMS

Sine, square, triangle, DC, positive ramp, negative ramp, sin(x)/x, pulse, pulse train, cosine, haversine and havercosine.

Sine, Cosine, Haversine, Havercosine

Range:	0.1 mHz to 40 MHz.
Resolution:	0.1mHz or 10 digits
Accuracy:	Better than 10 ppm for 1 year.
Temperature Stability:	Typically <1 ppm/ ^{o}C
Output Level:	5mV to 20V p-p from 50Ω.
Harmonic Distortion:	<0.15% THD to 100kHz; <-60dBc to 20kHz, <-50dBc to 1MHz, <-40dBc to 10MHz, <-35dBc to 40MHz.
Non-harmonic Spurii:	<-60dBc to 1MHz, <-60dBc + 6dB/octave to 1MHz to 40MHz.

Square

Range:	1 mHz to 50MHz.
Resolution:	1mHz (4 digits)
Accuracy:	±1 digit of setting.
Output Level:	5mV to 20V p-p from 50Ω.
Rise and Fall Times:	<8ns

Triangle

Range:	0.1 mHz to 100kHz.
Resolution:	0.1mHz or 10 digits
Accuracy:	Better than 10 ppm for 1 year.
Output Level:	5mV to 20V p-p from 50Ω.
Linearity Error:	<0.1% to 30 kHz

Ramps and Sin(x)/x

Range:	0.1 mHz to 100kHz.
Resolution:	0.1mHz or 10 digits
Accuracy:	Better than 10 ppm for 1 year.
Output Level:	5mV to 20V p-p from 50Ω.
Linearity Error:	<0.1% to 30 kHz

Pulse and Pulse Train

Output Level:	5mV to 20V p-p from 50Ω.
Rise and Fall Times:	<8ns
Period:	Range - 100ns to 100s. Resolution - 4-digits. Accuracy - ±1 digit of setting.
Delay:	Range - -99.9s to + 99.99s. Resolution - 0.001% of period or 10ns.
Width:	Range - 10ns to 99.99s. Resolution - 0.001% of period or 10ns.

Trains of up to 10 pulses may be specified, each having independently defined width, delay and level. The baseline voltage is separately defined and the sequence repetition rate is set by the pulse train period.

MODULATION MODES

Continuous

Waveform runs continuously.

Triggered Burst

Each active edge of the trigger signal will produce one burst of the waveform.

Carrier Waveforms:	All standard and arbitrary.
Max.Carrier Freq.:	The smaller of 2.5MHz or the maximum for the selected waveform. 100Msamples/s for ARB or Sequence.
Number of Cycles:	1 to 1048575
Trigger Rep. Rate:	0.005Hz to 100kHz internal, dc to 1MHz external.
Trigger Source:	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.
Start/Stop Phase:	± 360° settable with 0.1° resolution, subject to waveform frequency and type.

Gated

Waveform will run while the Gate signal is true and stop while false.

Carrier Waveforms:	All standard and arbitrary.
Max.Carrier Freq.:	The smaller of 2.5MHz or the maximum for the selected waveform. 100Msamples/s for ARB or Sequence.
Trigger Rate:	0.005Hz to 100kHz internal, dc to 1MHz external.
Gate Signal Source:	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.
Start/Stop Phase:	± 360° settable with 0.1° resolution, subject to waveform frequency and type.

Sweep

Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques are used to perform the sweep.

Carrier Waveforms:	All standard and arbitrary except pulse, pulse train and sequence.
Sweep Mode:	Linear or logarithmic, continuous or triggered.
Sweep Direction:	Up, down, up/down or down/up.
Sweep Range:	1mHz to 40 MHz in one range. Phase continuous. Independent setting of start/stop frequency.
Sweep Time:	1ms to 999s (3 digit resolution).
Marker:	Variable during sweep.
Sweep Trig. Source:	The sweep may be free run or triggered from the following sources: Manually from keyboard. Externally from TRIG IN input or remote interface.
Sweep Hold:	Sweep can be held and restarted by HOLD key.

Tone Switching

Capability provided for both standard and arbitrary waveforms. Arbitrary waveforms are expanded or condensed to exactly 4096 points and DDS techniques used to allow instantaneous frequency switching.

Carrier Waveforms:	All waveforms bar pulse, pulse train, sequence.
Frequency List:	Up to 16 frequencies from 1mHz to 40MHz.
Trigger Rep. Rate:	0.005Hz to 100kHz internal, dc to 1MHz external. Usable repetition rate and waveform frequency depend on the tone switching mode.
Source:	Internal from keyboard or trigger generator. External from TRIG IN or remote interface.

Tone Switching Modes:

Gated:	The tone is output while the trigger signal is true and stopped, at the end of the current waveform cycle, while the trigger signal is false. The next tone is output when the trigger signal is true again.
Triggered:	The tone is output when the trigger signal goes true and the next tone is output, at the end of the current waveform cycle, when the trigger signal goes true again.
FSK:	The tone is output when the trigger signal goes true and the next tone is output, immediately, when the trigger signal goes true again.

Using 2 instruments with their outputs summed together it is possible to generate DTMF test signals.

External Amplitude Modulation

Carrier frequency:	Entire range for selected waveform.
Carrier waveforms:	All standard and arbitrary waveforms
Modulation source:	Modulation socket.
Frequency Range:	DC - 500 kHz.
Signal Range:	Approx. 1V pk-pk for 100% level change at maximum output.

External Signal Summing

Carrier frequency:	Entire range for selected waveform.
Carrier waveforms:	All standard and arbitrary waveforms.
Sum source:	Sum socket.
Frequency Range:	DC to 30MHz.
Signal Range:	Approximately 2Vpk-pk input for 20Vpk-pk output.

Trigger Generator

Internal source 0.005 Hz to 100kHz squarewave adjustable in 10us steps. 3 digit resolution. Available for external use from the SYNC OUT socket.

OUTPUTS

Main Output

Output Impedance:	50Ω
Amplitude:	5mV to 20V pk-pk open circuit (2.5mV to 10V pk-pk into 50Ω). Amplitude can be specified open circuit (Hi Z) or into an assumed load of 50Ω or 600Ω, in Vpk-pk, Vrms or dBm.
Ampl. Accuracy:	Better than 2% ±1mV at 1kHz into 50Ω.
Ampl. Flatness:	±0.2dB to 1MHz; ±0.4dB to 40MHz.
DC Offset Range:	±10V. DC offset plus signal peak limited to ±10V from 50Ω.
Offset Accuracy:	Typically within ±3% ±10mV, unattenuated.
Resolution:	3 digits or 1mV for both Amplitude and DC Offset.

Sync Out

Multifunction output user definable or automatically selected to be any of the following:

Waveform Sync: (all waveforms)	A square wave with 50% duty cycle at the main waveform frequency, or a pulse coincident with the first few points of an arbitrary waveform.
Position Markers: (Arbitrary only)	Any point(s) on the waveform may have associated marker bit(s) set high or low.
Burst Done:	Produces a pulse coincident with the last cycle of a burst.
Sequence Sync:	Produces a pulse coincident with the end of a waveform sequence.
Trigger:	Selects the current trigger signal. Useful for synchronising burst or gated signals.
Sweep Sync:	Outputs a pulse at the start of sweep to synchronise an oscilloscope or recorder.
Sweep Marker:	Additional output pulse for use as a marker in sweep mode.
Phase Lock Out:	Used to phase lock two generators. Produces a positive edge at the 0° phase point.
Output Signal Level:	Logic level of <0.8V to >3V for all outputs except Sweep Sync. Sweep Sync is a 3-level waveform, logic level as above at start of sweep, with narrow 1V pulse at marker point.

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

INPUTS

Trig In

Frequency Range:	DC - 1MHz.
Signal Range:	Threshold nominally TTL level; max. input ±10V.
Min. Pulse Width:	50ns for Trigger and Gate modes; 50µs for Sweep mode.
Input Impedance:	10kΩ

Modulation In

Frequency Range:	DC - 500kHz.
Signal Range:	VCA: - approximately 1V pk-pk for 100% level change at maximum output. SCM: - approximately ± 1Vpk for maximum output.
Input Impedance:	Typically 1kΩ.

Sum In

Frequency Range:	DC - 30MHz.
Signal Range:	Approximately 2Vpk-pk input for 20Vpk-pk output.
Input Impedance:	Typically 1kΩ.

Hold

Holds an arbitrary waveform at its current position. A TTL low level or switch closure causes the waveform to stop at the current position and wait until a TTL high level or switch opening which allows the waveform to continue. The front panel MAN HOLD key or remote command may also be used to control the Hold function. While held the front panel MAN TRIG key or remote command may be used to return the waveform to the start.

Input Impedance: 10kΩ

Ref Clock In/Out

Set to Input:	Input for an external 10MHz reference clock. TTL/CMOS threshold level.
Set to Output:	Buffered version of the internal 10MHz clock. Output levels nominally 1V and 4V from 50Ω.
Set to Phase Lock:	Used together with SYNC OUT on a master and the TRIG IN on a slave to synchronise (phase lock) two generators.

ARB Clock In

Frequency Range:	DC to 50MHz.
Max. Input Voltage:	+5V, -1V

INTERFACES

Full remote control and waveform download facilities are available through the RS232, USB or GPIB interfaces.

RS-232:	Variable Baud rate, 38,40 0 Baud maximum. 9-pin D-connector. Fully compatible with TTi ARC (Addressable RS232 Chain) system.
GPIB:	Conforming with IEEE488.1 and IEEE488.2
USB:	Conforming with USB 1.1

ARBITRARY WAVEFORM EDITING

Basic arbitrary waveform creation and editing tools are built into the instrument. Arbitrary waveforms can be built-up using insertion of standard waveforms between points, point by point value setting, and straight line drawing between points.

"Waveform Manager Plus" Software

The TGA12101 is supplied with Waveform Manager Plus software for Windows which provides full PC based waveform creation, editing and management. See the main TGA1200 series brochure.

GENERAL

Display:

20 character x 4 row alphanumeric LCD.

Data Entry:

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

Memory Card:

Removable memory card conforming to the Compact Flash memory card standard. Sizes from 32MB to 1GB can be used.

Stored Settings:

Up to 500 complete instrument set-ups may be stored and recalled from the memory card.
Up to 500 arbitrary waveforms can also be stored independent of the instrument settings.

Size:

3U (130mm) height; half-rack (212mm) width; 335mm deep.

Weight:

4.1kg. (9lb.)

Power:

220 - 240V nominal, 50/60Hz; 110 - 120V or 100V nominal 50/60/400Hz. Voltage adjustable internally; operating range ±10% of nominal; 60VA max. Installation Category II.

Compliance

Operating Range:	+5°C to 40°C, 20-80% RH.
Storage Range:	-20°C to + 60°C.
Environmental:	Indoor use at altitudes to 2km, Pollution Degree 2.
Safety:	Complies with EN61010-1.
EMC:	Complies with EN61326.

N.B. Specifications apply at 18-28 °C after 30 minutes warm-up, at maximum output into 50 Ω

Instrument Drivers

Labview and LabWindows CVI drivers are either supplied with the instrument or are available for download without charge from the TTi website.

Supplied Items:

IEC Mains Lead
Printed Manual (partly multi-language)
Multi-language manual on CD
Waveform Manager Plus software
Compact Flash memory card
Compact Flash card reader/writer (USB connection to PC)

Options:

19 inch rack mounting kit.

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