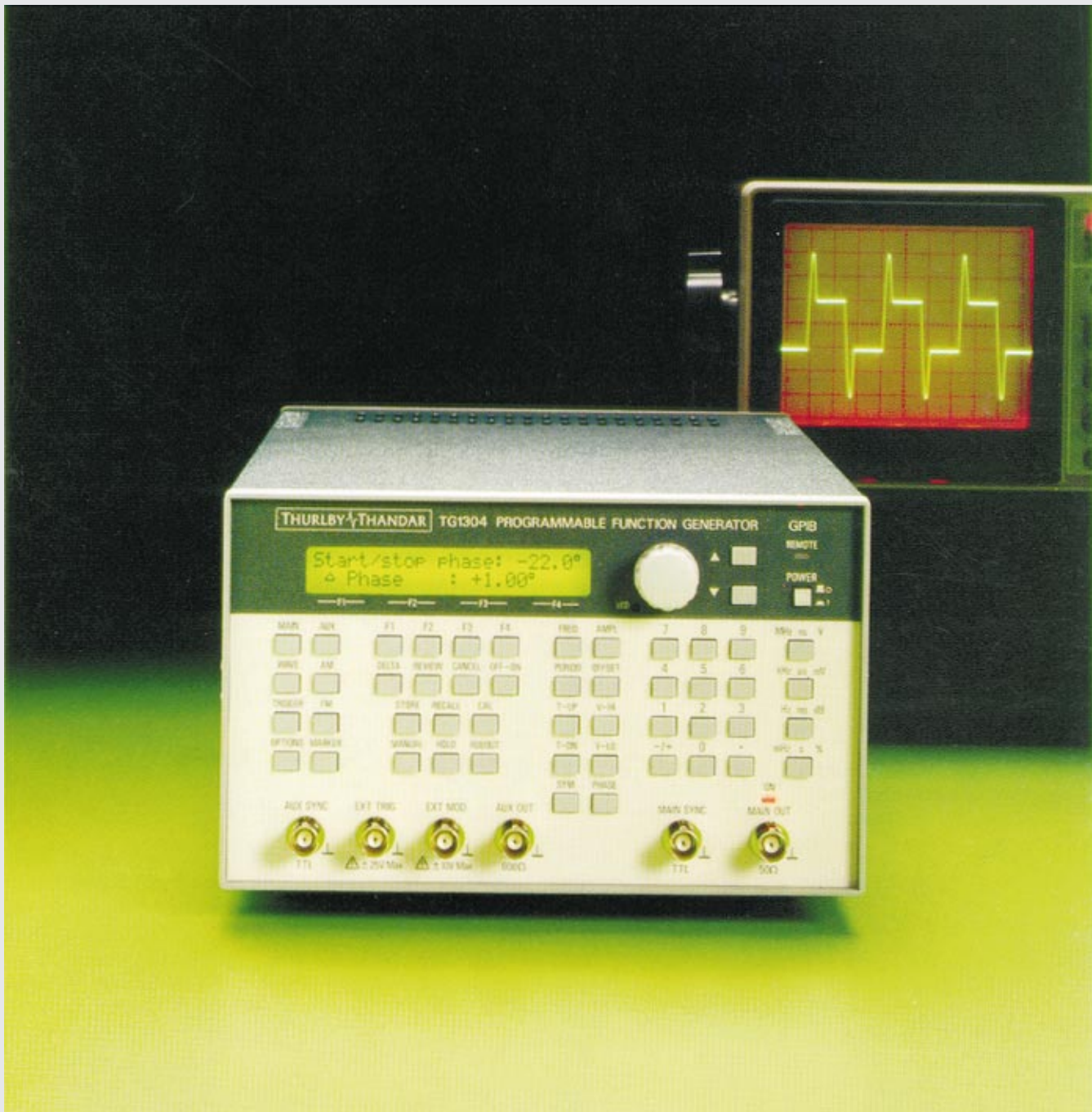




THURLBY THANDAR INSTRUMENTS

TG 1304



13MHz Programmable Function Generator

GPIB Series

# The versatility of a conventional function generator

# The convenience and precision of digital control

The TG1304 is a classic analogue function generator with all the versatility that this implies including the generation of complex waveshapes right up to the maximum generator frequency of 13MHz.

Unlike other analogue generators, however, it harnesses the power of a digital control system to provide an unrivalled range of features.

## Frequency stabilisation

The TG1304 uses digital "measure and correct" techniques to stabilise the main generator frequency to an accuracy of up to 0.01%. That provides not only precision setting but also negligible drift with time.

## Complex waveform generation

In addition to the normal sine, square and triangle waveforms the TG1304 can generate uni-polar pulse waveforms and DC levels. Variable symmetry, variable start/stop phase and variable frequency trigger gating also enable complex waveshapes such as haversines, variable transition time pulses and sine-edged pulses to be obtained.

## The power of a full dual generator architecture

The TG1304 contains two full specification function generators. The main generator covers a frequency range of 10mHz to 13MHz from a 50 Ohms output impedance while the auxiliary generator covers 5mHz to 50kHz from a 600 Ohms output impedance. Both generators can provide output levels between 2mV and 20V pk-pk.

```
Aux: 50.000kHz 20.0Vpp
Wave Freq Sym Ampl
```

Although the auxiliary generator is intended primarily for providing sweep and modulation facilities for the main generator, it can also be used completely independently as a source of sine, triangle or square waves with variable symmetry.

A third internal generator provides a variable frequency source for the gated and triggered burst modes.

## Intelligent data entry

The entry of parameters is completely flexible. For instance, the frequency 10.5kHz can be alternatively entered as .0105MHz or 10500Hz.

Frequency can be displayed or entered as period; symmetry can be entered directly as a percentage or can be set automatically by centering an up-time and down-time for the waveform.

```
266.67nsU 133.33nsD Sine
+6.50dBm+1.75Vdc
```

Output level can be displayed or entered as volts pk-pk or dBm. DC offset can be entered independently or can be set automatically by entering a positive and negative peak voltage for the waveform.

## Powerful trigger modes

The TG1304 offers both gated and burst trigger modes. An internal gating/trigger generator can be set for periods between 150ns and 200s (800ns and 200s for gating waveforms) and the burst count range covers 0.5 cycles to 99999 cycles.

## Frequency modulation and sweep

Full FM and sweep modes are provided via the auxiliary generator. Internal frequency modulation is specified by setting a carrier frequency and a peak deviation. Internal sweep provides repetitive or triggered sweep between specified start and stop frequencies. External voltage controlled frequency is also available.

In sweep mode both the sweep ramp and the retrace can be externally triggered. Up to 8 markers can be set (plus start and stop).

## Full amplitude modulation

Comprehensive amplitude modulation modes are provided including normal AM, linear VCA, and log VCA either internally via the auxiliary generator or externally. A Sum mode for the two generator outputs is also available.

The versatility of the trigger modes combined with the ability to generate half cycles with variable start/stop phase enables many complex waveshapes to be generated.



In normal AM mode the modulation depth is proportional to the modulating signal amplitude regardless of carrier level.

In voltage controlled amplitude (VCA) mode the output amplitude is linearly or logarithmically proportional to the instantaneous modulating signal voltage.

In Sum mode the main signal and the modulating signal are added to produce a two tone output.

## Keyboard or rotary control

All parameters can be set either directly from the numeric keypad, by up/down increment keys or by a quasi-analogue rotary control. The incremental step size can be set by the user.

## Full GPIB control of all functions

The TG1304 comes fitted with a GPIB interface as standard. Every function of the instrument can be controlled from the bus.

The interface conforms fully with the IEEE-488.2 standard. The .2 standard contains many enhancements which are essential when programming a system comprising several instruments.

A National Instruments "Labwindows"\* device driver will be available as an option. Labwindows is an interactive software package which permits fast, simple GPIB program generation on MS-DOS based computers.

## Half-rack case size

The TG1304 is housed in a 3U height, half rack width case. The small footprint case has a built-in tilt stand and is ideal for bench use. Alternatively the optional rack mount kit enables one or two units to be mounted within a standard 19" rack.

## Multiple set-up memories

The TG1304 contains non-volatile memory for storing up to 50 complete set-ups of the instrument. This allows commonly used waveshapes, frequencies and modulations to be instantly recalled. Alternatively the memories can be read and re-loaded from the GPIB enabling complete test sequences to be set up for stand-alone operation.

The power-down conditions are also stored in non-volatile memory.



- Traditional analogue generator with digital control
- Frequency stabilisation to high accuracy
- GPIB interface fitted as standard (IEEE-488.2)
- 10mHz to 13MHz range, 20V pk-pk output
- Dual generator architecture, independent operation
- Comprehensive amplitude/frequency modulation
- Full triggering and gating capabilities
- Keyboard or rotary control of major parameters
- All functions controllable from GPIB

## Maximum waveform versatility

The TG1304 can generate sine, square and triangle waves over the full frequency range of 10mHz to 13MHz; pulse waveforms can be bi-polar or uni-polar. Unlike many generators variable symmetry remains active on the highest range.



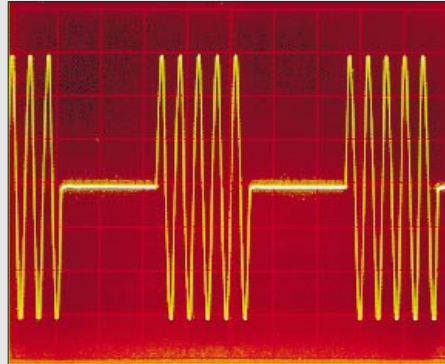
Single cycle triangle waveform

Complex amplitude and frequency modulation modes are instantly selectable making use of the wide-range auxiliary generator. Modes include linear or logarithmic sweep, FM specified by carrier and deviation, AM, linear or logarithmic VCA and sum. All modes are selected from menus.

```
F±2.000kHz; Tri 435.0 Hz  
dev'n Wave Mod-F
```

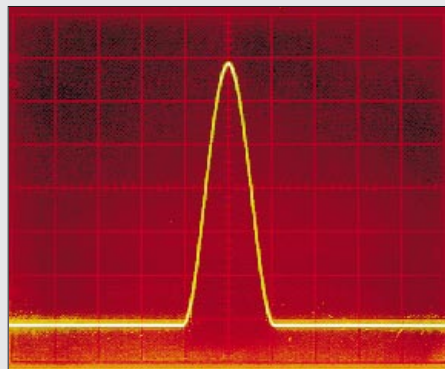
The internal gating generator increases the versatility still further. Start and stop phase is fully variable and half cycles can be generated as well as integer numbers of cycles.

Not only can counted bursts and period gated signals be generated, but highly complex pulse waveforms can be produced using the gating generator to define the period and using the main generator to define the shape of the edges.



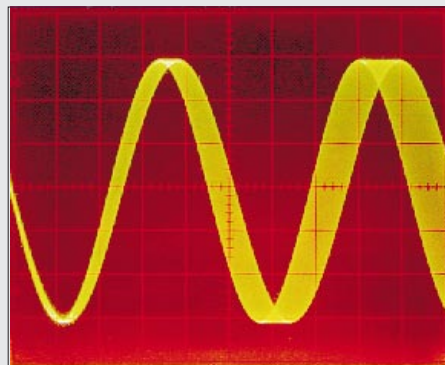
Burst signal

The burst count can be set anywhere between 0.5 cycles and 99999.5 cycles. The burst trigger can be from the internal generator or from an external source.

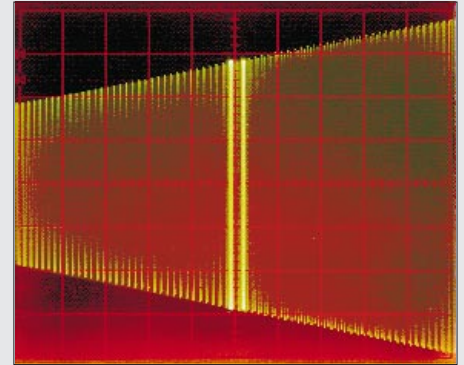


Haversine waveform

The ability to set start-stop phase to any value allows more complex waveshapes such as haversine to be produced.

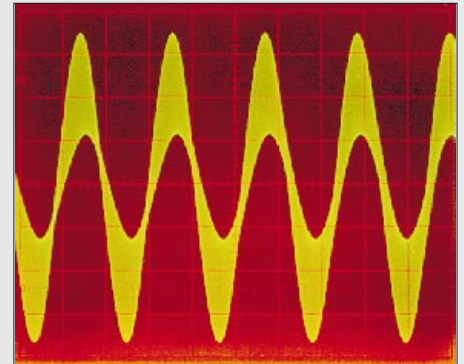


Frequency modulated carrier wave



Sweep waveform with markers

Up to 8 markers (plus start and stop) can be defined for sweep modes. Markers can be defined either as absolute frequencies or as percentages of sweep range.



Amplitude modulated carrier wave



Sine-edged pulse

The combination of an internal trigger generator with the ability to define half cycles with variable start-stop phase enables special waveforms such as sine-edged pulses to be produced.

# Technical specifications

## Main Generator

### Frequency

Total Range:	10 MHz to 13 MHz in 8 ranges (x1 Hz to x10 MHz)
Data Entry:	May be specified as frequency or period (with symmetry), or as up time and down time.
Resolution:	5 digits or 0.1mHz
Accuracy:	± 0.01% of range stabilised, ± 3% unstabilised (50% Sym)

### Symmetry

Range:	5% to 95% (1:19 to 19:1), subject to: 45ns minimum triangle ramp time (high frequency) 50s maximum triangle ramp time (low frequency).
Data Entry:	May be specified as a percentage, or implicitly by up time and down time waveform specification.
Resolution:	0.1 percent
Accuracy:	± 1% (20% to 80%) over 12 Hz to 500 kHz ± 5% otherwise 0.1Hz to 5 MHz ± 10% below 0.1Hz & above 5 MHz

### Stabilisation

Technique:	Processor controlled measure & correct.
Application:	Frequency >12Hz, continuous, no FM.
Measurement Time:	30ms plus 1 complete waveform period.
Settling Time:	10 measurements to 0.2%

### Start/stop phase:

Range:	Settable at any point on the waveform except within ± 20ns of the triangle peaks.
Data Entry:	Degrees (-360 to +360 accepted)
Resolution:	1 degree
Accuracy:	± 2 degrees ± 20 ns

### Sync output

Output Voltage:	TTL/CMOS levels, or 1.5Vpp typical into 50 Ohm
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## Main Output

<b>Waveforms</b>	Sine, Triangle, Square (Bipolar pulse), Positive pulse, Negative pulse DC offset only, DC at positive peak, DC at negative peak.
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### Amplitude and Offset

N.B. All values quoted are emf. Voltages halve into matched 50 Ohm load.

Amplitude Range:	2mVpp to 20Vpp emf for sine, square and triangle. 1mVpp to 10Vpp emf for unipolar pulse waveforms.
Offset Range:	-10V to +10V emf
Data Entry:	Amplitude may be specified as peak-peak or dBm, with offset specified as voltage; or amplitude and offset may be specified together as High voltage and Low voltage.
Resolution:	3 digits or 1 mV
Basic Accuracy:	±3% ±1mV (f = 1kHz, no DC, loaded with 50 Ohms).
Amplitude Flatness:	±0.1dB typical, up to 5MHz.
Offset Accuracy:	±2% of attenuator range ±2mV (loaded with 50 Ohms).

### Characteristics

Output Impedance:	50 Ohms nominal.
Output Attenuator:	10dB, 20dB, 30dB sections; giving 0-60 dB total.
Variable Attenuator Range:	>40dB below 500kHz, reducing to 20dB at 13 MHz.
DC Shift:	<20mV over full range
Max Output Voltage:	Sum of peak signal plus DC offset cannot exceed ±10V at amplifier output.
Max Output Current:	±100 mA max for linear operation.
Short Circuit:	60 seconds max

### Protection

An output protection circuit switches the output off if the voltage at the output terminal exceeds the positive or negative protection thresholds which may be applied to rear panel terminals by the user.

Default Thresholds:	-12V and +12V
User Applied Range:	-12V to +12V for each threshold (provided that the positive threshold is greater than the negative).
Input Impedance:	9k Ohm nominal from +12V and -12V
Accuracy:	± 0.5V
Response Time:	<10ms

### Waveform Quality

Sine Distortion:	< 0.5% 20Hz to 50kHz, <1% below 20Hz & 50kHz to 500kHz. Each harmonic > 30dB down 500kHz to 10MHz.
Triangle Aberrations:	< 1% below 50kHz.
Pulse Transition Time:	< 30ns, 18ns typical.
Pulse aberrations:	< 5% + 20mV.

## Trigger

### Trigger Modes

Continuous:	Generator runs continuously with frequency stabilisation applied.
Gated:	Generator gated on by trigger signal. Waveform starts and stops at the defined start/stop phase. The last cycle is completed.
Burst:	Generator produces a burst of a counted number of cycles following each trigger. Waveform starts and stops at the defined start/stop phase.

### Trigger Sources

External, Internal, Sweep, Manual or GPIB command

### External Trigger Input

Threshold:	-10V to +10V
Sensitivity:	±0.5V about threshold
Input Impedance:	5k Ohm nominal
Max. Input:	±25V
Min. Pulse Width:	50 ns (active or inactive)
Re-trigger period:	50 ns after waveform stop
Ext Trigger Slope:	Selectable rising, falling, or both edges.
Ext Gate level:	Selectable high or low.

### Internal Burst Trigger

Repetition Rate:	150 ns to 858 sec
Resolution:	5 digits or 50ns

### Internal Gating Waveform

On/Off Time:	800ns to 858 sec
Resolution:	5 digits or 400ns

### Burst count

Range:	1/2 to 524288 cycles
Resolution:	1/2 cycle

## Auxiliary Generator

### Frequency

Range:	5mHz to 50 kHz
Data Entry:	Frequency or period
Resolution:	3 digits
Accuracy:	± 3% (at 50% symmetry)

### Symmetry

Range:	5% to 95%, subject to 10us minimum and 100 sec maximum triangle ramp time.
Data entry:	Percent
Resolution:	1 percent
Accuracy:	1 percent (20% to 80%)

### Waveforms

Sine, Square, Triangle, Ramp

### Ramp

Ramp Time:	100ms to 200s
Dwell Time:	5ms to 1 sec (5ms increments, as marker duration)
RetraceTime:	<20ms

### Sync Output (pen lift)

Output Low Voltage:	<0.4V at 2 TTL loads
Max. Sink Current:	25mA
Internal Pull Up:	1k Ohm to +5V
Max Off-state Voltage:	+15V

## Auxiliary Output

Signals:	Sine, Square, Triangle, Ramp (from Auxiliary generator) Main generator Frequency control voltage (FCV) Main generator Amplitude control voltage (ACV)
Output Impedance:	600 Ohms
Output Amplitude:	2mV to 20V pk-pk emf (sine, square, triangle) 1V to 10V full scale (FCV, ACV)

## External Modulation Input

Input Impedance:	10k Ohm nominal
Nominal Input Level:	5V pk-pk
Bandwidth:	50 kHz

# Technical specifications (continued)

## Amplitude Modulation

### Modes

Normal AM:	The modulation depth is proportional to the modulating signal amplitude regardless of carrier level.
Linear VCA	Voltage Controlled Amplitude: the output signal amplitude is directly proportional to the instantaneous modulating signal voltage.
Log VCA	The output signal amplitude is logarithmically proportional to the instantaneous modulating signal voltage.
Sum	The main and modulating signals are added to produce a two tone output.

### Internal AM

Mod Waveforms:	Sine, triangle, square
Data Entry:	Percentage modulation
Range:	0 to 99%
Resolution:	1 percent
Accuracy:	± 5%

### Internal VCA

Waveforms:	Triangle, rising ramp or falling ramp
Law:	Linear or Log
Data Entry:	Maximum and minimum amplitudes
Triggering:	On ramp waveforms only. Selectable Polarity and variable threshold. One edge triggers forward trace, other edge triggers retrace.

### Internal SUM

Data Entry:	The waveform, frequency, and amplitude of the two signal components are separately specified.
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### External Sensitivity

AM:	Nominally 10Vpp (about 0V) for 100% modulation.
VCA:	5V nominal span for zero to full output on selected range.

### Amplitude Modulator Performance

Variable Atten. Range:	>50dB to 50 kHz sine or triangle >40dB to 500kHz >30dB to 13 MHz 10 dB less for pulses (to 10% aberration)
Carrier Distortion:	<2 times rated unmodulated distortion
Envelope Distortion:	<3% between 10% and 80% modulation.
VCA Linearity:	±3%
Modulation Bandwidth:	DC to 50kHz
Envelope Rise Time:	<5 us
Envelope Overshoot:	<5% (of carrier amplitude)
Intermodulation (sum):	<2%

## Frequency Modulation and Sweep

### Modes

Internal FM:	Normal Frequency modulation, specified by carrier frequency and peak deviation.
Internal Sweep:	Repetitive or triggered sweep between specified start and stop frequencies.
External VCF:	Voltage Controlled Frequency: the frequency is determined by the sum of the applied external voltage and an internal value (equivalent to the dial of a conventional generator). The main display shows the actual frequency of the generator measured by the counter.

### Internal FM

Mod. Waveforms:	Sine, triangle, square
Data Entry:	Peak deviation
Max Deviation:	± 90% of carrier, subject to oscillator limits. (Automatic re-ranging if needed)
Resolution:	0.1 percent of frequency range
Deviation Accuracy:	±4% deviation ±0.1% carrier

(for peak frequency 12Hz to 1.2MHz)

Bandwidth:	DC to 50kHz (dev <10% range)
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### Internal Sweep

Waveforms:	Triangle, rising ramp or falling ramp
Law:	Linear or Log
Data Entry:	Start and stop frequencies.
Range:	1000 to 1 below top of frequency range.
Triggering:	On ramp waveforms only. Selectable Polarity and variable threshold. One edge triggers forward trace, other edge triggers retrace.

### Markers

Number:	Up to 8 plus start and stop
Duration:	5 ms to 1 sec (5 ms increments)
Accuracy:	±2% of sweep width

### External VCF

Law:	Linear or Log.
Data Entry:	Frequency range and internal adder may be explicitly specified.
Input Sensitivity:	5V nominal span for full range
Linearity:	<3% up to 1.2 MHz range <10% on 13MHz range

## Other Facilities

### Parameter Adjustment

Major numeric parameters can be varied, using either the step up and step down keys or the continuous rotation knob.

Any desired step size may be specified; the knob sensitivity (steps per revolution) is automatically adjusted for optimum ease of use at that step size.

### Stored Settings

Up to 64 complete instrument setups may be stored in battery backed memory, and can be recalled as required.

## Remote Control

The TG1304 has full remote control facilities through the GPIB interface which is fitted as standard.

Interface:	IEEE-488 compatible, not isolated.
Subsets:	SH1 AH1 T6 TE0 L4 LE0 SR1 RL1 PP1 DC1 DT1 C0 E2
Address:	0 to 30, set from front panel.
Command Set:	IEEE-488.2 compliant.
Capabilities:	All facilities are remotely programmable. Programming may be by mnemonic command or binary block transfer. Full learn capabilities, either in text command or binary block form.

## Environmental

### Mechanical

Dimensions:	3U (130mm) height; Half rack (212mm) width; 330mm depth
Mounting:	Free standing (with tilt feet), or optional rack mounting kit
Weight:	5kg

### Power requirements

Nominal Voltage:	220/240v 50/60 Hz AC or 100/120v 50/60 Hz AC by rear panel adjustment.
Consumption:	60VA max (at nominal voltage)

### Ambient

Operating temp:	+5oC to +40oC (performance to spec at 230oC ± 5°C).
Humidity:	20% to 80% RH, non-condensing.
Storage temp:	0oC to +50oC

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

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