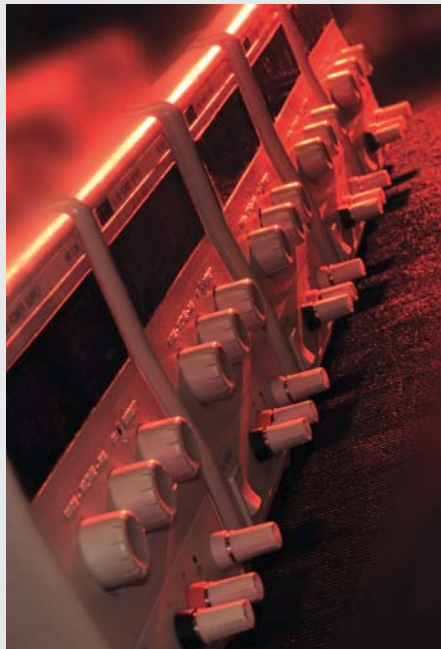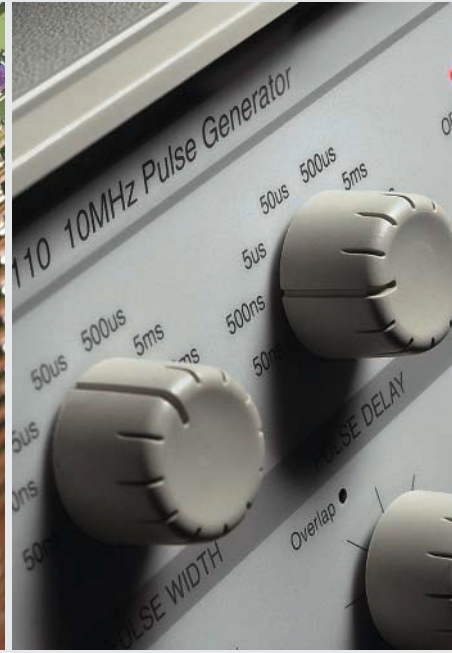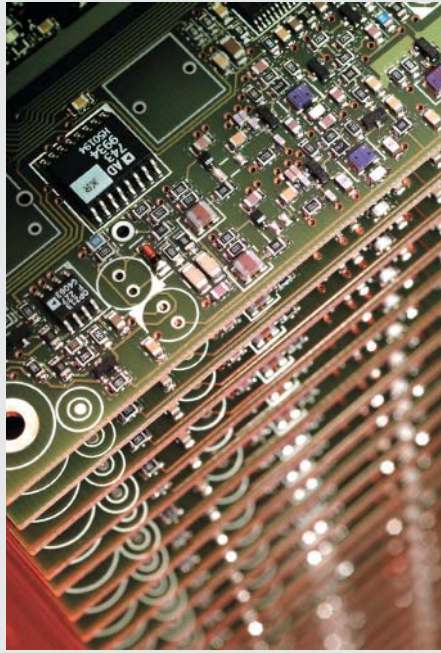# TTi

# THURLBY THANDAR INSTRUMENTS

## SHORTFORM

- Bench and Bus Programmable DC Power Supplies •
- Function, Arbitrary, Pulse and RF Signal Generators •
- Multimeters, Counters, Component and EMC Measurement •
- Logic Analysers and Data Analysers •

# TTi

## Measurably better value

## Laboratory DC Power Supplies

TTi is one of the world's major producers of laboratory power supply units (PSUs) with more than 25 years of experience.

Hundreds of thousands of TTi dc power supplies are in everyday use around the world.

### Power technologies

TTi laboratory power supplies use both linear and switch-mode technologies in order to optimise performance and value for money.

### Linear regulation

Pure linear regulation still provides the lowest output noise and best transient response. The disadvantage is greater physical size and weight for a given power, together with higher heat output.

Pure linear regulation is used on the EL, PL, QL and TS series, as well as on the TSP3222.

### Mixed-mode regulation

For higher power levels, TTi have developed a technology that uses switch-mode pre-regulation and linear final regulation. This technique combines exceptional efficiency with noise levels that are close to that of pure linears.

Mixed-mode regulation is used in the EX and TSX series.

### PowerFlex regulation

The TTi PowerFlex system uses a modified form of mixed-mode regulation to provide higher levels of current when the voltage is set to lower values. Although producing slightly higher noise levels than the standard mixed-mode regulation, performance is still excellent.

PowerFlex regulation is used on the CPX series.

### Silent Cooling

Most TTi power supplies use convection cooling thus removing the need for a fan and providing silent operation.

Certain models which offer particularly high power density (e.g. EX4210R) use fan-blown cooling to limit temperature rise in the power section.

Additionally, the QL series of high precision linear power supplies uses fan cooling to minimise power related temperature variation within the precision analogue circuitry.

### Measurement and control

All TTi laboratory power supplies offer high accuracy digital meters together with high resolution controls and dc output switches.

### Standard models

The EL and EX series incorporate three digit meters for both voltage and current. This provides a level of accuracy and resolution sufficient for many purposes.

Separate coarse and fine voltage controls allow rapid and precise adjustment whilst a semi-logarithmic current control provides increased setting resolution at lower currents.

### Precision models

The EX-R, PL, TS, TSX and CPX series offer a higher level of precision by incorporating four digit meters and remote sense terminals.

Four digit meters provide higher resolution and accuracy. Remote sense enables the PSU to regulate the voltage directly at the load thus eliminating the effect of connection lead resistance.

### High precision digital control models

The QL series offer an unprecedented level of precision by incorporating 16-bit digital control and five digit metering with a resolution of 1mV. This is matched with 0.1mA current resolution and remote sense terminals.

Voltage and current can be set directly from a numeric keyboard or can be set in quasi-analogue mode using a rotary encoder.

The very high accuracy and stability of the QL series makes it suitable for use as a calibration source as well as a power supply.



### Bus programmability

As well as the large range of standard bench power supplies, TTi also offers bus programmable units incorporating varying combination of GPIB (IEEE-488), RS-232 and USB interfaces.

LabView or LabWindows drivers are available for most power supplies.

These models are equally suited to use on the bench, and in some cases have additional features which will be particularly useful to bench users.

### Rack mounting

Rack-mount kits are available for both bus programmable and standard bench power supplies.

TSX and CPX models use a 3U rack capable of taking one or two units. PL and QL models use a 4U rack. Up to three QL singles can be mounted side by side; alternatively one triple can be combined with one single.

### Power supply selector table

### Basic and Powerpack models

In addition to the models detailed on the following pages, TTi also offers a 'basic' triple output general-purpose bench power supply, the EB2025T; and a 'powerpack' PSU for battery simulation, the TS1410.

### NEW - Electronic DC Load

In addition to the ranges of dc power supplies, TTi also offer an electronic dc load.

## EL series: compact linear bench PSUs



Specifications for Main Outputs: Line & load regulation <0.01%. Output noise <1mV rms. Meter accuracies 0.3% ±1digit - voltage, 0.6% ±1digit - current.

▶ Single, dual or triple outputs - 30W to 125W
▶ Linear regulation with low noise and good regulation
▶ 3 digit voltage and current meters on each output
▶ Constant voltage or constant current operation
▶ Switchable 3.3V/5V output on triple output model
▶ Compact design uses less bench space
▶ DC output switches, automatic mode indication
▶ Bus programmable (RS-232) version available ▶▶

## PL series: precision bench PSUs



Specifications for Main Outputs: Line & load regulation <0.01%. Output noise <1mV rms. Meter accuracies 0.1% ±1digit - voltage, 0.3% ±1digit - current.

▶ Single, dual or triple outputs - 66W to 240W
▶ Linear regulation, precision metering, remote sense terminals
▶ 4 digit voltage and current meters on each output
▶ Meter resolution 10mV and 1mA
▶ Constant voltage or constant current operation
▶ Duals and triples have four modes of operation: isolated, series, series-tracking, true parallel
▶ Higher current 'logic voltage' output on triples
▶ DC output switches, automatic mode indication
▶ Bus programmable (GPIB, RS232) versions available ▶▶

## QL series: advanced precision linear PSUs



Specifications for Main Outputs: Line & load regulation <0.01%. Output noise <0.35mV rms. Setting accuracies 0.03% ± 5mV - voltage, 0.3% ± 0.5mA - current.

▶ Single or triple outputs - 105W to 215W
▶ Linear regulation for highest performance
▶ Setting by direct numeric entry or spin wheel
▶ Very high precision with 1mV and 0.1mA resolution
▶ Multiple ranges for increased current flexibility
▶ Excellent noise, regulation and dynamics
▶ Multiple non-volatile setting memories
▶ OVP and OCP trips with alarm output
▶ Electronically switchable remote sense terminals
▶ Switchable 2.7V/3.3V/5V output on triple
▶ Bus controlled (GPIB, RS232,USB) versions available ▶▶

## TS series: precision bench PSUs



Specifications for Main Outputs: Line & load regulation <0.01%. Output noise <1mV rms. Meter accuracies 0.1% ±1digit - voltage, 0.3% ±1digit - current.

▶ Single or dual outputs - 60W or 120W
▶ Linear regulation and precision metering
▶ Remote sense terminals
▶ 3.5 digit voltage and current meters on each output
▶ High contrast LCD displays
▶ Meter resolution 10mV and 1mA
▶ Constant voltage or constant current operation
▶ DC output switches, automatic mode indication

## Power supply selector table

A full listing of all the models in each power supply series is given on the page 5. ▶▶

This also makes it easy to choose a power supply quickly from some known requirements such as maximum voltage and current.

## EX series: compact high power bench PSUs

Specifications for Main Outputs: Line & load regulation <0.01%. Output noise <2mV rms. Meter accuracies 0.3% ±1digit - voltage, 0.6% ±1digit - current.

▶ Single, dual or triple outputs - 175W to 420W
▶ Mixed-mode regulation, silent fan-free cooling (except EX4210R)
▶ 3 digit voltage and current meters on each output (4 digit meters on EX-R versions)
▶ Constant voltage or constant current operation
▶ Remote sense terminals on EX-R versions
▶ Switchable 3.3V/5V output on triple output model
▶ Compact design uses less bench space
▶ DC output switches, automatic mode indication
▶ Bus programmable (RS-232) version available  ▶▶

## CPX series: PowerFlex dual output PSUs

Line regulation <0.01%. Load regulation <0.02%. Output noise <2mV rms. Meter accuracies: 0.2% ±1digit - voltage, 0.5% ±1digit - current.

▶ Dual outputs, 350W to 840W maximum
▶ PowerFlex design - see Power Envelope graph
▶ 4 digit voltage and current meters on each output
▶ Constant voltage or constant current operation
▶ Switchable remote or local sensing
▶ Individual dc output switches
▶ Comprehensive protection, variable OVP trips
▶ Compact half-rack 3U case size
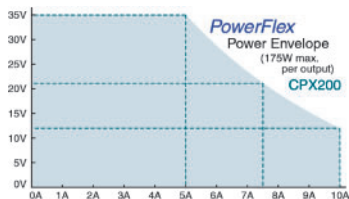
The CPX200 can provide up to 350 watts (175W per channel).  As the set voltage is reduced below 35V, the maximum output current is increases up to a maximum of 10A.
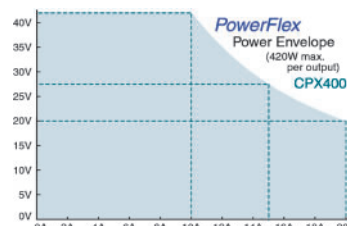
The CPX400 can provide up to 840 watts (420W per channel).  As the set voltage is reduced below 42V, the maximum output current is increases up to a maximum of 20A.

## TSX series: high power bench PSUs
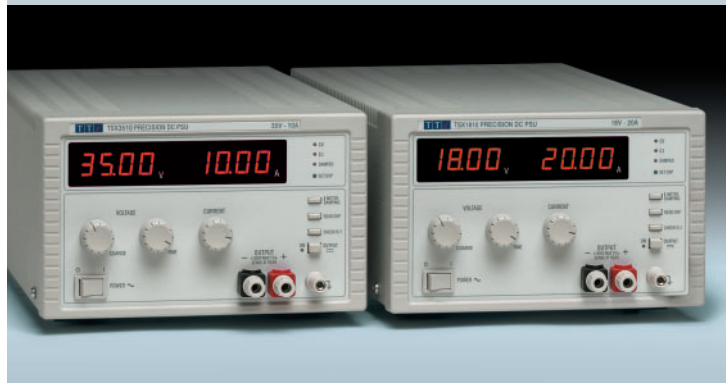
Specifications: Line & load regulation <0.01%. Output noise <1mV rms. Meter accuracies 0.2% ±1digit - voltage, 0.5% ±1digit - current.

▶ High power single output - 350W plus
▶ Mixed-mode regulation, silent fan-free cooling
▶ Precision metering and control, remote sense
▶ 4 digit voltage and current meters on each output
▶ Meter resolution 10mV and 10mA
▶ Constant voltage or constant current operation
▶ DC output switches; variable OVP protection
▶ Compact half-rack 3U case size
▶ Bus programmable (GPIB, RS232) versions available  ▶▶

## *Bus programmable power supplies*

As well as the large range of standard bench power supplies, TTi also offers bus programmable units incorporating varying combination of GPIB (IEEE-488), RS-232 and USB interfaces.

These models are equally suited to use on the bench, and in some cases have additional features which will be particularly useful to bench users.

For example, the TSX1810P provides many extra features such as setting memories, watts display and increment stepping which are not incorporated into the standard TSX1810.  Digitally controlled PSUs can also provide faster set-up and better setting stability than analogue controlled units.

Bus programmable power supplies are supported with instrument drivers that allow simple integration into generalised test software.  LabView or LabWindows drivers are available from the TTi website.

## QL-P series:  with GPIB, RS-232 and USB

▶ Single or triple output - 105W to 215W
▶ Linear regulation for highest performance
▶ RS-232, GPIB (IEEE-488.2) and USB interfaces
▶ Front and rear output terminals
▶ Bench or rack mounting
▶ Features and specifications as per standard QL series  ◀◀

## EL-P and EX-P: with RS-232



- Low-cost single output PSUs with RS-232
- 30V/2A linear or 35V/5A mixed-mode regulation
- Setting resolution of 10mV and 10mA
- Front panel control using rotary encoders
- Other features as per EL and EX series ◄◄

## PL-P series: with RS-232 and GPIB



- Single, dual or triple outputs, linear - 32V/3A
- Setting and readback resolution of 10mV and 1mA
- 4-6V/7A logic output on triple output model
- RS-232 and GPIB (IEEE-488.2) interfaces
- Other specifications as per bench PL series ◄◄

## TSP3222: with GPIB



Linear Regulation
Line regulation <0.001%.
Load regulation <0.005%.
Output noise <1mV rms.
Meter accuracies:
0.1% ±1digit - voltage,
0.3% ±1digit - current.

- Dual isolated outputs (0-32V, 0-2A each)
- Linear regulation
- GPIB interface (IEEE-488.2)
- Total control from front panel or GPIB
- Full voltage and current readback
- Relay switched series and parallel modes
- Variable OVP trip, full thermal protection
- Compact half-rack 3U case size

## TSX-P series: with GPIB and RS-232



- High power single output - 18V/20A or 35V/10A
- RS-232 and GPIB (IEEE-488.2) interfaces
- Regulation and metering as per standard TSX ◄◄
- Rotary and delta (step) control of V and I
- Watts display, non-volatile storage of 25 settings
- Digital setting via keypad or spinwheel
- Compact half-rack 3U case size

## System Integration

### Software Support

Bus programmable power supplies are supported with instrument drivers to allow simple integration into generalised test software.

LabView or LabWindows drivers are available for QL-P series, TSX-P series, PL-P series and TSP3222 power supplies.  The QL-P series is supplied with a full IVI driver.

The RS-232 interface fitted to the QL-P, TSX-P and PL-P series is ARC compatible and is supported by ARC Windows software (see page 14).

The EL-P and EX-P are supported by a dedicated piece of software that provides remote control and logging via RS-232.

### Rack Mounting

Rack-mount kits are available for both bus programmable and standard bench power supplies.

TSX and CPX models use a 3U rack capable of taking one or two units.  PL and QL models use a 4U rack.  Up to three QL singles can be mounted side by side or one single plus one triple.
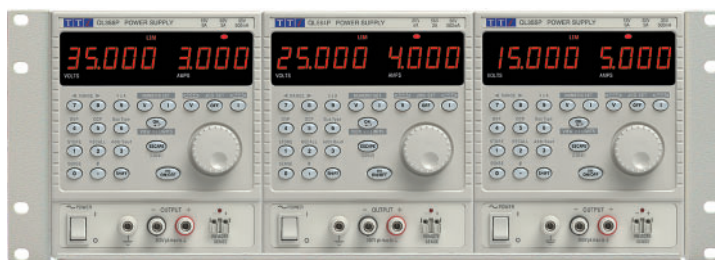


## Power supply selector table

A full listing of all the models in each power supply series is given on the next page.  ►►

This also makes it easy to choose a power supply quickly from some known requirements such as maximum voltage and current.

## Power Supply Selector Table

### BENCH MODELS

| Model No | Type | Regulation | O/Ps | Main Output(s) | Logic Output | Power | Fan | OVP | Controls | Meters | Size mm | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EB2025T | Basic | Linear | Triple | 0.3 - 20V@ 0.25A | 5V @ 1A | 15W | No | No | Analogue | Analogue | 220x82x230 | 1.8kg |
| TS1410 | PowerPack | Linear | Single | 12V - 14V @ 10A | | 140W | No | No | Analogue | Analogue | 190x160x273 | 7.8kg |
| EL301 | Compact | Linear | Single | 0V - 30V @ 1A | | 30W | No | No | Analogue | LED | 140x160x195 | 3.4kg |
| EL183 | Compact | Linear | Single | 0V - 18V @ 3.3A | | 60W | No | No | Analogue | LED | 140x160x195 | 4.4kg |
| EL302 | Compact | Linear | Single | 0V - 30V @ 2A | | 60W | No | No | Analogue | LED | 140x160x195 | 4.4kg |
| EL561 | Compact | Linear | Single | 0V - 56V @ 1.1A | | 60W | No | No | Analogue | LED | 140x160x195 | 4.4kg |
| EL155 | Compact | Linear | Single | 0V - 15V @ 5A | | 75W | No | No | Analogue | LED | 140x160x195 | 5.0kg |
| EL303 | Compact | Linear | Single | 0V - 30V @ 3A | | 90W | No | No | Analogue | LED | 140x160x195 | 5.0kg |
| EL302D | Compact | Linear | Dual | 0V - 30V @ 2A | | 120W | No | No | Analogue | LED | 260x160x195 | 7.5kg |
| EL302T | Compact | Linear | Triple | 0V - 30V @ 2A | 3.3V/5V @ 1A | 125W | No | No | Analogue | LED | 260x160x195 | 7.5kg |
| EX1810R | Precision | Mixed Mode | Single | 0V - 18V @ 10A | | 180W | No | No | Analogue | LED | 140x160x195 | 3.0kg |
| EX355 | Compact | Mixed Mode | Single | 0V - 35V @ 5A | | 175W | No | No | Analogue | LED | 140x160x195 | 3.0kg |
| EX4210R | Precision | Mixed Mode | Single | 0V - 42V @ 10A | | 420W | Yes | No | Analogue | LED | 140x160x195 | 3.5kg |
| EX354D | Compact | Mixed Mode | Dual | 0V - 35V @ 4A | | 280W | No | No | Analogue | LED | 260x160x195 | 4.3kg |
| EX354T | Compact | Mixed Mode | Triple | 0V - 35V @ 4A | 3.3V/5V @ 5A | 305W | No | No | Analogue | LED | 260x160x195 | 4.3kg |
| EX752M | Compact | Mixed Mode | Dual ** | 0V - 75V @ 2A | | 300W | No | No | Analogue | LED | 260x160x195 | 4.4kg |
| PL154 | Precision | Linear | Single | 0V - 15V @ 4A | | 60W | No | No | Analogue | LED | 155x170x265 | 5.0kg |
| PL320 | Precision | Linear | Single | 0V - 32V @ 2.1A | | 65W | No | No | Analogue | LED | 155x170x265 | 5.0kg |
| PL330 | Precision | Linear | Single | 0V - 32V @ 3.1A | | 95W | No | No | Analogue | LED | 155x170x300 | 6.0kg |
| PL320QMD | Precision | Linear | Dual * | 0V - 32V @ 2.1A | | 130W | No | No | Analogue | LED | 350x170x265 | 9.5kg |
| PL330QMD | Precision | Linear | Dual * | 0V - 32V @ 3.1A | | 190W | No | No | Analogue | LED | 350x170x300 | 12.0kg |
| PL320QMT | Precision | Linear | Triple * | 0V - 32V @ 2.1A | 4V - 6V @ 4A | 155W | No | No | Analogue | LED | 425x170x265 | 13.5kg |
| PL330QMT | Precision | Linear | Triple * | 0V - 32V @ 3.1A | 4V - 6V @ 7A | 230W | No | No | Analogue | LED | 425x170x300 | 15.5kg |
| TS3021S | Precision | Linear | Single | 0V - 30V @ 2A | | 60W | No | No | Analogue | LCD | 160x160x238 | 4.9kg |
| TS3022S | Precision | Linear | Dual | 0V - 30V @ 2A | | 120W | No | No | Analogue | LCD | 308x160x238 | 9.6kg |
| QL355 | High Precision | Linear | Single | 0V - 35V @ 5A # | | 105W | Yes | Yes | Digital | LED | 141x171x300 | 5.0kg |
| QL564 | High Precision | Linear | Single | 0V - 56V @ 4A # | | 112W | Yes | Yes | Digital | LED | 141x171x300 | 5.0kg |
| QL355T | High Precision | Linear | Triple | 0V - 35V @ 5A # | 2.7V-5V @ 1A | 215W | Yes | Yes | Digital | LED | 282x171x300 | 10.0kg |
| TSX1820 | Precision | Mixed Mode | Single | 0V - 18V @ 20A | | 360W | No | Yes | Analogue | LED | 210x130x350 | 5.0kg |
| TSX3510 | Precision | Mixed Mode | Single | 0V - 35V @ 10A | | 350W | No | Yes | Analogue | LED | 210x130x350 | 5.0kg |
| CPX200 | Precision | PowerFlex | Dual | 0V - 35V @ 10A † | | 350W | No | Yes | Analogue | LED | 210x130x350 | 6.0kg |
| CPX400 | Precision | PowerFlex | Dual | 0V -42V @ 20A † | | 840W | Yes | Yes | Analogue | LED | 210x130x350 | 7.5kg |

### BUS PROGRAMMABLE MODELS

| Model No | Interfaces | Regulation | O/Ps | Main Output(s) | Logic Output | Power | Fan | OVP | Local Cntrl | Meters | Size mm | Weight |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EL302-P | RS-232 | Linear | Single | 0V - 30V @ 2A | | 60W | No | No | Digital | LED | 140x160x195 | 4.4kg |
| EX355-P | RS-232 | Mixed Mode | Single | 0V - 35V @ 5A | | 175W | No | No | Digital | LED | 140x160x195 | 3.0kg |
| PL330-P | RS-232 & GPIB | Linear | Single | 0V - 32V @ 3.1A | | 95W | No | No | Analogue | LED | 207x170x300 | 6.5kg |
| PL330D-P | RS-232 & GPIB | Linear | Dual | 0V - 32V @ 3.1A | | 190W | No | No | Analogue | LED | 350x170x300 | 12.5kg |
| PL330T-P | RS-232 & GPIB | Linear | Triple | 0V - 32V @ 3.1A | 4V - 6V @ 7A | 230W | No | No | Analogue | LED | 425x170x300 | 16.0kg |
| QL355-P | USB/RS232/GPIB | Linear | Single | 0V - 35V @ 5A # | | 105W | Yes | Yes | Digital | LED | 141x171x300 | 5.0kg |
| QL564-P | USB/RS232/GPIB | Linear | Single | 0V - 56V @ 4A # | | 112W | Yes | Yes | Digital | LED | 141x171x300 | 5.0kg |
| QL355T-P | USB/RS232/GPIB | Linear | Triple | 0V - 35V @ 5A # | 2.7V-5V @ 1A | 215W | Yes | Yes | Digital | LED | 282x171x300 | 10.0kg |
| TSP3222 | GPIB | Linear | Dual | 0V - 30V @ 2A | | 120W | Yes | Yes | Digital | LCD | 210x130x380 | 11.0kg |
| TSX1820-P | RS-232 & GPIB | Mixed Mode | Single | 0V - 18V @ 20A | | 360W | No | Yes | Digital | LED | 210x130x350 | 5.5kg |
| TSX3510-P | RS-232 & GPIB | Mixed Mode | Single | 0V - 35V @ 10A | | 350W | No | Yes | Digital | LED | 210x130x350 | 5.5kg |

### Explanatory Notes

**\* Quad-mode switching** (PL Series)

The main outputs on most TTi power supplies are isolated and have automatic crossover between CV and CI modes. This allows wiring in series or parallel in order to achieve higher voltages or higher currents.

The PL series also features "quad-mode" switching on duals and triples which allows push-button selection of four modes of operation: isolated, series, series-tracking, or parallel.

**\*\* Multi-mode switching** (EX752M)

The EX752M incorporates switching that enables it to operate as a dual power supply with two independent and isolated outputs, or as a single power supply of double the power.

As a dual, each output provides 0 to 75V at 0 to 2A (mode A). As a single the output can be selected as either 0 to 75V at 0 to 4A (mode B) or 0 to 150V at 0 to 2A (mode C). In single modes, the unused half of the unit becomes completely inoperative and its displays are blanked.

**† PowerFlex** (CPX Series)

The PowerFlex system enables a power supply to provide higher currents at lower voltages. Each output of the CPX200, for example, can provide 5 amps at 35 volts. As the voltage is reduced, the maximum current available increases up to a maximum of 10 amps at 12 volts or below.

**# Multi-range** (QL Series)

The QL series uses all linear regulation and incorporates range switching to provide higher currents at lower voltages. The maximum voltage and current shown in the table are not available simultaneously.

### NEW - Electronic DC Load

In addition to the ranges of dc power supplies, TTi also offer an electronic dc load. See the Precision Measurement section (page 13). ▶▶

## Signal and Waveform Generators

TTi have been innovators in signal and waveform generators more than two decades. The original Thandar TG series of analogue function generators rapidly earned a reputation for outstanding waveform quality whilst offering unrivalled value for money.

The same attributes were later applied to the TGP series of pulse generators.

During the 1990's, digital function generators and arbitrary waveform generators were added. TTi is now at the forefront of arbitrary generator technology offering high speed multi-channel instruments with unrivalled facilities.



Most recently TTi has used its expertise to develop synthesised RF signal generators. As with other TTi generators, the guiding principle has been to offer unmatched value for money without compromise to signal quality.

## Function Generators

The function generator is one of the most versatile pieces of test and 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.

Voltage control of frequency enables a source of swept frequency to be generated for frequency response testing. AM and FM modulation facilities can also be utilised.

### Analogue or digital ?

Function generators fall into two basic categories, analogue and digital. Analogue generators use a voltage controlled oscillator (VCO) to generate a triangular waveform of variable frequency. Sinusoidal waveforms and squarewaves are generated from this.

Digital generators use a digital to analogue converter (DAC) to generate a waveshape from values stored in memory. Normally such generators can only produce sine and square waves up to the maximum generator frequency. Triangle waves and other waveforms are limited to a much lower frequency.

A third type of generator uses digital techniques to control an analogue VCO. Digital frequency locking is employed in the TG550.

### Advantages of analogue generators

Analogue function generators offer several advantages:

1. They provide simple and instantaneous control of frequency and amplitude.
2. They do not have the high frequency limitations on non-sinusoidal waveforms such as triangles and ramps that digital generators do.
3. The starting price for an analogue generator is considerably lower than for a digital generator.

### Advantages of digital generators

Digital generators normally derive the waveform frequency from a crystal clock using a digital technique. Consequently the frequency accuracy and stability will usually be higher than can be obtained from an analogue generator. Digital generators may be able to generate a much greater number of standard waveforms than analogue generators.

A variety of techniques may be used of which the most versatile is direct digital synthesis (D.D.S.).

DDS uses a phase accumulator, a look-up table and a DAC. It offers not only exceptional accuracy and stability but also high spectral purity, low phase noise and excellent frequency agility.
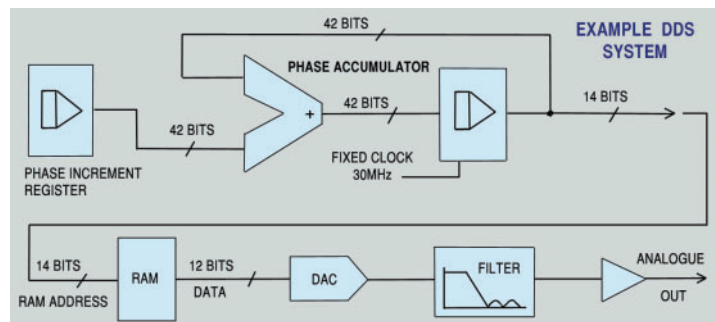


A DDS generator can be swept over a much wider frequency range than an analogue generator and can perform phase continuous frequency hopping.

### Disadvantages of digital generators

The maximum frequency for triangles and other non-sinusoidal waveforms is limited to a small fraction of the upper frequency for sinewaves. This is related to the maximum clock rate combined with the filter characteristics.

Rectangular waveforms can be generated from the sinewave using analogue comparators and can therefore avoid this restriction, but performance limits will apply to pulse waveforms.

Digital generators are more complex to use. This can be a drawback in simple or traditional test environments.

### Arbitrary waveforms

Digital function generators have the potential for generating arbitrary waveforms. However, the architecture of a function generator differs from that of a true arbitrary generator with consequent limitations to the arbitrary capabilities.

Nevertheless, function generators with an arbitrary capability can generate non-standard and custom waveforms which may be sufficient for many applications.

## TG200 series: 2MHz function generators



▶ Analogue generator with 0.02Hz to 2MHz frequency range
▶ Very high waveform quality at all frequencies and levels
▶ 1000:1 frequency change by vernier or external voltage
▶ Precision internal lin/log sweep (TG230 only)
▶ Internal/external AM up to 100% (TG230 only)
▶ Digital display of frequency (not TG210)
▶ Digital display of amplitude and offset (not TG210)

Model Range:
TG210 - function generator with calibrated dial.
TG215 - function generator with digital dispay.
TG230 - function generator with digital dispay, internal sweep and AM.

## TG300 series: 3MHz function generators

## TG550: advanced 5MHz function generator

▶ Analogue generator with 0.03Hz to 3MHz frequency range

▶ Simultaneous display of frequency and amplitude or offset

▶ External 7 digit 120MHz frequency counter (not TG315)

▶ Very high waveform quality at all frequencies & levels

▶ 1000:1 frequency change by vernier or external voltage

▶ Precision internal lin/log sweep (TG330 only)

▶ Internal/external AM up to 100% (TG330 only)

Model Range: TG315 - function generator with digital display.
TG320 - function generator with digital dispay and external counter.
TG330 - function generator with digital display, external counter, internal sweep and AM.

▶ Analogue generator with 0.005Hz to 5MHz frequency range

▶ Digital frequency locking for crystal controlled stability

▶ Simultaneous display of frequency and amplitude or offset

▶ External frequency counter with 7 digit resolution

▶ Precision internal linear or logarithmic sweep

▶ Very high waveform quality at all frequencies & levels

▶ 20V pk-pk from 50Ω or 600Ω, plus TTL/CMOS output

▶ 1000:1 frequency change by vernier or sweep voltage

▶ Internal or external amplitude modulation up to 100%

## Function Generators Selector Table

| MODEL NUMBER (1) | TG210 | TG215 | TG230 | TG315 | TG320 | TG330 | TG550 | TG120 | TG1010A | TGA1240 | TGA12100 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Generator Type (2) | Analogue | | | Analogue | | | Analogue* | Analogue | DDS | DDS | DDS |
| Highest Frequency | 2MHz | | | 3MHz | | | 5MHz | 20MHz | 10MHz | 16MHz | 40MHz |
| Lowest Frequency | 0.02Hz | | | 0.03Hz | | | 0.005Hz | 0.2Hz | 0.0001Hz | | |
| Setting Readout | Dial | LCD | | Dual LCD | | | Dual LCD | Dial | Four line backlit LCD | | |
| External Freq Counter | No | | | No | Yes | | Yes | No | No | | |
| Variable Symmetry | Yes | | | Yes | | | Yes | Yes | Yes | | |
| Complex Waveshapes | No | | | No | | | No | No | Yes (3) | | |
| Arbitrary Waveforms | No | | | No | | | No | No | Yes (4) | | |
| Pulse Patterns | No | | | No | | | No | No | Yes (5) | | |
| Tone Switching | No | | | No | | | No | No | FSK/Hop | Full Tone Switching | |
| Trigger/Gate/Burst | No | | | No | | | No | No | Yes | | |
| Int. Gate Generator | No | | | No | | | No | No | Yes | | |
| Variable Start Phase | No | | | No | | | No | No | Yes | | |
| Internal Sweep Gen. | No | Yes | | No | | Yes | Yes | No | Yes | | |
| Sweep Modes | Ext. Lin only | Lin/Log | | Ext. Lin only | | Lin/Log | Lin/Log | Ext. only | Lin/Log | | |
| Sweep Range | | 1000:1 | | | | 1000:1 | 1000:1 | | Full Range | | |
| Sweep Rate | | 20ms-20s | | | | 20ms-20s | 20ms-20s | | 20ms - 999s | | |
| Triggered Sweeps | | No | | | | No | No | | Yes | | |
| Adjustable Markers | | No | | | | No | No | | 2 | 1 | |
| Max. O/C Output Level | 20V p-p | | | 20V p-p | | | 20V p-p | 20V p-p | 20V p-p | | |
| Output Impedance | 50/600 | 50 | | 50/600 | | | 50/600 | 50 | 50 | | |
| AM Internal & External | No | Yes | | No | | Yes | Yes | No | Yes | | |
| Phase Lock (In/Out) | No | | | No | | | No | No | Yes | | |
| Multiple Channels | No | | | No | | | No | No | No | 1, 2 or 4 | TBA |
| RS-232 Interface | No | | | No | | | No | No | Yes | | |
| GPIB Interface | No | | | No | | | No | No | Option | Yes | |

Explanatory Notes:

(1) - Model Number. The TGA1240 series is available with one, two or four channels with model numbers of TGA1241, TGA1242 and TGA1244 .

(2) - Generator Type. * The TG550 is an analogue generator with a digital frequency locking capability. DDS stands for direct digital synthesis.
The TGA1240 and TGA12100 series operate in DDS mode when in function generator mode, but have full variable-clock capability as arbitrary generators.

(3) - Complex Waveshapes. All the generators can produce sine, square and triangle waveforms with variable symmetry (pulse/ramp).
The DDS generators provide additional complex waveshapes such as haversine and sin-x/x.

(4) - Arbitrary Waveforms. The TG1010A is a DDS function generator which can  generate arbitrary waveforms using DDS.
The TGA1240 and TGA12100 series are universal generators incorporating both a DDS function generator and a full variable-clock arbitrary generator.

(5) - Pulse Patterns. The TG1010A can produce a multi-level pulse waveform from up to 16 steps of variable amplitude and duration. This can be used for staircases as well as pulse trains. The TGA1240 and 12100 series can generate trains of up to 10 pulses with individual adjustment of duration, delay and level.

## TG120: 20MHz function generator

- ► Analogue generator with 0.2Hz to 20MHz frequency range
- ► Sine, square and triangle waveforms plus dc
- ► 10mV to 20V pk-pk from 50
- ► DC offset control with zero detent
- ► Variable symmetry control
- ► External sweep input
- ► Low cost

## TG1010A: 10MHz DDS function generator

- ► 0.1mHz to 10MHz range, 7 digit resolution
- ► Direct Digital Synthesis for stability and resolution
- ► Eight standard waveforms, plus "complex" waveforms, arbitrary waveforms and noise
- ► Powerful modulation modes including Sweep, AM, Gating, Trigger/Burst, FSK and Hop
- ► Variable symmetry, variable start/stop phase
- ► Storage for five Arbitrary waveforms (1024 x 10-bits)
- ► Facility for phase locking two or more generators
- ► Programmable via RS-232 or optional GPIB interfaces

## Waveform Amplification

## WA301: 30V pk - pk waveform amplifier

- ► 30 V pk to pk swing
- ► DC to 1MHz B/W
- ► High impedance input
- ► 0dB to +20dB gain
- ► 50 & 600 outputs
- ► 20db O/P attenuator
- ► Full output protection

The WA301 is intended for extending the maximum output voltage swing of function and arbitrary generators.

## Arbitrary Waveform Generators

Arbitrary waveform generators differ from function generators in being able to recreate virtually any waveshape.

An arbitrary waveform is defined by a set of digital values with respect to time which are 'replayed' through a DAC to provide the analogue output signal. The generator can replay the waveform at a wide range of repetition rates and at a wide range of amplitudes.

The generator may also be able to modulate the waveform in a variety of ways.

### Differing types of arbitrary generator

Before purchasing a generator intended for arbitrary waveform use, it is important to discover what technology it uses.

A true arbitrary generator provides a fully variable clock frequency to read the data out of the waveform memory. This variable-clock type of arbitrary generator can faithfully reproduce the stored waveform at any repetition rate within the limits of its maximum and minimum clock frequencies. The waveform can potentially have any length up to the maximum of the store.

A simpler type of arbitrary generator is often incorporated into DDS function generators. In this system the clock frequency is fixed and the repetition rate of the stored waveform is varied by changing the addressing interval. The TG1010A is an example of a DDS function generator which provides this type of arbitrary generation.
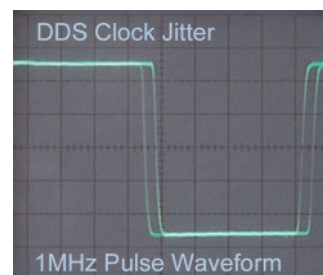
The DDS type of arbitrary generator only faithfully reproduces a waveform at a repetition rate equal to the DDS clock frequency divided by the waveform length (or sub-multiples of this). At all other frequencies samples are either omitted or are duplicated an uneven number of times. For repetitive waveforms this results in clock jitter, (see above).

For waveforms which do not contain rapid transitions, the resultant distortions may not be significant. However this type of waveform generation imposes limitations on the type of waveform that can be faithfully reproduced.

The DDS type of arbitrary generator also imposes restrictions in terms of the waveform length. Unlike a variable-clock generator, the number of samples replayed must be made equal to a specific number. Undesirable compression or expansion of the original waveform may be necessary to achieve this.

### Resolution and speed

The precision with which a waveshape can be reproduced is a function of both the vertical and horizontal resolutions. Vertical (amplitude) resolution is normally described in terms of bits, e.g. 12-bits gives a maximum of 4096 different amplitudes. Horizontal (time) resolution is defined by the number of memory points that have been used to create the waveform. This is limited by the maximum waveform memory size of the generator (e.g. 65536 points for a TGA1240).

The maximum repetition rate for a waveform is a function of the waveform length and the maximum clock frequency (often referred to as Sampling Rate). For a waveform of 1000 points and a maximum clock frequency of 40MHz, the maximum repetition frequency is 40kHz. To achieve a repetition rate of say 500kHz, the waveform would have to be re-defined within 80 horizontal points or less.

In a DDS arbitrary generator it would not be necessary to redefine the waveform as, in effect, the DDS sampling reduces it automatically. However, distortion and jitter are introduced as described above.

### Universal signal sources

Some waveform generators incorporate both a variable-clock arbitrary generator and a DDS function generator within the same unit. In addition, they may incorporate sweep generator and pulse generator capabilities. These multi-function generators are commonly referred to as Universal Signal Sources.

The TGA1240 and TGA12100 series are examples of this type of waveform generator.
►►

## Multiple channels

Many situations require multiple arbitrary waveforms to be generated simultaneously. Most generators provide the facility to phase lock to another in order to achieve this. Where multiple outputs are regularly required however, a dedicated multi-channel generator such as the TGA1242 or TGA1244 will be required.

## Creating or capturing a waveform

An arbitrary waveform is made up of a set of data values against time. A waveform could be captured from a 'real world' signal using a DSO or Digitiser. Alternatively a waveform could be created from a mathematical formula, created graphically using drawing tools, or could be constructed from a library of waveform shapes. To be fully flexible an arbitrary generator needs to have access to all of these methods.

Many generators include some level of built-in waveform editing such as point-by-point value insertion, straight line interpolation between points and standard waveform insertion between points. However, complex arbitrary waveforms are more likely to be created outside of the generator and downloaded via the digital interfaces.

Sophisticated software for waveform creation and editing is available using a PC. TTi offers software operating under Windows which provides comprehensive facilities for waveform import, creation, editing, storage and manipulation.

## Arbitrary Generators Selector Table

| Model Number | TG1010A | TGA1241/42/44 | TGA12101 |
|---|---|---|---|
| No. of Channels | One | One/Two/Four | One |
| Arbitrary System | DDS | Variable-clock | Variable-clock |
| Vertical Resolution | 10 Bits | 12 Bits | 12 Bits |
| Clock Range | 27.48MHz | 0.1Hz - 40MHz | 0.1Hz - 100MHz [2] |
| Waveform Length | 1024 points | 4 - 65536 points | 8 - 1048576 points |
| Memory Options | No | No | Yes - TBA |
| Waveforms Storable | 5 | 100 | 500 (per Card) |
| Removable Storage | No | No | Yes (Memory Card) [3] |
| Built-in Editing | No | Yes | Yes |
| Sequencing | No | 16 Waveforms | 1024 Waveforms |
| Looping | No | 32768/1048575 | 32768/1048575 |
| Arbitrary Sweep | Yes | Yes (DDS) | Yes (DDS) |
| Standard Waveforms | 12 | 12 | 12 |
| Minimum Frequency | 0.0001Hz | 0.0001Hz | 0.0001Hz |
| Sine maximum | 10MHz | 16MHz | 40MHz |
| Square maximum | 10MHz | 16MHz | 50MHz |
| Pulse Capabilities | Multi-level | Pulse Trains | Pulse Trains |
| Phase Locking | Yes | Yes [1] | Yes |
| Definable Sync Pulses | No | Yes | Yes |
| Digital interfaces | RS-232 [4] | RS-232/GPIB | RS-232/GPIB/USB |

[1] Phase Locking - the TGA1242 and TGA1244 provide phase locking between channels as well as between generators.

[2] External Clock - as well as the external reference clock input, the TGA12101 has a direct external waveform clock facility.

[3] Memory Card Storage - the TGA12101 uses removable Compact Flash memory cards for unlimited waveform storage.

[4] The TG1010A is optionally available with both RS-232 and GPIB (IEEE-488) interfaces.

## Waveform Manager Plus: waveform software
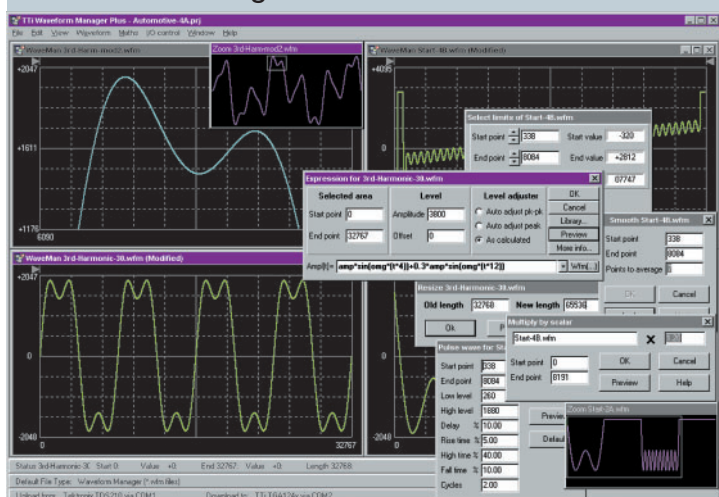


▶ Full Windows based waveform creation, import and editing
▶ Operates under Windows 9x, ME, NT, 2000 & XP
▶ Provides full waveform building tools including standard waveforms, mathematical expressions & freehand drawing
▶ Full waveform conversion and management
▶ Horizontal / vertical resolutions to 65536 points
▶ Waveform import and export via clipboard
▶ Direct import from Tektronix DSOs
▶ Supports RS232, USB and GPIB (IEEE-488) interfaces
▶ Supports all TTi products with ARB capability

## TGA1240 series: 40MS/S universal ARBs



▶ Three models; one, two or four channels
▶ 40MHz clock speed and 12-bit vertical resolution
▶ 256K point waveform memory fitted as standard
▶ Complex waveform sequencing and looping
▶ Waveform Manager Plus software included
▶ Universal architecture incorporates DDS function generator
▶ Multiple "standard" waveforms including sine, square, triangle, ramp, pulse and sin(x)/x
▶ Pulse pattern generation with up to 10 pulses
▶ Interfaceable via RS-232 or GPIB (IEEE-488.2)

Model Range:
TGA1241 - single channel generator, half-rack width case.
TGA1242 - two channel generator, full width case.
TGA1244 - four channel generator, full width case.

## TGA12101: 100MS/S universal ARB generator

- ▶ 100MHz clock speed and 12-bit vertical resolution
- ▶ 1M point waveform memory fitted as standard
- ▶ 8 to 1048576 point waveform length
- ▶ Unlimited waveform storage using removable memory cards
- ▶ Complex waveform sequencing and looping
- ▶ Waveform Manager Plus software included
- ▶ Universal architecture incorporates DDS function generator
- ▶ Multiple "standard" waveforms  including sine, square, triangle, ramp, pulse and sin(x)/x
- ▶ Pulse pattern generation with up to 10 pulses
- ▶ Interfaceable via RS-232, GPIB (IEEE-488.2) and USB

## Pulse Generators

The architecture of an analogue function generator gives it only a limited capabilities for the production of pulses.

TTi therefore offers a dedicated pulse generator incorporating all of the facilities needed to produce controlled pulses of variable width, repetition rate and delay over a wide range.

## TGP110: 10MHz pulse generator

- ▶ 0.1Hz to 10MHz frequency range
- ▶ Independent control of pulse width, frequency and delay
- ▶ 50ns minimum pulse width
- ▶ Squarewave, double pulse and delayed pulse modes
- ▶ Free-run, gated and triggered modes
- ▶ 50 Ohm output: 0.1V to 10V amplitude
- ▶ TTL/CMOS and Sync outputs
- ▶ Low cost

## RF Signal Generators

TTi have recently extended their range of signal sources to include high performance RF signal generators.

The TGR series are low cost, synthesised RF signal generators that incorporate the essential features required for most development, test and service work; namely high frequency accuracy and stability, wide dynamic range, low phase noise and leakage, and flexible modulation capabilities.

## TGR2050: 2GHz RF signal generator

- ▶ 150kHz to 2000MHz frequency range
- ▶ 10Hz setability, ±1ppm frequency stability
- ▶ Locking to external frequency standard
- ▶ -127dBm to +7dBm amplitude, 0.1dB steps
- ▶ AM, FM and Phase modulation, internal or external
- ▶ 80 character back-lit LCD display
- ▶ Keyboard and rotary encoder control
- ▶ Full remote control through RS232 and GPIB

## TGR1040: 1GHz RF signal generator

- ▶ 10MHz to 1000MHz frequency range
- ▶ 1kHz setability, ±1ppm frequency stability
- ▶ -127dBm to +7dBm amplitude, 0.1dB steps
- ▶ FM modulation, internal or external
- ▶ 80 character back-lit LCD display
- ▶ Keyboard and rotary encoder control
- ▶ Full remote control through RS232 or optional GPIB

## Precision Measurement Instruments

TTi has been designing and manufacturing multimeters and frequency counters for more than 25 years.

These products were later joined by component measurement products (LCR bridge, Micro-ohmmeter) and by EMC measurement instruments for EN61000-3-2 and EN6100-3-3.

Now TTi has developed an electronic dc load suitable for testing and characterising a wide range of dc power sources.

The TTi commitment to precision measurement is reflected in every aspect of design, manufacture and calibration.

## Choosing a Digital Multimeter

### Bench-top DMMs versus hand-held

Low cost hand-held DMMs have replaced bench-top DMMs in many applications. Although the performance of these meters may be sufficient for some tasks, it is likely that most engineers will regularly encounter measurement problems that are beyond the capability of a hand-held unit.

### An instrument intended for serious use

A TTi bench-top DMM is a substantial instrument. It stays where you put it even with heavy test leads connected. The multi-position tilt stand ensures that the large display is always readable. The functions buttons are large and the front panel is clearly marked.

### Sensitivity, Resolution and Accuracy

Compare the performance of any TTi bench-top DMM with a good quality 4000 count hand-held DMM of 0.3% basic dcV accuracy.

Longer scale length, greater sensitivity and higher accuracy ensure that measurement uncertainty is a full order of magnitude better.

TTi bench-top DMMs maintain good accuracy on all functions including ac voltage, resistance and current. For most hand-helds, the accuracies for functions other than dc voltage are dramatically poorer.

### Wideband ac measurement and true RMS

Most hand-held DMMs have an ac frequency response specified to below 1kHz. All TTi bench-top DMMs provide excellent accuracy on all ranges throughout the audio band (40Hz to 20kHz) with a 3dB bandwidth extending well above this.

Most ac signals are not sinusoidal. However, most hand-held DMMs incorporate a mean sensing ac converter which only gives useful results on sinusoids, those that do have a True RMS converter often have insufficient bandwidth to cope with complex waveshapes. All TTi bench-top DMMs combine True RMS ac with sufficient bandwidth to ensure accurate results.

### PC and System connectivity

At some point most engineers are going to want to connect their DMM to their personal computer to provide automatic measurement control or importing of data into a computer programme. Unlike a hand-held DMM, all TTi bench-top DMMs include a fully isolated RS-232 interface.

For full system applications, the 1705-GP and 1906-GP also have a GPIB (IEEE-488) interface.

### Functions & features of real value

TTi bench-top DMMs offer features which are of real use and not just "gimmicks". Features such as dual Measurement & display, precision frequency measurement, dBm, data logging, power and VA, to mention just a few.

Hand-held DMMs may offer a few "smart" features but these are rarely well enough implemented to be of real use.

### 1604: 4¾ digit LED bench multimeter

▶ 40,000 counts, auto/manual ranging

▶ Accuracy and resolution, 0.08%, 10µV, 10m

▶ Large and bright LED display (14mm/0.56")

▶ True RMS ac functions, wide ac bandwidth

▶ Frequency, Relative, T-Hold and Min-Max

▶ Isolated RS232 interface standard

▶ Optional PC based data-logging and control software

## Multimeter Selector Table

| MODEL | 1604 | 1705 & 1705-GP | 1906 & 1906-GP |
|---|---|---|---|
| **Display Type** | LED | Dual LCD | LED |
| **Scale Length (Counts)** | 40,000 | 12,000 | 210,000 |
| **Dual Measurement** | | Yes | |
| **DC Voltage:** Ranges | 400mV to 1000V (5) | 120mV to 1000V (5) | 200mV to 1000V (5) |
| Best Resolution | 10µV | 10µV | 1µV |
| Basic Accuracy | 0.08% | 0.04% | 0.012% |
| **AC Voltage:** Ranges | 400mV to 750V (5) | 120mV to 750V (5) | 200mV to 750V (5) |
| True RMS Conversion | Yes | Yes | Yes |
| Frequency Response | 20kHz | 50kHz | 100kHz |
| **DC/AC Current:** Ranges | 4mA to 10A (3) | 1.2mA to 10A (3) | 200µA to 10A (6) |
| Best Resolution | 100nA | 100nA | 1nA |
| **Resistance:** Ranges | 400 to 40M (6) | 120 to 20M (7) | 200 to 20M (6) |
| Best Resolution | 10m | 10m | 1m |
| **Frequency** | 40kHz max. | 100kHz max. | |
| **Capacitance** | | Yes | |
| **Smart Functions** | 3 | 12 | 9 |
| **Interfaces:** RS-232 | Yes | Yes | Yes |
| GPIB (IEEE-488) | | Yes (GP version) | Yes (GP version) |
| **Power Source** | AC Line | AC Line or Battery | AC Line |

### A range to cover most needs

The TTi range of bench-top multimeters consists of five models. All incorporate automatic or manual ranging, true RMS ac measurement, and interfaceability using RS-232 or GPIB (IEEE-488) depending upon model.

The 1604, 1705-GP, 1906, and 1906-GP are ac mains powered units. The 1705 can be operated from either ac mains or from batteries.

## 1705: 4¼ digit LCD dual measurement DMM

- ▶ Dual 12,000 count displays, auto/manual ranging
- ▶ Accuracy and resolution: 0.04%, 10µV, 10m
- ▶ Dual displays & 'dual measurement' technology
- ▶ True RMS ac functions, Frequency, Capacitance
- ▶ Wide range of computing functions e.g. Ax + B
- ▶ Isolated RS232 interface standard (ARC compatible)
- ▶ Model with GPIB (IEEE-488) interface available
- ▶ Mains and battery operation as standard
- ▶ 100 step data-logger, timed or triggered logging
- ▶ Large and clear LCD with annunciators

## 1906: 5½ digit high precision DMM

- ▶ 5½ digits (±210,000 counts), auto/manual ranging
- ▶ 1µV, 1nA, 1m  resolution, 0.012% accuracy
- ▶ Wide range of computing functions included
- ▶ Automatic data logging functions included
- ▶ Integral True RMS AC converter
- ▶ Full set of current ranges (six in all)
- ▶ Isolated RS232 interface standard (ARC compatible)
- ▶ Model with GPIB (IEEE-488) interface available

## *Bus control of multimeters*

All TTi multimeters can be operated using a digital bus.  The bus interfaces are fully isolated providing fully floating measurement inputs.

The 1705 and 1906 are available with a GPIB interface.  A LabWindows CVI driver is available for the 1906.

The RS-232 interface on the 1705 and 1906 is ARC compatible (see page 14) and is supported by ARC Windows software.

The 1604 and 1906 multimeters are also supported by individual dedicated PC-based Control and Data-logging programs.

## *Component Measurement*

In addition to high performance multimeters, TTi offers instruments for the precision measurement of capacitance, inductance and resistance including very low resistance.

## LCR400: precision LCR bridge

- ▶ 0.1% basic measurement accuracy
- ▶ Three test frequencies of 100Hz, 1kHz and 10kHz
- ▶ Automatic component recognition
- ▶ Built-in 4 terminal component fixture
- ▶ Dual 5 digit high brightness displays
- ▶ Limits comparator with multiple pass and fail bins
- ▶ RS-232 interface for PC connectivity, optional PC software

## BS407: precision micro-ohmmeter

- ▶ High basic accuracy of 0.1%
- ▶ Wide measurement range of 1µ   to 20k
- ▶ Current reversal switch for detecting thermal emf
- ▶ Current diversion switch for easy zero setting
- ▶ Four terminal measurement with Kelvin clip leads
- ▶ Battery operation with built-in charger
- ▶ Switchable 20mV clamp for 'dry circuit' testing

## P240: Proving unit for neon voltage indicators

- ▶ Essential equipment for safety compliance
- ▶ Long-life battery operation
- ▶ Belt-clip mountable
- ▶ Automatic switch-free operation

## DC power source characterisation

An electronic dc load is an essential item for testing and characterising dc power sources such as modular power supplies, charging circuits and batteries. TTi now offers a highly cost effective solution.

## LD300: electronic dc load, 300W



▶ Versatile solution for testing dc power sources
▶ Constant current, resistance, voltage and power modes
▶ Wide voltage and current range, 80V and 80A max.
▶ Low minimum operating voltage of <1V at 40A
▶ Built-in transient generator with variable slew
▶ Current monitor output for waveform viewing
▶ Variable drop-out voltage for battery testing
▶ Analogue remote control capability

## Frequency Measurement

Frequency is one of the fundamental parametric measurements within electronics.

TTi have been innovators in the use of the reciprocal counting technique for frequency measurement to improve measurement resolution.

Reciprocal counting involves synchronized multiple period measurements followed by computation of the reciprocal value. This results in high resolution measurements regardless of the signal frequency and eliminates the ±1 input cycle errors of a conventional frequency counter.

## TF830: 1.3GHz universal counter



▶ Frequency, period, pulse width, frequency ratio and event counter modes
▶ 5Hz to 1300MHz range, 0.001mHz resolution
▶ Reciprocal Counting measurement technique gives high resolution at all frequencies
▶ Low power, mains or battery operation
▶ Excellent sensitivity across the frequency range
▶ Optional RS-232 interface (ARC compatible)

## PFM1300: 1.3GHz hand-held counter



▶ 0.001mHz resolution
▶ 5Hz to 1300MHz range
▶ Measures frequency or period
▶ Large eight digit display with annunciators
▶ High sensitivity at all frequencies
▶ Reciprocal counting measurement technique
▶ Push-to-measure function with auto power-down
▶ Very low cost

## EMC measurement

Since the introduction of CE marking in the early 1990s, TTi has offered inexpensive equipment for in-house compliance testing with emphasis upon mains borne interference and current waveform harmonics.

The HA1600 provides full compliance quality measurements to EN61000-3-2 for harmonics and EN61000-3-3 for flicker.

## HA1600: power & harmonics analyser



▶ Compliance quality harmonics measurements to EN61000-3-2
▶ Compliance quality flicker meter to EN61000-3-3
▶ Measures peak or rms voltage or current, real or apparent power, power factor, phase angle etc.
▶ Tabular, histogram and waveform displays
▶ Wide range of power connectors available
▶ RS232 interface, printer output, optional PC software

## AC1000: low-distortion 1kW power source

▶ Provides an EN61000–3–2 compliant source
▶ 1000W power capability at 230V
▶ Up to 4·4A rms load current and up to 10A peak currents

## Logic Analysis

TTi has a track record in logic analysis dating back to the early 1980s, and was the first company to manufacture a truly affordable logic analyser.

The capabilities of a logic analyser have become important within virtually every area of electronics.   Development, production, service and education all have a potential need for logic analysis.

TTi provides a unique solution by offering low cost stand-alone logic analysers suitable for a wide range of applications.

### TA320S: 32 channel logic analyser



▶ 32 data channels at 25MHz

▶ Built-in high contrast LCD screen

▶ 100MHz asynchronous operation (using optional pods)

▶ 2K word acquisition memory

▶ 5ns glitch capture (ising optional pods)

▶ Multi-level trigger sequencing

▶ Disassembler options for popular uPs

▶ RS-232 interface (ARC compatible)

### LA4800: 48 channel logic analyser



▶ 48 data channels at 25MHz

▶ High resolution 9"/23cm screen

▶ 100MHz asynchronous operation (using optional pods)

▶ 8K word data memory

▶ 5ns glitch capture (using optional pods)

▶ Multi-level trigger sequencing

▶ Multiple non-volatile reference/set-up memories

▶ Signature and performance analysis

▶ Disassembler options for popular µPs

▶ RS-232 interface

## Instrument Control

### ARC: Addressable RS-232 Chain

ARC is a low-cost system for linking instruments together so that they can be controlled and monitored by a personal computer.

The interface differs from conventional RS-232 in that it allows multiple instruments (up to 32) to be controlled using a single RS-232 port of a PC.

The ARC interface is an extension of the industry standard RS-232 interface and can be used as a normal "single instrument" RS-232 interface whenever required.

TTi instruments fitted with an ARC compatible RS232 interface include:



QL-P dc power supplies
TSX-P dc power supplies
PL-P dc power supplies
TF830-RS232 counter
1705 and 1906 multimeters
TG1010A function generator
TGA1240 arbitrary generators
TGR1040/2050 RF generators
TA320S logic analyser

▶ Multi-instrument control from a personal computer

▶ Up to 32 instruments via a single serial port

▶ No special interface card required

▶ Inexpensive lightweight cabling

▶ Operation via standard serial port driver software

▶ Windows based software package available

**ARC-Windows** is a low cost applications package that supports the ARC interface under Windows 9x through to XP.  It provides pre-programmed commands and tools for building text based control programs that can be stored as file macros.

A command line driven (DOS) program is also available as a free download from the web site.

# TT*i*

## Measurably Better Value

### About TTi

Thurlby Thandar Instruments is one of Europe's leading test and measurement instrument companies with more than 25 years of experience. Based in the United Kingdom, our products are available in more than 50 countries across the world.

All TTi products are built at our factory in Huntingdon, close to the famous university city of Cambridge.

TTi is an ISO9001 registered company operating fully traceable quality systems for all processes from design through to final calibration.

BS EN ISO9001:2000
Certificate number FM 20695

### New Products

Further products may have been added since this shortform brochure was printed.
 For the latest information please visit our website: www.tti-test.com

### Where to buy

TTi products are widely available from a network of distributors and agents across the world.
 To find your local distributor, please contact us or visit our website.
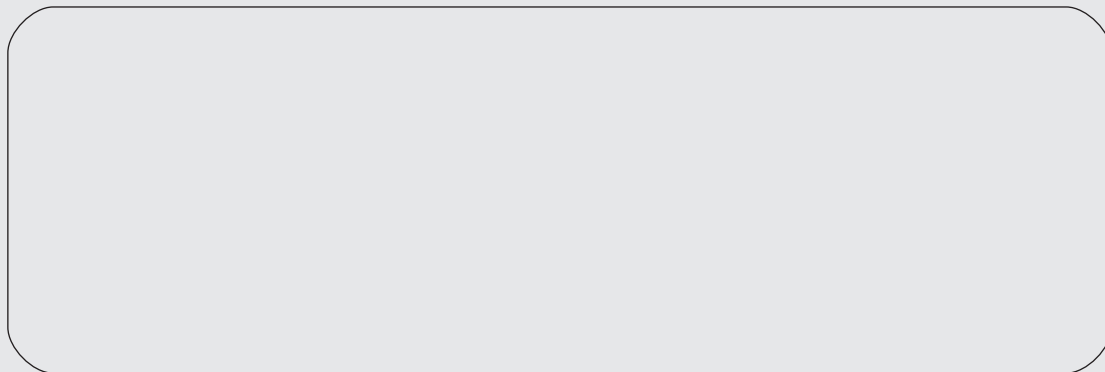
Designed and built in Europe by:

# TT*i*

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