

# TEKRON



# TCG 02-E

TIME CODE GENERATOR

User Manual

4<sup>th</sup> Edition – Aug 2012



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## 1 Introduction

The TCG 02-E Time Code Generator produces precision time code signals, serial strings and pulses for use in synchronizing industrial control and SCADA equipment. The clock is ideally suited to providing time synchronization simultaneously to many different devices, such as Phasor Measurement Units (PMUs), Protection Relays, Remote Telemetry Units (RTUs) and other Intelligent Electronic Devices (IEDs) used in electrical sub-stations and industrial control installations.

The TCG 02-E features one amplitude modulated IRIG-B output, four amplitude modulated / unmodulated IRIG-B outputs, three programmable outputs and a serial port which is user-configurable to output serial strings and report event data. Factory options include a choice of output connectors: BNC, 2-pin plug, or ST Fiber. Non fiber outputs that can be ordered are TTL, RS422/485, or high voltage switching.

All TCG 02-E units feature a front panel display (See figure 1) giving visual feedback about the time data being generated on the outputs. LED indicators provide “at a glance” status information.



**Figure 1 – TCG 02-E chassis and front panel**

The optimized receiver / antenna system used by TCG02-E obtains time with near-atomic clock precision from the GPS satellite constellation. The result is output timing accuracy similar to that normally seen only in laboratory instruments.

However, unlike laboratory instruments, TCG02-E is suited for hostile electromagnetic environments such as sub-stations and electrical switchyards. Each output of the TCG02-E is isolated from every other output, so that attached wiring can feed out to operating areas in different earth potential zones without compromising the overall site earthing security. Further isolation protects the internal electronics, and transient suppression devices protect I/O from both longitudinal and transverse high voltage events.

The TCG02-E features a 100Mb Ethernet port that through which all of the units operating options are configured. Firmware license options include a stratum 1 NTP server and IEEE1588 V2 functionality. When the IEEE 1588 (PTP V2) option is enabled, the unit can operate as a PTP Grand Master, an ordinary PTP clock, or a Slave-Only Clock.

Automatic IRIG-B slave functionality allows the TCG02-E to accept two DCLS IRIG-B signals for synchronizing purposes. Sync source selection is entirely automatic.

The TCG02-E is supplied complete with all hardware and software required for installation, including connectors, network cables, antenna cable, and antenna.

## 2 Front Panel



Figure 2 – TCG02-E front panel

TCG02-E features two LED indicators on the front panel (See figure 2), together with a 2-line by 16-character backlit LCD display.

**LCD DISPLAY:** The display unit updates every second, and by default displays local time and date, together with the offset of the local time from UTC. It also provides more information on the GPS receiver operation. A recessed push-button located on the front panel between the two indicator LEDs is used to switch between display pages.

**GPS LED:** This LED shows the status of an incoming GPS signal. Refer to 2.2 for further details.

**IRIG LED:** This LED shows the status of an incoming IRIG-B time code signal. Refer to 2.2 for further details.

### 2.1 LCD Display

On initial power-up, the LCD display shows a copyright message, along with the serial number and revision level of the unit (See figure 3a). Approximately 10 seconds after power-up, the display changes automatically to indicate that it is waiting for satellites (See figure 3b). Once one or more satellites have been discovered, it transitions to the operating default display, (See figure 3c, 3d and 3e) show alternative time displays that the user can access by pushing the recessed button on the front panel between the LED indicators. Successive button-pushes can be used to cycle through all the display screens in turn. The screen display examples below all show the same instant in time.

```
TCG 02-E Ver.   FO.XX  
(C)          2011 Sn18748
```

3a – Start up (Clock ID)

```
WAITING FOR SATS  
GPS RX STAT: 00A
```

3b – Waiting for satellites

```
UTC+1200      17MAR10  
076   11:16:53   87A
```

3c – Operating default

```
LST: TUE 17MAR10  
076   11:16:53   87A
```

3d – Local time

```
UTC: MON      16MAR10  
075   23:16:53   87A
```

3e – UTC Time

Figure 3 – LCD display screens

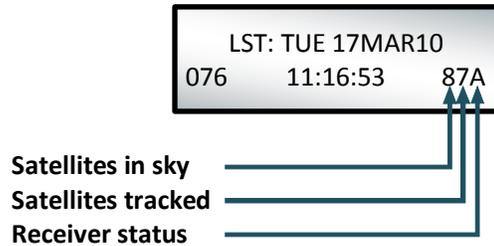
“UTC” denotes Universal Time Coordinated (approximately equivalent to GMT). The top line of screen 3c shows the clock’s current local time offset from UTC (hours & minutes), together with local date. The local time day-of-year and time-of-day are on the bottom line.

Screen 3c shows that the clock is operating with a local time offset of 12 hours ahead of UTC. The local date is 17th March 2010, and the local time is 11:16:53 in the morning.

Screen 3d shows the same time and date, but also indicates that the time displayed is Local Standard Time, and that the day is Tuesday. “LST” denotes Local Standard Time. If daylight savings time is active, the “LST” in screen 3d changes to “LDT”, denoting Local Daylight Time.

Screen 3e shows the UTC time and date which is 11:16:53 on the evening of Monday 17th March 2010.

The display screens in Figure 3b, 3c, 3d and 3e, each show a three-character status field at the bottom right-hand side of the display (See figure 4). This three-character field provides feedback on the parameters that affect the operation of the GPS receiver.



**Figure 4 – Satellite tracking status**

Character	Values	Description
Satellites in the sky	“0 - 9”=0 - 9 “A - E”=10-14	Represents the total number of satellites currently present in the sky according to the GPS almanac. “0” in this position means that TCG02-E has lost its knowledge of the GPS satellites’ orbit geometries. This occurs if the unit has been in storage for an extended period, or if the GPS receiver has been reset. It may take up to two hours for the TCG02-E to operate normally again.
Satellites tracked	“0 - 9”=0 - 9 “A - E”=10 - 14	This digit represents the number of satellites currently being used to compute the time solution. A “0” value means that no updated time solution is available, (“out of lock” condition). If this condition persists for the “Sync Hold” time (5.10.1) the clock will indicate the “out of sync” condition described under (2.2) below.
Receiver status	“A”	TCG02-E in Acquisition mode - attempting to get satellite fixes.
	“G”	“Poor satellite geometry”: Satellites are positioned in almost a straight line so best accuracy cannot be obtained, but the unit will still sync to UTC.
	“2”	A 2D position is in use (no height). This may occur before Position Hold mode has been reached if only 3 satellites are tracked. Synchronization is not compromised.
	“3”	A 3D position is in use, which includes height. A site survey begins next, so this mode is rarely seen.
	“S”	Site Survey in progress. TCG02-E is calculating an accurate position; once complete the mode will change to Position hold.
	“P”	“Position hold”: Position is known accurately, and the GPS is providing its most accurate time, typically better than 40 ns to UTC.



**If the clock is acting as a PTP slave “PTP” will be displayed in the status field.**

## 2.2 LED Indicator

The **GPS LED** shows the status of the GPS receiver, while the **IRIG LED** shows the status of the time synchronization to UTC reference time derived from the IRIG-B input time signal (if the option is selected) (5.7.3). Each of the two LED Indicators has five different operating modes representing five possible states of the incoming signal. These states are defined as follows:

State	Definition
No Monitor:	The clock is not actively monitoring this input.
No Signal:	The clock cannot detect any input signal from this source. The most common cause is that the input cabling is faulty (e.g. disconnected or shorted in the case of the GPS antenna, or cross-wired in the case of the IRIG-B signal).
Seeking Lock:	A signal is present, and the clock is still gathering data from it.
Locked In:	The incoming signal has been fully decoded and is immediately ready to act as the source of UTC time to sync the clock if needed.
Signal In Use:	The incoming signal is actively being used as the source of time to maintain the clock in sync with UTC.

The states are shown on the LED indicators by varying the flashing cadence as follows:

Signal State	Second (n)	Second (n+1)	Signal Description
No Monitor			LED off always
No Signal	— — — — —	— — — — —	Continuous fast flash (5 flashes per sec)
Seeking Lock	— —	— —	Two flashes, repeating (2 flashes per sec)
Locked In	—————	—————	Single long flash, repeating (1 flash per sec)
Signal In Use	—————	—————	LED on always
PTP Slave Enabled			
Not Synced	— — — — —		Short flashes
Synced	—————		Long flashes

### 3 Back Panel

Examples of TCG02-E back panels are shown (See figure 5, 6, 7, and 8). Their appearance may vary, as different connector types can be fitted at the factory to suit your requirements.



Figure 5 – Rear panel of TCG02-E Base unit



Figure 6 – Rear panel of TCG02-E with expansion module 1



Figure 7 – Rear panel of TCG02-E with expansion module 2



Figure 8 – Rear panel of TCG02-E with expansion module 3

#### 3.1 P1A/B: Power Input



Power is applied to the unit via **P1A** and **P1B**. The TCG02-E can be ordered with IEC-320 power connectors (shown to the left) for high voltage AC supplies, or 5.08mm 2-pin connectors for low, medium or high voltage DC supplies. Despite the markings on P1, the polarity of the power connectors is not important. Maximum steady state power consumption is 12W, and surge protection is provided.

The unit and case are fully isolated from the power supply inputs so that positive earth, negative earth or a floating supply can be used. If either of the power supplies fails the clock will remain operational provided that each power supply is supplied from a different source.

The input voltage range is marked above the **P1A/B** connectors. Refer to section 6.1 for a list of orderable ranges.



**Check the label on the unit base for power supply voltage ratings**

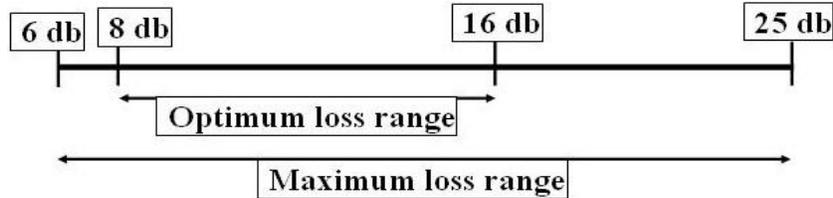
### 3.2 Ant: Antenna Connector (SMA Connector)



The “ant” antenna input provides an interface for an external active antenna via low-loss coaxial cable, 50Ω impedance. 5V DC @ 50mA max is supplied to power an active antenna. The total combined gain of the antenna system (antenna plus cable and connectors) should fall in the range of 10 to 35dB, the optimum being 22dB.

TCG02-E is normally supplied complete with a timing-optimized narrow-band antenna and 30m of lead-in cable, this combination provides an overall gain near the optimum of 22dB. For lead-in lengths longer than 60m, amplification and/or larger diameter, lower loss cable can be supplied to order.

#### 3.2.1 Antenna Cable Considerations



**CNT-400** – 16.73 dB/100 m. Plus 1 dB/connector  
 Approx. Optimum Length Range: 34 to 79 meters  
 Approx. Maximum Length Range: 23 to 129 meters

**CNT-240** – 32.8 dB/100 m. Plus 1 dB/connector  
 Approx. Optimum Length Range: 18 to 42 meters  
 Approx. Maximum Length Range: 12 to 70 meters

**Note:** Figures are based on an average GPS signal strength of -130dBm at sea level



**Care should be taken to ensure that the connector is not cross-threaded when attaching the antenna lead-in cable. The connector should be tightened firmly by hand only. Do not over tighten**

A lightning protection device may be inserted into the antenna lead. A suitable device complete with additional cable connectors, a connector crimping tool, and mounting hardware is available as an option (See section 6.4). Introduction of the lightning protector does not degrade the performance of the antenna system.

### 3.3 P2, P3: Programmable Outputs (2-pin [3.81 mm] / BNC or ST Fiber)

#### 3.3.1 Electrical and Physical Configuration

Each output port may be fitted at the factory according to the following:

Electrical	Electrical Specification	Physical
TTL	CMOS/TTL (5 V) logic level driver output ports, 150 mA sink and source. The port is fully floating and has independent electrical isolation to 2.5 kV.	2-pin or BNC
RS422	High Speed RS422/485 (+/- 5 V) output ports. The port is fully floating and has independent electrical isolation to 2.5 kV.	2-pin
HV MOSFET	Power MOSFET Switch, allowing switching of 300 VA, 1 A max. The port is fully floating and had independent electrical isolation to 2.5 kV. Refer to Section 6.2 for suggested wiring configurations for use with Power MOSFET switching.	2-pin
Fiber	ST fiber transmitters, compatible with ST-terminated 62.5µm fiber diameter, 125 µm jacket diameter multi-mode fiber optic cabling. The maximum length of fiber recommended is 750 m. (λ=820 nm)	ST Fiber

Examples of the three connector types :( Figure 9 to 11).



Figure 9 – 2-pin connector



Figure 10 – BNC connector



Figure 11 – Fiber connector

### 3.3.2 P2, P3 Programmable Output Options

The user may configure P2 and P3 to output in either inverted or non-inverted polarity:

- A configurable number of pulses per second, minute, hour, day with adjustable pulse-width and offset.
- IRIG-B and DCF-77 time codes.

**Note:** See section 5.8 for further information.

### 3.4 P4: RS232 Serial Port and Programmable Output (DB9 Connector)



TCG 02-E is normally shipped as a DCE configuration, so the “straight-wired” Socket-to-Socket 9-way data cable can be used to connect directly to a standard PC serial port. The CTS and DSR lines are permanently asserted. As the serial outputs are usually precisely timed messages, there is no provision for either hardware or software flow control.



**Do not over-tighten the securing screws of the connectors**

The following signals are present on P4 (DCE configuration only):

- Pin 1: RS232 level (-9V to +9V) programmable output.
- Pin 2: RS232 level serial string.
- Pin 5: RS232 signal ground.
- Pin 4 & Pin 6: RS422 level (-5V to +5V) differential programmable output.
- Pin 8 & Pin 9: RS422 level serial string.

The RS232 signal lines are not HV-isolated from each other, but the port as a whole is isolated to a level of 2.5 kV from all other ports.

#### 3.4.1 P4 Serial Strings

The serial port can be configured to output any one of a number of different serial time messages on a broadcast basis. The serial port runs at a user configurable data rate between 1200 and 38400 bps (available rates are 1200, 2400, 4800, 9600, 19200 and 38400). Message formats typically operate at 9600 baud, 8-bit with no parity, no flow control and 1 stop bit. Most messages are transmitted once per second.

A wide range of message strings and protocols can be outputted on this port, including:

- NGTS protocol (transmits once per minute)
- IRIG J-17
- Six pre-set messages, String/Tekron A – G for compatibility with most IED.
- NMEA ZDA and RMC messages
- GPS Binary/Messages, these are subject to change without notice.

See Appendix B for details on each of the message string formats.

A common application for the programmable output on P4-pin 1 (RS232 level) is to provide an independent drive to an RS232-Fiber converter unit for use in transporting the code signals to a distant location. (Tekron manufactures a range of interface devices (MOFRs) that include such converters.) In such cases, pin 1 should be “broken out” of the normal 9-way cable optionally used to connect to an external PC, and used in conjunction with pin 5 signal return.

### 3.4.2 P4-pin 1 Programmable Output

The user may configure the P4-pin 1 output to operate with inverted or non-inverted polarity as well as:

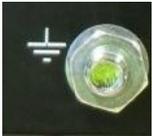
- A user-configurable number of pulses per second, minute, hour, day with adjustable pulse-width and offset.
- IRIG-B and DCF-77 time codes.

**Note:** See section 5.8.1 for further information.



**P4-pin 1 is not available on TCG02-E's with DTE serial ports. If not specified, TCG02-E will ship with a DCE serial port.**

### 3.5 Earth Stud (M4 Nut)



Two M4 bolts (to chassis) are provided for earthing of cable shields. There is one located to the left of P7 and one located on top of P1 and P2

### 3.6 P5: AM IRIG-B Output (BNC Connector)



P5 provides amplitude modulated IRIG-B (B12x) over a BNC connector.

Use either coaxial cable or shielded twisted pair, to feed signal from P5 to any connected IED. When using shielded twisted pair, connect the shield to ground.

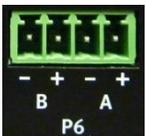
The mark/space amplitude modulation ratio is 10:3, and peak-to-peak output level is 8 V (max), 120  $\Omega$  impedance. The output is fully floating, and is transformer-isolated to a minimum of 2.5 kV.

This output is not programmable for other types of signal, and 1 kHz carrier is present whenever the unit is powered. The particular IRIG-B data content is as specified by the configuration program.



**Most devices with amplitude-modulated IRIG-B time sync inputs have an input impedance of between 4 k $\Omega$  and 20 k $\Omega$ , and maximum allowable peak- to-peak level of 6 V or so. The P5 output on TCG02-E is designed to drive many of these devices all in parallel, with a terminating resistor (typically 100-180  $\Omega$ ) fitted at the far end of the coax line feeding all of the attached loads. In this way P5 can drive at least 20, and typically 30 or more devices without any external amplification required. The terminating resistor is essential to ensure good noise immunity and correct voltage levels.**

### 3.7 P6: Alarm Outputs (4-pin 3.81 mm Connector)

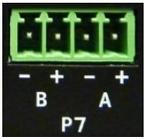


The plug-able connector provides two alarm output channels. Wiring size is up to 1.00 mm<sup>2</sup>. The alarm outputs are type A (normally-open) dry contact types (implemented using solid state relays). Note: the “Normally-Open” descriptor refers to the de-energized state of the relay. The convention used in the TCG02-E is to have the alarm relays energized during normal operation, and de-energized in the alarm state. In the case of all power to the clock being lost, all of the alarm relays then default to the “alarm” state (open contact). The “+” and “-” symbols represent the positive and negative terminals respectively. Contact rating: 200 V, 150 mA DC or 150 V, 100mA AC.

**P6 A** is a power A fail alarm and **P6 B** is a Power B fail alarm. Alarm signaling is delayed by 5 seconds. That is, if power supply A fails, the Power A alarm contact will open 5 seconds later.

**Note:** Type B (Normally-closed) alarm relays can be fitted by special order if required. In this case, the alarm conditions are indicated by the contacts being closed.

### 3.8 P7: Sync Relay (4-pin 3.81 mm Connector)



The plug-able connector provides two alarm output channels. Wiring size is up to 1.00 mm<sup>2</sup>. The alarm outputs are type A (normally-open) dry contact types (implemented using solid state relays). Note: the “Normally-Open” descriptor refers to the de-energized state of the relay. The convention used in the TCG02-E is to have the alarm relays energized during normal operation, and de-energized in the alarm state. In the case of all power to the clock being lost, all of the alarm relays then default to the “alarm” state (open contact). The “+” and “-” symbols represent the positive and negative terminals respectively. Contact rating: 200 V, 150 mA DC or 150 V, 100mA AC.

**P7 A** is a GPS signal receive fail (Antenna fail) alarm. Alarm signaling is delayed by 10 seconds.

**P7 B** is a synchronization fail alarm. This alarm is triggered if TCG02-E is unable to synchronize to any incoming time source. TCG02-E will synchronize to UTC time derived from GPS if GPS reception is available. In the absence of GPS, the unit will then attempt to sync to an IRIG-B time source connected via the P9 and/ or P10 inputs. (P9 takes priority over P10). If the unit is optioned for PTP operation, it can also sync to time from a distant PTP Master clock.

If all sync is lost, the TCG02-E will operate in “Sync Hold” mode for a period defined by the “Sync Hold time” parameter). At the expiry of the “Sync Hold time”, the alarm condition is signaled. When sync is restored, the alarm condition is retained for 5 seconds before being cancelled.

**Note:** Type B (Normally-closed) alarm relays can be fitted by special order if required. In this case, the alarm conditions are indicated by the contacts being closed.

### 3.9 P8: ECP – Ethernet Communication Port (RJ45 Connector)



The Ethernet communication port option (ECP), features an RJ45 connector supporting a 100 Mbps Ethernet port (100baseT). A standard (i.e. non-crossover) drop lead should be used to connect the TCG02-E to a convenient port on a local network hub or switch. If a direct connection to a PC is required, a crossover drop lead should be used.

Located adjacent to the Ethernet port are four LEDs, which convey multiple statuses.

The green link LED indicator lights when a network cable (UTP drop lead) is correctly connected between the TCG02-E RJ45 port and the local network hub/switch or PC.

The Lck indicator illuminates steadily when the TCG02-E has a validated source of UTC time and is synchronized to that source. In most cases, the source will be time from the GPS satellite constellation, but it could also be time from an externally connected IRIG-B source or, if the TCG02-E unit has been optioned appropriately, time from a distant PTP master.

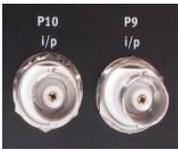
The bottom red and yellow LEDs act as power alarms. The red LED is a power alarm for power port A and the yellow LED, power port B.

### 3.10 Multiport Hub Expansion Option (Expansion Options 1 and 2)

A TCG 02-E can be configured with a Multiport Hub Expansion board. Below are the possible port configuration options for the Multiport Hub Expansion board:

Port	Expansion Option 1 (Physical)	Expansion Option 2 (Physical)
P9 & P10	BNC	2-Pin
P11, P12,P13,P14 & P15	BNC or ST Fibre	BNC or ST Fibre
P16	Not Present	Secondary Ethernet Communication Port (RJ45)

### 3.10.1 P9, P10: Event Recording / IRIG-B Sync Inputs



The two input channels are implemented using isolated BNC connectors, (2.5 kV min).

P9 and P10 can be used for either:

- Event recording. For a full description, see (5.7.3).
- Synchronization of TCG02-E to an external IRIG-B signal. See (5.7.3) for further information on this feature.



**If a Secondary Ethernet Communication Port is fitted to the board the two input channels will be implemented using 2-pin connectors.**

### 3.10.2 P11: Isolated Programmable Output



P11 is an output that shares the same logical signal as P4-pin 1. It can be factory fitted with either a BNC (5 V TTL signal with 75 mA sink and source current) or ST fiber connectors (compatible with ST-terminated 62.5  $\mu$ m fiber diameter, 125  $\mu$ m jacket diameter multi-mode fiber optic cabling).

### 3.10.3 P12 – P15: Modulated / Unmodulated IRIG-B Outputs



P12 to P15 outputs can be individually fitted with either a BNC or ST fiber connectors (compatible with ST-terminated 62.5  $\mu$ m fiber diameter, 125  $\mu$ m jacket diameter multi-mode fiber optic cabling).

If BNC connectors are fitted, each output is independently switchable between AM IRIG-B (B12x) or DCLS IRIG-B (B00x). The output mode for each port is selected using the dip switch beneath the connector.

**AM IRIG-B (B12x):** 8 Vpk-pk transformer-isolated signals with 120  $\Omega$  output impedance.

**DCLS IRIG-B (B00x):** 5 V TTL signals with 25 mA sink and source current, sharing a common ground with all other DCLS IRIG-B outputs.

### 3.10.4 P16: SECP – Secondary Ethernet Communication Port (RJ45 Connector)



The Secondary Ethernet Communication Port features an RJ45 connector supporting a 100 Mbps Ethernet port (100baseT). A standard (i.e. non-crossover) drop lead should be used to connect the TCG02-E to a convenient port on a local network switch. If a direct connection to a PC is required, a crossover drop lead should be used. There are four LEDs associated with the ECP module:

The green Ink LED indicator lights when a network cable (UTP drop lead) is correctly connected between the TCG02-E RJ45 port and the local network hub/switch or PC.

The st1 indicator lights when the TCG02-E has a validated source of UTC time and is synchronized to that source. In most cases, the source will be time from the GPS satellite constellation, but it could also be time from an externally connected IRIG-B source or, if the TCG02-E unit has been optioned appropriately, time from a distant PTP master.

The st2 and st3 LEDs have no function in the Secondary Ethernet Port for the TCG02-E.



**The Secondary Ethernet Port cannot be used to configure the TCG02-E main clock. Only the Ethernet communication port (P8) may be used for configuration.**

### 3.11 Telecommunications Expansion (Expansion Option 3)

A TCG02-E can be configured with a Telecommunications Expansion board. Below are the possible port configuration options for the Telecommunications Expansion board:

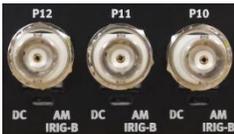
Port	Physical
P9, P10, P11 & P12	BNC or ST Fiber
P13 & P14	BNC
P15 & P16	RJ48

#### 3.11.1 P9: Isolated Programmable Output



P11 is an output that shares the same logical signal as P4-pin 1. It can be factory fitted with either a BNC (5 V TTL signal with 75 mA sink and source current) or ST fiber connectors (compatible with ST-terminated 62.5  $\mu\text{m}$  fiber diameter, 125  $\mu\text{m}$  jacket diameter multi-mode fiber optic cabling).

#### 3.11.2 P10, P11, P12: Modulated / Unmodulated IRIG-B Outputs



P10 to P12 outputs can be individually fitted with either a BNC or ST fiber connectors (compatible with ST-terminated 62.5  $\mu\text{m}$  fiber diameter, 125  $\mu\text{m}$  jacket diameter multi-mode fiber optic cabling).

If BNC connectors are fitted, each output is independently switchable between AM IRIG-B (B12x) or DCLS IRIG-B (B00x). The output mode for each port is selected using the dip switch beneath the BNC connector.

**AM IRIG-B (B12x):** 8 Vpk-pk transformer-isolated signals with 120  $\Omega$  output impedance.

**DCLS IRIG-B (B00x):** 5 V TTL signals with 25 mA sink and source current, sharing a common ground with all other DCLS IRIG-B outputs.

#### 3.11.3 P13, P14: T1/E1/10M BNC Outputs



The frequencies of the two T1/E1/J1 BNC outputs can be independently programmed via the configuration tool. The mode configuration is common to all T1/E1/10M ports (P13, P14, P15 and P16). The outputs can be switched between sine and square waves via switches just below the BNC connectors.

**Frequency:** 10 MHz or 1.544 MHz when mode is T1/J1. 10 MHz or 2.048 MHz when mode is E1.

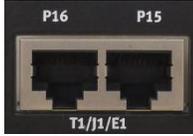
**Sine wave:** 1 VRMS 50  $\Omega$

**Square wave:** 5 V TTL 100 mA sink and source sharing a common ground.

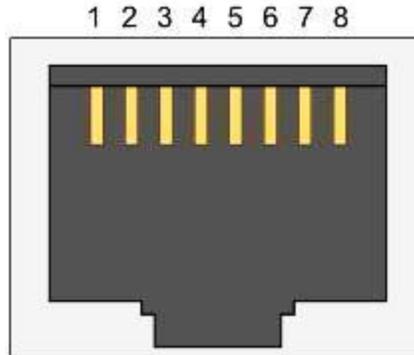


**P13 and P14 outputs may not be fitted in all configurations.**

### 3.11.4 P15, P16: T1/E1/J1 RJ48 Outputs



The two T1/E1/10M RJ48 outputs can be independently programmed via the configuration tool. The configurable options include, framing format, encoding, waveform shaper, transmitter impedance matching, high impedance output, all zeros, long haul and SSM. The mode configuration sets the frequency options on all T1/E1/10M ports (P13, P14, P15 and P16).



**Figure 12 – Pin detail of P15 and P16 RJ48 connector**

The following shows the pin-out for P15 and P16:

Pin1 - RX Ring -  
Pin2 - RX Tip +  
Pin3 - GND  
Pin4 - TX Ring -

Pin5 - TX Tip +  
Pin6 - NC  
Pin7 - NC  
Pin8 - NC

## 4 Installation

### 4.1 Identification

Each TCG02-E unit is shipped with an identification label on the base. The label provides details of the particular options fitted to the unit, the power supply requirement, the serial number and firmware revision.

**!** Check the identification label on the base of the unit to ensure that the correct model has been supplied before proceeding to install

### 4.2 Packing List

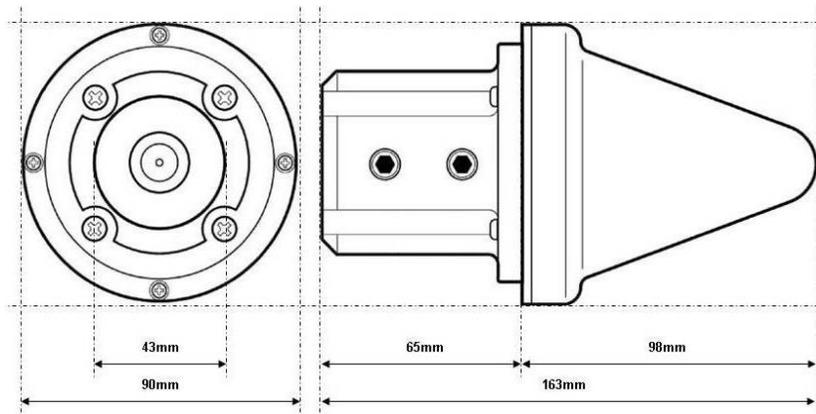
Each TCG02-E kit is shipped with the following:

- TCG02-E time code generator
- GPS antenna optimized for stationary applications, with mounting plinth
- Antenna lead-in cable fitted with matching connectors
- Cat-5 Ethernet cable
- Configuration software

### 4.3 GPS Antenna and Cable Installation

#### 4.3.1 GPS Antenna

The TCG02-E unit's standard shipping configuration includes an active GPS antenna radome specifically designed for industrial/static timing environments, together with a pipe-mounting plinth. The mechanical diagram below shows the radome and pipe mounting plinth attached. (See section 7.1.1 for the complete antenna specifications.)



**Figure 13 – Dimensions of antenna pipe-mounting plinth**

The antenna pipe-mounting plinth (See figure 13) is designed to fit over the top of a pipe like a capping. The mount has an internal diameter of 43 mm, to fit a pipe with external diameter of between 40 and 42 mm (1inch / 32 mm nominal ID galvanized pipe). The top end of the pipe should be cut flat, so that the rubber gasket inside the antenna mount sits flush against it, forming an effective weather seal. The mount is fixed to the pipe with two stainless steel M8 hexagon- socket set screws (supplied).

#### 4.3.2 Available Accessories

- Adjustable antenna mounting bracket – See section 7.1.2
- Antenna cable – See section 7.1.3
- In-line amplifier – See section 7.1.5
- Lightning protection kit – See section 7.1.6

### 4.3.3 Pre-installation

Prior to the acquisition and installation of a GPS Clock, ascertain where and how you will fix the antenna to ensure that the clock will perform nominally. All TCG 02-E antenna installations should follow the guidelines below:

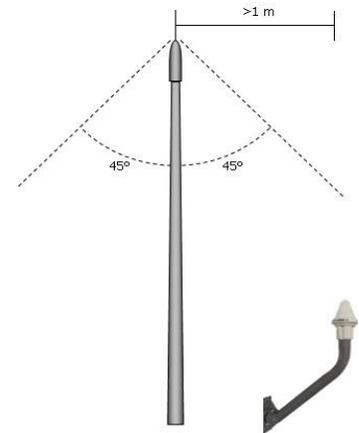
#### Step 1 – GPS antenna placement

The GPS antenna should be installed in a position where it has a clear view of the satellites. When surveying a site prior to installation, consider any fixed or moving obstructions, which may affect GPS reception (E.g. Terrain, Pylons, mobile obstructions). Avoid close proximity to antennas from other services where possible. The antenna has excellent rejection characteristics to out-of-band signals, as does the GPS receiver, but high-powered RF signals in close proximity to the antenna may swamp the very low-level signals from the GPS satellites.

#### Reducing the risk of lightning strike

The first line of protection against the effects of lightning-induced surge events involves positioning the antenna in a “lightning-protected zone”. In practice, this means ensuring that there is at least one other earth-bonded structure located in the same rooftop area (e.g. another antenna, or a lightning rod) that reaches significantly higher than the top of the GPS antenna. The GPS Antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GPS antenna mount itself should also be securely bonded directly to the building protection earth and not connected via any of the other earthed structures.

The risk of lightning strike is greatly reduced if the installation is carried out as described above. However, there is no way to completely prevent lightning strikes. In areas that are especially prone to lightning, a lightning arrestor device should also be installed to further reduce the risk of damage.



#### Lightning protection

At installations where lightning frequently occurs, it is prudent to install a lightning arrestor between the antenna and clock. The Tekron antenna lightning protection kit LPK 01 provides additional protection through the use of an impulse suppressor. In the event of a lightning-derived high voltage surge, the impulse suppressor activates, short-circuiting the cable directly to earth.

#### Step 2 – Antenna mounting bracket

The antenna pipe-mounting plinth is designed to fit over the top of a user-supplied pipe like a capping. The pipe should have an external diameter of between 40 and 42 mm (1¼ inch / 32 mm nominal ID galvanized pipe). The top end of the pipe should be cut flat, so that the rubber gasket inside the antenna mount sits flush against it, forming an effective weather seal.

Establish the mounting method for the pipe, such as strapping or bolting to a frame on the edge of the building, or strapping to an air conditioning exhaust or similar. The base of the pipe needs to be accessible for the cable entry, if this is not practical, then a hole or slot can be made in the side of the pipe to allow the cable to enter and be passed up to the top of the pipe.

An adjustable antenna mounting bracket can be ordered from Tekron. See section A.2 for specifications.

#### Step 3 – Antenna cable

Calculate the cable length required between the antenna and GPS Clock, allowing 5 – 10% extra for contingencies.

Tekron GPS Clocks can be ordered with 15, 30, or 60 meters of high performance RF cable factory-fitted with a TNC-type male connector at one end, and a SMA male connector at the other. The TNC-type connector mates with the connector on the antenna and provides a robust weather-resistant connection. The smaller SMA connector mates with the connector on the GPS clock rear panel and is only fractionally larger in diameter than the cable itself; this facilitates installation in conduit and through small apertures.

Custom lengths can be ordered upon request however additional costs may be incurred.

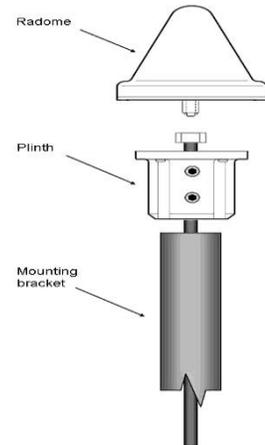
Where antenna cable distance exceeds 60 meters, either lower loss (e.g. CNT-400) cable can be used or an in-line amplifier can be installed. Refer to Tekron for further advice.

#### Step 4 – Antenna cable installation

While the cable shielding is excellent, the cable should not be routed in close proximity to power cables or other RF cables carrying transmitter signals – in particular, parallel runs are to be avoided if possible. If such runs are absolutely unavoidable, a minimum separation of 300 mm may be used as a guideline.

The GPS receiver has excellent out of band rejection characteristics, as does the antenna itself. However, sound engineering practice should not rely on these factors alone to guarantee performance. Careful installation will enhance the long-term reliability and on-going stability of the Time Code Generator.

The absolute minimum bend radius for the antenna cable supplied is 40mm, but it is preferable to use a larger radius if possible. Caution should be taken at all times during the installation of the cable to avoid crushing or shorting the cable.



#### Step 5 – GPS antenna installation

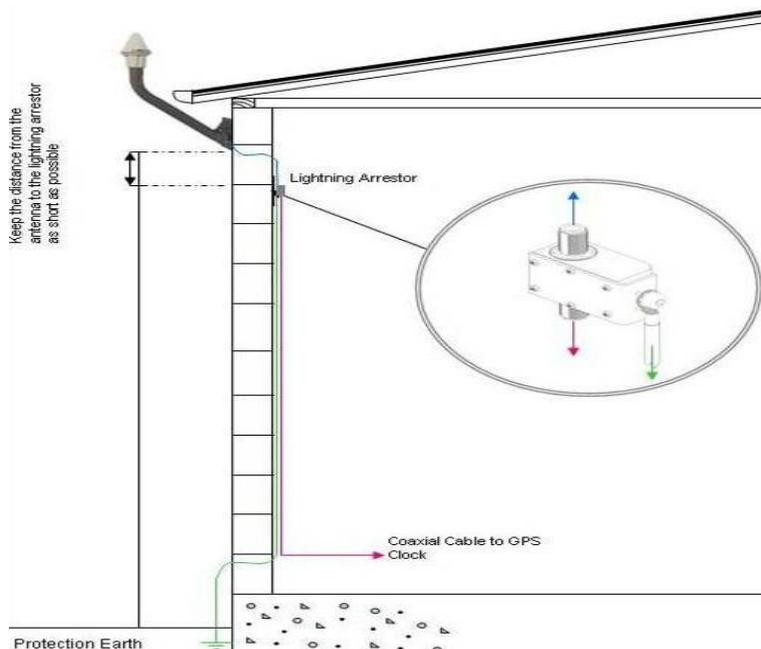
Feed the antenna cable up the mounting bracket/ pipe from the bottom end, through the plinth, and connect directly to the TNC connector on the base of the antenna. It is advisable to wrap self-amalgamating tape around the connector to seal the connection and provide protection against moisture ingress.

Fasten the antenna to the plinth using the four stainless screws supplied with the kit. The complete antenna assembly can then be placed on the mounting bracket/ pipe and secured by tightening the grub screws on the side of the plinth using the supplied Hex key.

#### Step 6 – Installing the lightning protection kit (when applicable)

The lightning protector must be firmly mounted to a conductive metal surface that is itself bonded to the building protective earth. Ensure that a good electrical connection is made between the surge protector and the earthing system. All earthing connections should be as short as possible, should have no sharp bends or loops.

The preferred mounting position is on the inside of the building's exterior wall, adjacent to the antenna lead entry point.



See lightning protection installation guide for connection details

## 4.4 Mounting the TCG02-E

The TCG02-E is designed to be mounted in a 19" rack.

## 4.5 Operation



**Check the label on the base for voltage requirements before switching on**

Connect the antenna lead and the antenna (with a good view of the sky). Then connect the power source to P1.

The time required that will achieve tracking and synchronization given a good view of the sky is typically within a minute. Reactivating a unit that was previously synchronized thousands of kilometers away from the present position will take longer but not more than 45 minutes.

## 4.6 Event Recording Option

### 4.6.1 General Description & Specification

TCG02-E clocks that are ordered with expansion modules 1 and 2 automatically come with the event recording (time-tagging) option on P9 and P10 channels. This is a TTL level input with an input burden of 7 mA.

Recorded time tags contain timestamps corresponding to the rising edge of a pulse. The minimum pulse duration is 1  $\mu$ s, and the maximum rate of time tag recording is 100 tags per second (aggregated over both inputs). In the event of pulses occurring simultaneously on both inputs, both events are captured and recorded independently with the same time data.



**The event recording option makes use of the same input connector (P6) as the external IRIG-B input function. See section 5.7.3 for configuration details.**

### 4.6.2 Tag Data

Time tags use UTC time, and each tag includes the year, day of year, hour, minute and second, as well as fraction of second to a resolution and accuracy of 100 ns. TCG02-E measures time internally in 40 ns intervals, rounding to the nearest 100 ns for time tag storage purposes, thus allowing accuracy to equate to resolution. Each tag record includes the input channel number, as well as the clock sync status as at the tag time.

### 4.6.3 Tag Storage

TCG02-E stores time tags in a data queue designed as a circular buffer. The maximum number of time tags that may be stored is 512. If further events occur when the buffer is full, TCG02-E sets an overflow status and continues storing tags, overwriting the oldest data first.

### 4.6.4 Tag Retrieval

The user can retrieve time tags from the buffer using a request/response protocol operating over TCG02-E's serial port interface. Tags are retrieved from the buffer - oldest data first.

TCG02-E can be configured to broadcast either status or serial time strings over the serial port. Most users of the time tag option will want to suppress all broadcast outputs to simplify the task of time tag data collection. However, if output strings are selected, then TCG02-E will still output time tag information when requested, timing the responses to avoid interference with the other traffic on the port.

### 4.6.5 TCG02-E Command / Response Message Structure

Units equipped with the event recording option provide four command/response message pairs that specifically support time tag management and retrieval.

All command and response messages used by TCG02-E have the same structure:

Prefix: 2 bytes (ASCII "@" characters)

Type: 2 bytes (ASCII alphabetic characters - case matters!)  
 Data: n\* bytes (May be ASCII or binary data)  
 Checksum: 1 byte, binary XOR over all bytes in the "Type" and "Data" fields  
 Suffix: 2 bytes (ASCII <CR><LF>)

\* The length of the "Data" field is determined by "Type". Command and Response commands, while sharing the same "Type" field, have different data content and length.

#### 4.6.6 TCG02-E Commands related to Event Time Tagging

These commands and their responses contain ASCII characters only. A general serial communications program can be used to explore the event recording command / retrieval functions manually. Note that the TCG02-E native serial protocol does not include station addressing. In a network-connected system, the address of the Serial to Ethernet interface device can serve as the station address. Tekron can supply such devices if required.

#### 4.6.7 Ps command: Get Status

The Ps command invokes a Ps response that contains the clock status – which includes the number of tags currently in the time-tag event buffer.

Command (7 bytes [0-6]): Transmitted format: @@Ps#<CR><LF>  
 Response: (33 bytes [0-32]): Received format: @@Ps{26 data bytes}{cs}<CR><LF>

Byte #	Description (Data bytes only, bytes 4 - 29 in received message)
4	Antenna feed fault –[A] only if antenna line is short or open circuit
5	No GPS Solutions – [T] only if no satellites are available for time calculations
6	S/N level low – [S] only if S/N level is abnormally low for more than an hour
7	Oscillator Error High – [X] only if Oscillator Control value is extreme
8	Oscillator DAC out of range – [H] or [L] only if Oscillator Control tending towards extreme
9	GPS Fail – [B] only if internal GPS receiver sub-system not operating properly
10	Not implemented – ASCII [space] always
11	Tracking Satellites – [0-9] = # of satellites in time solution (see note 1 below)
12	Receiver Operating Mode – [0-5] see note 2 below
13 – 15	Time Tag Queue Indicator – [000-512, 999] # of tags in queue (999=overflow)
16 – 18	Outage Indicator – [000-999] Hours since receiver was last locked to GPS signals. Becomes non-zero one hour after loss of lock. Resets to zero when lock is re-acquired
19 – 20	Outage Indicator – [00-59] Minutes since receiver was last locked to GPS signals. Becomes non-zero one minute after loss of lock. Resets to zero when lock is re-acquired.
21	Oscillator Correction. Most significant 4 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [O] (hex 40 to hex 4F)
22	Oscillator Correction. More significant 6 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [del] (hex 40 to hex 7F)
23	Oscillator Correction. Least significant 6 bits of 16-bit D/A converter used for oscillator control. Range is ASCII [@] to [del] (hex 40 to hex 7F)
24-29	Frequency Error. Local Oscillator frequency offset as compared with GPS received signal. In ASCII, ±00000-99999 referenced to 1E-12

#### 4.6.8 Notes concerning the Ps command:

\*An ASCII [space] is transmitted if there is no alarm condition present

1. The TCG02-E can track up to 14 satellites simultaneously. The message limitation of 9 is to retain compatibility with older equipment using this message format.
2. Mode = 1: Satellite search, 2D/3D fix.  
 Mode = 2: GPS Automatic site survey.  
 Mode = 3: GPS position hold (most accurate time).



## 5 TCG02-E CONFIGURATION SOFTWARE

### 5.1 Introduction

Configuration software is provided on a CD with all TCG02-E units. This software is compatible with all versions of the Windows operating system from Windows XP through to Windows 7. The software uses the PC's Ethernet port to communicate with the clock. Each clock ships with a straight-wired Ethernet cable (for connection to a LAN switch) and a crossover Ethernet cable (for direct connection to a PC).

### 5.2 Connection via LAN

Run the supplied CD and locate the configuration software, which is in [Drive] "\TCG02E". This software may be run directly from the CD or be copied to a local folder. [Drive] is typically "D:"

Apply power to TCG02-E and connect the unit to a network switch located on the LAN using a CAT5e straight-wired Ethernet cable (2 m cable supplied with clock). Using a PC connected to the LAN, run the configuration software program "TekronConfigTool-x.x.x.x.exe".



**Preset IP addresses are NOT required if PC and clock(s) are on the same IP sub-net.**

### 5.3 Discovery Window

The window shown in (See figure 14) will appear. Clicking the 'Discover' button the configuration software will automatically locate and identify all Tekron "E" level clocks that are connected to the LAN on the same sub-net as the PC. The clocks serial number, IP address and status will be displayed in the discovery window. Select the type of unit you would like to configure and click "Open".

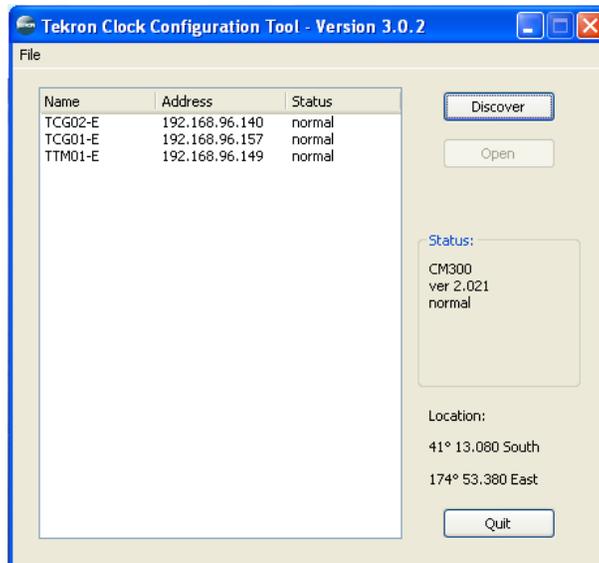


Figure 14 – Unit selection



**If no units are found on the network and you are confident that the TCG02-E is connected properly, check the Windows firewall settings on your PC to ensure that the program is not being blocked.**

### 5.3.1 Add Clock

Tekron clocks that have already been configured with an IP address also support remote configuration over one or more network routers (WAN). The user can communicate with the target clock by selecting “Add Clock” under the File menu and entering the clock’s IP address in the field provided. The “Add Clock” feature can also be accessed by right clicking on the clock list. The availability of the remote configuration feature over a WAN is dependent on the WAN configuration. Please refer to your WAN support personnel for further information.

### 5.3.2 Open Saved Configuration

General clock configuration data that was saved on your PC as a “.tcf” file” (reference the save file chapter) can be previewed by selecting the “Open Saved Config” from the File menu.

### 5.3.3 Save & Open Clock Lists

The units that are being displayed inside the discovery window can be saved to a text file by selecting the “Save Clock List” from the File menu. These units can then be loaded back into the discovery window by selecting “Load Clock List” from the File menu. Note that the default file (“clock\_ip.txt”) if saved in the same directory as the configuration tool will be loaded into the discovery window automatically once the executable is run again. Please ensure that the files are named accordingly when saving.

After successful connection, the configuration tool opens with the “Time” tab active (See figure 15).

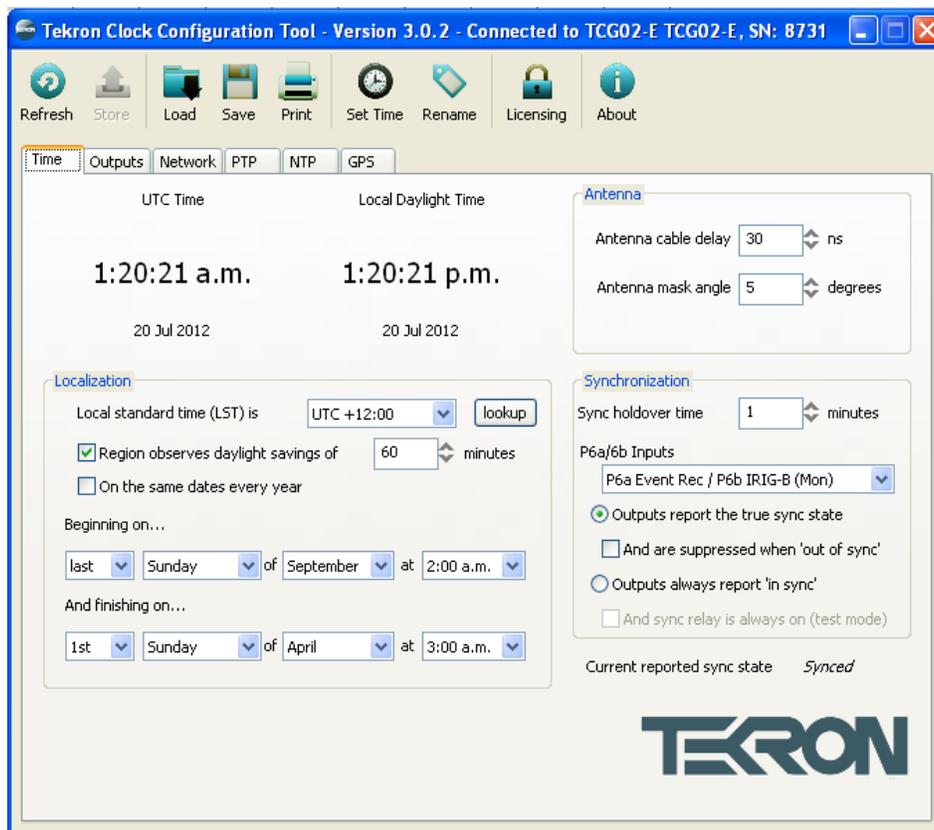


Figure 15 – Time configuration tab

## 5.4 Direct connection method

Run the supplied CD and locate the configuration software, which is in [Drive] “\TCG02E”. This software may be run directly from the CD or be copied to a local folder. [Drive] is typically “D:”.

Apply power to TCG02-E, connect the unit via an Ethernet crossover cable to a PC and run the configuration software program “TekronConfigTool-x.x.x.x.exe”. As in the case of connection via a LAN, a window will appear showing the serial number of the TCG02-E unit connected. Select the serial no of the unit and click “open” to see the “Time” tab as per figure 15.



**If the TCG02-E unit is not found and you are confident that the units are connected properly, check the Windows firewall settings on your PC to ensure that the program is not being blocked.**

## 5.5 Firmware Upgrade

For instructions on how to upgrade the firmware of your clock, please refer to the upgrade procedures as detailed on our website (<http://www.tekroninternational.com>).

## 5.6 Toolbar

### 5.6.1 Refresh and Store



Changes made in the configuration tool can be applied to the TCG02-E using the “Store” button. Note that the “Store” button can only be selected when the configuration displayed does not match what is actually stored in the clock. After storing the configuration changes, the TCG02-E may reset, registering a loss of sync for a brief period.



If password protection is enabled on the clock (See section 5.9.2) an authentication window will appear when the “Store” button is pressed.

Enter your password and click “OK” to proceed. If the correct password has been entered and the write is successful, this window will disappear.

Otherwise, it will indicate failure and prompt for a retry.

If password protection is disabled on the clock, the configuration tool will immediately attempt to write its changes to the device. The Write window that appears will prompt for a retry on failure, and close on success.

The “Refresh” button can be used to undo any changes that have been made to the configuration options on screen that have not yet been stored using the “Store” button.

### 5.6.2 Load, Save and Print



General clock configuration data can be saved on your PC as a “.tcf” file using the “Save” button, and loaded using the “Load” button. Note that configuration options are not applied to the TCG02-E until the “Store” button is pressed. The “Print” button prints a text document listing all currently stored configuration data.

### 5.6.3 Set Time



When the true time is unknown and the antenna is disconnected, the time can be arbitrarily set using the “Set Time” button. This function allows the TCG02-E to be used as a signal source for testing the ability of externally attached equipment to correctly process received time codes through unusual time transitions such as the 28/29 February rollover during leap years, or daylight savings transitions.

The TCG 02-E would normally be configured with “Outputs report “in sync” always” and “And sync relay is always on” settings activated when arbitrarily setting the time.

## 5.6.4 Rename



The TCG 02-E clocks can be configured using the "Rename" button with a name up to 16 alpha numeric characters long to differentiate each unit from others on the same network.

## 5.6.5 Licensing



The "Licensing" button opens a window in which new license keys can be entered to enable additional functionality. Currently NTP Server and / or PTP functions are controlled in this way. A license may be purchased at any time to activate these features. A License can also be used to reset the security password.

## 5.6.6 About

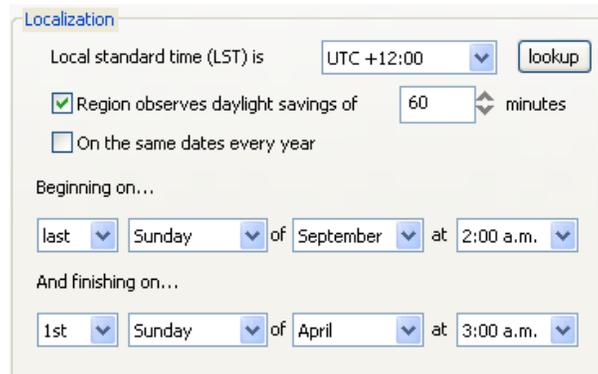


The "About" button opens a windows showing copyright information, website link and firmware / software version numbers.

## 5.7 Time Tab

The "Time" tab (See figure 13) displays the current time and contains regional, antenna and synchronization settings.

### 5.7.1 Localization



#### Local Standard Time (LST)

The time offsets define the number of hours (and, in rare cases, minutes) that the local time differs from UTC time. A positive offset means that the local time is ahead of UTC.

#### Lookup...

The "Lookup..." button provides a convenient way to automatically set time offset and daylight savings parameters simply by selecting a geographical location. Note: this information is derived from Windows™ Date and Time settings, so should be verified as correct before use.

#### Region observes daylight savings

Selecting this option allows the TCG02-E to be configured to make daylight savings changes automatically.

Further options are then made available including:

- DST (Daylight Savings Time) offset in reference to LST (Local Standard Time).
- Fixed date or fixed rule for calculating a date method.

## 5.7.2 Antenna

### Antenna Cable Delay

Antenna

Antenna cable delay	<input type="text" value="31"/>	ns
Antenna mask angle	<input type="text" value="5"/>	degrees

All antenna systems introduce signal delay (depending on the cable length). To optimize the precision of the output signals enter a value in this field corresponding to 4ns per meter of antenna cable. For example, if the antenna cable has a length of 30 meters, enter “120”.

### Antenna Mask Angle

This is the elevation above the horizon below which satellites will not be used in time and position calculations. A good starting value is 5°, but this may need to be increased in areas with land based obstacles to prevent time quality loss due to multi-pathing effects. Increasing this value reduces the field of sky view so may reduce the number of satellites in view at any given time.



**The mask angle will only take effect when the clock is in “Position Lock” (displays P as the receiver status).**

## 5.7.3 Synchronization

### Sync Holdover Time

This parameter is used to control the period after loss of satellite sync that will be tolerated before TCG02-E will show the “loss of sync” status, and release the “sync” relay. Correct installation will make the “loss of sync” event rare; although in areas with poor GPS coverage there can be occasions where satellite tracking is momentarily lost. The “sync holdover” feature is used to mask these effects.

The accuracy of all outputs when there is a complete satellite “blackout” is maintained to the sub-microsecond level over short periods (a few minutes), and to within 10 μs for up to 40 minutes. A single satellite signal sufficiently recovers accuracy to within 1 μs.



**In typical SCADA operations, time syncing to within 0.5 ms is considered adequate. Setting Sync Hold to the maximum (42 minutes) will prevent “loss of sync” alarms in the event that satellites are temporarily obstructed.**

### Outputs report the true sync state

Under normal conditions this option should be selected. The clock reports the true state of synchronization to the connected IEDs.

### And are suppressed when “out of sync”

This option suppresses TCG02-E outputs when it goes out of sync. The sync relay operation is unaffected by this option and will still indicate the true sync state of TCG02-E.

### Outputs report “in sync” always \*\*\*\*

The clock will output time sync signals as if it were synced to GPS, even if this is not true (e.g. there is no antenna attached). In this mode the sync indication outputs will be active at all times.

### And sync relay is always on \*\*\*\*

Enabling this option forces TCG02-E to output time sync signals as if it were synced to GPS, even if this is not true (e.g. there is no antenna attached). In this mode the sync relay will be on at all times.

When the TCG02-E is in this mode, the time can be arbitrarily set. This function allows the TCG02-E to be used as a signal source for testing the ability of externally attached equipment to correctly process received time codes through unusual time transitions such as the 28/29 Feb rollover during leap years, or daylight savings transitions.



**The latter two options (marked \*\*\*\*) are typically used only for testing. They should NEVER be used in applications where a true UTC time reference is required.**

### P9/P10 Input Function (IRIG-B / Event Recording)

This feature provides a means to monitor / control signal activity on the two input channels P9/P10. The TCG02-E clock supports both IRIG-B and event input functions on the two P9/P10 input lines (See figure 16). If one IRIG-B input function and one Event input function are selected, then P9 should be connected to the Event input source, and P10 connected to the IRIG-B signal source. If both inputs are selected as Event Recording inputs, the IRG LED remains inactive. If an IRIG-B input is selected, then, the IRG LED is used to show the status of the IRIG-B sync (See section 2.2).

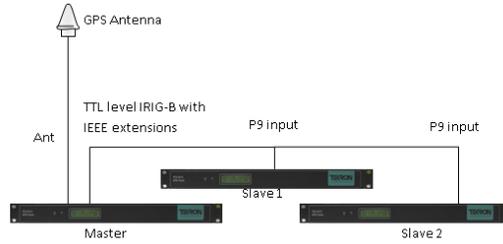


Figure 16 – Multiple Time Code Generators with one GPS antenna

## 5.8 Outputs Tab

The “Outputs” tab (Figure 17) enables the selection and configuration of TCG02-E output ports.

### 5.8.1 Programmable Outputs

#### P2 / P3 / P4-pin 1

Each of the three outputs (P2, P3 and P4-pin 1) can be programmed to give one of four different output waveforms. Selection between the four options is achieved via a drop-down menu (See figure 17).

The options available independently for each output are:

- DCF-77 Output Pulse Simulation
- IRIG-B DCLS (B000/B001 or B002/B003)
- IRIG-B Modified Manchester Encoded (B220/B223 or B221/B222)
- User Defined Pulse Sequence (separate definition stored for each output)

Each of the three programmable outputs can also be inverted in its operation.

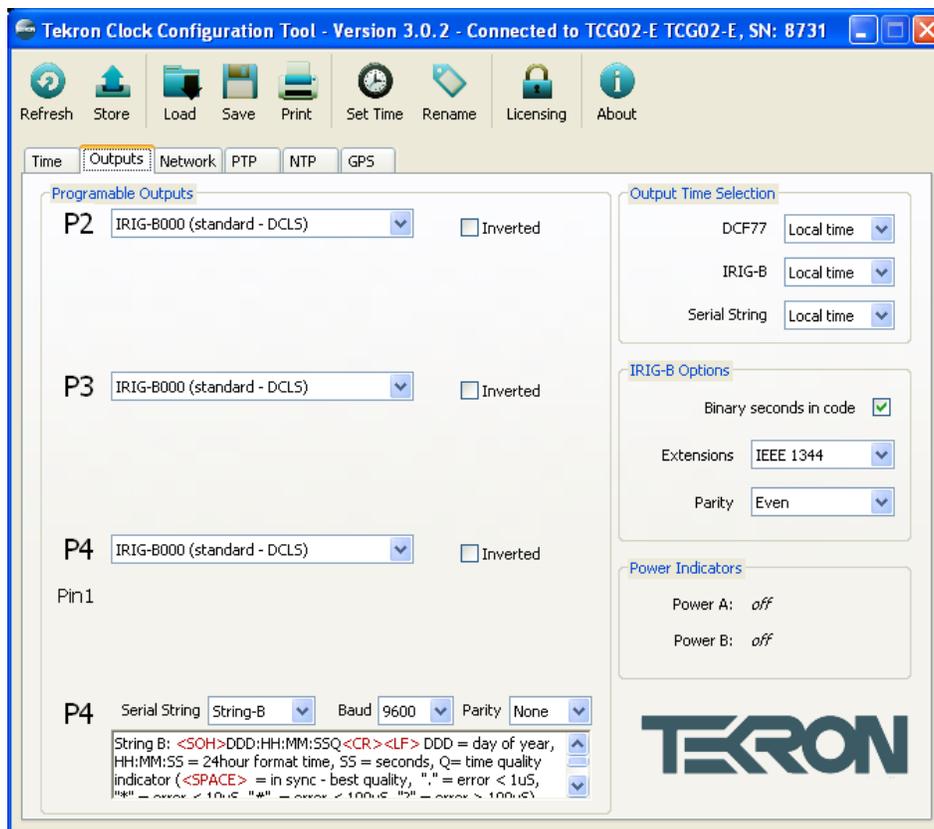


Figure 17 – Outputs configuration tab



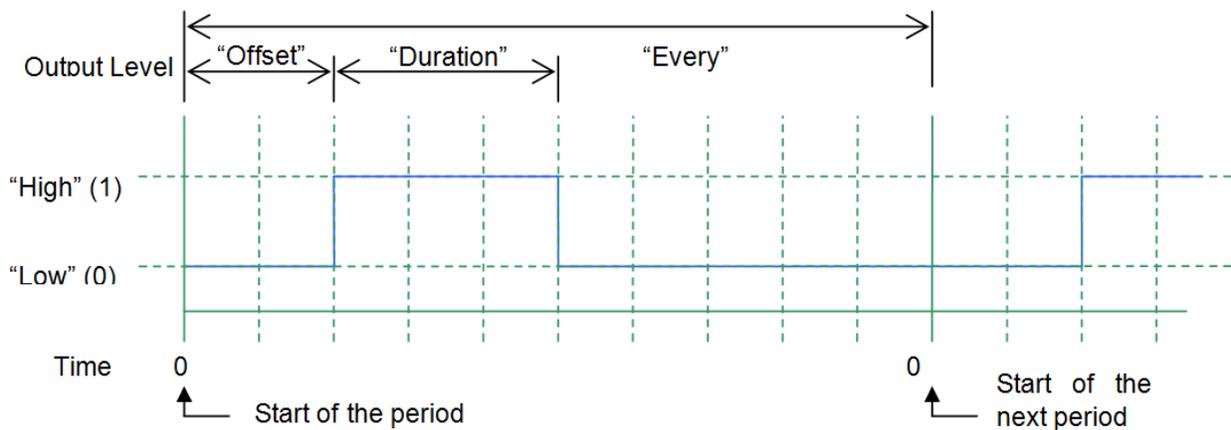
Figure 17 shows the settings for a user-defined pulse on the P4-pin 1 output. The values shown will result in a single pulse per minute. The pulse will begin 59.99 seconds after the start of the minute, and will last for 1/100th of a second (10ms). These settings of the pulse output on P4-pin 1 are normally used in conjunction with the “NGTS” string on P4 to give an NGTS synchronization protocol.

In the case of the User-Defined Pulse option being selected for any outputs, further parameters are entered to define the pulse sequence. The parameters are as follows:

1. A drop-down menu allows the user to choose to have pulses output every “second”, “minute”, “hour”, or “day”. Specify the frequency of pulses under the “Every” and “Pulses” fields: The table below shows what number of pulses per second are valid:

Period “Every”	Number of “Pulses”
Second	1, 2, 4, 5, 10, 20, 25, 50, 1000
Minute	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Hour	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30
Day	1, 2, 3, 4, 6, 8, 12

2. Specify the “Offset” this is the interval from the start of the day, hour, minute, or second to the start of the pulse.
3. Specify the “Duration”; this is the time the pulse stays asserted.
4. Check “inverted” to swap the polarity of the pulse – that is “High” and “Low” levels are swapped.



### Serial string

The serial port output P4 operates at user configurable data rates between 1200 and 38400 bps (available rates are 1200, 2400, 4800, 9600, 19200 and 38400), with no flow control, with 8-bits and user configurable parity. The standard TCG02-E outputs are broadcast messages sent at regular intervals. The broadcast repetition rates, timings, and message content are all described in “Specifications”. Descriptions of each string are also displayed below the dropdown selection box in the configuration tool.



**For the serial configuration tool to function the serial string settings must be set to 9600 baud with no parity.**

## 5.8.2 IRIG-B Options

The IRIG-B time code includes Local (or UTC) Time (See section 5.8.3) in the form of Seconds, Minutes and Hours fields, together with Day\_of\_Year and a two-digit Year fields. Additional data can be selected for transmission in all of the outputs that are programmed for IRIG-B.

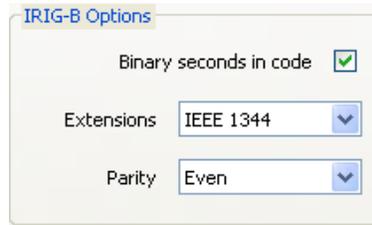


Figure 18 – IRIG-B output options

### Binary seconds in code

The “Binary seconds in code” field (See figure 18) is an option specified by IRIG standard 200-04. If this option is selected, all of the outputs programmed for IRIG-B code – including the amplitude-modulated output - will include the “Binary Seconds of Day” data.

### IEEE 1344 extensions

Outputs programmed for IRIG-B code will additionally output: impending leap second information, local time offset, impending daylight savings change, and time-quality information all in accordance with IEEE1344 specification. Synchro-phasor Standard C37.118 specifies that these extensions be present when synchronizing Synchro-phasor equipment.

### Parity

This option enables the selection of even or odd parity checking within the IEEE1344 extensions of the IRIG-B code.

### AFNOR S87-500 extensions

If this option is selected, all of the outputs programmed for IRIG-B code will also output: day of week, month, and day of month in accordance with the European AFNOR S87-500 specification.

## 5.8.3 Output Time Selection

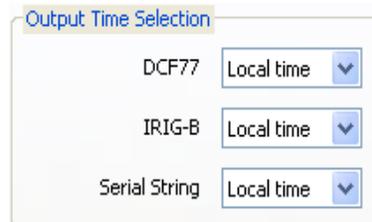


Figure 19 – Output time selection

### IRIG-B

When selected from the menu shown in figure 19, UTC time will be output in IRIG-B time code signals. Otherwise, local time using the current localization settings will be output.

### DCF77

When selected, UTC time will be output in DCF77 time code signals. Otherwise, local time using the current localization settings will be output.

### Serial string

When selected, UTC time will be output in serial strings. Otherwise, local time using the current localization settings will be output.

## 5.9 Network Tab

This tab contains network addresses and options such as SNMP and Syslog (See figure 20).

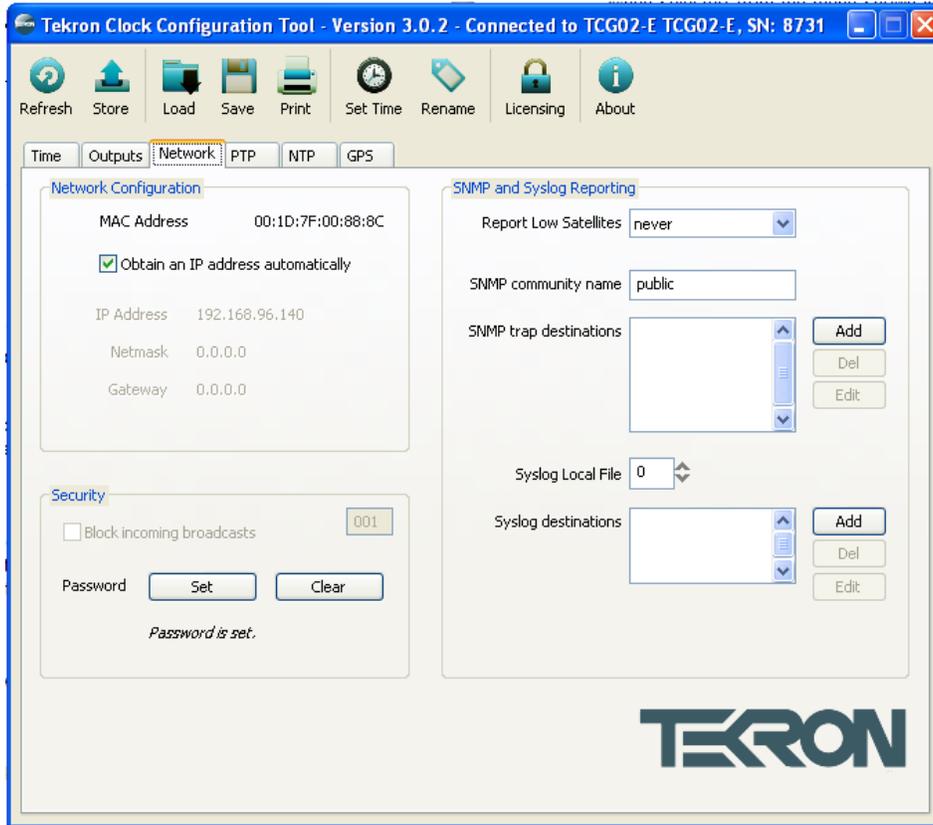


Figure 20 – Network configuration tab

### 5.9.1 Network Configuration

#### MAC Address

Shows the MAC address assigned to the unit. This field cannot be modified.

#### IP Configuration

Selecting “Obtain an IP address automatically” will invoke DHCP operation. Networks that include a DHCP server offer automatic address allocation via Dynamic Host Configuration Protocol (DHCP). In such a network, the unit will automatically use DHCP to fetch a dynamic address if it does not already have a fixed address configured.

#### IP Address

If a DHCP server is unavailable, or if fixed addressing is preferred, an IP address can be entered manually

#### Netmask

Defaults to 255.255.255.0

#### Gateway

Please contact your network administrator for the correct setting in this field.

## 5.9.2 Security



### Enabling Password Protection

Click on the “Set” button. A window prompt will appear to enter and confirm your new password. Note that the password will only be stored inside the unit once the “Store” button has been clicked.

### New Password

When entering a new password it should contain at least 1 character. Underneath the entry field an indicator will display the ‘strength’ of the password chosen. If the device already contains a password, you will be prompted for the previous password when this change is stored.

### Confirm Password

Retype the new password. A warning message will be displayed if the two password fields do not match.

### Clear Password

The password protection can be removed by clicking on the “Clear” button. Underneath the button a text indicator will display “Password is not set” label. Note that the password will only be removed once the “Store” button has been clicked and a correct password has been entered.

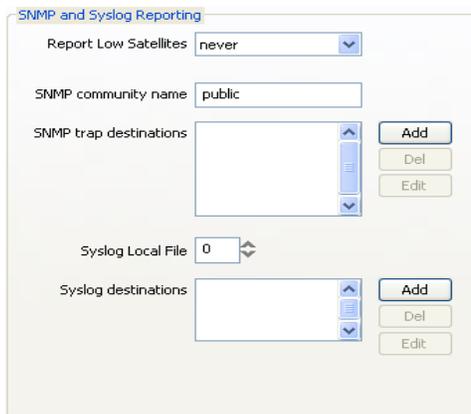
### Resetting Password

To reset your password you will need to contact Tekron and provide the MAC address and security code (located in the top right hand corner) numbers of your unit. You will then be issued a license key which will allow you to set a new password (See section 5.6.5).

### Block Incoming Broadcasts

Enabling “Block incoming broadcasts” will cause the clock to ignore all broadcast messages, including DHCP and configuration discovery messages.

## 5.9.3 Simple Network Management Protocol (SNMP) and Syslog Reporting



### Report low satellites

If the number of GPS Satellites drops below this threshold, an SNMP message “low satellites” is generated. After the unit has been operating with four satellites or more, the clock is tuned such that it can maintain full specified accuracy even if satellite visibility drops to just one satellite. For this reason, the default value for this parameter is “1”. This prevents the transmission of numerous unnecessary “low satellites” messages.

### SNMP community name

The default value is “public”. This may be changed to suit the specific SNMP architecture on the network if required. If SNMP is not implemented for other purposes on the network, then the “public” setting allows the use of a simple SNMP trap display utility running on a remote

monitoring PC to display the status messages sent from the unit.

### SNMP trap destination

This parameter allows for up to five destination IP addresses to be entered. Machines on any or all of these IP addresses can then receive the status messages from the unit. Even if there is no formal SNMP system running on the network, the messages can be received and displayed on the destination machines running “Windows NT” or higher using the freeware utility “SNMPTRAP.EXE”, which is on the CD supplied with the TCG02-E kit.

### SNMP walk

Please use Tekron’s MIB file which can be found on the provided software CD.

### Syslog local file

Normally you would set to zero unless further categorizations of the Syslog messages are required.

## Syslog destination

One or two IP addresses may be entered to define destination machines running system logs.

## 5.10 PTP & NTP Tabs

A TCG02-E unit licensed for NTP/SNTP operation provides a complete Stratum-1 time-server function while still retaining all other output services. A further license option is also available that enables support for PTP v2 time synchronization.

The features on this tab (See figure 21) are inactive and invisible unless NTP/SNTP or PTP options are ordered (See section 5.6.5 for instructions on enabling an NTP or PTP license).

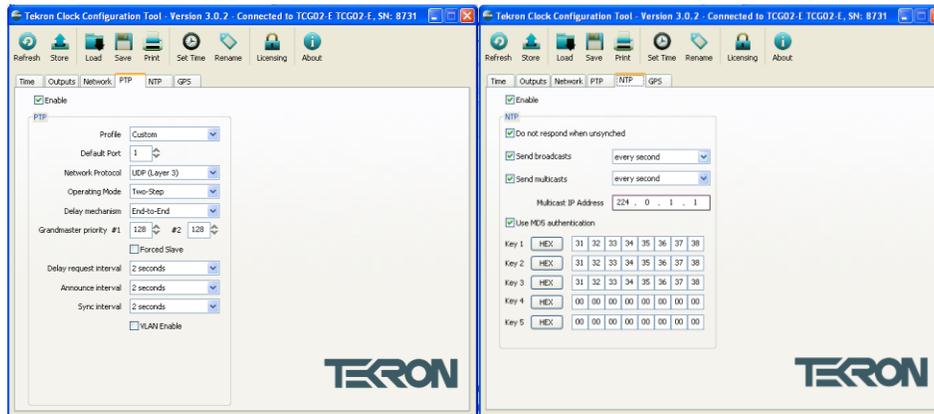


Figure 21 – PTP/NTP configuration tab

### 5.10.1 PTP

#### PTP Enable

Select this box to enable Precision Time Protocol v2 (IEEE 1588-2008) time synchronization (PTP license must be procured).

#### Profile

This drop down list provides a quick way to configure PTP parameters based on industry recognized profiles. Once these changes are applied (or if any parameters are altered) this option will revert to “custom”.

- Default
- Custom

#### Default Port

Select the default PTP port.

#### Network Protocol

The network protocol must be consistent across the entire subnet.

- UDP (Layer 3)
- ETH (Layer 2)



**UDP is the most common PTP network protocol in use.**

#### Operation Mode

Operation mode is a network wide parameter. In any given network, only one mode of operation will be present.

- One-Step
- Two-Step



**Select Two-Step operation if the mode is unknown.**

### Delay Mechanism

Delay mechanism is a network wide parameter. The delay selected must be consistent across the network.

- End-to-End
- Peer-to-Peer



**The Peer-to-Peer option requires the network to use PTP v2 transparent switches. Use End-to-End if standard switches are employed in the network.**

### Grandmaster Priority

These parameters modify the automatic selection of master clocks in PTP networks. Lower values indicate higher probability that the unit will be selected as master clock. The first value overrides all other selection criteria, whereas the second value gives a finer-grained priority used for selection between otherwise-equal clocks.

The input range is 0 to 255, where 0 is the highest priority. The default setting is 128.

### Force Slave

Tick this box to force the unit to become a PTP slave. In this mode, the GPS time is ignored and the unit will never allow itself to become a master clock.

### Delay Request Interval

Delay request interval specifies the time interval between successive Delay Request messages being sent to other PTP devices on the network.

### Announce Interval

Announce interval specifies the time interval between successive Announce messages.

### Sync Interval

The sync interval specifies the time interval between successive Sync messages.

### VLAN Enable

Tick this box to enable VLAN tagging of PTP packets. Enabling VLAN changes the network packet structure to include VLAN ID and Priority fields.

### VLAN ID

This parameter sets the ID field inside the VLAN tag. PTP time synchronization is only allowed between clocks with the same VLAN ID, unless one (or both) has the default value of 0. The allowable input range is 0 to 4094.

### VLAN Priority

This parameter sets the Priority field inside the VLAN tag. The allowable input range is 0 to 7.

## 5.10.2 NTP

NTP

Do not respond when unsynched

Send broadcasts

Send multicasts

Multicast IP Address

Use MD5 authentication

Key 1	HEX	31	32	33	34	35	36	37	38
Key 2	HEX	31	32	33	34	35	36	37	38
Key 3	HEX	31	32	33	34	35	36	37	38
Key 4	HEX	00	00	00	00	00	00	00	00
Key 5	HEX	00	00	00	00	00	00	00	00

### NTP Enable

Select this box to enable the clock to function as a Network Time Protocol (NTP/SNTP) server (NTP license must be procured).

### Compatibility: Do not respond when unsynchronized

Selecting this option causes the time server not to respond to NTP time synch requests unless it is itself synced to UTC time.

### Broadcasts: Send broadcasts

If this option is selected, the unit prompts for a poll interval. The unit will then broadcast time packets at the interval specified.

### Send multicasts

If this option is selected, the unit prompts for a poll interval and Multicast Group IP. The unit will then broadcast time packets at the interval specified to the multicast group specified.

### Security: Use MD5 authentication

The TCG02-E supports fully encrypted requests. If this option is selected, the unit then prompts for five ASCII or Hex keys.



**The length of the MD5 keys is limited to 8 characters; longer keys will be clipped.**

## 5.11 GPS Tab

The information in the “GPS” tab helps with troubleshooting and optimizing an antenna installation.

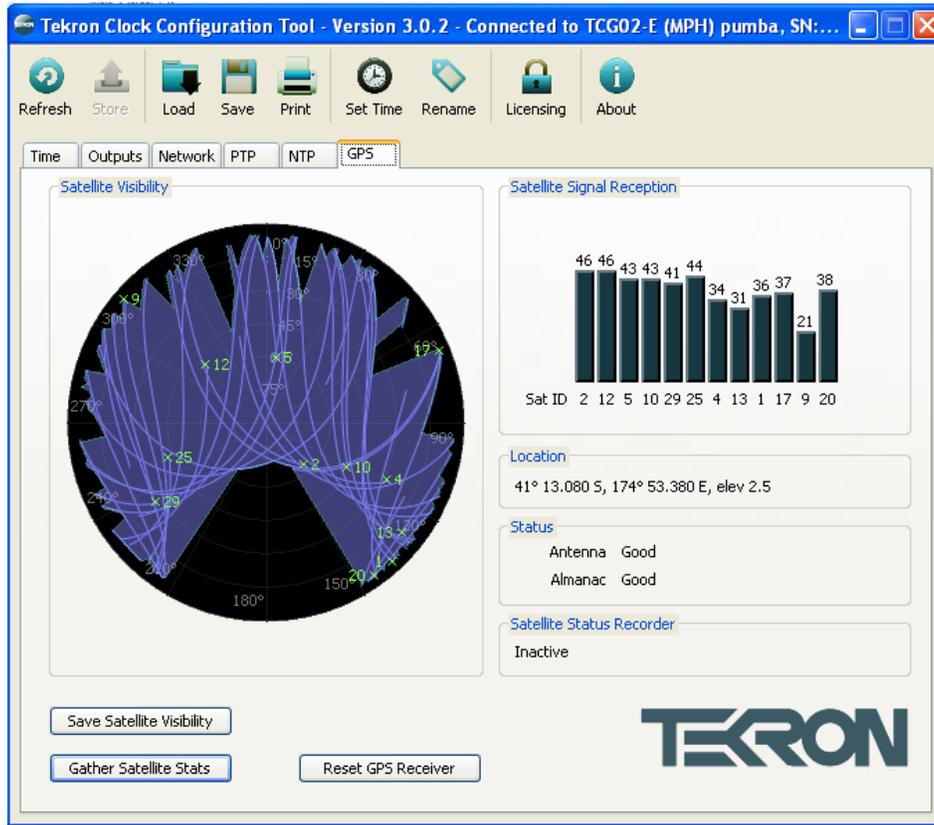
### 5.11.1 Satellite Visibility

Visible satellites are shown on a polar-display. The rings mark the 'elevation' and the sectors mark 'azimuth'. The center of the display represents directly overhead and the elevation is 90° at this point. The edge of the display, elevation = 0°, represents the horizon. The 'azimuth' is a compass direction where 0° represents true north, 90° is east and 180° is south. Satellites being used are marked by a colored cross on the display, and a green bar on the Satellite Signal Strength Indicator, otherwise it is grey on both.

Satellite trails and a minimum elevation plot (the blue area) are also shown in the polar display. Over time this minimum elevation plot will show the viewable horizon. An example of an elevation plot obtained from Wellington, New Zealand is shown in Figure 22.



**To ensure reliable performance, when operating TCG02-E at extreme southern latitudes, position the antenna with a clear view of the northern sky. Similarly, when operating in extreme northern latitudes, the antenna must be able to “see” the southern sky.**



**Figure 22 – GPS configuration tab showing minimum elevations**

### 5.11.2 Satellite Signal Reception

The satellite signal strength indicator gives real-time information regarding the signal reception from GPS satellites.

- Dark blue bars indicate satellites are being used for timing.
- Grey bars indicate poor reception.

### 5.11.3 Location

This shows the latitude, longitude and elevation of the installation.

### 5.11.4 Status

This shows the Antenna and Almanac status.

### 5.11.5 Reset GPS Receiver

This forces the GPS receiver to hard reset. This also wipes the GPS receiver’s memory, by doing this the receiver loses track of all previously tracked satellites (resets the Almanac).

### 5.11.6 Save Satellite Visibility

By clicking on this button the current satellite visibility image can be saved as a .BMP image inside a specified location.

### 5.11.7 Gather Satellite Stats

This feature enables satellite statistics to be gathered for the purpose of commissioning and evaluating the antenna position and GPS reception. The “Gather Satellite Stats” button opens a separate window giving recording options for the information.



Figure 23 – Gather Satellite Statistics

#### Begin

This feature gives the user the option to commence recording the satellite statistics at a defined time and date. If not selected the recording will commence immediately.

#### Duration

Select the length of time for satellite recording to last. If not selected the data recording will continue until the user selects the “Stop” button.

#### Record Raw Data

Selecting this option will enable you to save to a .txt file the raw satellite data. If you choose not to use this option, the raw data will be deleted once the configuration tool is closed.

#### View Gathered Stats

Clicking on this button will open a window which displays a summary of the recorded satellite information. This information can either be disregarded or printed as a ‘Commissioning Report’ along with clock information (Including clock type, firmware revision(s) etc.) and configuration settings of the clock.

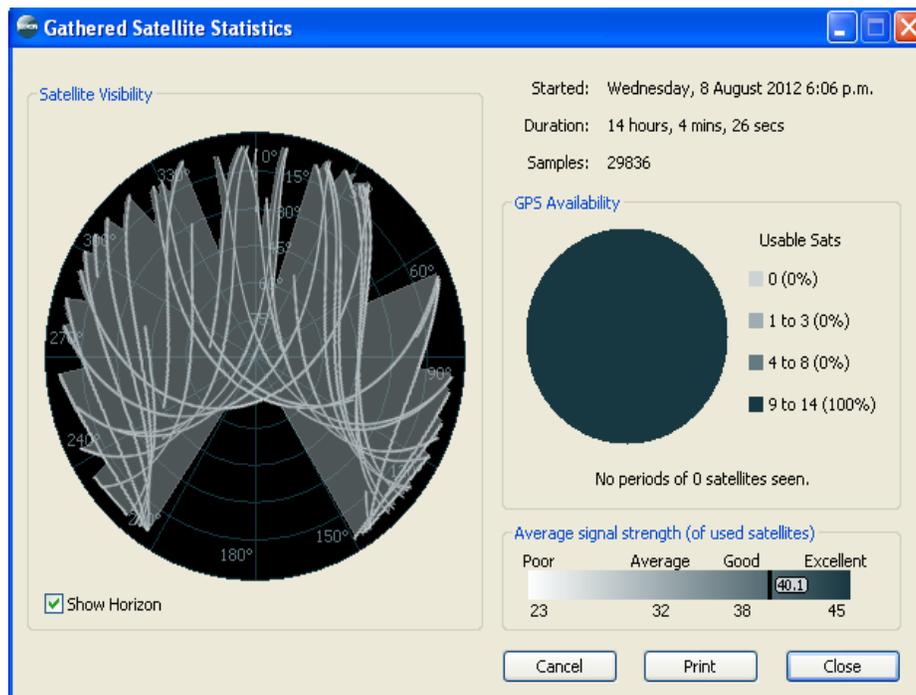


Figure 24 – Gathering Satellite Statistics

Inside the “Gathered Satellite Statistics” window select the ‘Cancel’ button to close the window and abandon all current saved data. The ‘Close’ button will close the current window without affecting the saved results and the ‘Print’ button will print the commissioning report to a user selectable printer.

### 5.12 Telecom Tab

When a TCG02-E unit is configured with a Telecommunications Expansion option instead of a Multiport Hub, a Telecom tab will become available in the configuration tool. This tab is used to configure outputs P13, P14, P15 and P16.

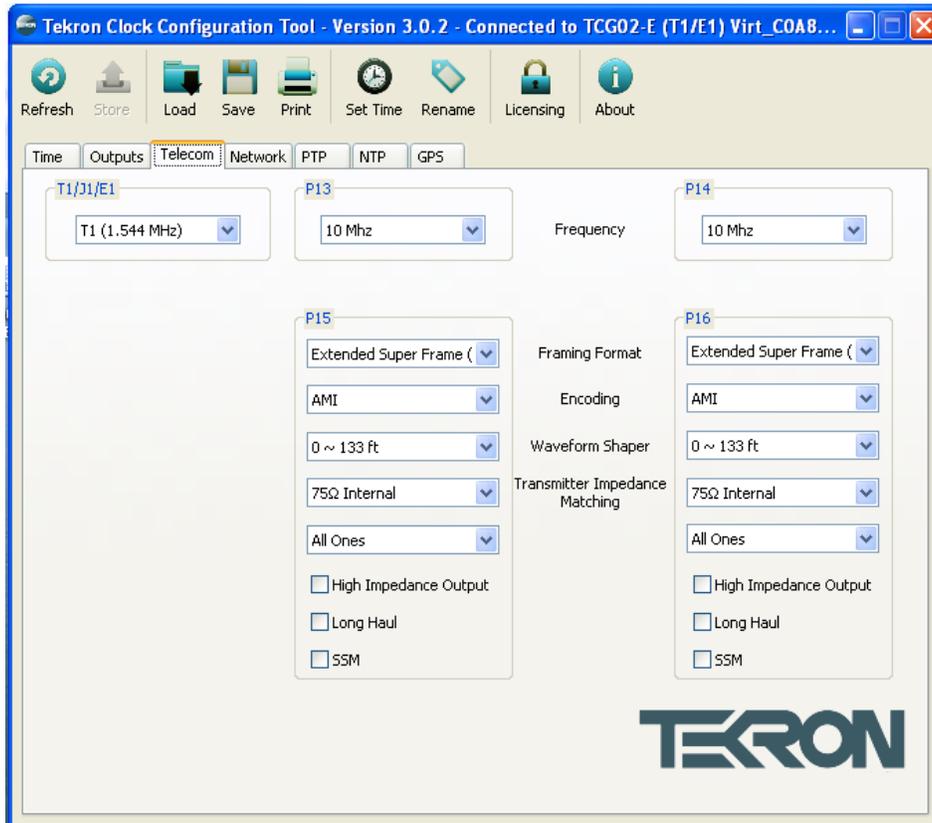


Figure 25 – Telecom configuration tab

The following configurations are available:

**Mode: T1 (used in North America)**

Parameter	Available Options
<b>P15 &amp; P16</b>	
Framing Format	<ul style="list-style-type: none"> <li>• Super-frame (SF)</li> <li>• Extended super-frame (ESF)</li> <li>• Digital multiplexer (DM)</li> <li>• Switch line carrier – 96 (SLC-96)</li> </ul>
Encoding	<ul style="list-style-type: none"> <li>• AMI</li> <li>• BZ8F</li> </ul>
Waveform Shaper	<ul style="list-style-type: none"> <li>• 0 ~ 133 ft.</li> <li>• 133 ~ 266 ft.</li> <li>• 399 ~ 533 ft.</li> <li>• 533 ~ 655 ft.</li> </ul>
Transmitter Impedance Matching	<ul style="list-style-type: none"> <li>• Internal 75 <math>\Omega</math></li> <li>• Internal 100 <math>\Omega</math></li> <li>• Internal 110 <math>\Omega</math></li> <li>• Internal 120 <math>\Omega</math></li> </ul>
<b>P13 &amp; P14</b>	
Frequency	<ul style="list-style-type: none"> <li>• 1.544 MHz</li> <li>• 10 MHz</li> </ul>

**Mode: J1 (used in Japan and South Korea)**

Parameter	Available Options
<b>P15 &amp; P16</b>	
Framing Format	<ul style="list-style-type: none"> <li>• No Framing</li> <li>• Super-frame (SF)</li> <li>• Extended super-frame (ESF)</li> </ul>
Encoding	<ul style="list-style-type: none"> <li>• AMI</li> <li>• BZ8F</li> </ul>
Waveform Shaper	<ul style="list-style-type: none"> <li>• 0 ~ 655 ft.</li> </ul>
Transmitter Impedance Matching	<ul style="list-style-type: none"> <li>• Internal 75 <math>\Omega</math></li> <li>• Internal 100 <math>\Omega</math></li> <li>• Internal 110 <math>\Omega</math></li> <li>• Internal 120 <math>\Omega</math></li> </ul>
<b>P13 &amp; P14</b>	
Frequency	<ul style="list-style-type: none"> <li>• 1.544 MHz</li> <li>• 10 MHz</li> </ul>

**Mode: E1 (used in Europe)**

Parameter	Available Options
<b>P15 &amp; P16</b>	
Framing Format	<ul style="list-style-type: none"><li>• Basic frame</li><li>• CRC multi-frame</li><li>• Modified CRC multi-frame</li><li>• Channel associated signaling (CAS) multi-frame</li></ul>
Encoding	<ul style="list-style-type: none"><li>• AMI</li><li>• HDB3</li></ul>
Waveform Shaper	<ul style="list-style-type: none"><li>• 0 ~ 655 ft.</li></ul>
Transmitter Impedance Matching	<ul style="list-style-type: none"><li>• Internal 75 <math>\Omega</math></li><li>• Internal 100 <math>\Omega</math></li><li>• Internal 110 <math>\Omega</math></li><li>• Internal 120 <math>\Omega</math></li><li>• External resistor 9.4 <math>\Omega</math></li></ul>
<b>P13 &amp; P14</b>	
Frequency	<ul style="list-style-type: none"><li>• 2.048 MHz</li><li>• 10 MHz</li></ul>

The following options are available for P15 and P16:

- High impedance output
- All zeros (all zeros inserted inside the output data stream, default is all ones)
- Long Haul (default is short haul)
- SSM [Only in selected configurations] (this enables synchronization status messages to be transmitted on P15/P16 outputs)

## 6 Factory Hardware Options

### 6.1 Power Supply Options

This table shows the three different power supply configurations that may be ordered with TCG02-E. The TCG02-E has dual power supplies, each supply is independently configurable.

Designator	DC Input Range
I (High) (IEC320 Inlet)	85 - 264 V AC
H (High) (2 pin)	80 - 300 V DC

### 6.2 Expansion Board Options

This table shows the two different Expansion board configurations that may be ordered with TCG02-E.

Multiport Hub Expansion	Telecommunications Expansion
2x Event Recording / IRIG-B Sync Inputs	1x Isolated Programmable Output
1x Programmable Output	3x Modulated / Unmodulated IRIG-B Outputs
4x Modulated / Unmodulated IRIG-B Outputs	2x T1/E1/10M BNC Outputs
	2x T1/E1/J1 RJ45 Outputs

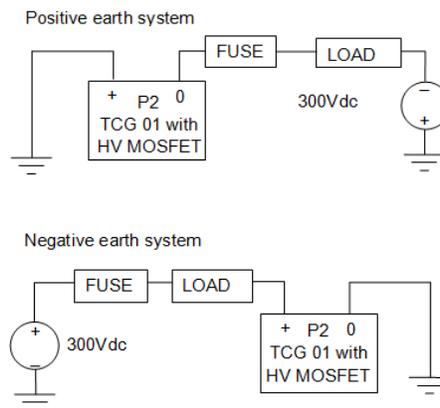
### 6.3 High Voltage (MOSFET) Output Option

TCG02-E may be ordered with either or both of the P2 and P3 outputs configured with a high voltage FET switching transistor instead of the standard 5 V logic output. When fitted in this manner, each output can switch an external load of up to 300 VA, with a maximum “on” current rating of 1 A, and a maximum rated Voltage of 300 V DC.

External wiring should be arranged so that the external high voltage supply line (up to 300 V DC max) is connected, via a fuse, to the load (See figure 26). The return connection from the load is then wired to one terminal of the P2 (P3) output, and the other terminal of the P2 (P3) output is then wired to complete the circuit back to the other side of the power supply. Do not connect the high voltage supply to P2 or P3 unless the high voltage option is fitted – check the label on the base of the TCG02-E unit.



**IMPORTANT! It is the user’s responsibility to provide adequate protection in the form of an external fuse to protect the external power supply, the TCG02-E output switch and the load. Note: At all times, the polarity of the P2 (P3) connections should be such that conventional current flow is into the “+” terminal and out of the “0” terminal – i.e. “+” is at higher positive potential than “0”.**



**Figure 26 – High voltage MOSFET output switch option: Suggested wiring arrangements**

Output isolation (from chassis and other I/O) is still maintained when the HV option is fitted. This simplifies the external load / supply arrangements, particularly when operating with positive-earth systems

## 6.4 Lightning Protection Option

A lightning Protection kit may be fitted into the antenna lead-in cable. The kit contains a protection device, two coaxial cable connectors, a connector crimp tool, and mounting hardware. Refer to Appendix (A.6) for specifications and installation information.

### 6.4.1 General

The first line of protection against the effects of lightning-induced surge events involves positioning the antenna in a “lightning-protected zone” as far as is possible. In practice, this means ensuring that there is at least one other earth-bonded structure located in the same rooftop area (e.g. another antenna, or a lightning rod) that reaches significantly higher than the top of the GPS antenna. The GPS Antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GPS antenna mount itself should also be securely bonded directly to the building protection earth – and not connected via any of the other earthed structures.

However, this will not provide immunity from damage caused by a direct lightning strike, or voltages induced in the antenna lead-in cable due to side flashes or induction.

 **All Tekron antenna installations should follow the guidelines above – regardless of whether a separate lightning protection device is to be fitted to the antenna lead-in cable.**

In areas with a low incidence of electrical storms, careful attention to antenna positioning and earth connections may be all the protection deemed necessary. The antenna lightning protection kit LPK 01 affords additional security through the use of an impulse suppressor installed in the antenna lead-in coax cable. In the event of a lightning-derived high voltage surge occurring on the coaxial cable, the impulse suppressor activates, short-circuiting the cable directly to the protection ground.

 **While the LP kit provides a high degree of protection, there is no guarantee of protection against ALL surge related events, including a direct lightning strike to the antenna. Careful antenna positioning is strongly advised!**

The performance of the antenna system under normal (non-surge) conditions is unaffected by the introduction of a correctly installed EMP Protector.

### 6.4.2 LPK 01 Kit Contents

Quantity	Description
1	NexTek FPLNFNFBxxx Impulse Suppressor
2	N-type Male Crimp Style Coaxial cable connector set to match antenna cable
1	Crimp Tool to match the above connectors (RG59)
1	Roll Self-amalgamating Insulation tape

### 6.4.3 Installation

The impulse suppressor should be installed as per the instructions provided with the impulse suppressor.

For the lightning protector to be effective, it must be firmly mounted to a conductive metal surface that is itself bonded to the building protective earth. **Please ensure that a good electrical connection is made between the surge protector and the earthing system.**

All earthing connections should be as short as possible, should have no sharp bends or loops and should not be coiled to take up extra cable.

The preferred mounting position is on the inside of the building’s exterior wall, adjacent to the antenna lead entry point.

 **The absolute minimum bend radius for the antenna cable supplied is 40 mm, but it is preferable to use a larger bending radius if possible. One way of achieving this is by positioning the protector so that the**



### Mounting and Grounding

Ground the protector within 3ft (1m) of entry into the protected area. Ground bond conductors should be less than 3ft (1m) feet long. Ground bond conductors should be 2X the area of the coaxial shield, or a minimum of 6 AWG (15mm<sup>2</sup>) for a 7-16 or 10 AWG (3.5 mm<sup>2</sup>) for an N protector.

<p style="text-align: center;"><b>Through Panel / Bulkhead</b></p>	<p style="text-align: center;"><b>To a ground bar or panel surface</b></p>	<p style="text-align: center;"><b>Grounded by a wire jumper or strap</b></p>
<ul style="list-style-type: none"> <li>✦ Best grounding and shielding</li> <li>✦ Strain relief loop needed for rigid cable</li> <li>✦ Mounting hole size for each connector</li> </ul>	<ul style="list-style-type: none"> <li>✦ Better grounding</li> <li>✦ Easily installed with simple holes</li> <li>✦ Cable should include strain and drip loop</li> </ul>	<ul style="list-style-type: none"> <li>✦ Good ground with a short wire</li> <li>✦ Accomodates cable movement</li> <li>✦ Very easy installation</li> </ul>

### Tightening

Mount the protector and tighten the connector coupling nuts and mounting or grounding nuts to ensure long term reliable operation.

Component	N Mount Nut	N or TNC Coupling Nut	7-16 Mount Nut	7-16 Coupling Nut	M8 (Boss)	M5 (Bracket)
Inch-pounds	80	12	300	200	130	40
N-m	10	1.4	35	22	15	4.5

### Other Application Tips

1. Select the protector based on the RF frequency, connector, RF power and dc capability.
2. Limit the unprotected coaxial lead-in into the protected zone to 3' (1m) to reduce high energy into the protected area. For severe exposure locations, use a bulkhead mount to eliminate this risk.
3. Make sure that the mounting surfaces are clean, dry and fully tightened.
4. If a protector is rigidly mounted, install a strain relief bend in large coaxial cables.
5. Allow for access to replaceable components, preferably with access ports oriented down.
6. Use weatherproof mating connectors. Field terminations may need moisture wrap.
7. Do not install during precipitation, as water can enter unmated ends. Use o-rings for bulkheads.
8. Shield protectors from damage, including cable loading, abuse, corrosion, ice or water.
9. Use copper alloy materials (including brass). (Plated aluminum only for dry indoor locations.)

**Figure 28 – Mounting and Grounding**

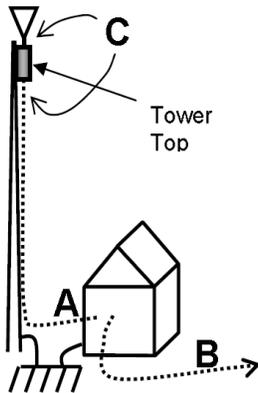
## General Mounting and Grounding Instructions for Coaxial Surge Protectors

NexTek Coaxial Surge Protectors provide reliable protection from high voltage surges in coaxial lines. These protectors provide long life protection and are critical component for high reliability and uptime communication systems.

The source of surges usually includes lightning, power line faults and switching, and static discharge. In order to function properly and protect against these surges, the protector must be installed, grounded and maintained properly, and used within specified limits.

### General Rules

1. Install within 3' (1m) of the entrance to a protected zone (building, shelter or enclosure).
2. Ground bond wires should be short, avoid bends, and be larger ampacity than the shield.
3. Use a common ground for all suppressors (ac power mains, network and telecom lines).
4. If a unit has a "PROTECTED" side, orient this side toward the protected equipment, away from the exposed lead-in coaxial cable.



### Location

Protectors should be installed near the coaxial entry from exposed cable runs. Typical coaxial entries from exposed areas include:

- A. Down leads into a building or cabinet from towers or outdoor antennas.
- B. Cable entry from other buildings or outside networks.
- C. Antenna interface into transmitters or tower top amplifiers, and transmitter or tower top amplifier down leads.

For critical applications, an interior second protector near the equipment to be protected is recommended in addition to A or B.

### CAUTION

NexTek lightning protectors are high capacity devices for coaxial lines. The high energy and current associated with the operation of these devices should have expert installation and maintenance.

1. Do not install or repair while there is a threat of thunderstorm activity.
2. Do not replace protective Gas Discharge Tubes while transmitting high RF power.
3. Consult a protection professional for a complete protection design, including protection of personnel and all wiring interfaces, and ground system qualification.
4. Follow electrical, grounding, building and lightning protection codes and practices.
5. Follow RF power handling practices appropriate to the application.

Figure 29 – General mounting and grounding

#### **6.4.4 Disclaimer**

Tekron disclaims any liability or responsibility for the results of improper or unsafe installation practice including, but not limited to, any excessive performance degradation of the antenna system resulting from incorrect field installation of coaxial cable connectors.

## 7 Appendix

### 7.1 Specifications

#### 7.1.1 GPS Antenna

Physical Specifications		
Performance Property		Metric
Dimensions	Diameter	90 mm
	Height	98 mm (without connector or plinth)
Weight		200 g
Environmental Specifications		
Performance Property		°C
Operating Temperature Range		-40 ~ +85°C
Electrical Specifications		
Performance Property		Metric
Polarization		Right hand circular polarization
Bandwidth		1575.42 MHz ± 1.023 MHz
Power Supply		5 V DC ± 0.5 V
Current Drain	20 mA Typical	
	27 mA Maximum	
Total Gain	38 dBi Typical	
	30 dBi At 90° elevation	
Attenuation		60 dB at 1525 MHz, 1625 MHz (± 50 MHz on center frequency)
Output VWSR		1.5 Typical
Output VWSR		2.5 Maximum
Lightning Protection		80 V for IEC1000-4-5 standard

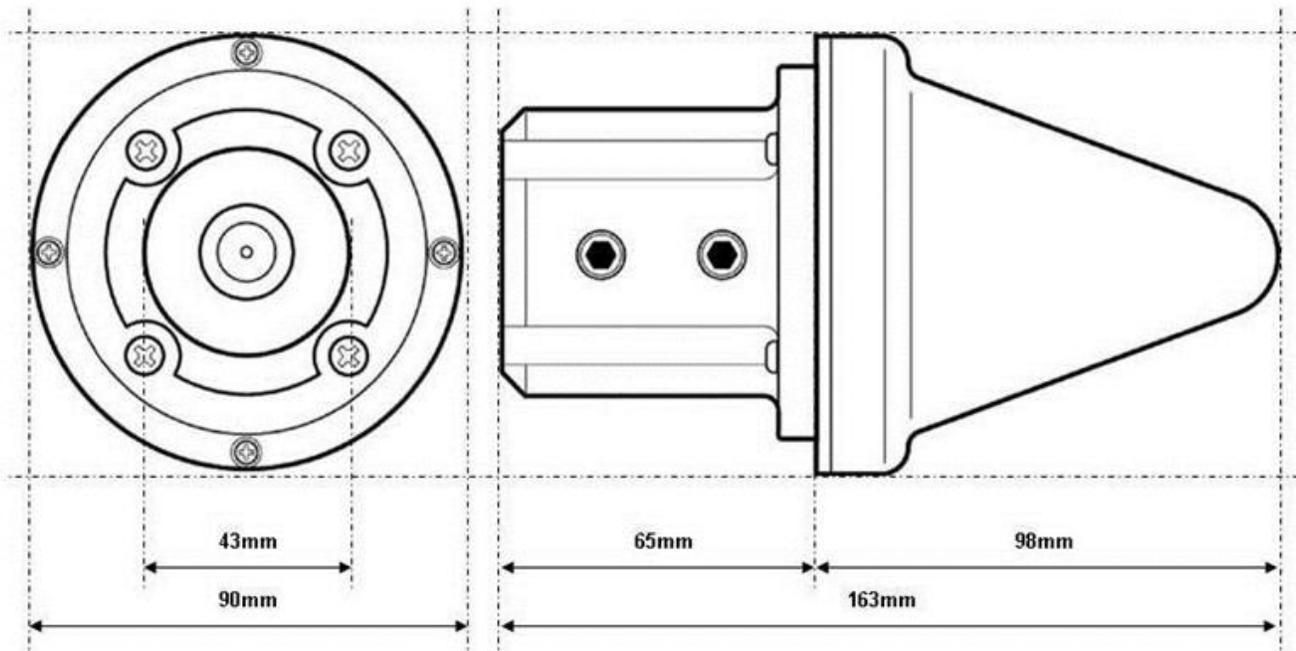
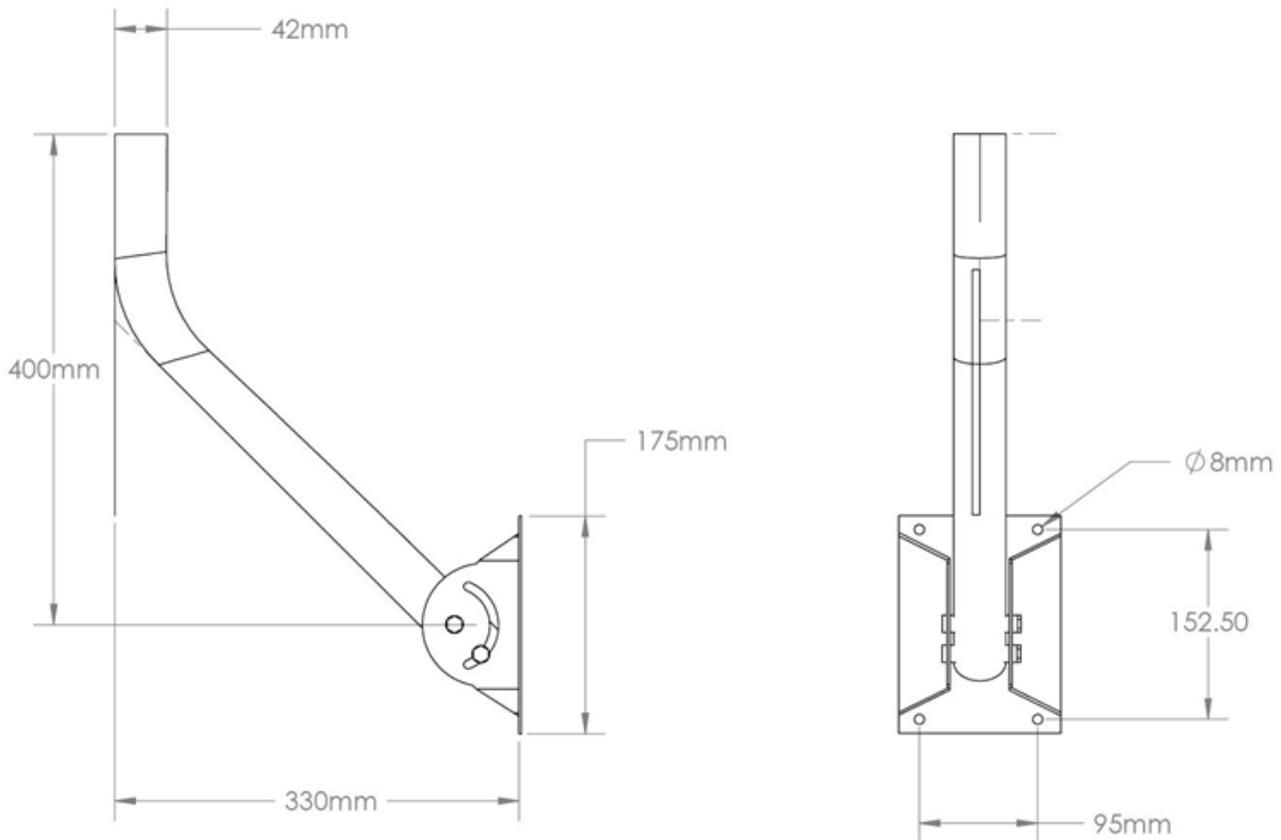


Figure 30 – Antenna pipe-mounting plinth

### 7.1.2 Adjustable Antenna Mounting Bracket

The steel adjustable antenna mounting bracket (See figure 31) will assist in the dissipation of energy should the antenna be struck by lightning. The mounting bracket should be securely bonded directly to the building protection earth – and not connected via any of the other earthed structures.



**Figure 31 – Antenna mounting bracket**

### 7.1.3 Antenna Cable

The TCG02-E can be ordered with 15, 30, or 60 meters of high performance CNT-240 cable factory-fitted with a TNC-type male connector at one end, and a SMA male connector at the other. The TNC-type connector mates with the connector on the antenna and provides a robust and weather-resistant connection. The smaller SMA connector mates with the connector on the TCG02-E and is only fractionally larger in diameter than the cable itself; this facilitates installation in conduit and through small apertures.

Custom lengths can be ordered upon request (additional charges may occur).

Where antenna cable distances exceed 60 meters, CNT-400 can be used, or an in-line amplifier can be installed. Refer to Tekron for further advice.

Environmental Specifications	
<b>Performance Property</b>	°C
Operating Temperature Range	-40 ~ +85°C
Electrical Specifications	
<b>Performance Property</b>	<b>Metric</b>
Attenuation (1575.42MHz)	32.80~dB/100 m
Velocity of Propagation	83%
Time Delay	4.00 ~ ns/m
Impedance	50 Ω
Capacitance	79.8 pF/m
Shielding Effectiveness	>90 dB
DC Resistance Inner Conductor	10.830 Ω/km
DC Resistance Outer Conductor	12.760 Ω/km
Voltage Withstand	1500 V DC
Jacket Spark	5000 V RMS
Peak Power	5.6 kW

#### 7.1.4 TCG02-E Unit

Physical Specifications		
<b>Performance Property</b>	<b>Metric</b>	
Dimensions	Width	430 mm
	Depth	270 mm
	Height	45 mm
Weight	2.0 kg	
GPS Receiver		
L1 (1575.42 MHz) Frequency, C/A Code, 14 Channel, parallel-tracking receiver		
<b>Performance Property</b>	<b>Metric</b>	
Position Accuracy	Horizontal	<9 m (90%)
	Altitude	<18 m (90%)
Timing Accuracy	<15 ns to UTC	
Acquisition	Reacquisition	<2 s (90%)
	Hot Start	<18 s (90%)
	Warm Start	<45 s (90%)
	Cold Start	<50 s (90%)
Sensitivity	Acquisition	-160 dBm
	Tracking	-155 dBm
Voltage	3.0 ~ 5.5 V DC	

Input and Output Specifications			
Type	Electrical	Physical	Accuracy at the port
AM IRIG-B (modulated)	8 V	BNC	≤2 μs of UTC
TTL	5 V	2 pin Phoenix or BNC	≤100 ns of UTC
RS422/485		2 pin Phoenix or BNC	≤100 ns of UTC
RS232/RS422 (Pulse)		DB9	≤1.5 μs of UTC
RS232/RS422 (String)		DB9	Baud rate dependent
HV Switching(MOSFET)		2 pin Phoenix	≤100 ns of UTC
Fiber (λ=820 nm)	N/A	ST	≤100 ns of UTC
NTP/ SNTP		RJ45	≤200 ns of UTC
Environmental Specifications			
Performance Property	°C		
Operating Temperature Range	-10 ~ +65°C		

Electrical Specifications		
Performance Property	Metric	
Power Supply	Low Voltage	18 ~ 36 V DC
	Medium Voltage	36 ~ 72 V DC
	High Voltage	80 ~ 300 V DC / 85 ~ 264 V AC
Power drain	12 W max	

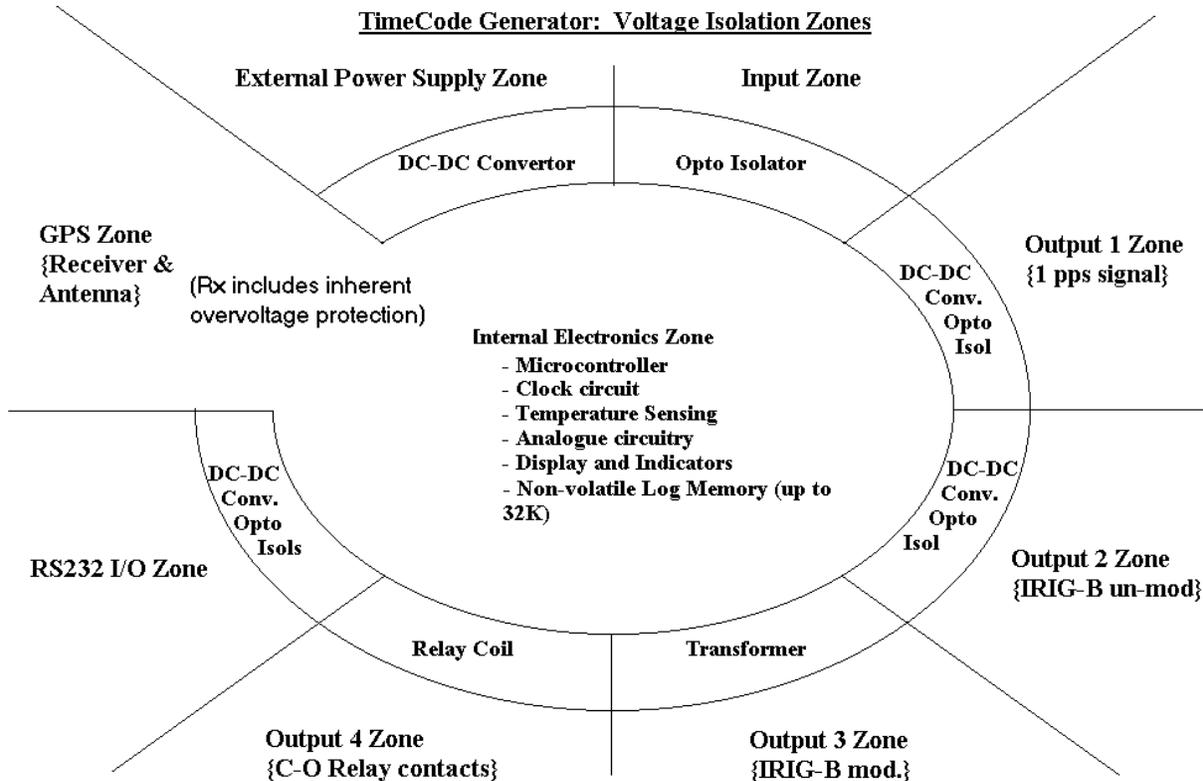
## Isolation and Protection

All inputs and outputs feature 2.5kV isolation from each other. In addition, the logic level outputs (P2 and P3) are each protected against damage from transverse voltage events via a three-stage network of varistor, auto-resetting fuse, and transient suppressor diode.



Fuse and varistor protection is removed when the switching MOSFET factory option is fitted. The user must provide an external power supply and suitable fusing to use the MOSFET output option (See section 6.1) for further information).

Varistor protection and current limiting (nominally 5 mA) are employed for protection on the general-purpose input.



**Figure 32 – TCG02-E isolation zones**

Transformer isolation via DC-DC converter is used for the main power supply and for power to each of the logic output-drive circuits. The serial communications interface is also separately powered via isolating DC-DC converter. High-speed, fixed delay opto-isolators are used in each of the time-sensitive signaling paths. The isolation does not degrade the time accuracy of the output signals, as the fixed delays of the isolating components (together with the delay associated with the antenna lead-in) are all internally compensated.

### 7.1.5 In-Line Amplifier

The Raven LA Series inline amplifier, filters and amplifies GPS signals to extend cable runs hundreds of feet.

Physical Specifications		
Performance Property		Metric
Dimensions	Length	95 mm (approximately)
	Diameter	163 mm
	Weight	420 g
Connector Type		N-Type Female (Both Ends)
Environmental Specifications		
Performance Property		Metric
Operating Temperature Range		-55 ~ 45°C
Electrical Specifications		
Performance Property		Metric
Power Consumption		8 mW
Input Voltage		3 – 8 VDC
Operating Current		< 10 mA typical
Noise Figure		< 4 dB typical

### 7.1.6 Lightning Protection Kit

The NexTek FPL series of protectors reduce lightning transients to very low voltage levels and pass dc through as well. Fine-protectors are usually necessary on sensitive receiver lines that must pass dc, or need protection against HEMP or NEMP surges.

Physical Specifications		
Performance Property		Metric
Dimensions	Width	32.9 mm
	Depth	32.9 mm
	Height	108 mm
Connector Type		N-Type Female (Both Ends)
Environmental Specifications		
Performance Property		°C
Operating Temperature Range		-40 ~ +90°C
Salt Fog		MIL-STD-202 Method 101D / Condition B (35°C/48 hours)
Immersion		MIL-STD-202 Method 104A / Condition A (65°C to 25°C w/NaCL – 2 cycles)
Moisture Resistance		MIL-STD-202 Method 106E / 65°C/98% RH condensing/ 240 hours
Temperature Shock		MIL-STD-202 Method 107D / Condition B-1 (96 hours at 100°C)
Life (Elevated Temperature)		MIL-STD-202 Method 108A / Condition A (96 hours at 100°C)
Dust and Waterproof Rating		IEC529 IP68 (dust-tight and water proof 24 hours / 1m)
Vibration		MIL-STD-202 Method 204D / Condition D (10 Hz – 2 kHz 0.06" DA / 20g)
Mechanical Shock		MIL-STD-202 Method 213 / Condition A (50 g / 11 ms ~ 24")
Electrical Specifications		
Performance Property		Metric
Operating Voltage		+5 ~ 6.7 V DC
Maximum RF Power @ 20°C		30 W
Frequency		1150 ~ 1610 MHz
Insertion Loss		0.1 dB (Typical)
Surge (Max)		30 kA
Surge (Max) Multi-strike		20 kA, 8/20 μs (IEC61000-4-5)
Response Time		10 ns
Through Current		1A

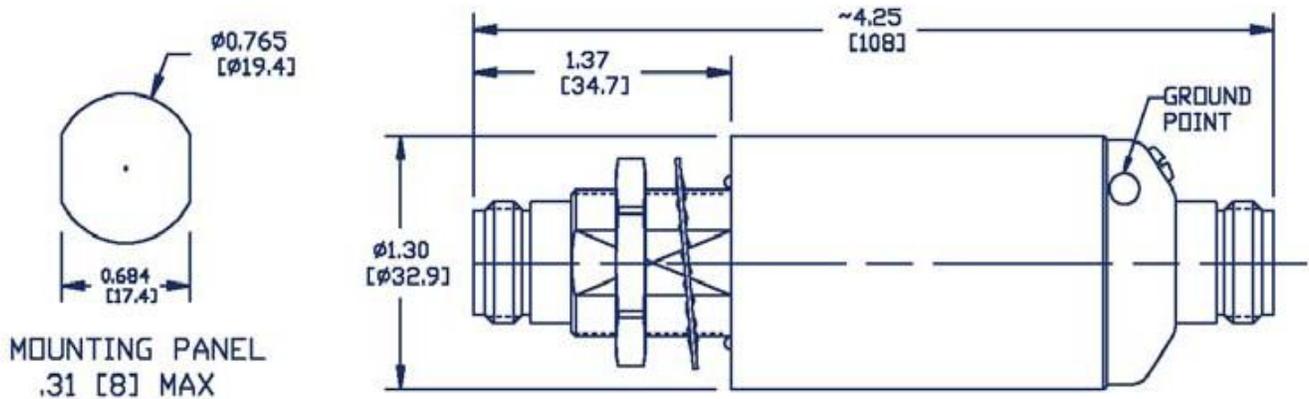


Figure 33 – Lightning Arrester

## 7.2 Serial Output Strings

### 7.2.1 NGTS Time Code O/P on P4

<b>About</b>	Normally used in conjunction with 10 ms pulse on P4 pin 1 that finishes precisely on the minute. See the hint in (5.8.1).
<b>Timing</b>	Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	YYMMWhhmmx<CR><LF>
<b>Placeholder</b>	<b>Content</b>
T	"T"
yy	Last two digits of the year: e.g. "12" = the year 2012
mm	Month: "00" = January ... "12" = December
w	Day of week: "01"=Monday ... "07"=Sunday
hh	Two digit hour
mm	Two digit minute
x	Time mode: "0" = Local time, "1" = UTC time
<CR>	Carriage Return: HEX 0D
<LF>	Line Feed: HEX 0A

**Example Interpretation:**

T020422112340<CR><LF>

Monday 22 April 2002 – 12:34 local time

### 7.2.2 IRIG J-17 Time Code O/P on P4

<b>About</b>	This code is compatible with IRIG Standard 212-00.
<b>Timing</b>	Transmitted once every second. The leading edge of the "start" bit of the first character <SOH> is exactly on the second that the message describes.
<b>Comms</b>	9600bps, 7-bit ASCII, odd parity
<b>Definition</b>	<SOH>ddd:hh:mm:ss<CR><LF>
<b>Placeholder</b>	<b>Content</b>
<SOH>	HEX 01
ddd	Day of year: range "001" – "366"
:	HEX 3A
hh	hour: "00" – "23"
mm	minute: "00" – "59"
ss	Seconds: "00" – "59"
<CR>	HEX 0D
<LF>	HEX 0A

**Example Interpretation:**

<SOH>112:12:34:36<CR><LF>

day 112, time 12:34:36

### 7.2.3 String-A Time Code O/P on P4

<b>About</b>	This code is very similar in data content to the IRIG J-17 code, but adds a two-character field containing the year, and uses 8-bit ASCII, no parity data format.
<b>Timing</b>	Transmitted once every second. The leading edge of the “start” bit of the first character <SOH> is exactly on the second that the message describes.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	<SOH>ddd:hh:mm:ss:yy<CR><LF>
<b>Placeholder</b>	<b>Content</b>
<SOH>	HEX 01
ddd	Day of Year: range “001” – “366”
:	HEX 3A
hh	hour: “00” – “23”
mm	minute: “00” – “59”
ss	seconds: “00” – “59”
yy	year: “00” – “99” representing the last two digits of the year
<CR>	HEX 0D
<LF>	HEX 0A

**Example Interpretation:**

<SOH>112:12:34:36:10<CR><LF>                      day 112, time 12:34:36, year (20)10

### 7.2.4 String-B Time Code O/P on P4

<b>About</b>	This code substitutes a “Quality” indicator byte for the year field, but otherwise is identical in form, function and timing to String-A.	
<b>Timing</b>	Transmitted once every second. The leading edge of the “start” bit of the first character <SOH> is exactly on the second that the message describes.	
<b>Comms</b>	9600bps, 8-bit ASCII, no parity	
<b>Definition</b>	<SOH> DDD:hh:mm:ssQ<CR><LF>	
	<b>“Quality” Character (Q)</b>	<b>Content</b>
HEX	ASCII	HEX 01
20	‘ ’ (space)	Day of Year: range “001” – “366”
2E	‘.’ (full stop)	HEX 3A
2A	‘*’	hour: “00” – “23”
23	‘#’	minute: “00” – “59”
3F	‘?’	seconds: “00” – “59”

\*Refer to String-A table (above) for the definitions of the common digits

**Example Interpretation:**

<SOH>112:12:34:36?<CR><LF>                      day 112, time: 12:34:36, >100 µs sync error

### 7.2.5 String-C Time Code O/P on P4

<b>About</b>	This code is effectively a combination of String-A and String B. It provides both year information and a sync indicator field.
<b>Timing</b>	Transmitted once every second. The leading edge of the “start” bit of the first character, <CR>, is exactly on the second to which the message data refers.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	<CR><LF>Q★yy★ddd★hh★mm★ss.000★ ★ ★
<b>Placeholder</b>	<b>Content</b>
<CR><LF>	HEX 0D,0A
Q	Quality indicator: “ ” = in-sync, “?” = out-of-sync
★	HEX 20 (space)
yy	Year: “00” – “99” representing the last two digits of the year
★	HEX 20 (space)
ddd	Day of year: range “001” – “366”
★	HEX 20 (space)
hh	hour: “00” – “23”
mm	minute: “00” – “59”
ss	seconds: “00” – “59”
.000	ASCII “.000”
★	HEX 20 (space)
★	HEX 20 (space)
★	HEX 20 (space)

**Example Interpretation:**

<CR><LF>? 02 112 12:34:36.000                      day 112 of year (20)02, time: 12:34:36, out-of-sync

### 7.2.6 String-D Time Code O/P on P4

String-D is IDENTICAL in content to String-B, but the second mark is at the leading edge of the start-bit of the (<CR>).

**Example Interpretation:**

<SOH>112:12:34:36?<CR><LF>                      day 112, time: 12:34:36, >100 μs sync error

### 7.2.7 String-E Time Code O/P on P4

<b>About</b>	This provides time, year information, and a sync indicator field.
<b>Timing</b>	The string is transmitted once every second, with the leading edge of the “start” bit of the <CR> exactly on the second.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	<SOH>yyyy:ddd:hh:mm:ssQ<CR><LF>
<b>Placeholder</b>	<b>Content</b>
<SOH>	HEX 01
yyyy	4-digit year
:	HEX 3A
ddd	Day of year: range “001” – “365”
hh	hour: “00” – “23”
mm	minute: “00” – “59”
ss	seconds: “00” – “59”
Q	Quality character, as defined in String-B (above)
<CR>	HEX 0D
<LF>	HEX 0A

**Example Interpretation:**

<SOH>2004:112:12:34:36?<CR><LF>            2004, day 112, 12:34:36pm, >100us sync error

## 7.2.8 String-F Time Code O/P on P4

<b>About</b>	This string complies with the protocol required to drive Vorne type Time Displays.
<b>Timing</b>	The string is transmitted once every second, with the leading edge of the “start” bit of the last <BEL> exactly on the second.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	<CR><LF>1100<CR><LF>44hhmmss<CR><LF>54ddd<CR><LF> <CR><LF>45HHMMss<CR><LF>55DDD<CR><LF><BEL>
<b>Placeholder</b>	<b>Content</b>
<CR>	HEX 0D
<LF>	HEX 0A
1100	ASCII “1100”
44	ASCII “44” (means local time follows)
54	ASCII “54” (means local day of year follows)
45	ASCII “45” (means UTC time follows)
55	ASCII “55” (means UTC day of year follows)
ddd	Local day of year: “001” – “365”
hh	Local hour of day: “00” – “23”
mm	Local minute of day: “00” – “60”
ss	seconds: “00” – “59”
DDD	UTC Day of year: “001” – “365”
HH	UTC hour: “00” – “23”
MM	UTC minute: “00” – “59”
<BEL>	HEX 07
<CR>	HEX 0D
<LF>	HEX 0A
<CR>	HEX 0D
<LF>	HEX 0A

### 7.2.9 String-G Time Code O/P on P4

<b>About</b>	This general time string is used predominantly in Europe.
<b>Timing</b>	The string is transmitted once every second, with the leading edge of the “start” bit of the last <ETX> exactly on the second.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	<STX>Swhhmmssddmmyy<LF><CR><ETX>
<b>Placeholder</b>	<b>Content</b>
<STX>	HEX 02
s	Clock Status (see below)
w	Day of Week (see below)
hh	hour of day: “00” – “23”
mm	minute of day: “00” – “60”
ss	seconds: “00” – “59”
dd	day of month: “01” – “31”
mm	month of year: “01” – “12”
yy	year: “10” – “99”
<LF>	HEX 0A
<CR>	HEX 0D
<ETX>	HEX 03

The s “Clock Status” is an ASCII character in the range 0-9, A-F representing a single hex digit (nibble)

Bits: 3 2 1 0

- x x x 0 No announcement for time change
- x x x 1 Announcement for time change – active for an hour before
- x x 0 x Local Standard Time (LST)
- x x 1 x Daylight Saving Time (DST)
- 0 0 x x Time/date invalid – clock is out of sync
- 0 1 x x Hold-over mode – running on local Oscillator
- 1 0 x x GPS / IRIGB controlled mode
- 1 1 x x GPS / IRIGB controlled mode (high accuracy)

The w “Day of Week” is an ASCII character in the range 1-7, 9, A-F representing a single hex digit (nibble)

Bits: 3 2 1 0

- 1 x x x UTC time
- X 0 0 1 Monday
- X 0 1 0 Tuesday
- X 0 1 1 Wednesday
- X 1 0 0 Thursday
- X 1 0 1 Friday
- X 1 1 0 Saturday
- X 1 1 1 Sunday

#### Example Interpretation:

<STX>E3123456170410<LF><CR><ETX> High Accuracy Mode, DST, Wed, 12:34:56, 17/4/2010

### 7.2.10 NMEA ZDA Time Code O/P on P4

<b>About</b>	This string is in accordance with the NMEA-0183 standard in content, but is transmitted at 9600bps.
<b>Timing</b>	Transmission is once every second. The leading edge of the “start” bit of the “\$” is exactly on the second.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	\$GPZDA,hhmmss.00,dd,mm,yyyy,s,xx,yy*CC<CR><LF>
<b>Placeholder</b>	<b>Content</b>
\$GPZDA	ASCII “\$GPZDA”
,	ASCII “,” (comma)
hh	UTC hour of day: “00” – “23”
mm	UTC minute of day: “00” – “60”
ss	UTC Seconds: “00” – “59”
.00	ASCII “.00”
dd	UTC day of month: “01” – “31” depending on which month
mm	UTC month: “01” – “12”, “01” = January
yyyy	UTC year, 4 digits.
s	Local time zone offset sign (positive means local time leads UTC)
xx	Local time zone offset from UTC in hours
yy	Local time zone offset from UTC in minutes
*	ASCII “*”
CC	2-digit hex representation of the result of XORing the 8 data bits of each character between, but not including the “\$” and “*”. (00-FF)
<CR>	HEX 0D
<LF>	HEX 0A

**Example Interpretation:**

\$GPZDA,123456.0023042010+1200\*

UTC time is 12:34:56, 23 April 2010, the local time offset is +12:00

### 7.2.11 NMEA RMC Time Code O/P on P4

<b>About</b>	This string is compatible with and defined by the NMEA-0183 standard.
<b>Timing</b>	Transmission is once every second. The leading edge of the “start” bit of the “\$” is exactly on the second.
<b>Comms</b>	9600bps, 8-bit ASCII, no parity
<b>Definition</b>	\$GPRMC,hhmmss.00,a,tt,tt.tttt,n,ggg,gg.gggg,w,0.0,0.0,DDMMYY,0.0,E*CC<CR><LF >
<b>Placeholder</b>	<b>Content</b>
\$GPZDA	ASCII “\$GPRMC”
,	ASCII “,” (comma)
hhmmss	UTC hour of day, minute of day, seconds
.	ASCII “.” (full stop)
0	ASCII “0”
a	Status: “A” = valid, “V” = invalid
tt,tt.tttt	Latitude (degrees, minutes): “00,00.0000” – “89,59.9999”
N	Latitude (north/south): “N” = north, “S” = south
ggg,gg.gggg	Longitude (degrees, minutes): “000,00.0000” – “359,59.9999”
W	Longitude (east/west): “E” = east, “W” = west
Ddmmyy	UTC day of month, month, 2-digit year:
E*	ASCII “E*”
CC	2-digit hex representation of the result of XORing the 8 data bits of each character between, but not including the “\$” and “*”.
<CR>	HEX 0D
<LF>	HEX 0A

### 7.3 Warranty Statement

Tekron International Ltd (Tekron) warrants for a period of TEN years from the date of shipment that each Product supplied shall be free of defects in material and workmanship. During this period, if the customer experiences difficulty with a product and is unable to resolve the problem by phone with Tekron Technical Support, a Return Material Authorization (RMA) will be issued. Following receipt of an RMA number, the customer is responsible for returning the product to Tekron, freight prepaid. Tekron, upon verification of warranty will, at its option, repair or replace the product in question and return it to the customer, freight prepaid. No services are handled at the customer's site under this warranty.

Tekron shall have no obligation to make repairs, or to cause replacement required through normal wear and tear or necessitated in whole or in part by catastrophe, fault or negligence of the user, improper or unauthorized use of the Product, or use of the Product in such a manner for which it was not designed, or by causes external to the Product, such as, but not limited to, power or failure of building services.

A product will not be warranted if it is an accessory not carrying the Tekron brand name. In this case, warranties are limited to the warranty provided by the original manufacturer of the accessory. Examples of such products and accessories are antennas, cables, etc.

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Warranty claims must be received by Tekron within the applicable warranty period. A replaced product, or part thereof, shall become the property of Tekron and shall be returned to Tekron at the Purchaser's expense.

A return material authorization number issued by Tekron must accompany all return material.



### **Notes**

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### **Warning**

This product has been designed to comply with the limits for a Class A digital device pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against such interference when operating in a commercial environment.