

TEKRON



TCG 01-E

TIME CODE GENERATOR

User Manual

4th Edition – Aug 2012



...because timing is everything

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1 Introduction

The TCG01-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 TCG01-E features one amplitude modulated IRIG-B output and three user-programmable outputs, including a serial port. The serial port is user-configurable to output serial strings and report event data for units fitted with event recording capability. Factory options include a choice of physical connectors: BNC, 2-pin plug, or ST Fibre. Non-fibre outputs can be ordered as TTL, RS422/485, or high voltage switching.

All TCG01-E units feature a front panel display (Figure 1) giving visual feedback about the time data being generated on the outputs. LED indicators provide “at a glance” status information.



Figure 1 – TCG01-E chassis and front panel

The optimized receiver/antenna system used by TCG01-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, TCG01-E is suited for hostile electromagnetic environments such as sub-stations and electrical switchyards. Each output of the TCG01-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 TCG01-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 TCG01-E to accept two DCLS IRIG-B signals for synchronizing purposes. Sync source selection is entirely automatic.

The TCG01-E is supplied complete with all hardware and software required for installation, including rack-mount kit, connectors, network cables, antenna cable, and antenna.

2 Front Panel



Figure 2 – TCG01-E front panel

TCG01-E features two LED indicators on the front panel (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.

IRG 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)

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

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.

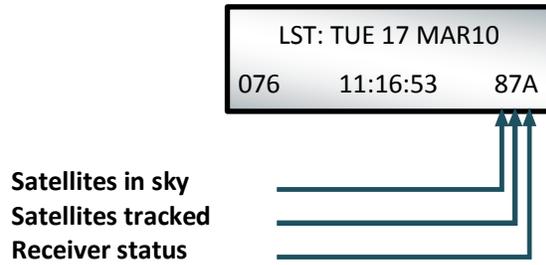


Figure 4 – Satellite tracking status

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 TCG01-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 TCG01-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"	TCG01-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. TCG01-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 Indicators

The **GPS** LED shows the status of the GPS receiver, while the **IRG** 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

An example TCG01-E back panel is shown in (Figure 5). Its appearance may vary, as different connector types can be fitted at the factory to suit your requirements.



Figure 5 – Rear panel of TCG01-E, configured with 2-pin connectors (P2 and P3)

3.1 P1: Power Input (2-pin Connector [5.08 mm])



Power is applied to the unit via this plug. Maximum steady state power consumption is 6 W, and surge protection is provided. Despite the markings on P1, the polarity of the power connection is not important and the unit is fully isolated internally from the power source. A mating connector is supplied that is suitable for wiring up to 1.5 mm².

The casing is isolated from the power supply inputs so that either (or neither) power supply polarity can be earthed to station earth.

The input voltage range is marked on the option label that is attached to the TCG01-E. Refer to (6.1) for a list of orderable ranges.



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

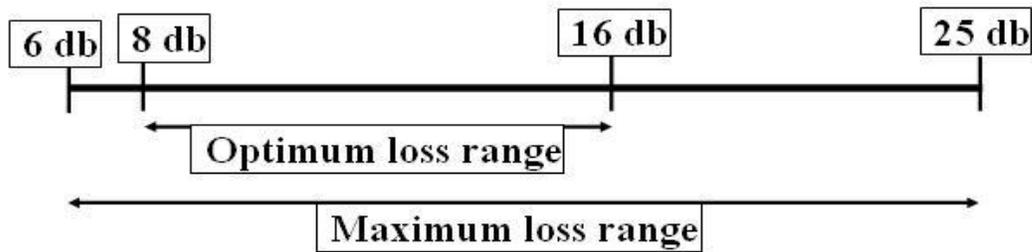
3.2 Ant: Antenna Connector (SMA Connector)



The “ant” antenna input provides an interface for an external active antenna via low-loss coaxial cable, 50 Ω impedance. 5 V DC @ 50 mA 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 35 dB, the optimum being 22 dB.

TCG01-E is normally supplied complete with a timing-optimized narrow-band antenna and 30 m of lead-in cable, this combination provides an overall gain near the optimum of 22 dB. For lead-in lengths longer than 60 m, 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 (6.3). 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 Fibre)

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. ($\lambda=820$ nm)	ST Fiber

Examples of the three connector types are given in (Figure 6) to (Figure 8).

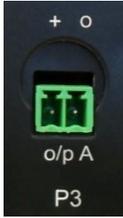


Figure 6 – 2-pin connector



Figure 7 – BNC connector



Figure 8 – Fibre 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.

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



TCG01-E is normally shipped as a DCE configuration, so that a “straight-wired” Socket-to-Socket 9-way data cable can be used to connect directly to a standard PC serial port. (A suitable 2 m cable is included with each TCG01-E.) 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 output on this port. They include:

- NGTS protocol (transmits once per minute)
- IRIG J-17
- Seven preset 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 (Serial Output Strings) 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 time-code/pulse 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 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, and:

- 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 TCG01-E's with DTE serial ports. If not specified, TCG01-E will ship with a DCE serial port.

3.5 Earth Stud (M4 Nut)



An M4 bolt (to chassis) is provided for earthing of cable shields. This is located under the serial port to the left of the P4 designator.

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.

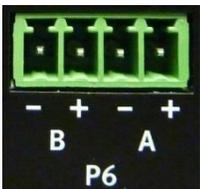
The mark/space amplitude modulation ratio is 10:3, and peak to peak output level is 8 V (max), 120 Ω impedance. The output is fully floating, and is transformer-isolated to a minimum of 2.5 kV.

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 Ω and 20 k Ω , and maximum allowable peak-to-peak level of 6 V or so. The P5 output on TCG01-E is designed to drive many of these devices all in parallel, with a terminating resistor (typically 100-180 Ω) 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: Event Recording / IRIG-B Sync Inputs (4-pin 3.81 mm Connector)



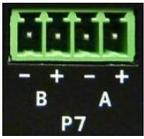
The pluggable connector provides two input channels that may be driven by TTL logic levels. Wiring size is up to 1.00 mm². The two ports are isolated from the rest of the system by a 2.5 kV barrier however the ports have limited isolation from each other.

Each input is protectively clamped to 25V and uses a 470 Ω resistor to limit the current.

The expected input is 5 V, 7 mA however; inputs up to 10 V, 20 mA may be applied.

If both event recording and IRIG-B Sync input functions are selected (5.7.3) then channel ‘A’ is the Event Input and channel ‘B’ is the IRIG-B sync input. The “+” and “-” symbols represent the positive and negative terminals respectively.

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



P7 provides two alarm output channels. Wiring size is up to 1.00 mm². 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 TCG01-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 signalling is delayed by 5 seconds

P7 B is a synchronization fail alarm. This alarm is triggered if TCG01-E is unable to synchronize to any incoming time source. TCG01-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 P6A and/or P6B inputs (P6A takes priority over P6B). 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 TCG01-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 signalled. 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 TCG01-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 **Lnk** LED indicator lights when a network cable (UTP drop lead) is correctly connected between the TCG01-E RJ45 port and the local network hub/switch or PC.

The **Lck** indicator illuminates steadily when the TCG01-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 TCG01-E unit has been optioned appropriately, time from a distant PTP master.

The bottom red and yellow LEDs have no function in the TCG01-E.

4 Installation

4.1 Identification

Each TCG01-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 TCG01-E kit is shipped with the following:

- TCG01-E time code generator
- GPS antenna optimized for stationary applications, with mounting plinth
- Antenna lead-in cable fitted with matching connectors
- 19" rack mounting plate
- Cat-5 Ethernet cable
- Configuration software

4.3 GPS Antenna and Cable Installation

4.3.1 GPS Antenna

The TCG01-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. Refer to 7.1.2 for the complete antenna specifications.

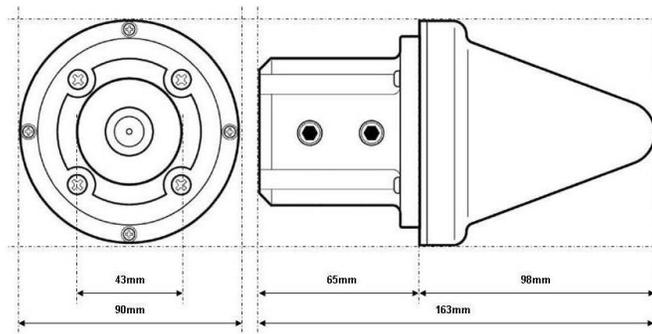


Figure 9 – Dimensions of antenna pipe-mounting plinth

The antenna pipe-mounting plinth (Figure 9) 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 (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. The mount is fixed to the pipe with two stainless steel M8 hexagon-socket setscrews (supplied).

4.3.2 Available Accessories

- Adjustable antenna mounting bracket - Refer to 7.1.2
- Antenna cable - Refer to 7.1.3
- In-line amplifier - Refer to 7.1.6
- Lightning protection kit - Refer to 7.1.7

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.

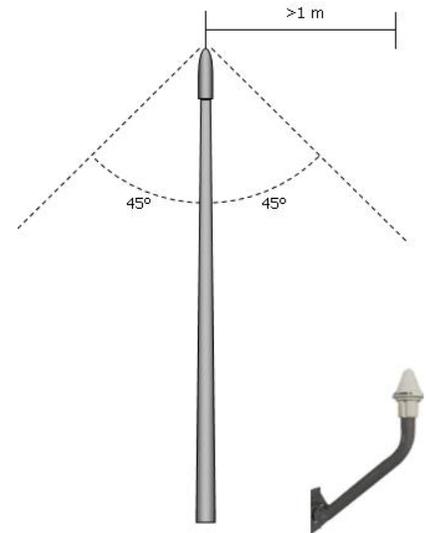
Step 1 – GPS antenna placement

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. Tekron's 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. Refer to (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

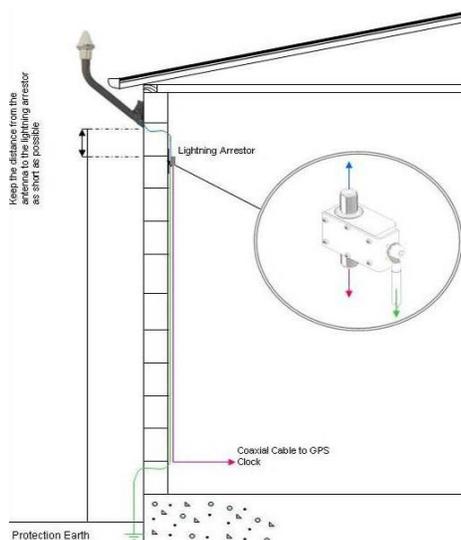
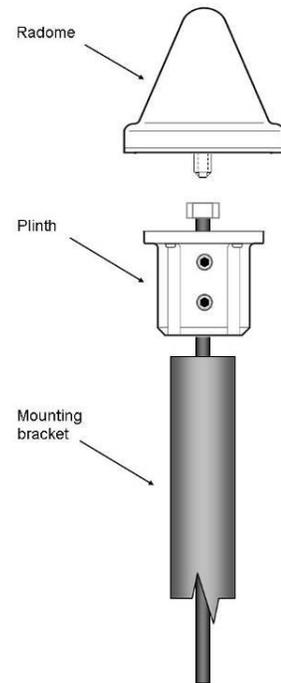
Feed the antenna cable up the mounting bracket/ pipe from the bottom end, through the plinth, and connect directly to the TNC connector on the base of the antenna. It is advisable to wrap self-amalgamating tape around the connector to seal the connection and provide protection against moisture ingress.

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 TCG01-E

The clock can be used on a bench or mounted in a 19" rack. Each unit ships with a rack-mount bracket (Figure 10).



Figure 10 – TCG01-E with rack-mount bracket

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 kilometres away from the present position will take longer but not more than 45 minutes.

4.6 Event Recording Function

4.6.1 General Description & Specification

TCG01-E clocks can provide event recording channels on each channel of **P6**. The P6 inputs A and B are TTL level inputs 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 μ 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. TCG01-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

TCG01-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, TCG01-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 TCG01-E's serial port interface. Tags are retrieved from the buffer - oldest data first.

TCG01-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 TCG01-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 TCG01-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 TCG01-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)

* 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.

Checksum: 1 byte, binary XOR over all bytes in the “Type” and “Data” fields
 Suffix: 2 bytes (ASCII <CR><LF>)

4.6.6 TCG01-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 TCG01-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 International 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 TCG01-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)

4.6.9 Pc command: Clear Time-Tag Buffer

The Pc command invokes a **Pc** response that returns the number of time-tags that were in TCG01-E's event buffer when the **Pc** command was received. The event buffer is then cleared.

Command (7 bytes [0-6]): Transmitted format: **@@Pc3<CR><LF>**
 Response (10 bytes [0-9]): Received format: **@@Pc{3 data bytes}{cs}<CR><LF>**

Byte #	Description (Data bytes only, bytes 4 - 6 in received message)
4 – 6	ASCII [000-512, 999] Number of time-tag entries in TCG01-E queue before reset.

4.6.10 Pt command: Get next Time-Tag

The Pt command invokes a **Pt** response that contains a single time-tag record – the oldest one in the data queue. Successive “Pt” commands will result in successive time tag data being retrieved. If the queue is empty, the **Pt** response is a null time tag. (ASCII [0] characters in all fields except delimiters).

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

Byte #	Description (Data bytes only, bytes 4 - 29 in received message)
4	Day of Year in ASCII, 001 to 366
7	Delimiter, ASCII [:] (hex 3A)
8 – 9	Hour of Day in ASCII, 00-23
10	Delimiter, ASCII [:] (hex 3A)
11 – 12	Minute of Hour in ASCII, 00-59
13	Delimiter, ASCII [:] (hex 3A)
14 – 15	Second of Minute in ASCII, 00-60
16	Delimiter, ASCII [.] (hex 2E)
17 – 23	Fraction of Second in ASCII (100's of nanoseconds), 0000000-9999999
24	Quality Indicator. Codes are: ASCII [space] (hex 20) if receiver locked, sub-100 ns Output accuracy ASCII [?] (hex 3F) if receiver unlocked for more than 1 minute ASCII [*] (hex 2A) if receiver in alarm mode – antenna fail
25 – 27	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.
28	Delimiter, ASCII [#] (hex 23)
29	Number of Time-Tag Channel in ASCII, 1-2

4.6.11 Pr command: Repeat last Tag Sent

The Pr command invokes a Pr response that contains a single time-tag record – the same data that was sent in response to the last Pt command.

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

Data format is identical to **Pt** data format above

5 TCG01-E Configuration Software

5.1 Introduction

Configuration software is provided on a CD with all TCG01-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 cross-over 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] "\TCG01E . This software may be run directly from the CD or be copied to a local folder. [Drive] is typically "D:"

Apply power to TCG01-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 (Figure 11) 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".

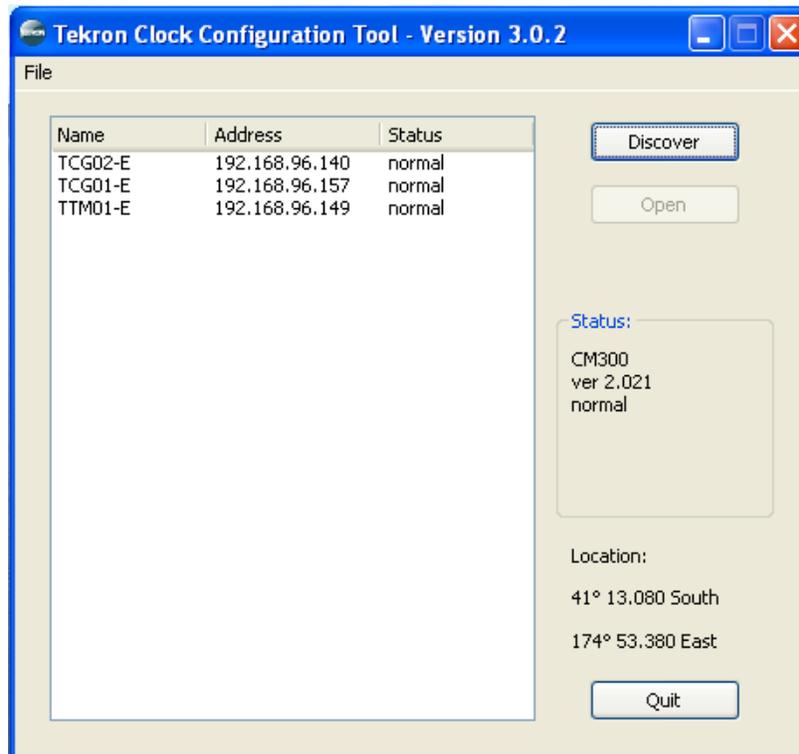


Figure 11 – Unit selection



If no units are found on the network and you are confident that the TCG01-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 (Figure 12).

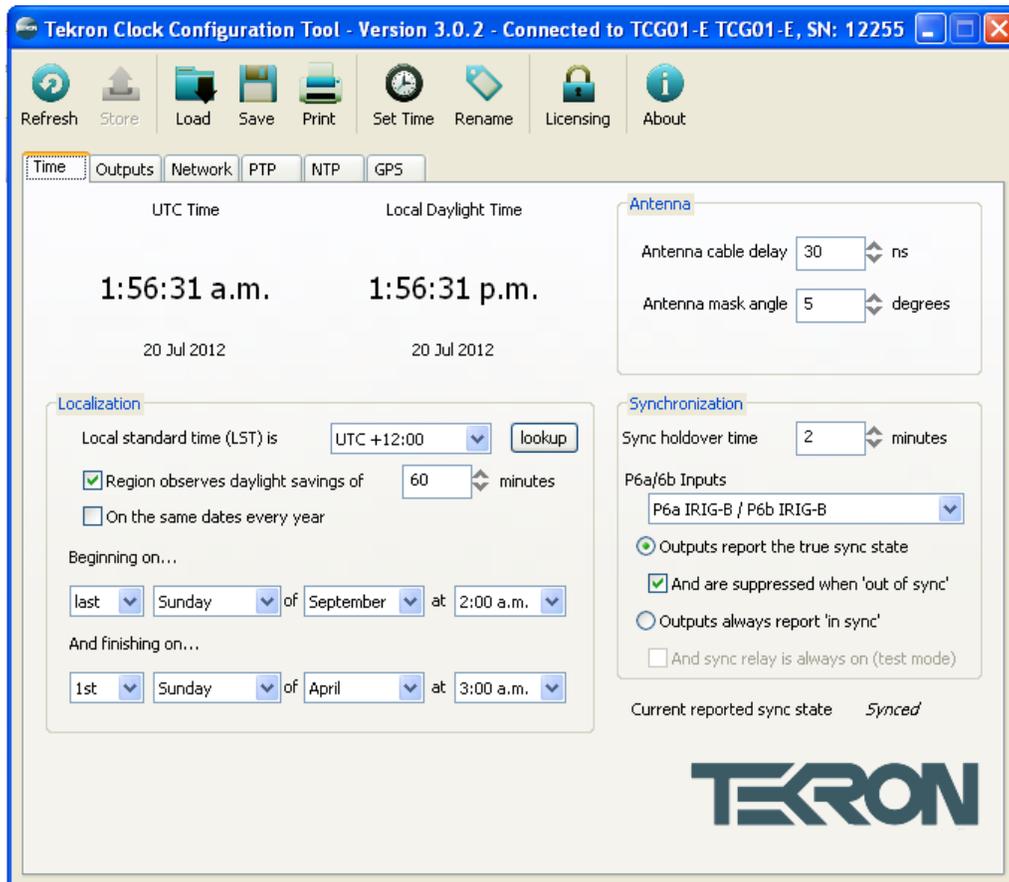


Figure 12 – Time configuration tab

5.4 Direct connection method

Run the supplied CD and locate the configuration software, which is in [Drive] "\TCG01E". This software may be run directly from the CD or be copied to a local folder. [Drive] is typically "D:".

Apply power to TCG01-E, connect the unit via an Ethernet crossover cable to a PC and run the configuration software program "TerkonConfigTool-x.x.x.x.exe". As in the case of connection via a LAN, a window will appear showing the serial number of the TCG01-E unit connected. Select the serial no of the unit and click "open" to see the "Time" tab as per (Figure 12).



If the TCG01-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 TCG01-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 TCG01-E may reset, registering a loss of sync for a brief period.



If password protection is enabled on the clock (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 TCG01-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 TCG01-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 TCG01-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 01-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

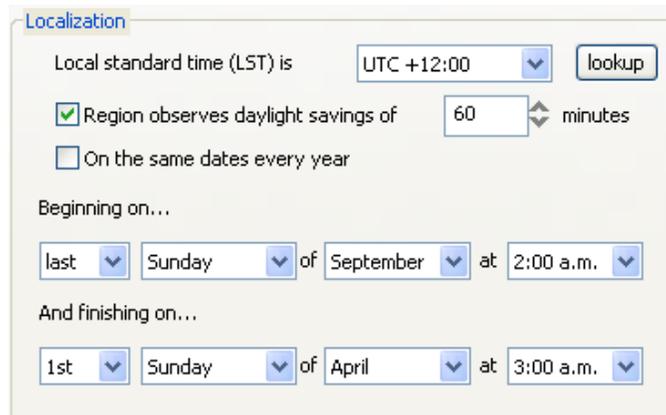


The "About" button opens a windows showing copyright information, website link and the firmware / software version numbers.

5.7 Time Tab

The "Time" tab (Figure 12) 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

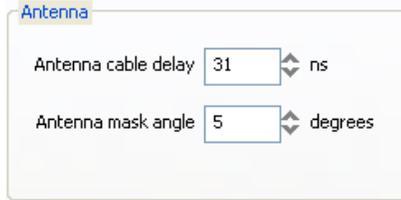
Selecting this option allows the TCG01-E to be configured to make daylight savings changes automatically.

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 ns

Antenna mask angle 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”.

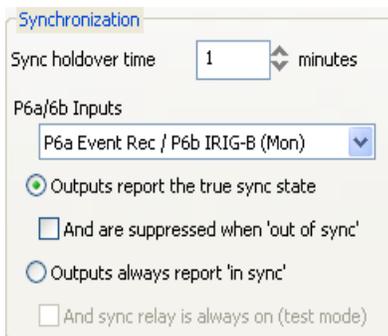
Antenna Mask Angle

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



Synchronization

Sync holdover time minutes

P6a/6b Inputs

Outputs report the true sync state

And are suppressed when 'out of sync'

Outputs always report 'in sync'

And sync relay is always on (test mode)

Sync Holdover Time

This parameter is used to control the period after loss of satellite sync that will be tolerated before TCG01-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. Output options which include sync status data report the true state of synchronization for use by connected IEDs.

And are suppressed when “out of sync”

This option suppresses TCG01-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 TCG01-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 relay always reports the true sync status.

And sync relay is always on ****

Enabling this option forces TCG01-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 TCG01-E is in this mode, the time can be arbitrarily set. This function allows the TCG01-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.**

P6 Input Function (IRIG-B / Event Recording)

This feature provides a means to monitor /control signal activity on the two input channels of **P6**. The TCG01-E clock supports both IRIG-B and event input functions on the two **P6** input lines (Figure 13). If one IRIG-B input function and one Event input function are selected, then P6A should be connected to the Event input source, and P6B 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 (2.2).

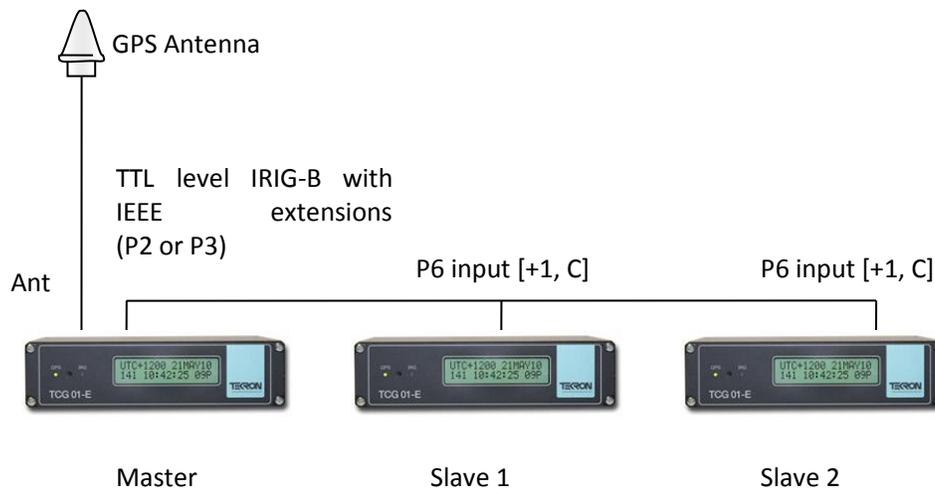


Figure 13 – Multiple Time Code Generators with one GPS antenna

5.8 Outputs Tab

The “Outputs” tab (Figure 14) enables the selection and configuration of TCG01-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 (figure 14).

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.

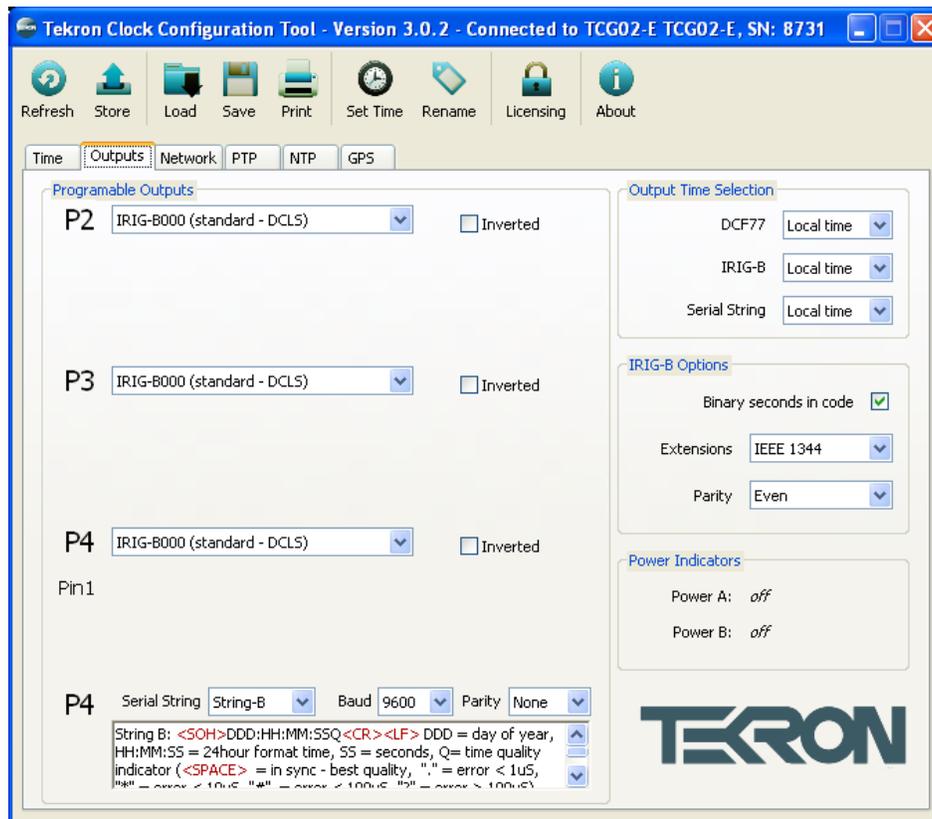


Figure 14 - Outputs configuration tab



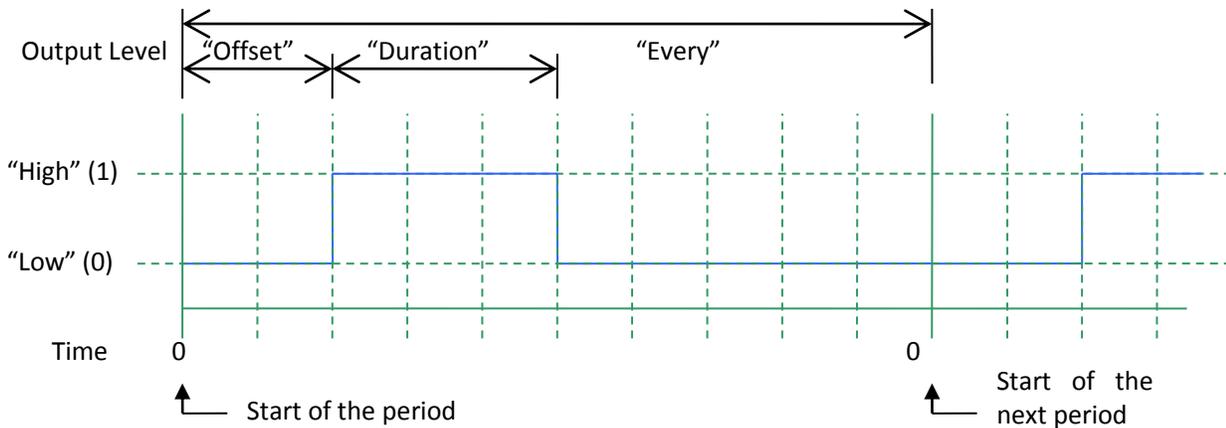
Figure 14 shows the settings for a user-defined pulse on the P4-pin 1 output. The values shown will result in a single pulse per minute. The pulse will begin 59.99 seconds after the start of the minute, and will last for 1/100th of a second (10ms). These settings of the pulse output on P4-pin 1 are normally 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 TCG01-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 (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.

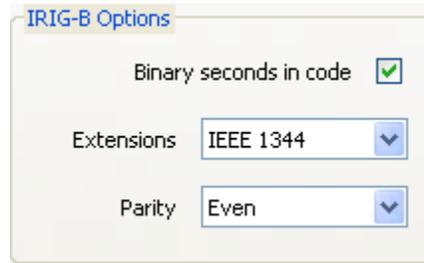


Figure 15 – IRIG-B output options

Binary seconds in code

The “Binary seconds in code” field (Figure 15) 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 16 – Output time selection

IRIG-B

When selected from the menu shown in Figure 156 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 (Figure 17).

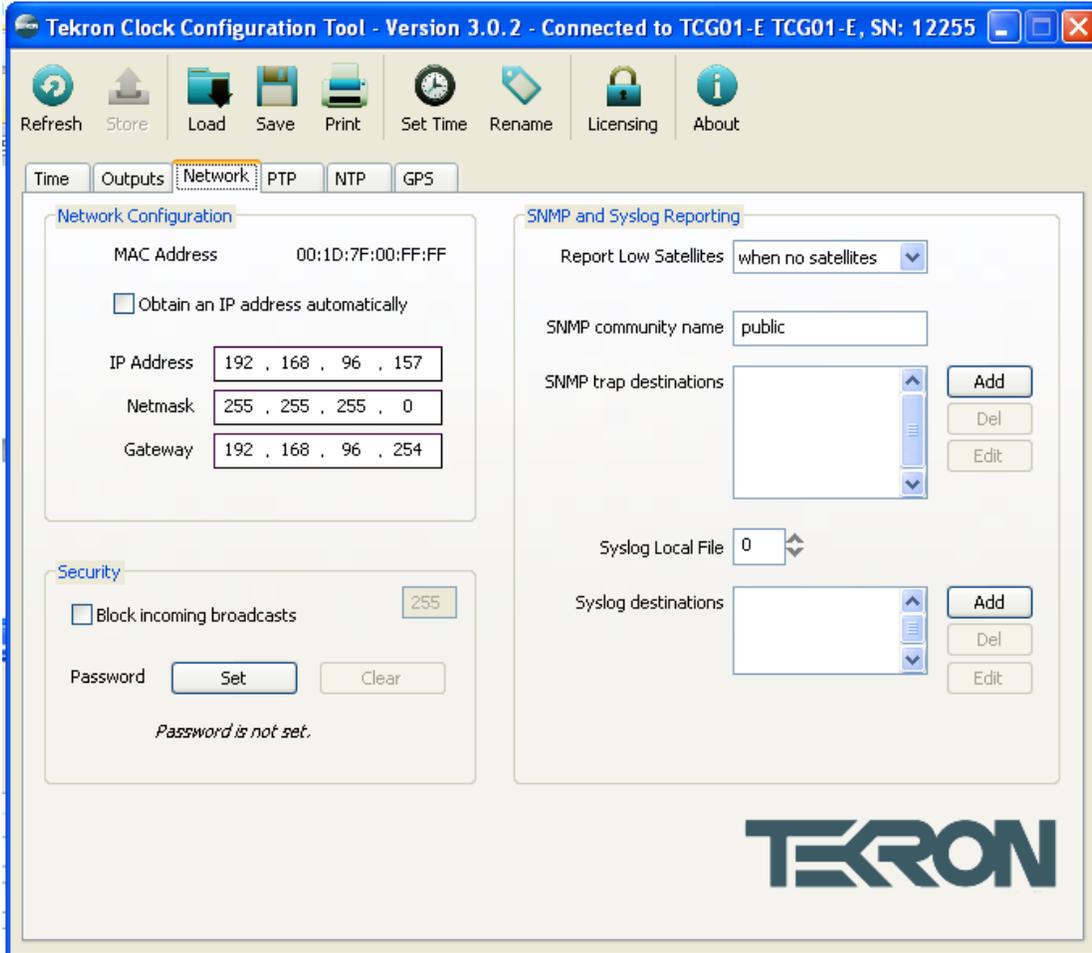


Figure 17 – Network configuration tab

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 **D**ynamic **H**ost **C**onfiguration **P**rotocol (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

Default is 255.255.255.0.

Gateway

Please refer to 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.

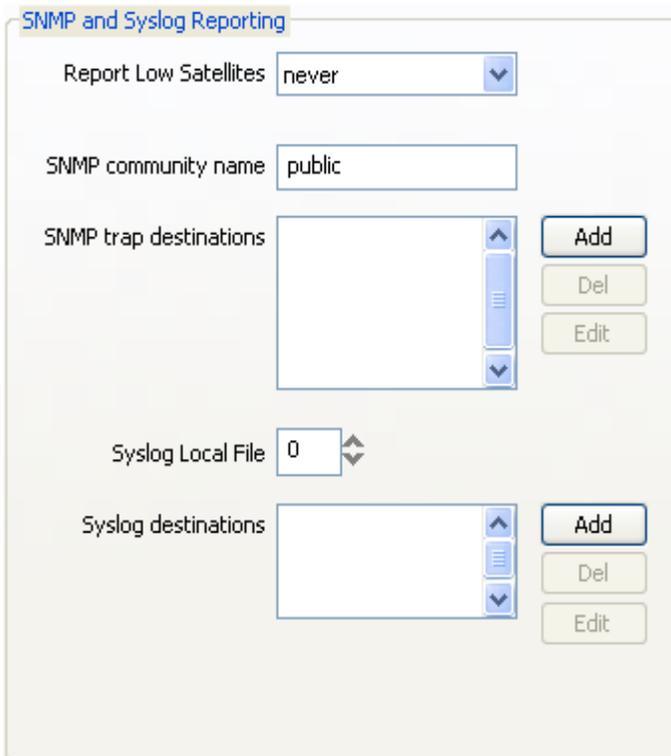
Resetting Password

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 (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 TCG01-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 TCG01-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 (Figure 18) are inactive and invisible unless NTP/SNTP or PTP options are ordered (refer to (5.6.5) for instructions on enabling an NTP or PTP license).

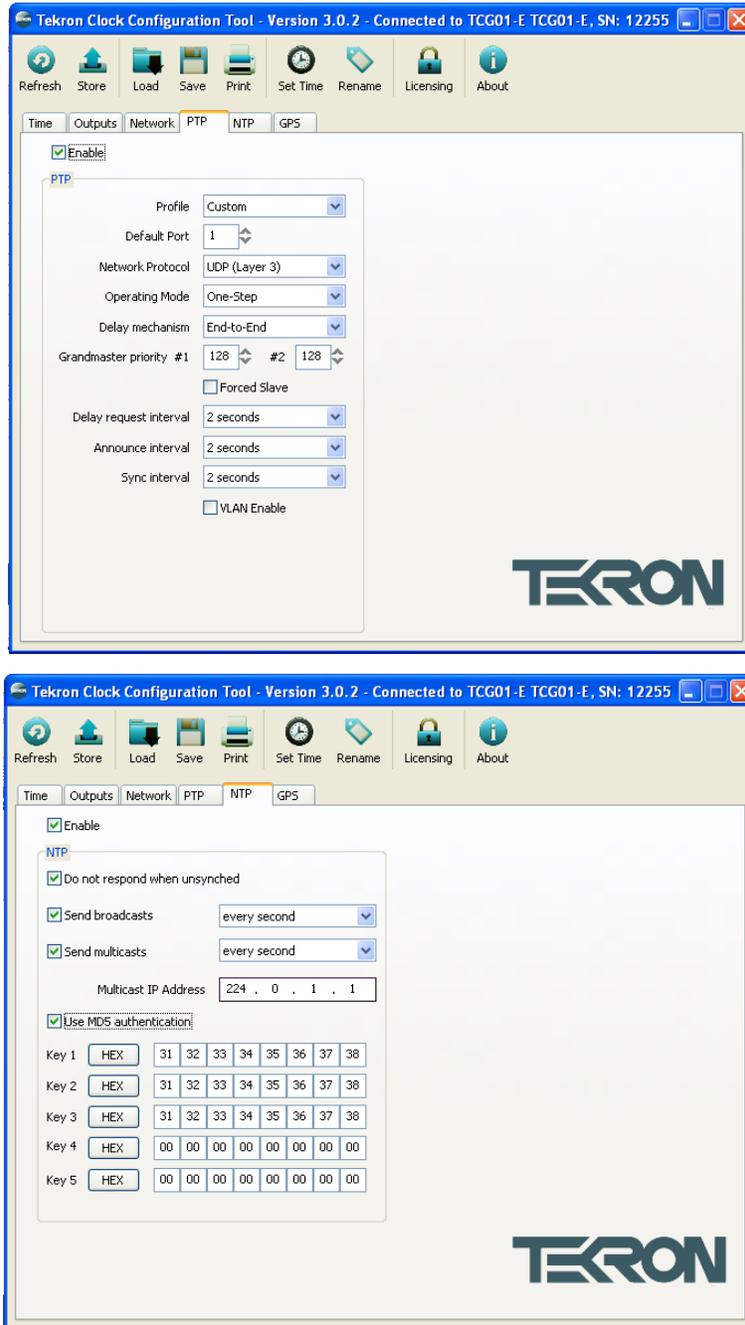


Figure 18 – PTP/NTP configuration tab

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 every second

Send multicasts every second

Multicast IP Address 224 . 0 . 1 . 1

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 sync 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 TCG01-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 centre 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 coloured 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 a minimum elevation plot obtained from Wellington, New Zealand is shown in (Figure 19). This example shows that there is poor satellite coverage in southern latitudes.



To ensure reliable performance, when operating TCG01-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.

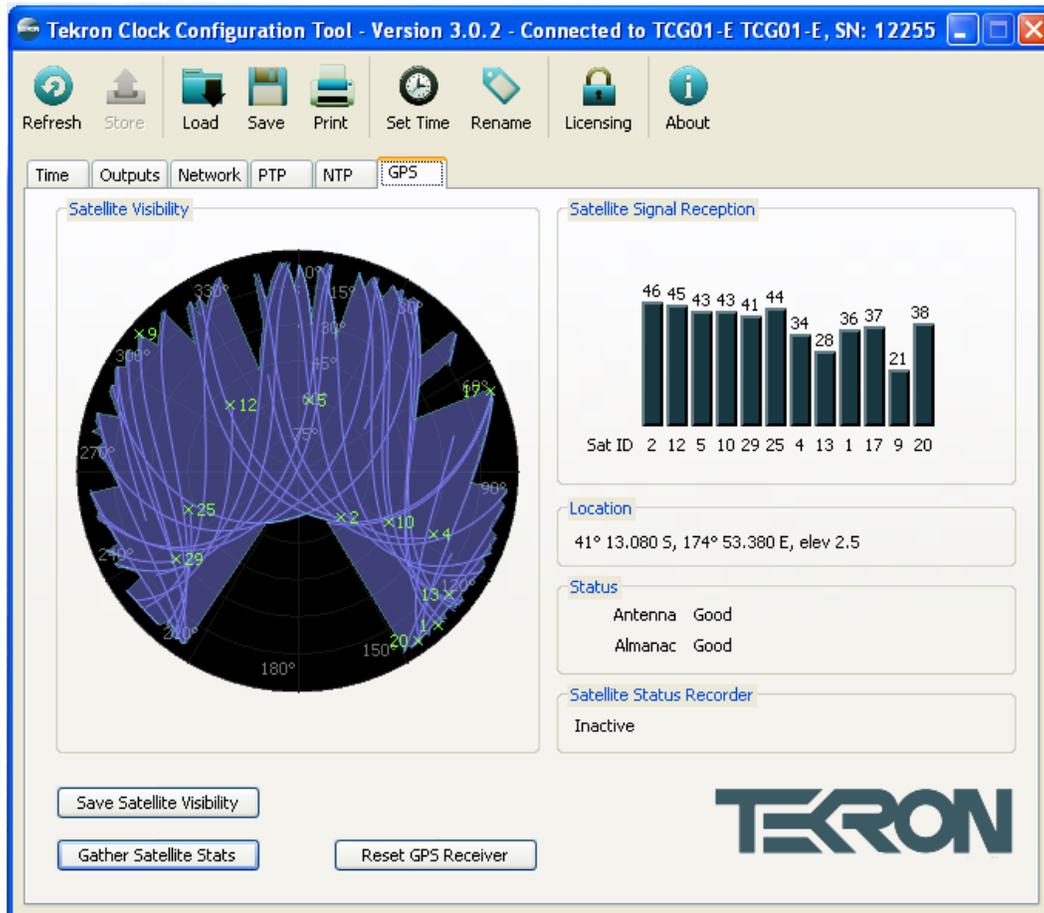


Figure 19 – GPS configuration tab showing trails and minimum elevations

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.

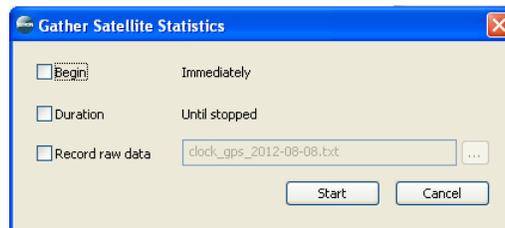


Figure 20 – Gather Statistics

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.

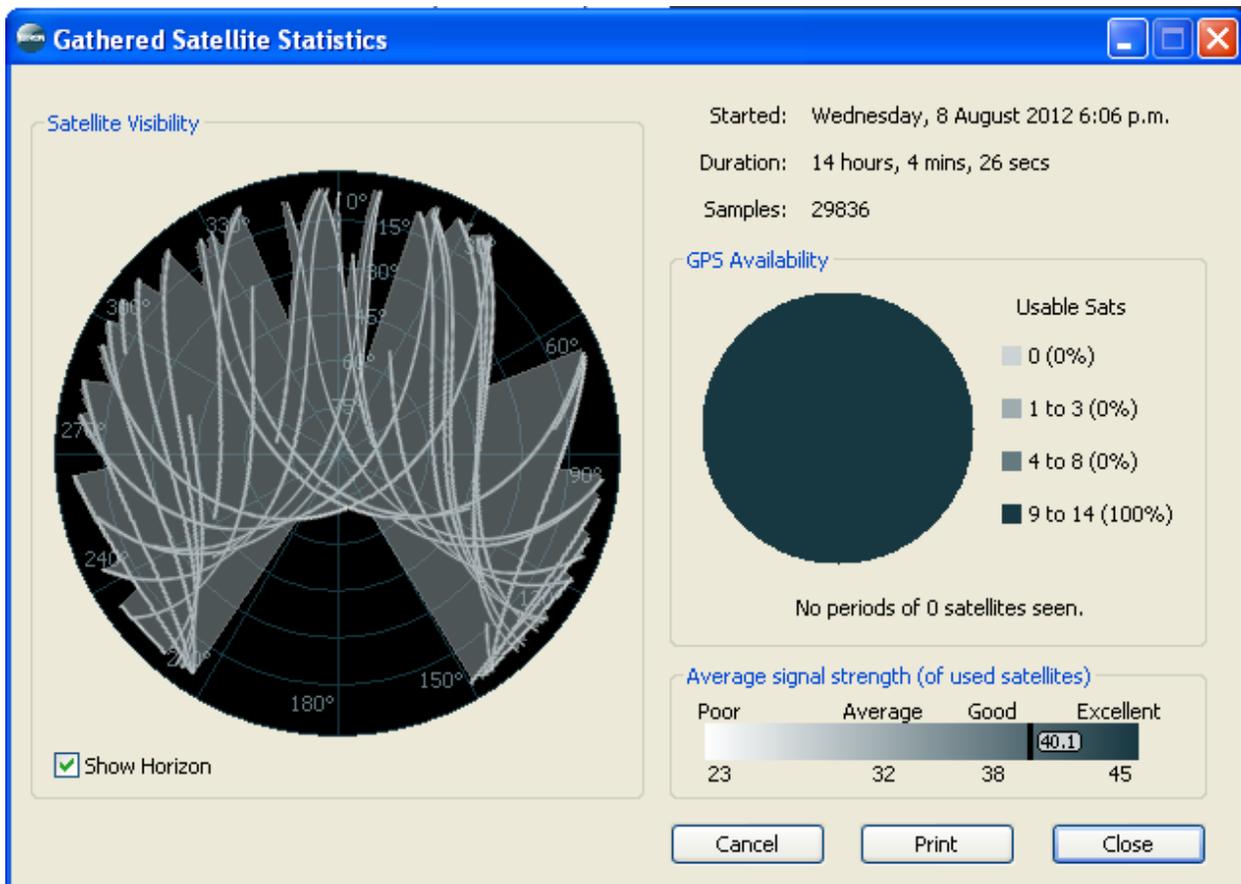


Figure 21 – Gathering satellite statistics

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.

6 Factory Hardware Options

6.1 Power Supply Options

This table shows the three different power supply configurations that may be ordered with TCG01-E.

Designator	DC Input Range
L (Low)	14-36 V DC
M (Medium)	20-72 V DC
H (High)	90-300 V DC

6.2 High Voltage (MOSFET) Output Option

TCG01-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 (Figure 22). 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 TCG01-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 TCG01-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”.

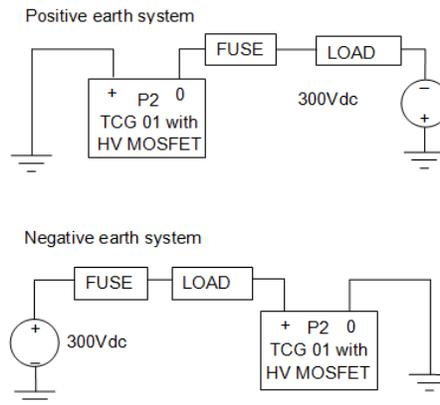


Figure 22 – High voltage MOSFET output switch option: Suggested wiring arrangements

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 – as in many utility facilities.

6.3 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 (A.6) for specifications and installation information.

6.3.1 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.

6.3.2 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

6.3.3 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.

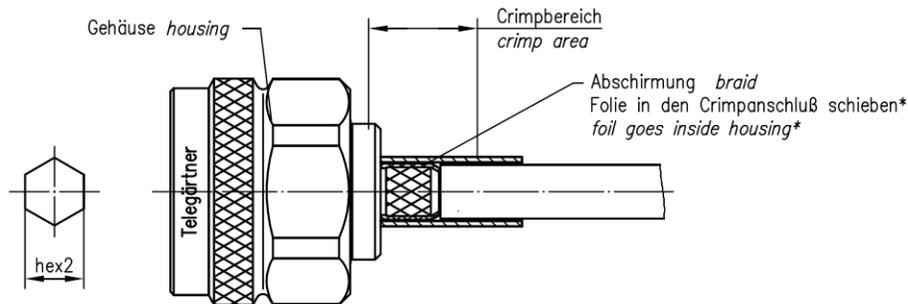
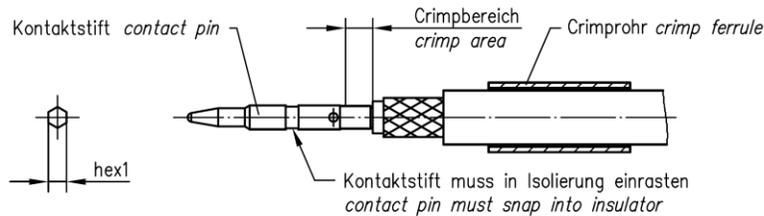
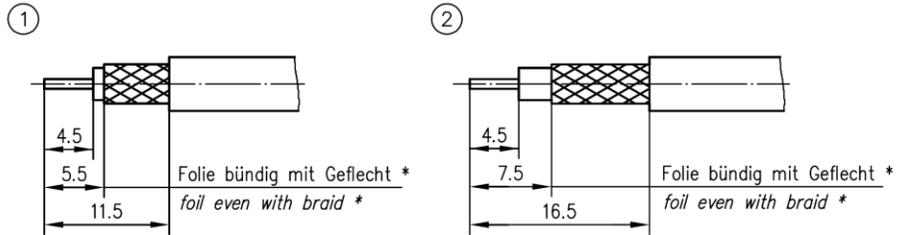


The absolute minimum bend radius for the antenna cable supplied is 40 mm, but it is preferable to use a larger bending radius if possible. One way of achieving this is by positioning the protector so that the incoming antenna cable comes through the wall about 150 mm away from the protector's connector. This provides some space to ease the incoming cable into a gentle arc back on to the connector.

The antenna cable must be cleanly cut at the appropriate point and the resulting two ends terminated with the N-type connectors provided. The connectors are then attached to the protector assembly and tightened firmly by hand. Seal each of the connections by stretch-wrapping them with the self-amalgamating tape supplied in the kit. The seal provides protection against moisture ingress, and prevents the connections from loosening over time.

Care must be taken to mount the N-type connectors to the coax cable correctly according to (Figure 23). As the GPS antenna operates at a frequency in excess of 1.5 GHz, it is **essential** that the cable be prepared **exactly** as per the drawing (use **Option 2 measurements shown** – all measurements in millimetres). A crimp tool is included in the kit – use the 0.68" die for the centre pin and the 0.256" die for the external hex housing.

Abisoliermaße *stripping instruction*



* nur für Kabel mit Folie / *only for cables with foil*

XX	Crimpeinsatz <i>crimp insert</i>	6kt.1 x Länge <i>hex1 x length</i>	6kt.2 x Länge <i>hex2 x length</i>	Abisoliermaße <i>stripping instruction</i>	
05	N01001A0005	1.69x2.5	5.41x8	①	
06	N01001A0007	1.69x2.5	6.48x8	②	

Index <i>index</i>	Änderung <i>modification</i>	Datum <i>date</i>	Name <i>name</i>
Original	A4	Blatt <i>sheet</i>	1/1

Datum <i>date</i>	Name <i>name</i>
Gez. <i>drawn</i>	29.09.00 HM
Gepr. <i>app'd</i>	11.10.00 GJ
Maßstab <i>scale</i>	2:1

**Serie N crimp
Series N crimp**

Unter- Art	TG-Nr. T00100B3300
Ersatz für/ <i>replacement for</i>	



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Figure 23 – N-type connector cable preparation and termination

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 (15mm²) for a 7-16 or 10 AWG (3.5 mm²) for an N protector.

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

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 24 – Mounting and Grounding

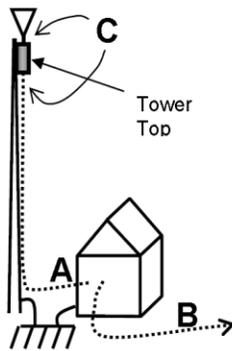
General Mounting and Grounding Instructions for Coaxial Surge Protectors

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 25 – General mounting and grounding

6.3.4 Disclaimer

TEKRON INTERNATIONAL 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

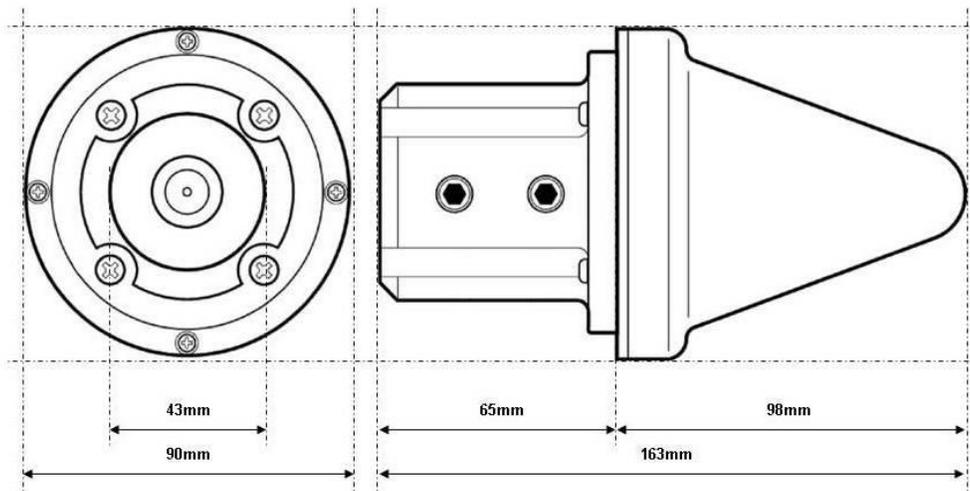


Figure 26 – Antenna pipe-mounting plinth

7.1.2 Adjustable Antenna Mounting Bracket

The steel adjustable antenna mounting bracket (Figure 27) 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.

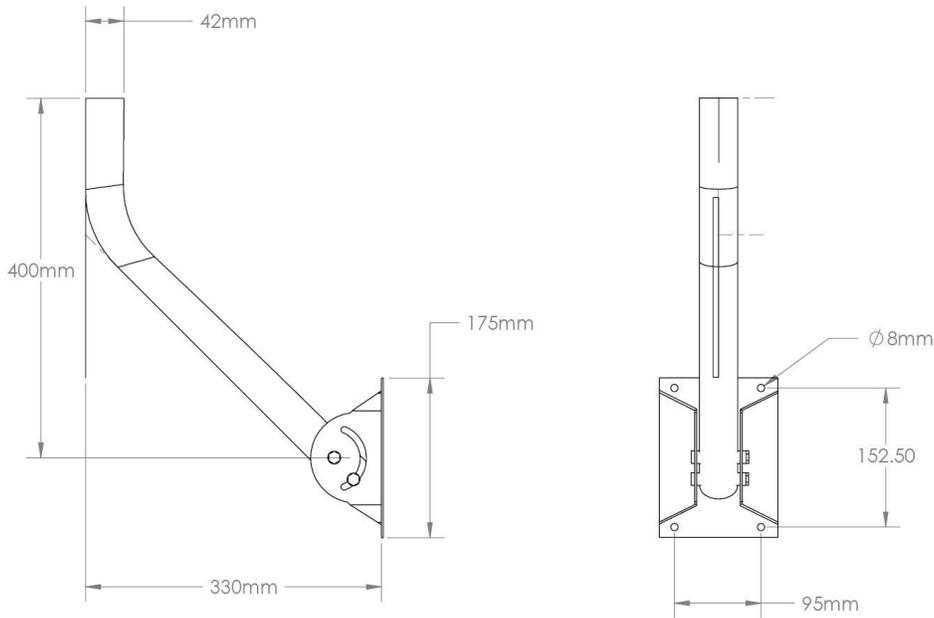


Figure 27 – Antenna mounting bracket

7.1.3 Antenna Cable

The TCG01-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 TCG01-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	
Performance Property	°C
Operating Temperature Range	-40 ~ +85°C
Electrical Specifications	
Performance Property	Metric
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 TCG01-E Unit

Physical Specifications		
Performance Property		Metric
Dimensions	Width	160 mm
	Depth	155 mm
	Height	45 mm
Weight		800 g
GPS Receiver		
L1 (1575.42 MHz) Frequency, C/A Code, 14 Channel, parallel-tracking receiver		
Performance Property		Metric
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	14 ~ 36 V DC
	Medium Voltage	20 ~ 72 V DC
	High Voltage	90 ~ 300 V DC
Power drain		6 W max

7.1.5 Isolation & Protection

All inputs and outputs feature 2.5 kV 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.

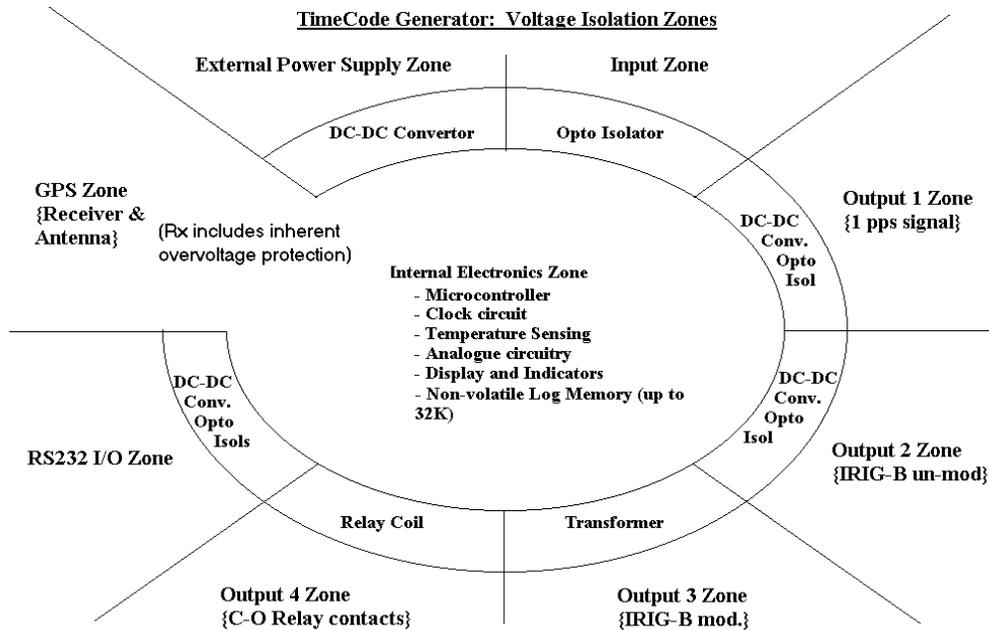


Figure 28 – TCG01-E isolation zones

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 signalling 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.

7.1.6 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		°C
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

7.1.7 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

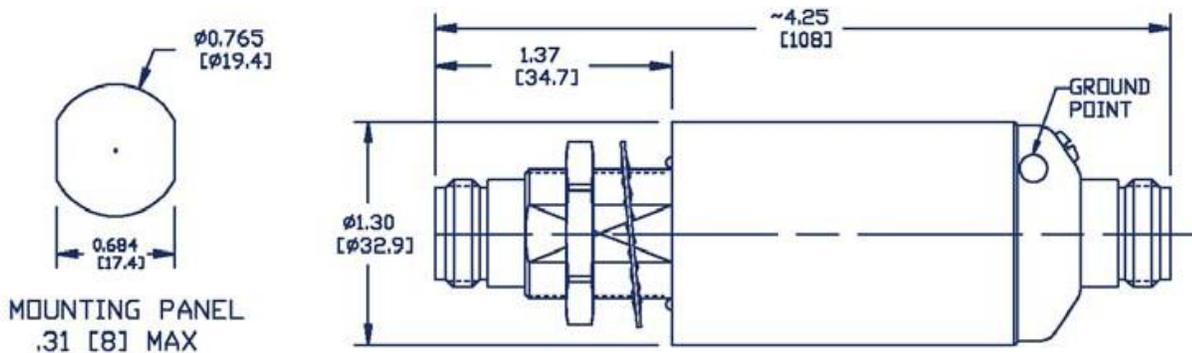


Figure 29 – Lightning arrester

7.2 Serial Output Strings

7.2.1 NGTS Time Code O/P on P4

About	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).
Timing	Transmitted once per minute. Sent during the last second before the minute rollover to which the data in the string refers.
Comms	9600bps, 8-bit ASCII, no parity
Definition	TYMMWWhhmmx<CR><LF>
Placeholder	Content
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

About	This code is compatible with IRIG Standard 212-00.
Timing	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.
Comms	9600bps, 7-bit ASCII, odd parity
Definition	<SOH>ddd:hh:mm:ss<CR><LF>
Placeholder	Content
<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

About	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.
Timing	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.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<SOH>ddd:hh:mm:ss:yy<CR><LF>
Placeholder	Content
<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

About	This code substitutes a “Quality” indicator byte for the year field, but otherwise is identical in form, function and timing to String-A.	
Timing	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.	
Comms	9600bps, 8-bit ASCII, no parity	
Definition	<SOH> DDD:hh:mm:ssQ<CR><LF>	
“Quality” Character (Q)		
	ASCII	Content
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

About	This code is effectively a combination of String-A and String B. It provides both year information and a sync indicator field.	
Timing	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.	
Comms	9600bps, 8-bit ASCII, no parity	
Definition	<CR><LF>Q★yy★ddd★hh★mm★ss.000★ ★ ★	
Placeholder		
	Content	
<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

About	This provides time, year information, and a sync indicator field.
Timing	The string is transmitted once every second, with the leading edge of the “start” bit of the <CR> exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<SOH>yyyy:ddd:hh:mm:ssQ<CR><LF>
Placeholder	Content
<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

About	This string complies with the protocol required to drive Vorne type Time Displays.
Timing	The string is transmitted once every second, with the leading edge of the “start” bit of the last <BEL> exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<CR><LF>1100<CR><LF>44hhmmss<CR><LF>54ddd<CR><LF> <CR><LF>45HHMMss<CR><LF>55DDD<CR><LF><BEL>
Placeholder	Content
<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

About	This general time string is used predominantly in Europe.
Timing	The string is transmitted once every second, with the leading edge of the “start” bit of the last <ETX> exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	<STX>Swhhmmssddmmy<LF><CR><ETX>
Placeholder	Content
<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

About	This string is in accordance with the NMEA-0183 standard in content, but is transmitted at 9600bps.
Timing	Transmission is once every second. The leading edge of the “start” bit of the “\$” is exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	\$GPZDA,hhmmss.00,dd,mm,yyyy,s,xx,yy*CC<CR><LF>
Placeholder	Content
\$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

About	This string is compatible with and defined by the NMEA-0183 standard.
Timing	Transmission is once every second. The leading edge of the “start” bit of the “\$” is exactly on the second.
Comms	9600bps, 8-bit ASCII, no parity
Definition	\$GPRMC,hhmmss.00,a,tt,tt.tttt,n,ggg,gg.gggg,w,0.0,0.0,DDMMYY,0.0,E*CC<CR><LF >
Placeholder	Content
\$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

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