# TCG 02-G

## USER MANUAL

## Contents

# 1. INTRODUCTION

Welcome to the TCG 02-G user manual! This document contains everything you need to know about the key features, hardware, and installation process of the TCG 02-G.

## 1.1 Product Overview

The TCG 02-G 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.

## 1.2 Hardware

The TCG 02-G features one amplitude modulated (AM) IRIG-B output, four amplitude modulated/unmodulated IRIG-B outputs, three programmable outputs, and a user configurable serial port for outputting serial strings and event reporting data.

Factory options include a choice of output connectors: BNC, 2-pin plug, or ST Fiber. Non-fiber outputs that can be ordered are TTL, RS422/485, or high voltage switching.

All TCG 02-G 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 – TCG 02-G chassis and front panel

The optimized receiver/antenna system used by TCG 02-G obtains time with near-atomic clock precision from the available Global Navigation Satellite Systems (GNSS). The result is output timing accuracy similar to that normally seen only in laboratory instruments.

However, unlike laboratory instruments, the TCG 02-G is suited for hostile electromagnetic environments such as sub-stations and electrical switchyards. Each output of the TCG 02-G 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. In addition, isolation protects the internal electronics from longitudinal transient voltages and transient suppression devices protect from transverse transient voltages.

## 1.3 Configuration

The TCG 02-G features a 10/100 Mbps Ethernet port through which the unit can be configured. Firmware license options include a stratum 1 NTP server and IEEE 1588-2008 functionality. When the IEEE 1588 (PTPv2) option is enabled, the unit can operate as a PTP grandmaster, an ordinary PTP clock, or a slave-only clock.

## 1.3 Accessories

The TCG 02-G comes complete with Ethernet cables to allow for customization and easy setup from the Windows™ Configuration software which is available to download from www.support.tekron.com

Optional accessories include antenna, low loss antenna cable, antenna pipe mounting components and lightning protection kit.

## 2. FRONT PANEL


Figure 2 – TCG 02-G front panel

TCG 02-G features two LED indicators on the front panel (Figure 2), together with a 2-line by 16-character backlit LCD display.

**SYN LED:** This LED shows the status of the current sync source.

**ALM LED:** This LED shows the alarm status of the TCG 02-G.

### LCD Display

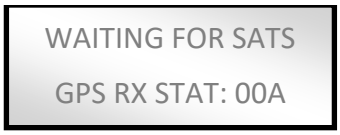
On initial power-up, the LCD display shows a copyright message, along with the serial number and firmware version of the unit (Figure 3).

After power-up, if the TCG 02-G is configured to operate in its default mode (GNSS synchronized), the display changes automatically to indicate that it is waiting for satellites (Figure 4).

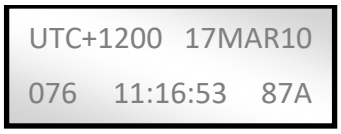
Once one or more satellites have been discovered, it transitions to the operating default display (Figure 5).

Figures 6 and 7 show alternative time displays that the user can access by pressing the button on the front panel between the LED indicators. Successive button presses can be used to cycle through all the display screens in turn. Examples of the display screens are shown below.


3 – Start Up (Clock ID)




4 – Waiting for Satellites

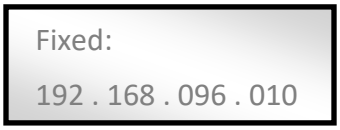



5 – Operating Default


6 – Local Time


7 – UTC Time


8 – Alarm




9 – IP Address

"UTC" is short for Coordinated Universal Time (approximately equivalent to GMT). The top line of the screen in Figure 5 shows the clock's current local time offset from UTC (hours and minutes), together with the local date. The local time day-of-year and time-of-day are on the bottom line.

Figure 5 shows that the clock is operating with a local time offset of 12 hours ahead of UTC. The local date is the 17th of March 2010, and the local time is 11:16:53 in the morning.

Figure 6 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 6 changes to "LDT", denoting Local Daylight Time.

Figure 7 shows the UTC time and date which is 11:16:53 on the evening of Monday the 17th of March 2010.

Figure 8 shows that an antenna current low alarm is active. All active alarms will be displayed in the same way. Up to three alarms can be displayed simultaneously. If more than three alarms are active, only the three highest priority alarms will be shown. Refer to Table 5 below for a description of all possible alarms.

Figure 9 shows the IP address of the ADMIN/ETH1 network port. In this example, it shows the port has been configured with a fixed/static IP address of 192.168.96.10.

The display screens in Figures 4, 5, 6, 7, and 8 each show a three-character status field at the bottom right-hand side of the display. This three-character field provides feedback on the parameters that affect the operation of the GNSS receiver. These are explained in Figure 10.

When the TCG 02-G is synchronized to a source other than GNSS, this field directly indicates the alternate sync source being used by the TCG 02-G. Table 2 shows the alternate sync sources supported by the TCG 02-G.

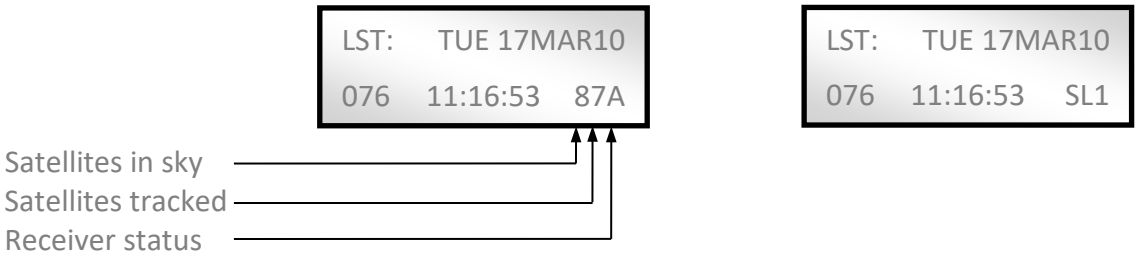



Figure 10 – Satellite tracking status

| Character | Values | Description |
|---|---|---|
| Satellites in the sky | "0 - 9": 0 - 9<br>"A - E": 10-14<br>"F": >14 | This character represents the total number of satellites currently present in the sky according to the GNSS almanac.<br>"0" in this position means that TCG 02-G has lost its knowledge of the GNSS satellites' orbit geometries. This occurs if the unit has been in storage for an extended period, or if the GNSS receiver has been reset.<br>It will typically take 20 minutes (worst case two hours) for the unit to gain sufficient GNSS synchronization for the TCG 02-G to recommence normal operation (position hold). |
| Satellites tracked | "0 - 9": 0 - 9<br>"A - E": 10-14<br>"F": > 14 | This digit represents the number of satellites currently being used to compute the time solution.<br>A "0" value means that no updated time solution is available ("out of lock" condition).<br>If this condition persists for the "Holdover" time the clock will indicate the "out of sync" condition. |
| Receiver status | "A" | TCG 02-G is in Acquiring mode - attempting to get satellite fixes. |
| | "G" | "Poor satellite geometry": Satellites are positioned in almost a straight line, so the best accuracy cannot be obtained, but the unit will still sync to UTC. |

| Character | Values | Description |
|---|---|---|
| | “S” | Site Survey in progress. The TCG 02-G is calculating an accurate position; once complete the mode will change to Position hold. |
| | “P” | “Position hold”: Position is known accurately, and the GNSS reference is providing its most accurate time, typically better than 40 ns to UTC. |

Table 1 – GNSS Status

| Character | Values | Description |
|---|---|---|
| Alternate Sync Source | “SL1” | The TCG 02-G is synchronized to an IRIG-B source on its P9 input “Slave: copper 1” |
| | “SL2” | The TCG 02-G is synchronized to an IRIG-B source on its P10 input “Slave: copper 2”. |
| | “SLF” | The TCG 02-G is synchronized to an IRIG-B source on the Fiber input “Slave: Fiber”. This sync source only exists for the “Fiber Slave” variant of the TCG 02-G, which has an ST Fiber input in place of the antenna connector. |
| | “PTP” | The TCG 02-G is synchronized to a Precision Time Protocol (PTP) master clock. |
| | “NTP” | The TCG 02-G is synchronized to a Network Time Protocol (NTP) server. |
| | “TST” | The TCG 02-G is operating with a manually set time (Test Mode). Please refer to the configuration tool’s “Set Time” function for further details. |

Table 2 – Alternative Sync Source

**If the TCG 02-G is configured with GNSS disabled, or is a “Fiber Slave” variant, then “SL?” will be displayed in the status field if there is no available IRIG-B, PTP, or NTP source.**

### Contrast Adjustment Mode

The LCD contrast can be adjusted by entering the Contrast Adjustment Mode. This mode is entered by double pressing the button on the front panel.

Once in Contrast Adjustment Mode, pressing the button will lighten the contrast and decrease the contrast by one level. There are five different contrast levels and the LCD will cycle from the lightest to darkest if the button is pressed when on the lightest setting.

To exit the Contrast Adjustment Mode, simply double-press the button on the front panel again. The button will return to normal operations after this.

## LED Indicators

The **SYN LED** shows the status of the sync source. The various states are shown as follows:

| State | Description |
|---|---|
| off | The TCG 02-G has no power |
| on | The TCG 02-G is synchronized to the source indicated by the LCD display |
| Slow Flash (1 per second) | The TCG 02-G is operating in the “holdover” state (holdover timer running) |
| Fast Flash (5 per second) | The TCG 02-G is not synchronized. “Out of Sync” condition |

Table 3 – SYN LED

The ALM LED indicates the internal alarm status of the TCG 02-G. It has only two operating states:

| State | Description |
|---|---|
| Off | The TCG 02-G is operating normally. i.e., there are no alarms. |
| Fast Flash (5 per second) | Alarms are active. In this case, the actual alarm state is shown on the top line of the LCD display, replacing the normal date information (see example in Figure 8 above). |

Table 4 – ALM LED

## Alarm Messages

When an alarm condition is active, a four-character message is shown on the top line of the LCD, replacing the normal date information (see example in  above). The possible alarm messages are shown below:

| LCD Alarm | Alarm Name | Specification |
|---|---|---|
| PwrA | No Power A | The TCG 02-G is fitted with dual redundant power supplies, and power to input P1A has failed or is not present. |
| PwrB | No Power B | The TCG 02-G is fitted with dual redundant power supplies, and power to input P1B has failed or is not present. |
| Sats | Satellites Low | The number of satellites currently being used for time and position calculations is below the threshold. |
| Hold | Holdover | The TCG 02-G is operating in the “holdover” state (Holdover timer running). |
| Sync | No Sync | The TCG 02-G is not synchronised to any source and holdover period has expired. |
| AntL | No Antenna | The antenna circuit current drain is low (typically under 3mA). This could be caused by poor connections, or if the connected antenna has a lower current drain specification or if a component in the antenna system is providing power to the antenna and therefore the clock is not seeing a connected load. |
| AntH | Antenna Short | The antenna circuit current drain is high (typically over 100 mA). This is caused by a short in the antenna circuit, or by moisture ingress in the circuit, or if the antenna connected has a higher current draw specification. |
| IRIG | No IRIG-B Input | IRIG-B monitoring is enabled on the P9 and/or P10 input, and a valid IRIG-B signal is not present on that input. |
| IPe1 | IPv4 Address Fault on ETH1 | The clock has failed to obtain an IPv4 address via DHCP, or has detected an IP address conflict, and has adopted an ARP tested Link-Local address (169.254.xxx.xxx).<br>When this alarm occurs, the user may need to update their network adapter settings to a Link-Local address to gain access to the clock.<br>The alarm will persist until the IPv4 address settings are changed or the clock is connected to a DHCP enabled network. |

| | | |
|---|---|---|
| IPe2 | IPv4 Address Fault on ETH2 | As above, but for the ETH2 Ethernet port, on TCG 02-G units fitted with a second Ethernet port. |
| FRP Armed Press Again to Disarm | Factory Reset Procedure (FRP) Armed | This message appears on the LCD, in place of all other text, when the Factory Reset Procedure is initiated by the user. The Factory Reset Procedure is used to reset the TCG 02-G to factory default settings in the case of a lost or forgotten administrator password, or configuration error that renders the TCG 02-G inaccessible. Refer to the Tekron Configuration Tool Manual for further information. |

Table 5 – Alarm Messages

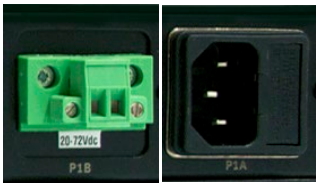
## 3. BACK PANEL

Examples of the TCG 02-G back panels are shown in Figure 11 and Figure 12. Their appearance may vary, as different configuration connector types can be fitted at the factory to suit your requirements.


Figure 11 – Rear panel of TCG 02-G, with no expansion module and a 2-pin power connector


Figure 12 – Rear panel of TCG 02-G, with IEC-320 power connectors and BNC and Fiber outputs (P2 and P3)

### P1A/B: Power Input




Power is applied to the unit via **P1A** and/or **P1B** (when fitted). A 5.08 mm, 2-pin screw lock connector (shown to the left) is used for low voltage (LV), medium voltage (MV) or high voltage (HV) DC inputs, while the IEC-320 power connectors (shown to the right) are used for HV AC.

The TCG 02-G can be ordered with HV AC supplies and/or HV/MV/LV DC supplies, or a combination.

The polarity of DC power sources is not important as both the unit and case are isolated from the supply inputs.

The power supplies are fully redundant so if either of the power supplies fails the clock will remain operational provided the other power supply remains powered.

The maximum steady state power consumption is 12 W (24 W if fitted with advanced oscillator option), and surge protection is provided.

The power supply inputs are isolated from earth so that any earthing system is acceptable (PEN, positive earth, negative earth or non-earthed low voltage supply). The earth pins in IEC-320 connectors, if fitted, are connected to the unit's case.

**Check the label on the side of the unit for power supply voltage ratings before powering the unit.**

**If IEC connectors are used, then a 1 A, 250 Vac 5x20 mm glass or ceramic slow blow fuse should be fitted into the IEC connector.**

**If 2-pin connectors are used, then a 5 A fuse of appropriate voltage rating should be fitted into the non-earthed power supply line.**

**NOTE: The fuse working voltage should be greater than the supply voltage.**

**Note: The DC input is protected against an incorrect power supply polarity.**

The power supply has an internal fuse rated at 4 A, 300 Vac/dc in the positive supply to protect the unit. If the fuse blows, the unit should be returned for a service to verify that its power supply isn't faulty.

## Earth Stud: M4 Nut

Two M4 bolts are provided for earthing. They are located on the rear panel to the left of P7 and on top of P1 and P2. An external ground connection must be connected to ensure appropriate grounding for the unit. This provides a safe discharge path in the event of a short circuit or high voltage transient.

# 4. BACK PANEL – INPUTS AND OUTPUTS

## ANT: Antenna Connector (SMA Connector)


The “ANT” port is the GNSS antenna input port. The antenna port provides an interface for an external active antenna via low-loss coaxial cable.

A 50 Ω impedance cable should be used with the port.

5 V DC at 50 mA max is supplied to power an active antenna.

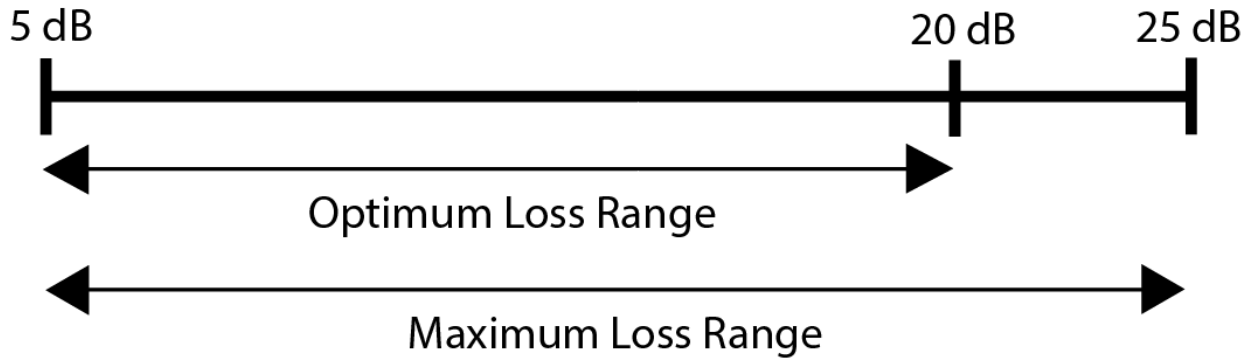
If the Fiber Slave option is ordered, the antenna is replaced by a fiber input port.

**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! Ensure the antenna SMA male connector center pin is straight before plugging in.**

### Antenna Cable Considerations

The Tekron antenna port expects a signal with at least 15 dB of gain, and no more than 35 dB of gain, with 20-35 dB being the optimal gain range.

The Tekron supplied antenna delivers 40 dB of gain into the antenna cable, hence the loss of the antenna cable in the installation should fall within the ranges specified below.




**Note**: The above figures are based on an average GNSS signal strength of -130dBm at sea level, and they assume that the Tekron supplied antenna is used (the Tekron supplied antenna is recommended).

| | |
|---|---|
| CNT-240 | 32.8 dB/100 m (10dB/100ft). Plus 1 dB/connector<br>Approximate optimum length range: 15 to 60 meters<br>Approximate maximum length range: 15 to 76 meters |
| CNT-400 | 16.73 dB/100 m. Plus 1 dB/connector<br>Approximate optimum length range: 30 to 120 meters<br>Approximate maximum length range: 30 to 150 meters |

A lightning protection device should 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. The introduction of the lightning protector introduces an additional loss of 0.1 dB, and approximately 2 dB of connector loss.

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

### 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 differential) 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, 100 mA max. The port is fully floating and has independent electrical isolation to 2.5 kV. Refer to Figure 18 for suggested wiring configurations for use with Power MOSFET switching. | 2-pin |
| Fiber | ST fiber transmitters, compatible with ST-terminated multi-mode fiber optic cabling. (λ=820 nm). | ST Fiber |

Examples of the three connector types are given in (**Figure 13**) to (**Figure 15**);




**Figure 13 – 2-pin connector** **Figure 14 – BNC connector** **Figure 15 – Fiber connector**

If an output is not being used, it may be left unconnected. The dust cap should remain in place on unused fiber connectors.

### P2, P3 Programmable Output Options

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

- A configurable number of pulses per second, minute, hour, or day with adjustable pulse width and offset.
- IRIG-B time code (unmodulated DCLS or modified Manchester) with optional IEEE C37.118.1 or AFNOR NF S87-500 extensions.
- Simulated DCF77 receiver time code.

Refer to the Tekron Configuration Tool Manual for further information.

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


The TCG 02-G is normally shipped with a DCE configuration on P4, so that a "straight-wired" socket-to-socket 9-way data cable can be used to connect it directly to a standard PC serial port.

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 connector!**

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 and Pin 6: RS422 level (-5V to +5V) differential programmable output (same content as Pin 1).
- Pin 8 and Pin 9: RS422 level serial string (same content as Pin 2).

The RS232/RS422 signal lines are not isolated from each other, but the port as a whole is isolated to a level of 2.5 kV from all other ports.

Any P4 pins that are not being used may be left unconnected.

### 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 bps). The default message format operates 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 (IRIG Standard 212 Format J-1x)
- Eight pre-set messages, Tekron Strings A – H for compatibility with most IEDs.
- NMEA ZDA and RMC messages
- GNSS binary/raw messages, these are subject to change without notice.

See Appendix (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. 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).

### 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, or day with adjustable pulse width and offset.
- IRIG-B time code (unmodulated DCLS or modified Manchester) with optional IEEE C37.118.1 or AFNOR NF S87-500 extensions.
- Simulated DCF77 receiver time code.

Refer to the Tekron Configuration Tool Manual for further information.

**P4 pin 1 is not available on TCG 02-G with DTE serial port. If not specified, TCG 02-G will ship with a DCE serial port.**

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


**P5** provides AM IRIG-B (B12x[1]) over a BNC connector. This output is not programmable for other types of signal and a 1 kHz carrier is present whenever the unit is powered. The particular IRIG-B data content is as configured by the Tekron Configuration Tool program.

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

The mark/space amplitude modulation ratio is 3:1, and peak to peak output level is 8 V (max), 120 Ω impedance. The output is fully floating, and is transformer-isolated to 3.75 kV.

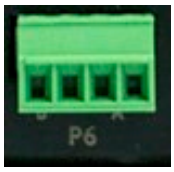
If the P5 output is not being used, it may be left unconnected.

**Most devices with amplitude-modulated IRIG-B time sync inputs have an input impedance of between 4 kΩ and 20 kΩ, and maximum allowable peak-to-peak level of 6 V or so. The P5 output on the TCG 02-G is designed to drive multiple devices 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 configuration, P5 can drive at least 20, and typically 30 or more devices (dependent upon layout, device input impedance, etc.) without any external amplification. The terminating resistor is essential to ensure good noise immunity and correct voltage levels.**

[1] Refer to Appendix – Port Specifications

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




The pluggable connector 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).

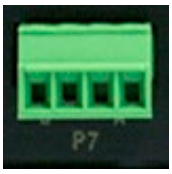
**Note:** the "*Normally-Open*" descriptor refers to the *de-energized* state of the relay.

The TCG 02-G operates with 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 will default to the "alarm" state (open contact).

The "+" and "-" symbols are included for reference purposes only, as the alarm contacts are not polarized. The rating of the contacts is 150 mA at 200 V DC or 100mA at 150 V AC.

**P6 A** is a Power A fail alarm and **P6 B** is a Power B fail alarm. The power alarms will only be triggered if enabled in the Tekron Configuration Tool.

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




**P7** provides two alarm output channels.

**P7 A** is a GNSS signal receive fail (Antenna fail) alarm. The antenna alarm only occurs after a continuous 10 seconds with the antenna disconnected or short-circuited.

**P7 B** is a synchronization fail alarm. This alarm is active (contact open) when the unit is not synchronized and is not in the holdover state.

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 TCG 02-G operates with 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 will default to the "alarm" state (open contact).

The "+" and "-" symbols are included for reference purposes only, as the alarm contacts are not polarized. The supported wiring size is up to 1.00 mm². The contact rating is 150 mA at 200 V DC or 100 mA at 150 V AC.

## ADMIN/ETH1: Ethernet Communication Port (RJ45 Connector)


The Ethernet port (ETH1) features an RJ-45 connector and supports 10/100 Mbps, Auto MDI-X and Auto Negotiate. The LEDs convey Link (**LNK**) and Activity (**ACT**) status for the port.

The LNK LED will be illuminated when an Ethernet link has been achieved with a link partner, whilst the ACT LED will be illuminated when there is activity on either the transmit or receive pair.

This port is also used to configure the clock via the Tekron Configuration Tool, which is available for download on the TCG 02-G page on the Tekron website at [https://tekron.com/power/gnss-timing-generator-tcg02g/#resources](https://tekron.com/power/gnss-timing-generator-tcg02g/#resources).

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

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

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

Note that Expansion Option 1 is legacy and is no longer an orderable option.

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


**P9** and **P10** are two input channels that may be driven by TTL sources. The input can either be a pulse for event recording, or an un-modulated IRIG-B signal (IRIG-B004 with C37.118.1 extensions only) to provide a secondary sync source.

The input type is software configurable. If both event recording and IRIG-B sync input functions are selected, then channel 'A' is the Event Input and channel 'B' is the IRIG-B sync input.

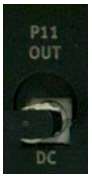
**If a secondary Ethernet Communication Port is fitted to the board the two input channels will be fitted as 2-pin connectors.**

The expected input is 5 V, 7 mA, however; inputs up to 10 V, 20 mA may be applied. The '+' and '-' symbols represent the positive and negative terminals respectively. The supported 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 and the ports have a 60 VDC isolation from each other. Each input is protectively clamped to 25 V and uses a 470 Ω resistor to limit the current.

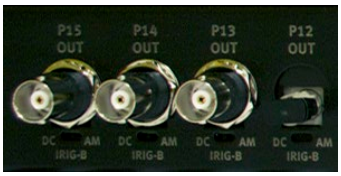
Refer to the Event Recording Specification section of this manual for further information on the event recording feature.

### P11: Isolated Programmable Output




**P11** is an output that shares the same logical (but not physical) signal as **P4 pin 1**. It can be factory fitted with either a BNC (5 V TTL signal with 75 mA sink and source current) or ST fiber connector (compatible with ST-terminated multi-mode fiber optic cabling).

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




**P12** to **P15** outputs can be individually fitted with either a BNC or ST fiber connectors (compatible with ST-terminated multi-mode fiber optic cabling).

If BNC connectors are fitted, each output is independently switchable between AM IRIG-B (B12x[2]) or DCLS IRIG-B (B00x[2]). The output mode for each port is selected using the DIP switch beneath the connector. The DIP switch can be moved left to select DCLS IRIG-B, or right to select AM IRIG-B. The signals have the following characteristics:

- **AM IRIG-B (B12x[2]):** 8 Vpk-pk transformer-isolated signals with 120 Ω output impedance.
- **DCLS IRIG-B (B00x[2]):** 5 V TTL signals with 25 mA sink and source current, sharing a common ground with all other DCLS IRIG-B outputs.

**Note:** The DIP switches are fragile and are only designed to be used during the initial installation of the unit if required. To avoid damaging the switches, please avoid switching them multiple times after installation.

If ST fiber outputs are fitted, then outputs P11 to P15 are IRIG-B (B00x[2]) outputs. Only P11 can have its encoding independently configured (via the Configuration Tool), similarly to P2 and P3 (P2, P3 Programmable Output Options).

[2] Refer to Appendix – Port Specifications

### P11 and P12

The order code will specify these as being built with either BNC or Fibre outputs (these must match)

| Port | P11 (Programmable) | P12 (Switchable) |
|---|---|---|
| BNC (Code BB) | You can select DC IRIG-B, DCF77 or Pulse output via the configuration software | Only IRIG-B output provided. Switch below the connector allows DC or AM signal to be selected |
| ST FIbre (Code CC) | You can select unmodulated IRIG-B, DCF77 or Pulse output via the software | Only unmodulated IRIG-B output provided |

### P13

The order code will specify this as being built with either a BNC or Fibre output .

| Order Option | P13 (Switchable) |
|---|---|
| BNC (Code B) | Only IRIG-B output provided. A dip switch below the connector allows a DC or AM IRIG-B signal to be selected |
| ST Fibre (Code C) | Only unmodulated IRIG-B output provided |

### P14 and P15

The order code will specify these as being built with either BNC or Fibre outputs (the two ports must match).

| Port | P14 (Switchable) | P15 (Switchable) |
|---|---|---|
| BNC (Code BB) | Only IRIG-B output provided. A dip switch below the connector allows a DC or AM IRIG-B signal to be selected | Only IRIG-B output provided. A dip switch below the connector allows a DC or AM IRIG-B signal to be selected |
| ST FIbre (Code CC) | Only unmodulated IRIG-B output provided | Only unmodulated IRIG-B output provided |

### ETH2: Secondary Ethernet Communication Port (RJ-45 Connector)


The Secondary Ethernet Communication Port (ETH2), features a RJ-45 connector and supports 10/100 Mbps, Auto MDI-X and Auto Negotiate. The LEDs convey Link (LNK) and Activity (ACT) status for the port.

**The Secondary Ethernet Port cannot be used to configure the TCG 02-G main clock. Only the Ethernet communication port (ETH1) may be used for configuration.**

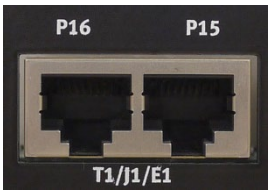
**Note:** The TCG 02-G features absolute security between the ports, so that no Ethernet paths exist between the two Ethernet ports. For this reason, the TCG 02-G does not support hub, switch, or router functions.

## Telecommunications Expansion (Expansion Option 3)

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

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

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




**P15** and **P16** can be independently programmed via the Configuration Tool. The configurable settings include framing format, encoding, waveform shape, transmitter impedance matching, high impedance output, long haul and SSM. The mode configuration sets the frequency options and is common to P13, P14, P15, and P16.

### *P15, P16 T1/E1/J1 RJ48 Pinout configuration*

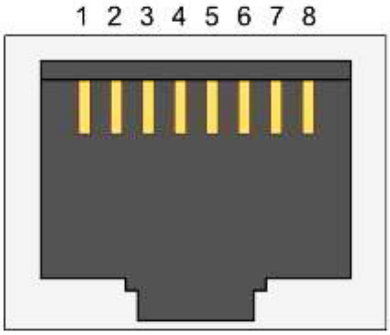



Figure 16 - Pins of P15 and P16 RJ-48 connector

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

| | |
|---|---|
| Pin1 - RX Ring - | Pin5 - TX Tip + |
| Pin2 - RX Tip + | Pin6 - NC |
| Pin3 - GND | Pin7 – NC |
| Pin4 - TX Ring - | Pin8 - NC |

**Note:** The P15 and P16 ports are outputs only. Incoming T1/E1/J1 signals are ignored.

# 5. SOFTWARE

## Configuration Tool

The configuration tool software can be downloaded from the Tekron website: www.support.tekron.com. By default, the unit is shipped with DHCP enabled for automatic IP address assignment, with a fall back to link local addressing (169.254.xxx.xxx) if no DHCP server is present.

**Default Username:** admin

**Default Password:** Password

**Note:**
**The user is required to change the default password on first login.**

# 6. INSTALLATION

## Identification

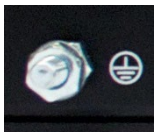
Each TCG 02-G unit is shipped with identification labels on the base and side. The label provides details of the particular options fitted to the unit, the power supply requirements, and serial number.

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

## Mounting the TCG 02-G

The TCG 02-G is designed to be mounted in a 19” rack. The unit is mounted to the 19” rack by using four screws through the front panel corner holes.

## Earthing



When powered by AC, the earth pathway is provided by the earth pin in the IEC connector.

When powered by DC, a wire from the earth stud to a known electrical earth is needed to earth the unit. This provides a safe discharge path in the event of a short circuit or large voltage transient.

**Note**: The paint on the unit’s case is non-conductive, so earthing the rack the unit is mounted in isn’t enough on its own, a connection is also needed from the rack to the unit's earth stud.

**The unit must be safety earthed whenever it is powered on, using the earth terminal as pictured above. The cable’s cross section must be equal to or greater than 0.75 mm2 (18 AWG).**

## Operation

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

Assess the antenna installation site for RF interference sources, and ensure the antenna has a good view of the sky. Once the site has been assessed, connect the antenna lead to the TCG 02-G's antenna port, then connect the power source to **P1A** and/or **P1B**.

The time required to achieve tracking and synchronization given a good view of the sky is typically within three minutes. For TCG 02-G fitted with advanced oscillator options (OCXO or Rubidium), allow up to one hour for initial synchronization.

Once powered up, the operator can determine correct operation of the TCG 02-G by observing the LEDs. The ALM LED should be off and the SYN LED should be continuously on. If the LEDs are flashing, refer to the LED Indicators section for an explanation of the status.

## Event Recording Option

### General Description and Specification

TCG 02-G clocks ordered with expansion modules 1 and 2 can provide event recording (time-tagging) on their **P9** and **P10** inputs. These 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 µs, 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 connectors (P9 / P10) as the external IRIG-B input function.**

The user can retrieve time tags from the buffer using a request/response protocol operating over TCG 02-G's P4 serial port interface. Tags are retrieved from the buffer oldest data first.

See the Event Recording Specification section of the Appendix for more detail on the event recording functionality, and a specification of the time tag format and the retrieval commands.

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

The TCG 02-G clock supports both IRIG-B and event recording input functions on the two **P9/P10** inputs. If one IRIG-B input function and one event input function are selected, then **P9** is the event input, and **P10** is the IRIG-B signal input. As described in LCD Display , when synced to IRIG-B, on the bottom right of the LCD will show SL1 or SL2 to indicate synchronization with a source from P9 or P10 respectively. Figure 17 below shows how the P9 (or P10) IRIG-B input can be used to connect multiple TCG 02-G units together.

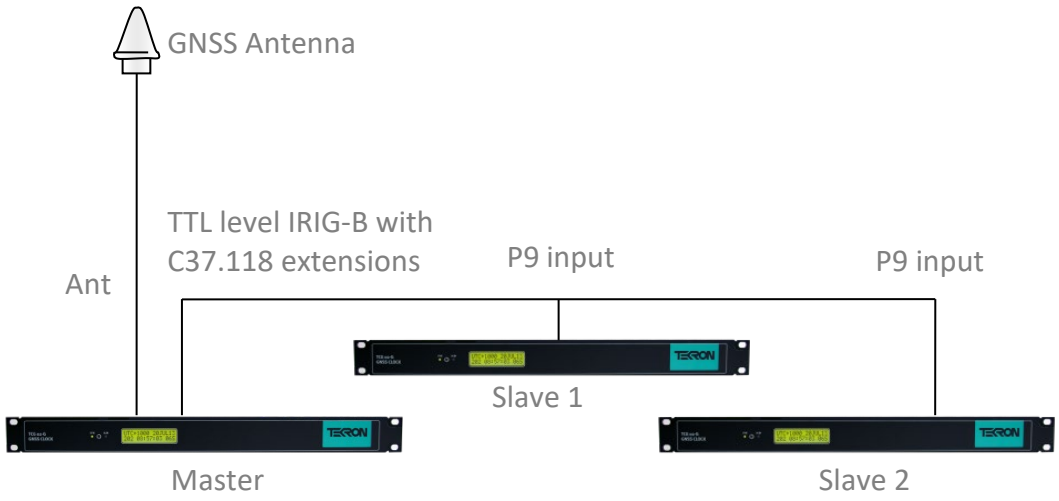



Figure 17 – Multiple Time Code Generators with one GNSS antenna

# 7. FACTORY RESET

The TCG 02-G features the ability to reset to factory default settings in the event that the administrator password is forgotten, or if the clock is rendered unreachable on the network due to incorrect settings, provided that physical access to the unit is available.

This feature is disabled by default in order to maximize security and must be enabled via the Tekron Configuration Tool before it can be used. When disabled, there is no method to gain full access to the unit without the administrator password, and if the administrator password is forgotten, the unit must be returned to Tekron for reprogramming at the customer's expense.

This feature may be permanently disabled on the unit by Tekron on request.

For further details on this feature, see the Configuration Tool Manual, which can be downloaded from the Tekron website at support.tekron.com

# 8. FACTORY HARDWARE OPTIONS

## Power Supply Options

The TCG 02-G has dual power supply options, each supply is independently configurable. This table shows the different power supply options of the TCG 02-G.

| Designator | DC Input Range |
|---|---|
| M (Medium) (2 pin) | 20 - 75 Vdc |
| H (High) (2 pin) | 90 - 300 Vdc |
| H (High) (IEC320 Inlet) | 90 - 300 Vdc, 85 - 250 Vac |

## Expansion Board Options

This table shows the two different Expansion board configurations that may be ordered with TCG 02-G.

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

## High Voltage (MOSFET) Output Option

The TCG 02-G 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 a 300 V DC, 100 mA external load.

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 18). The return connection from the load is then wired to one terminal of the **P2 (or P3)** output, and the other terminal of the **P2 (or 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 side of the TCG 02-G unit.

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.

**IMPORTANT! Failure to check that the high voltage option is fitted before connecting the high voltage supply may result in hardware damage.**

**It is the user's responsibility to provide adequate protection in the form of an external fuse to protect the external power supply, the TCG 02-G output switch and the load.**

**Note: At all times, the polarity of the P2 (or P3) connections should be such that conventional current flow is into the "+" terminal and out of the "-" terminal – i.e. "+" is at higher positive potential than "-". Failure to observe the polarity will result in the output being permanently on, regardless of the state of the output.**

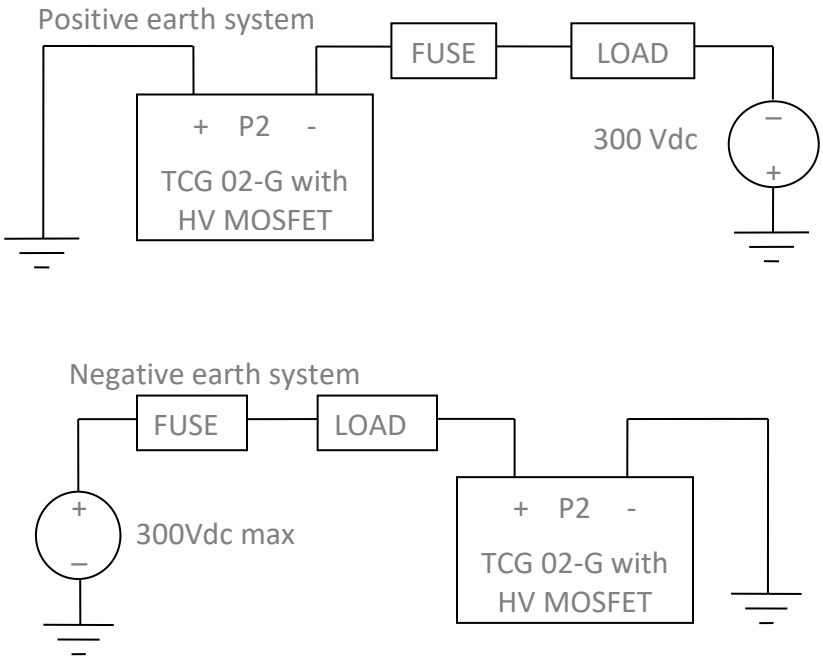



Figure 18 – High voltage MOSFET output switch option: Suggested wiring arrangements

## 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.

### 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 GNSS antenna. The GNSS antenna should then be mounted so that it lies within a 45-degree angle from the top of the other earth-bonded structure. The GNSS 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 offers 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 Lightning Protector 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 Lightning Protector.

### Installation

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

### 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.

# 9. APPENDIX

## TCG 02-G Specifications

### Physical Specifications

| Performance Property | | Metric |
|---|---|---|
| Dimensions | Width | 430 mm |
| | Depth | 270 mm |
| | Height | 45 mm |
| | Weight | 2.0 kg |

### GNSS Receiver

L1/GLONASS (1575.42 / 1598-1606 MHz) Frequency, C/A Code, 32 Channel, parallel-tracking receiver

| Performance Property | | Metric |
|---|---|---|
| Position Accuracy | Horizontal | <9 m (90%) |
| | Altitude | <18 m (90%) |
| Timing Accuracy | | 15 ns (1 sigma) to UTC |
| Sensitivity | Acquisition | -148 dBm |
| | Tracking | -160 dBm |

### Input and Output Specifications

| Type | Electrical | Physical | Accuracy at the port |
|---|---|---|---|
| AM IRIG-B00x[1] (modulated) | 8 $V_{p-p}$ | BNC | ≤2 µs of UTC |
| IRIG-B00x[1], IRIG-B22x[1], DCF77, Pulses[2] | 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 |

| Type | Electrical | Physical | Accuracy at the port |
|---|---|---|---|
| HV Switching (MOSFET) | | 2 pin Phoenix | ≤100 ns of UTC |
| Fiber (λ=820 nm) | N/A | ST | ≤100 ns of UTC |
| NTP/SNTP/PTP | | RJ-45 | ≤100 ns of UTC |

## Port Specifications

| Port | Signal Support | Base Model | Exp 1 | Exp 2 | Exp 3 |
|---|---|---|---|---|---|
| P2 | IRIG-B00x[1], IRIG-B22x, DCF77, Pulses[2] | X | X | X | X |
| P3 | IRIG-B00x[1], IRIG-B22x, DCF77, Pulses[2] | X | X | X | X |
| P5 | AM IRIG-B12x | X | X | X | X |
| P9 (**Input**) | IRIG-B00x, IRIG-B22x | | X | X | |
| P9 (**Output**) | IRIG-B00x, IRIG-B22x, DCF77, Pulses[2] | | | | X |
| P10 (**Input**) | IRIG-B00x, IRIG-B22x | | X | X | |
| P10 (**Output**) | IRIG-B00x, IRIG-B22x, AM IRIG-B12x | | | | X |
| P11 (Exp 1, 2) | IRIG-B00x, IRIG-B22x, DCF77, Pulses[2] | | X | X | |
| P11 (Exp 3) | IRIG-B00x, AM IRIG-B12x | | | | X |
| P12 | IRIG-B00x, AM IRIG-B12x | | X | X | X |
| P13 (Exp 1, 2) | IRIG-B00x, AM IRIG-B12x | | X | X | |
| P13 (Exp 3) | T1/J1: 10 or 1.544 MHz E1: 10 or 2.048 MHz | | | | X |
| P14 (Exp 1, 2) | IRIG-B00x, AM IRIG-B12x | | X | X | |
| P14 (Exp 3) | T1/J1: 10 or 1.544 MHz E1: 10 or 2.048 MHz | | | | X |
| P15 (Exp 1, 2) | IRIG-B00x, AM IRIG-B12x | | X | X | |
| P15 (Exp 3) | T1/E1/J1 Framed Output | | | | X |

| Port | Signal Support | Base Model | Exp 1 | Exp 2 | Exp 3 |
|---|---|---|---|---|---|
| P16 | T1/E1/J1 Framed Output | | | | X |

[1]x = 4 to 7 – See IRIG-B translation chart below

[2]Programmable pulses ranging from 1000 pulses per second to pulse per day. Refer to configuration manual for full details.

## IRIG-B Translation Chart

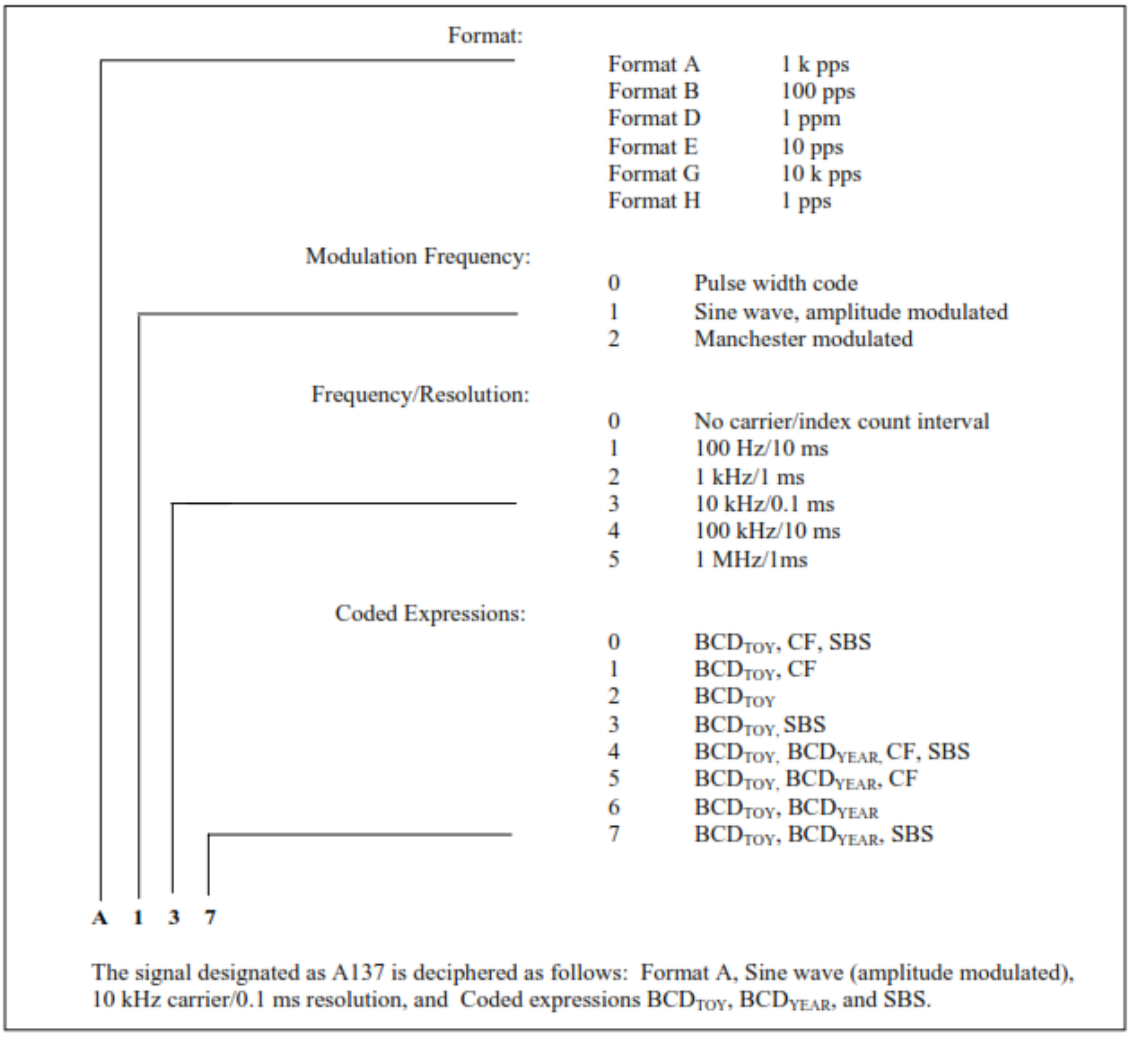



Figure 19 – Image sourced from IRIG Standard 200-04

**Note** – Only the IRIG 'B' format is supported by Tekron products, but all three modulations are supported. With DCLS/no modulation (pulse width code) no carrier is used, and with Manchester modified and amplitude modulation (AM) only the 1khz carrier is supported. Therefore Tekron products support IRIG-B00x, IRIG-B12x, and IRIG-B22x where 'x' is the coded expression.

For the coded expression, BCDtoy and BCDyear are always included in the signal, but straight binary seconds (SBS) are only included if 'binary seconds in code' is enabled, and the control field (CF) is only included if either AFNOR or C37.118.1 extensions are used. Therefore, coded expressions 4-7 are supported by Tekron products. Tekron recommends using coded expression 4 with C37.118.1 extensions, as this provides the most information possible to end devices.

### Environmental Specifications

| Performance Property | Metric |
|---|---|
| Operating Temperature Range | -10 ~ +65 °C |
| Operating Humidity | 10 ~ 95% non-condensing |

### Electrical Specifications

| Performance Property | Connector Type | | Metric |
|---|---|---|---|
| Power Supply | 2 pin | Medium Voltage | 20 - 75 Vdc |
| | 2 pin | High Voltage | 90 - 300 Vdc |
| | IEC-320 | High Voltage | 90 - 300 Vdc;<br>85 - 250 Vac |
| | | Connector fuse | 250 Vac, 1 A, 5x20 mm, slow blow |
| Power drain | 24 W max (with OCXO or Atomic clock)<br>12 W max | | |

## Isolation and Protection

All inputs and outputs feature 2.5 kV isolation from earth and 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 FACTORY HARDWARE OPTIONS for further information).**

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

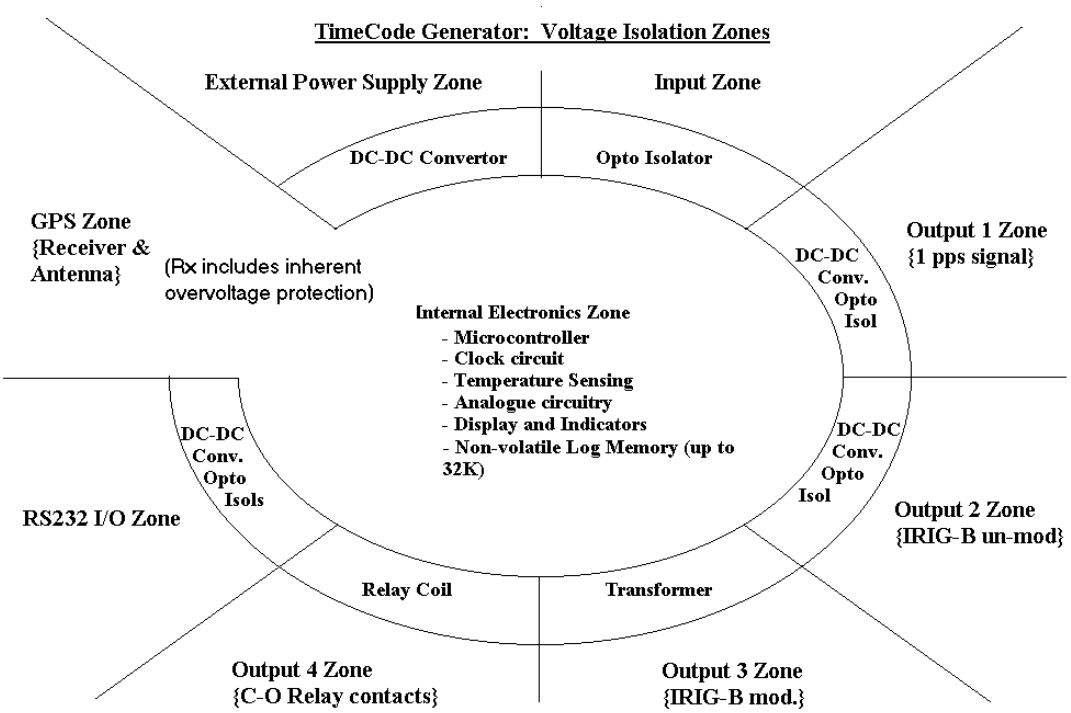



Figure 20 – TCG 02-G isolation zones

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 through an isolating DC-DC converter.

High-speed, fixed delay opto-isolators are used in each of the time-sensitive signaling paths. The isolation does not degrade the time accuracy of the output signals, as the fixed delays of the isolating components (together with the delay associated with the antenna lead-in) are all internally compensated.

## Serial Output Strings

### 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. |
| 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 | TyyMMDDwhhmmx<CR><LF> |

| Placeholder | Content |
|---|---|
| T | ASCII "T" |
| yy | Last two digits of the year: e.g.“12” = the year 2012 |
| MM | Month: “00” = January … “12” = December |
| DD | Day of Month: 01…31 |
| w | Day of week: “1”= Monday … “7”= Sunday |
| hh | Two digit hour |
| mm | Two digit minute |
| x | Time mode: ”0” = Local time, “1” = UTC time |
| <CR><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

| Example | Interpretation |
|---|---|
| T020422112340<CR><LF> | Monday 22 April 2002 – 12:34 local time |

### 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> | Start of Header: HEX 01 |
| ddd | Day of year: range “001” – “366” |
| : | HEX 3A |
| hh | hour: “00” – ”23” |
| mm | minute: “00” – “2 |
| ss | Seconds: “00” – “59” |
| <CR><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

| Example | Interpretation |
|---|---|
| <SOH>112:12:34:36<CR><LF> | day 112, time 12:34:36 |

### 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> | Start of Header: 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><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

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

### 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> |

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

| “Quality” Character (Q) | | Meaning |
|---|---|---|
| HEX | ASCII | |
| 20 | ‘ ’ (space) | Clock in sync, timing accuracy is better than 60 ns |
| 2E | ‘.’ (full stop) | Clock is accurate to 1 µs |
| 2A | ‘*’ | Clock is accurate to 10 µs |
| 23 | ‘#’ | Clock is accurate to 100 µs |
| 3F | ‘?’ | Clock accuracy may be worse than 100 µs |

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

### 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> | Carriage Return Line Feed Pair: 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 |

### 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 |

### 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> | Start of Header: 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><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

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

### 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><br><CR><LF>45HHMMss<CR><LF>55DDD<CR><LF><BEL> |

| Placeholder | Content |
|---|---|
| 1100 | ASCII “1100” |
| 44 | ASCII “44” (means local time follows) |
| hh | Local hour of day: “00” – ”23” |
| mm | Local minute of day: “00” – “60” |
| ss | seconds: “00” – “59” |
| 54 | ASCII “54” (means local day of year follows) |
| ddd | Local day of year: “001” – “365” |
| 45 | ASCII “45” (means UTC time follows) |
| HH | UTC hour: “00” – ”23” |
| MM | UTC minute: “00” – “59” |
| 55 | ASCII “55” (means UTC day of year follows) |
| DDD | UTC Day of year: “001” – “365” |
| <BEL> | HEX 07 |
| <CR><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

### 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>swhhmmssddMMyy<LF><CR> <ETX> |

| Placeholder | Content |
|---|---|
| <STX> | Start of Text: 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" |
| <CR><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |
| <ETX> | End of Text: HEX 03 |

### Clock Status

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 | GNSS / IRIGB controlled mode |
| | 1 | 1 | X | X | GNSS / IRIGB controlled mode (high accuracy) |

### Day of Week

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> 17/4/2010 | High Accuracy Mode, DST, Wed, 12:34:56, |

### String-H Time Code O/P on P4

| | |
|---|---|
| Timing | The string is transmitted once every second, with the leading edge of the “start” bit of the first character <STX> exactly on the second that the message describes. |
| Comms | 9600bps, 8-bit ASCII, no parity |
| Definition | <STX>D:dd.MM.yy;T:w;U:hh.mm.ss;uvxy<ETX> |

| Placeholder | Content |
|---|---|
| <STX> | Start of Text (HEX 02) |
| D | ASCII “D” |
| : | HEX 3A (colon) |
| dd | Day of month: “01” – “31” |
| . | HEX 2E (full stop) |
| MM | Month of year: “01” – “12” |
| yy | year: “10” – “99” representing the last two digits of the year |
| : | HEX 3B (semicolon) |
| T | ASCII “T” |
| w | Day of Week “1” to “7”, “1” = Monday |
| U | ASCII “U” |
| hh | Hour: “00” – “23” |
| mm | Minute: “00” – “60” |
| ss | Second: “00” – “59” |
| u | ASCII "#" (hash) if not synchronised since last reset, or space (HEX 20) if synchronised since last reset |
| v | ASCII "*" (asterisk) if clock is running on local oscillator, or space (HEX 20) if clock is currently synchronised |
| x | ASCII "U" if UTC time, or ASCII "S" if DST, or space (HEX 20) if standard time |
| y | ASCII "!" (exclamation) if DST change pending, or ASCII "A" if leap second pending, or space (HEX 20) otherwise |
| <ETX> | End of Text (HEX 03) |

| Example | Interpretation |
|---|---|
| <STX>D:17.04.10;T:6;U:12.34.56;#*S!<ETX> | 17 April 2010, Saturday, 12:34:56, out of sync, DST, DST change pending |

### 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><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

| Example | Interpretation |
|---|---|
| $GPZDA,123456.0023042010+1200* | UTC time is 12:34:56, 23 April 2010, the local time offset is +12:00 |

### 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,tttt.tttt,N,ggggg.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 |
| tttt.tttt | Latitude (degrees, minutes): “0000.0000” – “8959.9999” |
| N | Latitude (north/south): “N” = north, “S” = south |
| ggggg,gggg | Longitude (degrees, minutes): “00000.0000” – “35959.9999” |
| 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><LF> | Carriage Return Line Feed Pair: HEX 0D 0A |

## Event Recording Specification

### 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. The TCG 02-G 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.

### Tag Storage

The TCG 02-G 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, the TCG 02-G sets an overflow status and continues storing tags, overwriting the oldest data first.

### Tag Retrieval

The user can retrieve time tags from the buffer using a request/response protocol operating over TCG 02-G's P4 serial port interface. Tags are retrieved from the buffer - oldest data first.

TCG 02-G 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 TCG 02-G will still output time tag information when requested, timing the responses to avoid interference with the other traffic on the port.

### TCG 02-G 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 TCG 02-G 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>)

## TCG 02-G 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 TCG 02-G 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.

### 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 GNSS 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 | GNSS Fail – [B] only if internal GNSS 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 GNSS 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 GNSS 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) |

| Byte # | Description (Data bytes only, bytes 4-29 in received message) |
|---|---|
| 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) |
| 23 | Frequency Error. Local Oscillator frequency offset as compared with GNSS received signal. In ASCII, ±00000-99999 referenced to 1E-12 |

### *Notes concerning the Ps command:*

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

1. The TCG 02-G can track up to 32 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: GNSS Automatic site survey.
   Mode = 3: GNSS position hold (most accurate time)

### Pc command: Clear Time-Tag Buffer

The Pc command invokes a **Pc** response that returns the number of time-tags that were in «TCG_XXE»'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 TCG 02-G queue before reset. |

### 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:<br>ASCII [space] (hex 20) if receiver locked, sub-100 ns Output accuracy<br>ASCII [?] (hex 3F) if receiver unlocked for more than 1 minute<br>ASCII [*] (hex 2A) if receiver in alarm mode – antenna fail |
| 25– 27 | Outage Indicator – [000-999] Hours since receiver was last locked to GNSS 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 |

### 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

## 10. WARRANTY

For terms and conditions of Tekron's Warranty see the Web Site

http://tekron.com/about-tekron/warranty


WARNING

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

Notes

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