T-GPS3000 Time Synchroniser

User Manual V1.2

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Revision history:

Data version	Revision date	Revision reason	Person
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1.1	2020.04.17	Updated	TonYip
1.2	2020.08.13	Referencing (T-506)	DiaKib

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1. Safety Instructions

Safety Note: This user manual is the basic commissioning and on-site operation guide for the T-GPS3000. All operators of the T-GPS should read the contents of this manual in advance. The manufacturer of this product is not responsible for any loss caused by the operator's failure to comply with the operating procedures of this manual or for violation of the safe working procedures of the operator.

Meaning of the manual symbols Important instructions concerning personal safety, operating procedures, technical safety, etc., are marked with the following symbols:

Symbol	Meaning
	Indicates a potential hazard that could result in serious or fatal injury
	Indicates a potential hazard which, if not avoided, may result in minor personal injury or property damage.
	Indicates that it contains important information and useful guidance for using this product. Failure to heed this information may result in the test not functioning properly.
	Indicates that this is a useful guideline based on field practice.

Use of accessories: Please be sure to use Kehui's spare parts to ensure the safe and reliable use of this instrument. Using accessories made by other companies will make any warranty null and void.

Repair and maintenance: This instrument must be repaired and maintained by Kehui or an agent authorised by Kehui. If you have any questions concerning maintenance, cable fault detection, on-site test consultation, etc., please contact the company at info@kehui.com.

2. Product Overview

2.1 Application

T-GPS3000A Time Synchroniser (T-GPS3000A) is a time synchronisation product that utilises the Global Positioning System (GPS) to provide a very accurate time reference for the electric power system.

It combines a GPS receiver with a micro-computer and buffers, to provide a local time source with a variety of outputs. The format of the output signals is configured to match the requirements of all available disturbance recorders, sequence of event recorders, travelling wave fault locators, SCADA systems and other equipment requiring accurate timing.

T-GPS3000A is mainly used in the following applications:

- Providing an accurate time reference for substation equipment such as; Digital Fault Recorders (DFRs), Sequence of Event Recorders (SERs), Supervisory Control and Data Acquisition (SCADA) Systems, Relays, and other similar equipment.
- Frequency monitoring comparing the difference between working frequency time and a standard time reference.
- Measuring phase angles.
- Fault location.
- Relay protection experimentation.

2.2 Master Slave Designation

A T-GPS3000 can be designated as a Master or slave device. It is necessary to have a slave unit when a single GPS device does not have sufficient outputs to synchronise all the equipment in the substation, and there is a restriction in the number of antennas that can be set up. The master unit will synchronise itself to the satellites through the antenna, the slave(s) will then synchronise to the master.

2.3 Product Features

- 1 µS accuracy.
- High reception reliability, immune to adverse field conditions.
- Multiple time code outputs, display of time information via serial port,
- Easy connection to other equipment.

2.4 Technical Data Sheet

Power Supply	– DC 190-260V – AC 190-260V, 47Hz-63Hz
Power Consumption:	5W maximum
Data Acquisition Time During Start-Up	– 90s maximum typical – 90s maximum with location changes – 45s maximum without location change – 20s maximum after power supply interruption
Time Accuracy	1 µs
Selectable Output Port Features:	– Pulse output (1PPS/1PPM/ 1PPH): – Dry output, – TTL output, – 422/485 output
IRIG-B output	– DC output (TTL output and 422/485 output), – AC output
DCF77 output	Dry contact
Serial Output	RS232 and RS422/485 Ethernet output
Pulse output	1 PPS, 1PPM and 1PPH (signal pulse width is 200ms)
Configuration:	Master or slave (with correct configuration)
Optional output modules	Dry contact output module (Maximum 12 outputs, 6 modules) Serial port output module (Maximum 4 outputs, 6 modules) TTL output module (Maximum 12 outputs, 3 modules – Pulse or IRIG-B) RS422/ 485 (Maximum 12 outputs, 3 modules – Pulse or IRIG-B) Ethernet (1 per module, 6 modules)
Environmental	Operating temperature 0°C to 50 °C Storage temperature -40°C to 50 °C
Dimensions	483mm x 323 x 83mm (19”, 2U rack)
Weight	2 kg

3. Layout

3.1 Front Panel

The front panel is shown below in Figure 1.

Figure 3.1: Front Panel

- Power

  The light indicates that the power is on.

- Synch. Lost

  When the equipment is initially powered-up, this indicator will blink, showing that the GPS3000A is not synchronised; when the light is off, it indicates that the system is synchronised. If it blinks during operation, it indicates that the T-GPS3000A has lost synchronisation.

- 1PPS Pulse Indicator

  If the light is blinking, the system is running correctly.

- Time display (LED)

  Normally this displays the current time. When the user is operating the equipment via the front panel, it will display the setting mode.

- Buttons

  Four buttons are on the front panel, labelled; 'ITEM', '►', '+' and 'ENTER'. For details of their operation, refer to Section 5.4 Front Panel Setting.

3.2 Rear Panel

Figure 3.2 shows the detailed layout of a fully configured rear panel.

Figure 3.2: Rear Panel

3.3 Module Configuration

The rear panel shows the module configuration, which has 10 blank module positions. The modules include Power, Outputs and Signal Input (Antenna). The Power Module and Signal Input (Antenna) Module are mandatory. The different types of output module are categorised into 7 different types including; dry contact output, TTL output, 485/422 output, serial output, IRIG-B AC output, DCF77 output and Ethernet output. The dimensions of the modules are the same, with the exception of the power Module which is installed on the far left of the rear panel. The others can be installed anywhere on the rear panel. Customers can order different modules according to their specific application requirements.

3.4 Outputs

There are different signal outputs for different modules which can be changed by changing jumper or terminals.

- Pulse x 4 includes A, B, C and D groups. These four pulses can be set from the front panel as 1 pulse per hour (1PPH), 1 pulse per 30 minutes (1PP30M), 1 pulse per 10 minutes 1PP10M, 1 pulse per minute (1PPM), 1 pulse per 30 seconds (1PP30S), 1 pulse per 10 seconds (1PP10S), 1 pulse per second (1PPS), and event. For the detailed setting method, refer to Section 7.3 Front Panel Setting. The pulse has three kinds of outputs, Dry Contact Output, TTL Outputs, and Differential Outputs.
- Serial Port: this provides TXD0 and TXD1 signals. The user can find the signal format from Section 7.4 Serial Port Output, and the output format from Section 4.7 Serial Port Output Module.
- IRIG-B Code: this includes IRIG-B DC and IRIG-B AC codes. IRIG-B DC code can be output from the TTL Output or the Differential Output.

- DCF77 Code: since this code is used rarely, it only is output from a Dry Contact.

T-GPS has 7 blank modular spaces for the various optional modules. However, for power consumption reasons, the maximum number of TTL modules is limited to three, the maximum number of 422/485 is also three and IRIG-B has a maximum of four modules.

If T-GPS is used as a master, the mandatory modules are the Power Supply module, the Alarm module, the Antenna module and the Signal Output module (to slave). Leaving 6 blank modules for other options.

If used as a slave, the mandatory modules are two IRIG-B IN modules (for redundancy), one Power Supply module and one Alarm module. There will again, be 6 blank modules for other options.

3.5 Customisation

T-GPS3000A is configured using a selection of modules and the outputs can be modified by adding additional modules as required.

The Dry Contact Output Modules can have maximum of twelve outputs, each can be configured as 1PPH, 1PP30M, 1PP10M, 1PPM, 1PP30S, 1PP10S, 1PPS, or event outputs.

The Serial Output Modules can have a maximum of four RS232 or RS422 outputs.

The IRIG-B AC Output Module can have maximum twelve outputs, with adjustable amplitude.

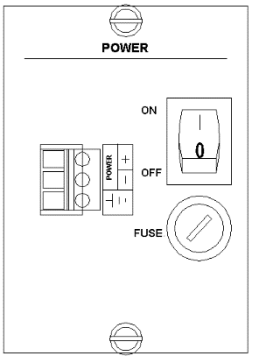
The TTL Output Module can have maximum of twelve outputs.

The Differential Output Module can have an RS422 output, pulse output, each can have maximum of 6 outputs.

Customers should specify the required modules at the time of ordering.

4. Module Descriptions

4.1 Power Module



The Power Module provides the power supply for the T-GPS3000, the layout is as the diagram below shows.

A) ON/OFF: to power on or off the GPS.

B) Fuse: 5A fuse is inside (**Note: The unit should be powered off when replacing the fuse).**

C) Terminals:

① The terminals marked + and - are for the power supply.

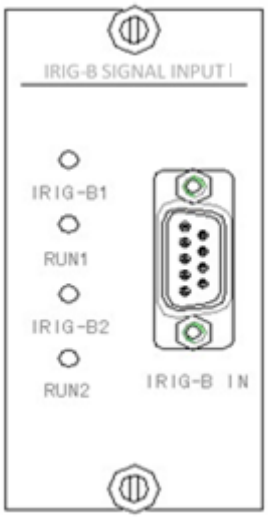
② Earth this device with the terminal marked ⏚

4.2 Signal Input (Antenna)

This Module is connected to the antenna, to provide the satellite signal.

Refer to section 6.4 for Antenna installation.

4.3 IRIG-B Signal Input I Module

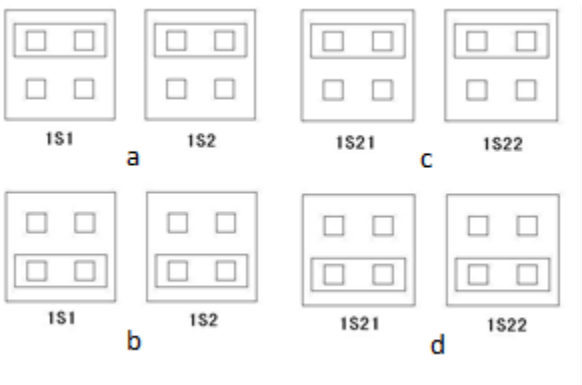


Each IRIG-B signal input module accepts two TTL and 422 switchable level signals.

They can indicate whether they are connected and running normally. Both level signals are accessed through a DB9 socket. Pins 1 - 4 of the socket are connected to the first 422 level signal, 1 and 4 are connected to "+" with 2 and 3 connected to "-". Pins 6 -9 are connected to the second 422 level signal, 6 and 9 are connected to "+", with 7 and 8 connected to "-".Pin 5 is not used.

In addition, there are four indicators on the panel, from top to bottom: IRIG-B1, RUN1, IRIG-B2, RUN2.

IRIG-B1 indicates whether the first level signal input is normal. RUN1 indicates whether the first level signal is running normally. IRIG-B2 indicates whether the input of the second level signal is normal. RUN2 indicates whether the second level signal is running normally. Each signal can be set by the short circuit jumper on the board. The specific setting method is as follows:



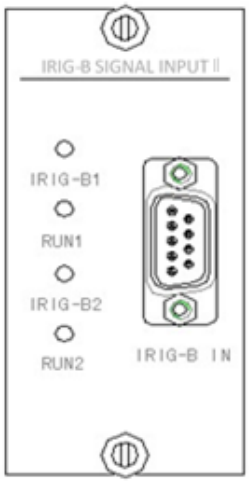
When the first channel is connected to the TTL level signal, the 1S1 and 1S2 jumpers are connected as in Figure (a).

When the first channel is connected to the 422 level signal, the 1S1 and 1S2 jumpers are connected as in Figure (b)

When the second channel is connected to a TTL level signal, the 1S21 and 1S22 jumpers are connected as in Figure (c).

When the second channel is connected to the 422 level signal, the 1S21 and 1S22 jumpers are connected as in Figure (d)

4.4 IRIG-B Signal Input Module

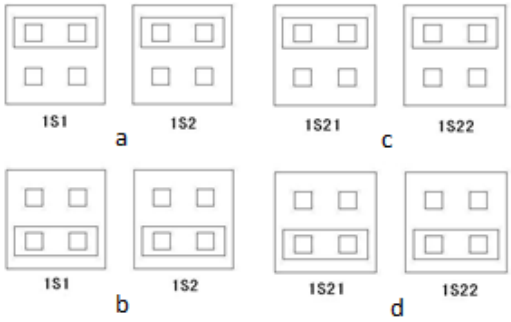


Each IRIG-B signal input module accepts two TTL and 422 switchable level signals.

They can indicate whether they are connected and running normally. Both level signals are accessed through a DB9 socket. Pins 1 - 4 of the socket are connected to the first 422 level signal, 1 and 4 are connected to "+" with 2 and 3 connected to "-". Pins 6 -9 are connected to the second 422 level signal, 6 and 9 are connected to "+", with 7 and 8 connected to "-".Pin 5 is not used.

In addition, there are four indicators on the panel, from top to bottom: IRIG-B1, RUN1, IRIG-B2, RUN2.

IRIG-B1 indicates whether the first level signal input is normal. RUN1 indicates whether the first level signal is running normally. IRIG-B2 indicates whether the input of the second level signal is normal. RUN2 indicates whether the second level signal is running normally. Each signal can be set by the short circuit jumper on the board. The specific setting method is as follows:



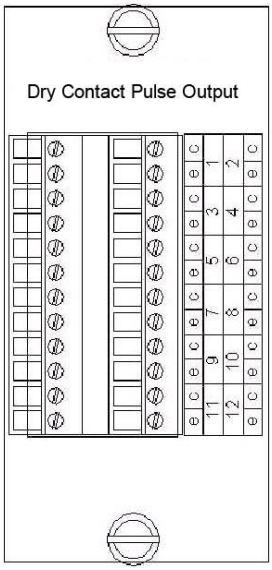
When the first channel is connected to the TTL level signal, the 1S1 and 1S2 jumpers are connected as in Figure (a).

When the first channel is connected to the 422 level signal, the 1S1 and 1S2 jumpers are connected as in Figure (b)

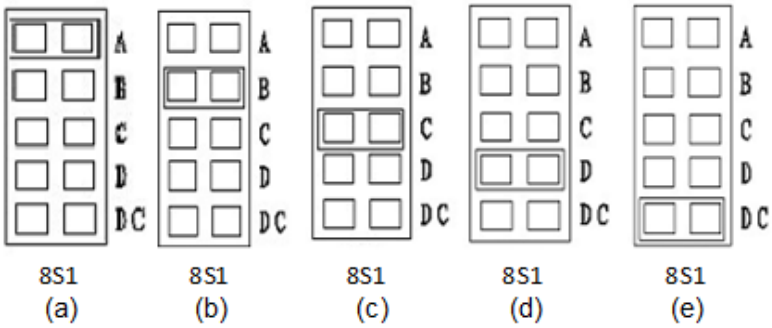
When the second channel is connected to a TTL level signal, the 1S21 and 1S22 jumpers are connected as in Figure (c).

When the second channel is connected to the 422 level signal, the 1S21 and 1S22 jumpers are connected as in Figure (d)

4.5 Dry Contact Pulse Output



Maximum twelve inputs. Two connectors make a pair and are marked with ‘c’ and ‘e’ from the top. The left column comprises numbers. 1, 3, 5, 7, 9, 11 and the right one is 2, 4, 6, 8, 10, 12 from top to bottom. Each output can be set as an A, B, C or D pulse via the jumper on the PCB. The 8S1 to 8S12 represents outputs 1 to 12.



The detailed setting method is as following:

If 8S1 is in location (a), its output pulse is set to A.

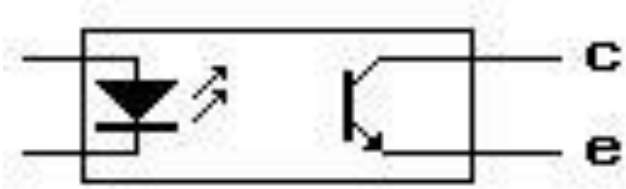
If 8S1 is in location (b), its output pulse is set to B.

If 8S1 is in location (c), its output pulse is set to C.

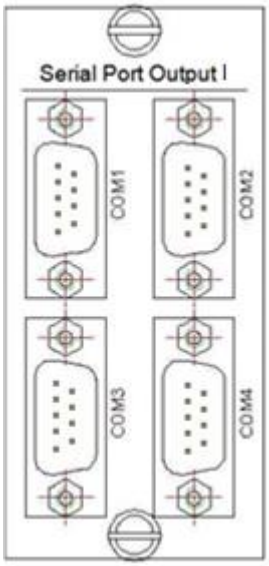
If 8S1 is in location (d), its output pulse is set to D.

If 8S1 is in location (e), its output pulse outputs the IRIG-B DC signal.

The remaining 11 pairs have the same setting method. Below is the schematic for a dry contact.

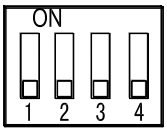


4.6 Serial Port Output Module



The module has up to four serial signals, each routed to a DB9 interface. Each output can be configured as an RS-232 level or RS-422 level output.

The four-position DIP switch on the board is used to set the baud rate of the serial port output. When pins 1 to 4 of the DIP switch are turned to "ON", the status is "1", otherwise it is status "0". Pins 1 and 2 control the baud rates of "COM1" and "COM2"; Pins 3 and 4 control the baud rates of "COM3" and "COM4".

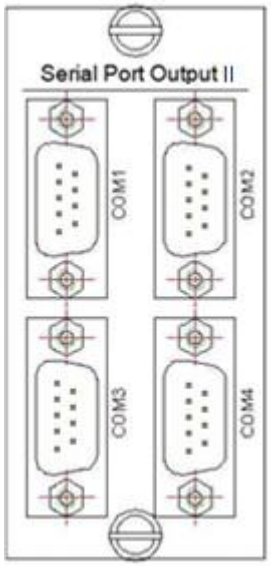


The correspondence between the DIP switch pin status and the serial port baud rate is as follows:

1, 2 Pin Status	COM1, COM2 Baud Rate
11	1200
01	2400
10	4800
00	9600

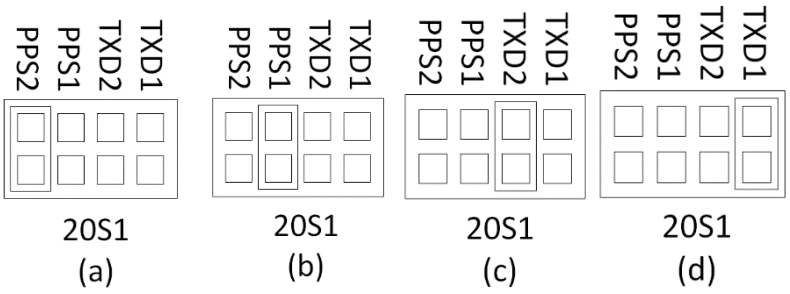
3, 4 Pin Status	COM3, COM4 Baud Rate
11	1200
01	2400
10	4800
00	9600

4.7 Serial Port Output Module II



The module has up to four serial signals, each routed to a DB9 interface. Each output can be configured as an RS-232 level or RS-422 level output.

20S1 to 20S4 on the printed board are used to control the outputs of COM1 to COM4 respectively. The specific setting methods are as follows:



When 20S1 is in the (a) state, COM1 port outputs “PPS2” type pulse signal.

When 20S1 is in the (b) state, COM1 port outputs “PPS1” type pulse signal.

When 20S1 is in the (c) state, COM1 port outputs “TXD2” type pulse signal.

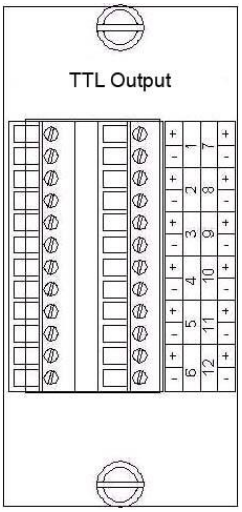
When 20S1 is in the (d) state, COM1 port outputs “TXD1” type pulse signal.

20S2 to 20S4 are set in the same way as 20S1.

Two four-pin DIP switches 20S7 and 20S8 on the board are used to set the serial baud rate of TXD2 and TXD1. When the DIP switch pin is set to "ON", the status changes from “0” to "1". The serial port baud rate settings are:

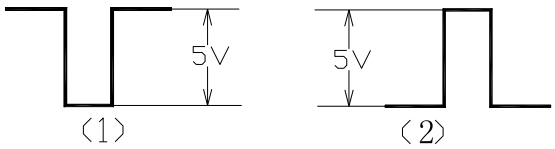
1, 2, 3, 4 Pin Status	TXD1, TXD2 Baud
0000	300
1000	600
0100	1200
1100	2400
0010	4800
1010	9600
0110	14400
1110	19200
0001	38400
1001	56000
0101	57600
1101	115200
Other states	9600

4.8 TTL Output Module

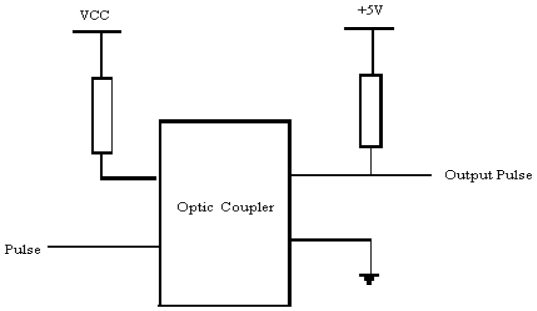


A maximum of twelve TTL outputs are provided in each module, each output can be set to be either a Pulse or an IRIG-B output. The terminals are in pairs with the upper one being **+** and lower one **-**. The left column is marked 1, 2, 3, 4, 5 and 6; the right column is marked 7, 8, 9, 10, 11 and 12. Each signal can be set with a jumper as pulse A, B, C; pulse A', B', C' or IRIG-B DC.

A', B' and C' are similar to A, B, and C but have opposite polarities as shown below

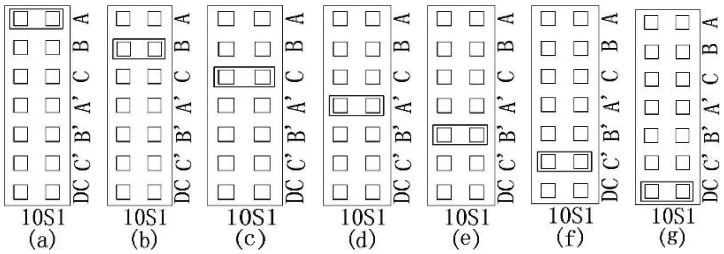


A, B, C A', B', C'



TTL output format

Jumper 10S1 to 10S12 controls outputs 1 to 12, the detailed settings are as follows:



If 10S1 is as shown in (a), pair 1 outputs pulse A.

If 10S1 is as shown in (b), pair 1 outputs pulse B.

If 10S1 is as shown in (c), pair 1 outputs pulse C.

If 10S1 is as shown in (d), pair 1 outputs pulse A', with opposite signal polarity

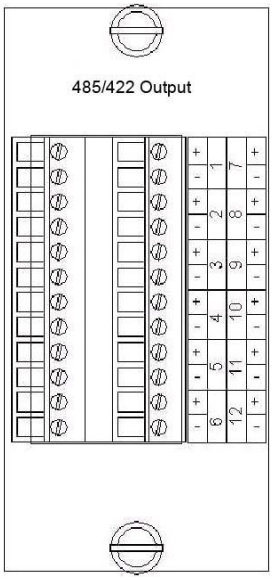
If 10S1 is as shown in (e), pair 1 outputs pulse B', with opposite signal polarity

If 10S1 is as shown in (f), pair 1 outputs pulse C', with opposite signal polarity

If 10S1 is as shown in (g), pair 1 outputs an IRIG-B DC signal.

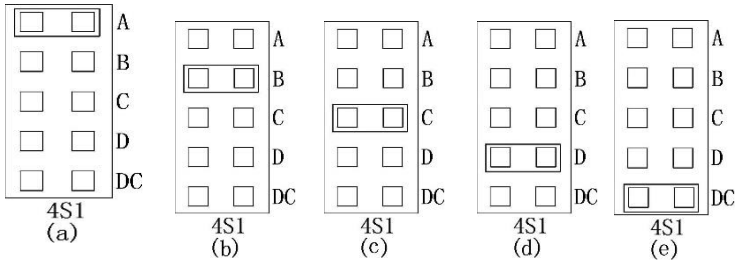
The setting method for 10S2 to 10S12 is the same as 10S1.

4.9 RS485 Output Module

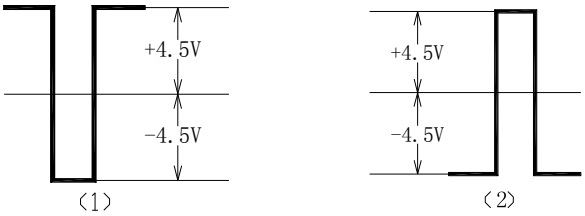


A maximum of twelve RS485 outputs are provided in each module, each output can be set to be either a Pulse or an IRIG-B DC output. The terminals are in pairs with the upper one being **+** and lower one **-**. The left column is marked 1, 2, 3, 4, 5 and 6; the right column is marked 7, 8, 9, 10, 11 and 12.

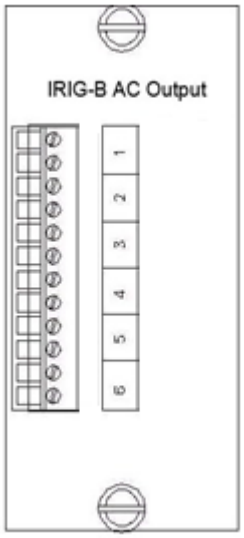
The detailed settings are as follows. Putting the jumper in A, B, C or D produces a Pulse, and DC provides an IRIG-B DC output.



The signal format for pulse A, B, C and D is as (1) below, however if the output (2) is required, the connections to “+” and “-” should be reversed.

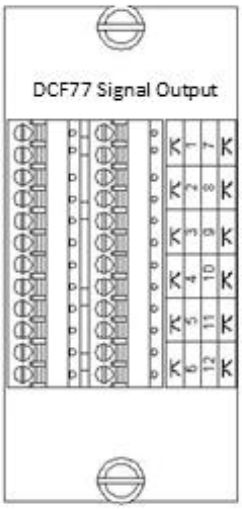


4.10 IRIG-B AC Output

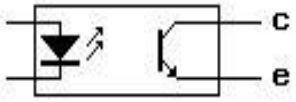


A maximum of six IRIG-B AC outputs are provided in each module, with each pair of terminals representing one channel. Output impedance is 600Ω. The amplitude of the six output signals is controlled by the potentiometer 14R1 which is situated internally. The amplitude adjustment is 0 – 10V.

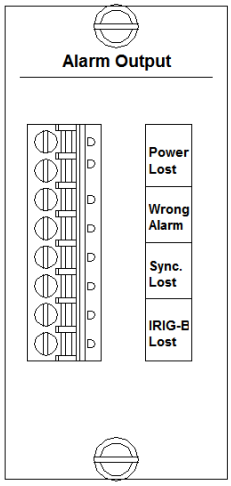
4.11 DCF77 Signal Output Module



A maximum of twelve DCF77 outputs are provided in each module. The output format is as follows:



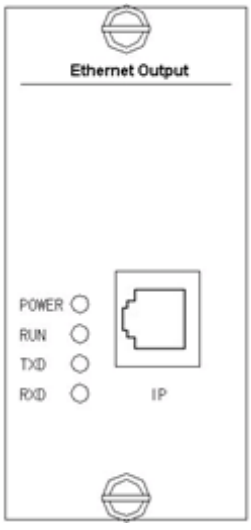
4.12 Alarm Output Module



Each Alarm Output Module provides 4 outputs. They are; Power Lost Alarm, Wrong Alarm, Sync. Lost Alarm and IRIG-B Lost Alarm. If this T-GPS3000 unit is used for slave device, the Sync. Lost Alarm becomes the IRIG-B 1 Alarm, and the IRIG-B Alarm becomes the IRIG-B 2 Alarm.

The alarm output is a relay with capacity: 220V, 1A.

4.13 Ethernet module



Each Ethernet Module can output one NTP/SNTP signal. There are four indication lights on the Module:

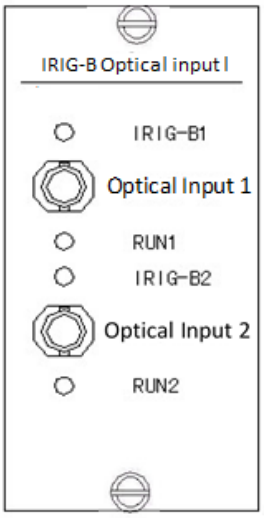
POWER: Illuminated when the power is on.

RUN: Provides a working condition indication, blinking once per second to indicate correct operation.

TXD: Data transmit indication, the light will blink when data is transmitted.

RXD: Data receiving indication, the light will blink when data is received.

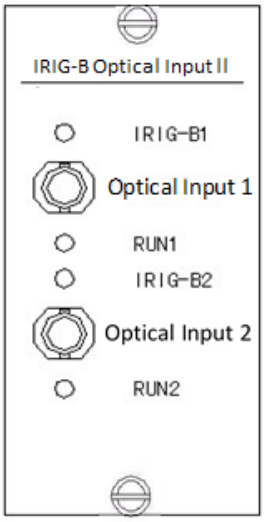
4.14 IRIG-B Optical Input Module I



Each module has inputs for two IRIG-B optical signals (used for GPS extension time synchronisation) and can indicate whether the optical signals are connected and operating normally. There are four indicators on the panel, from top to bottom: IRIG-B1, RUN1, IRIG-B2 and RUN2.

IRIG-B1 indicates whether the first optical signal input is present and RUN1 indicates that it is operating normally. Under normal conditions, IRIG-B1 flashes quickly and RUN1 flashes more slowly. IRIG-B2 and Run2 have the same function for the second optical signal input.

4.15 IRIG-B Optical Input Module II

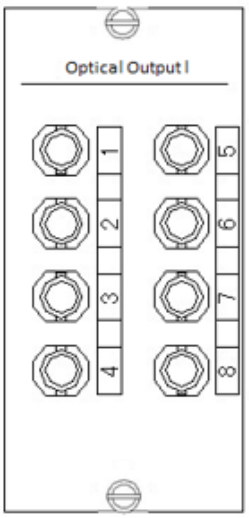


Each module has inputs for two IRIG-B optical signals (used for GPS extension time synchronisation) to indicate whether the optical signals are connected and operating normally. There are four indicators on the panel, from top to bottom: IRIG-B1, RUN1, IRIG-B2 and RUN2.

IRIG-B1 indicates whether the first optical signal input is present and RUN1 indicates that it is operating normally. Under normal conditions, IRIG-B1 flashes quickly and RUN1 flashes more slowly. IRIG-B2 and Run2 have the same function for the second optical signal input.

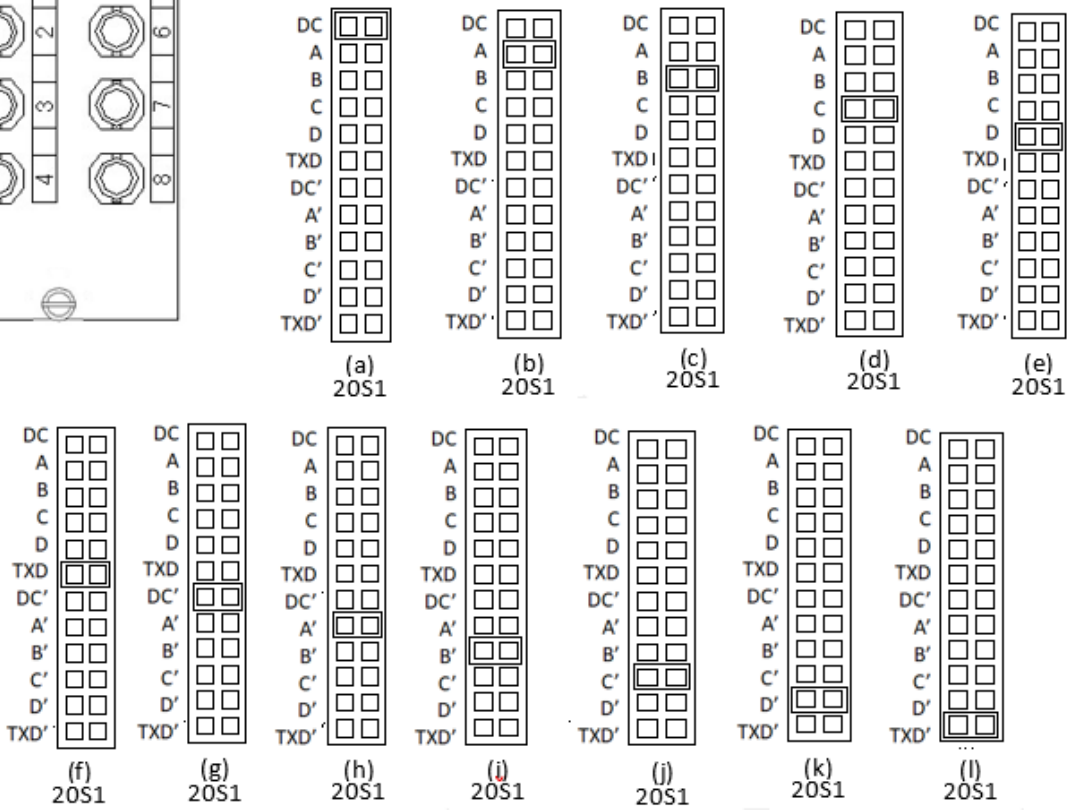
The CPU board reserves 3 groups of interfaces, the first group is 1PPS + serial port message, the second group is TTL level IRIG-B, and the third group is 1PPS + serial port Message. The main clock GPS uses the first group, and, if used, Beidou would utilise the third group; the extended clock uses the first group and the second group, so the "IRIG-B input I module" decodes the IRIG-B signal into 1PPS and serial port messages. The output to the CPU board, "IRIG-B input II module" to identify the IRIG-B code, if the IRIG-B code is correct, the code is directly output to the CPU board.

4.16 Optical Output Module



Each optical signal output I module provides 8 optical signals. Each signal can be set to IRIG-B DC; Pulse A, B, C, D; TXD; IRIG-B DC', pulse A', B', C', D'; and TXD' optical signal outputs.

Jumpers 20S1 to 20S8 control the outputs, as follows:



When 20S1 is as shown in (a) Optical output 1 is providing an IRIG-B DC optical signal

When 20S1 is as shown in (b) Optical output 1 is controlled by Pulse A

When 20S1 is as shown in (c) Optical output 1 is controlled by Pulse B

When 20S1 is as shown in (d) Optical output 1 is controlled by Pulse C

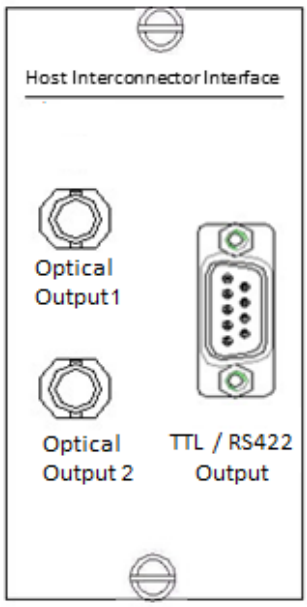
When 20S1 is as shown in (e) Optical output 1 is controlled by Pulse D

When 20S1 is as shown in (f) Optical output 1 is providing a TXD optical signal

The remaining positions DC', A' – D' and TXD' (20S1 (g) –(l)) are similar, except their on/off states are opposite to the corresponding signals above.

Outputs 2 – 8 are controlled in the same manner but by the jumpers 20S2 – 20S8 respectively.

4.17 Host Interconnect Interface Module



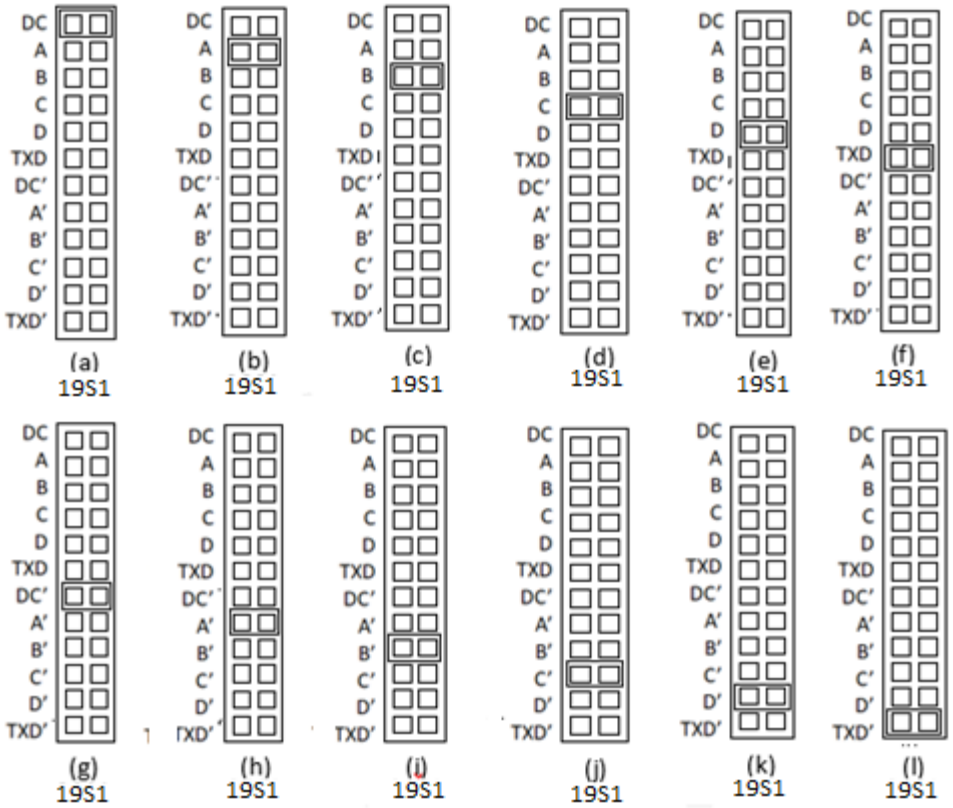
Each host interconnect interface board can output two optical signals, two TTL level signals and two RS422 level signals.

The optical signals are output through the optical ports and the TTL and RS422 level signals are output through the DB9 interface socket.

Pins 1 - 4 of the DB9 output two RS422 level signals; pins 1 and 3 are positive while 2 and 4 are negative. Pin 5 is not used.

Pins 6 - 9 of the DB9 output provide two TTL level signals; pins 6 and 8 are positive while 7 negative and 9 are negative.

Optical and electrical signals can be set as IRIG-B DC; Pulse A, B, C, D; TXD; IRIG-B DC', pulse A', B', C', D'; and TXD' optical signal outputs using internal short-circuit jumpers. Jumper 19S1 controls the optical output port 1, 19S2 controls the output port 2, 19S3 and 19S4 control two 422 level signals, while 19S5 and 19S6 control the two TTL level signals. The specific setting method is as follows (take 19S1 as an example):



When 19S1 is as shown in (a) Optical output 1 is providing an IRIG-B DC optical signal

When 1951 is as shown in (b) Optical output 1 is controlled by Pulse A

When 2S01 is as shown in (c) Optical output 1 is controlled by Pulse B

When 2S01 is as shown in (d) Optical output 1 is controlled by Pulse C

When 2S01 is as shown in (e) Optical output 1 is controlled by Pulse D

When 2S01 is as shown in (f) Optical output 1 is providing a TXD optical signal

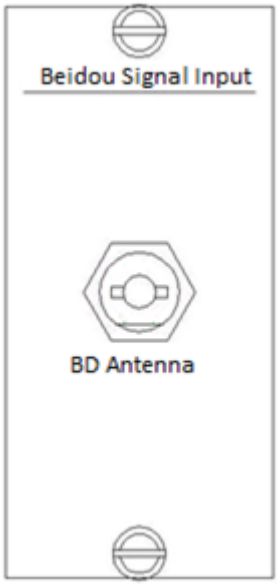
The remaining positions DC', A' – D' and TXD' (20S1 (g) –(l)) are similar, except their on/off states are opposite to the corresponding signals above.

The other outputs are controlled in the same manner but by the jumpers 20S2 – 20S6 respectively.

19S2 operates in the same way

19S3, 19S4, 19S5 and 19S6 operate in a similar manner but all outputs are electrical.

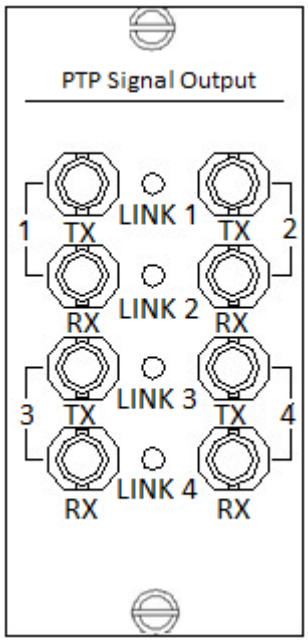
4.18 Beidou Signal Input Module



Beidou is a satellite system, which can provide time synchronisation signals similar to the GPS system.

The Beidou signal input board provides a Beidou satellite signal input for the device. A Q9 connector marked "BD Antenna" should be connected to the Beidou antenna. Refer to section 6.4 for Antenna installation.

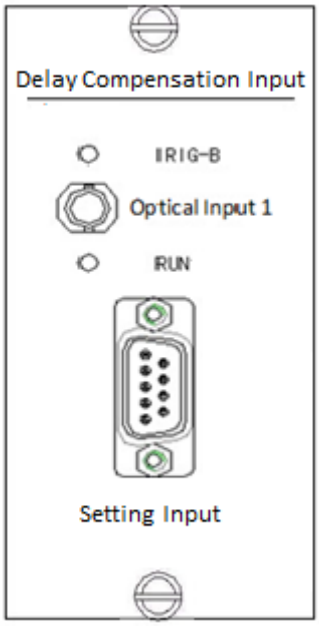
4.19 PTP Signal Output Module



Each PTP output can provide up to four PTP optical signals. Each signal requires two physical interfaces, one transmitting (TX) and one receiving (RX). The output interface is a multi-mode ST interface with a maximum transmission distance of 2Km. The PTP output signal can be connected directly to the PTP client or through a dedicated PTP switch.

The PTP output board complies with the content requirements of IEEE1588 v2, the message format is IEEE802.3, and the delay measurement mechanism is peer to peer mode. The timing accuracy can reach 1μs, and the time jitter is ≤200ns.

4.20 Delay Compensation Module



This function requires two modules (input and output) and is used where there is a large distance (>300m) between the main clock and subsidiary clocks. Due to the length of the transmission path, a delay occurs, such that the 1μs accuracy cannot be guaranteed. Using the Delay Compensation modules allows this accuracy to be maintained. Additionally, it can be used to directly synchronise equipment located a long distance from the clock.

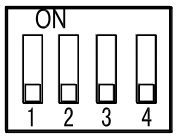
Each delay compensation input module provides an input for one IRIG-B optical signal and gives a compensation range of -400ms to + 200ms. It uses an ST port pigtail interface.

The IRIG-B light flashes following the input of an IRIG-B signal, it has a blinking frequency of 100Hz / s.

The RUN lamp indicates whether the input IRIG-B optical signal is operating normally, in which case it starts blinking at a frequency of 1Hz/s

The DB9 socket input is used as a setting port. Settings, such as the delay compensation value can be made through this port.

Further setting can be made through an internal four-position DIP switch.



The four-position DIP switch on the printed board is defined as follows:

Switch 1 is spare

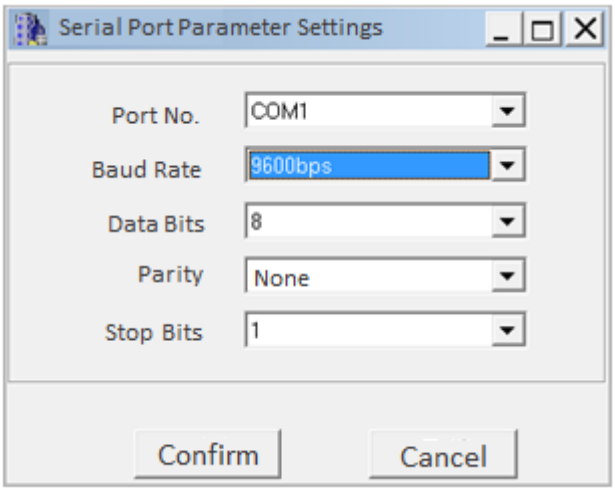
Switch 2: When the signal is ON, the input signal is NOT calculated.

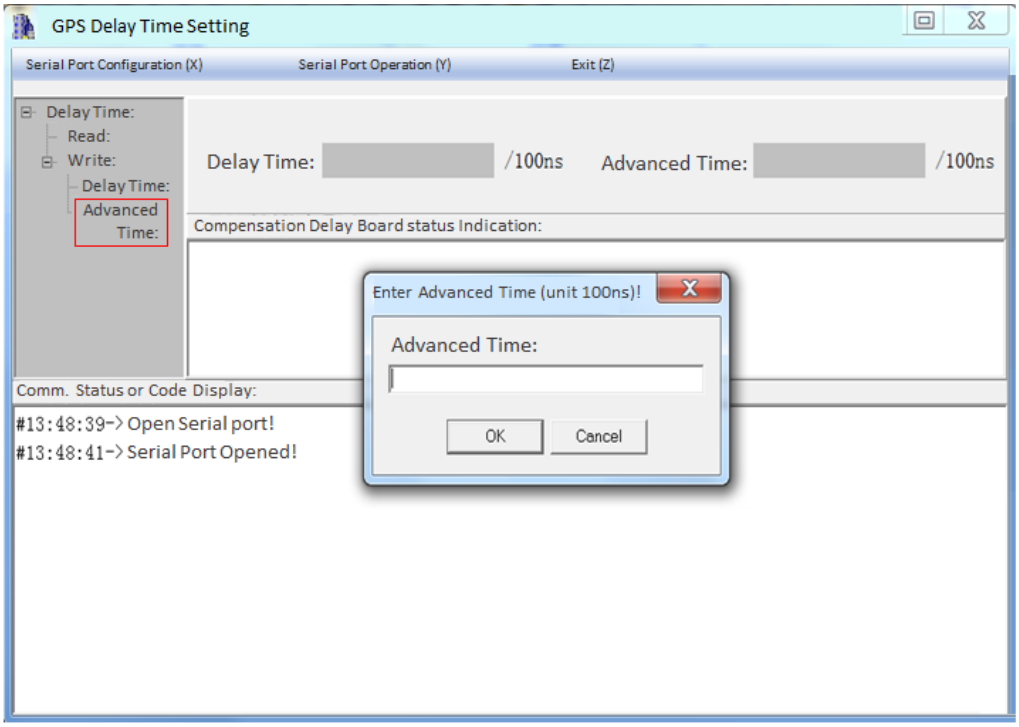
Switch 3: No compensation will be performed when “ON”.

Switch 4: When “ON”, it is used as “IRIG-B input I board”; When "OFF", it is used as "IRIG-B Input II Module".

The "Delay Compensation Input Module" can be set via the "GPSDelayTimePanel.exe" software via the serial port on the front panel. The "setting" port is a standard DB9 male connector.

The delay compensation of the "Delay Compensation Input Board" and "Delay Compensation Output Board" is set by Kehui’s "GPSDelayTimePanel.exe" software. The software sends the delay compensation value by sending a serial message to the delay compensation module. “Serial port settings" is shown below:

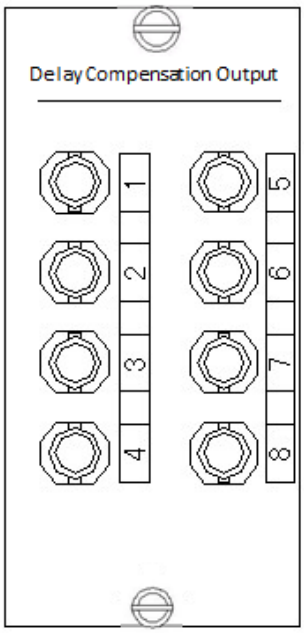




Click "Serial Port Configuration"-> "Open Serial Port", click "Advance Time" to enter the delay compensation value.

The basic compensation unit is 100ns. For example, when the protection cell to be synchronised, is 500 meters away from the main control building, the "delay compensation input board" of the extended clock generally needs to compensate 20 units, that is, 2us. Because the transmission path delay is 290 meters, the delay is 1us, so for 500 meters, the delay is approximately 1.7us, the output of the multimode optical signal, the input photoelectric conversion is 70 - 90ns, so the conversion delay is 140 - 180ns, a total compensation of 1.8 units. However, as the minimum unit is 100ns, it is more appropriate to compensate 200ns, which is within the claimed accuracy.

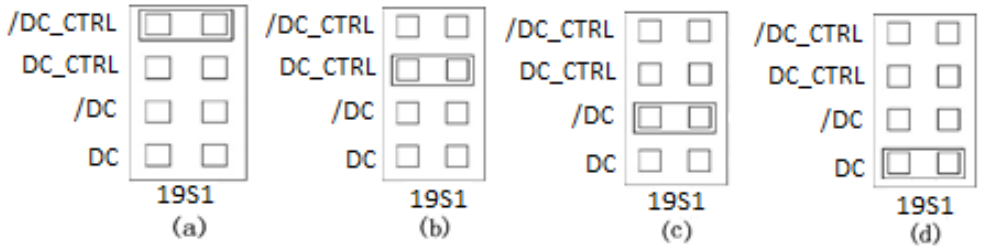
4.21 Delay Compensation Output Module



Each delay compensation output modules provides 8 optical IRIG-B signals.

The S2 code jump switch labelled "No Time Delay" on the printed board is used to set whether the output is compensated. When the S2 code jump switch is short-circuited (plug in a short-circuit), the output signal is not compensated.

19S1 to 19S4 are used to control the first to fourth signal outputs; 19S6 to 19S9 are used to control the fifth to eighth signal outputs. The specific settings are as follows:



When the 19S1 jumper is in the state shown in Figure (a), the first channel outputs a controlled rising edge IRIG-B optical signal.

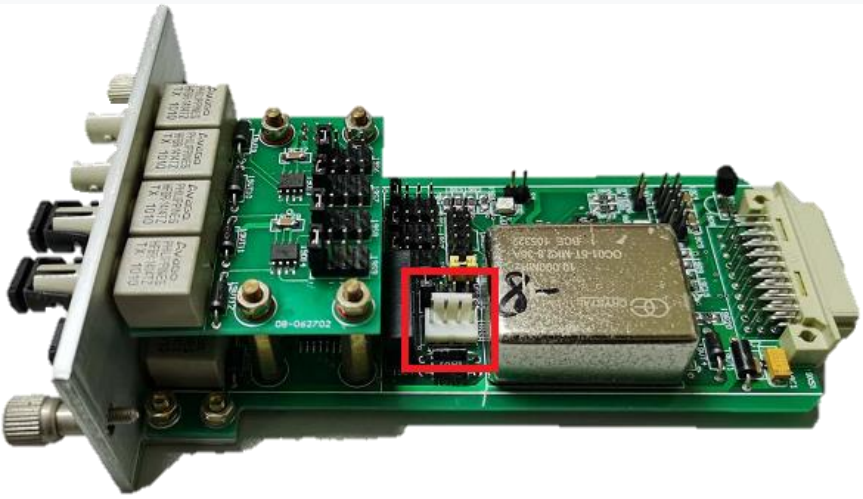
When 19S1 jumps to the state of figure (b), the first channel outputs a controlled falling edge IRIG-B optical signal.

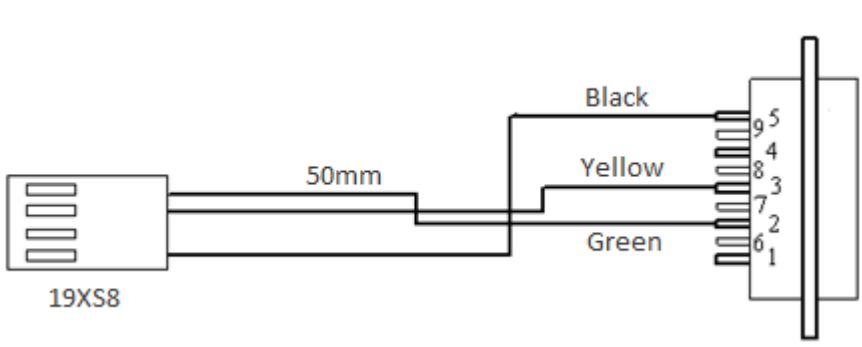
When the 19S1 jumper is in the state shown in Figure (c), the first output is an uncontrolled rising edge IRIG-B optical signal.

When the 19S1 jumper is in the state shown in Figure (d), the first output is an uncontrolled falling edge IRIG-B optical signal.

19S2 to 19S8 are set in the same way as 20S1. The 8-channel optical IRIG-B code output can be set through the 19XS8 plug-in communication line for delay compensation setting. The delay compensation range is -400ms to + 200ms.

The "Delay Compensation Output Board" is also set through the "GPSDelayTimePanel.exe" software, but the serial port connection is a little more complicated. The serial line needs to be connected to the 19XS8 single-row pin on the printed board through the transfer line to set. The wiring diagram is shown in the figure below.





5. Working Principle

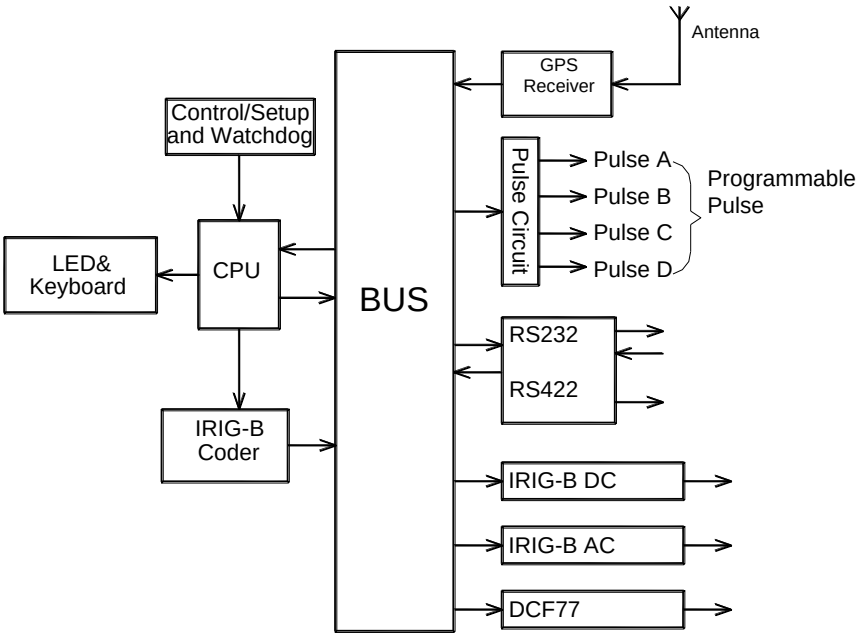


Figure 5.1: Schematic of T-GPS3000A

i. GPS Receiver

This receiver is the module used to receive Satellite signals, it outputs a pulse at 1 PPS to an accuracy of 1 µS, and provide UTC time, date and the precise location.

ii. Pulse Generation Circuit

This outputs a pulse per second (1 PPS), per minute (1PPM), or per hour (1 PPH). The pulse can be TTL, a wet contact or a dry contact.

iii. Central processing Unit

The CPU monitors the whole system, receives satellites signals, correlates, displays local time through the front-panel LED, and also controls the output port status.

iv. RS-232/422/485 Port

The RS-232/422/485 port outputs the local time, date and position with optional baud rate

v. IRIG-B Port

The IRIG-B port outputs sine modulated signals and DC demodulated signals.

6. Installation and Adjustment

6.1 Delivery Inspection

- Ensure that the contents match the items in the order. Refer to Appendix A.
- Check that all required components are present.
- Check the packaging is undamaged and has not been opened. If damaged the packaging should be photographed and retained.
- Check for any damage to the product. In case of damage; take photographs, provide a description of the damage and obtain a signature from the freight agent.
- Check that the labelling of the T-GPS3000 corresponds with the order.

If there are any of the above issues at the point of delivery ensure Kehui is notified without delay.

6.2 Installation

T-GPS3000 is designed for installation in a standard 19-inch rack. It can be mounted alone or with other devices as shown here.

The dimensions of the unit are shown below (Figure 6.1):

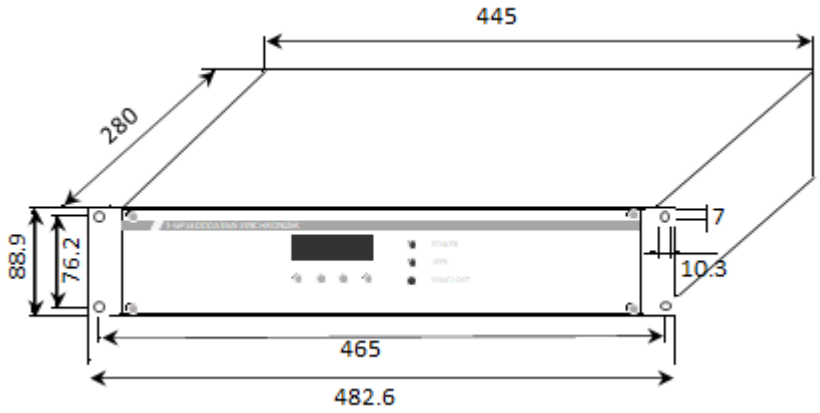


Figure 6.1 Case dimensions

Figure 6.2 T-GPS3000 rack-mounted in a cubicle

To mount the unit into a panel there are four screws on the front.

Note: Leave 5cm above and below the unit to allow for heat dissipation.

Loosen the screws of the cabinet at the point of installation of the T-GPS-3000.

Install the unit from the front of the cabinet, and align the front panel to the holes.

There is access for up to fourteen modules to provide various functionality within the device. Modules must be chosen when ordering, as the module positions will change depending on which modules are included.

It should be noted that the inputs read from right to left on the rear of the unit (i.e., Input 1 is at the extreme right position).

It is extremely important that the T-GPS is earthed before use.

6.3 Master Slave Schemes

6.3.1 Single Master

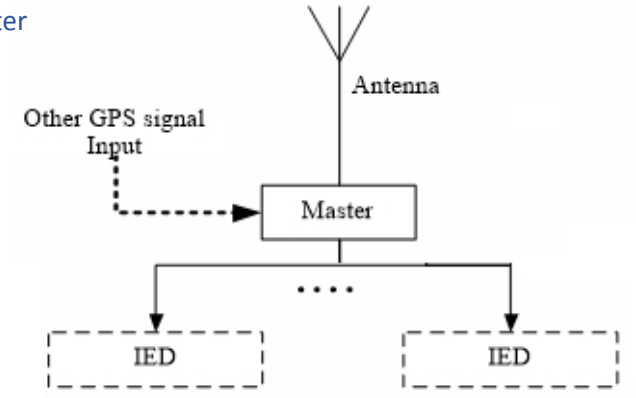


Figure 6.3 Single master system

This is suitable when a single T-GPS unit has sufficient outputs to provide a synchronising signal to all IEDs in the substation. The Master is synchronised directly from the satellite GPS signal picked up by the antenna. The input is a BNC cable from the antenna, the output depends upon the users' preference, which in turn will decide which type of output module is used.

6.3.2 Master and Slave

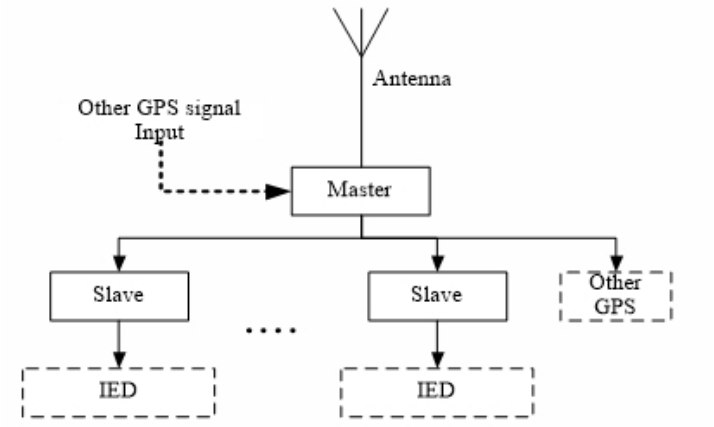


Figure 6.4 Master and slave system

This scheme provides additional outputs from a single antenna. The slave units are synchronised to the Master which, in turn, is synchronised to the satellite signal picked up by the antenna. The signal to the slave is carried by an optic fibre, the other connections remain the same.

6.3.3 Redundant Master and Slave

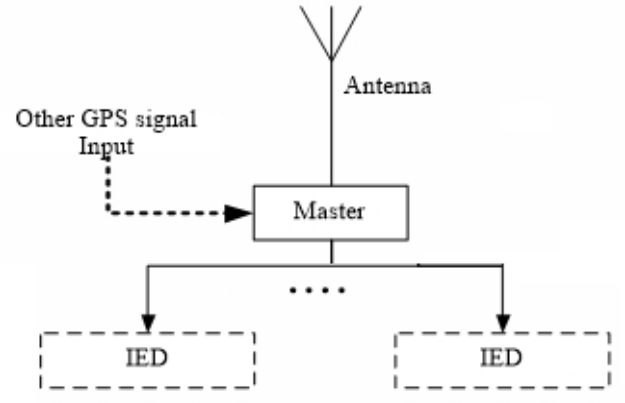


Figure 6.5 Redundant Master and slave system

Where the system requires a higher level of security, this scheme protects against the loss of the GPS signal at one of the antennae, or a hardware failure in a master unit. Connections are as in 6.3.2.

6.4 Antenna

An easy-to-mount antenna is equipped with T-GPS3000A. The antenna should be mounted in an open location with an unobstructed view of the sky.

The antenna has diameter: 100 mm and total height 180 mm. It is mounted on a rod having a diameter of 32 mm; the antenna and its mounting kit are shown below, together with a picture of the total assembly.

Figure 6.6 Antenna components

The antenna should be mounted in an open area where it can see the sky at an angle of 160 ° or more. Take care that no buildings, trees or other obstructions can prevent a direct line to the satellites, and cause the loss of the system synchronisation signal.

Another important consideration is safety; a lightning protection device (not supplied) should be mounted in close proximity to, and above, the antenna to prevent damage being caused by a lightning strike.

As further protection, a surge protective device (SPD) is connected in series with the antenna cable is provided (see below):

Figure 6.7 Surge protective device

The SPD should be mounted directly on to the copper ground bar of the cabinet. If this is impossible, use the short yellow-green cable provided.

The antenna cable is connected to the SPD; the output of the SPD is connected to the Signal Input (Antenna) module using the additional cable, 3 m long. Do not shorten this cable!

The length of the antenna cable should be specified at order. The cable has a BNC connector.

NOTE: the surge arrester attenuates the antenna signal, especially if the cable is long. If synchronisation problems occur, remove the arrester, and directly connect the antenna to the module. After synchronisation, insert the arrester, the synchronisation should then be established quickly (less than one minute).

6.5 Antenna installation

The following are some suggestions for the correct installation of the antenna. Figure 6.8 shows the correct and incorrect method of mounting.

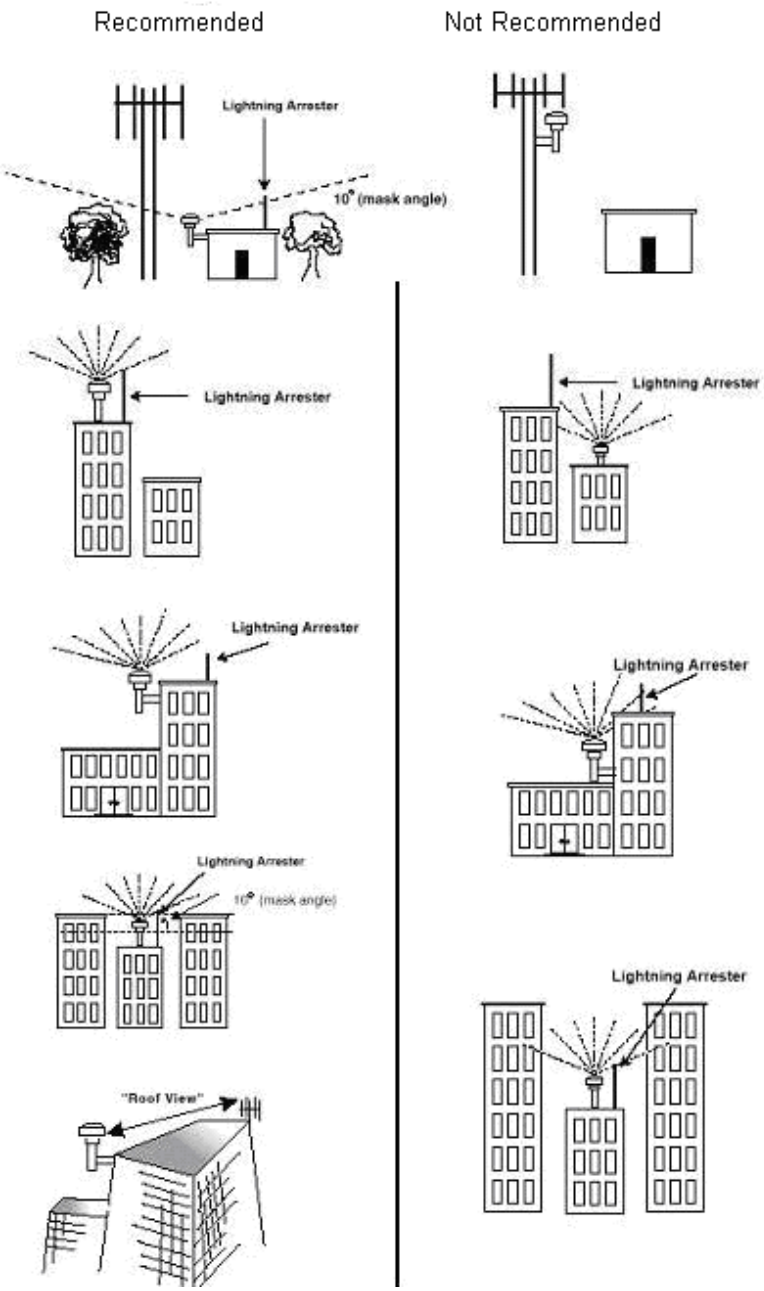


Figure 6.8: Antenna Mounting

6.6 Location

The T-GPS3000A should be mounted in a location where the signal is strongest and the antenna cable length is minimised. Note, the distance between the antenna and the unit should not exceed 90m.

7. Settings

7.1 Initialisation

After powering-on, the time displayed on the LED is the unsynchronised time. The PPS Indicator and Lost Synchronisation Indicator will blink, which indicates that the T-GPS3000A is initialising. After about 90 seconds, the initialisation will finish and the equipment will display the local time via the LED, and the Lost Synchronisation Indicator will no longer blink.

7.2 Front Panel Settings

There are four buttons on the front panel, 'ITEM', ' ▸ ', '+', 'ENTER' which control the settings of the T-GPS3000 Figure 7.1.

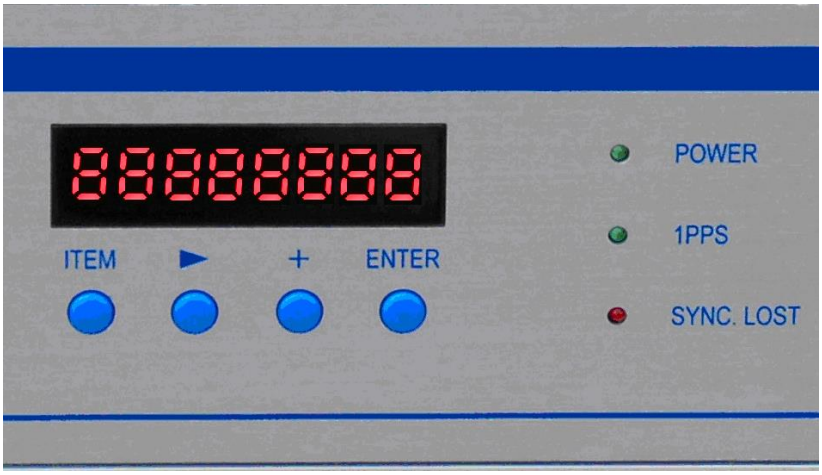


Figure 7.1 T-GPS Control Panel

7.2.1 Brightness Adjustment

The third LED segment from the left is the Brightness Indicator, '0' is the minimum and 'F' is the maximum brightness. When the T-GPS3000 is in working mode, pressing ' ▸ 'and '+' will adjust the brightness of the LED.

7.2.2 Date View

In running mode, press 'ENTER' and the current date is displayed.

7.3 Menu Set-up

In running mode, pressing 'ITEM' and 'ENTER' together allows access to the set-up menu. The First LED position from the left gives the Menu option when the T-GPS3000 is under setting mode. Pressing the 'Item' button once will increase the value by one. The meaning of each menu option number is given in the following sections.

7.3.1 Set Pulses A, B, C and D

Menu options 3, 4, 5 and 6 allow the selection of the required pulse type for 'Pulse A, B, C or D' (PPH, PPM, PPS, event, etc.) respectively. Press the ' ▸ ' button, until the third LED from the left blinks; press the '+' button, until 'P' displays, then press' ▸ ', until LEDs 4 - 8 blink, pressing the '+' button repeatedly, sets 'Pulse A' as every;

- hour (LED displays 3□P1 □□ □□),
- minute (LED displays 3□P□ □1 □□),
- second (LED displays 3□P□ □□ □1),
- 30 minutes (LED displays 3□P□ 30 □□),
- 10 minutes (LED displays 3□P□ 10 □□),
- 30 seconds (LED displays 3□P□ □□ 30),
- 10 seconds (LED displays 3□P□ □□ 10)

Press the 'Enter' button to save the setting. If it is required to output a pulse at a specific time (14:21:33 as an example), press the ' ▸ ' button, until the third LED blinks, press '+' button, to set as 1, then press the ' ▸ 'button, the LED blinks, then press the '+'button, to set as 4. Do the same to set the minute and the second (LED displays as 3□14 21 33, after all these have been set, press 'ENTER' to save the setting. The signal set will be sent-out via the Dry Contact Module, or the TTL Module.

7.3.2 Setting the time zone

Menu option 7: The fourth digit from the left represents the tens of the hours ahead or behind UTC. Press ▸ to enter, then press '+' to set it as 1, -1, 0 or -0. When it is 0 or 1, it is in the eastern hemisphere; if it is -0 or -1, it is in the western hemisphere. The 5th digit from the left represents the unit value of the hour, press ▸ to enter and then press the '+' to set the required figure from 0 to 9. The seventh digit is the tens of minutes, press ▸ to enter and press '+' to set it from 0 to 5. The eighth digit is for the unit value of minutes, press ▸ to enter and then press '+' to set it, from 0 to 9. After all are set, press 'ENTER' to save the setting.

For example,

- The eighth time zone ahead of UTC (Eastern) is displayed as: 7□□ 0 8 □ 0 0
- The sixth time zone behind UTC (Western) is displayed as: 7□□ -0 6 □ 0 0

7.3.3 Setting the Daylight Saving Time Start Date

Menu option 8: The fourth digit from the left represents the tens of the number of the month in which DST starts; Press ▸ to enter and press '+' to set it as 0 or 1; the fifth digit from the left is the unit value of this month; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is the week within the month when DST starts; press ▸ to enter and press '+' to set it from 1 to 5. The eighth digit from the left is the day of the week in which DST starts; Press ▸ to enter and press '+' to set it from 0 to 6, where 0 represents Sunday and 1 to 6 represent Monday to Saturday respectively. After all are set, press 'ENTER' to save the setting.

For example:

- LED displays 8□□ 0 3 ≡ 2 3, the DST starts on Wednesday, the second week of March.
- LED displays 8□□ 0 5 ≡ 4 0, the DST starts on Sunday, the fourth week of May.

7.3.4 Setting the Daylight Saving Time Start Time

Menu option 9: The fourth digit from the left is the tens of the hour at which DST starts; press ▸ to enter and press '+' to set it from 0 to 2.; the fifth digit from the left is the unit value of this hour; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is tens of the minute at which DST starts; press ▸ to enter and press '+' to set it from 0 to 5. The eighth digit from the left is the unit value of this minute; press ▸ to enter and press '+' to set it from 0 to 9. After all are set, press 'ENTER' to save the setting.

For example,

- LED displays 9□□ 1 3 ═ 3 0, the DST starts at 13:30.
- LED displays 9□□ 0 1 ═ 0 1, the DST starts at 01:01.

7.3.5 Setting the Daylight Saving Compensation Time

Menu option 10: The fourth digit from the left is the tens of the number of hours the time changes due to DST (compensation time); press ▸ to enter and press '+' to set it from 0 to 2.; the fifth digit from the left is the unit value of this hour; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is the tens of these minutes; press ▸ to enter and press '+' to set it from 0 to 5. The eighth digit from left is the unit of the compensation minute, press ▸ to enter and press '+' to set it from 0 to 9. After all are set, press 'ENTER' to save the setting. For example,

- LED displays 1 0 □ 0 1 — 0 0, the DST time adds one hour to the standard local time.
- LED displays 1 0 □ 0 1 — 3 0, the DST time adds an hour and a half to the standard local time.

7.3.6 Setting the Daylight Saving Time End Date

Menu option 11: The fourth digit from the left represents the tens of the number of the month when DST finishes; Press ▸ to enter and press '+' to set it as 0 or 1; the fifth digit from the left is the units; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is the week when DST finishes; press ▸ to enter and press '+' to set it from 1 to 5. The eighth digit from the left is the day of the week in which DST finishes; Press ▸ to enter and press '+' to set it from 0 to 6, where 0 represents Sunday and 1 to 6 represent Monday to Saturday respectively. After all are set, press 'ENTER' to save the setting.

For example,

- LED displays 1 1 □ 1 0 ≡ 3 0, the DST ends on Sunday, the third week of October.
- LED displays 1 1 □ 0 9 ≡ 1 1, the DST ends on Monday, the first week of September.

7.3.7 Setting the Daylight Saving Time End Time

Menu option 12: The fourth digit from the left is the tens of the hour at which DST ends; press ▸ to enter and press '+' to set it from 0 to 2.; the fifth digit from the left is the units; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is tens of the minute at which DST ends; press ▸ to enter and press '+' to set it from 0 to 5. The eighth digit from the left is the units; press ▸ to enter and press '+' to set it from 0 to 9. After all are set, press 'ENTER' to save the setting.

For example;

- LED displays 1 1 □ 1 1 ═ 5 9, the DST ends at 11:59.
- LED displays 1 1 □ 2 3 ═ 3 0, the DST ends at 23:30.

7.3.8 Setting the Delay for the GPS Lost Alarm

Menu option 13: The fourth digit from the left is the tens of the number of hours the alarm is delayed; press ▸ to enter and press '+' to set it from 0 to 2.; the fifth digit from the left is the units; press ▸ to enter and press '+' to set it from 0 to 9. The seventh digit from the left is the tens of the minutes, press ▸ to enter and press '+' to set it from 0 to 5. The eighth digit from left is the units; press ▸ to enter and press '+' to set it from 0 to 9. After all are set, press 'ENTER' to save the setting.

For example;

- LED displays 1 3 □ 0 0 □ 0 0, it alarms immediately once the GPS is lost.
- LED displays 1 3 □ 0 1 □ 3 0, it alarms after one and a half hours if the GPS is lost.

7.3.9 Setting of the Output Time Interval of TXD1

In certain applications there is a requirement for an additional serial port output TXD1, which may require a delayed output time. This is provided by menu option 14, which can be set as follows: Set the output time interval of the second TXD1. Three settings can be made using the ▸ and '+'. Press 'ENTER' to save.

- LED displays 1 4 □ 1 ————, the second TXD1 communicates once per hour.
- LED displays 1 3 □ ——1 ——, the second TXD1 communicates once per minute.
- LED displays 1 3 □ ————1, the second TXD1 communicates once per second.

7.4 Output Ports

The output message format for the Serial Port Output (TXD0) is as follows;

a) Baud rate: 9600, 4800, 2400 and 1200 optional.

b) Data format: one start bit, 8 information bits, one stop bit, XN (Exclusive Or Not) check, check the time data between frame <T> and check bit, ASC II code.

c) Information format: once per second, the format is as follows:

＜S＞＜T＞ D D D D D D D D D D D D D D D＜A＞

Note:

＜S＞: start of pulse per second.

＜T＞: start of frame.

H1: hour(tens). H2: hour(units)

M1: minute (tens), M2: minute(units)

S1: second(tens), S2: second(units)

D1: date(tens), D2: date(units)

M1: month(tens), M2: month(units)

Y1: year (thousands), Y2: year(hundreds), Y3: year(tens), Y4: year(units)

C: check byte

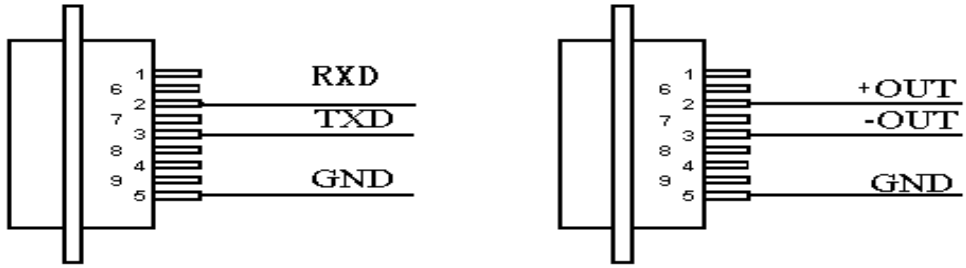
＜A＞: standard time end.

Here, 'S' is level with PPS rising edge.

For example, it is 08:20:30 Feb.10, 2020, when the T-GPS3000A is synchronised, the information format sent by the T-GPS3000A is ST08203010022020 <F7H> A.

If the GPS has just powered-on, or has lost synchronisation, the information format will not appear <S>, that is, the information outputted with the <T> as its frame head is not time-synchronised, while information with <S><T> as its frame head has a synchronised time.

a) Serial Output Pin is as Figure 7.2 below.



RS-232C Port RS422/485 Port

Figure 7.2: Serial Port Output

8. Maintenance and Troubleshooting

8.1 Inspection

The device should be inspected periodically, regular inspection should include checking that:

- the environment is clean and well-ventilated and the T-GPS is free of dust
- the temperature of the cabinet is normal. T-GPS requires an ambient temperature not exceeding 50°C to perform correctly.
- the LED ON is on and the lights SYNC and Com are flashing normally
- the connections on the rear panel fit firmly

8.2 Troubleshooting

If problems are identified during the inspection described previously, the first step to clearing them is to check the connection of the wires and cables. If all these connections are good but problems persist, the ensuing trouble-shooting procedures should be followed:

- Turn on the power, if the LED displays is no showing anything or the power indication light does not illuminate, check the connections and the fuse
- If the Running Indication light is off during operation, or the LED display cannot reset automatically, turn off the power then turn it on again.
- If the T-GPS3000A is not synchronised even after the power has been turned on for about 30 minutes, examine the antenna connection. If that is made properly, check the antenna installation.
- If the Synchronisation Indication light blinks during running, this indicates that the T-GPS3000A is not synchronised, check the connection and the antenna as above.

If the problem persists after completing the above, please contact Kehui (via info@kehui.com or your normal local contact)

8.3 Alarms

There are two alarm outputs, one named “Wrong Alarm”, and the other “GPS Fail Alarm”.

8.3.1 Wrong Alarm

This indicates that the T-GPS3000 has mal-operated. When the Wrong Alarm is activated, the operator should check whether the power indicator is on and if not, power on the instrument using the on-off switch at the rear of the power module. If this is unsuccessful, check the fuse and replace it if necessary. Finally, check the LED on the front-panel to determine that it is updating, the 1PPS indicator blinks if it is working correctly.

8.3.2 GPS Fail Alarm

This alarm indicates that the unit is unable to receive a GPS signal. Check that the connection to the antenna is secure and the antenna is situated correctly.

9. Transportation

9.1 Transportation considerations

Use the transport boxes provided and observe the environmental conditions specified in the technical data sheet.

9.2 Storage conditions, storage period and precautions

Observe the environmental conditions specified in the technical data sheet when storing the instrument.

The instrument should be stored in a dry environment providing suitable protection against mechanical damage and dust.

Where the instrument is not used on a regular basis, it should be stored indoors using the original packaging, and should not be exposed to the sun or rain. The room should be air-conditioned and should not contain corrosive gas. The instrument should not be subjected to severe mechanical vibration or shock and there not be a strong electromagnetic field.

If the instrument is not used for a long time, make sure that the detector and tablet are turned off and fully charge them every 10 months.

10. Unpacking and inspection

Before unpacking for the first time, follow the steps below.

i) Take out the document bag containing the instructions and packing list.

ii) Check the packing list to ensure that the contents are complete and intact.

iii) Check that the serial number is consistent with the instrument and the factory number of the warranty card.

Appendix A: T-GPS3000 Packing list

No.	Materials	Quantity
1a	T-GPS Master Unit: includes mandatory modules: Power Supply Module, Antenna Module, Alarm Module, Signal Out (to slave) Module (With 6 free slots)	1
1b	T-GPS Slave unit: Power Supply Module, Alarm Module, Two IRIG-B In Modules (With 6 free slots for housing optional modules)	1
2	Optional modules (refer to section 4)	
3	Antenna with Cable	1
4	Antenna Mounting Kit	1
5	Surge Protection Device (SPD)	1
6	Earth cable for SPD	1
7	Connection cable for SPD (To T-GPS unit)	1
8	User Manual	1