

**GPS-200**

**MASTER CLOCK**

**IRIG-B or SMPTE**

**TIME CODE GENERATOR**

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## **DISCLAIMER**

The information contained in this document is subject to change without notice.

W Clark & Associates, Ltd. (hereinafter C&A) makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose.

C&A shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material.

See important *limited warranty* information starting on page 15.

## **ADVISORY NOTICE**

### **CONCERNING GPS SATELLITE SYSTEM AND THE GPS-200 TIME CODE GENERATOR**

Depending on many factors beyond the control of C&A, the signals that are received from the GPS Satellites **are subject to interference, fading, satellite failure and other influences *that could cause*** the GPS-200 to generate erroneous time and/or date information and, under some conditions, ***could prevent*** it from generating a time code signal and or cause it to generate an erroneous time code signal.

***It is the responsibility of the user to determine the adequacy and suitability of this device for the intended use.***

## **INTRODUCTION**

The GPS-200 is a precision IRIG-B or SMPTE time code generator that provides a source of very stable time code and accurate time and date information. It receives reference time information from Atomic Clocks in the GPS (Global Positioning System) satellites.

## **GPS SATELLITES**

The GPS satellites are operated and maintained by the US Department of Defense and allow for the precise determination of local time and location at any point on (or above) the Earth. This is accomplished via the transmission of very accurate timing information from a series of satellites that provide coverage of the entire planet.

The GPS-200 extracts timing reference from these signals and generates IRIG-B or SMPTE time code that is synchronized to within less than 10 microseconds of UTC (Universal Coordinated or Greenwich mean time).

## **UTC/ GREENWICH TIME**

UTC is the local time at the prime reference meridian at Greenwich, England. At a given location on the planet, local time can be displaced (referenced to UTC) by -11 to +12 hours. North and South America are from -3 to -11 hours delayed; most of Europe and Africa and all of Asia and Australia are advanced by +1 to +12 hours.

## **TIME ZONES & DAYLIGHT SAVING TIME**

Local time in the US and some other countries can also be offset by Daylight Saving Time (DST) whereby the local time is advanced by 1 hour in the Spring of the year and set-back in the Fall. UTC is not affected or changed by any of these local variations.

The GPS-200 can provide offset to local time. Hour offsets of -11 to +12 hours (including ½ hour offsets) can be configured via a switch bank on the GPS-200 board. U.S. and Canadian daylight savings time adjustment can also be enabled. Other daylight savings offsets can be provided on special order. Additional time zone and daylight savings time configurations can be programmed via the GPS-200's RS-232 interface.

## **SMPTE OR IRIG-B - WHICH TO USE**

The GPS-200 will generate either SMPTE (24, 25 & 30 fps) or IRIG-B (1 kHz modulated) time codes (TC). All of these TCs work well and all are in use in thousands of locations throughout the world. If your operation, installation or facility is currently using a particular type of TC it is probably best to continue using the same TC. If not and if the GPS-200 is to be used as a Master Clock generator then we recommend the use either 25 or 30 fps SMPTE. (30 fps in countries with 60Hz AC line frequency & 25 fps in countries with 50Hz AC line frequency.)

The reason for the above recommendation is that C&A encodes/decodes *year* information in the SMPTE TC but not in the IRIG-B. This encoded year information allows automatic calculation of Leap Years and setting of the correct year in computers and other devices that can decode the information.

## **INITIAL OPERATION**

The GPS-200 was thoroughly tested with its external power supply (PS) and antenna prior to shipment. Installation and setup is simply a matter of connecting the antenna and PS.

## **OPERATING THE GPS-200 FOR THE FIRST TIME**

When the GPS-200 is initially powered up, after having been shipped to a new location, the time to first fix (time the unit takes to acquire satellites and extract correct local time) could be up to 25 minutes although it is typically 5 - 15 minutes. Factors such as atmospheric conditions, type of antenna, antenna location, and antenna cable length will affect the time to first fix.

The GPS-200's GPS navigation module has a backup battery that maintains startup data when the unit is powered down. If, when starting up, the location, time and number of satellites that the unit can receive has not changed significantly since last power down then the unit will startup much faster.

## **ANTENNA LOCATION**

Depending on the type of building where the GPS-200 is located and obstructions that may block reception of signals from the GPS satellites, the antenna may have to be located where it has an unobstructed view of the sky. In some cases this can be accomplished by placing the antenna adjacent to a window. In most cases it will require mounting it outside of the building or on a roof. In the worse case, the basic requirement for assured system operation is that the antenna module have a clear and unobstructed view of the sky for initial satellite acquisition and lock (generation of time code by the GPS-200). It is possible that the system will operate indoors and under other obstructions however this can only be determined empirically; it is not guaranteed.

If a longer cable is required, cables of various lengths (up to 500') with pre-amplified antennas are available from C&A. *Bringing the GPS-200 up for the first time with an indoor antenna may prevent or significantly increase the time to first fix.*

## **TIME CODE INTERCONNECT CABLE**

The IRIG-B and SMPTE time code signals are audio signals similar to that of a Modem. This time code signal can be routed over unshielded wire like a telephone or, if desired, over a RG-58/59 coaxial cable. The GPS-200 generates time code on pin 6 of the male DB-9 connector located on the rear of the unit. Pin 5 is the associated ground.

The necessary connectors and wire can be purchased at a Radio Shack or other electronic supply store or from C&A. Check with factory for details.

## **INITIAL OPERATIONS AND I/O CONNECTIONS**

1. Locate the antenna in a suitable area so that the top of the antenna module has a clear view of the sky. Do not move it until after the GPS-200 has initiated TC generation (explained below).
2. Connect the antenna coax to the TNC connector on the rear of the unit.
3. Connect your time code reader system to the DB-9 connector on the rear of the GPS-200. (The SMPTE output of the GPS-200 is approximately 2 volt PP. The IRIG-B output of the GPS-200 is amplitude modulated and approximately 5 volt PP. The output is unbalanced.
4. Apply power by inserting the PS module into an appropriate AC power source and the power connector into the male power socket on the rear of the unit.
5. If desired the unit can be operated from a nominal 12 VDC battery (9-18 VDC range). Observe voltage polarity - printed on the rear panel.
6. When power is first applied the initial sequence of the front panel LED is:
  - LED on briefly
  - LED off for one second
  - LED steady on.
7. The unit first calculates coordinates and distances for acquisition of GPS satellites. The LED will remain on until satellites are acquired and precise location and timing references are established.

## **NORMAL OPERATION**

After acquisition of satellites the GPS-200 will begin generating time code and the LED will blink on and off once each second; the start of each on period is in precise time alignment with UTC and the beginning of frame 0 of the SMPTE signal or the beginning of the first reference marker of IRIG-B time code..

## **FREEWHEELING**

During continuous operation it is likely that the unit will experience outages and loss of satellite reference time. This can be caused by atmospheric and many other outside conditions which are essentially unavoidable with a simplex system. Such signal losses can last from a few minutes to hours. When the condition disappears and the unit re-acquires satellite timing reference it will automatically resync to the satellite time reference.

During such outages the GPS-200 will continue to generate time code (TC) referenced to the last available satellite timing information. This mode is referred to as freewheeling. When the unit first acquires satellite time it calibrates an internal reference oscillator against the incoming atomic time. During freewheeling the generated time code will be referenced to this calibrated oscillator and will typically be accurate to within a few milli seconds over a 24 hour period (if the power is not disconnected). As is covered in other areas of this IB the freewheeling status is encoded/decoded by the TCRSYNC software supplied by C&A and the operator is given the option of synchronizing to the TC during the freewheeling state. The freewheeling state is also indicated with a TTL signal available on the DB-9 connector

## **FREEWHEELING/NON LOCKED LED INDICATION**

During a freewheeling period the front panel LED will flash twice each second.

## **HARDWARE**

### **OPERATING ENVIRONMENT**

The GPS-200 is not water or moisture proof. Treat it as you would any other delicate electronic device and do not expose it to water, excessive heat or physical abuse, particularly when using the unit as a portable TC generator.

### **ACCESS TO PC BOARD**

In order to gain access to the pin jumpers it is necessary to remove the case from the GPS-200. This is accomplished as follows:

First disconnect the power and antenna cable from the unit. Even though the highest voltage inside the GPS-200 is 12 VDC (which is generally not dangerous to touch), accidentally shorting a trace or wire inside the unit with power-on could destroy or damage any one of the extremely sensitive electronic modules. **Accidentally shorting a wire or trace or subjecting the unit to a static discharge, even for a very small fraction of a second, can destroy these modules. Such damage is not covered by the warranty.**

Remove the two outside Phillips screws in the rear panel (this is the end with the power, and antenna socket, and DB-9 connector). Holding the case of the unit in one hand, slide the rear panel assembly outward from the rear. The entire rear panel assembly and PC board will slide out.

As was mentioned above, the PC board is sensitive to any electrical signal including static discharge. Do not touch the PC board with any external wiring and, whenever possible, handle the unit by the rear panel or on the edge of the PC board as you would a Compact Disk. When not changing the jumpers always keep the PC board installed in the case.

When reassembling the unit take care that the PC board is properly fitted into the slots in the base of the chassis. When properly inserted, the PC board and rear panel assembly will slide easily into the case, no force is necessary. The warranty does not cover damage caused to the unit while removing or reassembling the PC board.

## **OPERATIONAL MODES**

There are four operational modes for the GPS-200, they are:

- SMPTE time code output (30 frames/second, non drop-frame)
- SMPTE time code output (25 frames/second)
- SMPTE time code output (24 frames/second)
- IRIG-B(1) (modulated 1 kHz)

Normally the unit is shipped for the appropriate mode of operation at the time of order. Should it be necessary to change this mode is accomplished by setting positions 9 and 10 of SW1 switch bank on the PC board inside the unit and possibly changing the jumpers on J4. (See hardware section for details of gaining access to the PC Board.)

## **CONFIGURING OPERATION VIA ON-BOARD SWITCHES**

The on-board 10 position switch bank (SW1) is used to configure the basic operation modes of the GPS-200. If switch settings are changed while the GPS-200 is operating power must be cycled off/on the unit for the new settings to take affect.

Switch positions 1 through 4 configure the hour offset the GPS-200 will apply to generated time code. The offset is referenced to UTC (Greenwich Mean Time).

Position	1	2	3	4	Hour offset
	off	off	off	off	No offset
	on	off	off	off	1 hour
	off	on	off	off	2 hours
	on	on	off	off	3 hours
	off	off	on	off	4 hours
	on	off	on	off	5 hours
	off	on	on	off	6 hours
	on	on	on	off	7 hours
	off	off	off	on	8 hours
	on	off	off	on	9 hours
	off	on	off	on	10 hours
	on	on	off	on	11 hours
	off	off	on	on	12 hours

Switch 6 in the ON position applies an additional ½ hour offset to the offset specified by switches 1 - 4.

Switch 5 in the ON position indicates that the offset specified by switches 1 - 4 & 6 is negative.

Switch 7 in the ON position instructs the GPS-200 to apply a daylight savings time adjustment to generated time code (when applicable). *(The default daylight savings time definition is U.S./Canada, where daylight time begins on the first Sunday of April, at 2:00AM and ends on the last Sunday of October at 2:00AM. Additional daylight savings time configurations can be provided(permanently programmed) by C&A on special order. )*

Switch 8 OFF starts TC at GPS satellite lock. ON starts TC at power on starting at 00:00:00

Switches 9 and 10 configure the time code output format of the GPS-200.

Position	9	10	Time code type
	off	off	SMPTE 30 frames/second
	on	off	SMPTE 25 frames/second
	off	on	SMPTE 24 frames/second
	on	on	IRIG-B(1)

***Important note: Jumper J4 must be switched to route generated time code to pin 6 of the DB-9. For SMPTE-format time codes the pin header should jumper pins 1 and 2 of jumper J4. For IRIG-B the pin header should jumper pins 2 and 3.***

Note: Some switch banks may refer to on as “closed” and off as “open”.

## **DB-9 CONNECTIONS**

### **Pin 1 - Pulse Out**

TTL-level 100ms active low pulse generated once per second by the GPS receiver. The negative-going edge of the pulse is aligned with UTC (Greenwich Mean Time) when the receiver has a 3-dimensional GPS satellite fix. This pulse is not available when the GPS-200 is first powered on. The pulse may become unavailable if the receiver loses GPS satellite fix for an extended period of time. Accuracy of this pulse (when synchronized to GPS satellite) is nominally +/- 1us.

### **Pin 2 - RS-232 RX**

RS-232 receive line.

### **Pin 3 - RS-232 TX**

RS-232 transmit line.

### **Pin 4 - Pulse Per Frame**

10ms active low (-4V) pulse generated once per frame when generating any of the three SMPTE time code formats. The negative-going edge of the pulse is aligned with the beginning of bit 0 of the SMPTE time frame. This pulse is not generated when the GPS-200 is configured for IRIG-B operation.

### **Pin 5 - Ground**

Connect this pin to the ground of any host communicating to the GPS-200 via RS-232. Also connect this pin to the ground of any device decoding time code from the GPS-200.

### **Pin 6 - Time Code Out**

SMPTE or IRIG-B time code is generated on this pin. Jumper J4 must be switched to properly route generated time code to this pin. For SMPTE-format time codes the pin header should jumper pins 1 and 2 of jumper J4. For IRIG-B the pin header should jumper pins 2 and 3.

### **Pin 7 - Locked/Unlocked**

TTL-level time code locked/unlocked indication. +5V when GPS-200 is generating time code valid for critical timing. 0V when GPS-200 not generating time code or GPS-200 is freewheeling.

### **Pin 8 & 9 - no connection**

These pins are reserved for future use.

## **COMMUNICATING WITH THE GPS-200 VIA RS-232**

The GPS-200 supports a robust protocol for determining operation status. The following lists some of the information available to the user:

- GPS-200 status bits
- GPS receiver diagnostics
- GPS fix status and type
- UTC and generate time (including frame rate output)
- Enhanced time zone and daylight savings time configuration capability

The full GPS-200 RS-232 protocol specification is available for download at the W Clark & Associates, Ltd. home page on World Wide Web (<http://www.masterclock.com>). See the GPS-200 folder in the [Downloadable Files](#) area.

## **PRE-AMPLIFIED ANTENNA**

The GPS-200 requires a pre-amplified antenna. It provides 5 VDC via the center pin of the coaxial for remote power. ***Warning: Attaching a passive (non pre-amplified) antenna to the GPS-200 could destroy the GPS receiver module. This is a major repair cost which is not covered by warranty.***

The unit is tested and shipped with the appropriate cable for the antenna that was ordered. Should you require a longer antenna cable we recommend that you contact C&A so that a properly matched cable and antenna can be supplied.

Although changing the GPS antenna or coaxial cable is not technically difficult, you are on your own should you decide to make such changes. We do not warrant or support operation with any hardware not installed or supplied by us.

### **ANTENNA COAXIAL CABLE**

The coaxial cable should not be crushed, crimped or bent at a sharp angle nor should it be strained by pulling. Any damage to the cable could result in the GPS-200 not functioning properly. If the cable is to be coiled for storage, the coil diameter should be at least 6”.

### **PROBLEMS - TROUBLE SHOOTING**

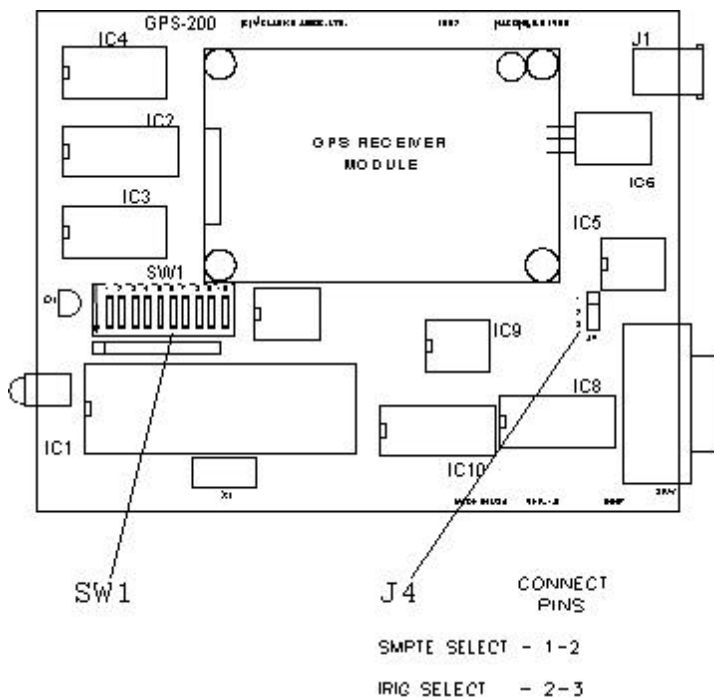
All GPS-200 units are checked for proper operation before shipment and unless physical damage is found, the unit is probably functional.

Please remember for an initial startup at a new location the unit could take up to 30 minutes. After the unit has acquired satellites at the new location the startup time is greatly reduced to anywhere from a few seconds to several minutes.

If the antenna (and coaxial cable) has not been damaged and has an unobstructed view of the sky, the power connector is properly installed and the front panel LED follows the startup sequence described earlier (on, off & then on) the unit will probably work.

If you continue to have problems even after the above precautions have been noted, please contact the factory.

### **PC BOARD LAYOUT**



## **SPECIFICATIONS**

### **OUTPUT**

Format:.....SMPTE - 24, 25 or 30 fps (non drop-frame)  
Level:.....Approx. - 2 Vpp  
Connector:.....DB-9 pin 6 (pin 5 associated ground)

Format:.....IRIG-B(1) amplitude modulated  
Level:.....Approx. - 5V Vpp  
Connector:.....DB-9 pin 6 (pin 5 associated ground)

Format:.....Pulse per second, negative going, 100ms width  
Level:.....TTL  
Connector:.....DB-9 pin 1 (pin 5 associated ground)

### **OUTPUT TIME**

Reference:.....UTC/GMT (default)  
Date:.....SMPTE: included in user bits IRIG-B: day of year is provided  
Short term accuracy ..... +/- 10  $\mu$ s  
Long term stability ..... same as GPS atomic clock

### **POWER SUPPLY REQUIREMENTS**

Input Voltage ..... 12 VDC  
Input Power Connector.....2 mm male power jack  
Power Consumption - @ 12V .... @ 220 ma (2.64W)

### **PHYSICAL**

Size: ..... 1.5 x 4.1 x 5.5 in. (3.8 x 10.4 x 14 cm)  
Weight ..... 17 oz. (480 g)

### **OPERATING TEMPERATURE**

Temperature ..... 0 to +70 °

### **ANTENNA**

#### **Pre-Amplified**

Frequency ..... 1575 MHz  $\pm$  10 MHz  
Polarization.....Right Hand Circular  
Impedance ..... 50 Ohm  
Weight ..... 8.3 Oz (235 gr.)  
Voltage.....5 VDC  
Power Consumption ..... @ 20 ma (.24W)  
Gain ..... 26 DB Standard  
Temperature ..... -40 to +70°

### **COAXIAL CABLE**

Type ..... 51 Ohm low loss - RG-58/U (Belden 8219 or equivalent)  
TNC connectors

## **OPTIONS**

### **RACK MOUNT**

RM-4

### **PRE-AMPLIFIED ANTENNA**

### **ANTENNA MOUNTING KIT**

#### **Remote Antenna**

Antenna mounts on a threaded pipe.  
Shown here with 50' (15m) coaxial cable

Standard coaxial cable lengths are 50 (15m), 100 (30m ), 150 (45m)

Up to 500' - 150m on special order.

Antenna mounting kit consist of threaded coupling, 18" (45 cm) PVC pipe section and 2 galvanized clamps for attaching to vertical surface.

#### **ANT-MNT**

### **LIMITED WARRANTY**

This W Clark & Associates, Ltd. (hereinafter C&A) product warranty extends to the original purchaser.

C&A warrants the GPS-200 against defects in materials and workmanship for a period of one year from date of sale. If C&A receives notice of such defects during the warranty period, C&A will, at its option, either repair or replace products which prove to be defective.

Should C&A be unable to repair or replace the product within a reasonable amount of time, the customer's alternate remedy shall be a refund of the purchase price upon return of the product to C&A. This warranty gives the customer specific legal rights. Other rights, which vary from state to state or province to province, may be available.

### **Exclusions**

The above warranty shall not apply to defects resulting from improper or inadequate maintenance by the customer, customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product or improper site preparation and maintenance (if applicable).

### **Warranty Limitations**

C&A MAKES NO OTHER WARRANTY, EITHER EXPRESSED OR IMPLIED, WITH RESPECT TO THIS PRODUCT. C&A SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

In any state or province which does not allow the foregoing disclaimer, any implied warranty of merchantability or fitness for a particular purpose imposed by law in those states or provinces is limited to the one-year duration of the written warranty.

### **Exclusive Remedies**

THE REMEDIES PROVIDED HEREIN ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT SHALL C&A BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

In any state or province which does not allow the foregoing exclusion or limitation of incidental or consequential damages, the customer may have other remedies.

### **HARDWARE SERVICE**

You may return your GPS-200 to C&A for repair service. Please contact the factory for return authorization before returning the unit.