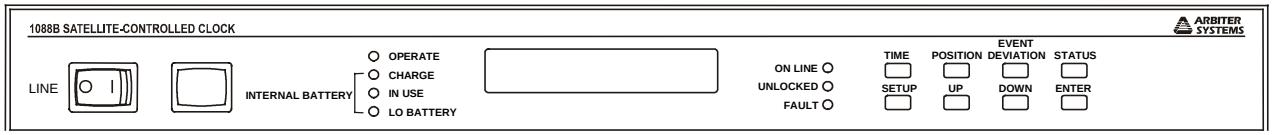
MODEL 1088B
SATELLITE-CONTROLLED CLOCK

OPERATION MANUAL



ARBITER SYSTEMS, INC.
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U.S.A.

This manual is issued for reference only, at the convenience of Arbiter Systems. Reasonable effort was made to verify that all contents were accurate as of the time of publication. Check with Arbiter Systems at the address below for any revisions made since the original date of publication.

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What This Manual Covers

This manual describes the operation and configuration of the Model 1088B GPS Satellite-Controlled Clock.

ROM Dates

This version of the manual is written for clocks having ROM dates of 4-1-03 or later. Any changes made in subsequent revisions which affect operation or specifications will be noted with either (a) a new manual or (b) a revised version of this manual. To display the ROM date for your instrument, hold down the SETUP key at power-on. The ROM date (software version) will be displayed. You can also read the ROM date via RS-232, using the "V" command; see Appendix A.

The specifications and functions in this manual also apply for IRIG code ROM dates of 5-19-94 or later. To determine the IRIG-B code date, the cover of the instrument must be removed. Earlier versions of this ROM do not implement the IRIG-B Modified Manchester output signal selection, and some earlier versions do not meet the IRIG-B synchronization specification.

Firmware Updates

Firmware updates are available to customers on an exchange basis. Contact our factory service department for information. Where applicable, this update may include new documentation, such as a new version of this manual.

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- Five years from the date of delivery.

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ii. Accident;
iii. Repair or maintenance performed by Buyer, except in accordance with the operation and maintenance manuals, if any, and any special instructions of Arbiter Systems;
iv. Modification without the prior written authorization of Arbiter Systems (whether by the substitution of non-approved parts or otherwise).

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FOR THE FASTEST POSSIBLE SERVICE, PLEASE PROCEED AS FOLLOWS:

1. Notify Arbiter Systems, Inc., specifying the instrument model number and serial number and giving full details of the difficulty. Service data or instrument-return authorization will be provided upon receipt of this information.
2. If instrument return is authorized, forward prepaid to the manufacturer. If it is determined that the instrument is not covered by this warranty, an estimate will be made before the repair work begins, if requested.

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Model 1088B

Satellite-Controlled Clock

Operation Manual

PD0013700G

Table of Contents

List of Tables and Figures

1.0 General Information

1.1 Scope

This manual describes the Model 1088B GPS Satellite-Controlled Clock and is divided into five sections and three appendixes as follows:

Section 1.	General Information.
Section 2.	Technical Specifications and Operational Parameters.
Section 3.	Physical Configuration and Installation.
Section 4.	Operation.
Section 5.	Firmware Setup and Configuration.
Appendix A.	RS-232 Commands.
Appendix B.	I/O Signal Description.
Appendix C.	Options List

1.2 Equipment Needed

The standard Model 1088B uses detachable connectors for Power, Antenna, and all Input and Output connections. To operate, the Model 1088B requires a power source for supply and connection to a GPS antenna through antenna cabling. These are provided and described below.

1.2.1 Antenna, Cables and Accessories Chart

A standard Model 1088B Satellite-Controlled Clock comes equipped with the following accessories:

- GPS Antenna, pipe mountable AS0076200
- 15-m (50-ft) Antenna Cable CA0021315
- Rack-Mount Kit (for standard 19-inch rack) AS0028200
- Operation Manual AS0029900
- Power Cord P01 – P10

Antenna and Cable: The antenna supplied with the 1088B is specifically designed for use with GPS receivers. Housed in a weatherproof case, it includes 15 meters (50 feet) of RG-6 weatherproof, low loss, coaxial cable. Longer cable runs require one of the optional cable assemblies listed (see paragraph 1.2.2) intended to be added to the existing 15-meter cable.

Main Power Module: The Model 1088B comes equipped with one of three input power options, specified at the time of order. These options include:

- Standard: 85 – 264 Vac, 47 – 440 Hz or 110 – 370 Vdc, less than 20 Watts, IEC-320 type power input module, with an IEC-320 ac cord.

- Option 7: Three-position, screw-type, terminal strip replaces the IEC-320 power inlet module. Used with the Option 15X Surge-Withstand protection circuitry.
- Option 08: 10 – 60 Vdc (DC ONLY), less than 20 Watts, power module; uses Option 07, 3-pole terminal strip for power inlet. Power cord supplied by customer.

Refer to paragraph 1.3 for a detailed description of each power module option.

Mounting: The Model 1088B includes two separate brackets for mounting in a 19-inch rack. It also includes rubber feet for desktop use. Cover mounting hardware allows easy attachment of the rack-mount ears to the 1088B.

1.2.2 Available Accessories

Available accessories and associated part numbers for the Model 1088B are listed below. This list does not include available options. For options see section 1.3, Options.

Description	Order No.
15-m (50-ft) RG-6 Antenna Cable	CA0021315
30-m (100-ft) RG-6 Antenna Cable	CA0021330
45-m (150-ft) RG-6 Antenna Cable	CA0021345
60-m (200-ft) RG-6 Antenna Cable	CA0021360
75-m (250-ft) RG-6 Antenna Cable	CA0021375
GPS Antenna Mounting Kit	AS0044600
21-dB In-Line Preamplifier	AS0044700
GPS Surge Protector Kit	AS0049000
Grounding Block Kit	AS0048900
1000-ft Roll RG-11 Cable	WC0004900
RG-6 Crimp Tool	TF0006400
RG-11 Crimp Tool + 25 Type F Connectors	AS0044800

For RG-6 cable lengths between 75 and 150 meters (250 – 500 feet), Arbiter Systems offers an inline 21-dB preamplifier to make up for signal losses up to 21 dB; see section 3.0 for further information concerning Antennas and Cables. The same 21-dB preamplifier makes up the signal loss for RG-11 cable lengths of greater than 122 meters (400 feet) and up to 244 meters (800 feet).

Standard, RG-6 Antenna Cable

The standard antenna cable assembly included with the clock is constructed using a 15-meter (50-foot) length of RG-6 low-loss coaxial cable, terminated with male Type F RF connectors. Cable delay is 1.19 ns per foot. Optional lengths of RG-6 coax are separately available for longer runs. For further information, see paragraph 3.5.1.3.

GPS Antenna Mounting Kit

A mounting kit, separately available as P/N AS0044600, can be used to mount the antenna to a vertical mast (up to approximately 2-in. diameter), or to the wall or roof of a structure such as an antenna tower or a building. This kit contains a short length of threaded, plastic pipe, a stainless

steel bracket, and hardware to attach the pipe to the bracket in any of several orientations. With this kit, it is possible to mount the bracket to any surface from vertical to horizontal, while maintaining acceptable orientation for the antenna. This bracket will accept user-supplied screws for surface mounting, and straps (such as pipe clamps) for mounting to a pipe or mast.

GPS Surge Protector Kit

Designed for GPS protection against lightning and other surges. Multi-stage circuitry with a heavy-duty gas discharge tube, toroidal inductor, MOV, and capacitors provide less than 1 nanosecond response time and power handling capacity of 20,000 amps (8/20 μs). Passes dc power to the antenna and preamplifier. Includes two, Type-F female mating connectors for RG-6 cable; crimp tool is available separately. Operating temperature is –40° to +120° C.

Grounding Block Kit

The Grounding Block Kit consists of a Type-F bulkhead feedthrough mounted in an extruded aluminum bracket with grounding screw. It also includes two, Type-F female mating connectors for RG-6; a crimp tool is available.

RG-11 Cable, 1000-foot Roll

A larger diameter cable, RG-11 comes in a 1000-foot roll for individual applications. With a lower loss characteristic than RG-6 (5.25 dB/100’ compared to 9 dB), it can be used where longer runs are required. Also, its quad-shield design provides better shielding from nearby interfering signals to the low-level GPS signal.

RG-6 Crimp Tool

This crimp tool is designed for use with a 0.360” RG-6, hex crimp connector. Advanced design crimp ring of connector can accommodate a wide range of cable sizes, and is made of brass. Connection provides excellent shielding and mechanical retention.

RG-11 Crimp Tool and 25 Connectors

This crimp tool is designed for use with 0.480” RG-11, hex crimp connector. Crimp-on center pin of 0.030” prevents potential damage to F female. Attached crimp ring, of connector, provides excellent electrical shielding and mechanical retention.

1.3 Options

The Model 1088B allows for installation of options, which can enhance various aspects of performance and/or features. The following is a list of those options available for the Satellite Controlled Clock, Model 1088B:

1.3.1 Option Data Sheet Details

See Appendix C at the end of this manual for complete information on options listed in this section.

1.3.2 Available Options

Option 01	LCD Backlight
Option 03	Four Additional Configurable Outputs
Option 04	Parallel BCD Interface
Option 07	Terminal Power Strip
Option 08	10 – 60 Vdc Power Supply with Terminal Power Strip
Option 12A	Oven-Controlled Crystal Oscillator & Four Additional Configurable Outputs
Option 15A	Power Inlet Surge Withstand Capability, 125 Vdc
Option 15B	Power Inlet Surge Withstand Capability, 250 Vdc
Option 17	BCD Output with Additional RS-232C Port
Option 18	Self Monitor, Additional RS-232C Port, IRIG-B Distribution System and Redundant Clock Control
Option 19	Terminal Strip Out-of-Lock Relay
Option 20A	Four Configurable Fiber-Optic Outputs
Option 23	COMTRADE Sample Rate Generator
Option 26	Rack Slide Kit
Option 27	8-Channel High Drive IRIG-B Output
Option 28	Power System Time, Frequency, and Phases Monitor
Option 29	Four Additional +5 Vdc CMOS Outputs and Two Configurable Solid-State Relay Outputs, with Dry Contact and +25/50 Vdc
Option 32	Internal Network Time Protocol (NTP) Server

2.0 Technical Specifications and Operating Parameters

2.1 Scope

This section contains information pertinent to the functional and operational characteristics of the standard Model 1088B Satellite Controlled Clock. Topics presented in this section are: Receiver Characteristics, I/O Configuration, System Interface(s), Antenna System, Operator Interface(s), and Physical Specifications.

NOTE: Specifications are subject to change without notice.

2.2 Receiver Characteristics

2.2.1 Input Signal

- 1575.42 MHz., GPS L1 C/A code

2.2.2 Timing Accuracy

- GPS/UTC time +/-50 ns rms (at 1-PPS output), when receiving 4 or more satellites (one satellite if position is known within 25 meters.), and Position-Hold mode ON.

2.2.3 Internal Oscillator, Accuracy

- Standard: DCXO, $1x10^{-7}$ unlocked

2.2.4 Allen Variance (locked to GPS, in Position-Hold Mode)

- 1 second 5×10^{-10} (2×10^{-10} typical)
- 1 day 5×10^{-13}

2.2.5 Position Accuracy (rms)

- 25 meters, SA OFF
- 100 meters, SA[1] ON.
- 140 meters (elevation), SA ON.

2.2.6 Satellite Tracking

- 12 channels, C/A code (1575.42 MHz)

The receiver simultaneously tracks up to twelve satellites. Results from all tracked satellites are averaged in Position-Hold Mode or, with Position Hold Off, are determined by least-squares estimation.

[1] USA Department of Defense Selective Availability: All specifications rms, 95% confidence, with Position-Hold Mode off and receiving at least four satellites.

2.2.7 Acquisition

- 25 seconds, TTFF[2]-hot (with Almanac, time, position and ephemeris[3] less than 4 hours old)
- 50 seconds, TTFF-warm (with Almanac, position and time)
- 200 seconds, TTFF-cold (no stored information)

2.3 I/O Configuration

Any output signal, or the designated input, may be selected on any connector by means of internal push-on jumpers. Each output connector is independently buffered.

2.3.1 I/O Connectors

Each connector may be configured as a specific input function or to any one of the output signals listed below.

- Signals, four BNC user configurable
- Option 03 adds four extra outputs for a total of eight.

2.3.2 Output Signals

- IRIG-B: 1 kHz modulated, 10 Vpp.
- IRIG-B, D, E, or H: 5 V CMOS level-shift.
- 1 PPS, 1 PPM, 1 PPH: 5 V CMOS.
- 10, 50, 60, or 100 PPS.
- 1, 10, or 100 kPPS.
- 1, 5, or 10 MPPS.
- 5 V CMOS.
- 1-PPS deviation (chart recorder): +/- 5V at 10µs/v.
- IRIG-B Modified Manchester (IEEE Std P1344)
- Out of Lock: 5V CMOS (HI = Locked, LO = Unlocked).
- Programmable Pulse, user-selectable: 5V CMOS.
- CMOS outputs are buffer type (74HC126) with 47- source resistors.
- Analog outputs are op-amp (LF353) followers with 560-Ω protective resistors.

[2] TTFF – Time To First Fix.

[3] Ephemeris data is a list of (accurate) positions or locations of a celestial object as a function of time. This is transmitted as a part of the GPS satellite transmission and is valid for approximately 4 hours. It is saved on loss of power since the GPS receiver has it's own, integral data backup battery.

2.3.3 Input Functions

- Event A/1-PPS input: 5 V TTL/CMOS.
- Event B/1-PPS input: 5 V TTL/CMOS.
- External Timebase Input: 100 kHz, 1, 5, or 10 MHz.
- Units with S/N of A119 and below: 5V TTL/CMOS.
- Units with S/N of A120 and above: AC- or DC-Coupled signals with a slew rate of 10 V/µs minimum and level of 5 Vpp maximum.
- Uncommitted input for special configurations.

2.3.4 Event Inputs

- These inputs have 100-ns timing resolution and can record up to 300 sequential events, provided that the events are separated by at least 11 milliseconds. Read the event log later from either the front panel or RS-232 interface. A command is also provided to clear the event log. Event data is stored in battery-backed RAM.
- The Event A and B inputs may also be configured to accept an external 1-PPS signal, and measure the deviation from 1 PPS/GPS with 100-ns resolution.

2.3.5 Synchronization

- For a received data message, the leading edge of the start bit may be selected to trigger the Event A input, providing synchronization with 100-ns resolution.

2.4 System Interface

2.4.1 RS-232C Port

- Connector: 9-pin D-Type subminiature:

Pin #	Function	Pin #	Function
1	Not Connected	6	Not Connected
2	RS-232, Receive Data*	7	Not Connected
3	RS-232, Transmit Data*	8	Auxiliary Input
4	Auxiliary Output	9	Not Connected
5	Ground*		

* only function pins available at second optional serial port

Communication Parameter

- Selectable 1,200-19,200 baud; 7 or 8 data bits, 1 or 2 stop bits, odd/even/no parity.
- Supports all keyboard functions

Broadcast Data Formats

Supports continuous output data in the following formats (see Table A-1 for details):

- <SOH>ddd:hh:mm:ss<CR><LF>	Broadcast Mode, ASCII Std
- 44hhmmss<CR><LF>55ddd<CR><LF> ...<BEL>	Broadcast Mode, Vorne Std
- mm/dd/yyyy hh:mm:ss.sssssss nnn<CR><LF>	Broadcast Mode, Event Data
- ddd:hh:mm:ss I=nn:nn X=nn:nn<CR><LF>	Broadcast Mode, Status
- <CR><LF>Q_yy_ddd_hh:mm:ss.000___<CR><LF>	Broadcast Mode, Extended ASCII
- <SOH>ddd:hh:mmm:ssQ<CR><LF>	Broadcast Mode, ASCII w/Time Quality
- <SOH>yyyy:ddd:hh:mm:ssQ<CR><LF>	Broadcast Mode, ASCII year with TQ

For more information refer to RS-232 Broadcast Commands contained in Appendix A. Table A-1.

2.5 Antenna System

The included antenna is directly mounted in 19-mm (¾-in.) hole. Other mounting configurations are available (contact Arbiter Systems).

- GPS Antenna Assembly, ¾-in. Pipe Thread Mount
- Bracket available to mount on 60-mm (2-in. nominal) pipe or various other structures (Accessories: P/N AS0044600, see paragraph 1.2.2).

2.5.1 Antenna Cable

- 15-meter (50-foot) cable included with antenna.
- Other cable styles and lengths available – see paragraphs 1.2.2 and 3.5.

2.6 Operator Interface

2.6.1 Setup Methods

- Via RS-232C Interface
- 8 Front-panel keys

2.6.2 Setup Functions

- Initial Position
- RS-232 Parameters
- Local Hour
- Out-of-Lock
- Backlight
- System Delays
- Programmable Pulse
- IRIG Time Data
- Event/Deviation
- Frequency Reference
- Auto Survey
- Position Hold
- Option Board

2.6.3 Display

- 2-line by 20-character supertwist LCD
- Backlight available (Option 01)

Display Functions

- Time: UTC or Local
- Position: Latitude, Longitude and Elevation
- Status: Clock & Receiver
- 1-PPS (input) Deviation
- Event Time

2.6.4 Annunciators

- OPERATE (Green)
- ON LINE (Green)
- UNLOCKED (Red)
- FAULT (Red)
- INTERNAL BATTERY
  - CHARGE (Green)
  - IN USE (Green)
  - LO BATTERY (Red)

2.7 Physical Specifications

2.7.1 Dimensions

- Instrument: 430-mm W x 44-mm H x 280-mm D (16.9-in. x 1.7-in. x 11.1-in.)
- Antenna: 77-mm diameter x 66-mm height (3.05-in. x 2.61-in.)

2.7.2 Weight

- 2.0 kg (4.4 lbs.) net. (Instrument)
- 2.2 kg (4.85 lbs.) net. (Antenna and Cable)
- 7 kg (15 lbs) Shipping (includes antenna, cables, and accessories)

2.7.3 Power Requirements

The Model 1088B requires that power be supplied from one of the two optional supplies described below. Additionally, the antenna receives power through the antenna cable connected to the Type-F connector on the rear panel of the Model 1088B. Power is supplied internally.

- 85 – 264 Vac, 47 – 440 Hz, or 110 – 250 Vdc, less than 20 Watts (Standard power supply).
- 10 – 60 Vdc, less than 20 Watts (Option 08). Uses Option 07 input connection.

2.7.4 Power Connector

- Standard Power Supply: includes a fused IEC-320 power inlet module with mating ac cord. Plug type specified as Options P1 through P10 (see paragraph 3.1.8).
- Options 07 and 08: Using a 3-pole terminal strip with SWC for power inlet.

2.7.5 Electro-Magnetic Interference (EMI)

- Conducted Emissions: power supply (Options 07 and 08) complies with FCC 20780, Class A and VDE 0871/6.78, Class A
- Surge Withstand Capability (SWC), power inlet (Options 07 and 08) designed to meet ANSI/IEEE C37.90-1 and IEC 801-4.

2.7.6 Temperature and Humidity

Temperature	Operating	Storage
Instrument	0 to 50ºC	-40 to 75ºC
Antenna	-40 to 85ºC	-55 to 100ºC
Antenna Cable	-40 to 60ºC	-40 to 80ºC
Humidity	10 to 90% non-condensing	10 to 90% non-condensing

3.0 Physical Configuration

3.1 Instrument

3.1.1 Location Considerations

The Model 1088B Satellite-Controlled Clock is designed for operation in an environment having an ambient temperature range of 0 to 50°C (32 to 122°F). No external ventilation is necessary. Operation is possible at temperatures of -20° to +65°C, although operation of the LCD display will be degraded. Normal operation will be restored once the temperature has returned to the specified range.

Allow adequate clearance for rear-panel connections, especially in rack-mounting situations. Adequate clearance reduces the possibility of damage to the connectors, cables, or the instrument. Ideally, the clock should be located close enough to the antenna location so that the standard 15-meter (50-foot) cable can be used. The loss and delay characteristics of the cable are important factors in the calibration and accuracy of the instrument (refer to paragraph 3.5.1); thus, the entire cable length should be used, with any excess coiled up and placed out of the way.

Arbiter Systems offers standard accessories allowing the antenna to be mounted up to 240 m (800 ft) from the clock if longer cable runs are required. These are described in sections 1.2.2 and 3.5.1. If a longer antenna cable than this is required, please contact the factory for advice.

3.1.2 Model Display Visibility

For best readability, consider the Model 1088B in its situation with the ambient light. The standard Model 1088B uses a 20-character by 2-line, *non-backlighted*, Liquid Crystal Display (LCD). In subdued lighting or at odd angles, the LCD may be difficult to read. In low-light conditions, choose a mounting height that will allow easy viewing and consider an *optional* backlighted LCD display (Option 01).

3.1.3 Power Requirements

The standard ac input voltage range for the Model 1088B Satellite-Controlled Clock is 85 – 264 Vac, 47 – 440 Hz., 110 – 250 Vdc. Also available is the Low Voltage DC Power Supply, Option 8, 10 – 60 Vdc (DC Only). The maximum power required is 3 VA typical.

Model 1088B Clocks, accompanying this manual revision, have a GPS data backup battery (rechargeable lithium) located on the GPS receiver. Use of a data backup battery results in reduced satellite acquisition time when power is restored after an outage. The data backup battery should keep the receiver data active for at least 1 month after a power outage. Battery durability for memory backup applications like this is up to five years.

3.1.4 Power Line connection

All standard Model 1088 Clocks are equipped with a *user specified* Power Input Module. The modules available are described in the following paragraphs.

3.1.5 AC/DC Power Inlet Module (IEC-320 Inlet) - Standard

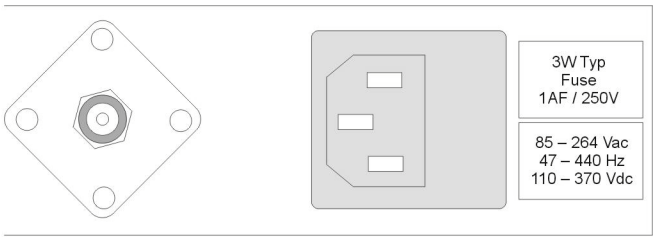

Figure 3-1. IEC-320 Power Inlet Module

AC Operation

This power-inlet module operates from any ac-input voltage of 85 – 264 Vac at 47 – 440 Hz. The mating ac cord provided depends upon the option (P1 through P10) which was specified at the time of purchase. For further information about ac power cords see paragraph 3.1.8.

To connect the input power, first plug the end of the power cord having the mating IEC connector into the power inlet module on the rear panel, then plug the other end into an appropriate power outlet.

> **WARNING** For maximum safety and best performance, always connect the input cord to a properly grounded power source.

DC Operation

For 110 – 250 Vdc operation, the dc voltage should be applied between the LINE and NEUTRAL terminals of the power inlet module, without regard to polarity (the internal power supply will accept either polarity). When viewing the power inlet module from the rear of the instrument, the LINE connection is the one nearest the bottom, and the NEUTRAL is nearest the top. The GROUND terminal is offset from the others, and protrudes slightly farther out of the connector.

> **WARNING** Connect input only to a properly grounded power source.

3.1.6 Options 07, 08, and 15

If Option 07 (terminal strip power inlet), Option 08 (10 Vdc to 60 Vdc input power), or Option 15 (Power Inlet Surge Withstand) is ordered, the standard IEC-320 inlet is replaced with a three-terminal screw-type barrier strip. This connection configuration may not meet all international specifications for ac line inlets; however, its manufacturer rates the terminal strip for the voltage and current levels involved. The terminal strip is intended for connection to a DC power sources, although with Option 07 (which utilizes the standard internal power supply), the unit is capable of operation from both AC and DC sources as described above.

Option 15 adds Surge Withstand Capability to the power inlet of the Model 1088B.

When connecting power to a clock with Option 08, **BE SURE TO OBSERVE CORRECT POLARITY**, as the power supply used with Option 08 *will not accept reverse input polarity*. *Option 15x does not work with the lower dc-voltage, Option-08 power supply.*

Option 07, terminal Power Strip, AC/DC Power Input Module

Option 07 for the Model 1088B Satellite-Controlled Clock replaces the standard IEC-320 power input module with a three-position, screw-type terminal strip. This feature is intended for use in installations where it is necessary or desirable to have the instrument power hard-wired.

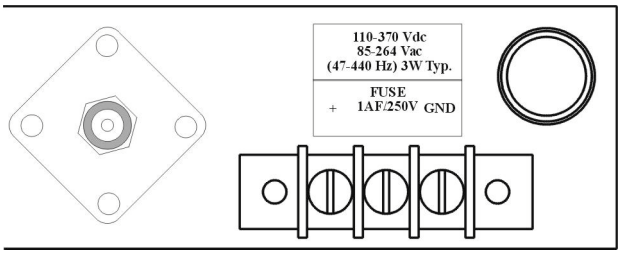

Figure 3-2. Terminal Strip with Standard 85 – 264 Vac Power Supply

For connection and more detailed technical information, see Option 07 data sheet, PD0014400A.

Option 08, 10 – 60 Vdc Power Inlet Module

If Option 08 is ordered, the power module accepts only *dc-input* voltages from 10 – 60 Vdc. The standard IEC-320 inlet is replaced with a 3-pole terminal strip and is intended for connection to dc power sources. When connecting power to a clock with Option 08, **BE SURE TO OBSERVE CORRECT POLARITY**, as the power supply used with Option 08 will not accept reverse input polarity.

CAUTION DO NOT CONNECT OPTION 08 MODULE TO ANY AC VOLTAGE SOURCE.

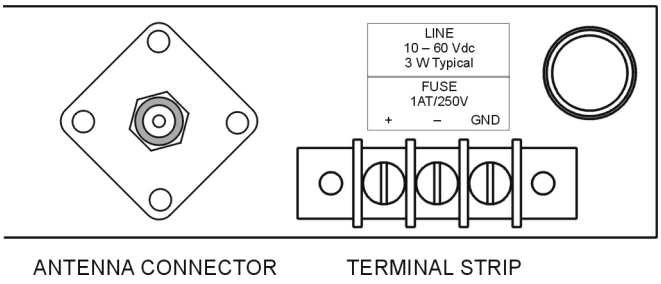

Figure 3-3. Terminal Strip with Option 08 10 – 60 Vdc Power Supply

3.1.7 Fuse Replacement

The IEC-320 input power connector-assembly includes a 1A, 250 V fast acting 5 x 20-mm fuse. The fuse is contained in a small compartment with a snap-fit latch, which also has a compartment for a spare fuse.

CAUTION: FOR CONTINUED PROTECTION, REPLACE THE INPUT FUSE ONLY WITH ONE OF THE SAME TYPE, VOLTAGE RATING, AND CURRENT RATING AS ORIGINALLY SUPPLIED WITH OPTION 07, 08 AND 15.

To replace the fuse, first disconnect the line cord from the power source, then remove the cord from the rear-panel IEC connector. The fuse compartment is located directly adjacent to the input connector socket, and can be opened by pulling both sides directly upward, or by gently prying with a small flat-blade screwdriver.

The fuse, which was in the circuit, is the innermost one; inspect it to determine whether it is open. If replacement is necessary, the fuse in the outer compartment is a spare included with the instrument, which can be used to replace the original.

For instruments supplied with Option 07, 08, or 15, the fuse is located in the fuse holder on the rear panel near the power inlet terminal strip. The fuse for the standard power supply is a 1A, 250 V fast acting 5 x 20-mm fuse (Option 08 uses a time-lag fuse). No spare fuse is provided.

3.1.8 Power Cords and Plug Styles

The following list shows the available IEC-320 power cords and plug styles.

Option No.	Country	Specification	Voltage Rating
P01	Continental Europe	CEE 7/7	220 V
P02	Australia/NZ/PRC	1981	240 V
P03	U.K.	BS 1363	240 V
P04	Denmark	Afsnit 107-2-01	240 V
P05	India	BS 546	220 V
P06	Israel	SI 32	220 V
P07	Italy	CEI 23-16/VII 1971	220 V
P08	Switzerland	SEV 1011.1959	220 V
P09	North America and ROC	NEMA 5-15P CSA C22.2 #42	120 V
P10	Japan	JIS8303	120 V

3.1.9 Rear Panel Layout

The rear panel of a standard Model 1088B is arranged in the following manner, left to right (see Figure 3-4):

- A rectangular opening to accommodate connectors for Options 04, 17, 18, 19, 27, 29 or 32. If none of these options are included with the Model 1088B, a metal plate will cover this opening.
- Four openings for optional connectors. These are for input and output BNC connectors used by Options 03, 20A, 23 and 28, and if not used are covered by plastic hole-plugs.
- Four BNC connectors used for the configurable inputs and outputs, which are standard on the unit. These I/O connections are configured using an internal jumper system, based on customer specifications at the time of purchase. The connector locations are labeled in accordance with the originally specified instrument configuration.
- A 9-pin, D-subminiature plug for connection of the RS-232C serial interface. For pin designations, refer to paragraph 2.4.1.

- A Type-F RF connector (female) to accept the antenna cable.
- An IEC-320 power inlet connector, with built-in fuse holder. (If Option 07, 08, or 15 is ordered, a three-terminal, screw-type barrier strip and a separate fuse holder replace this connector. See Figures 3-1, 3-2, and 3-3).

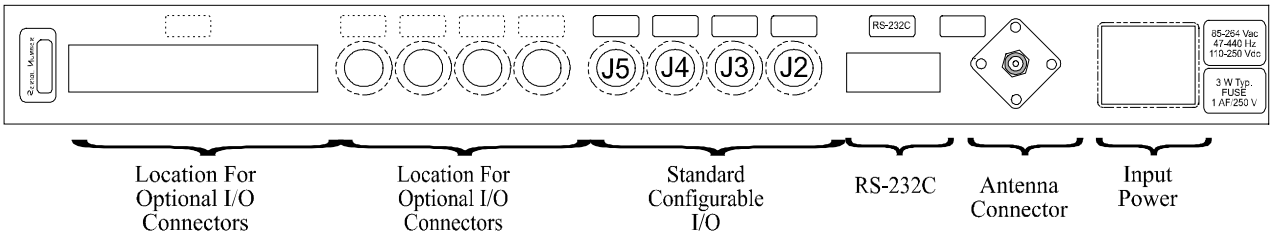

Figure 3-4. Model 1088B Rear Panel

3.1.10 Rack Mounting

Rack-mounting ears are included with the 1088B to facilitate mounting the instrument in a standard 483-mm (19-in.) equipment rack. To install the rack-mounting ears, observe the following steps:

1. Using a T-25 driver, remove the two screws on one side of the unit. Leave the cover in place.
2. Position one of the rack's mounting ears on that side of the unit, so that the rack-mounting flange is at the front of the instrument and extends away from the front panel.
3. Replace the cover screws by routing them through the lower set of holes in the rack-mounting ear, and back into the threaded holes in the instrument.
4. Repeat the above steps for the opposite rack-mounting ear.

3.2 Changing Hardware Settings Via Internal Jumpers

The 1088B incorporate a flexible input and output (I/O) selection system, which is made possible by an innovative internal jumper scheme. Each of the four, standard, rear-panel I/O connectors can be reconfigured to perform any of the available output functions. Alternatively, any or all of the I/O connectors can be set to act as an input to the 1088B. However, each of the I/O connectors is assigned only one specific and exclusive input function.

3.2.1 Cover Removal

To change jumper configurations, the instrument cover must be removed. Remove top cover as follows:

1. On all Models disconnect the power cord. If equipped with Option 04 (power switch), first turn the power switch to OFF.
2. Using a T-25 driver, remove the four screws securing the cover (and rack-mount ears, if used).
3. Lift the cover off.

4. Figure 3-5 illustrates the main board and locates all the jumpers. Also, a label located on the inside of the top cover provides a quick reference for the I/O functions and their respective jumper settings.

> **Warning** DO NOT REMOVE TOP COVER WHILE POWER IS APPLIED. HAZARDOUS VOLTAGES ARE PRESENT WHILE THE POWER CORD IS CONNECTED. ALWAYS DISCONNECT THE UNIT FROM THE INPUT POWER SOURCE BEFORE REMOVAL OF THE TOP COVER.

3.3 I/O Connectors Used as Output

For each I/O connector, it is necessary to set 2 jumpers in order to assign the output (or input) signal. The following paragraphs describe the procedure for setting these jumpers.

3.3.1 Output Function Selection

Jumpers JMP4, JMP7, JMP10, and JMP13 determine the output signals, which can be made available at I/O connectors J2, J3, J4, and J5, respectively. Figure 3-5 illustrates the relationship between these jumpers and the I/O connectors (the position of some jumpers is slightly different in the Model 1088A). The first step in setting an I/O channel for a specific output signal is to move the associated jumper to the location corresponding to the desired signal. Table 3-1 lists the jumper settings required for various signals.

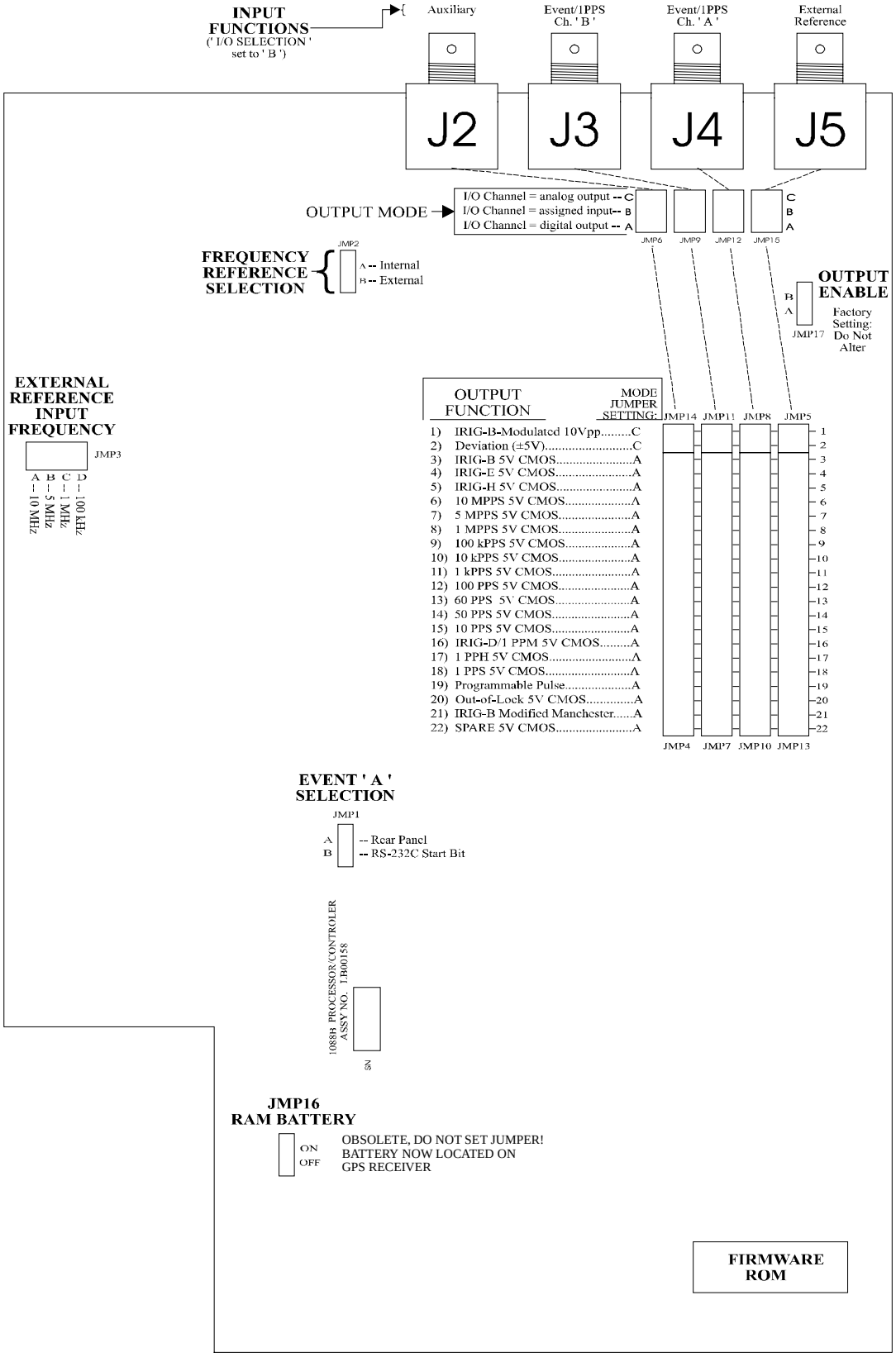

Figure 3-5. Model 1088B Main Board Layout

3.3.2 Output Mode Selection

The next step in configuring the I/O connectors is to determine whether the assigned signal is an analog output, a digital output, or an input (configuring the connectors as inputs is described in paragraph 3.3.3). Select the output mode by setting jumpers JMP6, JMP9, JMP12, and JMP15 to the appropriate positions. These jumpers correspond to connectors J2, J3, J4, and J5, respectively (see Figure 3-4). If the I/O channel is to be used as a digital output, the corresponding jumper should be set to position ' A '. If the I/O channel is to be used as an analog output, the jumper should be set to position ' C '. Table 3-1 lists jumper positions for individual output signals.

Table 3-1. Output Signal Selection Jumper Settings

Output Signal	Output Function Jumper Position	Output Mode Jumper Position
IRIG-B Modulated 10 Vpp	1	C
Deviation (±5 V)	2	C
IRIG-B	3	A
IRIG-E	4	A
IRIG-H	5	A
10 MPPS	6	A
5 MPPS	7	A
1 MPPS	8	A
100 kPPS	9	A
10 kPPS	10	A
1 kPPS	11	A
100 PPS	12	A
60 PPS	13	A
50 PPS	14	A
10 PPS	15	A
IRIG-D/1 PPM	16	A
1 PPH	17	A
1 PPS	18	A
Programmable Pulse	19	A
Out-of-Lock	20	A
IRIG-B Modified Manchester	21	A
Spare 5 V CMOS	22	A

3.3.3 I/O Connector Used as Input

Any of the four I/O connectors included with the standard model can be reconfigured to operate as “an input.” However, each connector is restricted to the input function listed for it as seen below in Table 3-2.

To reconfigure any I/O connector as “an input”, all that is required is to set the corresponding I/O jumper to position ' B '. It is not necessary to change the position of the output function jumper, as this will have no effect on input operation.

Table 3-2. Rear Panel I/O Connector Input Functions

Connector	Function
J2	Auxiliary Input
J3	Event B Input
J4	Event A Input
J5	External Reference Input

3.3.4 Other Jumper Settings

Frequency Reference Selection, JMP2

The Model 1088B is capable of operation using its internal standard high-performance DCXO frequency reference, Optional internal, high-stability OCXO, or using an external frequency reference signal input to rear-panel I/O connector J5. Jumper JMP2 controls the frequency reference source as follows:

Set JMP2 to position ' A ' to configure unit for internal standard (frequency) reference operation.

Set JMP2 to position ' B ' to configure to use external reference or optional, built-in OCXO.

For external reference input operation, it is also necessary to set jumpers JMP15 and JMP3 (see paragraphs 3.3 and below, respectively).

External Reference Input Frequency, JMP3

Configure the 1088B to accept an external frequency reference at I/O connector J5 (JMP15 and JMP2 both set to position ' B ') with jumper JMP3; it should be set to match the frequency of the incoming signal as listed in Table 3-3. When the 1088B is configured to use internal reference, the position of JMP3 will have no effect on unit operation.

Table 3-3. External Reference Input Frequency Settings (JMP3)

Reference Frequency	JMP2	JMP3	JMP15	Fig. 5-8
Internal Standard	A	X	A,C	Internal
Option 12A	B	B	A,C	Internal
External 10 MHz	B	A	B	External
External 5 MHz	B	B	B	External
External 1 MHz	B	C	B	External
External 100 kHz	B	D	B	External

Event A Selection, JMP1

Jumper JMP1 determines how a signal (used to register an event on Event/Deviation channel A) interfaces with the 1088B. If the jumper is in position 'A', the unit will accept a 5 Volt CMOS/TTL level signal at J4 (provided that jumper JMP12 is set to position 'B'). If JMP1 is set to position 'B', event channel A will recognize the leading edge of the start bit of the first character sent over the RS-232C interface (after arming) as an event.

For RS-232C event trigger operation, it is necessary to configure the 1088B as described in paragraph 4.12, “RS-232C Event Trapping.”

RAM Backup Battery, JMP16 – Obsolete

~~The purpose of jumper JMP16 is to connect or disconnect the Random Access Memory (RAM) backup battery on the main board~~. Current Model 1088B clocks incorporate a data backup battery on the GPS receiver and do not need this Option with jumper setting. JMP16 now has no function.

Output Enable, JMP17

This jumper is used at the factory for setting the output enable for the 5V CMOS output buffers. For normal operation, set jumper to position 'A'. With two clocks containing Option 18 and configured for redundant operation, this jumper may be set to position 'B', allowing the CMOS outputs to be paralleled and driven by the on-line clock. Normally, this jumper will be configured as required when delivered from the factory.

3.4 Antenna

3.4.1 Antenna Location

The antenna module supplied with the standard Satellite Clock is designed for outdoor use in all weather conditions. The operating temperature range extends from -40°C to +85°C (-40°F to +185°F), and the module is both weatherproof and waterproof. For maximum signal strength and satellite acquisition capability, the antenna should be mounted out-of-doors and away from large structures. Mounting height is not particularly critical, provided that the antenna has the clearest possible view of the sky in all directions. An ideal installation is one in which the view is unobstructed from the horizon to directly overhead at each point of the compass.

Alternatively, mount the antenna indoors, below a skylight or other structure that is transparent to RF energy at the GPS-L1 frequency of 1.575 GHz. When in doubt as to the suitability of such a structure, there is no harm in trying it. Such an installation can reduce costs and improve reliability, because even though the antenna and cable are intended for outdoor mounting, operating life will be extended by exposure to a more benign environment.

3.4.2 Antenna Gain Pattern

When the antenna module is mounted to a vertical pole, the maximum gain lobe extends vertically above the antenna, and is nearly spherical in shape. Therefore, the antenna should be oriented with the mounting surface parallel to the ground, i.e. mounted to a vertical pole. In this position, the gain of the antenna above the horizon will be nearly uniform in all directions, which will allow the best overall reception of all visible satellites. Mount to non-vertical surfaces using the GPS Antenna Mounting Bracket (Part No. AS0044600).

3.4.3 Antenna Mounting

> **Note**: Please read PD00336000, Supplemental Antenna Installation Instructions (located in the front of this manual), before installing the antenna. Serious damage to the antenna assembly may result if not installed correctly.

The standard antenna module is designed for pole mounting on a 26-mm pole (1.05-in. OD or ¾-in. ID pipe), with either a standard 1-in. – 14 (approximately M25.4 x 1.81) marine-mount thread or a ¾-in. NPT pipe thread. The Type-F connector on the inside of the antenna module is protected from direct exposure to the elements when the antenna is mounted in this way. This will extend the operational life of the antenna-to-cable interface.

When mounting the antenna, first route the supplied antenna cable up through the pole. Then, attach the Type-F connector, on the end of the cable, to the mating connector inside the antenna-mounting socket before mounting on the pole. If possible, to reduce stress on the cable and connection, allow the cable to rotate freely when screwing the antenna onto the pole. Alternatively, rotate the pole while holding the antenna in a fixed position.

3.4.4 Optional Antenna Mounting Kit

A mounting kit, separately available as P/N AS0044600, can be used to mount the antenna to a vertical mast (up to approximately 2-in. diameter), or to the wall or roof of a structure such as an antenna tower or a building. This kit contains a short length of threaded, plastic pipe, a stainless

steel bracket, and hardware to attach the pipe to the bracket in any of several orientations. With this kit, it is possible to mount the bracket to any surface from vertical to horizontal, while maintaining acceptable orientation for the antenna. This bracket will accept user-supplied screws for surface mounting, and straps (such as pipe clamps) for mounting to a pipe or mast.

3.5 Antenna Cable

3.5.1 Length Loss Considerations

Standard Antenna Cable

The standard antenna cable assembly included with the clock is constructed using a 15-meter (50-foot) length of RG-6 low-loss coaxial cable, terminated with male Type-F RF connectors. Optional lengths of RG-6 coax are separately available for longer runs; see later in section 3.5.1.

Effects of Cable Parameters

To receive GPS signals and properly operate the clock, the type and length of the cable are important. Due to their effect on specific parameters described in the following paragraphs, any changes to the length and/or type of antenna cable should be made carefully. Damaged cables may also affect performance.

Cable Delay

The velocity factor and the physical length of the cable determine cable delay. During the initial factory calibration of the clock, a value for cable delay (based upon the length and type of cable supplied) is entered into the clock memory. Firmware uses this figure to counteract the effect that the delay has upon GPS timing accuracy. The value entered for a standard 15-meter cable is 60 nanoseconds. For other cable options, the delay is tabulated later in section 3.5.1. The formula for calculating cable delay is:

$$T = \lambda \frac{1}{CK_v} + 1ns$$

Where:

T = Cable delay, in nanoseconds;

λ = Cable length, in meters;

C = Speed of light ($3x10^8$ meters per second);

K_v = Nominal velocity of propagation (0.85).

One nanosecond is added to the calculated value to account for the length and velocity factor of the short connecting cable inside of the clock.

Attenuation

Attenuation depends upon the cable length, and the loss per unit length. The total attenuation must be limited to 21 dB (maximum) at the GPS L1 frequency of 1575.42 MHz. Loss up to 42 dB can be accommodated with the separately available 21-dB, in-line preamplifier (AS0044700).

DC Resistance

The cross-sectional area and length of the conductors in the cable determine the dc resistance. Since power to the RF preamplifier in the antenna module is supplied via the antenna cable, excessive dc resistance will degrade performance.

Because of the above factors, changes to the length and/or type of antenna cable should be made carefully. Damaged cables may also affect performance.

Available Antenna Cables and Accessories for Longer Runs

Arbiter Systems offers longer antenna cables for use with all models of clocks when the standard 15-meter (50-foot) cable is inadequate. For RG-6 cable runs greater than 250 feet, up to 500 feet, Arbiter offers a 21-dB in-line amplifier, P/N AS0044700. A larger RG-11 style cable is available (P/N WC0004900, 305-m / 1000-ft roll), that can be used for runs to 120 meters (400 feet) without the in-line preamplifier, or 240 meters (800 feet) with the AS0044700 amplifier.

The available cables and accessories are summarized here:

Part No.	Description	Delay, ns	Loss
CA0021315	15-m (50-ft) cable, RG-6 tri-shield (standard)	60 ns	-5 dB
CA0021330	30-m (100-ft) cable, RG-6	119 ns	-9 dB
CA0021345	45-m (150-ft) cable, RG-6	177 ns	-13 dB
CA0021360	60-m (200-ft) cable, RG-6	236 ns	-17 dB
CA0021375	75-m (250-ft) cable, RG-6	295 ns	-21 dB
WC0004900	305-m (1000-ft) roll RG-11 quad-shield cable (non-terminated)	3.92 ns/m 1.19 ns/ft	-17.5 dB/100m -5.25 dB/100 ft
AS0044800	Kit, crimp tool and 25 connectors for RG-11 style cable	N/A	N/A
AS0044700	21-dB in-line amplifier	1 ns	+21 dB

3.5.2 Routing Considerations

Orientation

The ends of the antenna cable have identical connectors, so cable orientation is not important.

Physical Protection

When routing the antenna cable, protect it from physical damage, which may result from closing doors, falling objects, foot traffic, etc. Also, when routing around corners, allow for sufficient bend radius to prevent kinks. Extra length should be allowed at both ends of the cable to prevent tension on the connectors, which could cause damage or failure. Extra length is useful as a service loop, in the event that a connector needs replacement.

Do not stretch the cable mid-air over any appreciable distance without support. Cable degradation or failure could result. Always leave a ‘drip loop’ wherever the cable enters a structure, to prevent water from entering the structure via the cable jacket.

The maximum temperature rating for the type of cable provided with the clock is 60°C (140°F). Exercise care when routing the cable near sources of heat to avoid cable damage.

Adjacent Signals

Although the standard RG-6 style cable is triple-shielded and has excellent shielding properties, be cautious when routing near high power RF sources or alongside cables carrying high power RF, such as transmitter cables. In these applications, consider using RG-11 style cable (P/N WC0004900). Its quad-shielded design provides even more isolation.

3.5.3 Antenna Module Power

The RF preamplifier within the antenna module requires 5 Vdc at 30 mA (maximum) for operation. A power supply within the clock generates this voltage, which is applied to the antenna module via the two conductors of the coaxial antenna cable. Avoid shorting the center conductor to the shield of the coaxial cable as it may damage the preamplifier. Conversely, a high-resistance connection or open circuit would deprive the preamplifier of power. Either a short- or open-circuit condition in the antenna cable will render the clock inoperable.

Prior to initial operation or if problems are suspected, perform the Antenna/Cable Operational Test Procedure contained in paragraph 3.5.6.

3.5.4 Connection to Antenna

> **Note**: Please read PD00322000, Supplemental Antenna Installation Instructions (located in the front of this manual), before installing the antenna. Serious damage to the antenna assembly may result if not installed correctly.

The male Type-F RF connector on one end of the antenna cable mates with the female Type-F connector on the antenna module. Avoid placing mechanical stress on the cable attachment to the antenna module. See paragraph 3.4.3.

3.5.5 Connection to Clock

The male Type-F RF connector on the opposite end of the antenna cable connects to the female Type-F connector on the rear panel of the Satellite Clock (see Figure 3-4).

3.5.6 Antenna and Cable Operation Test

Prior to initial operation or any time antenna/cable problems are suspected, perform the following procedure:

> **NOTE** PERFORM THE FOLLOWING TEST WITH THE ANTENNA CONNECTED NORMALLY AT THE FAR END OF ANTENNA CABLE. *THE RESULTS OF THIS TEST WILL BE AFFECTED IF YOUR INSTALLATION INCLUDES THE AS0044700 IN-LINE AMPLIFIER. CONSULT THE SEPARATE DATA PROVIDED WITH THIS UNIT FOR GUIDANCE.*

1. Disconnect antenna cable from rear panel of the clock.
2. At the rear panel Antenna connector, connect a voltmeter between the center conductor and ground. The voltage measured should be approximately +5 Vdc.
3. Connect an ohmmeter between the cable center conductor and the cable shield. The dc resistance should be 260 - 270 ohms.
4. If the resistance measured exceeds 500 ohms, an open-circuit condition may be indicated (typically measures >100 kΩ if open).
5. If the resistance measured is less than 100 ohms, a short-circuit condition may be indicated (It typically measures much less than 100 Ω if shorted).

> **CAUTION** DO NOT ATTEMPT TO OPERATE THE CLOCK UNTIL ALL ERRORS ARE CORRECTED. ANY ERRORS ENCOUNTERED DURING THIS TEST WILL PREVENT PROPER OPERATION.

3.5.7 User-Supplied Antenna Cables

Any RF cable meeting the requirements described above for loss (≤21 dB at 1575 MHz) and dc resistance (≤13 ohms total loop resistance) may be used with the clock. However, prior to using a non-standard antenna cable, verify proper installation by performing the Operational Test contained in paragraph 3.5.6.

4.0 Operation

4.1 Front Panel Layout

The Model 1088B front panel is illustrated in Figure 4-1 and described in the following paragraphs. (The 1088A front panel is similar, but without the indicator LEDs or optional internal battery switch.)

4.1.1 Line Power Switch

Controls the power supplied to the Model 1088B via the rear-panel power inlet (On/Off switch).

4.1.2 Internal Battery Power Switch (Optional)

When installed, it supplies power to the Model 1088B via an internal backup battery. On a standard clock, a plastic cover replaces this switch. (On the Model 1088A, battery backup power cannot be externally controlled.)

4.1.3 Power Status Indicators

These four indicators are located directly to the left of the main display and provide information about the status of the power sources available to the instrument. The following table contains a brief description of their functions:

OPERATE* Indicates that power is being supplied to the Model 1088B, either by the line or the battery.

CHARGE* Active only with clock power backup battery. Illuminates when the charging circuit for the internal battery is in the *high charge* mode. Whenever power is present at the rear-panel power inlet, the charging circuit will provide a *trickle charge*. If the battery charge level falls below a preset threshold, the *high charge* mode will be activated.

IN USE* Active only with clock power backup battery. Indicates that the internal battery is supplying power to the instrument.

LO BATTERY* Active only with clock power backup battery. Provides warning when the battery voltage falls below 5.6 volts.

* With instruments featuring an internal backup battery refer to the option information sheet for details on operation from the internal battery.

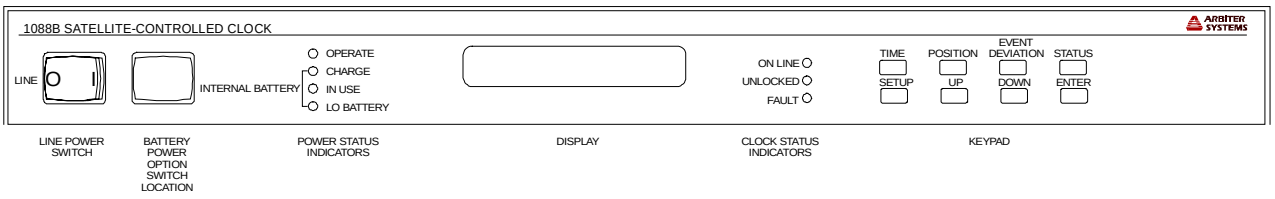

Figure 4-1. Model 1088B Front Panel Layout

4.1.4 Display

The front panel contains a liquid crystal display, which provides a 20-character by 2-line readout. The readout displays instrument time, position, event data and status. The readout is also used to display the current configuration of operational parameters.

4.1.5 Status Indicators

These three indicators are located directly to the right of the main display and provide information about the operational status of the instrument. The following table contains a brief description of their functions:

ON LINE	Always illuminates when the power is ON. In redundant clock systems implemented with Option 18, this indicator reflects the status of the three-state CMOS output buffers and the IRIG-B output bus (refer to Data Specification Sheets provided with Option 18).
UNLOCKED	Illuminates when loss of satellite lock (after a preset delay) occurs. This indication exactly follows 'Out-of-Lock' signal available from the rear-panel configurable I/O connectors.
FAULT	Illuminates when fault conditions exist in the receiver and/or when the voltage-controlled oscillator is out of range (refer to paragraph 4.4). When Option 18 is installed, Fault indicator functions are expanded.

4.1.6 Front Panel Keys

Control the various instrument functions and configure operational parameters by using the eight pushbutton keys on the front panel. However, using RS-232 commands 'FB' and 'FL' will disable all or part of the keyboard and display functions. Full operation is still possible via RS-232, and normal front-panel functions may be restored with the 'FE' command. See Appendix A for a detailed description of RS-232 commands. The following table contains a brief description of the front panel controls and indicators:

TIME	Sets the display to the Time Display Mode. There are four modes of time display available and repeated pressing of this key will cause the display to scroll through all four modes continuously. Changing the time display has no effect on the time data, which is output from rear-panel connections.
POSITION	Cycles the display through the longitude, latitude, and elevation data readouts of the antenna location according to the most recent position fix or survey.
EVENT/ DEVIATION	Selects a review of event and/or 1-PPS deviation data for event/deviation channels A and B.

STATUS	Toggles between the two Status display modes, Clock and Receiver, and to display data relative to GPS satellite acquisition and synchronization.
SETUP	Invokes a series of sub-menus used to adjust configurable parameters within the 1088B. In numeric data entry mode, moves the cursor left.
UP	Used in conjunction with the SETUP menus to adjust values upward, or to scroll upward through available menu choices.
DOWN	Used in conjunction with the SETUP menus to adjust values downward, or to scroll downward through available menu choices.
ENTER	Used for confirming changes made within SETUP sub-menus. Generally, pressing ENTER also advances to the next parameter, or returns to the previous menu level. In numeric data entry mode, moves the cursor right.

4.2 Operational Procedures

The following paragraphs describe the procedures required to enter operational parameters using the front panel controls and display indicators. Prior to performing these procedures, review Section 5 and determine the optimal configuration of the operational parameters for your specific location.

4.2.1 Almanac and Position Data

The GPS receiver module employed in the Model 1088B Satellite-Controlled Clock includes non-volatile memory for storage of almanac (satellite orbit) data and position (longitude, latitude, and elevation) information. In normal operation, the data in the non-volatile memory is updated when all of the following conditions are met for a period of 10 seconds or more:

- Position Shift of greater than 50 km.
- A Position Dilution of Precision[4] (PDOP) of less than 5.
- Continuous position fix from at least four satellites.

If input power is removed from the instrument, the last recorded values for these parameters are retained. This will expedite the acquisition of satellites when power is restored.

4.2.2 Satellite Acquisition Time

When the unit is received from the factory, initial satellite acquisition could take as long as 3 minutes. The time required for acquisition of satellites is dependent upon the accuracy and age of the almanac and position data last stored. An updated version of this information will be stored for the new operating location in accordance with paragraph 4.2.1. After this, satellite acquisition should typically occur in less than 1 minute.

[4] "A description of the purely geometrical contribution to the uncertainty in a position fix, given by the expression DOP = SQRT TRACE (A A), where A A is the design matrix for the instantaneous position solution (dependent of satellite-receiver geometry). PDOP: Position (three coordinates)," p1.8 Oncore Receiver Manual, Motorola.

4.3 Startup Sequence

Upon initial power-on sequence, the following display will appear for approximately four seconds:

ARBITER SYSTEMS GPS
Model 1088A/B CLOCK

followed by:

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ARBITER SYSTEMS, INC

After the initial display, the 1088B will automatically default to the clock status display mode. Prior to achieving satellite lock, the display will appear as follows:

CLOCK STATUS
STARTUP

4.4 Clock Status Display Modes

When the Model 1088B is initially switched on, it will default to the *Clock* S*tatus* display mode. The Clock Status Display Mode provides the status of specific clock parameters. The status display readouts are Position Hold-ON, Survey Mode, Fault Conditions, and Receiver Status.

The Position Hold and Survey status displays occur only *after* the instrument has achieved satellite lock and are dependent upon whether the Auto Survey and Position Hold Modes are enabled (ON) or disabled (OFF). The Fault Condition status will be displayed whenever the appropriate fault condition exists. The Receiver Status readout displays the condition of the internal GPS Receiver with respect to the GPS Satellite System.

The Status Display Flowchart(s) shown in Figure 4-2 illustrate the various readouts displayed and correspond to their descriptions contained in the following paragraphs.

4.4.1 Position Hold Mode ON

This display signifies that the clock is locked to at least one satellite, and that some form of Position Hold Mode is active. In this case, the instrument is using the position data, which was last stored in non-volatile memory to perform the time computation. The position data will *not* be updated based on received satellite data.

CLOCK STATUS
LOCKED*POSITION HOLD

> **Note** THE FACTORY DEFAULT SETTING FOR POSITION-HOLD MODE IS ENABLED (ON).

4.4.2 Position Hold Mode OFF

When Position Hold Mode is OFF and as soon as the 1088B successfully acquires and locks to the first satellite, the following readout will be displayed:

CLOCK STATUS
LOCKED

The most recent position fix from the GPS satellites will be used for the time calculation. If there are not enough satellites in view (4) to provide an accurate position fix, the position data which was last stored into non-volatile memory will be used until a new fix is available.

4.4.3 Fault Conditions

In the event of an error, which causes the front-panel FAULT LED to illuminate, the clock status display will change to read:

CLOCK STATUS
ERROR XXX

The meaning of this error code is determined by interpreting it as an 8-bit byte, with each bit having a weight from 1 to 128. The eight bits of the status byte have the following assignments and weighting:

Bit	Weight	Function
0	1	OCXO Not Installed
1	2	Reserved (Set to 0)
2	4	Power Supply Error*
3	8	IRIG Fault (External)*
4	16	Out-of-Lock
5	32	Reserved (Set to 0)
6	64	DCXO Error
7	128	Receiver Failure

* requires Option 18

4.4.4 Receiver Status display

When the Model 1088 is first turned on it will default to the *clock* status display mode. However, pressing the STATUS key once will toggle the display to the *receiver status* display mode. The purpose of the receiver status mode is to display the condition of the internal GPS Receiver with respect to the GPS Satellite System.

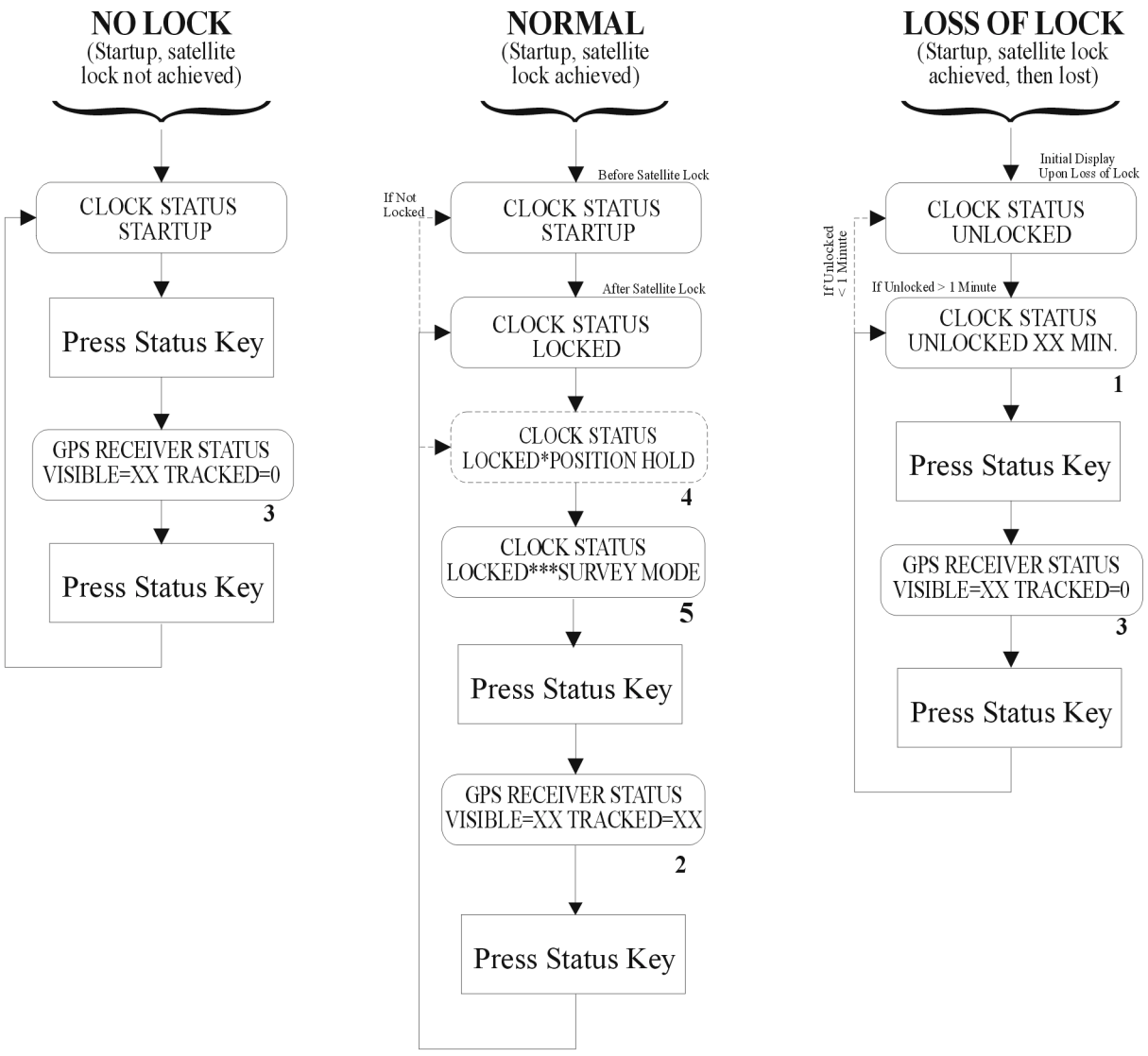
When in the Receiver Status Mode, the following readout will be displayed:

GPS RECEIVER STATUS
VISIBLE=XX TRACKED=XX

The number for *visible* is the number satellites that are within view of the antenna (given a full view of the sky) and could potentially be used. This figure is based on the last almanac data stored in the non-volatile memory. The number for *tracked* indicates how many of these satellites are actually being used to obtain position and time data (a maximum of twelve).

A value of zero for *tracked* indicates that the instrument has lost synchronization with the GPS system. The clock status display mode, the Out-of-Lock output, and the front panel Unlocked indicator (1088B only) will also reflect this condition.

Pressing the STATUS key repeatedly will toggle the display back and forth between the receiver status display and the clock status display modes.



NOTES:
1. Amount of time satellite lock has been continuously lost (max: 99 min).
2. Number of satellites available for tracking and number actually tracked.
3. Same as #2 above, however, number of satellites tracked during Out-of-Lock is always Zero.
4. This readout displayed only if Position Hold Mode is enabled (ON) and after Auto Survey is complete (if enabled).
5. This readout only displayed if Auto Survey Mode is enabled (ON) and is active (i.e. Currently surveying).

Figure 4-2. Status Display Mode Response Flow Chart

4.5 Time Display Modes

After establishing GPS satellite synchronization, view the date and time information on the front panel by pressing the function key labeled TIME repeatedly to scroll through the four available display modes. The Time Display Flowchart(s) shown in Figure 4-3 illustrate the various readouts displayed and correspond to their descriptions contained in the following paragraphs.

4.5.1 Date and Time Display, Universal Time Coordinated (UTC)

Displays UTC time as maintained by the United States Naval Observatory (USNO), using the following format:

UTC DATE/TIME www
dd mmm yyyy hh:mm:ss

Where:
'www' is the day of the week (Mon – Sun).
'dd' is the day of the month.
'mmm' is the month (Jan – Dec).
'yyyy' is the year.
'hh' is the hour.
'mm' is the minute (00 – 59).
'ss' is the second (00 – 59).

4.5.2 Time of Year Display, Universal Time Coordinated (UTC)

Displays UTC time, with a display format that differs from the previous display as follows:

UTC DATE/TIME www
yyyy ddd:hh:mm:ss

where:

'ddd' is the day of the year (001 – 366).

4.5.3 Date and Time Display, Local Time

Displays the date and time after the daylight saving correction and local offset have been applied.

> **NOTE** UNLESS THE DAYLIGHT SAVING AND LOCAL OFFSET PARAMETERS HAVE BEEN SET PROPERLY, THIS DISPLAY MAY NOT REFLECT THE CORRECT LOCAL TIME (REFER TO PARAGRAPH 5.2).

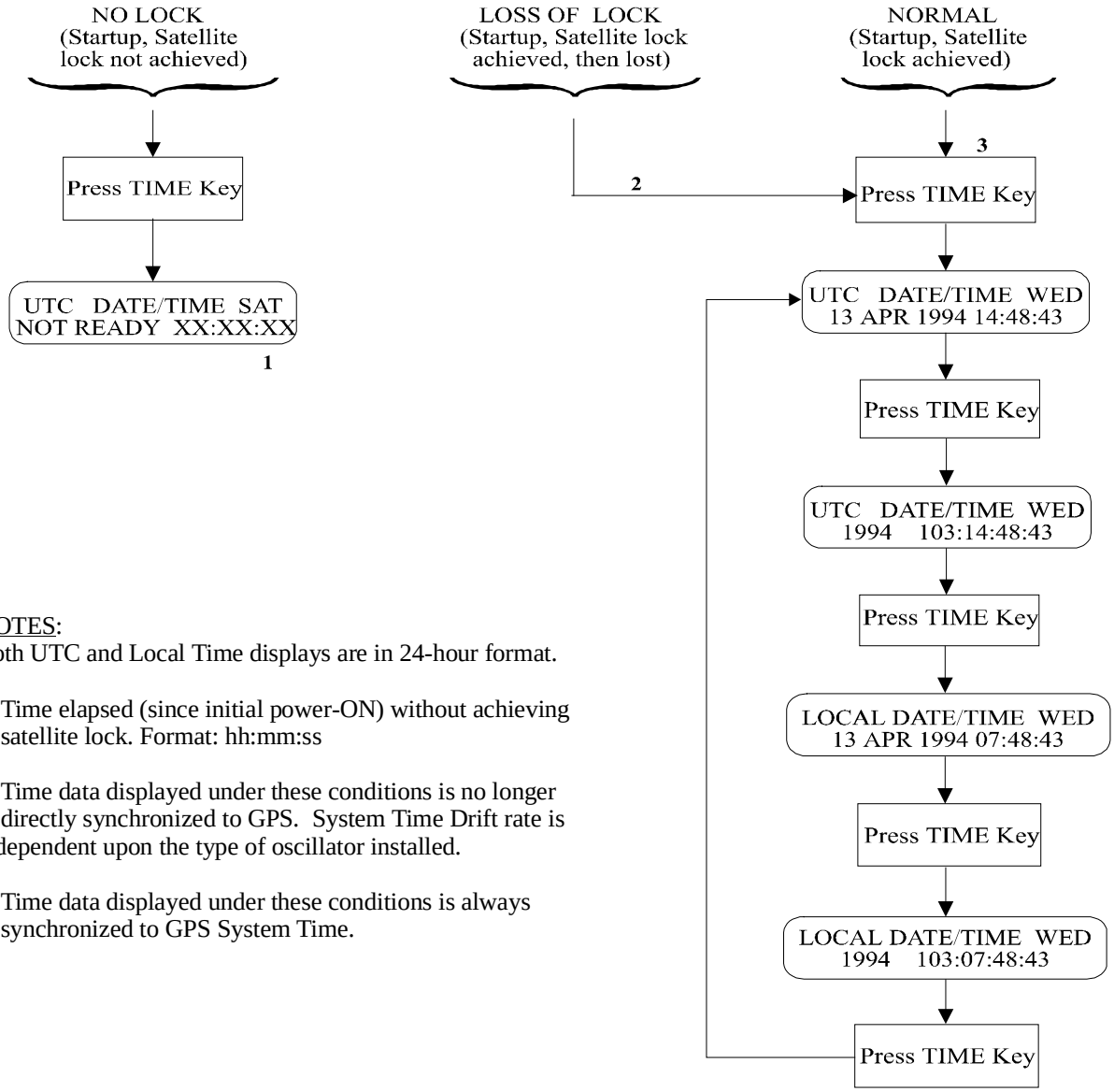
LOCAL DATE/TIME www
dd mmm yyyy hh:mm:ss

4.5.4 Time of Year Display, Local Time

Displays the date and time after the daylight saving correction and local offset has been applied, but in the same format as that of the Time of Year UTC display (see paragraph 4.5.2):

LOCAL DATE/TIME www
yyyy ddd:hh:mm:ss

NOTE SET THE DAYLIGHT SAVING AND LOCAL OFFSET PARAMETERS PROPERLY, OR THIS DISPLAY MAY NOT REFLECT THE CORRECT LOCAL TIME (REFER TO FIGURE 5.2).



NOTES:
Both UTC and Local Time displays are in 24-hour format.

1. Time elapsed (since initial power-ON) without achieving satellite lock. Format: hh:mm:ss

2. Time data displayed under these conditions is no longer directly synchronized to GPS. System Time Drift rate is dependent upon the type of oscillator installed.

3. Time data displayed under these conditions is always synchronized to GPS System Time.

Figure 4-3. Time Display Mode Response Flow Chart

4.6 Position Display Modes

When the clock is first powered up and prior to acquisition of satellites, the only position information available is that which is stored in the non-volatile memory of the GPS receiver module. This position information reflects the location of the receiver at the last point in time at which all of the criteria necessary for accurate position location were satisfied (refer to paragraph 4.7.2).

Press the key labeled POSITION to access the longitude, latitude, and elevation data values. Continue pressing the POSITION key to cycle through these values. If pressed prior to acquisition of enough satellites to accurately determine and update position data, the values shown on the readout will correspond to those last stored in the GPS receiver non-volatile memory.

Synchronization to a minimum of four satellites is necessary for the Model 1088B to determine longitude, latitude, and elevation precisely. When meeting this minimum satellite lock requirement (and POSITION HOLD is disabled), the displayed position values will accurately correspond to the present antenna location.

The position values are displayed in the following sequence and formats:

Longitude:

ANTENNA LONGITUDE
XXX° XX’ XX.XXX” W*

*West or E (EAST)

Latitude:

ANTENNA LATITUDE
XX° XX’ XX.XXX” N**

**North or S (South)

Elevation:

ANTENNA ELEVATION
XXXXX.XX M WGS-84

4.7 Position Hold and Auto-Survey Modes

Operation in Position Hold Mode forces the clock to utilize a single set of position data as a reference for time calculations, rather than the position information obtained from the continuously updated receiver position fix. If accurate information is used, this results in a reduced standard deviation for the time data. The Model 1088B can use four means to establish Position:

1. From a value previously stored in the receiver non-volatile memory,
2. From a new position fix determined at power-up (Auto Survey)

3. From a value entered via RS-232C command (refer to Appendix A, Table A-8)
4. From a value edited via the front panel using the SETUP menu.

By using the Auto-Survey Mode, the Model 1088B also has the ability to determine its own position with greater accuracy than is possible with a single fix. This function operates by accurately averaging a specified number of position fixes from 1 to 86,400 (from no averaging to averaging approximately 24 hours of fixes, respectively). Because Selective Availability (SA) is a pseudo-random error, it is reduced by averaging, thus delivering an approximate position uncertainty (1 sigma) of 0.2 arc-seconds (approximately 6 meters) in latitude and longitude, and 20 meters in elevation for a 1-hour average.

For longer and shorter averages these errors scale approximately with the inverse square root of the ratio of the number of fixes. For example, in 24 hours of averaging the results will be approximately 1√24 or 0.2 x uncertainty for 1-hour average; or approximately 0.04 arc-seconds and 4 meters elevation (1 sigma).

4.7.1 Position Accuracy Requirements

Errors in Position of up to 100 meters have only a small effect on timing accuracy. A GPS position fix, even in the presence of SA, is generally within 100 meters of the correct position, and can be used directly with minimal errors if a more accurate position is not available. If a surveyed position is available, using this data can eliminate these residual errors. A position within 0.5 arc-second of latitude and longitude and 5 meters elevation is sufficient to eliminate these residual errors almost completely.

If only one or two of the position parameters are accurately known, it is best to edit these parameters while leaving the others unchanged. This may be the case if, for example, latitude and longitude are known from an accurate survey but elevation is unknown; or if elevation is obtained from a topographic map, but accurate longitude and latitude position is unavailable. Using the best available information will give the best overall performance. This is particularly true for elevation, because elevation errors will cause a bias error (offset) in the time solutions of up to 3 nanoseconds per meter. In general, latitude and longitude errors, if large enough, cause an increase in the rms variations of the time solution, but cause only a minimal bias error.

4.7.2 Auto-Survey Mode Activation

The Auto Survey function can be activated via RS-232C command or by front panel keys. To access this mode, press SETUP, then select “Set Auto Survey?” (see Figure 4-4). For RS-232 access, refer to Appendix A, Table A-9. Initially, three settings are normally available: (1) Turn Off Survey, (2) Single Survey, and (3) Power On Survey. After a survey has been initiated, two more settings become available: (1) Suspend Survey and (2) Resume Survey. Suspend and Resume are used as the names suggest, i.e. to temporarily suspend an in-progress survey, and to resume it after being suspended. A Power On survey occurs after the inlet power has been cycled, according to the number of fixes set up prior to power being cycled. A single survey occurs only once after being initiated from the front panel or through the serial port (see Appendix A. RS-232 Commands).

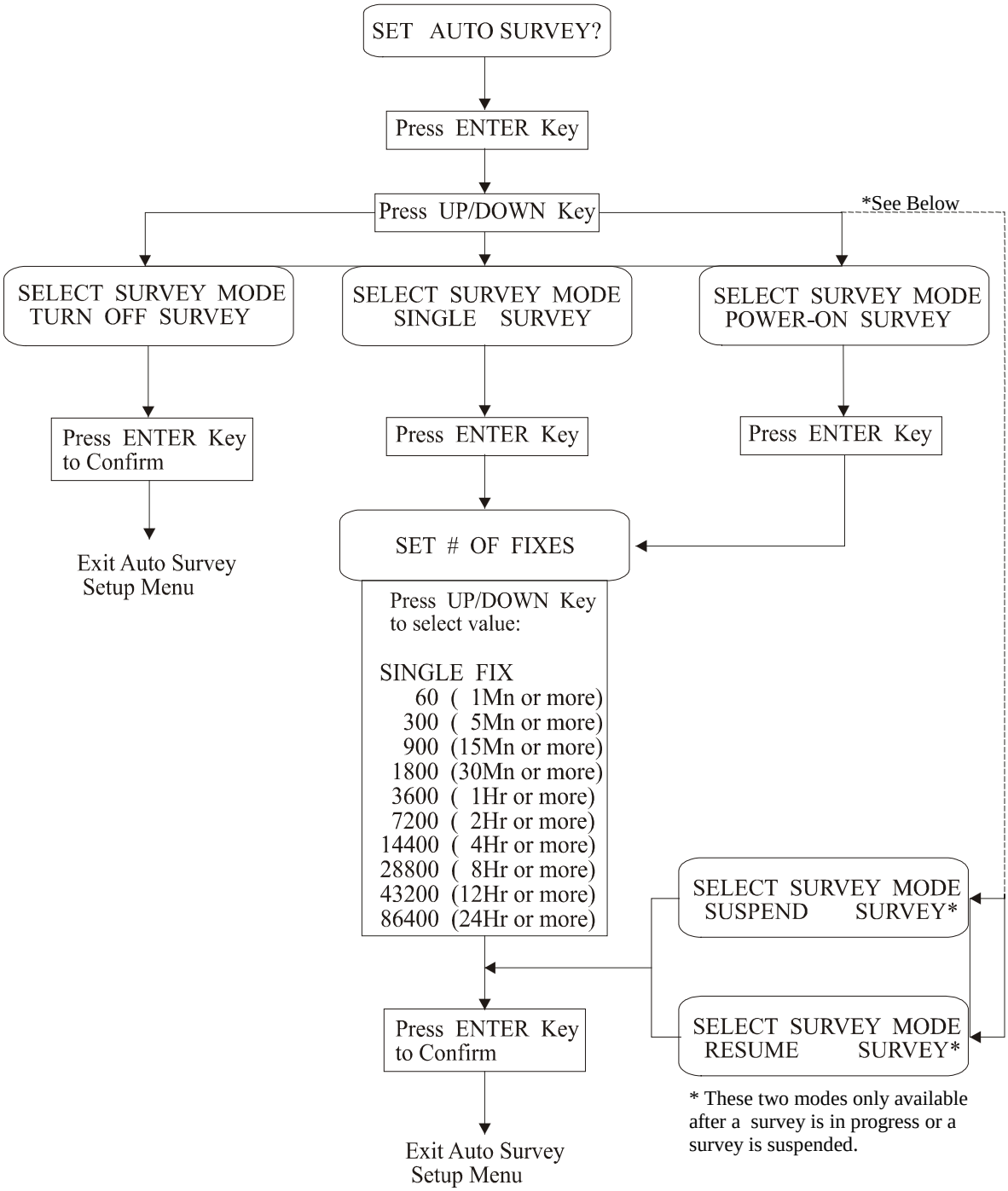


Figure 4-4. Auto-Survey Mode Flow Chart

4.7.3 Position Hold Mode Activation

The flow chart of Figure 4-5 illustrates the following sequence of steps required to activate Position Hold Mode from the front panel.

1. Access the setup menu by pressing the front panel key labeled SETUP. Scroll through the menu structure by repeatedly pressing the SETUP key, or using the UP and DOWN keys, until the readout displays:

   SET POSITION HOLD?

2. Press the ENTER key and the display will change to read:

   POSITION HOLD

   ON (or OFF)

   The current setting will be displayed. The factory default setting for Position-Hold Mode is enabled (ON).

3. To change between ON and OFF, press the UP and DOWN keys (respectively). When the desired setting is displayed, press ENTER to confirm the selection.

   a. If OFF is selected, the instrument will return to displaying the next sub-menu of the SETUP menu, and may be returned to normal operation by pressing one of the primary function keys (e.g. TIME, POSITION, EVENT/DEVIATION, STATUS).

   b. Position information will be updated, as it is determined, and will be reflected as such in the front-panel position display.

4. While in the Position-Hold menu with Position Hold set to “ON” (and no survey in progress) press ENTER and the readout will display:

   EDIT POSITION
   HOLD DATA?

   If changes to the position hold data are not required, press SETUP to return to the main SETUP menu and then press one of the primary function keys (e.g., POSITION).

   If changes to the position hold data (e.g., to match a surveyed position) are required, proceed to the next step.

5. Press ENTER to proceed with position data editing. The readout display will change to:

   EDIT LONGITUDE
   XXX° XX’ XX.XXX” E (East or West)

   a. Press the UP and DOWN keys to increase or decrease the Longitude data in steps of 0.01 arc-second. (A raw GPS position fix will generally be within 4.0 arc-seconds of the accurate surveyed position.)

   b. When the correct value is displayed, press ENTER. The readout display will change to:

   EDIT LATITUDE
   XX° XX’ XX.XXX” N (North or South)

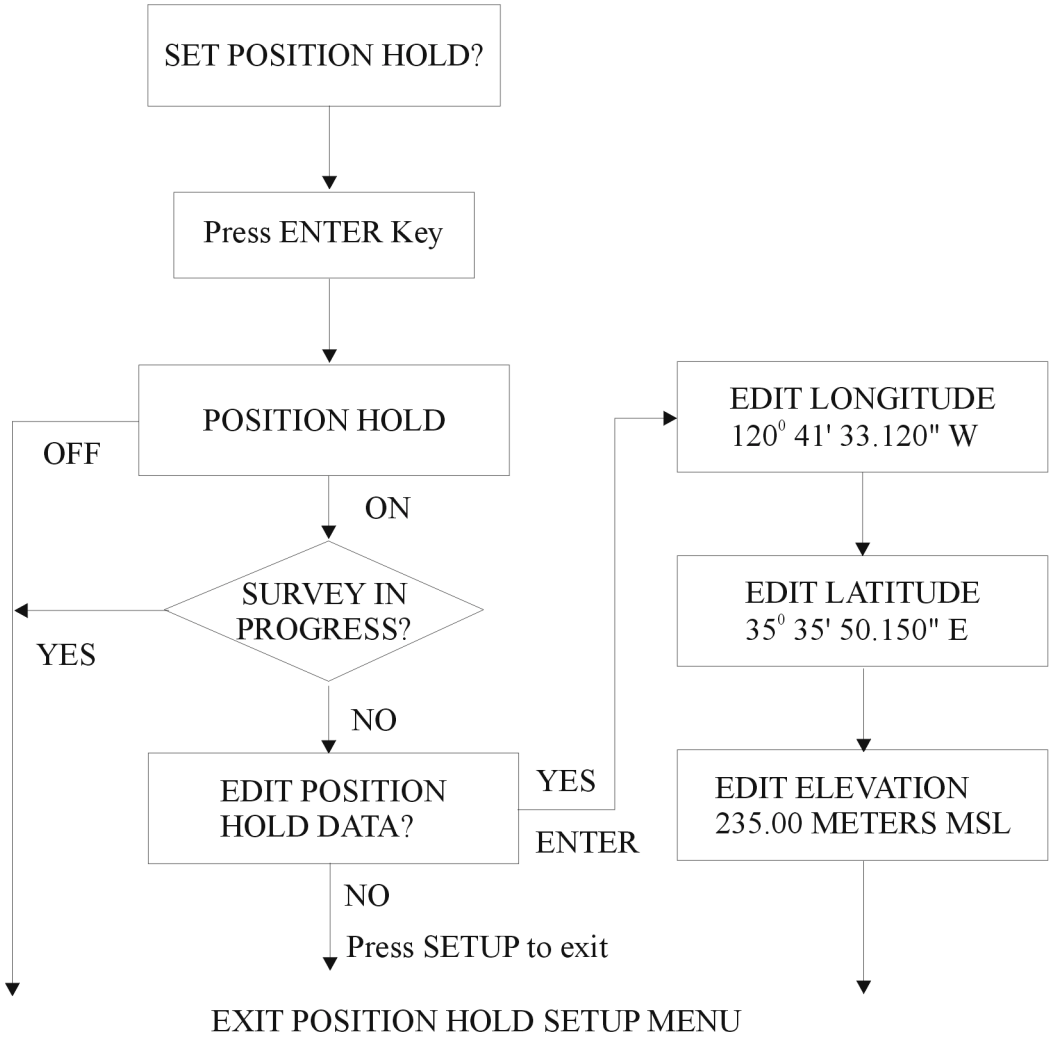
   c. Adjust Latitude data in accordance with steps a and b, above.

d. When the desired value is displayed, press ENTER. The display will change to read:

EDIT ELEVATION
XXXXX.XX M WGS-84

e. Adjust Elevation data in accordance with steps a and b, above.

To exit from the SETUP menu, press one of the primary function keys (e.g. POSITION).



NOTES:
1. When a survey is in progress, the Edit Position Hold Data screens do not appear.
2. Adjust the longitude, latitude and elevation values with the UP and DOWN buttons. Move the cursor right and left using the SETUP and ENTER buttons.
3. Confirm altered position settings by pressing the ENTER button.

Figure 4-5. Position-Hold Mode Flow Chart

4.8 Event and Deviation Recording and Display Modes

The Model 1088B Satellite-Controlled Clock can be configured to provide two input channels, designated **A** and **B**, applied to rear-panel connectors J4 and J3 respectively. Each of the channels can be independently used to either record event time data or monitor 1 pulse-per-second (PPS) deviation.

4.8.1 Record Event Times

The event/deviation inputs will accept TTL or 5V CMOS level signals, and will record the precise time of each rising edge, up to a total of 300 events per channel. The events are numbered from '000 - 299', and stored in a circular memory buffer.

Data for individual recorded events can be recalled using either the Event/Deviation front panel key or via the RS-232C interface (refer to Appendix A, Table A-2). Data for each event will be retained until it is retrieved using one of these two methods. Thus, if none of the event data points are retrieved, recording will be suspended when the total number of events for a channel reaches 300. As soon as data is retrieved for a recorded event, its address (000 - 299) is made available for data corresponding to a new incoming event.

Because of the configuration of the event recording circuit, a minimum of 11 milliseconds must elapse between one event (rising edge) and the next, in order to guarantee that the second event will be recorded. If the second event occurs sooner than 11ms after the first, the second event may be ignored, but the time data for the first will still be recorded.

4.8.2 Event Time Measurement

The method used to determine event times is illustrated in Figure 4-6. The 1088B generates an internal 100 Hz signal, which is used for various timing purposes within the instrument. Once every second, one of the rising edges of this signal will coincide with the leading edge of the 1 pulse-per-second (PPS) signal. Thus, the period of every 1-PPS pulse is divided into 100 equal segments, each having a known starting time. Each event will fall within one of these segments, and will initiate the counting cycle of a 10-MHz counter. The counter stops at the rising edge of the next 100-Hz pulse. The resultant count is subtracted from the starting time of this 100-Hz pulse. The difference corresponds to the time at which the event occurred. The value is assigned an event number and stored in the buffer for eventual output or display.

4.8.3 Deviation Measurement

The **A** and **B** input channels on the Model 1088B can also be configured to display and output 1 pulse-per-second (PPS) deviation measurements. Intended purpose of the deviation measurement function is to allow comparison of an external 1-PPS signal to the clock's internal 1-PPS signal. The 1088B determines the mean time difference between the two signals, which can be displayed on the front panel, read via the RS-232 Interface, or output as a ±5 V analog value (for driving a chart recorder).

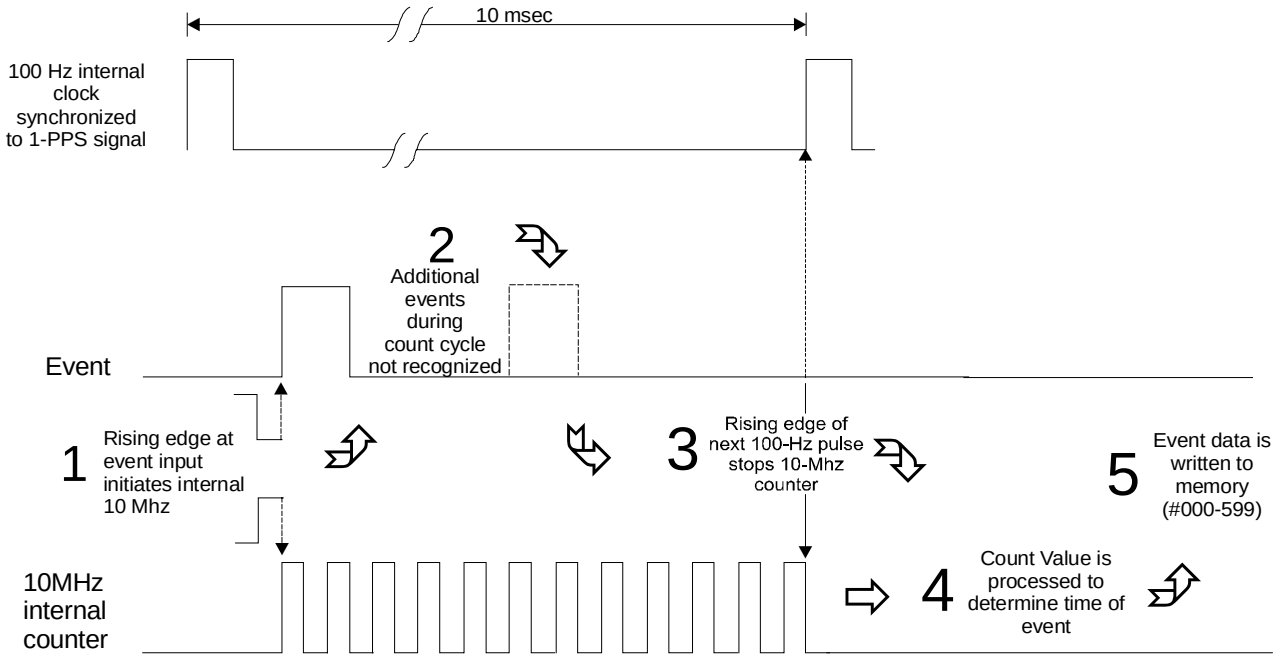


Figure 4-6. Event Time Measurement Principle

4.8.4 Measurement Principle

The measurement technique employed for 1-PPS deviation uses the same time determination and recording scheme that is used for event time measurement (refer to paragraph 4.8.1 and Figure 4-6 above), but makes the assumption that the input signal is periodic and continuous. Also, the operation of the circular memory buffer is modified somewhat, in that recording does not stop after the first 300 events; new event data coming in is given priority over existing data, and will overwrite it. Since the incoming signal is at 1 Hz and the circular buffer holds 300 events per channel, each event time record will be overwritten once every 300 seconds.

Once every second the processor circuitry in the 1088B looks at the most recent group of 16 events. For the deviation computation, only the portion of the event data describing fractional seconds is used (e.g. values between 0.0000000 and 0.9999999). The 16 fractional-second values are normalized around 0.0000000, so that the range of results from the deviation computations will be centered on zero (–0.4999999 to +0.5000000 seconds). Statistical computations are then performed on the 16 values to determine their mean and sigma (standard deviation) values, which can then be displayed and/or output.

4.9 Event/Deviation Channel Configuration

In order for the Model 1088B to record Event Times and/or Display 1-PPS Deviation, adjustments to both the hardware and software configuration may be required. The following paragraphs describe the required hardware changes.

4.9.1 Input Connections

On a standard Model 1088B, there are four BNC, RF connectors located on the rear panel (see Figure 3-4 for location). Any of these four connectors can be configured to provide any of the available output signals. However, each connector can also be used for a single, unique input function. These input functions and their assigned connectors are as follows:

I/O Connector	Function	Jumper No.
J2	Auxiliary Input	JMP6
J3	Channel B Event/1 PPS	JMP9
J4	Channel A Event/1 PPS	JMP12
J5	External Frequency Reference	JMP15

4.9.2 Jumper Configuration

To reconfigure any I/O connector as input, simply set the corresponding I/O jumper to position ' B'. It is not necessary to change the position of the output function jumper, as it will have no effect on input operation.

4.10 Firmware Setup

Configuration of the firmware may also be required to allow measurement and display of Event Time Data and/or 1-PPS Deviation. The following steps describe how to reconfigure the Model 1088B for (example) recording Event Time on channel A and 1-PPS Deviation on channel B and Figure 4-7 provides a corresponding flow chart.

a. Enter the SETUP menu by pressing the front panel SETUP key.

b. Press the SETUP key repeatedly until the display shows SET EVENT/DEVIATION. The UP and DOWN keys may also be used.

> **NOTE** DUE TO INTERNAL PROCESSOR TIME-SHARING REQUIREMENTS, THERE MAY BE A SLIGHT DELAY BEFORE THE DISPLAY RESPONDS TO KEYSTROKES. ALLOW ABOUT A SECOND AFTER PRESSING A KEY FOR THE DISPLAY TO BE UPDATED PRIOR TO PRESSING ANOTHER KEY.

c. When SET EVENT/DEVIATION? is displayed, press the ENTER key. The readout will display the present configuration for channel A (either event timer mode or 1-PPS deviation mode). Use the UP and DOWN keys on the front panel to change channel configuration to the event timer mode.

d. When Event Timer Mode for channel A is displayed, press the ENTER key. The display offers two choices for time data mode: UTC (Coordinated Universal Time), and Local Time (which adds the offset which converts UTC time data to the local hour). Use the UP and DOWN keys

to select Time Data Mode. When the desired mode is displayed, press ENTER to confirm the choice and move to the next menu.

e. The readout displays the present configuration setting for channel B, either Event Timer mode or 1-PPS Deviation mode. Press the UP or DOWN keys to change this setting to the 1-PPS Deviation mode. Press “ENTER” to confirm the selection.

f. The readout should now display, “SET RECORDER CH.” This shows which channel is driving the ±5 V Analog Recorder output at the rear panel (if the instrument is so configured). The UP and DOWN keys toggle the setting between channel A and channel B. Set the recorder output to channel B for this example.

g. Press ENTER to confirm the recorder channel selection and return to the main SETUP menu. Press one of the primary keys, such as POSITION, to exit the configuration menus.

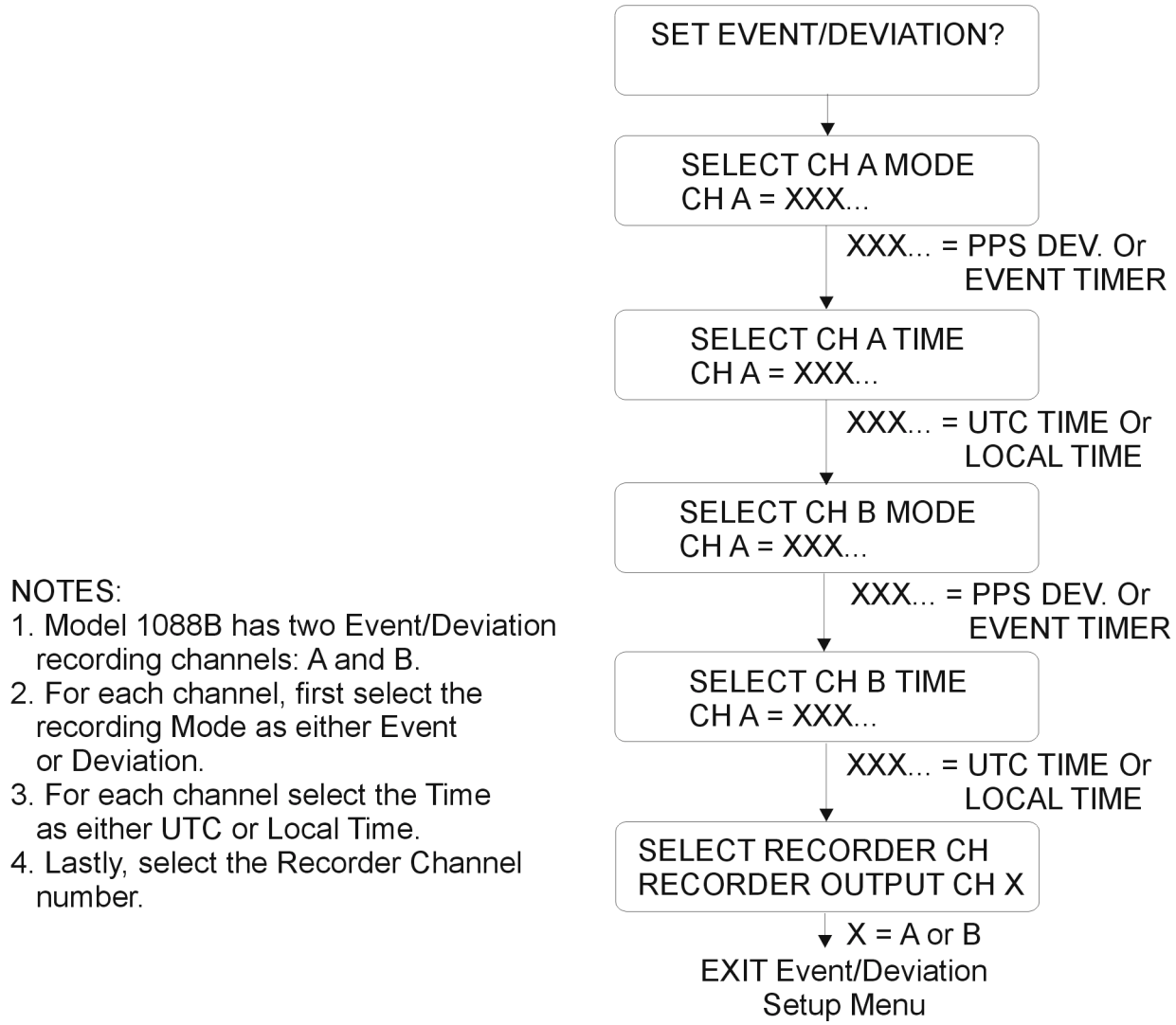


Figure 4-7. Event/Deviation Response Flow Chart

4.11 Displaying Data

Event and Deviation data can be accessed from either the front panel or via RS-232 commands. The following paragraphs describe the steps required to access data using the front panel EVENT/DEVIATION key.

Press the EVENT/DEVIATION key to enter a circular scroll of recorded event data. It begins by showing the event data (if any is present) for channel A, as previously configured for Event Recording in paragraph 4-10. The readout will display one of the event times (for record #000 to #299), using the following format:

CH A EVENT #nnn TIME
hh:mm:ss.sssssss

where:

'nnn' indicates the event number (000 to 299);
'hh' indicates the hour of the event (00 to 23);
'mm' indicates the minute of the event (00 to 59);
'ss.sssssss' indicates the second and fractional second of the event (00.0000000 to 59.9999999).

Press the UP and DOWN keys to scroll the display through all events presently stored in the event time buffer. If the event display mode is exited and then re-entered, the first event data displayed for a given channel will correspond to the same event number as was last displayed for that channel. However, the data itself may be changed if it has been overwritten (refer to paragraph 4.8.1).

During the time that event data (or 1-PPS deviation) is being displayed for channel A, pressing "EVENT/DEVIATION" again will change the readout to display data from channel B. Depending on the configuration this will be either Event Time or 1-PPS Deviation data. If the unit is configured as in the example shown above, the readout will display the deviation of channel B 1-PPS input signal. In this case, the readout display will have the format:

B 1 PPS XXXXX.XX μS
SIGMA: XXXXX.XX μS

where:

The top number is the mean (average) value of the most recent 16 records in the event buffer, and represents the mean deviation (in microseconds) of the measured 1-PPS signal from the GPS 1-PPS signal.

The bottom number is the standard deviation (sigma) of the values of the 16 samples.

If the instrument is configured as shown in the preceding example, pressing EVENT/DEVIATION again will cause the display to issue the following prompt:

CLEAR EVENT (A)?

If ENTER is pressed during this display, all of the records in the event buffer for channel A will be deleted, and recording of new event times will begin. Use any of the top row buttons to escape.

The CLEAR EVENT prompt is displayed only for channels previously configured for event time recording. If neither channel is configured for event time recording, the CLEAR EVENT prompt

will not be displayed. If only one channel is configured for event time recording (as in the example above), only the CLEAR EVENT prompt for that channel will be displayed.

4.12 RS-232C Event Trapping

Event/Deviation channel A on the 1088B can be configured to capture one or more events via the RS-232C Serial Interface. The time mark for a captured event will correspond to the leading edge of the start bit of the first character in the RS-232C signal. This event mode can be both armed and interrogated for data over the RS-232C interface, allowing automated synchronization of an external computer or system.

To perform event trapping via the RS-232C interface, the circuit must first be ARMED; that is, made ready to receive an event trigger. Only one event may be captured after every arming, but the events are stored sequentially in the event buffer in exactly the same manner as the normal event time mode, thereby allowing up to 300 events to be recorded.

4.13 Event Trapping Setup

Configuring the 1088B to trap events on the RS-232C interface requires changing jumper JMP1, which determines whether the signal to channel A event/deviation circuitry comes from a rear-panel connector (position A), or from the RS-232C interface (position B). Refer to Event A Recording after paragraph 3.3.4 for a detailed description of reconfiguring jumper settings and see Figure 3-5 for jumper locations.

Arming of the Event Trapping circuit from the front panel is accomplished from the SET RS-232 sub-menu of the SETUP menu. This menu also provides for configuration of communications port parameters (e.g. baud rate, word length, etc.) to match those of the computer or equipment to be interfaced. The following steps are required to arm the Event Trapping circuitry:

1. Press the SETUP key on the front panel, the first readout displayed is:

   SET RS-232?

2. Press ENTER to select the RS-232C sub-menu, the next readout displayed is:

   SET PORT CONFIG.?

3. Press ENTER to confirm this selection (or SETUP to skip to the next parameter).

   a. The first parameter to be modified is the baud rate. The display will show the present setting. Use the UP and DOWN keys to change the value. When the desired setting is displayed, press ENTER to confirm it and move on to the next parameter.

   b. The next three parameters to be modified are: Word Length, Stop bits, and Parity. The display will show the present setting. Use the UP and DOWN keys to change the value. When the desired setting is displayed, press ENTER to confirm it and move on to the next parameter.

4. After confirming the value for Parity, press ENTER and the readout will display:

   SET BROADCAST?

This selection involves the automatic output of time data over RS-232C, and is not related to RS-232C event trapping. Bypass this menu selection by pressing SETUP. The readout will display:

SET A EVENT?

5. This is the preliminary level of the sub menu used to arm the RS-232C error trapping. Press ENTER, the readout will display:

ARM A EVENT?
PRESS ENTER TO ARM

Press ENTER (at this point) to arm the event trapping circuit, and return the display to the top level of the SETUP menu. Press any primary function key (e.g., TIME or POSITION) to. return the clock to normal operation.

When the event occurs on the RS-232C port (i.e. the start bit of the next received character), the event data can be reviewed in the event mode, exactly as any normally captured event would be. To capture further events, the circuit must be re-armed, either by the front panel or by using the RS-232 Command 'AR'. Note that received commands are viewed as complete when the final character in the command is received. Control characters, such as carriage-return and line-feed, are ignored and may follow the 'AR' command, but the start bit of the next character after the 'R' (even if a carriage return) may trigger the event timer. For a complete list of RS-232C commands, refer to Appendix A.

5.0 Firmware Configuration

5.1 General

Some operational parameters of the Model 1088B Satellite-Controlled Clock can be modified for specific user requirements. These changes are performed either through hardware settings, or by changing internal operating firmware configuration (or combination of both). The following paragraphs describe the general procedures used to modify these parameters.

5.2 Change firmware Configuration Using SETUP Menu

The SETUP menu allows the user to modify internal operating firmware parameters within the Model 1088B. The SETUP menu can be easily accessed from the front panel keyboard, and also modified via the RS-232C interface.

Software is available, as a separate option, for use with the standard Model 1088B which allows RS-232 SETUP control via a PC. This software interface provides all of the SETUP functions described below and illustrated (as flow charts) in this section. Contact Arbiter Systems for details.

> **NOTE** RS-232 COMMANDS 'FB' (BLANK FRONT PANEL DISPLAY AND DISABLE KEYBOARD) AND 'FL' (LOCK SETUP KEYS) WILL DISABLE THE SETUP MENUS. RS-232 SETUP (REFER TO APPENDIX A) IS STILL ACTIVE, AND FULL KEYBOARD CONTROL MAY BE RE-ENABLED USING THE 'FE' COMMAND (ENABLE KEYBOARD AND DISPLAY).

The SETUP menu consists of twelve (12) sub-menus which control many of the operating functions of the Model 1088B and are illustrated in flow chart format in Figure 5-1 through Figure 5-9 (the remaining three menus are contained in Section 4 and listed below). The figures are generally in the same sequence as their respective menu selections when scrolling through the SETUP menu:

Figure 5-1.	Set RS-232	Figure 4-4.	Set Auto Survey
Figure 5-2.	Set Local Hour	Figure 4-5.	Set Position Hold
Figure 5-3.	Set Out-of-Lock	Figure 4-6.	Set Event/Deviation
Figure 5-4.	Set Back Light		
Figure 5-5.	Set System Delays		
Figure 5-6.	Set Programmable Pulse		
Figure 5-7.	Set IRIG Time Data		
Figure 5-8.	Set Frequency Reference		
Figure 5-9.	Set Option board		

The flow charts in this section are for reference only. Each graphically illustrates the basic firmware configuration of that specific operating parameter. Each configuration parameter may be modified, however, all possible combinations are not shown.

To access individual setup menus:

1. Press the SETUP key on the front panel.

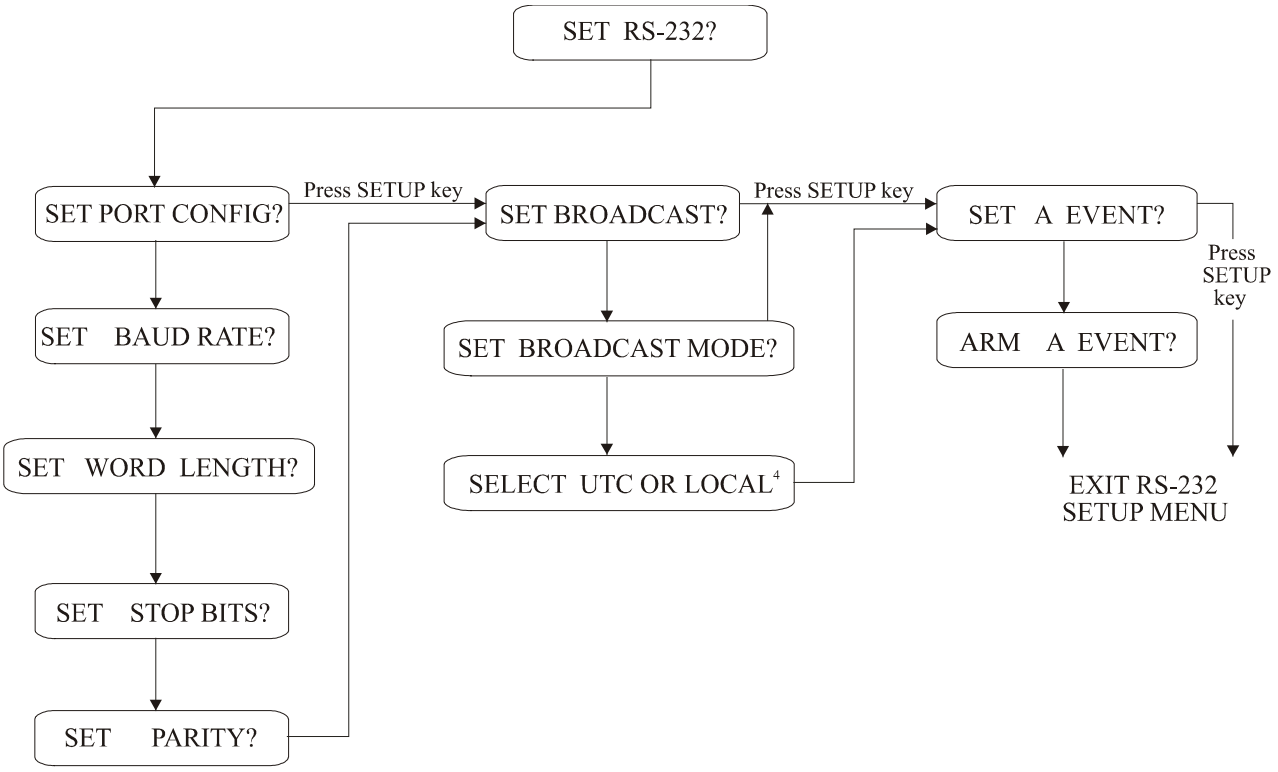
2. Navigate through the series of menu selections by using either the SETUP (forward only) or the UP/DOWN keys (to move forward/back respectively).

3. Confirm the selection by pressing the ENTER key.

> **NOTE** After entering the selected menu and while viewing parameters, some selections can be bypassed by pressing the SETUP key.

4. If a parameter is adjustable, the UP and DOWN keys can be used to change the value. In the numeric data entry mode, the SETUP key will increment the cursor to the next left-hand digit and the ENTER key will decrement the cursor to the next right-hand digit.

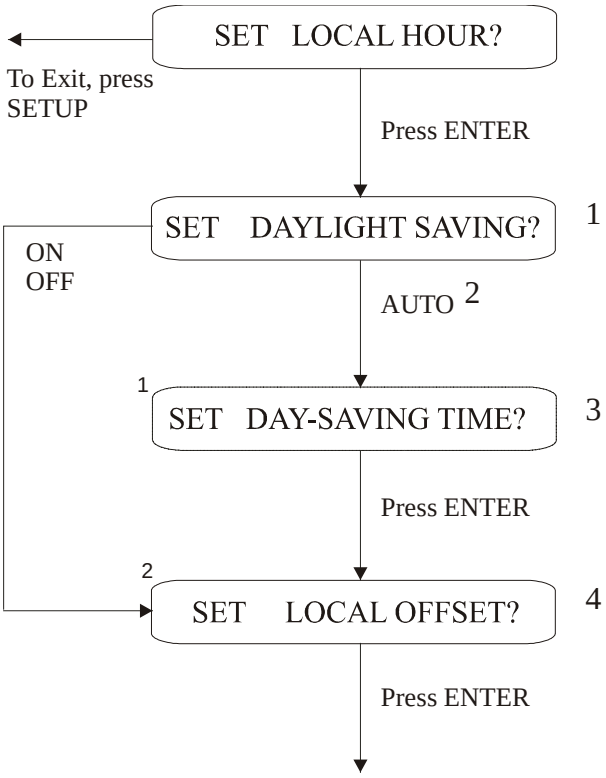
5. After modifying the parameter, press ENTER to confirm the new value and proceed to either the next parameter or to exit the menu.



NOTES:

1. Pressing the SETUP key during Port Configuration is the same as pressing the ENTER key in that the value is confirmed and the display increments to the next parameter.
   - Baud Rate: selectable from 1200 to 19200.
   - Word Length: 7 or 8.
   - Stop Bits: 1 or 2.
   - Parity: OFF, EVEN, ODD.
2. Broadcast Mode: Interrogate Mode, Broadcast ASCII Std, Broadcast VORNE Std, Broadcast Event Data, Broadcast Status, Broadcast Ext. ASCII, Broadcast ASCII with Quality.
3. To escape from this setup menu at any time, press any of the four keys in the upper row.
4. This selection only available if one of the broadcast modes is active.

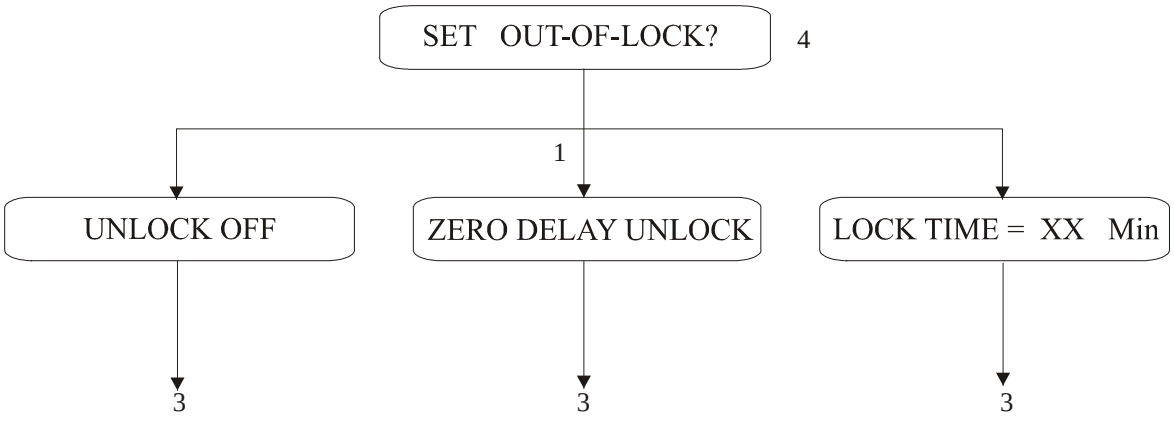
Figure 5-1. RS-232 Setup Menu Flow Chart



EXIT Set Local Hour Setup Menu

NOTES:
1. Use the UP/DOWN keys to select between OFF, ON, or AUTO.
2. Auto Only - Adjust Day-Saving Time for time-of-day that Daylight Savings time adjustment occurs. Selectable in hours and minutes.
3. Use UP/DOWN keys to adjust the Change-over Hours and Minutes and press ENTER to confirm.
4. Set Local Offset for difference, in hours and minutes, between Local and UTC Time (with Daylight Saving OFF). Minutes limited to ± 30.

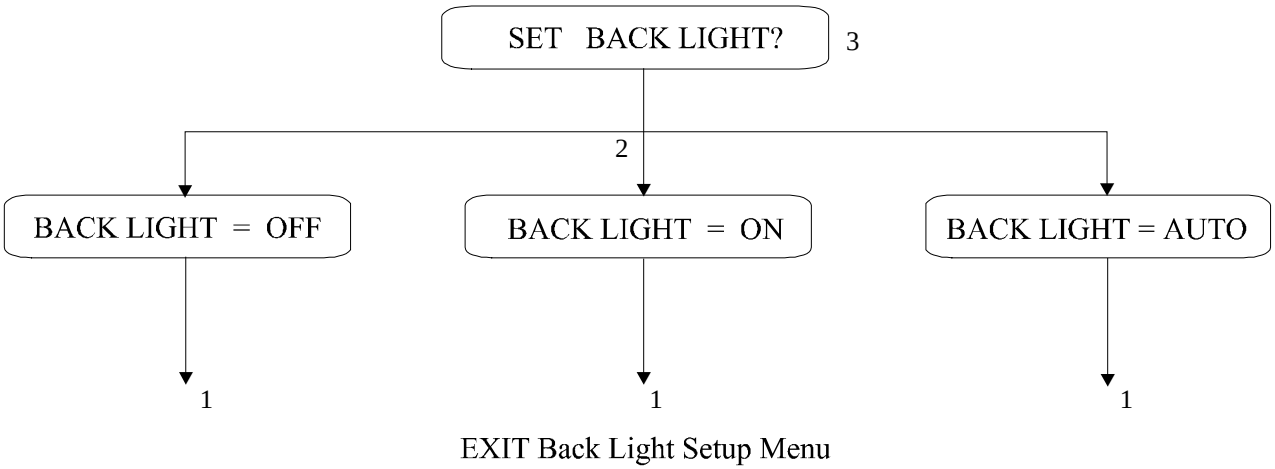
Figure 5-2. Set Local Hour Flow Chart



NOTES:

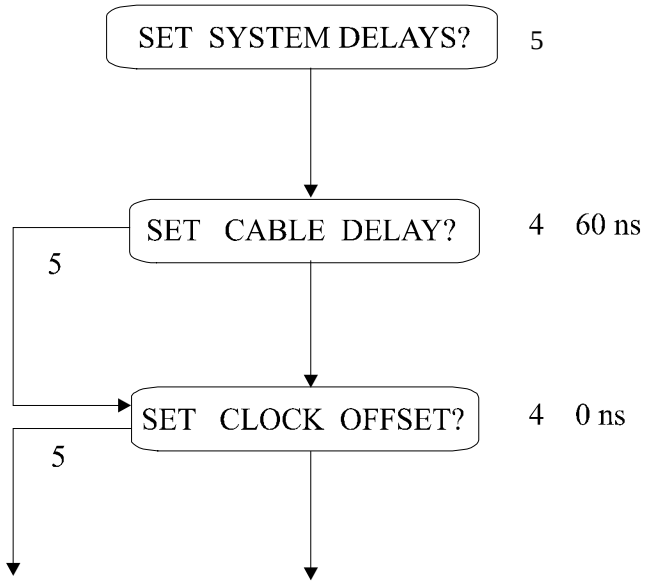
1. Use UP/DOWN keys to toggle between unlock selections and Lock TIME minutes.
2. Lock Time adjustable between 0 - 99 minutes.
3. Press ENTER to select Out-of-Lock menu, confirm any selection, and to Exit Out-of-Lock menu.
4. Press SETUP to bypass this menu selection.

Figure 5-3. Set Out-of-Lock Flow Chart



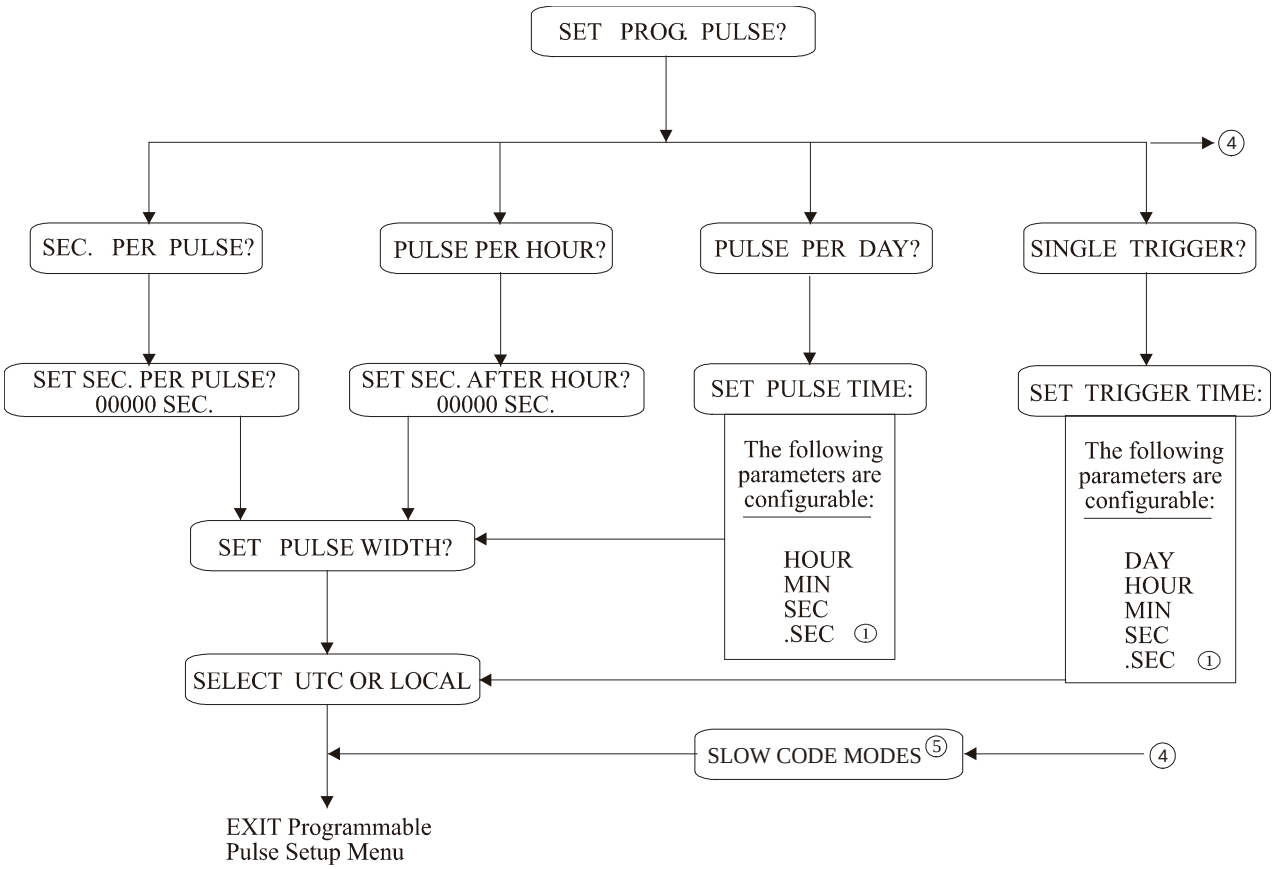
NOTES:
1. Press ENTER to select Backlight menu, to confirm any selection and to exit Backlight menu.
2. Use the UP/DOWN keys to toggle between selections.
3. Use the SETUP key to bypass this menu.

Figure 5-4. Set Back Light Flow Chart



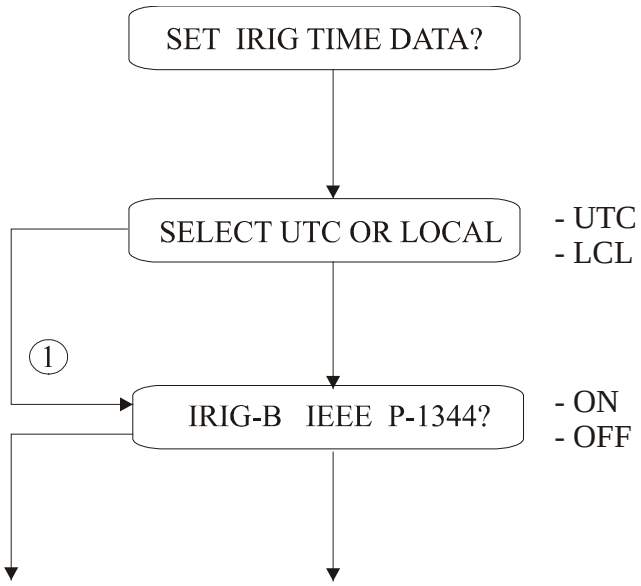
NOTES:
1. Press ENTER to select System Delays menu, confirm selection and Exit System Delays menu.
2. ENTER also used to move cursor right after toggling digits with UP/DOWN keys.
3. SETUP key used to move cursor left after toggling digits with UP/DOWN keys.
4. "60 ns" is the factory default setting for 15 meters (50 feet) of antenna cable. "0 ns" is factory default value for Clock Offset.
5. Press SETUP to bypass this menu.

Figure 5-5. Set System Delays Flow Chart



NOTES:
1. Press ENTER to select Programmable Pulse menu, confirm selections and to Exit Programmable Pulse menu.
2. Use the UP/DOWN keys to move between any of the Programmable Pulse modes or to increment and decriment the digits in any position.
3. After pressing either the UP or DOWN key to increment a digit, the ENTER key can be used to move the cursor to the right, and the SETUP key can be used to move the cursor to the left.
4. Press the UP or DOWN keys to access the Slow Code modes: UTC, LCL, (+) or (-).
5. See Appendix A, Table A-11 for additional information on Slow Codes.

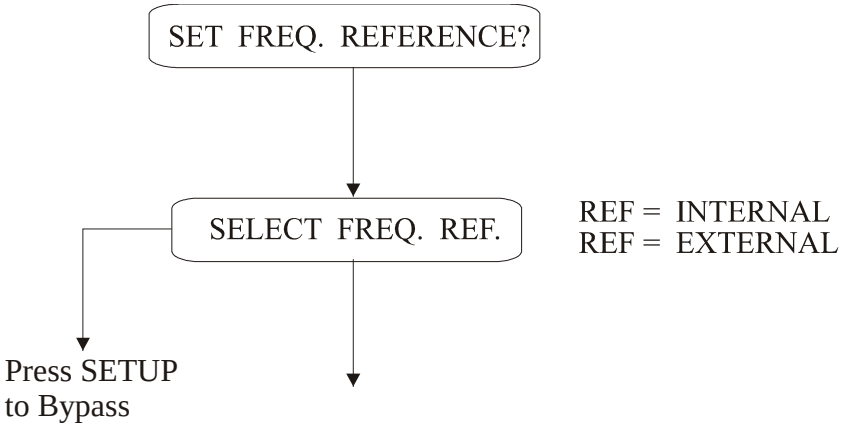
Figure 5-6. Programmable Pulse Flow Chart



NOTES:

1. Press ENTER to access the IRIG Data menu, or confirm any selections.
2. Use the UP/DOWN keys to toggle between selections
3. Press SETUP to bypass the IRIG menu.

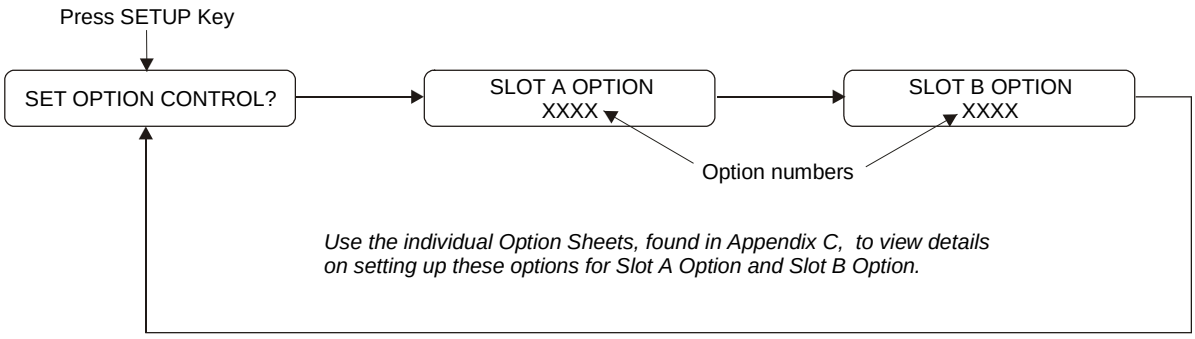
Figure 5-7. IRIG Time Data Flow Chart



NOTES:

1. Press ENTER to select the Frequency Reference menu, confirm selection, or Exit from the menu.
2. Use the UP/DOWN keys to toggle between selections.
3. Press the SETUP key to bypass this menu.

Figure 5-8. Frequency Reference Flow Chart



AUXILIARY BOARD OPTIONS		SLOT
NONE		N/A
Option 3 -	Four Additional Configurable Outputs	A
Option 4 -	Parallel BCD Output	B
Option 17-	Parallel BCD Output & Second RS-232 port	B
Option 17A-	Second RS-232 Port	B
Option 18-	Self Monitor IRIG-B Distribution System and 2nd RS-232 port	B
Option 19-	Out-of-Lock Relay	B
Option 20A -	Four Fiber Optic Outputs	A or B
Option 23 -	Comtrade Sample Rate Generator	A or B
Option 27 -	Eight-Channel High Drive	B
Option 28 -	Power System, Time, Frequency and Phase Monitor	A
Option 29 -	Four Additional Outputs with Two Solid-State Relays	B
Option 32 -	Internal NTPServer	B

GENERAL NOTES FOR SETTING UP OPTIONS

1. Press SETUP to locate the "SET OPTION CONTROL?" Menu. Continue pressing the SETUP button or use the DOWN button to locate the 'SET OPTION CONTROL?" Menu.
2. Use the ENTER key to move between menus and confirm selection.
3. Use the UP/DOWN keys to select individual items in each menu.
4. Use the SETUP and ENTER keys to select specific digits for various options. First, press UP or DOWN to activate the cursor on the Least Significant Digit, then use the SETUP or ENTER keys ot move cursor.

Figure 5-9. Set Option Board Flow Chart

6.0 Appendix A. RS-232 Command Summary

The following appendix contains a listing of commands, which may be used to control and communicate with the Model 1088B via the RS-232C serial interface. All of the RS-232 commands are functionally grouped into 14 tables. For example, Table A-10 lists all of the commands used to both set and retrieve the date and time in one of the standard formats.

Each command name and syntax is highlighted in bold at the first line of each definition. Additional information to use and interpret the inputs and outputs follows below the command headline. For example, the first command in this summary is Broadcast Mode Off. The exact RS-232 command to switch the broadcast mode off is B0 (B-zero). B1 (Broadcast Mode-ASCII) causes the Model 1088B to continually send out the Time and Date to the serial port.

When a command requests information from the Model 1088B, it returns the most current data available. Numeric data is returned as an ASCII string of numeric characters, with leading sign and embedded decimal point as needed. Strings are terminated with carriage return and line feed characters. Enter RS-232 commands as written in these tables without pressing ENTER, or by sending a programming sequence of carriage-return/line-feed characters. Wherever possible identical commands used for different channels (e.g. channel A or B) are combined with the actual command syntax and are denoted as [A/B].

The following symbols and syntax are used throughout and are repeated here for emphasis:

↵ shorthand for <CR><LF>.
‘A’ Channel A.
‘B’ Channel B.
‘U’ UTC Time, Channel A or B.
‘L’ Local Time, Channel A or B.
[A/B] Channel A or B.

Underlines are used for clarity only and graphically represents the location of ASCII SPACES.

Table A-1. Broadcast Mode Commands

Broadcast Mode – OFF B0

Deactivates the RS-232C Broadcast Mode (resetting to the Interrogate Mode). It includes the Options Broadcast Mode OFF command – **O0**.

Response: ↵

Broadcast Mode – ASCII B1

Configures the RS-232C Broadcast Mode to return the time-of-day as ASCII data. It includes the Options 17 and 18 Broadcast Mode ASCII command – **O1**.

Response: <SOH>ddd:hh:mm:ss↵

<SOH> = Hex 01. The start-bit of the <SOH> character is transmitted on time, and *is broadcast once per second*.

Broadcast Mode – Vorne B2

Configures the RS-232 Broadcast Mode to support Vorne large format time displays. Refer to Arbiter Systems Application Note 103 for more information. It includes the Options 17 and 18 Broadcast Mode Vorne commands – **O2**.

Response:	11nn↵	(out-of-lock time)
	22±ff.fff↵	(frequency error)*
	33±s.ss↵	(time error)*
	44hhmmss↵	(UTC/Local time)
	55ddd↵	(day-of-year)
	66hhmmss↵	(system time)*
	77nn.nnn↵	(system frequency)*
	88nnn.nn↵	(system phase)*
	<BEL>	<BEL> = hex 07

Response (1/sec; number and order of strings returned depend upon options ordered with clock):

Data is transmitted *ahead-of-time*, and the <BEL> character is transmitted *on time*. When properly configured, the Vorne displays update simultaneously upon receipt of the <BEL> character.

The decimal points shown above are not actually transmitted in the data stream, but their position is implied as shown here. The displays are configured to show the decimal point in this position.

** This field is transmitted when the clock is equipped with Option 28.*

Broadcast Mode – Event B3

Configures the RS-232C Broadcast Mode to return Event Data. It includes the Options 17 and 18 Broadcast Mode Event command – **O3**.

Response:

-Local	mm/dd/yyyy hh:mm:ss.sssssss nnnAL↵
	mm/dd/yyyy hh:mm:ss.sssssss nnnBL↵
-UTC	mm/dd/yyyy hh:mm:ss.sssssss nnnAU↵
	mm/dd/yyyy hh:mm:ss.sssssss nnnBU↵

'nnn'	Event-Buffer Read Index Number
'A'	Channel A
'B'	Channel B
'U'	UTC Time, channel A or B
'L'	Local Time, channel A or B

Updates whenever a new event occurs.

Broadcast Mode – Status B4

Configures the RS-232C Broadcast Mode to return Status Data. It includes the Options 17 and 18 Broadcast Mode Status command – **O4**.

Response: ddd:hh:mm:ss I=nn:nn X=nn:nn↵ (Updates whenever status changes)

"I"	Internal clock conditions
"X"	External clock conditions, when Option 18 is used.
"nn:nn"	Status byte (Hex). The 2 digits preceding the colon describe the present condition of the instrument. The 2 digits after the colon indicate the parameters, which have changed.

The 8-bits of the Status byte are weighted and assigned as follows:

Bit	Weight	Function	Bit	Weight	Function
0	1	OCXO Not Installed	4	16	Out-of-Lock
1	2	Reserved (Set to 0)	5	32	Time Error
2	4	Power Supply Error*	6	64	VCXO Tune Error
3	8	IRIG Fault (External)*	7 (MSB)	128	Receiver Failure

*Requires Option 18

Broadcast Mode – Extended ASCII B5

Configures the RS-232C Broadcast Mode to return time-of-day as ASCII data using an extended format prefaced with a Time Quality Indicator. It includes the Options 17 and 18 Broadcast Mode, Extended ASCII command – **O5**.

Response: <CRLF>Q_yy_ddd_hh:mm:ss.000___ (Updates once per second)

Format:

<CRLF>		Carriage-return, line-feed. The start-bit of a carriage-return is transmitted on time, once per second.
Q		Time Quality Indicator, and may be represented by:
	space	Locked, maximum accuracy
	?	(ASCII 63) Unlocked, accuracy not guaranteed
	underline	Used here for clarity only and graphically represents the location of ASCII spaces.

Broadcast Mode – ASCII with Time Quality Indicator B6

Configures the RS-232C Broadcast Mode to return time-of-day as ASCII data appended with a Time Quality Indicator. It includes the Options 17 and 18 Broadcast Mode – ASCII with Time Quality Indicator command – **O6**.

Response: <SOH>ddd:hh:mm:ssQ↵ (Updates once per second)

Format:

<SOH>		Hex 01 – The start bit of the <SOH> character is transmitted on time.
Q		Time quality indicator. May be represented by:
	space	Locked, maximum accuracy
	.	(ASCII 46) Error < 1 microsecond
	*	(ASCII 42) Error < 10 microseconds
	#	(ASCII 35) Error < 100 microseconds
	?	(ASCII 63) Error > 100 microseconds

Broadcast mode – ASCII, Year with Time Quality B8

Configures the RS-232C Broadcast Mode to return year and time-of-day as ASCII data appended with a Time Quality Indicator. It includes the Options 17 and 18 Broadcast Mode – ASCII with Time Quality Indicator command – **O8.**

Response: <SOH>yyyy:ddd:hh:mm:ssQ↵. (Updates once per second)

Time quality format is the same as given above under B6.

Broadcast mode - NMEA-0183 m,nB

Enables the broadcast of the National Marine Electronics Association Standard (NMEA - 0183), where m=0 for GLL and m=1 for ZDA. Set n for the update rate, with n=0 for broadcast off and

n=1 thru 9999 for the update rate in seconds.

GLL - Geographic Position, Latitude / Longitude

Latitude and Longitude of present vessel position, time of position fix and status.
Format: $--GLL,lll.ll,a,yyyyy.yy,a,hhmmss.ss,A↵
Where:

GLL = Geographic Position, Latitude / Longitude
llll.ll = Latitude of position
a = N or S
yyyyy.yy = Longitude of position
a = E or W
hhmmss.ss = UTC of position
A = status: A = valid data

ZDA - Time & Date

UTC, day, month, year, and local time zone.
Format: $--ZDA,hhmmss.ss,dd,mm,yyyy,xx,xx↵
Where:

ZDA = Time and date
hhmmss.ss = Time in UTC
dd = Day, 01 to 31
mm = Month, 01 to 12
yyyy = Year
xx = Local zone description, 00 to +/- 13 hours
xx = Local zone minutes description (same sign as hours)

Broadcast Data – Local BL

Configures the RS-232C Broadcast Mode to return data using the Local Time reference. Broadcast Data – Local may be used concurrently with other Broadcast commands. It includes the Options 17 and 18 command – **OL**.

Response: ↵

Broadcast Data – UTC BU

Configures the RS-232C Broadcast Mode to return data using UTC Time Reference. Broadcast Data – UTC may be used concurrently with other Broadcast commands. It includes the Options 17 and 18 command – **OU**.

Response: ↵

Table A-2. Event Mode Commands

Specific Event Channel A [B] nnnA[B]

Sets the event buffer Read Index to a specific event number (nnn), and returns that event for channels A or B. (e.g. ‘10A’ sends event number 11 of channel A).

Response:	-Local	mm/dd/yyyy hh:mm:ss.sssssss nnnAL↵
		mm/dd/yyyy hh:mm:ss.sssssss nnnBL↵
	-UTC	mm/dd/yyyy hh:mm:ss.sssssss nnnAU↵
		mm/dd/yyyy hh:mm:ss.sssssss nnnBU↵

‘nnn’	Event-Buffer Read Index Number
‘A’	Channel A
‘B’	Channel B
‘U’	UTC Time, Channel A or B
‘L’	Local Time, Channel A or B

Set Channel Event Time A [B] nTA[B]

Sets the channel A or B time source.

Format: n = ‘0’ UTC time
n = ‘1’ Local time

Response: ↵

Clear Event Buffer A [B] CA[B]

Clears the channel [A or B] event buffer and then resets the read and write indices to 0.

Response: ↵

Set Channel – Deviation A [B] A[B]D

Sets either channel A or B to the 1-PPS deviation mode.

Response: ↵

Deviation for the Channel A [B] DA[B]

Returns 1-PPS deviation and sigma for channel A or B.

Response: ±dddd.dd ssss.ss↵ (Results are in microseconds)

Format:	‘dddd.dd’	= the deviation from 1 PPS (GPS), averaged over 16 samples
	‘ssss.ss’	= the standard deviation (sigma) of samples

Set Channel – Event A [B] A[B]E

Sets channel A or B to the Event-Recording mode.

Response: ↵

Arm Event Trigger AR

Arms the RS-232C Event-Capture circuitry (see paragraph 4.13).

Response: ↵

Event A EA[B]

Returns a single event record from the selected channel A or B event buffer. The record number (‘nnn’) increments once for every issuance of this command.

Response:	- Local time	mm/dd/yyyy hh:mm:ss.sssssss nnnAL↵
		mm/dd/yyyy hh:mm:ss.sssssss nnnBL↵
	- UTC time	mm/dd/yyyy hh:mm:ss.sssssss nnnAU↵
		mm/dd/yyyy hh:mm:ss.sssssss nnnBU↵
Format:	‘A’	= Channel A
	‘B’	= Channel B
	‘U’	= UTC Time, Channel A or B
	‘L’	= Local Time, Channel A or B
(if buffer is empty):		NO DATA↵

Recorder Channel A [B] RA[B]

Sets the Recorder ±5 V analog output to follow 1-PPS deviation for channel A or B.

Response: ↵

Table A-3. Status Mode Commands

Status of Event / Deviation SA[B]

Returns the channel A or B setup information, read index number and write index number.

Response: D/E R = nnn S = mmm↵

Format:
- 'D' Indicates channel A or B is in 1-PPS deviation mode ('E' for event recorder Mode)
- 'nnn' Channel A read index (000 to 299)
- 'mmm' Channel A write index (000 to 299)

Note: When 'nnn' = 'mmm', and when using the 'EA' command to read event data, the event buffer is 'empty', i.e., all event data which has been recorded has also been read.

Clock Status SC

Returns the current clock status.

Response: L/U U=xx S=nn↵

Format:
- L Clock currently locked to GPS ("U" for unlocked).
- xx Indicates loss of lock period, up to 99 minutes.
- nn User specified out-of-lock delay, 00 to 99 minutes (refer to Table A-13). If the out-of-lock function is deactivated, this field is returned as S=Off. S=ZDL indicates zero delay.

Receiver Status SR

Returns the current receiver status.

Response: V=vv S=ss T=tt P=Off E=0↵

Format:
- vv Number of satellites, which should be visible to the antenna, per almanac.
- ss Indication of relative signal strength.
- tt Number of satellites being actively tracked
- P=Off Indicates that the time dilution of precision (TDOP) calculation is not being performed. Returns 1.0 – 99.0, depending on satellite geometry, when TDOP calculation is being performed. A TDOP calculation is NOT performed if less that 3 satellites are visible, OR if Position-Hold is active.
- E=0 Describes the status of internal communications between the receiver and clock boards. A "0" indicates no errors. If clock operation is improper and any other character is persistently returned, contact Arbiter Systems.

Survey Status SQ

Returns Auto Survey mode data. For a survey in progress, it returns current status of the survey. For a completed survey, it returns the final results of the survey, i.e. the averaged position.

Response: Sn Pm Fnnnn #nnnn Tyyyy:ddd:hh:mm:ss Eddd:mm:ss.sss Ndd:mm:ss.sss Hmmmmm.mm↵

Format:		
	Sn	Represents the status of the Auto-Survey Mode
	Pm	Represents the status of the Position-Hold Mode
	Fnnnn	Current number of fixes
	#nnnn	Total number of fixes required
yyyy:ddd:hh:mm:ss		Time of completion of the most recent average, updated each 60 fixes (approximately each minute).
Eddd:mm:ss.sss		Antenna longitude (East or West, in degrees:minutes:seconds)
Ndd:mm:ss.sss		Antenna latitude (North or South, in degrees:minutes:seconds)
Hmmmmm.mm		Antenna elevation (in meters)

Table 1 shows the significant three bits of the Auto Survey status byte, weighting and assignments. Table 2 shows the significant three bits of the Position Hold Status byte, weighting and assignments.

TABLE 1			TABLE 2		
Bit	Weight	Function*	Bit	Weight	Function*
0 (LSB)	1	Single Auto Survey	0 (LSB)	1	Position Hold Enabled
1	2	Power-On Auto Survey	1	2	Position Hold Active
2	4	Suspend Survey	2	4	Position Hold ID: 0: Surveyed 1: User-Entered
3-7	N/A		3-7	N/A	

* may simultaneously set more than one bit.

The remainder of the information is the running position average, including all fixes since the beginning of the Auto Survey cycle. Gives latitude and longitude in degrees, minutes and seconds. Indicates E, W, N, and S respectively as East or West longitude and North or South latitude, and H indicating elevation in meters WGS-84 (World Geodetic System).

System Status SS

Returns the instrument operational status whenever the status changes. Also provides Options 17 and 18 status, if installed.

Response: I=nn:nn X=nn:nn

Format:

"I"	Internal clock conditions
"X"	External clock conditions, returned as FF
"nn:nn"	Hexadecimal representations of the status byte. The two digits preceding the colon describe present condition of the instrument. The two digits after the colon indicate the parameters that have changed.

The eight bits of the status byte, their weighting and assignments, are as follows:

Bit	Weight	Function	Bit	Weight	Function
0	1	OCXO Not Inst. (Set to 1)	4	16	Out-of-Lock
1	2	Reserved (Set to 0)	5	32	Time Error
2	4	Power Supply Error*	6	64	VCXO Tune Error**
3	8	IRIG Bus Fault*	7	128	Receiver Failure

*requires Option 18
**Out-of-bounds

Time Quality TQ

Returns a single ASCII Hex character (0, 4-9, A,B,F) indicating estimated worst case time quality, which follows the IEEE Standard, P1344.

Response: h↵

h	Condition	h	Condition
0	Clock locked, maximum accuracy	8	Clock unlocked, accuracy < 10 ms
4	Clock unlocked, accuracy < 1 us	9	Clock unlocked, accuracy < 100 ms
5	Clock unlocked, accuracy < 10 us	A	Clock unlocked, accuracy < 1 s
6	Clock unlocked, accuracy < 100 us	B	Clock unlocked, accuracy < 10 s
7	Clock unlocked, accuracy < 1 ms	F	Clock failure, time not reliable

Table A-4. Local Daylight Savings Time Setup Commands

Daylight Saving – Off **D0**

Deactivates the Daylight Saving time adjust feature (does not add 1 hour to local time display and output).

Response: ↵

Daylight Saving – On **D1**

Dactivates Daylight Saving time feature (adds 1 hour to local time display and output).

Response: ↵

Daylight Saving – Auto **D2**

Provides for the automatic adjustment of local time to standard daylight saving time. Time changes occur on the first Sunday in April (adds 1 hour to local time) and the last Sunday in October (does not add 1 hour to local time). Local time adjustment normally occurs at 0200 and can be changed using the DT command.

Response: ↵

Daylight Saving – Auto Changeover Time **hh:mmDT**

Defines when the daylight saving time automatic adjustment occurs (a time other than 0200). “hh:mm” are changeover hours and minutes.

Response: ↵

Local Offset **±hh[mm]L**

Configures the instrument to display and output Local time corresponding to UTC by setting the time offset (difference in number of hours between local and UTC).

Maximum offset: ±12 hours, 30 minutes [minutes optional].

Response: ↵

Table A-5. Front Panel Control Commands

Disable Control Panel **FB**

Disables all control-panel keys and blanks the front panel display.

Response: ↵

Enable Control Panel **FE**

Enables all control-panel keys and activates the front panel display.

Response: ↵

Lock Setup Keys **FL**

Disables setup control keys and activates the front panel display.

Response: ↵

Table A-6. IRIG Data Output Commands

IRIG Data – IEEE P1344 **In**

Activates (n=1) or deactivates (n=0) the IEEE P1344 extension, which uses IRIG-B control bits for additional information such as year, local offset, time quality and notification of pending non-sequence events such as leap seconds and daylight savings time changeovers.

Response: ↵

IRIG Data – Local **IL**

Configures all IRIG time data outputs to local time code reference.

Response: ↵

IRIG Data – UTC **IU**

Configures all IRIG time data outputs to UTC time code reference.

Response: ↵

Table A-7. Backlight Commands

Backlight Off **L0**

Disables the backlight operation in models having a backlighted display (Option 01).

Response: ↵

Backlight On **L1**

Selects the continuous backlight operation in models having a backlighted display (Option 01).

Response: ↵

Backlight On – Auto **L2**

Enables automatic backlight operation (backlight active for 30 seconds after any key is pressed) in models having a backlighted display (Option 01).

Response: ↵

Table A-8. Position Data and Position-Hold Commands

Set Position-Hold – Elevation MMMMM.mmH

Sets the antenna elevation in meters MSL (mean sea level); fractional meters of elevation are optional.

Format:	'MMMMM.mm'	
	'M'	Meters (from –1000.00 to +18000 meters, WGS-84)
	'm'	fractional meters (from 00 to 99 centimeters)
Response:	↵	

Set Position-Hold – Latitude dd:mm:ss.sssN(S)

Sets antenna latitude (in Position-Hold Mode) in degrees, minutes and seconds, North or South.

Format:	'dd'	degrees
	'mm'	minutes
	'ss.sss'	seconds (fractional seconds optional)
	'N'	North ('S' for South)
Response:	↵	

Set Position-Hold – Longitude ddd:mm:ss.sssE(W)

Sets antenna longitude (in Position-Hold Mode) in degrees, minutes and seconds, East or West.

Format:	'ddd'	degrees
	'mm'	minutes
	'ss.sss'	seconds (fractional seconds optional)
	'E'	East ('W' for West)
Response:	↵	

Elevation LH

Returns the current antenna elevation. In Position-Hold Mode, LH returns the current position-hold elevation setting. In fix mode, returns the most recent computed elevation value (calculated each second). Elevation is referenced to the WGS-84 datum.

Response:	nnnnn.nn↵	Meters (from –1000.00 to +18000 meters, WGS-84)
Format:	'nnnnn.nn'	Elevation in meters above mean sea level

Latitude LA

Returns the current antenna latitude. In Position-Hold Mode, returns the current position-hold latitude setting.

Response: Ndd:mm:ss.sss↵

Format:		
	'N'	North ('S' for South)
	'dd'	degrees
	'mm'	minutes
	'ss.sss'	seconds (fractional seconds optional)

Longitude LO

Returns the current antenna longitude. In Position-Hold mode, LO returns the current Position-Hold longitude setting.

Response: Wddd:mm:ss.sss↵

Format:		
	'W'	West ('E' for East)
	'ddd'	degrees
	'mm'	minutes
	'ss.sss'	seconds (fractional seconds optional)

Position-Hold – OFF PH0

Deactivates the Position-Hold timing mode. The receiver resumes computing time and position solutions.

Response: ↵

Position-Hold – ON PH1

Activates the Position-Hold timing mode. In this mode, the receiver position is held fixed and each channel is used to compute a timing solution. These solutions are averaged together, resulting in reduced timing noise due to Selective Availability and RF channel noise. To operate properly, the position used by the receiver must be fairly accurate.

Position-Hold position information is set using the "Set Position-Hold – Latitude (Longitude or Elevation)" RS-232 commands (for Latitude, Longitude and Elevation), the front-panel Edit Position Hold function, or the Auto-Survey function.

Due to the risk that previously stored position data may be inaccurate, *exercise caution* when activating the Position-Hold Mode without either performing an Auto Survey or setting the position directly. Failure to observe these precautions may result in serious timing errors.

Response: ↵

Table A-9.Survey Mode Commands

Auto Survey Mode m:nQ

Sets the Survey Mode (m) and number of fixes to average (n). Used to automatically determine position for Position-Hold position.

Format:

m	Condition
0	Survey Off
1	Initiate single auto-survey
2	Perform auto survey at power on.
3	Temporarily suspend auto survey.
4	Resume suspended auto survey.

n	Condition
0	Single position fix.
1	60 fixes (approximately 1 minute)
2	300 fixes (5 minutes).
3	900 fixes (15 minutes).
4	1800 fixes (30 minutes).
5	3600 fixes (60 minutes).
6	7200 fixes (2 hours).
7	14400 fixes (4 hours).
8	28800 fixes (8 hours).
9	43200 fixes (12 hours).
10	86400 fixes (24 hours).

Response: ↵

During a survey, obtain a survey status with the ‘SQ’ command. Activate the Position-Hold mode with the ‘PH1’ command.

Table A-10. Date and Time Commands

Set Receiver Time — yyyy:mm:dd:hh:mmTS

Sets receiver (UTC) time. The *command is ignored* when locked to satellites. When the receiver is initially activated, and has not locked onto satellites, acquisition time may be improved by giving the clock an initial estimate of UTC time, which it can use (with stored position and almanac data) to determine which satellites and Doppler shifts to use in acquisition.

Format:		
	‘yyyy’	year
	‘mm’	month
	‘dd’	day
	‘hh’	hour
	‘mm’	minute

Response: ↵

Local Date — DL

Returns the current date, in local time.

Response: ddmmmyyyy↵

UTC Date — DU

Returns the current date, in UTC time.

Response: ddmmmyyyy↵

Local Time — TL

Returns the current Local time.

Response: ddd:hh:mm:ss↵

UTC Time — TU

Returns current UTC time.

Response: ddd:hh:mm:ss↵

Note: The DL, DU, TL and TU command formats are as follows:

Format:				
	‘yyyy’	year	‘hh’	hour
	‘mmm’	month (JAN – DEC)	‘mm’	minute
	‘dd’	day of month	‘ss’	second
	‘ddd’	day of year		

Table A-11. Programmable Pulse Output Commands

Pulse Width, Seconds-Per-Pulse nnn.nnPW

Configures the Programmable Pulse (1 PnnnnS) output pulse width in seconds (rear panel connector).

Format:	'nnnnn'		0.01 to 600.00 seconds in 10 ms increments. For values > 1 use a decimal point and enter trailing zeros as applicable.
Examples:	1	=	0.01 sec
	10	=	0.10 sec
	1.00	=	1 sec
	100	=	1.00 sec
Response:	↵		

Seconds-Per-Pulse / Pulse-Per-Hour m,nPS

Configures Programmable Pulse (1PnnnS) period in seconds (output from rear panel connector).

Format:	m	=	0, seconds-per-pulse mode
	m	=	1, pulse-per-hour mode
	n	=	1 to 60,000 seconds if seconds-per-pulse mode
	n	=	0 to 3599 seconds offset from hour if pulse-per-hour mode

For the Seconds-per-Pulse mode, the first pulse will be on time at the top of the minute. If 'n' is evenly divisible by 60, the first pulse will be on time at the top of the hour.

For the Pulse-Per-Hour mode, the pulse will be on time at the second after the hour described by n. For example, 1,1200ps would cause a pulse at exactly 20 minutes after the hour.

If only one number is present then the number sets the seconds as in seconds-per-pulse mode.

Response: ↵

Set Alarm Time Mark ddd:hh:mm:ss(.ss)OU(OL)

Sets the time at which the Model 1088B issues the programmable pulse. If 'ddd' is set to 0, the pulse will repeat daily at the specified time (Pulse per Day). If 'ddd' is set from 001 to 366, the output pulse will be generated at the next occurrence of the specified time and date (Single Trigger).

Format:	'ddd'	day of year
	'hh'	hour
	'mm'	minute
	'ss'	second
	'(.ss)'	seconds to 0.01 optional
	'OU'	UTC Time ('OL' for Local time)
Response:	↵	

Set Pulse Output to Slow Code nCM

Sets the programmable pulse output to slow code. Slow code outputs and format, as defined in this clock are as follows: (a) the BNC output is normally held high, (b) it will go low for 2 seconds on the minute, and (c) low for 4 seconds on the hour, and low for 6 seconds of the day indicator.

Format: n = 0, slow code off
1, UTC slow code
2, Local slow code

Response: ↵

Set Pulse Polarity nPP

Sets the programmable pulse output polarity (i.e. TTL/CMOS high or low).

Format: n = 0, programmable pulse polarity positive
1, programmable pulse polarity negative

Response: ↵

Table A-12. Antenna and System Delay Commands

Set Cable Delay **nnnnnnDA**

Sets antenna cable delay compensation value. Note: Factory default setting for the standard 15-meter (50-foot) cable is 60 ns. The exact syntax for a 60-ns delay is 60DA. See paragraph following section 3.5.1 for information on calculating cable delay.

Time Range: Nnnnnn 0 to 999999 ns

Response: ↵

Set Clock Offset **nnnnnnDS**

Sets internal system delay compensation value. This includes the remote receiver cable delay. It is also used to advance the output pulse, by an arbitrary offset of zero up to one millisecond, from actual time.

Time Range: nnnnnn 0 to 999999 ns

Response: ↵

Table A-13. Out-of-Lock Commands

Set Out-of-Lock Time **(-)nnK**

Sets the amount of delay time (in minutes) following loss of satellite synchronization before an out-of-lock signal is generated and output via rear panel connector.

Format:	nn	0 to 99 minutes*
	-nn	The negative sign disables this function (Out-of-Lock always 'HI' when power is ON.)

*a value of 0 results in no delay between loss of lock and out-of-lock indication.

Response: ↵

Table A-14. Miscellaneous Commands

Firmware Version **V**

Returns the Firmware Revision date of the installed ROM.

Response: dd mmm yyyy↵

Display Buffer **Z**

Returns the contents of Display Buffer.

Response: Echoes current display (40 characters). No line wrap.

Debug Mode – OFF **DG0**

Deactivates the broadcast of debug output data streams.

Debug Mode – ON **DGn**

A private command used to broadcast output of test data (1/sec). Used for factory testing only.

7.0 Appendix B. I/O Signal Description Summary

This appendix contains a listing of all Input and Output Signals and briefly describes the type of signal, voltage levels (TTL/CMOS), and signal format(s).

7.1 Table B-1. Output Signal Descriptions

Signal Name / Type	Description
IRIG-B, Modulated	Standard IRIG-B code format, modulated onto 1-kHz, 10-Vpp sine-wave carrier.
Deviation	±5 Volts analog, corresponding to 1-PPS deviation channel A or B (depending on configuration; refer to Section 4.8.3) Proportion is 1 V per 10 μs deviation (±50 μs full scale).
IRIG-B	Standard IRIG-B code format, unmodulated, 5-Volt CMOS levels.
IRIG-E	Standard IRIG-E code format, unmodulated, 5-Volt CMOS levels.
IRIG-H	Standard IRIG-H code format, unmodulated, 5-Volt CMOS levels.
10 MHz	10-MHz square wave, 5-Volt CMOS levels
5 MHz	5-MHz square wave, 5-Volt CMOS levels
1 MHz	1-MHz square wave, 5-Volt CMOS levels
100 kPPS	100-kPPS square wave, 5-Volt CMOS levels, rising edge on time.
10 kPPS	10-kPPS square wave, 5-Volt CMOS levels, rising edge on time.
1 kPPS	1-kPPS square wave, 5-Volt CMOS levels, rising edge on time.
100 PPS	100-PPS square wave, 5-Volt CMOS levels, rising edge on time.
60 PPS	60-PPS square wave, 5-Volt CMOS levels, rising edge on time.
50 PPS	50-PPS square wave, 5 Volt CMOS levels, rising edge on time.
10 PPS	10-PPS square wave, 5 Volt CMOS levels, rising edge on time.
IRIG-D / 1 PPM	Standard IRIG-D format, unmodulated, 5 Volt CMOS levels. Rising edge is on time, 1 pulse per minute.
1 PPH	1 pulse per hour, rising edge on time (1-minute pulse), 5-Volt CMOS levels.
1 PPS	1 pulse per second, rising edge on time, 5-Volt CMOS levels.
Programmable Pulse	Programmable pulse output, 5-Volt CMOS levels. Configured using SETUP menu (see Figure 5.6).
Out-of-Lock	5-Volt CMOS levels. Normally LO at time of power-on but transitions to HI after acquisition of satellite signals. Toggles to LO ‘nn’ minutes after loss of signal lock. Range for ‘nn’ is 00 to 99, with ‘nn’ set using SETUP menu (see paragraph 5.2) or Appendix A, Table A-13). Setting of –01 disables out-of-lock function (output always high).
IRIG-B Modified Manchester	IRIG-B code, encoded in modified Manchester format with 1 kPPS clock rate and bit-cell transitions on time per IEEE Std P1344. 5 Volt CMOS levels.

7.2 Table B-2. Input Signal Descriptions

Signal Name / Type	Description
External Reference	Accepts input frequency of 100 kHz, 1 Mhz, 5 MHz, or 10 MHz. Refer to Section 3.3.4, Table 3-3 and Figure 5.8 for configuration information and input level requirements.
Event/1-PPS Channel A (or) Event/1-PPS Channel B	Rear-panel I/O connector (J4) input; Rear-panel I/O connector (J3) input. 5-Volt TTL/CMOS levels. Event corresponds to rising edge of this signal. Deviation indication represents difference between rising edge of applied 1-PPS signal and rising edge of internal 1-PPS signal. RS-232C input: See Appendix A, Table A-2 and Section 4, paragraph 4.8. Event corresponds to leading edge of the start bit of the first character received after arming.
Auxiliary Input	This is an uncommitted input, reserved for future use and special configurations.

8.0 Appendix C. Options List

Introduction

Each Arbiter Satellite-Controlled Clock has a number of standard options for the Model 1088B that may be installed for special purposes. This section is devoted to these options, and provides supplemental and detailed information for operation and configuration of these options.

Option 01: Backlighted Display

General Description

Option 01 for the Arbiter System line of Satellite-Controlled Clocks adds illumination to the front panel display, if so equipped. The standard reflective liquid crystal display (LCD) is replaced with a transflective LCD. An Electro-luminescent (EL) panel located behind the transflective LCD provides backlighting; thereby increasing the readability of the display in subdued lighting conditions. The backlight can be set to remain on indefinitely, or to turn off after a predetermined time following the last keystroke. With the backlight turned off, the display is still readable in ordinary ambient light.

Specifications

Initial Luminance:	30 cd/m^2 minimum
Service Life (down to 10 cd/m^2):	4000 hours

Configuration

The SETUP menu outlined in the Operation Manual contains a sub-menu which allows selection of the backlight operating mode. To set the backlight operating mode, observe the following steps:

1. With the clock power turned on, press the SETUP key. The display should change to read, SET RS-232.
2. Press the SETUP key repeatedly, until the display reads, SET BACK LIGHT?. Press the ENTER key to select the backlight sub-menu. The current backlight operating mode will be displayed, from one of the following selections:

- OFF Backlight never on.
- ON Backlight always on.
- AUTO Backlight turns on when a key is pressed, remains on for 30 seconds after the last key is pressed. This is the preferred mode for applications requiring a lighted display, since it will provide the longest EL panel lifespan (see Specifications, above).

3. Pressing the UP and DOWN keys will change the selection. When the desired operating mode is displayed, press the ENTER key to confirm the choice and return to the first level of the SETUP menu. To return the clock to normal operation, press one of the function keys in the top row of the front panel keyboard.

The backlight operating mode can also be changed via the RS-232C port, using the L0, L1, or L2 commands for OFF, ON, and AUTO, respectively. For details regarding this and other capabilities of the RS-232C port, refer to the Operation Manual, Appendix A.

Option 01 Firmware Setup

No setup is required for this option.

Option 03: Four Additional Outputs

General Description

Option 03 adds four rear-panel outputs, the functions of which can be selected individually from 2 analog or 19 digital signals. The configuration of the four outputs can be changed at any time via internal jumper settings.

Specifications

General

Output Connectors: BNC-type RF connectors (4).

Analog Outputs

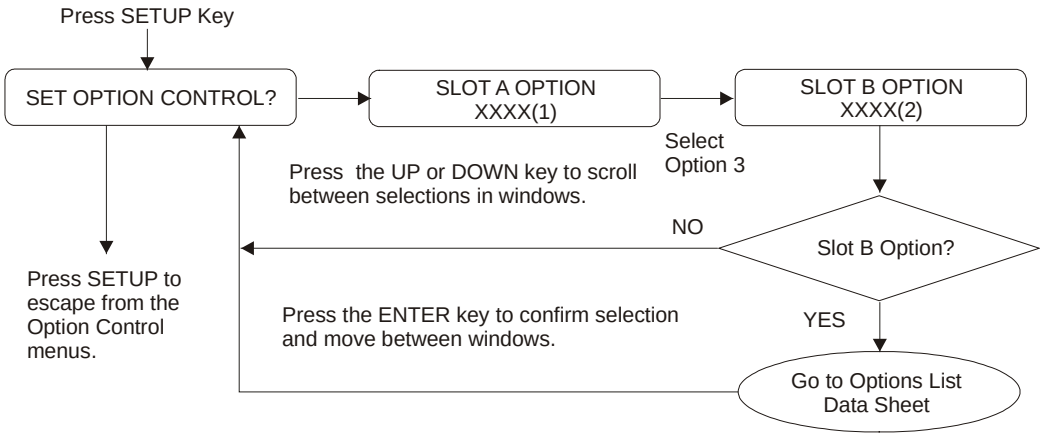
Output Type: Operational amplifier (LF353) output, with 557-ohm series resistor.

Available Outputs: *Note: All outputs available on clock Models 1088B, 1084A/B/C, 1093A/B/C and other clocks as noted.*

IRIG-B, Modulated: IRIG format B time code, modulated onto 1 kHz 10 Vpp sine wave carrier. *Available only on clock Model 1093A/B/C with Option 92, IRIG-B Modulated Output*.

Deviation: ±5 volts analog, corresponding to 1 PPS deviation channel A or B (see individual clock Operation Manual). The proportion is 1 V per 10µs deviation (±50 µs full scale).

Option 03 Firmware Setup



Notes:
(1) XXXX = NONE, 03, 10, 11, 12, 13, 14, 20A, 23, 25, or 28 (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXXX = 4, 17, 17A, 18, 20A, 23, 29 or 32 (Option 19, Out-of-Lock Relay, is a valid Slot B option but does not require firmware configuration).

Digital Outputs

Output Type:	High-Speed CMOS (74HC126), 0 to 5 volts, with 47 ohm series resistance.
Available Outputs:	*Note: All outputs available on Model 1088B and other clocks as noted.*
IRIG-B:	IRIG format B time code (unmodulated). *Also available on clock Models 1088BP, 1084A/B/C, 1089A/B and 1093A/B/C.*
IRIG-E:	IRIG format E time code.
IRIG-H:	IRIG format H time code.
10 MPPS:	10,000,000 pulse-per-second (PPS) square wave, synchronous to the 1 PPS output.
5 MPPS:	5,000,000 PPS square wave, synchronous to the 1 PPS output.
1 MPPS:	1,000,000 PPS square wave, synchronous to the 1 PPS output.
100 kPPS:	100,000 PPS square wave, synchronous to the 1 PPS output.
10 kPPS:	10,000 PPS square wave, synchronous to the 1 PPS output.
1 kPPS:	1,000 PPS square wave, synchronous to the 1 PPS output.
100 PPS:	100 PPS square wave, synchronous to the 1 PPS output.
60 PPS:	60 PPS square wave, synchronous to the 1 PPS output.
50 PPS:	50 PPS square wave, synchronous to the 1 PPS o utput.
10 PPS:	10 PPS square wave, synchronous to the 1 PPS output.
IRIG-D/1 PPM:	IRIG format D time code (1 pulse per minute), rising edge on time.
1 PPH:	1 pulse per hour, rising edge on time.
1 PPS:	1 PPS (10 ms ‘high’), synchronous to 1 PPS/GPS. *Also available on clock Models 1084A/B/C, 1088B and 1089A/B.*
Programmable:	Outputs a single pulse at a preprogrammed time, or a continuous pulse train having a period of one day or less. Pulse width is adjustable from 0.01 to 600 seconds. *Also available on clock Model 1093A/B/C*
Out-of-Lock:	Normally ‘HI’ after acquisition of satellite signals. Toggles ‘LO’ nn minutes after loss of satellite signal lock. Range for ‘nn’ is 00 to 99, and is set using the SETUP menu or RS-232C (refer to clock Operation Manual). Setting of 00 disables this function (output remains ‘HI’). This output follows the standard ‘Out-of-Lock’ function on the clock.
IRIG-B (Modified Manchester):	IRIG format ‘B’ time code, Manchester encoded with 1 kPPS carrier, and data transitions on time mark. *Also available on clock Models 1088BP, 1084A/B/C, and 1089A/B.*

Changing Output Settings via Internal Settings

Case Removal

To change the configuration of Option 03, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 torx driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING** Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

General Information

Option 03 incorporates an extremely flexible output selection system using jumpers on the Option 03 printed circuit board. Each of the four rear-panel BNC-type I/O connectors, included with Option 03, can be configured to perform any of the available output functions. Figure 1 shows the locations and functions for all of the jumpers on the Option 03 board.

Function Selection

Jumpers JMP3 through JMP10 determine which output function their respective I/O connectors perform. The dotted lines in Figure 1 show the relationships between the jumper strips and the connectors. Set the jumper for each connector to the appropriate location for the type of output signal desired. Jumpers JMP4, 6, 8 and 10 refer to Output Function selections 1 and 2. Jumpers JMP3, 5, 7, and 9 refer to Output Function selections 3 through 22. The signals available are listed in the text to the left of the jumpers in Figure 1.

Mode Selection

In addition to specifying the output signal type for each individual connector, it is necessary to define whether the signal is analog or digital. This is accomplished using jumpers JMP11, JMP12, JMP14, and JMP15. Each of these jumpers corresponds to the output function jumper for one of the output connectors; the relationships are illustrated by the dotted lines in Figure 1. Table 1 shows the Function and Mode jumper settings for all of the various output signal types. Only the Modulated IRIG-B and Deviation outputs are analog; all others are digital.

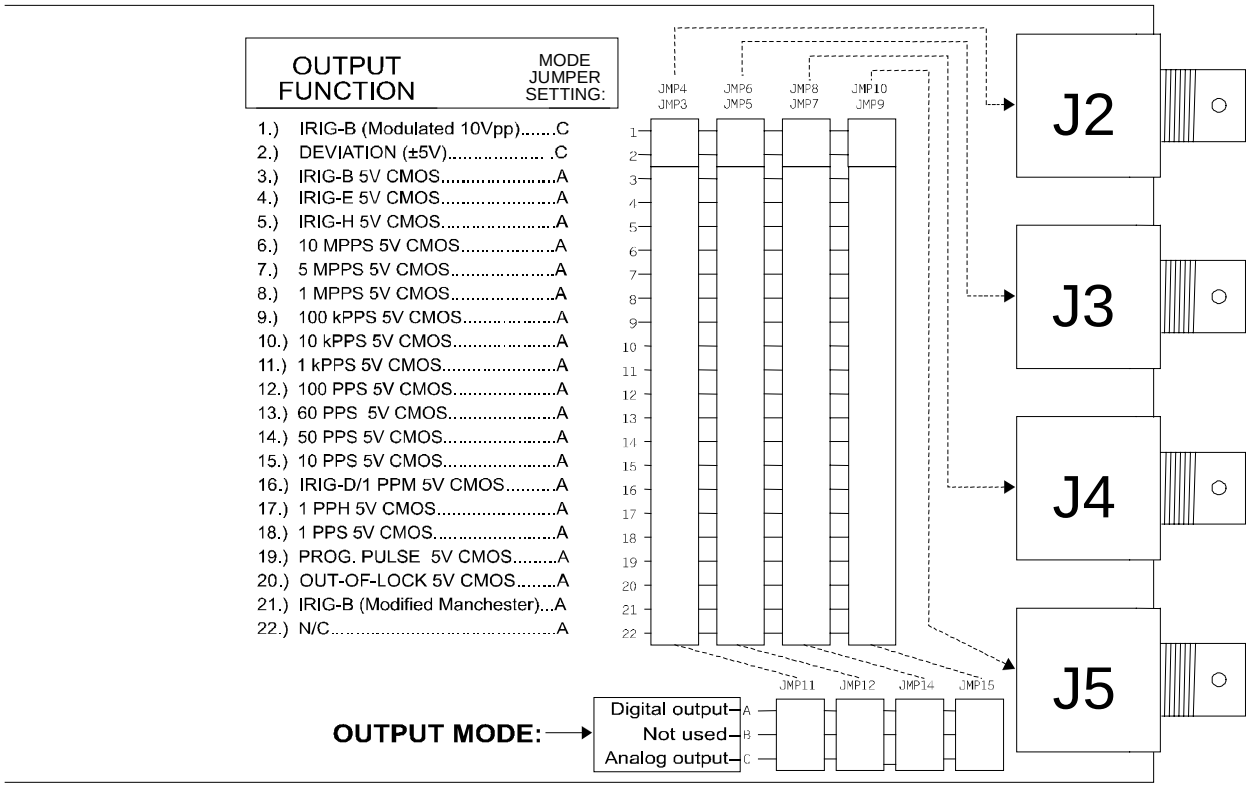


Figure 1. Jumper Locations

Table 1. Output Connector Jumper Settings

Output Signal	Function Select Jumper	Mode Select Jumper
IRIG-B Modulated	1	C
Deviation	2	C
IRIG-B	3	A
IRIG-E	4	A
IRIG-H	5	A
10 MPPS	6	A
5 MPPS	7	A
1 MPPS	8	A
100 kPPS	9	A
10 kPPS	10	A
1 kPPS	11	A
100 PPS	12	A
60 PPS	13	A
50 PPS	14	A
10 PPS	15	A
IRIG-D/1PPM	16	A
1 PPH	17	A
1 PPS	18	A
Prog. Pulse	19	A
Out-of-Lock	20	A
IRIG-B Modified Manchester	21	A
No Connection	22	A

Option 04: Parallel BCD Output (1 millisecond resolution)

General Description

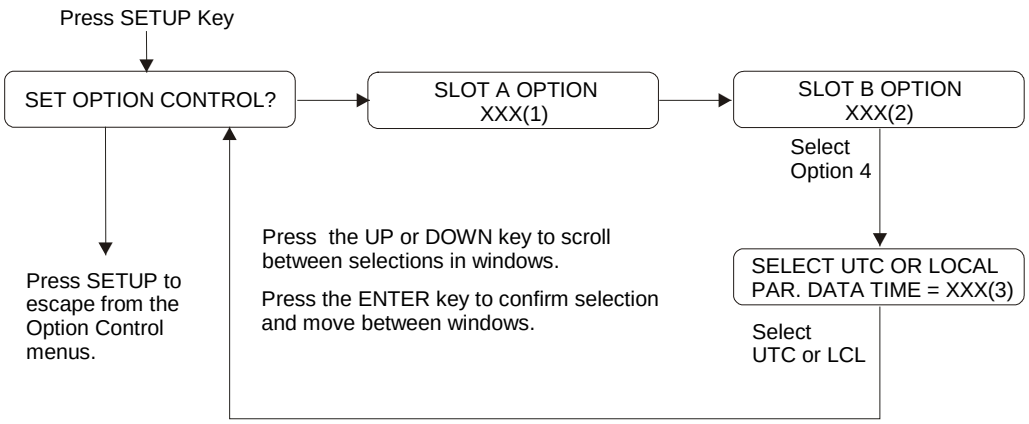
Option 04 for the Model 1088B expands the capabilities of the instrument to include:

- Either of the following:
  a). Time-of-year output in Binary-Coded Decimal (BCD) format, with resolution down to 1 millisecond;
  b). Parallel Data output, with up to 48 bits that can be custom-configured at the factory for specific applications;
- A continuous 1 pulse-per-second (1 PPS) output, with the rising edge of a 10 millisecond-wide pulse synchronous to the rising edge of 1 PPS/GPS;
- A continuous 1,000 PPS (1 kPPS) square wave output, with rising edges synchronous to the rising edge of 1 PPS/GPS;
- Four pins of the output connector that can be configured with combinations* of the following:
  a. Up to four digital signal outputs, the functions of which can be selected individually from 18 choices.
  b. Up to two analog signal outputs, the functions of which can be selected individually from two choices.
  c. An RS-232C serial communications port, which can use between two and four lines.

  ***Note:** Since these auxiliary functions must share four connector pins, certain limitations will apply when selecting combinations:

  - ☑ Enabling any one (or more) of the digital signal outputs precludes four bits from the parallel data output, if used;
  - ☑ Each analog signal output used precludes one of the digital signal outputs; if two analog signal outputs are employed, only two digital signal outputs are possible. Also, each analog signal output displaces one bit from the parallel data interface, if used;
  - ☑ A two- or four-wire RS-232C port configuration uses two or four of the data output lines, so these lines become unavailable for digital and/or analog signal outputs, or for the assigned data bits of the parallel output (if used).

Option 04 Firmware Setup



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28. (Option 10, 11, 13, 14 and 25 no longer available.)
(2) XXX = 4, 17, 17A, 18, 23, 27, 29 or 32; use UP or DOWN keys to select option. (No configuration is necessary for Option 19.)
(3) IRIG-B Data configured for either UTC or Local time zone.

Specifications

General

Output Connector: 50 contact;
Amphenol P/N 850-57L-40500-2700
or equivalent.

Mating Connectors:
Plastic: Amphenol P/N 850-57F-30500-20
Metal Shell: Amphenol P/N 850-57FE-30500-20

Parallel BCD Output

Data Bus Width: 42 bits. For weighting, refer to Table 1.

Output Type: High-Speed CMOS, buffered, (74HCXXX), 0 to 5 volts.

Time Data Format: UTC or Local time data; corresponds to setting for IRIG time data (see 1088B Operation Manual).

Time Accuracy: Rising edge delay of 100 nS maximum (1 mS bit), relative to 1 PPS output rising edge.

Analog Outputs

Output Type: Operational amplifier (LF353) output, with 562 ohm series resistor.

Pin Numbers: Output 1: pin 22
Output 2: pin 47

Available Outputs

IRIG-B, Modulated: IRIG format B time code, modulated onto 1 kHz 10 Vpp sine wave carrier.

Deviation: ±5 volts analog, corresponding to 1 PPS deviation channel A or B (depending on configuration; see 1088B Operation Manual). Proportion is 1 V per 10 µS deviation (±50 µS full scale).

Digital Outputs

Output Type:	High-Speed CMOS (74HCXXX), 0 to 5 volts, with 47 ohm series resistance.
Pin Numbers:	Output 1: pin 22 Output 2: pin 47 Output 3: pin 23 Output 4: pin 48
Available Outputs:	
IRIG-B:	IRIG format B time code, 5 V CMOS (unmodulated).
IRIG-E:	IRIG format E time code, 5 V CMOS.
IRIG-H:	IRIG format H time code, 5 V CMOS.
IRIG-D/1 PPM:	IRIG format D time code (1 pulse per minute), 5 V CMOS. Rising edge on time.
10 MPPS:	10 MPPS square wave, synchronous to the 1 PPS output.
5 MPPS:	5 MPPS square wave, synchronous to the 1 PPS output.
1 MPPS:	1 MPPS square wave, synchronous to the 1 PPS output.
100 kPPS:	100,000 PPS square wave, synchronous to the 1 PPS output.
10 kPPS:	10,000 PPS square wave, synchronous to the 1 PPS output.
1 kPPS:	1,000 PPS square wave, synchronous to the 1 PPS output.
100 PPS:	100 PPS square wave, synchronous to the 1 PPS output.
60 PPS:	60 PPS square wave, synchronous to the 1 PPS output.
50 PPS:	50 PPS square wave, synchronous to the 1 PPS output.
10 PPS:	10 PPS square wave, synchronous to the 1 PPS output.
1 PPS:	1 PPS (10 mS "high"), synchronous to 1 PPS/GPS.
1 PPnnnS:	1 pulse per "nnn" seconds (10 mS "high", synchronous to 1 PPS/GPS); "nnn" corresponds to a number of seconds entered by the user.
1 PPH:	1 pulse per hour, rising edge on time.
Out-of-Lock:	5 volt CMOS levels. Normally "high" after acquisition of satellite signals. Toggles "low" nn minutes after loss of satellite signal lock. Range for "nn" is 00 to 99, and is set using the SETUP menu or RS-232C (refer to 1088B Operation Manual). Setting of 00 disables this function (output remains "high"). This output follows the standard "out-of-lock" function on the 1088B.

RS-232C

Output Type:	CMOS, -12 to +12 volts.
Input Type:	Standard RS-232C levels.
Inputs Available:	
Receive Data ("RXD"):	Connector pin 47. Receives data from external device. Requires that JMP3 be set to position "B". Precludes use of digital signal output 2 or parallel data bit 27.
Data Terminal Ready ("DTR"):	Connector pin 48. Informs 1088B that remote device is ready to receive data. Requires that JMP5 be set to position "C". Precludes the use of digital signal output 4, analog signal output 2, or parallel data bit 45.
Outputs Available:	
Transmit Data ("TXD"):	Connector pin 22. Sends data to external device. Requires that JMP2 be set to position "B". Precludes the use of digital signal output 1 or parallel data bit 19.
Data Set Ready ("DSR"):	Connector pin 23. Informs the remote device that 1088B is prepared to send data. Requires that JMP4 be set to position "C". Precludes the use of digital signal output 3, analog signal output 1, or parallel data bit 43.

Table 1. Option 04 Connector Pin Designation

Pin No:	BCD Mode Function/Bit Weighting:	Parallel Data Mode Function:	RS-232C Function:
1	Ground	Ground	Ground
2	1 PPS output	Data Bit 47	—
*3	Output 4 (Dig. only)	Data Bit 45	DTR
*4	Output 2 (Dig./An.)	Data Bit 27	RXD
5	Day 200	Data Bit 35	—
6	Day 80	Data Bit 43	—
7	Day 20	Data Bit 41	—
8	Day 8	Data Bit 39	—
9	Day 2	Data Bit 37	—
10	20 Hr.	Data Bit 33	—
11	8 Hr.	Data Bit 31	—
12	2 Hr.	Data Bit 29	—
13	40 Min.	Data Bit 26	—
14	10 Min.	Data Bit 24	—
15	4 Min.	Data Bit 22	—
16	1 Min.	Data Bit 20	—
17	20 Sec.	Data Bit 17	—
18	8 Sec.	Data Bit 15	—
19	2 Sec.	Data Bit 13	—
20	800 mS	Data Bit 11	—
21	200 mS	Data Bit 9	—
22	80 mS	Data Bit 7	—
23	20 mS	Data Bit 5	—
24	8 mS	Data Bit 3	—
25	2 mS	Data Bit 1	—
26	Ground	Ground	Ground
27	1 kPPS output	Data Bit 46	—
*28	Output 3 (Dig. only)	Data Bit 44	DSR
*29	Output 1 (Dig./An.)	Data Bit 19	TXD
30	Day 100	Data Bit 34	—
31	Day 40	Data Bit 42	—
32	Day 10	Data Bit 40	—
33	Day 4	Data Bit 38	—
34	Day 1	Data Bit 36	—
35	10 Hr.	Data Bit 32	—
36	4 Hr.	Data Bit 30	—
37	1 Hr.	Data Bit 28	—
38	20 Min.	Data Bit 25	—
39	8 Min.	Data Bit 23	—
40	2 Min.	Data Bit 21	—
41	40 Sec.	Data Bit 18	—
42	10 Sec.	Data Bit 16	—

43	4 Sec.	Data Bit 14	—
44	1 Sec.	Data Bit 12	—
45	400 mS	Data Bit 10	—
46	100 mS	Data Bit 8	—
47	40 mS	Data Bit 6	—
48	10 mS	Data Bit 4	—
49	4 mS	Data Bit 2	—
50	1 mS	Data Bit 0	—

*These pins can be configured for any of the listed functions, regardless of the main mode of operation for Option 04.

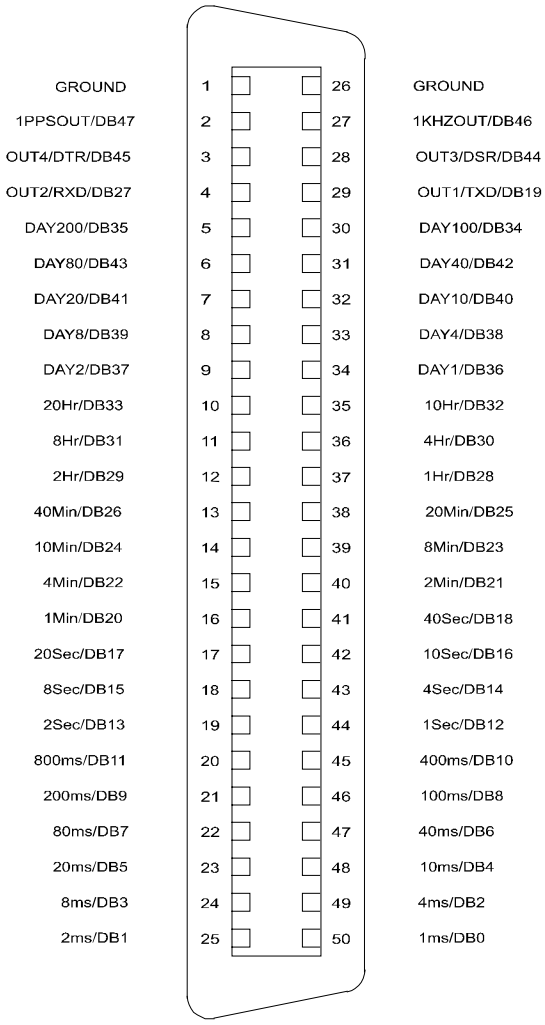


Figure 1. Option 01 Output Connector

Configuration

General

Case Removal

To change the configuration of Option 04, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING** Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

Jumper Functions and Locations

Upon removal of the top cover, locate the circuit board for Option 04 (a diagram of the board, showing jumper locations, is given in Figure 2). The following sections outline the jumper setting changes and other steps necessary to utilize the various features available with Option 04.

BCD Output Mode

General

When configured for BCD output of time data, Option 04 utilizes pins 1 through 21 and 26 through 46, along with ground pins 25 and 50. The weighting for the individual bits, along with the connector pin locations, is given in Table 1. To configure Option 04 for BCD operation, observe the following steps:

a. Set jumper JMP1 to position "B". This enables the BCD output mode.

b. Set jumper JMP6 to position "A". This jumper is included to set the timing mode when utilizing the parallel data output, and must be set to position "A" for the BCD output to function properly.

Operation in the BCD output mode allows use of the analog and/or digital signal outputs, the 1 PPS and 1 kPPS outputs, and the RS-232C communications port. Refer to the appropriate sections of this document for details of these functions.

Time Data Format

The format of the BCD time data which is output from the rear-panel connector can be either Local time or Coordinated Universal Time (UTC), and will be the same as the time format which is specified in the SETUP menu for the IRIG time data outputs. For further details, refer to the flowchart titled "Set IRIG Time DATA? in the 1088B Operation manual.

Parallel Data Output Mode

Full operation in the parallel data output mode utilizes all 50 contacts of the output connector. However, use of any combination of digital signal outputs, analog signal outputs, or RS-232C will reduce the number of data bits available by up to four (data bits 19, 27, 44, and 45). For details, refer to the sections pertaining to these individual functions.

The functions of the individual data bits are defined for specific customer applications, upon request.

To configure Option 04 for parallel data mode, observe the following steps:

a. Set jumper JMP1 to position "B". This jumper enables the parallel data output mode.

b. Set jumpers JMP2, JMP3, JMP4, JMP5, and JMP11 to position "A" (these settings will vary if the analog and/or digital signal outputs or RS-232C port are used; refer to the applicable sections for more information on these functions).

c. If it is desired that the parallel output data be synchronous to the 1 PPS output, set jumper JMP6 to position "A"; for non-synchronous operation, set this jumper to position "B".

Digital Signal Outputs

The four digital signal outputs can be individually enabled and configured, using the following steps:

a. Set jumper JMP11 to position "A". This enables the digital signal output mode. At the same time, making this jumper selection eliminates parallel data bits 19, 27, 44, and 45.

b. To enable digital signal output number 1, set jumper JMP2 to position "A". This also eliminates the "TXD" RS-232C line.

c. To set the type of output signal for digital signal output number 1, make the appropriate selection on jumper JMP8 (refer to Figure 2). Note that positions 1 and 2 correspond to analog signal outputs, and will be occupied by a jumper only if analog signal output number 1 is enabled.

d. To enable digital signal output number 2, set jumper JMP3 to position "A". This also eliminates the "RXD" RS-232C line.

e. To set the type of output signal for digital signal output number 2, make the appropriate selection on jumper JMP7 (refer to Figure 2). Note that positions 1 and 2 correspond to analog signal outputs, and will be occupied by a jumper only if analog signal output number 2 is enabled.

f. To enable digital signal output number 3, set jumper JMP4 to position "A". This also eliminates the possibility of using analog signal output number 1, or of having a "DSR" RS-232C line.

g. To set the type of output signal for digital signal output number 3, make the appropriate selection on jumper JMP9 (refer to Figure 2).

h. To enable digital signal output number 4, set jumper JMP5 to position "A". This also eliminates the possibility of using analog signal output number 2, or of having a "DTR" RS-232C line.

i. To set the type of output signal for digital signal output number 4, make the appropriate selection on jumper JMP10 (refer to Figure 2).

Analog Signal Outputs

The two analog signal outputs can be individually enabled and configured, using the following steps:

To enable analog signal output number 1, set jumper JMP4 to position "B". This setting also eliminates the possibility of having parallel data bit 44, digital signal output number 3, or the "DSR" RS-232C line.

To select the type of signal for analog output 1, remove the jumper from jumper strip JMP9 (which is no longer active, since it corresponds to digital signal output number 3), and place it on jumper strip JMP8 in either position 1 or 2 (refer to Figure 2).

To enable analog signal output number 2, set jumper JMP5 to position "B". This setting also eliminates the possibility of having parallel data bit 45, digital signal output number 4, or the "DTR" RS-232C line.

To select the type of signal for analog output 2, remove the jumper from jumper strip JMP10 (which is no longer active, since it corresponds to digital signal output number 4), and place it on jumper strip JMP7 in either position 1 or 2 (refer to Figure 2).

1 Pulse-per Second (1 PPS) Output, 1,000 Pulse-per-Second (1 kPPS) Output

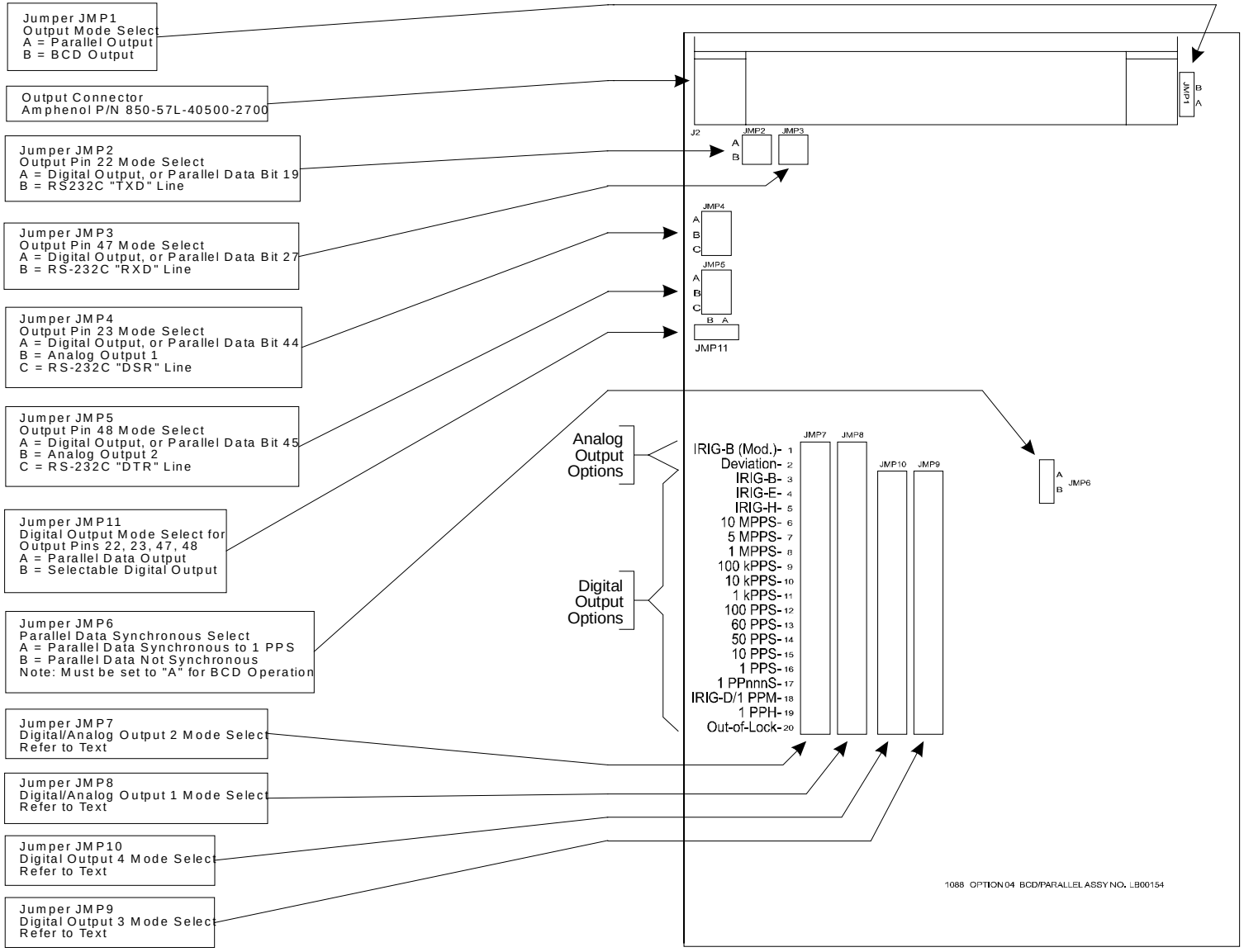
The 1 PPS and 1 kPPS outputs are enabled whenever Option 04 is placed in the BCD output mode (jumper JMP1 set to position "B").

Table 2.

Configurable Output Jumper Settings

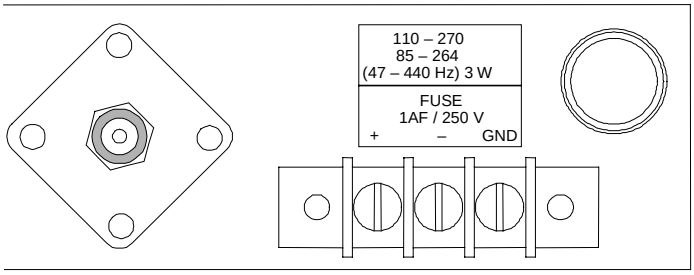
J2 Pin	Function	JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	JMP11
22	Synchronous (1 PPS) Parallel Data Bit 19	A	A	--	--	--	A	A
22	Asynchronous Parallel Data Bit 19	A	A	--	--	--	B	A
22	Digital Signal Output 1	--	A	--	--	--	--	B
22	RS--232C "T--D"	--	B	--	--	--	--	--
47	Synchronous (1 PPS) Parallel Data Bit 27	A	--	A	--	--	A	A
47	Asynchronous Parallel Data Bit 19	A	--	A	--	--	B	A
47	Digital Signal Output 2	--	--	A	--	--	--	B
47	RS--232C "R--D"	--	--	B	--	--	--	--
23	Asynchronous Parallel Data Bit 44	A	--	--	A	--	--	A
23	Digital Signal Output 3	--	--	--	A	--	--	B
23	RS--232C "DSR"	--	--	--	C	--	--	--
23	Analog Signal Output 1	--	--	--	B	--	--	--
48	Asynchronous Parallel Data Bit 45	A	--	--	--	A	--	A
48	Digital Signal Output 4	--	--	--	--	A	--	B
48	RS--232C "DTR"	--	--	--	--	C	--	--
48	Analog Signal Output 2	--	--	--	--	B	--	--

Figure 2. Jumper Locations and Functions



Option 07: Terminal Power Strip

Option 07 for the Model 1088B Satellite-Controlled Clock replaces the standard IEC-320 power input module with a three-position, screw-type terminal strip. This feature is intended for use in installations where it is necessary or desirable to have the instrument power hard-wired. Unless Option 08 (10-85 Vdc power) is also ordered, the power requirements and limitations for the unit are same as for a standard clock.



Specifications

Terminal Strip:

Terminal Assignment*:	(+), (-), Ground, left to right, viewed from rear.
Block Size:	49mm W x 15mm H x 16.5mm D. (1.9" x 0.6" x 0.6")
Block Material:	Glass-filled thermoplastic.
Screw Size:	6-32 x 1/4".
Screw Material:	Cadmium-plated steel.
Terminal Spacing:	9 mm (0.35").
Approvals:	U. L. recognized; C.S.A. approved.

*For AC operation, input line may be connected between (+) and (-), without regard to polarity; However, proper grounding should always be employed.

Fuse

Type:	Bussman GBD-1A.
Current Rating:	1 Ampere, fast-acting.
Voltage Rating:	250 Volts.
Size:	5 mm x 20 mm.

Input Power

AC Voltage Range:	85 to 264 Vac.
Frequency Range:	47 to 440 Hz.
DC Voltage Range:	110 to 250 Vdc.

Connections

All input power line connections to the rear-panel terminal strip should be made using spade lugs or ring lugs suitable for use with #6 screws. If a DC source is used, the positive lead should be connected to the left-hand terminal, when viewing the instrument from the rear (see Figure 1). The negative lead should be connected to the center terminal, and the right-hand terminal should be connected to a safety ground.

If an AC power source is to be used, the line and neutral wires may be connected between the left and the center terminals, without regard to polarity. The right-hand terminal should still be connected to a safety ground.

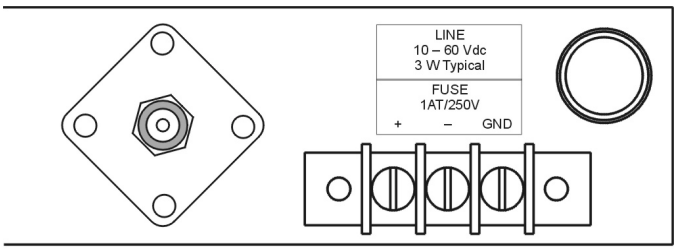
Option 07 Firmware Setup

No set up is necessary for this option.

Option 08: 10 – 60 Vdc Input Power

General Description

Option 08 for the Model 1088B Satellite-Controlled Clock allows operation of the instrument from a dc input power source, with a voltage range of 10 to 60 volts. Option 08 also incorporates Option 07, which replaces the standard IEC-320 power input module with a three-position, screw-type terminal strip. This feature is intended for use in installations where it is necessary or desirable to have the instrument power hard-wired.



Specifications

Input Power

DC Voltage Range:	10 to 60 Vdc.
Input Power:	3 W Typical.

Terminal Strip

Terminal Assignment:	(+), (-), Ground, left to right, viewed from rear.
Block Size:	49mm W x 15mm H x 16.5mm D. (1.9" x 0.6" x 0.6")
Block Material:	Glass-filled thermoplastic.
Screw Size:	6-32 x 1/4".
Screw Material:	Cadmium-plated steel.
Terminal Spacing:	9 mm (0.35").
Approvals:	U. L. recognized; C.S.A. approved.

Fuse

Type:	Bussman GDC-1A.
Current Rating:	1 Ampere, time-lag.
Voltage Rating:	250 Volts.
Size:	5 mm x 20 mm.

Connections

All input power line connections to the rear-panel terminal strip should be made using spade lugs or ring lugs suitable for use with #6 screws. The positive lead should be connected to the left-hand terminal, when viewing the instrument from the rear (see Figure 1). The negative lead should be connected to the center terminal, and the right-hand terminal should be connected to a safety ground.

Option 08 Firmware Setup

No set up is necessary for this option.

Option 12: OCXO and Four Additional Configurable Outputs

General Description

Option 12 for the Model 1088A/B adds a disciplined oven-controlled crystal oscillator (OCXO) having stability if 1 part in 10^7 over temperature, and four additional configurable outputs.

Specifications

General

Output Connectors:	BNC-type RF connectors (4).
Oscillator:	Oven-controlled, $1x10^{-7}$ over 0 to 50 degrees C.

Firmware Setup for Option 12

Hardware and firmware configuration of the Model 1088A/B is performed at the factory when this option is ordered at the same time as the clock. The following instructions are intended primarily for field installation or maintenance. In addition, if the instrument configuration is ever reset to factory default settings, then this initialization will need to be performed so that the unit's firmware will automatically recognize the Option 12 assembly.

To change the firmware setup for Option 12, use the SETUP menu of the Model 1088A/B. Press the SETUP key repeatedly until SET OPTION BOARD appears in the display. Press ENTER, and then press the UP key until OPTION 12 appears. Press ENTER again, and select the option (if any) present in the B option slot of the unit. Press ENTER again. This completes the firmware configuration for Option 12. More information about instrument firmware configuration with the SETUP menus is found in section 5 of the Model 1088A/B Operation Manual.

Main Board Setup via Internal Jumpers

Hardware and firmware configuration of the Model 1088A/B is performed at the factory when this option is ordered at the same time as the clock. The instructions, which follow are intended primarily for field installation.

Case Removal:

To change the main board configuration for Option 12, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 torx driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING** Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

Jumpers 2 and 3 of the main board assembly (see Figure 3-2 in the 1088A/B Operation Manual) must be set properly to allow the Option 12 oscillator to drive the clock. The setting for Jumper 2 should be changed to 'B' (External Reference) and the setting for Jumper 3 should be changed to

'B' (5 MHz). When these settings have been completed, reinstall the instrument cover and reapply power.

Digital Outputs

Output Type:	High-Speed CMOS (74HC126), 0 to 5 volts, with 47 ohm series resistance.
Available Outputs:	*Note: All outputs available on Model 1088B and other clocks as noted.*
IRIG-B:	IRIG format B time code (unmodulated). *Also available on clock Models 1088BP, 1084A/B/C, 1089A/B and 1093A/B/C.*
IRIG-E:	IRIG format E time code.
IRIG-H:	IRIG format H time code.
10 MPPS:	10,000,000 pulse-per-second (PPS) square wave, synchronous to the 1 PPS output.
5 MPPS:	5,000,000 PPS square wave, synchronous to the 1 PPS output.
1 MPPS:	1,000,000 PPS square wave, synchronous to the 1 PPS output.
100 kPPS:	100,000 PPS square wave, synchronous to the 1 PPS output.
10 kPPS:	10,000 PPS square wave, synchronous to the 1 PPS output.
1 kPPS:	1,000 PPS square wave, synchronous to the 1 PPS output.
100 PPS:	100 PPS square wave, synchronous to the 1 PPS output.
60 PPS:	60 PPS square wave, synchronous to the 1 PPS output.
50 PPS:	50 PPS square wave, synchronous to the 1 PPS output.
10 PPS:	10 PPS square wave, synchronous to the 1 PPS output.
IRIG-D/1 PPM:	IRIG format D time code (1 pulse per minute), rising edge on time.
1 PPH:	1 pulse per hour, rising edge on time.
1 PPS:	1 PPS (10 ms 'high'), synchronous to 1 PPS/GPS. *Also available on clock Models 1084A/B/C, 1088B and 1089A/B.*
Programmable:	Outputs a single pulse at a preprogrammed time, or a continuous pulse train having a period of one day or less. Pulse width is adjustable from 0.01 to 600 seconds. *Also available on clock Model 1093A/B/C*
Out-of-Lock:	Normally 'HI' after acquisition of satellite signals. Toggles 'LO' nn minutes after loss of satellite signal lock. Range for 'nn' is 00 to 99, and is set using the SETUP menu or RS-232C (refer to clock Operation Manual). Setting of 00 disables this function (output remains 'HI'). This output follows the standard 'Out-of-Lock' function on the clock.
IRIG-B (Modified Manchester):	IRIG format 'B' time code, Manchester encoded with 1 kPPS carrier, and data transitions on time mark. *Also available on clock Models 1088BP, 1084A/B/C, and 1089A/B.*

Changing Output Settings via Internal Jumpers

Case Removal

To change the configuration of Option 12, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 Torx driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING** Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

General Information

Option 12 incorporates an extremely flexible output selection system, which is made possible by the same jumper scheme used in the main clock. Each of the four rear-panel BNC-type I/O connectors included with Option 12 can be configured to perform any of the available output functions. Figure 1 shows the locations and functions for all of the jumpers on the Option 12 board.

Function Selection:

Jumpers JMP3 through JMP10 determine what output function their respective I/O connectors perform. The dotted lines in Figure 1 show the relationships between the jumper strips and the connectors. Set the jumper for each connector to the appropriate location for the type of output signal desired. The signals available are listed in the text to the left of the jumpers in Figure 1.

Mode Selection:

In addition to specifying the output signal type for each individual connector, it is necessary to define whether the signal is analog or digital. This is accomplished using jumpers JMP11, JMP12, JMP14, and JMP15. Each of these jumpers corresponds to the output function jumper for one of the output connectors; the relationships are illustrated by the dotted lines in Figure 1. Table 1 shows the Function and Mode jumper settings for all of the various output signal types. Only the Modulated IRIG-B and Deviation outputs are analog; all others are digital.

Main Board Hardware Setup via Internal Jumpers

Hardware and firmware configuration of the Model 1088A/B is performed at the factory when this option is ordered at the same time as the clock. The following instructions are intended primarily for field installation.

Case Removal

To change the main board configuration for Option 12, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 torx driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING** Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

Jumpers 2 and 3 of the main board assembly (see figure 3-2 in the 1088A/B Operation Manual) must be set properly to allow the Option 12 oscillator to drive the clock. The setting for Jumper 2 should be changed to 'B' (External Reference) and the setting for Jumper 3 should be changed to 'B' (5 MHz). When these settings have been completed, reinstall the instrument cover and reapply power.

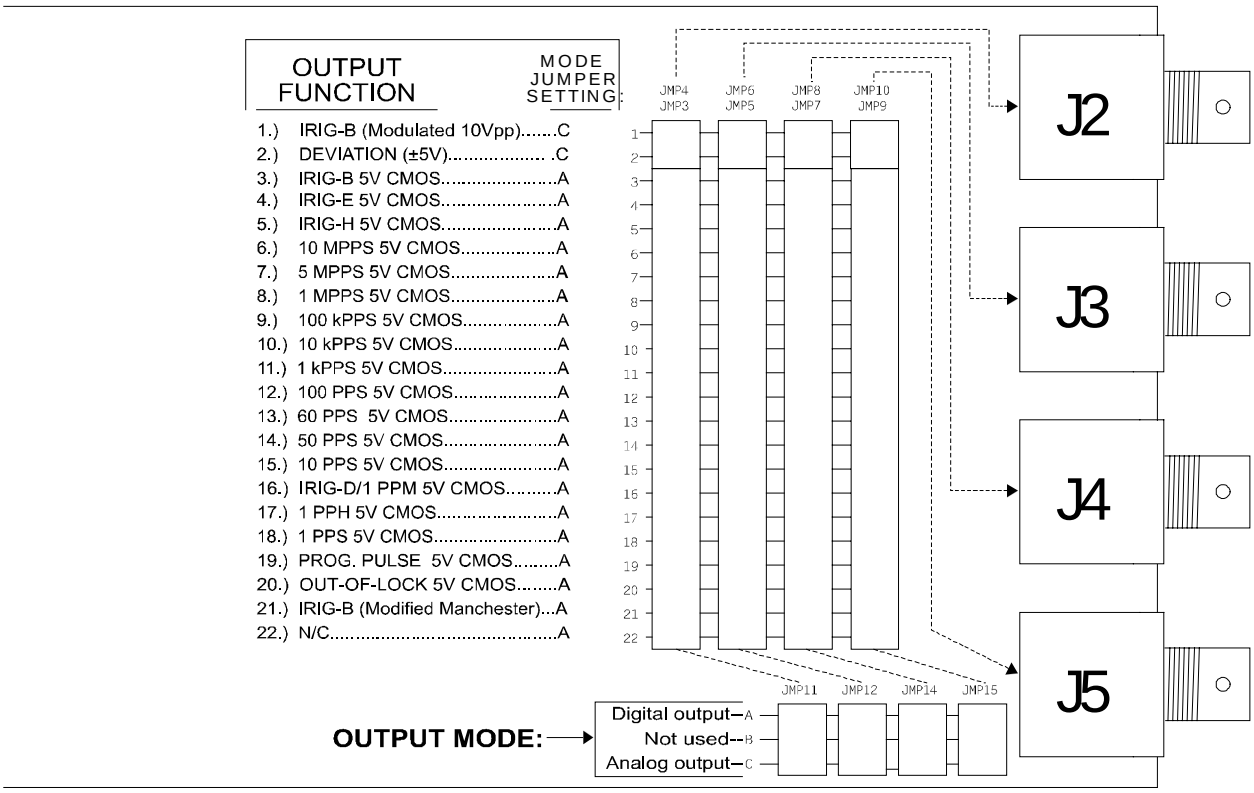


Figure 1. Jumper Locations

Table 1. Output Connector Jumper Settings

Output Signal	Function Select Jumper	Mode Select Jumper
IRIG-B Modulated	1	C
Deviation	2	C
IRIG-B	3	A
IRIG-E	4	A
IRIG-H	5	A
10 MPPS	6	A
5 MPPS	7	A
1 MPPS	8	A
100 kPPS	9	A
10 kPPS	10	A
1 kPPS	11	A
100 PPS	12	A
60 PPS	13	A
50 PPS	14	A
10 PPS	15	A
IRIG-D/1PPM	16	A
1 PPH	17	A
1 PPS	18	A
Programmable Pulse	19	A
Out-of-Lock	20	A
IRIG-B Modified Manchester	21	A
No Connection	22	A

Option 15A: Power Inlet Surge Protection

General Description

Option 15A for the Model 1088A/B is designed to provide power inlet surge withstand capability in accordance with specifications including ANSI C37.90-1 and IEC 801-4. Option 15A also incorporates Option 07, which is a three-pole barrier strip inlet for 125 volt DC substation power.

Specifications

Test Transient Wave Shape

Option 15A was designed and tested to allow the Model 1088A/B to operate without interruption or performance degradation when subjected to an input transient having the following characteristics:

Peak Voltage:	8,000 V
Rise Time:	<10 nanoseconds
Fall Time (to 4,000 V):	≈190 nanoseconds
Fall Time (to 2,250 V per C37.90-1):	≈340 nanoseconds

During testing, transients were applied to the unit using the following terminal combinations:

- Line ground to chassis ground;
- Positive line to line ground;
- Positive line to chassis ground;
- Negative line to line ground;
- Negative line to chassis ground;
- Positive and negative line (tied together) to line ground;
- Positive and negative line (tied together) to chassis ground;
- Positive line to negative line.

Additional Specifications

Input Voltage Range:	110 to 170 Vdc.
Input Power:	3 Watts, nominal.
Input Terminals:	Three-terminal screw-type barrier strip.

Option 15A Firmware Setup

No set up is necessary for this option.

Option 15B: Power Inlet Surge Protection

General Description

Option 15B for the Model 1088A/B is designed to provide power inlet surge withstand capability in accordance with specifications including ANSI C37.90-1 and IEC 801-4. Option 15B also incorporates Option 07, which is a three-pole barrier strip inlet for 250 volt DC substation power.

Specifications

Test Transient Wave Shape

Option 15B was designed and tested to allow Model 1088A/B to operate without interruption or performance degradation when subjected to an input transient having the following characteristics:

Peak Voltage:	8,000 V
Rise Time:	<10 nanoseconds
Fall Time (to 4,000 V):	≈190 nanoseconds
Fall Time (to 2,250 V per C37.90-1):	≈340 nanoseconds

During testing, transients were applied to the unit using the following terminal combinations:

- Line ground to chassis ground;
- Positive line to line ground;
- Positive line to chassis ground;
- Negative line to line ground;
- Negative line to chassis ground;
- Positive and negative line (tied together) to line ground;
- Positive and negative line (tied together) to chassis ground;
- Positive line to negative line.

Additional Specifications

Input Voltage Range:	110 to 330 Vdc.
Input Power:	3 Watts, nominal.
Input Terminals:	Three-terminal screw-type barrier strip.

Option 15B Firmware Setup

No set up is necessary for this option.

Option 17: Parallel BCD Output and Second RS-232C Port

General Description

Option 17 for the standard Model 1084A/B/C and 1088A/B clocks expand the capabilities of the instrument to include:

- Either of the following:

a. Time-of-year output in Binary-Coded Decimal (BCD) format, with resolution down to 1 millisecond; or

b. Parallel Data output, with up to 48 bits that can be custom-configured at the factory for specific applications;

- A continuous 1 pulse-per-second (1 PPS) output, with the rising edge of a 10 millisecond-wide pulse synchronous to the rising edge of 1 PPS/GPS;
- A continuous 1,000 PPS (1 kPPS) square wave output, with rising edges synchronous to the rising edge of 1 PPS/GPS;
- Four pins of the output connector that can be configured with combinations* of the following:

a. Up to four digital signal outputs, the functions of which can be selected individually from 18 choices.

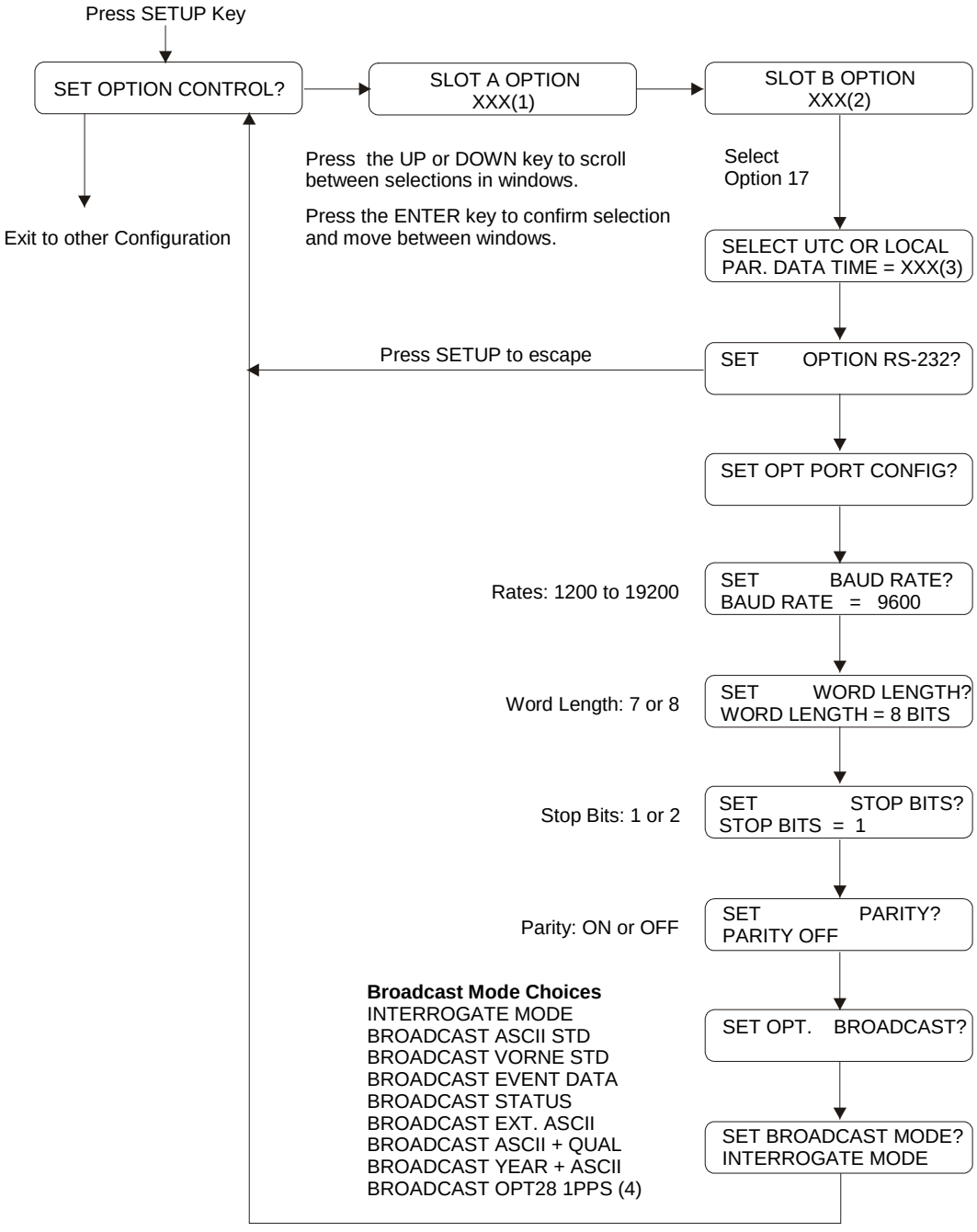
b. Up to two analog signal outputs, the functions of which can be selected individually from two choices.

c. An RS-232C serial communications port, which can use between two and four lines.

***Note:** Since these auxiliary functions must share four connector pins, certain limitations will apply when selecting combinations:

- ☑ Enabling any one (or more) of the digital signal outputs precludes four bits from the parallel data output, if used;
- ☑ Each analog signal output used precludes one of the digital signal outputs; if two analog signal outputs are employed, only two digital signal outputs are possible. Also, each analog signal output displaces one bit from the parallel data interface, if used;
- ☑ A two- or four-wire RS-232C port configuration uses two or four of the data output lines, so these lines become unavailable for digital and/or analog signal outputs, or for the assigned data bits of the parallel output (if used).

Option 17 Firmware Setup Procedure



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28; (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 4, 17, 17A, 18, 23, 27, 29 or 32
(3) XXX = LCL or UTC
(4) Only available with Option 28 installed and configured

Specifications

General

Output Connector:	50 contact; Amphenol P/N 850-57L-40500-2700 or equivalent.
Mating Connectors:	
Plastic:	Amphenol P/N 850-57F-30500-20
Metal Shell:	Amphenol P/N 850-57FE-30500-20

Parallel BCD Output

Data Bus Width:	42 bits. For weighting, refer to Table 1.
Output Type:	High-Speed CMOS, buffered, (74HCXXX), 0 to 5 volts.
Time Data Format:	UTC or Local time data; corresponds to setting for IRIG time data (refer to Operation Manual).
Time Accuracy:	Rising edge delay of 300 ns, maximum (1 ms bit), relative to 1 PPS output rising edge.

Analog Outputs

Output Type:	Operational amplifier (LF353) output, with 562 ohm series resistor.
Pin Numbers:	Output 1: pin 22 Output 2: pin 47
<u>Available Outputs:</u>	
IRIG-B, Modulated:	IRIG format B time code, modulated onto 1 kHz 10 Vpp sine wave carrier.
Deviation:	±5 volts analog, corresponding to 1 PPS deviation channel A or B (depending on configuration; refer to Operation Manual). Proportion is 1 V per 10 µs deviation (±50 µs full scale).

Digital Outputs

Output Type:	High-Speed CMOS (74HCXXX), 0 to 5 volts, with 47 ohm series resistance.		
Pin Numbers:	Output 1:	pin	29
	Output 2:	pin	4
	Output 3:	pin	28
	Output 4:	pin 3	

Available Outputs:

IRIG-B:	IRIG format B time code, 5 V CMOS (unmodulated).
IRIG-E:	IRIG format E time code, 5 V CMOS.
IRIG-H:	IRIG format H time code, 5 V CMOS.
IRIG-D/1 PPM:	IRIG format D time code (1 pulse per minute), 5 V CMOS. Rising edge on time.
10 MPPS:	10 MPPS square wave, synchronous to the 1 PPS output.
5 MPPS:	5 MPPS square wave, synchronous to the 1 PPS output.
1 MPPS:	1 MPPS square wave, synchronous to the 1 PPS output.
100 kPPS:	100,000 PPS square wave, synchronous to the 1 PPS output.
10 kPPS:	10,000 PPS square wave, synchronous to the 1 PPS output.
1 kPPS:	1,000 PPS square wave, synchronous to the 1 PPS output.
100 PPS:	100 PPS square wave, synchronous to the 1 PPS output.
60 PPS:	60 PPS square wave, synchronous to the 1 PPS output.
50 PPS:	50 PPS square wave, synchronous to the 1 PPS output.
10 PPS:	10 PPS square wave, synchronous to the 1 PPS output.
1 PPS:	1 PPS (10 ms ‘HI’), synchronous to 1 PPS/GPS.
1 PPnnnS:	1 pulse per ‘nnn’ seconds (10 ms ‘HI’, synchronous to 1 PPS/GPS); ‘nnn’ corresponds to a number of seconds entered by the user.
1 PPH:	1 pulse per hour, rising edge on time.
Out-of-Lock:	5 volt CMOS levels. Normally ‘HI’ after acquisition of satellite signals. Toggles ‘LO’ nn minutes after loss of satellite signal lock. Range for ‘nn’ is 00 to 99, and is set using the SETUP menu or RS-232C (refer to 1088A/B Operation Manual). Setting of 00 disables this function (output remains ‘HI’). This output follows the standard ‘Out-of-Lock’ function on the clock.

RS-232C

Output Type:	CMOS, -12 to +12 volts.
Input Type:	Standard RS-232C levels.
Inputs Available:	
Receive Data (‘RXD’):	Connector pin 4. Receives data from external device. Requires that JMP3 be set to position ‘B’. Precludes use of digital signal output 2 or parallel data bit 27.
Data Terminal Ready (‘DTR’):	Connector pin 3. Informs clock that remote device is ready to receive data. Requires that JMP5 be set to position ‘C’. Precludes the use of digital signal output 4, analog signal output 2, or parallel data bit 45.
Outputs Available:	
Transmit Data (‘TXD’):	Connector pin 29. Sends data to external device. Requires that JMP2 be set to position ‘B’. Precludes the use of digital signal output 1 or parallel data bit 19.
Data Set Ready (‘DSR’):	Connector pin 28. Informs the remote device that clock is prepared to send data. Requires that JMP4 be set to position ‘C’. Precludes the use of digital signal output 3, analog signal output 1, or parallel data bit 44.

Table 1. Option 04 Connector Pin Designations

Pin No:	BCD Mode Function/Bit Weighting:	Parallel Data Mode Function:	RS-232C Function:
1	Ground	Ground	Ground
2	1 PPS output	Data Bit 47	—
*3	Output 4 (Dig. only)	Data Bit 45	DTR
*4	Output 2 (Dig./An.)	Data Bit 27	RXD
5	Day 200	Data Bit 35	—
6	Day 80	Data Bit 43	—
7	Day 20	Data Bit 41	—
8	Day 8	Data Bit 39	—
9	Day 2	Data Bit 37	—
10	20 Hr.	Data Bit 33	—
11	8 Hr.	Data Bit 31	—
12	2 Hr.	Data Bit 29	—
13	40 Min.	Data Bit 26	—
14	10 Min.	Data Bit 24	—
15	4 Min.	Data Bit 22	—
16	1 Min.	Data Bit 20	—
17	20 Sec.	Data Bit 17	—
18	8 Sec.	Data Bit 15	—
19	2 Sec.	Data Bit 13	—
20	800 ms	Data Bit 11	—
21	200 ms	Data Bit 9	—
22	80 ms	Data Bit 7	—
23	20 ms	Data Bit 5	—
24	8 ms	Data Bit 3	—
25	2 ms	Data Bit 1	—
26	Ground	Ground	Ground
27	1 kPPS output	Data Bit 46	—
*28	Output 3 (Dig. only)	Data Bit 44	DSR
*29	Output 1 (Dig./An.)	Data Bit 19	TXD
30	Day 100	Data Bit 34	—
31	Day 40	Data Bit 42	—
32	Day 10	Data Bit 40	—
33	Day 4	Data Bit 38	—
34	Day 1	Data Bit 36	—
35	10 Hr.	Data Bit 32	—
36	4 Hr.	Data Bit 30	—
37	1 Hr.	Data Bit 28	—
38	20 Min.	Data Bit 25	—
39	8 Min.	Data Bit 23	—
40	2 Min.	Data Bit 21	—
41	40 Sec.	Data Bit 18	—
42	10 Sec.	Data Bit 16	—
43	4 Sec.	Data Bit 14	—

44	1 Sec.	Data Bit 12	—
45	400 ms	Data Bit 10	—
46	100 ms	Data Bit 8	—
47	40 ms	Data Bit 6	—
48	10 ms	Data Bit 4	—
49	4 ms	Data Bit 2	—
50	1 ms	Data Bit 0	—

*These pins can be configured for any of the listed functions, regardless of the main mode of operation for Option 17.

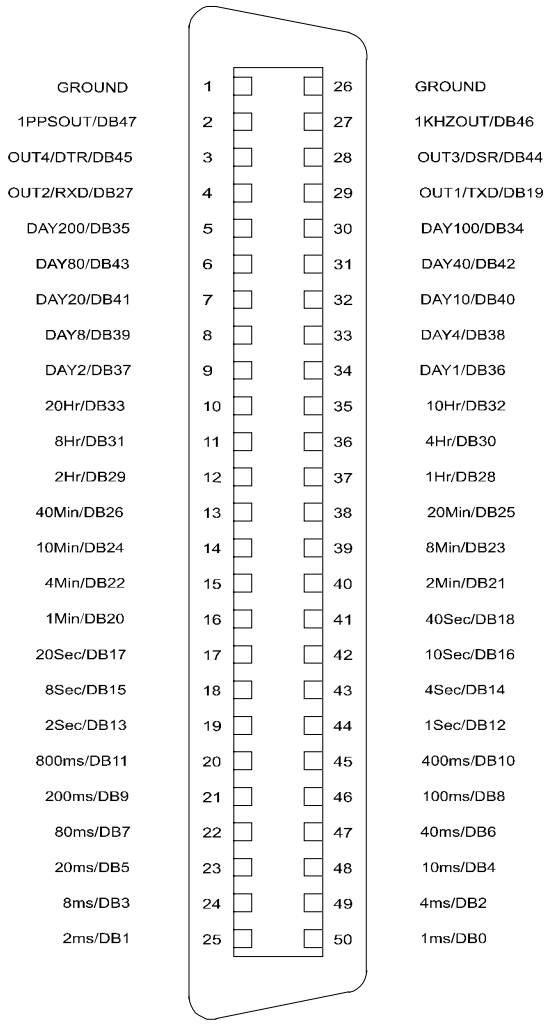


Figure 1. Option 17 Output Connector

Configuration

General

Case Removal

To change the configuration of Option 17, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 torx driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> WARNING Do not remove the top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

Jumper Functions and Locations

Upon removal of the top cover, locate the BCD circuit board (jumper locations are shown in Figure 2). The following sections outline the jumper setting changes and other steps necessary to utilize the various features available with Option 17.

BCD Output Mode

General

When configured for BCD output of time data, Option 17 utilizes pins 1 through 21 and 26 through 46, along with ground pins 1 and 26. The weighting for the individual bits, along with the connector pin locations, are listed in Table 1. To configure Option 17 for BCD operation, perform the following steps:

a. Set jumper JMP1 to position ‘B’. This enables the BCD output mode.

b. Set jumper JMP6 to position ‘A’. This jumper is included to set the timing mode when utilizing the parallel data output, and must be set to position ‘A’ for the BCD output to function properly.

Operation in the BCD output mode allows use of the analog and/or digital signal outputs, the 1 PPS and 1 kPPS outputs, and the RS-232C communications port. Refer to the appropriate sections of this document for details of these functions.

Time Data Format

The format of the BCD time data which is output from the rear-panel connector can be either Local time or Coordinated Universal Time (UTC), and will be the same as the time format which is specified in the SETUP menu for the IRIG time data outputs. For further details, refer to the flowchart titled ‘Set IRIG Time DATA?’ in the Operation Manual.

Parallel Data Output Mode

Full operation in the parallel data output mode utilizes all 50 contacts of the output connector. However, use of any combination of digital signal outputs, analog signal outputs, or RS-232C will reduce the number of data bits available by up to four (data bits 19, 27, 44, and 45). For details, refer to the sections pertaining to these individual functions.

The functions of the individual data bits are defined for specific customer applications, upon request.

To configure Option 17 for parallel data mode, perform the following steps:

a. Set jumper JMP1 to position ‘A’. This jumper enables the parallel data output mode.

b. Set jumpers JMP2, JMP3, JMP4, JMP5, and JMP11 to position ‘A’ (these settings will vary if the analog and/or digital signal outputs or RS-232C port are used; refer to the applicable sections for more information on these functions).

c. If it is desired that the parallel output data be synchronous to the 1 PPS output, set jumper JMP6 to position ‘A’; for non-synchronous operation, set this jumper to position ‘B’.

Digital Signal Outputs

The four digital signal outputs can be individually enabled and configured, using the following steps:

a. Set jumper JMP11 to position ‘A’. This enables the digital signal output mode. At the same time, making this jumper selection eliminates parallel data bits 19, 27, 44, and 45.

b. To enable digital signal output number 1, set jumper JMP2 to position ‘A’ This also eliminates the ‘TXD’ RS-232C line.

c. To set the type of output signal for digital signal output number 1, make the appropriate selection on jumper JMP8 (see Figure 2). Note that positions 1 and 2 correspond to analog signal outputs, and will be occupied by a jumper only if analog signal output number 1 is enabled.

d. To enable digital signal output number 2, set jumper JMP3 to position ‘A’ This also eliminates the ‘RXD’ RS-232C line.

e. To set the type of output signal for digital signal output number 2, make the appropriate selection on jumper JMP7 (see Figure 2). Note that positions 1 and 2 correspond to analog signal outputs, and will be occupied by a jumper only if analog signal output number 2 is enabled.

f. To enable digital signal output number 3, set jumper JMP4 to position ‘A’ This also eliminates the possibility of using analog signal output number 1, or of having a ‘DSR’ RS-232C line.

g. To set the type of output signal for digital signal output number 3, make the appropriate selection on jumper JMP9 (see Figure 2).

h. To enable digital signal output number 4, set jumper JMP5 to position ‘A’. This also eliminates the possibility of using analog signal output number 2, or of having a ‘DTR’ RS-232C line.

i. To set the type of output signal for digital signal output number 4, make the appropriate selection on jumper JMP10 (see Figure 2).

Analog Signal Outputs

The two analog signal outputs can be individually enabled and configured, using the following steps:

To enable analog signal output number 1, set jumper JMP4 to position ‘B’. This setting also eliminates the possibility of having parallel data bit 44, digital signal output number 3, or the ‘DSR’ RS-232C line.

To select the type of signal for analog output 1, remove the jumper from jumper strip JMP9 (which is no longer active, since it corresponds to digital signal output number 3), and place it on jumper strip JMP8 in either position 1 or 2 (refer to Figure 2).

To enable analog signal output number 2, set jumper JMP5 to position ‘B’. This setting also eliminates the possibility of having parallel data bit 45, digital signal output number 4, or the ‘DTR’ RS-232C line.

To select the type of signal for analog output 2, remove the jumper from jumper strip JMP10 (which is no longer active, since it corresponds to digital signal output number 4), and place it on jumper strip JMP7 in either position 1 or 2 (refer to Figure 2).

1 Pulse-Per-Second (1 PPS) Output, 1,000 Pulse-Per-Second (1 kPPS)

The 1 PPS and 1 kPPS outputs are enabled whenever Option 17 is placed in the BCD output mode (jumper JMP1 set to position ‘B’).

Table 1. Option 04 Configurable Output Jumper Settings

J2 Pin	Function	JMP1	JMP2	JMP3	JMP4	JMP5	JMP6	JMP11
22	Synchronous (1 PPS) Parallel Data Bit 19	A	A	--	--	--	A	A
22	Asynchronous Parallel Data Bit 19	A	A	--	--	--	B	A
22	Digital Signal Output 1	--	A	--	--	--	--	B
22	RS--232C 'TXD'	--	B	--	--	--	--	--
47	Synchronous (1 PPS) Parallel Data Bit 27	A	--	A	--	--	A	A
47	Asynchronous Parallel Data Bit 19	A	--	A	--	--	B	A
47	Digital Signal Output 2	--	--	A	--	--	--	B
47	RS--232C 'RXD'	--	--	B	--	--	--	--
23	Asynchronous Parallel Data Bit 44	A	--	--	A	--	--	A
23	Digital Signal Output 3	--	--	--	A	--	--	B
23	RS--232C 'DSR'	--	--	--	C	--	--	--
23	Analog Signal Output 1	--	--	--	B	--	--	--
48	Asynchronous Parallel Data Bit 45	A	--	--	--	A	--	A
48	Digital Signal Output 4	--	--	--	--	A	--	B
48	RS--232C 'DTR'	--	--	--	--	C	--	--
48	Analog Signal Output 2	--	--	--	--	B	--	--

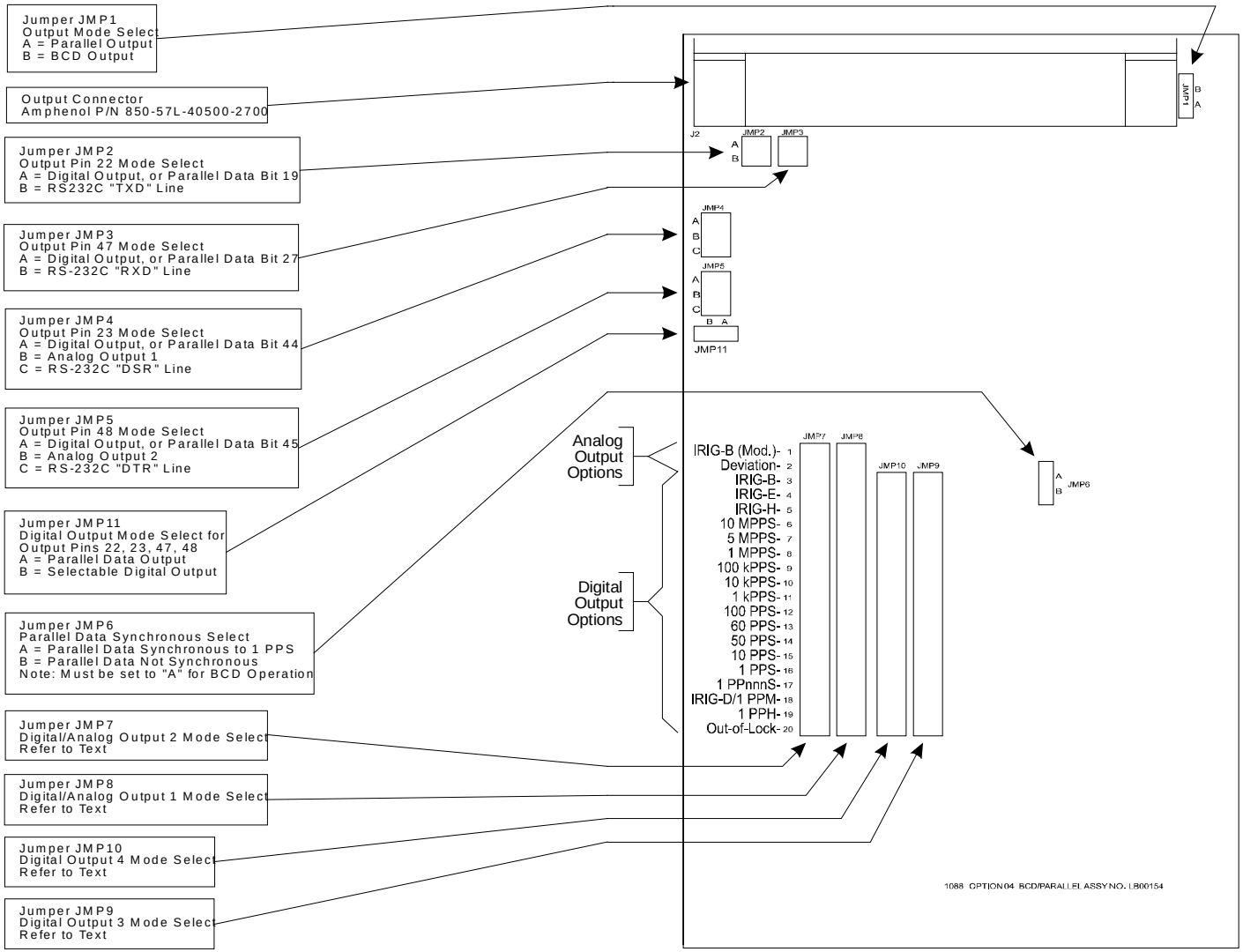


Figure 1. Option 17 Jumper Settings

Option 17A: Second RS-232C Interface Installation

General Description

Option 17A for the Model 1088B adds a second RS-232C port, allowing communications and control via a 9-pin connector on the rear panel. This document provides specifications and instructions for installing this option in the Model 1088B Satellite-Controlled Clock.

Specifications

Commands

All commands which are available for the main RS-232C port on the Model 1088B may be used with Option 17A. A list of commands is located in the back of the operation manual.

RS-232 Pinout

The pinout of the RS-232 connector is as follows:

Pin 1	No Connection
Pin 2	Receive Data input (RXD)
Pin 3	Transmit Data output (TXD)
Pin 4	RS-232 Aux. Output[1]
Pin 5	Signal Common
Pin 6	RS-232 Aux. Input[1]
Pin 7	RS-232 Aux. Output[1]
Pin 8	RS-232 Aux. Input[1]
Pin 9	No Connection

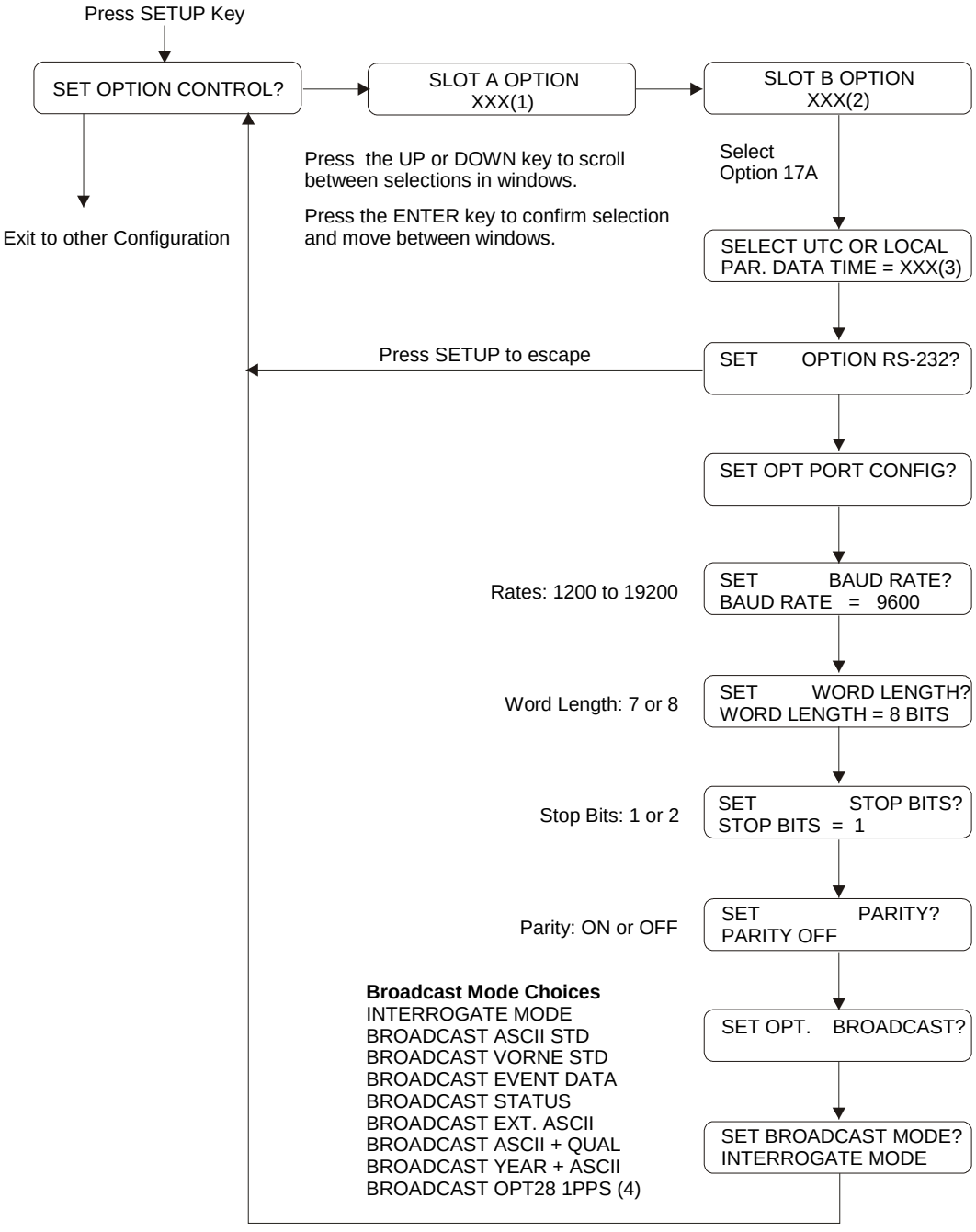
[1]These pins may be programmed at customer request, for example, for modem or printer control. In the standard unit, they have no function.

Option 17A Field Installation Kit – Parts List

Assembly Number; AS0070600

1. CA0015402 Clock Option Interface Cable 1 each
2. HD0043700, 1088 Option 17A Mounting Bracket 1 each
3. Screw, M3 x 0.5 x 8mm Lg., T-10 panhead, machine 2 each
4. LA0005002, Rear Panel Label, Option RS-232 1 each
5. LB0015601, 1088 OPT. 17A Board; Second RS-232 Port 1 each
6. PD0017900A, Installation Instructions, Option 17A 1 each

Option 17A Firmware Setup



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28; (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 4, 17, 17A, 18, 23, 2 7, 29 or 32; use UP or DOWN keys to select option.
(3) XXX = LCL or UTC
(4) Only available with Option 28 installed and configured

Installation

Physical Installation

Option 17A may be installed in a Model 1088B Satellite-Controlled Clock by performing the following steps:

1. Disconnect the power source from the instrument.
2. Using a T-25 torx driver (or large slot screwdriver), remove the four screws holding the instrument top cover in place. Remove the cover.
3. Locate the rear-panel opening for optional I/O connectors. When viewing the instrument from the front, the opening is located at the right-rear, and is covered by a plate.
4. Using a T-10 torx driver, remove the two screws holding the cover plate, and remove the cover plate. Save the screws.
5. Insert the Option 17A Bracket (HD0043700) included with Option 17A kit in place of the old cover plate, but do not install the screws.
6. Carefully punch two holes in the Mylar tape on the bottom of the option board to allow screws to pass through the Option 17A board and the mounting bracket.
7. Position the Option 17A circuit board over the four mounting studs, with the 9-pin connector protruding through the rear-panel opening.
8. Secure the option board and the cover plate in place, using the two screws removed in step 4 and the two screws included with Option 17A.
9. Install the interconnect cable between J9 on the Model 1088B main circuit board and J1 on the Option 17A circuit board. The connectors on the cable are keyed so as to prevent backwards installation.
10. Install the middle connector if a second option board is already installed in option slot A (located between Option 17A and the main board).
11. Replace the instrument top cover and screws, restore input power, and turn the instrument ON.

Firmware Configuration

The internal operating firmware for the Model 1088B must be configured to recognize that the Option 17A has been installed. This is accomplished by performing the following steps:

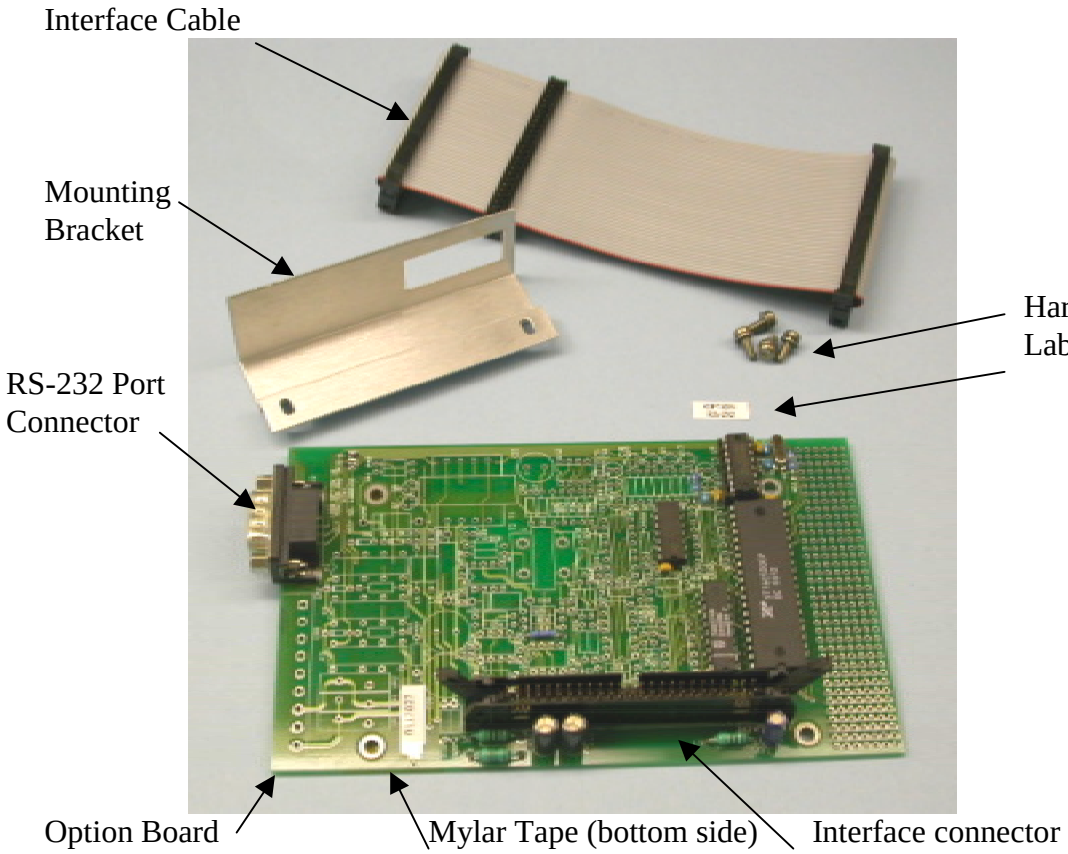
1. Enter the Setup Menu by pressing the SETUP key.
2. Press the UP key repeatedly, until the display reads ‘SET OPTION BOARD’. Press the ENTER key.
3. The display will indicate whether an option is installed in Option Slot ‘A’. Press the ENTER key to confirm this status without changing it.

4. The display will now indicate the status of Option Slot ‘B’. Press the UP or DOWN keys until the display reads:

   OPTION SLOT B
   OPTION 17A

5. Pressing the ENTER key confirms the selection of Option 17A and enables a series of sub-menus for configuration of communications parameters. When all of the parameters have been set, the display returns to the top level of the Setup Menu. Pressing any of the top row function keys returns the instrument to normal operation.

Parts Identification



Option 18: IRIG-B BUS Distribution, Fault Monitor and 2nd RS-232 Port

General Description

Option 18 for the Model 1088B adds several capabilities to the clock, which are often used in systems applications. These capabilities include:

- An IRIG-B distribution bus amplifier that drives dozens of loads over distances of hundreds of meters
- A fault monitor that expands the ability of the Model 1088B to detect internal faults and provides two form-C (SPDT) fail-safe relay contact sets to indicate the Unlocked and Fault conditions. These relay contacts are for connection to external equipment such as a digital fault recorder.
- A second serial (RS-232) port, which can be used as a status event logger, for a broadcast time output, to connect to a second computer; or as a redundant clock interface allowing two Model 1088B clocks to be interconnected to form a redundant timing system.

Specifications

IRIG-B Distribution Bus	
Output Connector:	Pluggable terminal strip, 5mm centers.
Loads	24, minimum, with Model 10882A load taps.
Bus Length	Limited by bus configuration; will drive 500m (1500') of AWG18 twisted-pair cable in a linear configuration.
Delay	Less than 100 microseconds, typical; depends on loading and bus configuration.
Output Level, Tap Output	6.4-11 Vpp, open-circuit; 3.2-5.5 Vpp, into 600 ohm load.

Fault Monitor	
Indication:	Via rear-panel relay, front-panel display, or serial port.
Faults Detected:	
IRIG-B Distribution:	Three fault modes will generate an alarm: Any break in the distribution bus; or A short circuit, or load impedance below 50 ohms; or Any loss of the IRIG-B drive signal.
Processor:	Watchdog violation or other reset condition.
Power Supply:	5 volt, +12 volt and -12 volt supplies out of limits.

Redundant Clock Control Interface	
Interconnect:	Using Arbiter Systems P/N CA0017200 cable assembly.
Communications:	Uses RS-232 port and two dedicated hardware lines.

Relays	Two, form-C (SPDT), fail-safe (in faulted position with power off).
Contact Rating:	130 Vdc at 0.3 A; 24 Vdc at 1 A.
Function:	Unlocked (energized when locked to satellites); Fault (energized when no fault conditions present).

Associated Products

Model 10882A	IRIG-B Distribution Tap
Model 10883A	IRIG-B Distribution Bus Splitter
Model 10884A	IRIG-B Distribution Bus Terminator
Model 10885A	IRIG-B Distribution Redundant Ring Adapter

Discussion - IRIG-B Distribution System

Option 18 for the Model 1088B GPS Satellite-Controlled Clock provides an IRIG-B distribution bus output which is capable of driving 24 separate taps, loaded at 600 ohms, over a length of 500 meters of cable. Longer cable lengths, or more taps, may be possible, depending on the loading and signal levels required.

Option 18 includes a built-in distribution system monitor, which continually checks for two conditions: the presence of an IRIG signal at the bus output terminals, and dc electrical continuity in the distribution bus cable. Any fault in the clock mainframe or Option 18 board which results in loss of IRIG drive, any bus short within approximately one kilometer of the clock (or more, depending on bus configuration and loading), and any electrical open circuit (a cut cable, for instance) will be detected and reported as a FAULT via the front-panel FAULT LED, the FAULT relay output, and RS-232.

Even in the presence of a break in the cable, service may be maintained at all taps, and the break detected and reported for maintenance, using the Model 10885A IRIG-B Distribution Redundant-Ring Adapter with a ring or loop-configured distribution bus (where the 'far end' of the bus is physically brought back to the start). This allows the system to offer a substantial degree of survivability with respect to broken cables, while nonetheless reporting the problem for corrective action. The Model 10885A also provides 3750 Vrms isolation from the return end of the bus to the clock mainframe, to prevent voltages induced in the bus loop from causing currents to flow in the distribution bus or its shield.

The Model 10882A tap is used to provide a decoupled, isolated output signal to your system loads. The source impedance of this tap is approximately 600 ohms, and it will provide an open-circuit signal level of 6.4 to 11 Vpp, depending on overall system loading and distance from the clock mainframe. Each tap provides 3750 Vrms isolation from the distribution bus to the load, as well as surge suppression and EMI filtering. The taps are capacitively-isolated from the dc bus monitoring current.

One Model 10884A terminator is located at the end of a linear distribution bus, and one at the end of each branch. This inductive terminator provides a high impedance to the IRIG-B signal while providing a return path for the dc loop current used for continuity monitoring.

The Model 10883A splitter is used to drive a branch from the main distribution bus, or to split a bus into two branches. It drives the two output branches in parallel as far as the IRIG-B signal is concerned, while they are connected in series for the dc loop monitoring current.

Bus Configurations

Using these three components, a linear or branched network can be assembled in any required configuration, while maintaining the ability of the Option 18 bus monitor to detect an open-circuit fault at any point along the bus or any branch. If the Model 10885A redundant-ring adapter is used to build a basic ring network, the Model 10884A terminator and Model 10883A splitter are not required. However, as shown in the accompanying figures, a complex system can be built using rings, branches, and linear segments in various combinations as needed to satisfy your requirements.

Determining Actual Signal Output Levels

The actual signal levels at the outputs of the various taps may be approximated with acceptable accuracy by treating the network as a resistive array. The source impedance of the Option 18 bus output is approximately 21 ohms. The recommended cable (Belden 8760 or equivalent, #18 AWG shielded twisted pair) has a resistance of 43 ohms per kilometer (13 ohms per thousand feet). The Model 10885A redundant-ring adapter has an effective series resistance to the ac signal of approximately 10 ohms. The Model 10883A splitter has an effective series resistance of less than one ohm.

Each Model 10882A tap places a load across the bus of approximately 580 ohms plus the load impedance it is driving; i.e. the tap acts like a 580-ohm resistor in series with the load, with which it forms a voltage divider. The Model 10884A terminator may be treated as an open circuit so far as the IRIG signal is concerned.

By using these numbers, along with the load impedances, in a suitable circuit-analysis program, or by solving the loop equations manually, the attenuation from the Option 18 bus output to the load at each tap may be determined. The open-circuit output level at the Option 18 bus output is nominally 11 volts peak-to-peak with a tolerance of $\pm$5%; knowing this, along with the attenuation values, you can calculate the signal level at each tap.

Total DC Resistance Limit - Bus Monitor

There is a 500-ohm limit on the total dc resistance of the distribution system to ensure proper operation of the bus continuity monitor. This limit will not normally be a factor in system design. Still, loop dc resistance should be calculated for each system.

Since all of the components which pass dc current are effectively in series as far as the dc current is concerned, the resistances can simply be summed up. If the total is less than 500 ohms, proper operation is ensured.

The cable resistance is 43 ohms/km (13 ohms/Mft.) for the dc monitor current. The dc resistance of the Model 10885A redundant-ring adapter is 4 ohms. The dc resistance of each Model 10884A terminator and each Model 10883A splitter is 30 ohms. The number of taps has no effect on the system dc resistance.

The magnitude of the dc monitor current is 10 mA ±10% with a maximum dc open-circuit voltage of 8.5 volts. In the USA, NEC class-2 wiring is acceptable.

Detection of Short Circuits; Drive Capability

The Option 18 bus output is intended to drive a total ac load of 50 ohms or greater, although it will continue to operate without excessive signal distortion into any impedance. The bus monitor includes a circuit which detects the presence of the IRIG-B signal at the system output. The bus monitor is sensitive to both the waveshape of the signal at the bus output (it must look like a modulated IRIG-B signal), and the level of that signal.

If the load impedance drops below approximately 40 ohms, a drop in signal level will occur due to the 21-ohm source resistance of the bus driver. At this point, the output level will drop below the threshold required by the bus monitor, in turn causing a bus FAULT to be reported. Since in normal operation the system load exceeds 50 ohms, such a fault must be the result of a short circuit at some point along the bus.

Thus, the bus monitor function of the Option 18 IRIG-B distribution output is capable of detecting the three most likely types of system fault: failure of the IRIG-B drive signal at the source, an open circuit along the distribution bus, or a short of the distribution bus.

Installation

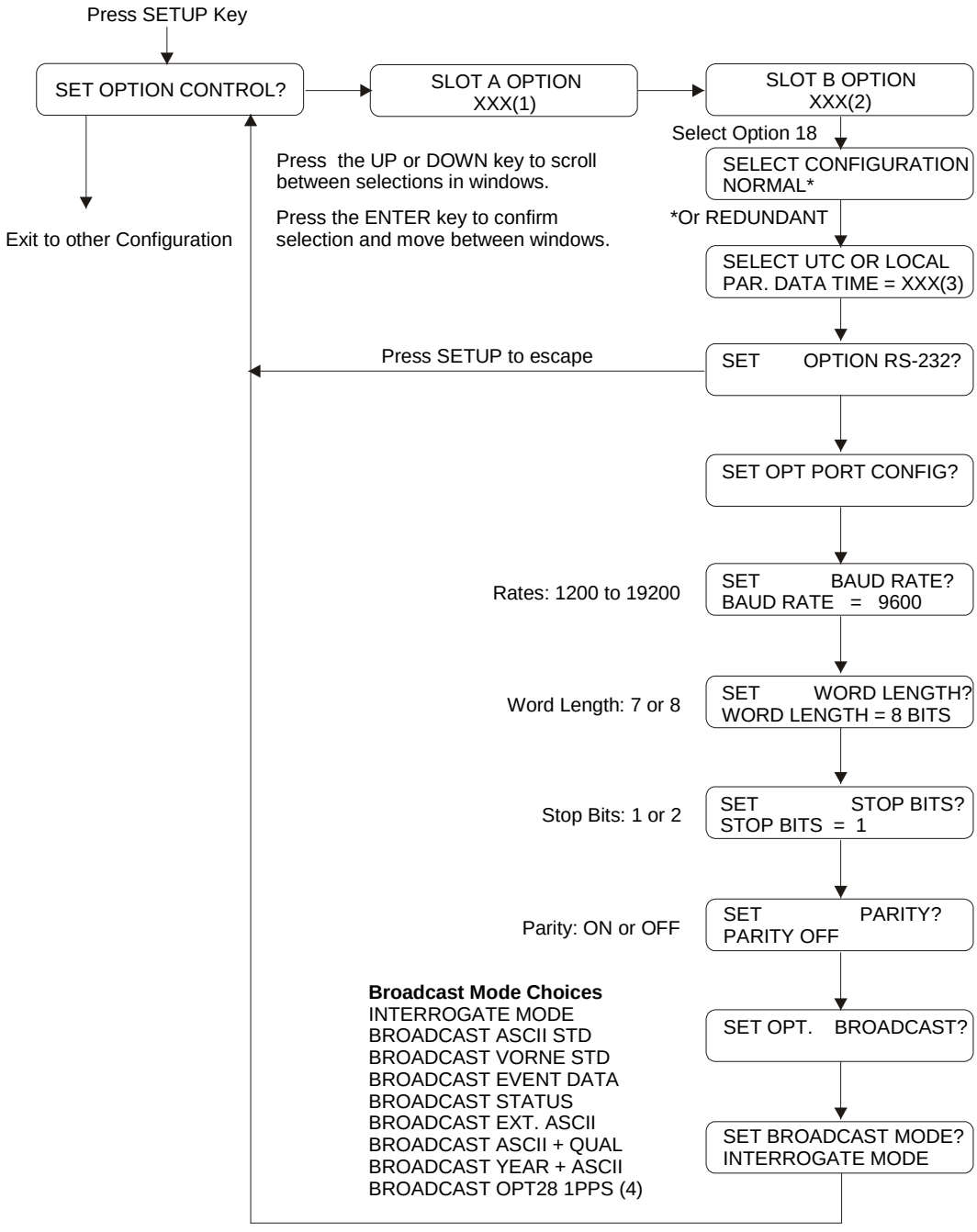
Installation of the IRIG-B distribution bus is straightforward for those experienced with the installation of control and communication wiring. No special tools are required. All of the components are terminated with pluggable, screw-type terminal blocks. A 3 mm (1/8") flat-bladed screwdriver, wire cutters and strippers are all that is required to terminate the cable.

The figures which follow show typical network topologies. The various components may be connected together in any configuration desired, provided that the basic rules described above are not broken. Multiple branches or loops may be used, and the number of taps is limited only by the loading and signal level requirements described above. The limit of 24 taps only applies if they all are loaded with 600 ohms; for higher or lower load impedances, a greater or fewer number of taps will be possible.

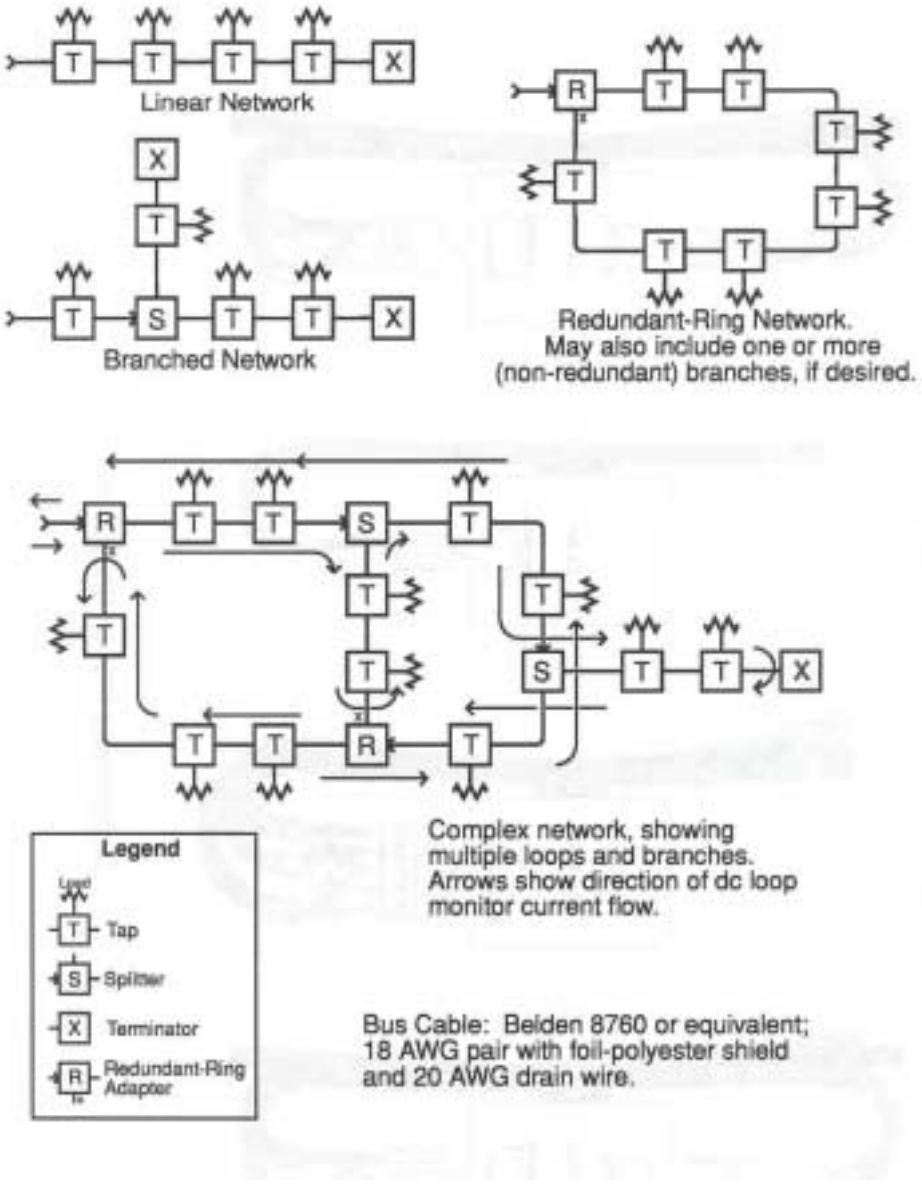
When connecting the network, observe polarity of all components. Both the IRIG-B signal and the dc loop monitor current have polarity which must be observed for proper operation. All of the components needed to assemble your system are marked for polarity.

The output of the taps is isolated and floating, and either end may be grounded. However, if the signal polarity is incorrect, the device being driven by the tap may not operate properly.

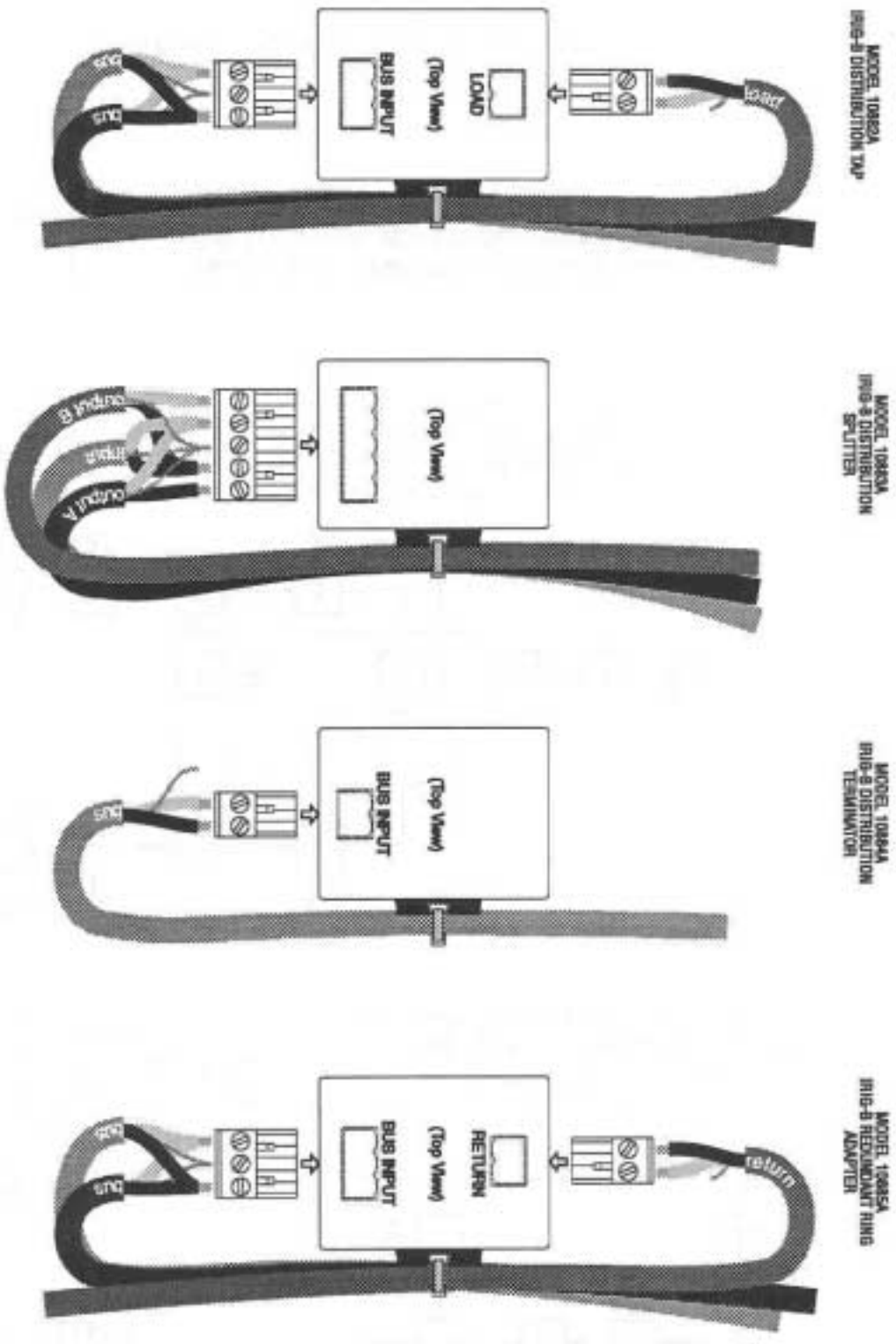
Option 18 Firmware Setup



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28; (Options 10, 11, 13, 14 and 25 are no longer available)
(2) XXX = 4, 17, 17A, 18, 23, 27, 29 or 32
(3) XXX = LCL or UTC
(4) Only available with Option 28 installed and configured



Typical Network Configuration



Component Wiring Diagrams

Discussion – Redundant Timing Operation

In redundant-clock mode, two Model 1088B clocks, each with Option 18, are interconnected with the Arbiter Systems part number CA0017200 cable assembly. This cable installs between the two 9-pin D-subminiature connectors on the Option 18 assemblies of the two units. Either end of the cable may go to either clock; neither unit has higher or lower priority than the other.

Output Signal Enable and Configuration

When jumper JMP17 on the main clock board is set properly, the digital outputs of that clock are controlled by the redundant-control interface. The status of the drivers is indicated by the 'On Line' LED annunciator on the clock front panel. Refer to paragraphs 3.2 through 3.3.4 of the 1088B Operation manual if it should be necessary to modify the jumper settings; they are normally preset at the factory prior to shipment.

To make the best use of the redundant clock feature, both clocks should have their main four outputs set for the same set of signals. Then, the outputs may be directly tied in parallel, and the 'On Line' clock will drive the connected loads. Note that the output enable only affects the digital outputs (everything except IRIG-B modulated and chart recorder output). If you connect two analog outputs together, no damage will be done, but both signals will be present simultaneously. The IRIG bus distribution output of the Option 18 assembly should be used for a redundant modulated IRIG-B output; it includes an on-line enable relay, which is also controlled by the output enable function.

On-Line Control and Arbitration

In normal operation, when no fault is detected, the 'On Line' clock is determined by the 'luck of the draw.' The only exception to this is if one of the clocks includes a higher-stability internal timebase, such as Option 12. In this case, the clock with the higher-quality timebase will be the nominal on-line clock.

Once each second, the clocks exchange status information via the RS-232 interface. In the event that one of the clocks determines that it is not as healthy as the other, it will automatically relinquish on-line status to the other unit. For the most part, this is performed in firmware; however, there is also a hardware input to the redundant-control circuit which is driven by the microprocessor watchdog/reset generator. If this circuit detects any error, a direct hardware transfer to the other unit is performed. Thus, in the event of a processor failure which might prevent the clock from relinquishing on-line status via firmware, the transfer will be accomplished automatically through this hardware feature.

Determination of the on-line clock in the event of multiple failures is made by comparison of the status bytes (refer to paragraph 4.4 for a discussion of clock status). The clock with the lower-valued status byte will be elected to on-line status. The status of both clocks may be monitored from either of the clocks via the ‘SS’ RS-232 command; see Appendix A of the 1088B Operation manual for a description.

Use With Other Options

Certain other options, including Options 03 and 20, can be installed in the clock mainframe along with the Option 18 board, and also can provide redundant control of their outputs via the redundant clock control function of the Option 18 assembly. See the documentation for these options to determine if any jumper settings are required to take advantage of this feature.

Option 18 Setup

The setup menu to control the operation of the Option 18 interface is shown earlier in this section (Option 18 Firmware Setup). No internal configuration is necessary for proper operation of the Option 18, except to convert between redundant and normal operation as regards the output-enable control for the clock digital output drivers. If you need to change this setting, refer to paragraph 3.3 of the 1088B Operation Manual for instructions. These jumpers are normally configured at the factory to match each customer's order.

RS-232 Pinout

The pinout of the RS-232 connector is as follows:

Pin 1	Redundant Control Interface Disable Input[2]
Pin 2	TXD, Transmit Data output
Pin 3	RXD, Receive Data input
Pin 4	RS-232 Aux. Output[1]
Pin 5	Signal Common
Pin 6	RS-232 Aux. Input[1]
Pin 7	RS-232 Aux. Output[1]
Pin 8	RS-232 Aux. Input[1]
Pin 9	Redundant Control Interface Disable Output[2]

[1] These pins may be programmed at customer request, for example, for modem or printer control. In the standard unit, they have no function.

[2] These pins have 5-volt CMOS levels, unlike the others, which have RS-232 levels. If you are not using the redundant clock interface, do not connect these pins.

Terminal Strip Pinout

Pin 1 is the leftmost pin, viewing the panel from the rear. Pin 9 is the rightmost. Three mating connectors (three pins each), Arbiter Systems part number CN0019203A, are included with the unit.

Pin 1	Fault Relay Normally-Closed Contact[1]
Pin 2	Fault Relay Normally-Open Contact[2]
Pin 3	Fault Relay Common Contact
Pin 4	Unlocked Relay Normally-Closed Contact[1]
Pin 5	Unlocked Relay Normally-Open Contact[2]
Pin 6	Unlocked Relay Common Comtact
Pin 7	IRIG Bus Positive Polarity Output
Pin 8	IRIG Bus Common (Chassis Ground)
Pin 9	IRIG Bus Negative Polarity Output

1 The normally-closed contact is connected to Common when power is off, and when the relay is in the 'fault' or 'unlocked' state.

2 The normally open contact is connected to Common during normal operation, with no fault conditions present.

Option 19: Model 1088B – Fault Relay

General Description

Option 19 for the Model 1088B Satellite-Controlled Clock incorporates a fail-safe single-pole, double-throw (SPDT) relay into the Out-of-Lock function already available in the standard instrument. Relay activation is subject to the same user-configurable delay as the standard output; thus it will occur at the same moment as the logic-level Out-of-Lock signal from the rear panel (if so configured). Normally-open, normally-closed, and common connections are available at screw terminals on the rear panel.

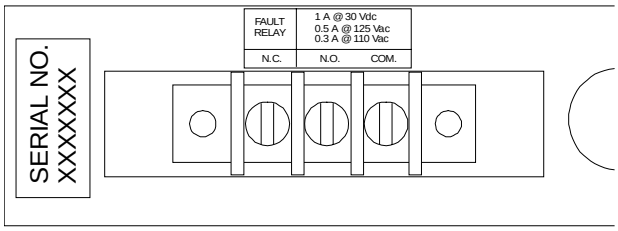


Figure 1. Option 19 External Wired Fault Relay

Specifications

Relay Contacts

Type:	Dry; gold-clad silver.
Contact Resistance:	60 milliohms
UL/CSA Ratings:	1 A @ 30 Vdc; 0.5 A @ 125 Vac 0.3 A @ 110 Vdc

Terminal Strip

Terminal Assignment:	N.C./N.O./COM., left to right, viewed from rear.
Block Size:	49-mm W x 15-mm H x 16.5-mm D (1.9: x 0.6” x 0.6”)
Block Material:	Glass-filled thermoplastic.
Screw Size:	6-32 x ¼”
Screw Material:	Cadmium-plated steel.

Option 19 Firmware Setup

There is no setup in firmware for this option.

Connections
All connections to the rear-panel terminal strip should be made using spade lugs or ring lugs suitable for use with #6 screws. Refer to Figure 1 and the specifications given above for terminal assignments. The designations 'normally-open' and 'normally-closed' refer to the position of the relay contacts during normal operation, prior to encountering an out-of-lock condition. This is a fail-safe relay; it is in the faulted state with power OFF.

Note that in the above diagrams, 'n.c.' and 'n.o.' correspond to the rear-panel terminal markings, and refer to the condition when the relay is *energized* (normal clock operation).

Configuration

After the connections have been made, configuration of the fault relay is accomplished in the same manner as configuration of the Out-of-Lock function (the relay is driven internally by the Out-of-Lock circuitry). The Out-of-Lock function is enabled and configured using the SETUP menu for the 1088B, which is described in Section 5 of the 1088B Operation Manual.

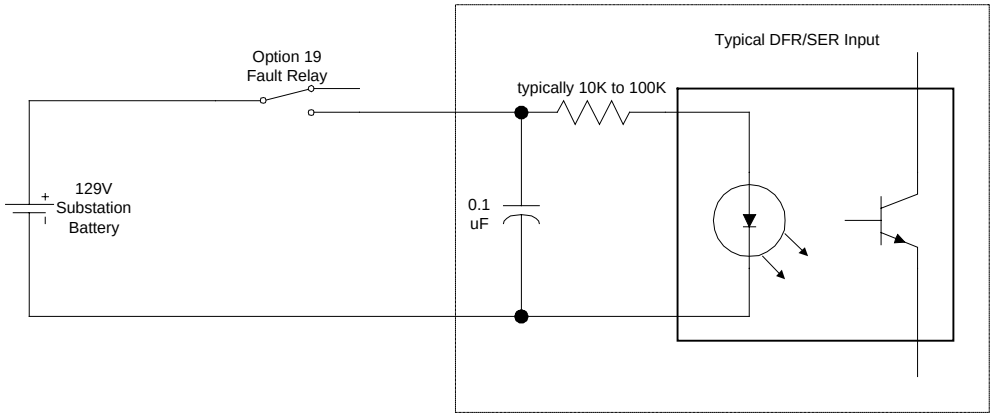
The SETUP menu allows entry of a value between '00' and '99' for Out-of-Lock *Delay Time*. The delay time value represents the amount of time, in minutes, that satellite synchronization must be continuously lost before the instrument outputs an Out-of-Lock signal and simultaneously activates the Out-of-Lock relay. If the value is set to '00', the Out-of-Lock function is disabled, and the Out-of-Lock output and the relay are both in the 'locked' state whenever power is on.

The procedure for setting the Out-of-Lock function is as follows:

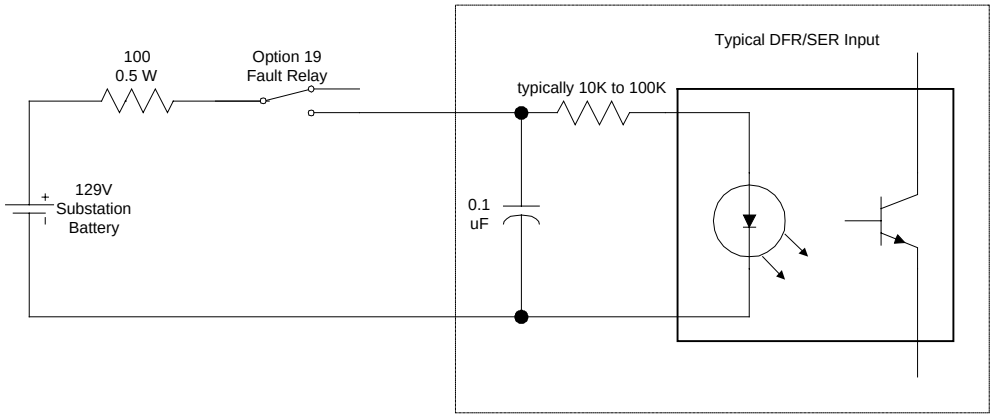
1. With the clock power turned on, press the SETUP key. The display should change to read, 'SET RS-232?'.
2. Press the SETUP key repeatedly, until the display reads, 'SET OUT-OF-LOCK?'. Press the ENTER key to select the Out-of-Lock sub-menu. The current out-of-lock delay time (between '00' and '99') will be displayed.
3. Pressing the UP and DOWN keys will change the selection. When the desired out-of-lock delay time is displayed, press the ENTER key to confirm the choice and return to the first level of the SETUP menu. To return the 1088B to normal operation, press one of the function keys in the top row of the front panel keyboard.

Special Note

In some applications, the fault relay may be required to switch into a capacitive load. An example would be an input to a substation DFR or SER, in which a capacitor is placed across the input terminals for surge or noise suppression (see schematic below).



Note that if the relay contacts are closed, a substantial momentary current will flow into the 0.1 uf capacitor. This could damage or degrade the contacts of the relay. This problem may be alleviated by adding a 100 ohm, 0.5 watt resistor in series with the relay, thereby limiting the charging current to the capacitor (see below).

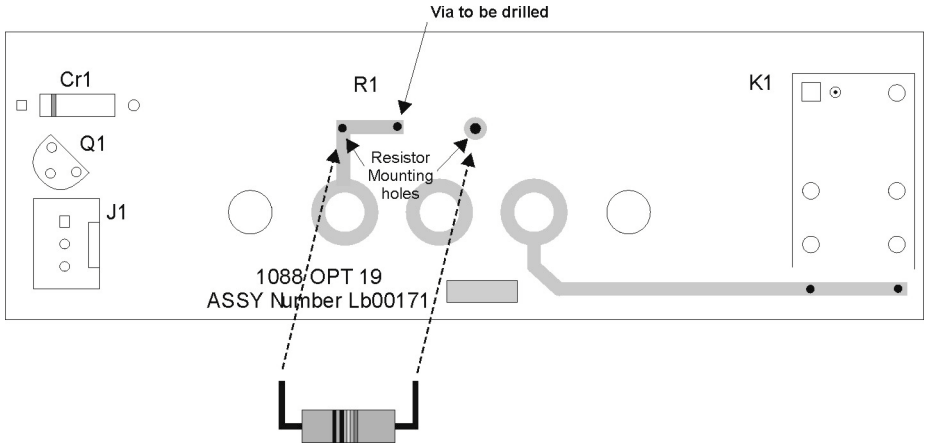


This resistor is not normally installed at the factory, due to the range of different applications in which Option 19 may be used, and the fact that in many applications, no resistor is needed or desired.

The modification can be implemented by adding a resistor to the Option 19 circuit board inside of the Model 1088B. The following steps describe the procedure necessary for installing the resistor.

1. Disconnect the input power to the Model 1088B.
2. Using a T-25 torx driver (or a flat-blade screwdriver), remove the four screws securing the top cover of the instrument, and remove the cover.
3. Locate the Option 19 terminal strip assembly. Using a T-10 torx driver, remove the two screws holding the assembly to the main chassis.
4. Remove the three-wire connector from the header on the Option 19 circuit board. (Note: It will be necessary to perform step 3 prior to removing the connector, in order to allow clearance.)
5. Remove the entire Option 19 fault relay assembly from the Model 1088B.

6. The location for the optional resistor is shown on the circuit board as “R1”. Directly below this lettering on the board is a via (a plated-through hole connecting the two board layers). Using a number 60 (.040”) or larger drill bit, carefully enlarge the via to remove the plating, which will break the connection between the two layers. CAUTION: The via is the middle of three holes; be careful not to drill out either of the two outside holes.
7. Install a 100 ohm, 0.5 watt resistor (or the value of your choice) between the two outside holes, and solder into place.
8. Re-attach the connector to the Option 19 circuit board, using care to insure the proper polarity.
9. Install the Option 19 assembly back into the Model 1088B, and secure in place with the two mounting screws.
10. Replace the instrument top cover, and secure with the four T-25 screws.



Option 20A: Four Fiber Optic Outputs, Type ST 820 nm

PURPOSE

When installed into the standard Model 1093A/B/C, 1084A/B/C or 1088A/B, Option 20A provides four individually selectable fiber-optic outputs with Type ST connectors and 820nm transmitters compatible with multi-mode fiber.

SPECIFICATIONS

Each fiber-optic output is jumper-configurable to each of the standard *digital* (CMOS) signal outputs available on each clock model. Analog signals, IRIG-B Modulated, and ± 5v Recorder are not selectable.

Option 20A provides an optical power output of -15dBm minimum (-12dBm typical) into 62.5/125μm fiber.

The optical signal is ON whenever the selected logic signal is HI. Transmitter bandwidth is compatible with all available logic signals.

Option 20A may be installed in Slot A of Model 1084A/B/C and in either Slot A or B of the standard Model 1088A/B clock.

OUTPUT ENABLE (JMP1)

This jumper is used at the factory for setting the output enable for the optical transmitters. For normal operation, set jumper to position 'A'. With two clocks containing Option 18 and configured for redundant operation, this jumper may be set to position 'B', allowing the optical outputs to be externally paralleled and driven by the on-line clock. Normally, this jumper will be configured as required when delivered from the factory.

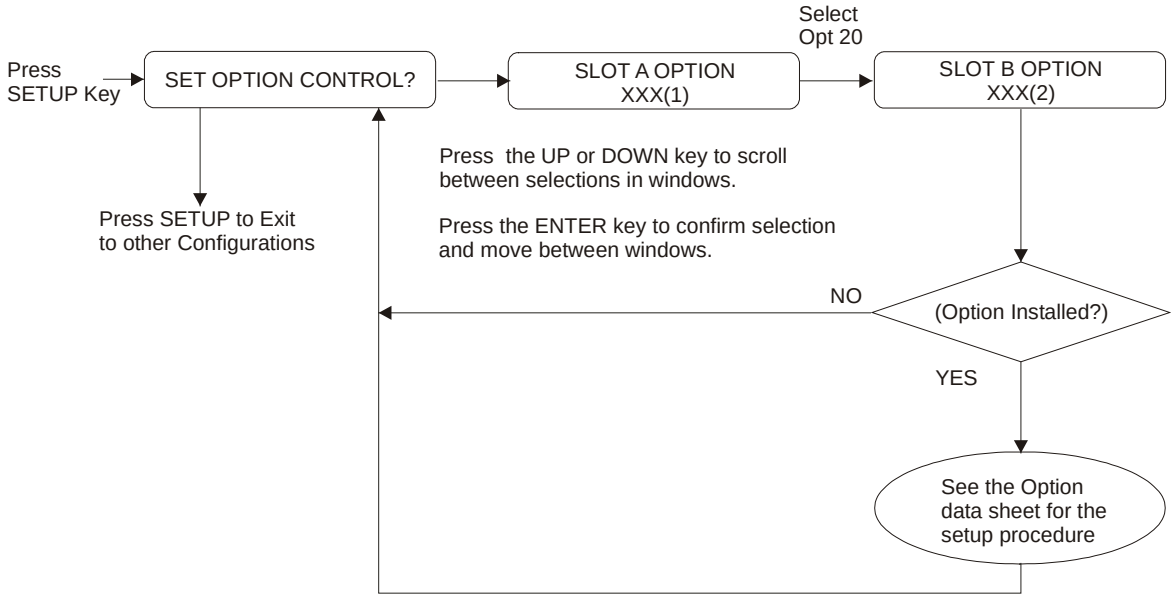
OUTPUT JUMPER CONFIGURATION (JMP2-JMP5).

The standard digital (CMOS) output signals can be selected for output via one of the fiber-optic output transmitters by setting jumpers JMP2 through JMP5 on the Fiber-Optic Option Board as illustrated in Figure 4-1.

The following tables provide a list of jumper to corresponding output transmitter and a list digital signals available for configuration to a fiber-optic output connector. The same signals are available via each jumper (JMP2 – JMP5) and corresponding setting.

Option 20A Firmware Setup

After installing the Option 20A option board in the clock, the clock firmware must be set to accept the specific option by number. Normally, the factory performs these configurations, however it may be necessary to reconfigure this option at a later date.



Notes:

(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 OR 28 (Options 10, 11, 13, 14 and 25 are no longer available).

(2) XXX = NONE, 4, 17, 17A, 18, 23, 27, 29 or 32 (Option 19 does not need any set up in firmware; 20A does not show up in Slot B list, but can be configured under NONE).

CONFIGURATIONS

Output Transmitter	Jumper	Pin	Signal	Notes
CR1	JMP2	1	IRIG-B	1, 2, 3
CR2	JMP3	2	IRIG-E	2, 3
CR3	JMP4	3	IRIG-H	2, 3
CR4	JMP5	4	10 MPPS	2, 3
		5	5 MPPS	2, 3
		6	1 MPPS	2, 3
		7	100 kPPS	2, 3
		8	10 kPPS	2, 3
		9	1 kPPS	2, 3
		10	100 PPS	2, 3
		11	60 PPS	2
		12	50 PPS	2
		13	10 PPS	2, 3
		14	1 PPM	2, 3
		15	1 PPH	2, 3
		16	1 PPS	1, 2, 3
		17	Programmable Pulse	1, 2, 3
		18	IRIG-B Modified Manchester (IEEE 1344)	1, 2, 3

Notes:
1. Signals available on the Model 1093A/B/C
2. Signals available on the Model 1088A/B
3. Signals available on the Model 1084A/B/C

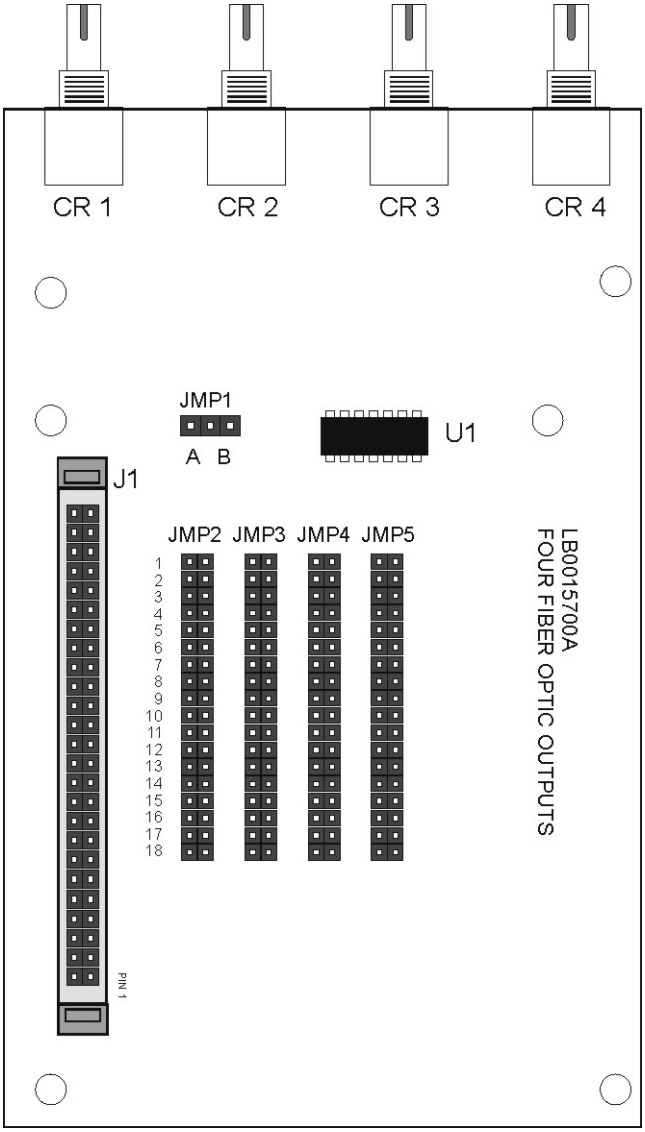


Figure 1. Option 20A Board, Physical Layout

Option 23: COMTRADE Sample Rate Generator

General Description

When equipped with the Option 23 COMTRADE Sample Rate Generator, the Satellite-Controlled Clock generates any one of the 48 standard sampling rates for waveform digitization in 50 or 60 Hz systems which are defined in IEEE Standard C37.111-1991, Data Exchange (COMTRADE) for Power Systems. Standard COMTRADE Sampling Rates are listed in Tables 1 and 2 (on following page).

The selected sample rate is available as a 5V CMOS-level square wave in both normal (rising edge of clock synchronous with 1PPS) and complemented (falling edge of clock synchronous with 1PPS) polarities. The sampling pulse is synchronized to within ±50ns of 1PPS, and has sample-to-sample jitter less than 1ns.

Principles of Operation

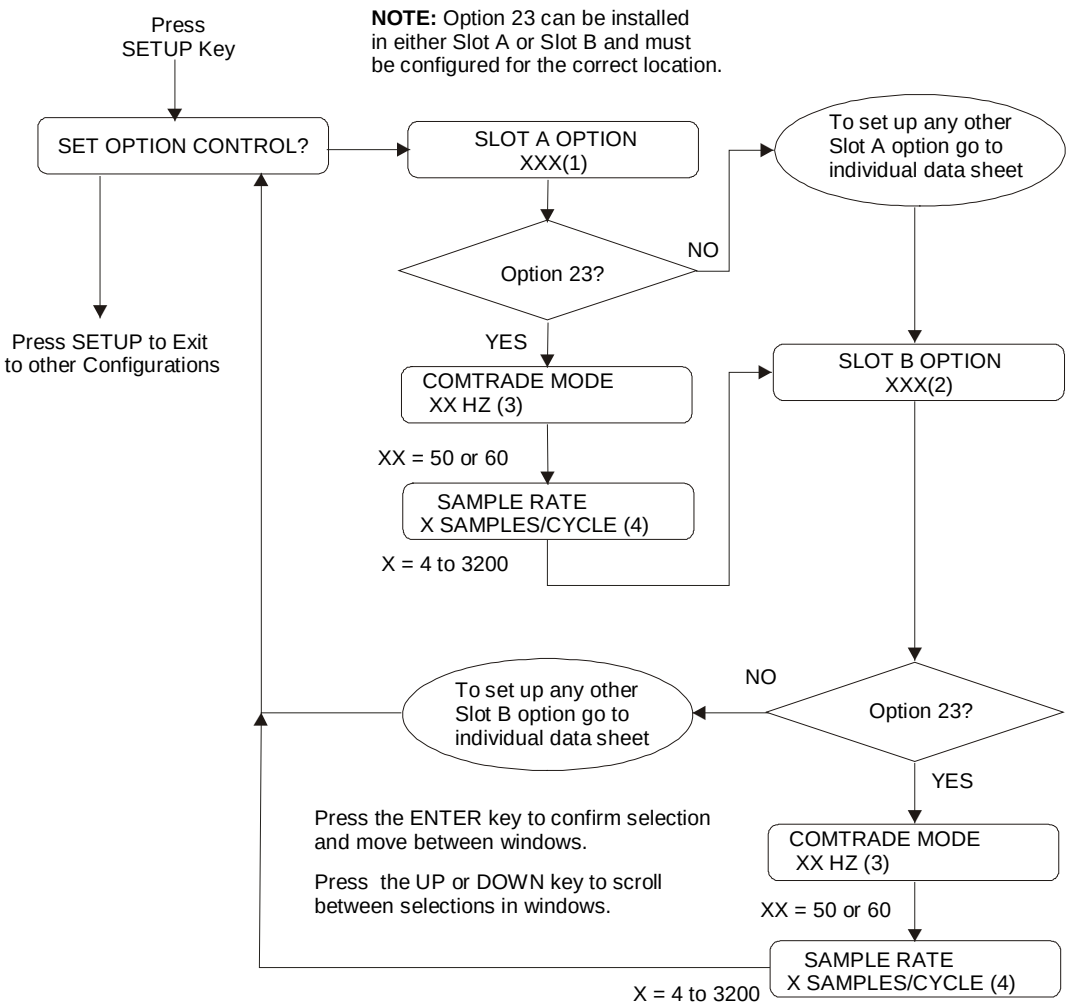
The Option 23 assembly generates sampling signals, which are precisely locked to 1PPS-GPS by phase locking a precision voltage-controlled crystal oscillator (VCXO) to the internal 1kPPS signal present in the clock. This VCXO output signal is then divided down to obtain the desired sampling rate. Synchronization logic is also provided, to ensure that the output divider is synchronized to 1PPS-GPS. By using a precision VCXO, pulse-to-pulse sampling jitter is held to an absolute minimum, and is specified not to exceed 1 ns rms. The output signals have a 50% duty cycle (square wave).

Other Features

The Option 23 assembly includes four configurable BNC outputs, which are in addition to those available for the standard model clock. Either normal or complemented-polarity COMTRADE sampling frequency signals may be made available at each of these additional outputs. Furthermore, any output not configured for a COMTRADE sampling rate output can be used as a general-purpose configurable output, and can deliver any of the 21 standard signals available in the Model 1088B or Model 1084A/B/C.

The Option 23 assembly may be installed in either Slot A or Slot B of the standard Model 1088B; if required, two assemblies may be installed into a single Model 1088B. The standard Model 1084A/B/C has only one option slot available (Slot B).

Option 23 Firmware Setup



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28 (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 3, 6, 17, 17A, 18, 23, 27, 29 or 32 (Option 20A does not appear but may be set up as NONE).
(3) XX = 50 or 60 Hz (system frequency).
(4) Sample Rates are: 4, 6, 8, 10, 12, 16, 20, 24, 32, 40, 48, 50, 64, 80, 96, 100, 128, 160, 192, 200, 320, 384 400, 640, 800, 1600, 3200

Figure 1. Option 23 Firmware Setup Flow Chart

Specifications

Sampling Rates

Table 1: Sample Rates, $f_{LCM} = 384 \times f_{base}$

Samples/cycle	f_S for 60 Hz	f_S for 50 Hz
384	23040	19200
192	11520	9600
128	7680	6400
96	5760	4800
64	3840	3200
48	2880	2400
32	1920	1600
24	1440	1200
16	960	800
12	720	600
8	480	400
6	360	300
4	240	200

Table 2: Sample Rates, $f_{LCM} = 3200 \times f_{base}$

Samples/Cycle	f_S for 60 Hz	f_S for 50 Hz
3200	192000	160000
1600	96000	80000
800	48000	40000
640	38400	32000
400	24000	20000
320	19200	16000
200	12000	10000
160	9600	8000
128	7680	6400
100	6000	5000
80	4800	4000
64	3840	3200
50	3000	2500
40	2400	2000
32	1920	1600
20	1200	1000
16	960	800
10	600	500
8	480	400
4	240	200

Performance

Accuracy: ± 50ns from 1PPS, max (-10ns, typical)

Jitter: 1ns rms, max. pulse to pulse (guaranteed by design, not production tested)

Outputs

Connectors: Four, BNC 50-ohm, configurable

Signals: Normal Polarity COMTRADE Sample Rate, 50% Duty Cycle

Complemented COMTRADE Sample Rate, 50% Duty Cycle

All 21 Other Signals Available in1088B or 1084A/B/C Clock

Drive Capability

Digital: 5V CMOS Buffer, 50 Ohms Impedance

Analog: Opamp Buffer, 600 Ohms Impedance

Setup

Setup Menu

The SETUP menu allows the user to modify internal operating firmware parameters within both the Model 1088A/B. The SETUP menu can be easily accessed from the front panel keyboard. The Option 23 SETUP menu is illustrated in Figure 1 for the Model 1088A/B. However, for clarity *only* Option 23 is described.

RS-232 Commands

Option 23 can also be configured via the RS-232C interface using one of the following commands:

m:r CA
m:r CB

Where:

m : 0 = 50 Hz
1 = 60 Hz
r : Table 1 or 2 SAMPLES/CYCLE number.
CA : Option Slot A (used with 1084A/B/C or 1088B)
CB : Option Slot B (used with 1088B only)

Changing Hardware Settings via Internal Jumpers

It is necessary to set a jumper in order to assign the output signal to a specific I/O connector. The following paragraphs describe the procedure for setting these jumpers.

Cover Removal

To change the I/O configuration of the rear-panel connectors, the top cover of the instrument must be removed. Turn off the instrument, and disconnect the power cord. Using a T-25 driver, remove the four screws holding the cover (and rack mount ears, if used) in place, and lift the cover off.

> **WARNING**: DO NOT REMOVE top cover while power is applied. Hazardous voltages are present while the power cord is connected. Always disconnect the unit from the input power source before removal of the top cover.

The Option 23 Comtrade Board is illustrated in Figure 2, which shows the location of all the jumpers, and a brief description of them given in Table 3.

Output Function Selection

Jumpers JMP1, JMP2, JMP3, and JMP4 determine the output signals, which can be made available at I/O connectors J2, J3, J4, and J5, respectively. Figure 2 illustrates the relationship between these jumpers and the I/O connectors. The first step in setting an I/O channel for a specific output signal is to move the associated jumper to the location corresponding to the desired signal. Table 3 lists the jumper settings required for various signals.

Output Mode Selection

The next step in configuring the I/O connectors is to determine whether the assigned signal is an analog output or a digital output. This selection is accomplished by setting jumpers JMP5, JMP6, JMP7, and JMP8 to the appropriate positions. These jumpers correspond to connectors J2, J3, J4, and J5, respectively (see Figure 2). If the I/O channel is to be used as a digital output, the corresponding jumper should be set to position ' A '. If the I/O channel is to be used as an analog output, the jumper should be set to position ' C '. Table 3 lists jumper positions for individual output signals.

Table 3. Output Signal Selection Jumper Settings

Output Signal	Output Function Jumper Position	Output Mode Jumper Position
IRIG-B Modulated 10Vpp	1	C
Deviation (±5 V)	2	C
IRIG-B	3	A
IRIG-E	4	A
IRIG-H	5	A
10 MPPS	6	A
5 MPPS	7	A
1 MPPS	8	A
100 kPPS	9	A
10 kPPS	10	A
1 kPPS	11	A
100 PPS	12	A
60 PPS	13	A
50 PPS	14	A
10 PPS	15	A
IRIG-D/1PPM	16	A
1 PPH	17	A
1 PPS	18	A
Programmable Pulse	19	A
Out-of-Lock	20	A
IRIG-B Modified Manchester	21	A
Normal Polarity COMTRADE	22	A
Complemented Polarity COMTRADE	23	A

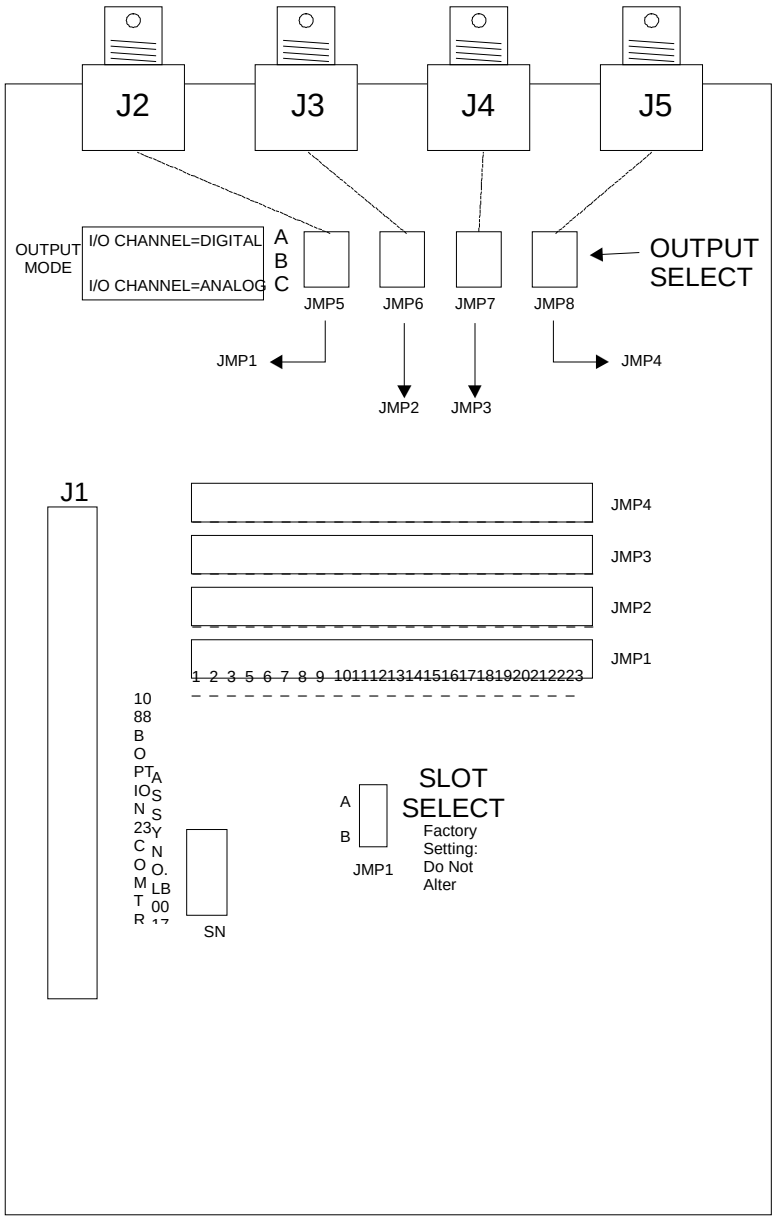


Figure 2. Option 23 Comtrade Board

Option 24: Extended BCD Output used with Option 28 - Obsolete

General Description

This document describes the Option 24, which is used in Option Slot B of the standard Model 1088B Satellite Clock. Option 24 provides extended BCD output via a 78-pin rear panel connector. A total of 74 output lines are provided, including Time-of-Year with 1-second resolution, 6 lines of Clock Status, and 38 lines which are normally used for Power System Frequency and Time Error with the Power System Phase, Frequency and Time Monitor (1088\28).

Hardware Installation

To install the Option 24 board, perform the following steps:

1. Set Line Power switch to OFF position. Disconnect power cord from rear-panel.
2. Remove rack-ears (if equipped) and remove top cover using a T-25 Torx driver (4 screws).
3. Install Option 24 board in Option Slot B of the clock (if not already installed) using the supplied M3 (metric) screws and a T10 Torx driver.
4. Connect the option board(s) to the main board with the supplied ribbon cable.
5. The connections to the Option 24 assembly are described in Option 24 Output. Signal and Pin assignment for the Option 24 Connector are listed in Table1.

Firmware Configuration

1. Apply power and observe front panel display, when 'CLOCK STATUS STARTUP' is displayed, press the SETUP key.
2. Navigate through the series of menu selections, using either the SETUP or UP key, until “SET OPTION BOARD?” appears.
3. Press ENTER, verify Option 28 is displayed and then press the ENTER key.
4. Press the UP key at the OPTION SLOT B prompt until Option 24 appears. Press ENTER to confirm the selection.
5. You will be given additional setup choices or UTC or Local Time and Time Quality Output (IEEE 1344 or TT FTM). Select the desired choices. When complete (if this is the first time these options have been activated), turn the clock OFF and back ON again to initialize the Option Boards.

After the boards have been installed and initialized, and the basic option setup (24) has not changed, modifications to the operating parameters (such as Time Quality format or UTC/Local time) may be made without re-initialization.

Output Signals

Option 24 provides four BCD digits of time and frequency deviation, with 0.001 Hz and 0.001 second resolution, in addition to time of year with one second resolution. Each output is a 5 V CMOS buffer output (74HC541 or equivalent). The output signals are available on a 78-pin female high-density D-subminiature connector (a mating connector is supplied) and listed in Table 1. Deviaiton data is updated ten times per second (10/sec). The following signal definitions apply to this output port:

T Sign	(Pin 12) HI for positive deviaiton, LO for negative.
F Sign	(Pin 11) HI for positive deviaiton, LO for negative.
T Overrange	(Pin 31) HI if greater than specified full range.
F Overrange	(Pin 30) HI if greater than specified full range.
T Data-Ready	(Pin 51) HI while data valid; drops while data updated.
F Data-Ready	(Pin 50) HI while data valid; drops while data updated.
1 PPS	(Pin 70) Positive-going pulse, on time; duration 10 ms.
Locked	(Pin 69) High when locked to satellites.
Time Quality	(Pins 9, 28, 48, 67) described below.

Table 1. Option 24 Connector Pinout and Signal List

Deviation Outputs

Signal	Pin	Signal	Pin	Signal	Pin
.001 Hz	20	1 Hz	17	.1 sec	14
.002 Hz	39	2 Hz	36	.2 sec	33
.004 Hz	59	4 Hz	56	.4 sec	53
.008 Hz	78	8 Hz	75	.8 sec	72
.01 Hz	19	.001 sec	16	1 sec	13
.02 Hz	38	.002 sec	35	2 sec	32
.04 Hz	58	.004 sec	55	4 sec	52
.08 Hz	77	.008 sec	74	8 sec	71
.1 Hz	18	.01 sec	15	ΔT Sign	12
.2 Hz	37	.02 sec	34	ΔF Sign	11
.4 Hz	57	.04 sec	54		
.8 Hz	76	.08 sec	73		

Time of Day Outputs

1 sec	1	8 min	42	1 day	6
2 sec	21	10 min	62	2 day	26
4 sec	40	20 min	4	4 day	45
8 sec	60	40 min	24	8 day	64
10 sec	2	1 hr	43	10 day	7
20 sec	22	2 hr	63	20 day	27
40 sec	41	4 hr	5	40 day	46
1 min	61	8 hr	25	80 day	66
2 min	3	10 hr	44	100 day	8
4 min	23	20 hr	64	200 day	47

Status and Ground Signals

ΔF Overrange	30	TQ0	9	Locked	69
ΔF Data Ready	50	TQ1	28	1 PPS	70
ΔT Overrange	31	TQ2	48	Ground	10,29
ΔT Data Ready	51	TQ3	67	Ground	49, 68

Time Quality Indicator

Using the SET OPTION menu, this output may be configured to either of two operating modes. The IEEE-1344 mode follows the Time Quality Code established in the 1344 standard, and is described below. The TT FTM mode is intended for compatibility with applications currently using the TrueTime FTM monitor, and provides four lines which are LO when locked to satellites, and go HI in turn as various levels of error are potentially exceeded: pin 48, 50 ms; and pin 67, 500 ms.

IEEE Time Quality Indicator Definition

Pin 9 corresponds to the LSB of this code, followed by pin 28, pin 48, and pin 67, MSB. 'Potential error,' used below, means the worst-case upper bound of the time error relative to UTC, including all sources of local timebase error.

Code	Condition
0000	Locked; maximum accuracy
0100	Potential error < 1 μs
0101	Potential error < 10 μs
0110	Potential error < 100 μs
0111	Potential error < 1 ms
1000	Potential error < 10 ms
1001	Potential error < 100 ms
1010	Potential error < 1 s
1011	Potential error < 10 s
1111	Clock Failed; time unreliable

Option 27: 8-Channel High Drive

General Description

Option 27 provides eight independent, IRIG-B buffered outputs, each capable of driving multiple loads. Outputs are short circuit and surge protected. Each output is individually configurable for either modulated or unmodulated IRIG-B signals via jumper settings as illustrated in Figure 1. Option 27 uses Option Slot B (Model 1088B).

Specifications

Output Selection

Each output is jumper selectable for either a Modulated or Unmodulated signal. See Figure 1 for jumper locations and configuration settings.

Number of Channels: Eight (8).

Signal Levels:

Modulated:	4.5 Vpp with 20-Ω source impedance; each channel will drive a 50-Ω load to 3 Vpp minimum; requires Option 92 in Model 1093A/B/C
Unmodulated:	+5-V open-circuit; +4 V minimum at 250-mA load current; each channel will drive 25 Schweitzer SEL-3xx (in parallel) or 50 SEL-2xx (in series/parallel) relays at 10 mA per relay.

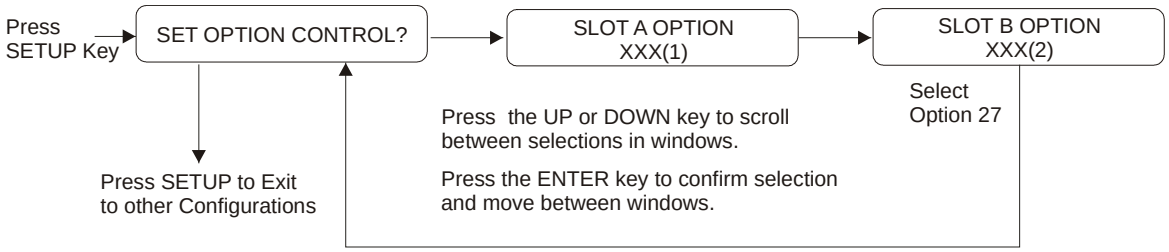
Maximum Load (per driver):

Modulated:	No Limit: will drive a short circuit.
Unmodulated:	250-mA peak current; pulse-by-pulse shutdown if load current exceeds internal limit (self-resetting).

Output Connector

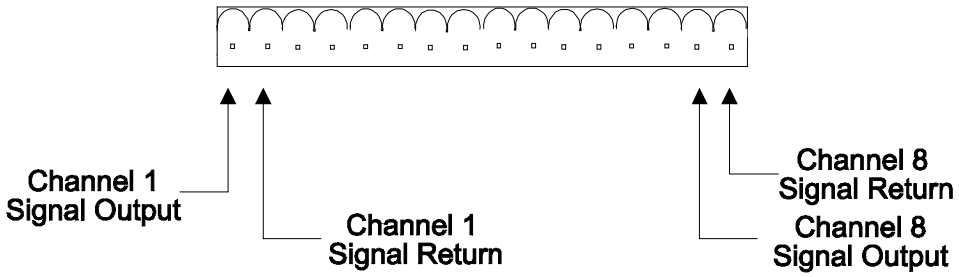
16-position pluggable 5-mm (Phoenix-type) terminal strip with eight 2-position mating connectors.

Option 27 Firmware Setup



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28 (Options 10, 11, 13, 14 or 25 are no longer available).
(2) XXX = 3, 6, 17, 17A, 18, 23, 27, 28, 29 or 32 (Option 20A does not appear in list, but can be configured as NONE)..

Option 27 Board, rear view



16-position I/O Connector with eight 2-position mating connectors.

Option 27 Board, top view

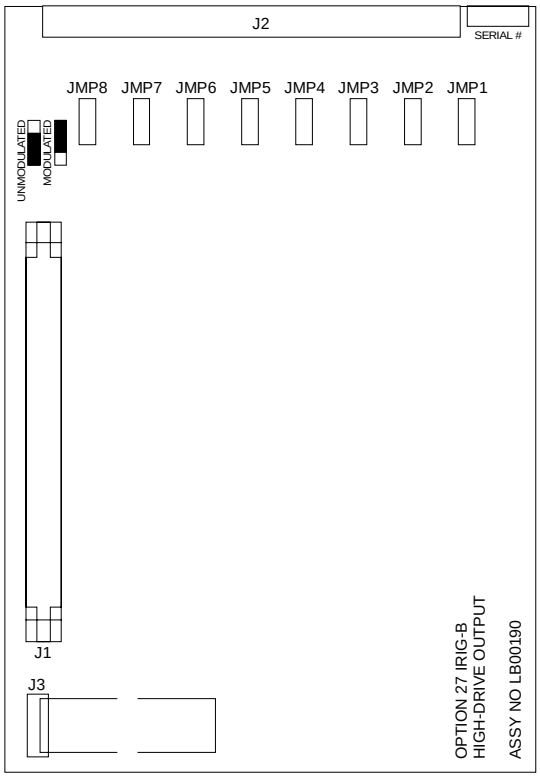


Figure 1. Option 27 Board

Option 28: Power System Time, Frequency and Phase Monitor

General Description

This document describes Option 28 Power System Time, Frequency, and Phase Monitor, which is used in the Arbiter Systems line of standard Satellite-Controlled Clocks. *Option 28 may only be mounted in option Slot A.*

Discussion

Option 28 provides the clock with the ability to accept either a 50Hz or 60Hz, 30-300 Vrms input signal and measure the instantaneous phase, magnitude and frequency of the fundamental component while rejecting the effects of harmonics, noise and DC offsets. This option also integrates total time deviation, which is system time minus GPS time. Measurement results may be output via the rear-panel RS-232 connector or displayed on the front panel.

To determine phase shift across a transmission line, the measured phase angles from two units placed at the ends of the line are subtracted and normalized into the range of 0-360 (or ±180) degrees. By subtracting the two measurements of absolute phase, which are measured using the same (GPS time) reference, the reference cancels leaving the phase angle between the two units: A-B = (A-R) - (B-R).

System Reference Connection

To connect the Option 28 board to the system reference input perform the following steps:

1. Connect System Reference (50 or 60 Hz signal) input to the Option 28 assembly, using the 6m (20 ft.) length of twinaxial cable provided. Strip the unterminated end of this cable and prepare it as required for termination to your System Reference signal. Do not connect the shield of the cable at the reference input end.

> **NOTE:** The supplied cable is terminated at one end with a twin-BNC connector which mates with the system reference input of the Option 28 board.

2. Attach this cable to the Option 28 System Reference input. Hold the cable connector by its body (not by the rotating locking ring) and rotate it inside the twin-BNC connector until you feel it begin to mate with the twin-BNC input of the Option 28 assembly. Once the connectors begin to mate, then use the locking ring to secure the connectors together.

> **CAUTION:** The twin-BNC connector, unlike a standard BNC connector, will only mate properly in one orientation, and any attempt to force the connector into position with the locking ring when it is improperly oriented (as may be done with standard BNC connectors) will not work, and may damage the connector.

Firmware Configuration

Apply power and observe front panel display, when 'CLOCK STATUS STARTUP' is displayed, press the SETUP key.

Navigate through the series of menu selections, using either the DOWN, UP or SETUP key, until SET OPTION BOARD? appears.

Press ENTER, and then press the UP key until Option 28 is displayed. Press ENTER.

You will be given additional setup choices for Option 28; Set System Time Dev?, Set UTC/Local Time, Set 50/60 Hz Input, and Return to Main Menu. Select the desired choices. When complete (if this is the first time these options have been activated), turn the clock OFF and back ON again to initialize the Option Boards.

Modifications to the operating parameters (such as Time Quality format or UTC/Local time) may be made without re-initialization after the board has been installed and initialized. If the basic option setup has changed then reinitialization may be necessary.

View the deviations on the front panel display as follows:

1. To view Channel C, press the EVENT/DEVIATION key and observe the following display on the front panel:

   System Input 114.91 V
   Phase 359.60 º

2. Press the EVENT/DEVIATION key again and the following is displayed:

   System ΔF -0.0010 Hz
   ΔT +0.0000 Sec

3. Press the EVENT/DEVIATION key again and the following is displayed:

   System Frq 59.993 Hz
   Time 19:39:25.4327

> **NOTE:** Selection of Option 28 results in the deactivation of the Event front panel displays. The event displays may be re-enabled if desired, by entering the SET EVENT/DEVIATION menu and following the procedure below. This choice is only available when Option 28 is installed in the unit.

4. Use the SETUP key and access the SET EVENT DEVIATION ? setup menu. Press ENTER. The following is displayed:

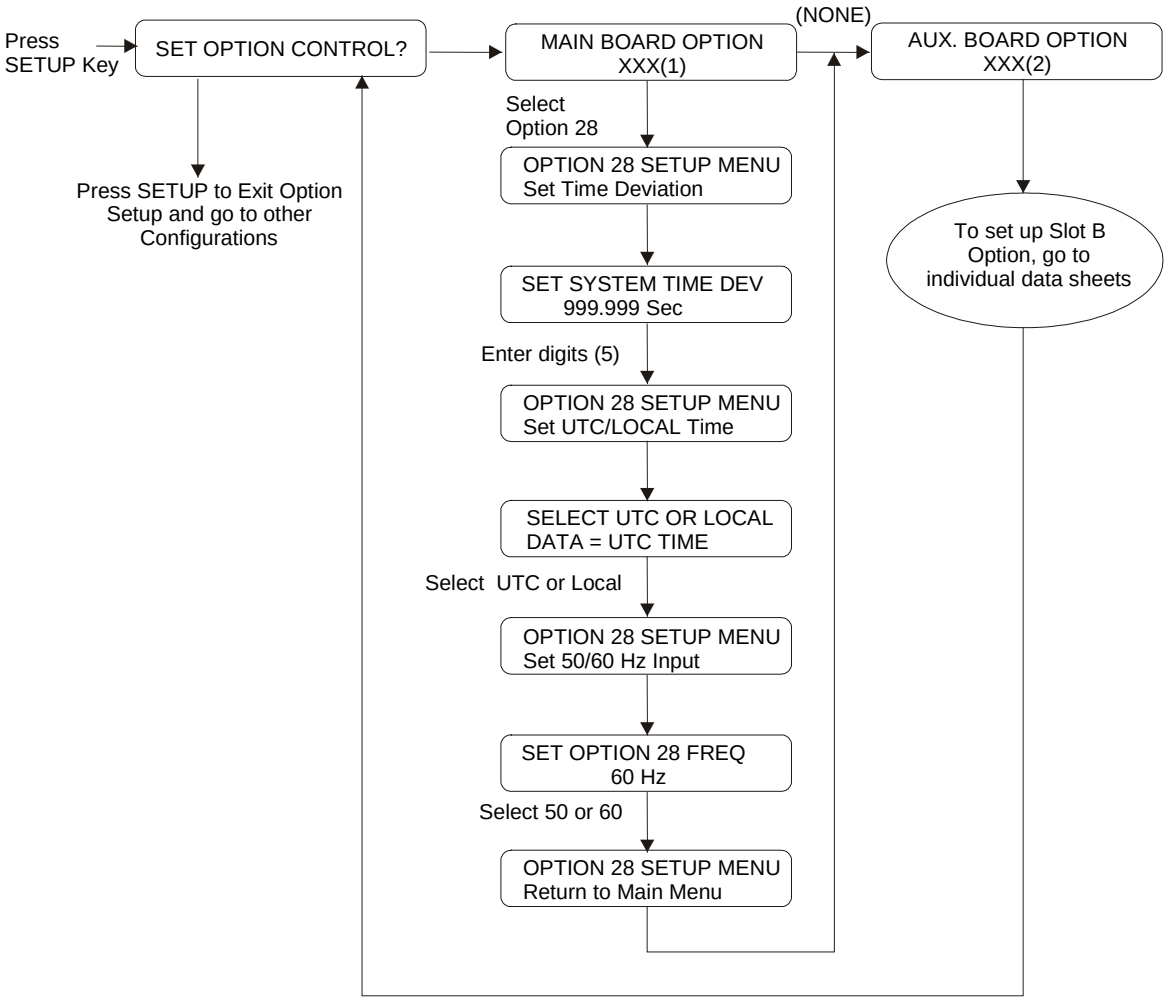
   DISPLAY OPT 28 ONLY?
   UP = YES DOWN = NO

5. To view Option 28 only, press the UP key, then press the front panel key EVENT/DEVIATION to display Option 28 deviations.

6. To enable Event/Deviation A and B displays as well, press the DOWN key and configure the Channel Mode, Time, and Recorder Channel. Then press the front-panel key

7. EVENT/DEVIATION to sequentially display all three channels. For a detailed description, refer to Section 4 of the Operation Manual.

Option 28 Firmware Flow Chart



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28 (Option 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 3, 6, 17, 17A, 18, 23, 27, 29 or 32 (Option 20A does not appear in list, but may be configured as NONE).
(3) Press the UP or DOWN key to scroll between selections in windows.
(4) Press the ENTER key to confirm selection and move between windows.
(5) To move right or left (with digits), use ENTER and SETUP after pressing the UP or DOWN key.
(6) To change digits, use the UP and DOWN keys.

Calibration

The clock is now configured for operation. Calibration for phase and amplitude may be further performed, if necessary, but will not be necessary for most applications. Specifically, these calibrations have no effect on system time and frequency measurements, and are unnecessary if only time and frequency are required.

Uncalibrated phase accuracy is usually less than 0.3 degree, and can be reduced to 0.1 degree typical and 0.2 degree guaranteed with calibration. Uncalibrated amplitude accuracy is usually less than 1%, which is the typical performance of this measurement. Amplitude accuracy is not guaranteed, and amplitude measurements are provided primarily to verify that the unit is properly connected and receiving the expected signal level.

Phase Calibration

Phase calibration has been performed at the factory, and the calibration factor (which must be entered into the clock non-volatile memory for it to be effective) is supplied with the assembly. Entering this factor into the clock requires connecting the clock to a computer or terminal via the RS-232 interface (see clock manual). For the computer, use a terminal-emulation program such as Procomm or Windows Terminal. Send the character 'V' to the clock to check that connections and port settings are correct. The clock should respond with the firmware dates in the format '01 Jan 1997 Op28 02 Jan 1997'.

To send the phase calibration factor to the clock, key in the message:

dd.dd,1084PC or ***dd.dd,1088PC*** or ***dd.dd,1093PC***

where ***dd.dd*** is the calibration factor in degrees, for example '-0.16'; and 1084, 1093 or 1088 is the clock model number (a security key to prevent unintentional modification):

-0.16,1084PC.

Amplitude Calibration

For amplitude calibration, the format is similar, replacing 'PC' with 'RV'. The calibration factor (supplied with boards having a serial number with prefix greater than 97420) is approximately 1.0, and is multiplied by the measured result to generate the displayed value. If an accurate ac source at 50 or 60 Hz is available (for example, the Arbiter Systems, Inc. Model 1040C Panel Meter Calibrator), the error (for boards with prefix 97420) can be measured and the correction factor entered as described. For example, if 120 Vrms is applied to the Option 28 assembly, and the display indicates 119.1 Vrms, the calibration factor is (120.0 / 119.1) or 1.0076. You would enter '***1.0076,1084RV***' to calibrate the unit (model 1084B/C). The display should then read close to 120.0 Vrms. To clear the calibration factor, you may set the unit to factory defaults or send the command '***1,1088RV***'. Again, use either 1084, 1093 or 1088 to match the clock model number.

Appendix A. RS-232 Commands

The following symbols and syntax are used throughout the RS-232 Commands listing and are repeated here for emphasis:

↵	Shorthand for <CR><LF>.
'A'	Channel A.
'B'	Channel B.
'U'	UTC Time, Channel A (or B).
'L'	Local Time, Channel A (or B).

Thirteen (13) new RS-232 commands are available with Option 28. The following conventions apply to all RS-232 communications:

- Phase angle, in all messages, is defined as zero (or 360) for the positive-going zero crossing coincident with 1PPS-GPS, and is scaled between zero and 360 degrees. Phase angle increases with frequency below nominal (50 or 60 Hz) and decreases with frequency above nominal; in other words, if the zero crossing occurs just after 1PPS-GPS, the phase angle will be just above zero, and if the zero crossing occurs just prior to 1PPS-GPS, phase angle will be just under 360.
- Time deviation decreases (becomes more negative) with frequency below nominal, and increases (becomes more positive) with frequency above nominal.

Option 28 RS-232 Commands

FS	System Frequency	Returns Option 28 System Frequency. *Response*: SS ff.fff↵ *Where:* SS = UTC seconds ff.fff = Frequency
FD	System Frequency Deviation	Returns the System Frequency Deviation *Response*: SS±f.fff↵ *Where*: SS = UTC seconds f.fff = frequency deviation
PS	System Phase	Returns the System Phase. *Response*: SS ppp.pp↵ *Where*: SS = UTC seconds ppp.pp = phase, 0 to 360 degrees
TD	System Time Deviation	Returns System Time deviation. *Response:* SS±tt.tttt↵ Where: SS = UTC seconds tt.tttt = time deviation
TS	System Time	Returns Option 28 System Time. *Response:* MM DD YYYY hh:mm:ss.ssss SS↵ *Where:* 'MM' Month 'DD' day of year 'YYYY' year 'hh' hour 'mm' minutes 'ss.ssss' seconds 'SS' UTC Seconds
SU	Option 28 SystemTime, UTC	Sets Option 28 to reflect System time in UTC format.
SL	Option 28 Time, Local	Sets Option 28 to reflect System time in Local format.

SM	System Status	Returns Option 28 System Status. *Where:* 0 = System OK 1 = No System Reference 2 = System okay now but reference lost since last request.
B2 (or) O2	Broadcast Mode-Vorne Optional RS-232 Broadcast Mode Vorne	Configure RS-232 Broadcast Mode to support Vorne large format time displays. Refer to Arbiter Systems Application Note 103 for more information. *Response (1/sec; number and order of strings returned depends upon options ordered with clock):* 11nn↵ (out-of-lock time) 22±ff.fff↵ (frequency error)* 33±s.ss↵ (time error)* 44hhmmss↵ (UTC/local time) 55ddd↵ (day of year) 66hhmmss↵ (system time)* 77nn.nnn↵ (system frequency)* 88nnn.nn↵ (system phase)* <BEL> <BEL> = hex 07. Data is transmitted *ahead-of-time*, and the <BEL> character is transmitted *on-time*. When properly configured, the Vorne displays update simultaneously upon receipt of the <BEL> character. The decimal points shown above are not actually transmitted in the data stream, but their position is implied as shown here. The displays are configured to show the decimal point in this position. *This field is transmitted when the clock is equipped with Option 28.*
B7 (or) O7	Broadcast Mode, 1/sec ASCII Optional RS-232 Broadcast Mode, 1/sec ASCII	Configure RS-232C Broadcast Mode to send Time, Frequency, and Phase Deviation 1/sec in ASCII format. *Response:* Broadcast Mode, UTC: mm/dd/yyyy hh:mm:ssU ss +f.ffff +t.tttt ppp.ppp vvv.vv↵ Broadcast Mode, Local: mm/dd/yyyy hh:mm:ssL ss +f.ffff +t.tttt ppp.ppp vvv.vv↵ Where: mm/dd/yyy = Date hh:mm:ssU = Time of Day, UTC, or hh:mm:ssL = Time of Day, Local ss = Status, first character is reference (0:Locked, 1: Unlocked), Second Character is Clock status per IEEE 1344 +f.ffff = Signed Frequency Error in Hz. +t.tttt = Signed Time Deviation in Seconds ppp.pp = Phase Angle, 0 to 360 degrees. vvv.vv = Line Voltage, rms Volts

(-)s.fsRD	Set Deviation	Sets the System Deviation. *Where:* s = 0 to +/- 2000 seconds fs = fractional seconds.
p:kPC	Set Phase Calibration	Sets the Phase Calibration Offset. *Where:* p = Phase Offset in degrees. k = Security Key (i.e. 1088). Phase Offset is stored in protected RAM.
v:kRV	Set Amplitude correction	Sets the Amplitude Calibration Offset. *Where:* v = Voltage correction 'per unit' with 1.000000 equal to no correction. k = Security Key (i.e. 1088).
nPD	Send Time, Freq, Phase Deviation with UTC Time	Returns Time, Frequency, Phase Deviation with UTC time reference. *Response:* n=0 mm/dd/yyyy hh:mm:ssU ss +f.ffff +t.tttt ppp.pp vvv.vv↵ or n=1 mm/dd/yyyy hh:mm:ssL ss +f.ffff +t.tttt ppp.pp vvv.vv↵ *Where:* mm/dd/yyyy = Date hh:mm:ssU = Time of Day, UTC or hh:mm:ssL = Time of Day, Local ss = Status; first character is Reference Status: 0 : Locked; 1 : Unlocked; second character is Clock Status per IEEE P1344. +f.ffff = Signed Frequency Error in Hz. +t.tttt = Signed Time Deviation in seconds. Ppp.pp = Phase Angle, 0 to 360 degrees. vvv.vv = Line voltage, rms Volts

Option 29: Four Additional Outputs with Dry Contact and +25/50 Vdc

General Description

This document describes Option 29: Four Additional Outputs With Dry Contact and +25/50 VDC; which may be used in the Arbiter Systems Models 1084A/B/C, 1088B, and 1093A/B/C GPS Satellite-Controlled Clocks. Option 29 includes six configurable outputs. Four are standard, 5V CMOS outputs; two are Aromat AQV210E solid-state relays (SSRs). A +25 or +50VDC supply is available on-board and may be switched by the SSR outputs.

Specifications

General

Output Connector:	16-position, 5mm Pluggable Terminal Strip. Four 2-position and two 4-position mating connectors provided. The connectors accept wire sizes of 0.25 to 2.5 mm^2 (AWG 12 to 22). See Table 2 and Figure 2 for Connector Configuration.

Digital Outputs

Output Quantity:	4
Output Type:	5V CMOS, individually configurable.
Output Rating:	+5V open-circuit, nominal, 75mA peak current, per channel, +3.5V typical at 75mA peak current
Available Output Signals:	Jumper selectable to any of the digital signals available from the clock mainframe plus on board generation of 1PPM and 1PPH for the 1093 clock models. See Figure 1 for Jumper location and selections.

Solid State Relay Output

Output Quantity:	2
Output Type:	Aromat AQV210E solid-state relays, 130mA AC or DC at 350V peak.
Output Rating:	Limited to 100mA DC, 140Vrms / 180V peak by the fuse and surge suppression devices.
Output timing:	Propagation Delay, 90µs Nominal, to 50%. Rise Time, 50µs Nominal, 20-80%.

Solid-State Relay Output continued

Output Power Supply: Individually configurable for 0, +25, or +50VDC.

Available Output Signals: 1PPM, 1PPH, 1PPS, Programmable Pulse, Locked/Out of lock.

Pulse Width: Individually configurable for a fixed, 50ms pulse or the default width of pulse provided by the clock mainframe.

Available Output Configurations:
1. Dry contact closure
2. Contact closure to ground
3. +25/50VDC switched for grounded load
4. +25/50VDC with contact closure to ground for non-grounded load

See Table 1: Operating Modes of SSR Outputs.

Table 1: Operating Modes of SSR Outputs

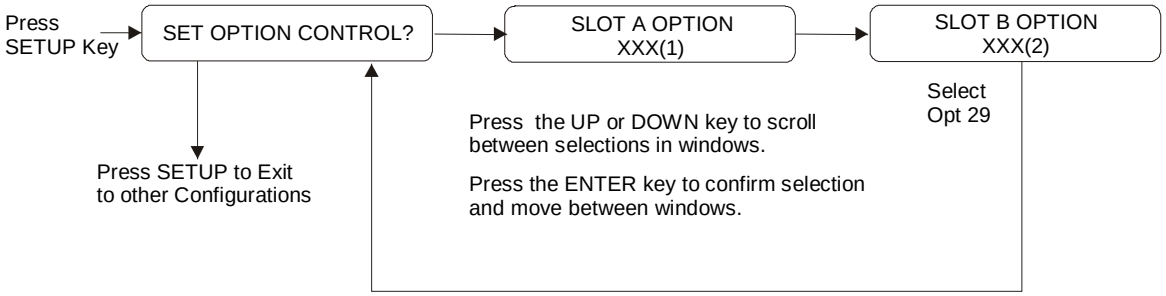
Mode	SSR Output 1	SSR Output 2
Dry Contact Closure	Connect load to pins 10 & 11 (polarity not important)	Connect load to pins 14 & 15 (polarity not important)
Contact Closure to Ground	Short pins 9 & 10, connect load to pin 11	Short pins 13 & 14, connect load to pin 15
+25/50VDC Switched to Grounded Load	Short pins 11 & 12, connect load to pins 9 (-) & 10 (+)	Short pins 15 & 16, connect load to pins 13 (-) & 14 (+)
+25/50VDC Switched to Floating Load	Short pins 9 & 10, connect load to pins 11 (-) & 12 (+)	Short pins 13 & 14, connect load to pins 15 (-) & 16 (+)

Table 2: Output Connectors and Setup Jumpers

Pin	Function	
1 (Rightmost)	CMOS Output 1	JMP4: Signal Select – Default = 1PPH
2	Ground	-
3	CMOS Output 2	JMP3: Signal Select – Default = 1PPM
4	Ground	-
5	CMOS Output 3	JMP2: Signal Select – Default = Prog. Pulse
6	Ground	-
7	CMOS Output 4	JMP1: Signal Select – Default = IRIG-B
8	Ground	-
9	Ground	-
10	SSR Output 1	JMP5: Signal Select – Default = 1PPM
11	SSR Output 1	JMP7: Standard/50ms – Default = 50ms
12	+25/50VDC 1	JMP10: +25/50VDC – Default = 50VDC
13	Ground	-
14	SSR Output 2	JMP6: Signal Select – Default = 1PPM
15	SSR Output 2	JMP8: Standard/50ms – Default = 50ms
16 (Leftmost)	+25/50VDC 2	JMP11: +25/50VDC – Default = 50VDC

Firmware Configuration

1. It is necessary to verify the configuration in the Option Setup Menu so Option 29 is recognized.
2. Apply power and observe the front panel display, when 'CLOCK STATUS STARTUP' is displayed, press the SETUP key.
3. Press SETUP (or SETUP and UP or DOWN), until reaching “SET OPTION BOARD?”. Option 29 must be set up as a SLOT B OPTION (see flow chart below).
4. Press ENTER, and then press the UP key until reaching Option 29. Press ENTER. Remember that the Option 29 is located in Option Slot B of the Model 1088B.
5. Press SETUP to exit from the SET OPTION BOARD configuration.



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28 (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 4, 17, 17A, 18 , 23, 27, 29 or 32.

Output Jumper Setting Changes

1. Set Line Power switch to OFF position (if equipped). Disconnect the power cord from rear-panel.
2. Remove rack-ears (if equipped) and remove top cover using a T-25 Torx driver (4 screws).
3. Locate the appropriate Jumper using Figure 1 and move the jumper to the desired setting.
4. Replace the top cover and rack-ears (if equipped).
5. Connect the power cord to the rear-panel and set the Line Power switch to ON position (if equipped).

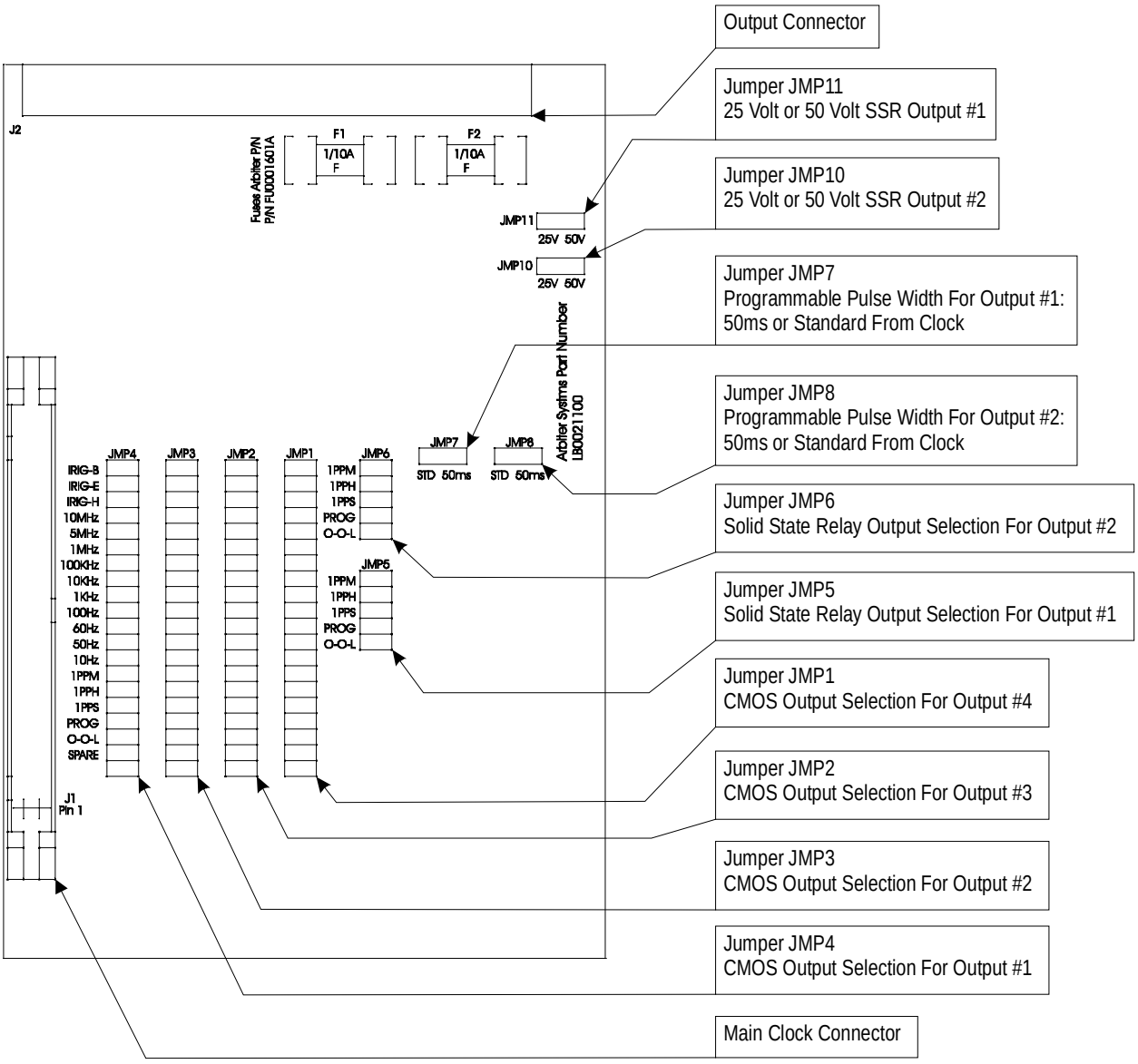


Figure 1. Option 29 Jumper Locations and Functions

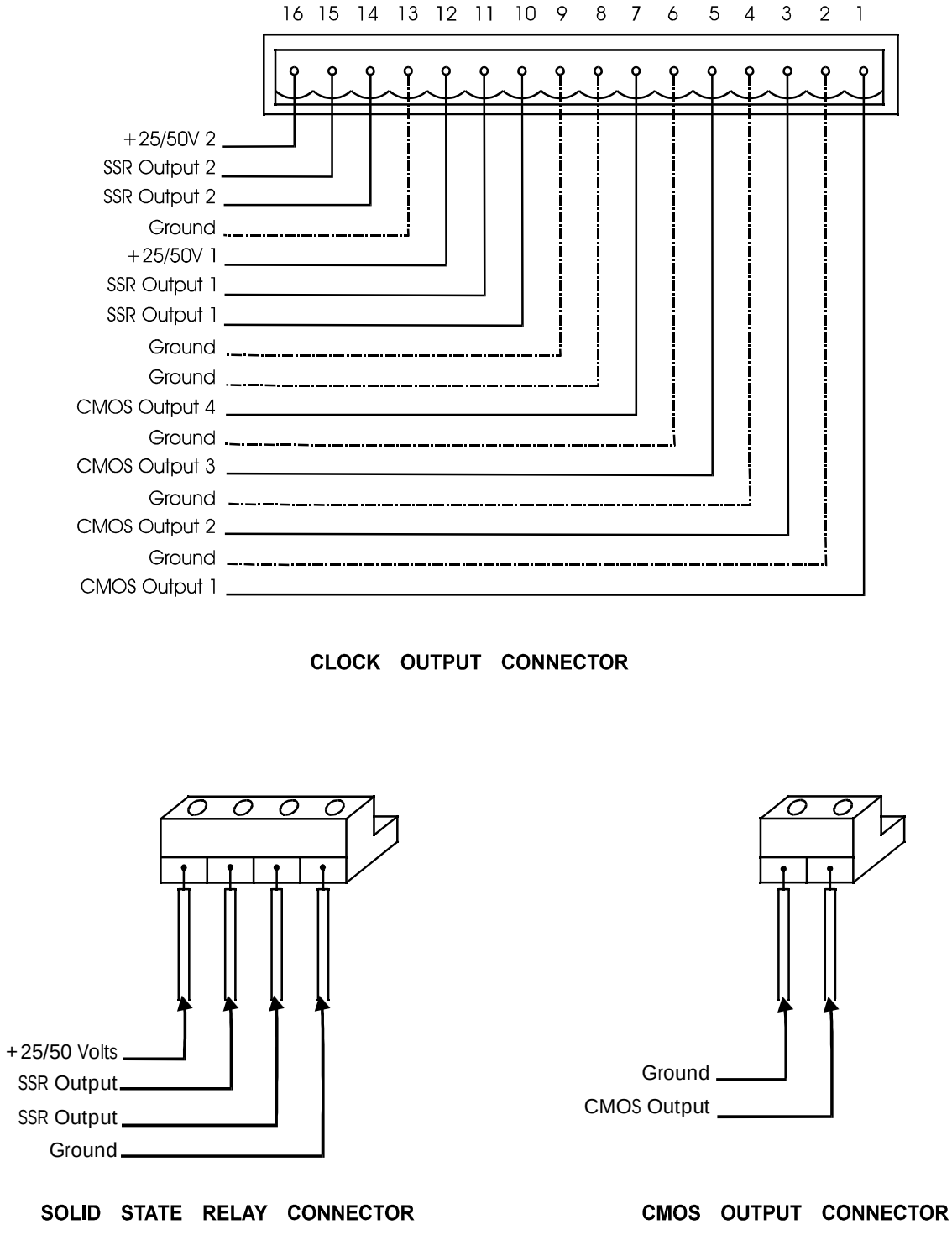


Figure 2. Option 29 Output and Output Mating Connector Details

Option 32: Internal Network Time Protocol Server

General Description

Option 32: Internal Network Time Protocol (NTP) Server, is used in the Arbiter Systems line of 19" rack mount Satellite-Controlled Clocks. *It mounts in Option Slot B only*.

Option 32

Option 32 allows the clock to act as time server over an ethernet network using the network time protocol operating in server mode - symmetric operation modes are not supported. Time is distributed over the network interface to computers, controllers and other equipment needing the correct time. Option 32 understands NTP Version 1, Version 2, and Version 3 frames, and optionally supports authentication via DES and MD5 cryptographic checksums. If authentication is not used, the controller can typically be used for hundreds of clients without overloading it. Authentication requires typically 40ms for checking and generating the cryptograms, which is covered and averaged out by the protocol. Option 32 supports full SNTP and all NTP functions required for reliable server operation. Functions not required for server operation are not implemented.

Hardware Configuration

Option 32 consists of two building blocks; an OEM NTP module and an interface to the GPS clock. The NTP Server (Option 32) is connected to the main board via the standard 50 pin option cable. The NTP Server has two external connectors, an RS-232 (DB-9 male) and a 10 Base-T (RJ 45). In addition to the connectors there are three status LED's on the rear Panel. See figure 1.

External Connectors

The RS-232 connector can be used to interrogate the clock or to configure the NTP module depending on the jumper settings (see section 2.3 Jumper Settings). The port parameters are set to 9600, N, 8, 1. This RS-232 port is not operational during normal use. The ethernet port is used to distribute time and can also be used to configure the NTP module.

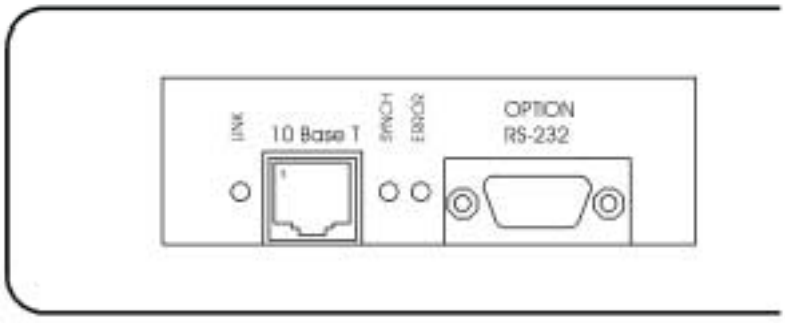


Figure 1: Option 32 Rear Panel

RS-232

The RS-232 port uses a 9 pin d-sub connector. This connector is configured as a DTE device with the following pin out:

Transmit (TXD)	Pin 2
Receive (RXD)	Pin 3
Ground (GND)	Pin 5

10 Base-T

Option 32 uses the standard 10 base-T connection for connecting to an ethernet. Figure 1 indicates the location of pin 1.

Txd +	Pin 1
Txd -	Pin 2
Rxd +	Pin 3
Rxd-	Pin 6

Status LED's

There are three status LED's on the rear panel of Option 32. The LED's are Link (green), Synch (green) and Error (red). Option 32 will perform an initial self test when powered on. After the initial self-test phase, where all status LEDs should be lit, the LED's indicate the status of the NTP Server.

Link LED

Link (green) LED on: ethernet 10 base-T connection is good.

Synch LED

Synch (green) LED on: synchronized to the time signal, correct reception of time data, requires the satellite controlled clock to be synchronized.

Synch LED flashing 50% duty cycle: Some information received, but not yet synchronized reliably.

Error LED

If the Error LED is on or blinking the Synch LED will give a diagnostics code.

Error (red) LED stable on , Synch (green) LED flashing

1x: EPROM-checksum error

2x: RAM-error

3x: Network controller error

4x: E²PROM checksum error or bad

5x: IP address already used on network

Error LED flashing, Synch LED flashing

4x: Faulty network connection

5x: No DHCP response was received

Jumper Settings

There are three jumpers on Option 32. Jumpers 1 and 2 (JMP1 and JMP2 on figure 2) control the serial port. When JMP1 and JMP2 are in position A (top), Option 32 will operate as an NTP Server. Setting JMP1 and JMP2 to the B (middle) allows the clock to be interrogated. Both JMP1 and JMP2 must be placed in position C (bottom) to configure the NTP module via the RS-232 port. Jumper 3 (JMP3) is set according to clock model.

Table 1: JMP1 and JMP2 Settings.

Position	Function
A	Clock connected to the NTP module (default)
B	Clock connected to the external RS-232 port *
C	NTP module connected to the external RS-232 port.

*The clock must be configured for the second RS-232 Option 17A (Model 1088B) to allow bi-directional communication.

JMP1 and JMP2 should be in the same position and are required to be in position A for normal operation of Option 32.

Table 2: JMP 3 Settings.

Position	Function
A	For installation in the Model 1088B
B	For installation in the Model 1084A/B/C or Model 1093A/B/C

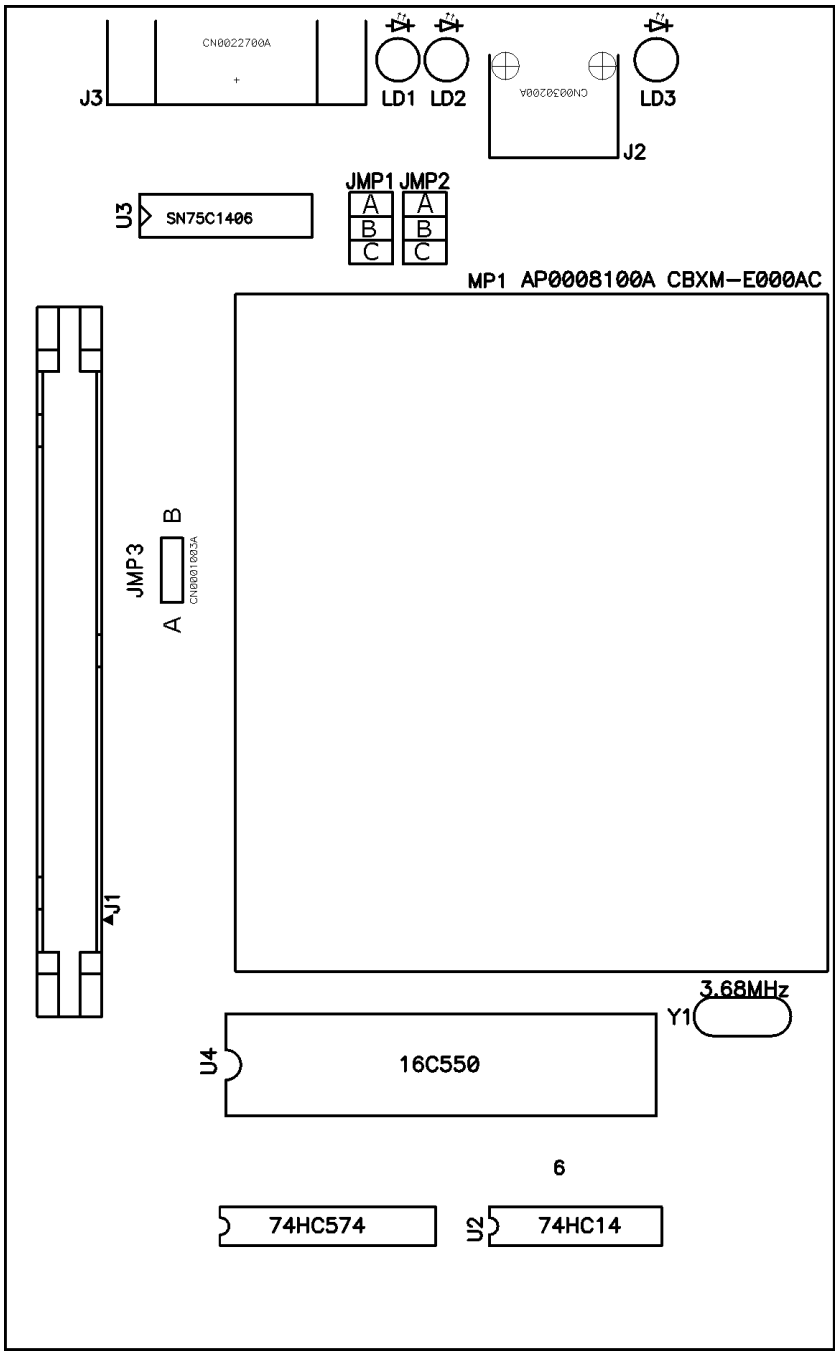


Figure 2: Jumper Locations.

Firmware Configuration.

Firmware configuration for the Option 32 is performed in two parts: the first part involves setting the correct option number via the front panel; next requires configuring the ethernet port via the option RS-232 port or the ethernet port.

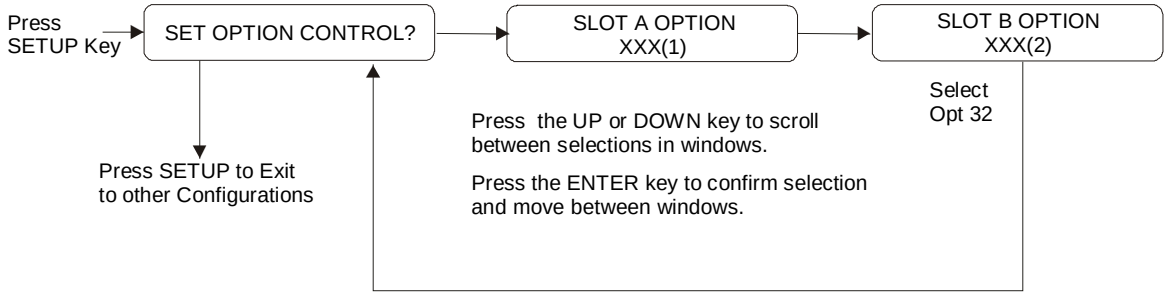
Front Panel

1. Apply power and observe the front panel display, when 'CLOCK STATUS STARTUP' is displayed, press the SETUP key.

2. Navigate through the series of menu selections, using either the DOWN, UP or SETUP key, until SET OPTION BOARD? Appears (Slot B for the Model 1088B).

3. Press ENTER, and then press the UP key until Option 32 is displayed. Press ENTER.

Modifications to the operating parameters (such as Time Quality format or UTC/Local time) may be made without re-initialization after the board has been installed and initialized. If the basic option setup has changed then initialization may be necessary.



Notes:
(1) XXX = NONE, 3, 10, 11, 12, 13, 14, 20, 23, 25 or 28 (Options 10, 11, 13, 14 and 25 are no longer available).
(2) XXX = 4, 17, 17A, 18 , 23, 27, 29 or 32.

NTP Module

The NTP module can be configured over the ethernet port or the option RS-232 port. The ethernet is the preferred port, as no configuration changes are required to use this port.

Ethernet

To configure the NTP module over the network, a Telnet connection to port 9999 must be established. The default IP number for the ethernet is 192.168.0.232. If the IP address of the NTP Server (NTS) is unknown or undefined, the following sets a temporary IP address:

a) Set a static ARP with the desired IP address using the hardware address of the NTS, which is printed on the product label. The address can also be calculated from the serial number. Below is the command example for WinNT/Win95, using the DOS prompt, when the hardware address of the NTS is 00-20-4A-02-64-0B.

arp -s 192.168.0.232 00-20-4A-02-64-0B

NOTE: *In order for the ARP command to work in Windows, the ARP table on the PC must have at least one IP address defined other than its own. Type "ARP –A" at the DOS command prompt to verify that there is at least one entry in the ARP table. If there is no other entry beside the local machine, ping another IP machine on your network to build the ARP table. This has to be a host other than the machine that you're working on. Once there is at least one entry in the ARP table, use the listed commands to ARP an IP address to the NTP Server.*

The command example for most **Unix** systems is:

arp -s 192.168.0.232 00:20:4A:02:64:0B

b) Open a telnet connection to port number 1. This connection will fail, but the NTS will change its IP address to the desired one in that step. **telnet 192.168.0.232 1**

c) Open a telnet connection to port 9999 and set all required parameters.

telnet 192.168.0.232 9999

NOTE: *The temporary IP address is reverted after every power reset of the NTS. Be sure to enter the configuration and store the parameters to make the changes permanent.*

Serial

An ASCII terminal or PC with a terminal emulation can be connected to the option RS-232 port, but JMP1 and JMP2 must be set to "C". The terminal (or PC) should be configured to 9600 Baud, no parity, 8 data-bit, 1- stop bit. The power must be cycled to enter the configuration mode. The self-test begins after power-up. About a half-second later the Error (red) LED starts blinking. Now send three lowercase 'x' characters to the NTP Server. These characters must all be sent within one second to start configuration mode.

NOTE: The easiest way to enter configuration mode is to hold down the 'x' key at the terminal (emulation) and then powering the NTP Server. This will ensure that the x characters will arrive in time

General Configuration

After configuration mode is entered (confirm with <CR>), the parameters can be changed; default values can be confirmed with the enter key. When leaving the setup mode – after selecting function 9 – all parameters are stored in a nonvolatile memory and the NTP server resets.

Basic Parameters

To change the basic parameters, type '0'. The following values can be set/changed:

Ethernet Interface: Set to (N).

IP Address: The IP address must be set to a unique value in your network. If the NTP Server is set to an address, which is already in use, it will display an error code with the LEDs (see "LED Status") and will not connect to the network.

Gateway IP Address: The router/gateway address is needed to communicate to other LAN segments. The default gateway must be set to address the router that connects these segments. This address must be within the local network. If in doubt, consult the network administrator.

Netmask: A netmask defines how many bits from the IP address are to be taken as the network section and how many bits are to be taken as the host section (reminder: Standard class A 8/24 (net/host), class B 16/16, class C 24/8 bits). If set to 0, the standard appropriate netmask for the actual IP address is used. The NTS prompts for the number of host bits, and then calculates the netmask. It is shown in standard format "255.255.xxx.xxx" when parameters are displayed.

Telnet Config Password: The Telnet configuration password can be set to disable unauthorized access to the setup menu through a Telnet connection to the setup port (9999). For the setup through the serial port, it is not necessary to enter the password. The controller can be configured over a Telnet connection to port 9999 (assuming the network parameters are set correctly and the NTS is connected to the network).

NTP Server Parameters

The network operations of the server are controlled by various parameters.

Antenna Type: Set type to 6=GPS/Arbiter

UDP-Port: The UDP port selects the port number for the NTP proprietary protocol.

Send Block Every n Minutes: This parameter determines how often the data block should be sent.

Send UDP-Broadcast: If the time information should be sent to all devices connected to this LAN (broadcast), set this parameter to "Y" = yes.

UDP-Target Address: This parameter determines the target addresses to which the data block should be sent. The data block can be sent over a Gateway or other devices to another part of the network. The maximum number of defined addresses is eight. NTP and UDP/time port numbers are fixed to the values defined in RFC-37 and RFC-123 respectively. If the authentication option is enabled, up to seven MD5 or DES keys can be entered (key numbers 1..7). All key input must be done in hexadecimal format; MD5 key length is limited to eight characters.

When leaving the setup mode – after selecting function 9 – all parameters are stored in a nonvolatile memory and the NTP server resets. Select 8 to exit without saving modifications.

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