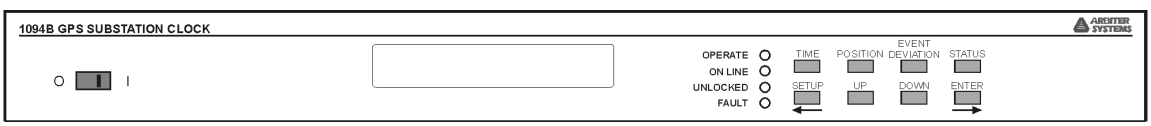
ARBITER SYSTEMS

MODEL 1094B
GPS SUBSTATION CLOCK
MANUAL



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Description
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 set up and operation of the Model 1094B GPS Substation Clock.

ROM Dates
This version of the manual is written for clocks having ROM dates of 8 May 2007 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 "VE" command; see Chapter 9, page 82, Serial Communications and Command Set.

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

LIMITED WARRANTY

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Clock products manufactured by Arbiter Systems are guaranteed against defective materials and workmanship under normal use and service from the date of delivery for the period listed as Limited Lifetime.[1] The responsibility of Arbiter Systems under this warranty is limited to repair or replacement, at Arbiter Systems' option, of any product found to be defective. Arbiter Systems shall have no liability under this warranty unless it receives written notice of any claimed defect.

For warranty service or repair, products must be returned to a service facility designated by Arbiter Systems. Buyer shall prepay all shipping charges to Arbiter Systems, and Arbiter Systems shall pay shipping charges incurred in returning the product to Buyer. However, Buyer shall pay all shipping charges, duties and taxes for products returned to Buyer in a country other than the United States of America.

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1. Improper use or application, abuse, or operation beyond its rated capacity, or contrary to the instructions in the operation and maintenance manuals (if any);

2. Accident;

3. Repair or maintenance performed by Buyer, except in accordance with the operation and maintenance manuals, if any, and any special instructions of Arbiter Systems;

4. Modification without the prior written authorization of Arbiter Systems (whether by the substitution of non-approved parts or otherwise). The remedies provided herein are Buyer's sole and exclusive remedies. In no event shall Arbiter Systems be liable for direct, indirect, incidental or consequential damages (including loss of profits), whether based on contract, tort, or other legal theory.

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.

See Contact Information on page ii.

[1] Limited Lifetime means that Arbiter Systems will repair or replace the defective component as long as components are available and for no more than five years after the product has been deemed obsolete.

Model 1094B

GPS Substation Clock

Manual

PD0036600A

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Chapter 1

Unpacking the Clock

1.1 Introduction

This section will assist you with unpacking the clock from its shipping container; other parts and accessories shipped with the clock include:

- 1094B GPS Clock (includes internal power supply)
- Antenna Cable, 50 feet with Type F connectors
- GPS Antenna
- Rack-Mount Ears, 2 ea.
- 1094B Operation Manual

1.2 Precautions

Mechanical Shock Note that the GPS antenna is small and smooth, and can be damaged if dropped. Use care when handling. Remember to store the antenna in a safe place before the final installation.

Static Discharge Note that the Model 1094B is an electronic device and uses static-sensitive components in its operation. Therefore, use care when handling against static discharges. Generally, these components are protected in their normal situation, however some of these are accessible when the cover is removed.

CAUTION Antenna Input Connector - Connect only the antenna cable coming from the antenna into this connector. The antenna input connector on the clock itself leads to the GPS receiver, which could be damaged from high voltage or a static discharge.

1.3 Unpacking and Locating Accessories

The Model 1094B and included accessories are packed between two closed-cell foam shells. Carefully pull apart the two shells to extract the clock and accessories. Some of the accessories (i.e. antenna and rack-mount ears) are located in one of these shells for protection. In the diagram below, you can see how the GPS antenna and rack-mount ears are located in the closed-cell foam marked with the label that reads,

ADDITIONAL PARTS INSIDE

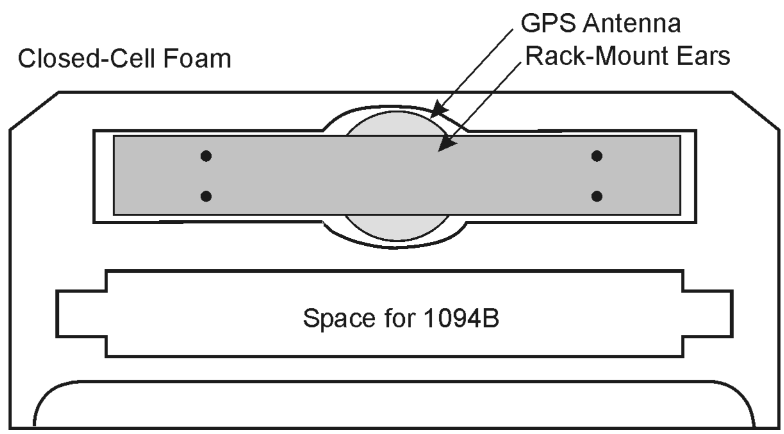

Figure 1.1: Packaging of Accessories

Antenna cable, clock and setup guide are located between the two pieces of closed-cell foam. The rack-mount ears and antenna are embedded in the packing foam side labeled ADDITIONAL PARTS INSIDE.

1.4 Attaching Rack-Mount Ears to Clock

Each Model 1094B comes with two rack-mount ears suitable for mounting in a 19-inch system rack. These ears have four mounting holes, two of which are used to attach them to the sides of the clock. Since it is required to remove the M25 x 10 screws which attach the cover to the chassis, it may be good to attach the ears after first making any jumper configuration inside the clock. You will want to return to this section after making these changes.

1.4.1 Mounting Instructions

1. Using a Torx T25 driver or large slot screwdriver, remove the four M25 screws attaching the clock cover to the chassis. Use either a Torx T25 driver, or a large slot screwdriver.
2. With the ear facing out from the front panel, match the lower set of holes of the rack-mount ear to the cover/chassis and remount the M25 screws.
3. Repeat this procedure with the other side of the chassis and other rack-mount ear.

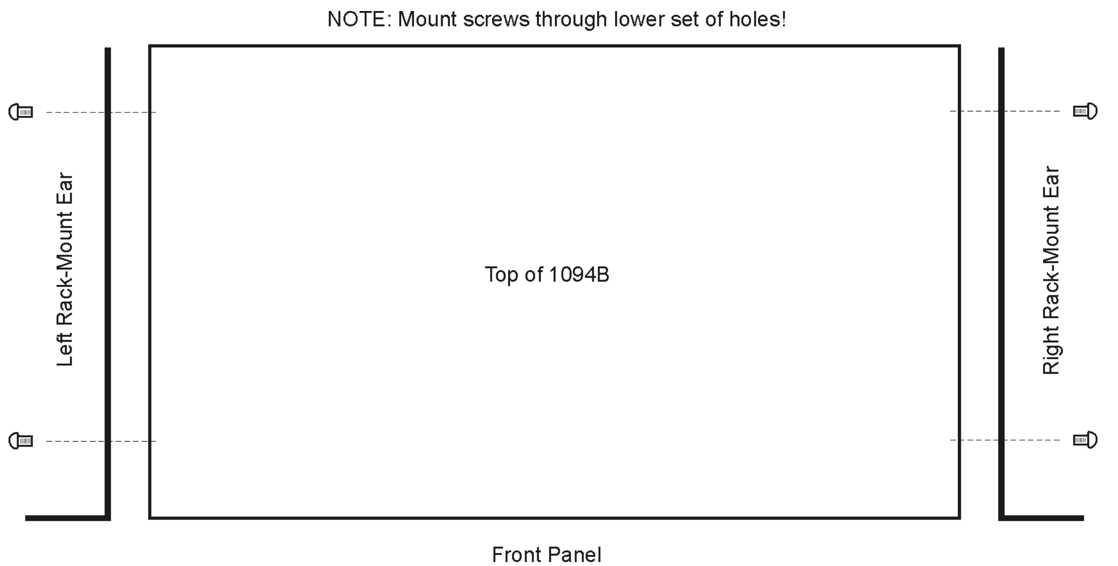

Figure 1.2: Attaching Rack-Mount Ears

NOTE: Before installing the rack-mount ears, you might want to determine if you need to set any internal jumpers. To install the rack-mount ears requires removal of the top cover, which would be a good time to make any changes to jumper settings. See Chapter 5, Setting Internal Jumpers, for information on doing this.

Chapter 2

Front and Rear Panels

2.1 Introduction

This section identifies the connectors, controls, and displays found on the front and rear panels of the 1094B. Take care to review all of these items prior to connecting cables to, and configuring, the Model 1094B.

2.2 Front Panel Controls and Indicators

The Model 1094B front panel has a two-line by 20-character, backlighted, supertwist Liquid Crystal Display (LCD), four annunciator LED's, an eight-button keypad and ON-OFF power switch. The upper row of keys are for viewing clock information and the lower row of keys are for configuring the instrument. Illustrated in the figure below are the displays and controls used to determine and configure the operating state of the 1094B.

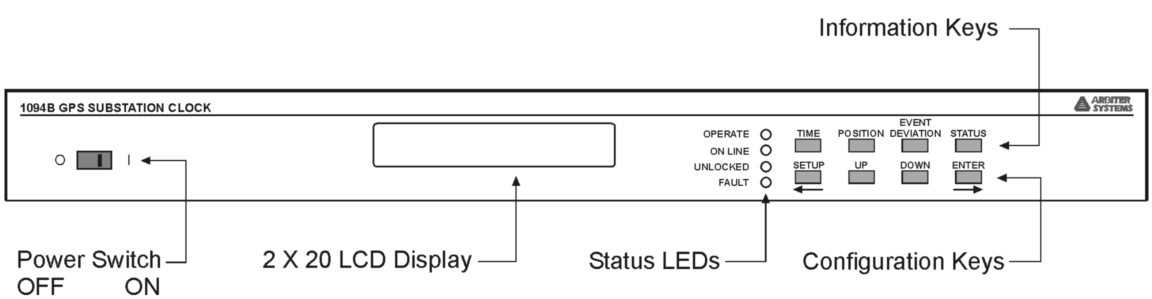

Figure 2.1: Model 1094B Front Panel Description

Definitions for the annunciator LEDs are found in Table 2.1, and definitions for keys in Table 2.3. Each of upper row of keys allow you to view clock information, like Time and Date, Geographical Position and Instrument Status. Each of the lower row of keys have specific and alternate functions for configuring operation. To configure, see Chapter 6, The Setup Menus.

2.2.1 Annunciator LED Definitions

Annunciator LED	Color	Purpose
Operate	Green	Clock Operating
Stabilized	Flashing Green Steady Green	Clock Time stabilizing Clock Time accurate
Unlocked	Red	Out-of-Lock when ON
Fault	Red	Internal fault when ON

Table 2.1: Annunciator LED Definitions

The four LED's provide information about the operational status of the instrument. The Operate and Stabilized LED's are green and the Out-of-Lock and Fault LED's are red. For normal operation, with the clock locked and accurate, both green LED's should be ON and both red LED's should be OFF. The following definitions apply to these indicators:

- **OPERATE**: Indicates that power is being supplied to the clock.
- **STABILIZED**: Flashes (ON-OFF, 1 second intervals) when clock time is stabilizing with GPS. Steady when the clock time is accurate.
- **OUT OF LOCK**: Illuminates when the clock has not yet synchronized, or has lost synchronization, with the GPS.
- **FAULT**: Illuminates when an internal fault occurs. Faults are listed below.

Fault Indication	Definition
Out-of-Lock	GPS Receiver is not receiving satellite signals
Receiver Failure	Clock not communicating with GPS receiver
Antenna Short	Voltage (5 V) at antenna connector low (shorted)

Table 2.2: Fault Indications and Definitions

2.2.2 LCD Display

The Model 1094B contains a liquid crystal display, which provides a 20-character by 2-line readout. The readout displays instrument time, date, event data and status. Using the lower set of keys, the readout is also used to display the current configuration of operation parameters.

2.2.3 Command Key Definitions

Control the various functions and configuration of operational parameters using the eight push-button keys on the front panel. However, by using the RS-232 command "m,nFP", control the

Key	**Function**	**Alternate Function**
TIME	time and date	NA
POSITION	view latitude, longitude and elevation	NA
EVENT or DEV.	view Event or Deviation	NA
STATUS	view Clock and Receiver Status	NA
SETUP	enter setup mode	move cursor left in data entry mode
UP	select upper value	increase numerical value
DOWN	select lower value	decrease numerical value
ENTER	install selected value	move cursor right in data entry mode

Table 2.3: Command Key Definitions

operation of the keypad and display; this includes locking and unlocking the keypad and turning the backlight on or off. See page 77, for a detailed description of the "m,nFP" RS-232 command. All front-panel keys are described below.

Time
Sets the display to the Time Display Mode. There are four modes of the 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 timing outputs.

Position
Cycles the display through the longitude, latitude, and elevation data readouts of the antenna location according to the most recent position fix.

Event/Deviation
Select review of Event and/or Deviation Data for the Event/Deviation input. For additional details, see Event Inputs in Chapters 5, 6, 8 and 9.

Status
Press the Status key to toggle between four status display modes: Clock, Receiver, Tracking and EEPROM, and the display of GPS satellite acquisition and synchronization. For more detail on these readouts, see Chapter 10, Startup and Basic Operation.

Setup
Invokes a series of menus used to adjust configurable parameters within the clock. In numeric data entry mode, moves the cursor to the left.

Up
Used in conjunction with the Setup menus to adjust numerical values upward, or to scroll upward

through the available menu choices. Also assists in navigating through main Setup menus in normal order.

Down

Used in conjunction with the Setup menus to adjust numerical values downward, or to scroll downward through available menu choices. Also assists in navigating through main Setup menus in reverse.

Enter

Used for confirming changes made within Setup 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 to the right.

2.3 Rear Panel Identification and Connectors

This section contains information to assist you in identifying where to connect inlet power, the GPS antenna cable and all of the input and output cables on the Model 1094B.

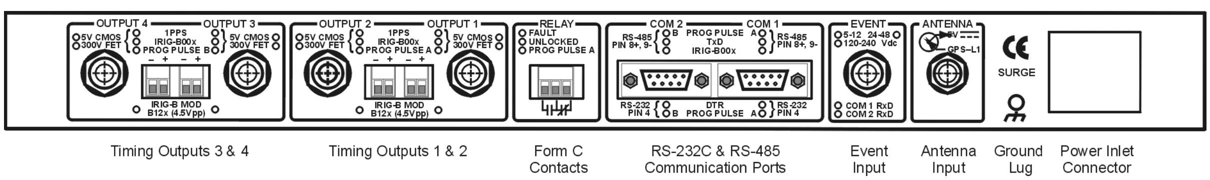

Figure 2.2: Model 1094B Rear Panel Description

2.3.1 Power Inlet

To cover all of the possible inlet power conditions, the Model 1094B has three optional power supplies. Please examine the paperwork you received with the Model 1094B, to make sure you have correctly identified the inlet connection. Supply types are listed below:

Option 07

IEC-320 supply with a range of 86 to 264 Vac, 50 to 440 Hz and 110 to 370 Vdc.

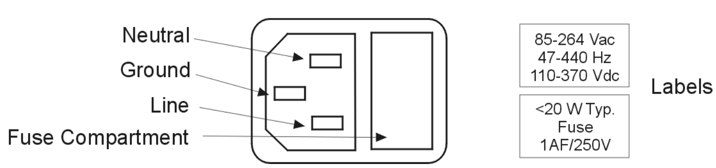

Figure 2.3: Option 07 Power Supply Inlet Connector

Option 08

10 to 60 Vdc ONLY, Terminal Power Strip with Surge Withstand Protect Circuitry (SWC) power.

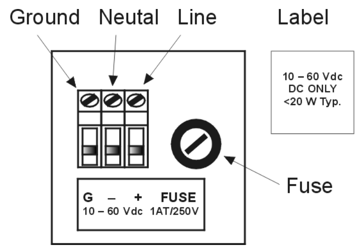

Figure 2.4: Option 08 Power Supply Inlet Connector

Option 10

110 to 370 Vdc and 85 to 264 Vac, 47 to 440 Hz, Terminal Power Strip with Surge Withstand Protect Circuitry (SWC)

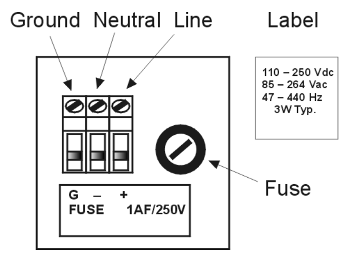

Figure 2.5: Option 10 Power Supply Inlet Connector

2.3.2 Antenna Input

The Model 1094B provides a Type F, GPS antenna input connector not only as the connection point for GPS signal, but also supplies 5 volts to energize the antenna. It is equipped with a threaded, Type F female connector.

Shown below is a diagram of the Type F female, antenna connector. For further information on antennas and antenna cabling, see Chapter 4, Antenna and Cable Information.

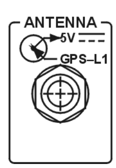

Figure 2.6: GPS Antenna Connector

2.3.3 Event Input

For timing external events based on the GPS-synchronized time, use the Event Input function. External events may also be timed from either of the two standard communication ports. The standard Event Input is equipped with an isolated, BNC female connector.

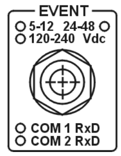

Figure 2.7: Event Input Connector

2.3.4 RS-232 and RS-485 Communication Ports

The Model 1094B has two identical communication ports with RS-232 and RS-485 supported. The RS-232 port does not use flow control and the RS-485 is transmit only (uses Transmit A and Transmit B; there is *NO ReceiveA or ReceiveB*). Generally, for RS-232 communications, you will only need pins 2, 3 and 5 using a null-modem cable. For more information, see Chapter 8, Serial Communications and Command Set.

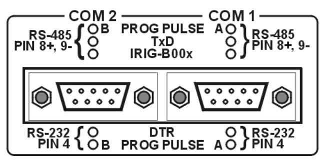

Figure 2.8: Communication Port Connectors

2.3.5 Form C Contacts

The Model 1094B has one set of Form C relay contacts that have three contact points: Normally Open (NO), Normally Closed (NC) and Common (C). Contact functions include Fault, Out of Lock or Programmable Pulse A. To configure the contact function, see Section 5.3. For information on how to connect to them and their specifications, see Chapter 8, Relay Contacts and Event Inputs.

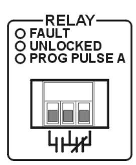

Figure 2.9: Relay Contact Connectors

2.3.6 Timing Outputs

The Model 1094B has four identical timing outputs with two different types of connectors to suit a variety of cabling requirements. Viewed from the rear panel, they are labeled Output 1, Output 2, Output 3 and Output 4 from right to left. Both connectors may be used simultaneously from the same output channel. Single connectors may also be "Tee'ed" for parallel-connected loads. For more information concerning how to connect any timing output for distribution to protective relays, see Chapter 7, Timing, IRIG-B and Pulses.

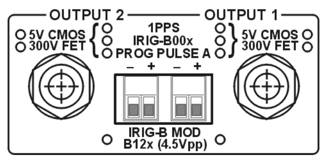

Figure 2.10: Timing Connectors, IRIG-B and Pulse

Chapter 3

Connecting Inlet Power

To provide for a wide range of inlet power sources, the 1094B can be ordered with three different power inlet modules. Each of the power inlet module connectors are illustrated here and also in Chapter 2. Take time to examine the power inlet module connection on your clock to verify that it is correct according to your order. Make sure to check the inlet module before connecting power to the clock.

3.1 Option 07, IEC-320 Power Inlet Module

The Option 07, IEC-320 power inlet module has a "computer type" power connector with power cord for the required country code. Voltage and system frequency are given below with an outline of the connector.

Input Ratings: 85 to 264 Vac, 47 to 440 Hz, or 110 to 370 Vdc

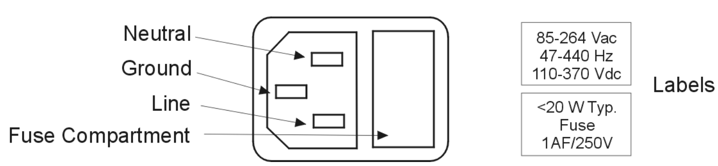

Figure 3.1: Option 07 Power Supply Inlet Description

3.1.1 Cordsets and Plug Styles for Option 07

Make sure that the cordset matches the wall connector for your country. The following are available IEC-320 mating cordset plug style and specifications:

No.	Country	Specification	Rating
P01	Continental Europe	CEE 7/7	220V
P02	Australia, NZ, PRC	AS3112-1981	240V
P03	U.K.	BS 1363	240V
P04	Denmark	Afsnit 107-2-01	240V
P05	India	BS 546	220V
P06	Israel	SI 32	220V
P07	Italy	CEI 23-16/VII 1971	220V
P08	Switzerland	SEV 1011.1959	220V
P09	North America and ROC	NEMA 5-15P CSA C22.2#42	120V
P10	Japan	JIS8303	120V

Table 3.1: Available IEC-320 Cordsets by Country

3.1.2 Option 07, Connecting Power to the 1094B

Connect the IEC-320 plug to the IEC-320 connector on the 1094B, and then connect the wall plug into the wall socket.

3.2 Option 08, 10 to 60 Vdc Power Inlet Module

This option replaces the standard power supply with one accepting 10 to 60 Vdc (only), < 20 VA typical. Replaces the standard IEC-320 inlet with a 3-pole terminal strip. Provides input surge protection (SWC) for compliance with ANSI C37.90-1 and IEC 801-4. Option 08 operates from common low-voltage battery systems, including 12, 24, and 48 Vdc.

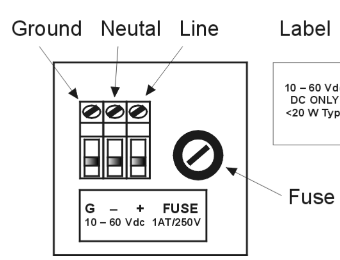

Figure 3.2: Option 08 Power Supply Inlet Connector

3.2.1 Option 08, Connecting Inlet Power

When wiring station batteries to this power supply, make sure to first connect an earth ground wire to the terminal strip connector labeled “G” (for ground). Line and neutral terminals are marked on a label below as “+” and “–”. After connecting a ground wire, connect the positive and negative leads from the station batteries to the corresponding Option 08 terminals.

3.3 Option 10, 110 to 370 Vdc Terminal Power Strip, Surge Withstand

This option replaces the standard IEC-320 inlet with a 3-pole terminal strip and provides input surge protection for compliance with ANSI C37.90-1 and IEC 801-4. Input voltages are: 85 to 264 Vac, 47 to 440 Hz, or 110 to 370 Vdc, < 20 VA typical.

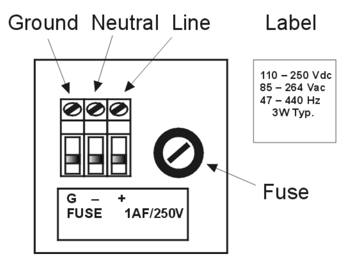

Figure 3.3: Option 10 Power Supply Inlet Connector

3.3.1 Option 10, Connecting Inlet Power

When wiring this power supply, make sure to first connect an earth ground wire to the terminal strip connector labeled “G” (for ground). Positive and negative terminals are marked on the terminals as “+” and “–”. After connecting a ground wire, connect the positive and negative leads to the clock power inlet terminals. Lastly, connect the power inlet leads to the station batteries.

3.4 Fuse Locations and Types

Use the fusing table below for identifying the correct fuse for your option power supply.

PS Option	Arbiter P/N	Fuse ID	Size, mm
07	FU0001816	F1AL250V	5 x 20
08	FU0001416	T1AL250V	5 x 20
10	FU0001816	F1AL250V	5 x 20

Table 3.2: Fuse Chart

3.4.1 Replacing Fuses

An IEC-320 power inlet connector includes a 1-A, 250-V fast acting fuse. The fuse is contained in a small compartment with a snap-fit latch, which also has a compartment for a spare fuse. Check Table 3.2, earlier on in this chapter, for a fuse location diagram.

The fuse compartment is located directly adjacent to the input connector socket, and can be opened by pulling both sides directly out away from the chassis, or by gently prying with a small flag-blade screwdriver. To replace the fuse, first disconnect the line cord from the power source and then remove the cord from the rear-panel IEC connector. The in-circuit fuse is the innermost one; inspect it to determine whether it is open. As required, replace with fuse in the outer compartment, and replace the spent fuse.

With an Option 08 or 10, the input power module includes separate, threaded fuse holder adjacent to the terminal power strip. See the chart above for the correct fuse configured for your option.

To check the fuse, use a small flat-bladed screwdriver and turn the cover counter-clockwise. The cover and fuse should pop out. CAUTION: Replace fuse only with another of the same type and rating. See Table 3.2 above for the correct fuse configured for your option.

To replace the fuse, first disconnect inlet power from the clock. Using a small flat-blade screwdriver, turn the fuse cover counter-clockwise (CCW) and it should pop outward. Replace fuse with the same size and type.

Chapter 4

GPS Antenna and Cable Information

The Model 1094B comes complete with the necessary hardware to be able to receive GPS signals: 50-feet of RG-6 cable and a GPS antenna. The antenna cable is connected to the female F connector at the rear panel.

This section should help you with installing the GPS antenna and antenna cable(s) to the 1094B. It should also be a source of information if you should need to trouble shoot the antenna cable system. The Model 1094B achieves its accuracy by comparing the internal clock signal to the incoming GPS signal.

4.1 GPS Antenna Installation

To properly receive GPS signals, the GPS antenna needs to be mounted clear of buildings and surrounding elements that would block the GPS signals being transmitted by the satellites. For complete coverage, the antenna needs to have a clear view of the sky from 10 degrees above the horizon to directly overhead for all points of the compass. Minimal installations, where the antenna is mounted in a less favorable location, may work however reception may be somewhat limited during certain hours of the day.

4.1.1 Mounting the Antenna

To mount the antenna, you will need a short piece of gray, 3/4" plastic pipe nipple that can be attached to a solid fixture. The piece of pipe nipple should be threaded up into the antenna receptacle after connecting the antenna cable to the Type F cable adapter. Arbiter Systems sells an antenna mounting kit (P/N AS0044600) that simplifies installation for a variety of locations. Figures 4.1, 4.2 and 4.3 illustrate several components for a suggested mounting method.

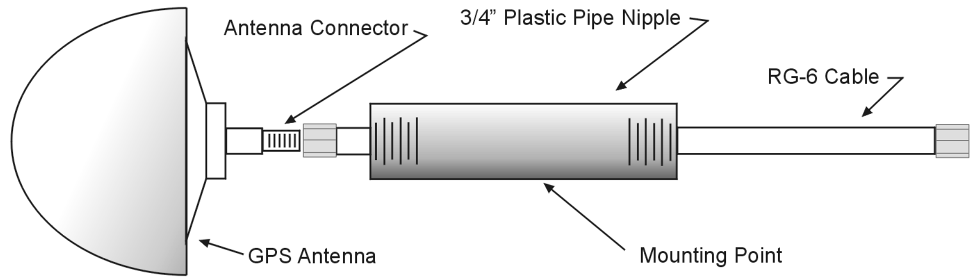

Figure 4.1: Antenna Assembly for Mounting

Antenna mounting procedure:

1. Thread the RG-6 antenna cable through the plastic pipe
2. Tighten the Type F male connector to the antenna connector
3. Thread the plastic pipe into the antenna
4. Mount the plastic pipe and antenna/cable assembly to a fixture

4.1.2 Optional Antenna Mounting Kit, P/N AS0044600

The AS0044600 Antenna Mounting Kit, specifically for use with antennas shipped with Arbiter Systems GPS-controlled clocks, includes several items including the mounting bracket. The hardware included with the bracket allows installation of the antenna on a mast or pipe up to about 2” in diameter, and a different clamp may be substituted for use with a larger diameter pipe. Also, the bracket can be mounted to a wall, a roof, or any other flat surface.

For complete details on this product request installation instructions for Arbiter Systems GPS Antenna Mounting Kit found on document number PD0024700A. All metallic hardware is stainless steel.

Qty	Description	ASI P/N
1	GPS antenna mounting bracket	HD0052700
1	U-bolt, 1-1/8”, with 2 hex nuts	HP0014700
1	3/4” x 4” threaded pipe, PVC, schedule 80	HP0014800
1	Hose clamp, worm drive	HP0014900
1	Mounting bracket stabilizer	HD0054200

Table 4.1: Antenna Mounting Kit Parts List

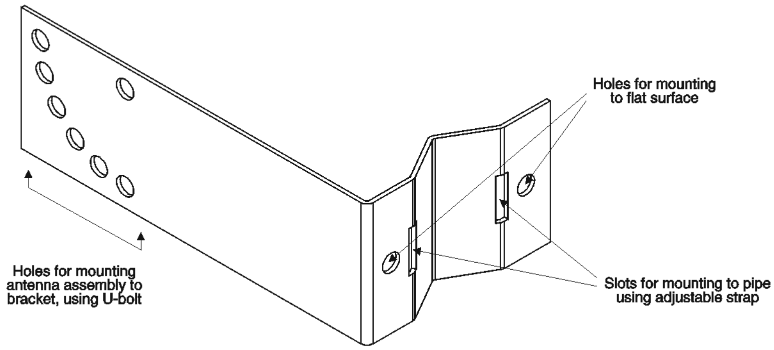

Figure 4.2: Antenna Mounting Bracket

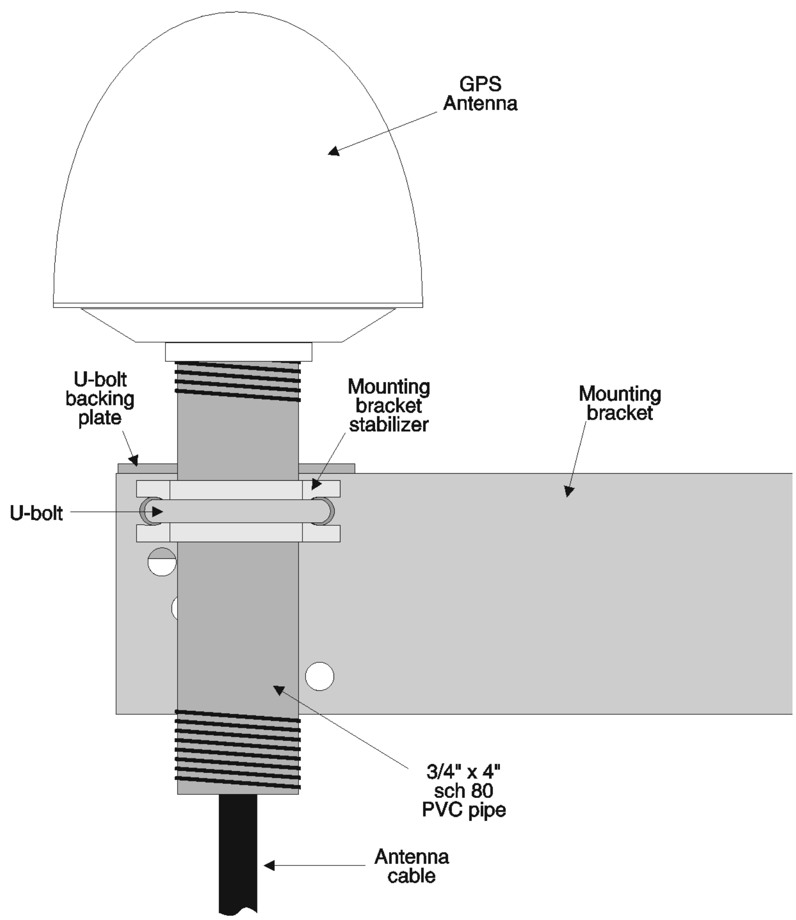

Figure 4.3: Antenna Mounting with AS0044600

4.2 Antenna and Cable Testing

The antenna and cable assembly can easily be tested prior to or after installation. All that is required is a basic multimeter that measures DC volts and resistance.

4.2.1 Checking the Antenna Voltage

The GPS clock provides a +5 Vdc signal at 30 mA maximum, carried through the antenna cable to the GPS antenna. Without the signal, the antenna and the GPS clock will not synchronize with the Global Positioning System, and can generate an out-of-lock alarm if the Out-of-Lock feature is enabled. To verify this signal, set your voltmeter to DC volts and measure from the center pin to the threads at the antenna connector on the rear panel of the 1094B. This signal should be between 4.9 and 5.1 Vdc.

4.2.2 Power Supply Check

The Antenna Voltage test (above) actually tests the main power supply voltage for the Model 1094B.

4.2.3 Checking the Antenna Resistance

The current antenna is a Trimble Bullet 3 and has a nominal internal resistance of about 270 ohms. Measure this with the antenna cable disconnected from the Model 1094B and connected to the antenna. This way you will know if you have a good connection. Change your multimeter to read resistance and measure from the center pin of the cable connector to the threads (shield).

4.3 Antenna Surge Suppressor

If you have ordered the GPS Surge Suppressor kit, you should mount it in line with the antenna cable. Additional information on grounding GPS antennas, and grounding in general, are available from Arbiter (Kit P/N AS0049000).

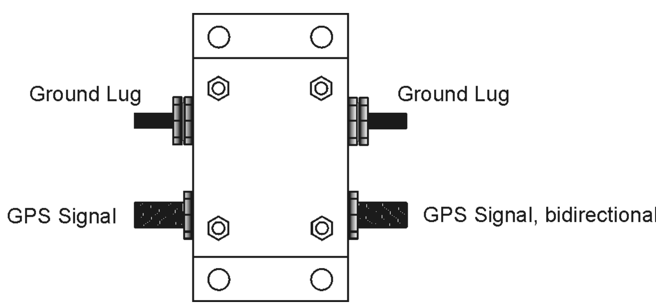

Figure 4.4: GPS Surge Suppressor

4.3.1 Using the Antenna Surge Suppressor

If using the antenna surge suppressor, it would be good to review documentation on this device, including tips on grounding. Please check Appendix B in this manual for details on the importance of using surge suppressors and proper grounding.

4.4 Technical Details on GPS, Antennas and Cables

4.4.1 Antenna Cable

Length and 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 type low-loss coaxial cable, terminated with male Type F connectors. Optional lengths of RG-6 coax are separately available for longer runs; see Table 4.2, Cable Data and Accessory Information.

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 in Table 4.2 below. The formula for calculating cable delay is:

$$T = \lambda \frac{1}{CKv} + 1ns \tag{4.1}$$

Where:

T = Cable delay, in nanoseconds;
λ = Cable length, in meters;
C = Speed of light (3×10^8 meters per second);
Kv = 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 (P/N 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 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.

P/N	Description	Delay, ns	Signal Level, dB
CA0021315	15-m (50-ft) cable, RG-6	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	3.92 ns/m	-17.5 dB/100 m
AS0044600	Kit, crimp tool and 25 connectors, RG-11	N/A	N/A
AS0044700	21-dB in-line amplifier	1 ns	+21 dB

Table 4.2: GPS Cable Data and Accessory Information

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.

Antenna Power

The RF preamplifier within the antenna requires 5 Vdc at 30 mA maximum for operation. A power supply within the clock generates this voltage, which is applied to the antenna 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 described above.

Connection to Antenna

The male Type F connector on one end of the antenna cable mates with the female Type F connector on the antenna. Avoid placing mechanical stress on the cable attachment to the antenna.

Connection to Clock

The male Type F connector on the opposite end of the antenna cable connects to the female Type F connector on the rear panel of the Substation Clock.

User-Supplied Antenna Cables

Any RF cable meeting the requirements described above for loss (<21 dB at 1575 MHz) and dc resistance (<15 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 Power Supply Test and Antenna Resistance Test above.

For additional technical details concerning the GPS, antennas and antenna cabling see Appendix A, Technical Details and Specifications.

Chapter 5

Setting Internal Jumpers

5.1 Introduction

This section should assist you with understanding and configuring the internal jumpers in the Model 1094B so that all the input and output signals are routed correctly. After correctly setting the necessary jumpers, go to Chapter 6, The Setup Menu, to configure clock settings. The Setup menus provide details on how to configure these signals from the front panel keys. For additional technical details about timing signals, please see Chapter 7, Timing, IRIG-B, and Pulses. **NOTE:** *Values in tables marked with an "*" show default positions.*

5.1.1 Jumper Locations

Figure 5.1 outlines the main board in the Model 1094B depicting the approximate locations of the various jumpers. Use this drawing to assist you with locating the jumpers you want to configure. Jumpers are noted on the main board with a "JMP" prefix before the numbered location. For example, jumper 1 would have a label of JMP1 on the main board, however the drawing only references this jumper as "1." Also, note that JMP1 is not used, and should have been hard wired or soldered in its intended position at the factory.

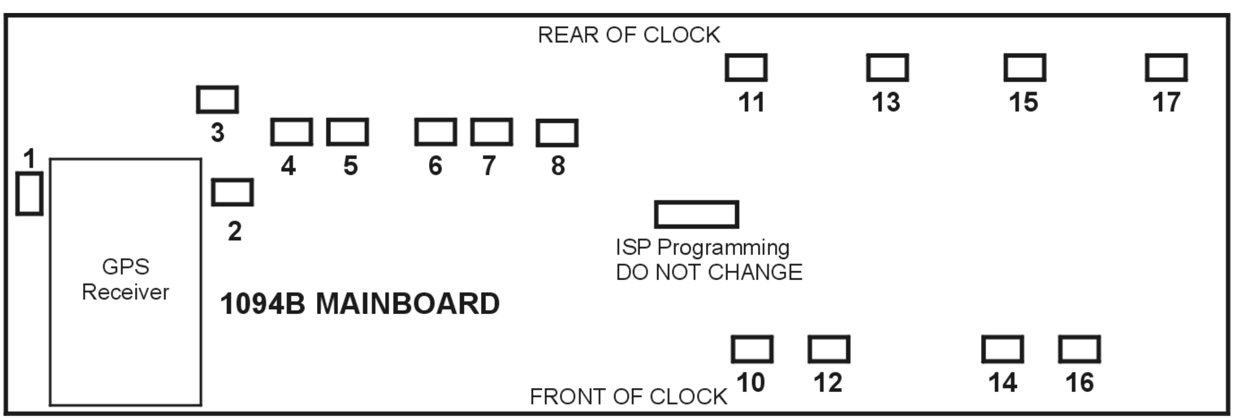

Figure 5.1: Main board Jumper Locations

5.1.2 List of Jumpers and Functions

Listed below are the various jumpers and their functions.

Jumper	Function	Default Setting
JMP1	Antenna Preamp	Fixed (do not change)
JMP2	Event Input Connector	C - Event Panel
JMP3	Event Input Voltage	A, 5 to 12 Vdc
JMP4	Comm Port 1	A, Txd - ch
JMP5	Comm Port 1	B, DTR
JMP6	Comm Port 2	A, Txd - ch
JMP7	Comm Port 2	B, DTR
JMP8	Relay Mode (Form C Contacts)	B, Out-Of-Lock
JMP10	Timing Output 1	A, IRIG-B, unmodulated
JMP11	Timing Output 1	C, CMOS - 5 Vdc
JMP12	Timing Output 2	A, IRIG-B, unmodulated
JMP13	Timing Output 2	C, CMOS - 5 Vdc
JMP14	Timing Output 3	A, IRIG-B, unmodulated
JMP15	Timing Output 3	C, CMOS - 5 Vdc
JMP16	Timing Output 4	A, IRIG-B, unmodulated
JMP17	Timing Output 4	C, CMOS - 5 Vdc

Table 5.1: Default Main board Jumper Settings

NOTE: Jumpers in the following tables are grouped according to main functions and not necessarily in numerical order.

NOTE: Values in tables marked with an "*" show the default positions.

5.2 Configuring Output Jumpers

The Model 1094B has four identical and separate timing outputs that may be configured independently. To configure any of the output jumpers, follow the steps numbered below. Table 5.2 organizes the four outputs in one table, since they are all configured in the same manner. For additional information on Timing, IRIG-B and Pulses, see Chapter 7.

Signal	**Output 1**	**Output 2**	**Output 3**	**Output 4**
IRIG-B00X 1 PPS Prog Pulse	JMP10 = A* JMP10 = B JMP10 = C P-P A	JMP12 = A* JMP12 = B JMP12 = C P-P A	JMP14 = A* JMP14 = B JMP14 = C P-P B	JMP16 = A* JMP16 = B JMP16 = C P-P B
300-V FET IRIG-B12X CMOS, 5 V	JMP11 = A JMP11 = B JMP11 = C*	JMP13 = A JMP13 = B JMP13 = C*	JMP15 = A JMP15 = B JMP15 = C*	JMP17 = A JMP17 = B JMP17 = C*
* = default setting				

Table 5.2: Timing Output Jumper Selection

NOTE: The 'X' in 'IRIG-B00X' (unmodulated) and 'IRIG-B12X' (modulated) is set to 0 or 3 depending on the the IEEE 1344 setting - ON or OFF. Set this value when you configure IRIG-B in the Setup Menus; see Chapter 6 for details on setting the IEEE 1344 Extension. See Chapter 7 for technical details on the IEEE 1344 Extension.

5.2.1 Configuration Notes

1. To set Output 1 as unmodulated IRIG-B (5 VCMOS, demodulated, or level shift) set jumper JMP10 = A and jumper JMP11 = C. Similarly, to set Output 2 for unmodulated IRIG-B, set JMP12 = A and JMP13 = C.

2. To set any output as modulated IRIG-B, set only one jumper. For example, to set Output 2 as modulated IRIG-B, set jumper JMP13 = B. Jumper JMP12 is not required.

3. To set any output as programmable pulse, use two jumpers. For example, to set Output 3 to programmable pulse and 300 V FET, set jumper JMP14 = C and JMP15 = A. Note that Programmable Pulse A configures Outputs 1 and/or 2, and Programmable Pulse B configures Outputs 3 and/or 4.

4. Remember to configure any IRIG-B timing output from the front panel for the UTC or Local time zone and whether you want IEEE 1344 ON or OFF. See Figure 6.18 for setup information.

5.3 Configuring Relay Mode Jumpers

The Model 1094B has one set of Form C relay contacts that may be configured to alarm (or trip) for a Fault, for an unlocked condition, or according to the Programmable Pulse B function. By default, the relay is connected to indicate an unlocked condition. When the 1094B is unlocked (i.e. not tracking GPS satellites) the red, front-panel annunciator LED, should also be lit to indicate an unlocked condition. See Table 5.3.
NOTE: If configuring relay contacts for programmable pulse, use only Programmable Pulse B Mode.

Function	Jumper Position
Unlocked	A*
Fault	B
Prog. Pulse A	C

Table 5.3: Relay Jumper Positions

5.3.1 Relay Contact Specifications

Life expectancy (electrical) is 100,000 operations; resistive load test at 250 VAC, 8 A, room temperature with diode. Continuous monitoring must be performed to detect contact sticking and short circuit. Dielectric strength measured at 500 V for 1 minute with same polarity.

5.4 Configuring Communication Port Jumpers

The Model 1094B has two communication ports (COM 1 and COM 2) that can provide both RS-232C and RS-485 levels. Alternately, these ports may be configured to provide a programmable pulse output and IRIG-B at RS-485 levels. See Table 5.4 for details on jumper positions. See Table 9.1 for RS-232 port pin locations.

Driver	Output Signal	COM 1	COM 2
RS-232	Prog Pulse A	JMP5=A	JMP7=A
”	DTR*	JMP5=B	JMP7=B
RS-485	TXD-Ch*	JMP4=A	JMP6=A
”	Prog Pulse B	JMP4=B	JMP6=B
”	IRIG-B	JMP4=C	JMP6=C

Table 5.4: Communication Port Jumper Selection

NOTE: COM 1 can serve as an alternate port for Programmable Pulse A, and COM 2 can serve as an alternate port for Programmable Pulse B.

1. For standard RS-232 communications on COM 1 or COM 2, move jumpers JMP5 or JMP7 to position B.

2. To transmit a programmable pulse from COM ports at RS-232 levels, move jumper JMP5 or JMP7 to position A.

3. To transmit a programmable pulse from COM ports as RS-485, move jumper JMP4 or JMP6 to position B.

4. To transmit IRIG-B data from either COM 1 or COM 2, move jumper JMP4 or JMP6 to position C. To set up IRIG-B timing, use ”SET IRIG MAIN?” found in Chapter 6, The Setup Menus.

5.5 Configuring Event Input Jumpers

The Model 1094B has one Event Input that has two modes; Event Capture, and 1-PPS Deviation measurement. Connect the cable with the event or deviation signal to the dedicated event input connector, or either COM 1 or COM 2 (pin 2). Additionally, you can set the event input voltage level to one of three ranges: 5 to 12 Vdc, 24 to 48 Vdc, or 120 to 240 Vdc. See Table 5.5.

Driver	**Input Signal**	**Jumper & Position**
Voltage	5 - 12 Vdc	JMP3 = A*
”	24 - 48 Vdc	JMP3 = B
”	120 - 240 Vdc	JMP3 = C
Input Conn.	COM 1	JMP2 = A
”	COM 2	JMP2 = B
”	Event Panel	JMP2 = C*

Table 5.5: Event Input Jumper Selection

5.5.1 Event Channel Setup

1. Select the input channel as the designated BNC Event Input (default), COM 1 or COM 2 (pin 2); choose jumper position A for COM 1, B for COM 2, or C for the BNC Event connector (default).

2. To select a voltage level, move jumper JMP3 to A for 5 to 12 Vdc (default), to B for 24 to 48 Vdc, or to C for 120 to 240 Vdc.

5.5.2 Event Programming

Configure the Event Input feature by using the setup menus or remotely through COM 1 or COM 2. To use the setup menus, see Section 6.12. To use either serial COM 1 or serial COM 2, see Chapter 9, Communication Ports and Command Set (specifically see Section 9.3.3, Event Mode Commands.

Chapter 6

The Setup Menus

This section should guide you in configuring the Model 1094B operation using the SETUP Menus. These menus allow you to configure the 1094B according to your preferences. Logically, using the setup menus should follow after setting any of the main board jumpers (see Chapter 5).

Two of the most common setup menus for any application are (1) configuring the Local Offset and Daylight Saving values, and (2) setting up the IRIG-B outputs for the correct time zone. For the 1094B to operate with the correct time in your location, you will need to configure the Local Offset (from UTC) and Daylight Savings, or Summer Time, changeover settings. There are a number of other settings that may be important to your application, however local time offsets are normally fundamental requirements. For a complete list of setup menus, see Table 6.1.

There are two methods of configuring the 1094B: (1) Using the lower row of keys on the front panel, and (2) remotely, by using either COM 1 or COM 2. For information on configuring the 1094B remotely through either COM 1 or COM 2, please refer to Chapter 9, Serial Communication and Command Set.

Table 6.1, on the next page, lists the various menus used to configure the operation of the Model 1094B. Other definitions follow the list that discuss how to begin configuring, the function of each key, and how to escape the configuration process if necessary. After this introductory material, each menu is covered in detail.

6.1 Setup Menus

No.	Setup Menus	Setup Items
1	Serial COM 1	Serial 1 Port Parameters and Broadcast
2	Serial COM 2	Serial 2 Port Parameters and Broadcast
3	Local Time	Set Local Offset and DST/Summer Time
4	Out Of Lock	Set Time Interval Before Alarm
5	Backlight	Set to ON, OFF or AUTO
6	Cable Delay	Set Delay in Nanoseconds
7	Programmable Pulse A	Set Mode and Pulse Width
8	Programmable Pulse B	Set Mode and Pulse Width
9	IRIG-B Main	Set IRIG-B Time Zone and IEEE-1344
10	Set Auto Survey	Set Type of Survey and turn off
11	Event/Deviation	Set for either Events or 1 PPS Deviation

Table 6.1: Front-Panel Setup Menus

6.1.1 To Begin Configuring

Press the SETUP key to enter the clock configuration menus, starting with communication port parameters (Set Serial COM 1?).

SETUP: Press the Setup key repeatedly to scroll through the main menus. Also, after pressing SETUP once, you can press the UP or DOWN keys to scroll the menus. In numeric data entry mode, pressing SETUP moves the cursor to the left.

ENTER: Press the Enter key to confirm changes made within SETUP menus. Generally, pressing ENTER also advances the next parameter, or returns to the previous menu level. In numeric data entry mode, pressing ENTER moves the cursor to the right.

UP: Press the UP key, within the SETUP menus, to adjust numerical values upward, or to scroll upward through the available menu choices. The UP key also assists in navigating through main Setup Menus in normal order.

DOWN: Press the DOWN key, within the SETUP menu, to adjust numerical values downward, or to scroll downward through available menu choices. Also assists in navigating through main Setup menus in reverse order.

6.1.2 Numeric Data Entry Mode

Numeric data entry mode is activated anytime you enter a menu that requires a change in numerical value. When in this mode, the function of the SETUP and ENTER keys change to give left and right cursor control.

6.1.3 Default Firmware Settings

When shipped from the factory, and unless specified otherwise, the Model 1094B will be configured with a default set of values and features. This set of values and features are configured primarily through the front panel, lower row of keys, and alternately through either communication ports. These default settings are listed in Table 6.2 below. For menu order, read table from left to right, and down.

Menu Item	**Function**	**Menu Item**	**Function**
COM 1	DTR, 9600, 8, N, 1	COM 2	DTR, 9600, 8, N, 1
Local Offset	none	Daylight Saving	OFF
Out-of-Lock	01 min.	Backlight	Auto
Cable Delay	60 ns	Prog Pulse A	Pulse Mode
Prog Pulse B	Pulse Mode	IRIG-B Main	1344 OFF, UTC
Auto Survey	Power On Survey	Event/Deviation	Deviation

Table 6.2: Default Firmware Settings

6.1.4 To Exit Setup Menus

To exit any configuration menu without saving, press any key of the upper row of keys before pressing ENTER to change a value. To return to the configuration menus, press SETUP again. If you make a configuration error, you can scroll through the menus again and press ENTER when you find the menu you want to change.

6.2 Set Serial COM 1

Press SETUP key to configure Serial COM 1. To enter the Set Serial COM 1 menu, press the SETUP key and then the ENTER key. After this you will be able to choose between configuring the serial port parameters (PORT CONFIG) or selecting one of the broadcast options (BROADCAST). If you select BROADCAST, by pressing the DOWN key, you will also be able to select the preferred time zone in the broadcasted string (either UTC or LOCAL). See Figure 6.1.

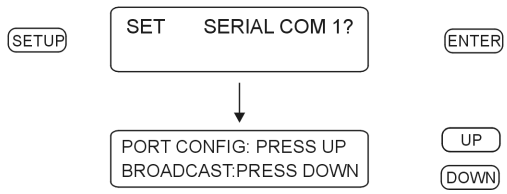

Figure 6.1: COM 1 Setup

6.3 Set Serial COM 2

Setup Serial COM 2 in the same manner as for Set Serial COM 1. From any view menu, press the SETUP key twice and then the ENTER key. Follow the on screen instructions as described above for Set Serial COM 1.

6.3.1 Set Broadcast Mode from Serial COM 1

From the menu shown in Figure 6.1, press the DOWN key to select the Broadcast option and set up the 1094B to broadcast one of the available strings. Press the UP or DOWN keys to navigate through the fourteen choices for the broadcast strings, starting with INTERROGATE MODE (as seen in Figure 6.2). Interrogate Mode means that the 1094B is not broadcasting, but waiting for a command. When you have selected the desired broadcast string, press ENTER to apply the broadcast. For broadcast strings other than INTERROGATE MODE, two menus should follow: (1) select the time zone (UTC or Local), and (2) select the broadcast rate (1 to 9999 seconds between successive broadcasts, depending on type of broadcast).

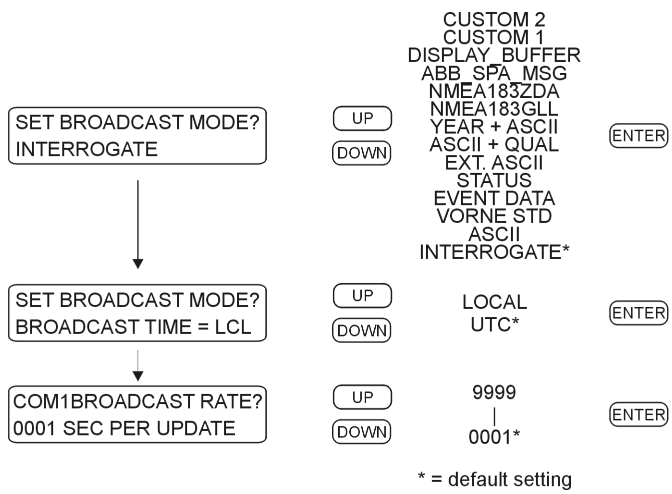

Figure 6.2: Broadcast Mode Setup

For a full list and discussion of these strings, please see Section 9.3.1, Broadcast Mode Commands.

6.3.2 Configure Serial COM 1 Port Parameters

To set COM parameters, press the UP key as shown in Figure 6.1. Work through each menu to select your desired settings. See Figure 6.3.

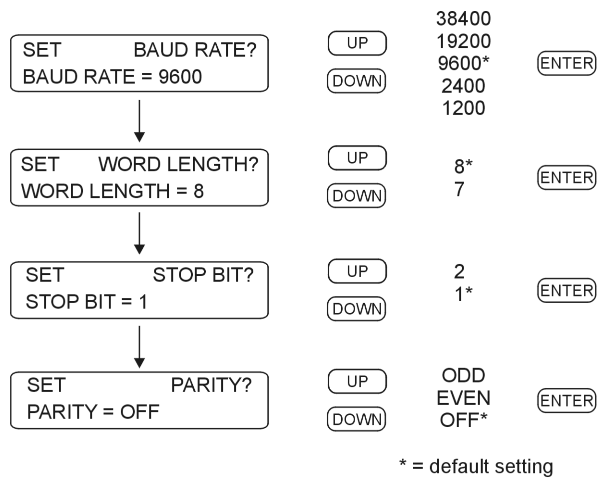

Figure 6.3: COM 1 and COM 2 Parameter Setup

Configure COM 1 and COM 2 in the same manner as shown in Figure 6.3. The "SET SERIAL COM 2?" menu immediately follows the "SET SERIAL COM 1?" menu. Another method of directly entering the SET SERIAL COM 2? menu is to press the SETUP key twice.

6.4 Set Local Offset

The Local Offset equals the difference in time (in 15-minute increments) from UTC (or GMT) to your time zone. Locations west of the Prime Meridian have negative offsets and locations east of the Prime Meridian have positive offsets. For example, Karachi is +5 hours and New York is -5 hours offset from UTC. See Figure 6.4.

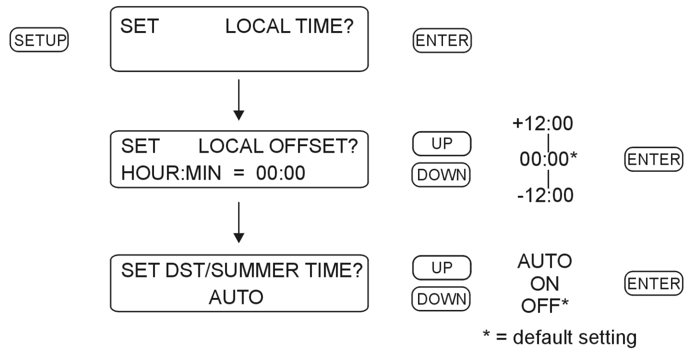

Figure 6.4: Local Time Setup

6.5 Set DST/Summer Time

Daylight Saving and Summer Time are hereafter referred to as DST/Summer Time. These settings follow immediately after setting the Local Offset, and are actually part of the Local Offset main menu. DST/Summer Time settings are normally used to advance and retard the time once each year. The menus in this section allow you to customize the clock time for your region in 15 minute increments over a plus or minus 12 hour interval.

Continuing from the Local Offset menu, follow the menus below to complete the DST/Summer Time setup. After setting the Local Offset, there are two basic values that are necessary to complete this configuration:

- DST/Summertime Start Date and Time
- DST/Summertime Stop Date and Time

The menu in Figure 6.5 illustrates how to set up the Start Date and Time. The Stop Date and Time menus are identical except that the menus say "STOP" instead of "START." Before setting up your DST/Summer Time feature, make sure that you understand when DST/Summer Time starts and stops in your region. In each menu, the list of selections are shown with each category.

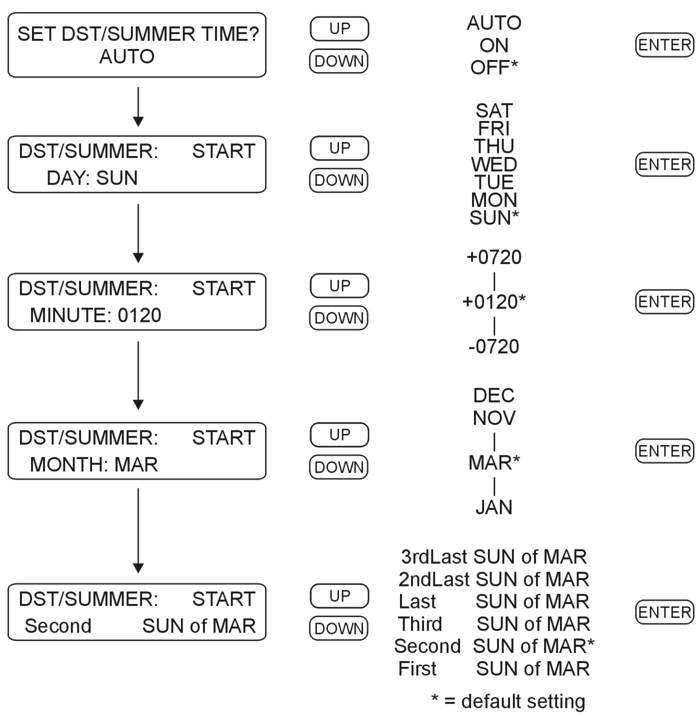

Figure 6.5: Daylight Saving and Summer Time Setup

6.6 Set Out of Lock

Set the Out-of-Lock time to control how the clock generates an alarm when it loses synchronization with the Global Positioning System. If set to OFF, the Out-of-Lock function will not give an alarm. If set to Zero Delay, then it will alarm immediately with an unlocked indication. If set to a value in minutes, then the 1094B will signal an alarm the configured number of minutes after an out-of-lock condition occurs. This is different than when the Model 1094B first operates at startup. During startup, the 1094B will immediately trigger an out-of-lock alarm since the clock is not locked to the GPS and the time is not accurate. See Figure 6.6.

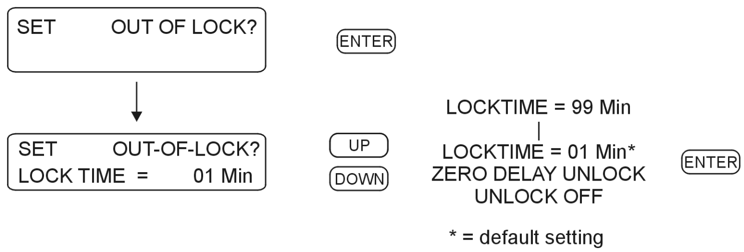

Figure 6.6: Out-of-Lock Time Setup

6.7 Set Backlight

The backlight function in the Model 1094B can be set to operate in three modes: Always ON, Always OFF and Automatic Shutoff (AUTO). AUTO is the most recommended setting, which causes the backlight to turn off automatically after period of 30 seconds. See Figure 6.7.

NOTICE: The backlight has been specified with a 100,000 hour (12 year) life. To conserve backlight operation, configure the backlight for AUTO mode.

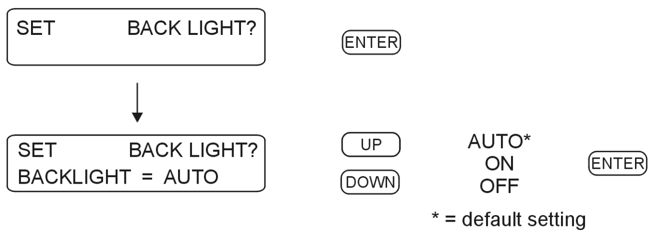

Figure 6.7: Backlight Setup

6.8 Set Cable Delay

GPS time is referenced to the time it is received by the antenna. Without setting the cable delay, the time would be late by the time it would take to travel the distance from the antenna to the GPS receiver. To accurately set the cable delay, you need to know the length and velocity factor of the antenna cable. For the cable supplied with the Model 1094B, calculate the delay by multiplying the the length of the cable (in feet) by 1.19 nanoseconds per foot. The result of this calculation will be in nanoseconds, and you can enter in the whole part of this number into the 1094B. See Figure 6.8.

Calculating Cable Delay

Use Formula 6.1 below for calculating cable delay for Arbiter-supplied RG-6 antenna cables.

$$T = \lambda \frac{1}{CKv} + 1ns \quad (6.1)$$

Where:

T = Cable delay, in nanoseconds;
λ = Cable length, in meters;
C = Speed of light (3×10^8 meters per second);
Kv = 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.

EXAMPLE: A 50-foot antenna cable would contribute the following delay; 50 ft. x 1.19 ns/ft = 59.5 (round up and enter 60).

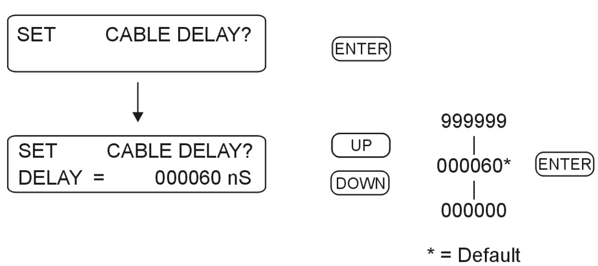

Figure 6.8: Cable Delay Setup

Numeric Data Entry Mode Numeric data entry mode is activated anytime you enter a menu that requires a change in numerical value. Press SETUP to move the cursor to the left; press ENTER to move the cursor to the right. Press the UP and DOWN keys to adjust values.

6.9 Set Programmable Pulse A and B

There are two independent programmable pulse outputs available in the Model 1094B: Programmable Pulse A and Programmable Pulse B. Pulses may be connected at the following ports:

- **Prog Pulse A**, Available on Timing Outputs 1 and 2, and on COM 1.
- **Prog Pulse B**, Available on Timing Outputs 3 and 4, and on COM 2.

Each of these outputs can be set in one of several modes, including:

6.9.1 Programmable Pulse A

- **Pulse Per Second**, pulses occur after a fractional number of seconds have elapsed each second.
- **Pulse Per Minute**, pulses occur at the designated time each minute
- **Pulse Per Hour**, pulses occur at the designated time, each hour
- **Pulse Per Day**, pulses occur at the designated time each day
- **Single Trigger**, pulses occur at the designated time each year
- **Slow Code UTC**, Slow Code is a programmable pulse with a voltage that is held high and goes low for 6 seconds on the day, 4 seconds on the hour and 2 seconds on the minute.

6.9.2 Programmable Pulse B

Programmable Pulse B has all of the features of Programmable Pulse A, but also include:

- **Frequency Mode**, allows the 1094B to produce a square wave on the chosen port, from 1 to 1000 pulses per second.
- **Auxiliary IRIG-B Mode**, allows the 1094B to produce an alternate IRIG-B timing signal, different than what is set in Main IRIG-B. It allows for a different time zone and capability of switching the IEEE 1344 mode ON or OFF.

6.9.3 Programmable Pulse Signal Levels

Due to the different output ports available, the programmable pulse feature is able to produce pulses at the following signal levels:

- **5 V, CMOS**, available at all timing outputs.
- **300 V FET**, available at all timing outputs, for open drain signals.
- **RS-232 Levels**, available with Programmable Pulse A on COM 1.
- **RS-485 Levels**, available with Programmable Pulse B on COM 2.

6.9.4 Programmable Pulse A or B Preliminary Setup

Except for two additional modes with Programmable Pulse B (i.e. Frequency Mode and Aux IRIG Mode), setting up the preliminary information for Programmable Pulse A and B is the same and will be covered here. Before actually choosing the Pulse Mode, you will need to choose the Pulse Polarity (positive or negative), Pulse Width and Pulse Time Zone. Pulse Width is adjustable in 10 millisecond increments from 0.01 to 600 seconds. See Figure 6.9.

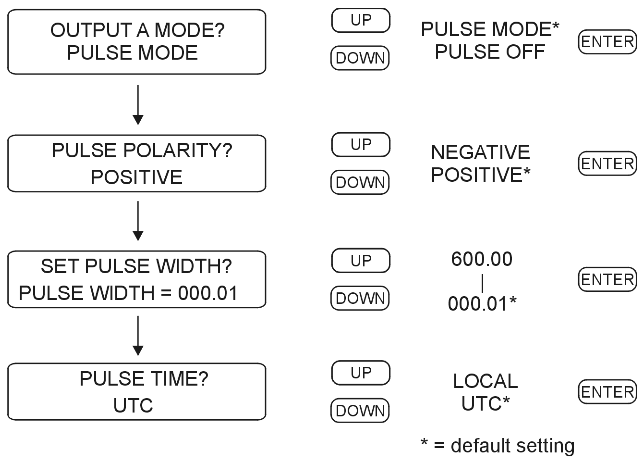

Figure 6.9: Programmable Pulse Setup, Preliminary Information

6.9.5 Setting the Pulse-Per-Second Mode

Use the Pulse-per-Second mode to produce a pulse every second at the set number of fractional seconds after the top of the second. Adjust the time delay after the on-time second mark at which the pulse will occur. Delay values range from 0.01 to 0.99 seconds. See Figure 6.10.

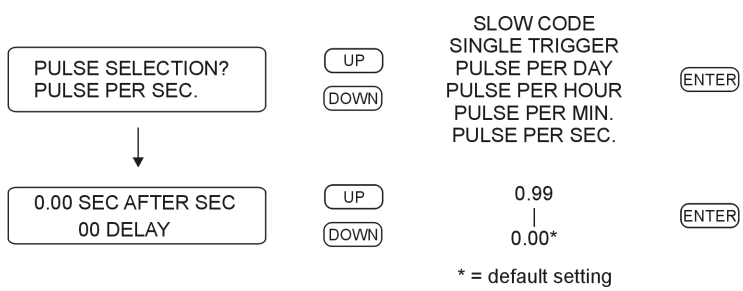

Figure 6.10: Programmable Pulse Setup, Pulse Per Second

6.9.6 Setting the Pulse-Per-Minute Mode

Use the Pulse-per-Minute mode to produce a pulse every minute, at the set number of seconds (and fractional seconds) after the top of the minute. See Figure 6.11.

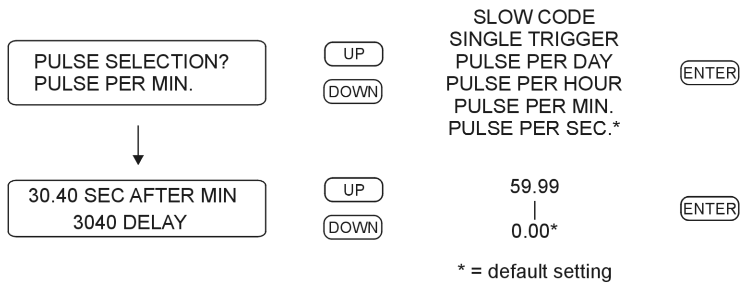

Figure 6.11: Programmable Pulse Setup, Pulse Per Minute

6.9.7 Setting the Pulse-Per-Hour Mode

Use the Pulse-Per-Hour mode to produce a pulse every hour at the set number of seconds (and fractional seconds) after the top of the hour. See Figure 6.12.

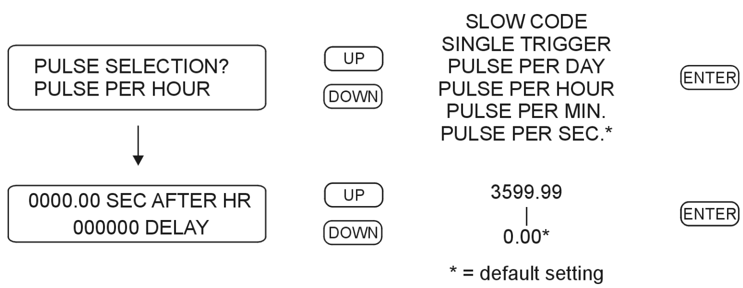

Figure 6.12: Programmable Pulse Setup, Pulse Per Hour

NOTE: Pulse width can be set in 10 millisecond increments from 10 milliseconds up to 600 seconds.

6.9.8 Setting the Pulse-Per-Day Mode

Use the Pulse-Per-Day mode to produce one pulse each day at the set number of seconds (and fractional seconds) after midnight. See Figure 6.13.

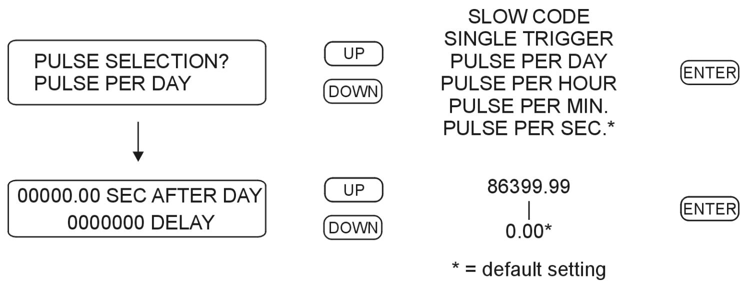

Figure 6.13: Programmable Pulse Setup, Pulse-Per-Day Mode

NOTE: Pulse width can be set in 10 millisecond increments from 10 milliseconds wide up to 600 seconds.

6.9.9 Setting the Single-Trigger Mode

Use the Single Trigger mode to trigger a pulse each year at a specific day of the year and time of day. Setup menus include entries for Julian Day, Hour, Minute, Second and Fractional Seconds. To configure Single-Trigger mode settings, follow the procedure illustrated in Figure 6.14.

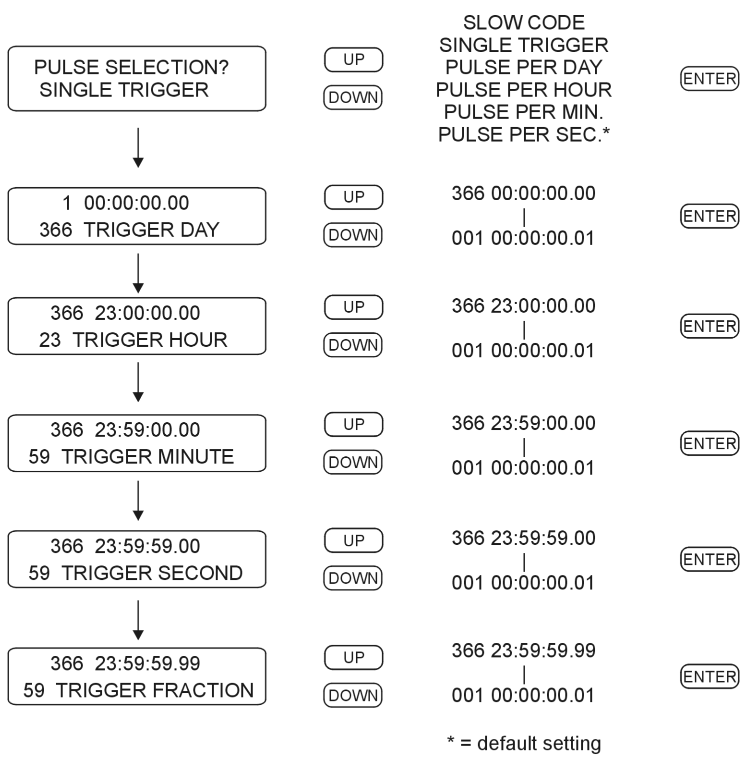

Figure 6.14: Programmable Pulse Setup, Single-Trigger Mode

6.9.10 Setting the Slow-Code Mode

Use the Slow-Code mode to trigger a pulse normally defined as follows: the output voltage is normally held high and it will go low for 2 seconds on the minute, 4 seconds on the hour and 6 seconds on the day. Set the time mode for either UTC or Local time. Slow-Code pulse polarity is always negative. Even if you select Pulse Polarity as Positive in a previous menu, it will be changed to Negative. See Figure 6.15.

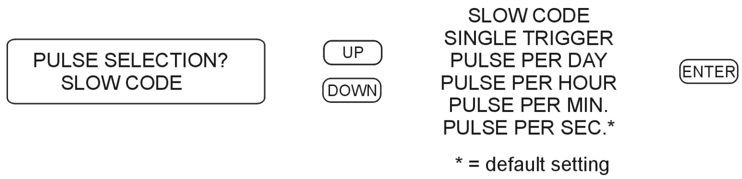

Figure 6.15: Programmable Pulse Setup, Slow-Code Mode

6.9.11 Setting the Frequency Mode, Programmable Pulse B

The frequency mode is available with Programmable Pulse B, not Programmable Pulse A. To use the frequency mode, you must select Programmable Pulse B from the main menus. The frequency mode broadcasts a square wave from the configured port at a rate of 1 to 1000 pulses per second. See Figure 6.16.

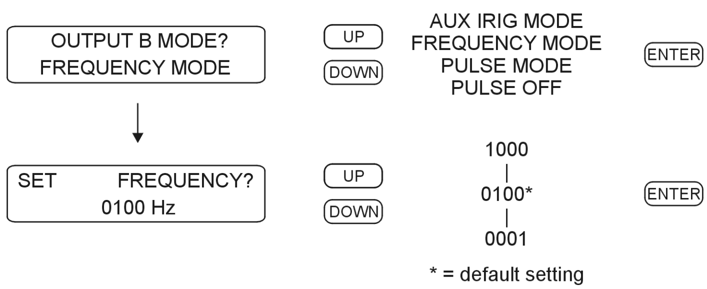

Figure 6.16: Programmable Pulse Setup, Frequency Mode

6.9.12 Setting the Aux IRIG Mode, Programmable Pulse B

The Model 1094B allows you to set up two different forms of the unmodulated IRIG-B time code. For example, one group of relays may require UTC time, and others may require the Local time. Also, this feature allows you to set up one output with the IEEE 1344 ON and OFF for the others. To use the Aux IRIG Mode, you must select Programmable Pulse B from the main menu. See Figure 6.17.

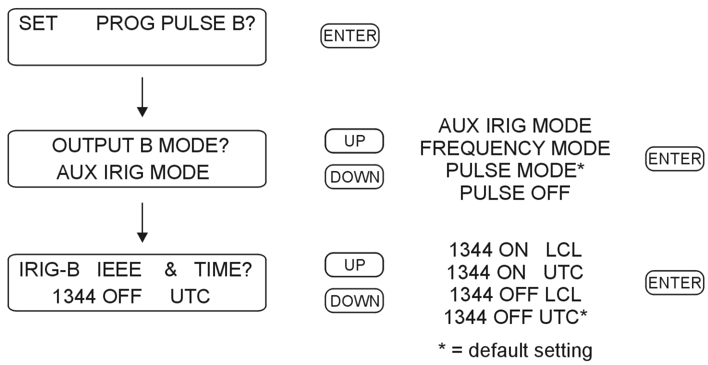

Figure 6.17: Programmable Pulse Setup, Aux IRIG-B Mode

Before configuring this option, please make sure to read over how to configure the internal jumpers for Programmable Pulse B mode. Also, determine which port or connector you would like to use. The Model 1094B allows setting up Programmable Pulse B from Timing Output 3 and/or 4 and also COM 2, RS-485 only. If you would like to use Timing Outputs 3 and/or 4, please turn to Section 5.2, and if you wish to use COM 2, please turn to Section 5.4.

6.10 Set IRIG-B Main

There are two separately-controlled IRIG-B outputs in the Model 1094B: "Set IRIG-B Main" and "Aux IRIG-B Mode." Configure the main IRIG-B settings from this section, and auxiliary (AUX) IRIG-B mode from Section 6.9.12. In this way, you can set up two different time zones for IRIG-B. IRIG-B is an electronic time code, synchronized to the GPS, that is transmitted each second from the Model 1094B. The four choices are (1) setting the time zone to UTC or Local, and (2) having the IEEE-1344 extension turned ON or OFF. To transmit the IRIG-B time code in the UTC time zone, the time will be offset from your local time determined by your locale. IEEE-1344 extension increases the amount of information contained in the time code, including the two-digit date and time quality. To use the IEEE-1344, your receiving equipment (e.g. relays, RTU's, etc.) must be designed to receive the IEEE-1344 time code. See Figure 6.18.

NOTE: Make sure to set your main board jumpers correctly for each of the IRIG-B outputs. For information on setting the IRIG-B jumpers, see Chapter 5, The Setup Menus (Section 5.2) in this manual, or check the Quick Setup Guide.

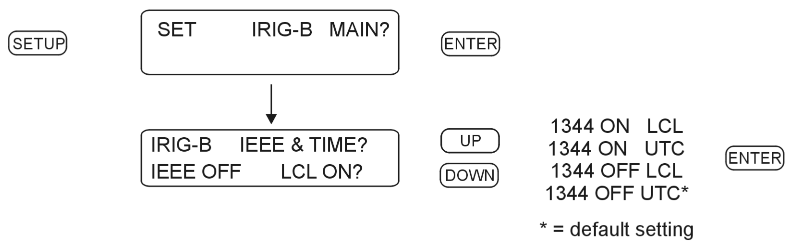

Figure 6.18: IRIG-B Configurations

For additional detail and definition on the different forms of IRIG-B, see Chapter 7, Timing, IRIG-B and Pulses.

6.11 Set Auto Survey

The Model 1094B GPS receiver uses an Auto Survey Mode that determines its position relative to the available Global Positioning Satellites. It has three operating modes that are selectable from the front panel or through either of the serial ports. These modes are (1) Power On Survey, (2) Single Survey and (3) Turn Off Survey. See Figure 6.19.

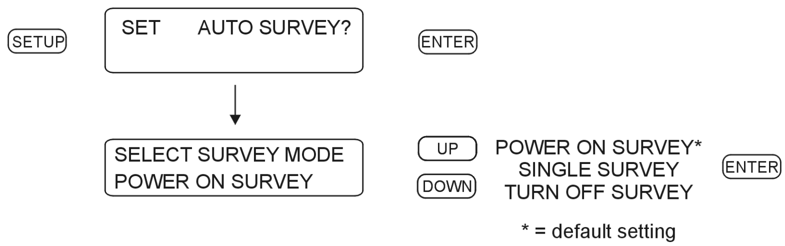

Figure 6.19: Auto Survey Configurations

Once the survey has been started, the Model 1094B will indicate that it is locked to the GPS, and continue to refine the surveyed position. The survey may also be turned off at any time by selecting Turn Off Survey from the front panel.

The Auto Survey averages a total of 10,000 (slightly over 2 1/2 hours) valid 2D and 3D position fixes. If the averaging process is interrupted, the averaging resumes where it left off when tracking resumes. Once the position is surveyed, the M12M timing receiver automatically enters the Position-Hold Mode. Once the antenna site has been surveyed in this manner, the user can expect a 2D position error of less than 10 meters with 95% confidence, and a 3D error of less than 20 meters with 95% confidence.

6.12 Set Event/Deviation

The event inputs are used to time a signal received by the Model 1094B based on the internal time base synchronized to the GPS. The accuracy of these timed events are within a microsecond with a resolution of 0.1 microsecond. See Figure 6.20.

A second feature is to use the event input to measure the deviation of a periodic signal, like the 1-PPS signal.

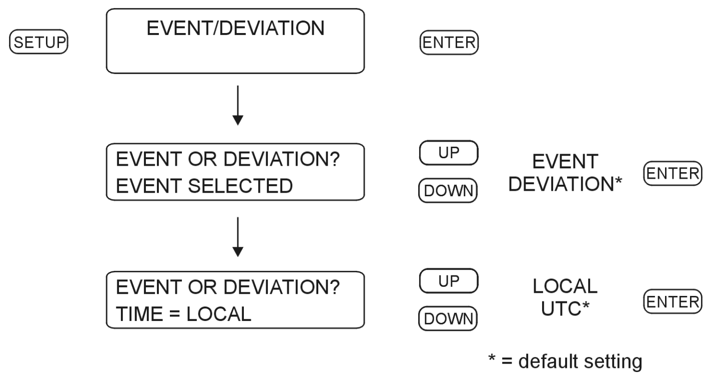

Figure 6.20: Event Configurations

NOTE: If you are configuring for event capture, the next menu will allow you to clear any previously stored events.

CLEAR EVENT DATA?
YES:UP NO:DOWN

NOTE: Events may also be cleared using serial port 1 or 2. See Section 9.3.3

6.12.1 Technical Details of Event/Deviation Timing

For additional technical details on Event and Deviation timing, see Chapter 8, Fault Relay and Event Inputs. For information on setting the Event/Deviation jumpers on the main board, see Section 5.5 in Chapter 5, Setting Internal Jumpers.

Chapter 7

Timing, IRIG-B and Pulses

7.1 Introduction

This section should help you to understand, choose and connect the correct outputs from the 1094B to synchronize your external equipment, or IED's. It should also answer some basic questions, such as:

- What are the different types of IRIG-B, and what are the differences?
- How do you connect multiple devices to one 1094B timing output?
- How far can you transmit timing signals?
- What kind of cabling and connectors should I use?

Often, questions arise about how many loads the output driver will support, and how they should be connected. Also, with each timing output the Model 1094B offers two connector styles from which to choose: BNC for coaxial cables and 5 mm terminals for twisted-pair cabling. Occasionally, a meter requires an RS-485 signal, which differs from the standard TTL/CMOS-level timing signal. This section should help answer these common questions.

The steps involved in getting your devices synchronized to the GPS are fairly simple and should not take long to complete. To expedite the process, make sure that you know:

1. the type of timing signal each piece of equipment requires, and
2. how to enable the equipment to receive the timing signal.

Sometimes, you will need to set a physical jumper, or you may need to configure it through the instrument setup program. Some equipment can auto detect the timing signal, so that nothing else is required, other than connecting the cable.

7.2 Timing Output Description

When viewing the rear panel of the Model 1094B, you will see that there are a number of different types of connectors as illustrated in Figure 7.1. Starting from the right-hand side, there is a power inlet connector, a GPS antenna connector, one event input connector, two DB-9 serial connectors, one SPDT relay connector and four timing outputs. Except for the GPS antenna connector, each connector can have multiple functions. In the sections that follow, you should be able to understand each function to correctly configure them.

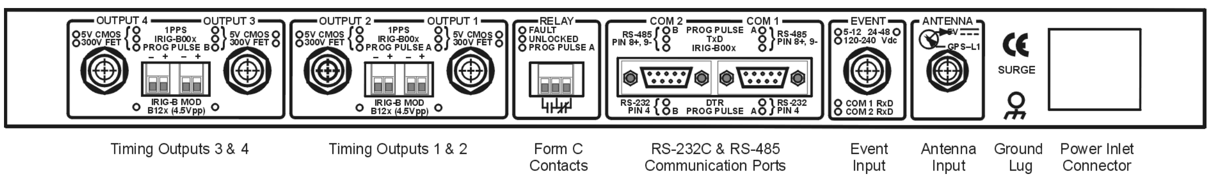

Figure 7.1: Model 1094B Rear Panel Description

7.2.1 High-Drive Timing Outputs

The Model 1094B has four, identical and separate high-drive outputs, each with two connector styles to simplify use. Outputs may be configured for modulated IRIG-B (AM or analog), unmodulated IRIG-B (demodulated or CMOS Level Shift), 1 Pulse Per Second (1 PPS) and Programmable Pulse (PROG PULSE). Designed with a low source impedance, the output drive should be able to support a large number of loads that depend on the device (IED) load impedance. In addition, each output may be configured for 300 V, open-drain FET for high-level switching.

7.2.2 Digital Drivers

Each of the four timing outputs uses a separate NDS332P Logic level, enhanced-mode FET for digital signals (like unmodulated IRIG-B, 1 PPS and Programmable Pulse), capable of 250 mA at 5 Vdc. Together, these four outputs together can provide up to one amp of drive current at TTL/CMOS levels. This permits you to connect a large number of IED's that would draw up to that amount of current. For example, if the IED timing signal input (e.g. IRIG-B003) requires 10 mA, one output channel should be able to support 25 identical devices.

7.2.3 Analog Drivers

Each of the four outputs also has a separate analog driver to be used exclusively for *modulated IRIG-B signals*. The analog driver is basically a push-pull audio design (MMBT4401/4403), which supplies a 4.5 Volt peak-to-peak (Vpp) signal through a 19.6-ohm source resistor to IED's. As the load current increases (by adding external IED's), more voltage is dropped across the clock source resistor and the drive voltage decreases. Due to this change in peak-to-peak output, matching the modulated IRIG-B output voltage to the IED input is sometimes critical. Make sure to check the equipment specification so that you understand the input voltage levels. Table 7.1 shows how the actual drive voltage varies with increasing load current. For IED's with a restricted input range, it may be necessary to match the available drive voltage to the IED through a small dropping resistor.

Drive Current, mA	Actual Drive Voltage, Vpp
0	4.5
1	4.48
10	4.3
100	2.54

Table 7.1: Drive Current vs. Voltage

7.3 Output Signal Description

The Model 1094B has four separate and independent timing outputs (labeled Output 1, 2, 3 and 4) with a selection of signal options for each output. Signals are selected both by internal jumpers and through firmware. By jumper, there are three separate timing signals available on each of the four outputs, and by firmware you can change specific information in the timing signal. By jumper, the three signal types are:

1. IRIG-B, modulated (B120 and B123) and unmodulated (B000 and B003)
2. 1 Pulse Per Second
3. Programmable Pulse

7.3.1 IRIG-B Description

IRIG-B is a complete serial time code that occurs once per second and is defined by four terms: Format, Modulation Frequency, Frequency Resolution, and Coded Expressions (e.g. for B120, B = Format B, 1 = sinewave, 2 = 1 kHz, and 0 = BCD, CF and SBS). The Model 1094B allows only Format B with four variations as seen in Table 7.2. Other IRIG formats are A, D, E, G, and H. Note that with the newer IRIG Standard 200-04, two of the designations have changed: the older B000 has become B004 and B120 has become B124.

Designation	Signal Type	Code Components
B000	Pulse width code, No carrier	BCD_{TOY}, CF, SBS
B003	Pulse width code, No carrier	BCD_{TOY}, SBS
B120	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, CF, SBS
B123	Sine wave, amplitude modulated, 1 kHz	BCD_{TOY}, SBS

Table 7.2: IRIG-B Time Code Types Available in the 1094B

There are three functional groups of bits in the IRIG-B time code, in the following order: - Binary Coded Decimal (BCD), Control Function (CF) and Straight Binary Seconds (SBS). The BCD group contains only time information including the seconds, minutes, hours and days, recycling yearly. The CF group contains year, time quality, leap year, pending leap seconds and parity. The SBS consists of the total elapsed seconds, recycling daily. Position identifiers separate the various components of the IRIG-B time code.

The 1094B also has an alternate mode for broadcasting IRIG-B, called the Aux IRIG Mode, that is a function of the Programmable Pulse B feature. When using this feature, the Model 1094B can send IRIG-B in two different time zones from the same clock. For example, you could send time to one device in Local time format and to another in UTC time format.

7.3.2 Modulated and Unmodulated IRIG-B

Figure 7.2 illustrates the primary differences between modulated and unmodulated IRIG-B. You will notice that the while modulated IRIG-B (B120) is distinctive because it uses a sinewave carrier signal of 1 kHz, it is similar to unmodulated IRIG-B (B000) since the peak-to-peak values of the carrier follow the same form as the digital waveform, where the information is contained.

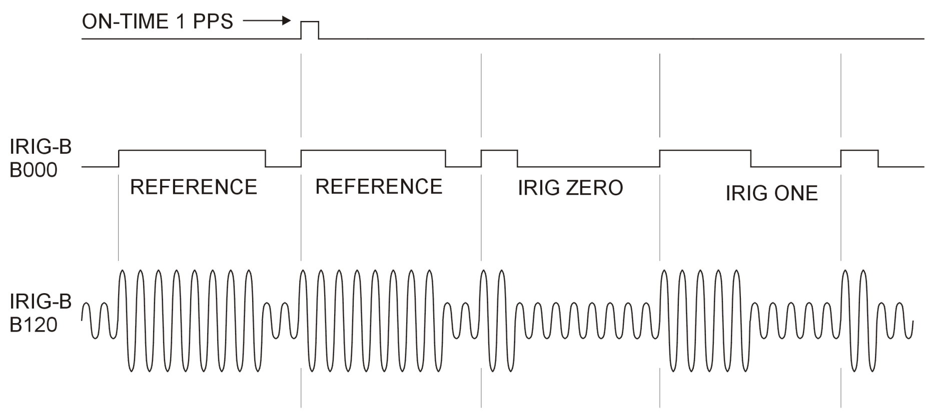

Figure 7.2: IRIG-B Waveforms

The IRIG-B time code consists of 100 bits produced every second, 74 bits of which contain various time, date, time changes and time quality information of the time signal. Consisting of logic ones, zeros and position identifier bits, the time code provides a reliable method of transmitting time to synchronize various equipment.

7.3.3 IRIG-B Produced by the 1094B

The Model 1094B provides IRIG-B that follows four type codes: two with unmodulated IRIG-B and two with modulated IRIG-B. The two signal types for each group are because of the IEEE 1344 extension, or CF portion of the time code. The Model 1094B allows you to turn the IEEE 1344 extensions ON or OFF, the differences depicted in Table 7.3.

IRIG-B Type	**1344 ON**	**1344 OFF**
Unmodulated, B00X	B000*	B003
Modulated, B12X	B120*	B123

Table 7.3: IRIG-B Code Designations

*The IRIG Standard 200-04 has changed the designations so that Year information is now considered part of BCD and denoted as BCD_{YEAR}. This means that what was considered B000 and B120 would now be denoted as B004 and B124.

7.3.4 IRIG-B IEEE 1344 Extension

As mentioned above, the IEEE 1344 enables extra bits of the Control Function (CF) portion of the IRIG-B time code. Within this portion of the time code, bits are designated for additional features, including:

- Calendar Year (old method, now called BCD_{YEAR})
- Leap seconds, and Leap seconds pending
- Daylight saving time (DST), and DST pending
- Local time offset
- Time quality
- Parity
- Position identifiers

To be able to use these extra bits of information, relays, RTU's and other equipment receiving the time code must be able to decode them. Consult your equipment manual to determine if the IEEE 1344 feature should be turned ON in the Model 1094B. To view details of the IEEE Std 1344-1995, please check with the IEEE.

NOTE: To download a copy of of the IRIG-B 2004 specification, please use the link to the Arbiter web site.

http://www.arbiter.com/catalog/timing_freq_index.php and click on IRIG-B.

7.3.5 1 Pulse-per-Second (1 PPS)

A one Pulse-Per-Second timing output signal is very simple in concept. It is a digital bit transmitted every second with a pulse width of 10 milliseconds. Probably the most critical part of this signal is that it is "on time" at the rising edge, compared with the signal from the Global Positioning System (GPS). When configured from any of the TTL/CMOS (5-volt) drivers, it has the same drive power as the IRIG-B and the Programmable Pulse. See Figure 7.2 for a comparison between unmodulated IRIG-B and 1 PPS.

7.3.6 Programmable Pulse (PROG PULSE)

The Model 1094B has two independent programmable pulse functions: Programmable Pulse A and Programmable Pulse B. Programmable Pulse A has a pulse mode that allows various pulse timing options from pulses each second up to one pulse per year. Programmable Pulse B has the same functions as A except that it has a Frequency Mode and Auxiliary IRIG Mode. The Programmable Pulse A and B feature set is shown in Table 7.4 below.

Other possible signals include controlling a 300-Volt FET for high-level signal handling with any of the available digital signals. The Programmable Pulse feature also has an adjustable pulse width in 10 millisecond increments from 10 milliseconds to 10 minutes in duration.

7.3.7 Programmable Pulse with 300-Volt FET, Setup

With this setting you can perform high-level switching at any of the four timing outputs, setting the 1094B to trigger a pulse at the required time of day or time interval. Connect a voltage of

Programmable Pulse Function	Prog Pulse A	Prog Pulse B
Pulse Per Second	yes	yes
Pulse Per Minute	yes	yes
Pulse Per Hour	yes	yes
Pulse Per Day	yes	yes
Single Trigger	yes	yes
Slow Code	yes	yes
Frequency Mode	no	yes
Aux IRIG Mode	no	yes

Table 7.4: Programmable Pulse Output Functions

up to 300 volts and pull down a signal with the Open Drain 300-Volt FET. Remember to connect the FET with suitable protection against overvoltage transients and over current conditions. To set timing output jumpers for programmable pulse with 300-Volt FET, see Section 5.2. Next, you will need to configure the type of programmable pulse through the Setup Menus. See Section 6.9 for more details on setting up the programmable pulse through the Setup Menus. Programmable Pulse features may also be set up remotely through either serial communication port. For setup through the RS-232C ports, see also Section 9.3.10, Programmable Pulse Output Commands.

7.3.8 Protecting the 300-Volt FET Connection

Open-drain outputs are not internally protected against overcurrent or overvoltage. Maximum peak ratings are 10 A and 400V. External protections (current-limiting resistors, surge suppression diodes, snubbers, etc.) must be provided by the user, if required, to ensure that maximum ratings are not exceeded even momentarily. Also, please check the data sheet of the IRF740S FET used in the Model 1094B.

7.4 Connecting Outputs

The Model 1094B comes equipped with two types of output connectors: BNC female and screw terminals. BNC connectors are standard and are compatible with most coaxial cables. Terminal connectors are compatible with twisted pair cabling, in which the wires are stripped bare, tinned and fixed into the correct screw terminal positions.

NOTE: If using a shielded, twisted-pair cable (like Belden 8760), DO NOT connect the cable shield at the clock. Always connect a cable shield at the receiving equipment (IED) grounding point.

7.4.1 Attaching Cables to Screw Terminals

Prepare the twisted pair cable by stripping back at least 1/4 inch of the insulation and any shielding, and tin the bare wire. Tighten the screws down on the wire. *Do not ground the shield to the Arbiter clock.*

7.4.2 How Far Can I Run IRIG-B Cabling?

Some important considerations for transmitting IRIG-B over long distances are: (1) resistive losses in cabling, (2) electromagnetic interference, (3) propagation delays and (4) installation and maintenance costs.

For details on distributing IRIG-B signals over long distances, see application note, AN101, Distributing Timing Signals in a High-EMI Environment. Download file *appnote101.pdf* at the following link:

http://www.arbiter.com/ftp/datasheets/

For important considerations about IRIG-B connections, distribution of signals and accuracy, download the file, *IRIG-B_accuracy_and_connection_requirements.pdf* at the following link:

http://www.arbiter.com/ftp/datasheets/.

7.4.3 Synchronizing Multiple IED's From One Masterclock Output

In many installations, master clock signals (e.g. the 1094B) are "fanned out" to a number of devices. This method makes more efficient use of the clock synchronizing capability since the clock drivers are designed to handle multiple loads. The exact number of possible loads must be determined from the input impedance of each connected IED. For example, if the input impedance of the IED is 5 kilohms, determine the device current (I) drawn as follows:

$$I = V/Z = 5\ Volts/5000\ Ohms = 0.001\ Amps(1\ mA) \tag{7.1}$$

If you were to connect ten of the same IED's to the same output, then the total current drawn would be 10 x 0.001 A = 0.01 A (10 mA).

7.4.4 Connecting Unmodulated IRIG-B

To drive multiple loads from a single 1094B timing output, make sure they are wired in parallel. Some technicians might call this "Daisy-Chaining", however the idea is to drive all of these loads in parallel from the single output. It is much simpler to connect loads to unmodulated IRIG-B than for modulated. This is because all of the loads are driven at the same voltage and each draws current from the transmission line.

To determine capacity for Unmodulated IRIG-B, follow these steps:

1. determine the number of loads to be connected to a single clock output
2. determine the impedance (or resistance) of each load
3. divide the drive voltage (5 V) by the resistance of each device
4. sum up all the load currents for the total current for one clock output.

Another method is to determine the lumped impedance of all of the connected IED's in parallel. Then, determine the overall current by dividing the drive voltage (5 V) by the computed lumped impedance value. This current should not exceed 250 mA.

7.4.5 Connecting Modulated IRIG-B

The total load capacity for the modulated IRIG-B driver depends on the type and number of loads. The main difference in computing the load capacity for modulated IRIG-B and unmodulated IRIG-B is that modulated IRIG-B decoders tend to be sensitive to the peak-to-peak voltage. When adding loads, the 1094B modulated driver produces more current, which is passes through the internal source resister, dropping the available output voltage. The open circuit voltage (i.e. no loads) is approximately 4.5 Vpp, so any connected loads will cause the available voltage to drop. It is a simple task to compute the available output voltage (Vpp) with a known current.

$$Vpp = 4.5\ Vpp - I(19.6\ Ohms) \tag{7.2}$$

Therefore, if you had 10 mA of load current (I load) the available voltage (Vpp) would be 4.304 Vpp. If the load current equals 100 mA, then the available voltage would be 2.54 Vpp. So, you can see how the increasing load current (i.e number of loads) affects the available drive voltage at the clock output. See also Table 7.1.

7.4.6 Wire Losses

Another factor affecting the available voltage is the resistive losses through the cabling. Wire has a certain resistivity associated with it that is determined by its metallic composition, and resistance determined by the diameter and length. For example, single-strand, 22 AWG (bare, enamel-coated) copper wire has a resistance of approximately 19.6 ohms per 1000 feet. To compute the loss we must include both wires in the connection, signal and return. For coaxial cabling, the resistance of the center conductor is rated differently than the shield. For a twisted pair, both of them should essentially have the same resistance per cut length. If we use a twisted pair of 22 AWG (copper as above), then the available voltage (at 100 mA of current) for 500 feet of wire including the source resistor would be:

$$Vpp\ available = 4.5 - I(19.6\ source) - I(19.6\ wire) = 0.58\ Vpp \tag{7.3}$$

So, you can see that most of the drive voltage is lost with 100 mA of current and 500 feet of 22 AWG twisted pair transmission line, including the losses at the source resistor. 0.58 Vpp may very likely not be detected by the decoder in most IED's. Remember to make your cable runs as short as possible, to use a larger diameter cable, and to carefully distribute the loads.

7.4.7 Voltage Matching for Modulated IRIG-B

With modulated IRIG-B, it was mentioned that certain decoders are very intolerant of drive voltage variation. If the IED specification says that the acceptable voltage range is 3.3 Vpp +/- 0.5 volt, and the available voltage is high, then you must reduce the voltage using a dropping resistor. The value of the dropping resistor is determined by dividing the difference voltage by the device current. For example, suppose that the available voltage is 4.5 Vpp, the (nominal) acceptable voltage is 3.3 Vpp, and the device current is 10 mA. Determine the dropping resistor value.

$$R\ drop = V\ difference/I\ device = (4.5 - 3.3)/0.01 = 120\ Ohms \tag{7.4}$$

The Power dissipation (P) is:

$$P = I^2R = (0.01)^2(120) = 0.012\ Watts \tag{7.5}$$

An eighth-watt resistor should work fine.

For a voltage that is too low, then the modulated IRIG-B signal level must be increased by some other means, such as (1) distributing the load differently to reduce the current (raising the available voltage), (2) increase the wire size, or (3) by using an amplifier.

7.4.8 Cable Delays

Electromagnetic waves travel at the speed of light (C) in free space or vacuum and a fraction of that through cabling. The speed of an electromagnetic wave in free space is given by Constant 7.6.

$$C \approx 9.84(10^8)\ feet/second \tag{7.6}$$

Since electromagnetic waves travel slower through any cable, cable manufacturers normally specify cable with a velocity factor (VF), which is a percentage of the speed of light in free space, and characteristic of the specific cable. The Velocity Factor for the RG-6 cabling used by Arbiter Systems for GPS antenna connections, is about 83% of C. Most transmission lines have velocity factors in the range of 65% to 97%. Using these values you can determine the actual time delay in your cable distribution system and compare it to your required accuracy. As an example, it would take 840 feet of RG-6 cable (with a velocity factor of 83%) to delay the signal by one microsecond. For IRIG-B timing applications, these delays may not be important, compared to other criteria. Otherwise, you would be forced to compensate for the time delay using another method, such as advancing the timing output or placing another master clock at the remote site.

7.4.9 Solutions

There are many solutions to providing an accurate timing signal in distant locations. However, the most satisfying solution may not be to string cabling for hundreds of meters. The costs associated with installing and maintaining cabling over a wide area may be unsatisfactory. Since the GPS is so pervasive, it may prove to be less costly to install another clock at a distant location, which would also improve accuracy and provide redundancy. Before installing cabling over a wide area, be sure to first examine all the possibilities.

Chapter 8

Relay Contacts and Event Inputs

8.1 Introduction to Relay Operation

The Model 1094B has one set of mechanical, Form C relay contacts that may be configured to switch with a predetermined fault, an out-of-lock condition, or driven by the programmable pulse feature. When configuring the 1094B relay contacts for programmable pulse, take care to compare the pulse rate with the life expectancy of the contacts. See Chapters 5, 6 and 9 for details on configuring the Model 1094B for programmable pulse.

8.2 Configuring

To configure these contacts, you will need to remove the cover to the clock chassis locate JMP8. It is located just slightly left of center. See Section 5.3 for more information on configuring these jumpers.

8.3 Fault Conditions

If the FAULT LED illuminates, the clock status message will change to read:

CLOCK STATUS
ERROR XXX

Where XXX = one of the error messages listed below.

1. Receiver Failure (no communication between clock and GPS Receiver)

2. Antenna Short (antenna voltage is very low; it is normally 5 Vdc)

3. Antenna Open (antenna not drawing any current)

8.4 Viewing the Fault Status

If the Model 1094B executes a fault due to one of the conditions listed above, it will display the Clock Status fault condition on the LCD and illuminate the Fault LED. The fault status will also be available using the Event Status commands through either of the serial communications ports. See Chapter 9, Serial Communication and Command Set, for details on using the serial port to configure and access the event information.

8.5 Connecting to the Multimode Relay

When connecting the 1094B multimode relay, do not exceed the ratings and specifications. Figure 8.1 below illustrates the 5-mm spaced terminals on the connector plug for fastening wiring. Normal procedure is to strip the wire by one-fourth inch or more and tin with solder prior to attaching to the connector plug. Tighten the set screw to fasten the wires.

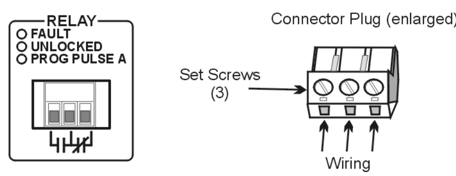

Figure 8.1: Rear Panel Relay Contact location and Connector Plug

8.6 SPST Relay Specifications

- Type, SPST, plastic encapsulated, sealed plastic construction
- Make/Model, OMRON/G6RN-1-DC5
- Rated switching current: 8 A @ 250 VAC and 5 A @ 30 VDC
- Max. switching capacity: 2,000 VA, 150 W
- Life expectancy: approx. 100,000 cycles/electrical, 10,000,000 cycles/mechanical
- Max. Frequency: approx. 360 operations/hour
- plastic sealed construction

8.7 Introduction to Event Inputs

This section should provide more detail on the operation of the Event Inputs on the 1094B. To configure the event capture settings, see Section 5.5, Configuring Event Input Jumpers, and Section 6.12, Set Event/Deviation.

8.8 Event Timing Inputs

The Model 1094B provides one dual-function Event Input channel with 1-microsecond resolution at three possible input connectors: dedicated Event Input connector, COM 1 or COM 2. The Event Input channel may be used to time an input signal or continuously measure the 1-PPS deviation.

Data for individual recorded events can be recalled using either the Event/Deviation front panel key or via the RS-232C interface (see Section 9.3.3). Data for each event will be retained until it is retrieved using one of these two methods. Thus, if no event data points are retrieved, recording will be suspended when the total number of events 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.

8.8.1 Event Timing – Latency

Event data are recorded using a high-speed capture circuit operating with a 96 MHz time-base. Latency is limited by the interrupt processing speed of the clocks microcontroller, which in turn depends on its workload at the time the event is received. Since the workload varies from time to time, latency likewise varies. However, response time will, in general, never be less than a few hundred microseconds nor greater than 10 milliseconds.

8.8.2 Deviation Measurement

The event input can also be configured to display measured event times as 1 pulse-per-second (1 PPS) deviation measurements. The 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 clock determines the mean time difference between the two signals, which can be displayed on the front panel or read via either COM 1 or COM 2.

8.8.3 Measurement Principle

The measurement technique employed for 1-PPS Deviation uses the same time determination and recording scheme used for Event Time measurement (refer to paragraph 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 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, each Event Time Record will be overwritten once every 300 seconds.

Once every second, the processor 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 ($\pm$ 0.5 seconds). Statistical computations are then performed on the 16 values to determine their Mean and Sigma (Standard Deviation) values, which can then be displayed on the front panel or output via either COM 1 or COM 2.

8.8.4 Event Timer Input Channel Configuration

In order for the Model 1094B to receive a timing input, adjustments to both the hardware and software configuration may be required. The hardware configuration is described in Section 5.5, where jumpers JMP2 and JMP3 are identified.

8.8.5 Displaying Event Data

Event and Deviation data can be accessed from either the front panel, COM 1 or COM 2. The following paragraphs describe the steps required to access data using the front panel EVENT/DEVIATION key. When pressing the EVENT/DEVIATION key, the display will enter a circular scroll, which begins by showing the data (if any is present), as previously configured for Event Recording. The readout will display one of the event times (000 to 299), using the following format:

EVENT nnn
ddd:hh:mm:ss.sssssss

Where:

"nnn" = event number (000 to 299)
"ddd" = day of year of the event (1 to 366)
"hh" = hour of the event (00 to 23)
"mm" = minute of the event (00 to 59)
"ss.sssssss" = second and fractional seconds of the event

Press the UP or 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.

8.8.6 Clearing Events

You can only clear stored events if EVENT is selected. To clear all events stored in the event storage buffer, press the SETUP key until you reach the menu that says,

SET EVENT/DEVIATION?

Press ENTER and the display should read,

SET EVENT/DEVIATION?
EVENT SELECTED

Press ENTER and the display should read

CLEAR EVENT DATA?
YES:UP NO:DOWN

NOTE: Events may also be cleared using serial port 1 or 2. See Section 9.3.3

Chapter 9

Serial Communication and Command Set

9.1 Introduction

The Model 1094B has two RS-232/485 ports, called COM 1 and COM 2. COM 1 combines the two functions of RS-232 and RS-485 at one DB9M connector (J5), and COM 2 combines the two functions of RS-232 and RS-485 in a separate DB9M connector (J7). The RS-232 ports do not use flow control, and the RS-485 ports function in transmit only mode.

Use the two serial ports interchangeably for separate functions. You may wish to interrogate the clock on one port for basic information (i.e to configure something) and at the same time be able to have the second serial port broadcasting a specific time code to a meter. While most recent substation equipment has standardized on the IRIG-B time code, some devices are designed to receive ASCII data through the serial port. Another common serial-port function is to connect a digital wall display to indicate the time.

9.2 Communication Port Information

Table 9.1 lists functions and associated pins for both the RS-232 and RS-485 ports.

Pin No.	**Function**	**Pin No.**	**Function**
1	Not Connected	6	RS-232 Input
2	RS-232, Rx Data	7	Not Connected
3	RS-232, Tx Data	8	RS-422/485, Tx-A
4	RS-232 Output/Prog Pulse	9	RS-422/485, Tx-B
5	Ground	–	–

Table 9.1: COM 1 and COM 2 Pin Definitions

9.3 Command Set

This section provides information for controlling and communicating with the Model 1094B via the RS-232C serial interface. All off the RS-232 commands are functionally grouped into similar categories. For example, Section 9.3.8 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. Detailed information used to interpret the commands and responses follows each command heading. Sometimes the command is very short, such as the command to return the Local Time: TL. Other commands require a prefix before the letter command to specify them, such as to broadcast: m,n,o,pBR. For example, the command to start the ASCII Standard broadcast string at a rate of once per second, on Local time, from COM 1 is 1,1,1,0BR.

When a command requests information from the 1094B, 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 if programming, by sending a sequence of carriage-return/line-feed characters.

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

↵ = Shorthand for carriage-return, line-feed
U = UTC Time
L = Local Time
soh = An ASCII character (start of header) = Hex 01
bel = An ASCII character = Hex 07
n = integer used for various numerical values (e.g. nnn in minutes)
yyyy = four digit year
ddd = Julian day-of-year
mm = month
hh = hour
mm = minute
ss = second

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

9.3.1 Broadcast Mode Overview

Command Explanation

Broadcast strings are controlled by using the command **m,n,o,pBR**, where m = 0 to 13, and include the following broadcast messages:

0, INTERROGATE MODE
1, ASCII STD
2, VORNE STD
3, EVENT DATA
4, STATUS
5, EXT. ASCII
6, ASCII + QUAL
7, YEAR + ASCII
8, NMEA183GLL
9, NMEA183ZDA
10, ABB_SPA_MSG
11, DISPLAY_BUFFER
12, CUSTOM 1 (Patek Philippe Msg)
13, CUSTOM 2 (Kissimmee Msg)

n = the update rate, from 0 to 9999 seconds o = the Time Zone, where 0 = UTC and 1 = Local p

= the COM port, where 0 = COM 1 and 1 = COM 2

Broadcast Example: Set the 1094B to broadcast the Vorne Std output at a rate of once per second, in Local time from COM 1.

Send: **2,1,1,0BR**

To turn off a broadcast, Send: **0BR**, for COM 1, or **1BR**, for COM 2.

Returned Settings After sending certain commands to configure the Model 1094B, the clock will

send the new settings back to the computer or terminal. For example after sending 2,1,1,0BR, the clock will return the following: Returned: **m:02 n:0001 o:01 p:00**

9.3.2 Broadcast Commands

Broadcast Mode – INTERROGATE (OFF)

Command: **0BR, 1BR** 0BR deactivates the RS-232C Broadcast Mode (resets to Interrogate Mode) on COM 1. 1BR deactivates the RS-232C Broadcast Mode on COM 2. m,n and o are not necessary to turn off the broadcast from either COM port.

Response: ↵

Broadcast Mode – ASCII STD

Command: **1,n,o,0BR, 1,n,o,1BR**

1,n,o,0BR configures the 1094B to broadcast the time-of-day as ASCII standard data on COM 1. 1,n,o,1BR configures the 1094B to broadcast ASCII standard data on COM 2. Set n equal to the desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local), where o = 0 for UTC and o = 1 for Local.

Response: <soh>ddd:hh:mm:ss↵

Broadcast Mode – VORNE STD

Command: **2,n,o,0BR, 2,n,o,1BR**

2,n,o,0BR configures the 1094B to broadcast from COM 1 data formatted for Vorne large format time displays. Refer to Arbiter Systems Application Note 103 for more information. 2,n,o,1BR configures the 1094B to broadcast Vorne-formatted data on COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Response:

44hhmmss↵(UTC/Local Time)
55ddd↵(day of year)
11nn↵(out-of-lock time)
bel (bel = Hex 07; sounds at the end of the time code)

Response (broadcast interval depends on n; the number and order of strings returned depend upon options ordered with clock, for example Option 28):

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.

Broadcast Mode – EVENT DATA

Command: **3,n,o,0BR, 3,n,o,1BR** 3,n,o,0BR configures the 1094B to broadcast from COM 1 any event data at the time it is recorded. 3,n,o,1BR configures the 1094B to broadcast from COM 2 any event data at the time it is recorded. n is ignored and o determines whether the event time is either UTC (o=0) or Local (o=1).

Response:

Local mm/dd/yyyy hh:mm:ss.sssssss nnnAL↵
UTC mm/dd/yyyy hh:mm:ss.sssssss nnnU↵

Where:

nnn = Event-Buffer Read Index Number
U = UTC Time
L = Local Time

Broadcast Mode – STATUS

Command: **4,n,o,0BR, 4,n,o,1BR** 4,n,o,0BR configures the 1094B to broadcast any status data from COM 1 when it changes. 4,n,o,1BR configures the 1094B to broadcast any status data from COM 2 when it changes. n and o are ignored. NOTE: When a valid fault is detected, the specific status fault is broadcast (with Julian day, and time) to the chosen serial port once. When the fault clears, another message is sent describing the cleared fault.

Response with fault:

ddd:hh:mm:ss OUT OF LOCK ↵

or:

ddd:hh:mm:ss ANTENNA OPEN ↵

or:

ddd:hh:mm:ss ANTENNA SHORT ↵

or:

ddd:hh:mm:ss RECEIVER FAILURE ↵

Response when fault clears:

ddd:hh:mm:ss LOCKED ↵

or:

ddd:hh:mm:ss ANTENNA OK (after OPEN or SHORT) ↵

or:

ddd:hh:mm:ss RECEIVER OK ↵

Broadcast Mode – EXT. ASCII

Command: **5,n,o,0BR, 5,n,o,1BR** EXT. ASCII (or Extended ASCII) and adds a time quality indicator to the end of the Standard ASCII time string. 5,n,o,0BR configures the 1094B to broadcast from COM 1 the time-of-day as ASCII using an extended format prefaced with a time quality indicator (Q). 5,n,o,1BR configures the 1094B to broadcast the same data from COM 2. The start bit of a carriage-return is transmitted on time. Set n equal to your desired broadcast interval (in seconds), o according to the desired time zone (UTC or Local).

Response:

↵Q␣yy␣ddd␣hh:mm:ss.000␣␣␣

Format:

↵ = Carriage-return, line-feed.
Q = Time quality indicator, and may be represented by:
(a space) = meaning it is locked with maximum accuracy.
? = (ASCII 63) unlocked, accuracy not guaranteed
␣ = used for clarity only and graphically represents the location of ASCII spaces.

Broadcast Mode – ASCII + QUAL

Command: **6,n,o,0BR, 6,n,o,1BR** ASCII + QUAL means Standard ASCII plus Time Quality Indicator. 6,n,o,0BR configures the 1094B to broadcast from COM 1 the time-of-day as ASCII data appended with a time quality indicator. 6,n,o,1BR configures the 1094B to broadcast from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Response:

<soh>yyyy:ddd:hh:mm:ssQ↵

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 – YEAR + ASCII

Command: **7,n,o,0BR, 7,n,o,1BR** YEAR + ASCII is the same as ASCII plus Time Quality Indicator adding the four-digit year to the beginning of the string. 7,n,o,0BR configures the 1094B to broadcast from COM 1 the year and time-of-day as ASCII data appended with a time quality indicator. 7,n,o,1BR configures the 1094B to broadcast from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Response:

<soh>yyyy:ddd:hh:mm:ssQ↵

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 - NMEA183GLL

Command: **8,n,o,0BR, 8,n,o,1BR** 8,n,o,0BR configures the 1094B to broadcast the National Marine Electronics Association Standard (NMEA - 0183) to broadcast from COM 1. 8,n,o,1BR configures the 1094B to broadcast the same standard from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

GLL - Geographic Position, Latitude-Longitude
Latitude and Longitude of present vessel position, time of position fix and status.
Response:

$–GLL,llll.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

Broadcast Mode - NMEA183ZDA

Command: **9,n,o,0BR, 9,n,o,1BR** 9,n,o,0BR configures the 1094B to broadcast the National Marine Electronics Association Standard (NMEA - 0183) to broadcast from COM 1. 9,n,o,1BR configures the 1094B to broadcast the standard from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

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 – ABB_SPA_MSG

Command: **10,n,o,0BR, 10,n,o,1BR** 10,n,o,0BR configures the 1094B to broadcast the ABB SPA format from COM 1. 10,n,o,1BR configures the 1094B to broadcast the same format from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

The ABB SPA Time String is a sequence of 32 ASCII characters starting with the characters >900WD and ending with the Carriage Return character. The letters printed in Italics are replaced by ASCII numbers whereas the other characters are part of the time string. The groups of characters as defined below:

Response:

>900WD:yy-mm-dd_hh.mm;ss.fff:cc ↵
yy-mm-dd the current date:
yy = year of century, (00..99)
mm = month, (1..12)
dd = day of month, (01..31)
_ = Space (ASCII code 20H)
hh.mm;ss.fff the current time:
hh = hours, (00..23)
mm = minutes, (00..59)
ss = seconds, (00..59, or 60 while leap second)
fff = milliseconds, (000..999)
cc = Check sum*
↵ = Carriage Return (ASCII code 0Dh)

*EXCLUSIVE-OR result of previous characters, displayed as HEX byte (2 ASCII characters 0..9 or A..F)

Broadcast DISPLAY_SCREEN

Command: **11,n,o,0BR, 11,n,o,1BR** 11,n,o,0BR configures the the 1094B to broadcast the Display Buffer (information as currently viewed on the front-panel display) from the COM 1. 11,n,o,1BR configures the 1094B to broadcast the Display Buffer from COM 2. Set, n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Broadcast PATEK_PHILIPPE_MSG (CUSTOM 1)

Command: **12,n,o,0BR, 12,n,o,1BR** 12,n,o,0BR configures the 1094B to broadcast the Patek Philippe Message (or CUSTOM 1) from COM 1. 12,n,o,1BR configures the 1094B to broadcast the Patek Philippe Message from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Response:

T:yy:mm:dd:dw:hh.mm:ss ↵

Where:

dw = day of week

Broadcast KISSIMMEE_MSG (CUSTOM 2)

Command: **13,n,o,0BR, 13,n,o,1BR** 13,n,o,0BR configures the 1094B to broadcast the Kissimmee Message (or Custom 2) from COM 1. 13,n,o,1BR configures the 1094B to broadcast the Kissimmee Message from COM 2. Set n equal to your desired broadcast interval (in seconds) and o according to the desired time zone (UTC or Local).

Response:

ddd:hh.mm:ssQ<LF><CR>

Where:

Q = quality indicator (with indicators shown below)
_ = locked, maximum accuracy
. = (ASCII 46) Error < 1 microsecond
* = (ASCII 42) Error < 10 microseconds
# = (ASCII 35) Error < 100 microseconds
? = (ASCII 63) Error > 100 microseconds

9.3.3 Event Mode Commands

Return Specific Event

Command: **nED** nED sets the event buffer Read Index to a specific event number (0 to 299), and returns that event information in either Local or UTC time format depending on how the command, nTA is configured.

Response:

LCL mm/dd/yyyy hh:mm:ss.sssssss nnnL↵
UTC mm/dd/yyyy hh:mm:ss.sssssss nnnU↵

Format:

n = Event-Buffer Read Index Number
U = UTC Time
L = Local Time

Set Event Channel Time

Command: **nTA** Sets the time source as either Local or UTC, where n = 0 sets the event time to UTC and n = 1 sets the event time to Local.

Control Event Operation

Command: **m,nEV** m,nEV controls event operation, where m = 0 sets the Event mode, and m = 1 sets the 1-PPS Time Deviation mode. n = 123 clears the event buffer.

For example: 0ev sets the Event Mode, 1ev sets the 1-PPS Deviation Mode, 0,123ev clears the event data.

Response: ↵

Return Deviation for Event Channel

Command: **DA** Returns 1-PPS deviation and sigma for the event input.

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

9.3.4 Status Mode Commands

Status of Event/Deviation

Command: **SA** SA returns the event/deviation Channel setup information, read index number and write index number.

Response:

D/E, R = nnn, S = mmm ↵

Format:

D indicates the input channel is in 1 PPS deviation mode
E indicates the input channel is in Event Mode
nnn Channel read index (000 to 299)
mmm Channel 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

Command: **SC**

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-8).
S = Off if the out-of-lock function is deactivated, S = ZDL indicates zero delay.

EEPROM Status

Command: **SE**

SE returns the EEPROM status.
Response:

T=t CE=ee

Format:

t = 0, No Timeout Error; t = 1, Timeout Error
ee = Number of corrected errors in reading EEPROM data

Receiver Status

Command: **SR**

SR returns the current receiver status.
Response:

V=vv S=ss T=t P=Off E=0↵

Format:

vv = Number of satellites, visible to the antenna, per almanac.
ss = relative signal strength (range: 0 to 255, nominal value = 15)
t = Number of satellites being actively tracked (up to twelve)
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 than 3 satellites are visible, OR if Position-Hold is active. E = 0, currently unused

Time Quality

Command: **TQ**

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

Response: h↵ (h = Condition; values shown below)

0 = Clock locked, maximum accuracy
4 = Clock unlocked, accuracy < 1 us
5 = Clock unlocked, accuracy < 10 us
6 = Clock unlocked, accuracy < 100 us
7 = Clock unlocked, accuracy < 1 ms
8 = Clock unlocked, accuracy < 10 ms
9 = Clock unlocked, accuracy < 100 ms

A = Clock unlocked, accuracy < 1 s
B = Clock unlocked, accuracy < 10 s
F = Clock failure, time not reliable

9.3.5 Local / Daylight Saving Time Setup Commands

Set Daylight Saving/Summer Time Mode

Command: **1,mDT**

1,mDT activates the Daylight Saving Mode, where m = 0 to 2, with 0 = OFF, 1 = ON, and 2 = AUTO. When OFF this time adjust feature does not add the specified offset to local time display and output. With m = 1 (ON), the Daylight Saving / Summertime feature is always on. With m = 2, the Daylight Saving / Summertime feature will automatically change at the specified dates and times. To complete the Daylight Saving / Summer Time setup, you must also use the Set Daylight Saving Auto Start and Stop commands that follow below.

Return Daylight Saving/Summer Time Settings

Command: **0DT**

0DT returns the current Daylight Saving / Summer Time Settings to the current COM port. Response: (Mode: OFF, ON, or AUTO)

Mode:AUTO ↵
START:02:00 Second SUN of MAR ↵
STOP :02:00 First SUN of NOV ↵

Set Daylight Saving/Summer Auto Start Time

Command: **2,w,x,y,zDT**

Sets the date and time when Daylight Saving / Summer Time starts.
Where,

w = Month (0 through 11), with 0 = Jan, 1 = Feb, ... 11 = Dec.
x = WeekOfMonth (0 through 5), with 0 = First, 1 = Second, 2, = Third,
3 = Last, 4 = Second from Last, and 5 = Third from Last.
y = DayOfWeek (0 through 6), with 0 = Sun, 1 = Mon, ... , 6 = Sat.
z = Minutes after midnight z (0 through 1440).

Response: ↵

Set Daylight Saving/Summer Auto Stop Time

Command: **3,w,x,y,zDT**

Sets the date and time when Daylight Saving / Summer Time stops. Where,

w = Month (0 through 11), with 0 = Jan, 1 = Feb, ... 11 = Dec.
x = WeekOfMonth (0 through 5), with 0 = First, 1 = Second, 2, = Third,
3 = Last, 4 = Second from Last, and 5 = Third from Last.
y = DayOfWeek (0 through 6), with 0 = Sun, 1 = Mon, ... , 6 = Sat.
z = Minutes after midnight z (0 through 1440).

Response: ↵

Local Offset Command

Command: **mLT**
mLT sets the local offset in minutes from -720 to +720 (-12 to +12 hours), where m equals the number of minutes, positive (East) or negative (West).

Response: ↵

9.3.6 Front Panel Control Commands

Front Panel and Backlight Control

Command: **m,nFP**

This command controls two actions; it enables or locks the keypad, and offers backlight control. m = 0 enables the keypad, and m = 1 locks the keypad. n = 0 turns OFF the backlight, n = 1 turns ON the backlight, and n = 2 sets the backlight to the AUTO mode, where it automatically turns off after 30 seconds of inactivity. When m = 1, n is not effective.

Response: ↵

9.3.7 IRIG-B Data Output Commands

IRIG Data IEEE P1344

Command: **m,n,oIR**

This command controls the activity of the IRIG-B IEEE P1344 control bits.
Where:
m = 0, IRIG-B IEEE P1344 control bits OFF, m = 1, control bits ON,
n = 0, IRIG Time = UTC, n = 1, IRIG Time = Local
o = 0, IRIG Output on Main, o = 1, IRIG Output on Aux port.

Response: ↵

9.3.8 Position Data Commands

Return Elevation

Command: **LH**

Returns the current antenna elevation.

Response:
nnnnn.nn↵ (from -1000.00 to +18000.00 meters WGS-84)

Format:

Where:
Elevation in meters referenced to the WGS-84 datum
n = -1000.00 to +18000.00 meters.

Return Latitude

Command: **LA**

Returns the current antenna latitude.

Response:

Ndd:mm:ss.sss ↵

Format:

N = North (S for South)
dd = degrees
mm = minutes
ss.sss = seconds

Longitude

Command: **LO**

Returns the current antenna longitude.

Response:

Wddd:mm:ss.sss ↵

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

9.3.9 Date and Time Commands

Set Receiver Time

Command: **yyyy:mm:dd:hh:mmTS**

TS sets the receiver (UTC) time only when not locked to the GPS. 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
mm = minute
hh = hour

Response: ↵

Local Date

Command: **DL**

DL returns the current date, in Local time.

Response: ddmmmyyyy

UTC Date

Command: **DU**

DU returns the current date, in UTC time.

Response: ddmmmyyyy ↵

Local Time

Command: **TL**

TL returns the current Local time.

Response: ddd:hh:mm:ss ↵

UTC Time

Command: **TU**

TU returns current UTC time.

Response: ddd:hh:mm:ss ↵
NOTE: The DL, DU, TL and TU command formats are identified as follows:

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

9.3.10 Programmable Pulse Output Commands

Pulse Width, Seconds-Per-Pulse

Command: **m,nPW**

m,nPW configures the Programmable Pulse output pulse width in seconds. Where, m = 0 through 60,000 in 10 millisecond increments. n = 0 for Output A (Timing Outputs 1 and 2), n = 1 for Output B (Timing Outputs 3 and 4).

Response: ↵

Programmable Pulse Output Mode

Command: **m,nPM**

m,nPM configures the programmable pulse mode and output port. Programmable Pulse A can go to Timing Outputs 1 and 2, Programmable Pulse B can go to Timing Outputs 3 and 4. Frequency Mode and Aux IRIG Mode only apply to Programmable Pulse B. m = 0, 1, 2 and 3; n = 0 and 1, where:

Format: m = 0, Pulse OFF
1 = Pulse Mode
2 = Frequency Mode
3 = Aux IRIG Mode.

Format: n = 0, Timing Outputs 1 and 2
1, Timing Outputs 3 and 4

Response: ↵

Set Alarm Time Mark

Command: **d,h,m,s,hs,oAL**

Sets the time at which the Model 1094B issues the programmable pulse. d, h, m, s and hs set the output pulse to be generated at the next occurrence of the specified time and date. o sets the output to either Programmable Pulse A (communication ports 1 and 2) and Programmable Pulse B (communication ports 3 and 4).

Format: d = day of year (1 through 366)
h = hour (0 through 23)
m = minute (0 through 59)
s = second (0 through 59)
hs = fractional seconds in 0.01 increments (00 through 99)
o = Programmable Pulse A or B; 0 = A, 1 = B

Response: ↵

Set Programmable Pulse Mode Type

Command: **m,nPT**

m,nPT configures the programmable pulse mode type, where m = 0 through 5 are the types and n = slow code values. 0 = slow code off, 1 = UTC slow code, and 2 = Local slow code.

Format: m = 0 PULSE-PER-SECOND
m = 1 PULSE-PER-MINUTE
m = 2 PULSE-PER-HOUR
m = 3 PULSE-PER-DAY
m = 4 SINGLE-TRIGGER
m = 5 SLOW-CODE

Response: ↵

Set Pulse Polarity

Command: **m,nPP**

m,nPP sets the programmable pulse output polarity (i.e. TTL/CMOS high or low). m = 0, positive and m = 1, negative, with 0 = UTC Time and 1 = Local Time. n = 0 and 1, with 0 = Programmable Pulse A and 1 = Programmable Pulse B.

Response: ↵

9.3.11 Antenna System Delay Commands

Set Antenna Delay

Command: **nnnnnnDA**

Sets antenna system delay compensation value. NOTE: Factory default setting for the standard 15-meter (50-foot) cable is 60 ns. Time range is from 0 to 999999 nanoseconds. The exact syntax for a 60-ns delay is 60DA. See Section 4.4.1 for information on calculating cable delay.

Response: ↵

9.3.12 Out-of-Lock Commands

Set Out-of-Lock Time

Command: **(-)nLK**

(-)nLK configures the Out-Of-Lock function in the 1094B. A negative number turns the out-of-lock function OFF. n = 0 sets the out-of-lock time to zero delay. n = 1 to 99 sets the amount of delay time (in minutes) following loss of satellite synchronization before an out-of-lock signal is generated and the relay contacts close.

Response: ↵

9.3.13 Miscellaneous Commands

Return Firmware Version

Command: **VE**

Returns the Firmware Revision date of the installed ROM.

Response: dd mmm yyyy ↵

Survey Mode Selection

Command: **mSS**

Sets the survey mode to either Power On Survey, Single Survey, and Turn Off Survey, where m = 0 for Turn Off Survey, m = 1 for Single Survey and m = 2 for Power On Survey. Use m > 2 to return survey mode.

Return Display Buffer

Command: **DZ**

Returns the contents of Display Buffer.

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

Chapter 10

Startup and Basic Operation

10.1 Initial Startup Sequence

Before powering ON the Model 1094B, make sure that the chassis cover is installed and that inlet power is properly connected to the power inlet connector. The power switch is recessed to prevent accidental switching of power ON or OFF to the Model 1094B. When you slide the switch to ON, several things should things should happen in the sequence listed below:

- The four annunciator LED's initially should flash momentarily, then the OPERATE LED and UNLOCKED LED should light steadily.
- The LCD should display several introductory messages - see below.
- The Out-of-Lock Relay (Fault) will be in the out-of-lock (or faulted) position.
- Eventually, the UNLOCKED LED should extinguish.
- The Out-of-Lock Relay (Fault) should change to Locked (non-faulted) position after a few minutes (depends how long the clock has been turned off).
- The LCD should indicate that the clock is Locked.
- The Stabilized LED should light steadily after a few minutes of locked operation.

10.1.1 Clock Time, Startup Mode

When the Model 1094B first starts, it will not indicate the correct time until it is locked to the GPS. Pressing the TIME key before the UNLOCKED LED is extinguished will produce the message:

TIME NOT AVAILABLE

For IRIG-B time, it will begin counting from zero, with the Julian Day also set to zero. This method was chosen so that there would be no mistake in interpreting that the clock was in startup mode. For example, the time could indicate as follows:

000:00:00:01
000:00:00:02
000:00:00:03
.
.
.
265:13:45:21
265:13:45:21 (these values chosen for illustrative purposes only)

During a short period of time (from a few minutes to a few seconds) the displayed clock time may jump and add or lose some seconds as more satellites are acquired. This is normal, until the full set of ephemeris data is received by the GPS receiver from the GPS (satellites), at which the time will be accurate. After running for a few minutes, the Stabilized LED will glow steadily, and the Out-of-Lock relay should close.

10.2 Front Panel Indication

10.2.1 LCD Display Indication at Startup

In the startup sequence, the LCD display should indicate clock status as follows:

ARBITER SYSTEMS GPS
SUBSTATION CLOCK

followed by:

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followed by:

CLOCK STATUS
STARTUP

followed by:

CLOCK STATUS
UNLOCKED 01 MIN

After this, the second line of the status display should change to UNLOCKED, or LOCKED depending on the previous operation, inactivity or if the clock has been moved. During startup, the UNLOCKED LED could turn OFF and ON. After a few minutes the STABILIZED LED should change from OFF to ON.

10.2.2 Other Display Indications When Unlocked

Time Display	TIME NOT AVAILABLE
Position Display	POSITION NOT AVAILABLE
Event Display	PLEASE WAIT!

TIME ADJUSTMENTS

Status Display GPS RECEIVER STATUS
ACQUIRING SATS

10.2.3 Status Display Indications

There are three indications when successively pressing the STATUS key. These are as follows:

CLOCK STATUS
STARTUP*

*The second line will change between STARTUP, to UNLOCKED (with time), to LOCKED.
followed by:

GPS RECEIVER STATUS
3D FIX

*Possible Receiver Status messages are:

BAD GEOMETRY
ACQUIRING SATS
POSITION HOLD
2D FIX
3D FIX
AUTO SURVEY

followed by:

GPS TRACKING STATUS
TRACKING 12 SATS

*The number of tracked satellites can change from 0 to 12.
followed by:

EEPROM STATUS
CORR. ERRORS 0

If the number of corrected (CORR.) errors begins to climb, contact the factory about replacing the EEPROM.

10.2.4 Event/Deviation Display

There are separate displays when pressing the EVENT/DEVIATION key, depending on the setting. Successive events appear when repeatedly pressing the EVENT/DEVIATION key, or if configured for DEVIATION, it will indicate the 1-PPS Deviation (updates once per second). If there are no records, the display will indicate NO DATA.

Event Display

EVENT nnn
ddd:hh:ss.sssssss

Where:

nnn = event number(000 to 499)
ddd = day of year of the event(1 to 366)
hh = hour of the event(00 to 23)
mm = minute of the event(00 to 59)
ss.sssssss = second and fractional seconds of the event

Deviation Display

1 PPS:	0.00 μS
SIGMA:	0.00 μS

10.2.5 IRIG-B Time Data

IRIG-B time is immediately sent out, when the 1094B is powered ON, from any Timing Output port configured for IRIG-B as indicated above. Time will not be accurate until the Stabilized LED glows steadily.

10.3 Clock Status Display Mode

When first applying power to the Model 1094B, the display will indicate several startup messages, then will revert to Clock Status mode condition called STARTUP. After a short time, while the GPS receiver begins collecting data from the GPS, it will indicate either UNLOCKED (XX Min) or LOCKED. There are several faults that are indicated, if they exist, and are as follows:

- Receiver Failure
- Antenna Short (low antenna voltage)
- Antenna Open (no current drawn by antenna system)

For additional information on internal faults, please see Chapter 2, Front and Rear Panels, and Chapter 9, Serial Communications and Command Set, status commands.

10.4 Time Display Modes

After establishing GPS satellite synchronization, date and time information can be displayed on the front panel by pressing the TIME key and scrolling through the four available displays. Press this key to select the time display mode (UTC or Local) time data (Date/Time or Day of Year).

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

This mode displays UTC, in the Date and Time format, as maintained by the United States Naval Observatory (USNO), as described below:

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

Where:

www = day of the week (Mon - Sun)
dd = day of the month
mmm = month (Jan - Dec)
yyyy = the year
hh = the hour (00 - 23)
mm = the minute (00 - 59)
ss = the second (00 - 59)

This mode displays UTC, Time of Year mode, without the application of daylight saving correction and local offset.

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

This mode also displays UTC, in Time of Year format, which differs from the previous format as follows:

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

Where:

ddd = day of the year (001 366)

This mode displays UTC, Time of Year mode, without the application of daylight saving correction and local offset. NOTE: Daylight saving and local-offset have no effect on this display.

10.4.3 Date and Time Display, Local Time

This mode displays the date and time after the daylight-saving correction and local offset have been applied, but in the same format as that of the Date and Time, UTC:

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

10.4.4 Time of Year Display, Local Time

This mode displays the time of year after the daylight-saving correction and local offset have been applied, but in the same format as that of the Time of Year, UTC:

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

NOTE: Unless the daylight saving and local offset parameters have been set properly, this display may not reflect the correct local time.

10.4.5 Daylight Saving-Summer Time

The Daylight Saving-Summer Time (DST) configuration feature allows expanded settings. The addition of AUTO allows the user to customize the DST/Summertime settings to match the requirements of locations in either Northern or Southern latitudes.
The DST/Summertime configuration can be changed through the serial port or through the front panel keypad.

10.5 Position Display Modes

When the clock is first powered ON and acquiring satellites, the only position information available is the previous position, stored in the clocks setup EEPROM. This position information reflects the location of the receiver as determined by the last position while locked to at least four satellites. Displayed position will be based on the most recent position fix.

Press the front-panel button named POSITION to access longitude, latitude, and elevation data values. Repeatedly pressing the POSITION key scrolls the readout display continuously through these values. If pressed prior to acquisition of enough satellites to accurately determine and update position data, these numbers will reflect the receivers power-on defaults.

Synchronization to a minimum of four satellites is necessary for precise determination of longitude, latitude, and elevation. When meeting this minimum satellite lock requirement, POSITION values will accurately correspond to the present antenna location.

10.5.1 Longitude Display

ANTENNA LONGITUDE
XXX° XX' XX.XXX" W*

Where:

*W for WEST, or E for EAST

10.5.2 Latitude Display

ANTENNA LATITUDE
XX° XX' XX.XXX" N*

Where:

*N for NORTH, or S for SOUTH

10.5.3 Elevation Display

ANTENNA ELEVATION
XXXXX.XX m WGS-84

Where the elevation is displayed referenced to the WGS-84 datum.

Appendix A

Technical Specifications and Operating Parameters

A.1 Introduction

In this section you will find information relating to the functional and operational characteristics of the Model 1094B Satellite-Controlled Clock. Topics include Receiver Characteristics, I/O Configuration, System Interfaces, Antenna System, Operator Interfaces, and Physical Specifications.

NOTE: Specifications subject to change without notice.

A.2 Receiver Characteristics

A.2.1 Input Signal

GPS L1 C/A code, 1575.42 MHz

A.2.2 Timing Accuracy

Specifications apply at the 1 PPS output as of date of publication.
UTC/USNO ±400 ns peak
less than ±100 ns typical (SA off)

A.2.3 Internal Oscillator

The Model 1094B uses a high performance crystal synchronized to GPS time.

A.2.4 Position Accuracy

8 meters, rms, 90% confidence

A.2.5 Satellite Tracking

12 channel, C/A code (1575.42 MHz). Receiver simultaneously tracks up to twelve satellites.

A.2.6 Acquisition

- less than 5 minutes with current almanac
- less than 20 minutes without current almanac
- greater than 20 minutes in areas where antenna has limited or obstructed view of sky

A.3 I/O Configuration

A.3.1 Timed Outputs

Outputs: Four, each with BNC and 5-mm pluggable terminal strip in parallel. Output Select is jumper selectable between unmodulated IRIG-B, 1 Pulse Per Second (PPS), and Programmable Pulse. Output Mode is jumper selectable between 300 volt FET, modulated IRIG-B, and 5 Vdc (250 mA at >4 V). Note that Programmable pulse is divided between Programmable Pulse A on outputs 1 and 2 and Programmable Pulse B on outputs 3 and 4. The MOSFET output is not electrically isolated from instrument common.

A.3.2 I/O Connectors

Each timing output has one BNC and 5-mm pluggable terminal strip in parallel. Event Input is BNC and DB-9M.

A.3.3 Standard Output Signals

- IRIG-B 003 and 000 (now 004), unmodulated
- IRIG-B 123 and 120 (now 124), modulated
- 1 PPS; Programmable Pulse
- 300 V FET switching

A.3.4 Input Functions

Input functions included one Event Input. Input connector is dedicated BNC or either of RS-232 connectors (COM 1 and COM 2).

A.3.5 Event Input Timing

For a received data message, the leading edge of the start bit may be selected to trigger the event input, providing synchronization with 10-ns resolution.

A.4 Systems Interface

A.4.1 RS-232C COM 1 and COM 2

Connector: 9-pin D-type sub-miniature:

Pin No.	Function	Pin No.	Function
1	Not Connected	6	RS-232 Input
2	RS-232, Rx Data or Event Input	7	Not Connected
3	RS-232, Tx Data	8	RS-422/485, Tx-A
4	RS-232 Output/Prog Pulse	9	RS-422/485, Tx-B
5	Ground	–	–

Table A.1: COM 1 and COM 2 Pin Definitions

A.4.2 Communication Parameters

Selectable 1200 to 19200 baud; 7 or 8 data bits; 1 or 2 stop bits; odd/even/no parity. Supports all front-panel functions.

A.4.3 Broadcast Data Formats

Supports continuous output data in various formats. See Chapter 9, Serial Communication and Command Set, Section 9.3.1.

A.4.4 Antenna System

Included with the Model 1094B is an all-weather, weather proof, GPS antenna. The included antenna is directly mounted using 19-mm (3/4-in.) pipe threads. Other mounting configurations are available (contact Arbiter Systems). Operates using 5 Vdc conducted through included antenna cable.

A.4.5 Antenna Cable

15-meter (50-foot) cable included with antenna. Other cable styles and lengths available – see Table 4.2.

A.4.6 Operator Interface

RS-232C Interface or eight, front-panel buttons

A.4.7 Setup Functions

See Chapter 6, The Setup Menus, for complete details on setting up the operation of the Model 1094B.

A.4.8 Display

2-line by 20-character, backlighted supertwist LCD

A.4.9 Display Functions

- Time: UTC or Local
- Position: Latitude, Longitude and Elevation
- Status: Clock, Receiver, EEPROM, Antenna
- 1-PPS (input) Deviation
- Event Time
- Configuration (four keys: SETUP, UP, DOWN, ENTER)

A.4.10 Annunciators - LEDs

- Operate (green)
- Stabilized (green)
- Unlocked (red)
- Fault (red)

A.5 Physical Specifications

A.5.1 Dimensions

Chassis:	430-mm W x 44-mm H x 280-mm D (16.9-in. x 1.7-in. x 11.0-in.)
Antenna:	77-mm Diameter x 66-mm height (3.05-in. x 2.61-in)

A.5.2 Weight

Clock:	1.9 kg (4.3 lbs.) net. (instrument)
Antenna and Cable:	2.0 kg (4.4 lbs.) net.
Shipping:	6.0 kg (13 lbs.) net. (includes antenna, cables and accessories)

A.5.3 Power Requirements

Option 07 and Option 10

Voltage: 85 to 264 Vac, 47 to 440 Hz, 20 VA max. or 110 to 275 Vdc, 15 W maximum

Option 08

Voltage: 10 to 60 Vdc ONLY, 15 W maximum

A.5.4 Power Connector

Three-pole terminal strip and surge-withstand capability – Options 8 and 10

A.5.5 Electromagnetic Interference

- 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 08 and 10) designed to meet ANSI/IEEE C37.90-1 and IEC 801-4.

A.5.6 Temperature and Humidity

Temperature	**Operate**	**Storage**
Instrument	-40 to +85°C	-40 to +85°C
Antenna	-40 to +85°C	-55 to +100°C
Antenna Cable	-40 to +60°C	-40 to +80°C

Table A.2: Specified Temperatures

Humidity: Non-condensing.

Appendix B

Using Surge Protectors

B.1 Introduction

Today's data equipment has become extremely vulnerable to a phenomenon known as voltage and electrical transients. A single IC package can contain over 100,000 memory bits and more than 5,000 logic gates. The high sensitivity due to the small size of the chips used in these packages makes them susceptible to quick degradation from voltage surges and transients. PLCs, MUXs, HUBs, RTUs, SCADA, and Telemetry equipment are especially vulnerable to electrical surges because of their low operation voltages. Many of these components can be damaged beyond repair by an electrical surge as low as 20 volts.

Sources of electrical surges are numerous. The most common is a nearby lightning strike, which will affect nearby data lines through induction. Industrial transients are also significant because they are man made disturbances caused by switching and commuting of electrical motors. The operation of such devices can cause abrupt shifts in the ground potential that can generate a current flow through a nearby data-line in order to equalize the ground potential.

Electrostatic discharge is another form of an electrical surge that can be included in this group. Although often overlooked, (ESD) can potentially be a very harmful transient to fragile data equipment. ESD occurs due to two non-conducting materials rubbing together, causing electrons to transfer from one material to another.

The consequences of electrical surges and transients may be severe. Although the life span of these electrical phenomenons is very short, the amount of energy that is carried can be extremely high. A typical transient event can last from a few nanoseconds to several milliseconds carrying several thousand volts and at least a few hundred amps of current. These events may cause burnt-line cards, lockups, loss of memory, problems in retrieving data, altered data, garbling...etc.

B.2 Grounding

A protection system with a poor ground is the same as having no protection at all. Too many times proper grounding has been overlooked. Recommended grounds are the utility company ground, a ground rod, well casings, and cold water pipes that are of continuous metal. Caution! Sometimes the metal-cold water pipes are repaired and/or extended PVC piping. The introduction of PVC material renders the cold water pipe ground unacceptable. A thorough investigation of a cold water pipe ground is important since the PVC repairs or extensions may be covered by drywall.

Grounds that are unacceptable include sprinkler pipes, PVC pipe, conduit, buried wire, and any ground that cannot be verified.

Bonding ensures the most effective ground. Bonding ties all of the grounds in the building together electrically. If there is a rise in ground potential and all of the grounds are bonded, no damage will occur since it is differential voltage that causes problems.

It is absolutely necessary to make sure that the ground used for the AC power is the same as the ground used for the data-line surge protectors. A common ground reference must be achieved for all equipment. All ground wires must be as short as possible and it is imperative that the ground wire not be coiled or looped. The ground wire must be as straight as possible; remember that it must be the path of least resistance. Regarding the diameter of the ground wire, the larger the better. The larger the diameter, the better electrical conductivity. Finally, the earth ground resistance on which the whole grounding system relies must be less than 5 ohms.

Lines that typically need protection include incoming central office trunks, lines to off-premise sites, local area networks and campus environments with multiple buildings. A good rule of thumb to remember is that all lines entering or exiting a building need protection. Both ends of the cables between buildings must be protected!

For additional technical details, please contact Citel, Inc. at www.citelprotection.com, 1515 NW 167th Street, Miami, FL 33169, USA, (800) 248-3548 / (305) 621-0022.

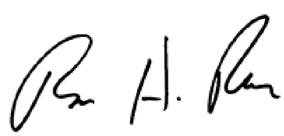
Appendix C

CE Mark Certification

C.1 Introduction

On the following pages contain the individual CE Mark Certifications for models covered in this manual. This includes Model 1094B.

Declaration of Conformity with European Union Directives

Date of Issue:	June 30, 2003
Directives:	89/336/EEC Electromagnetic Compatibility 73/23/ EEC Low Voltage Safety
Model Number(s):	1094B GPS Satellite-Controlled Clock
Manufacturer:	Arbiter Systems, Inc. 1324 Vendels Circle, Suite 121 Paso Robles, CA 93446 – USA
Harmonized Standard Referenced:	EN55011 Class A, Radiated and Conducted Emissions EN50082-1 Generic Immunity, Part 1 Residential, Commercial and Light Industrial Environments EN61010-1 Safety requirements of Electrical Equipment for Measurement, Control and Laboratory Use.
Signed:	
Signatory:	Bruce H. Roeder

This certificate declares that the described equipment conforms to the applicable requirements of the directives on Electromagnetic Compatibility 89/339/EEC, Safety 73/23/EEC, and amendments by 93/68/EEC adopted by the European Union.

Appendix D

Statement of Compliance

D.1 Introduction

The following page is a statement of compliance that includes Model 1094B.

G.P.S. Satellite Clock Statement of Compliance

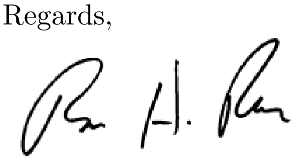
February 5, 2008

TO WHOM IT MAY CONCERN:

All Arbiter Systems, Incorporated G.P.S. Satellite Controlled Clocks are Primary Standards. They provide time traceable to U.T.C. and U.S.N.O. within published accuracy specifications anywhere in the world. All Arbiter Systems Incorporated G.P.S. Satellite Controlled Clocks also carry a limited lifetime warranty, which is based on in field MTBF (Mean Time Between Failures) of over one million (1,000,000) hours. These products are available with all known time synchronization signals presently in use world wide by the electric power industry.

Arbiter Systems does not supply a type test certificate as requested for G.P.S. systems as the accuracy is a function of the G.P.S. system and not of the receiver. However we (Arbiter) hereby certify that this equipment conforms to all Arbiter Systems Incorporated specifications for material and process. All Arbiter Systems calibration products are supplied with a type test certificate guaranteeing traceability to National Standards, but are inappropriate for G.P.S. clocks, which are Primary Standards by definition.

Regards,



Bruce H. Roeder
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Arbiter Systems, Inc.
BHR/sc

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