S P E C T R A C O M
PUBLIC SAFETY) SECURITY) GOVERNMENT

MODEL 8182 NETCLOCK/2

WWVB SYNCHRONIZED MASTER CLOCK

INSTRUCTION MANUAL

REVISIONS, IF ANY, ARE LOCATED AT THE END OF THE MANUAL

WARRANTY REGISTRATION

Spectracom Corporation
101 Despatch Drive
East Rochester, New York 14445
Phone 585-381-4827, Fax 585-381-4998

Dear Customer,

Spectracom occasionally contacts customers regarding our products. We must know to whom we should send manual updates, change notices, and new product information. Because people sometimes change job assignments, we request department, mail station, and title information to ensure that correspondence in future years will reach either the user of our products or his/her supervisor. In filling out the registration, please use the title or mail station or department of the supervisor most interested in keeping the equipment and its documentation up-to-date. Thank you.

Name_____   Title_____

Department _____   Mail Stop_____

Company_____   Model Number _____

Address _____   Serial No. _____

City _____   Date Installed _____

State _____   Zip_____

Telephone _____   Ext. _____

Comments: _____

_____

_____

_____

_____

_____

TIME OF DAY PRODUCT FIVE YEAR WARRANTY

LIMITED WARRANTY AND WARRANTY CLAIMS: Spectracom warrants each new product manufactured and sold by it to be free from defects in material, workmanship, and construction, except for batteries, fuses, or other material normally consumed in operation that may be contained therein, for five years after shipment to the original purchaser (which period is referred to as the "warranty period"). This warranty shall not apply if the product is used contrary to the instructions in its manual or is otherwise subjected to misuse, abnormal operations, accident, lightning or repairs or modifications not performed by Spectracom. Spectracom is not responsible for products that it does not manufacture.

Software and receiver modules not manufactured by Spectracom and any cable assemblies and adapters are warranted for one year from date of shipment and subject to exceptions listed above.

Spectracom's obligation under this warranty is limited to in-factory service and repair, at Spectracom's option, of the product or the component thereof which is found to be defective. If in Spectracom's judgment the defective condition in a Spectracom product is for a cause listed above for which Spectracom is not responsible, Spectracom will make the repairs or replacement of components and charge its then current price, which buyer agrees to pay.

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EXTENDED WARRANTY COVERAGE

Extended warranties can be purchased for additional periods beyond the standard five year warranty. Contact Spectracom during the last year of the standard five year warranty for extended coverage.

6/1/98

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GENERAL INFORMATION

1.0   INTRODUCTION

The National Institute of Standards and Technology (NIST) broadcasts a time and frequency standard on Station WWVB from Fort Collins, Colorado. WWVB transmits a 60-kHz carrier frequency derived from the National atomic time standard. Time code is added to the broadcast by reducing carrier power 10 dB once-per-second for fixed intervals of time. The WWVB code contains information on the current year, day-of-year, and time reflecting Coordinated Universal Time (UTC). Indicators warning of Daylight Saving Time, leap second, and leap year are also encoded into the WWVB transmission. A complete description of WWVB is found in Appendix A of this manual.

The Spectracom NetClock/2, shown in Figure 1-1, receives and demodulates the WWVB signal. Once the signal is decoded, the NetClock/2 automatically sets and provides accurate and traceable time data outputs. The outputs may be used to synchronize computer networks, dispatch consoles, voice loggers and event loggers.
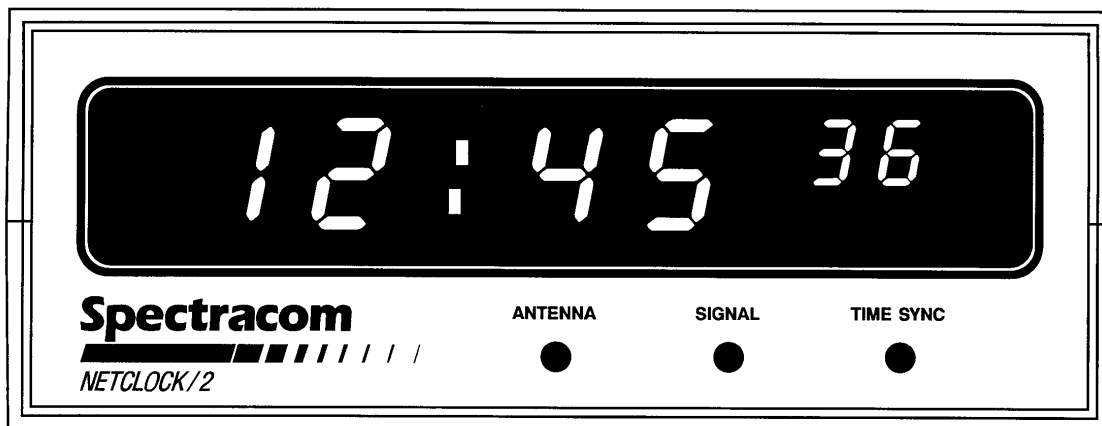
FIGURE 1-1   MODEL 8182 NETCLOCK/2 MASTER CLOCK

1.1   FEATURES

The Spectracom Model 8182 NetClock/2 offers the following features:

NENA Compliant: The Model 8182 conforms to the National Emergency Number Association, NENA 04-002 PSAP Master Clock Standard.

Traceability: Received WWVB broadcast provides direct traceability to the National Institute of Standards and Technology.

Automatic Operation: Automatically decodes and synchronizes to the WWVB time code and adjusts for Daylight Saving Time, Leap Year, and Leap Second corrections.

Timing Outputs: The NetClock/2 timing outputs are used to synchronize voice recorders, ANI/ALI, consoles, CADs and other devices found in the Dispatch Center. Each NetClock/2 includes an RS-232 interrogation port, RS-232 and RS-485 broadcast port, and both amplitude modulated and pulse width coded IRIG outputs.

1.2   WARRANTY INFORMATION AND PRODUCT SUPPORT

Warranty information is found on the leading pages of this manual. Should it become necessary to exercise the warranty, contact Spectracom Corporation to obtain service or a replacement.

Spectracom continuously strives to improve its products and therefore greatly appreciates any and all customer feedback given. Please direct any comments or questions regarding application, operation, or service to Spectracom's Customer Service Department. Customer Service is available Monday through Friday from 8:00 A. M. to 5:00 P. M. Eastern time at 585-381-4827.

In addition, please contact Customer Service to obtain a Return Material Authorization Number (RMA#) before returning any instrument to Spectracom Corporation. Please provide the serial number and failure symptoms. Transportation to the factory is to be prepaid by the customer.

Product support is also available by e-mail. Questions on equipment operation and applications may be e-mailed to Spectracom at:
        techsupport@spectracomcorp.com

Visit our web page for product information and upgrade notices as they become available at: http://www.spectracomcorp.com

1.3   MANUAL ERRATA AND SPECIAL DOCUMENTATION

Information concerning manual corrections or product changes occurring after printing are found in the Errata Section. Errata, when required, is found at the end of this manual. Please review and incorporate changes into the manual whenever an Errata Section is included.

Spectracom will make instrument modifications upon special request. A customer documentation packet associated with the modification will be included with this manual.

1.4   UNPACKING

Upon receipt, the carton and its contents should be carefully examined. If there is damage to the carton which results in damage to the unit, contact the carrier immediately. Retain the carton and packing materials in the event the carrier wishes to witness the shipping damage. Failing to report shipping damage immediately may forfeit any claim against the carrier. In addition, notify Spectracom Corporation of shipping damage or shortages, to obtain replacement or repair services.

Carefully open the shipping carton and remove the packing list from the envelope on the outside of the carton. Check the packing list against the contents to be sure all items have been received, including an instruction manual and an ancillary kit.

1.5   SPECIFICATIONS

Sections 1.5.0 through 1.5.11 list the electrical and mechanical specifications for the Model 8182 NetClock/2. Section 1.5.12 lists the specifications for the Model 8219 Passive Loop Antenna. Section 1.5.13 lists the specifications for the Model 8207 In-line Amplifier.

1.5.0   Receiver

Received Signal:	NIST Station WWVB.
Carrier Frequency:	60 kHz.
Sensitivity:	0.4 µV rms.
Minimum field strength:	25 µV per meter.
Receiver Delay:	Typically 19 milliseconds. Actual receiver delay is recorded on the bottom cover.
Typical Accuracy:	± 1 millisecond when continuously phase locked and time synchronized.

1.5.1   ***Status Indicators and Alarm Outputs***

Three dual color front panel LED's indicate operational information:

Antenna: Green indicates normal operation.
                  Red indicates possible problem with the preamplifier or antenna coax.

Signal: Green indicates receiver is phase locked to the carrier.
                  Alternating red/green warns that the VCXO needs adjustment. See
                  Section 4, Service Information, in this manual.
                  Red indicates receiver is not locked to the carrier.

Time Sync: Green indicates synchronization to WWVB to within ±1 millisecond
                  when continuously carrier locked.
                  Red indicates unit is not time synchronized to WWVB. Time data
                  outputs may be in error ≥ 50 milliseconds. The TIME SYNC lamp
                  turns red after a 1 hour period without carrier lock. The lamp is also
                  red if the clock is unable to decode valid data over the past 24 hours.

Rear Panel Alarm output relay contacts indicate WWVB synchronization status.

Alarm Output: Time Sync.

Relay Contacts: NO, NC, and common.

Contact Rating: 30 VDC, 2 Amps.

Connector: 4-position terminal strip (supplied).

1.5.2   ***Manual Controls***

All user-selectable parameters are made by switches located on the bottom cover. Switch
functions include the following:

- Data format
- Baud Rate
- Path Delay
- Time Zone Offset
- 12 or 24-hour Display
- Automatic DST corrections
- Manual Set Disable
- IRIG Format
- IRIG AM or TTL

1.5.3   Time Data Formats

Three time data formats are available and briefly described below. See Section 3, Operation, for complete data stream information.

Format 0: (CR)(LF)I(^)(^)DDD(^)HH:MM:SS(^)DTZ=XX(CR)(LF)
Format 1: (CR)(LF)I(^)WWW(^)DDMMMYY(^)HH:MM:SS(CR)(LF)
Format 2: (CR)(LF)IQYY(^)DDD(^)HH:MM:SS.XXX(^)LD
   where:

CR =	Carriage Return
LF =	Line Feed
I =	Sync Status (space, ?, *)
Q =	Quality Indicator (space,A,B,C,D)
YY =	Year (99, 00, 01 etc.)
^ =	space
DDD =	Day of Year (001 - 366)
HH:MM:SS =	Hours:Minutes:Seconds
. =	Decimal Separator
XXX =	Milliseconds
L =	Leap Second Indicator (space, L)
D =	Daylight Saving Time Indicator (S,I,D,O)
XX =	Time Zone Setting (00-23)
WWW =	Day of Week (MON, TUE, WED)
DD =	Day of Month (^1-31)
MMM =	Month (JAN, FEB, MAR)

1.5.4   Data Output Specifications

Bit Rate: Switch selectable, available settings are 300, 600, 1200, 2400, 4800, and 9600 baud.

Character Structure: A character consists of 1 start, 8 data, and 1 stop bit, no parity.

Accuracy: The start of the data stream marks the on-time point. Accuracy at 9600 baud with calibrated delay:
Format 0: ±2 milliseconds.
Format 1: ±3 milliseconds.
Format 2: ±2 milliseconds.
At lower baud rates, longer delays reduce accuracy.

1.5.5 Serial Communication Port

Output Signal: RS-232C.

Connector: DB9 Female.

Classification: Data Communication Equipment (DCE).

Command Set: The NetClock/2 responds to the following commands:

T command	outputs the time in the selected format.
S command	allows the clock to be set manually.
Y command	allows the year to be set manually.
R command	generate the Signal Quality Log report.
CB command	Clear Buffer command resets the Signal Quality Log report.
V command	outputs the firmware release level.
W command	outputs switch setting information.

1.5.6 Remote Output

Output Signals: RS-232 and RS-485, continuous once per second data stream in Format 0 or Format 1 only. In addition, RS-485 compatible outputs of the on-time pulse and time sync status are also present.

Connector: DB9 Female.

1.5.7 AM IRIG Output

Signal: Selectable IRIG B or IRIG E amplitude modulated sinewave.
                            IRIG B: 1000 Hz carrier.
                            IRIG E: 100 Hz carrier.
Signal Level: Adjustable from 1.0 - 9.0V p-p mark amplitude into loads $\geq$600 ohms.
Accuracy: $\pm$ 300 microseconds of on-time point.
Connector: BNC.
Output Options: Signature control: This feature removes the modulation code from the IRIG output whenever the clock is not synchronized to WWVB.

                            TTL output: Placing DIP switch 3 in the OFF position changes this output to a pulse-width coded TTL-compatible output.

1.5.8 IRIG TTL Output

Signal: Selectable IRIG B or IRIG E pulse width coded squarewave.
Signal Level: TTL-compatible.
Accuracy: $\pm$ 300 microseconds of on-time point.
Connector: BNC.
Output Options: Signature control: This feature, when selected, removes the pulse width modulation code whenever the clock is not synchronized to WWVB.

1.5.9   1PPS Output

Signal: One pulse-per-second squarewave locked to the WWVB carrier and time code. The leading edge represents the on-time point.
Signal Level: TTL-compatible.
Accuracy: ± 1 millisecond of NIST when corrected for receiver and propagation delays and continuously phase locked.
Connector: BNC.

1.5.10   Mechanical and Installation

Size: 3.0H x 7.8W x 11D inches. (76H x 198W x 279D mm).
Weight: 4.75 lbs. (2.2 Kg) Shipping Wt. 6.25 lbs. (2.9 Kg).
Line Power: 115/230 VAC ±10%, 50/60 Hz, 12 W typical.
Temperature: 32° to 122°F (0° to 50°C).
Rack Mount: Option 1, 3.5H x 19W inches. (89H x 483W mm).

1.5.11   FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

> NOTE: Shielded data cables were not required to achieve FCC compliance.

1.5.12   Model 8219 Passive Loop Antenna

Electrical
Type: Passive ferrite loop antenna
Frequency: Tuned to 60.0 kHz ±0.3 kHz.
Bandwidth: 700 Hz @ 3 dB points.
Minimum field strength: 50 µV/meter.
Temperature range: -30° to +70°C (-22° to 158°F).
Connector: BNC, female.
Recommended cable: RG58.
Maximum cable length: 1500 ft.

Mechanical
Length: 10.0 inches (25.4 cm).
Width: 2.8 inches (7.1 cm).
Housing material: PVC.
Assembled weight: 2.5 lbs (1.13 kg).
Mounting: PVC Mast and hose clamps provided.
Accessories   Model 8213 Antenna Base
                             Model MP08455 Antenna surge Suppressor

1.5.13   Model 8207 Preamplifier

Electrical

Frequency:	Tuned to 60.0 kHz ±0.2 kHz.
Bandwidth:	800 Hz @ 3 dB points.
Gain:	40 dB.
Connector:	BNC, female.

Mechanical

Size:	5.3L x 2.6W x 1.7H inches (133L x 67W x 43H mm).
Mounting Pattern:	4.75 x 1.75 inches (121 x 44 mm).
Temperature:	0° to +50°C (32° to 122°F).

INSTALLATION

2.0   INTRODUCTION

This section contains installation instructions for the Model 8182 NetClock/2 and Spectracom WWVB antenna system. To ensure proper operation, please read this chapter prior to performing the actual installation.

2.1   WWVB ANTENNA SYSTEM

The Spectracom WWVB antenna system consists of the Model 8219 Passive Loop Antenna and the Model 8207 Preamplifier.

Figure 2-1 illustrates a typical antenna installation including the MP08455 Surge Suppressor. Refer to Section 2.1.4 for information on the antenna surge suppressor.

The Model 8219 is a passive ferrite loop antenna tuned to receive the 60-kHz WWVB broadcast. The antenna MUST be installed OUTDOORS. Follow the antenna location guidelines listed in Section 2.1.1 when selecting a mounting location. The Model 8219 is a directional antenna. Refer to Section 2.1.2 and Figure 2-3 for aiming instructions.

The Model 8207 is a low-noise 40 dB gain amplifier. The Model 8207 installs into the antenna feed line and is powered by the NetClock/2. Install the Model 8207 indoors, preferably where the antenna coax enters the building. Connect the coax from the antenna to the input side of the Model 8207. Connect the output side to the NetClock/2 Receiver. Each Model 8207 includes two field-installable BNC connectors to splice the preamplifier into the antenna RG-58 coax. Refer to Figure 2-5 for connector assembly instructions.
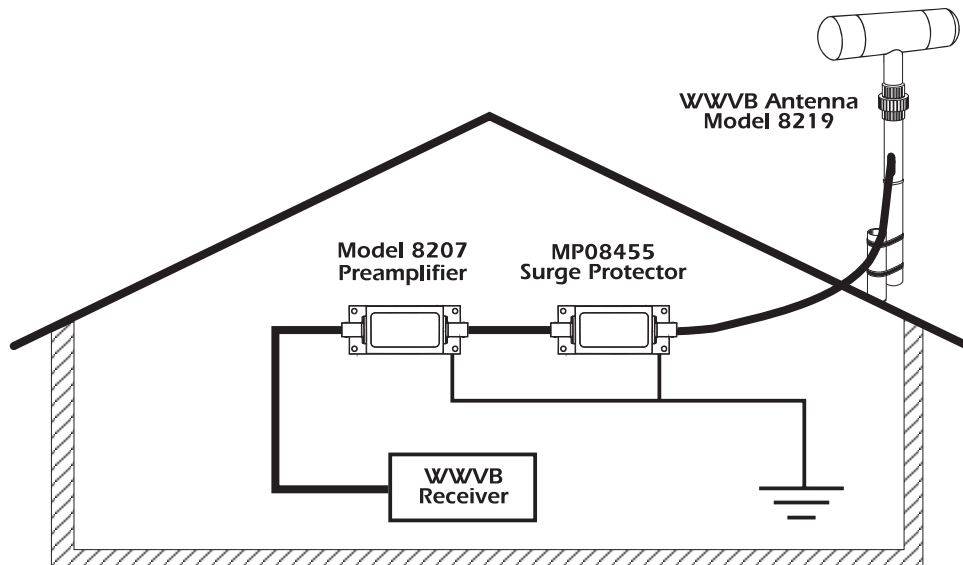
FIGURE 2-1   TYPICAL WWVB ANTENNA INSTALLATION

2.1.1   Antenna Location

Proper antenna placement is crucial for optimum receiver operation. Observe the following guidelines when selecting an antenna site.

- The antenna must be installed outdoors. Locate the antenna where it will not be disturbed. A rooftop location is preferred over placement on an antenna tower.

- To optimize the signal-to-noise ratio, locate the antenna as far as possible from local RF noise sources such as any broadcast antenna, large electric motors or power lines. Any equipment containing a switching power supply is a probable source of interference.

- Antenna height is not critical, as the WWVB 60-kHz carrier is a ground wave. Holding the antenna two to three feet off the ground or rooftop is adequate.

- To prevent regeneration, the antenna must be kept a minimum of 25 feet from the preamplifier. Locate the preamplifier at least 10 feet from the receiver. Never place an antenna or preamplifier next to or on top of the receiver.

- Locate the antenna a minimum of 10 feet from another Model 8219 antenna when installations require more than one antenna.

- Mount the antenna a minimum of 2 feet away from any steel structures, beams, roof decking, pipes, etc., as metal will detune the antenna and may cause as much as a 20 dB degradation of the signal-to-noise ratio.

2.1.2   Antenna Installation

Each antenna includes a two-foot long mast assembly and two hose clamps to simplify installation. The hose clamps may be used to affix the mast to a roof vent as shown in Figure 2-1. Spectracom offers an aluminum antenna stand, Model 8213, for installations where vent pipe mounting is not practical or desired. The Model 8213, shown in Figure 2-2, is furnished with ballast for added stability.

The Model 8219 is a directional antenna. The tubular housing must be positioned broadside to Fort Collins, Colorado, (See Figure 2-2) and horizontal to the ground to allow maximum signal reception. No signal will be received if the tube points directly toward the transmitter site, as the antenna pattern nulls are located off the ends of the tube. The Great Circle Map shown in Figure 2-3 is used to determine the correct antenna orientation per receiver location. Follow the instructions below the map scale to determine a compass heading. The antenna position may be optimized using the AGC measurements described in Section 4.1, Signal Strength Measurement.
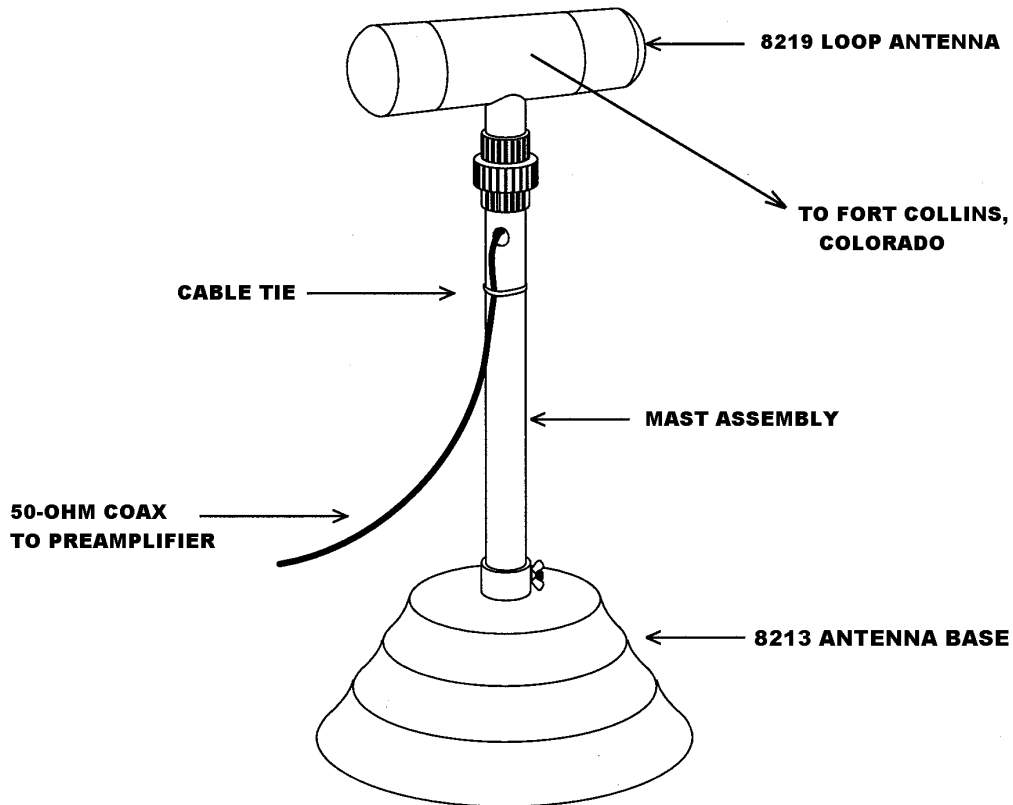
FIGURE 2-2   MODEL 8219 INSTALLATION

2.1.3   *Antenna Cable*

Spectracom recommends RG-58 coax for the antenna cable, though other 50-ohm coax with superior specifications may be used. The antenna coax provides the preamplifier with its DC operating voltage and the receiver with the amplified WWVB signal.

Spectracom offers RG-58 antenna coax terminated with BNC connectors. Specify part number CA01xxx, where xxx equals the cable length in feet. Apply a weatherproof sealant or tape over the antenna BNC connector to ensure the connection integrity.

Due to low attenuation characteristics at 60 kHz and the very low power requirement of the preamplifier (10 mW), cable lengths up to 1,500 feet are possible. Avoid bundling the antenna cable with other cables whenever possible.
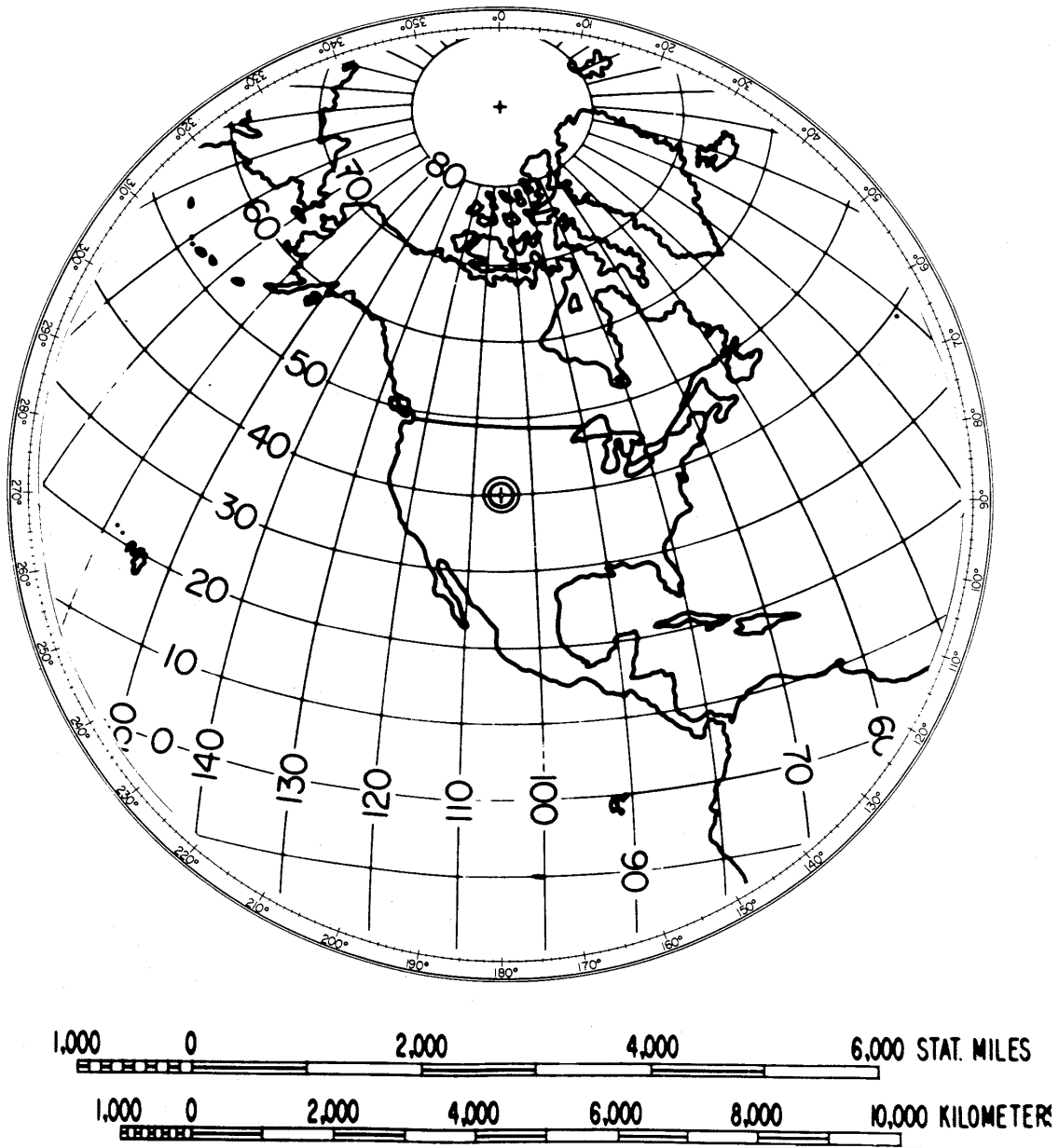
TO AIM ANTENNA AT FORT COLLINS, CO., DETERMINE COMPASS HEADING FROM THIS MAP.

Draw a straight line from the receiver location through Fort Collins, CO at the center of the
map. Continue until the line intersects the outer ring. The point at which the line intersects the
outer ring indicates the compass heading for Fort Collins from your location.

**FIGURE 2-3   GREAT CIRCLE MAP CENTERED
ON FORT COLLINS, COLORADO**

2.1.4   *Antenna Surge Suppressor*

Installation of a surge suppression device into the antenna line is recommended to protect the NetClock/2 and connected devices from lightning damage. Spectracom offers the MP08455, Antenna Surge Suppressor, to shunt potentially damaging voltages on the antenna coax to ground.

Each MP08455, shown in Figure 2-4, includes two field installable BNC connectors. The connectors may be used to splice the MP08455 into the antenna coax. Refer to Figure 2-5 for connector assembly instructions.
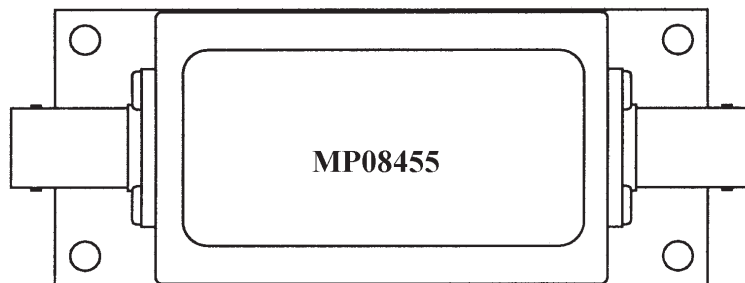
FIGURE 2-4   MP08455 SURGE SUPPRESSOR

Install the MP08455 where the antenna coax enters the building as shown in Figure 2-1. Secure the surge suppressor mounting plate to a grounding panel or bulkhead. If these are not available, connect the mounting plate to an earth ground using the largest wire conductor possible.

CLAMP TYPES

NUT　　WASHER　GASKET　CLAMP　　MALE CONTACT　　PLUG BODY
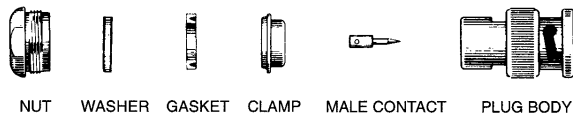
Tools Required:		
1	Sharp knife	
1	Cable cutter	
1	Soldering iron, solder	
1	Ruler	
1	Wire cutters/scissors	
2	7/16" Open end wrench or	
	adjustable wrench	
1	Multimeter	

Step 1

Step 2

Step 3

Step 4

Step 5

Step 1 Place the nut, washer and gasket, with "V" groove toward clamp, over cable and cut off jacket to 0.250 inches (a).
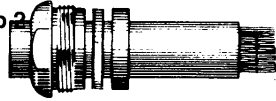
Step 2 Comb out braid and fold out. Cut off center dielectric to 0.094 inches (b) from end of center conductor.

Step 3 Pull braid wires forward and taper toward center conductor. Place clamp over braid and push back to cable jacket.
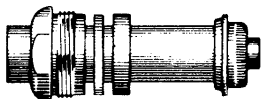
Step 4 Fold back braid wires over clamp and trim to proper length. Solder contact to center conductor.
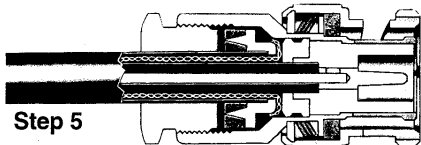
Step 5 Insert cable and parts into connector body. Make sure sharp edge of clamp seats properly in gasket. Tighten nut.

Step 6 Using the multimeter, measure continuity from center conductor of the other end of cable. It should be very close to 0 ohms. Measure continuity of center conductor to connector body. It should be open.

FIGURE 2-5 CONNECTOR ASSEMBLY INSTRUCTIONS

2.2　　*PREPARATION FOR USE*

This section outlines the set-up procedure for the NetClock/2. The configuration switches described in this section are located on the bottom cover. Refer to Section 3, Operation, for detailed information on switch functions and time data outputs.

2.2.1　　*PROPAGATION PATH DELAY*

The time required for a transmitted signal to reach the receiving antenna is known as its propagation path delay. This delay, along with the receiver delay, must be compensated for to achieve millisecond accuracy to NIST. The NetClock/2 utilizes three 10-position BCD switches to correct for path and receiver delays. The receiver delay is recorded on the bottom label and preset into the path delay switches at the factory.

Figure 2-6, Path Delay Map, shows propagation path delays based on the speed of light, 300 km/msec. This map provides approximate path delay values. To use the path delay map, obtain the distance from Fort Collins, Colorado, to the receiver location using dividers or marking the edge of a piece of paper. Transfer the distance against the path delay scale to find the propagation path delay. Add this value to the receiver delay and enter the sum into the path delay switches.
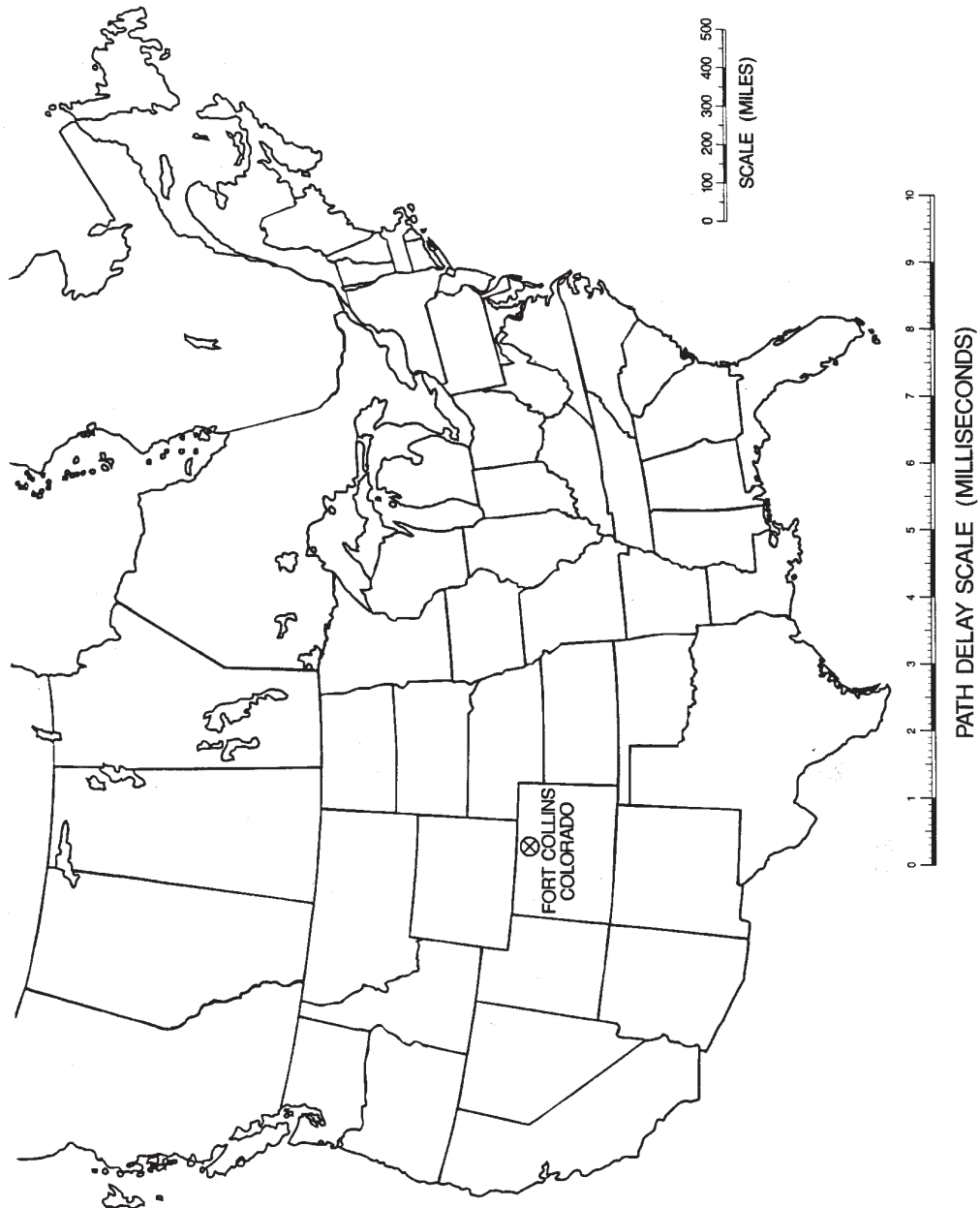
FIGURE 2-6   PATH DELAY MAP

2.2.2   UTC or Local Time Selection

The TIME ZONE switches offset the received UTC time allowing the receiver to display and output data reflecting a local time. If UTC time is desired, set the TIME ZONE switches to 00. Table 2-1 lists the time zone settings for most NetClock/2 installations.

TIME ZONE	SETTING
Atlantic	04
Eastern	05
Central	06
Mountain	07
Pacific	08
UTC	00

TABLE 2-1   TIME ZONE SETTINGS

2.2.3   Automatic Daylight Saving Time

DIP switch number 2 controls the automatic Daylight Saving Time feature. Placing this switch in the ON position allows the unit to correct for DST/Standard time changes. Changes are implemented at 2:00 AM local time.

If the NetClock/2 is installed where DST is not observed, or UTC time is desired, place this switch in the OFF position.

2.2.4   12- or 24-hour Display Time

The NetClock/2 display may be configured to display either 12- or 24-hour time. The instrument is factory-selected to display 24-hour time. To display 12-hour time, place DIP switch number 1 in the ON position. The time data contained in the SERIAL COMM, REMOTE, and IRIG outputs are in 24-hour format and are unchanged by this switch.

2.2.5   Data Format Selection

The NetClock/2 can be configured to output one of three data streams. Refer to Section 3.4 for a complete description of these data streams.

Format 0
Format 0 complies with the National Emergency Number Association, NENA 04-002 PSAP Master Clock Standard. This data stream contains the day-of-year, time reflecting time zone setting, time sync status character, DST/Standard Time indicator, and the time zone setting. Format 0 is shown below:

315 13:23:36 STZ=05

Format 1
This data stream contains the day of the week, day and month, the year, time sync status character, and the time reflecting the time zone setting. Format 1 is shown below:

    THU 11NOV99 13:23:36

Format 2
Format 2 data stream includes the year, day of year, UTC time with millisecond resolution, and indicators for Daylight Saving Time/Standard Time, leap second, time sync status, and time quality. An example of this format is shown below:

    99 315 18:36:14.267 S

The Data Format Switch selects the data format found on the Remote Output and Serial Comm connectors. Table 2-2 lists the switch settings and the corresponding data format configuration.

Switch Position	Serial Comm Format	Remote Output Format
0	Format 0	Format 0
1	Format 1	Format 1
2	Format 2	Format 0
3	Format 0	Format 1
4	Format 1	Format 0
5	Format 2	Format 1

TABLE 2-2   DATA FORMAT CONFIGURATION

2.2.6 *Baud Rate Selection*

The NetClock/2 has switch selectable baud rates of 300, 600, 1200, 2400, 4800, and 9600. The Remote Output and Serial Comm baud rates are configured with the baud switch as shown in Table 2-3.

SWITCH SETTING	BAUD RATE
0	300
1	600
2	1200
3	2400
4	4800
5	9600

TABLE 2-3   BAUD RATES

2.2.7   IRIG Output Configuration

The IRIG Format switch selects the format of the amplitude modulated (AM) and TTL IRIG outputs. Table 2-4 lists the IRIG formats available. The signature control feature removes the IRIG modulation time code whenever the clock is not synchronized to WWVB.

SWITCH SETTING	IRIG FORMAT
0	IRIG B
1	IRIG B with Signature Control
2	IRIG E
3	IRIG E with Signature Control

TABLE 2-4   IRIG FORMATS

The IRIG AM LEVEL ADJ potentiometer sets the AM IRIG to the desired signal level. The mark amplitude is variable from 0-10V peak-to-peak.

> **NOTE: DIP switch number 3 must be in the ON position to enable an AM IRIG output.**

2.2.8   Chassis Ground

The chassis ground lug allows the NetClock/2 chassis to be connected to an earth ground or single point ground. Connecting the chassis to a single point ground system may be required in some installations to ensure optimum lightning protection. An earth ground is also recommended in installations where excessive noise on the power line degrade receiver performance.

2.2.9   AC Input

The NetClock/2 is factory set for 115 VAC operation. The AC input module can be configured for 230 VAC operation as described in Section 3.2.4 of this manual.

2.3   OPTION 1 RACK MOUNT KIT

Option 1 provides the necessary hardware to mount the NetClock/2 into an EIA standard 19-inch rack. The rack mount panel measures 3.5 inches high. Table 2-5 lists the parts supplied with Option 1. Verify that these items have been received.

QUANTITY	DESCRIPTION
1	Mounting Panel
2	Bracket
8	#6-32 Hex Nut
8	#6 Split Lockwasher
2	#4-40 Hex Spacer, 2-15/16 inches
4	#4-40 Screw, 5/16 Phillips Pan Head
4	#4 Split Lockwasher

TABLE 2-5   OPTION 1 CHECKLIST

A Phillips screwdriver and a 5/16 nut driver are needed to assemble the rack mount kit. Refer to Figure 2-7 and the instructions below to assemble the rack mount kit.

1.   Attach the two brackets to the mounting panel using the #6 hex nuts and #6 split lockwashers. **DO NOT TIGHTEN THE NUTS**. The brackets must be loose to slip over the NetClock/2 body. Note the orientation of the brackets as shown in Figure 2-6.

2.   To prepare the NetClock/2 for rack mount installation, two screws must be removed from the bottom cover. The two Phillips head screws are located 4-1/2 inches back from the front panel. These screws are used to secure the NetClock/2 to the rack mount assembly.

3.   Slide the rack mount assembly over the front of the NetClock/2. Align the bracket mounting holes with the screw holes on the bottom cover. Reinstall the screws removed in Step 2 here. Install the hex spacers using the #4 screws and lockwashers. Tighten the 8 nuts securing the brackets to the mounting panel.

4.   Install the NetClock/2 into a 19-inch rack.
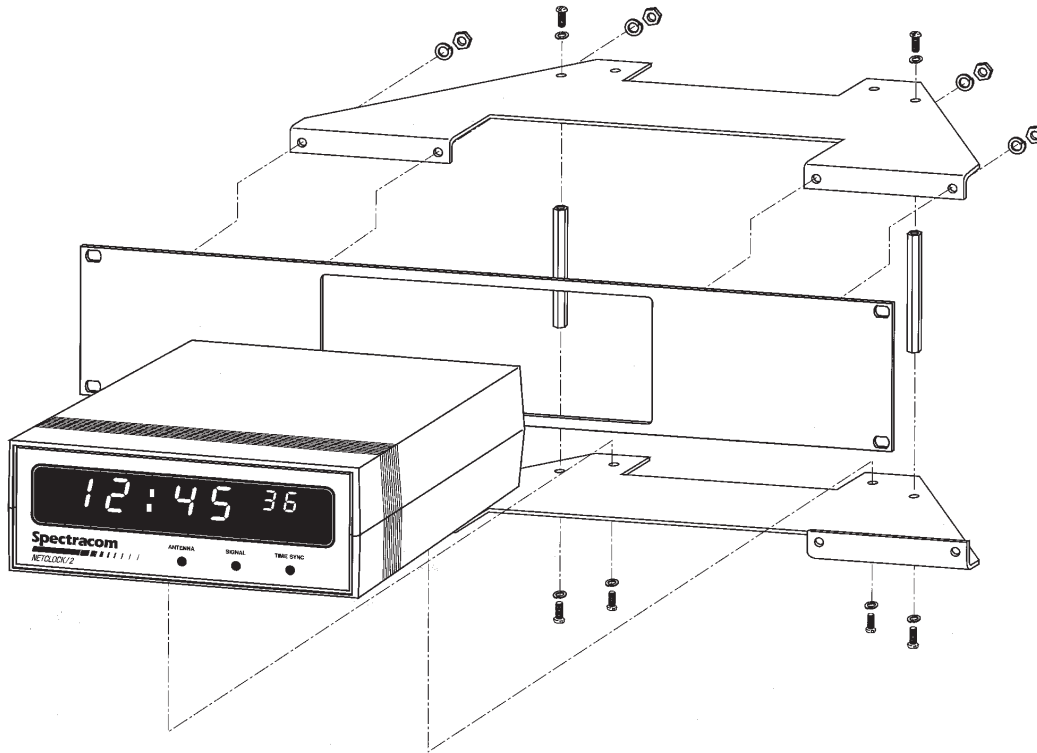
FIGURE 2-7   OPTION 1, RACK MOUNT ASSEMBLY

2.4   *INITIAL OPERATION*

Connect the supplied line cord to the AC power jack and a properly grounded outlet. The display and the three LED indicators light up after power is applied.

The ANTENNA status lamp is green if the antenna is connected properly. The ANTENNA lamp is red if the antenna cable is not connected or has opens or shorts.

The SIGNAL lamp is used to indicate carrier lock status to WWVB. A red SIGNAL lamp indicates there is insufficient signal received to allow receiver locking. The SIGNAL lamp is green when the receiver is phase locked to WWVB. This typically takeS less than one minute for most installations.

During the initial synchronization process, the TIME SYNC lamp is red. The displayed time is based upon the time retrieved from the battery backed clock. The receiver reads and qualifies each time code bit received.

Once the receiver decodes the data, the display will set itself. The TIME SYNC lamp turns green when the receiver has adjusted its on-time point to within 1 millisecond of the received time code. The time it takes to synchronize depends upon the quality of the signal received. Under good signal conditions, the clock typically synchronizes within 15 minutes. Poor signal quality may extend the synchronization period to several hours. Refer to Section 4, Service Information, for troubleshooting reception problems.

OPERATION

3.0   INTRODUCTION

This section describes the front and rear panel functions, switch functions, and operational information for the NetClock/2.

3.1   FRONT PANEL FUNCTIONS

Figure 3-1, NetClock/2 Front Panel, and the following paragraphs describe the front panel functions.

3.1.1   Display

During initial operation, the time displayed and output is derived from the SmartWatch™. SmartWatch maintains timekeeping functions whenever AC power is removed. The SmartWatch lithium battery has a ten-year life expectancy, and a typical accuracy of ±2 seconds per day.

The receiver reads and qualifies the received WWVB time code. Once the time code is decoded , the Coordinated Universal Time (UTC) minus the Time Zone switch setting and Daylight Saving Time correction (if applicable) is displayed. Time may be displayed in a 12- or 24-hour format based on the 12/24 hour DIP switch setting.

Display characters are red LED digits measuring 0.8 inches high for the hours and minutes, and 0.56 inches high for the seconds. The display area features a red filter with an anti-glare surface for optimum viewing.

The display may also be configured to show the time code characters received from WWVB each second. This feature is used when troubleshooting reception problems. Refer to Section 4, Service Information, for additional information.

FIGURE 3-1   MODEL 8182 NETCLOCK/2 FRONT PANEL

3.1.2   *Status Indicators*

The NetClock/2 utilizes dual color LED's to indicate operational status. When all three status lamps are green, the unit will operate within specifications. A red lamp alerts the user that a problem has arisen which may cause out-of-specification operation.

ANTENNA - This lamp monitors the condition of the antenna coaxial cable. A red lamp indicates that a short or open has been detected and the cable must be serviced. Failure to repair the cable will result in loss of carrier lock and time synchronization to WWVB. The receiver is short-circuit protected to prevent cable shorts from causing damage.

A green antenna lamp indicates cable integrity is good.

SIGNAL - This lamp monitors the carrier lock status and warns when a receiver adjustment is required.

This lamp is green whenever the receiver is phase locked to the WWVB carrier. The lamp is red when insufficient signal is received to maintain carrier lock. An occasional loss of signal can be considered normal. Typically the receiver will regain carrier lock within five minutes. Extended periods of unlock suggest a receiver or antenna problem.

The signal lamp blinks red and green when the voltage controlled crystal oscillator (VCXO) requires an adjustment. The adjustment is made to compensate for crystal aging and may be required approximately every five years. A complete adjustment procedure is described in Section 4, Service Information.

TIME SYNC -This lamp indicates the synchronization status to WWVB. This lamp is green when the clock is synchronized to WWVB.

The following conditions cause the Time Sync lamp to be red:

1. The receiver has lost phase lock to WWVB for a period greater than one hour. At this point, the expected time error may exceed 50 milliseconds.

2. The receiver has not decoded a minimum of 5 consecutive error-free minutes over the past 24 hours. This condition is typically caused by local interference disrupting the received time code.

3. The time has been manually set using the RS-232 Set command.

4. A power failure.

The lamp shall remain red until the clock successfully decodes and locks within one millisecond of the WWVB time code.

Time synchronization characters in the time data outputs and the Alarm Output relay follow the state of the Time Sync lamp.

3.2   REAR PANEL FUNCTIONS

Figure 3-2, NetClock/2 Rear Panel, and the following paragraphs describe the rear panel functions.

3.2.1   AGC Test Points

The AGC test points are used to measure the relative field strength of the 60-kHz WWVB signal. This measurement may be used to optimize reception by indicating the best location and orientation of the antenna. This is especially useful for the Model 8219 Loop Antenna, due to its directional reception pattern. Refer to Section 4, Service Information, for instructions on performing signal strength measurements.

3.2.2   Antenna

This BNC connector is the antenna input to the receiver. The Model 8207 Preamplifier receives its operational power from this connector. The connector provides 10.7 VDC and is short-circuit protected. Antenna and preamplifier installation is described in Section 2.1 of this manual.
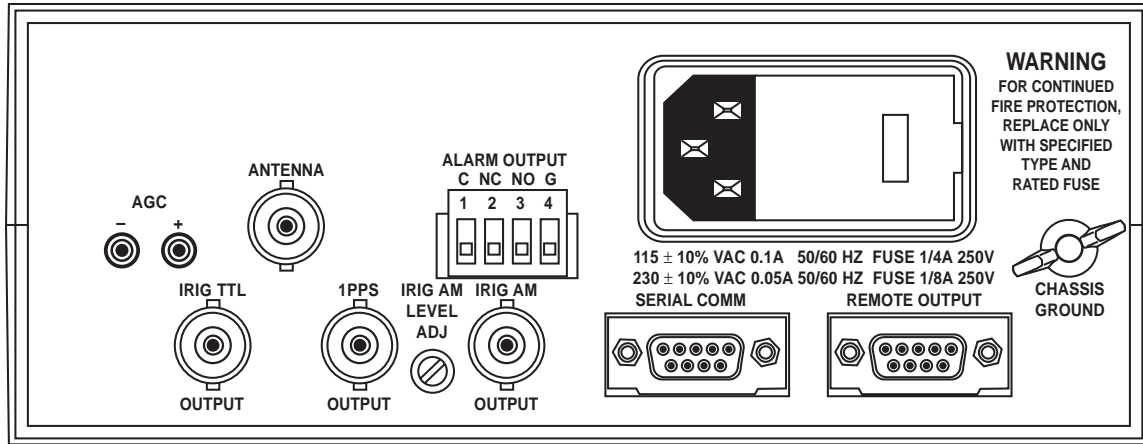
FIGURE 3-2   MODEL 8182 NETCLOCK/2 REAR PANEL

3.2.3   *Alarm Outputs*

The Alarm Output relay contacts may be used to remotely monitor the time synchronization status. An alarming device such as a horn or lamp can be turned on whenever WWVB time synchronization or power is lost. The Alarm Output pin assignments are shown in Figure 3-3. The removable 4-position terminal strip is included in the ancillary kit.
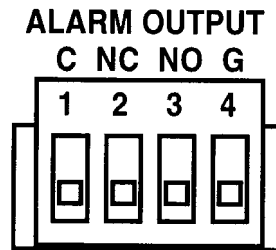
FIGURE 3-3   ALARM OUTPUT CONNECTOR

A schematic representation of the Alarm Output relay contacts is shown in Figure 3-4. The relay contacts are rated a 2.0 Amps, 30 VDC.

1	Common
2	Normally Closed
3	Normally Open
4	Ground
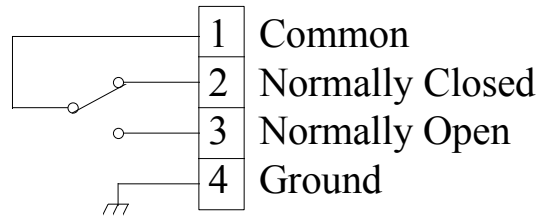
FIGURE 3-4   ALARM RELAY CONTACTS

Continuity exists between Pin 1 (Common) and Pin 2 (Normally Closed) whenever the Time Sync lamp is red or loss of AC power.

Continuity exists between Pin 1 (Common) and Pin 3 (Normally Open) whenever the Time Sync lamp is green.

The relay contacts can be referenced to ground by connecting Pin 1 (Common) to Pin 4 (Ground).

3.2.4   *AC Power*

The NetClock/2 is supplied with a detachable line cord. This cord plugs into the AC power module. The power module contains RFI filters, line fuse, and the line voltage selector. The NetClock/2 may be operated from a 115 VAC or 230 VAC, 50/60 Hz power line. To access the fuse and line voltage selector, refer to Figure 3-5 and as described below:

1. Remove the line cord (if installed) from the power module.

2. Open the fuse and selector drum cover with a small flat-bladed screwdriver. Insert the screwdriver blade into the cover notch and pry.

3. The NetClock/2 is factory-set for 115 VAC operation. To change to 230 VAC operation, pull the voltage selection drum from the power module. Reinsert the drum so that the desired line voltage appears through the cover cut-out.

4. Pull the fuse block from the power module. Replace fuse with a 1/4 amp, 250V slow blow fuse for 115 VAC operation, and 1/8 amp, 250V slow blow fuse for 230 VAC operation.

5. Reinstall the fuse block into the lower fuse compartment. Make certain the arrow on the fuse block is pointing down.

6. Snap the cover door closed.
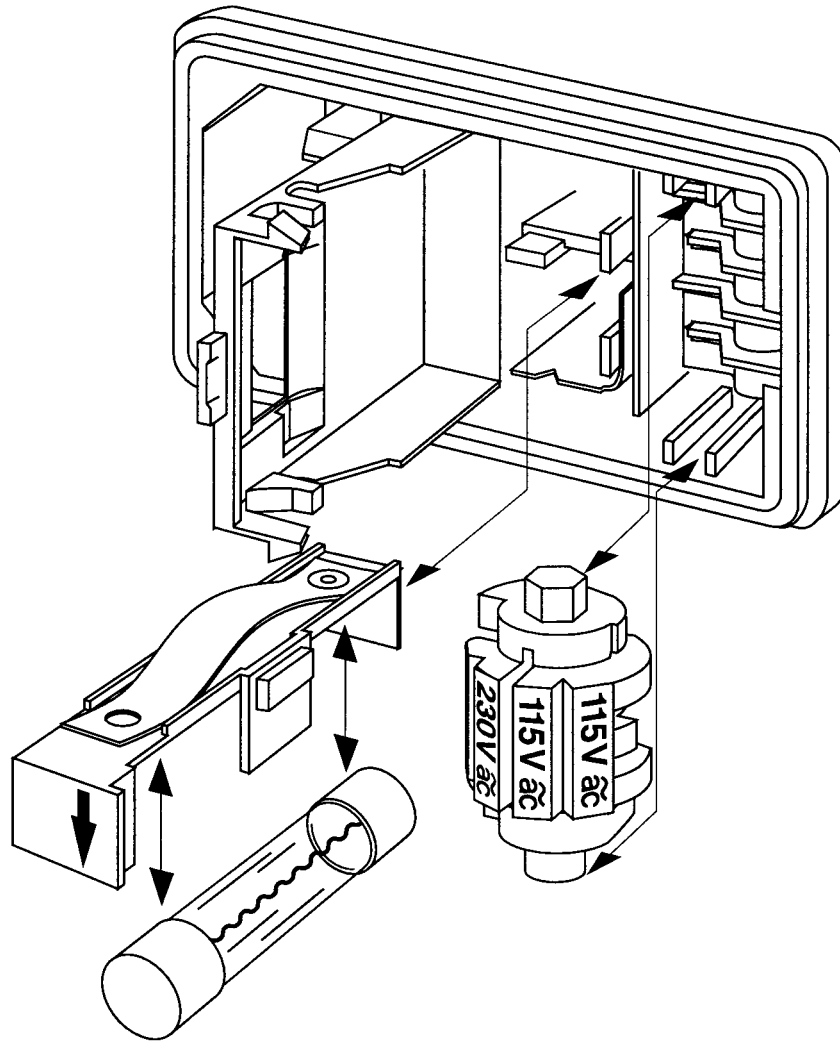
FIGURE 3-5   AC POWER MODULE

3.2.5   *Chassis Ground*

The chassis ground lug allows the NetClock/2 chassis to be connected to an earth ground or single point ground. Connecting the chassis to a single point ground system may be required in some installations to ensure optimum lightning protection. An earth ground is also recommended in installations where excessive noise on the power line degrade receiver performance. Connect to a well-grounded cold water pipe or ground-stake using the largest cable conductor possible.

3.2.6   IRIG TTL Output

This BNC connector provides the selected IRIG code in a TTL-compatible pulse width coded format. The output resembles a series of square waves with varying pulse widths. The pulse width duration encodes the time code elements of Binary 0, Binary 1 or Position Identifier. Refer to Appendix B of this manual for detailed information on the IRIG code structure.

The IRIG format switch configures this output for IRIG B or IRIG E with or without Signature Control. Signature Control removes the pulse width modulation from the output whenever the receiver has lost WWVB synchronization.

3.2.7   1-PPS Output

This BNC connector outputs a one pulse-per-second on-time pulse. The leading edge of the pulse is synchronized to the WWVB carrier reduction that occurs at the beginning of each second. When the Signal and Time Sync lamps are green the on-time pulse is synchronized within 1 millisecond. Typical short term jitter is typically less than 2 microseconds. This jitter is due in part to the time code modulation and atmospheric conditions. The output has a 10% duty cycle and is TTL-compatible into loads greater than 100 ohms.

3.2.8   IRIG AM Output

This BNC connector provides the selected IRIG code in an amplitude modulated format. The IRIG format switch selects between IRIG B and IRIG E with or without Signature Control. IRIG B has a 1-kHz carrier and IRIG E has a 100-Hz carrier. The Signature Control feature removes the amplitude modulation from the output whenever the receiver has lost WWVB synchronization.

The signal amplitude is set using the IRIG AM Level Adj potentiometer. The mark amplitude may be set from 0 to 10 volts peak-to-peak. The IRIG mark amplitude is factory set for 2 Volts peak-to-peak.

Appendix B of this manual provides detailed information on the IRIG code structure.

> *NOTE: DIP switch 3 must be in the ON position to enable an amplitude modulated IRIG signal. Placing this switch in the OFF position changes this output to a pulse width coded, TTL-compatible output.*

3.2.9   *Serial Comm*

This is the RS-232 serial communications port. Commands to output the time, operational information, and to manually set the time are entered here. Refer to Section 3.4 for a complete description of the RS-232 commands and output data formats. The bit rate and data format selection are made by switches found on the bottom cover.

The Serial Comm connector is a 9-pin series D female. Connector pin numbering is illustrated in Figure 3-6. Serial Comm pin assignments are shown in Table 3-1.
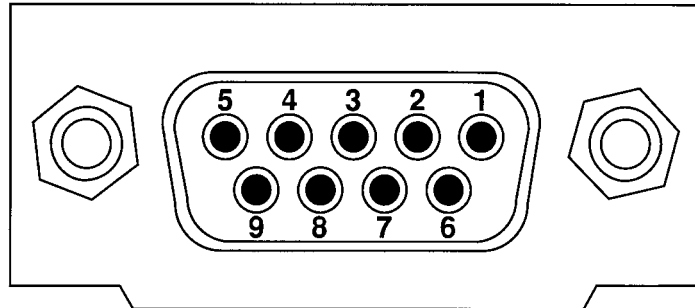
FIGURE 3-6   SERIAL COMM PIN NUMBERING

PIN	SIGNAL	I/O	DESCRIPTION
2	RXD	O	Receive Data
3	TXD	I	Transmit Data
5	GND	-	Signal Common
6	DSR	O	Data Set Ready
7	RTS	*	Request to Send
8	CTS	*	Clear to Send

*Pins 7 and 8 are connected together internally.

TABLE 3-1   SERIAL COMM PIN ASSIGNMENTS

The NetClock/2 is classified as data communication equipment (DCE). Time data is output on Pin 2, RXD and commands are input on Pin 3, TXD. When interfacing to data terminal equipment, DTE, (i.e. a personal computer) a one-to-one cable is used. Interfacing to a DCE requires reversing Pins 2 and 3 or a null modem. The SERIAL COMM port requires no flow control. The Request to Send and Clear to Send signals are internally connected together, and the DSR signal is held high through a pull-up resistor. The character structure is 1 start bit, 8 data bits, 1 stop bit with no parity.

3.2.10   Remote Output

This port broadcasts a once-per-second time data stream in RS-232 and RS-485 levels.
The Remote Output is typically used to distribute time data throughout a facility using
the RS-485 time data outputs. Spectracom offers many products which utilize the RS-485 timing outputs. Refer to Section 3.5, Remote Output Usage, for additional
information.

The Remote Output connector is a 9-pin series D female. Connector pin numbering is
illustrated in Figure 3-7. Pin assignments are shown in Table 3-2.
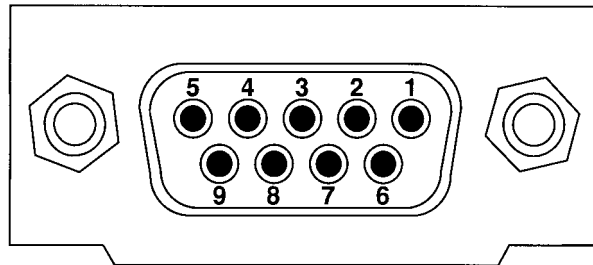
FIGURE 3-7   REMOTE OUTPUT PIN NUMBERING

PIN	SIGNAL	DESCRIPTION
3	-DATA	RS-485 inverted time data
8	+DATA	RS-485 non-inverted time data
2	-ON-TIME	RS-485 inverted on-time pulse
7	+ON-TIME	RS-485 non-inverted on-time pulse
1	-TSYNC	RS-485 inverted time sync status
6	+TSYNC	RS-485 non-inverted time sync status
4	ENABLE	+5V Enable output
9	GND	Signal Ground
5	TDATA	RS-232 time data output

TABLE 3-2   REMOTE OUTPUT PIN ASSIGNMENTS

Time data is broadcast in ASCII once-per-second in RS-485 levels, ±DATA, and at
RS-232 levels, TDATA. Bit rate and data format selection are made by switches located
on the bottom cover.

The +ON-TIME signal is a positive-going 0.1 second pulse relative to -ON-TIME, occurring once per second. The source of this output is the same as the 1-PPS output. Refer to Section 3.2.7 for additional information about the on-time pulse output.

The +TSYNC signal is high relative to -TSYNC whenever the front panel TIME SYNC lamp is green. If the TIME SYNC lamp is red, the -TSYNC is high relative to the +TSYNC signal.

The ENABLE signal is +5 volts through a 68-ohm series resistor.

3.3 SWITCH FUNCTIONS

The NetClock/2 utilizes switches located on the bottom cover to enter user selectable parameters. Rotary switches are used wherever possible to simplify selection entries. Figure 3-8, Switch Functions, and the following paragraphs describe the NetClock/2 switch functions.

MODEL 8182 NETCLOCK/2
SPECTRACOM CORPORATION   EAST ROCHESTER NY 14445

PATH DELAY

PATH DELAY IS THE SUM OF THE RECEIVER DELAY AND THE CALCULATED PROPAGATION DELAY. REFER TO MANUAL FOR PROPAGATION DELAY INFORMATION.

RECEIVER DELAY: MILLISECONDS

TIME ZONES 00-23

00 - UTC	REFER TO
04 - ATLANTIC	MANUAL
05 - EASTERN	FOR
06 - CENTRAL	ADDITIONAL
07 - MOUNTAIN	OFFSETS.
08 - PACIFIC	

DIP SWITCH

1	ON	12 HR DISPLAY
	OFF	24 HR DISPLAY
2	ON	AUTO DST YES
	OFF	AUTO DST NO
3	ON	AM IRIG OUTPUT
	OFF	TTL IRIG OUTPUT
4	ON	MANUAL SET YES
	OFF	MANUAL SET NO
5-7		SPARE

1 2 3 4 5 6 7
OFF

PATH DELAY TENS MSEC
PATH DELAY UNITS MSEC
PATH DELAY TENTHS MSEC
TIME ZONE TENS
TIME ZONE UNITS

DATA FORMAT
IRIG FORMAT
BAUD RATE

BAUD RATE

0 - 300
1 - 600
2 - 1200
3 - 2400
4 - 4800
5 - 9600
6-9 SPARE

DATA FORMAT

0: (CR)(LF)I(^)(^)DDD(^)HH:MM:SS(^)(D)TZ=XX(CR)(LF)
1: (CR)(LF)I(^)WWW(^)DDMMMYY(^)HH:MM:SS(CR)(LF)
2: (CR)(LF)IQYY(^)DDD(^)HH:MM:SS.XXX(^)LD
3-9: SPARE
NOTE: REFER TO MANUAL FOR FORMAT DESCRIPTION.

SWITCH POSITION	SERIAL COMM FORMAT	REMOTE OUTPUT FORMAT
0	FORMAT 0	FORMAT 0
1	FORMAT 1	FORMAT 1
2	FORMAT 2	FORMAT 0
3	FORMAT 0	FORMAT 1
4	FORMAT 1	FORMAT 0
5	FORMAT 2	FORMAT 1

IRIG FORMAT

0 - IRIG B
1 - IRIG B W/SIGNATURE CONTROL
2 - IRIG E
3 - IRIG E W/SIGNATURE CONTROL
4-9 SPARE

NOTE: CONSULT MANUAL WHEN SIGNAL LAMP FLASHES.

THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES. OPERATION IS SUBJECT TO THE CONDITION THAT THIS DEVICE DOES NOT CAUSE HARMFUL INTERFERENCE.

FIGURE 3-8   SWITCH FUNCTIONS

3.3.1   *Path Delay Switches*

These switches are used to compensate for propagation and receiver delays in 0.1 millisecond steps. Refer to Section 2 of this manual to determine the propagation path delay.

The receiver delay is measured at the factory. This value is entered into the path delay switches and recorded on the bottom cover.

Enter the sum of the propagation delay and the receiver delay into the path delay switches. The NetClock/2 will advance its on-time point by the sum amount to eliminate errors caused by these delays.

3.3.2   *Time Zone Switches*

These switches are used to offset the received UTC time allowing the NetClock/2 to display and output a local time. The received time may be offset by 0 to 23 hours in one-hour steps. See Figure 3-9, World Time Zones/Time Zone Switch Settings.

3.3.3   *Baud Rate Switch*

This switch controls the bit rate operation of the Serial Comm and Remote Output. Table 3-3 lists the baud rates available.

SWITCH SETTINGS	BAUD RATE
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6-9	SPARE

TABLE 3-3   BAUD RATES

3.3.4   *IRIG Format Switch*

This switch selects the IRIG format applied to the IRIG TTL and IRIG AM output connectors. The switch selects between IRIG B and IRIG E with or without Signature Control. Signature Control removes the modulation code from the IRIG outputs whenever WWVB synchronization is lost. Table 3-4 lists the switch settings available.
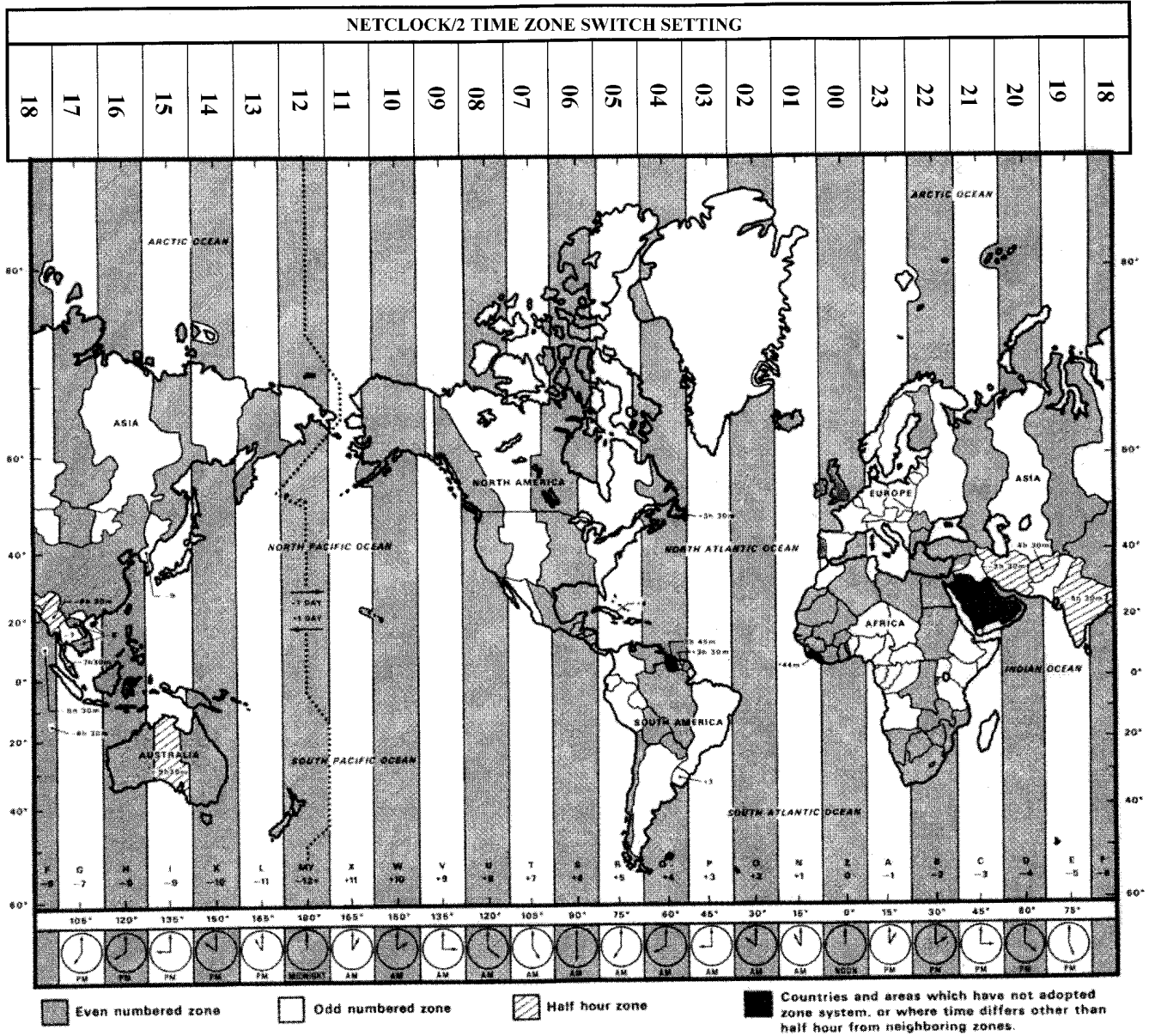
FIGURE 3-9   WORLD TIME ZONES/TIME ZONE SWITCH SETTINGS

SWITCH SETTING	IRIG OUTPUT
0	IRIG B
1	IRIG B with Signature Control
2	IRIG E
3	IRIG E with Signature Control
9	Test Mode

TABLE 3-4   IRIG OUTPUTS

Placing the IRIG switch in Position 9 enables a test mode feature used to indicate WWVB reception quality. This feature allows the leftmost display digit to show the received WWVB time code characters. Refer to Section 4.2.3 for a complete description of this feature.

3.3.5   Dip Switch Functions

Dip Switch 1 - 12- or 24-Hour Display

Dip switch number 1 controls the time format displayed on the front panel. Dip switch 1 in the ON position displays the time in the 12-hour format. Placing Dip switch 1 in the OFF position displays the time in the 24-hour format.

The time data contained in the Serial Comm, Remote, and IRIG outputs are in 24-hour format and are unchanged by this switch.

Dip Switch 2 - Automatic DST Corrections

This switch enables or disables the automatic Daylight Saving Time feature. Placing Dip switch 2 in the ON position allows the NetClock/2 to automatically correct the display and output data for DST. Corrections for DST will be made at 2:00 AM local time.

In applications here UTC time is desired or DST is not implemented, place this switch in the OFF position.

Dip Switch 3 - IRIG Signal

Placing this switch in the OFF position changes the IRIG AM output to a TTL-compatible pulse width coded output.

To assure proper operation of the IRIG AM output, place this switch in the ON position.

Dip Switch 4 - Manual Set Disable

This switch, when in the ON position, allows the clock to accept manual SET commands. Placing this switch in the OFF position prevents the clock from accepting manual SET commands.

Dip Switch 5 through Switch 7 - Spares

These switches are reserved for future use. Place these switches in the OFF position.

3.3.6   *Data Format Switch*

The Data Format switch selects the time data stream output on the Serial Comm and Remote Output. The three output data formats are listed below:

Format 0: (CR)(LF)I(^)(^)DDD(^)HH:MM:SS(^)DTZ=XX(CR)(LF)
Format 1: (CR)(LF)I(^)WWW(^)DDMMMYY(^)HH:MM:SS(CR)(LF)
Format 2: (CR)(LF)IQYY(^)DDD(^)HH:MM:SS.XXX(^)LD

where:

CR =	Carriage Return
LF =	Line Feed
I =	Time Sync Status (space, ?, *)
Q =	Quality Indicator (space, A, B, C, D)
YY =	Year (99, 00, 01 etc.)
^ =	space separator
DDD =	Day of Year (001 - 366)
HH:MM:SS =	Hours:Minutes:Seconds
. =	Decimal Separator
XXX =	Milliseconds (000-999)
L =	Leap Second Indicator (space, L)
D =	Daylight Saving Time Indicator (S, I, D, O)
XX =	Time Zone Setting (00-23)
WWW =	Day of Week (MON, TUE, WED)
DD =	Numerical Day of Month (^1-31)
MMM =	Month (JAN, FEB, MAR)

Refer to Section 3.4 for a complete description of the data formats.

The Data Format switch configures the Serial Comm and Remote Output as shown in Table 3-5.

Switch Position	Serial Comm Format	Remote Output Format
0	Format 0	Format 0
1	Format 1	Format 1
2	Format 2	Format 0
3	Format 0	Format 1
4	Format 1	Format 0
5	Format 2	Format 1

TABLE 3-5   DATA FORMAT CONFIGURATION

3.4   *USING THE SERIAL COMM PORT*

This section provides information on using the Serial Comm port. General guidelines, output data formats and the command set are described.

3.4.1   *General Guidelines*

The guidelines listed below outline the Serial Comm operation.

1. Serial Comm is a serial ASCII RS-232 port.

2. The NetClock/2 is a DCE. Transmit Data, Pin 3, is an input. Receive Data, Pin 2, is an output. Pin assignments conform to EIA/TIA-574 standard. Refer to Section 3.2.9 for the Serial Comm pin assignments.

3. Flow control is not required. The RTS and CTS lines are internally connected together. A simple 3-wire interface may be used.

4. Data format and baud rate are selected by switches found on the bottom cover.

5. Output data streams are 26 characters long. Each character consists of 1 start, 8 data, and 1 stop bit, no parity.

6. All commands issued to the Serial Comm port must be uppercase letters.

7. The NetClock/2 responds with an asterisk (*) to all invalid commands or characters received.

8. Do not follow a command with a line terminator (i.e. carriage return, enter, etc).

3.4.2   *Time Data Formats*

This section describes each of the three output time data formats.

3.4.2.1   Format 0

This format provides the day-of-year time data stream. The data stream contains a time sync status character, day of year, time reflecting time zone setting, DST/Standard Time Indicator, and the time zone switch setting. Format 0 data structure is shown below:

(CR)(LF)I(^)(^)DDD(^)HH:MM:SS(^)DTZ=XX(CR)(LF)

where:

CR =	Carriage Return
LF =	Line Feed
I =	Time Sync Status (space, ?, *)
^ =	space separator
DDD =	Day of Year (001 - 366)
HH =	Hours (00-23)
: =	Colon separator
MM =	Minutes (00-59)
SS =	Seconds (00 - 60)
D =	Daylight Savings Time indicator (S,I,D,O)
TZ =	Time zone
XX =	Time Zone Switch Setting (00-23)

The leading edge of the first character (CR) marks the on-time point of the data stream.

Time sync status character I is described below:

I =	(space) when the receiver is synchronized to WWVB.
=	* when the time is derived from the SmartWatch or set manually using the Serial Comm port.
=	? when the receiver has lost synchronization to WWVB.

The Daylight Saving Time indicator provides notice whether Standard Time or DST is in effect and warns of upcoming transitional periods. The Daylight Saving Time indicator D is described below:

D =	S during periods of Standard Time.
=	I on the day of the change INTO Daylight Saving Time.
=	D during periods of Daylight Saving Time.
=	O on the day of the change OUT of Daylight Saving Time.

Format 0 time data is output in a 24-hour time format only. The 12/24 hour time Dip switch has no effect on the output data stream. The time may be offset to a local time by setting the time zone switches to the appropriate value.

3.4.2.2   Format 1

This format provides the fully decoded time data stream. Format 1 converts the received day of year data (1-366) to a date consisting of day of week, month, and day of the month. Format 1 also contains a time sync status character, year, and time reflecting time zone switch setting. Format 1 data structure is shown below:

Format 1: (CR)(LF)I(^)WWW(^)DDMMMYY(^)HH:MM:SS(CR)(LF)

where:

CR =	Carriage Return
LF =	Line Feed
I =	Time Sync Status (space, ?, *)
^ =	space separator
WWW =	Day of Week (MON, TUE, WED, THU, FRI, SAT, SUN)
DD =	Numerical Day of Month (^1-31)
MMM =	Month (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC)
YY =	Year without century (99, 00, 01 etc.)
HH =	Hours (00-23)
: =	Colon separator
MM =	Minutes (00-59)
SS =	Seconds (00-60)

The leading edge of the first character (CR) marks the on-time point of the data stream.

Time sync status character I is described below:

I =	(space) when the receiver is synchronized to WWVB.
=	* when the receiver time is derived from the SmartWatch, or set manually using the Serial Comm port.
=	? when the receiver has lost synchronization to WWVB.

Format 1 time data is output in a 24-hour time format only. The 12/24 hour time Dip switch has no effect on the output data stream. The time may be offset to a local time by setting the time zone switches to the appropriate value.

3.4.2.3   *Format 2*

This format provides a time data stream with millisecond resolution. The Format 2 data stream consists of indicators for time sync status, time quality, leap second and Daylight Saving Time. Time data reflects UTC time and is in the 24-hour format   The time zone switches and the 12/24 time format switch have no effect on the output data stream. Format 2 data structure is shown below:

Format 2: (CR)(LF)IQYY(^)DDD(^)HH:MM:SS.XXX(^)LD

where:

CR =	Carriage Return
LF =	Line Feed
I =	Time Sync Status (space, ?, *)
Q =	Quality Indicator (space, A, B, C, D)
YY =	Year without century (99, 00, 01 etc.)
^ =	space separator
DDD =	Day of Year (001 - 366)
HH =	Hours (00-23 UTC time)
: =	Colon separator
MM =	Minutes (00-59)
SS =	Seconds (00-60)
. =	Decimal Separator
XXX =	Milliseconds (000 - 999)
L =	Leap Second Indicator (space, L)
D =	Daylight Saving Time Indicator (S, I, D, O)

The leading edge of the first character marks the on-time point of data stream.

Time sync status character I is described below:

I =	(space) when the receiver is synchronized to WWVB.
=	* when the receiver time is derived manually from the SmartWatch, or set manually using the Serial Comm port.
=	? when the receiver has lost synchronization to WWVB.

The quality indicator Q provides an inaccuracy estimate of the 1-PPS on-time pulse. When the receiver is time synchronized to WWVB, the inaccuracy is less than 1 millisecond. When the receiver loses phase lock, the VCXO will begin to drift to a control voltage rail. The VCXO frequency at a rail may be off by 2×10^{-5}. Table 3-6 lists the various quality indicators and their corresponding error based on time since loss of phase lock.

Inaccuracy Code	Time Error (mSec)	Time Since Unlock (Sec)	Time Since Unlock (Hour)
Space	<1	Locked	Locked
A	<10	<800	<.22
B	<100	<5300	<1.47
C	<500	<25300	<7.03
D	>500	>25300	>7.03

TABLE 3-6 QUALITY INDICATORS

The leap second indicator "L" is defined as:

(Space) =   When a leap second correction is not scheduled for the end of the month.

L =   When a leap second correction is scheduled for the end of the month.

The Daylight Saving Time indicator "D" is defined as:

S =   During periods of Standard time for the selected DST schedule.

I =   During the 24-hour period preceding the change into DST.

D =   During periods of Daylight Saving Time for the selected DST schedule.

O =   During the 24-hour period preceding the change out of DST.

3.4.3   RS-232 Commands and Outputs

Communication over the SERIAL COMM port is accomplished only through the use of a command set. The command set queries the NetClock/2 for time, firmware revision, switch settings, and signal quality information. Commands are also available to set the time and year manually. The NetClock/2 responds to the following commands:

    T command: outputs the selected time data format.
    V command: outputs the firmware revision level.
    W command: outputs switch setting information.
    R command: outputs the Signal Quality Log report.
    CB command: clears the Signal Quality Log.
    S command: allows the clock to be set manually.
    Y command: allows the year to be entered manually.

All commands must be upper case letters. The T, V, W, and R commands cause an output after command letter is sent. The manual set commands, S and Y, require data entered after the command letter is sent. Do not end the command with a line terminator (CR, enter, etc.).

3.4.3.1   Time Command

The NetClock/2 outputs the time in the selected data format upon receiving a capital letter T. Format 0 and Format 1 data streams are output at the beginning of the next second.

The Format 2 data stream output is not coincident with the 1 PPS on-time pulse, and responds immediately to a "T" command.

3.4.3.2   Version Command

The firmware revision level is accessed by sending a capital letter V. The version statement contains firmware revision level, copyright date and company name. An example of the VERSION command response is shown below:

> VERSION 1.15
> COPYRIGHT 1992
> SPECTRACOM CORPORATION

The firmware version level may need to be known if future upgrades are required.

3.4.3.3   Switch Setting Command

Switch setting information may be retrieved remotely using the W command. The Netclock/2 responds to a capital letter W as shown in the example below:

        PD = 25.4
        TZ = 05
       FMT = 2
      IRIG = 0
        SW = 11?10
       INT = 10000

where:
        PD = Path Delay switch setting
        TZ = Time Zone switch setting
       FMT = Selected Time Data format
        SW = Dip Switch settings
       INT = Internal configuration

The DIP switch setting information is described below:

SW = AB?CD

where:
A = Display Time Format

    A = **0** when switch 1 is in the OFF position, selecting 24-hour time display.
    A = **1** when switch 1 is in the ON position, selecting 12-hour time display.

B = Automatic Daylight Saving Time.

    B = **0** when switch 2 is in the OFF position, disabling the automatic DST feature.
    B = **1** when switch 2 is in the ON position, enabling the automatic DST feature.

? = IRIG Signal Type

    Switch 3 selects the IRIG output as amplitude modulated or TTL compatible. This
    switch is not monitored by the microprocessor. A ? always appears in this location.

C = Manual Set Disable

    C = **0** when switch 4 is in the OFF position, preventing the clock from accepting
    manual set commands.
    C = **1** when switch 4 is in the ON position, allowing the clock to accept manual set
    commands.

D = Spare

    D = **0**, switch 5 is reserved for future use. This switch should be placed in the OFF
    position.

Internal configuration is determined by **INT**. This feature is reserved for factory use
    only.

3.4.3.4   *Signal Quality Log Command*

Sending a capital letter R to the clock outputs the Signal Quality Log report. The report
contains an hourly count of good compare minutes and the number of times phase lock to
WWVB was lost. The report is updated at the end of each hour and continuously
overwrites previous data contained in that hour location. An example of the Signal
Quality Log is shown below:

SIGNAL QUALITY LOG					
HOUR END	COMPARE MINUTES	LOST LOCK COUNTER	HOUR END	COMPARE MINUTES	LOST LOCK COUNTER
0	60	00	12	60	00
1	59	00	13	60	00
2	60	00	14	60	00
3	60	00	15	60	00
4	60	00	16	60	00
5	60	00	17	60	00
6	60	00	18	49	01
7	60	00	19	34	00
8	60	00	20	60	00
9	60	00	21	60	00
10	60	00	22	60	00
11	60	00	23	60	00

The Hour End column in the report represents display time. Display time may be UTC or local time depending on how the clock was initially set up. Clocks displaying UTC time have the TIME ZONE offset switches set to zero and the automatic DST correction feature disabled.

The Compare Minutes is the number of error free minutes accumulated over each one hour period. The WWVB time code is one minute in duration and consists of 60 characters. The Netclock/2 receives this code and qualifies each character received. If a received character is ruled invalid, the Compare Minutes counter is not incremented for that minute. Invalid characters or bit errors are primarily due to poor atmospheric conditions. Local interference, solar flares, and poor antenna location or position may also contribute to a high bit error rate, resulting in a low compare minutes count.

The Lost Lock Counter is incremented each time carrier lock to WWVB is lost over that one hour period.

3.4.3.5   *Clear Buffer Command*

The Clear Buffer command is used to restart the Signal Quality Log. Sending the capital letters CB resets the Compare Minutes and Lost Lock Counter to all zeroes.

3.4.3.6   Manual Set Command

The Time Set and Year Set commands allow the NetClock/2 to be set manually.
"S" command enters the day and time data; "Y" command enters the year data.

To set the day and time enter:

       SDDDHHMMSS

where:

S =	Capital Letter S
DDD =	UTC Day of Year (001-366)
HH =	UTC Hours (00-23)
MM =	Minutes (00-59)
SS =	Seconds (00-59)

> Note: The values entered for the days and hours must
> reflect UTC time. The TIME ZONE switches offset the
> time entered to local time.

After entering the last character the receiver accepts the SET command and the clock is
updated on the next second.

To Set the year enter YXX
      where:

Y =	Capital Letter Y
XX =	Year without Century (99, 00, 01 etc.)

After entering the year value the receiver accepts the data and updates on the next
second. The manual SET commands are ignored if Dip Switch 4 is in the OFF position.

3.5   RS-485 OUTPUT USAGE

The RS-485 Output provides a continuous once-per-second time data stream in the
selected format. RS-485 is a balanced differential transmission which offers exceptional
noise immunity, long cable runs and multiple loading. These characteristics make RS-
485 ideal for distributing time data throughout a facility. The RS-485 Output can drive
32 devices over cable lengths up to 4000 feet. Spectracom manufactures wall clocks,
talking clocks, RS-485 to RS-232 converters and radio link products which utilize the
RS-485 data stream as an input. Figures 3-10 and 3-11 illustrate typical RS-485 time
data bus inter-connections. Follow the guidelines listed below when constructing the RS-
485 data bus.

3.5.1   Cable Selection

Low capacitance, shielded twisted pair cable is recommended for installations where the RS-485 cable length is expected to exceed 1500 feet. Table 3-7 suggests some manufacturers and part numbers for extended distance cables. These cables are specifically designed for RS-422 or RS-485 applications. They have a braided copper shield, nominal impedance of 120 ohms, and a capacitance of 12 to 16 picofarads per foot.

RS-485 cable may be purchased from Spectracom. Specify part number CW04xxx, where xxx equals the length in feet.

MANUFACTURER	PART NUMBER
Belden Wire and Cable Company 1.800.BELDEN-1	9841
Carol Cable Company 606.572.8000	C0841
National Wire and Cable Corp. 323.255.5611	D-210-1

TABLE 3-7 CABLE SOURCES FOR RS-485 LINES OVER 1500 FEET

For cable runs less than 1500 feet, a lower-cost twisted pair cable may be used. Refer to Table 3-8 for possible sources.

MANUFACTURER	PART NUMBER
Alpha Wire Corporation 1.800.52ALPHA	5471
Belden Wire and Cable Company 1.800.BELDEN-1	9501
Carol Cable Company 606.572.8000	C0600

TABLE 3-8 CABLE SOURCES FOR RS-485 LINES UNDER 1500 FEET

3.5.2   Connection Method

The RS-485 transmission line must be connected in a daisy chain configuration as shown in Figure 3-10. In a daisy chain configuration, the transmission line connects from one RS-485 receiver to the next. The transmission line appears as one continuous line to the RS-485 driver.

A branched or star configuration is not recommended. This method of connection appears a taps or stubs to the RS-485 transmission line. Stub lengths affect the bus impedance and capacitive loading which could result in reflections and signal distortion.
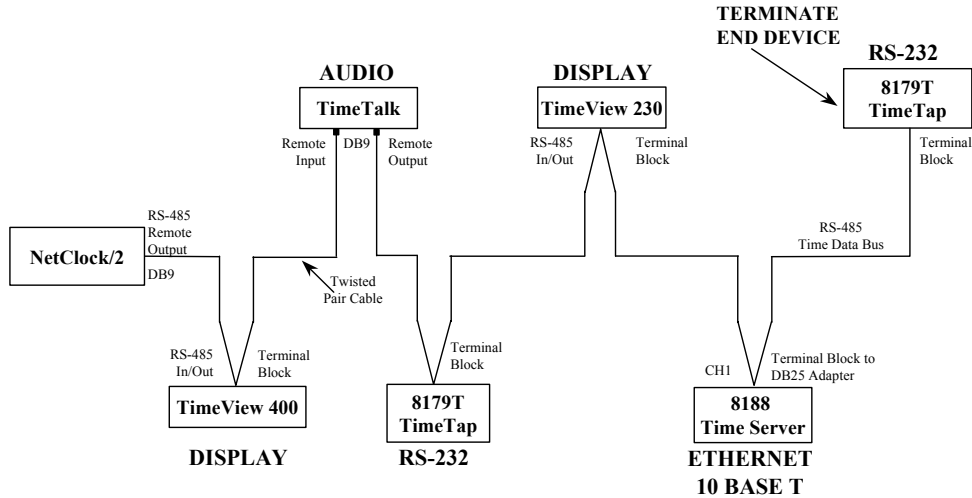

FIGURE 3-10 ONE-WAY BUS INSTALLATION

The RS-485 Output can be split in two directions as shown in Figure 3-11. This allows the NetClock/2 to be centrally located. Connecting in this method can simplify installation and possibly reduce the amount of cable required.
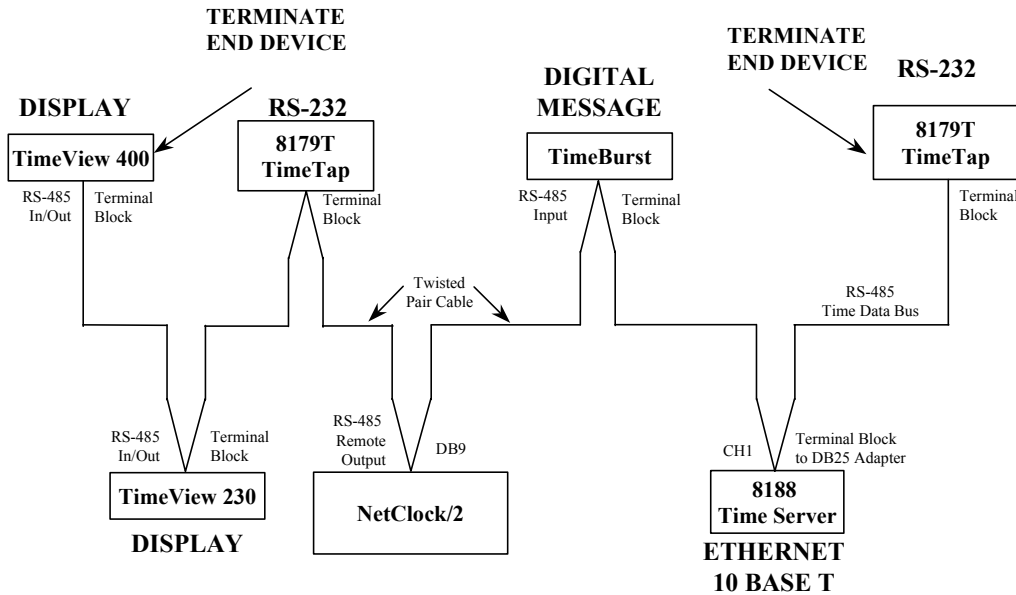
FIGURE 3-11   SPLIT BUS CONFIGURATION

Most RS-485 connections found on Spectracom equipment are made using a removable terminal strip. Wires are secured by a jaw which compresses the wires when tightened. When using small diameter wire, 22-26 gauge, a strain relief can be fashioned by wrapping the stripped wire over the insulating jacket as shown in Figure 3-12. Wrapping the wires in this manner prevents smaller gauge wires from breaking off when exposed to handling or movement.

STRIP
WIRE

WRAP WIRE OVER
INSULATING JACKET

INSERT AND
TIGHTEN
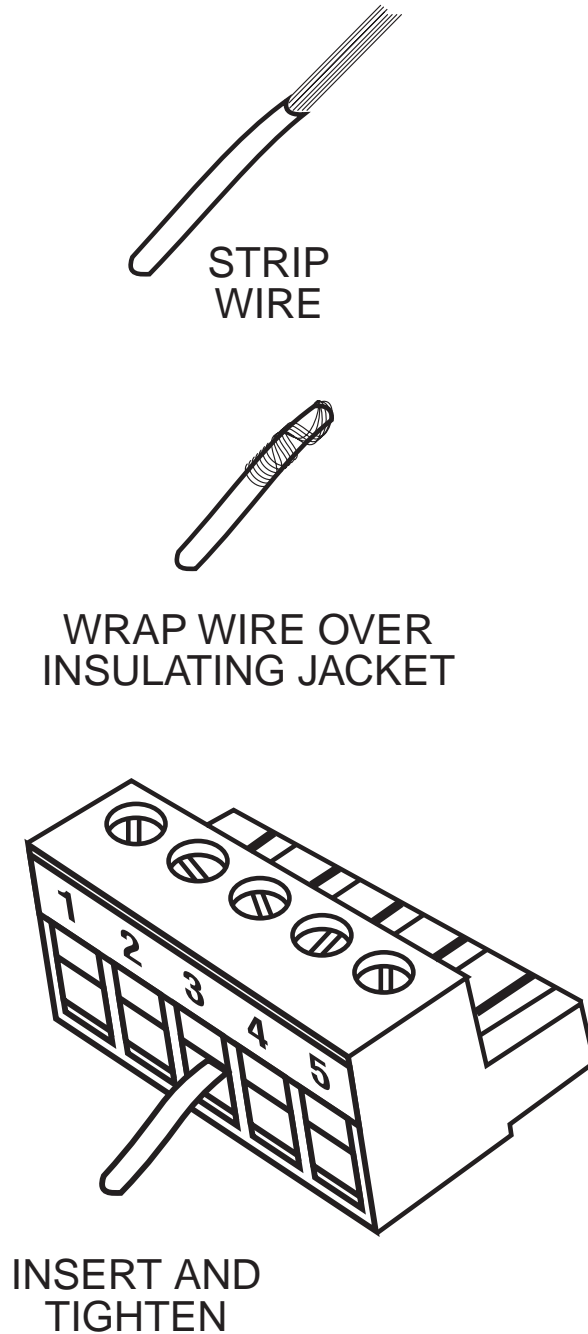
FIGURE 3-12   WIRE STRAIN RELIEF

The Spectracom Model 8175, TimeView 230, is a display clock with 2.3 inch high digits. The Model 8177 TimeView 400 features 4.0 inch display digits. TimeView display clocks use a 6-position terminal block to connect to the RS-485 data bus. Connect the TimeView Wall Clock to the NetClock/2 Remote Output as shown in Figure 3-13.
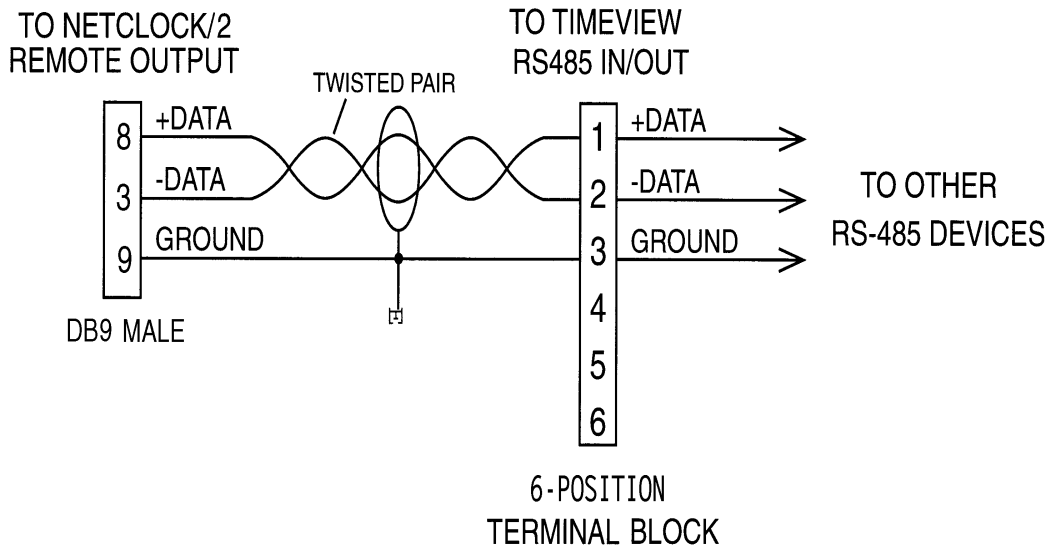
FIGURE 3-13 TIMEVIEW RS-485 INTERFACE

The Spectracom Model 8179T, TimeTap, is an RS-485 to RS-232 converter. The Model 8179T has a DB9 RS-232 interface which receives operational power from the RS-232 flow control pins RTS or DTR. Connect the TimeTap to the RS-485 Output as shown in Figure 3-14.
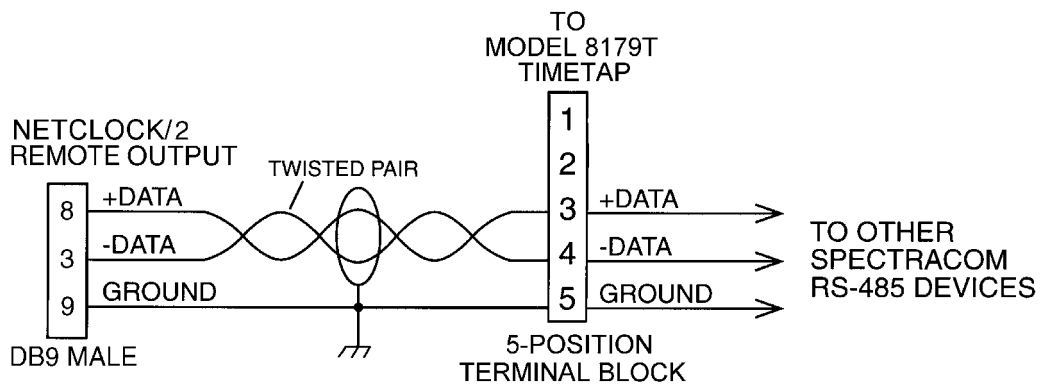
FIGURE 3-14 MODEL 8179T TIMETAP INTERFACE

The Model 8180 TimeTalk provides an audio time of day announcement to time stamp voice recorders or for broadcast over radio transmitters. Connect the TimeTalk to the RS-485 time data bus as shown in Figure 3-15. The synchronizing data stream is input on the TimeTalk Remote Input connector (DB9 male) and passed through to the Remote Output connector (DB9 female).
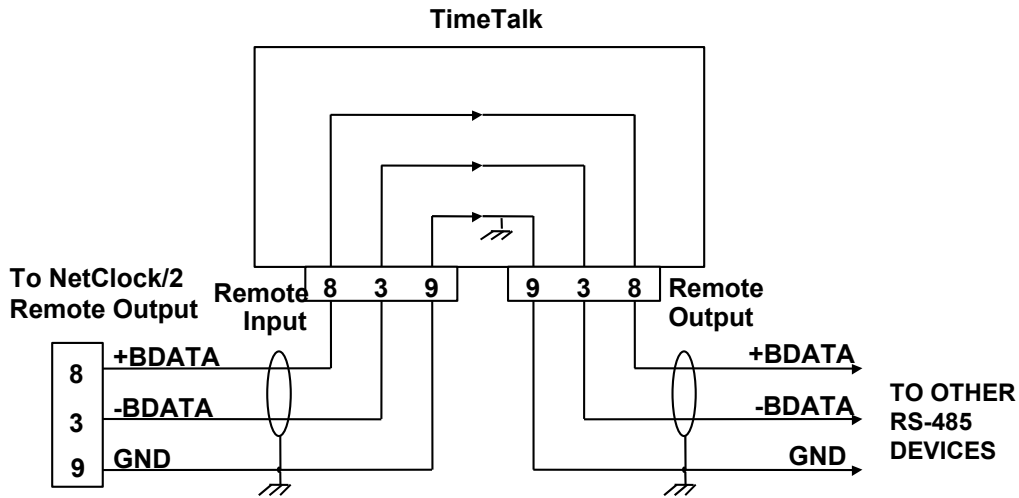
**FIGURE 3-15 TIMETALK RS-485 INTERFACE**

The Model 8185, TimeBurst™, provides a digital time-of-day data burst to a radio transmitter. The TimeBurst, when used with the Spectracom Model 8186 TimeBridge™, provides community-wide time synchronization from a single NetClock/2.   The TimeBurst accepts only Format 0.

TimeBurst connects to the RS-485 data bus using a 3-position terminal block. Connect as shown in Figure 3-16.
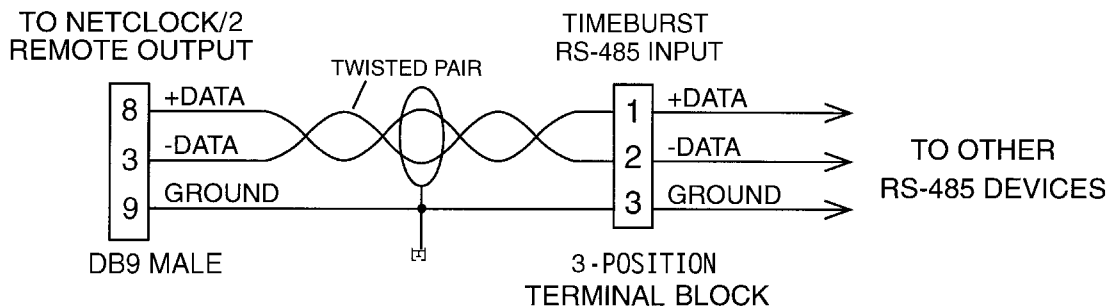
FIGURE 3-16 TIMEBURST RS-485 INTERFACE

Spectracom Model 8188 is an Ethernet Time Server which supports NTP, SNTP and UDP/Time protocols. The Model 8188 accepts Format 0 and connects to the RS-485 data bus through a Terminal Block to DB25 adapter. Connect to the NetClock/2 as shown in Figure 3-17.
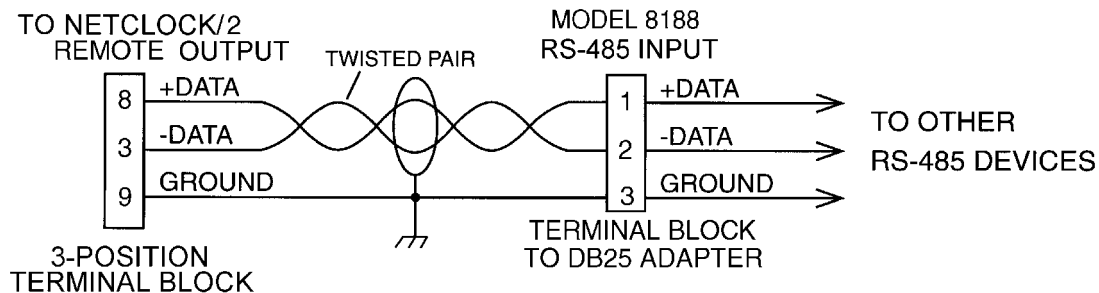
FIGURE 3-17   MODEL 8188 RS-485 INTERFACE

3.5.3   *Termination*

A termination resistor is required on devices located at the ends of the RS-485 transmission line. Terminating the cable end preserves data integrity by preventing signal reflections.

For a one-way bus installation (shown in Figure 3-10), terminate the last device on the bus. The RS-485 data bus can be split in two directions as shown in Figure 3-11. In a split bus configuration, terminate the devices installed on each end of the bus. Most Spectracom products include a built in termination switch to terminate the RS-485 bus when required.

SERVICE INFORMATION

4.0   INTRODUCTION

The NetClock/2 is designed to provide years of trouble-free operation without requiring routine calibration or maintenance. Under rare circumstances an installation may experience poor reception quality. This may cause the clock to lose or never acquire WWVB synchronization. This condition is typically caused by local interference.

Front panel indicators provide notification that a reception problem exists or an adjustment is required. This section contains the VCXO adjustment procedure, signal strength measurement, and information on troubleshooting reception problems.

Contact Spectracom's Customer Service Department for assistance in troubleshooting and repair information. Customer Service is available Monday through Friday, 8:00 AM to 4:30 PM Eastern Time at (716) 381-4827.

4.1   SIGNAL STRENGTH MEASUREMENT

The NetClock/2 may be used to measure the relative field strength of the 60-kHz WWVB signal. This measurement is used to optimize reception by indicating the best location and orientation of the antenna. This is especially useful for the Model 8219 Loop Antenna, due to its directional reception pattern.

The NetClock/2 employs synchronous AGC which responds to the 60-kHz signal only, and is not affected by noise. The AGC level, therefore, provides an excellent indication of field strength.

To measure the AGC voltage, connect a DC voltmeter to the rear panel AGC test points. The AGC voltage is approximately 2.3 VDC at a field strength of 100 µV/meter using a properly-oriented Model 8219 Loop Antenna and Model 8207 Preamplifier. The AGC voltage increases in strong signal locations, rising to a limiting value of approximately 3.6 VDC.

As the signal strength decreases to the receiver phase lock threshold of about 0.2 µV, the AGC voltage decreases to about +1.0 VDC. The SIGNAL lamp changes from green to red below this level. The AGC voltage will decrease to a varying level around zero if the input signal is removed completely. As the signal is reapplied and increased, the receiver will again lock at an AGC level of approximately 1.0 volt.

The relative signal strength measurement may be used to aid antenna orientation by placing the antenna so as to maximize the AGC voltage measurement. The circuit that develops the AGC voltage has a very long time constant. A pause of 30 to 60 seconds is necessary after each move of the antenna to allow the AGC to stabilize. A few minutes of experimentation should produce optimum antenna orientation.

4.2   RECEPTION PROBLEMS

Reception problems are often detected by the status of the front panel Antenna, Signal and Time Sync lamps. Whenever one of these lamps is red, a problem exists which may prevent WWVB synchronization. This chapter provides troubleshooting guidelines based upon the status of the indicator lamps.

4.2.1   Antenna Lamp

A green Antenna lamp indicates that the antenna is connected and the antenna cable is good. The Antenna lamp is driven by a comparator which monitors the DC voltage present on the Antenna connector. This voltage powers the Model 8208 and 8206A active antennas and the Model 8207 Inline Preamplifier, if installed. The comparator window ranges from 2.0 to 8.0 VDC. Whenever the antenna voltage falls outside this window, the Antenna lamp is red. This usually indicates that a cable open or short exists.

To troubleshoot this condition, remove the antenna cable from the clock. With a DC voltmeter, measure the antenna voltage output from the NetClock/2. Place the positive lead on the BNC center and the negative lead on the shell. The voltage under this no-load condition is 10.7 VDC. If no voltage is present, the NetClock/2 has a failure; contact Spectracom.

To test the antenna cable, temporarily place a BNC "T" connector onto the antenna cable. Reconnect the antenna to the clock and measure the antenna voltage using the "T" connector. If the voltage falls to 0 VDC, a short exists. If the voltage remains at 10.7 VDC, an open exists. Check the coax, connectors and surge arrestor for failures.

If the antenna voltage measures within the comparator window of 2.0 to 8.0 VDC, the comparator circuit has failed. This failure could be due to lightning damage; contact Spectracom.

4.2.2   Signal Lamp

This lamp indicates the receiver phase lock status to the WWVB carrier. The lamp is green when the receiver is phase locked, and red when it is not. In addition to lock status, this lamp blinks red and green when a VCXO adjustment is needed. The VCXO adjustment procedure is described in Section 4.3.

In most installations, carrier lock is easily maintained by the receiver. An occasional loss of lock can be considered normal. Typically, the receiver reacquires phase lock within minutes. During winter months, the WWVB antenna can accumulate ice. This is rare, but when this does occur, the carrier may be reduced for a few hours. Contact Spectracom to verify signal quality whenever carrier lock is lost for more than a one-hour period.

It is not considered normal for the receiver to lose lock on a regular basis. Typically, this problem is solved by relocating the antenna. Follow the signal strength measurement procedure described in Section 4.1 when finding a new location. Select the location which yields the highest AGC voltage. If the maximum obtainable AGC voltage is less than 1.8 VDC, the antenna or preamplifier gain or tuning could be the problem. Contact Spectracom for replacement or repair service.

If the Signal lamp is constantly red, the problem could be either the antenna or receiver. Troubleshooting this symptom requires an oscilloscope, multimeter and possibly a signal generator. Contact Spectracom for additional information.

4.2.3   *Time Sync Lamp*

When a receiver is unable to achieve or maintain WWVB synchronization, the problem is usually due to local interference. The Time Sync lamp is red when any of the following conditions are true:

1. During initial operation or after a power failure.

2. The receiver has lost phase lock to WWVB for a period greater than one hour.

3. The receiver has not decoded a minimum of five consecutive error-free minutes over the past 24 hours.

The NetClock/2 includes a test mode feature to assist in troubleshooting reception problems. While in the test mode, the tens of hours digit displays the receiver WWVB time code bit every second. This feature is useful because it provides an instant indication of the received signal quality. To enter the test mode, place the IRIG Format switch into Position 9.

In test mode, the left-most display digit shows valid time code characters as the numbers 0, 1, and 2. When a 0 is displayed, the receiver decoded a Binary 0 for that time code bit. A number 1 represents a Binary 1 was received. Every ten seconds, WWVB transmits a position identifier. This character is represented by the number 2. The pulse width of the demodulated time code determines which character was received. Refer to Appendix A of this manual for a description of the WWVB time code.

If the received time code character does not meet the criteria for a Binary 0, Binary 1 or position identifier, it is considered invalid and is ruled a bit error. A bit error is represented by the number 4 on the display. Displaying frequent or constant bit errors is cause for concern, as the time required to synchronize is greatly extended. Bit errors may be caused by solar flares, poor atmospheric conditions, or local interference. Little can be done about the sun or weather, but local interference problems can be solved. Interference can be conducted over the power line and ground or radiated into open air.

A possible source of power line noise is the Uninterruptible Power Supply, or UPS. The switching frequency of the DC to AC converters found in the UPS may disrupt the NetClock/2 receiver. If the NetClock/2 is connected to a UPS, temporarily power the clock from an unprotected outlet. Note the rate of bit errors displayed prior to changing the power source. If no improvement is detected, connect the rear panel Chassis Ground stud to a known good earth ground. If no improvement in signal quality is detected, the problem is due to radiated interference.

This type of reception problem is often solved by relocating the antenna. Try to locate the antenna as far away as possible from any RF generating source. Refer to Section 1 for antenna installation guidelines. If the antenna is installed on an antenna tower, try a rooftop location. If no improvement in signal quality is shown, the problem could be due to antenna saturation caused by local interference. To verify the problem is site-related and not equipment-related, try moving the clock off site. If the clock time syncs offsite, consider exchanging the WWVB clock for a GPS-based clock system. Contact Spectracom's Customer Service Department for assistance.

4.3   VCXO ADJUSTMENT

The NetClock/2 phase locks a Voltage Controlled Crystal Oscillator (VCXO) to the received WWVB signal.

Crystals inherently change in frequency due to temperature and aging characteristics. Crystal aging may eventually cause the crystal to operate beyond the pull-in range of the Phase Lock Loop (PLL), producing a failure. The NetClock/2 provides ample notice when a VCXO adjustment is needed.

The oscillator control voltage is monitored by comparators set to upper and lower control voltage limits. If the PLL-generated control voltage exceeds either limit, the SIGNAL lamp blinks red and green at a one-second rate, indicating an adjustment is needed. To ensure continued operation, perform the VCXO adjustment within a month. Typically this adjustment should not be necessary until after five years of operation.

4.3.1   VCXO Adjustment Procedure

Should it become necessary to adjust the VCXO, follow the instructions described in this section.

> **WARNING**: The procedures described in this section are performed with power applied and the top cover removed. Risk of electrical shock does exist, and therefore only qualified service personnel should attempt these procedures.

This adjustment requires a flat-bladed screwdriver, a multimeter, and a flat-bladed non-metallic tuning tool.

> *FOR BEST RESULTS:*
> *A) Perform this adjustment only after the unit has reached operational temperature and under the same ambient temperature conditions normally found.*
>
> *B) Select a day when the weather is generally clear. Poor atmospheric conditions increase the control voltage variations, making the final VCXO adjustment difficult.*
>
> *C) The antenna must be connected and in good working order to make this adjustment.*

1.   Remove the NetClock/2 from the rack mount assembly, if so equipped.

2.   Remove the top cover by unscrewing the two recessed flat head screws found on the bottom cover. With the screws removed, slowly lift off the top cover.

3.   Set the multimeter to measure DC volts. Connect the negative probe to Test Point E2 or any available chassis ground. Insert the positive probe into Test Point TP2. Refer to Figure 4-1 for test point and component locations.

4.   Adjust trimmer capacitor C34 until the multimeter reads 7.7 ±0.2 VDC. Make very small adjustments and allow a minimum of 30 seconds between adjustments.

5.   Remove the tuning tool from C34 and allow the unit to operate a few minutes without making any adjustments. Readjust trimmer capacitor C34 if the control voltage settled out beyond 7.7 ±0.2 VDC. Repeat as necessary.

6.   Adjustment is complete. Reassemble the unit and return it to service.
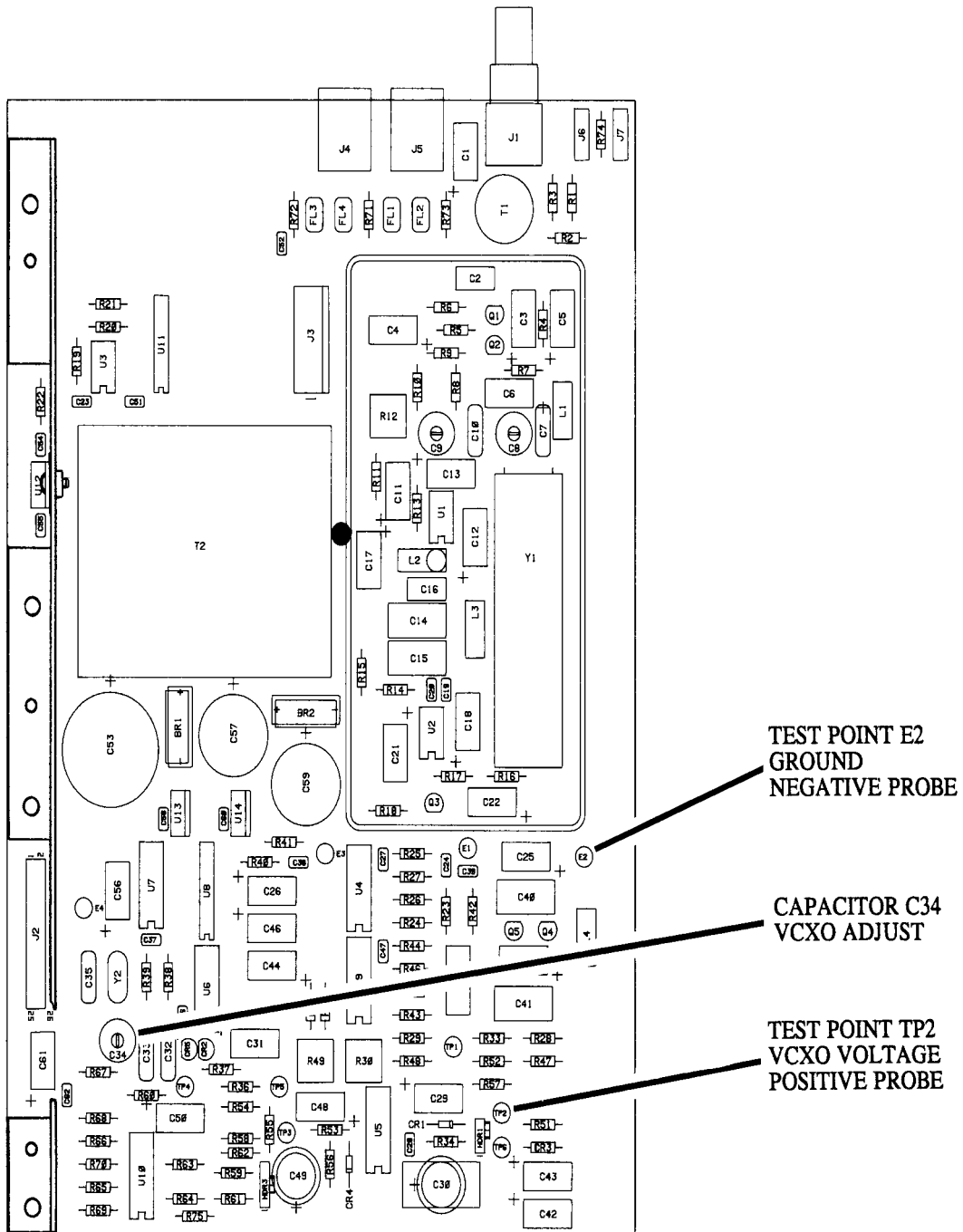
FIGURE 4-1   TEST POINT LOCATIONS

APPENDIX A - WWVB INFORMATION

Portions of the following section contains information extracted from NBS Special Publication 432, issued January 1976. This material provides detailed technical information on Station WWVB. Refer to the NIST web page for additional information on WWVB and other services provided by NIST. The NIST address is

http://www.boulder.nist.gov/timefreq/pubs/bulletin/index.htm

WWVB transmits continuously on a standard radio carrier frequency of 60 kHz. Standard time signals, time intervals, and UT1 corrections are provided by means of a BCD time code. The station is located in Fort Collins, Colorado, which provides effective coverage for the majority of North America.

The frequency of WWVB is normally within its prescribed value to better than 1×10^{-12}. Effects of the propagation medium on received signals are relatively minor at low frequencies; therefore, frequency comparisons to better than 1×10^{-11} are possible using appropriate receiving and averaging techniques.

WWVB identifies itself by advancing its carrier phase 45° at 10 minutes after each hour and returning to normal phase at 15 minutes after the hour. WWVB can also be identified by its unique time code.

The effective radiated power from WWVB is 50 kW. The antenna is a 122-meter, top-loaded vertical installed over a radial ground screen. Typical WWVB Coverage is shown in Figure A-1. The grey shaded area represents signal levels of 100 microvolts per meter or greater.

The WWVB time code is generated by amplitude modulating the 60-kHz carrier. The carrier power is reduced 10 dB at the beginning of each second and restored to full power 200 milliseconds later for a binary zero, 500 milliseconds later for a binary one, and 800 milliseconds later for a reference marker or position identifier. Certain groups of pulses are encoded to represent decimal numbers which identify the minute, hour, and day of year. The binary-to-decimal weighting scheme is 8-4-2-1 with the most significant binary digit transmitted first. The BCD groups and their basic decimal equivalents are tabulated in Table A-1.

	BINARY GROUP	DECIMAL
Weight:	8 4 2 1	EQUIVALENT
	0 0 0 0	0
	0 0 0 1	1
	0 0 1 0	2
	0 0 1 1	3
	0 1 0 0	4
	0 1 0 1	5
	0 1 1 1	6
	1 0 0 0	8
	1 0 0 1	9

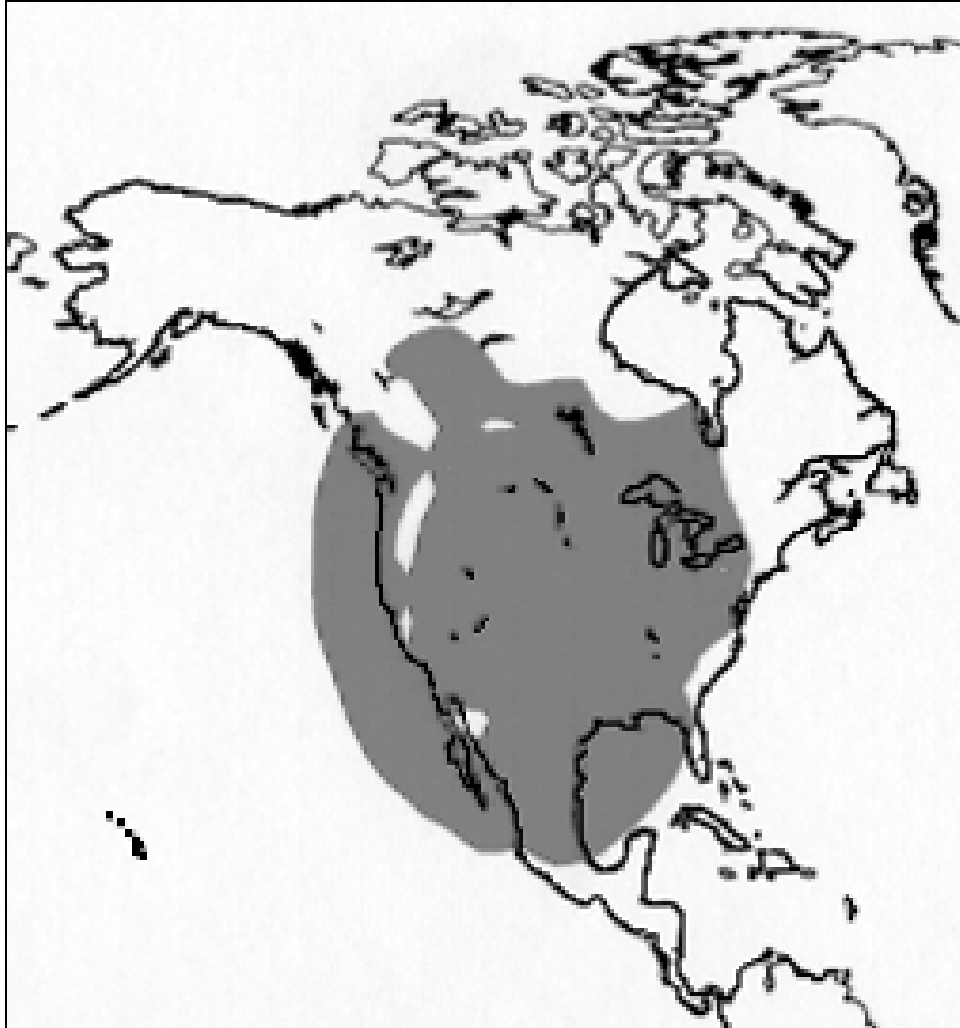**TABLE A-1   BCD WEIGHTING**

FIGURE A-1   TYPICAL WWVB COVERAGE AT 50 kW ERP

The decimal equivalent of each group is derived by multiplying the individual binary digits by the weight factor of their respective columns and then adding the four products together. For example, the binary sequence 1001 in 8-4-2-1 code is equivalent to (1 x 8) + (0 x 4) + (0 x 2) = (1 x 1) = 8 + 0 + 0 + 1 = 9, as shown in the table. If fewer than nine decimal digits are required, one or more of the high-order binary digits may be dispensed with.

Once every minute, in serial fashion, the code format presents BCD numbers corresponding to the current minute, hour, and day on the UTC scale. Two BCD groups identify the minute (00 through 59); two groups identify the hour (00 through 23); and three groups identify the day of year (001 through 366). When representing units, tens, or hundreds, the basic 8-4-2-1 weights are multiplied by 1, 10, or 100 respectively. The coded information refers to the time at the beginning of the one-minute frame. Within each frame, the seconds may be determined by counting pulses.

Every new minute commences with a frame reference pulse which lasts for 0.8 second. Also, every ten-second interval within the minute is marked by a position identifier pulse of 0.8 second duration.

UT1 corrections to the nearest 0.1 second are transmitted at seconds 36 through 44 of each frame. Coded pulses at 36, 37, and 38 seconds indicate the positive or negative relationship of UT1 with respect to UTC. Pulses at 36 and 38 seconds are transmitted as binary ones only if UT1 is early with respect to UTC, in which case a correction must be added to the UTC signals to obtain UT1. The pulse transmitted at 37 seconds is a binary one if UT1 is late with respect to UTC, in which case the required UT1 correction must then be subtracted. The magnitude of the UT1 correction is transmitted as a BCD group at 40, 41, 42, and 43 seconds. Because UT1 corrections are expressed in tenths of seconds, the basic 8-4-2-1 weight of that particular binary group is multiplied by 0.1 to obtain its proper decimal equivalent.

Figure A-2 WWVB Time Code Format shows a sample frame of the time code in rectified or DC form. The negative-going edge of each pulse coincides with the beginning of a second. Position identifiers are labeled P1, P2, P3, P4, P5, and P0. Brackets show the demarcation of the minutes, hours, days, and UT1 sets. The applicable weight factor is printed beneath the coded pulses in each BCD group. Except for the position identifiers and the frame reference marker, all uncoded pulses are binary zeros.

DAY AND TIME INFORMATION

In Figure A-2, the most significant digit of the minutes set is $(1 \times 40) + (0 \times 20) + (0 \times 10) = 40$; the least significant digit of that set is $(0 \times 8) + (0 \times 4) + (1 \times 2) + (0 \times 1) = 2$. Thus, at the beginning of the frame, UTC was precisely 42 minutes past the hour. The sets for hours and days reveal further that it is the 18th hour of the 258th day of the year. The UT1 correction is -0.7 second, so at the beginning of the frame the correct time on the UT1 scale was 258 days, 18 hours, 41 minutes, 59.3 seconds.

YEAR INFORMATION

The last two digits of the current year (i.e. 97, 98) are encoded into the WWVB time code format into the bit locations shown in Table A-2.

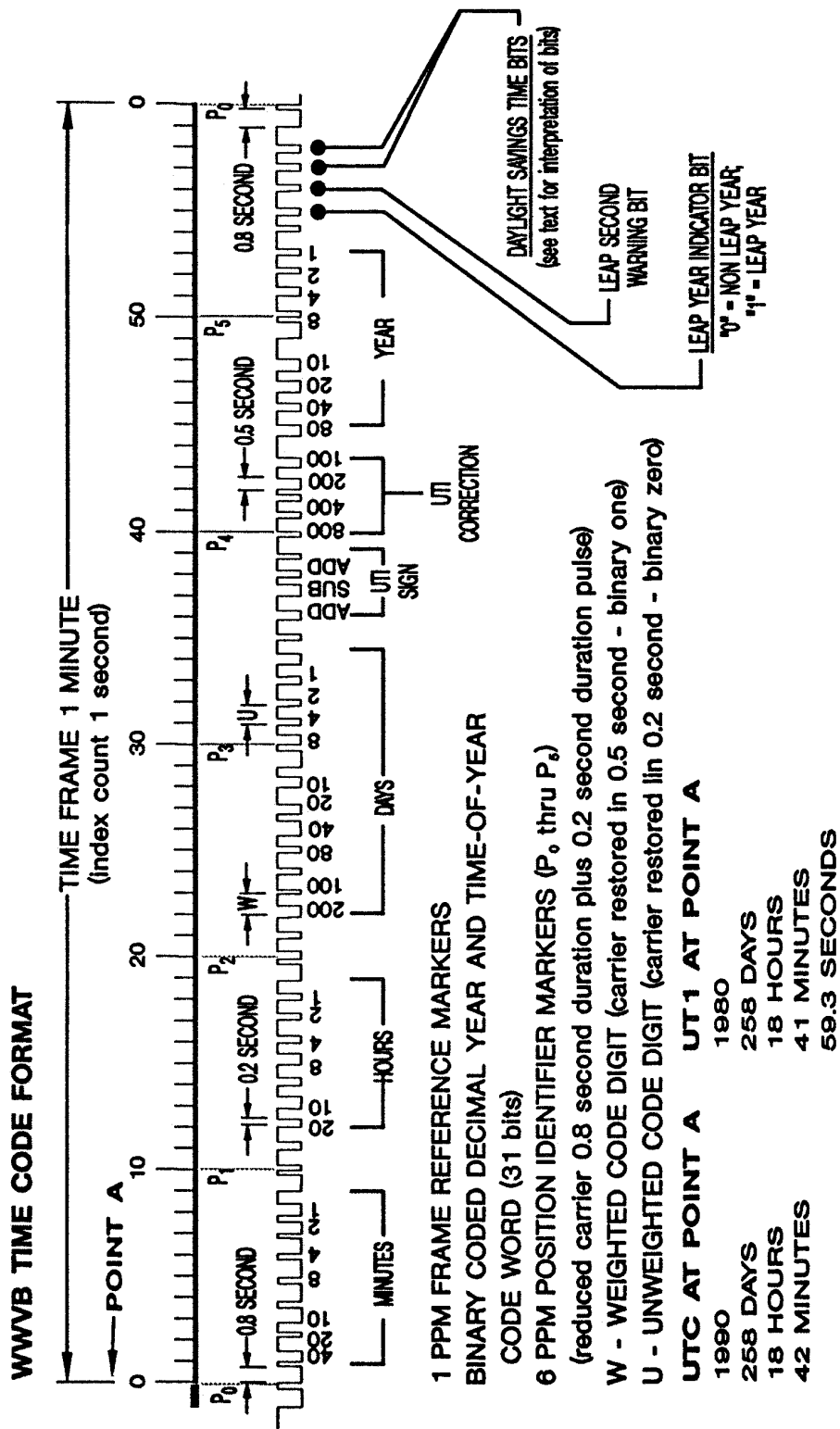| TENS OF YEARS				UNITS OF YEARS			
BITS 45	46	47	48	50	51	52	53
WEIGHT 80	40	20	10	8	4	2	1

TABLE A-2   WWVB YEAR DATA

**FIGURE A-2   WWVB TIME CODE FORMAT**

LEAP YEAR INDICATOR

Bit #55 is changed from a "0" to a "1" during each leap year sometime after 1 January but before 29 February. Bit #55 remains set to "1" through 1 January of the year following the leap year. This procedure allows receivers to automatically convert day-of-year properly to month-and-day during leap years, and allows receivers that convert UTC to local time to "back up" properly to either day #365 or #366 as appropriate upon change-of-year.

LEAP SECOND INDICATOR

Bit #56 is set to a "1" early in the month in which a leap second is inserted at the end of that month. Bit #56 is then reset to "0" on the first day of the next month.

Leap second adjustments are necessary to keep the broadcast time signals (UTC) within ±0.9 second of the earth-related UT1 time scale, the addition or deletion of exactly 1 second occurs at the end of the UTC month. By international agreement, first preference is given to December 31 or June 30, second preference to March 31 or September 30, and third preference to any other month.

When a positive leap second is required (UT1 is slow relative to UTC) an additional second is inserted beginning at 23h 59m 60s of the last day of the month and ending at 0h 0m 0s of the first day of the following month. In this case, the last minute of the month contains 61 seconds. To assign dates to events which occur around this extra second, refer to Figure A-3.
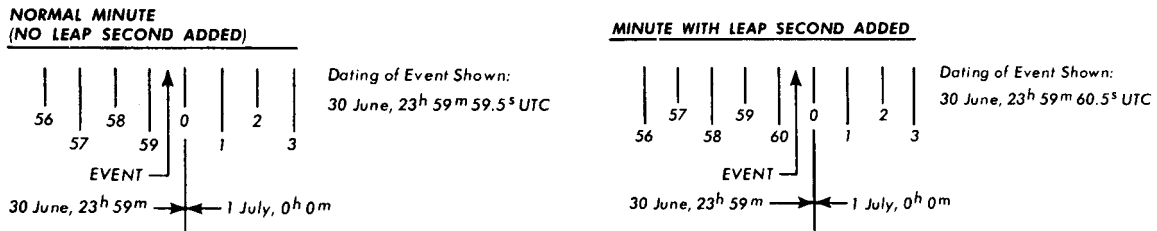
**FIGURE A-3   DATING OF EVENTS IN THE VICINITY
OF A LEAP SECOND**

Assuming that unexpected large changes do not occur in the earth's rotation rate in the future, it is likely that positive leap seconds will continue to be needed about once per year. If, however, the earth should speed up significantly at some future time, so that UT1 runs at a faster rate than UTC, then provision is also made for negative leap seconds in the UTC time scale. In this case, exactly one second would be deleted at the end of some UTC month, and the last minute would contain only 59 seconds.

DAYLIGHT SAVING TIME

Bits #57 and #58 are used to indicate periods of Standard Time and Daylight Saving Time and the 24-hour transitional period into and out of DST.

During periods of Standard Time, excluding the day of change, both bits will be set to "0"; during periods of Daylight Saving Time, except for the day of change, both bits will be set to "1".

On the day of change from Standard to Daylight Saving Time, bit #57 will change from "0" to "1" at approximately 0000 UTC (within a few minutes after 0000 UTC), followed by bit #58 24 hours later. On the day of change back to "standard" time, bit #57 will be toggled back to "0" at approximately 0000 UTC, again followed by bit #58 24 hours later.

IRIG CODE DESCRIPTION

B.0   INTRODUCTION

IRIG is an acronym for Inter-Range Instrumentation Group. In the late 1950's this group created a series of time code standards suitable for use with recording oscillographs, magnetic tape and real time transmission. Each IRIG code specifies a carrier frequency which is modulated to encode time data, as well as control bits to time stamp events. Initially, IRIG applications were primarily military and government associated. Today, IRIG is commonly used to synchronize voice loggers, recall recorders and sequential event loggers found in emergency dispatch centers and power utilities.

The NETCLOCK/2 is able to provide an IRIG B or IRIG E code in amplitude modulated (AM) and pulse width coded (TTL) formats. A signature control feature may be enabled for any IRIG output. Signature control removes the modulation code when the clock has lost WWVB synchronization.

B.1   IRIG B OUTPUT

The IRIG B code contains the Binary Coded Decimal (BCD) time of year, Control Function (CF) field and the Straight Binary Seconds time of day. Figure B-1 illustrates the IRIG B data structure. The BCD time of year provides the day of the year, 1-366, and the time of day including seconds. The hour of the day is expressed in 24-hour format. The SBS time is the number of seconds elapsed since midnight. The Control Function field contains year information and a time sync status bit.

B.1.1   IRIG B General Description

    1.   Time frame: 1.0 seconds.

    2.   Code digit weighting:

            A.   Binary Coded Decimal time-of-year.
                       Code word - 30 binary digits.
                       Seconds, minutes hours, and days.
                       Recycles yearly.

            B.   Straight Binary Seconds time-of-day.
                       Code word - 17 binary digits.
                       Seconds only, recycles daily.
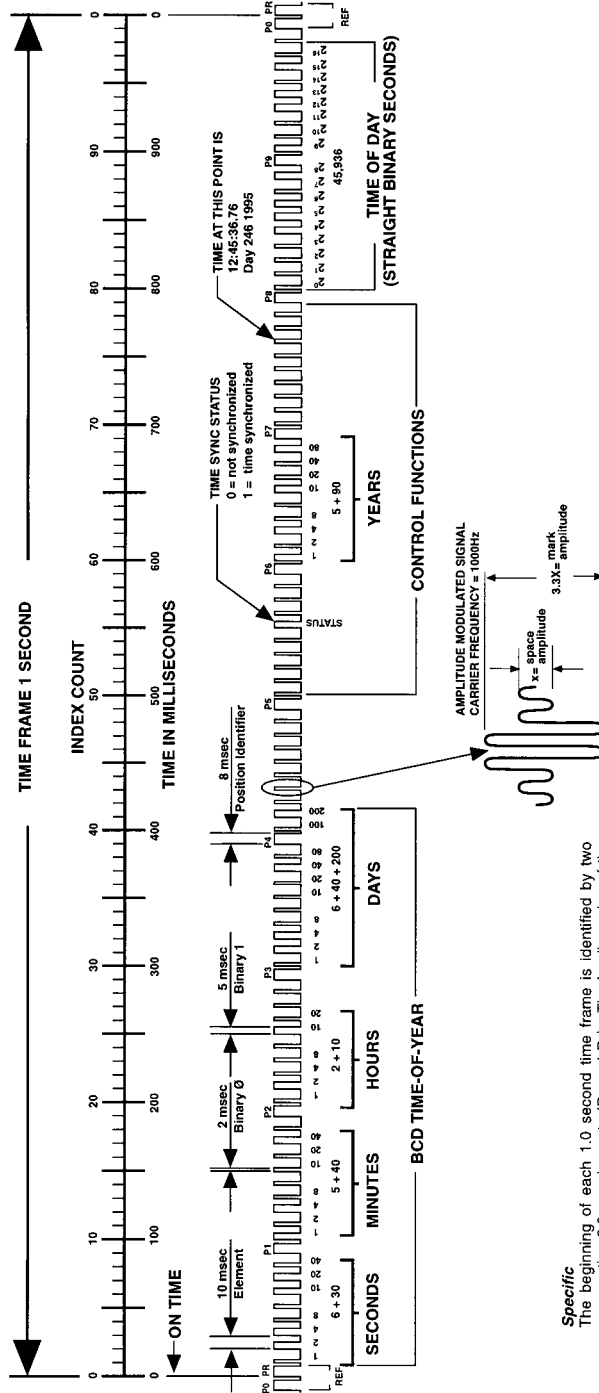
FIGURE B-1   IRIG B TIME CODE

3.   Code word structure:

BCD: Word seconds digits begin at index count 1. Binary coded
        elements occur between position identifier elements P_0 and P_5
        (7 for seconds, 7 for minutes, 6 for hours, and 10 for days) until the
        code word is complete. An index marker occurs between decimal
        digits in each group to provide separation for visual resolution.
        Least significant digit occurs first.

CF: IRIG formats reserve a set of elements known as Control
        Functions (CF) for the encoding of various control, identification,
        or other special purpose functions. IRIG B has 27 Control
        Functions located between elements 50 and 78. The
        NETCLOCK/2 uses the Control Functions to encode year
        information and time sync status.

        Table B-1 lists the Control Function Field and each element's
        function.

        Element 55 is the time sync status bit. Element 55 is a Binary 1
        when the front panel time sync lamp is green, and a Binary 0 when
        the lamp is red.

        Year information consists of the last two digits of the current year
        (i.e. 97, 98, 99 etc.). Elements 60 through 63 contain the binary
        equivalent of year units. Elements 65 through 68 contain the
        binary equivalent of tens of years. In keeping with IRIG formats,
        the least significant bit occurs first. All unused Control Functions
        are filled with a space (Binary 0).

SBS: Word begins at index count 80. Seventeen Straight Binary Coded
        elements occur with a position identifier between the 9th and 10th
        binary coded elements. Least significant digit occurs first.

4.   Pulse rates:

A.   Element rate: 100 per second.

B.   Position identifier rate: 10 per second.

C.   Reference marker rate: 1 per second.

5.   Element identification: The "on time" reference point for all elements is
        the pulse leading edge.

A.   Index marker (Binary 0 or uncoded element): 2 millisecond
        duration.

B.   Code digit (Binary 1): 5 millisecond duration.

C.   Position identifier: 8 millisecond duration.

D.   Reference marker, 1 per second. The reference marker appears as two consecutive position identifiers. The second position identifier marks the on-time point for the succeeding code word.

6.   Resolution:

Pulse width coded signal: 10 milliseconds.
Amplitude modulated signal: 1 millisecond.

7.   Carrier frequency: 1 kHz when modulated.

ELEMENT #	C.F. DIGIT #	FUNCTION
50	1	Space
51	2	Space
52	3	Space
53	4	Space
54	5	Space
55	6	Time Sync Status
56	7	Space
57	8	Space
58	9	Space
59	PID P6	Position Identifier
60	10	Years Units Y1
61	11	Years Units Y2
62	12	Years Units Y4
63	13	Years Units Y8
64	14	Space
65	15	Years Tens Y10
66	16	Years Tens Y20
67	17	Years Tens Y40
68	18	Years Tens Y80
69	PID P7	Position Identifier
70	19	Space
71	20	Space
72	21	Space
73	22	Space
74	23	Space
75	24	Space
76	25	Space
77	26	Space
78	27	Space

TABLE B-1   IRIG B CONTROL FUNCTION FIELD

B.2 IRIG E OUTPUT

The IRIG E code contains the Binary Coded Decimal (BCD) time of year and Control Functions. Figure B-2 illustrates the IRIG E data structure. The BCD time of year provides the day of year, 1-366, and time of day to tens of seconds. The hour of the day is expressed in 24 hour format. The Control Function field includes a time sync status bit, year information and SBS time of day.

B.2.1 IRIG E General Description

1. Time frame: 10 seconds.

2. Code Digit Weighting:

   Binary Coded Decimal time of year.
   Code world - 26 binary digits.
   Tens of seconds, minutes, hours, and days.
   Recycles yearly.

3. Code Word Structure: BCD word tens of seconds digits begin at index count 6. Binary coded elements occur between position identifier elements P_0 and P_5 (3 for seconds, 7 for minutes, 6 for hours, and 10 for days) until the code word is complete. An index marker occurs between decimal digits in each group to provide separation for visual resolution. Least significant digit occurs first.

4. Control Functions: IRIG formats reserve a set of elements known as Control Functions (CF) for the encoding of various control, identification, or other special purpose functions. IRIG E has 45 Control Functions located between elements 50 and 98. The NETCLOCK/2 uses the Control Function field to encode year data, time sync status, and SBS time data. Table B-2 lists the Control Function Field and each element's function.

   Element 55 is the time sync status bit. Element 55 is a Binary 1 when the front panel time sync lamp is green, and a Binary 0 when the lamp is red.
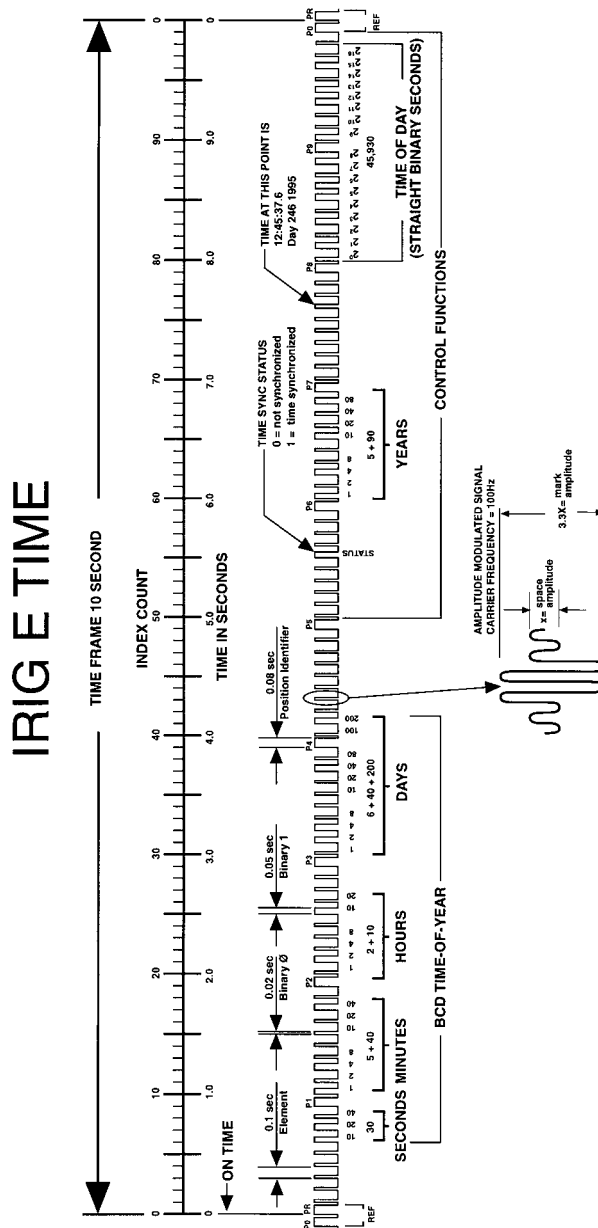
FIGURE B-2   IRIG E TIME CODE

BIT #	CF ELEMENT #	FUNCTION
50	1	SPACE
51	2	SPACE
52	3	SPACE
53	4	SPACE
54	5	SPACE
55	6	TIME SYNC STATUS
56	7	SPACE
57	8	SPACE
58	9	SPACE
59	PID P6	POSITION IDENTIFIER
60	10	YEAR UNITS Y1
61	11	YEAR UNITS Y2
62	12	YEAR UNITS Y4
63	13	YEAR UNITS Y8
64	14	SPACE
65	15	YEAR TENS Y10
66	16	YEAR TENS Y20
67	17	YEAR TENS Y40
68	18	YEAR TENS Y80
69	PID P7	POSITION IDENTIFIER
70	19	SPACE
71	20	SPACE
72	21	SPACE
73	22	SPACE
74	23	SPACE
75	24	SPACE
76	25	SPACE
77	26	SPACE
78	27	SPACE
79	PID P8	POSITION IDENTIFIER
80	28	SBS 2^0
81	29	SBS 2^1
82	30	SBS 2^2
83	31	SBS 2^3
84	32	SBS 2^4
85	33	SBS 2^5
86	34	SBS 2^6
87	35	SBS 2^7
88	36	SBS 2^8
89	PID P9	POSITION IDENTIFIER
90	37	SBS 2^9
91	38	SBS 2^{10}
92	39	SBS 2^{11}
93	40	SBS 2^{12}
94	41	SBS 2^{13}
95	42	SBS 2^{14}
96	43	SBS 2^{15}
97	44	SBS 2^{16}
98	45	SPACE
99	PID P0	POSITION IDENTIFIER

TABLE B-2   IRIG E CONTROL FUNCTION FIELD

Year information consists of the last two digits of the current year (i.e. 96, 97, etc.). Elements 60 through 63 contain the binary equivalent of year units. Elements 65 through 68 contain the binary equivalent of tens of years. In keeping with IRIG formats, the least significant bit occurs first.

Elements 80 through 97 are encoded with the Straight Binary Seconds (SBS) time data. The SBS time data is incremented in 10-second steps and recycles every 24 hours.

    5.   Pulse rates:

          A.   Element rate: 10 per second.

          B.   Position identifier rate: 1 per second.

          C.   Reference marker rate: 1 per 10 seconds.

    6.   Element identification: The "on time" reference point for all elements is the pulse leading edge.

          A.   Index marker (Binary 0 or uncoded element): 20 millisecond duration.

          B.   Code digit (Binary 1): 50 millisecond duration.

          C.   Position identifier: 80 millisecond duration.

          D.   Reference marker: 80 millisecond duration, 1 per 10 seconds. The reference marker appears as two consecutive position identifiers. The second position identifier or reference marker is the on-time point for the succeeding code word.