MODEL 940A
TIMING SYSTEM ANALYZER
USER’S MANUAL

Arbiter Systems, Inc.
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   covered by this warranty, an estimate will be made before the
   repair work begins, if requested.

See Contact Information on page ii.
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Features

The Model 940A is a powerful diagnostic tool for analyzing time-codes in time sensitive instruments. IRIG-B, DCF77 and 1 PPS signals can be received and evaluated to verify correct operation. These signals may also be sourced from the 940A to verify operation of the receiving equipment.

Operating on four Li-ion batteries, the 940A can run continually for about 12 hours with about 80 percent backlight brightness, and for about 24 hours at 20 percent brightness. Included in a 940A kit are the following: USB charger/power supply, USB Cable, 8 feet of RG-58 with BNC connectors, quick setup guide, and several cable adapters to match a variety of wire types and connectors.

The 940A features two timing input ports, one timing source output port, a mini USB charging port, variable output flashlight, speaker and auxiliary port.

Available input signals are unmodulated IRIG-B, modulated IRIG-B, IRIG-B Manchester, 1 Pulse Per Second and DCF77. Three different load conditions are available, which are Load Off, 100 Ohm Load and 50 Ohm Load.

Special Features

Model 940A is designed to provide both a pictorial view and a description of signals connected to either Input 1 or Input 2. It also provides a method to compare two signals connected to Input 1 and 2.

A timing source output is also available to verify devices receiving these signals. Available timing output signals include unmodulated IRIG-B, modulated IRIG-B, 1 Pulse Per Second and DCF-77.
Multi-View Display

In the display’s descriptive view, you can read all the values provided in the timecode, such as time, date, day or year, time offset, leap second information and the state of daylight saving time. Other useful information includes jitter error, time difference (Input 1 - Input 2) and signal amplitude in volts.

Additionally, the 940A provides a time domain display much like an oscilloscope. In this mode, each bit of the time code is identified, and may be verified with the specification.

Construction

Constructed of tough polycarbonate/polyester alloy, the 940A case was designed for durability and easy handling. It has a 5-inch diagonal, color graphic, touch screen display made of tempered, scratch-resistant glass, with self-adjusting brightness controls. A bail assembly is useful for propping up the instrument. Input and output connections are through female BNC connectors.

Input/Output Connectors

Two female BNC connectors are available for connecting two different input signals. One female BNC connector is available to source any timing signal selection in the 940A.

AUX Port

The RJ-45 port is available for further development of features and accessories.

Micro USB Port

A micro USB port is available for charging the internal Li-Ion batteries, powering the 940A and updating firmware.

Flashlight

An LED flashlight is available near the micro USB port with variable brightness control.
Power Supply and Charging

The Model 940A can operate from the included power supply/charger, or from the internal Li-ion batteries. Internal batteries consist of four 2250 milliampere hour Li-ion cells, which should be able to operate the 940A for up to 18 hours with reduced backlight.

Battery charging

A micro USB connector is used to connect the included battery charger/power supply to 940A. Depending on the state of charge, charging time should be less than 8 hours, or longer if the batteries are completely depleted. Fully charged, the 940A should operate for up to 24 hours with the display backlight set to 20 percent brightness, and the flash light and the speaker switched off.

Operating with Power Supply/Charger

With the included power adapter/charger connected, the 940A should operate indefinitely.

Powering ON or OFF

Press (the ON/OFF button) at the bottom of the front panel to energize and de-energize the 940A.

Battery Indication

100%
Charged, not connected to charger
52%  H
Charging High, connected to charger
15%
Battery very low, connect to charger!

Charging Characteristics

While charging, text below the battery symbol indicates the percentage of charge remaining and a small letter to indicates the charge rate, which depends on the type of charger and USB cable.

Three letters indicate the charging rate: L for low (100 mA), M for medium (500 mA) and H for high (1000 mA – with included charger/cable). Both the AC Adapter/Charger and the cable contribute to the charging rate.
Checking Battery Status

Check the battery status while the unit is turned off and being charged by pressing the ON/OFF button quickly.

Model 940A Accessories

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<td>AP0003400</td>
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<tr>
<td>BNC Barrel (F-F)</td>
<td>CN0003400</td>
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<tr>
<td>BNC Breakout F to Wires</td>
<td>AP0008900*</td>
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<tr>
<td>BNC Adapt M to 2 Pos Term.</td>
<td>AP0014900*</td>
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<tr>
<td>BNC M to 2 Screw Term</td>
<td>AP0015000</td>
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<tr>
<td>USB 2.1A Wall Charger</td>
<td>AP0015300*</td>
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<tr>
<td>Quick Setup Guide</td>
<td>PD0055400*</td>
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<tr>
<td>940A Printed Operation Manual</td>
<td>AS0106800</td>
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<td>USB 2.0A Male to Micro Cable</td>
<td>CA0033700*</td>
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<tr>
<td>BNC Coax Cable M/M</td>
<td>CA0033808*</td>
</tr>
<tr>
<td>BNC ”T” Conn F-M-F</td>
<td>CN0003500*</td>
</tr>
<tr>
<td>Terminal Block, Plug 2 Pin</td>
<td>CN0019202*</td>
</tr>
<tr>
<td>Case Soft 940A</td>
<td>HD0068600*</td>
</tr>
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Table 1: 940A Accessories, *Included
Connecting Time Signals

This section describes how and where to connect the input and output signals in the Model 940A.

The Model 940A has three standard BNC connectors for connecting the two inputs and one output, as seen in Figure 1. Coaxial cable and shielded, twisted-pair cable are the most commonly used cable types used with timing equipment.

![Figure 1: 940A Connections and Features](image)

The source, BNC connector is seen on the right; the two input BNC connectors are on the left. A micro USB is between the Input 2 and AUX I/O port and a flashlight is located above the micro USB port.

Coaxial Cable

Input and output timing connectors on the Model 940A are female BNC, which is one of the most common connectors being used on electrical equipment today. Coaxial cables are usually fitted with
male BNC connectors, which connect directly to the 940A.

**Twisted Pair Cable**

To adapt a twisted pair of wires to the female BNC input connector on the Model 940A, use a BNC breakout as pictured in Figure 2.

![Figure 2: Male BNC Breakout with Terminals](image)

**Connecting**

Connect the breakout’s male BNC connector to the 940A, then attach the twisted pair of wires to the breakout terminals and tighten the screws. Make sure to observe the polarity marking on the breakout. *Do not tin stranded wire with solder.*
Setup Screens

Buttons & Screens

The Home Screen

Figure 3: The Home Screen at Startup

Figure 3 illustrates the Home screen. From the Home screen you can configure Input 1 and 2, the Source (signal output) and System parameters, which include flashlight brightness, speaker volume, display back light, and Real Time Clock (RTC). You only need to touch the screen buttons to make choices. When first powering on the 940A, it should display a startup message, as seen on page i, and then display the home screen, as seen above.
Navigating the Menus

With reference to Figure 3, there are two HOME menus – CONFIGURATION and DISPLAY – with different buttons within each menu.

** TOUCH ACTIVATED AREAS ARE BLUE **

**The Home Button**

Appears in the bottom left corner of most screens, except of course, the home screen. This symbol is used to return to the home screen from other menus.

**Gear Button**

Appears when further configuration is possible, or needed. It only appears when selecting a specific signal, but not if selecting DISABLED.

**Return Button**

Is normally found in the lower right corner of the display. Touch the return button to go back to the previous menu.

**Pause Button**

Is used to freeze the display when viewing a timing signal to capture the various bits for longer viewing.

**Play Button**

Is used to resume showing the active display after pressing the pause button.

**Slider Bar**

Used to move along the displayed time code to view other elements not in the current display.
Configuring Input 1

Figure 4: Input 1 Configuration Screen

1. Press \(\text{\textbullet}\) to power on the 940A.

2. Connect the cable from the equipment you want to test to Input 1.

3. In the Home screen CONFIGURATION menu, touch \(\text{INPUT 1}\).

4. In INPUT 1 CONFIGURATION display (see Figure 4) touch the desired signal. For example, IRIG-B UNMODULATED.

5. Touch one of the Load configuration buttons, such as Load Off.

6. Touch the Compensate for 1 Second Delay, if required. Keeps the 940A time in sync with source.

7. Touch \(\text{\textbullet}\) when finished.

Configuring Input 2

From the Home screen CONFIGURATION menu, touch \(\text{INPUT 2}\). Otherwise, the setup should be the same as for Input 1 as described above.
Viewing a Signal at Input 1

Continue from the previous page by connecting an unmodulated IRIG-B signal to Input 1.

1. In the Home screen DISPLAY menu, touch "INPUT 1".
2. The input 1 display could look similar to Figure 5.
3. Touch if necessary to change the 940A mode to IRIG-B UNMODULATED.
4. Press to pause (freeze) the active signal in the display.
5. Press to resume displaying the active signal.
6. Press either or to zoom in or out in the display.
7. Touch and slide to view other sections of the IRIG-B signal.

Figure 5: Displayed Unmodulated IRIG-B Input

For more information on viewing input signals see page 26 regarding Viewing Timecodes.
Configuring the SOURCE

Configuring the source is very similar to configuring either Input 1 or Input 2.

![Source Configuration Screen](image)

**Figure 6: The Source Configuration Screen**

1. In the Home screen CONFIGURATION menu, touch **SOURCE**.
2. In SOURCE SIGNAL SELECTION menu, touch desired signal – for example, IRIG-B UNMODULATED.
3. Touch 🔄 to configure other time settings, then touch 🔄 to return to the SOURCE SIGNAL SELECTION menu.
4. Touch 🏠 to return to the Home screen.

Once selected, the 940A produces the timing signal at source connector. When DISABLED, the 940A will not display the gear symbol.
IRIG Source Configuration

The source signal can come from Input 1, Input 2, or Custom. Custom can generate its own signal.

Use for either modulated or unmodulated IRIG-B.

1. Touch the Input 1, Input 2, or Custom buttons to select the signal source to transmit IRIG-B from the Source BNC connector.

2. Touch the Duplicate Input button if you want to exactly reproduce at the source the signal connected to Input 1 or 2.

3. If wanting to set to a custom time and date, touch Custom, then the Time/Date bar next to it – see page 13 to set the date and time.

4. Select the time zone as UTC or Local. If Local, touch the Local Offset value to adjust.

5. Touch one of the C37.118 values to set up the required standard, turn C37 values OFF, or switch year only ON.

Figure 7: Configuring the IRIG-B Output
Custom Start Date and Time

Figure 8: Set Custom Time Screen

Figure 8 illustrates the Custom Time window, which provides a method to manually set the source date and time.

1. Touch the up or down arrows for each item of date and time.

2. Touch **SET TIME** after setting the time and date.

3. Touch **SET FROM RTC** to set the custom clock from the Real Time Clock.

4. Touch **CANCEL** to escape from this menu.
Source IRIG-B Bits

IRIG-B Bits allows you to manipulate the IRIG bits to test time quality and a time change, such as Leap Seconds and Daylight Saving changes. One of the C37 values (i.e. 2005 or 2011 from Figure 7) must be enabled for this menu to appear.

![CONFIGURE SOURCE IRIG BITS](image)

Figure 9: Configuring the Source IRIG-B Bits

1. Start from the configuration steps on page 12.

2. Touch `IRIG BITS` to open the CONFIGURE SOURCE IRIG BITS menu as seen in Figure 9.

3. Make any changes to Time Quality, Leap Seconds and Daylight Saving Time selections.

4. Touch `to return to the SOURCE IRIG CONFIGURATION menu.

**NOTE:** Changing any of these bits does NOT change the time in the IRIG-B string. It only changes the specific Control Function bits for diagnostic purposes.

**To change the source time and date:** use the Custom button in the IRIG SOURCE CONFIGURATION menu.
Setting the DST Clock

Manually sets the DST clock for a Daylight Saving Time event.

Figure 10: Setting the DST Clock

1. Touch the Change Over Time bar as seen at the bottom of Figure 9.

2. From Figure 10, touch either the UP or DOWN arrows for Month, Day, Year, Hour, Minute and Second.

3. When the preferred date and time is selected, touch SET TIME.

4. To set the changeover time from the Real Time Clock, touch SET FROM RTC.

5. To return without applying anything, touch CANCEL.
Unmodulated IRIG-B Source Level

Sets the drive level for the specific timing output source impedance or voltage.

![SOURCE OUTPUT LEVEL](image)

Figure 11: Configuring the Source Output Level

1. From the SOURCE IRIG CONFIGURATION menu screen, touch **OUTPUT LEVEL** to open the SOURCE OUTPUT LEVEL menu screen.

2. Touch one of the three selection buttons.

3. *If selecting Variable*, touch the voltage button to open the voltage adjustment screen – see Figure 12.

4. Touch **go back** to go back to the SOURCE IRIG CONFIGURATION menu.
Source DC Voltage Adjustment

Use this menu to adjust the 940A source output voltage; works with unmodulated IRIG-B and 1 PPS.

1. Touch the UP and DOWN arrows to adjust the IRIG-B unmodulated voltage level to your desired level.

   Voltage range is from 1 to 15 Volts, with 50 ohm source impedance.

2. Touch SAVE to save the selected output voltage.

3. Touch CANCEL to return to the previous screen without changing anything.

Figure 12: Adjust the Source Voltage
Modulated IRIG-B Source Level

Sets the modulated IRIG-B peak voltage and the modulation ratio.

1. From the SOURCE IRIG CONFIGURATION menu screen, touch OUTPUT LEVEL to open the SOURCE OUTPUT LEVEL menu screen.

2. Touch Variable button to open the voltage adjustment screen – see Figure 14. Voltage range is 1 to 10 V. Touch the arrows to adjust, then SAVE.

Figure 13: Modulated IRIG Source Output Level

Figure 14: Adjust the Source AC Voltage
Source Modulation Ratio

Sets the modulation ratio for modulated IRIG (B12x).

Figure 15: Adjust the Source AC Modulation Ratio

1. Touch the Modulation Ratio button to select the desired ratio – includes 2:1, 3:1, 10:3, 4:1, 5:1, 6:1 and 7:1. **Note:** for higher modulation ratios (e.g. 4:1 and higher), the Source Output Level may need to be adjusted higher.

2. In the SOURCE OUTPUT LEVEL, Edit Modulation Ratio screen, touch the UP or DOWN buttons to set the modulation ratio.

3. Touch **SAVE** to store the new voltage and return to the previous menu screen.

4. Touch **CANCEL** to return to the previous screen without saving.
Source 1 PPS Configuration
Sets the time signal source from either Input 1, Input 2 or RTC.

Figure 16: Configuring the 1 PPS Time Source

1. From the SOURCE SIGNAL SELECTION menu screen, touch the 1 PULSE PER SECOND button.
2. Select the TIME SOURCE button: Input 1, Input 2 or RTC.
3. Touch the OUTPUT LEVEL to set the output voltage – see Figure 17.
1 PPS Source Output Level
Sets the 1 PPS source output impedance and voltage.

![SOURCE OUTPUT LEVEL](image)

Figure 17: Configuring the 1 PPS Output

1. Touch the Variable (50 Ohm Source) to open the SOURCE OUTPUT LEVEL adjustment screen. See Figure 18.

2. Touch the UP or DOWN arrows to choose the desired voltage level (1 Vpeak to 15 Vpeak).

3. Touch **SAVE** or **CANCEL** when finished.

![SOURCE OUTPUT LEVEL](image)

Figure 18: Adjusting the 1 PPS Voltage
DCF77 Source Configuration

Configures the DCF77 output for this one-minute time code.

![DCF77 Source Configuration](figure)

**Figure 19: Configuring the DCF77 Output**

1. From the SOURCE SIGNAL SELECTION screen (see Figure 6) touch the DCF77 button.

2. Touch one of the TIME SOURCE selections.

3. To configure a custom time touch CUSTOM, then touch the start time bar to adjust the date and time.

4. Configure UTC or your time zone button.

5. Configure leap seconds, if required. The Leap Second Pending bit (LSP) will change one hour prior to the addition, or subtraction, of a leap second.

6. Configure DST adjustments if required. DCF77 DST adjustments work the same as they do for IRIG-B.

For more information on the DCF77 time code, see page 35.
System Configuration

Choose from the five items shown in Figure 20.

![System Configuration Menu]

1. In the Home screen CONFIGURATION menu, touch **SYSTEM**.

2. Touch the Flashlight On button if desired. Deselect button if not wanting the flashlight. Touch the brightness bar to adjust the flashlight brightness.

3. Touch the Speaker Volume On button if desired, and adjust the volume with the slider.

4. Adjust the Backlight brightness manually, or use the Auto setting. Backlight slider does not function when Auto is selected.

5. For Real Time Clock Date/Time setting, go to page 25.

6. Synchronize RTC with Input1, Input 2 or OFF.

   Choose **OFF** if manually setting the RTC.
System Menu Notes

Flashlight

Provides brightness control and On selection. When selected ON, the brightness slider controls the LED output. The brightness slider has no effect if the ON button is not selected.

Speaker

Volume is similar to Flashlight, in that the slider controls the output level and “ON” turns the speaker on or off. The volume slider has no effect if the ON button is not selected.

Backlight

Controls are manual and automatic. With Auto selected, the backlight is automatically adjusted for the ambient light. With Auto not selected, the slider manually controls the backlight brightness. The backlight uses the most power from the batteries.

RTC Date/Time

Set the RTC in one of two ways: (1) from an incoming timing signal from Input 1, or Input 2, and (2) set manually. By selecting Input 1 or Input 2, the Real Time Clock will be set automatically when a valid time signal is connected to either input.

NOTE: For Flashlight, Speaker and Backlight: if the “ON” or “AUTO” buttons are not selected and one of the sliders are moved, the level is remembered and is used when the 940A is powered back on.
Manually Setting the RTC

Manually adjust the Real Time Clock (RTC) from this menu. Use the UP and DOWN arrows to change the date and time value(s) forward or backward.

![Diagram of System Configuration](image)

Figure 21: Set Real Time Clock Screen

1. Continued from page 23.

2. As required, touch the arrows above and below each of the date/time selections.

3. Touch **SET TIME** to set the time/date. Returns you to the system configuration menu.

4. Touch **CANCEL** to leave this menu without changing anything.
Viewing Timecodes

DISPLAY Functions

From the Home screen there are two categories: CONFIGURATION, and DISPLAY. DISPLAY allows you to view the incoming signals from INPUT 1, INPUT 2, both Input 1 and Input 2 and outgoing signal using the SOURCE connector.

Figure 22: DISPLAY on the Home Screen
Waveform Comparisons

Figure 23 illustrates two of the common methods of transmitting IRIG-B, plus one pulse per second (1PPS). Unmodulated is a square wave string of 100 bits and modulated is a 1 kHz carrier amplitude modulated with the same number of bits.

Notice that there are three different bit widths: 8 milliseconds, 5 milliseconds and 2 milliseconds. The 8 millisecond pulse is considered a reference bit, the 5 millisecond pulse is a digital one and the 2 millisecond pulse width is a digital zero.

Also, notice that the 1 kHz sine wave amplitude follows the same time frame and pattern as the digital (unmodulated) signal.
Unmodulated IRIG-B

From the Home screen DISPLAY menu, press the button of the signal you wish to view.

![INPUT 1 IRIG-B UNMODULATED](image)

The lower portion of Figure 24 graphically illustrates a part of the unmodulated IRIG-B signal: view adjusted using the slider.

- **Time/Date**: UTC time; date; Day of Year; Straight Binary Seconds (SBS); Time offset; IEEE 1344: ON or OFF.

- **Time quality (TQ)**: Continuous Time Quality (CTQ); Leap Second Pending (LSP); Daylight Saving change Pending (DSP).

- **Jitter, or Pulse Jitter**: Two values measured and displayed: average jitter and rms jitter. Acceptable jitter depends on your requirement. See Figure 25.

- **In1 - In2 Delta T**: Time difference between the 1 PPS signals at Input 1 and Input 2.

- **Signal amplitude**: Shown in Volts.

Figure 24: Unmodulated IRIG-B Display
Figure 25: Average pulse jitter is the average difference between the 10 ms reference and measured spacing for all 100 pulses; RMS jitter is the calculated RMS of the difference between the 10 ms and measured spacing for all 100 pulses.

Viewing Tools

1. – Home button: move to the Home screen.

2. – Zoom in and Zoom out.

3. – Pause: freeze the display until play is pressed.

4. – Play: resume viewing the active display after pausing.

5. – Slider bar: at the bottom of the input screen allows you to scan through the entire range of 100 bits in the IRIG-B time code.

6. – Gear button: at the lower right allows you to more easily access the input configuration screen and change the configuration.

7. – Blue down arrow over line: use to enlarge the upper text information and lose the lower digital graphics. Touch again to return to the split display.
Modulated IRIG-B

Modulated IRIG-B carries the same time and date information as the unmodulated, however it is not as accurate as unmodulated IRIG-B. This is due to the difficulty in accurately measuring the time of the 1 kHz rising wave compared to digital signal’s fast rise time. Generally, acceptable accuracy for modulated IRIG-B is about 10 microseconds, whereas the unmodulated accuracy can be better than 100 nanoseconds.

In Figure 26 you will notice that the representative modulated IRIG-B waveform is not a perfect sine wave in all magnifications. This is because the 940A display is not able to reproduce it with resolution. For clarity the individual bits in the IRIG string are shown as a modified square wave, whereas the text above the waveform indicates accurate values. The analog waveform will appear more correctly as you zoom in using the zoom tool.

Figure 26: Modulated IRIG-B
Viewing the Source Signal

You can view the signal being produced at the source connector, similar to viewing a timing signal at Input 1 or Input 2. In addition the 940A can supply its own signal from the Real Time Clock.

Source Field Values

Five values are provided in the source viewing screen, the actual number dependent on the signal type.

- **Timing Source** – where the signal originates
- **Time Sync** – quality of the timing signal
- **Amplitude** – voltage of the output signal
- **Load** – a detected load current in milliamperes
- **Modulation Ratio** – only valid when the source is set for modulated IRIG-B

Timing Source Types

Three possibilities exist for a timing source: a signal at **Input 1**, **Input 2**, or the **Real Time Clock (RTC)**.

Field Values available per Signal Type

- **unmodulated IRIG-B** – Timing Source, Time Sync, Amplitude, Load
- **modulated IRIG-B** – Timing Source, Time Sync, Amplitude, Load, Modulation Ratio
- **1 PPS** – Timing Source, Time Sync Amplitude, Load
- **DCF77** – Timing Source, Time Sync

Time Sync Messages

Values for Time Sync, in the illustration above, can be as follows:

- **NA** – using RTC as Time Source; accuracy not known
- **Unlocked** – if a signal was connected to to either Input 1 or Input 2 and was removed
- **Syncing** – if the source is synchronizing to one of the inputs
- **Stabilizing** – if the source is stabilizing to one of the inputs
- **Locked** – if the source is synchronized to one of the inputs.
Amplitude
Provides the measured voltage at the source output.

Load
Provides the load current produced at the source output. An OVERLOAD message may appear if the source cannot produce the configured voltage.

Modulation Ratio
Indicates the configured modulation ratio set up in the modulated IRIG-B SOURCE OUTPUT LEVEL menu.

Example: Unmodulated IRIG-B as Source
In this example an unmodulated IRIG-B signal is being produced at the source using the Real Time Clock (RTC). Other time signals can be set up similarly.

Figure 27: Source Unmodulated IRIG-B

1. Under CONFIGURATION, set up the Source for unmodulated IRIG-B configuration. Use submenus as required.

2. Under DISPLAY, select to view the source output.

When the source sync originates from the RTC Time Sync does not apply (NA), as the accuracy of the RTC is not known.
The 1 PPS signal is generally a 10 millisecond pulse that occurs every second, with the rising edge on time. Synchronization between the 1 PPS and IRIG-B time code can be seen in Figure 23. A 1 PPS signal connected to Input 1 would display as illustrated in Figure 28.
Source 1 PPS Timing

The 1 PPS signal is generally a 10 millisecond pulse that occurs every second, with the rising edge on time. Synchronization between the 1 PPS and IRIG-B time code can be seen in Figure 23. A 1 PPS signal transmitted from the source connector would display as illustrated in Figure 29.

**TIME SOURCE INVALID**

Figure 29 illustrates an input signal originally connected to Input 1 that was disconnected and the accuracy is not known. Therefore, the Time Sync message states that it has been unlocked for 99 minutes – the maximum unlock time.
DCF77 Timing

Figure 30: DCF77 Signal Connected to Input 2

DCF77 is a one minute time code with 58 bits of time information. The 59th second bit is missing, which is normal for standard DCF77. It can be illustrated as an analog clock as seen in Figure 31.

DCF77 Marker Details – Figure 31

M: minute marker (second marker No. 0): 0.1 s
R: second marker No. 15 indicates service request to the DCF77 signal generation system
A1: announcement of a forthcoming change from CET to CEST or vice versa
Z1, Z2: time zone indication: CET: Z1, 0.1 s, Z2 0.2 s; CEST: Z1 0.2 s, Z2 0.1 s
A2: announcement of a leap second, 0.2 s
S: Start of encoded time. Always 1.
P1, P2, P3: parity check bits

DCF77 Time Zone Arrangement

- CET is Central European Time, UTC + 1:00
- CEST is Central European Summer Time, UTC + 2:00.
Figure 31: DCF77 Signal Elements show as a 60 second clock. Time and marker details are seen around the circumference of the circle. The 59th second bit is missing for Standard DCF77.
# Specifications

## INPUTS

<table>
<thead>
<tr>
<th>Connector</th>
<th>Two BNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals</td>
<td>IRIG-B (modulated, unmodulated, modified Manchester), DCF77, 1 PPS</td>
</tr>
<tr>
<td>Levels</td>
<td>25 Vpk, maximum</td>
</tr>
<tr>
<td>Impedance</td>
<td>Selectable: high impedance, 50 ohms or 100 ohms.</td>
</tr>
</tbody>
</table>

## OUTPUT

<table>
<thead>
<tr>
<th>Connector</th>
<th>One, BNC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signals</td>
<td>IRIG-B (modulated, unmodulated), DCF77, 1PPS</td>
</tr>
<tr>
<td>Levels</td>
<td>1 – 15 Vdc, 1 – 10 Vpk</td>
</tr>
<tr>
<td>Drive</td>
<td>125 mA @ 5V</td>
</tr>
<tr>
<td>Time Ref.</td>
<td>Input 1, Input 2, Real Time Clock, or Custom</td>
</tr>
</tbody>
</table>

## SYSTEM

<table>
<thead>
<tr>
<th>Display</th>
<th>800 x 480 color TFT capacitive touchscreen, backlit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single or Dual Timing Signals Data and/or Waveform</td>
</tr>
<tr>
<td>Reference</td>
<td>Input 1, Input 2 or Custom</td>
</tr>
</tbody>
</table>

## Features

<table>
<thead>
<tr>
<th>Flashlight</th>
<th>Built in LED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audio</td>
<td>Indicator tone (enable/disable)</td>
</tr>
</tbody>
</table>
### POWER

**Battery**
- **Type**: Li-ion (9000 mAh capacity)
- **Operation**: 24 hours, typical
- **Charge**: 8 – 12 hours with unit off

**External**
- **Voltage**: +5 Vdc
- **Current**: 1 A
- **Cable**: 24 AWG Required
- **Connector**: USB Micro-B

### GENERAL

**Physical**
- **Size**: 204.7 x 166.5 x 48.5 mm  
  (8.1 x 6.6 x 1.9 in.)  
  381 x 305 x 229 mm, shipping  
  (15 x 12 x 9 in.)
- **Weight**: 0.6 kg (1.4 lbs), maximum  
  2.5 kg (5.5 lbs), shipping

**Environ.**
- **Temperature**
  - Operating: -10 °C to +50 °C
  - Charging: 0 °C to +45 °C
  - Nonoperating: -40 °C to +75 °C
- **Humidity**: Noncondensing
The 940A Utility

Updating Firmware

This section describes how to update the firmware on your Model 940A. Check the Arbiter web site, or contact Arbiter Systems technical support, for information on firmware updates.

Firmware Package

Note that the new firmware will be in zipped format and does not need to be unzipped (or unpacked) before uploading to the 940A. The Utility will unpack the required files when necessary.

Driver Software

The 940A Utility software package includes the driver and the operation manual. For Windows 7, use the Device Manager to install the driver from the installation directory.

Updating the 940A

1. Power on the 940A and start the 940A Utility. See Figure 32.

Figure 32: 940A Utility Opening
2. Connect the supplied Micro USB cable between the USB 2.0 port on the 940A and the computer.

3. To select the COM port, click **Settings** then **Serial Port** in the Utility menu. Select the COM port of your computer, click **OK**. See Figure 33.

![Figure 33: Selecting COM Port](image)

4. The Utility should then read and display the current firmware version and the serial number. See Figure 34.

![Figure 34: 940A Utility Reading Serial Number](image)

5. In the 940A Utility main menu click **Device** then **Upload Firmware**; browse to the location of the new firmware, select the zipped file and click **Open**.

6. Click the **Upload To Device** button. A progress bar will appear that counts the number of blocks loaded and the total.

7. After the upload, the 940A should restart and pause on the startup screen. A message in the startup screen should ap-
Pear regarding the success of the upload and the new firmware version from the 940A.

8. On the 940A Utility you can also select Device, Read, and it should read the firmware version.

9. Touch the 940A display itself to leave the startup screen.
IRIG-B Information

IRIG Time Code Formats

Listed below are the various formats in the IRIG specification. Arbiter clock products produce Format B.

<table>
<thead>
<tr>
<th>Format</th>
<th>Pulse Rate</th>
<th>Index Count Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRIG-A</td>
<td>1000 PPS</td>
<td>1 ms</td>
</tr>
<tr>
<td><strong>IRIG-B</strong></td>
<td>100 PPS</td>
<td>10 ms</td>
</tr>
<tr>
<td>IRIG-D</td>
<td>1 PPM</td>
<td>1 minute</td>
</tr>
<tr>
<td>IRIG-E</td>
<td>10 PPS</td>
<td>100 ms</td>
</tr>
<tr>
<td>IRIG-G</td>
<td>10000 PPS</td>
<td>0.1 ms</td>
</tr>
<tr>
<td>IRIG-H</td>
<td>1 PPS</td>
<td>1 second</td>
</tr>
</tbody>
</table>

Table 2: Various IRIG Time Code Formats

Time Code Attributes

All IRIG time code formats use pulse-width coding. A ”binary 1” pulse has a duration of 50% of the index count interval (see Table 2); a ”binary 0” pulse has a duration of 20% of the index count interval; pulse identifiers have a duration of 80% and used as reference markers.

IRIG-B time code signals may be either Unmodulated or Modulated. Unmodulated time codes are DC level shift with no carrier signal. Modulated time codes are amplitude-modulated, sine wave carrier. For IRIG-B, the carrier is 1 kHz.
Encoding

IRIG-B consists of 100 bits produced every second, 74 bits of which contain various time, date, time changes and time quality information of the time signal. It consists of logic ones, zeros and position identifier bits. There are three functional groups of bits in the IRIG-B time code: Binary Coded Decimal (BCD), Control Functions (CF) and Straight Binary Seconds (SBS).

The BCD group contains time information including seconds, minutes, hours, days and year, and recycles yearly. It reads zero (0) hours at 2400 hours each day and day one (1) on day 365 at hour 2400. BCD year counts two-digit year and cycles to the next year on January 1st, and counts to 2099 (99).

The CF (Control Function) group contains year, time quality, leap year, pending leap seconds and parity. More recently, Continuous Time Quality (CTQ) was added according to IEEE C37.118-2011.

SBS (Straight Binary Seconds) counts time of day in seconds, recycling daily, reading zero (0) at 2400 each day.

IRIG-B Bit Assignments

Nomenclature

BCD = Binary Coded Decimal; CF = Control Functions; SBS = Straight Binary Seconds; TQ = Time Quality; CTQ = Continuous Time Quality
<table>
<thead>
<tr>
<th>Code Group</th>
<th>Bits</th>
<th>Includes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCD Seconds</td>
<td>0 to 8</td>
<td>Ref. bit at 0</td>
</tr>
<tr>
<td>BCD Minutes</td>
<td>9 to 18</td>
<td>Ref. bit at 9</td>
</tr>
<tr>
<td>BCD Hours</td>
<td>19 to 28</td>
<td>Ref. bit at 19</td>
</tr>
<tr>
<td>BCD Days</td>
<td>29 to 48</td>
<td>Ref. bit at 29</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7 index bits</td>
</tr>
<tr>
<td>BCD Year</td>
<td>49 to 58</td>
<td>Ref. bit at 49</td>
</tr>
<tr>
<td>CF, Offset</td>
<td>59 to 68</td>
<td>Ref. bit at 59</td>
</tr>
<tr>
<td>CF, TQ</td>
<td>69 to 74</td>
<td>Ref. bit at 69</td>
</tr>
<tr>
<td>CF, Parity</td>
<td>75</td>
<td>–</td>
</tr>
<tr>
<td>CF, CTQ</td>
<td>76 to 78</td>
<td>–</td>
</tr>
<tr>
<td>SBS, 86400 secs</td>
<td>79 to 98</td>
<td>Ref. bit at 79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>one index bit</td>
</tr>
<tr>
<td>Reference bit</td>
<td>99</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 3: IRIG Time Code Bit Assignments