Arbiter Systems, Inc.

Model 1088B GPS Satellite-Controlled Clock

Option 18: IRIG-B Distribution Bus, Fault Monitor, and Second RS-232

General Description

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

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

Specifications

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

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

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

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

Associated Products

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

Discussion - IRIG-B Distribution System

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

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

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

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

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

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

Bus Configurations

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

Determining Actual Signal Output Levels

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

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

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

Total DC Resistance Limit - Bus Monitor

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

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

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

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

Detection of Short Circuits; Drive Capability

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

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

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

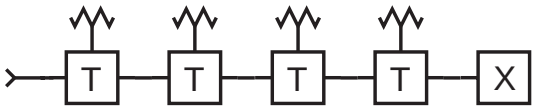
Installation

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

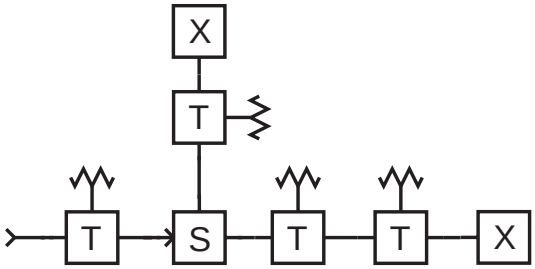
The figures which follow show typical network topologies. The various components may be connected together in any configuration desired, provided that the basic rules described above are not broken. Multiple branches or loops may be used, and the number of taps is limited only by the loading and signal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

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

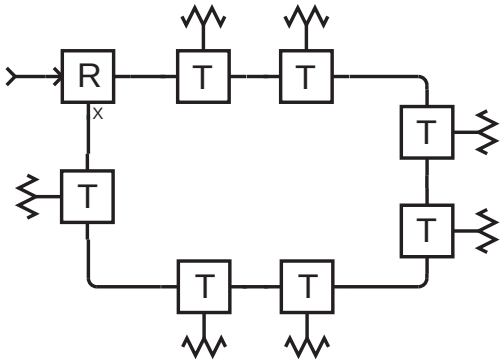
The output of the taps is isolated and floating, and either end may be grounded. However, if the signal polarity is incorrect, the device being driven by the tap may not operate properly.



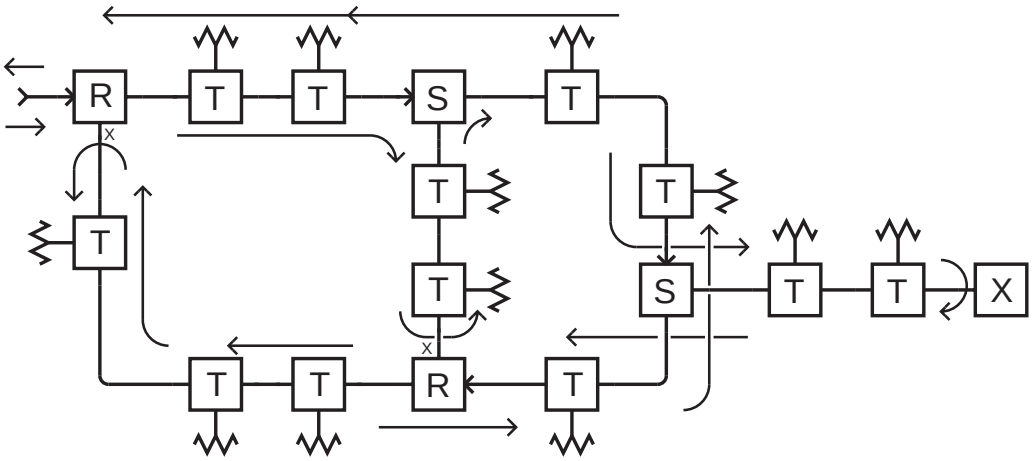
Linear Network



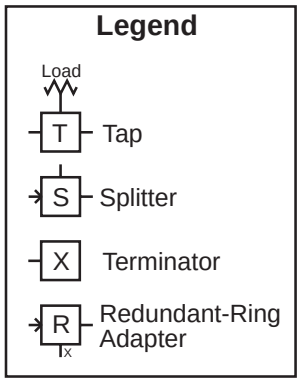
Branched Network



Redundant-Ring Network.
May also include one or more
(non-redundant) branches, if desired.

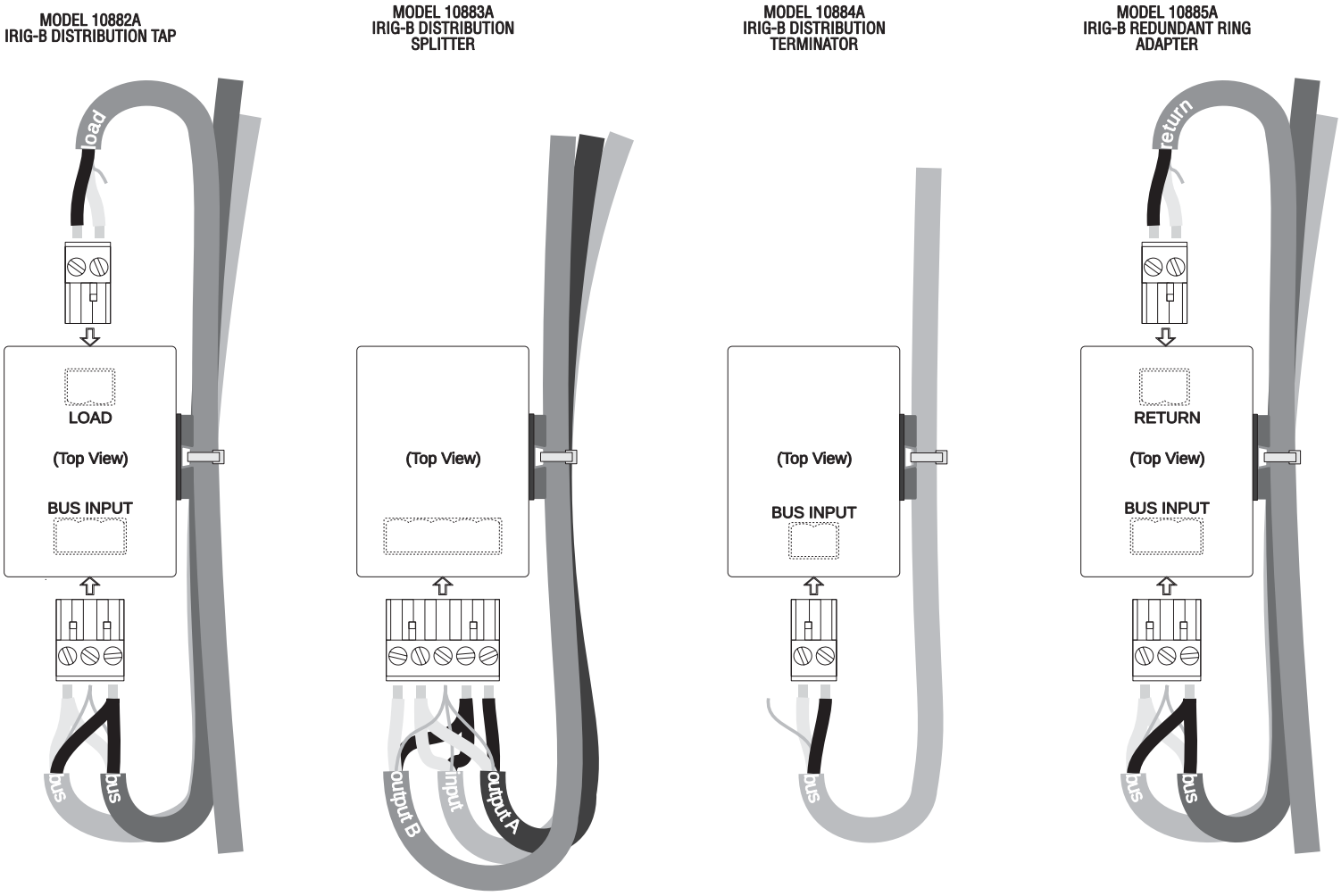


Complex network, showing
multiple loops and branches.
Arrows show direction of dc loop
monitor current flow.



Bus Cable: Belden 8760 or equivalent;
18 AWG pair with foil-polyester shield
and 20 AWG drain wire.

Typical Network Configurations



Component Wiring Diagrams

Discussion - Redundant Timing Operation

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

Output Signal Enable and Configuration

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

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

On-Line Control and Arbitration

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

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

Determination of the on-line clock in the event of multiple failures is made by comparison of the status bytes (refer to paragraph 4.4 for a discussion of clock status). The clock with the lower-valued status byte will be elected to on-line

status. The status of both clocks may be monitored from either of the clocks via the 'SS' RS-232 command; see Appendix A of the 1088B Operation manual for a description.

Use With Other Options

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

Option 18 Setup

The setup menu to control the operation of the Option 18 interface is shown in Figure 5.9 of the 1088B Operation manual. No internal configuration is necessary for proper operation of the Option 18, except to convert between redundant and normal operation as regards the output-enable control for the clock digital output drivers. If you need to change this setting, refer to paragraph 3.3 of the 1088B Operation Manual for instructions. These jumpers are normally configured at the factory to match each customer's order.

RS-232 Pinout

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

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

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

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

Terminal Strip Pinout

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

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

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

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