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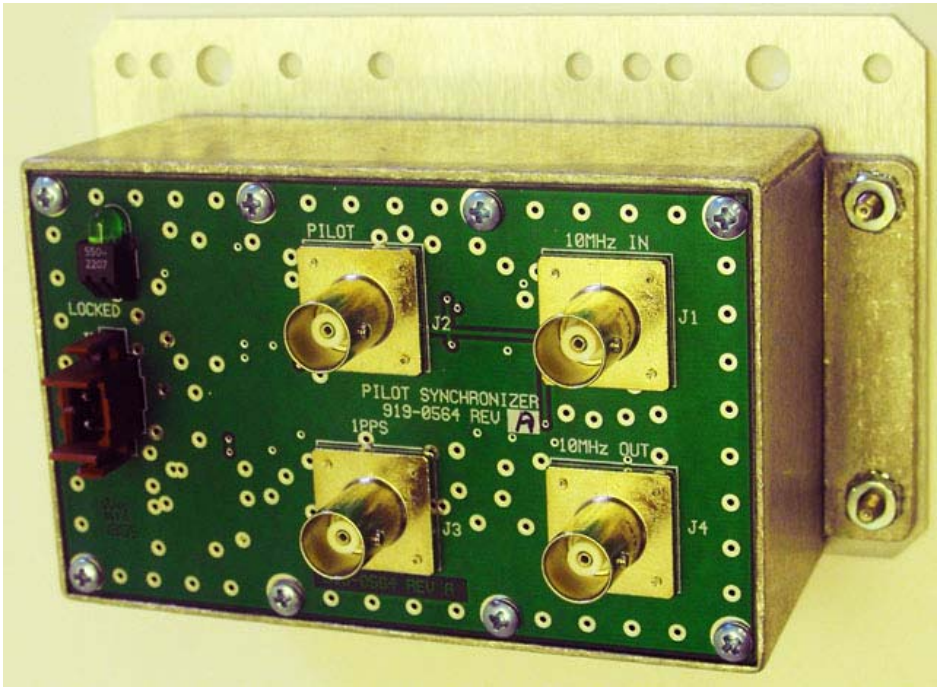

Pilot Sync Option

Pilot Sync Module Installation Application Guide

597-0564
10/27/09
Rev. B

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Pilot Sync Module Installation
Application Guide

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1 FXI Pilot Sync Option

1.1 Overview of Single Frequency Networks

A single-frequency network or SFN is a broadcast network where several transmitters simultaneously send the same signal over the same frequency channel.

Analogue as well as digital radio broadcast networks can operate in single frequency networks. A simplified form of SFN can be achieved by a low power co-channel repeater, booster or broadcast translator, which is utilized as gap filler transmitter. They can be used to improve service in a part of the main coverage area which receives a poor signal due to geographic constraints or to reach an area not covered by the signal of the originating station.

1.2 Pilot Sync

The B.E. Pilot Sync Option is intended for FXI customers building Single Frequency Networks (SFN) or simulcasting situations. The pilot of multiple transmitters on the same frequency needs to be synchronized with each other to minimize distortion or interference at the receiver during the transmitter capture period when the receiver is going from one transmitter coverage area to another.

Receivers will lock into the nearest (strongest signal) transmitter and continue receiving from that transmitter as long as the signal strength is the strongest available. Receivers in areas that have two strong signals or are in a moving vehicle that going further away from one transmitter and closer to another will benefit from Pilot sync. Receivers will switch to the stronger signal or "capture" the signal and lock onto it. If the pilots are not synchronized, the receiver will have interference when the two pilot signals can cancel each other out. To minimize this occurrence, all pilots in that SFN are synchronized so the capture is not interrupted. Syncing the pilot is one aspect of building a single frequency network. The carrier and the audio must also be synchronized independently for the pilot.

To synchronize the pilots, all transmitters in the SFN will need the Pilot sync option and will be time aligned to a GPS 1pps signal so that they will have a reference signal to align with. With the optional board, the pilot from the exciter is compared in time to the 1pps signal from a GPS receiver and removes one or multiple edges each second from a 10MHz reference signal. Each edge changes the pilot phase by 100ns, until the pilot is in phase with the reference.

2 Upgrade Preparation

2.1 Overview / Estimated Completion Time For Upgrade

B.E. Pilot Sync Option (979-0564) contains the necessary items to upgrade an FXI exciter with the Pilot Sync option.

Providing the GPS receiver and Exciter are co-located and you have the tools and items listed below, it will take approximately 10 minutes to complete the installation.

2.2 Items / Tools required for the Upgrade Process

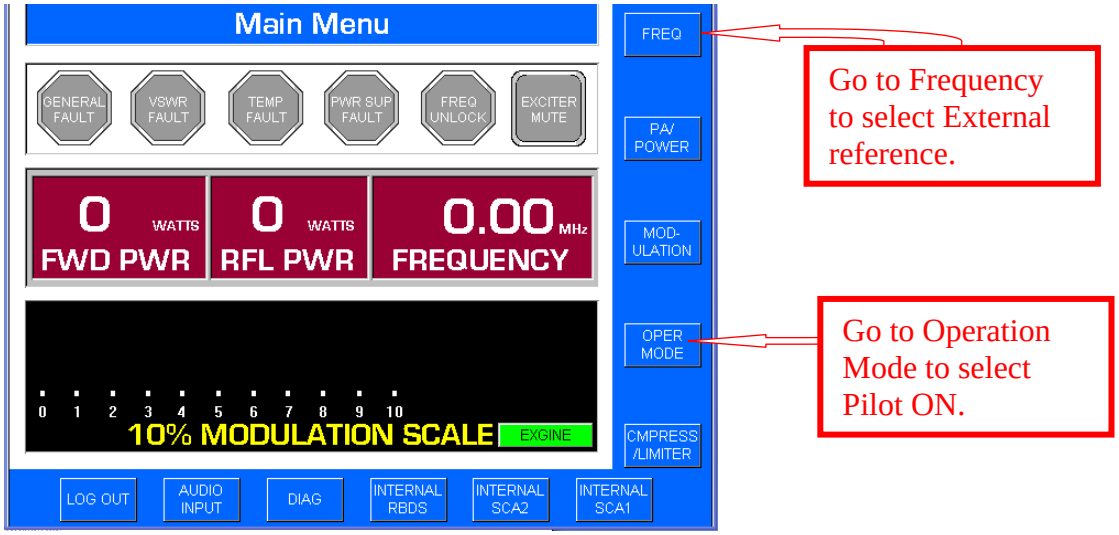
- ☐ 5/16" Nut Driver
- ☐ 3/8" Nut Driver
- ☐ No. 2 Phillips Screwdriver
- ☐ 979-0564 Kit, FXI, Pilot Synchronization
  - ☐ 420-0108, (Qty 2) SCREW, 10-32X.500"
  - ☐ 421-0102, (Qty 2) 10-32 KEP NUT
  - ☐ 421-6008, (Qty 6) 6-32 KEP NUT
  - ☐ 422-6107, (Qty 2) SCREW, 6-32 X 7/16".
  - ☐ 471-5362, (Qty 1) PLATE, PILOT SYNCHRONIZER
  - ☐ 597-0564, (Qty 1) INSTRUCTION MANUAL,FXI,PILOT SYNC
  - ☐ 947-0020, (Qty 4) ASSY,CABLE BNC ACCESS
  - ☐ 959-0012-100, (Qty 1) AC-DC CNVTR 12V 100 MA ASSY
  - ☐ 959-0564, (Qty 1) ASSY, PILOT SYNC

2.3 Installation

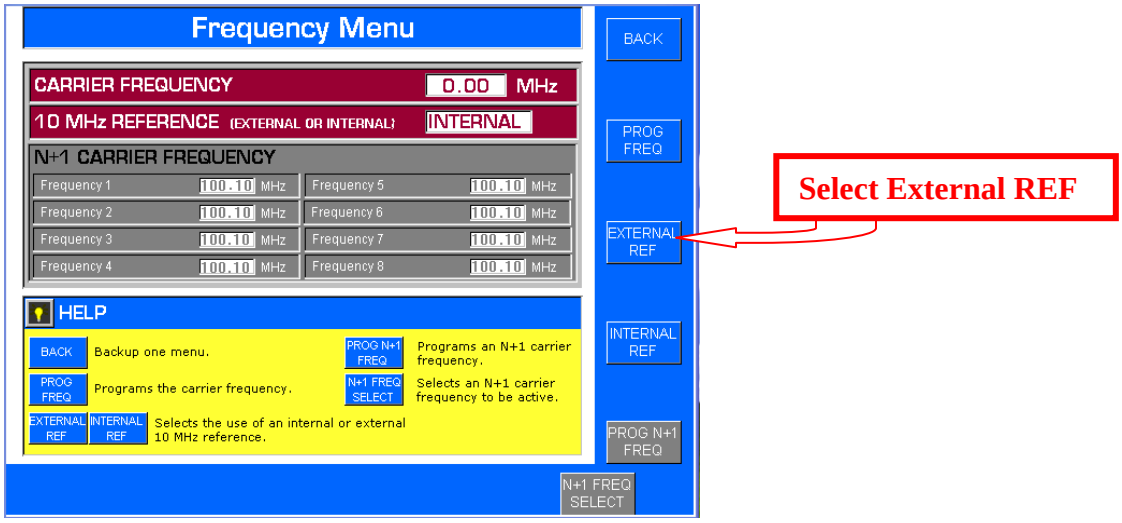
The Pilot sync comes already mounted to a plate for ease of installation in your equipment rack. Find a suitable location behind the Exciter to mount the Pilot Sync option so the supplied cables can reach the Exciter and the GPS receiver. Refer to Figure 1 for wire routing. When locating a place to mount the box, avoid locations that would require long coax runs over 10 feet. Excess cable length will attenuate the 10MHz signal to the point the Pilot sync doesn't function.

The Pilot Sync needs external power from the supplied AC to DC wall converter. Dependent on the revision and ship date of your Pilot Synchronization Kit, the supplied kit may include either a 100-120VAC wall converter (with a standard North American plug) or a 100-240VAC wall converter (with various plug adapters). Please inspect the kit for the converter type supplied and be sure to connect the wall converter to the appropriate AC Voltage source for proper operation. As needed, dress the DC wires from the wall wart to the Pilot Sync.

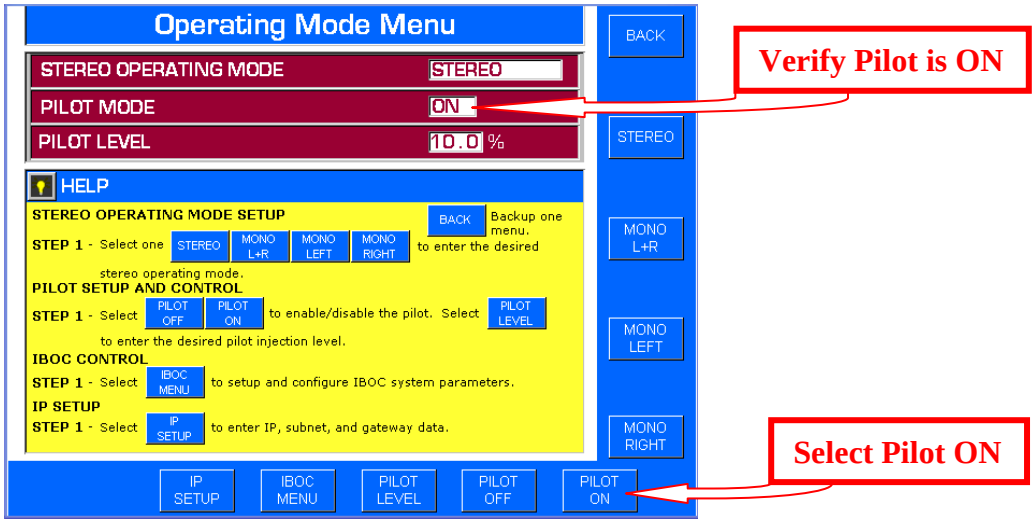
To enable the Pilot Sync option, two modes must be selected on the FXI exciter; External Reference and Pilot must be ON. From the Main Menu navigate to the Frequency screen to select External Reference, and the Operating Mode screen to turn the Pilot ON.



On the Frequency Menu GUI screen select External reference to enable the use of external 10MHz signal for the Pilot Sync option.



Verify the pilot is turned on by navigating to the Operating Mode Menu and selecting "Pilot ON" if it is not already on.



3 Detailed Theory

The 1PPS signal from a GPS receiver is applied to J3 where it feeds the transition inputs of two different one-shot multivibrator circuits. The pulse-width of the output signals from these devices is controlled by the RC time constant and that determines the rate at which the phase of the pilot is changed.

The 10MHz signal that would normally be used as the exciter reference is applied to J1 and is squared up by an inverting Schmitt trigger U3C. Then, to two NOR gates; one for the hi-speed loop, one for the low-speed loop. The NOR gates remove transitions for the 10MHz signal pulse train when the other gate input is driven by the Hi-speed loop one-shot and the low-speed loop one-shots.

The result is a modified 10MHz signal that is now used as the exciter reference. The resulting reference frequency is changed by removing transitions at each 1pps instant. This will change the generated pilot phase by 100ns for each edge removed.

U2 serves as the low-speed loop and removes only one edge each second from the reference in U4B. This usually will not cause the exciter to come unlocked but it can take up to 9 minutes to move the phase of the pilot far enough to be in alignment with the 1pps signal. The low-speed loop is the factory default setting.

U1 serves as a high-speed loop for fast alignment. Multiple reference transitions are removed each second in U4A due to the wider pulse-width of the fast one-shot. However, moving the 10MHz reference out signal at such a fast rate causes the exciter to come unlocked. Once the pilot is within 800ns in time of the 1pps signal the fast loop no longer functions and the slow loop makes the final correction. This phase shift can cause an audible click until the unit locks.

The factory default is set to low-speed loop, to enable the high-speed loop move P6 to jumper pins 1 to 2. J6 is located inside the box and will require you to remove the 8 Philips screws holding the circuit board to the box.

A pilot signal is applied to J2 and is squared up by Schmitt trigger U3D. This is the transition signal for the multivibrators U1 and U2. When the pilot phase is the same as the 1pps signal, the multivibrator circuits stop timing out and no longer modify the 10MHz reference which indicates phase coherence.

The slow-loop output also drives U7 that serves as a lock detector. Once the pulses no longer come out of U2, U7 is no longer triggering and after a time-out period turns on LED D2 to indicate lock.

4 RF Technical Services Contact Information

RF Technical Services -

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5 Interconnect Wiring Diagram

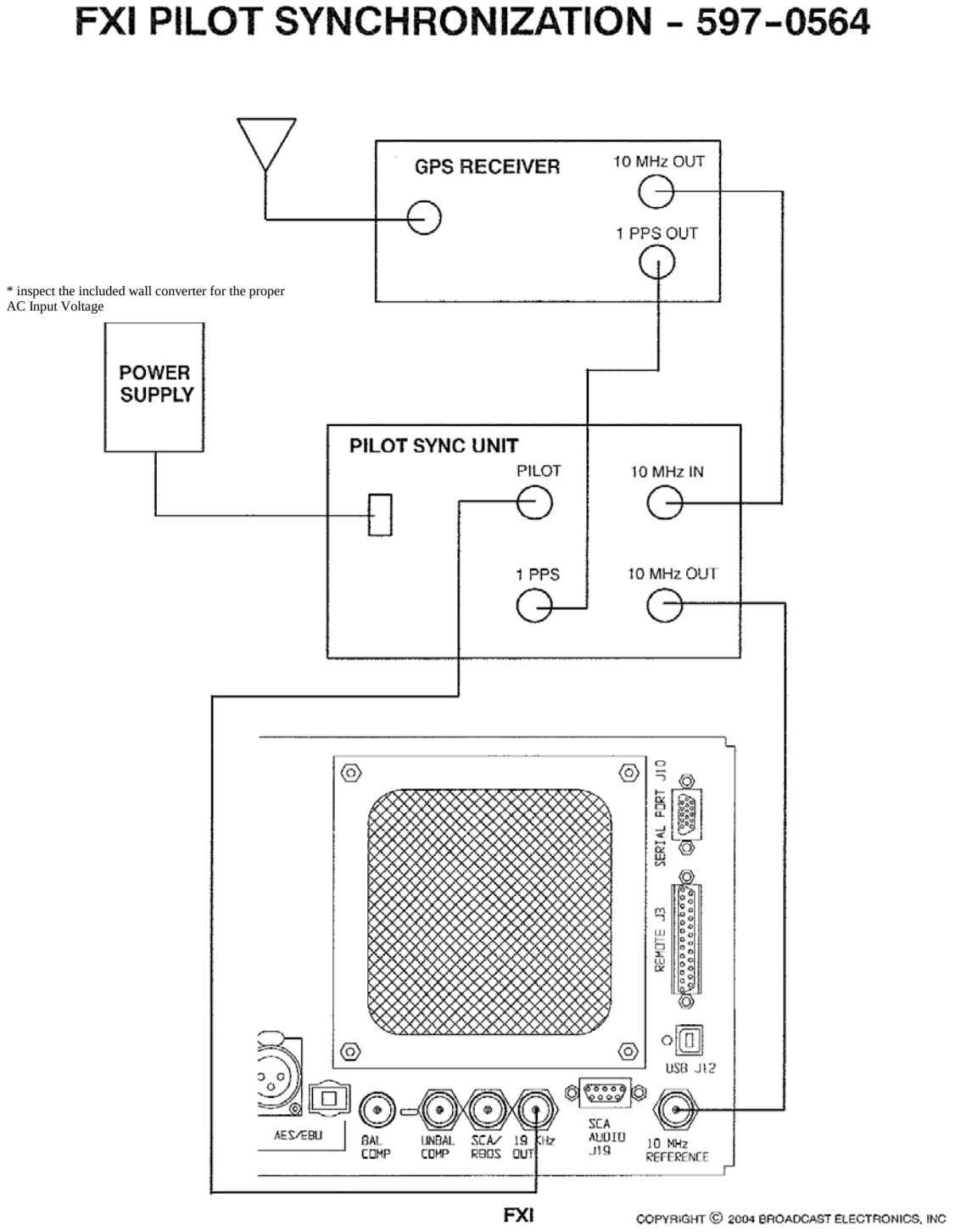

Figure 1.

6 Pilot Sync assembly drawing

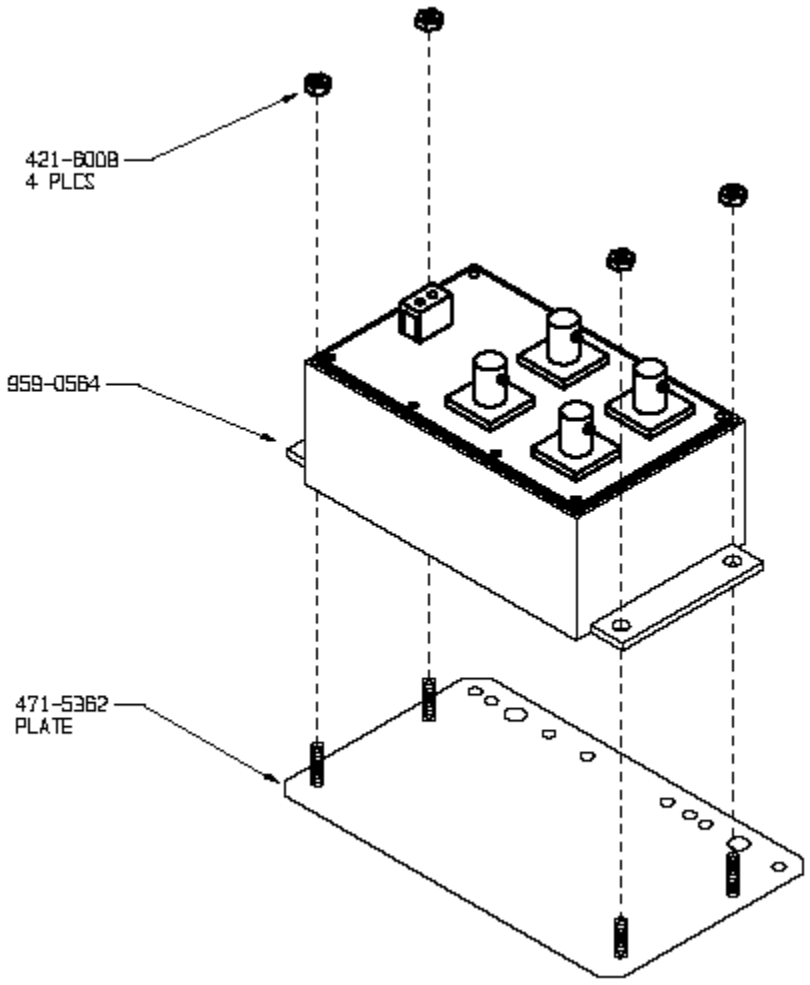

Figure 2