

## Barfield Competition TECHNICAL TIP Procedure

### DRAFT: Coaxial Cable & Antenna System Inspection with a Frequency Domain Reflectometer

INTRODUCTION: This Technical Tip establishes the standards of operation for the personnel unfamiliar with this unit to understand it, identify its parts, and operate it in accordance with proper procedures, operating techniques, precautions and limitations. The test procedures are described in place of any specifications by the airframe manufacturer. Particular attention should be addressed to the preliminary procedures so as to avoid erroneous test results. Refer to the specific instructions below on set-up and tests for the coaxial cable and antenna system.

#### GENERAL INTRODUCTION:

(1) This Technical Tip procedure has the steps using a frequency domain reflectometer to locate opens, shorts, improper crimps, bends, moisture, loose connectors, and defective antenna elements that lead to weak or intermittent RF operation. You can also use the FDR to test the antenna elements from the equipment rack for troubleshooting or directly at the antenna to make sure that reliable operation prior to installation.

(2) This procedure can be done on the entire Radio Frequency (RF) system's coaxial cables and antenna as a unit or on individual components.

(3) The FDR performs a Voltage Standing Wave Ratio (VSWR) or Return Loss (RL) test by transmitting a continuous RF sweep of the cables and antenna at their operating frequencies and then monitoring the absorption of the wave by the antenna. The FDR identifies standing or reflected waves due to loose connections, corrosion, moisture, or defective cable, or faulty antenna which changes the system impedance resulting in a reflected or standing wave. Standing waves not only decrease output transmission, resulting in weak, intermittent operation, but may also harm the transmitter if the reflection is excessive. The recommended FDR is an easy to use handheld tester, with a Go/No-Go function by use of a limit line and simple distance to fault measurement. It can be used to quickly identify improper connections, defective cables and faulty antennas easily from the Equipment rack, eliminating disassembly of the airplane to test the RF system.

(4) The test procedures are described in place of any specifications by the airframe manufacturer. Particular attention should be addressed to the preliminary procedures so as to avoid erroneous test results. Refer to the specific instructions below on set-up and tests for the coaxial cable and antenna system.

(a) To do a health check of the entire coaxial cable and antenna system, you must remove the black box from the EE rack and connect the tester directly to the rack's bench plug coax receptacle. There is no need to make any other disconnections unless the health check fails. The check will give a simple Go/No-Go indication of the health of the entire cable and antenna system. In the case of a No-Go indication, any faults may be isolated via the FDR's "distance to fault" function. Use the "distance to fault" readout and applicable system wire diagram to help isolate the failure to a specified connector, cable segment or antenna.

(b) The FDR facilitates both simple Go/No-Go testing. Use the specific instructions below for:

- 1) VSWR and RETURN LOSS (RL) TESTING: Displays the readings in Return loss or VSWR, the user simply selects the display they desire.
- 2) DISTANCE TO FAULT: Displays distance in ft/in or M/cm to the VSWR or Return Loss (RL) fault without initially disconnecting system.

#### PREPARATION

Refer to the specific instructions below on set-up and tests for the coaxial cable and antenna system.

#### Tools/Equipment:

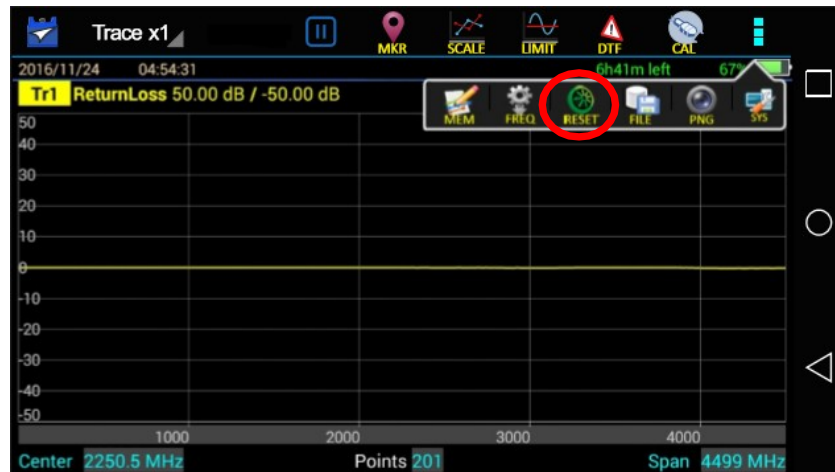
**FlightHawk 7003A001-4 RF Aviation & Cable Analyzer – Aviation Test Kit**

#### Procedure

##### A. COMBINED MEASURE MATCH MODE AND DISTANCE TO FAULT TESTING SET-UP PROCEDURE:

- (1) Prepare the applicable cable and antenna system and FlightHawk for testing.
  - (a) Push the Power button for 5 seconds.
  - (b) Press the Menu icon. Press RESET (ensure Default Units Feet selected) to clear all current data and settings (Figure 1.)

Figure 1.

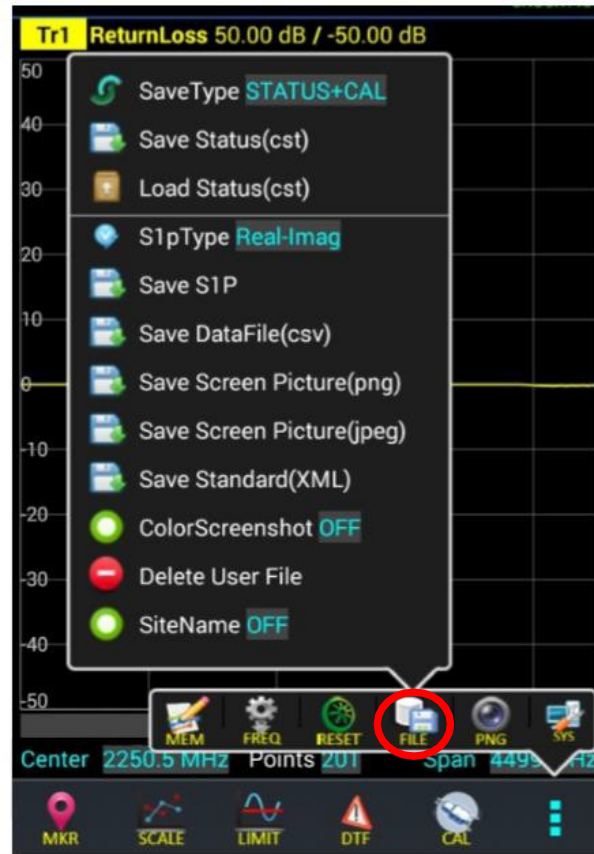


- (c) Recall previously saved set-up.
  - 1) FlightHawk status, calibration result, and tracing data can be saved to the instrument, and can be recalled to be displayed on the sweep display area. The parameters for this instrument setting include the scale, trace, cursor and analysis. These parameters are saved in the status files. Data .cst data files can be recalled and displayed with the current data trace.

**NOTE: .cst files will save the settings and calibration if the unit was calibrated when the file was saved.**

- a) Push the Menu icon.
- b) Push the FILE icon to display the file menu.
- c) Push Load Status (Figure. 2)

Figure 2. Recall Data File “COMPETITION”

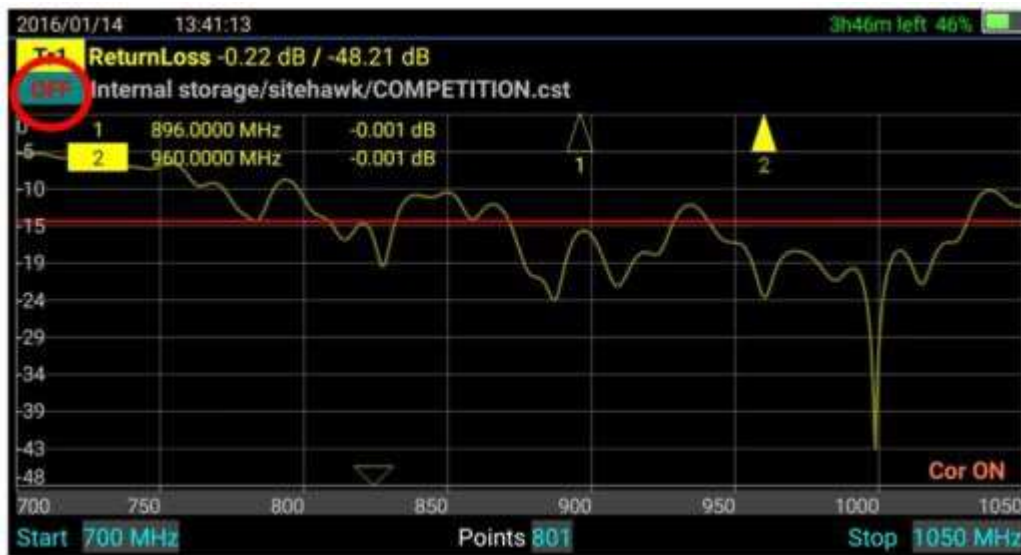


- d) Select the data file “COMPETITION” from the list.
- e) Push Load.

NOTE: The active and the recalled trace data will be displayed together in the sweep display area. In the example, Tr1 is the active trace, the recalled trace data is indicated with OFF and the file name.

- f) Push OFF to remove the recalled trace data (Figure 3).

Figure 3.



**CAUTION: DO NOT MANUALLY CHANGE PROFILE PARAMETERS AFTER SET-UP PER PROCEDURE A. "COMBINED MEASURE MATCH MODE AND DISTANCE TO FAULT TESTING SET-UP PROCEDURE". CHANGING PROFILE PARAMETERS MAY CAUSE ERRONOUS READINGS AND IMPACT SCORE DURING TESTING.**

**NOTE: CHANGING THE FREQUENCY SETTINGS WILL AUTOMATICALLY TURN THE CALIBRATION OFF.**

**NOTE: IF DURING COMPETITION TESTING IF A TEAM MEMBER CHANGES A PARAMETER, INCLUDING FREQUENCY SETTING IS CHANGED, RECOMMEND START FROM BEGINNING OF PROCEDURE A. "COMBINED MEASURE MATCH MODE AND DISTANCE TO FAULT TESTING SET-UP PROCEDURE" TO PREVENT ERRONOUS READINGS.**

**B. FACILITATE MEASURE MATCH MODE RETURN LOSS (RL) TESTING OF THE CABLE AND ANTENNA SYSTEM.**

**CAUTION: DO NOT TOUCH THE CONNECTOR PINS, OR OTHER CONDUCTORS. IF YOU TOUCH THESE CONDUCTORS, ELECTROSTATIC DISCHARGE CAN CAUSE DAMAGE TO THE COMPONENTS.**

- (1) Connect the FlightHawk to the device for the test.
  - a) Connect the test cable or phase stable cable (including the bench plug adapter) to the FDR's N-type connector.
  - b) Connect to the RF System's applicable coax rack connector PIN 1, where the black box was installed (see Appendix A).
- (2) In Measure Match Mode Return Loss (RL), wait 10 Seconds for the sweep to complete the update.
  - (c) Interpreting the Measurement (Figure 4A & 4B).

- 1) The graph contains the elements below:
  - a) The Vertical grid scale (y axis) shows return loss data values in -dB.
  - b) The Horizontal grid scale (x axis) shows the frequency or distance data values.
  - c) Marker values. For example: If markers are set at system operating frequencies.
  - d) The Trace number (Tr1) and color are used to identify the trace.

(3) Make sure that the Return Loss measurement falls under the Max Return Loss LIMIT LINE (Figure 4A & Table 1).

- a) If the system passes, put the system back to its usual condition.
- b) If the system fails, similar to Figure 4B, isolate by using the distance to fault feature using steps below, DISTANCE-TO-FAULT ISOLATION OF COAXIAL CABLE AND ANTENNA SYSTEM.

**Table 1. - RF SYSTEM FREQUENCY RANGE CHART**

Cable and Antenna System	Start/Stop Frequency	System Operating Frequency	Maximum VSWR and (Return Loss) LIMIT LINE
<b>COMPETITION BENCH</b>	<b>700/1050 MHZ</b>	<b>896/960 MHz</b>	<b>1.5 / (-14dB)</b>
Rad Alt (LRRRA) (Example Only)	4200/4400 MHz	4275/4325 MHz	1.5 / (-14dB)

Figure 4A. The graph below shows a typical PASS measurement for an antenna system.

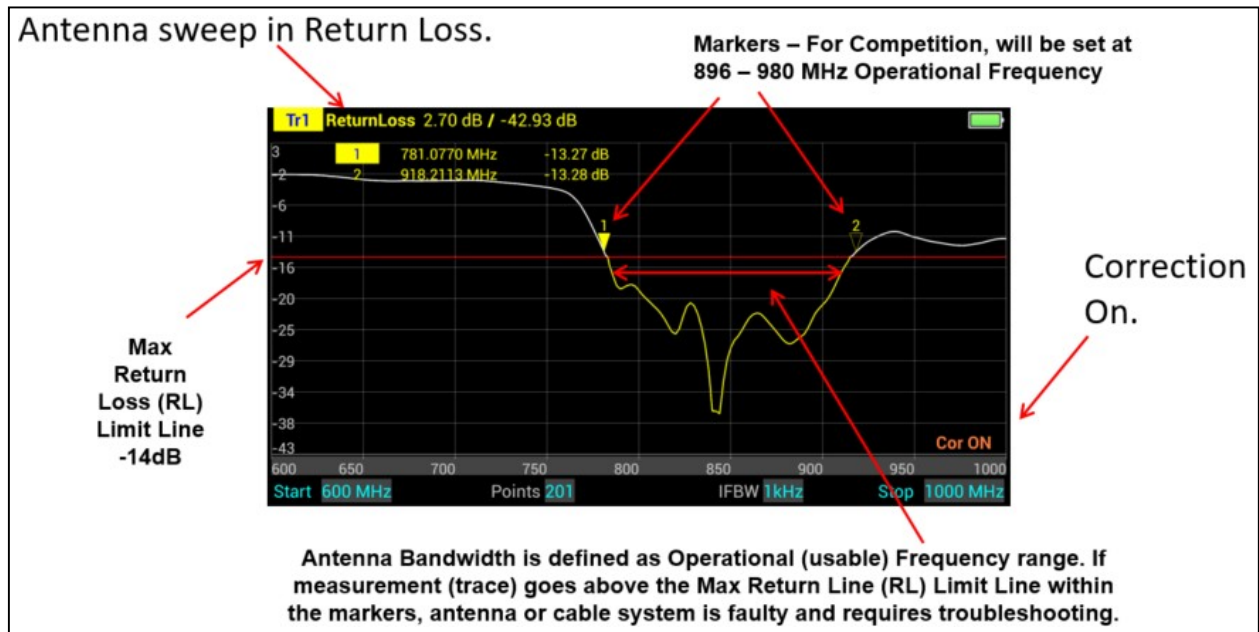
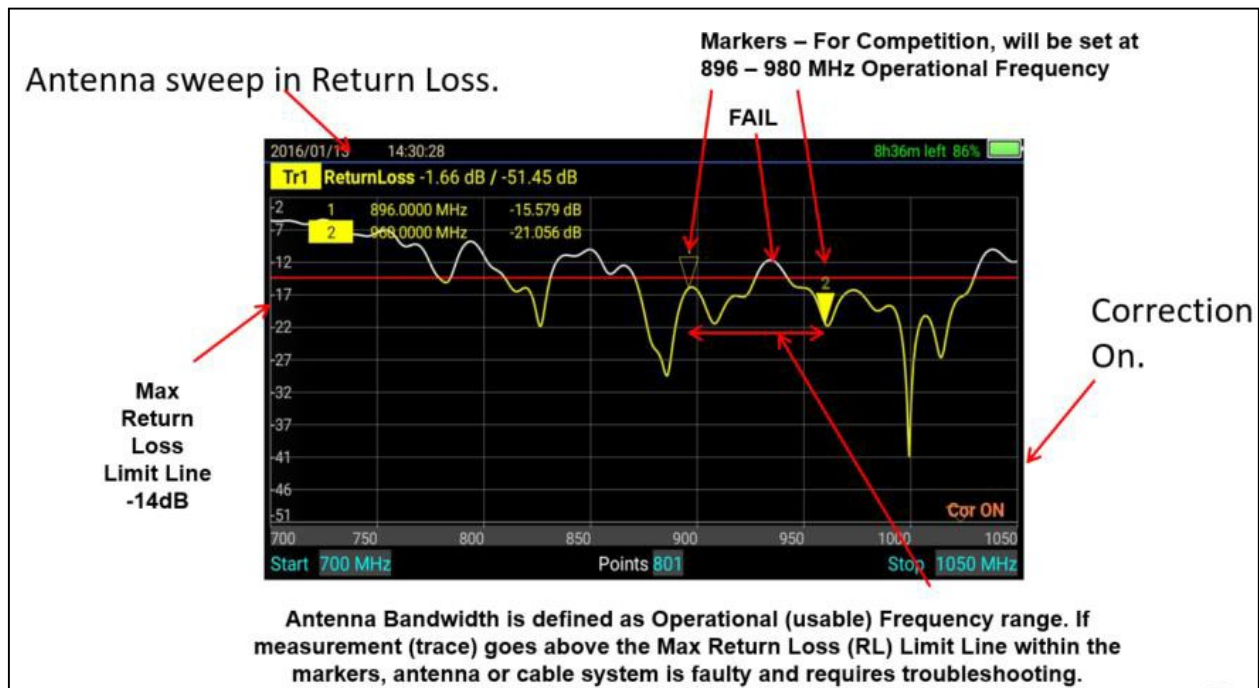


Figure 4B. The graph below shows a typical FAIL measurement for an antenna system.



## C. DISTANCE-TO-FAULT ISOLATION OF COAXIAL CABLE AND ANTENNA SYSTEM

- (1) Select Fault Location Mode.
  - (a) Push trace measurement field to display Measurement Mode menu.
  - (b) Push to select DTF\_RL from the following Measurement Mode drop down menu.  
NOTE: DTF\_RL units show for the Y (vertical) scale.
  - (c) Connect the FlightHawk Analyzer to the cable and antenna system being tested.
  - (d) Wait for a minimum of 10 seconds for the sweep to complete the update.
- (2) Interpreting the Fault Location Measurement (Figure 5 & 6).
  - (a) Isolate by using the FDR's distance to the fault readout, the applicable system schematic and the wiring diagram.
  - (b) Each connector or jumper will show as a spike. If it is larger than the typical value in Table 2, examine the connector for damage.
  - (c) Spikes where there are no components represent faults. Record the distance and then examine the line at that point for damage.
  - (d) The largest spike is usually due to the antenna. Typically, the trace after the antenna can be ignored (Ghosting). Verify distance to antenna via WDM.
- (3) Make sure that the fault location by replacing defective component with 50-ohm load (calibration combo or dummy load).
  - (a) Disconnect the component (cable, connector, antenna).
  - (b) Connect the 50-ohm terminator to the open end of the applicable cable.
  - (c) Re-perform Health Check per Steps B. (1) through (3) Measure Match Return Loss (RL) Testing.
    - 1) Make sure that the Return Loss test is PASS.
      - a) If the test still does not PASS, do the distance to the fault test above, Fault Isolation of Coaxial Cable and Antenna System one more time and continue to move 50-ohm load to further isolate.
- (4) Replace defective component.
  - (a) Re-perform Health Check per Steps B. (1) through (3) Measure Match Return Loss (RL) Testing.
    - 1) Make sure that the Return Loss test is PASS.
      - a) If the test still does not PASS, do the distance to the fault test above, Fault Isolation of Coaxial Cable and Antenna System one more time and continue to move 50-ohm load to further isolate.



Figure 5. The graph below shows a typical Fault Location measurement for an antenna system.

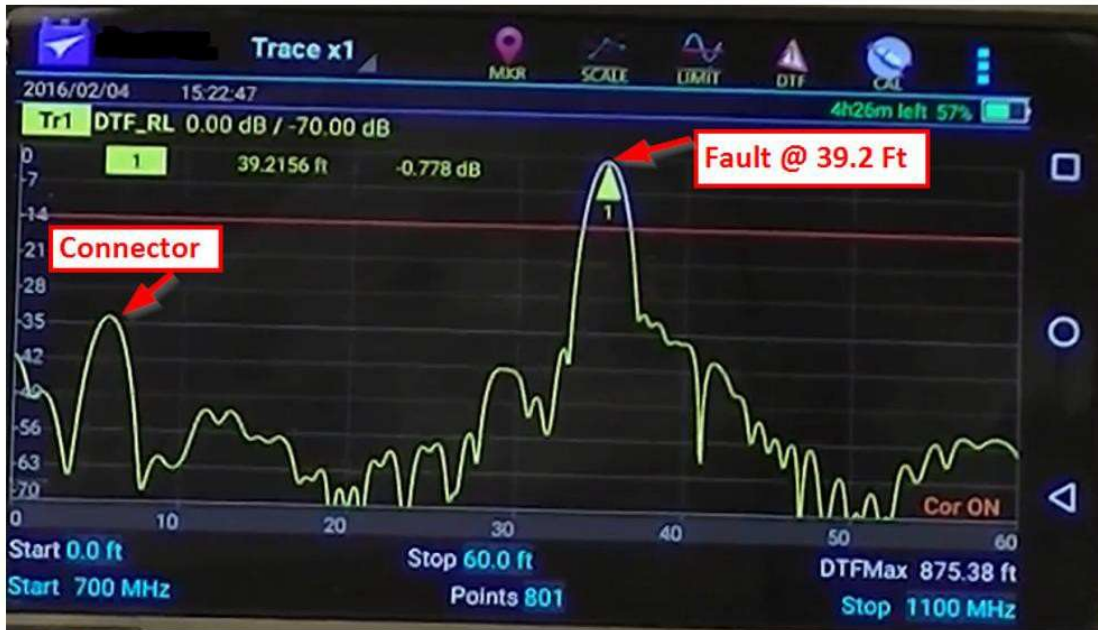
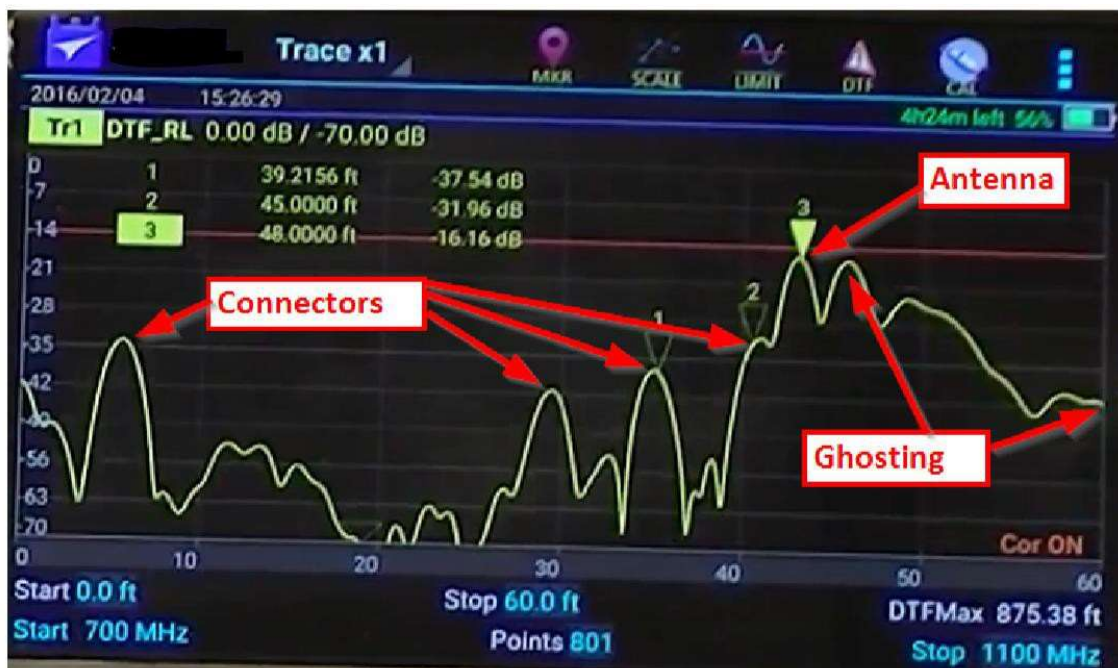


Table 2 - The table lists Typical Component Return Losses.

Antenna	-14 dB
Connector	-25 dB
Coaxial Cable	-30 dB

Figure 6. The graph below shows a typical Good Test measurement for an antenna system.

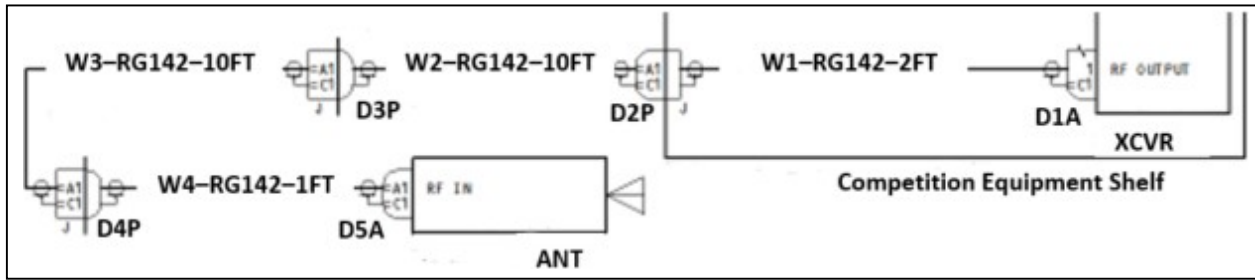




**D. PUT THE COMPETITION TEST BENCH BACK TO ITS USUAL CONDITION**

- (1) Disconnect the FDR adapter cable from the Competition Equipment Shelf Plug.
- (2) Remove the 50-ohm terminator from the other end of the applicable cable if used for troubleshooting.
- (3) Connect any cables previously disconnected for troubleshooting.

Appendix A – Wiring Diagram Manual (WDM) – COMPETITION BENCH SYSTEM



**Appendix B - FOR JUDGE REFERENCE, RECALL SETUP KEY PROFILE PARAMETERS FOR MEASURE MATCH MODE AND DISTANCE TO FAULT TESTING:**

Return Loss (RL) selected from the Measurement Mode menu.

Data Measurement points (default to 801).

Start/Stop Frequency Range (700/1050 (Table 1 - RF Frequency Range Chart)

Markers at Operational Frequency: 896/960 MHz (Table 1 - RF Frequency Range Chart)

FlightHawk has been calibrated, a COR ON indicator is shown in the lower right corner.

Limit Line: Max VSWR 1.5 / Max Return Loss (-14dB) (Table 1 - RF Frequency Range Chart)

DISTANCE TO FAULT cable length Start/Stop:: 0 to 30 ft

Part Number: RG142 Cable selected from FlightHawk

**LibraryTable 1. - RF SYSTEM FREQUENCY RANGE CHART**

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