

System Fault Isolation with BIT



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XIV INTERNATIONAL GIRO FORUM • 20-23 MAY

Outline

- Introduction to BIT
- BIT as a program included in a schedule
- Using BIT as a fault isolation aid
- Details of BIT testing and interpretation of results

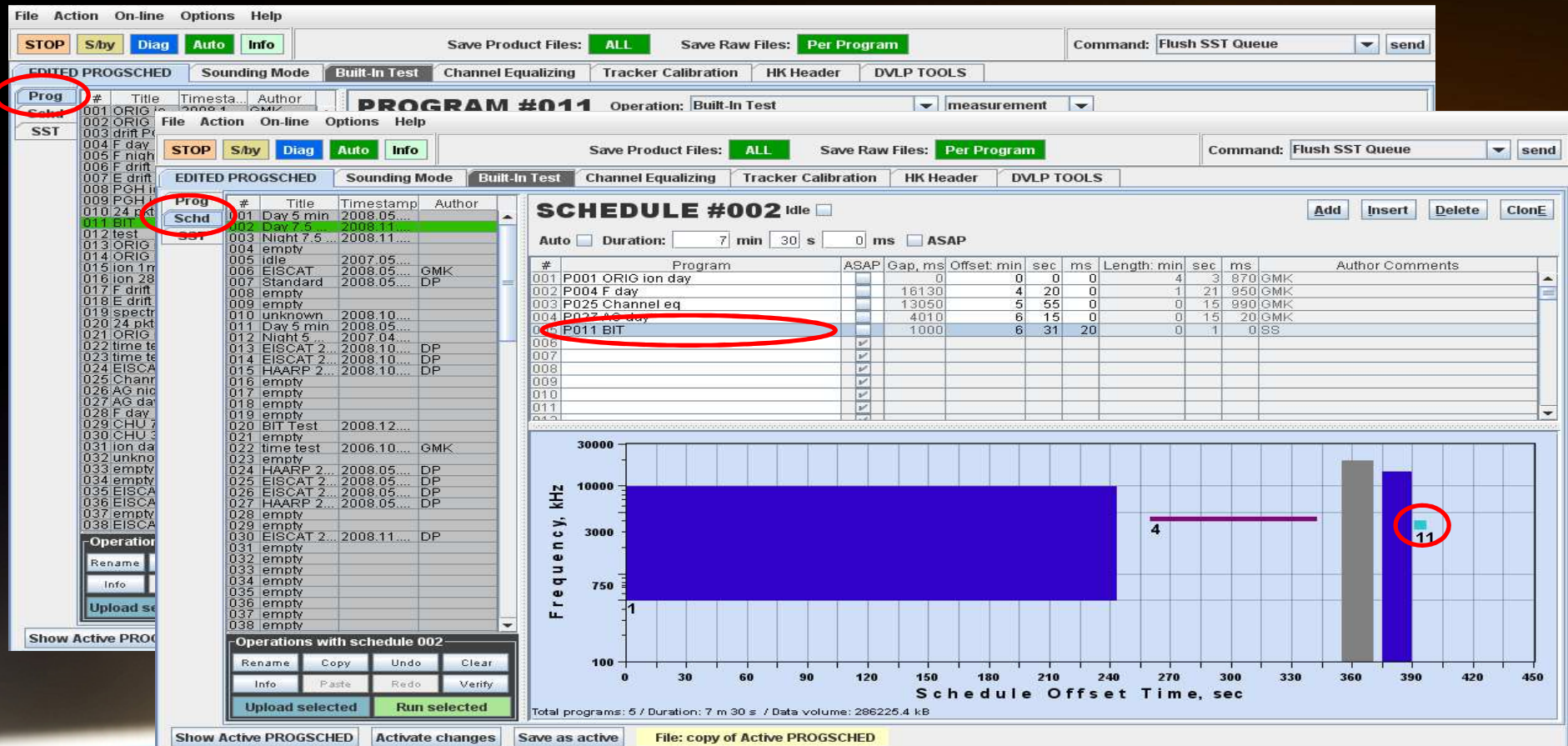
Introduction to BIT

- Earlier systems had troubleshooting assistance mechanisms but nothing automated
- Built-In Test (BIT) was introduced as an automated mechanism to determine and report Digisonde health
- Run on a user defined basis
- First place to look when problems arise
- Valuable aid in locating system fault

BIT Program

- BIT is a type of program that can be scheduled
- Please ensure it is included in the routine sounding schedule
- Can be run manually in DCART's "manual" mode
- Data display is available in 2 forms
 - Built-In Test Display
 - BIT Report
- BIT Report is also available on the Web Page

Example of BIT Included in a Schedule



Indications of Potential Problems

- No data
- Blank data (empty ionograms)
- Observe weak data, strange directions, etc
- BIT is reporting errors

BIT as a Fault Isolation Aid

- Recommended as the first place to look
- Evaluate the BIT report
 - View BIT report within DCART or website
 - Interpret “raw” BIT sensor values
- When possible use the DPS-4D system as a troubleshooting tool through use of special operating modes.

DCART: BIT Tab

DCART v1.5.1 Millstone Hill, model DPS-4D (DESC connected since 2014.05.16 19:54:28.486)

File Action Tools Options Help

STOP Stry Diag Auto Info Save Product Data: ALL Save Raw Data: Per Program Command: Flush SST Queue send

EDITED PROGSCHED Sounding Mode Built-In Test Channel Equalizing Tracker Calibration HK HEADER

Suspend Data Display Refresh every 250 ms View Program

Built-In Test (BIT): Millstone Hill 2014/05/17 21:09:23.315 Measurement Show all Failed Report Sys br

Mnemonic	Comment	Sensor	Raw	Phys	Units	GO	R low	Y low	Y hig
SD10_CMD_TIMEOUTS	Commanding Timeouts from last BIT program	Cmd Timeouts	0			GO			
SD11_RF_NOISE_LOW_V	Environmental RF noise voltage in Antenna with 0 dB gain in antenna switch measured at the track#4 input	RF noise low	0			GO			
SD12_RF_NOISE_HIGH_V	Environmental RF noise voltage in Antenna with 9 dB gain in antenna switch measured at the track#4 input	RF noise high	0			GO			
SD13_RX_CARD_TIMEOUTS	Rx Card Commanding Timeouts since last BIT program	Rx Card Timeouts	0			GO			
SD14_TRACKER1_CARD...	TRACKER1 Card Commanding Timeouts since last BIT program	TRACKER1 Card ...	0			GO			
SD15_TRACKER2_CARD...	TRACKER2 Card Commanding Timeouts since last BIT program	TRACKER2 Card ...	0			GO			
SD16_TRACKER3_CARD...	TRACKER3 Card Commanding Timeouts since last BIT program	TRACKER3 Card ...	0			GO			
SD17_TRACKER4_CARD...	TRACKER4 Card Commanding Timeouts since last BIT program	TRACKER4 Card ...	0			GO			
SD18_BIT_CARD_TIMEOUTS	BIT Card Commanding Timeouts since last BIT program	BIT Card Timeouts	0			GO			
1_DA00_AMP_RF1_V	RF voltage amplitude at the output of amplifier 1	Amp RF1 V	19	75.281 V		NOGO	175	200	3
1_DA01_AMP_RF2_V	RF voltage amplitude at the output of amplifier 2	Amp RF2 V	552	280.699 V		GO	175	200	3
1_DA02_TX_OUT1_V	Output voltage at transmitter card, channel 1	Tx Out1 V	699	4.17 V		GO	4.05	4.1	
1_DA03_TX_OUT2_V	Output voltage at transmitter card, channel 2	Tx Out2 V	699	4.17 V		GO	4.05	4.1	
1_DA04_RX_MAX1	Maximum amplitude value in the receiver channel 1	Rx Max1	41728	41,728		GO	30,000	32,000	42,0
1_DA05_RX_MAX2	Maximum amplitude value in the receiver channel 2	Rx Max2	38301	38,301		GO	30,000	32,000	42,0
1_DA06_RX_MAX3	Maximum amplitude value in the receiver channel 3	Rx Max3	38836	38,836		GO	30,000	32,000	42,0
1_DA07_RX_MAX4	Maximum amplitude value in the receiver channel 4	Rx Max4	34141	34,141		GO	30,000	32,000	42,0

2014.05.17 21:09:59.913: New measurement started, program 50, time 2014/05/17 21:10:00.000

2014.05.17 21:10:13.413: sent PM packet: 2014.05.17 21:10:13.000
 2014.05.17 21:10:30.413: sent PM packet: 2014.05.17 21:10:30.000
 2014.05.17 21:10:47.414: sent PM packet: 2014.05.17 21:10:47.000
 2014.05.17 21:11:04.412: sent PM packet: 2014.05.17 21:11:04.000
 2014.05.17 21:11:21.413: sent PM packet: 2014.05.17 21:11:21.000

CMD out: 818
 PM out: 15423
 SCI in: 24937767
 HK in: 6871
 FSW Errs: 0
 Bad Pckts: 0

STATE: Automatic
 S24 P50 55%

BIT Report Organization

- Report system failure if detected
- List suspected components
- Recommendations
- List of failed sensors, listing the “case” where failure occurred
- List of hardware by state: GO, NOGO, UNKNOWN
- List of sensor definitions
- List of sensor results by case

Digisonde Built-In Test

Station: MHJ45, Test Outcome: FAILED at 2014.05.14 20:24:22 UT

SYSTEM FAILURE DETECTED

Failed/Suspected Components:

Component	State
RF_AMPLIFIER_1	NOGO

Recommendations:

- Check for RF Amplifier channel 1 failure or TX1 cabling failure

Failed Sensors:

Sensor name	Case	Condition
AMP_RF1_V	Ext Loopback	RedLow
AMP_RF1_V	Dummy Load Tx	RedLow

Interpreting BIT Results

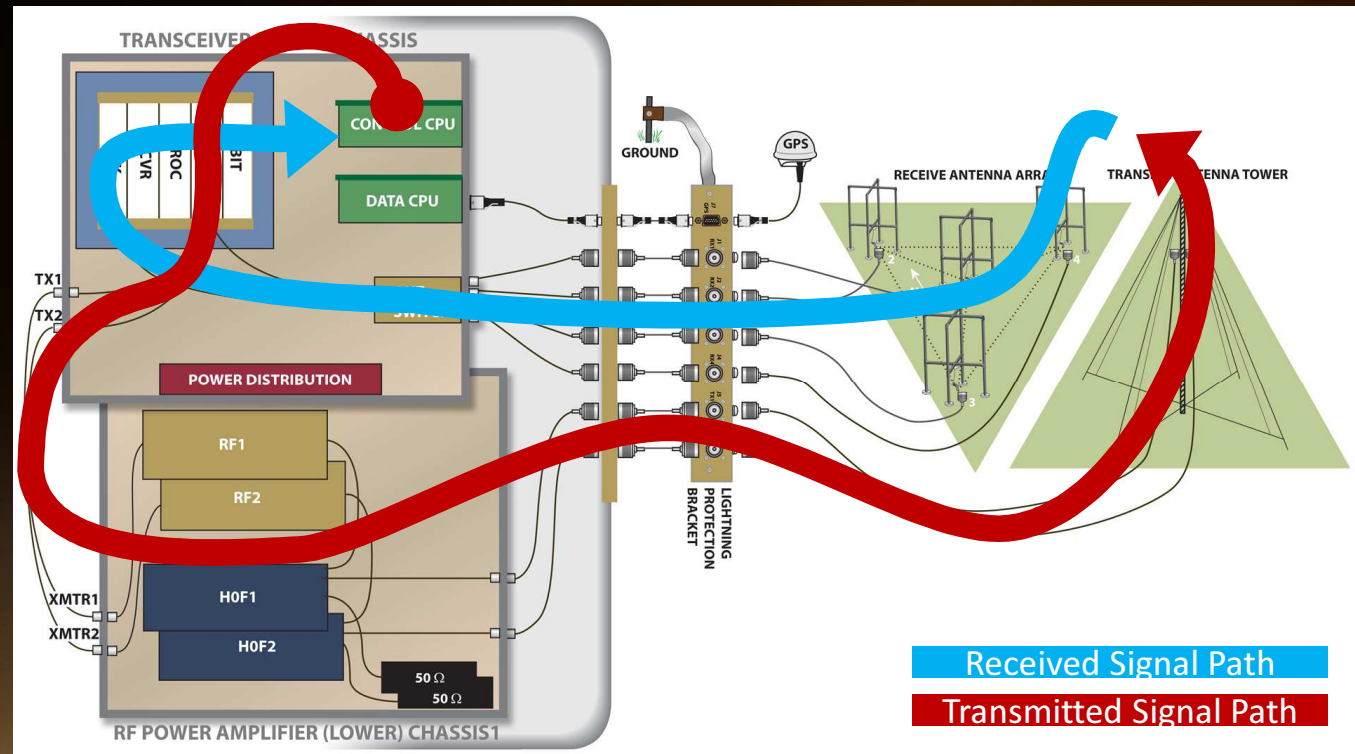
- Interpretation of BIT results may be required
- Having an understanding of how BIT tests the system helps
 - BIT runs 4 tests or “cases” to determine system health
- Understanding sensor names

4 Cases

- Case 1: External Loopback
- Case 2: Internal Loopback
- Case 3: Internal Loopback without Trackers
- Case 4: Transmission into Dummy Load

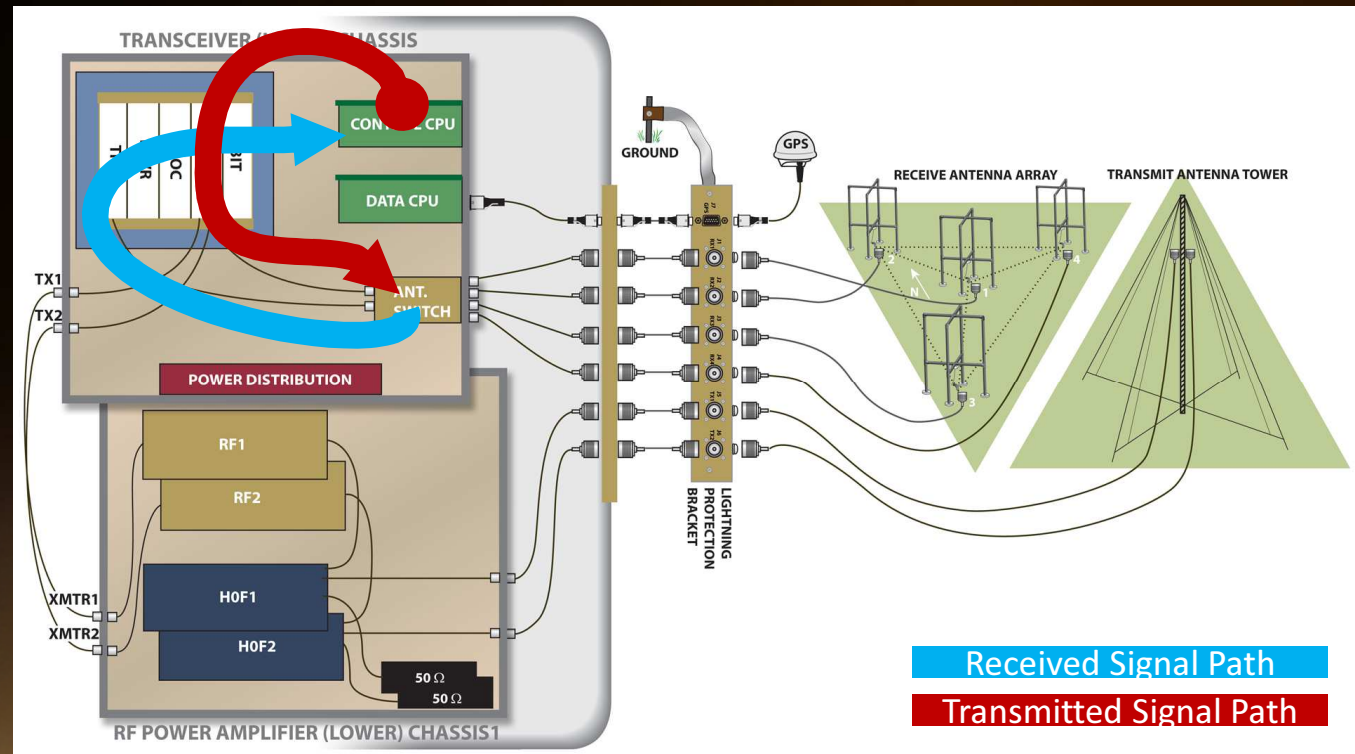
Case 1: External Loopback

- External Loopback
- Normal transmission as would be made during measurement
- Listening for direct reception of the transmitter pulse
- Signal enters through the receive antennas as it would during normal sounding



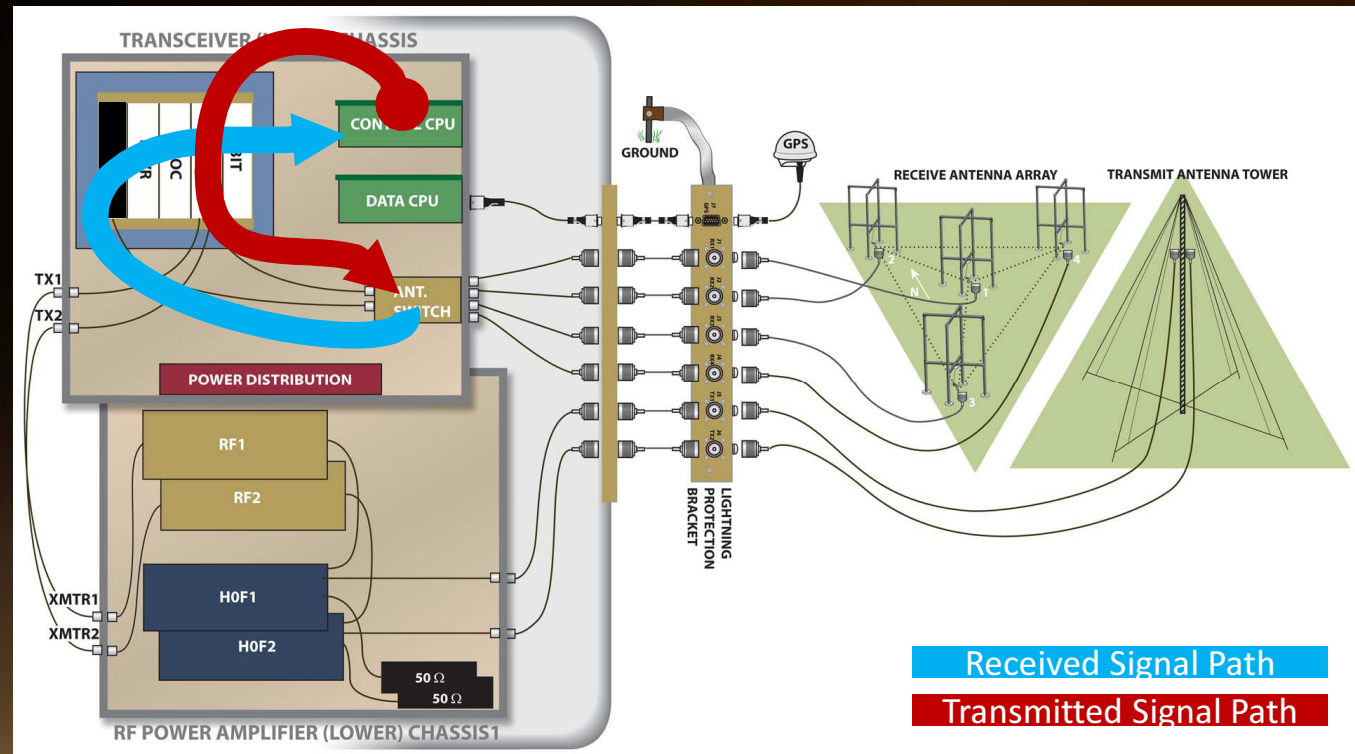
Case 2: Internal Loopback

- Internal Loopback
- CAL output to Antenna Switch
- Antenna switch routes signal to trackers



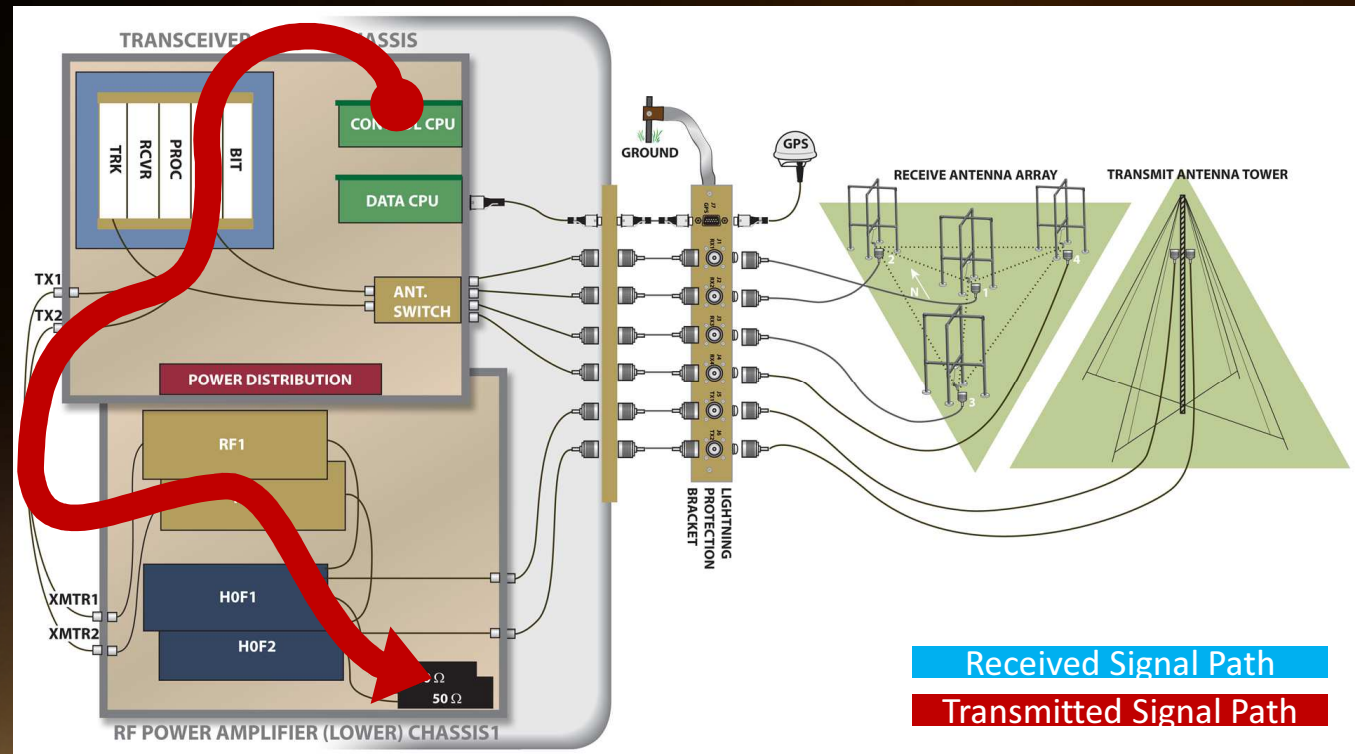
Case 3: Internal Loopback w/out Trackers

- Internal Loopback without trackers.
- CAL output to Antenna Switch
- Antenna switch routes signal to trackers
- Trackers switch input to output (are bypassed)



Case 4: Transmission into Dummy Load

- “Transmit” into dummy loads
- Half Octave Filters switch to dummy loads
- No transmission via transmit antenna
- This allows evaluation of the transmit antenna health



BIT Sensors

- X_YZAA_Name_Of_Sensor
 - X = Case Number
 - Y = When sensor is measured
 - S = Static
 - D = Dynamic
 - Z = Sensor type
 - D = Digital
 - A = Analog
 - AA = Sensor number, ie 04
 - Name = Name of sensor

†Mnemonic	Comment
SD10_CMD_TIMEOUTS	Commanding Timeouts from last BIT program
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SD15_TRACKER2_CARD_...	TRACKER2 Card Commanding Timeouts since last BIT program
SD16_TRACKER3_CARD_...	TRACKER3 Card Commanding Timeouts since last BIT program
SD17_TRACKER4_CARD_...	TRACKER4 Card Commanding Timeouts since last BIT program
SD18_BIT_CARD_TIMEOUTS...	BIT Card Commanding Timeouts since last BIT program
1_DA00_AMP_RF1_V	RF voltage amplitude at the output of amplifier 1
1_DA01_AMP_RF2_V	RF voltage amplitude at the output of amplifier 2
1_DA02_TX_OUT1_V	Output voltage at transmitter card, channel 1
1_DA03_TX_OUT2_V	Output voltage at transmitter card, channel 2
1_DA04_RX_MAX1	Maximum amplitude value in the receiver channel 1
1_DA05_RX_MAX2	Maximum amplitude value in the receiver channel 2
1_DA06_RX_MAX3	Maximum amplitude value in the receiver channel 3
1_DA07_RX_MAX4	Maximum amplitude value in the receiver channel 4
2_DA00_AMP_RF1_V	RF voltage amplitude at the output of amplifier 1
2_DA01_AMP_RF2_V	RF voltage amplitude at the output of amplifier 2
2_DA02_TX_OUT1C_V	Output voltage at transmitter card rev C and above, channel 1
2_DA03_TX_OUT2_V	Output voltage at transmitter card, channel 2
2_DA04_RX_MAX1	Maximum amplitude value in the receiver channel 1
2_DA05_RX_MAX2	Maximum amplitude value in the receiver channel 2
2_DA06_RX_MAX3	Maximum amplitude value in the receiver channel 3
2_DA07_RX_MAX4	Maximum amplitude value in the receiver channel 4

Analog Sensors thresholds

Red Low

Yellow Low

OK

Yellow High

Red High

Additional Tips

- DCART provides other useful information
- Check DCART settings (DCART.ini corruption)
- Use of the system as a diagnostic tool through data displays (can be done remotely)
- Make program changes to sustain operations, if possible

DCART: Important Places to Look

DCART v1.1.27 (DESC is not connected)

File Action On-line Options Help

STOP Soft STOP Auto Info

Command: Flush SST Queue send

EDITED PROGSCHED Sounding Mode Built-In T

PROGRAM #008 Operation: Sounding Mode Measurement

FREQUENCY STEPPING

Freq Stepping Law: linear [kHz]
Lower Freq Limit: 300 [kHz]
Upper Freq Limit: 11000 [kHz]
Coarse Freq Step: 25 [kHz]
Number of Fine Steps: 2
Fine Freq Step: 5 [kHz]
Fine Step Multiplexing: enabled

Total frequencies 858

RANGE SAMPLING

Start Range: 0 [km]
Number of Samples: 512
Inter-Pulse Period: auto 2 [5ms]
Range coverage 0 to 1277.5 / max 1499 km

PULSE INTEGRATION

Number of Integrated Repeats: 8
Interpulse Phase Switching: enabled

Pulses/freq : CIT : total 32 : 64 : 27456
CIT time 640 ms
Exact Running Time 4 m 34 s 590 ms

SYSTEM SETTINGS

Constant Gain: full gain (50 dB)
Auto Gain Control: use existing gain table
Rx Gain: +38 dB
Wave Form: 16-chip complementary
Polarizations: O and X Antennas enabled: 1 2 3 4
☐ Radio Silent ☒ Standard ☐ Oblique ☐ Compatible

DATA PROCESSING

Final Processing Step: Ionogram Calculation
☒ Apply RFIM
☒ Apply Channel EQ
☐ Data Reduction
☐ Clear data below MPA
View Process Chain 2-frequency PGH (5 kHz)

OUTPUT FILES

☒ Save product file ☐ Save raw file
RSF
DESC-to-DCART traffic 27456 packets = 227,994 kB
Internal data rate 6,642 kbit/s

Operations with program 008

Rename Copy Undo Clear
Info Paste Redo Verify
Run selected program

Show Active PROGSCHED Activate change File: copy of Active PROGSCHED

DCART Log and Card Version / Status

2008.12.04 23:11:36
STATE: Connecting
DESC is IDLE

DCART Error Count

CMD out: 57
PM out: 4867
SCI in: 47198
HK in: 72
FSW Errs: 1
Bad Pckts: 0

DCART Log

23:10:46.716: received ALIVE packet
23:11:02.404: sent PM packet: 2008.12.04 23:11:02.000
23:11:18.920: IP address: 10.0.0.2, port: 4100
23:11:18.920: COMMAND Client is trying to connect...
23:11:18.904: *** ERROR: ParserThread: ended because of java.io.IOException: An existing connection was forcibly closed by the remote host
23:11:18.904: *** ERROR: Communication error. Reset.

Network Status

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Internal Loopback Diagnostic Program

PROGRAM #047 Operation: Sounding Mode Internal Loopb...

FREQUENCY STEPPING

Freq Stepping Law: linear

Lower Freq Limit: 100 [kHz]

Upper Freq Limit: 30000 [kHz]

Coarse Freq Step: 25 [kHz]

Number of Fine Steps: none

Total frequencies: 1197

RANGE SAMPLING

Start Range: 0 [km]

Number of Samples: 256

Inter-Pulse Period: ☒ auto 1 [5ms]

Range coverage: 0 to 637.5 / max: 749.5 km

PULSE INTEGRATION

Number of Integrated Repeats: 1

Interpulse Phase Switching: disabled

Pulses/freq : CIT : total 2 : 2 : 2394
CIT time 10 ms
Exact Running Time 12 s

SYSTEM SETTINGS

Constant Gain: full gain (50 dB)

Auto Gain Control: fixed

Rx Gain: 0 dB

Wave Form: 16-chip complementary

Polarizations: O only Antennas enabled: 1 2 3 4

☐ Radio Silent ☒ Standard ☐ Oblique ☐ Compatible

DATA PROCESSING

Final Processing Step: Ionogram Calculation

☐ Apply RFIM

☐ Apply Channel EQ

☐ Clear data below MPA

[View Process Chain](#)

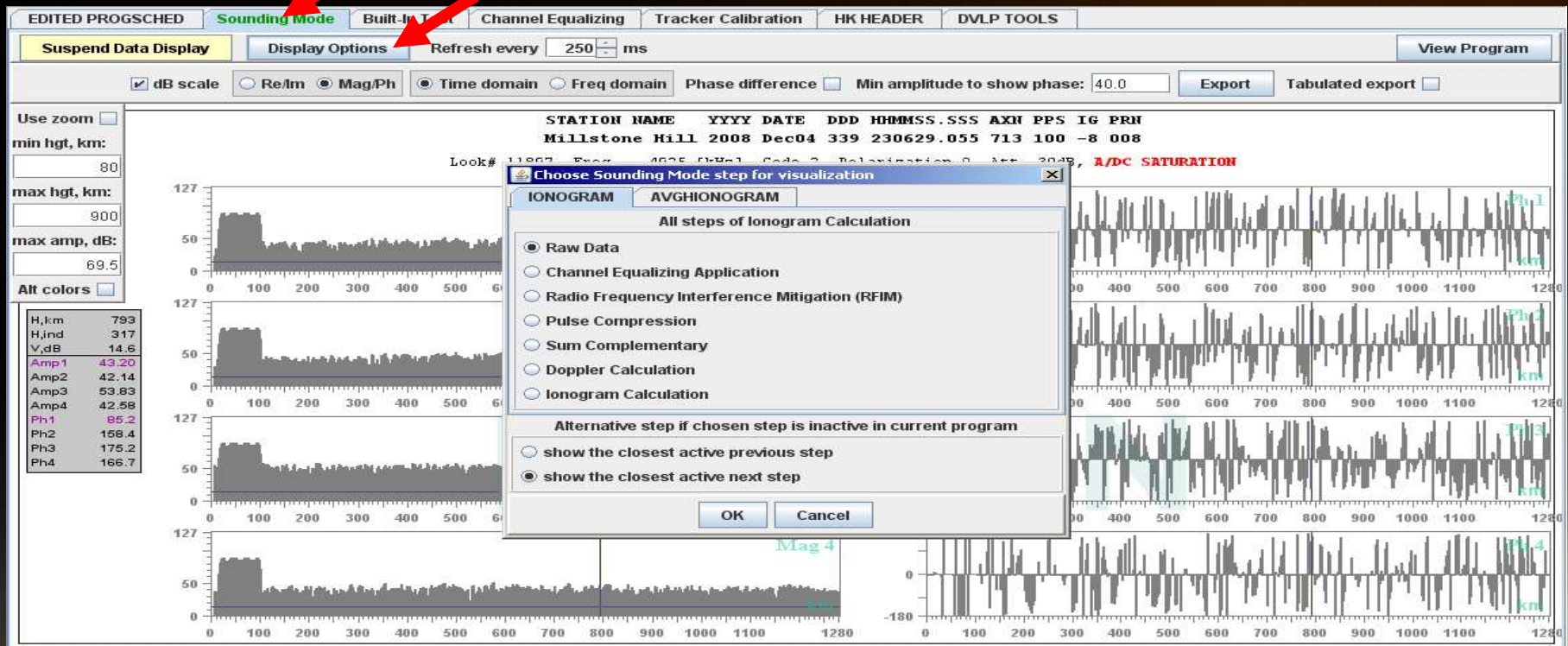
OUTPUT FILES

☒ Save product file ☐ Save raw file

DESC-to-DCART traffic 1197 packets = 9,954 kB
Internal data rate 6,636 kbit/s

DCART Raw Data Display

Sounding Mode / Display Options. Note: This program is started at 0 height



Diagnostic Program for Oscope

PROGRAM #001 Operation: Sounding Mode Measurement:

FREQUENCY STEPPING

Freq Stepping Law: fixed [kHz]

Fixed Frequency: 3275 [kHz]

Fixed Freq Repeats: 255

Number of Fine Steps: none

Total frequencies 255

SYSTEM SETTINGS

Constant Gain: full gain, Tracker (9) and Antenna Switch (0)

Auto Gain Control: fixed

Rx Gain: -12 dB

Wave Form: 16-chip complementary

Polarizations: 0 only Antennas enabled: 1 2 3 4

☐ Radio Silent ☒ Standard ☐ Oblique ☐ Compatible

RANGE SAMPLING

Start Range: 0 [km]

Number of Samples: 256

Inter-Pulse Period: ☒ auto 1 [5ms]

Range coverage 0 to 637.5 / max 749.5 km

DATA PROCESSING

☐ RFIM Raw Data

☐ CCEQ

☐ D-Spike ☐ ChipComp

[View Process Chain](#)

PULSE INTEGRATION

Number of Integrated Repeats: 256

Interpulse Phase Switching: disabled

Pulses/freq : CIT : total 512 : 512 : 130560

CIT time 2 s 560 ms

Exact Running Time 10 m 52 s 830 ms

OUTPUT FILES

☒ Save product file ☐ Save raw file

DESC-to-DCART volume 65280 packets = 530,145 KB

DESC-to-DCART flow 6,652 kbit/s

Exact on-disk volume 0 B

Sustainable Operations

- If damage has occurred along one or more receive channels, it may be possible to continue operating
- It may also be possible to operate if one transmit channel is damaged
- If computer damage or failure in a short (RF Amplifier) then it's unlikely system will be able to continue operating. DPS-4D could be off or unreachable

Damaged Receive Channel(s)

Damage in Receive Antenna / Polarization Box,
Antenna Switch, Tracker, or Receiver

Switch from Precision Ranging RSF Ionograms to
SBF data format

- SBF does not calculate directional information
(only Doppler)
- When making SBF data, the system is capable of
generating data using less than 4 channels

Changing from Routine Operation to Reduced Health Program

PROGRAM #008 Operation: **Sounding Mode** **Measurement**

FREQUENCY STEPPING

Frequency Stepping Law: linear
Lower Freq Limit: 300 [kHz]
Upper Freq Limit: 11000 [kHz]
Coarse Freq Step: 25 [kHz]
Number of Fine Steps: 2
Fine Freq Step: 5 [kHz]
Fine Step Multiplexing: enabled
Total frequencies: 858

RANGE SAMPLING

Start Range: 80 [km]
Number of Samples: 512
Inter-Pulse Period: ☒ auto 2 [5ms]
Range coverage: 80 to 1357.5 / max: 1499 km

PULSE INTEGRATION

Number of Integrated Repeats: 8
Interpulse Phase Switching: enabled
Pulses/freq : CIT : total : 32 : 64 : 27456
CIT time : 640 ms
Exact Running Time : 4 m 34 s 590 ms

SYSTEM SETTINGS

Constant Gain: full gain (50 dB)
Auto Gain Control: use existing gain table
Rx Gain: -30 dB
Wave Form: 16-chip complementary
Polarizations: O and X Antennas enabled: 1 2 3 4
☐ Radio Silent ☒ Standard ☐ Oblique ☐ Compatible

DATA PROCESSING

Final Processing Step: Ionogram Calculation
☒ Apply RFIM
☒ Apply Channel EQ
Data Reduction
☐ Clear data below MPA
View Process Chain 2-frequency PGH (5 kHz)

OUTPUT FILES

☒ Save product file ☐ Save raw file
RSF
DESC-to-DCART traffic : 27456 packets = 227,994 kB
Internal data rate : 6,642 kbit/s

Number of Fine Steps = 0

Disable Damaged Channels

Switch to SBF Format

Reduced Health Program

PROGRAM #063 Operation: **Sounding Mode** **Measurement**

FREQUENCY STEPPING

Freq Stepping Law: **linear**

Lower Freq Limit: **300** [kHz]

Upper Freq Limit: **11000** [kHz]

Coarse Freq Step: **25** [kHz]

Number of Fine Steps: **none**

Total frequencies: 429

SYSTEM SETTINGS

Constant Gain: **full gain (50 dB)**

Auto Gain Control: **use existing gain table**

Rx Gain: **+30 dB**

Wave Form: **16-chip complementary**

Polarizations: **O and X** Antennas enabled: **1 2 3 4**

☐ Radio Silent ☒ Standard ☐ Oblique ☐ Compatible

RANGE SAMPLING

Start Range: **80** [km]

Number of Samples: **512**

Inter-Pulse Period: ☒ auto **2** [5ms]

Range coverage: 80 to 1357.5 / max 1499 km

DATA PROCESSING

Final Processing Step: **Ionogram Calculation**

☒ Apply RFIM

☒ Apply Channel EQ

☐ Clear data below MPA

[View Process Chain](#)

PULSE INTEGRATION

Number of Integrated Repeats: **8**

Interpulse Phase Switching: **enabled**

Pulses/freq : CIT : total 32 : 32 : 13728

CIT time 320 ms

Exact Running Time 2 m 17 s 310 ms

OUTPUT FILES

☒ Save product file ☐ Save raw file

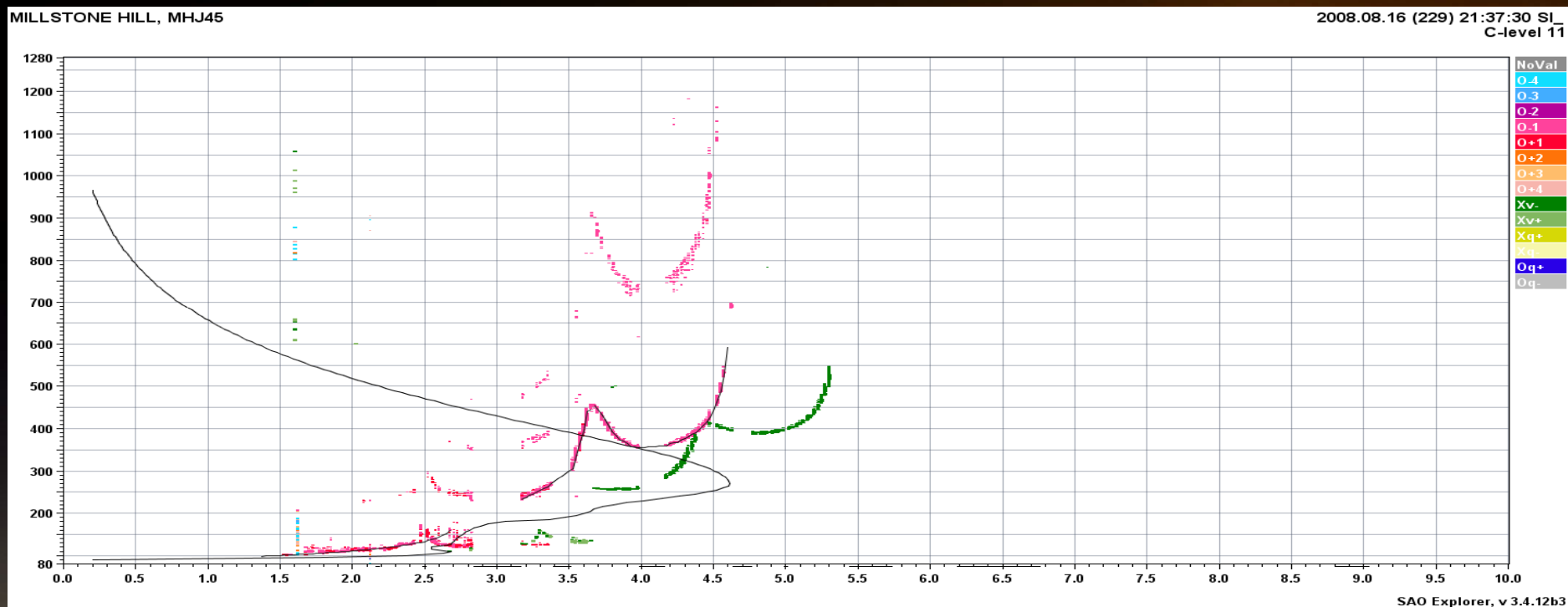
SBF

DESC-to-DCART traffic 13728 packets = 113,997 kB

Internal data rate 6,642 kbit/s

SBF Ionogram

- Millstone Hill DPS-4D generating SBF using 2 channels



SAO Explorer, v 3.4.12b3

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Dalu

감사합니다

Gracias Danke Ευχαριστίες

THANK YOU

Obrigado

Köszönöm

Tack Grazie Спасибо Dank 谢谢 Merci ありがとう

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BACKUP

Control Computer Display

- Control Computer was not intended for use by the end user (no rear case connections exist)
- DESC does produce output to the screen which may be useful for troubleshooting
- 15 pin VGA output is available on the rear of the transceiver chassis
- It is possible to connect a monitor
(reset the control computer via the red reset button on the front of the transceiver chassis or cycle the switch on the power distribution board)
- Investigation of the DESC display would be made in tandem with instruction from LDI or UML

Note Regarding Spares

Spares Include

Polarization Switch / Preamplifier

BIT

Transmitter

Pre-Processor

Receiver

- Run Receiver cross channel equalizing after replacement

1 Tracker

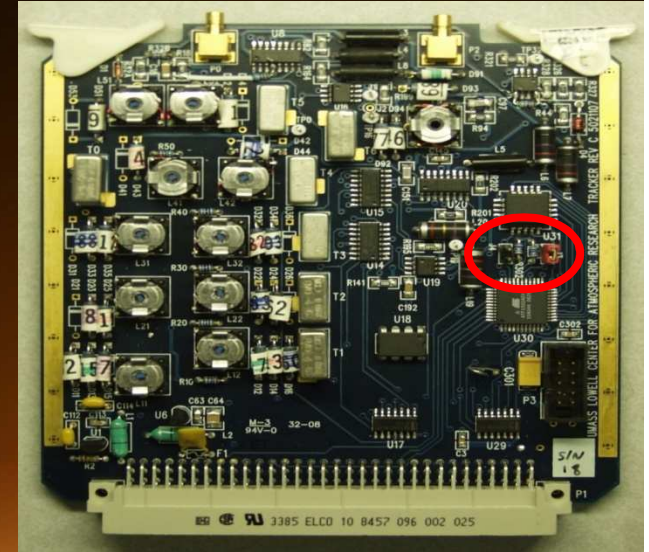
- Must set jumpers for position
- Run Tracker Calibration after replacement

Power Distribution Card

Antenna Switch

Computer

- BIOS must be configured for use!
- If in “Data Computer” role, must set jumpers properly for GPS connection
- If in “Control Computer” role, a PS2 Keyboard is needed for BIOS configuration



Most significant , Least significant binary number. No jumper = 1. This tracker is set to binary 10 = 2 (and so is configured as tracker 3)

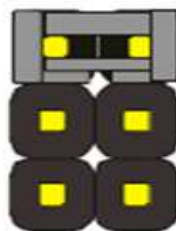
Data Computer Jumper Settings

The data computer should be jumper settings as follows:

JCSEL1

JCSEL2

RS-422



Pre BIT Fault Isolation

