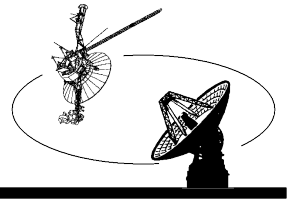
Cassini Bistatic Experiment 2014

DSS-43 and DSS-34

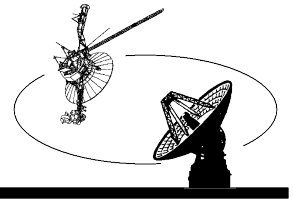
Rev6

Bistatic Experiment Overview



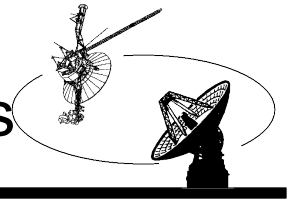
- To determine the surface dielectric constant ε (nature and composition)
- To determine surface roughness
- To characterize subsurface (volume) scattering processes, if measured

Bistatic Operational Overview

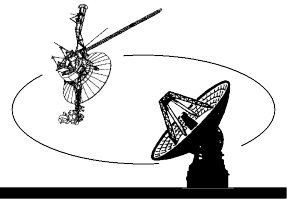


The DSN will be involved in the Cassini Radio Science bistatic experiment. DSN coverage for this experiment will include DSS-34 and DSS-43.

If possible, both polarizations at each frequency will be utilized during this experiment at each antenna. The Cassini spacecraft will be earth pointed at the start of the activity giving a baseline reference for signal levels. The Cassini spacecraft will then turn away from Earth and towards Titan. The RSR will attempt to detect the S-band, X-band and Ka-band echoes (both polarizations) reflected off of Saturn's largest moon Titan.



It is very important that during the estimate 2 to 3 hour set up that baseline reference measurements are made at the Radio Science open loop receiver for all three RF bands, both polarizations when possible. To do this, there will be a series of steps that will be called for by the Radio Science team. These steps will include:



- DSS-43 X-band: Configure the RCP path on the O1 output and the LCP path on the O2 output on the UWV display.
- DSS-43 S-band: Extend the dichroic plate for this experiment. Configure SRCP low noise to the LNA2 to the O1 output and SLCP Diplex to the LNA1 to the O2 output.

- DSS-34 X-band: Configure the RCP path on the O1 output on the UWV display (DSS-34 XLCP is not available).
- DSS-34 Ka-band: Configure KRCP on the O1 output.

Once the UWV switches are set, they do not need to change! It is very important that they do not change to avoid interface problems between the noise diodes. Any necessary switching throughout the operational steps will be done by selecting the appropriate I.F. selection on the DCC, not UWV switching.

It is very important that the DSN's configuration is correct and if it is noticed that the configuration is incorrect, the correction should not be made until the Radio Science team is advised. This is to allow the Radio Science team the knowledge of the incorrect configuration so when the correction is made they will understand the change that will be seen on the open loop RSR recording.

It will be very challenging for the Radio Science team to measure and record 3 different bands at both polarizations for all DSN antennas.

The starting configuration will be X-band out the horn or “Cold Sky” as it is commonly referred to with the diode off. The diode configuration will be the same on all antennas and all bands:

- 12.5 K diode selected
- SNT MFQ=ON (refer to figure 2)

See display on next page

Note: if change back to the nominal value is needed then:

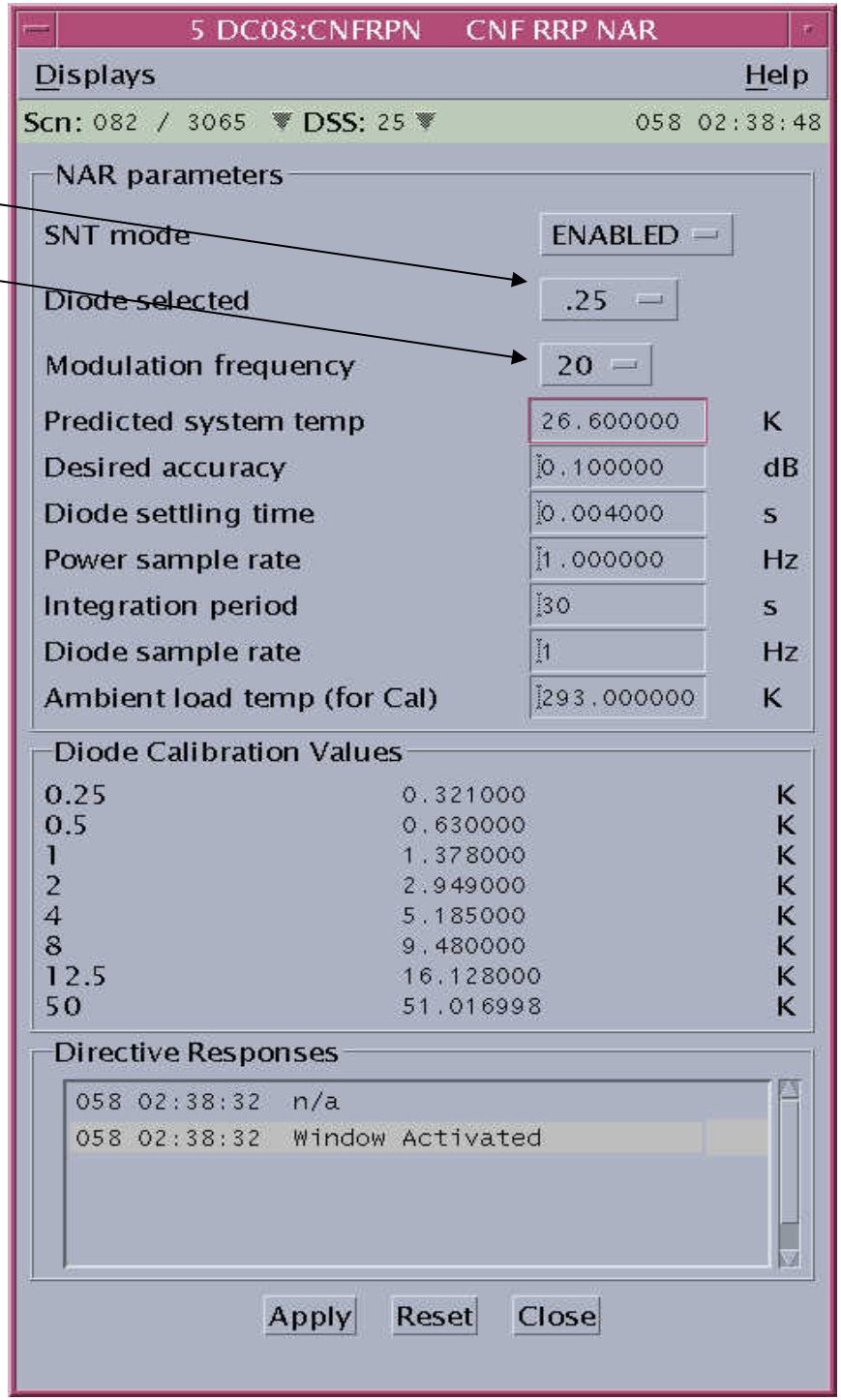
1. **SNT is disabled**
2. **Change MFQ=20 Hz**
3. **Change diode =.25 K**

Configure the diode for 12.5 K and the MFQ=on.

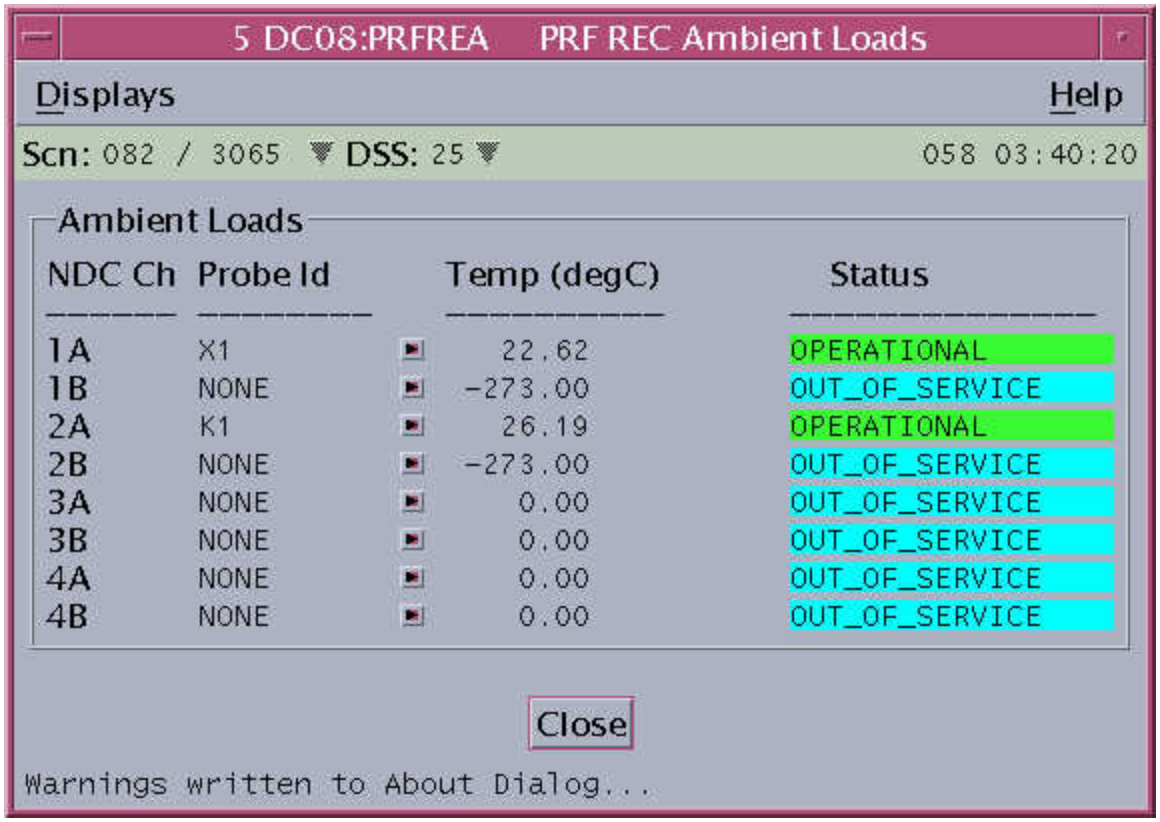
When requested to enable the diode, simply enable SNT from either this display or the DTT performance display.

Note: if change back to the nominal value is needed then:

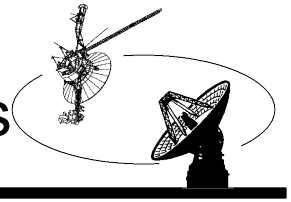
1. SNT is disabled
2. Change MFQ=20
3. Change diode =.25 K



When asked by the RS team what the ambient load temperature is, the DSN will use this display (PRFREA) and report the temperature as displayed.



DSS-43 and DSS-34 Bistatic Operational Steps

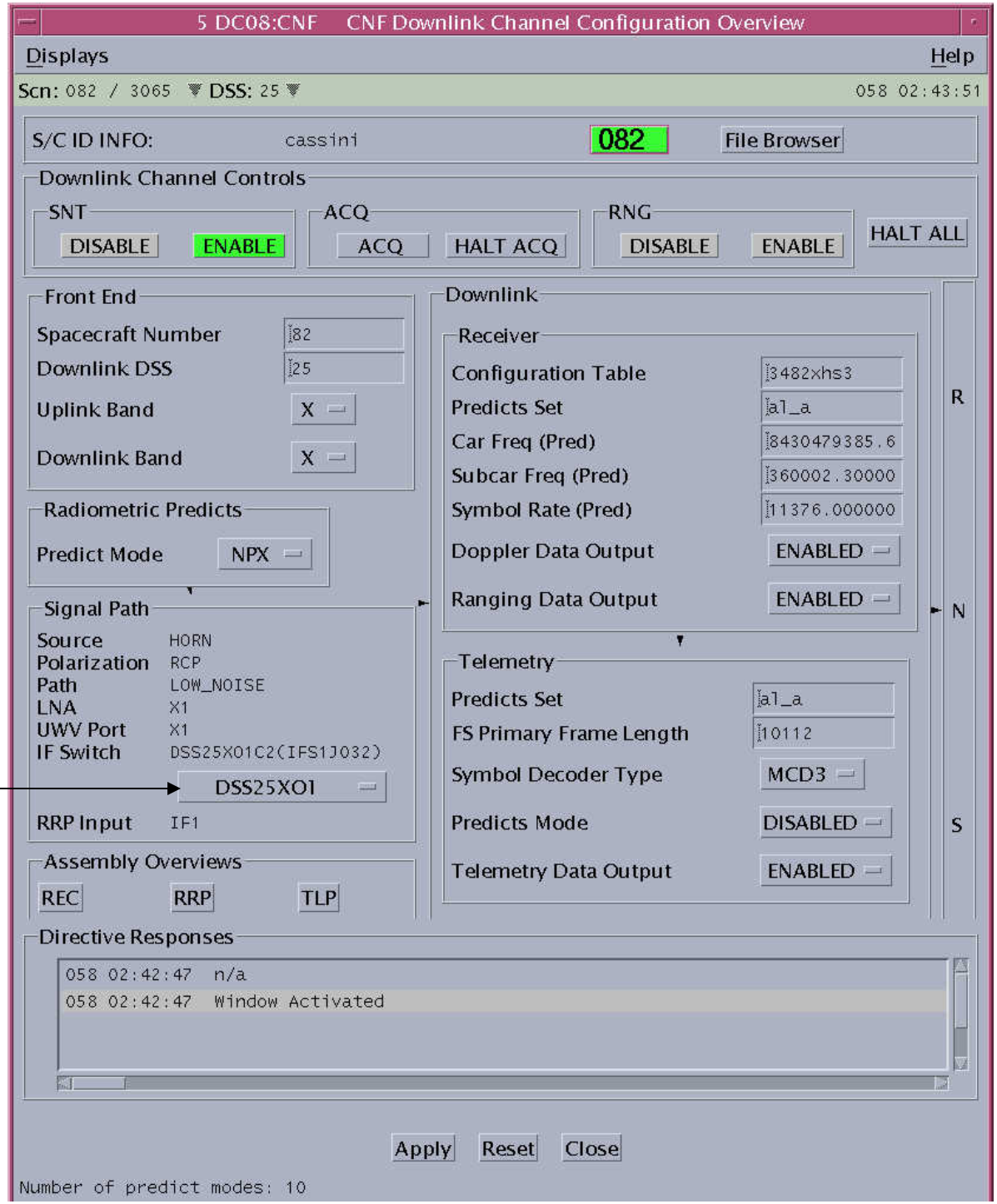


It will be necessary to **focus the antenna at stow** for the most accurate bistatic measurements **during pre- and post-cal**. The following steps are necessary before the Radio Science team starts their recordings:

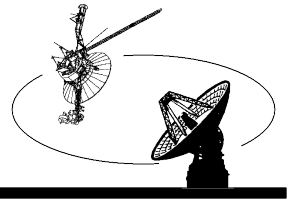
1. **AP AZEL aaa.aaa ee.eee** where aaa.aaa, ee.eee is as close to stow position as antenna operational limits will allow
2. **AP MODE ENC** *****DSS-43 only*****
   to use encoder (*aka* computer) mode, not autocollimator (*aka* precision mode)
3. **AP TRK**
4. When prompted, and safe to do so, enter:
   AP RESM TRK
5. **AP MOVE R Pn** *****DSS-43 only*****
   where n is the cone position for the subreflector, if necessary
6. Wait until antenna and subreflector errors are small (see TRK display)
7. **AP SET EL** to set the elevation brakes and hold the stow position
8. To track in azimuth only, enter
   AP DCOS to select nominal predict mode
   AP TRK AZ to begin to follow the spacecraft in azimuth only
9. Advise the Cassini Radio Science team that you are ready to begin the bistatic calibrations

10. During pre-cal only: At the completion of the bistatic calibrations and when directed by the Radio Science team to go to point in both AZ and EL THEN enter
    a) **AP MODE AC** *****DSS-43 only*****
    to select autocollimator pointing mode
    b) **AP TRK**

For DSS-43 the second DTT will need to be configured to LCP after the connection is built. It is very important to disconnect one DTT from the I.F. port, once the disconnect is complete then connect the second DTT to the O2 port for LCP.



DSS-43 Bistatic Operational Steps

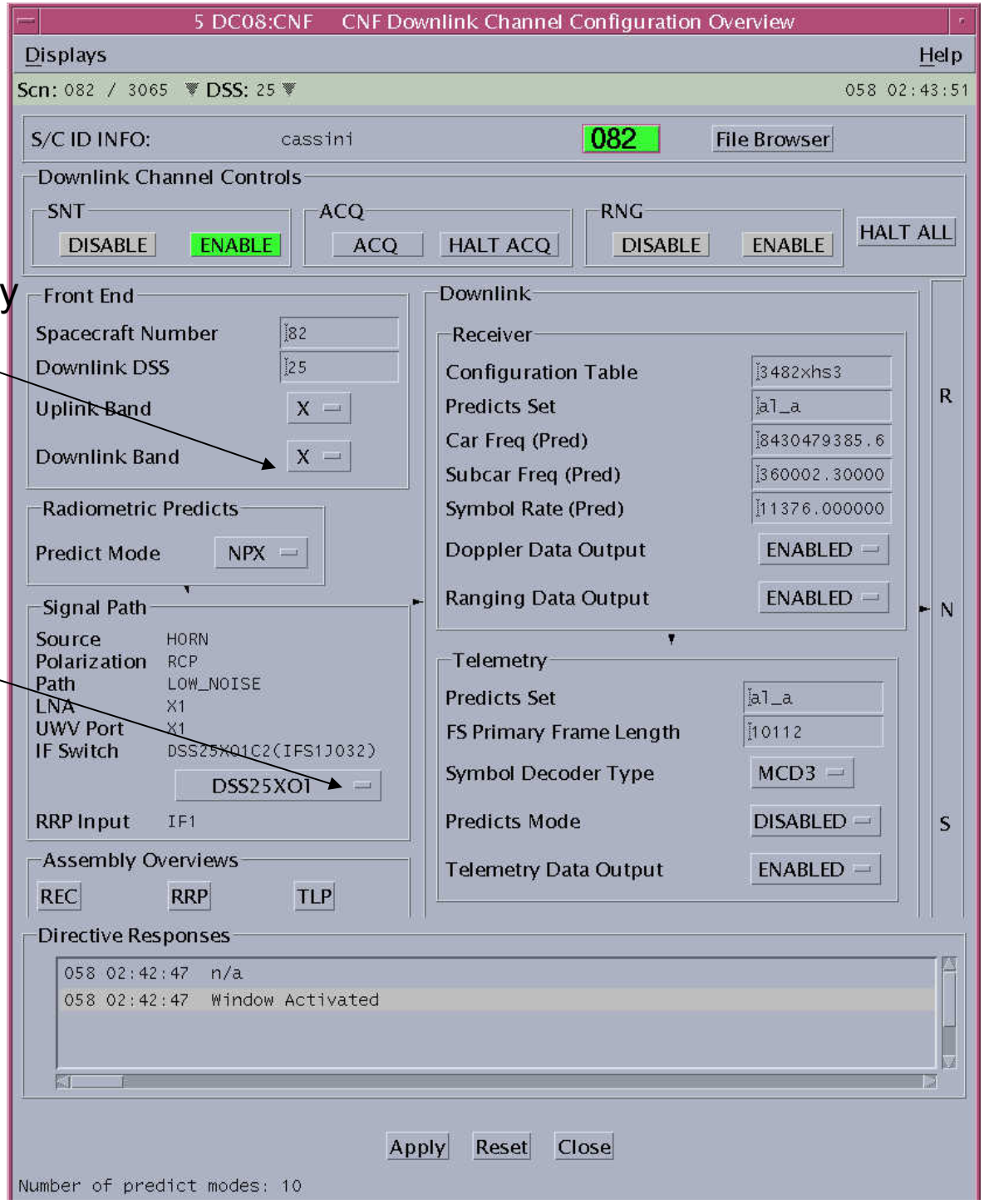


DSS-43 must have set-up activities completed prior to the bistatic calibrations. **While at stow**, two DTTs are required: One configured for XRCP and the second configured for XLCP (see previous page). Perform as directed by the Radio Science team (RS will record each step for 2 to 7 minutes if time allows):

1. XRCP/XLCP out the horn (cold sky) diode off.
2. XRCP/XLCP in the ambient load.
3. Provide verbal readouts of ambient loads temp X1, S1, S2 from PRFREA display (see page 9).
4. Provide weather info: Temperature, humidity, pressure, wind speed, sky condition.
5. XRCP diode on (12.5 K MFQ=on).
6. XLCP diode on (12.5 K MFQ=on).
7. XRCP/XLCP out the horn diode on.
8. XRCP out the horn diode off.
9. XLCP out the horn diode off. This completes the X-band calibrations.
10. Configure both DTT's for S-band. See next slide.

Step 10a.
Select S-band for the downlink Band. This action will automatically Load the proper S-band table From the SCAP.

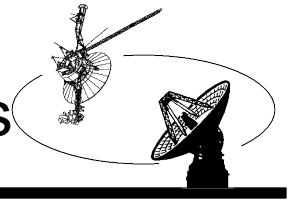
Step 10b.
Choose a DCC and disconnect, Then select the LCP output. Now we have two DCC's one for SRCP and SLCP.
Upon the band change the diode may have defaulted to .25 and MFQ=20.
Set back to 12.5 K and MFQ=ON



DSS-43 Bistatic Operational Steps

11. SRCP out the horn diode off.
12. SRCP in the ambient load.
13. SRCP in the ambient load 12.5 K diode on.
14. SRCP out the horn 12.5 K diode on.
15. SRCP out the horn diode off. This completes SRCP.
16. SLCP out the horn diode off.
17. SLCP in the ambient load diode off.
18. SLCP in the ambient load 12.5 K diode on.
19. SLCP out the horn 12.5 K diode on.
20. SLCP out the horn diode off. This completes the S-band calibrations.

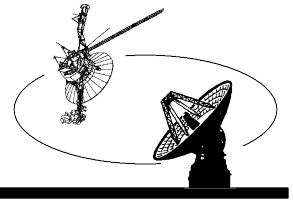
DSS-34 X & Ka Band Bistatic Operational Steps



DSS-34 must have the Monopulse cals and the set-up activities completed prior to the bistatic calibrations. **While at stow**, two DTTs are required: One DTT configured for XRCP and the second DTT configured for KRCP. Display PRFREA displays for both X and Ka-band. **Ka-band has one set of diodes that are visible on both RCP and LCP paths**, so there's no need to change one of the DTTs configuration to KLCP. Perform as directed by the Radio Science team (RS will record each step for 2 to 7 minutes if time allows):

1. XRCP/KRCP out the horn diode off, Switch 43 in B position.
2. Extend aperture load (S21 in the B position).
3. Provide verbal readouts of ambient loads temp X1 and K1 from PRFREA display (see page 9).
4. Provide weather info: Temperature, humidity, pressure, wind speed, sky condition.
5. XRCP aperture load extended 12.5 K diode on.
6. KRCP aperture load extended 12.5 K diode on.
7. Retract aperture load (S21 in the A position) 12.5 K diode on.
8. XRCP diode off.
9. KRCP diode off.

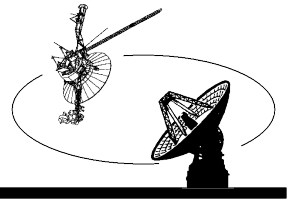
Mini Cal In-Track Activities



After the set-up activities are finished, **the Radio Science team will direct the stations to go to point**. When requested by the Radio Science team for a Mini Cal, please follow the steps on page 17 (DSS-43) or page 18 (DSS-34)

- **Stations are to go through the steps on their own**. There are only 6 to 8 minutes for the Mini Cal procedure to complete, so it is imperative that the stations (once given the start time) execute the Mini Cal entirely on their own and report accordingly. Do not wait on NOPE/NOA or Radio Science team direction
- Report completion of each step to the Radio Science team
- Ensure the noise diodes are off/disabled at the end of the Mini Cal
- Three Mini Cals will be conducted during the experiment

DSS-43 Mini Cal In-Track Steps



Stations are to go through the steps on their own. There are only 6 to 8 minutes for the Mini Cal procedure to complete, so it is imperative that the stations (once given the start time) execute the Mini Cal entirely on their own and report accordingly. Do not wait on NOPE/NOA or Radio Science team direction

1. Configure one DTT for XRCP and second DTT for SRCP
2. Enable XRCP and SRCP 12.5K noise diodes for two minutes to allow radio science team 2 minutes of recording. Station announces "DSS-43 RCP diodes on" to signify the start of the Mini Cal on time to the Radio Science team. Leave noise diodes on for 2 minutes
3. Disable XRCP and SRCP 12.5K noise diodes. Station announces "DSS-43 RCP diodes off."
4. Re-configure DTTs for XLCP and SLCP. Station announces "Reconfiguring for XLCP and SLCP."
5. Immediately after the reconfiguration to LCP (both DTT's), enable the diodes for two minutes (do not wait on other stations). Station announces "DSS-43 LCP diodes on" to signify the start of the LCP Mini Cal to the Radio Science team. Leave noise diodes on for 2 minutes.
6. Disable XLCP and SLCP 12.5K noise diodes and announce "DSS-43 LCP diodes off."
7. Re-configure DTTs for XRCP and SRCP. Station announces "Reconfiguring for XRCP and SRCP."
8. Station announces "DSS-43 RCP reconfiguration complete and Mini Cal complete."

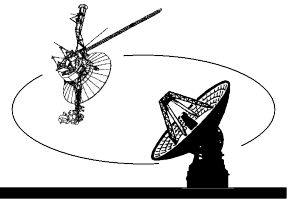
DSS-34 Mini Cal In-Track Steps

Stations are to go through the steps on their own. There are only 6 to 8 minutes for the Mini Cal procedure to complete, so it is imperative that the stations (once given the start time) execute the Mini Cal entirely on their own and report accordingly. Do not wait on NOPE/NOA or Radio Science team direction

Switch 43 must be in the B position for the Mini Cal. Wait for Radio Science direction to change the switch

1. Configure one DTT for XRCP and second DTT for KRCP
2. Enable XRCP and KRCP 12.5K noise diodes for two minutes to allow radio science team 2 minutes of recording. Station announces "DSS-34 RCP diodes on" to signify the start of the Mini Cal on time to the radio science team. Leave noise diodes on for 2 minutes.
3. Disable XRCP and KRCP 12.5K noise diodes. Station announces "DSS-34 RCP diodes off and Mini Cal complete."

Weather Information



The Radio Science team will prompt each complex at some point for weather information consisting of:

1. Current temperature
2. Humidity
3. Pressure
4. Wind speed
5. Sky conditions

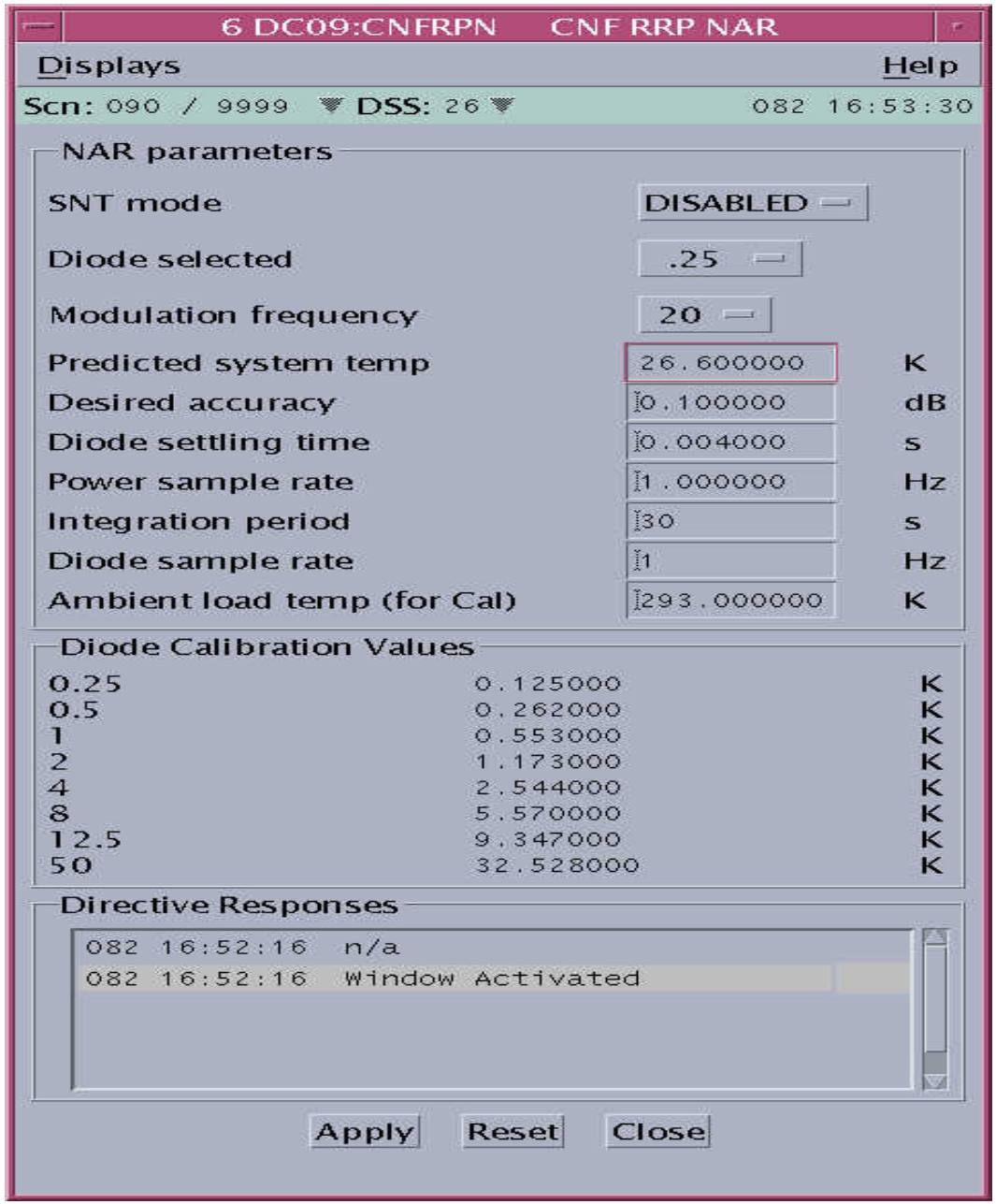
Bistatic SNT Measuremnets

Before Mini Cal 1 and again before Mini Cal 3, the Radio Science team will request that an SNT measurement be made. When requested to obtain SNT measurements, please follow the steps outlined on the next slide.

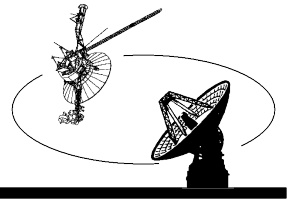
Bistatic SNT Measurements

When directed by Radio Science team to perform bistatic SNT measurement, perform the following steps from the CNFRPN display:

1. Set the MFQ to 20 (was previously set to ON)
2. For **Ka-band select the .5 K diode** (was set to 12.5 K)
3. For **X-band and S-band select the .25 K diode**.
4. Enable SNT.
5. Allow SNT to run for a minimum of 1-minute
6. Provide measurement to Radio Science team.
7. After SNT measurement is complete and concurrence has been given by the Radio Science team, disable SNT and set the MFQ back to “On.”
8. Reconfigure DSS-34 X-band and Ka-band diodes and DSS-43 X-band and S-band diodes to 12.5 K.



Post Cal Bistatic Operational Steps



At the end of the experiment, **the Radio Science team will direct the stations to go to stow**. During the bistatic post cal activities, we will repeat the bistatic calibration procedures for each antenna type.

End of another successful experiment!

Thank you for your supports