
# HiSeasNet Equipment Basic Training

November 5th, 2012
LDEO

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# Outline

- Safety
- Equipment (Purpose, expectations, diagnostics, etc)
  - Antenna
    - DacRemP
    - Air conditioner
  - RF gear
  - Modem
  - Router
- Troubleshooting the system
- Special procedures
- Case studies

# Safety Risks

- HiSeasNet Antennas are safe to use with basic safety precautions
- Potential Risks:
  - Electric shock from electric power voltages
  - Microwave radiation.
  - Working at heights.
  - Lightning strikes and electrostatic discharge (ESD).

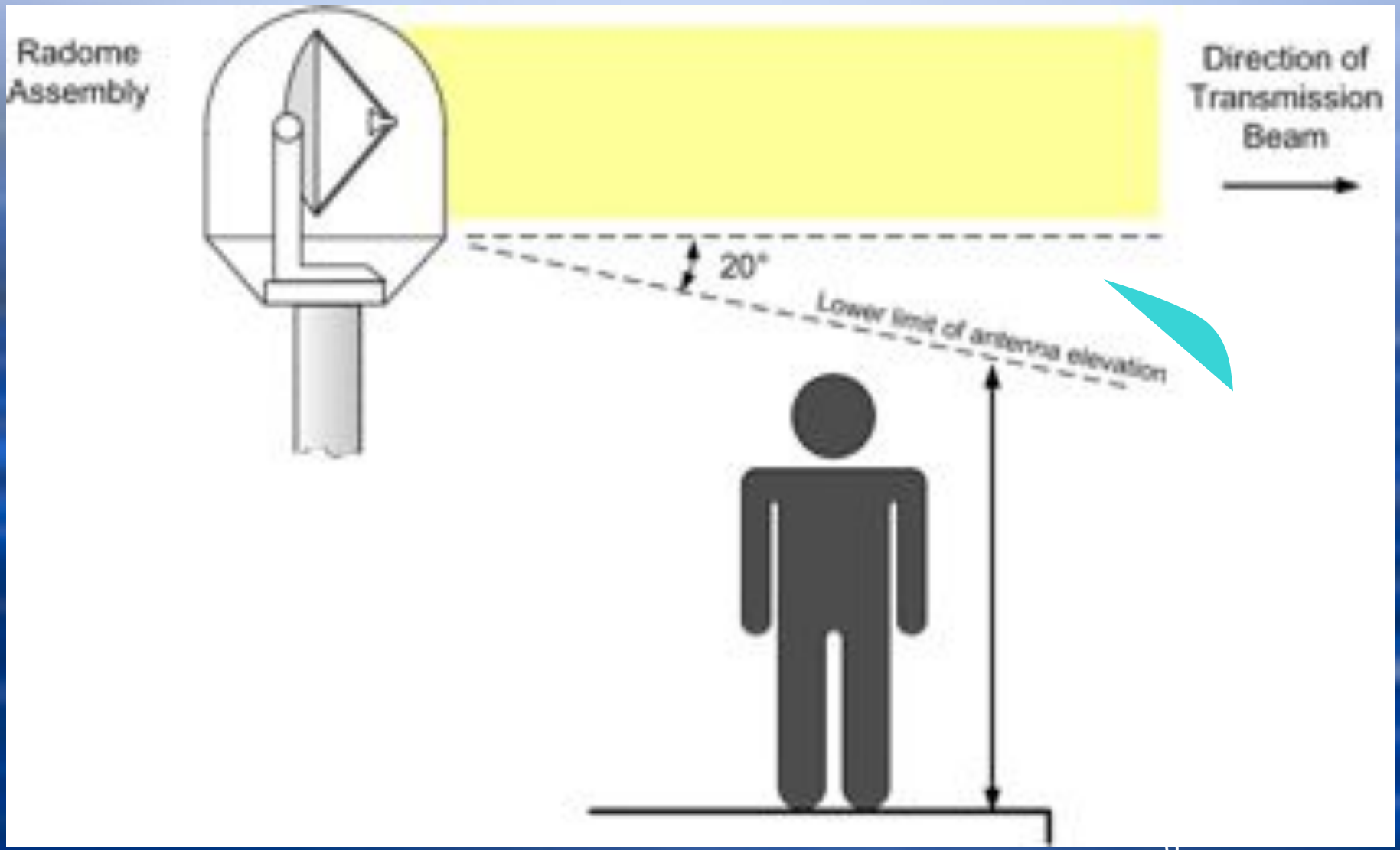
# Electric Shock: Hazards

- Risk of electrocution
- Electric power voltages are present inside radome for antenna and Codan RF equipment
- Antenna controller (DAC) and Comtech satellite modem (120 VAC).
- Voltage supplied to radome air conditioner (230 VAC).

# Electric Shock: Precautions

- Ensure Radome cover and hatch are fitted and secure.
- Ensure DAC and other below decks equipment (BDE) covers are fitted and secure.
- Isolate / switch OFF power to radome or BDE prior to working on these units.
- Restrict access to non-essential personnel when working on opened AC powered equipment.
- Place or verify warning labels are placed on equipment as appropriate.

# Microwave Radiation



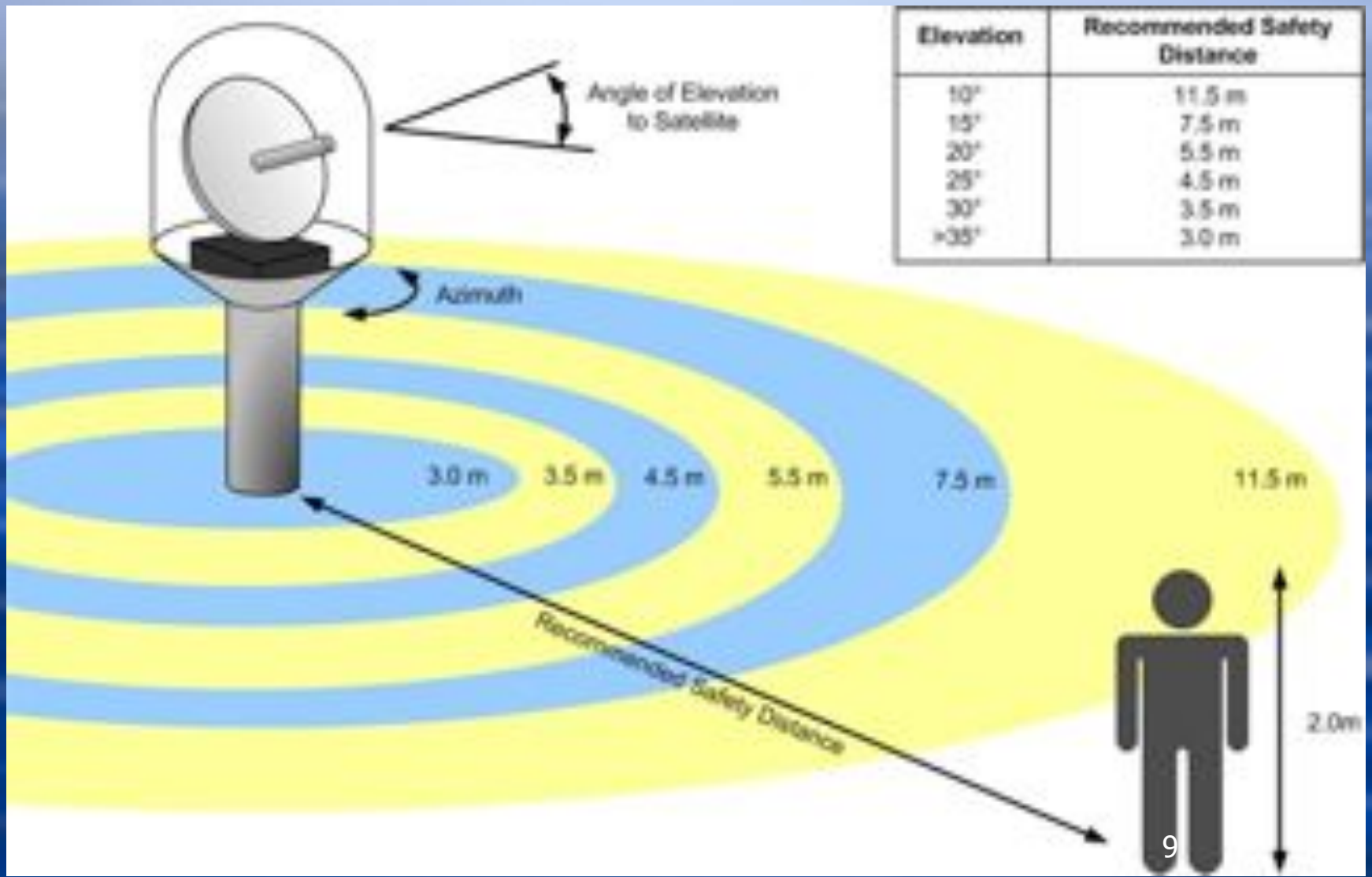
# Radiation Hazards

- Can cause tissue damage, including blindness.
- Radiation (RF energy) hazard restricted to focused antenna beam.
- RF energy levels outside focused beam are below industry standards (10 mW/ cm2).
- RF energy levels are higher inside radome cover in the beam path

# Radiation Precautions

- Choice of antenna location at planning stage can eliminate most hazard issues.
- Cordon off access to areas (e.g. walkways) that are at risk of radiation.
- Switch off power to antenna when working inside radome as applicable.
- Ensure Warning stickers are displayed prominently on Radome.

# Recommended Safety




| Elevation | Recommended Safety Distance |
|---|---|
| 10° | 11.5 m |
| 15° | 7.5 m |
| 20° | 5.5 m |
| 25° | 4.5 m |
| 30° | 3.5 m |
| >35° | 3.0 m |

# Working at Heights

- Use fixed ladders and platforms where possible.
- Always have someone at the base of the ladder to assist you.
- Carry out as much work at ground/deck level as possible.
- Cordon off area around and below ladder to mitigate against injury from dropped/falling objects.

# Lightning and Electrostatic

- Use appropriate lightning rod installation for radome position
- Antenna and air conditioner are connected to ship through radome base welded to deck
- Steel vessels protect Below Decks Equipment by acting as a 'Faraday Cage', but consider fitting lightning arrestors to cables at through-deck

# Hazardous Materials

- Beryllium present inside Codan BUCs and SSPAs.
  - These materials present no threat to health while sealed inside equipment.
  - When equipment is scrapped, ask local recycling center to collect items for correct disposal.
- Other failed electronic parts are e-waste

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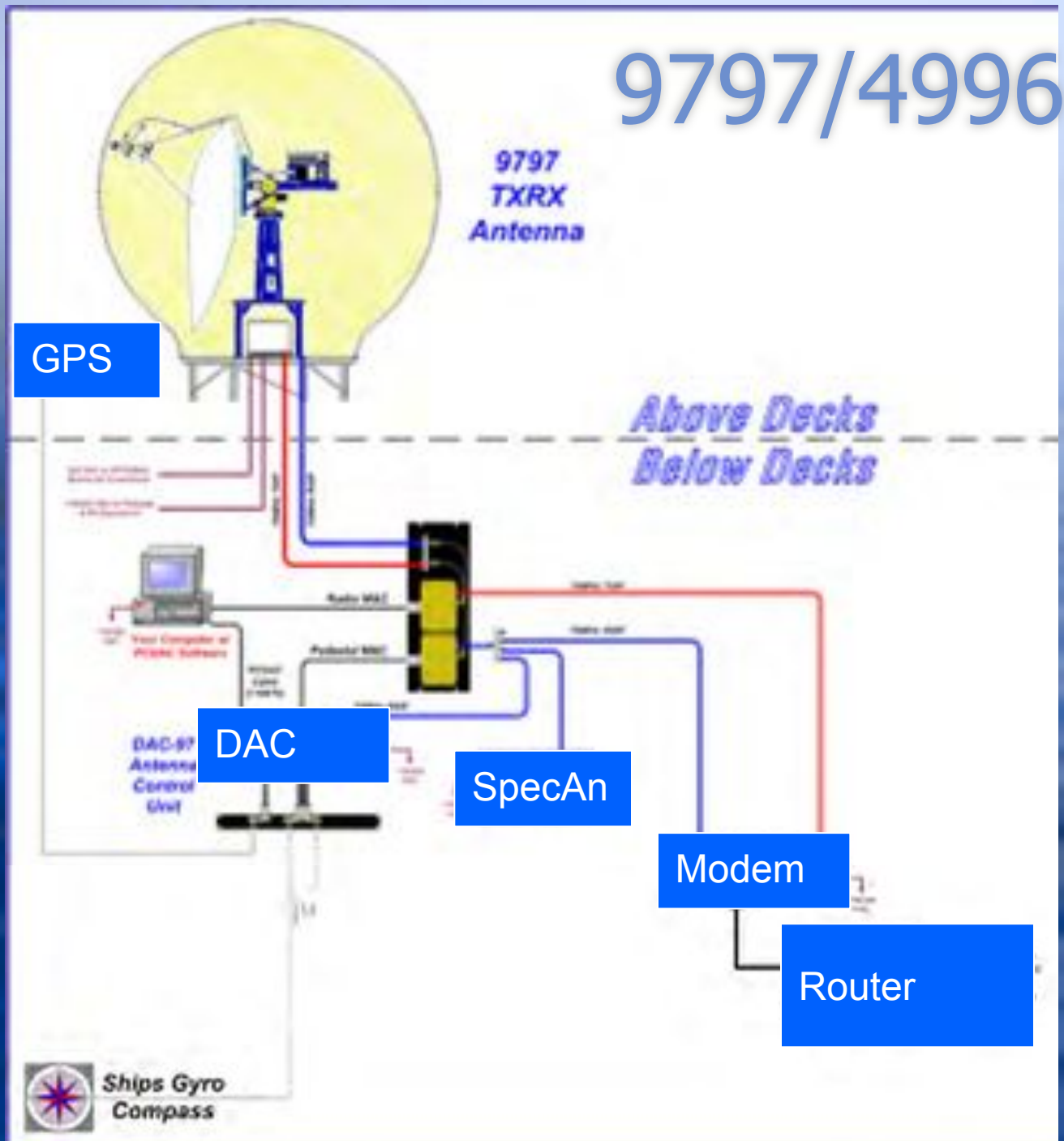
# The Antenna's Job

- Find the right satellite
- Track the right satellite well enough to distinguish a signal from the noise
- Deliver that signal to the modem and following gear
- Use signal level inputs, lat/lon, heading to track effectively.
- Do its best to overcome the tricky parts:
  - Bad inputs/sensors
  - Bad tracking movement (hardware or config)
  - Uncertainty about who's signal is being tracked (noise? other satellite? sun?)

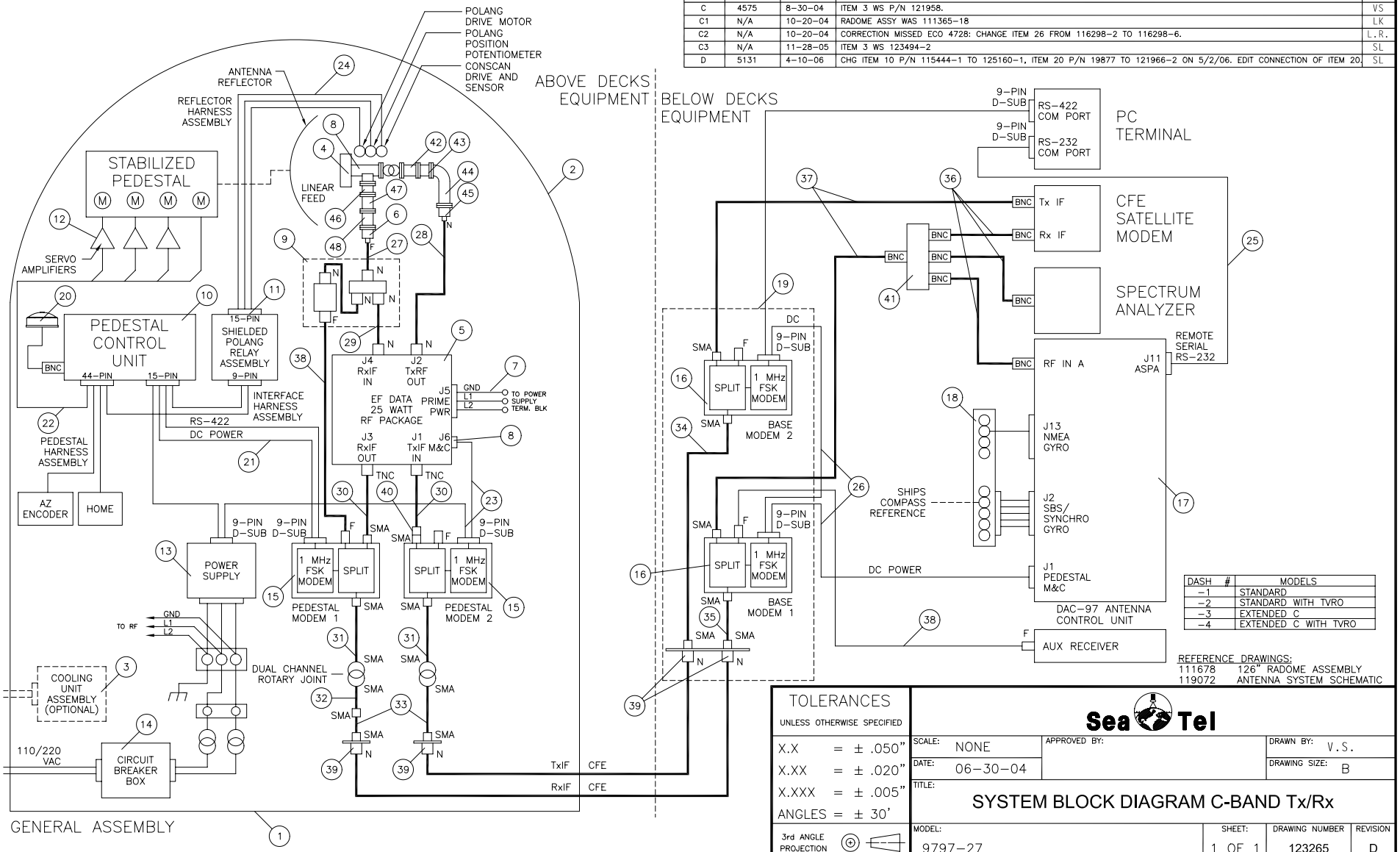
# Antenna components

- Above decks gear
  - Balanced antenna (reflector, feed, frame, pedestal)
  - Tracking gear (PCU, level cage, motors, GPS)
  - RF gear (LNA/LNB, Amplifier, converter)
- Below decks gear
  - DAC (aka ACU) controller and multiplexors
  - Modem
  - Router
- IFL cables carry control and signals

# 9797/4996 Diagram



| REV. | ECO# | DATE | DESCRIPTION | BY |
|---|---|---|---|---|
| B | 4531 | 8-16-04 | IMPLEMENTED DISHSCAN | VS |
| C | 4575 | 8-30-04 | ITEM 3 WS P/N 121958. | VS |
| C1 | N/A | 10-20-04 | RADOME ASSY WAS 111365-18 | LK |
| C2 | N/A | 10-20-04 | CORRECTION MISSED ECO 4728: CHANGE ITEM 26 FROM 116298-2 TO 116298-6. | L.R. |
| C3 | N/A | 11-28-05 | ITEM 3 WS 123494-2 | SL |
| D | 5131 | 4-10-06 | CHG ITEM 10 P/N 115444-1 TO 125160-1, ITEM 20 P/N 19877 TO 121966-2 ON 5/2/06. EDIT CONNECTION OF ITEM 20. | SL |




| DASH # | MODELS |
|---|---|
| -1 | STANDARD |
| -2 | STANDARD WITH TVRO |
| -3 | EXTENDED C |
| -4 | EXTENDED C WITH TVRO |

REFERENCE DRAWINGS:
111678 126" RADOME ASSEMBLY
119072 ANTENNA SYSTEM SCHEMATIC

TOLERANCES
UNLESS OTHERWISE SPECIFIED
X.X = ± .050"
X.XX = ± .020"
X.XXX = ± .005"
ANGLES = ± 30'
3rd ANGLE PROJECTION

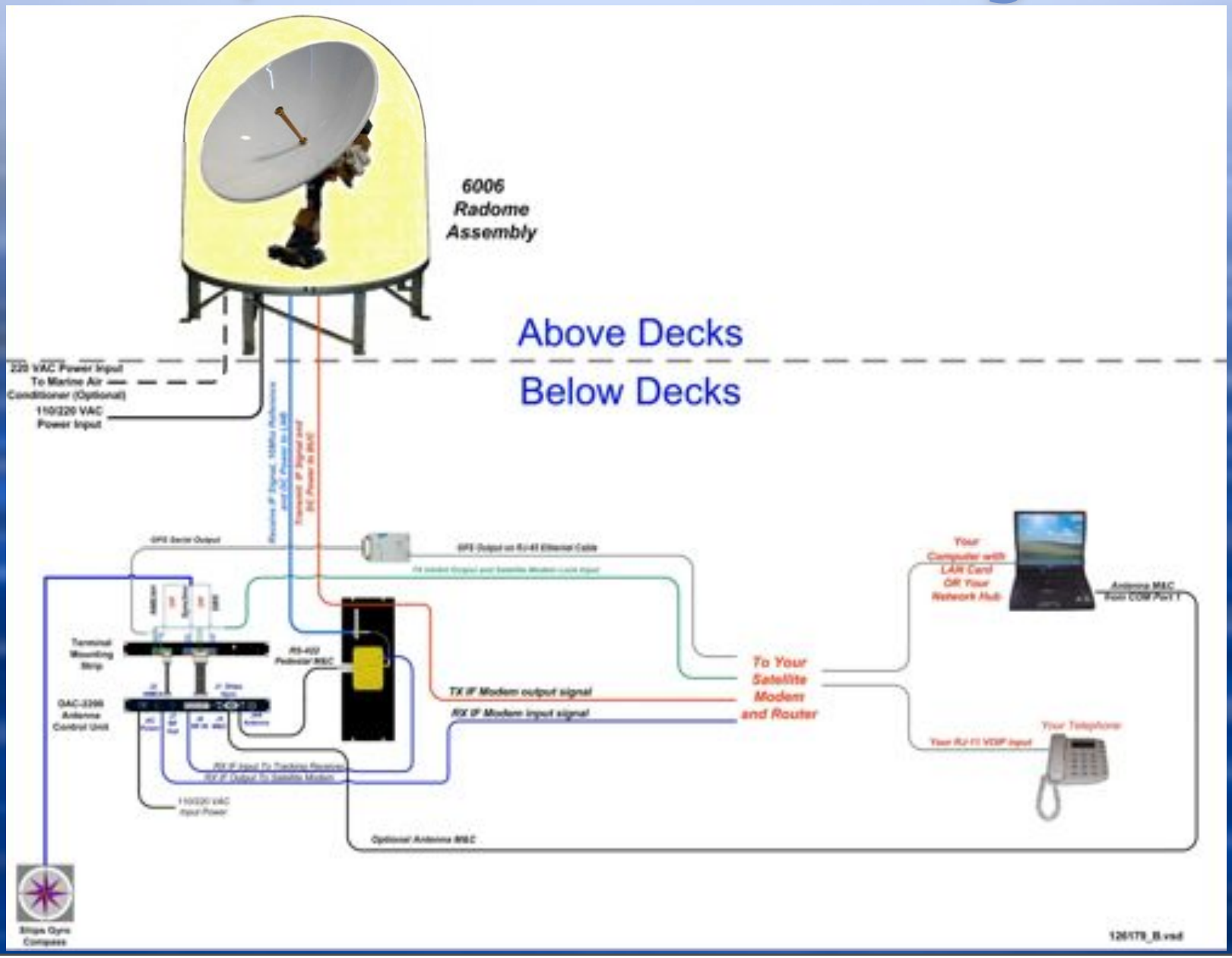
Sea Tel

SCALE: NONE
APPROVED BY:
DRAWN BY: V.S.
DATE: 06-30-04
DRAWING SIZE: B

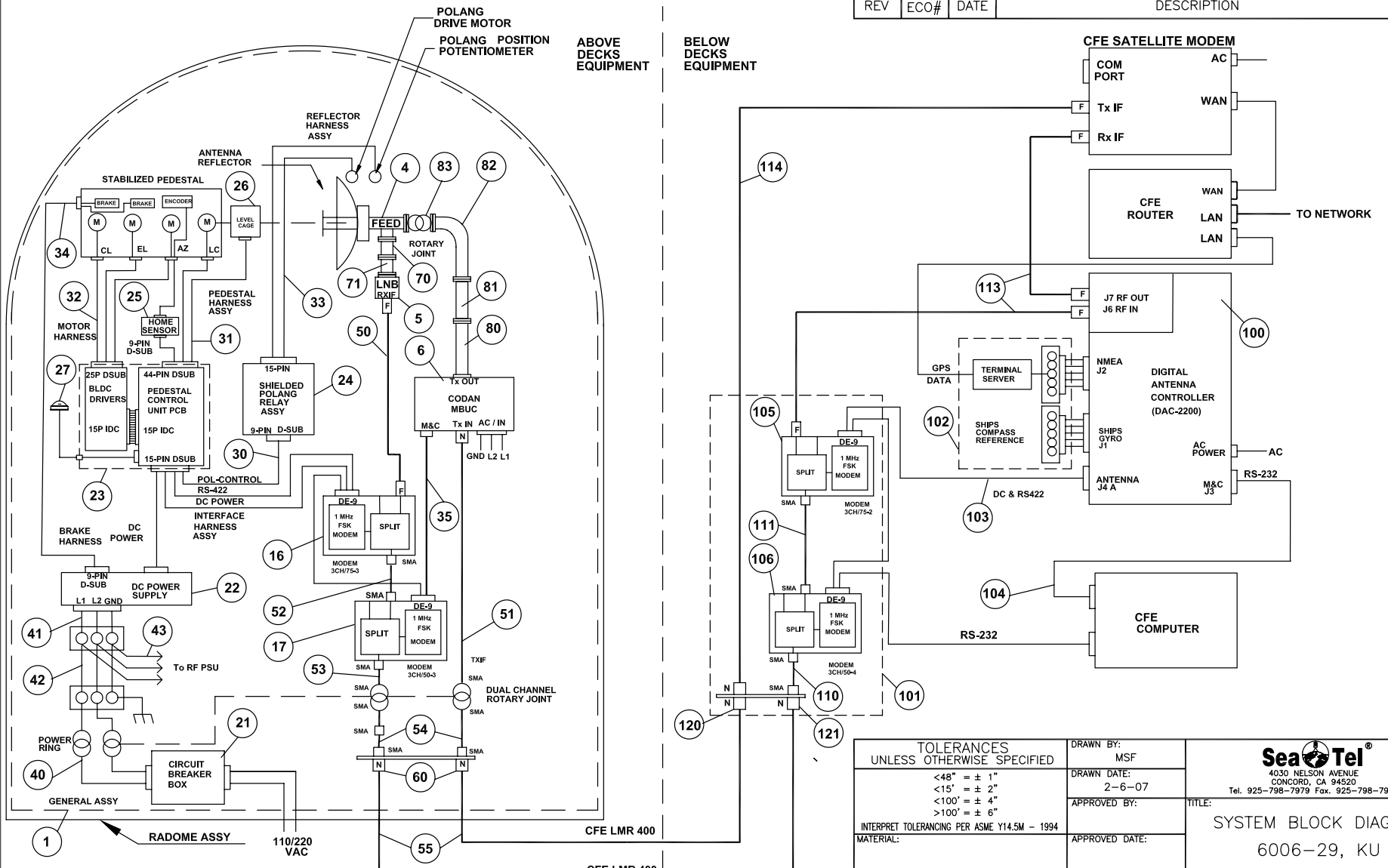
TITLE: SYSTEM BLOCK DIAGRAM C-BAND Tx/Rx

MODEL: 9797-27
SHEET: 1 OF 1
DRAWING NUMBER: 123265
REVISION: D

# 6006/4006 Antenna Diagram



| REVISION HISTORY | | | | |
|---|---|---|---|---|
| REV | ECO# | DATE | DESCRIPTION | BY |




FERENCE DRAWINGS
6021 ANTENNA SYSTEM SCHEMATIC
4348 ANTENNA PEDESTAL SCHEMATIC

| | | | |
|---|---|---|---|
| TOLERANCES UNLESS OTHERWISE SPECIFIED<br><48" = ± 1"<br><15' = ± 2"<br><100' = ± 4"<br>>100' = ± 6"<br>INTERPRET TOLERANCING PER ASME Y14.5M – 1994 | DRAWN BY: MSF<br>DRAWN DATE: 2-6-07<br>APPROVED BY:<br>APPROVED DATE: | Sea Tel®<br>4030 NELSON AVENUE<br>CONCORD, CA 94520<br>Tel. 925-798-7979 Fax. 925-798-7986 | |
| MATERIAL: | | TITLE: SYSTEM BLOCK DIAGRAM 6006-29, KU | |
| FINISH: | SIZE: B SCALE: | DRAWING NUMBER: 126020 | REV: A |
| 3rd ANGLE PROJECTION | FIRST USED: 6006-29 KU | SHEET NUMBER: 1 OF 1 | |

# Theory of Stabilization

- The antenna system is mounted on a 3-axis stabilization assembly that provides free motion in the 3 axes.
- Assembly allows the inertia of the antenna system to hold the antenna pointed motionless in inertial space while the ship moves beneath it.
  - Requires very little actual driving of the antenna with the motors, therefore small motors
- Low friction torque motors attached to each of the three axes of the assembly - Azimuth, Level (elevation), & Cross Level – provide the required force to overcome the disturbing torque imposed on the antenna system by cable restraints, bearing friction, and small air currents within the radome.
- These motors are also used to re-position the antenna in Azimuth and Elevation.
- The Pedestal Control Unit (PCU), uses inputs from the Level Cage sensors to calculate the amount of torque required in each axis to keep the antenna pointed within +/- -0.2 degrees.

# Theory of Stabilization

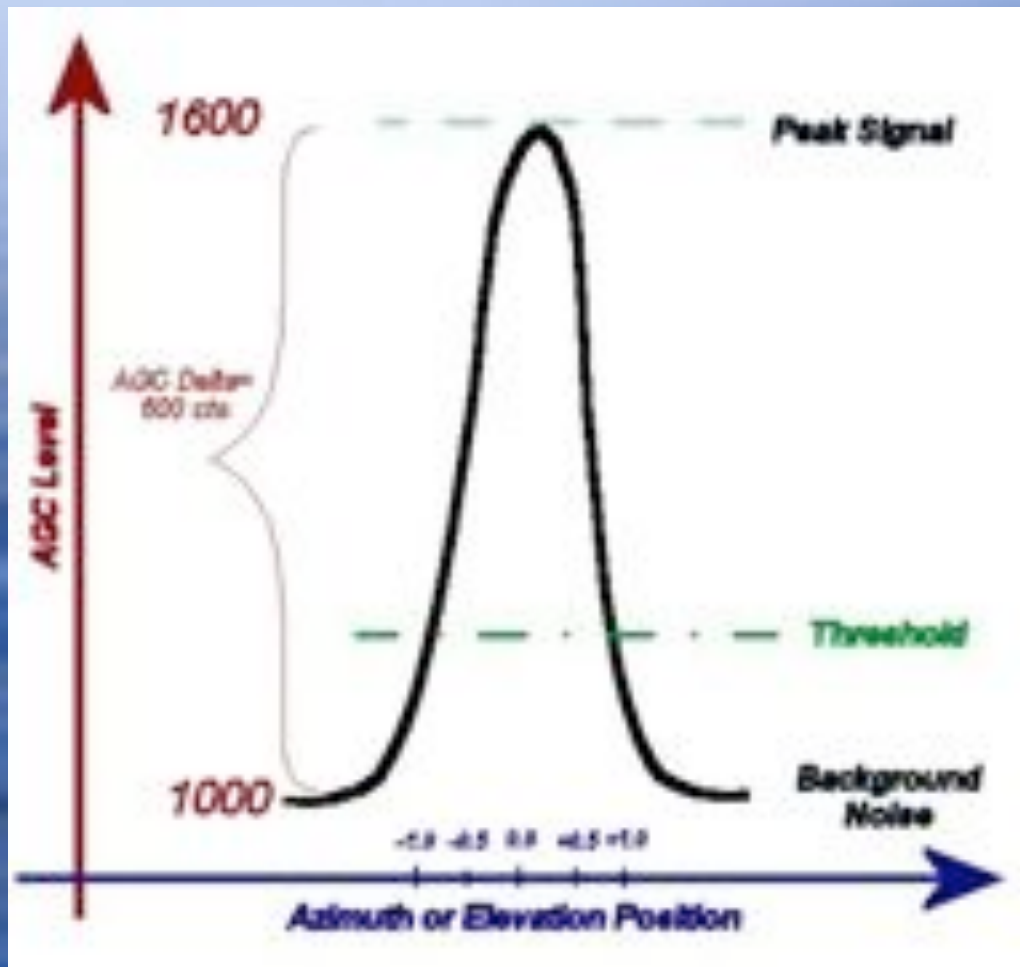
- The antenna is controlled by three independent control loops (AZ, LV, CL).
- The primary sensor input for each control loop is the rate sensor mounted in the level cage assembly.
- This sensor reports all motion of the antenna to the PCU. The PCU immediately responds by applying a torque in the opposite direction of the disturbance which brings the antenna back to its desired position.
- Both the instantaneous output of the rate sensor (Velocity Error) and the integrated output of the rate sensor (Position Error) are used to achieve high pointing accuracy.
- The calculated torque commands are converted to a 5 volt differential analog signal by a Digital to Analog converter (D/A) and sent to each of three brushless servo amplifiers.
- These amplifiers provide the proper drive polarities and commutation required to operate the brushless DC Servo Motors in torque mode. The torque acting on the mass of the antenna cause it to move, restoring the rate sensors to their original position and closing the control loop.

# Theory of Stabilization

- Since the rate sensors only monitor motion and not absolute position, a second input is required in each axis as a long term reference to keep the antenna from slowly drifting in position.
- The Level and Cross Level reference is provided by a 2-axis tilt sensor in the level cage assembly.
- The Azimuth reference is provided by combining the ship's Gyro compass input and the antenna relative position

# Antenna Tracking

- AGC vs. Pointing - As the antenna is moved in either AZ or EL through a satellite, from an "off satellite" position, through "peak satellite" reception to an opposite "off satellite" position, the AGC value on the DAC will be seen to change.
- At an "off satellite" position, the AGC value will be at or near the noise floor and below the Threshold value. The AGC value will then rise rapidly to a peak value as the antenna moves through the satellite signal, and then fall rapidly back to a level at or near the value of the noise floor.
- If the antenna position vs. AGC value was plotted on a graph, it would look similar to the graph at the right.
- Note the following:
  - AGC value equal or near to the background noise level when at an "off satellite" position.
  - Peak AGC level when antenna is "Peaked" on satellite signal.
  - AGC delta (difference in AGC value between off satellite and peak satellite). Note that this has a direct relationship to the C/N of the satellite signal. (30-40 counts of AGC = approx. 1dB of signal strength.



# About the DAC

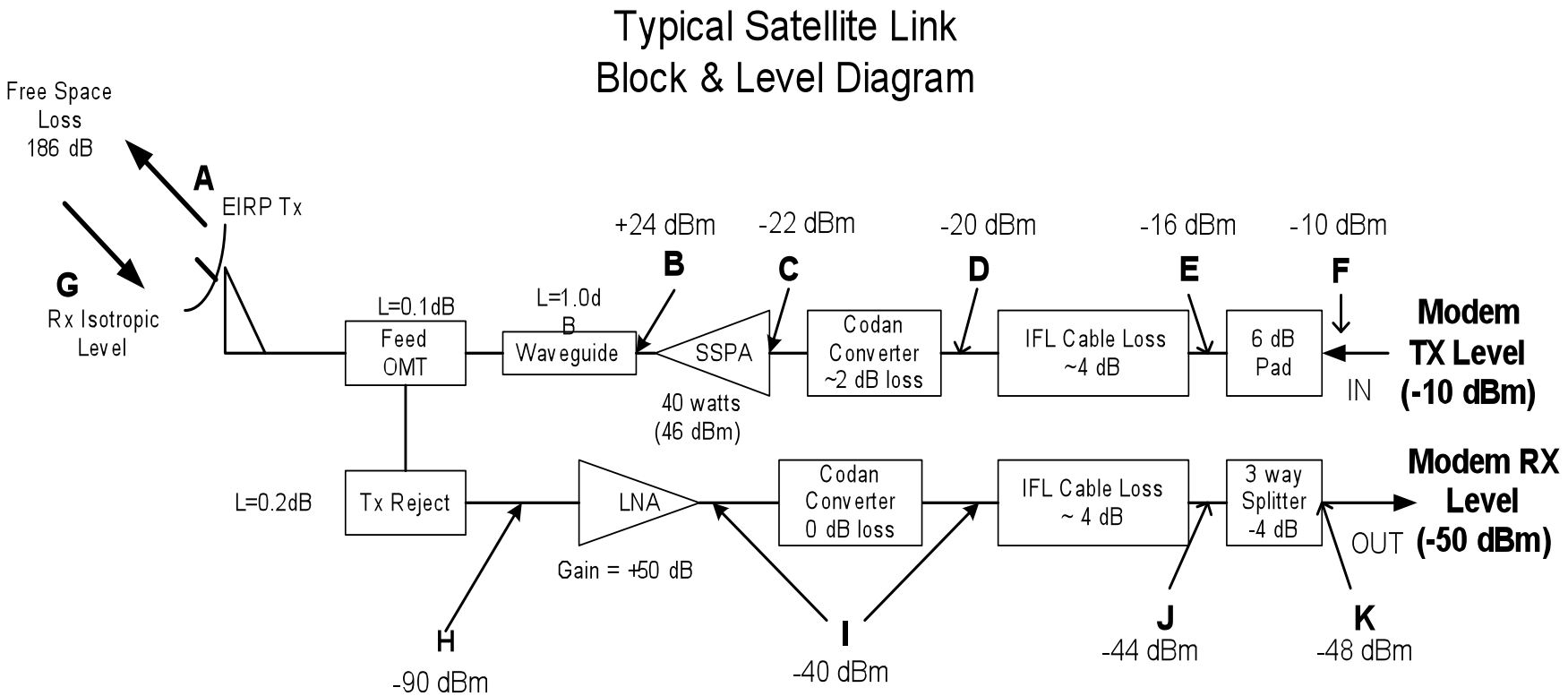
- Basic settings: Config that varies by satellite
- Expanded settings: Config that applies to the antenna installation
- Unit inputs and outputs: GPS and Gyro in, commands to PCU out
- Internet access: Some are web enabled
- Basic logic: Tells the antenna where to point and what to track
- Display modes: Ship-Satellite-Antenna-Status

- Emulator: http://support.seatel.com/training/SeaTel_DAC_DVB_Emulator/SeaTel_DAC_DVB_emulator.html

# System Gain

- System Gain - a measure of the ability of the system to increase the power or amplitude of a signal
- The overall gain of the Seatel antenna system determines its ability to receive enough signal for the DAC and Comtech modem to process it into usable data.
- The System Gain is determined by the size and type of the reflector, the type and proper alignment of the feedhorn, Noise Figure rating of the Low Noise Converters (LNB or LNA), the RF receive equipment, the DAC and Modem receiver specs and all of the loss factors (primarily cables and splitters).
- This is of paramount importance when trying to receive weaker signals (when in "fringe" areas of the footprint, especially from satellites transmitting low power or wide beam patterns).
- System Gain determines how far from beam center the "fringe area" is. The easiest way to determine the actual system performance is to observe where signals from a variety of satellites are lost, note that location and signal level from the footprint charts for those satellites.
- This will show what the value of the weakest signal level your system performance allows, therefore, which level satellite footprint contour is the "fringe area" for the system.

# Typical Ship Level Diagram




| Measurement Point | A | B | C | D | E | F | G | H | I | J | K |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Typical Value (dBm) | +23 | +24 | -22 | -20 | -16 | -10 | ~ -130 | -90 | -40 | -44 | -48 |

# Special modes/topics

- Satellite reference mode
  - When the antenna ignores gyro input for tracking and instead tracks the satellite as closely as it can
  - Usually works well, rare cases (usually failures) where this does not work well
- DishScan mode
  - Whole dish does little circles to decide which direction to move to peak up signal
  - Preferred tracking mode
- Some troubleshooting may ask you to get out of some of these modes to see how antenna responds

# Troubleshooting The Antenna

- Tools include:
  - Settings check
  - POST observation - http://bcove.me/3zzt997r
  - Visual inside the dome
  - DAC behavior
  - DacRemP errors and plots
  - Retarget and reset
- Key question: "Is it a tracking problem?"
- Key concept: "You are the eyes and ears. Any help you get from shore is a result of the information you send back."

# Common Problems

- Tracking frequency is not set correctly
  - Beware funky entering procedure for DAC-97s
  - Beware KHz field in DAC-03 and DAC-2200 series
  - Ku-band tracking frequency choice
    - Use the one for your footprint, try a few, know that they may disappear over time.
    - Some controllers have different width receiver boards
- Settings are wrong somewhere

# DAC Errors

- Red light on the panel, numbers displayed on error status screen
  - Number on **left** is comm errors between antenna and controller
  - Number on **right** is latched binary error code
- Okay errors
  - Random comm errors (but not steady)
  - Restart DAC yields sync errors (0020)
  - Ones that clear permanently after system change (ie mistake in sat longitude)
- Pedestal Error
  - Antenna tried to move, but something reported a failure during that move.
  - Shows error 0008
  - Can be decoding to find which axis had the problem

# DAC Error List

- 128 - Satellite Out Of Range
- 64 - Reserved for future use
- 32 - Reserved for future use
- 16 - DishScan Error
- 8 - Pedestal Error
- 4 - ACU-PCU Communication Failure
- 2 - Wrong Synchro Converter Type
- 1 - Gyro Read Error

# Decoding Pedestal Error

| Letter | REF | AZ | LV | CL | Description of Pedestal Error |
|---|---|---|---|---|---|
| @ | 0 | 0 | 0 | 0 | None |
| A | 0 | 0 | 0 | 1 | CL |
| B | 0 | 0 | 1 | 0 | LV |
| C | 0 | 0 | 1 | 1 | CL + LV |
| D | 0 | 1 | 0 | 0 | AZ |
| E | 0 | 1 | 0 | 1 | AZ + CL |
| F | 0 | 1 | 1 | 0 | AZ + LV |
| G | 0 | 1 | 1 | 1 | AZ + LV + CL |
| H | 1 | 0 | 0 | 0 | Ref |
| I | 1 | 0 | 0 | 1 | Ref + CL |
| J | 1 | 0 | 1 | 0 | Ref + LV |
| K | 1 | 0 | 1 | 1 | Ref + LV + CL |
| L | 1 | 1 | 0 | 0 | Ref + AZ |
| M | 1 | 1 | 0 | 1 | Ref + AZ + CL |
| N | 1 | 1 | 1 | 0 | Ref + AZ + LV |
| O | 1 | 1 | 1 | 1 | Ref + AZ + LV + CL |
| P | 0 | 0 | 0 | 0 | Stab Limit |
| Q | 0 | 0 | 0 | 1 | Stab Limit + CL |
| R | 0 | 0 | 1 | 0 | Stab Limit + LV |
| S | 0 | 0 | 1 | 1 | Stab Limit + CL + LV |
| T | 0 | 1 | 0 | 0 | Stab Limit + AZ |
| U | 0 | 1 | 0 | 1 | Stab Limit + AZ + CL |
| V | 0 | 1 | 1 | 0 | Stab Limit + AZ + LV |
| W | 0 | 1 | 1 | 1 | Stab Limit + AZ + LV + CL |
| X | 1 | 0 | 0 | 0 | Stab Limit + Ref |
| Y | 1 | 0 | 0 | 1 | Stab Limit + Ref + CL |
| Z | 1 | 0 | 1 | 0 | Stab Limit + Ref + LV |
| [ | 1 | 0 | 1 | 1 | Stab Limit + Ref + LV + CL |
| \ | 1 | 1 | 0 | 0 | Stab Limit + Ref + AZ |
| ] | 1 | 1 | 0 | 1 | Stab Limit + Ref + AZ + CL |
| ^ | 1 | 1 | 1 | 0 | Stab Limit + Ref + AZ + LV |
| _ | 1 | 1 | 1 | 1 | Stab Limit + Ref + AZ + LV + CL |

- Result of "S0000" command (6006) SABC@
- Or use DacRemP to query status, then look at errors that are checked

# Misc/common Procedures

- **Theses procedures (and others) are in the manual. I can sometimes send more detailed procedures/photos.**
- Stowing the antenna
  - Should only be either:
    - Powered up (and able to stabilize itself)
    - Powered down and lashed down
  - Unpowered antennas on ships can thrash themselves apart
- Reset/reinitialize (power cycle or issue command)
- Replacing a PCU (swap and reprogram)
- Adjusting the level cage tilt

# Maintenance Visits

- Visually inspect equipment
- Repair where needed
- Upgrades as per service bulletins or experience
- Tune antenna parameters
- Record the latest settings
- Training / Q&A

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# DacRemP

- "DAC Remote Panel"
- Finally released and supported as of v1.0 -- everyone should have a copy
- Windows software for IP or RS-232 connection to a DAC
- Logs antenna position and sensor values
  - ADMC (Position)
  - DispIVC (Loop Error, forces on antenna)
  - DispV (Verify level cage alignment)
  - DispW (Rate sensor outputs)
  - DispTC (Torque commands sent to servo amps)
  - DishScanXY (Dish Scan timing parameters)
- Allows for control of PCU and error visibility

# DacRemP Comm Diag

- Remote command entry and response window
- Last Command sent
- Left click on ?S icon, then right click to decode pedestal query
- Toggle DishScan On/Off
- Sat Reference Mode
  - Only turns on, not a toggle function
- Normal Mode
  - Clears any special test modes set such as Sat Reference Mode
- Save Remote
  - Save PCU parameters to NVRAM

# DacRemP Plots

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# Air Conditioner

- 9797 and 4996 antennas have air conditioner units
- Antennas run best when A/C is set to 85degF
- We have had fan and compressor failures, slow refrigerant leaks, front panel failures
- Can often be serviced in ports worldwide, but we have a spare, too.
- Keep the screens clean
- Check the manual for error codes

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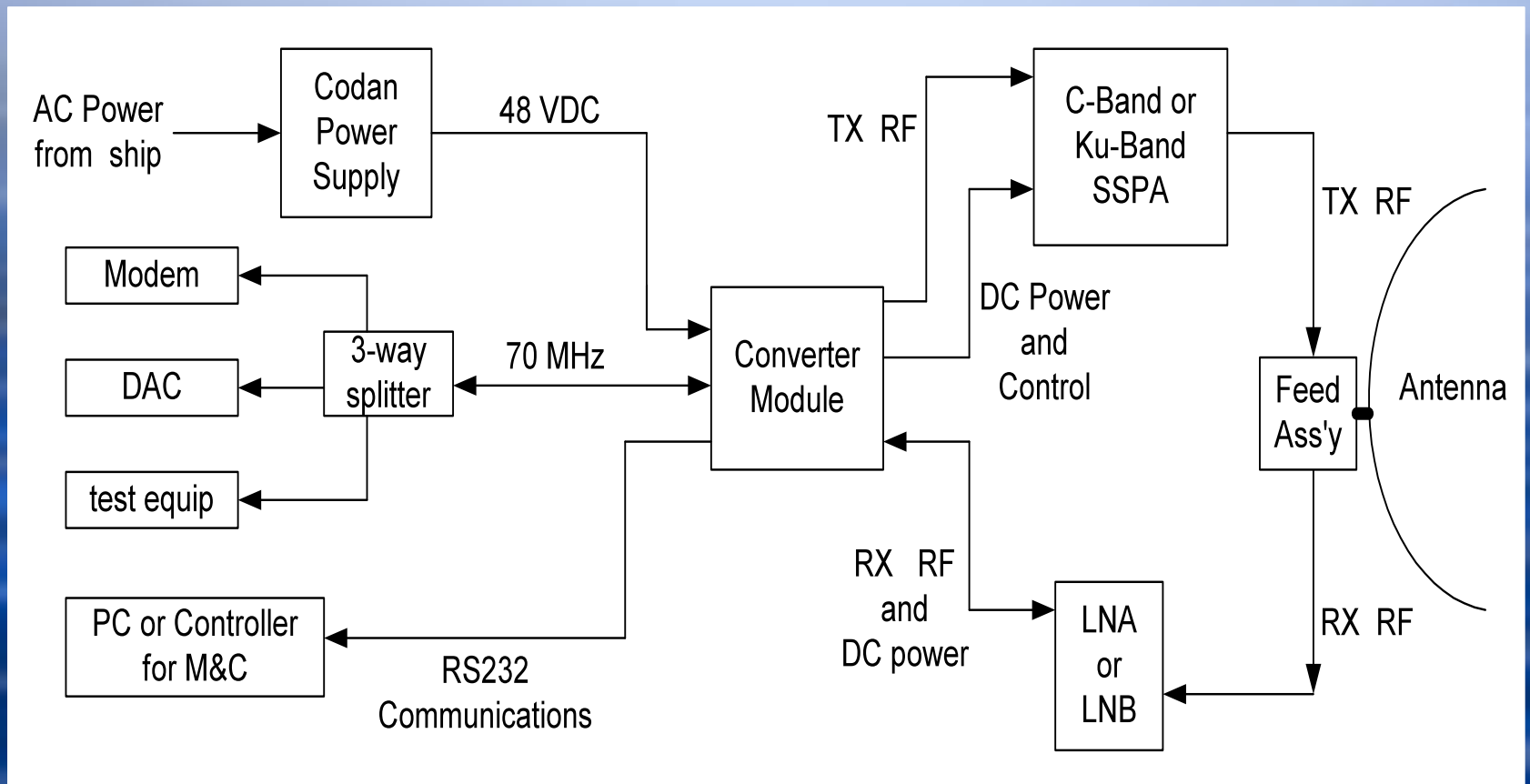
# RF Equipment

- 9797s and 4996s have 70MHz transceivers
  - Power supply - 110/220VAC to 48VDC
  - 2 main parts:
    - "Converter" for IF transmit frequency change at modem to outgoing C-band or Ku-band
    - "SSPA" for amplification
  - Serial interface for control

- 4006 and 6006 have BUCs
  - Cheaper, more modern, lighter
  - L-band based instead of 70MHz
  - Power, reference frequency, M&C, signal from modem

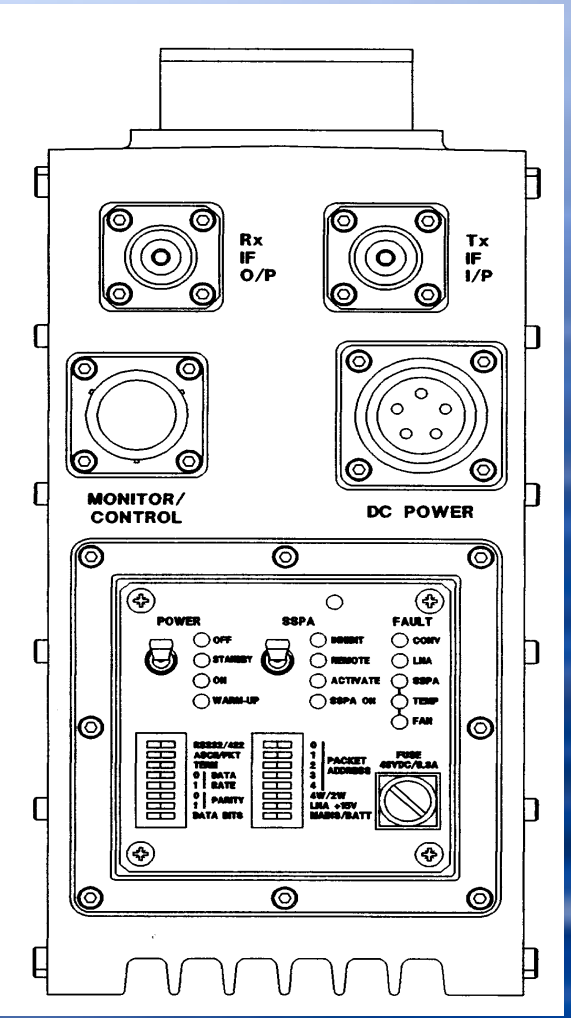
- LNA (C-band) and LNB (Ku-band) convert received C- or Ku-band signal down to working frequency

# Transceiver Block Diagram



# RF M&C Interface

- BUC gear has a serial interface for detailed troubleshooting, but all the necessary configuration bits are in the modem, faults via LED on BUC
- Converter has RS-232 interface
  - Accessible in lab via 9600bps 8N1 interface on "octopus cable"
  - Direct connect to converter in dome with MIL/DB-9 cable that came with the antenna
- Converter has "front panel" with fuses, fault/status lights
- SSPA has no direct interface, status/ faults visible through converter interface



# Codan Converter Commands

- “>” prompt, usually echo
- 3 character codes, arguments (if any) immediately concatenated
- “HLP” gets you the top level help menu
- Manual is generally thorough
- “VPS”, “VSS”, and “VFS” are key status commands
- “STAn” (ie “STA13”) sets transmit attenuation to the value specified (ie 13 dB)

# Codan Converter Stat Display

```
----------------------Parameter Settings----------------------
System Command  : On              Tx Freq     : 6240   Atten : 20
SSPA Activate   : On              Rx Freq     : 4015   Atten : 10
SSPA Inhibit    : Off             Cable Comp  : 0
Echo            : Off             Impedance   : 50
Ref. Override   : Off             IF Freq     : 70
SSPA Mode       : Extended        Faults      : LNA  - Enable
SSPA Comp Type  : 5720-40                       FAN  - Enable
Conv Comp Type  : 5700AVG                       SSPA - Enable
Packet protocol : Codan           Packet addr : 0 (00H)
Power Up        : Last State
--------------------------------------------------------------

        For actual transceiver status use VSS command
--------------------------------------------------------------

----------------------System Status-------------------------
System      : On                  SSPA : On          Tx IF  : On
Summary SSPA Activate: On         Enabled Logging :  Faults - Off
Summary SSPA Inhibit : Off                           Status - Off
Reference Osc.       : Warm                          Lock   - Off
                                                     Temp.  - Off
--------------------------------------------------------------
```

# Codan Fault Display

- "VFS" shows current faults, should match looking at the red LEDs in the converter window.

```
--------Fault Status--------
Converter    :  OK
LNA          :  OK
SSPA         :  OK
Temperature  :  OK
Fan          :  OK
----------------------------
```

# RF Failures/Issues

- Converters and amps fail too often, BUCs seem more stable
  - Keep spares on board if you can
  - Usually swap both amp and converter
- Common failure modes include:
  - Varying power level as SSPA attenuators get flaky
  - Tx flickers rapidly (faster than SpecAn can show sometimes)
  - Tx turns off entirely (sometimes temporary due to heat)
  - Fuses blow

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- MODulation and DEModulation
  - Translate data packets of 0s and 1s into RF waveform wiggles
  - And back again on the other end (need pairs of modems to be useful)

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- MODulation and DEModulation
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  - And back again on the other end (need pairs of modems to be useful)
- 2 carriers involved…uplink and downlink
- Parameters are:
  - Frequency (Tx and Rx)
  - Data rate (Tx and Rx)
  - Forward Error Correction (FEC, Tx and Rx)
  - Power level and Tx mode (On/Off/RTI)
  - Spectral Inversion
  - Test Modes (Loopback, CW, etc.)

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- Rx parameters (Bit Error Rate)
- Panel lights (Fault, Rx lock, Tx on/off, Online, Stored Events)
- Error log and stored events
- Serial port interface (EIA-530 is RS-422 in DB-25 package)

# Modems

- 9797/4996 antennas use Comtech CDM-550 modems for 70 MHz IF
- 4006/6006 antennas use Comteh CDM-570L for L-band IF
- Earth station uses CDM-550 and CDM-570 modems
- CDM-570s are the replacements for the 550s, but have some additional built-in support for:
  - Web and SNMP M&C support
  - Router clocking (No dongle)
  - IP feature expansion

# L-band additions

- Block Uplink Converter
  - Power DC
  - 10 MHz reference oscillator
  - FSK comms
  - Address
- Low Noise Block downcoverter
  - Power
  - 10 MHz reference oscillator or PLL (Phase Lock Loop)
  - Local Oscillator frequency

# Features we don't use

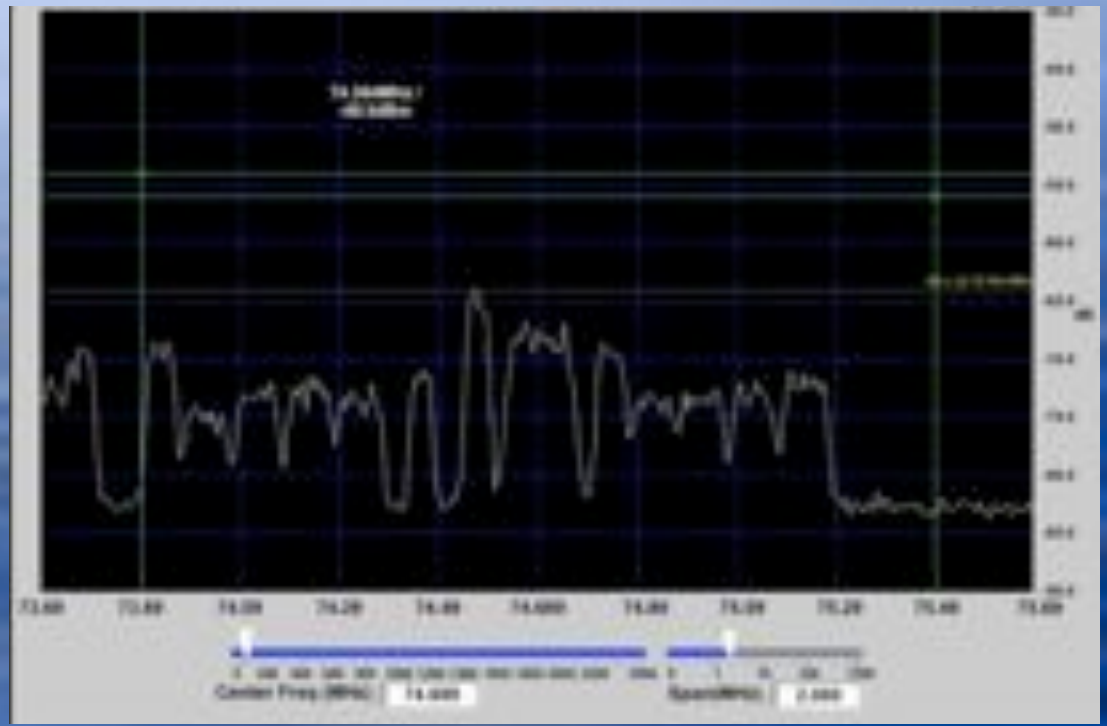
- Automatic Uplink Power Control (AUPC)
  - Auto power level adjust based on the quality of the signal we receive
  - Used to compensate for rain fade
  - Would reduce usable bandwidth by 10% or so
  - We cannot use it since we move around…power level change based on location is part of our bandwidth contract.
- Remote EbNo
  - Prevented by shared shore-to-ship carrier
- Alarm masks
  - Opens and closes pins on the 15-pin alram interface on the back panel.
  - Really…would you monitor your alarm port?

# Modem Troubleshooting

- Generally quite stable, few problems with modems, usually not catastrophic
- Settings, settings, settings! They change...mysteriously!
- Cables connected
  - Serial dongle for CDM-550s
- Check for solid signal with SpecAn
- Monitoring with Web/SNMP for CDM-570L

# Spectrum analyzers

- aka "SpecAn"
- Measure energy in a given frequency bands
  - Axes are frequency (x-axis) and RF energy (y-axis)
- Controls are
  - Frequency (where the center of the plot is)
  - Span (how wide the plot is)
  - Amplitude (how tall the carriers are)
- Shows what is happening in space. Sensitive to antenna size and footprint position!



# Spectrum analyzer use

- Troubleshooting and system monitoring
- They tell you:
  - How good a signal is
    - On/off the air
    - Quality/Level (shoulders? short? relative to other ships)
  - What your antenna is seeing
    - What kind of carriers
    - Which carriers
    - What satellite
- All ships should have one to help see what is going on with your antenna

# Outline

- Safety
- Equipment (Purpose, expectations, diagnostics, etc)
  - Antenna
    - DacRemP
    - Air conditioner
  - RF gear
  - Modem
  - Router
- Troubleshooting the system
- Special procedures
- Case studies

# Routing Equipment

- Routers exist to move some stream of binary data into IP packets that can be sent over computer networks
- Ships use several models of Cisco routers to translate between synchronous serial streams at the modem and ship IP networks
- Ciscos are very flexible
- Routers have many ports:
  - Serial on modem side
  - Ethernet on network side
  - Possibly several more (SWAP, 3G, may ship nets, etc)

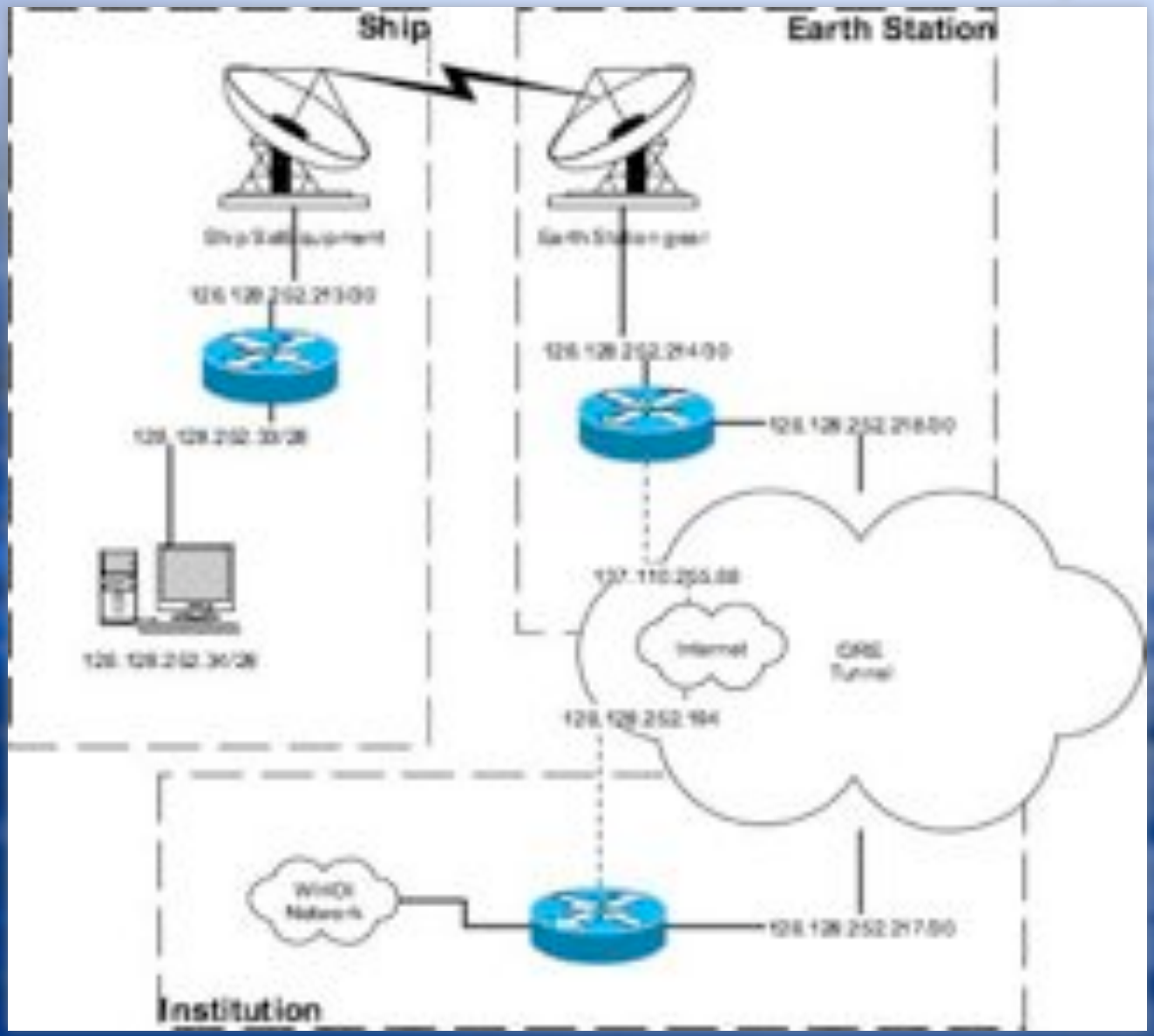
# Diagnostics

- Routers tend to run quietly along for long periods of time
- May have blinking lights when data goes through a port (see the serial port for its own green light)
- Requires power and ALL cables connected to work
- Has a running configuration
- Has a serial console (9600bps 8N1 usually, requires special RJ-45 cable)
- Errors and boot messages show up on the console
- Can login and ping/traceroute from inside the router, but be sure to specify the source port.
- Ciscos can get a little tricky to work with

# HiSeasNet Subnet Layout

- DMZ (subnet before firewall) is usually a /29 (5 usable addresses + router/gateway) or, better yet, a /28 subnet (13 usable addresses + router/gateway)
- Sat P2P (between ship and earth station) is a /30 subnet
- Tunnel P2P (between earth station and home institution) is a /30 subnet. Physical end points are internet hosts, logical addresses in tunnel are /30.
- All three of these subnets come from **home institution address space** be it public or private. This is the key to making the ship appear as though it is part of the home institution network!

# Oceanus Example




- Ship DMZ
  .32 Net
  .33 Gateway
  .34-.46 Hosts
  .47 Broadcast

  Sat P2P
  .212 Net
  .213 Ship
  .214 Shore
  .215 Broadcast

  Tunnel P2P
  .216 Net
  .217 WHOI
  .218 SIO
  .219 Broadcast

# Accelerators

- HiSeasNet uses Expand 4830 and 4930 IP accelerators in the fleet
  - IP packet caching, sometimes web caching
  - TCP window faking
  - Compression on the fly
- Sits between router and rest of the network
- Silently intercepts packets destined for the Internet, tunnels them to shore accelerator (doing magic along the way)
- If it fails, the in/out Ethernet ports are shunted together.

# Typical Issues

- Sometimes routers freak out due to software bug or hardware issue
- Reboots may be helpful (watch the console) and take a while
- Cables got unplugged during work in the rack...look for link lights.
- Modem link is down (because connection is bad)
- Problem at the earth station or campus

# IP troubleshooting

- Use standard tools like ping and traceroute to poke along the path
- mtr might get through a little better
- Packet sniffers like tcpdump and wireshark sometimes help
- MRTG, Cricket, smokeping, Nagios, Intermapper, and others may help with monitoring

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# System-wide troubleshooting

- Split the problem into tracking or not tracking
  - Lots of moving parts to fail
  - Lots of seemingly quirky behavior with the antenna
  - Lots of day-to-day issues with neighboring satellites if antenna params are not tuned well.
  - Sometimes tracking looks like a signal problem
    - If tracking is bad, modem will have trouble since you cannot get a stable lock on the satellite.
- **Only when tracking is good can one really focus on other problems.**

# System-wide troubleshooting

- Power cycles sometimes help...lots of bits talking to other bits, easy to get out of sync
- Break down the symptoms
  - Tracking? Modem connection? Routing? Interference?
- Check the settings
  - We do maintenance visits for a reason
  - Buttons get pushed. Or not. But settings change. Magically.
- Trace the path (Rx, Tx, packets, whatever)

# Requirements for data flow

1. The antenna needs to see the satellite
   - Stable, preferably tracking, no obstruction, solid AGC over THRS
2. Modem needs Rx light on (green)
3. Modem needs Tx light on (green)
4. Modem needs an EbNo over 3.5 or so
5. Proper cabling
   - Coax in and out of modem
   - Data cables (with dongle on 550s)
6. Router needs to be on, connected to **Ethernet**

# Getting good help

- I aim to reduce the number of exchanges we have for convenience.
- I try to give explanations and options in my emails should we not be able to communicate again
- Remember that I cannot see what you see. You are all of my senses out there.

# Good help YES

- **Complete** information of your situation
  - Tracking info AND modem AND data flow AND weather/ship stuff.
- If you don't know something, offer more info rather than less
- Tell me about changes and what was happening
- Tell me what you have done so far
- Tell me how long it has been happening or when you noticed something
- Check your parameters
- Answer my questions. All of them. Really.
- Humor me...Ive seen crazy things happen over the years and want to rule some of them out.

# Good help NO

- Don’t just focus on one thing (DAC, modem, etc.)...its a system
- Don’t ignore my questions or answer different ones. I ask for a reason that may not be obvious at first.
- Don’t flail with the gear...ask for help or look in manuals
- Don’t sail without knowing location of spares, manuals, and latest maintenance report

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# Procedures

- Changing satellites/beams
- Adjusting levels
- Ku-band ships going to the edge of the beam
- Expanding bandwidth with multiple slots
- Expanding bandwidth with additional lease
- Securing your transmit

# Changing Satellites/Beams

- Many forms of this procedure
  - Moving to a new ocean area and need a new satellite or beam
  - Moving to a new frequency in the same beam (we get reshuffled sometimes)
- A change document can be generated with step-by-step instructions
  - Usually involves DAC, modem, and/or amplifier changes.
  - Sent out at least a day in advance
- Timing may or may not be critical. Generally all works when both ends have changes made to them.

# Typical Sat Change

- Shut down transmit at the modem
- Make frequency changes to the transceiver
- Change the DAC to track a new frequency and see a new satellite
- Change the modem settings to send/ receive new frequencies and data rates
- Adjust power levels
- May tweak router if there is a major change to data rate

**Programming Changes for the June 2012 IS-707 (AOR) to NSS-9 (POR) Satellite move for R/V Melville**

**Overview**

We need to move the Melville from one set of frequencies on Atlantic Ocean satellite (IS-707) to a set of frequencies on the Pacific Ocean satellite (NSS-9). We also need to change the tracking position and shore-to-ship data rate since the satellite carriers are not the same data rates. This change requires modification of the shipboard antenna tracking parameters in the SeaTel DAC, the Codan transceiver Tx frequency, and the Comtech modem frequencies and data rates for the Melville.

**Changes to the configuration can happen at any time, but will only be working when both the earth station and the ship have made their changes. Be sure to have an Inmarsat/Iridium phone available if you have any trouble. Should there be catastrophic trouble of some sort, changing the ship settings to point back to the previous values on the AOR satellite will NOT be enough to restore service. Routing changes will also need to be made at the SIO earth station to get the ship completely back to the IOR service (unless the satellite is out of view). Steve Foley's phone number is 858-822-3356. If you are still having trouble 1 hour after the designated time and have not been in touch with Steve, try Geoff Davis at 858-822-5756.**

To navigate the Comtech modem's menus, press the back key to go to the previous menu. The enter key should go into the selected menu. The screen with the serial number on it is the first screen. The arrow keys should move the cursor until it is over the desired menu, number, or option. For more information about changing Comtech or DAC settings, see the respective manuals.

**Codan Transceiver Changes**

1. Connect to the Codan 5700 transceiver (aka converter) in the dome (possibly using the magic RS-422/RS-232 connector) via the DB-9 connector on the octopus cable in the lab or via the short Codan-supplied DB-9/MIL connector to the Control or M&C port on the transceiver in the dome. The transceiver is the rectangular box with a clear Plexiglas window on one of the antenna arms. The serial link should be 9600 baud, 8N1.
2. Hit enter a couple of times to get a ">" prompt from the Codan gear.
3. Enter the command "VPS" and look for the transmit frequency. It should be "6320".
4. Enter the command "STF6240" to set the transmit frequency to 6240.
5. Enter the command "VPS" and verify that the transmit frequency is 6240. The receive frequency will set itself to the correct value when the transmit frequency is set.

**DAC Controller Changes**

1. Set the DAC's AGC Frequency to 55.400 MHz (it should have been 66.242 MHz)
    a. Note the AGC value before making a change.
    b. Select the SAT/RCVR mode by pressing the "SAT" key.
    c. Select the IF input using the "NS/EW" key.
    d. Key in the frequency (55.400 MHz). That is 55 MHz and 0400 KHz.
2. Set the DAC's satellite to 183 degrees East (NSS-9's location)
    a. Select the SAT/RCVR mode by pressing the "SAT" key
    b. Select the IF input using the "NS/EW" key until the satellite longitude is the only thing showing (the old longitude should be "307E")
    c. Key in the new satellite longitude by pressing "1", "8", "3", "[enter]" and "NS/EW" to toggle the hemisphere to E if needed
3. Search for the new satellite (can usually be done by pressing "MODE", "MODE", "[up arrow]"). Wait until the satellite is being tracked. If it does not after 5-10 minutes, you may need to re-enter the satellite longitude, increase the azimuth a few degrees, and search again. If that does not find the satellite, re-enter the satellite longitude, decrease the azimuth a few degrees, and search again. If you are still having trouble finding the satellite, try doing the same adjustments with elevation instead of azimuth. It may also help to set your "SEARCH LIMIT" value to 200 (it may be 120 or so) and try searching again with a wider search limit. When you do find it, note how far off the initial search lat/lon is from where the actual satellite is. This difference can be used to adjust trim values if needed.

# Setting Levels

- Ship tech gets on IM with HSN staff (Steve)
- Steve connects to satellite operator
- As operator watches signal, Steve relays commands to the tech on the ship
  - May be adjusting Codan power level
  - May be adjusting Comtech power level
  - May be going into or out of test mode
- When everyone is happy, record new values
- This works well when ship tech is attentive and available via a backup link (FBB just in case?)

# Beam Edge Operations

- With C-band ships, the beam edge is the horizon. Once you get to the edge, you lose reliable sight of the satellite, not just your signal.
- For Ku-band ships, there is some fade at the edges but still decent look angle
- With a small ship antenna, the Tx side will fade before the Rx side does. There will be a time when the ship can see the shore signal, but not the other way around.
- To fix this, the ship can bump power up a little bit (up to about 3 dB) and still be heard for some extra range...
- **...BUT YOU MUST GRADUALLY TURN IT BACK DOWN AS YOU HEAD HOME!**
- Check the EbNo reporting page (http://anfmon.ucsd.edu/cgi-bin/ebnos.pl) as you move around. Let me know if it doesnt show your ship.

# Multiple Slot Expansion

- If 2 adjacent Ship-to-Shore slots are open at the same time, with some careful planning, ships may be able to Tx double the rate (ship-to-shore) by using both slots
- You must have a real need
- We cant do it for an extended period of time without a little planning
- You need to involve me
- You owe something (beer?) to the other ship that is giving up their slot

# Expanded Lease

- When you expand a lease for some period of time, Tx and/or Rx links will be boosted.
- When boosting bandwidth, most of the changes will be in the modem.
- Changes must be witnessed by satellite operator
- Levels must be set during that initial bring up, so be available and patient
- It takes a while to get leases done, so let me know ASAP
- Router may need adjustment if there is any traffic shaping being done. Make sure your computers are tuned for a long fat pipe.

# Securing your Transmit

- Maybe another ship needs the slot temporarily, maybe its an emergency request from the operator, maybe something else.
- Can be done at the modem (Tx Off) or antenna (power down the whole dome)
  - If you power down the antenna, **LASH IT DOWN!**
- Make a big note that the gear is offline for a reason and not to turn it on without contacting me.

# Homework

- Find your antenna manual and skim or read through it
- Find your latest maintenance report and look through it
- Look through the HiSeasNet wiki (http://www.hiseasnet.net/wiki), especially the FAQ
- Check out the DAC emulator
- Watch your antenna startup sequence
- Let me know if you have any questions

# Anything else?

- **What else do you want to see?**
- Case studies
- Specific procedures for equipment replacement
- More discussion in some areas