

# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

# INTERNATIONAL SPACE STATION (ISS) EARLY COMMUNICATIONS (ECOMM) NETWORK SUPPORT OVERVIEW

**Network Support Group**

Doug Lumsden  
Lockheed Martin  
GSFC Code 450  
February 11-12, 1998

# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### AGENDA

- **EARLY COMMUNICATIONS (ECOMM) FUNCTIONAL OVERVIEW**
- **ECOMM IT&V PROGRAM OVERVIEW**
- **GSFC ECOMM TRANSCEIVER TEST ACTIVITIES**
  - » **QUALIFICATION MODEL XCVR**
  - » **FLIGHT MODEL XCVR**
  - » **XCVR PERFORMANCE COMPARISON - TEST RESULTS**
- **NEAR TERM ACTIVITIES**
- **GSFC ECOMM SYSTEM/TRANSCEIVER TEST SUPPORT SCHEDULE**

## **ISS ECOMM NETWORK SUPPORT OVERVIEW**

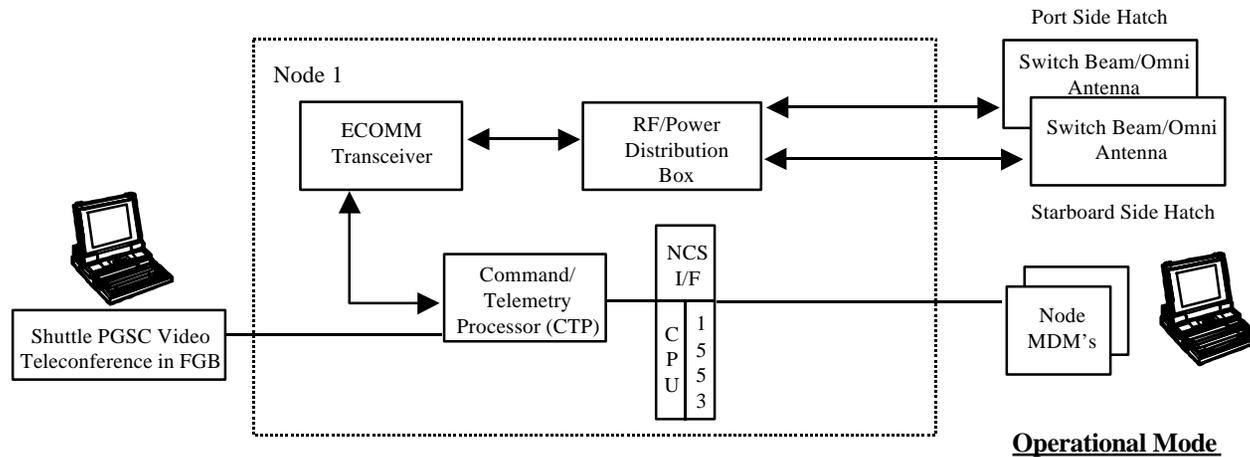
### **EARLY COMMUNICATIONS (ECOMM) FUNCTIONAL OVERVIEW**

- ECOMM Transceiver: Modified COTS Box to Meet JSC Schedule and On-Orbit Needs/Environment
- Provides Early S-Band Communications Prior to Baseline ISS C&T System
  - Two Way Command, Voice, and Telemetry Capability Independent of Russian Comm
  - KCA/OCA Type Two Way Video/Storyboard Capability on ISS
- ECOMM Lifetime Is Flight 2A (Node 1) to Flight 6A (Lab Activation) - 7/98 Through 7/99
- Stowed for Launch/Landing in STS Mid-Deck Lockers and Stowage Bags. Install via EVA/IVA.
- Equipment Placed in Node 1. Antennas Mounted on Node 1 Hatch(s) Exterior
  - Low Gain Omni-Directional Antenna to Support LDR Return Modes (6 / 20.48 Kbps)
  - A High Gain Active Switched-Beam Antenna to Support HDR Return Videoteleconferencing Service (128/128 Kbps)

# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### EARLY COMMUNICATIONS (ECOMM) FUNCTIONAL OVERVIEW - Continued



#### Operational Mode

<b>Forward</b>	
Date Rates:	128/6 Kbps (SSAF)
Data Format:	NRZ-L
Carrier Modulation:	UQPSK
Carrier Frequency:	2106.4 MHz
Polarization:	LHCP
Encoding:	Rate 1/2, Reed-Solomon
<b>Return</b>	
Date Rates:	128/20.48 Kbps (SSAR)
Data Format:	NRZ-L
Carrier Modulation:	BPSK
Carrier Frequency:	2287.6 MHz
Polarization:	LHCP
Encoding:	Rate 1/2, Reed-Solomon
SN Mode:	DG1, Mode 2

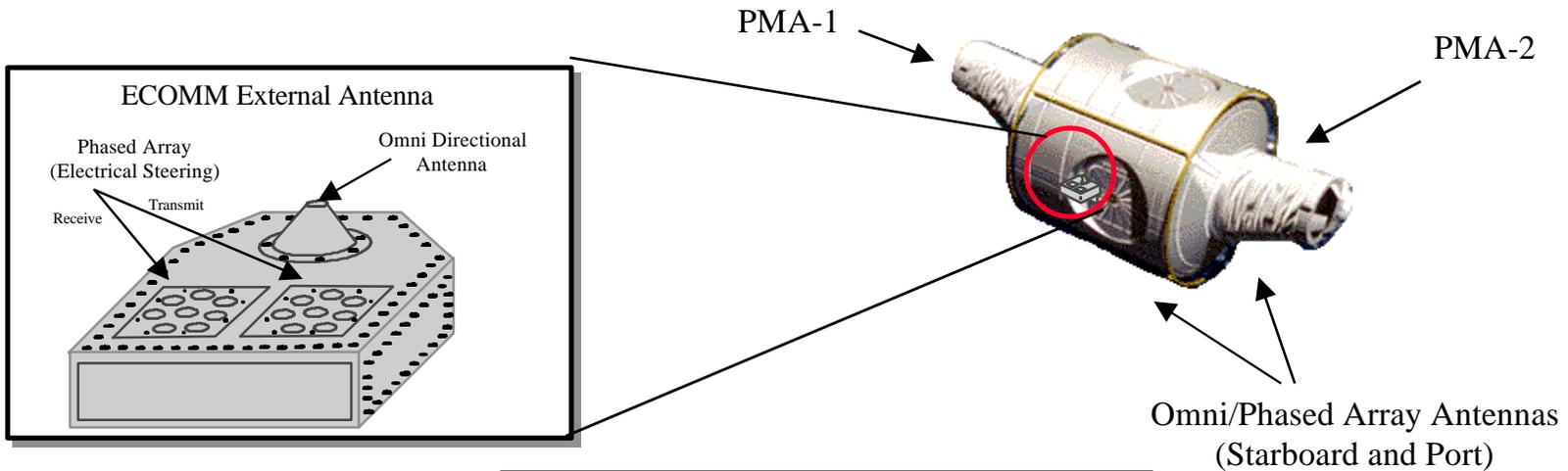
- **High Data Rate Operations**
  - 128 Kbps Downlink Telemetry, Voice, and Video
  - 128 Kbps Uplink Command, Voice, and Video
- **Low Data Rate Operations**
  - 20.48 Kbps Downlink Telemetry Data
  - 6 Kbps Uplink Commands and Data

# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

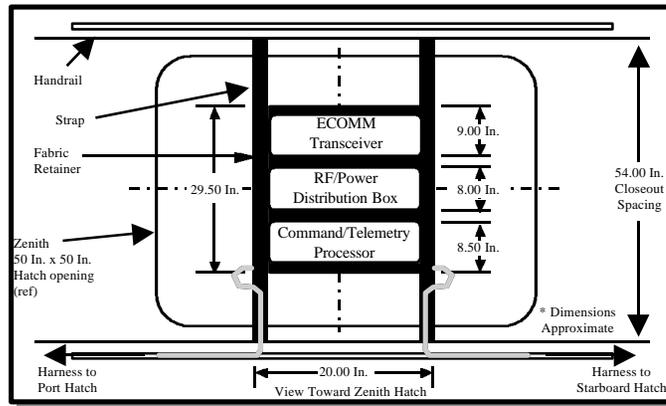
### EARLY COMMUNICATIONS (ECOMM) FUNCTIONAL OVERVIEW - Continued

#### NODE 1 OUTFITTING



#### Node ECOMM 1 Outfitting

Node 1 ECOMM  
Internal Outfitting

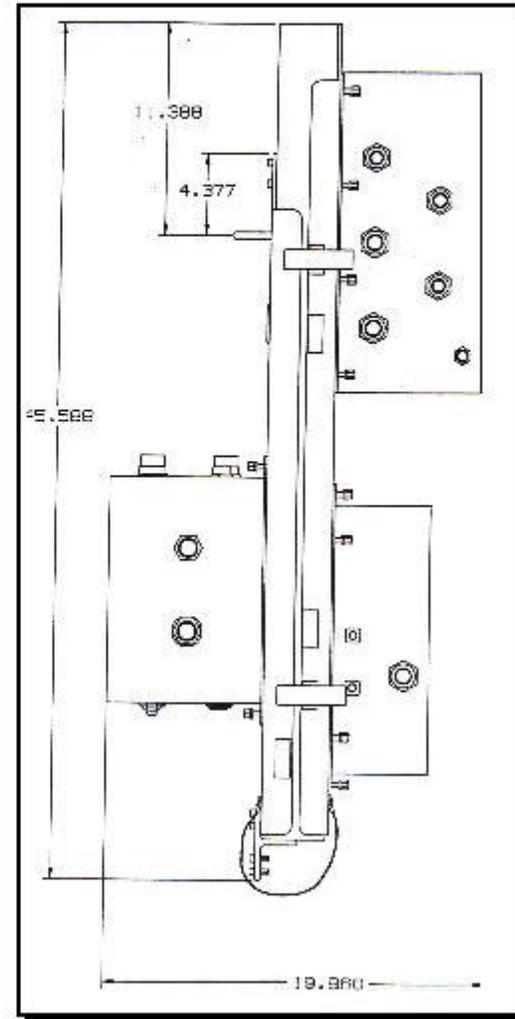
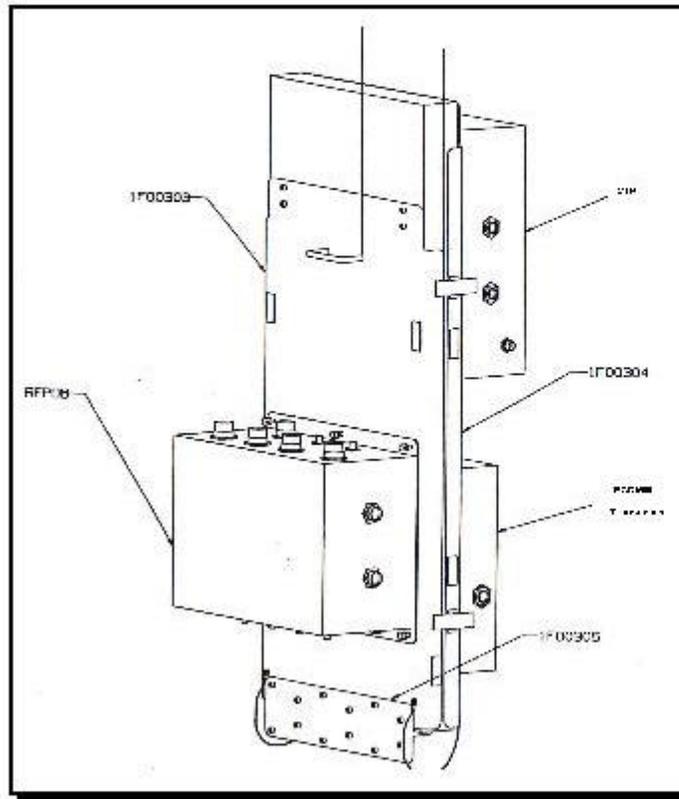




# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### EARLY COMMUNICATIONS (ECOMM) FUNCTIONAL OVERVIEW - Continued



# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### ECOMM VERIFICATION PROGRAM OVERVIEW

### On-Orbit Checkout

Entering into CE2A

### Cargo Element Tests @ KSC

### System Integration Tests @ JSC

### Unit-Level Testing @ GSFC & JSC

#### • Vendor Acceptance Test

- Box-Level Spec/ Requirement Verification

- Acceptance Testing

- Functional & Performance Test
  - GSFC (Transceiver)
  - JSC/GSFC (EMI, Thermal)\*
  - Indiana Univ (radiation)
  - White Sands (toxicity)

\* JSC responsible for Transceiver Acceptance/Environmental Tests on Engineering Unit and Qual Unit. GSFC will conduct Transceiver Acceptance/Environmental Tests on Flight Units.

- System Integration
- Detailed Performance
- ESTL End-to-End with Testbed
- ESTL End-To-End with TDRSS
- HSI Testing at ESTL

- Fit Check (Astronaut Installation)
- Power Up Tests
- CTP/MDM Checkout
- Radiation Test (Hat Coupler)
  - View RF Spectrum in LDR/HDR

- RF End-To-End with TDRSS
  - Send Commands from MCC
  - Radiate TLM from ECOMM to MCC
  - Command to HDR and verify two-way videotelecon

- No STS DTO's are Planned
- Antennas Installed FD7 on EVA 2
- Internal Node Elements and cabling installed FD8 (Node Ingress)
- System Powered up and Checked out

- Functional HDR Checks
- Functional LDR Checks
- Antenna Characterization after crew departs Node

- System Left in LDR Mode

GSFC Activities for XCVR Flight Units

GSFC/SN Involvement

## **ISS ECOMM NETWORK SUPPORT OVERVIEW**

### **ECOMM VERIFICATION PROGRAM OVERVIEW - Continued IT&V HIGHLIGHTS**

- ECOMM Xcvr Delta CDR Sept 1997
- Qualification Unit Xcvr Testing Completed at GSFC Compatibility Test Lab in Nov 1997
- ECOMM RF End-to-End Test Through TDRSS Conducted at JSC in Oct and Dec 1997 with data flow to/from the ISS Mission Control Center
- Flight Unit #1 Xcvr Environmental Test at GSFC (Vendor Thermal Vac) in Dec 1997
  - Key Event Successfully Validating the Performance of the Thermal Control System
- Commenced Flight Unit Xcvr Testing at GSFC Compatibility Test Lab on Jan 7, 1998
  - FU #1 TDRSS Compat Test (January 7 - 21)
  - FU #1 Workmanship Vibration Test (January 23-29)
  - FU #1 Thermal Test (February 4-6) - followed by TDRS Pre-Ship Testing Feb. 9
  - FU #2 Workmanship Vibration Test (early February 1998)
  - FU #2 TDRSS Compat Test (February 1998)
  - FU #2 Thermal Test (February 1998)
- ECOMM Cargo Element Integration Test (CE2A) (Feb - March 1998)

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### **ECOMM VERIFICATION PROGRAM OVERVIEW - Continued**

#### TRANSCEIVER ENHANCEMENTS

- ECOMM Transceiver Qual Unit and Flight Unit Changes from the Engineering Unit
  - Mechanical Design (Epoxy Paint and Electrical Bonding Requirements Met )
  - Frequency Separation (Separate Receive and Transmit Reference)
  - Reconfiguration of the Backplane (Simplified Design)
  - Thermal Control Design Modification (Heater Boards Redesign & Variable Speed Fan)
  - Latch-Up Board (Developed by JSC and Installed in Xcvrs by JSC After GSFC Delivery)
    - » ECOMM XCVR Not Rad Hardened and Digital Signal Processor (DSP) Chips Suseptible to Proton Radiation
    - » Latch-Up Board Detects XCVR Latch-up (Sudden Current Draw) and Powers Off the System for Protection

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### GSFC ECOMM TRANSCEIVER MILESTONE EVENTS QUALIFICATION MODEL XCVR

- Compatibility Testing, Phase Noise Testing, and VSWR Testing Completed at GSFC
  - Significant Performance Improvements over Engineering Unit
- Radiation Testing at University of Indiana & Texas A&M
  - As with the EU, DSP Susceptibility Encountered, JSC Latch-Up Board to Correct
- Acceptance Environmental Testing at JSC (Integrated ECOMM Components on Mounting Plate)
- Cargo Element Testing (CE2A) at KSC\*

\* Qual Unit used for first CE2A, Flight Unit to be used if a second CE2A is conducted as planned

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### GSFC ECOMM TRANSCIEVER MILESTONE EVENTS

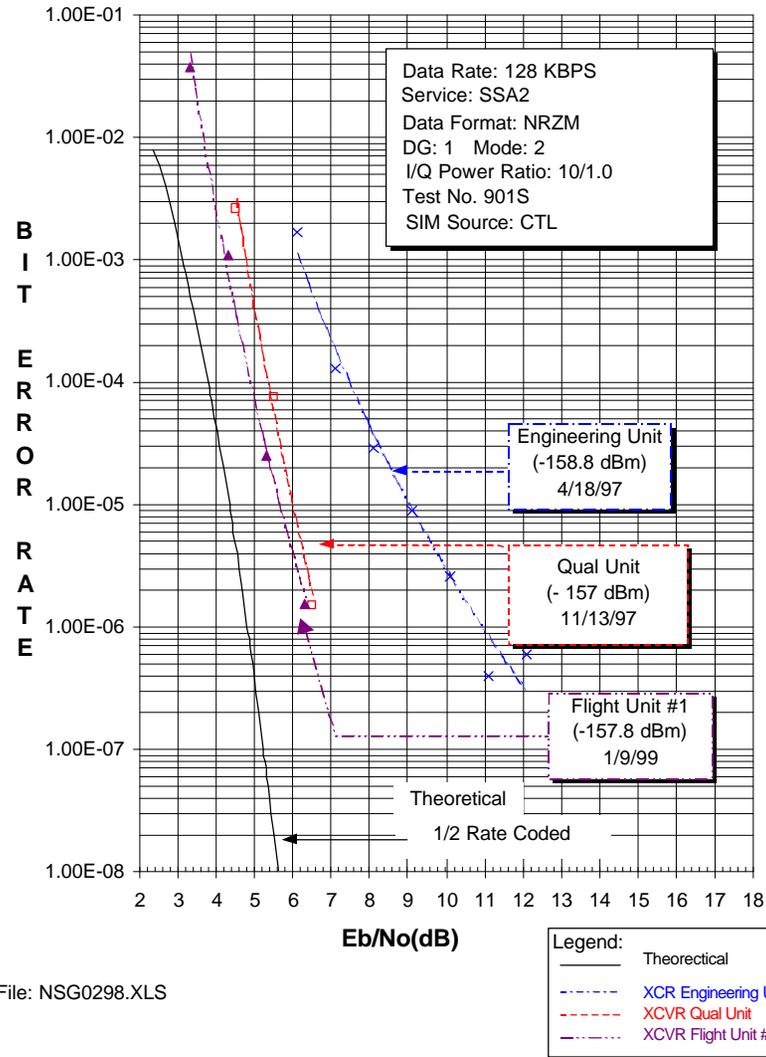
#### FLIGHT MODEL XCVR

- ECOMM XCVR Flight Unit #1
  - Vendor Thermal Test Conducted at GSFC (Prior to Official Delivery)
    - » Successfully Verified Performance of the Thermal Control System
  - Workmanship Vibration Test
    - » First Vibration Test Resulted in Two Cracked Capacitors. Capacitors Replaced and Retested. No Impact to RF Integrity
    - » Second Vibration Test Conducted Successfully
  - Acceptance Thermal Vacuum Testing Completed Successfully at GSFC
- ECOMM XCVR Flight Unit #2
  - Experience from XCVR FU #1 Lead to Early Workmanship Vibration Test upon Delivery to GSFC. Anomaly Detected with Fan Blade Counterbalance & Solder Crack
  - Second Vibration to be Completed This Week
  - Progress on with Remainder of Testing

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### XCVR PERFORMANCE COMPARISON - TEST RESULTS

**HIGH DATA  
RATE  
FORWARD LINK  
BER  
(EU, QU, & FU #1)**

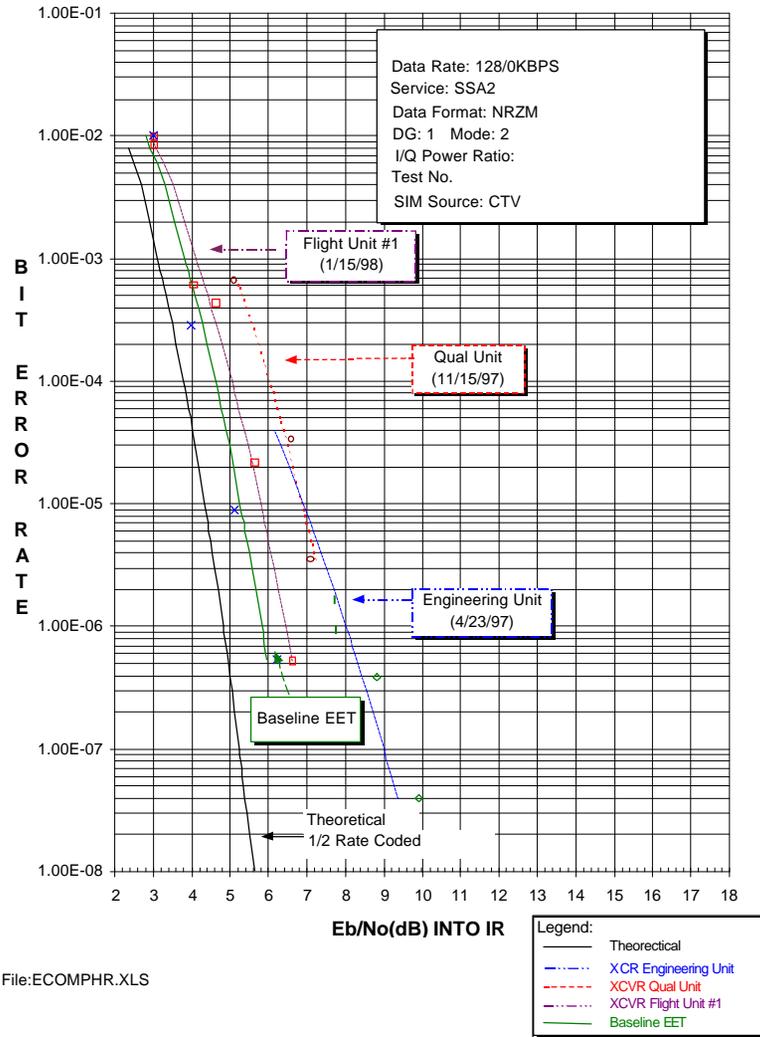


File: NSG0298.XLS

# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW XCVR PERFORMANCE COMPARISON - TEST RESULTS

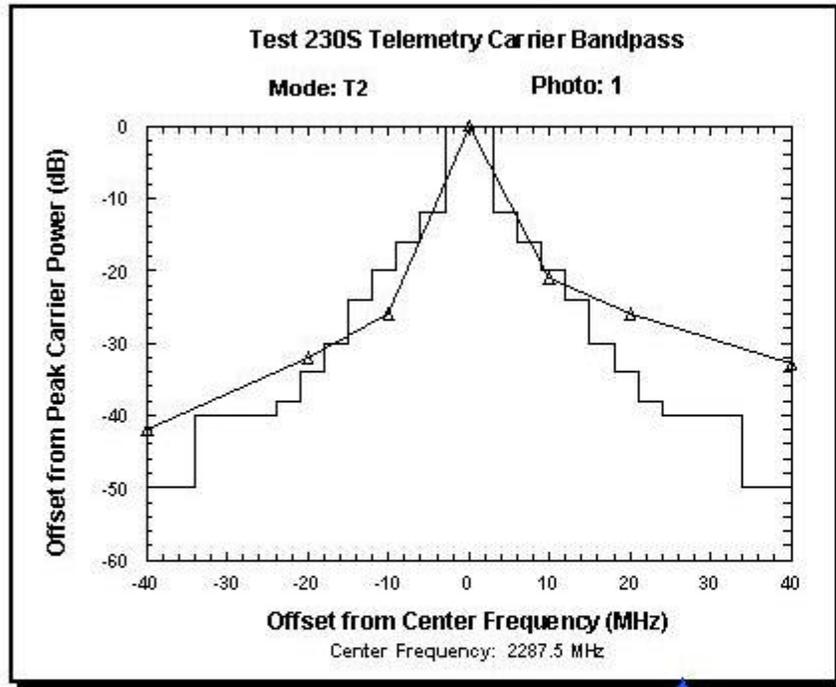
**HIGH DATA RATE  
RETURN LINK  
BER  
(EU, QU, & FU #1)  
-157 dBm**



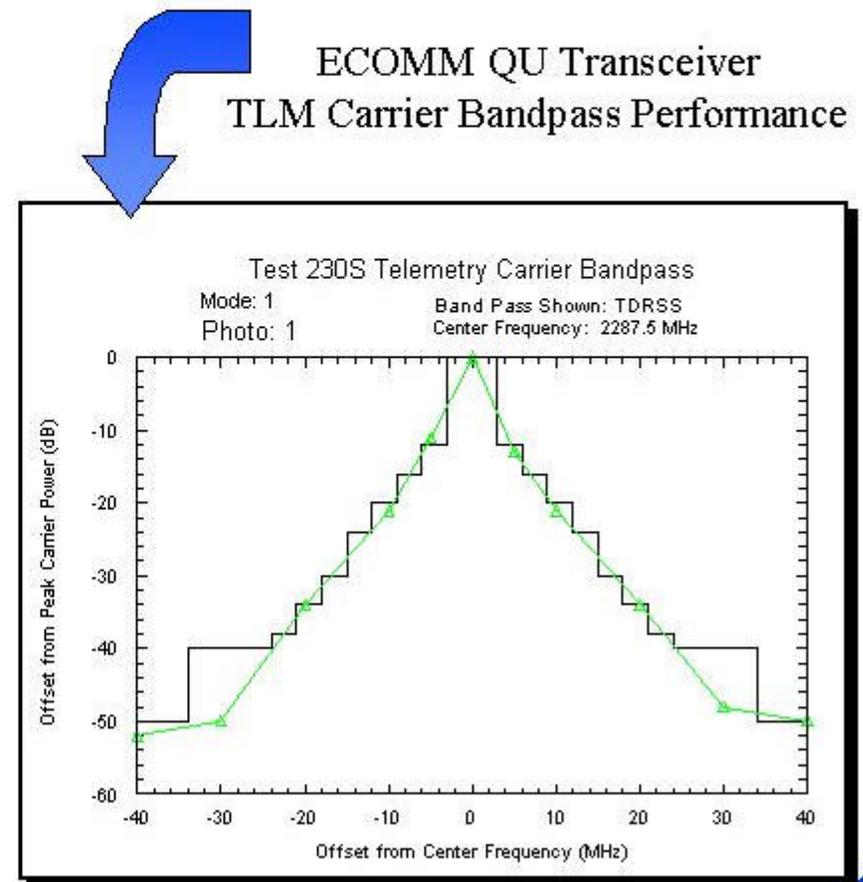
# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### XCVR PERFORMANCE COMPARISON - TEST RESULTS

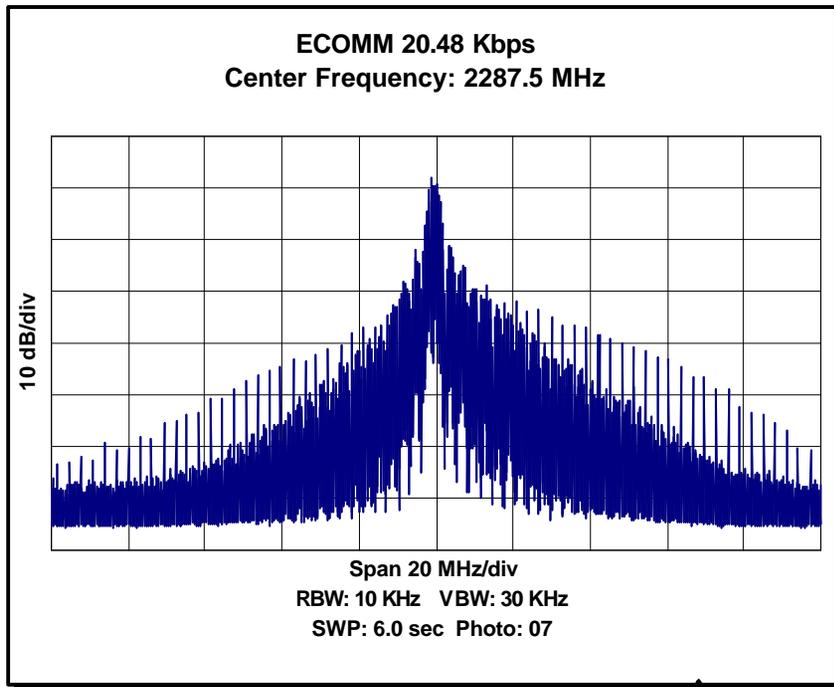


ECOMM EU Transceiver  
TLM Carrier Bandpass Performance

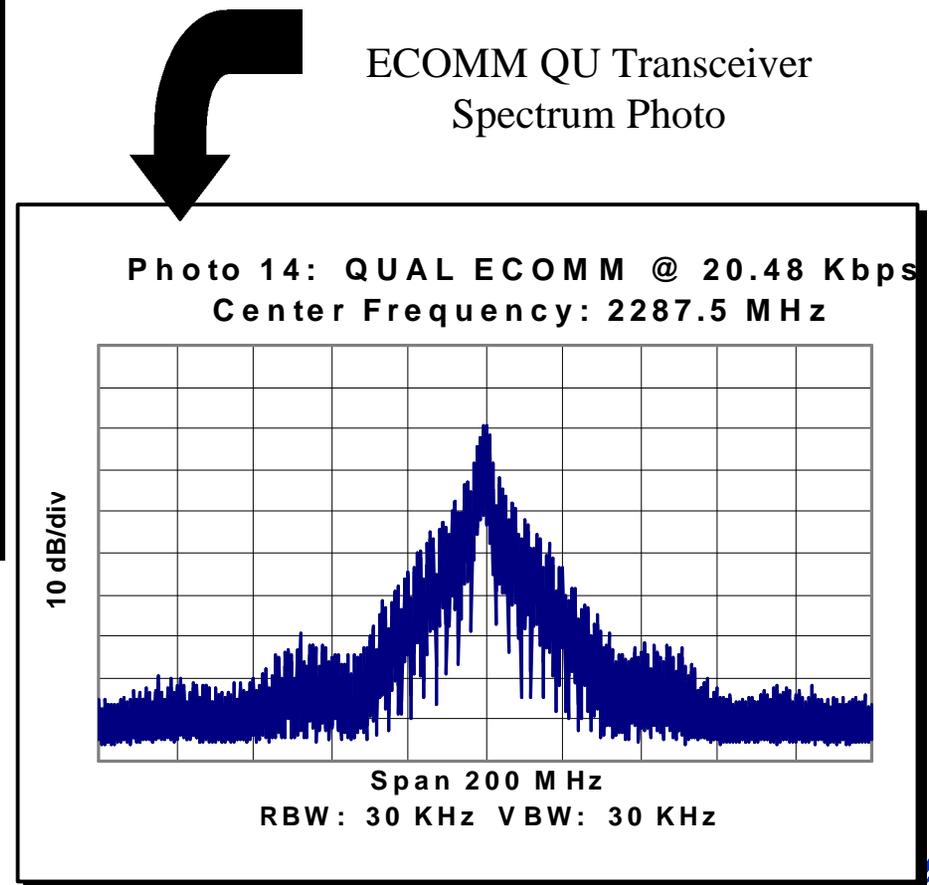


## ISS ECOMM NETWORK SUPPORT OVERVIEW

### XCVR PERFORMANCE COMPARISON - TEST RESULTS



ECOMM EU Transceiver  
Spectrum Photo



# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### NEAR TERM ACTIVITIES

- FU #1 Delivered to JSC for Completion of Acceptance Testing Activities and Eventual Shuttle Stowage Processing
- Complete FU #2 Testing at GSFC
  - Compatibility Testing
  - Phase Noise and VSWR Testing
  - Thermal Acceptance Testing
- Cargo Element Flight 2A Testing at KSC
  - Two Test Periods Being Discussed
  - February Test Period to use ECOMM Transceiver Qual Unit
  - March Test Period to use ECOMM Transceiver Flight Unit #2
  - GSFC Operations Involved in CE2A testing for SN RF Testing



# Consolidated NMOS

## ISS ECOMM NETWORK SUPPORT OVERVIEW

### ACRONYM LISTING

BER	- Bit Error Rate	Kbps	- Kilobits Per Second
BPSK	- Binary Phase Shift Keying	KCA	- K-band Communications Assembly
CDR	- Critical Design Review	KSC	- Kennedy Space Center
CE	- Cargo Element	LDR	- Low Data Rate
C&T	- Command and Telemetry	LHCP	- Left Hand Circular Polarization
CNMOS	- Consolidated Network Maintenance & Operations Support Contract	MBPS	- Megabit Per Second
COHO	- Coherent	MCC	- Mission Control Center
COTS	- Commercial Off The Shelf	MDM	- Multiplex/Demultiplex
CPU	- Central Processing Unit	MHZ	- Mega Hertz
CTP	- Compatibility Test Plan	NCS	- Node Control System
dB	- Decibals	NRZ-L	- Non Return to Zero - Level
DG	- Data Group	NRZ-M	- Non Return to Zero - Mark
DSP	- Digital Signal Processor	OCA	- Orbiter Communications Assembly
DTO	- Detailed Test Objective	PGSC	- Payload General Support Computer
Eb/No	- Bit Energy to Noise Signal Ratio	PMA	- Pressurized Mating Adapter
ECOMM	- Early Communications	QU	- Qualification Unit
EET	- End-to-End Test	RAD	- Radiation
EMI	- Electro Magnetic Interference	RF	- Radio Frequency
ESTL	- Electronics Systems Test Laboratory	RFPDB	- RF Power Distribution Box
EU	- Engineering Unit	SN	- Space Network
EVA	- Extra Vehicular Activity	SSA	- S-Band Single Access
FGB	- Functional Cargo Block	SSAF	- S-band Single Access Forward
FU	- Flight Unit	SSAR	- S-band Single Access Return
GSFC	- Goddard Space Flight Center	STS	- Space Transportation System (Space Shuttle)
HDR	- High Data Rate	TDRS	- Tracking and Data Relay Satellite
HSI	- Hardware Software Integration	TDRSS	- Tracking and Data Relay Satellite System
I/F	- Interface	UQPSK	- Unbalanced Quadriphase Shift Keying
ISS	- International Space Station	VAC	- Vacuum
IT&V	- Integration Test and Verification	VSWR	- Voltage Standing Wave Ratio
IVA	- IntraVehicular Activity	XCVR	- Transceiver
JSC	- Johnson Space Center		