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X/K_a-Band Feed for the DSN Array

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Section 333:Communications Ground Systems

Agenda

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- Requirements
- Design Options
- Description of Prototype
- Measured Data
- Evolution to 12-Meter Antennas
- Test Plan
- Schedule

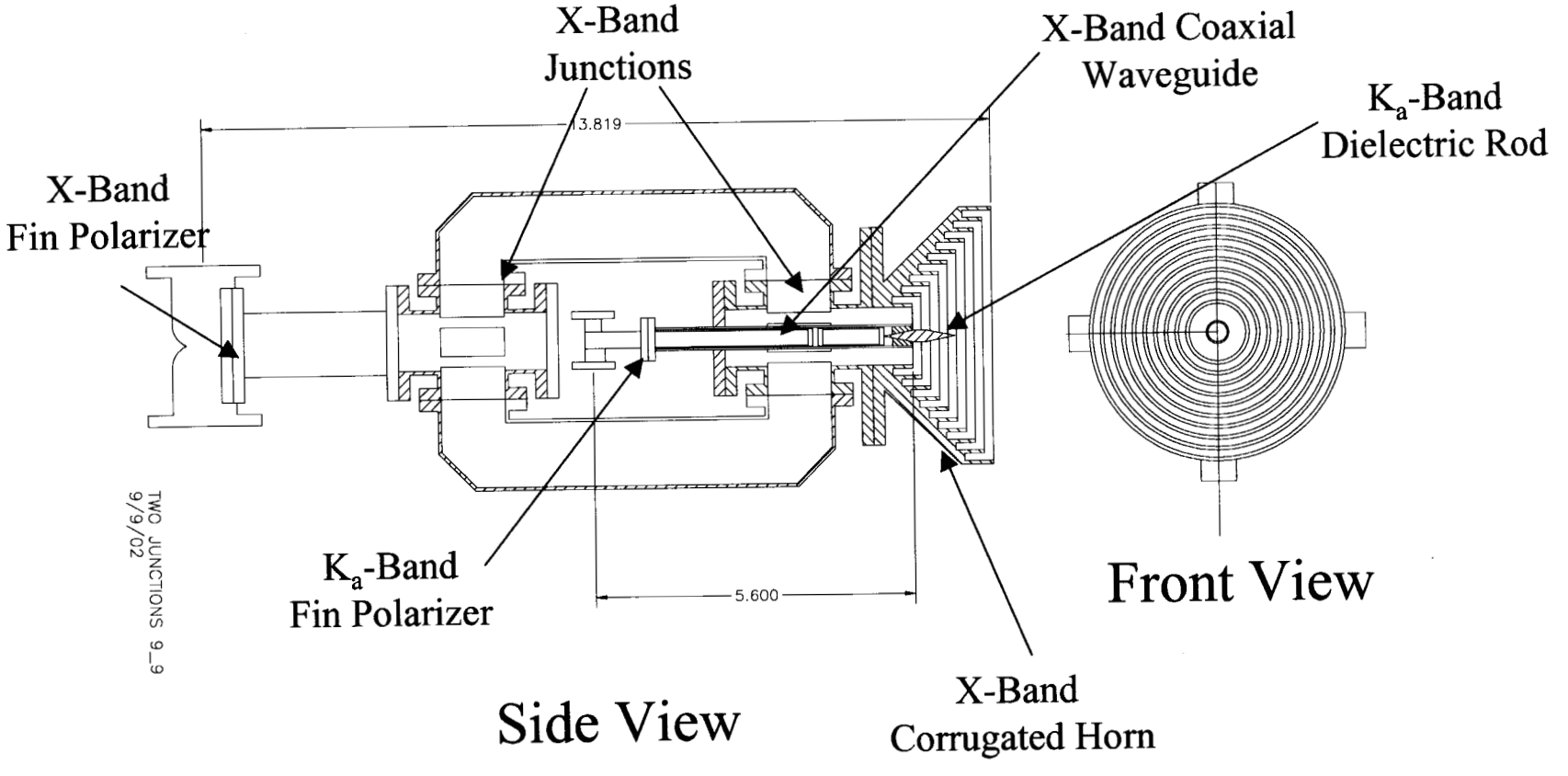
Requirements

Parameter	Source	Requirement	Performance	Req. Met	Compliance
Receive/Transmit	828-042 PAS195	Receive Only	Receive Only	Yes	Design
X-Band Bandwidth	828-042 PAS 71, 323	8.4-8.62 GHz	8.0-8.8 GHz	Yes	Measurement
X-Band Bandwidth	Self Imposed	8.0-8.8 GHz	8.0-8.8 GHz	Yes	Measurement
Ka-Band Bandwidth	828-042 PAS74	31.8-32.3, 37-38 GHz	30.0-40.0 GHz	Yes	Measurement
Ka-Band Bandwidth	Self Imposed	30.0-40.0 GHz	30.0-40.0 GHz	Yes	Measurement
Simultaneous Reception	828-042 PAS78,79,80	Dual Pol., Both Bands	Dual Pol.	Yes	Measurement
Ellipticity	Self Imposed	<0.75 dB 8.4-8.5, 31.8-32.3, 37-38 GHz	<0.75 dB	Yes	Design
Isolation	828-042 PAS171	< -30 dB @ Ant. Boresight, 8.5-8.62 GHz	-25 dB	No	Measurement
Return Loss	Self Imposed	< -20 dB, 30-40 and 8-8.8 GHz	< -20 dB	Yes	Measurement
Illumination	Self Imposed	Approx. -12 dB @ 42 Degrees, All Bands	Approx. -12 dB	Yes	Measurement
Mass Production	828-042 PAS 49-52	Consider in Design	Manufacturing Study	Yes	Design

Options Considered

- Frequency Selective Surface and Two Feeds
  - Simple Feeds
  - Difficult FSS, Large Beam Width and Bandwidth
- Coaxial Feeds
  - Slot-Coupled Jason II Style Feed
    - Single Polarization Design, Complicated Corrugation Design
  - Johansson All-Metal Design (1995 APS, pg. 1158)
    - Matching Difficulties, Complicated Corrugation Design
  - NRO S/X USNO-VLBI Dielectric Rod Design
    - Simple Corrugation Design (X-Band Only), Dielectric Rod Controls K_a-Band Radiation Characteristics

X/K_a-Band Coaxial Feed



Design Features

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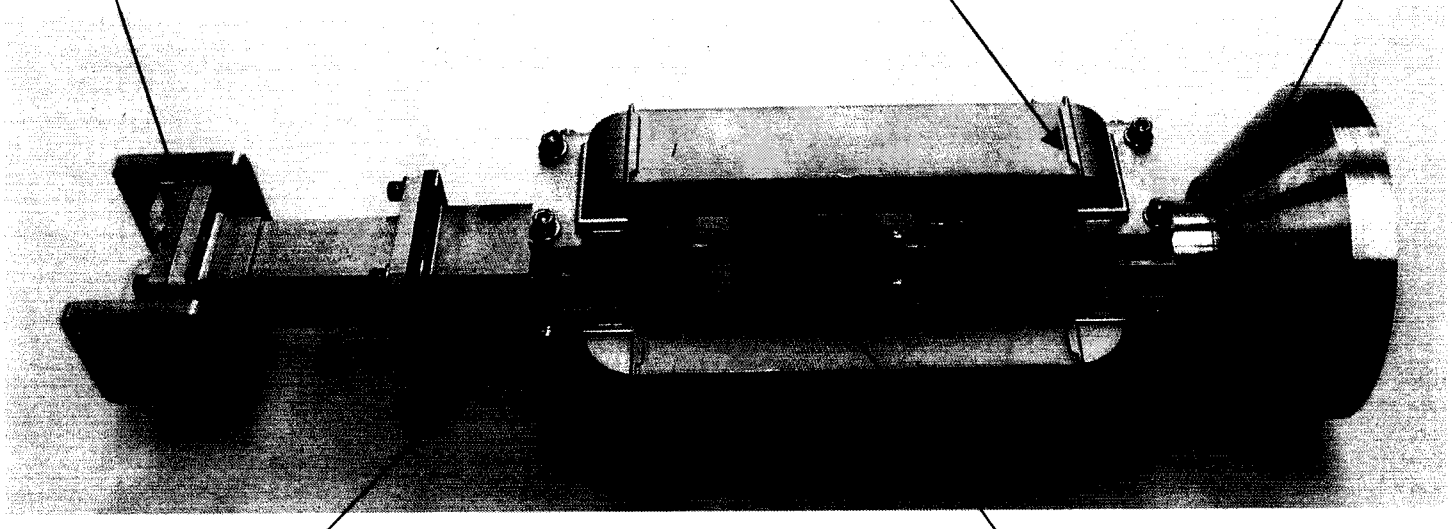
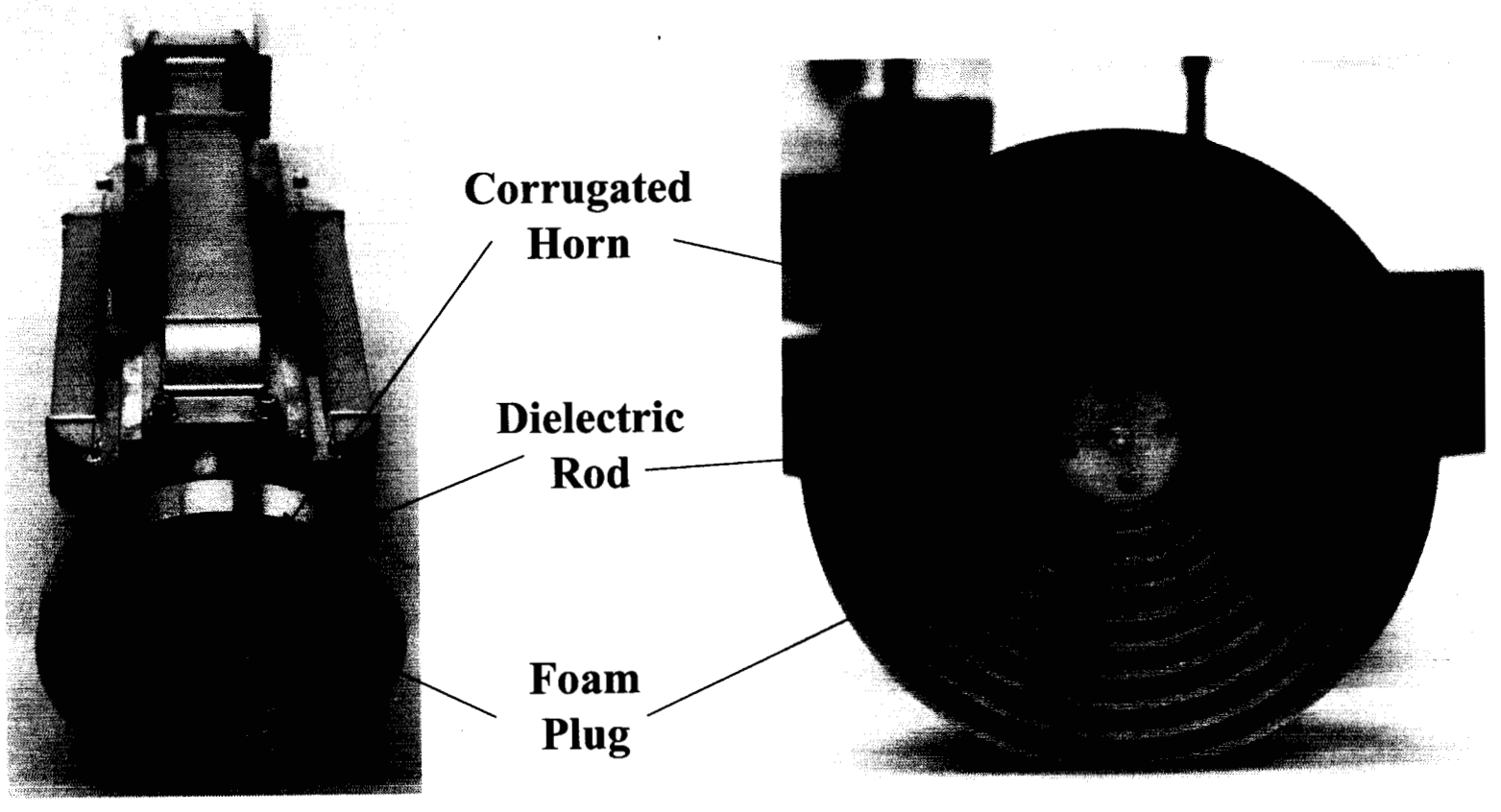
- Radiation Pattern at X-Band Controlled by Slot Depth and Flare Angle (Saturated Operation)
- Radiation Pattern at K_a-Band Controlled by Dielectric Rod Profile
- X-Band Enters Horn Throat Via TE_{11} Coax Mode (Narrow Band, 2 Iris Matching)
- K_a-Band Enters Horn Conventionally (Broad Band)
- X-Band $\Rightarrow$ Commercial Fin Type Polarizer
- K_a-Band $\Rightarrow$ Commercial Fin Type Polarizer

Breadboard: Side View



Breadboard: Front View



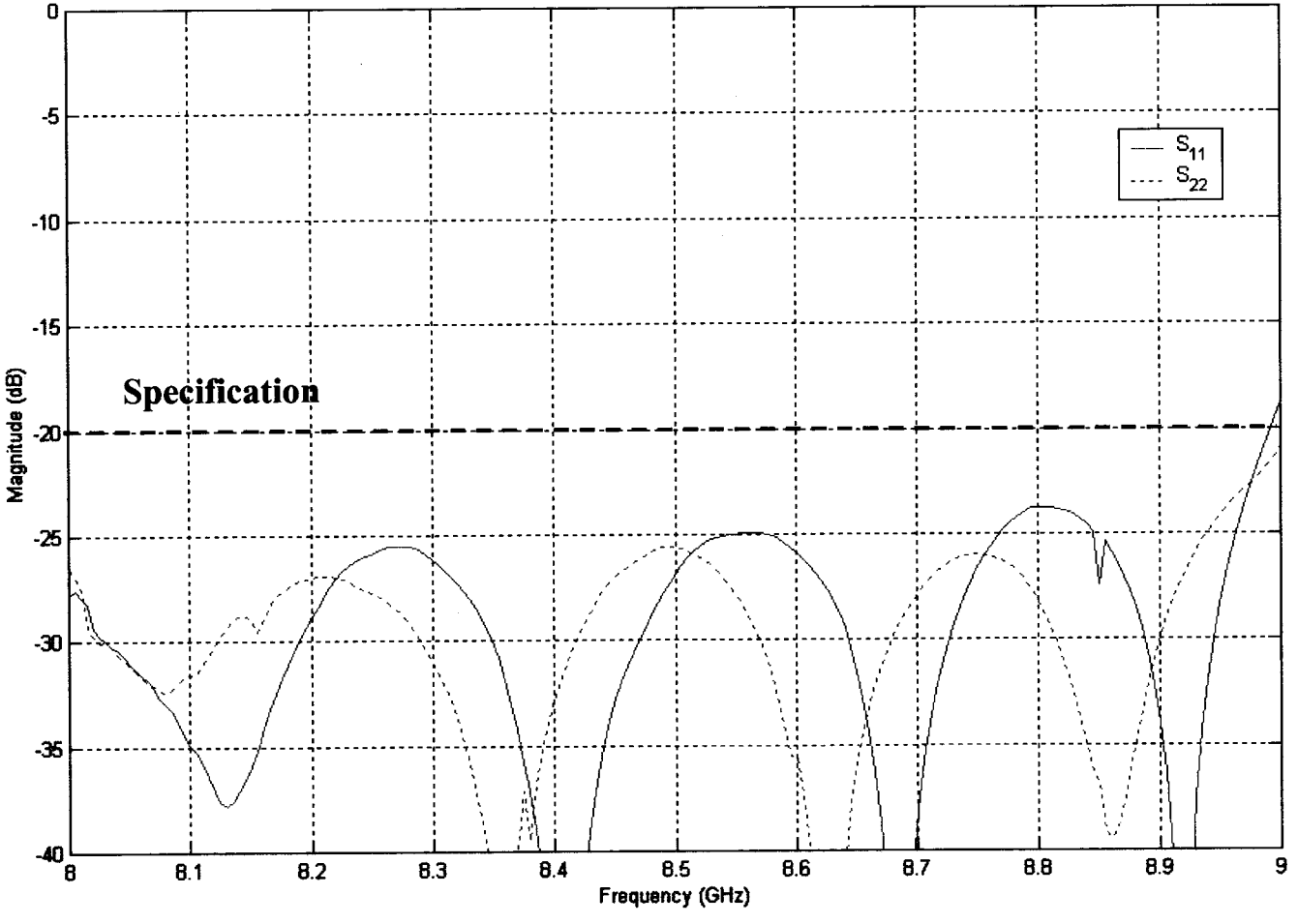
Prototype/Breadboard Status

- Return Loss of Prototype Feed Measured in Both Bands
- Linearly Polarized Radiation Patterns Measured Across Both Bands
- Selected Noise Temperature Measurements Have Been Made, To Be Discussed in Cryo Portion of Review
- Both the X-Band and K_a-Band Polarizers Have Been Received and will be Integrated into Breadboard Units
- All Other Components for the Breadboard Feeds are Available, 2 Units Assembled and Partially Tested
- Report on Feed Design Complete

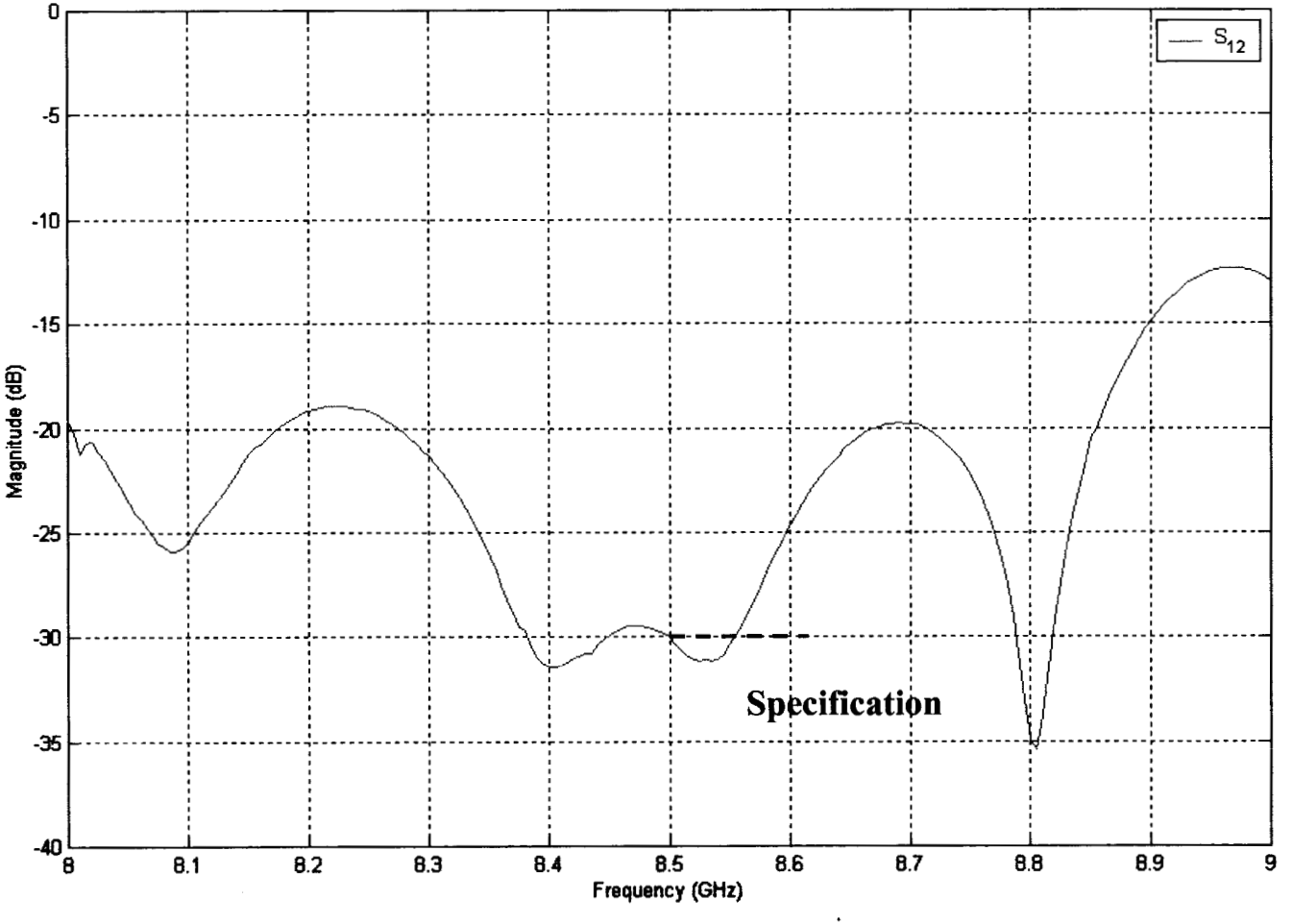
Fin-Polarizers

- Commercial Fin-Polarizers are Employed at Both X and K_a-Band
- X-Band: Catalog Item AMC 1869
  - WR-112 Inputs [RF Interface to LNA/Cryo]
  - 8-8.8 GHz, 1.2:1 VSWR, Ellipticity <0.8 dB, Isolation > 25 dB
  - All Units Delivered and In-Spec.
- K_a-Band: Custom Design, Item AMC 1866
  - WR-28 Inputs [RF Interface to LNA/Cryo]
  - 31.8-38 GHz, 1.2:1 VSWR, Ellipticity < 0.75 dB [31.8-32.3, & 37-38 GHz], Isolation > 25 dB
  - All Units Delivered, Out of Spec. on Isolation, Achieved 23 dB
- All Polarizers to be Fully Characterized before Installation in Breadboard Feeds

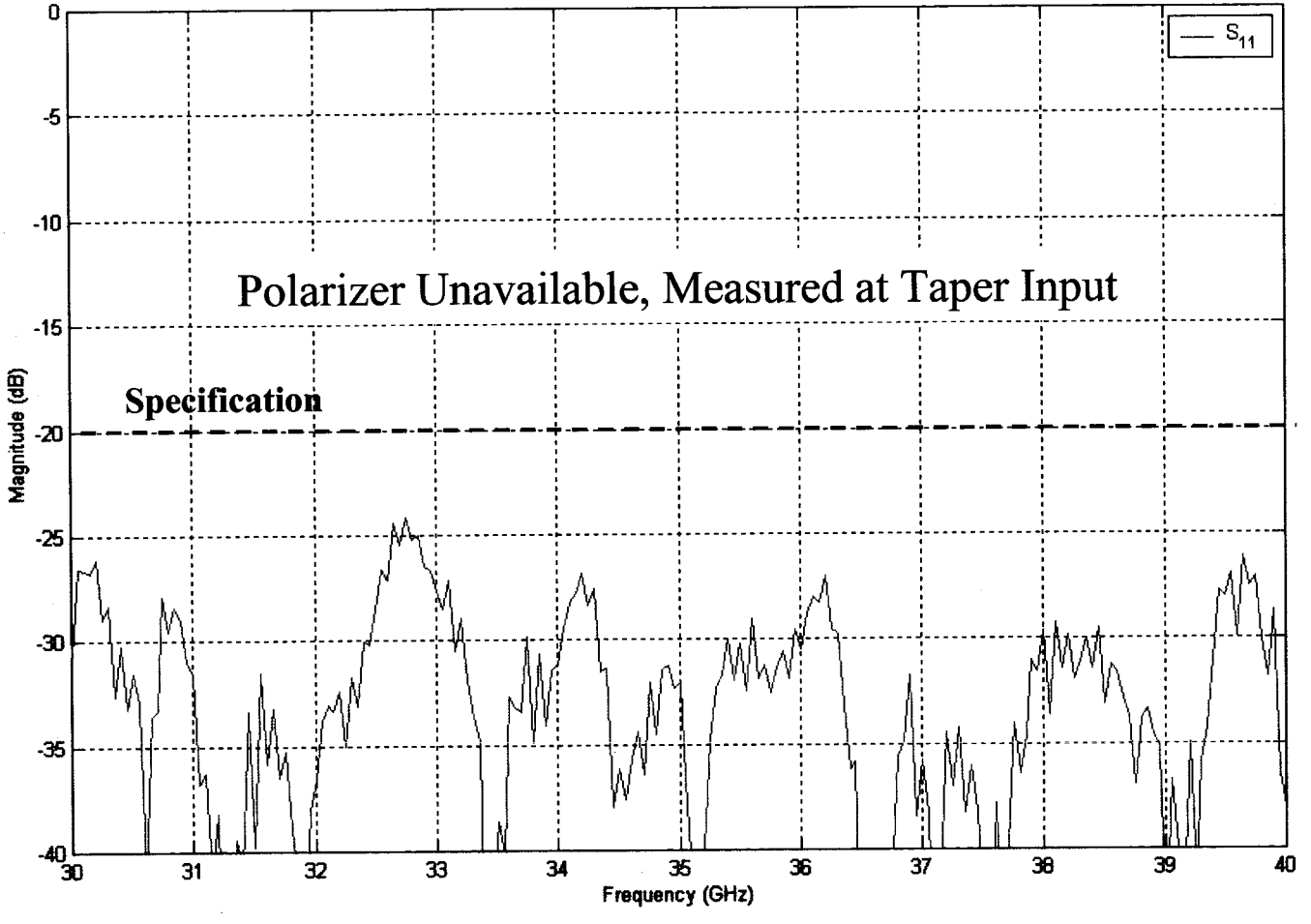
X-Band Return Loss, Measured at Polarizer Input



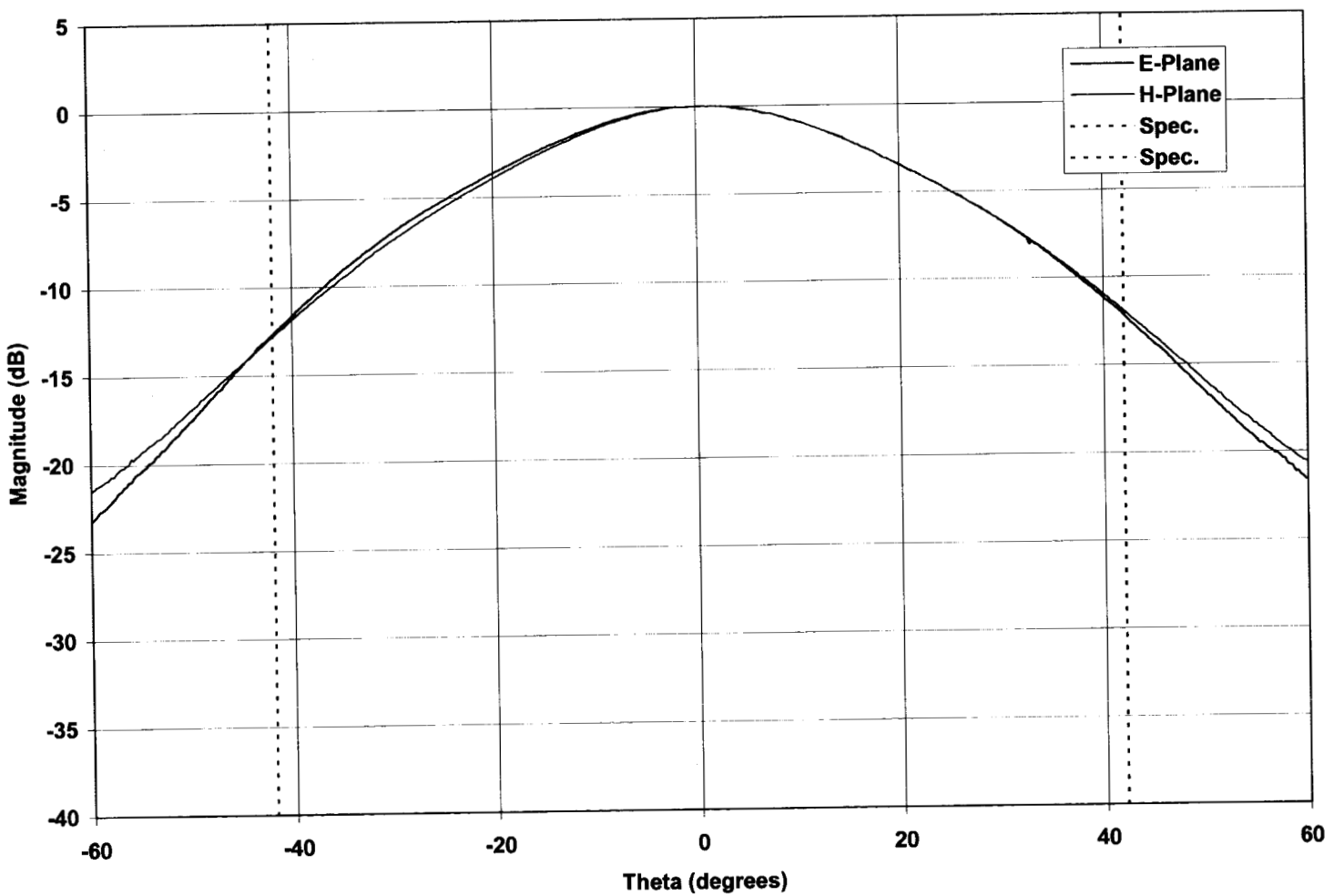
X-Band Isolation, Measured Between Polarizer Inputs



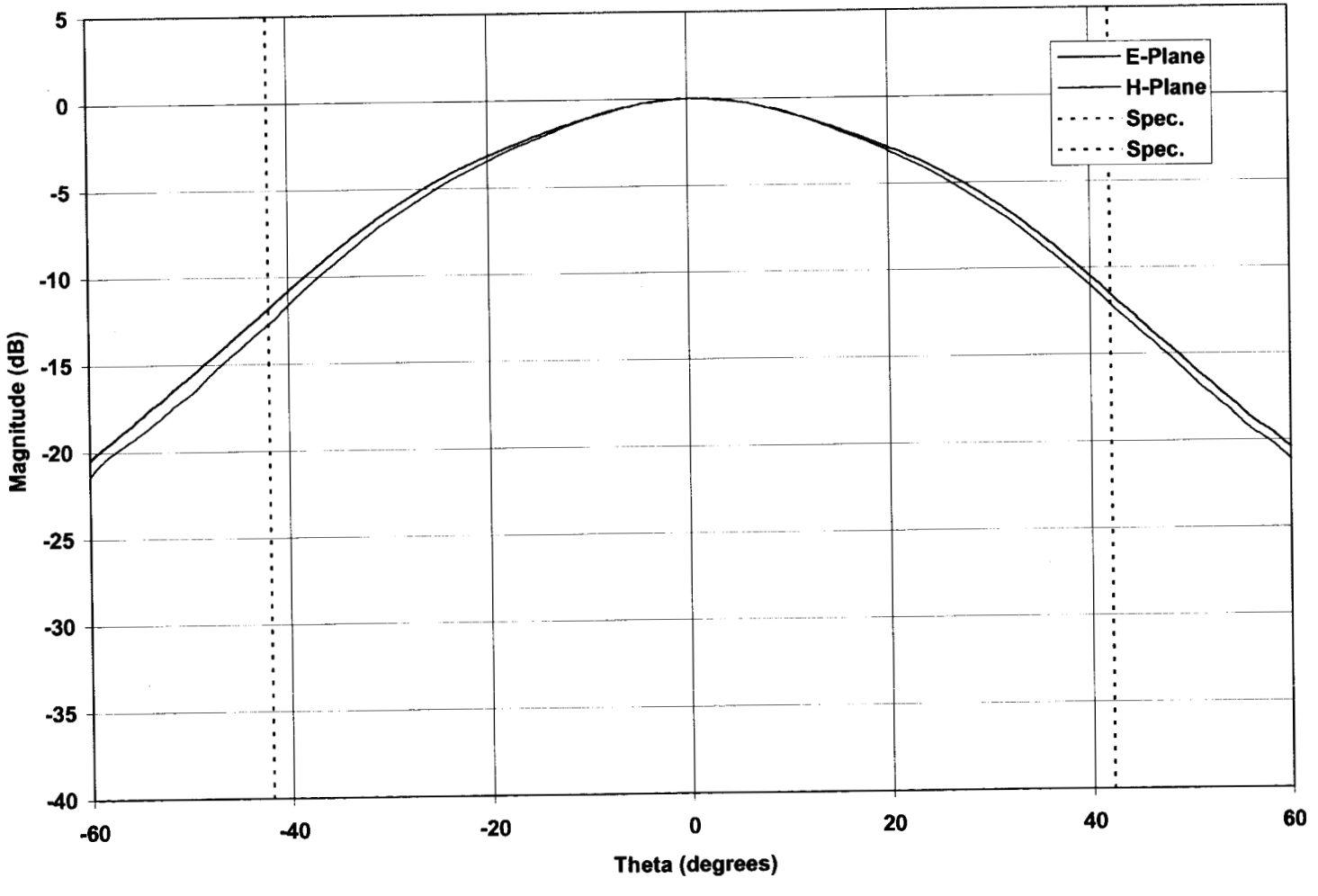
K_a-Band Return Loss, Measured at Taper Input



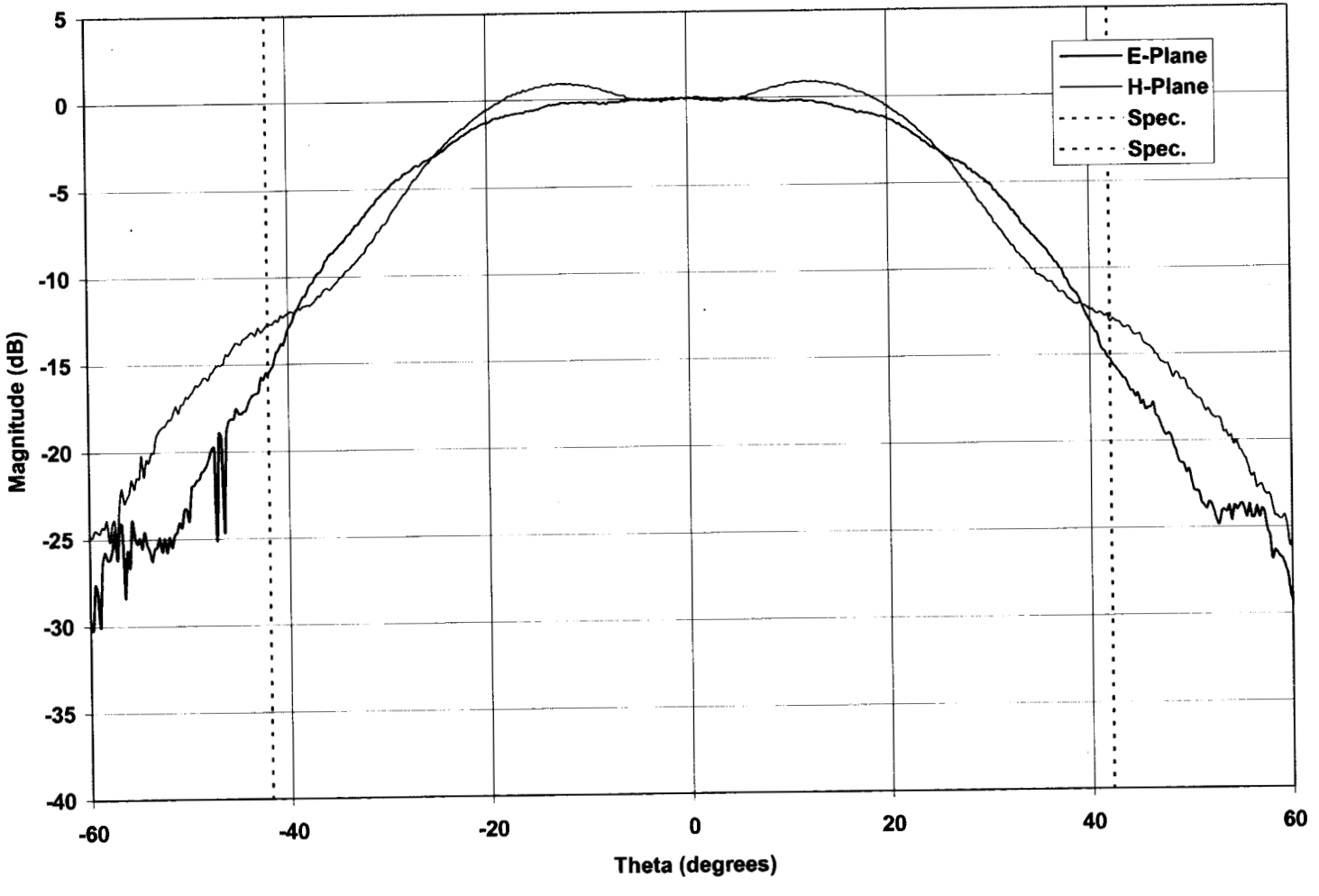
X-Band Radiation Patterns, 8.0 GHz



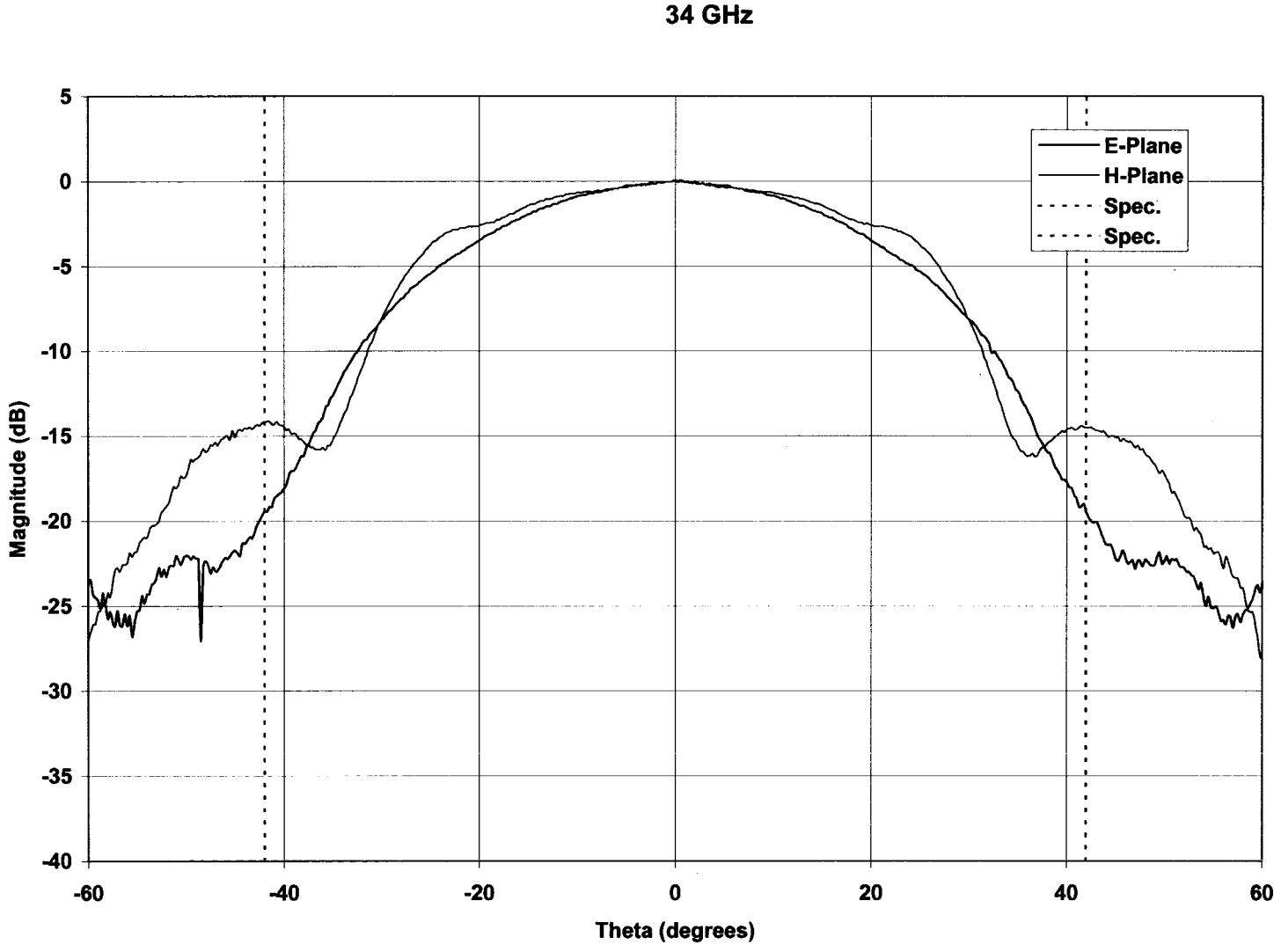
X-Band Radiation Patterns, 8.8 GHz



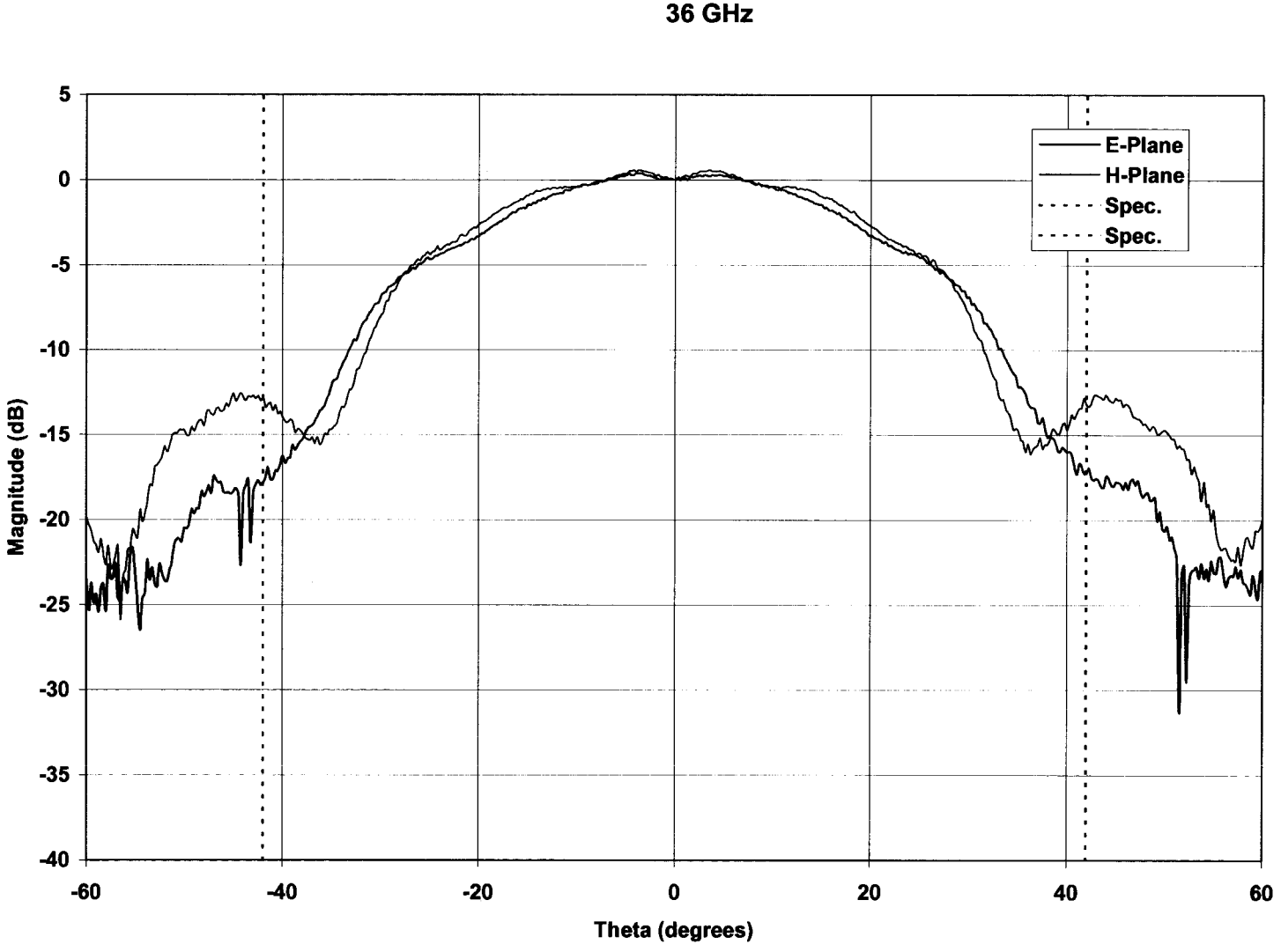
K_a-Band Radiation Patterns, 32.0 GHz



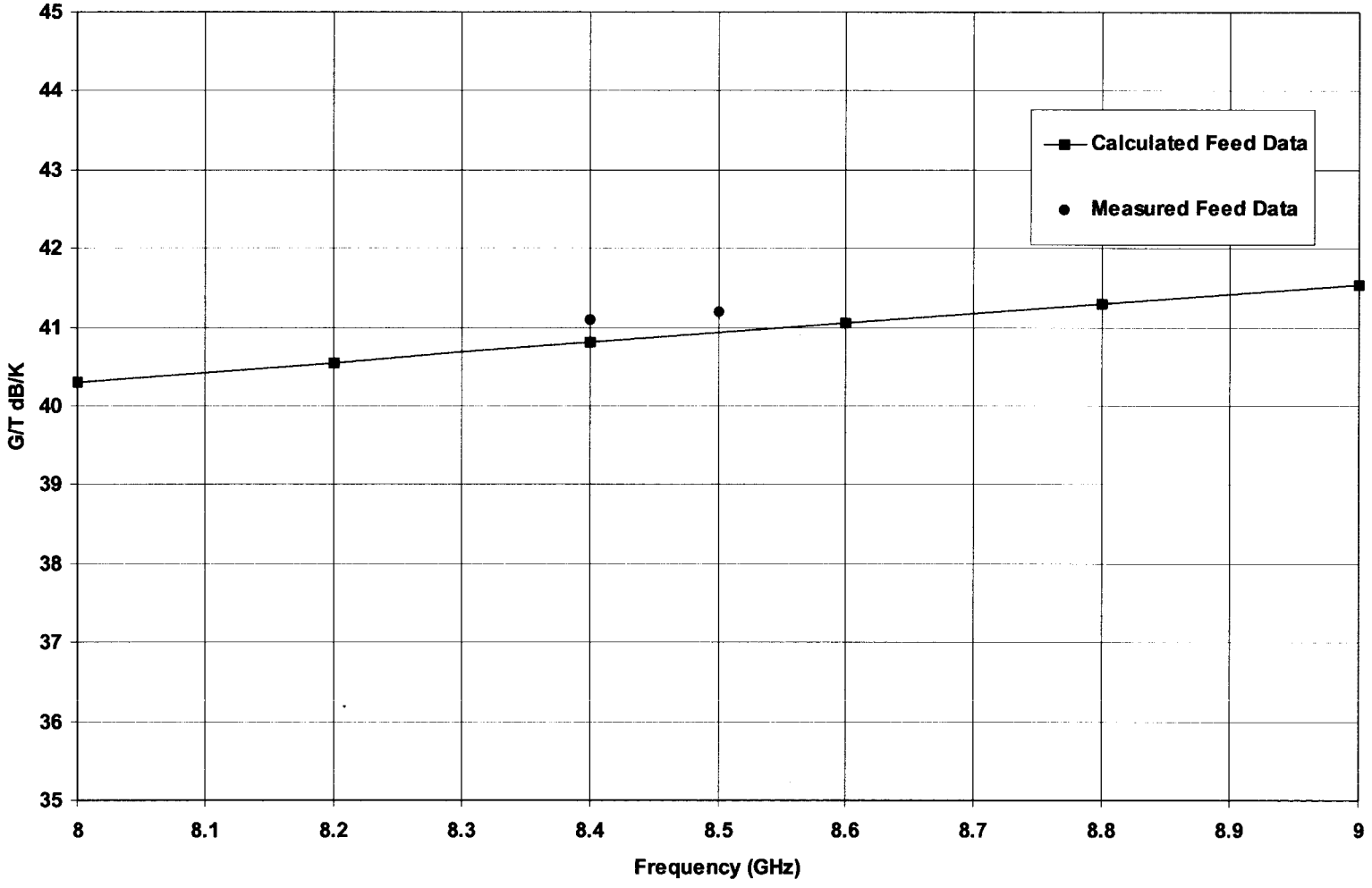
K_a-Band Radiation Patterns, 34.0 GHz



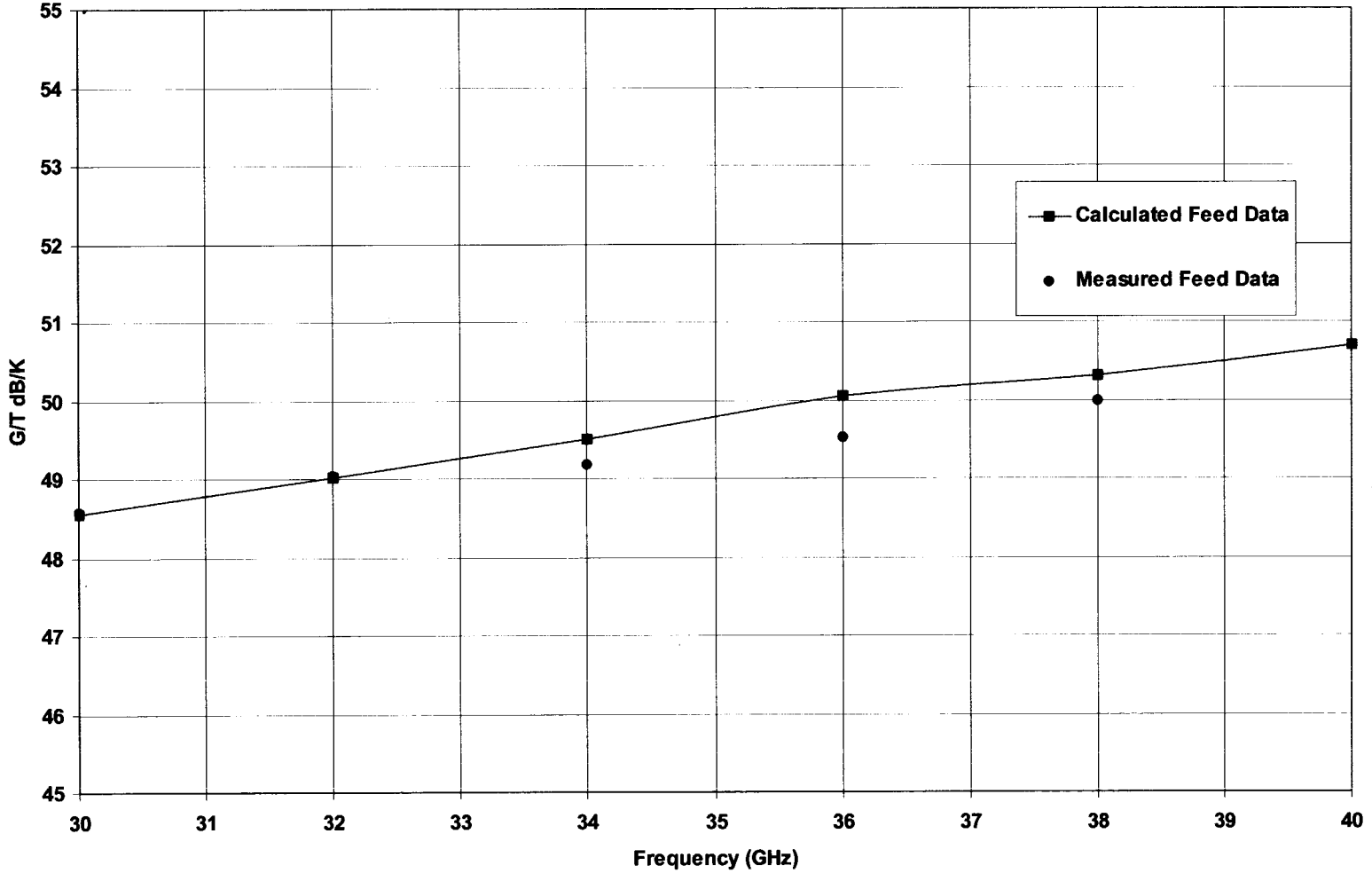
K_a-Band Radiation Patterns, 36.0 GHz



Computed Antenna Performance using Measured X-Band Radiation Patterns



Computed Antenna Performance using Measured K_a-Band Radiation Patterns



Evolution to 12-Meter Antennas

- Manufacturing Plan
  - Meet with JPL Manufacturing Engineers
  - Deliver Complete Drawing Package
  - Perform Vendor Search
  - Assume We Will Build to Print
    - 4 WR112 Waveguide Tolerance is Only Area of Concern
  - Meet with Potential Vendors to Discuss Fabrication and any Necessary Modifications
  - Goal is to have Cost Estimate by PDCR in July, 2004

Test Plan

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- Breadboards
  - Measure VSWR and Isolation, Both Bands, Both Polarization Ports
  - Antenna Patterns (X-Band $\Rightarrow$ Center Freq., K_a-Band $\Rightarrow$ Center and Band Edges)
- 12-Meter Units
  - Mechanical Q.A. and Certification On All Units
  - Review Q.A. Reports
  - 'Random' Full (Breadboard-Level) Test on 1 of Every 25 Units (4% Testing)

FY04 Schedule

ID	Task Name
1	**Reviews**
2	**Feeds/LNA/Cryo peer review**
5	**PDCR**
8	**Breadboard Feeds**
9	**Update drawings for feed**
10	**Fabrication and procurement**
15	**Feed #1 assembly and test**
19	**Feeds #2 and #3 assembly and test**
22	**Complete report on feed design**
23	**Support LNA work area with window design**
24	**Fabrication Techniques Study**