

Use of WR28 Waveguide on 47 GHz?



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The background of the slide features a blue gradient with a stylized Earth on the left side. A bright light source, possibly the sun, is positioned in the upper left, creating a lens flare effect. The overall aesthetic is clean and professional, typical of a technical presentation.

Use of WR28 Waveguide on 47 GHz?

- **Why the Use of WR28 is Significant**
- **Technical Specifications**
- **Problems Anticipated**
- **Test Results**
- **Recommendations**



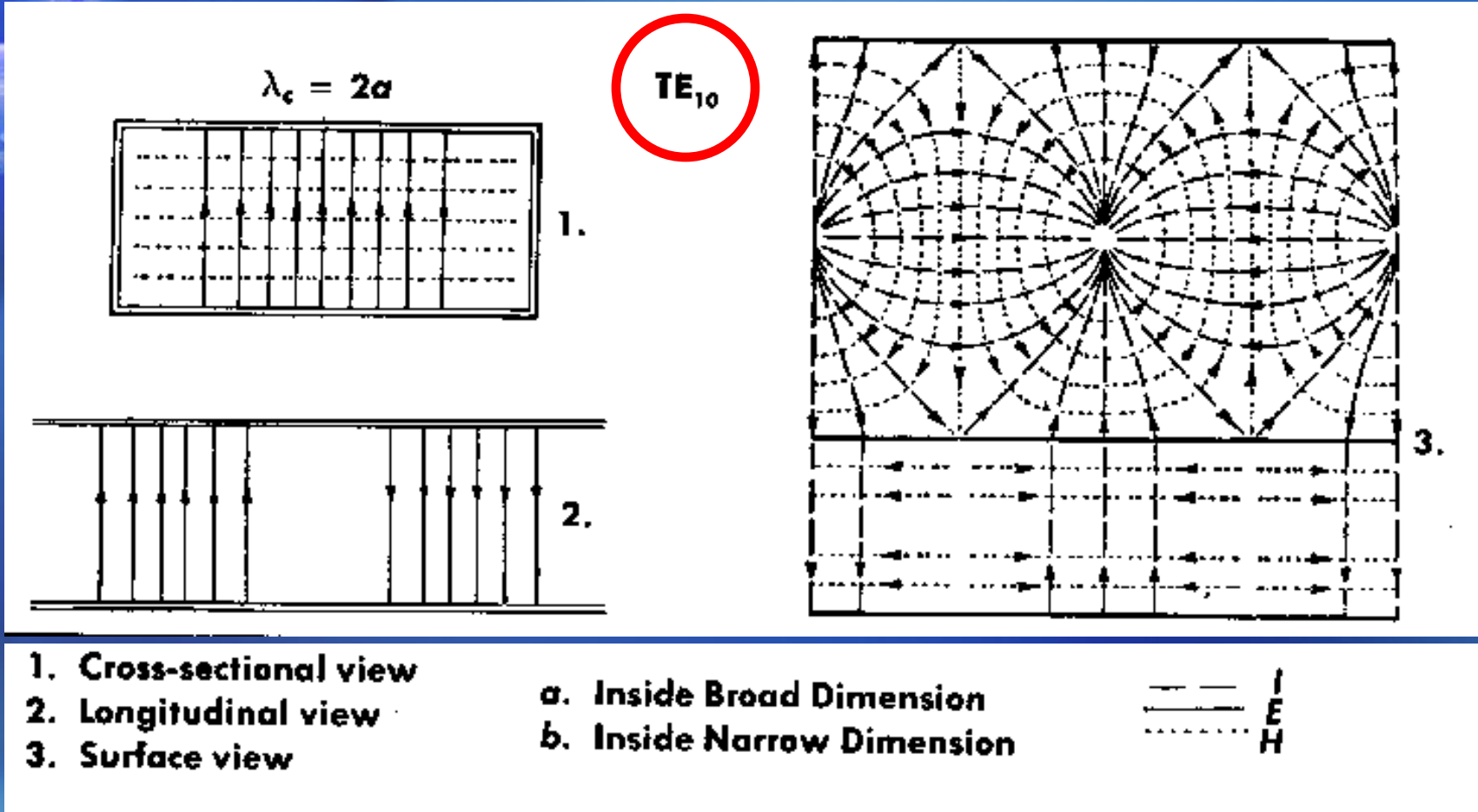
Significance of WR28 Use on 47 GHz?

- **WR28 is Intended for 26-40 GHz Use**
- **Readily Available on Surplus Market at Good Prices**
- **WR22 and WR19 Pieces are Rare and Expensive**
- **Round & Square Flanges Interconnect with WR22 Waveguide Flanges**

Problems Anticipated With WR28

- **The dominant TE_{10} propagation mode is dependent on Width of Waveguide**
- **Tendency to Go Into Higher Modes (TE_{xx} , etc) with Higher Frequency & Discontinuities in Waveguide**
- **Expect problems With Bends, Twists, etc**

Waveguide Propagation Modes

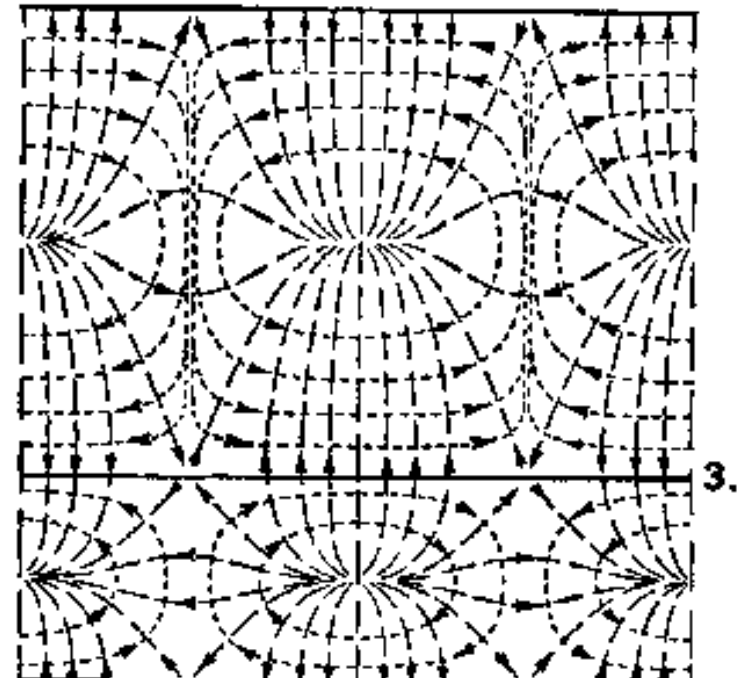
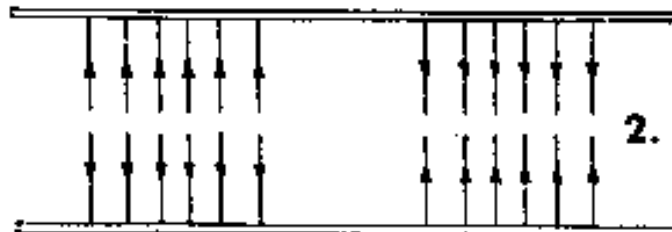
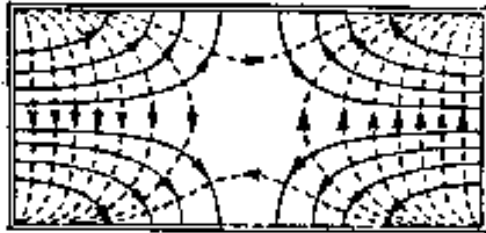


Cutoff Wavelength = 21.1 GHz

Waveguide Propagation Modes

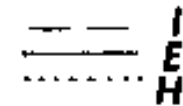
$$\lambda_c = \frac{2a}{\sqrt{1 + (a/b)^2}}$$

TE₁₁



1. Cross-sectional view
2. Longitudinal view
3. Surface view

- a. Inside Broad Dimension
b. Inside Narrow Dimension

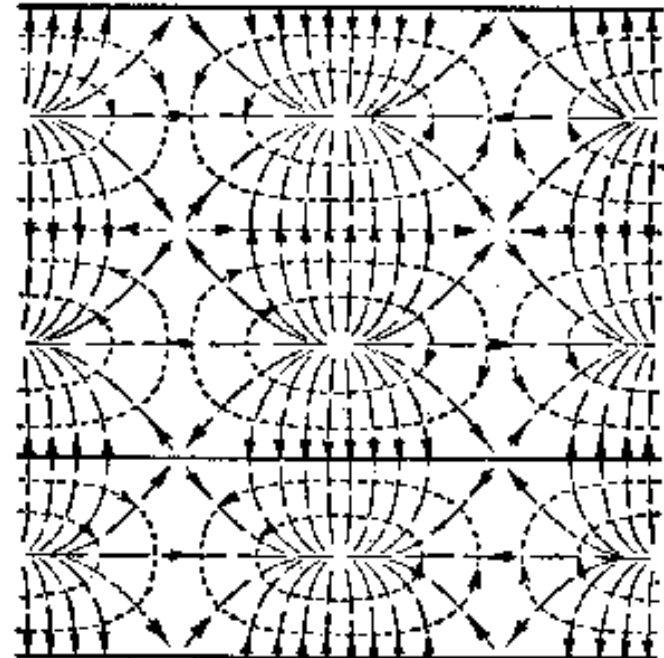
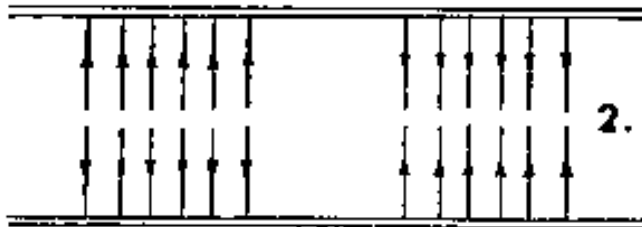
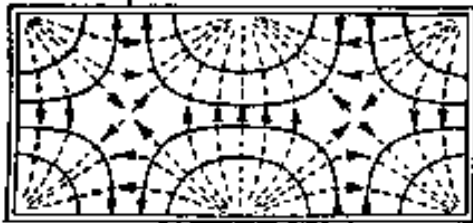


Cutoff Wavelength = 47.2 GHz

Waveguide Propagation Modes

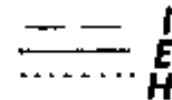
$$\lambda_c = \frac{a}{\sqrt{1 + (a/2b)^2}}$$

TE₂₁



1. Cross-sectional view
2. Longitudinal view
3. Surface view

- a. Inside Broad Dimension
b. Inside Narrow Dimension



Cutoff Wavelength = 59.6 GHz



Measurement System & Tests

- **Scalar Network Analyzer HP 8757A**
- **HP 82025 Q Band WG Detectors (WR22)**
- **HP 8697A-H50 Sweeper 33-50 GHz**
- **Baytron WR22 20 dB Broadwall Coupler**
- **Various Q Band Loads, Attenuators**
- **Test System in WR22 WG Round Flanges**
- **Commercial Round to Rectangular Adaptors**
- **Tests Conducted**
 - **Return Loss & Through Attenuation**
 - **40 to 50 GHz**

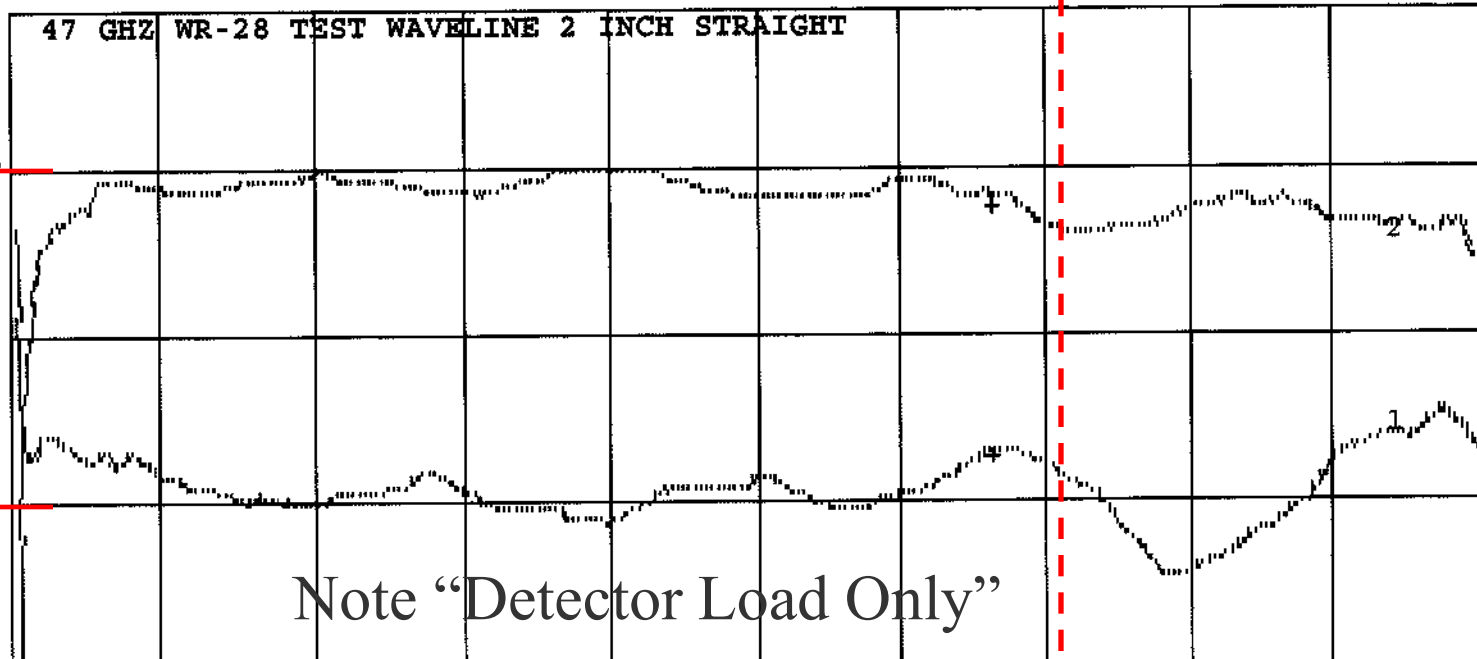
Test Results- “2 Inch” Straight WG



Test Results- "2 Inch" Straight WG

CH1: A -M S - 19.60 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .35 dB
1.0 dB/ REF - .00 dB



20 dB
RL

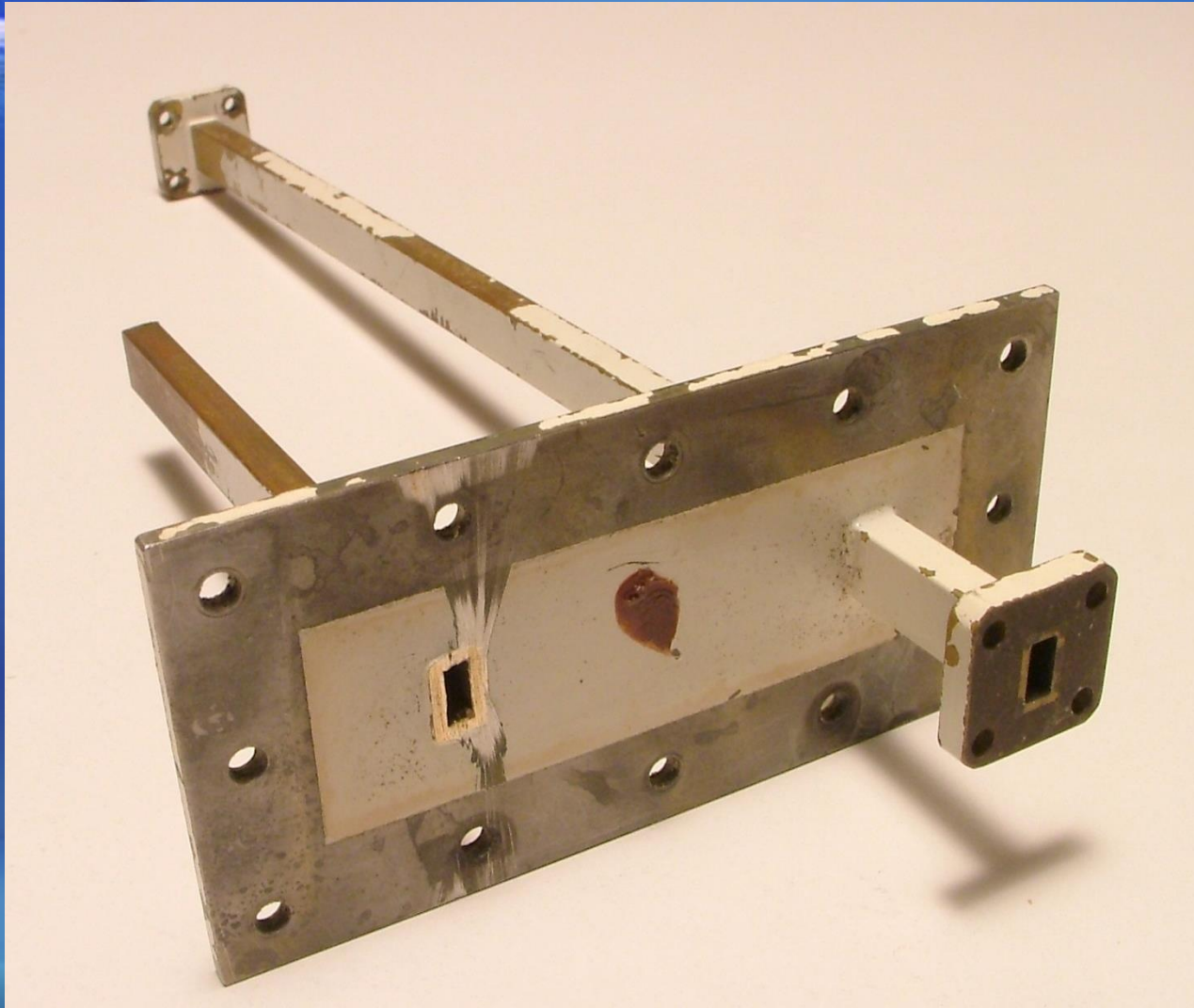
1 dB
IL

40 GHz

47 GHz

50 GHz

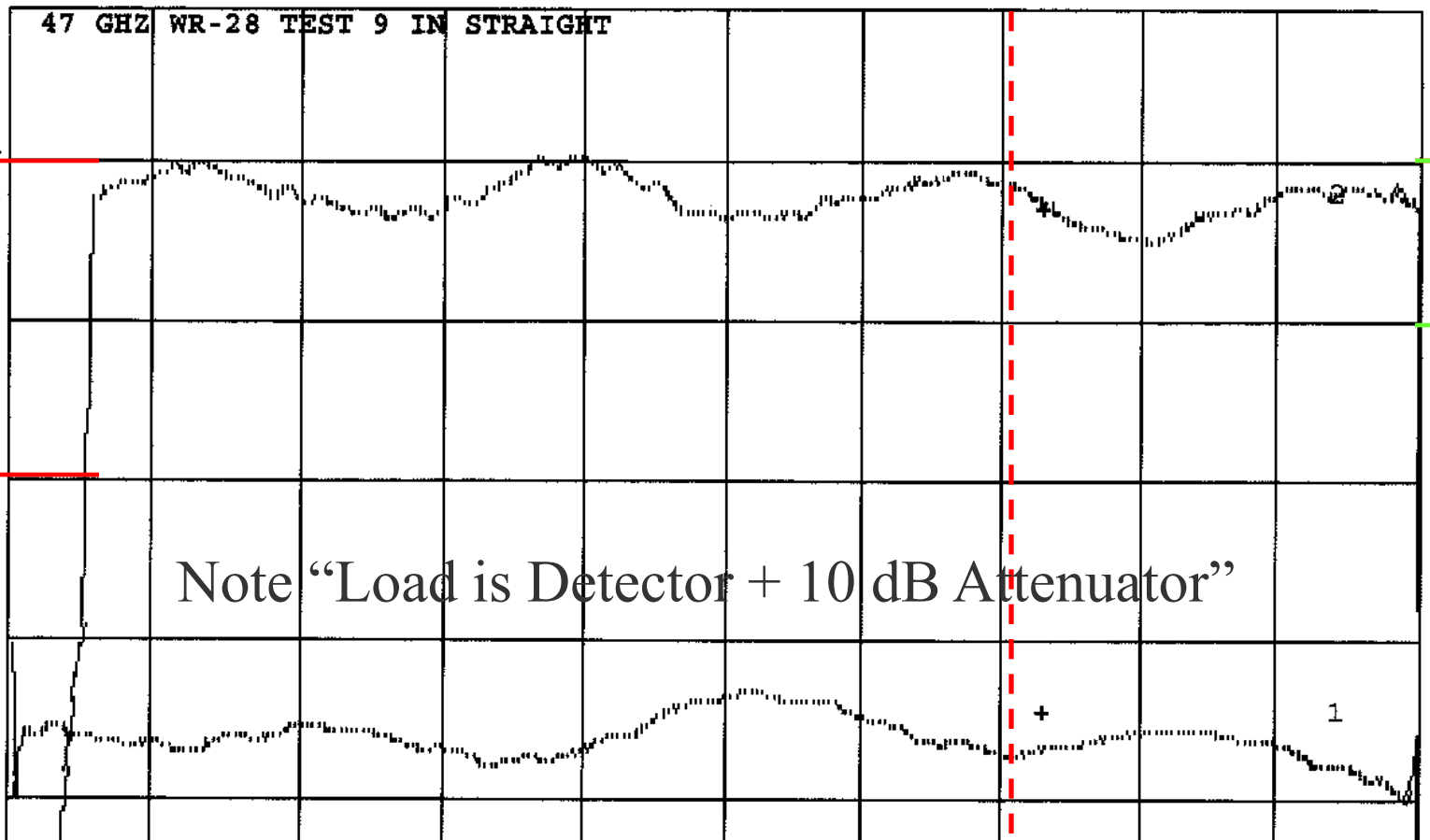
Test Results- “9 Inch” Straight WG



Test Results- “9 Inch” Straight WG

CH1: A -M S - 35.76 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .42 dB
1.0 dB/ REF - .00 dB



1 dB
IL

40 GHz

47 GHz

50 GHz

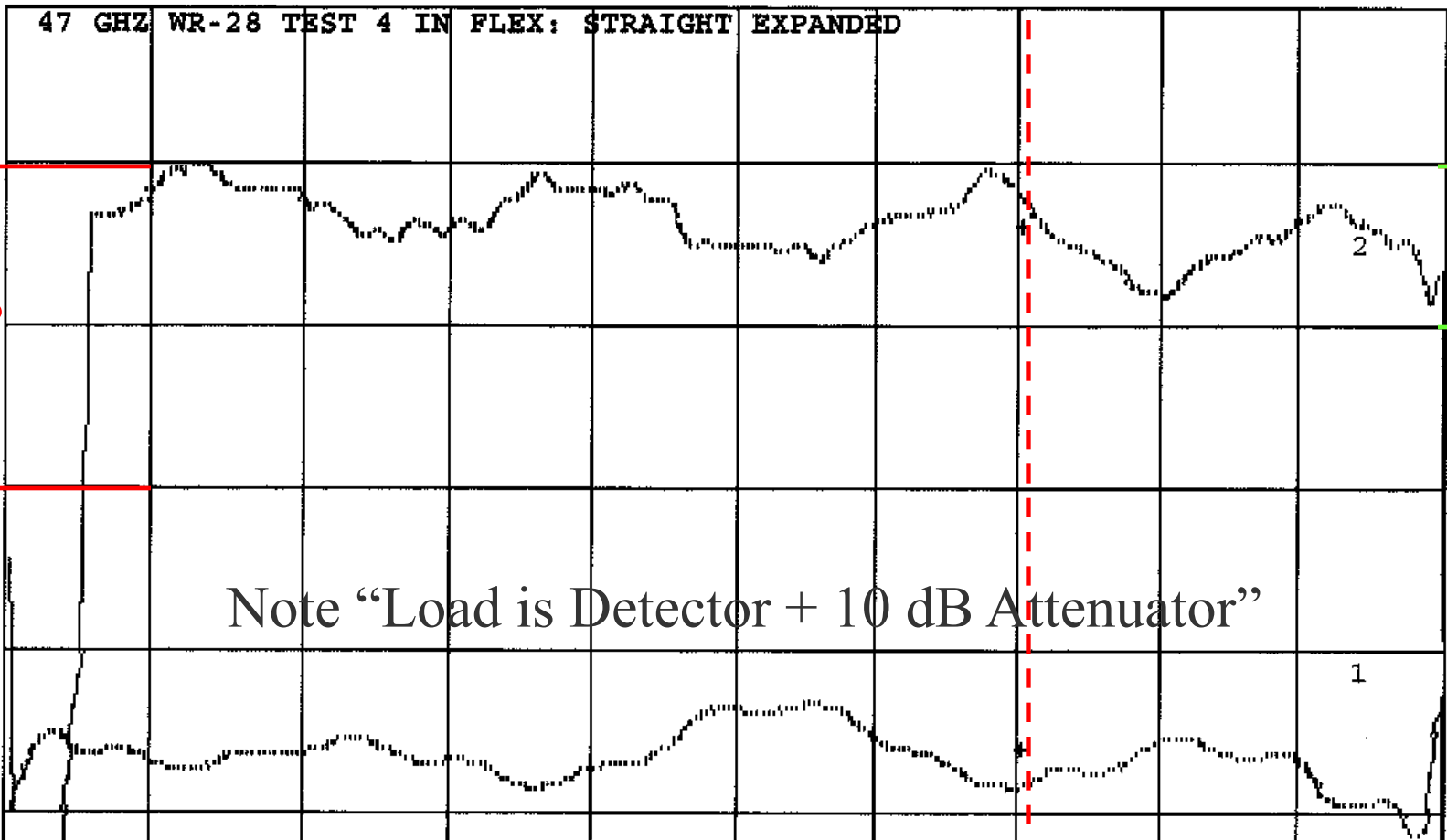
Test Results- “4 Inch” FLEX WG



Test Results- “4 Inch” FLEX WG

CH1: A -M S - 37.35 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .53 dB
1.0 dB/ REF - .00 dB



40 GHz

47 GHz

50 GHz

20 dB
RL

1 dB
IL

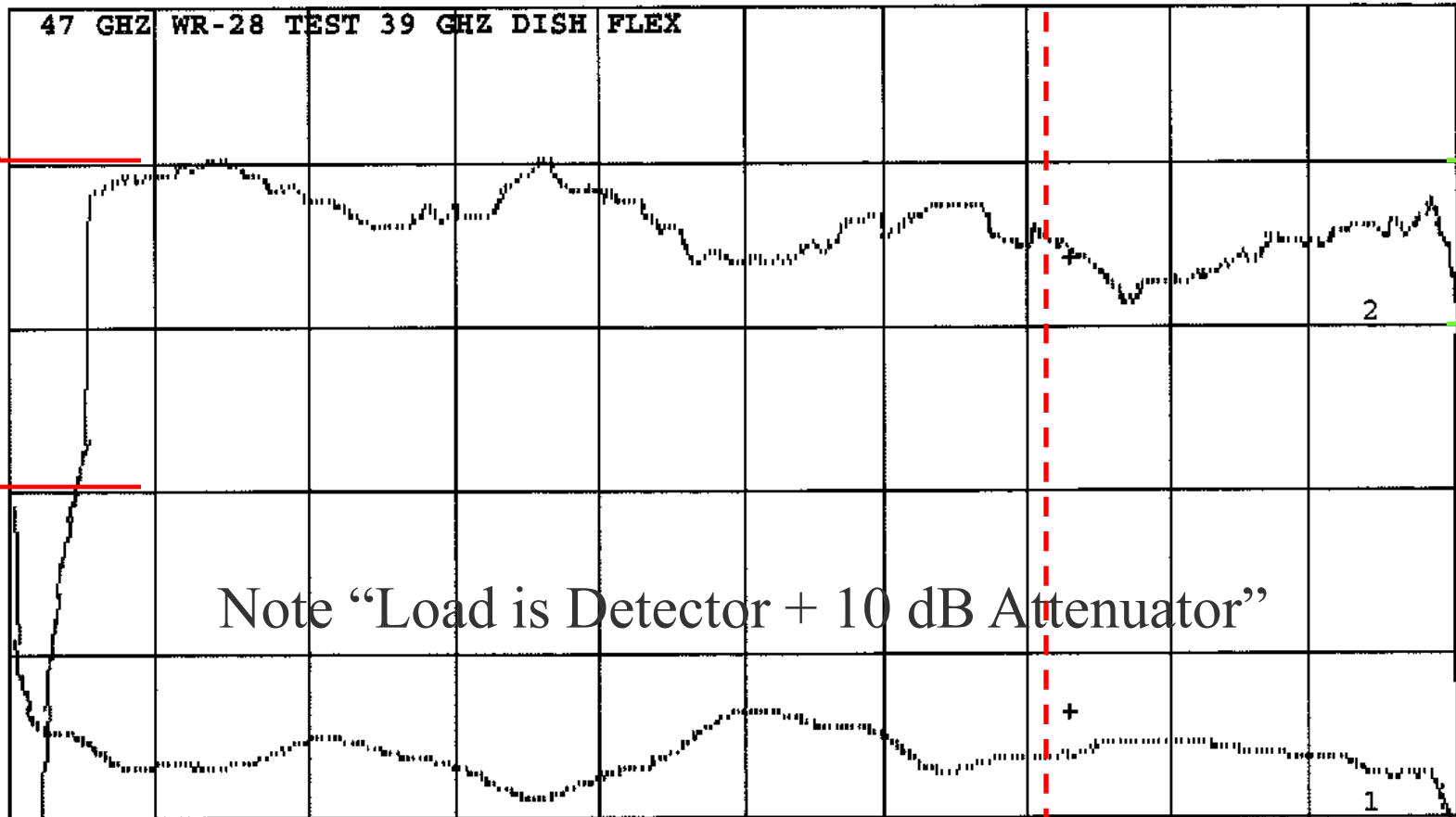
Test Results- “39 GHz Dish” FLEX



Test Results- “39 GHz Dish” FLEX

CH1: A -M S - 35.03 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .71 dB
1.0 dB/ REF - .00 dB



40 GHz

47 GHz

50 GHz

16

Test Results- “E” Plane Bend

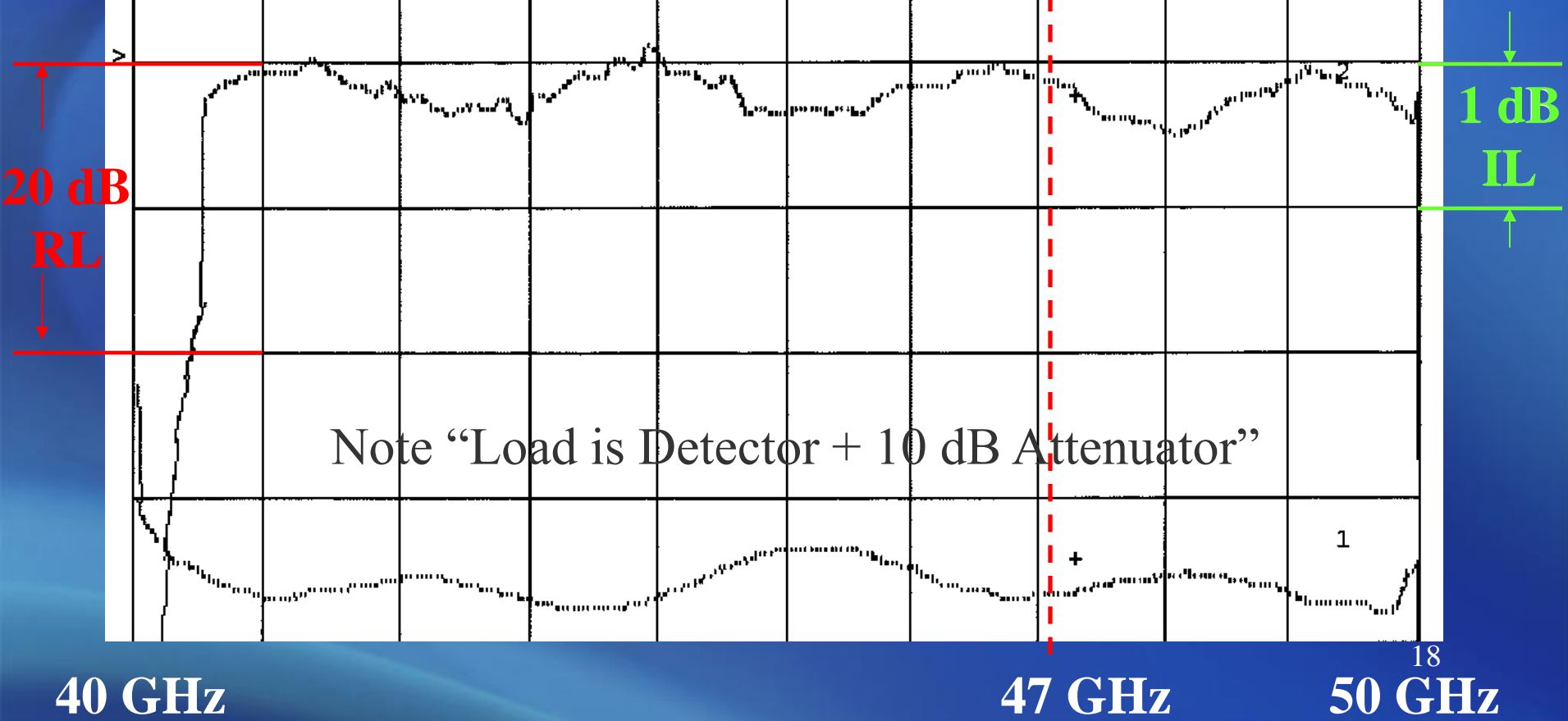


Test Results- “E” Plane Bend

CH1: A -M S - 35.55 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .37 dB
1.0 dB/ REF - .00 dB

47 GHZ WR-28 TEST E BEND 90 DEG



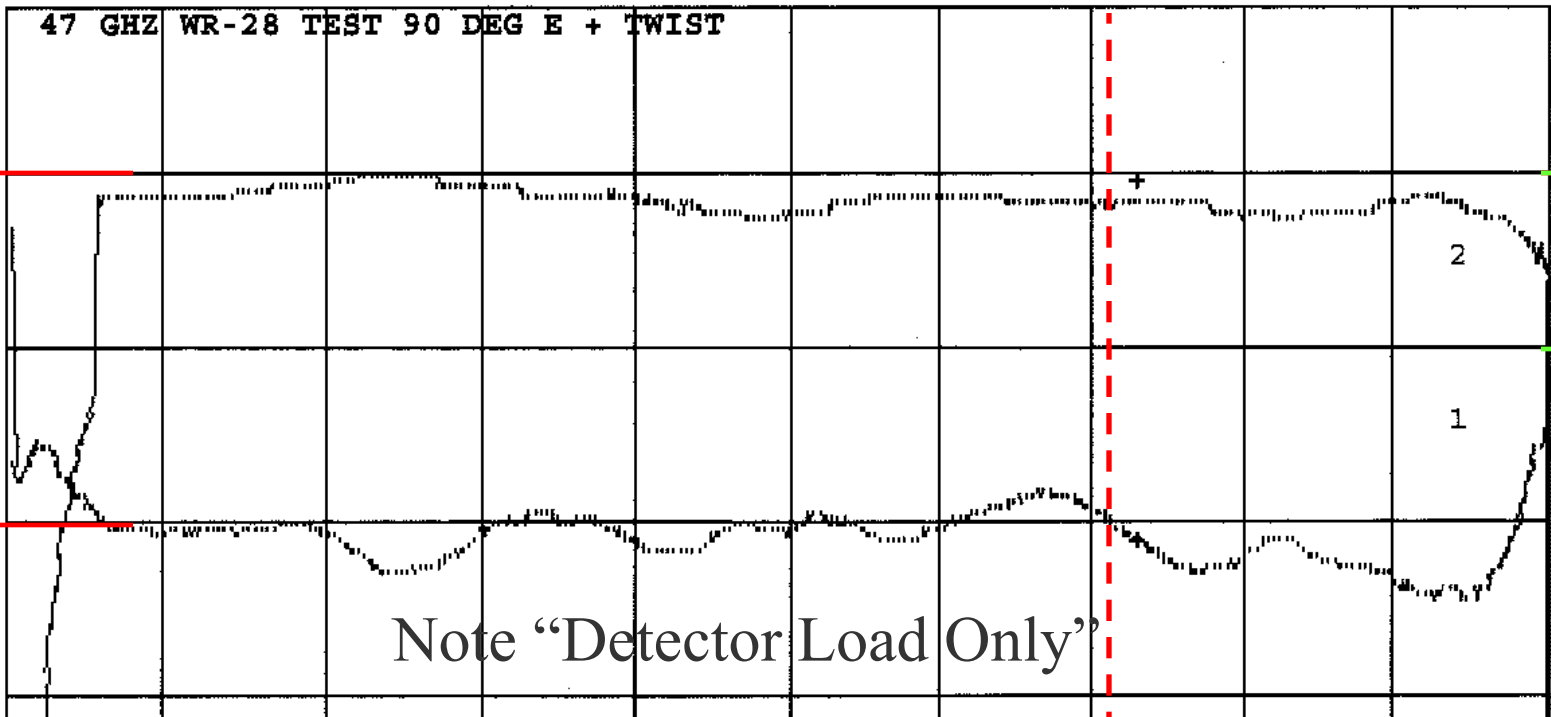
Test Results- “E” Plane Bend + TWIST



Test Results- "E" Plane Bend + TWIST

CH1: A -M S - 22.27 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .18 dB
1.0 dB/ REF - .00 dB



20 dB
RL

1 dB
IL

40 GHz

47 GHz

50 GHz

Test Results- “H” Plane Bend

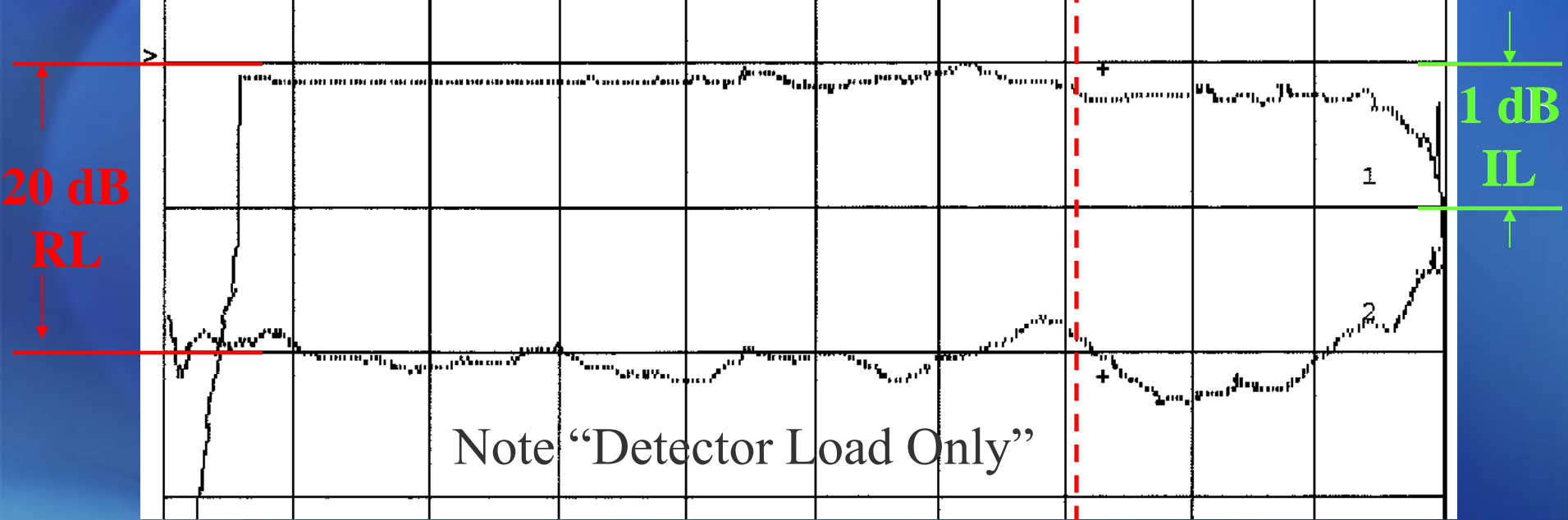


Test Results- “H” Plane Bend

CH1: A -M S - 23.08 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .16 dB
1.0 dB/ REF - .00 dB

47 GHZ WR-28 TEST 90 DEG H BEND

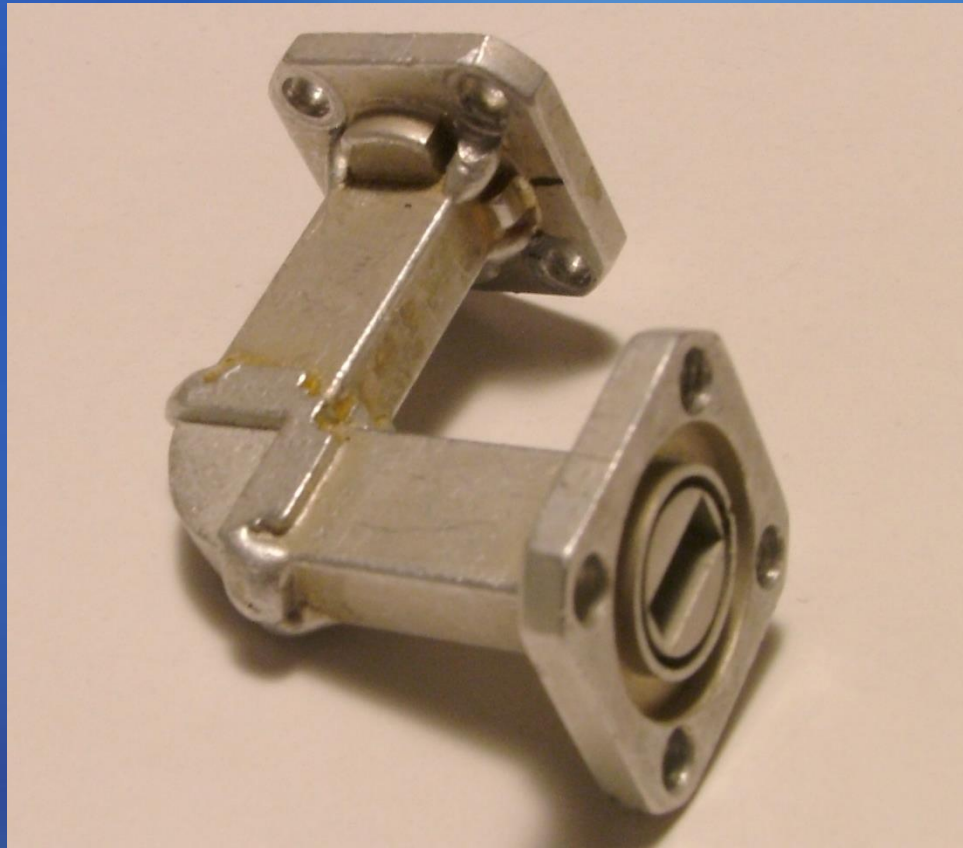


40 GHz

47 GHz

50 GHz

Test Results- CAST “H” Plane Bend

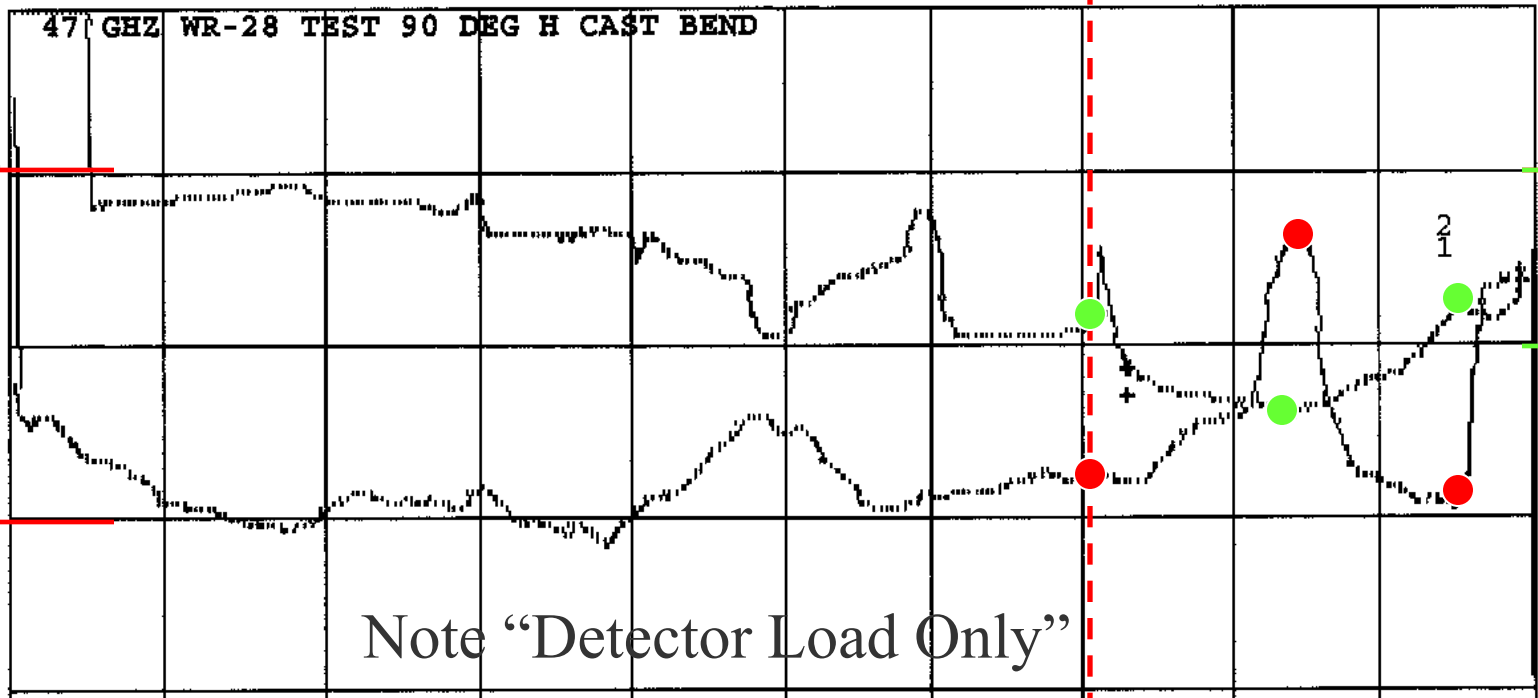


- **Note the Choked Flange**

Test Results- CAST "H" Plane Bend

CH1: A -M S - 14.25 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - 1.26 dB
1.0 dB/ REF - .00 dB



20 dB
RL

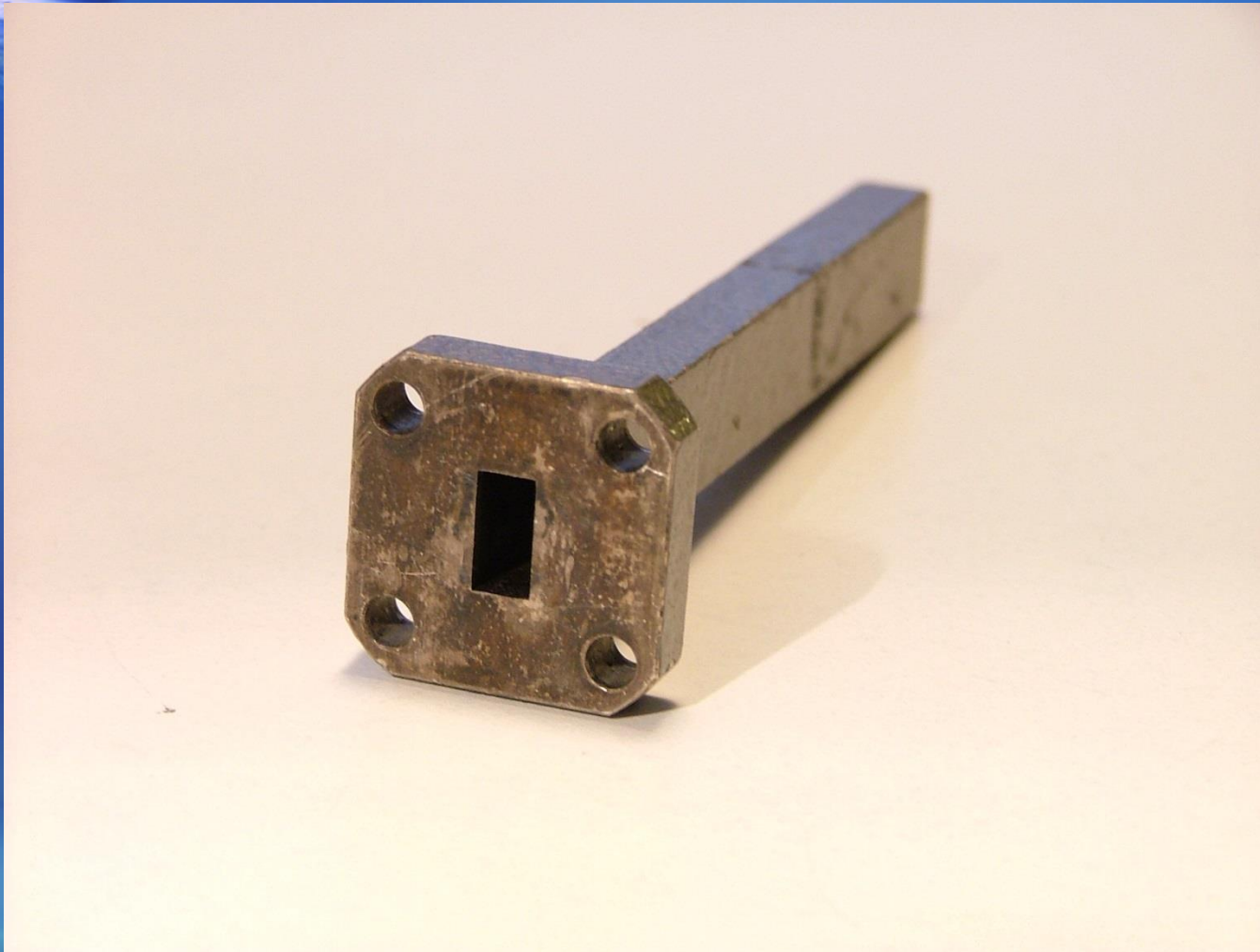
1 dB
IL

40 GHz

47 GHz

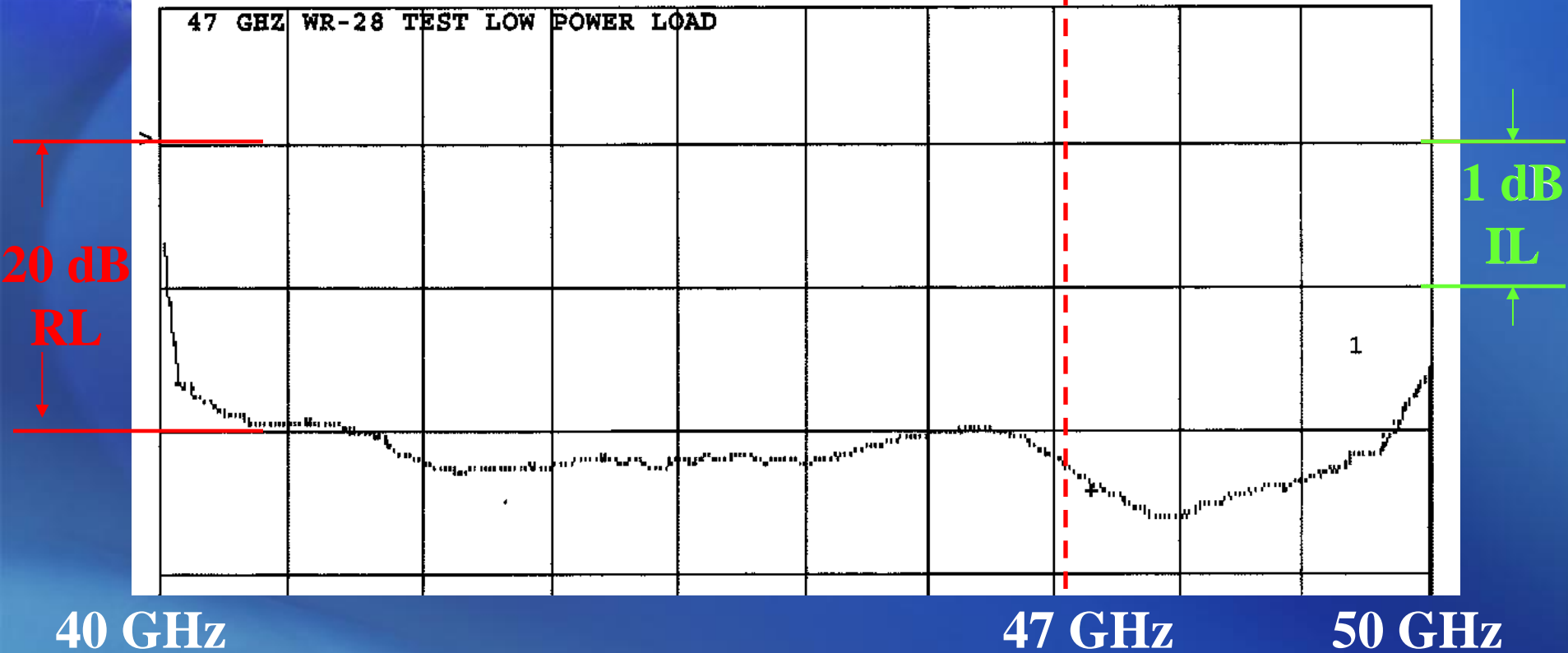
50 GHz

Test Results- Low Power Load

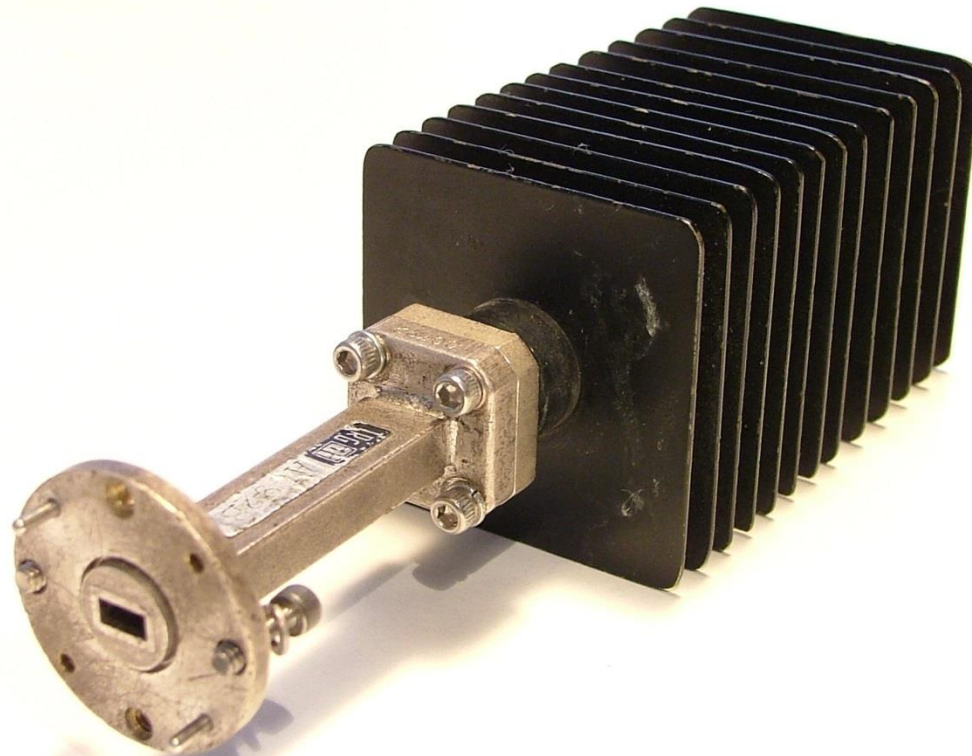


Test Results- Low Power Load

CH1: A -M S - 25.52 dB
10.0 dB/ REF - .00 dB



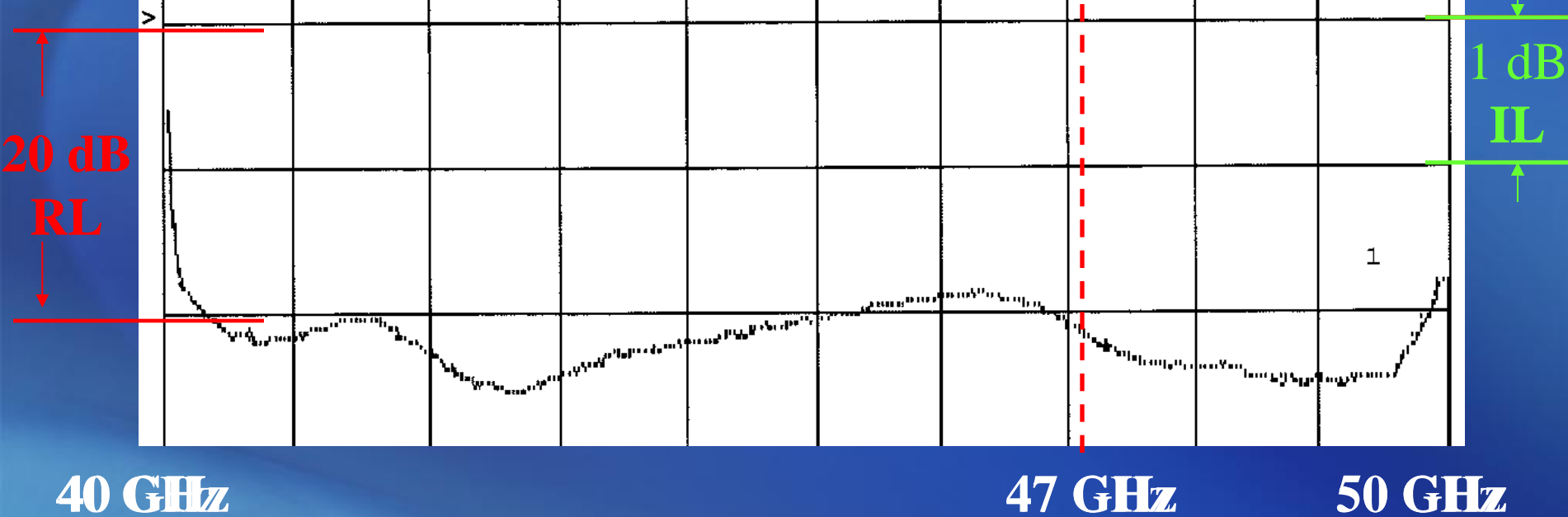
Test Results- High Power Load



Test Results- High Power Load

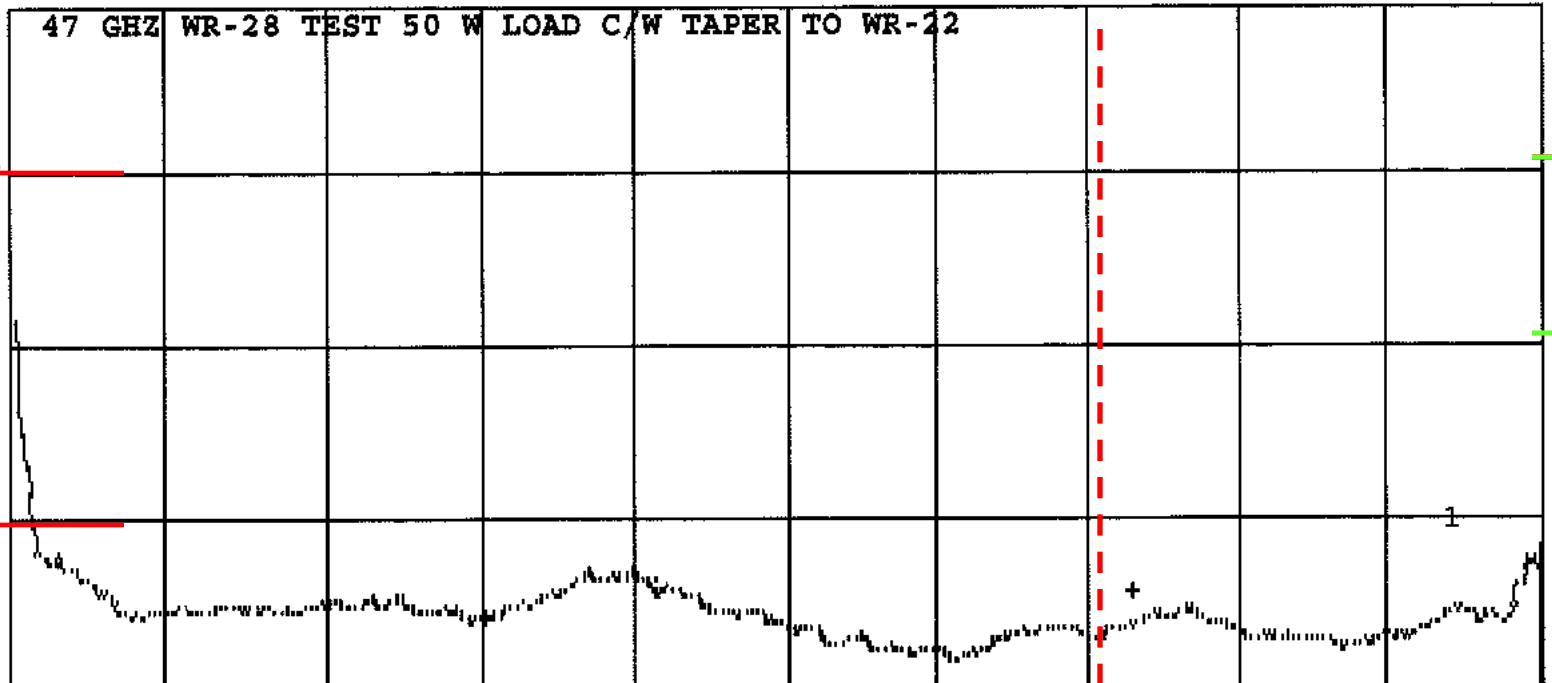
CH1: A -M S - 23.54 dB
10.0 dB/ REF - .00 dB

47 GHz WR-28 TEST 50 W LOAD NO TAPER



High Power Load With Taper to WR22

CH1: A -M S - 25.80 dB
10.0 dB/ REF - .00 dB



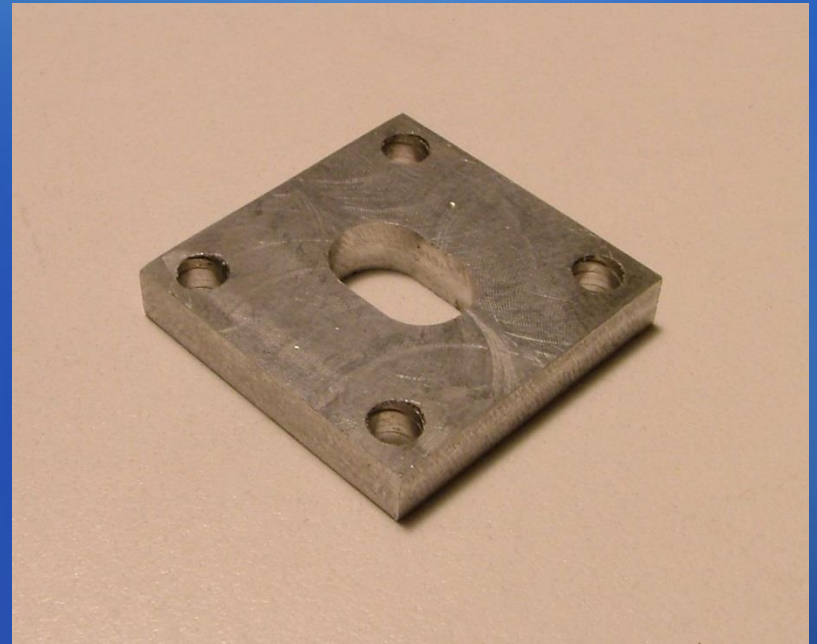
40 GHz

47 GHz

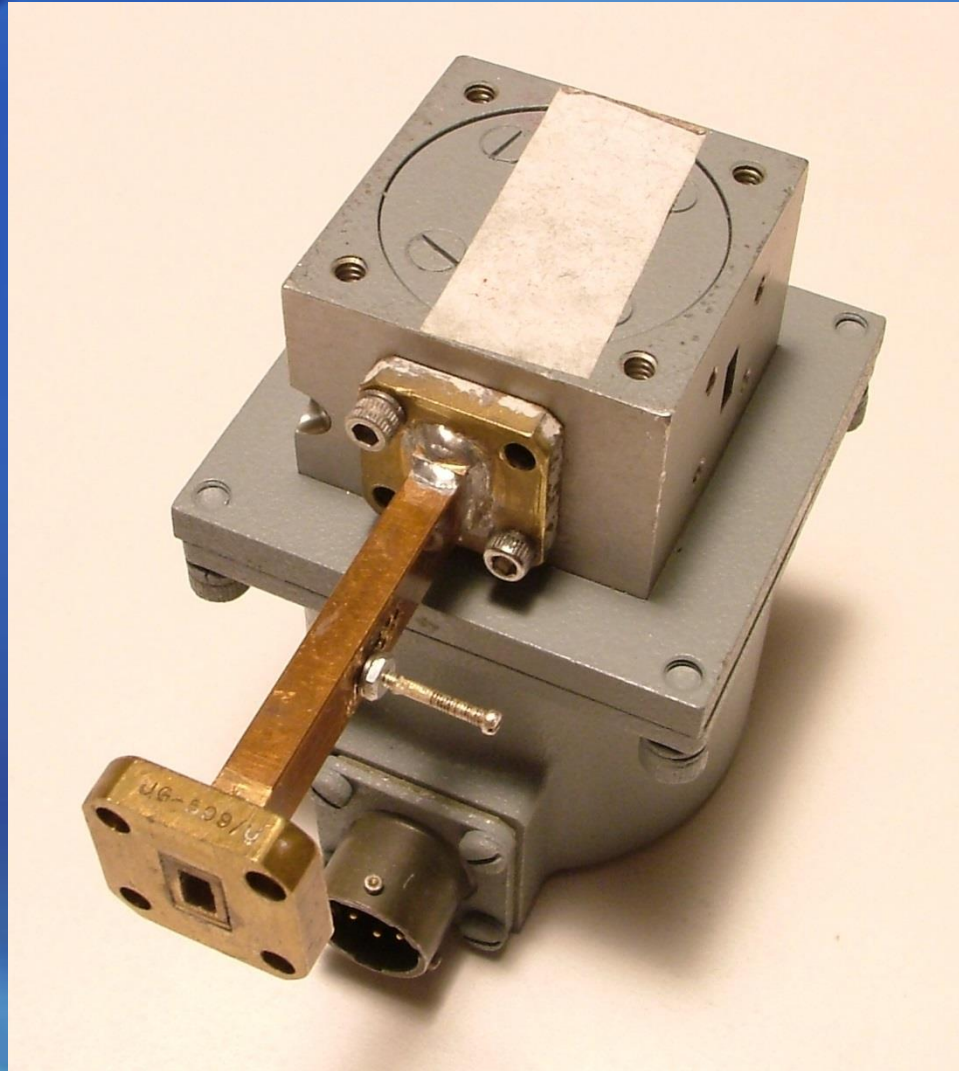
50 GHz

Impedance Matching to WR19/22

- **Can Use Bolted Step Transition**
- **Smooth Taper Gives Better Broadband Results**
- **$\frac{1}{4}$ Wavelength Transformer OK for Narrower Bandwidth**



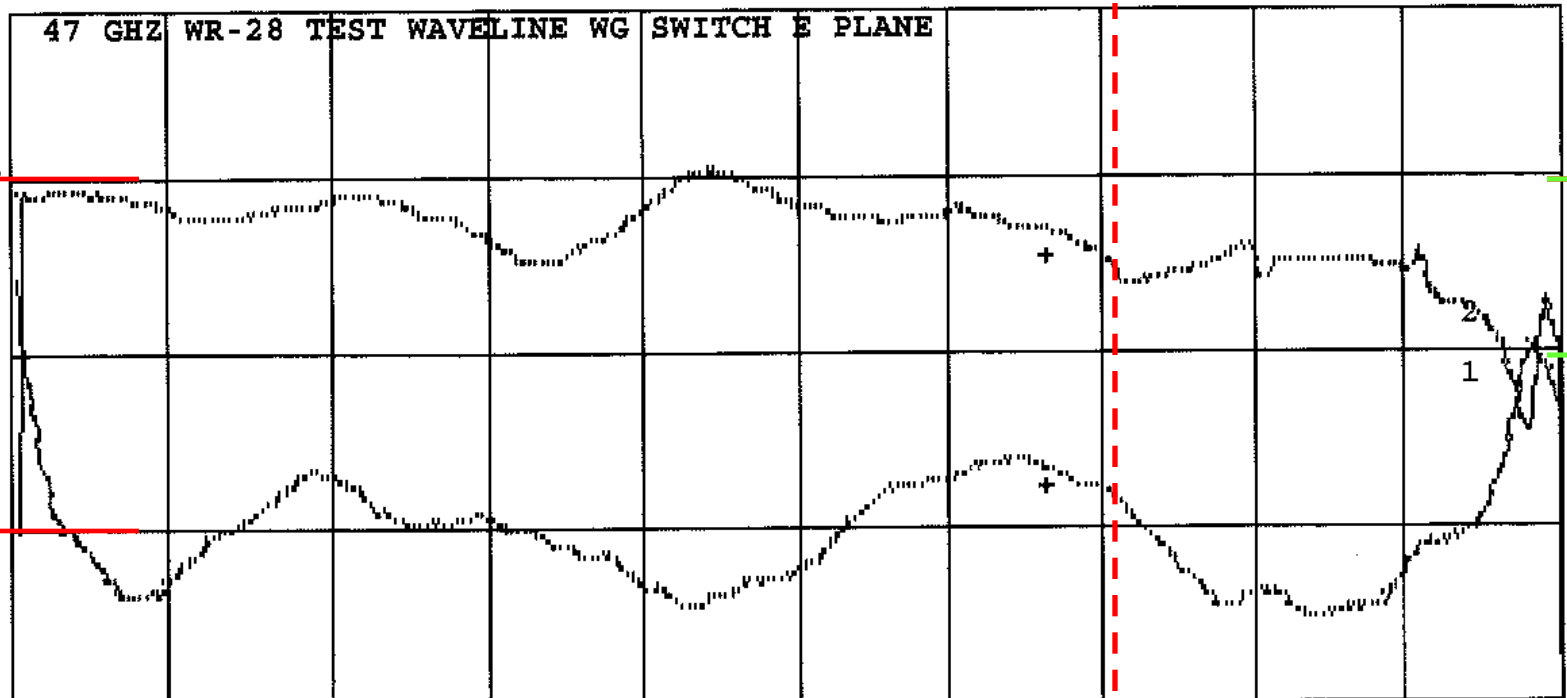
Waveline 1077 “E Plane” WG Switch



Waveline 1077 "E Plane" WG Switch

CH1: A -M S - 18.87 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - .57 dB
1.0 dB/ REF - .00 dB



20 dB
RL

1 dB
IL

40 GHz

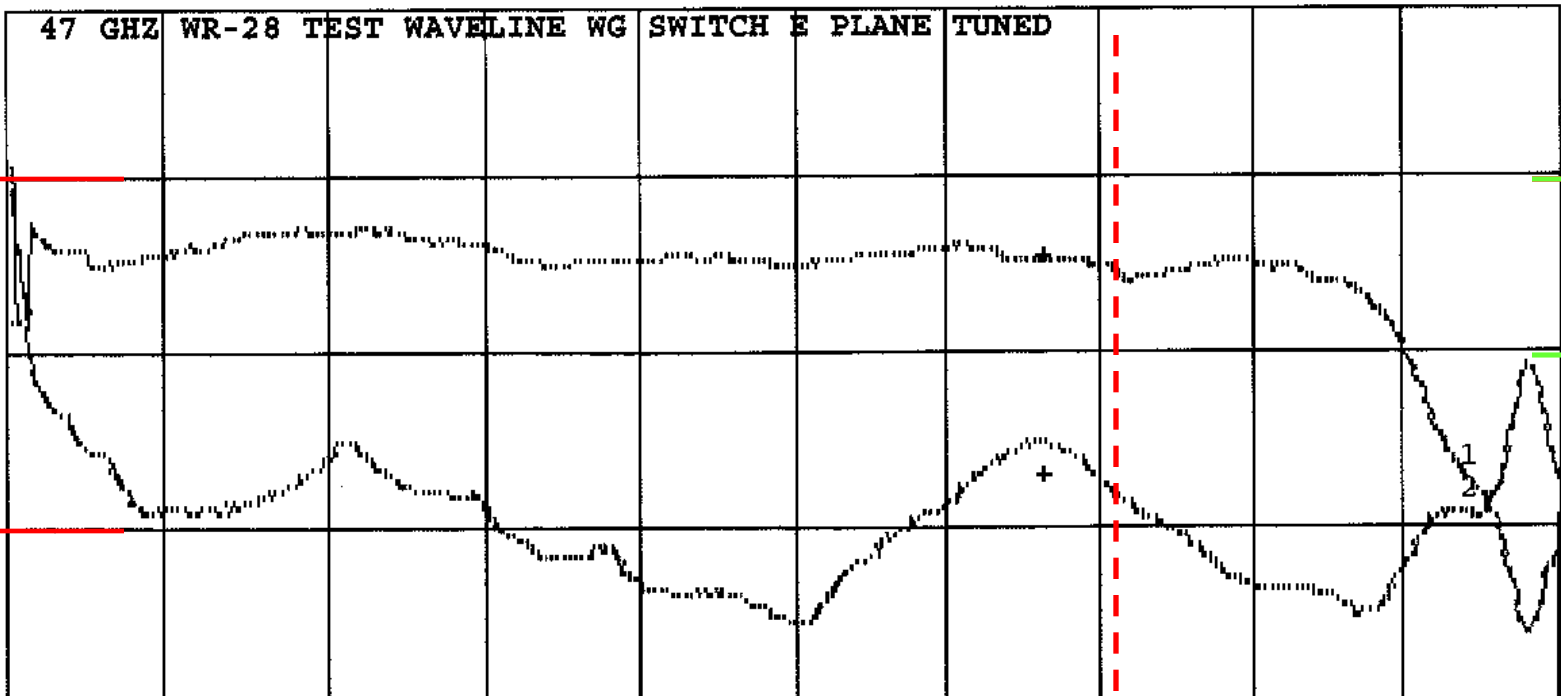
47 GHz

50 GHz

1077 “E Plane” WG Switch “Tuned”

CH1: A -M S - 18.13 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - ~~18.13~~ 1.52 dB
1.0 dB/ REF - .00 dB



20 dB
RL

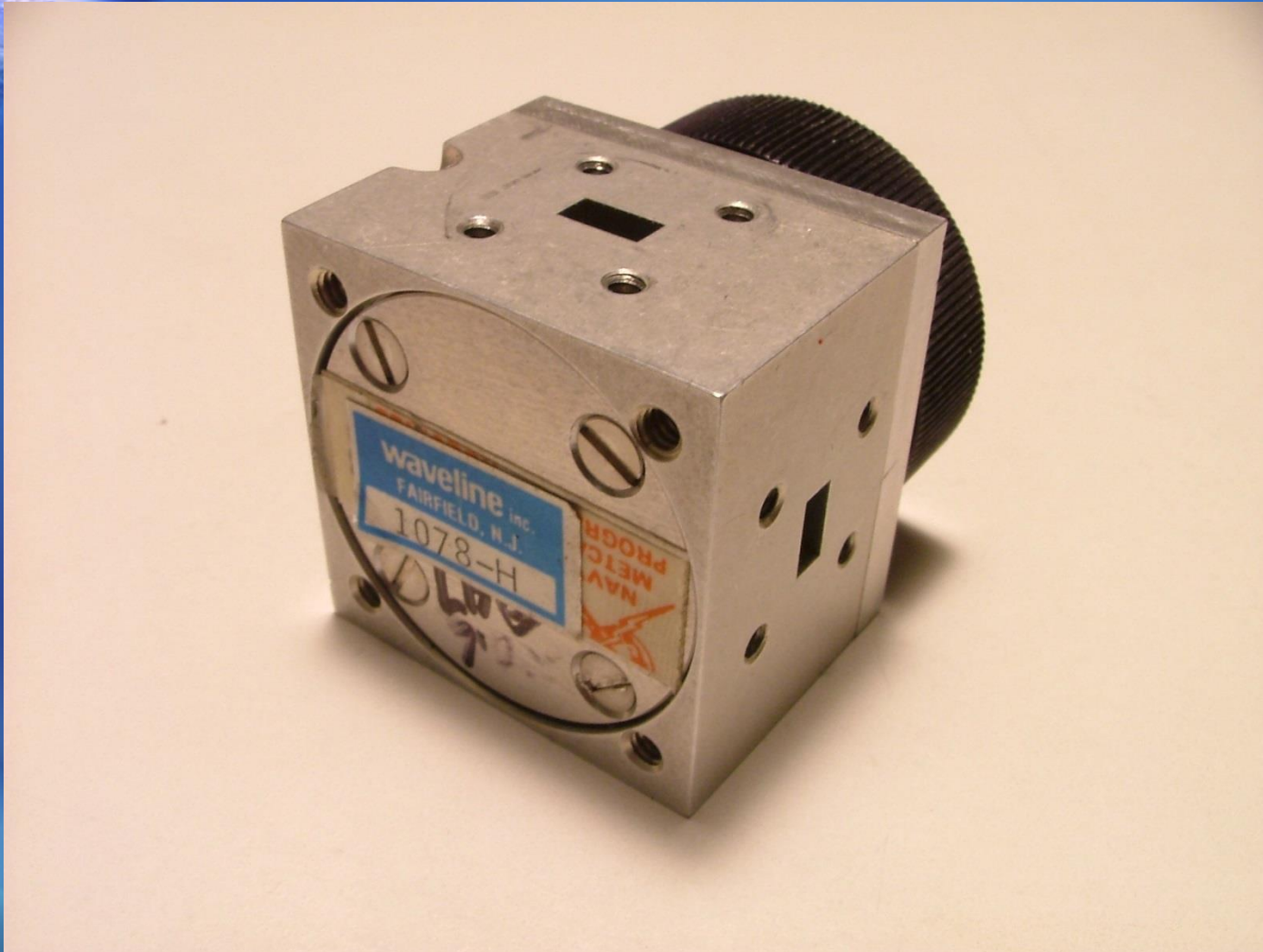
1 dB
IL

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Waveline 1078 “H Plane” WG Switch



Waveline 1078 "H Plane" WG Switch

CH1: A -M S - 15.85 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - 1.00 dB
1.0 dB/ REF - .00 dB

47 GHz WR-28 TEST H PLANE WG SWITCH

20 dB
RL

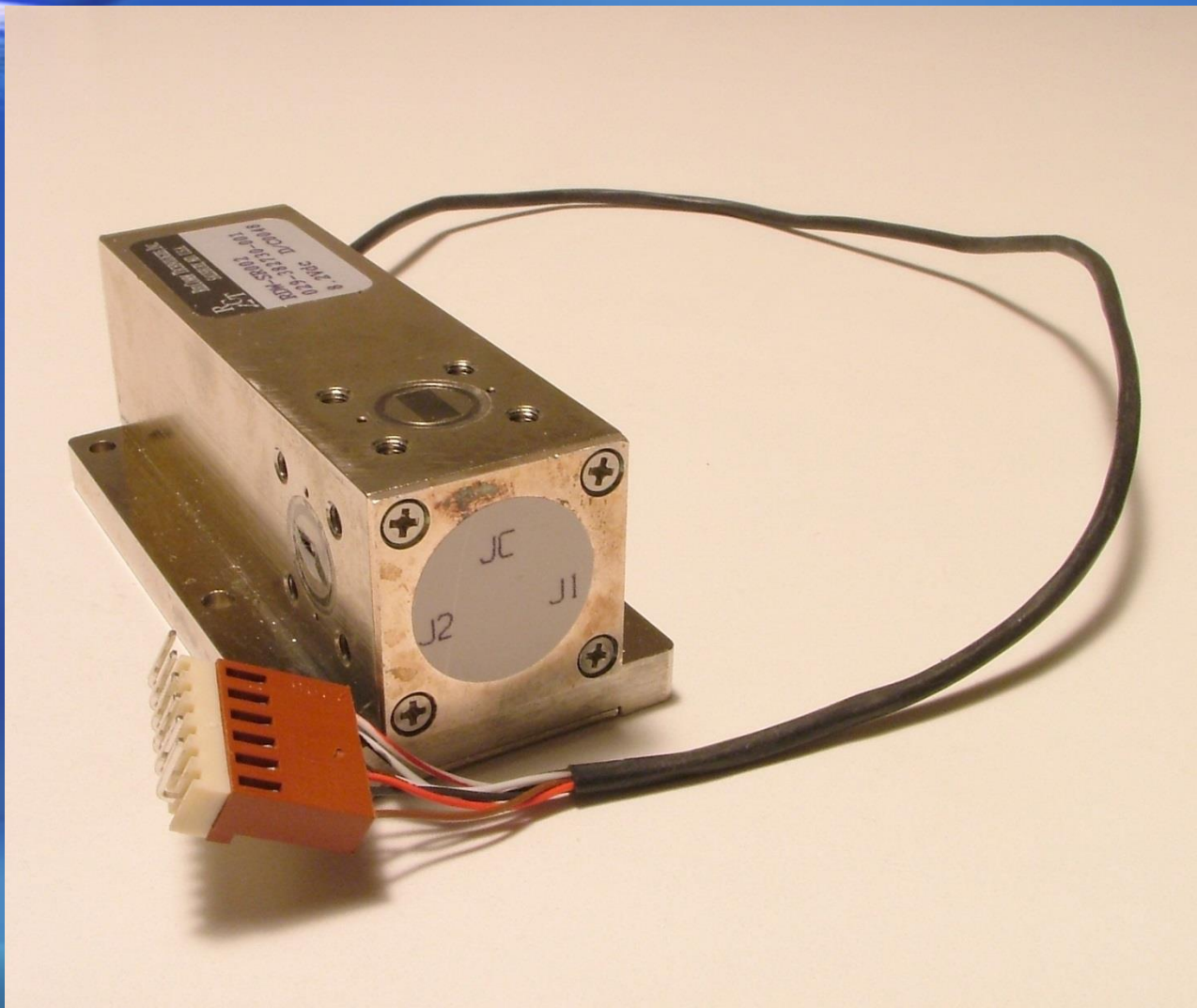
1 dB
IL

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RelComm Tech “ZL” E Plane Switch



RelComm Tech "ZL" E Plane Switch

CH1: A -M S - 8.27 dB
10.0 dB/ REF - .00 dB

CH2: B -M S - 4.01 dB
1.0 dB/ REF - .00 dB

47 GHz WR-28 TEST ZL WG SWITCH E PLANE

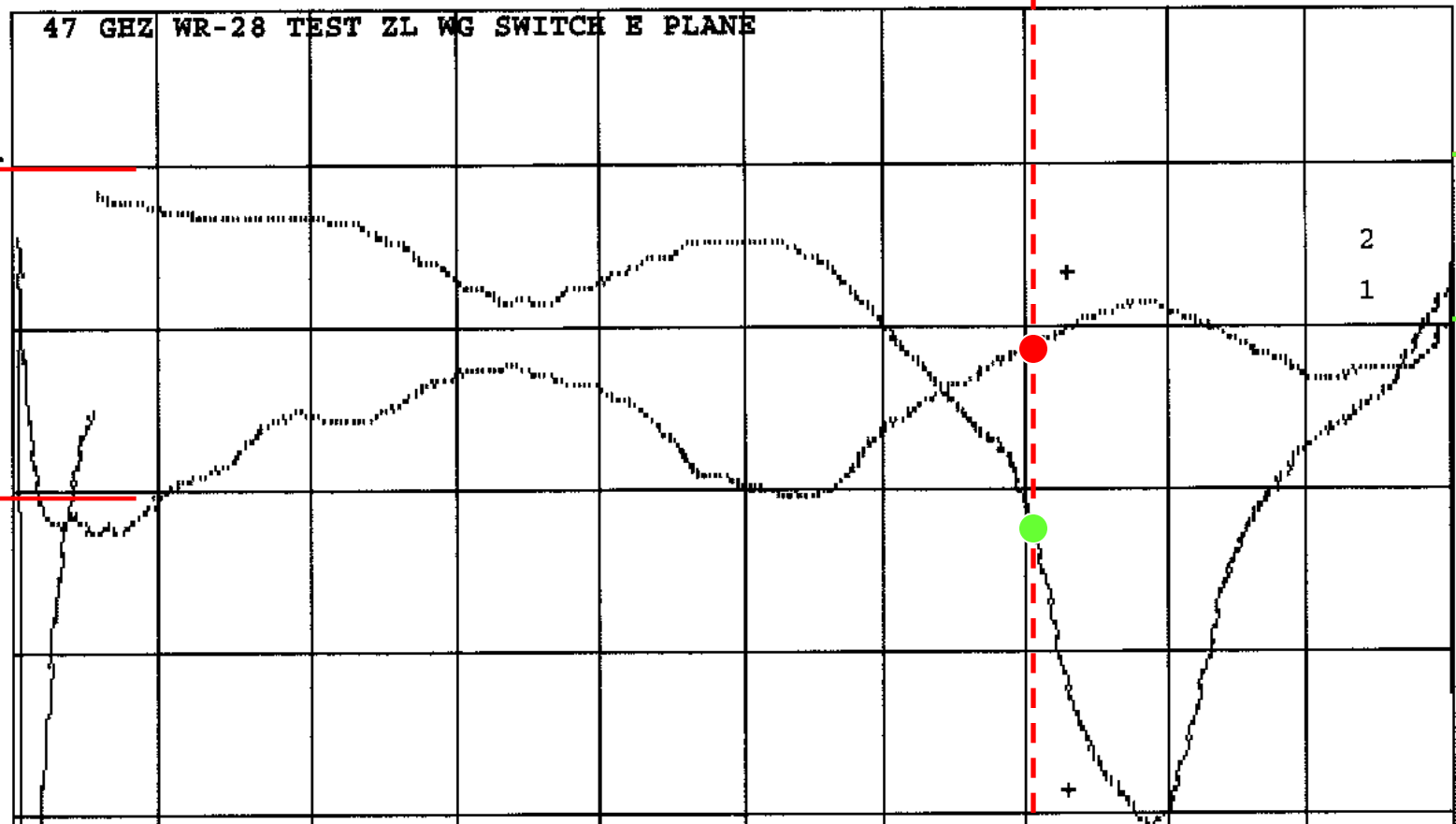
20 dB
RL

1 dB
IL

40 GHz

47 GHz

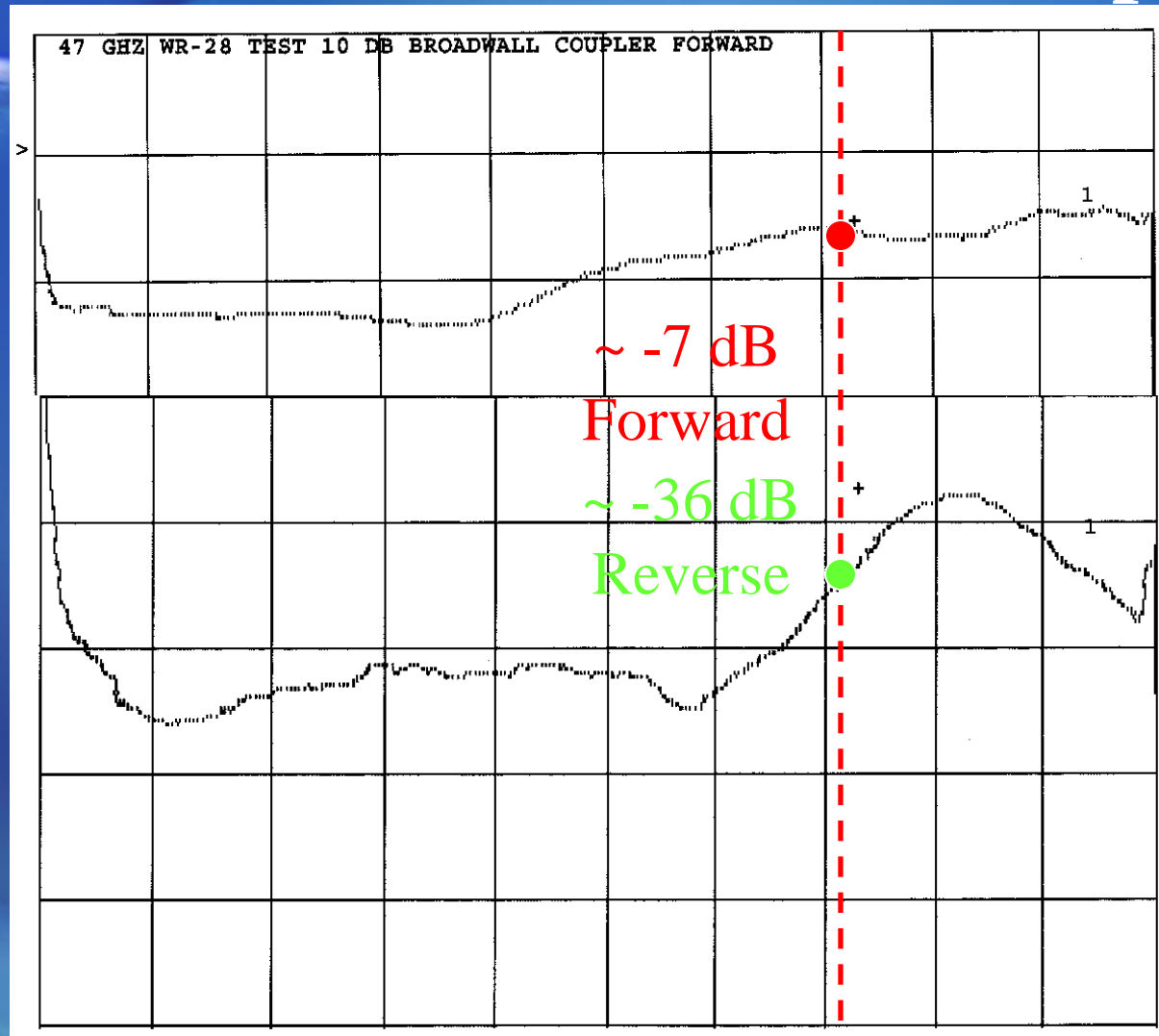
50 GHz



MCS R382-B Broadwall Coupler



MCS R382-B Broadwall Coupler



40 GHz

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50 GHz

47 GHz WR28 WG Recommendations

- **OK to Use WR28 If Lowest Loss Not Req'd**
- **Use Only Short Straight Sections If Possible**
- **“E” Bend Best, and Large Radius Preferred**
- **“H” Plane Bends May Be OK....Test !**
- **“Cast” 90 Deg Bends VERY BAD**
- **High Power Loads “OK”, Better With Taper**
- **Waveline Switches OK, E Plane Best, “ZL” Bad**
- **Choke Flanges are Suspect...Test Them!**



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- **Technical Specifications**
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- **Test Results**
- **Recommendations**
- **Questions?**