

NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA

ELECTRONICS DIVISION TECHNICAL NOTE NO. 187

Title: "Single-Step Right-Angle E-Plane Bend Geometry"

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DISTRIBUTION:

Simple Split-Block 90° E-Plane Bends for Low Power Applications

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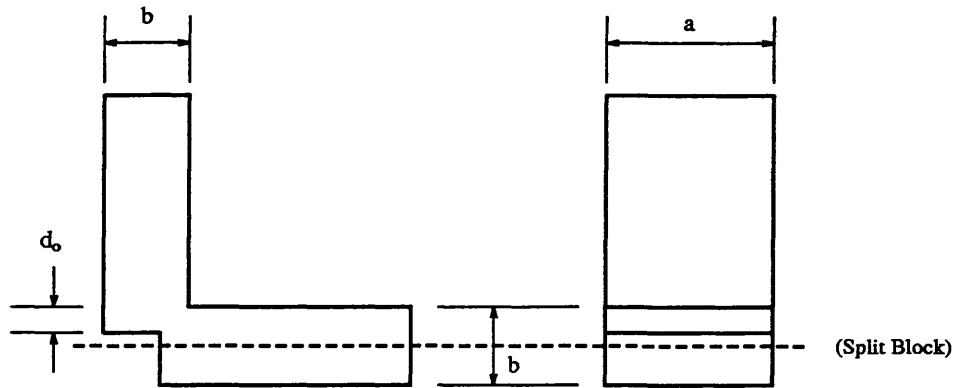


Figure 1. Single-Step Right-Angle E-Plane Bend Geometry.

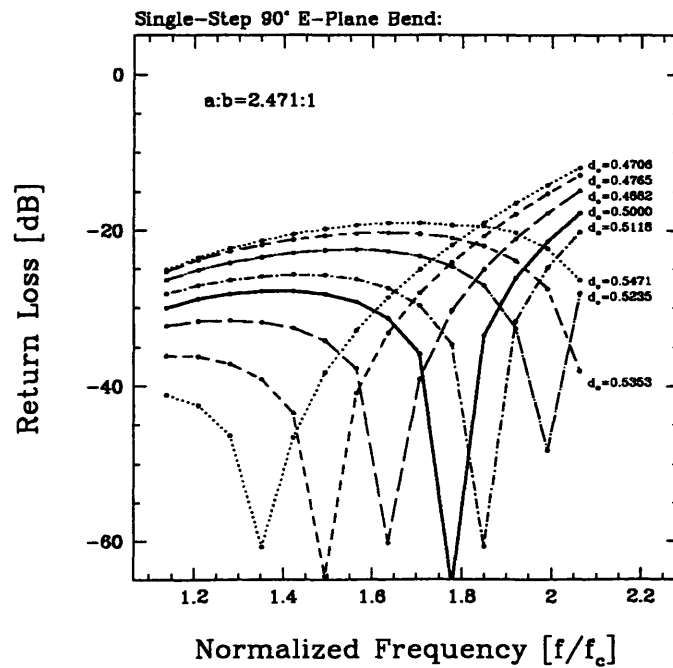


Figure 2. Modeled Single-Step Right-Angle E-Plane Bend Return Loss.

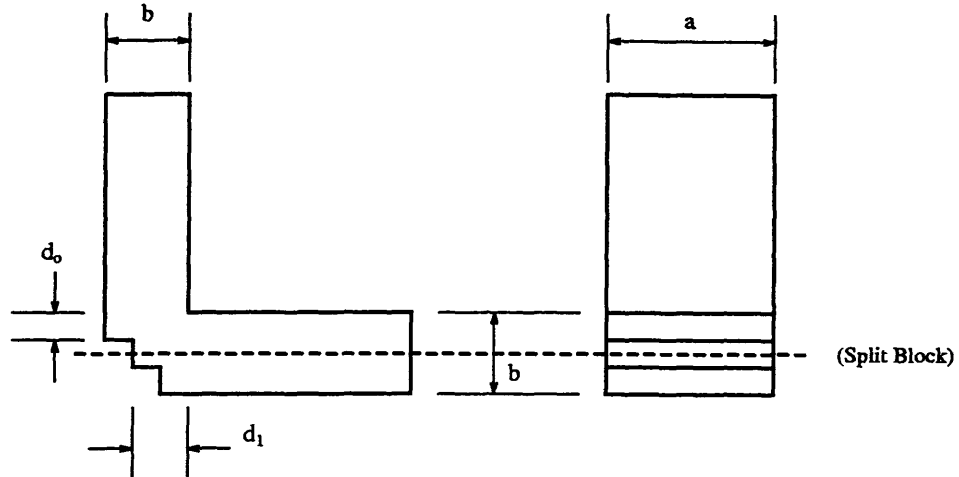


Figure 3. Two-Step Right-Angle E-Plane Bend Geometry.

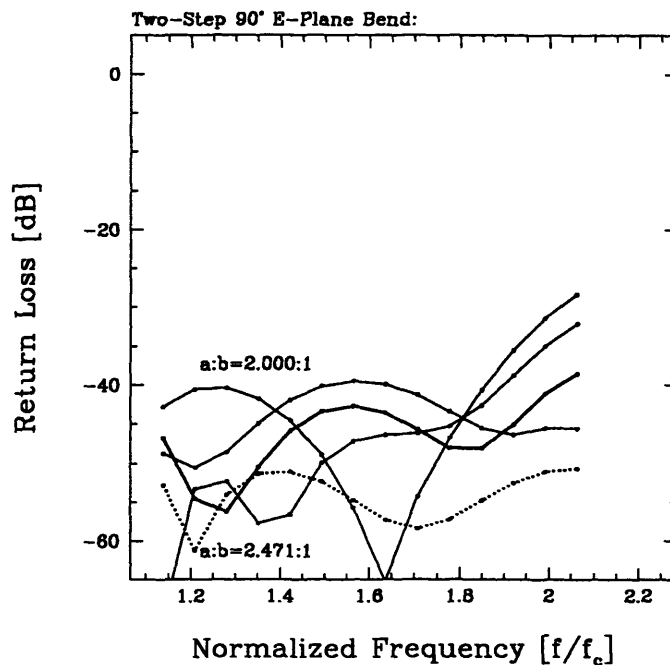


Figure 4. Modeled Two-Step Right-Angle E-Plane Bend Return Loss. For 2.0:1 guide, return loss curves representative of the tolerance range given in Table 1 are shown. For 2.5:1 aspect ratio guide, the nominal design is designated by a dashed line.

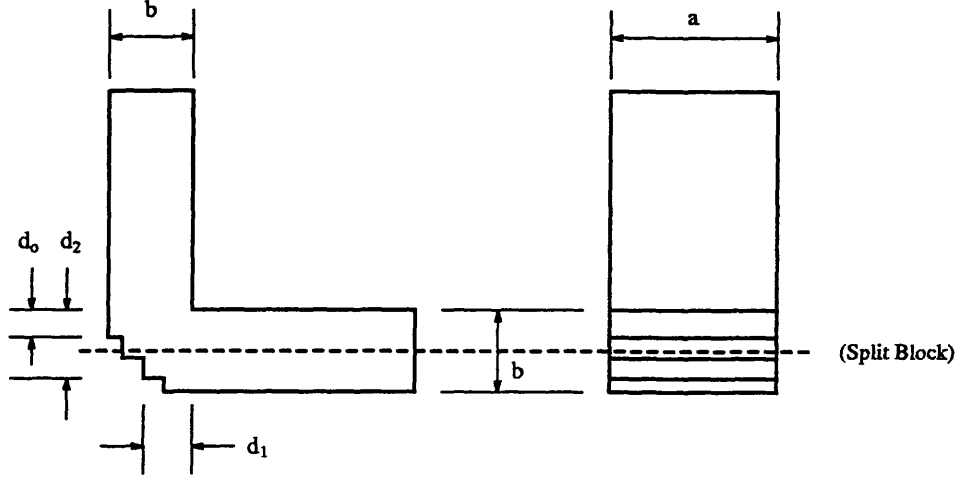


Figure 5. Three-Step Right-Angle E-Plane Bend Geometry.

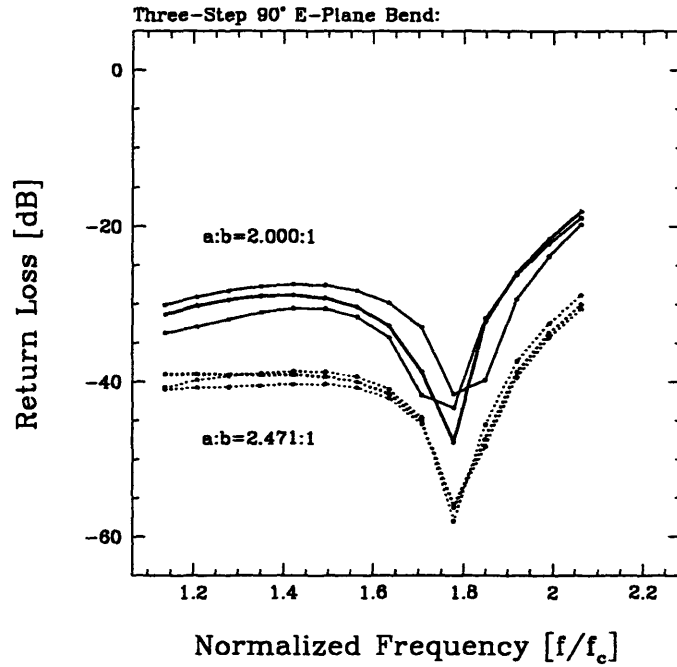


Figure 6. Modeled Three-Step Right-Angle E-Plane Bend Return Loss. The family of return loss curves displayed approximately outlines the bend performance for the designs given in Table 1.

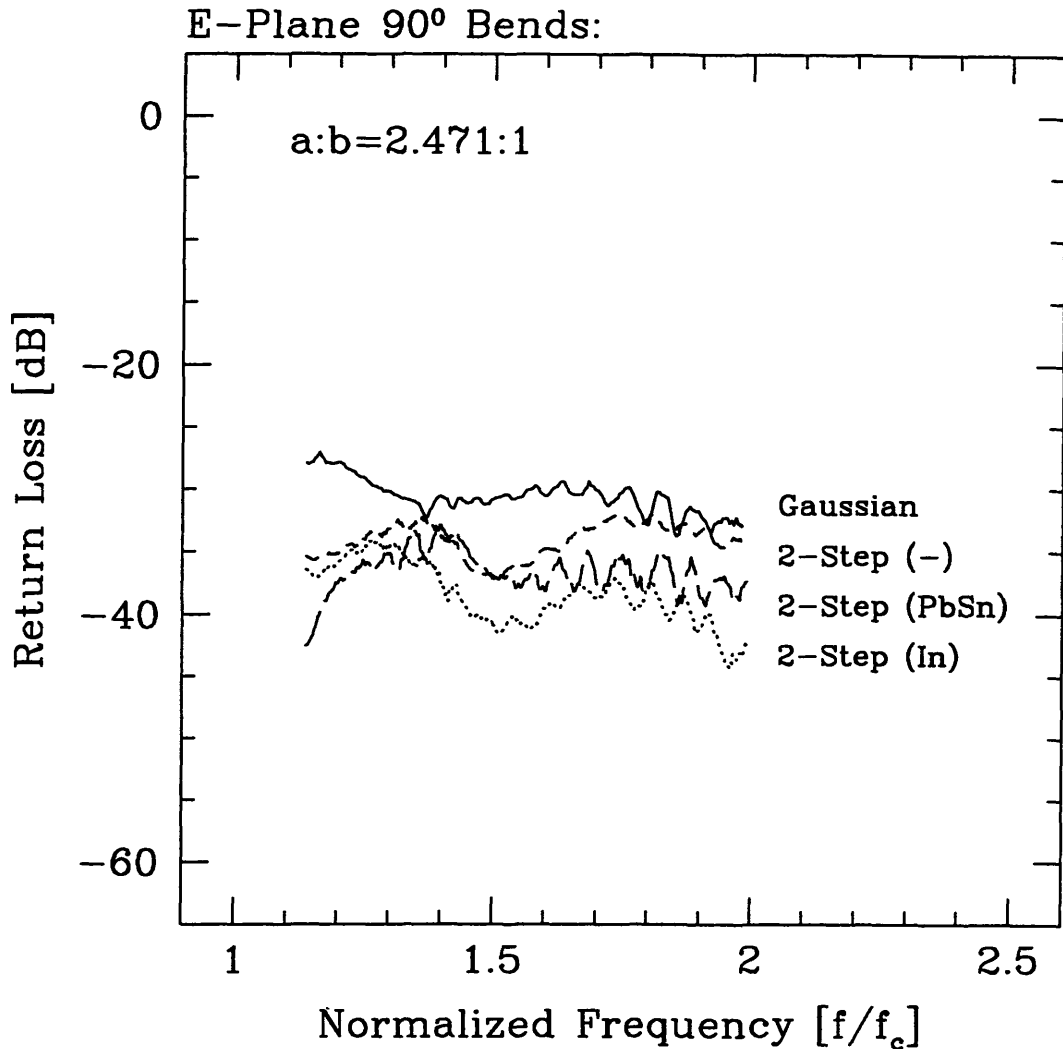


Figure 7. Measured Two-Step Right-Angle E-Plane Bend Return Loss. The two-step bend was manufactured as a centered split-block resulting in a $\sim 25 \mu\text{m}$ seam behind the upper tuning step. The upper split-block was broached to form the output waveguide. The two-step curves denoted '-', 'In', and 'PbSn' are respectively bolted split-block, indium packed seam, and soldered. The measured return loss of this bend is comparable to an electroformed single-mitre bend. Realizing the step bend as an off-center split block, casting, or electroform would reduce this perturbation on the modeled geometry and improve the bend performance. The curve labeled 'Gaussian' is a 3σ Gaussian curvature bend $3a$ in length which occupies approximately the same volume as a two-step bend with flanges.

TABLE 1
 STEPPED RIGHT-ANGLE E-PLANE BEND SUMMARY

# Steps	Guide Aspect [$a : b$]	d_o [d_o/b]	d_1 [d_1/b]	d_2 [d_2/b]	VSWR
1	2.000 : 1	0.530 ± 0.010			1.2
	2.471 : 1	0.500 ± 0.005			1.1
2	2.000 : 1	0.235 ± 0.007	0.747 ± 0.005		1.04
	2.471 : 1	0.235 ± 0.007	0.748 ± 0.005		1.02
3	2.000 : 1	0.229 ± 0.006	0.548 ± 0.012	0.848 ± 0.012	1.05
	2.471 : 1	0.206 ± 0.006	0.541 ± 0.012	0.835 ± 0.012	1.03
Single	2.000 : 1	0.228 ± 0.010			1.12
Mitre	2.471 : 1	0.200 ± 0.005			1.05

A fractional bandwidth of $\Delta\nu/\nu \sim 0.4$ ($1.2f_c$ to $1.9f_c$) is used in estimating the VSWR. If the bend is fabricated with a split-block parallel to the broadwall, a tool diameter small compared to $\sim 0.2a$ should be used for the corners. A single-mitre bend (45° back mirror used for compensation of the bend discontinuity) is also included for reference. The dimensions in the table are normalized by the guide height, b . The simulations were performed with HFSS (Hewlett Packard High Frequency Structure Simulator).