Correspondence

A Low Input VSWR Coaxial Diode Switch for the UHF Band

A unique SPDT coaxial diode switch has been developed at the Boulder Laboratories of the National Bureau of Standards, Boulder, Colo. By using a system of outer conductor reducers, special blocking capacitors and a series of tuning screws, an input VSWR of less than 1.07 is achieved over a broad frequency band centered at 1000 Mc. The characteristic impedance of the switch is 50 Ω, the isolation in one arm is greater than 63 db, the insertion loss is about 1.5 db, the switching time is 20 nsec and it has a power handling capability of 3 w CW.

Commercially available crystal diode switches are usually constructed in a section of slab transmission line. They have nanosecond switching speeds, low insertion loss and high isolation. Little attention, however, has been given to reducing their input VSWR to below about 1.5. An RF measurement system[1] recently developed at the Boulder Laboratories of the National Bureau of Standards required a SPDT diode switch with an input VSWR below 1.10 in the frequency range 900–1200 Mc. This low VSWR would allow the use of a directional coupler-bolometer mount combination for measuring the input power to the switch with negligible power being reflected.

Since none of the commercially available diode switches had a satisfactory VSWR, an experimental conventional type slabline diode switch was constructed in the laboratory. Broad-band impedance matching was achieved by adding shunt capacitance at each spacer between the diodes. This was accomplished with tuning screws in the switch lid as shown in Fig. 1. The distributed matching capacitances are separated by the diode resistances which greatly lower the Q of the effective matching circuit as compared to a lossless, lumped constant section in front of the switch. The switch input was matched to a VSWR of 1.10 or less in both switch positions for a 75-Mc bandwidth centered on 1000 Mc. Since a bandwidth of at least 300 Mc was needed, further modifications to remove impedance discontinuities were necessary.

It was shown that the sections of the line containing the commercial 150-pf blocking capacitors (see Fig. 1) were causing a severe impedance discontinuity apparently due to a relatively large parasitic inductance in these capacitors. A coaxial capacitor having a much lower series inductance was designed and constructed. Fig. 2 shows a 150-pf capacitor constructed with a tapered pin in a 6/0 reamed hole, with 0.005 inch thick mylar dielectric. Three of these were used as part of the center conductor of the coaxial transmission line section and improved the VSWR to about 1.06 at 1000 Mc. Improvement in the bandwidth, however, was slight.

Manuscript received November 6, 1963.

[1] P. A. Hudson, W. L. Ecklund and A. R. Ondrejka, "Measurement of RF peak-pulse power by a sampling-comparison method," IRE Trans. on Instrumentation, vol. I-2, pp. 280–284; December, 1962.

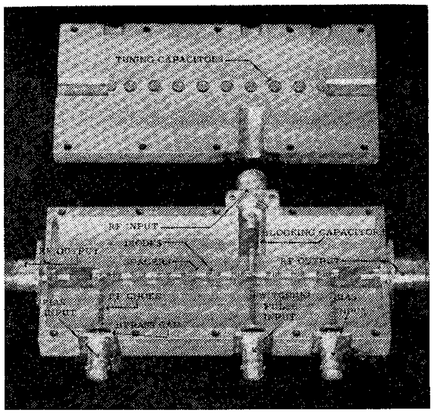

Fig. 1—Slabline diode switch.

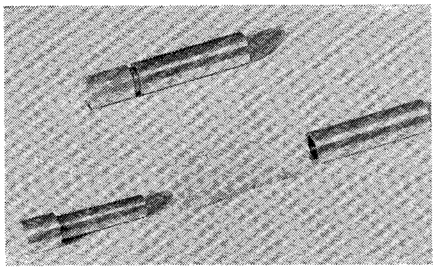

Fig. 2—Construction of coaxial capacitor.

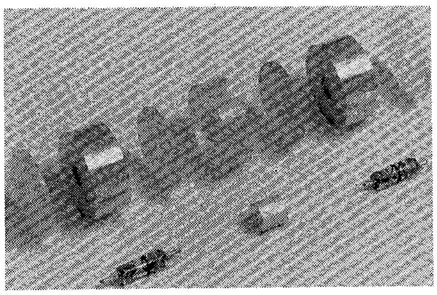

Fig. 3—Typical diode section assembly.

A second discontinuity was known to exist at the coaxial to slab transition. Efforts to eliminate this discontinuity were unsuccessful and the switch was redesigned in a completely coaxial configuration.

In order to maintain the correct inner-to-outer diameter ratio (to keep the diode-spacer region of the switch 50 Ω), a series of Rexolite spacers and aluminum outer conductor reducers were constructed as shown in Fig. 3. The characteristic impedance of a diode when mounted in a coaxial line is necessarily higher than 50 Ω because the glass envelope restricts the smallest possible outer conductor diameter to about 0.09 inch. This means that the section containing the 0.1-inch long diode whisker of 0.0015-inch diameter has a characteristic impedance of about 200 Ω. It was found that the inductive diode sections could be compensated by making the spacer section slightly capacitive. The outer conductor reducers on the two diodes nearest the input center conductor have larger inner diameters than the others. This was necessary so that the switch arm in the "open" position could present a high impedance in its first diode section and thus it would have negligible shunting effect on the "closed" arm.

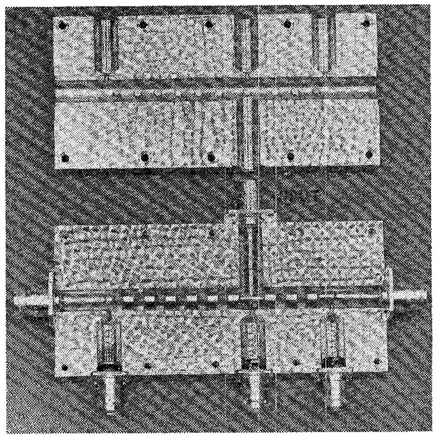

Fig. 4—Coaxial diode switch.

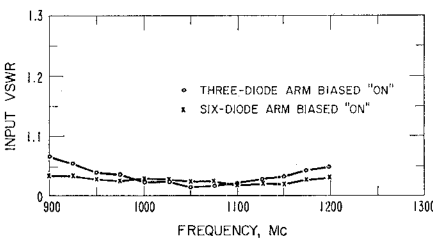

Fig. 5—Input VSWR of coaxial diode switch.

The completed switch, shown in Fig. 4, had an input VSWR of 1.07 or less in both switch positions for a 300-Mc bandwidth centered on 1050 Mc (see Fig. 5). Isolation through the six-diode arm was greater than 63 db with an insertion loss of 1.5 db. Isolation through the three-diode arm was greater than 30 db with 1.5-db insertion loss. Using 30 v back bias and a 50-v switching pulse with 12 nsec rise time, the switching time was 20 nsec for power levels up to 3 w CW.

Although the interest here has been in low input VSWR broad-band matching near 1000 Mc, the same technique should work for any coaxial frequency, particularly 500 Mc and higher.

W. L. Ecklund
Nat'l Bur. Standards
Boulder, Colo.