# DSN Diplexer, Noise Burst Testing

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*This article describes the testing of a new design high power S-band diplexer, the megawatt Cassegrain diplexer (MCD), to be used for DSN operations. The tests described were performed at 100 kW at the Venus Deep Space Station (DSS 13) Transmitter Test Area. At 100 kW or less no degradation of receive performance was detected.*

## I. Introduction

A diplexer is a passive microwave network that allows simultaneous transmission and reception of microwave signals. To communicate with distant spacecraft, it is necessary to utilize high transmitter power and low noise receivers. A DSN station can use up to 400 kW of continuous-wave transmitter power with receiver temperatures as low as 10 K (0.15 dB noise figure). To operate under these conditions without introducing additional system noise, a high-power diplexer must be designed for minimum voltage gradient to prevent arcing, corona discharge, and other nonlinear phenomena. The testing was performed under controlled conditions to detect any excess noise generated within the diplexer.

## II. Test Configuration

The diplexer was installed in an existing DSN feedcone, the S-band Megawatt Transmit (SMT), to provide a horn as a low noise termination for the diplexer. The rest of the configuration duplicates the operating system of a DSN high-power station. A receive band reject filter, the megawatt transmitter filter (MTF) is installed between the transmitter and diplexer to reject broadband beam noise from the klystron amplifier. The receive output port of the diplexer is connected to a traveling wave maser and noise monitoring rack. A waveguide switch in the maser input allows for calibration of the maser by means of comparison with an ambient load. Figure 1 is a block diagram of the test configuration. Figures 2 through 6 show overall views of the test area.

## III. Test Result

When the system was operated under high power into the water load, the voltage standing wave ratio (VSWR) was excessive (return loss of less than 20 dB). Investigation of the various components and waveguide interconnects failed to reveal any one defective component, so it was surmised that the individual reflection coefficient vectors were phased so that they added. Figure 7 shows the VSWR of various components and sections of the system as measured with a WR-430 waveguide slotted line and a WR-430 restive load (VSWR < 1.01). To correct the problem, the E dimension of a short section of waveguide was adjusted to provide an acceptable match to the transmitter. Although it would have been possible to broad-band with this matching technique, this cone will be completely refurbished before reinstallation, and it was felt that it would not justify the time required.

The diplexer was operated at both high VSWR ($f$ = 2110 MHz) and low VSWR ($f$ = 2117 MHz) at 100 kW CW for four hours at each frequency. The system temperature was approximately 28 K and the recorder sensitivity was approximately 2.7 K/major division. At various times during the four-hour runs, the diplexer and other waveguide parts were examined for any heating. Also, the diplexer, waveguide, and feed were pounded with a rubber mallet to determine if there were any mechanical instabilities in the system.

## IV. Results

Figure 8 is a portion of the diplexer test chart. At no time during either the high- or low-VSWR runs was any excess noise detected in the system. The slow drift of the chart to the left is caused by the zero drift of the power meter used as a noise detector. The pounding with a mallet was undetectable in the noise spectra, either on the chart recorder or the spectrum analyzer. Also, no detectable temperature rise due to RF heating was noted.

## V. Conclusion

Within the constraints of relatively low-power testing (100 kW instead of the 400 kW designed operating level), no faults were found in this diplexer under RF power conditions. It is recommended that this unit be tested at 400 kW CW RF for a period of not less than four hours when a suitable power klystron becomes available. The complete testing of this diplexer, including set-up calibration, debugging and tear down of equipment for these tests, utilized 165 JPL and 320 contractor manhours.

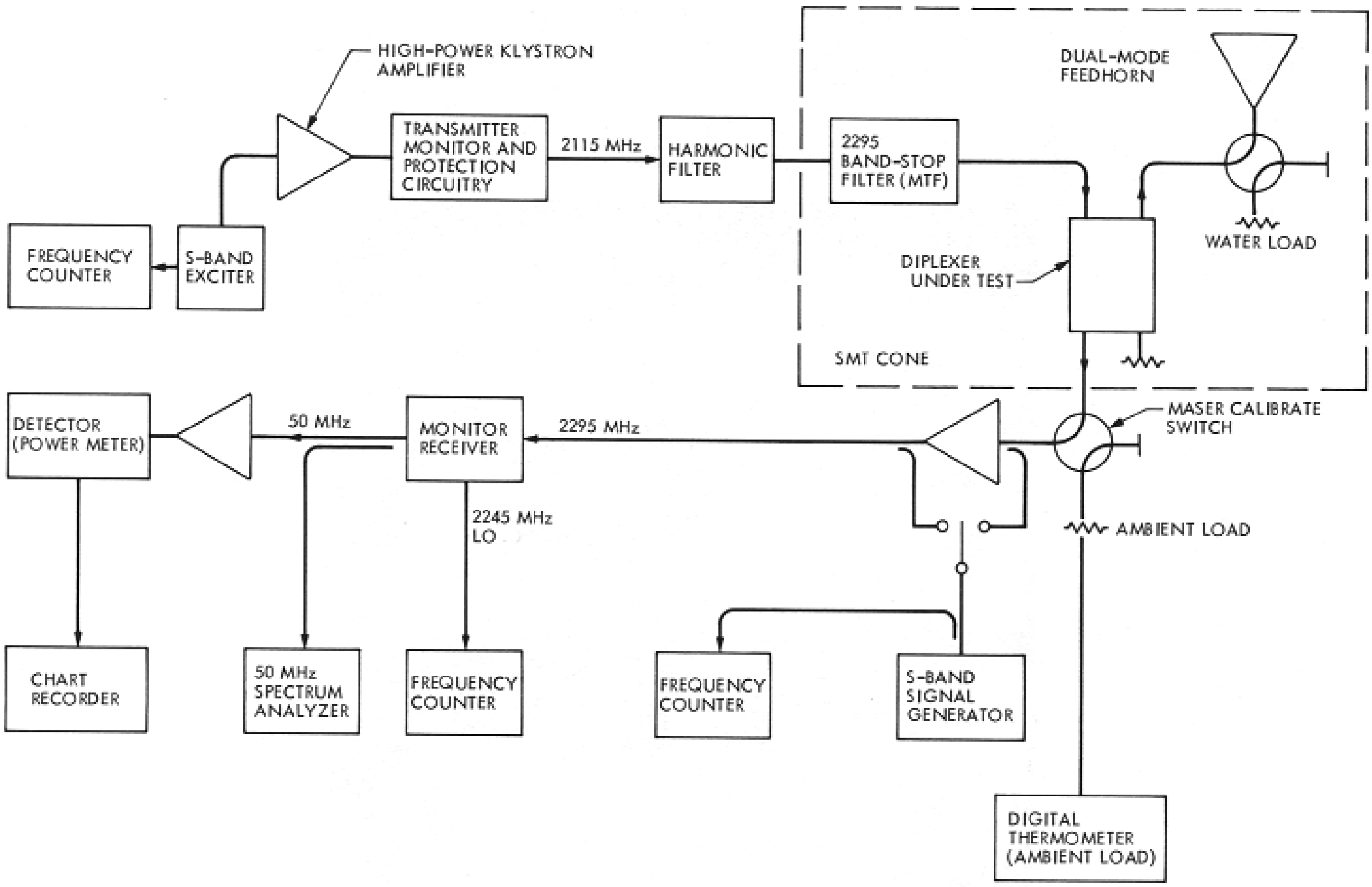


**Fig. 1. Equipment configuration-diplexer test**

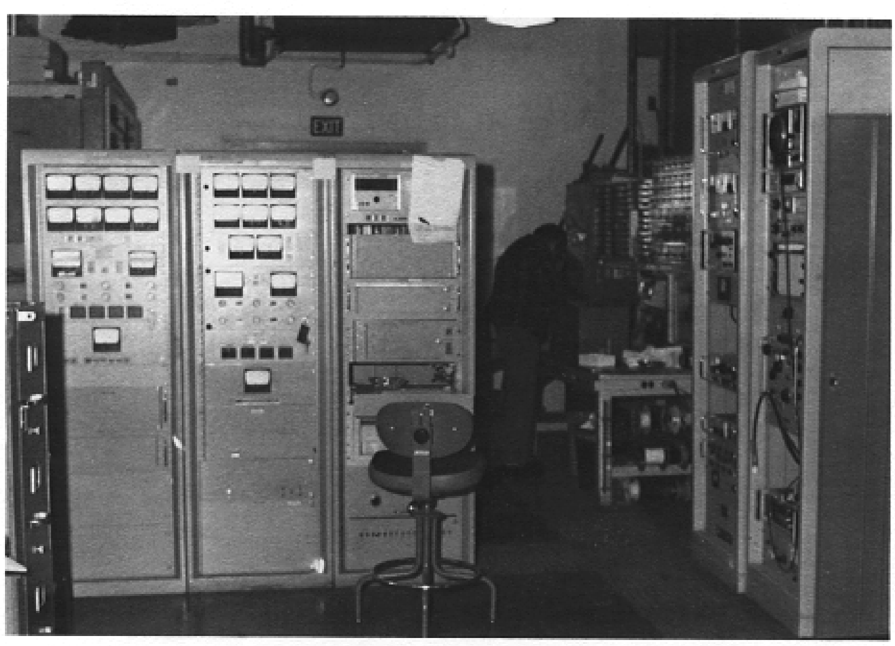

**Fig. 2. Instrumentation and control racks**

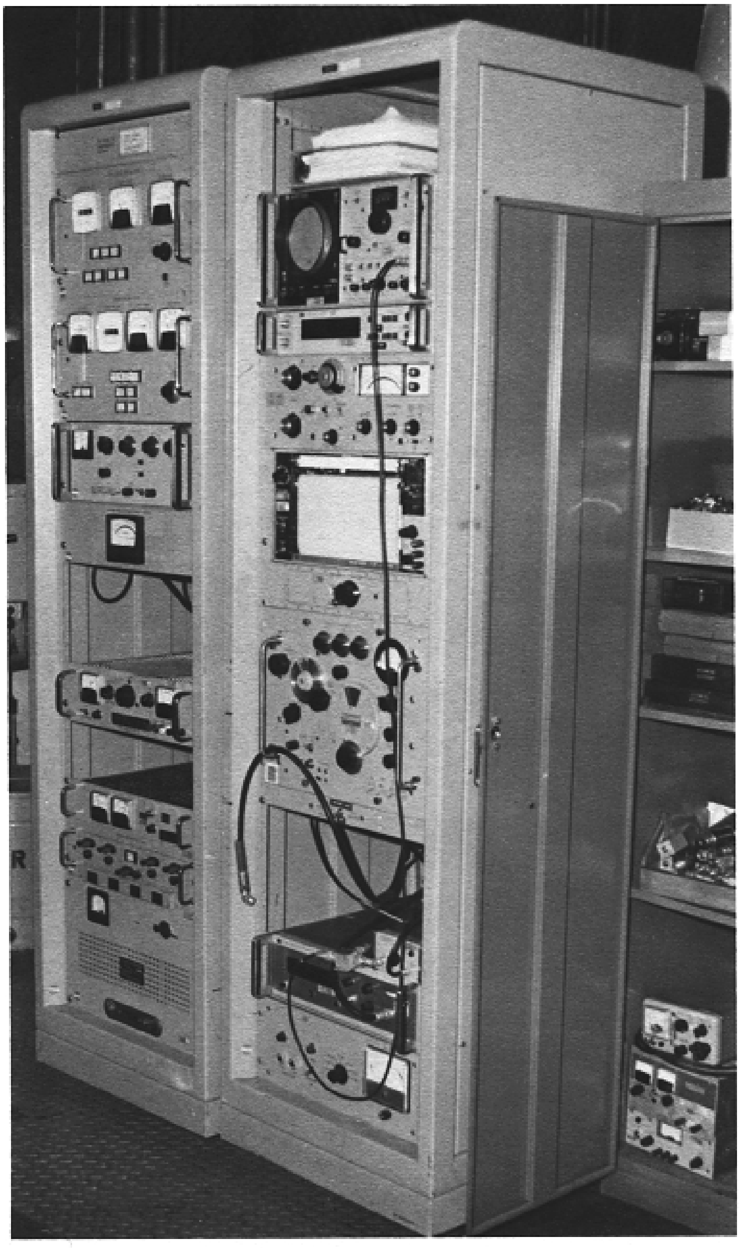

Fig. 3. Maser control and instrumentation

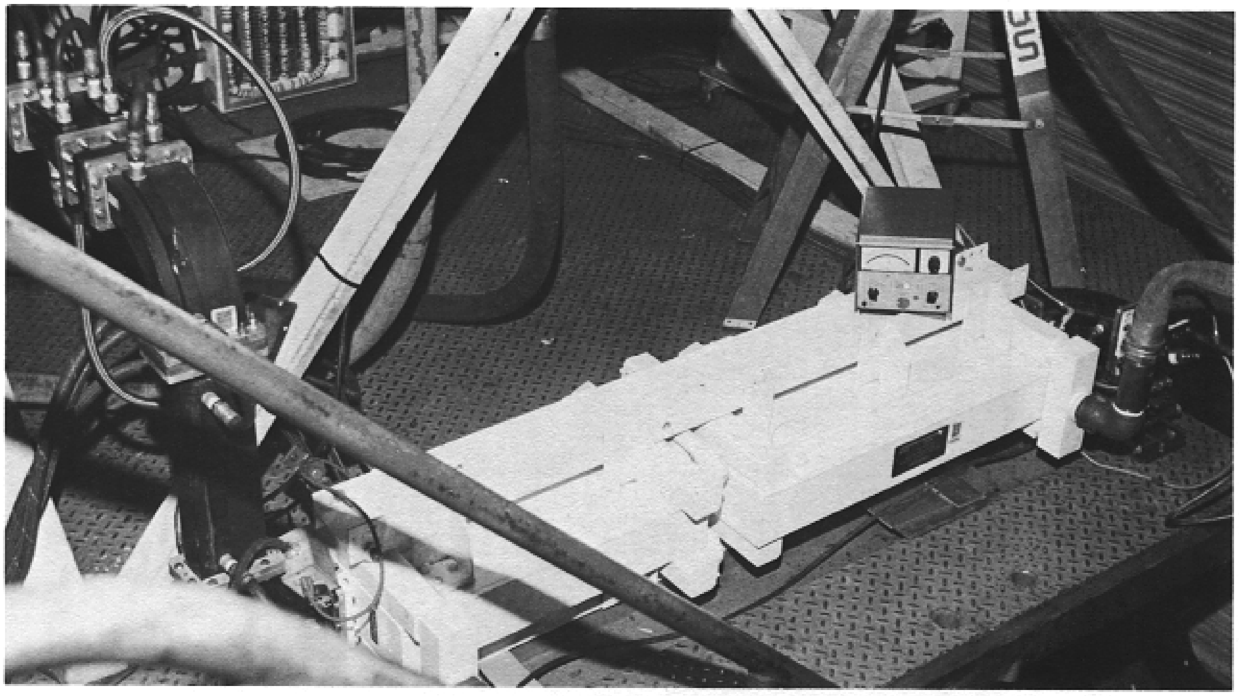

Fig. 4. Harmonic filter and input power monitor

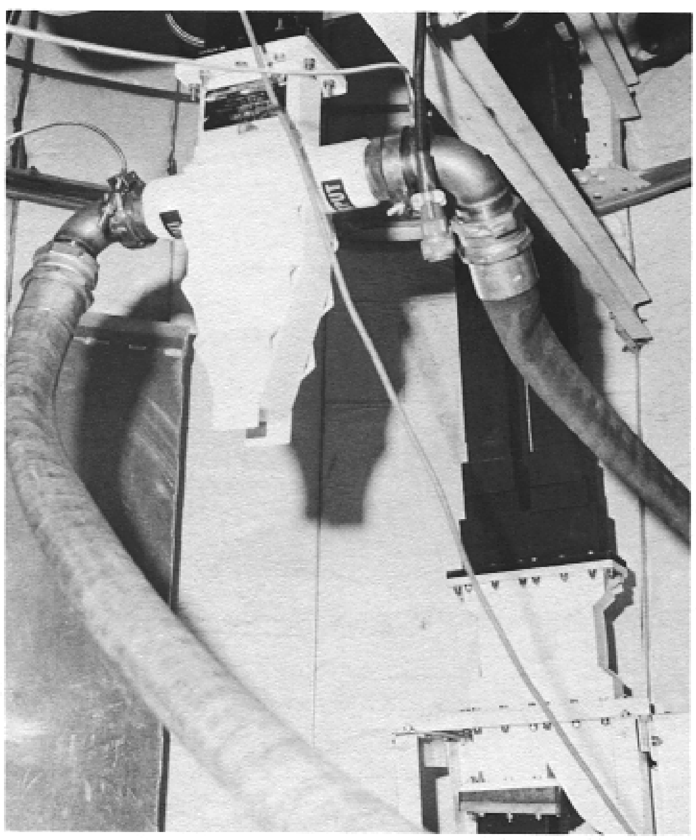

Fig. 5. Water load and diplexer installation



Fig. 6. Maser and diplexer installation

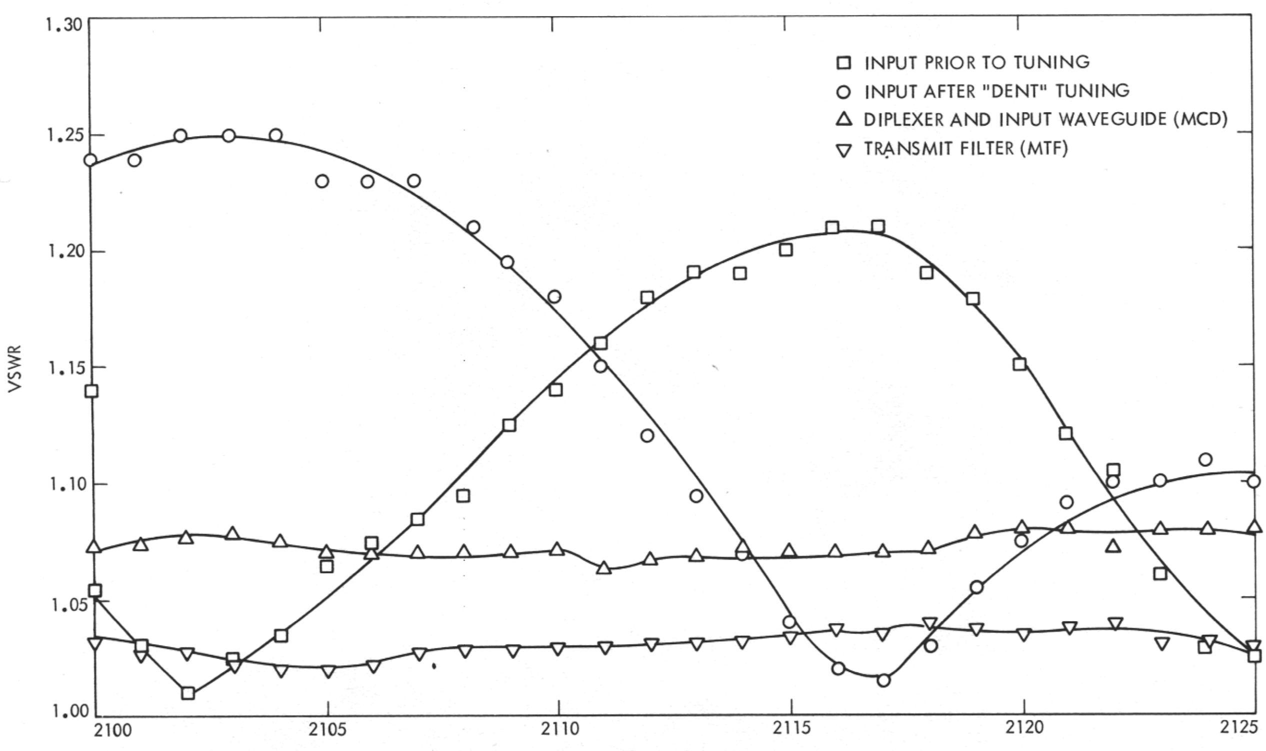



Fig. 7. VSWR data

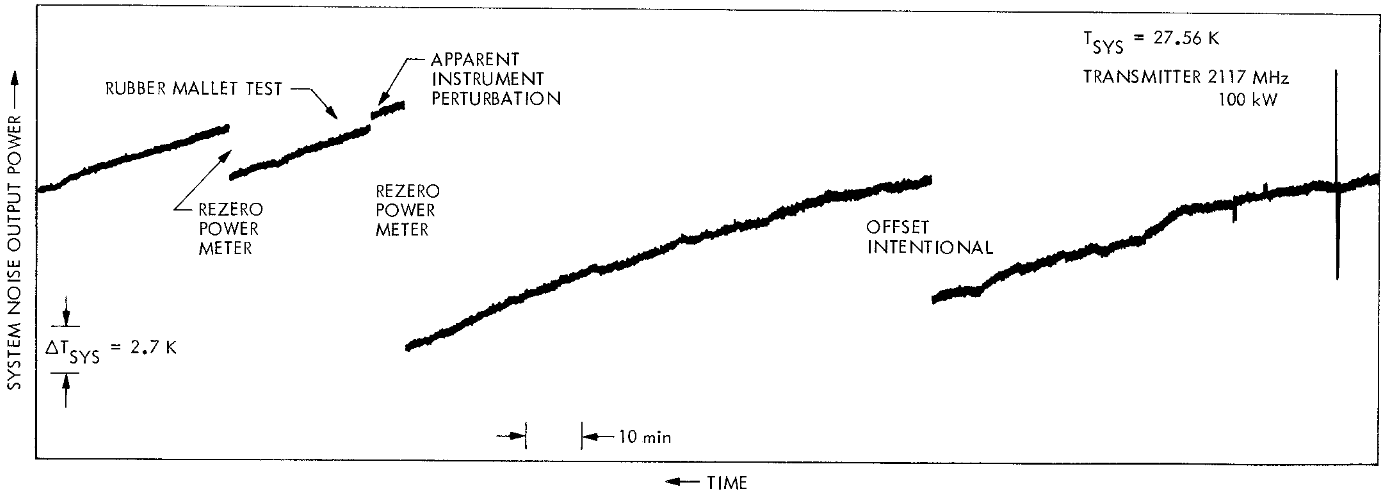


Fig. 8. Diplex test system temperature chart