Temperature Testing of the New S-Band Transmitter Filter for DSS 54

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The 1.7- to 2.6-GHz (S-Band) transmitter filter, installed in the beam-waveguide (BWG) antennas, originally was designed for the 34-m high-efficiency antennas (HEFs). This filter operated at a very high physical temperature. In the BWG antennas, this filter is accessible to the maintenance personnel while the antenna is operational. Therefore, it is considered a safety risk. To reduce the risk, it was decided to design a new filter with lower insertion loss and better cooling that would lower the physical temperature. The new filter was specified at JPL but designed and fabricated at Gamma 'F' Corporation. The design replaced copper for aluminum to reduce ohmic loss and added copper cooling fins to help radiate the heat away. This filter will be installed in Deep Space Station 54 (DSS 54) near Madrid, Spain. In this article, the physical temperatures of the new filter are presented and compared with the old filter at various transmitting power levels. The frequency response of the filter also is provided for future reference.

I. Introduction

The 1.7- to 2.6-GHz (S-Band) transmitter filter (STF) II with a matching section (see Fig. 1) was designed to pass the transmit signal, 2.025–2.120 GHz, and to stop the transmitter noise in the receive band, 2.2–2.3 GHz, to protect the low-noise amplifier (LNA).

The original STF was used at the DSN standard and high efficiency (HEF) 34-m antennas. In those antennas, personnel were not allowed in the feed cone when the antenna was operational. However, in the beam-waveguide (BWG) antennas, the whole feed is located in the pedestal room, and the STF is accessible to the antenna personnel. During transmit testing at 20 kW, it was discovered that the physical temperature of the STF stabilized at 168 deg C. With this newly designed filter that has fins to radiate heat and is made of copper to reduce ohmic loss, the temperature at 20 kW was reduced to 71 deg C.

II. Test Results

The filter was first tested on the Hewlett Packard 8510C Vector Network Analyzer to confirm the design test parameters (see Figs. 2 through 4, which present the plots of the output of the screens). The HP 8510C measures all the electromagnetic S-parameters. The maximum insertion loss at the pass band was 0.098 dB from 2.025 GHz up to 2.13 GHz. The return loss at the same band was better than 29 dB. The rejection at the receiver frequency band, 2.2–2.3 GHz, was better than 71 dB.

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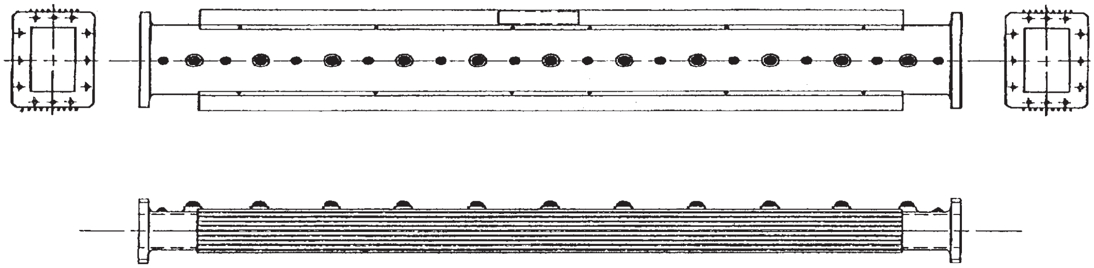

Fig. 1. The physical structure of the filter does not show the four fins on top (where the screw are located) and bottom. There are three fins on both sides of the filter.

It was determined that temperature testing of the STF II would be the main factor that needed to be confirmed. This test was performed at DSS 13 at the Deep Space Communications Complex at Goldstone, California, using the 20-kW S-Band transmitter that is housed in a building. This transmitter uses a waveguide that is attached from the transmitter filter into a water load. The purpose of the water load is to absorb the heat radiated from the transmitter.

For this test, three thermocouple sensors were used. Two were located about 2.54 cm away from each flange, and one sensor was at the center of the filter. The transmitter at 2.114 GHz was stepped up in 5-kW steps from 10 kW to 25 kW. At each step, the transmitter was run for about 1 hour to allow the temperature to stabilize. The building housing the transmitter was connected to a control room with a computer system that automatically graphed and tracked the system. The data recorded every 15 seconds were the temperature and time. The results are shown in Fig. 5 and Table 1.

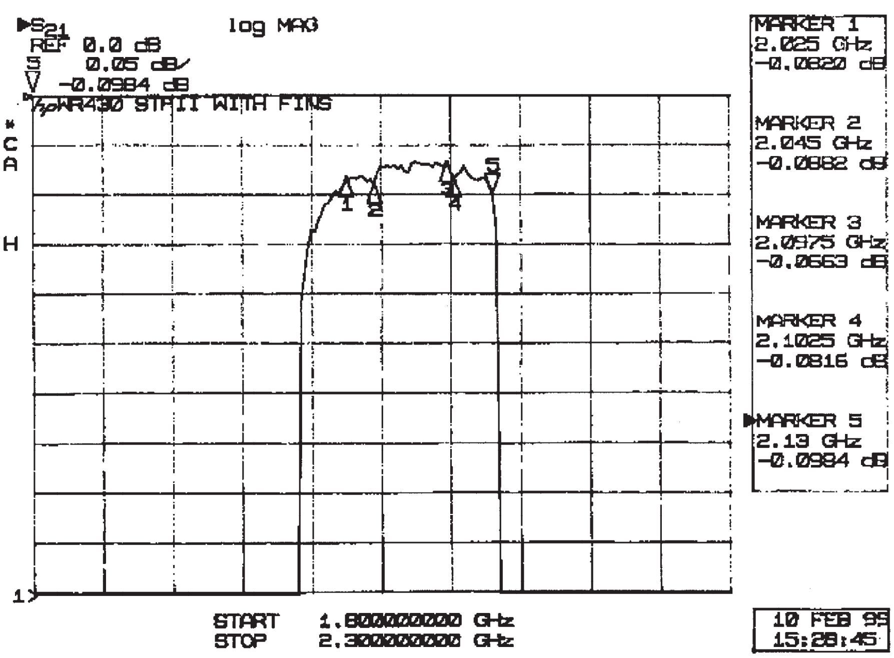

Fig. 2. The insertion loss measurement.

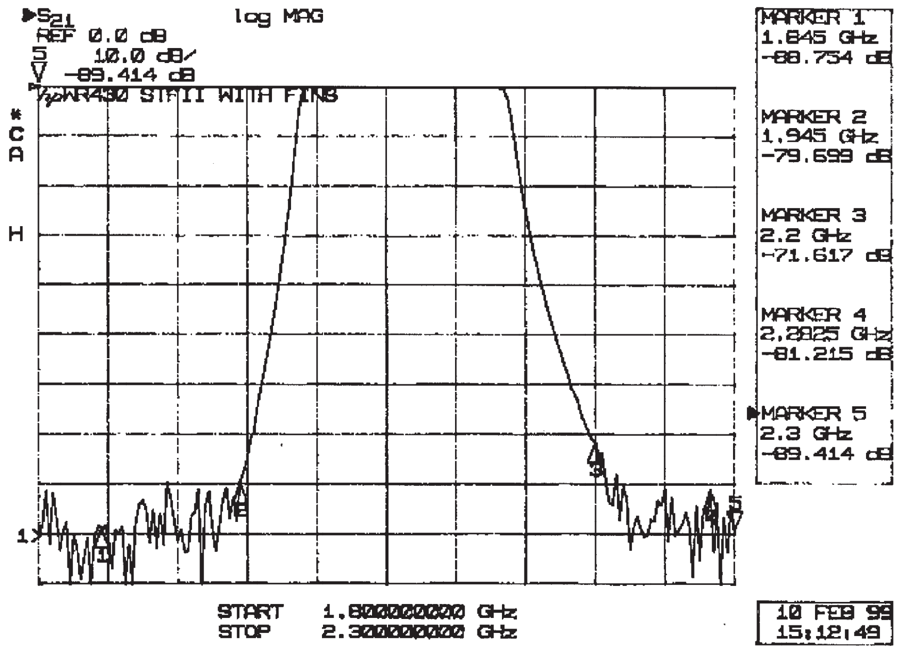

Fig. 3. The rejection measurement.

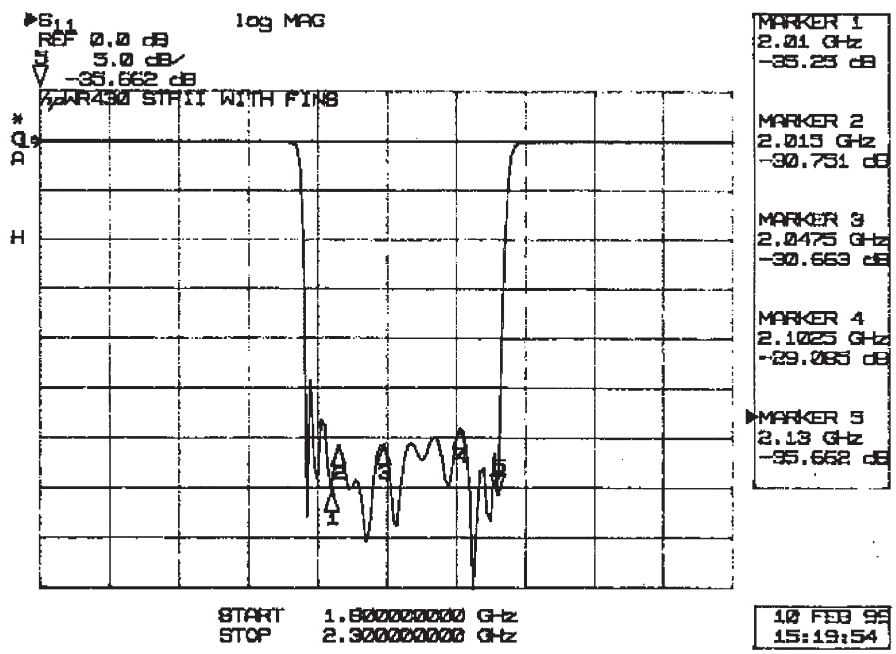

Fig. 4. The reflection loss measurement.

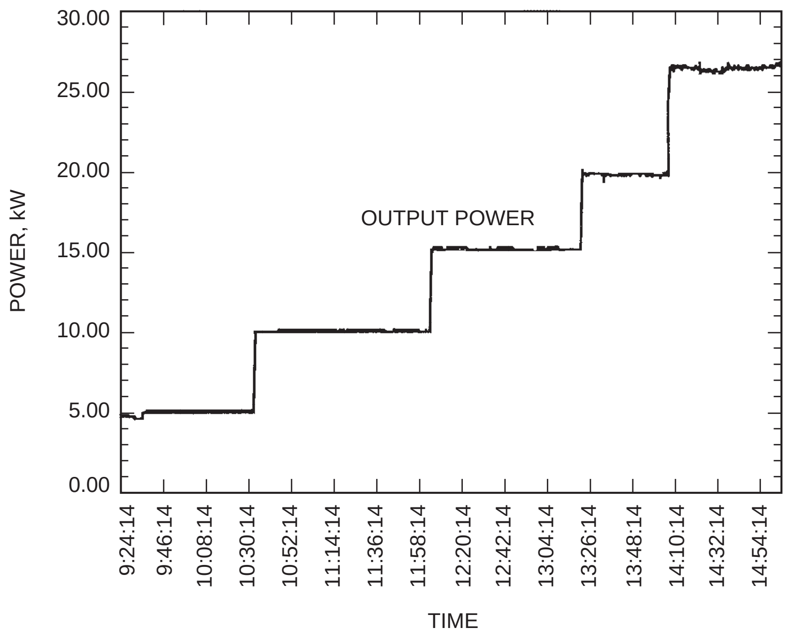

Fig. 5. A graph showing that the power was increased by 5-kW steps during the time shown in Table 1.

Table 1. Measured physical temperatures of the old and new STF filters (STF and STF II) at various power levels.

STF			STF II		
Time, h	Power, kW	Highest temperature, deg C	Time, h, min	Power, kW	Highest temperature, deg C
1	10	92	1, 31	10	52.18
1	15	115	1, 18	15	62.22
1	20	168	55	20	70.28
N/A	N/A	N/A	27	25	79.81

III. Conclusion

The S-Band transmitter filter (STF) II was fabricated from copper and incorporated cooling fins. This filter operated at a much lower temperature due to its lower insertion loss and better cooling capability. The significance of this is that the filter is not a danger to maintenance workers in the pedestal room of the BWG antenna. If the maintenance personnel touch or bump into the filter, they will not burn themselves. Therefore, maintenance personnel can work in a safe environment during transmission of signals at high power.

Reference

[1] J. L. Galvez, H. Marlin, and P. Stanton, "ISEE-3 Microwave Filter Requirements," *The Telecommunications and Data Acquisition Progress Report 42-76, October–December 1983*, Jet Propulsion Laboratory, Pasadena, California, pp. 114–119, February 15, 1984.