Improved RF Calibration Techniques: System Operating Noise Temperature Calibrations

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System operating noise temperatures and other calibration data of the S-band research operational (SRO) cone at DSS 13 and the tricone system at DSS 14 are reported for the period October 1, 1971 through January 31, 1972. During this reporting period the tricone system consisted of the polarization diversity S-band (PDS) cone, the S-band megawatt transmit (SMT) cone, and the multifrequency X- and K-band (MXK) cone. S-band calibration data for various configuration modes of the PDS and SMT cones are reported as well as X-band calibration data for the MXK cone.

The system operating noise temperature performance of the low noise research cones at the Goldstone Deep Space Communications Complex is reported for the period October 1, 1971 (day 274) through January 31, 1972 (day 31). Most of the operating noise temperature calibrations were performed with the ambient termination technique[1] (Ref. 1). Measurements made with an aperture load are indicated in Table 1. System temperature calibrations were made on the following cones:

(1) S-band research operational (SRO) cone at DSS 13.

(2) Polarization diversity S-band (PDS) cone at DSS 14.

(3) S-band megawatt transmit (SMT) cone at DSS 14.

(4) Multifrequency X- and K-band (MXK) cone at DSS 14.

The averaged operating noise temperature calibrations for the SRO cone at DSS 13, and other calibration data, are summarized in Table 2. Maser serial number 96S2 was

[1]Most of the measurements were taken by DSS 13 (Venus) and DSS 14 (Mars) personnel.

in operation on the 26-m-diameter antenna at DSS 13 up to January 25, 1972. On this date, the maser was replaced by one with a superconducting magnet (maser serial number 96S5). Table 2 shows calibration data prior to January 25 with 96S2, as well as data that were taken between January 25 and 31 with 96S5. Measurements made with the maser (96S2) connected to the gain standard horn at 2278.5 MHz are also shown in Table 2.

Averaged operating noise temperature calibrations, and other calibration data, are presented in Table 1 for the tricone system at DSS 14. The tricone configuration for this reporting period consists of the PDS, SMT, and MXK cones. Maser serial number 80S1, which is located in the 3A section, can be switched into either the PDS system or the SMT system. Calibrations made with this maser are tabulated under the cone into which the maser was switched for those measurements. The *new low-noise path* is an additional receive-only mode which bypasses the 2100-MHz transmit band notch filter. Insufficient measurements have been made to make a good comparison with the original low-noise path. Measurements made with an aperture load on the SMT cone agree well with the data from the ambient load technique, as shown in Table 1. The focused MXK cone data were taken with the subreflector correctly positioned on the X-band main horn, while the defocused data were taken with the subreflector positioned on either the PDS or the SMT cones.

The calibration data were reduced with JPL computer program number 5841000, CTS20B. Measurement errors of each data point average are recorded under the appropriate number in the tables. The indicated errors are the standard deviation of the individual measurements and of the means, respectively. They do not include instrumentation systematic errors. The averages were computed using only data with:

(1) Antenna at zenith.

(2) Clear weather.

(3) No RF spur in the receiver passband.

(4) Standard deviation of computed operating noise temperature due to measurement dispersion less than 0.15 K.

Figure 1 is a plot of system operating noise temperature of the maser connected to the gain standard horn (DSS 13) as a function of time in day numbers. The frequency was 2278.5 MHz and the maser was 96S2. Figure 2 is a plot of system operating noise temperature of the SRO cone at 2278.5 MHz as a function of time in day numbers. The date when the superconducting magnet was installed is indicated. Figure 3 is a similar plot of the SRO cone at 2388 MHz. In all figures in this article, data that satisfy the four conditions stated above are plotted as solid circles or triangles while data that fail one or more conditions are plotted as open circles or triangles.

Figures 4 and 5, respectively, are plots of the system operating noise temperatures of the SMT cone using the 3A section maser (80S1) and the SMT cone maser (96S4), both at 2295 MHz. Each graph contains data taken by both the ambient load technique and the aperture load technique. No distinction is made between the two methods in the figures.

System operating noise temperatures of the PDS cone, both low-noise path and diplexed, are plotted in Fig. 6 as a function of time in day numbers. In all cases the frequency is 2296 MHz. Although these data were taken using the ambient termination method, most of them were not reduced by the above CTS20B computer program. These data are single Y-factor numbers, made with the antenna at zenith but with no regard for weather conditions, which were reported into Operational Data Control (SFOF) as part of the daily track report.

Figure 7 is a plot of system operating noise temperatures of the MXK cone at 8415 MHz. Focused data are plotted as circles and defocused data as triangles.

Reference

1. Stelzried, C. T., "Operating Noise-Temperature Calibrations of Low-Noise Receiving Systems," *Microwave J.*, Vol. 14, No. 6, pp. 41–48, June 1971.

Table 1. System operating noise temperature calibrations of the PDS, SMT, and MXK cones on the 64-m-diameter antenna at DSS 14

Cone	Configuration or measuring technique	Frequency, MHz	Maser serial number	Maser gain, dB	Follow-up receiver contribution, K	System operating noise temperature, K
PDS	Low-noise path	2296	80S1 (3A section)	40.2 1 measurement	0.07 1 measurement	25.1 ±0.06 1 measurement
PDS	Low-noise path	2296	96S3	52.4 ±1.39/0.57 4 measurements	0.03 ±0.005/0.002 4 measurements	19.4 ±0.52/0.29 4 measurements
PDS	New low-noise path	2296	80S1 (3A section)	37.9 1 measurement	0.05 1 measurement	24.0 ±0.16 1 measurement
PDS	New low-noise path	2296	96S3	51.9 ±0.14/0.10 2 measurements	0.03 ±0.002/0.001 2 measurements	19.6 ±0.87/0.62 2 measurements
PDS	Diplexed	2296	80S1 (3A section)	40.3 1 measurement	0.07 1 measurement	30.8 ±0.02 1 measurement
PDS	Diplexed	2296	96S3	51.7 1 measurement	0.03 1 measurement	22.9 ±0.38 1 measurement
SMT	Aperture load	2295	80S1 (3A section)	38.1 ±0.14/0.10 2 measurements	0.06 ±0.001/0.0006 2 measurements	25.8 ±0.06/0.04 2 measurements
SMT	Aperture load	2295	96S4	48.1 ±0.06/0.03 4 measurements	0.17 ±0.007/0.003 4 measurements	15.9 ±0.11/0.06 4 measurements
SMT	Ambient load	2295	80S1 (3A section)	38.0 ±0.17/0.06 9 measurements	0.06 ±0.006/0.002 9 measurements	25.4 ±0.50/0.15 9 measurements
SMT	Ambient load	2295	96S4	48.5 ±1.11/0.24 20 measurements	0.16 ±0.03/0.01 20 measurements	15.4 ±0.26/0.06 20 measurements
MXK	Focused	8415	150X1	No measurements	0.54 ±0.53/0.27 4 measurements	23.3 ±0.90/0.44 4 measurements
MXK	Defocused	8415	150X1	No measurements	1.3 ±0.75/0.33 5 measurements	30.5 ±1.5/0.67 5 measurements

Table 2. System operating noise temperature calibrations of the SRO cone and the gain standard horn on the 26-m-diameter antenna at DSS 13

Maser serial number	9652				9655		
Frequency, MHz	2278.5		2295	2388	2278.5	2295	2388
	Gain standard horn	SRO cone					
Maser gain, dB	46.9 ±2.51/1.02 6 measurements	46.7 ±3.07/0.55 31 measurements	50.2 ±1.81/0.74 6 measurements	36.6 ±1.10/0.16 47 measurements	No measurements	No measurements	32.5 ±0.07/0.05 2 measurements
Follow-up receiver contribution, K	0.12 ±0.08/0.03 6 measurements	0.11 ±0.05/0.01 31 measurements	0.05 ±0.02/0.01 6 measurements	0.54 ±0.07/0.01 31 measurements	0.17 ±0.01/0.006 5 measurements	0.24 1 measurement	1.1 ±0.04/0.03 2 measurements
System operating noise temperature, K	26.2 ±1.86/0.75 6 measurements	17.2 ±0.63/0.11 31 measurements	17.0 ±0.84/0.40 6 measurements	17.8 ±0.72/0.13 31 measurements	15.2 ±0.29/0.14 5 measurements	15.0 ±0.01 1 measurement	16.9 ±0.65/0.45 2 measurements

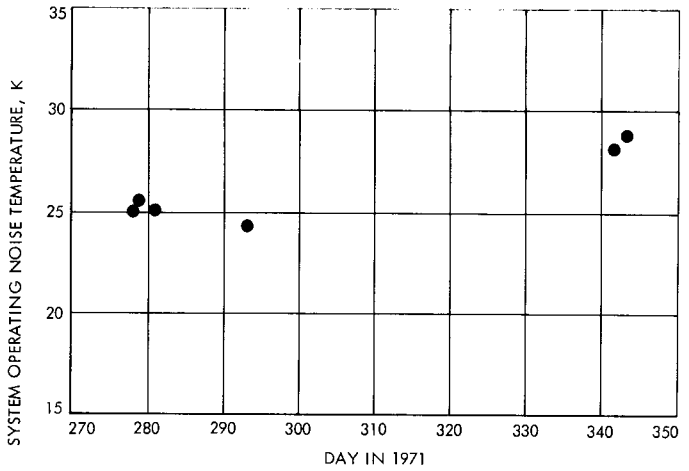

Fig. 1. System operating noise temperatures with the 96S2 maser connected to the gain standard horn at 2278.5 MHz; 26-m-diam antenna at DSS 13

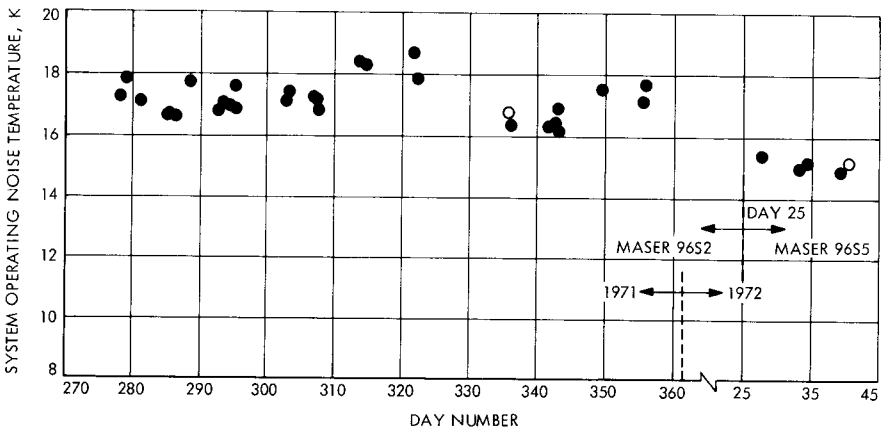

Fig. 2. System operating noise temperatures of the SRO cone at 2278.5 MHz; 26-m-diam antenna at DSS 13

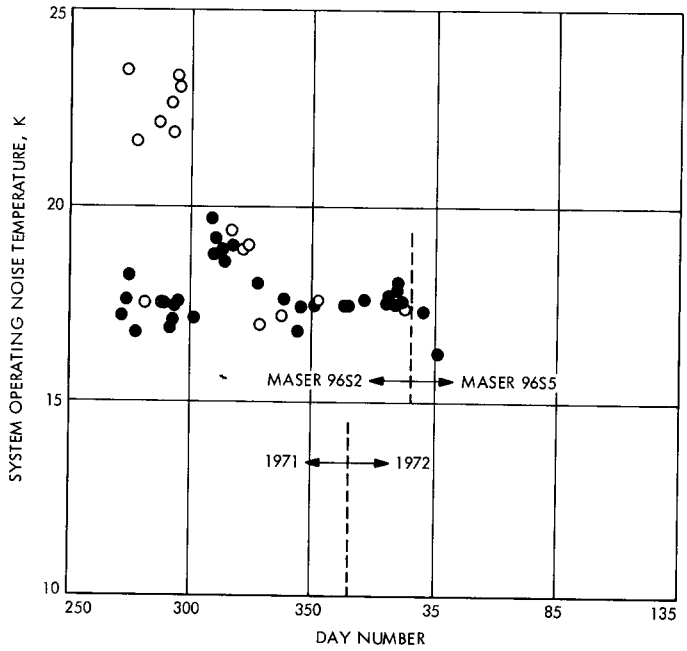

Fig. 3. System operating noise temperatures of the SRO cone at 2388 MHz; 26-m-diam antenna at DSS 13

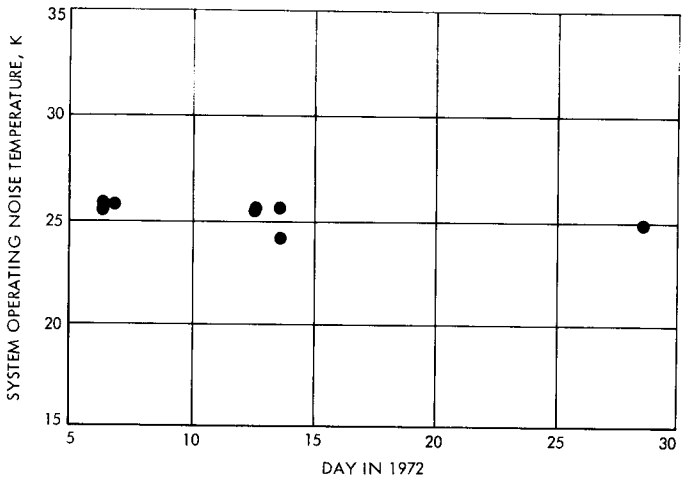

Fig. 4. System operating noise temperatures of the SMT cone at 2295 MHz; maser serial number 80S1 (3A section); 64-m-diam antenna at DSS 14

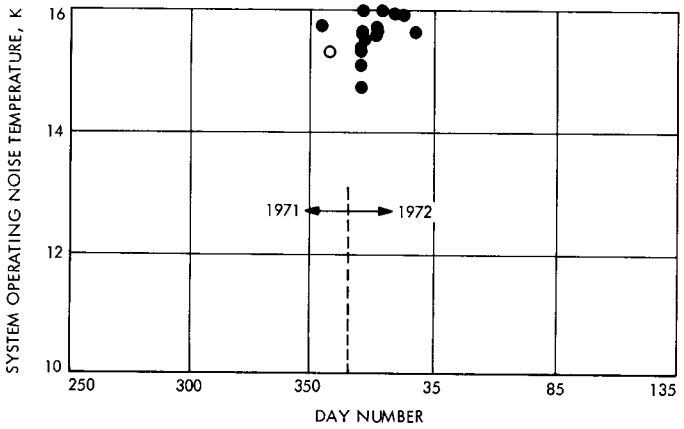

Fig. 5. System operating noise temperatures of the SMT cone at 2295 MHz; maser serial number 96S4 (SMT cone maser); 64-m-diam antenna at DSS 14

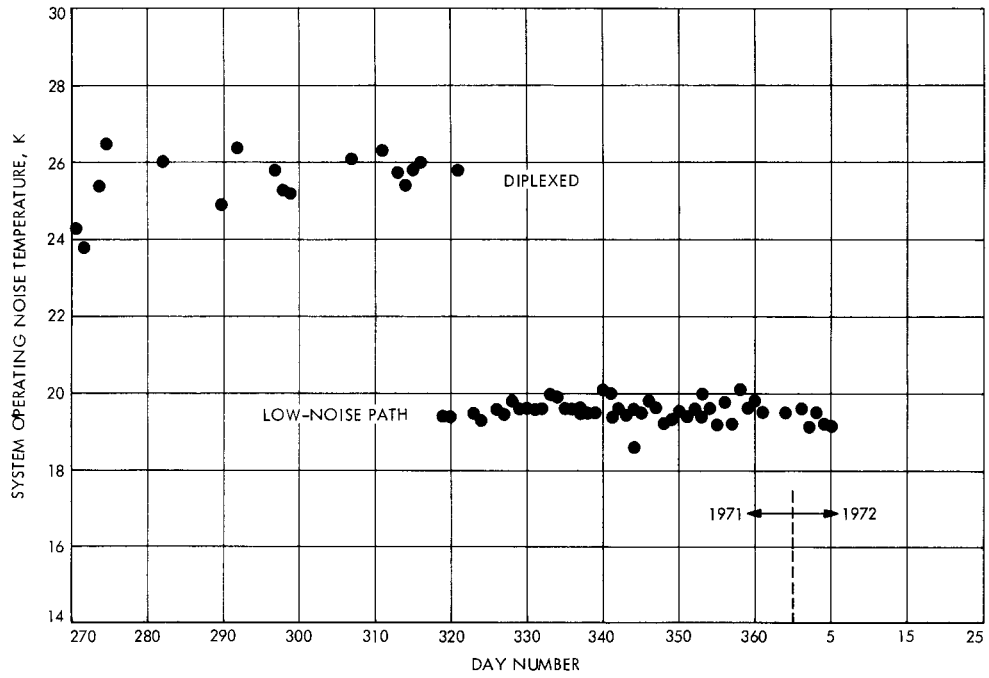

Fig. 6. System operating noise temperatures of the PDS cone at 2296 MHz; maser serial number 96S3; diplexed and low-noise path; 64-m-diam antenna at DSS 14

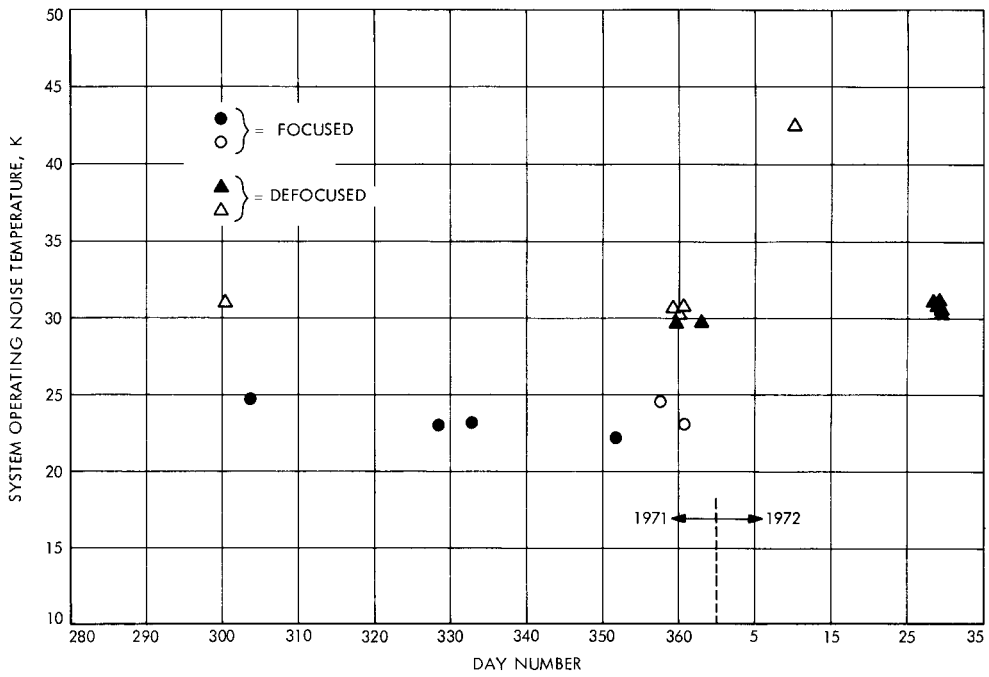

Fig. 7. System operating noise temperatures of the MXK cone at 8415 MHz; maser serial number 150X1; 64-m-diam antenna at DSS 14