TCI-20; REV. A
DSN TELECOMMUNICATIONS INTERFACES, 26-METER ANTENNA SUBNET

(Insert this modular document in your 810-5; Rev. D Handbook)

EFFECTIVE DATE: 1 October 1977 Change 1: 15 January 1978

Approved by: B D L Mulhall

A. PURPOSE.

This module describes the primary telecommunications parameters pertaining to the DSN 26-meter antenna station subnet.

B. SCOPE.

The intent of this document is to provide the significant telecommunications parameters for system noise temperature, transmitter, and other RF-related data in sufficient detail to allow the telecommunications designer to predict link performance.

C. LOCATION OF MATERIAL.

1. Contents.

2. Illustrations.

3. Tabular Data.

D. GENERAL INFORMATION.

1. Deep Space Network.

The DSN includes three basic subnets as follows:

(a) 64-meter diameter antenna subnet (DSS 14, 43, 63)
(b) 26-meter diameter antenna subnet (DSS 11, 44, 62)
(c) 26-meter diameter antenna subnet (DSS 12, 42, 61) which will be upgraded to a 34-meter subnet per the schedule in Figure 1 of TCI-30.

Other elements of the DSN include a Compatibility Test Area (CTA 21) at JPL, Pasadena, and a similar configuration of equipment in the Spaceflight Tracking and Data Network (STDN) station at Merritt Island, Florida.

2. Telecommunications Parameters, S-Band.

The more significant telecommunications parameters for the 26-meter antenna station subnet are given in Table 1. They include (1) S-band transmit characteristics for 20 kilowatts, (2) S-band receive characteristics for traveling wave maser operation and Block III receiver configurations, and (3) characteristics for frequency and timing.

The operating system noise temperature (T_{op}) varies as a function of elevation angles, and typical values for the 26-meter antenna stations are given in Figure 1.

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 1 of 7)

Main Antenna		
Transmit Characteristics	Value	Remarks
Gain (dBi)	51.8 ±0.9	For matched polarization. Referenced to transmitter output port (includes feedline losses).
Beamwidth (deg)	0.36 ±0.03	Half-power angular width
Polarization (matched to receive)	Normally RCP Fixed linear	LCP available if required Orthogonal polarization available if required
Ellipticity (RCP or LCP)(dB)	1.0 ±0.4	Peak-to-peak voltage axial ratio
Pointing loss		
Angular	See TRK-10	--
Power (dB, 3 sigma)	0.1	Conical scan control (to be implemented in CY 1978)
Acquisition Antenna (DSS 11, 12, 42, and 62 only)		
Gain (dBi)	18.9 ±1.2	Referenced to transmitter output port (includes feedline losses)
Beamwidth (deg)	17 ±1.0	Half-power angular width
Ellipticity (dB)	1.0 +0.05	Peak-to-peak voltage axial ratio
Polarization	RCP or LCP	--

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 2 of 7)

Transmitter Exciter		
Transmit Characteristics	Value	Remarks
RF power output	20 kW power amplifier +73 ±0.5 dBm saturated drive Down to +53 ±1.5 dBm	Across VCO tuning range. Referenced to transmitter output terminal Unsaturated drive
Total bandwidth (-1 dB)	8 MHz nominal saturated drive (2110 to 2118 MHz) TBD	 Unsaturated drive
Power stability (dB) Long term (12 hour period) Short term	 ±0.25 ±1.0 $\geq$0.1	 Saturated drive Unsaturated drive Peak-to-peak, saturated or unsaturated drive conditions in ±0.5 Hz bandwidth about the carrier frequency, under fixed primary (400 Hz) voltage conditions.
Frequency range (MHz)	2100 to 2120	Two-way coherent mode extends from 2110 to 2118 MHz only
VCO frequency setting	0.96 Hz increments	
Manual VCO operation frequency stability	1 part in 10^7 3 parts in 10^6	For 20 min For 10 hr
VCO tuning range	±9 parts in 10^5	--
Spurious radiation Phase modulation (deg, rms) Amplitude modulation (dB) 2nd harmonic (dB) 3rd harmonic (dB) 4th harmonic (dB)	 5 60 85 85 85 or more	Saturated drive Below carrier Below carrier Below carrier Below carrier

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 3 of 7)

Main Antenna		
Receive Characteristics	Value	Remarks
Frequency range (MHz)	2270 to 2300	--
Gain to maser 1 (dBi)	53.3 ±0.6	For matched polarization, referenced to maser input terminal. (Includes feedline losses.)
Gain to maser 2 (dBi)	53.1 ±0.6	For matched polarization, referenced to maser input terminal. (Includes feedline losses.)
Beamwidth (deg)	0.33 ±0.03	Half-power angular width
Polarization (matched to transmit)	RCP or Fixed linear	LCP and orthogonal polarization available if required.
Ellipticity RCP or LCP)(dB)	0.4 ±0.1	Peak-to-peak voltage axial ratio
Pointing loss		
Angular (deg)	See module TRK-10 for angular loss	--
Power (dB, 3 sigma)	0.1	Conical scan control (to be implemented in CY 1978)
Total System Noise Temperature		
TWM 1 receiver connected to main antenna (Kelvins)	33 ±3	Referenced to traveling wave maser (TWM 1) input terminal[1]. (Includes feedline losses.)

[1]With simultaneous transmission of 20 kW, antenna directed to cold sky (near zenith), and for signal input value less than -110 dBm.

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 4 of 7)

Total System Noise Temperature		
Receive Characteristics	Value	Remarks
System temperature, TWM 1 receiver to main antenna vs elevation angle (Kelvins)	Refer to Figure 1	For low elevation angles, the characteristic is dependent on azimuth and the terrain of particular site. See GEO-10.
System temperature, TWM 2 received connected to main antenna (Kelvins)	41 ±3	Referenced to TWM 2 input terminals[2]. (Includes feedline losses.)
System temperature, TWM 2 connected to acquisition antenna (Kelvins)	41 ±3 max at zenith; 84 max at 10 deg elevation	Referenced to TWM 2 input terminals[2]. (Includes feedline losses.)
System temperature, receiver only connected to acquisition antenna (Kelvins)	3300 max	Referenced to receiver preselector input terminal[2]. (Includes feedline losses.)

[2] With simultaneous transmission of 20 kW, antenna directed to cold sky (near zenith), and for signal input value less than -110 dBm

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 5 of 7)

Acquisition Aid Antenna (DSS 11, 12, 42, and 62 only)		
Receive Characteristics	Value	Remarks
Frequency range (MHz)	2290 to 2300	--
Gain to maser 2 (dBi)	21.7 ±1.1	Above isotropic, referenced to maser 2 input terminal (includes feedline losses)
Beamwidth (deg)	16 ±1.0	Half-power angular width
Polarization	RCP LCP	--
Ellipticity (dB)	0.3 ±0.1	Peak-to-peak voltage axial ratio
Minimum received signal strength (dBm)	-115	For reliable transfer from acquisition aid to main antenna with conical scan (to be implemented in CY 1978)
Reference Channel RF Noise Bandwidth		
Receive Characteristics	Value (Hz)	Remarks
Noise bandwidths	$12^{+0}_{-20\%}$ $48^{+0}_{-20\%}$ $152^{+0}_{-20\%}$	Effective two-sided threshold (design point) noise bandwidth, $2B_{L_o}$

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 6 of 7)

Recommended Minimum Operating Carrier Signal Levels (dBm)[3]			
	12 Hz Blk III	48 Hz Blk III	152 Hz Blk III
TWM 1	-162.6	-156.6	-151.6
TWM 2	-161.6	-155.6	-150.6
Receiver direct input	-142.6	-136.6	-131.6

Frequency and Timing		
Characteristics	Value	Remarks
Frequency stability		
Rubidium standard	5 parts in 10^{12} for 1 second	
	5 parts in 10^{13} for 100 seconds	
	5 parts in 10^{13} for 1000 seconds	
	5 parts in 10^{13} for 12 hours	
	1 part in 10^{11} for 1 year	
Hydrogen maser	3 parts in 10^{13} for 1 second	Projected implementation by July 1978 at DSS 42 and 61 only
	2 parts in 10^{14} for 100 seconds	
	2 parts in 10^{14} for 12 hours	
	2 parts in 10^{13} for 1 year	
Cesium beam standard	5 parts in 10^{12} for 1 second	DSS 42 and 61 only
	8 parts in 10^{13} for 100 seconds	
	2.5 parts in 10^{13} for 1000 seconds	
	8 parts in 10^{14} for 10^{4} seconds	
	TBD for > 12 hours	

[3]Levels are 10 dB above RF loop design threshold with nominal system noise temperature and loop bandwidths assumed, referenced to respective amplifier input terminals.

Table 1. Primary Telecommunication Parameters for 26-Meter Subnet (Sheet 7 of 7)

Frequency and Timing (cont'd)		
Characteristics	Value	Remarks
Station time relative to DSN master clock	20 microseconds	Rubidium standard synchronized by OTS
	3 milliseconds	Calibrated by HF radio
DSN master clock relative to NBS	50 microseconds	Calibrated by portable cesium clock
DSS frequency offset relative to DSN master reference frequency	1 part in 10^{11}	Rubidium standard or cesium beam standard synchronized by OTS

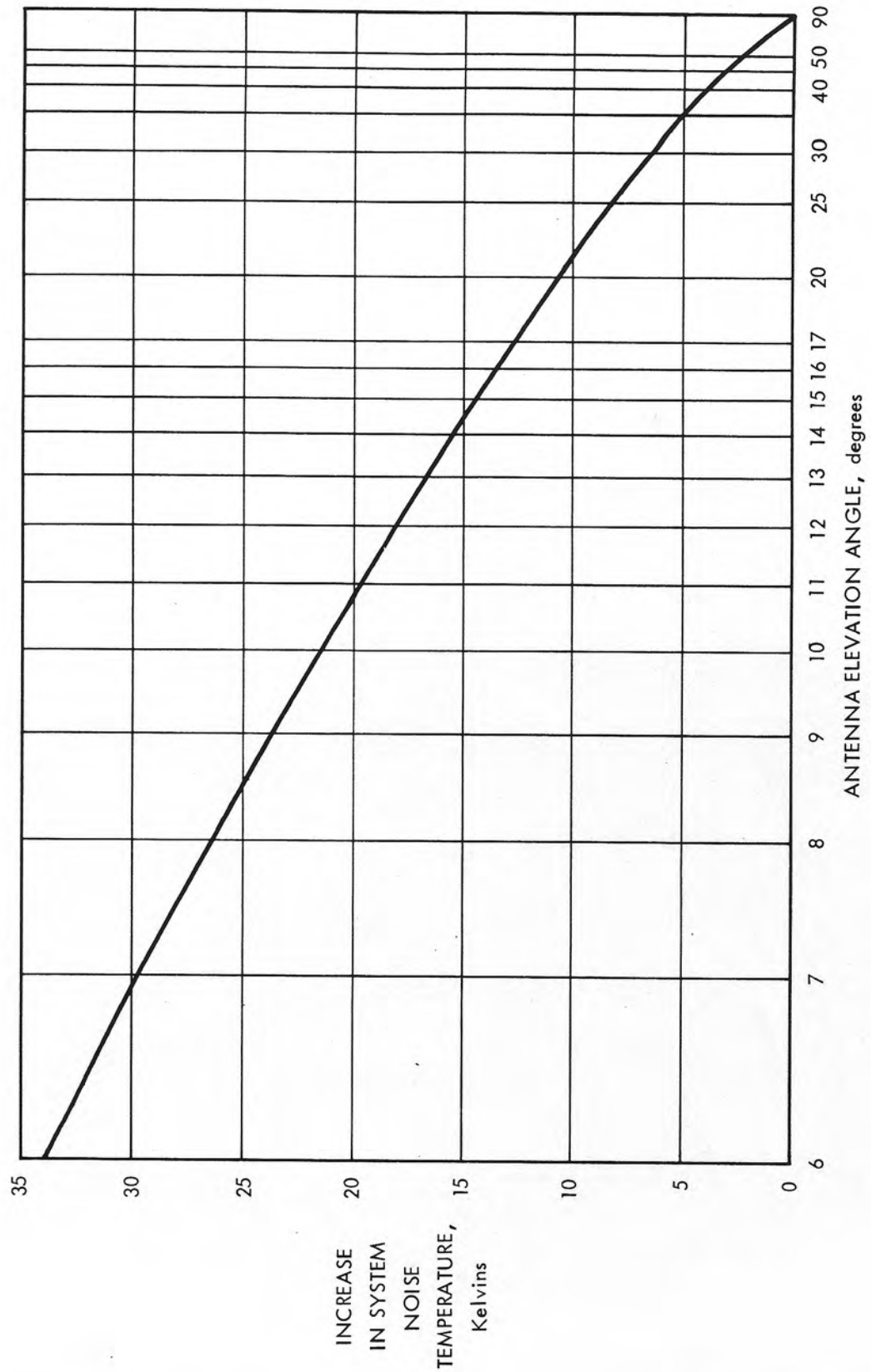

Figure 1. Increase in System Noise Temperature vs Elevation Angle at S-Band (Typical) for 26-Meter Antenna Stations