Coherent Reference Generator for DSN Mark III Data System

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A new frequency generator/distribution subsystem is being developed to meet the increasing complexity of the Deep Space Network Mark III data system. The coherent reference generator is an assembly that will accept the primary frequency standard from the hydrogen maser (or possible secondary standard from the rubidium, cesium, or remote standards) and furnish required reference frequencies for a deep space station.

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The coherent reference generator is an assembly that will accept the primary frequency standard from the hydrogen maser (or possible secondary standard from the rubidium, cesium, or remote standards) and furnish the required reference frequencies for:

(1) Receiver assembly (9 each).

(2) Programmed exciter assembly (3 each).

(3) Subcarrier demodulator assembly (8 each).

(4) Ranging demodulator assembly (2 each).

(5) Mark II frequency/timing system (1 each).

The basic design goals that have been stressed are (1) performance, (2) economy, (3) computer control/monitoring, and (4) minimum physical size.

A simplified block diagram of the Mark III frequency distribution and the coherent reference generator is shown in Fig. 1. All the inputs to the coherent reference generator will be simultaneously switched when a change in the input frequency standard source is made.

A simplified block diagram of the coherent reference generator is shown in Fig. 2. Note that the 1-MHz reference output will have a fail/safe power supply so that there will be no interruption to the station timing system should primary power fail.

A list of the preliminary detailed design specifications for the coherent reference generator is shown in Table 1.

Table 1. Coherent reference generator performance specifications[a]

Parameter	Source of requirement	Requirement	Proposed specification
Phase stability	DSN Mark III data system development plan [Document 803-1, Vol. III, p. 11.C (1)]	Charged particle calibration = 0.2 m; variation in electrical phase path = 0.2 m	
	Phase budget for Mark III receiver/exciter (based on differenced range versus integrated doppler technique)	Receiver ≤ ±0.06 m which implies ±330 deg at S-band	Receiver reference (0.1, 1, 10, 10.1, 45 MHz) = ±33 deg at S-band
		Exciter ≤ ±0.08 m which implies ±440 deg at S-band	Exciter reference (50 MHz) = ±44 deg at S-band
Power output	Accepted DSIF reference level		Range = +10 to +13 dBm; stability ≤ ±0.5 db
[b]$VSWR_{in}$	Engineering judgment		1.1:1
[b]$VSWR_{out}$	Engineering judgment		1.5:1
Harmonic distortion	Engineering judgment		≤ 5%
Non-harmonically related spurious output	Engineering judgment		Minimum of 70 dB below nominal output
Isolation output to output	Engineering judgment		Frequency, MHz / Isolation, dB: 0.1 / ≥120; 1 / ≥120; 5 / ≥120; 10 / ≥110; 45 / ≥90; 100 / ≥70

[a]Environment: time = 12 h; temperature = control room temperature ±2.17°C (±5°F); power supply variations of 3%; elastic survival for temperature of 0 → 50°C; dc power variation of ±5%.
[b]VSWR = voltage standing-wave ratio.

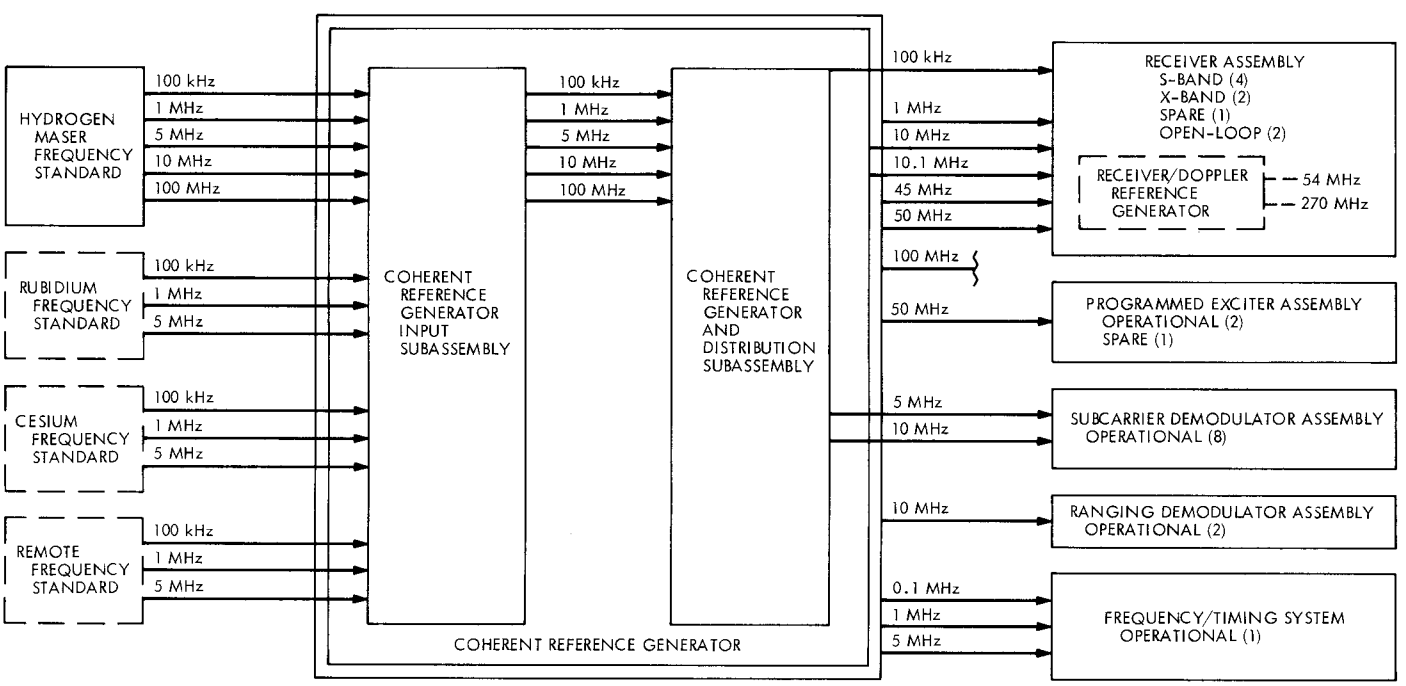

Fig. 1. Simplified block diagram of Mark III frequency distribution and coherent reference generator

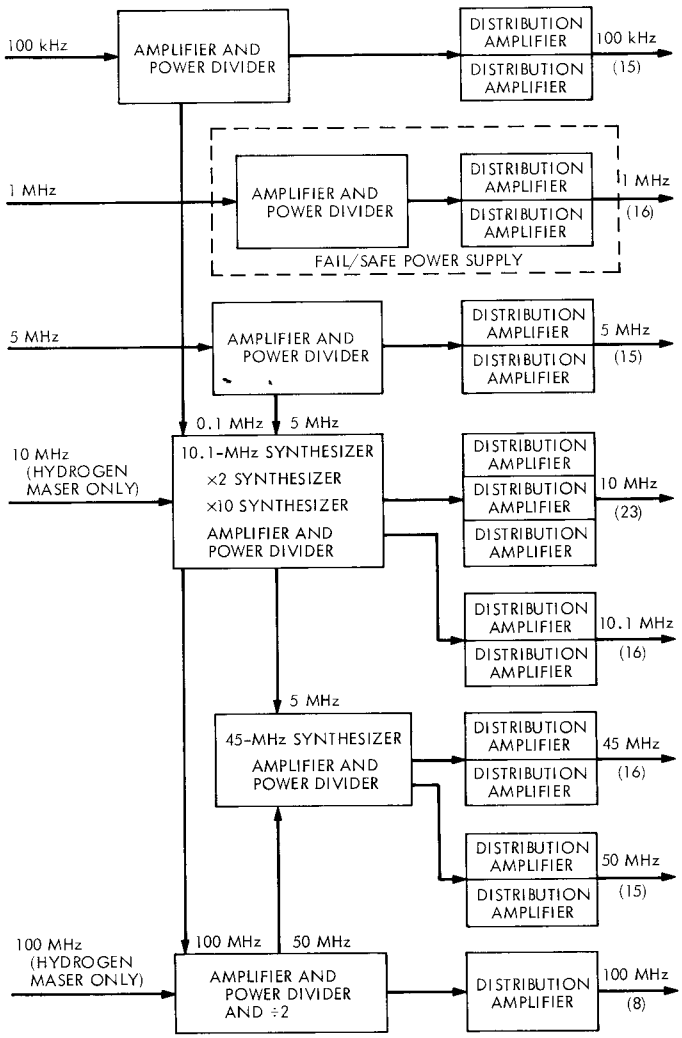

Fig. 2. Simplified block diagram of coherent reference generator

These specifications were developed to assure that the frequency distribution and synthesis of the coherent reference generator offer reference frequencies that allow the receiver/exciter subsystem to meet design requirements as dictated in the Mark III Data System Development Plan (Document 803-1, Vol. III).

A typical distribution amplifier that will be a basic building block in the coherent reference generator is shown in Fig. 3. Broadband circuits with internal feedback will be used to meet the phase and amplitude stability requirement. No intentional filtering or automatic gain control will be attempted in the distribution amplifier since these characteristics have already been defined either in the frequency standard or the reference generator.

Preliminary design of the coherent reference generator was started in the middle of January 1971. Present plans call for an engineering model to be completed in fiscal 1972.

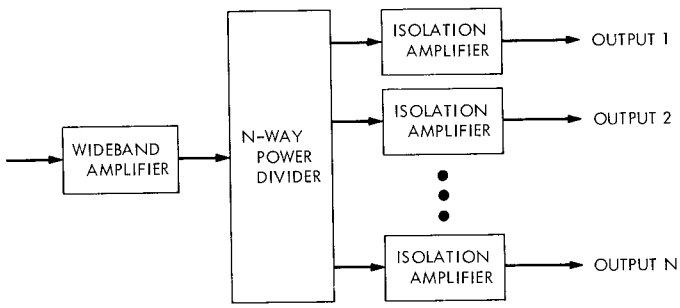

Fig. 3. Simplified block diagram of coherent reference generator distribution amplifier