Short-Term Frequency Measurement Capability in DSN Equipment Maintenance Facilities

R. M. Smith, D. Crawford, and C. H. Fourtner
DSN Facility Operations Office

A short-term frequency measuring capability has been established at the Goldstone and Madrid DSN Complex Maintenance Facilities to afford rapid, complete service to DSN synthesizers. Future development of the capability may include the testing of station frequency standards.

The DSN Maintenance Center (DMC) recently conducted a training seminar covering the servicing of DSN frequency synthesizers and the performance of precision short-term frequency measurements. Representatives of the Goldstone and Madrid Complex Maintenance Facilities (CMFs) attended.

Early in 1971 it was realized that, with the expected increase in types and quantity of synthesizers, a uniform testing capability was required. Without such a capability the CMFs at Tidbinbilla, Madrid, and Goldstone would be at a serious disadvantage not only in synthesizer test and repair but later in the testing of other precise frequency sources. DMC personnel assembled a small system, using mostly commercially available equipment, that affords a capability for present DSN synthesizer requirements and is expandable to accommodate future requirements for short-term frequency testing. In the future the test system will be modified as necessary and practicable, to allow testing of station frequency standards and newly added synthesizers.

Concurrent with the planning of the test system, a training seminar was planned and developed to aid in developing expertise at the CMFs. The seminar provided: knowledge of, and exposure to, specific test methods for DSN synthesizers; insight into peculiar problems and specific, positive treatment of those problems. This, plus the equipment given to the attendees, provided the Madrid and Goldstone CMFs with the capability for diagnostic and functional test of DSN synthesizers to the limits of DSN requirements. The advantage of this capability is that synthesizers can be repaired and fully tested in the field and returned to the DSS or to spares with a high degree of confidence established for the synthesizers.

In contrast, at a location not so equipped, synthesizers must be returned to the DMC if complete confidence is desired or, alternatively, repaired and returned to the DSS with no suitable level of confidence, to be "smoke tested" in the system.

Figure 1 is a view of the test system taken during the training seminar at the DMC. Don Irwin of the Goldstone CMF and Domingo Duarte of the Madrid CMF are shown operating the system. Each attendee was required to assemble a test system during the course and to determine his system's noise figure. Delivery of the systems to each CMF was subject to a representative being present at the seminar.

Figure 2 is a block diagram of the system that includes expanded capabilities planned for fiscal year (FY) 1975 (selectable 1 to 160 MHz reference and a distribution amplifier).

Table 1 lists the system parameters and system accuracies and stability.

Table 1. Synthesizer test set capabilities

Parameters	
$S/N_\phi\ (f_L, f_H)$[a]	for $f_L = 1$ Hz, $f_H = 100$ Hz, 1 kHz, 15 kHz, or 50 kHz
$S/N_{AM}\ (f_L, f_H)$[a]	for $f_L = 1$ Hz, $f_H = 100$ Hz, 1 kHz, 15 kHz, or 50 kHz
$\int (f_m)$[a]	for $f_m = 10$ Hz to 50 kHz
$\sigma\ (2, T, \tau)$[a]	for $T \cong \tau = 0.01$ to 100 s
Long term stability at 0.1, 1, or 5 MHz	
Accuracies	
S/N_ϕ (1 Hz, 15 kHz) measurements to 100 dB; tolerance $\cong \pm 2$ dB	
S/N_{AM} (1 Hz, 15 kHz) measurements to 110 dB; tolerance $\cong \pm 2$ dB	
$\int (f_m)$ measurements from -110 dB/Hz to measurement floor of -135 dB/Hz at $f_m = 20$ Hz increasing to an eventual floor of -160 dB/Hz at higher offset frequencies; tolerance $\cong \pm 2$ dB	
$\sigma\ (2, T, \tau)$ measurements to 2×10^{-12}, expressed in proportional parts, with $T \cong \tau = 1$ s with a system noise $\simeq 7 \times 10^{-13}$; tolerance $\cong \pm 2 \times 10^{-13}$	
Long Term Stability measurement limited to aging rate of quartz oscillator, ($< 5 \times 10^{-10}$/24 h)	

[a]These parameters can be measured at carrier frequencies from 1 to 160 MHz.

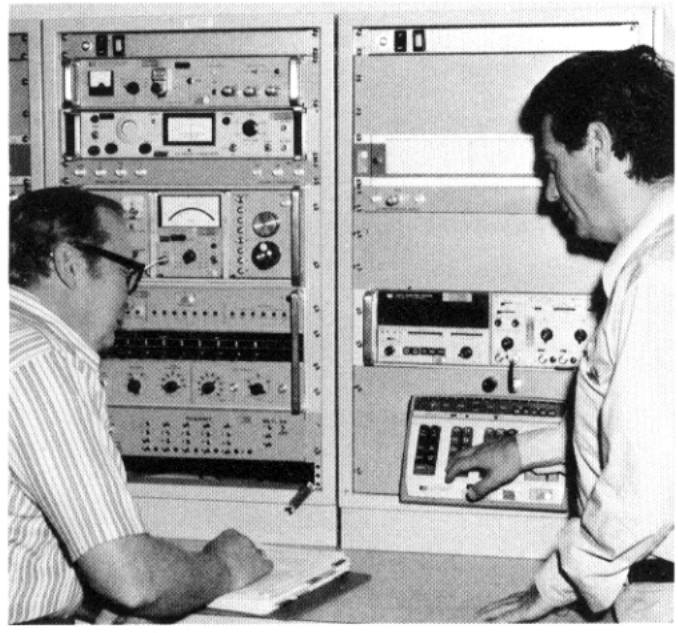

Fig. 1. Front view of synthesizer test set

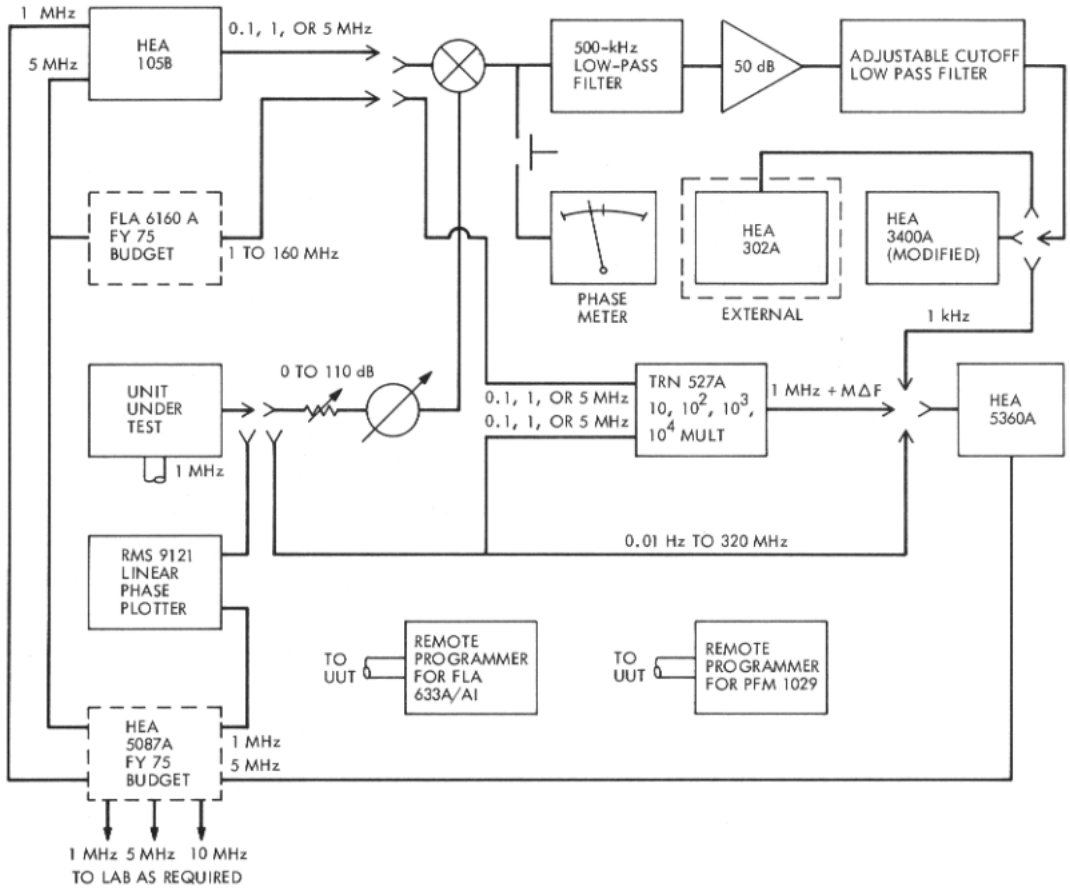

Fig. 2. Block diagram of synthesizer test set