Location: National Technical System (NTS), Boxborough, MA
System: TDMA 6CMR System
Subject: Frequency Stability
Date: January 2001

Purpose of Test:

The purpose of this test is to measure the frequency stability over the valid operating temperature range and varying input voltage.

The frequency stability is measured every 10C from the temperature range of –30C to +50C. At 0C, +30C, and +50C, the system is powered down, powered back on, and the time it takes for the frequency to stabilize is measured. The Remote voltage is varied from 220 VAC +/- 15%. The Hub voltage was varied from 115 VAC +/- 15%.

Summary:

There was no definitive movement in frequency when the voltage varied at the hub or remote.

The reverse frequency is +25 to +38 Hz off from the expected value. The forward frequency is about –27 to -33 Hz off from the expected value.

Test Equipment / Setup:

- HP8648C signal generator to supply a CW tone (Transcept Supplied)
- HP53131A frequency counter to take the measurements (The signal generator and frequency counter were phase locked together by connecting the 10 Mhz ref output of the counter to the 10 Mhz input of the signal generator) (Transcept Supplied)
- VARIAC Type 5—B adjustable transformer (NTS # PA 316) to vary the remote 220 and 110 AC voltages (NTS Supplied)
- STACO 3PN2210 adjustable transformer (NTS #PA 516) to vary the hub AC voltage (NTS Supplied)
- Fluke Multimeters to measure VAC out of the adjustable transformers (NTS Supplied)

The following frequencies were used:

- D Band, Channel 659, Reverse, 1869.75 MHz
- D Band, Channel 659, Forward, 1949.79 MHz

These frequencies (high D band) were chosen for two reasons:

- Mid PCS range - To get as close to mid range as possible within the test setup constraints (1850-1910 MHz receive, 1930-1990 MHz transmit)
- Flexibility - Due to the Tower Mounted Amplifiers (TMAs) used in the test setup, bands A and D were the only bands accessible in all three paths: forward, reverse primary, and reverse diversity:

Results:

There are two sets of results:

1) Data taken on 15 Jan 01, with varying voltage
2) Data taken on 5, 11 and 12 Jan 01, no varying voltage

Data Set #1

The frequency stability was measured five times at each 10C:

- Reference: Remote 220 VAC / Hub 115 VAC
- Remote Minimum: Remote 187 VAC / Hub 115 VAC
- Remote Maximum: Remote 243 VAC* / Hub 115 VAC
- Hub Minimum: Remote 220 VAC / Hub 97.8 VAC
- Hub Maximum: Remote 220 VAC / Hub 132.3 VAC

- Note- The NTS VARIAC adjustable transformer and NTS power supply (208 VAC) would only allow a maximum of 244 Volts, rather than the calculated maximum of 253 Volts.

The frequency tested was: D Band, Channel 659, Reverse, 1869.75 MHz.

The frequency did not lose stability when the voltage varied. There was variation of +8 Hz over temperature.

Table 1. Frequency Stability Over Temperature and Varying Voltage

Temp (C)	Reference (Hz)	Remote Minimum (Hz)	Remote Maximum (Hz)	Hub Minimum (Hz)	Hub Maximum (Hz)
+50	+ 31 to +33	+ 31 to +33	+ 31 to +33	+ 31 to +33	+ 30 to +32
+40	+ 33 to +35	+ 33 to +35	+ 33 to +35	+ 33 to +35	+ 33 to +35
+30	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36
+20	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36
+10	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36	+ 34 to +36
0	+ 36 to +38	+ 36 to +38	+ 36 to +38	+ 36 to +38	+ 36 to +38
-10	+ 35 to +37	+ 35 to +37	+ 35 to +37	+ 35 to +37	+ 35 to +37
-20	+ 35 to +37	+ 35 to +37	+ 35 to +37	+ 35 to +37	+ 35 to +37
-30	+ 33 to +35	+ 33 to +35	+ 34 to +35	+ 34 to +35	+ 34 to +35

At 0C, +30C, and +50C, the hub and remote were powered down, and then powered back on with reference voltages. The time, in minutes, it took to stabilize was measured. For each case, the frequency stabilized in less than three minutes from the system locking and the initial reading of the signal.

Note: The system itself took approximately 1 minute and 45 seconds to lock on each restart.

Table 2. Frequency Stability Over Temperature At System Startup

Temp (C)	Initial Frequency After Power Cycle (1:45 mins) (Hz)	1 Minute After Initial Reading (2:45 mins) (Hz)	2 Minutes After Initial Reading (3:45 mins) (Hz)	3 Minutes After Initial Reading (4:45 mins) (Hz)
+50	+ 9	+ 30	+ 31	+ 30 to +32
+30	+ 38	+ 36	+ 34 to +36	+ 34 to +36
0	+ 50	+ 41	+ 39	+ 36 to +38

Also, at +10C, the hub and remote voltages were maximized. There was no difference in frequency stability. At +20C, the hub and remote voltages were minimized. There was no difference in frequency stability.

Data Set #2

Forward frequencies were taken starting at +23C down to –30C (5 Jan 01), then from +28C to +40C (11 Jan 01). Different frequency values (reverse frequencies) were taken for +45C and +50C (12 Jan 01) due to system failures unrelated to frequency stability. Note: The frequency output usually toggled by 2 to 3 hz. The recorded frequency was the average.

The following frequencies were used:

- D Band, Channel 659, Reverse, 1869.75 MHz, for +45 and +50C
- D Band, Channel 659, Forward, 1949.79 MHz for other temperatures

Table 3. Frequency Stability Over Temperature

TEMP (C)	Measured Output Frequency (Hz)	Delta from Input Frequency (Hz)
+50	1,869,750,025	+25
+45	1,869,750,025	+25
+40	1,949,789,972	-28
+35	1,949,789,972	-28
+30	1,949,789,971	-29
+28	1,949,789,971	-29
+23	1,949,789,973	-27
+20	1,949,789,973	-27
+15	1,949,789,972	-28
+10	1,949,789,972	-28
+5	1,949,789,972	-28
0	1,949,789,971	-29
-5	1,949,789,970	-30
-10	1,949,789,969	-31
-15	1,949,789,969	-31
-20	1,949,789,968	-32
-25	1,949,789,967	-33
-30	1,949,789,967	-33