ETS

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TEST 39: Frequency Stability in the

iDEN & MOTOTalk ISM Bands

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Introduction

The purpose of this test was to measure the frequency error of the transmitter in the iDEN and MOTOTalk modes at different temperatures, ranging from -30 to 70 degrees Celsius. A communication system analyzer (R-2660) was used to simulate the base station.

Set up

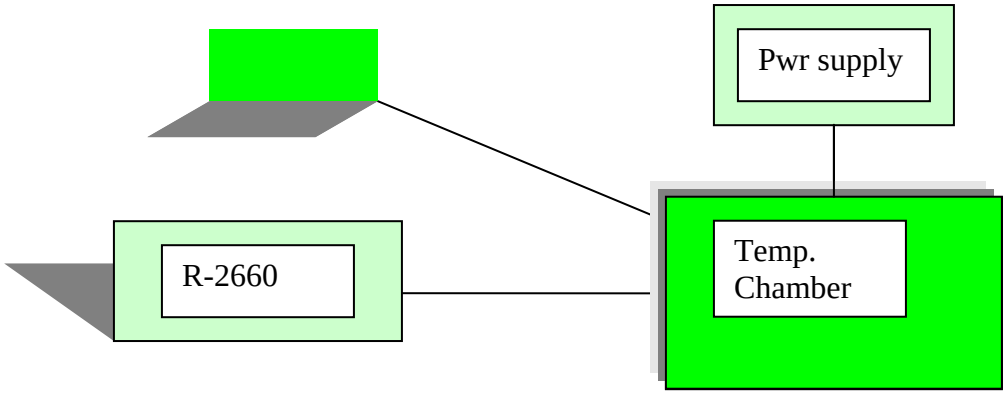

Figure 1: Schematic of the test set up for iDEN.

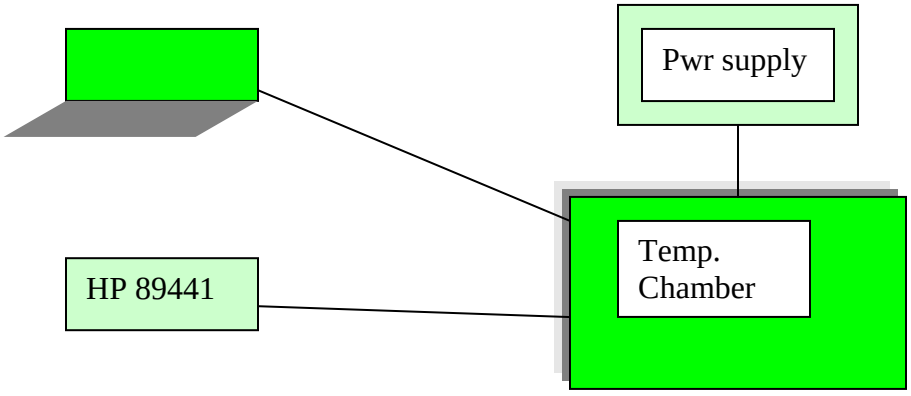

Figure 2: Schematic of the test set up for MOTOTalk.

Equipment Used

Device	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSEM 30 20Hz…26.5Hz		Jan 12 05	Jan 04 06
Power Attenuator	Narda	768-30 DC-11GHz		May 18 06	Jun 18 06
Battery Eliminator	N/A	N/A	N/A	N/A	N/A
DC Power Supply	Hewlett Packard	6632A		Not Required	N/A
Power Meter	Hewlett Packard	437B		Jun 25 05	Jun 25 06
Temperature Chamber	Heraeus Votsch	HT 4002		Dec 6 05	Dec 6 06
Vector Signal Analyzer	Hewlett Packard	89441A DC-2650 MHz	E47056	Feb 19 04	Feb 19 05
iDEN Digital Communications System Analyzer	Hewlett Packard	R-2660		Not Required	N/A

Calibration

If required the RF cables and power pad should be calibrated using a network analyzer. The objective is to measure and take note of the losses (usually less than 0.5 dB) of each of instrument.
During calibration use the floppy disk from the calibration kit along with the following buttons from the network analyzer: CAL, MEASURE, and FORMAT (Smith Chart) to accurately measure the losses.

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R-2660 Set Up

The iDen communication box needs to be especially set up as a full duplex. More details are illustrated in the Figure below, which replicates the screen of the R-2660.

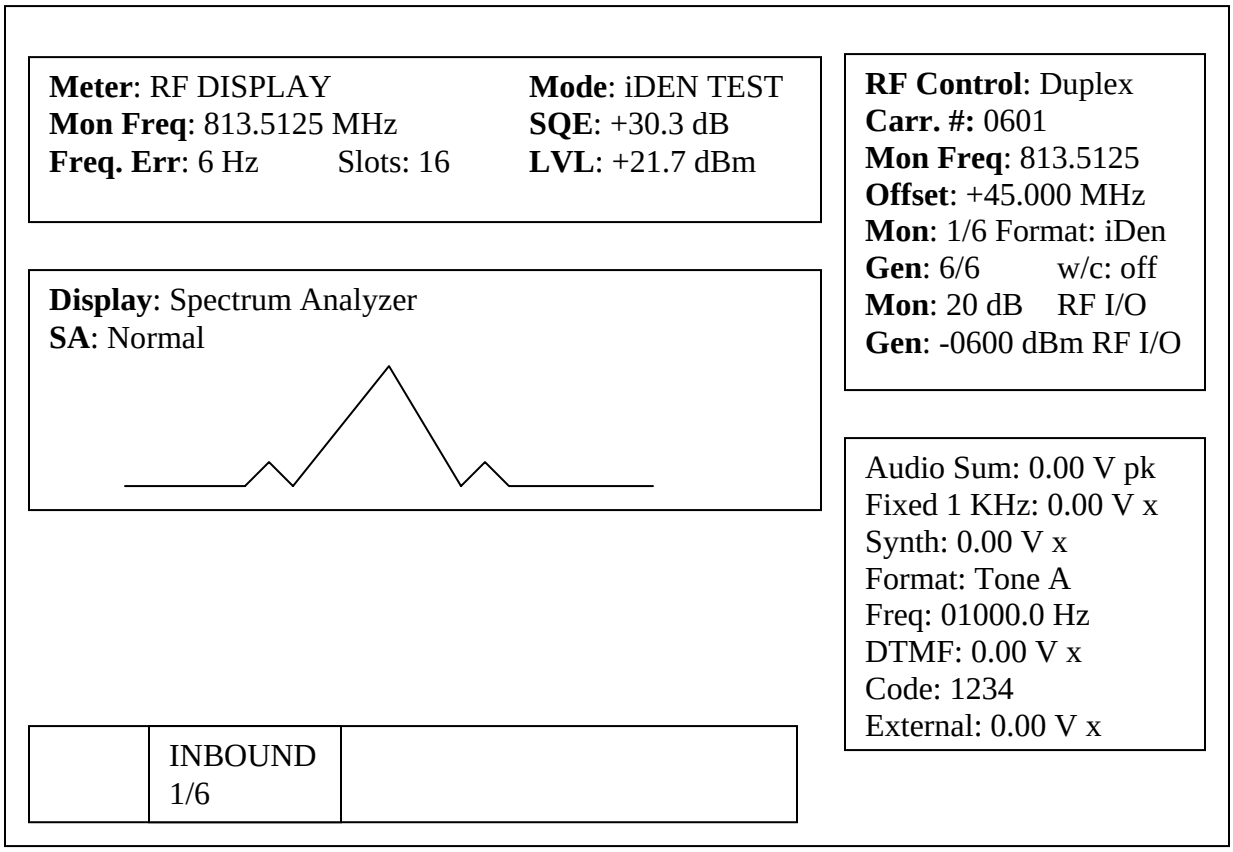

Figure 3: R-2660 Set up.

89441A Set Up

Ser Num: 3416A02787 (89410A); 3509A01580 (89431A)
Firmware: A.08.25 (89410A); A.00.04 (89431A); A.02.00 (89450A H01)

1. **First set up for spectrum and RF envelope**
   Instrument Mode… Vector
   A (Active Trace)
   Measurement Data…spectrum… ch1
   Data Format…magnitude… log(dB)
   Trigger….trigger type…free run
   Frequency… center…<915.525-MHz>
   Frequency… span… <30-KHz or 96-KHz>
   Range ….ch1 range… <-30 dBm (max D.R.)>
   ResBW/Window… rbw coupling…auto
   ResBW/Window… rbw mode… arb
   ResBW/Window… main window….gaussian top

   B(Active Trace)
   Measurement Data…main time…ch1
   Data Format….magnitude…log(dB)
   Trigger….trigger type…IF channel 1
   Trigger….trig hold off…on
   Trigger …more…holdoff delay…<88-ms>
   Trigger …ch1 delay…<1-ms(bypass phase squiggle)>
   Time…main length….<88-ms (30-KHz span allows full slot view)>

   C(Active Trace)
   Measurement Data…main time….ch1
   Data Format…part….real (I)

   D(Active Trace)
   Measurement Data…main time…ch1
   Data Format part….real (Q)

   Shift+Instrument Mode+Occupied bandwidth – enables frequency error function

Results for the 1st Radio

Frequency Stability at 813.5125 MHz (iDEN)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	9	5	6
-20	7	5	4
-10	9	8	7
0	7	5	6
10	9	9	8
20	7	6	5
30	6	5	4
40	9	6	7
50	7	7	8
60	8	9	8
70	11	12	10

Table 1: Radio 00L4 Transmitter Frequency Stability vs. Temperature at 813.5125.

Frequency Stability at 915.525 MHz (MOTOTalk)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	249	222	211
-20	127	126	122
-10	112	110	125
0	269	249	241
10	328	377	346
20	314	327	332
30	153	175	185
40	177	164	294
50	105	128	214
60	88	108	146
70	161	289	374

Table 2: 00L4 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

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Frequency Stability in ppm at 813.5125 MHz (iDEN)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.011	0.006	0.007
-20	0.009	0.006	0.005
-10	0.011	0.010	0.009
0	0.009	0.006	0.007
10	0.011	0.011	0.010
20	0.009	0.007	0.006
30	0.007	0.006	0.005
40	0.011	0.007	0.009
50	0.009	0.009	0.010
60	0.010	0.011	0.010
70	0.014	0.015	0.012

Table 3: Radio 00L4 Transmitter Frequency Stability vs. Temperature at 813.5125 MHz.

Frequency Stability in ppm at 915.525 MHz (MOTOTalk)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.27	0.24	0.23
-20	0.14	0.14	0.13
-10	0.12	0.12	0.14
0	0.29	0.27	0.26
10	0.36	0.41	0.38
20	0.34	0.36	0.36
30	0.17	0.19	0.20
40	0.19	0.18	0.32
50	0.11	0.14	0.23
60	0.10	0.12	0.16
70	0.18	0.32	0.41

Table 4: Radio 00L4 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

Frequency Stability in ppm at 813.5125MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	5	0.006
4.1	7	0.009
4.0	5	0.006
3.9	4	0.005
3.8	6	0.007
3.7	7	0.009
3.6	6	0.007
3.55	5	0.006

Table 5: Radio 00L4 Transmitter Frequency Stability vs. Voltage at 813.5125, 25º C.

Frequency Stability in ppm at 915.525MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	235	0.257
4.1	195	0.213
4.0	257	0.281
3.9	194	0.212
3.8	252	0.275
3.7	274	0.299
3.6	263	0.287
3.55	267	0.292

Table 6: Radio 00L4 Transmitter Frequency Stability vs. Voltage at 915.525, 25º C.

Results for the 2nd Radio

Frequency Stability at 813.5125 MHz (iDEN)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	12	7	8
-20	8	7	6
-10	10	9	7
0	11	11	10
10	7	6	8
20	6	5	6
30	6	4	5
40	3	4	3
50	5	4	4
60	10	9	8
70	7	7	6

Table 7: Radio 00FD1 Transmitter Frequency Stability vs. Temperature at 813.5125.

Frequency Stability at 915.525 MHz (MOTOTalk)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	49	57	75
-20	169	142	114
-10	222	165	192
0	213	182	170
10	318	277	238
20	125	139	147
30	137	121	123
40	169	141	122
50	148	152	168
60	172	163	174
70	185	181	141

Table 8: 00FD1 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

Frequency Stability in ppm at 813.5125 MHz (iDEN)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.015	0.009	0.010
-20	0.010	0.009	0.007
-10	0.012	0.011	0.009
0	0.014	0.014	0.012
10	0.009	0.007	0.010
20	0.007	0.006	0.007
30	0.007	0.005	0.006
40	0.004	0.005	0.004
50	0.006	0.005	0.005
60	0.012	0.011	0.010
70	0.009	0.009	0.007

Table 9: 00FD1 Transmitter Frequency Stability vs. Temperature at 813.5125 MHz.

Frequency Stability in ppm at 915.525 MHz (MOTOTalk)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.05	0.06	0.08
-20	0.18	0.16	0.12
-10	0.24	0.18	0.21
0	0.23	0.20	0.19
10	0.35	0.30	0.26
20	0.14	0.15	0.16
30	0.15	0.13	0.13
40	0.18	0.15	0.13
50	0.16	0.17	0.18
60	0.19	0.18	0.19
70	0.20	0.20	0.15

Table 10: 00FD1 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

Frequency Stability in ppm at 813.5125MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	5	0.006
4.1	5	0.006
4.0	5	0.006
3.9	3	0.004
3.8	4	0.005
3.7	6	0.007
3.6	7	0.009
3.55	4	0.005

Table 11: Radio 00FD1 Transmitter Frequency Stability vs. Voltage at 813.5125, 25º C.

Frequency Stability in ppm at 915.525MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	151	0.165
4.1	147	0.161
4.0	156	0.170
3.9	174	0.190
3.8	168	0.184
3.7	174	0.190
3.6	177	0.193
3.55	168	0.184

Table 12: Radio 00FD1 Transmitter Frequency Stability vs. Voltage at 915.525, 25º C.

Results for the 3rd Radio

Frequency Stability at 813.5125 MHz (iDEN)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	7	4	6
-20	6	8	4
-10	9	7	8
0	8	6	7
10	9	7	5
20	9	8	7
30	7	4	5
40	6	4	5
50	4	2	3
60	6	8	6
70	8	5	9

Table 13: Radio 0F41 Transmitter Frequency Stability vs. Temperature at 813.5125.

Frequency Stability at 915.525 MHz (MOTOTalk)			
	3.55V	4.0V	4.2V
Temp, ºC	Freq Err (Hz)	Freq Err (Hz)	Freq Err (Hz)
-30	138	117	52
-20	126	86	118
-10	81	99	112
0	78	59	76
10	61	109	142
20	125	74	56
30	109	135	143
40	74	105	118
50	282	128	95
60	118	144	223
70	263	220	218

Table 14: 0F41 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

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Frequency Stability in ppm at 813.5125 MHz (iDEN)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.009	0.005	0.007
-20	0.007	0.010	0.005
-10	0.011	0.009	0.010
0	0.010	0.007	0.009
10	0.011	0.009	0.006
20	0.011	0.010	0.009
30	0.009	0.005	0.006
40	0.007	0.005	0.006
50	0.005	0.002	0.004
60	0.007	0.010	0.007
70	0.010	0.006	0.011

Table 15: 0F41 Transmitter Frequency Stability vs. Temperature at 813.5125 MHz.

Frequency Stability in ppm at 915.525 MHz (MOTOTalk)			
Temp, ºC	**3.55V**	**4.0V**	**4.2V**
-30	0.15	0.13	0.06
-20	0.14	0.09	0.13
-10	0.09	0.11	0.12
0	0.09	0.06	0.08
10	0.07	0.12	0.16
20	0.14	0.08	0.06
30	0.12	0.15	0.16
40	0.08	0.11	0.13
50	0.31	0.14	0.10
60	0.13	0.16	0.24
70	0.29	0.24	0.24

Table 16: 0F41 Transmitter Frequency Stability vs. Temperature at 915.525 MHz.

Frequency Stability in ppm at 813.5125MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	6	0.007
4.1	5	0.006
4.0	5	0.006
3.9	6	0.007
3.8	7	0.009
3.7	8	0.010
3.6	9	0.011
3.55	10	0.012

Table 17: Radio 0F41 Transmitter Frequency Stability vs. Voltage at 813.5125, 25º C.

Frequency Stability in ppm at 915.525MHz, 25 deg C		
Voltage, V	**TX Freq Stability, Hz**	**TX Freq Stability, ppm**
4.2	121	0.132
4.1	123	0.134
4.0	98	0.107
3.9	93	0.102
3.8	84	0.092
3.7	75	0.082
3.6	81	0.088
3.55	74	0.081

Table 18: Radio 0F41 Transmitter Frequency Stability vs. Voltage at 915.525, 25º C.

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BERBUG Commands

The BerBug commands used to test the radio are shown below.

```
BERBUG> cp write 18 1 115 00          // avoids shut down/reset at hot & cold
#CP WRITE: 00
BERBUG> cp write 18 1 118 7A
#CP WRITE: 00
BERBUG> tx freq 813.5125
TX FREQ 813.0125
BERBUG> mode rtr
MODE RTR
BERBUG> mode idle
MODE IDLE
BERBUG> mode rtr
MODE RTR
BERBUG> mode idle
MODE IDLE
BERBUG>
```

At higher frequency (MOTOTalk mode) the following commands were used:

```
TA BERBUG> tx freq 915.525
TX FREQ 915.525
TA BERBUG> tx tch
TX TCH
TA BERBUG> tx ber unc
TX BER UNC
TA BERBUG> mode tx
MODE TX
TA BERBUG> mode idle
MODE IDLE
TA BERBUG>
```