1 CHANNEL FREQUENCIES

Clause: **15.303 (d) & (g) / 8.0**

Requirement: Within 1920 – 1930 MHz band for isochronous devices

UPCS CHANNEL	FREQUENCY (MHz)
Band Edge	1930.000
5 (High)	1928.448
4	1926.720
3 (Mid)	1924.992
2	1923.264
1 (Low)	1921.536
Band Edge	1920.000

Test Condition: Refer to RF Communication Protocol or Test Mode Procedure for the selection of channel in normal and test modes of operation.

2 ANTENNA REQUIREMENT

Clause: **15.317 (15.203) / 5.5**

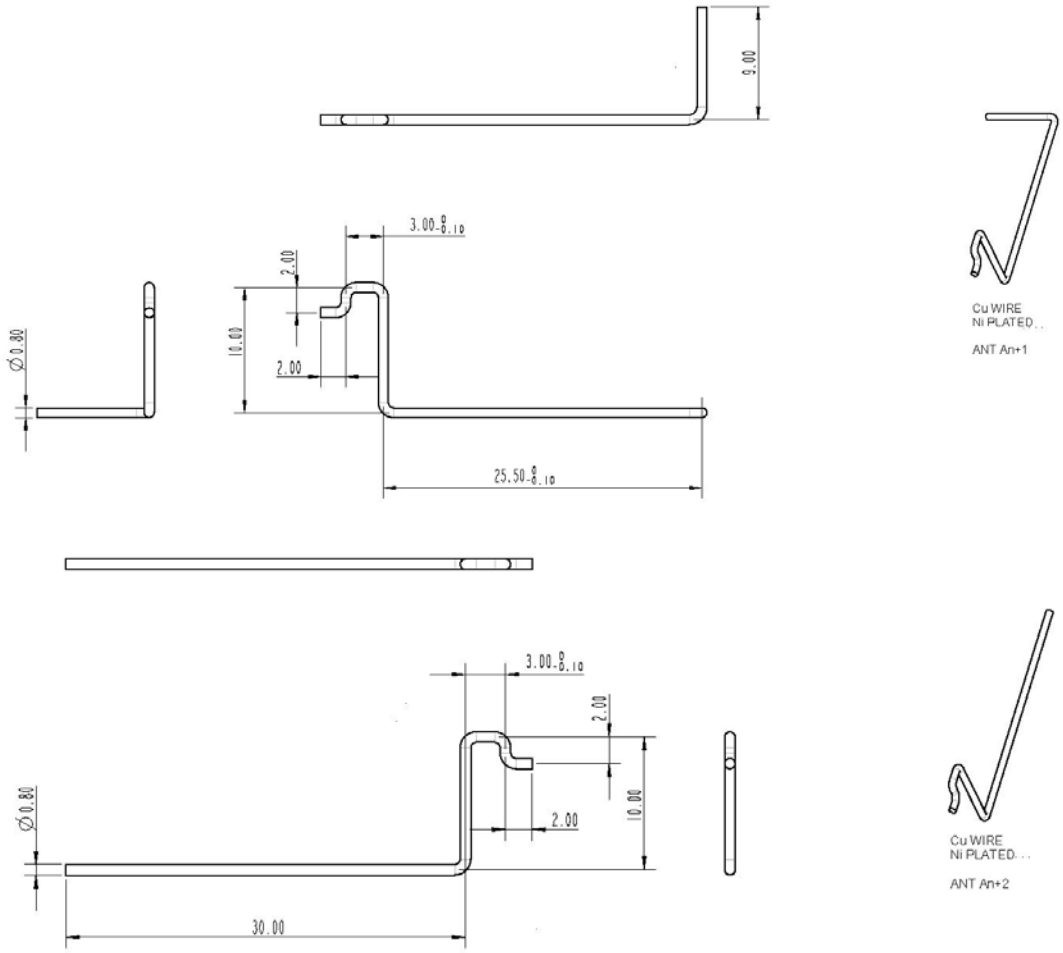
Requirement: No antenna other than that furnished by the responsible party shall be used with the device

Observation: Base and Handset have each a pre-formed wire antenna permanently attached on the PCB; it is not user replaceable. Base has an additional internal antenna for diversity configuration. There is no external antenna or connector provided on the base or handset for the user to use antenna other than that furnished originally.

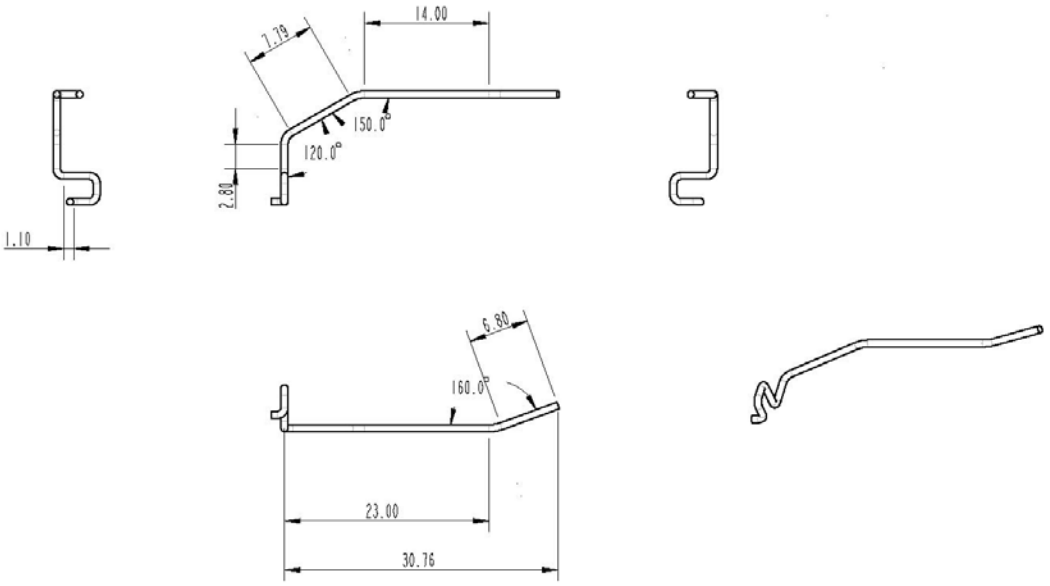
Spec of Antenna: As follows

Antenna transmit gain = 0.7 - 2.0 dBi (1.175 - 1.585 numeric) across the band

BASE



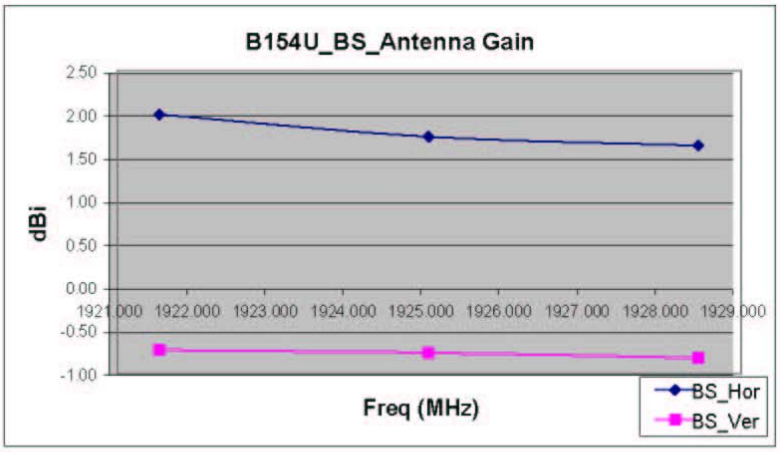
HANDSET

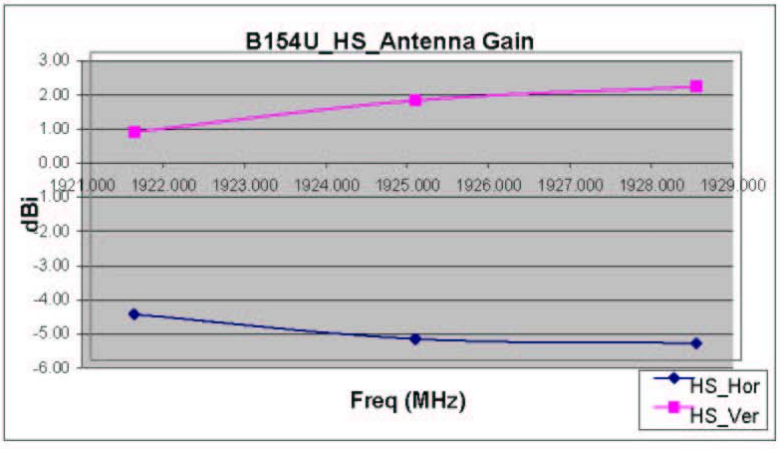


GAIN

B154U Antenna Gain
Ascalade Technologies Inc.
Date: June 14, 2005

	Channel	1	3	5
	Freq (MHz)	1928.448	1924.992	1921.536
Base	Hor	1.64	1.74	2.00
	Ver	-0.82	-0.76	-0.73
Handset	Hor	-5.52	-5.39	-4.67
	Ver	2.00	1.59	0.67



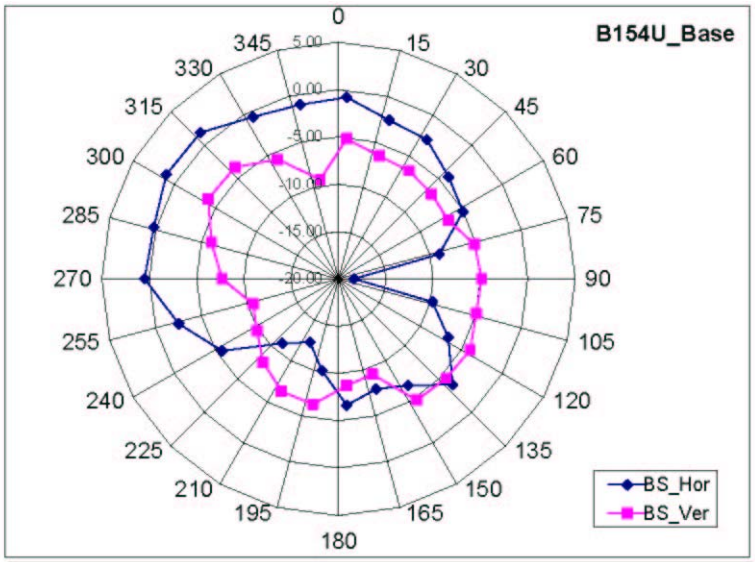


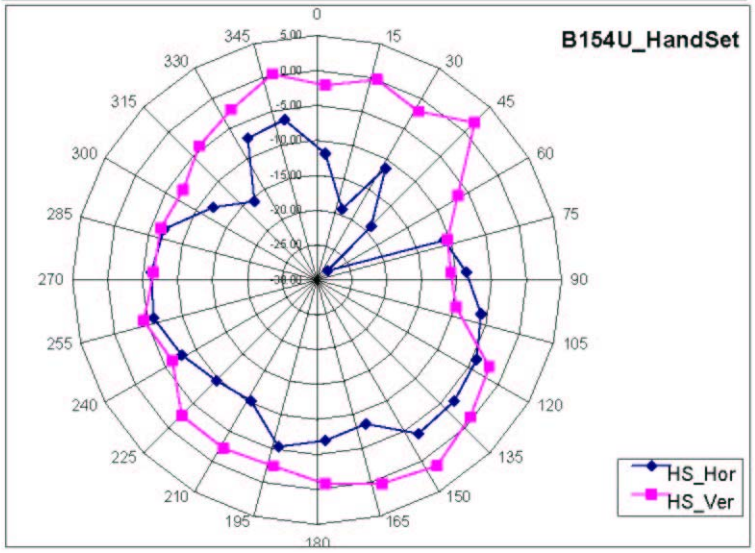
POLARIZATION PATTERN

B154U Antenna Radiation Pattern
Ascalade Technologies Inc.
Date: June 14, 2005

Degree	BS_Hor (dBi)	BS_Ver (dBi)	HS_Hor (dBi)	HS_Ver (dBi)
0	-0.82	-5.20	-13.03	-3.24
15	-2.65	-6.58	-20.66	-1.46
30	-3.05	-6.79	-12.80	-3.41
45	-4.76	-7.32	-20.69	0.28
60	-5.81	-7.61	-29.60	-8.11
75	-9.90	-5.99	-12.37	-11.86
90	-19.23	-5.74	-9.83	-12.05
105	-10.62	-5.84	-6.91	-10.62
120	-7.61	-4.95	-4.98	-2.90
135	-4.19	-5.17	-3.93	-0.68
150	-7.03	-5.22	-3.33	2.00
165	-7.94	-9.55	-7.53	1.32
180	-6.64	-8.72	-5.91	0.27
195	-9.95	-6.27	-4.10	-1.24
210	-12.25	-6.25	-8.74	-0.89
225	-10.41	-7.53	-8.02	-0.99
240	-4.79	-9.06	-6.28	-4.70
255	-1.62	-9.76	-4.57	-3.08
270	1.34	-6.85	-5.11	-5.42
285	1.11	-5.20	-6.10	-5.64
300	2.00	-3.12	-11.48	-6.51
315	1.86	-3.32	-15.67	-4.44
330	-0.24	-5.44	-7.85	-3.13
345	-0.95	-9.13	-7.40	-0.66
360	-0.82	-5.44	-13.41	-0.23

Max (dBi)	2.00	-3.12	-3.33	2.00
Min (dBi)	-19.23	-9.76	-29.60	-12.05
Diff (dB)	21.23	6.64	26.27	14.05





Result: As antenna gain < 3 dBi, no correction factor necessary to be applied to subsequent radiation measurement readings.

3 EMISSION BANDWIDTH

Clause: **15.323 (a) / 8.2**

Requirement: 50 kHz < B < 2.5 MHz

SA Setting: RBW ≃ 1 % of Emission BW (or 0.5 % < RBW < 2 % for fixed setting)

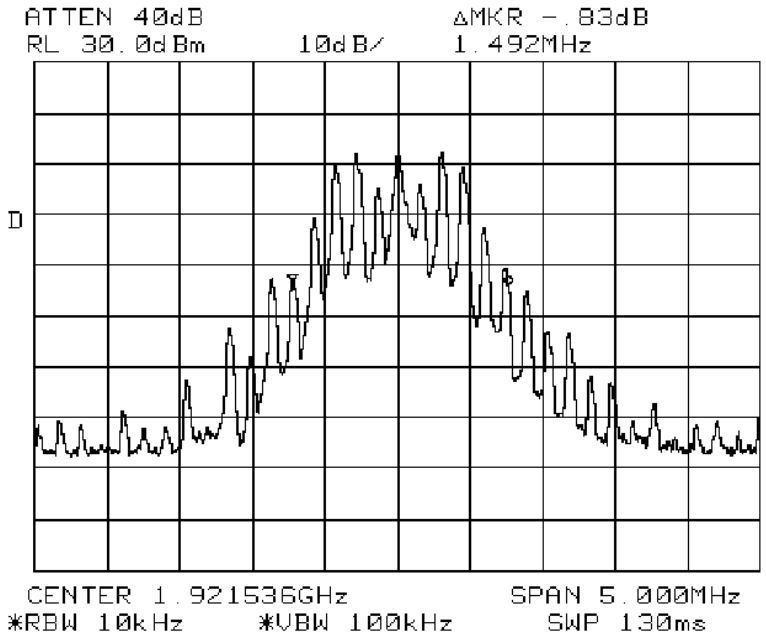
ANSI 6.1.3 VBW ≥ 3 x RBW
Span ≥ 2 x B
Sweep: Sufficient to stabilize trace
Detection: Peak hold

Test Result: Base: 1.492 MHz < Limit 2.5 MHz
Handset: 1.492 MHz < Limit 2.5 MHz

3.1 Base

Test Mode	Channel No.	Frequency (MHz)	26 dB Bandwidth (kHz)
4	5	1928.448	1476
5	3	1924.992	1485
6	1	1921.536	**1492**

Worst-case plot follows:

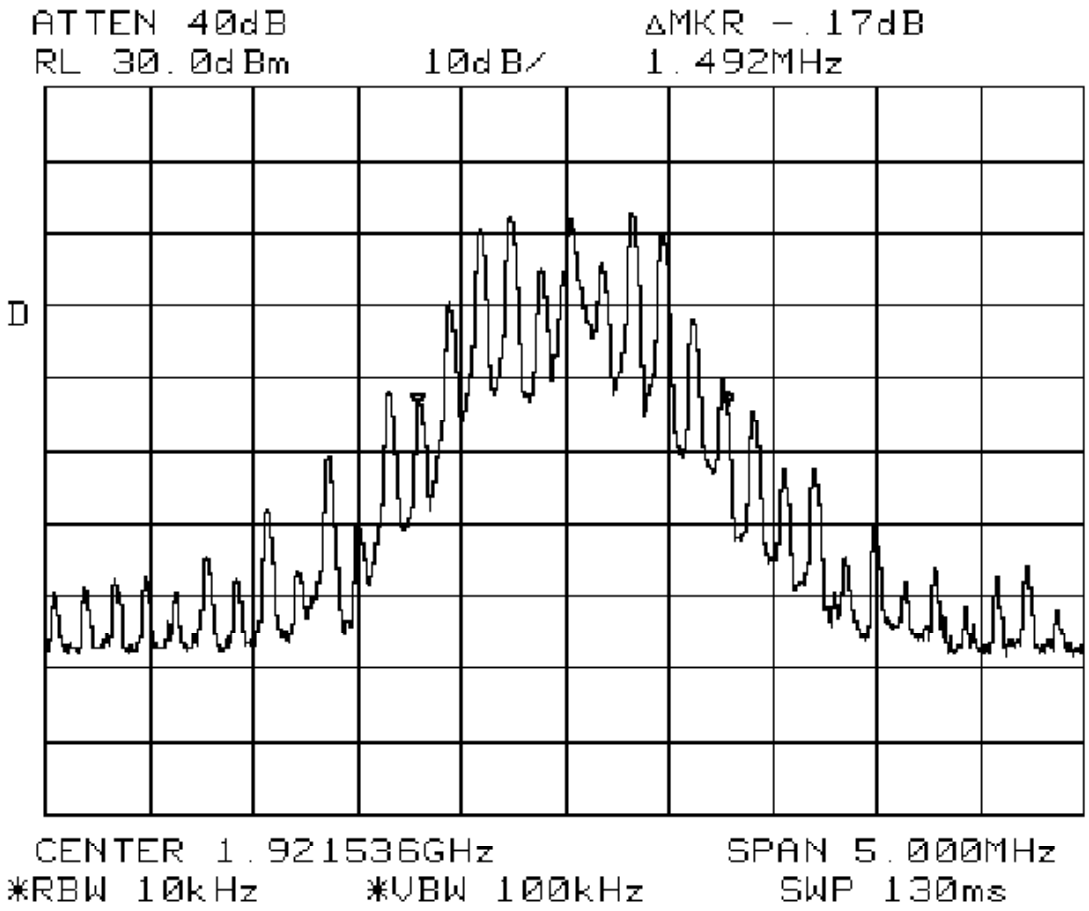


Base emission BW at Low Channel

3.2 Handset

Test Mode	Channel No.	Frequency (MHz)	26 dB Bandwidth (kHz)
1 (Mod ON), 2 (Ch 05)	5	1928.448	1475
1 (Mod ON), 2 (Ch 03)	3	1924.992	1483
1 (Mod ON), 2 (Ch 01)	1	1921.536	**1492**

Worst-case plot follows:



Handset emission BW at Low Channel

4 CONDUCTED PEAK TRANSMIT POWER

Clause: **15.319 (c) / 8.1**

Requirement: ≤ 100 μW x $\sqrt{B}$ = 5 logB - 10 dBm = 20.8 dBm, where B rated 1.5 MHz maximum

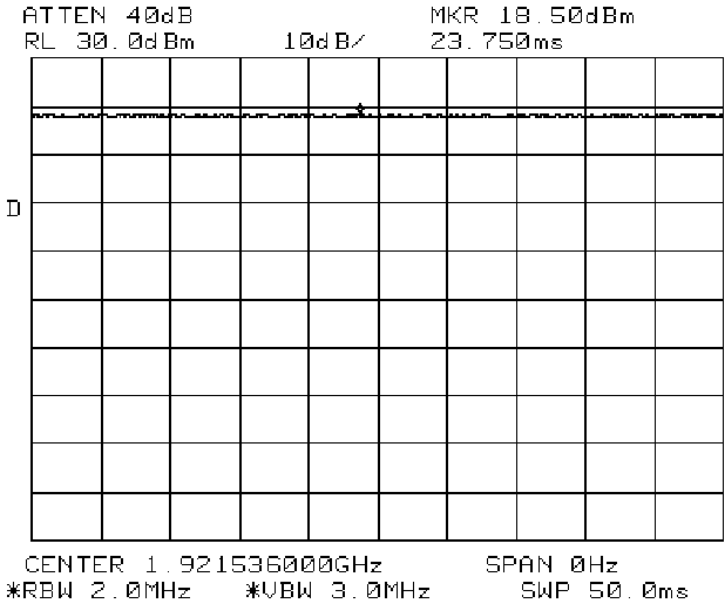
SA Setting: RBW ≥ Emission BW (or increased until no more than 0.5 dB change in power)
ANSI 6.1.2 VBW ≥ 3 x RBW
Span = zero, centered on channel center
Sweep: fast enough to resolve transmit pulse
Detection: Peak

Test Result: Base: 19.30 dBm (worst case)
Handset: 18.97 dBm (worst case)

4.1 Base

Test Mode	Chan. No.	Freq. (MHz)	Reading (dBm)	Cable (dB)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
4	5	1928.448	18.00	0.8	18.80	20.8	2.00
5	3	1924.992	18.17	0.8	18.97	20.8	1.83
6	1	1921.536	**18.50**	0.8	**19.30**	20.8	1.50

Worst-case plot follows:

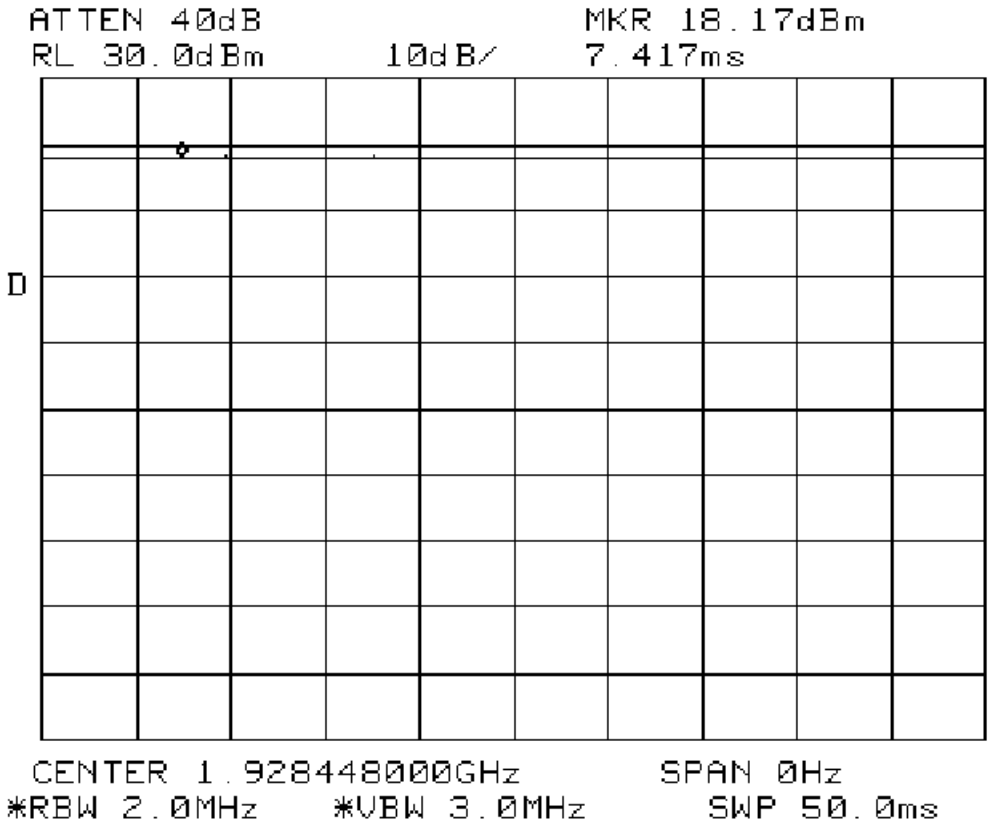


Base peak power at Low Channel

4.2 Handset

Test Mode	Chan. No.	Freq. (MHz)	Reading (dBm)	Cable (dB)	Peak Power (dBm)	Limit (dBm)	Margin (dB)
1, 2	5	1928.448	**18.17**	0.8	**18.97**	20.8	1.83
1, 2	3	1924.992	18.17	0.8	18.97	20.8	1.83
1, 2	1	1921.536	18.17	0.8	18.97	20.8	1.83

Worst-case plot follows:



Handset peak power at High Channel

6 RF EXPOSURE

Clause: **15.319 (i) / 12.0**

Requirement: **1.1307(b), 2.1091 and 2.1093 / RSS-102 as appropriate**
MPE ≤ 1 mW/cm^2 at 20 cm
SAR ≤ 1.6 W/kg over any 1 g of tissue

Reference: OET Bulletin 65 for General Population / Uncontrolled Exposure

Test Result: Base: Compliant
Handset: Compliant

6.1 Base MPE

Power density S = EIRP / $4\pi R^2$, where R is distance 20 cm
= 79.5 / $4\pi(20)^2$ = 0.016 mW/cm^2 < 1 mW/cm^2 limit

6.2 Handset SAR

Refer to separate SAR testing report by Celltech

7 DUTY CYCLE CORRECTION FACTOR

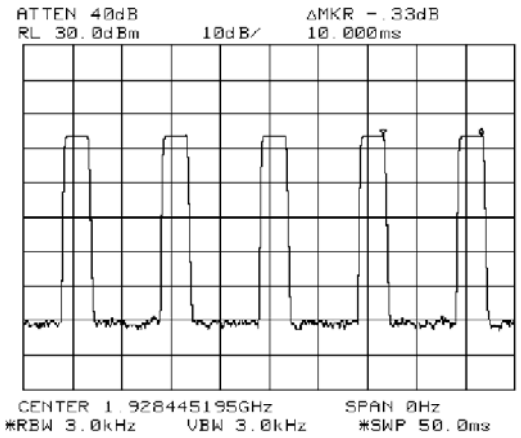
Clause: **N/A**

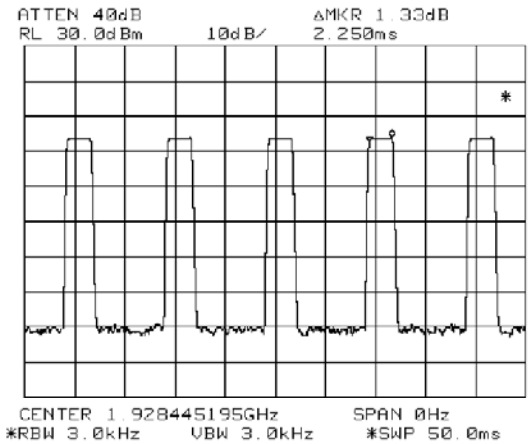
Max. Allowed: 6 dB per IC clause 8.2.3

SA Setting: RBW = 3 kHz
VBW = RBW
Sweep = 100 ms (or less for better resolution)
Span = zero, centered on channel center
Detection: Peak

7.1 Base

DCF_BS = 10 log (TX-on Time/100 ms) for power in dBm
= 10 log (2.25 ms x 5 /50 ms) from timing plots below
= –6.47 dB => –6 dB maximum allowed





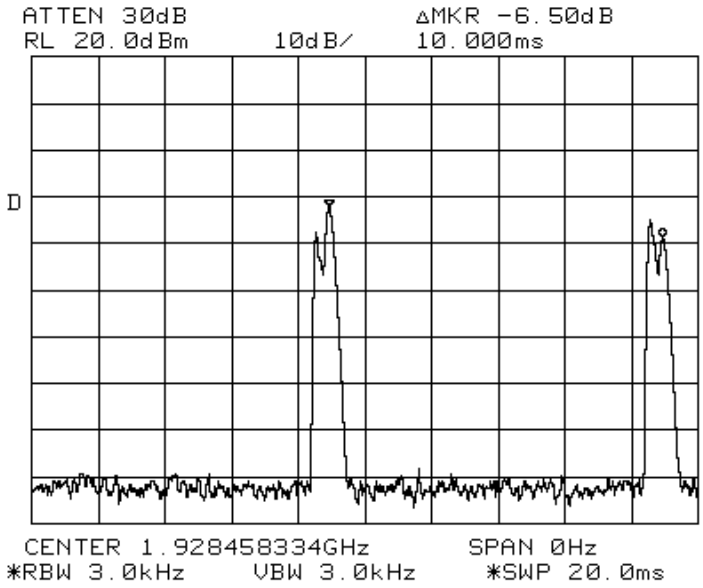
Base TX pulse width in 50 ms for 4 time slots in multi-handset operation

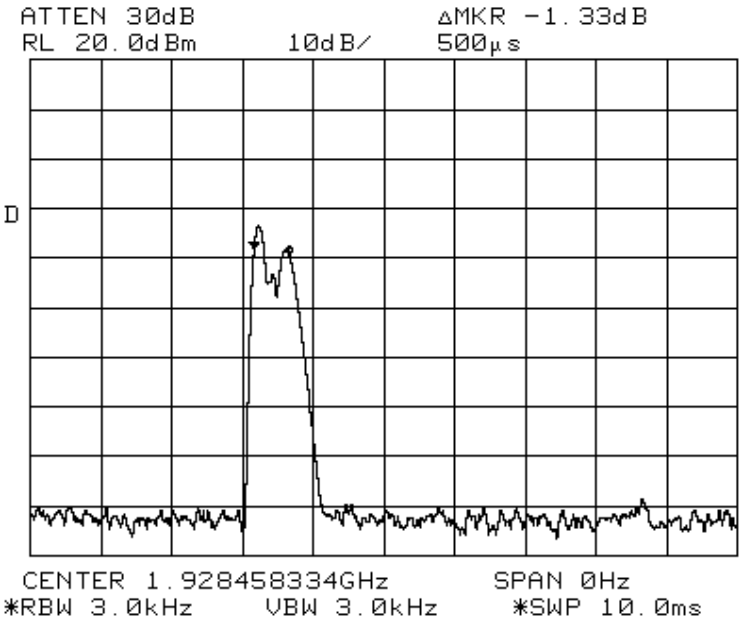
7.2 Handset

DCF_HS = –6 dB maximum allowed (same pulse operation in TDMA as base)

7.3 Single-Handset Operation

DCF = 10 log (TX-on Time/100 ms) for power in dBm
= 10 log (500 μs /10 ms) from timing plots below
= –13 dB => –6 dB maximum allowed





TX pulse width in 10 ms for 1 time slot in single-handset operation

8 POWER SPECTRAL DENSITY

Clause: **15.319 (d) / 8.2**

Requirement: ≤ 3 mW (4.77 dBm) by average detection or 12 mW (10.8 dBm) by peak-hold detection

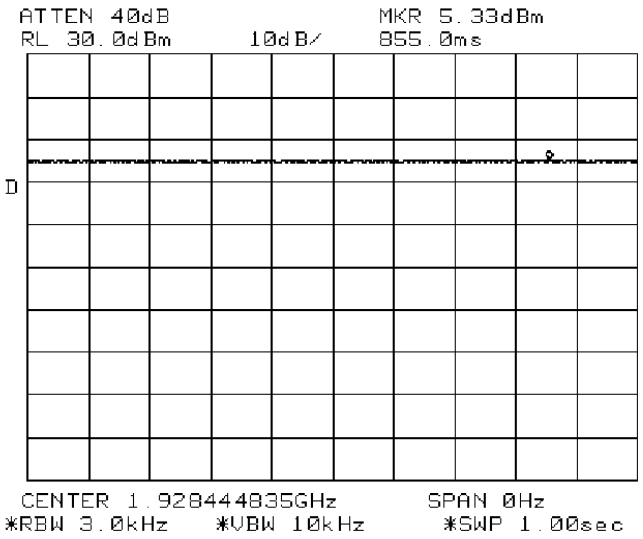
SA Setting: RBW = 3 kHz
ANSI 6.1.5 VBW = RBW
Span = B first to locate peak, then 10 kHz to read power within 3 kHz
Sweep: slow enough for at least 2 bursts to occur in each 3 kHz of span swept; e.g. 10 s sweep captures 1000 bursts of 10 ms-burst-rate signal while sweeping across 1.5 MHz, for 2 bursts per 3 kHz interval
Detection: Average or Peak (see applicable limit above)

Test Result: Base: 0.13 dBm (worst case)
Handset: 0.63 dBm (worst case)

8.1 Base

Test Mode	Chan. No.	Freq. (MHz)	Reading (dBm)	Cable (dB)	DC Factor	PSD (dBm)	Limit (dBm)	Margin (dB)
4	5	1928.448	**5.33**	0.8	-6.0	**0.13**	4.77	4.64
5	3	1924.992	4.83	0.8	-6.0	-0.37	4.77	5.14
6	1	1921.536	4.67	0.8	-6.0	-0.53	4.77	5.30

Worst-case plot follows:

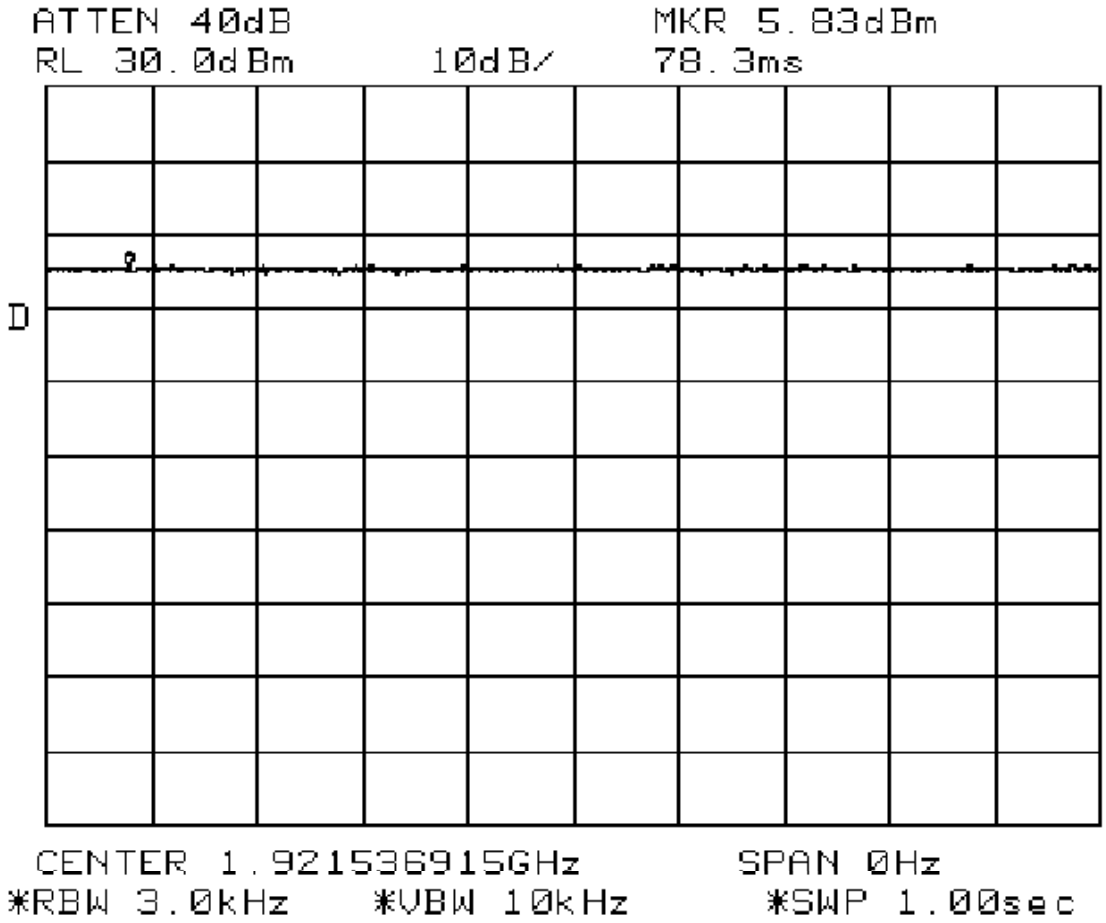


Base PSD at High Channel

8.2 Handset

Test Mode	Chan. No.	Freq. (MHz)	Reading (dBm)	Cable (dB)	DC Factor	PSD (dBm)	Limit (dBm)	Margin (dB)
1, 2	5	1928.448	5.50	0.8	-6.0	0.30	4.77	4.47
1, 2	3	1924.992	5.33	0.8	-6.0	0.13	4.77	4.64
1, 2	1	1921.536	**5.83**	0.8	-6.0	**0.63**	4.77	4.14

Worst-case plot follows:

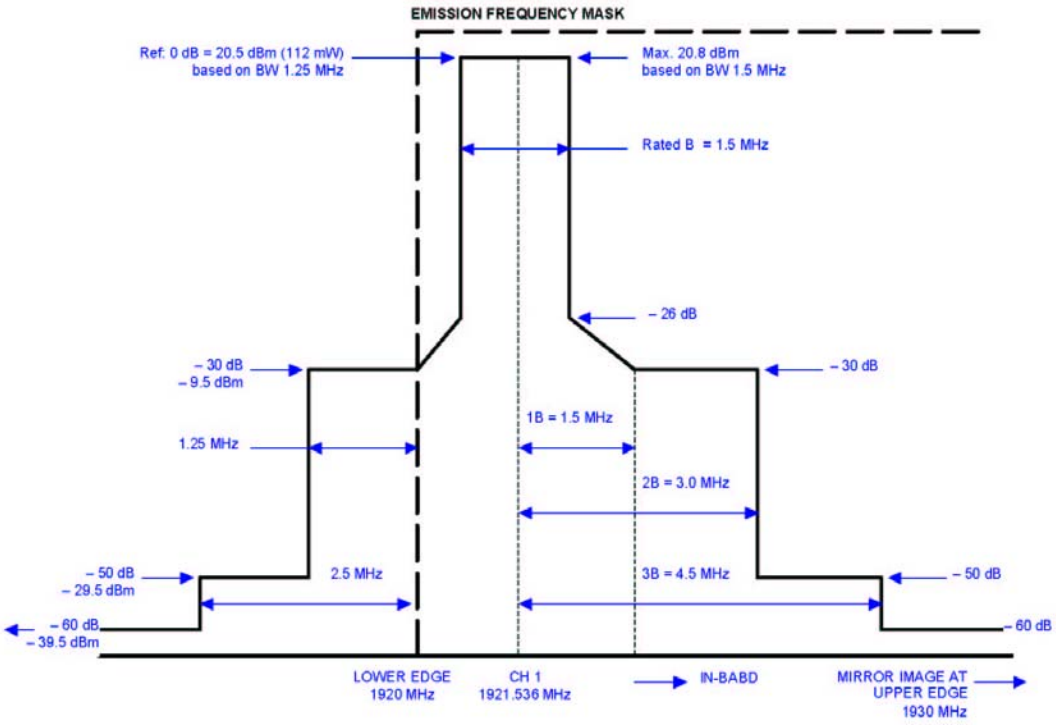


Handset PSD at Low Channel

9 EMISSIONS AT BAND EDGE AND BEYOND

Clause: **15.323 (d) / 8.3.1**

Requirement: As shown in diagram of Emission Mask



SA Setting: RBW ≃ 1 % of Emission BW (or 0.5 % < RBW < 2 % for fixed setting)

ANSI 6.1.6.2 VBW = 3 x RBW
Span ≥ 3.5 x B
Sweep: Sufficient to stabilize trace (≥ pulse repetitive interval x no. of trace elements)
Detection: Peak hold

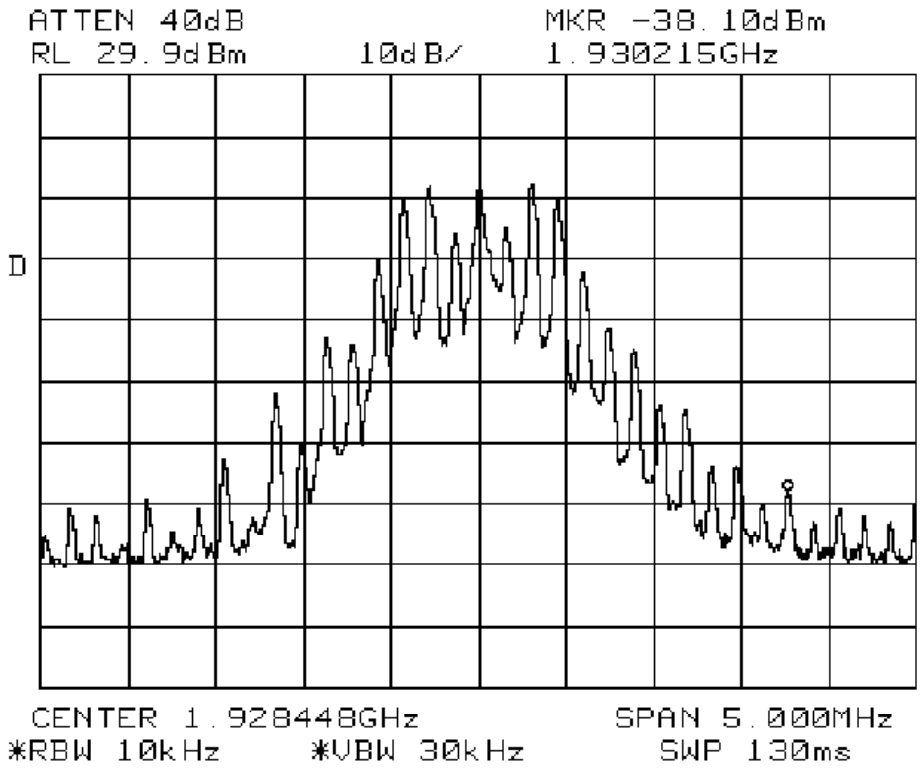
Test Result: Base: –65.6 dBc (worst case at lower band edge)
Handset: –66.0 dBc (worst case at upper band edge)

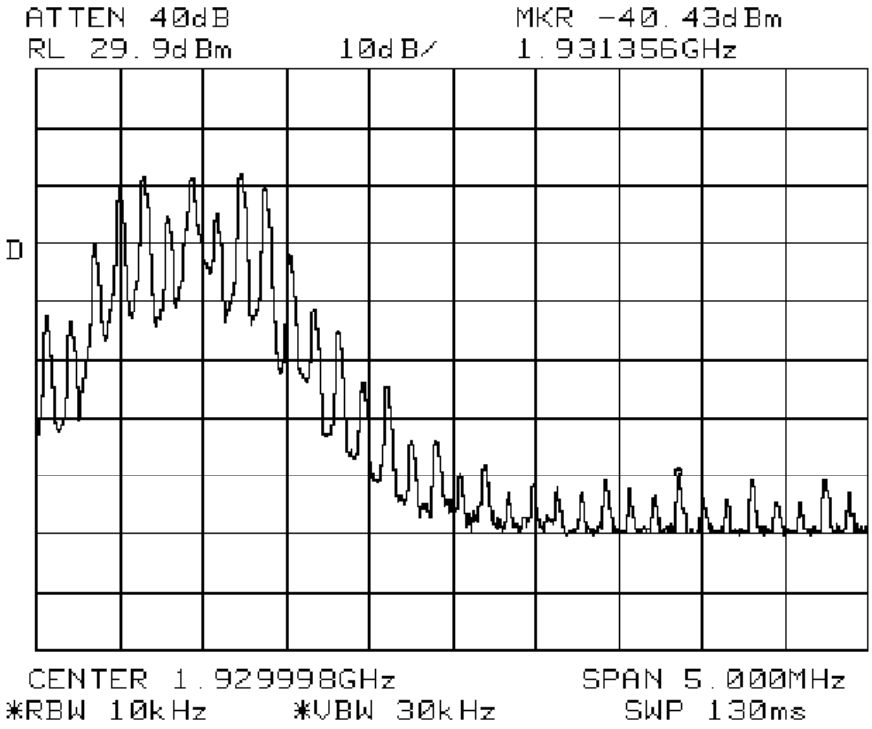
For in-band out-of-channel emissions, since emission bandwidth B is greater than out-band step bandwidth 1.25 MHz and occupied bandwidth is symmetrical about channel center, compliance in out-band emissions will automatically lead to compliance in in-band out-of-channel.

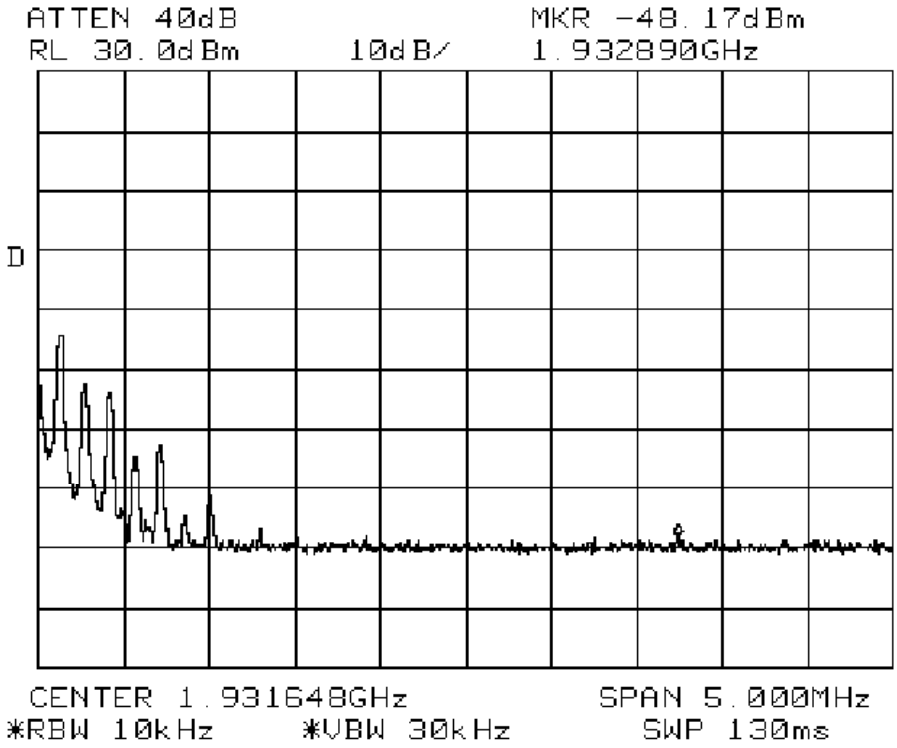
9.1 Base Near Band Edge

Test Mode	Chan. No.	Freq. (MHz)	Freq. Range (MHz)	Reading (dBm)	Rel. Att. (dBc)	Limit (dBc)	Margin (dB)
4	5	1928.448	Upper edge	18.00	0. 00	---	---
		1930.215	1930 ~1931.25	-38.10	-56.10	-30	26.10
		1931.356	1931.25 ~1932.5	-40.43	-58.43	-50	8.43
		1932.890	1932.5 ~ up	-48.17	-66.17	-60	6.17
6	1	1921.536	Lower Edge	18.50	0. 00	---	---
		1919.803	1918.75 ~1920	-38.43	-56.93	-30	26.93
		1917.644	1917.5 ~1918.75	-40.93	-59.43	-50	9.43
		1916.636	Down ~1917.5	**-47.17**	-65.67	-60	**5.67**

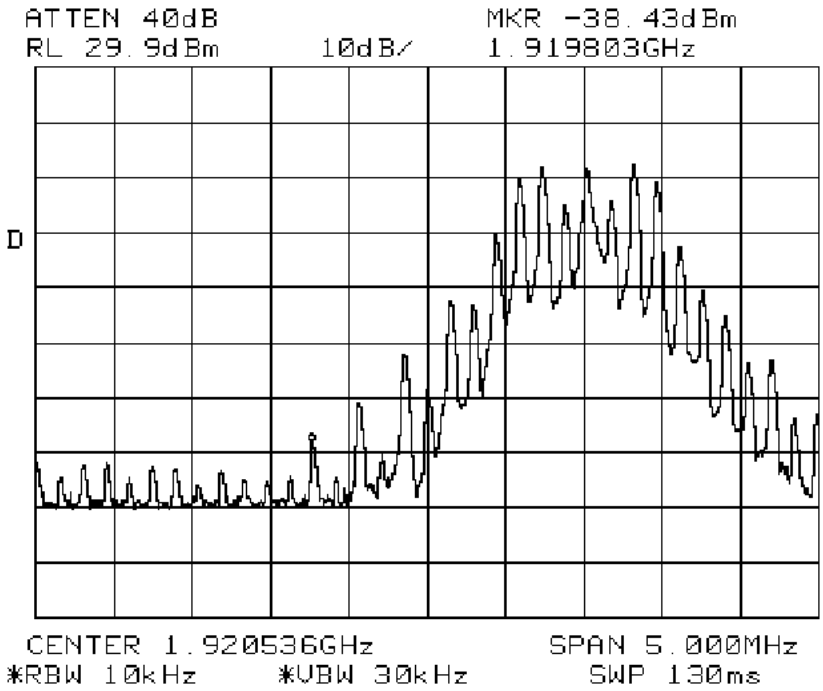
Upper out-band plots follow:

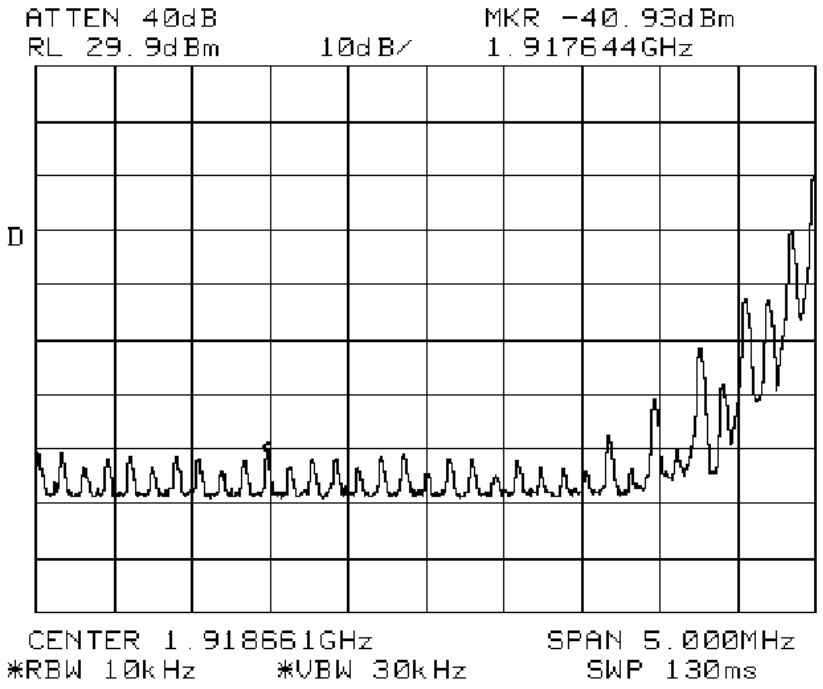


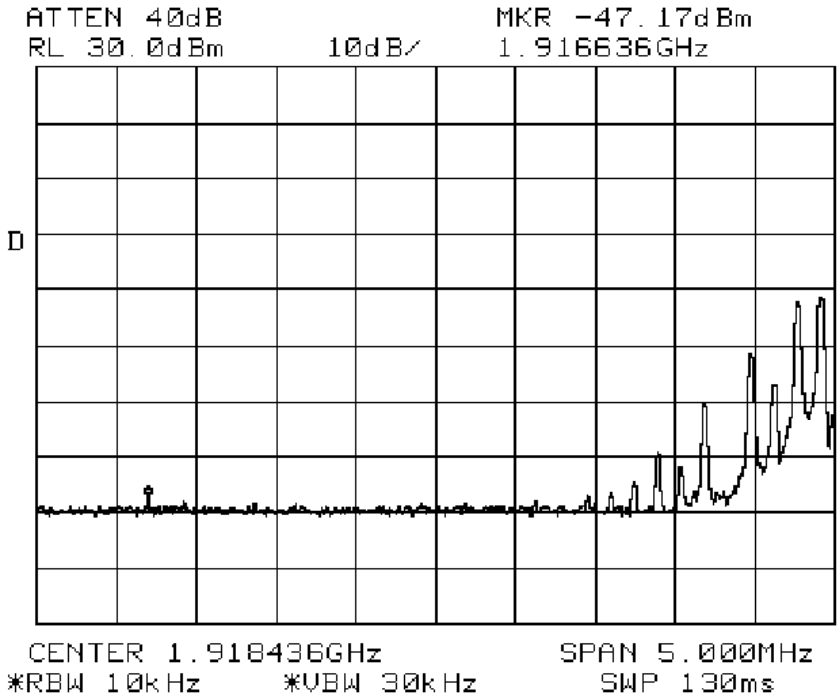




Lower out-band plots follow:





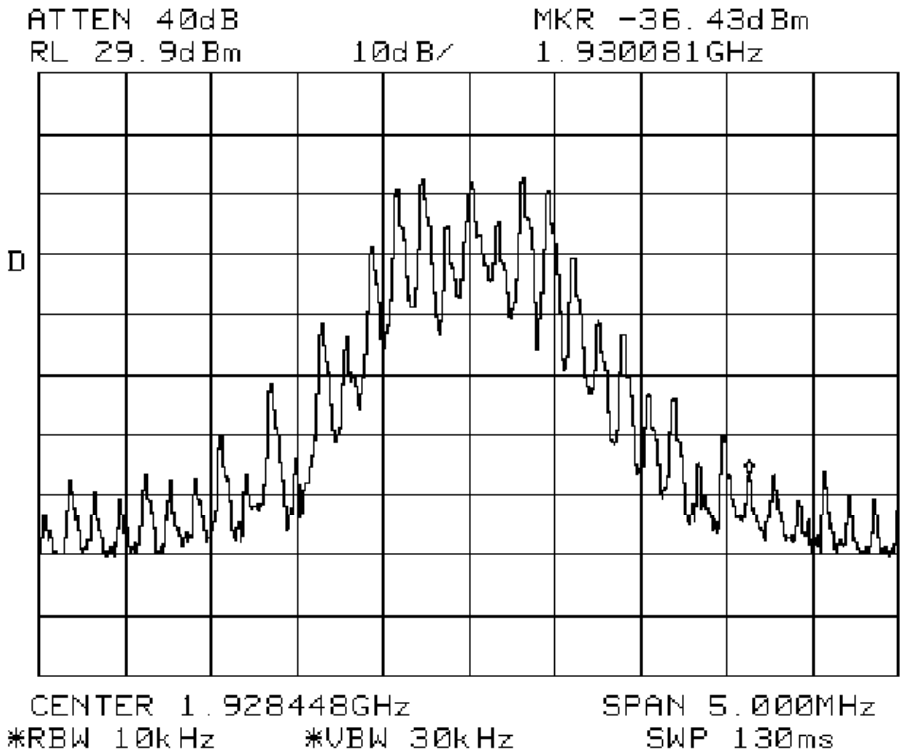


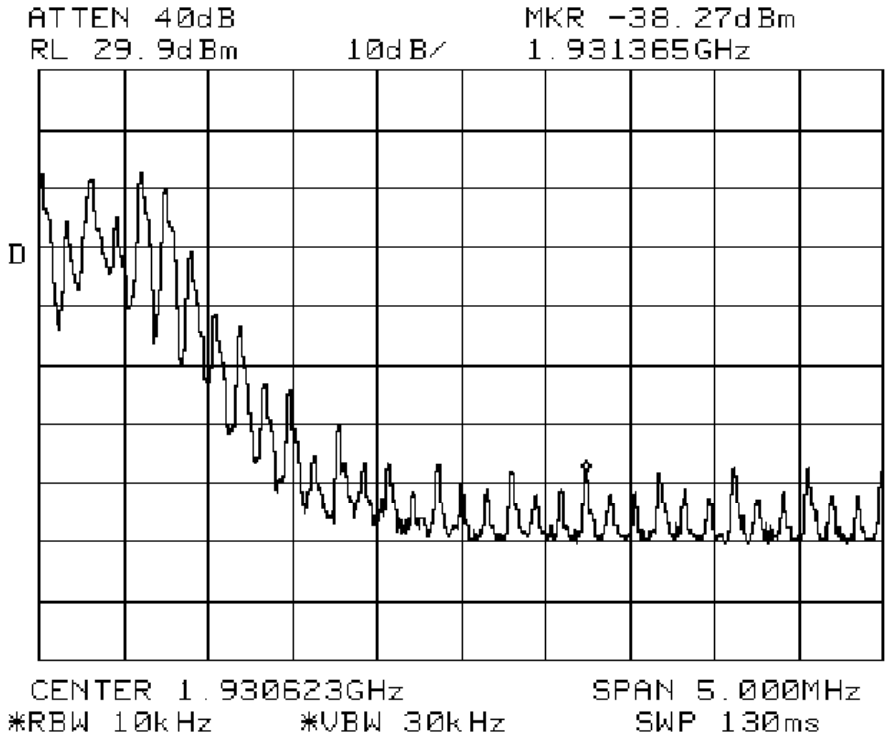
9.2 Base Tx Harmonics

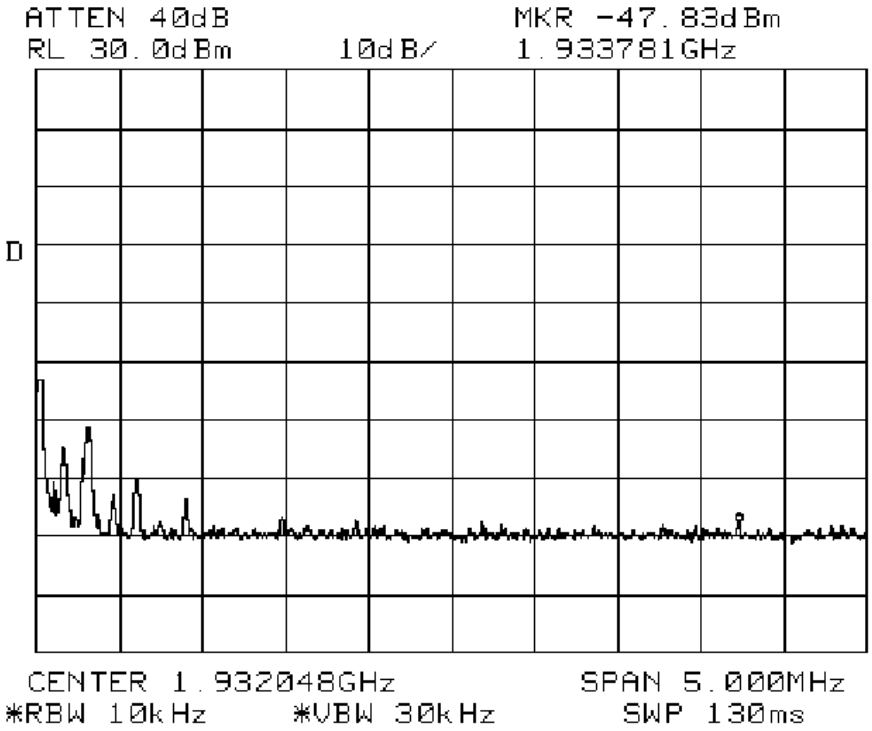
9.3 Handset Near Band Edge

Test Mode	Chan. No.	Freq. (MHz)	Freq. Range (MHz)	Reading (dBm)	Rel. Att. (dBc)	Limit (dBc)	Margin (dB)
1, 2	5	1928.448	Upper edge	18.17	0. 0	---	---
		1930.081	1930 ~1931.25	-36.43	-54.60	-30	24.60
		1931.365	1931.25 ~1932.5	-38.27	-56.44	-50	6.44
		1933.71	1932.5 ~ up	**-47.83**	-66.00	-60	**6.00**
1, 2	1	1921.536	Lower Edge	18.17	0. 0	---	---
		1919.661	1918.75 ~1920	-35.77	-53.94	-30	23.94
		1918.378	1917.5 ~1918.75	-37.10	-55.27	-50	5.27
		1917.803	Down ~1917.5	-48.00	-66.17	-60	6.17

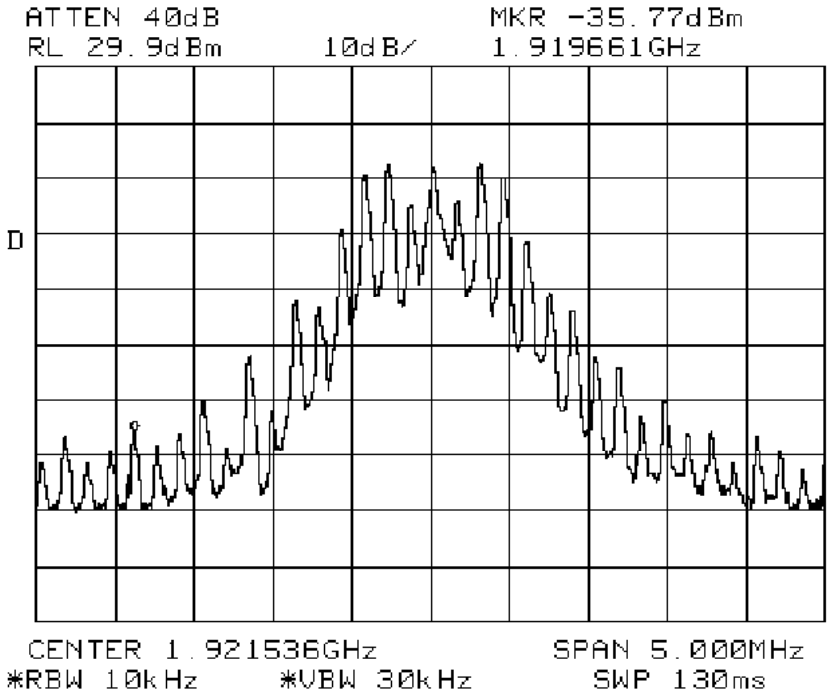
Upper out-band plots follow:

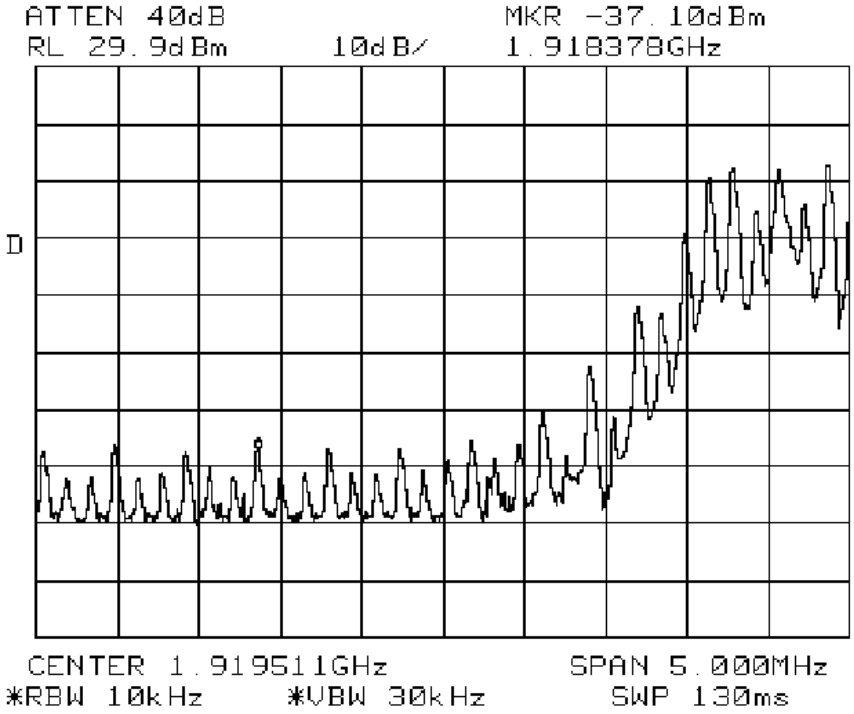


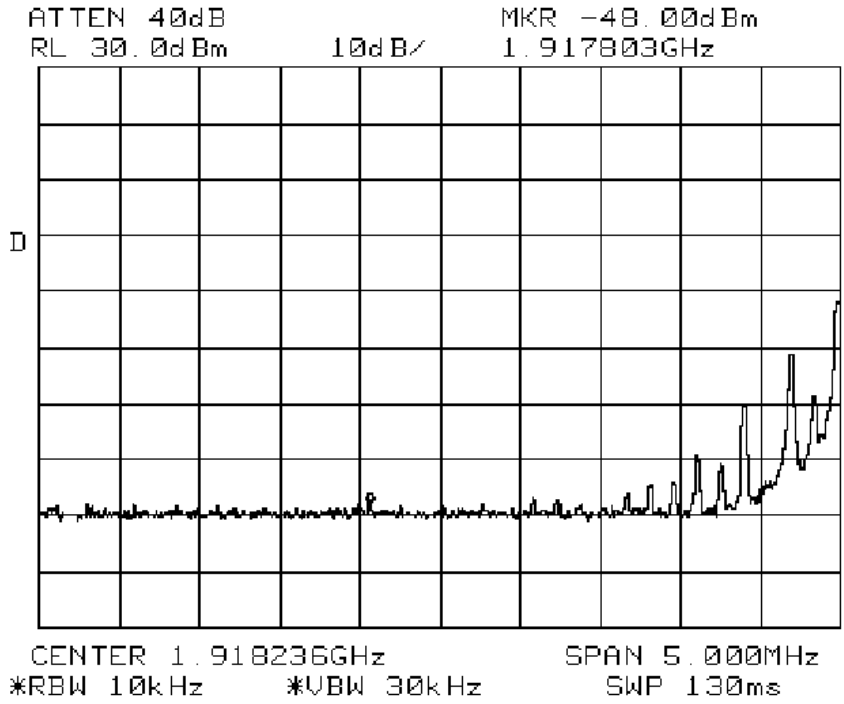




Lower out-band plots follow:







9.4 Handset Tx Harmonics

11 FREQUENCY STABILITY AND JITTER

Clause: **15.323 (e), 15.323(f) / 9.0**

Requirement:

- Frame frequency stability ≤ 50 ppm
- TDMA frame frequency stability ≤ 10 ppm over 1 hour or interval between channel access monitoring, whichever is shorter
  (That translates to frequency drift of19.2 kHz for 1920 MHz carrier)
- Frame jitter ≤ 25 μs
- Carrier frequency stability over –20 to +50 ^{0}C at normal supply voltage, and over 85% to 115% of rated supply voltage (voltage variation not required for battery operated device)

Equipment: ROHDE & SCHWARZ Digital Radio Tester MODEL CTS60
S/N 100407
Last calibrated 2004-7-20

Eq. Setting: Offset –18 (for UPCS frequency band)
Data Pattern = Fig 31 (specific for frequency drift and jitter tests), or
0000111100001111 for other stability tests
Attenuation 1 dB (to compensate for cable loss to antenna connector)

Test Result: Complies with requirements

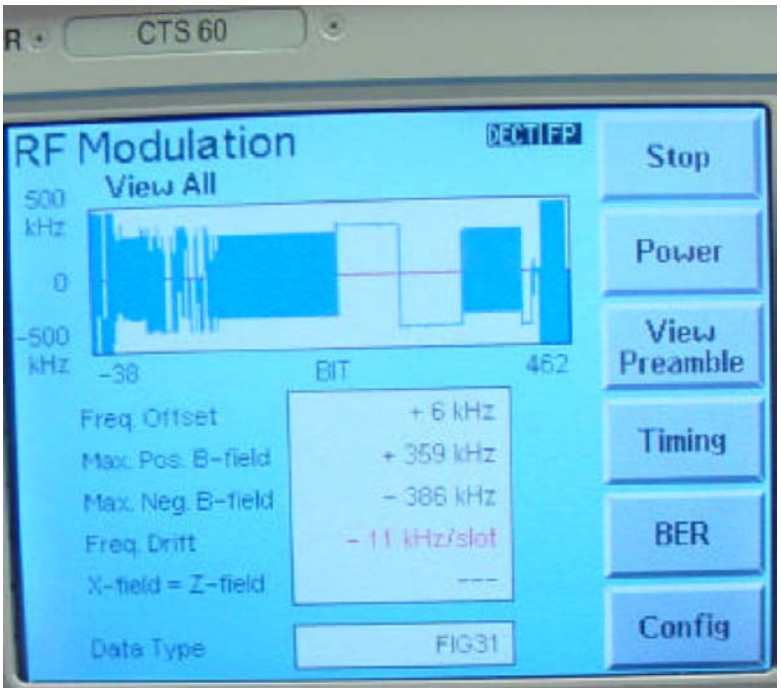
11.1 Base

11.1.1 Frame Frequency Drift and Jitter

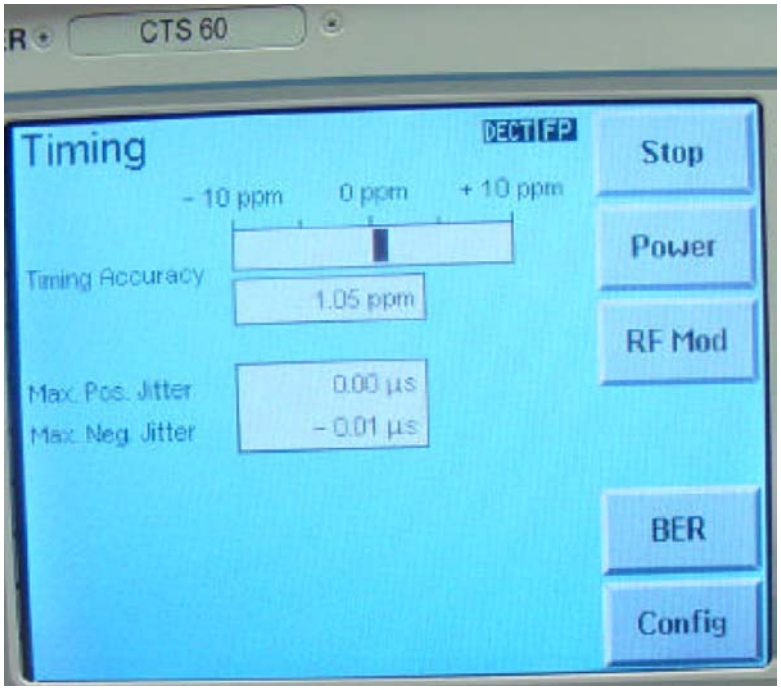
Test Mode	Channel No.	Frequency (kHz / slot)		Jitter (μs)	
		Drift	Limit	Meas.	Limit
TBR6	5	-11	19.2	-0.01	25
TBR6	3	**-11**	19.2	-0.01	25
TBR6	1	-8	19.2	-0.01	25

Note: Test Mode TBR6 is built-in per ETSI standard and resides in firmware preceding the FCC test mode in Test Mode Menu.

Photos of worst-case display follow:



Base Frequency Drift at Mid Channel



Base TDMA Frame Jitter

11.1.2 Carrier Frequency Stability with Supply voltage

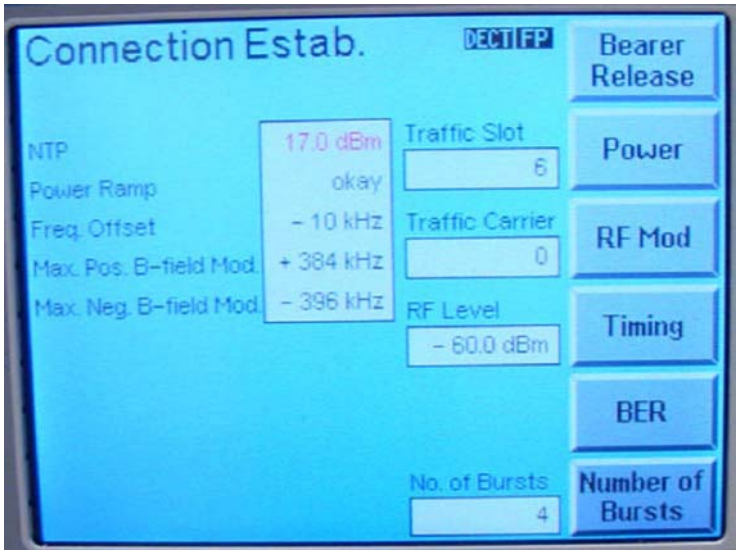
Test Mode	Channel No.	Frequency (kHz / slot)			Limit (kHz / slot)
		4.25 V (85%)	5 V (Norm.)	5.75 V (115%)	
TBR6	5	-10	-11	-11	19.2
TBR6	3	**-12**	-11	**-12**	19.2
TBR6	1	-9	-8	-8	19.2

Note: Test Mode TBR6 is built-in per ETSI standard and resides in firmware preceding the FCC test mode in Test Mode Menu.

11.1.3 Carrier Frequency Stability with Temperature and Time

Test Mode	Channel No.	Frequency Offset (kHz)			Limit (kHz)
		–20 °C	25 °C	50 °C	
TBR6	5	-4	-8	**-10**	± 19.2
TBR6	3	-2	-4	-5	± 19.2
TBR6	1	-0	-2	-4	± 19.2

Test was conducted for duration longer than 1 hour. Photos of worst-case display follow:



Base Carrier Frequency Offset with Temperature

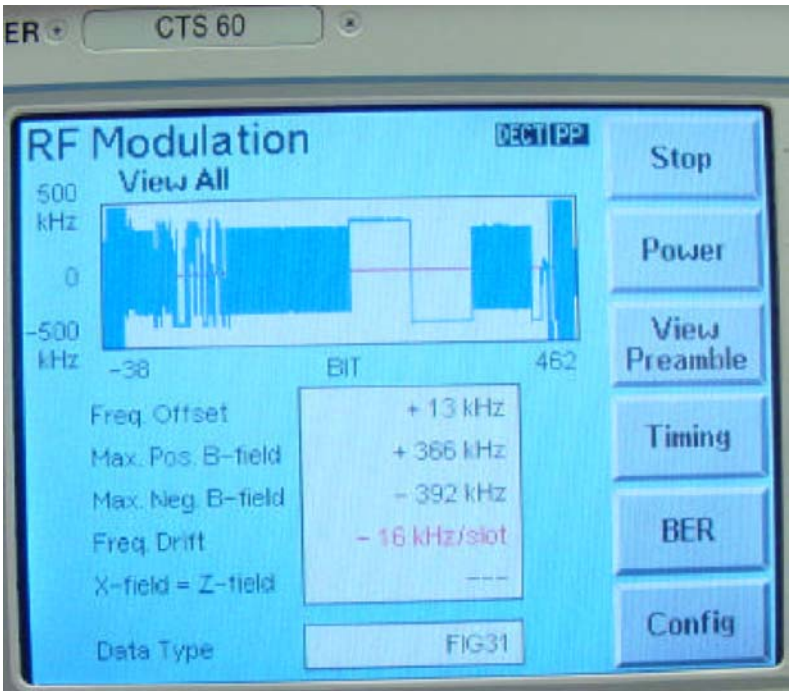
11.2 Handset

11.2.1 Frame Frequency Drift and Jitter

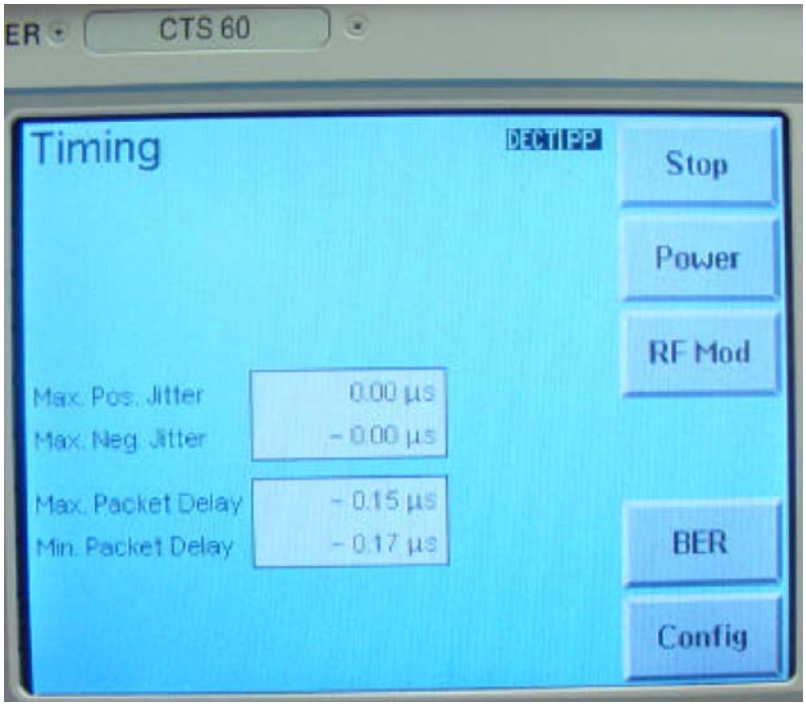
Test Mode	Channel No.	Frequency (kHz / slot)		Jitter (μs)	
		Drift	Limit	Meas.	Limit
TBR6	5	-8	19.2	0.00	25
TBR6	3	**-16**	19.2	0.00	25
TBR6	1	-10	19.2	0.00	25

Note: Test Mode TBR6 is built-in per ETSI standard and resides in firmware preceding the FCC test mode in Test Mode Menu.

Photos of worst-case display follow:



Handset Frequency Drift at Mid Channel



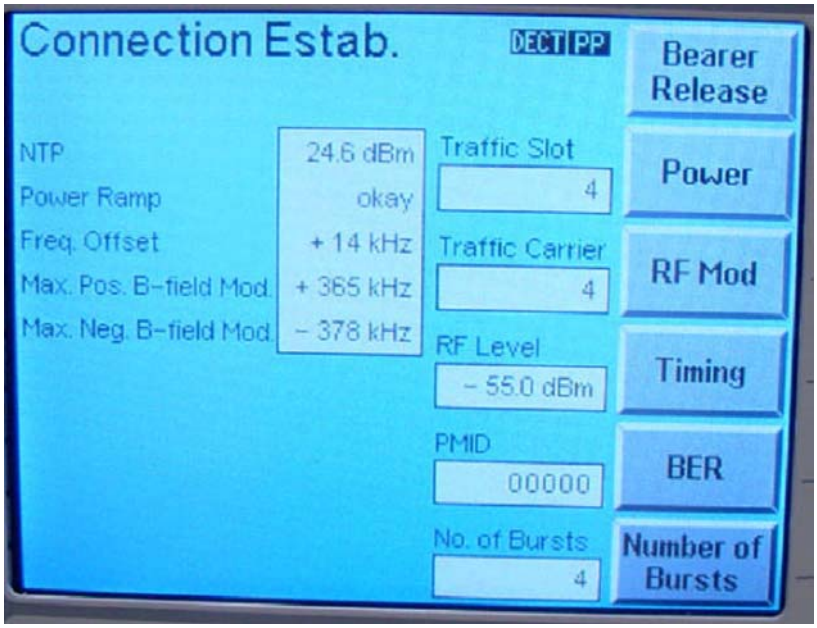
Handset TDMA Frame Jitter

11.2.2 Carrier Frequency Stability with Temperature and Time

Test Mode	Channel No.	Frequency Offset (kHz)			Limit (kHz)
		–20 °C	25 °C	50 °C	
TBR6	5	11	5	-4	± 19.2
TBR6	3	13	5	-1	± 19.2
TBR6	1	**14**	7	3	± 19.2

Note: Test Mode TBR6 is built-in per ETSI standard and resides in firmware preceding the FCC test mode in Test Mode Menu.

Test was conducted for duration longer than 1 hour. Photos of worst-case display follow:



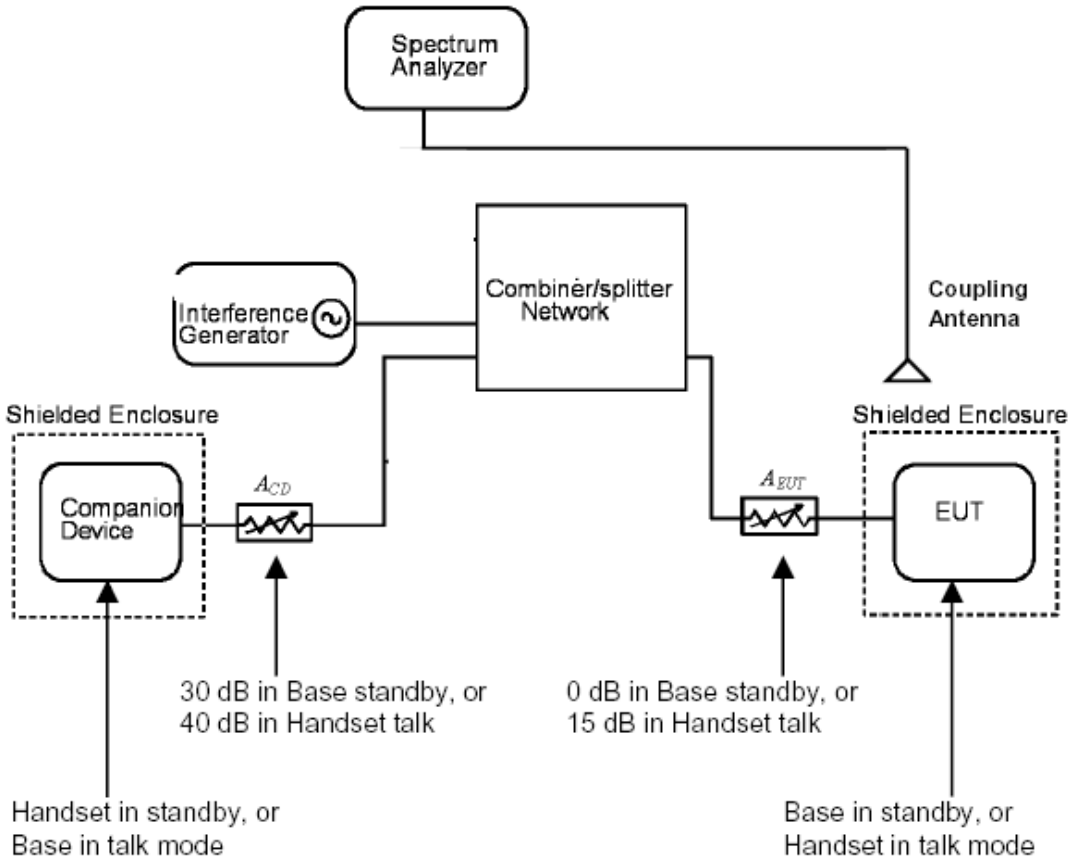
Handset Carrier Frequency Offset with Temperature

12 MONITORING THRESHOLD

Clause: **15.323 (c)(5) / 8.4 (c)(5)**

Requirement: ≤ –61 dBm for 1.5 MHz BW and 20.5 dBm Tx power derived from formula as follows:
Upper limit = 15 logB – 184 + 50 – P as per ANSI 63.17 Sec. 7.2.1

Test Setup: As shown below per Fig. 8 of 7.1.1 in ANSI C63.17 – 1998



EUT (Base and Handset) modified in

- Tx power purposely reduced by about 10 dB to reduce requirement on external attenuators A_{EUT} and A_{CD}
- Limited 2-channel operation by EEPROM setting
- Incorporated Baseband Test Mode to simulate TALK mode without the base connected to the USB port of a PC

Mode	EUT	A_{EUT} (dB)	Companion Device	A_{CD} (dB)
Standby	Base	0	Handset	30
Talk	Handset	15	Base	40

Test Result: Threshold < –61 dBm

12.1 Standby

Note:
- Base is the initiator; handset the responding device.
- Main deciding factor in protocol is signal strength RSSI.

Combiner / Coupler insertion loss = 4 dB
Cable loss 1 = 0.8 dB
Cable loss 2 = 1.6 dB
Total insertion loss = 6.4 dB

Measured threshold = Sig Gen reading – Insertion loss
= –56.5 – 6.4 = –62.9 dBm

12.2 Talk

Note:
- Handset is the initiator; base the responding device.
- Main deciding factors in protocol are CRC (or BER), sync pulse and clock jitter besides signal strength RSSI.
- Base conveys information on channel conditions to add to that detected by handset before handset decides on initiating channel change.

Measured threshold = –57.0 – 6.4 = –63.4 dBm