4 TCB SUBMISSION

This section addresses points specifically requested by EMCT upon submission to TCB selected by EMCT (Curtis-Strauss). The TCB requested clarifications are pasted in italic.

Refer to [16] as well as exchange of correspondence in Section 5 below.

Equipment used:

- **Spectrum analyser: Agilent ESA E4407B**
- **Oscilloscope: Agilent 54642A**
- **RF Signal generator: Agilent E4437B**

4.1 PCB Overlays.

1. Layout diagrams have been mentioned in the confidentiality request. This document was not supplied. Please provide the document or revise the confidentiality request.

Please refer to CD Rev 1.0.3, under the directory "/PCB Overlays".

4.2 Operational Description

2. An operational description is required as a separate exhibit. If this is part of the manual, it needs to be extracted and supplied. This description should also address the following issues;

The mentioned issues are dealt with separately below.

4.2.1 Pseudo-random hopping sequences

a. Is the hopping sequence pseudorandom? Provide examples of the hopping sequence.

The hopping pattern sequences are pseudo-random. Hopping pattern sequences are calculated using a linear congruential generator, of the form [11]:

$$y_{n+1} = (ay_n + b) \bmod m$$

The MINSTD generator is used, having constants:

$$m = 2^{31} - 1 = 2147483647$$
$$a = 7^5 = 16807$$
$$b = 0$$

The procedure for generating the 32 hopping patterns is as follows.

1. Set $y_0 = 389$.

2. Generate the first hopping pattern channel c_1 by calculating (y_1 mod MAX_CHANNELS [3]).

3. Generate the n^{th} hopping pattern channel by calculating (y_n mod MAX_CHANNELS). If this is the same as any of the channels c_1 to c_{n-1} already in the sequence, discard the result and use (y_{n+1} mod MAX_CHANNELS) instead. Repeater until a valid hopping pattern channel is found.

4. Repeat step 3 until such time as a full hopping pattern is generated.

5. Repeat steps 2, 3, and 4 until each hopping pattern is generated.

An example of different hopping patterns is provided in Table 12 below [12]. HSN stands for "Hopping Sequence Number". The slot number corresponds to the FCC channel number visited in successive time slots.

HSN [0..31]	Slot Number [0..101]
0	29, 98, 26, 30, 17, 99, 36, 64, 79, 74, 13, 9, 85, 57, 61, 89, 8, 81, 69, 96, 75, 14, 6, 33, 15, 22, 34, 95, 45, 23, 2, 35, 32, 83, 41, 78, 90, 43, 12, 87, 53, 21, 3, 80, 48, 40, 7, 91, 42, 16, 1, 54, 38, 44, 18, 73, 20, 71, 62, 101, 11, 52, 39, 47, 82, 4, 58, 97, 46, 56, 60, 55, 50, 25, 37, 77, 19, 94, 70, 67, 88, 76, 0, 27, 24, 100, 5, 93, 49, 68, 72, 31, 92, 65, 63, 86, 66, 51, 28, 59, 10, 84
16	81, 90, 31, 77, 100, 70, 86, 53, 68, 3, 62, 58, 41, 92, 1, 28, 61, 46, 101, 79, 20, 4, 60, 91, 24, 93, 87, 12, 35, 40, 57, 73, 19, 48, 27, 6, 69, 95, 7, 74, 36, 49, 55, 5, 33, 59, 54, 30, 51, 82, 42, 25, 85, 29, 56, 64, 45, 8, 17, 2, 34, 80, 38, 22, 63, 52, 71, 13, 65, 83, 32, 78, 10, 76, 18, 9, 66, 88, 67, 75, 89, 37, 47, 96, 50, 98, 0, 26, 16, 84, 44, 14, 15, 99, 43, 94, 21, 39, 72, 11, 97, 23
31	96, 55, 25, 100, 95, 64, 91, 12, 40, 97, 10, 17, 45, 31, 81, 101, 51, 65, 73, 47, 6, 79, 82, 61, 59, 36, 20, 77, 88, 34, 14, 4, 50, 15, 84, 44, 76, 32, 43, 46, 52, 74, 18, 66, 86, 70, 68, 71, 22, 42, 67, 63, 75, 8, 94, 16, 1, 7, 69, 2, 53, 99, 62, 19, 85, 28, 54, 23, 48, 29, 3, 58, 38, 0, 90, 78, 39, 5, 24, 37, 21, 57, 41, 9, 98, 72, 93, 27, 92, 49, 33, 60, 35, 30, 26, 11, 13, 56, 89, 80, 83, 87

Table 12: Example FCC hopping patterns

In addition to the standard 32 hopping patterns, three additional patterns are supplied that are only available in factory mode, as shown in Table 13 below.

These patterns cannot be used to link or transfer data, they are only used for the purpose of testing the VCO range.

HPSN	**Description**
32	Hops between channels 0 and 100 only.
33	Only hops over the lower 50% of the band.
34	Only hops over the higher 50% of the band.

Table 13: Factory mode hopping patterns

4.2.2 Equi-probable channels

b. How is the equal use of each channel on average ensured by the device?

[3] MAX_CHANNELS = 102, for the FCC image.

The method for generating the hopping sequence described in 4.2.1 ensures that within each hopping sequence, each of the 102 channels occurs once. Under normal operation the hopping sequence is cycled i.e. after the EUT has dwelled on the last channel in the sequence it will then hop back to the first and then hop through the sequence ad infinitum. Therefore each channel is visited once every 102 channels.

The frame time is the amount of time that the RFI-9256 will spend on each channel in the hopping pattern. This is also referred to as the channel dwell time. [9]

The frame time is user-configurable, 5ms to 35ms [9] with the **one setting being applied to all the channels in the hopping sequence**. Therefore equal use of all channels is guaranteed. Some evidence for this is shown in the following figure.

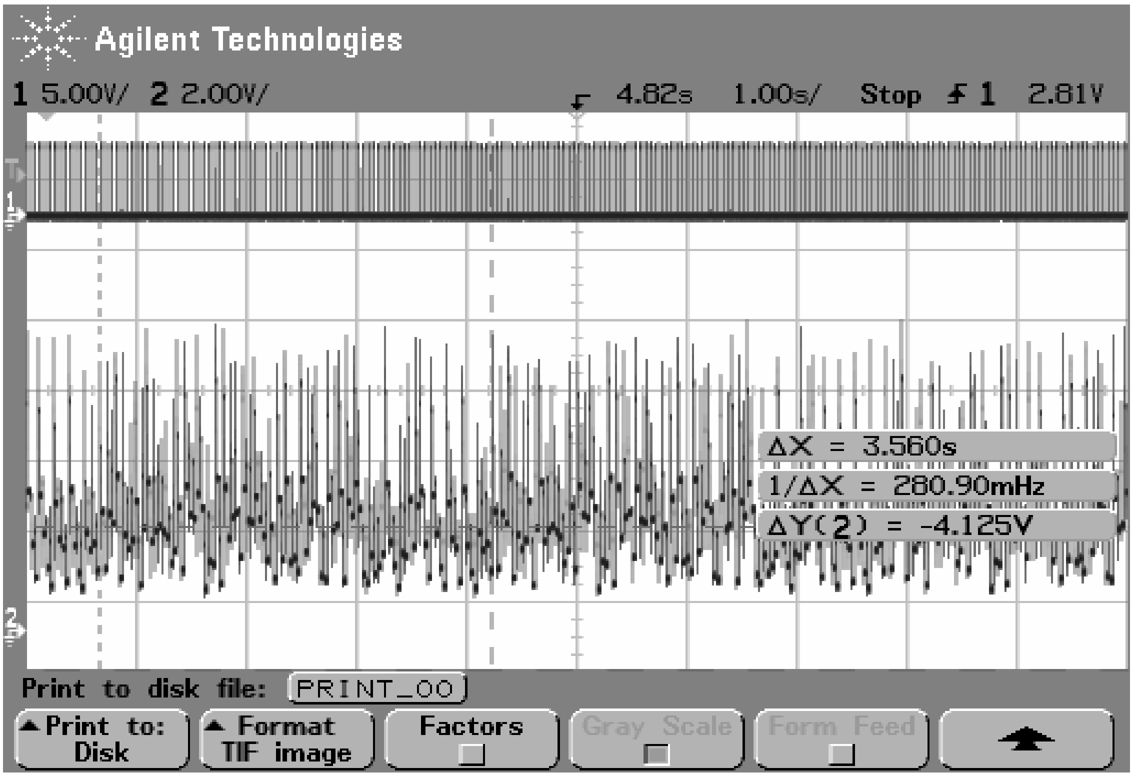

Figure 5 :Channel frequency tuning voltage

In figure 5 the lower trace is the tuning voltage on the channel changing main VCO of the EUT measured at TP1 of the circuit. The upper trace is the TX/RX switch line measured at TP34 and was used to trigger the oscilloscope. The vertical time cursors show where the pattern repeats indicating the period for a complete 102 channel hopping sequence.

4.2.3 Compliant receiver bandwidth

c. Does the associated system receiver have a compliant input bandwidth, based on the measured 20 dB emission bandwidth?

The RFI-9256 OEM module receiver bandwidth is determined by its last (2^{nd}) IF (10.7MHz).

The IF filter used is Murata SFELA10M7JAA0-B0. Refer to filter characteristics in Figure 6 below. As can be seen, the filter bandwidth comfortably fits within the declared 20dB channel bandwidth (250KHz).

Part Number	Center Frequency (fo) (MHz)	3dB Bandwidth (kHz)	Attenuation (kHz)	Insertion Loss (dB)	Spurious Attenuation (dB)	Input/Output Impedance (ohm)
SFELA10M7JAA0-B0	10.700 ±30kHz	150 ±40kHz	360 max.	4.5 ±2.0dB	35 min.	330
SFELA10M7HAA0-B0	10.700 ±30kHz	180 ±40kHz	470 max.	3.5 ±1.5dB	35 min.	330
SFELA10M7GAA0-B0	10.700 ±30kHz	230 ±50kHz	520 max.	3.0 ±2.0dB	35 min.	330
SFELA10M7FAA0-B0	10.700 ±30kHz	280 ±50kHz	590 max.	2.5 ±2.0dB	30 min.	330

Attenuation Bandwidth : at 20dB loss point Area of Spurious Attenuation : [within 9MHz to 12MHz]
Insertion Loss: at minimum loss point
Center frequency (fo) defined by the center of 3dB bandwidth.
The order quantity should be an integral multiple of the "Minimum Quantity" shown in the package page.

Figure 6 : Characteristics of the 10.7MHz IF filter [20]

4.2.4 Syncronised receiver hopping with transmitter

`d. Does the associated system receiver have the ability to hop in the synchronization with the transmitter?`

The receiver (slave) has the ability to hop with in synchronisation with the transmitter (master).

The initial synchonisation method is described in [11]:

“A Slave that has not acquired a frame lock with a Master radio will listen on a each channel within its hopping table for a for a period of time calculated as the product of frame time, number of channels within the hopping pattern and two, before changing to the next channel from the hopping pattern. This produces a slow crawl through the pattern and protects the slave for being jammed by noise or another radio”

The “frame locking” (synchronised hopping) method is further described:

Whilst a Slave is listening to a channel it is continually checking RSSI and awaiting a trigger of produced by a carrier of better than a configurable level, usually –110 dBm. On the RFI-9256/2256 there is a hardware comparator that does part of this task to reduce the amount of processor utilisation required and increase the response time for the radio to acquire lock.

When an RSSI has been detected that is above the threshold then the FX919 or Altera data recovery/correlator is enabled to attempt to obtain a packet header from the data. If a header has been validated correct then a hardware timer (frame timer) is started which produces a frame interrupt of the duration set by the radios configuration

“Frame lock” (synchronised hopping) is guaranteed from then on as described below:

Once a slave has acquired frame lock with a master it then makes tiny adjust adjustments to the frame timing every time it acquires a valid header.

4.3 External photos

`3. The photos of the device supplied appear to be internal photos only. Please supply external photos of the device (at least front and the rear views). The report refers to the device as a module. If this device will be installed in other hosts and does not operate as a stand-alone product, then it is considered as a module. Please note that modular applications require a cover letter. The manual shows some external casing to the device, which implies that it's not a module. Please clarify and supply external photos as appropriate.`

The RFI-9256 OEM module would not be considered as a “module”, within the context of the above statement. It can operate in the absence of an attached host (Data Terminal Equipment, or DTE) as Data Communications Equipment (DCE). As such, and given that it is not a “modular application”, a separate cover letter is deemed not necessary.

Please refer to CD Rev 1.0.3, under the directory "/Pictures/Detailed Views", for requested pictures:

- "9256 OEM Top.jpg": Whole view of the top (primary or component side) of the module, showing the IDC connected, for illustration purposes only.
- "9256 OEM Bottom.jpg": Whole view of the bottom (secondary or solder side) of the module, showing the IDC connected, for illustration purposes only.
- "9256 OEM Top detail 1.jpg": Top view of the top (primary or component side) of the module, with focus on the baseband section.
- "9256 OEM Bottom detail 1.jpg": Bottom (secondary or solder side) view of the module, with focus on baseband section.

4.4 Transmitter views

4. Please supply closer and more detailed views of the transmitter board. Both sides with and without shields are required. The components must be clearly visible.

Please refer to CD Rev 1.0.3, under the directory "/Pictures/Detailed Views", for detailed views of the transmitter section:

- "9256 OEM Top.jpg": Whole view of the top (primary or component side) of the module, showing the IDC connected, for illustration purposes only.
- "9256 OEM Bottom.jpg": Whole view of the bottom (secondary or solder side) of the module, showing the IDC connected, for illustration purposes only.
- "9256 OEM Top detail 2.jpg": Top view of the top (primary or component side) of the module, with focus on the RF section. Shown with OEM and VCO cans removed.
- "9256 OEM Bottom detail 2.jpg": Bottom (secondary or solder side) view of the module, with focus on transmitter ground plane:
- "9256 OEM can1.jpg": Top view of the top (primary or component side) of the module, with OEM can removed. VCO can is shown. Tabs on top of VCO can connect to OEM can.
- "9256 OEM TX strip.jpg": Detailed view of the transmitter section of the RF transceiver. The VCO canned section has been removed for the sake of clarity.

4.5 Antenna connector specifications

5. Please supply the specifications of the antenna connector on the board.

Please refer to CD Rev 1.0.3, under the directory "/BNC Connector", for detailed views of the transmitter section:

- "FCC_FERRULE.PDF" is the mechanical drawing for the ferrule and contains all required specifications for its manufacture;
- "FCC_BNC_CONNECTOR.PDF "is the mechanical drawing for the matching BNC connector and also contains all required specifications for its manufacture.

4.6 Label

6. Please specify the label material and supply a placement photo on the device.

The label is made of JAC self-adhesive Dataflex SRP (http://www.jmcpaper.co.uk).

For placement photo refer to CD Rev 1.0.3, under the directory "/Pictures/Label Placement":

- "9256 OEM Top.jpg": View of the top of the module, with sticker over OEM can;

- "9256 OEM Sticker.jpg": Sticker detail.

4.7 User manual

7. The manual needs to include a warning statement againts modifications (15.21) as well as 15.105(b) and RF exposure statements (safe distance from the antenna to nearby people and no-colocation with any other antenna/transmitter) Please supply a revised manual.

Please refer to CD Rev 1.0.3, under the directory “/Manual”, for revised Technical Reference Manual.

4.8 Programmable parameters

8. Section 4 of the report states that there are no external user controls, however it appears that the device power level can be varied by the user (explained in manual). Also is the hopping configuration for US fixed at the factory? Does the user have the capability to change it? And have different power settings of the device been varied to see if they cause any non-compliant operation? Please clarify these points.

The RFI-9256 OEM supports 32 FCC-compliant user-settable hopping patterns. Radios within the same sub-network use the same hopping pattern. This aspect is covered in detail in the User Manual [9].

An extract from [11] clarifies carrier power restrictions for FCC operation:

> *“Although the RFI-9256 has a maximum transmit power of 30dBm, FCC versions may need to prevent the user from selecting this power setting depending on the antenna that has been supplied. In order to support this functionality a new menu option has been added to the factory menus, limit maximum transmit power.*
>
> *This allows the user to select an upper limit on the transmit power.”*

The absolute maximum carrier power is only settable in factory mode and takes into account the gain of the supplied antenna. The factory-mode is password protected. The password is not disclosed to users.

The user is however allowed to set a carrier power below the factory-set maximum.

4.9 Carrier frequency separation

9. Carrier frequency separation plots are required in accordance with the test method described in the attached public notice DA 00-705. Please supply plots showing the separation between channels.

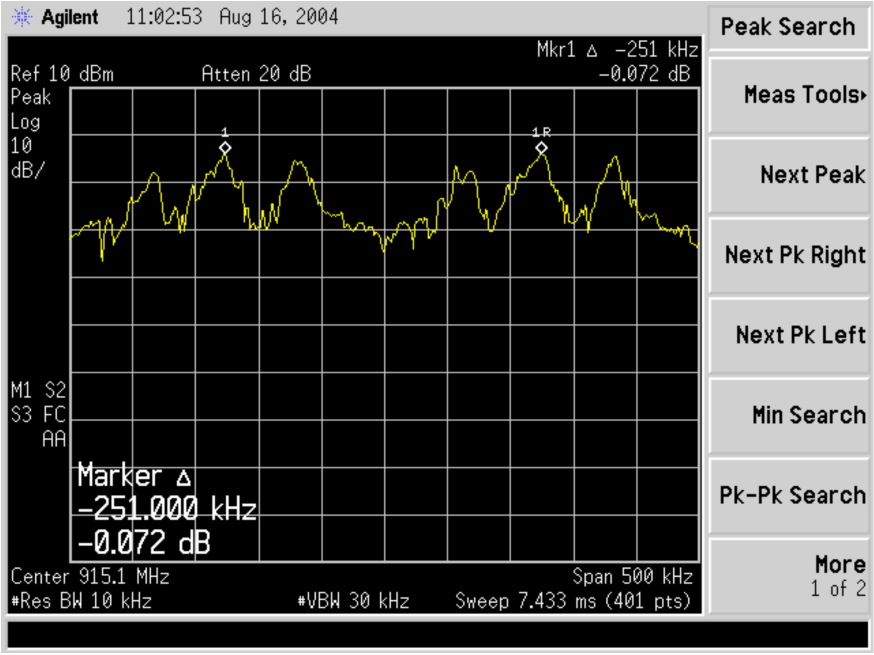

Figure 7 : Carrier frequency separation

Figure 7 above shows a measured carrier frequency separation of 251 kHz. The spectrum analyser span was set to 500 kHz, wide enough to capture the peaks of two adjacent channels, while the RBW was 10 kHz (> 1% of span). The detector was set to peak and the trace was captured in peak hold.

4.10 Channel dwell time

10. The analyzer settings for the dwell time (RBW, VBW, etc.) must be in accordance with DA 00-705. Please supply corrections.

As described in 4.2.1 and 4.2.2 the EUT visits a channel every 102 channels. The channel repetition period is thus:

Trep = 102*Frame time

As shown in figure 5, 'Trep' for a 35ms frame time is 3.57 seconds (indicated by Δx in the figure). Over a period of 20 seconds, the average channel occupancy will thus be:

Tdwell = Frame time * [(20s) / Trep] = Frame time * 20s/(102 * Frame time)

Clearly the 'Frame time' in this equation cancels and the dwell time is independent of the frame time.

Tdwell = 20s / 102 = 196ms

This theoretical dwell time is the absolute maximum transmit dwell time and meets the 400ms requirement stated in 15.247(a)(1)(i) [2]. The actual maximum transmit dwell time is dependent on the time division duplexing of the frame into a transmit and receive (TX/RX) duty cycle. The default TX/RX duty cycle is 50% with a user selectable 'Directional bias' option, described in reference [9] p21-22. The worst case directional bias occurs with a frame time of 35ms. In this case the duty cycle is 93% [9]. This translates to a maximum TX dwell time of 32.6ms. The measurement shown below is this scenario with the TX data buffers full.

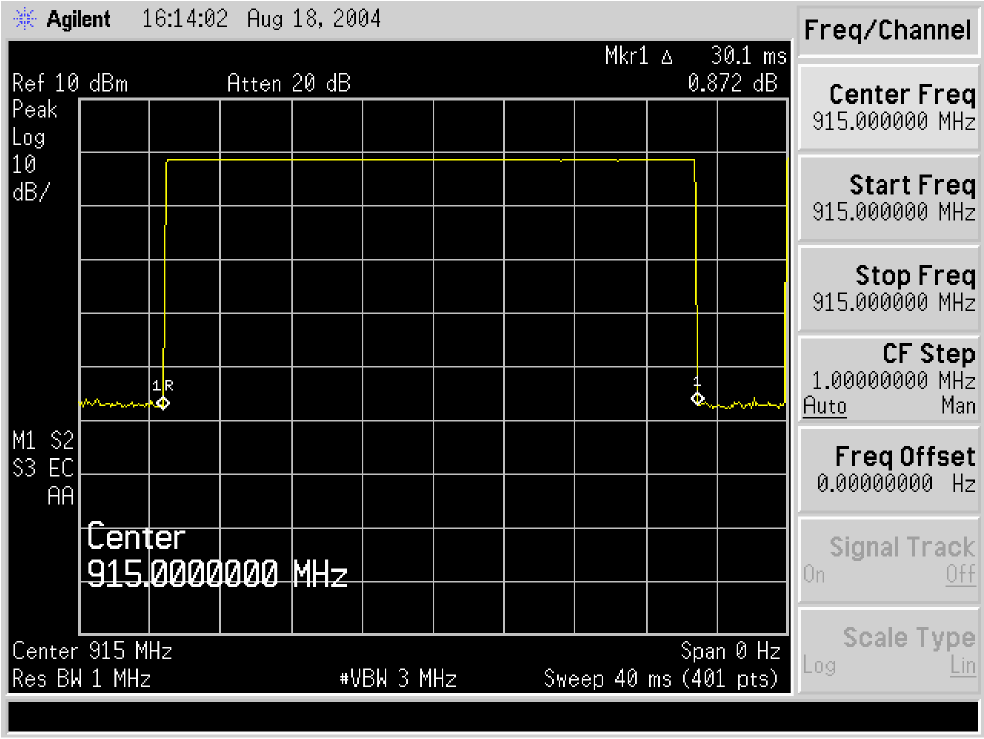

Figure 8 :Dwell time on channel 50

The detector was set to peak and the trace was captured in peak hold. Therefore the measured dwell time per hopping cycle is 30.1ms. To confirm the channel repetition period the sweep was increased to 20s, shown below.

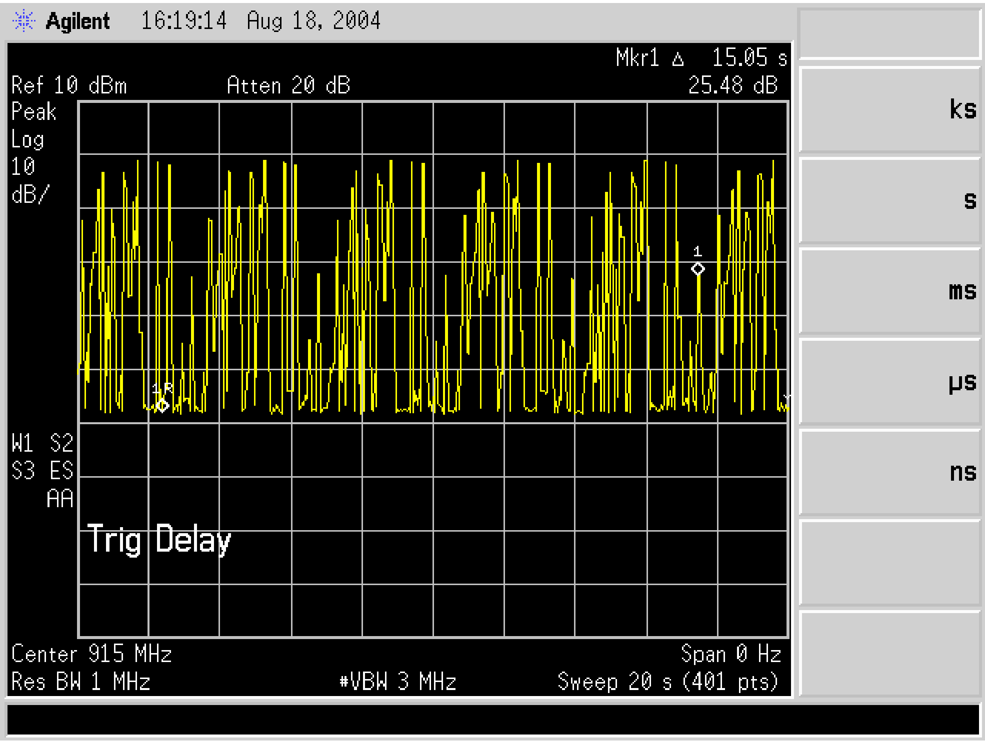

Figure 9 : Sweep increased to 20s to confirm channel repetition period

With the RBW at 1MHz it is very difficult to determine which the on-channel peak is and which are peaks from adjacent channels. Note the following figure showing a spectrum analyser detecting a signal from an Agilent E4437B ESG. A signal as far away as 4MHz is still detected due to the wide RBW.

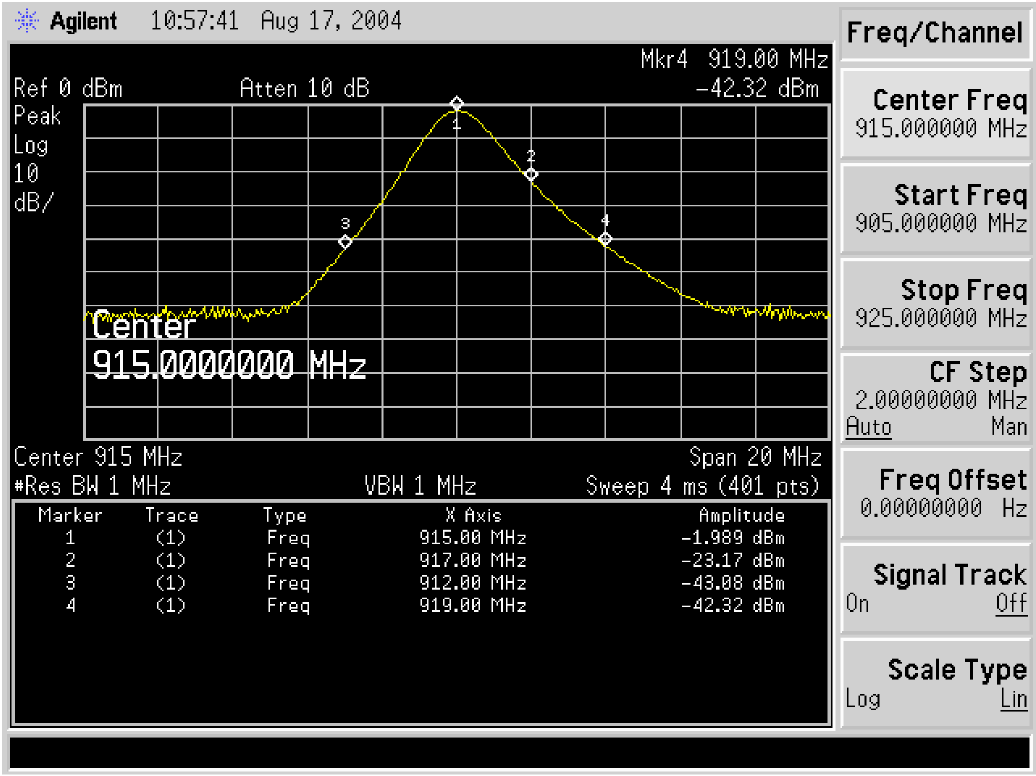

Figure 10 :The 1MHz RBW spectrum analyser detecting a E4437B generated signal

For this reason to confirm the channel repetition period the spectrum analyser RBW was reduced to 10kHz.

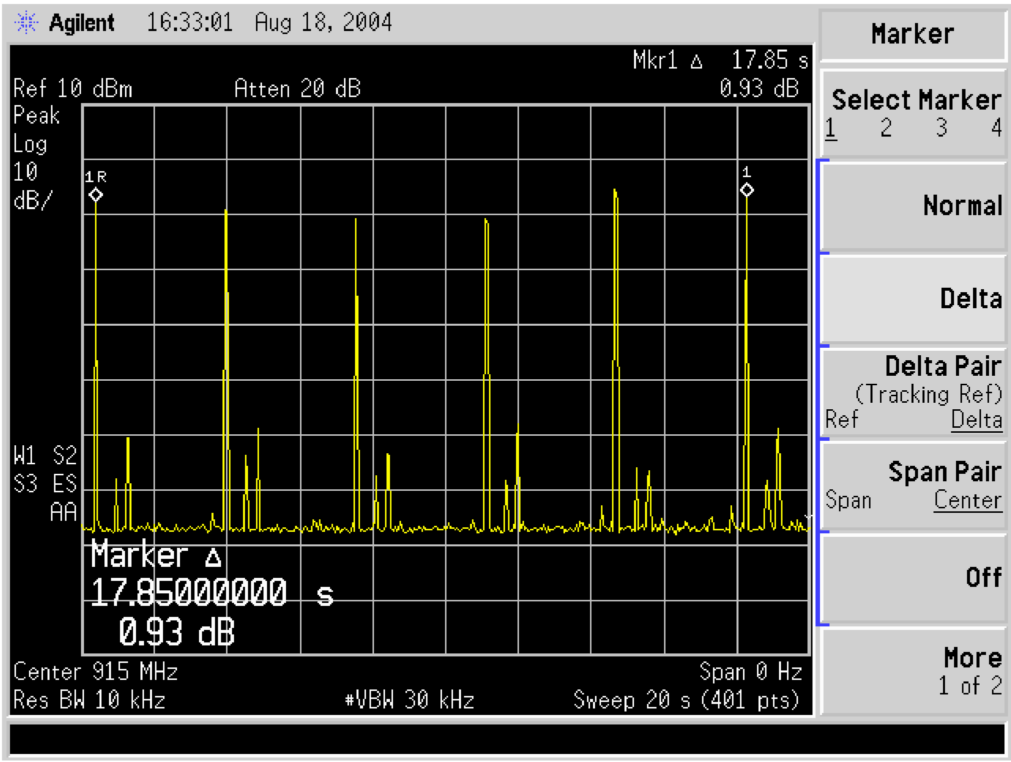

Figure 11 : Sweep increased to 20s to confirm channel repetition period with 10kHz RBW

The above figure shows 5 channel repetitions in 17.85s confirming a channel repetition period of 3.57s. Therefore the maximum TX frame time measured for 20s period is:

Tdwell = 30.1ms*20000ms /3570ms = 168.6ms

This maximum measured dwell time meets the 400ms requirement stated in 15.247(a)(1)(i) [2].

4.11 Channel bandwidth

11. 20dB bandwidth of 255kHz is higher than the declared channel separation of 250kHz. According to 15.247(a)(1), frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20dB bandwidth of the hopping channel, whichever is higher. How does the device comply with this requirement? Please clarify.

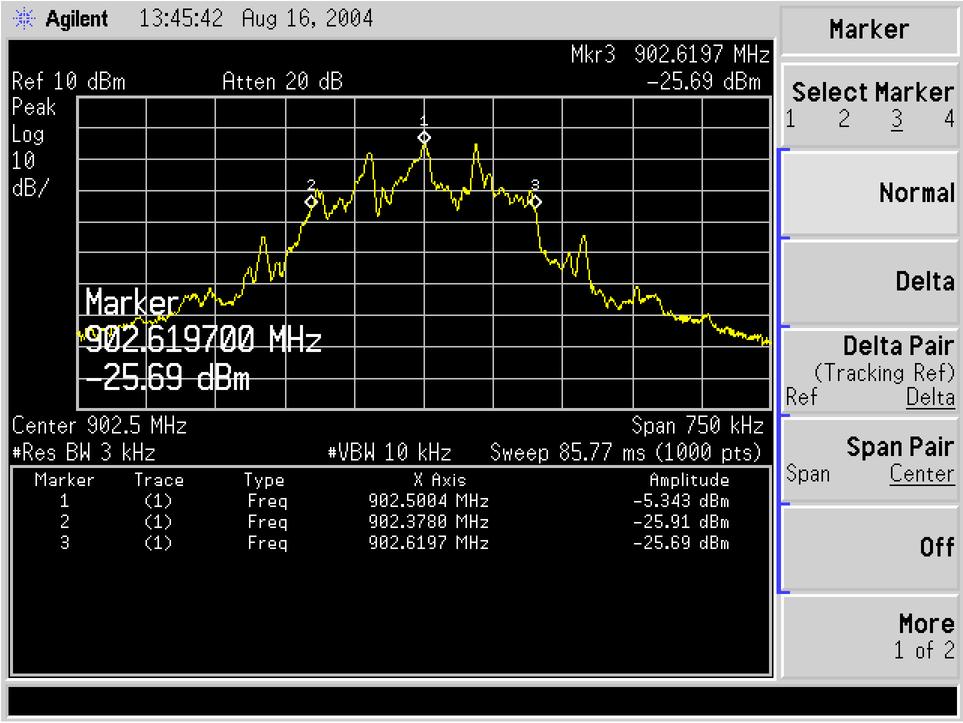

Figure 12 : 20 dBc points for channel 0

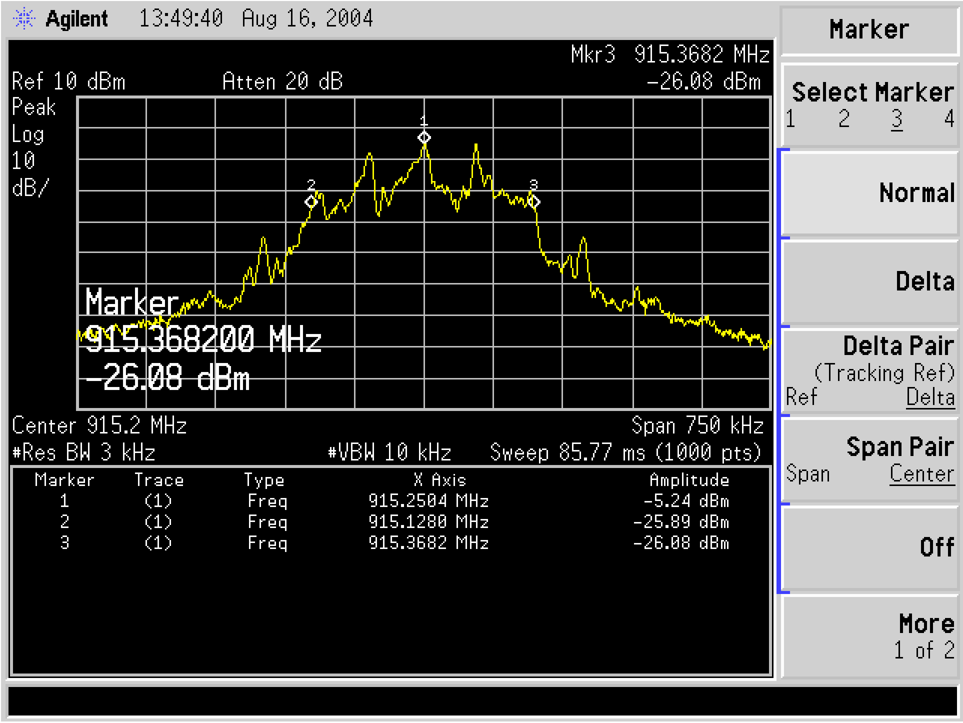

Figure 13 : 20 dBc points for channel 51

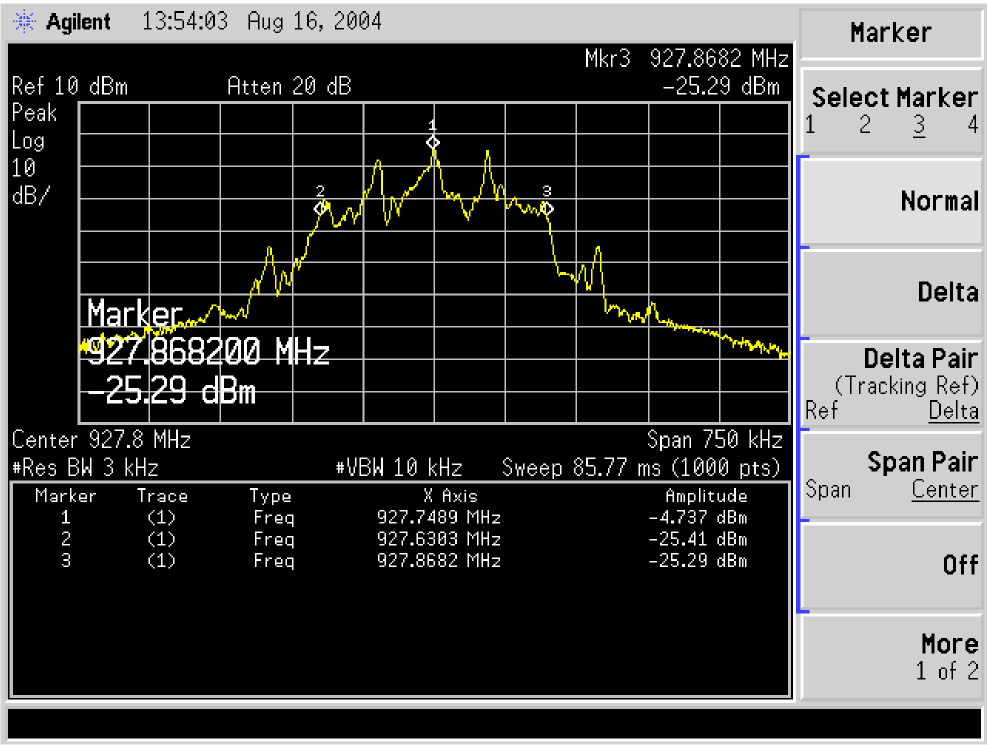

Figure 14 : 20 dBc points for channel 101

Figure 12, Figure 13 and Figure 14 illustrate 20 dB bandwidth measurements for channels 0, 51 and 101.

The span was set to 750 kHz, which is approximately 3 times the 20 dB bandwidth, while the RBW was 3 kHz (required RBW > 1% of 20 dB bandwidth, in this case > 2.4 kHz). The detector was set to peak and the trace was captured in peak hold.

Table 14 below lists the 20 dB bandwidths calculated directly from the screenshots above. Since the channel frequency separation of 251 kHz is greater than the 20 dB bandwidths shown below, the relevant subparagraph in section 15.427(a)(1) is satisfied.

Channel	Frequency (MHz)	20 dB Bandwidth (kHz)
0	902.500	241.7
51	915.250	240.2
101	927.750	237.9

Table 14: 20 dB bandwidths

4.12 Out-of-band conducted emissions

12. Please clarify what was meant with ">-41dBm" for out of band conducted emissions on Pg 20 and 21 of the report.

To be clarified by EMCT.

4.13 Radiated emissions

13. For radiated emissions above 1GHz, have peak levels of the emissions (with 1MHz RBW and VBW) complied with 74dBuV/m limit (20dB above average)? Also the data tables have no readings on them, does this mean no emissions have been recorded? What was the noise floor of the measurement system? Please clarify.

To be clarified by EMCT.

4.14 AC line conducted emissions

14. The radiated emissions test set-up photos does not show the antenna connected to the device as seen in AC line conducted emissions test set-up photo. Was the antenna connected to the board during radiated emissions test? Has the antenna position of the device been varied in all possible orthogonal orientations to maximize the emissions? Please clarify.

To be clarified by EMCT.

4.15 Emissions EIRP

15. Please supply an EIRP reading calculated from the fundamental field strength reading of the emission (on 3 channels). This is needed to verify that the measured EIRP complies with the 36dBm limit and the antenna gain is close to its specifications.

To be clarified by EMCT.

4.16 LISN usage

16. Please confirm that a 50ohm/50uH LISN has been used for AC line conducted emissions test.

To be clarified by EMCT.

5 TRACEABILITY

5.1 Clarifications from the FCC

----- Original Message -----
From: LabHelp
To: carlos.t@rfinnovations.com.au
Sent: Thursday, August 19, 2004 3:18 AM
Subject: RE: FCC Public Notice DA 00-705 (30 Mar 2000): Request for clarification

QUESTION:

We are unclear on the objectives of specifying a set bandwidth (1MHz) for an unknown channel bandwidth. Assuming eg a channel bandwidth of 250KHz, a measurement with this setting will produce "leakage" of other channels into the selected measurement channel (the middle channel). As a result of that and depending on what sweep time you choose, you will get "blurred" images, with hopefully a peak on the chosen channel. You are not guaranteed to visit that channel during the sweep time, unless you make it sufficiently long. If you do, you will get the mentioned "blurring " effect.

ANSWER:

You may lower the RBW from 1 MHz as needed to obtain a clear dwell time plot. The 1 MHz RBW referenced is the maximum recommended for this test.

----- Original Message -----
From: Carlos Tomaz
To: labhelp@fcc.gov
Cc: Carlos.Tomaz@rfinnovations.com.au ; Richard Wilkins
Sent: Wednesday, August 18, 2004 12:37 PM
Subject: FCC Public Notice DA 00-705 (30 Mar 2000): Request for clarification

TO:
The Office of Engineering and Technology Laboratory
Federal Communications Commission
7435 Oakland Mills Rd
Columbia MD 21046-1609
Phone: +1-301-362-3000
Fax: +1-301-344-2050
E-mail: labhelp@fcc.gov

From:
Carlos M. Tomaz
Engineering Manager, RF Innovations Pty Ltd

RE: Request for clarification on DA 00-705, "Filing and Measurement Guidelines for Frequency-Hopping Spread Spectrum Systems"

Perth, 18 Aug 2004

Dear Sir/Madam,

I refer to the above document, section "Time of Occupancy (Dwell Time)".

The method proposed by the FCC in this section suggests a resolution bandwidth (RBW) of 1MHz.

We are unclear on the objectives of specifying a set bandwidth (1MHz) for an unknown channel bandwidth. Assuming eg a channel bandwidth of 250KHz, a measurement with this setting will produce "leakage" of other channels into the selected measurement channel (the middle channel). As a result of that and depending on what sweep time you choose, you will get "blurred" images, with hopefully a peak on the chosen channel. You are not guaranteed to visit that channel during the sweep time, unless you make it sufficiently long. If you do, you will get the mentioned "blurring " effect.

I have attached an illustration screen shot for your perusal. In this case, the nominal channel separation is 250KHz and the nominal 20dB channel bandwidth is also 250KHz.

Your clarification on this matter would be much appreciated. We are undergoing FCC type approval of our equipment and this very issue has come up.

Best regards,
Carlos M. Tomaz

Carlos M. Tomaz
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