

Global EMC Inc. Labs

EMC & RF Test Report

As per
FCC Part 90 Subpart M:2014
&

RSS-137 Issue 2:2009

Location and Monitoring Service (LMS)
Operation in the 902 – 928 MHz Band

on the

JANUS Multi-Protocol RF Module-Smart



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Testing produced for

kapsch >>>

See Appendix A for full customer & EUT details.





Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

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Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Report Scope

This report addresses the EMC verification testing and test results of Kapsch TrafficCom Canada Inc's JANUS Multi-Protocol RF Module-Smart (MRFM-S), model 802295 herein referred to as EUT (Equipment Under Test) performed at Global EMC Labs. The EUT is a standard rack mount unit.

The EUT was tested for compliance against the following standards:


FCC Part 90 Subpart M:2014
RSS-137 Issue 2:2009

Test procedures, results, justifications, and engineering considerations, if any, follow later in this report.

The results contained in this report relate only to the item(s) tested.

This report does not imply product endorsement by A2LA or any other accreditation agency, any government, or Global EMC Inc.


Opinions/interpretations expressed in this report, if any, are outside the scope of Global EMC Inc accreditation. Any opinions expressed do not necessarily reflect the opinions of Global EMC Inc, unless otherwise stated.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Summary

The results contained in this report relate only to the item(s) tested.

EUT FCC Certification #, FCC ID:	JQU802295A
EUT Industry Canada Certification #, IC:	2665A-802295A
EUT Passed all tests performed.	Yes (see test results summary)
Tests conducted by	Min Xie


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Test Results Summary

Standard/Method	Description	Class/Limit	Result
FCC 90.205 RSS-137 Clause 6.4	Output Power	30 W	Pass
FCC 90.207 RSS-137 Clause 6.2	Types of Modulation	--	Pass See Justifications
FCC 90.209 RSS-137 Clause 6.1.2	Occupied Bandwidth	902 - 904 MHz: 2 MHz 909.75 - 921.75 MHz 12 MHz	Pass
FCC 90.210 (K) RSS-137 Clause 6.5.3	Spurious antenna port conducted emissions	$55 + 10 \log_{10} P_{max}$ dB.	Pass
FCC 90.210 RSS-137 Clause 6.5.3	Spurious radiated emissions	$55 + 10 \log_{10} P_{max}$ dB.	Pass
FCC 90.213 RSS-137 Clause 6.3	Frequency stability	2.5 ppm	Pass
FCC 90.214	Transient Behavior	--	N/A See Justifications
Overall Result			PASS

All tests were performed by Min Xie.

If the product as tested or otherwise complies with the specification, the EUT is deemed to comply with the requirement and is deemed a 'PASS' grade. If not 'FAIL' grade will be issued. Note that 'PASS' / 'FAIL' grade is independent of any measurement uncertainties. A 'PASS' / 'FAIL' grade within measurement uncertainty is marked with a '*'.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Justifications, Descriptions, or Deviations

The following justifications for tests not performed or deviations from the above listed specifications apply:

The EUT supports the following 6 protocols: KTDM, ATA, SeGo, 6B, 6C and Allegro

1. Kapsch Time Division Multiplex (TDM), hereafter referred to as the “KTDM” protocol
2. Allegro
3. Super eGo® (SeGo)
4. ISO-18000-6C a.k.a. EPC Class 1 Gen 2, hereafter referred to as the “6C” protocol
5. ISO-10374 a.k.a. American Association of Railroads (AAR) S-918, a.k.a. American Trucking Association (ATA), hereafter referred to as the “ATA” protocol
6. ISO-18000-6B, hereafter referred to as the “6B” protocol

The EUT only transmits a CW signal in ATA mode and the other five protocols uses Shaped ON-OFF Keying to transmit information. According to FCC 90.207, the EUT have two types of emission:

1. NON for ATA
2. K1D for the other five protocols

For FCC 90.214, the EUT operates in the 902-928 MHz band, and this requirement is not applicable.

For the requirements of FCC 90.210 (K) and FCC 2.1053 Measurements required: Field strength of spurious radiation. Spurious radiated emissions of the EUT was performed at 3 meters. The limit specified in FCC 90.210 (K) is $55 + 10 \log(P)$ dBc. For all intensive purpose, the limit is -25 dBm. The field strength limit for the EUT is give in the below:


$$E(\text{dB}\mu\text{V/m}) = \text{ERIP}(\text{dBm}) + 95.2$$

$$\text{Where EIRP} = \text{ERP} + 2.15$$

$$E(\text{dB}\mu\text{V/m}) = \text{ERP}(\text{dBm}) + 97.35$$

$$E(\text{dB}\mu\text{V/m}) = -25 \text{ dBm} + 97.35 = 72.35 \text{ dBuV}$$

This limit is applicable all emission at 3 meter measurement distance.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Applicable Standards, Specifications and Methods

ANSI C63.4:2009 - Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.10:2009 - American national standard for testing unlicensed wireless devices

ANSI/TIA-603-C-2004 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

CFR 47 FCC Part 2 Subpart J –
Code of Federal Regulations – Equipment Authorization Procedure


CFR 47 FCC Part 90 Code of Federal Regulations – Private Land Mobile Radio Services

FCC KDB 412172 D01 Determining ERP and EIRP v01

ISO 17025:2005 General Requirements for the competence of testing and calibration laboratories

RSS-GEN:2010 Issue 3: General Requirements and Information for the Certification of Radio Apparatus

RSS 137:2009 Issue 2: Spectrum Management and Telecommunications. Radio Standards Specification, Location and Monitoring Service in the Band 902-928 MHz.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Sample calculation(s)

Margin = limit – (received signal + antenna factor + cable loss – pre-amp gain)

Margin = 50.5dBuV/m – (50dBuV + 10dB + 2.5dB – 20dB)

Margin = 8.5 dB


Reference Offset = Attenuator + Cable Loss

Reference Offset = 10 dB + 0.4 dB

Reference Offset = 10.4 dB

Document Revision Status

Revision 1 - May 1, 2014
Initial release

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Definitions and Acronyms

The following definitions and acronyms are applicable in this report.
See also ANSI C63.14.

AE – Auxillary Equipment.

BW – Bandwidth. Unless otherwise stated, this refers to the 6 dB bandwidth.

EMC – Electro-Magnetic Compatibility

EMI – Electro-Magnetic Immunity


EUT – Equipment Under Test

ITE – Information Technology Equipment with a primary function(s) of entry, storage, display, retrieval, transmission, processing, switching, or control, of data.

LISN – Line impedance stabilization network

NCR – No Calibration Required

RF – Radio Frequency


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Testing Facility

Testing for EMC on the EUT was carried out at Global EMC labs in 11 Gordon Collins, Gormley, Ontario, Canada. The testing lab consists of a 3m semi-anechoic chamber calibrated to be able to allow measurements on an EUT with a maximum width or length of up to 2m and height up to 3m. The chamber is equipped with a turn table that is capable of testing devices up to 3300lb in weight. This facility is capable of testing products that are rated for 120 Vac and 240Vac single phase, or 208 Vac 3 phase input. DC capability is also available. The chamber is equipped with an antenna mast that controls polarization and height from the control room adjoining the shielded chamber. Radiated emissions measurements are performed using a Bilog, and Horn antenna where applicable. Conducted emissions, unless otherwise stated, are performed using a LISN.

Calibrations and Accreditations


The 3m semi-anechoic chamber is registered with Federal Communications Commission (FCC, 377448), Industry Canada (IC, 6844A-3) and VCCI (R-4023, G-506, T-1246, and C-4498). This semi-anechoic chamber complies with the requirements of EN55016-2-3:2006, section 7.5 and the site attenuation requirements of EN55016-1-4. This chamber was additionally calibrated for Normalized Site Attenuation (NSA) using test procedures outlined in ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz”. The chamber is lined with ferrite tiles and absorption cones to minimize any undesired reflections. The NSA data is kept on file at Global EMC. For radiated susceptibility testing, a 16 point field calibration has been performed on the chamber. The field uniformity data is kept on file at Global EMC. Global EMC Inc is accredited to ISO 17025 by A2LA with Testing Certificate #2555.01. The laboratories current scope of accreditation listing can be found as listed on the A2LA website. All measuring equipment is calibrated on an annual or bi-annual basis as listed for each respective test.

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Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Testing Environmental Conditions and Dates

Following were the environmental conditions in the facility during time of testing –

Date	Test	Init.	Temperature (°C)	Humidity (%)	Pressure (kPa)
April 28-30, 2014	All	MX	20-24°C	35 - 41%	96 -102kPa

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Detailed Test Results Section

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Output Power and Antenna Heights

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element does not exceed the limits specified.

Limits

The limits are defined in FCC Part 90.205 (l) and RSS 137 Clause 6.4 as per the following paragraph:

902-928 MHz. LMS systems operating pursuant to subpart M of this part in the 902-927.25 MHz band will be authorized a maximum of 30 watts ERP. LMS equipment operating in the 927.25-928 MHz band will be authorized a maximum of 300 watts ERP. ERP must be measured as peak envelope power. Antenna heights will be as specified in §90.353(h).

Test procedure is as per eCFR 47 Part 2 Clause 2.1046.

Results


The EUT passed.

The EUT supports the following 6 protocols: KTDM, ATA, SeGo, 6B, 6C and Allegro. Each protocol have its own frequency channels and frequency ranges. Where a protocol have more than one channel, the Low, middle and high channels were measured. The table below gives the results for each protocol.

The ATA and 6C protocols operate in both sub-bands allocated for non-multilateral LMS transmitters. Output power for both sub-bands were measured.

Antenna selection varies by application. RF cable loss and fixed attenuations (added inline or manually set inside the unit under control of a commanding reader) is used to compensate for antenna gain so that the ERP is 30 watts or less. See page Tuning Procedure for further details.

Guidance for antenna height requirement and restrictions on setting module power to meet ERP are given in User Manual.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Table(s)

6B			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Low Channel	911	33.66	2.32
Mid Channel	915	33.69	2.34
High Channel	920.5	33.73	2.36

6C – 902 – 904 MHz Sub-Band			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Channel	903	33.68	2.33


6C – 909.75 to 921.75 MHz Sub-Band			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Low Channel	910.5	33.66	2.32
Mid Channel	915	33.68	2.33
High Channel	920.5	33.68	2.33

Allegro			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Channel	915.75	33.74	2.37

KTDM			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Channel (Modulated)	915.75	33.47	2.22

SeGO			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Low Channel	911.5	33.60	2.29
Mid Channel	915	33.68	2.33
High Channel	919.5	33.85	2.43


ATA – 902 – 904 MHz Sub-Band			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Low Channel	902.5	33.61	2.30
Mid Channel	903	33.63	2.31
High Channel	903.5	33.57	2.28

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

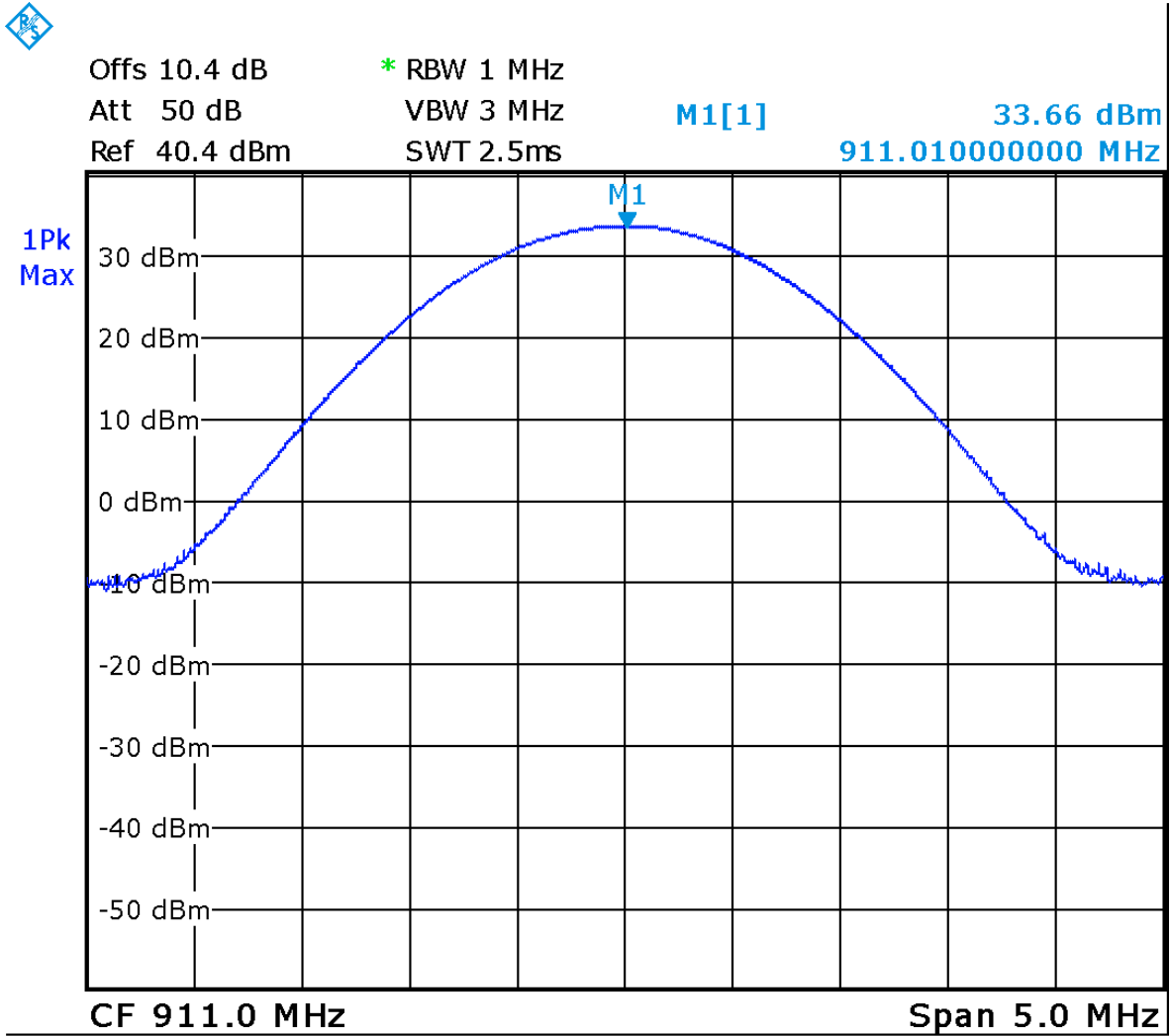
ATA – 909.75 – 921.75 MHz Sub-Band			
Channel	Frequency (MHz)	Power (dBm)	Power (W)
Low Channel	910	33.54	2.26
Mid Channel	915	33.63	2.31
High Channel	921.5	33.6	2.29

Graph(s)


The graphs below shows the Peak Power during the operation of the device. Measurements were performed using a spectrum analyzer with a Peak detector of 1 MHz RBW / 3 MHz VBW. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

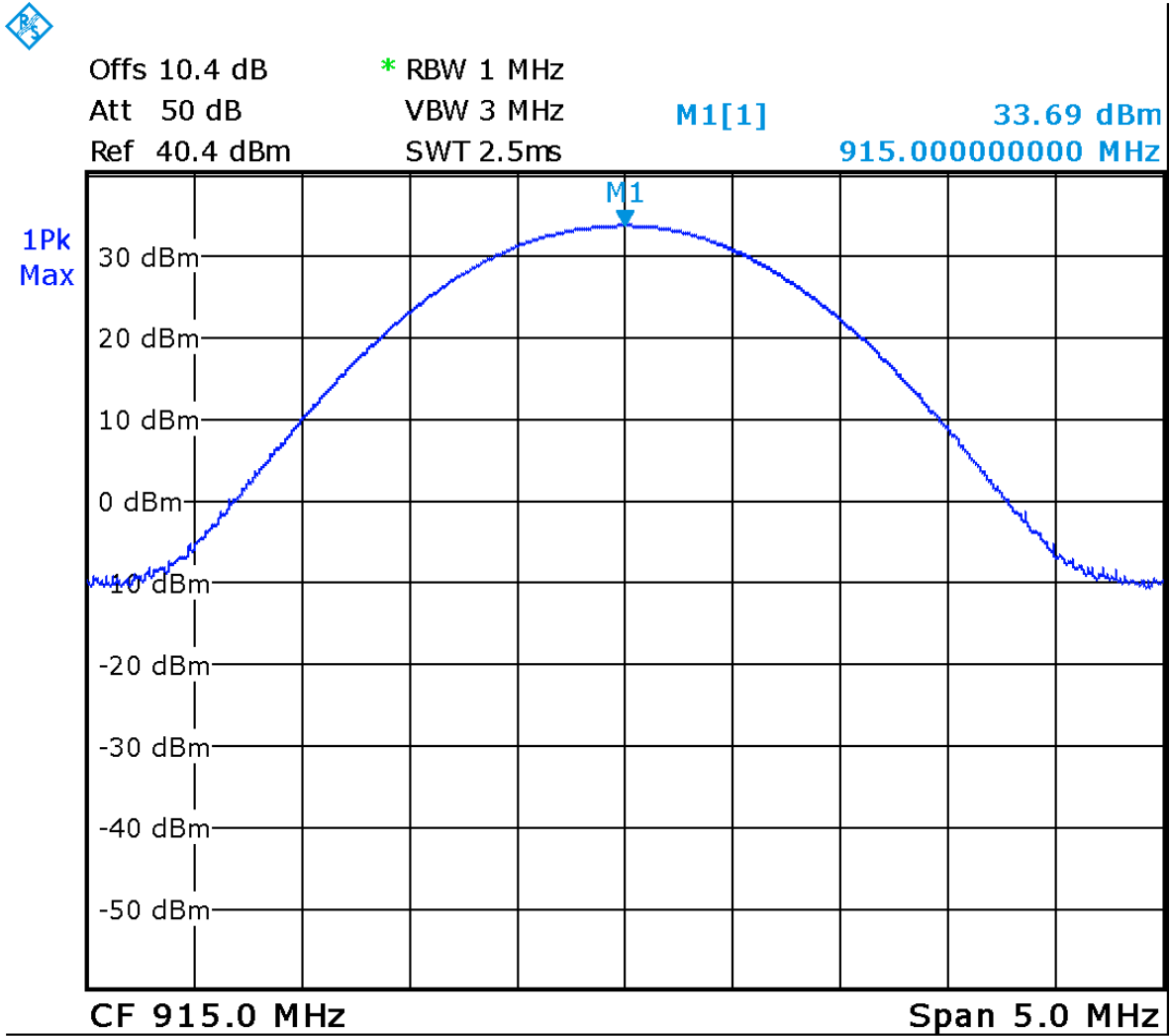
Protocol: 6B
Low Channel




Date: 29.APR.2014 12:22:49

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: 6B
Mid Channel



Date: 29.APR.2014 12:23:44

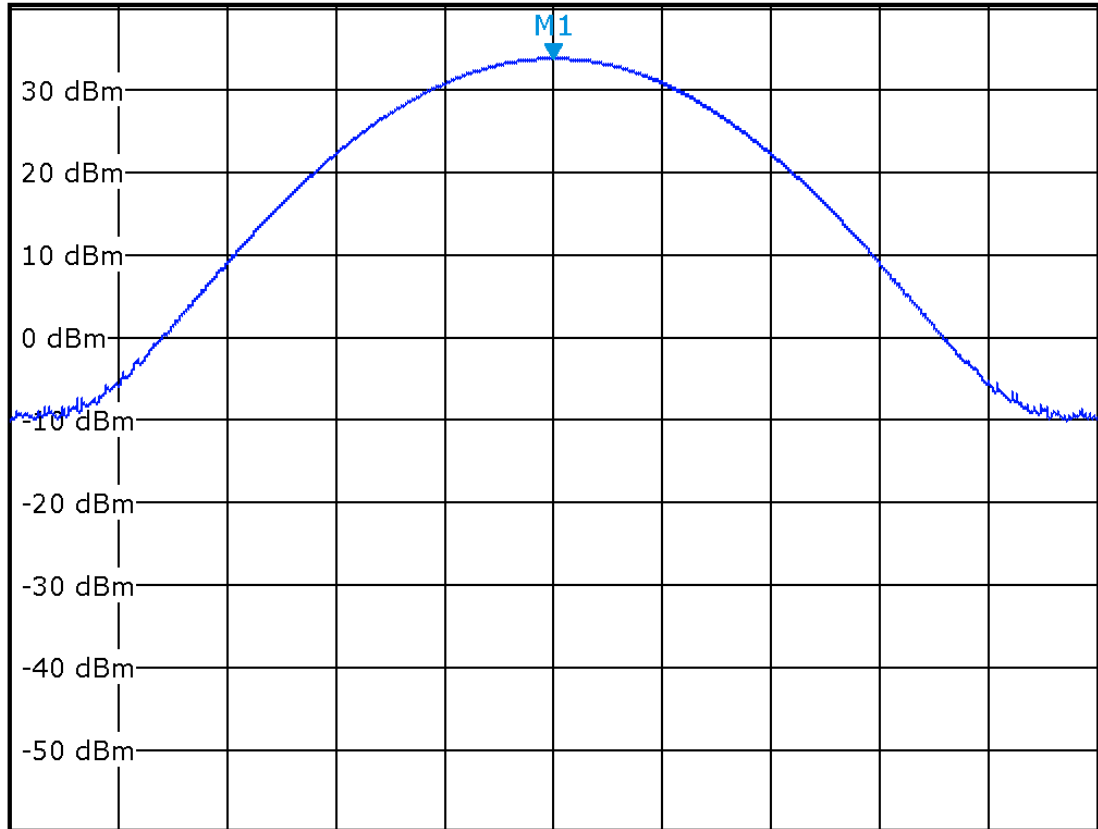
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: 6B
High Channel



Offs 10.4 dB * RBW 1 MHz
 Att 50 dB VBW 3 MHz **M1[1]** **33.73 dBm**
 Ref 40.4 dBm SWT 2.5ms **920.50000000 MHz**


1Pk
Max



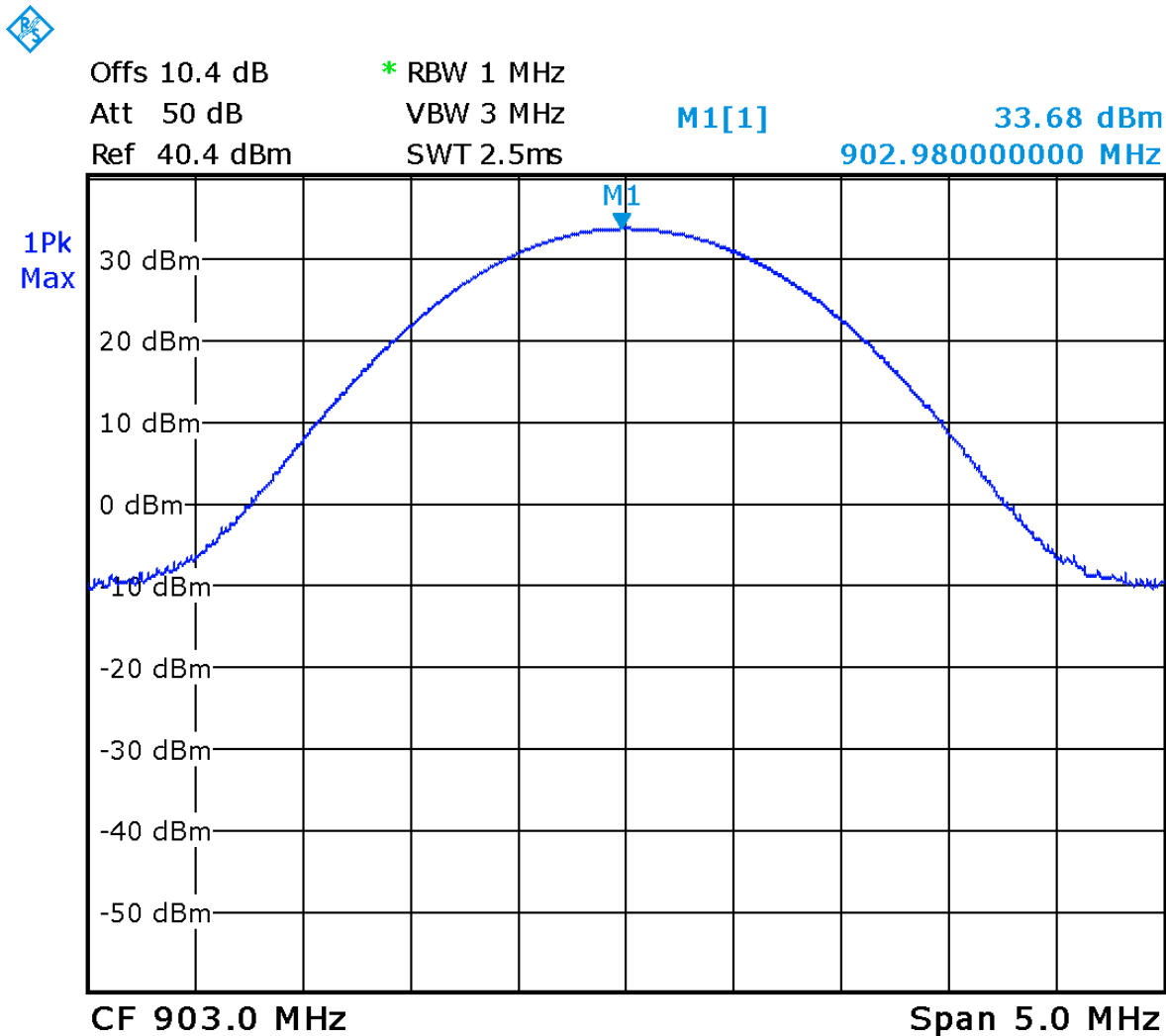
CF 920.5 MHz

Span 5.0 MHz


Date: 29.APR.2014 12:31:27

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

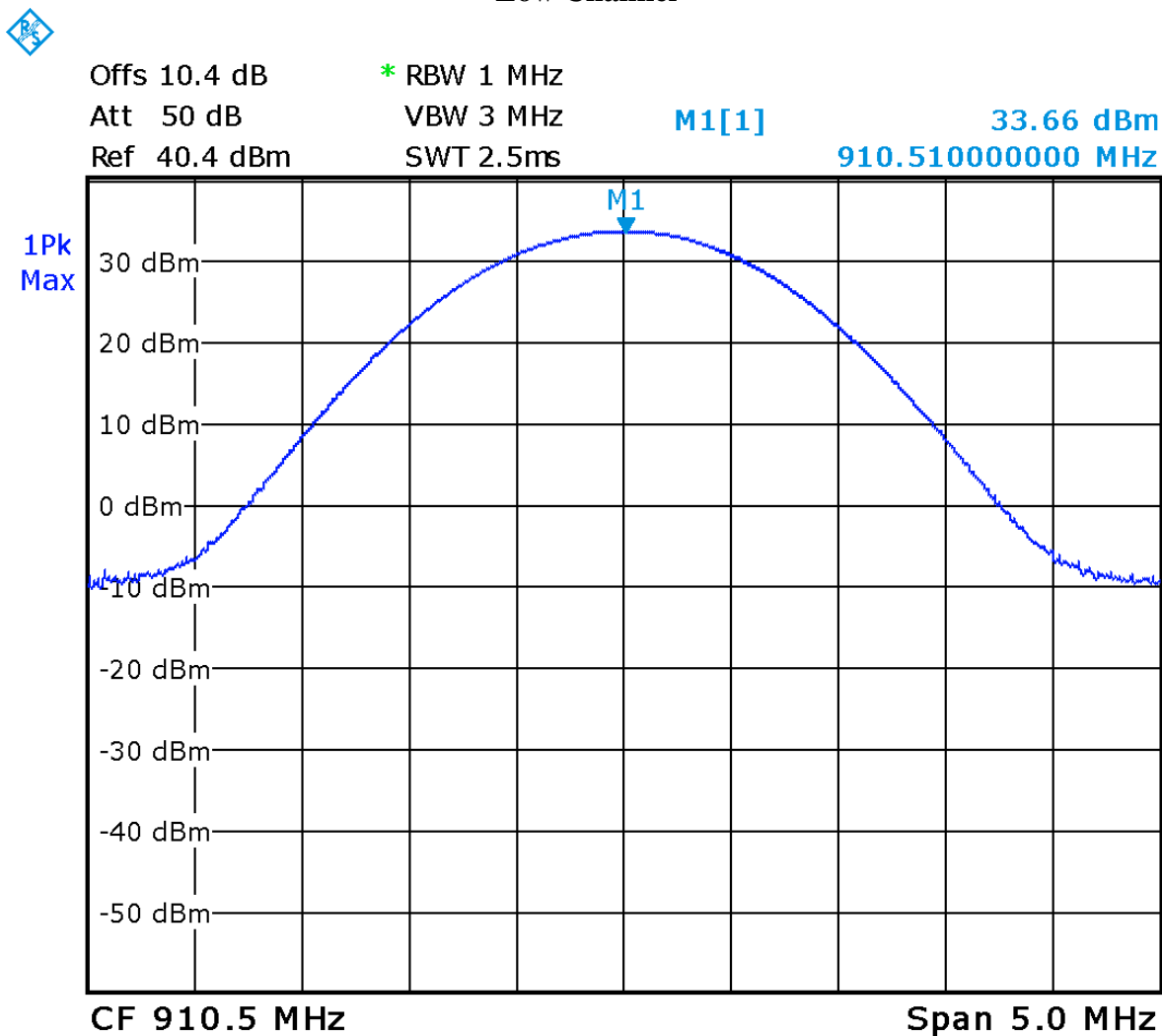
Protocol: 6C: 902 – 904 MHz Sub-Band




Date: 29.APR.2014 12:35:52

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

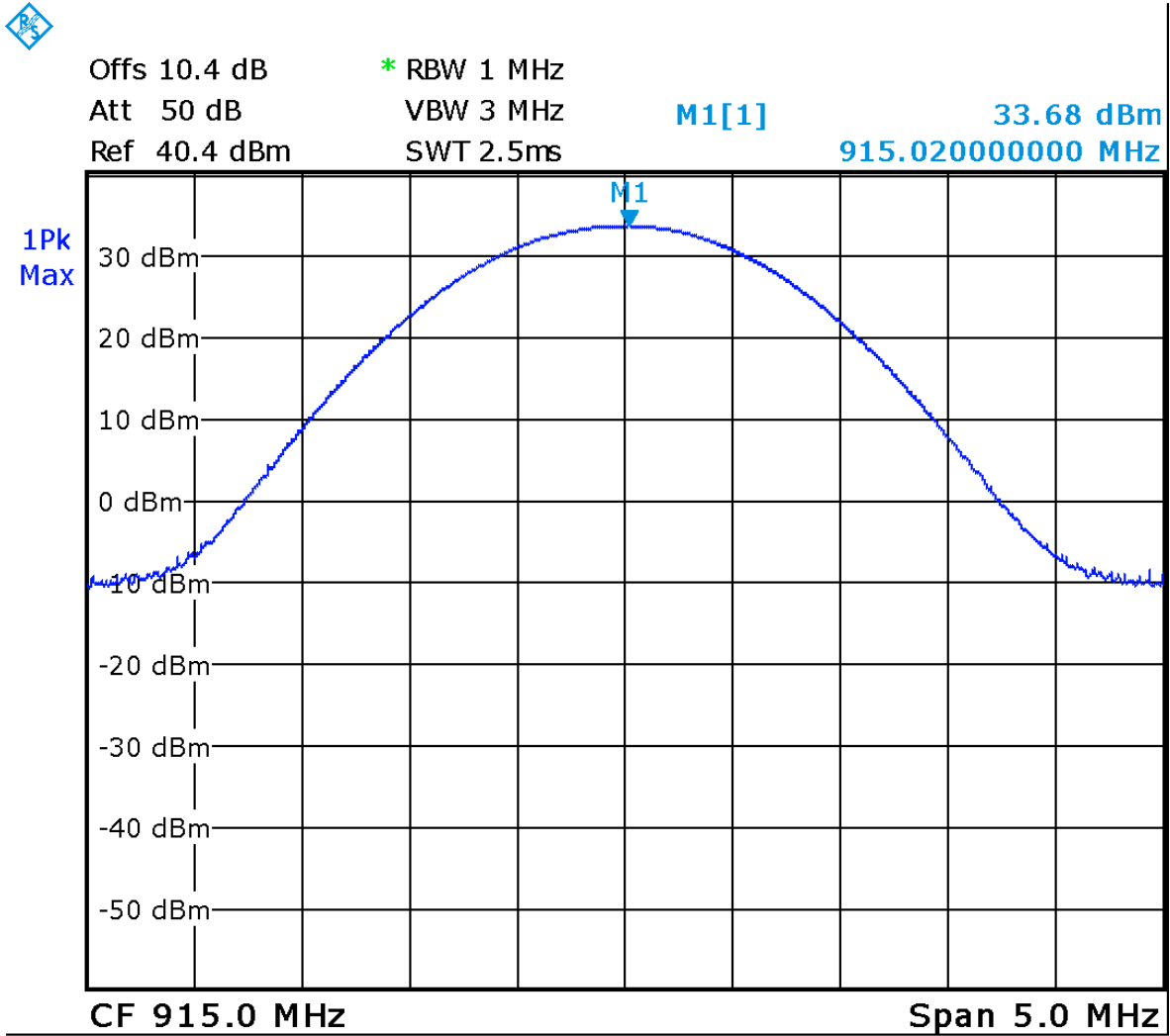
Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
Low Channel




Date: 29.APR.2014 18:20:42

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

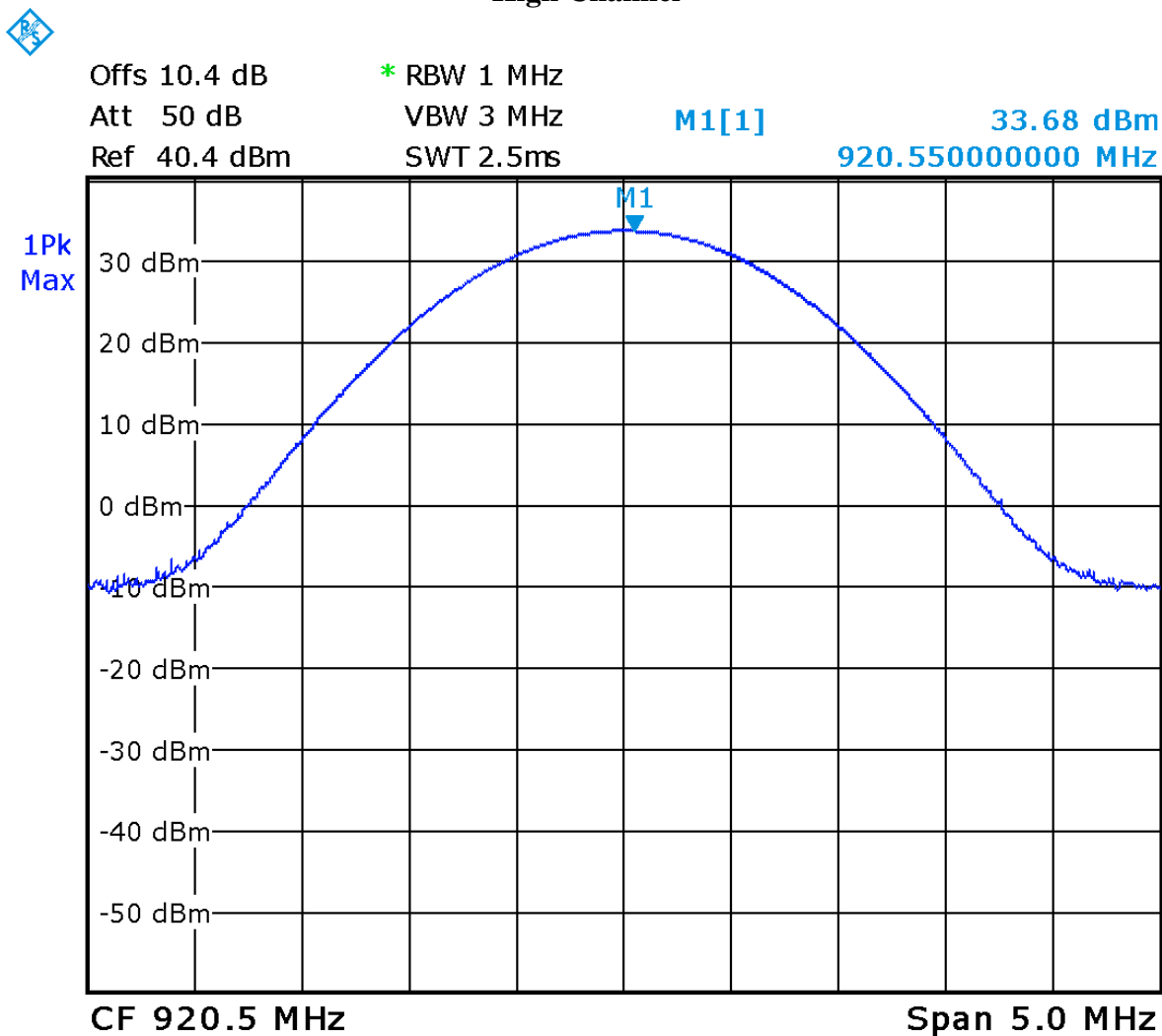
**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
Mid Channel**




Date: 29.APR.2014 12:45:46

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
High Channel**



Date: 29.APR.2014 12:52:11

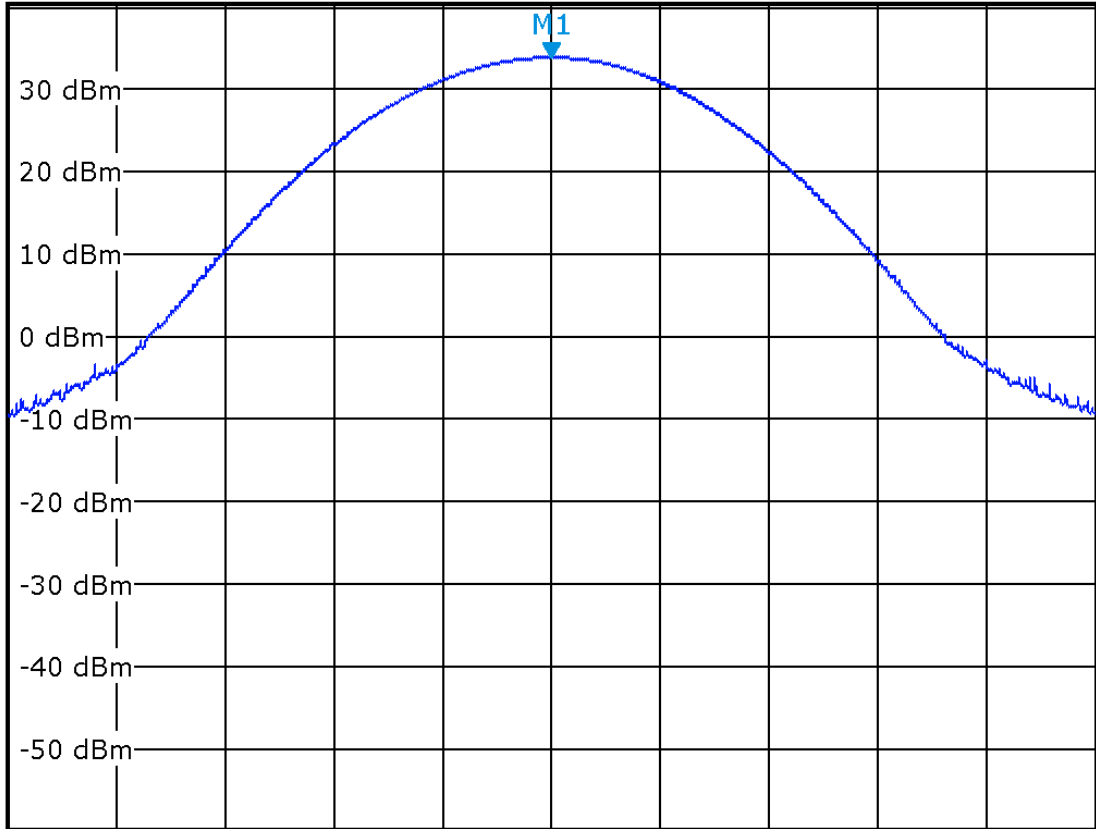
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: Allegro



Offs 10.4 dB * RBW 1 MHz
 Att 50 dB VBW 3 MHz **M1[1]** **33.74 dBm**
 Ref 40.4 dBm SWT 2.5ms **915.75000000 MHz**


1Pk
Max



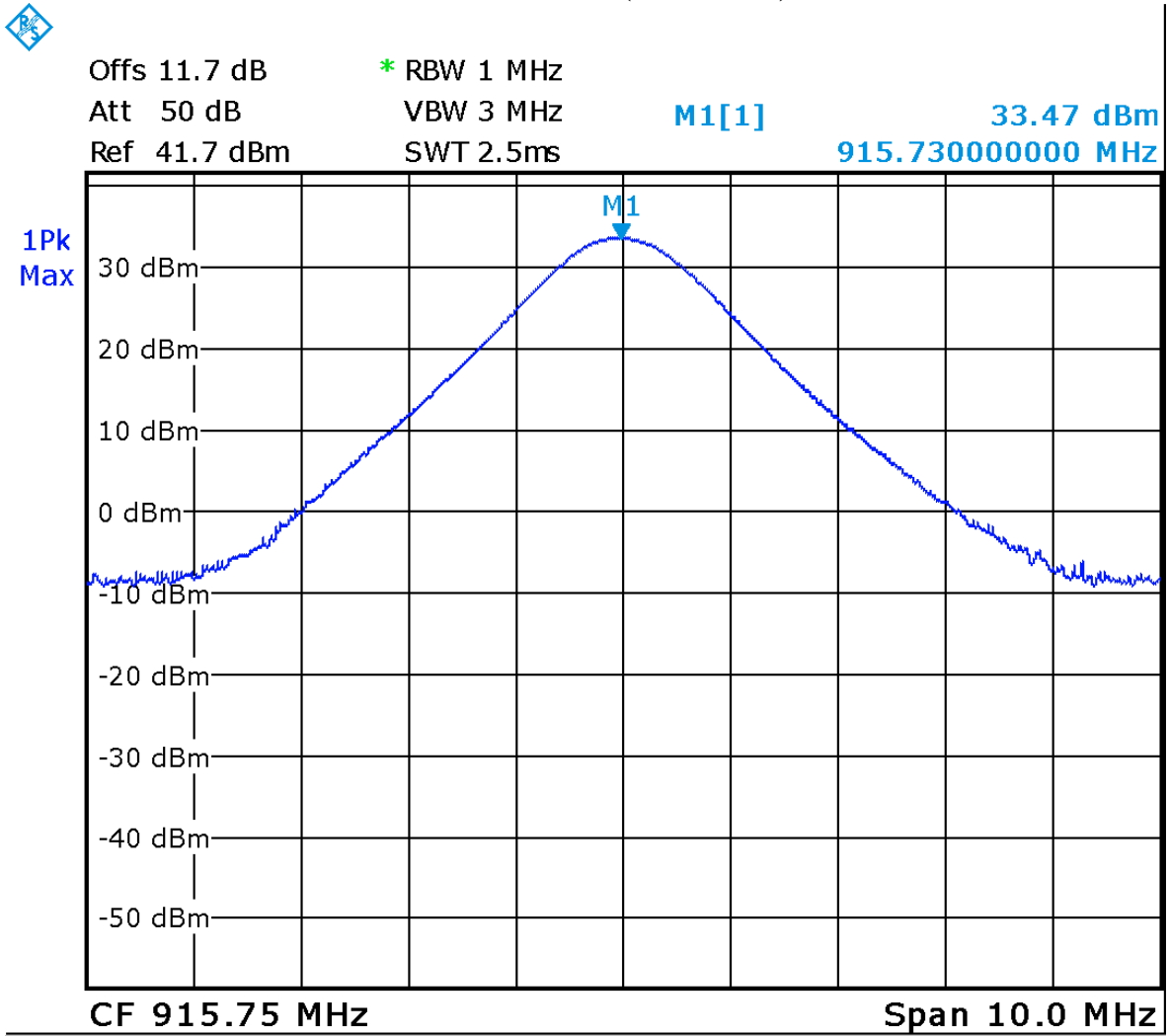
CF 915.75 MHz

Span 5.0 MHz


Date: 29.APR.2014 13:05:51

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: KTDM (Modulated)



Date: 29.APR.2014 14:33:36

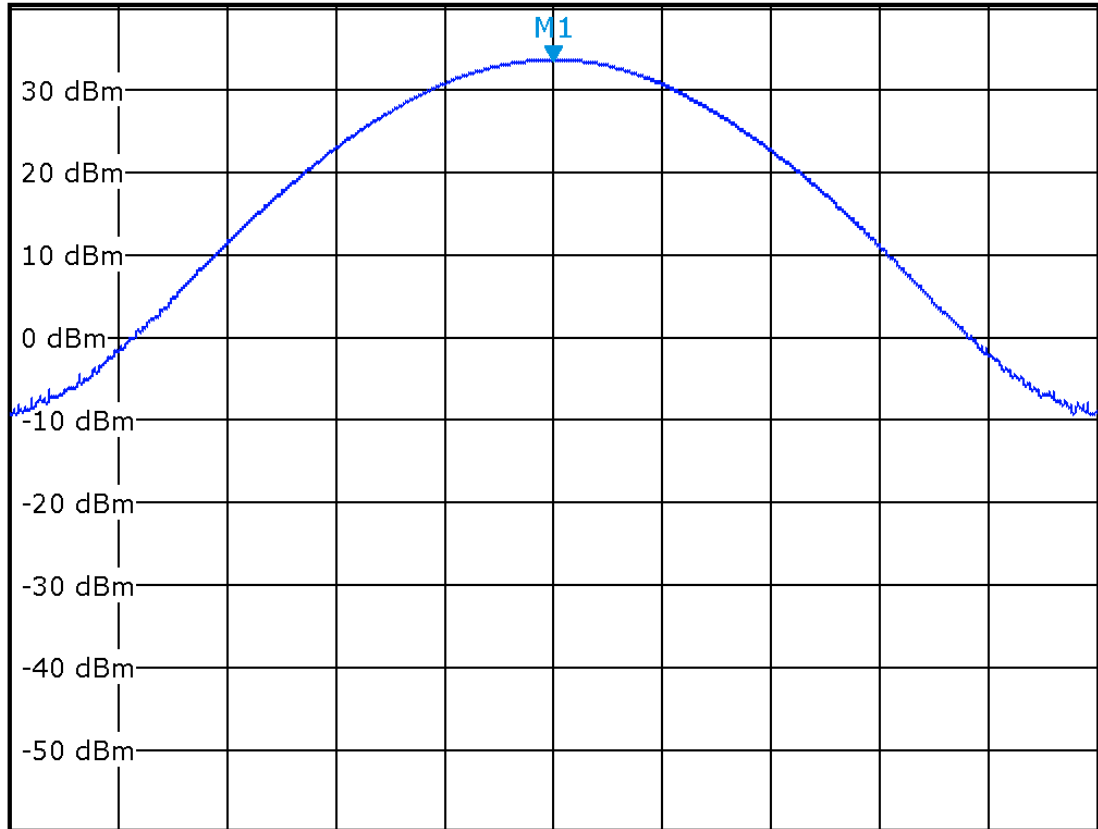
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: SeGO
Low Channel



Offs 10.4 dB * RBW 1 MHz
 Att 50 dB VBW 3 MHz **M1[1]** **33.60 dBm**
 Ref 40.4 dBm SWT 2.5ms **911.50000000 MHz**


1Pk
Max



CF 911.5 MHz

Span 5.0 MHz

Date: 29.APR.2014 12:07:56

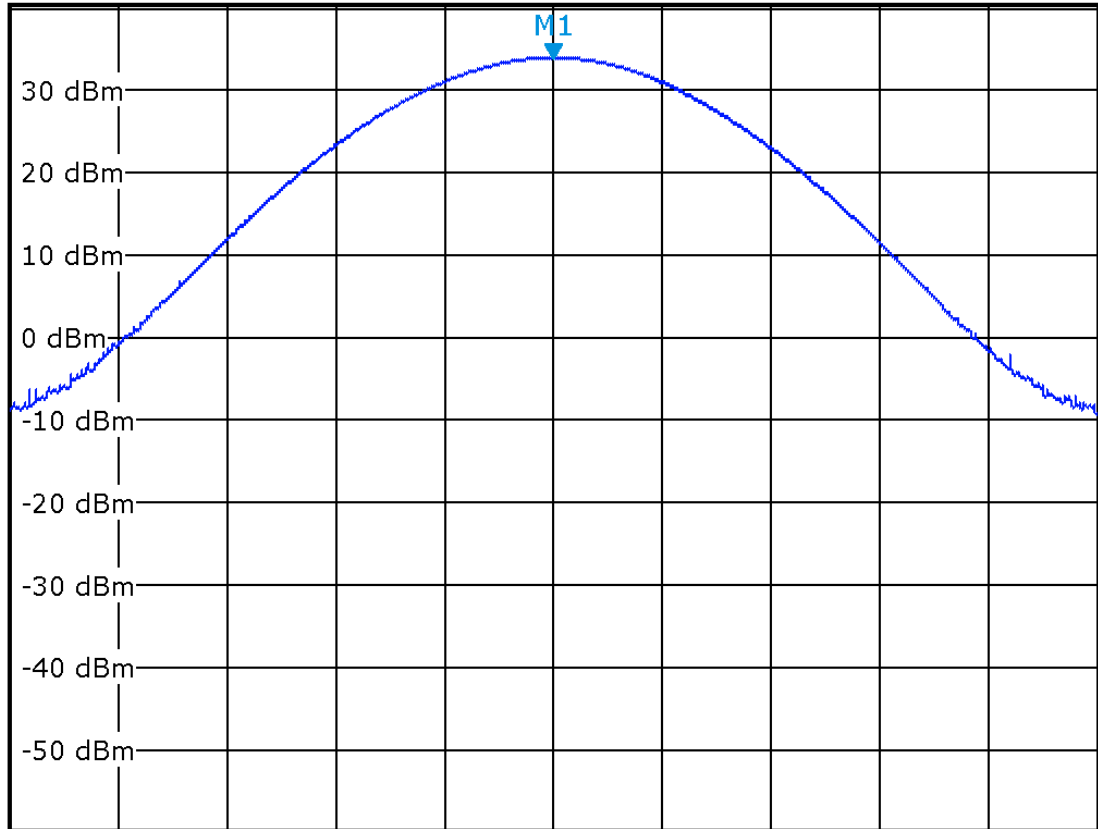
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: SeGO
Hi Channel**



Offs 10.4 dB * RBW 1 MHz
 Att 50 dB VBW 3 MHz **M1[1]** **33.85 dBm**
 Ref 40.4 dBm SWT 2.5ms **919.50000000 MHz**


**1Pk
Max**



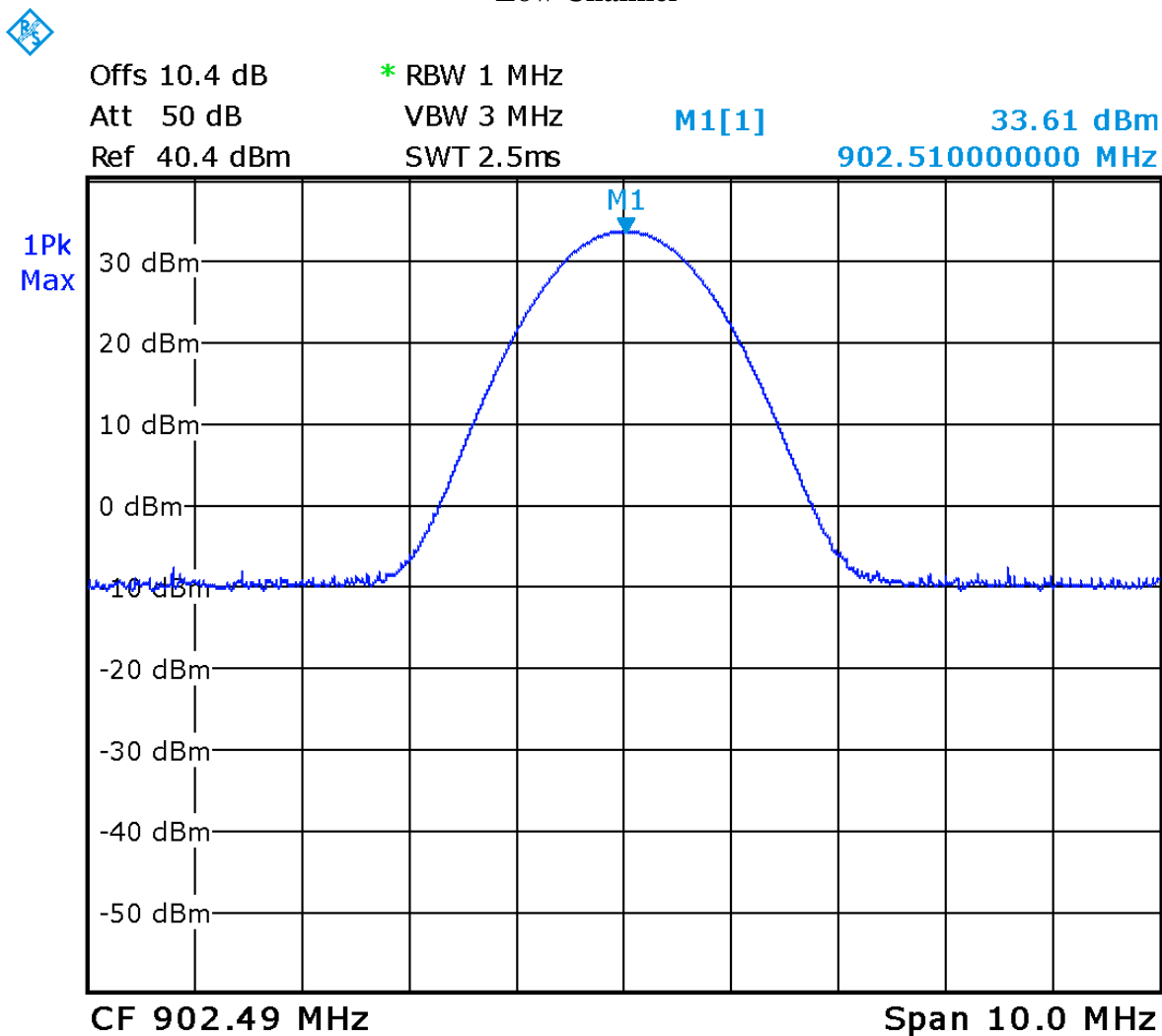
CF 919.5 MHz

Span 5.0 MHz


Date: 29.APR.2014 17:40:25

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

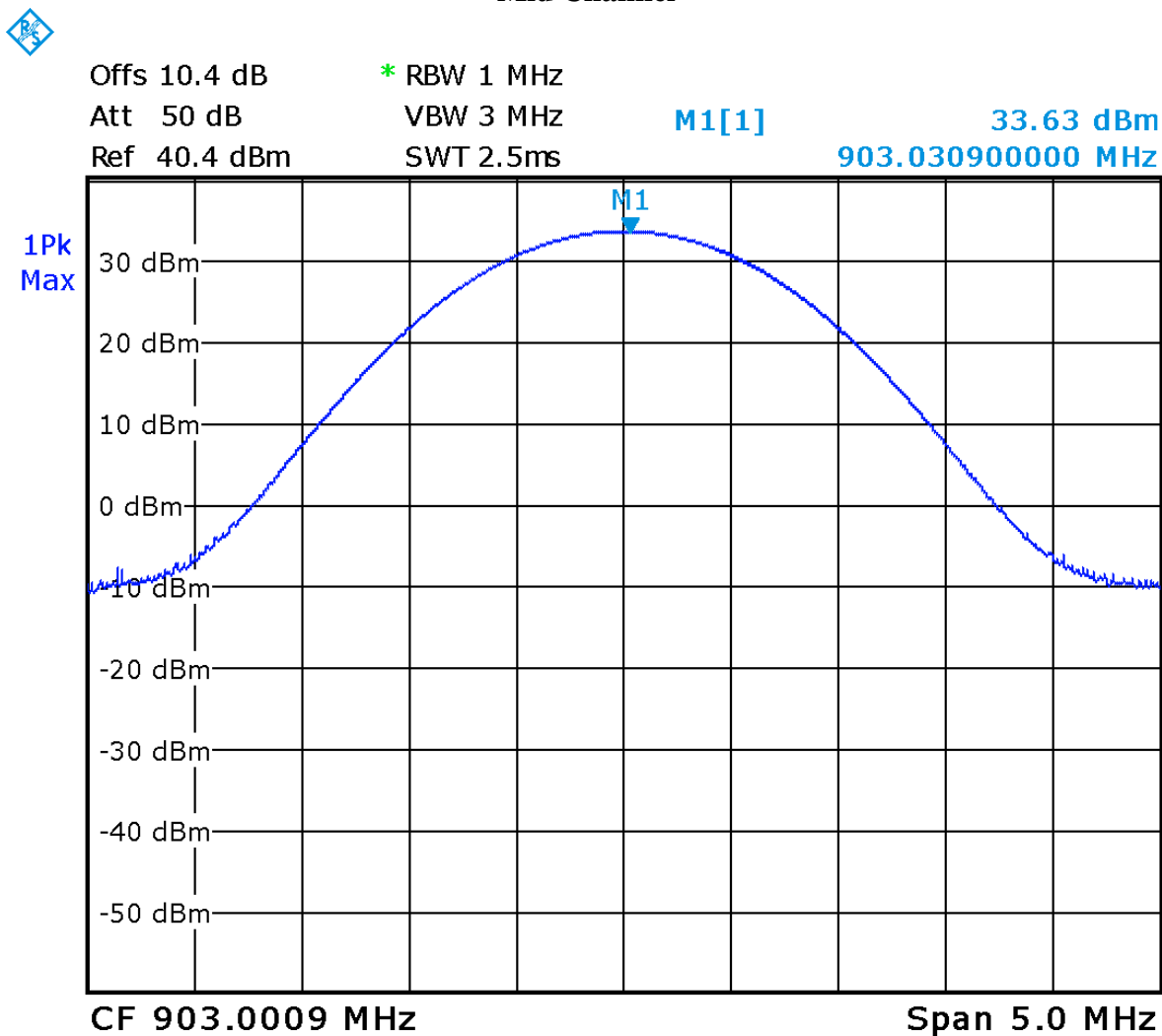
**Protocol: ATA – 902 – 904 MHz Sub-Band
Low Channel**




Date: 29.APR.2014 11:26:53

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

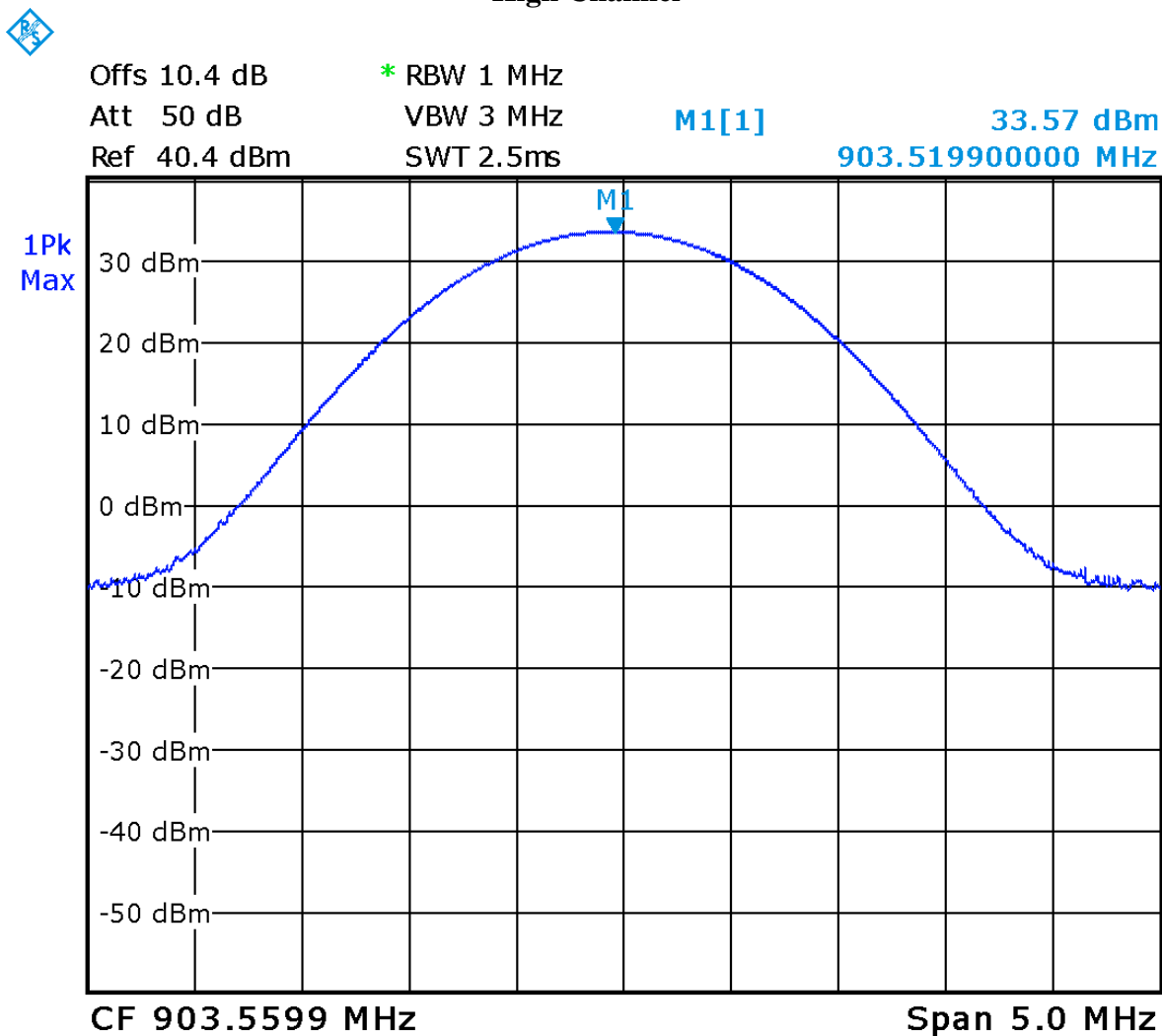
**Protocol: ATA – 902 – 904 MHz Sub-Band
Mid Channel**




Date: 29.APR.2014 11:39:01

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

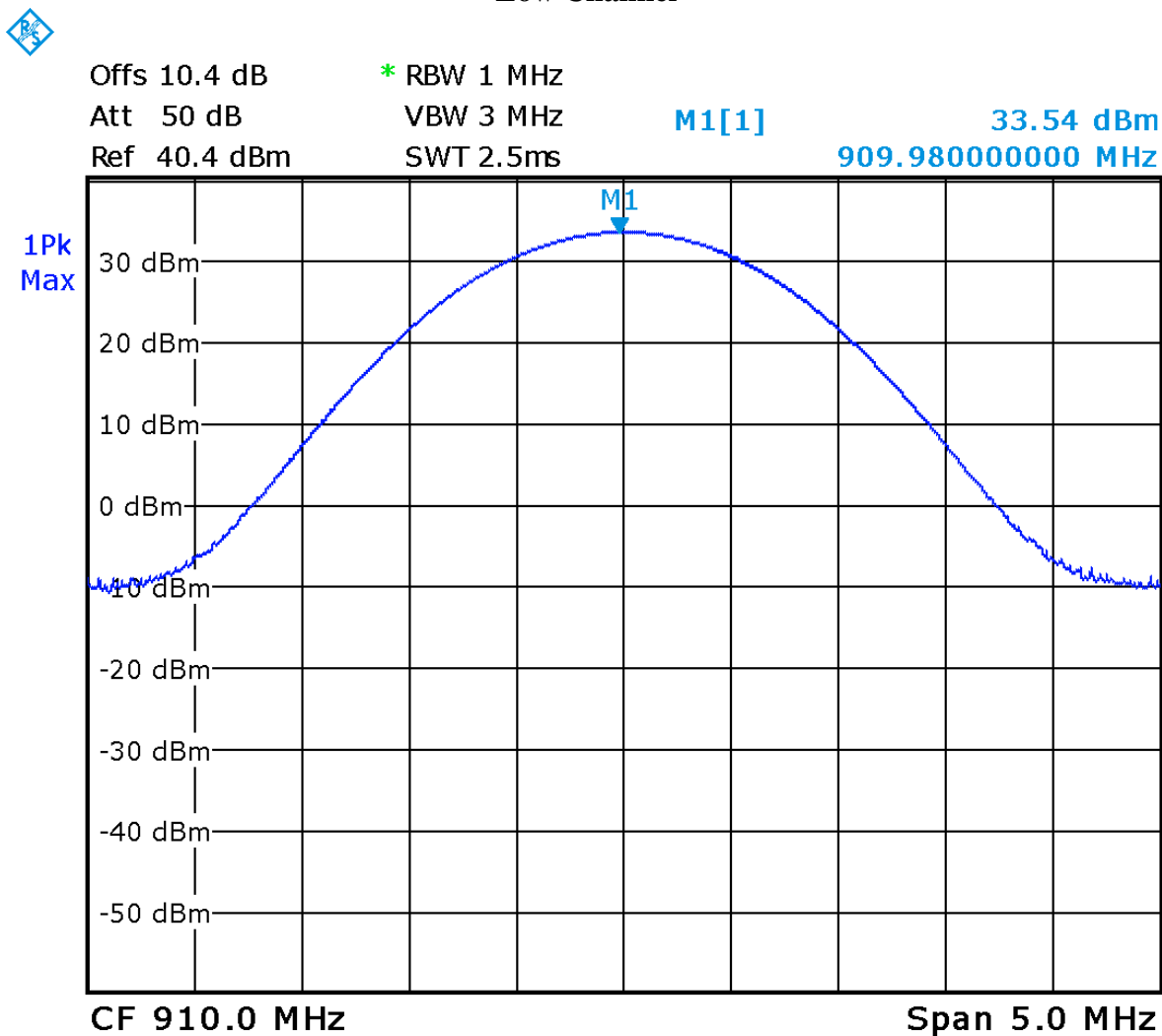
**Protocol: ATA – 902 – 904 MHz Sub-Band
High Channel**




Date: 29.APR.2014 11:40:37

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

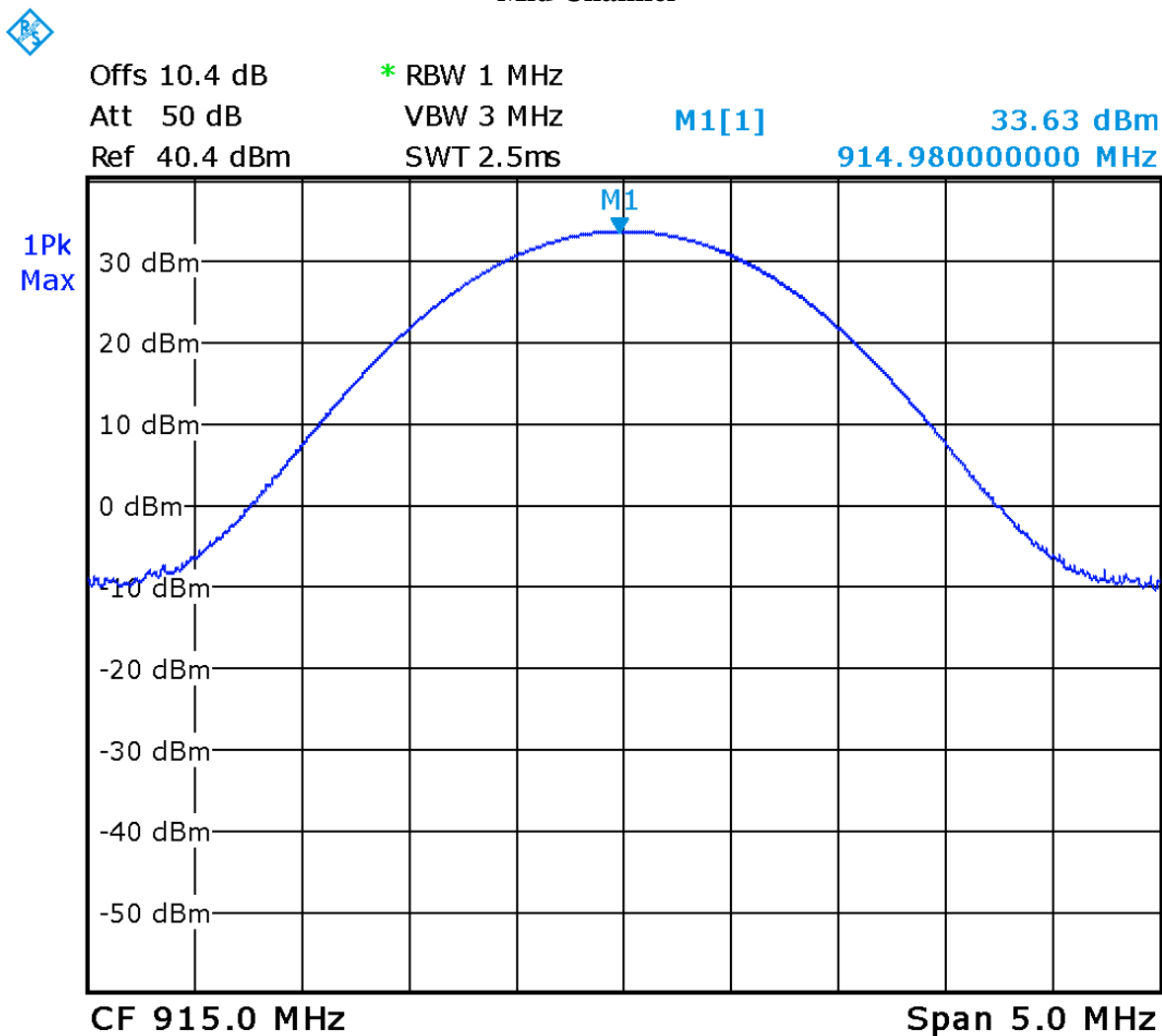
**Protocol: ATA – 909.75 – 921.75 MHz Sub-Band
Low Channel**



Date: 29.APR.2014 11:50:31


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: ATA -909.75 – 921.75 MHz Sub-Band
Mid Channel**




Date: 29.APR.2014 11:53:14

Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	15-Nov-2013	15-Nov-2015	GEMC 160
Inmet Med. Power 10dB Attenuator	12N-10	Inmet	NCR	NCR	GEMC6405
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

Client	Kapsch TrafficCom Canada Inc	
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Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Occupied Bandwidth

Purpose

The purpose of this test is to ensure that the bandwidth occupied exceeds a stated minimum. This helps ensure the utilization of the frequency allocation is sufficiently wide. This also helps prevent corruption of data by ensuring adequate data separation to distinguish the reception of the intended information.

Limits

The Limit is as specified in FCC Part 90.209 and RSS-137 Clause 6.1.2.

The maximum authorized bandwidth shall be 12 MHz for non-multilateration LMS operations in the band 909.75-921.75 MHz and 2 MHz in the band 902.00-904.00 MHz. The maximum authorized bandwidth for multilateration LMS operations shall be 5.75 MHz in the 904.00-909.75 MHz band; 2 MHz in the 919.5-921.75 MHz band; 5.75 MHz in the 921.75-927.25 MHz band and its associated 927.25-927.50 MHz narrowband forward link; and 8.00 MHz if the 919.75-921.75 MHz and 921.75-927.25 MHz bands and their associated 927.25-927.50 MHz and 927.50-927.75 MHz narrowband forward links are aggregated.


Test procedure is as per eCFR 47 Part 2 Clause 2.1049.

Results

The EUT passed.

Each of the 6 supported protocol was tested. Where a protocol have more than one channel, the Low, middle and high channels were measured. The table below gives the results for each protocol.

The ATA protocol operates in both non- multilateration LMS sub-bands and the other 5 protocols operate in the 909.75 – 921.75 MHz sub-band.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Tables

6B		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	911.0	471.06
Mid Channel	915.0	479.04
High Channel	919.5	499.00

6C – 902 – 904 MHz Sub-Band		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Channel	903	465.07


6C – 909.75 – 921.75 Sub-Band		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	910.5	455.08
Mid Channel	915.0	475.05
High Channel	920.5	453.09

Allegro		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Channel	915.75	762.48

KTDM		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Channel	915.75	1656.7

SeGO		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	911.5	634.73
Mid Channel	915.0	634.73
High Channel	919.5	678.64


ATA – 902 – 904 MHz Sub-Band		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	902.5	230.54
Mid Channel	903.0	230.53
High Channel	903.5	230.54

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

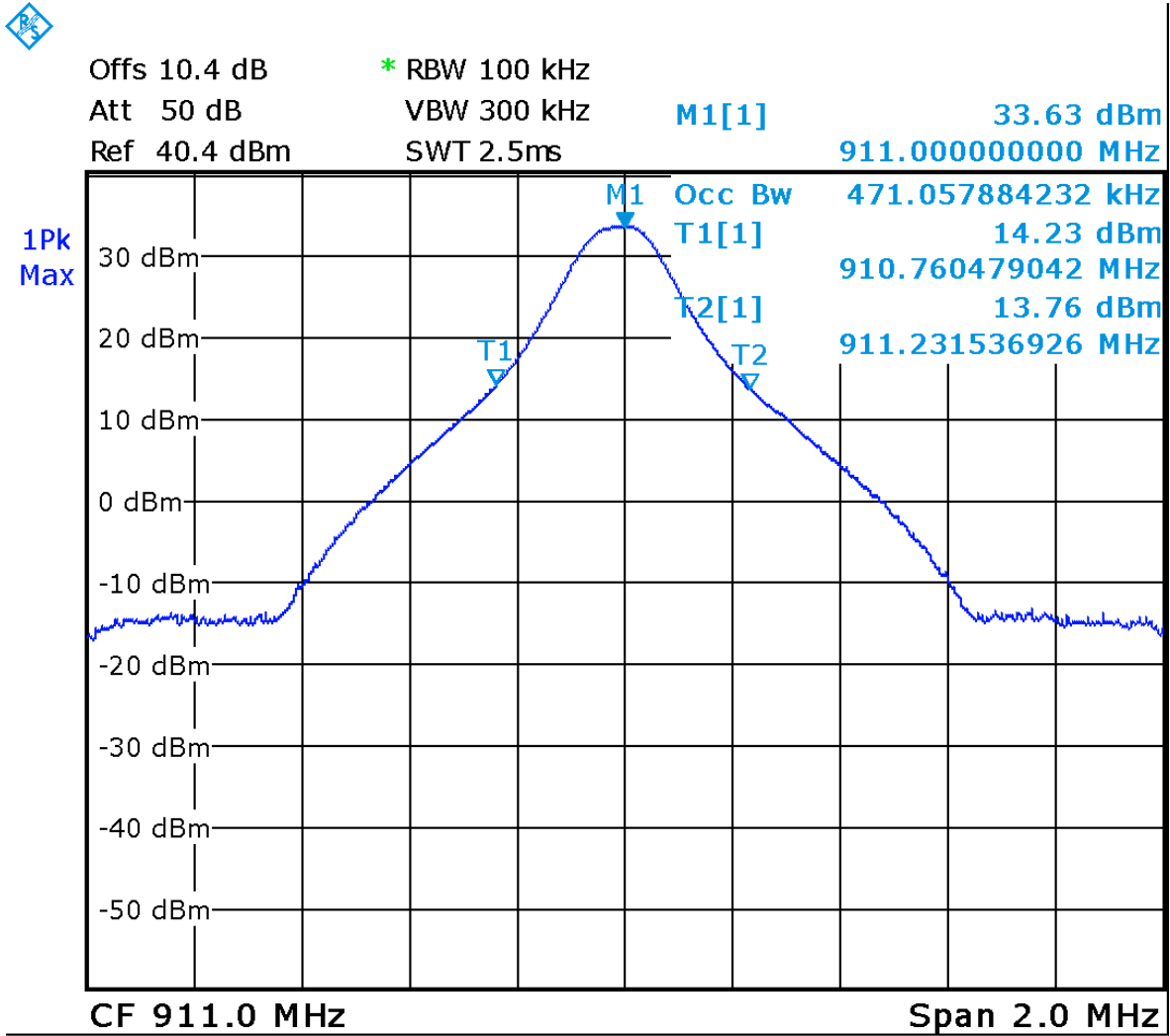
ATA – 909.75 – 921.75 MHz Sub-Band		
Channel	Frequency (MHz)	99% Bandwidth (kHz)
Low Channel	910.0	231.54
Mid Channel	915.0	247.50
High Channel	921.5	231.54

Graph(s)


The graphs showed below shows the OBW during the operation of the device. This is measured by a max hold on the spectrum analyzer and the highest resolution bandwidth that is sufficiently low to exhibit the 20 dB bandwidth of a channel during operation of the EUT. This measurement is a peak measurement. Max hold is performed for a duration of not less than 1 minute.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

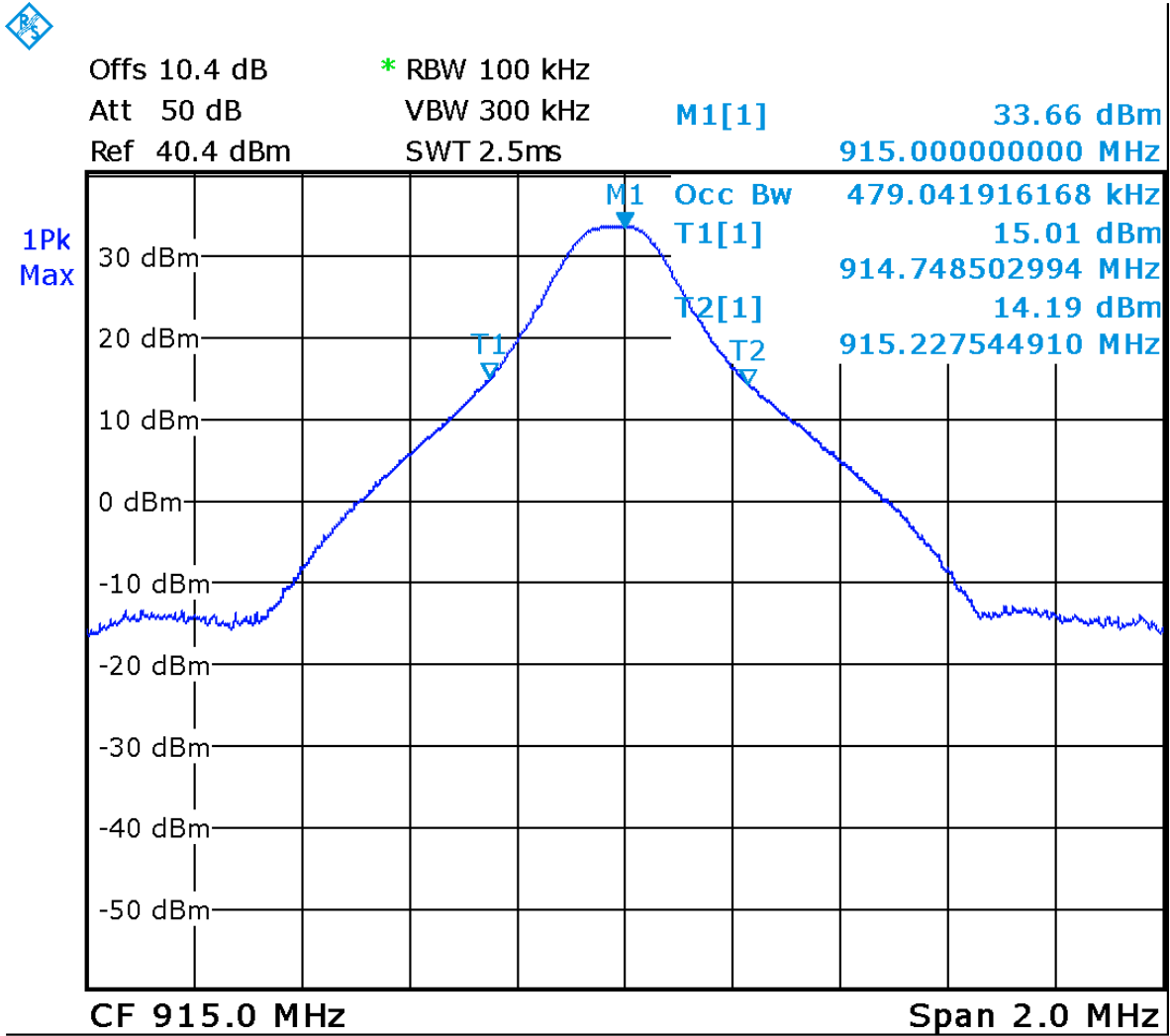
Protocol: 6B
Low Channel




Date: 29.APR.2014 12:21:39

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

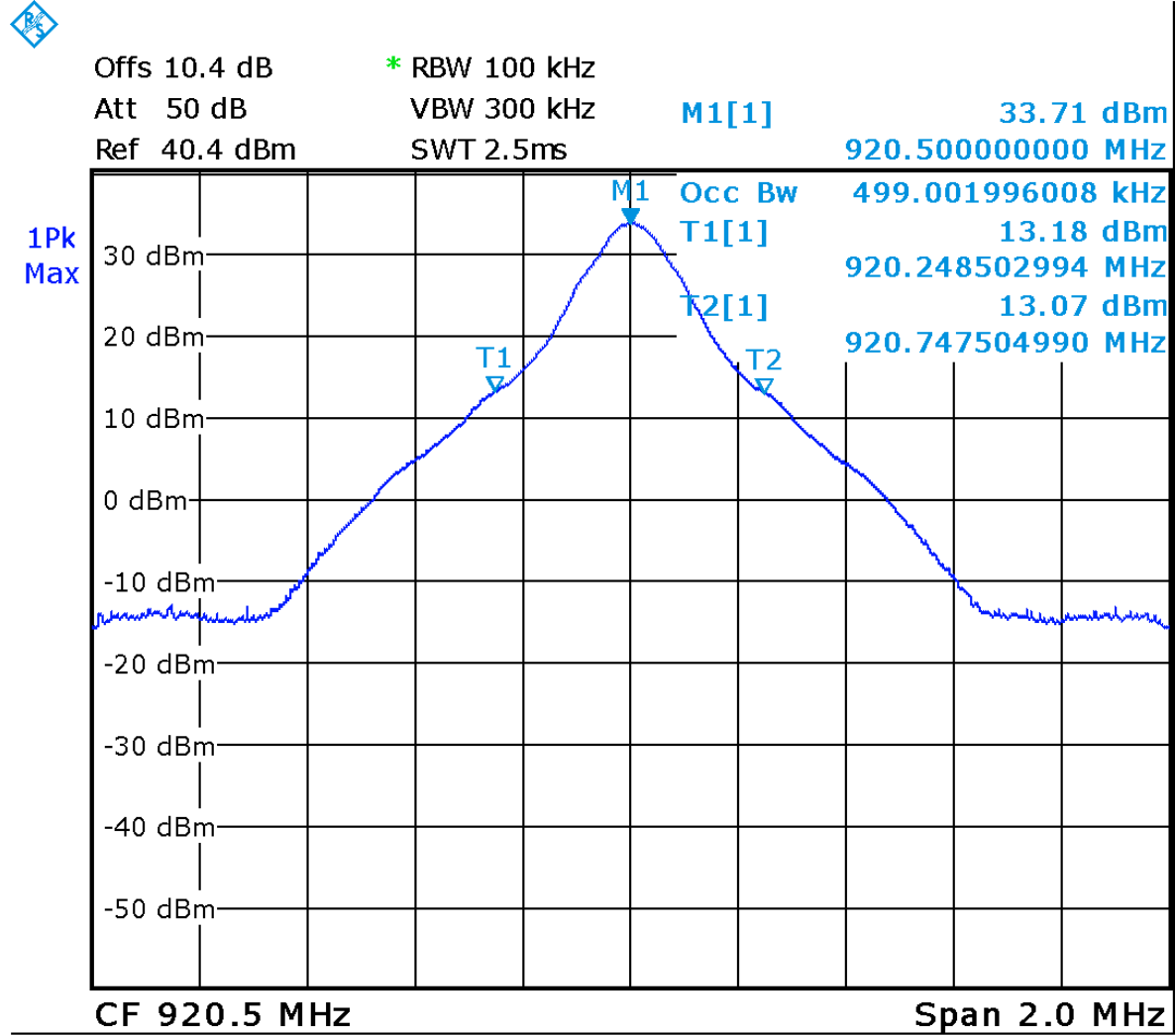
Protocol: 6B
Mid Channel




Date: 29.APR.2014 12:25:47

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

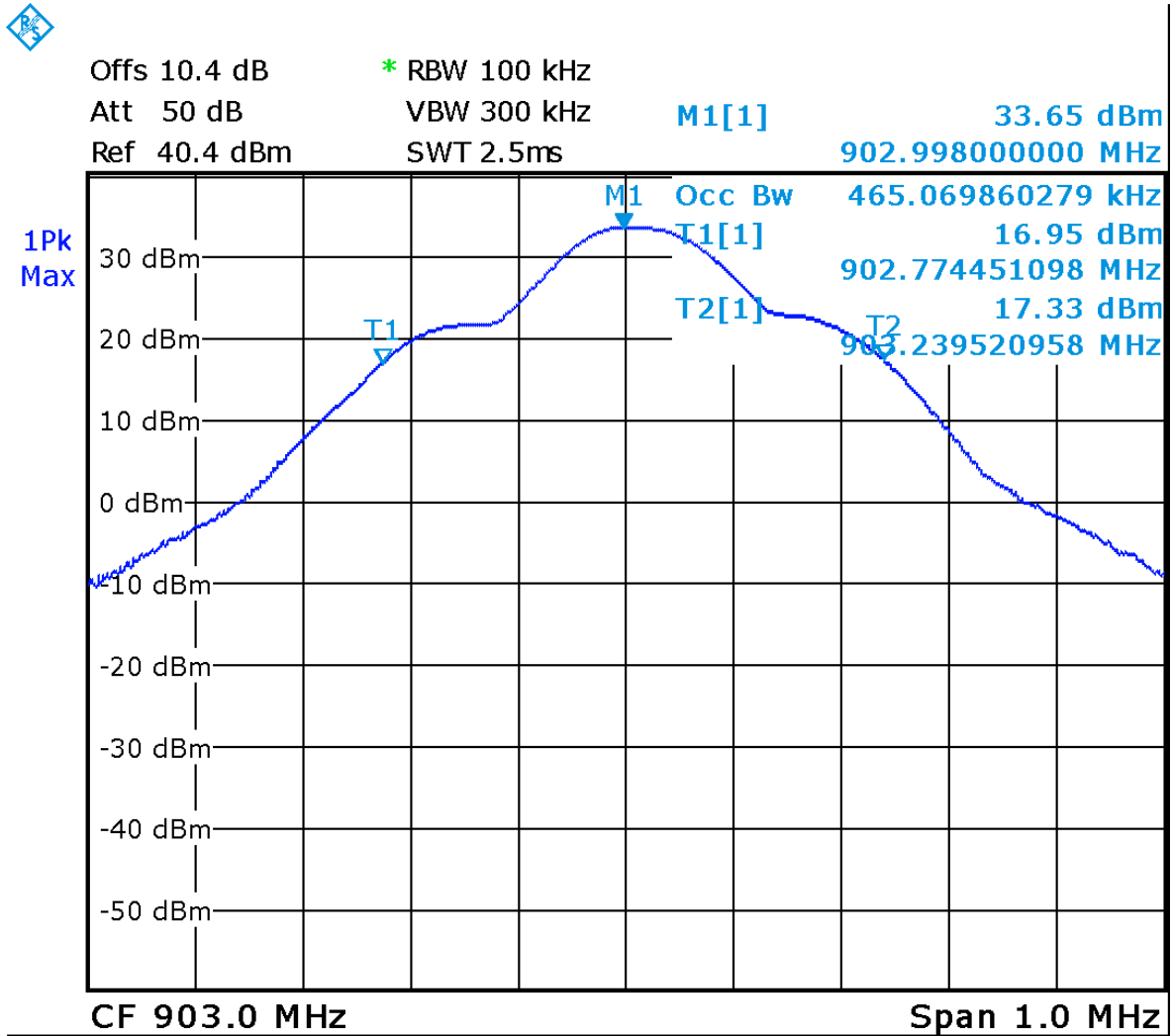
**Protocol: 6B
High Channel**




Date: 29.APR.2014 12:28:14

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

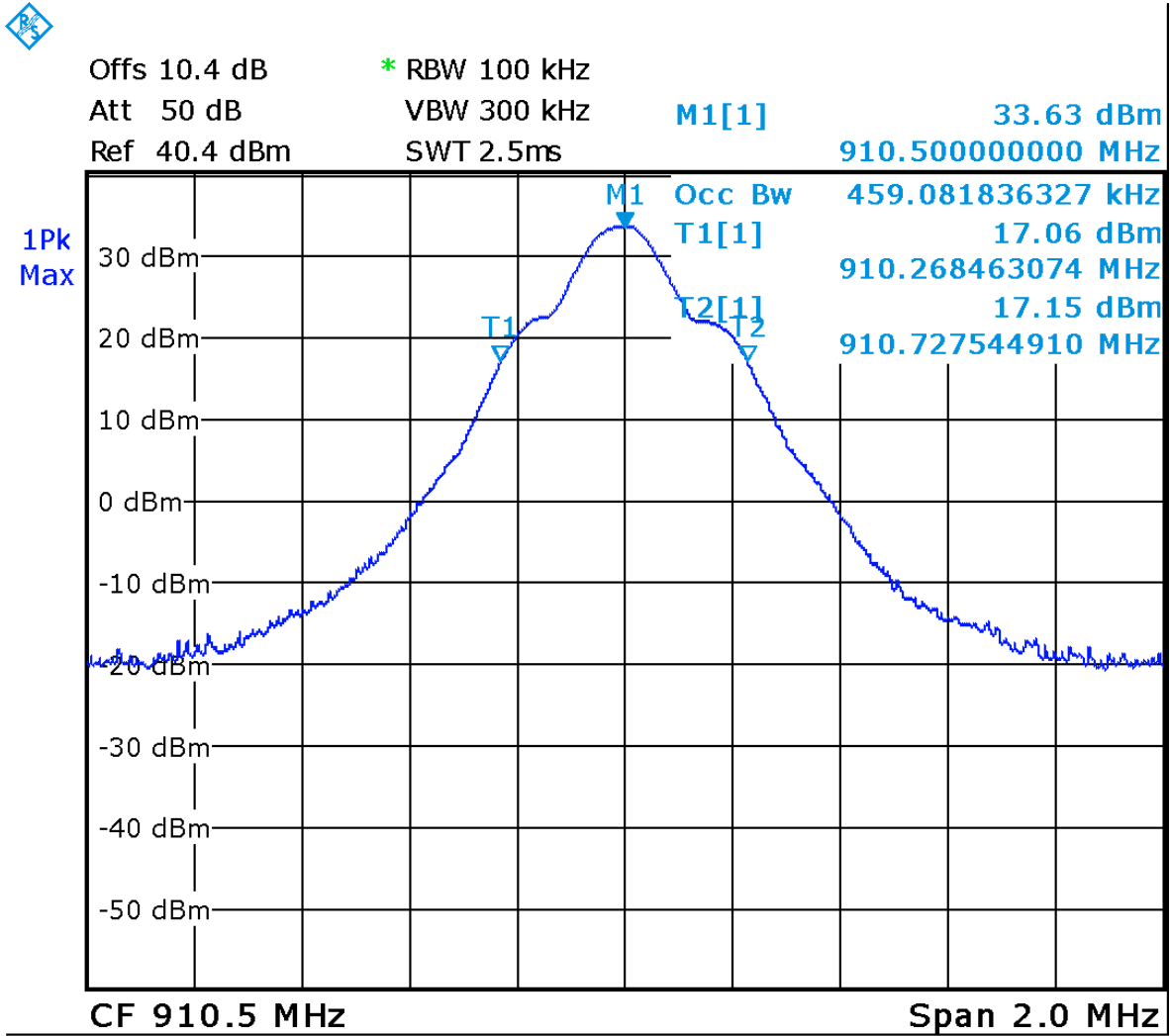
Protocol: 6C: 902 – 904 MHz Sub-Band




Date: 29.APR.2014 12:38:34

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

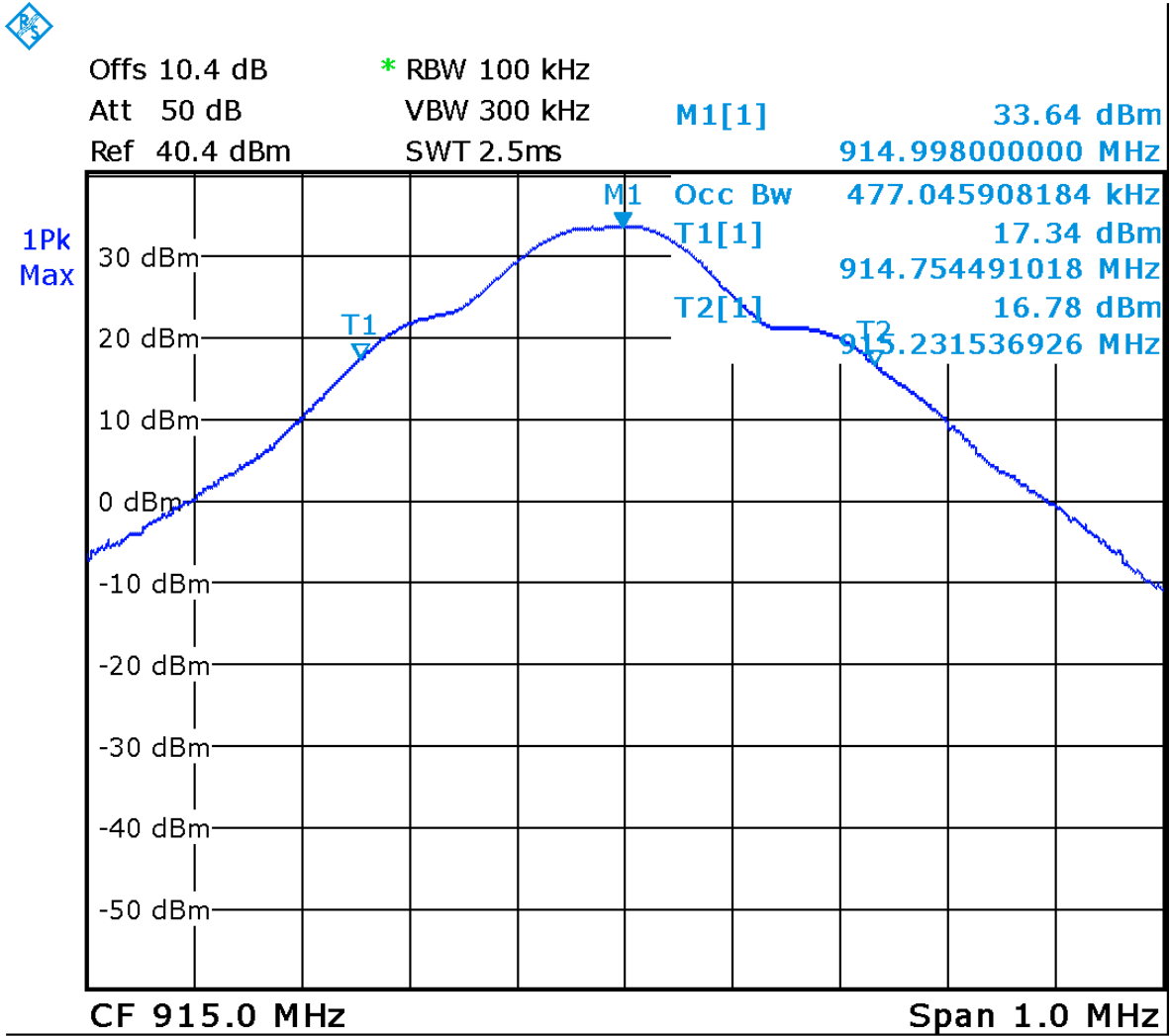
**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
Low Channel**




Date: 29.APR.2014 18:23:41

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

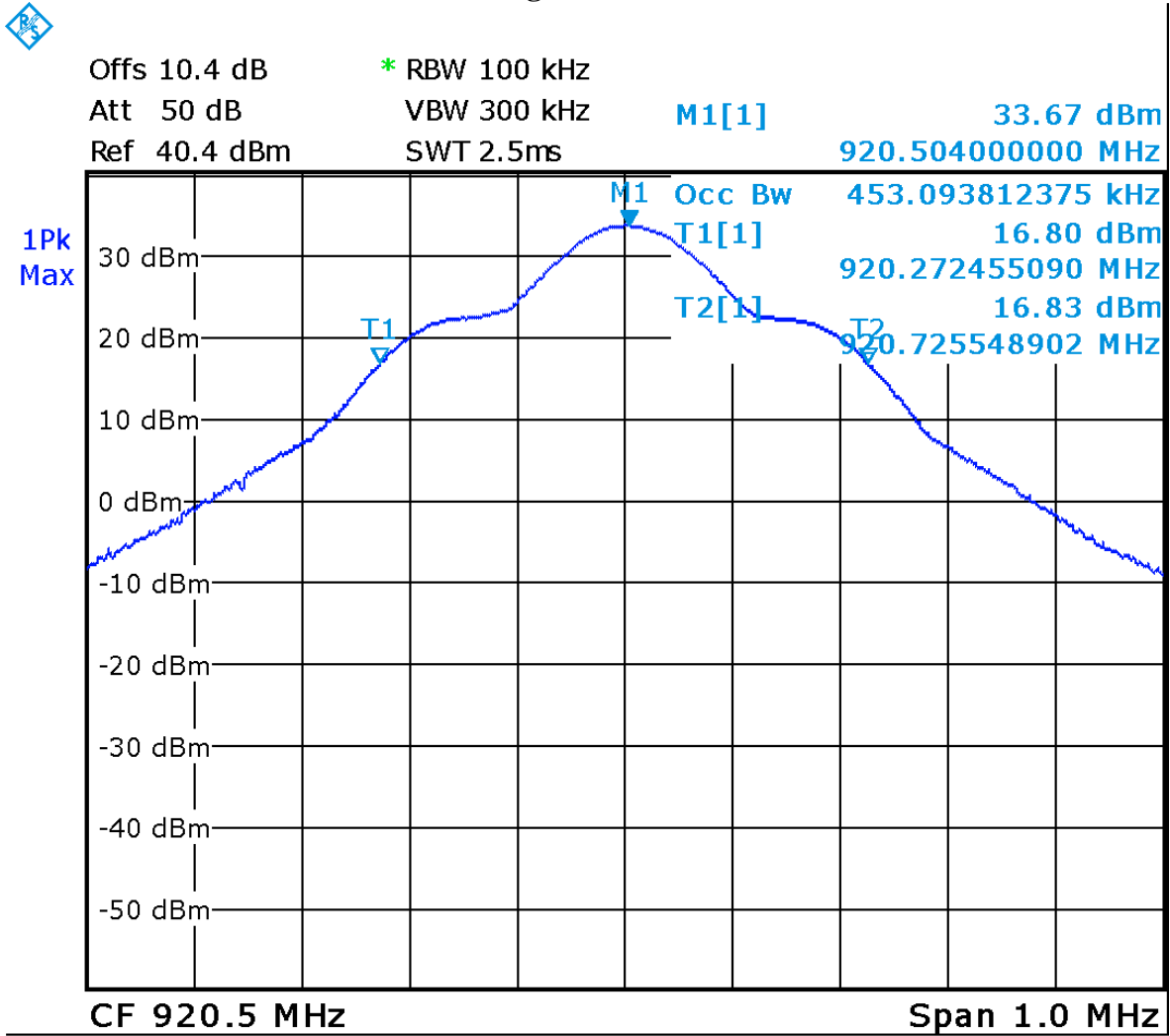
**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
Mid Channel**




Date: 29.APR.2014 12:47:34

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

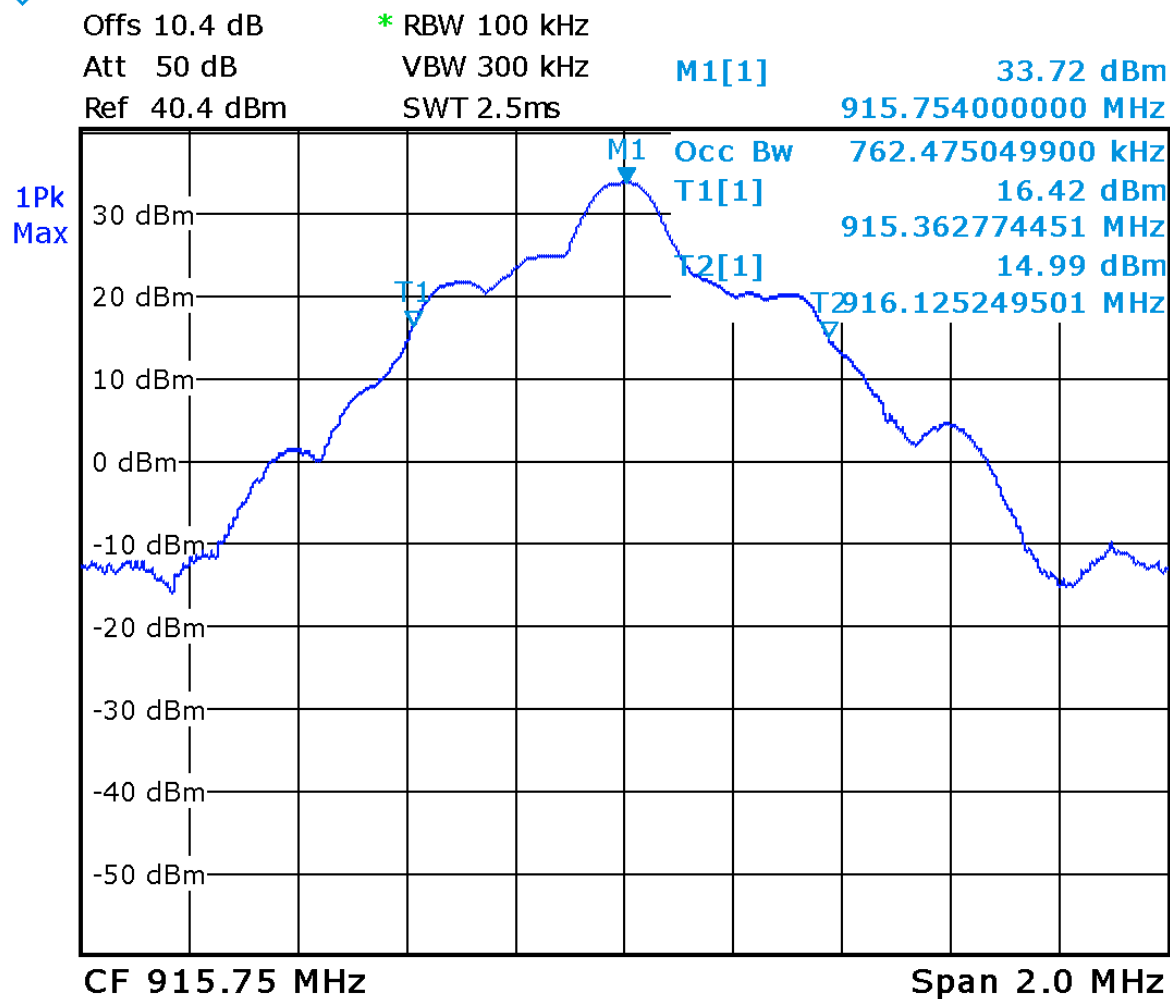
**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
High Channel**




Date: 29.APR.2014 12:51:18

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

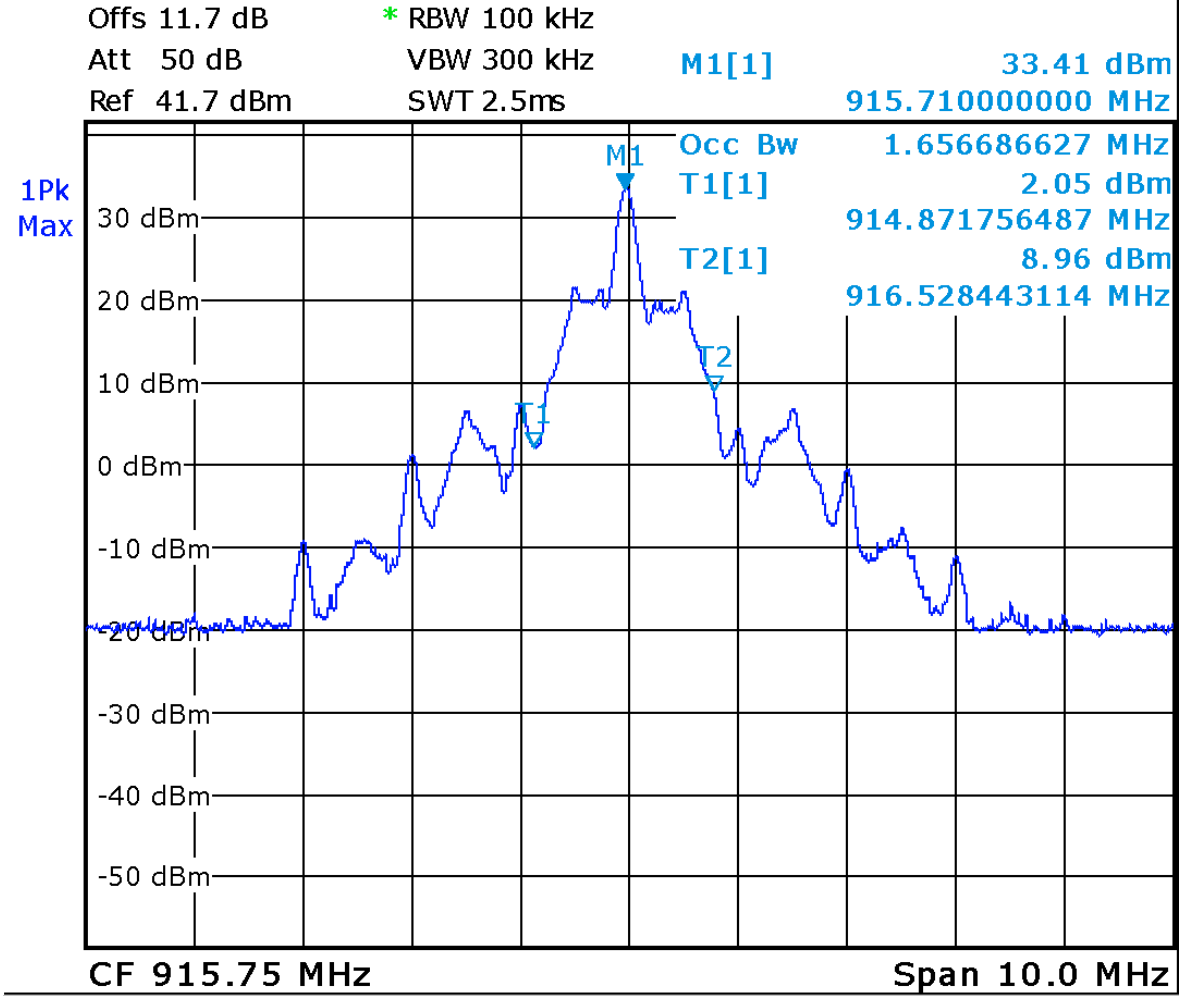
Protocol: Allegro




Date: 29.APR.2014 13:08:26

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

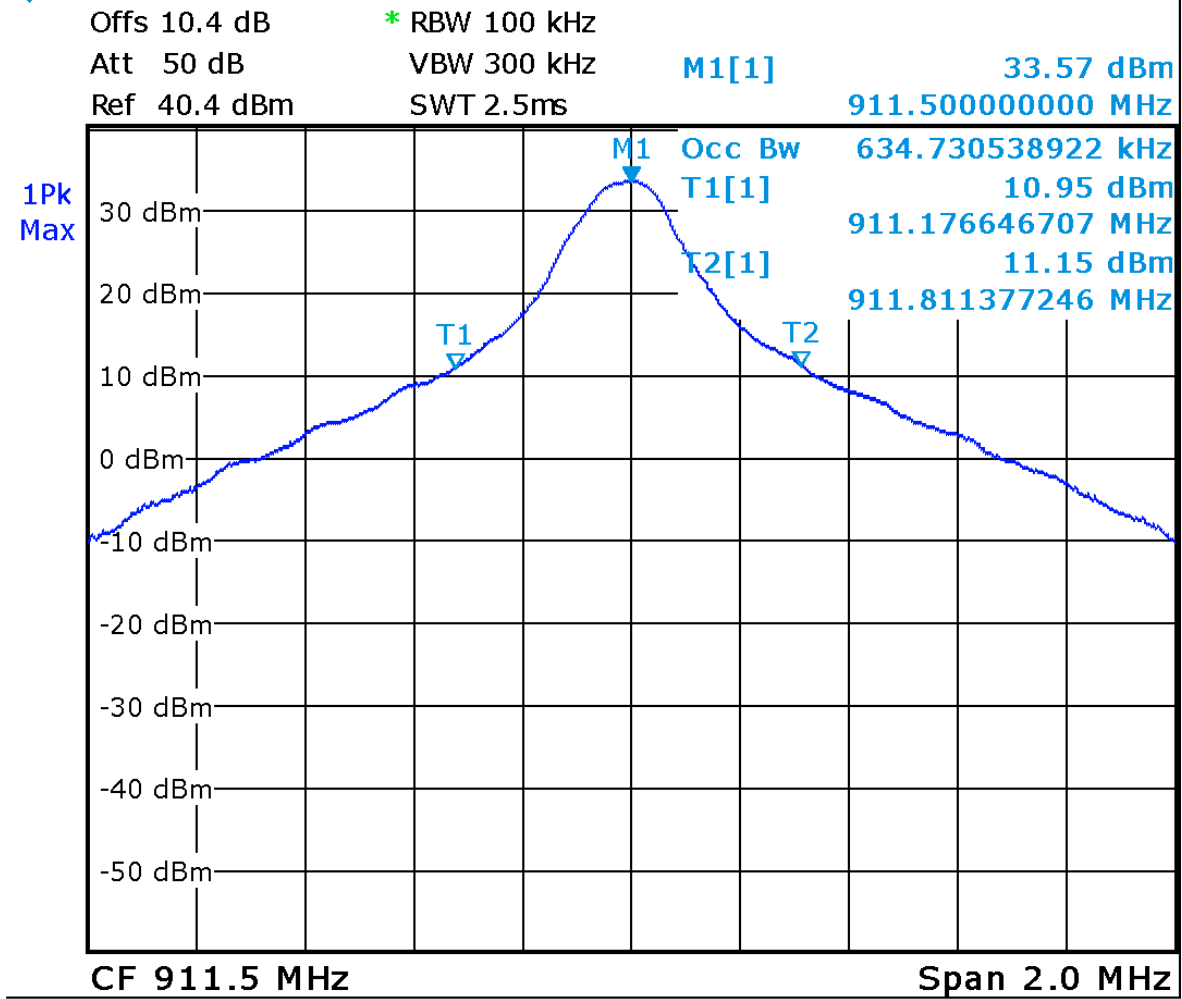
Protocol: KTDM




Date: 29.APR.2014 14:39:14

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

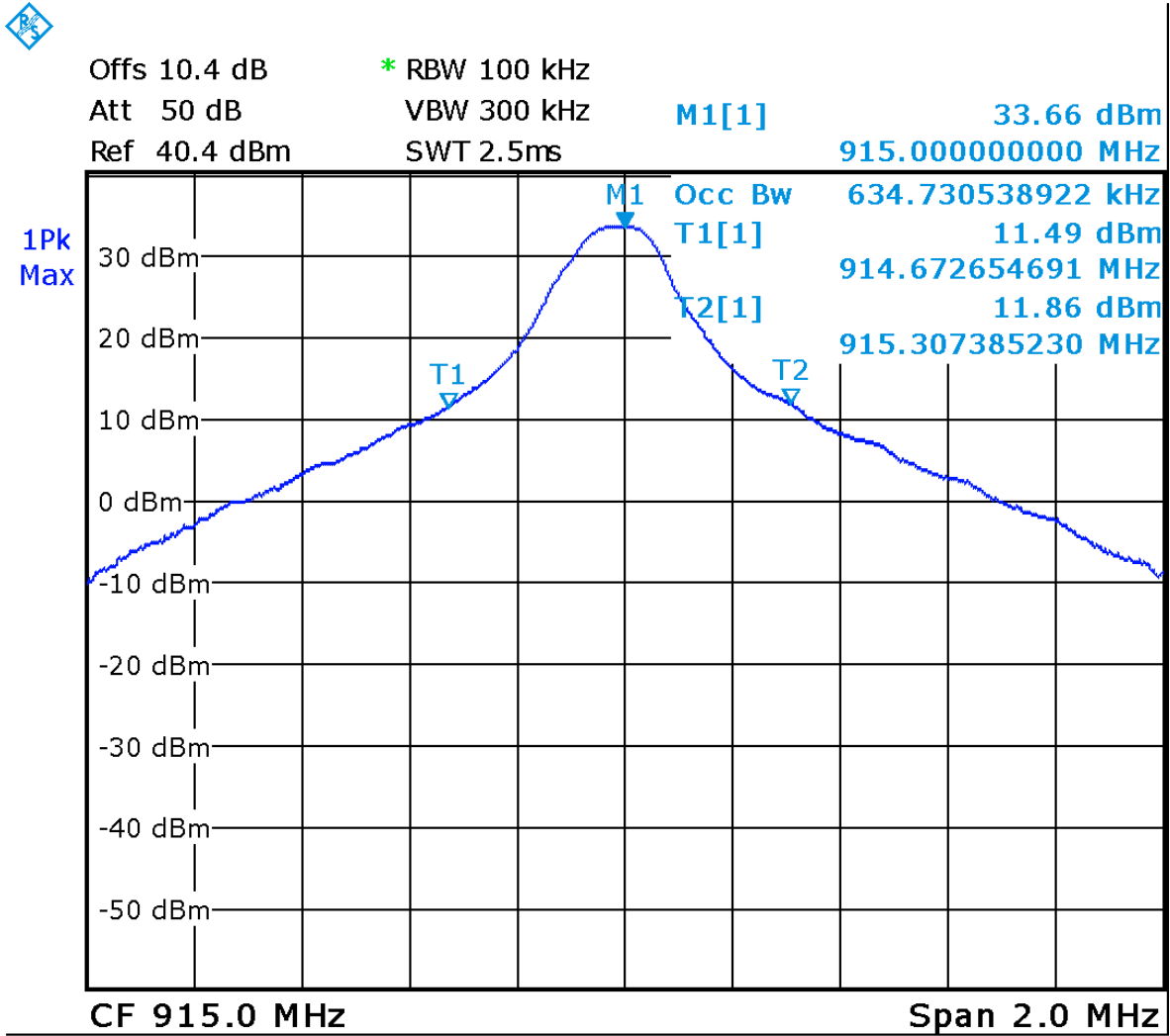
Protocol: SeGO
Low Channel




Date: 29.APR.2014 12:06:03

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: SeGO
Mid Channel



Date: 29.APR.2014 12:13:19

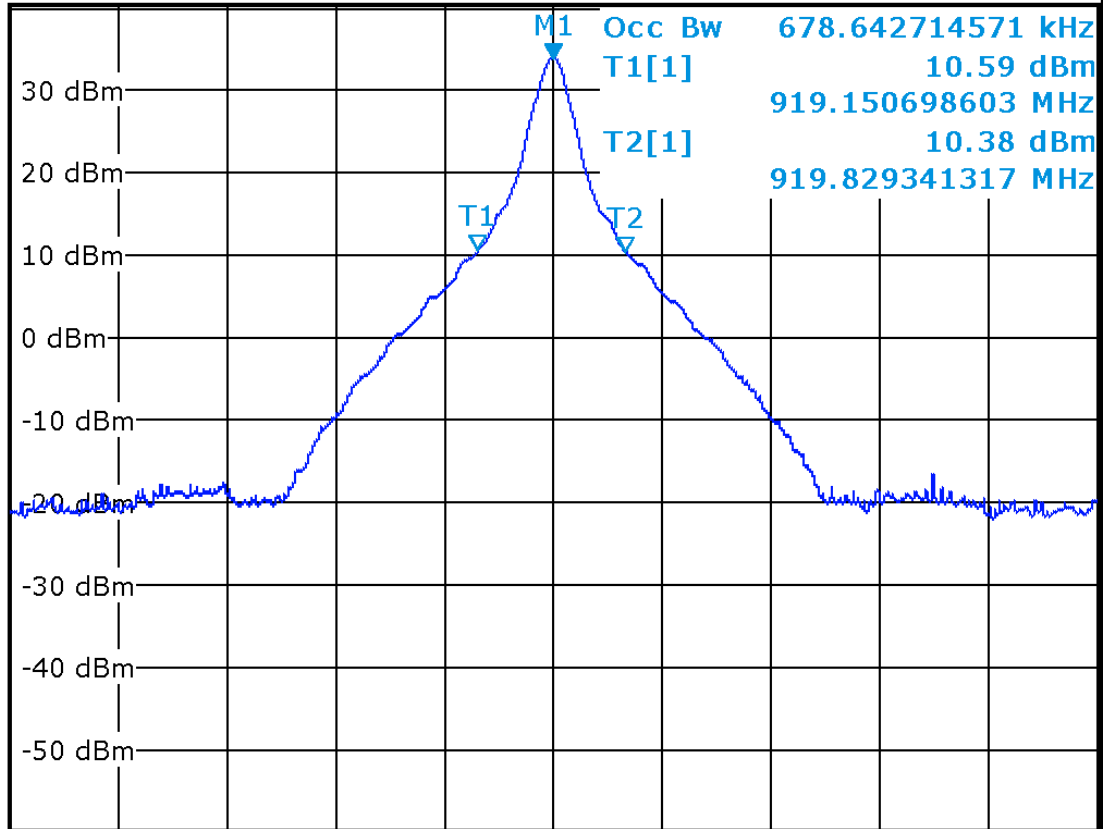
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Protocol: SeGO
Hi Channel



Offs 10.4 dB * RBW 100 kHz
 Att 50 dB VBW 300 kHz **M1[1]** **33.75 dBm**
 Ref 40.4 dBm SWT 2.5ms **919.500000000 MHz**


1Pk
Max



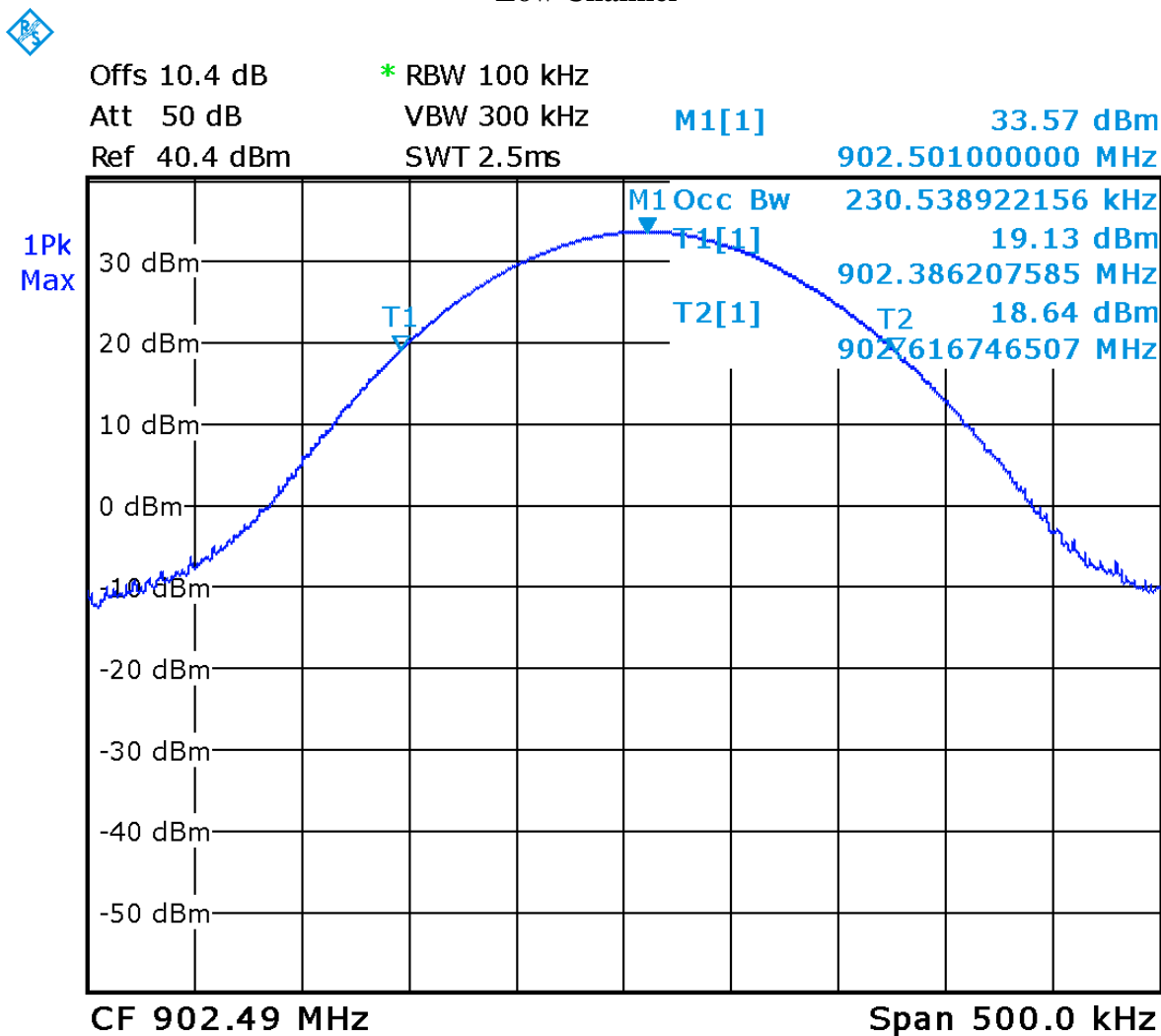
CF 919.5 MHz

Span 5.0 MHz


Date: 29.APR.2014 17:42:36

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

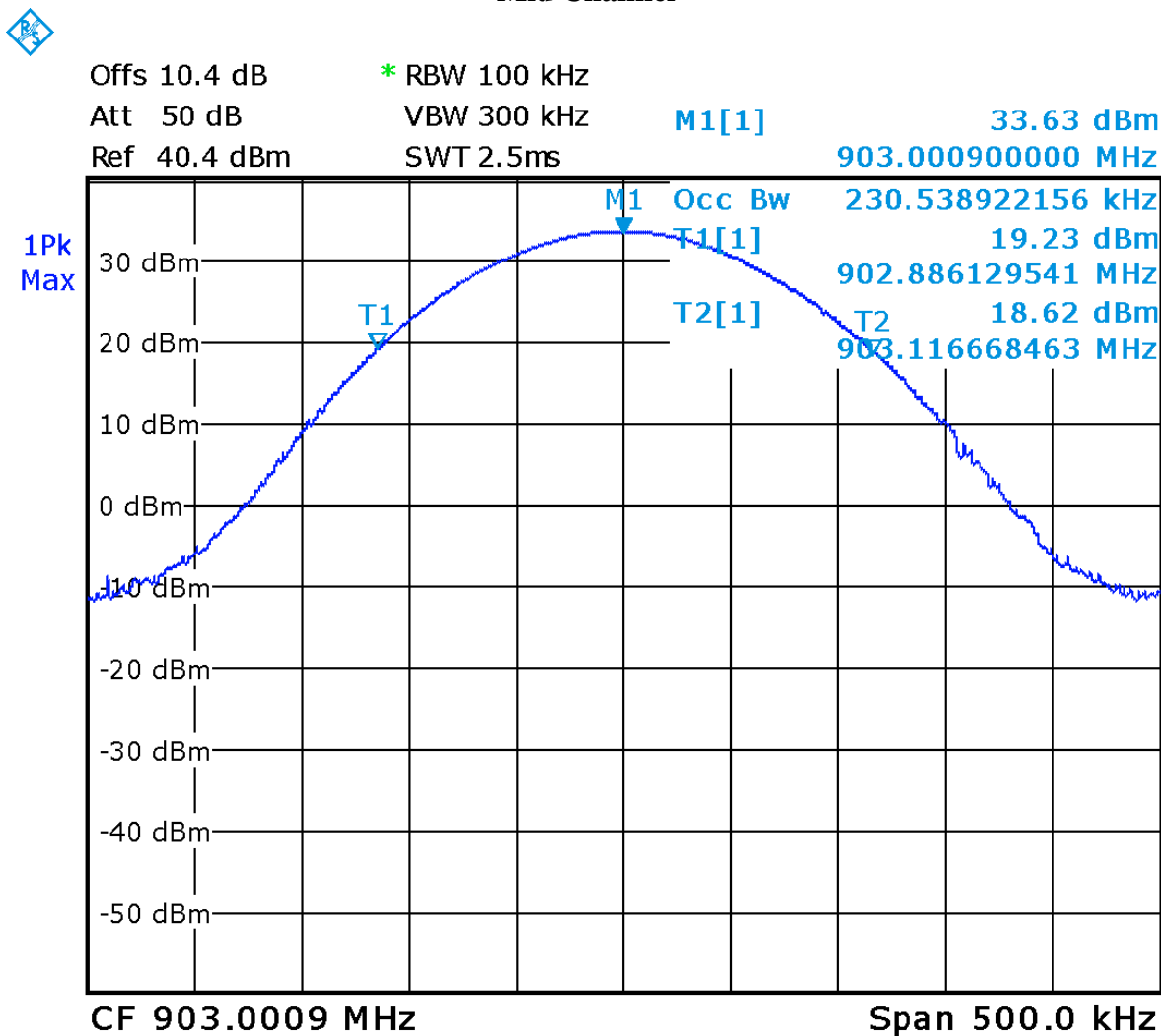
**Protocol: ATA – 902 – 904 MHz Sub-Band
Low Channel**




Date: 29.APR.2014 11:31:07

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

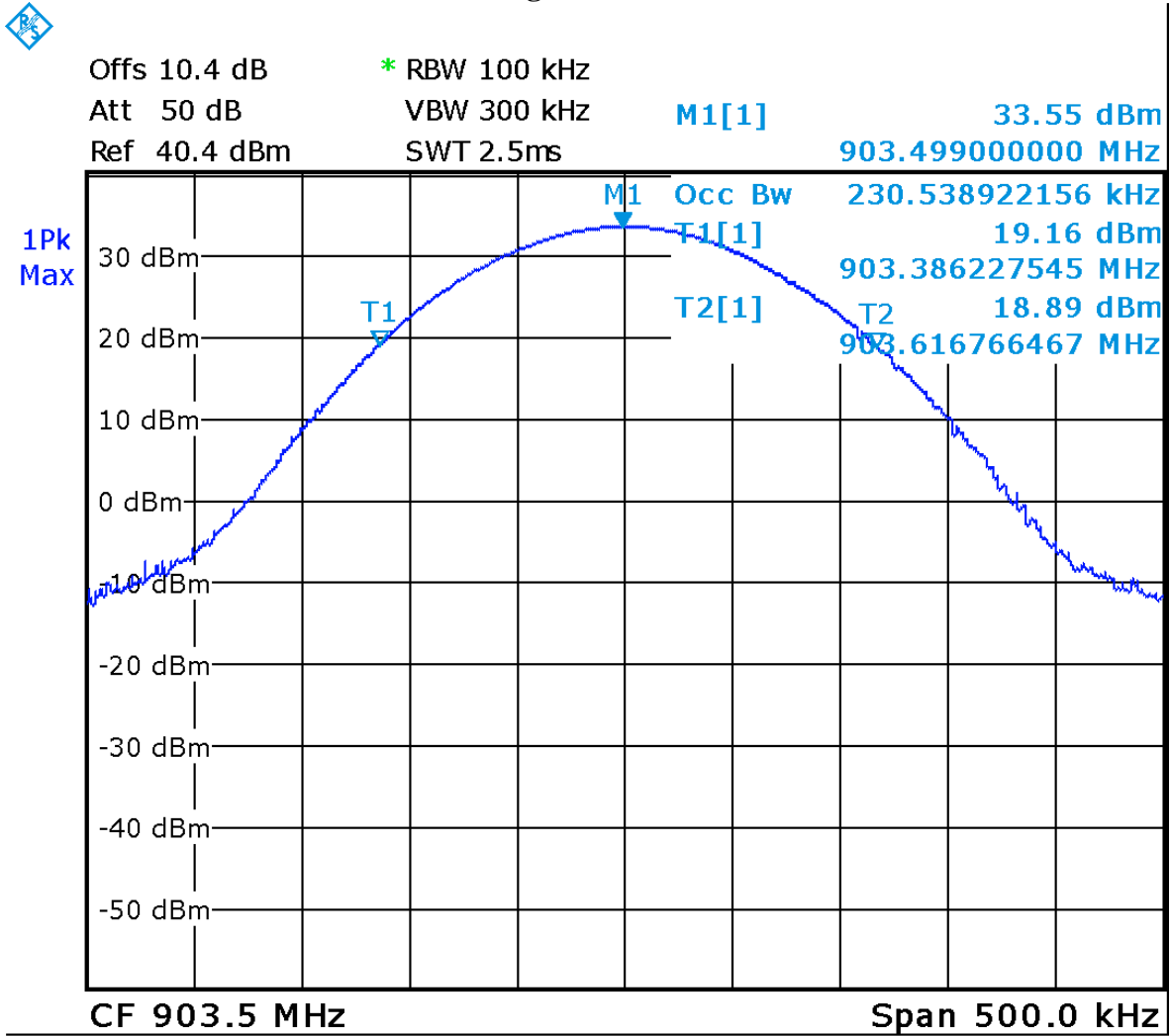
**Protocol: ATA – 902 – 904 MHz Sub-Band
Mid Channel**




Date: 29.APR.2014 11:36:28

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

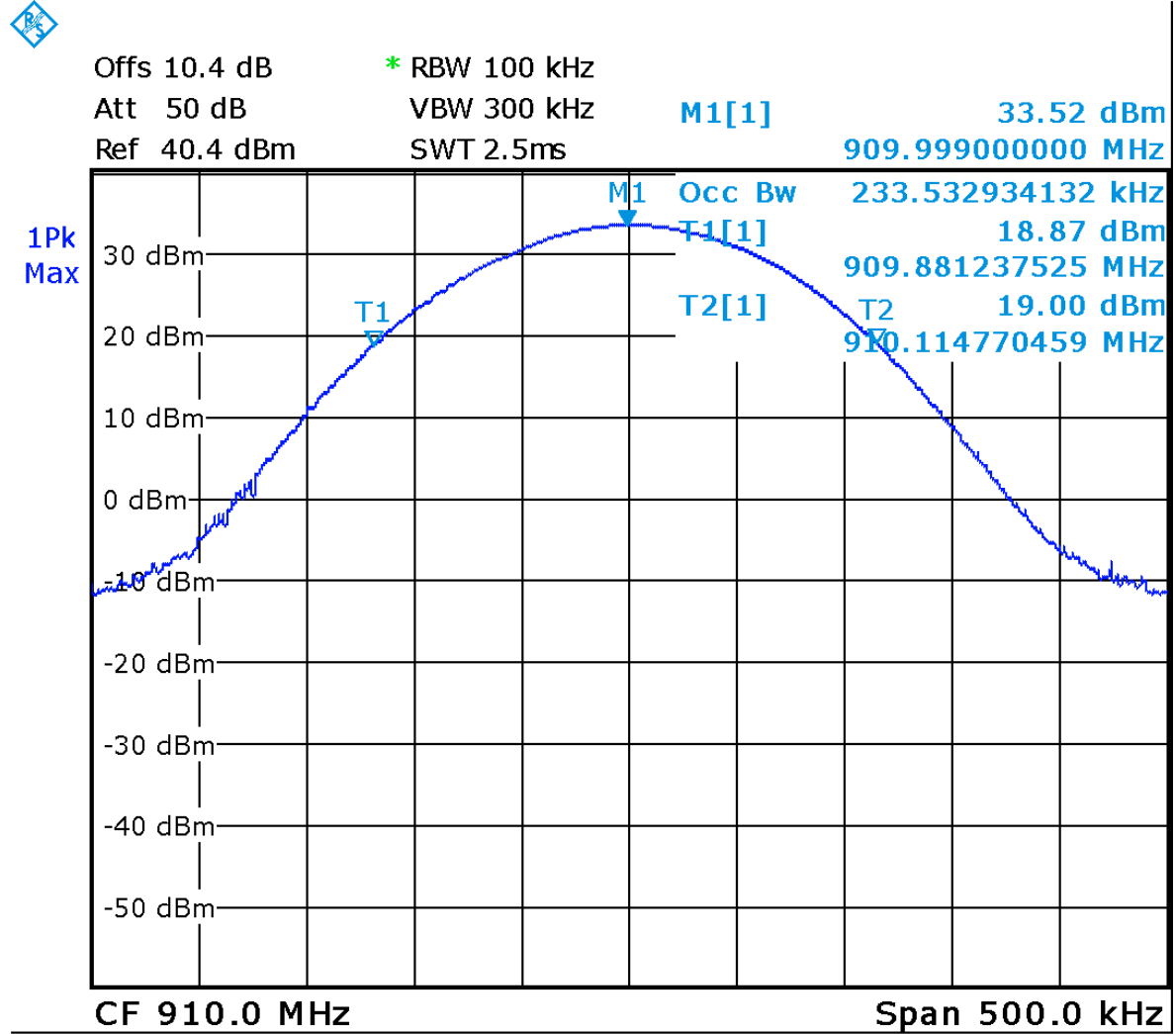
**Protocol: ATA – 902 – 904 MHz Sub-Band
High Channel**




Date: 29.APR.2014 11:42:23

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

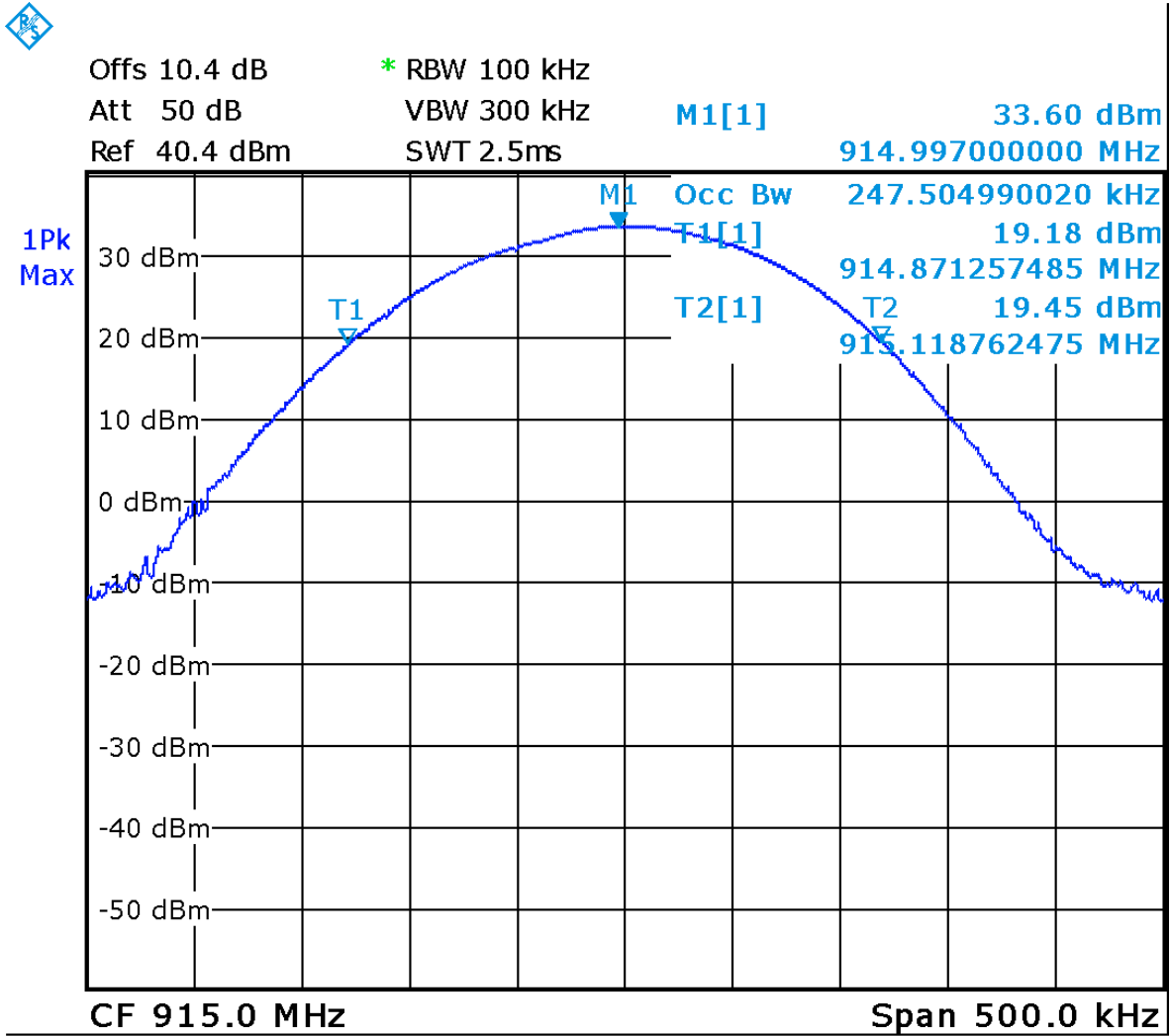
**Protocol: ATA – 909.75 – 921.75 MHz Sub-Band
Low Channel**




Date: 29.APR.2014 11:49:22

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

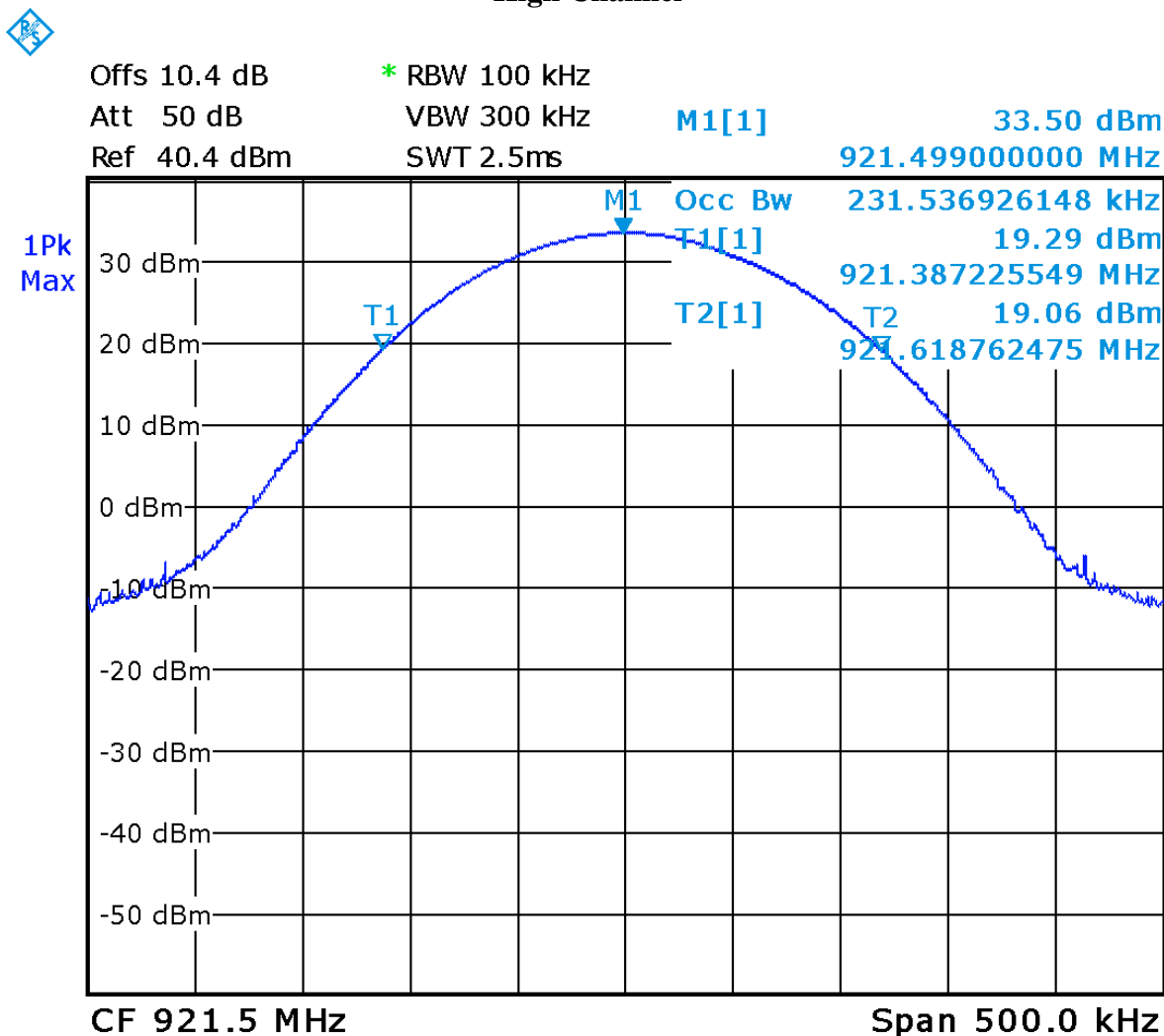
**Protocol: ATA -909.75 – 921.75 MHz Sub-Band
Mid Channel**



Date: 29.APR.2014 11:57:26


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: ATA -909.75 – 921.75 MHz Sub-Band
High Channel**



Date: 29.APR.2014 11:59:15


Note: See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	15-Nov-2013	15-Nov-2015	GEMC 160
Inmet Med. Power 10dB Attenuator	12N-10	Inmet	NCR	NCR	GEMC6405
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Emission Mask

Purpose

The purpose of this test is to ensure that the maximum power conducted to the radiating element at frequencies outside of the authorized spectrum does not exceed the limits specified. This ensures that the only the intended signal is delivered to the radiating element.

Limits

The Limit is as specified in FCC Part 90.210 (K) and RSS-137 Clause 6.5.3

Emission Mask K—(1) Wideband multilateration transmitters. For transmitters authorized under subpart M to provide forward or reverse links in a multilateration system in the subbands 904-909.75 MHz, 921.75-927.25 MHz and 919.75-921.75 MHz, and which transmit an emission occupying more than 50 kHz bandwidth: in any 100 kHz band, the center frequency of which is removed from the center of authorized sub-band(s) by more than 50 percent of the authorized bandwidth, the power of emissions shall be attenuated below the transmitter output power, as specified by the following equation, but in no case less than 31 dB:

$$A=16+0.4 (D-50)+10 \log B \text{ (attenuation greater than 66 dB is not required)}$$


Where:

- A = attenuation (in decibels) below the maximum permitted output power level
- D = displacement of the center frequency of the measurement bandwidth from the center frequency of the authorized sub-band, expressed as a percentage of the authorized bandwidth B
- B = authorized bandwidth in megahertz.

(2) Narrowband forward link transmitters. For LMS multilateration narrowband forward link transmitters operating in the 927.25-928 MHz frequency band the power of any emission shall be attenuated below the transmitter output power (P) in accordance with following schedule:

On any frequency outside the authorized sub-band and removed from the edge of the authorized sub-band by a displacement frequency (fd in kHz): at least $116 \log ((fd+10)/6.1)$ dB or $50 + 10 \log (P)$ dB or 70 dB, whichever is the lesser attenuation.

(3) Other transmitters. For all other transmitters authorized under subpart M that operate in the 902-928 MHz band, the peak power of any emission shall be attenuated below the power of the highest emission contained within the licensee's sub-band in accordance with the following schedule:

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

- (i) On any frequency within the authorized bandwidth: Zero dB.
- (ii) On any frequency outside the licensee's sub-band edges: $55 + 10 \log(P)$ dB, where (P) is the highest emission (watts) of the transmitter inside the licensee's sub-band.

(4) In the 902-928 MHz band, the resolution bandwidth of the instrumentation used to measure the emission power shall be 100 kHz, except that, in regard to paragraph (2) of this section, a minimum spectrum analyzer resolution bandwidth of 300 Hz shall be used for measurement center frequencies with 1 MHz of the edge of the authorized subband. The video filter bandwidth shall not be less than the resolution bandwidth.

(5) Emission power shall be measured in peak values.

(6) The LMS sub-band edges for non-multilateration systems for which emissions must be attenuated are 902.00, 904.00, 909.5 and 921.75 MHz.

Note: The EUT is a non- multilateration LMS transmitter. Emission limit (3) applies to the EUT. A $55 + 10 \log(P)$ dB attenuation or -25 dBm was applied all frequency from the outside authorized band.

Test procedure is as per eCFR 47 Part 2 Clause 2.1051.


Results

Pass. The EUT meet the requirements.

Each of the 6 supported protocol was tested. Where a protocol have more than one channel, the low and high channels were measured. The worst case is presented as a graph for the spectrum.

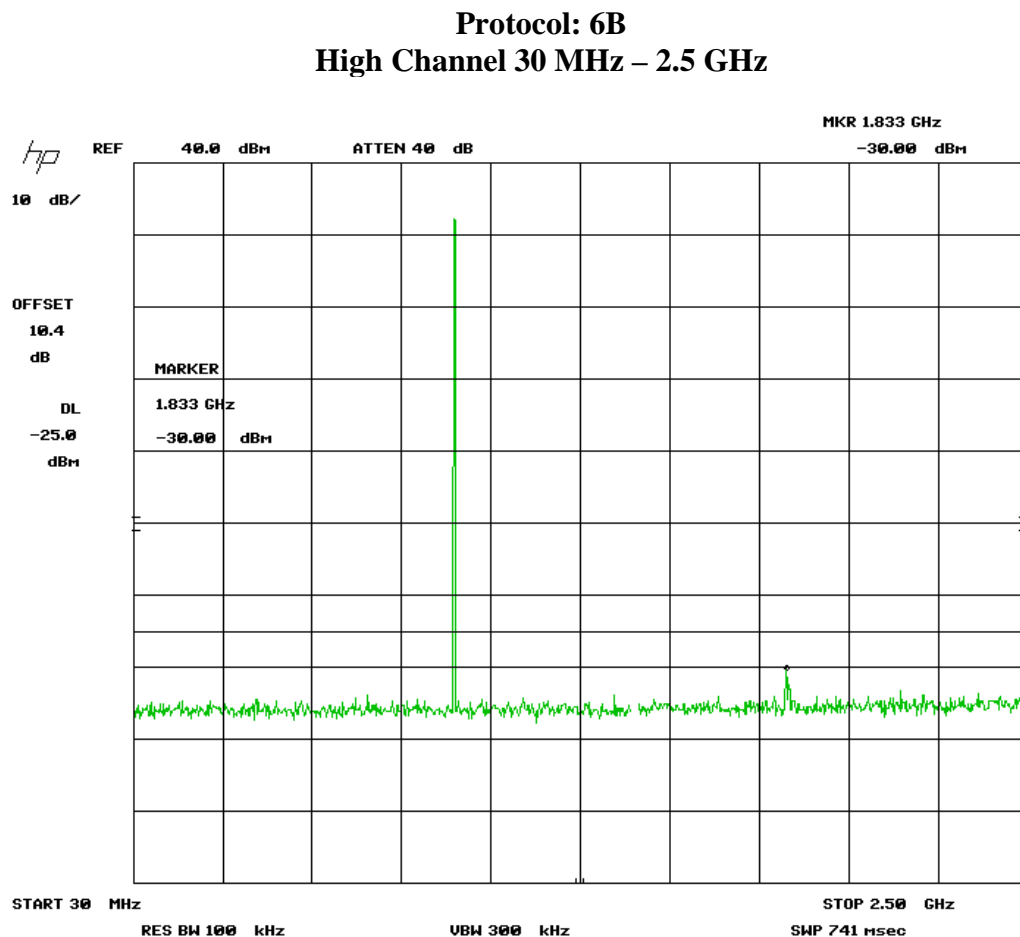
The ATA and 6C protocols operate in both non- multilateration LMS sub-bands and the other 4 protocols operate in the 909.75 – 921.75 MHz sub-band.


Band edge requirements were shown for the lower band edge at 902.0 and 909.5 MHz in the low band where applicable. Band edge requirements were also shown for the higher band edge at 904.0 and 921.75 MHz in the high band where applicable.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

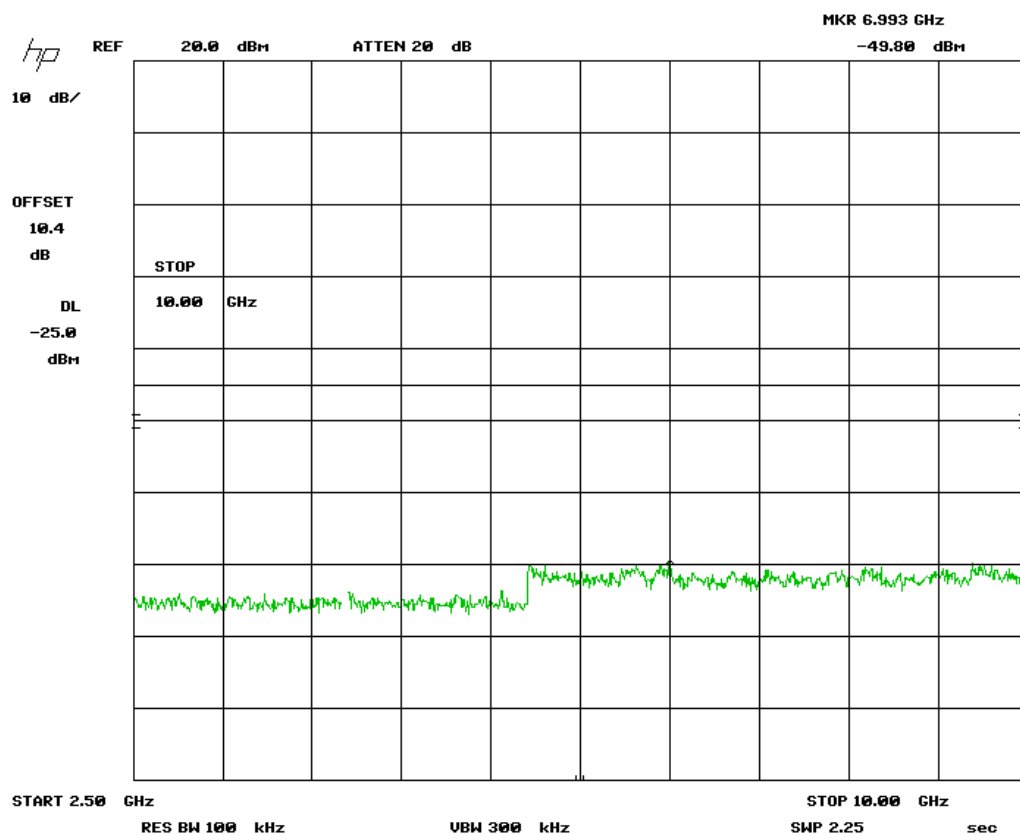
Graph(s)


The graphs shown below shows the peak power output of the device during the antenna conducted measurement during transmit operation of the EUT.



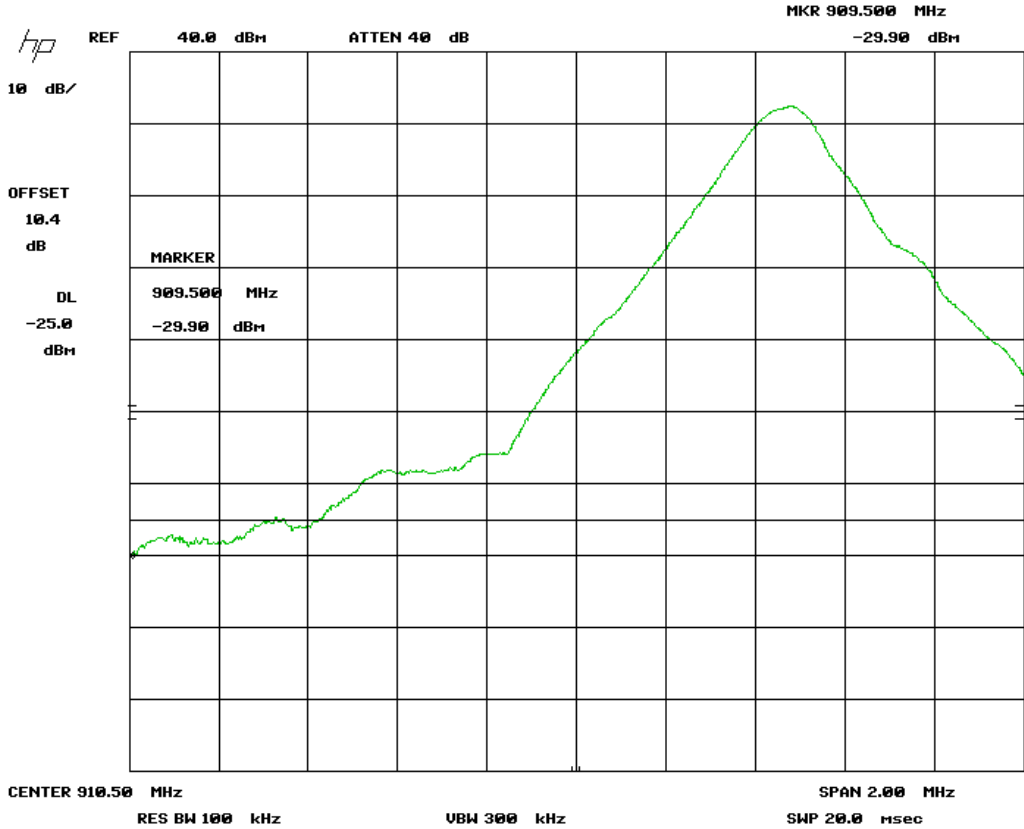
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: 6B
High Channel 2.5 GHz – 10 GHz



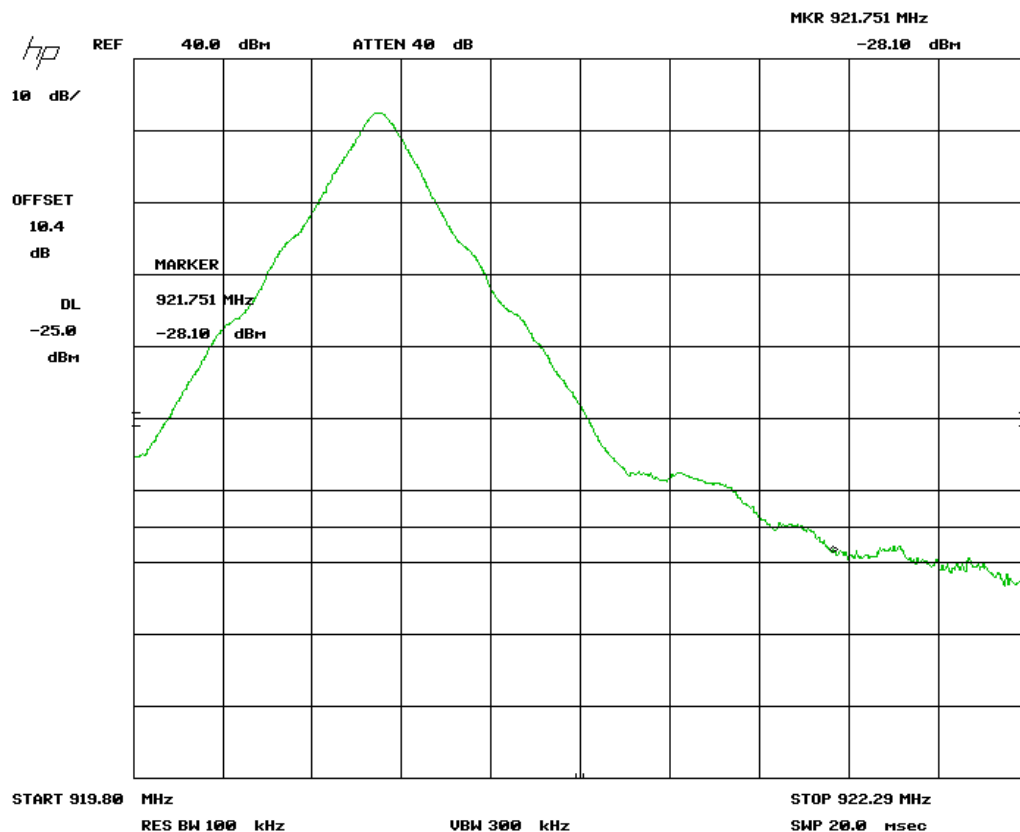
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: 6B
Low Channel – 909.5 MHz Band Edge



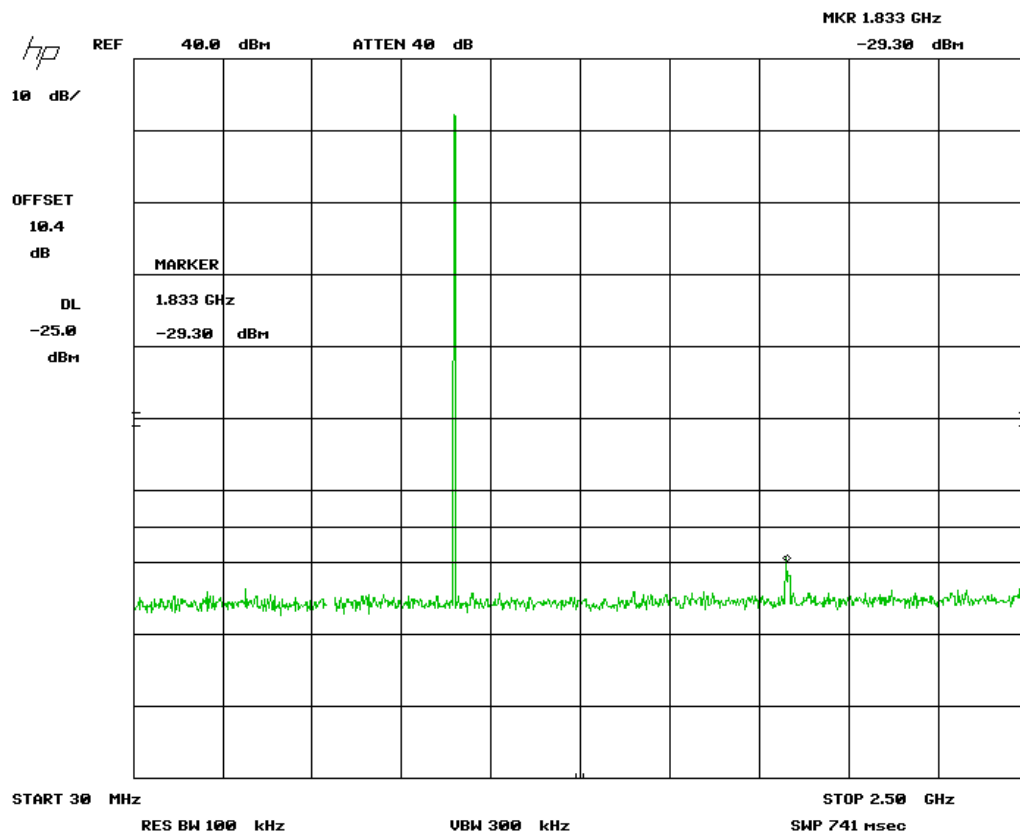
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: 6B
High Channel – Band Edge 921.75



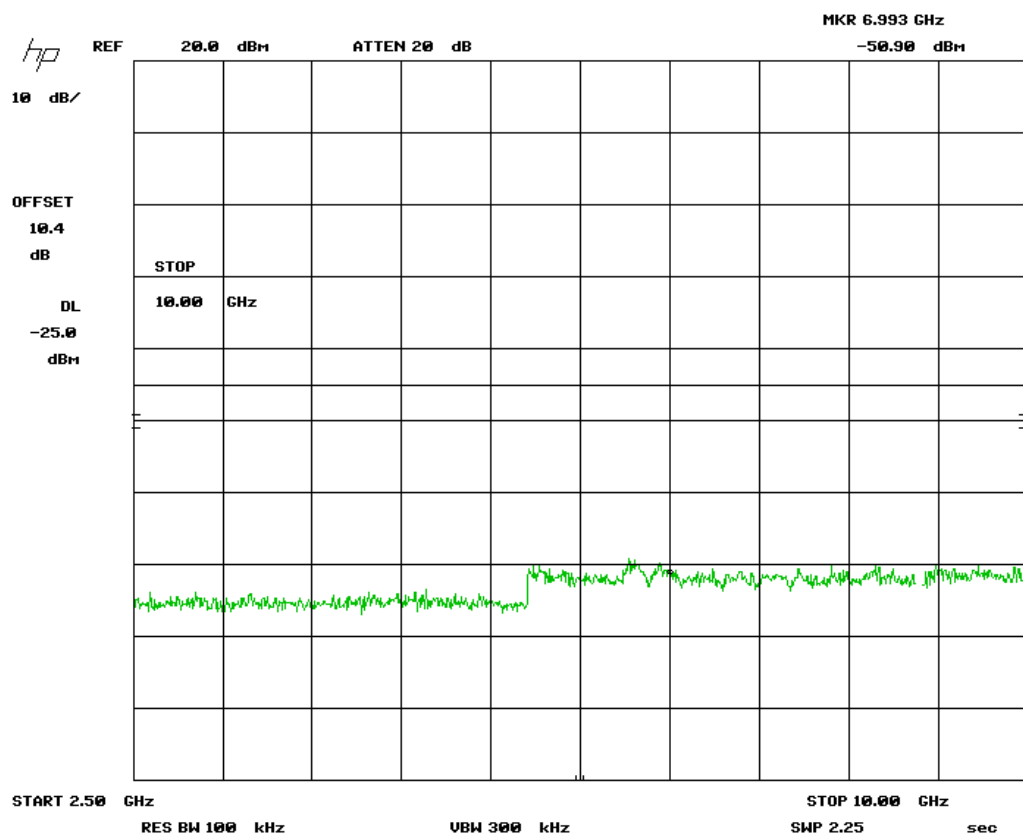
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: 6C
High Channel 30 MHz – 2.5 GHz



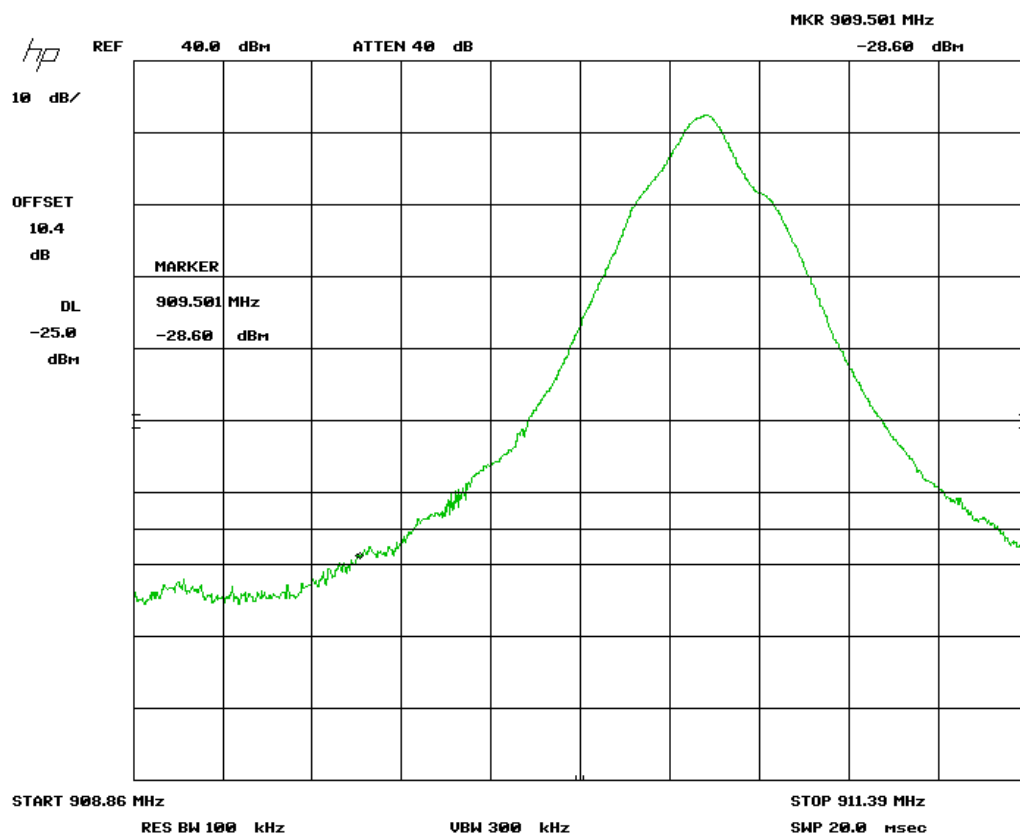
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: 6C
High Channel 2.5 GHz – 10 GHz



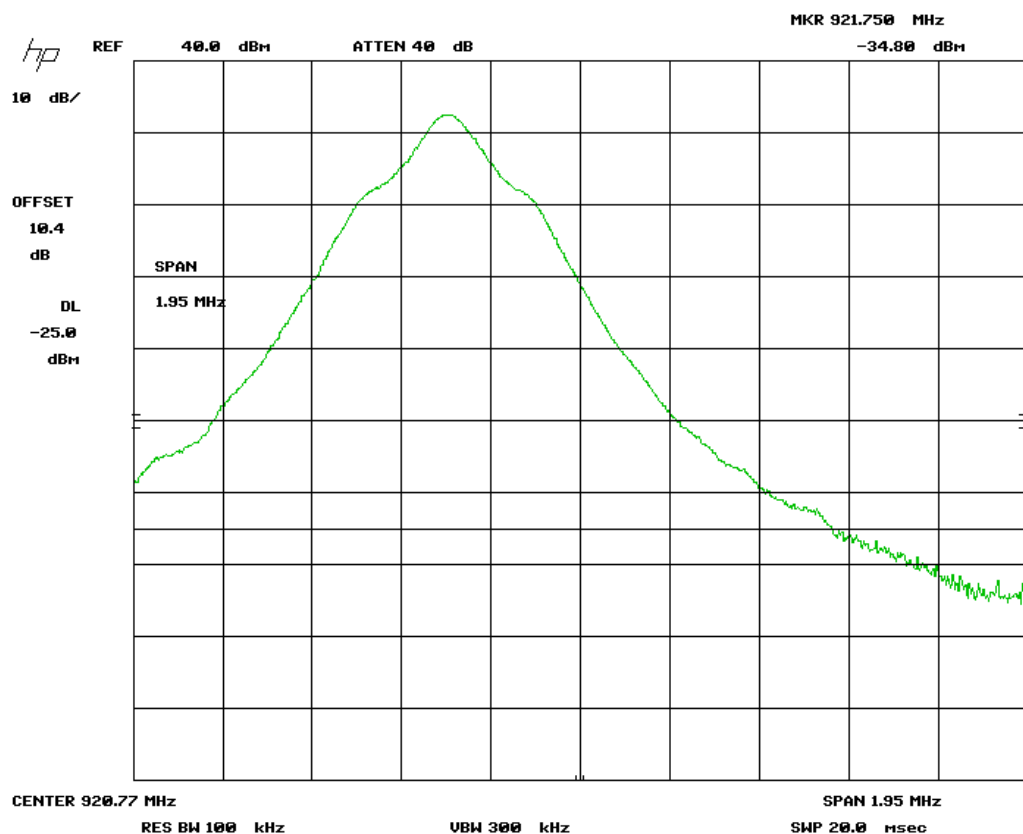
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
Low Channel – 909.5 MHz Band Edge**



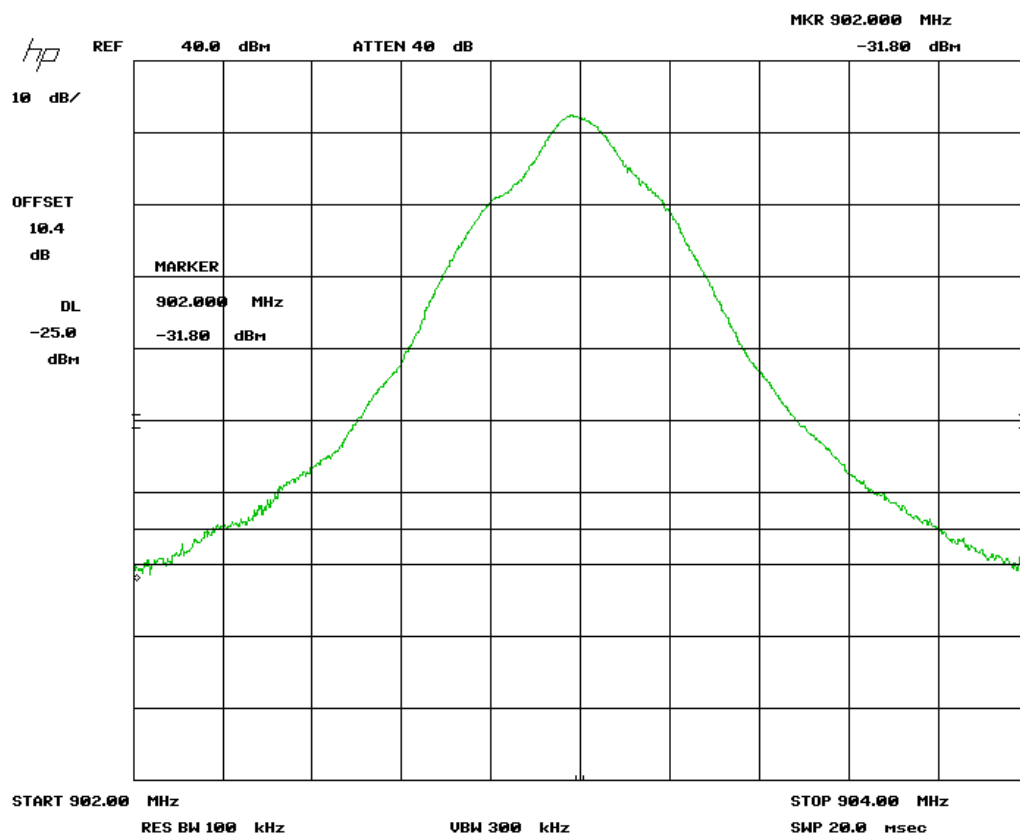
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


**Protocol: 6C: 909.75 – 921.75 MHz Sub-Band
High Channel –921.75 MHz Band Edge**



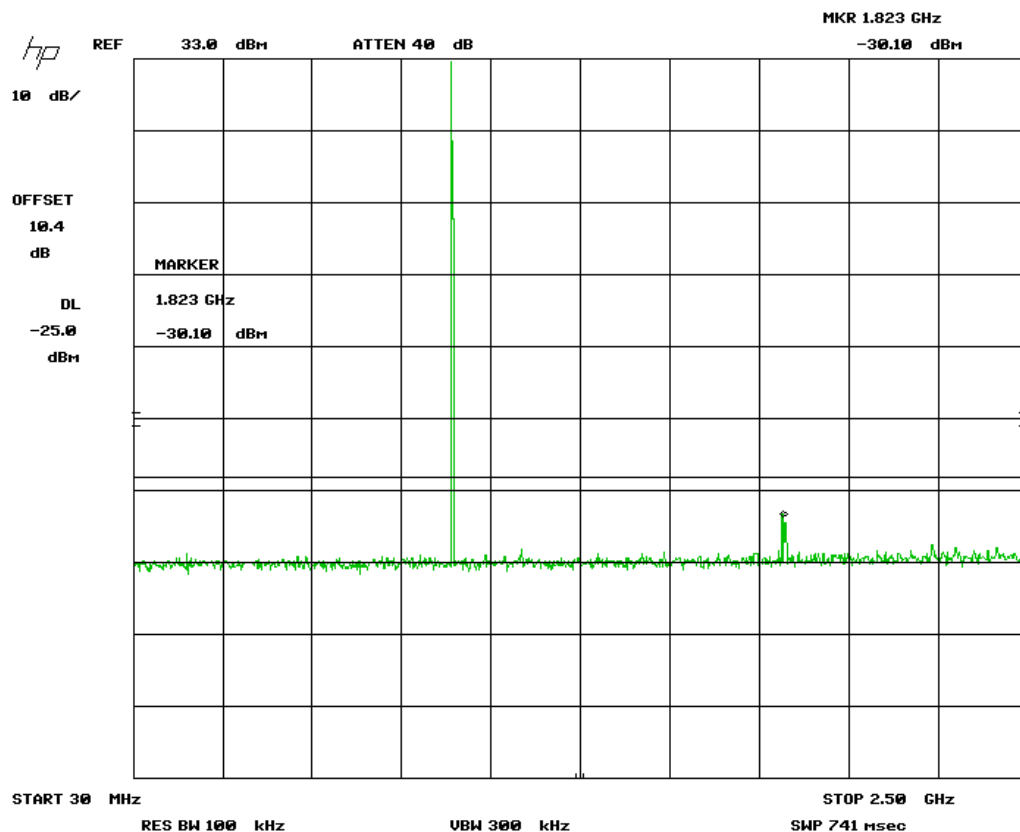
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


**Protocol: 6C: 902 – 904 MHz Sub-Band
902 and 904 MHz Band Edges**



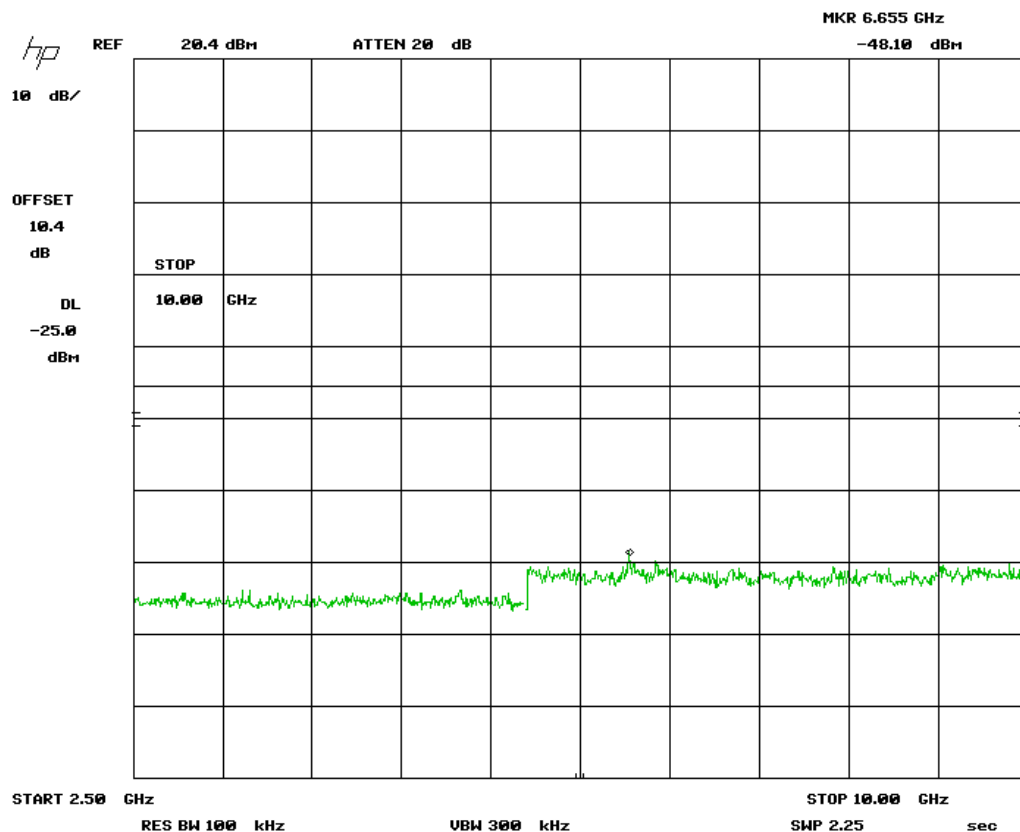
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: Allegro
30 MHz – 2.5 GHz



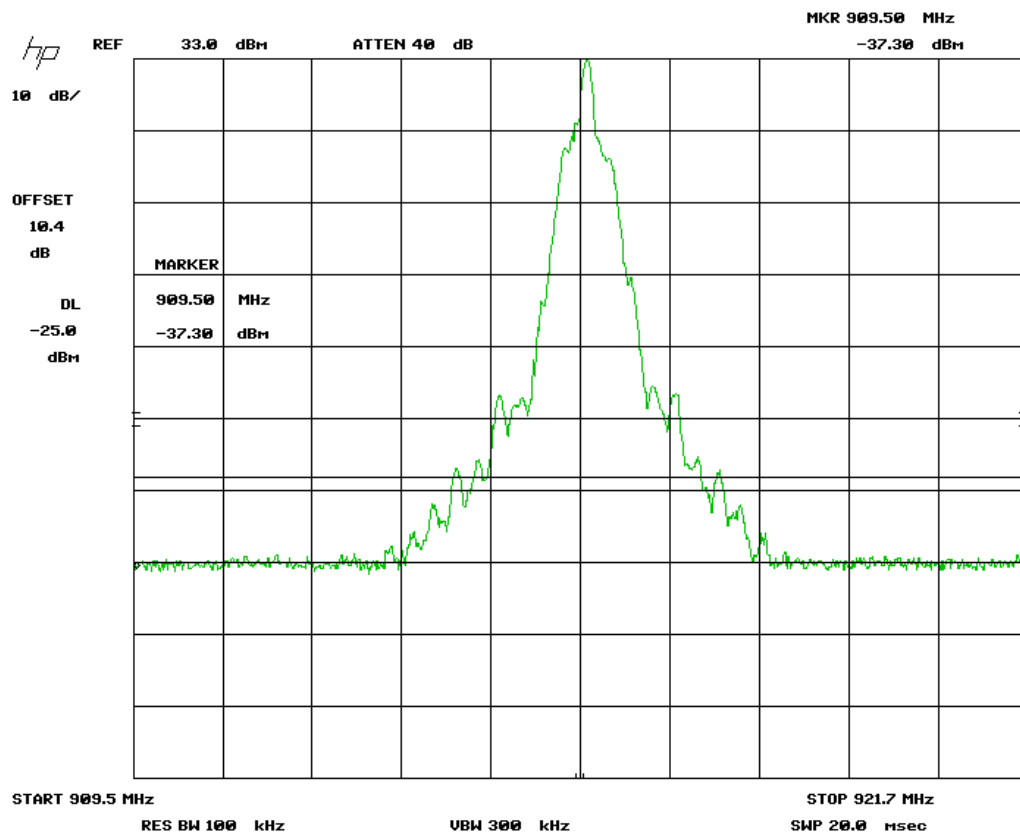
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: Allegro
2.5 GHz – 10 GHz



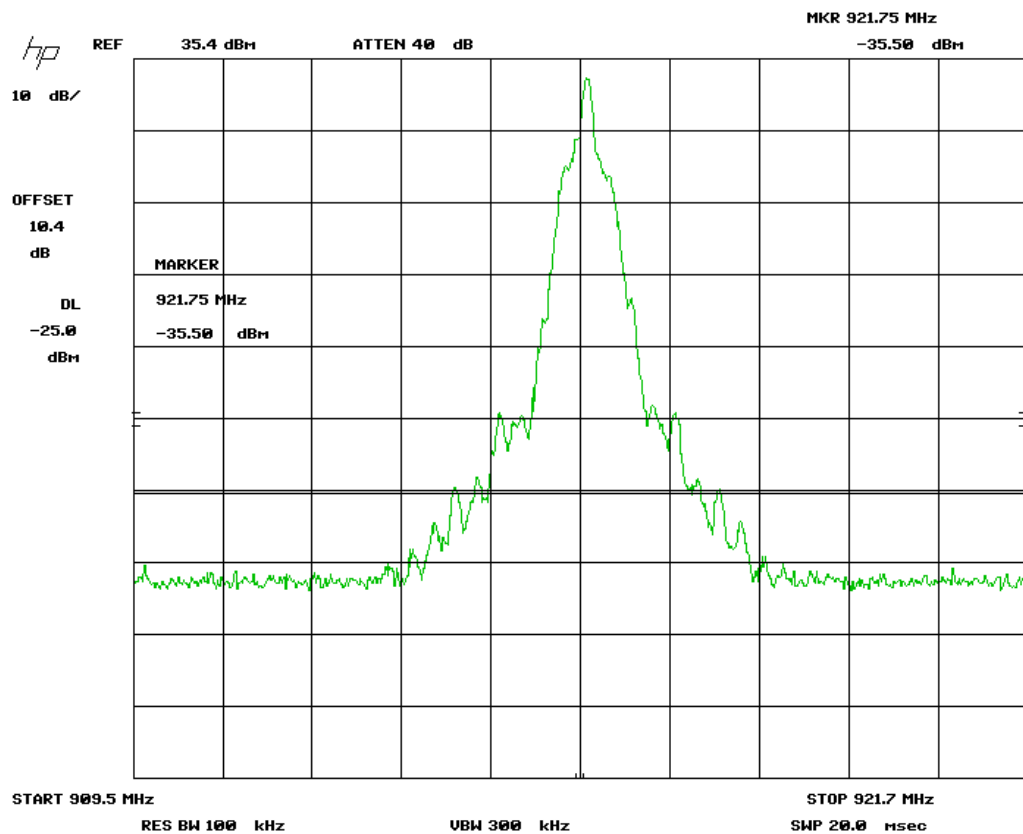
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


**Protocol: Allegro
909.5 MHz Band Edge**



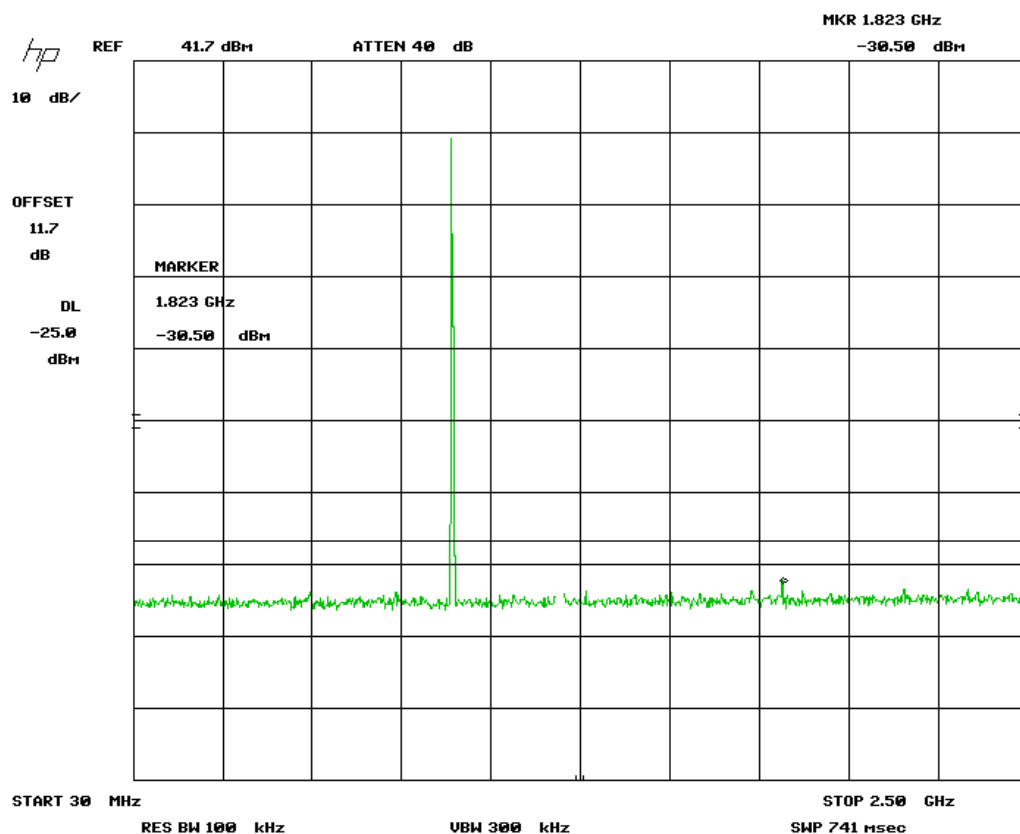
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: Allegro
921.75 MHz Band Edge



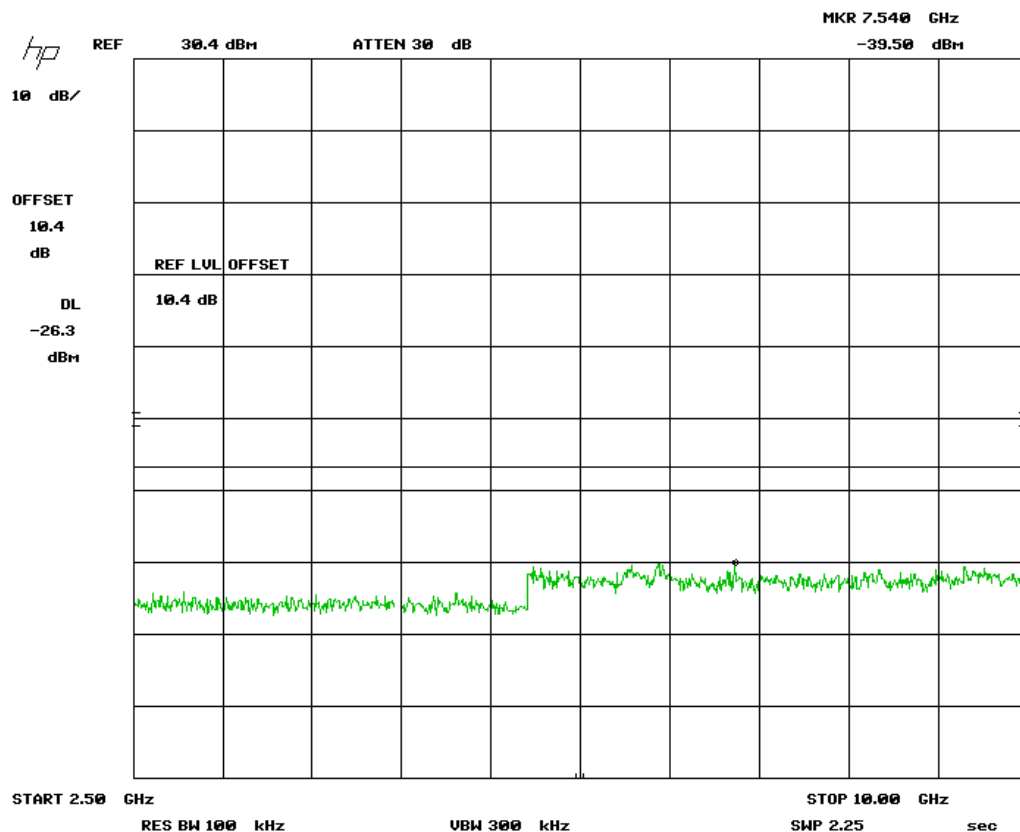
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: KTDm
30 MHz – 2.5 GHz



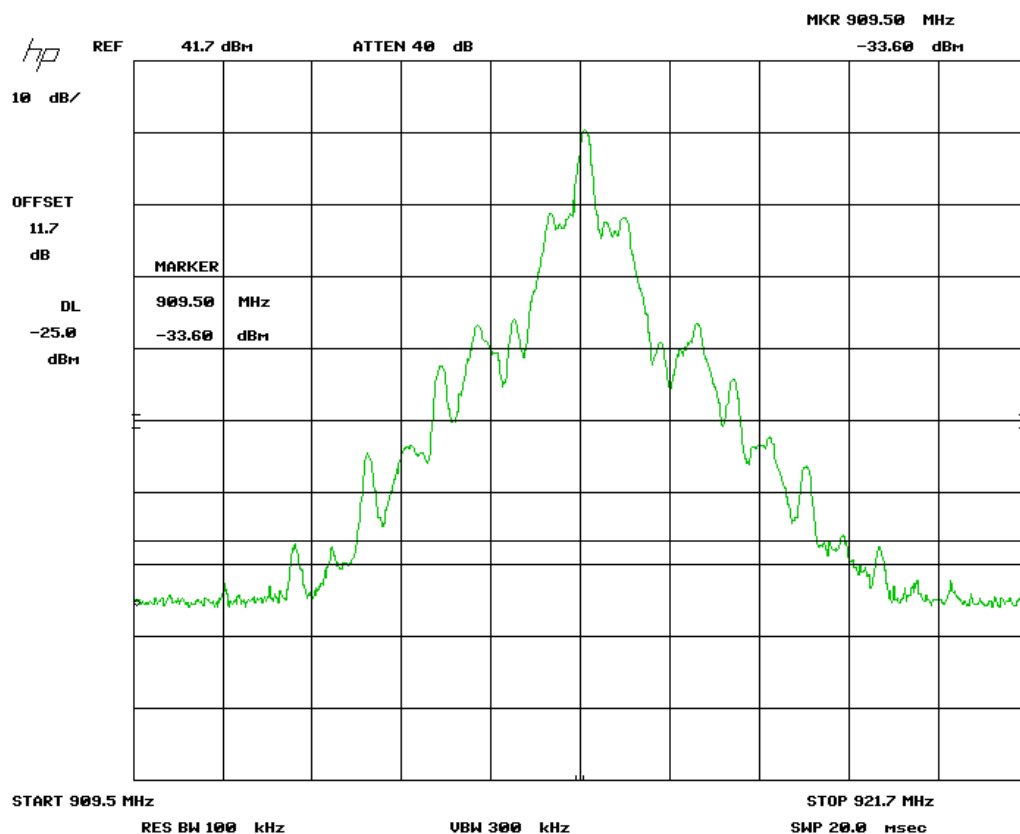
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: KTDM
2 GHz – 10 GHz



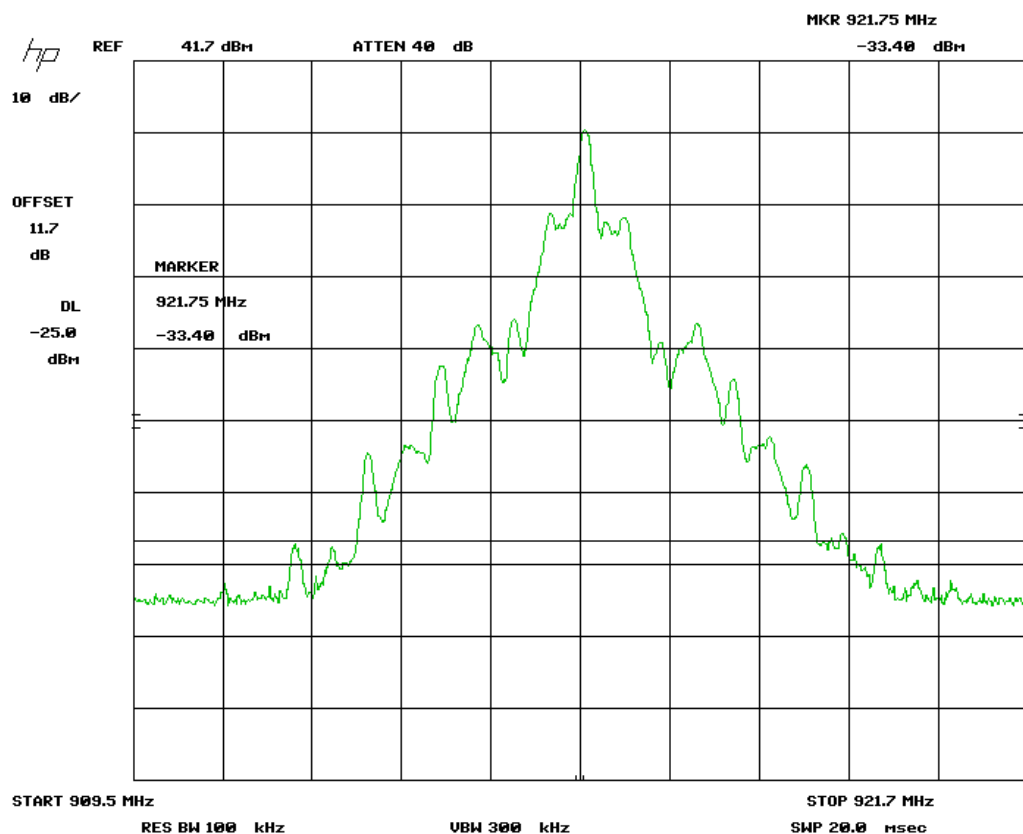
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: KTDM
909.5 MHz Band Edge



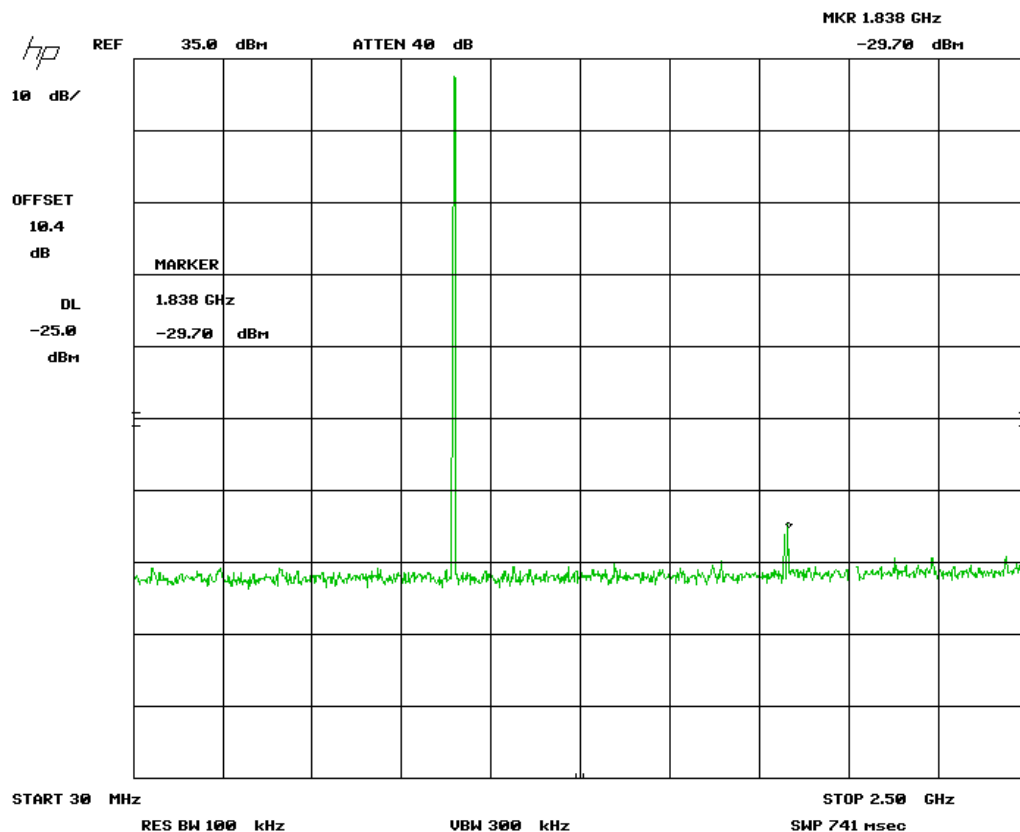
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: KTDM
921.75 MHz Band Edge



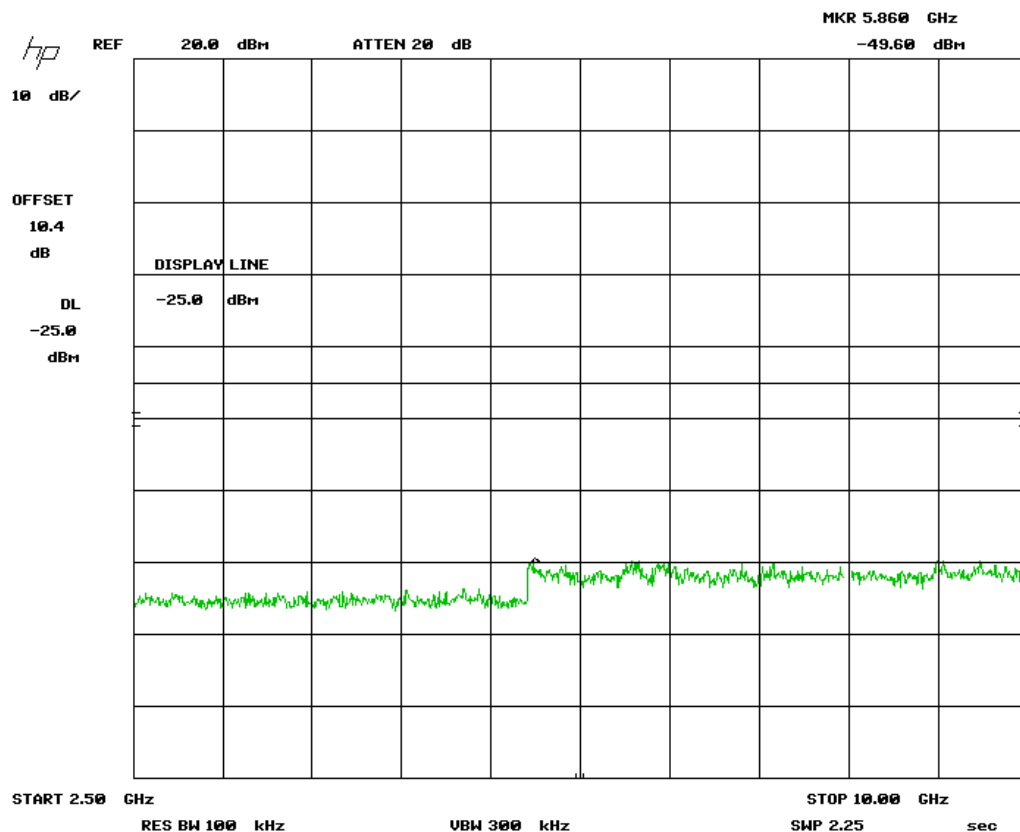
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: SeGO
High Channel 30 MHz – 2.5 GHz



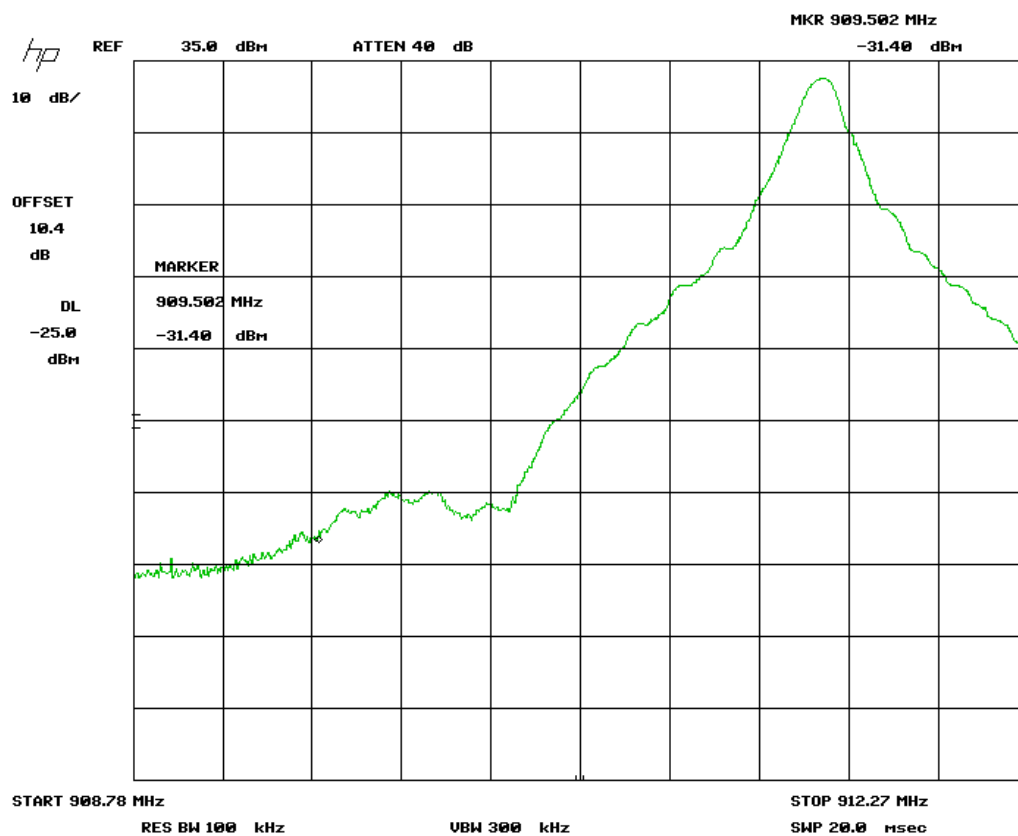
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: SeGO
High Channel 2.5 GHz – 10 GHz



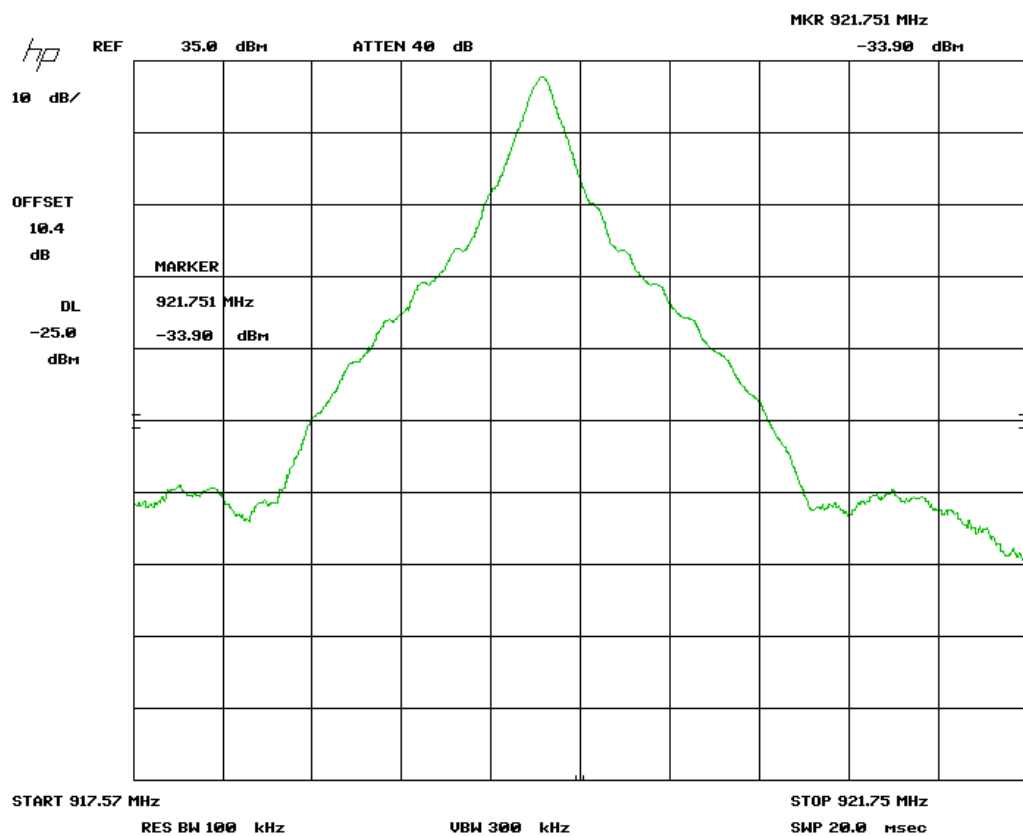
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: SeGO
Low Channel – 909.5 MHz Band Edge



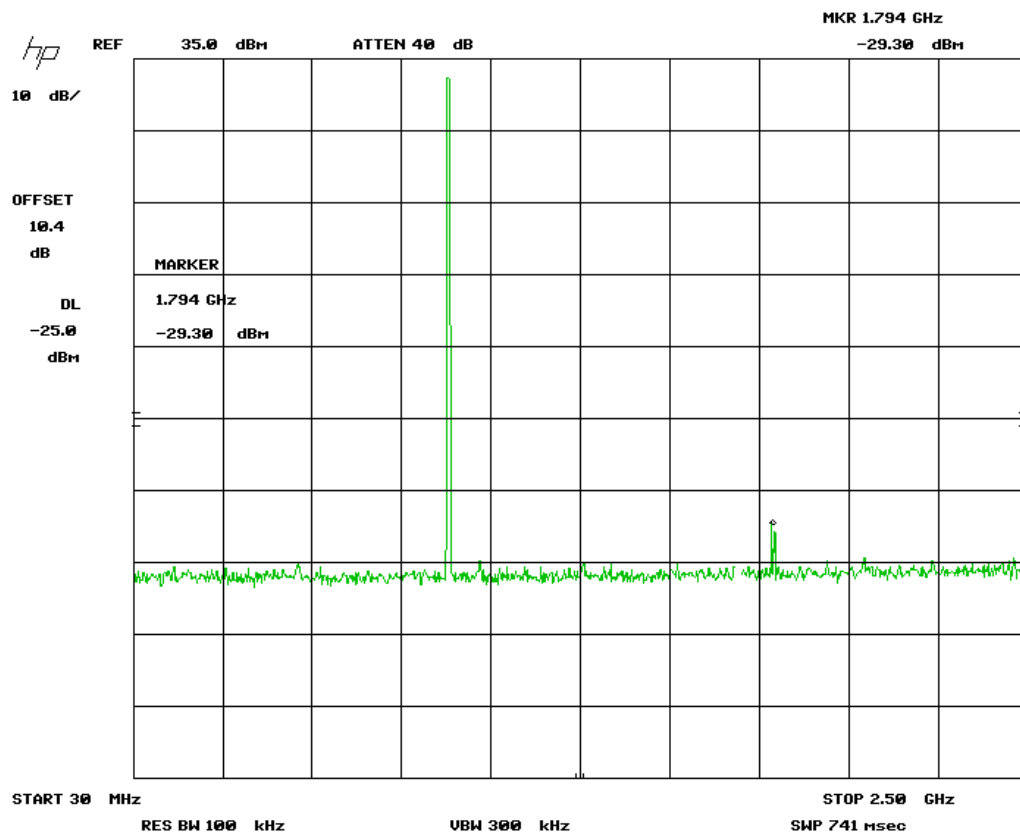
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: SeGO
High Channel – 921.75 MHz Band Edge



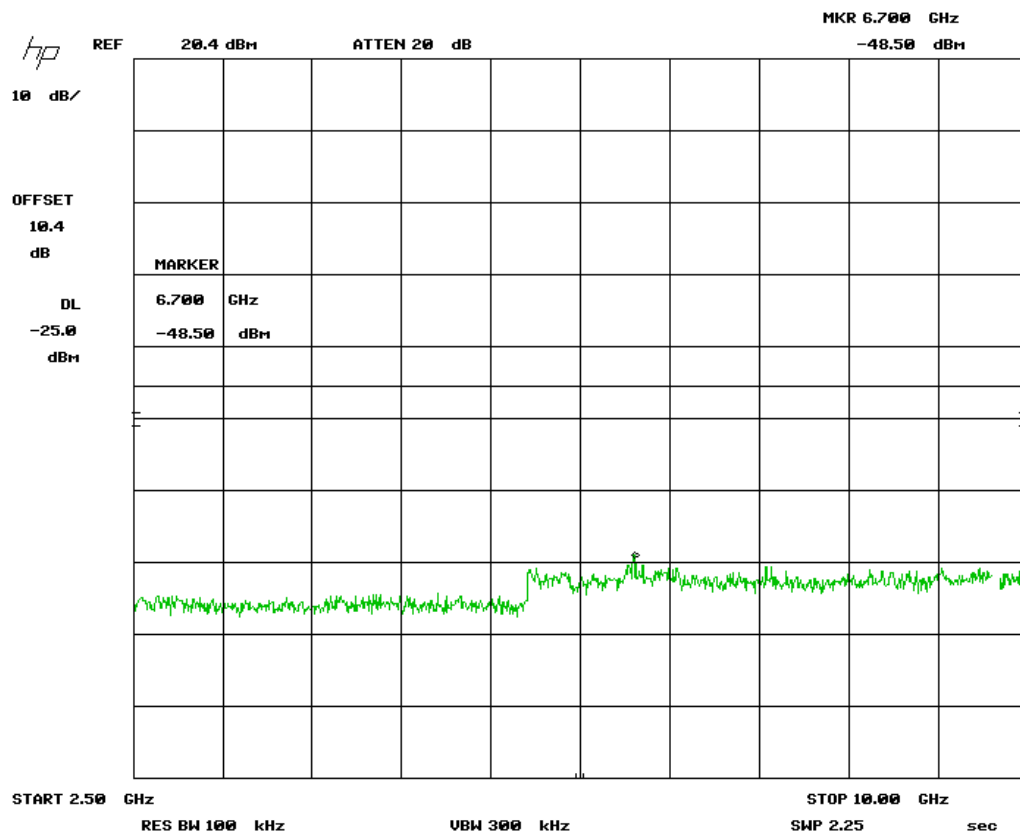
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: ATA
High Channel 30 MHz – 2.5 GHz



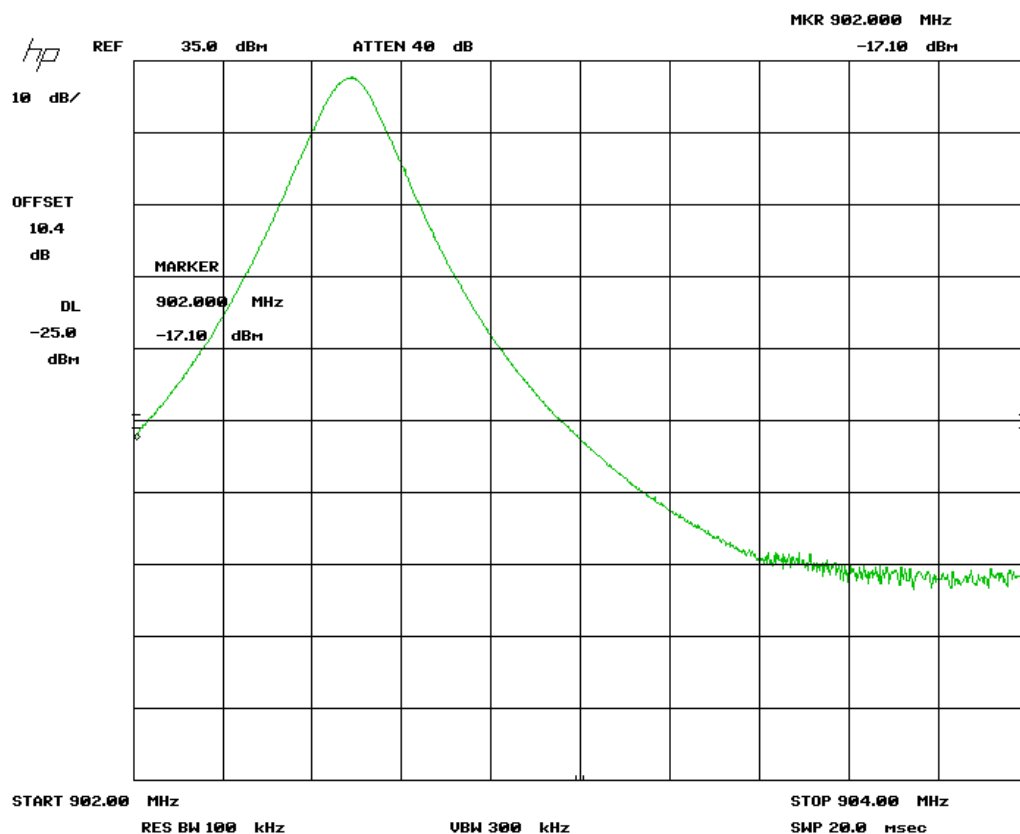
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Protocol: ATA
High Channel 2.5 MHz – 10 GHz



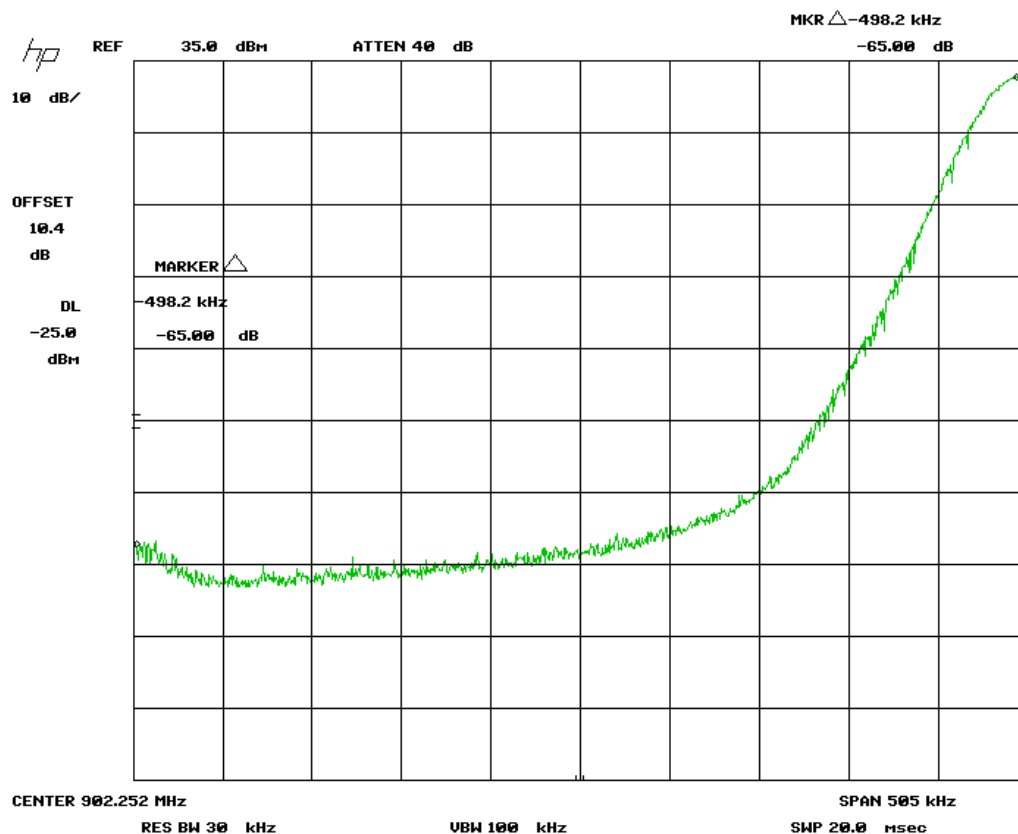
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: ATA – 902 – 904 MHz Sub-Band
Low Channel – 902 MHz Band Edge**




Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

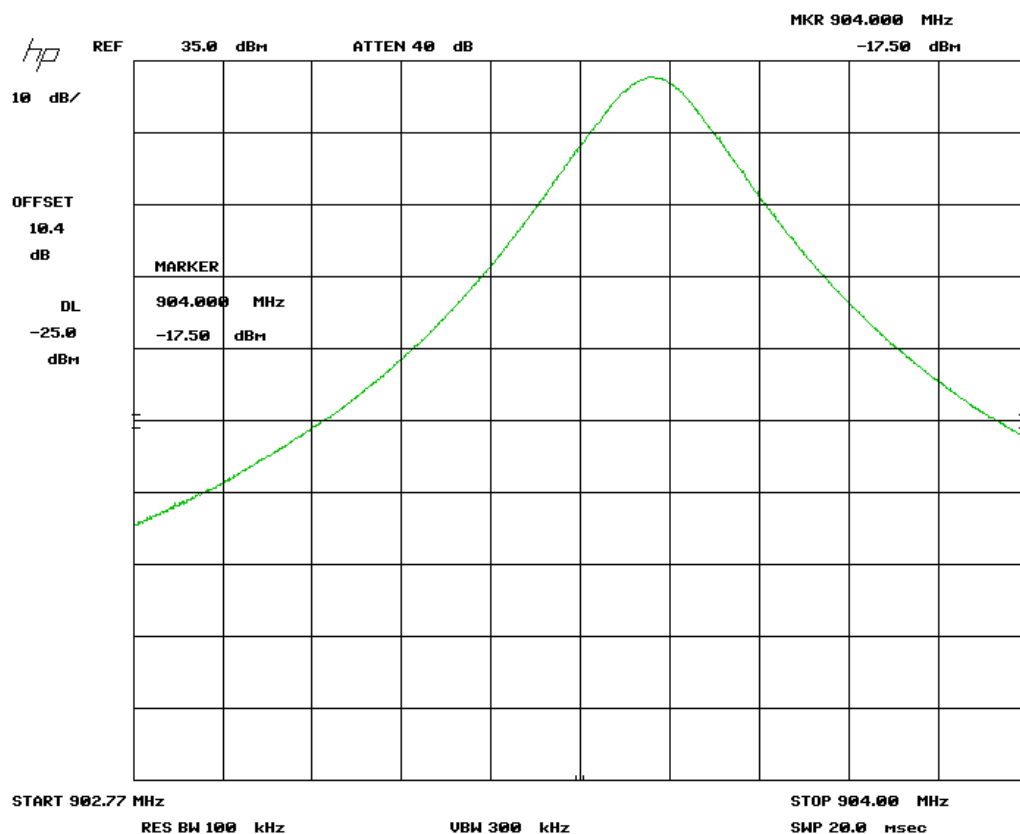
**Protocol: ATA – 902 – 904 MHz Sub-Band
Low Channel – 902 MHz Marker Delta**




Note: Marker Delta, as per attached FCC inquiry, was applied to the 902 MHz Band edge.
See tables for details.

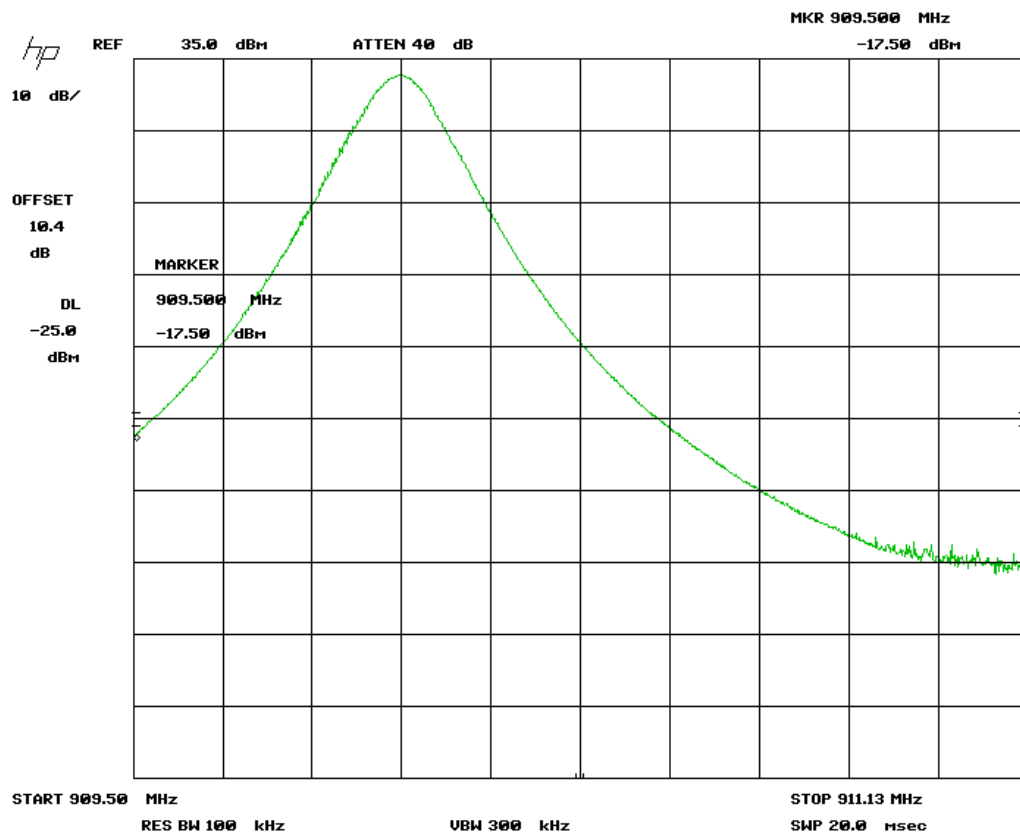
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


**Protocol: ATA – 902 – 904 MHz Sub-Band
High Channel – 904 MHz Band Edge**



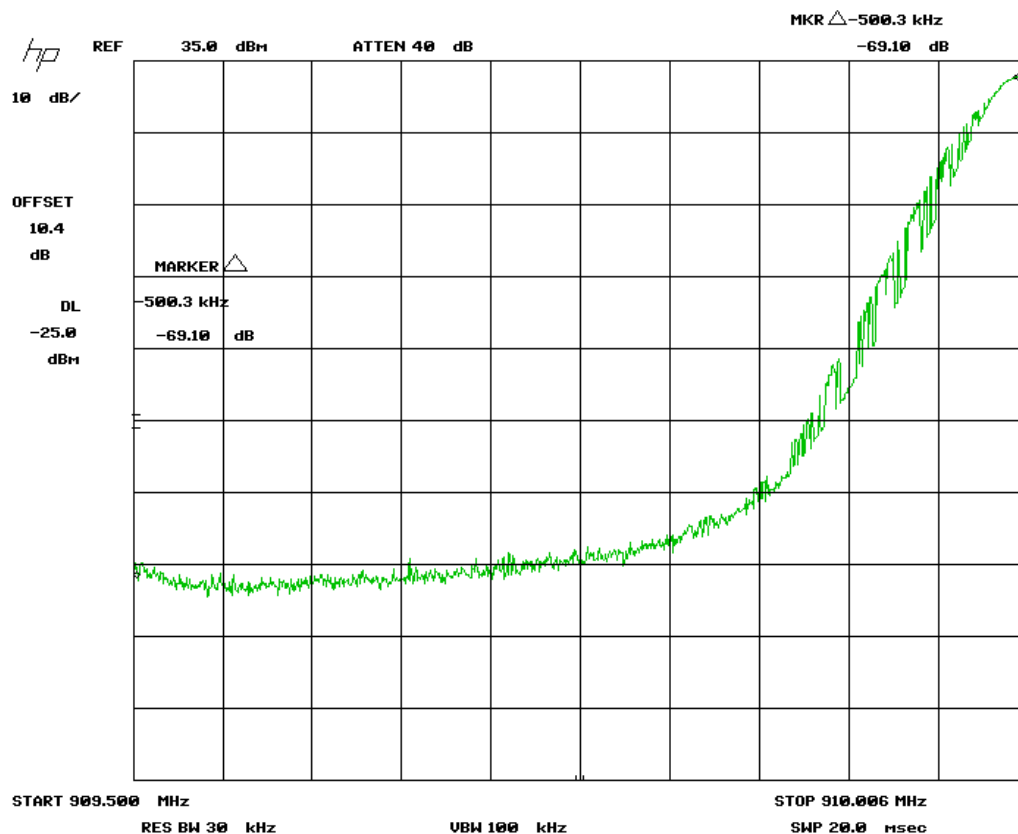
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: ATA – 909.75 – 921.75 MHz Sub-Band
Low Channel – 909.5 MHz Band Edge**




Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

**Protocol: ATA – 909.75 – 921.75 MHz Sub-Band
Low Channel – 909.5 MHz Marker Delta**



Note: Marker Delta, as per attached FCC inquiry, was applied to the 909.5 MHz Band edge. See tables for details.

See 'Appendix B – EUT & Test Setup Photographs' for photos showing the test set-up.


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Final Measurements

Note: All measurements were made with an external 10 dB attenuator. The attenuator and cable insertion loss were adjusted with Reference Level Offset function in the spectrum analyzer.

Protocol	Frequency (MHz)	Level (dBm)	Limit (dBm)	Margin (dB)
ATA	902	-31.39	-25	6.39 ^a
ATA	904	-31.63	-25	6.63 ^a
ATA	909.5	-35.57	-25	10.57 ^a
ATA	921.75	-30.80	-25	5.8 ^a
ATA	1805	-33.60	-25	8.6
Allegro	909.5	-37.3	-25	12.3
Allegro	921.75	-35.5	-25	10.5
Allegro	1823	-37.0	-25	12
KTDM	909.5	-34.4	-25	9.4
KTDM	921.75	-33.4	-25	8.4
KTDM	1823	-30.5	-25	5.5
SeGO	909.5	-31.5	-25	6.5
SeGO	921.75	-33.9	-25	8.9
SeGO	1839	-34.8	-25	9.8
6B	909.5	-29.9	-25	4.9
6B	921.75	-28.1	-25	3.1
6B	1841	-34.2	-25	9.2
6C	902	-31.8	-25	6.8
6C	904	-30.2	-25	5.2
6C	909.5	-28.6	-25	3.6
6C	921.75	-34.8	-25	9.8
6C	1823	-34.3	-25	9.3


Note a: Marker Delta were used obtain these margins.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Inmet Med. Power 10dB Attenuator	12N-10	Inmet	NCR	NCR	GEMC6405
1.2 GHz High pass filter	5IH30-1078	K & L Microwave	NCR	NCR	GEMC118
Spectrum Analyzer	8566B	HP	2013-10-02	2015-10-02	GEMC190
Quasi Peak Adapter	85650A	HP	2013-10-01	2015-10-01	GEMC191
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29

This report module is based on GEMC template "FCC – Power Line Conducted Emissions Class B_Rev1"

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Transmitter Spurious Radiated Emissions

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the limits listed below as defined in the applicable test standard, as measured from a receiving antenna. This helps protect broadcast radio services such as television, FM radio, pagers, cellular telephones, emergency services, and so on, from unwanted interference.

Limit(s) and Method

The method is as defined in FCC 2.1053 and the limits are as defined in FCC Part 90.210(K).

(3) *Other transmitters.* For all other transmitters authorized under subpart M that operate in the 902-928 MHz band, the peak power of any emission shall be attenuated below the power of the highest emission contained within the licensee's sub-band in accordance with the following schedule:

(i) On any frequency within the authorized bandwidth: Zero dB.

(ii) On any frequency outside the licensee's sub-band edges: $55 + 10 \log(P)$ dB, where (P) is the highest emission (watts) of the transmitter inside the licensee's sub-band.

Spurious radiated emissions of the EUT was performed at 3 meters. The limit specified in FCC 90.210 (K) is $55 + 10 \log(P)$ dBc. For all intensive purpose, the limit is -25 dBm. The field strength limit for the EUT is give in the below:

$$E(\text{dB}\mu\text{V/m}) = \text{ERIP}(\text{dBm}) + 95.2$$


$$\text{Where EIRP} = \text{ERP} + 2.15$$

$$E(\text{dB}\mu\text{V/m}) = \text{ERP}(\text{dBm}) + 97.35$$

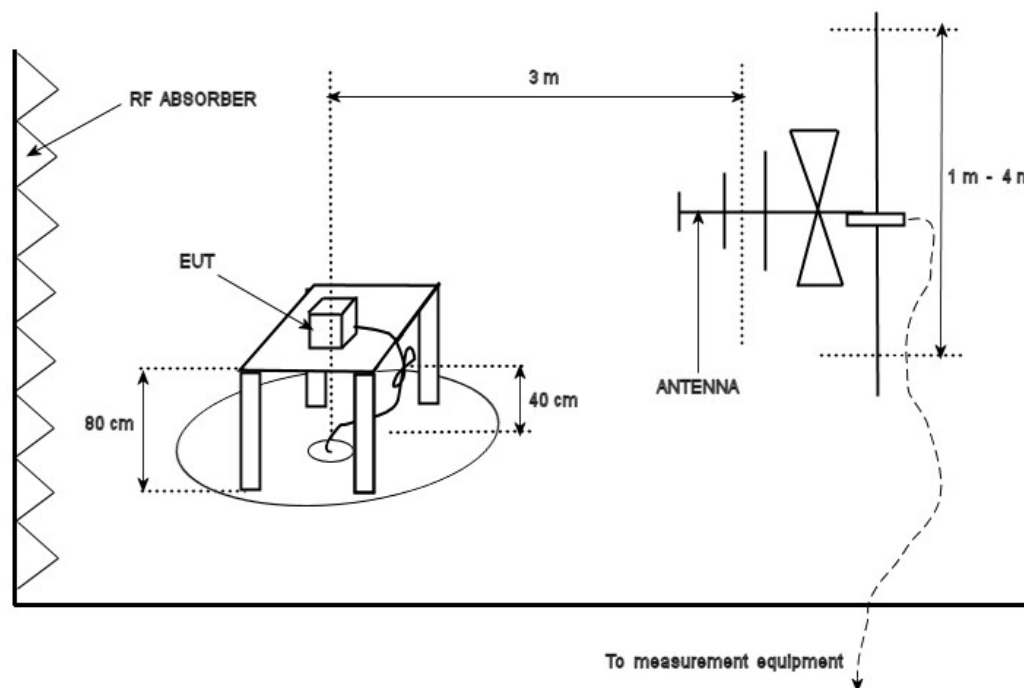
$$E(\text{dB}\mu\text{V/m}) = -25 \text{ dBm} + 97.35 = 72.35 \text{ dBuV}$$

This limit is applicable all emission at 3 meter measurement distance.

The Limit is with 100 kHz measurement bandwidth and using a Peak detector.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Typical Radiated Emissions Setup



Measurement Uncertainty


The expanded measurement uncertainty is calculated in accordance with CISPR 16-4-2 and is +/-4.4 dB with a 'k=2' coverage factor and a 95% confidence level.

Preliminary Graphs

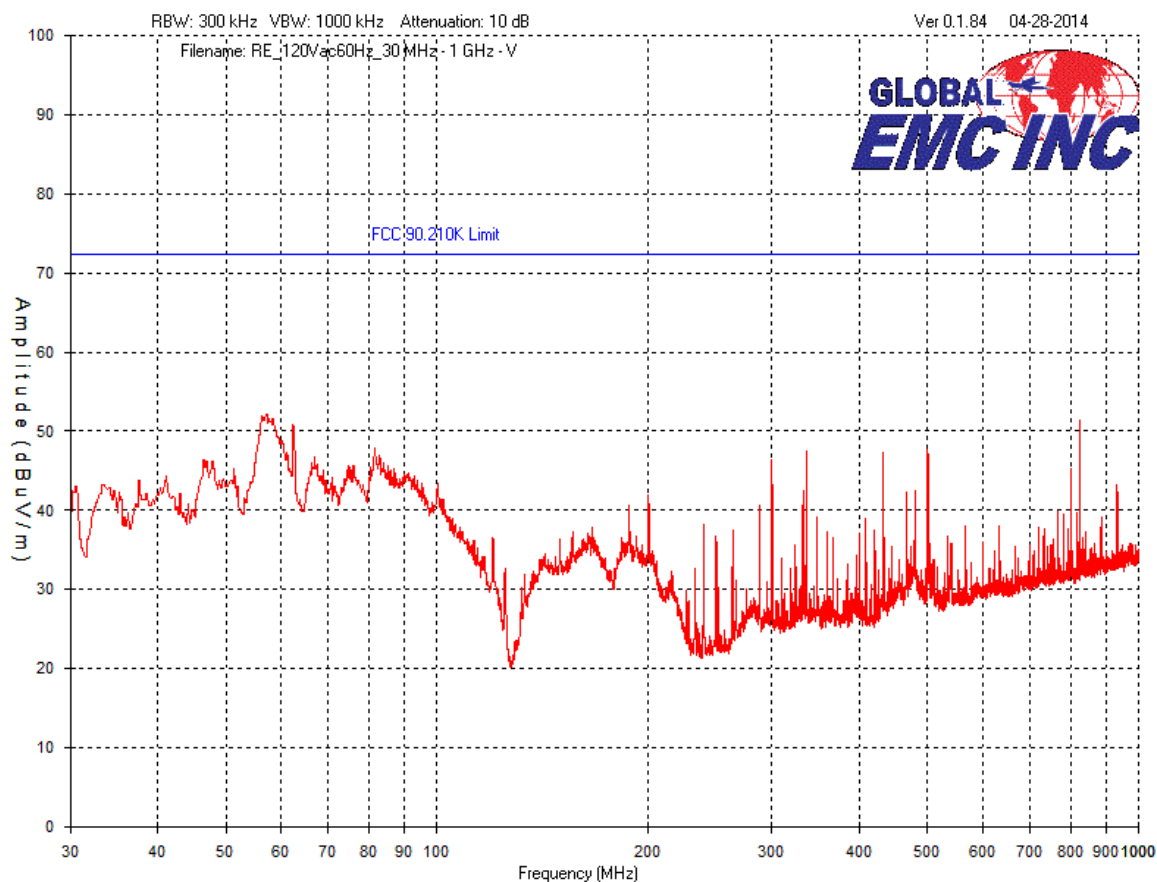
Note the graphs shown below are for graphical illustration only. For final measurements with the appropriate detector, please refer to the final measurement table where applicable. The graph shown below is a maximized peak measurement graph, measured with a resolution bandwidth greater than the final required detector and over a full 0-360 rotation. This peaking process is done as a worst case measurement. This process enables the detection of frequencies of concern for final measurement, and provides considerable time savings.


The device was scanned to the 10th harmonic (a minimum of a 10 GHz).

The measured radiation includes the emissions from the reader being used to control the EUT.

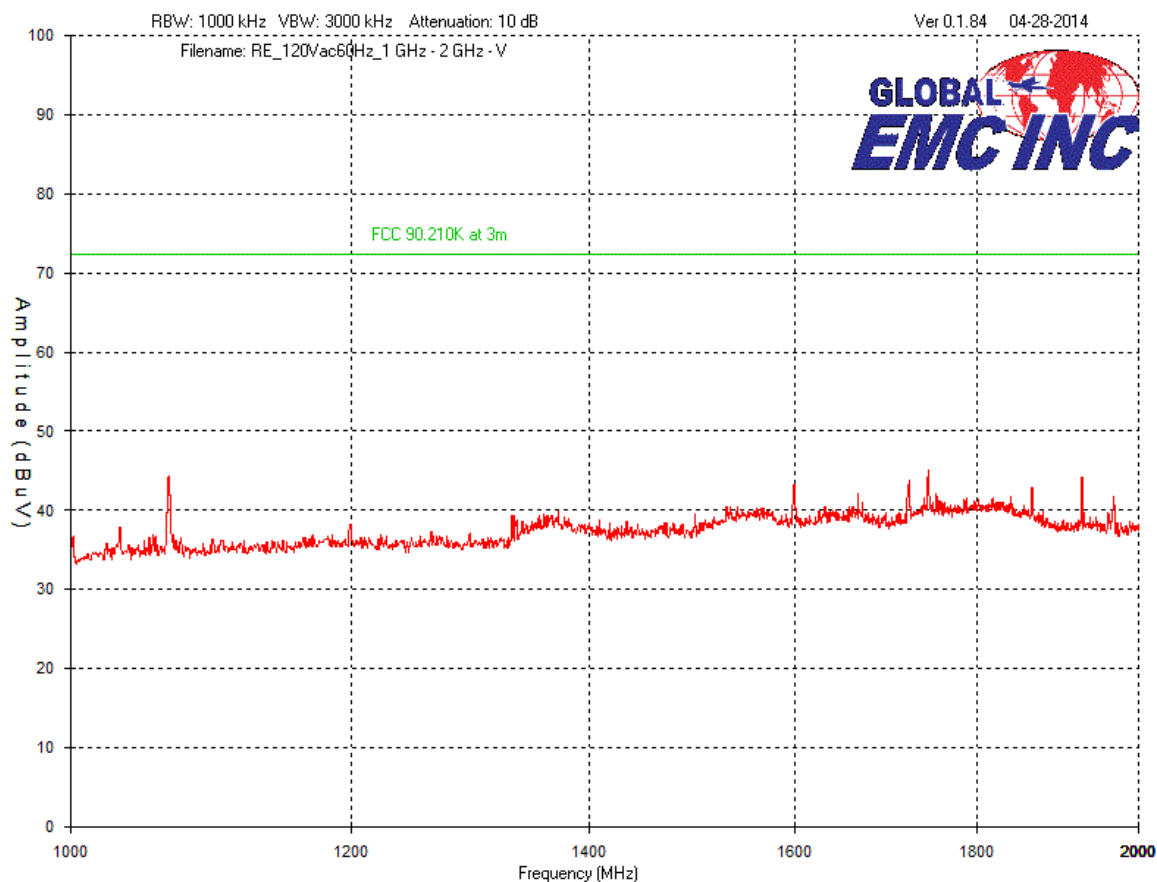
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Vertical – Peak Emission Graph 30 MHz – 1 GHz



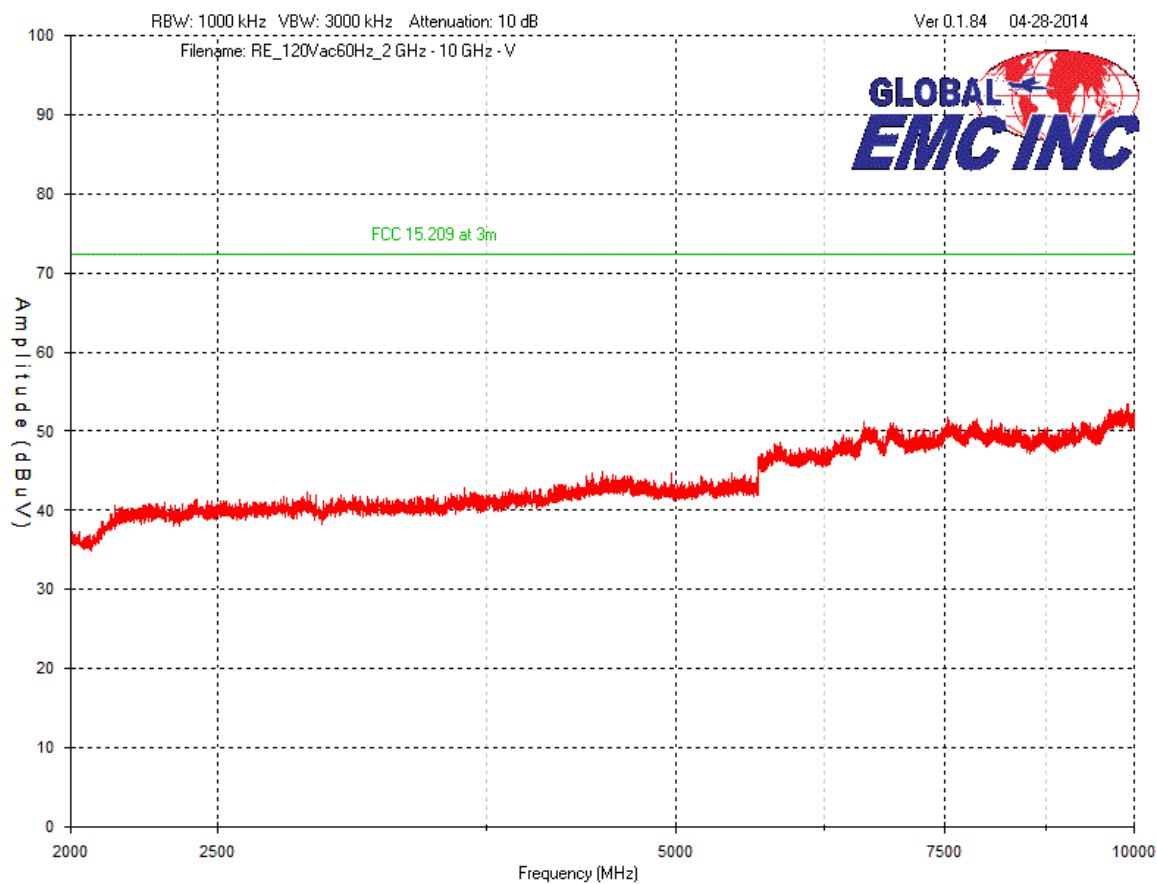
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Vertical – Peak Emission Graph 1 GHz – 2 GHz



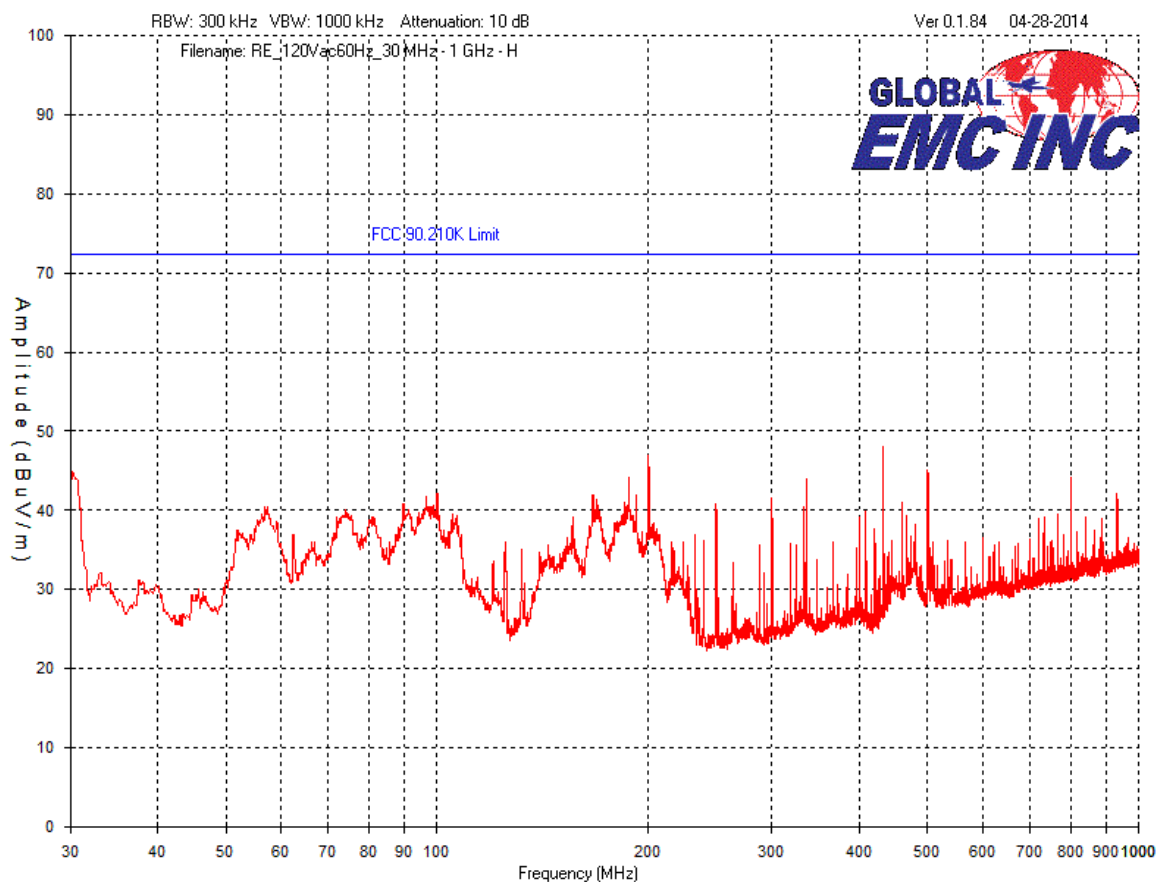
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Vertical – Peak Emission Graph 2 GHz – 10 GHz



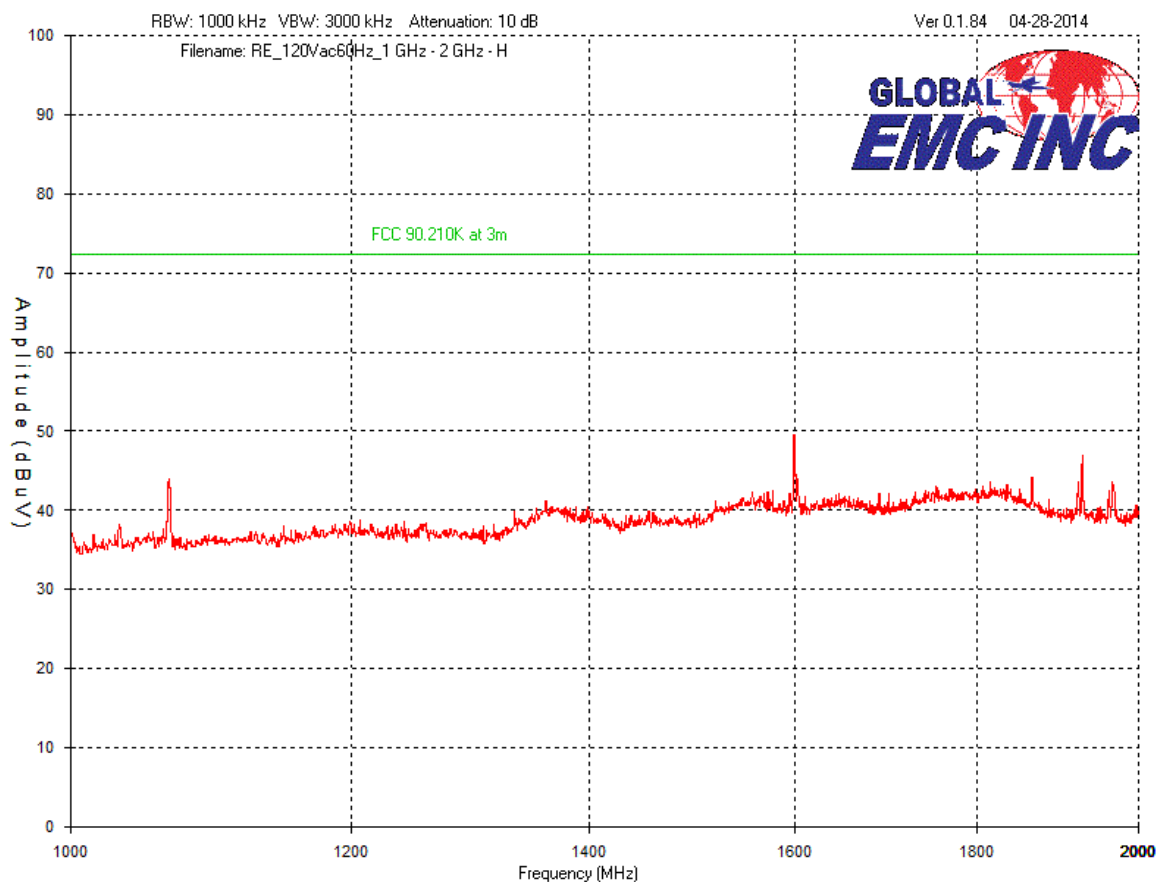
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Horizontal – Peak Emission Graph 30 MHz – 1 GHz



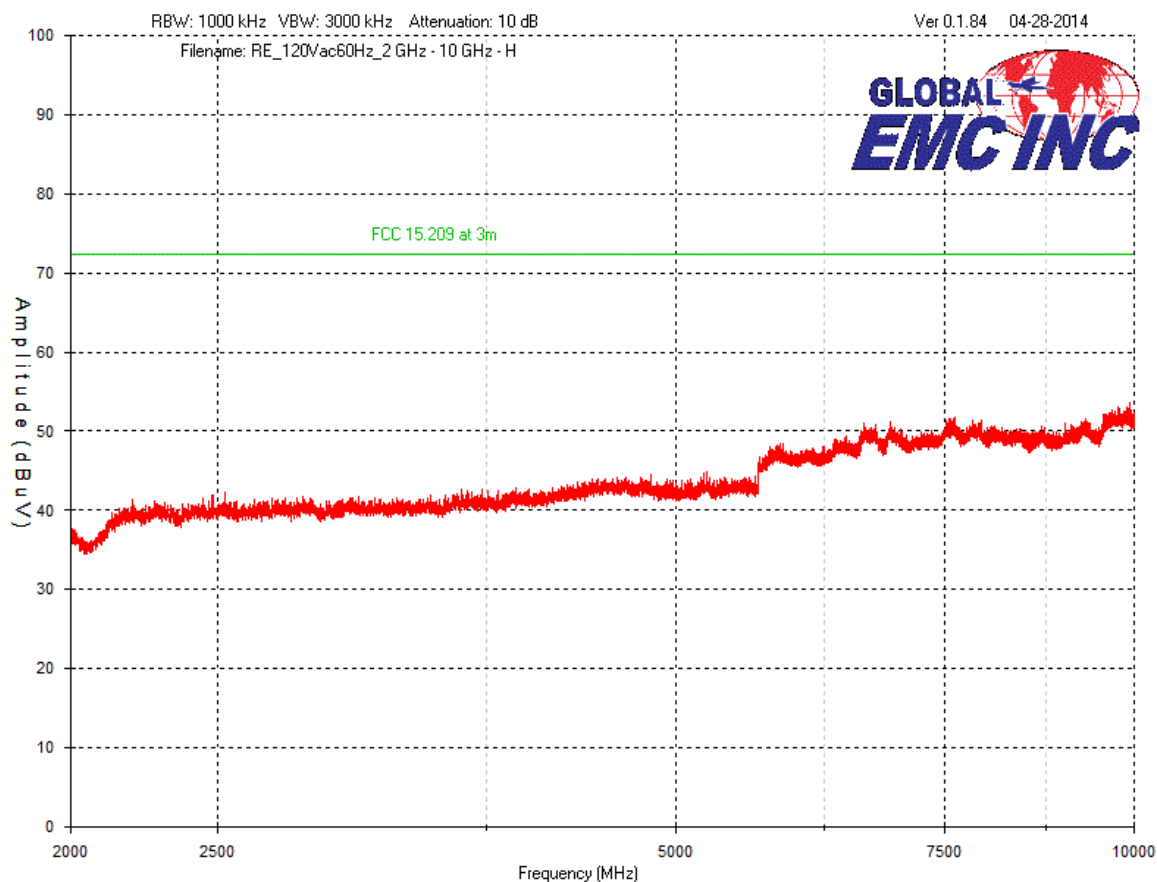
Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Horizontal – Peak Emission Graph 1 GHz – 2 GHz



Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Horizontal – Peak Emission Graph 2 GHz – 10 GHz



Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Results

Pass.


The EUT meets the Transmitter Spurious Radiated Emissions requirements.

All scan were perform with a measurement bandwidth greater than the required bandwidth.
No peak emissions were above the limit.

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	8566B	HP	2013-10-02	2015-10-02	GEMC190
Quasi Peak Adapter	85650A	HP	2013-10-01	2015-10-01	GEMC191
BiLog Antenna	3142-C	ETS	Feb 4, 2013	Feb 4, 2015	GEMC 137
Band Reject Filter	BRC50722	Micro-Tronics	NCR	NCR	GEMC186
Chase Preamp 9kHz - 2 GHz	CPA9231A	Chase	8/29/2012	8/29/2014	GEMC 6403
Q-Par 1.5-18 GHz Horn	6878/24	Q-par	8/23/2012	8/23/2014	GEMC 6365
1-26G pre-amp	HP 8449B	HP	8/22/2012	8/22/2014	GEMC 6351
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
RF Cable 1m	LMR-400-1M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 29
RF Cable 0.5M	LMR-400-0.5M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 31

This report module is based on GEMC template "FCC - 15.209 - Radiated Emissions_Rev1.doc"

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Temperature Frequency Stability

Purpose

The purpose of this test is to ensure that the RF energy unintentionally emitted from the EUT does not exceed the permitted bandwidth during extreme temperature variations. This helps protect radio broadcasts and receivers with spectrum nearby to the equipment under test from unwanted interference. This also helps ensure proper reception of the intended signal by ensuring the transmit frequency is correct in any temperature.


Limit(s) and Method

The methods are given in FCC Part 2.1055. There limits given in FCC Part 90.213.

However, the device meets the following condition:

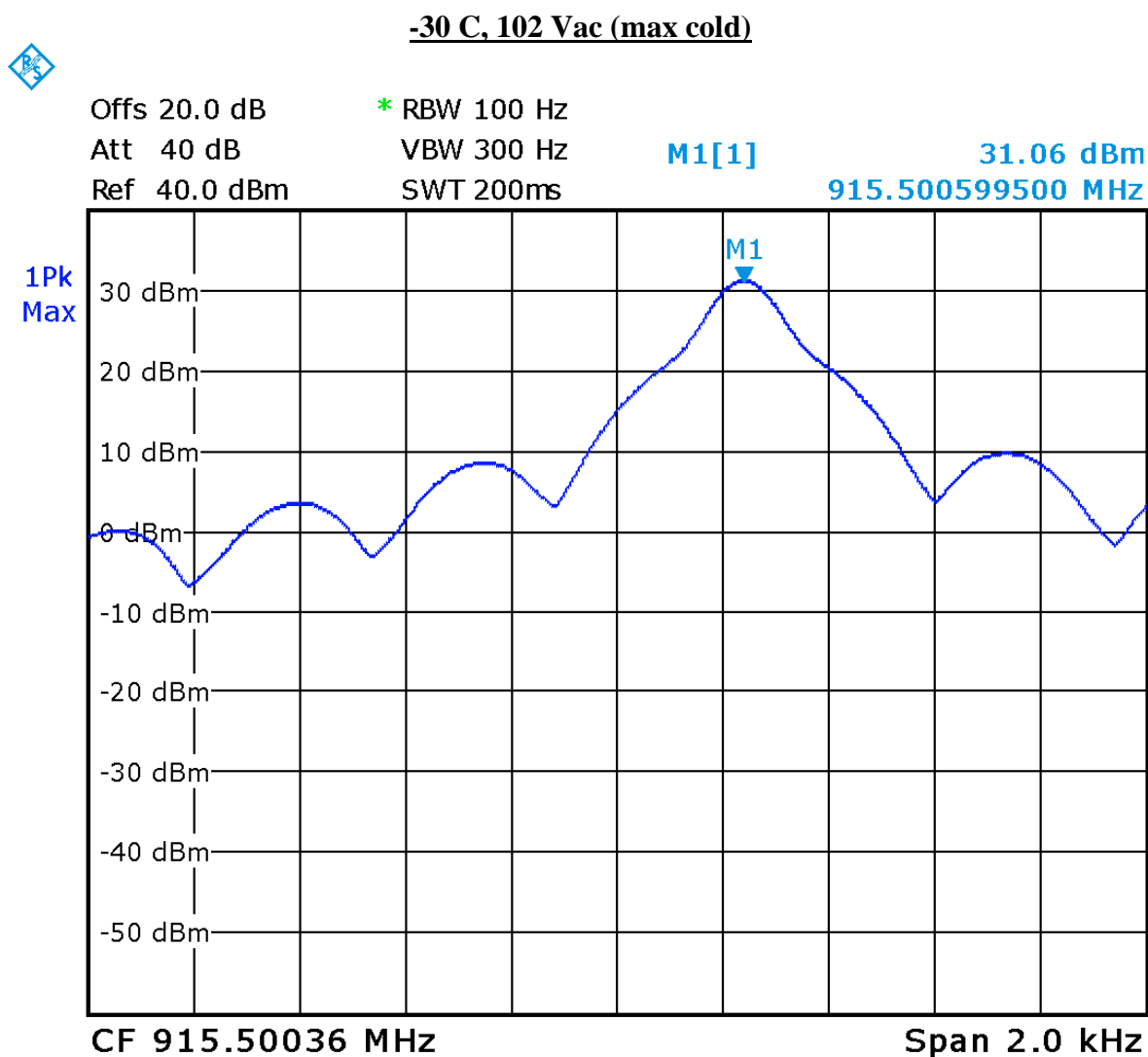
Fixed non-multilateration transmitters with an authorized bandwidth that is more than 40 kHz from the band edge, intermittently operated hand-held readers, and mobile transponders are not subject to frequency tolerance restrictions.

Frequency tolerances measurements are taken for information purpose. Frequency must be maintained from -30 C to +50 C. The EUT is monitored at each 10 degree increment. At each temperature, the device is checked after a stabilization period required for the device to reach the temperature.


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Measurement Graphs

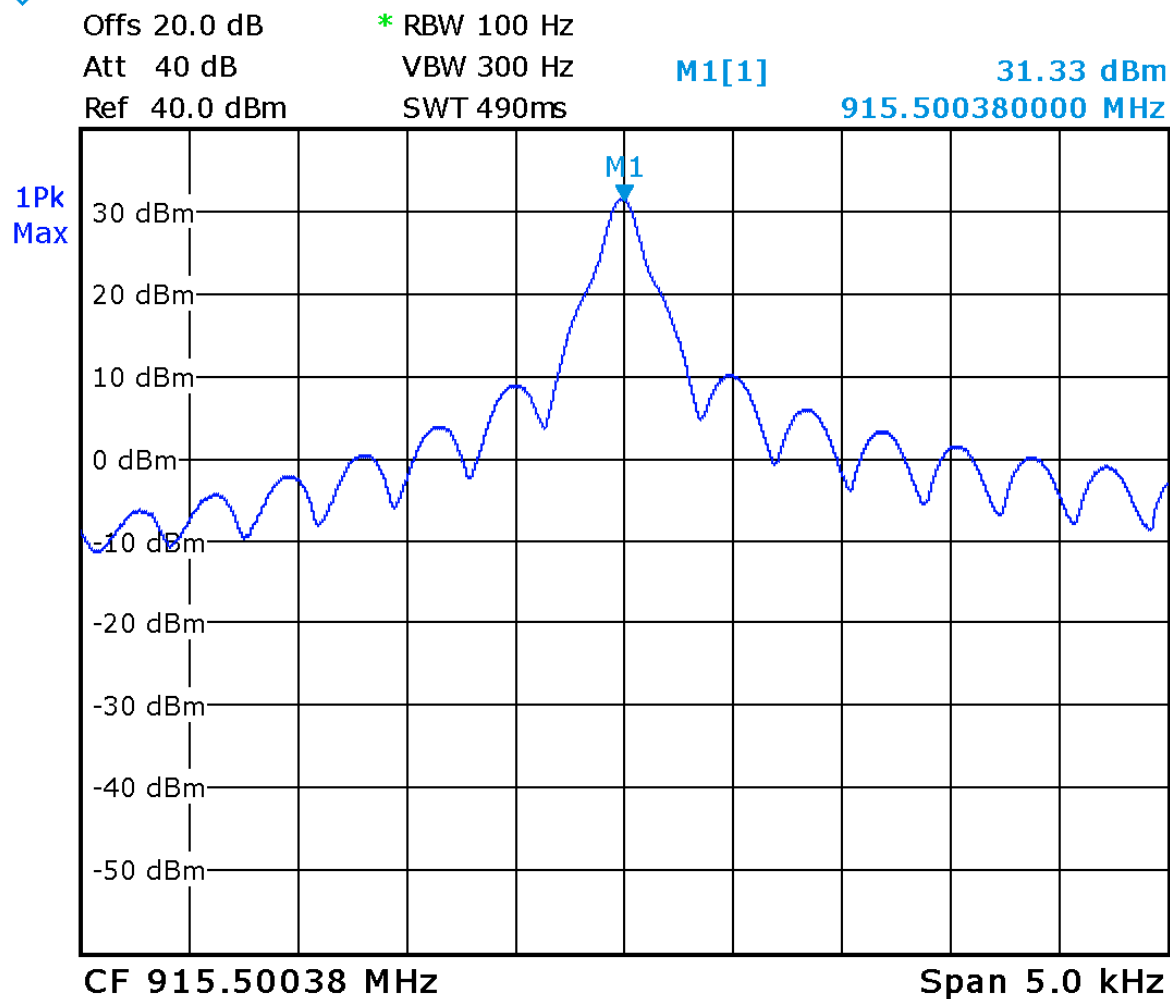
The worst case results are presented, with the frequency shown. The device was checked at each 10 degree increment of temperature




Date: 28.APR.2014 16:35:27

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

20C, 120 Vac (Room temperature)



Date: 28.APR.2014 14:36:53

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

+50C, 102Vac (max heat)



Offs 20.0 dB

* RBW 100 Hz

Att 40 dB

VBW 300 Hz

M1[1]

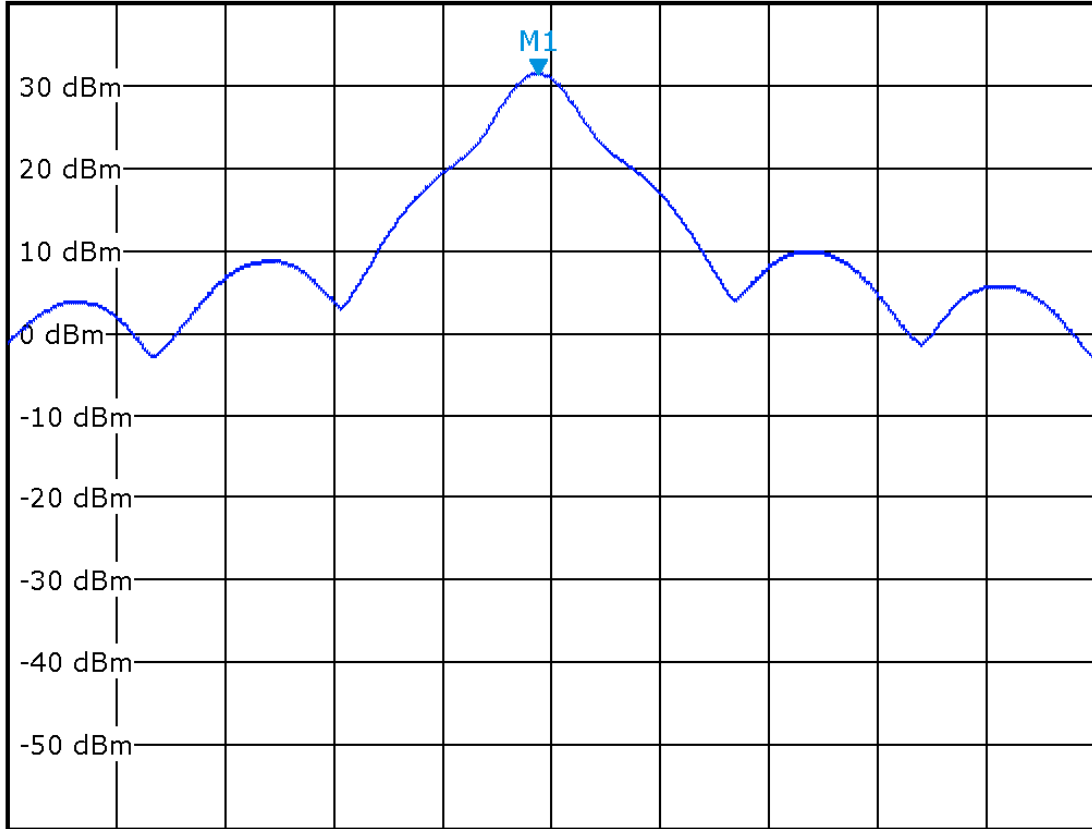
31.26 dBm

Ref 40.0 dBm

SWT 200ms

915.500336000 MHz


1Pk
Max



CF 915.50036 MHz

Span 2.0 kHz

Date: 28.APR.2014 18:41:23

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	


Table

Test Condition	Measured Frequency (MHz)	Frequency Drift (ppm)
+22°C, 120 Vac	915.5003800	
+22°C, 102 Vac	915.5003600	-0.022
+22°C, 138Vac	915.5003600	-0.022
-30°C, 120 Vac	915.5005955	0.235
-30°C, 102 Vac	915.5005995	0.240
-30°C, 138Vac	915.5005995	0.240
+50°C, 120 Vac	915.5003360	-0.048
+50°C, 102 Vac	915.5003360	-0.048
+50°C, 138Vac	915.5003360	-0.048

Test Equipment List

Equipment	Model No.	Manufacturer	Last calibration date	Next calibration due date	Asset #
Spectrum Analyzer	ESL 6	Rohde & Schwarz	15-Nov-2013	15-Nov-2015	GEMC 160
Attenuator 10 dB	8493B	Agilent	NCR	NCR	GEMC 133
RF Cable 7m	LMR-400-7M-50OHM-MN-MN	LexTec	NCR	NCR	GEMC 28
Environmental Chamber	SM-32-7800	Thermotron	NCR	NCR	GEMC 153

This report module is based on GEMC template "FCC - 15.225 - RFID Freq Stab_Rev1.doc"


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Appendix A – EUT Summary

For further details for filing purposes, refer to filing package.


General EUT Description

Client Details	
Organization / Address	Kapsch TrafficCom Canada Inc. 6020 Ambler Drive, Mississauga, Ont. Canada L4W 2P1
Contact	Richard Turnock, CTO
Phone	905-624-3020 x 7900
Email	richard.turnock@kapsch.net
Manufacturer Details (if not same as above)	
Organization / Address	
Contact	Alastair Malarky, Chief Engineer
Phone	905-624-3020 x 7900
Email	alastair.malarky@kapsch.net
EUT (Equipment Under Test) Details	
EUT Name (for report title)	JANUS Multi-Protocol Reader 2
EUT Model / SN (if known)	802295
EUT revision	002 Rev. CC
Software version	N/A
Equipment category	
EUT is powered using	DC
Input voltage range(s) (V)	15VDC and 5VDC
Frequency range(s) (Hz)	N/A
Nominal power consumption (W)	22W
Number of power supplies in EUT	None
Transmits RF energy? (describe)	Yes
Testing is required for the following standards	FCC 90, RSS 137, as NM-LMS transmitter and verification as receiver required under FCC 15.
Basic EUT functionality	See separate document CONF FCCID_Operation

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

description	Description
High level block diagram of EUT (attachment)	See separate document CONF FCCID_Operation Description
Modes of operation	See separate document CONF FCCID_Operation Description
Customer to setup EUT on site?	Yes
EUT response time (ms)	Click here...
EUT setup time (min)	
Frequency of all clocks present in EUT	48 MHz used for FPGA, 10 MHz reference for Synthesizer, 8 MHz for microcontroller, 500 kHz for power supplies
I/O cable description Specify length and type	N/A
Available connectors on EUT	See separate document CONF FCCID_Operation Description
Peripherals required to exercise EUT Ex. Signal generator	Kapsch Reader, test coupler and TDM test tag

Note the EUT is considered to have been received the date of the commencement of the first test, unless otherwise stated. For a close-up picture of the EUT, see ‘Appendix B – EUT & Test Setup Photographs’.

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Technical Specifications

Operation Band: 902 – 928 MHz

Modulation: On-Off Keying

Emission Designator ATA Protocol: N0N
6B, 6C, SeGO, Allegro, KTDM: K1D

Operation Frequency:

Protocol	ATA	Sego	6B	6C	Allegro	KTDM
TX modulation symbol rate	CW only	Manchester 80 kbps	Manchester Bi Phase 40 kbps	Pulse Interval Encoded 160 kbps	Manchester 300 kbps	Manchester 500 kbps
TX frequency range permitted	902.5 MHz to 903.5 MHz 910 MHz to 921.5 MHz	911.5 MHz to 919.5 MHz	911 MHz to 920.5 MHz	903MHz and 910.5 MHz to 920.5 MHz	915.75 MHz	915.75 MHz

EUT Configurations


Please see Appendix B for a picture of the unit running in normal conditions.

- Unit was installed in a Reader Electronics for all testing.
- During Transmitter spurious radiated emissions, RF output was dissipated in a 50 Ω load.
- Cables and earthing are connected as per manufacturer's specification.


Operational Setup

These devices are required to be attached to the EUT for its normal operation.

- The EUT transmits continuously

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Appendix B – EUT and Test Setup Photographs

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

Note: These photos are for information purposes only. Also refer to PDF files that are separate from this test report.



Illustration 1: 802295 front view


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	



Illustration 2: 802356 Radiated emission setup – photo 1


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	



Illustration 3: 802356 Radiated emission setup - photo 2


Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	



Illustration 4: 802356 Radiated setup - photo 3



Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	



Illustration 5: Antenna conducted emission setup

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

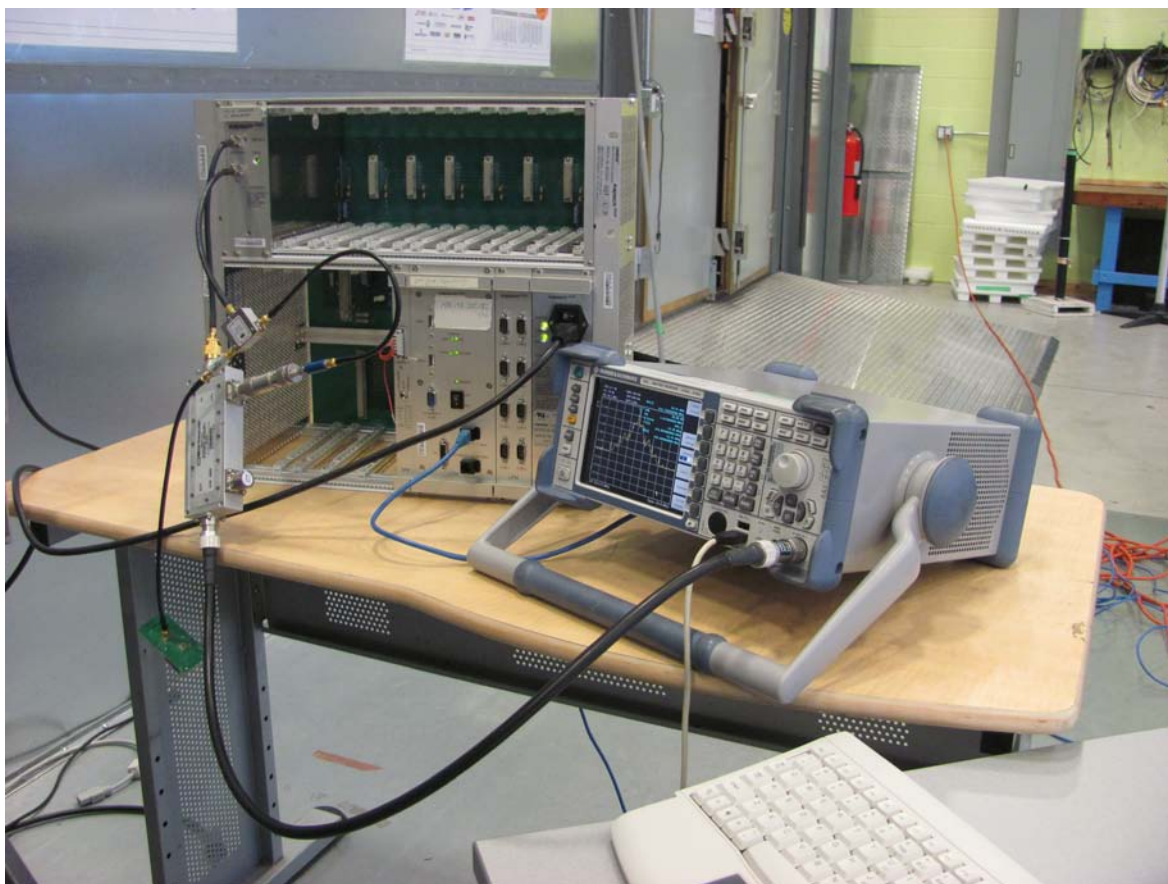



Illustration 6: Antenna conducted emission – KTDM setup with circulator

Client	Kapsch TrafficCom Canada Inc	
Product	JANUS Multi-Protocol RF Module-Smart	
Standard(s)	RSS-137 Issue 2:2009 / FCC Part 90 Subpart M:2014	

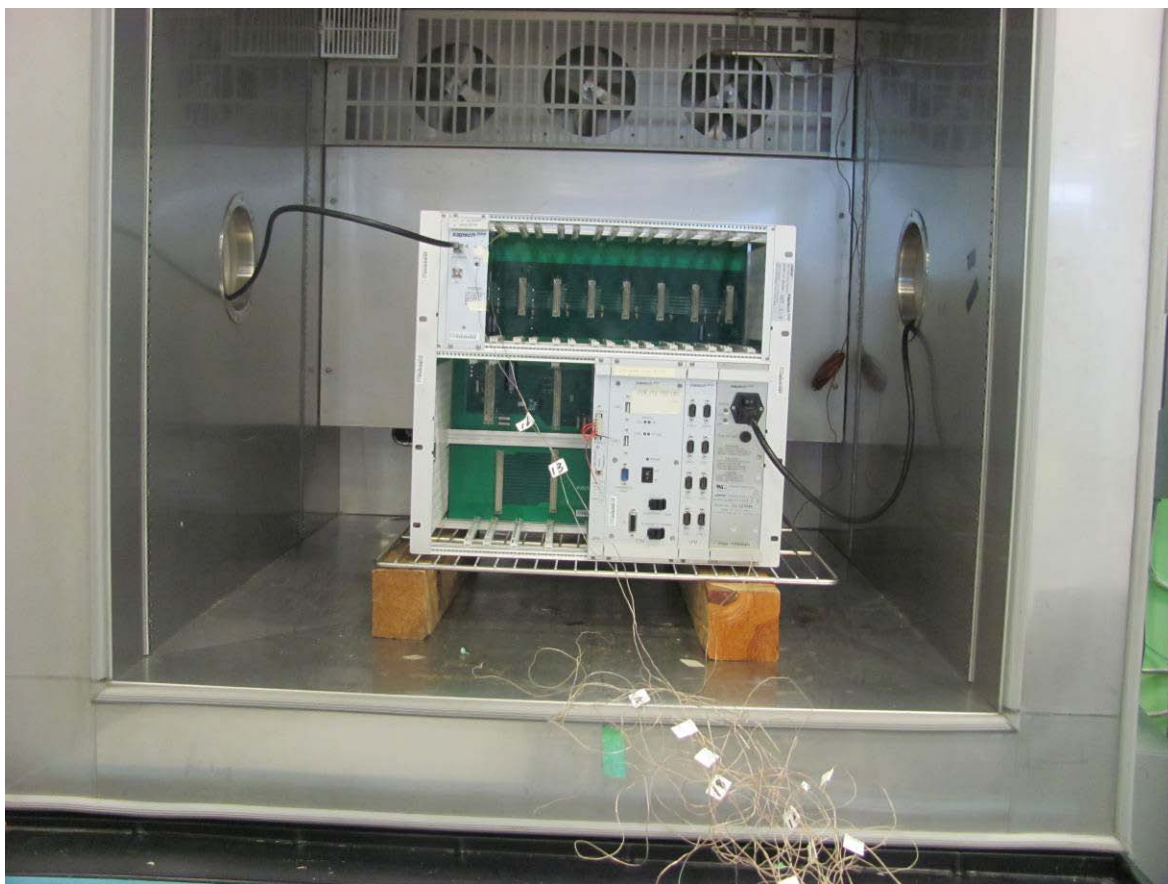


Illustration 7: Temperature stability setup - photo