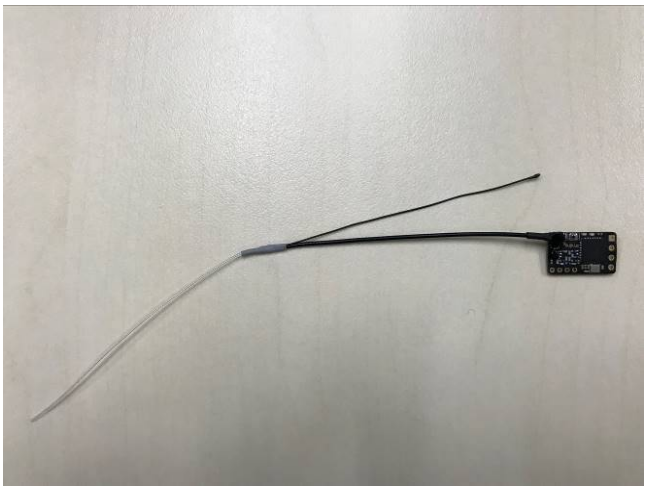
Prüfbericht-Nr.: *Test Report No.*:	**50159765 001**	**Auftrags-Nr.:** *Order No.*:	**144188446**	**Seite 1 von 18** *Page 1 of 18*
Kunden-Referenz-Nr.: *Client Reference No.*:	**N/A**	**Auftragsdatum:** *Order date*:	**27.06.2018**	
Auftraggeber: *Client*:	**TBS Avionics Limited 9/F, Tungtex Building, 203 Wai Yip Street, Kwun Tong, Hong Kong, China**			
Prüfgegenstand: *Test item*:	**915 MHz Receiver Module (Transceiver)**			
Bezeichnung / Typ-Nr.: *Identification / Type No.*:	**TBS Crossfire Nano Receiver**			
Auftrags-Inhalt: *Order content*:	**FCC Certification**			
Prüfgrundlage: *Test specification*:	**FCC Part 15 Subpart C ANSI C63.10-2013**			

Wareneingangsdatum: *Date of receipt*:	**08.08.2019**
Prüfmuster-Nr.: *Test sample No.*:	**A000801936-010**
Prüfzeitraum: *Testing period*:	**13.08.2019 - 04.10.2019**
Ort der Prüfung: *Place of testing*:	**Hong Kong**
Prüflaboratorium: *Testing laboratory*:	**TÜV Rheinland Hong Kong Ltd.**
Prüfergebnis*: *Test result**:	**Pass**



geprüft von / *tested by*:			**kontrolliert von** / *reviewed by*:		
12.12.2019	Mika Chan / Project Manager		12.12.2019	Sharon Li / Senior Unit Manager	
Datum *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*	**Datum** *Date*	**Name / Stellung** *Name / Position*	**Unterschrift** *Signature*

Sonstiges / *Other*: **FCC ID: QOS-RXNANO**

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the test item at delivery*:	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	1 = sehr gut	2 = gut	3 = befriedigend	4 = ausreichend	5 = mangelhaft
	P(ass) = entspricht o.g. Prüfgrundlage(n)		F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
Legend:	*1 = very good*	*2 = good*	*3 = satisfactory*	*4 = sufficient*	*5 = poor*
	P(ass) = passed a.m. test specification(s)		*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens.

This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.

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Product information

Manufacturers declarations

	Transceiver
Operating frequency range	902.75 - 927.25 MHz
Type of modulation	Frequency Hopping Spread Spectrum
Number of channels	50
Channel separation	0.5 MHz
Type of antenna	Dipole Antenna
Antenna gain (dBi)	2.0 dBi
Power level	fix
Type of equipment	stand alone radio device
Connection to public utility power line	No
Nominal voltage	7.6 VDC
Independent Operation Modes	Transmit and receive

Product function and intended use

The equipment under test (EUT) is an UHF long range receiver for drone. The TX function is for reporting drone flight status back to the controller. It is powered by 7.6 VDC battery.

FCC ID: QOS-RXNANO

Models	Product description
TBS **Crossfire Nano Receiver**	915 MHz Receiver Module (Transceiver)

Submitted documents

Circuit Diagram
Block Diagram
Technical Description
User manual
Label

Independent Operation Modes

The basic operation modes are:

- Transmitting mode.
- Receiving mode

For further information refer to User Manual

Related Submittal(s) Grants

This is a single application for certification of the UHF transmitter.

Remark

The test results in this test report are only relevant to the tested sample and does not involve any assessment in the production.

For the test result of receiver function, please refer to the test report 50308842 001 issued by TÜV Rheinland Hong Kong Ltd.

Test Set-up and Operation Mode

Principle of Configuration Selection

Emission: The equipment under test (EUT) was configured to measure its highest possible radiation level. The test modes were adapted accordingly in reference to the instructions for use.

Test Operation and Test Software

Test operation should refer to test methodology.

- During test, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power was selected according to the instruction given by the manufacturer. The setting of the RF output power expected by the customer shall be fixed on the firmware of the final end product.

Special Accessories and Auxiliary Equipment

The product has been tested together with the following additional accessories:

- NIL

Countermeasures to achieve EMC Compliance

- NIL

Test Methodology

Radiated Emission

The radiated emission measurements of the transmitter part were performed according to the procedures in ANSI C63.10-2013.

For measurement below 1GHz - the equipment under test (EUT) was placed at the middle of the 80 cm height turntable. For measurement above 1GHz - the EUT was placed at the middle of the 1.5 m height turntable and RF absorbing material was placed on ground plane between turntable and measuring antenna. During the testing, the EUT was operated standalone and arranged for maximum emissions. The EUT was tested in three orthogonal planes.

The investigation is performed with the EUT rotated 360 ˚, the antenna height scanned between 1m and 4m, and the antenna rotated to repeat the measurements for both the horizontal and vertical antenna polarizations. Repeat the measurement steps until the maximum emissions were obtained.

All radiated tests were performed at an antenna to EUT with 3 meters distance, unless stated otherwise in particular parts of this test report.

Field Strength Calculation

The field strength at 3 m was established by adding the meter reading of the spectrum analyzer to the factors associated with antenna correction factor, cable loss, preamplifiers and filter attenuation.

The equation is expressed as follow:

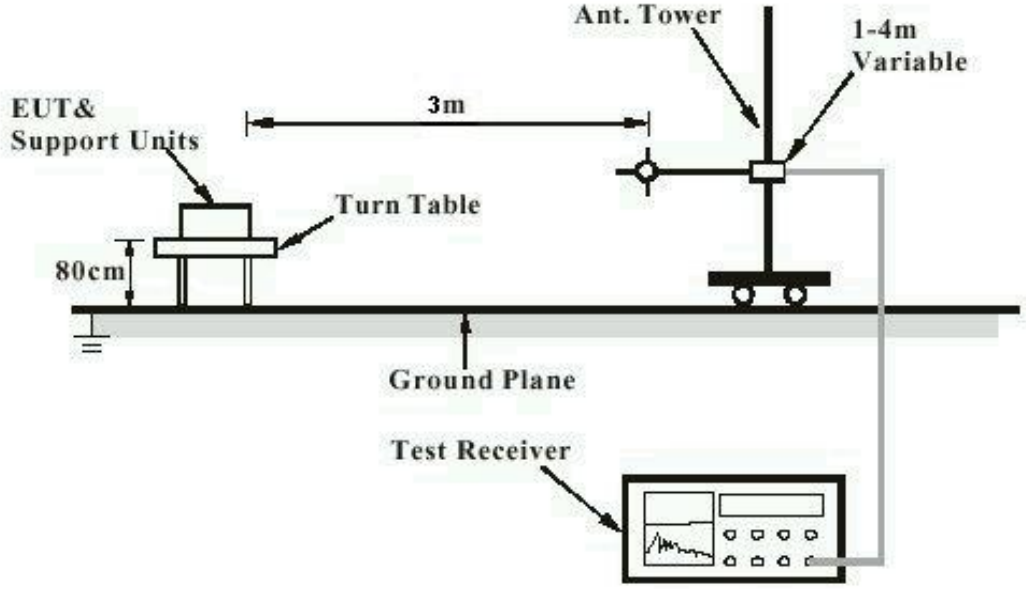
FS = R + AF + CF + FA – PA

Where FS = Field Strength in dBuV/m at 3 meters.
R = Reading of Spectrum Analyzer in dBuV.
AF = Antenna Factor in dB.
CF = Cable Attenuation Factor in dB.
FA = Filter Attenuation Factor in dB.
PA = Preamplifier Factor in dB.

FA and PA are only be used for the measuring frequency above 1 GHz.

Test Setup Diagram

Diagram of Measurement Configuration for Radiation Test



Note: Measurements above 1 GHz are done with a table height of 1.5m. In addition, there is RF absorbing material on the floor of the test site for above 1GHz measurement.

Diagram of Measurement Equipment Configuration for Mains Conduction Measurement (if applicable)

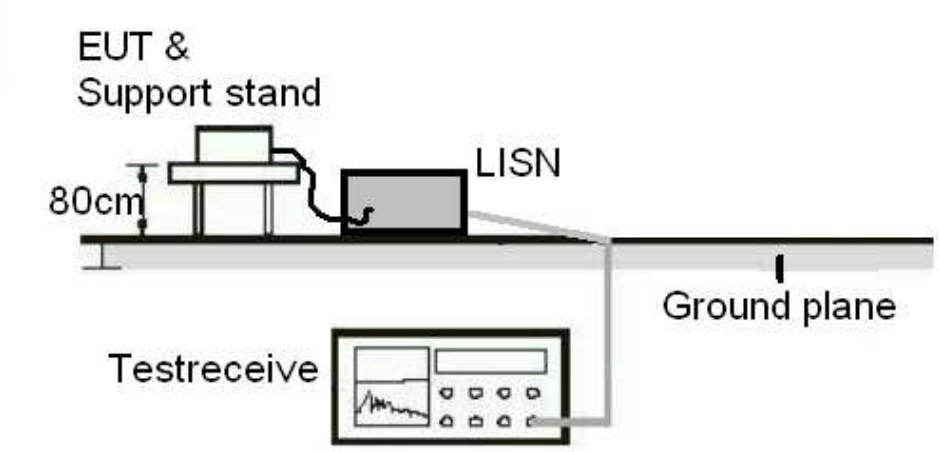
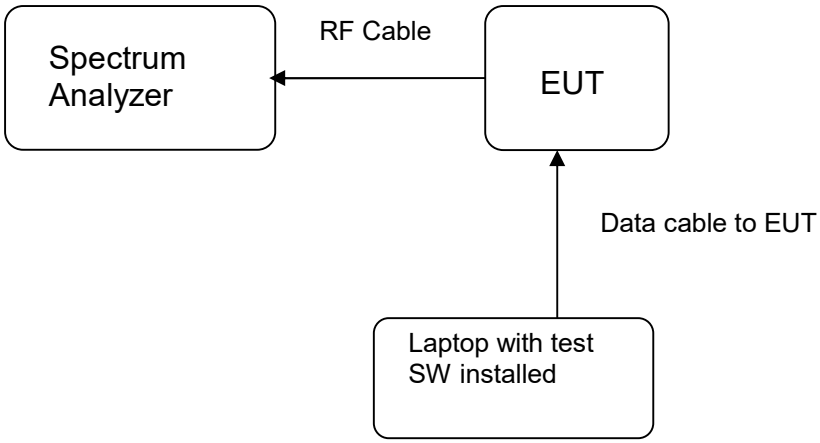


Diagram of Equipment Configuration for Antenna-port Conducted Measurement (if applicable)



Test Facility

Test Laboratory Information

TÜV Rheinland Hong Kong Ltd.
Address: 3-4, 11/F., Fou Wah Industrial Building, 10-16 Pun Shan Street, Tsuen Wan, N.T., Hong Kong·
Tel.: +852 2192 1000
Fax: +852 2192 1001
Email service-gc@tuv.com
Web: www.tuv.com

The test facility is recognized or accredited by the following organizations:

FCC

Type	:	Accredited Test Firm
Designation Number	:	HK0013
Test Firm Registration Number	:	371735
Scope	:	Intentional Radiators

List of Test and Measurement Instruments

Radiated Emission

Equipment	Manufacturer	Type	Cal. Date	Due Date
Semi-anechoic Chamber	Frankonia	Nil	23 Apr 2019	23 Apr 2020
Test Receiver	R & S	ESU26	11 Jun 2019	11 Jun 2020
Bi-conical Antenna	R & S	HK116	21 Mar 2018	21 Mar 2020
Log Periodic Antenna	R & S	HL223	22 Mar 2018	22 Mar 2020
Cable with I-Joint Conector	Huber+Suhner	CNM-NMCMILX800-473	04 Oct 2018	04 Oct 2020
Active Loop Antenna	EMCO	6502	25 Oct 2018	25 Oct 2019
Double-Ridged Waveguide Horn	EMCO	3116	05 Oct 2018	05 Oct 2019
Double-Ridged Waveguide Horn	EMCO	3117	30 Aug 2018	30 Aug 2020
Cable with I-Joint Conector	Huber+Suhner	CNM-NMCMILX800-473	04 Oct 2018	04 Oct 2020
Microwave Preamplifier	COM-POWER Corporation	PAM-118A	25 Jun 2019	25 Jun 2020
Preamplifier 18GHz to 40GHz with cable (EMC656)	A.H. Systems, Inc.	PAM-1840VH	30 Jan 2019	30 Jan 2020
High Pass Filter (cutoff freq. =1000MHz)	Trilithic	23042	30 Oct 2017	30 Oct 2019
High Frequency Cable	Pasternack	PE3VNA4001-3M	29 Jan 2019	29 Jan 2020
Horn Antenna	EMCO	3115	28 Mar 2018	28 Mar 2020

Radio Test

Equipment	Manufacturer	Type	Cal. Date	Due Date
Spectrum Analyzer	R & S	FSP30	26 Jun 2019	26 Jun 2020

Measurement Uncertainty

The estimated combined standard uncertainty for power-line conducted emissions measurements is ±2.42dB.

The estimated combined standard uncertainty for radiated emissions measurements is ±4.81dB (9kHz to 30MHz) and ±4.62dB (30MHz to 200MHz) and ±5.67dB (200MHz to 1000MHz) and is ±5.07dB (1GHz to 8.2GHz) and ±4.58dB (8.2GHz to 12.4GHz) and ±4.78dB (12.4GHz to 18GHz)

The estimated combined standard uncertainty for antenna conducted emission is ±2.1dB

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor of k=2, which for the level of confidence is approximately 95%.

Results FCC Part 15 – Subpart C

FCC 15.203 – Antenna Requirement 1		**Pass**
FCC Requirement:	No antenna other than that furnished by the responsible party shall be used with the device	
Results:	a) Antenna type:	Dipole antenna
	b) Manufacturer and model no:	N/A
	c) Peak Gain:	2.0 dBi
Verdict:	Pass	

FCC 15.204 – Antenna Requirement 2	**Pass**
FCC Requirement:	An intentional radiator may be operated only with the antenna with which it is authorized. If an antenna is marketed with the intentional radiator, it shall be of a type which is authorized with the intentional radiator.
Results:	Only one integral antenna can be used.
Verdict:	N/A

FCC 15.207 – Conducted Emission on AC Mains	**N/A**
There is no AC power input or output ports on the EUT.	

FCC 15.247 (b)(1) – Peak Output Power	**Pass**
Test Specification : ANSI C63.10 – 2013 Test date : 02.10.2019 Mode of operation : Tx mode Port of testing : Temporary antenna port Supply voltage : 7.6VDC Temperature : 23ºC Humidity : 50%	
FCC Requirement : For frequency hopping systems operating in the 902-928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels.	
Results:	For test protocols please refer to Appendix 1.

Frequency (MHz)	**Maximum peak output power (dBm)**	**Limit (W/dBm)**	**Verdict**
902.75	15.60	1 / 30.0	Pass
914.75	15.57	1 / 30.0	Pass
927.25	15.48	1 / 30.0	Pass

FCC 15.247 (a) – 20 dB Bandwidth	**Pass**

FCC Requirement: N/A

Test Specification : ANSI C63.10 – 2013
Test date : 02.10.2019
Mode of operation : Tx mode
Port of testing : Temporary antenna port
Supply voltage : 7.6VDC
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test protocols refer to Appendix 1.

Frequency (MHz)	20 dB left (MHz)	20 dB right (MHz)	20dB bandwidth (MHz)
902.75	902.603	902.852	0.249
914.75	914.604	914.851	0.247
927.25	927.100	927.354	0.254

FCC 15.247(a)(1)– Carrier Frequency Separation	**Pass**

FCC Requirement:

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 greater.

Test Specification : ANSI C63.10 – 2013
Test date : 02.10.2019
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 7.6VDC
Temperature : 23ºC
Humidity : 50%

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

For test Results plots refer to Appendix 1.

Channel Separation (kHz)	20dB bandwidth (KHz)	Verdict
500	254	Pass

FCC 15.247 (a)(1)(iii)– Number of hopping channels	**Pass**

FCC Requirement:

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the system shall use at least 50 hopping frequencies; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, the system shall use at least 25 hopping frequencies.

Test Specification : ANSI C63.10 – 2013
Test date : 02.10.2019
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 7.6VDC
Temperature : 23ºC
Humidity : 50%

Results: For test Results plots refer to Appendix 1.

No. of hopping channels	Limit	Verdict
50	25	Pass

FCC 15.247 (a)(1)(iii) – Time of Occupancy (Dwell Time)	**Pass**

FCC Requirement:

For frequency hopping systems operating in the 902-928 MHz band: if the 20 dB bandwidth of the hopping channel is less than 250 kHz, the average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 20 second period; if the 20 dB bandwidth of the hopping channel is 250 kHz or greater, average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 10 second period.

Test Specification : ANSI C63.10 – 2013
Test date : 02.10.2019
Mode of operation : Tx mode (hopping on)
Port of testing : Temporary antenna port
Supply voltage : 7.6VDC
Temperature : 23ºC
Humidity : 50%

Results: Time period calculation = 10

Dwell time = 10 x 5.88 x 10^{-3} = 0.0588 s
<= 0.4 s

For test protocols please refer to Appendix 1.

Verdict: Pass

FCC 15.247 (a) – Hopping Sequence	**Pass**
FCC Requirement:	The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.
Refer to LoRa Specification	

FCC 15.247 (a) – Equal Hopping Frequency Use	**Pass**
FCC Requirement:	Each of the transmitter's hopping channels is used equally on average. The system radio frequency (RF) bandwidth is equal to the channel bandwidth multiplied by the number of channels in the hopset. The hopset shall be such that the near-term distribution of frequencies appears random, with sequential hops randomly distributed in both direction and magnitude of change in the hopset, while the long-term distribution appears evenly distributed.
Refer to LoRa Specification	

FCC 15.247 (a) – Receiver Input Bandwidth	**Pass**
FCC Requirement:	The associated receiver(s) complies with the requirement that its input bandwidth matches the bandwidth of the transmitted signal.
Refer to LoRa Specification	

FCC 15.247 (a) – Receiver Hopping Capability	**Pass**
FCC Requirement:	The associated receiver has the ability to shift frequencies in synchronisation with the transmitted signals.
Refer to LoRa Specification	

FCC 15.247 (d) – Spurious Conducted Emissions **Pass**

Test Specification : ANSI C63.10 – 2013
Test date : 02.10.2019
Mode of operation : Tx mode
Port of testing : Temporary antenna port
Supply voltage : 7.6VDC
Temperature : 23 ºC
Humidity : 50 %

FCC Requirement: In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement.

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and packet types.

There is no peak found outside any 100kHz bandwidth of the operating frequency band in the three transmit frequency. All three transmit frequency modes comply with the limit stated in subclause 15.247(d). For test protocols refer to Appendix 1.

Operating frequency (MHz)	Spurious frequency (MHz)	Spurious Level (dBm)	Reference value (dBm)	Delta (dB)	Verdict
902.75	9790.000	-31.09	15.73	46.82	Pass
914.75	7424.000	-31.70	15.71	47.41	Pass
927.25	928.000	-30.74	15.61	46.35	Pass

FCC 15.205– Radiated Emissions in Restricted Frequency Bands	**Pass**

Test Specification : ANSI C63.10 – 2013
Test Date : 13.08.2019
Mode of operation : Tx mode
Port of testing : Enclosure
Frequency range : 9kHz – 25GHz
Supply voltage : 7.6VDC
Temperature : 23ºC
Humidity : 50%

FCC Requirement: In any 100kHz bandwidth outside the frequency band at least 20dB below the highest level of the desired power. In addition, radiated emissions which fall in the restricted bands, as defined in section15.205(a), must also comply with the radiated emission limits specified in section 15.205(c).

Results: Pre-scan has been conducted to determine the worst-case mode from all possible combinations between available modulations and data rate.

All three transmit frequency modes comply with the field strength within the restricted bands. There is no spurious found below 30MHz.

Mode: 902.75 MHz TX Vertical Polarization

Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
1805.500	63.2	74.0 / PK
1805.500	48.4	54.0 / AV
7221.750	64.5	74.0 / PK
7221.750	49.8	54.0 / AV

Mode: 902.75 MHz TX Horizontal Polarization

Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
1805.500	51.1	74.0 / PK
1805.500	40.1	54.0 / AV
7222.250	60.7	74.0 / PK
7222.250	44.8	54.0 / AV

Mode: 914.75 MHz TX Vertical Polarization

Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
6402.487	54.9	74.0 / PK
6402.487	38.7	54.0 / AV
7317.560	67.3	74.0 / PK
7317.560	51.8	54.0 / AV
8232.618	56.1	74.0 / PK
8232.618	38.9	54.0 / AV

Mode: 914.75 MHz TX Horizontal Polarization

Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
1829.500	56.0	74.0 / PK
1829.500	45.0	54.0 / AV
6403.160	54.5	74.0 / PK

6403.160	40.6	54.0 / AV
7313.897	67.1	74.0 / PK
7313.897	51.7	54.0 / AV
Mode: 927.25 MHz TX	Vertical Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
1854.480	52.5	74.0 / PK
1854.480	41.5	54.0 / AV
7417.923	65.0	74.0 / PK
7417.923	49.2	54.0 / AV
8345.163	56.8	74.0 / PK
8345.163	39.7	54.0 / AV
Mode: 927.25 MHz TX	Horizontal Polarization	
Freq MHz	**Level dBuV/m**	**Limit/ Detector dBuV/m**
1854.592	56.7	74.0 / PK
1854.592	45.4	54.0 / AV
7417.137	67.2	74.0 / PK
7417.137	49.0	54.0 / AV
6490.987	54.4	74.0 / PK
6490.987	39.0	54.0 / AV