



TESTING LABORATORY
CERTIFICATE #4820.01



FCC PART 22H, PART 24E MEASUREMENT AND TEST REPORT

For

WTS Positioning Solutions AB

Wallingatan 18, Stockholm, Sweden, 111 24

FCC ID: 2AR8M-TRAX3G

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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

EUT Name:	Trax G+
EUT Model:	Trax 3.1
Operation modes:	GPRS/EDGE Data, WCDMA(R99 (Data), HSDPA/HSUPA/HSPA+,DC-HSDPA)
Operation Frequency:	GSM 850: 824-849 MHz(TX); 869-894 MHz(RX) PCS 1900: 1850-1910 MHz(TX); 1930-1990 MHz(RX) WCDMA Band 2: 1850-1910 MHz(TX); 1930-1990 MHz(RX) WCDMA Band 5: 824-849 MHz(TX); 869-894 MHz(RX)
Maximum Output Power: (Conducted)	GSM 850 : 31.15dBm; PCS 1900: 26.27 dBm WCDMA Band 2: 22.95 dBm; WCDMA Band 5: 22.26 dBm
Modulation Type:	GMSK,8PSK, QPSK, 16QAM
Rated Input Voltage:	DC 3.7V from battery or Charged by wireless charger
External Dimension:	55mm(L)*38mm(W)*10.7mm(H)

Objective

This report is prepared on behalf of *WTS Positioning Solutions AB* in accordance with: Part 2-Subpart J, Part 22-Subpart H, and Part 24-Subpart E of the Federal Communications Commission's rules.

The objective is to determine compliance with FCC Rules for output power, modulation characteristic, occupied bandwidth, spurious emissions at antenna terminal, spurious radiated emission, frequency stability and band edge.

Related Submittal(s)/Grant(s)

FCC Part 15C DTS submissions with FCC ID: 2AR8M-TRAX3G

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the Code of Federal Regulations Title 47 Part 2, Sub-part J as well as the following parts:

Part 22 Subpart H - Public Mobile Services
Part 24 Subpart E - Personal Communication Services

Applicable Standards: TIA/EIA 603-D-2010.

All radiated and conducted emissions measurements were performed at Bay Area Compliance Laboratories Corp.(Dongguan).

Measurement Uncertainty

Parameter	Measurement Uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.61dB
Unwanted Emissions, radiated	30MHz ~ 1GHz: 5.85 dB 1G~26.5GHz: 5.23 dB
Unwanted Emissions, conducted	±1.5 dB
Temperature	±1 °C
Humidity	±5%
DC and low frequency voltages	±0.4%
Duty Cycle	1%

Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Dongguan) to collect test data is located on the No.69 Pulongcun, Puxinhu Industry Area, Tangxia, Dongguan, Guangdong, China.

The lab has been recognized as the FCC accredited lab under the KDB 974614 D01 and is listed in the FCC Public Access Link (PAL) database, FCC Registration No. : 897218, the FCC Designation No. : CN1220.

The lab has been recognized by Innovation, Science and Economic Development Canada to test to Canadian radio equipment requirements, the CAB identifier: CN0022.

SYSTEM TEST CONFIGURATION

Justification

The EUT was configured for testing according to TIA/EIA-603-D 2010.

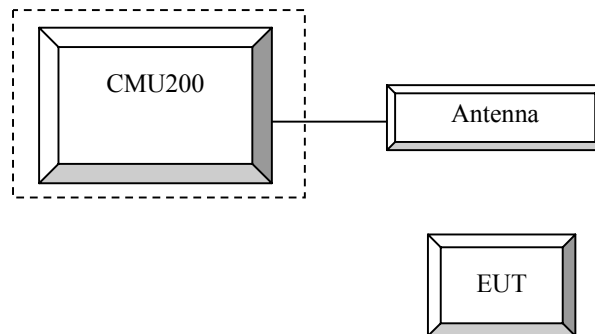
Equipment Modifications

No modification was made to the EUT.

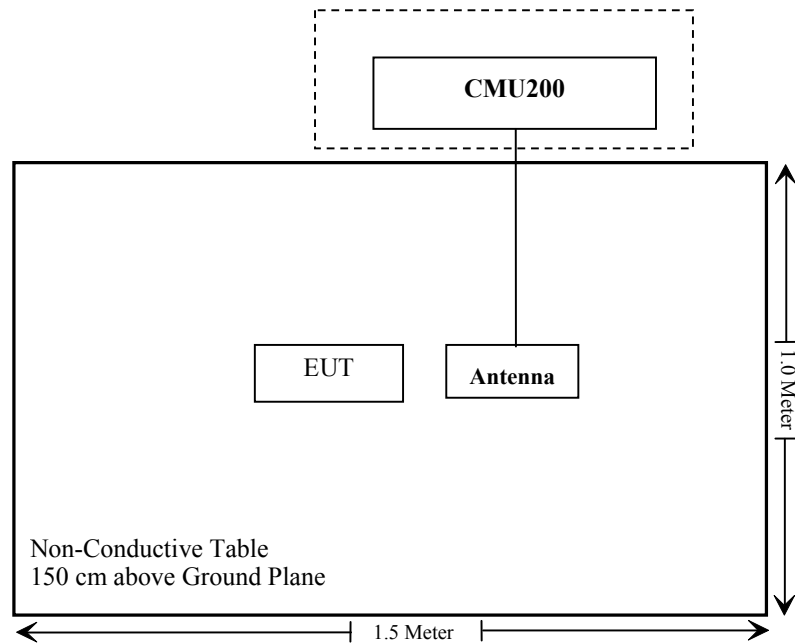
Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
R&S	Universal Radio Communication Tester	CMU200	106 891
Un-known	ANTENNA	/	/

Configuration of Test Setup



Block Diagram of Test Setup



SUMMARY OF TEST RESULTS

FCC Rules	Description of Test	Result
§1.1310, §2.1093	RF Exposure	Compliance
§2.1046; § 22.913 (a); § 24.232 (c);	RF Output Power	Compliance
§ 2.1047	Modulation Characteristics	Not Applicable
§ 2.1049; § 22.905 § 22.917; § 24.238	Occupied Bandwidth	Compliance
§ 2.1051, § 22.917 (a); § 24.238 (a)	Spurious Emissions at Antenna Terminal	Compliance
§ 2.1053 § 22.917 (a); § 24.238 (a)	Spurious Radiation Emissions	Compliance
§ 22.917 (a); § 24.238 (a)	Out of band emission, Band Edge	Compliance
§ 2.1055 § 22.355; § 24.235	Frequency stability vs. temperature Frequency stability vs. voltage	Compliance

FCC §1.1310 & §2.1093- RF EXPOSURE

Applicable Standard

According to §1.1310, systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB447498 D01 General RF Exposure Guidance v06:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f}(\text{GHz})]$
 ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria: $[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f}(\text{GHz})/x]$ W/kg, for test separation distances ≤ 50 mm; where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

Measurement Result

Operation modes	Frequency (MHz)	Maximum Power (dBm)	Duty Cycle (%)	Time based average Power (mW)	Separated distance from user (mm)	Calculated value	Exempt from Test? (Yes/No)
GSM 850	824-849	32	0.175	2.77	0	0.51	Yes
PCS 1900	1850-1910	27	0.175	0.88	0	0.24	Yes
WCDMA Band II	1850-1910	23	0.02188	0.04	0	0.01	Yes
WCDMA Band V	824-849	23	0.02188	0.04	0	0.01	Yes
BLE	2402-2480	4	100.00	2.51	0	0.79	Yes

The maximum transmission rate when active is once every 10 second and the data consist of 140bytes.

In 2G network(GPRS/EDGE), At the lowest data rate 8 kbit/s every transmission will last for less than 0,0175s with a resulting dutycycle of <0.175%.

In 3G network, At the lowest data rate 64 kbit/s every transmission will last for less than 0,002188s with a resulting dutycycle of <0.02188%.

Please refer to the attention letter for more detail.

WWAN and Bluetooth can transmit Simultaneously:

Operation modes	Frequency (MHz)	Maximum Power (dBm)	Duty Cycle (%)	Time based average Power (mW)	Separated distance from user (mm)	SAR estimation (W/kg)
GSM 850	824-849	32	0.175	2.77	0	0.07
PCS 1900	1850-1910	27	0.175	0.88	0	0.03
WCDMA Band II	1850-1910	23	0.02188	0.04	0	0.0016
WCDMA Band V	824-849	23	0.02188	0.04	0	0.0011
BLE	2402-2480	4	100.00	2.51	0	0.11

SAR estimation=

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}/x]$
W/kg, for test separation distances ≤ 50 mm; where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

$\Sigma\text{SAR} = 0.07 + 0.11 = 0.18 \text{ W/kg} < 1.6 \text{ W/kg}$

So the SAR test is not necessary.

FCC §2.1047 - MODULATION CHARACTERISTIC

According to FCC § 2.1047(d), Part 22H & 24E there is no specific requirement for digital modulation, therefore modulation characteristic is not presented.

FCC § 2.1046, § 22.913 (a) & § 24.232 (c) - RF OUTPUT POWER

Applicable Standard

According to FCC §2.1046 and §22.913 (a), the ERP of mobile transmitters and auxiliary test transmitters must not exceed 7 watts.

According to FCC §2.1046 and §24.232 (C), mobile and portable stations are limited to 2 watts EIRP and the equipment must employ a means for limiting power to the minimum necessary for successful communications.

According to §24.232 (d) Power measurements for transmissions by stations authorized under this section may be made either in accordance with a Commission-approved average power technique or in compliance with paragraph (e) of this section. In both instances, equipment employed must be authorized in accordance with the provisions of §24.51. In measuring transmissions in this band using an average power technique, the peak-to-average ratio (PAR) of the transmission may not exceed 13 dB.

Test Procedure

GSM/GPRS/EGPRS

Function: Menu select > GSM Mobile Station > GSM 850/1900

Press Connection control to choose the different menus

Press RESET > choose all the reset all settings

Connection Press Signal Off to turn off the signal and change settings

Network Support > GSM + GPRS or GSM + EGSM

Main Service > Packet Data

Service selection > Test Mode A – Auto Slot Config. off

MS Signal Press Slot Config Bottom on the right twice to select and change the number of time slots and power setting

> Slot configuration > Uplink/Gamma

> 33 dBm for GPRS 850

> 30 dBm for GPRS 1900

> 27 dBm for EGPRS 850

> 26 dBm for EGPRS 1900

BS Signal Enter the same channel number for TCH channel (test channel) and BCCH channel

Frequency Offset > + 0 Hz

Mode > BCCH and TCH

BCCH Level > -85 dBm (May need to adjust if link is not stable)

BCCH Channel > choose desire test channel [Enter the same channel number for TCH channel (test channel) and BCCH channel]

Channel Type > Off

P0 > 4 dB

Slot Config > Unchanged (if already set under MS signal)

TCH > choose desired test channel

Hopping > Off

Main Timeslot > 3

Network Coding Scheme > CS4 (GPRS) and MCS5 (EGPRS)

Bit Stream > 2E9-1 PSR Bit Stream

AF/RF Enter appropriate offsets for Ext. Att. Output and Ext. Att. Input

Connection Press Signal on to turn on the signal and change settings

WCDMA-Release 99

The following tests were conducted according to the test requirements outlines in section 5.2 of the 3GPP TS34.121-1 specification. The EUT has a nominal maximum output power of 24dBm (+1.7/-3.7).

WCDMA General Settings	Loopback Mode	Test Mode 1
	Rel99 RMC	12.2kbps RMC
	Power Control Algorithm	Algorithm2
	β_c / β_d	8/15

WCDMA HSDPA

The following tests were conducted according to the test requirements outlines in section 5.2 of the 3GPP TS34.121-1 specification.

	Mode Subset	HSDPA 1	HSDPA 2	HSDPA 3	HSDPA 4
WCDMA General Settings	Loopback Mode	Test Mode 1			
	Rel99 RMC	12.2kbps RMC			
	HSDPA FRC	H-Set1			
	Power Control Algorithm	Algorithm2			
	β_c	2/15	12/15	15/15	15/15
	β_d	15/15	15/15	8/15	4/15
	β_d (SF)	64			
	β_c / β_d	2/15	12/15	15/8	15/4
	β_{hs}	4/15	24/15	30/15	30/15
	MPR(dB)	0	0	0.5	0.5
HSDPA Specific Settings	DACK	8			
	DNAK	8			
	DCQI	8			
	Ack-Nack repetition factor	3			
	CQI Feedback	4ms			
	CQI Repetition Factor	2			
	$A_{hs} = \beta_{hs} / \beta_c$	30/15			

WCDMA HSUPA

The following tests were conducted according to the test requirements outlines in section 5.2 of the 3GPP TS34.121-1 specification.

	Mode	HSUPA	HSUPA	HSUPA	HSUPA	HSUPA
	Subset	1	2	3	4	5
WCDMA General Settings	Loopback Mode	Test Mode 1				
	Rel99 RMC	12.2kbps RMC				
	HSDPA FRC	H-Set1				
	HSUPA Test	HSUPA Loopback				
	Power Control Algorithm	Algorithm2				
	β_c	11/15	6/15	15/15	2/15	15/15
	β_d	15/15	15/15	9/15	15/15	0
	β_{ec}	209/225	12/15	30/15	2/15	5/15
	β_c / β_d	11/15	6/15	15/9	2/15	-
	β_{hs}	22/15	12/15	30/15	4/15	5/15
	CM(dB)	1.0	3.0	2.0	3.0	1.0
	MPR(dB)	0	2	1	2	0
HSDPA Specific Settings	DACK	8				
	DNAK	8				
	DCQI	8				
	Ack-Nack repetition factor	3				
	CQI Feedback	4ms				
	CQI Repetition Factor	2				
	$A_{hs} = \beta_{hs} / \beta_c$	30/15				
HSUPA Specific Settings	DE-DPCCH	6	8	8	5	7
	DHARQ	0	0	0	0	0
	AG Index	20	12	15	17	21
	ETFCI	75	67	92	71	81
	Associated Max UL Data Rate kbps	242.1	174.9	482.8	205.8	308.9
	Reference E_FCI	E-TFCI 11 E E-TFCI PO 4 E-TFCI 67 E-TFCI PO 18 E-TFCI 71 E-TFCI PO23 E-TFCI 75 E-TFCI PO26 E-TFCI 81 E-TFCI PO 27	E-TFCI 11 E-TFCI PO4 E-TFCI 92 E-TFCI PO 18	E-TFCI 11 E-TFCI PO4 E-TFCI 92 E-TFCI PO 18	E-TFCI 11 E E-TFCI PO 4 E-TFCI 67 E-TFCI PO 18 E-TFCI 71 E-TFCI PO23 E-TFCI 75 E-TFCI PO26 E-TFCI 81 E-TFCI PO 27	E-TFCI 11 E E-TFCI PO 4 E-TFCI 67 E-TFCI PO 18 E-TFCI 71 E-TFCI PO23 E-TFCI 75 E-TFCI PO26 E-TFCI 81 E-TFCI PO 27

HSPA+

The following tests were conducted according to the test requirements in Table C.11.1.4 of 3GPP TS 34.121-1

Sub-test	β_c (Note 3)	β_d	β_{HS} (Note 1)	β_{ec}	β_{ed} (2xSF2) (Note 4)	β_{ed} (2xSF4) (Note 4)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 4)	E-TFCI (Note 5)	E-TFCI (boost)
1	1	0	30/15	30/15	β_{ed1} : 30/15 β_{ed2} : 30/15	β_{ed3} : 24/15 β_{ed4} : 24/15	3.5	2.5	14	105	105

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 30/15$ with $\beta_{hs} = 30/15 * \beta_c$.

Note 2: CM = 3.5 and the MPR is based on the relative CM difference, MPR = MAX(CM-1,0).

Note 3: DPDCH is not configured, therefore the β_c is set to 1 and $\beta_d = 0$ by default.

Note 4: β_{ed} can not be set directly; it is set by Absolute Grant Value.

Note 5: All the sub-tests require the UE to transmit 2SF2+2SF4 16QAM EDCH and they apply for UE using E-DPDCH category 7. E-DCH TTI is set to 2ms TTI and E-DCH table index = 2. To support these E-DCH configurations DPDCH is not allocated. The UE is signalled to use the extrapolation algorithm.

DC-HSDPA

The following tests were conducted according to the test requirements in Table C.8.1.12 of 3GPP TS 34.121-1

Table C.8.1.12: Fixed Reference Channel H-Set 12

Parameter	Unit	Value
Nominal Avg. Inf. Bit Rate	kbps	60
Inter-TTI Distance	TTI's	1
Number of HARQ Processes	Processes	6
Information Bit Payload (N_{INF})	Bits	120
Number Code Blocks	Blocks	1
Binary Channel Bits Per TTI	Bits	960
Total Available SML's in UE	SML's	19200
Number of SML's per HARQ Proc.	SML's	3200
Coding Rate		0.15
Number of Physical Channel Codes	Codes	1
Modulation		QPSK
Note 1: The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table.		
Note 2: Maximum number of transmission is limited to 1, i.e., retransmission is not allowed. The redundancy and constellation version 0 shall be used.		

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100035	2018-08-03	2019-08-03
Sunol Sciences	Antenna	JB3	A060611-3	2017-07-21	2019-07-21
EMCO	Adjustable Dipole Antenna	3121C	9109-753	N/A	N/A
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-02	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0530-01	2018-09-24	2019-09-24
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-02	2018-09-05	2019-09-05
R&S	Universal Radio Communication Tester	CMU200	106 891	2017-12-14	2018-12-14
Agilent	Signal Generator	E8247C	MY43321350	2017-12-11	2018-12-11
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-01-04	2019-01-04
TDK RF	Horn Antenna	HRN-0118	130 084	2016-01-05	2019-01-04
ETS-Lindgren	Horn Antenna	3115	000 527 35	2016-01-05	2019-01-04
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-02	2018-09-05	2019-09-05

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	21.3~27 °C
Relative Humidity:	35~43 %
ATM Pressure:	99.7~100.5 kPa

* The testing was performed by Elena Lei & Vem Shen & Elena Lei from 2018-12-06 to 2018-12-10.

Test Result: Compliance

Conducted Output Power**Cellular Band & PCS Band**

Band	Channel No.	Conducted Peak Output Power (dBm)							
		GPRS 1 TX Slot	GPRS 2 TX Slot	GPRS 3 TX Slot	GPRS 4 TX Slot	EGPRS 1 uplink slot	EGPRS 2 uplink slot	EGPRS 3 uplink slot	EGPRS 4 uplink slot
Cellular	128	31.13	31.01	30.38	29.30	29.80	29.65	29.11	27.33
	190	31.06	29.98	30.45	29.36	29.70	29.53	28.99	27.36
	251	31.15	31.13	30.46	29.33	29.54	29.33	28.87	27.15
PCS	512	26.11	26.07	25.24	24.22	26.19	26.13	25.70	24.63
	661	26.14	26.09	25.31	24.35	26.17	26.10	25.08	24.65
	810	26.27	26.15	25.36	24.40	26.14	26.04	25.66	24.61

WCDMA Band II

Mode	3GPP Sub Test	Low Channel		Middle Channel		High Channel	
		Ave. Power (dBm)	PAR (dB)	Ave. Power (dBm)	PAR (dB)	Ave. Power (dBm)	PAR (dB)
Rel 99	1	22.59	2.72	22.95	2.82	22.93	2.76
HSDPA	1	22.03	3.43	22.36	3.78	22.54	3.85
	2	21.83	3.43	22.25	3.35	22.03	3.75
	3	21.81	3.42	22.04	3.17	22.47	3.30
	4	21.50	3.47	21.26	3.42	22.24	3.33
HSUPA	1	22.37	3.14	22.58	3.62	21.33	3.08
	2	22.23	3.33	22.05	3.25	21.43	3.15
	3	21.41	3.72	21.64	3.37	22.07	3.60
	4	22.10	3.67	22.26	3.52	22.44	3.43
	5	21.23	3.43	21.85	3.25	21.63	3.35
DC-HSDPA	1	22.41	3.52	21.84	3.47	21.87	3.10
	2	21.50	3.67	21.86	3.22	22.24	3.33
	3	22.43	3.43	21.25	3.75	21.83	3.25
	4	22.01	3.52	21.24	3.17	21.87	3.10
HSPA+ (16QAM)	1	21.50	3.27	21.66	3.42	21.84	3.13

WCDMA Band V

Mode	3GPP Sub Test	Low Channel		Middle Channel		High Channel	
		Ave. Power (dBm)	PAR (dB)	Ave. Power (dBm)	PAR (dB)	Ave. Power (dBm)	PAR (dB)
Rel 99	1	22.15	2.60	22.26	2.63	22.07	2.66
HSDPA	1	21.64	4.20	21.67	3.33	21.58	4.49
	2	21.43	3.63	21.85	3.75	21.43	3.35
	3	22.11	3.62	21.44	3.27	21.56	3.60
	4	21.50	3.17	21.86	3.42	21.69	3.13
HSUPA	1	21.67	3.72	21.69	4.29	21.60	4.39
	2	21.83	3.13	21.25	3.35	21.63	3.45
	3	22.01	3.52	21.64	3.47	21.69	3.20
	4	21.70	3.47	21.46	3.72	21.44	3.23
	5	21.63	3.23	21.65	3.15	21.33	3.25
DC-HSDPA	1	21.41	3.12	21.84	3.77	21.27	3.60
	2	21.50	3.37	22.03	3.52	21.84	3.23
	3	21.23	3.13	22.15	3.25	21.43	3.45
	4	22.01	3.32	21.44	3.37	21.47	3.50
HSPA+ (16QAM)	1	21.50	3.67	21.86	3.72	21.78	3.43

ERP & EIRP

Part 22H

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
GPRS 850 Middle Channel								
836.60	H	104.51	29.59	0.00	0.97	28.62	38.45	9.83
836.60	V	97.53	25.74	0.00	0.97	24.77	38.45	13.68
EGPRS 850 Middle Channel								
836.60	H	97.36	22.44	0.00	0.97	21.47	38.45	16.98
836.60	V	89.99	18.20	0.00	0.97	17.23	38.45	21.22
WCDMA Band V Middle Channel								
836.60	H	89.99	18.20	0.00	0.97	17.23	38.45	21.22
836.60	V	85.07	10.15	0.00	0.97	9.18	38.45	29.27

Part 24E

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
GPRS 1900 Middle Channel								
1880.00	H	93.89	21.28	11.66	2.66	30.28	33.00	2.72
1880.00	V	86.72	14.25	11.66	2.66	23.25	33.00	9.75
EGPRS 1900 Middle Channel								
1880.00	H	88.68	16.07	11.66	2.66	25.07	33.00	7.93
1880.00	V	85.84	13.37	11.66	2.66	22.37	33.00	10.63
WCDMA Band II Middle Channel								
1880.00	H	86.17	13.56	11.66	2.66	22.56	33.00	10.44
1880.00	V	81.69	9.22	11.66	2.66	18.22	33.00	14.78

Note:

- 1) The unit of Antenna Gain is dBd for frequency below 1GHz, and the unit of Antenna Gain is dBi for frequency above 1GHz.
- 2) Absolute Level = Substituted Level - Cable loss + Antenna Gain
- 3) Margin = Limit-Absolute Level

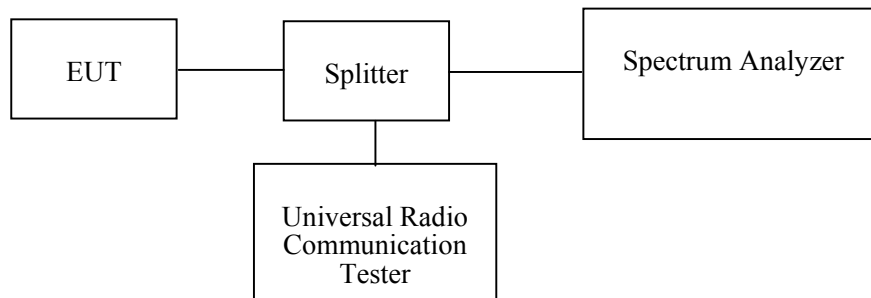
FCC §2.1049, §22.917, §22.905 & §24.238 - OCCUPIED BANDWIDTH**Applicable Standard**

FCC §2.1049, §22.917, §22.905, §24.238

Test Procedure

The RF output of the transmitter was connected to the simulator and the spectrum analyzer through sufficient attenuation.

The 26 dB & 99% bandwidth was recorded.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A
E-Microwave	Two-way Splitter	ODP-1-6-2S	OE0120142	Each time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	35 %
ATM Pressure:	99.8 kPa

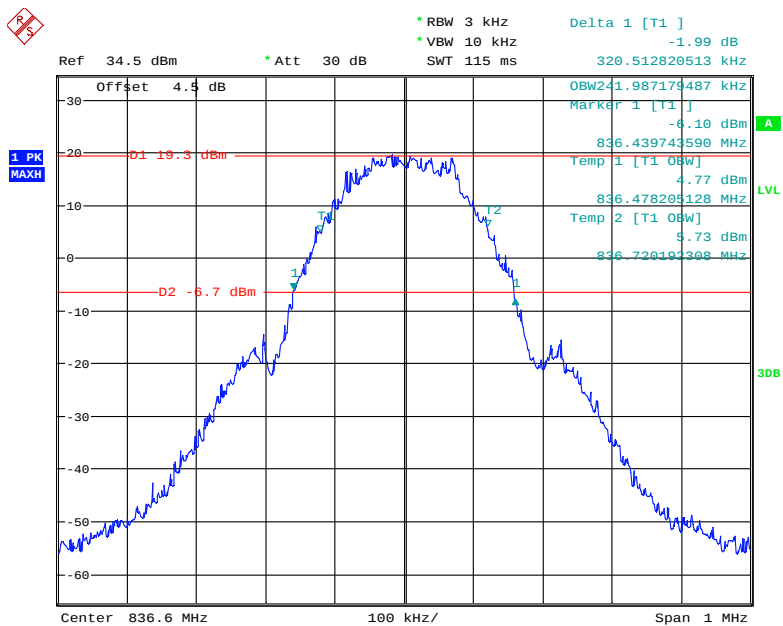
* The testing was performed by Elena Lei on 2018-12-12.

Test Mode: Transmitting

Test Result: Compliance. Please refer to the following table and plots.

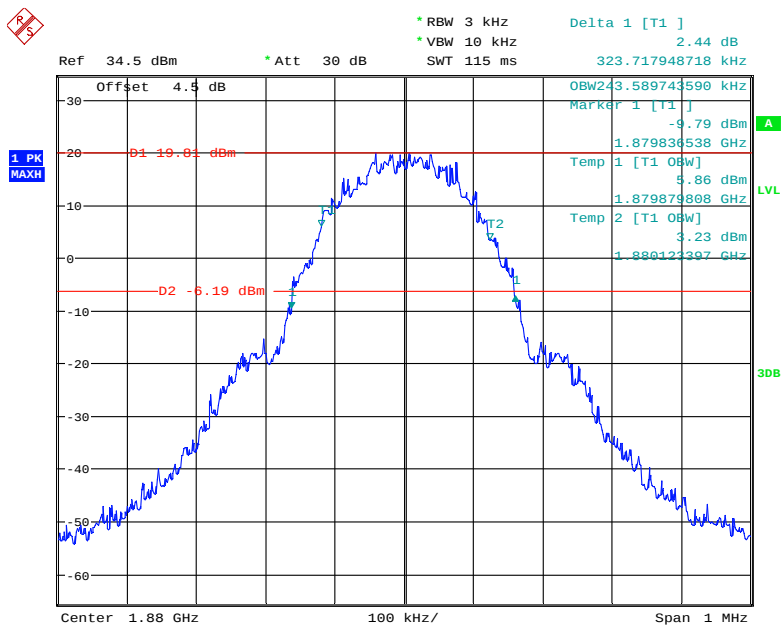
Band	Test Channel	Mode	99% Occupied Bandwidth (MHz)	26 dB Occupied Bandwidth (MHz)
Cellular	M	GPRS	0.242	0.321
		EDGE	0.250	0.321
PCS		GPRS	0.244	0.324
		EDGE	0.248	0.322
WCDMA Band II		Rel 99	4.071	4.663
		HSDPA	4.087	4.647
		HSUPA	4.071	4.663
WCDMA Band V		Rel 99	4.087	4.696
		HSDPA	4.071	4.663
		HSUPA	4.054	4.696

GPRS 850 Cellular Band



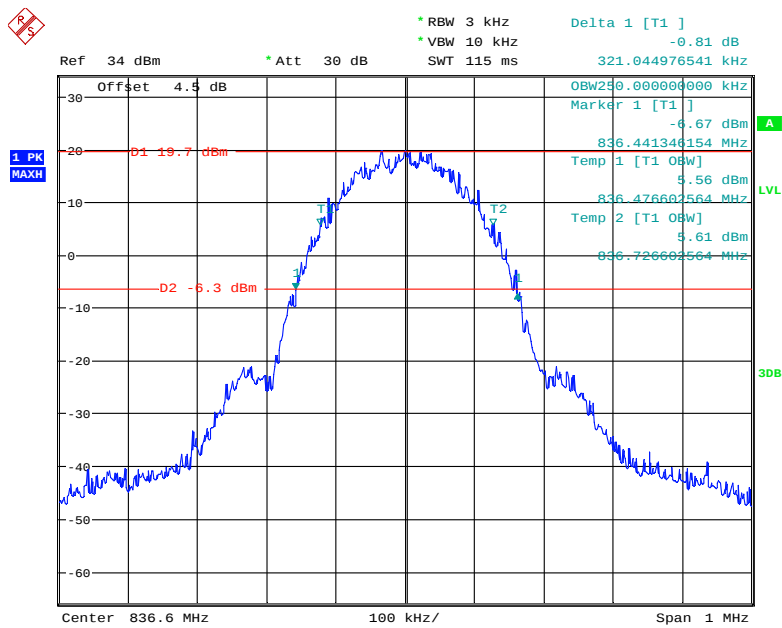
Date: 12.DEC.2018 14:52:57

GPRS PCS1900 Cellular Band



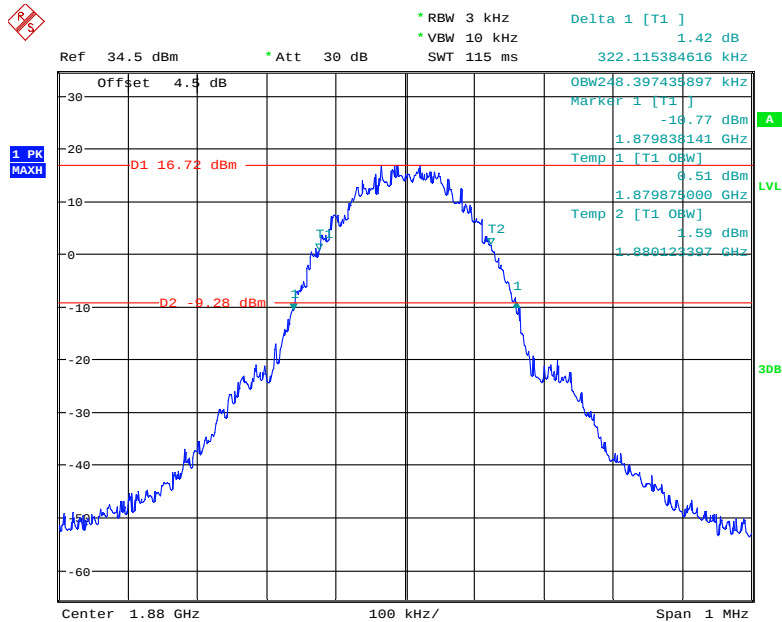
Date: 12.DEC.2018 15:05:28

EDGE 850 Cellular Band



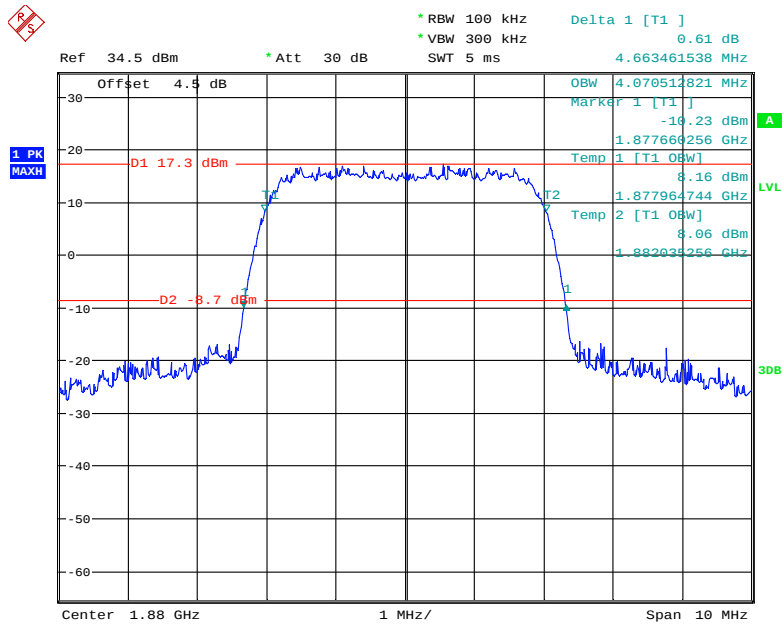
Date: 12.DEC.2018 14:34:28

EDGE PCS1900 Cellular Band



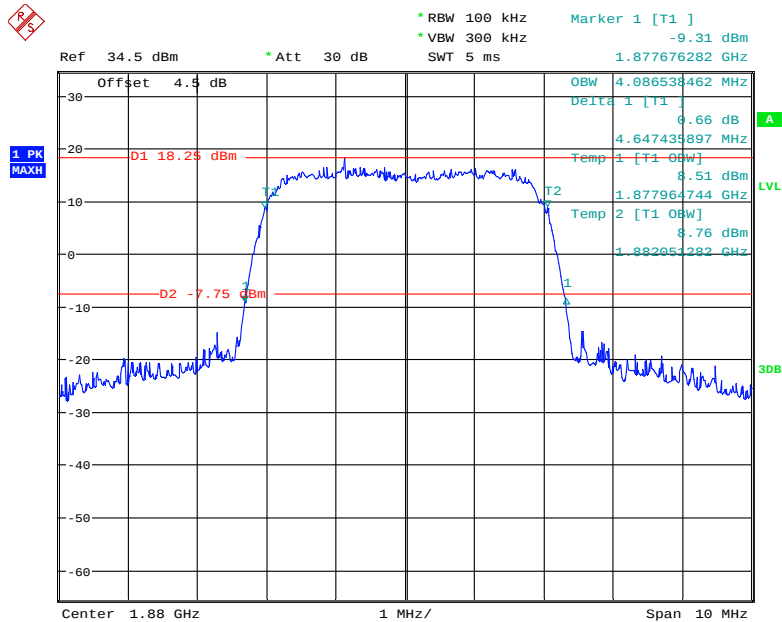
Date: 12.DEC.2018 15:21:10

REL99 Band II



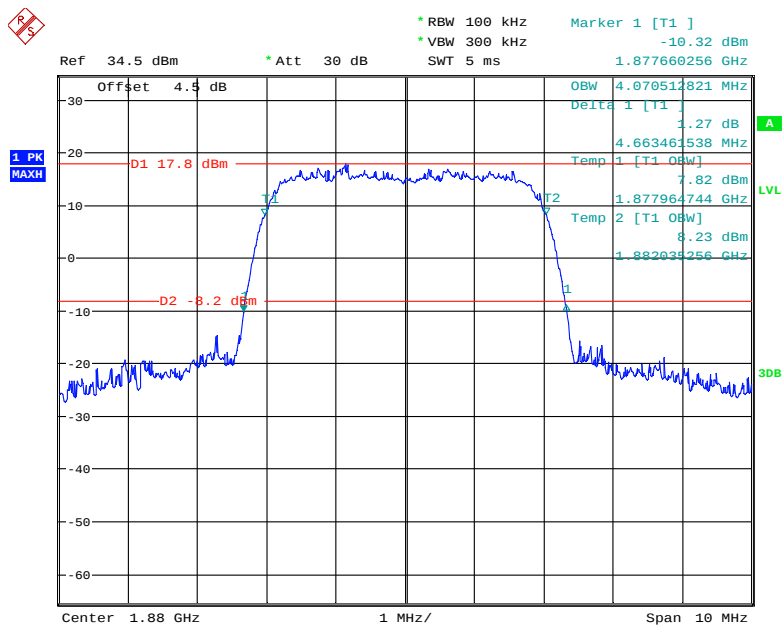
Date: 12.DEC.2018 11:32:04

HSDPA Band II



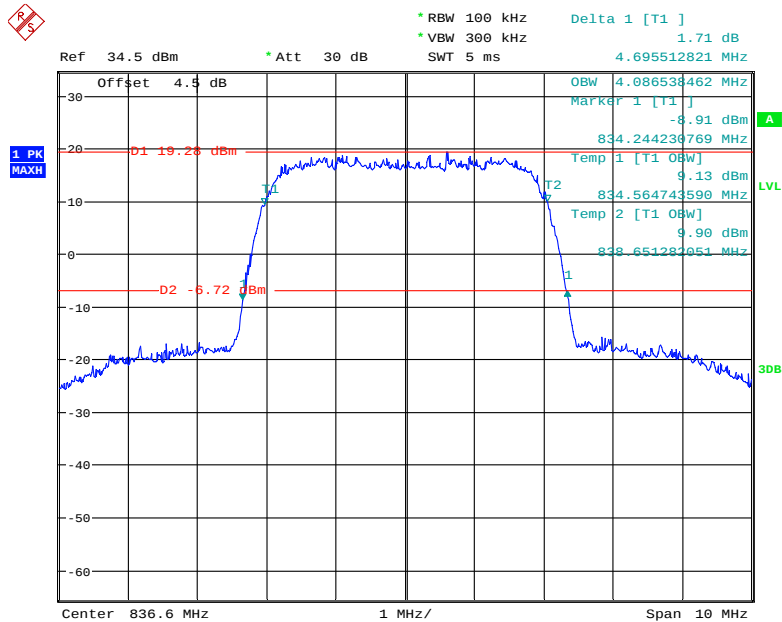
Date: 12.DEC.2018 11:22:45

HSUPA Band II



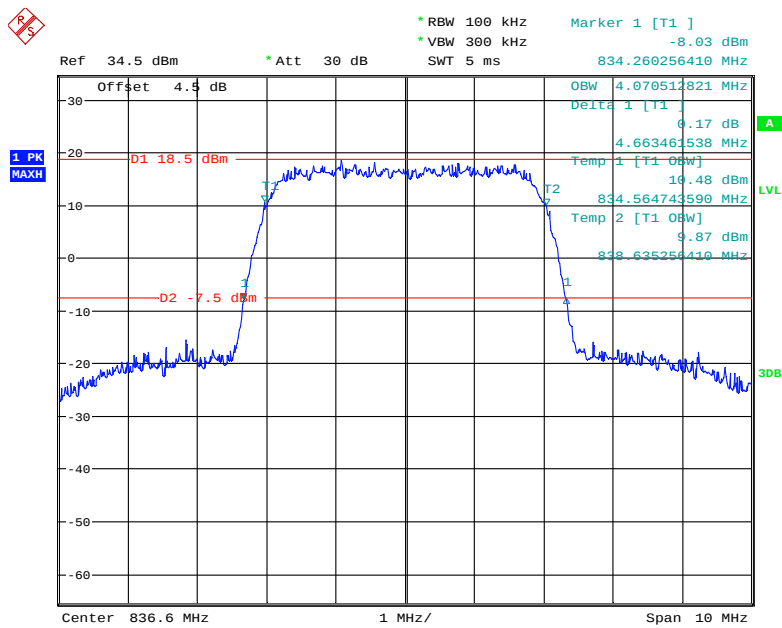
Date: 12.DEC.2018 11:34:44

REL99 Band V



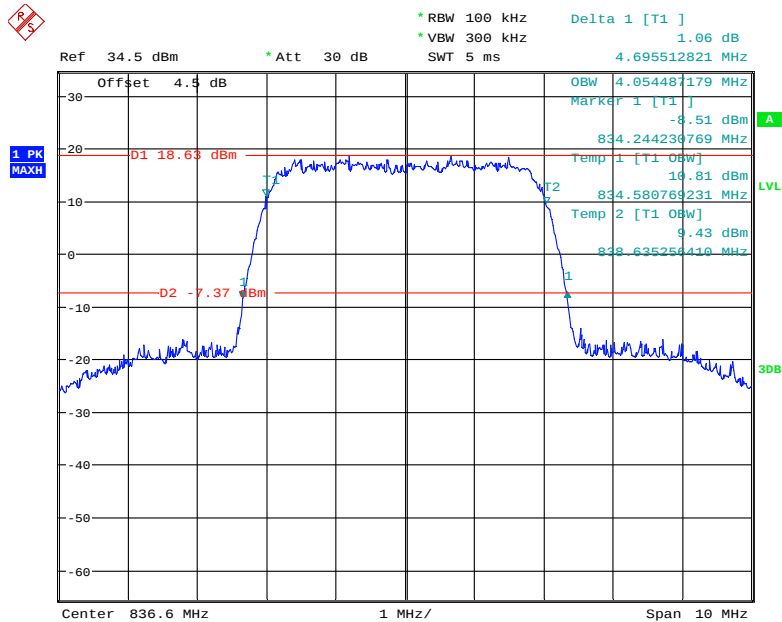
Date: 12.DEC.2018 11:13:18

HSDPA Band V



Date: 12.DEC.2018 11:25:21

HSUPA Band V



Date: 12.DEC.2018 11:39:34

FCC §2.1051, §22.917(a) & §24.238(a) - SPURIOUS EMISSIONS AT ANTENNA TERMINALS

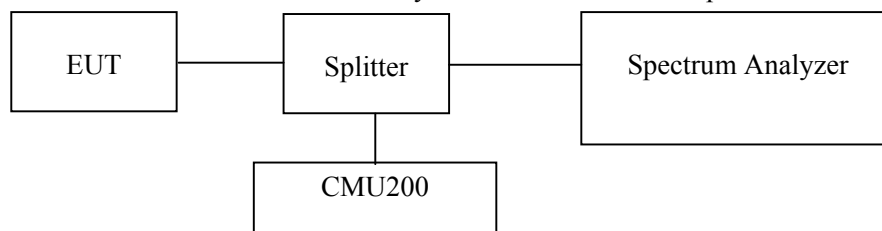
Applicable Standard

FCC §2.1051, §22.917(a) , §24.238(a).

The spectrum was to be investigated to the tenth harmonics of the highest fundamental frequency as specified in § 2.1051.

Test Procedure

The RF output of the transceiver was connected to a spectrum analyzer and simulator through appropriate attenuation. Sufficient scans were taken to show any out of band emissions up to 10th harmonic.



Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005011	Each time	N/A
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A
E-Microwave	Two-way Splitter	ODP-1-6-2S	OE0120142	Each time	N/A

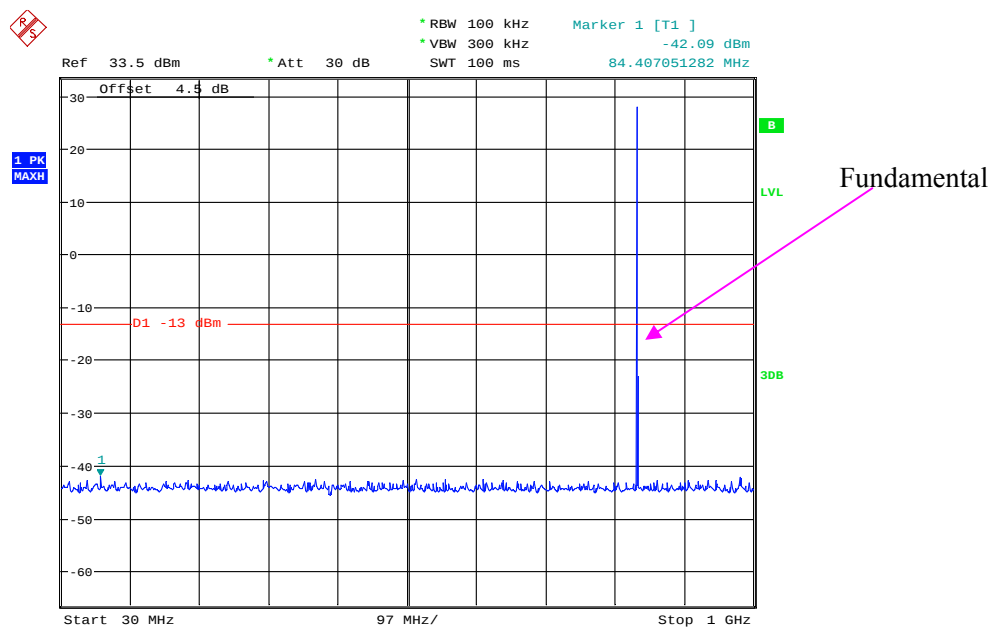
* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

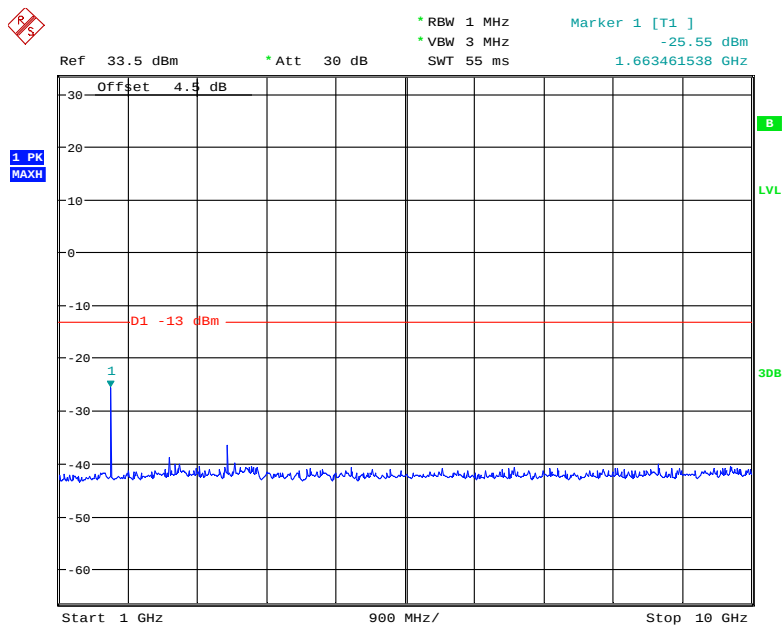
Temperature:	23.9 °C
Relative Humidity:	35 %
ATM Pressure:	99.8 kPa

* The testing was performed by Elena Lei on 2018-12-12.

Test Result: Compliance. Please refer to the following plots.

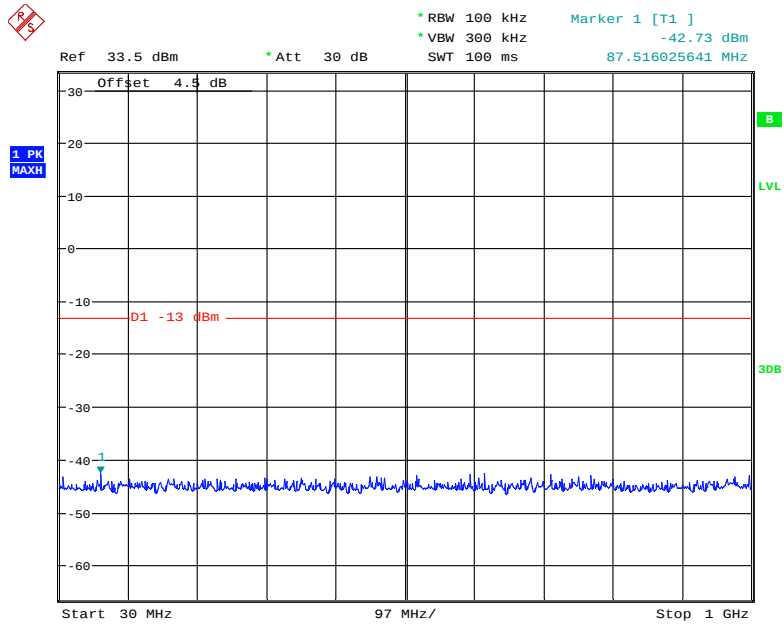
GPRS850_Middle Channel

Date: 12.DEC.2018 14:57:48

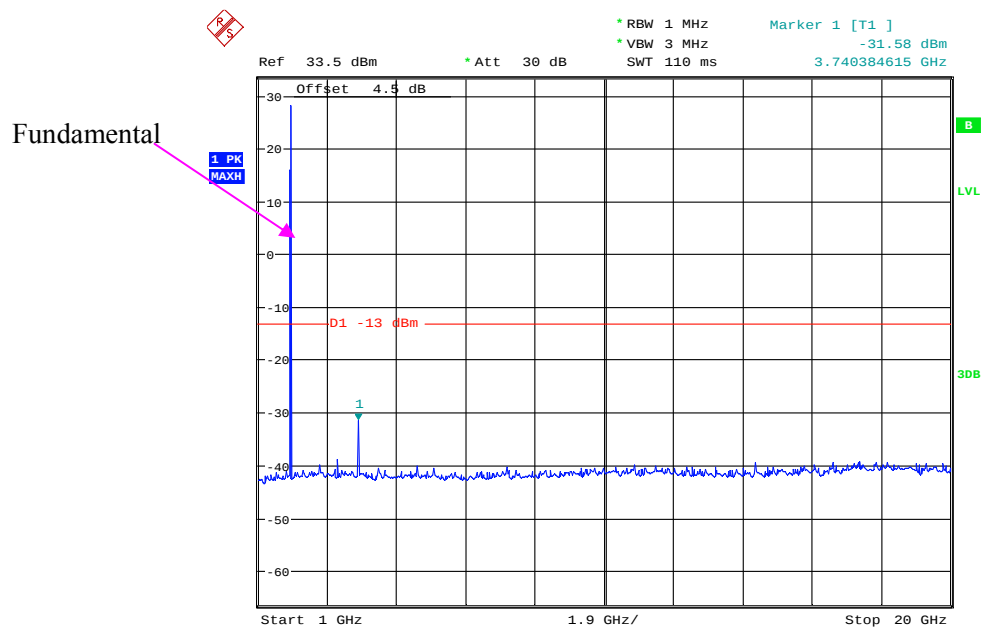


Date: 12.DEC.2018 14:58:18

GPRS1900_Middle Channel

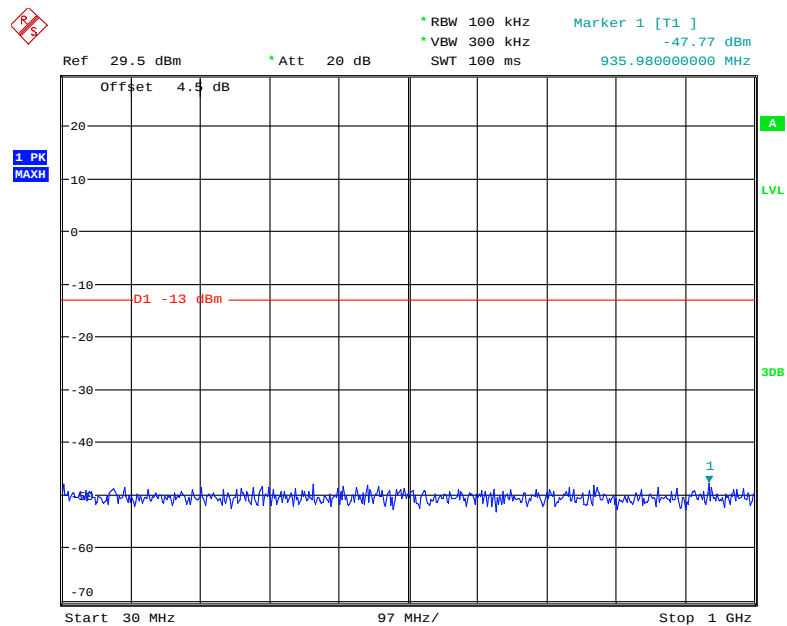


Date: 12.DEC.2018 15:04:14

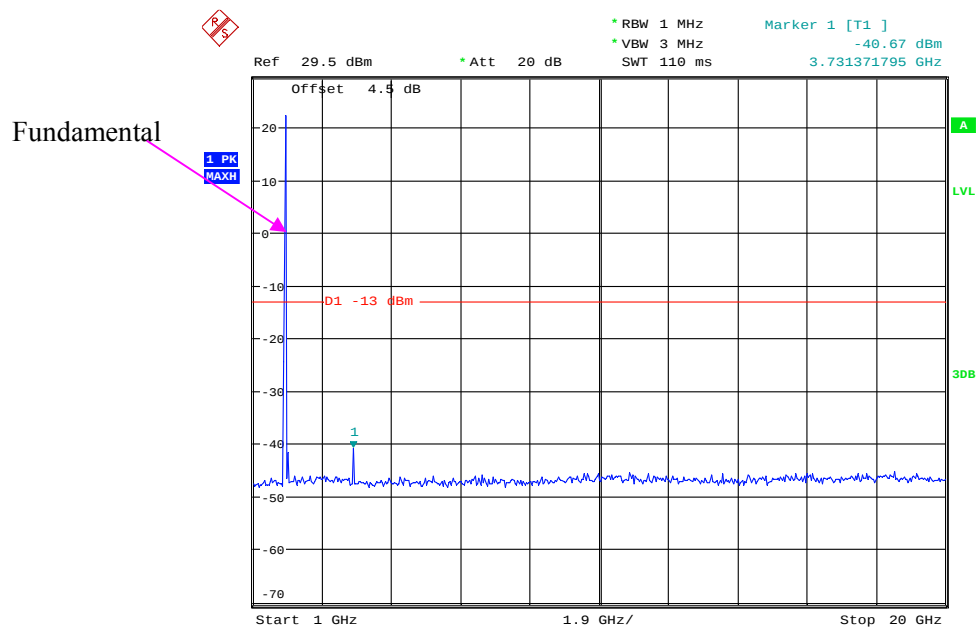


Date: 12.DEC.2018 15:03:43

REL99 Band II_Middle Channel

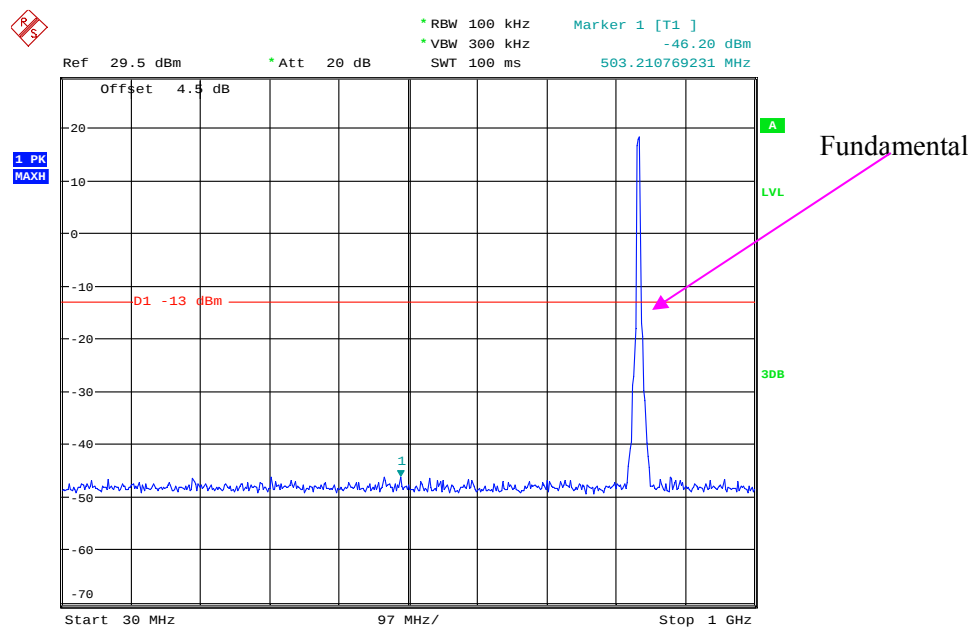


Date: 12.DEC.2018 11:06:31

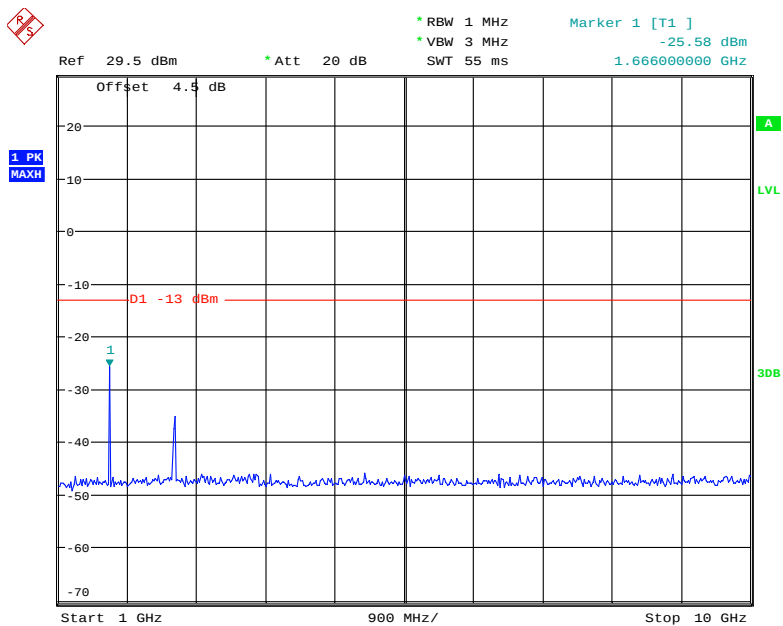


Date: 12.DEC.2018 11:07:05

Rel 99 Band V_Middle Channel



Date: 12.DEC.2018 11:09:10



Date: 12.DEC.2018 11:08:32

FCC §2.1053, §22.917 & §24.238 & §27.53 - SPURIOUS RADIATED EMISSIONS

Applicable Standard

FCC § 2.1053, §22.917, § 24.238 and § 27.53.

Test Procedure

The transmitter was placed on a wooden turntable, and it was transmitting into a non-radiating load which was also placed on the turntable.

The measurement antenna was placed at a distance of 3 meters from the EUT. During the tests, the antenna height and polarization as well as EUT azimuth were varied in order to identify the maximum level of emissions from the EUT. The test was performed by placing the EUT on 3-orthogonal axis.

The frequency range up to tenth harmonic of the fundamental frequency was investigated.

Remove the EUT and replace it with substitution antenna. A signal generator was connected to the substitution antenna by a non-radiating cable. The absolute levels of the spurious emissions were measured by the substitution.

Spurious emissions in dB = $10 \lg (\text{TXpwr in Watts}/0.001)$ – the absolute level

Spurious attenuation limit in dB = $43 + 10 \text{Log}_{10} (\text{power out in Watts})$

Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	EMI Test Receiver	ESCI	100224	2017-12-11	2018-12-11
Sunol Sciences	Antenna	JB3	A060611-1	2017-11-10	2020-11-10
EMCO	Adjustable Dipole Antenna	3121C	9109-753	N/A	N/A
Unknown	Coaxial Cable	C-NJNJ-50	C-0400-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0075-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-1000-01	2018-09-05	2019-09-05
Unknown	Coaxial Cable	C-NJNJ-50	C-0200-02	2018-09-05	2019-09-05
HP	Amplifier	8447D	2727A05902	2018-09-05	2019-09-05
Agilent	Signal Generator	E8247C	MY43321350	2017-12-11	2018-12-11
Agilent	Spectrum Analyzer	E4440A	SG43360054	2018-01-04	2019-01-04
ETS-Lindgren	Horn Antenna	3115	000 527 35	2016-01-05	2019-01-04
TDK RF	Horn Antenna	HRN-0118	130 084	2016-01-05	2019-01-04
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-01 1304	2016-11-18	2019-11-18
Ducommun Technologies	Horn Antenna	ARH-4223-02	1007726-02 1304	2016-11-18	2019-11-18
Unknown	Coaxial Cable	C-SJSJ-50	C-0800-01	2018-09-05	2019-09-05
MITEQ	Amplifier	AFS42-00101800- 25-S-42	2001271	2018-09-05	2019-09-05
Sinoscite	Band-stop filter	BSF824-862MS- 1438-001	1438001	2018-06-16	2019-06-16
Sinoscite	Band-stop filter	BSF1850-1910MS- 0935V2	0935V2	2018-06-16	2019-06-16

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	21.3~27 °C
Relative Humidity:	35~43 %
ATM Pressure:	99.7~100.5 kPa

* The testing was performed by Kami Zhou & Vem Shen on 2018-12-06 & 2018-12-10.

Test Result: Compliance.

*EUT Operation Mode: Transmitting***Cellular Band (PART 22H)****30 MHz-10 GHz:**

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
GSM850, Frequency:836.600 MHz								
1673.200	H	82.61	-31.6	10.6	0.73	-21.7	-13.0	8.7
1673.200	V	77.63	-37.18	10.6	0.73	-27.3	-13.0	14.3
2509.800	H	62.55	-50.47	13.1	1.25	-38.6	-13.0	25.6
2509.800	V	61.55	-51.5	13.1	1.25	-39.6	-13.0	26.6
3346.400	H	52.43	-58.23	13.8	1.61	-46.0	-13.0	33.0
3346.400	V	52.39	-58.32	13.8	1.61	-46.1	-13.0	33.1
549.920	H	40.30	-62.88	0.0	0.73	-63.6	-13.0	50.6
466.500	V	39.30	-68.26	0.0	0.68	-68.9	-13.0	55.9
WCDMA Band V R99, Frequency:836.600 MHz								
1673.200	H	65.10	-49.11	10.6	0.73	-39.2	-13.0	26.2
1673.200	V	59.04	-55.77	10.6	0.73	-45.9	-13.0	32.9
2509.800	H	45.36	-67.66	13.1	1.25	-55.8	-13.0	42.8
2509.800	V	45.45	-67.6	13.1	1.25	-55.7	-13.0	42.7
3346.400	H	45.22	-65.44	13.8	1.61	-53.2	-13.0	40.2
3346.400	V	44.78	-65.93	13.8	1.61	-53.7	-13.0	40.7
175.500	H	45.16	-64.01	0.0	0.43	-64.4	-13.0	51.4
365.620	V	38.87	-69.92	0.0	0.58	-70.5	-13.0	57.5

PCS Band (PART 24E)**30 MHz-20 GHz:**

Frequency (MHz)	Polar (H/V)	Receiver Reading (dBμV)	Substituted Method			Absolute Level (dBm)	Limit (dBm)	Margin (dB)
			Substituted Level (dBm)	Antenna Gain (dBd/dBi)	Cable Loss (dB)			
GSM1900, Frequency:1880.000 MHz								
3760.000	H	58.27	-50.53	13.8	1.63	-38.4	-13.0	25.4
3760.000	V	56.41	-52.26	13.8	1.63	-40.1	-13.0	27.1
5640.000	H	46.95	-59.08	14.0	1.31	-46.4	-13.0	33.4
5640.000	V	46.24	-59.67	14.0	1.31	-47.0	-13.0	34.0
287.540	H	41.54	-67.25	0.0	0.52	-67.8	-13.0	54.8
457.000	V	40.54	-67.11	0.0	0.67	-67.8	-13.0	54.8
WCDMA Band II, R99, Frequency:1880.000 MHz								
3760.000	H	53.48	-55.32	13.8	1.63	-43.2	-13.0	30.2
3760.000	V	50.42	-58.25	13.8	1.63	-46.1	-13.0	33.1
5640.000	H	46.57	-59.46	14.0	1.31	-46.8	-13.0	33.8
5640.000	V	46.55	-59.36	14.0	1.31	-46.7	-13.0	33.7
377.260	H	43.67	-62.01	0.0	0.59	-62.6	-13.0	49.6
365.620	V	45.76	-63.03	0.0	0.58	-63.6	-13.0	50.6

Note:

- 1) The unit of Antenna Gain is dBd for frequency below 1GHz, and the unit of Antenna Gain is dBi for frequency above 1GHz.
- 2) Absolute Level = Substituted Level - Cable loss + Antenna Gain
- 3) Margin = Limit-Absolute Level

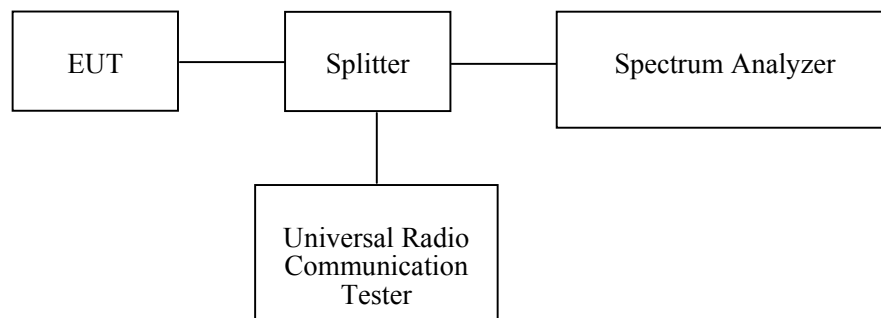
FCC §22.917(a) & §24.238(a)- BAND EDGES**Applicable Standard**

FCC § 2.1053, §22.917, § 24.238.

Test Procedure

The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation.

The center of the spectrum analyzer was set to block edge frequency.

**Test Equipment List and Details**

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Spectrum Analyzer	FSU 26	200256	2018-01-04	2019-01-04
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41005012	Each time	N/A
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A
E-Microwave	Two-way Splitter	ODP-1-6-2S	OE0120142	Each time	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data

Environmental Conditions

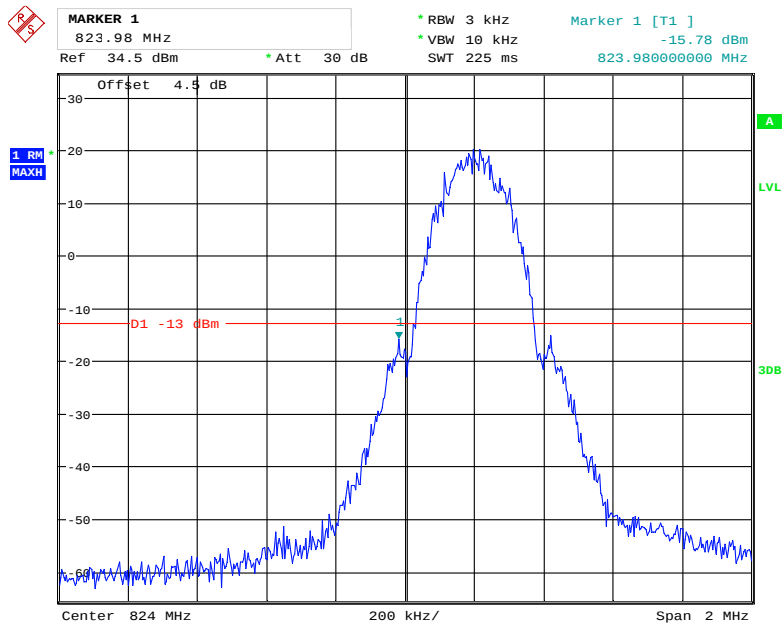
Temperature:	23.9 °C
Relative Humidity:	35 %
ATM Pressure:	99.8 kPa

* The testing was performed by Elena Lei on 2018-12-12.

Test Mode: Transmitting

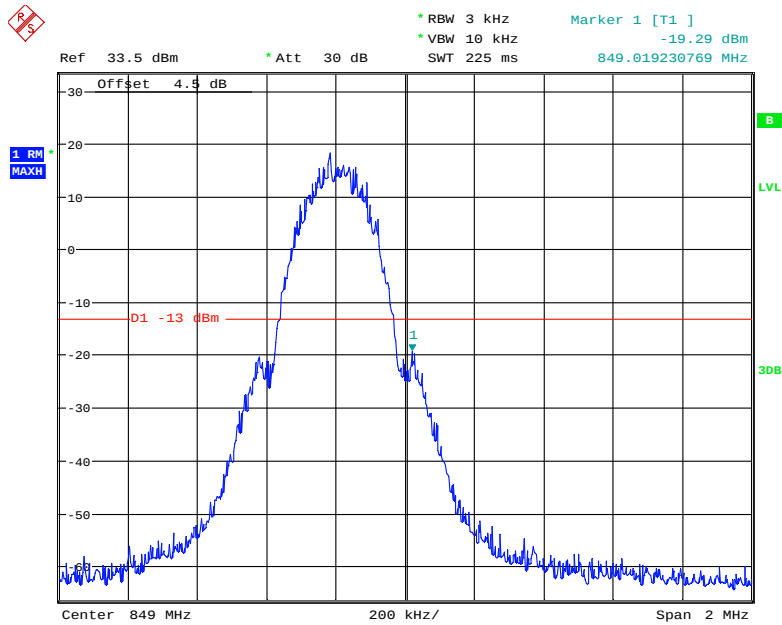
Test Result: Compliance. Please refer to the following plots.

GPRS 850, Left Band Edge



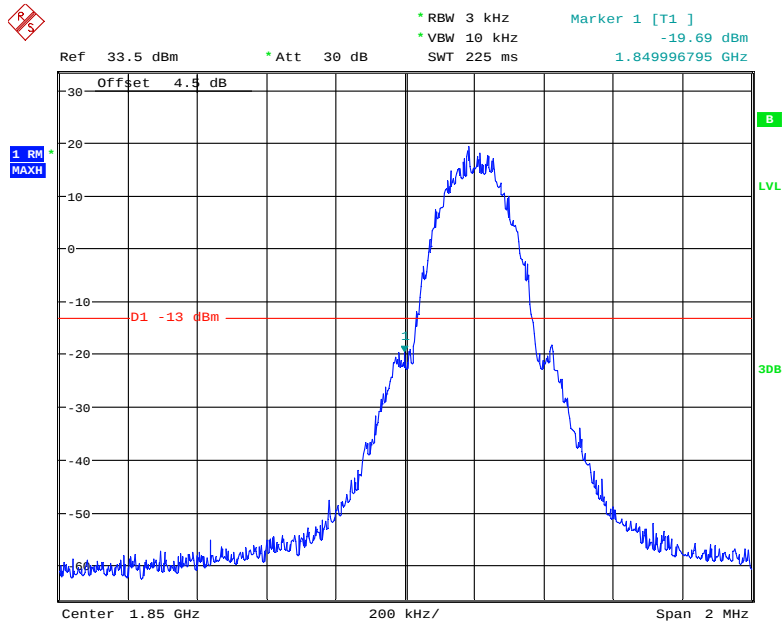
Date: 20.DEC.2018 08:08:49

GPRS 850, Right Band Edge



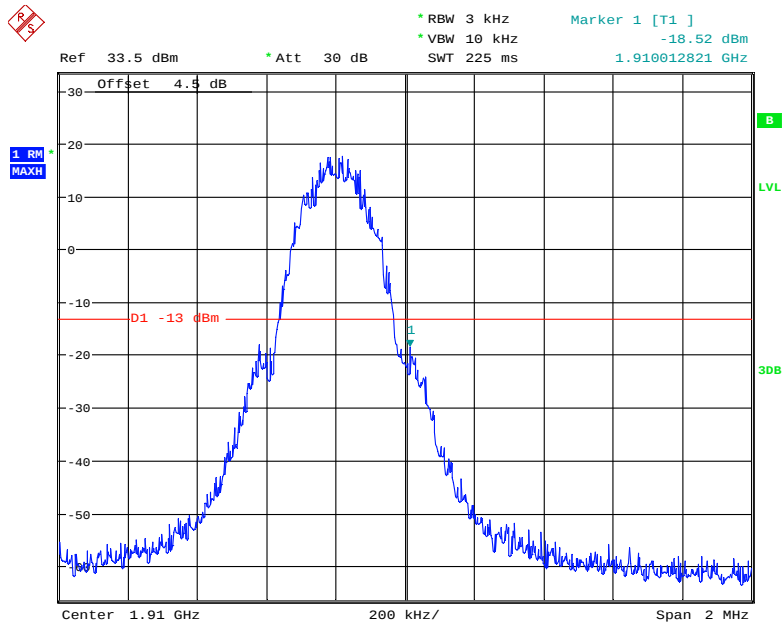
Date: 12.DEC.2018 14:55:53

GPRS 1900, Left Band Edge



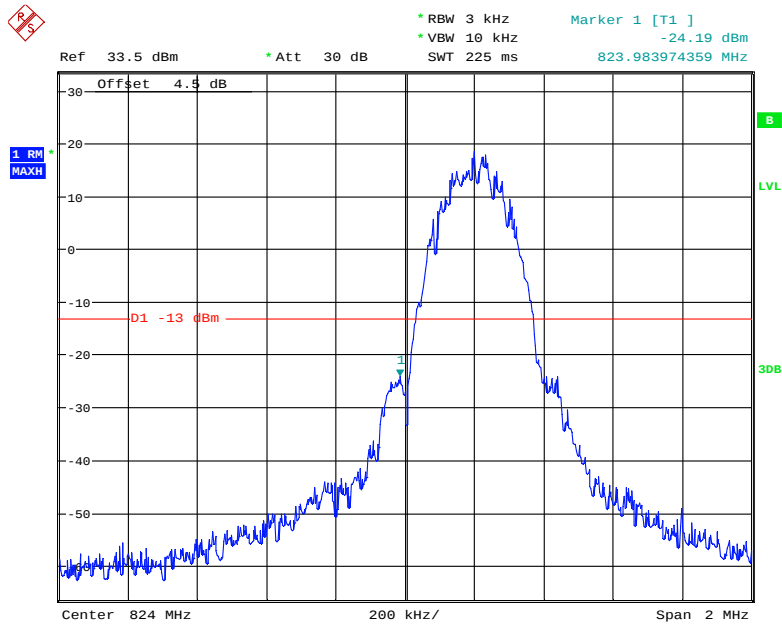
Date: 12.DEC.2018 15:09:25

GPRS 1900, Right Band Edge



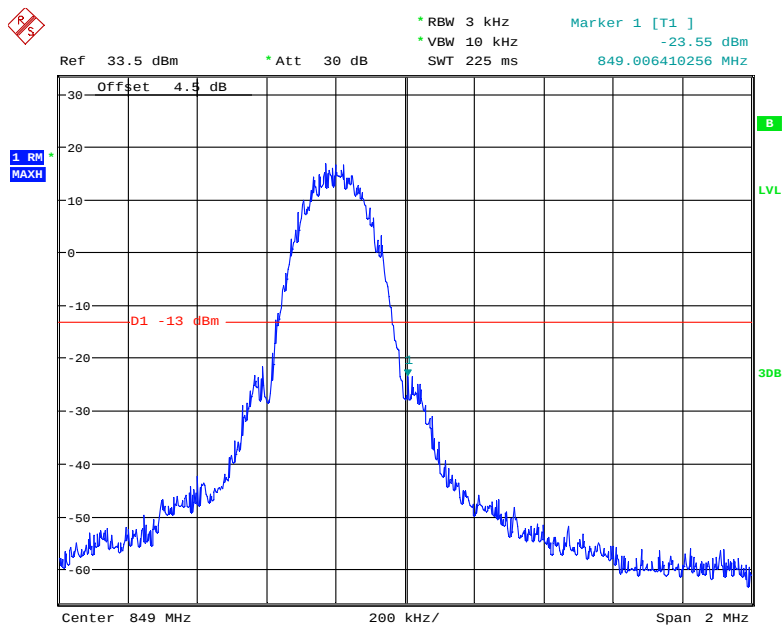
Date: 12.DEC.2018 15:10:46

EDGE 850, Left Band Edge



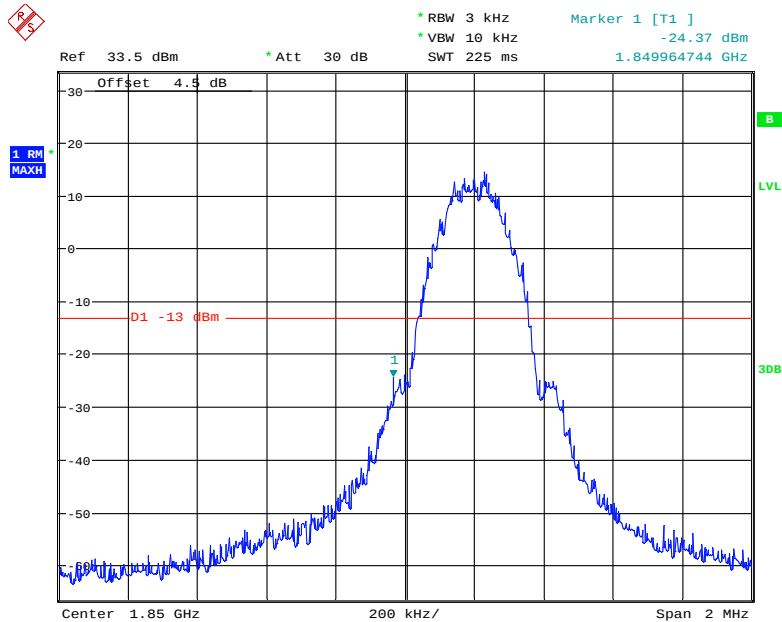
Date: 12.DEC.2018 14:37:12

EDGE 850, Right Band Edge



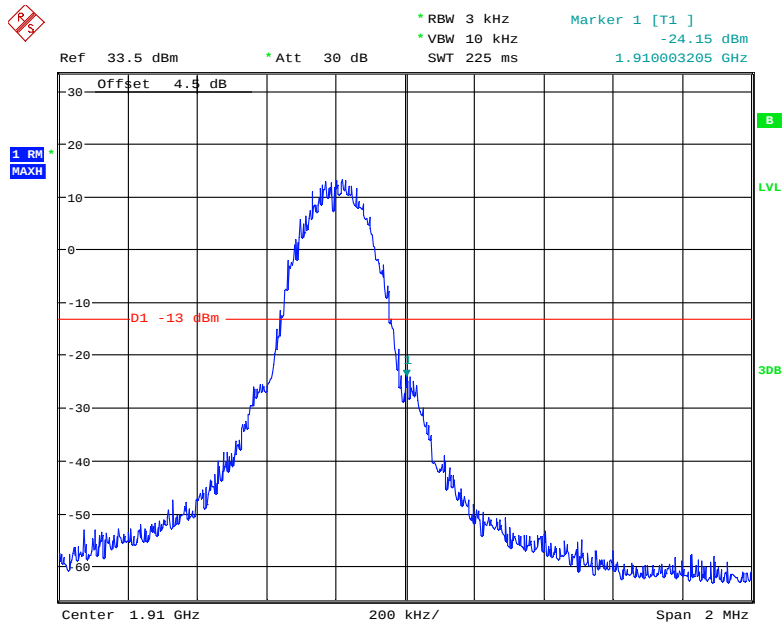
Date: 12.DEC.2018 14:37:58

EDGE 1900, Left Band Edge



Date: 12.DEC.2018 15:22:41

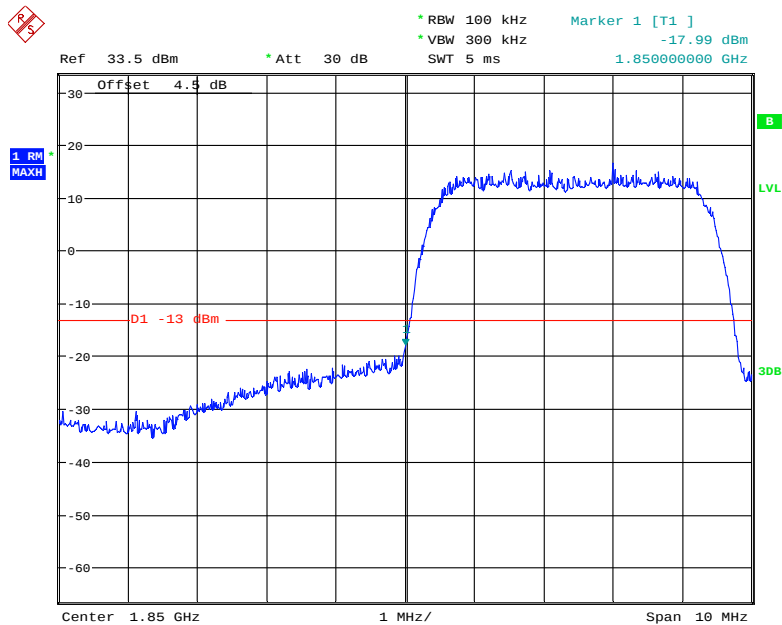
EDGE 1900, Right Band Edge



Date: 12.DEC.2018 15:23:44

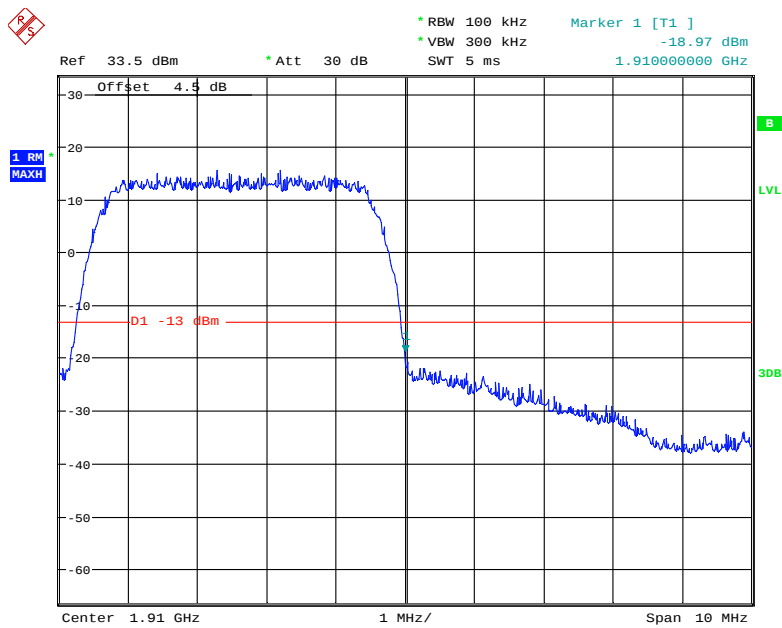
WCDMA Band II:

REL99 Band II, Left Band Edge



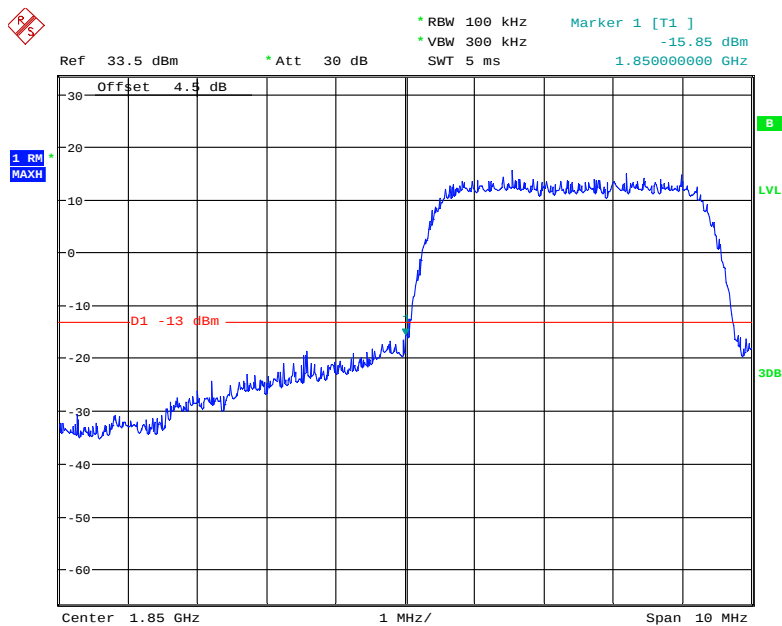
Date: 12.DEC.2018 11:18:39

REL99 Band II, Right Band Edge



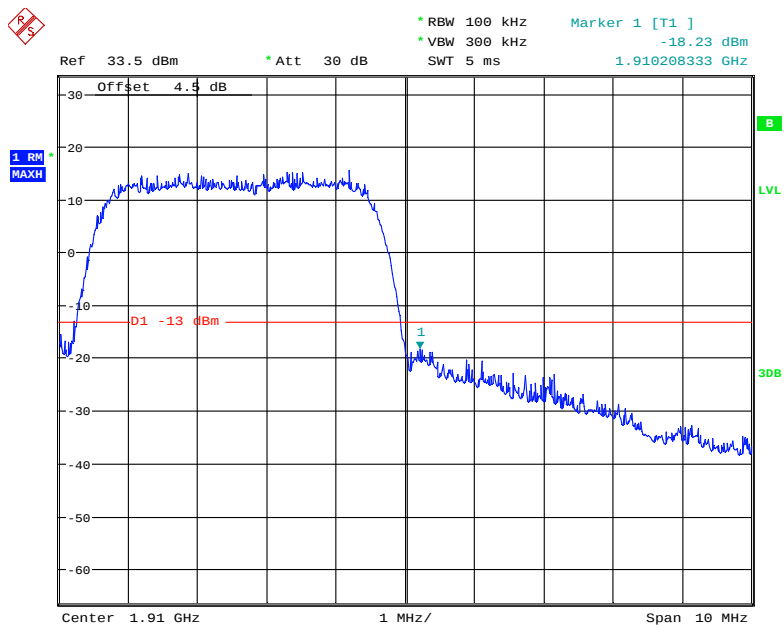
Date: 12.DEC.2018 11:19:13

HSDPA Band II, Left Band Edge



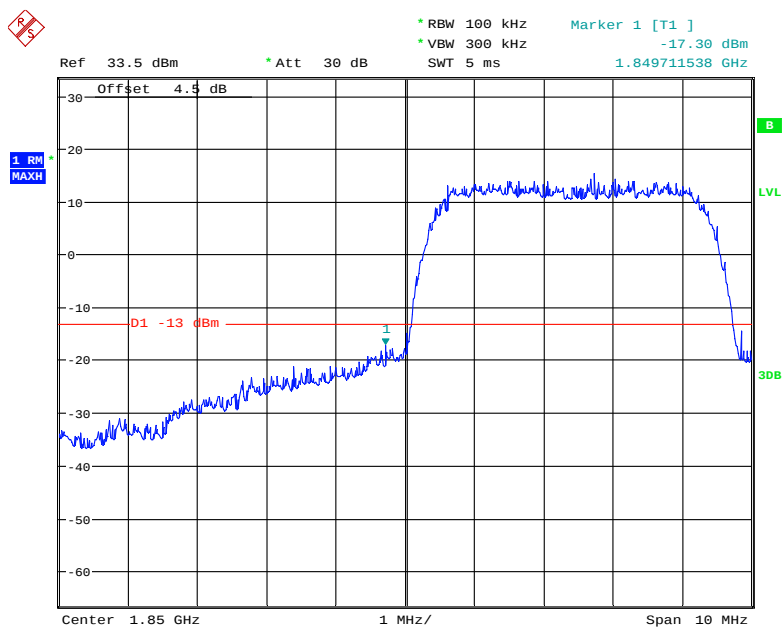
Date: 12.DEC.2018 11:21:04

HSDPA Band II, Right Band Edge



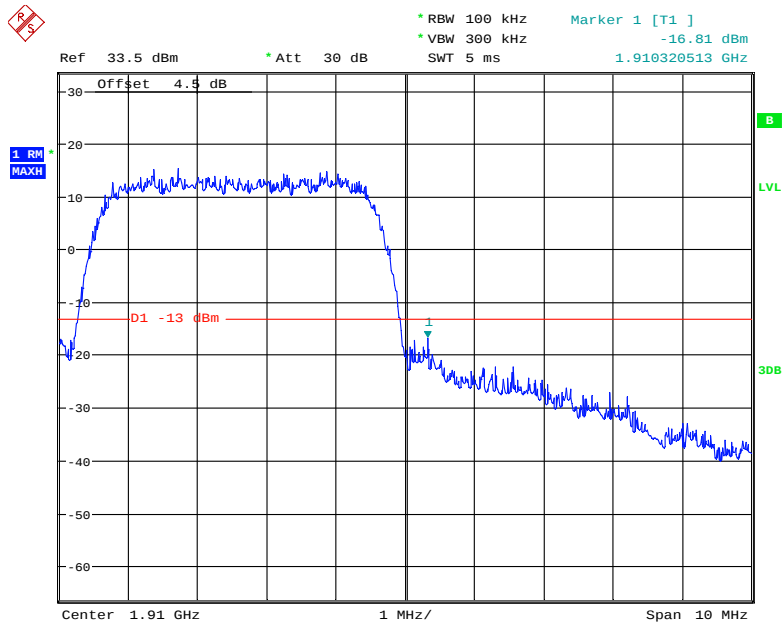
Date: 12.DEC.2018 11:20:35

HSUPA Band II, Left Band Edge



Date: 12.DEC.2018 11:35:41

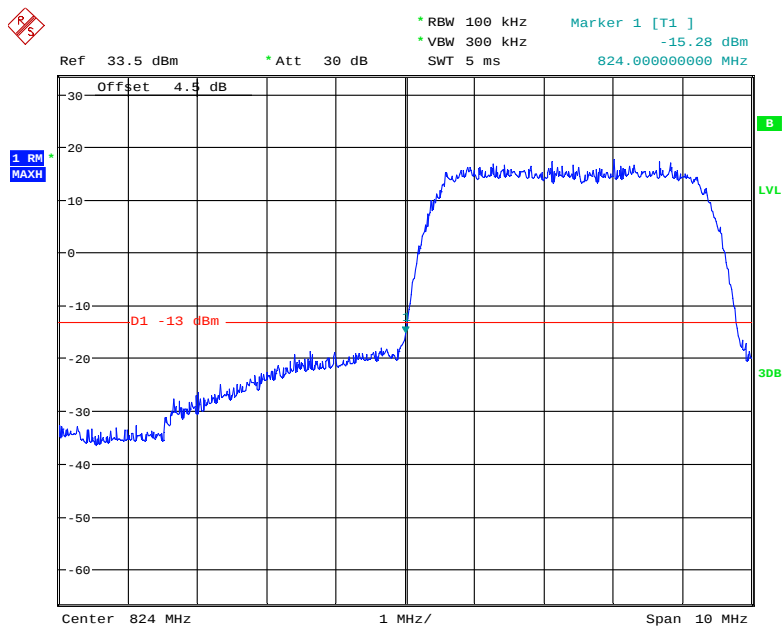
HSUPA Band II, Right Band Edge



Date: 12.DEC.2018 11:36:32

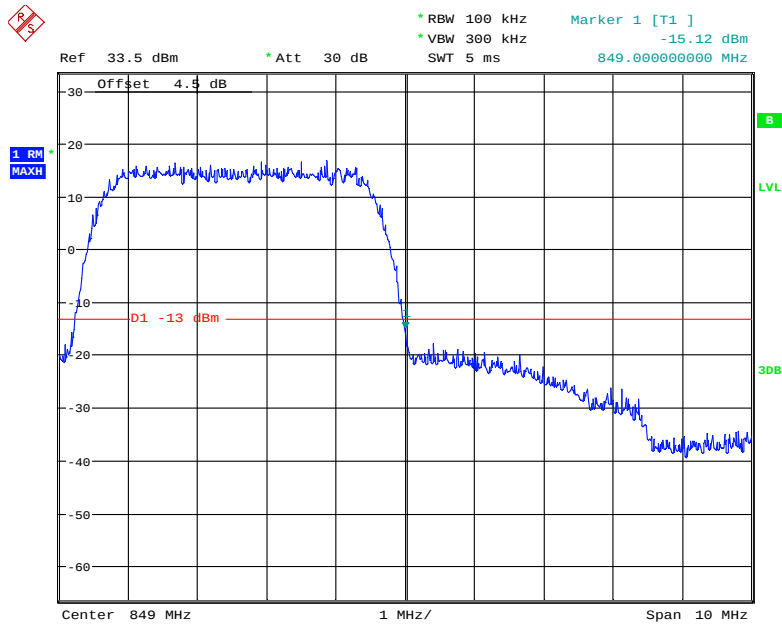
WCDMA Band V

REL99 Band V, Left Band Edge



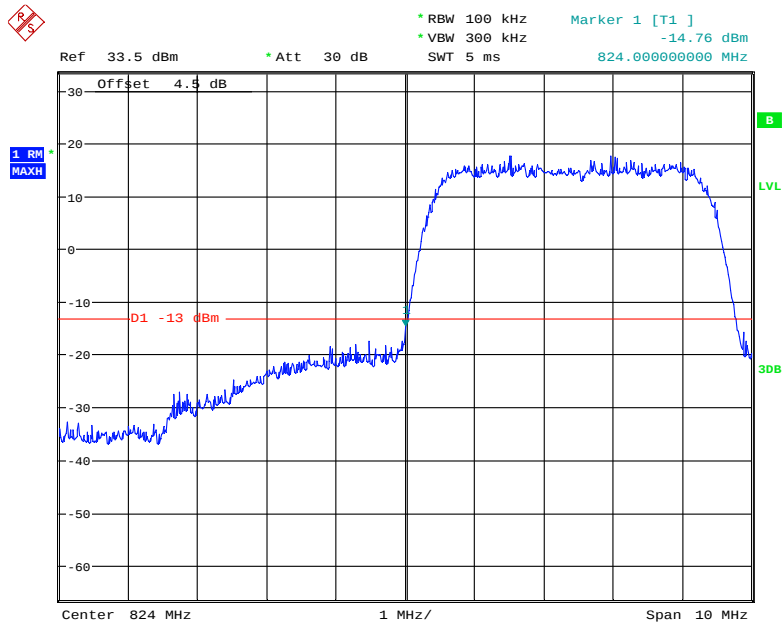
Date: 12.DEC.2018 11:17:32

REL99 Band V Right Band Edge



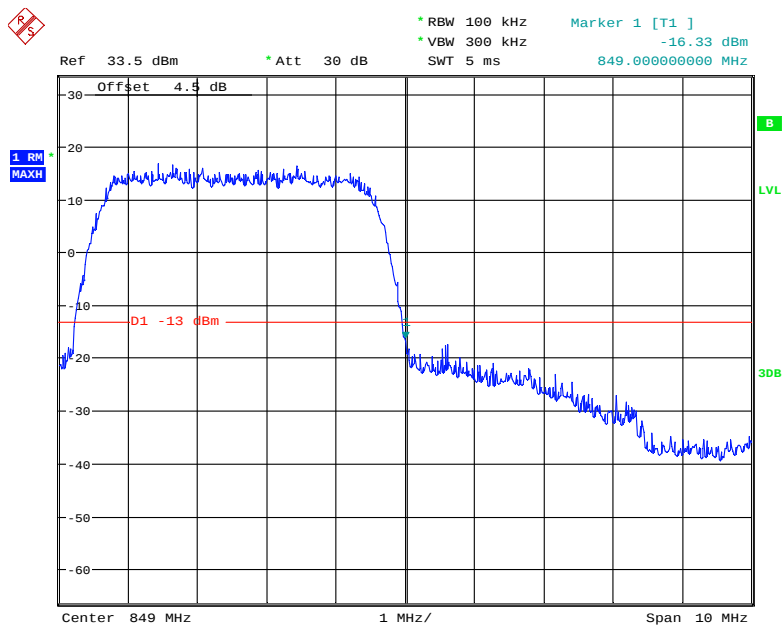
Date: 12.DEC.2018 11:16:35

HSDPA Band V, Left Band Edge



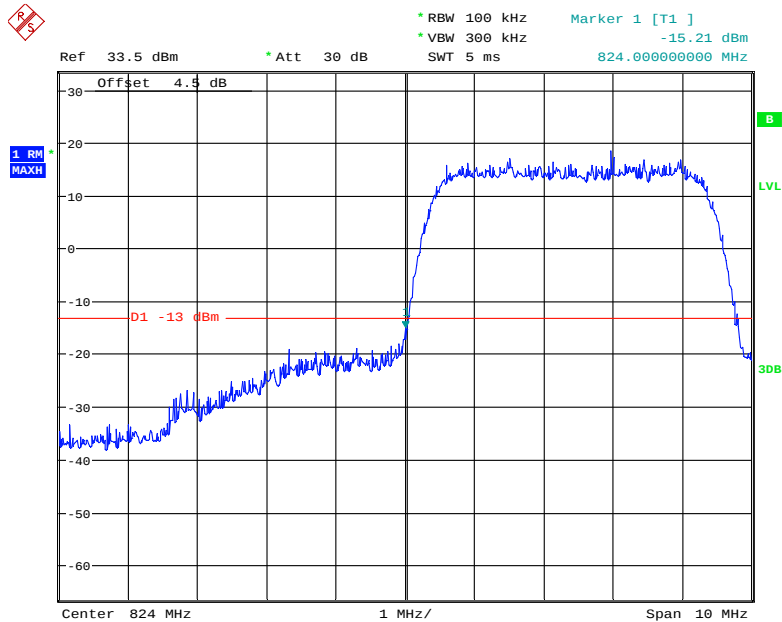
Date: 12.DEC.2018 11:28:29

HSDPA Band V, Right Band Edge



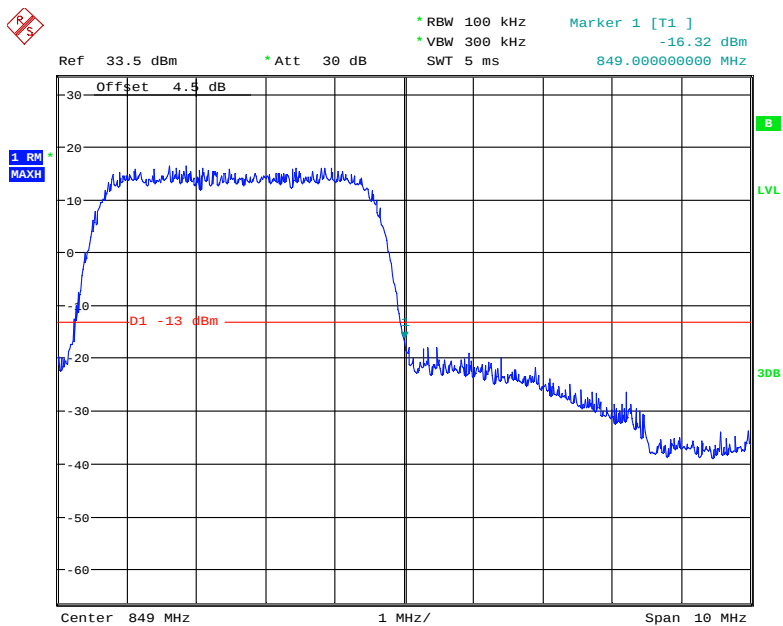
Date: 12.DEC.2018 11:28:53

HSUPA Band V, Left Band Edge



Date: 12.DEC.2018 11:37:14

HSUPA Band V, Right Band Edge



Date: 12.DEC.2018 11:37:57

FCC §2.1055, §22.355 & §24.235 - FREQUENCY STABILITY**Applicable Standard**

FCC § 2.1055 (a), § 2.1055 (d), §22.355, §24.235

According to §22.355, the carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerances given in Table below:

Frequency Tolerance for Transmitters in the Public Mobile Services

Frequency Range (MHz)	Base, fixed (ppm)	Mobile > 3 watts (ppm)	Mobile ≤ 3 watts (ppm)
25 to 50	20.0	20.0	50.0
50 to 450	5.0	5.0	50.0
450 to 512	2.5	5.0	5.0
821 to 896	1.5	2.5	2.5
928 to 929.	5.0	N/A	N/A
929 to 960.	1.5	N/A	N/A
2110 to 2220	10.0	N/A	N/A

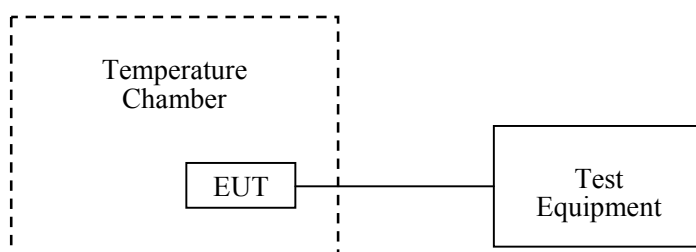
According to §24.235, the frequency stability shall be sufficient to ensure that the fundamental emissions stays within the authorized frequency block.

Test Procedure

Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to communication test set via feed-through attenuators. The EUT was placed inside the temperature chamber. The DC leads and RF output cable exited the chamber through an opening made for the purpose.

After the temperature stabilized for approximately 20 minutes, the frequency output was recorded from the communication test set.

Frequency Stability vs. Voltage: An external variable DC power supply was connected to the battery terminals of the equipment under test. The voltage was set from 85% to 115% of the nominal value and was then decreased until the transmitter light no longer illuminated; i.e., the battery end point. The output frequency was recorded for each battery voltage.



Test Equipment List and Details

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
R&S	Universal Radio Communication Tester	CMU200	106 891	2017-12-14	2018-12-14
ESPEC	Constant temperature and humidity Tester	ESX-4CA	018 463	2018-03-26	2019-03-26
Unknown	Coaxial Cable	C-SJ00-0010	C0010/01	Each time	N/A
UNI-T	Multimeter	UT39A	M130199938	2018-07-24	2019-07-24
Pro instrument	DC Power Supply	pps3300	N/A	N/A	N/A

* **Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Dongguan) attests that all calibrations have been performed, traceable to National Primary Standards and International System of Units (SI).

Test Data**Environmental Conditions**

Temperature:	23.9 °C
Relative Humidity:	35 %
ATM Pressure:	99.8 kPa

* The testing was performed by Elena Lei on 2018-12-12.

Test Result: Compliance.

Cellular Band

GPRS, GMSK modulation, Middle Channel, $f_c = 836.6$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Limit
°C	V _{DC}	Hz	ppm	ppm
-30	3.7	-3	-0.00359	2.5
-20		-5	-0.00598	
-10		-4	-0.00478	
0		-1	-0.00120	
10		1	0.00120	
20		3	0.00359	
30		-2	-0.00239	
40		-5	-0.00598	
50		1	0.00120	
20	3.5	-6	-0.00717	2.5
20	4.2	7	0.00837	

EDGE,8PSK Middle Channel, $f_c = 836.6$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Limit
°C	V _{DC}	Hz	ppm	ppm
-30	3.7	-6	-0.00717	2.5
-20		-9	-0.01076	
-10		-5	-0.00598	
0		-4	-0.00478	
10		-7	-0.00837	
20		-10	-0.01195	
30		-12	-0.01434	
40		-8	-0.00956	
50		-6	-0.00717	
20	3.5	-5	-0.00598	
20	4.2	-4	-0.00478	

PCS Band

GPRS,GMSK modulation, Middle Channel, $f_c = 1880.0$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Results
°C	V _{DC}	Hz	ppm	
-30	3.7	2	0.00106	Pass
-20		4	0.00213	
-10		6	0.00319	
0		3	0.00160	
10		4	0.00213	
20		1	0.00053	
30		5	0.00266	
40		3	0.00160	
50		6	0.00319	
20	3.5	2	0.00106	
20	4.2	-2	-0.00106	

EDGE, 8PSK modulation, Middle Channel, $f_c = 1880.0$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Results
°C	V _{DC}	Hz	ppm	
-30	3.7	-3	-0.00160	Pass
-20		-4	-0.00213	
-10		-2	-0.00106	
0		1	0.00053	
10		3	0.00160	
20		4	0.00213	
30		2	0.00106	
40		-3	-0.00160	
50		-5	-0.00266	
20	3.5	-3	-0.00160	
20	4.2	-1	-0.00053	

WCDMA Band II: R99

Middle Channel, $f_c = 1880.0$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Results
°C	V _{DC}	Hz	ppm	
-30	3.7	-5	-0.00266	Pass
-20		-6	-0.00319	
-10		-9	-0.00479	
0		-8	-0.00426	
10		-6	-0.00319	
20		-2	-0.00106	
30		-1	-0.00053	
40		-6	-0.00319	
50		-9	-0.00479	
20	3.5	-13	-0.00691	
20	4.2	-17	-0.00904	

WCDMA Band V: R99

Middle Channel, $f_c = 836.6$ MHz				
Temperature	Voltage	Frequency Error	Frequency Error	Limit
°C	V _{DC}	Hz	ppm	ppm
-30	3.7	-9	-0.01076	2.5
-20		-12	-0.01434	
-10		-15	-0.01793	
0		-11	-0.01315	
10		-13	-0.01554	
20		-10	-0.01195	
30		-8	-0.00956	
40		-13	-0.01554	
50		-17	-0.02032	
20	3.5	-22	-0.02630	
20	4.2	-25	-0.02988	

***** END OF REPORT *****