TEST REPORT

Dt&C Co., Ltd.
42, Yurim-ro, 154Beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea, 17042
Tel : 031-321-2664, Fax : 031-321-1664

1. Report No : DRTFCC2403-0031(1)

2. Customer

• Name (FCC) : Ecube Labs Co.,Ltd.

• Address (FCC) : #710, Daeryungposttower, 288, Digital-ro, Guro-gu Seoul South Korea

3. Use of Report : FCC Original Grant

4. Product Name / Model Name : CleanCUBE / CCB2-120L
FCC ID : 2AHTD-CCB2

5. FCC Regulation(s): Part 24
Test Method Used : KDB971168 D01v03, ANSI/TIA-603-E-2016, ANSI C63.26-2015

6. Date of Test : 2023.09.26 ~ 2024.03.20

7. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing

8. Testing Environment : See appended test report.

9. Test Result : Refer to the attached test result.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : Seokho Han (Signature)	Technical Manager Name : JaeJin Lee (Signature)

2024 . 04 . 19 .

Dt&C Co., Ltd.

If this report is required to confirmation of authenticity, please contact to report@dtnc.net

Test Report Version

Test Report No.	Date	Description	Revised by	Reviewed by
DRTFCC2403-0031	Mar. 22, 2024	Initial issue	Seokho Han	JaeJin Lee
DRTFCC2403-0031(1)	Apr. 19, 2024	Product Name retouch	Seokho Han	JaeJin Lee

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1. GENERAL INFORMATION

Equipment Class	PCS Licensed Transmitter (PCB)
Product Name	CleanCUBE
Model Name	CCB2-120L
Add Model Name	CCB2-100L, CCB2-240L
FVIN(Firmware Version Identification Number)	1.0
EUT Serial Number	No Specified
Supplying power	DC 12 V
Antenna Information	Antenna Type : Dipole Antenna Antenna Gain : 5.0 dBi (LTE Band 2)

Note: The difference between models is the size of the product.

	Antenna gain(dBi)	Cable loss(dB)	Antenna gain including connected cable loss between transmitter and antenna (dBi)
LTE Band 2	5.00	1.55	3.45

2. INTRODUCTION

2.1. EUT DESCRIPTION

The Equipment Under Test (EUT) supports LTE Band 2.

2.2. TESTING ENVIRONMENT

Ambient Condition	
▪ Temperature	+22 ℃ ~ +24 ℃
▪ Relative Humidity	41 % ~ 43 %

2.3. MEASURING INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment, which is traceable to recognized national standards.

2.4. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with requirements of ANSI C 63.4-2014. All measurement uncertainty values are shown with a coverage factor of *k* = 2 to indicate a 95 % level of confidence.

Parameter	Measurement uncertainty
Radiated Disturbance (Below 1 GHz)	5.0 dB (The confidence level is about 95 %, k = 2)
Radiated Disturbance (1 GHz ~ 18 GHz)	4.8 dB (The confidence level is about 95 %, k = 2)
Radiated Disturbance (Above 18 GHz)	5.7 dB (The confidence level is about 95 %, k = 2)

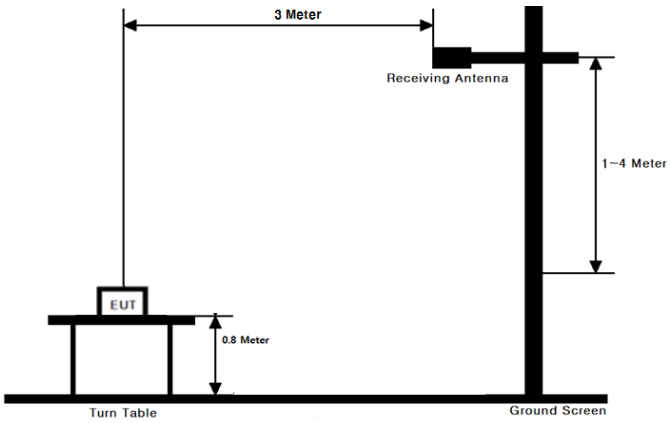
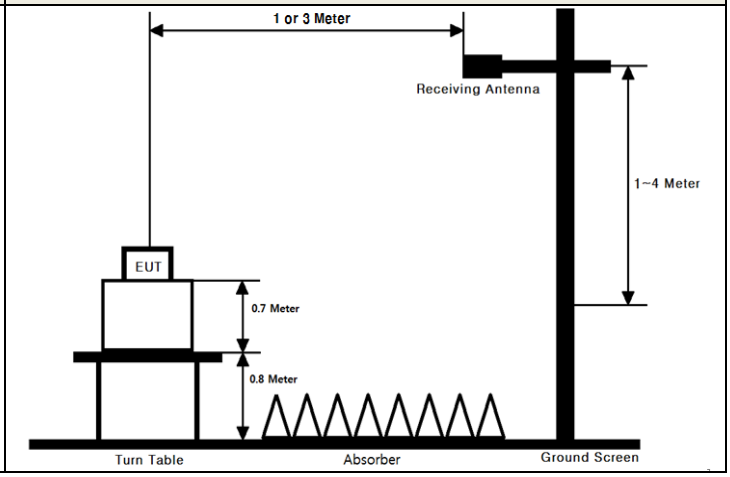
2.5. TEST FACILITY

Dt&C Co., Ltd.		
The 3 m test site and conducted measurement facility used to collect the radiated data are located at the 42, Yurim-ro, 154beon-gil, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea 17042. The test site complies with the requirements of Part 2.948 according to ANSI C63.4-2014. **- FCC & IC MRA Designation No. : KR0034** **- ISED#: 5740A**		
www.dtnc.net		
Telephone	:	+ 82-31-321-2664
FAX	:	+ 82-31-321-1664

3. DESCRIPTION OF TESTS

3.1. ERP & EIRP (Effective Radiated Power & Equivalent Isotropic Radiated Power)

Test Set-up

Below 1GHz	Above 1GHz
	

These measurements were performed at 3 m test site. The equipment under test is placed on a non-conductive table 0.8 or 1.5-meters above a turntable which is flush with the ground plane and 3 meters from the receive antenna. For measurements above 1GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.

Test Procedure

- **ANSI/TIA-603-E-2016 - Section 2.2.17**
- **KDB971168 D01v03 - Section 5.2.2**
- **ANSI C63.26-2015 – Section 5.2.4.4.1**

Test setting

1. Set span to 2 x to 3 x the OBW.
2. Set RBW = 1 % to 5 % of the OBW.
3. Set VBW ≥ 3 x RBW.
4. Set number of points in sweep ≥ 2 × span / RBW.
5. Sweep time:
   1) Set = auto-couple, or
   2) Set ≥ [10 × (number of points in sweep) × (transmission period)] for single sweep (automation-compatible) measurement. Transmission period is the on and off time of the transmitter.
6. Detector = power averaging (rms).
7. If the EUT can be configured to transmit continuously, then set the trigger to free run.
8. If the EUT cannot be configured to transmit continuously, then use a sweep trigger with the level set to enable triggering only on full power bursts and configure the EUT to transmit at full power for the entire duration of each sweep. Verify that the sweep time is less than or equal to the transmission burst duration. Time gating can also be used under similar constraints (i.e., configured such that measurement data is collected only during active full-power transmissions).
9. Trace average at least 100 traces in power averaging (rms) mode if sweep is set to auto-couple. To accurately determine the average power over multiple symbols, it can be necessary to increase the number of traces to be averaged above 100 or, if using a manually configured sweep time, increase the sweep time.

10. Compute the power by integrating the spectrum across the OBW of the signal using the instrument's band or channel power measurement function, with the band/channel limits set equal to the OBW band edges. If the instrument does not have a band or channel power function, then sum the spectrum levels (in linear power units) at intervals equal to the RBW extending across the entire OBW of the spectrum.

The receiver antenna height and turntable rotations were adjusted for the highest reading on the receive spectrum analyzer.

A half-wave dipole was substituted in place of the EUT. This dipole antenna was driven by a signal generator and the level of the signal generator was adjusted to obtain the same receive spectrum analyzer reading. The conducted power at the terminal of the substitute antenna is measured.

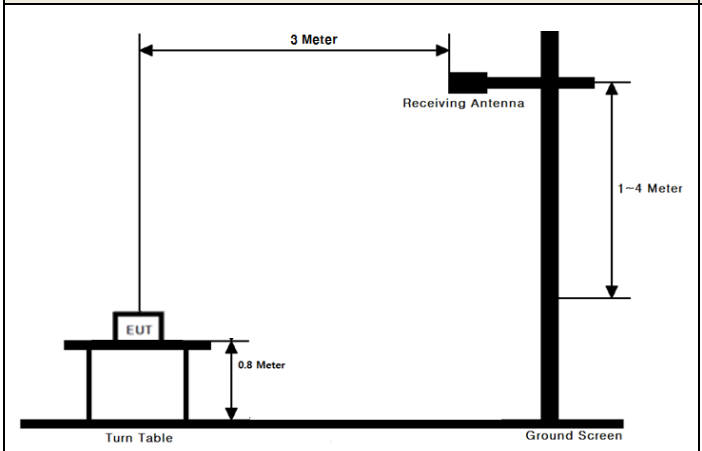
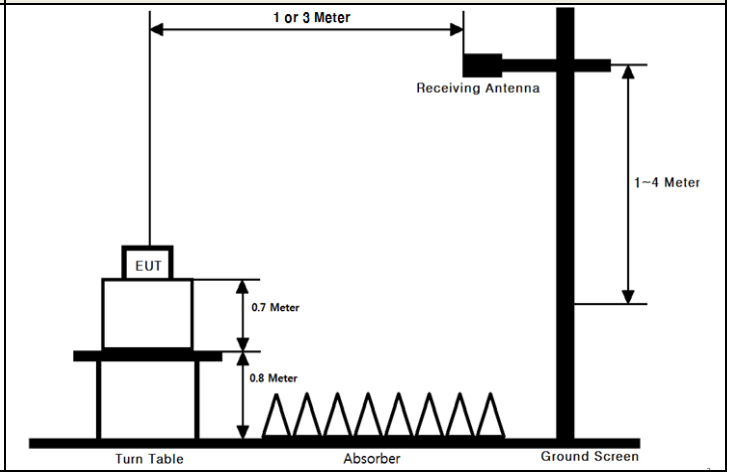
The ERP/EIRP is calculated using the following formula:

ERP/EIRP = The conducted power at the substitute antenna`s terminal [dBm] + Substitute Antenna gain [dBd for ERP , dBi for EIRP]

For readings above 1 GHz, the above procedure is repeated using horn antennas and the difference
Between the gain of the horn antenna and an isotropic antenna are taken into consideration.

3.2. UNDESIRABLE EMISSIONS

Test Set-up

Below 1GHz	Above 1GHz
	

These measurements were performed at 3 test site. The equipment under test is placed on a non-conductive table 0.8 or 1.5 meters above a turntable which is flush with the ground plane and 3 meters from the receive antenna. For measurements above 1 GHz absorbers are placed on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1 GHz, the absorbers are removed.

Test Procedure

- **ANSI/TIA-603-E-2016 - Section 2.2.12**
- **KDB971168 D01v03 - Section 5.8**
- **ANSI C63.26-2015 – Section 5.5**

Test setting

1. RBW = 100 kHz for below 1 GHz and 1 MHz for above 1 GHz / VBW ≥ 3 X RBW
2. Detector = RMS & Trace mode = Max hold
3. Sweep time = Auto couple
4. Number of sweep point ≥ 2 X span / RBW
5. The trace was allowed to stabilize

The receive antenna height and turntable rotations were adjusted for the highest reading on the receive spectrum analyzer. For radiated power measurements below 1 GHz, a half-wave dipole was substituted in place of the EUT. This dipole antenna was driven by a signal generator and the level of the signal generator was adjusted to obtain the same spectrum analyzer reading.
For radiated power measurements above 1 GHz, a Horn antenna was substituted in place of the EUT. This Horn antenna was driven by a signal generator and the level of the signal generator was adjusted to obtain the same spectrum analyzer reading. The difference between the gain of the horn and an isotropic antenna are taken into consideration.

4. LIST OF TEST EQUIPMENT

Type	Manufacturer	Model	Cal.Date (yy/mm/dd)	Next.Cal. Date (yy/mm/dd)	S/N
Spectrum Analyzer	Agilent	N9020A	22/12/16 23/12/15	23/12/16 24/12/15	MY50110097
DC power supply	Agilent Technologies	66332A	23/06/23	24/06/23	US37474125
Multimeter	FLUKE	17B+	22/12/16 23/12/15	23/12/16 24/12/15	36390701WS
Radio Communication Analyzer	Anritsu	MT8820C	23/06/23	24/06/23	6200951873
Thermohygrometer	BODYCOM	BJ5478	22/12/16 23/12/15	23/12/16 24/12/15	120612-1
Thermohygrometer	BODYCOM	BJ5478	22/12/16 23/12/15	23/12/16 24/12/15	120612-2
Signal Generator	Rohde Schwarz	SMBV100A	22/12/16 23/12/15	23/12/16 24/12/15	255571
Signal Generator	ANRITSU	MG3695C	22/12/16 23/12/15	23/12/16 24/12/15	173501
Loop Antenna	ETS-Lindgren	6502	22/04/22	24/04/22	00203480
Hybrid Antenna	Schwarzbeck	VULB 9160	22/12/16 23/12/15	23/12/16 24/12/15	3362
Horn Antenna	ETS	3117	22/12/16 23/12/15	23/12/16 24/12/15	00140394
Horn Antenna	A.H.Systems	SAS-574	23/06/23	24/06/23	155
PreAmplifier	H.P	8447D	22/12/16 23/12/15	23/12/16 24/12/15	2944A07774
PreAmplifier	Agilent	8449B	22/12/16 23/12/15	23/12/16 24/12/15	3008A02108
PreAmplifier	tsj	MLA-1840-J02-45	23/06/23	24/06/23	16966-10728
High Pass Filter	Wainwright Instruments	WHKX12-935-1000-15000-40SS	22/12/16 23/12/15	23/12/16 24/12/15	7
High Pass Filter	Wainwright Instruments	WHKX10-2838-3300-18000-60SS	22/12/16 23/12/15	23/12/16 24/12/15	2
High Pass Filter	Wainwright Instruments	WHKX6-6320-8000-26500-40CC	22/12/16 23/12/15	23/12/16 24/12/15	2
Cable	HUBER+SUHNER	SUCOFLEX100	23/01/04 24/01/03	24/01/04 25/01/03	M-01
Cable	HUBER+SUHNER	SUCOFLEX100	23/01/04 24/01/03	24/01/04 25/01/03	M-02
Cable	JUNKOSHA	MWX241/B	23/01/04 24/01/03	24/01/04 25/01/03	M-03
Cable	JUNKOSHA	MWX221	23/01/04 24/01/03	24/01/04 25/01/03	M-04
Cable	JUNKOSHA	MWX221	23/01/04 24/01/03	24/01/04 25/01/03	M-05
Cable	JUNFLON	J12J101757-00	23/01/04 24/01/03	24/01/04 25/01/03	M-07
Cable	HUBER+SUHNER	SUCOFLEX104	23/01/04 24/01/03	24/01/04 25/01/03	M-08
Cable	HUBER+SUHNER	SUCOFLEX106	23/01/04 24/01/03	24/01/04 25/01/03	M-09
Cable	Junkosha	MWX315	23/01/04 24/01/03	24/01/04 25/01/03	M-10
Cable	JUNKOSHA	MWX241	23/01/03 24/01/03	24/01/03 25/01/03	mmW-1
Cable	JUNKOSHA	MWX241	23/01/03 24/01/03	24/01/03 25/01/03	mmW-4
Cable	Dt&C	Cable	23/01/04 24/01/03	24/01/04 25/01/03	RFC-44
Test Software	tsj	Radiated Emission Measurement	NA	NA	Version 2.00.0185

Note1: The measurement antennas were calibrated in accordance to the requirements of ANSI C63.5-2017.
Note2: The cable is not a regular calibration item, so it has been calibrated by Dt&C itself.

5. SUMMARY OF TEST RESULTS

FCC Part Section(s)	Test Description	Test Limit	Test Condition	Status Note 1
24.232(c)	Radiated Output Power(B2)	< 2 Watts max. EIRP	Radiated	**C**
2.1053 24.238(a)	Undesirable Emissions(B2)	> 43 + 10log$_{10}$(P) dB for all out-of-band emissions		**C**

Note 1: **C**=Comply **NC**=Not Comply **NT**=Not Tested **NA**=Not Applicable
Note 2: This device uses the certified module. (FCC ID: XMR202112EC200AAU)
Please refer to the module test report for conducted signal test items.
The conducted output power was verified to be the same as module.

6. SAMPLE CALCULATION

A. Emission Designator

1) The EUT was placed on a turntable with 0.8 meter height for frequency below 1GHz and 1.5 meter height for frequency above 1 GHz respectively above ground.
2) The EUT was set 3 meters from the receiving antenna mounted on the antenna tower.
3) During the test, the turn table is rotated until the maximum signal is found.
4) Record the field strength meter's level. (ex. Spectrum reading level is -8.5 dBm)
5) Replace the EUT with dipole/Horn antenna that is connected to a calibrated signal generator.
6) Increase the signal generator output till the field strength meter's level is equal to the item (4). (ex. Signal generator level is -18.04 dBm)
7) The gain of the cable and amplifier between the signal generator and terminals of substituted antenna is 46.92 dB at test frequency.
8) Record the level at substituted antenna terminal. (ex. 28.88dBm)
9) The result is calculated as below;

EIRP(dBm) = LEVLE@ANTENNA TERMINAL + TX Antenna Gain (dBi)
ERP(dBm) = LEVLE@ANTENNA TERMINAL + TX Antenna Gain (dBd)
Where, TX Antenna Gain (dBd) = TX Antenna Gain (dBi) - 2.15 dB

7. TEST DATA

7.1. ERP & EIRP

- Test Notes

1) This is device was tested under all bandwidths, modulations and RB configurations and the worst case data are reported in the below table.

7.1.1. LTE Band 2

Model: CCB2-120L

Channel Bandwidth (MHz)	Tx Freq. (MHz)	Test Mode	RB Size/ Offset	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	EIRP (dBm)	EIRP (W)
20	1 860	QPSK	1/0	V	18.28	4.31	22.59	0.182
		16QAM	1/0	V	17.77	4.31	22.08	0.161
	1 880	QPSK	1/0	V	19.11	4.26	23.37	0.217
		16QAM	1/0	V	18.53	4.26	22.79	0.190
	1 900	QPSK	1/50	V	17.92	4.20	22.12	0.163
		16QAM	1/50	V	17.07	4.20	21.27	0.134
15	1 857.5	QPSK	1/0	V	18.43	4.32	22.75	0.188
		16QAM	1/0	V	17.94	4.32	22.26	0.168
	1 880	QPSK	1/0	V	19.89	4.26	24.15	0.260
		16QAM	1/0	V	19.38	4.26	23.64	0.231
	1 902.5	QPSK	1/0	V	19.36	4.21	23.57	0.228
		16QAM	1/0	V	18.61	4.21	22.82	0.191
10	1 855	QPSK	1/0	V	18.32	4.33	22.65	0.184
		16QAM	1/0	V	17.58	4.33	21.91	0.155
	1 880	QPSK	1/0	V	19.81	4.26	24.07	0.255
		16QAM	1/0	V	19.05	4.26	23.31	0.214
	1 905	QPSK	1/0	V	18.89	4.22	23.11	0.205
		16QAM	1/0	V	18.01	4.22	22.23	0.167
5	1 852.5	QPSK	1/0	V	18.69	4.33	23.02	0.200
		16QAM	1/0	V	17.91	4.33	22.24	0.167
	1 880	QPSK	1/0	V	19.61	4.26	23.87	0.244
		16QAM	1/0	V	18.90	4.26	23.16	0.207
	1 907.5	QPSK	1/24	V	19.03	4.23	23.26	0.212
		16QAM	1/24	V	18.61	4.23	22.84	0.192
3	1 851.5	QPSK	1/0	V	18.42	4.34	22.76	0.189
		16QAM	1/0	V	17.63	4.34	21.97	0.157
	1 880	QPSK	1/0	V	19.43	4.26	23.69	0.234
		16QAM	1/0	V	18.75	4.26	23.01	0.200
	1 908.5	QPSK	1/14	V	19.11	4.23	23.34	0.216
		16QAM	1/14	V	18.65	4.23	22.88	0.194
1.4	1 850.7	QPSK	1/0	V	18.67	4.34	23.01	0.200
		16QAM	1/0	V	18.05	4.34	22.39	0.173
	1 880	QPSK	1/0	V	19.43	4.26	23.69	0.234
		16QAM	1/0	V	18.82	4.26	23.08	0.203
	1 909.3	QPSK	1/0	V	19.69	4.24	23.93	0.247
		16QAM	1/0	V	18.92	4.24	23.16	0.207

Model: CCB2-100L

Channel Bandwidth (MHz)	Tx Freq. (MHz)	Test Mode	RB Size/ Offset	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	EIRP (dBm)	EIRP (W)
15	1 857.5	QPSK	1/74	V	15.18	4.32	19.50	0.089
		16QAM	1/74	V	14.25	4.32	18.57	0.072
	1 880	QPSK	1/0	V	16.78	4.26	21.04	0.127
		16QAM	1/0	V	15.82	4.26	20.08	0.102
	1 902.5	QPSK	1/0	V	16.47	4.21	20.68	0.117
		16QAM	1/0	V	15.60	4.21	19.81	0.096

Model: CCB2-240L

Channel Bandwidth (MHz)	Tx Freq. (MHz)	Test Mode	RB Size/ Offset	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	EIRP (dBm)	EIRP (W)
15	1 857.5	QPSK	1/0	V	18.17	4.32	22.49	0.177
		16QAM	1/0	V	17.64	4.32	21.96	0.157
	1 880	QPSK	1/0	V	17.34	4.26	21.60	0.145
		16QAM	1/0	V	16.71	4.26	20.97	0.125
	1 902.5	QPSK	1/0	V	15.64	4.21	19.85	0.097
		16QAM	1/0	V	14.92	4.21	19.13	0.082

7.2. UNDESIRABLE EMISSIONS (Radiated)

- Test Notes

1) This device was tested under all bandwidths, modulations and RB configurations and the worst case data are reported.
2) The frequency spectrum is examined from 9 kHz to the 10th harmonic of the fundamental frequency of the transmitter. No other spurious and harmonic emissions were reported greater than listed emissions.
3) Limit for Band 2 = -13dBm

7.2.1. LTE Band 2

Model: CCB2-120L

Channel Bandwidth (MHz)	Test Freq. (MHz)	RB Size/ Offset	Test Mode	Freq.(MHz)	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	Result (dBm)	Limit (dBm)	Margin (dB)
20	1 860	1/0	QPSK	3 702.19	H	-63.19	8.34	-54.85	-13.00	41.85
			16QAM	3 702.26	H	-63.77	8.34	-55.43	-13.00	42.43
	1 880	1/0	QPSK	3 742.25	H	-57.92	8.29	-49.63	-13.00	36.63
			16QAM	3 742.15	H	-58.54	8.29	-50.25	-13.00	37.25
	1 900	1/50	QPSK	3 800.18	H	-59.28	8.48	-50.80	-13.00	37.80
			16QAM	3 800.24	H	-60.20	8.48	-51.72	-13.00	38.72
15	1 880	1/0	QPSK	3 746.63	H	-58.08	8.28	-49.80	-13.00	36.80
			16QAM	3 746.63	H	-58.72	8.28	-50.44	-13.00	37.44

Model: CCB2-100L

Channel Bandwidth (MHz)	Test Freq. (MHz)	RB Size/ Offset	Test Mode	Freq.(MHz)	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	Result (dBm)	Limit (dBm)	Margin (dB)
20	1 860	1/0	QPSK	3 702.19	H	-59.24	8.34	-50.90	-13.00	37.90
			16QAM	3 702.15	H	-59.97	8.34	-51.63	-13.00	38.63
	1 880	1/0	QPSK	3 742.22	H	-61.01	8.29	-52.72	-13.00	39.72
			16QAM	3 742.08	H	-61.30	8.29	-53.01	-13.00	40.01
	1 900	1/50	QPSK	3 800.18	H	-60.08	8.48	-51.60	-13.00	38.60
			16QAM	3 800.24	H	-60.75	8.48	-52.27	-13.00	39.27

Model: CCB2-240L

Channel Bandwidth (MHz)	Test Freq. (MHz)	RB Size/ Offset	Test Mode	Freq.(MHz)	Ant Pol (H/V)	Level at Antenna Terminal(dBm)	Substitute Antenna Gain(dBi)	Result (dBm)	Limit (dBm)	Margin (dB)
20	1 860	1/0	QPSK	3 702.17	H	-59.05	8.34	-50.71	-13.00	37.71
			16QAM	3 702.20	H	-59.70	8.34	-51.36	-13.00	38.36
	1 880	1/0	QPSK	3 742.26	H	-57.16	8.29	-48.87	-13.00	35.87
			16QAM	3 742.22	H	-57.73	8.29	-49.44	-13.00	36.44
	1 900	1/50	QPSK	3 800.13	H	-57.87	8.48	-49.39	-13.00	36.39
			16QAM	3 800.07	H	-58.83	8.48	-50.35	-13.00	37.35