TEST REPORT

Product Name	**:**	**VHF Handheld Marine Radio**
Model Number	**:**	**EXM300**
FCC ID	**:**	**2BCI6-EXM300**

Prepared for	:	Enfinity Pty Ltd
Address	:	UNIT 206, 27 MARS RD LANE COVE NSW 2066, AUSTRALIA
Prepared by	:	EMTEK (SHENZHEN) CO., LTD.
Address	:	Building 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China Tel: (0755) 26954280 Fax: (0755) 26954282
Report Number	:	ENS2307270180W00301R
Date(s) of Tests	:	July 27, 2023 to October 29, 2023
Date of issue	:	October 29, 2023

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1 TEST RESULT CERTIFICATION

Applicant	:	Enfinity Pty Ltd
Address:	:	UNIT 206, 27 MARS RD LANE COVE NSW 2066, AUSTRALIA
Applicant	:	Auctus Technologies Co.,Ltd.
Address:	:	17F, Building 3, China Science and Technology Development Park, No. 009, 1st South Gaoxin Road, Nanshan District, Shenzhen, Guangdong, China
EUT	:	VHF Handheld Marine Radio
Model Name	:	EXM300
Trademark	:	Ecoxgear

Measurement Procedure Used:

APPLICABLE STANDARDS	
STANDARD	**TEST RESULT**
FCC 47 CFR Part 2 FCC 47 CFR Part 80	PASS

The above equipment was tested by EMTEK (SHENZHEN) CO., LTD. The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10 (2013) and ANSI/TIA-603-E: 2016 the energy emitted by the sample EUT tested as described in this report is in compliance with the requirements of Part 2 and Part 80.

The test results of this report relate only to the tested sample identified in this report

Date of Test : July 27, 2023 to October 29, 2023

Prepared by : Una Yu /Editor

Reviewer : Mill Chen/Supervisor

Approve & Authorized Signer : Lisa Wang/Manager

2 EUT TECHNICAL DESCRIPTION

Characteristics	Description
Product:	VHF Handheld Marine Radio
Model Number:	EXM300
Rated Input Voltage:	3 AA NiMH Rechargeable batteries DC 3.6V from Charging base
Adapter:	Model:HJ-0501000E1-US Input: 100~240V, 50~60Hz, 0.2A Output: 5.0V, 1.0A
Frequency Range:	Transmit: 156.050-157.425 MHz Receive: 156.050-163.275 MHz
Modulation:	FM
Channel Spacing:	25kHz
Rated Output Power:	High: 3W Low: 1W
Type of Antenna:	Spring Antenna
Antenna Gain:	-4.77dBi
Software Version:	V04
Hardware Version:	V1.2

Note: *for more details, please refer to the User's manual of the EUT.*

3 SUMMARY OF TEST RESULT

FCC Part Clause	Test Parameter	Verdict	Remark
Part 2.104; Part 80.215;	RF Output Power	PASS	
Part 2.1047; Part 80.213(e);	Modulation Characteristic	PASS	
Part 2.1049; Part 80.205; Part 80.207;	Occupied Bandwidth & Emission Mask	PASS	
Part 2.1051; Part 80.211;	Spurious Emission at Antenna Terminal	PASS	
Part 2.1053; Part 80.211;	Spurious Radiated Emissions	PASS	
Part 2.1055; Part 80.209;	Frequency Stability	PASS	
NOTE1: N/A (Not Applicable)			

RELATED SUBMITTAL(S) / GRANT(S):

This submittal(s) (test report) is intended for FCC ID: 2BCI6-EXM300 filing to comply with Section H of the FCC Part 2 and Part 80.

4 TEST METHODOLOGY

4.1 GENERAL DESCRIPTION OF APPLIED STANDARDS

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 individual parts:

Part 80—stations in the maritime services

Applicable Standards: ANSI/TIA-603-E.

4.2 MEASUREMENT EQUIPMENT USED

4.2.1 Radiated Emission Test Equipment

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
Pre-Amplifier	Bonn	BLMA 011001N	2213967A	2022/10/31	1Year
EMI Test Receiver	Rohde & Schwarz	ESR7	102551	2022/10/31	1Year
Bilog Antenna	Schwarzbeck	VULB9163	9163142	2022/7/24	2Year
Horn antenna	Schwarzbeck	BBHA9120D	9120D-1198	2023/6/2	2Year
Pre-Amplifier	Bonn	BLMA 0118-5G	2213967B-01	2022/10/31	1Year
Spectrum Analyzer	Rohde & Schwarz	FSV3044	101290	2022/10/31	1Year
Horn antenna	Schwarzbeck	BBHA9170	9170-399	2023/5/12	2Year
Pre-Amplifier	Lunar EM	LNA18G26-40	J1012131010001	2023/5/10	1Year
Pre-Amplifier	Lunar EM	LNA26G40-40	J1013131028001	2023/5/10	1Year
Loop Antenna	Schwarzbeck	FMZB1519	1519-012	2023/5/12	2Year

4.2.2 Radio Frequency Test Equipment

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Cal. Interval
Signal Analyzer	Agilent	N9010A	MY53470879	May 10, 2023	1Year
Vector Signal Generater	Agilent	N5182B	MY53050878	May 10, 2023	1Year
Analog Signal Generator	Agilent	N5171B	MY53050553	May 10, 2023	1Year
RF Control Unit(Power Meter)	Tonscend	JS0806-2	\	May 13, 2023	1Year
Temperature&Humidity Chamber	ESPEC	EL-02KA	12107166	May 10, 2023	1 Year
Communication Tester	HP	8921A	3524A02336	May 10, 2023	1Year

Remark: *Each piece of equipment is scheduled for calibration once a year.*

4.3 DESCRIPTION OF TEST MODES

The EUT has been tested under its typical operating condition.
The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

Test of channel included the lowest and middle and highest frequency to perform the test, then record on this report.

Test Frequency :

25KHz

Test Frequency		
Frequency (MHz)	Frequency (MHz)	Frequency (MHz)
/	156.6	/

4.4 ENVIROMENTAL CONDITIONS

Norminal Test Voltage:	VN = 3.6V
Extrem Test Voltage @115%VN:	VH =4.1V
Extrem Test Voltage @85%VN:	VL = 3.1V

4.5 MODULATION TYPE

Modulation Type	Description
UM	Un-modulation
AM2	Apply a 1000 Hz tone and adjust the audio frequency generator to produce 20% of the rated system deviation.
AM6	Apply a 1000 Hz modulating signal to the transmitter from the audio frequency generator, and adjust the level to obtain 60% of full rated system deviation, then increase the level from the audio generator by 20 dB
AM5	Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that necessary to produce 50% of rated system deviation.

4.6 TEST SOFTWARE

Item		Software
Conducted Emission	:	EMTEK(Ver.CON-03A1)-Shenzhen
Radiated Emission	:	EMTEK(Ver.RA-03A1)-Shenzhen

5 FACILITIES AND ACCREDITATIONS

5.1 FACILITIES

All measurement facilities used to collect the measurement data are located at

Bldg 69, Majialong Industry Zone District, Nanshan District, Shenzhen, China
The sites are constructed in conformance with the requirements of ANSI C63.7, ANSI C63.10 and CISPR Publication 22.

5.2 LABORATORY ACCREDITATIONS AND LISTINGS

Site Description		
EMC Lab.	:	**Accredited by CNAS** The Certificate Registration Number is L2291. The Laboratory has been assessed and proved to be in compliance with CNAS-CL01 (identical to ISO/IEC 17025:2017) **Accredited by FCC** Designation Number: CN1204 Test Firm Registration Number: 882943 **Accredited by A2LA** The Certificate Number is 4321.01. **Accredited by Industry Canada** The Conformity Assessment Body Identifier is CN0008
Name of Firm	:	EMTEK (SHENZHEN) CO., LTD.
Site Location	:	Building 69, Majialong Industry Zone, Nanshan District, Shenzhen, Guangdong, China

6 TEST SYSTEM UNCERTAINTY

The following measurement uncertainty levels have been estimated for tests performed on the apparatus:

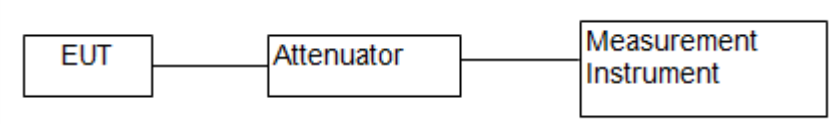
Parameter	Uncertainty
Radio Frequency	±1x10^-5
Output Power Test	±1.0dB
Conducted Emissions Test	±2.0dB
Radiated Emission Test	±3.0dB
Occupied Bandwidth Test	±1.0dB
Antenna Port Emission	±1dB
Temperature	±0.5℃
Humidity	±3%

Measurement Uncertainty for a level of Confidence of 95%

7 SETUP OF EQUIPMENT UNDER TEST

7.1 RADIO FREQUENCY TEST SETUP 1

The component's antenna ports(s) of the EUT are connected to the measurement instrument per an appropriate attenuator. The EUT is controlled by PC/software to emit the specified signals for the purpose of measurements.



7.2 RADIO FREQUENCY TEST SETUP 2

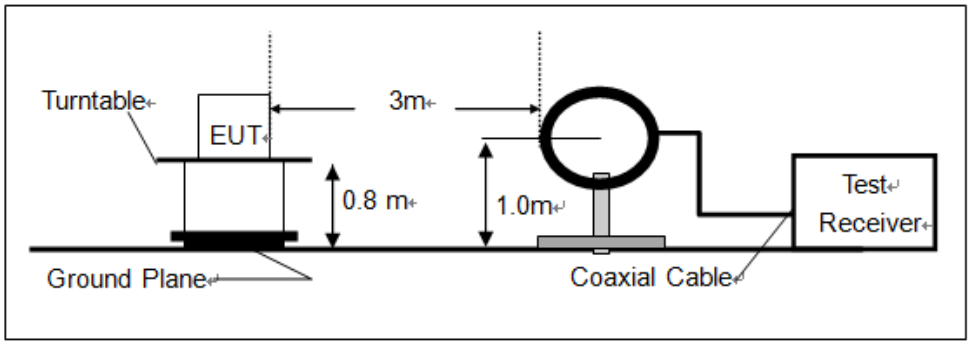
The test site semi-anechoic chamber has met the requirement of NSA tolerance 4 dB according to the standards: ANSI C63.10. The test distance is 3m.The setup is according to the requirements in Section 13.1.4.1 of ANSI C63.10-2013 and CAN/CSA-CEI/IEC CISPR 22.

Below 30MHz：
The EUT is placed on a turntable 0.8meters above the ground in the chamber, 3 meter away from the antenna (loop antenna). The Antenna should be positioned with its plane vertical at the specified distance from the EUT and rotated about its vertical axis for maximum response at each azimuth about the EUT. The center of the loop shall be 1 m above the ground. For certain applications, the loop antenna plane may also need to be positioned horizontally at the specified distance from the EUT.

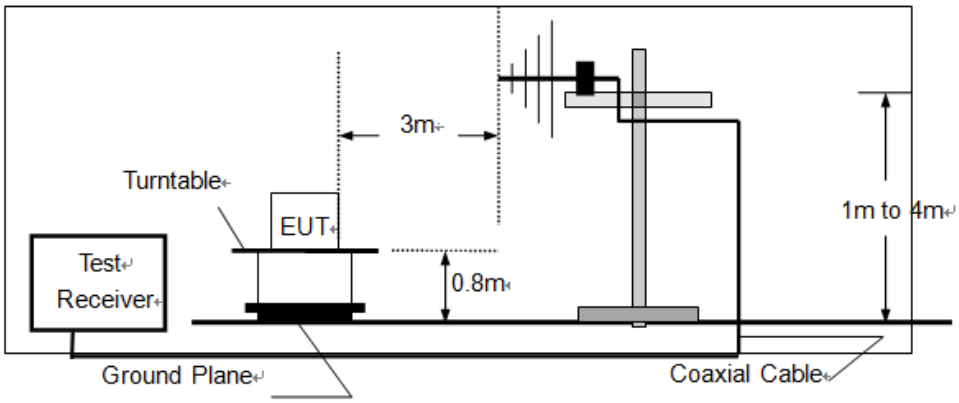
Above 30MHz：
The EUT is placed on a turntable 1.5meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

Above 1GHz:
(Note: the FCC's permission to use 1.5m as an alternative per TCBC Conf call of Dec. 2, 2014.)
The EUT is placed on a turntable 1.5 meters above the ground in the chamber, 3 meter away from the antenna. The maximal emission value is acquired by adjusting the antenna height, polarisation and turntable azimuth. Normally, the height range of antenna is 1 m to 4 m, the azimuth range of turntable is 0° to 360°, and the receive antenna has two polarizations Vertical (V) and Horizontal (H).

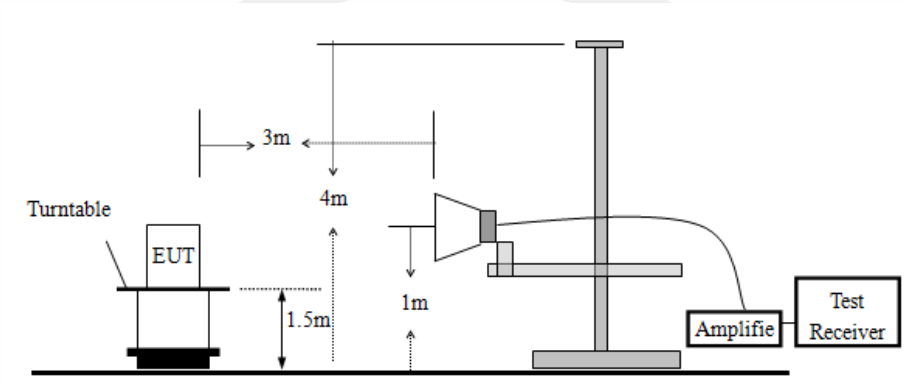
(a) Radiated Emission Test Set-Up, Frequency Below 30MHz



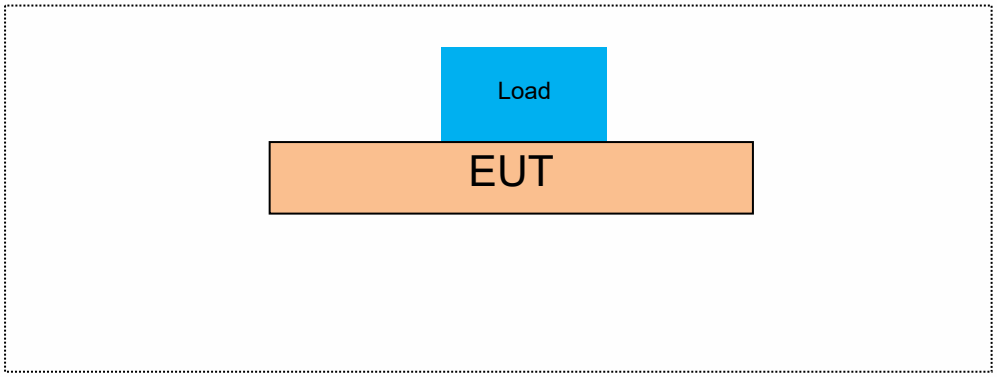
(b) Radiated Emission Test Set-Up, Frequency Below 1000MHz



(c) Radiated Emission Test Set-Up, Frequency above 1000MHz



7.3 BLOCK DIAGRAM CONFIGURATION OF TEST SYSTEM



7.4 SUPPORT EQUIPMENT

EUT Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
Adapter cable	1.5	Unshielded	Without Ferrite

Auxiliary Cable List and Details			
Cable Description	Length (m)	Shielded/Unshielded	With / Without Ferrite
/	/	/	/

Auxiliary Equipment List and Details			
Description	Manufacturer	Model	Serial Number
/	load	100W/50Ohm	/

Notes:

1. *All the equipment/cables were placed in the worst-case configuration to maximize the emission during the test.*
2. *Grounding was established in accordance with the manufacturer's requirements and conditions for the intended use.*

8 TEST REQUIREMENTS

8.1 RF OUTPUT POWER

8.1.1 Applicable Standard

According to FCC part 2.1046, part 80.215

8.1.2 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.1.3 Test Procedure

1. The maximum peak output power was measured with a Spectrum Analyzer connected to the antenna terminal while EUT was operating in unmodulated situation.

2. Connect a spectrum analyzer, using a quasi peak detector, meeting the requirements of IEC CISPR Publication 16, (through a resistive matching network if required to match the receiver input impedance Rn to the spectrum analyzer) to the receiver antenna terminals.

3. The RF output of the transmitter was connected to the input of the spectrum analyzer through sufficient attenuation
Set to the maximum power setting and enable the EUT transmit continuously
Set RBW = 100 kHz.
Set the video bandwidth (VBW) =300kHz.
Set Span=2 times OBW
Set Detector = Peak.
Set Trace mode = max hold.
Set Sweep = auto couple.
Allow the trace to stabilize.

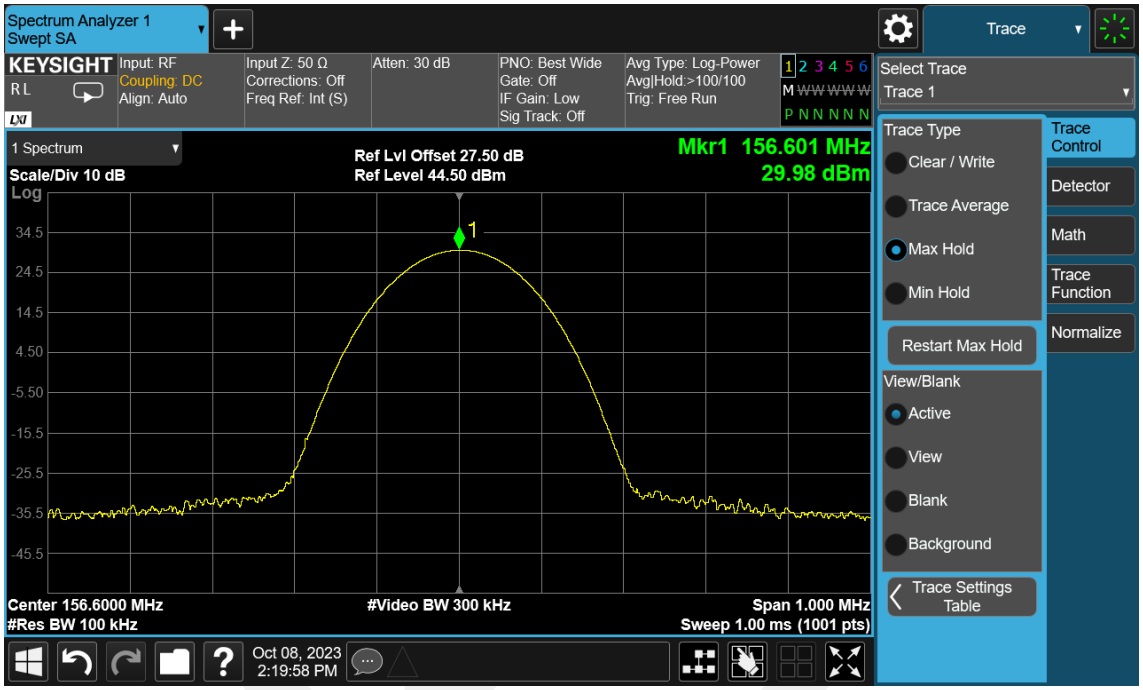
Measure and record the results in the test report.

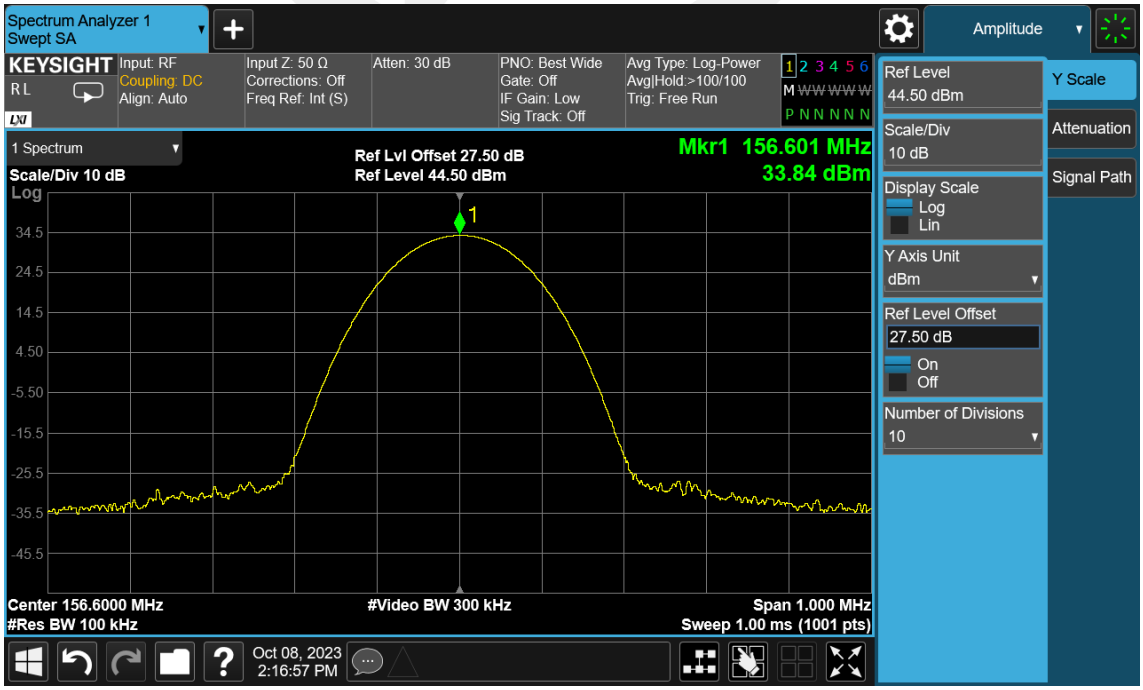
8.1.4 Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Modulation Mode	Channel Separation (kHz)	Frequency (MHz)	Power Level	Conducted Output Power (dBm)	Conducted Output Power (W)
Analog	25KHz	156.6	High	33.84	2.42
			Low	29.98	1.00

Note：The rated high power is 3W. The limit of the high output power is 10W.
The rated low power is 1W. The limit of the low output power is 1W.





8.2 MODULATION CHARACTERISTIC

8.2.1 Applicable Standard

According to FCC part 2.1047 and part 80.213

8.2.2 Conformance Limit

Equipment which utilizes voice modulated communication shall show the frequency response of the audio modulating circuit over a range of 100 to 5000 Hz. for equipment which is required to have a low pass filter, the frequency response of the filter, or all of the circuitry installed between the modulation limited and the modulated stage shall be supplied.

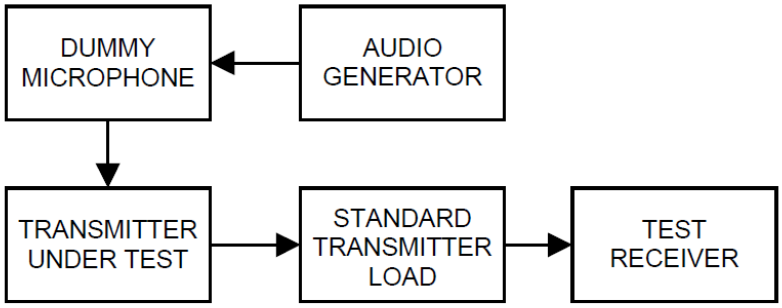
Equipment which employs modulation limiting, a curve showing the percentage of modulation versus the modulation input voltage shall be supplied.

8.2.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

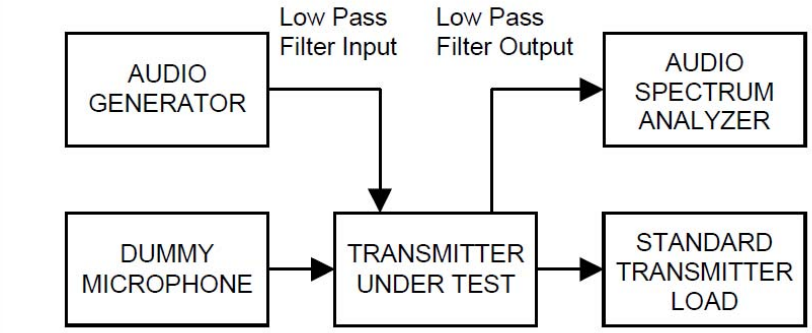
8.2.4 Test Procedure

Test is carried out under the procedure of TIA/EIA-603-E,2.2.3.



a) Connect the equipment as illustrated.
b) Adjust the transmitter per the manufacturer's procedure for full rated system deviation.
c) Set the test receiver to measure peak positive deviation. Set the audio bandwidth for ≤0.25 Hz to ≥15,000 Hz. Turn the de-emphasis function off.
d) Apply a 1000 Hz modulating signal to the transmitter from the audio frequency generator, and adjust the level to obtain 60% of full rated system deviation.
e) Increase the level from the audio frequency generator by 20 dB in one step (rise time between the 10% and 90% points shall be 0.1 second maximum).
f) Measure both the instantaneous and steady-state deviation at and after the time of increasing the audio input level.
g) With the level from the audio frequency generator held constant at the level obtained in step e), slowly vary the audio frequency from 300 Hz to 3000 Hz and observe the steady-state deviation. Record the maximum deviation.
h) Set the test receiver to measure peak negative deviation and repeat steps d) through g).
i) The values recorded in steps g) and h) are the modulation limiting

Audio Low Pass Filter Response test procedure please refer to TIA/EIA-603-E,2.2.15.



a) Connect the equipment as illustrated.
b) Connect the audio frequency generator as close as possible the input of the post limiter low pass filter within the transmitter under test.
c) Connect the audio spectrum analyzer to the output of the post limiter low pass filter within the transmitter under test.
d) Apply a 1000 Hz tone from the audio frequency generator and adjust the level per manufacturer's specifications.
e) Record the dB level of the 1000 Hz spectral line on the audio spectrum analyzer as LEVREF .
f) Set the audio frequency generator to the desired test frequency between 3000 Hz and the upper low pass filter limit.
g) Record audio spectrum analyzer levels, at the test frequency in step f).
h) Record the dB level on the audio spectrum analyzer as LEVFREQ .
i) Calculate the audio frequency response at the test frequency as:
low pass frequency response = LEVFREQ - LEVREF
j) Repeat steps f) through i) for all the desired test frequencies

8.2.5 Test Results

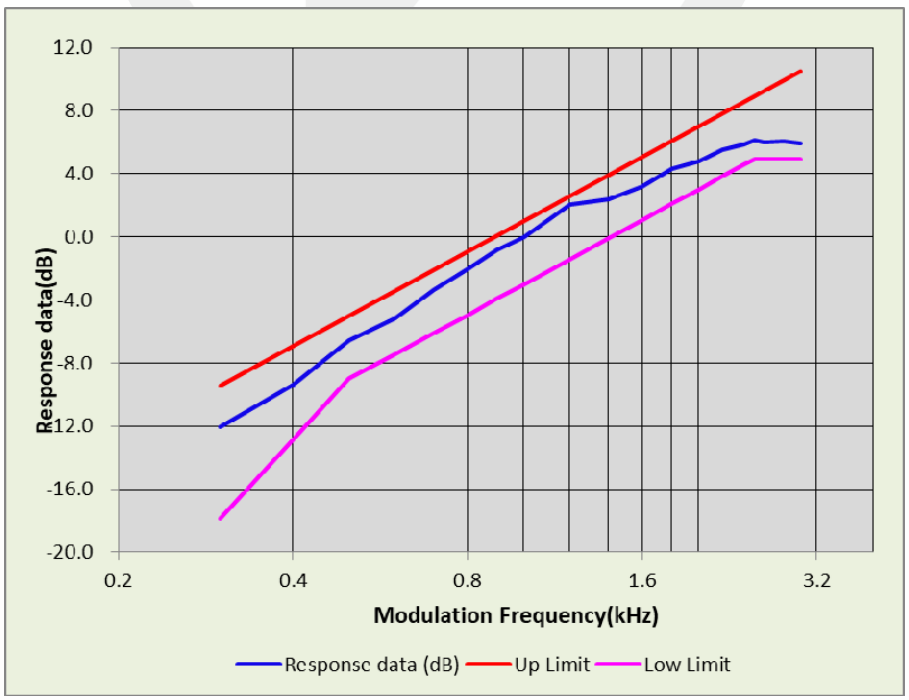
Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Analog Modulation:

Audio Frequency Response

Carrier Frequency: 156.6 MHz, Channel Separation=25 kHz

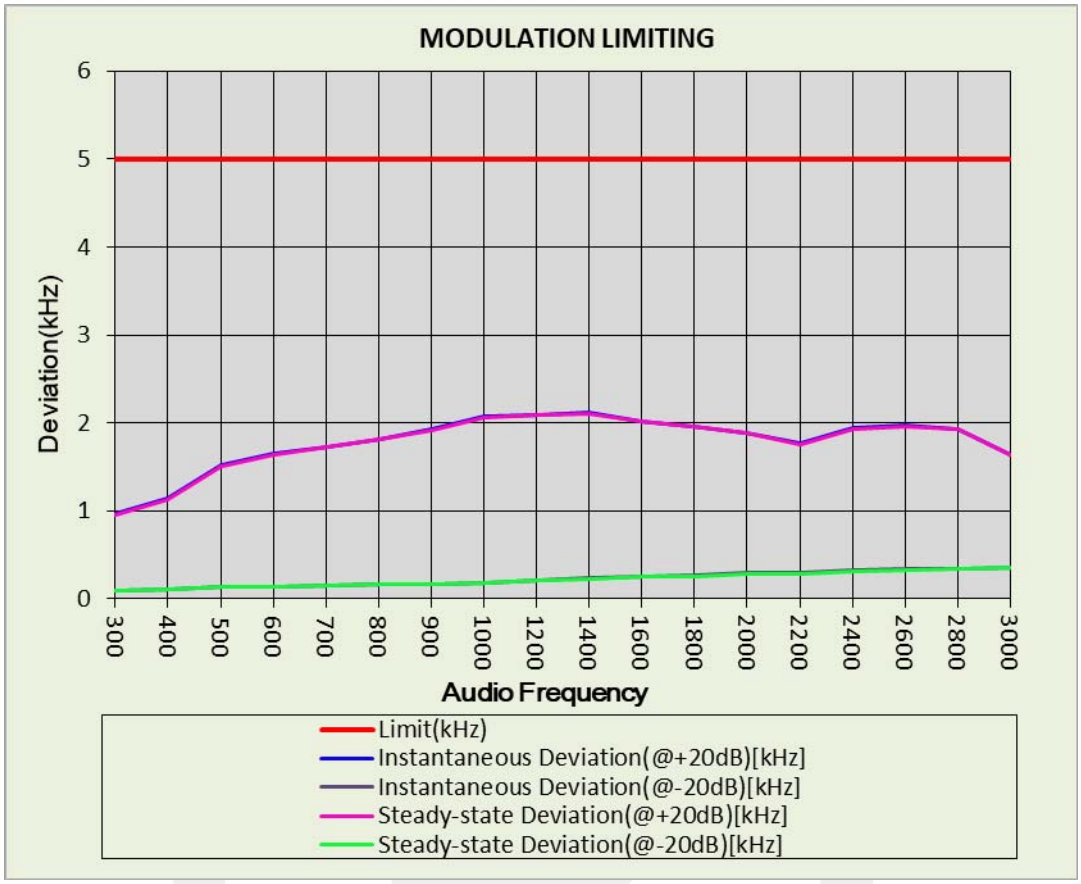
Audio Frequency (Hz)	Response Attenuation (dB)
300	-12.04
400	-9.37
500	-6.56
600	-5.19
700	-3.35
800	-2.05
900	-0.82
1000	0.00
1200	2.08
1400	2.41
1600	3.17
1800	4.35
2000	4.81
2100	5.53
2200	5.85
2300	6.11
2400	5.98
2500	6.06
2600	5.93
2700	-12.04
2800	-9.37
2900	-6.56
3000	-5.19



MODULATION LIMITING

Carrier Frequency: 156.6 MHz, Channel Separation=25 kHz

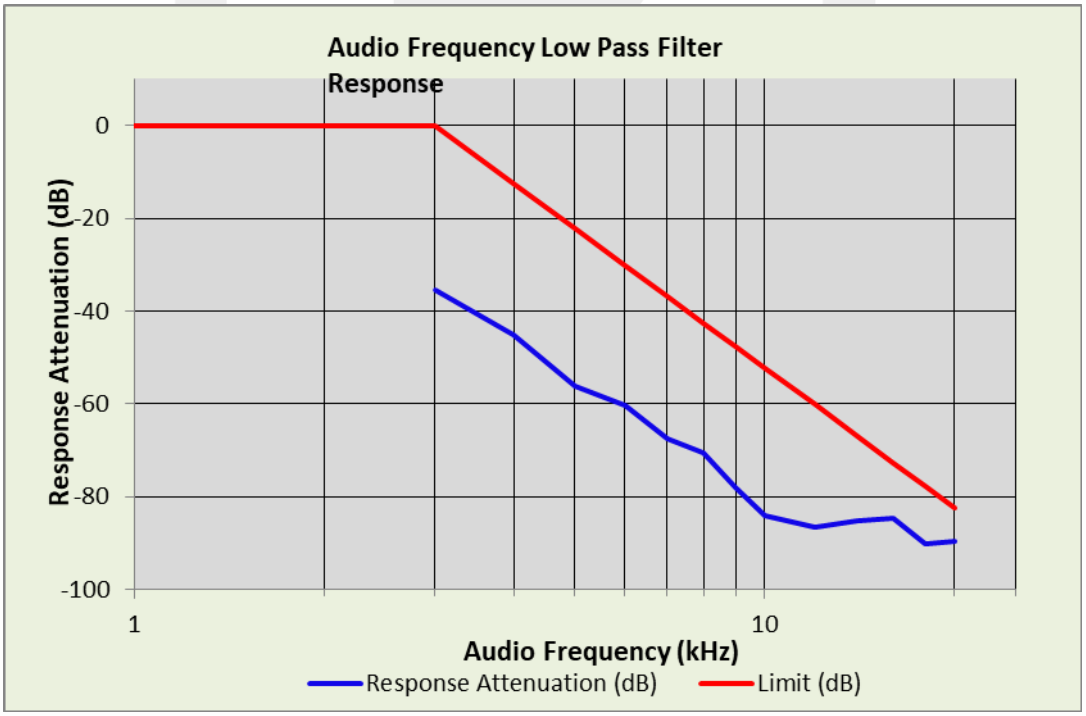
Audio Frequency (Hz)	Instantaneous		Steady-state		Limit [KHz]
	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	Deviation (@+20dB) [KHz]	Deviation (@-20dB) [KHz]	
300	0.962	0.097	0.951	0.092	5
400	1.143	0.107	1.134	0.102	5
500	1.524	0.139	1.501	0.133	5
600	1.654	0.142	1.633	0.139	5
700	1.731	0.157	1.724	0.152	5
800	1.812	0.168	1.806	0.161	5
900	1.926	0.172	1.915	0.164	5
1000	2.074	0.184	2.061	0.176	5
1200	2.089	0.214	2.082	0.203	5
1400	2.112	0.231	2.106	0.225	5
1600	2.021	0.257	2.013	0.249	5
1800	1.962	0.262	1.955	0.253	5
2000	1.891	0.289	1.882	0.277	5
2100	1.765	0.291	1.756	0.284	5
2200	1.944	0.326	1.934	0.315	5
2300	1.969	0.338	1.96	0.327	5
2400	1.939	0.347	1.928	0.341	5
2500	1.646	0.351	1.637	0.348	5
2600	0.955	0.097	0.951	0.092	5
2700	1.149	0.107	1.134	0.102	5
2800	1.528	0.139	1.501	0.133	5
2900	1.657	0.142	1.633	0.139	5
3000	1.735	0.157	1.724	0.152	5


MODULATION LIMITING
Deviation(kHz)
0
1
2
3
4
5
6
300
400
500
600
700
800
900
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
Audio Frequency
Limit(kHz)
Instantaneous Deviation(@+20dB)[kHz]
Instantaneous Deviation(@-20dB)[kHz]
Steady-state Deviation(@+20dB)[kHz]
Steady-state Deviation(@-20dB)[kHz]

Audio frequency lows pass filter response

Carrier Frequency: 156.6 MHz, Channel Separation=25 kHz

Audio Frequency (kHz)	Response Attenuation (dB)	Limit (dB)
1	0.0	/
3	-1.85	0.00
4	-9.62	-7.50
5	-14.52	-13.31
6	-20.13	-18.06
7	-23.95	-22.08
8	-27.58	-25.56
9	-30.24	-28.63
10	-34.28	-31.37
15	-43.49	-41.94
20	-53.00	-50.00
30	-53.00	-50.00
50	-53.00	-50.00
70	-53.00	-50.00



8.3 OCCUPIED BANDWIDTH & EMISSION MASK

8.3.1 Applicable Standard

According to FCC part 2.1049, part 80.205 and part 80.207

8.3.2 Conformance Limit

(b) Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:
(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

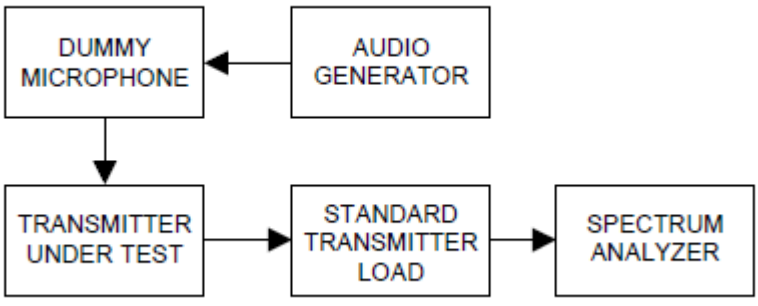
(d) Emission Mask D. channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd−2.88 kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

8.3.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.3.4 Test Procedure

Test is carried out under the procedure of TIA/EIA-603-E,2.2.11



a) Connect the equipment as illustrated. Use the table 17 to determine the spectrum analyzer resolution bandwidth:

Table 17 - Spectrum Analyzer Resolution Bandwidth

Frequency Band (MHz)	Mask for Equipment with Audio Low Pass Filter	Mask for Equipment without Low Pass Filter	Spectrum Analyzer Resolution Bandwidth (Hz)
25-50	B	C	300
72-76	B	C	300
138-174	NTIA	NTIA	300
150-174	B	C	300
150-174	D or E	D or E	100
380-420	NTIA	NTIA	300
421-512	B	C	300
421-512	D or E	D or E	100
809-824/854-869	B or EA	G or EA	300
806-809/851-854	B	H	300
896-901/935-940	I	J	300

b) Adjust the spectrum analyzer for the following settings:
1) Resolution Bandwidth per the above table.
2) Video Bandwidth at least 10 times the resolution bandwidth.
3) Sweep Speed slow enough to maintain measurement calibration.
4) Detector Mode = Positive Peak.
5) Span that will allow proper viewing of the test bandwidth (see 1.3.4.4).
c) Set the center frequency of the spectrum analyzer to the assigned transmitter frequency. Key the transmitter, and set the level of the unmodulated carrier to a full scale reference line. This is the 0 dB reference for the measurement.
d) Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that necessary to produce 50% of rated system deviation. The input level shall be established at the frequency of maximum response of the audio modulating circuit. Transmitters employing digital modulation techniques that bypass the limiter and the audio low-pass filter shall be modulated as specified by the manufacturer.

e) Record the resulting spectrum analyzer presentation of the emission level with an on-line recording evice or in a photograph. It is recommended that the emission limit (as given in 3.2.11) be drawn on the plotted graph or photograph. The spectrum analyzer presentation is the sideband spectrum.

8.3.5 Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

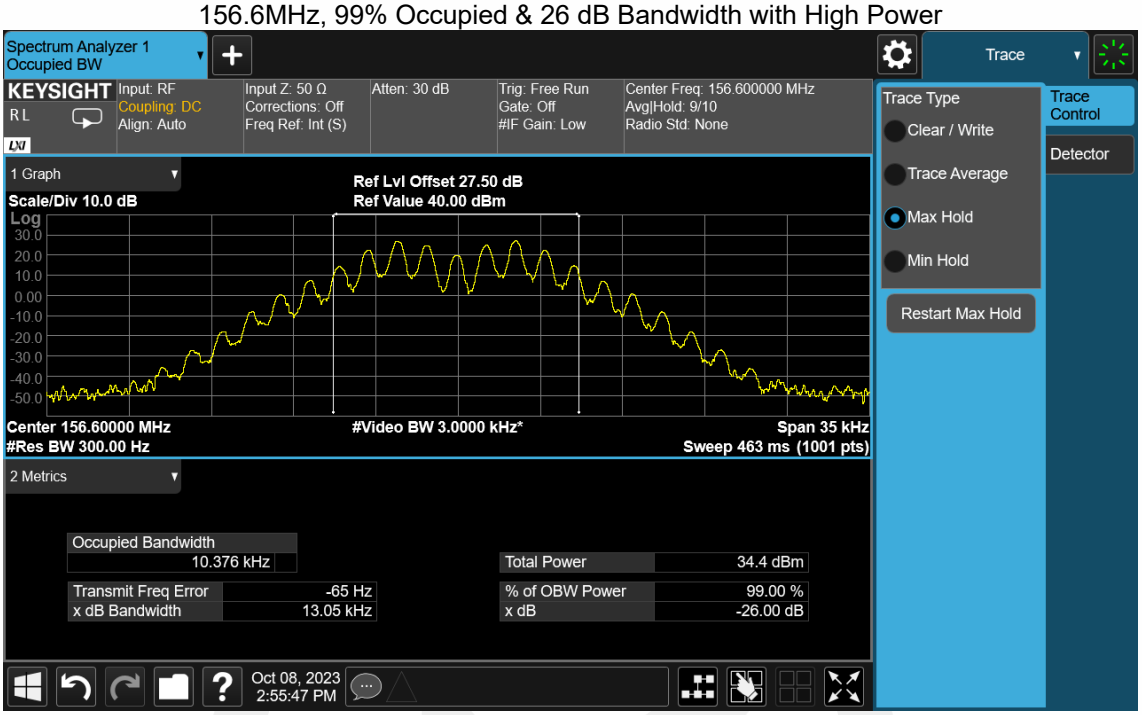
Modulation Mode	Channel Separation (kHz)	Frequency (MHz)	Power Level	99% Occupied Bandwidth (kHz)	26 dB Bandwidth (kHz)
Analog	25	156.6	High	10.376	13.05
			Low	10.365	13.06

Note: Emission bandwidth was based on calculation method instead of measurement. Emission Designator
Per CFR 47 §2.201& §2.202, BW = 2M + 2D

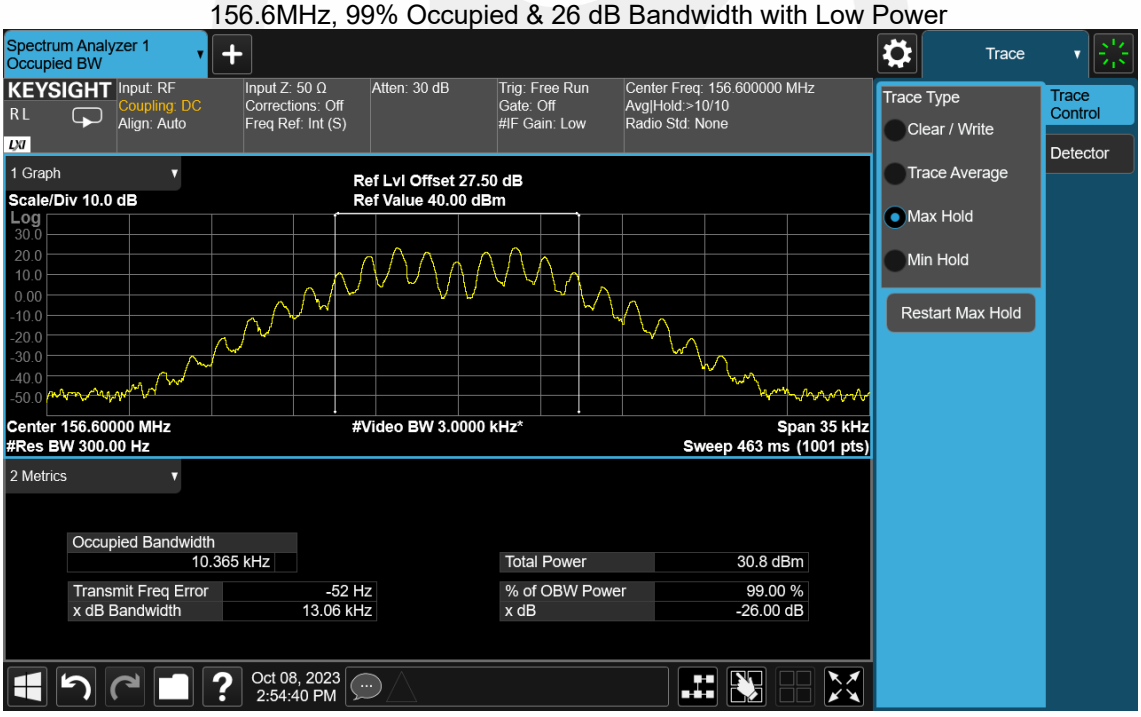
For FM Mode (Channel Spacing: 25 kHz)
Emission Designator 16K0F3E
In this case, the maximum modulating frequency is 5.0 kHz with a 3 kHz deviation.
BW = 2(M+D) = 2*(5 kHz + 3 kHz) = 16 kHz = 16K0
F3E portion of the designator represents an FM voice transmission
Therefore, the entire designator for 25 kHz channel spacing FM mode is 16K0F3E.

Analog Modulation (Channel Spacing 25 kHz):

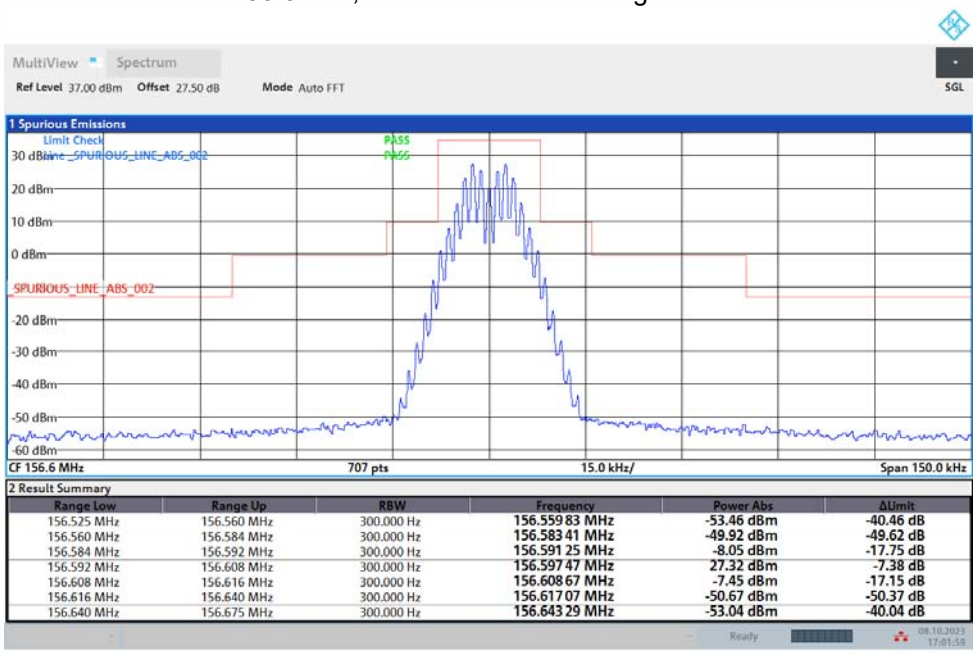
156.6MHz, 99% Occupied & 26 dB Bandwidth with High Power



156.6MHz, 99% Occupied & 26 dB Bandwidth with Low Power



156.6MHz, Emission Mask with High Power



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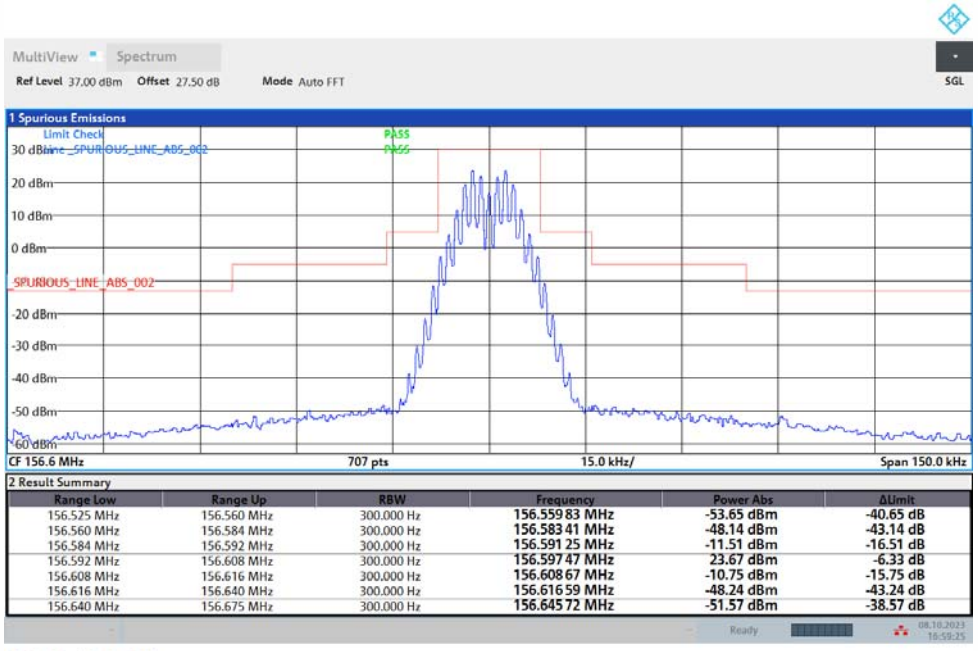
156.6MHz, Emission Mask with Low Power



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8.4 SPURIOUS EMISSIONS AT ANTENNA TERMINALS

8.4.1 Applicable Standard

According to FCC part 2.1051 and part 80.211

8.4.2 Conformance Limit

(b) Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:
(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

(d) Emission Mask D. channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd−2.88 kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

8.4.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 1

8.4.4 Test Procedure

The setup of EUT is according with per TIA/EIA Standard 603 and ANSI C63.4-2014 measurement procedure.
a) Connect the equipment as illustrated, with the notch filter by-passed.
b) Set the center frequency of the spectrum analyzer to the assigned transmitter frequency, key the transmitter, and set the level of the carrier to the full scale reference line.
c) Modulate the transmitter with a 2500 Hz sine wave at an input level 16 dB greater than that necessary to produce 50% of rated system deviation. The input level shall be established at the frequency of maximum response of the audio modulating circuit.
d) Adjust the spectrum analyzer for the following settings:
1) Resolution Bandwidth = 10 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1 GHz.
2) Video Bandwidth ≥3 times the resolution bandwidth.
3) Sweep Speed ≤2000 Hz per second.
4) Detector Mode = mean or average power.
e) Adjust the center frequency of the spectrum analyzer for incremental coverage of the range from:
   1) The lowest radio frequency generated in the equipment to the carrier frequency minus the test bandwidth (see 1.3.4.4).
   2) The carrier frequency plus the test bandwidth to a frequency less than 2 times the carrier frequency.
f) Record the frequencies and levels of spurious emissions from step e).
g) Unkey the transmitter. Replace the transmitter under test with the signal generator and adjust the signal level to reproduce the frequencies and levels of every spurious emission recorded in step f).

Record the signal generator levels in dBm.
h) Insert the notch filter.
i) Adjust the spectrum analyzer for the following settings:
1) Resolution Bandwidth = 10 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1 GHz.
2) Video Bandwidth ≥3 times the resolution bandwidth.
3) Sweep Speed ≤2000 Hz per second.
4) Detector Mode = mean or average power.
j) Key the transmitter. Adjust the center frequency of the spectrum analyzer for incremental coverage of the range from a frequency equal to 2 times the carrier frequency and to the tenth harmonic of the carrier frequency.
k) Record the frequencies and levels of spurious emissions from step j).
l) Unkey the transmitter. Replace the transmitter under test with the signal generator and adjust the signal level to reproduce the frequencies and levels of every spurious emission recorded in step k). Record the signal generator levels in dBm.
m) The levels recorded in steps g) and l) are the absolute levels of conducted spurious emissions in dBm. The conducted spurious attenuation can be calculated by the following:

$$\text{Spurious attenuation (dB)} = 10\ \log_{10}\left(\frac{TX\ power\ in\ watts}{0.001}\right) - the\ levels\ in\ steps\ g)\ and\ l)$$

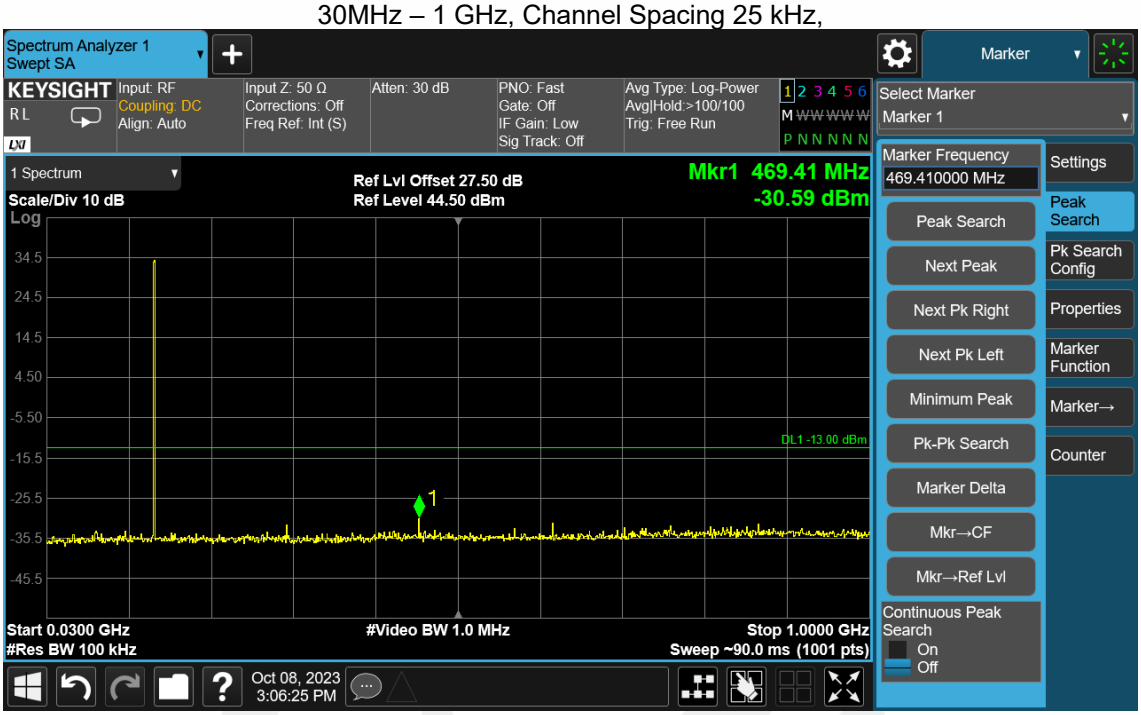
by the substitution.
Spurious emissions in dB =10 1g (TXpwr in Watts/0.001)-the absolute level
Spurious attenuation limit in dB =43+10 Log10 (power out in Watts) for EUT with a 25 kHz channel bandwidth.

8.4.5 Test Results

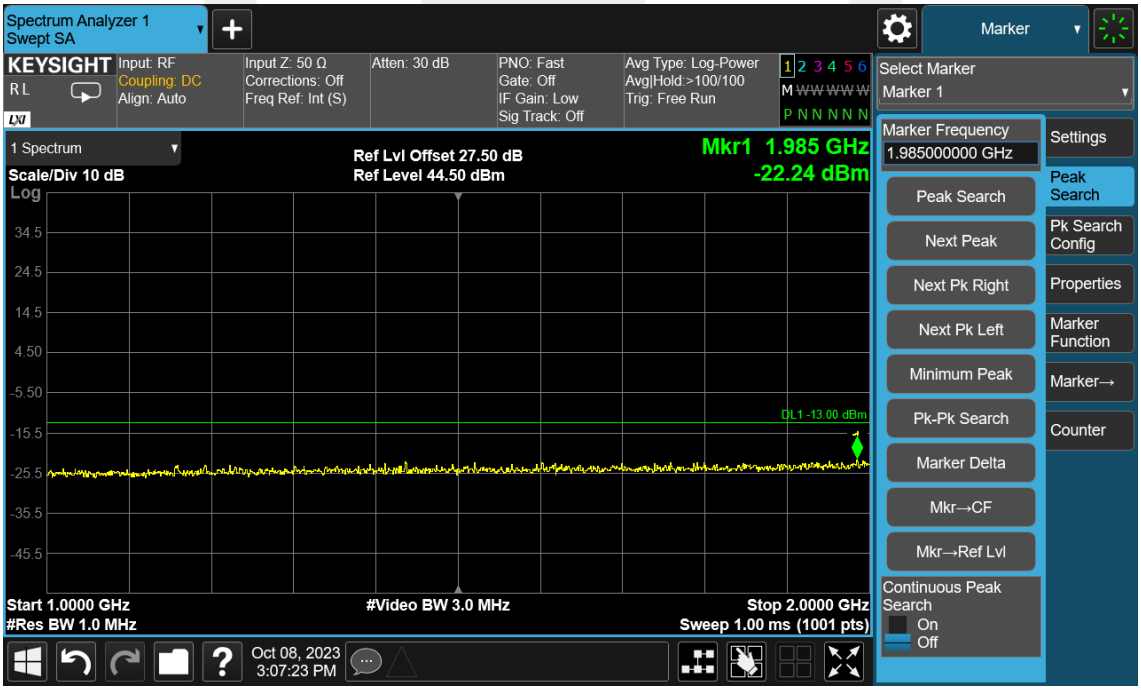
Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

Analog modulation：

30MHz – 1 GHz, Channel Spacing 25 kHz,



1 GHz – 2 GHz, Channel Spacing 25 kHz,



8.5 RADIATED SPURIOUS EMISSIONS

8.5.1 Applicable Standard

According to FCC part 2.1053, part 80.211

8.5.2 Conformance Limit

(b) Emission Mask B. For transmitters that are equipped with an audio low-pass filter, the power of any emission must be attenuated below the unmodulated carrier power (P) as follows:
(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.
(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.
(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10 log (P) dB.

(d) Emission Mask D. channel bandwidth equipment. For transmitters designed to operate with a 12.5 kHz channel bandwidth, any emission must be attenuated below the power (P) of the highest emission contained within the authorized bandwidth as follows:
(1) On any frequency from the center of the authorized bandwidth f0 to 5.625 kHz removed from f0: Zero dB.
(2) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 5.625 kHz but no more than 12.5 kHz: At least 7.27(fd−2.88 kHz) dB.
(3) On any frequency removed from the center of the authorized bandwidth by a displacement frequency (fd in kHz) of more than 12.5 kHz: At least 50 + 10 log (P) dB or 70 dB, whichever is the lesser attenuation.

8.5.3 Test Configuration

Test according to clause 7.1 radio frequency test setup 2

8.5.4 Test Procedure

a) Connect the equipment as illustrated.
b) Adjust the spectrum analyzer for the following settings:
1) Resolution Bandwidth = 10 kHz for spurious emissions below 1 GHz, and 1 MHz for spurious emissions above 1GHz.
2) Video Bandwidth = 300 kHz for spurious emissions below 1 GHz, and 3 MHz for spurious emissions above 1 GHz.
3) Sweep Speed slow enough to maintain measurement calibration.
4) Detector Mode = Positive Peak.
c) Place the transmitter to be tested on the turntable in the standard test site, or an FCC listed site compliant with ANSI C63.4 clause 5.4. The transmitter is transmitting into a nonradiating load that is placed on the turntable. The RF cable to this load should be of minimum length. For transmitters with integral antennas, the tests are to be run with the unit operating into the integral antenna.
d) For each spurious measurement the test antenna should be adjusted to the correct length for the frequency involved. This length may be determined from a calibration ruler supplied with the equipment. Measurements shall be made from the lowest radio frequency generated in the equipment to the tenth harmonic of the carrier, except for the region close to the carrier equal to ± the test bandwidth (see 1.3.4.4).
e) Key the transmitter.
f) For each spurious frequency, raise and lower the test antenna from 1 m to 4 m to obtain a maximum reading on the spectrum analyzer with the test antenna at horizontal polarity. Then the turntable should be rotated 360° to determine the maximum reading. Repeat this procedure to obtain the highest possible reading. Record this maximum reading. g) Repeat step f) for each spurious frequency with the test antenna polarized vertically.

h) Reconnect the equipment as illustrated.
i) Keep the spectrum analyzer adjusted as in step b).
j) Remove the transmitter and replace it with a substitution antenna (the antenna should be half-wavelength for each frequency involved). The center of the substitution antenna should be approximately at the same location as the center of the transmitter. At the lower frequencies, where the substitution antenna is very long, this will be impossible to achieve when the antenna is polarized vertically. In such case the lower end of the antenna should be 0.3 m above the ground.
k) Feed the substitution antenna at the transmitter end with a signal generator connected to the antenna by means of a nonradiating cable. With the antennas at both ends horizontally polarized, and with the signal generator tuned to a particular spurious frequency, raise and lower the test antenna to obtain a maximum reading at the spectrum analyzer. Adjust the level of the signal generator output until the previously recorded maximum reading for this set of conditions is obtained. This should be done carefully repeating the adjustment of the test antenna and generator output.
l) Repeat step k) with both antennas vertically polarized for each spurious frequency.
m) Calculate power in dBm into a reference ideal half-wave dipole antenna by reducing the readings obtained in steps k) and l) by the power loss in the cable between the generator and the antenna, and further corrected for the gain of the substitution antenna used relative to an ideal half-wave dipole antenna by the following formula:

$P_d(\text{dBm}) = P_g(\text{dBm}) - \textit{cable loss}\ (\text{dB}) + \textit{antenna gain}\ (\text{dB})$

where:

P_d is the dipole equivalent power and

P_g is the generator output power into the substitution antenna.

n) The Pd levels record in step m) are the absolute levels of radiated spurious emissions in dBm. The radiated spurious emissions in dB can be calculated by the following:

Radiated spurious emissions (dB) =

$$10\ \log_{10}\left(\frac{TX\ power\ in\ watts}{0.001}\right) - the\ levels\ in\ step\ m)$$

NOTE: It is permissible to use other antennas provided they can be referenced to a dipole.

by the substitution.
Spurious emissions in dB =10 1g (TXpwr in Watts/0.001)-the absolute level
Spurious attenuation limit in dB =43+10 Log10 (power out in Watts) for EUT with a 25 kHz channel bandwidth.

8.5.5 Test Results

Below 1GHz:

Analog Modulation			
Temperature:	24℃	Channel Spacing	25 kHz
Humidity:	53%	Test Mode:	TX
Air Pressure:	106kPa	Traffic Channel:	156.6MHz

Frequency (MHz)	Antenna Polarization	RBW (kHz)	Emission level (dBm)	Limit (dBm)	Margin (dB)	Verdict
313.3108	V	100	-62.12	-13.00	49.12	PASS
469.7624	V	100	-58.72	-13.00	45.72	PASS
626.4566	V	100	-55.09	-13.00	42.09	PASS
783.1508	V	100	-60.43	-13.00	47.43	PASS
968.9522	V	100	-60.91	-13.00	47.91	PASS
313.3108	H	100	-59.71	-13.00	46.71	PASS
469.7624	H	100	-58.06	-13.00	45.06	PASS
626.4566	H	100	-59.49	-13.00	46.49	PASS
820.5051	H	100	-63.84	-13.00	50.84	PASS
985.2038	H	100	-61.49	-13.00	48.49	PASS

Above 1GHz:

Analog Modulation			
Temperature:	24℃	Channel Spacing	25 kHz
Humidity:	53%	Test Mode:	TX
Air Pressure:	106kPa	Traffic Channel:	156.6MHz

Frequency (MHz)	Antenna Polarization	RBW (kHz)	Emission level (dBm)	Limit (dBm)	Margin (dB)	Verdict
1154.4309	V	1000	-55.79	-13.00	42.79	PASS
1284.4569	V	1000	-53.94	-13.00	40.94	PASS
1418.2837	V	1000	-53.37	-13.00	40.37	PASS
1504.1008	V	1000	-54.80	-13.00	41.80	PASS
1704.3409	V	1000	-56.49	-13.00	43.49	PASS
1964.793	V	1000	-54.39	-13.00	41.39	PASS
1025.4051	H	1000	-54.95	-13.00	41.95	PASS
1299.4599	H	1000	-53.11	-13.00	40.11	PASS
1496.2993	H	1000	-53.96	-13.00	40.96	PASS
1506.5013	H	1000	-54.37	-13.00	41.37	PASS
1737.3475	H	1000	-37.28	-13.00	24.28	PASS
1972.9946	H	1000	-55.46	-13.00	42.46	PASS

Note:
Absolute Level = Substituted Level - Cable loss + Antenna Gain
Margin = Limit- Absolute Level

8.6 FREQUENCY STABILITY

8.6.1 Applicable Standard

According to FCC part 2.1055, part 90.209

8.6.2 Conformance Limit

Frequency Band	Coast Stations		Ship Stations
	Below 3 W	3 to 100 W	
156–162 MHz	10 ppm	[1]5 ppm	[2]10 ppm

[1] For transmitters operated at private coast stations with antenna heights less than 6 meters (20 feet) above ground and output power of 225 Watts or less the frequency tolerance is 10 parts in 10^6.

[2] For transmitters in the radiolocation and associated telecommand service operating on 154.585 MHz, 159.480 MHz, 160.725 MHz and 160.785 MHz the frequency tolerance is 15 parts in 10^6.

8.6.3 Test Configuration

Test according to clause 7.2 radio frequency test setup 1

8.6.4 Test Procedure

Test method: ANSI/TIA-603-E 2010, section 2.2.2
Frequency Stability vs. Temperature: The equipment under test was connected to an external DC power supply and the RF output was connected to a frequency counter 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 counter.

8.6.5 Test Results

Temperature:	26° C
Relative Humidity:	54%
ATM Pressure:	1011 mbar

For Analog Modulation

Reference Frequency: 156.6 MHz, Limit: ±5 ppm, 25 kHz			
Test Environment		Frequency Measure with Time Elapsed	
Temperature (℃)	Power Supplied (VDC)	Measured Frequency (MHz)	Frequency Error (ppm)
Frequency Stability versus Input Temperature			
50	3.6	156.5998761	-0.791
40	3.6	156.5999112	-0.567
30	3.6	156.5998811	-0.759
20	3.6	156.5998419	-1.010
10	3.6	156.5997897	-1.343
0	3.6	156.5997629	-1.514
-10	3.6	156.5997544	-1.569
-20	3.6	156.5997238	-1.764
Frequency Stability versus Input Voltage			
20	4.1	156.5998919	-0.691
20	3.1	156.5998424	-1.006

Detail of factor for radiated emission

Frequency(MHz)	Ant_F(dB)	Cab_L(dB)	Preamp(dB)	Correct Factor(dB)
0.009	20.6	0.03	\	20.63
0.15	20.7	0.1	\	20.8
1	20.9	0.15	\	21.05
10	20.1	0.28	\	20.38
30	18.8	0.45	\	19.25
30	11.7	0.62	27.9	-15.58
100	12.5	1.02	27.8	-14.28
300	12.9	1.91	27.5	-12.69
600	19.2	2.92	27	-4.88
800	21.1	3.54	26.6	-1.96
1000	22.3	4.17	26.2	0.27
1000	25.6	1.76	41.4	-14.04
3000	28.9	3.27	43.2	-11.03
5000	31.1	4.2	44.6	-9.3
8000	36.2	5.95	44.7	-2.55
10000	38.4	6.3	43.9	0.8
12000	38.5	7.14	42.3	3.34
15000	40.2	8.15	41.4	6.95
18000	45.4	9.02	41.3	13.12
18000	37.9	1.81	47.9	-8.19
21000	37.9	1.95	48.7	-8.85
25000	39.3	2.01	42.8	-1.49
28000	39.6	2.16	46.0	-4.24
31000	41.2	2.24	44.5	-1.06
34000	41.5	2.29	46.6	-2.81
37000	43.8	2.30	46.4	-0.3
40000	43.2	2.50	42.2	3.5

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