IEC 62238:2003

TEST REPORT

For

Garmin International Inc.

1200 E. 151st Street Olathe, KS 66062, United States

Test Model: CA1654
Multiple Models: BA1653, DA1654

Report Type:	**Product Type:**
Original Report	MARINE VHF RADIO

Report Number:	DG2211015-52964E-01B
Report Date:	2021-11-23
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GENERAL INFORMATION

Product Description for Equipment under Test (EUT)

Product Name:	MARINE VHF RADIO
Tested Model:	CA1654
Multiple Models:	BA1653, DA1654
Model Difference:	Refer to Dos
Rated Input Voltage:	DC 12V
Serial Number:	CA1654: DG2211015-52964E-RF-S1 DA1654: DG2211015-52964E-RF-S2 BA1653: DG2211015-52964E-RF-S3
EUT Received Date:	2021.10.18
EUT Received Status:	Good

Technical Specification

Operation Frequency Range (MHz):	**Transmit:**	156.025-157.425
	Receive:	156.050-163.275
Rated RF Output Power (Conducted) (W):		High power level: 25 Low power level: 1
Modulation Type:		FM
Channel Spacing (kHz):		25

Objective

This test report is prepared on behalf of ***Garmin International Inc.*** in accordance with IEC 62238:2003. Maritime navigation and radiocommunication equipment and systems - VHF radiotelephone equipment incorporating Class "D" Digital Selective Calling (DSC) - Methods of testing and required test results

Test Methodology

All tests and measurements indicated in this document were performed in accordance with the IEC 62238 First edition 2003-03, Maritime navigation and radiocommunication equipment and systems-VHF radiotelephone equipment incorporating Class “D” Digital Selective Calling (DSC)-Methods of testing and required test results.

Measurement Uncertainty

Parameter	F_{lab}	Maximum allow uncertainty
Radio Frequency (RF)	$\pm 0.082 \times 10^{-6}$	$\pm 1 \times 10^{-7}$
RF power/level	±0.61dB	±0,75 dB
Maximum frequency deviation: - within 300 Hz to 6 kHz of modulation frequency - within 6 kHz to 25 kHz of modulation frequency	 ±4.57 % ±0.53 dB	 ±5 % ±3 dB
Deviation limitation	±3.25 %	±5 %
Adjacent channel power	±0.93 dB	±5 dB
Conducted spurious emission of transmitter	±2.47dB	±4 dB
Radiated spurious emission of transmitter	±3.62dB	±6 dB
Audio output power	±0,38 dB	±0,5 dB
Amplitude characteristics of receiver limiter	±1,14 dB	±1,5 dB
Sensitivity at 20 dB SINAD	±2.27 dB	±3 dB
Conducted emission of receiver	±2.47dB	±3 dB
Two-signal measurement	±3.10dB	±4 dB
Three-signal measurement	±1.20dB	±3 dB
Transmitter transient time	13.90%	±20 %
Transmitter transient frequency	±161Hz	±250 Hz
Temperature	±1℃	±3℃
Relative Humidity	±1%	±3%

Note: Otherwise required by the applicant or Product Regulations, Decision Rule in this report did not consider the uncertainty. The extended uncertainty given in this report is obtained by combining the standard uncertainty times the coverage factor K with the 95% confidence interval.

Declarations

BACL is not responsible for the authenticity of any test data provided by the applicant. Data included from the applicant that may affect test results are marked with a triangle symbol "▲". Customer model name, addresses, names, trademarks etc. are not considered data.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

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SYSTEM TEST CONFIGURATION

Description of Test Configuration

The system was configured for testing in a DSC mode in accordance with IEC 62238.

Test Frequency List:

Modulation Type	Test Frequency
DSC	CH70(156.525MHz)

The extreme temperature test conditions and the normal conditions are as below which was declared by manufacturer:

NT: Normal Temperature 25℃, NV: Normal Voltage 12Vdc
LT: Low Temperature -15℃, LV: Low Voltage 10.8Vdc
HT: High Temperature +55℃, HV: High Voltage 15.6Vdc

Equipment Modifications

No modification was made to the EUT.

EUT Exercise Software

No software was used for testing.

Support Equipment List and Details

Manufacturer	Description	Model	Serial Number
/	/	/	/

Support Cable List and Details

Cable Description	Shielding Type	Ferrite Core	Length (m)	From Port	To
/	/	/	/	/	/

Test Equipment List

Manufacturer	Description	Model	Serial Number	Calibration Date	Calibration Due Date
RF Conducted					
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41010012	2021-09-04	2022-09-03
yzjingcheng	Coaxial Cable	KTRFBU-141-50	41010013	2021-09-04	2022-09-03
E-Microwave	Blocking Control	EMDCB-00036	OE01203219	2021-05-06	2022-05-05
Weinschel	Coaxial Attenuators	53-20-34	LN749	2021-09-04	2022-09-03
E-Microwave	Coaxial Attenuators	EMCA40-200SN-6	OE01201046	2021-09-04	2022-09-03
HP	RF Communications Test Set	8920A	3438A05201	2021-07-22	2022-07-21
Agilent	MXG Vector Signal Generator	N5182B	MY51350142	2021-04-25	2022-04-24
Agilent	Signal Generator	E8247C	MY43321350	2021-04-25	2022-04-24
BACL	TEMP&HUMI Test Chamber	BTH-150	30022	2021-02-24	2022-02-23
UNI-T	Multimeter	UT39A	M130199938	2021-06-30	2022-06-29
Pro instrument	DC Power Supply	pps3300	3300012	N/A	N/A
Gaoxin	Simuslated Transport Vibration Test Stand	GX-MZ-100	120 42315	2021-03-12	2022-03-12

* 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).

Environmental Conditions

Test Item:	RF Conducted
Temperature:	22.1~26.2 °C
Relative Humidity:	47~59%
ATM Pressure:	101.0~101.4kPa
Tester:	Levi Shi
Test Date:	2021.10.20~2021.11.05

SUMMARY OF TEST RESULTS

S/N	Clause	Description of Test	Results
1	7.4 & 7.5	Vibration & Temperature Test	Compliance
2	8.14	Test of Gennerated Call Sequences	Compliance
3	9.13	Multiple Watch Characteristics	Compliance
4	10.3	DSC Receiver Adjacent Channel Selectivity	Compliance
5	10.5	DSC Receiver Intermodulation Response	Compliance
6	10.8	Verification of Correct Decoding of Various Types of DSC Calls	Compliance
7	10.9	Reaction to VTS and AIS Channel Management DSC Transmissions	Compliance
8	10.10	Simultaneous Reception	Compliance
9	Annex D	Recommended standards for equipment operating in high level electromagnetic environments	Compliance

Note: A brief summary of the tests carried out in accordance with IEC 62238 standards.

1 - VIBRATION TEMPERATURE TEST

Applicable Standard

According to IEC 62238 §7.4 & §7.5.

Method of Measurement

According to IEC 62238 §7.4 & §7.5.

Requirement

According to IEC 62238 §7.4 & §7.5.

Test Result

	Test Level	Test Voltage (VDC)	Performance Check
Vibration Test	2Hz to 5Hz and up to 13.2Hz with and excursion of ±1.43mm ± 10% (9.8m/s2 maximum acceleration at 13.2Hz)	12	Compliance
	Above 13.2Hz and up to 600Hz with a constant acceleration of 1g	12	Compliance
	Note: Endurance Test for 2 hour sat each resonant frequency or frequency with a g level ≥ 5 times the drive g level. If no resonant frequencies or frequency with a g level ≥ 5 times the drive g level are found endurance test shall be performed at 30Hz.		

	Temperature Condition		Period (Hour)	Performance Check
Storage Test	Dry Heat	+70℃ ±1℃	15	Compliance
	Low Temperature	-25℃ ±1℃	15	Compliance

	Environment Condition		Relative Humidity	Period (Hour)	Test Voltage (V_{DC})	Performance Check
Functional Test	Dry Heat	+55℃ ±1℃	/	15	15.6	Compliance
				15	12	Compliance
				15	10.8	Compliance
	Damp Heat	+40℃ ±1℃	93 % ± 1 %	15	15.6	Compliance
				15	12	Compliance
				15	10.8	Compliance

2 - TESTING OF GENNERATED CALL SEQUENCES

Applicable Standard

Generated call sequences are calls which comply with the requirements of ITU-R Recommendation M.493-10.

Limit

The requirements of ITU-R Recommendation M.493-10 regarding message composition and content shall be met.

The generated calls shall be analyzed with the calibrated apparatus for correct configuration of the signal format, including time diversity.

It shall be verified that, after transmission of a DSC call, the transmitter re-tunes to the original channel. However, in the case of a distress call, the transmitter shall tune to channel 16 and automatically select the maximum power.

The telecommands used and the channels tested for switching shall be stated in the test report.

Method of Measurement

The output of the transmitter shall be suitably connected to an apparatus for decoding and printing out the information content of the call sequences generated by the equipment.

The transmitter shall be set to transmit DSC calls as specified in annex A.

Test Data

Please refer to following table:

Format Specifier	Category	1st telecommand (symbol No.)	2st telecommand (symbol No.)
Distress	/	100	126
All Ships	Urgency	100	126
All Ships	Safety	100	126
Individual	Urgency	100	126
Individual	Safety	100	126
Individual	Routine	100	126
Group	Routine	100	126

Test Result: Compliance

3 - MULTIPLE WATCH CHARACTERISTICS

Applicable Standard

The scanning period is the time between the start of two successive samples of the priority channel in the absence of a signal on that channel.

The dwell time on the priority channel is the time between the start and finish of any sample of the priority channel in the absence of a signal on that channel.

The dwell time on the additional channel is the time between the start and finish of any sample of the additional channel.

Method of Measurement

The equipment shall be adjusted to scan the priority channel and one additional channel.

The squelch shall be operational and so adjusted that the receiver just mutes on both the channels.

A test signal at the carrier frequency equal to the nominal frequency of the additional channel of the receiver, modulated by the normal test modulation (see 6.3) shall be connected to the receiver via a combining network (see 6.1). A second test signal with a frequency equal to the nominal frequency of the priority channel having no modulation shall be connected to the receiver via the other input of the combining network. The level of the two test signals shall be +12 dBµV (e.m.f.) at the receiver input.

A storage oscilloscope shall be connected to the audio output. Initially, the output of the test signal on the priority channel shall be switched off. The scanning process is started and the output observed on the oscilloscope. The gap between and the duration of the audio bursts shall be measured. Now the test signal on the priority channel shall be switched on and the scanning shall stop on the priority channel after the last burst and within the dwell time on the priority channel. The measurement shall be carried out where the additional channel is a simplex channel and repeated where it is a duplex channel.

The measurements shall be made under normal and under extreme test conditions.

Requirement

The scanning period shall not exceed 2 s.
The dwell time on the priority channel shall not exceed 150 ms.
The dwell time on the additional channel shall be between 850 ms and 2 s as indicated by the time of the gap between two output bursts.

Test Data

Please refer to following table:

Frequency (MHz)	Test Condition	Scanning Period (s)	Limit (s)	Dwell time on the Priority Channel (ms)	Limit (ms)	Dwell time on the Additional Channel (s)	Limit (s)
156.8	LTLV	1.4	2	122	150	1.59	0.85 - 2
	LTHV	1.4	2	122	150	1.59	0.85 - 2
	NTNV	1.4	2	122	150	1.59	0.85 - 2
	HTLV	1.4	2	122	150	1.59	0.85 - 2
	HTHV	1.4	2	122	150	1.59	0.85 - 2

Test Result: Compliance

4 - DSC RECEIVER ADJACENT CHANNELSELECTIVITY

Applicable Standard

The adjacent channel selectivity is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted modulated signal which differs in frequency from the wanted signal by 25 kHz.

Limit

The bit error ratio shall be equal to or less than 10^{-2}

Method of Measurement

The two input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dBµV under normal test conditions and +9 dBµV under extreme test conditions.

The unwanted signal shall be modulated to 400 Hz with a deviation of ±3 kHz. The unwanted signal shall be tuned to the centre frequency of the upper adjacent channel. The input level of the unwanted signal shall be 73 dBµV under normal test conditions and 63 dBµV under extreme test conditions.

The bit error ratio in the decoder output shall be determined as described in 6.9.

The measurement shall be repeated with the unwanted signal tuned to the centre frequency of the lower adjacent channel.

The measurement shall be carried out under normal test conditions (see 6.12) and under extreme test conditions (see 6.13.1 and 6.13.2 applied simultaneously).

Test Data

Please refer to following table:

Frequency (MHz)	Test Condition	BER (%)	Limit
156.525	LTLV	0.7	10^{-2}
	LTHV	0.7	
	NTNV	0.6	
	HTLV	0.7	
	HTHV	0.7	

Test Result: Compliance

5 - DSC RECEIVER INTER-MODULATIONRESPONSE

Applicable Standard

The intermodulation response is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal frequency.

Limit

The bit error ratio shall be equal to or less than 10^{-2}.

Method of Measurement

The three input signals shall be connected to the receiver input terminal via a combining network (see 6.1).

The wanted signal represented by signal generator A shall be at the nominal frequency of the receiver and shall be the DSC standard test signal (see 6.8) containing DSC calls. The level of the wanted signal shall be +3 dBµV.

The unwanted signals shall be applied, both at the same level. The unwanted signal from signal generator B shall be unmodulated and adjusted to a frequency 50 kHz above (or below) the nominal frequency of the receiver. The second unwanted signal from signal generator C shall be modulated by 400 Hz with a deviation of ±3 kHz and adjusted to a frequency 100 kHz above (or below) the nominal frequency of the receiver.

The input level of the unwanted signals shall be 68 dBµV.

The bit error ratio in the decoder output shall be determined as described in 6.9.

Test Data

Please refer to following table:

Frequency	BER (%) (worst case)	Limit
156.525MHz	0.5	10^{-2}

Test Result: Compliance

6 - VERIFICATION OF CORRECT DECODING OF VARIOUS TYPES OF DSC CALLS

Applicable Standard

DSC call sequences are calls that comply with ITU-R Recommendation M.493-10.

Limit

The requirements of ITU-R Recommendation M.493-10 regarding message composition and content shall be met.

The decoded call sequences at the output of the receiver shall be examined for correct technical format, including error-check characters.

When receiver measurements are made by use of a printer or a computer, a check shall be made to ensure accordance between printer output and display indication.

It shall be verified that the equipment is capable of switching to a channel identified in the DSC call.

The telecommands used and channels tested for switching shall be stated in the test report.

Method of Measurement

The input terminal of the receiver shall be suitably connected to a calibrated apparatus for generation of digital selective call signals.

DSC calls as specified in annex A shall be applied to the receiver.

Test Data

Please refer to following table:

Format Specifier	Category	1st telecommand (symbol No.)	2st telecommand (symbol No.)
Distress	/	100	126
All Ships	Urgency	100	126
All Ships	Safety	100	126
Individual	Urgency	100	126
Individual	Safety	100	126
Individual	Routine	100	126
Group	Routine	100	126

Items	Confirm (Y or N)
Confirm that the decoded call sequences at the output of the receiver have been examined for correct technical format, including error check characteristics:	Y
Error found:	N
Confirm that the checks have been made to ensure accordance between printer output and display:	Y
Error found:	N
It has beenverified that the equipment is capable of switching to a channel identified in the DSC call:	Y

Test Result: Compliance

7 - REACTION TO VTS AND AIS CHANNEL MANAGEMENT DSC TRANSMISSIONS

Applicable Standard

VTS and AIS channel management DSC transmissions are any DSC transmissions that are in accordance with Recommendation ITU-R M.825 or M.1371.

Limit

The equipment shall not sound an alarm, display a message (an accurate, informative display is permissible but not required), transmit a response or suggest a transmitted response, lock up, or require operator intervention.

Method of Measurement

The input terminal of the receiver shall be connected as per 10.8.2. DSC polling and regional channel management in accordance with Annex 3 of ITU-R M.1371-1 shall be applied to the receiver. A DSC transmission of format specifier symbol 112 and then with 116, category symbol 103, and otherwise similar to a distress call described in Table 4 of ITU-R M.493-10 shall also be made.

Test Data

Please refer to following table:

Items	Confirm (Y or N)
Not sound an alarm	Y
Not display a message (An accurate informative display is permissible but not required)	Y
Not transmit a response	Y
Not suggest a transmitted response	Y
Not lock up	Y
Not require operator intervention	Y

Test Result: Compliance

8 - DSC RECEIVER SIMULTANEOUS RECEPTION

Applicable Standard

Simultaneous reception is the ability of the unit to correctly receive DSC traffic and radiotelephony traffic at the same time.

Limit

For radiotelephony operation the SINAD ratio shall be no less than 20 dB in the presence of the DSC test signal.

The DSC bit error ratio shall be equal to or less than 10^{-2}.

Method of Measurement

The radiotelephone shall be set for operation on channel 16.

Two input signals shall be connected to the receiver input terminal via combining network (see clause 6.1).

The radiotelephone test signal shall be at a carrier frequency equal to the nominal frequency of the receiver, modulated by the normal test modulation (see clause 6.3) shall be applied to the receiver input.

An audio frequency load and a measuring instrument for measuring SINAD ratio (through a psophometric network as specified in clause 9.3.1) shall be connected to the receiver output terminals.

The radiotelephone test signal level shall be set for +20 dBμV.

The SINAD shall be measured with and without the presence of the DSC test signal.

The DSC standard test signal input level shall be 0 dBμV (e.m.f.) (see clause 6.8) containing DSC calls.

The bit error ratio in the decoder output shall be determined as described in clause 6.9.

Test Data

Please refer to following table:

Frequency	SINAD (dB)		BER Measured Value	BER Limit
(MHz)	Measure Value	Limit		
156.8	33.1	> 20	0	$<10^{-2}$

Test Result: Compliance

9 - RECOMMENDED STANDARDS FOR EQUIPMENT OPERATING IN HIGH LEVEL ELECTROMAGNETIC ENVIRONMENTS

Applicable Standard

In some areas of the world, high power transmitters are located in close proximity to navigable waterways which can produce large power levels ranging from typically –40 dBm to –10 dBm. This has been observed, for instance, in the New Orleans/Baton Rouge waterway areas in the USA. Such power levels generate in-band nonlinear reactions, such as desensitization or intermodulation in the receiver input of greater severity than those anticipated by the blocking and intermodulation tests of this standard.

Equipment intended for use in such areas is recommended to meet the requirements of the test below. Receivers meeting the requirements below should be capable of useful reception in such environments better than 95 % of the time.

Optional circuitry accessible by operator, for example a switched RF attenuator, may be used to meet the limits required by the test.

Limit

The SINAD ratio of the radio receiver tuned to the wanted frequency of 156,650 MHz. at the receiver audiofrequency output, psophometrically weighted, shall indicate a level no less than 14 dB, averaged over a 1 min measurement interval.

Method of Measurement

Please refer to IEC 62238 §D.2 for the measurement method.

Test Data

Please refer to following table:

Frequency (MHz)	SINAD Ratio Result (dB)	Limit (dB)
156.65	17	≥14dB

Test Result: Compliance

EXHIBIT A - EUT PHOTOGRAPHS

For photos in this section, please refer to report No.: DG2211015-52964E-02A EXHIBIT A.

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