Serial No. GM24073x

EXTREME CONDITIONS PHYSICAL TEST REPORT FOR THE L3 COMMUNICATIONS AVIATION RECORDERS CORPORATION AUTOMATIC IDENTIFICATION SYSTEM PERFORMANCE TESTS

Prepared for:

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Submitted by:

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L3 Communications Aviation Recorders Corporation
Extreme Conditions Physical Tests
By
Green Mountain Electromagnetics, Inc.
Middlebury, Vermont

Unit: Automatic Identification System (AIS)
Evaluated: September 28 – October 15, 2004 at Qualtest, Orlando, Florida

I. Applicable Standards:

The unit described in this report was evaluated for compliance with extreme condition portions of paragraph 15, "Physical Tests" of IEC 61993-2, "Maritime Navigation and Radiocommunication Equipment and Systems – Automatic Identification Systems (AIS), Part 2: Class A Shipborne Equipment of the Universal AIS – Operational and Performance Requirements, Methods of Test and Required Test Results (December 2001)."

The unit described in this report was also measured for compliance with European Standard IEC 60945, "Maritime Navigation and Radiocommunication Equipment and Systems – General Requirements – Methods of Testing and Required Test Results (August 2002):" paragraph 7.1, "Extreme Power Supply," paragraph 8.2 "Dry Heat," paragraph 8.3 "Damp Heat," paragraph 8.4 "Low Temperature," and paragraph 8.7 "Vibration." Environmental procedures and equipment were in accordance with IEC 60945 and IEC 61993. See Qualtest report #JN04564.

II. Unit Tested:

The L3 Communications Aviation Recorders Corporation, Automatic Identification System provides continuous signal and data transmission for ship identification. The AIS uses 24-VDC power, has TDMA/DSC transmitters and TDMA/GPS/DSC receivers. It consists of the two-piece metal enclosure with connector hardware, the transmit/receive circuits, the micro-processor/data-storage electronics, and the antenna interface. The table below describes the unit tested to determine compliance with the standards:

Model/P/N	Manufacturer	H/W/D in cm	Serial Number
AISD1-000-00	L3 Communications	8/15/20	104

III. Summary of Results:

The L3 Communications Aviation Recorders Corporation AIS complies with the requirements in IEC 61993-2, paragraph 15 under the conditions required in IEC 60945 paragraph 8.2.2, "Dry Heat," paragraph 8.4.2.2, "Low Temperature," and per paragraph 7.1, "Extreme Power Supply." Section VIII contains the results summarized in the tables below.

Dry Heat

	Test	Mode/Port	IEC 61993-2 Para.	Tolerance/Limit	Specified Value	Measured Value
1	Frequency Error	TDMA Transmit	**15.1.1**	±1000 Hz	156,025,000 Hz	156,025,085 Hz
				±1000 Hz	157,412,500 Hz	157,412,588 Hz
				±1000 Hz	160,637,500 Hz	160,637,566 Hz
				±1000 Hz	162,025,000 Hz	162,025,058 Hz
		DSC Transmit	**15.2.1**	±13 Hz	1300 Hz	1299.310 Hz
				±21 Hz	2100 Hz	2100.576 Hz
2	Carrier Power	TDMA Transmit	**15.1.2**	+2/-3 dB	40.96 dBm	40.50 dBm
					33.01 dBm	32.45 dBm
5	Sensitivity	TDMA Receive	**15.3.1**	20% PER	-101 dBm	-112 dBm
			15.3.2	20% PER	-92 dBm	-106 dBm
		DSC Receive	**15.4.1**	0.01 BER	-101 dBm	-116 dBm
7	Adjacent Channel Selectivity	TDMA Receive	**15.3.6**	20% PER	≥60 dB	77 dB
			15.3.7	20% PER	≥50 dB	54 dB
		DSC Receive	**15.4.4**	0.01 BER	≥60 dB	81 dB

Low Temperature

	Test	Mode/Port	IEC 61993-2 Para.	Tolerance/Limit	Specified Value	Measured Value
1	Frequency Error	TDMA Transmit	**15.1.1**	±1000 Hz	156,025,000 Hz	156,025,329 Hz
				±1000 Hz	157,412,500 Hz	157,412,831 Hz
				±1000 Hz	160,637,500 Hz	160,637,814 Hz
				±1000 Hz	162,025,000 Hz	162,025,305 Hz
		DSC Transmit	**15.2.1**	±13 Hz	1300 Hz	1299.317 Hz
				±21 Hz	2100 Hz	2100.578 Hz
2	Carrier Power	TDMA Transmit	**15.1.2**	+2/-3 dB	40.96 dBm	40.47 dBm
					33.01 dBm	32.46 dBm
5	Sensitivity	TDMA Receive	**15.3.1**	20% PER	-101 dBm	-112 dBm
			15.3.2	20% PER	-92 dBm	-106 dBm
		DSC Receive	**15.4.1**	0.01 BER	-101 dBm	-114 dBm
7	Adjacent Channel Selectivity	TDMA Receive	**15.3.6**	20% PER	≥60 dB	60 dB
			15.3.7	20% PER	≥50 dB	54 dB
		DSC Receive	**15.4.4**	0.01 BER	≥60 dB	80 dB

The AIS complies with the requirements in IEC 61993-2, paragraph 15 under the conditions required in IEC 60945 paragraph 8.3, "Damp Heat" and per paragraph 7.1, "Extreme Power Supply." Section VIII contains the results.

Damp Heat

	Test	Mode/Port	IEC 61993-2 Para.	Tolerance/Limit	Specified Value	Measured Value
1	Carrier Power	TDMA Transmit	**15.1.2**	+2/-3 dB	40.96 dBm 33.01 dBm	40.51 dBm 32.36 dBm
2	Sensitivity	TDMA Receive	**15.3.1**	20% PER	-101 dBm	-112 dBm

The AIS also complies with the requirements in IEC 61993-2, paragraph 15 under the conditions required in IEC 60945 paragraph 8.7, "Vibration." The unit meets performance checks before, during, and after the conditions are applied. Section VIII contains the results.

Testing was performed by Kyle R. Kowalczyk, president, Green Mountain Electromagnetics and requested by:

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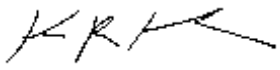


Kyle R. Kowalczyk
12/21/04

IV. Laboratory Description:

The GME laboratory and Open Area Test Site (OATS) are located at 219 Blake Roy Road, Middlebury, VT. GME is internationally accredited by the American Association for Laboratory Accreditation (A2LA) and meets the quality requirements in ISO/IEC 17025 (1999), "General Requirements for the Competence of Testing and Calibration Laboratories." For scope of accreditation, contact GME. The Qualtest Laboratory is located in Orlando Florida.

V. Measuring Equipment:

The table below describes the instrumentation used by Green Mountain Electromagnetics to perform this testing:

Unit	Manufacturer	Model	Serial/ID #	Last Cal.	Next Cal.
Signal Generator	IFR	3412	10411	6/14/04	6/14/05
Signal Generator	Marconi	2031	ID5165	8/11/04	8/11/05
Signal Generator	Marconi	2031	1160	9/5/04	9/5/05
Spectrum Analyzer	Hewlett-Packard	8563	10415	9/8/04	9/8/05
Radio Test Set	Hewlett-Packard	8920B	501717	5/23/04	5/23/05
PC/Monitor	L3 Configured	9591 9411	MIS9591 MIS9411	n/a	n/a
Frequency Counter	Agilent	53181A	ID5111	4/27/04	4/27/05
Power Sensor	Agilent	E9301B	ID5119A/B	6/7/04	6/7/05
Power Meter	Agilent	E4418B	ID5113	4/27/04	4/27/05
Power Supply	Hewlett-Packard	6038A	500771	12/10/03	12/10/04
Power Attenuator	Hewlett-Packard	8498A	ID5122	5/24/04	5/24/05
Splitter	Mini-Circuits	ZSC-4-1	n/a	n/a	n/a

VI. Measurement Procedures for AIS Extreme Physical Tests:

Preface: The following is a brief description of GNS test setup used to perform Packet Error Rate Test (PER) and Bit Error Rate Test (BER). Two audio files, one for 12.5 kHz and one for 25 kHz channel, are used as GMSK modulation data into the signal generator. Also, a third file is used for the BER test as FSK modulation data into the signal generator. These audio files were created by converting GMSK and FSK data into audio format (.wave file). The signal generated is set to a carrier frequency and FM modulation is set to ON. Signal generator FM deviation is set according to the channel bandwidth. A PC is used to play the audio files, and the audio output is fed into the signal generator. The audio format data is used as modulation IN of the signal generator and RF output is taken out from the signal generator. Pilot port of the EUT is monitored for PER and BER test results using Hyper Terminal.
The diagram below shows the test setup.

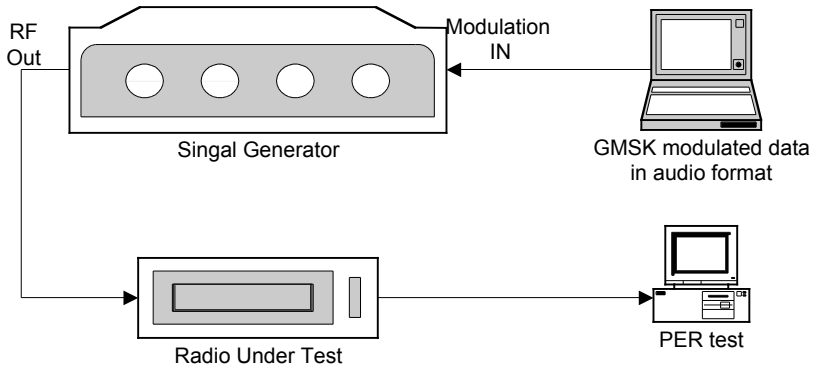


Figure 1: Test setup for PER test

GMSK and FSK data can be continuously played via windows media software (preferably with high quality sound card) and number of packets can be monitored on the Pilot port output of the radio under test.

For BER test, a packet that contains 90 bits of payload, which consists of 9 ten-bit symbols, is used. The symbols used are hex value 0x355, because this symbol is closest to the dot-pattern. The packet length is 400 ms, so in continuous mode the maximum of 450 bits can be received in two seconds (90 x 5).

For PER test, one GMSK packet takes about 26.666 ms to transmit. So, in continuous mode, maximum of 75 packets can be received in two seconds. Attached table for PER is based on the success rate of the raw packet data received by the unit under test.

Success Rate in %	Packets in 2 seconds
100	75
95	71.25
90	67.5

85	63.75
80	**60**
75	56.25
70	52.5
65	48.75
60	45
55	41.25
50	37.5
45	33.75
40	30
35	26.25
30	22.5
25	18.75
20	15
15	11.25
10	7.5

Table 1: PER = (100% -Success rate) within pre-defined time period

The EUT outputs the following every 2 seconds via the Pilot port.

"AIS: x/75 packets (Avg. X) DSC: y/z bit-errors (Avg. Y)"

Where

x = the number of packets received in the last 2 second time interval
X = the average number of packets received per 2 seconds since the beginning of the PER test.
y = number of errored bits received.
z = total number of bits received.
Y = the average bit error rate.

So, "AIS: 75/75 packets (Avg. 70.0) DSC: 1/450 bit-errors (Avg. 0.0001)" means that during this 2-second interval 75 packets were received in the AIS channel and the average number of packets received since the start of the test is 70.0. Also, the above example shows that during this 2-second interval, 450 bits were received on the DSC channel, one of them was in error, and the average BER since the start of the test is 0.0001 (10 ^ -4).

VI. Measurement Procedures for AIS Physical Tests:

1. Frequency Error.

TDMA Frequencies: 156.025, 157.4125, 160.6375, 162.025 MHz

Specification: ±1 kHz Extreme Operation

DSC Frequencies: 1300, 2100

Specification: ±13 Hz, ±21 Hz Extreme Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna; attach 30-dB attenuator to VHF port.

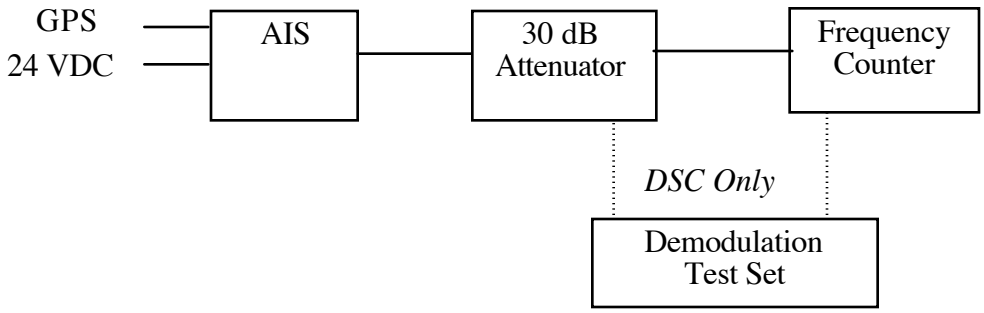
b. Verify frequency counter and AIS operation.
   i. Frequency counter is connected to 30-dB attenuator.
   ii. AIS channels are selected from front panel.
   iii. Frequency counter requires warm-up period.

c. Verify AIS frequency with non-contact probe and spectrum analyzer.

d. Operate EUT at first selected channel with no modulation.

e. Record frequency displayed on counter.
   i. Repeat for each TDMA channel – settings are 1060, 1228, 2260 & 2088.

f. Perform state error test on DSC channel 70 using demodulated output.
   i. Demodulation is connected between 30 dB and counter.
   ii. States B & Y are D21 and D13 on AIS front panel.
   iii. Use PC to demodulate for state error.



Block Diagram of Frequency Test

VI. Measurement Procedures for AIS Extreme Physical Tests Cont'd:

2. Carrier Power.

High Specification: 40.96 +2/-3 dBm (12.5W +7.3W/-6.25W) Extreme Operation

Low Specification: 33.01 +2/-3 dBm (2W +1.2W/-1W) Extreme Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna; attach 30-dB attenuator to VHF port.

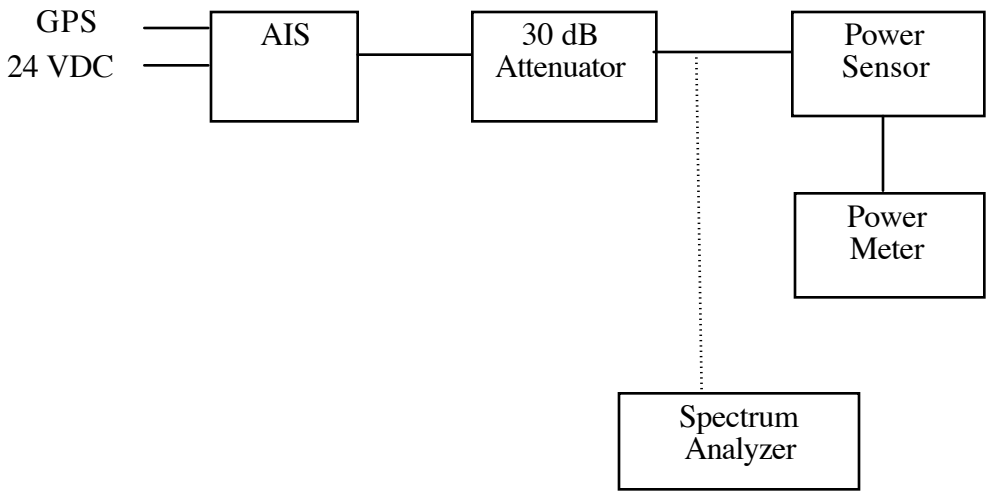
b. Verify power meter/sensor and AIS operation.
   i. Power sensor is connected to 30-dB attenuator.
   ii. AIS power levels are selected from front panel.
   iii. Power meter requires zeroing and calibration each time.

c. Verify AIS frequency with spectrum analyzer.

d. Operate EUT at high power unmodulated.

e. Record level displayed on meter.

f. Repeat for low power.



Block Diagram of Carrier Power Test

VI. Measurement Procedures for AIS Extreme Physical Tests Cont'd:

3. Sensitivity.

25 kHz Specification: -101 dBm @ 20% PER Extreme Operation

12.5 kHz Specification: -92 dBm @ 20% PER Extreme Operation

DSC Specification: -101 dBm @ 0.01 BER Extreme Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to 24-VDC power and GPS antenna.

b. Verify PC and AIS operation.
   i. PC provides input to AIS.
   ii. Signal generator set to provide -101 dBm at EUT (25 kHz).
   iii. Spectrum analyzer verifies correct signal level.

c. Operate with standard modulation at 156.025 MHz.

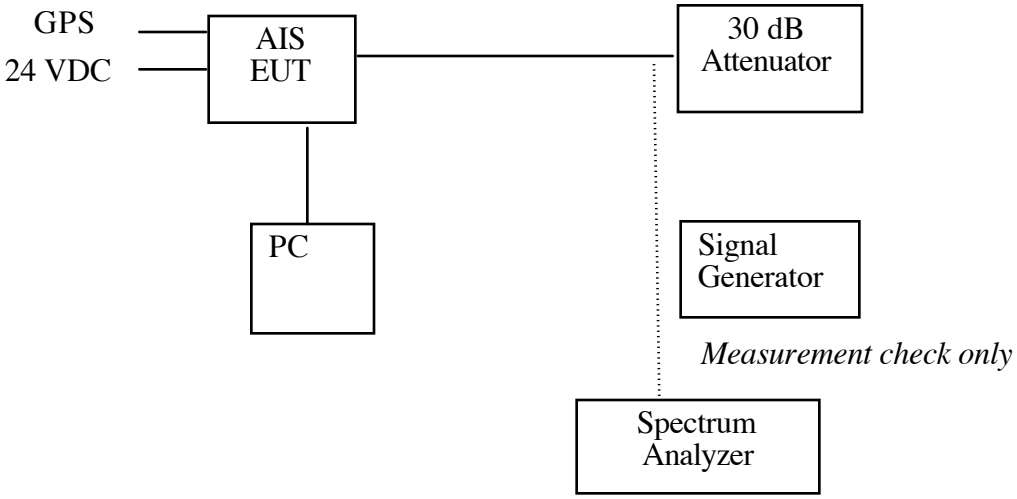
d. Operate AIS EUT with standard modulation at 156.025 MHz.

e. Run sensitivity software program on PC.
   i. Software determines TDMA packet error rate.

f. Repeat step e. for 162.025 MHz.

g. Set signal generator to provide -92 dBm (12.5 kHz).

h. Repeat step e. for 157.4125 MHz and 160.6375 MHz.



Block Diagram of Receiver Sensitivity Test

VI. Measurement Procedures for AIS Extreme Physical Tests Cont'd:

4. Adjacent Channel Selectivity.

25 kHz Specification & DSC: ≥60 dB Extreme Operation

12.5 kHz Specification: ≥50 dB Extreme Operation

a. Set up EUT and test instrumentation in laboratory.
   i. Connect AIS to PC, 24-VDC power, GPS antenna.

b. Verify PC and AIS operation.
   i. PC monitors AIS, then sig. gen. A & B are connected to combiner.
   ii. Signal generator is set to provide -104 dBm at EUT (25 kHz).
   iii. Signal generator B set to provide -44 to EUT (60-dB result) at channel immediately above the AIS channel.
   iv. Spectrum analyzer verifies correct signal level.

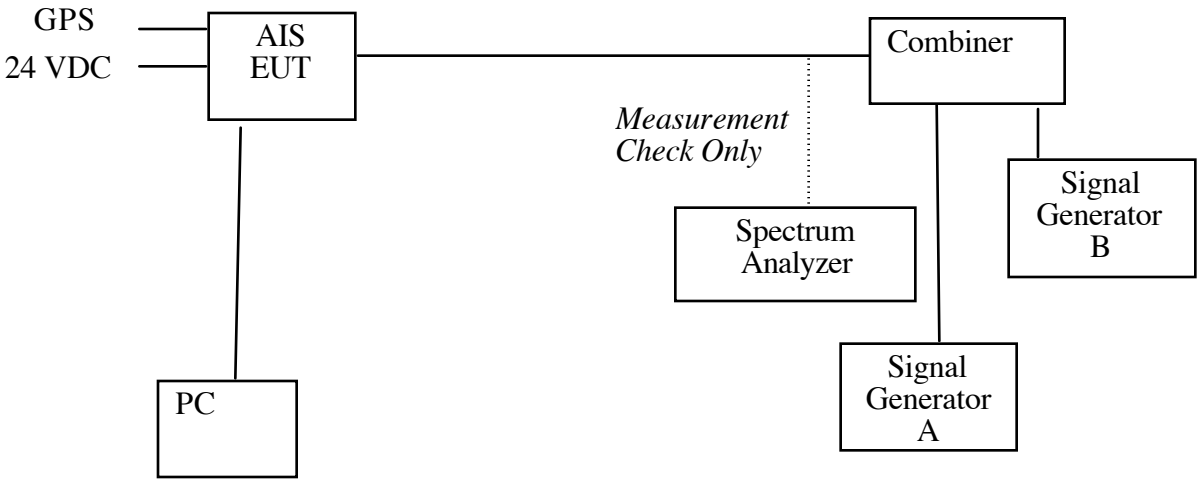
c. Operate PC and AIS EUT with standard modulation at default channel.

d. Run adjacent-channel software program on PC.
   i. Software determines packet error rate from messages.
   ii. Proceed as in IEC 61993 para. 15.3.6 steps a. – k. if PER >20%.

e. Repeat step d. for channel immediately below AIS channel.

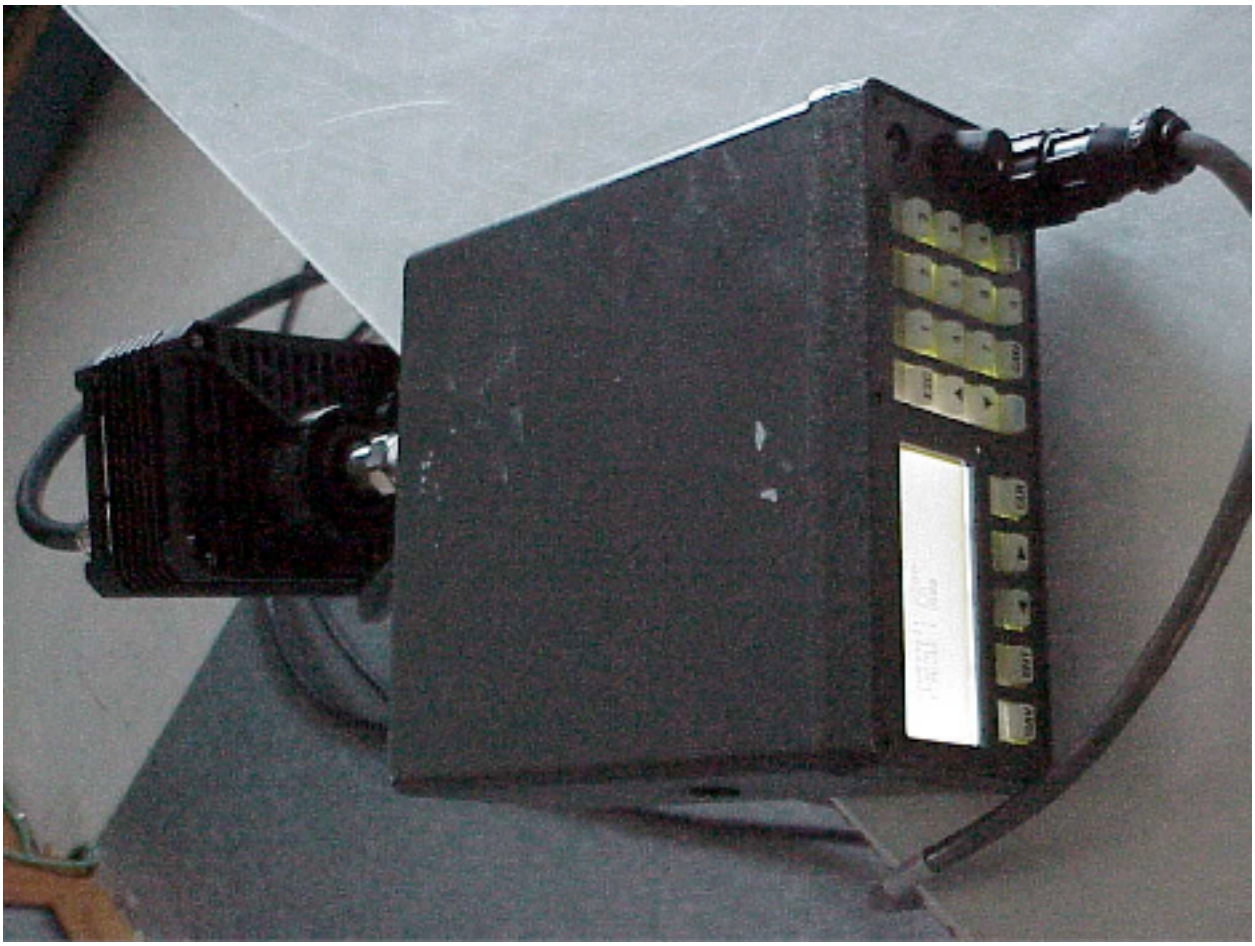
f. Repeat steps d. and e. for 12.5-kHz AIS channel.
   i. Set signal generator to provide -95 dBm/-50 dBm.

g. Repeat step a. – c. for DSC; Generator provides -34-dBm FM modulated at 400 Hz/3kHz.



Block Diagram of Receiver Adjacent-Channel Test

VII. Test Setup Photographs for AIS Extreme Physical Tests:



Equipment Under Test

VII. Test Setup Photographs for AIS Extreme Physical Tests Cont'd:

EUT and Support Equipment for Temperature Tests

VII. Test Setup Photographs for AIS Extreme Physical Tests Cont'd:

Vibration Test Setup

VIII. Measurement Results for AIS Extreme Physical Tests:

1. Frequency Error at Dry Heat and Low Temperature.

Frequencies: 156.025, 157.4125, 160.6375, 162.025 MHz

Specification: ±1 kHz Extreme Operation

Frequencies: 1300 Hz, 2100 Hz

Specification: 1% (13 Hz, 21 Hz) Extreme Operation

Temperature	SupplyVoltage	Channel	Specified Frequency(Hz)	Measured Frequency(Hz)
High	High	1060	156,025,000	156,025,085
High	High	1228	157,412,500	157,412,588
High	High	2260	160,637,500	160,637,566
High	High	2088	162,025,000	162,025,058
Low	Low	1060	156,025,000	156,025,329
Low	Low	1228	157,412,500	157,412,831
Low	Low	2260	160,637,500	160,637,814
Low	Low	2088	162,025,000	162,025,305
Low	Low	D21	2100.000	2100.578
Low	Low	D13	1300.000	1299.317
High	High	D21	2100.000	2100.576
High	High	D13	1300.000	1299.310

VIII. Measurement Results for AIS Extreme Physical Tests Cont'd:

2. Carrier Power at Dry Heat & High Supply Voltage.

High Specification: 40.96 +2/-3 dBm (12.5W +7.3W/-6.25W) Extreme Operation

Low Specification: 33.01 +2/-3 dBm (2W +1.2W/-1W) Extreme Operation

VIII. Measurement Results for AIS Extreme Physical Tests Cont'd:

2. Carrier Power at Low Temperature & Low Supply Voltage.

High Specification: 40.96 +2/-3 dBm (12.5W +7.3W/-6.25W) Extreme Operation

Low Specification: 33.01 +2/-3 dBm (2W +1.2W/-1W) Extreme Operation