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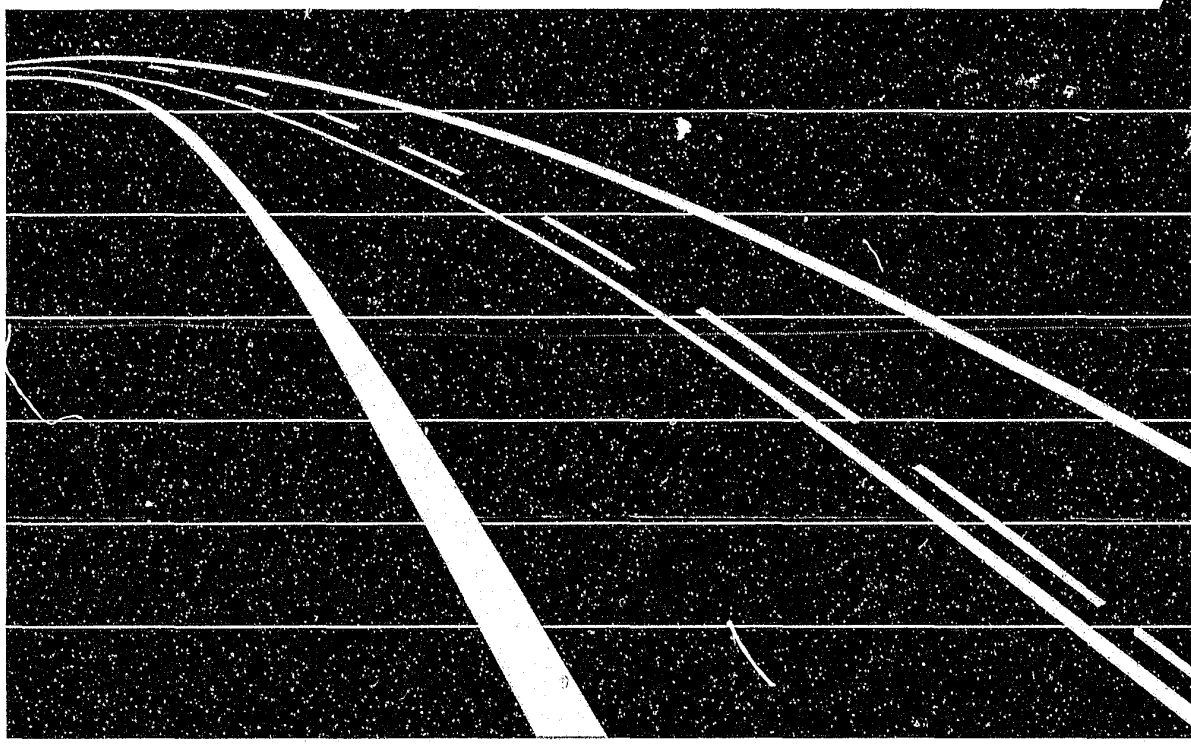

Equipment Performance Report:

Vehicle Tracking Devices

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Washington, D.C.

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Police Department
Omaha, Nebraska

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Equipment Performance Report: Vehicle Tracking Devices

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Prepared and published by:

Technology Assessment Program Information Center
Paul Brechbiel, *Testing Coordinator*
Marita Menaker, *Senior Writer-Editor*
Box 6000, Rockville, MD 20850
1-800-248-2742; 1-301-251-5060

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National Institute of Justice

James K. Stewart

Director

Lester Shubin

Director of Science and Technology
TAP Program Manager

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About the Technology Assessment Program

The Technology Assessment Program (TAP) is an applied research project of the National Institute of Justice (NIJ). TAP develops minimum performance standards for law enforcement equipment and tests equipment based on these standards.

To accomplish program tasks, NIJ coordinates the activities of two organizations: the TAP Information Center (TAPIC) and the Law Enforcement Standards Laboratory (LESL) of the National Institute of Standards and Technology (NIST). LESL prepares equipment standards, reports, and guides; TAPIC coordinates the testing of law enforcement equipment by independent laboratories and publishes the test results. LESL, TAPIC, and NIJ support one another in accomplishing TAP's tasks and goals.

TAP's major tasks and goals are:

Coordination of the TAP Advisory Council. Composed of nationally recognized professionals from Federal, State, and local criminal justice agencies, the Advisory Council helps NIJ set priorities for developing new equipment standards and for testing available products.

Coordination of equipment testing. TAPIC develops Requests For Proposals to select testing laboratories, evaluates proposals with assistance from LESL, selects laboratories, and monitors the testing activities.

Compilation and dissemination of test results. TAPIC compiles and analyzes the test results and, after review by NIJ and LESL, publishes the results in TAP bulletins (summaries issued periodically) and in Equipment Performance Reports (also published periodically and containing complete testing data on specific equipment).

Dissemination of information. TAP educates the criminal justice community about its resources and services in a number of ways. Staff prepare articles for criminal justice periodicals, develop exhibits, make presentations at major criminal justice conferences, and serve as a clearinghouse of information about equipment and technology.

For more information, or to add your name to TAPIC's mailing list, call 1–800–248–2742 (in Maryland and Metropolitan Washington, D.C., call 1–301–251–5060.)

James K. Stewart
Director
National Institute of Justice

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Introduction

Locating or following vehicles used in the conduct of criminal activities has been an ever-increasing challenge to law enforcement officials. In recognition of the need for electronic aids in this effort, the National Institute of Justice (NIJ) conducted research that led to the development of *Vehicle Tracking Devices: NIJ Standard-0223.00*. This standard established minimum performance requirements and test procedures for these devices. The standard and the results of equipment tests, using procedures set forth in the standard, provide information that will help law enforcement agencies evaluate and select suitable equipment.

This report includes test results on five transmitters and four receivers. A system, consisting of a transmitter and a receiver with appropriate antennae, provides distance and direction information between the transmitter and receiver. Other information, such as whether the transmitter is in motion or stationary, may also be available at the receiver.

No item of equipment tested met all the requirements of the standard. The test results show that some equipment did not perform well at high or low temperatures, or at voltages higher or lower than specified. However, each item tested performed satisfactorily in many tests. The data compiled from the tests, and included in this report, will guide the prospective purchaser in selecting the equipment that performs best under the conditions in which it will be operated. As an aid in evaluating the performance of an overall system—a transmitter working with a particular receiver and antenna—figure of merit values are included with the test results. Figure of merit values give an indication of the performance of a transmitter/receiver system operated under four environmental conditions. The figure of merit numerical value results from adding together the peak output power of the transmitter at 80% of its rated voltage input and the absolute value of the minimum receiver direction indication sensitivity.

Prospective purchasers of equipment are urged to study the entire report for additional information that will help them select a transmitter/receiver system most likely to perform satisfactorily in the environment in which the system will be operated.

Results of the transmitter and receiver tests are summarized in Tables 2, 3, and 4, noting only compliance or noncompliance with requirements of the test standard. Test data are set forth in full in Appendixes C, D, E, and F.

Please call the Technology Assessment Program Information Center (TAPIC) if you have any questions concerning the test results: 1–800–248–2742, or in Maryland and Metropolitan Washington, D.C., 1–301–251–5060.

The Test Program

According to the TAP equipment testing program procedures (discussed in Appendix B), TAPIC solicited bids to test vehicle tracking devices (VTD's) from independent testing laboratories. Underwriters Laboratories, Inc., in Northbrook, Illinois, was selected based on its proposal score.

One of the first steps in the testing procedure involved a review of VTD's that were available to police. After LESL and TAPIC identified VTD's to be included in the testing, TAPIC invited the manufacturers/distributors to provide representative samples for testing. Law enforcement agencies were also solicited for equipment. Table 1 identifies the manufacturers and the equipment lent for testing.

Staff members from TAPIC, the Law Enforcements Standards Laboratory (LESL), and the National Institute of Standards and Technology (NIST) Laboratory Accreditation Program attended preliminary testing to ensure that the laboratory was staffed appropriately, had the correct equipment, and followed the procedures set forth in NIJ Standard-0223.00. For the preliminary test, the laboratory tested one receiver and one transmitter. After TAP reviewed and approved the preliminary test, the laboratory tested the remaining equipment.

After completion of the testing, LESL staff members assisted TAPIC in the data analysis and the compilation of results presented in this *Equipment Performance Report.*

Table 1
VEHICLE TRACKING DEVICES TESTED

Manufacturer	Transmitter	Receiver
Audio Intelligence Devices (AID)	TX–602A[1]	RX–360
Audio Intelligence Devices (AID)		RX–890B
Mobile Electronic Tracking Systems (METS)	M7047[2]	M7101
Household Data Services (HDS)	BT–175[1]	
Household Data Services (HDS)	BT–180[1]	
Ocean Applied Research (OAR)	VB–342[1]	347ED

1. Type II transmitter. Type II transmitters operate in the 150–174 MHz band. The OAR VB–342 was tested as a Type II transmitter, although its frequency did not fall into the frequency range.

2. Type I transmitter. Type I transmitters operate in the 30–50 MHz band. This transmitter was tested as a Type I, although its frequency did not fall into the frequency range.

Minimum Performance Requirements/ Methods of Testing

Vehicle Tracking Devices: NIJ Standard-0223.00, dated May 1986, established requirements and methods for testing transmitters and receivers that locate and track vehicles during surveillance operations. The following discussion summarizes the specific requirements and briefly describes how compliance is determined. Appendix A discusses the purpose of each requirement. The following descriptions reflect clarifications and one variance (radiated spurious emissions) to the standard.

1. *User information*

The standard requires that the manufacturer or distributor specify a nominal value for each performance characteristic shown in the transmitter and receiver data sheets in Appendixes C, D, and E, and the findings are outlined in Appendix F: Transmitter/Receiver User Information. The following items are also required: (a) the range of temperatures within which the transmitter and receiver are designed to be operated; (b) transmitter and receiver operating frequencies; (c) transmitter peak and average radio frequency carrier output power; (d) transmitter current drain during and between transmitted pulses; (e) transmitter pulsed-carrier repetition rate and either pulse width or duty cycle; (f) transmitter radio frequency output impedance; (g) receiver radio frequency input impedance; (h) receiver current drain and supply voltage; and (i) transmitter battery type and voltage.

Compliance is determined by examining the information provided to determine if all the items required by the standard are included in the equipment documentation.

2. *Transmitter no-load characteristic*

With the transmitter antenna disconnected, the transmitter shall operate for at least 1 minute without any performance degradation. The antenna is disconnected and the transmitter turned on and operated for at least 1 minute. The transmitter is then turned off and not turned back on for at least 20 minutes.

Compliance is determined by the satisfactory operation of the transmitter after this test.

3. *Transmitter load condition*

When tested under two different load conditions, the transmitter output shall remain stable and not change from a pulsed-carrier to a continuous wave. The transmitter is first connected to an output load and then to a short circuit. The power output of the transmitter is monitored with a power meter under these conditions.

Compliance is determined by verifying that the power meter indication continues to fluctuate at both load conditions.

4. *Transmitter performance at environmental extremes*

A. Low-temperature stability. The transmitter is placed in a temperature chamber set to -30 °C (-22 °F) or the lowest temperature at which the manufacturer states that the equipment will operate, whichever is lower. The transmitter's radio frequency carrier characteristics are tested while the transmitter is in the chamber. The transmitter is powered by a power supply while it is in the chamber.

Compliance with the requirement is determined as described in Section 5, paragraphs B, E, F, and G below.

B. High-temperature stability. The transmitter is placed in a temperature chamber set to 60 °C (140 °F) or the highest temperature at which the manufacturer states that the equipment will operate properly, whichever is higher. The transmitter's radio frequency carrier characteristics are tested while the transmitter is in the chamber. The transmitter is powered by a power supply while it is in the chamber.

Compliance with the requirement is determined as described in Section 5, paragraphs B, E, F, and G below.

C. Humidity stability. The transmitter is placed in a temperature chamber set to 50 °C (122 °F) and 90% relative humidity. The transmitter's radio frequency carrier characteristics are tested while the transmitter is in the chamber. The transmitter is powered by a power supply while it is in the chamber.

Compliance with the requirement is determined as described in Section 5, paragraphs B, E, F, and G below.

D. Vibration stability. The transmitter is placed on a vibration table and vibrated at frequencies between 10 and 30 Hz, and between 30 and 60 Hz at the amplitudes of 0.38 mm and 0.19 mm respectively, in three mutually perpendicular directions, including the vertical. The transmitter's peak output power and carrier frequency are tested while the transmitter is on the vibration table. The transmitter is powered by batteries while it is on the vibration table.

Compliance with the requirement is determined as described in Section 5, paragraphs B and E below.

5. *Transmitter radio frequency carrier characteristics*

A. Peak carrier output power. The peak carrier output power, when the transmitter is operating at room temperature and the input voltage at nominal, shall not vary more than ±1 dB from the nominal value specified by the manufacturer. A spectrum analyzer is connected to the antenna output, and the peak output power of the transmitter's pulses is measured. Measurements are taken with the transmitter powered by a power supply and by batteries.

Compliance is determined by verifying that the measured peak carrier output power is within ±1 dB of the nominal peak carrier output power.

B. Peak carrier output power variance. The amount that the peak carrier output power varies when the transmitter is at room temperature with the input voltage varied +10% and -20% and when the transmitter is tested at the environmental extremes shall not be more than allowed for by the standard. At room temperature the peak carrier output power is measured when the transmitter input voltage is varied +10% and -20% from nominal. At low temperature, high temperature, and humidity, measurements are taken with the input voltage at nominal, nominal +10%, and nominal -20%. During vibration, measurements are taken for each of the six vibration conditions with the transmitter powered by batteries.

Compliance is determined by verifying that the measured peak output power at each test condition is within the specified tolerances as follows:

(1) The measurements taken at room temperature with the input voltage varied +10% and -20% and all of the measurements taken at low temperature, high temperature, and humidity conditions are compared to the measurement taken in paragraph A of this section with the transmitter powered by a power supply.

(2) The measurements taken during vibration testing are compared to the measurement taken in paragraph A with the transmitter powered by batteries.

The tolerances are shown in Appendix C: Transmitter Data Sheets.

C. Maximum peak carrier output power. The peak carrier output power measurement made in paragraph A of this section with the transmitter powered by a power supply is converted from decibels to watts.

Compliance is determined by verifying that the calculated power value in watts does not exceed 1 W.

D. Maximum average carrier output power. This is determined by multiplying the maximum peak carrier output power (in watts) by the transmitter's duty cycle. In cases where the transmitter's output changes when it is in motion, or the pulse width and/or pulsed-carrier repetition rate are switch-selectable, the duty cycle that produced the higher average was used for the final calculation. Duty cycles are derived from the pulsed-carrier repetition rate and pulse width measurements. The maximum average output power is calculated for three test conditions where the input voltage is set to nominal, nominal +10%, and nominal -20%.

Compliance is determined by verifying that all three calculated values do not exceed 30 mW.

E. Carrier frequency variance. The transmitter's antenna output is connected to a frequency counter and the frequency is measured. For room temperature, low temperature, high temperature, and humidity tests, the input voltage is set to nominal, nominal +10%, and nominal -20%. Measurements are taken at all six of the vibration test conditions with the batteries installed.

Compliance is determined by verifying that the measured frequencies are within ±.002% of the nominal frequency.

F. Pulsed-carrier repetition rate variance. The transmitter's antenna output is connected to an oscilloscope and measurements of the repetition rate are made. An initial measurement is made at room temperature with the input voltage set to nominal. The remaining measurements are taken under conditions of room, low, and high temperatures and humidity, with the input voltage set to nominal +10% and nominal -20%. If the transmitter has two motion-dependent transmission modes, initial measurements are made for both modes. The remaining room temperature measurements are made in the mode that produces the higher duty cycle. The measurements made during the environmental tests can be made during either transmission mode. For transmitters with switch-

selectable repetition rates, the shortest repetition rate should be selected; however, if this rate is longer than the rate produced by a transmitter when it is in motion, any switch setting is acceptable.

Compliance is determined by comparing all of the remaining measurements to the initial measurement and verifying that they do not vary from the initial measurement more than specified by the standard. Tolerances are shown in Appendix C: Transmitter Data Sheets.

G. Pulsed-carrier pulse width variance. The pulsed-carrier pulse width shall not vary more than specified by the standard.

Compliance is determined by using the same procedure as in the repetition rate variance. Tolerances are shown in Appendix C: Transmitter Data Sheets.

6. *Transmitter electromagnetic compatibility characteristics*

A. Radiated spurious emissions attenuation. Each transmitter-radiated spurious emission shall be attenuated at least $43 + 10 \log_{10}$ (nominal output power in watts) dB below the field strength of the carrier frequency. The first step is to measure the field strength of the carrier frequency 10 meters from the transmitter using a field strength meter. Then the field strength of any other frequency at which the transmitter is radiating (spurious emission) is measured up to 1,000 MHz or 10 times the carrier frequency, whichever is higher. The attenuation of each spurious emission is calculated by subtracting the field strength of each emission from the field strength of the carrier frequency.

Compliance is determined by verifying that the calculated radiated spurious emissions attenuations are at least $43 + 10 \log_{10}$ (nominal output power in watts) dB.

B. Sideband spectrum attenuation. The output of the transmitter is attached to a spectrum analyzer and the transmitter power supply is adjusted until the carrier frequency is centered on the analyzer display. The reduction in power of the frequencies ±1 KHz and ±2 KHz from the carrier frequency is determined from the display.

Compliance is determined by verifying that the sideband frequencies are attenuated at least as much as specified in the standard. Tolerances are shown in Appendix C: Transmitter Data Sheets.

7. *Transmitter dislodgement characteristic*

The transmitter is attached to an unpainted steel plate and pulled off three times using a force gauge to measure the force required to dislodge the transmitter. Any measurement exceeding 14 kg is recorded as 14 kg. The three measurements are averaged to yield the result.

Compliance is determined by verifying that the average of the three measurements is at least 9 kg.

8. *Transmitter antenna radiation efficiency*

The antenna radiation efficiency shall be at least 10% for Type II transmitters. The efficiency is calculated as follows:

efficiency = $E^2R^2/30P$

where

E = Field strength of the carrier frequency in volts per meter.

R = The distance from the transmitter where the field strength was measured.

P = Transmitter peak output power.

Compliance is determined by verifying that the calculated efficiency is at least 10%.

9. *Transmitter shock stability*

The transmitter shall suffer no more than superficial damage, and no fixed part shall come loose, nor movable part shift in position or adjustment as a result of the shock. With its antenna disconnected, the transmitter is dropped on four or more sides (all sides not having a protusion or antenna connection). It is dropped from a height of 1 meter (3.28 feet) onto a smooth concrete floor while turned off.

Compliance is determined by testing the transmitter after it is dropped to see that it operates, and verifying that any physical damage is superficial.

10. *Transmitter battery service life*

The minimum and maximum battery service life shall meet the requirements set in the standard. Transmitter battery service life is tested at 25, O, and -30 °C (77, 32, and -22 °F) (or the lowest temperature at which the manufacturer states the transmitter will operate, whichever is lower), and 60 °C (140 °F) (or the highest temperature at which the manufacturer states the transmitter will operate, whichever is higher). A spectrum analyzer is connected to the transmitter output and the peak output

power measured 10 minutes after it is turned on. Then the time it takes for the power to decrease by 3 dB from the initial measurement is recorded. This is the minimum battery service life. The time it takes for the power to decrease by 10 dB from the initial measurement is then recorded. This is the maximum battery service life.

Compliance for the maximum service life for all test conditions is determined by verifying that the recorded time does not exceed 10 days. Compliance for the minimum service life for each test condition is determined by verifying that the recorded time is at least the value specified in the standard for that battery type. Minimum service life tolerances are shown in Appendix C: Transmitter Data Sheets.

11. *Receiver performance at environmental extremes*

A. Low-temperature stability. The receiver is placed in a temperature chamber set to -10 °C (14 °F) or the lowest temperature at which the manufacturer states the equipment will operate, whichever is lower. The receiver's direction indication sensitivity, selectivity characteristics, and dynamic range are tested at low temperature.

Compliance with the requirement is determined as described in Section 12, paragraph B, and Sections 13 and 14.

B. High-temperature stability. The receiver is placed in a temperature chamber set to 50 °C (122 °F) or the highest temperature at which the manufacturer states that the equipment will operate properly, whichever is higher. The receiver's direction indication sensitivity, selectivity characteristics, and dynamic range are tested at high temperature.

Compliance with the requirement is determined as described in Section 12, paragraph B, and Sections 13 and 14.

C. Humidity stability. The receiver is placed in a temperature chamber that has been set to 50 °C (122 °F) and at least 85% relative humidity. The receiver's direction indication sensitivity, selectivity characteristics, and dynamic range are tested at the humidity condition.

Compliance with the requirement is determined as described in Section 12, paragraph B, and Sections 13 and 14.

D. Vibration stability. The receiver is placed on a vibration table and vibrated at frequencies between 10 and 30 Hz, and between 30 and 60 Hz, at the amplitudes of 0.38 mm and 0.19 mm respectively, in mutually perpendicular directions, including the vertical. The receiver's direction indication sensitivity and selectivity characteristics are tested during the vibration tests.

Compliance with the requirement is determined as described in Section 12, paragraph B, and Section 13.

12. *Receiver sensitivity characteristics*

A. Direction indication sensitivity. The receiver is connected to a power supply and a signal generator. With the receiver input voltage set to nominal, the signal generator's output amplitude is increased until a direction indication has been achieved equal to 10% of full scale or twice the amplitude of random noise variations, whichever is greater. Next, the input voltage is varied from 11.4 to 14.4 volts, stopping at the voltage that results in minimum deflection of the direction indication device. The signal generator output is readjusted to achieve the 10% deflection. The receiver direction indication sensitivity is the signal generator output (in dB), plus any corrections for signal losses.

Compliance is determined by verifying that the measured value is at least -113 dBm (larger negative numbers being the values in tolerance).

B. Direction indication sensitivity variance. The amount that the direction indication sensitivity varies from the room temperature measurement when tested under conditions of low and high temperatures and humidity shall not exceed +3, -6 dB. When tested during vibration, the variance shall not exceed ±1 dB. Measurements are made as described above.

C. Distance indication sensitivity. The distance indication sensitivity shall be at least -103 dBm.

Compliance is determined by the same procedure as the direction indication sensitivity, with distance indication substituted for direction indication.

13. *Receiver selectivity characteristics*

A. Adjacent-channel attenuation. The adjacent-channel attenuation shall be at least 60 dB. The signal generator frequency is set to a receiver test frequency and the generator power output measured for a receiver direction indication of 10% of full scale. This is repeated for frequencies one channel above and one channel below the receiver test frequency. The attenuation for each adjacent channel is determined by subtracting the power values for the adjacent channels from the test frequency power value. The smallest of these two values is the adjacent-channel attenuation.

Compliance is determined by verifying that the smallest attenuation value is at least 60 dB.

B. Spurious response attenuation. The spurious response attenuation shall be at least 50 dB. The signal generator frequency is set to a receiver test frequency and the generator power output measured for a receiver direction indication of 10%. Next the signal generator frequency is decreased to a value below the receiver's intermediate frequency, and output amplitude is increased by 70 dB. The frequency is increased to 1,000 MHz, stopping at any frequency that causes a change in the direction indication. At these frequencies, the generator output power is measured for a 10% direction indication. Any frequency that is a harmonic of the test frequency is ignored. For each spurious response, the measured power is subtracted from the test frequency power measurement. The smallest of these values is the spurious response attenuation.

Compliance is determined by verifying that the smallest attenuation is at least 50 dB.

14. *Receiver dynamic range characteristics*

The receiver is set to minimum sensitivity. The signal generator is set to a receiver test frequency and adjusted until the largest input signal from which the receiver can produce a reliable direction indication is achieved. The dynamic range is calculated by subtracting the direction indication sensitivity measurement made in Section 12 from the measurement made here. This is done for the room, low, and high temperature, and humidity tests.

Compliance is determined by verifying that the calculated minimum dynamic range is at least 90 dB.

15. *Transmitter/receiver figures of merit*

The figure of merit is calculated by adding the transmitter peak output power in dBm with the input voltage at nominal -20% (Section 5, paragraph A or B above) to the absolute value of the minimum receiver direction indication sensitivity in dBm (Section 11, paragraph A or B above). If there was no reading for either of the devices, no value is calculated.

Compliance is determined by verifying that the calculated value meets the minimum requirement. Tolerances are shown in Appendix E: Transmitter/Receiver Figures of Merit.

Test Results

Tables 2, 3, and 4 summarize the results of the vehicle tracking device test program. Appendixes C through F show the actual results of the testing. When reading the summary tables, be aware that an item in the table may summarize the results of more than one item from the data sheets. For instance, the transmitter user information requirement includes 13 data items. If only one item was not included, the summary table indicates that the user information is not in compliance with the standard. The following paragraphs give a short summary of the results.

1. *User information*

The user information provided for all of the transmitters and receivers was incomplete.

2. *Transmitter no-load characteristic*

All of the transmitters complied with this requirement.

3. *Transmitter load condition*

All of the transmitters complied with this requirement.

4. *Transmitter performance at environmental extremes*

A. Low-temperature stability. None of the transmitters fully complied with this requirement. One transmitter's power output fell by about 50 dB when tested at low temperature.

B. High-temperature stability. Three of the five transmitters fully complied with this requirement.

C. Humidity stability. Three of the transmitters fully complied with this requirement.

D. Vibration stability. Two of the transmitters fully complied with this requirement.

5. *Transmitter radio frequency characteristics*

A. Peak carrier output power. Four transmitters complied with this requirement when powered by a power supply. Only two of the transmitters complied when powered by batteries.

B. Peak carrier output power variance. None of the transmitters complied at all five of the environmental conditions. Three transmitters complied at four of the environmental conditions.

C. Maximum peak carrier output power. All of the transmitters complied with this requirement.

D. Maximum average carrier output power. Only one transmitter complied with this requirement.

E. Carrier frequency variance. One transmitter complied with this requirement under all environmental conditions. One transmitter did not comply under any environmental condition.

F. Pulsed-carrier repetition rate variance. Two transmitters complied under all of the environmental conditions. One transmitter did not comply under any environmental condition.

G. Pulsed-carrier width variance. Two transmitters complied under all environmental conditions. The others complied under three of the four environmental conditions.

6. *Transmitter electromagnetic compatibility characteristics*

A. Radiated spurious emissions attenuation. Two transmitters complied with this requirement.

B. Sideband spectrum attenuation. Four transmitters complied with this requirement.

7. *Transmitter dislodgement characteristic*

Four transmitters complied with this requirement.

8. *Transmitter antenna radiation efficiency*

Three transmitters complied with this requirement. This requirement is not applicable to one of the transmitters.

9. *Transmitter shock stability*

Four transmitters complied with this requirement. Only one transmitter did not operate after this test.

10. *Transmitter battery service life test*

Three transmitters fully complied with the minimum service life requirement. The minimum service life requirement is not applicable to one of the transmitters because the standard does not cover lithium batteries. Two transmitters fully complied with the maximum service life requirement. Two transmitters did not comply under any environmental conditions.

11. *Receiver performance at environmental extremes*

A. Low-temperature stability. Two receivers fully complied with this requirement.

B. High-temperature stability. One receiver fully complied with this requirement. One receiver did not have an output when tested at high temperature.

C. Humidity stability. One receiver fully complied with this requirement. One receiver did not have an output when tested during the humidity test.

D. Vibration stability. One receiver fully complied with this requirement.

12. *Receiver sensitivity characteristics*

A. Direction indication sensitivity. All of the receivers complied with this requirement.

B. Direction indication sensitivity variance. None of the receivers fully complied with this requirement. One receiver complied during three of the four environmental tests.

C. Distance indication sensitivity. All receivers complied with this requirement.

13. *Receiver selectivity characteristics*

A. Adjacent-channel attenuation. Two receivers fully complied with this requirement under all of the environmental conditions. One receiver did not comply under any of the environmental conditions.

B. Spurious response attenuation. Three receivers fully complied with this requirement.

14. *Receiver dynamic range characteristics*

Only one receiver complied under all four of the environmental conditions.

15. *Transmitter/receiver figures of merit*

Two of the six transmitter/receiver systems complied for the four environmental conditions.

Table 2

SUMMARY OF TRANSMITTER TEST RESULTS

Characteristic	Model HDS BT–175	HDS BT–180	OAR VB–342	AID TX–602A	METS M7047
User information	N	N	N	N	N
Transmitter no-load characteristic	C	C	C	C	C
Transmitter load condition	C	C	C	C	C
Radio frequency carrier characteristics					
Peak carrier output power					
Power supply	C	C	C	C	N
Batteries	C	N	C	N	N
Peak carrier output power variance					
Room temperature	N	N	C	C	C
Low temperature	C	N	C	N	N
High temperature	C	N	C	C	C
Humidity	C	C	C	C	C
Vibration	C	C	N	N	C
Maximum peak carrier output power	C	C	C	C	C
Maximum average carrier output power	N	N	N	N	C
Carrier frequency variance					
Room temperature	C	N	N	N	C
Low temperature	N	N	N	N	C
High temperature	C	N	N	C	C
Humidity	C	N	N	C	C
Vibration	C	N	C	C	C
Pulsed-carrier repetition rate variance					
Room temperature	C	N	N	C	C
Low temperature	C	C	N	N	C
High temperature	C	C	N	C	C
Humidity	C	C	N	C	C
Pulsed-carrier pulse width variance					
Room temperature	C	C	N	C	C
Low temperature	C	C	C	N	N
High temperature	C	C	C	C	C
Humidity	C	C	C	C	C
Electromagnetic compatibility characteristics					
Radiated spurious emissions attenuation	N	N	C	N	C
Sideband spectrum attenuation					
±1 KHz	N	C	C	C	C
±2 KHz	N	C	C	C	C
Dislodgement characteristic	C	C	C	C	N
Antenna radiation efficiency	C	C	N	C	NA

Table 2

TRANSMITTER TEST RESULTS *(Continued)*

Characteristic	Model HDS BT–175	HDS BT–180	OAR VB–342	AID TX–602A	METS M7047
Shock stability	N	C	C	C	C
Battery service life					
Minimum service life					
25 °C	C	C	C	C	NA
0 °C	C	C	C	N	NA
-30 °C	C	C	C	N	NA
60 °C	C[1]	C	C	C	NA
Maximum service life					
25 °C	N	C	C	N	N
0 °C	N	C	C	N	N
-30 °C	I	C	C	N	N
60 °C	N[1]	C	C	N	N

Notes:

1. Test conducted at 70 °C for the BT–175.

C = Complies with the requirements of the standard.
I = Inconclusive (see data sheet for explanation).
N = Does not comply with the requirements of the standard.
NA = Not applicable.

Table 3

SUMMARY OF RECEIVER TEST RESULTS

Characteristics	Model			
	OAR 347ED	AID RX-360	AID RX-890B	METS M7101
User information	N	N	N	N
Sensitivity characteristics				
Direction indication sensitivity	C	C	C	C
Direction indication sensitivity variance				
Low temperature	C	N	C	C
High temperature	C	C	N	N
Humidity	C	N	N	C
Vibration	N	C	N	N
Distance indication sensitivity	C	C	C	C
Selectivity characteristics				
Adjacent-channel attenuation				
Room temperature	N	C	C	C
Low temperature	N	C	C	C
High temperature	N	C	N	C
Humidity	N	C	N	C
Vibration	N	C	C	C
Spurious response attenuation				
Room temperature	C	C	C	C
Low temperature	C	C	C	C
High temperature	C	C	N	C
Humidity	C	C	N	C
Vibration	C	C	C	C
Dynamic range characteristics				
Minimum dynamic range				
Room temperature	C	C	C	C
Low temperature	N	C	C	C
High temperature	C	C	N	C
Humidity	C	N	N	C

C= Complies with the requirements of the standard.
N= Does not comply with the requirements of the standard.

Table 4

SUMMARY OF TRANSMITTER/RECEIVER FIGURES OF MERIT

		Test environment			
		Room temperature	Low temperature	High temperature	Humidity
Transmitter Model No.	**Receiver Model No.**				
AID TX–602A	AID RX–360	C	N	C	C
AID TX–602A	AID RX–890B	C	N	N	N
HDS BT–175	OAR 347ED	C	C	C	C
HDS BT–180	OAR 347ED	N	C	N	C
OAR VB–342	OAR 347ED	N	C	C	C
METS M7047	METS M7101	C	C	C	C

C = Complies with the requirements of the standard.
N = Does not comply with the requirements of the standard.

Appendix A: Commentary—NIJ Standard-0223.00

Vehicle Tracking Devices: NIJ Standard-0223.00, May 1986, establishes minimum performance requirements for vehicle tracking transmitters and receivers. Each requirement of the standard is discussed in this appendix in terms of the purpose of the requirement. Some of the characteristics specified in the standard are Federal Communications Commission (FCC) requirements. Others were derived from laboratory testing of typical vehicle tracking devices offered to the law enforcement community.

1. *User information*

The items listed in the user information section include those nominal values necessary to make the required measurements and those helpful in the selection of equipment most suitable for the particular weather and electromagnetic environment to be encountered. They are also used to enable test personnel to design matching impedance networks, if necessary, and provide critical labeling as to operating frequencies and the transmitter/battery interface.

2. *Transmitter no-load characteristic*

With the transmitter antenna disconnected, the transmitter shall operate for at least 1 minute without any performance degradation. Operation of a transmitter with its output load (antenna) disconnected may damage the circuitry providing power to the antenna. Damage to this circuitry with the antenna disconnected for 1 minute could indicate either poor design or poor construction.

3. *Transmitter load condition*

When tested under two different load conditions, the transmitter output shall remain unconditionally stable and not change from a pulsed-carrier to a continuous wave output. If the output were to change, the ability to determine the distance to the transmitter would be lost. This criterion was determined during laboratory testing.

4. *Transmitter performance at environmental extremes*

The ability of the transmitter to operate in environmental extremes shall be tested at low temperature, high temperature, humidity, and vibration. When the transmitter is in use, it will be subjected to a wide range of environmental conditions. The ability of the transmitter to operate well in these environments could be critical to the success of any surveillance operation.

5. *Transmitter radio frequency carrier characteristics*

A. Peak carrier output power. With the transmitter input voltage at the nominal value and the transmitter at room temperature, the peak output power shall be within ±1 dB of its nominal value. This allows the peak output power of the transmitted pulses to increase as much as 26% or decrease as much as 20% from the manufacturer's stated output power. Failure of the transmitter to maintain its proper output could indicate poor design or poor construction.

B. Peak carrier output power variance. The peak carrier output power, when the transmitter is at room temperature with the input voltage varied +10% and -20%, and when the transmitter is tested at the environmental extremes, shall not vary more than allowed by the standard. Failure of a transmitter to maintain its output power within the tolerances set in the standard could affect the reliable operation of the transmitter. It would also affect the distance over which the transmitter could effectively transmit.

C. Maximum peak carrier output power. The maximum peak carrier output power shall not exceed 1 W. This is an FCC requirement.

D. Maximum average carrier output power. The maximum average carrier output power shall not exceed 30 mW. This is an FCC requirement.

E. Carrier frequency variance. The transmitter's carrier frequency shall not vary more than ±.002% from the nominal carrier frequency. This is an FCC requirement. Failure of a transmitter's frequency to remain within this tolerance could affect the ability of the receiver to detect the transmitter. The stringency of the requirement is meant to prevent interference with other units operating on adjacent channels.

F. Pulsed-carrier repetition rate variance. The pulsed-carrier repetition rate shall not vary more than ±5% at

room temperature or ±10% at the environmental extremes. The transmitter sends a pulse or series of pulses followed by a period of little or no output. It is this pattern of pulses and little or no output that the receiver must detect and recognize. The instability of this pattern could provide inaccurate range indications.

G. Pulsed-carrier pulse width variance. The pulsed-carrier pulse width shall not vary more than ±5% at room temperature or ±10% at the environmental extremes. This requirement is included to ensure that the receiver continues to receive and recognize signals from its companion transmitter.

6. *Transmitter electromagnetic compatibility characteristics*

A. Radiated spurious emissions attenuation. Each radiated spurious emission shall be attenuated at least 43 + 10 $\log_{10}$ (nominal output power in watts) dB below the field strength of the carrier frequency. This is an FCC requirement and prevents interference with other equipment.

B. Sideband spectrum attenuation. The minimum attenuation of the sideband frequencies shall be as follows:

(1) The ±1 kHz frequencies shall be attenuated 25 dB for Type I transmitters and 30 dB for Type II transmitters.

(2) The ±2 KHz frequencies shall be attenuated 50 dB for Type I transmitters and 60 dB for Type II transmitters.

These are FCC requirements that state the carrier shall have no modulation applied to carry information and that its occupied bandwidth shall not exceed 2 kHz.

7. *Transmitter dislodgement characteristic*

The average force required to pull a transmitter from an unpainted steel plate shall be at least 9 kg. Failure of a transmitter to meet this criterion increases the likelihood that the transmitter would fall off a vehicle.

8. *Transmitter antenna radiation efficiency*

The antenna radiation efficiency shall be at least 10% for Type II transmitters. This calculation determines the effectiveness of the antenna to radiate the power delivered to it by the transmitter. If the calculated efficiency does not meet this criterion, the effective range of the transmitter could be limited.

9. *Transmitter shock stability*

When tested in accordance with the standard, the transmitter will suffer no more than superficial damage and no fixed part shall come loose, nor movable part shift in position or adjustment as a result of the shock. The failure of a transmitter to operate after mishandling or dislodgement from a vehicle could delay or end a surveillance operation.

10. *Transmitter battery service life*

The minimum and maximum battery service life shall meet the requirements set in the standard. The minimum battery service life requirement is necessary to ensure a suitable operating life for each transmitter and the maximum battery service life limit of 10 days is imposed by the FCC.

11. *Receiver performance at environmental extremes*

The ability of the receiver to operate in environmental extremes shall be determined using the test methods described in the standard. The receiver will be tested under conditions of low temperature, high temperature, humidity, and vibration. When the receiver is in use, it can be subjected to a wide range of environmental conditions. The ability of the receiver to operate well in these environments could be critical to the success of any surveillance operation.

12. *Receiver sensitivity characteristics*

A. Direction indication sensitivity. The receiver direction indication sensitivity shall be at least -113 dBm. This is a measurement of the weakest signal from which the receiver can give a reliable direction indication. This criterion was determined during laboratory testing.

B. Direction indication sensitivity variance. The amount that the direction indication sensitivity varies from the room temperature measurement when tested under environmental extremes shall not exceed +3, -6 dB. This limit is specified to prevent the performance of the receiver from varying too greatly under these types of conditions.

C. Distance indication sensitivity. The distance indication sensitivity shall be at least -103 dBm. This is a measurement of the weakest signal from which the receiver can give a reliable distance indication. This criterion was determined during laboratory testing.

13. *Receiver selectivity characteristics*

A. Adjacent-channel attenuation. The adjacent-channel attenuation shall be at least 60 dB. The failure of a receiver to meet this criterion increases the probability of the receiver giving false indications or not operating correctly due to interference from signals emanating from transmitters operating on frequencies close to the frequency used by the receiver. It can also degrade the accuracy of the information received and displayed by the system.

B. Spurious response attenuation. The spurious response attenuation shall be at least 50 dB. The failure of a receiver to meet this criterion increases the probability of the receiver giving false indications and degrading the accuracy of the information received and utilized by the system. This criterion was determined during laboratory testing.

14. *Receiver dynamic range characteristics*

The receiver dynamic range shall be at least 90 dB. This reading shows the range of signal strengths from which the receiver can produce reliable indications. Failure to meet this criterion would reduce the ability of the receiver to operate with various transmitters.

15. *Transmitter/receiver figures of merit*

The transmitter/receiver figures of merit shall be at least 140 dBm for room temperature and 130 dBm for environmental extremes. This requirement has been specified to ensure that, in addition to the transmitter and receiver operating up to specifications individually, they also work efficiently together as components of a vehicle tracking device system.

Appendix B: Testing Program Procedures

The National Institute of Justice (NIJ) Technology Assessment Program Advisory Council was originally established to recommend research priorities consistent with the "real time" needs of the law enforcement community. Based on the recommendations of the Advisory Council, NIJ subsequently established an equipment testing program to evaluate equipment in accordance with the performance standards that NIJ issues for voluntary national use and to publish the test results in an NIJ *Equipment Performance Report*.

Each year, the Advisory Council gives NIJ its recommendations for testing equipment. The recommendations are given in priority order according to overall interest and importance to State and local law enforcement agencies. Funding considerations normally limit the scope of testing programs to two items of equipment, which NIJ selects from the Advisory Council recommendations.

The testing program is complex, involving NIJ, the Technology Assessment Program Information Center (TAPIC), the National Institute of Standards and Technology (NIST), and independent testing laboratories. The testing program provides valid, unbiased test results that assist law enforcement agencies in selecting and procuring equipment suitable for their needs. Moreover, the program is structured so that manufacturers can continue to have their products tested according to the NIJ standard and the results disseminated to users as new products are tested.

Following the decision to test an item of equipment, TAPIC and the Law Enforcement Standards Laboratory (LESL) of NIST identify manufacturers and models of equipment that are available. The TAPIC staff then invite the manufacturers to participate in the program. When TAPIC knows the number of models to be tested, LESL and NIJ assist TAPIC in developing a Request For Proposal (RFP) to solicit bids from independent testing laboratories. The National Voluntary Laboratory Accreditation Program (NVLAP) staff at NIST develop a laboratory questionnaire to initially evaluate the testing laboratory capabilities, which is used as part of the RFP. A laboratory that is biased toward a manufacturer or derives a major portion of its income from such a manufacturer is prohibited from bidding on testing.

TAPIC normally seeks to award contracts to two independent testing laboratories, one east and one west of the Mississippi River. For the testing of vehicle tracking devices, only a single testing contract was awarded—to Underwriters Laboratories in Northbrook, Illinois.

When the responses to the RFP are received, LESL, TAPIC, and NVLAP staff evaluate each proposal independently and score it according to the scoring criteria specified in the RFP. A final score is then established, and TAPIC recommends to NIJ the laboratory with the highest score for contract award.

A laboratory awarded a contract is required to demonstrate its competence and ability to properly conduct tests in accordance with the NIJ standard. This is accomplished through an onsite inspection by representatives of TAPIC, LESL, and the NVLAP staff. During the inspection, a single item of equipment is tested, and the staff evaluate all the factors associated with laboratory competence. Once the laboratory has been found fully capable of conducting tests in accordance with the NIJ standard, and its test report found adequate, it becomes a TAPIC-approved independent laboratory for future tests of that item. Should the laboratory not be competent, it is eliminated from the program and another laboratory is awarded a contract and subjected to full evaluation.

The approved laboratory is authorized to proceed with the remaining or "main quantity" testing. Representatives of TAPIC, LESL, and NVLAP may periodically visit the laboratory during the final testing.

After TAPIC has received the final test reports, LESL and TAPIC staff analyze and interpret the results to ensure accuracy and validity. Data are reviewed with the laboratories to resolve any ambiguities prior to preparation of the *Equipment Performance Report*.

Manufacturers are encouraged to test additional items of equipment after the *Equipment Performance Report* is published. Such testing must be accomplished according to NIJ standards, by a TAPIC-approved laboratory, and subject to TAPIC administrative controls. TAPIC issues supplements to the *Equipment Performance Report* after new equipment is tested.

Appendix C: Transmitter Data Sheets

TRANSMITTER DATA SHEET
HDS BT–175

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Transmitter no-load characteristic	No performance degradation	No degradation
Transmitter load condition	Output does not change	Did not change
Radio frequency carrier characteristics		
Peak carrier output power		
Power supply	30 ±1 dBm	29 dBm
Batteries[1]	30 ±1 dBm	29 dBm
Peak carrier output power variance		
Room temperature		
Nominal voltage +10%	29 +1.5, -3 dB	31 dB*
Nominal voltage -20%	29 +1.5, -3 dB	29 dB
Low temperature		
Nominal voltage	29 ±3 dB	30 dB
Nominal voltage +10%	29 +3, -6 dB	31 dB
Nominal voltage -20%	29 +3, -6 dB	29 dB
High temperature		
Nominal voltage	29 ±3 dB	30 dB
Nominal voltage +10%	29 +3, -6 dB	31 dB
Nominal voltage -20%	29 +3, -6 dB	29 dB
Humidity		
Nominal voltage	29 ±3 dB	31 dB
Nominal voltage +10%	29 +3, -6 dB	31 dB
Nominal voltage -20%	29 +3, -6 dB	29 dB
Vibration		
0.38 mm x direction	29 ±1 dB	30 dB
0.38 mm y direction	29 ±1 dB	30 dB
0.38 mm z direction	29 ±1 dB	30 dB
0.19 mm x direction	29 ±1 dB	30 dB
0.19 mm y direction	29 ±1 dB	30 dB
0.19 mm z direction	29 ±1 dB	30 dB

* Not in compliance with the standard.

Model: HDS BT–175 *(Continued)*

Characteristic	Requirement	Result
Maximum peak carrier output power	1 W maximum	0.79 W
Maximum average carrier output power		
Nominal voltage	30 mW maximum	48.4 mW*
Nominal voltage +10%	30 mW maximum	76.5 mW*
Nominal voltage -20%	30 mW maximum	47.4 mW*
Carrier frequency variance		
Room temperature		
Nominal voltage	170.1 MHz ±0.002%	170.0995 MHz
Nominal voltage +10%	170.1 MHz ±0.002%	170.0997 MHz
Nominal voltage -20%	170.1 MHz ±0.002%	170.0995 MHz
Low temperature		
Nominal voltage	170.1 MHz ±0.002%	170.0931 MHz*
Nominal voltage +10%	170.1 MHz ±0.002%	170.0908 MHz*
Nominal voltage -20%	170.1 MHz ±0.002%	170.0936 MHz*
High temperature		
Nominal voltage	170.1 MHz ±0.002%	170.0991 MHz
Nominal voltage +10%	170.1 MHz ±0.002%	170.0990 MHz
Nominal voltage -20%	170.1 MHz ±0.002%	170.0989 MHz
Humidity		
Nominal voltage	170.1 MHz ±0.002%	170.0987 MHz
Nominal voltage +10%	170.1 MHz ±0.002%	170.0988 MHz
Nominal voltage -20%	170.1 MHz ±0.002%	170.0987 MHz
Vibration		
0.38 mm x direction	170.1 MHz ±0.002%	170.0998 MHz
0.38 mm y direction	170.1 MHz ±0.002%	170.0997 MHz
0.38 mm z direction	170.1 MHz ±0.002%	170.0996 MHz
0.19 mm x direction	170.1 MHz ±0.002%	170.0998 MHz
0.19 mm y direction	170.1 MHz ±0.002%	170.0998 MHz
0.19 mm z direction	170.1 MHz ±0.002%	170.0998 MHz
Pulsed-carrier repetition rate variance		
Room temperature		
Nominal voltage (measurement 1)[2]	—	7.2331 s
Nominal voltage (measurement 2)	—	821.6 ms
Nominal voltage +10%	821.6 ms ±5%	822 ms
Nominal voltage -20%	821.6 ms ±5%	824.5 ms
Low temperature		
Nominal voltage +10%	7.2331 s ±10%	7.5066 s
Nominal voltage -20%	7.2331 s ±10%	7.6586 s

* Not in compliance with the standard.

Model: HDS BT–175 *(Continued)*

Characteristic	Requirement	Result
High temperature		
Nominal voltage +10%	7.2331 s ±10%	7.2812 s
Nominal voltage -20%	7.2331 s ±10%	7.5043 s
Humidity		
Nominal voltage +10%	7.2331 s ±10%	7.3694 s
Nominal voltage -20%	7.2331 s ±10%	7.563 s
Pulsed-carrier pulse width variance		
Room temperature		
Nominal voltage (measurement 1)[3]	—	90 ms
Nominal voltage (measurement 2)	—	12.5 ms
Nominal voltage +10%	12.5 ms ±5%	12.5 ms
Nominal voltage -20%	12.5 ms ±5%	12.3 ms
Low temperature		
Nominal voltage +10%	90 ms ±10%	91 ms
Nominal voltage -20%	90 ms ±10%	95 ms
High temperature		
Nominal voltage +10%	90 ms ±10%	90 ms
Nominal voltage -20%	90 ms ±10%	92 ms
Humidity		
Nominal voltage +10%	90 ms ±10%	90 ms
Nominal voltage -20%	90 ms ±10%	92 ms
Electromagnetic compatibility characteristics		
Radiated spurious emissions attenuation		
127.7 MHz	43 dB minimum	41.9 dB*
340.5 MHz	43 dB minimum	50 dB
Sideband spectrum attenuation		
Carrier frequency -1 kHz	30 dB minimum	22.3 dB*
Carrier frequency +1 kHz	30 dB minimum	26.5 dB*
Carrier frequency -2 kHz	60 dB minimum	28.5 dB*
Carrier frequency +2 kHz	60 dB minimum	40 dB*
Dislodgement characteristic	9 kg (19.8 lb) minimum	14 kg
Antenna radiation efficiency	10% minimum	19.2%
Shock stability	No more than superficial damage	Transmitter inoperative*

* Not in compliance with the standard.

Model: HDS BT–175 *(Continued)*

Characteristic	Requirement	Result
Battery service life[1]		
Minimum service life		
25 °C	30 hours	47 hours
0 °C	15 hours	4.5 days
-30 °C	3 hours	1 day
70 °C	36 hours	13 days
Maximum service life		
25 °C	10 days	14 days*
0 °C	10 days	12 days*
-30 °C	10 days	Inconclusive[4]
70 °C	10 days	13 days*

Notes:

1. Four 9-volt alkaline batteries.

2. The BT–175 has two transmit modes, the stationary mode with selectable pulse-train repetition rates of 1.8, 3.6, 7.2, and 14.4 s, and the motion mode with a pulse-train repetition rate of 821.6 ms.

3. The BT–175 has a pulse-train width of 90 ms and an individual pulse width of 12.5 ms. The pulse-train consists of four pulses each separated by about 13 ms.

4. The data collected for this test are not detailed enough to show whether or not the unit passed this test.

* Not in compliance with the standard.

Appendix C *(Continued)*

TRANSMITTER DATA SHEET
HDS BT–180

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Transmitter no-load characteristic	No performance degradation	No degradation
Transmitter load condition	Output does not change	Did not change
Radio frequency carrier characteristics		
Peak carrier output power		
Power supply	30 ±1 dBm	30 dBm
Batteries[1]	30 ±1 dBm	24 dBm*
Peak carrier output power variance		
Room temperature		
Nominal voltage +10%	30 +1.5, -3 dB	31 dB
Nominal voltage -20%	30 +1.5, -3 dB	24 dB*
Low temperature		
Nominal voltage	30 ±3 dB	29 dB
Nominal voltage +10%	30 +3, -6 dB	31 dB
Nominal voltage -20%	30 +3, -6 dB	23 dB*
High temperature		
Nominal voltage	30 ±3 dB	14 dB*
Nominal voltage +10%	30 +3, -6 dB	14 dB*
Nominal voltage -20%	30 +3, -6 dB	10 dB*
Humidity		
Nominal voltage	30 ±3 dB	30 dB
Nominal voltage +10%	30 +3, -6 dB	32 dB
Nominal voltage -20%	30 +3, -6 dB	26 dB
Vibration		
0.38 mm x direction	24 ±1 dB	24 dB
0.38 mm y direction	24 ±1 dB	24 dB
0.38 mm z direction	24 ±1 dB	24 dB
0.19 mm x direction	24 ±1 dB	24 dB
0.19 mm y direction	24 ±1 dB	24 dB
0.19 mm z direction	24 ±1 dB	24 dB
Maximum peak carrier output power	1 W maximum	1 W
Maximum average carrier output power		
Nominal voltage	30 mW maximum	270 mW*

* Not in compliance with the standard.

Model: HDS BT–180 *(Continued)*

Characteristic	Requirement	Result
Nominal voltage +10%	30 mW maximum	340 mW*
Nominal voltage -20%	30 mW maximum	54 mW*
Carrier frequency variance		
Room temperature		
Nominal voltage	174.38 MHz ±0.002%	174.3424 MHz*
Nominal voltage +10%	174.38 MHz ±0.002%	174.3428 MHz*
Nominal voltage -20%	174.38 MHz ±0.002%	174.352 MHz*
Low temperature		
Nominal voltage	174.38 MHz ±0.002%	174.3021 MHz*
Nominal voltage +10%	174.38 MHz ±0.002%	174.2927 MHz*
Nominal voltage -20%	174.38 MHz ±0.002%	174.2608 MHz*
High temperature		
Nominal voltage	174.38 MHz ±0.002%	174.3714 MHz*
Nominal voltage +10%	174.38 MHz ±0.002%	174.3714 MHz*
Nominal voltage -20%	174.38 MHz ±0.002%	174.3713 MHz*
Humidity		
Nominal voltage	174.38 MHz ±0.002%	174.3704 MHz*
Nominal voltage +10%	174.38 MHz ±0.002%	174.3704 MHz*
Nominal voltage -20%	174.38 MHz ±0.002%	174.3703 MHz*
Vibration		
0.38 mm x direction	174.38 MHz ±0.002%	174.3713 MHz*
0.38 mm y direction	174.38 MHz ±0.002%	174.3713 MHz*
0.38 mm z direction	174.38 MHz ±0.002%	174.3712 MHz*
0.19 mm x direction	174.38 MHz ±0.002%	174.3712 MHz*
0.19 mm y direction	174.38 MHz ±0.002%	174.3712 MHz*
0.19 mm z direction	174.38 MHz ±0.002%	174.3712 MHz*
Pulsed-carrier repetition rate variance		
Room temperature		
Nominal voltage (measurement 1)[2]	—	6.0002 s
Nominal voltage (measurement 2)	—	2.0001 s
Nominal voltage +10%	2.0001 s ±5%	2.0001 s
Nominal voltage -20%	2.0001 s ±5%	2.4521 s*
Low temperature		
Nominal voltage +10%	6.0002 s ±10%	6.0007 s
Nominal voltage -20%	6.0002 s ±10%	6.0008 s
High temperature		
Nominal voltage +10%	6.0002 s ±10%	6.0002 s
Nominal voltage -20%	6.0002 s ±10%	6.0002 s

* Not in compliance with the standard.

Model: HDS BT–180 *(Continued)*

Characteristic	Requirement	Result
Humidity		
Nominal voltage +10%	6.0002 s ±10%	6.0001 s
Nominal voltage -20%	6.0002 s ±10%	6.0001 s
Pulsed-carrier pulse width variance		
Room temperature		
Nominal voltage (measurement 1)[3]	—	116 ms
Nominal voltage (measurement 2)	—	540 ms
Nominal voltage +10%	540 ms ±5%	540 ms
Nominal voltage -20%	540 ms ±5%	530 ms
Low temperature		
Nominal voltage +10%	116 ms ±10%	110 ms
Nominal voltage -20%	116 ms ±10%	110 ms
High temperature		
Nominal voltage +10%	116 ms ±10%	115 ms
Nominal voltage -20%	116 ms ±10%	115 ms
Humidity		
Nominal voltage +10%	116 ms ±10%	116 ms
Nominal voltage -20%	116 ms ±10%	116 ms
Electromagnetic compatibility characteristics		
Radiated spurious emissions attenuation		
196.23 MHz	43 dB minimum	53.9 dB
218.11 MHz	43 dB minimum	63.9 dB
348.87 MHz	43 dB minimum	66.4 dB
523.27 MHz	43 dB minimum	59 dB
22.14 MHz	43 dB minimum	31.6 dB*
23.68 MHz	43 dB minimum	74.9 dB
Sideband spectrum attenuation		
Carrier frequency -1 kHz	30 dB minimum	43.6 dB
Carrier frequency +1 kHz	30 dB minimum	43.7 dB
Carrier frequency -2 kHz	60 dB minimum	69 dB
Carrier frequency +2 kHz	60 dB minimum	71 dB
Dislodgement characteristic	9 kg (19.8 lb) minimum	13.9 kg
Antenna radiation efficiency	10% minimum	13.3%
Shock stability	No more than superficial damage	One broken screw —transmitter operated normally

* Not in compliance with the standard.

Model: HDS BT–180 *(Continued)*

Characteristic	Requirement	Result
Minimum service life		
25 °C	60 hours	7 days
0 °C	12 hours	2 days
-30 °C	NA	1 day
60 °C	60 hours	8 days
Maximum service life		
25 °C	10 days	9 days
0 °C	10 days	3 days
-30 °C	10 days	28 hours
60 °C	10 days	10 days

Notes:

1. Two type TR134 mercury batteries.

2. The BT–180 has two transmit modes; the stationary mode with a repetition rate of 6 seconds and the motion mode with a repetition rate of 2 seconds.

3. The pulse width can be set by a switch and pulse widths of 500, 250, and 150 ms are selectable. The longest and shortest widths were selected for testing.

Appendix C *(Continued)*

TRANSMITTER DATA SHEET
OAR VB–342

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Transmitter no-load characteristic	No performance degradation	No degradation
Transmitter load condition	Output does not change	Did not change
Radio frequency carrier characteristics		
Peak carrier output power		
Power supply	27 ±1 dBm	28 dBm
Batteries[1]	27 ±1 dBm	27 dBm
Peak carrier output power variance		
Room temperature		
Nominal voltage +10%	28 +1.5, -3 dB	28 dB
Nominal voltage -20%	28 +1.5, -3 dB	25 dB
Low temperature		
Nominal voltage	28 ±3 dB	27 dB
Nominal voltage +10%	28 +3, -6 dB	30 dB
Nominal voltage -20%	28 +3, -6 dB	22 dB
High temperature		
Nominal voltage	28 ±3 dB	28 dB
Nominal voltage +10%	28 +3, -6 dB	30 dB
Nominal voltage -20%	28 +3, -6 dB	22 dB
Humidity		
Nominal voltage	28 ±3 dB	28 dB
Nominal voltage +10%	28 +3, -6 dB	30 dB
Nominal voltage -20%	28 +3, -6 dB	25 dB
Vibration		
0.38 mm x direction	27 ±1 dB	28 dB
0.38 mm y direction	27 ±1 dB	29 dB*
0.38 mm z direction	27 ±1 dB	26 dB
0.19 mm x direction	27 ±1 dB	28 dB
0.19 mm y direction	27 ±1 dB	29 dB*
0.19 mm z direction	27 ±1 dB	27 dB
Maximum peak carrier output power	1 W maximum	0.63 W

* Not in compliance with the standard.

Model: OAR VB–342 *(Continued)*

Characteristic	Requirement	Result
Maximum average carrier output power		
Nominal voltage	30 mW maximum	29.47 mW
Nominal voltage +10%	30 mW maximum	30.1 mW*
Nominal voltage -20%	30 mW maximum	NR[2]*
Carrier frequency variance		
Room temperature		
Nominal voltage	143.666 MHz ±0.002%	143.666 MHz
Nominal voltage +10%	143.666 MHz ±0.002%	143.6661 MHz
Nominal voltage -20%	143.666 MHz ±0.002%	NR[2]*
Low temperature		
Nominal voltage	143.666 MHz ±0.002%	143.6665 MHz
Nominal voltage +10%	143.666 MHz ±0.002%	143.6665 MHz
Nominal voltage -20%	143.666 MHz ±0.002%	NR[2]*
High temperature		
Nominal voltage	143.666 MHz ±0.002%	143.6646 MHz
Nominal voltage +10%	143.666 MHz ±0.002%	143.6651 MHz
Nominal voltage -20%	143.666 MHz ±0.002%	NR[2]*
Humidity		
Nominal voltage	143.666 MHz ±0.002%	143.6648 MHz
Nominal voltage +10%	143.666 MHz ±0.002%	143.6651 MHz
Nominal voltage -20%	143.666 MHz ±0.002%	NR[2]*
Vibration		
0.38 mm x direction	143.666 MHz ±0.002%	143.6647 MHz
0.38 mm y direction	143.666 MHz ±0.002%	143.6647 MHz
0.38 mm z direction	143.666 MHz ±0.002%	143.6646 MHz
0.19 mm x direction	143.666 MHz ±0.002%	143.6659 MHz
0.19 mm y direction	143.666 MHz ±0.002%	143.6651 MHz
0.19 mm z direction	143.666 MHz ±0.002%	143.6649 MHz
Pulsed-carrier repetition rate variance		
Room temperature		
Nominal voltage (measurement 1)[3]	—	4.604 s
Nominal voltage (measurement 2)	NA	NA
Nominal voltage +10%	4.604 s ±5%	4.608 s
Nominal voltage -20%	4.604 s ±5%	NR[2]*
Low temperature		
Nominal voltage +10%	4.604 s ±10%	4.953 s
Nominal voltage -20%	4.604 s ±10%	NR[2]*
High temperature		
Nominal voltage +10%	4.604 s ±10%	4.629 s
Nominal voltage -20%	4.604 s ±10%	NR[2]*

* Not in compliance with the standard.

Model: OAR VFI–342 *(Continued)*

Characteristic	Requirement	Result
Humidity		
Nominal voltage +10%	4.604 s ±10%	4.672 s
Nominal voltage -20%	4.604 s ±10%	NR[2]*
Pulsed-carrier pulse width variance		
Room temperature		
Nominal voltage (measurement 1)[4]	—	215 ms
Nominal voltage (measurement 2)	NA	NA
Nominal voltage +10%	215 ms ±5%	220 ms
Nominal voltage -20%	215 ms ±5%	230 ms*
Low temperature		
Nominal voltage +10%	215 ms ±10%	215 ms
Nominal voltage -20%	215 ms ±10%	225 ms
High temperature		
Nominal voltage +10%	215 ms ±10%	215 ms
Nominal voltage -20%	215 ms ±10%	225 ms
Humidity		
Nominal voltage +10%	215 ms ±10%	215 ms
Nominal voltage -20%	215 ms ±10%	225 ms
Electromagnetic compatibility characteristics		
Radiated spurious emissions attenuation		
71.8 MHz	39.9 dB minimum	55.8 dB
933.834 MHz	39.9 dB minimum	54.2 dB
Sideband spectrum attenuation		
Carrier frequency -1 kHz	30 dB minimum	43.1 dB
Carrier frequency +1 kHz	30 dB minimum	43.8 dB
Carrier frequency -2 kHz	60 dB minimum	72.3 dB
Carrier frequency +2 kHz	60 dB minimum	69.8 dB
Dislodgement characteristic	9 kg (19.8 lb) minimum	13.9 kg
Antenna radiation efficiency[5]	10% minimum	6.65%*
Shock stability	No more than superficial damage	Some screws loosened, transmitter operative
Battery service life[1]		
Minimum service life		
25°C	30 hours	3 days
0°C	15 hours	16 hours

* Not in compliance with the standard.

Model: OAR VB–342 *(Continued)*

Characteristic	Requirement	Result
Minimum service life		
-30 °C	3 hours	3.5 hours
60 °C	36 hours	4 days
Maximum service life		
25 °C	10 days	4 days
0 °C	10 days	2 days
-30 °C	10 days	1 day
60 °C	10 days	8 days

Notes:

1. Four type 1604 alkaline batteries.

2. No reading—the output was distorted and widened at this input voltage. Frequency and pulse repetition rates were not measurable.

3. The repetition rate does not change when the transmitter is in motion.

4. The pulse width does not change when the transmitter is in motion.

5. The requirement of the 150–174 MHz range was used, even though the frequency is approximately 6.5 MHz less than the lower limit of this range.

Appendix C *(Continued)*

TRANSMITTER DATA SHEET
AID TX–602A

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Transmitter no-load characteristic	No performance degradation	No degradation
Transmitter load condition	Output does not change	Did not change
Radio frequency carrier characteristics		
Peak carrier output power		
Power supply	30 ±1 dBm	29 dBm
Batteries[1]	30 ±1 dBm	28 dBm*
Peak carrier output power variance		
Room temperature		
Nominal voltage +10%	29 +1.5, -3 dB	30 dB
Nominal voltage -20%	29 +1.5, -3 dB	27 dB
Low temperature		
Nominal voltage	29 ±3 dB	-24 dB*
Nominal voltage +10%	29 +3, -6 dB	-20 dB*
Nominal voltage -20%	29 +3, -6 dB	NR[2]
High temperature		
Nominal voltage	29 ±3 dB	30 dB
Nominal voltage +10%	29 +3, -6 dB	30 dB
Nominal voltage -20%	29 +3, -6 dB	30 dB
Humidity		
Nominal voltage	29 ±3 dB	29 dB
Nominal voltage +10%	29 +3, -6 dB	30 dB
Nominal voltage -20%	29 +3, -6 dB	26 dB
Vibration		
0.38 mm x direction	28 ±1 dB	30 dB*
0.38 mm y direction	28 ±1 dB	30 dB*
0.38 mm z direction	28 ±1 dB	29 dB
0.19 mm x direction	28 ±1 dB	29 dB
0.19 mm y direction	28 ±1 dB	28 dB
0.19 mm z direction	28 ±1 dB	28 dB
Maximum peak carrier output power	1 W maximum	0.79 W
Maximum average carrier output power		
Nominal voltage	30 mW maximum	25.1 mW
Nominal voltage +10%	30 mW maximum	31.7 mW*
Nominal voltage -20%	30 mW maximum	15.2 mW
Carrier frequency variance		
Room temperature		
Nominal voltage	171.6375 MHz ±0.002%	171.6375 MHz
Nominal voltage +10%	171.6375 MHz ±0.002%	171.6374 MHz
Nominal voltage -20%	171.6375 MHz ±0.002%	171.6279 MHz*

* Not in compliance with the standard.

Model: AID TX–602A *(Continued)*

Characteristic	Requirement	Result
Low temperature		
Nominal voltage	171.6375 MHz ±0.002%	NR*
Nominal voltage +10%	171.6375 MHz ±0.002%	NR*
Nominal voltage -20%	171.6375 MHz ±0.002%	NR*
High temperature		
Nominal voltage	171.6375 MHz ±0.002%	171.6375 MHz
Nominal voltage +10%	171.6375 MHz ±0.002%	171.6375 MHz
Nominal voltage -20%	171.6375 MHz ±0.002%	171.6374 MHz
Humidity		
Nominal voltage	171.6375 MHz ±0.002%	171.6368 MHz
Nominal voltage +10%	171.6375 MHz ±0.002%	171.6368 MHz
Nominal voltage -20%	171.6375 MHz ±0.002%	171.6367 MHz
Vibration		
0.38 mm x direction	171.6375 MHz ±0.002%	171.6374 MHz
0.38 mm y direction	171.6375 MHz ±0.002%	171.6374 MHz
0.38 mm z direction	171.6375 MHz ±0.002%	171.6373 MHz
0.19 mm x direction	171.6375 MHz ±0.002%	171.6372 MHz
0.19 mm y direction	171.6375 MHz ±0.002%	171.6373 MHz
0.19 mm z direction	171.6375 MHz ±0.002%	171.6372 MHz
Pulsed-carrier repetition rate variance		
Room temperature		
Nominal voltage (measurement 1)[3]	NA	1.7694 s
Nominal voltage (measurement 2)	NA	885 ms
Nominal voltage +10%	885 ms ±5%	883 ms
Nominal voltage -20%	885 ms ±5%	887 ms
Low temperature		
Nominal voltage +10%	1.7694 s ±10%	NR*
Nominal voltage -20%	1.7694 s ±10%	NR*
High temperature		
Nominal voltage +10%	1.7694 s ±10%	1.7633 s
Nominal voltage -20%	1.7694 s ±10%	1.7716 s
Humidity		
Nominal voltage +10%	1.7694 s ±10%	1.7636 s
Nominal voltage -20%	1.7694 s ±10%	1.7719 s
Pulsed-carrier pulse width variance		
Room temperature		
Nominal voltage (measurement 1)[4]	NA	42 ms
Nominal voltage (measurement 2)	NA	14 ms
Nominal voltage +10%	14 ms ±5%	14 ms
Nominal voltage -20%	14 ms ±5%	13.5 ms
Low temperature		
Nominal voltage +10%	42 ms ±10%	44 ms
Nominal voltage -20%	42 ms ±10%	NR*
High temperature		
Nominal voltage +10%	42 ms ±10%	41 ms
Nominal voltage -20%	42 ms ±10%	42 ms
Humidity		
Nominal voltage +10%	42 ms ±10%	43 ms
Nominal voltage -20%	42 ms ±10%	42 ms

* Not in compliance with the standard.

Model: AID TX–602A *(Continued)*

Characteristic	Requirement	Result
Electromagnetic compatibility characteristics		
Radiated spurious emissions attenuation		
169.94 MHz	43 dB minimum	17.1 dB*
173.5 MHz	43 dB minimum	19.9 dB*
229 MHz	43 dB minimum	68.3 dB
397.91 MHz	43 dB minimum	78.8 dB
453.18 MHz	43 dB minimum	35.5 dB*
513.35 MHz	43 dB minimum	61.2 dB
521.23 MHz	43 dB minimum	66.1 dB
Sideband spectrum attenuation		
Carrier frequency -1 kHz	30 dB minimum	40 dB
Carrier frequency +1 kHz	30 dB minimum	40 dB
Carrier frequency -2 kHz	60 dB minimum	70 dB
Carrier frequency +2 kHz	60 dB minimum	60 dB
Dislodgement characteristic	9 kg (19.8 lb) minimum	13.4 kg
Antenna radiation efficiency	10% minimum	20.6%
Shock stability	No more than superficial damage	No damage, transmitter operational
Battery service life[1]		
Minimum service life		
25 °C	30 hours	12 days
0 °C	15 hours	NR*
-30 °C	3 hours	NR*
60 °C	36 hours	11 days
Maximum service life		
25 °C	10 days	12 days*
0 °C	10 days	NR*
-30 °C	10 days	NR*
60 °C	10 days	11 days*

Notes:

1. Three type 1604 9-volt alkaline batteries.
2. No reading. The test lab was unable to make measurements at these points. The output of the transmitter was approximately 50 dB below nominal output power at 0 °C and below.
3. The 602A has two transmit modes, the stationary mode with a pulse-train repetition rate of 1.7694 s and the motion mode with a pulse-train repetition rate of 885 ms.
4. The 602A has a pulse-train width of 42 ms and an individual pulse width of 14 ms. The pulse-train consists of two pulses separated by 14ms.

* Not in compliance with the standard.

TRANSMITTER DATA SHEET
METS M7047

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Transmitter no-load characteristic	No performance degradation	No degradation
Transmitter load condition	Output does not change	Did not change
Radio frequency carrier characteristics		
Peak carrier output power		
Power supply	30 ±1 dBm	10 dBm*
Batteries[1]	30 ±1 dBm	10 dBm*
Peak carrier output power variance		
Room temperature		
Nominal voltage +10%	10 +1.5, -3 dB	10 dB
Nominal voltage -20%	10 +1.5, -3 dB	9 dB
Low temperature		
Nominal voltage	10 ±3 dB	3 dB*
Nominal voltage +10%	10 +3, -6 dB	3 dB*
Nominal voltage -20%	10 +3, -6 dB	3 dB*
High temperature		
Nominal voltage	10 ±3 dB	9 dB
Nominal voltage +10%	10 +3, -6 dB	9 dB
Nominal voltage -20%	10 +3, -6 dB	9 dB
Humidity		
Nominal voltage	10 ±3 dB	9 dB
Nominal voltage +10%	10 +3, -6 dB	9 dB
Nominal voltage -20%	10 +3, -6 dB	9 dB
Vibration		
0.38 mm x direction	10 ±1 dB	10 dB
0.38 mm y direction	10 ±1 dB	9 dB
0.38 mm z direction	10 ±1 dB	11 dB
0.19 mm x direction	10 ±1 dB	9 dB
0.19 mm y direction	10 ±1 dB	10 dB
0.19 mm z direction	10 ±1 dB	10 dB
Maximum peak carrier output power	1 W maximum	0.01 W
Maximum average carrier output power		
Nominal voltage	30 mW maximum	0.66 mW

* Not in compliance with the standard.

Model: METS M7047 *(Continued)*

Characteristic	Requirement	Result
Nominal voltage +10%	30 mW maximum	0.66 mW
Nominal voltage -20%	30 mW maximum	0.52 mW
Carrier frequency variance		
Room temperature		
Nominal voltage	74.493 ±0.002%	74.4929 MHz
Nominal voltage +10%	74.493 ±0.002%	74.4930 MHz
Nominal voltage -20%	74.493 ±0.002%	74.4929 MHz
Low temperature		
Nominal voltage	74.493 ±0.002%	74.4934 MHz
Nominal voltage +10%	74.493 ±0.002%	74.4930 MHz
Nominal voltage -20%	74.493 ±0.002%	74.4931 MHz
High temperature		
Nominal voltage	74.493 ±0.002%	74.4931 MHz
Nominal voltage +10%	74.493 ±0.002%	74.4931 MHz
Nominal voltage -20%	74.493 ±0.002%	74.4930 MHz
Humidity		
Nominal voltage	74.493 ±0.002%	74.4930 MHz
Nominal voltage +10%	74.493 ±0.002%	74.4932 MHz
Nominal voltage -20%	74.493 ±0.002%	74.4930 MHz
Vibration		
0.38 mm x direction	74.493 ±0.002%	74.49321 MHz
0.38 mm y direction	74.493 ±0.002%	74.49321 MHz
0.38 mm z direction	74.493 ±0.002%	74.49324 MHz
0.19 mm x direction	74.493 ±0.002%	74.49307 MHz
0.19 mm y direction	74.493 ±0.002%	74.49325 MHz
0.19 mm z direction	74.493 ±0.002%	74.49324 MHz
Pulsed-carrier repetition rate variance		
Room temperature		
Nominal voltage (measurement 1)[2]	—	3.836 s
Nominal voltage (measurement 2)	NA	NA
Nominal voltage +10%	3.836 s ±5%	3.828 s
Nominal voltage -20%	3.836 s ±5%	3.849 s
Low temperature		
Nominal voltage +10%	3.836 s ±10%	4.137 s
Nominal voltage -20%	3.836 s ±10%	4.114 s
High temperature		
Nominal voltage +10%	3.836 s ±10%	3.726 s
Nominal voltage -20%	3.836 s ±10%	3.746 s
Humidity		
Nominal voltage +10%	3.836 s ±10%	3.721 s
Nominal voltage -20%	3.836 s ±10%	3.748 s

Model: METS M7047 *(Continued)*

Characteristic	Requirement	Result
Pulsed-carrier pulse width variance		
Room temperature		
Nominal voltage (measurement 1)[3]	—	115 ms
Nominal voltage (measurement 2)	NA	NA
Nominal voltage +10%	115 ms ±5%	115 ms
Nominal voltage -20%	115 ms ±5%	115 ms
Low temperature		
Nominal voltage +10%	115 ms ±10%	130 ms*
Nominal voltage -20%	115 ms ±10%	125 ms
High temperature		
Nominal voltage +10%	115 ms ±10%	120 ms
Nominal voltage -20%	115 ms ±10%	120 ms
Humidity		
Nominal voltage +10%	115 ms ±10%	120 ms
Nominal voltage -20%	115 ms ±10%	120 ms
Electromagnetic compatibility characteristics		
Radiated spurious emissions attenuation		
112.1 MHz	43 dB minimum	57.2 dB
149.1 MHz	43 dB minimum	45.6 dB
372.6 MHz	43 dB minimum	45.2 dB
447.1 MHz	43 dB minimum	43.3 dB
Sideband spectrum attenuation		
Carrier frequency -1 kHz	30 dB minimum	43 dB
Carrier frequency +1 kHz	30 dB minimum	43.4 dB
Carrier frequency -2 kHz	60 dB minimum	71.9 dB
Carrier frequency +2 kHz	60 dB minimum	71.9 dB
Dislodgement characteristic	9 kg (19.8 lb) minimum	6.2 kg*
Antenna radiation efficiency[4]	NA	5.72%
Shock stability	No more than superficial damage	No damage—transmitter operated normally
Battery service life[1]		
Minimum service life[5]		
25 °C	NA	12 days
0 °C	NA	11 days
-30 °C	NA	8 days
60 °C	NA	13 days

* Not in compliance with the standard.

Model: METS M7047 *(Continued)*

Characteristic	Requirement	Result
Maximum service life		
25 °C	10 days	12 days*
0 °C	10 days	11 days*
-30 °C	10 days	11 days*
60 °C	10 days	13 days*

Notes:

1. Four size C lithium batteries.

2. The repetition rate does not change when the transmitter is in motion.

3. The pulse width does not change when the transmitter is in motion.

4. The standard does not have a requirement at this frequency range.

5. The standard does not specify minimum service life for lithium batteries.

* Not in compliance with the standard.

Appendix D: Receiver Data Sheets

RECEIVER DATA SHEET
OAR 347ED

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Sensitivity characteristics		
Direction indication sensitivity	-113 dBm minimum	-113 dBm
Direction indication sensitivity variance		
Low temperature	-113 +3, -6 dB	-110.5 dB
High temperature	-113 +3, -6 dB	-115 dB
Humidity	-113 +3, -6 dB	-115 dB
Vibration		
0.38 mm x direction	-113±1 dB	-115 dB*
0.38 mm y direction	-113±1 dB	-115 dB*
0.38 mm z direction	-113±1 dB	-116 dB*
0.19 mm x direction	-113±1 dB	-113 dB
0.19 mm y direction	-113±1 dB	-113 dB
0.19 mm z direction	-113±1 dB	-113 dB
Distance indication sensitivity	-103 dBm minimum	-113 dBm
Selectivity characteristics		
Adjacent-channel attenuation		
Room temperature	60 dB minimum	54.5 dB*
Low temperature	60 dB minimum	53.5 dB*
High temperature	60 dB minimum	54 dB*
Humidity	60 dB minimum	51 dB*
Vibration		
0.38 mm x direction	60 dB minimum	54 dB*
0.38 mm y direction	60 dB minimum	56.5 dB*
0.38 mm z direction	60 dB minimum	49 dB*
0.19 mm x direction	60 dB minimum	56 dB*
0.19 mm y direction	60 dB minimum	54.5 dB*
0.19 mm z direction	60 dB minimum	51 dB*
Spurious response attenuation[1]		
Room temperature	50 dB minimum	56 dB
Low temperature	50 dB minimum	57.5 dB
High temperature	50 dB minimum	56 dB
Humidity	50 dB minimum	60 dB
Vibration		
0.38 mm x direction	50 dB minimum	54 dB
0.38 mm y direction	50 dB minimum	58 dB
0.38 mm z direction	50 dB minimum	56 dB
0.19 mm x direction	50 dB minimum	56 dB
0.19 mm y direction	50 dB minimum	55.5 dB
0.19 mm z direction	50 dB minimum	56.5 dB

* Not in compliance with the standard.

Model: OAR 347ED *(Continued)*

Characteristic	Requirement	Result
Dynamic range characteristics		
Minimum dynamic range		
Room temperature	90 dB minimum	108 dB
Low temperature	90 dB minimum	77.5 dB*
High temperature	90 dB minimum	101 dB
Humidity	90 dB minimum	109 dB

Notes:

1. The recorded value is the minimum value determined during testing for all of the detected spurious responses.

* Not in compliance with the standard.

Appendix D *(Continued)*

RECEIVER DATA SHEET
AID RX–360

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Sensitivity characteristics		
Direction indication sensitivity	-113 dBm minimum	-125 dBm
Direction indication sensitivity variance		
Low temperature	-125 +3, -6 dB	-119.5 dB*
High temperature	-125 +3, -6 dB	-124.5 dB
Humidity	-125 +3, -6 dB	-121.5 dB*
Vibration		
0.38 mm x direction	-125 ±1 dB	-125 dB
0.38 mm y direction	-125 ±1 dB	-125 dB
0.38 mm z direction	-125 ±1 dB	-125 dB
0.19 mm x direction	-125 ±1 dB	-125 dB
0.19 mm y direction	-125 ±1 dB	-124.5 dB
0.19 mm z direction	-125 ±1 dB	-125 dB
Distance indication sensitivity	-103 dBm minimum	-112 dBm
Selectivity characteristics		
Adjacent-channel attenuation		
Room temperature	60 dB minimum	85 dB
Low temperature	60 dB minimum	68 dB
High temperature	60 dB minimum	82 dB
Humidity	60 dB minimum	86.5 dB
Vibration		
0.38 mm x direction	60 dB minimum	87 dB
0.38 mm y direction	60 dB minimum	86 dB
0.38 mm z direction	60 dB minimum	86 dB
0.19 mm x direction	60 dB minimum	88 dB
0.19 mm y direction	60 dB minimum	87.5 dB
0.19 mm z direction	60 dB minimum	86 dB
Spurious response attenuation[1]		
Room temperature	50 dB minimum	105 dB
Low temperature	50 dB minimum	109.5 dB
High temperature	50 dB minimum	117.5 dB
Humidity	50 dB minimum	112.5 dB

* Not in compliance with the standard.

Model: AID RX–360 *(Continued)*

Characteristic	Requirement	Result
Vibration		
0.38 mm x direction	50 dB minimum	105 dB
0.38 mm y direction	50 dB minimum	105 dB
0.38 mm z direction	50 dB minimum	105 dB
0.19 mm x direction	50 dB minimum	105 dB
0.19 mm y direction	50 dB minimum	104.5 dB
0.19 mm z direction	50 dB minimum	105 dB
Dynamic range characteristics		
Minimum dynamic range		
Room temperature	90 dB minimum	125 dB
Low temperature	90 dB minimum	90 dB
High temperature	90 dB minimum	99.5 dB
Humidity	90 dB minimum	83.5 dB*

Notes:

1. The recorded value is the minimum value determined during testing for all of the detected spurious responses.

* Not in compliance with the standard.

RECEIVER DATA SHEET
AID RX–890B

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Sensitivity characteristics		
Direction indication sensitivity	-113 dBm minimum	-122 dBm
Direction indication sensitivity variance		
Low temperature	-122 +3, -6 dB	-121 dB
High temperature	-122 +3, -6 dB	NR[1]*
Humidity	-122 +3, -6 dB	NR[1]*
Vibration		
0.38 mm x direction	-122 ±1 dB	-122.5 dB
0.38 mm y direction	-122 ±1 dB	-122 dB
0.38 mm z direction	-122 ±1 dB	-123 dB
0.19 mm x direction	-122 ±1 dB	-124 dB*
0.19 mm y direction	-122 ±1 dB	-121 dB
0.19 mm z direction	-122 ±1 dB	-123 dB
Distance indication sensitivity	-103 dBm minimum	-122 dBm
Selectivity characteristics		
Adjacent-channel attenuation		
Room temperature	60 dB minimum	71 dB
Low temperature	60 dB minimum	75 dB
High temperature	60 dB minimum	NR[1]*
Humidity	60 dB minimum	NR[1]*
Vibration		
0.38 mm x direction	60 dB minimum	79.5 dB
0.38 mm y direction	60 dB minimum	66 dB
0.38 mm z direction	60 dB minimum	70 dB
0.19 mm x direction	60 dB minimum	71 dB
0.19 mm y direction	60 dB minimum	70 dB
0.19 mm z direction	60 dB minimum	70 dB
Spurious response attenuation[2]		
Room temperature	50 dB minimum	86 dB
Low temperature	50 dB minimum	83 dB
High temperature	50 dB minimum	NR[1]*
Humidity	50 dB minimum	NR[1]*

* Not in compliance with the standard.

Model: AID RX–890B *(Continued)*

Characteristic	Requirement	Result
Vibration		
0.38 mm x direction	50 dB minimum	73.5 dB
0.38 mm y direction	50 dB minimum	86 dB
0.38 mm z direction	50 dB minimum	77.5 dB
0.19 mm x direction	50 dB minimum	79 dB
0.19 mm y direction	50 dB minimum	86 dB
0.19 mm z direction	50 dB minimum	79 dB
Dynamic range characteristics		
Minimum dynamic range		
Room temperature	90 dB minimum	110 dB
Low temperature	90 dB minimum	101 dB
High temperature	90 dB minimum	NR[1]*
Humidity	90 dB minimum	NR[1]*

Notes:

1. No reading—there was no output at the high temperature and humidity tests.

2. The recorded value is the minimum value determined during testing for all of the detected spurious responses.

* Not in compliance with the standard.

Appendix D *(Continued)*

RECEIVER DATA SHEET
METS M7101

Characteristic	Requirement	Result
User information	Complete data	Incomplete*
Sensitivity characteristics		
Direction indication sensitivity	-113 dBm minimum	-136 dBm
Direction indication sensitivity variance		
Low temperature	-136 +3, -6 dB	-134 dB
High temperature	-136 +3, -6 dB	-131 dB*
Humidity	-136 +3, -6 dB	-134 dB
Vibration		
0.38 mm x direction	-136 ±1 dB	-136 dB
0.38 mm y direction	-136 ±1 dB	-132 dB*
0.38 mm z direction	-136 ±1 dB	-132 dB*
0.19 mm x direction	-136 ±1 dB	-136 dB
0.19 mm y direction	-136 ±1 dB	-132 dB*
0.19 mm z direction	-136 ±1 dB	-132 dB*
Distance indication sensitivity	-103 dBm minimum	-110 dBm
Selectivity characteristics		
Adjacent-channel attenuation		
Room temperature	60 dB minimum	106 dB
Low temperature	60 dB minimum	69 dB
High temperature	60 dB minimum	99 dB
Humidity	60 dB minimum	82 dB
Vibration		
0.38 mm x direction	60 dB minimum	103 dB
0.38 mm y direction	60 dB minimum	99 dB
0.38 mm z direction	60 dB minimum	97 dB
0.19 mm x direction	60 dB minimum	88 dB
0.19 mm y direction	60 dB minimum	99 dB
0.19 mm z direction	60 dB minimum	101 dB
Spurious response attenuation[1]		
Room temperature	50 dB minimum	62 dB
Low temperature	50 dB minimum	61 dB
High temperature	50 dB minimum	61 dB
Humidity	50 dB minimum	61 dB

* Not in compliance with the standard.

Model: METS M7101 *(Continued)*

Characteristic	Requirement	Result
Vibration		
0.38 mm x direction	50 dB minimum	62 dB
0.38 mm y direction	50 dB minimum	61 dB
0.38 mm z direction	50 dB minimum	61 dB
0.19 mm x direction	50 dB minimum	62 dB
0.19 mm y direction	50 dB minimum	61 dB
0.19 mm z direction	50 dB minimum	61 dB
Dynamic range characteristics		
Minimum dynamic range		
Room temperature	90 dB minimum	123 dB
Low temperature	90 dB minimum	129 dB
High temperature	90 dB minimum	128 dB
Humidity	90 dB minimum	131 dB

Notes:

1. The recorded value is the minimum value determined during testing for all of the detected spurious responses.

Appendix E: Transmitter/Receiver Figures of Merit

Transmitter: AID TX–602A — Receiver: AID RX–360

Temperature	Transmitter POP[1]	Receiver MDIS[2]	Minimum requirement	Figure
Room	27 dBm	125 dBm	140 dBm	152 dBm
Low	NR	119.5 dBm	130 dBm	——*
High	30 dBm	124.5 dBm	130 dBm	154.5 dBm
Humidity	26 dBm	121.5 dBm	130 dBm	147.5 dBm

Transmitter: AID TX–602A — Receiver: AID RX–890B

Temperature	Transmitter POP	Receiver MDIS	Minimum requirement	Figure
Room	27 dBm	122 dBm	140 dBm	149 dBm
Low	NR	121 dBm	130 dBm	——*
High	30 dBm	NR	130 dBm	——*
Humidity	26 dBm	NR	130 dBm	——*

Transmitter: HDS BT–175 — Receiver: OAR 347ED

Temperature	Transmitter POP	Receiver MDIS	Minimum requirement	Figure
Room	29 dBm	113 dBm	140 dBm	142 dBm
Low	29 dBm	110.5 dBm	130 dBm	139.5 dBm
High	29 dBm	115 dBm	130 dBm	144 dBm
Humidity	29 dBm	115 dBm	130 dBm	144 dBm

Transmitter: HDS BT–180 — Receiver: OAR 347ED

Temperature	Transmitter POP	Receiver MDIS	Minimum requirement	Figure
Room	24 dBm	113 dBm	140 dBm	137 dBm*
Low	23 dBm	110.5 dBm	130 dBm	133.5 dBm
High	10 dBm	115 dBm	130 dBm	125 dBm*
Humidity	26 dBm	115 dBm	130 dBm	141 dBm

* Not in compliance with the standard.

Transmitter: OAR VB–342			Receiver: OAR 347ED	
Temperature	**Transmitter POP**	**Receiver MDIS**	**Minimum requirement**	**Figure**
Room	25 dBm	113 dBm	140 dBm	138 dBm*
Low	22 dBm	110.5 dBm	130 dBm	132.5 dBm
High	22 dBm	115 dBm	130 dBm	137 dBm
Humidity	25 dBm	115 dBm	130 dBm	140 dBm

Transmitter: METS M7047			Receiver: METS M7101	
Temperature	**Transmitter POP**	**Receiver MDIS**	**Minimum requirement**	**Figure**
Room	9 dBm	136 dBm	140 dBm	145 dBm
Low	3 dBm	134 dBm	130 dBm	137 dBm
High	9 dBm	131 dBm	130 dBm	140 dBm
Humidity	9 dBm	134 dBm	130 dBm	143 dBm

Notes:

1. POP—Peak output power in dBm with transmitter voltage at nominal voltage -20%.

2. MDIS—Minimum direction indication sensitivity in dBm.

* Not in compliance with the standard.

Appendix F: Transmitter/Receiver User Information

Transmitter User Information Provided by the Manufacturer

	BT–175	BT–180	VB–342	TX–602A	M7047
1. Temperature range	C	C	N	N	N
2. Operating frequency	C	C	C	C	N
3. Peak RF carrier output power	C	C	C	C	C
4. Average RF carrier output power	N	N	N	N	N
5. Current drain	C	C	N	N	N
6. Pulse repetition rate	C	N	C	N	C
7. Pulse width or duty cycle	C	C	C	N	C
8. RF output impedance	C	C	N	C	N
9. Battery type and voltage	N	C	C	C	N
10. Radiated spurious emissions attenuation	C	C	N	C	N
11. Sideband spectrum attenuation	N	N	N	N	N
12. Dislodgement force	N	N	N	N	N
13. Antenna radiation efficiency	N	N	N	N	N

Receiver User Information Provided by the Manufacturer

	347ED	RX–360	RX–890B	M7101
1. Temperature range	C	C	N	N
2. Operating frequency	C	C	C	C
3. RF input impedance	N	N	N	N
4. Current drain	C	C	N	C
5. Supply voltage	C	C	C	C
6. Direction indication sensitivity	N	C	C	N
7. Relative distance indication sensitivity	N	N	N	N
8. Adjacent-channel attenuation	N	N	N	N
9. Spurious response attenuation	N	N	C	N
10. Minimum dynamic range	C	N	N	N

C = Complies with the requirements of the standard.
N = Does not comply with the requirements of the standard.

Appendix G: Glossary

Abbreviations

°C	Degree Centigrade
dB	Decibel
dBm	Decibel (referenced to 1 milliwatt)
°F	Degree Fahrenheit
Hz	Hertz
kg	Kilogram
KHz	Kilohertz
MDIS	Minimum direction indication sensitivity
MHz	Megahertz
mm	Millimeter
ms	Millisecond
mW	Milliwatt
NA	Not applicable
NR	No reading
POP	Peak output power
rf	Radio frequency
s	Second
W	Watt

Conversions

dBm	= 10 x log (1,000 x watts)
mW	$= 10^{dBm/10}$
°F	= 9/5 (°C) +32

Definitions

Duty cycle	The ratio of the "on time" interval (pulse width) occupied in operating a device to the total time of one operating cycle (pulsed-carrier repeition rate).
Nominal	The value assigned to an operating characteristic by the manufacturer.
Type I transmitter	A transmitter that operates in the 30–50 MHz band.
Type II transmitter	A transmitter that operates in the 150–174 MHz band.

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