CLASS 200

PHYSICAL-CHARACTERISTICS TESTS

METHOD 201A

VIBRATION

1. PURPOSE. The vibration test is used to determine the effects on component parts of vibration within the predominant frequency ranges and magnitudes that may be encountered during field service. Most vibration encountered in field service is not of a simple harmonic nature, but tests based on vibrations of this type have proved satisfactory for determining critical frequencies, modes of vibration and other data necessary for planning protective steps against the effects of undue vibration. Vibration, by causing loosening of parts or relative motion between parts in the specimen, can produce objectionable operating characteristics, noise, wear, and physical distortion, and often results in fatigue and failure of mechanical parts.

2. PROCEDURE. Prior to vibration, the specified tests or measurements shall be made. The specimens shall be mounted as specified using suitable mounting apparatus to assure that mounting is free from resonances over the test frequency range. The specimens shall be subjected to a simple harmonic motion having an amplitude of 0.03 inch (0.06 inch maximum total excursion), the frequency being varied uniformly between the approximate limits of 10 and 55 hertz (Hz). The entire frequency range, from 10 to 55 Hz and return to 10 Hz, shall be traversed in approximately 1 minute. Unless otherwise specified, this motion shall be applied for a period of 2 hours in each of 3 mutually perpendicular directions (total of 6 hours).1/ If applicable, this test shall be made under electrical-load conditions.

3. MEASUREMENTS. The specified measurements shall be made during and after vibration.

4. SUMMARY. The following details are to be specified in the individual specification:

a. Tests and measurements prior to vibration (see 2).

b. Method of mounting (see 2).

c. Duration of vibration, if other than that specified (see 2).

d. Direction of motion, if other than that specified (see 2).

e. Electrical-load conditions, if applicable (see 2).

f. Tests and measurements during and after vibration (see 3).

1/ In the previous issue of this method, test conditions A and B referred to a length of test of 5 hours and 2-1/2 hours, respectively.

METHOD 202D

SHOCK

(SPECIMENS WEIGHING NOT MORE THAN 4 POUNDS)
(CANCELED)

When method 202 is specified		Use test method 213		
Test condition	g (peak values)	Test condition	g (peak values)	Waveform
A B C	15g (pk) 30g (pk) 50g (pk)	K H I	30g (pk) 75g (pk) 100g (pk)	Sawtooth Sawtooth Sawtooth

METHOD 203C

RANDOM DROP

1. PURPOSE. The random-drop test is used to determine the effects on component parts of random, repeated impact due to handling, shipping, and other field service conditions. The test is an accelerated test designed to indicate structural and mechanical weaknesses of types not necessarily detected in shock and vibration tests.

2. APPARATUS. The random-drop test machine consists of an assembly of either two or four steel cages as shown on figure 203-2, with provisions for rotation about a common axis. The interior of each cage shall be as shown on figure 203-3. A typical 4-cage machine is shown on figure 203-1. Steel sleeves as shown on figure 203-4 shall be used to mount the specimen.

3. PROCEDURE. The specimen shall be rigidly mounted by the normal mounting means in the steel sleeve so that no part of the specimen, including terminals or external hardware of the component, will extend beyond the sleeve. When necessary, a suitable adapter may be used within the sleeve. End caps shall not be used on the sleeves. Through bolts may be employed as needed to mount the specimens in the sleeve. Only one sleeve shall be placed in each cage during test. The number of specimens mounted in each sleeve shall be limited only by the available space. Specimens shall be subjected to the random-drop test for a period of 45 minutes at a speed of four to six (4 – 6) revolutions per minute. The machine shall be rotated in the direction shown on figure 203-3.

4. MEASUREMENTS. Upon completion of the test, measurements shall be made as specified in the individual specification.

5. SUMMARY. The following detail shall be specified in the individual specification:

a. Measurements after test (see 4).

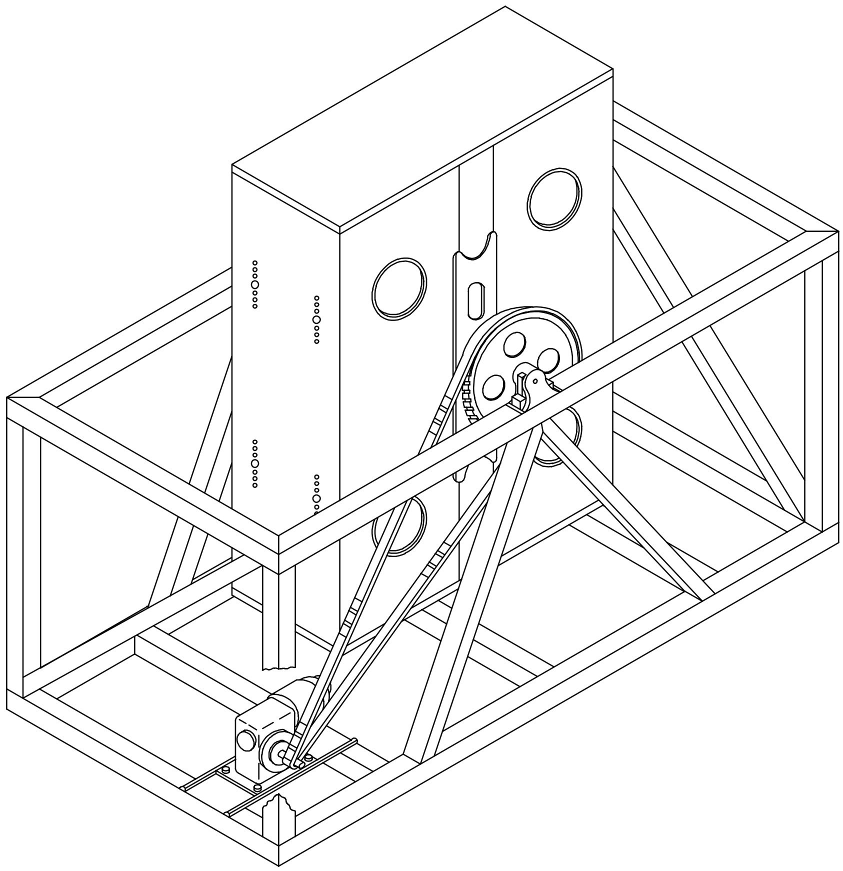


FIGURE 203-1. Typical assembly of four-cage random-drop-test machine.

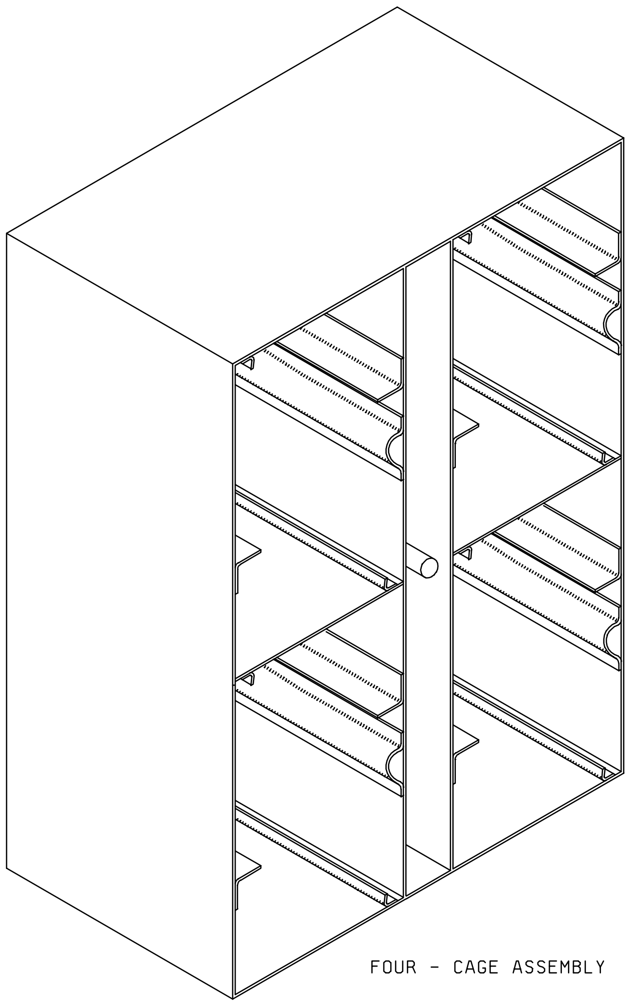


FIGURE 203-2. Cage assembly.

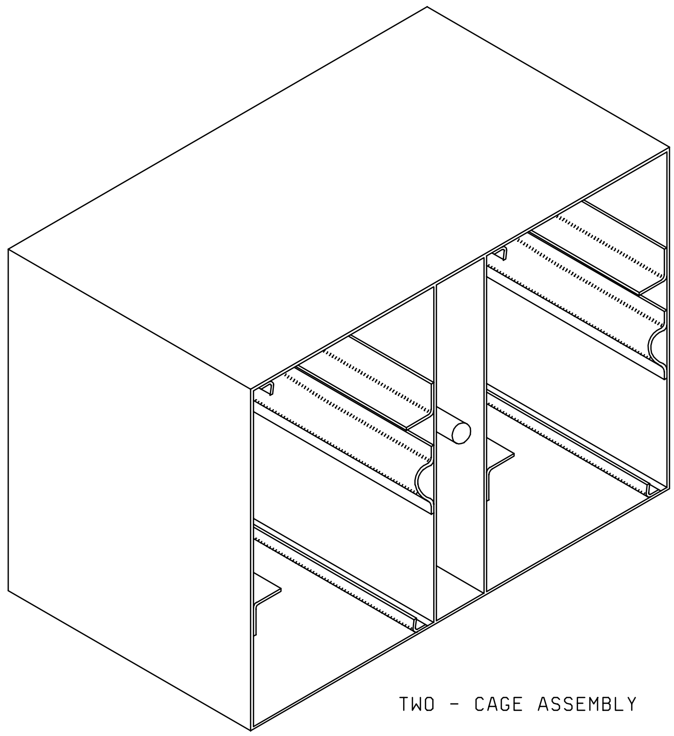
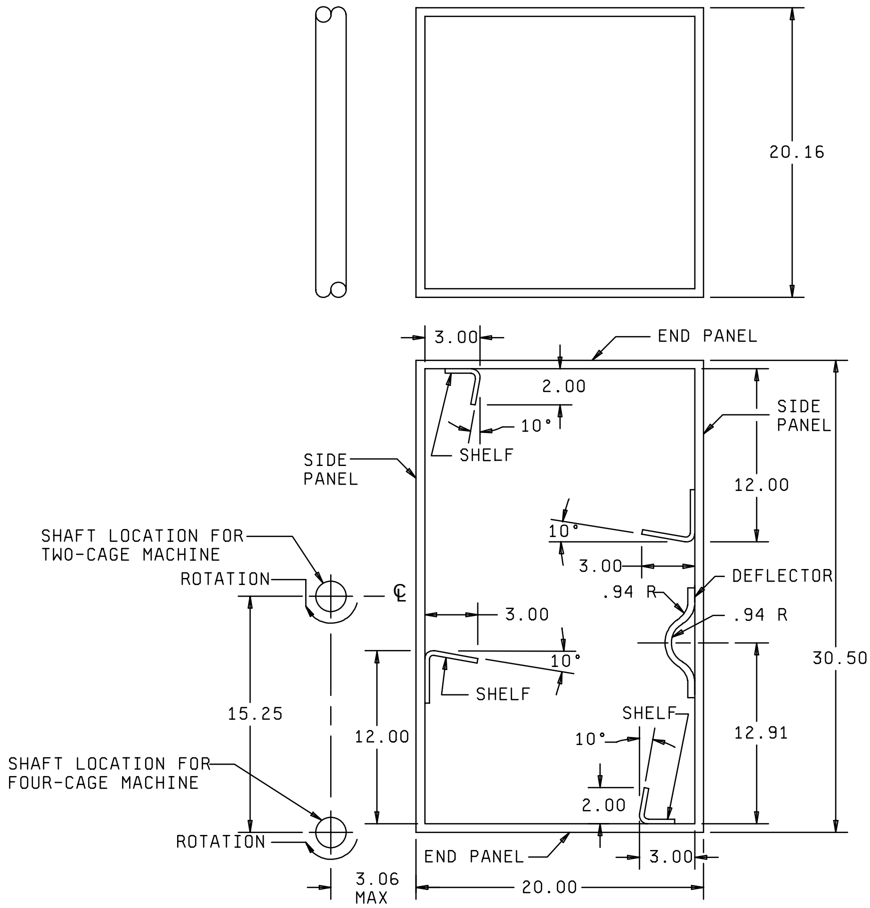


FIGURE 203-2. Cage assembly - Continued.

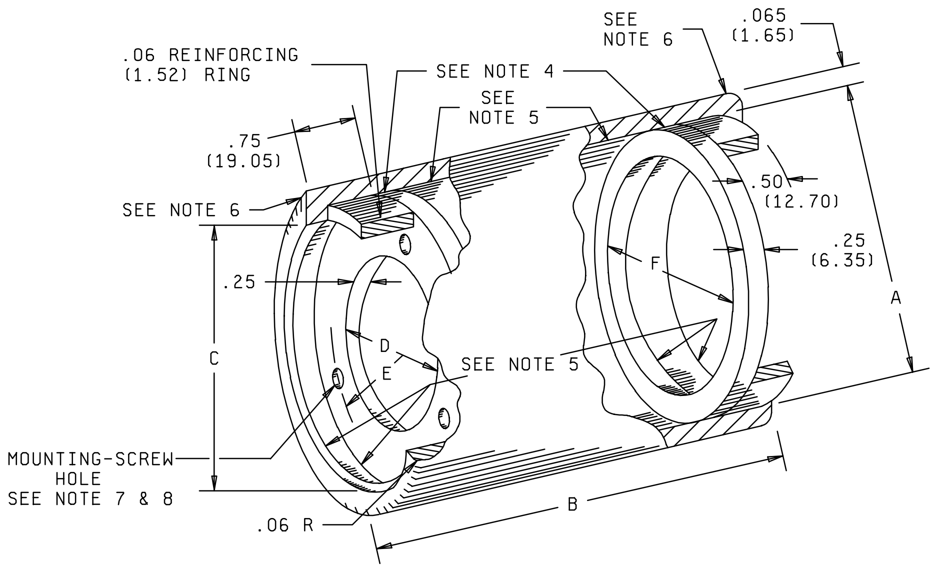


Inches	mm	Inches	mm	Inches	mm
.94	23.83	12.00	304.80	20.00	508.00
2.00	50.80	12.91	327.91	20.16	512.06
3.00	76.20	15.25	387.35	30.50	774.70
3.06	77.72				

NOTES:

1. Unless otherwise specified, tolerances are ±.06 (1.52 mm) on decimals and ±0° 30' on angles.
2. Material for end and side panels shall be steel .0747 (1.90 mm) nominal thickness.
3. Material for shelves and deflectors shall be steel .083 (2.11 mm) nominal thickness.

FIGURE 203-3. Cage (interior).



Dimensions					
A	B ±.06 (1.52)	C ±.06 (1.52)	D	E (Rad)	F ±.06 (1.52)
3.870 (98.30)	4.03 (102.36)	3.75 (95.25)	2.220 (56.39)	7/ 1.220 (30.99)	3.370 (85.60)
3.870 (98.30)	4.03 (102.36)	3.75 (95.25)	2.820 (71.63)	7/ 1.580 (40.13)	3.370 (85.60)
4.870 (123.70)	5.03 (127.76)	4.75 (120.65)	3.820 (97.03)	8/ 2.062 (52.37)	4.370 (111.00)

NOTES:
1. Metric equivalents are in parentheses.
2. Unless otherwise specified, tolerances are ±.005 (0.13 mm) for three place decimals, and ±.02 (0.51 mm) for two place decimals.
3. Material for sleeve and reinforcing rings shall be carbon steel, condition CWSR, grade MT1015 or 1015, conforming to ASTM A 519-96.
4. Material shall be hot-rolled steel strip, annealed condition, annealed finish, conforming to QQ-S-698.
5. Silver solder all around. Silver solder shall conform to class 1 of QQ-B-654.
6. End of cylinder to be spun-over after insertion of reinforcing ring.
7. Radius of 3 holes equally spaced.
8. Radius of 6 holes equally spaced.

FIGURE 203-4. Sleeve.

METHOD 204D

VIBRATION, HIGH FREQUENCY

1. PURPOSE. The high frequency vibration test is performed for the purpose of determining the effect on component parts of vibration in the frequency ranges of 10 to 500 hertz (Hz), 10 to 2,000 Hz or 10 to 3,000 Hz, as may be encountered in aircraft, missiles, and tanks. The choice of test condition A, B, C, D, E, F, G, or H should be based on the frequency range and the vibration amplitude dictated by the applications of the component under consideration, and the state of the component part in relation to resistance-to-vibration damage.

2. PROCEDURE.

2.1 Mounting. The specimens shall be mounted as specified. For specimens with attached brackets, one of the vibration test directions shall be parallel to the mounting surface of the bracket. Vibration input shall be monitored on the mounting fixture in the proximity of the support points of the specimen.

2.2 Test condition A (10g peak). The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 2.2.1, 2.2.2, and 2.2.3, respectively (see figure 204-1).

2.2.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 10 gravity units (g peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.2.2 Frequency range. The vibration frequency shall be varied logarithmically between the approximate limits of 10 and 500 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

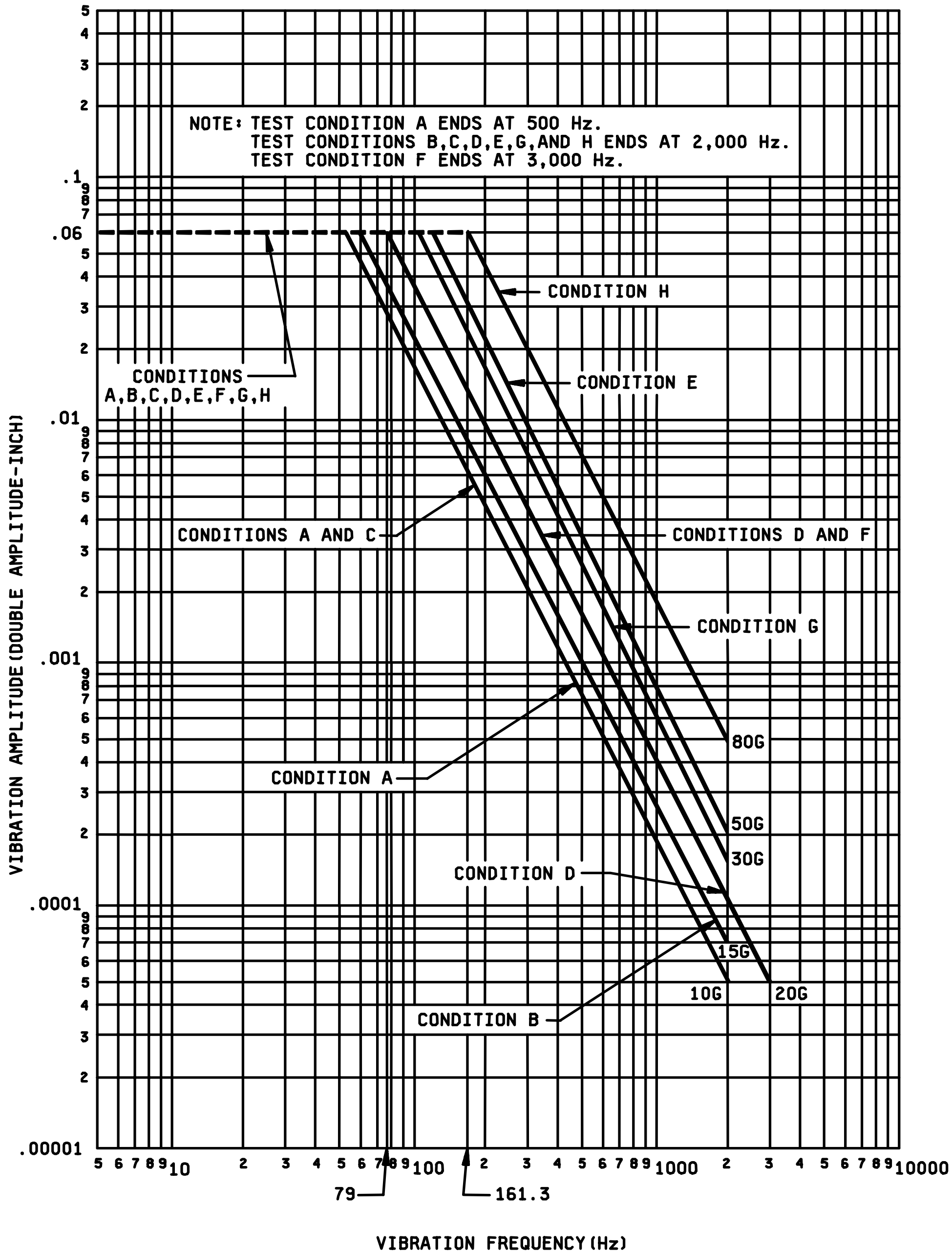
2.2.3 Sweep time and duration. The entire frequency range of 10 to 500 Hz and return to 10 Hz shall be traversed in 15 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 9 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).

2.3 Test condition B (15g peak). The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 2.3.1, 2.3.2, and 2.3.3, respectively (see figure 204-1).

2.3.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 15g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.3.2 Frequency range. The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.3.3 Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).



G = .0512f^2DA (f = frequency in hertz, DA = double amplitude in inches.)

FIGURE 204-1. Vibration-test curves.

2.4 Test condition C (10g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude and frequency range shown on figure 204-1. The tolerance on vibration amplitude shall be ±10 percent.

2.4.1 Part 1. The specimens shall be tested in accordance with method 201 of this standard for 6 hours; 2 hours in each of three mutually perpendicular directions.

2.4.2 Part 2. The specimens shall be subjected to a simple harmonic motion having an amplitude varied to maintain a constant peak acceleration of 10g (peak), the frequency being varied logarithmically between the approximate limits of 55 and 2,000 Hz (see 2.10). The entire frequency range of 55 to 2,000 Hz (no return sweep) shall be traversed in 35 ±5 minutes, except that in the vicinity of what appears to be resonance, and in order to facilitate the establishment of a resonant frequency, the above rate may be decreased. If resonance is detected, specimens shall be vibrated for 5 minutes at each critical resonant frequency observed. This procedure shall be performed in each of three mutually perpendicular directions. Interruptions are permitted provided the requirements for rate of change and test duration are met.

2.4.3 Resonance. A critical resonant frequency is that frequency at which any point on the specimen is observed to have a maximum amplitude more than twice that of the support points. When specified, resonant frequencies shall be determined either by monitoring parameters such as contact opening, or by use of resonance-detecting instrumentation.

2.5 Test condition D (20g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency, range, and duration specified in 2.5.1, 2.5.2, and 2.5.3, respectively (see fig. 204-1).

2.5.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 20g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.5.2 Frequency range. The vibration frequency shall be varied logarithmically between the approximate limits of 10 to 2,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.5.3 Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).

2.6 Test condition E (50g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency, range, and duration specified in 2.6.1, 2.6.2, and 2.6.3, respectively (see figure 204-1).

2.6.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 50g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.6.2 Frequency range. The vibration frequency shall be varied logarithmically between the approximate limits of 10 and 2,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.6.3 Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately 1-1/3 hours in each of three mutually perpendicular directions).

2.7 Test condition F (20g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 2.7.1, 2.7.2, and 2.7.3, respectively (see figure 204-1).

2.7.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 20g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.7.2 Frequency range. The vibration frequency shall be varied logarithmically between the limits of 10 and 3,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.7.3 Sweep time and duration. The entire frequency range of 10 to 3,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately) 1-1/3 hours in each of three mutually perpendicular directions.

2.8 Test condition G (30g peak). The specimens, while deenergized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 2.8.1, 2.8.2, and 2.8.3, respectively (see figure 204-1).

2.8.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having an amplitude of either 0.06-inch double amplitude (maximum total excursion) or 30g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.8.2 Frequency range. The vibration frequency shall be varied logarithmically between the limits of 10 and 2,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.8.3 Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately) 1-1/3 hours in each of three mutually perpendicular directions.

2.9 Test condition H (80g peak). The specimens, while de-energized or operating under the load conditions specified, shall be subjected to the vibration amplitude, frequency range, and duration specified in 2.9.1, 2.9.2, and 2.9.3, respectively (see figure 204-1).

2.9.1 Amplitude. The specimens shall be subjected to a simple harmonic motion having a constant amplitude of either 0.06-inch double amplitude (maximum total excursion) or 80g (peak), whichever is less. The tolerance on vibration amplitude shall be ±10 percent.

2.9.2 Frequency range. The vibration frequency shall be varied logarithmically between the limits of 10 and 2,000 Hz (see 2.10), except that the procedure of method 201 of this standard may be applied during the 10 to 55 Hz band of the vibration frequency range.

2.9.3 Sweep time and duration. The entire frequency range of 10 to 2,000 Hz and return to 10 Hz shall be traversed in 20 minutes. This cycle shall be performed 12 times in each of three mutually perpendicular directions (total of 36 times), so that the motion shall be applied for a total period of approximately 12 hours. Interruptions are permitted provided the requirements for rate of change and test duration are met. Completion of cycling within any separate band is permissible before going to the next band. When the procedure of method 201 of this standard is used for the 10 to 55 Hz band, the duration of this portion shall be the same as the duration for this band using logarithmic cycling (approximately) 1-1/3 hours in each of three mutually perpendicular directions.

2.10 Alternate procedure for use of linear in place of logarithmic change of frequency. Linear rate of change of frequency is permissible under the following conditions:

a. The frequency range above 55 Hz shall be subdivided into not less than three bands. The ratio of the maximum frequency to the minimum frequency in each band shall be not less than two.

b. The rate of change of frequency in hertz per minute (Hz/min) shall be constant for any one band.

c. The ratios of the rate of change of frequency of each band to the maximum frequency of that band shall be approximately equal.

2.10.1 Example of alternate procedure. As an example of the computation of rates of change, assume that the frequency spectrum has been divided into three bands, 55 to 125 Hz, 125 to 500 Hz, and 500 to 2,000 Hz, in accordance with 2.10a. Let the (constant) ratio of rate of frequency change in Hz/min, to maximum frequency in Hz be k for each band. Then the rates of change for the three bands will be 125k, 500k, and 2,000k, respectively. The times, in minutes, to traverse the three frequency bands will therefore be respectively:

$$\frac{125-55}{55k}, \frac{500-125}{500k}, \frac{2000-500}{2{,}000k}$$

Since the minimum total sweep time is 30 minutes,

$$30 = \frac{70}{125k} + \frac{375}{500k} + \frac{1{,}500}{2{,}000k}$$

from which: k = 0.0687

The required maximum constant rates of frequency change for the three bands are therefore 8.54, 34.4, and 136.6 Hz/min, respectively. The minimum times of traverse of the bands are 8.2, 10.9, and 10.9 minutes, respectively.

3. MEASUREMENTS. Measurements shall be made as specified.

4. SUMMARY. The following details are to be specified in the individual specification:

a. Mounting of specimens (see 2.1).

b. Electrical-load conditions, if applicable (see 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, and 2.9).

c. Test condition letter (see figure 204-1).

d. Method of determining resonance, if applicable (see 2.4.3).

e. Measurements (see 3).

METHOD 205E

SHOCK, MEDIUM IMPACT
(CANCELED)

When method 205 is specified		Use test method 213		
Test condition	g (peak values)	Test condition	g (peak values)	Waveform
A B C	15g (pk) 30g (pk) 50g (pk)	K H I	30g (pk) 75g (pk) 100g (pk)	Sawtooth Sawtooth Sawtooth

METHOD 206

LIFE (ROTATIONAL)

1. PURPOSE. This test is performed for the purpose of determining the effects of subjecting electronic and electrical parts, which are actuated by rotational motion, to a number of operations approximating the life of the part. Total resistance, contact resistance, and dielectric strength are samples of measurements which may be made prior to, during, or after test, and which would show the effects of rotational actuation. Measurements prior to and after test are generally made for comparison purposes and would indicate the amount of change that results from this test. Parts with sealed shafts and bushings might have the effectiveness of the seal disturbed by rotation; a sealing test performed after this test would disclose this inadequacy. A switch-life test may be performed in conjunction with this test method.

2. PROCEDURE.

2.1 Mounting. Specimens shall be mounted in their normal operating position by the intended means. Normal care shall be taken in the mounting procedure to prevent the binding of shafts during rotation. Figure 206-1 shows a suggested means of preventing this condition, when applicable. Mechanisms such as slip clutches may be used to prevent damage from the application of excessive torque to the specimens. When this test is conducted at an elevated temperature (see 2.6), the spacing between a group of like specimens shall be as specified.

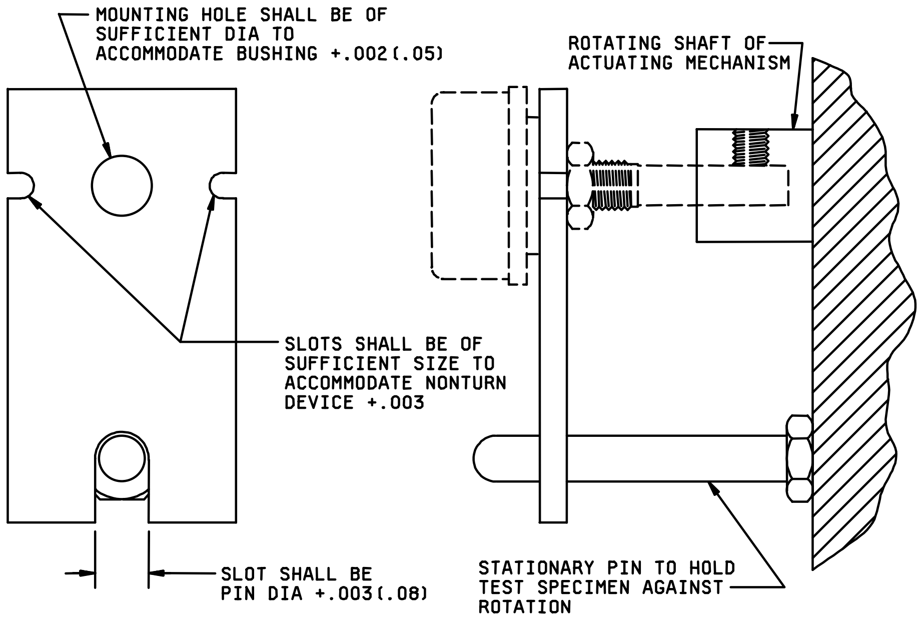
2.2 Test potential and load. The test potential and load applied to the specimens during rotation shall be as specified.

2.3 Cycle. A cycle shall consist of a rotation of the shaft from one stop position to the other stop position (passing through detent positions, if any), and return to the original position. For specimens not having stops, a cycle shall consist of a rotation of the shaft 360° and return, unless otherwise specified. Specimens with adjustable stops shall have the stops so placed as to permit maximum rotation. Specimens that are rotated by means other than a shaft shall meet the requirements of this paragraph by rotation 360° and return, unless otherwise specified, or from stop to stop.

2.4 Cycle rate. The cycle rate shall be expressed in cycles per minute (cpm), and shall be as specified.

2.5 Number of cycles. Specimens shall be subjected to one of the following test conditions, as specified:

Test condition	Number of cycles
A	500
B	2,000
C	5,000
D	10,000
E	15,000
F	25,000
G	50,000
H	100,000
J	200,000
K	300,000
L	500,000
M	1,000,000
N	2,000,000



NOTE: Metric equivalents are in parentheses.

FIGURE 206-1. Suggested mounting fixture for rotational-life test.

2.6 Temperature and atmospheric pressure. When specified, this test shall be performed at elevated or reduced temperature and at other than room ambient atmospheric pressure.

3. MEASUREMENTS. Specified measurements or tests shall be made prior to, during, or after rotations, as specified.

4. SUMMARY. The following details are to be specified in the individual specification:

a. Spacing of specimens for elevated-temperature testing, when applicable (see 2.1).

b. Test potential and load (see 2.2).

c. Cycle, if other than specified (see 2.3).

d. Cycle rate in cpm (see 2.4).

e. Test condition letter (see 2.5).

f. Temperature and atmospheric conditions, when applicable (see 2.6).

g. Measurements or tests prior to, during, or after rotations, as applicable (see 3).

METHOD 207B

HIGH-IMPACT SHOCK

1. PURPOSE. This test is performed for the purpose of determining the ability of various parts to withstand shock of the same severity as that produced by underwater explosions, collision impacts, near-miss gunfire, blasts caused by air explosions, and field conditions. Exact simulation of some of the severe shock motions experienced in the field is difficult to reproduce; however, parts that successfully complete the test of this method have been found to possess the necessary ruggedness for this use. The test apparatus utilized in this method is the same as that designated as Shock Testing Machine for Lightweight Equipment in MIL-S-901, Shock Tests, HI (High-Impact), Shipboard Machinery, Equipment and Systems, Requirements for. The purpose of this apparatus is to determine the ability of equipment installed aboard naval ships to withstand shock and still continue to perform its operational function. This test method is limited to testing of parts weighing not more than 300 pounds.

2. PRECAUTIONS. The apparatus shall be examined periodically for damage. Any hardware that has become defective by being deformed or cracked shall be replaced. Particular attention shall be given to the anvil plate which shall not be bowed more than 1 inch at the center. Proper safeguards shall be taken to protect personnel from objects that may become loosened and act as projectiles as a result of this test. A sound-warning arrangement shall be made, for use in alerting personnel in the vicinity of the test of the impending drop of the hammer.

3. APPARATUS. The apparatus used in this test method shall be as shown on figure 207-1 and the associated detail drawings. The parts shall be installed on a mounting fixture which is attached to the anvil plate of the shock-testing apparatus. A 400-pound hammer shall be dropped from a specified height (see 4.4) onto a shock pad located on the anvil plate. The shock motion is then transmitted by the anvil plate to the parts attached on the mounting fixture.

3.1 Anvil plate. The test apparatus of this method is so constructed that the anvil plate (see figure 207-3) can be installed, in sequence, in two positions. By utilizing these two installation positions and separately employing both hammers of the apparatus shock is applied through the three principal mutually perpendicular axes of the part being subjected to test. One position is to locate the anvil in such a manner that it will receive blows through the back of the anvil plate by contact from the horizontal hammer, and blows on the top shock pad of the anvil plate by a drop of the vertical hammer as shown on figure 207-2. The other position is as shown on figure 207-1, whereby the end shock pad is contacted by the horizontal hammer.

3.2 Hammers. The test apparatus is equipped with two 400-pound hammers. One hammer renders a blow by a vertical drop. The other hammer applies a force in a horizontal direction. In this manner, and by changing the orientation of the anvil plate, blows may be delivered to the anvil and the parts in three directions.

3.3 Mounting fixtures. Figure 207-4A, figure 207-4B, figure 207-5, and figure 207-6 show standard mounting fixtures that shall be used when testing parts with this test apparatus. These mounting fixtures simulate platform and panel mountings. The applicable mounting fixture shall be as specified. When one of the standard mounting fixtures shown on figure 207-4A, figure 207-4B, figure 207-5, and figure 207-6 cannot be used, the individual specification shall specify a mounting fixture or adapter which approximates the actual rigidity encountered in service.

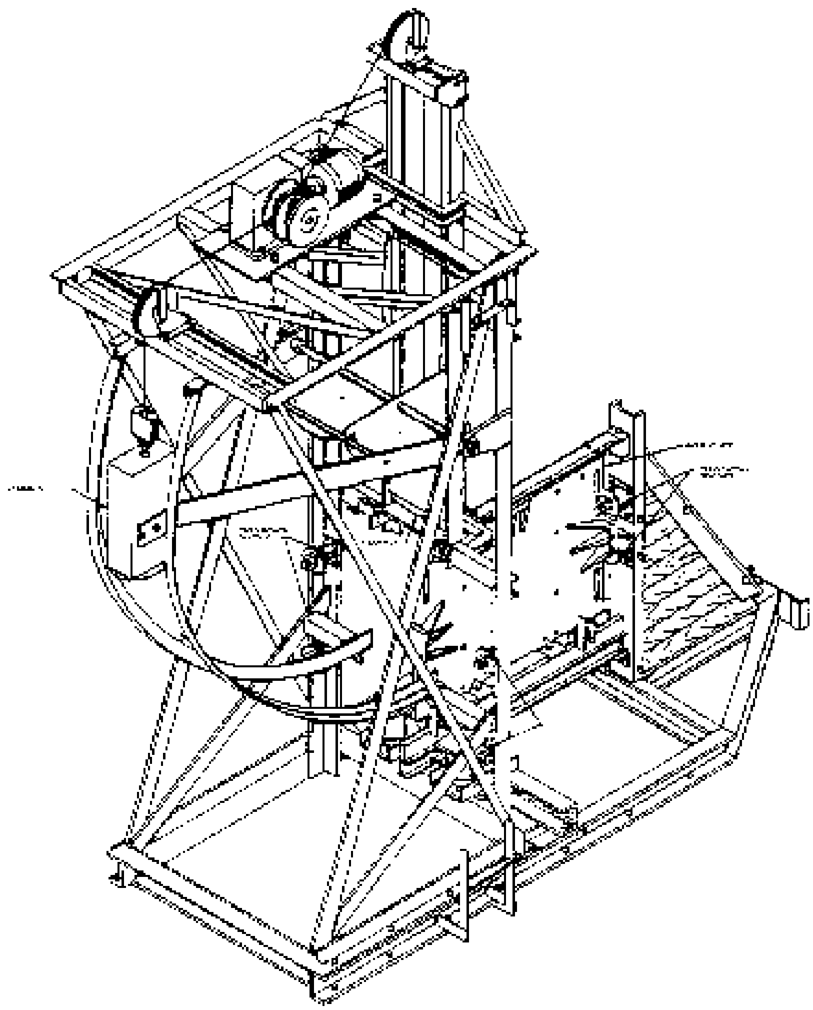


FIGURE 207-1. High-impact shock-testing apparatus.

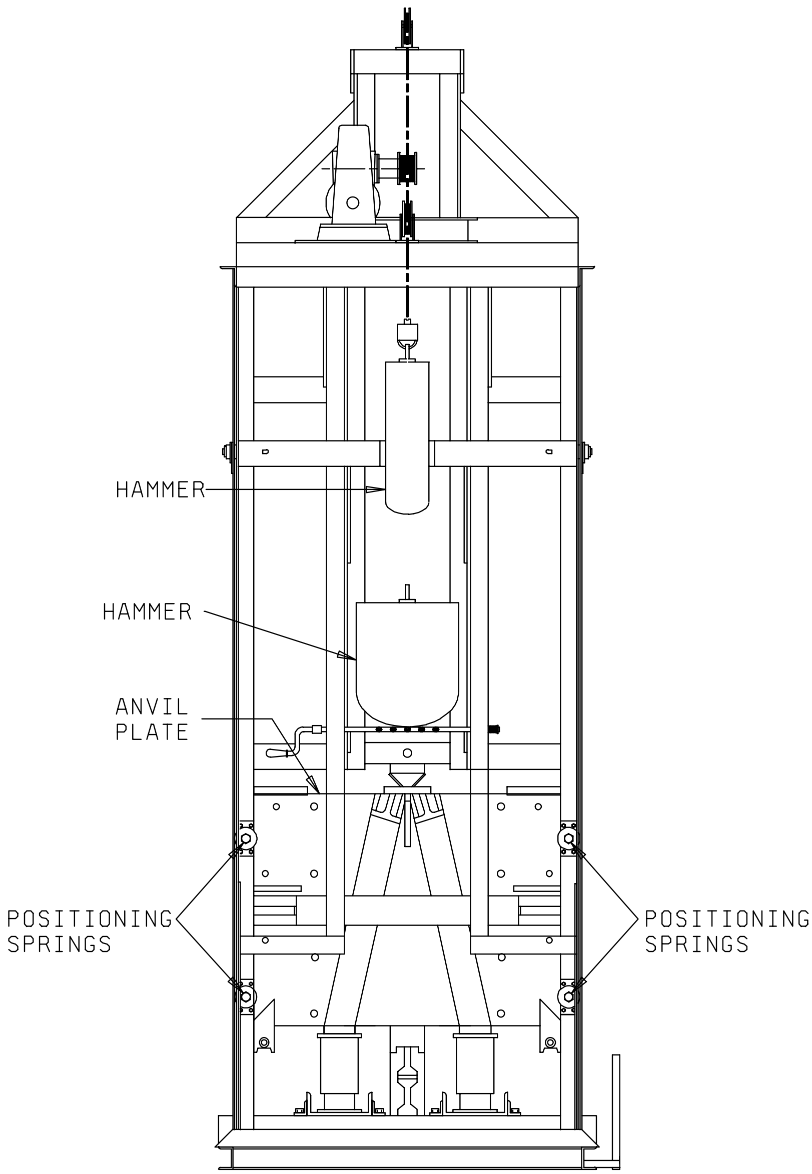
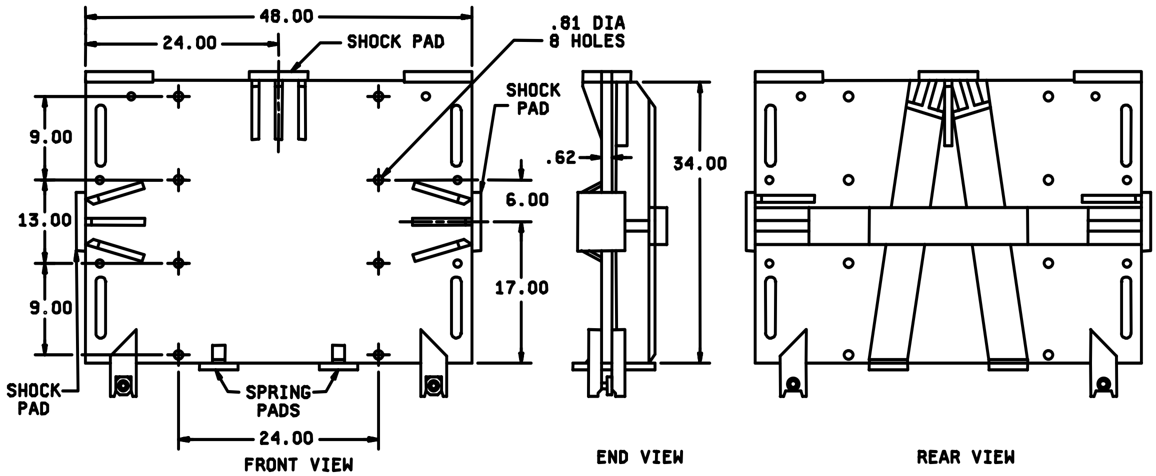


FIGURE 207-2. High-impact shock-testing apparatus (backview) with anvil plate located for back and top blows.



Inches	mm	Inches	mm
.62	15.75	17.00	431.80
.81	20.57	24.00	609.60
6.00	152.40	34.00	863.60
9.00	228.60	48.00	1,219.20
13.00	330.20		

NOTE: Unless otherwise specified, tolerances are ±.06 (1.52 mm).

FIGURE 207-3. Anvil plate of shock-testing apparatus.

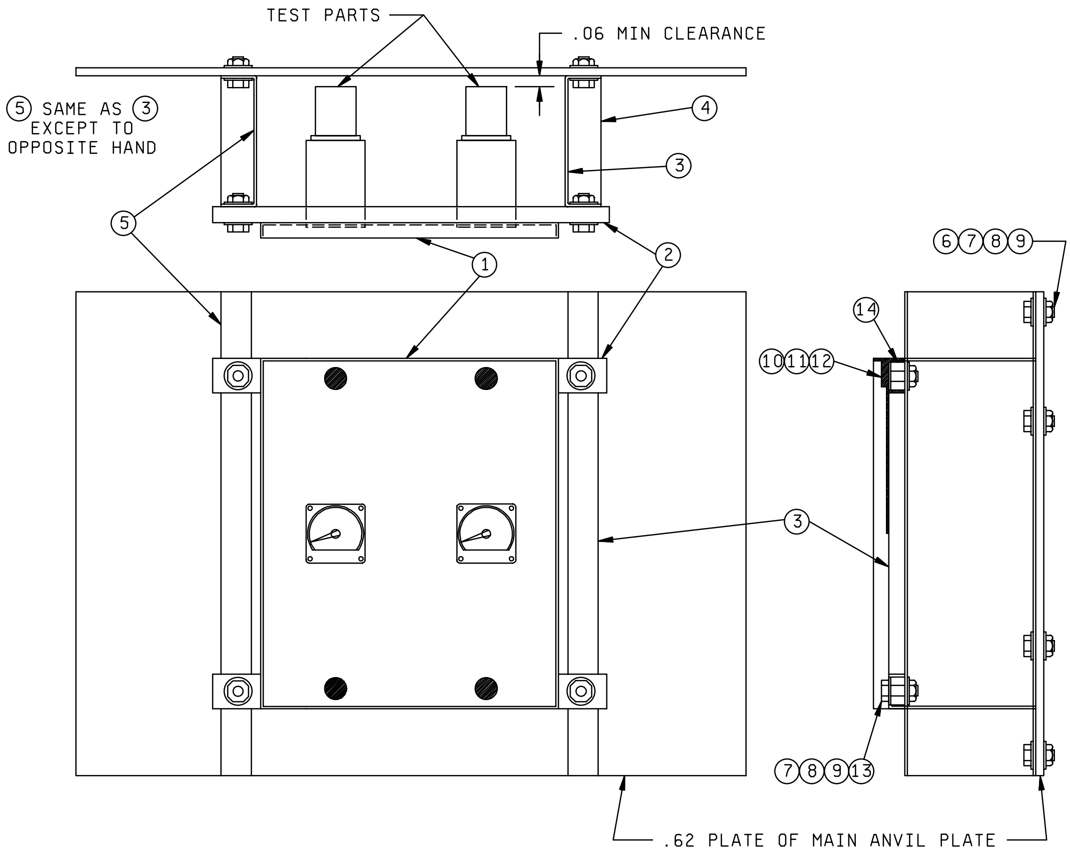


FIGURE 207-4A. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts.

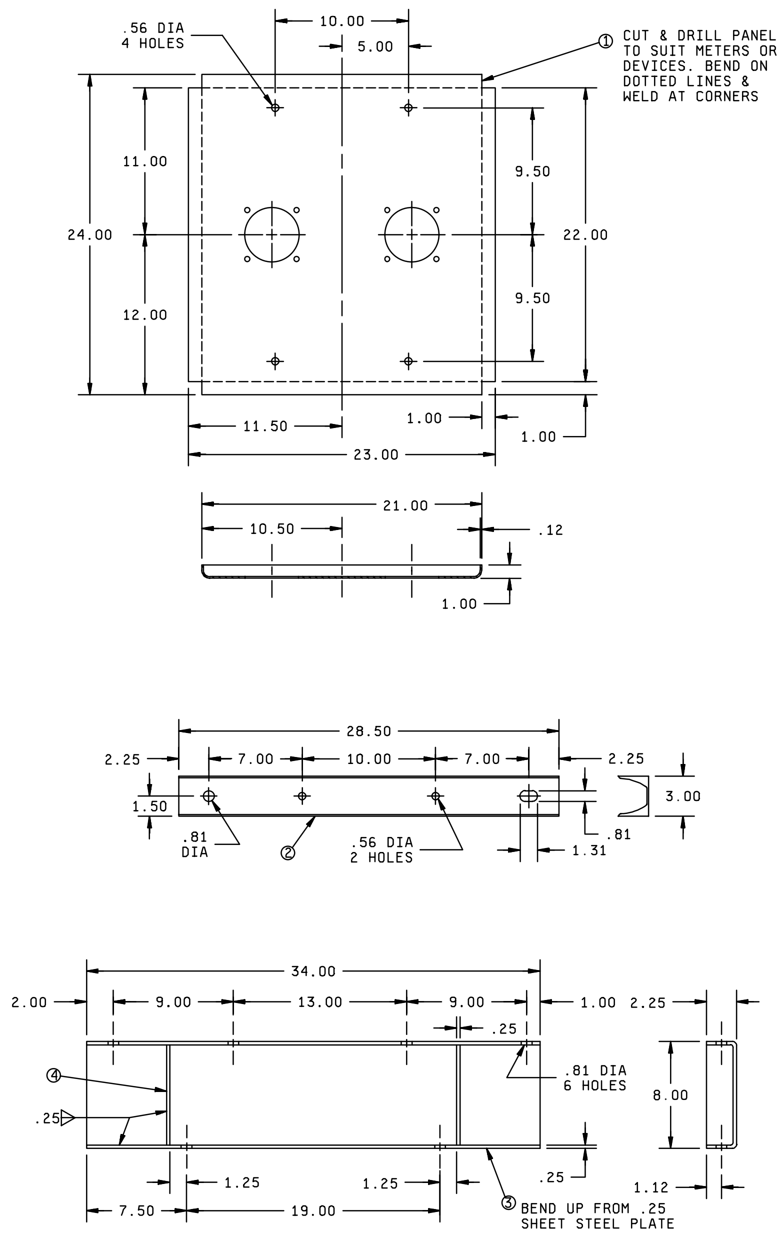


FIGURE 207-4A. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts - Continued.

Item	Description	Material	Quantity 1/
1	Panel	Steel	1
2	Standard channel, 3 x 5 pound	Steel	2
3	Fabricated spacer	Steel	1
4	Spacer stiffener	Steel	4
5	Fabricated spacer	Steel	1
6	Hex head bolt, .750-10UNC-2A x 1.75 lg	Steel	1
7	Hex head nut, .750-10UNC-2B	Steel	12
8	Washer, 2.00 OD x .81 ID	Steel	12
9	Washer, 1.38 OD x .81 ID	Steel	12
10	Hex head bolt, .500-13UNC-2A x 1.00 lg	Steel	4
11	Hex head nut, .500-13UNC-2B	Steel	4
12	Washer, 1.38 OD x .56 ID	Steel	4
13	Hex head bolt, .750-10UNC-2A x 2.50 lg	Steel	4
14	Block, 2.25 x 2.00 x 1.25	Steel	4

1/ Quantities are for one mounting.

Inches	mm	Inches	mm	Inches	mm	Inches	mm
.06	1.52	1.31	33.27	7.00	177.80	12.00	304.80
.12	3.05	1.38	35.05	7.50	190.50	13.00	330.20
.25	6.35	1.50	38.10	8.00	203.20	19.00	482.60
.56	14.22	1.75	44.45	9.00	228.60	21.00	533.40
.62	15.75	2.00	50.80	9.50	241.30	22.00	558.80
.81	20.57	2.25	57.15	10.00	254.00	23.00	584.20
1.00	25.40	2.50	63.50	10.50	266.70	24.00	609.60
1.12	28.45	3.00	76.20	11.00	279.40	28.50	722.90
1.25	31.75	5.00	127.00	11.50	292.10	34.00	863.60

NOTES:

1. Unless otherwise specified, tolerance is ±.06 (1.52 mm).
2. Two identical specimens shall be mounted on the panel provided there is a minimum separation of 3.00 inches (76.20 mm) when the indicated 10.00 inches (254.00 mm) centers are used (total weight not to exceed 40 pounds).
3. In the event that the requirement of note 2 can be met, but is desired to test only one specimen, a counterbalance of approximately the same weight shall be mounted in a corresponding position on the opposite side of the panel. Mounting dimensions for the counterbalance shall be the same as for the specimen.
4. In the event that the requirement of note 2 cannot be met, the specimen shall be mounted centrally on the panel; if the individual specimen weight is in excess of 20 pounds, the panel shall be reinforced as indicated on figure 207-4B.
5. Specimens too large to be tested on this panel shall utilize the panel indicated on figure 207-4B.
6. If the depth of the specimen is such that the minimum clearance of 1.00 inch (25.40 mm) cannot be maintained, the specimen shall be turned around so that the front faces the anvil plate.

FIGURE 207-4A. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts - Continued.

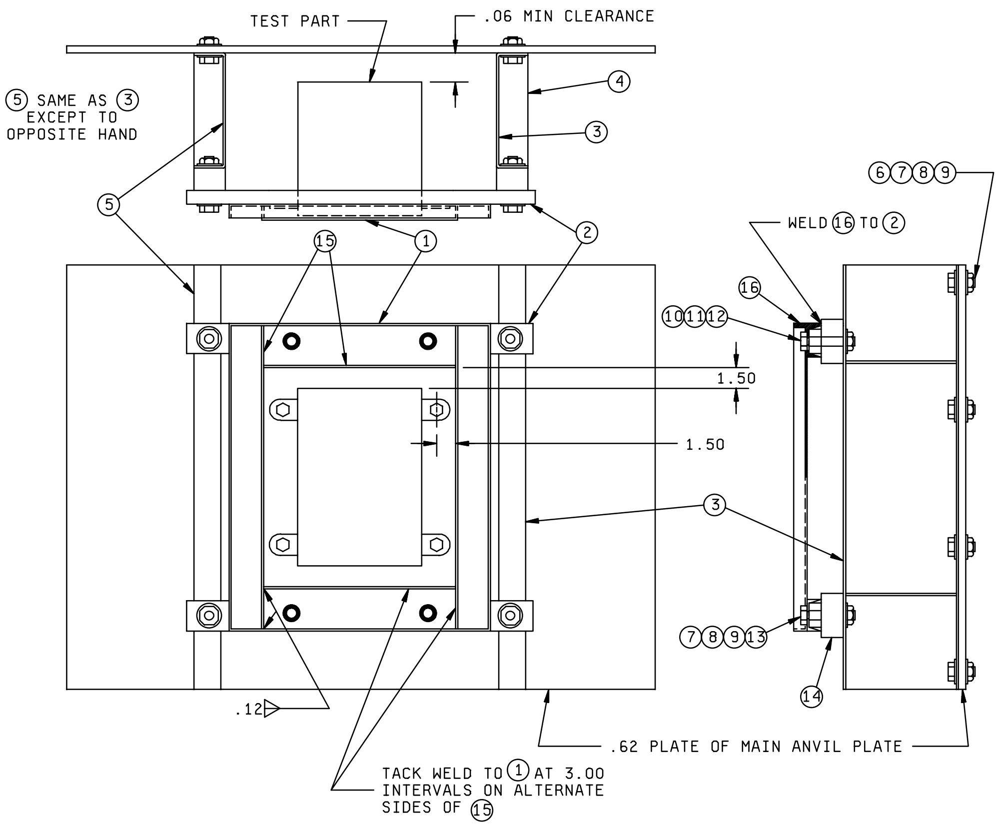


FIGURE 207-4B. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts.

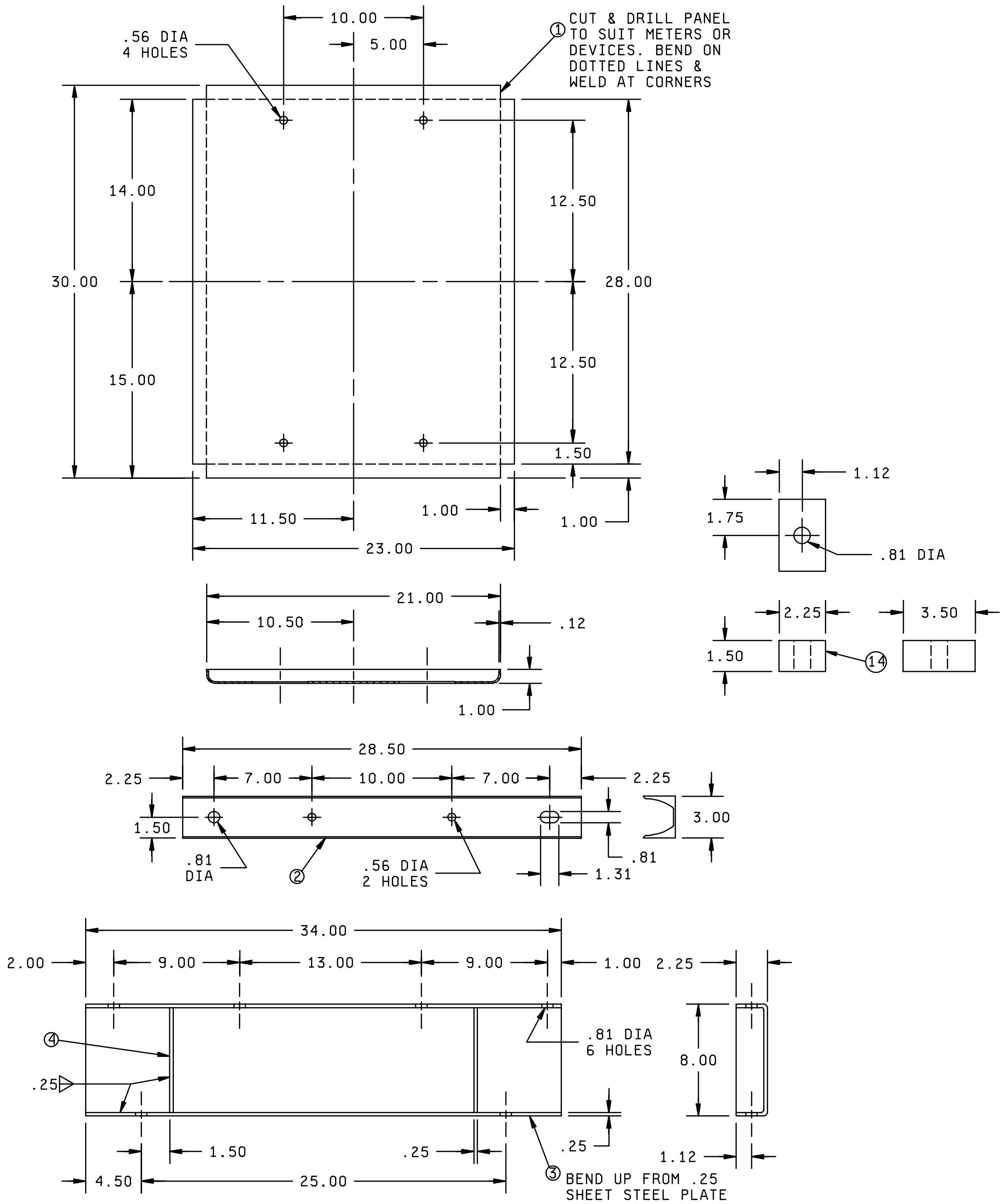


FIGURE 207-4B. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts - Continued.

Item	Description	Material	Quantity 1/
1	Panel	Steel	1
2	Standard channel, 3 x 5 pound	Steel	2
3	Fabricated spacer	Steel	1
4	Spacer stiffener	Steel	4
5	Fabricated spacer	Steel	1
6	Hex head bolt, .750-10UNC-2A x .75 lg	Steel	8
7	Hex head nut, .750-10UNC-2B	Steel	12
8	Washer, 2.00 OD x .18 ID	Steel	12
9	Washer, 1.38 OD x .18 ID	Steel	12
10	Hex head bolt, .500-13UNC-2A x 1.00 lg	Steel	4
11	Hex head nut, .500-13UNC-2B	Steel	4
12	Washer, 1.38 OD x .56 ID	Steel	4
13	Hex head bolt, .750-10UNC-2A x 4.00 lg	Steel	4
14	Spacer block	Steel	4
15	Strap, .12 x 1.00	Steel	4
16	Block, 2.25 x 21.25	Steel	4

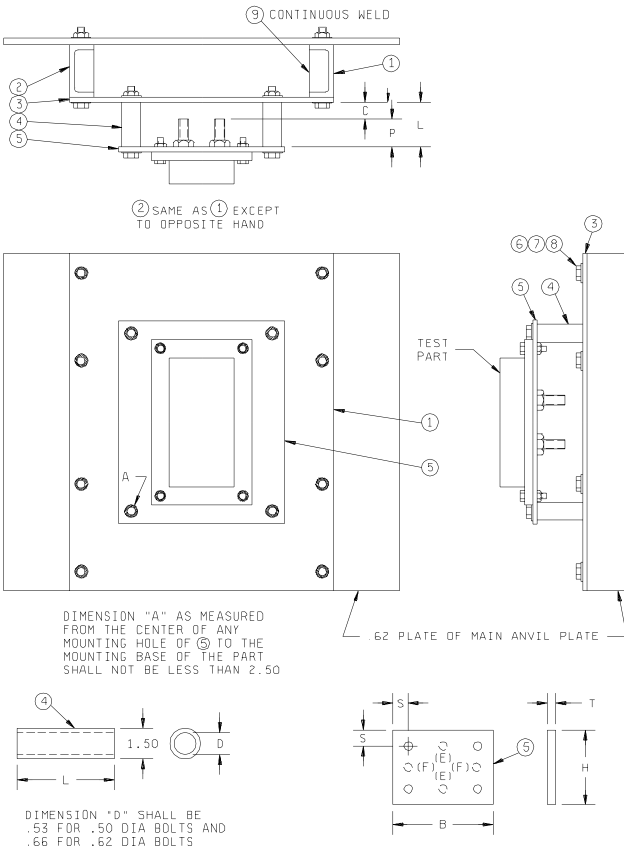
1/ Quantities are for one mounting.

Inches	mm	Inches	mm	Inches	mm	Inches	mm
.06	1.52	1.12	28.45	4.00	101.60	12.50	317.50
.12	3.05	1.31	33.27	4.50	114.30	13.00	330.20
.18	4.57	1.38	35.05	5.00	127.00	14.00	355.60
.25	6.35	1.50	38.10	7.00	177.80	15.00	381.00
.56	14.22	1.75	44.45	8.00	203.20	21.00	533.40
.62	15.75	2.00	50.80	9.00	228.60	21.25	539.75
.75	19.05	2.25	57.15	10.00	254.00	23.00	584.20
.81	20.57	3.00	76.20	10.50	266.70	25.00	635.00
1.00	25.40	3.50	88.90	11.50	292.10	28.00	710.20
						30.00	762.00
						34.00	863.60

NOTES:

1. Unless otherwise specified, tolerance is ±.06 (1.52 mm).
2. This panel shall not be used if the panel indicated on figure 207-4A is applicable.
3. The spacer blocks, item 14, shall be used only when necessary to maintain a minimum clearance of 1.00 inch (25.40 mm) between the specimen and the anvil plate.
4. In the event that the depth of the specimen is such that the minimum clearance of 1.00 inch (25.40 mm) cannot be maintained, the spacer blocks shall be removed and the specimen mounted with the front surface toward the anvil plate.

FIGURE 207-4B. Standard mounting fixtures for electrical-indicating switchboard meters and other panel-mounted parts - Continued.



Inches	mm
.18	4.57
.50	12.70
.53	13.46
.62	15.75
.66	16.76
1.00	25.40
1.50	38.10
1.94	49.28
2.00	50.80
2.50	63.50
7.00	177.80
27.00	685.80
34.00	863.60
36.00	914.40

Item	Description	Material	Quantity 1/
1	Car building channel, 4 x 13.8 pounds	Steel	1
2	Car building channel, 4 x 13.8 pounds	Steel	1
2/ 3	Auxiliary mounting plate, .50 x 27.00 x 34.00	Steel	1
4	Spacer (see table 1)	Steel	
5	Plastic mounting panel (see table 2)	Plastic, laminated, type FBG, in accordance with MIL-I-24768/14	
6	Hex head bolt; .750-10UNC-2A x 7.00 lg	Steel (heat-treated)	8
7	Hex head nut, .750-10UNC-2B	Steel	8
8	Washer, 2.00 OD x .18 ID	Steel	16
9	Pipe spacer, 1.00 standard, 1.94 lg	Steel	8

1/ Quantities are for one mounting.
2/ The size of the auxiliary mounting plate shall be increased to .50 x 36.00 x 34.00 for panels No. 5 and No. 6 listed in table II.

FIGURE 207-5. Standard mounting fixtures for electrical controller parts (contractors, relays, resistors, etc.).

Holes (E) are drilled equidistant from corner holes on same center line - panels No. 5 and No. 6 only. Holes (F) are drilled equidistant from corner holes on same center line - panels No. 4 and No. 6 only.

TABLE I. Spacers.

When P (note assembly plan view) is:		L	Remarks
Less than	Greater than		
.75 (19.05)		1.50 (38.10)	
3.25 (82.55)	.75 (19.05)	P + .75	
	3.25 (82.55)	4.00 (101.60)	Cut out .50 inch (12.70 mm) thick auxiliary mounting plate, item 3, to give .75 inch clearance around rear projections.

Selection of panel size: The panel employed shall be the smallest size shown in the above table that will result in a clearance, "A" (note assembly front elevation view), of at least 2.50.

TABLE II. Mounting panels.

Panel number	B	H	T	S	Size of bolts	Bolt-hole diameter	Quantity
1	9.00 (228.60)	12.00 (304.80)	.75 (19.05)	1.00 (25.40)	.500-13UNC-2A	.56 (14.22)	4
2	12.00 (304.80)	16.00 (406.40)	1.00 (25.40)	1.00 (25.40)	.500-13UNC-2A	.56 (14.22)	4
3	16.00 (406.40)	20.00 (508.00)	1.00 (25.40)	1.00 (25.40)	.500-13UNC-2A	.56 (14.22)	4
4	20.00 (508.00)	24.00 (609.60)	1.00 (25.40)	1.00 (25.40)	.500-13UNC-2A	.56 (14.22)	6
5	32.00 (812.80)	24.00 (609.60)	1.00 (25.40)	1.25 (31.75)	.625-11UNC-2A	.69 (17.53)	6
6	36.00 (914.40)	34.00 (863.60)	1.00 (25.40)	1.25 (31.75)	.625-11UNC-2A	.69 (17.53)	8

NOTES:
1. Metric equivalents are in parentheses.
2. Unless otherwise specified, tolerances are ±.06 inch (1.52 mm).

FIGURE 207-5. Standard mounting fixtures for electrical controller parts (contractors, relays, resistors, etc.) - Continued.

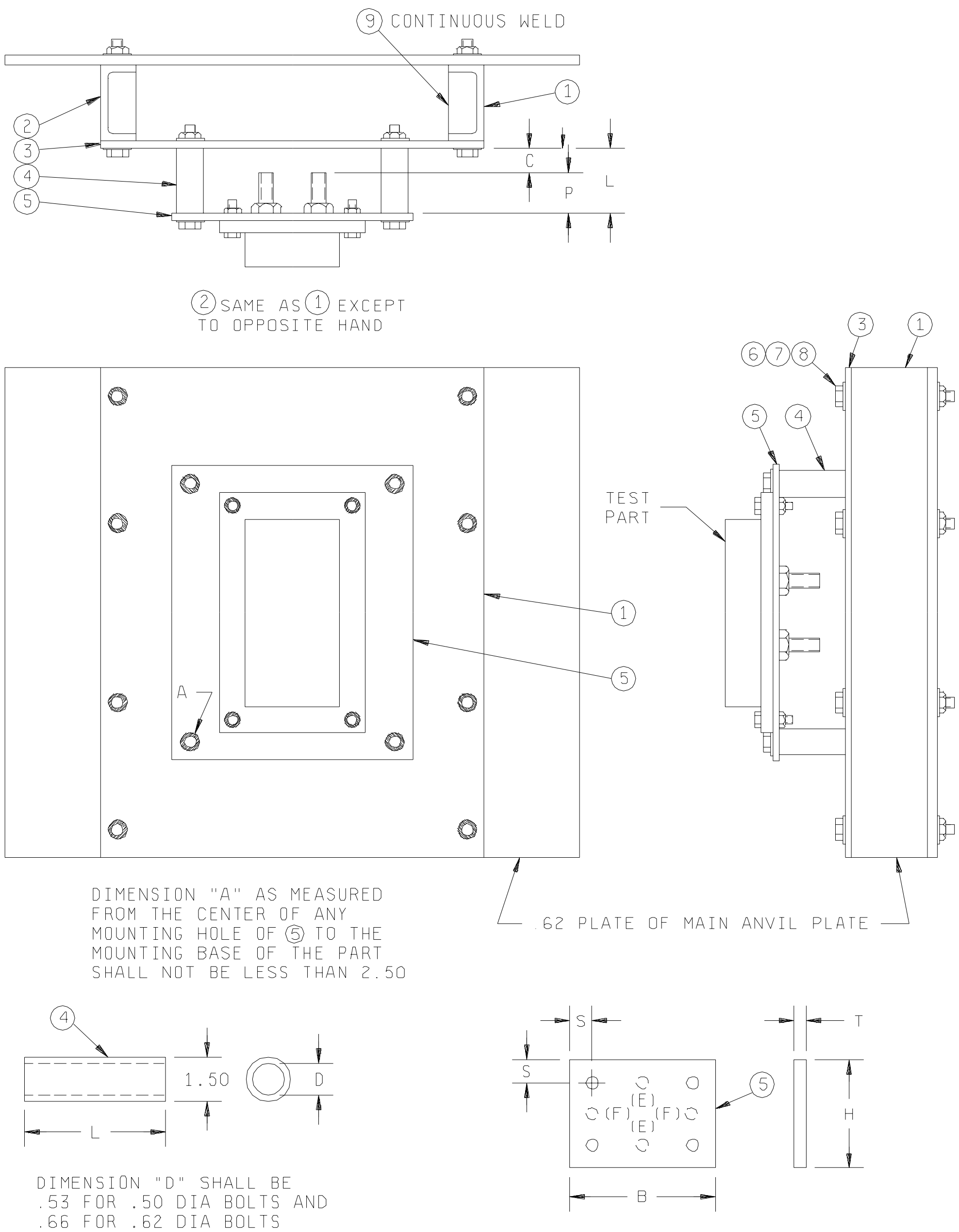


FIGURE 207-6. Standard mounting fixtures for deck, or platform, mounted parts.

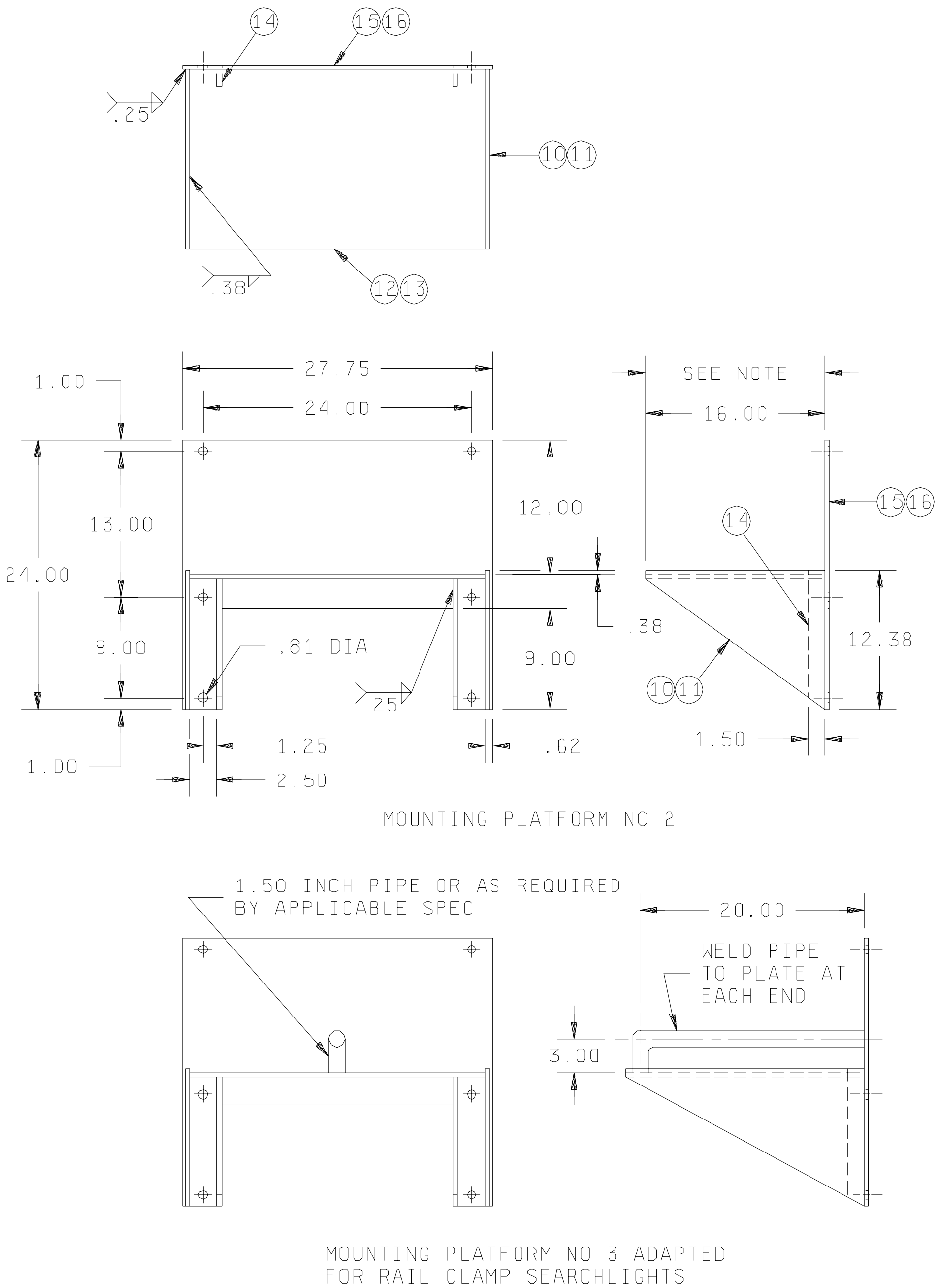


FIGURE 207-6. Standard mounting-fixtures for deck or platform mounted parts - Continued.

Item	Description	Material	Quantity 1/
1	Car building channel, 4 x 13.8 lb	Steel	1
2	Car building channel, 4 x 13.8 lb	Steel	1
3	Auxiliary mounting plate, .38	Steel	1
4	Horizontal mounting plate, .50	Steel	1
5	Hex head bolt, .750-10UNC-2A x 7.00 lg	Steel (heat-treated)	6
6	Hex head nut, .750-10UNC-2B	Steel (heat treated)	6
7	Washer, 2.00 OD x .18 ID	Steel	12
8	Pipe spacer, 1.00 standard, 2.81 lg	Steel	6
9	Gusset plate, .38	Steel	2
10	Gusset plate, .38	Steel	2
11	Gusset plate, .38	Steel	2
12	Horizontal mounting plate, .50	Steel	1
13	Horizontal mounting plate, .50	Steel	1
14	Stiffener, .38	Steel	4
15	Auxiliary mounting plate, .38	Steel	1
16	Auxiliary mounting plate, .38	Steel	1

1/ Quantities are for three mountings.

Inches	mm	Inches	mm	Inches	mm	Inches	mm
.18	4.57	1.25	31.75	9.00	228.60	20.00	508.00
.25	6.35	1.50	38.10	11.00	279.60	24.00	609.60
.38	9.65	2.00	50.80	12.00	304.80	26.50	647.70
.50	12.70	2.50	63.50	12.38	314.45	27.00	685.80
.62	15.75	2.81	71.73	13.00	330.20	27.75	704.85
.81	20.57	3.00	76.20	15.00	381.00		
1.00	25.40	7.00	177.80	16.00	406.40		

NOTES:
1. Unless otherwise specified, tolerance is ±.06 (1.52 mm).
2. Mounting platform number 3 shall be similar to mounting platform number 2 with the exception of the horizontal mounting plate and the side gusset plates shall be increased to 22.00 inches (558.80 mm).
3. The smallest mounting platform which will satisfactorily accommodate the specimen shall be selected.
4. If the deep gussets interfere with the mounted specimen, the extra bolt holes shall be used in bolting of mounting platform number 1 in the inverted position to the four lower bolt holes of the anvil plate.

FIGURE 207-6. Standard mounting-fixtures for deck or platform mounted parts - Continued.

4. PROCEDURE.

4.1 Mounting method. The specimens shall be installed by their normal mounting means on the mounting fixture in their normal operating position. Bolts for mounting the parts shall conform to type I, type II, or type III, grade 2, of MIL-DTL-1222, Studs, Bolts, Hex Cap Screws, Socket Head Cap Screws and Nuts. Mounting bolts shall be checked for tightness before each blow. Care shall be taken in the mounting procedure to prevent initial stresses being applied to the specimens prior to shock.

4.2 Anvil-plate bolts and positioning springs. Due to the severity of the shock applied to the anvil plate by a series of three blows, the anvil-plate bolts shall be checked for tightness before each series of blows. The spacing between stops of the positioning springs (1.5 inches) shall also be corrected before each succession of blows.

4.3 Direction of shock. A total of nine blows, three through each of the three principal mutually perpendicular axes for the heights indicated in 4.4, shall be delivered to the anvil plate supporting the specimens under test. Direction of the shock shall be, in order, to the back, top, and side. Back and top blows shall be applied with the anvil plate located to receive blows from the horizontal and vertical hammers. Side blows are delivered by the horizontal hammer contacting the end shock pad of the anvil plate (see 3.1).

4.4 Height of hammer drops. The hammer shall strike the shock pad on the anvil plate, in sequence, from heights of 1 foot, 3 feet, and 5 feet.

4.5 Hammer supports. During the test, the hammer not in use shall be disengaged from the lifting cable and supported so that the hammer and its support are not in contact with the anvil plate.

4.6 Electrical load and operating conditions. The electrical load and operating conditions applied to the specimens shall be as specified.

4.7 External resilient mountings. Unless otherwise specified, no external resilient mountings associated with the specimen being tested shall be used. Integral mounting devices and external resilient mountings (if specified) associated with the specimen shall remain unblocked during tests.

5. MEASUREMENTS. Monitoring of the specimens during test (e.g., delayed contact opening of relays, momentary stopping of dynamotors, calibration errors in meters) shall be as specified. Upon completion of the required number of blows, electrical and physical measurements shall be made as specified. Allowable tolerances shall be as specified.

6. SUMMARY. The following details are to be specified in the individual specification:

a. Mounting fixtures (see 3.3).

b. Electrical load on operating conditions, if applicable (see 4.6).

c. External resilient mountings, if required (see 4.7).

d. Monitoring during test, measurements after test, and allowable tolerances, as applicable (see 5).

METHOD 208H

SOLDERABILITY

1. PURPOSE. The purpose of this test method is to determine the solderability of all terminations which are normally joined by a soldering operation. This determination is made on the basis of the ability of these terminations to be wetted by solder and the predictability of a suitable fillet resulting from solder application. These procedures will verify that the pre-assembly lead finish provides a solderable surface of sufficient quality to enable satisfactory soldering.

2. PROCEDURE. The solderability test shall be performed in accordance with ANSI/J-STD-002 "Solderabiilty Tests for Component Leads, Terminations, Lugs, Terminals and Wires" and herein. The following details and exceptions shall apply:

2.1 Contractual agreements. The contractual agreements statement in ANSI/J-STD-002 shall not apply. Any exceptions to the requirements specified in ANSI/J-STD-002 and this test method shall be documented in the individual military procurement document or approved by the procuring military activity.

2.2 Coating durability. The coating durability category (from ANSI/J-STD-002) shall be as follows:

a. Category 2 - for stranded wire (1 hour ±5 minutes steam aging with insulation removed).

b. Category 3 - for all other components (8 hours ±15 minutes steam aging).

2.3 Test method. The test method used (from ANSI/J-STD-002) shall be as follows:

a. Test A - for through-hole mount and surface mount leaded components, solid wire less than .045 inch diameter and stranded wire 18 AWG or smaller. If not otherwise specified in the procurement document, angle of immersion for surface mount leaded components shall be 90°.

b. Test B - for surface mount leadless components.

c. Test C - for lugs, tabs, terminals, solid wire greater than .045 inch diameter and stranded wire larger than 18 AWG.

3. SOLDERING IRON TEST METHOD. When specified in the individual specification, the soldering iron test method shall be performed as specified herein.

3.1 Apparatus. The soldering iron used shall be temperature controlled and shall be capable of maintaining the measured idling tip temperature within ±5.5°C. Three-wire cords and tip grounding shall be used. The solder iron shall be of such design as to provide zero voltage switching. Solder guns of the transformer type shall not be used.

3.2 Materials. The solder shall be composition Sn60Pb40A or Sn63Pb37A of ANSI/J-006 "Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications". The solder shall be of form W, flux symbol A, flux percentage symbol 6 or 7 (see ANSI/J-STD-006).

3.3 Procedure. Preparation of terminations and aging shall be as specified in ANSI/J-STD-002 and 2.2 above. Flux shall be applied by a suitable method (e.g., brush) and allowed to drain for 5 to 20 seconds. Solder in accordance with 3.2 shall be applied to the terminal along with the clean solder coated tip of an iron (unless otherwise specified in the individual specification, iron temperature shall be 350°C) to a point ¼ inch from the nearest insulating material or ½ the exposed length of the terminal, whichever is closer. The termination shall be positioned so that the iron can be applied to the test surface in a horizontal position as in figure 208-1. Unless otherwise specified in the individual specification, the iron shall be applied for a period of 5 ±0.5 seconds and shall remain stationary during this period. Only enough solder shall be applied to flow a single thin layer of new solder.

Should mechanical support for the termination be required while performing this test, such support shall be of thermally insulating material. For solder cups, the cup shall be filled with solder in accordance with 3.2, and the excess solder wicked out with a compatible fluxed solder wick. Prior to examination, flux residue shall be removed from the terminations by cleaning in a suitable solvent. Terminations shall be examined as specified in ANSI/J-STD-002.

4. SUMMARY. The following details shall be specified in the applicable procurement document.

a. Depth of immersion if other than specified.

b. Angle of immersion for surface mount leaded components, if other than 90°.

c. Measurements after test, when applicable.

d. Whether soldering iron method is to be used.

1. Soldering iron temperature if other than 350°C.

2. Duration of application of soldering iron if other than 5 ±0.5 seconds.

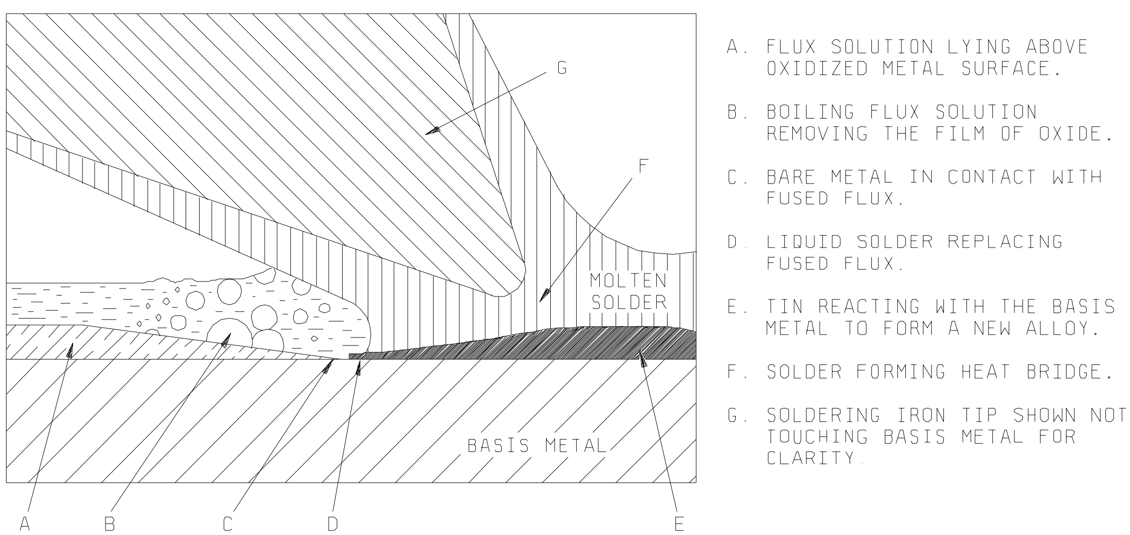


FIGURE 208-1. Soldering iron position and process diagram.

METHOD 209

RADIOGRAPHIC INSPECTION

1. PURPOSE. Radiographic inspection is generally a nondestructive (see 1.1) method for detecting internal physical defects in small component parts which are not otherwise visible. Radiographic techniques are intended to reveal such flaws as improper positioning of elements, voids in encapsulating or potting compounds, inhomogeneities in materials, presence of foreign materials, broken elements, etc.

1.1 Precautions. Radiographic inspection may be performed on most parts; however, radiation may cause changes in electrical behavior of some materials.

2. APPARATUS AND MATERIALS.

2.1 Radiographic equipment. The radiographic equipment used shall be capable of producing the required radiographic quality as specified in the individual specification. When using X-ray equipment, X-ray tubes with small effective focal-spot sizes and low inherent filtration are recommended.

2.2 Film holder. A lightproof film holder of low inherent filtration to radiation is recommended when using voltages of 50 kilovolts. A lead backing plate should be used behind the film holder to minimize fogging due to secondary back-scatter.

2.3 Image-quality indicator. The image-quality indicators used to indicate radiographic sensitivity shall be as specified in the individual specification. The sensitivity is the combined measure of the definition and contrast of the radiograph and should be such that the maximum allowable defect shall be shown. The image-quality indicator may be made from a sample part of the same type as the part being radiographed and should contain either an actual or simulated defect which is at least 10 percent smaller than the smallest defect to be detected.

2.4 Film. The film shall be compatible with the sensitivity required in 2.1. In general, finer detail is achieved by the use of finer grain films with lower exposure indexes. If extreme magnification techniques are required, the use of single emulsion films is recommended.

2.5 Nonfilm techniques. Nonfilm techniques may be used if required sensitivity levels, and records (when specified) can be obtained (see 2.1).

2.6 Personnel safety precautions. The safety precautions described in National Bureau of Standards (NBS) Handbook 76 - X-Ray Protection; NBS Handbook 73 - Protection Against Radiations From Sealed Gamma Sources; Atomic Energy Commission Book Title 10, Part 20 - Standard for Protection Against Radiation, Part 30 - Licensing of By-product Material, Part 31 - Radiation Safety Requirements for Radiographic Operations, shall be complied with when applicable.

3. PROCEDURE.

3.1 Positioning of specimen. The leaded film holder is backed up by the lead plate (see 2.2), and the specimen to be radiographed shall be placed in the position or positions specified in the individual specification.

3.2 Exposure parameters. The following exposure parameters may be varied to obtain the radiographic quality specified in 2.1:

a. Source - film distance.

b. Kilovoltage or type of isotope.

c. Milliamperage or source strength of isotope.

d. Exposure time.

e. Film speed.

f. Intensifying screen.

The detail sensitivity is affected by the following:

a. Focal spot size.

b. Film grain size.

c. Nature of the specimen.

d. Placement of the specimen.

The above factors should be taken into consideration when determining the exposure parameters.

3.3 Intensifying screens. In general, metallic intensifying screens should be used at X-ray tube voltages above 125 kilovolts to minimize fogging and for intensifying effects.

3.4 identification of radiographs. Suitable means shall be employed to identify individual specimens on the radiographic record.

3.5 Marking of radiographed specimens. If required, suitable marking shall be specified in the individual specification indicating that specimens have been inspected radiographically.

4. EVALUATIONS. The final image shall be examined with suitable viewing equipment, which may include magnification, to determine such defects as improper positioning of elements, voids in encapsulating or potting compounds; inhomogeneities in materials; presence of foreign materials; broken elements; and other defects as specified in the individual specification.

5. SUMMARY. The following details are to be specified in the individual specification:

a. Required radiographic quality (see 2.1 and 4).

b. Image-quality indicator to be used (see 2.3).

c. Records, if required for nonfilm techniques (see 2.5).

d. Position or positions of specimen (see 3.1).

e. Marking indicating that specimens have been radiographed, if required (see 3.5).

f. Evaluation of images (see 4).

(1) Specific kind of viewing equipment, if required.

(2) Magnification, if required.

(3) Defects to be sought in the specimen.

METHOD 210F

RESISTANCE TO SOLDERING HEAT

1. PURPOSE. This test is performed to determine whether wire and other component parts can withstand the effects of the heat to which they will be subjected during the soldering process (solder iron, solder dip, solder wave, or solder reflow). The heat can be either conducted heat through the termination into the component part, or radiant heat from the solder bath when in close proximity to the body of the component part, or both. The solder dip method is used as a reasonably close simulation of the conditions encountered in wave soldering, in regard to radiated and conducted heat. This test also is intended to evaluate the impact of reflow techniques to which components may be exposed. The heat of soldering can cause solder reflow which may affect the electrical characteristics of the component part and may cause mechanical damage to the materials making up the part, such as loosening of terminations or windings, softening of insulation, opening of solder seals, and weakening of mechanical joints.

2. APPARATUS.

2.1 Solder pot. A static solder pot, of sufficient size to accommodate the mounting board (see 2.4) and to Immerse the terminations to the depth specified for the solder dip (without touching the bottom of the pot), shall be used. This apparatus shall be capable of maintaining the solder at the temperature specified. The solder bath temperature shall be measured in the center of the pot at a depth of at least .500 inch (12.7 mm), but no deeper than 1 inch (25.4 mm) below the surface of the solder.

2.2 Heat sinks or shielding. The use of heat sinks or shielding is prohibited except when it is a part of the component. When applicable, heat sinks or shielding shall be specified in the individual specification, including all of the details, such as materials, dimensions, method of attachment, and location of the necessary protection.

2.3 Fixtures. Fixtures, when required, shall be made of a non-solderable material designed so that they will make minimum contact (i.e., minimum heat sink) with the component. Further, they shall not place undue stress on the component when fixtured.

2.4 Mounting board. A mounting board, in accordance with NEMA grade FR-4 of IPC-4101, 9 square inches (i.e., 3 x 3, 1 x 9, etc.), minimum area, .062 inch ±.0075 inch (1.57 mm ±.191 mm) thick, shall be used, unless otherwise specified. Component lead holes shall be drilled such that the diametrical clearance between the hole and component terminals shall not exceed .015 inch (0.38 mm). Metal eyelets or feed-throughs shall not be used. Surface mount boards, when specified in the individual specification, shall have pads of sufficient size and number to accommodate the component being tested.

2.5 Solder iron. A solder iron, capable of maintaining a temperature of 350°C ±10°C, shall be used.

2.6 Reflow chambers. The reflow chambers or equivalent (Vapor Phase Reflow (VPR) chamber, Infrared Reflow (IRR) oven, air circulating oven, etc.) shall be of sufficient size to accommodate the mounting board and components to be tested. The chamber shall be capable of generating the specified heating rate, temperatures, and environments.

2.7 Temperature measurement. Low mass thermocouples that do not affect the heating rate of the sample shall be used. A temperature recording device is recommended. The equipment shall be capable of maintaining an accuracy of ±1°C at the temperature range of interest.

3. MATERIALS.

3.1 Solder. The solder or solder paste shall be tin-lead alloy with a nominal tin content of 50 percent to 70 percent in accordance with ANSI/J-STD-006, "Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Soldering Applications" or ANSI/J-STD-005, "Requirements for Soldering Pastes". When specified in the individual specification, other solders can be used provided they are molten at the specified temperature.

3.2 Flux. When flux is used, it shall conform to type A of ANSI/J-STD-004, “Requirements for Soldering Fluxes”, or as specified in the individual specification.

3.3 VPR fluid. A perfluorocarbon fluid that has a boiling point of 215°C shall be used.

4. PROCEDURE.

4.1 Special preparation of specimens. Any special preparation of specimens prior to testing shall be as specified in the individual specification. This could include specific instructions such as bending or any other relocation of terminations, cleaning, application of flux, pretinning, or attachment of heat sinks or protective shielding (see 2.2), prior to the solder immersion.

4.2 Preparation of solder bath. The molten solder shall be agitated to assure that the temperature is uniform. The surface of the solder shall be kept clean and bright.

4.3 Application of flux. When flux is used, the terminations to be tested shall be immersed in the flux (see 3.2), which is at room ambient temperature, to the depth specified for the solder dip. The duration of the immersion shall be from 5 seconds to 10 seconds.

4.4 Test conditions. Unless otherwise specified in the individual specification, the test shall be performed on all solder terminations attached to the component part. There are six types of soldering techniques covered by these test conditions. The test conditions are outlined below and in table I.

Test condition A: Solder iron - Hand soldering of solder cups, through hole components, tab and post terminations, solder eyelet terminations.

Test condition B: Solder dip - Simulates hot solder dipping (tinning) of leaded components.

Test condition C: Wave solder - Simulates wave solder of topside board mount product.

Test condition D: Wave solder - Simulates wave solder of bottomside board mount product.

Test condition H: VPR - VPR environment without preheat.

Test conditions I, J, K: Infrared/Convection reflow - Simulates IRR, natural convection, and forced air convection reflow environments.

4.4.1 Test condition A: Solder iron.

a. When testing a solder cup, tab and post termination, or solder eyelet termination, the applicable wire size, properly prepared for the solder termination, shall be attached in the appropriate manner.

   When testing a board mount component, the component shall be placed on a mounting board (see 2.4).

b. When specified, the components shall be fluxed (see 4.3).

c. Unless otherwise specified, a solder iron in accordance with 2.5 shall be used.

d. The solder iron shall be heated to 350°C ±10°C and applied to the termination for a duration of 4 seconds to 5 seconds as specified in table I. The solder and iron shall be applied to the area of the assembly closest to the component body that the product is likely to experience. For surface mount components, the iron shall be placed on the pad only.

e. Remove the iron and allow the component to cool and stabilize at room ambient conditions. If flux was used, the component shall be cleaned using an appropriate cleaning solution.

f. The component shall be visually examined under 10X magnification.

4.4.2 Test condition B: Solder dip.

a. Place the component in an appropriate fixture (see 2.3).

b. When specified, the leads shall be fluxed (see 4.3).

c. The specific combination of temperature, immersion and emersion rate, immersion duration, and number of heats shall be as specified in table I. Unless otherwise specified, terminations shall be immersed to within .050 inch (1.27 mm) of the component body. Terminations shall be immersed simultaneously, if the geometry of the component permits.

d. After the solder dip, the component shall be allowed to cool and stabilize at room ambient conditions. If flux was used, the component shall be cleaned using an appropriate cleaning solution.

e. The component shall be visually examined under 10X magnification.

4.4.3 Test condition C: Wave solder - topside board mount component.

a. The component under test shall be mounted on a mounting board (see 2.4).

Wire leads: Wire leads shall be brought through the board holes and bent at least 30 degrees from a line perpendicular to the board. Leads shall extend from .050 inch to .100 inch (1.27 mm to 2.54 mm) from the bottom of the board. Axial leads shall be bent at a 90° angle at a point between .06 inch and .08 inch (1.5 mm and 2.1 mm) from the body, eyelet fillet or weld unless otherwise specified (see figure 210-1).

Pin leads: Where the component is designed with rigid pin leads, the full length of the termination shall be retained. Pin leads shall not be cut or bent (see figure 210-1).

b. When specified, the leads shall be fluxed (see 4.3).

c. The specific combination of temperature, duration, and number of heats shall be as specified in table I.

d. The components, mounted on the board, shall be immersed in the solder pot so that the bottom of the board floats on the molten solder.

e. After the float, the components shall be allowed to cool and stabilize at room ambient conditions. If flux was used, the components shall be cleaned using an appropriate cleaning solution.

f. The components shall be visually examined under 10X magnification.

4.4.4 Test condition D: Wave solder - bottomside board mount product.

a. Place the component in an appropriate fixture (see 2.3).

b. When specified, the terminations shall be fluxed (see 4.3).

c. The specific combination of temperature, preheat conditions, immersion and emersion rates, immersion duration, and number of heats shall be as specified in table I.

d. The component shall be preheated and fully immersed in the solder bath in accordance with 4.4.4c.

e. After the immersion, the component shall be allowed to cool and stabilize at room ambient conditions. If flux was used, the component shall be cleaned using an appropriate cleaning solution.

f. The component shall be visually examined under 10X magnification.

4.4.5 Test condition H: Vapor phase reflow soldering.

a. Components shall be mounted on a mounting board (see 2.4). Through-hole mounted components shall have their terminals inserted into the termination holes. Surface mount components shall be placed on top of the board.

b. A test chamber (see 2.6) shall be used which is large enough to suspend the mounting board without touching the sides or the solution. The VPR fluid shall be placed in the test chamber and shall be heated until it is boiling. The solution shall be allowed to boil for 5 minutes prior to suspending the mounting board.

c. The specific combination of temperature, duration of exposure, and number of heats shall be as specified in table I.

d. After chamber equalization, the mounting board shall be suspended into the vapor in a horizontal plane. The mounting board shall not touch the solution.

e. After the heat, the components shall be allowed to cool and stabilize at room ambient conditions. If a solder paste was used, the component shall be cleaned using an appropriate solution.

f. The components shall be visually examined under 10X magnification.

4.4.6 Test conditions I, J, K: Infared/convection reflow soldering.

a. Components shall be mounted on a mounting board (see 2.4). Through-hole mounted components shall have their terminals inserted into the termination holes. Surface mount components shall be placed on top of the board.

b. A test chamber as specified in 2.6 shall be used.

c. A low mass thermocouple shall be attached tightly to the component at an appropriate position away from the edges.

d. The specific combination of temperature, preheat, duration, and number of heats shall be as specified by test condition I, J, or K in table I and the individual procurement document.

e. The board shall be placed into the test chamber and the temperature of the component ramped at a rate of 1°C/s to 4°C/s as measured by the thermocouple. The assembly shall be above 183°C for 90 seconds to 120 seconds and held at the final temperature and time designated by the test condition. The assembly shall then be allowed to cool to room ambient temperature. This constitutes one heat cycle. The assembly shall be exposed to three heat cycles.

f. The components shall be visually examined under 10X magnification.

5. EXAMINATIONS AND MEASUREMENTS. Examinations and measurements to be made before and after the test, as applicable, shall be as specified in the individual specification. After the procedure, the specimens shall be allowed to cool and stabilize at room ambient conditions, for the time specified in the individual specification.

5.1 Internal examination. When specified, internal examination of the part shall be made after the test to check for solder reflow or heat damage.

6. SUMMARY. The following details are to be specified in the individual specification:

a. The use of heat sinks or shielding is prohibited except when they are part of the component (see 2.2).

b. Mounting board, if different from that specified (see 2.4).

c. Solder, if different from that specified (see 3.1).

d. Flux, if applicable and if different from that specified (see 3.2, 4.1, and 4.3).

e. Solder terminations that are not to be tested, if applicable (see 4.4).

f. Special preparation of specimens if applicable (see 4.1).

g. Depth of immersion in the molten solder, if different from that specified (see 4.4.2).

h. Test condition letter (see 4.4).

i. Cooling time prior to final examinations and measurements (see 4.4 and 5).

j. Examinations and measurements before and after test, as applicable (see 5).

k. Method of internal inspection, if required (see 5.1).

TABLE I. Test conditions.

Solder technique simulation	Test condition	Temperature (°C)	Time (s)	Temperature ramp/ immersion and emersion rate	Number of heat cycles
Solder iron	A	350 ±10 (solder iron temp)	4 - 5		1
Dip	B	260 ±5 (solder temp)	10 ±1	25mm/s ±6 mm/s	1
Wave: Topside board-mount product	C	260 ±5 (solder temp)	20 ±1		1
Wave: Bottomside board-mount product	D	260 ±5 (solder temp)	10 ±1	Preheat 1°C/s-4°C/s to within 100°C of solder temp. 25 mm/s ± 6 mm/s	1
	E	CANCELLED			
	F	CANCELLED			
	G	CANCELLED			
Vapor phase reflow	H	215 ±5 (vapor temp)	60 ±5		1
IR/convection reflow	I	215 ±5 (component temp)	30 ±5	1°C/s-4°C/s; time above 183°C, 90 s - 120 s	3
	J	235 ±5 (component temp)	30 ±5	1°C/s-4°C/s; time above 183°C, 90 s - 120 s	3
	K	250 ±5 (component temp)	30 ±5	1°C/s-4°C/s; time above 183°C, 90 s - 120 s	3

Test condition E is cancelled; use test condition C.
Test condition F is cancelled; use test condition B.
Test condition G is cancelled.

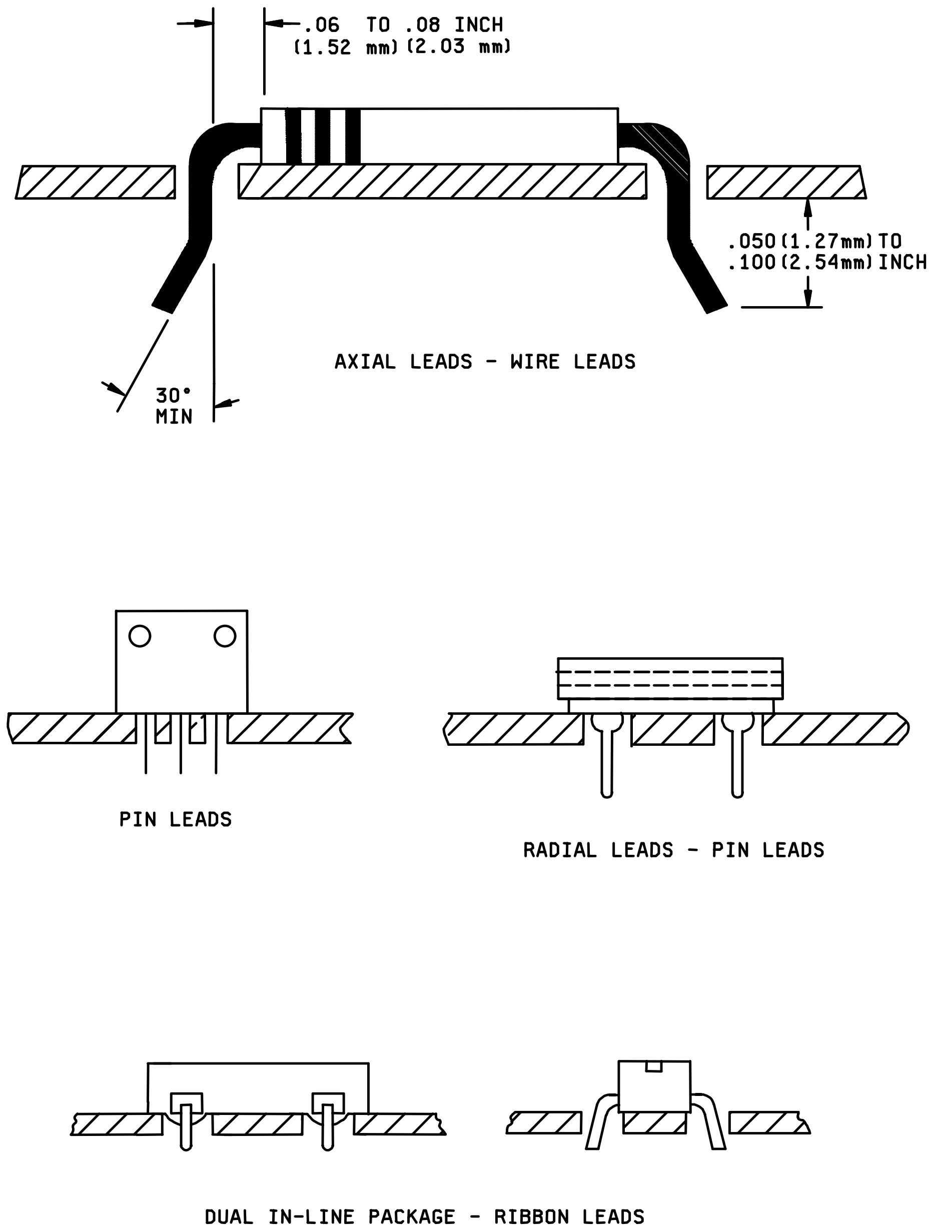


FIGURE 210-1. Component lead and mounting examples.

METHOD 211A

TERMINAL STRENGTH

1. PURPOSE. This test is performed to determine whether the design of the terminals and their method of attachment can withstand one or more of the applicable mechanical stresses to which they will be subjected during installation or disassembly in equipment. These stresses must be withstood by the component part without sustaining damage which would affect either the utility of the terminals or the operation of the component part itself. Evidence of damage caused by this test may not become evident until subsequent environmental tests are performed, such as seal, moisture resistance, or life. Procedures are established in this method for testing wire-lead terminals, flexible-flat-strip or tab-lead terminals, and rigid-type terminals which are threaded or have other arrangements for attaching conductors. The forces applied consist of direct axial, radial or tension pulls, twist, bending torsion, and the torque exerted by the application of nuts or screws on threaded terminals. These applied stresses will disclose poor workmanship, faulty designs, and inadequate methods of attaching terminals to the body of the part. Other evidence of damage may be disclosed by mechanical distortion of the part, breaking of seals, cracking of materials surrounding the terminals, or changes in electrical characteristics, such as shorted or interrupted circuits and changes in resistance values.

2. TEST CONDITIONS.

2.1 Selection. In this method there are five test conditions, A, B, C, D, and E. The selection of test conditions to perform the terminal-strength test depends on the type of terminal to be tested. The individual specification shall specify the test condition required. The following is included as a guide to be used, as applicable:

Test condition A: Pull test - also known as a tension or tensile test for terminals. It is usually applicable to most types of terminals.

Test condition B: Flat-terminal bend test - also known as a bend test. It is applicable to flexible-flat-strip or tab-lead terminals which can be bent by finger pressure.

Test condition C: Wire-lead bend test - also known as a lead-fatigue, bend, or flexibility test. It is applicable to solid-wire-lead terminals of limited ductility, such as nickel-alloy-type leads and those used in hermetically-sealed component parts.

Test condition D: Twist test - also known as a torsion test. It is usually applicable to ductile, solid-wire-lead terminals intended for wraparound connections.

Test condition E: Torque test - It is applicable to rigid-type terminals having either external screw threads or threaded inserts which are located at the center of the terminal, or to other non-wire, rigid-type terminals which should withstand the turning moment that results from a force applied from an off-center point on the terminal.

3. PROCEDURE. One or more of the following test condition letters shall be specified in the individual specification:

3.1 Test condition A (pull test).

3.1.1 Method of holding. If the method of holding or clamping is pertinent, it shall be specified in the individual specification.

3.1.2 Applied force. The force applied to the terminal shall be 1/2, 1, 2, 3, 5, 10, or 20 pounds, as specified in the individual specification.

3.1.3 Direction of applied force. The point of application of the force and the force applied shall be in the direction of the axes of the terminations, as shown on figure 211-1.

3.1.4 Duration of applied force. The force shall be applied gradually to the terminal and then maintained for a period of 5 to 10 seconds.

3.2 Test condition B (flat-terminal bend test).

3.2.1 Starting position of terminal. Prior to the test, the terminal shall be observed to determine if it is oriented in its normal or unbent position, or if it is permanently bent out of position, as could occur as a result of prior testing.

3.2.2 Bending cycle. If the method of bending is not critical, the terminals may be bent by finger pressure through a bending cycle of three bends, as shown on figure 211-2. The bending cycle shall start with a 45° bend to one side of the normal position. If the terminal is already bent to an angle between 0° and 45° to one side of the normal position prior to test, it shall be bent in the same direction until an angle of 45° is achieved. The terminal shall then be bent 90° in the opposite direction to a point 45° on the opposite side of the normal position, and then back 45° to normal. If the method of bending is critical, the individual specification shall specify the method of bending and any fixture required to control the point of application. The rate of bending shall be approximately 3 seconds per bend in each direction.

3.2.3 Number of bending operations. The number of bending operations shall be two or five, as specified in the individual specification.

3.3 Test condition C (wire-lead bend test).

3.3.1 Preparation of specimen. A load of 1/4, 1/2, 1, 5, or 10 pounds, as specified in the individual specification, shall be suspended from the terminal. The load selected shall be that closest in value to one-half the load applied during the pull test. The body of the component part shall be held with a suitable clamping or attaching device, so that the terminal is in its normal position with respect to the component part. The load shall be suspended at a point within 1/4 inch from the free end of the terminal.

3.3.2 Bending cycle. The body of the component part shall be slowly inclined so as to bend the terminal through 90° and then return it to normal position, as shown on figure 211-3. This entire action shall be limited to one vertical plane. A bend through 90° and return to normal position shall be defined as one bend. Consecutive bends shall be in the same direction. The load shall be restricted such that the bend starts 3/32 ±1/32 inch from the body of the component part. The rate of bending shall be approximately 3 seconds per bend in each direction.

3.3.3 Number of bending operations. The number of bending operations shall be three.

3.4 Test condition D (twist test).

3.4.1 Preparation of specimen. The solid-wire-lead terminal shall be bent 90° at a point 1/4 inch from its juncture with the body of the component part, as shown on figure 211-4. The radius of curvature of the 90° bend shall be approximately 1/32 inch. The free end of the terminal shall be clamped at a point 3/64 ±1/64 inch away from the bend, as shown on figure 211-4.

3.4.2 Application of torsion. The body of the component part or the clamped terminal shall be rotated through 360° about the original axis of the bent terminal, in alternating directions, for a total of three rotations 1080°, at the rate of approximately 5 seconds per rotation.

3.5 Test condition E (torque test).

3.5.1 Direction and application of torque. The torque shall be applied clockwise and then counterclockwise in a plane perpendicular to the axis of the terminal, as shown on figure 211-5.

3.5.2 Duration of applied force. The force shall be applied gradually to the terminal and then maintained for a period of 5 to 15 seconds.

3.5.3 Screw-thread terminals. When testing screw-thread terminals, the torque, in accordance with the terminal size, shall be applied to the centerline of the terminal assembly, as follows:

Screw-thread terminals	Torque (pound-inches)
No. 4	3.0
No. 6	5.0
No. 8	11.0
No. 10	15.0
No. 12	24.0
1/4 inch	32.0

3.5.4 Other non-wire, rigid-type terminals. When testing other non-wire, rigid-type terminals, the applied torque is dependent on the equivalent diameter of the external portion of the terminal assembly. The equivalent diameter is defined as equal to twice the distance from the terminal axis to the point of normal wire connection, as shown in the examples on figure 211-6. The torque shall be applied in accordance with the equivalent diameter, as follows:

Equivalent diameter (inch)	Torque (ounce-inches)
1/16 or less	0
>1/16 to 1/8 inclusive	8
>1/8 to 3/16 inclusive	18
>3/16 to 5/16 inclusive	40
>5/16 to 1/2 inclusive	80
>1/2	As specified in the individual specification

4. MEASUREMENTS. Measurements to be made before and after the test, as applicable, shall be as specified in the individual specification.

5. SUMMARY. The following details are to be specified in the individual specification:

a. Test condition letter(s) (see 3).

b. If test condition letter A is specified:

(1) If pertinent, the method of holding or clamping (see 3.1.1).

(2) Whether applied force shall be 1/2, 1, 2, 3, 5, 10, or 20 pounds (see 3.1.2).

c. If test condition letter B is specified:

(1) If critical, the method of bending and fixture required (see 3.2.2).

(2) Whether number of bends shall be 2 or 5 (see 3.2.3).

d. If test condition letter C is specified:

(1) Whether the load shall be 1/4, 1/2, 1, 5, or 10 pounds (see 3.3.1).

e. If test condition letter E is specified:

(1) Torque to be applied to non-wire, rigid-type terminals when equivalent diameter is greater than 1/2 inch (see 3.5.4).

f. Measurements before and after test, as applicable (see 4).

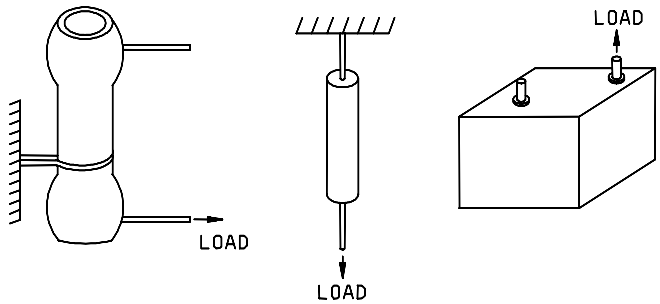


FIGURE 211-1. Test condition A.

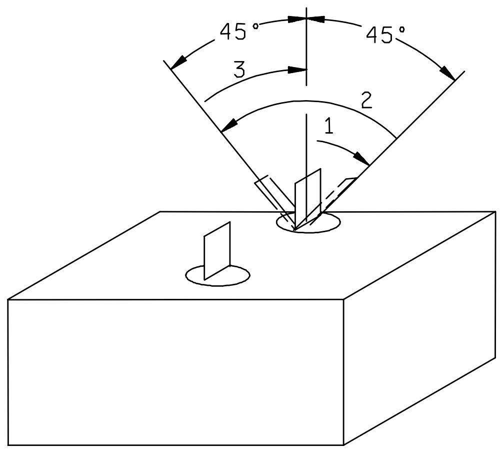


FIGURE 211-2. Test condition B.

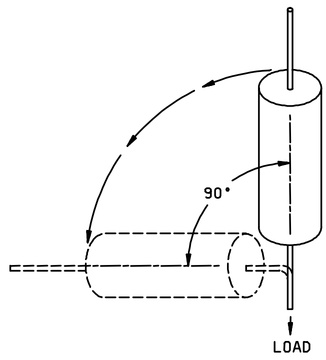
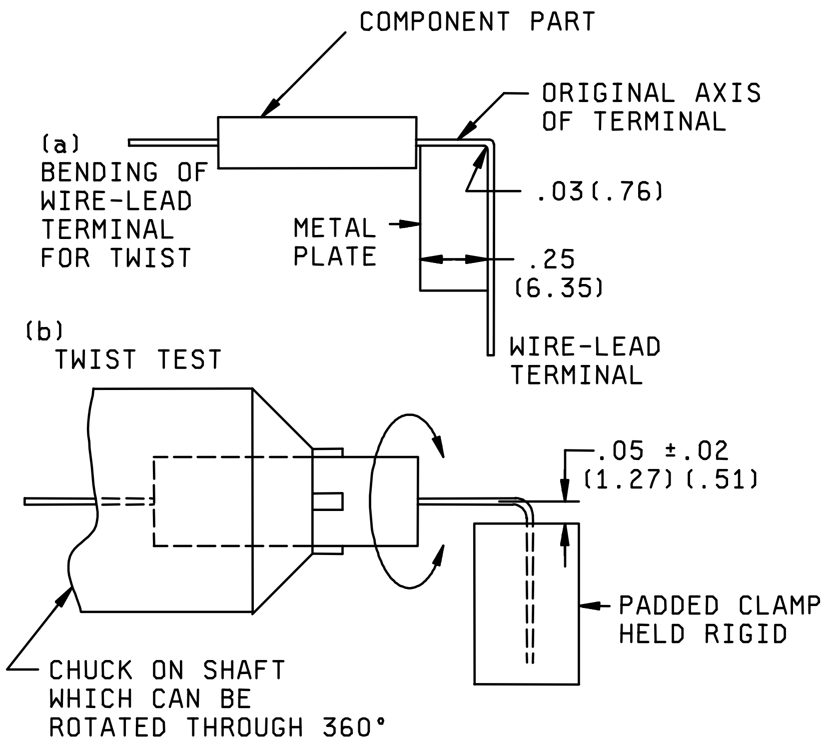


FIGURE 211-3. Test condition C.



STEP 1. Bend lead with fingers, over rounded edge of metal plate as shown in (a).
STEP 2. Center component part in chuck; secure lead in clamp as shown in (b).
STEP 3. Rotate chuck part through 360° at a rate of approximately 5 seconds per 360° rotation. Successive rotations shall be in alternate directions. A total of three such 360° rotations shall be performed. During this test, the chuck shall rotate around an axis which is fixed with respect to the padded clamp, or vice versa. The chuck shall have no appreciable end play during rotation.

NOTE: Metric equivalents are in parentheses.

FIGURE 211-4. Test condition D.

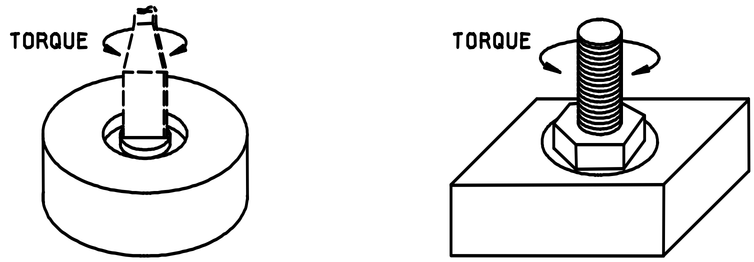
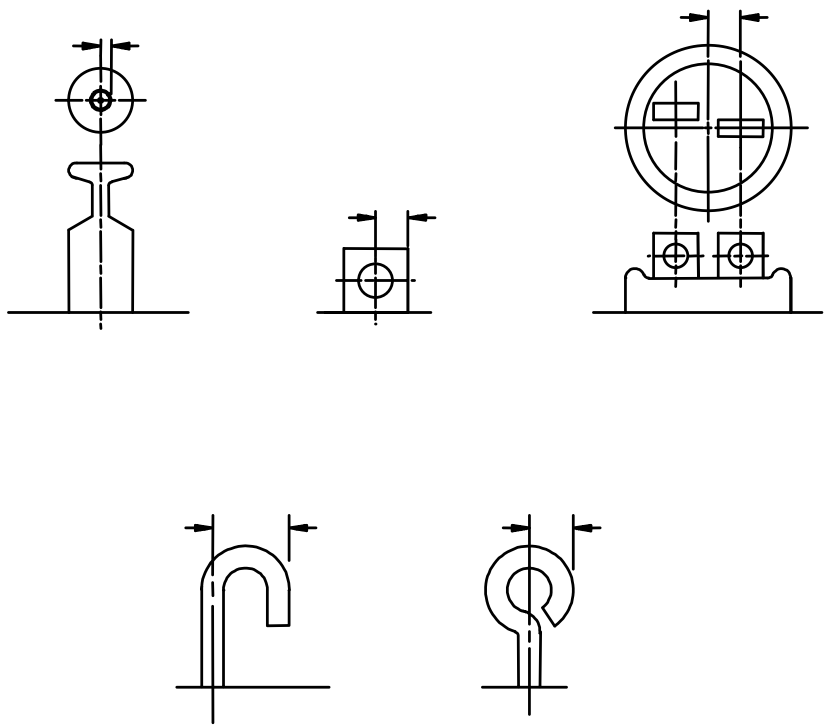


FIGURE 211-5. Test condition E.



NOTE: Equivalent diameter is twice the distance between the lines indicated by the arrows.

FIGURE 211-6. Method of determining equivalent diameter.

METHOD 212A

ACCELERATION

1. PURPOSE. This test is performed for the purpose of determining the effects of acceleration stress on component parts, and to verify the ability of the component parts to operate properly during exposure to acceleration stress such as would be experienced in aircraft, missiles, etc.

2. APPARATUS. Unless otherwise specified, the acceleration test apparatus shall be the centrifuge-type and shall be capable of subjecting the test specimen to the value of acceleration (g's) as specified in 3. The acceleration gradient across the specimen shall not exceed 15 percent of the specified g level.

2.1 Mounting accessories. Provisions shall be made to permit mounting by the normal means so that the specimen can be tested in both directions, 180 degrees apart, of each of three mutually perpendicular axes, unless otherwise specified. Parts with axial terminations weighing less than 0.5 ounce shall be soldered to stand-off terminals, leaving a distance of 0.2 inch to 0.3 inch from the point of emergence to the terminals. Parts weighing 0.5 ounce and more shall be clamped so as to avoid any stress on the leads. Parts having radial leads and those of unusual mass distribution shall be mounted as specified in the individual specification. If loading, actuating, or polarizing currents are required, they shall be specified. Provisions shall be made for all electrical connections to be secure.

3. PROCEDURE. The specimen under test shall be mounted in a rigid position as specified in 2.1 and shall be subjected to one of the following test conditions, as specified in the individual specification:

3.1 Test condition A. The specimen shall be subjected to 5 minutes acceleration of the specified "g" level in both directions of each of three mutually perpendicular axes for a total of 30 minutes at either 20, 50, or 100g level. The acceleration measured at any point of the component part shall not exceed 15 percent of the "g" level.

3.2 Test condition B. The specimen shall be subjected for 1 minute at nominally 10,000 or 20,000g in the direction as specified in the individual specification. The rate of acceleration shall be increased smoothly from zero to the specified value in not less than 20 seconds. The rate of acceleration shall be decreased smoothly to zero in not less than 20 seconds.

3.3 Test condition C. The specimen shall be subjected to the value of acceleration specified in the individual specification for 10 minutes in both directions of each of three mutually perpendicular axes. The acceleration shall be increased smoothly from zero to the specified value in approximately 2 minutes. The acceleration shall be decreased smoothly to zero in not less than 2 minutes.

4. MEASUREMENTS. The measurements made before, during, or after the test shall be as specified.

5. SUMMARY. The following details are to be specified in the individual specification:

a. Mounting of specimens (see 2.1).

b. Electrical loading if applicable (see 2.1).

c. Test condition letter (see 3).

d. If test condition A is specified, the value of g (see 3.1).

e. If test condition B is specified, the directions of application of acceleration and value of g (see 3.2).

f. If test condition C is specified, the value of acceleration (see 3.3).

g. Measurements (see 4).

METHOD 213B

SHOCK (SPECIFIED PULSE)

1. PURPOSE. This test is conducted for the purpose of determining the suitability of component parts and subassemblies of electrical and electronic components when subjected to shocks such as those which may be expected as a result of rough handling, transportation and military operations. This test differs from other shock tests in this standard in that the design of the shock machine is not specified, but the half-sine and sawtooth shock pulse waveforms are specified with tolerances. The frequency response of the measuring system is also specified with tolerances.

2. APPARATUS.

2.1 Shock machine. The shock machine utilized shall be capable of producing the specified input shock pulse as shown on figures 213-1 or 213-2, as applicable. The shock machine may be of the free fall, resilient rebound, nonresilient, hydraulic, compressed gas, or other activating types.

2.1.1 Shock machine calibration. The actual test item, or a dummy load which may be either a rejected item or a rigid dummy mass, may be used to calibrate the shock machine. (When a rigid dummy mass is used, it shall have the same center of gravity and the same mass as that of the test item and shall be installed in a manner similar to that intended for the test item.) The shock machine shall then be calibrated for conformance with the specified waveform. Two consecutive shock applications to the calibration load shall produce waveforms which fall within the tolerance envelope given on figures 213-1 or 213-2. The calibration load shall then be removed and the shock test performed on the actual test item. If all conditions remain the same, other than the substitution of the test item for the calibration load, the calibration shall then be considered to have met the requirements of the waveform.

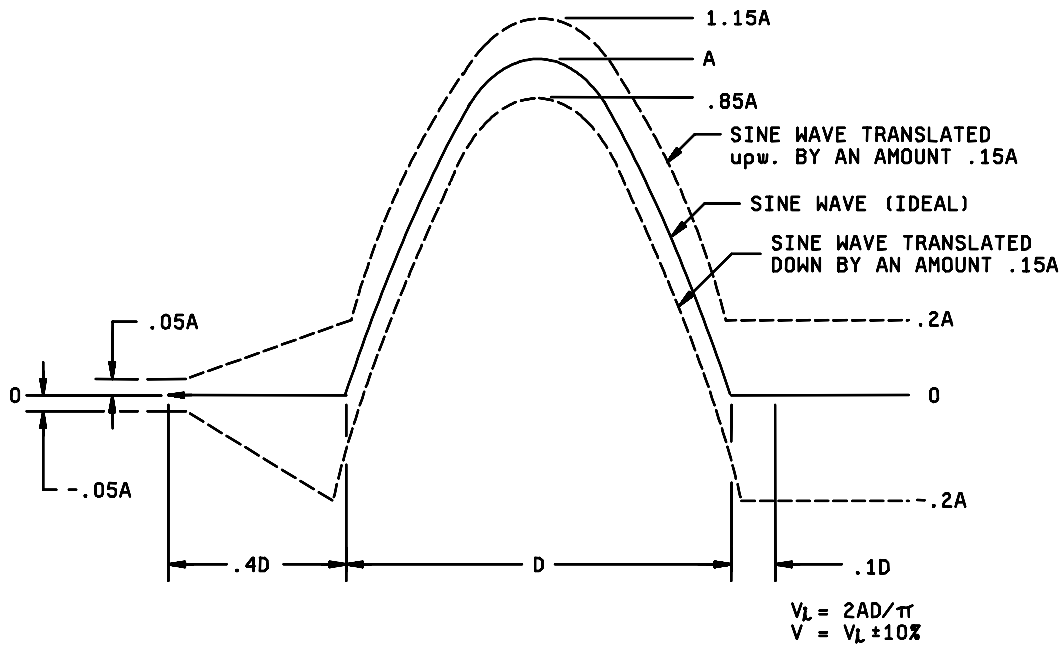
NOTE: It is not implied that the waveform generated by the shock machine will be the same when the actual test item is used instead of the calibration load. However, the resulting waveform is considered satisfactory if the waveform with the calibration load was satisfactory.

2.2 Instrumentation. In order to meet the tolerance requirements of the test procedure, the instrumentation used to measure the input shock shall have the characteristics specified in the following paragraphs.

2.2.1 Frequency response. The frequency response of the complete measuring system, including the transducer through the readout instrument, shall be as specified by figure 213-3.

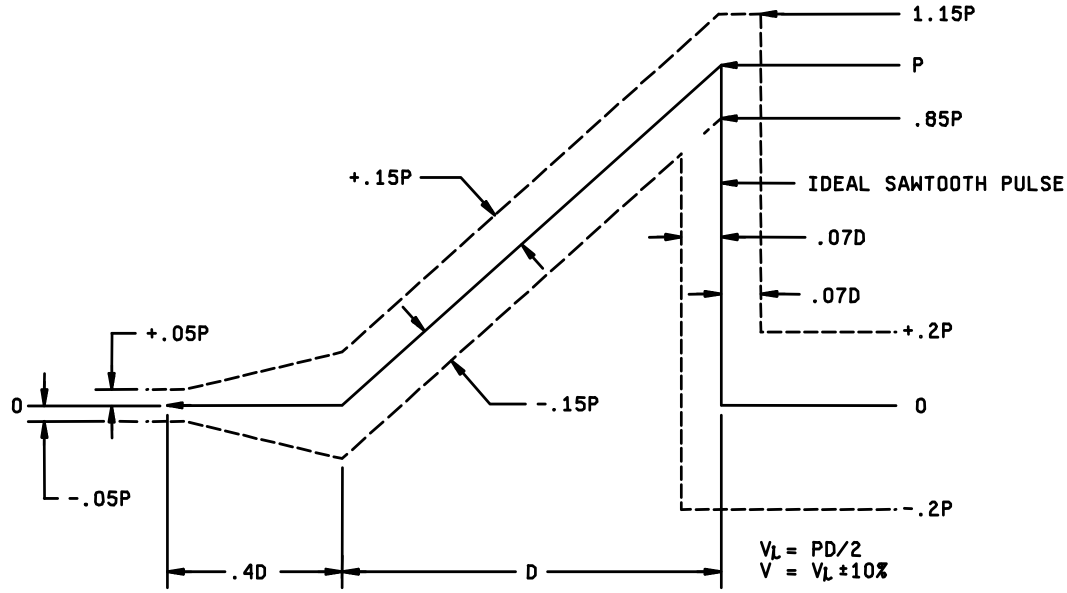
2.2.1.1 Frequency response measurement of the complete instrumentation. The transducer-amplifier-recording system can be calibrated by subjecting the transducer to sinusoidal vibrations of known frequencies and amplitudes for the required ranges so that the overall sensitivity curve can be obtained. The sensitivity curve, normalized to be equal to unity at 100 Hz, should then fall within the limits given on figure 213-3.

2.2.1.2 Frequency response measurement of auxiliary equipment. If calibration factors given for the accelerometer are such that when used with the associated equipment it will not affect the overall frequency response, then the frequency response of only the amplifier-recording system may be determined. This shall be determined in the following manner: Disconnect the accelerometer from the input terminals of its amplifier. Connect a signal voltage source to these terminals. The impedance of the signal voltage source as seen by the amplifier shall be made as the impedance of the accelerometer and associated circuitry as seen by the amplifier. With the frequency of the signal voltage set at 100 Hz, adjust the magnitude of the voltage to be equal to the product of the accelerometer sensitivity and the acceleration magnitude expected during test conditions. Adjust the system gain to a convenient value. Maintain a constant input voltage and sweep the input frequency over the range from 1.0 to 9,000 Hz, or 4 to 25,000 Hz, as applicable, depending on duration of pulse. The frequency response in terms of dB shall be within the limits given on figure 213-3.



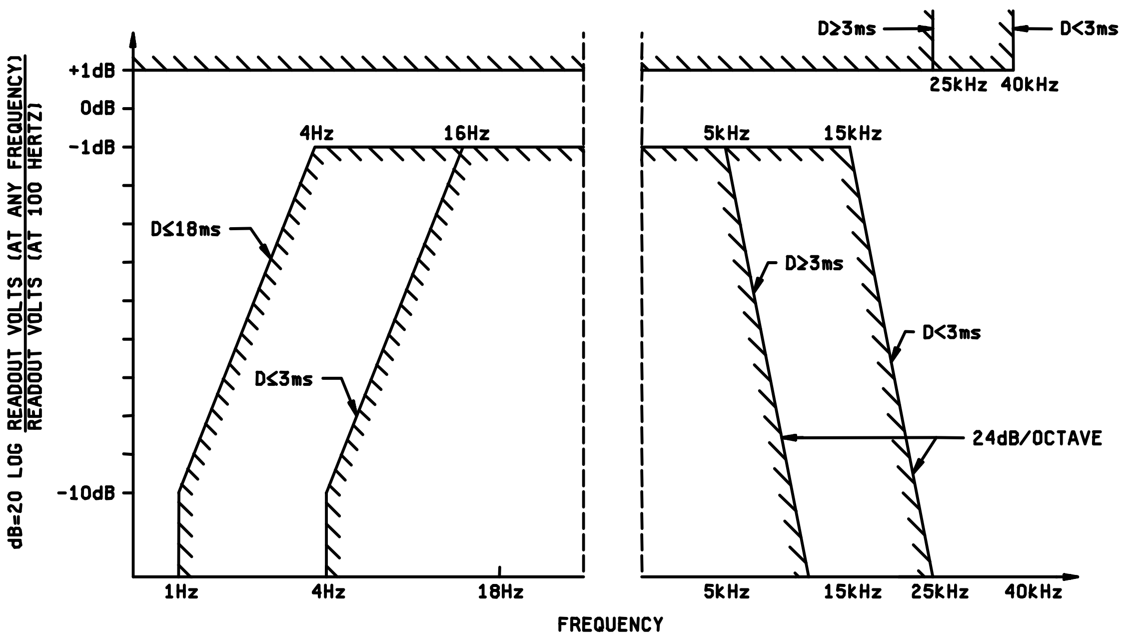
NOTE: The oscillogram should include a time about 3D long with the pulse located approximately in the center. The integration to determine velocity change should extend from .4D before the pulse to .1D beyond the pulse. The acceleration amplitude of the ideal half sine pulse is A and its duration is D. Any measured acceleration pulse which can be contained between the broken line boundaries is a nominal half sine pulse of nominal amplitude A and nominal duration D. The velocity change associated with the measured acceleration pulse is V.

FIGURE 213-1. Tolerances for half sine shock pulse.



NOTE: The oscillogram should include a time about 3D long with the pulse approximately in the center. The integration to determine the velocity change should extend from .4D before the pulse to .1D beyond the pulse. The peak acceleration magnitude of the sawtooth pulse is P and its duration is D. Any measured acceleration pulse which can be contained between the broken line boundaries is a nominal terminal-peak sawtooth pulse of nominal peak value, P, and nominal duration, D. The velocity change associated with the measured acceleration pulse is V.

FIGURE 213-2. Tolerances for terminal-peak sawtooth shock pulse.



Duration of pulse (ms)	Low frequency cut-off (Hz)		High frequency cut-off (kHz) -1 dB	Frequency beyond which the response may rise above +1 dB (kHz)
	-1dB	-10dB		
3				
<3	16	4	15	40
3	16	4	5	25
>3	4	1	5	25

FIGURE 213-3. Tolerance limits for measuring system frequency response.

2.2.2 Transducer. The fundamental resonant frequency of the accelerometer shall be greater than 30,000 Hz, when the accelerator is employed as the shock sensor.

2.2.3 Transducer calibration. Transducers shall be calibrated in accordance with ASA STD S2.2-1959. The accuracy of the calibration method shall be at least ±5 percent over the frequency range of 2 to 5,000 Hz. The amplitude of the transducer being calibrated shall also be ±5 percent over the frequency range of 4 to 5,000 Hz.

2.2.4 Linearity. The signal level of the system shall be chosen so that the acceleration pulse operates over the linear portion of the system.

2.2.5 Transducer mounting. When conformance to 2.3 is required, the monitoring transducer shall be rigidly secured and located as near as possible to an attachment point of the specimen but not on the specimen itself.

2.3 Application of shock measuring instrumentation. Shock measuring instrumentation shall be utilized to determine that the correct input shock pulse is applied to the test specimen. This is particularly important where a multi-specimen test is made. Generally, the shock pulse should be monitored whenever there is a change in the test setup, such as a different test fixture, different component (change in physical characteristics), different weight, different shock pulse (change in pulse shape, intensity, or duration) or different shock machine characteristics. It is not mandatory that each individual shock be monitored, provided that the repeatability of the shock application as specified in 2.1.1 has been established.

3. SHOCK PULSES. Two types of shock pulses, a half-sine shock pulse and a sawtooth shock pulse, are specified. The pulse shape and tolerances are shown on figures 213-1 and 213-2, respectively. For single degree of freedom systems, a sawtooth shock pulse can be assumed to have a damage potential at least as great as that of the half-sine pulse if the shock spectrum of the sawtooth pulse is everywhere at least as great as that of the half-sine pulse. This condition will exist for two such pulses of the same duration if over most of the spectrum the acceleration peak value of the sawtooth pulse is 1.4 times the acceleration peak value of the half-sine pulse.

3.1 Half-sine shock pulse. The half-sine shock pulse shall be as indicated on figure 213-1. The velocity change of the pulse shall be within ±10 percent of the velocity change of the desired shock pulse. The velocity change may be determined either by direct measurement, indirectly, or by integrating (graphically or electrically) the area (faired acceleration pulse may be used for the graphical representation) under the measured acceleration pulse. For half-sine acceleration pulses of less than 3 milliseconds duration the following tolerances should apply: The faired maximum value of the measured pulse shall be within ±20 percent of the specified ideal pulse amplitude, its duration shall be within ±15 percent of the specified ideal pulse duration, and the velocity change associated with the measured pulse shall be within ±10 percent of $V_i = 2AD/\pi$. See figure 213-1. The measured pulse will then be considered a nominal half-sine pulse with a nominal amplitude and duration equal to respective values of the corresponding ideal half-sine pulse. The duration of the measured pulse shall be taken as $D_m = D(.1A)/.94$; where D(.1A) is the time between points at .1A for the faired measured acceleration pulse.

3.1.1 The ideal half-sine pulse. An ideal half-sine acceleration pulse is given by the solid curve. See figure 213-1. The measured acceleration pulse must lie within the boundaries given by the broken lines. In addition, the actual velocity change of the shock must be within 10 percent of the ideal velocity change. The actual velocity change can be determined by direct measurements, or from the area under the measured acceleration curve. The ideal velocity change is equal to $V_i = 2AD/\pi$; where A is the acceleration amplitude and D is the pulse duration of the ideal pulse.

3.2 Sawtooth shock pulse. The sawtooth pulse shall be as indicated on figure 213-2. The velocity change of the faired measured pulse shall be within ±10 percent of the velocity change of the ideal pulse.

3.2.1 The ideal terminal-peak sawtooth. An ideal terminal-peak sawtooth acceleration pulse is given by the solid line. See figure 213-2. The measured acceleration pulse must be within the boundaries given by the broken lines. In addition, the actual velocity change of the shock pulse must be within 10 percent of the ideal value. The actual velocity change can be determined from direct measurements, or from the area under the measured acceleration curve. The ideal velocity change is equal to $V_i = PD/2$; where P is the peak value of acceleration, and D is the pulse duration.

4. PROCEDURE. The test specimen shall be mounted as specified in the component specification. Whenever possible, the test load shall be distributed uniformly on the test platform in order to minimize the effects of unbalanced loads.

4.1 Basic design test. Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen (18 shocks). If the test specimen is normally mounted on vibration isolators, the isolators shall be functional during the test. The specified test pulse (half-sine or sawtooth pulse) shall be in accordance with figures 213-1 and 213-2, respectively, and shall have a duration and peak value in accordance with one of the test conditions of table 213-1.

TABLE 213-1. Test condition values.

Test condition	Peak value (g's)	Normal duration (D) (ms)	Waveform	Velocity change (V_i) ft/sec
A	50	11	Half-sine	11.3
B	75	6	Half-sine	9.2
C	100	6	Half-sine	12.3
D	500	1	Half-sine 1/ 2/ 3/	10.2
E	1,000	0.5	Half-sine 1/ 2/ 3/	10.2
F	1,500	0.5	Half-sine 1/ 2/ 3/	15.4
G	50	11	Sawtooth 2/	8.8
H	75	6	Sawtooth 2/	7.2
I	100	6	Sawtooth 2/	9.7
J	30	11	Half-sine	6.8
K	30	11	Sawtooth	5.3

1/ For half-sine shock pulses of less than 3 milliseconds duration, it is not required that the envelope fall within the tolerances specified on figure 213-1. The faired amplitude of the measured pulse shall be within ±20 percent of the ideal amplitude. The measured duration shall be within ±15 percent of the specified amplitude duration. The velocity change of the faired measured pulse shall be within ±10 percent of the ideal pulse. The duration of the pulse shall be measured at the 0.1A point on the pulse. The duration of the pulse shall be the duration measured at the 0.1A point divided by .94. Test conditions D, E, and F are principally applicable to semiconductors.

2/ Test conditions G, H, and I (sawtooth) waveforms are preferred, except for semi- conductors, for which test conditions D, E, and F (half-sine) are preferred.

3/ For test condition D. Where the weight of multi-specimen and fixtures exceeds 150 pounds, there is a question as to whether the shock pulse is properly transmitted to all specimens. Due consideration should be given to the design of the test fixture to assure the proper shock input to each specimen. This also applies to test conditions E and F except that where the weight of the multi-specimen and fixtures exceeds 25 pounds.

5. MEASUREMENTS. Measurements are to be made before and after the required number of shocks unless otherwise specified, and during the test if specified.

6. SUMMARY. The following details are to be specified in the individual specification:

a. Mounting method and accessories (see 2.2.5 and 4).

b. Test condition letter (see 4.1).

c. Measurements before, during, and after the test (see 5).

METHOD 214A

RANDOM VIBRATION

1. PURPOSE. This test is conducted for the purpose of determining the ability of component parts to withstand the dynamic stress exerted by random vibration applied between upper and lower frequency limits to simulate the vibration experienced in various service field environments. Random vibration is characteristic of modern field environments produced by missiles, high-thrust jets and rocket engines. In these types of environments, the random vibration provides a more realistic test. For design purposes, however, a swept frequency sinusoidal test may yield more pertinent design information.

2. APPARATUS.

2.1 Vibration system. The vibration system, consisting of the vibration machine, together with its auxiliary equipment shall be capable of generating a random vibration for which the magnitude has a gaussian (normal) amplitude distribution, except that the acceleration magnitudes of the peak values may be limited to a minimum of three times the rms (three-sigma (σ) limits). The machine shall be capable of being equalized so that the magnitude of its spectral density curve will be between specified limits (for example, see figures 214-1 and 214-2) when the test item, or a substitute equivalent mass, is appropriately secured to the vibration machine. The equalization of an electro-dynamic vibration machine system is the adjustment of the gain of the electrical amplifier and control system so that the ratio of the output vibration amplitude to the input signal amplitude is of a constant value (or given values) throughout the required frequency spectrum.

2.1.1 Control and analysis of vibration.

a. Spectral density curves. The output of the vibration machine shall be presented graphically as power spectral density versus frequency. 1/ The spectral density values shall be within +40 and -30 percent (±1.5 dB) of the specified values between a lower specified frequency and 1,000 Hz, and within +100 and -50 percent (±3 dB) of the specified values between 1,000 and 2,000 Hz. A filter bandwidth will be a maximum of 1/3 octave or a frequency of 25 Hz, whichever is greater.

b. Distribution curves. A probability density distribution curve may be obtained and compared with a gaussian distribution curve. The experimentally obtained curve should not differ from the gaussian curve by more than ±10 percent of the maximum value.

1/ Power spectral density is the mean square value of an oscillation passed by a narrow-band filter per unit filter bandwidth. For this application it is expressed as G^2/f where G^2/f is the mean square value of acceleration expressed in gravitational units per number of cycles of filter bandwidth. The spectral density curves are usually plotted either on a logarithmic scale, or in units of decibels (dB). The number of decibels is defined by the equation:

$$dB = 10 \log \frac{G^2/f}{G^2r/f} = 20 \log \frac{G/\sqrt{f}}{G_r/\sqrt{f}}$$

The rms value of acceleration within a frequency band between f_1 and f_2 is:

$$Grms = \left[\int_{f_1}^{f_2} G^2 \quad f \; df \right]^{1/2}$$

Where G^2r/f is a given reference value of power spectral density, usually the maximum specified value.

2.2 Monitoring. Monitoring involves measurements of the vibration excitation and of the test item performance. When required in the individual specification, the specimen may be monitored during the test. The details of the monitoring circuit, including the method and points of connection to the specimen, shall be specified.

2.2.1 Vibration input. The vibration magnitude shall be monitored on a vibration machine, on mounting fixtures, at locations that are as near as practical to the test item mounting points. When the vibration input is measured at more than one point, the minimum input vibration shall normally be made to correspond to the specified test curve (see figures 214-1 and 214-2). For massive test items and fixtures, and for large force exciters or multiple vibration exciters, the input-control value may be an average of the average magnitudes of three or more inputs. Accelerations in the transverse direction, measured at the test item attachment points, shall be limited to 100 percent of the applied vibration. The individual specification shall specify the number and location of the test points.

3. METHOD OF MOUNTING. The specimens shall be mounted in accordance with the instructions in the individual specifications. The orientation of the specimen or direction(s) of the applied vibration motion shall be as specified. Any special test fixtures or jigs required to run the test shall be as specified in sufficient detail in the individual specification to assure reproducibility of the input motion applied to the specimen. These details shall include the dimensions, the materials, temper, etc., as applicable.

4. PROCEDURE. The specimen, or substitute equivalent mass, shall be mounted in accordance with 3 and the monitoring equipment attached, if applicable, in accordance with 2.2. The vibration machine shall then be operated and equalized or compensated to deliver the required frequencies and intensities conforming to the curves specified test condition I, figure 214-1, or test condition II, figure 214-2 (see 2.1). If the order of application of the different directions is critical, it also shall be specified in the individual specification. The specimen shall then be subjected to the vibration specified by the test condition letter (see tables 214-I and 214-II) for the duration as specified in the individual specification:

3-minutes; 15-minutes; 1-1/2 hours; or, 8-hours;

In each of three mutually perpendicular directions, and in the order specified as applicable. The measurements made before, during, and after the test shall be made in accordance with 5 and if the specimen shall be monitored during the test, the details shall be as specified in 2.2.

5. MEASUREMENTS. Measurements shall be performed before, during, and after the test as specified in the individual specification.

6. SUMMARY. The following details are to be specified in the individual specification:

a. Monitoring instrumentation, if applicable (see 2.2).

b. The number and location of test points (see 2.2.1).

c. Method of mounting and orientation (see 3).

d. Test condition (I or II); letter (A-K); and duration of test (3-minutes, 15-minutes, 1-1/2 hours, or 8-hours) (see 4).

e. Order of application of vibration direction, if applicable (see 4).

f. Measurements before, during, and after test (see 5).

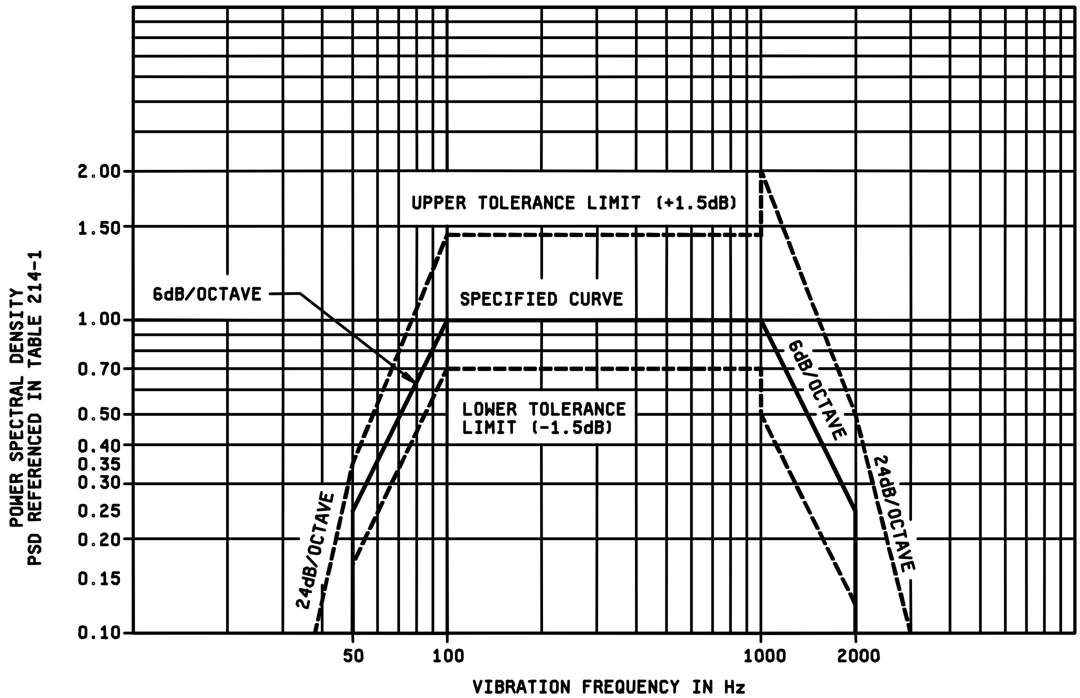


FIGURE 214-1. Test condition I, random vibration test-curve envelope (see table 214-I).

TABLE 214-I. Values for test-condition I. 1/

Characteristics		
Test condition letter	Power spectral density	Overall rms G
A	.02	5.35
B	.04	7.56
C	.06	9.26
D	.1	11.95
E	.2	16.91
F	.3	20.71
G	.4	23.91
H	.6	29.28
J	1.0	37.80
K	1.5	46.30

1/ For duration of test, see 4.

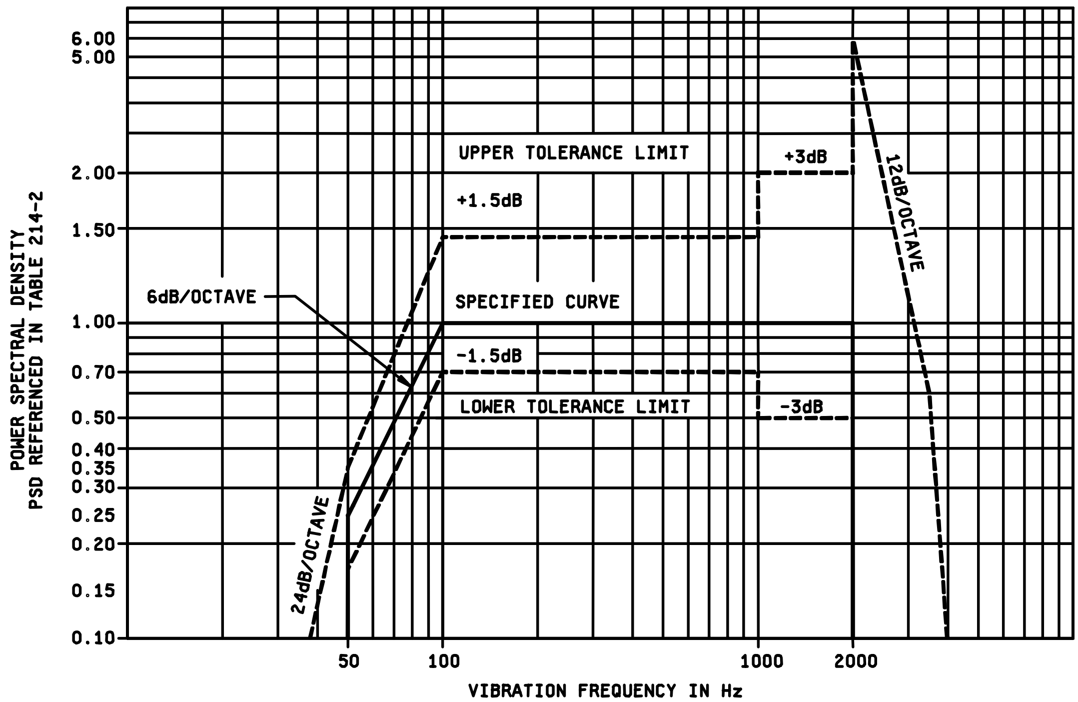


FIGURE 214-2. Test condition II, random vibration test-curve envelope (see table 214-II).

TABLE 214-II. Values for test-condition II. 1/

Characteristics		
Test condition letter	Power spectral density	Overall rms G
A	.02	6.21
B	.04	8.78
C	.06	10.76
D	.1	13.89
E	.2	19.64
F	.3	24.06
G	.4	27.78
H	.6	34.02
J	1.0	43.92
K	1.5	53.79

1/ For duration of test, see 4.

METHOD 215K

RESISTANCE TO SOLVENTS

1. PURPOSE. The purpose of this test is as follows:

   a. To verify that markings or color coding will not become illegible or discolored on the parts (including printed wiring boards) when subjected to solvents and processes normally used to clean solder-flux, fingerprints, and other contaminants from printed-wiring and terminal-board assemblies, etc.

   b. To verify that component protective coatings and encapsulant materials are not degraded to the point where electrical or mechanical integrity is disturbed when subjected to solvents and processes normally used to clean solder flux, fingerprints, and other contaminants from printed-wiring and terminal-board assemblies, etc.

1.1 Formulation of solvents. The formulation of solvents is considered typical and representative of the solvents used in printed wiring assembly processing of electronic components. Processing conditions are representative of processes used for printed wiring assembly.

1.2 Checks for conflicts. When this test is referenced, care should be exercised to assure that conflicting requirements, as far as the properties of the specified finishes and markings are concerned, are not invoked.

2. MATERIALS

2.1 Solvent solutions. The solvent solutions used in this test shall consist of the following (see table I for summary).

   a. A mixture consisting of the following:

      1. One part by volume of isopropyl alcohol, American Chemical Society (ACS) reagent grade, or isopropyl alcohol in accordance with TT-I-735, grade A or B, and

      2. Three parts by volume of mineral spirits in accordance with MIL-PRF-680, type I, or three parts by volume of a mixture of 80 percent by volume of kerosene and 20 percent by volume ethylbenzene.

   b. This solvent has been deleted. When a suitable replacement solvent has been determined, it will be added as solution b.

   c. A terpene defluxer consisting of a minimum of 90 percent d-limonene and 10 percent surfactant. 1/

   d. A mixture consisting of the following:

      1. Forty-two parts by volume water, 1 megohm-cm minimum resistivity.

      2. One part by volume of propylene glycol monomethyl ether (glycol ether PM, 1-methoxy-2-propanol).

      3. One part by volume of monoethanolamine. 2/

2.1.1 Solvent solutions, safety aspects. Solvent solutions listed in 2.1a through 2.1d exhibit some potential for health and safety hazards. Safety precautions as listed in the appropriate manufacturers material safety data sheet shall be observed.

1/ A commonly used terpene defluxer is BIOACT EC-7R. "BIOACT" is a registered Trademark of Petroferm INC; "EC-7 and EC-7R" are trademarks of Petroferm INC.
2/ Normal safety precaution for handling this solution (e.g., same as those for diluted ammonium hydroxide) based on O.S.H.A. rules for monoethanolamine.

2.2 Vessel. The vessel for solvent immersion shall be a container made of non-reactive material and of sufficient size to permit complete immersion of the specimens in the solvent solutions specified in 2.1.

2.3 Brush. The brush shall be a toothbrush with a handle made of a non-reactive material. The brush shall have three or four long rows, 1 and 1/8 ±1/8 inch in length, of hard bristles. Each row shall contain eight to twelve tufts, the free ends of which shall lie substantially in the same plane. The brush shall be used with a single solvent and when there is any evidence of softening, bending, wear, or loss of bristles, it shall be discarded.

3. PROCEDURE

3.1 Procedure. The specimens subjected to this test shall be divided into three groups of approximately equal size.

a. The first group shall be exposed to the solution specified in 2.1a.

The solution shall be maintained at a temperature of 25°C ±5°C. The specimens shall be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel specified in 2.2. Immediately following immersion, each specimen shall be tested as follows: The bristle portion of the brush, specified in 2.3, shall be dipped in the solution until wetted and the specimen shall be brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke shall be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure shall be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens shall be air-blown dry. The specimens shall be inspected in accordance with 4.1 and 4.2 to determine the extent, if any, of deterioration that has occurred.

b. This solvent solution has been deleted.

c. The second group shall be exposed to the solution specified in 2.1c.

The solution shall be maintained at a temperature of 25°C ±5°C. The specimens shall be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel specified in 2.2. Immediately following immersion, each specimen shall be tested as follows: The bristle portion of the brush, specified in 2.3, shall be dipped in the solution until wetted and the specimen shall be brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke shall be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure shall be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens shall be rinsed in approximately 25°C water and all surfaces air-blown dry. The specimens shall be inspected in accordance with 4.1 and 4.2 to determine the extent, if any, of deterioration that has occurred.

d. The third group shall be exposed to the solution specified in 2.1d.

The solution shall be maintained at a temperature of 63°C to 70°C. The specimens shall be completely immersed for 3 minutes +0.5, -0 minutes in the specified solution contained in the vessel specified in 2.2. Immediately following immersion, each specimen shall be tested as follows: The bristle portion of the brush, specified in 2.3, shall be dipped in the solution until wetted and the specimen shall be brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied. The brush stroke shall be directed in a forward direction across the surface of the specimen being tested. Immediately after brushing, the procedure shall be repeated two more times, for a total of three immersions, followed by brushing. After completion of the third immersion and brushing, the specimens shall be rinsed in approximately 25°C water and all surfaces air-blown dry. The specimens shall be inspected in accordance with 4.1 and 4.2 to determine the extent, if any, of deterioration that has occurred.

3.2 Optional exposure procedure for the third group. The test specimens shall be located on a test surface of known area which is located 6 ±1 inches (15 ±2.5 centimeters) below a spray nozzle which discharges .16 ±.005 gpm (0.62 ±0.02 liters per minute) of solution per in^2(6.5 square centimeters) of surface area at a pressure of 20 ±5 lbs/in^2 (138 ±34 kilopascal). The solvent shall be held at a temperature range of 63°C to 70°C. The specimens shall be subjected to this spray for a period of 10 minutes. After completion of the spray exposure, the specimens shall be thoroughly rinsed in water and all surfaces air-blown dry and inspected in accordance with 4.1 and 4.2 to determine the extent, if any, of deterioration that has occurred. If this optional procedure is specified, brushing of the samples in the third group is not required. If a conflict arises from the use of the spray option, the brush method of 3.1d shall be used as the referee procedure. The measurements shown in parentheses are not exact equivalents and are shown for convenience only.

3.3 Immersion test for components with marking protected by a sleeve material. Components with a protective sleeve shall be divided into three groups as specified in 3, and each group shall be subjected to testing using the solution defined for that group. Each solution shall be maintained at a temperature of 25°C ±5°C, except the solution in 2.1d shall be maintained at a temperature of 63°C to 70°C. The specimens shall be completely immersed for 3 minutes +.5, -0 minutes in the specified solution contained in the vessel specified in 2.2. Immediately following immersion, each specimen shall be tested as follows: The bristle portion of the brush specified in 2.3 shall be dipped in the solution until wetted and the specimen shall be brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the sleeve directly above the area of the marking. Immediately after brushing, the procedure shall be repeated two more times for a total of three immersions followed by brushing. The brush stroke shall be directed in a forward direction across the sleeve area above the marking. After completion of the third immersion and brushing, the specimens shall be air-blown dry. The specimens shall be inspected in accordance with 4.1 and 4.2 to determine the extent, if any, of deterioration that has occurred, including the sleeve.

3.4 Open construction parts and parts not intended for PCB mounting. Parts of open construction which are susceptible to internal damage by immersion in solvents and parts not intended for mounting on printed circuit boards, shall be divided into three groups as specified in 3, and each group shall be subjected to testing using the solution defined for that group. Each solution shall be maintained at a temperature of 25°C ±5°C, except for the solution in 2.1d, which shall be maintained at a temperature range of 63°C to 70°C, and shall be contained in the vessel specified in 2.2. Each group shall be tested as follows: The bristle portion of the brush specified in 2.3 shall be immersed in the respective solution for each group until wetted. The marking area of the specimen to be tested shall then be immediately brushed with normal hand pressure (approximately 2 to 3 ounce force applied normal to the surface) for ten strokes on the portion of the specimen where marking has been applied (test area not to exceed one-half inch square). The brush stroke shall be directed in a forward direction across the marked surface. This test shall be repeated twice for a total of three times for each specimen. The specimens shall then be inspected in accordance with 4.1 and 4.2 to determine the extent of deterioration, if any.

4. EXAMINATION AND MEASUREMENTS

4.1 Marking resistance to solvents. After subjection to the test, any specified markings which are missing in whole or in part, faded, smeared, blurred, or shifted (dislodged) to the extent that they cannot be readily identified from a distance of at least 6 inches with normal room lighting without the aid of magnification or with a viewer having a magnification no greater than 3X shall constitute failure.

4.2 Component protective coating, encapsulation material and sleeve material resistance. After subjection to the test, the specimen shall be examined for cracks, separations, crazing, swelling, softening, and degradation of body material, end caps and seals if present, or any other damage or degradation that has occurred due to solvent exposure and which effects the mechanical integrity or reliability shall constitute a failure. The examination shall be made with a viewer having a magnification of 10X maximum.

5. SUMMARY. The following details are to be specified in the individual specification:

a. The number of specimens to be tested.

b. Optional procedure for the third group allowed (see 3.2).

TABLE I. Summary table for resistance to solvents.

Solvent 1	Solvent 2	Solvent 3	Solvent 4
1 part (by volume) of isopropyl alcohol (ACS) reagent grade or TT-I-735, grade A or B and 3 parts (by volume) of mineral spirits per Mil-Prf-680, type I, or three parts (by volume) of a mixture of 80% (by volume) of kerosene and 20% (by volume) ethylbenzene.	This solvent has been deleted.	Terpene defluxer	42 parts (by volume) of water 1 part (by volume) of propylene glycol monomethyl ether 1 part (by volume) of monoethanolamine
Immersion 3 +.5, -0 minutes, 25°C ±5°C		Immersion 3 +.5, -0 minutes, 25°C, ±5°C	Immersion 3 +.5, -0 minutes, 63°C to 70°C
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
Immersion 3 +.5, -0 minutes, 25°C ±5°C.		Immersion 3 +.5, -0 minutes, 25°C ±5°C.	Immersion 3 +.5, -0 minutes, 63°C to 70°C.
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
Immersion 3 +.5, -0 minutes, 25°C ±5°C.		Immersion 3 +.5, -0 minutes, 25°C ±5°C.	Immersion 3 +.5, -0 minutes, 63°C to 70°C.
Brush 10 strokes (wet bristle) 2 to 3 oz.		Brush 10 strokes (wet bristle) 2 to 3 oz.	Brush 10 strokes (wet bristle) 2 to 3 oz.
		Rinse in water	Rinse in water.
Air blow dry.		Air blow dry	Air blow dry.
Inspect at 3X maximum for marking. Inspect at 10X maximum for part damage.		Inspect at 3X maximum for marking. Inspect at 10X maximum for part damage.	Inspect at 3X maximum for marking. Inspect at 10X maximum for part damage.

METHOD 216

RESISTANCE TO SOLDER WAVE HEAT

<u>NOTICE</u>

Method 216 has been canceled effective 16 April 1973. Use the test conditions in method 210 in lieu of the test conditions of method 216. Use the table below for the applicable cross reference.

When method 216 is specified	Use method 210
Test condition A	Test condition C
Test condition B	Test condition D
Test condition C	Test condition E

METHOD 217A

PARTICLE IMPACT NOISE DETECTION (PIND)

1. PURPOSE. The purpose of this test is to detect the presence of free moving particulate contaminants within sealed cavity devices. This test method is specifically directed toward relays and other devices where internal mechanism noise makes rejection exclusively by threshold level impractical. This test method also may be used prior to final sealing in the manufacturing sequence as a means of eliminating loose particles from the interior of the device.

2. APPARATUS. The basic PIND system is comprised of the following components: (Substitutions of individual units or complete system may be made providing the test requirements of paragraph 3 are met.)

a. Vibration power source consisting of electrical driver audio oscillator and low frequency audio amplifier.

b. Ultrasonic sound detection system consisting of a crystal transducer with frequency response of 36 kHz - 44 kHz and associated translator preamplifier capable of converting transducer output to 20 Hz - 5 kHz.

c. Small vibration shaker or two shakers coupled together.

d. Oscilloscope, single beam, with 100 kHz minimum bandwidth capable of external synchronization.

e. Audio speaker or headset.

f. Test fixture to adapt transducer to shaker head and isolate it from external noise sources.

g. Holding fixture designed to hold flat surface of unit under test firmly against the sensing surface of the transducer.

h. Shock test fixture (see figure 217-3).

i. Calibration unit per 3.1c.

j. Random vibration generator.

3. PROCEDURE. Test equipment shall be assembled as shown on figure 217-1. System calibration, as defined in 3.1b, shall be performed at the following intervals:

a. Each time equipment is turned on.

b. Each change of operators.

c. At initial and completion of test for each group of devices.

d. Every four hours throughout testing.

Whenever system sensitivity is found to be below specified minimum, all units tested subsequent to previous acceptable calibration shall be retested. Units rejected for particle noise shall not be reworked or retested for the purpose of acceptance. Units rejected for excessive mechanism noise may be retested for the purpose of eliminating the mechanism noise.

3.1 Calibration.

a. Each unit of test equipment subject to calibration shall be maintained in accordance with ANSI/NCSL Z540-1.

b. System calibration shall consist of verifying the proper oscilloscope pattern while calibration unit is being energized by the shaker head at the frequency and acceleration specified in 3.2. Calibration shall also include elimination of extraneous noise which interferes with proper performance of the test.

c. Test the system with a container (size approximately ½" (12.7 mm) X 1" (25.4 mm) X 1" (25.4 mm) or smaller) which contains a 60/40 solder ball with a diameter of 0.005''. Listen to the audible sound and observe the oscilloscope response to the solder ball.

d. Test the system with a container (size approximately 1/2" (12.7 mm) X 1" (25.4 mm) X 1" (25.4 mm) or smaller) which contains no particle, and compare the audible sound and the oscilloscope response to the results of step c to insure that particles are detectable.

3.2 Test setup. The area in which the PIND system is used shall be carefully selected to avoid external interference from electrical and mechanical noise which will decrease the effectiveness of the test.

a. Set audio oscillator to 27 ±1 Hz.

b. Adjust audio amplifier to produce 3-5g (.07" (1.78 mm) - .14" (3.56 mm) displacement) at shaker head.

c. Check mechanical and electrical systems to minimize background noise. Background noise shall not increase more than 3 dB when shaker is placed in operation (except shaker reversal noise) and total system noise shall not exceed 20 mV. Adjust oscilloscope trace to less than 4 divisions displacement and center shaker reversal noise as shown on figure 217-2a. No other noise spikes shall be detectable.

d. Adjust audio output to comfortable level.

e. With calibration unit mounted on shaker verify proper oscilloscope and system sensitivity to produce random noise spikes of 40 mV minimum (figure 217-2c).

3.3 Test procedure.

3.3.1 Degausing. Devices not incorporating permanent magnets and devices being tested prior to final magnetization shall be degaused prior to PIND testing.

3.3.2 Lead protection. When a device incorporates relatively long and flexible leads, the leads shall be suitably restrained from striking the shaker/fixture or striking each other during test. Care shall be taken to prevent damage caused by resonance.

3.3.3 Testing. Mount unit under test in the center of acoustic transducer with largest flat surface down (paragraph 4b). Energize shaker and monitor for visual and audible evidence of loose internal material as evidenced by nonperiodic noise spikes (figure 217-2c). A single burst of noise is cause for rejection whether or not the indication can be repeated.

Allow test to proceed for approximately 5 seconds. If no failure is detected, apply a random acceleration for 3 seconds maximum or 3 to 5 shock pulses (not to exceed the rating of the device) perpendicular to the axis of vibration (see figure 217-3). Monitor for 5 seconds then repeat random vibration or shocks and monitor for an additional 5 seconds (30 seconds maximum per axis).

NOTE: If excessive mechanism noise occurs (figure 217-2d) such that particle noise would be undetectable, the following action may be taken to reduce the noise:

a. Reorient unit by rotation about the shaker axis.

b. Change shaker amplitude within the specified limits.

c. Tilt shaker axis off vertical in any direction (not exceeding 30°) to provide a gravitational side component to the shaker acceleration.

d. With approval of the procuring agency, a different test frequency may be established for a given device.

e. Cancel out periodic noise.

If no particle is detected rotate unit to another flat surface providing vibration in a different axis. Repeat above test for not to exceed 30 seconds. Units shall not be tested with terminals or other non-cavity portions of the assembly in contact with the transducer.

3.3.4 Marking. If specified (see 4d), those units which successfully pass PIND test shall be marked "PIND" on any surface providing existing markings are not obscured.

3.3.5 Failed units. Those units which exhibit either particle noise or excessive mechanism noise which cannot be eliminated as described in 3.3.3 shall be rejected from the lot.

4. SUMMARY. The following details are to be specified in the individual specification:

a. Test frequency and acceleration if other than specified.

b. Axes of vibration if other than specified.

c. Test duration if other than specified.

d. Test acceptance marking if specified.

e. Frequency and magnitude of random noise generator shall be specified.

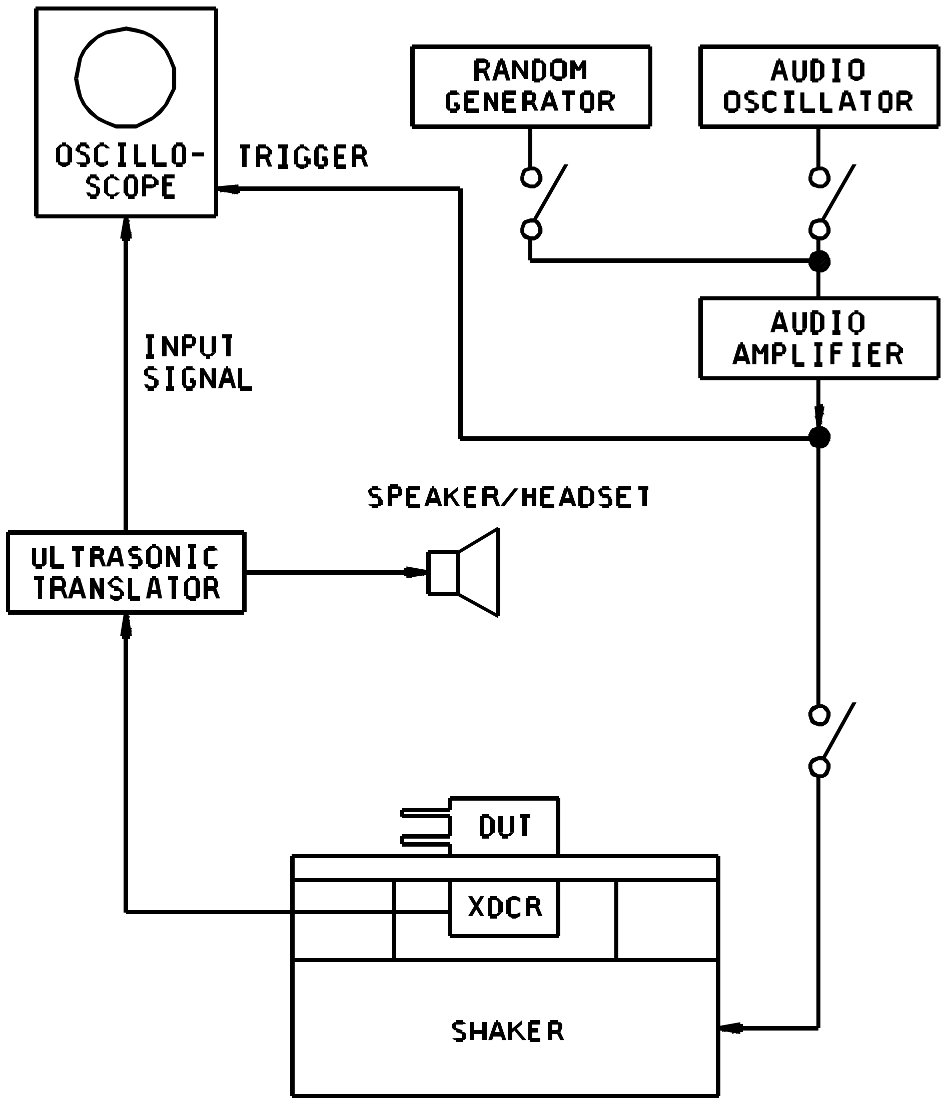
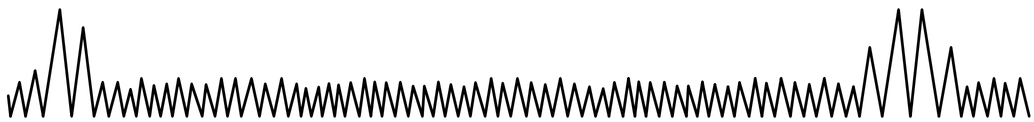
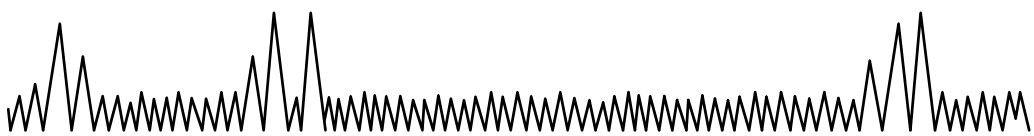


FIGURE 217-1. Typical test circuit.

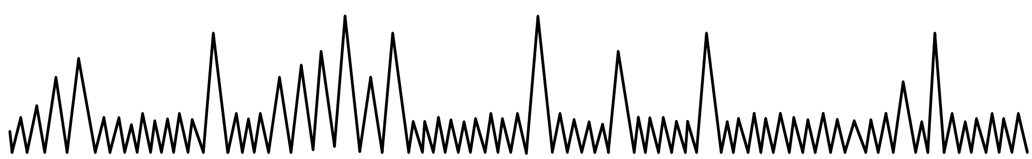
ACCEPTANCE CRITERIA: Each unit tested shall meet the acceptance.



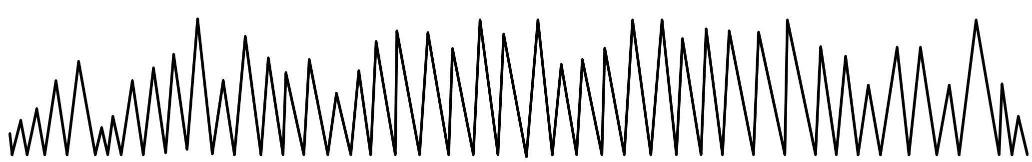
SHAKER NOISE
Timebase adjusted to locate shaker reversal noise bursts at ends of oscilloscope trace. Test unit not mounted. a



INHERENT MECHANICAL NOISE
Synchronized spike may appear at different locations on time base for each unit under test. b

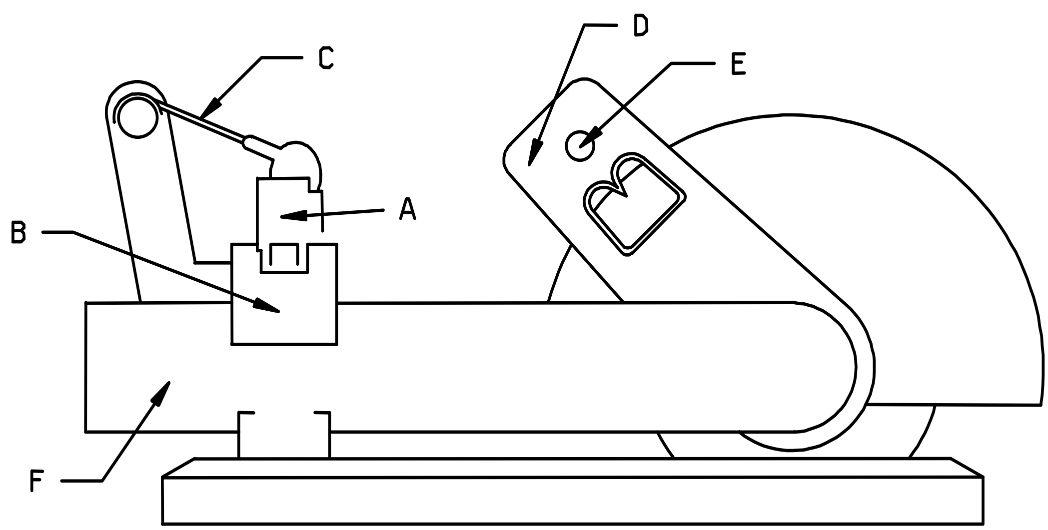


PARTICULATE NOISE
Non-synchronized spikes of any magnitude appear randomly and may disappear as test progresses. Unit is rejectable. c



EXCESSIVE MECHANICAL NOISE
Synchronized trace masks more than 50% of oscilloscope trace. Unit is rejectable. d

FIGURE 217-2. Representative oscilloscope traces.



A. Unit under test.
B. Holding fixture.
C. Holding spring.
D. Angle indicator and adjustment.
E. Holding and dropping pin.
F. Dropping arm.

FIGURE 217-3. Shock test fixture.