

INCH-POUND
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16 January 2001
SUPERSEDING
(See 6.8)

PERFORMANCE SPECIFICATION

SPEEDOMETERS; TACHOMETERS; FLEXIBLE SHAFT ASSEMBLIES; FLEXIBLE SHAFT ASSEMBLY CORES, ADAPTERS AND TRANSMITTERS

This specification is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This specification covers mechanical and electrical speedometers and tachometers, flexible shaft assemblies, flexible shaft assembly cores, adapters and transmitters.

1.2 Classification. The speedometers, tachometers, shaft assemblies, cores, adapters and transmitters are of the following types, groups and classes as specified below (see 6.2(b)).

Type I - Mechanical

Group A - Speedometer, fixed mounting.

Group B - Tachometer, fixed mounting.

Class 1 - Shaft assembly, flexible, metallic.

Class 4 - Core, flexible shaft assembly.

Class 5 - Adapter, speedometer, and tachometer, 90° drive.

Class 7 - Adapter, speedometer, and tachometer, straight drive.

Class 8 - Adapter, coupling/bulkhead, speedometer and tachometer drive.

Class 9 - Shaft assembly, flexible, plastic.

Type II - Electrical

Group C - Speedometer, fixed mounting.

Group D - Tachometer, fixed mounting.

Class 2 - Transmitter, electrical, transmission or engine mounted.

Class 3 - Transmitter, electrical, distributor mounted.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Supply Center Richmond, ATTN: DSCR-VBD, Richmond, VA 23297-5610, by using the Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents:

2.2.1 Specifications and standards. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation (see 6.2(c)).

SPECIFICATIONS

DEPARTMENT OF DEFENSE

- | | |
|-------------|---|
| MIL-STD-202 | - Test Methods for Electronic and Electrical Component Parts. |
| MIL-STD-461 | - Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment. |

(Unless otherwise indicated, copies of the above specifications, standards, and handbooks are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the DoDISS cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2(c)).

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- | | |
|------------|---|
| ASTM B 117 | - Standard Practice for Operating Salt Spray (Fog) Apparatus (DoD adopted). |
| ASTM G 21 | - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi (DoD adopted). |

(Application for copies should be addressed to the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.)

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2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2 (d)), a sample shall be subjected to first article inspection in accordance with 4.2.

3.2 Design, materials and construction. Unless otherwise specified herein, material shall be in accordance with the manufacture standard practice. The design and construction of the instruments and components shall be in accordance with interface and envelope dimensions of figures 1 through 10 but are not intended to limit manufacturer's design (see 4.5.1).

3.2.1 Speedometer and tachometer. The instruments shall be provided with a bezel, a means for mounting and a connector for attachment of a flexible drive shaft assembly or transmitter cable, as applicable.

3.2.1.1 Case. A case window shall be provided to facilitate illumination of the dial from an outside source. Means shall be provided to dehumidify trapped air after the speedometer or tachometer is sealed. Dehumidification means shall be secured so that it will not become loose when the speedometer and tachometer are subjected to vibration.

3.2.1.2 Dial. The face of the dial shall include the markings specified in figures 8 through 10. The printing shall be commercial style lettering and shall be legible from a normal driving position. The dial face shall have a black background with numerals, letters and graduations in lusterless white. The dial shall be secured to the body of the speedometer or tachometer in such a position that the marking on the face of the dial and the numerals on the odometer or engine hour meter shall be legible when illuminated through the case window from an outside source.

3.2.1.3 Pointer. The pointer shall be attached to the indicator movement and shall be damped to reduce oscillation from vibration. The pointer shall not touch the dial or window. The shape of the pointer shall facilitate reading of any point in the range of the dial. At least the top half of the visible portion of the pointer shall be lusterless white in color.

3.2.1.3.1 Damping. The pointer shall be damped to prevent an oscillation of more than ± 0.5 miles per hour (mph) (± 1 kilometers per hour (km/h)) above 10 mph (16 km/h) on the speedometer dial, or ± 30 revolutions per minute (rpm) above 500 rpm on the tachometer dial when the speedometer or tachometer is operated directly off a drive shaft or transmitter, as applicable, having no fluctuation in speed.

3.2.2 Odometer and engine hour meter. The instruments, when furnished for use with a speedometer or a tachometer, shall be of the nonreset-type. Numerals shall be white on a black

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background, except that the decimal numerals shall be black on a white background. The height of the numerals shall be not less than 0.156 inch (4 millimeter (mm)).

3.2.3 Drive mechanism. Mechanical speedometers and tachometers shall be driven by a flexible shaft assembly with adapters, as required. Electrical speedometers and tachometers shall be actuated by an electric impulse through an insulated cable.

3.2.3.1 Flexible shaft assembly. The flexible shaft assembly shall consist of a flexible outer casing and a flexible inner core. The outer casing shall be equipped with reusable means for attaching the assembly to both the instrument and the take-off point. The configuration shall fall within the envelope limits indicated in figures 1, 2 or 3, as applicable. End connections affecting interchangeability shall conform to the interface requirements in figures 1, 2 and 3. A means shall be provided in the assembly to prevent the core from falling out.

3.2.3.1.1 Core. Cores shall conform to figure 4.

3.2.3.2 Adapters. Adapters shall conform to figures 5, 6 or 7, as applicable.

3.2.3.3 Transmitters. Transmitters for electric speedometers and tachometers shall be mountable either on the engine, transmission or distributor as specified (see 6.2(e)) and shall conform to the applicable drawings or standards.

3.2.4 Cover window. The cover window shall be clear.

3.2.5 Recycled, recovered, or environmentally preferable materials. Recycled, recovered, or environmentally preferable materials should be used to the maximum extent possible provided that the material meets or exceeds the operational and maintenance requirements, and promotes economically advantageous life cycle costs.

3.3 Performance.

3.3.1 Speedometers, tachometers and transmitters. Speedometers, tachometers and transmitters shall indicate vehicle performance within ± 3 percent after 1000 hours of operation. Electrical speedometers, tachometers and transmitters shall meet the applicable conducted and radiated electromagnetic emission requirements of MIL-STD-461 for ground equipment.

3.3.1.1 Speedometers. Speedometer pointer shall accurately indicate the vehicle speed in an ambient temperature range of -65 to 160 °F (-54 to 71 °C).

3.3.1.2 Tachometers. Tachometers shall accurately indicate engine speed within ± 60 rpm in an ambient temperature range of -65 to 160 °F (-54 to 71 °C).

3.3.1.3 Transmitters. Transmitters shall cause the speedometer and tachometer to operate within the applicable limits.

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3.3.2 Odometer. The odometer shall register actual mileage within +1 percent. The odometer shall totalize and record up to 99,999.9 in multiples of 0.1 mile or 0.1 kilometer before automatically turning to zero.

3.3.3 Engine hour meter. The engine hour meter shall accurately record hours of engine operation within ± 2 percent. The engine hour meter shall totalize and record up to 9,999.9 hours in multiples of 0.1 hours or up to 9,999.99 hours in multiples of 0.01 hours before automatically turning to zero.

3.3.4 Adapters.

3.3.4.1 Wear. Adapters of each class shall withstand operation for 500 hours without failure.

3.3.4.2 Torque. The torque required to rotate the adapters shall not exceed 80 ounce-inches (oz-in) (0.56 Newton-meter (N-m)).

3.3.5 Flexible shaft assembly.

3.3.5.1 Wear. The flexible shaft assembly shall withstand operation for 500 hours without failure.

3.3.5.2 Torque. The torque required to rotate the flexible drive shaft core shall not exceed 80 oz-in (0.56 N-m).

3.3.5.3 Oscillation. Pointer oscillation shall not exceed 1 mph (2 km/h) at speeds above 10 mph (16 km/h) on the speedometer dial, and shall not exceed 50 rpm on the tachometer dial at rotating speeds above 500 rpm.

3.3.5.4 Flexibility (flexible shaft assembly, non-metallic). The flexible shaft assembly shall be able to bend 180° in a 10-inch diameter with not more than 8 pounds (lbs) (3.6 kilograms (kg)) of force.

3.3.5.5 Strength. The flexible shaft assembly core shall have a torsional breaking strength of not less than 15 pound-inches (lb-in) (1.7 N-m). End fittings attached to the core shall withstand a pull of 50 lbs (22.7 kg).

3.4 Environmental.

3.4.1 Lubrication leakage (lubricated flexible shaft assembly only). The flexible drive shaft assembly shall show no evidence of lubricant leakage, and shall pass the requirement of the test in 4.5.3.1.

3.4.2 Vibration resistance. The instrument and transmitter shall show no evidence of component or assembly degradation as a result of vibration.

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3.4.3 Shock resistance. Speedometers, tachometers, and transmitters shall show no evidence of pointer sticking, delay of functioning, and component or assembly degradation as a result of shock.

3.4.4 Waterproofness.

3.4.4.1 Instruments and transmitters. Type II speedometers, tachometers and transmitters shall meet the waterproofness requirements specified in section 4.5.4.

3.4.4.2 Flexible shaft assemblies and adapters. Flexible shaft assemblies and adapters shall be waterproof.

3.4.5 Corrosion resistance. Speedometers, tachometers, flexible shaft assemblies, transmitters and adapters shall show no evidence of corrosion affecting operation.

3.4.6 Fungus resistance. Speedometers, tachometers, flexible shaft assemblies, transmitters and adapters shall show no evidence of fungus growth affecting operation.

3.4.7 Ozone resistance. The flexible shaft assembly shall show no evidence of cracking, rupture or other deterioration.

3.5 Painting. Unless otherwise specified (see 6.2(f)), all parts shall be cleaned, primed and painted. When instrument bezels made of stainless steel are used, they shall be appropriately passivated, primer washed and finish painted green. When mechanical speedometers and tachometers (figures 8, 9 and 10) are used in the interior of a vehicle or system and epoxy finish topcoated, color lusterless green shall be used (see 4.5.1 and 6.4).

3.6 Identification and marking. Unless otherwise specified (see 6.2(g)), identification and marking shall be permanent and legible and shall include as a minimum the manufacturer's CAGE code and the applicable military part number. All markings shall be printed or stamped on the dial of the speedometers and tachometers, on the casings of the flexible shaft assemblies, and on the housing of the adapters and the transmitters. The drive ratio shall be marked on the housing of all adapters. The flexible shaft assembly cores shall be tagged (see 4.5.1).

3.7 Safety. All components shall be free of defects involving burrs and sharp edges which may result in injury of personnel (see 4.5.1).

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4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

- a. First article inspection (see 4.2).
- b. Conformance inspections (see 4.3).

4.2 First article inspection. First article inspection (see 3.1), shall include examination of product (see 4.5.1) and the applicable tests of table I.

TABLE I. Classification of inspection.

Title	Requirement	Inspection	First Article	Conformance
Instruments	3.3.1	4.5.2.1	X	X
Speedometers	3.3.1.1	4.5.2.2	X	
Tachometers	3.3.1.2	4.5.2.3	X	
Transmitters	3.3.1.3	4.5.2.2, 4.5.2.3	X	
Odometer	3.3.2	4.5.2.4	X	
Engine hour meter	3.3.3	4.5.2.5	X	
Adapters				
Wear	3.3.4.1	4.5.2.6.1	X	
Torque	3.3.4.2	4.5.2.6.2	X	
Flexible shaft assemblies				
Wear	3.3.5.1	4.5.2.7.1	X	X
Torque	3.3.5.2	4.5.2.7.2	X	
Oscillation	3.3.5.3	4.5.2.7.3	X	
Flexibility	3.3.5.4	4.5.2.7.4	X	
Strength	3.3.5.5	4.5.2.7.5	X	
Environmental				
Lubrication leakage	3.4.1	4.5.3.1	X	
Vibration resistance	3.4.2	4.5.3.2	X	
Shock resistance	3.4.3	4.5.3.3	X	
Waterproofness				
Instruments and transmitters	3.4.4.1	4.5.4.1- 4.5.4.1.5, 4.5.4.3	X	X
Flexible shaft assembly and adapters	3.4.4.2	4.5.4.2, 4.5.4.3	X	
Corrosion resistance	3.4.5	4.5.5	X	
Fungus resistance	3.4.6	4.5.6	X	
Ozone resistance	3.4.7	4.5.7	X	

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4.2.1 First article sample. First article sampling shall be in accordance with table II.

TABLE II. First article sample and sample size.

Sample item	Sample size
Type I, group A speedometer, mechanical	3
Type II, group C speedometer, electrical	3
Type I, group B tachometer, mechanical	3
Type II, group D tachometer, electrical	3
Type I, class 1 or class 9 shaft assembly, flexible, mechanical speedometer and tachometer	4
Type I, class 5 adapter, speedometer and tachometer 90 degree drive	4
Type I, class 7 adapter, speedometer and tachometer straight drive	4
Type I, class 8 adapter, coupling/bulkhead-speedometer and tachometer drive	4
Type II, class 2 transmitter, electrical, transmission or engine mounted	3
Type II, class 3 transmitter, electrical, distributor mounted	3

4.2.2 First article test sequence. The first article sample selected from table II for inspection shall be tested in accordance with the sequence specified in tables III-A through III-D for the applicable item.

TABLE III-A. First article test sequence for speedometer and tachometer.

Specimen	Test
A:	
4.5.2.1	Wear
4.5.4	Waterproofness
4.5.2.2	See note 1
B:	
4.5.2.2	See note 1
4.5.3.3	Shock
4.5.6	Fungus resistance
C:	
4.5.2.2	See note 1
4.5.3.2	Vibration
4.5.5	Corrosion resistance

Note: 1. Test at ambient temperature (77 ± 15 °F) (25 ± 8 °C).

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TABLE III-B. First article test sequence for flexible shaft assemblies.

Specimen	Test
A: 4.5.4 4.5.2.7.1 4.5.5	Waterproofness Wear Corrosion resistance
B: 4.5.3.1 4.5.2.7.2	Lubrication leakage Operating torque
C: 4.5.2.7.4 4.5.2.7.3 4.5.6	Flexibility (non metallic) Oscillation Fungus resistance
D: 4.5.2.7.5 4.5.7	Torsional strength Ozone resistance

TABLE III-C. First article test sequence for adapters.

Specimen	Test
A: 4.5.2.6.1 4.5.4	Wear Waterproofness
B: 4.5.5	Corrosion resistance
C 4.5.6	Fungus resistance
D: 4.5.2.6.2	Operating torque

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TABLE III-D. First article test sequence for transmitters.

Specimen	Test
A:	
4.5.2.2	See note 1
4.5.3.2	Vibration
4.5.2.1	Wear
B:	
4.5.2.2	See note 1
4.5.3.3	Shock resistance
4.5.6	Fungus
C:	
4.5.2.2	See note 1
4.5.4	Waterproofness
4.5.5	Corrosion resistance

Note: 1. Test at ambient temperature (77 ± 15 °F) (25 ± 8 °C).

4.3 Conformance inspections. Conformance inspection (CI) shall include the examinations of product (see 4.5.1) and the applicable tests of table I.

4.3.1 Sampling plan. Unless otherwise specified (see 6.2(h)), the sampling plan for CI examination and tests shall be randomly selected from the inspection lot in accordance with table IV.

TABLE IV. Sampling plan for CI.

Inspection lot size	Sample size		
	Examination		Test
	Major	Minor	
2 to 8	*	5	5
9 to 15	13	5	5
16 to 25	13	5	5
26 to 50	13	5	5
51 to 90	13	7	7
91 to 150	13	11	11
151 to 280	20	13	13
281 to 500	29	16	16
501 to 1200	34	19	19
1201 to 3200	42	23	23
3201 to 10000	50	29	29
10001 to 35000	60	35	35
35001 to 150000	74	40	40
1500001 to 500000	90	40	40
5000001 and over	102	40	40

* Indicates entire lot must be inspected (100% inspection).

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4.3.1.1 Lot formation. An inspection lot shall consist of all speedometers, tachometers and flexible shaft assemblies of a single type, group, class, and part identification number (PIN), from an identifiable production period, from one manufacturing location, submitted at the same time for acceptance.

4.4 Inspection conditions. Unless otherwise specified herein, all testing shall be conducted in an ambient temperature of 77 ± 15 °F (25 ± 8 °C). Unless otherwise specified herein, test specimen shall be thermally stabilized for 1 hour prior to being subjected to tests.

4.5 Methods of inspection.

4.5.1 Examination of product. Instruments and components shall be examined for the defects listed in table V. Examination shall be visual, tactile, or by measurement with Standard Inspection Equipment (SIE).

TABLE V. Classification of defects.

Category	Defect	Method of examination
<u>Major:</u>		
101	Design, materials and construction affecting interchangeability (see 3.2)	SIE and functional
<u>Minor:</u>		
201	Design, material and construction not affecting interchangeability (see 3.2)	SIE and functional
202	Painting not as specified (see 3.5)	Visual
203	Identification and marking not as specified (see 3.6)	Visual
204	Safety not as specified (see 3.7)	Visual

4.5.2 Performance.

4.5.2.1 Speedometers, tachometers and transmitters. Speedometers, tachometers and transmitters shall be operated for 1000 hours at the speeds and temperature specified in table VI. At the conclusion of the 1000 hour test period, the speedometers, tachometers and transmitters shall be subjected to the applicable calibration tests specified in 4.5.2.2 through 4.5.2.4. The instruments and transmitters shall be tested in accordance with test methods CE102 and RE102 of MIL-STD-461.

TABLE VI. Speedometer and tachometer wear test.

Hours	Temperature	Speed
750	77 ± 15 °F (25 ± 18 °C)	Equal indicating period for 1/3, 2/3, and full scale reading
250	160 ± 5 °F (71 ± 3 °C)	(Same as above)

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4.5.2.2 Speedometers. Speedometers, while connected to a flexible shaft assembly or transmitter, as applicable, shall be mounted in an air chamber with the dial face tilted 10° backward from the vertical. The air chamber shall be maintained at each of the following temperatures for 4 hours: 77 ±15 °F (25 ±18 °C) and 160 ±5 °F (71 ±3 °C). After each 4 hour period and while still maintaining the temperature, the drive shaft and transmitter shall be rotated at 167500 and 1000 rpm. The electrical speedometer shall be energized at 28.5 volts (V) and shall be operated for 5 minutes before observing the reading.

4.5.2.3 Tachometers. Tachometers shall be tested as specified in 4.5.2.2, except that the drive shaft and transmitter shall be rotated at 250, 1000, and 1500 rpm.

4.5.2.4 Odometer. At the conclusion of the test specified in 4.5.2.2, rotation of the drive shaft and transmitter shall be continued for 6 hours at a speed of 1000 rpm in an ambient air temperature of 77 ±15 °F (25 ±18 °C). The odometer indicated mileage or kilometers for the 6-hour period shall be compared with the correct mileage or kilometers.

4.5.2.5 Engine hour meter. At the conclusion of the test specified in 4.5.2.3, the drive shaft and transmitter shall be rotated at one of the optional speeds and for the time length specified in table VII. During and after the test, the engine hour meter reading shall be observed.

TABLE VII. Tachometer hour meter optional test speeds.

Tachometer type	RPM	Time
I	1000	6 hours, 9.6 minutes
II	1000	6 hours, 36 minutes
I	1026	6 hours
II	1100	6 hours

4.5.2.6 Adapters.

4.5.2.6.1 Wear. The adapter shall be mounted in a fixture with a constant load of 22 ±2 ounce-force-inches (ozf-in) (0.16 ±0.01 N-m) and operated at the speeds, temperatures and times specified in table VIII.

TABLE VIII. Flexible shaft assembly and adapter wear test.

Hours	Temperature, °F (°C)	Speed (rpm)
100	77 ±15 °F (25 ±18 °C)	750
100	77 ±15 °F (25 ±18 °C)	1250
200	77 ±15 °F (25 ±18 °C)	2000
25	160 ±5 °F (71 ±3 °C)	750
25	160 ±5 °F (71 ±3 °C)	1250
50	160 ±5 °F (71 ±3 °C)	2000

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4.5.2.6.2 Torque. To determine the operating torque, the adapter shall be placed in a test fixture with the test sample temperature and air temperature maintained at -65 ± 5 °F (-54 ± 3 °C) for 7 hours. At the conclusion of the 7-hour period and while still at the above specified temperature, the adapter shall be rotated without load. The torque required to rotate the adapter in starting and accelerating shall be measured.

4.5.2.7 Flexible shaft assemblies.

4.5.2.7.1 Wear. A flexible shaft assembly 10 feet (ft) (3 meters (m)) long shall be mounted in a test fixture in such a manner that the shaft is confined in a S-shape having two bends 180° in the same plane with each bend having a 5-inch (12.7 centimeters (cm)) radius. With a constant load of 22 ± 2 ozf-in, (0.16 ± 0.01 N-m) at the speedometer and tachometer end of the shaft core, the core shall be operated at the speeds, temperatures and times specified in table VIII.

4.5.2.7.2 Torque. To determine the operating torque, the flexible shaft assembly shall be placed in a test fixture with the test sample temperature and air temperature maintained constant at -65 ± 5 °F (-54 ± 3 °C) for 7 hours. At the conclusion of the 7-hour period and while still held at the above specified temperature, the core shall be rotated without load. The torque required to rotate the core in starting and accelerating shall be measured.

4.5.2.7.3 Oscillation. A flexible shaft assembly 10 ft (3 m) long shall be connected to a previously calibrated speedometer and shall be rotated at indicated speedometer speeds from 10 to 60 mph at 10 mph intervals or 20 to 100 km/h at 20 km/h intervals. Running time at each speed shall then be repeated with a previously calibrated tachometer. The indicated tachometer rpm shall be between 500 and 4000 at 500 rpm intervals with a running time of 10 minutes at each rotating speed.

4.5.2.7.4 Flexibility (non metallic). A section of flexible shaft assembly, approximately 17 inches (43 cm) from one end, shall be bent 180° around a 10-inch (25.4 cm) diameter mandrel.

4.5.2.7.5 Torsional strength. The flexible shaft assembly core shall be placed in a torsion-testing machine in a straight position without slack so that 10 inches (25.4 cm) of the speedometer and tachometer end of the core will be subjected to torsion. The core shall be twisted in a clockwise direction. The test shall be repeated with the drive end of the core in the machine. The core end fittings shall then be subjected to a pull test with the fittings anchored and the load applied to the core.

4.5.3 Environmental.

4.5.3.1 Lubrication leakage (lubricated flexible shaft assembly only). The flexible shaft assembly shall be carefully sealed at both ends and placed in a temperature-controlled air chamber at a constant temperature of 250 ± 5 °F (121 ± 3 °C) for 2 hours. At the conclusion of the 2-hour period, the assembly shall be removed from the oven and suspended from the transmission end in a vertical position. The flexible shaft assembly shall be observed for

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evidence of leakage of lubricant. Subsequently, the flexible shaft assembly shall be subjected to the test specified in 4.5.2.7.2.

4.5.3.2 Vibration. The speedometer, tachometer and transmitter shall be mounted as if in operation and subjected to the vibration test as specified in MIL-STD-202, method 201, except that motion shall be applied for 1 hour in each direction of the three major axes. During vibration, the speedometers and tachometers shall be operated in such a manner that the speedometer and tachometer pointer shall be at midscale, and observation shall be made for oscillation. At the conclusion of the test, the speedometer, tachometer and transmitter shall be subjected to the applicable calibration tests specified in 4.5.2 at 77 ± 15 °F (25 ± 18 °C).

4.5.3.3 Shock. The speedometer, tachometer and transmitter shall be mounted as if in operation and subjected to the shock test as specified in MIL-STD-202, method 213, test condition I (using the sawtooth waveform). The test shall be repeated 10 times and applied in the vertical axis. During shock, the speedometers and tachometers shall be operated in such a manner that the speedometer and tachometer pointer shall be at midscale, and observation shall be made for oscillation. At the conclusion of the test, the speedometer, tachometer and transmitter shall be subjected to the applicable calibration tests specified in 4.5.2 at 77 ± 15 °F (25 ± 18 °C).

4.5.4 Waterproofness.

4.5.4.1 Type II, instruments and transmitters. The speedometers, tachometers and transmitters shall be tested for waterproofness as specified in sections 4.5.4.1.1 through 4.5.4.1.2. The speedometer and transmitter connectors shall be sealed with caps simulating the mating flexible cable connectors.

4.5.4.1.1 Saline solution. The salt used shall be sodium chloride containing on a dry basis not more than 0.1 percent of sodium iodide and not more than 0.2 percent of total impurities. The solution shall be prepared by dissolving 5 parts by weight of salt in 95 parts by weight of distilled water. The solution shall be kept free of sediment by filtration or decantation.

4.5.4.1.2 Pretest performance. Prior to submersion, continuous rotating and non-rotating electrical devices shall be installed in a test circuit equivalent to their normal dry environment and operated both mechanically and electrically, as applicable, for a period of 30 minutes at full rated current and voltage. Intermittent rotating electrical devices shall be operated three times for 30 seconds each. Operation shall be with no load, at reduced voltage (18-20 volts), and 5-minute intervals shall be allowed between each operation.

4.5.4.1.3 Procedure 1. The electrical device, with its electrical connections, shall be submerged in a container with the uppermost surface a minimum of one inch below the surface of the saline solution (see 4.5.4.1.1) and installed in the chamber. The device shall be carefully observed during its entire period of submersion and shall be operated while submerged for 30 minutes at full rated current and voltage. The chamber shall be evacuated to pressure 6 pounds below atmospheric so as to apply a minimum of 6 pounds per square inch (psi) internal pressure to all voids within the device. Test results obtained shall be compared with the data obtained

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from the test of 4.5.4.1.2. During this period the device shall be carefully observed for poor seals, as evidenced by bubbles escaping from the interior of the device. Leakage shall be considered as noncompliance and the device shall be rejected. Bubbles which are the result of entrapped air on the exterior surfaces of the device shall not be considered a leak.

4.5.4.1.4 Procedure 2. The chamber shall then be pressurized to 6 pounds above atmospheric and the device again operated for 30 minutes. Test results obtained shall be compared with the data from the test of 4.5.4.1.2.

4.5.4.1.5 Procedure 3. Sealed electrical devices that are serviceable shall be disassembled as normally required in servicing and inspection made for the presence of water. If water is present, the device shall be rejected. If the device is dry, it shall be reassembled and subjected to 15 hours of dry operation (three 5-hour periods) at full rated current and voltage. The results shall be compared with the test data obtained in 4.5.4.1.2.

4.5.4.2 Flexible shaft assemblies and adapters. The flexible shaft assemblies and adapters shall be subjected to an internal pressure of 6 pounds psi (0.42 kilograms per square centimeter) for 30 minutes while totally immersed in tap water. Observation for air bubbles from the interior of the device shall be maintained during the 30-minute period. Bubbles which are the result of entrapped air on the various exterior surfaces of the device shall not be considered a leak. The flexible shaft assemblies and adapters shall be sealed against leakage.

4.5.4.3 Waterproofness conformance test. Speedometers, tachometers, flexible shaft assemblies, transmitters and adapters shall be subjected to the waterproofness test in 4.5.4.2 except the time duration shall be 5 minutes. The speedometer and transmitter connectors and both ends of the flexible shaft assemblies and adapters shall be sealed against leakage with connectors simulating the applicable mating parts or as otherwise specified.

4.5.5 Corrosion resistance. The speedometer, tachometer and transmitter shall be subjected to the corrosion resistance test as specified in ASTM B 117 for 200 hours. At the conclusion of the 200-hour period, the speedometer, tachometer and transmitter shall be subjected to the applicable test specified in 4.5.2. The speedometer, tachometer and transmitter connectors and both ends of the flexible shaft assemblies and adapters shall be sealed against leakage with connectors simulating the applicable mating parts or as otherwise specified in applicable documents.

4.5.6 Fungus resistance. The speedometer, tachometer, flexible shaft assemblies, transmitters and adapters shall be tested as specified in ASTM G 21. At the conclusion they shall be subjected to the applicable test specified in 4.5.2. The speedometer, tachometer and transmitter connectors and both ends of the flexible shaft assemblies and adapters shall be sealed against leakage with connectors simulating the applicable mating parts or as otherwise specified in applicable documents.

4.5.7 Ozone resistance. The specimen shall be conditioned at ambient room temperature for 45 minutes. The specimen shall then be placed in a test exposure chamber containing air

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mixed with ozone in the proportion of 50 ± 5 parts per 100 million parts of atmospheric air by volume for 168 hours, at a temperature of 100 ± 5 °F (38 ± 3 °C). Immediately after the completion of the test period, each sample shall be examined for evidence of cracking using 7 x magnification, with the specimen coiled in a 12-inch (30 cm) inside diameter loop.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2(i)). When actual packaging of material is to be performed by DoD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. These devices are used to indicate speed in miles per hour or kilometers per hour, or engine speed in revolutions per minute, and to record total distance in miles or kilometers traveled by the vehicle or total hours of operation of the engine.

6.1.1 Military unique. Speedometers, tachometers, and related parts covered by this specification are intended for use in military motor vehicles. These devices are subjected to severe conditions including vibration, shock, saltwater submersion, and temperature extremes.

6.2 Acquisition requirements. Acquisition documents must specify the following:

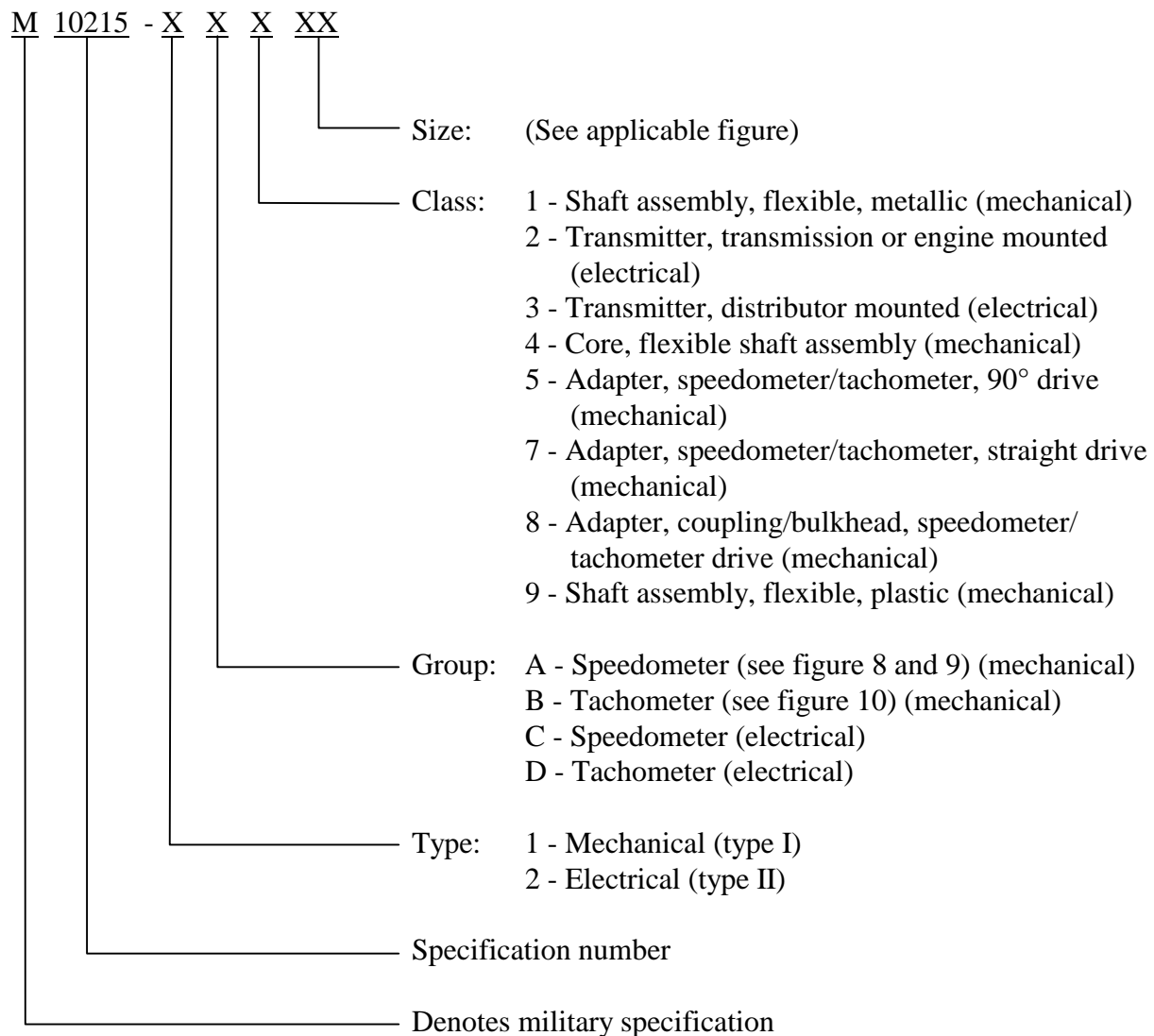
- a. Title, number, and date of this specification.
- b. Type, group, class, PIN and quantity required (see 1.2 and 6.5).
- c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2.1 and 2.3).
- d. First article, if required (see 3.1).
- e. Whether type II, group D shall be engine, transmission, or distributor mounted (see 3.2.3.3).
- f. Painting, if other than as specified (see 3.5).
- g. Identification and marking if other than as specified (see 3.6).
- h. Sampling plan (see 4.3.1).
- i. Packaging requirements (see 5.1).

6.3 Qualification. Manufacturers previously having parts qualified on the QPL may have First Article waived by submitting proof of prior qualification.

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6.4 Painting. The primers and paints which resist chemical agents in accordance to the military needs are Chemical Agent Resistant Coating (CARC) paint systems, selected from Drawing Number 1236900. When instrument bezels made of stainless steel are used, they should be passivated per ASTM A 380, primer washed per DOD-P-15328, finish painted per MIL-C-46168, color Green 383 of FED-STD-595. When mechanical speedometers and tachometers are used in the interior of a vehicle or system and epoxy finish topcoated per MIL-PRF-22750, color lusterless green 34094 or 34095 of FED-STD-595 should be used.

6.5 Part or identification number (PIN). The PINs to be used for instruments acquired to this specification are created as follows (see 6.2(b)):



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6.6 Subject term (key word) listing.

Electrical gages, transmission and engine
 Gages, vehicle, electrical and mechanical
 Instrument, panel gages and connectors
 Instrumentation, vehicle
 Mechanical gages, transmission and engine

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

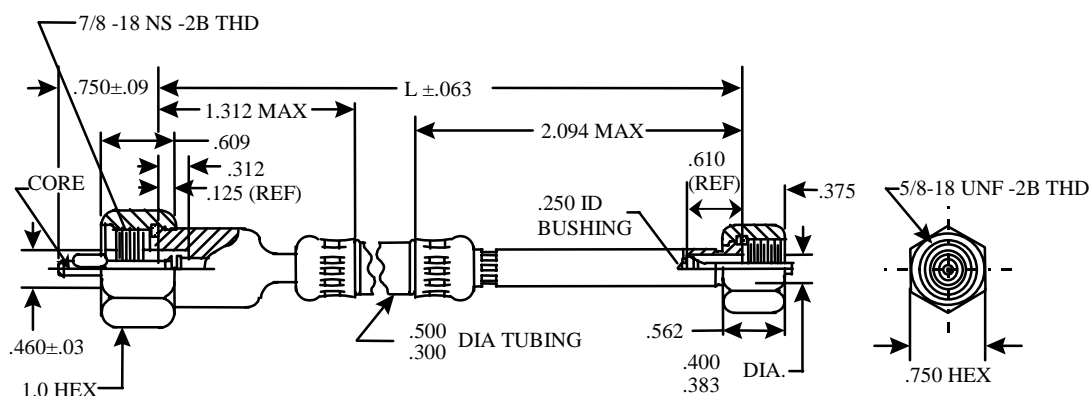
6.8 Supersession. This performance specification supersedes the following documents:

<u>Document</u>	<u>Date</u>
MIL-S-10215H	4 November 1992
MS35916D	11 July 1991
MS39021F	11 July 1991
MS39130D	14 November 1985
MS39132G	27 January 1988
MS51071H	12 August 1987
MS51072F	4 August 1987
MS52116A	19 January 1988
DS52140	28 September 1977
MS53099A	24 June 1970

6.9 Cross-reference data. Instruments and components conforming to this specification are interchangeable/substitutable with instruments and components conforming to the following documents:

<u>Document</u>	<u>Date</u>	<u>MIL-PRF-10215J</u>
MIL-S-10215H	4 November 1992	_____
MS35916D	11 July 1991	(Figure 10)
MS39021F	11 July 1991	(Figure 8)
MS39130D	14 November 1985	(Figure 5)
MS39132G	27 January 1988	(Figure 6)
MS51071H	12 August 1987	(Figure 1)
MS51072F	4 August 1987	(Figure 4)
MS52116A	19 January 1988	(Figures 2 and 3)
DS52140	28 September 1977	(Figure 9)
MS53099A	24 June 1970	(Figure 7)

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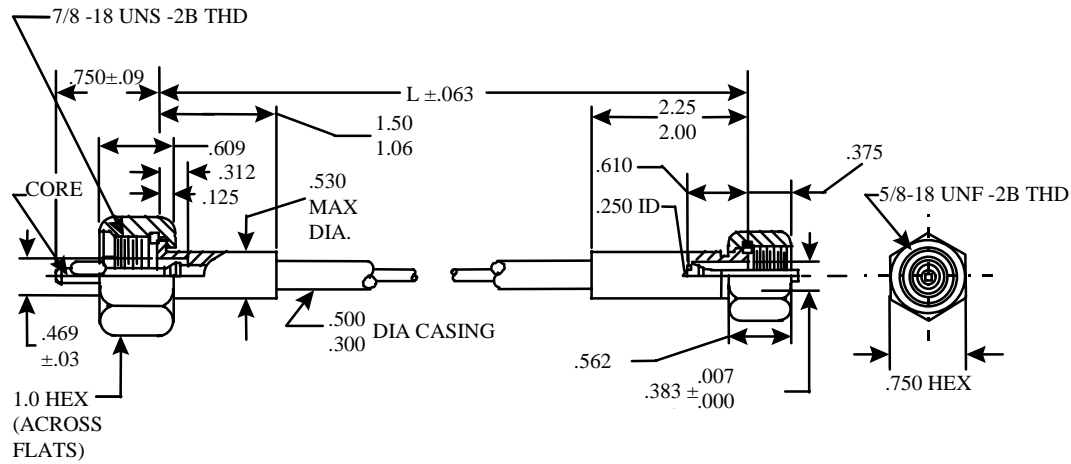


Size no.	Former MS part no.	Former Army part no.	Shaft length
-01	MS 51071-1	8735736	17.5
-02	MS 51071-2	7976738	22.5
-03	MS 51071-3	7983060	40
-04	MS 51071-4	7527480	55
-05	MS 51071-5	7320561	62.5
-07	MS 51071-7	7064526	67.5
-08	MS 51071-8	7415912	72.5
-09	MS 51071-9	7096559	77.5
-10	MS 51071-10	7526039	85
-11	MS 51071-11	7412913	90
-12	MS 51071-12	7983059	95
-13	MS 51071-13	7527479	100
-14	MS 51071-14	7983213	107.5
-15	MS 51071-15	7983057	144
-16	MS 51071-16	7954735	156
-17	MS 51071-17	7987478	168
-18	MS 51071-18	8340482	216
-19	MS 51071-19	7344191	120
-20	MS 51071-20	8345795	138
-21	MS 51071-21	-----	13

FIGURE 1. Shaft assembly, flexible metallic - tachometer and speedometer.

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PREFERRED CONSTRUCTION
(See FIGURE 3 for optional construction)

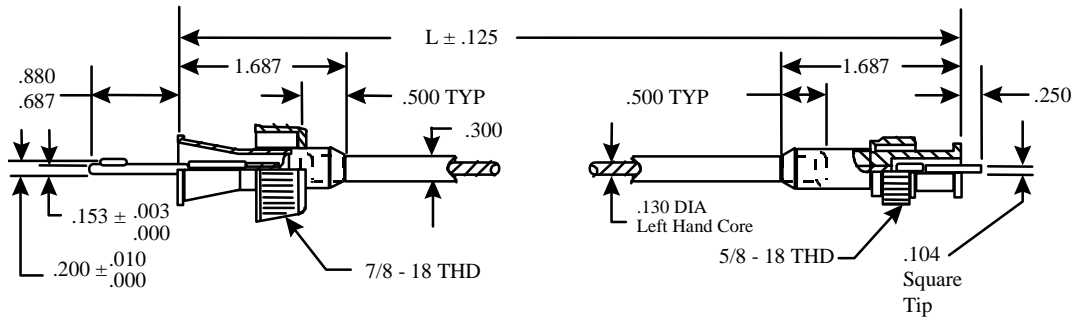


Size no.	Former MS part no.	Shaft length
-01	MS 52116-1	17.5
-02	MS 52116-2	22.5
-03	MS 52116-3	40
-04	MS 52116-4	55
-05	MS 52116-5	62.5
-07	MS 52116-7	67.5
-08	MS 52116-8	72.5
-09	MS 52116-9	77.5
-010	MS 52116-10	85
-011	MS 52116-11	90
-012	MS 52116-12	95
-013	MS 52116-13	100
-014	MS 52116-14	107.5
-015	MS 52116-15	144
-016	MS 52116-16	156
-017	MS 52116-17	168
-018	MS 52116-18	216
-019	MS 52116-19	120
-020	MS 52116-20	138

FIGURE 2. Shaft assembly: flexible, plastic - tachometer and speedometer.

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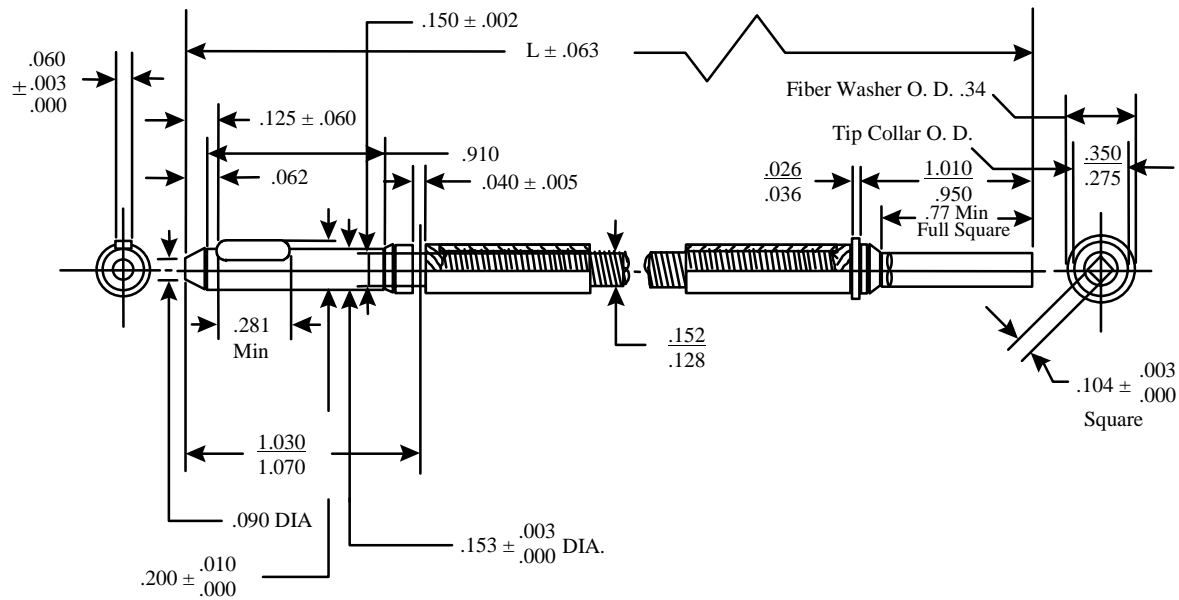
OPTIONAL CONSTRUCTION
(See FIGURE 2 for preferred construction)



Size no.	Former MS part no.	Shaft length
-21	MS 52116-21	72
-22	MS 52116-22	84
-23	MS 52116-23	96
-24	MS 52116-24	108
-25	MS 52116-25	120
-26	MS 52116-26	132
-27	MS 52116-27	144
-28	MS 52116-28	156
-29	MS 52116-29	168
-30	MS 52116-30	180
-31	MS 52116-31	192
-32	MS 52116-32	204
-33	MS 52116-33	216
-34	MS 52116-34	228
-35	MS 52116-35	240
-36	MS 52116-36	252
-37	MS 52116-37	264
-38	MS 52116-38	276
-39	MS 52116-39	288
-40	MS 52116-40	300

FIGURE 3. Shaft assembly: flexible, plastic - tachometer and speedometer.

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Size no.	Former MS part no.	Former Army part no.	Core length
-01	MS 51072-1	8749985	18.7
-02	MS 51072-2	7976737	23.7
-03	MS 51072-3	7418497	41.2
-04	MS 51072-4	7527483	56.2
-05	MS 51072-5	7064607	63.7
-07	MS 51072-7	7064520	68.7
-08	MS 51072-8	7418498	73.7
-09	MS 51072-9	7418491	78.7
-10	MS 51072-10	7527481	86.2
-11	MS 51072-11	7415830	91.2
-12	MS 51072-12	7418490	96.2
-13	MS 51072-13	7527482	101.2
-14	MS 51072-14	7984852	108.7
-15	MS 51072-15	7984853	145.2
-16	MS 51072-16	7064524	157.2
-17	MS 51072-17	8366051	169.2
-18	MS 51072-18	8741685	217.2
-19	MS 51072-19	7355827	121.2
-20	MS 51072-20	8345796	139.2
-21	MS 51072-21		14.2

FIGURE 4. Core, flexible shaft assembly - tachometer and speedometer.

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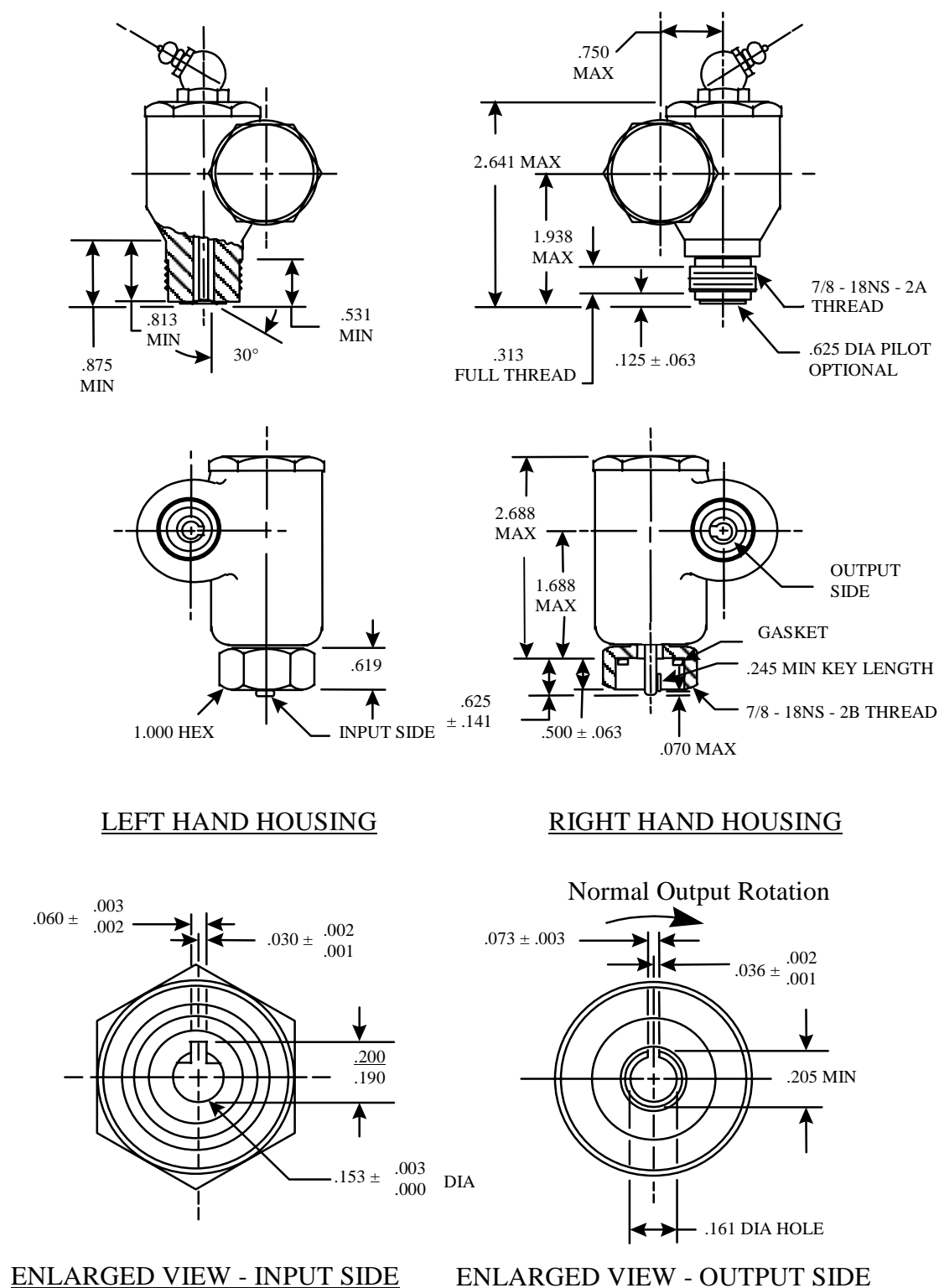


FIGURE 5. Adapter, speedometer-tachometer, 90° drive.

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Size no.	Former MS part no.	Former Army part no.	RPM ratio output/input	Input shaft rotation with respect to output side	Housing type
-01	MS 39130-1		0.158	Reverse	Right hand
-02	MS 39130-2		0.166	Same	Right hand
-03	MS 39130-3	7372726	0.200	Reverse	Right hand
-04	MS 39130-4		0.200	Same	Right hand
-05	MS 39130-5	10900477	0.210	Reverse	Left hand
-06	MS 39130-6	10917230	0.222	Reverse	Right hand
-07	MS 39130-7		0.250	Reverse	Right hand
-08	MS 39130-8		0.250	Same	Right hand
-09	MS 39130-9		0.300	Reverse	Right hand
-10	MS 39130-10		0.300	Same	Right hand
-11	MS 39130-11	10900443	0.364	Reverse	Right hand
-12	MS 39130-12	10921625	0.364	Same	Right hand
-13	MS 39130-13		0.416	Reverse	Right hand
-14	MS 39130-14		0.421	Same	Right hand
-15	MS 39130-15	8340483	0.500	Reverse	Right hand
-16	MS 39130-16		0.500	Same	Right hand
-17	MS 39130-17	6228369	0.500	Reverse	Left hand
-18	MS 39130-18	6228367	0.500	Same	Left hand
-19	MS 39130-19		0.611	Reverse	Right hand
-20	MS 39130-20		0.611	Same	Right hand
-21	MS 39130-21		0.705	Reverse	Right hand
-22	MS 39130-22		0.714	Same	Right hand
-23	MS 39130-23		0.833	Same	Right hand
-24	MS 39130-24		0.909	Reverse	Right hand
-25	MS 39130-25	7983058	1.000	Reverse	Right hand
-26	MS 39130-26		1.000	Same	Right hand
-27	MS 39130-27	7987721	1.000	Reverse	Left hand
-28	MS 39130-28	6209787	1.000	Same	Left hand
-29	MS 39130-29		1.100	Reverse	Right hand
-30	MS 39130-30		1.100	Same	Right hand
-31	MS 39130-31	12255454	1.000	Reverse	Right left

FIGURE 5. Adapter, speedometer-tachometer, 90° drive - (continued).

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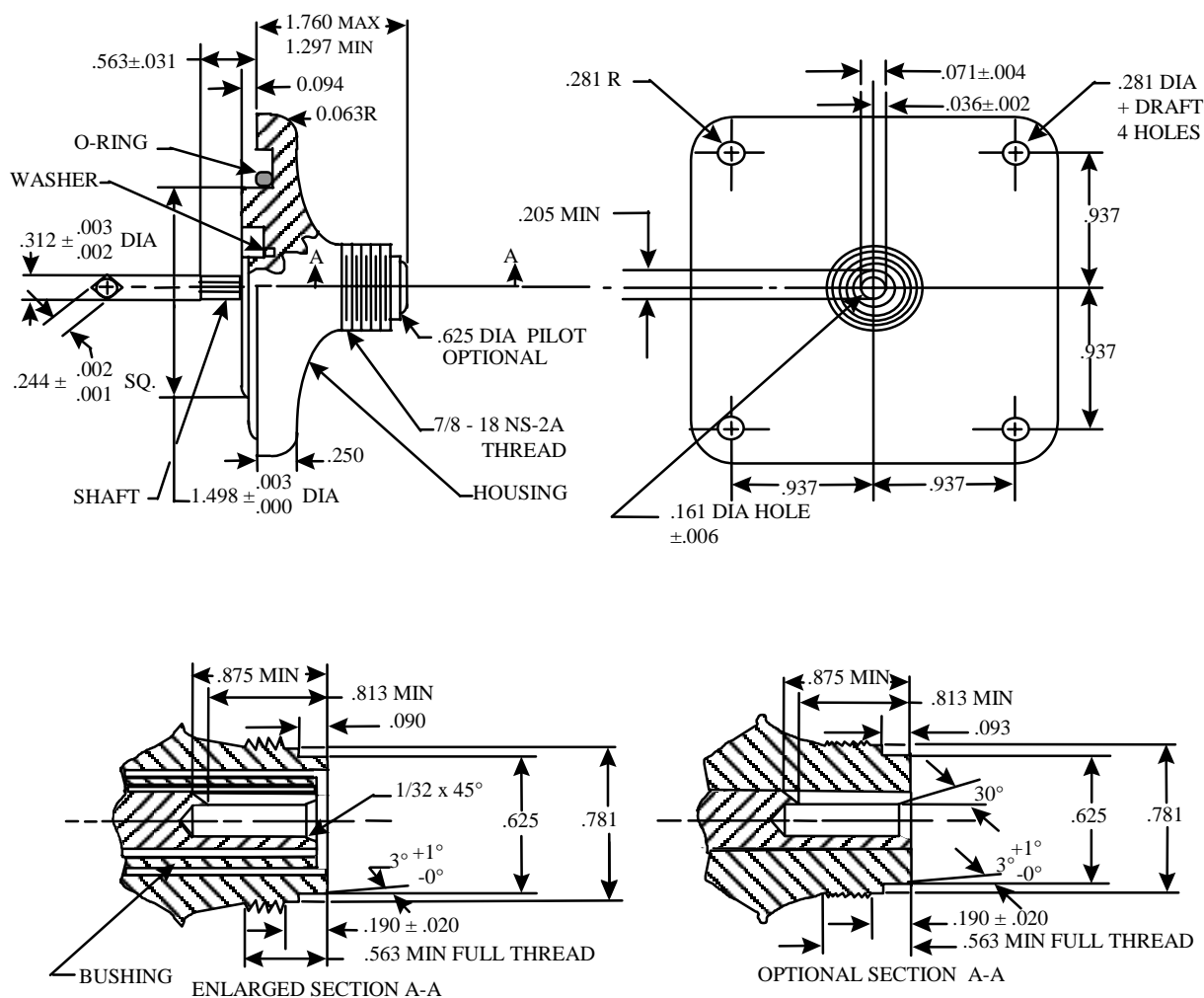
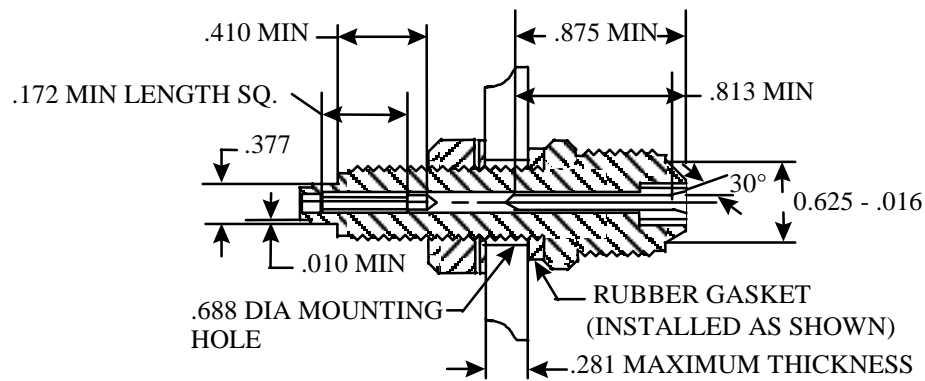
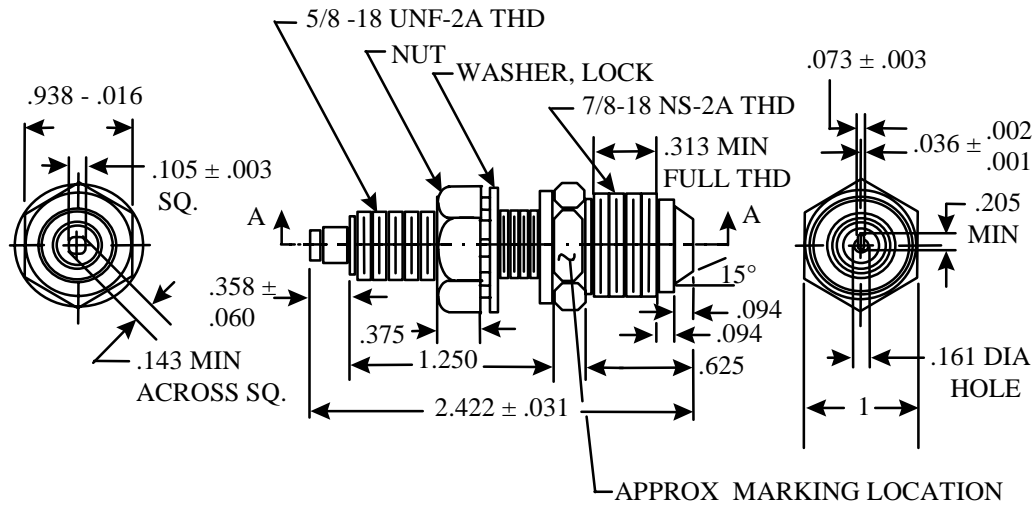


FIGURE 6. Adapter, speedometer-tachometer, straight drive.

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SECTION A-A

Size no.	Former MS part no.	Former Army part no.	Description	Application
-01	MS 53099-1	7983056	Without rubber gasket	Non-waterproof
-02	MS 53099-2	None	With rubber gasket	Waterproof

FIGURE 7. Adapter, coupling/bulkhead - tachometer and speedometer drive.

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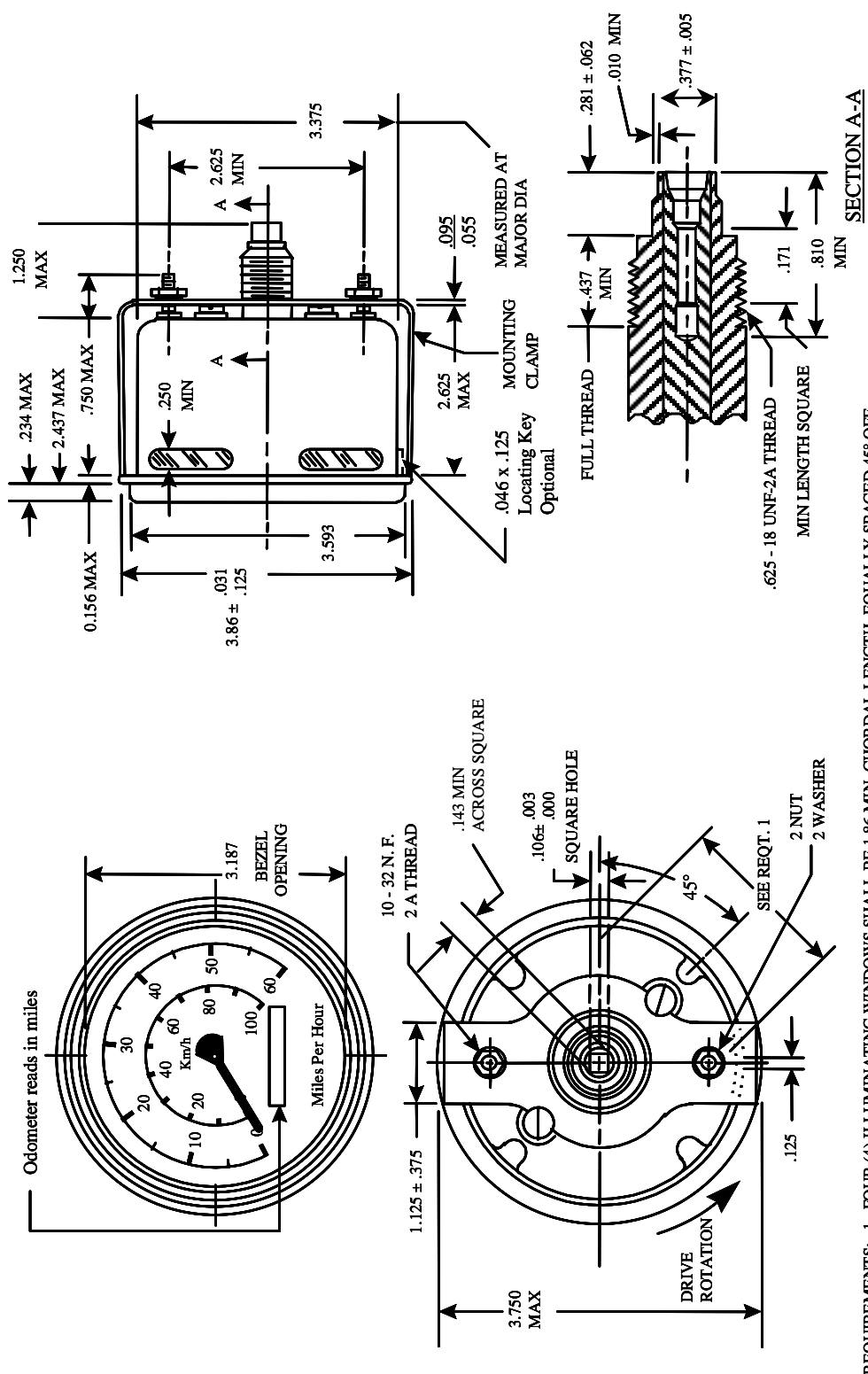


FIGURE 8. Speedometer, mechanical (0-60 mph).

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(Project 6680-0248)

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SPEEDOMETERS; TACHOMETERS; FLEXIBLE SHAFT ASSEMBLIES; FLEXIBLE SHAFT ASSEMBLY CORES, ADAPTERS, AND TRANSMITTERS

4. **NATURE OF CHANGE** (Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)

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