MILITARY SPECIFICATION

ENCODERS, SHAFT POSITION TO DIGITAL, NON-CONTACT TYPE, ALTITUDE REPORTING

This specification is approved for use by Naval Air Systems Command, Department of the Navy, and is available for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 This specification covers the requirements for multi-turn non-contact type altitude reporting encoders.

1.2 Classification. The encoder shall be one of the following types:

TABLE I. Encoder type classification.

Type	Class	Power Input	Code Range	Number of Turns for Full Range	See Figure
Type I	A	28 VDC	-1200 ft. to +38,700 ft.	5	1
	B	115V, 400 Hz			
Type II	A	28 VDC	-1200 ft. to +126,700 ft.	16	2
	B	115V, 400 Hz			

2. APPLICABLE DOCUMENTS

2.1 General. The following documents, of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

SPECIFICATIONS

MILITARY

MIL-W-16878 -Wire, Electrical, Insulated, High Temperature

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to Commander, Naval Air Systems Command (AIR-52022), Department of the Navy, Washington, D. C. 20361 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

SPECIFICATIONS

MILITARY (Continued)

MIL-T-18303	-Test Procedures; Procedures; Preproduction, Acceptance and Life for Aircraft Electronic Equipment; Format for
MIL-N-18307	-Nomenclature and Identification for Aeronautical, Electronic and Associated Equipment
MIL-S-19500	-General Specification for Semiconductor Devices
MIL-I-81400	-Instruments, Aircraft, General Specification for

STANDARDS

MIL-STD-105	-Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-143	-Specifications and Standards, Order of Precedence for Selection of
MIL-STD-454	-Standard General Requirements for Electronic Equipment
MIL-STD-461	-Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-462	-Measurement of Electromagnetic Interference Characteristics
MIL-STD-463	-Definitions and Systems of Units, Electromagnetic Interference Technology
MIL-STD-704	-Electric Power, Aircraft, Characteristics and Utilization of
MIL-STD-794	-Parts and Equipment Procedures for Packaging and Packing of
MIL-STD-810	-Environmental Test Method for Aerospace and Ground Equipment

2.2 Other Publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NAVAL AIR SYSTEMS COMMAND

AR-5	-Microelectronic Device Used in Avionic Equipment Procedures for selection and approval of

(Copies of specifications, standards, drawings, and publications required by contractors in connection with specific procurement functions shall be obtained form the procuring activity or as directed by the contracting officer.)

DEPARTMENT OF DEFENSE

SD-6 - Provisions Governing Qualifications

(Application for copies should be addressed to Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.)

DEPARTMENT OF TRANSPORTATION

ORDER 1010.51 - U. S. National Aviation Standard for the IFF Mark X (SIF)/Air Traffic Control Radar Beacon System Characteristics SIF/ATCRBS

(Application for copies should be addressed to the Federal Aviation Administration, Washington, D. C. 20553.)

3. REQUIREMENTS

3.1 Qualification. The encoders furnished under this specification shall be products which have been tested and meet the quality assurance provisions specified herein and have been listed on or approved for listing on the applicable qualified products list.

3.2 Parts and materials. Selection and use of parts, materials and processes shall be in accordance with MIL-S-19500, MIL-I-81400 and AR-5. Specifications for items not covered above shall be selected in accordance with MIL-STD-143.

3.3 Design and construction. The encoder specified herein is a multi-turn non-contact encoder which converts analog shaft position into coded digital form in accordance with:

U. S. National Aviation Standard for the IFF Mark X(SIF)/ Air Traffic Control Radar Beacon System Characteristics SIF/ATCRBS.

3.3.1 Outline dimensions. The outline dimensions of the encoder shall be in accordance with Figures 1 and 2.

3.3.2 Weight. The weight of the encoder shall not exceed eight ounces, including external power supply, if used.

3.3.3 Code range. Encoder types I and II shall have the code ranges specified in paragraph 1.2.

3.3.4 Resolution. The encoder resolution shall be 80 discrete counts for 360° rotation of input shaft. Each count shall be equivalent to 100 feet of altitude change with the code starting at -1200 feet of altitude.

3.3.5 Shaft rotation and code output. The direction of rotation for increasing count, as viewed from the shaft end of the encoder, may be clockwise or counterclockwise. The direction of rotation for increasing count (increasing altitude) shall be as specified in the contract.

3.3.6 Stops. The encoder shall contain no mechanical stops. The input shaft shall be capable of continuous rotation in either direction.

3.3.7 Starting torque. The encoder shall have a starting torque not to exceed 0.5 inch-ounce at -54 ± 2°C and at +71 ± 2°C in any attitude when tested in accordance with paragraph 4.5.10.

3.3.8 Running torque. The encoder shall have a running torque not to exceed 0.3 inch-ounce at -54 ± 2°C and at +71 ± 2°C in any attitude when tested in accordance with paragraph 4.5.10.

3.3.9 Operating speed. The encoder shall be capable of operating at a speed of 15 RPM.

3.3.10 Slew speed. The encoder shall be capable of withstanding slew speeds of 20 RPM.

3.3.11 Radial play. Radial play shall not exceed 0.0015 TIR maximum on the input shaft, measured at 0.250 inches from the nearest mounting surface under a load of eight ounces applied to the shaft as described in paragraph 4.5.5.

3.3.12 Shaft run-out. The shaft run-out or eccentricity shall not exceed .001 TIR when tested in accordance with paragraph 4.5.6.

3.3.13 End play. The input shaft of the encoder shall have end play not exceeding 0.004 inches measured with an eight ounce load applied as described in paragraph 4.5.7.

3.3.14 Wire leads.

3.3.14.1 Wire lead identification. The encoder shall be provided with teflon-insulated leads color coded as shown in Table II. The wire shall conform to MIL-W-16878/6 and shall be #28 AWG (seven strands minimum). The length of the wire leads shall be as specified in the contract.

3.3.14.2 Wire lead stress. Each lead shall be able to withstand a two pound pull when tested in accordance with paragraph 4.5.4.

3.3.15 Code source and sensors. If more than one source is used, the sources shall be connected in a series string such that if any one source fails, the series string fails. The sensors (code switching devices) shall be electrically tied to the bit common lead as shown in Figure 4.

TABLE II. Identification of wire leads.

Encoder Bit		Color
bit common		black
D_2		white/purple tracer
D_4		white/blue tracer
A_1		white/yellow tracer
A_2		white/orange tracer
A_4		white/brown tracer
B_1		gray
B_2		purple
B_4		blue
C_1		yellow
C_2		orange
C_4		brown
PWR Supply Internal or External	Positive power lead	red
	Power common	white
	Case ground if necessary	green

NOTE: The white lead (power common) shall float with respect to case ground; i.e., the green and white wire leads shall not be connected internally.

3.3.16 External power supply. Power to the electronics portion of an encoder may, if necessary, be supplied by an external power supply as specified in paragraphs 3.3.16.1 and 3.3.16.2. This external power supply shall be considered as part of the encoder and must meet all environmental requirements of the encoder. If no external power supply is required for operation of the encoder, the encoder shall operate with the input voltages specified for the external power supply. The power supply input voltage shall be either 28 VDC or 115V, 400 Hz as specified in the contract and paragraph 3.3.16.2.

3.3.16.1 External power supply configuration. The configuration of the external power supply, if used, shall be as specified in the contract and in Figure 3.

3.3.16.2 Input power requirements. The external power supply shall operate on a voltage of 28 VDC ± 10%, at 50 mA maximum, or when designed to operate at 115V, 400 Hz, the maximum input current shall not exceed 25 mA.

3.3.17 Insulation resistance. The encoder shall withstand a voltage of 200 VDC applied between each bit lead and the case as described in paragraph 4.5.14. If an external power supply is required, it also must meet the requirements of paragraph 4.5.14.

3.3.18 Dielectric strength. The encoder shall withstand a voltage of 200 VAC, 60 Hz, applied between all leads and the case as described in paragraph 4.5.15. If an external power supply is required, it also must meet the requirements of paragraph 4.5.15.

3.3.19 Electromagnetic interference. The encoder and its external power supply, if required, shall meet the requirements of MIL-STD-461, Class 1C, when tested in accordance with paragraph 4.5.18. The definition and system of units shall be in accordance with MIL-STD-463.

3.3.20 Life. The encoder shall have a minimum life of 1,500,000 shaft revolutions at a test rate of 15 RPM. The test shall be conducted as specified in paragraph 4.5.28.

3.4 Performance.

3.4.1 Transition accuracy. Each encoder code transition shall occur at 4 1/2° intervals, ± 27 minutes of arc, when tested in accordance with paragraph 4.5.11.

3.4.2 Transition gradient. When tested in accordance with paragraph 4.5.12, the transition gradient (or sharpness of switching) shall not exceed 14 minutes of arc (five feet) for the current to change from 20% to 80% of its full conducting value, i.e., a current change of 0.5 mA to 2.0 mA for a 2.5 mA "ON" current and vice versa. The transition gradient shall occur within the ±27 minutes of arc tolerance specified in paragraph 3.4.1.

3.4.3 Encoder output characteristics. When tested in accordance with paragraph 4.5.13, the "ON" (conducting) state output voltage drop shall not exceed 6.25 VDC with a source current of 2.50 ± 0.05 mA and shall not exceed 2.0 VDC with a source current of 0.5 ± 0.05 mA. The "OFF" (non-conducting) state current shall not exceed 200 uA at 30.0 ± 0.1 VDC.

3.5 Environmental.

3.5.1 Temperature altitude. The encoder shall be capable of operation from -1200 to 38,700 or 126,700 feet altitude, as applicable, in combination with any temperature from -54 ± 2°C to +71 ± 2°C. The encoder shall meet the requirements specified when tested in accordance with paragraphs 4.5.19 and 4.5.20.

3.5.2 Vibration failure. The vibration failure test shall be performed in accordance with MIL-STD-810, Method 514.2, Procedure 1, Categories B1 and C, Part 2, Figure 514.2-2, Curve H, Frequency 5-2000 Hz, 10G. Operational performance of the encoder during and after this test shall be as specified in paragraph 4.5.17.

3.5.3 Humidity. The encoder shall be capable of operation in an atmosphere of 100% relative humidity. After testing in accordance with paragraph 4.5.21, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2.

3.5.4 Sand and dust. The encoder shall be capable of operation in presence of a sand and dust laden atmosphere. After testing in accordance with paragraph 4.5.22, the encoder shall meet the torque requirements of paragraphs 3.3.7 and 3.3.8 and the performance requirements of paragraphs 3.4.1 and 3.4.2.

3.5.5 Fungus. The encoder shall be capable of operation after exposure to fungi. After testing in accordance with paragraph 4.5.23, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2. There shall be no deterioration of the encoder performance as a result of this test.

3.5.6 Salt fog. The encoder shall be capable of withstanding atmospheres with salt-laden moistures. After testing in accordance with paragraph 4.5.24, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2. There shall be no evidence of corrosion or deterioration of the encoder performance as a result of this test.

3.5.7 Acceleration. The encoder shall be capable of withstanding 20G accelerations for a period of one minute in any attitude. After testing in accordance with paragraph 4.5.25, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2. There shall be no evidence of deterioration of the encoder performance as a result of this test.

3.5.8 Mechanical shock. The encoder shall be capable of withstanding shock blows at an acceleration of 20G of ten millisecond duration. After testing in accordance with paragraph 4.5.26, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2.

3.5.9 Temperature shock. The encoder shall be capable of withstanding sudden temperature changes between +71 ± 2°C to -54 ± 2°C as defined in Method 503 of MIL-STD-810. After testing in accordance with paragraph 4.5.27, the encoder shall meet the requirements of paragraphs 3.3.7, 3.3.8, 3.4.1 and 3.4.2. There shall be no evidence of deterioration of the encoder performance as a result of this test.

3.5.10 Identification. The encoder and external power supply, if required, shall each be identified with a name plate. Markings shall conform to MIL-N-18307. In addition, the encoder wire lead color code shall be provided on the name plate. The name plate shall withstand all of the environmental tests required of the encoder without any loss of legibility or adhesion to the case.

3.5.10.1 Encoder part numbers.

Military Part Numbers	Type	Class
M85051-1	I	A
M85051-2	I	B
M85051-3	II	A
M85051-4	II	B

3.5.11 Encoder maintainability. The design of the encoder shall facilitate maintenance repairs to the maximum practical extent. No special tools shall be required for disassembly. Parts shall be suitably marked where necessary to ease the operation of reassembly.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection and test. Qualification shall be in accordance with the Department of Defense Standardization Program Publication SD-6, Provisions Governing Qualification. The information to be supplied to the Government as specified by Publication SD-6, Section 106 shall include engineering data, detailed plans and assembly drawings necessary to identify the encoder to be qualified. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all test requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. Prior to initiating qualification testing, the manufacturer shall submit detailed test procedures to the Government for approval. The required test procedures shall be prepared in accordance with MIL-T-18303. The Government reserves the right to perform any additional tests that are deemed necessary to assure that the encoder conforms to specification requirements.

4.1.1 Retention of qualification. Retention of qualification consists of periodic verification to determine compliance of the qualified product with the requirements of this specification. Periodic verification shall be by certification unless otherwise specified by the activity responsible for the Qualified Products List and shall be at intervals of not more than two years.

4.2 Classification of test. Tests of the encoders shall be classified as follows:

a. Qualification Tests
b. Quality Conformance Tests

4.2.1 Qualification tests. Qualification tests shall be conducted at a government laboratory or private test facility approved by the Naval Air Systems Command. Sample encoders submitted for qualification tests shall be subjected to the tests shown in paragraph 4.4.2.2. For qualification, the manufacturer shall submit three samples manufactured in accordance with this specification. The encoders submitted shall have been previously subjected only to the individual tests. The samples and data shall be forwarded at the manufacturer's expense to the laboratory designated in the letter of authorization. The data supplied shall include a thoroughly detailed report on the examination of product in order to verify that all specification Section 3 requirements that are not covered by a specific test are met.

4.2.1.1 Qualification test sample identification. The qualification test samples shall be plainly identified by durable tags, securely attached and marked with the following information:

Sample for Qualification Test
Encoder, Type (e.g., IA or IIB)
Submitted by (manufacturer's name, date)
For qualification test in accordance
with Specification MIL-E-85051(AS)
under authorization (reference
letter authorizing tests).

4.2.2 Quality conformance tests. The contractor shall furnish all samples and shall be responsible for accomplishing all tests except sampling plan B tests which will be performed at a Government laboratory designated by the procuring activity. Quality conformance tests, except for sampling plan B tests, shall be under the supervision of the Government Quality Control Representative. The contractor shall furnish test reports showing quantitative results for all tests required by this specification (including detailed results of the examination of product test with respect to meeting each applicable specification requirement), signed by an authorized representative of the contractor or laboratory as applicable. Acceptance or approval of material during the course of manufacture shall in no case be construed as a guarantee of the acceptance of the finished product. Quality conformance tests shall consist of the following tests:

a. Individual tests
b. Sampling plan A tests
c. Sampling plan B tests

4.3 Individual tests. Each encoder submitted for acceptance shall be subjected to the individual tests to determine compliance with the requirements of material, workmanship and operational adequacy. As a minimum, each encoder accepted shall have passed the following tests, performed in the order listed:

a. Visual (4.5.1)
b. Dimensions (4.5.2)
c. Weight (4.5.3)
d. Wire lead stress (4.5.4)
e. Radial play (4.5.5)
f. Shaft runout (4.5.6)
g. End play (4.5.7)
h. Shaft perpendicularity (4.5.8)
i. Mounting boss concentricity (4.5.9)
j. Torque (4.5.10)
k. Transition accuracy (4.5.11)
l. Encoder output characteristics (4.5.13)
m. Insulation resistance (4.5.14)
n. Dielectric strength (4.5.15)

4.4 Sampling plans - The sampling plans shall consist of sampling plan A and sampling plan B. The test samples which have been subjected to sampling plan A test shall not be delivered on contract until they have been refurbished and resubmitted and passed all of the individual tests. Test samples which have been subjected to the sampling plan B test shall not be delivered on contract as useable production equipment.

4.4.1 Sampling plan A sample selection - Sampling plan A samples shall be selected at random in accordance with the following schedule:

Quantity Offered for Acceptance	Quantity to be Selected for Tests
First 15	1 (Zero When Sampling Plan B is Invoked)
Next 50	1
Next 75	1
Next 100	1
Each Additional 200 or Fraction Thereof	1

When an encoder failure occurs, no items from those still on hand or later produced shall be accepted until the extent and cause of failure have been determined and appropriately corrected. In addition, when a failure occurs, shift to one sample out of each 15 from those still on hand and proceed with sampling as indicated above when the next quantity is offered for acceptance. If the lot size is less than 25 encoders, the quantity produced in two months shall be considered as one lot. Concurrent delivery shall be permitted during the storage period.

4.4.1.1 Sampling plan A tests. Each sample selected for sampling plan A test shall be subjected to the following tests in the order listed.

a. Individual tests
b. Transition gradient (4.5.12)
c. Count sequence (4.5.16)
d. Vibration failure (4.5.17)

4.4.2 Sampling plan B instructions. Three samples shall be selected at random from the first 15 produced on contract and submitted within ten days after manufacture. Unless otherwise directed, these samples shall be forwarded at the contractor's expense to a Government laboratory designated by the procuring activity. Each sample shall be plainly identified by a securely-attached durable tag marked with the following information:

Encoder, Type
Submitted by (manufacturer's name, date)
for production acceptance Sampling Plan B
tests of MIL-E-85051(AS) with Contract
No. _____. Manufacturer's
part no. _____.

4.4.2.1 Sampling plan B approval. Approval of sampling plan B encoders shall be by the procuring activity upon satisfactory completion of the designated tests of paragraph 4.4.2.2. Any design, material or performance defect made evident during this test shall be corrected by the contractor to the satisfaction of the procuring activity. Failure of the sample encoders to pass any of the tests shall be cause for deliveries of encoders under the contract to cease until proper corrective action is approved and accomplished.

4.4.2.2 Sampling plan B tests. Each encoder sample selected for sampling plan B test shall be subjected to the following tests in the order listed:

a. Sampling plan A tests
b. Electromagnetic interference (4.5.18)
c. Altitude - low temperature (4.5.19)
d. Altitude - high temperature (4.5.20)
e. Humidity (4.5.21)
f. Sand and dust (4.5.22)
g. Fungus (4.5.23)
h. Salt fog (4.5.24)
i. Acceleration (4.5.25)
j. Mechanical shock (4.5.26)
k. Temperature shock (4.5.27)
l. Life (4.5.28)

4.4.3 Test conditions.

4.4.3.1 Standard conditions. Unless otherwise specified, all tests required by this specification shall be made under the following conditions:

Temperature:	25°C ± 5°C
Pressure:	Room ambient
Humidity:	Room ambient

4.4.3.2 Attitude. Unless otherwise specified, all tests required by this specification may be conducted with the encoder in any attitude, orientation or position.

4.5 Tests.

4.5.1 Visual inspection. Each encoder shall be inspected for quality of workmanship. Workmanship shall be of the level expected in high quality electromechanical devices. Any evidence of inferior workmanship or non-conformance with the requirements of Section 3 of this specification shall be cause for rejection.

4.5.2 Dimensions. Each encoder (and external power supply, if required) shall have all dimensions measured to assure that the dimensions are within the tolerances specified in Figures 1 through 3. Any out-of-tolerance dimension shall be cause for rejection.

4.5.3 Weight. The encoder (including external power supply, if required) shall be weighed and the weight shall not exceed the eight ounce value listed in 3.3.2.

4.5.4 Wire lead stress. Each wire lead shall be individually tested by having a two-pound force applied to the extreme end. The force shall be applied pulling from the encoder in any direction. Any indication of a lead pulling loose, wire strands breaking, or a permanent deformation of the insulation shall be cause for rejection.

4.5.5 Radial play. The encoder housing shall be rigidly mounted. A dial indicator shall be rigidly mounted in a position to measure shaft movement perpendicular to the shaft axis. The indicator plunger shall contact the shaft at 0.250 inches from the mounting face. A force of eight ounces shall be applied to the shaft directly opposite the point of contact between the indicator plunger and the shaft. A reading shall be taken and without disturbing the position of the shaft, the positions of the indicator plunger and the force shall be rotated to 90°, 180° and 270° and the measurement repeated at each position. The deviations in the indicator readings in all positions after the application of the eight ounce force shall not exceed the value specified in paragraph 3.3.11.

4.5.6 Shaft run-out. The encoder housing shall be rigidly mounted at the mounting face. A dial indicator shall be mounted to measure shaft eccentricity at a distance of 0.125 inch from the end of the shaft. When the shaft is rotated, the extreme indicator readings shall not exceed the value specified in 3.3.12.

4.5.7 End play. The encoder housing shall be rigidly mounted in a suitable position. A dial indicator shall be rigidly mounted in a position to measure shaft motion along the encoder shaft axis. An axial force of one pound shall be applied to the end of the shaft. Note the reading of the dial indicator. Reverse the applied force and note the dial indicator reading. The difference between the two readings shall be within the limits for end play specified in 3.3.13.

4.5.8 Shaft perpendicularity. The encoder shaft shall be rigidly mounted in a vertical position. The dial indicator plunger shall be located on the mounting face surface as close to the outer edge as possible. When the housing is rotated through 360°, the difference between the extreme indicator readings shall not exceed the value specified in Figures 1 and 2.

4.5.9 Mounting boss concentricity. The encoder shaft shall be rigidly mounted in a vertical position. The indicator plunger shall be located on the peripheral surface of the mounting collar. When the housing is rotated through 360°, the extreme indicator readings shall not exceed the value specified in Figures 1 and 2.

4.5.10 Torque. The starting and running torque at -54 ± 2°C and at +71 ± 2°C shall be determined in both the clockwise and counterclockwise directions. The running torque shall be determined over a minimum of 360° of shaft rotation. The starting and running torques shall not exceed the values specified in paragraphs 3.3.7 and 3.3.8, respectively.

4.5.11 Transition accuracy. The encoder shall be electrically connected to an encoder readout device (see paragraph 4.5.11.1) and mechanically connected to a suitable dividing head having a minimum accuracy capability of ± 30 seconds. The encoder shaft shall be rotated and the transition points as indicated by the readout device shall not differ from the theoretically correct transition points by more than ± 10 feet of altitude (± 27 minutes of arc).

4.5.11.1 Encoder readout device. The encoder readout device specified in paragraph 4.5.11 shall be capable of monitoring both the current through and the voltage drop of each encoder bit under the conditions specified in paragraph 3.4.3.

4.5.11.2 Zero position. The mean angular position of the transitions from 0 to -100 feet and 0 to +100 feet, measured at room temperature, shall be used as the zero reference position in all transition accuracy tests. To find the mean position (equivalent to 0 feet altitude) turn the encoder shaft in a decreasing count direction to the transition from 0 to -100 feet and note the angular position. The encoder shaft shall then be rotated in an increasing count direction to the transition from 0 to +100 feet and the angular position shall be noted. The average of the two angular positions shall be used as the zero position of the encoder. All altitude transitions shall be referenced to this zero position angle.

4.5.11.3 Transition accuracy test points. Transition accuracy shall be determined for every code transition from 0 feet to 8,000 feet and for the altitude test points specified in column A of Table III, as applicable to the encoder type.

4.5.11.4 Backlash. Upon completion of the transition accuracy test and without disturbing the test setup, the encoder shaft shall be rotated in the opposite direction (decreasing altitude) until the transition to zero feet code output just occurs. The angular position, as indicated on the dividing head, shall be read and shall not differ from the theoretically correct transition by more than ±27 minutes of arc.

4.5.12 Transition gradient. The encoder shall be mechanically connected to a suitable dividing head having a minimum accuracy capability of ± 30 seconds. Each encoder bit shall be connected as shown in Figure 4. With the current source set to supply 2.50 ± 0.05 mA to each bit in the "ON" state, two readings shall be taken during a transition from an "OFF" to an "ON" state. The first reading shall be the angular position where the current level is 0.5 mA. The second reading shall be the angular position where the current level has risen to 2.0 mA. The difference between the two readings shall not exceed 14 minutes of arc (five feet of altitude). Repeat the test in the reverse sequence (transition from the "ON" state to the "OFF" state) for each output bit. The difference between these two readings shall not exceed 14 minutes of arc (five feet of altitude). A minimum of one transition on each bit shall be measured.

4.5.13 Encoder output characteristics. The encoder output between each bit lead and common in the "ON" and "OFF" state shall be determined while the encoder is at room temperature, at -54 ± 2°C and at +71 ± 2°C. Each encoder bit shall be connected as shown in Figure 4. With the current source set to impress 2.50 ± 0.05 mA on each bit in the "ON" state, measure the voltage drop near the midpoint of an "ON" state segment of each bit. The "ON" state voltage drop on each bit shall not exceed 6.25 VDC at the temperatures specified. Repeat the measurement with the current source reduced to 0.50 ± 0.05 mA; the voltage drop on each bit shall not exceed 2.0 VDC at the temperatures specified. Replace the constant current source with a voltage source of +30.0 ± 0.1 VDC. The "OFF" state current measured near the midpoint of an "OFF" state segment of each bit shall not exceed 200 uA at the temperatures specified.

TABLE III. Encoder code transitions.

A	B	C	
Theoretical Transition Altitude (Feet)	Bit	Bit Transition	
		ON to OFF	OFF to ON
10800	A_4	X	
14800	A_1		X
18800	A_4		X
22800	A_2	X	
26800	A_4	X	
30800	D_4		X
34800	A_4		X
38800	A_2		X
42800	A_4	X	
46800	A_1	X	
50800	A_4		X
54800	A_2	X	
58800	A_4	X	
62800	D_2		X
66800	A_4		X
70800	A_2		X
74800	A_4	X	
78800	A_1		X
94800	D_4	X	
-1200	D_2	X	

4.5.14 Insulation resistance. The insulation resistance shall be measured by applying a potential of 200 VDC between each bit lead and the encoder case (green lead, if provided). The external power supply, if required, shall be similarly tested by applying a potential of 200 VDC between each power supply lead and the power supply case. The insulation resistance measured shall meet the requirements specified in 3.3.17. There shall be no breakdown of insulation or any other permanent damage to the encoder as a result of this test.

4.5.15 Dielectric strength. A potential of 200 VAC rms, 60 Hz, shall be applied between all leads tied together and the encoder case (green lead, if provided) for a period of one minute. The external power supply, if required, shall be similarly tested by applying a potential of 200 VAC, 60 Hz, between all the power supply leads tied together and the power supply case. Evidence of dielectric breakdown shall be cause for rejection.

4.5.16 Count sequence. With the encoder connected to the encoder readout device specified in paragraph 4.5.11.1, the code output shall be monitored to determine that each 100-foot transition occurs in the proper sequence throughout the altitude range of the encoder. The current through each bit in the "ON" state shall be set to a minimum level of 2.50 $\pm$ 0.05 mA. Any transient out-of-sequence code output shall be cause for rejection.

4.5.17 Vibration failure. The encoder shall be subjected to the vibration test in accordance with MIL-STD-810, Method 514.2, Procedure 1, Part 2, Figure 514.2-2, Curve H, Frequency 5-2000 Hz, 10 G. During the first third of the vibration period, the encoder shaft shall be rotated continuously at two RPM in a clockwise direction. During the second third, the encoder shaft shall not be rotated. During the last third of the vibration period, the encoder shaft shall be rotated continuously at two RPM in a counterclockwise direction. The count sequence test of paragraph 4.5.16 shall be conducted throughout the vibration period. Upon completion of the vibration period, the encoder shall be subjected to and meet the requirements of paragraphs 4.5.11, 4.5.14, 4.5.15 and 4.5.16. Failure to comply with any of the requirements shall be cause for rejection.

4.5.18 Electromagnetic interference. The encoder shall be subjected to the electromagnetic interference tests in accordance with MIL-STD-461 and MIL-STD-462 and meet the requirements of paragraph 3.3.19. During the EMI test, each encoder bit shall be connected as shown in Figure 4 and the "ON" state circuit current shall be maintained at 2.50 $\pm$ 0.05 mA in each bit. The encoder shaft shall be rotated at a rate of 6,000 feet per minute (3/4 RPM) over the entire code range. Failure to meet the requirements of this test shall be cause for rejection.

4.5.19 Altitude-low temperature test. The encoder shall be placed in a suitable test chamber and shall be electrically and mechanically connected as described in paragraph 4.5.11. The encoder shall be zeroed in accordance with paragraph 4.5.11.2 and the chamber temperature shall then be reduced to -54 ± 2°C. After the temperature has been stabilized for two hours and while still at the low temperature, the pressure of the chamber shall be reduced to that equivalent to 100,000 feet of altitude. While at this pressure and temperature, the encoder shall be subjected to and meet the requirements of the transition accuracy test, paragraph 4.5.11, the transition gradient test, paragraph 4.5.12 and the encoder output characteristics test, paragraph 4.5.13. While maintaining the low temperature, the pressure of the chamber shall be returned to ambient pressure. The encoder shall then be subjected to and meet the requirements of the torque test, paragraph 4.5.10. Failure to meet the requirements of this test shall be cause for rejection.

4.5.20 Altitude-high temperature test. The test of paragraph 4.5.19 shall be repeated except that the temperature shall be changed to +71 ± 2°C. Failure to meet the requirements of this test shall be cause for rejection.

4.5.21 Humidity. The encoder shall be subjected to the humidity test in accordance with Method 507 of MIL-STD-810. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.22 Sand and dust. The encoder shall be subjected to the sand and dust test in accordance with Method 510 of MIL-STD-810. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.23 Fungus. The encoder shall be subjected to the fungus test in accordance with Method 508 of MIL-STD-810. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.24 Salt fog. The encoder shall be subjected to the salt fog test in accordance with Method 509 of MIL-STD-810. Care shall be taken during this test to insure that the encoder is not sprayed directly with salt solution. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.25 Acceleration. The encoder shall be subjected to the acceleration test in accordance with Method 513 of MIL-STD-810. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.26 Mechanical shock. The encoder shall be subjected to the shock test in accordance with Method 516, Procedure I of MIL-STD-810. At the conclusion of the test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12. There shall be no deterioration of the encoder as a result of this test.

4.5.27 Temperature shock. The encoder shall be subjected to temperature shock as specified in Method 503 of MIL-STD-810. At the conclusion of this test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

4.5.28 Life. Each encoder bit shall be connected as shown in Figure 4 and the "ON" state current shall be maintained at 2.50 $\pm$ 0.05 mA per bit. The encoder shaft shall be rotated at 15 RPM in both clockwise and counterclockwise directions. The direction of rotation shall be changed at one minute intervals throughout the test. Between the one minute intervals, the encoder shaft shall be completely stopped momentarily (not to exceed two seconds) prior to reversing the shaft rotation. Power to the encoder and the shaft rotation shall be interrupted for a period of five minutes during each hour. The encoder shall be placed in a temperature chamber and the temperature shall be continuously cycled for the duration of the life test. The temperature duty cycle during one 24-hour period shall consist of eight hours at +71 $\pm$ 2°C, six hours at room temperature and the balance at -54 $\pm$ 2°C, in that order. The time to change from one stabilized temperature to the next shall not exceed one hour. This cycle shall be repeated continuously until the encoder has completed 1,600 hours of cycling. At each seven-day interval and at the conclusion of the test, the encoder shall be subjected to and meet the requirements of the torque test, paragraph 4.5.10, the transition accuracy test, paragraph 4.5.11 and the transition gradient test, paragraph 4.5.12.

5. PACKAGING

5.1 Unit packaging. Unless otherwise specified by contract or order, each encoder and external power supply, if required, shall be individually packaged in a sealed container in accordance with MIL-STD-794 with necessary cushioning to provide a tight package. The cushioning material shall have a pH value between 6.0 and 8.0 and shall not produce corrosive or deleterious fumes or vapors which could act on or attack the encoder.

5.2 Packing. Unless otherwise specified by contract or order, encoders shall be packed in accordance with MIL-STD-794 Level A, B or C as specified by the procuring activity.

5.3 Marking. The nomenclature on the shipment container shall provide six identifying markings:

a. Encoder, Altitude Reporting, Non-Contact
b. Part Number
c. Altitude Range (feet) _____
d. National Stock Number (NSN)
e. MIL-E-81501 (AS)
f. Direction of Shaft Rotation for Increasing Count

6. NOTES

6.1 Intended use. The encoders covered by this specification are for use in altitude reporting systems where it is necessary to convert analog shaft position in air mass instruments to digital form for display, computation or transmittal to air traffic control centers.

6.2 Ordering data. Procurement documents should specify the following:

a. Title, number and date of this specification.
b. The quantity, National Stock Number and part number.
c. Direction of shaft rotation for increasing count.
d. Length of wire leads.
e. Configuration and dimensions of external power supply, if used.
f. Levels of packaging and packing desired.
g. The laboratory that shall conduct tests.
h. Case ground. See Table II. Specify if needed.
i. Shaft length. Type II only.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for such products as have, prior to the time set for the opening of bids, been tested and approved for inclusion in the applicable Qualified Products List whether or not such products have actually been so listed by that date. Suppliers are directed to provisions governing qualification (SD-6) and are urged to arrange to have the products that they propose to offer to the Federal Government, tested for qualification, in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. The activity responsible for the Qualified Products List is the Naval Air Systems Command, Department of the Navy, Washington, D. C. 20361, and information pertaining to qualification of products may be obtained from the activity.

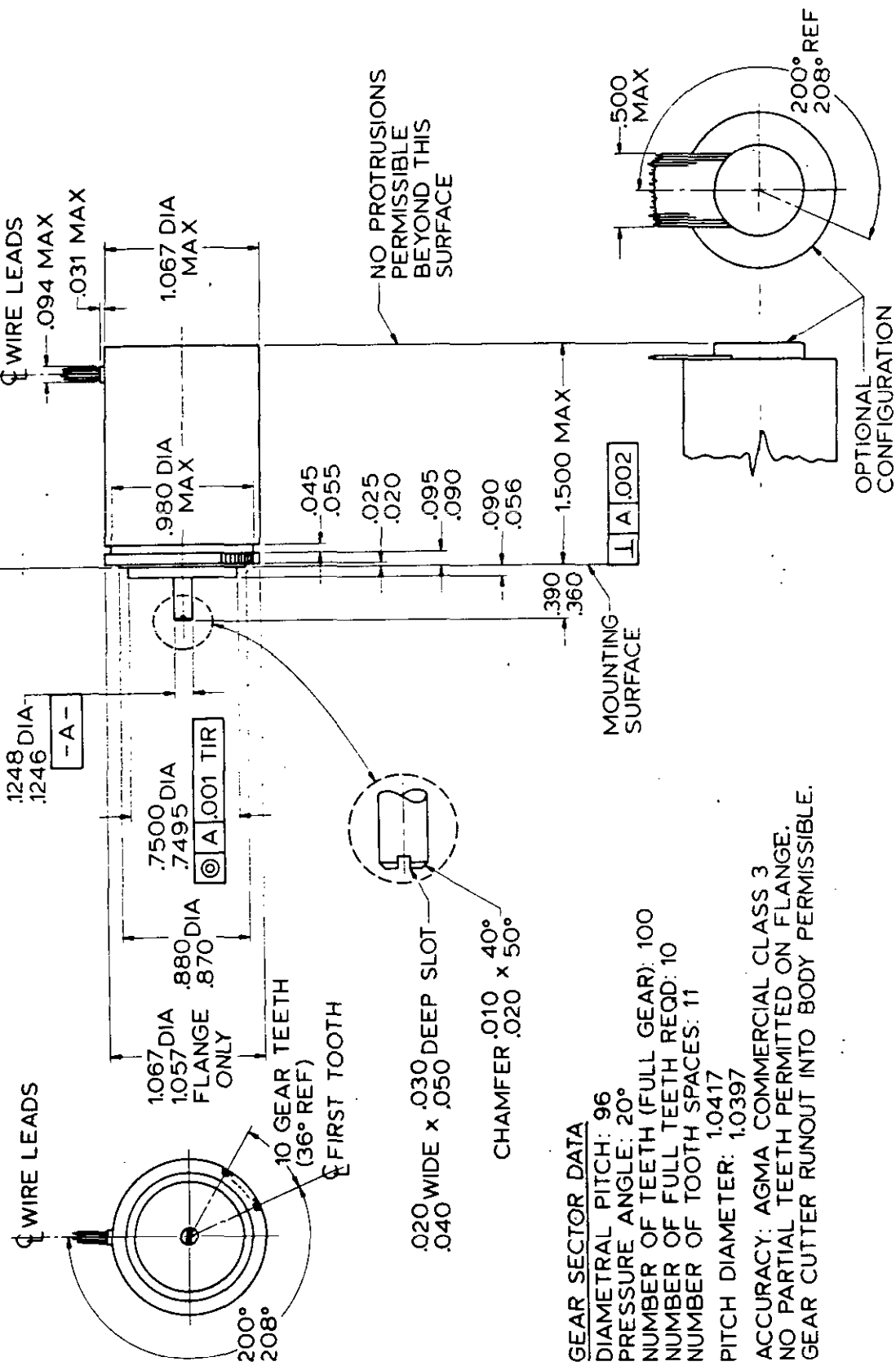
6.4 Precedence of documents. When the requirements of the contract, this specification, or applicable subsidiary specifications are in conflict, the following precedence applies.

a. Contract. The contract shall have precedence over any specification.

b. This specification. This specification shall have precedence over all applicable subsidiary specifications. Any deviation from this specification, or from subsidiary specifications where applicable, shall be specifically approved in writing by procuring activity.

c. Referenced specifications. Any referenced specification shall have precedence over all applicable subsidiary specifications referenced therein. All referenced specifications shall apply to the extent specified.

Preparing Activity:
Navy - AS
(Project No. 5990-N064)



GEAR SECTOR DATA
DIAMETRAL PITCH: 96
PRESSURE ANGLE: 20°
NUMBER OF TEETH (FULL GEAR): 100
NUMBER OF FULL TEETH REQD: 10
NUMBER OF TOOTH SPACES: 11
PITCH DIAMETER: 1.0417
1.0397
ACCURACY: AGMA COMMERCIAL CLASS 3
NO PARTIAL TEETH PERMITTED ON FLANGE.
GEAR CUTTER RUNOUT INTO BODY PERMISSIBLE.

FIGURE 1. TYPE I ENCODER OUTLINE

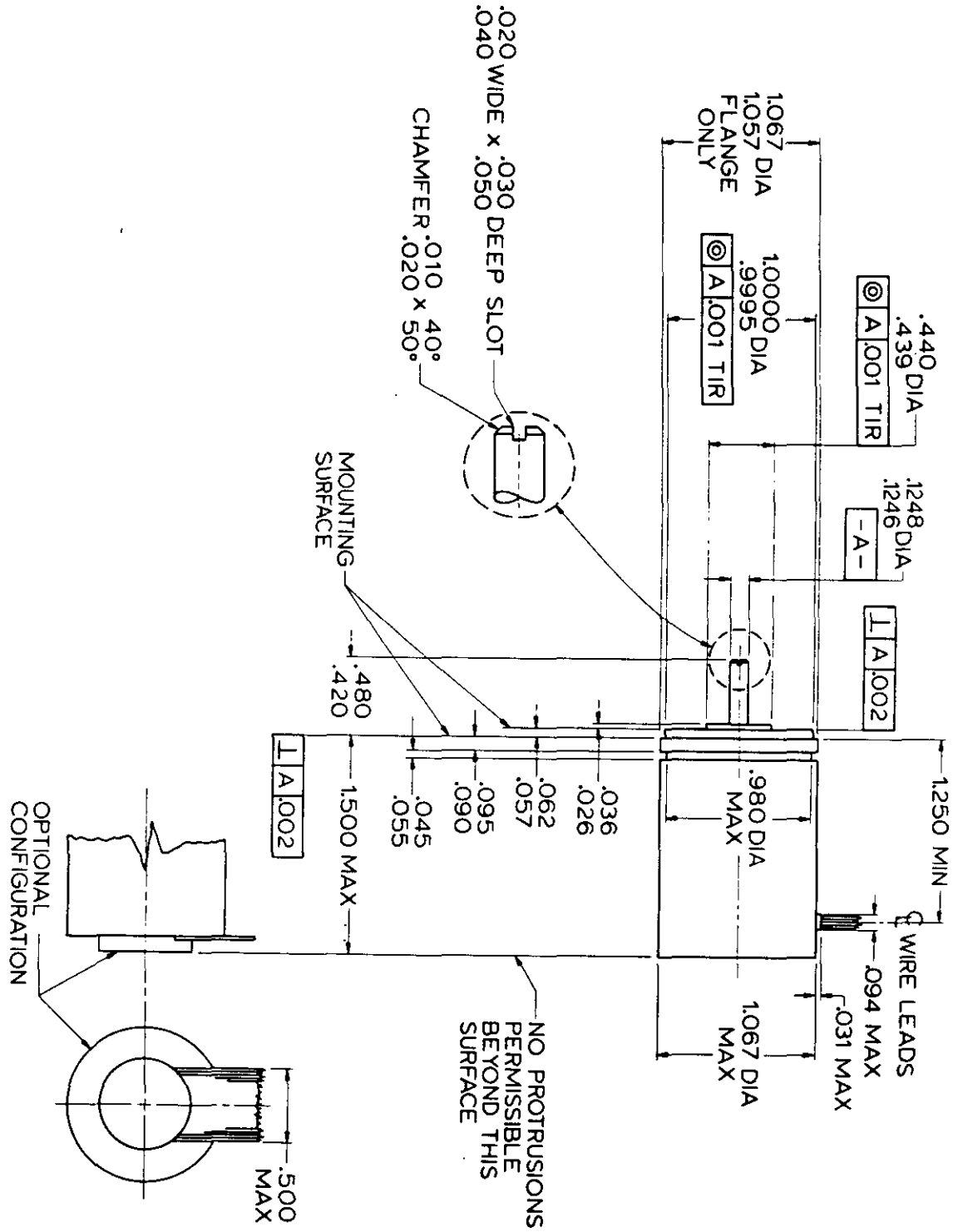
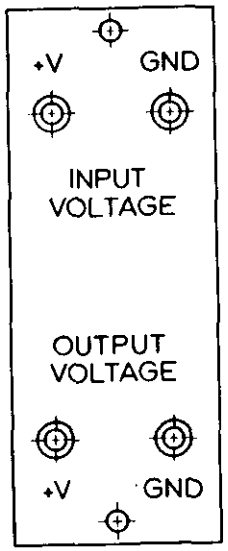


FIGURE 2. TYPE II ENCODER OUTLINE



NOTES:
1. ALL DIMENSIONS SHALL BE SPECIFIED IN THE CONTRACT OR PURCHASE ORDER. SHAPE IS NOT NECESSARILY AS INDICATED IN THIS DRAWING.
2. TERMINALS SHALL BE POSITIVELY IDENTIFIED ON THE CASE AS INDICATED STATING THE ACTUAL VOLTAGE VALUE.

FIGURE 3. EXTERNAL POWER SUPPLY.

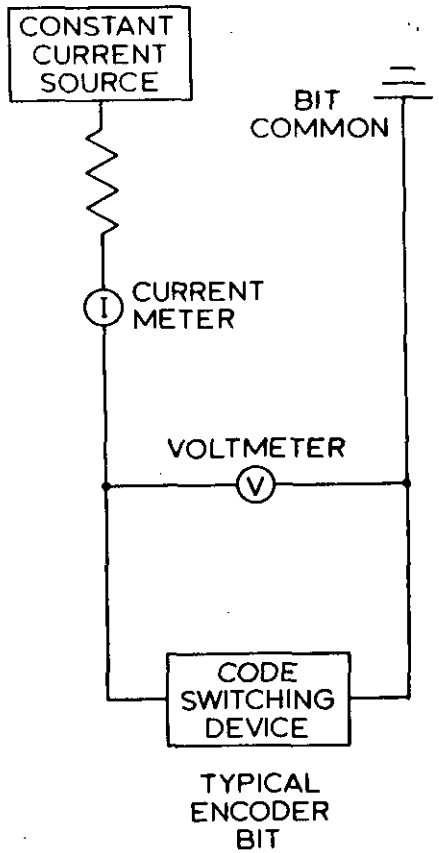


FIGURE 4. ENCODER BIT TEST SET UP.

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

OMB Approval
No. 22-R255

INSTRUCTIONS: The purpose of this form is to solicit beneficial comments which will help achieve procurement of suitable products at reasonable cost and minimum delay, or will otherwise enhance use of the document. DoD contractors, government activities, or manufacturers/vendors who are prospective suppliers of the product are invited to submit comments to the government. Fold on lines on reverse side, staple in corner, and send to preparing activity. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Attach any pertinent data which may be of use in improving this document. If there are additional papers, attach to form and place both in an envelope addressed to preparing activity.

DOCUMENT IDENTIFIER AND TITLE
MIL-E-85051(AS) Encoders, Shaft Position to Digital, Non-Contact Type, Altitude Reporting

NAME OF ORGANIZATION AND ADDRESS

CONTRACT NUMBER

MATERIAL PROCURED UNDER A
☐ DIRECT GOVERNMENT CONTRACT ☐ SUBCONTRACT

1. HAS ANY PART OF THE DOCUMENT CREATED PROBLEMS OR REQUIRED INTERPRETATION IN PROCUREMENT USE?
   A. GIVE PARAGRAPH NUMBER AND WORDING.

   B. RECOMMENDATIONS FOR CORRECTING THE DEFICIENCIES

2. COMMENTS ON ANY DOCUMENT REQUIREMENT CONSIDERED TOO RIGID

3. IS THE DOCUMENT RESTRICTIVE?
   ☐ YES ☐ NO *(If "Yes", in what way?)*

4. REMARKS

SUBMITTED BY *(Printed or typed name and address - Optional)*

TELEPHONE NO.

DATE

DD FORM 1 JAN 72 1426 REPLACES EDITION OF 1 JAN 66 WHICH MAY BE USED

S/N 0102-014-1802

☆ U.S. GOVERNMENT PRINTING OFFICE: 1973—714-866/3983 2-1

FOLD

DEPARTMENT OF THE NAVY

Naval Air Engineering Center
Lakehurst, NJ 08733

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

POSTAGE AND FEES PAID
DOD
316

U.S.MAIL

Engineering Specification and Sstandards Department (Code 93)
Naval Air Engineering Center
Lakehurst, NJ 08733

FOLD