

SPECIFICATIONS



SERIES MT40

MULTI-TURN ABSOLUTE POSITION ENCODERS

Approved for general release

INTRODUCTION

Because there are so many possible MT40 Absolute Position Encoder configurations, this specification was written to help you select the best configuration for your application. Each encoder has 13 different specification parameters, and each parameter has several options. While the standard options are designed to fit most applications, custom options are available. Determining a particular MT40 encoder model number will require specifying option codes for each of the 13 parameters. The section (“How to Order Your MT40 Encoder”) will help you identify these parameters and show you how to put together the Option Codes to form the whole encoder model number for ordering. Separate sections on Parameters 1 through 13 show how to select the appropriate options for your application.

Below are some general construction notes that apply to all standard models. Along with the notes in the various parameter sections, they will assist you in specifying encoders for your application.

GENERAL CONSTRUCTION

These notes supplement the notes and tables for the various options detailed in Parameters 1 through 13. When specifying an encoder for your application, those notes and tables should also be consulted.

WEIGHT AND DIMENSIONS

1. Basic encoders (direct reading, with output code options G or B1, and with no extra features):

MOUNTING TYPE	HOUSING LENGTH	WEIGHT
D, E, G, and J	4 to 6 inches	3 to 5 lb.

2. Adding some electronic options increases the encoder’s length and weight. Increases are 0.375 inches and approximately 1 oz for each option.

MATERIALS

HOUSING — Aluminum

SHAFT — Stainless steel — 416

BEARINGS — Stainless steel — 440C

COVER — Aluminum — Deep drawn

DISK — Glass

ENVIRONMENTAL CONSIDERATIONS

1. With a shaft seal and a sealed connector, the encoder is resistant to moisture, dust and oil, and can qualify for NEMA 4, 12 and 13 ratings.
2. Temperature:
 - Operating — 0°C to +70°C (Standard)
 - 40°C to +85°C (Extended Range, 9 to 13 bits)
 - [D9: -20°C Low Limit]
 - Storage — -65°C to +125°C
3. Shock (using MIL-STD-810C Method 516.2, procedure 1, figure 516.2-2): 50g, for 11 msec.
4. Humidity: 98% Relative Humidity without condensation.

OPTICAL CONSTRUCTION

1. The MT40 encoder has a single light source per code disk which affords higher reliability than units with multiple sources.
2. The encoder optics are assembled and mounted in the bearing housing. This assures maximum system rigidity and accuracy. The encoder is impervious to most external non-destructive forces. Only a severe blow, sufficient to do permanent damage, can deflect the optics relative to the code pattern.

ELECTRONIC NOTES

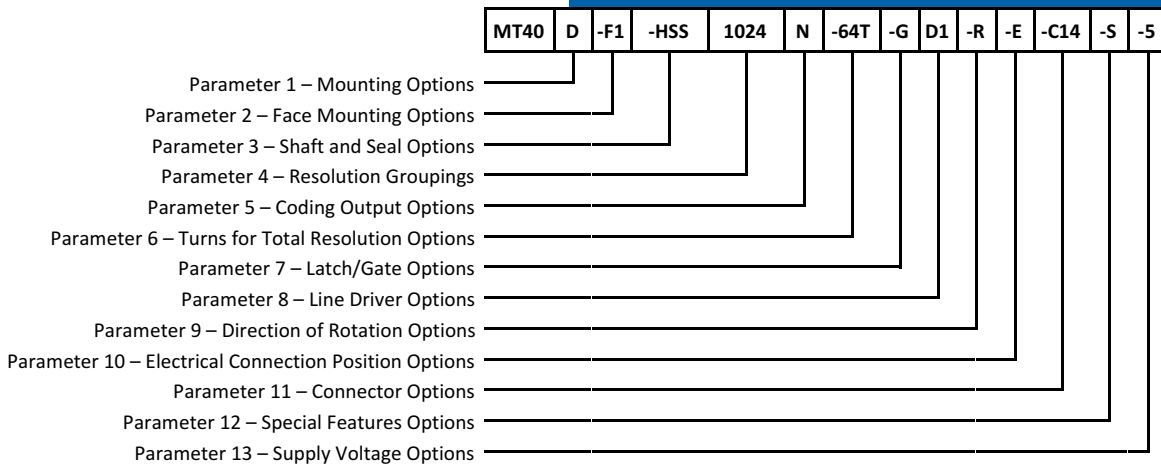
Encoder options such as code conversion, multipliers, and line drivers are assembled on electronic plug-in module boards within the encoder housing. The boards are mechanically secured, and do not use soldered interconnections. Each board contains one or more options. Combinations of options are literally plugged in.

HOW TO ORDER YOUR MT40 ENCODER

Ordering requires the encoder model number. The model number requires the specification of one option from each of the 13 design parameters involved. As you'll see in the example below, the complete model number starts with "MT40", and is followed by the 13 option codes. Each parameter (1 - 13) is fully described, and the most commonly used options are listed and explained.

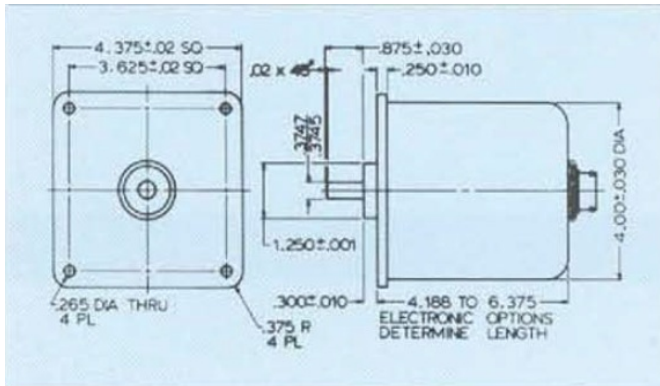
In many cases, custom variations can be accommodated. To discuss these unlisted options, please contact our sales representative in your area, or call the BEI PSSC factory direct at 501-851-4000.

HOW TO SPECIFY AN M40 ENCODER

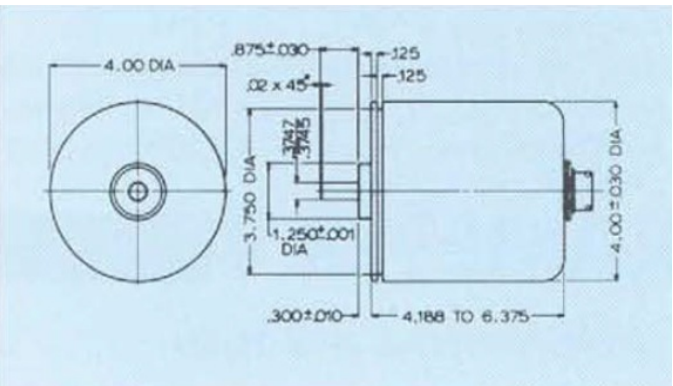


PARAMETER 1

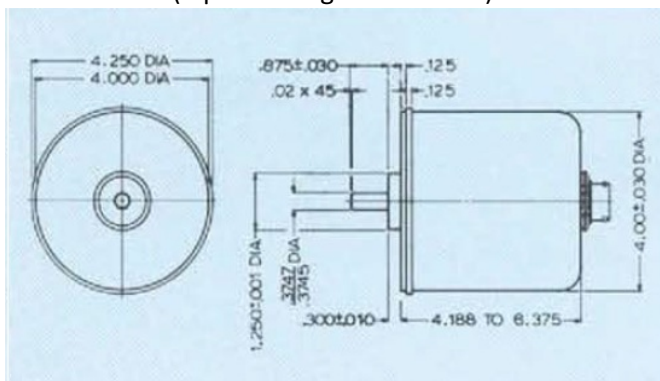
MOUNTING OPTIONS



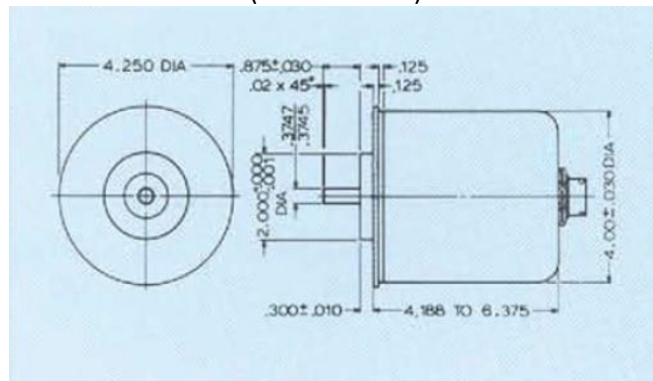
OPTION D
(Square Flange – Standard)



OPTION E
(Servo Mount)



OPTION G
(Servo Mount)



OPTION J
(Servo Mount)

NOTES:

1. Option D is standard.
2. All dimensions are in inches.
3. Shaft Sizes are optional.

PARAMETER 2

FACE MOUNTING OPTIONS

Specify X for no face mounting option. Because all face mounts require a special order, please contact our Application Engineering Department at the factory.

PARAMETER 3

SHAFT AND SEAL OPTIONS

	SHAFT DIAMETER	SHAFT TYPE	BEARING/SEAL TYPE	STARTING TORQUE (at 25°C, oz-in max)
H	3/8"	1	Shielded Bearings	2.0
HSS	3/8"	1	Heavy-Duty Shaft Seal	1.0
L	1/4"	2	Shielded Bearings	1.2
LSS	1/4"	2	Instrument Duty Shaft Seal	1.0
SP	Special Shaft or Seal Configuration (Send Drawing).			

NOTES:

- Shaft Type 1 is standard.
Diameter: 0.3747/0.3745 inches
Shaft loading: Axial – 40 lb.
Radial – 35 lb.
- Shaft Type 2
Diameter: 0.2497/.02495 inches
Shaft Loading: Axial – 8 lb.
Radial – 5 lb.
- Shaft Runout: 0.0005 inch/TIR maximum
- Bearings are class ABEC 7 or ABEC 7P.
- Bearing life (based upon the manufacturer's ratings according to AFBMA L_{10} calculations):
At rated shaft loading – 2×10^8 revolutions
At 10% of shaft loading – 5×10^{10} revolutions
- Moment of Inertia:
For 100:1 gear train encoder: 4.05×10^{-3} oz in sec^2 (For other values, please consult our Applications Engineering Department at the factory.)
- Maximum Slew Speed: 5000 rpm.
- Stated values are conservative and, under some circumstances, may be extended. Special shaft configurations such as: flats, splines, slots, threads, etc. can be supplied. Please contact our Application Engineering Department at the factory.
- Shaft and bearing case materials 416 corrosion resistant stainless steel.

PARAMETER 4

RESOLUTION OPTIONS

OPTION (WORD COUNT)	CODE TYPE	# OF PARALLEL DATA LINES	OPTION (WORD COUNT)	CODE TYPE	# OF PARALLEL DATA LINES
512	G/N	9	1,000	B1/B2/B4	10
1,024	G/N	10	1,000	B3 (BCD)	12(see note 7)
2,048	G/N	11	3,600	B1/B2/B4	12
4,096	G/N	12	3,600	B3 (BCD)	14(see note 7)
8,192	G/N	13	16,384	N	14
360	B1/B2/B4	9	32,768	N	15
360	B3 (BCD)	10(see note 7)	65,536	N	16

NOTES:

- MT40 'Fine' encoders can be manufactured for 'direct reading' in any even count (words) per turn up to 8,192. All encoder disks use a cyclic binary or Gray code pattern. For specifying the 'Coarse' encoder see Parameter 6.
- All non-cyclic binary codes employ an electronic code conversion model. Extended range natural binary outputs to 65,535 counts (16 bits) are available by using electronic multiplying techniques.
- The key to reference letters for available code types is in Parameter 5.
- The total word length is the sum of the outputs of the 'Fine' and 'Coarse' encoders. The least significant data lines are provided by the 'Fine' encoder, the most significant data lines by the 'Coarse' encoder. Please also see Note 7 below and Note 1 of Parameter 6.
- Transition Accuracy: ± 1 least significant bit, maximum
- For direction of rotation refer to Parameter 9.
- With BCD output multi-turn encoders, the outputs consist of the 'Fine' encoder reading angular position in BCD, and the 'Coarse' encoder reading the number of turns in BCD.

PARAMETER 5

OUTPUT CODE

OPTION	DESCRIPTION
G	Gray or Cyclic Binary
N	Natural Binary
B3	Binary Coded Decimal (BCD-8421)
B4	Natural Binary converted from cyclic coding.

NOTES:

- The disks of all BEI MT40s are encoded in cyclic or Gray code. For disks with resolutions that are an exact power of 2 (512, 1024, 2048, etc.), the full cyclic code is used. For disks with resolutions that are less than these values, excess cyclic codes are used.
- B3 uses additional internal electronic code conversion to produce a true binary coded decimal (BCD-8421) code output. The excess code is fully corrected, and the output starts at zero and goes to the full count.
- B4 uses internal code conversion circuits to produce a true natural binary output. The output starts at zero and goes to the full count. This is particularly useful for direct computer interfacing.
- For other codes, contact our Applications Engineering Department at the factory.

PARAMETER 6

TURNS FOR TOTAL RESOLUTION OPTIONS

OPTION (# of turns)	CODE TYPES	BITS	OPTION (# of turns)	CODE TYPES	BITS
16	G, N	4	10	B3 (BCD)	4 (see note 1)
32	G, N	5	10	B4	4
64	G, N	6	100	B3 (BCD)	8 (see note 1)
128	G, N	7	100	B4	7
256	G, N	8	NOTE: 1. Other turns ratios are available. Please consult factory.		
512	G, N	9			

PARAMETER 7

GATE OPTION

OPTION	DESCRIPTION
G	Gate feature required
X	No gate feature required

NOTES:

- This gate option allows the user, upon external command, to sample or 'freeze' the instantaneous value of the encoder output.
- When the command line is 'Hi', the output signals are normal. The output follows the rotation of the encoder. When the command line is 'Lo', the output is frozen at the value at the moment of change from Hi to Lo. The command line may be held Lo for as long as desired. The gate operates at the Gray code level of the circuits (Hi and Lo are standard TTL logic signals. The load is 12 TTL gates).

PARAMETER 8

INTERFACE OPTIONS

OPTION	DESCRIPTION	IC TYPE	SINK CURRENT	SOURCE CURRENT	COMMENTS
D1	Single-ended, positive logic, resistor pullup, 2-state	SN7407	40 ma	0.5 ma	Max cable 50 ft. 12 VDC max
D2	Single-ended, positive logic, open collector, 2-state	SN7407	40 ma	0.5 ma	Max cable 100 ft. 24 VDC max
D8	Differential, 3-state	AM26LS31	20 ma	20 ma	Max cable 1000 ft. Can be multiplexed RS422 5 VDC output
D9	Single-ended, open emitter, 2-state, current sourcing	UDN2987A	0	200 ma	Max cable 300 ft. Not available on 5 VDC models. Low Temperature Limit is -20°C
D10	Serial output, synchronous with user's clock	AM26LS31	20 ma	20 ma	Max cable 1000 ft. RS422 compatible 5 VDC output
D13	Serial output, asynchronous	MC1488/89	NA	NA	Max cable 50 ft. RS232 compatible.
D15	Single-ended, open collector, 2-state, current sinking	ULN2803A	200 ma	0	Max cable 300 ft. Transient suppression installed.
D17	Serial output, asynchronous	88C30	NA	NA	Max cable 1000 ft. RS422 compatible if 5 VDC output. D17 always sends.
A1	4 to 20 ma current output	Digital to Analog Converter	NA	NA	Not available on 5 VDC models. Consult factory for shaft angle range.

NOTES:

- All interfaces require the use of a properly shielded cable. Recommended wire size is AWG 20 or 22. Adequate power supply wires are necessary in order to avoid voltage drops in +5 VDC lines and in all return power lines.
- For additional information on any of these interfaces, contact our Applications Engineering Department at the factory.

PARAMETER 9

DIRECTION OF ROTATION OPTIONS

OPTION	DIRECTION OF ROTATION	
X	Counter-clockwise	increasing count, when viewing the shaft end of the encoder.
R	Clockwise	
CR	Electronically controllable (See Note 2.)	

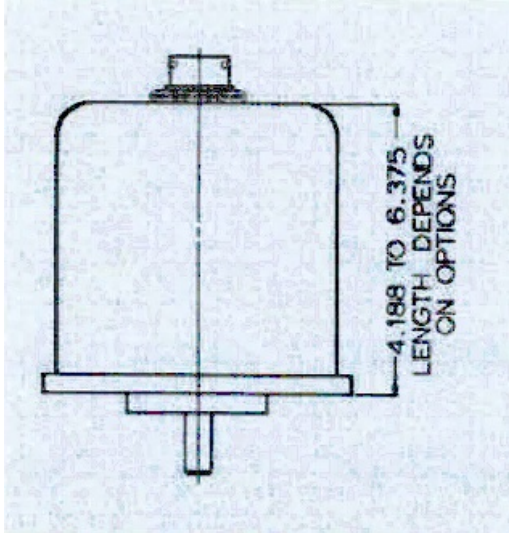
NOTES:

- Direction of rotation is defined as the direction of

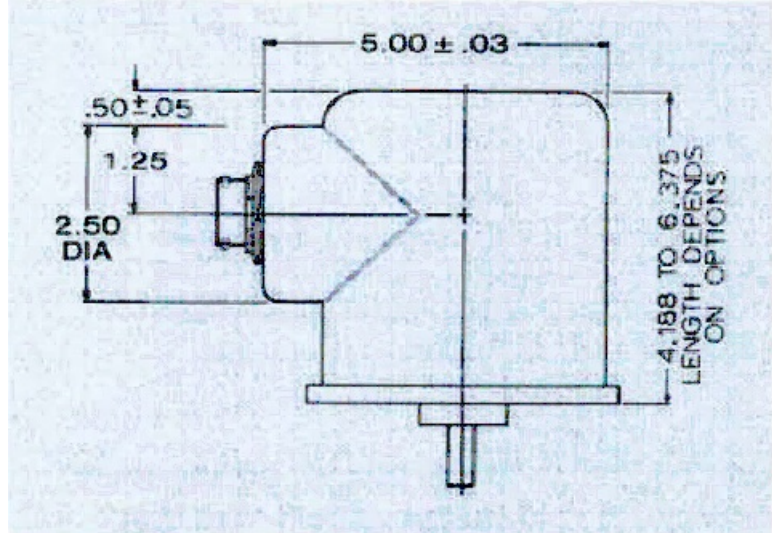
- For CR option, count normally increases in CW rotation when CR pin is connected to +V. To reverse count direction, connect CR pin to 0 V (circuit ground).

PARAMETER 10

ELECTRICAL CONNECTION POSITION OPTIONS



OPTION E – End Connection



OPTION S – Side Connection

NOTES:

- Encoder housings are available with a connector or pigtail cables for the output signal, power supply, and command signals. The standard housing designs are for connections to either end or side.
- Connector types are specified in Parameter 11.
- For dimensional data, contact our Application Engineering Department at the factory.
- Mating connectors are not a part of the encoder itself and, if required, must be called out separately.

PARAMETER 11

CONNECTOR OPTIONS

OPTION	CONNECTOR STYLE	TYPE NUMBER	PIN COUNT	MATING CONNECTOR NUMBER
C14	Bayonet Type	PT07C-14-19P	19	PT06E-14-19S(SR)
C22	Bayonet Type	PT07C-22-55P	55	PT06E-22-55S(SR)
C25	'D' Type	DBM25P	25	DBM25S

PARAMETER 12

SPECIAL FEATURES OPTIONS

OPTION	DESCRIPTION
X	No special features are required.
S	Special features are required.
T	For extended temperature range.

NOTES:

- Standard features are discussed under General Specifications and Parameters 1 through 11.
- Specify 'S' if special features are required. Please contact our Application Engineering Department at the factory regarding your required special features.
- Specify 'T' if the operating temperature is different from 0°C to +70°C. An extended temperature range of -40°C to +85°C is available for units with resolutions up to 11 bits. For resolutions of 12 to 16 bits, a 100°C operational window is available within the range of -40°C to +85°C.
- The low temperature limit of D9 driver is -20°C.

PARAMETER 13

SUPPLY VOLTAGE OPTIONS

OPTION	DESCRIPTION	NOTES:
5	5 VDC (standard)	1. 5 VDC \pm 5% (at the encoder connector) is standard.
12	12 VDC (optional)	2. Optional 12 and 24 VDC voltages require specification of both supply voltage and output voltage.
24	24 VDC (optional)	

The Do's and Don'ts of Encoder Installation.

Do not mount your encoder before you read this!

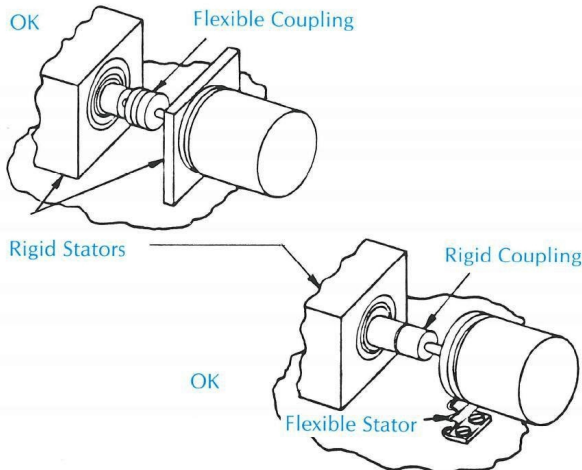
No two shafts ever have equal runout, regardless of their precision. This is a fact, not a challenge. Even if individual shaft assemblies have the same amount of runout, they will have different locus patterns which result in different magnitudes at various rotational positions. This holds true regardless of bearing types.

Encoder shafts and encoder stators must never both be rigidly coupled to a system shaft and system stator. Either the shafts or the stators should have a flexible member which allows freedom of movement in all planes except rotation. Several commercial shaft couplings are available, and simple stator mounts are easy to fashion to meet most installation requirements.

If these mounting rules are ignored, the system shaft assembly will 'fight' the encoder shaft assembly, resulting in the failure of the weakest bearing. Before mounting your encoder, think about your system requirements and carefully review these do's and don'ts.

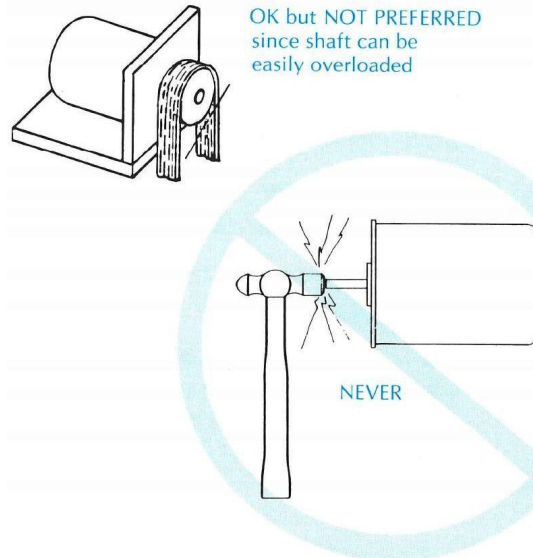
DO

1. Flex-couple either the rotor or the stator.
2. Consider the torsional windup when the system starts, stops, or reverses. (Coupling windup doubles with reversing systems.)
3. Consider shaft loads and rotational speeds.
4. Install the encoders for the best alignment possible. (Misalignment can result in system errors and shorter system life.)
5. Consider inertial loads and torsional vibration resonances when servo systems are involved.
6. Consider a method of system zero adjustment mounting.
7. Maintain service access to the system modules.



DON'T

1. Overload the encoder shaft.
2. Hammer the end of the encoder shaft.
3. Overload the flexible coupling.
4. Rigidly couple both the shaft and the stator.
5. Have fits so tight that the system modules need to be hammered in or out of their stations.
6. Forget to have a method to zero the system after the encoders are mounted. (Either mechanical zero such as encoder stator twist, or software bias, or some other means.)



Specifications Subject to Change Without Notice