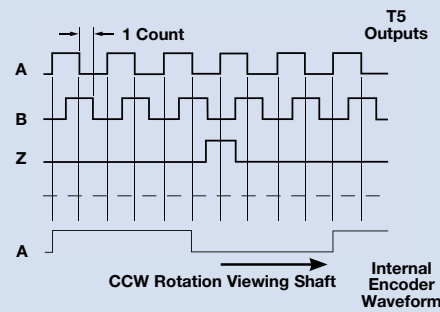


## Electronically Multiplied Squarewave Output

Interpolate encoders provide a higher degree of angular resolution. These encoders are ideal for position readouts and position servo applications. The major specifications of interest for this type of encoder are transition accuracy and frequency response. In position readout situations the system usually doesn't know where it is within a particular count, so tight transition accuracy specs tend to be wasted. What is desired in these applications is the ability to subdivide a "count" into smaller divisions to improve system resolution. Interpolation provides this ability without any sacrifice in mechanical integrity or internal electrical signal strength.

### Typical Waveform Pattern

Option T-5 Shown



## Ordering Interpolation Options

The factory will be pleased to assist you in construction of the model number.

Call toll free: **800-350-2727**

When constructing the model number for any one of BEI's standard encoders, insert the desired number of Cycles Per Turn, after multiplication and the correct interpolation designator, in the model number between Shaft Seal Configuration and Number of Channels.

Example:

**H25D-SS-7200-T2-ABZC-28V/V-SM18**

(one possible encoder configuration with Interpolation Option T2.)

**NOTES & TABLES:** All notes and tables referred to in the text can be found on pages 64 and 65.

	Option T-2	Option T-3	Option T-4
	Available on all models, except HS25, HS45, HS20, HS22	Available on all models, except HS25, HS45, HS20, HS22	Available on all models, except HS25, HS45, HS20, HS22
<b>Multiplication Factor</b>	X 2 (T2)	X 3 (T3)	X 4 (T4)
<b>Cycles Per Turn</b>	All Models, except L15, H20, HS35 and HS25: Up to 7200 (3600 X 2) Model H20: Up to 2048 (1024 X 2) Model HS35: Up to 10,000 (5000 X 2) Model L15: Up to 5,080 (2540 X 2)	Up to 10,600 (3600 X 3) Model HS35: Up to 15,000 (5000 X 3) Model H20: Up to 3072 (1024 X 3) Model L15: Up to 7,620 (2540 X 3)	Up to 14,400 (3600 X 4) Model HS35: Up to 20,000 (5000 X 4) Model H20: Up to 4096 (1024 X 4) Model L15: Up to 10,160 (2540 X 4)
<b>Supply Voltages Available</b>	5–28 VDC ± 5%; see note 5	5–28 VDC ± 5%; see note 5	5–28 VDC ± 5%; see note 5
<b>Output Options</b>	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC
<b>Current Requirements</b>	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5
<b>Transition Accuracy</b>	± 27° quadrature transition accuracy, measured at 1/5 maximum frequency response.	± 1 Count, measured at 1/5 maximum frequency response	± 1 Count, measured at 1/5 maximum frequency response
<b>Frequency Response</b>	250 kHz, minimum count width = 1/10 base count.	300 kHz, minimum count width = 1/10 base count.	400 kHz, minimum count width = 1/10 base count.
<b>Output Termination</b>			
<b>Mechanical Specifications</b>	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.



Model H25



Model E25



Model L25



Model H40

# Interpolation Options



<b>Option T-5</b> Available on all models except H20, HS25, HS45, HS20, HS22	<b>Option T-8</b> Available on all models except H20, HS25, HS45, HS20, HS22	<b>Option T-10</b> Available on models L15, H25, HS35, H38, H40	<b>Option T-12</b> Available on models L15, H25, HS35, H38, H40	<b>Option T-16</b> Available on models L15 H25, HS35, H38, H40	<b>Option T-20</b> Available on models H25, H38, H40
X 5 (T5)	X 8 (T8)	X 10 (T10)	X 12 (T12)	X 16 (T16)	X 20 (T20)
Up to 18,000 (3600 X 5) Model HS35: Up to 25,000 (5000 X 5) Model L15: Up to 12,700 (2540 X 5)	Up to 28,800 (3600 X 8) Model HS35: Up to 40,000 (5000 X 8) Model L15: Up to 20,320 (2540 X 8)	Up to 36,000 (3600 X 10) Model HS35: Up to 50,000 (5000 X 10) Model L15: Up to 25,400 (2540 X 10)	Up to 43,200 (3600 X 12) Model HS35: Up to 60,000 (5000 X 12) Model L15: Up to 30,480 (2540 X 12)	Up to 57,600 (3600 X 16) Model HS35: Up to 80,000 (5000 X 16) Model L15: Up to 40,640 (2540 X 16)	Up to 72,000 (3600 X 20)
5–28 VDC $\pm$ 5% see note 5	5–28 VDC $\pm$ 5% see note 5	5–28 VDC $\pm$ 5% see note 5	5–28 VDC $\pm$ 5% see note 5	5–28 VDC $\pm$ 5% see note 5	5–28 VDC $\pm$ 5% see note 5
Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC	Differential Line Driver: 28V/V 5 volt Regulated: 28V/5 Open Collector: 28V/OC
TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 100 mA + load current maximum, see note 5	TTL: 200 mA + load current maximum, see note 5
$\pm$ 1 Count, measured at 1/5 maximum frequency response	$\pm$ 2 Counts, measured at 1/5 maximum frequency response	$\pm$ 2 Counts	$\pm$ 4 Counts	$\pm$ 4 Counts	$\pm$ 4 Counts
500 kHz, minimum count width = 1/10 base count.	800 kHz, minimum count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.	1 MHz, minimum. count width = 1/10 base count.

See Table 1

See standard specifications for the encoder of interest. .	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	See standard specifications for the encoder of interest.	Overall Length may increase up to 1.67" depending on options. Consult Factory.
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Model H38



Model H20



Model HS25



Model HS35



Model L15



Model HS45



1. Mounting is usually done either using the D-style square flange mount, E- or G-style servo mounts, or one of the standard face mounts, F1 for example. Consult factory for additional face mount options.
2. The shaft seal is recommended in virtually all installations. The most common exceptions are applications requiring a very low starting torque or those requiring operation at both high temperature and high speed.
3. Non-standard index widths and multiple indices are available by special order. Consult factory.
4. Complementary outputs are recommended for use with line driver type (source/sink) outputs. When used with differential receivers, this combination provides a high degree of noise immunity.

## 5. Output IC's

Output IC's are available as either Line Driver (LD) or NPN Open Collector (OC) types. Open Collectors require pull-up resistors, resulting in higher output source impedance (sink impedance is similar to that of line drivers). In general, use of a Line Driver style output is recommended. Line Drivers source or sink current and their lower impedance mean better noise immunity and faster switching times.

**Warning:** Do not connect any line driver outputs directly to circuit common/OV, which may damage the driver. Unused outputs should be isolated and left floating. Our applications specialists would be pleased to discuss your system requirements and the compatibility of your receiving electronics with Line Driver type outputs.

### 28V/V

Multi-voltage Line Driver (7272\*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard (Note:  $V_{out} = V_{in}$ ). This driver is TTL compatible when used with 5 volt supply. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 120 mA typical (plus load current). This is the recommended replacement for 3904R and 7406R open collector outputs with internal pullup resistors. It is also a direct replacement for any 4469, 88C30, 8830 or 26LS31 line driver

### 28V/5

Multi-voltage Line Driver (7272\*): 100 mA source/sink. Input voltage 5 to 28 VDC +/- 5% standard, internally regulated with 5V (TTL compatible) logic out. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 90 mA typical (plus load current).

### 15V/V

Multi-voltage Line Driver (4469\*): 100 mA source/sink. Input voltage 5 to 15 VDC +/- 5% standard (Note:  $V_{out} = V_{in}$ ). TTL compatible when used with 5 volt supply. Supply lines are protected against overvoltage to 60 volts and reverse voltage. Outputs are short circuit protected for one minute. Supply current is 90 mA typical (plus load current). This is a direct replacement for the 4469 Line Driver.

### 28V/OC

NPN Open Collector (3904\*, 7273\*). Current sink of 80 mA max. Current sourced by external pull-up resistor. Output can be pulled up to voltage other than supply voltage (30 V max). Input voltage 5 to 28 VDC +/- 5% standard. Supply current is 120 mA typical. This replaces prior IC's with designations of 3904, 7406, 3302, 681 and 689.

### 5V/OCR, 15V/OCR, 24V/OCR

Open Collector (3904R\*, 7406R\*, 7273R\*): Current sink of 70 mA max. Includes internal pull-ups sized at approximately 100 ohms/volt. Max current source is 10 mA. Supply current is 100 mA typical, 120 mA with internal pull-ups. The 5V/OCR, 15V/OCR and 24V/OCR are often replaced by the 28V/V in system upgrades.

### 3904, 3904R, 4469, 5V/V, 5V/OC, 5V/OCR, 9V/OC

Intrinsically safe line driver and open collector outputs. These drivers are specific to intrinsically safe encoders, and are installed per the appropriate control drawings listed in Table 2.1 on page 48.

6. Special -S at the end of the model number is used to define a variety of non-standard features such as special shaft lengths, voltage options, or special testing. Please consult the factory to discuss your special requirements.
7. Higher frequency response may be available. Please consult with the factory.
8. Extended temperature ratings are available in the following ranges: -40 to 70°C, -40 to 85°C, -20 to 105°C and -40 to 105°C depending on the particular model. Some models can operate down to -55°C. Extended temperature ranges can affect other performance factors. Consult with factory for more specific information.
9. Mating straight plug receptacles may be ordered from the factory:
  - For M12 use MS3116F12-10S
  - For M14 use MS3106F14S-6S
  - For M14/19 use MS3116J14-19S
  - For M16 use MS3106F16S-1S
  - For M18 use MS3106F18-1S
  - For M20 use MS3106F20-29S

For additional Accessories refer to page 62-63.

For standard pinouts, refer to the facing page.

\* Products manufactured prior to April 2007 used the line driver IC number instead of voltage output in model number.

## Table 1: Incremental Output Terminations

The connector style will determine pinouts. For example, an encoder with ABC channels and an M18 connector uses the table to the right.

M14 CONNECTOR PIN	M16 CONNECTOR PIN	CHANNELS DESIGNATED IN MODEL NO	
		ABZ	ABC
E	A	A	A
D	B	B	B
C	D	Z	$\bar{A}$
B	C	+V (SUPPLY VOLTAGE)	
F	E	—	$\bar{B}$
A	F	0 V (CIRCUIT COMMON)	
	G	CASE GROUND (CG) (EXCEPT H20)	

M18 CONNECTOR	
PIN	CHANNEL
A	A
B	B
D	Z
C	+V
E	—
F	OV
G	CG
H	$\bar{A}$
I	$\bar{B}$
J	$\bar{Z}$

WIRE COLOR (22AWG)	DA 15P CONNECTOR	CHANNELS DESIGNATED IN MODEL NO.		
		ABZ	ABC	ABZC
YEL	13	A	A	A
BLUE	14	B	B	B
ORN	15	Z	—	Z
W-Yel	10	—	$\bar{A}$	$\bar{A}$
W-Blu	11	—	$\bar{B}$	$\bar{B}$
W-Orn	12	—	—	Z
RED	6	+V (SUPPLY VOLTAGE)		
BLK	1	0 V (CIRCUIT COMMON)		
GRN	9	CASE GROUND (CG) (except H20)		
WHITE		SHIELD DRAIN (Shielded Cable Only)		

M12 CONNECTOR	
PIN	CHANNEL
A	A
B	B
D	Z
C	+V
E	—
F	OV
G	CG
H	$\bar{A}$
J	$\bar{B}$
K	$\bar{Z}$

## Table 2: Disc Resolutions for Incremental Encoder Models H25, H38, H40, L25, E25 Only

Resolutions highlighted with    are available as standard **Model H25 EXPRESS ENCODERS\*** that ship in one to three days.

1, 2, 3, 5, 6, 7, 8, 10, 13, 16, 20, 24, 25, 26, 30, 32, 33, 34, 36, 37, 40, 45, 48, 50, 51, 56\*, 60, 64, 66, 72, 75, 80, 86, 88, 90, 100, 102, 120, 122, 125, 127, 128, 132, 144, 148, 150, 158, 160, 175, 176, 180, 187, 192, 200, 202, 204\*, 217, 220, 240, 250, 254, 255, 256, 264\*, 274, 280, 283, 288, 292, 300, 312, 320, 321, 325, 360, 366, 372, 375, 377, 380, 381, 384, 385, 393, 400, 430, 432, 450, 462, 480, 490, 500, 502, 508, 512, 522, 530, 550, 560\*, 576, 598, 600, 604, 625, 628, 635, 638, 640, 660, 672, 676, 680, 687, 690, 700, 720, 725, 735, 740, 744, 748, 750, 762, 768, 780, 785, 800, 812, 825, 850, 864, 878, 888, 900, 912, 914, 938, 942, 955, 960, 1000, 1016, 1024, 1030, 1035, 1036, 1040, 1054, 1056, 1074, 1076, 1080, 1088, 1100, 1101, 1125, 1136, 1200, 1237, 1250, 1257, 1270, 1280, 1300, 1314, 1332, 1333, 1390, 1400, 1414, 1427, 1440, 1484, 1500, 1562, 1570, 1596, 1600, 1650, 1666, 1718, 1745, 1774, 1800, 1840\*, 1850, 1855, 1875, 1894, 1920, 1952, 1968, 1979, 1995, 2000, 2048, 2080, 2094, 2100, 2160, 2164, 2199, 2200, 2250, 2356, 2400, 2485, 2500, 2514, 2519, 2540, 3000, 3125, 3600, 4000, 4096, 5000

\*AB or ABC output only. NOTE: Resolutions up to 72,000 are available.

For Model L15 Resolutions See Table 1 on Page 35.

For Model H20 Resolutions See Table A on Page 20.

For Model HS20 Resolutions See Table 2 on Page 32.

For Model HS22 Resolutions See Table 2 on Page 33.

For Model HS25 Resolutions See Table A on Page 22.

For Model HS35 Resolutions See Table A on Page 25.

For Model HS45 Resolutions See "Cycles per Turn" in Ordering Information on Page 27.

For Model M58 Resolutions See Table 3 on Page 35.