



This is the same Explosion Proof rated encoder as the H38 Incremental, in an absolute encoder version with output up to 13 bits of resolution. When your application needs the ability to recover position information quickly after a power loss and you are operating in a hazardous area—the H38 may be the answer to your needs.

## Electrical Specifications

**Code:** 12 or 13 bits NB or GC; excess gray and BCD available

**Counts Per Shaft Turn:** 4096 or 8192

**Count Transition Accuracy:** ± 1/2 bit maximum

**Supply Voltage:** 5–28 VDC

**Current Requirements:** 120 mA typical

**Output Formats:** Parallel: Gray Code, Natural Binary and Binary Coded Decimal; Serial: Serial Synchronous Interface (SSI); Analog: 4–20 mA, 0–10V

**Voltage/Output:** (see note 5)  
 28V/V: Line Driver, 5–28 VDC in,  $V_{out} = V_{in}$   
 28V/5: Line Driver, 5–28 VDC in,  $V_{out} = 5$  VDC  
 28V/OC: Open Collector, 5–28 VDC in  $OC_{out}$   
 SSI: 5–28 VDC in/5V $_{out}$

**Protection Level:** Reverse, overvoltage and output short circuit protection

**Frequency Response:** 100kHz (1200 RPM for 12-bits, 600 RPM for 13-bits)

**Output Termination Pinouts:** See table 3, back page

## Mechanical Specifications

**Shaft Diameter:** 3/8" nominal

**Flats On Shaft:** Two flats, 0.80" long X 0.30" deep at 90°

**Shaft Loading:** Up to 40 pounds axial and 20 pounds radial applied 1/4" from housing

**Shaft Runout:** 0.0005 T.I.R.

**Starting Torque at 25° C:** 4.0 in-oz (max)

**Bearings:** Class ABEC 7 standard

**Shaft Material:** 303 stainless steel

**Enclosure:** Die cast aluminum, hard anodized with dichromate sealed finish. Shaft seals and sealed bearings are standard to achieve environmental ratings.

**Bearing Life:** 2 X 10<sup>8</sup> revs (1300 hrs at 2500 RPM) at rated load; 1 X 10<sup>10</sup> revs (67,000 hrs at 2500 RPM) at 10% of rated load

**Maximum RPM:** 10,000 RPM (see frequency response, below)

**Moment of Inertia:** 4.1 X 10<sup>-4</sup> oz-in-sec<sup>2</sup>

**Weight:** 64 oz typical (approx 4 lbs)

## Environmental Specifications

**Enclosure Rating:** NEMA 4 X & 6 (IP66), outdoor Non-Hazardous locations, NEMA 4 X & 13 (IP66), indoor Non-Hazardous locations

**Temperature:** Operating, 0° to 70° C; extended temperature testing available (see note 8, pg 64); 80° C max for UL and CEN approved units; storage; -25° to 90° C.

**Shock:** 50 g's at 11 msec

**Vibration:** 5 to 2000 Hz @ 20 g's

**Humidity:** 100% RH

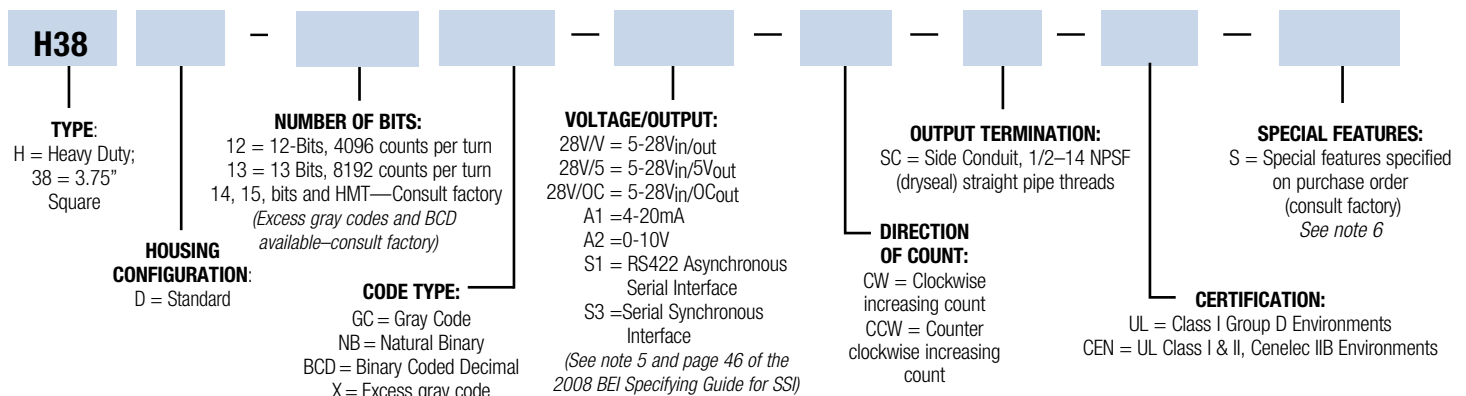
**Hazardous Area Rating:** Underwriters Laboratories listed for use in hazardous locations; NEMA Enclosure 7. Class 1, Group C & D, Division 1, NEC Class 2 circuits only, or Class 2, Groups E, F, and G (see Table 1)

**NOTES & TABLES:** All notes and tables referred to in the text can be found on the back of this page.

## H38 Absolute Encoder Ordering Options FOR ASSISTANCE CALL 800-350-2727

Use this diagram, working from left to right to construct your model number (example: H38D-12GC-28V/V-CW-SC-UL).

All notes and tables referred to can be found on the back of this page.



## Options and Tables

**Serial Synchronous Interface (SSI)** SSI output provides effective synchronization in a closed-loop control system. A clock pulse train from a controller is used to clock out sensor data: one bit of position data is transmitted to the controller per one clock pulse received by the sensor. The use of a differential driver permits reliable transmission of data over long distances in environments that may be electrically noisy. The encoder utilizes a clock signal, provided by the user interface, to time the data transmission. Receiving electronics must include an appropriate receiver as well as line terminating resistors.

**Features :** • Synchronous transmission • Transmission lengths to 1000 feet • Accepts clock rates from 100 KHz to 1.8 MHz

### Data Transmission Sequence

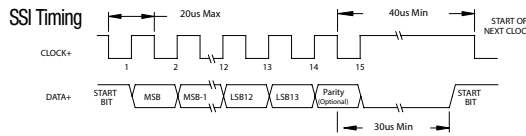
1. Output driver of the encoder is a MAX 491 transceiver in transmit mode. The recommended receiver is a MAX 491 transceiver in receive mode.
2. Controller provides a series of pulses (or differential pulse pairs) on the CLOCK input lines.
3. On the first HIGH-to-LOW CLOCK transition, the encoder latches its data at the current position and prepares to transmit.
4. Controller reads data on the falling edge of the next 15 clock cycles.
5. The first bit is a START bit and is always HIGH.
6. Next comes 13 data bits beginning with the most significant bit (MSB) and ending with the parity bit. On 12 bit encoders, bit 13 is LOW. When parity is not ordered, parity is LOW.
7. After the last CLOCK HIGH-to-LOW transition, a minimum of 40 microseconds must pass before the beginning of the next CLOCK series.

### Interfacing Long Data Lines

**Ordering SSI :** HOW TO SPECIFY SSI OUTPUT IN THE ENCODER MODEL NUMBER: Use the designation, S3 between the Code Format designation and the Connector designation. **Example: H25D-SS-12GC-S3-CW-SM18**

Cable impedance can create a transmission delay, in effect, shifting the phase relationship between the clock pulse and the data. If this phase shift exceeds 180°, then the wrong bit position will be sampled by the receiver. As a result, the maximum allowable clock frequency is a function of the cable length. For 24 AWG, stranded, 3 pair cable (BEI part number 37048-003 or equivalent) the group delay is 1.36ns/ft. The table below shows the maximum transmission rate allowable as a function of cable length to ensure a phase shift of less than 90°.

Cable Length (ft)	50	100	200	300	500	1000
Max Freq (kHz)	1800	900	500	300	200	100



Output Code and Terminations (12 & 13 Bit)					
	Gray Code		PARALLEL CODE		TERMINATION TYPE
	12 Bit	13 Bit	Natural Binary	Binary Coded Decimal	
MSB	G <sub>11</sub>	G <sub>12</sub>	2 <sup>11</sup>	2 <sup>12</sup>	A <sub>0</sub>
	G <sub>10</sub>	G <sub>11</sub>	2 <sup>10</sup>	2 <sup>11</sup>	B <sub>0</sub>
	G <sub>9</sub>	G <sub>10</sub>	2 <sup>9</sup>	2 <sup>10</sup>	C <sub>0</sub>
	G <sub>8</sub>	G <sub>9</sub>	2 <sup>8</sup>	2 <sup>9</sup>	D <sub>0</sub>
	G <sub>7</sub>	G <sub>8</sub>	2 <sup>7</sup>	2 <sup>8</sup>	A <sub>1</sub>
	G <sub>6</sub>	G <sub>7</sub>	2 <sup>6</sup>	2 <sup>7</sup>	B <sub>1</sub>
	G <sub>5</sub>	G <sub>6</sub>	2 <sup>5</sup>	2 <sup>6</sup>	C <sub>1</sub>
	G <sub>4</sub>	G <sub>5</sub>	2 <sup>4</sup>	2 <sup>5</sup>	D <sub>1</sub>
	G <sub>3</sub>	G <sub>4</sub>	2 <sup>3</sup>	2 <sup>4</sup>	A <sub>2</sub>
	G <sub>2</sub>	G <sub>3</sub>	2 <sup>2</sup>	2 <sup>3</sup>	B <sub>2</sub>
	G <sub>1</sub>	G <sub>2</sub>	2 <sup>1</sup>	2 <sup>2</sup>	C <sub>2</sub>
LSB <sub>12</sub>	G <sub>0</sub>	G <sub>1</sub>	2 <sup>0</sup>	2 <sup>1</sup>	D <sub>2</sub>
LSB <sub>13</sub>		G <sub>0</sub>	2 <sup>0</sup>	A <sub>3</sub>	GRY/RED
	OV (CIRCUIT COMMON)		B <sub>3</sub>		GRY/ORN
	DIRECTION OF COUNT				ORN
	CASE GROUND				GRN
	OV (CIRCUIT COMMON)				BLK
	LATCH CONTROL				YEL
	+V (SUPPLY VOLTAGE)				RED
	SHIELD DRAIN				BARE

\*Pin P is available for a tri-state option

SSI Output Termination Table		
	Cable Conn	Term. Board
DATA +	YEL	4
DATA-	WHT/YEL	7
CLOCK+	BLU	5
CLOCK-	WHT/BLU	8
DIR CONTROL	ORN	6
CASE GROUND	GRN	1
CIRCUIT COMMON	BLK	2
+V SUPPLY VOLTAGE	RED	3
SHIELD DRAIN	BARE	—

**Direction of Count:** Standard is CW increasing when viewed from the shaft end. Pin R is normally HI (or N/C) and is pulled up internally to +V. To reverse the count direction, Pin R must be pulled LO (COMMON).

**Latch control:** Encoder outputs are active and provide continuous parallel position information when Pin U is HI (or N/C). Pin U is pulled up internally to +V. When Pin U is LO (COMMON) the encoder outputs are latched at the logic state that is present when the latch is applied and will stay latched until Pin U is no longer grounded.

**M18 Connector** is a MS3102R18-1P, 10-pin connector on the encoder body and mates to an MS3106F18-1S connector or can be used with a standard cable/connector assembly, BEI P/N 924-31186-18XX (Where XX = 10, 20 30 or 50 for a 10, 20, 30, or 50 foot length). This is the preferred connector for SSI output.

**M14/19 Connector** is a MS3112E14-19P, 19-pin connector on the encoder body and mates to an MS3116J14-19S or equivalent.

## Notes

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<sub>out</sub> = V<sub>in</sub>). 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). **Note:** Limit encoder load to 2.5W max at ambient. Example at 12 VDC: 2.5W/(+12VDC minus +5VDC) = 357 mA total allowed current. Consult factory for your specific requirements.

**15V/V:** Multi-voltage Line Driver (4469\*): 100 mA source/sink. Input voltage 5 to 15 VDC +/- 5% standard (Note: V<sub>out</sub> = V<sub>in</sub>). 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-up 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.

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.

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

Table 1 – Europe and North American “Explosion Proof” Approvals			
Encoder Type	Ex	UL c-Us	UL c-Us
	CENELEC/ATEX	NEMA 7 U.S. Standards Class I, Div I, Group:	NEMA 7 U.S. Standards Class II, Div I, Group:
H38 (Standard)		D	
H38 (w/ Labyrinth Seal)	EExd IIB T4	C, D	E, F, G
H40		D	



Encoders with metal connector or conduit terminations are rated to EN 55011 and EN 61000-6-2. For plastic connector, pigtail or shielded/jacketed cable terminations, consult factory