ENCODER DATA SHEET

L690 OPTICAL RESOLVER® SERIES
ABSOLUTE POSITION ENCODERS

Features:

- Resolution to 0.309 arcsec (22-bits)
- Accuracy to 0.618 arcsec rms
- LED illuminators
- Wide air gap
- Self-contained electronics
- Serial output with differential driver
- High speed interrogation
- Hand shake interface
- Heavy duty preloaded bearing pairs
- Compatible with BEI's Ultra-Loc® System

Options:

- Parallel with or without differential drivers
- Solid, Hollow or Through shaft
- Single 5Vdc input
- Couplers
- Extended temperature
- Vacuum-rated materials

These compact absolute encoders, with a single LED illuminator per station and self- contained electronics, are available from 17 to 22 bits, natural binary code. They are a direct replacement for BEI's older 690 Series.

Typical applications include radar, optical and laser tracking systems and astronomical telescopes. Modifications can be made for spacecraft application to incorporate parts, materials and processes with space heritage. Space applications include high gain antennas and payload pointing.

Approved for general release.

SPECIFICATION 5.033A

Table of Contents

Figures

Tables

1.0 GENERAL:

The L690 Series LED Absolute Encoders are high resolution encoders providing up to 22 bits in a 6 inch diameter package. These units are available for operation from +5 VDC and ±12 VDC power or from a single +5 VDC power supply. The 5 volt units may be used as form, fit and functional replacement of BEI's older 690 Series Encoders, or for applications requiring single supply operation. For applications requiring higher performance, Series L690ER Series Encoders offer higher data speed and resolutions.

1.1 DESIGN FEATURES:

- High resolution in a 6 inch package. Divides circle into up to 4,194,304 parts.
- LED optical stations for long life and high reliability.
- Dual read station error cancellation for high accuracy.
- Available in solid shaft, hollow shaft, or through shaft options.
- Available with single-ended parallel or serial differential data output.
- Handshake interface eliminates the need for buffer storage when transferring data.
- Available with CCW, or connector pin selectable direction of increasing count.
- Available for operation from single +5 Volt power supply.

1.2 GENERAL:

The BEI L690 Series Encoders are absolute position binary encoders providing resolutions to 22-bits and accuracy to .618 arc seconds rms in a 6.00 inch diameter package. This encoder series utilizes BEI's patented Optical Resolver interpolation technique in conjunction with BEI's Dual Ramp Resolver technique to provide high resolution.

These encoders employ a single coarse LED read station and dual fine LED read stations placed 180 degrees apart to cancel disk runout due to bearing error or shaft loading. All read stations utilize grating optics to provide a minimum of .015 inch clearance spacing between the code disk and the optical components, which translates to greater tolerance of vibration and loading.

The L690 encoders contain all electronics necessary to produce up to 22-bit natural binary output word. Outputs are TTL compatible and will sink up to 12 mA. Data samples are taken at a nominal internal rate 32,768 Hz. A marker signal indicates data updates, rising 1.9 usec prior to update and falling 1.9 usec after update. Data may be held to prevent update during transfer by using the HOLD\ and HLDA handshake signals.

2.0 APPLICATIONS:

An absolute position shaft angle encoder is an analog-to-digital angular measurement device that divides the circle into a specific number of discrete shaft positions. The absolute encoder differs from incremental shaft angle encoders in that it provides a complete digital output word for each discrete shaft position, rather than up/down pulses or quadrature waves that must be counted to determine position. This means that no external memory or counting circuit is required, nor is it necessary to move the shaft to a "home" position after initial power-up to determine actual shaft position.

L690 series encoders provide binary angular division in the range of 131,072 (2^{17}) to 4,194,304 (2^{22}) positions per revolution, depending on the specific model number. These encoders are intended for applications such as telescopes, mirror positioners, precision grinding machines, angular gauges, or any application requiring very high resolution and accuracy.

3.0 REQUIREMENTS:

3.1 MECHANICAL:

TABLE 1
MECHANICAL SPECIFICATIONS

		Solid Shaft	Hollow Shaft	Through Shaft	
3.1.1	Encoder Outline:	Fig. 4	Fig. 5	Fig. 6	
3.1.2	Weight (max.)	9.6	10.1	10.9	lb
3.1.3	Starting Torque (max.)	4.0	6.0	4.0	oz-in
3.1.4	Running Torque (max.)	3.0	4.0	3.0	oz-in
3.1.5	Rotor Moment of Inertia	0.07	0.11	0.08	oz-in-sec^2
3.1.6	Slew Speed (max.)	15,000	15,000	15,000	rpm (note 1)
3.1.7	Angular Accel (max.)	50,000	50,000	50,000	rad/sec^2 (note 1)
3.1.8	Shaft Runout	0.0005	0.0005	0.0005	in
3.1.9	Shafting Loading, Axial (max.)	15.0	15.0	15.0	lb
3.1.10	Shaft Loading Radial (max.)	10.0	10.0	10.0	lb

Note 1: Maximum velocities and accelerations shown above are mechanical limits. For maximum operating conditions, see Table 2.

3.2 ELECTRICAL CHARACTERISTICS:

3.2.1 Output Formats:

24-bit (max) parallel w/hold input (single ended or differential pairs)
24-bit (max) serial (differential pairs)

3.2.1.1 Outputs, Single Ended:

Logical "1":	+2.0 V min @ Iout = -12 mA
Logical "0":	+0.4 V max @ Iout = 12 mA
Rise & Fall Times:	100 nsec max

3.2.1.2 Differential (each line):

Logical "1":	+3.8 V ± 0.5 V open circuit
Logical "0":	0 to +0.4 V open circuit
Output Impedance:	75 ohms max

3.2.2 Marker Pulse Output, Parallel Options Only:

Pulse Width:	3.82 usec ± 0.1%
Frequency:	32,768 Hz ± N * f_s
	N = Number of resolver cycles on disk
	f_s = Shaft speed (rps)

3.2.3 Inputs:

3.2.3.1 Single Ended Inputs:

Logical "0":	0.8 V max @ I," = - 4.1 mA max
Logical "1":	2.0 V min or open circuit (2.0 K pull-up to +5 VDC)

3.2.3.2 Differential Inputs:

Logical "0":	- 0.2 V min differential
Logical "1":	+0.2 V min differential
Common Mode Voltage:	±15 V max
Input Loading:	6.0 K Ohms min in parallel with (0.01 uF in series with 180 Ohms)

3.2.4 Power Requirements:

L690 Models:
+5 VDC ± 5'% @ 1.5 A max.
+12 VDC ± 5% @ 200 mA max.
-12 VDC 5°/0 @ 200 mA max.

5VL690 Models:
+5 VDC ± 5% @ 3.0 A max.

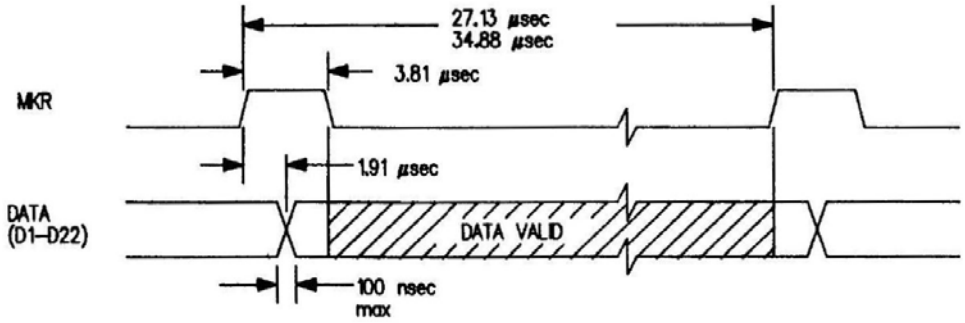

FIGURE 1, OUTPUT TIMING

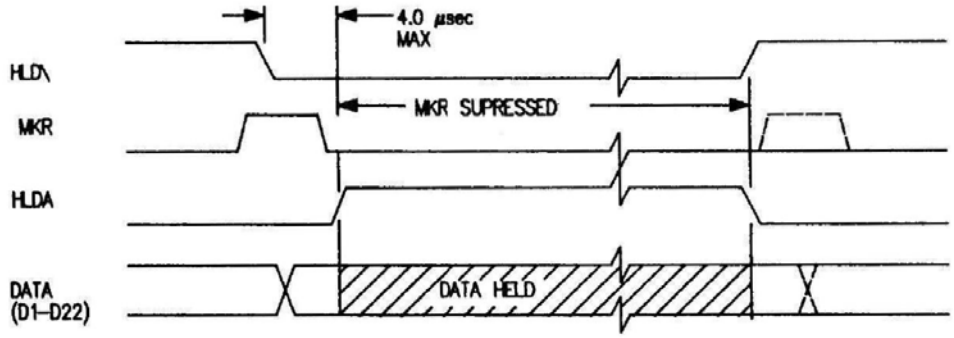

FIGURE 2, HLD – HLDA TIMING

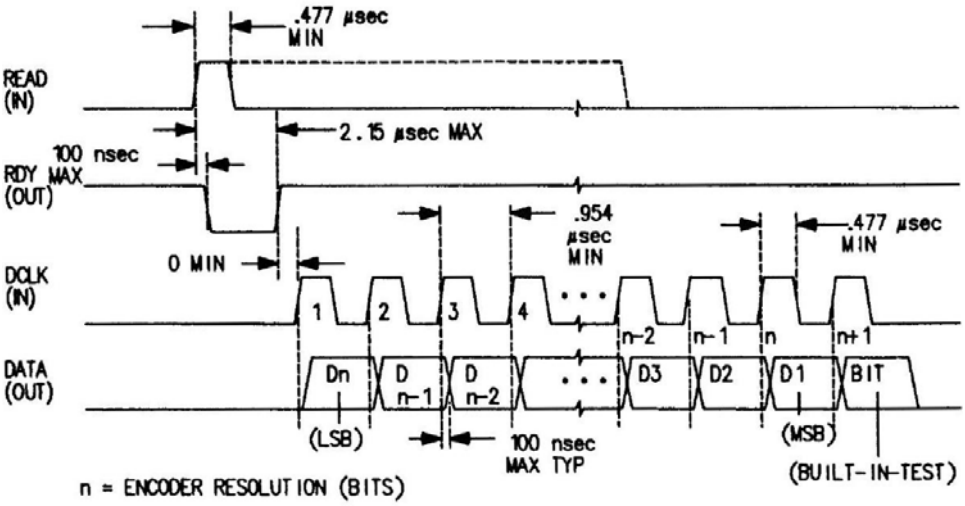

FIGURE 3, SERIAL DATA TIMING

3.2.5 Signal Definitions:

D1-D22	Encoder data outputs, active high, differential on serial models. D1 (2^{-1} rev) is most significant bit (MSB).
MKR	Marker pulse output, active high, not used on serial models. Indicates data update. PW = 3.82 usec. Starts 1.91 usec before data is updated. Inverse of MKR may be used as "Data Valid."
HLD\	Hold input, active low, not used on serial models. Assertion of this input causes the data to be held until HLD is returned high. Hold will be acknowledged by the HLDA signal going high. Data supplied is from the last sample taken before HLD\ is asserted. (See Figure 2.)
HLDA	Hold Acknowledge output, active high, not used on serial models. HLDA goes high upon assertion of HLD\. If the MKR pulse is high when HLD\ goes low, HLDA will go high on completion of the MKR pulse. HLDA will reset upon HLD\ returning high.
READ	Read differential input. (Serial models only) 0.5 usec pulse on this input starts interrogation sequence. Data may be shifted out on receipt of RDY signal or 2.15 usec after application of READ.
RDY	Ready differential output. (Serial models only) This output signifies that data is ready for output.
DCLK	Data Clock input. (Serial models only) Application of clock pulses on this input causes output data to be shifted out LSB first.
DIR	Direction Control input. A High or open circuit condition on this input causes the encoder to display increasing count in the clockwise direction as viewed from the shaft end. A low causes the count direction to be counterclockwise.
BIT	Built-in-test output, included in data string on "S" models. A low on this output indicates that the encoder self-test circuit has detected a failure.
+5V	Power input. Unit requires +5 VDC ± 5%.
+12V	Power input. Unit requires +12 VDC ± 5%. (except "5V" models)
-12V	Power input. Unit requires -12 VDC ± 5%. (except "5V" models)
GND	Ground. Power and signal return.
CASE	Case ground. Should be used for shield termination. Must be connected to GND at one point in the system. Case ground is isolated from GND.

3.3 ENVIRONMENTAL:

3.3.1 Thermal:

Operating Temperature

Standard range: 0 to +55° C

Extended range: -40 to +75° C

Storage Temperature: -40 to +85° C

3.3.2 Altitude: 70,000 ft. max

3.3.3 Humidity: 98% RH max (non-condensing)

3.3.4 Vibration: 0.01 in. double amplitude 5 to 20 Hz; 2 g pk, 20 to 500 Hz per MIL-E-5400T paragraph 3.2.24.6.1, Fig. 2-1, Curve II

3.3.5 Shock: 15g for 11 msec, per MIL-E-5400T, paragraph 3.2.24.6.1

4.0 QUALITY ASSURANCE PROVISIONS:

100% inspection of solder and workmanship.
100% inspection and test of electrical and mechanical parameters.

5.0 RESOLUTION AND ACCURACY:

TABLE 2
ENCODER BASIC MODEL NUMBERS

MODEL	RESOLUTION		ACCURACY (RMS)		N (CYCLES/ REV.)	MAX OPERATE SPEED (DEG/SEC)
	BITS	SEC	BITS	SEC		
(5V)L696	22	0.309	21	0.618	16,384	90
(5V)L695	21	0.618	20	0.618	8,192	180
(5V)L694	20	1.24	20	1.24	8,192	180
(5V)L693	19	2.47	19	2.47	4,096	360
(5V)L692	18	4.94	18	4.94	2,048	720
(5V)L691	17	9.88	17	9.88	2,048	720

6.0 CONNECTOR PIN DEFINITIONS:

TABLE 3
CONNECTOR (TYPE DC37P)
PARALLEL MODELS

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	D1 (MSB)	15	D15	28	+5V
2	D2	16	D16	29	+5V
3	D3	17	D17	30	DIR
4	D4	28	D18	31	HLDA
5	D5	29	D19	32	HLD/
6	D6	20	D20	33	GND
7	D7	21	D21	34	+5V
8	D8	22	D22 (LSB)	35	-12V
9	D9	23	BIT	36	MKR
10	D10	24	GND	37	CASE
11	D11	25	GND		
12	D12	26			
13	D13	27	+12V		
14	D14				

NOTES:

1. Pins 27 and 35 are not connected on "5V" models.
2. Pins assigned to unused bits are not connected. (e.g. Pins 20 through 22 are not connected on Model L693 encoder, pin 19 is LSB.)
3. Pin 30 not connected on CCW only units.

TABLE 4
CONNECTOR (TYPE DB25P)
SERIAL MODELS

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	DATA	10	GND	19	GND
2	DCLK	11	+5V	20	
3	READ	12	+12V*	21	
4	RDY	13	-12V*	22	GND
5		14	DATA/	23	GND
6	DIR	15	DCLK/	24	+5V
7		16	READ/	25	CASE
8		17	RDY/		
9	GND	18			

* Pin not used on "5V" models.

7.0 ORDERING INFORMATION:

5V	L690	H	P	E	U	- XX

- 5V: 5V OPTION
- L690: BASIC MODEL NO. (See Table 2)
- H: S – Solid Shaft; H – Hollow Shaft; T – Through Shaft
- P: P – Parallel output; S – Serial differential output; D – Parallel differential output
- E: C – Commercial Temp; E – Extended Temp
- U: U – Unidirectional (CCW increasing count); No Letter – Pin selectable
- XX: Reserved for special models

Special models are available at additional cost. Contact BEI sales representative for special requirements.

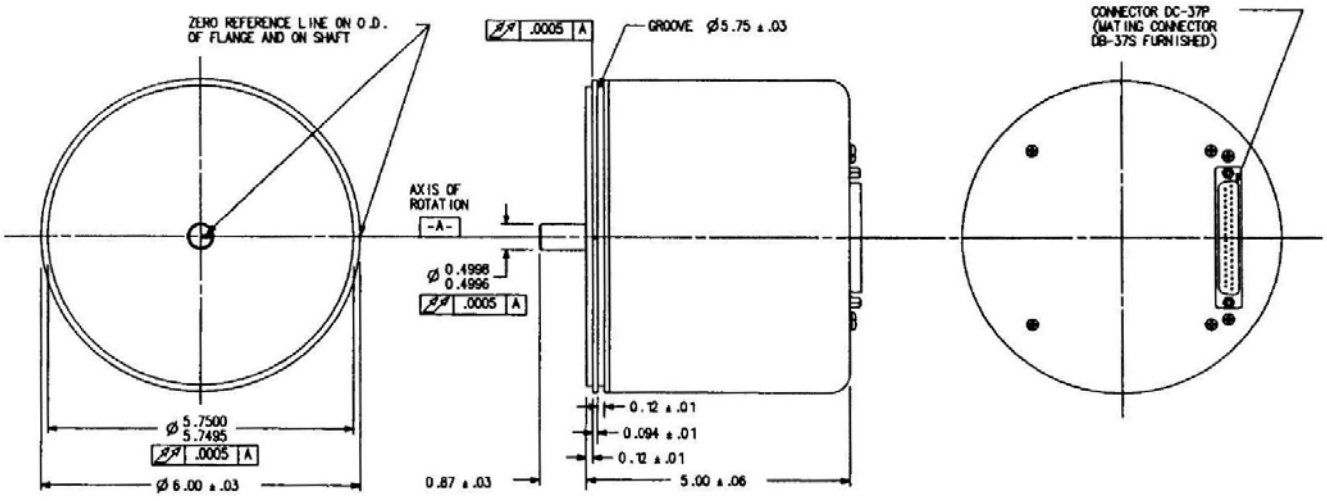

FIGURE 4, OUTLINE, SOLID SHAFT ENCODER

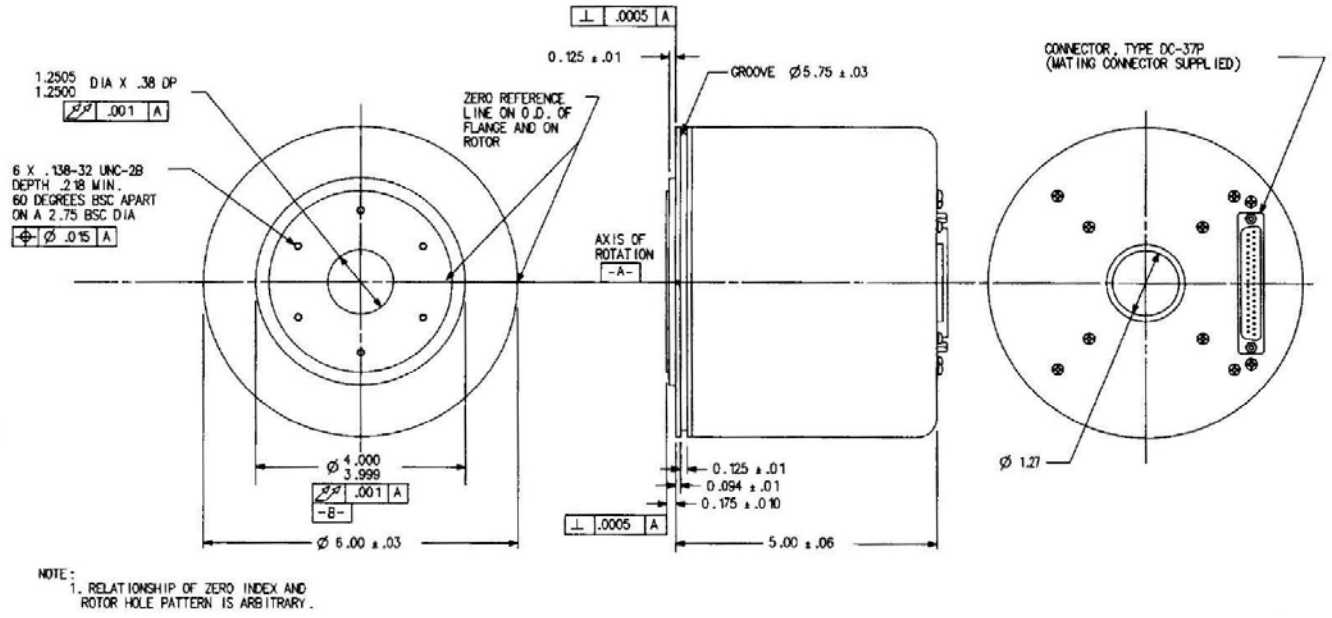

FIGURE 5, OUTLINE, HOLLOW SHAFT ENCODER

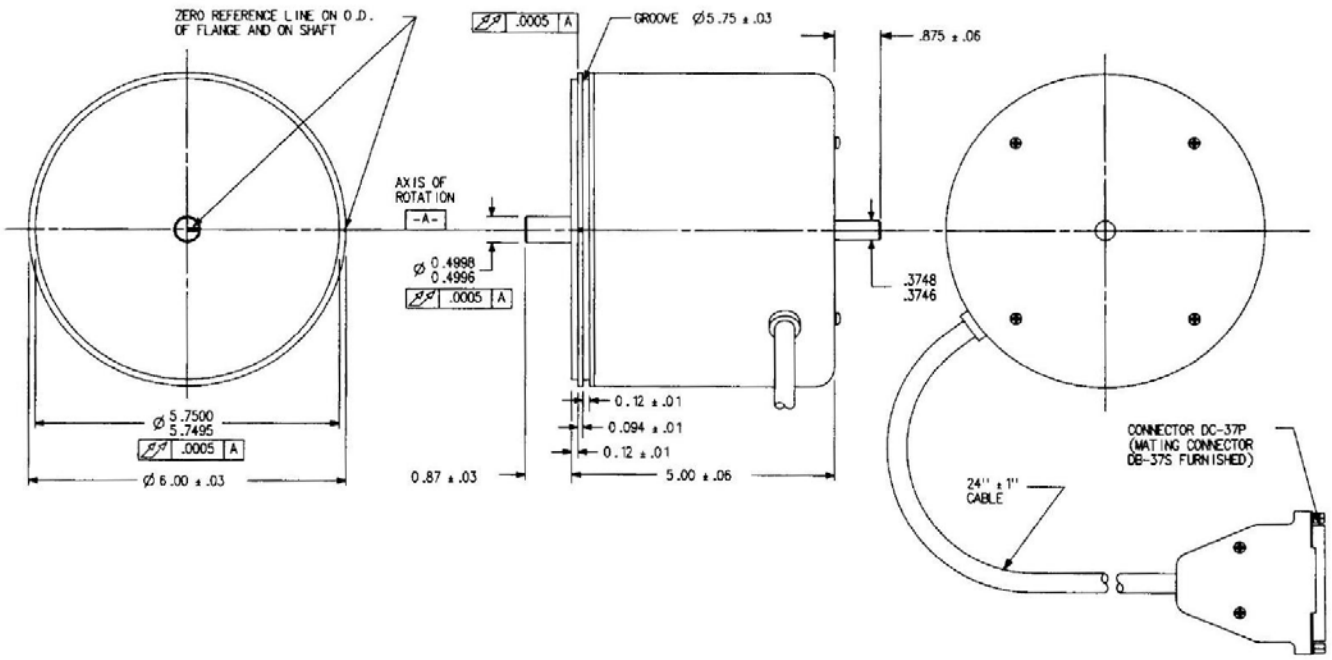

FIGURE 6, OUTLINE, THROUGH SHAFT ENCODER