

**Features:**

- Resolution to 0.17 Arc Minutes
- Accuracy to 0.2 Arc Minutes
- Small Size
- Absolute Non-Volatile Output
- LED Illuminators
- High Reliability
- Low Power, Single + 5V Input
- 3-State Outputs
- Microprocessor Interface Capability
- Environmentally Sealed Case
- Versatile Input/Output interfaces

**General Description**

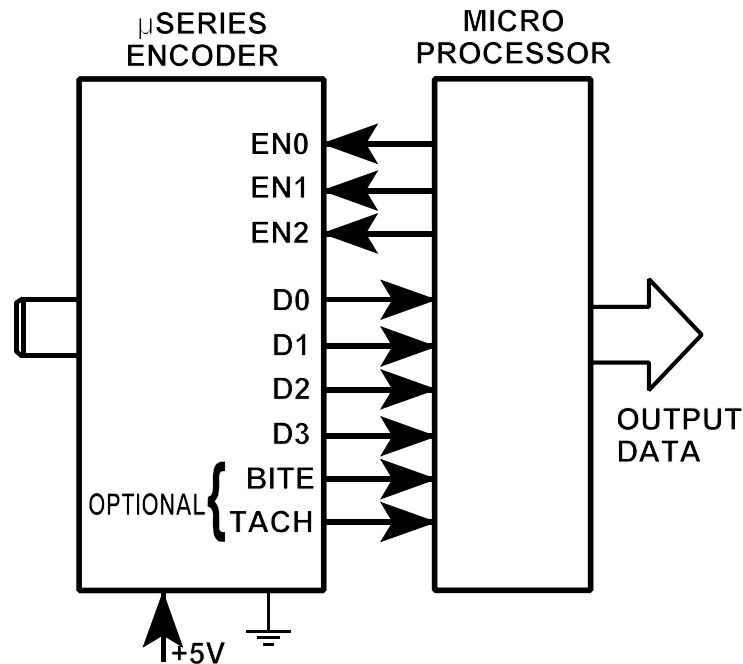
MicroSeries® Encoders are ultra small, absolute, optical shaft encoders. They have substantially better accuracy than other shaft angle digitizers. MicroSeries® Encoders are designed for applications where small size, medium resolution and insensitivity to power interruptions are desired. The LSI MicroSeries® was introduced to significantly reduce the size of the Encoder, lower the cost, and provide a more versatile electrical interface.

The basic model in the LSI MicroSeries® family is designated L. In this model, the outputs are 3-State and can interface directly with a microprocessor. The microprocessor demultiplexes the signals and converts them to natural binary code. The microprocessor can be provided by the user, or by BEI. For those applications where a microprocessor is not available or suitable, BEI offers a MicroSeries® Digital Decoder. The MicroSeries® Digital Decoder is a custom, monolithic gate array which can be separate (LS Models) or can be contained within the Encoder package (LC Models).

Detailed technical information is contained in Technical Bulletins "LSI MicroSeries® Encoders - Principles of Operation/Microprocessor Control and Decoding" and "MicroSeries® Digital Decoder." These bulletins are available upon request. For encoders of smaller size with comparable resolution, refer to Encoder Data Sheet "LSI MicroSeries®  $\mu$ S\_/16 Family." For encoders with a through hole, refer to Encoder Data Sheets "Pancake LSI MicroSeries®  $\mu$ S\_/40 Family,  $\mu$ S\_/50 Family and  $\mu$ S\_/80 Family." For reference to other BEI Models refer to the Short Form Catalog.

Specifications applicable to all members of the  $\mu$ S\_/23 Family are listed on the back page. Individual models are described on the pages headed  $\mu$ S\_/23L (pp. 2 & 3),  $\mu$ S\_/23LS (pp. 4 & 5), and  $\mu$ S\_/23LC (pp. 6&7).

*Approved for general release.*



## Detailed Description

The L model is the basic encoder configuration which outputs a 4 wire multiplexed, 3-State Logic Level, MicroSeries® Code Word. The encoder is addressed by 3 Enable Lines activated in a controlled sequence. This model is intended for direct interface with a user (or BEI) furnished microprocessor where the microprocessor can be programmed to perform the encoder's digital logic functions. For programming details, request BEI Technical Bulletin "LSI MicroSeries® Encoders - Principles of Operation/Microprocessor Control and Decoding."

## Detailed Specifications

### Mechanical

Length: 2.09-inches max. (Dimension A on back page)

Standard Cable: 9 Conductors (12 conductors with optional Tach and/or BITE)

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4,443,788    4,445,110    4,465,928

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**Electrical**

Typical Power Requirements (+ 5V DC, 2% Regulation, 1% max. pp Ripple)

	1 Station	2 Stations
Peak	425 mW	600 mW
Average*	250 mW	425 mW

\* Average power calculated at 100 interrogations/second.  
(For power requirements at other interrogation rates refer to Technical Bulletin.)

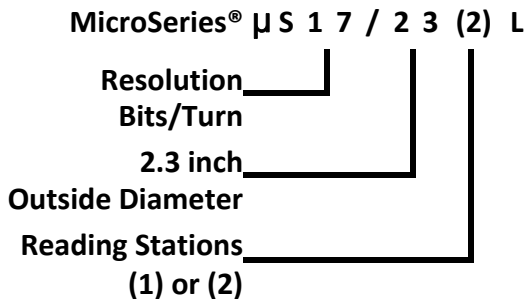
Input Octal Address (EN0, EN1, EN2)      0/5V CMOS Compatible  
1 µa Max., 20pf Max.

Output (DØ, D1, D2, D3)      0/5V  
Loading: 5 LSTTL Loads per Output

Pin/Wire Designations:

PIN or WIRE #	FUNCTION	
1 (Red Edge)	GND	} Power
2	+ 5V	
3	EN2	} Input Octal Address
4	EN1	
5	ENØ	
6	DATA 3	} Multiplexed Data Output
7	DATA 2	
8	DATA 1	
9	DATA Ø	
10	TACH	} Optional
11	BITE	
12	GND	

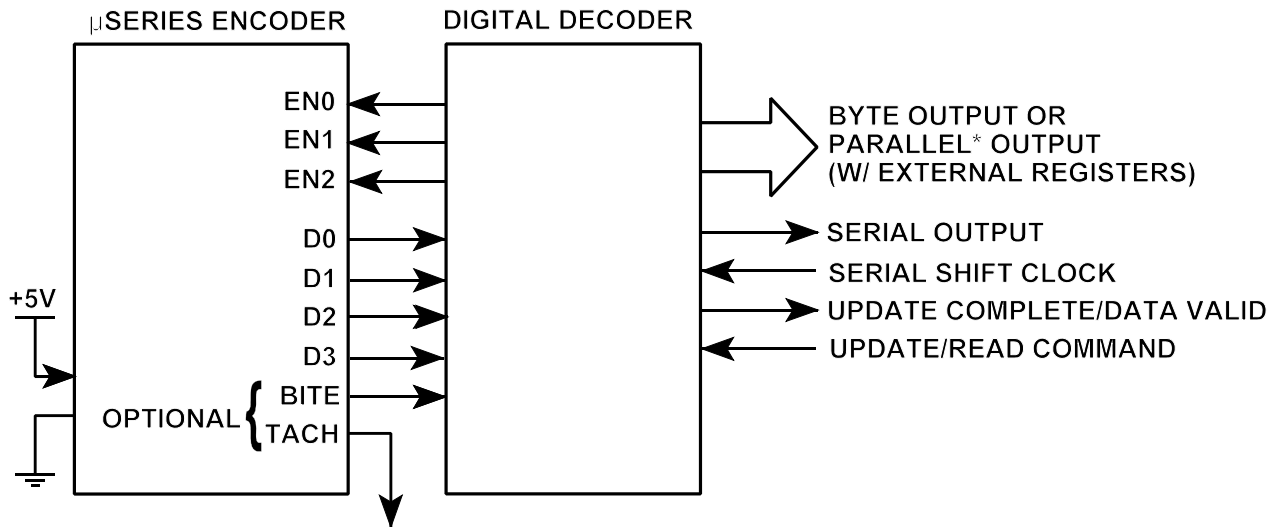
**Ordering Information**



**Specify options as follows:**

- MS1 Hi Rel Integrated Circuits
- MS2 Extended Temperature
- MS3 Built-in Test (BITE)
- MS4 Tach

Note: <sup>1</sup> Special modifications for Space/Vacuum operation can be provided.  
<sup>2</sup> Consult factory for 18 or 19-bit resolution (only applicable to L Model).



### Detailed Description

The LS model consists of the basic L encoder (described in the preceding pages) and a separate Digital Decoder. The use of the external Digital Decoder is suggested when the user does not have a microprocessor available to perform the digital processing of the outputs of the L Model encoder. The external digital decoder affords the user the flexibility to access the various input/output programming modes available with MicroSeries<sup>®</sup> encoders.

The external Digital Decoder can be user programmed for three output modes: serial, 8-bit byte, or parallel\*. Additionally, two data acquisition modes are possible: Update and Read. Request BEI Technical Bulletin "MicroSeries<sup>®</sup> Digital Decoder."

### Detailed Specifications

#### Mechanical

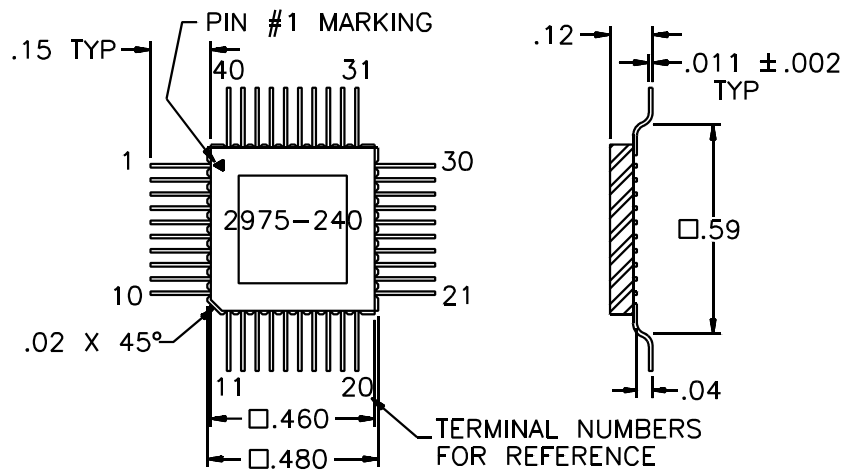
##### Encoder:

Length:  
2.09 inches max. (Dimension A on back page)

Standard Cable:  
9 Conductors (12 conductors with optional Tach and/or BITE)

##### Digital Decoder:

CMOS, Monolithic Gate Array  
40 Pin; 4 Sided, Flatpack with leads on .040 centers



\* 8-bit bytes with strobe signals to latch external registers

**Electrical**

Typical Power Requirements (+ 5V DC, 2% Regulation, 1% max. pp Ripple)

	1 Station	2 Stations
Peak	450 mW	625 mW
Average*	275 mW	450 mW

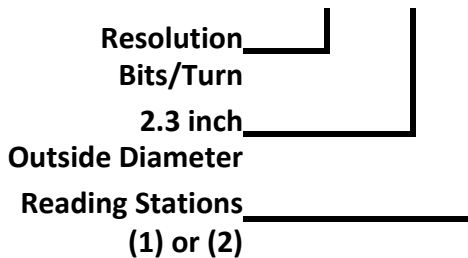
\* Average power calculated at 100 interrogations/second.  
 (For power requirements at other interrogation rates refer to Technical Bulletin.)

- Input Levels 0/5V, TTL and CMOS Compatible,  
1 CMOS unit load
- Output Levels 0/5V, Short Circuit Protected  
Loading: 8 LSTTL Loads per Output
- Pin/Wire Designations:
 

Encoder:	Same as $\mu$ S __/23L
Digital Decoder:	Refer to BEI Technical Bulletin "MicroSeries® Digital Decoder."
- Output Code Unambiguous Natural Binary

**Ordering Information**

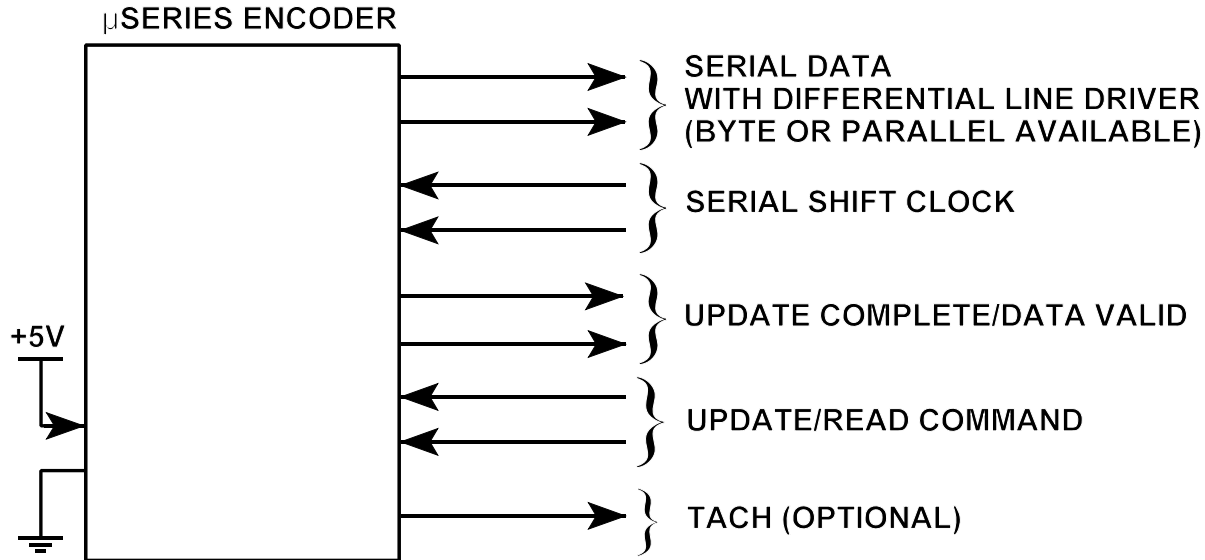
MicroSeries®  $\mu$ S 1 7 / 2 3 (2) LS



**Specify options as follows:**

- MS1 Hi Rel Integrated Circuits
- MS2 Extended Temperature
- MS3 Built-in Test (BITE)
- MS4 Tach

Note: <sup>1</sup> Special modifications for Space/Vacuum operation can be provided.



### Detailed Description

The LC Model contains an integral MicroSeries® Digital Decoder Chip. This model, essentially similar to the  $\mu$ S/\_23LS, is appropriate when an encoder without external processing circuits is desired. Output modes available are serial with differential line drivers, 8-bit bytes with TTL-compatible outputs, and parallel (8-bits at a time) with strobe signals to latch user-supplied external registers. Both Update and Read acquisition modes are available. User must specify the input and output modes of operation at time of order.

### Detailed Specifications

Length(Dimension A on back page): 2.47 inches max.

Standard Number of Cable Conductors:

- Serial Output - 12 standard\*
- Byte or parallel Output - 17 standard

### Electrical

#### ALL OUTPUT MODES

Typical Power Requirements (+5V DC, 2% Regulation, 1% Ripple):

	PARALLEL/8-BIT BYTE		SERIAL (Excludes Tach Option)	
	1 Station	2 Stations	1 Station	2 Stations
Peak	450 mW	775 mW	1 WATT	1.2 WATTS
Average**	275 mW	450 mW	850 mW	1 WATT

- Data Acquisition Time 120 $\mu$  Sec. Min.  
128 $\mu$  Sec. Min. (Parallel Output)
- Output Code Unambiguous Natural Binary

\* 9 conductor cable available without Update Complete/Data Valid Line and without Tach option.

\*\* Average power calculated at 100 interrogations/second. For other interrogation rates refer to Technical Bulletin.

**SERIAL OUTPUT MODE**

- Input/Output levels 9637/38 Receivers/Drivers
- Shift Clock 1MHz (User Supplied)
- Pin/Wire Designations:

PIN or		PIN or	
WIRE NO.	FUNCTION	WIRE NO.	FUNCTION
1 (Red Edge)	GND	7	Serial Clock'
2	Tach	8	Serial Output
3	Tach'	9	Serial Output'
4	Update/Read Command	10	Update Complete/Data Valid
5	Update/Read Command'	11	Update Complete/Data Valid'
6	Serial Clock	12	+5V

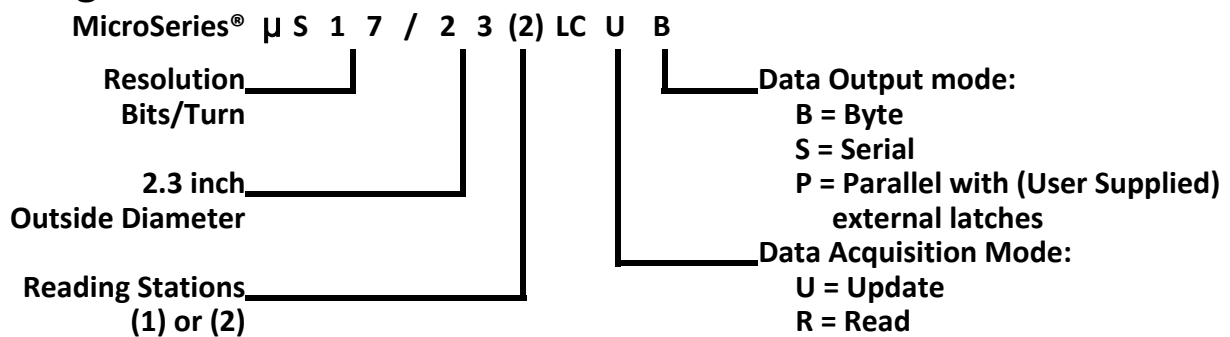
**BYTE (OR PARALLEL) OUTPUT MODE**

- Input Levels 0/5V, TTL and CMOS Compatible, 1 CMOS Unit Load
- Output Levels 0/5V, Short Circuit Protected
- Loading: 8 LSTTL Loads per Output
- Pin/Wire Designations:

PIN or		PIN or	
WIRE NO.	FUNCTION	WIRE NO.	FUNCTION
1 (Red Edge)	DB7	10	+5V
2	DB6	11	Update Complete/Data Valid*
3	DB5	12	Guard/NC
4	DB4	13	ADR $\emptyset$ (Latch1)
5	DB3	14	Guard/NC
6	DB2	15	ADR 1(Latch 2)
7	DB1	16	GND
8	DB $\emptyset$	17	Update/Read Command
9	Tach		

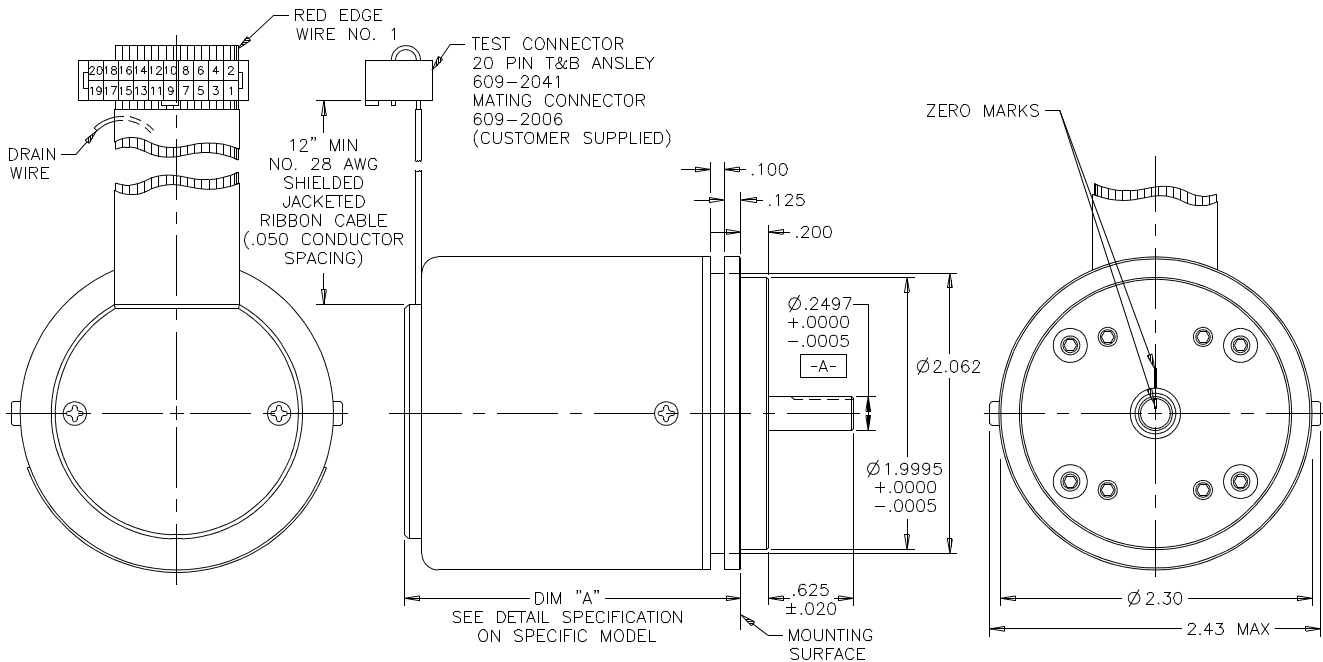
\* Pin 11 is Latch 3 on 16-bit units with BITE and 17 bit units

**Ordering Information**



**Specify Options As Follows:**

- MS1 Hi-Rel Integrated Circuits
- MS2 Extended Temperature
- MS3 Built-in Test (BITE)
- MS4 Tach
- MS5 CCW For Increasing Count Facing the Mtg. Surface



## General Specifications (L, LS and LC)

	Quanta/Revolution	Resolution (Arc Minutes)	Accuracy <sup>(1)</sup> (Arc Minutes)	
			No. of Stations	
			1	2
$\mu$ S14/23	16384	1.32	1.0	----
$\mu$ S15/23	32768	0.66	0.7	----
$\mu$ S16/23	65536	0.33	0.5	0.25
$\mu$ S17/23	131072	0.17	----	0.2
Interrogation Rate/Acquisition Time	5kHz max./Data Acquisition Time 120 $\mu$ sec min.			
Operating Speed	250 rpm max.			
Rotation (for increasing count)	Clockwise facing mounting surface			
Slew Speed (nonoperating)	3600 rpm max.			
Operating Temperature Range - Standard	-40 to +71°C			
Optional	-54 to +85°C			
Torque - Breakaway	1.5 oz-in max. at 25°C			
Running	1.5 oz-in max. at 25°C			
Moment of Inertia	0.068 oz-in <sup>2</sup> max. (0.18 x 10 <sup>-3</sup> oz-in-sec <sup>2</sup> max.)			
Shaft Loading - Axial	2.0 lb max.			
Radial	1.0 lb max. (at 0.125 inch from front face)			
Weight	16 oz. max. (Stainless steel base)			
Rated Life, Bearings	10 <sup>9</sup> revolutions min.			
Rated Life, LED	100,000 hours min.			
MTBF	300,000 hours typical (calculated per MIL-HDBK-217 Ground Fixed)			
Digital Tach Output Option	32768 Cycles/Revolution Square Wave			

(1) Peak transition error of transducer and electronics. Excludes quantizing error of 1/2 LSB.

Specifications subject to change without notice.