ENCODER DATA SHEET
LSI MicroSeries μS/16 Family

Features:

- Resolution to 0.33 Arc Minutes
- Accuracy to 0.5 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 with greater resolution, refer to Encoder Data Sheet "LSI MicroSeries® μS__/23 Family." For encoders with a through hole, refer to Encoder Data Sheets "Pancake LSI MicroSeries® μS__/40 Family, μS__/50 Family and μS__/80 Family." For reference to other BEI Models refer to the Short Form Catalog.

Specifications applicable to all members of the μS__/16 Family are listed on the back page. Individual models are described on the pages headed μS__/16L (pp. 2 & 3), μS__/16LS (pp. 4 & 5), and μS__/16LC (pp. 6&7).
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: 2.16 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
MicroSeries and MicroSeries are registered trademarks of BEI Precision Systems & Space Company, Inc.
Electrical

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

<table>
<thead>
<tr>
<th></th>
<th>1 Station</th>
<th>2 Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak</td>
<td>425 mW</td>
<td>600 mW</td>
</tr>
<tr>
<td>Average*</td>
<td>250 mW</td>
<td>425 mW</td>
</tr>
</tbody>
</table>

* 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:

<table>
<thead>
<tr>
<th>PIN or WIRE #</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (Red Edge)</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>+ 5V</td>
</tr>
<tr>
<td>3</td>
<td>EN2</td>
</tr>
<tr>
<td>4</td>
<td>EN1</td>
</tr>
<tr>
<td>5</td>
<td>ENØ</td>
</tr>
<tr>
<td>6</td>
<td>DATA 3</td>
</tr>
<tr>
<td>7</td>
<td>DATA 2</td>
</tr>
<tr>
<td>8</td>
<td>DATA 1</td>
</tr>
<tr>
<td>9</td>
<td>DATA Ø</td>
</tr>
<tr>
<td>10</td>
<td>TACH</td>
</tr>
<tr>
<td>11</td>
<td>BITE</td>
</tr>
<tr>
<td>12</td>
<td>GND</td>
</tr>
</tbody>
</table>

Ordering Information

MicroSeries® MS 1 5 / 1 6 (1) L

Specify options as follows:

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

Note:
1. Special modifications for Space/Vacuum operation can be provided.
2. Consult factory for 17 or 18-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 or when the length of the μS__/16LC encoder exceeds available space in the intended application. The external digital decoder affords the user the flexibility to access the various input/output programming modes available with MicroSeries® 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® Digital Decoder."

Detailed Specifications

Mechanical
Encoder:
- Length: 2.16 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: 450 mW
  - 2 Stations: 625 mW
  - Average*: 275 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 JS__16L

- Output Code: Unambiguous Natural Binary

**Ordering Information**

- MicroSeries® MS 15 / 16 (1) LS

  - Resolution
  - Bits/Turn
  - 1.6 inch
  - Outside Diameter
  - Reading Stations (1) or (2)

Specify options as follows:

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

Note: 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 μS/16LS, 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):  
- 8-Bit Byte/Parallel Output: 2.48 inches max.
- Serial Output: 2.74 inches max.

Standard Number of Cable Conductors:
- Serial Output: 12 standard*
- Byte or parallel Output: 17 standard

Electrical

ALL OUTPUT MODOES

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

<table>
<thead>
<tr>
<th>PARALLEL/8-BIT BYTE</th>
<th>SERIAL (Excludes Tach Option)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Station</td>
<td>1 Station</td>
</tr>
<tr>
<td>2 Stations</td>
<td>2 Stations</td>
</tr>
<tr>
<td>Peak</td>
<td>275 mW</td>
</tr>
<tr>
<td></td>
<td>450 mW</td>
</tr>
<tr>
<td>Average**</td>
<td>450 mW</td>
</tr>
<tr>
<td></td>
<td>850 mW</td>
</tr>
</tbody>
</table>

☐ Data Acquisition Time
- 120μSec. Min. (Parallel Output)
- 128μSec. 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.
LSI MicroSeries® μS/16LC

**SERIAL OUTPUT MODE**
- Input/output levels: 9637/38 Receivers/Drivers
- Shift Clock: 1MHz (User Supplied)
- Pin/Wire Designations:

<table>
<thead>
<tr>
<th>WIRE NO. or PIN</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(Red Edge)</td>
<td>GND</td>
</tr>
<tr>
<td>2</td>
<td>Tach</td>
</tr>
<tr>
<td>3</td>
<td>Tach'</td>
</tr>
<tr>
<td>4</td>
<td>Update/Read Command</td>
</tr>
<tr>
<td>5</td>
<td>Update/Read Command'</td>
</tr>
<tr>
<td>6</td>
<td>Serial Clock</td>
</tr>
</tbody>
</table>

**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:

<table>
<thead>
<tr>
<th>WIRE NO. or PIN</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(Red Edge)</td>
<td>DB7</td>
</tr>
<tr>
<td>2</td>
<td>DB6</td>
</tr>
<tr>
<td>3</td>
<td>DB5</td>
</tr>
<tr>
<td>4</td>
<td>DB4</td>
</tr>
<tr>
<td>5</td>
<td>DB3</td>
</tr>
<tr>
<td>6</td>
<td>DB2</td>
</tr>
<tr>
<td>7</td>
<td>DB1</td>
</tr>
<tr>
<td>8</td>
<td>DB0</td>
</tr>
<tr>
<td>9</td>
<td>Tach</td>
</tr>
</tbody>
</table>

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

**Ordering Information**

MicroSeries® μS 1 5 / 1 6 (1) LC U B

Resolution: Bits/Turn
1.6 inch Outside Diameter
Reading Stations: (1) or (2)

Data Output mode:
- B = Byte
- S = Serial
- P = Parallel with (User Supplied) external latches

Data Acquisition Mode:
- U = Update
- R = Read

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)

<table>
<thead>
<tr>
<th>Quadrant/Revolution</th>
<th>Resolution (Arc Minutes)</th>
<th>Accuracy (1) (Arc Minutes)</th>
<th>No. of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \mu S13/16 )</td>
<td>8192</td>
<td>2.64</td>
<td>1</td>
</tr>
<tr>
<td>( \mu S14/16 )</td>
<td>16384</td>
<td>1.32</td>
<td>1.4</td>
</tr>
<tr>
<td>( \mu S15/16 )</td>
<td>32768</td>
<td>0.66</td>
<td>1.0</td>
</tr>
<tr>
<td>( \mu S16/16 )</td>
<td>65536</td>
<td>0.33</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Interrogation Rate/Acquisition Time 5kHz max./Data Acquisition Time 120 µsec min.

Operating Speed 450 rpm max.

Rotation (for increasing count) Clockwise facing mounting surface

Slew Speed (nonoperating) 3600 rpm max.

Operating Temperature Range

<table>
<thead>
<tr>
<th>Standard</th>
<th>Optional</th>
</tr>
</thead>
<tbody>
<tr>
<td>-40 to +71°C</td>
<td>-54 to +85°C</td>
</tr>
</tbody>
</table>

Torque

<table>
<thead>
<tr>
<th>- Breakaway</th>
<th>- Running</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 oz-in max. at 25°C</td>
<td>1.5 oz-in max. at 25°C</td>
</tr>
</tbody>
</table>

Moment of Inertia 0.023 oz-in² max. (0.06 x 10⁻³ oz-in-sec² max.)

Shaf Load - Axial 2.0 lb max.

Radial 1.0 lb max. (at 0.125 inch from front face)

Weight 8 oz. max. (Stainless steel base)

Rated Life, Bearings 10⁷ 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 16384 Cycles/Revolution Square Wave

(1) Peak transition error of transducer and electronics. Excludes quantizing error of ½ LSB.

Specifications subject to change without notice.