

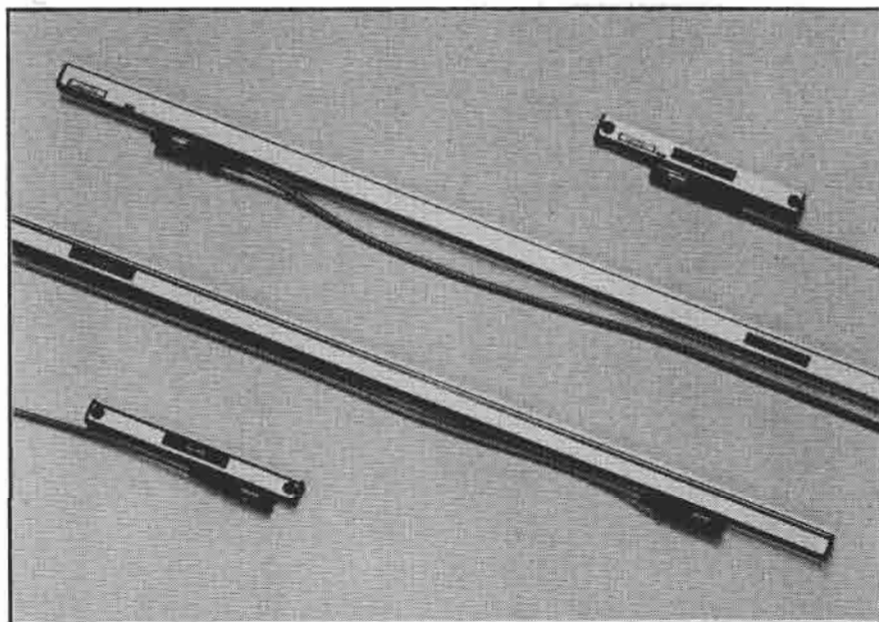
# Mini-Scale and Mate System Encoders

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Linear Encoders for Digital and Vision Readouts

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## REFERENCE MANUAL

**ACU-RITE®**

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# Mini-Scale and Mate System Encoders

# Section 1. Introduction

Mini-Scale and Mate System linear encoders are physically very similar. Mounting requirements for both types of encoders are the same.

Mini-Scale linear encoders are smaller-sized, general-purpose encoders intended for use with any of ACU-RITE's line of standard digital readouts (DROs) or vision readouts (VROs), with the exception of the Mate series of DROs. They are commonly used on mills, lathes, grinders, comparators, and other machine tool or measuring applications that demand the accuracy and reliability of an ACU-RITE measuring system.

Mini-Scale linear encoders can be identified by several characteristics. The aluminum encoder body has an even metal finish. The reading head casting has a bright silver-colored plating. The connector provided for attachment to a readout is round.

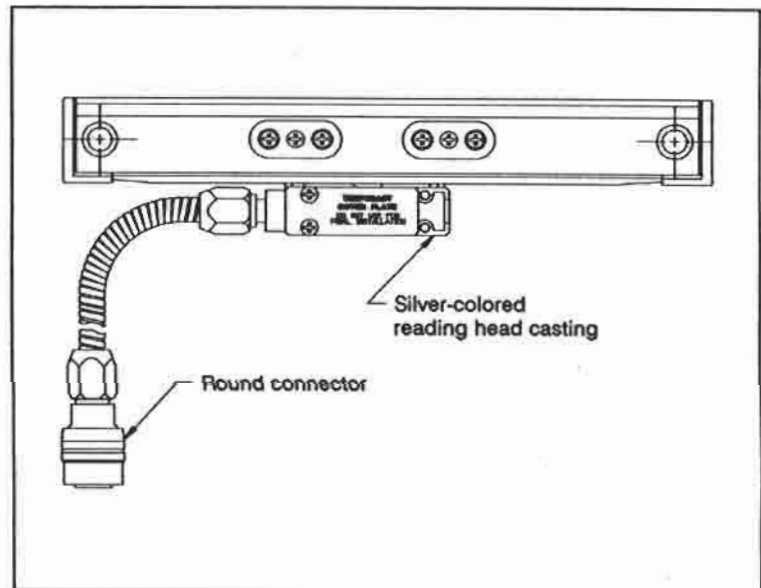
These encoders provide digital output signals for counting and for a Fiducial Trigger Output (FTO) reference signal (refer to Appendix B). Mini-Scales are available in several resolutions and accuracy grades.

Mini-Scales are available in sizes from 2" to 120" (1µm encoders are available from 2" to 40"). Mounting hardware is furnished with all Mini-Scale encoders. In addition, 24" to 60" encoders are furnished with center support kits. Encoders longer than 60" are furnished with backup spars.

## Mini-Scale encoders

**Table 1-1. Mini-Scale encoder part numbers**

Nominal encoder length	Encoder resolution			
	10µm (0.0005")	5µm (0.0002")	2µm (0.0001")	1µm (0.00005")
2" (50 mm)	383102-01	383202-01	380702-01	383402-01
4" (100 mm)	383104-01	383204-01	380704-01	383404-01
6" (150 mm)	383106-01	383206-01	380706-01	383406-01
8" (200 mm)	383108-01	383208-01	380708-01	383408-01
10" (250 mm)	383110-01	383210-01	380710-01	383410-01
12" (300 mm)	383112-01	383212-01	380712-01	383412-01
13" (330 mm)	383113-01	383213-01	380713-01	383413-01
14" (350 mm)	383114-01	383214-01	380714-01	383414-01
16" (400 mm)	383116-01	383216-01	380716-01	383416-01
18" (450 mm)	383118-01	383218-01	380718-01	383418-01
20" (500 mm)	383120-01	383220-01	380720-01	383420-01
24" (600 mm)	383124-01	383224-01	380724-01	383424-01
26" (650 mm)	383126-01	383226-01	380726-01	383426-01
28" (700 mm)	383128-01	383228-01	380728-01	
30" (750 mm)	383130-01	383230-01	380730-01	383430-01
31.5" (800 mm)	383131-01	383231-01	380731-01	383431-01
32" (813 mm)	383132-01	383232-01	380732-01	383432-01
35" (889 mm)	383135-01	383235-01	380735-01	383435-01
36" (900 mm)	383136-01	383236-01	380736-01	383436-01
40" (1000 mm)	383140-01	383240-01	380740-01	383440-01
42" (1050 mm)	383142-01	383242-01	380742-01	
48" (1225 mm)	383148-01	383248-01	380748-01	
52" (1325 mm)	383152-01	383252-01	380752-01	
54" (1375 mm)	383154-01	383254-01	380754-01	
60" (1525 mm)	383160-01	383260-01	380760-01	
65" (1625 mm)	383165-01	383265-01	380765-01	
72" (1800 mm)	383172-01	383272-01	380772-01	
78" (1950 mm)	383178-01	383278-01	380778-01	
84" (2100 mm)	383184-01	383284-01	380784-01	
90" (2250 mm)	383190-01	383290-01	380790-01	
100" (2550 mm)	383191-01	383291-01	380791-01	
110" (2800 mm)	383192-01	383292-01	380792-01	
120" (3050 mm)	383193-01	383293-01	380793-01	



**Figure 1-1. Mini-Scale linear encoder assembly**

# Mini-Scale and Mate System Encoders

# Mate System encoders

Mate System linear encoders are intended for use with lathes and mills, as a part of a TurnMate or MillMate system. These systems provide an economical solution to the need for a high quality measuring system. **Mate System encoders can only be used with a TurnMate or MillMate DRO; they are not compatible with ACU-RITE's other DROs or VROs.**

Mate System linear encoders can be identified by several distinct characteristics. The aluminum encoder body has a black stripe. The reading head casting has a black finish. The connector provided for attachment to a readout is a 9-pin, rectangular connector commonly referred to as a DB-9.

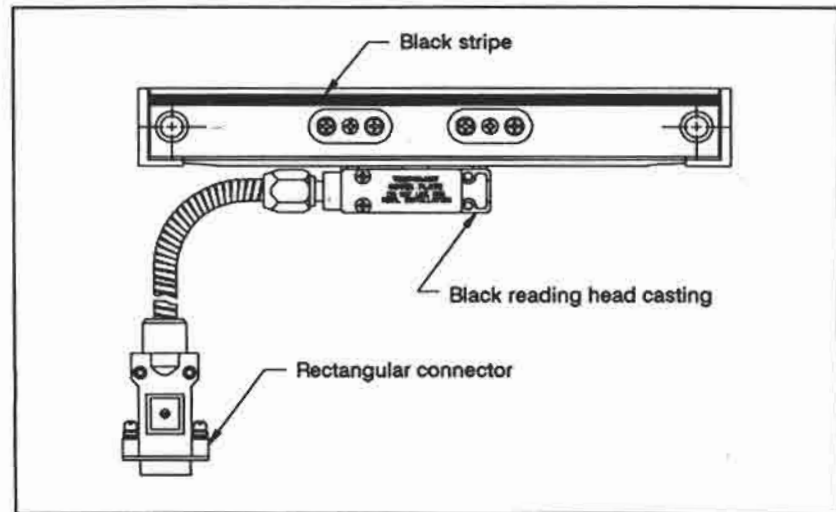
Mate System linear encoders provide analog counting signals to the DRO (refer to Appendix C). They are available in sizes from 2" to 120", in 5um (0.0002") resolution only. Mate System encoders are provided as a part of a TurnMate or MillMate system and include a Mate DRO, DRO mounting hardware, and an encoder installation kit.

**Table 1-2. Mate System encoder part numbers**

Nominal encoder length	MillMate encoder part no.	TurnMate encoder part no.
2" (50 mm)		384402-000
4" (100 mm)		384404-000
6" (150 mm)		384406-000
8" (200 mm)		384408-000
10" (250 mm)		384410-000
12" (300 mm)	384312-000	384412-000
13" (330 mm)	384313-000	
14" (350 mm)	384314-000	384414-000
16" (400 mm)	384316-000	384416-000
18" (450 mm)		384418-000
20" (500 mm)		384420-000
24" (600 mm)	384324-000	384424-000
26" (650 mm)	384326-000	384426-000
28" (700 mm)		384428-000
30" (750 mm)	384330-000	384430-000
31.5" (800 mm)	384331-000	
32" (813 mm)	384332-000	
35" (889 mm)	384335-000	
36" (900 mm)	384336-000	384436-000
40" (1000 mm)	384340-000	384440-000
42" (1050 mm)	384342-000	384442-000
48" (1225 mm)		384448-000
52" (1325 mm)		384452-000
54" (1375 mm)		384454-000
60" (1525 mm)		384460-000
65" (1625 mm)		384465-000
72" (1800 mm)		384472-000
78" (1950 mm)		384478-000
84" (2100 mm)		384484-000
90" (2250 mm)		384490-000
100" (2550 mm)		384491-000
110" (2800 mm)		384492-000
120" (3050 mm)		384493-000

The construction of all Mate System encoders is the same, except:

- MillMate encoders 24" and longer are furnished with center supports.
- MillMate encoders include 10-ft long cables.
- TurnMate encoders include 15-ft long cables.
- With TurnMate systems, the longer encoder (18" and up, intended for lathe bed installations) is furnished with a backup spar.



**Figure 1-2. Mate System linear encoder assembly**

## Mounting accessories

ACU-RITE offers accessories to speed the installation of your measuring system. Accessories include bracket kits, universal installation brackets, backup spars, impact shields, and extension cables. Your ACU-RITE Distributor or OEM/OEI can assist with selecting accessories and can provide additional information about any of these products.

# Mini-Scale and Mate System Encoders

## Section 2. Preparation

### IMPORTANT

This section contains general mounting information and tips for installing a linear encoder assembly. Read this section carefully and plan the installation before proceeding. Time spent in understanding the requirements for installation will make the job go much faster and can avoid damage to the encoder.

Mini-Scale and Mate System linear encoders come pre-assembled, ready to be mounted. Mounting brackets may have to be fabricated to install the encoders on the machine tool, fixture, etc.

### CAUTION

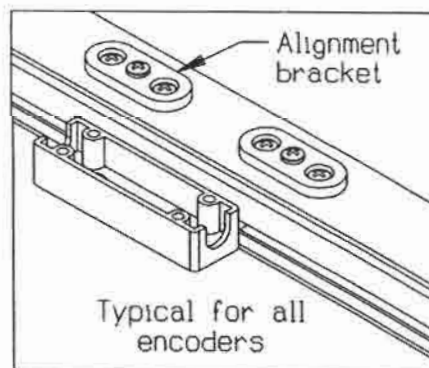
Temporary alignment brackets hold the reading head in proper alignment during installation. **Do not remove these brackets until instructed. The reading head cannot be installed properly without the alignment brackets and the encoder assembly could be damaged.**

Some key points to remember when planning the installation are:

- The encoder should be mounted as close to the machine ways as possible to maintain the highest accuracy.
- Mounting bracket lengths must be kept to a minimum and must be rigid enough to prevent vibration during machining operations.
- Clean all mounting surfaces and remove excess paint and foreign material. Machined surfaces used to mount the encoders must be flat and in good condition.
- A removable thread-locking adhesive such as Loctite 222 should be used on all mounting fasteners prior to final assembly.
- Ensure that the encoder alignment brackets are securely attached to the encoder. First loosen the two outside screws, then tighten the center screw if required, and finally snug the outside screws evenly. The surface of each bracket must be parallel with the face of the encoder.
- Plan the encoder mounting so that the encoder's protective lipseals are pointed away from the machine work area. If exposure cannot be prevented, fabricate a shield or obtain an ACU-RITE Impact Shield and install it to protect the lipseals. **Use of a shield is recommended for horizontally-mounted lathe cross-slide installations.**
- Encoder travel (Figures 2-1, 2-8 and Table 2-1) must be at least as great as the machine travel. **The reading head will be damaged if machine movements allow the head to contact the internally-installed end mounting screws or endcaps.** If the encoder provides less travel than the machine is capable of, hard stops must be installed to limit the machine movement.

## Installation planning

### Key points



## Mini-Scale and Mate System Encoders



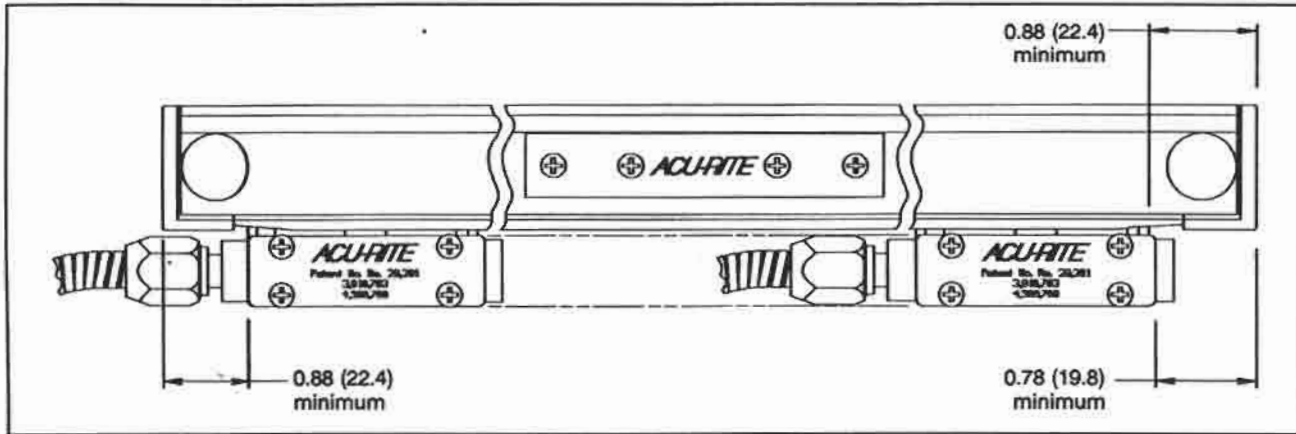


Figure 2-1. Maximum travel limits

## Length-dependent mounting requirements

Mini-Scale and Mate System encoders may be mounted in one of several ways. Regardless of method chosen, the mounting must provide for length-dependent mounting requirements.

### Less than 24" encoders:

- The encoder is mounted using the end mounting holes or a backup spar.
- A full-length mounting surface is not required. The encoder or spar can be mounted with standoffs to machined surfaces or by using custom fabricated brackets or adjustable mounts on non-machined mounting surfaces (Figure 2-13). Mounting surfaces must be flat and aligned parallel to the machine travel and to each other within 0.005" (0.13 mm). Shimming is allowed.
- Backup spars are included with the longer encoder on all TurnMate systems. Use the spar to mount the encoder.

### 13" encoder:

- The encoder must be mounted with a backup spar; no end mounting holes are provided. The 13" encoder is intended for use with specific-application mounting kits that provide a backup spar. For general applications, obtain a backup spar and use it to mount the encoder.

### 24" to 60" encoders (except 32" and 35"):

- The encoder is mounted using the end mounting holes and intermediate center supports or a backup spar. The correct number of ACU-RITE center supports are provided with Mini-Scale and MillMate encoders (Figure 2-11).
- Center supports are not required, and the encoder end mounting holes are not used, when using a backup spar (Figure 2-13). TurnMate encoders include a backup spar.
- An intermediate mounting bar may be used with these encoders (Appendix D). The bar must be wide enough to accommodate the required center supports.
- A full-length mounting surface is not required. The encoder or spar can be mounted with standoffs to machined surfaces, or by using custom fabricated brackets or adjustable mounts on non-

# Mini-Scale and Mate System Encoders



machined mounting surfaces (Figure 2-13). Mounting surfaces must be flat and aligned parallel to the machine travel and to each other within 0.005" (0.13 mm). Shimming is allowed. Center support mounting surfaces must provide a minimum of 1.405" (35.7 mm) height (1.435" for the 32" and 35" encoders) and 1.90" (48.3 mm) width.

- With a single ACU-RITE center support, install the support as close to the alignment brackets as possible. With two center supports, install the supports so that distances between all mounting points are equal. Refer to "Center support installation" for additional requirements.
- Backup spars are included with the longer encoder on all TurnMate systems. Use the spar to mount the encoder.

#### **32", 35" encoders:**

- These encoders are intended for use with specific-application mounting kits. With these applications, they are mounted onto a machined surface using the end mounting holes and the factory-installed center support (Figure 2-12). For general applications this same mounting method may be used.
- A backup spar may be used with these encoders. The center support must be removed.
- An intermediate mounting bar may be used with these encoders. The bar must be wide enough to provide a mounting surface for the attached center support (Appendix D).
- For end mounting hole/center support mountings, the encoder must be installed on a flat surface that runs the full length and width of the encoder (Figures 2-8, -9, -12, -13, Table 2-1, and Appendix D). A machined surface is preferred. The center support mounting surfaces must provide a minimum of 1.805" (45.85 mm) height and 0.500" (12.70 mm) width.

#### **65" and larger encoders:**

- Mount the encoder with the backup spars provided. Backup spars are included with all 65" and longer Mini-Scale and Mate System encoders.

*Refer to Figure 2-8. The upper side view illustrates a typical mill longitudinal encoder mounting. The encoder is mounted directly to a machined surface of the mill table (either the front or the back of the table). Here, the shape of the saddle (cross travel casting) provides just enough clearance for the reading head adjustment and mounting. The lower side view illustrates mounting directly to the same machined surface, but using a backup spar. In this case, the reading head casting is too far from the saddle, and a reading head mounting bracket is required.*

Either of these mounting methods are recommended. The encoder is attached as closely as possible to the machine ways, in this case the mill X-axis table.

## **Typical installations**

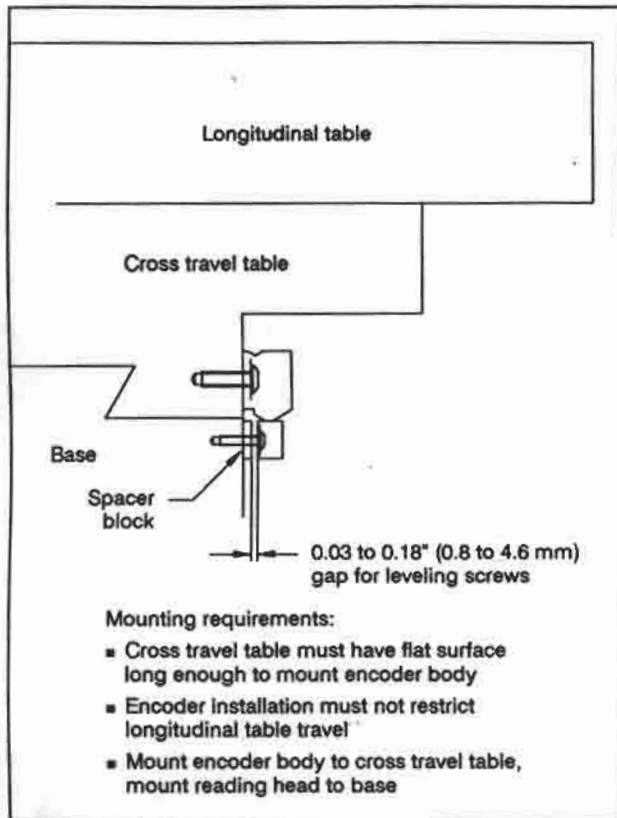
### **Longitudinal installation**

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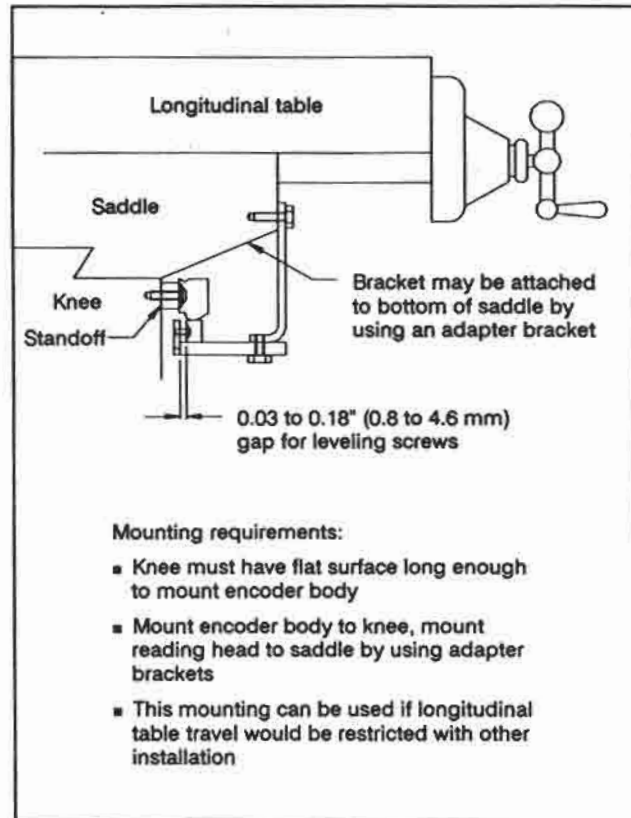
# **Mini-Scale and Mate System Encoders**

## Cross travel installation

Figure 2-2 is typical of installations on grinders, comparators, and other machine tools and measuring devices. The encoder body is attached to the moveable member, the cross travel table. Figure 2-3 is typical of knee mills and other machine tools; here, the encoder body is mounted to the fixed member, the knee. Note the difference in reading head mounting arrangements for the two types of installations.



**Figure 2-2. Mini-Scale or Mate System linear encoder assembly mounted to moveable table for cross travel installation**



**Figure 2-3. Mini-Scale or Mate System linear encoder assembly mounted to fixed base for cross travel installation**

## Cross-slide installation

Mounting an encoder on the cross-slide of a lathe can be difficult because of the limited room at the side of the cross-slide table. In addition, many cross-slide castings are rounded and offer no natural mounting areas. The preferred mounting is with the encoder mounted upright, with the lipseals down; this will minimize contamination from chips and cutting fluids. Refer to Figure 2-4 for an illustration of this type of mounting.

Another common arrangement is for the encoder to be mounted in a horizontal position, usually to a backup spar that has been modified to allow mounting the spar in this position (Figure 2-5). The encoder is attached to the spar by using the end mounting holes and bolting into threaded holes machined into the back of the spar.

# Mini-Scale and Mate System Encoders

Installation of an ACU-RITE Impact Shield is recommended when the encoder is mounted horizontally (for 2" to 20" encoders). As an alternative, a shield can be fabricated from sheet metal or neoprene and installed to protect the encoder from impacts and contaminants.

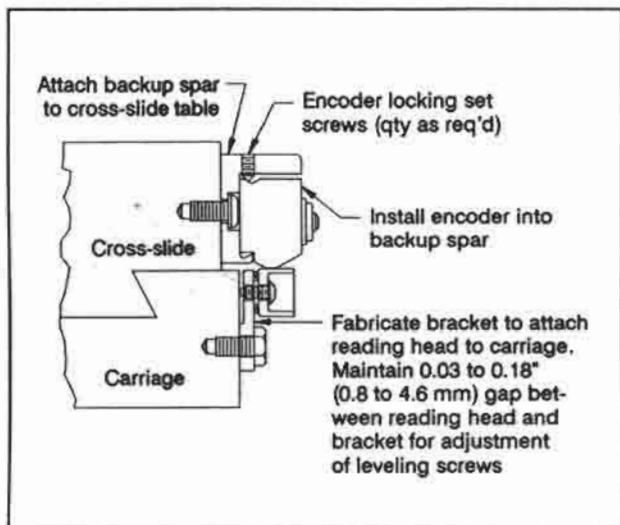


Figure 2-4. Vertical cross-slide mounting

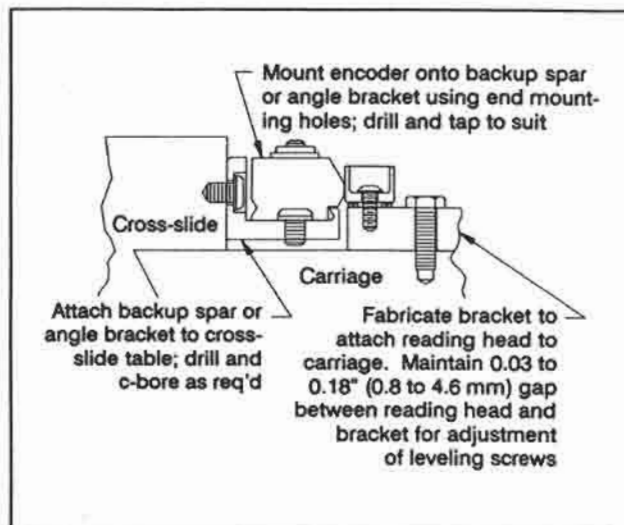


Figure 2-5. Horizontal cross-slide mounting

Figures 2-6 and 2-7 illustrate methods of installing encoders on vertical slides such as grinders or mills. These installations commonly must deal with mounting on rounded casting surfaces. Mountings must be firmly attached and must be properly aligned so that the encoder is not twisted.

If an encoder is installed with lipseals facing the machine work area, a shield must be installed to reduce contamination.

## Vertical installation

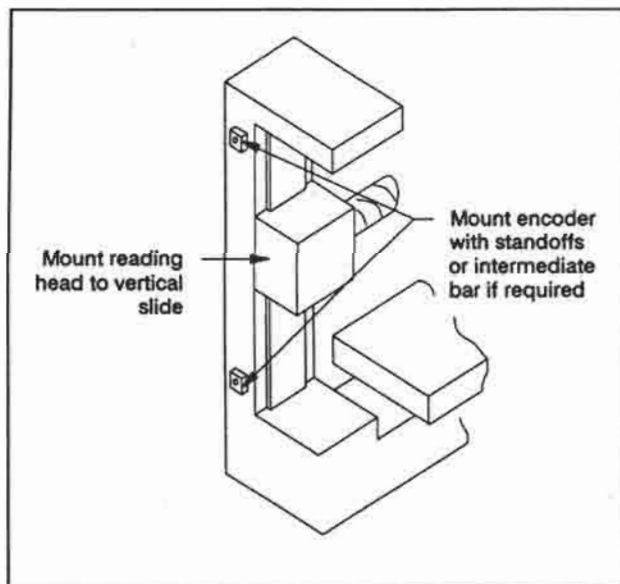


Figure 2-6. Vertical travel axis mounting

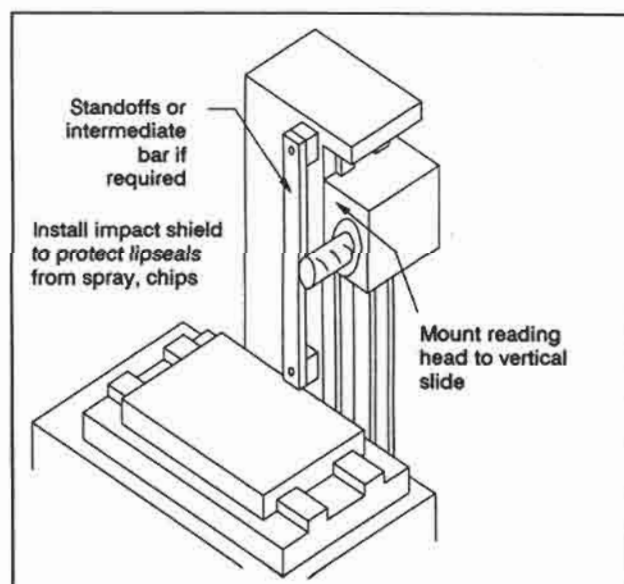


Figure 2-7. Vertical travel axis alternate mounting

# Mini-Scale and Mate System Encoders

# Encoder mounting dimensions

Refer to Figures 2-8 through 2-10 and Table 2-1 for encoder and backup spar mounting dimensions. The illustrations also show the amount of clearance space that must be provided for the encoder, both during and following installation. This clearance will assure that brackets, machine tool handles, etc. will not interfere with the encoder after installation.

Refer to Figures 2-11 and 2-12 for center support mounting dimensions.

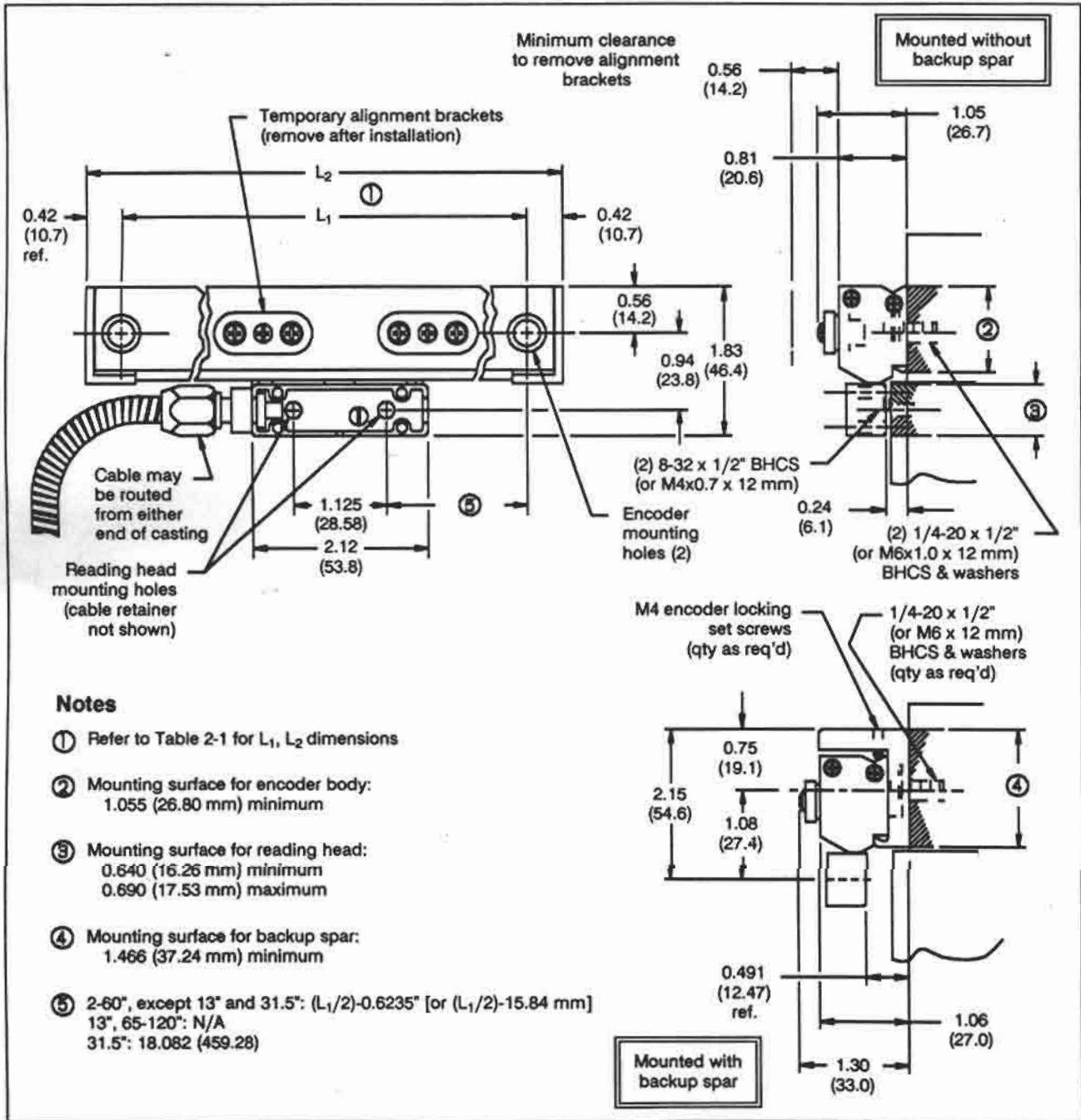


Figure 2-8. Mini-Scale or Mate System linear encoder assembly dimensions and mounting data (during installation)

## Mini-Scale and Mate System Encoders

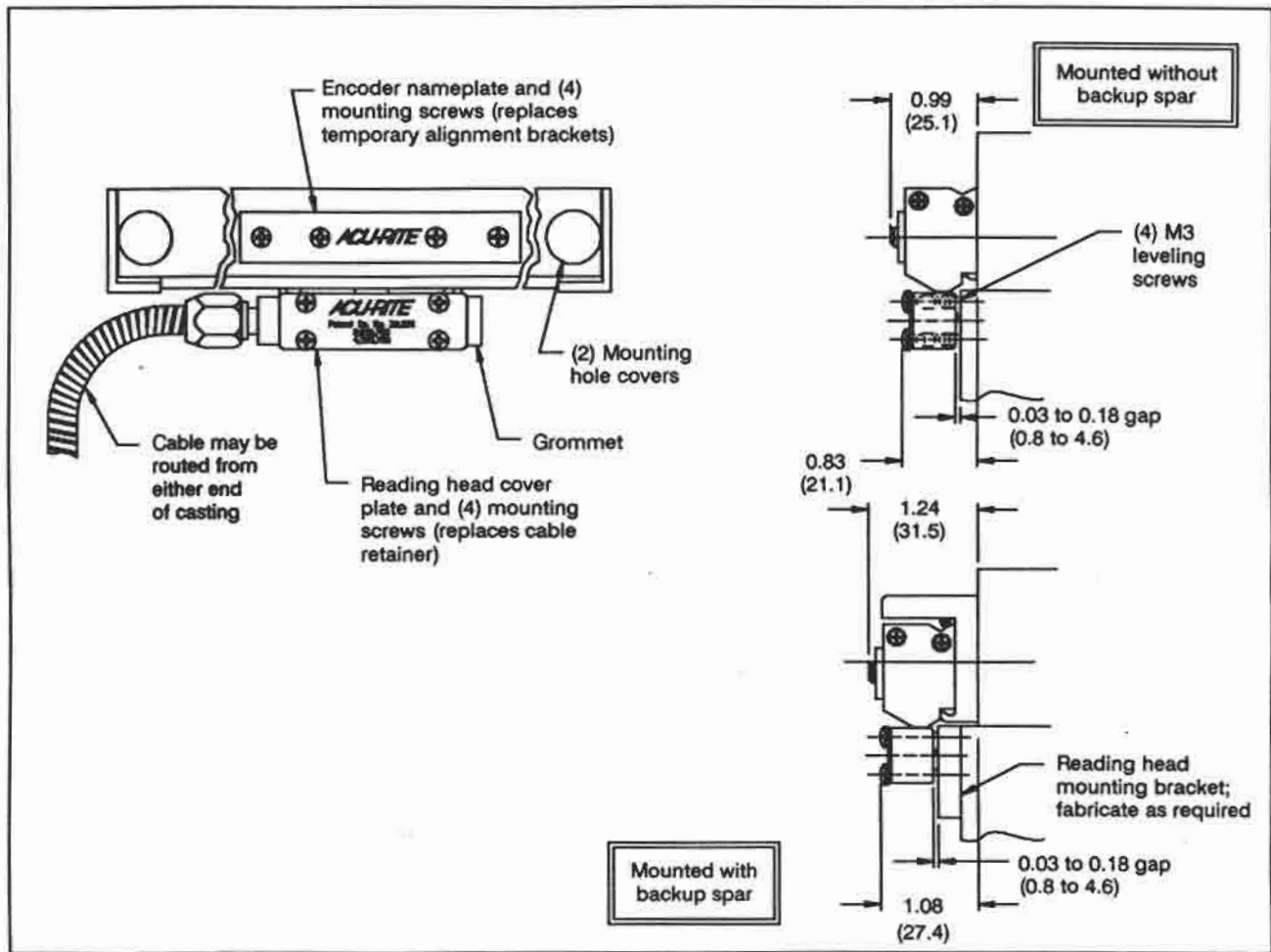


Figure 2-9. Mini-Scale or Mate System linear encoder assembly dimensions and mounting data (after installation)

Table 2-1. Mini-Scale and Mate System encoder lengths

Nominal encoder length	L1 +/- 0.007"	L2 +/- 0.025"	Nominal encoder length	L1 +/- 0.007"	L2 +/- 0.025"
2" (50 mm)	7.437" (188.90 mm)	8.39" (213.1 mm)	36" (900 mm)	41.437" (1052.50 mm)	42.39" (1076.7 mm)
4" (100 mm)	9.437" (239.70 mm)	10.39" (263.9 mm)	40" (1000 mm)	45.437" (1154.10 mm)	46.39" (1178.3 mm)
6" (150 mm)	11.437" (290.50 mm)	12.39" (314.7 mm)	42" (1050 mm)	47.437" (1204.90 mm)	48.39" (1229.1 mm)
8" (200 mm)	13.437" (341.30 mm)	14.39" (365.5 mm)	48" (1225 mm)	53.437" (1357.30 mm)	54.39" (1381.5 mm)
10" (250 mm)	15.437" (392.10 mm)	16.39" (416.3 mm)	52" (1325 mm)	57.437" (1458.90 mm)	58.39" (1483.1 mm)
12" (300 mm)	17.437" (442.90 mm)	18.39" (467.1 mm)	54" (1375 mm)	59.437" (1509.70 mm)	60.39" (1533.9 mm)
** 13" (330 mm)	N/A	19.39" (492.5 mm)	60" (1525 mm)	65.437" (1662.10 mm)	66.39" (1686.3 mm)
14" (350 mm)	19.437" (493.70 mm)	20.39" (517.9 mm)	65" (1625 mm)	N/A	71.39" (1813.3 mm)
16" (400 mm)	21.437" (544.50 mm)	22.39" (568.7 mm)	72" (1800 mm)	N/A	78.39" (1991.1 mm)
18" (450 mm)	23.437" (595.30 mm)	24.39" (619.5 mm)	78" (1950 mm)	N/A	84.39" (2143.5 mm)
20" (500 mm)	25.437" (646.10 mm)	26.39" (670.3 mm)	84" (2100 mm)	N/A + +	90.39" (2295.9 mm)
24" (600 mm)	29.437" (747.70 mm)	30.39" (771.9 mm)	90" (2250 mm)	N/A	96.39" (2448.3 mm)
26" (650 mm)	31.437" (798.50 mm)	32.39" (822.7 mm)	100" (2550 mm)	N/A	106.39" (2702.3 mm)
28" (700 mm)	33.437" (849.30 mm)	34.39" (873.5 mm)	110" (2800 mm)	N/A	116.39" (2956.3 mm)
30" (750 mm)	35.437" (900.10 mm)	36.39" (924.3 mm)	120" (3050 mm)	N/A	126.39" (3210.3 mm)
31.5" (800 mm)	37.155" (943.74 mm)	38.11" (968.0 mm)			
** 32" (813 mm)	34.813" (884.25 mm)	35.77" (908.6 mm)			
** 35" (889 mm)	40.437" (1027.10 mm)	41.39" (1051.3 mm)			

\*\* The 13", 32", and 35" encoders are configured for specific knee mill applications with ACU-RITE bracket kits. The 13" encoder has no end mounting holes and is used with a backup spar for cross travel (Y-axis) installations. The 32" and 35" encoders have a special center mounting bracket installed. They are intended for longitudinal table (X-axis) installations.

+ + Encoders over 60" do not have end mounting holes. They are furnished with backup spars.

# Mini-Scale and Mate System Encoders

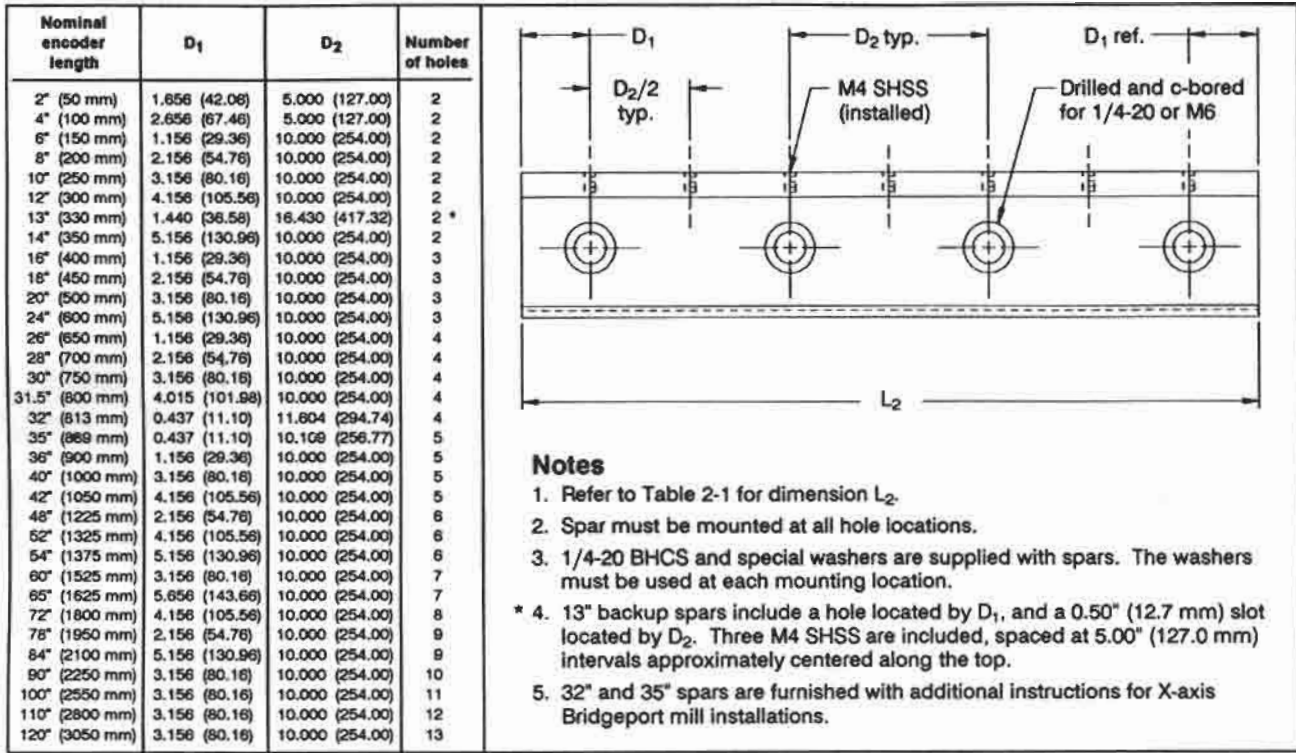


Figure 2-10. ACU-RITE backup spar mounting hole locations

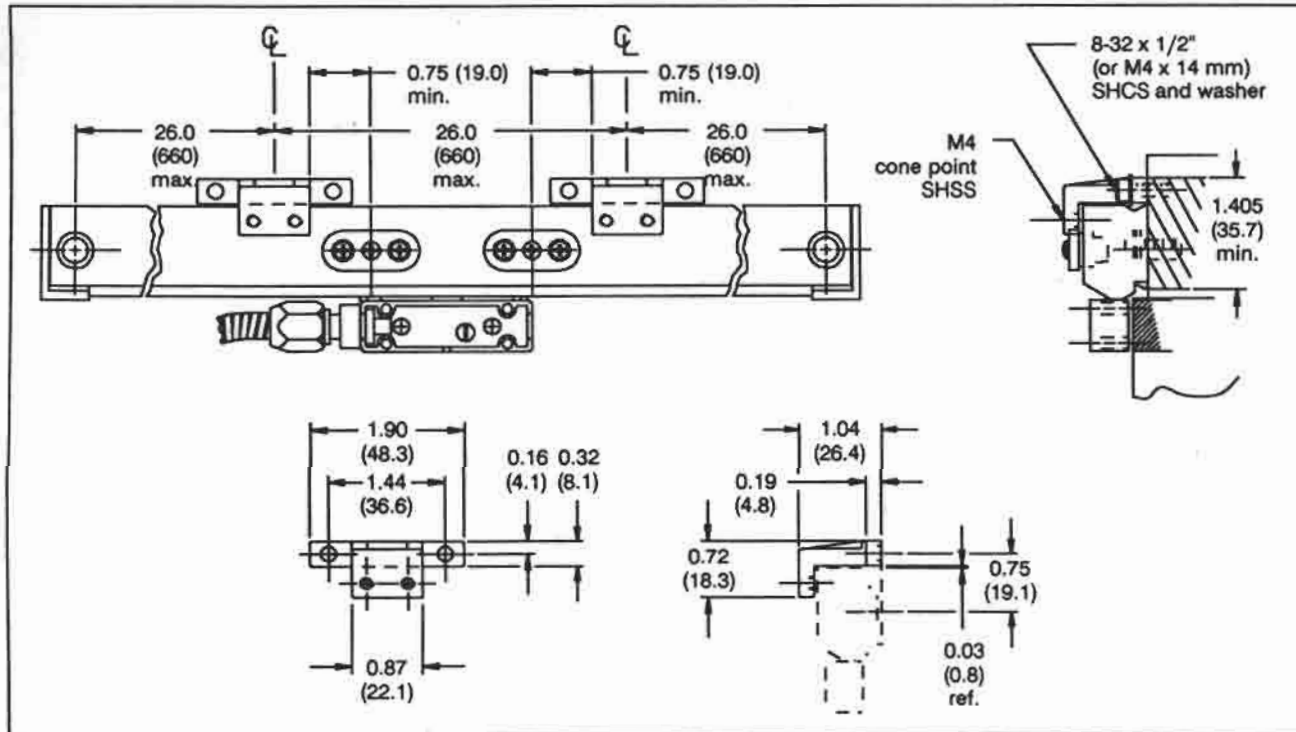


Figure 2-11. Mini-Scale and Mate System encoder mounting information for ACU-RITE center supports (24" to 60" encoders)

# Mini-Scale and Mate System Encoders



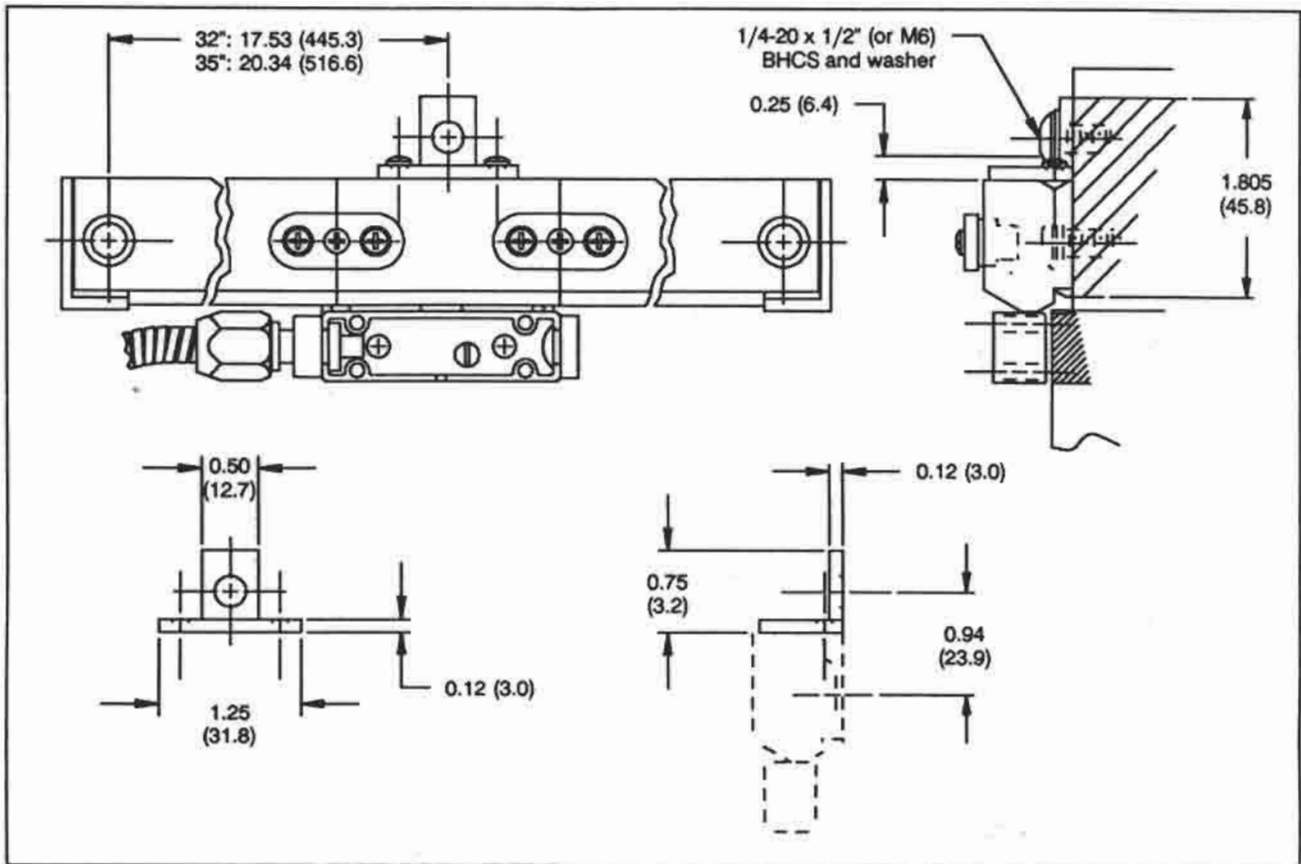


Figure 2-12. 32" and 35" Mini-Scale or Mate System encoder mounting information

Figure 2-13 illustrates several recommended mounting methods. The type of mounting that is chosen depends on the physical characteristics of the particular machine tool, such as if there are machined surfaces available in the proposed mounting areas.

Note that three of the installations involve fabricated mounting blocks. Appendix D illustrates examples of these three types of mounting blocks. Mounting blocks can be constructed from those drawings if required; dimensions can be altered to suit the installation.

If using an ACU-RITE bracket kit, refer to the instructions in the kit. The kit provides specific brackets and the related instructions required for installing the encoder(s). However, it is recommended that this manual be read through to familiarize the installer with general installation requirements.

Most Mini-Scale and Mate System encoders less than 24" are mounted directly to a machined surface using the encoder end mounting holes (Figures 2-8 and 2-9). 24" to 60" encoders can be mounted directly to a machined surface using the end mounting holes and center support brackets (see "Center support installation").

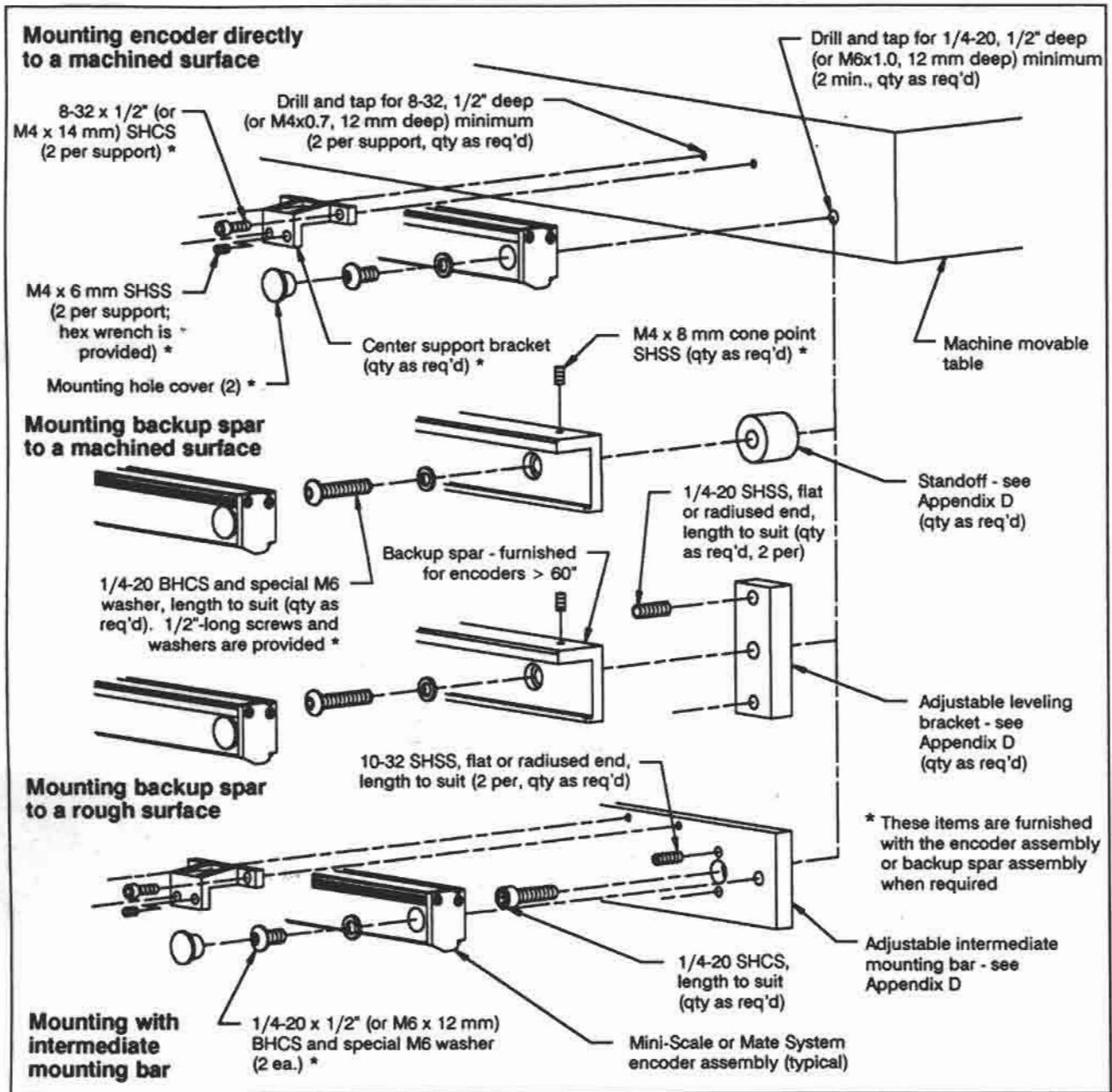
## Encoder mounting methods

### Mounting with a specific-application kit

### Direct mounting to a machined surface

# Mini-Scale and Mate System Encoders





**Figure 2-13. Recommended mountings for Mini-Scale and Mate System linear encoders**

Locate and machine one end mounting hole. Mount the encoder with a 1/4-20 BHCS and washer (provided with the encoder hardware). Align the encoder to the table travel within 0.015" (0.38 mm), and transfer punch the other end mounting hole. For 32" and 35" encoders, also transfer punch the center support mounting hole. Remove the encoder and machine the second mounting hole and, for 32" and 35" encoders, the center support hole. Mount the encoder to the machine at both ends. For 32" and 35" encoders, also mount the center support with a 1/4-20 x 1/2" BHCS and washer (provided separately with the encoder).

If ACU-RITE center supports are required, proceed with center support installation.

## Mini-Scale and Mate System Encoders

Fabricate standoffs or adjustable leveling blocks (Appendix D) for use at each end mounting hole. For 24" to 60" encoders, one or two additional mounting areas must be provided for center supports (see "Center support installation"). The mounting surfaces of all standoffs or mounting blocks **must be in the same plane** to prevent bending or twisting the encoder; unaligned mounting surfaces will reduce the accuracy of the installation.

Mount one end of the encoder to the machine with a standoff or leveling block. Use a 1/4-20 (or M6) BHCS and washer to mount the encoder (washers are provided with the encoder; the 1/4-20 x 1/2" and M6 x-12 mm BHCS provided may not be suitable). Align the encoder to the table travel within 0.015" (0.38 mm), and transfer punch the location of the other end mounting hole (for standoffs) or install the second leveling block then transfer punch the block's mounting locations. Mount the second end.

For 24" to 60" encoders, install the mounting blocks for the center supports. Proceed with center support installation.

An intermediate mounting bar may be used to install any 2" to 60" encoder (except for the 13" encoder; a spar is required). The bar provides a single aligned surface for end mounting points and for center supports. The bar can be fitted with leveling screws to easily align the mounting surface to the table travel.

Fabricate an intermediate mounting bar (Appendix D) with mounting holes for the encoder, and for center supports if required. Mount the bar to the machine at one of the bar's end mounting holes. Align the bar parallel to the table travel within 0.015" (0.38 mm) and transfer punch the remaining mounting holes.

Install the intermediate mounting bar. Install the encoder on the bar at the encoder end mounting holes with two 1/4-20 x 1/2" (or M6 x 12 mm) BHCS and washers (provided with the encoder). Proceed with center support installation if required.

For mounting 32" or 35" backup spars and encoders to Bridgeport mill X-axis tables, refer to the instructions furnished with the spars.

Locate and machine one spar end mounting hole. Mount the spar to the table with a 1/4-20 x 1/2" BHCS and washer (provided with the encoder or spar). Align the spar to the table travel within 0.015" (0.38 mm) and transfer punch the remaining spar mounting holes. Mount the spar to the table at all mounting locations. Proceed with aligning the spar.

## **Direct mounting to a non-machined surface**

## **Mounting with an intermediate mounting bar**

## **Mounting with a backup spar to a machined surface**

## Mounting with a backup spar to a non-machined surface

Fabricate standoffs or leveling blocks (Appendix D, one for each spar mounting location). Locate and machine a mounting hole for the standoff or leveling block at one of the spar's end mounting holes. Mount the spar with a 1/4-20 BHCS and washer. Align the spar to the table travel within 0.015" (0.38 mm) and transfer punch the location of all other standoff or leveling block mounting holes along the spar. Mount the spar to the table at all mounting locations. Proceed with aligning the spar.

## Other mounting requirements

### Center support installation

Center supports must be installed on all 24" to 60" encoders unless the installation includes a backup spar. 24" through 40" (except for the 32" and 35") encoders include one ACU-RITE center support kit. 32" and 35" encoders have a special center support installed on the encoder. 42" through 60" encoders include two ACU-RITE center support kits.

With a single ACU-RITE center support, install the support as close to the center of the encoder as possible; but the center of the support must be a minimum of 1.13" (28.7 mm) from the center of the nearest alignment bracket. With two center supports, install the supports so that distances between supports, and between supports and end mounting points, are approximately equal. **All mounting points must be less than 26" (660 mm) apart.**

For ACU-RITE center supports, refer to Figure 2-11. Mount the encoder using both end mounting holes. Place a 0.02 to 0.04" (0.5 to 1.0 mm) shim on top of the encoder and place the center support on top of the shim. Hold the center support against the support mounting surface and transfer punch the two support mounting holes. Remove the support and encoder. Drill and tap two holes for 8-32 x 3/8" (or M4x0.7 x 10 mm) deep minimum. Re-install the encoder.

### IMPORTANT

Holes for the center support may be machined with the encoder installed. However, machining chips that drop between the encoder and the support mounting surface will affect the accuracy of the installation.

For 32" and 35" encoder center supports, refer to Figure 2-12. Mount the encoder using both end mounting holes. Transfer punch the single center support mounting hole. Remove the encoder and drill and tap for 1/4-20 x 3/8" deep minimum. Re-install the encoder.

Loosely install ACU-RITE center supports with two 8-32 x 1/2" (or M4 x 14 mm) SHCS and washers. Install two M4 SHSS in the holes along the front of the support (fasteners and a hex wrench are provided with the support), but **do not tighten**. Loosely mount 32" and 35" encoder center supports with a 1/4-20 x 1/2" BHCS and washer (provided separately with these encoders). Proceed with encoder alignment.

## Mini-Scale and Mate System Encoders

A backup spar or encoder must be aligned to the table travel within 0.005"/foot (0.13mm/300mm) TIR and 0.010" (0.25 mm) TIR all along the front face (with the reading head alignment brackets). The top surface of the spar or encoder (opposite the lipseals) must be aligned to the table travel within 0.005" TIR as noted below. Refer to Figure 3-2 for illustrations of alignment procedures. Tighten all mounting screws during this alignment.

## Backup spar/encoder alignment

- a. **For encoders less than 24" nominal length:** the top surface of the encoder must be aligned to the table travel along 1" lengths directly over the encoder end mounting holes.
- b. **For 24" through 60" nominal length encoders or wherever center supports are used:** the top surface of the encoder must be aligned to the table travel along 1" lengths directly over the encoder end mounting holes and along 1" lengths to either side of all center supports.
- c. **For mountings that use a backup spar:** the top surface of the spar must be aligned to the table travel along 1" lengths directly over each mounting hole.

For 32" and 35" encoders, remove the center support bracket installed near the center of the encoder. Discard the support; it is not used when a backup spar is installed.

After aligning the spar, the encoder must be installed into the spar. Set the bottom, rear edge of the encoder into the lip of the spar, then rotate the encoder into place. Secure the encoder with the M4 SHSS along the top of the spar (a hex wrench is provided). First lightly tighten all set screws. Then tighten the center screw and tighten each screw in turn working out from the center in both directions. Tighten each set screw securely, but **do not over-tighten**.

Install an impact shield if required. A shield should be installed:

- on horizontally-mounted cross-slide applications.
- whenever the encoder lipseals are pointed towards the work area.
- where the encoder is installed in an area that is prone to impacts (dropped tools or workpiece).
- where the encoder is exposed to flood or spray coolants.

## Installing impact shields

If installing an ACU-RITE Impact Shield, refer to the instructions furnished with the shield. Otherwise, fabricate and install a shield that will provide the required protection. Make certain that the shield does not interfere with machine or encoder movements and that the reading head cable will not be pinched.

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# Mini-Scale and Mate System Encoders

## Installing extension cables

Install an extension cable by mating the receptacle end to the plug on the reading head cable. For Mini-Scales: align the keys, insert the plug, and give it a 1/4-turn to lock. For Mate System encoders: insert the plug and screw the retaining screws into the locking posts; install the sleeve over the center of the joint and close the sleeve. Dress the cable.

## Dressing of cables

Encoder signal cables must be routed to the readout. Carefully move the machine tables through their entire range of movements to assure that:

- cables will not be pinched or interfere with work areas.
- sufficient slack is provided so cables will not be strained.
- access to machine controls is maintained.
- excess cable does not lie on machine ways, lead screws, or the floor where it may be damaged.
- drip loops are provided near extension cable joints to prevent coolant collecting in the joint (Figure 2-14).

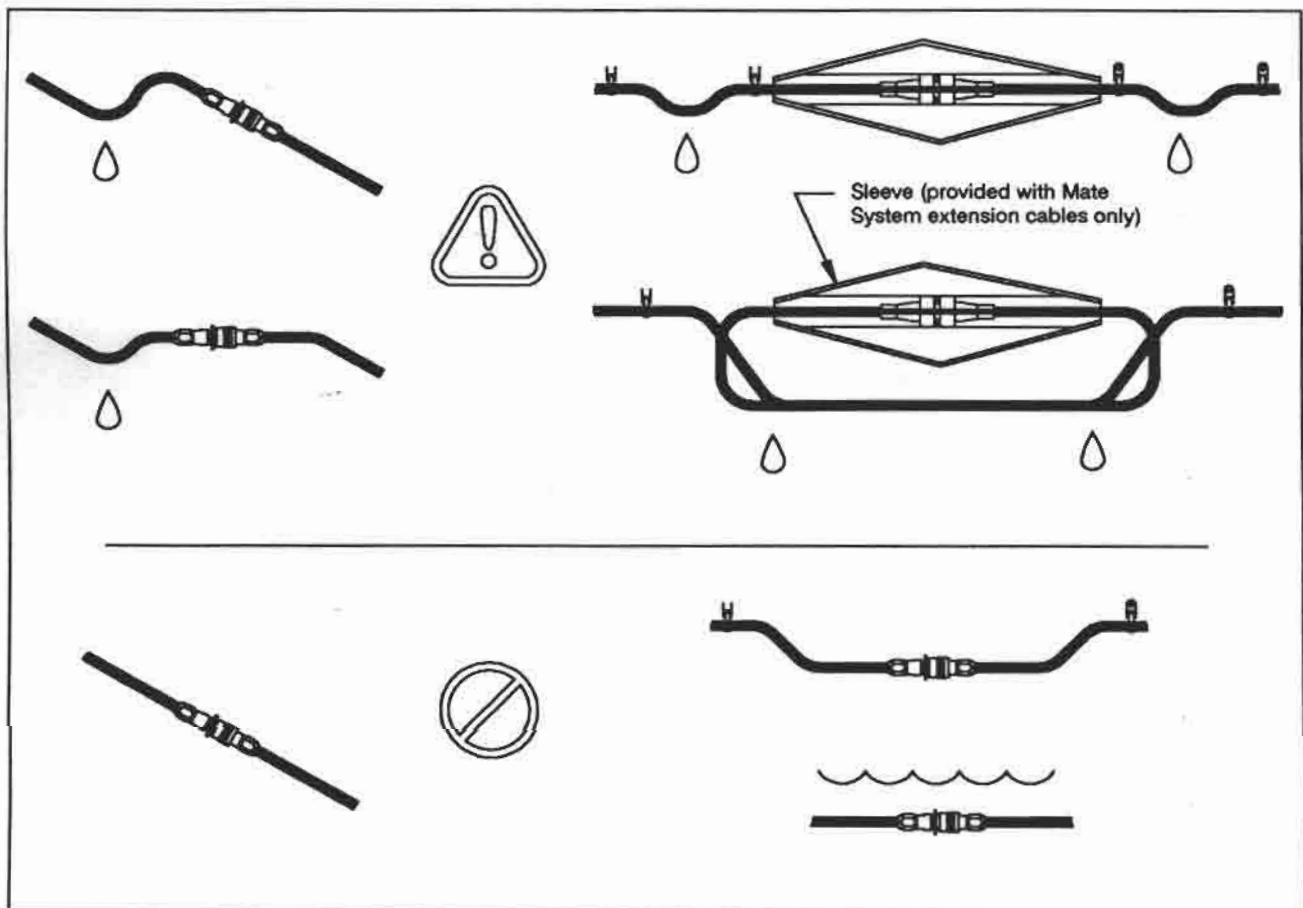


Figure 2-14. Extension cable drip loops

Cables can be run through wire ways installed on the machine to prevent excessive cable wear. Mount the cable neatly to the machine using the cable mounting hardware provided with the encoder and with extension cables.

# Mini-Scale and Mate System Encoders



# Section 3. Encoder installation

## Installation steps

- 1 Remove the linear encoder assembly from the box, and carefully remove the protective wrapping. Keep the wire ties on the cable whenever possible to ease handling. Set aside the hardware and (if applicable) the center support kit(s).

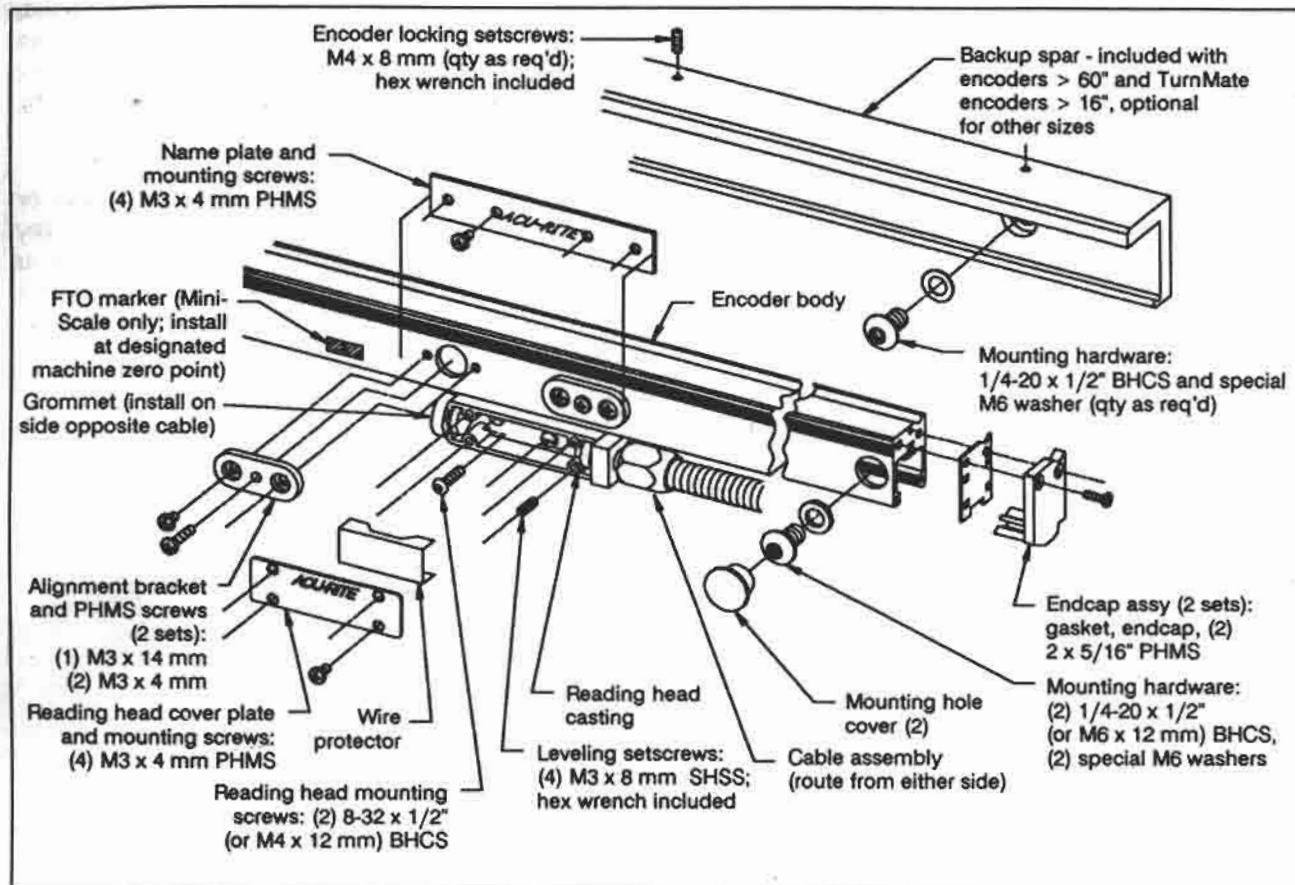


Figure 3-1. Mini-Scale and Mate System linear encoders, exploded view.

- 2 Move the machine table to the center of its travel. Mark this position for reference.
- 3 If using a separately-purchased backup spar, install the encoder into the spar. Lightly secure the encoder with the center M4 SHSS along the top of the spar (a hex wrench is provided with the spar). For longer spars/encoders, secure additional set screws along the spar.

Hold the spar/encoder assembly or encoder against the machine where it is to be mounted. Examine the mounting area and plan the installation as required:

- mounting to a machined or non-machined surface
- use of a spar or intermediate mounting bar
- use of standoffs or leveling blocks

## Mini-Scale and Mate System Encoders

- provisions for center support mountings
- provisions for reading head mounting

The encoder should be mounted so that the lipseals point down or away from the cutting area. Examine the area to assure that the mounting will not interfere with the operation of the machine controls, movements, or fixtures and tools. If mounting to the working table (as on a mill), make sure that the top of the encoder, mounting blocks, or required additional supports **do not project above the surface of the table**. Refer to Section 2 for information about specific mounting requirements, dimensions, and mounting illustrations.

- 4 Scribe a line along the top and one end of the spar or encoder. If mounting with a backup spar, use the hex key provided to loosen the M4 SHSS along the top of the spar (Figure 3-1). Remove the encoder assembly and set it aside. The backup spar will be mounted to the machine, then the encoder installed into the spar.
- 5 Fabricate any encoder and center support mounting blocks required. Mount the encoder or spar to the machine using one of the methods illustrated in Figure 2-13 and described in Section 2.
- 6 Install center supports if required. Refer to Section 2.
- 7 Align the spar/encoder assembly or encoder. Refer to Section 2.

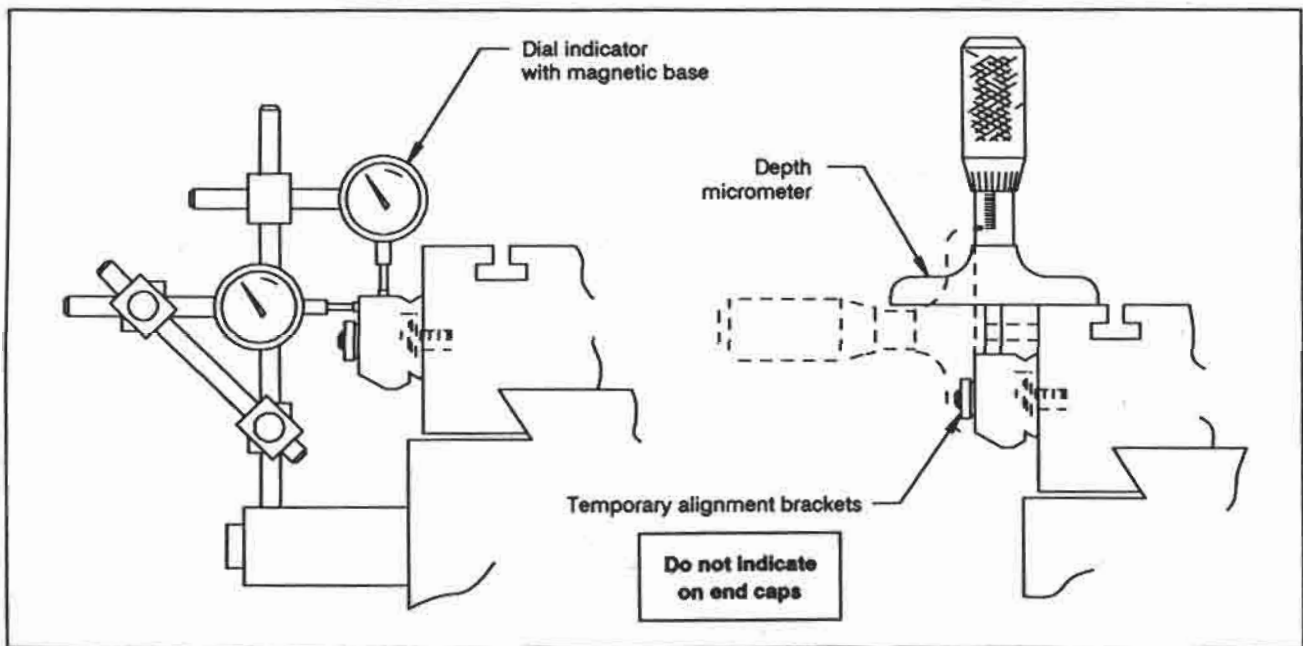


Figure 3-2. Methods of aligning encoder body

## Mini-Scale and Mate System Encoders



- 8 Remove the screws holding the reading head cable retainer to gain access to the reading head mounting holes and leveling screws. Set the wire protector (stiff paper insulator) and screws aside and discard the retainer. Carefully unseat the reading head cable strain relief and gently move the cable out of the way. **Do not pull on the cable or allow excessive strain on the wires; the reading head or wires can be damaged.**
  
- 9 Fabricate and install any mounting blocks required to mount the reading head to the machine base. Provide two 8-32 or M4x0.7 threaded holes for attaching the reading head casting. Be certain that mounting arrangements provide a 0.03 to 0.18" (0.8 to 4.6 mm) gap between the reading head casting and its mounting surface for leveling screw adjustment (Figure 2-9). If necessary, return the table to the center of its travel. **Do not move the table again until the following two steps have been completed; damage to the encoder assembly may result.**

#### CAUTION

Make certain that all wires are clear of screw heads when installing the reading head mounting screws inside the casting. Make certain that all wires are captured under the wire protector and are not pinched when installing the reading head cover plate. Wires on Mini-Scale encoders can be repaired in the field but only with difficulty due to the small wires and limited room available. **Broken or bare wires on Mate System encoders cannot be repaired in the field; they can only be repaired at the factory.**

- 10 Attach the reading head casting to the prepared mounting surface by installing two fasteners (both 8-32 x 1/2" and M4x0.7 x 12 mm BHCS are provided with the encoder hardware) through the reading head mounting holes **but do not tighten**. Keep all wires clear of the screw heads so they will not be damaged.
  
- 11 Four leveling set screws are provided in the reading head casting. Place a 0.002 to 0.005" (0.05 to 0.13 mm) feeler gage or paper strip between the set screw and the reading head mounting surface. Use the hex wrench (provided with the encoder hardware) to adjust each set screw so that a slight drag is felt on the feeler gage or paper strip. **Do not over-tighten the leveling screws** or the reading head casting will be forced out of its alignment position. Fully tighten the two 8-32 (or M4) BHCS.
  
- 12 Remove the two alignment brackets from the front of the encoder. Remove the protective film from the encoder name plate (provided with the encoder hardware) and install it over the alignment bracket holes.

## Mini-Scale and Mate System Encoders

- a **All encoders except 32" and 35":** use the shorter screws removed from the alignment brackets to install the name plate.
- b **32" and 35" encoders for Bridgeport longitudinal table installations:** a name plate, gasket, and M3 x 4 mm FHMS are provided with the encoder hardware. Install the gasket on the name plate and install the assembly over the alignment bracket holes with four FHMS.

#### IMPORTANT

Use of the gasket is recommended but installing the gasket will restrict the cross travel (Y-axis) movement of Bridgeport mill tables. Hard stops must be installed on the cross travel axis to prevent the name plate from striking the machine base.

- 13 Install the round plastic mounting hole covers at each end of the encoder (provided with the encoder hardware; not provided or required with 13" encoders or encoders 65" and longer). Save the alignment brackets and remaining screws; they must be re-installed if removal of the encoder is required.
- 14 Determine which cable exit from the reading head provides the best cable route to the readout and insert the cable strain relief into the mounting groove in the casting. Install the rubber grommet in the opposite groove and install the wire protector; remove the protective film from the reading head cover plate and install the cover plate with four M3 x 4 mm PHMS (two PHMS were removed from the cable retainer; the grommet, plate, and additional PHMS are provided with the encoder hardware). Ensure that all wires are tucked inside the casting and will not be pinched by the cover plate.
- 15 If required, install an impact shield. Install an ACU-RITE shield or fabricate and install a shield to provide the protection required.
- 16 Route the signal cable from the encoder to the readout. Use the cable mounting hardware (provided with the encoder) to secure the cable to the machine.
- 17 Unlock the machine table and move it in both directions through its full travel. Ensure that there is no interference between the encoder, its mountings, impact shields, and the machine components. For 32" and 35" encoders using the name plate gasket on Bridgeport X-axis mill installations, fabricate and install hard stops to limit cross travel movements. Ensure that the table travel does not exceed the maximum encoder travel allowed.

## Mini-Scale and Mate System Encoders

After installing all encoders, perform a system test as indicated in the readout manual. Readouts used with Mini-Scale installations must be set to match the resolution of the encoders installed. Refer to the resolution label on the front of each encoder or to the part number marked on the encoder shipping container and Table 1-1.

## Installation checkout

For Mini-Scales, encoder FTO signals should also be checked. Refer to the readout manual for instructions. After confirming that the FTO circuits are working, decide which FTO mark will be used for table referencing.

Move the table so that the reading head is close to the desired FTO trigger point and set the readout to sense the FTO signal. Slowly move the table until the FTO signal is sensed. Affix the FTO marker label to the front of the encoder body at this location, in line with an edge of the reading head casting.

If the encoder is not visible during normal operations, the FTO marker may be placed along a visible portion of the machine slide and a mark etched in the opposing member to designate the desired FTO position.

Check the mechanical integrity of the installation by performing a repeatability test. This test can indicate installation problems such as loose or non-rigid mounting brackets. Move the table to the end of its travel. Install a dial indicator with the tip touching an endcap of the encoder (Figure 3-3). Zero the indicator and zero reset the readout. Move the table to the other end of its travel, then return so that the dial indicator again reads zero. The readout should also read zero, within  $\pm$  one resolution count.

## Repeatability test

This test should be performed periodically to assure that the installation remains secure.

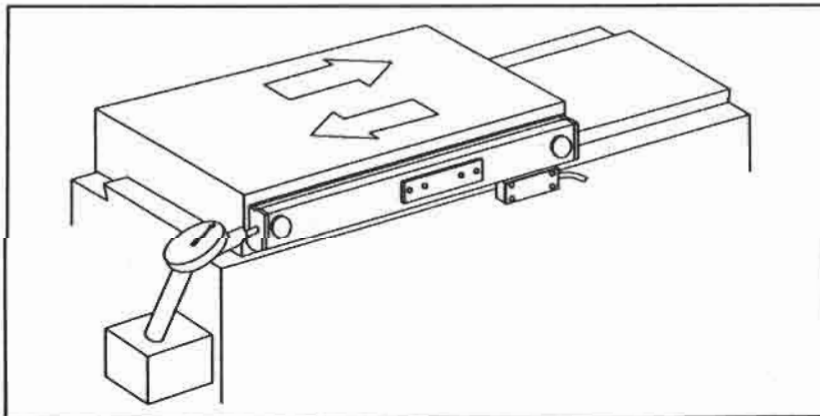


Figure 3-3. Repeatability test

The most common problems found with measuring systems are a loss of counting signals and intermittent operation. Loss of counting signals on one axis may be either an encoder problem or a readout problem; loss of counting on more than one axis is usually a readout problem.

## Troubleshooting

# Mini-Scale and Mate System Encoders

Assure that the encoder connectors are firmly seated. If the problem still persists and the installation involves more than one encoder, switch the encoder input cables to see if the problem is still shown in the same display. If the problem remains in the same display, the readout is at fault; if the problem follows the new encoder connection the encoder is at fault.

Intermittent problems can be difficult to troubleshoot. As a check, use the previous suggestion of connecting the encoder into another axis to see if the intermittent problem moves to the new axis display.

Many intermittent problems are found to be caused by changes in the installation: the mounting brackets have become loose, or the encoder body or reading head is no longer in alignment. Re-install the alignment brackets and dismount the reading head. Check that all mounting brackets are securely fastened. Re-check the encoder alignment as described in installation step 7. Remount and align the reading head as described in steps 10 and 11.

Another source of intermittent problems is a contaminated glass scale. The scale may have an accumulation of dirt or cutting fluids and must be cleaned. The glass scale may be cleaned while the encoder assembly is mounted to the machine or it may be removed from the machine and cleaned on a work bench. **If removing the encoder, re-install the reading head alignment brackets. The encoder assembly must be re-aligned after cleaning.**

Carefully separate the rubber lipseals and gently wipe the glass scale with a cotton swab saturated in rubbing (isopropyl) alcohol or acetone. Wipe the glass along the whole length of the encoder assembly, on both sides. **Make sure that the swab remains wetted at all times; wiping with dry swabs may damage the surface of the glass scale.** If removed from the machine, re-install and align the encoder per installation steps 7 (not required if a backup spar was used), and 10 and 11.

Intermittent problems can also be caused by an electrically "noisy" environment, such as operating near relays, coils, transmitters, etc. Radio frequency interference (RFI) can sometimes be intercepted by the readout, causing blanking, false counts, etc. Once the equipment causing the problem is isolated, use standard electrical isolation or RFI shielding techniques to eliminate the interference.

If the encoder or readout is found to be at fault, contact your ACURITE Distributor or OEM/OEI for repair instructions, or call the ACURITE Sales and Service Center at (800) 344-2311. Replacement reading heads are available for encoder assemblies, and replacement modules are available for the readouts to get your system up and running again promptly.

**Do not attempt repair to the encoder assembly or readout other than as instructed. The units are not serviceable other than by assembly replacement. Attempted repair can permanently damage the unit and void the warranty.**

## Mini-Scale and Mate System Encoders

# Section 4. Appendices

## Appendix A ACU-RITE encoder specifications

**Table 4-1. Encoder mechanical specifications**

Mechanical Specifications	Mini-Scale				Mate System
Resolution	1um	2um	5um	10um	5um
Grating pitch	8um	18um	40um	40um	20um
Scale medium	Light transmission through chrome-coated glass				
Accuracy (@ 20° C) um, +/-, in any 50mm um, +/-, in any 250mm um, +/-, in any 1000mm	1.5 2.5 5	** 2 4 5	6 8 10	6 8 10	6 6 10
Max. slew speed (inches/sec) @ 10°C to 30°C @ 0°C to 40°C	10 6.6	20 13.3	40 26.6	40 21	31.5 21
Force required to move reading head (lbs)	≤ 1				
Operating Environment Temperature Relative Humidity	0° to 50°C 25% to 95% (non-condensing)				0° to 40°C 25% to 95% (non-condensing)
Storage Environment Temperature Humidity	-40° to 65°C 20% to 95% (non-condensing)				-40° to 65°C 20% to 95% (non-condensing)
Weight (lbs)	1.8 + 0.4/ft of measuring length				
Connecting cable	Length = 10.0 ft, armored or vinyl Connector: Bendix PTO 6A-10-6P (or Cannon, Burydy equivalent)				TM: length = 15 ft MM: length = 10 ft Armored cable Connector: DE-9P
Max. cable length (ft)	36				26
Measuring lengths	2-40"	2-120"			2-120"
Repeatability	Within one resolution count				

\*\* Accuracy for 2um encoders 2" through 60" is as listed. For lengths greater than 60", accuracy is the same as 5um encoders.

**Table 4-2. Encoder electrical specifications**

Electrical Specifications	Mini-Scale	Mate System
Light source	LED (light-emitting diode)	
Operating voltage	5.1 +/- 0.1VDC	5.0 +/- 0.1VDC
Operating current (maximum)	140mA	32mA
Output signals Incremental	Two square-wave voltage signals, channels A and B, in 90° quadrature relationship	Similar phasing, but differential sinusoidal current output
FTO	One square-wave signal	N/A
Signal levels	TTL-level (with 450 Ohm +/- 10% load)	7-18.5uA p-p (w/ 1K Ohm load)

## Mini-Scale and Mate System Encoders

# Appendix B

## Mini-Scale pin-outs and electrical characteristics

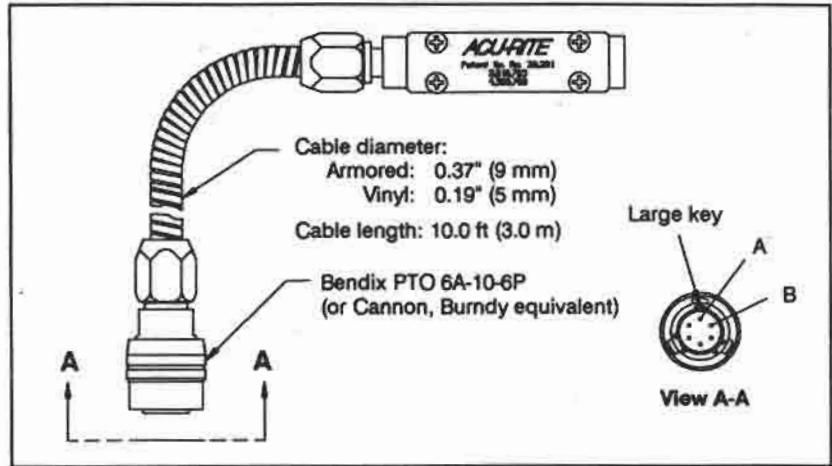


Figure 4-1. Mini-Scale encoder cable and connector

Table 4-3. Mini-Scale encoder connector pin-outs

Pin	Signal	Wire color
A	Channel A square wave counting signal	White
B	Channel B square wave counting signal in quadrature (90° nominal phase relationship) with channel A signal	Green
C	Vcc, +5.1 +/- 0.1 VDC @ 140mA max	Red
D	Common (power supply and signal return)	Black
E	Shield, reading head casting ground	Drain
F	Fiducial Trigger Output (FTO) signal	Blue

### Mini-Scale encoder electrical characteristics

- TTL-compatible open collector transistor output with internal pull-up resistor
- Logic "1" level: pull-up to Vcc (5.1 VDC +/- 0.1 VDC through a 450 ohm +/-10% resistor)
- Logic "0" level: 0.5VDC maximum @ -7mA maximum (current sinking limit)

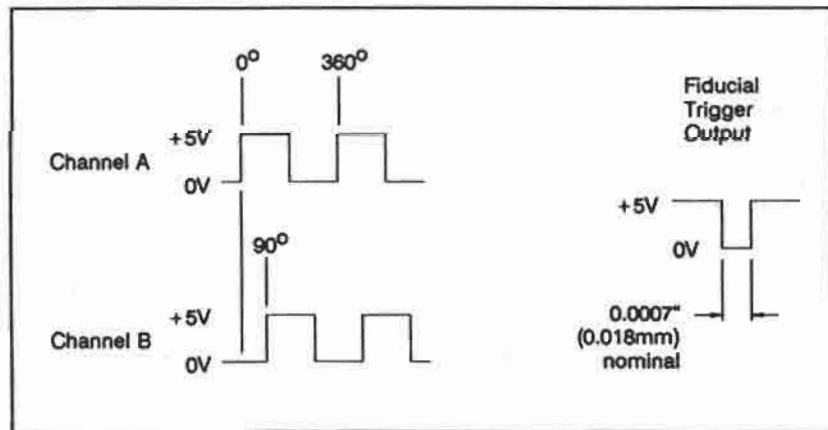


Figure 4-2. Mini-Scale encoder signal waveforms

# Mini-Scale and Mate System Encoders

## Appendix C

### Mate System pin-outs and electrical characteristics

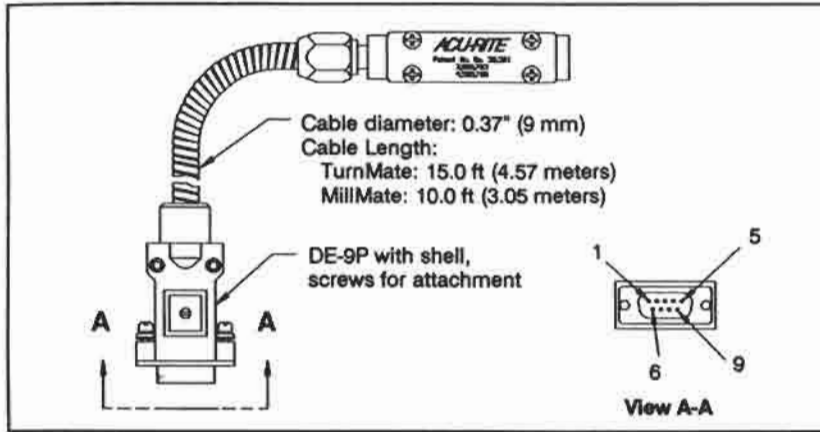


Figure 4-3. Mate System encoder cable and connector

Table 4-4. Mate System encoder connector pin-outs

Pin	Signal	Wire color
1	Ground	White
2	Channel A+	Green
3	Channel A-	Yellow
4	Channel B+	Blue
5	Channel B-	Red
6	N/C	
7	Vcc, +5.0 +/- 0.1 VDC @ 32mA max	Brown
8	N/C	
9	N/C	

#### Mate System encoder electrical characteristics

- Two-channel differential current output
- Signal level,  $I_A$  and  $I_B$  : 7 to 18.5uA p-p

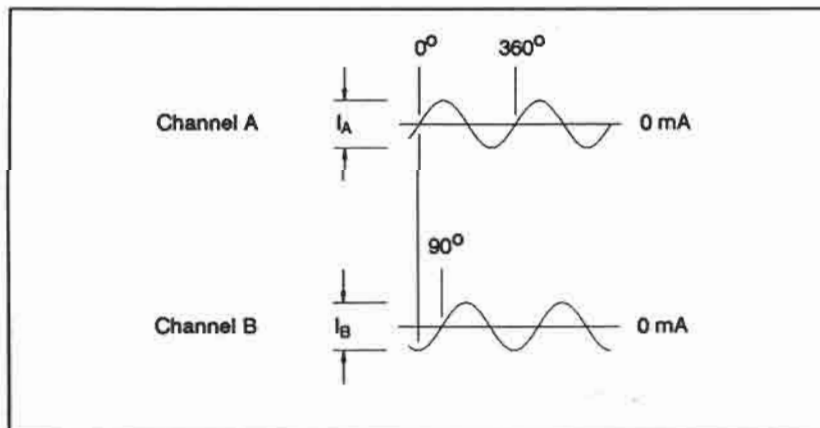


Figure 4-4. Mate System encoder signal waveforms



# Appendix D

## Common mounting brackets

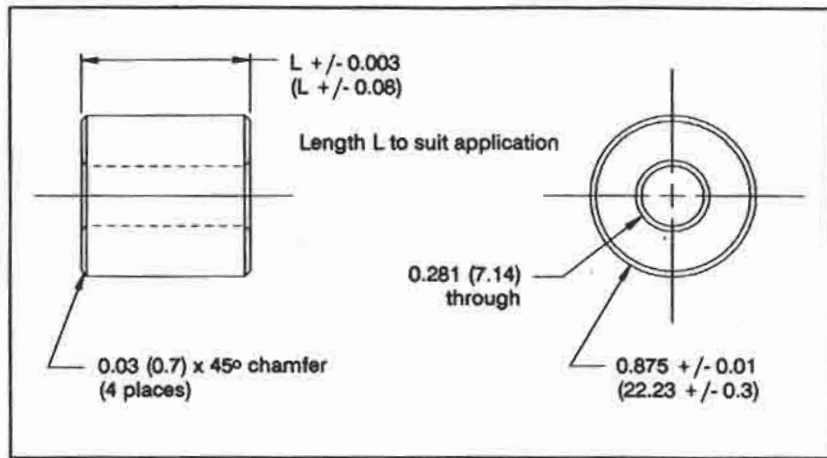


Figure 4-5. Standoff

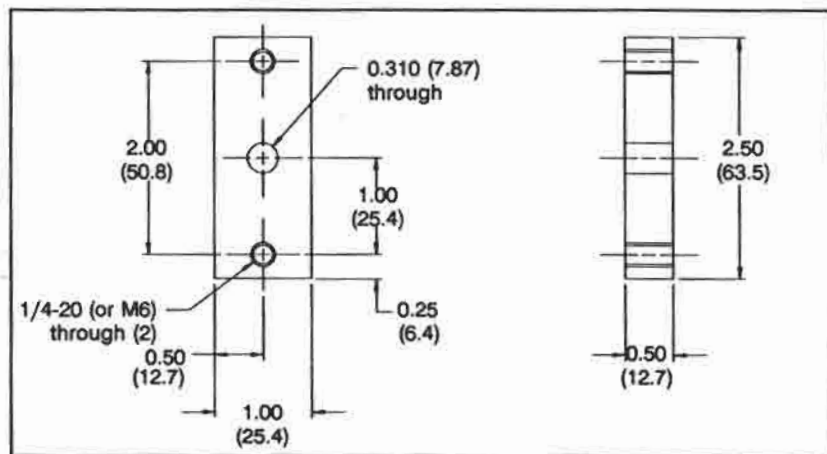
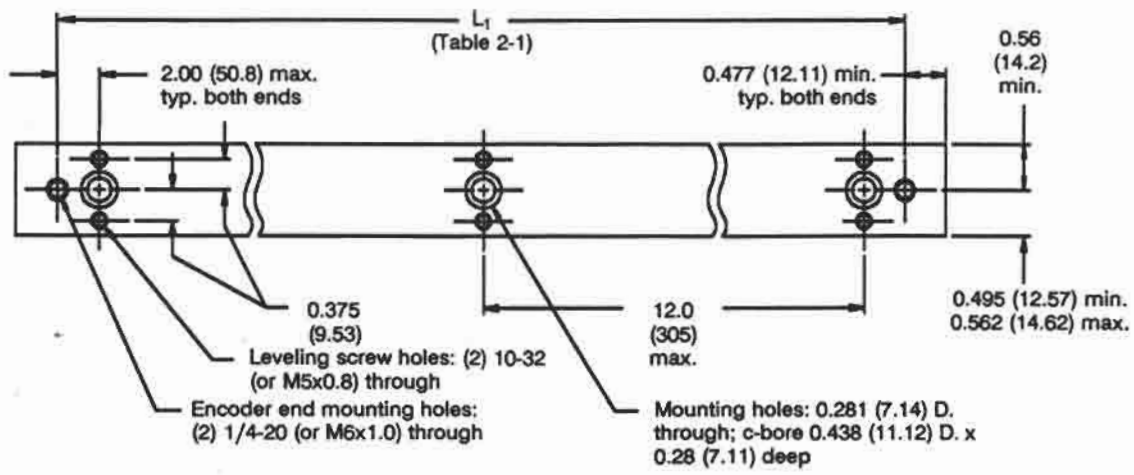
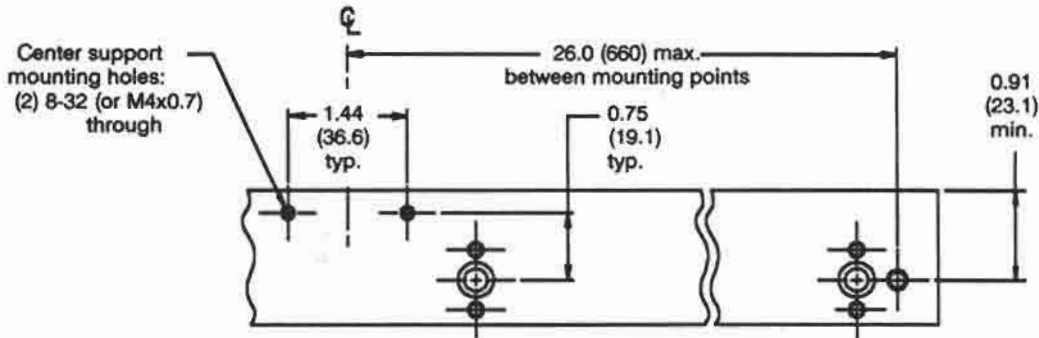


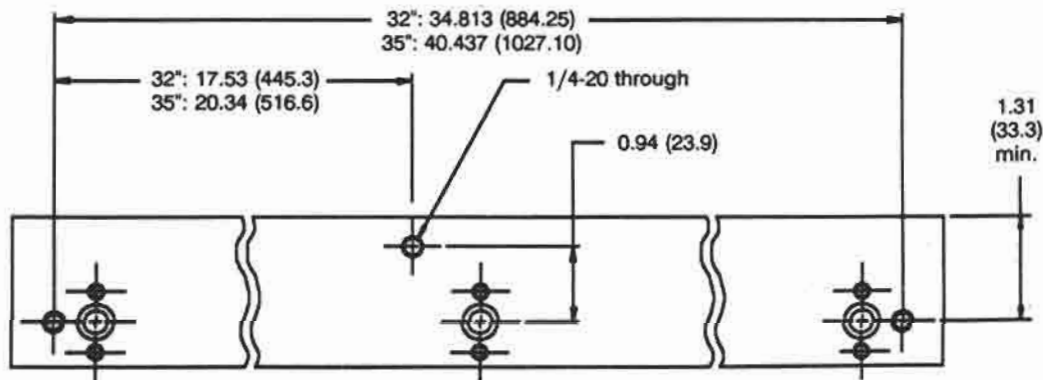
Figure 4-6. Adjustable backup spar leveling bracket



**Detail A. Mounting bar for 2-24" encoders (without center supports)**



**Detail B. Mounting bar for 24"-60" encoders (with ACU-RITE center supports)**



**Detail C. Mounting bar for 32", 35" encoders**

**Notes:**

1. Material: low carbon steel, 0.38" (9.7 mm) thick minimum.
2. Machining tolerance: +/- 0.015" (0.38 mm).
3. Check bar for flatness prior to machining. Bar must be installed flat to within 0.005"/ft (0.13 mm) TIR, and within 0.010" (0.25 mm) overall.

**Figure 4-7. Adjustable intermediate mounting bar**

# Mini-Scale and Mate System Encoders

## Appendix E

### The ACU-RITE warranty

ACU-RITE products and accessories are warranted against defects in material and workmanship for a period of three years from the date of purchase. ACU-RITE will, at its option and expense, repair or replace any part of the ACU-RITE product which fails to meet this warranty. This warranty covers both materials and factory service labor. In addition, ACU-RITE Distributors and OEM/OEI service representatives will provide service labor (field service) for a one-year period at no charge. Notice of the claimed defect must be received by ACU-RITE within the warranty period.

This warranty applies only to products and accessories installed and operated in accordance with this reference manual. ACU-RITE shall have no obligation, with respect to any defect or other condition caused in whole or part by the customer's incorrect use, improper maintenance, modification of the equipment, or by the repair or maintenance of the product by any person except those deemed by ACU-RITE to be qualified.

Responsibility for loss of operation or diminished performance due to environmental conditions such as humidity, dust, corrosive chemicals, deposition of oil or other foreign matter, spillage, or other conditions beyond ACU-RITE's control cannot be accepted by ACU-RITE.

There are no other warranties expressed or implied, and ACU-RITE INCORPORATED shall not be liable under any circumstances for consequential damages.

### 30-day Red Carpet warranty service

#### IMPORTANT

#### Keep the box and packing materials

All ACU-RITE products are covered by a 30-day Red Carpet Warranty Service. If in the first 30 days this product fails for any reason, repack it in the original packing materials and contact your ACU-RITE Distributor, OEM/OEI, or the ACU-RITE Sales and Service Center at (800) 344-2311 for return instructions.

For future ordering information or warranty service, record the encoder catalog and serial numbers:

Axis #1: \_\_\_\_\_

Axis #2: \_\_\_\_\_

Axis #3: \_\_\_\_\_

Axis #4: \_\_\_\_\_

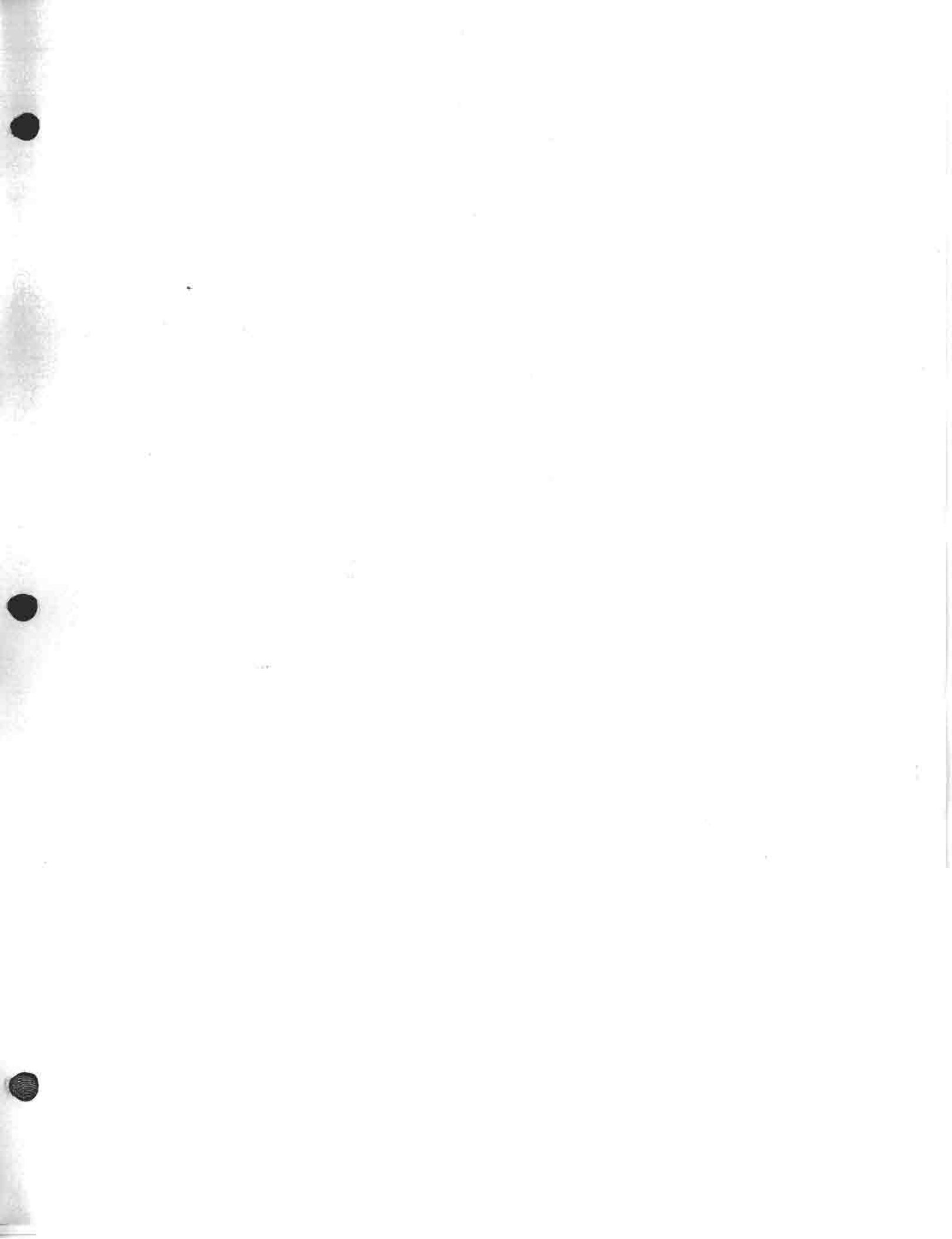
Date of purchase: \_\_\_\_\_

Distributor: \_\_\_\_\_

Address: \_\_\_\_\_

Telephone: \_\_\_\_\_

## Mini-Scale and Mate System Encoders





**ACU-RITE Readout Systems  
are manufactured in the USA**

**SALES & SERVICE:**  
**A Tech Authority, Inc.**  
13745 Stockton Ave.  
Chino CA 91710  
909-614-4522  
[sales@atechauthority.com](mailto:sales@atechauthority.com)

**ACU-RITE®**

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MASON INDUSTRIAL PARK  
JAMESTOWN, NEW YORK 14701  
(800) 344-2311

