

**SERIES:** AMT21 | **DESCRIPTION:** MODULAR ABSOLUTE ENCODER

**FEATURES**

- high speed protocol for fast low latency position data
- patented capacitive ASIC technology
- low power consumption
- 12 or 14-bit absolute position with multi-turn capability
- 3.3 V half-duplex RS485
- settable zero position
- configuration and programming via AMT Viewpoint™ software
- compact modular package with locking hub for ease of installation
- radial and axial cable connections
- -40 ~ 105°C operating temperature


**ELECTRICAL**

| parameter           | conditions/description | min | typ | max | units |
|---------------------|------------------------|-----|-----|-----|-------|
| power supply        | VDD                    | 3.8 | 5   | 5.5 | V     |
| start-up time       |                        |     | 200 |     | ms    |
| current consumption | with unloaded output   |     | 8   |     | mA    |

**ABSOLUTE POSITION CHARACTERISTICS**

| parameter                     | conditions/description                        | min | typ | max | units   |
|-------------------------------|---|-----|-----|-----|---------|
| resolution                    | 12 or 14-bit                                  |     |     |     |         |
| accuracy                      |   |     | 0.2 |     | degrees |
| absolute zero position        | settable via AMT Viewpoint™ GUI or RS485      |     |     |     |         |
| multi-turn                    | multi-turn and single-turn versions available |     |     |     |         |
| turns counter <sup>1</sup>    | signed binary number                          |     | 14  |     | bits    |
| absolute position update rate | 12-bit  |     | 25  |     | µs      |
|                               | 14-bit  |     | 100 |     | µs      |

Notes: 1. Multi-turn encoders only.

**MECHANICAL**

| parameter                           | conditions/description     | min | typ  | max   | units |
|-------------------------------------|----------------------------|-----|------|-------|-------|
| motor shaft length                  |                            | 9   |      |       | mm    |
| weight                              |                            |     | 15.7 |       | g     |
| axial play                          |                            |     |      | ±0.3  | mm    |
| rotational speed at each resolution | 12-bit position resolution |     |      | 8,000 | RPM   |
|                                     | 14-bit position resolution |     |      | 4,000 | RPM   |

**ENVIRONMENTAL**

| parameter             | conditions/description                         | min | typ | max | units |
|-----------------------|--|-----|-----|-----|-------|
| operating temperature |  | -40 |     | 105 | °C    |
| humidity              | non-condensing                                 |     |     | 85  | %     |
| vibration             | 10~500 Hz, 5 minute sweep, 2 hours on each XYZ |     |     | 5   | G     |
| shock                 | 3 pulses, 6 ms, 3 on each XYZ                  |     |     | 200 | G     |
| RoHS                  | 2011/65/EU                                     |     |     |     |       |
| REACH                 | EC 1907/2006                                   |     |     |     |       |

## RS485 INTERFACE

| parameter                                    | conditions/description                           | min | typ | max | units |
|--|--|-----|-----|-----|-------|
| protocol                                     | RS485 balanced digital multi-port interface      |     |     |     |       |
| data rate                                    | 8 data bits, no parity, 1 stop bit, asynchronous |     | 2   |     | Mbps  |
| transceiver                                  | Texas Instruments SN65HVD75                      |     |     |     |       |
| latency                                      | time before encoder responds with position       | 18  |     | 29  | μs    |
| driver differential output voltage magnitude | load resistance = 54 Ω                           | 1.5 | 2   | 3.3 | V     |

### AMT21 RS485 Interface

The AMT21 utilizes a half-duplex RS485 interface where the host sends a command over the differential bus at the proper baud rate (default 2 Mbps), then the encoder takes control and responds. The host sends a single character using 8 bits, 1 stop bit, and no parity. The encoder responds with 14-bit position, and 2 check bits. It sends this as two bytes also using 8 bits, 1 stop bit, and no parity. The low byte comes first. 12-bit encoders use the same format but the lowest two bits are zero.

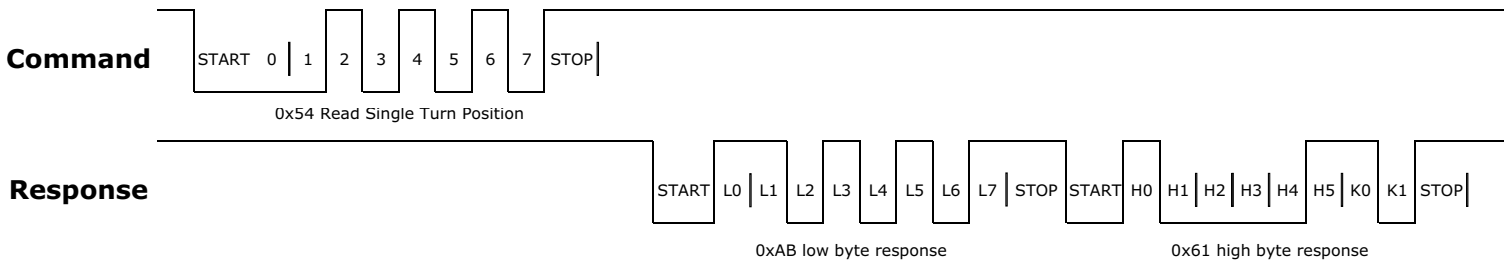
### Commands:

#### Read Single-Turn Position

Command char: T

Hex value: 0x54

**Figure 1**  
Read Single-Turn Configuration



Values K1 and K0 in the response are checkbits. The checkbits are odd parity over the odd and even bits in the position response shown in the equation below. The checkbits are not part of the position, but are used to verify its validity. The lower 14 bits are the encoder position.

Full response: 0x61AB

14-bit position: 0x21AB (8619 decimal)

#### Checkbit Formula

Odd:  $K1 = !(H5 \wedge H3 \wedge H1 \wedge L7 \wedge L5 \wedge L3 \wedge L1)$

Even:  $K0 = !(H4 \wedge H2 \wedge H0 \wedge L6 \wedge L4 \wedge L2 \wedge L0)$

From the above response 0x61AB:

Odd:  $0 = !(1 \wedge 0 \wedge 0 \wedge 1 \wedge 1 \wedge 1 \wedge 1) = \text{correct}$

Even:  $1 = !(0 \wedge 0 \wedge 1 \wedge 0 \wedge 0 \wedge 0 \wedge 1) = \text{correct}$

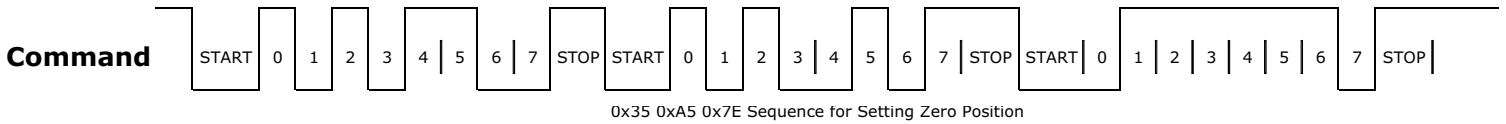
For 12-bit applications L0 and L1 are always 0. Because the low two bits are 0, 12-bit data will need right-shifted two bits. The checkbit calculation remains the same and unaffected.

## RS485 INTERFACE (CONTINUED)

### Set Zero Position (Single-Turn Encoders Only)

Hex command sequence: 0x35 0xA5 0x7E

**Figure 2**  
Set Zero Position



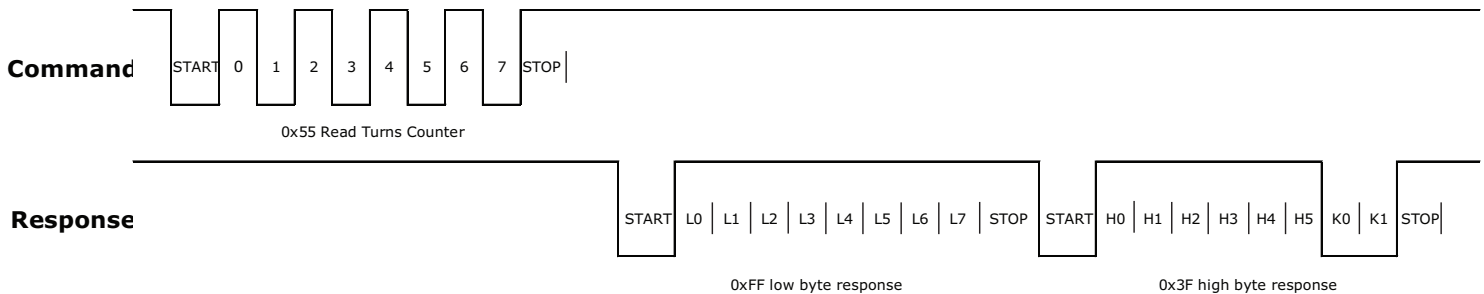
The encoder will not give a response but will store the zero position, and then restart. This operation takes approximately 200 ms.

### Read Turns Counter (Multi-Turn Encoders Only)

Command char: U

Hex command sequence: 0x55

**Figure 3**  
Read Turns Counter



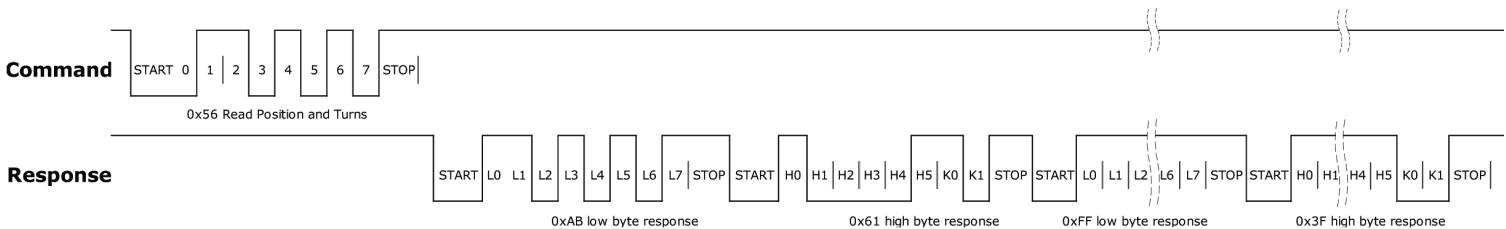
The turns counter is stored as a 14-bit signed number. The encoder responds with two bytes using the same checkbit formula as is used for position. After removing the check bits K0 and K1 the resulting value is still 0x3FFF. Since this is a signed number the resulting turns counter value is -1. The turns counter is always zero at startup, a battery backup may be required to prevent loss of turns count.

### Read Position and Turns (Multi-Turn Encoders Only)

Command char: V

Hex command sequence: 0x56

**Figure 4**  
Read Position and Turns



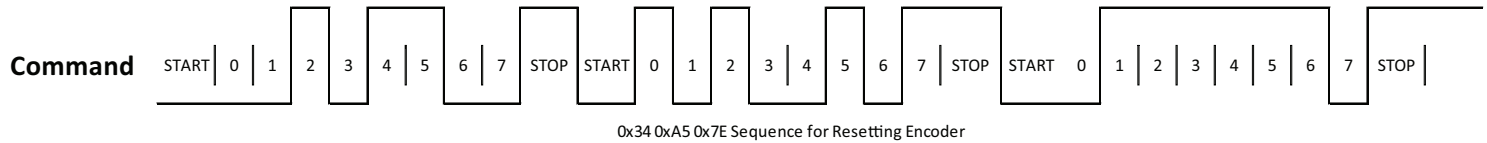
The encoder responds with the position response in the same format as is received by the 0x54 position command, immediately followed by the turns counter in the same format as the 0x56 turns command.

## RS485 INTERFACE (CONTINUED)

### Reset Encoder

Hex command sequence: 0x34 0xA5 0x7E

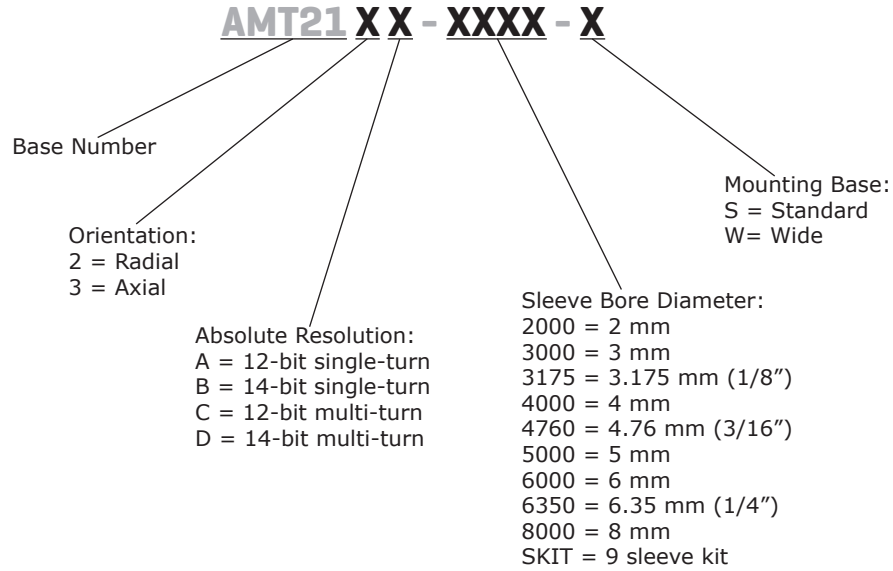
**Figure 5**  
Reset Encoder



This command resets the device. Note that for multi-turn encoders this command will result in a zero'ing of the turns counter as the encoder always starts with the turns counter at zero.

## PART NUMBER KEY

For customers that prefer a specific AMT21 configuration, please reference the custom configuration key below.



## AMT21-V KITS

In order to provide maximum flexibility for our customers, the AMT21 series is provided in kit form standard. This allows the user to implement the encoder into a range of applications using one sku#, reducing engineering and inventory costs.

### ORDERING GUIDE

#### AMT21XX-V

**Orientation:**  
2 = Radial  
3 = Axial

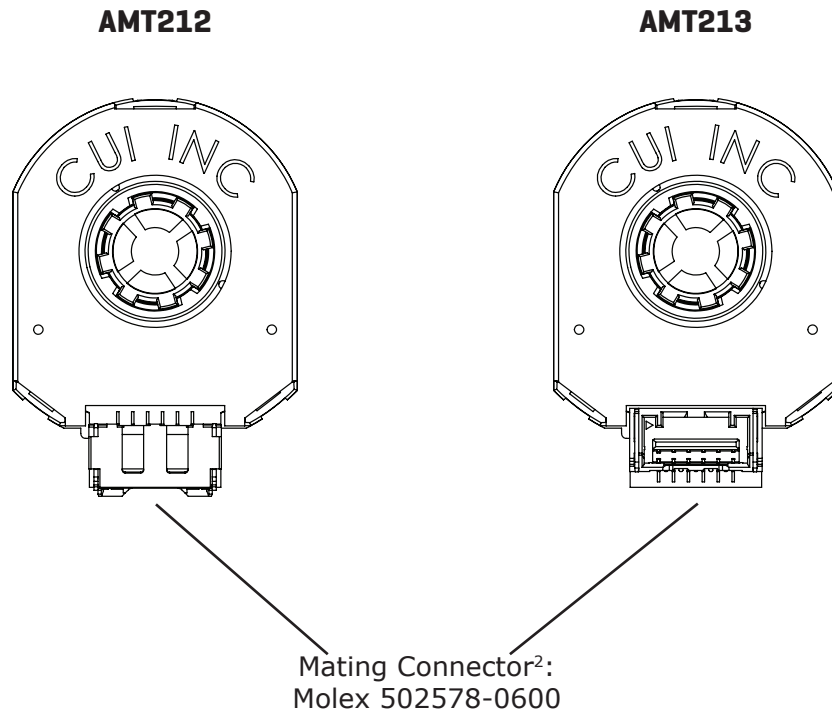
**Absolute Resolution:**  
A = 12-bit single-turn  
B = 14-bit single-turn  
C = 12-bit multi-turn  
D = 14-bit multi-turn

| SLEEVES        |        |                    |      |                    |       |     |                   |      |
|----------------|--------|--------------------|------|--------------------|-------|-----|-------------------|------|
|                |        |                    |      |                    |       |     |                   |      |
| 2mm            | 3mm    | 1/8 inch (3.175mm) | 4mm  | 3/16 inch (4.76mm) | 5mm   | 6mm | 1/4 inch (6.35mm) | 8mm  |
| Light Sky Blue | Orange | Purple             | Gray | Yellow             | Green | Red | Snow              | Blue |

| BASE | WIDE BASE | TOP COVER | SHAFT ADAPTER | TOOL A | TOOL C |
|------|-----------|-----------|---------------|--------|--------|
|      |           |           |               |        |        |

## ENCODER INTERFACE

| PINOUT CONNECTOR |          |
|------------------|----------|
| #                | Function |
| 1                | +5 V     |
| 2                | B        |
| 3                | A        |
| 4                | GND      |
| 5 <sup>1</sup>   | MODE     |
| 6                | MCLR     |



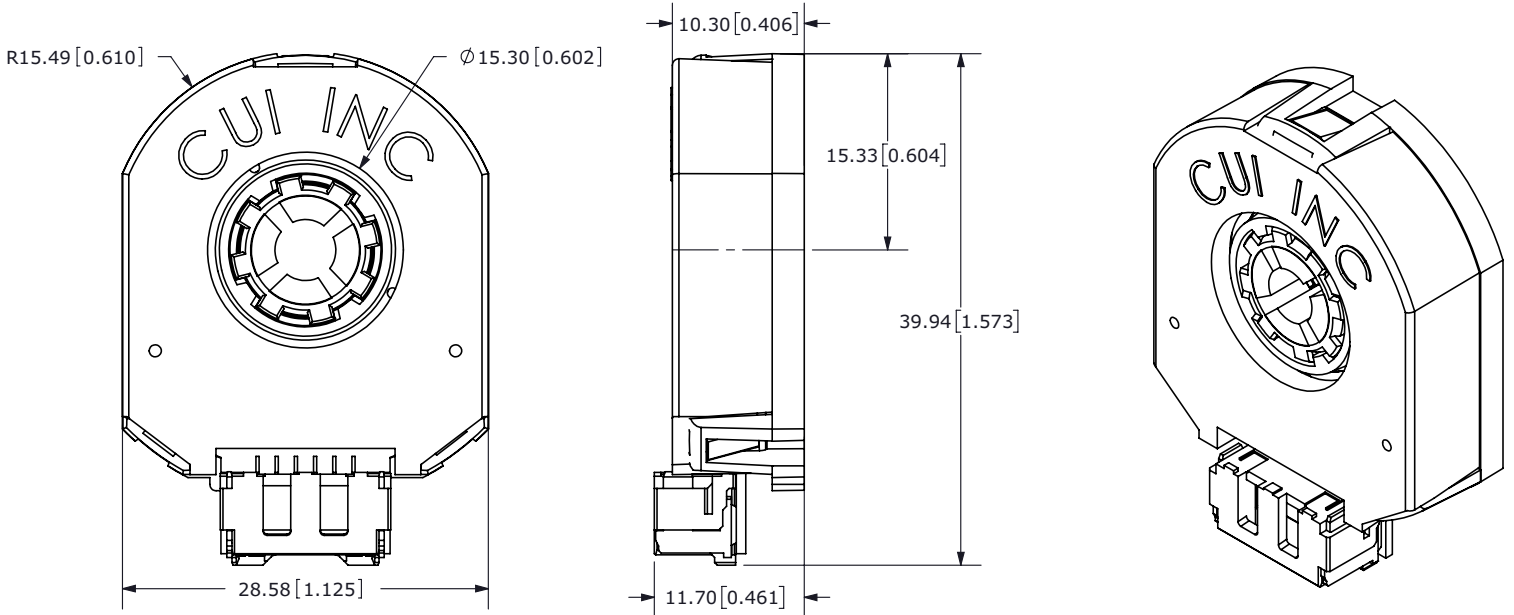
- Notes:
1. Mode pin is used by AMT Viewpoint for configuring the encoder and should be left disconnected during normal operation.
  2. Compatible with prototype cable AMT-06C-1-036 and programming cable AMT-06C-1-036-USB.

## MECHANICAL DRAWING

### AMT212

units: mm

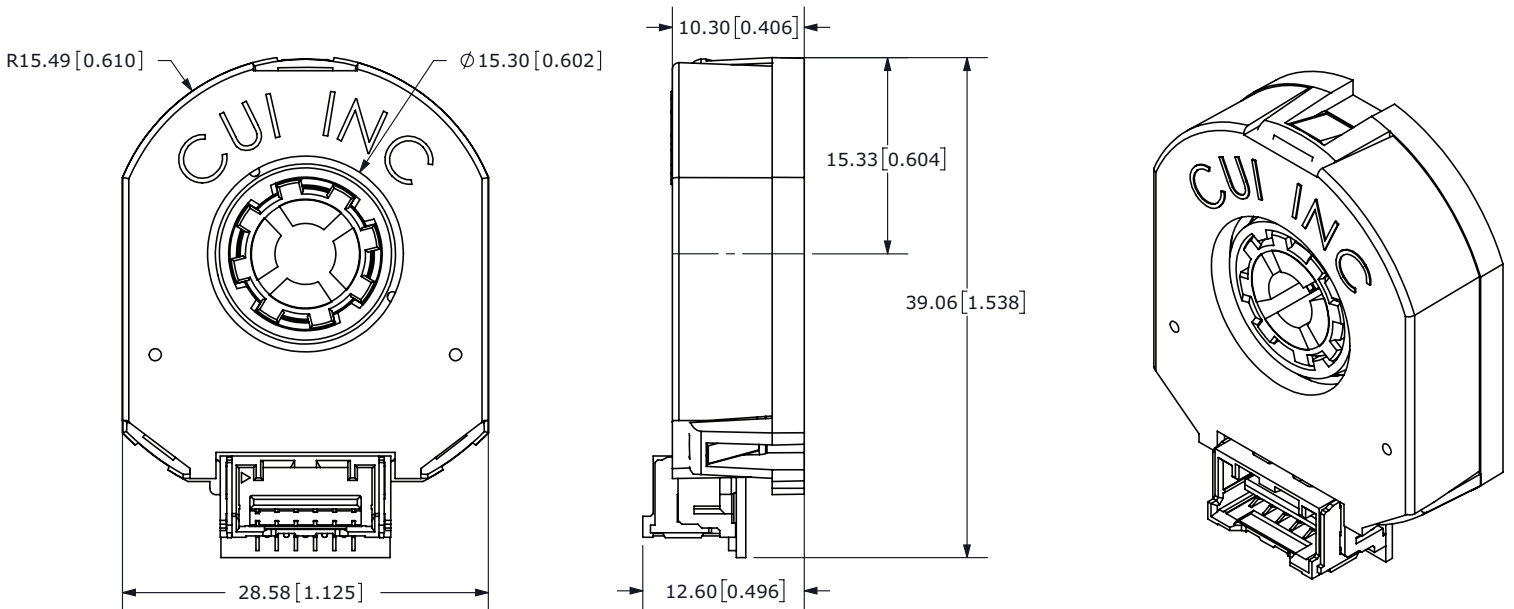
tolerance:  $\pm 0.1$



### AMT213

units: mm

tolerance:  $\pm 0.1$

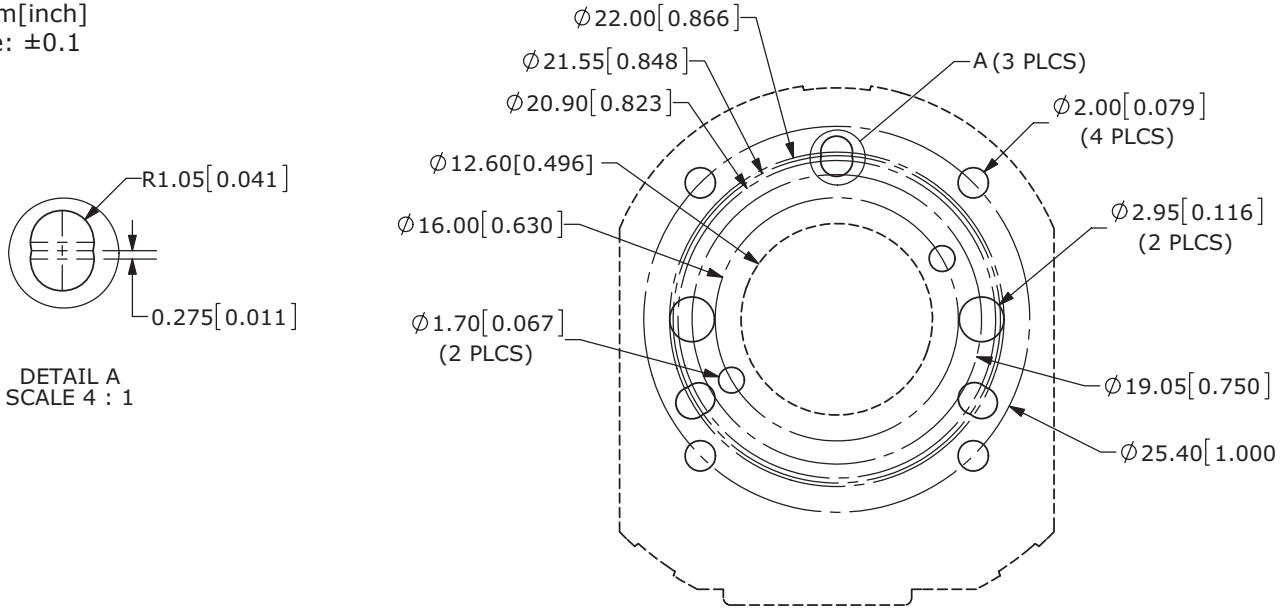


## MECHANICAL DRAWING (CONTINUED)

### MOUNTING HOLE PATTERNS

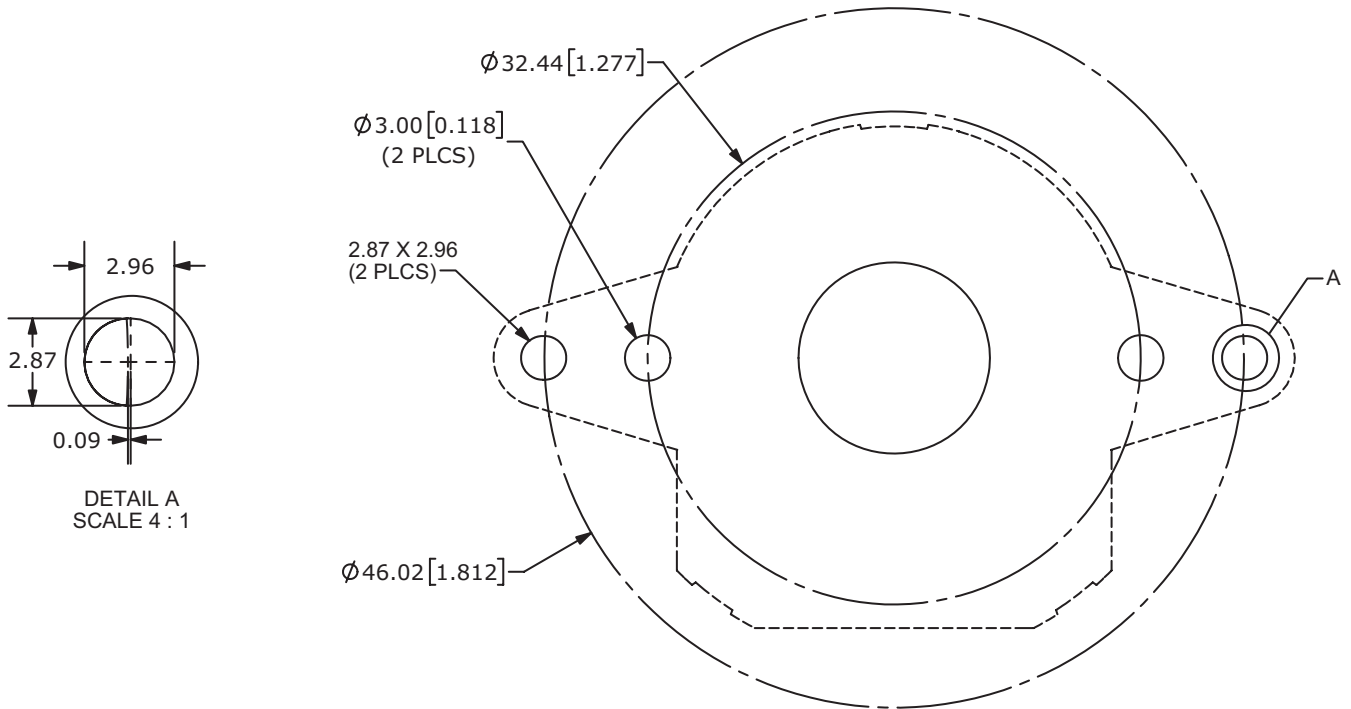
#### STANDARD BASE

units: mm[inch]  
tolerance:  $\pm 0.1$



#### WIDE BASE

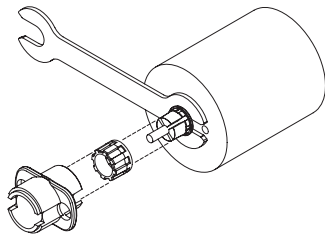
units: mm[inch]  
tolerance:  $\pm 0.1$





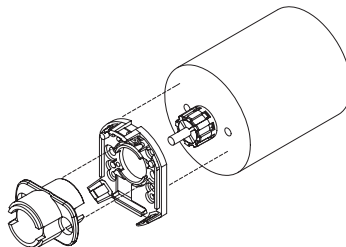
## ASSEMBLY PROCEDURE

### STEP 1



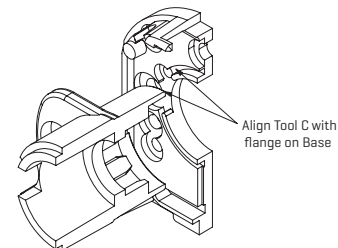
1. Insert Tool A as a spacer that defines the distance to the mounting surface.
2. Slide appropriate sized Sleeve over shaft all the way down to Tool A.
3. Slide Shaft Adaptor over Sleeve.
4. Use Tool C to press Shaft Adaptor over Sleeve [ensure Shaft Adaptor and Tool C spline alignment] until flush with Tool A.

### STEP 2



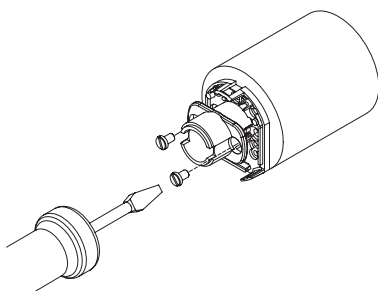
1. Remove Tools A and C.
2. Place Base on motor, with Tool C used as a centering tool.

### STEP 3



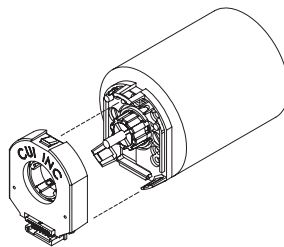
1. Align Tool C with flange on Base.
2. Slide Base and Tool C onto motor, centering onto the Shaft Adaptor.

### STEP 4



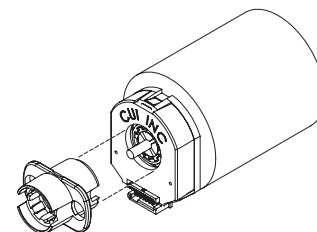
1. Fasten the Base on the motor (Tool C may need to be rotated to allow for some mounting configurations).
2. Remove Tool C.

### STEP 5



1. Snap the Top Cover onto the Base, carefully observing that the teeth of the Shaft Adaptor align with the grooves in the hub. \*
- \* We recommend no more than three cycles of mounting and removal of the AMT top cover base. Multiple cycles of mounting and removing the top cover can cause base fatigue over time and affect encoder performance.

### STEP 6



1. Make sure the snaps are fully engaged by pressing on the Hub with the reverse side of Tool C.
2. When assembly is finished, the Shaft Adaptor, Sleeve and Rotor Hub should all be flush with the Motor Shaft rotating freely.

## REVISION HISTORY

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| rev. | description                               | date       |
|------|---|------------|
| 1.0  | initial release                           | 02/20/2018 |
| 1.01 | added serial interface details            | 05/15/2018 |
| 1.02 | added multi-turn serial interface details | 06/29/2018 |

The revision history provided is for informational purposes only and is believed to be accurate.



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