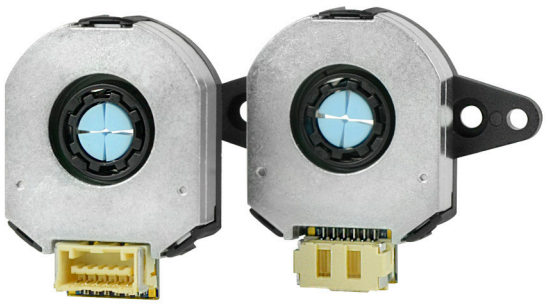
CUI Devices is now Same Sky! Learn More



# SERIES: AMT21 | DESCRIPTION: MODULAR ABSOLUTE ENCODER

## FEATURES

- high speed protocol for fast low latency position data
- proprietary capacitive ASIC technology
- low power consumption
- 12 or 14-bit absolute position with multi-turn capability
- half-duplex RS485 - high speed 2 Mbps or adjustable data rate
- 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



RoHS

## ELECTRICAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| power supply | VDD | 3.8 | 5 | 5.5 | V |
| start-up time[1] | | | 200 | | ms |
| current consumption | with unloaded output | | 16 | | mA |

Note: 1. Encoder must be stationary during start-up.

## 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 (single-turn versions only) | | | | |
| multi-turn | multi-turn and single-turn versions available | | | | |
| turns counter[2] | signed binary number | | 14 | | bits |
| absolute position update rate | 12-bit<br>14-bit | | 25<br>100 | | µs<br>µs |

Notes: 2. Multi-turn encoders only.

## MECHANICAL

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| motor shaft length | | 9 | | | mm |
| motor shaft tolerance | | | NOM +0/-0.015 | | mm |
| weight | | | 15.7 | | g |
| axial play | | | | ±0.3 | mm |
| rotational speed at each resolution | 12-bit position resolution<br>14-bit position resolution | | | 8,000<br>4,000 | RPM<br>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 | yes | | | | |
| REACH | EC 1907/2006 | | | | |

## RS485 INTERFACE – 2 MBPS DATA RATE (A,B,C,D OPTIONS)

| 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 | | | | |
| turnaround time | time before encoder responds with position | 3 | | | µs |
| driver differential output voltage magnitude | load resistance = 54 Ω | 1.5 | 2 | 3.3 | V |

## RS485 INTERFACE – ADJUSTABLE DATA RATE (E,F,G,H OPTIONS)

| parameter | conditions/description | min | typ | max | units |
|---|---|---|---|---|---|
| protocol | RS485 balanced digital multi-port interface | | | | |
| data rate[3,4] | 8 data bits, no parity, 1 stop bit, asynchronous<br>115,200; 38,400; 19,200; 9,600 | | | | bps |
| transceiver | Texas Instruments SN65HVD72 | | | | |
| turnaround time | time before encoder responds with position<br>115,200 bps<br>38,400 bps<br>19,200 bps<br>9,600 bps | <br>10.8<br>30<br>56<br>110 | | | <br>µs<br>µs<br>µs<br>µs |
| driver differential output voltage magnitude | load resistance = 54 Ω | 1.5 | 2 | 3.3 | V |

Notes: 3. Data rate configured with AMT Viewpoint™
4. Default data rate on kits is 115,200 bps.

### Checksum

The AMT21 encoder uses a checksum calculation for detecting transmission errors. The upper two bits of every response from the encoder are check bits. Those values are shown in the examples below as K1 and K0. The check bits are odd parity; K1 for the odd bits in the response, and K0 for the even bits in the response. These check bits are not part of the position, but are used to verify its validity. The remaining lower 14 bits are the useful data. Here is an example of how to calculate the checkbits for a 16-bit response, from a 14-bit encoder.

Full response: 0x61AB
14-bit position: 0x21AB (8619 decimal)

### Checkbit Formula

Odd: K1 = !(H5^H3^H1^L7^L5^L3^L1)

Even: K0 = !(H4^H2^H0^L6^L4^L2^L0)

From the above response 0x61AB:
Odd: 0 = !(1^0^0^1^1^1^1) = correct
Even: 1 = !(0^0^1^0^0^0^1) = correct

# RS485 INTERFACE (CONTINUED)

### Addressing

The AMT21 encoder supports multiple encoders on the RS485 bus. This is accomplished by giving each encoder a unique node address. This node address is 8 bits long but the low two bits must be 0. Therefore, the encoder can have any single byte value that is divisible by 4 which allows up to 64 encoders to share the bus.

By default, the node address is 0x54. Node addresses configurable via AMT Viewpoint™ or set at factory for specific configuration upon request.

| Available RS485 Node Addresses (HEX) | | | | | | | |
|---|---|---|---|---|---|---|---|
| 00 | 20 | 40 | 60 | 80 | A0 | C0 | E0 |
| 04 | 24 | 44 | 64 | 84 | A4 | C4 | E4 |
| 08 | 28 | 48 | 68 | 88 | A8 | C8 | E8 |
| 0C | 2C | 4C | 6C | 8C | AC | CC | EC |
| 10 | 30 | 50 | 70 | 90 | B0 | D0 | F0 |
| 14 | 34 | **54*** | 74 | 94 | B4 | D4 | F4 |
| 18 | 38 | 58 | 78 | 98 | B8 | D8 | F8 |
| 1C | 3C | 5C | 7C | 9C | BC | DC | FC |

*Default address

The node address serves also as the read position command which is why it will be referred to it as the base command. When the encoder sees a command on the RS485 it reads the first 6 bits to determine if it should be listening. If it sees its address, then it interprets the low two bits for the command.

| Low two bits | Hex | Command |
|---|---|---|
| 00 | 0x00 | Read position |
| 01 | 0x01 | Read turns counter (multi-turn encoders only) |
| 10 | 0x02 | Indicates extended command |
| 11 | 0x03 | Reserved |

For simplicity the user can abstract away the various bits and simply implement multiple commands in their system. For example:

| Byte | Command |
|---|---|
| 0x54 | Read position |
| 0x55 | Read turns counter (multi-turn encoders only) |
| 0x56 | Begin extended command |

### Extended Commands

There are some commands that require two bytes to be received before the encoder will enact them. This includes resets and zero saves. This prevents collisions and allows the encoder to be fully functional while sharing the bus with other encoders.

Note that there are no responses to these instructions, and once received the encoder initiates an immediate reset. The user's system should expect to wait until the encoder is powered back up to send any follow up commands. Power on time is listed in the electrical section above.

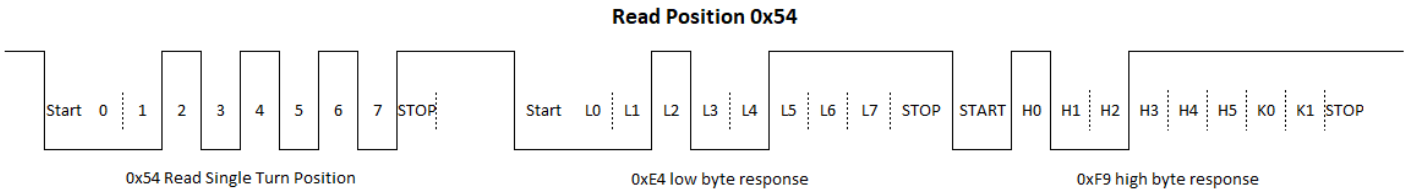
To send an extended command the user will send the <node address + 0x02> value (0x56 by default) followed by the <extended command>.

| Extended Commands | Function |
|---|---|
| 0x5E | Set zero position (Single turn encoders only) |
| 0x75 | Reset encoder |

## RS485 INTERFACE EXAMPLES

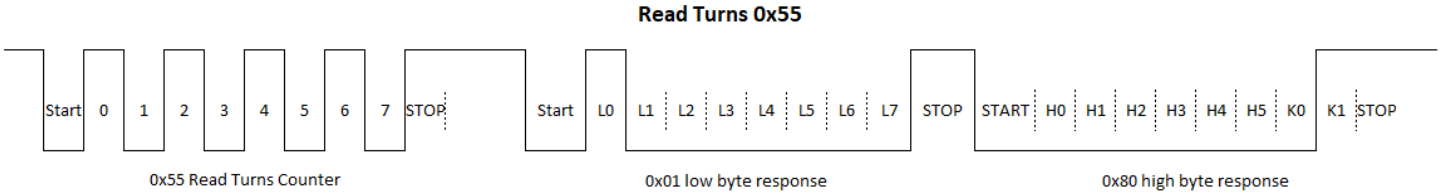
### Single character commands

Read Position: <node_address>




The read position command is the same as the node address which has a default value of 0x54 is sent and the response is received with the low byte first. After removing the checksum the result is 0x39E4. For a 14-bit encoder nothing else is required, the position is 14820 in decimal. However if this is a 12-bit encoder, the position must be shifted to the right 2 bits to throw away the low bits of the response. Therefore the position would be 3705 in decimal.

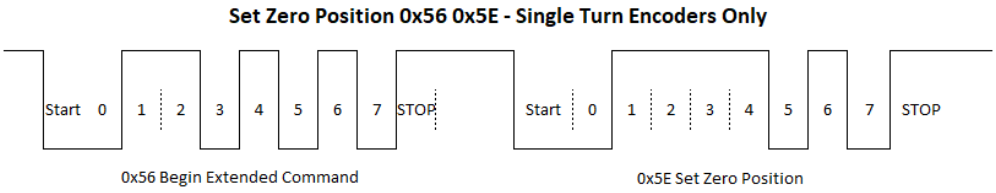
Read Turns (multi-turn encoders only): <node_address + 0x01>




The turns counter command is <node_address + 0x01>. By default the turns counter command is 0x55. The encoder responds with the low byte first and includes check bits same as the read position command. The resulting number is a signed 14 bit number. The response above is showing 1 turn. This value is not retained between power cycles. After a power cycle, the value is reset to zero.

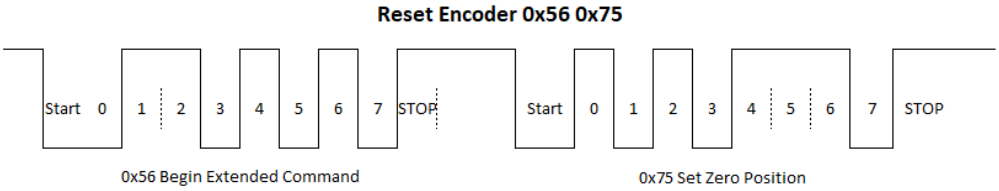
### Extended commands

Set Zero Position (single turn encoders only): <node_address + 0x02> <0x5E>




The zero set command is <node_address + 0x02> followed by <0x5E>. By default we send 0x56 and then 0x5E. The encoder zero's the position and immediately resets.

Encoder Reset: <node_address + 0x02> <0x75>




The reset command is <node_address + 0x02> followed by <0x75>. By default the command to reset the encoder is 0x56 0x75. The encoder performs and immediate reset.

## PART NUMBER KEY

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

**AMT21 X X - X - XX - XXXX - X - X**

Base Number

Orientation:
2 = Radial
3 = Axial

Absolute Resolution:
A = 12-bit single-turn, 2 Mbps data rate
B = 14-bit single-turn, 2 Mbps data rate
C = 12-bit multi-turn, 2 Mbps data rate
D = 14-bit multi-turn, 2 Mbps data rate
E = 12-bit single-turn, adj data rate
F = 14-bit single-turn, adj data rate
G = 12-bit multi-turn, adj data rate
H = 14-bit multi-turn, adj data rate

Data Rate:
F1 = 2 Mbps (A,B,C,D resolutions only)
A1 = 115,200 bps (E,F,G,H resolutions only)
A2 = 38,400 bps (E,F,G,H resolutions only)
A3 = 19,200 bps (E,F,G,H resolutions only)
A4 = 9,600 bps (E,F,G,H resolutions only)

RS485 Node Address:
54 = Default node address
XX = *Node address options

Bore Diameter:
2000 = 2 mm
3000 = 3 mm
3175 = 3.175 mm (1/8")
4000 = 4 mm
4760 = 4.76 mm (3/16")
5000 = 5 mm
6000 = 6 mm
6350 = 6.35 mm (1/4")
8000 = 8 mm

Mounting Base:
S = Standard
W= Wide

Termination Resistor:
blank = no resistor
T = with 120 Ω resistor

*Reference RS485 Interface Addressing section on page 3 for help selecting node address.

## 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.

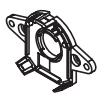
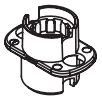
### ORDERING GUIDE

**AMT21XX-V**

Orientation:
2 = Radial
3 = Axial

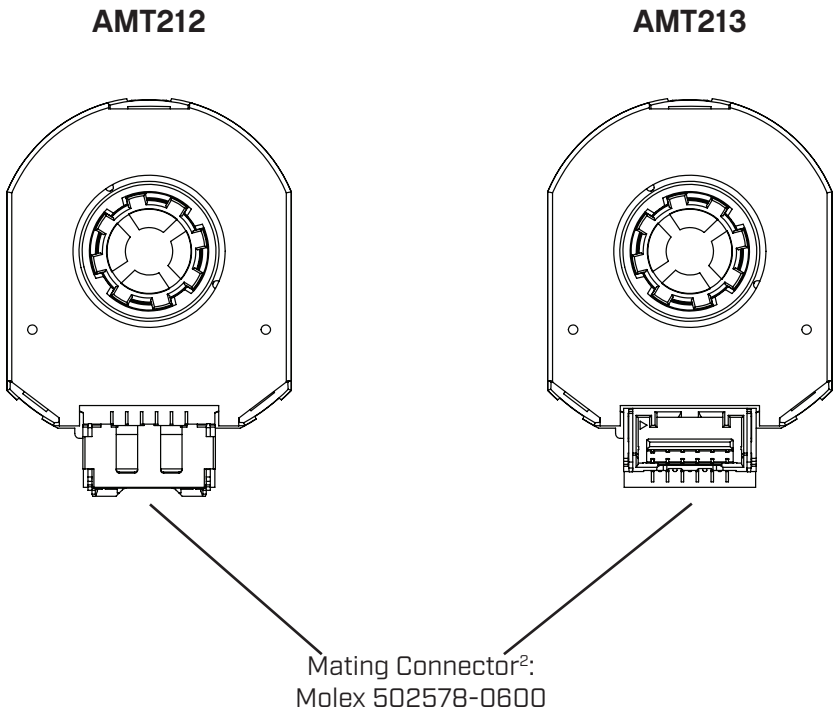
Absolute Resolution:
A = 12-bit single-turn, 2 Mbps data rate
B = 14-bit single-turn, 2 Mbps data rate
C = 12-bit multi-turn, 2 Mbps data rate
D = 14-bit multi-turn, 2 Mbps data rate
E = 12-bit single-turn, adj data rate
F = 14-bit single-turn, adj data rate
G = 12-bit multi-turn, adj data rate
H = 14-bit multi-turn, adj data rate

| 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[1] | MODE |
| 6[1] | MCLR |

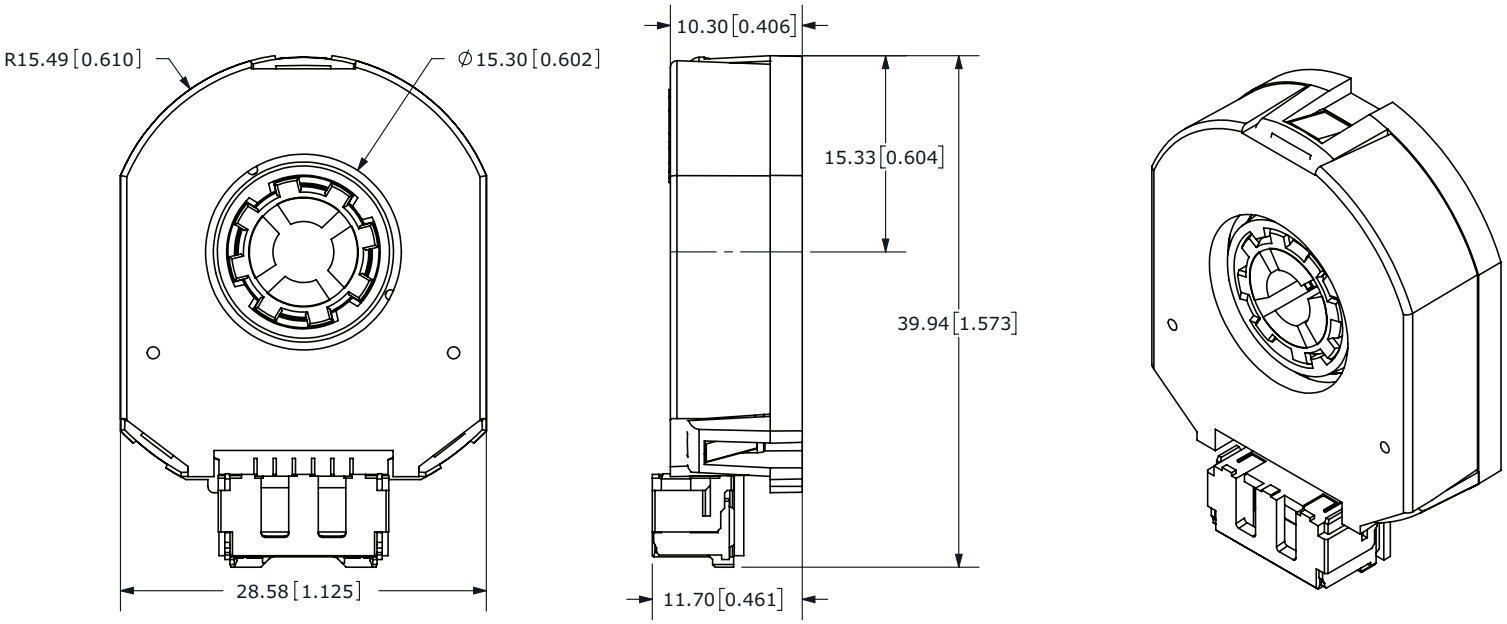



Notes: 1. Pins 5 and 6 are used for configuration only and should be left disconnected for RS485.
2. Compatible with prototype cable AMT-06C-1-036 and programming cable AMT-06C-1-036-USB.

# MECHANICAL DRAWING

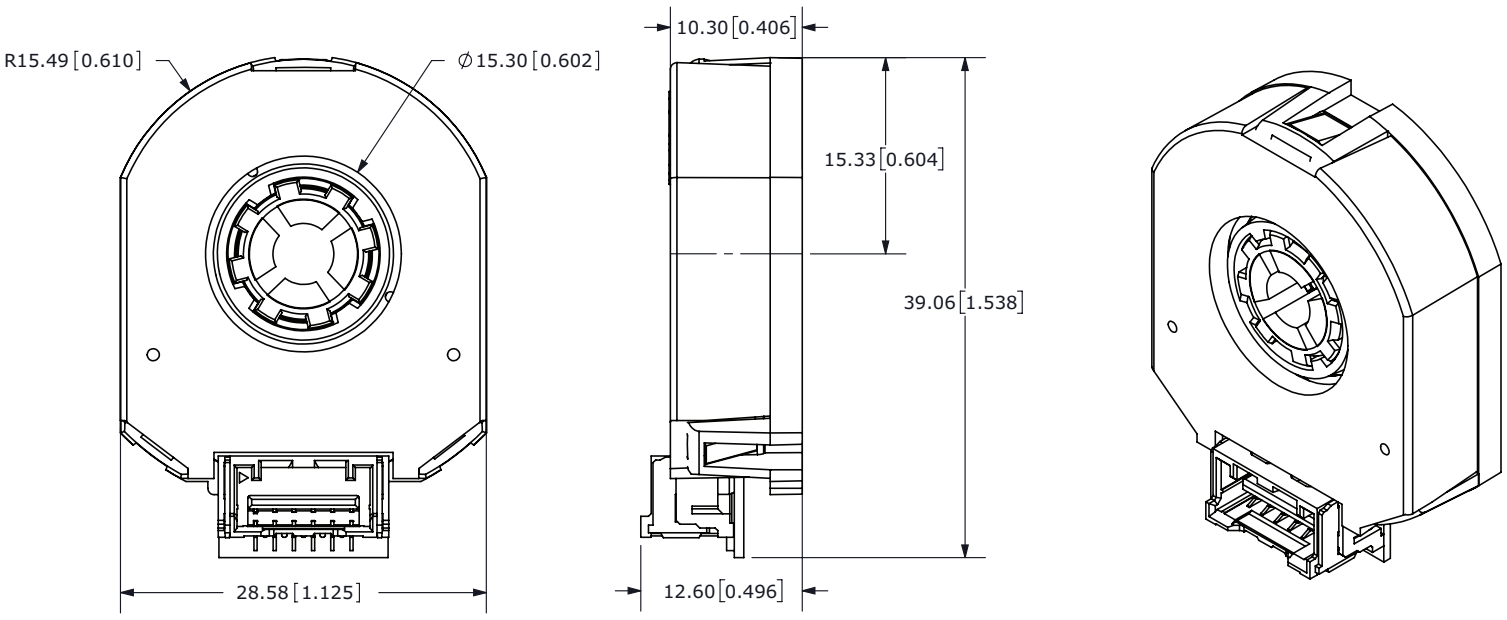
## AMT212

units: mm
tolerance: ±0.1




## AMT213

units: mm
tolerance: ±0.1

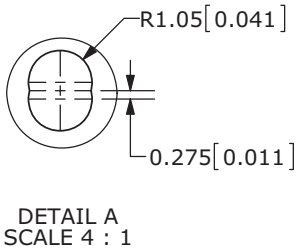


# MECHANICAL DRAWING (CONTINUED)

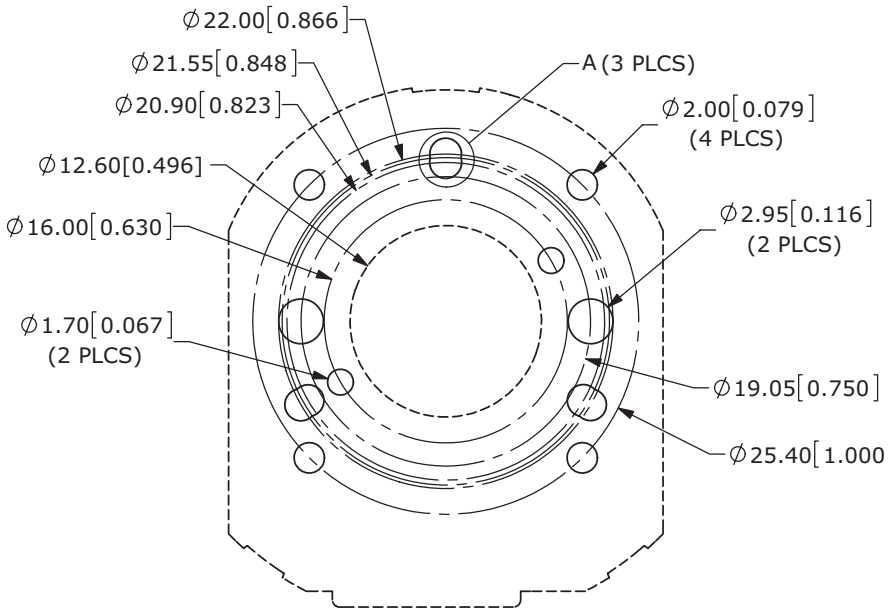
## MOUNTING HOLE PATTERNS

### STANDARD BASE

units: mm[inch]
tolerance: ±0.1

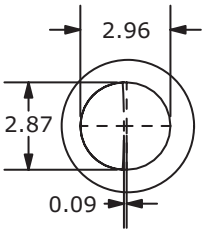



DETAIL A
SCALE 4 : 1

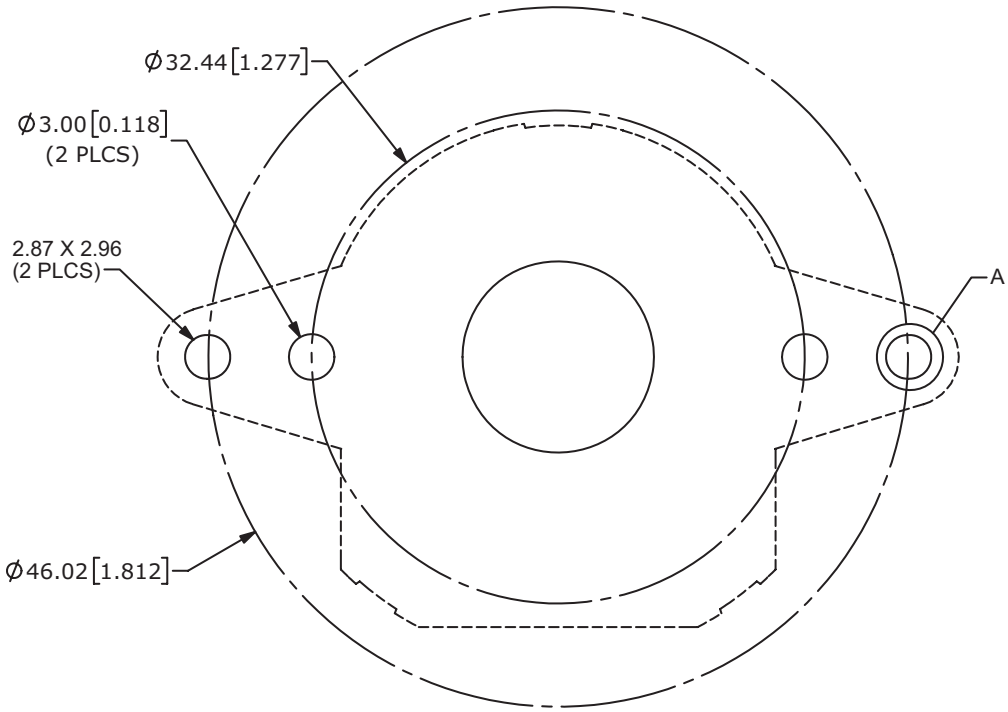



### WIDE BASE

units: mm[inch]
tolerance: ±0.1

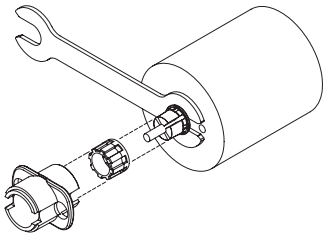



DETAIL A
SCALE 4 : 1



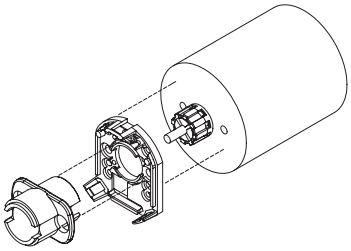
# ASSEMBLY PROCEDURE

## STEP 1



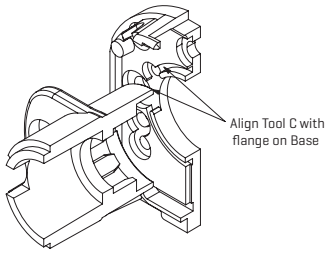
1. Insert Tool A as a spacer that defines the distance to the mounting surface.
2. Slide appropriate sized Sleeve over shaft all the way down to Tool A.
3. Slide Shaft Adaptor over Sleeve.
4. Use Tool C to press Shaft Adaptor over Sleeve (ensure Shaft Adapter and Tool C spline alignment) until flush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

## STEP 2



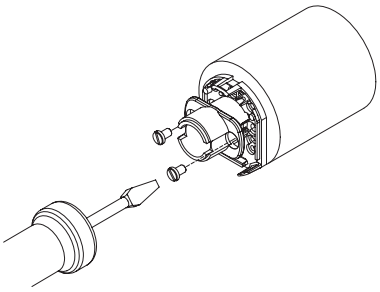
1. Remove Tools A and C.
2. Place Base on motor, with Tool C used as a centering tool.

## STEP 3



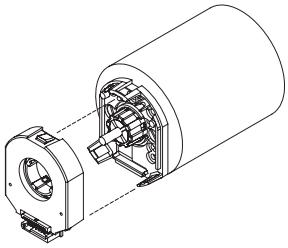

1. Align Tool C with flange on Base.
2. Slide Base and Tool C onto motor, centering onto the Shaft Adapter.

## 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.

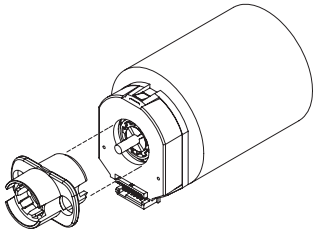
## STEP 5



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

| 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 |
| 1.03 | updated RS485 interface details | 06/26/2019 |
| 1.04 | added adjustable data rate options | 08/22/2019 |
| 1.05 | brand update | 11/21/2019 |
| 1.06 | added motor shaft tolerance details, updated start-up details | 09/10/2021 |
| 1.07 | logo, datasheet style update | 08/05/2022 |
| 1.08 | added multi-turn interface details | 05/11/2023 |
| 1.09 | CUI Devices rebranded to Same Sky | 09/12/2024 |
| 1.10 | added termination resistor option | 06/27/2025 |
| 1.11 | updated features | 06/23/2026 |

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

same sky

Same Sky offers a one (1) year limited warranty. Complete warranty information is listed on our website.

Same Sky reserves the right to make changes to the product at any time without notice. Information provided by Same Sky is believed to be accurate and reliable. However, no responsibility is assumed by Same Sky for its use, nor for any infringements of patents or other rights of third parties which may result from its use.

Same Sky products are not authorized or warranted for use as critical components in equipment that requires an extremely high level of reliability. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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