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E7N uCoder — Universal Resolver-Based Encoder

1 Introduction

The uCoder, a Digital Resolver

The uCoder is a resolver-based encoder, in which the analog signal produced by a brushless resolver is transformed into a digital format by a built-in ratiometric tracking converter. This new concept and the advanced technology of the uCoder, provides higher accuracy, increased reliability, higher operating speeds, more flexible counts per turn and a smaller size than optical encoders.

No Optics, Mil-Grade Resolver

There is no optical coded disc or similar component used in the uCoder. A miniature Mil-Grade resolver produces an analog position signal and high-grade electronics transforms this signal to digital format.

The resolver is a passive transducer, well known for its ruggedness and performance in hostile industrial environments. The uCoder combines the ruggedness of a resolver with the reliability of solid-state electronics and is designed to operate reliably under severe environmental conditions, such as mechanical shock, vibrations, temperature and humidity changes, oil mist, coolants and solvents. **NO** broken discs — **NO** disc misalignments—**NO** LED aging!

High Resolution in Small Compact Housing

The single-turn uCoder provides up to 12 bit Binary, Gray Code or BCD in a 2.5-inch diameter size (size 25) housing.

Single-Turn Operation

The uCoder is an absolute encoder, that is, it keeps track of the exact shaft position even during power outage or switching off the machine. At power-up, the uCoder will pick up the exact shaft position even if the machine moved during the power outage.

In a single-turn operation, the machine cycle is completed during one complete revolution of the transducer shaft, whereas in multi-turn operation the transducer shaft needs to make more than one turn for a complete machine cycle.

Field Selectable CW or CCW Operation

The uCoder is factory wired for ascending counts with Counterclockwise shaft rotation. However, the direction of operation can be easily changed in the field by removing the back cover plate and changing 4 DIP Switches.

Ratiometric Resolver-to-Digital Converter

The Autotech ratiometric tracking converter is practically immune to electrical noise, voltage, frequency and temperature variations, and can track speeds up to 5000 RPM.

Built-in PC Synchronization

An optional PC synchronization circuit is provided to ensure reliable data transfer to programmable controllers. The edge-triggered device allows data to be updated every scan, and a variety of outputs (TTL, PNP or NPN) permit interface to virtually all existing programmable controllers.

Choice of Mounting Styles

To match almost any application, the uCoder is available in two mounting styles.

The E7N uCoder is enclosed in size 25 (2.5-inch diameter), NEMA 4/4X housing and designed for medium duty applications. They are available for flange or servo mount with a MS connector located on the side.

Variety of Outputs

The uCoder is available with Binary, Gray Code, or BCD output formats. A further flexibility to interface to other devices is provided by TTL (5V logic), PNP source transistor (48 VDC @ 100 mA) or NPN sink transistor (48 VDC @ 100 mA) types of outputs.

18–32 VDC Voltage Range

The standard models are available, which can operate with a 18–32 VDC power supply. This wide voltage range provides an increased flexibility in using the uCoder in control systems of different voltage levels without requiring an extra power supply. An existing power supply can be used to power the uCoder, that is, if a programmable controller operates at 24 VDC, an 18–32 VDC uCoder model can be connected to the same power supply, thus cutting down the system cost.

Flexible Programming of Counts Per Turn

The advanced R to D converter used in the uCoder has made it possible to program any number of scaled BCD counts per revolution. The BCD output with counts per turn of 360, 1000 and 3600 is standard, however, the unit can be delivered with custom scaled counts if so desired. Consult the factory for special configurations or higher resolution.

Short Circuit Proof Outputs

Very often electricians try to make or change connections under power and that is when various electrical devices are damaged by shorting. The standard uCoder has short circuit proof PNP or NPN Sink transistor outputs. An accidental short on an output will not damage the unit.

2 Specifications

ELECTRICAL

Input Power

Voltage: 18–32 VDC

Current: 0.4 Amp — Single-turn

Power-on Settling Time

For 130 SEC. after power is turned "ON," the encoder output is frozen as follows: T and N: all zeros; P: all ones. After 130 ms, the uCoder reads the true position.

POSITION OUTPUT

Output Format and Number of Words/Counts

(Customer) Switch Selectable:

Single-turn

Gray Code: 256, 512, 1024, 4096

Binary: 1024, 4096

BCD: 360, 1000, 3600

(Custom counts available, consult factory)

OUTPUT DRIVERS

T: TTL (74HC245), high true logic

Logic True: 2 V @ 15 mA

Logic False: 0.35 V @ 24 mA

Low active, TTL level

P: Source Transistor, $V_{max} = 45$ V, high true logic (Sprague UDN-2982)

Logic True: Transistor ON, 1.7 V drop @ 100 mA

Logic False: Transistor OFF, 0.2 mA leakage @ 50 V

On ES the "P" type outputs are short circuit proof and are rated 20 mA @ 50 VDC

N: Sink Transistor, $V_{max} = 45$ V, low true logic

(Sprague ULN-2803)

Logic True: Transistor ON, 1.1 V drop @ 100 mA

Logic False: Transistor OFF, 0.1 mA leakage @ 50 V

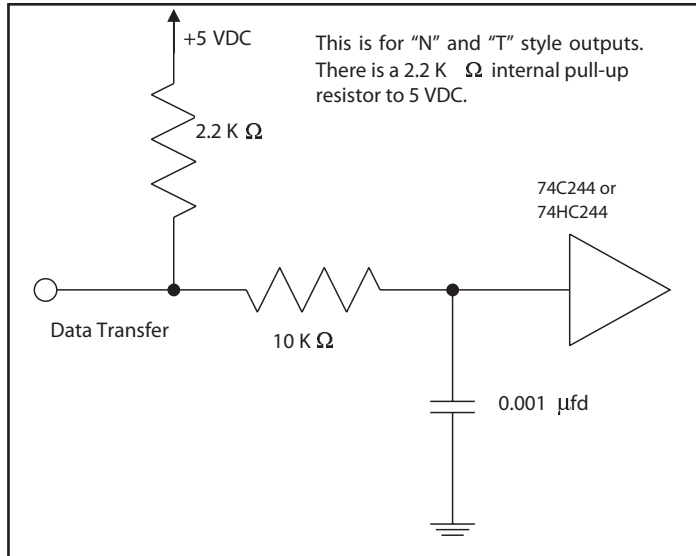
OUTPUT TIMING

Encoder position data is continuously updated at full speed. The data can be frozen for $100 \pm 10\%$ microseconds within 10 ms of either transition edge of data transfer command.

Encoder position data is latched 100 microseconds to 5 milliseconds (factory set at 3 milliseconds, field adjustable) after either transition edge of data transfer command from programmable controller (Non-retriggerable during timing period.)

Data Transfer Command: (see diagram, below)
 "N" and "T" Style Outputs: TTL compatible, 2.2 K internal pull-up to 5 V, high true logic, edge triggered.
 High level: 3.5 to 4.5 VDC
 Low level: 0 to 1 VDC
 Pulse width: Minimum to 10 microseconds
 "P" Style Outputs: (see diagram, below)

UCoder Data Transfer (PC-Synchronization)



Mechanical Specifications	
Maximum Starting Torque @ 25° C (oz-in)	8.0
Moment of inertial (gm/cm ²)	45
Maximum Slew Speed (RPM)	5000
Shaft size	3/8 inch
Maximum Shaft Load: Axial (lbs.) / Radial (lbs.)	50 / 100
Bearing Life at Max. Mfr. Spec. (Rev.)	2 x 10 ⁹
Weight (lbs.)	1.0
Environmental Specifications	
Shock	200 g for 11 mSec.
Vibration	20 g to 2000 Hz
Operating Temperature (Ambient)	0° to 60° C
Storage Temperature	
Enclosure	NEMA 13

3 Mounting and Wiring

3.1 Mounting

1. Servo-Mount:

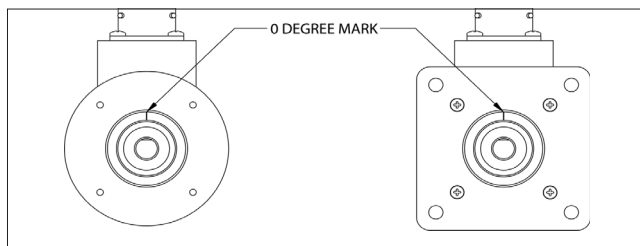
The uCoder can be either mounted with traditional servo-clamps or through the four 4-40 mounting holes on the face of the resolver.

Zero Reference ($\pm 5^\circ$): When flat on shaft lines up with the "0" mark on the face of the hub that also lines up with the cable connector.

2. Flange-Mount:

The uCoder can be mounted using the four 0.218 diameter mounting holes on the square face plate.

Zero Reference ($\pm 5^\circ$): When flat of shaft lines up with the "0" mark on the face of the hub that also lines up with the cable connector.



CAUTION NOTES:

1. It is recommended that the uCoder be coupled to an external shaft using a flexible coupling. Autotech recommends ACR series helical couplings. For further information contact helical products company directly at 805/928-3851.
2. NEMA 4/4X rating — to maintain the NEMA 4/4X rating of uCoder, the bearing seals must be checked once every six months and replaced if necessary. Lubricating the bearing seal periodically prolongs its life.
3. If the uCoder is to be axially driven, be sure that the shafts are aligned. If misaligned, it can destroy the uCoder bearings.
4. The uCoder contain surface mount electronics and must be returned to the factory for repair. DO NOT ATTEMPT TO REPAIR the electronics in the field; THIS WILL VOID ALL WARRANTIES.

3.2 Field Adjustments

Normally, there are no field adjustments required in the uCoder. However, if you need to change the direction of rotation or have a special need for PC-Handshake (PC Sync) time adjustment, remove the two screws on the backplate and remove backplate. You can access the PC Sync Trimpot, the Mode Switches, and the Shaft Rotation (ascending-descending) Switches. (See next page.)

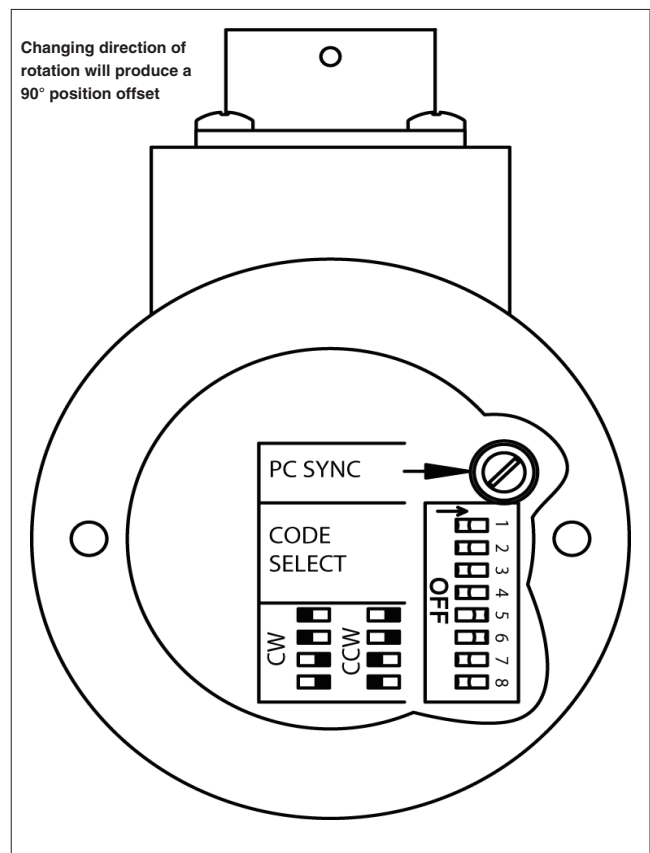
Direction of Rotation

The direction of rotation is normally set at the factory for increasing count with CCW rotation (viewed from the shaft end). This may be changed to increasing count with CW rotation by changing the switch settings SW1-5 through SW1-8. You must change all four switches. (See figure below and chart on page 5.)

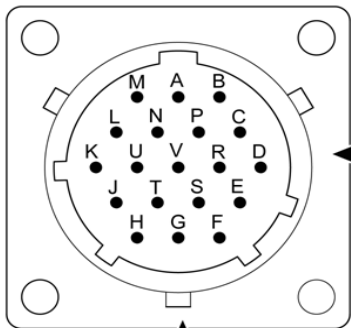
Delay Adjustment (PC Sync)

The delay adjustment for the PC Handshake option is accessible when the backplate is removed. This trimpot is set to maximum (CW) at the factory. It may be field adjusted from 100 μ s to 5.0 milliseconds. (See figure below and detail on page 5.)

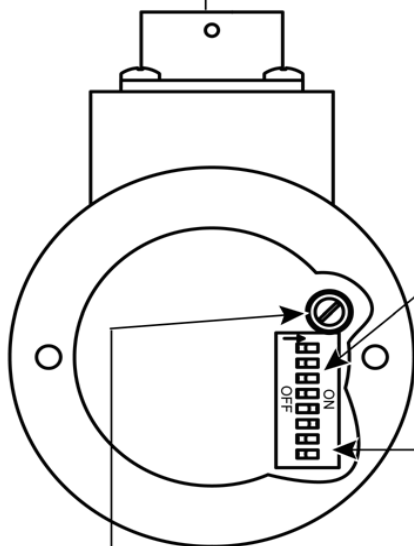
Direction of Rotation Vs Increasing Count Adjustment and Delay Adjustment Trimpot (PC Sync)



DIP Switch (SW1) Settings, MS Connector, and PC Sync Trimptot



MS CONN TO CUSTOMER			
PIN	BCD	BINARY	GRAY
A	1	B0	G0
B	2	B1	G1
C	4	B2	G2
D	8	B3	G3
E	10	B4	G4
F	20	B5	G5
G	40	B6	G6
H	80	B7	G7
J	100	B8	G8
K	200	B9	G9
L	400	B10	G10
M	800	B11	G11
N	1000	N/A	N/A
P	2000	N/A	N/A
R	CUSTOMER Vcc		
T	(-) Vin COMMON		
U	DATA TRANSFER		
V	(+) Vin 18-32VDC		
S	CHASSIS		



MODE SELECTION					
SWITCH 1 SETTING				ENCODING	SCALE FACTOR
SW1-1	SW1-2	SW1-3	SW1-4		
ON	ON	ON	ON	GRAY CODE	1024
ON	ON	ON	OFF	GRAY CODE	256
ON	ON	OFF	ON	GRAY CODE	360
ON	ON	OFF	OFF	GRAY CODE	512
ON	OFF	ON	ON	GRAY CODE	4096
ON	OFF	ON	OFF	BINARY	1024
ON	OFF	OFF	ON	BINARY	4096
ON	OFF	OFF	OFF	BCD	360
OFF	ON	ON	ON	BCD	1000
OFF	ON	ON	OFF	BCD	3600
OTHER SELECTIONS				FUTURE	

PC SYNC
DATA TRANSFER HOLD POT

5mS DATA HOLD

100µS DATA HOLD



DATA HOLD TRIGGERED FROM POSITIVE AND NEGATIVE EDGES ON DATA TRANSFER.

SWITCH POSITION	SHAFT ROTATION	
	CW	CCW
SW1-5 OFF	ASCENDING COUNT	DESCENDING COUNT
SW1-6 OFF		
SW1-7 ON		
SW1-8 ON		
* SW1-5 ON	ASCENDING COUNT	DESCENDING COUNT
* SW1-6 ON		
* SW1-7 OFF		
* SW1-8 OFF		

* FACTORY DEFAULT

3.3 Wiring

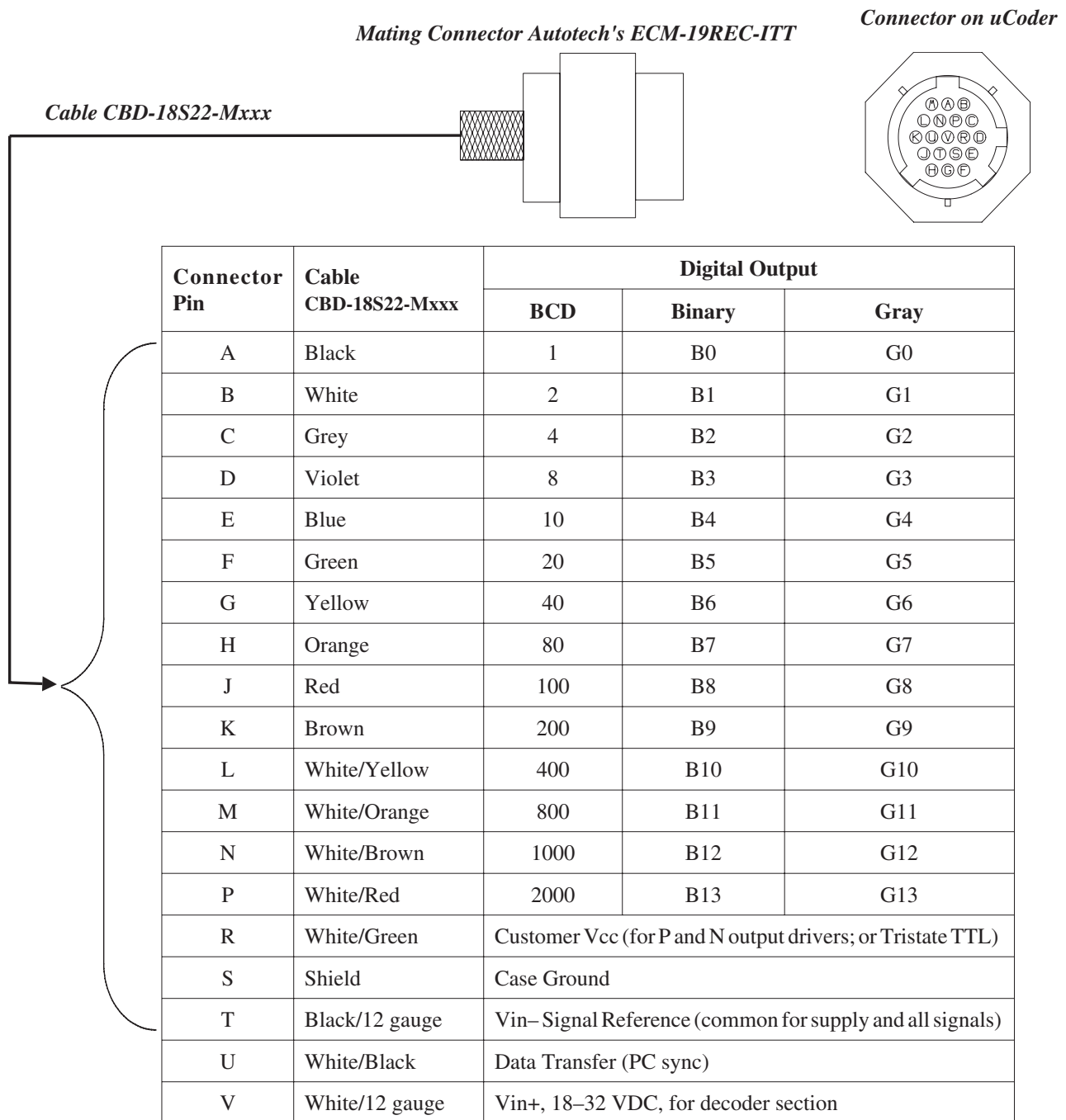
1. The shielded interconnecting cable should be routed in its own conduit and kept separate from other high voltages/high inductance wiring. The shield drain wire should be connected to earth ground at both ends of cable.
2. Use mating connector ECM-19REC-ITT for single turn units.
3. Data transfer logic required is same as logic selected for output drivers.

4. When power is applied to the uCoder, the outputs go to the power-up code state for approximately 130 milliseconds as listed below and this must be taken into consideration while designing the system:

- T Outputs: *Offstate*
- N Outputs: *All zeros*
- P Outputs: *All ones*

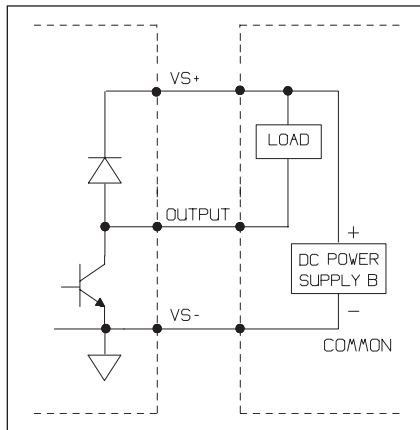
5. For more details about T, P, and N outputs, see the end of this section.

CAUTION: Check the cable wiring before applying power to the uCoder.

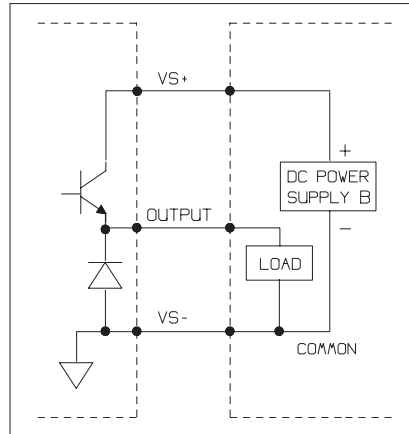


3.4 Output Configurations and Wiring

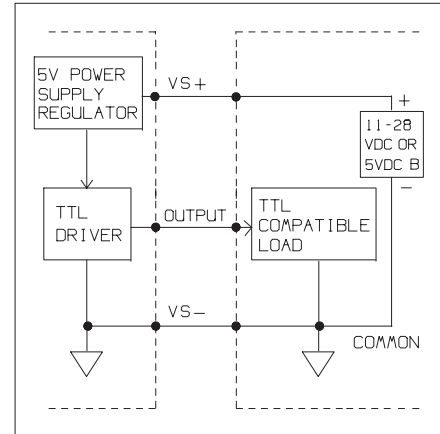
N Types of Outputs



P Types of Outputs



TTL Types of Outputs



3.5 Grounding and Shielding

CAUTION: Failure to observe any of these requirements may cause unpredictable operation and will void any warranty.

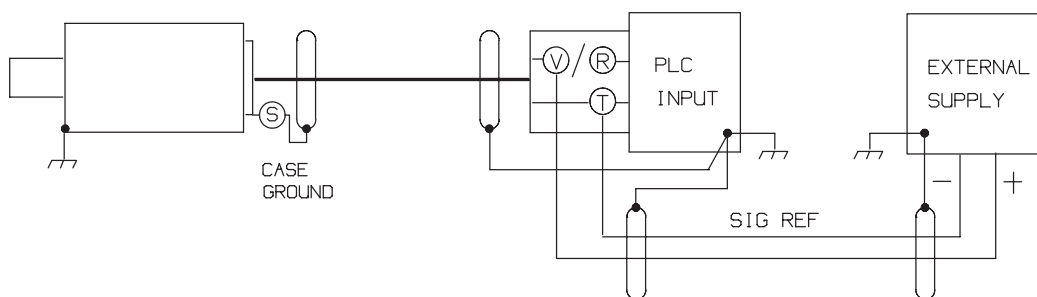
1. All logic level wiring (including external power supply) must be done using overall foil shielded cables, with shields and equipment grounded as per above drawings. It is recommended that the uCoder shielded cable be run in its own separate conduit. See "How to Order" section for suitable cables offered by Autotech.

2. All ground planes on which the uCoder and all external equipment are mounted must be held to the same RF potential, by good metallic connections to building frames, conduit or wiring trays.

3. All shielded cable must be kept at a minimum distance of 2 inches from all high voltage or inductive wiring.

4. All shielded resolver cables must be kept at a minimum distance of 12 inches from all motor wiring controlled by AC or DC drives.

5. **CAUTION:** This equipment has an isolated Sig Ref (common). Failure to maintain this isolation between chassis ground (earth ground) and Sig Ref in external equipment (power supply or I/O cards) may cause electrical noise interference resulting in unpredictable operation of this equipment.

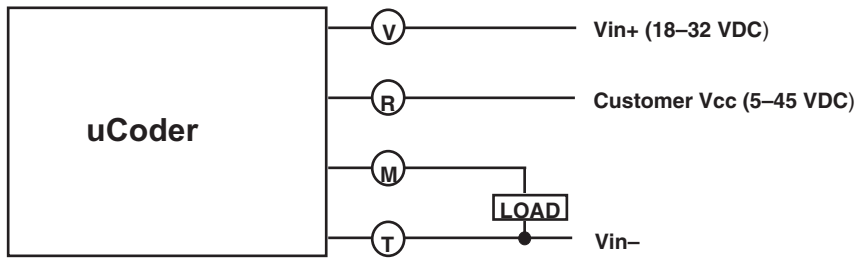


- Indicates uCoder connector pin designations
- ⏏ Indicates good metallic connection to ground plane on which each unit is mounted with shortest possible wire length of 14 gauge or less

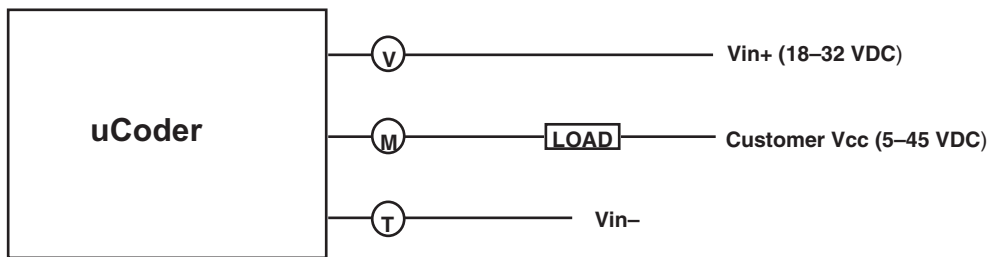
3.6 Ucoder Wiring Diagrams

UCoder Wiring Diagrams

“P” Type 5–45 Volt



“N” Type 5–45 Volt

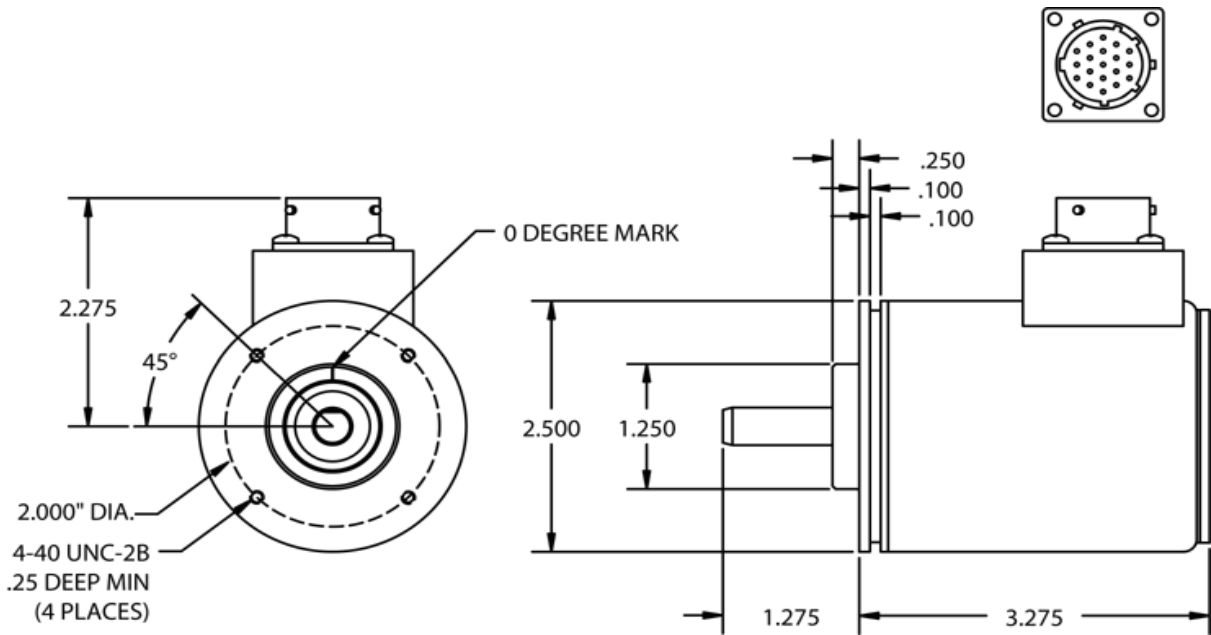


NO CONNECTION NEEDED on PIN “R”

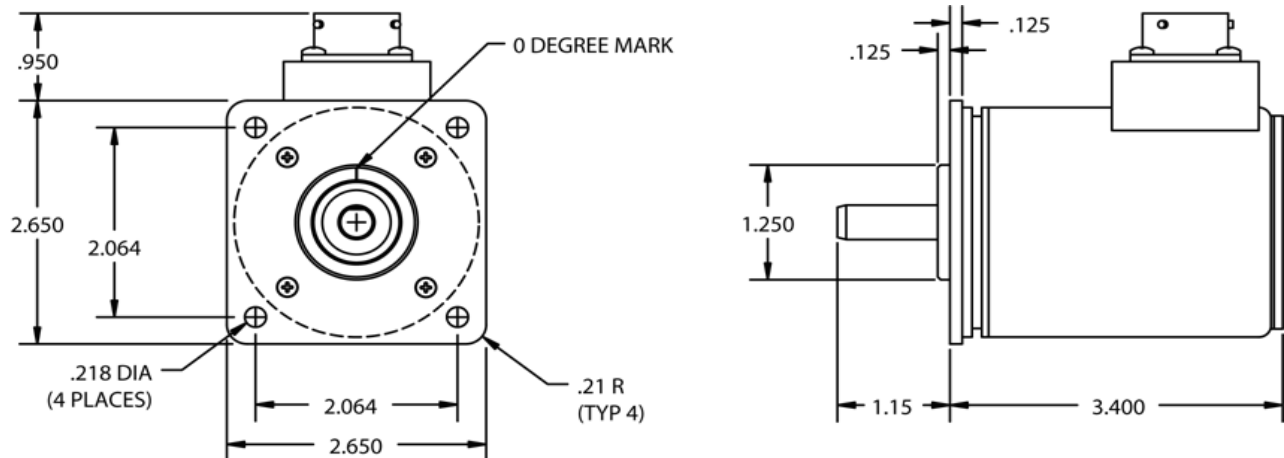
Note: With 18–32 V option, only one power supply may be required.

4 Outline Dimensions

Size 25, E7 uCoder with Servo-Mount



Size 25, E7 uCoder with Flange-Mount



5 How to Order

E7 uCoder: Single-Turn

E 7 N - UCODE - X X X X X
 1 2 3 4 5

1. Digital Output Type

T: TTL
P: PNP
N: NPN

2. PC Sync Option

0: None
P: PC Sync

3. Mounting

F: Flange
S: Servo

4. Connector Location

S: Side Mount
E: End Mount (Not yet implemented)

5. Direction Switch Option

1: Standard (Inside Switches)
2: External Direction Switch

Accessories

CPL-003/8-3/8	3/8" to 3/8" Flexible coupling (1" dia. x 1.25" length)
ECM-19REC-ITT	Mating MS Connector, 19 pin (for single-turn units)
SAC-P12DC-010	Regulated DC Power Supply, 12 VDC @ 1 A
SAC-P24DC-010	Regulated DC Inner Supply, 24 VDC @ 1 A
SAC-RD360-010	Remote angle readout, 0 to 359
SAC-RD999-010	Remote readout/latch, 0 to 999 (CMOS compatible)
SAC-RD999-MUX	Same as above, (TTL/CMOS compatible with MUX output)

WARRANTY

Autotech Controls warrant their products to be free from defects in materials or workmanship for a period of one year from the date of shipment, provided the products have been installed and used under proper conditions. The defective products must be returned to the factory freight prepaid and must be accompanied by a Return Material Authorization (RMA) number. The Company's liability under this limited warranty shall extend only to the repair or replacement of a defective product, at The Company's option. The Company disclaims all liability for any affirmation, promise or representation with respect to the products.

The customer agrees to hold Autotech Controls harmless from, defend, and indemnify Autotech Controls against damages, claims, and expenses arising out of subsequent sales of Autotech Controls' products or products containing components manufactured by Autotech Controls and based upon personal injuries, deaths, property damage, lost profits, and other matters which Buyer, its employees, or subcontractors are or may be to any extent liable, including without limitation penalties imposed by the Consumer Product Safety Act (P.L. 92-573) and liability imposed upon any person pursuant to the Magnuson-Moss Warranty Act (p.l. 93-637), as now in effect or as amended hereafter.

No warranties expressed or implied are created with respect to The Company's products except those expressly contained herein. The customer acknowledges the disclaimers and limitations contained and relies on no other warranties or affirmations.

CAUTION

Autotech Controls' products are carefully engineered and rigorously tested to provide many years of reliable operation. However any solid-state device may fail or malfunction sometime. The user must ensure that his system design has built-in redundancies if Autotech Controls' product is being used in applications where a failure or malfunction of the unit may directly threaten life or cause human injury. The system should be so designed that a single failure or malfunction does not create an unsafe condition. Regularly scheduled inspections, at least once a week, should be made to verify that the redundant circuits are fully functional. All faults should be immediately corrected by repair or replacement of the faulty unit. In addition, the user may have to comply with OSHA, ANSI, state or local standards of safety. The user of Autotech Controls' products assumes all risks of such use and indemnifies Autotech Controls against any damages.

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