Smart-Encoder™: EtherNet/IP & Modbus TCP/IP

1. Introduction

Autotech's Smart-Encoder is a new encoder with following unique characteristics:

- Single turn absolute encoder—no position loss after power cycle
- Resolver based encoder for robustness
- Field programmable resolution—up to 4095 counts per revolution
- Position and RPM display
- Ethernet connectivity
- Field selectable Ethernet/IP and Modbus TCP/IP protocols
- Available in size 25 and 40

Autotech smart encoder with Ethernet option provides a 12 bit absolute encoder position over Ethernet/IP, Modbus TCP/IP. In both cases the encoder acts as a server (or slave). In Modbus the position information is available in holding register 400001. In case of Ethernet/IP, the encoder is configured as a generic Ethernet module with 2 in, 2 output words, and the position is read from input word #1.

A free running counter is provided, which is updated frequently. By reading the counter, and comparing the previous and new values, user can ascertain the working of the encoder.

2. Specifications

INPUT POWER

Voltage: 18-30 VDC
Current: 250 mA @ 24 VDC exclusive of load

POWER-ON SETTLING TIME

Up to 100mSec

POSITION OUTPUT

Over Ethernet

ETHERNET SPEED

10/100Mbit

OUTPUT FORMAT AND RESOLUTION

Field programmable from:

Gray Code: Programmable up to 4096
Binary: Programmable up to 4096
BCD: Programmable up to 1999
(See description within for bit arrangement in BCD format)

PROTOCOLS

Field selectable from:

- Ethernet/IP
- Modbus TCP/IP

CONNECTOR

8 Pin round for power input and Ethernet

USER INTERFACE

4 Digit LED for position/rpm/configuration
2 push buttons

ETHERNET/IP CONNECTION PARAMETERS

Generic Ethernet I/O module, with
2 Input words,
2 Output words, and
1 config byte;
Input Assembly instance: 100
Output Assembly instance: 150
Input word #1: Position information
Input word #2: A free running heartbeat counter
Output words and config byte are not used currently

MODBUS TCP/IP CONNECTION

Implementation: Modbus TCP/IP server (slave)
Functions supported:
03 (read multiple holding registers)
Addresses Supported: Two holding registers
400001: Position information
400002: A free running heartbeat counter

ENVIRONMENTAL

Housing	Size 40 (4.0" dia.)	Size 40 explosion proof	Size 25 (2.5" dia.)
Max. Starting Torque @ 25 °C (oz. in.)	8 (576.1)	8 (576.1)	5 (360.04)
Moment of Inertia ($oz*in^2$)	6.4×10^{-4}	6.4×10^{-4}	4.0×10^{-4}
Max. Slew Speed (RPM)	5000	5000	5000
Shaft Size	5/8"	5/8"	3/8"
Max. Shaft Loading Axial and Radial:	120 lb.	120 lb.	80 lb.
Bearing Life at Max. Mfr. Spec.	2×10^9	2×10^9	2×10^9
Shock	150g for 11ms		100g for 11ms
Vibration	20g to 2000Hz		20g to 2000Hz
Enclosure	NEMA 4/IP 66	NEMA 4x (Div1 , Class 1, Group B,C,D)	NEMA 4/IP 66
Operating Temperature	-20°C to 85° C		
Storage Temperature	-40°C to 85°C		

3. Wiring

1. The shielded ethernet cable should be routed in its own conduit and kept separate from other high voltages/high inductance wiring.

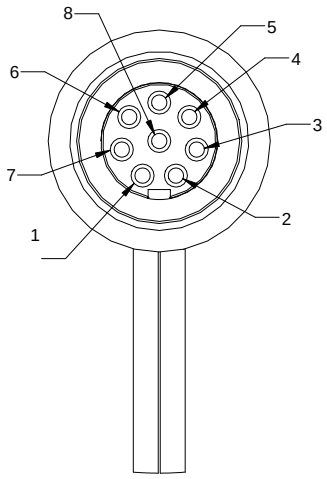
2. Follow the wiring diagram below:

CAUTION:

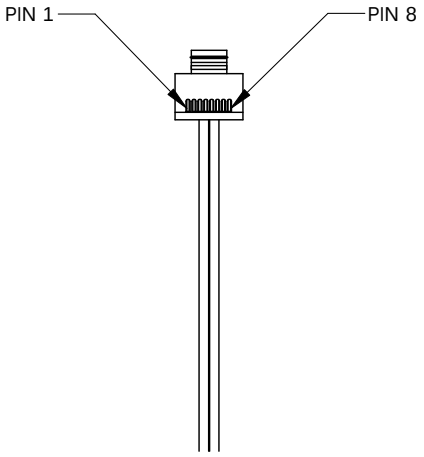
- Upon power-up the outputs are tri-stated for up to 100mSec.
- Check the cable wiring before applying power to the Smart-Encoder.

8 PIN CIRCULAR CONNECTOR PIN #	SIGNAL	CAT 5 COLOR CODE	RJ45 PIN NUMBER
3	Tx +	Green/ White	1
4	TX -	Green	2
5	Rx +	Orange/ White	3
6	Rx -	Orange	6
2	V +	Red	N/C
7	V -	Black	N/C
1	N/C	N/C	N/C
8	N/C	N/C	N/C

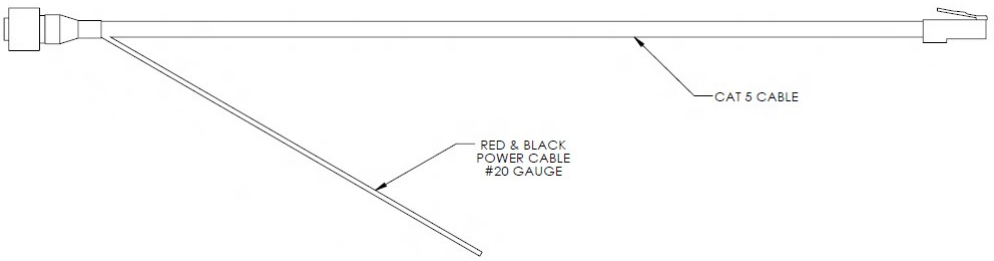
8 Pin Circular Connector



RJ45 Connector



Ethernet Cable Assembly



4. Mounting

Types of Mounting

1. Servo- Mount

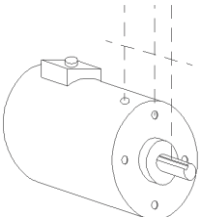
The Smart-Encoder can be either mounted with traditional servo-clamps or through the four 6-32 mounting holes on the face of the resolver.

Zero Reference (±5°): The position at which the flat on the shaft lines up with the screw in the case and the two mounting holes on the Smart-Encoder's face plate.

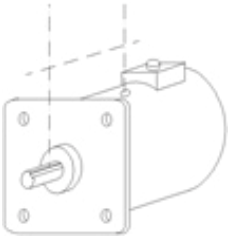
2. Flange-Mount

The Smart-Encoder can be mounted using the four mounting holes on the square face plate. Zero Reference (±5°): The position at which the flat on the shaft lines up with the screw on the housing along with the mounting hole on the Smart-Encoder's face plate.

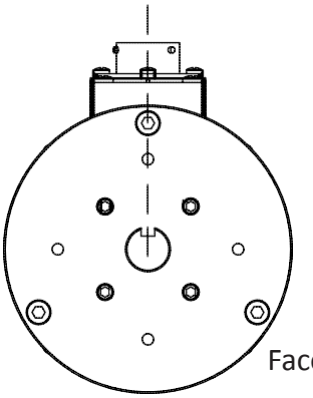
Size 25 Zero Reference



Servo Mount



Flange Mount

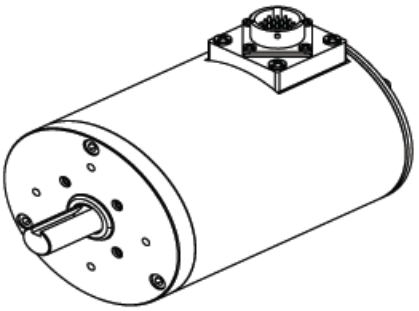


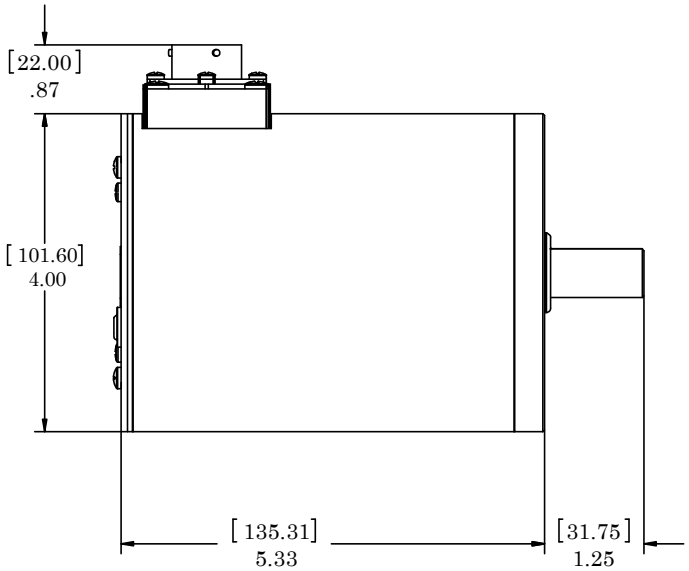
Face Mount

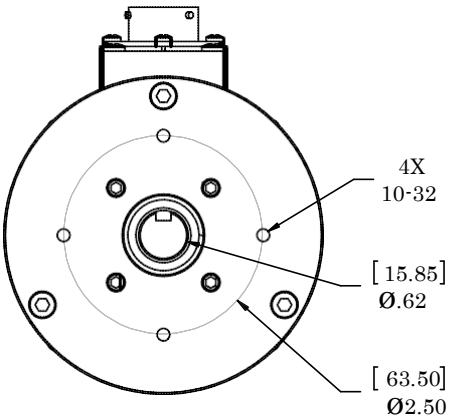
Mounting Dimensions

1. Size 40 Resolver Based (Face Mount)

Units: [mm]
inches

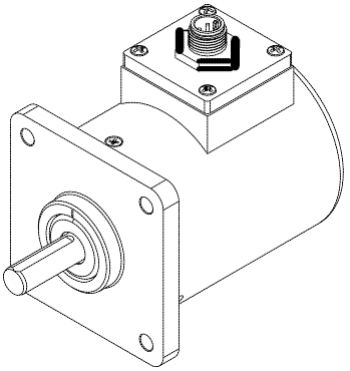


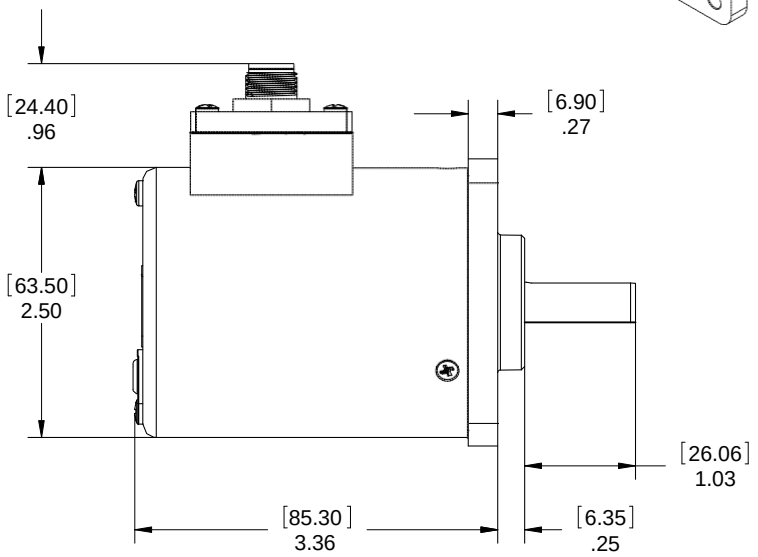


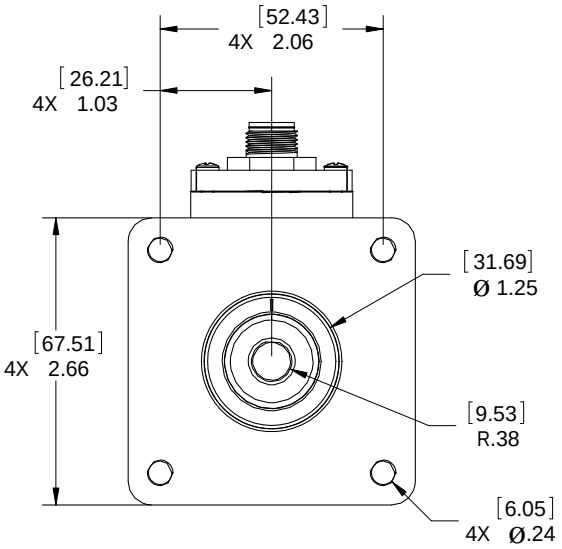


3. Size 25 Ethernet Encoder (Flange Mount)

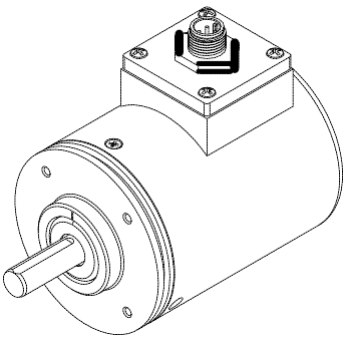
Units: [mm]
inches

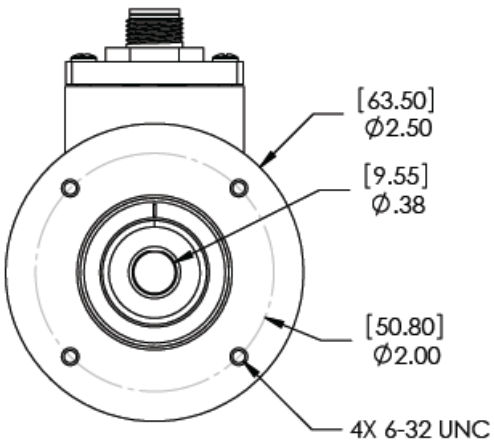


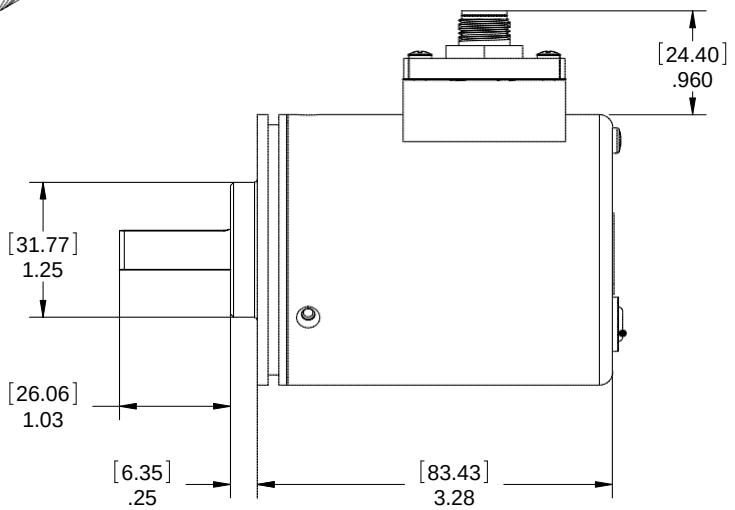




3. Size 25 Resolver (Servo Mount)







5. How to Order

A<u>XX</u> – RA – <u>X</u> – <u>XXXX</u> – S – NWET – <u>XX</u> – <u>XXX</u>
1 2 3 4 5 6 7 8

1. Size
   - **25** 2.5” Diameter
   - **40** 4.0” Diameter

2. Output Format
   - **RA** Resolver Absolute

3. Mounting
   - **F** Flange Mount (Size 25)
   - **S** Servo Mount (Size 25)
   - **A** Face Mount, (Size 40)

4. Input Power/ Output Driver (ET7272)
   - **30V/V** 10-30Vin , Vin=Vout
   - **30V/5** 10-30Vin , Vout =5V (TTL compatible)
   - **30V/N** Single ended N type (current sinking)

5. Output Connector Location
   - **S** Side mount

6. Output Connector Type
   - **NWET** Ethernet Connector Absolute

7. Construction/ Housing
   - **AL** Aluminum
   - **EX** Explosion Proof (Size 40 Only)
   - **SS** Stainless Steel, Water Submersible

8. Gear Trains (Size 40 only)

002 - 2:1	**003** - 3:1	**004** - 4:1
005 - 5:1	**008** - 8:1	**010** - 10:1
012 - 12:1	**016** - 16:1	**020** - 20:1
024 - 24:1	**032** - 32:1	**038** - 38:1
040 - 40:1	**048** - 48:1	**060** - 60:1
064 - 64:1	**080** - 80:1	**100** - 100:1

Product Number Example: A25 – RA – F – 30V/5 – S – NWET – AL

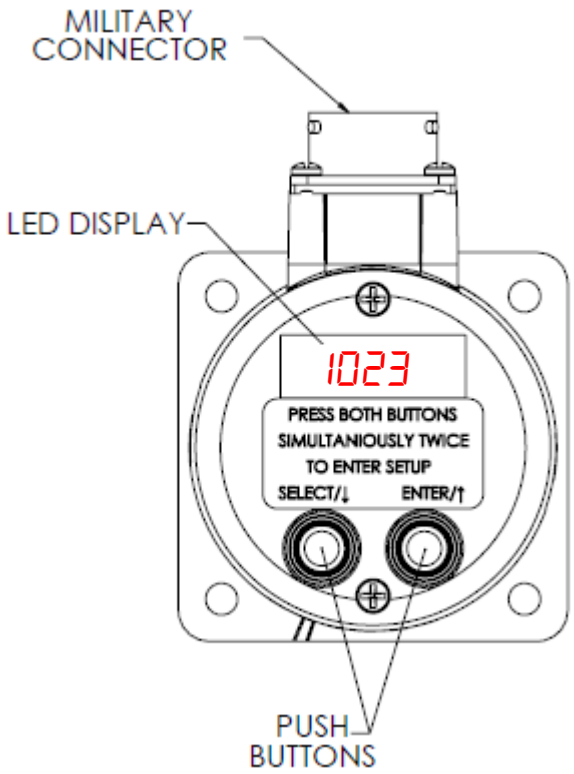
2.5” Diameter Encoder, Resolver Based Absolute, 5V Output Voltage, Ethernet Connector Absolute, Aluminum Housing.

Cable

CBL-ENC8P-Exx 8 PIN M12 Connector on one end and RJ45 on other end. Two (2) conductors for power separated from the ethernet cable on the M12 connector side (see page 2). xxx = length of the cable in feet.

6. Programming

The 7-segment LED Display (shown below) can be used for viewing user programmed parameters.



The Smart-Encoder has two (2) modes of operation **Run Mode** and **Programming Mode**.

1. Run Mode:

When in Run Mode the encoder will display the position or RPM (Revolutions Per Minute). To differentiate between the two parameters, the Resolver includes a decimal point following the right-most digit while displaying the RPM.

RUN MODE	EXAMPLE
Position	2473
RPM	0311.

Left Pushbutton:
Pressing the Left Push button in run mode toggles between the position and RPM display.

Right Pushbutton:
Pressing the Right Push button in the run mode provides the user with a quick overview of the Encoder's Resolution setting and the Firmware Version. After automatically scrolling through the values, the display returns to the Run Mode. These parameters are:

uEr - Firmware Version
PSEt - Position Set
rES - Resolution
tYPE - Type of code
dIr - Direction of rotation

2. Programming Mode

- To enter the programming mode press both of the push buttons simultaneously twice.
- Use the left push button to navigate through the parameters to be set.
- Use the right push button to select the parameter to be programmed.
- Use left push button to decrement and the right to increment values.
- Press both of the push buttons simultaneously to save the changes, program the flash and return to "Programming Mode" (all done in one step).
- After 10 sec. of inactivity in Programming Mode, the Encoder will discard the changes and go back to Run mode.

The following parameters may be programmed on the Smart- Encoder:

Main Menu		
1	Reset	rESt
2	Position Set	PSEt
3	Resolution	rES
4	Output Format	tYPE
5	Direction	dir
6	Password Set	PASS

* If a password has been previously set, upon entering the programming mode the user is immediately prompted to enter the password. The LED display shows PASS momentarily and then 0000. The left push button decreases the value while the right push button increases it. Once the desired value is set press both pushbuttons simultaneously to enter password.

- If an incorrect password is entered, the display prompts for the password once more.
- If an incorrect password is entered again the display shows bAd briefly and then returns to Run Mode.

Reset

In rESt mode, the display flashes the actual (scaled) offset and then displays ZEro. Pressing both push buttons at this time will set the current position of encoder to zero, and brings the Smart-Encoder back to the Programming menu.

Position

In PSEt mode, the LED display shows the actual (scaled) position. The left push button decrease the value while the right push button increases the value. Pressing both push buttons simultaneously saves the current position value and bring the Smart-Encoder back to the Programming menu.

Resolution

In rES mode, the encoder displays the current resolution (counts per turn). The left push button decrease the value while the right push button increases the value. Pressing both push buttons simultaneously saves the current resolution and brings the Smart-Encoder back to the Programming menu.

Note: For Binary and Gray Code the maximum programmable resolution is 4096. For BCD, the Resolution can be programmed up to 1999.

Output Format

In tYPE mode, the encoder displays the current type of output format. There are three types of outputs to choose from:

bin = Binary
bcd = BCD
Gry = Gray Code

Pressing any one of the push buttons cycles thru the available output formats. Pressing both push buttons simultaneously saves the current output format and proceeds to rES mode. Refer to "Resolution" programming above to set the desired counts per turn.

Direction

In dIr mode, the encoder display the current direction of ascending count: CU (clockwise) or CCU (counter clockwise). Pressing both push buttons simultaneously saves the direction and brings the Smart-Encoder back to the Programming menu.

Password

In PASS mode, the encoder displays On to indicate a password has been set or oFF to indicate password feature is disabled.

Pressing any one of the push buttons toggles between password "on" and "off". To disable password feature choose oFF and press both push buttons simultaneously. The encoder will then return to Run Mode. To enable password protection choose On. The encoder then shows the current password stored in memory. The right push button increases the value while left push button decreases it. When the desired value has been selected, pressing both the push buttons simultaneously saves the new password, and returns the Smart-Encoder to Run Mode.

3. Programming Example

This example will illustrate how to program the encoder with the following parameters: a resolution of 360 pulses per revolution, binary type outputs, counter clockwise direction for ascending count, and a password set to "1111".

a. Wire the encoder according to the wiring instructions on page 2 and supply the appropriate power.

b. The encoder is now in Run Mode. You may press the left push button to see the RPM while rotating the shaft of the encoder.

c. Press both push buttons twice simultaneously to enter Programming Mode. The LCD display will now show the first programming screen: rESt.

d. To set the resolution press the left push button two (2) times so that rES shows on the display. Press the right push button to enter resolution set mode. The current resolution will now be displayed. Using the left push button decrement the count to 0360. Press both push buttons simultaneously to save.

e. The display will now show tYPE. Press the right push button to enter the Output Type set mode. Press the left button until you see b in . Now press both push buttons simultaneously to save.

f. The screen will now display d ir. Press the right push button to enter set mode for the direction. Using either push button toggle the direction to CCW and then press Left and Right push button simultaneously to save.

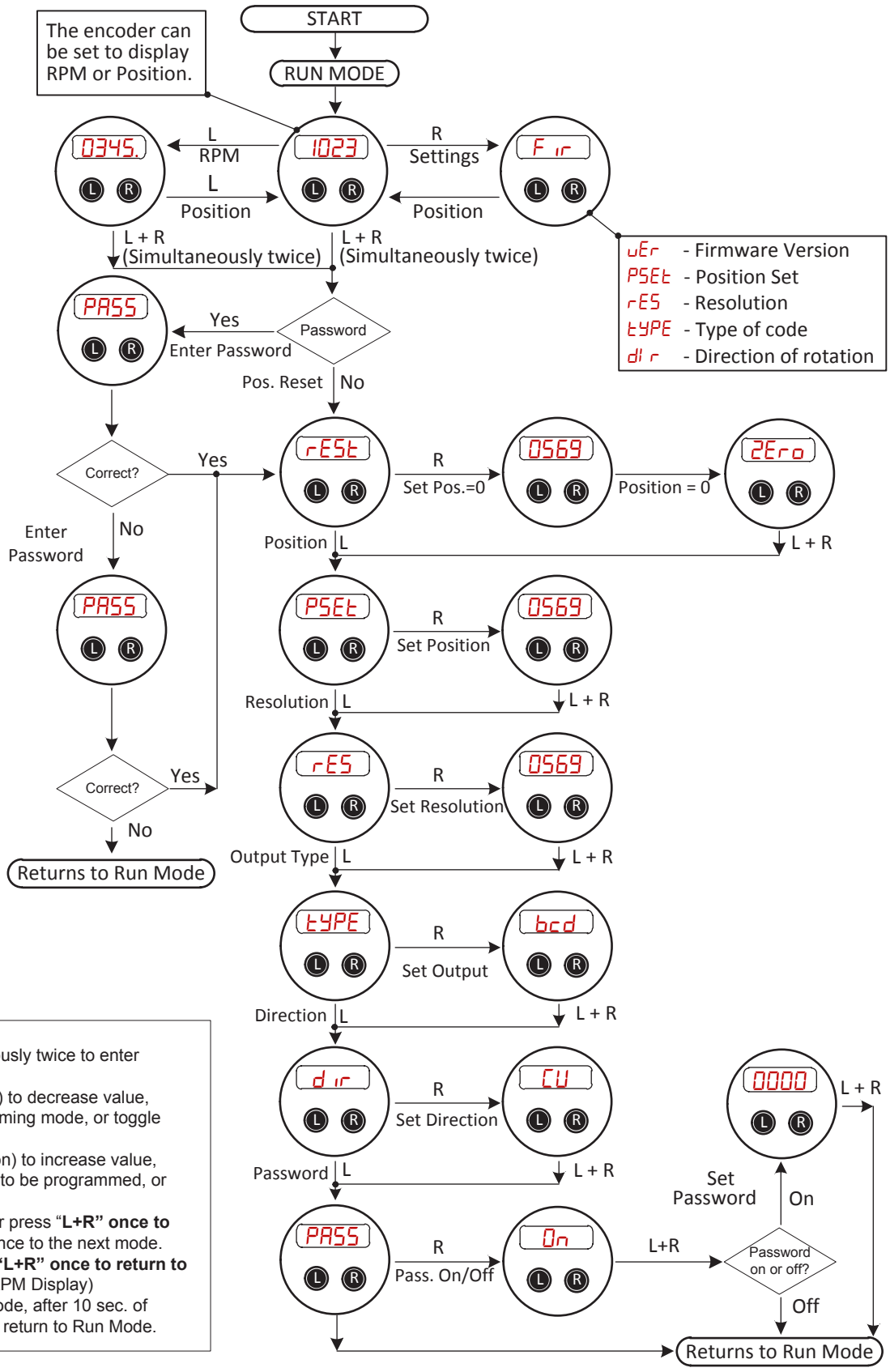
i. The screen will now display 0000 . Using the right push button increment the password to 1111. Press both push buttons to save the password.

h. The encoder will now return to Run Mode.

This completes the programming example. You may check the parameters by pressing the right push button while in run mode. It will be evident the password is set when you enter programming

*For instructions on resetting the password please consult the factory.

4. Programming Flowchart



NOTES

- Press “L + R” Simultaneously twice to enter programming mode.
- Use “L” (left push button) to decrease value, advance to next programming mode, or toggle settings.
- Use “R” (right push button) to increase value, select the current setting to be programmed, or toggle settings.
- While setting a parameter press “**L+R” once to save changes** and advance to the next mode.
- While navigating, **press “L+R” once to return to Run Mode** (Position or RPM Display)
- While in programming mode, after 10 sec. of inactivity the encoder will return to Run Mode.

7. Initial Setup and Configuration

1. Overview

The AVG Ethernet Utility along with the AVG Programmable Absolute Encoder utility are available for download by going to **autotechcontrols.net/SmartEncoderUtility**. You must download both files to set-up and configure the Smart Encoder.

2. AVG Ethernet Utility

This software can perform a scan of all AVG devices connected on the network and allow configuration of the ethernet parameters for the selected device. Follow the outline below for instructions on setting the ethernet parameters for the Smart-Encoder.

1. Run the installation file by double clicking the "AVG IP Config Setup " and follow the on-screen installation instruction.

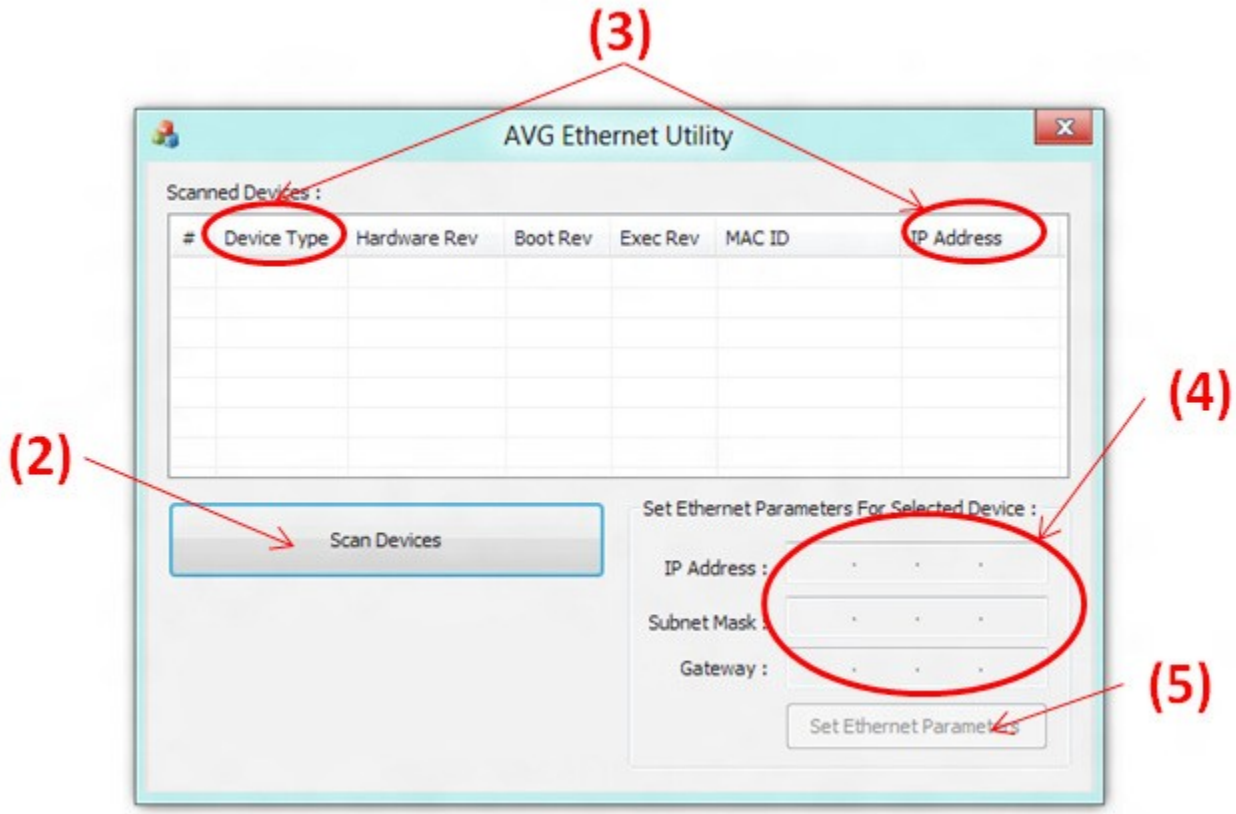
2. After the encoder has been properly connected to the network open the AVG Ethernet Utility and press "Scan Devices".

3. Locate the device by looking up the device type and IP address.

4. Select the device and enter the desired parameters in the fields in the bottom right hand corner.

5. Click "Set Ethernet Parameters" and exit the utility.

*If you are unable to identify the Smart-Encoder, connect the ethernet cable from the encoder directly to the PC and click "Scan Devices".



*AVG Ethernet Utility is available for download at **http://autotechcontrols.net/SmartEncoderUtility**

2. AVG Programmable Absolute Encoder

We can now use the AVG Programmable Absolute Encoder Utility to set the communication protocols and parameters. This software also supports changing the IP address of the unit, but only after the encoder has already been configured to the same Subnet Mask.

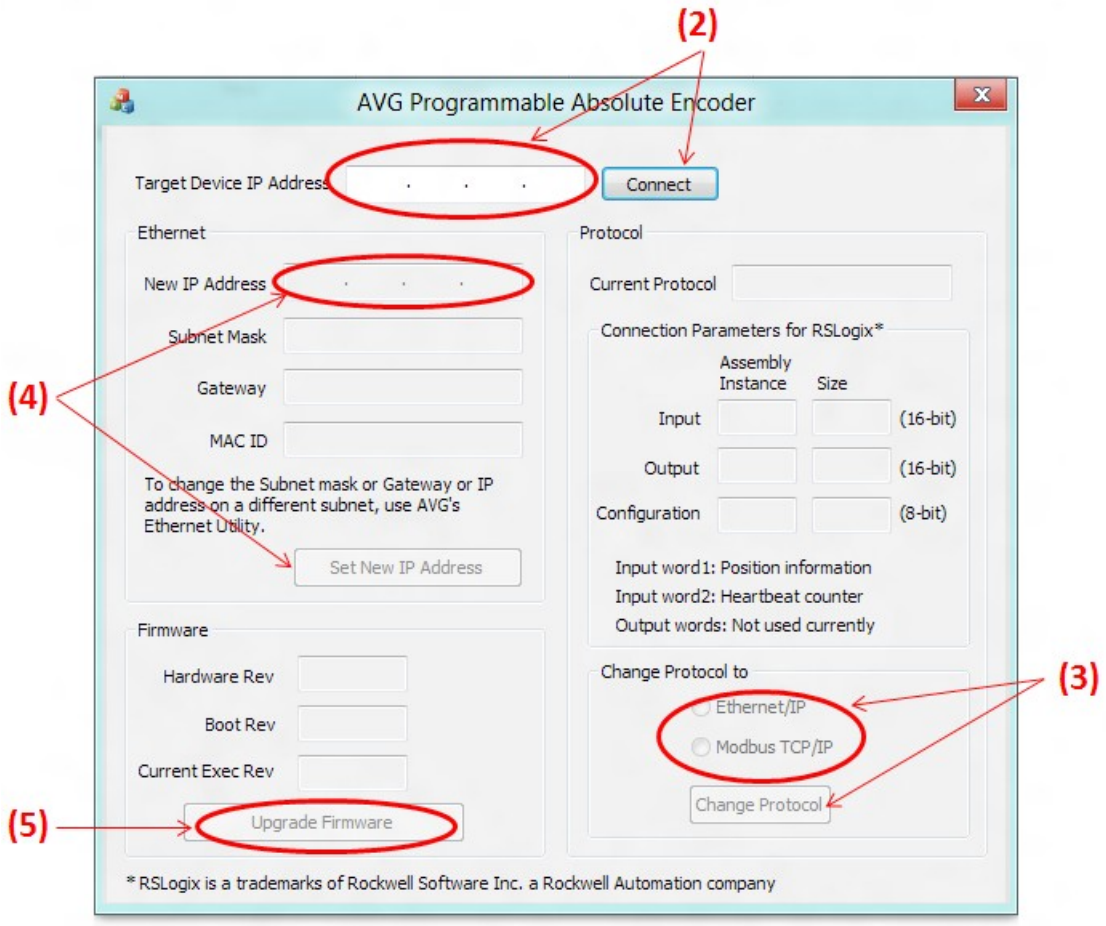
1. Open the installation file by double clicking the "AVG Programmable Absolute Encoder Setup " and follow the on-screen installation instruction.

2. Type the IP Address for the Smart-Encoder that was configured in part 1 and click "Connect".

3. Choose the desired communication protocol by selecting either Ethernet /IP or Modbus TCP/IP in the "Change Protocol to" Section located in the bottom right hand corner of the utility and click "Change Protocol".

4. Note the "Connection Parameters For RSLogix" as these will be necessary to set up communication. Change the IP address of the unit by typing in the New IP address in the "Ethernet" section and then by clicking "Set New IP Address".

5. Any future firmware revisions may be performed by clicking on "Upgrade Firmware" and then selecting the appropriate firmware file from your PC.



*AVG Programmable Absolute Encoder utility is available for download at **http://autotechcontrols.net/SmartEncoderUtility**

3. Setting Position Value

The encoder provides up to 12 bits of position information. The resolutions and format of the information is as per the user-programmed configuration of the encoder.

The position information is available in one 16-bit word (in 400001 for Modbus TCP/IP, and in Word #1 of the input words on Ethernet/IP). The information in the position word is in the same format as configured in the encoder (Binary, BCD, or Grey code). However the bits of BCD information are in reverse order (i.e. MSB of BCD position value is in LSB of the word). See diagram below:

Position word Bits -->	MSB															LSB
	Bit 15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	0	0	0	0	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
Gray Code	0	0	0	0	G11	G10	G9	G8	G7	G6	G5	G4	G3	G2	G1	G0
BCD	0	0	0	0	1	2	4	8	10	20	40	80	100	200	400	800

If your application requires using encoder in the BCD format, you would need to re-order the bits within the word. For example, bit0 of the word and bit11 would be swapped; bit1 and bit10 would be swapped, and so on, until all the BCD bits are in proper order.

4. Heartbeat Counter

Heartbeat counter is a free running counter which is updated frequently. This can be used to verify that the unit is functioning properly.

WARRANTY

Autotech Controls warrants 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.

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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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