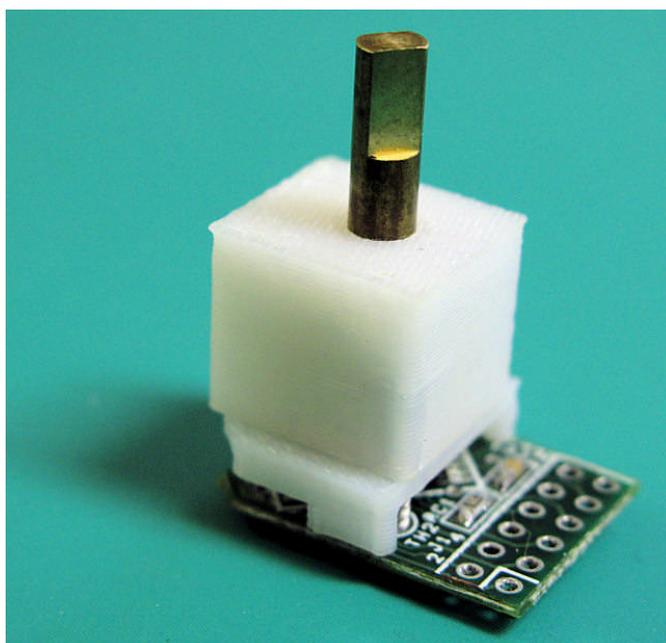


NUBOTICS

ME-110 Unicoder

Product Manual



Entry Level Incremental and Absolute High Resolution Encoder

1.0 4/8/2009

ME-110 Unicoder Features

- absolute nonvolatile angle sensing
- 1024 positions per rotation
- 3.3 volt operation
- readable angle
- incremental quadrature and index pulse output
- programmability (using Austria Microsystem's AS5040 interface):
 - index pulse location
 - zero angle location
 - resolution: 7, 8, 9, and 10 bit
 - direction of rotation (CW or CCW)
 - output modes: quadrature, sign-magnitude, or BLDC motor commutation

Description

Nubotics breaks new ground with this unique new sensor. Combining the best of both incremental and absolute encoders, the Nubotics Unicoder ME-110 solves many problems for electromechanical designers. And, as the shaft and case are designed to replace rectangular potentiometers used for angle sensing in many standard size RC servos, robot builders now have a powerful new way to measure joint position, wheel velocity, total distance travelled, and more.

Inside, the ME-110 contains an Austria Microsystems AS5040 magnetic encoder chip, with a matching rare earth magnet carefully mounted above the chip so that it can rotate over the center of the chip's die. The magnet's N and S poles are radially aligned, so that no matter what the magnet's orientation is, the encoder chip's 8 Hall effect sensors and DSP can determine its absolute position. The chip also provides standard quadrature incremental encoder outputs with a once-around index pulse. By changing the mode of the chip, one can instead obtain sign/magnitude outputs rather than quadrature. In yet another mode, it can even generate 3 phase BLDC motor control signals.

The ME-110 is designed for low speed applications only, due to its reliance on the bearing properties of ABS plastic.

Installation



Internal to an RC servo (continuous rotation):

The ME-110 Unicoder encoder can be press fit in the rectangular depression inside a standard size RC servo (depending on make and model) once the RC servo's feedback potentiometer has been removed (a common operation when converting an RC servo for continuous rotation operation). By adding an ME-110 Unicoder encoder, a customer supplied controller can accurately measure and control the operation of a continuous rotation servo.

Internal to an RC servo (angle positioning):

In this application, the feedback between shaft angle, as sensed by the ME-110, and control of the RC servo's DC motor must be provided in one of two ways:

1. External to the RC servo, a customer-developed controller produces RC servo control pulses to drive the RC servo electronics, while using the ME-110 as a feedback device, using a control system such as a PID position loop to effect desired motion.
2. External to the RC servo, a customer-developed controller, which includes a DC motor driver, directly controls the RC servo's DC motor itself, again using the ME-110 as a feedback device for the customer's control system.

NOTE: as the RC servo's feedback potentiometer has to be removed to

allow the ME-110 to be mounted inside, the RC servo control circuit will no longer be provided with the feedback signal it needs to close the loop and thus control position. As a result, some other means must be provided as described in points 1 and 2.

External to an RC servo (angle positioning):

By mechanically coupling the ME-110 Unicoder encoder to the RC servo output shaft externally, the RC servo control electronics continue to provide angle control using the internal potentiometer for feedback. Meanwhile, the customer-provided controller can use the ME-110 Unicoder encoder to sense the actual position of the shaft.

Other Applications:

The ME-110 Unicoder encoder is well suited for all kinds of rotary motion sensing.

Shaft:

The ME-110 Unicoder encoder's .125" diameter shaft is not designed to be load bearing.

Case retention:

The case can be press fit in a hole properly undersized for the nominal Unicoder dimension of .394" x .438". Other mounting schemes are possible.

Communications

The ME-110 Unicoder encoder makes the Austria Microsystems AS5040 signals available to the user; these signals include a PWM signal whose duty cycle is proportional to shaft angle; Index, ChA, and ChB incremental signals; and a unique synchronous serial programming and query interface as specified on the AS5040 datasheet.

Note: data is transferred most significant bit first.

Querying is done by keeping Prog low, then asserting /CS low with CLK high, then clocking the data using the CLK line. On each of 16 subsequent falling edges of CLK, sample the data on pin DO. Return CLK high, then /CS high to end the transfer.

Programming is done by asserting CLK and /CS low, then raising Prog high. After a delay, assert /CS high. After another delay, start transferring data. Assert each data bit in turn on the Prog line, clocking it in (after setting the Prog line to the value of the current bit) by raising and lowering the CLK line. Repeat for all 16 data bits. Finally, end the programming cycle with Prog and CLK low, while dropping /CS.

Please see the AS5040 data sheet for details, available here:
<http://www.austriamicrosystems.com/eng/Products/Magnetic-Encoders/Rotary-Encoders/AS5040>

AS5040 Query Register

<i>Bit Number</i>	<i>Name</i>	<i>Meaning</i>
0	Parity	Even parity of bits 1-15 for transmission error detection
1	Mag DEC	High when magnet pulled away from IC
2	Mag INC	High when magnet pushed towards IC; both high when out of range
3	LIN	Linearity alarm; when high, Angle data may be invalid
4	COF	Cordic overflow; when high, Angle data is invalid
5	OCF	Offset compensation finished; high when data is valid
6-15	Angle	Absolute angular position

AS5040 Program Register

<i>Bit Number</i>	<i>Name</i>	<i>Meaning</i>
0-1	Mode	output mode: 0: default; 1: quadrature; 2: sign/magnitude; 3: BLDC commutation
2-3	Div	resolution: 0: 10 bit; 1: 9 bit; 2: 8 bit; 3: 7 bit
4	IndexLen	0: 1 pulse wide; 1: 3 pulses wide
5-14	Zero/Idx	location of zero angle and index pulse (always 10 bit resolution)
15	CCW	0: angle increases clockwise; 1: angle increases counter clockwise

Servo Compatibility

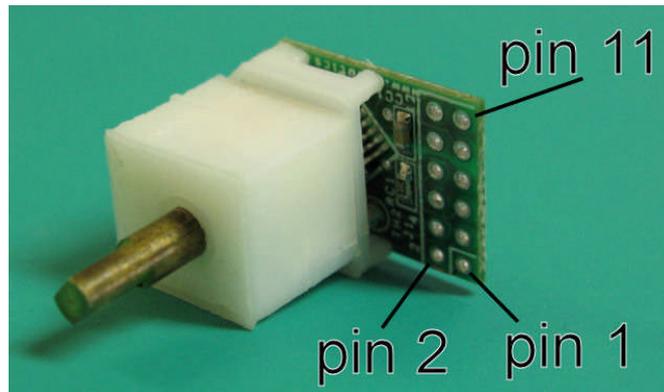
The ME-110's rectangular shape fits in the potentiometer recess of some makes and models of hobby servos. The following is an incomplete list.

Manufacturer	Model
GWS	S03N
	S03T
	S03TXF
	S06
Hitec	HS322HD

Note: if your specific servo is not listed, it may still fit. However, you will have to open up the servo case to determine the shape and size of the potentiometer. Many models use a round potentiometer, the result of which is that the currently shipping versions of the ME-110 would be incompatible. Opening of any RC servo will most likely violate it's manufacturer's warranty.

Connector Pinout

Pin	Mode			Description
	Quadrature	Sign/Magnitude	Commutation	
1	MagDec			open drain reduced magnetic field indicator
2	MagInc			open drain increased magnetic field indicator
3	PWM	PWM	LSB	1KHz PWM signal, where duty cycle indicates angle
4	Index	Index	W	once-around index pulse or BLDC motor W phase
5	/CS			chip select; pull low to enable ChA/ChB after power on
6	Vdd			+3.3v max
7	DO			data out of synchronous serial interface
8	Clk			clock for synchronous serial interface
9	ChB	DIR	V	quadrature B, rotation direction, or BLDC V phase
10	ChA	CLK	U	quadrature A, rotation clock, or BLDC U phase
11	Prog			data in for synchronous serial interface
12	Gnd			ground



Specifications

Value	Min	Max	Units
Supply Voltage, Vcc	3.0	3.6	Volts
Supply Current	16	21	mA
Resolution	64	1024	Ticks/360°
PWM Frequency	975.6		Hz
PWM Period	1025		µs
PWM Duty Cycle	1	1024	µs
Query Clock Rate	>0	1000	KHz
Programming Clock Rate	>0	250	KHz
Shaft Speed	0	240	RPM
Shaft Diameter	.125		inches
Shaft Length	.375		
Case Width	.394		
Case Length	.438		
PCB Width	.500		
PCB Length	.700		
Overall Width	.560		
Overall Length	.713		
Overall Height	.955		

Interfacing Examples

Please visit www.nubotics.com to view and download example code for Ridgesoft RoboJDE Java and other controllers.
 {contact Nubotics for correct URL – these are not public yet}

Document History
 Rev 1.0 - initial draft

For more information visit: www.nubotics.com
 Produced by Noetic Design, Inc., 25 NW 23rd PL, STE 6 PMB 181, Portland OR 97210
 Copyright ©2009 Noetic Design, Inc. All rights reserved