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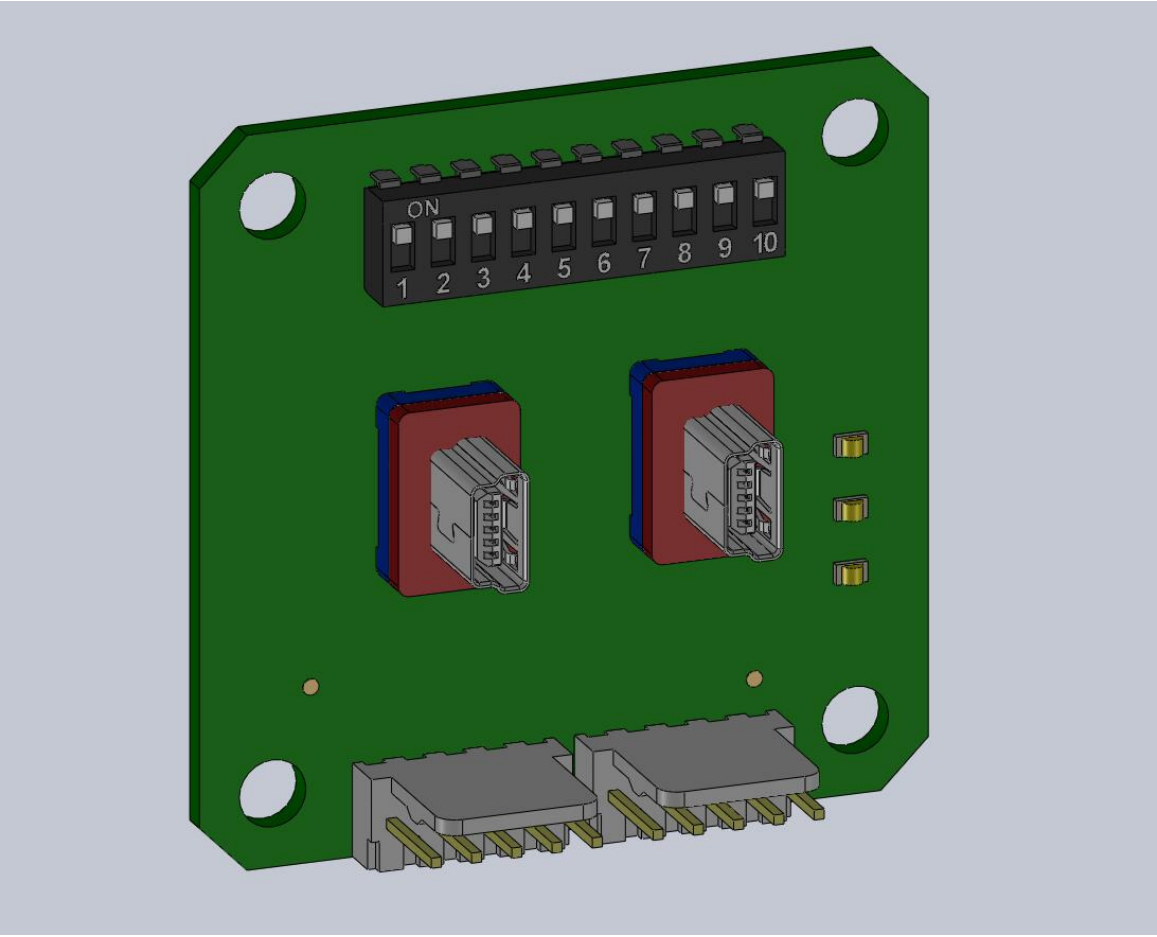
ENCODER12

SEBA Design P/L User Manual



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Contents

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Description

The Encoder12 is a digital encoder designed for rotational encoding used in position control systems, brushless dc motor applications, servo drive systems and any other applications where absolute position is required.

Features

- 6 step Hall output for BLDC motor commutation
- Quad encoder output with zero signal
- Serial data sending absolute position
- Simultaneous Hall step and encoder outputs allowing high resolution control of BLDC motors
- Re-programmable zero position and Hall commutation angle
- Advanced high speed processing calculates speed and automatically adjusts hall output to ensure accurate phase angle firing up to 10,000 rpm
- Selectable number of poles for BLDC motors
- Adjustable advance angle firing to improve motor efficiency
- Selectable Baud rate
- Two serial protocols settings
- Selectable Quad encoder resolution
- LED indication of signals
- Simple installation using magnet at end of motor shaft
- Two connector types available - modified mini-USB and friction lock crimp terminals

Usage

BLDC

Normal Hall sensors fitted to BLDC motors have a fixed firing point set to the center of the phase commutation boundary so that both direction of rotation are the same, these high speed devices allow for accurate firing of each phase, however as these are fixed devices, usually fitted deep inside the motor there is no ability to adjust the firing angle. By advancing the firing angle the timing can be changed and motor efficiency can be adjusted to the highest point. A fixed encoder system can only be optimized in one direction since the reverse direction would then have a retarded firing angle causing large currents, additionally to find the optimum point could take hours to adjust the buried halls.

By using the Encoder12 unit fitted to the motor, advance firing angles can easily and quickly be adjusted via the Dip switches while the motor is running. The high speed processor will automatically adjust the angle according to direction which keeps the optimum point in both directions for the best possible efficiency and maximum power use for frame size.

Quad

Highly reliable contactless magnetic technology creates a very accurate 4096 pulse per rev quadrature encoding output. Since the flux of the magnet is measured an absolute position is derived meaning that the angle is known without having to pass through a zero. This gives the ability to set the zero point offset within the onboard processor so that the zero can be adjusted to any angle.

The resolution can quickly be adjusted during operation via the dip switches to suite the application at hand.

Serial

The high speed serial port can run up to 1,000,000 Baud for high speed data transfer of the absolute position which allows for every position to be sent at over 700rpm. Since the absolute position is transmitted missed pulses are irrelevant as the updated position will be supplied in the next transmission. At higher speeds the receiving system will need to take into account the transmission time when making calculations.

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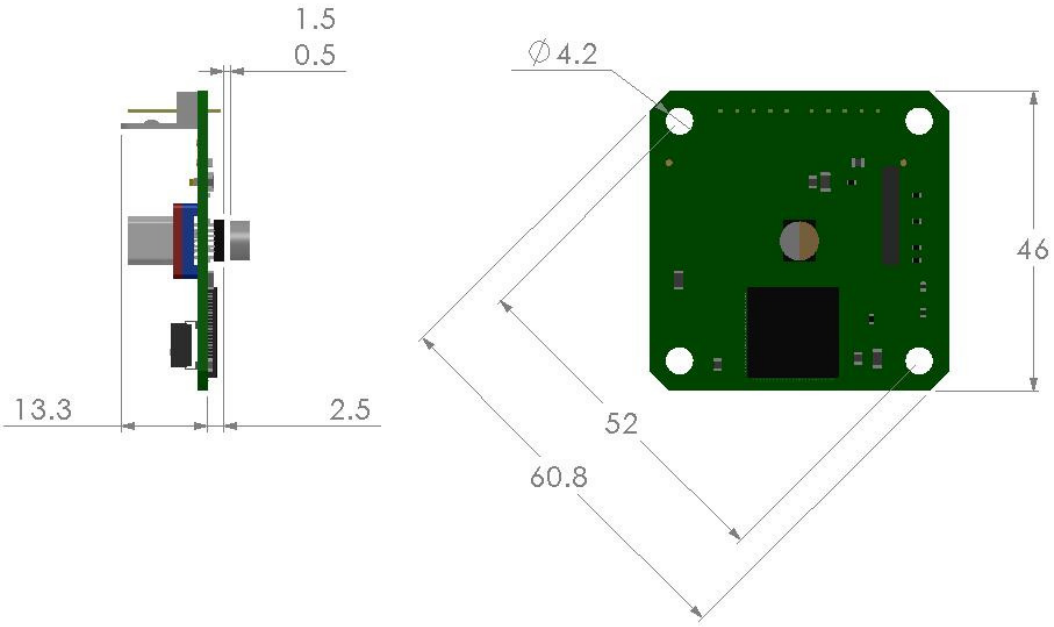
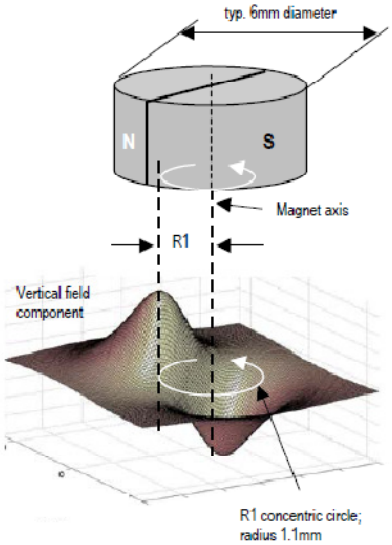
Installation



Mounting holes are located on a 52mm PCD for use with M4 mounting screws. The magnet should be placed on the end of the rotating shaft in the center of the PCB as shown above.



Magnet selection is important, typically the magnet should be 6mmØ x 3mm thick. Magnetic materials such as rare earth AlNiCo/SmCo5 or NdFeb are recommended. The magnetic field strength perpendicular to the die surface has to be in the range of ±45mT…±75mT (peak).

The gap between the Magnet and the pickup IC should be between 0.5 - 1.5mm with a radial tolerance of 0.25mm from center.

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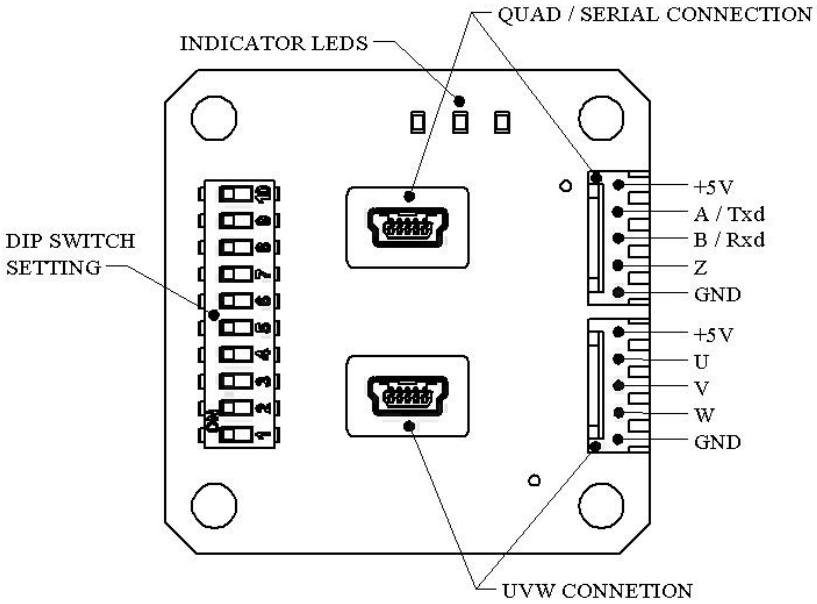
Wiring



Connections can be made either via the mini-USB connector or the friction lock crimp header. The wiring positions are shown above. If using standard USB cable then the colouring is as follows:

Quad / Serial connection	UVW Connection
Red = +5V	Red = +5V
White = A/Txd	White = U
Green = B/Rxd	Green = V
Black = Z	Black = W
Shield = GND	Shield = GND

!Warning! The USB connectors are not USB data ports and must not be attached to a USB data system. This may cause damage to both the encoder and your USB system!

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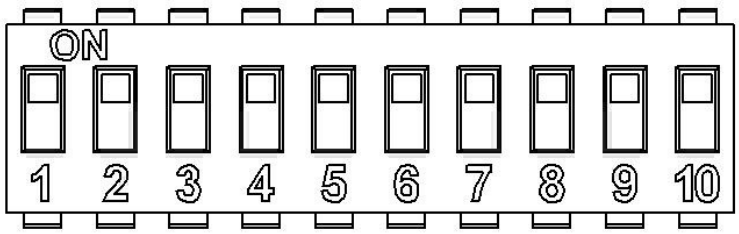
Electrical Specifications

Maximum supply range	4.5V - 5.5V
Nominal supply voltage	5V
Nominal supply current	60mA
Max current per signal	4mA (must be externally limited)
Max voltage per signal	supply ±0.5V
Operating Temperature	-40 - +85C

Dipswitch Settings

The 10way dipswitch located on the front is used for programming all features of the Encoder12. These set how the encoder will control the output signals. Once programmed the data is stored on the internal flash memory and are recalled during each power up. Careful attention should be paid to setting the zero position on a BLDC motor to ensure that commutation is correct before trying to run at full speed as this may cause damage to your motor control equipment



SWITCH	Program mode	Run mode - Quad	Run mode - Serial
DIP10	on = program mode	off = run mode	off = run mode
DIP9	Toggle to set Zero	off = Quad, on = Serial	off = Quad, on = Serial
DIP8-5	Advance angle	LED mode	Baud rate
DIP4-1	Number of pole pairs	Quad encoder resolution	LED mode / Serial mode

Initial Setup

The general method of setup is to program the zero point, advance angle and BLDC motor poles with the program dipswitch(10) set to on, these settings are saved to flash when the zero dipswitch(9) is toggled from on to off. When this is completed the rest of the user settings, Quad / Serial mode select, Baud select and Quad encoder resolution can be changed as required without affecting the zero position. Once set to run mode zero cannot be re-programmed without toggling the power, this is to help prevent accidental storage of an unwanted zero position, all other UVW settings will get stored whenever dipswitch(10) is toggled to off.

To ensure that the zero is not accidently re-programmed do not toggle dipswitch(9) while dipswitch(10) is on.

BLDC setup method

1. Set Dip(10) to on
2. Set Dip(9) to on
3. Set number of pole pairs as per table 2 on Dip(4-1)
4. Set advance angle as per table 3 on Dip(8-5)
5. Power motor phase-U with +ve current (enough to lock rotor in position)
6. Power motor phase-V with –ve current
7. Enable supply to encoder
8. Wait for LED1 to light
9. Set Dip(9) to off to save Zero point
10. Wait for LED2 to light
11. Remove current from motor windings
12. Set Dip(10) to off to save UVW settings
13. Six step Hall encoding can now be used for the BLDC motor commutation on the UVW connector

Note: Motor manufactures can also refer to windings as ABC, where A=U, B=V and C=W.

ABZ setup method

1. Set Dip(10) to off
2. Set Dip(9) to off
3. Set Dip(8) to on for Quad LED's or off for UVW LED's
4. Set Dip(7) to on for magnet check or off for position indication
5. Set bit resolution of quad encoding as per table 4 on Dip(4-1)
6. Quad encoding output can now be used on the Quad/Serial connector

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Serial data setup method

1. Set Dip(10) to off
2. Set Dip(9) to on
3. Set Baud rate as per table 5 on Dip(8-5)
4. Set Dip(4) to on for Quad LED's or off for UVW LED's
5. Set Dip(3) to on for data transmission or off for ASCII transmission
6. Set Dip(2) to on for Magnet check or off for position indication
7. Serial data is now output on the Quad/Serial connector at the selected Baud rate

Serial Data Protocol

Serial data is transmitted on the Txd pin at the selected Baud rate. The data is in 8bit data, no parity, 1 stop bit, LSB transfer. There are two data protocols available.

Data only Protocol

Data is continually transmitted as a two byte block. The position data is stored in bits 0-6 of each byte with bit 7 indicating high or low part of position word. The data is left justified between the bytes.

Examples of transmission are below:
0b1111111, 0b01111100 indicates position 4095
0b1001110, 0b00001100 indicates position 451
0b1000000, 0b00000000 indicates position 0

ASCII Protocol

Data is continually transmitted as an ASCII representation of the current position, followed by <CR>.

Examples of transmission are below:
'4' '0' '9' '5' <CR> indicates position 4095
'4' '5' '1' <CR> indicates position 451
'0' <CR> indicates position 0

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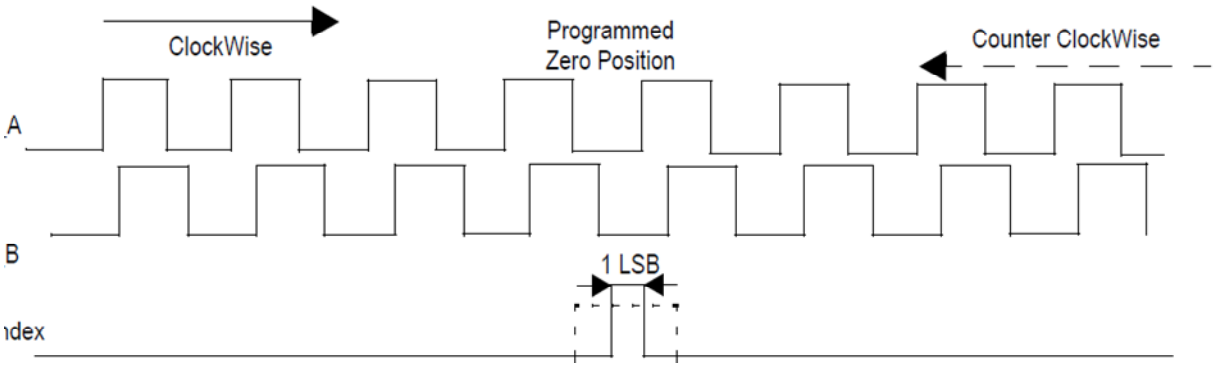
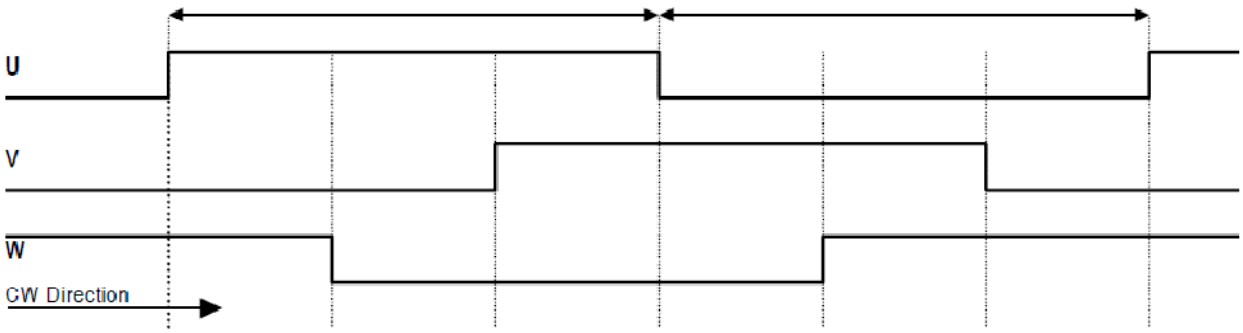
Output signals

Quad Encoder Output signal



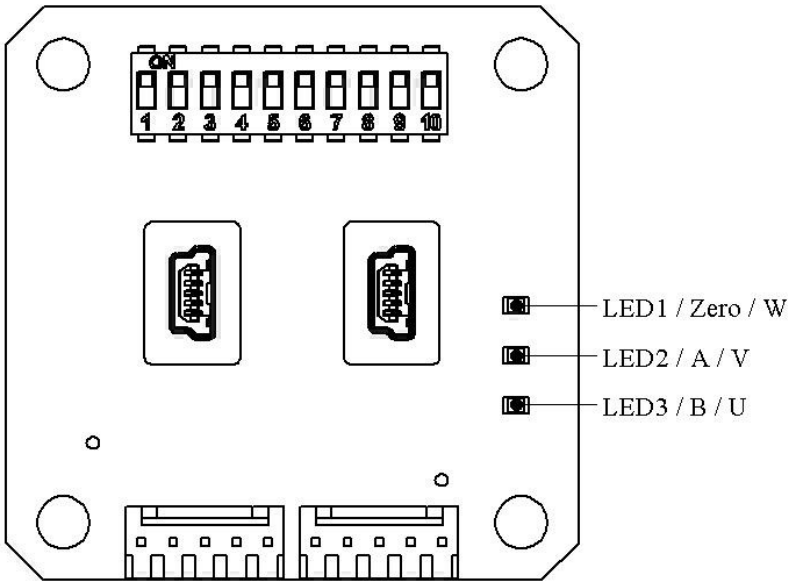
6 Step Hall Output signal



Magnet Status

The magnet status can be checked by setting Dip(7) in Quad mode or Dip(2) in serial mode. This disables the normal position display on the LED and shows the current status of the magnet strength and positioning. This status is indicated as per the below table:

LED1	LED2	LED3	status
on	on	on	magnet ok
off	on	on	magnet on yellow range (Unit may be operational up to 10bit)
off	off	on	magnet in red range (Unit may be operational up to 8bit)



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Dipswitch Tables

Table2

Number of pole pairs for UVW Hall commutation. (0 = off, 1 = on)

Dip(4)	Dip(3)	Dip(2)	Dip(1)	Pole Pairs
0	0	0	0	1
0	0	0	1	2
0	0	1	0	3
0	0	1	1	4
0	1	0	0	5
0	1	0	1	6
0	1	1	0	7
0	1	1	1	8
1	0	0	0	9
1	0	0	1	10
1	0	1	0	11
1	0	1	1	12
1	1	0	0	13
1	1	0	1	14
1	1	1	0	15
1	1	1	1	16

Table3

Advance angle for UVW Hall commutation. (0 = off, 1 = on)

Dip(8)	Dip(7)	Dip(6)	Dip(5)	Angle °
0	0	0	0	0
0	0	0	1	0.2
0	0	1	0	0.4
0	0	1	1	0.6
0	1	0	0	0.8
0	1	0	1	1.0
0	1	1	0	1.2
0	1	1	1	1.4
1	0	0	0	1.6
1	0	0	1	1.8
1	0	1	0	2.0
1	0	1	1	2.2
1	1	0	0	2.4
1	1	0	1	2.6
1	1	1	0	2.8
1	1	1	1	3.0

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Table4

Quad encoder resolution (0 = off, 1 = on)

Dip(4)	Dip(3)	Dip(2)	Dip(1)	Resolution (counts per rev)
0	0	0	0	12 bit (4096)
0	0	0	1	11 bit (2048)
0	0	1	0	10 bit (1024)
0	0	1	1	9 bit (512)
0	1	0	0	8 bit (256)
0	1	0	1	7 bit (128)
0	1	1	0	6 bit (64)
0	1	1	1	5 bit (32)
1	0	0	0	4 bit (16)
1	0	0	1	3 bit (8)
1	0	1	0	2 bit (4)
1	0	1	1	NA
1	1	0	0	NA
1	1	0	1	NA
1	1	1	0	NA
1	1	1	1	NA

Table5

Baud rate select (0 = off, 1 = on)

Dip(8)	Dip(7)	Dip(6)	Dip(5)	Baud
0	0	0	0	1Mhz
0	0	0	1	921600
0	0	1	0	460800
0	0	1	1	256000
0	1	0	0	230400
0	1	0	1	153600
0	1	1	0	128000
0	1	1	1	115200
1	0	0	0	57600
1	0	0	1	56000
1	0	1	0	38400
1	0	1	1	28800
1	1	0	0	19200
1	1	0	1	14400
1	1	1	0	9600
1	1	1	1	4800