



BLD04A

Brushless DC Motor Driver



User's Manual

V1.0

MARCH 2010

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1. INTRODUCTION

BLD04A is designed to drive the Linix 10W and 30W brushless dc (BLDC) motor. It offers several enhancements over the original Linix BLDC motor driver such as closed loop speed control, UART interface and better protection for both the motor as well as the driver. Besides that, the interface of BLD04A is compatible with the original Linix BLDC motor driver and this makes the upgrading for existing users an effortless process. This BLDC motor driver is designed with the capabilities and features as below:

- Powered by high performance dsPIC Digital Signal Controller.
- Operating at DC +24V \pm 15%.
- Support up to 4A per phase.
- 4-Quadrant control.
- 5V logic level input for Start/Stop, Run/Brake, Direction and Alarm Reset.
- Support analog voltage (0 – 5V) or PWM signal for speed control.
- Support UART interface.
- Selectable open loop or closed loop speed control.
- Current limiter.
- 12 pulses per revolution encoder output.
- Alarm indicator for overvoltage, undervoltage, out-of-phase and overload alarm.
- Comes with casing for better durability and easier mounting.
- Support the following Linix BLDC motor:
 - 10 Watt: 45ZWN10-5G
45ZWN10-15G
45ZWN10-30G
 - 30 Watt: 45ZWN30-10G
45ZWN30-20G

2. PACKING LIST

Please check the parts and components according to the packing list. If there are any parts missing, please contact us at sales@cytron.com.my immediately.



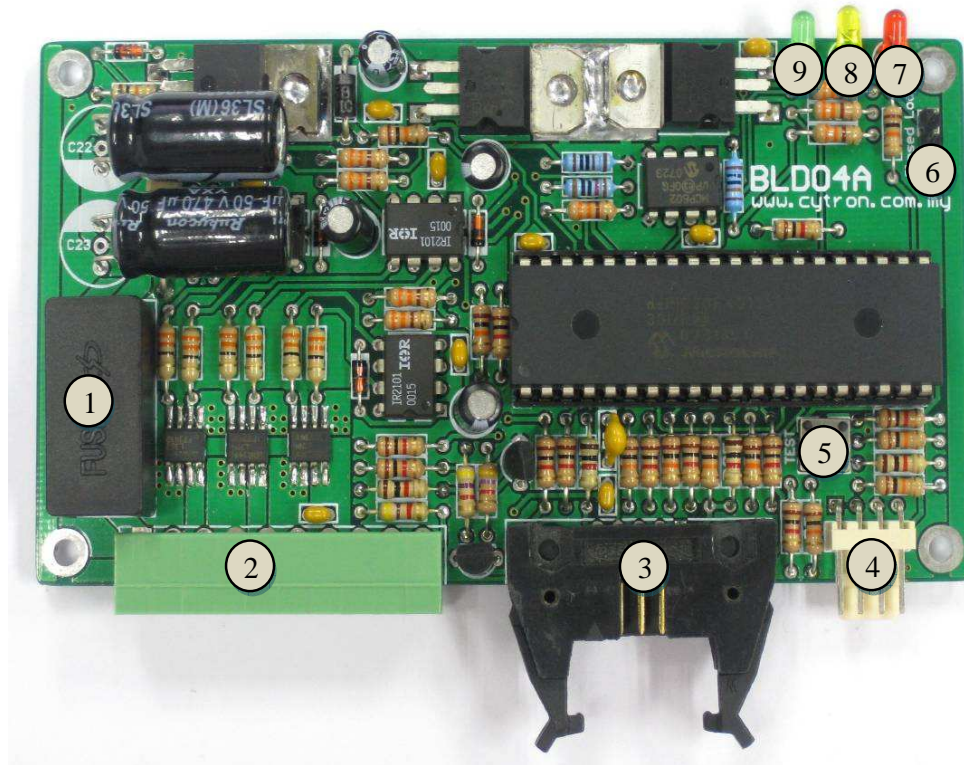
1. 1 x BLD04A Brushless DC Motor Driver
2. 1 x Rainbow Cable
3. 16 x 2510 Iron Pin
4. 1 x 2510-12 Female Connector
5. 1 x 2510-04 Female Connector
6. 1 x Pluggable Terminal Block
7. 1 x Mini Jumper (On the board)
8. User's manual, sample source codes and GUI can be downloaded from <http://www.cytron.com.my>.

3. PRODUCT SPECIFICATION AND LIMITATIONS

No	Parameters	Max	Typical	Min	Unit
1.	Input voltage	28	24	20	V
2.	Output Current (Per Phase)	4	-	-	A
3.	Speed				
	Open Loop*	3500	-	250	rpm
	Closed Loop	3000	-	400	rpm

* The open loop speed may vary from motor to motor.

4. BOARD LAYOUT



Components on BLD04A



BLD04A pins orientation

Components on BLD04A and their functions:

1. Fuse (5A) – To protect the BLD04A.

2. Pluggable Terminal Block – Connect to motor and power source.

Pin No.	Pin Name	Wire Color	Description
1	+24V	Red	Positive supply.
2	Ground	Black	Negative supply.
3	Motor Coil A	White	Connect to motor coil A.
4	Motor Coil B	Blue	Connect to motor coil B.
5	Motor Coil C	Green	Connect to motor coil C.
6	+5V	Red	Positive supply to the hall sensor.
7	Ground	Black	Negative supply to the hall sensor.
8	Hall Sensor A	White	Connect to hall sensor A.
9	Hall Sensor B	Blue	Connect to hall sensor B.
10	Hall Sensor C	Green	Connect to hall sensor C.

3. FRC Header – Parallel IO interface

Pin No.	Pin Name	Description
1	Start/Stop*	Internally pulled high, active low.
2	Run/Brake*	Internally pulled high, active low.
3	Direction*	Internally pulled high, active low.
4	Alarm Reset*	Internally pulled high, active low.
5	VRH	Connect to the higher terminal of external potentiometer for speed control.
6	Speed Input	PWM or analog voltage (0 – 5V) input for speed control.
7	VRL	Connect to the lower terminal of external potentiometer for speed control.
8	Ground	Logic ground.
9	Encoder Output**	Open Collector output, 12 pulses per revolution.
10	Alarm Output**	Open Collector output, active low.

* These pins are TTL / CMOS compatible and are internally pulled high. They can be controlled by a microcontroller output or a switch.

** These pins are open collector outputs. When they are connected to the input of the microcontroller, an external pull up resistor (1K – 10K Ohm).

Pin 1 (Start/Stop) and pin 2 (Run/Brake) – These 2 pins are used together to control the movement of the brushless motor. The effects of each pin are as follow:

Pin 1 (Start/Stop)	Pin 2 (Run/Brake)	Description
X (Don't Care)	High	Motor stops instantaneously (brake)
High	Low	Motor stops naturally (free running stop)
Low	Low	Motor rotates

Pin 3 (Direction) – This pin controls the direction of the motor. The actual direction of the motor depends on the gear ratio of the gearbox.

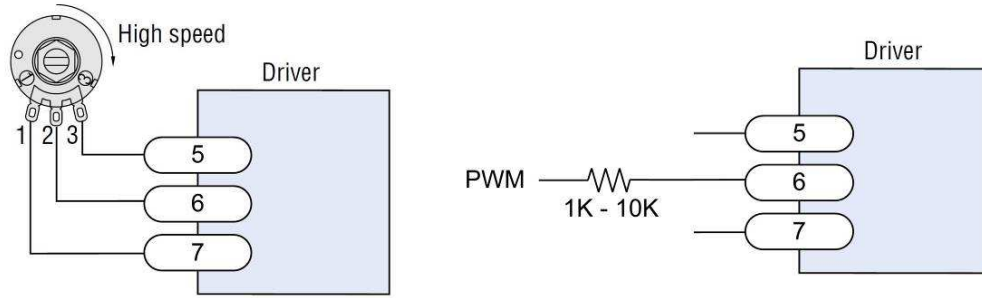
Linux BLDC Motor	Pin 3 (Direction)	Direction of the output shaft after gearbox (As viewed into the output shaft)
45ZWN10-5G	High (1)	Counter-Clockwise
45ZWN10-15G	Low (0)	Clockwise
45ZWN30-20G		
45ZWN10-30G	High (1)	Clockwise
45ZWN30-10G	Low (0)	Counter-Clockwise

Pin 4 (Alarm Reset) – When the error alarm is triggered, setting this pin to low level will reset the alarm. Please return the Start/Stop or Run/Brake input to high level before resetting the alarm. The alarm will not be reset if both inputs are at low level.

Pin 5 (VRH) – When speed control by potentiometer is desired, this pin is connected to the higher pin of the potentiometer. Please refer to figure below for the connection.

Pin 6 (Speed Input) – The speed of the motor can be controlled by the analog voltage (0 – 5V DC) or PWM signals on this pin. Please refer to figure below for the connection.

Pin 7 (VRH) – When speed control by potentiometer is desired, this pin is connected to the lower pin of the potentiometer. Please refer to figure below for the connection.



Pin 8 (Ground) – Connect this pin to the ground of the host.

Pin 9 (Encoder Output) – The BLD04A will output 12 pulses per motor rotation (before gearbox) on this pin. This can be used to determine the speed and number of rotations for the motor.

Pin 10 (Alarm Output) – This pin will be triggered (pulled to low) when there is an error occurred.

4. 2510-04 – UART interface.

Pin No.	Pin Name	Description
1	UART Rx	5V UART receive pin.
2	UART Tx	5V UART transmit pin.
3	Ground	Logic ground.
4	Not Connected	Leave this pin disconnected.

5. Test Button – When this button is pressed, the motor will rotate at speed 1000. This is to fast check the condition of the BLD04A. (This does not work in serial control mode).

6. Closed Loop Selection Jumper – Short this jumper for closed loop speed control, open it for open loop speed control (This need to be configured before power on the board).

7. Red LED – Error Alarm LED. The number of flashes indicates the type of alarm.

Number of Flashes	Alarm	Description
Off	No Alarm	No error has been detected.
2	Overvoltage	Input voltage is > 28V
3	Undervoltage	Input voltage is < 20V
4	Out-Of-Phase	The motor hall sensors state are invalid (Bad motor or loose connection).
5	Overload	The motor has been overloaded for more than 5 seconds.

8. Yellow LED – Speed Control Mode Indicator. Light on when closed loop speed control is selected.
9. Green LED – Power LED. Light on when the board is powered up.

5. INSTALLATION AND GETTING STARTED

5.1 Setting Speed Control Mode (Open/Closed Loop)

The mode of operation can be configured by JP2. The BLD04A PCB board needs to be disassembled from the casing in order to access this jumper. The speed control mode must be configured before power up the BLD04A. Once the board is powered up, any changes to the jumper status will be ignored. The default mode when shipped is Closed Loop mode.

Short this jumper for closed loop speed control and leave it open for open loop speed control. The different between closed loop and open loop speed control are as follow:

Open Loop – The speed of the motor is controlled by the PWM signal which duty cycle is directly proportional to the speed input. The actual speed of the motor may be different depending on the load of the motor. This mode of operation will provide wider speed range for the motor (250rpm – 3500rpm).

Closed Loop – The speed of the motor is controlled by a PI controller which will monitor the actual speed of the motor and alter the duty cycle of the PWM signal so that the actual speed will follow the speed input as close as possible. In this mode, the actual speed of the motor will be consistent disregarding the load of the motor. This is especially useful when the motor is used to drive the robot over the ramp. However, this operation mode has a limited speed range (400rpm – 3000rpm) compared to the open loop speed control. Other than that, the motor may jerk when operates without any load. The problem will go away when the motor is under load.



Closed Loop



Open Loop

5.2 UART Communication Protocol

The BLD04A supports 2 types of interface – Parallel IO and UART. By default, the BLD04A operates in parallel control mode where the motor is controlled by the input from the parallel IO interface. Once the BLD04A receives any valid command from the host, it will operate in the UART control mode since then and any changes on the parallel IO interface are neglected. To return back to the parallel control mode, the host need to send a “Set Parallel Control” command to the BLD04A. Another alternative will be power off and power on again the BLD04A.

In this section, the protocol for UART control mode is explained. The default baud rate is 9600bps.

Command	Host to BLD04A					BLD04A to Host			
	Byte 1 0x00 (Header 1)	Byte 2 0x00 (Header 2)	Byte 3 0xAA	Byte 4 -	Byte 5 -	Byte 1 0x00 (Header 1)	Byte 2 0x00 (Header 2)	Byte 3 0xAA	Byte 4 -
Test UART Communication	0x00 (Header 1)	0x00 (Header 2)	0xAA	-	-	0x00 (Header 1)	0x00 (Header 2)	0xAA	-
Set Baud Rate 0 = 4800 1 = 9600 2 = 19200 3 = 38400 4 = 57600 5 = 115200	0x00 (Header 1)	0x00 (Header 2)	0x22	0x00	Value	-	-	-	-
Stop the motor	0x00 (Header 1)	0x00 (Header 2)	0xF0	-	-	-	-	-	-
Brake the motor	0x00 (Header 1)	0x00 (Header 2)	0xF1	-	-	-	-	-	-
Run the motor	0x00 (Header 1)	0x00 (Header 2)	0xF2	-	-	-	-	-	-
Set direction to 0	0x00 (Header 1)	0x00 (Header 2)	0xF3	-	-	-	-	-	-
Set direction to 1	0x00 (Header 1)	0x00 (Header 2)	0xF4	-	-	-	-	-	-
Reset the alarm	0x00 (Header 1)	0x00 (Header 2)	0xF5	-	-	-	-	-	-
Set speed (0 - 3000)	0x00 (Header 1)	0x00 (Header 2)	0xF6	Value - MSB	Value - LSB	-	-	-	-
Set parallel control	0x00 (Header 1)	0x00 (Header 2)	0xF7	-	-	-	-	-	-
Read speed	0x00 (Header 1)	0x00 (Header 2)	0xF8	-	-	0x00 (Header 1)	0x00 (Header 2)	Value - MSB	Value - LSB
Read alarm state 0 = No alarm 1 = Overvoltage 2 = Undervoltage 3 = Out of phase 4 = Overload	0x00 (Header 1)	0x00 (Header 2)	0xF9	-	-	0x00 (Header 1)	0x00 (Header 2)	0x00	Value

Testing UART Communication

To test the UART communication, the host need to send 3 bytes of data one by one to the BLD04A. First 2 bytes are headers and third byte is command to test the UART communication.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command '0xAA'

After sending 3 bytes of data, host will receive 3 bytes of data from the BLD04A.

- i. 1st byte: Receive header 1 '0x00'
- ii. 2nd byte: Receive header 2 '0x00'
- iii. 3rd byte: Receive data '0xAA'

Set UART Baudrate

UART Baudrate can be set by sending 5 bytes of data from host to BLD04A. The value of baudrate must only be 0 – 5.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command '0x22'
- iv. 4th byte: Send data '0x00'
- v. 5th byte: Send value of baudrate (0 – 5)

Stop/Brake/Run/Set Direction/Reset Alarm/Set Parallel Control

3 bytes of data need to be sent for stop, brake, run, set direction, reset alarm and set parallel control. The first 2 bytes are headers and the third byte is the command to stop, brake, run, set direction, reset alarm and set parallel control.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command to stop, brake, run, set direction, reset alarm and set parallel control

Set Speed

5 bytes of data is needed to control the speed of the motor. The value of the speed must only be 0 – 3000.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command to set the motor speed '0xF6'
- iv. 4th byte: Send MSB value of speed
- v. 5th byte: Send LSB value of speed

Read Speed

Host need to send 3 bytes of data to read the motor speed. The value returned to the host is the speed of the motor in rpm.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command '0xF8'

After sending 3 bytes of data, host will receive 4 bytes of data from the BLD04A.

- i. 1st byte: Receive header 1 '0x00'
- ii. 2nd byte: Receive header 2 '0x00'
- iii. 3rd byte: Receive MSB value of speed
- iv. 4th byte: Receive LSB value of speed

Read Alarm State

3 bytes of data will be sent to read the alarm state.

- i. 1st byte: Send header 1 '0x00'
- ii. 2nd byte: Send header 2 '0x00'
- iii. 3rd byte: Send command '0xF9'

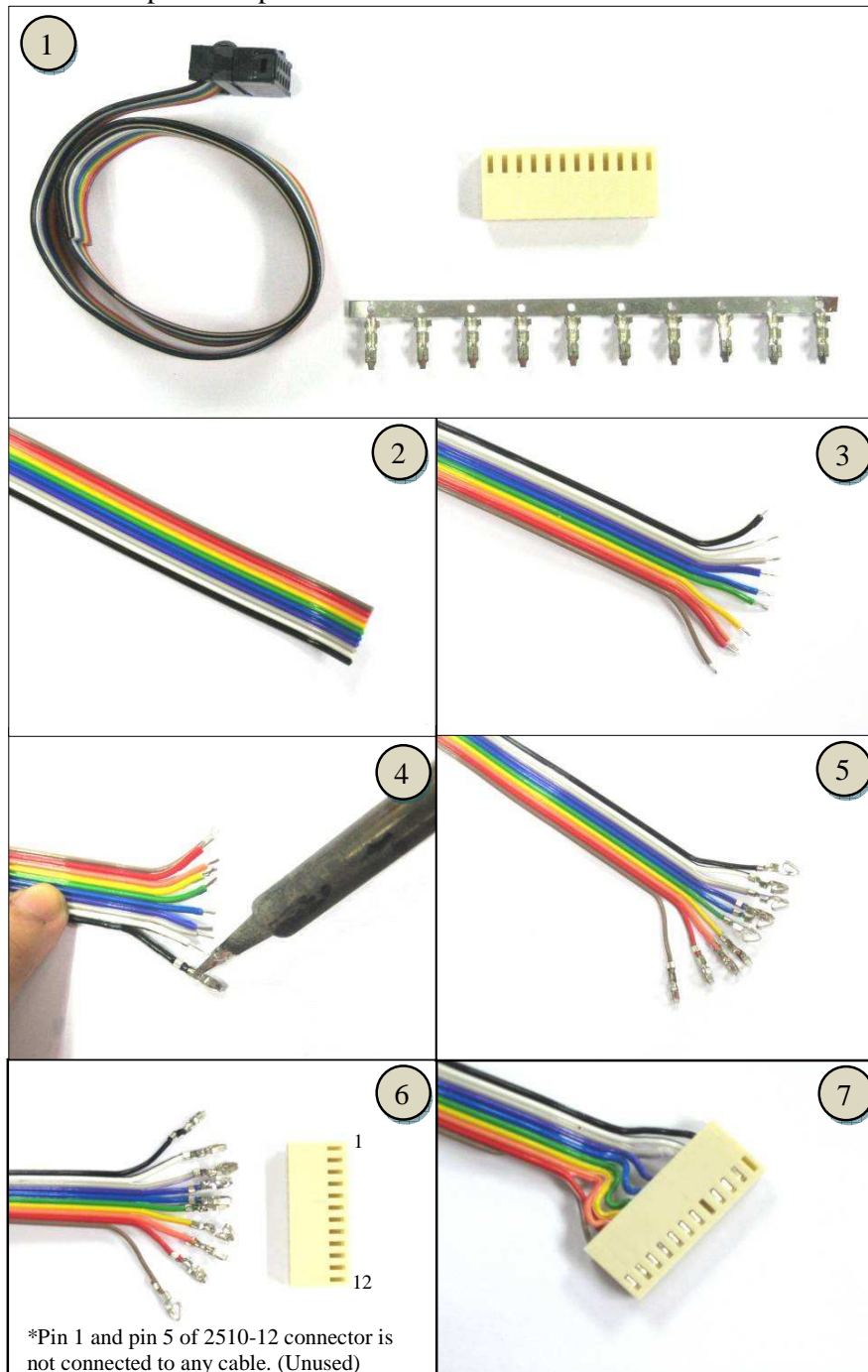
Then host will receive 4 bytes of data from BLD04A.

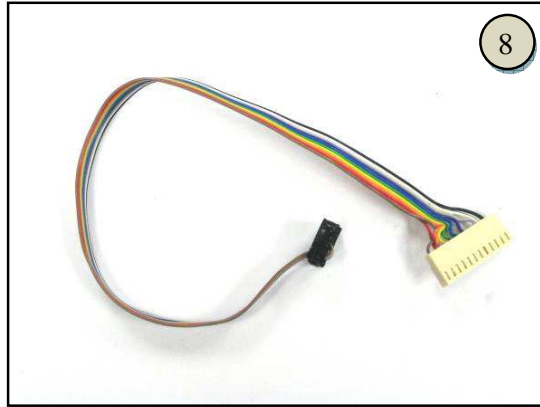
- i. 1st byte: Receive header 1 '0x00'
- ii. 2nd byte: Receive header 2 '0x00'
- iii. 3rd byte: Receive data '0x00'
- iv. 4th byte: Receive alarm value.

5.3 Using BLD04A with AR40B / IFC-BL02

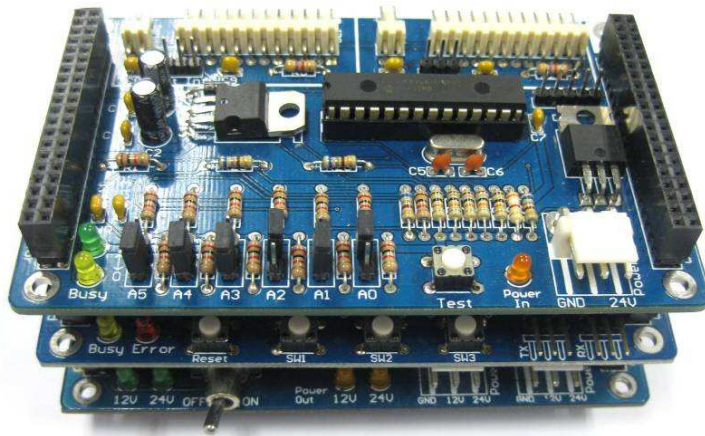
Guide for making 10 ways cable

This cable is used to interface Brushless Motor Driver with Parallel IO interface. 10 ways of rainbow cable will be used on a 2510-12 female connector. 2 pins from 2510-12 connector are unused which are pin1 and pin5.



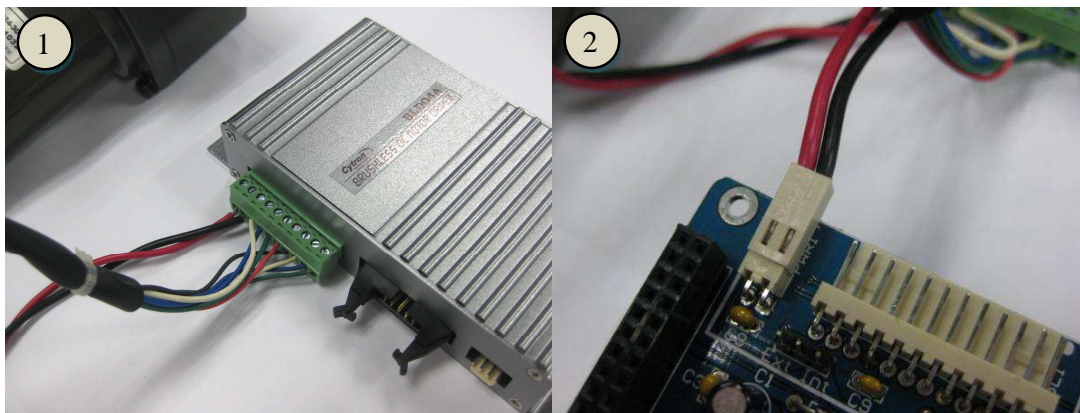


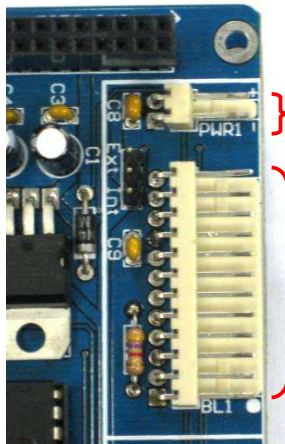
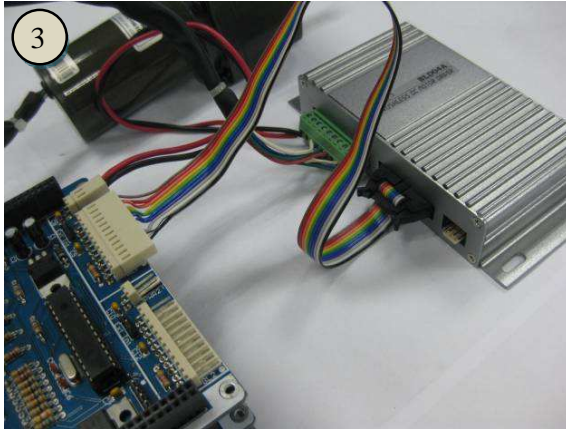
Please refer to IFC-BL02 User's Manual for IFC-BL02 hardware installation.



Connect the driver with the brushless motor to IFC-BL02 as shown in below figure.

1. Connect Pluggable Terminal Block from brushless motor to BLD04A.
2. Connect power supply (thick red and black wire) to IFC-BL02 card.
3. Connect Parallel I/O cable from BLD04A to IFC-BL02.





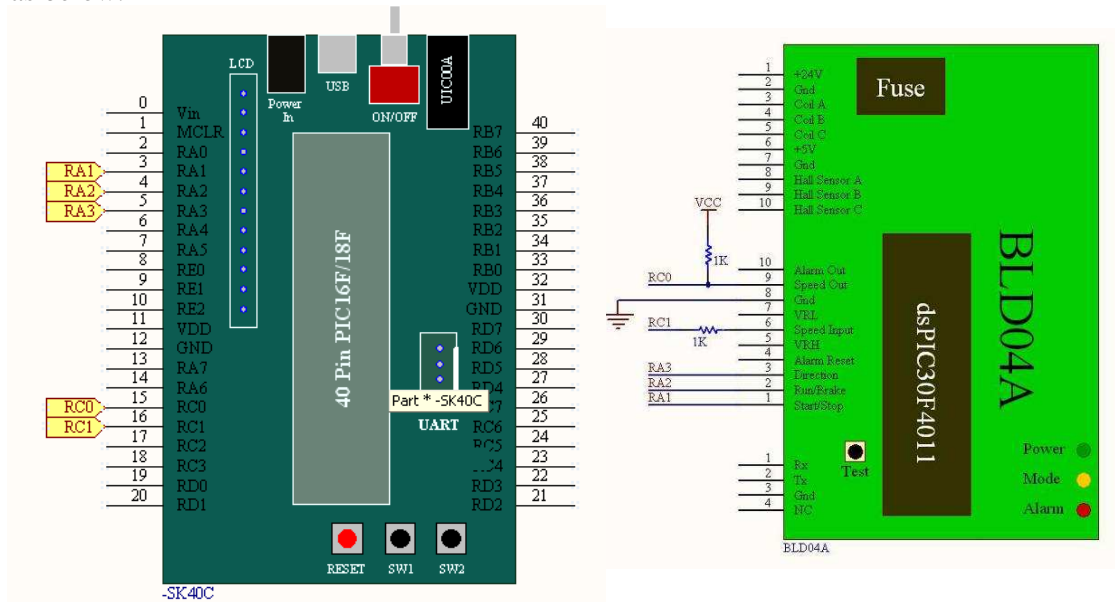
Pin	Connection
2	VCC
1	GND

Pin	Connection
12	Alarm Output
11	Encoder Output
10	Ground
9	VRL
8	Speed Input
7	VRH
6	Alarm Reset
5	NC
4	Direction
3	Run/Brake
2	Start/Stop
1	NC

5.4 Using BLD04A with Microcontroller (Parallel Mode)

Sample source code is provided to show how to interface BLD04A with SK40B/SK40C in Parallel Control Mode. The sample source code does not demonstrate all the features of BLD04A.

The connection between the Parallel IO Interface of the BLD04A and the SK40B/SK40C is as below:

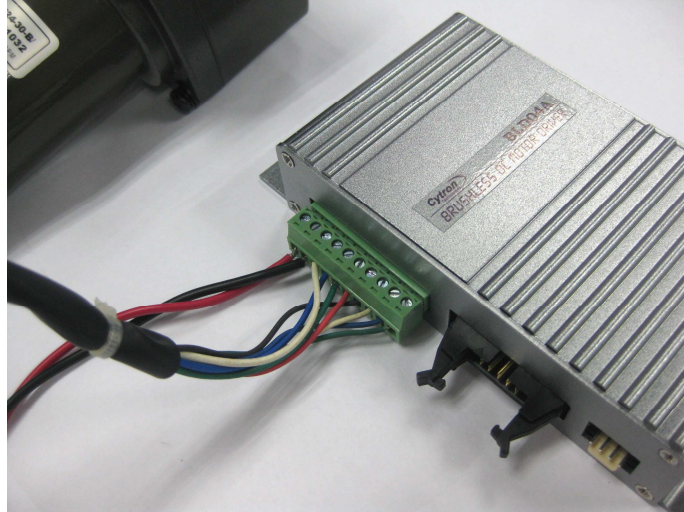


For this sample source code, every time the SW1 is pressed and released, the motor will go through the following cycle:

Free-Running Stop → Rotate at half speed with direction 1 → Brake → Rotate at full speed with direction 0 → Repeat again

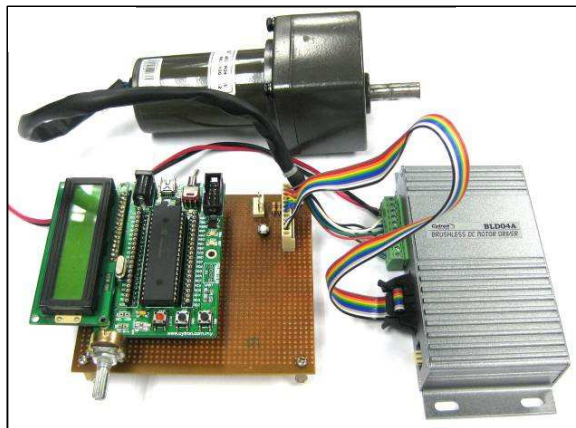
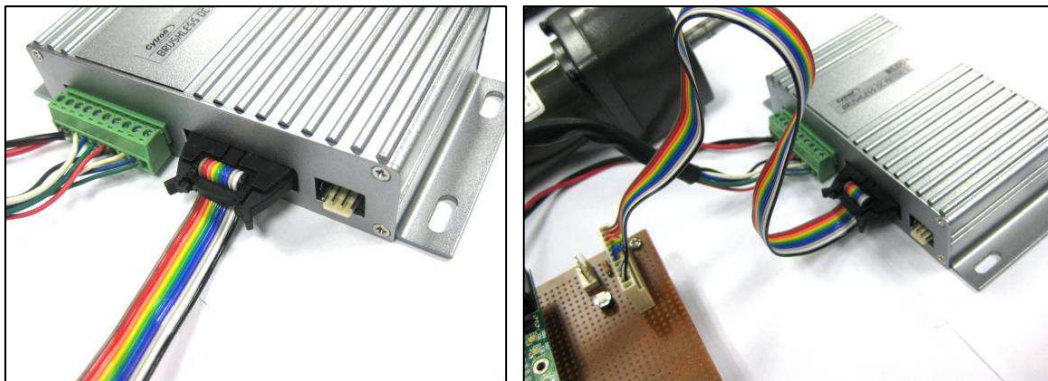
Connect the BLD04A to microcontroller as shown in figure below. This example uses SK40C as the host.

1. Connect Pluggable Terminal Block from brushless motor to BLD04A.



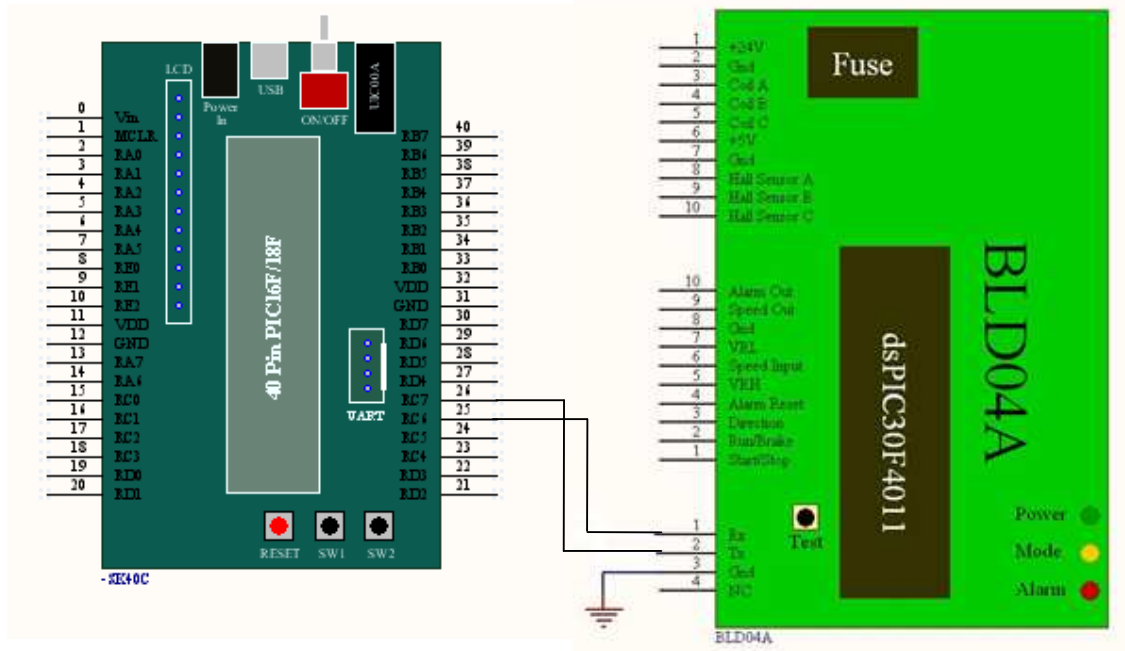
2. Connect power supply (thick red and black wire) to 24V power source.

3. Connect Parallel I/O cable from BLD04A to SK40C.



5.5 Using BLD04A with Microcontroller (UART Mode)

Sample source code in UART mode is also provided to show how to use the BLD04A with SK40C/SK40B in UART Control Mode. Sample source code can be downloaded from the website. However, the sample source code does not demonstrate all the features of BLD04A.

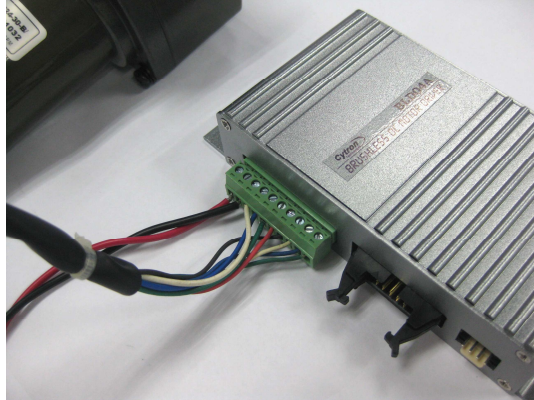


For this sample source code, every time the SW1 is pressed and released, the motor will go through the following cycle:

Free-Running Stop → Rotate at half speed with direction 1 → Brake → Rotate at full speed with direction 0 → Repeat again

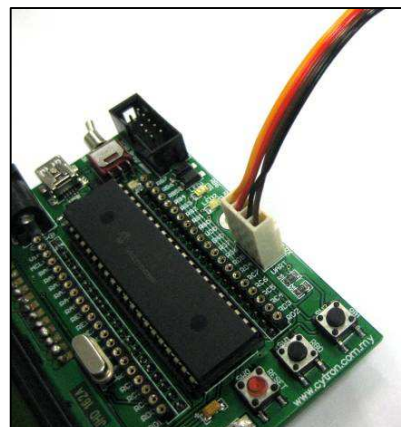
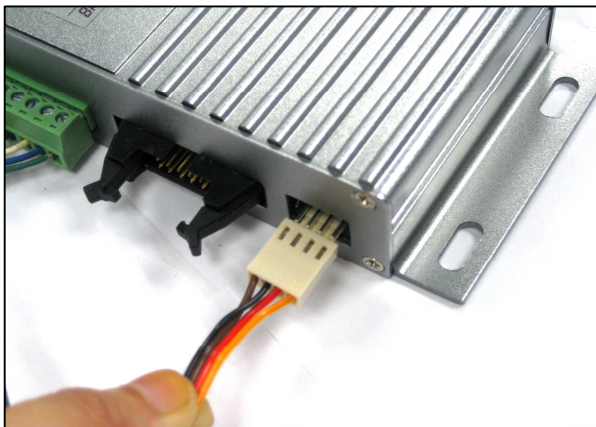
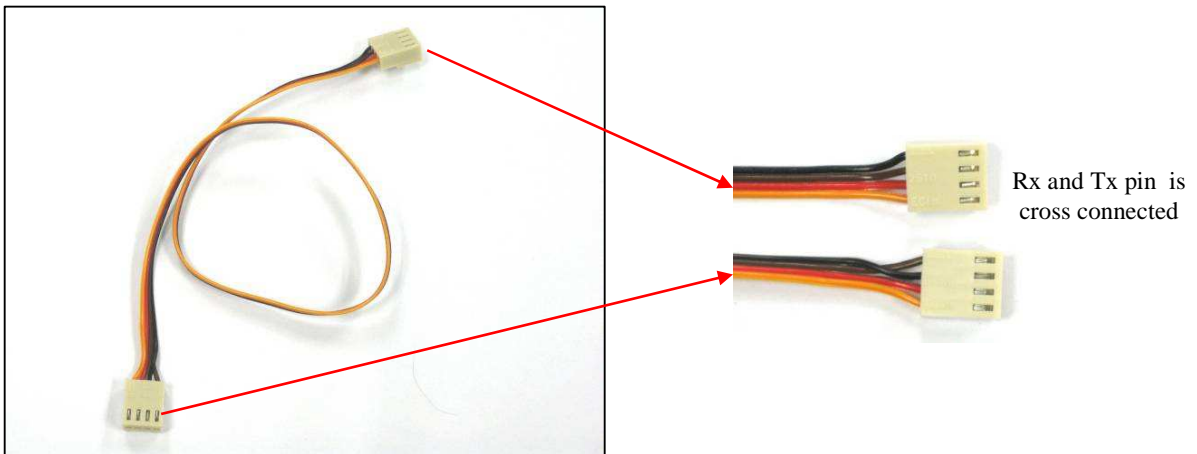
Connect the BLD04A to microcontroller as shown in figure below. This example uses SK40C as the host.

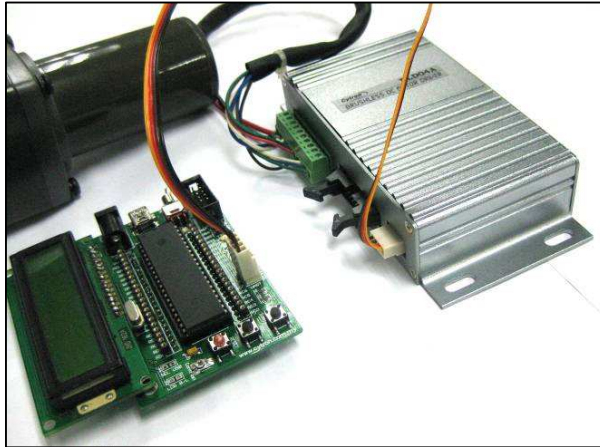
1. Connect Pluggable Terminal Block from brushless motor to BLD04A.



2. Connect power cable (thick red and black wire) to 24V power source.

3. Connect UART cable from BLD04A to SK40C.





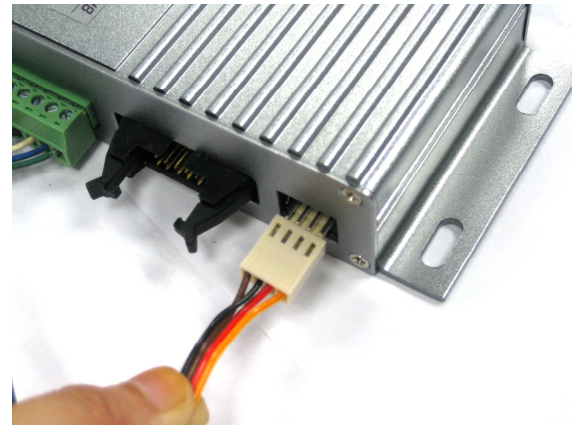
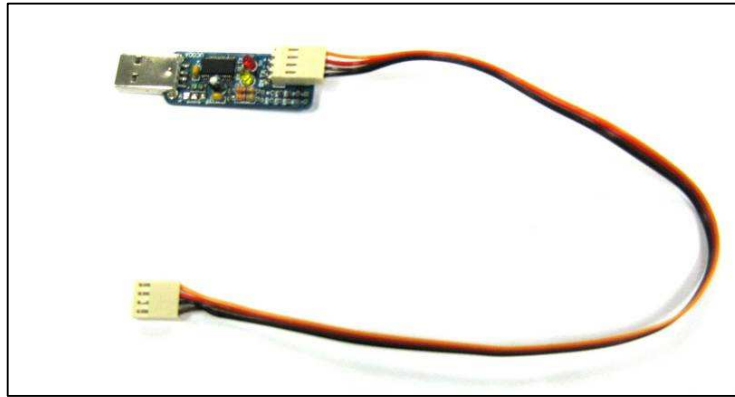
5.6 Using BLD04A with PC (UART Mode)

Besides controlling the BLD04A with a microcontroller, we also provide GUI to control the motor from a PC. UC00A is needed for UART communication between BLD04A and PC. Please refer to UC00A User's Manual for more details about the product.

1. Connect Pluggable Terminal Block from brushless motor to BLD04A.



2. Connect power source wire (thick red and black wire) to 24V power source.
3. Connect UC00A to PC USB port and another end of UC00A to UART port of BLD04A.

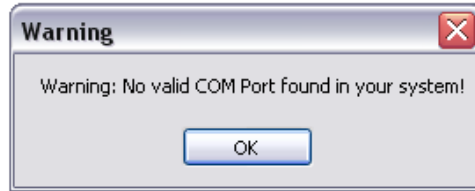


4. Open BLD04A GUI folder and click on 'Setup'. BLD04A GUI can be downloaded from the website. User may already have the .NET framework installed on PC, especially if users have already installed other applications which were built with one of the Visual Studio 2005 .NET languages. If you do not yet have it, the .NET framework can be freely downloaded from Microsoft's website. Users of Windows Vista do not need to install the .NET framework, as it comes pre-installed as part of the OS.

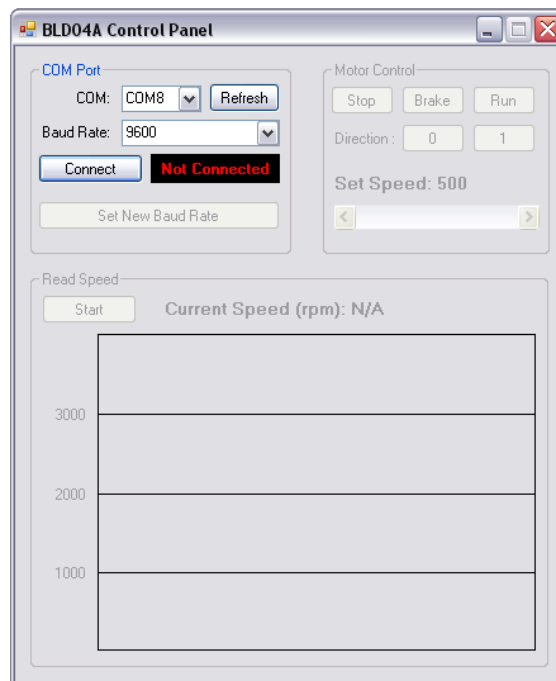
5. Click 'Install' to install the BLD04A GUI.



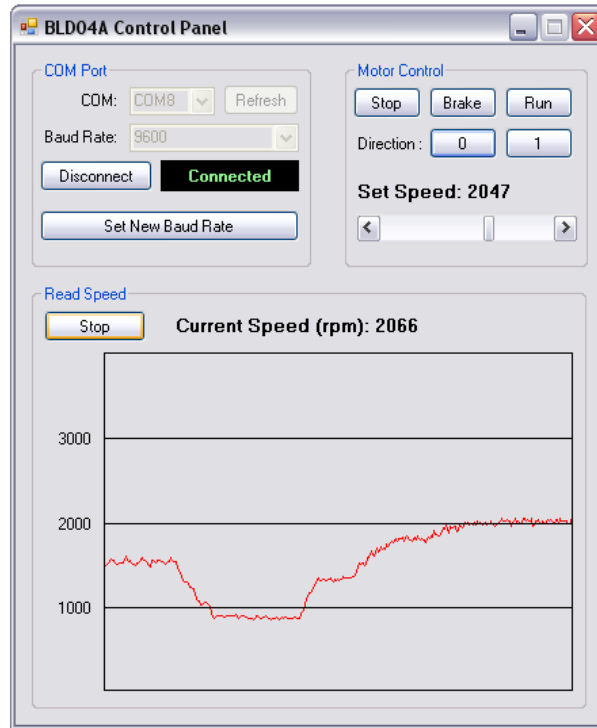
6. Run the GUI. Warning message may appear if you do not have any COM port on your PC. Plug in the UC00A and click 'OK'.



7. Figure below show the BLD04A GUI. Select the COM Port which is connected to the BLD04A and the correct baud rate. The default baud rate is 9600bps.



8. Click 'Connect' and buttons for motor control will be enabled. The movement of the motor can be controlled by clicking the corresponding button and the speed may be changed by using the 'Set Speed' slide bar. Besides that, the motor speed can be obtained by clicking the 'Start' button under the 'Read Speed' panel. The speed of the motor will be plotted on the graph as shown below.



6. WARRANTY

- Product warranty is valid for 6 months.
- Warranty only applies to manufacturing defect.
- Damage caused by miss-use is not covered under warranty.
- Warranty does not cover freight cost for both ways.

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