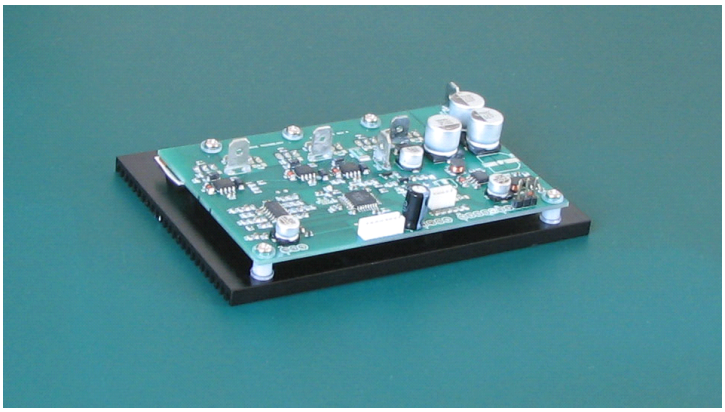

DESCRIPTION

The D113-36D10 is a DSP based low voltage brushless DC motor controller. This controller is for controlling the brushless DC motor with or without Hall position sensors. The sensorless operation is especially suitable for applications which do not require full torque at low speed, such as pump, blower and fan applications. When driving a BLDC motor with Hall sensors, it can be used for general applications.

User can specify current limit, PWM carrier frequency, current and speed loop regulator gains of the controller through GUI. Ramping current, ramping rate, frequency at which the transition from open loop ramping to close loop rotor position estimation occurs for sensorless operation mode, can also be set through GUI program.

FEATURES

- Runs BLDC motors with or without Hall sensors.
- Detects whether the BLDC motor Hall sensors are connected to the controller or not, and run sensorless algorithm if no Hall sensor is detected.
- Selectable serial communication ports, RS232 and RS485 (optional).
- Fault protection and recovery.
- PC GUI program for setting controller parameters such as current limits, PWM frequency, current and speed regulator gains, tuning the controller and running the controller.
- Control command (Run/Stop and speed command) from serial communication port or analog input (either voltage input or external potentiometer). Command from analog input is overridden if a command comes from serial port, i.e., analog input is ignored if command from serial port is received.
- Compact and low cost.

SPECIFICATIONS

Model Number:	D113-036D10
DC Supply Voltage:	12V to 36V
DC Current:	10 Amp continuous
Motor Current:	10 Amp continuous
PWM Carrier Frequency:	5 KHz to 25 KHz
Waveform:	Trapezoidal
Maximum Frequency:	1000 Hz (30,000 RPM for 4 pole motor), expandable to 2000 Hz

Operation Temperature: 0°C to 55°C

I/O PORTS AND PINOUTS

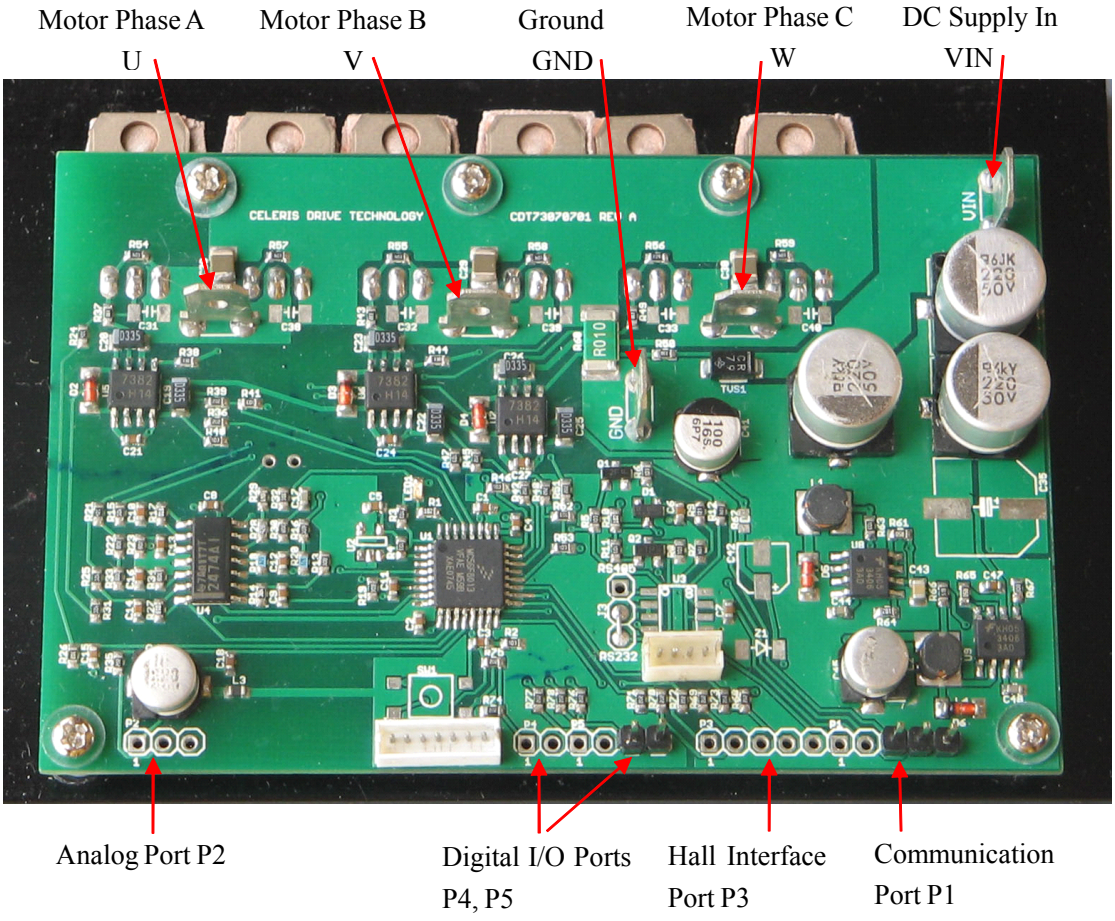

Fig. 1 Controller Ports

Fig. 1 shows the I/O ports of the controller. Count pin numbers from left to right.

Power Terminals (VIN, GND, U, V, W):

5 0.187" x 0.02" PC Quick-Fit terminals for DC power supply and 3 phase motor leads connections.

Hall Sensor Interface Port (P3):

Pin	Name	Description	I/O	Range
1	VDD	Digital Power Supply	Power Output	3.3V/5V
2	HA	Hall A	I	0V – 5V
3	HB	Hall B	I	0V – 5V
4	HC	Hall C	I	0V – 5V
5	GND	Ground	Power Return	0V

Digital I/O Interface Port (P4):

Pin	Name	Description	I/O	Range
1	IO1	GENERAL I/O	I/O	0V – 5V
2	GND	Ground	Power Return	0V

Digital I/O Interface Port (P5):

Pin	Name	Description	I/O	Range
1	IO2	GENERAL I/O	I/O	0V – 5V
2	IO3	GENERAL I/O	I/O	0V – 5V
3	SPDOUT	SPEED INDICATOR*	O	0V – 5V
4	GND	Ground	Power Return	0V

*pulse output. Motor speed (RPM) = 120*pulse frequency/number of poles of the motor

Analog I/O port (P2):

Pin	Name	Description	I/O	Range
1	VDDA	Analog Power Supply	Power Out	3.3V
2	SPDCMDV	Speed Command voltage	I	0 – 3.3V
3	GNDA	Analog Ground	Power Return	0V

Serial communication port (RS485 optional) (P1):

Pin	Name	Description	I/O	Range
1	RS485A	RS485 differential I/O A	I/O	-7/+12V
2	RS485B	RS485 differential I/O B	I/O	-7/+12V
3	SCITXD	Transmission, to DB9 pin 2	O	+/-12V
4	SCIRXD	Receiving, to DB9 pin 3	I	+/-12V
5	GND	Ground, to DB9 pin 5	Power Return	0V

OPERATION

The D113-36D10 BLDC motor controller is initialized with the following default parameters:

Current Limit:	10 Amp
Ramping Current:	1 Amp
Ramping Rate:	10
Close Loop Frequency:	10 Hz
PWM Carrier Frequency:	20 KHz
Speed Loop PI Gains:	Proportional Gain 10000, Integral Gain 30
Current Loop Gain:	Proportional Gain 3000, Integral Gain 30

However, it is recommended that user utilize the PC GUI program to adjust the parameters to achieve optimal performance.

SETTING UP THE CONTROLLER

Power Supply (Terminals VIN, GND, U, V, W): Connect positive DC power supply to VIN terminal, and DC power supply ground to GND terminal. Connect motor phase A to U terminal, phase B wire to V terminal, and phase C to W terminal of the controller.

Hall Interface (P3) (ignore this if the motor does not have Hall sensor): Connect Hall VDD to Pin 1, Hall ground to Pin 5, Hall output A to Pin 2, Hall output B to Pin 3, Hall output C to Pin 4.

RS232 (P1): Connect Pin 3 to PC serial port (DB9) Pin 2, Pin 4 to PC serial port (DB9) Pin 3, Pin 5 to PC serial port (DB9) pin 5.

RS485 (P1) (if available): Connect Pin 1 to RS485 A and Pin 2 to RS485 B.

Analog input (P3): Connect analog input voltage (0 - 3.3V) to Pin 2 , and ground to Pin 3. Connect potentiometer 2 end terminals to Pin 1 and Pin 3 respectively, and sweep terminal to Pin 2, if an external potentiometer is used. A 10 K potentiometer is recommended.

INSTALLING THE GUI PROGRAM

Copy the BLDCGUI.rar file to a directory on PC hard drive. Unzip the file, then run the Windows Installer file bldc.msi. Follow on-screen instructions.

INITIALLING THE CONTROLLER

The controller is initialized with default parameters for running BLDC motors. User can change the controller parameters by running the GUI program.

1. Launching GUI Program

Supply DC power to the controller. Launch the GUI program from PC desktop if the shortcut link is present, or from the PC start up menu. The main GUI window should appear on PC screen (Fig. 2). One of the controller state indicating LEDs and the “Drive On” LED should be on if the communication is established between the controller and GUI on the PC.

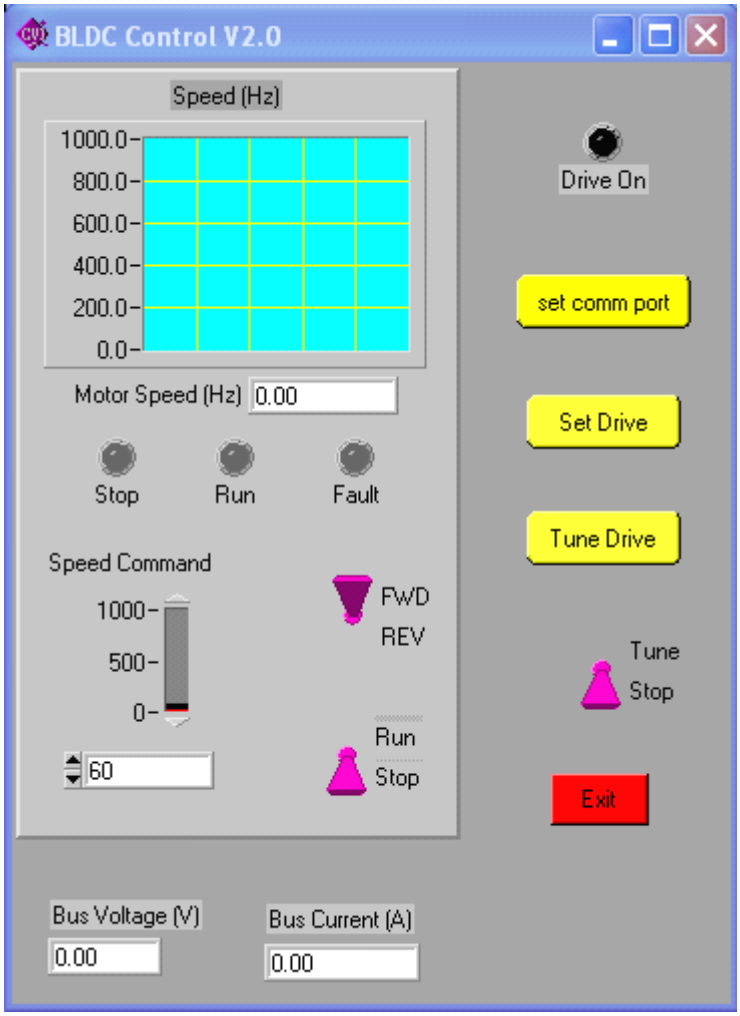

Fig. 2 GUI Main Window

An error message window may appear if the serial port of the PC is not set (Fig. 3). If it appears, click on "Ok" button, then click on "set comm. Port" button in the GUI main window. A "COM port config" window (Fig. 4) appears. Select COM port from PC's available serial port. Then click on "Ok" button. GUI will save the changes so that there is no need to set COM port next time the GUI is launched. One of the controller state indicating LEDs and the "Drive On" LED should be on if the communication is established between the controller and PC (Fig. 2).

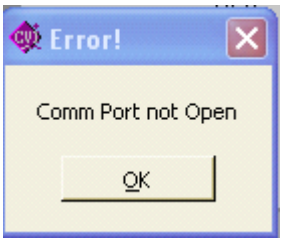

Fig. 3 Comm Port Error Message Window

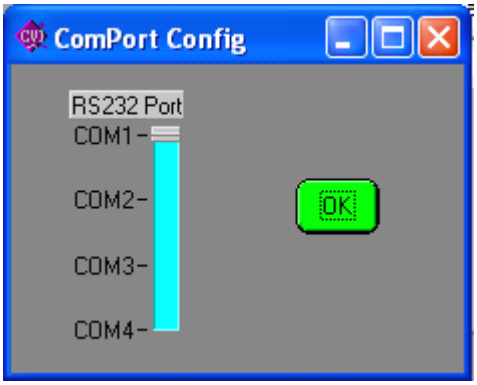

Fig. 4 COM Port Configuration Window

2. Setting controller Parameters

An error message window will appear if this is the first time the GUI program is launched (Fig. 5). Click on “Ok” button, then both “COM Port Config” window and “set drive parameters” window (Fig. 6) appears. Set COM port first. Make desired changes to controller parameters in the “set drive parameters” window. Click on “Ok” button to finish setting controller parameters. The parameters are stored on the PC and in the controller.

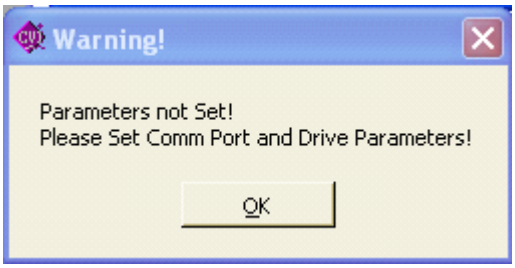

Fig. 5 Parameter Not Set Error Window

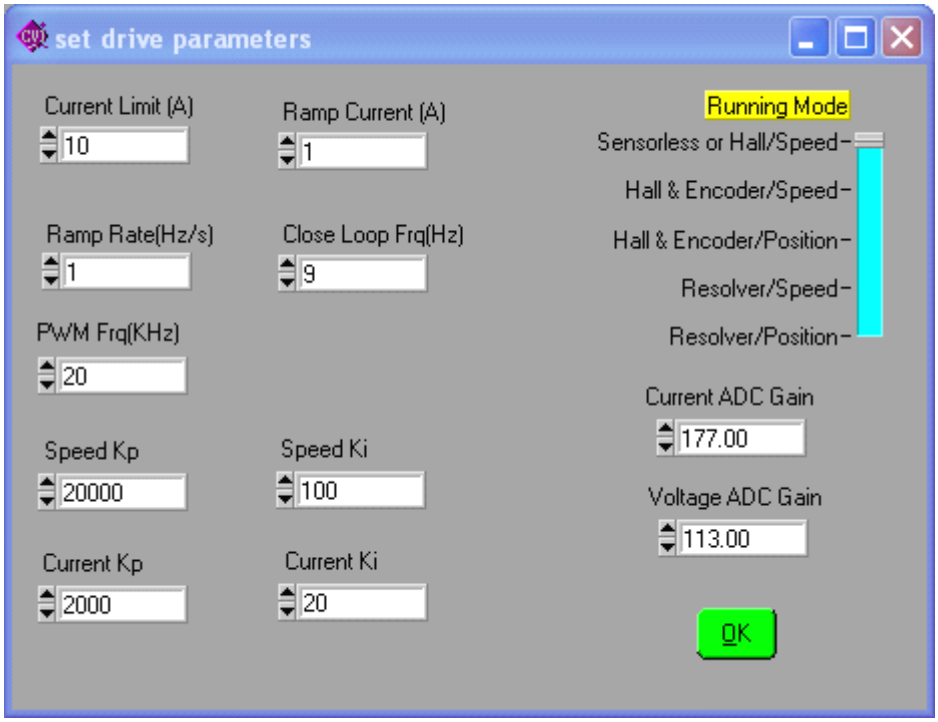

Fig. 6 Set Drive Parameters Window

3. Tuning controller

It is usually necessary to adjust current limit, regulator proportional and integral gains of both current loop and speed loop, to achieve best controller performance. Sometimes it is also desirable to change PWM carrier frequency according to motor parameters. For sensorless operation mode, adjusting ramping current, ramping rate and close loop frequency is crucial for a smooth motor start. GUI also allows user to specify the controller operation mode.

Motor with Hall sensors:

Step 1: Open "set drive parameters" window by clicking on "Set Drive" button in main GUI window. "set drive parameters" window pops up (Fig. 6). Set current limit according to the controller and motor ratings, set ramping current the same as current limit, set PI regulator gains of speed loop and current loop. Ignore close loop frequency and ramp rate because they are for sensorless operation mode. Click on "Ok" button to close the window.

Step 2: Open "tune drive" by clicking on "Tune Drive" button in main GUI window. "tune drive" window pops up (Fig. 7). In tuning process, GUI sends out a square waveform speed command: high speed is given by the "high speed (Hz)", low speed

is given by the "low speed (Hz)", and interval between each speed command change is given by the "interval (S)". Select desired high speed, low speed and interval. Click on "Ok" button to close the window.

NOTE: speed command is actually the frequency command. Below is the equation for calculating RPM from frequency:

RPM = 120*frequency/number of poles of the motor

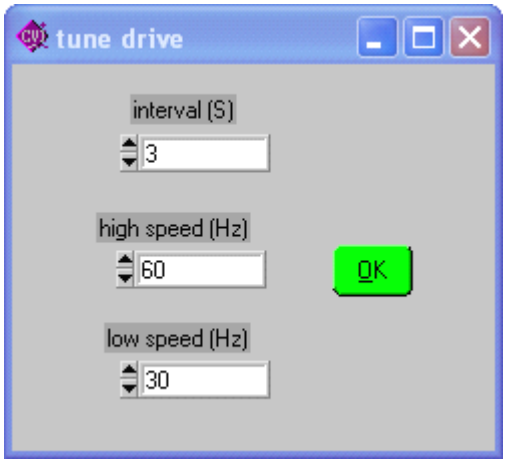

Fig. 7 Tune Drive Window

Step 3: Click on the "Tune/Stop" switch to "Tune" position. Click on the "Run/Stop" switch to "Run" position. The motor should start running. The "Speed (Hz)" display should display both traces of the speed command (red line) and motor speed (blue line). The "Run" indicating LED should be on. controller DC bus voltage and current should also be displayed. Observe the command and motor response. Fig. 8 shows the display of the speed command and motor speed response of the tuning process.

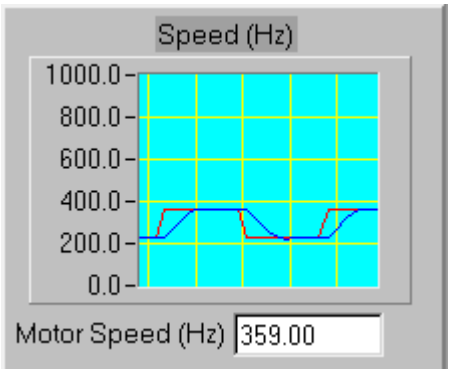

Fig. 8 Display of Speed Command and Motor Speed Response

Repeat step 1 to change regulator gains, and step 3 until a satisfactory response is achieved.

Motor without position sensor (sensorless mode):

Step 1: Open "set drive parameters" window by clicking on "Set Drive" button in main GUI window. "set drive parameters" window pops up (figure 6). Set current limit according to the controller and motor ratings. Leave PI regulator gains of speed loop and current loop unchanged (default value). Set ramping current to 1 amp, set close loop frequency to 10% of rated frequency, and set ramp rate to 10 Hz/s. Click on "Ok" button to close the window.

Step 2: Set speed command in main GUI window by entering the speed command value or pulling the slide bar. It is recommended that set the motor rated speed as the speed command. Click on the "Run/Stop" switch to "Run" position. The motor should start to ramp. When motor reaches the close loop frequency, the controller starts execute rotor position estimation algorithm. The motor should accelerate to commanded speed, or to the highest speed dictated by the DC bus voltage and load, if the rotor position estimation is correct. If the motor fails to ramp, go back to step 1 and increase ramping current until the motor can ramp to close loop frequency. After controller runs successfully, the ramping rate can be decreased and the close loop frequency can be decreased to achieve fast and smooth ramping and transition to rotor position estimation operation of the controller. It is not recommended to adjust regulator gains in this step, unless unstable operation is observed after entering rotor position estimation operation.

Step 3: Open "tune drive" by clicking on "Tune Drive" button in main GUI window. "tune drive" window pops up (Fig. 7). In tuning process, GUI sends out a square waveform speed command: high speed is given by the "high speed (Hz)", low speed is given by the "low speed (Hz)", and interval between each speed command change is given by the "interval (S)". Select desired high speed, low speed and interval. Click on "Ok" button to close the window.

Step 4: Click on the "Tune/Stop" switch to "Tune" position. Click on the "Run/Stop" switch to "Run" position. The motor should start running. The "Speed (Hz)" display should display both traces of the speed command (red line) and motor speed (blue line). The "Run" indicating LED should be on. controller DC bus voltage and current should also be displayed. Observe the command and motor response.

Repeat step 1 to change regulator gains, and step 4 until a satisfactory response is achieved.

RUNNING THE CONTROLLER

On power up, the controller stays idle until a STOP command is received. controller runs under the control of the GUI program on PC if the serial communication between the controller and PC is established. Otherwise it runs from the analog input.

Running the controller from the PC

This mode takes higher priority over the other mode. When GUI on the PC is running, and serial communications is established, controller will ignore command from analog input. It is the same as tuning the controller except that the parameters are already set.

Running the controller from the Analog input

Pin 2 of Analog Port (P2) is speed command input in the form of voltage.

Input voltage from 0V to 1.45 V send RUN REVERSE command, with 1.45V = 0 Hz and 0V = 903 Hz, decreasing linearly with increasing input voltage.

Input voltage of 1.45V to 1.85V sends STOP command (dead zone).

Input voltage of 1.85V to 3.3V sends RUN FORWARD command, with 1.85V = 0 Hz and 3.3V = 903 Hz, increasing linearly with increasing input voltage.

Connecting an external potentiometer to P2 can generate 0V to 3.3V to Pin 2 of P3.

FAULT HANDLING

The controller provides protection for motor stall, losing synch (for sensorless operation), open circuit, short circuit, over voltage and under voltage faults. It should shut down the motor when a severe fault is detected. It has the following fault recovering features:

Lost synchronization fault

Detects lost synchronization in sensorless mode. Stop for 10 seconds then restart.

Excessive current fault

Detects excessive DC bus current such as short circuit fault. Shut down the controller when this fault occurs.

Hall sensor fault

Detects Hall sensor failure fault when running BLDC motor with Hall sensors. Stop running 10 seconds when this fault occurs, then restarts in sensorless mode.

Under voltage fault

Detects DC bus under voltage fault. Stop operation when this fault occurs. Resume normal operation when voltage returns to operational range.

Over voltage fault

Detect DC bus over voltage fault. Stop operation when this fault occurs. Resume normal operation when voltage returns to operational range.

Clear faults

A "STOP" command clears all faults.

DIMENSIONS

Size: 4.5” x 3.0” x 0.8”