E-Lab Digital Engineering, Inc.

EDE16020

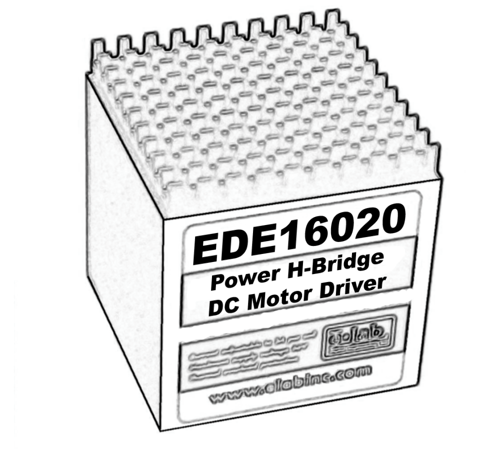
FULL H-BRIDGE DC MOTOR CONTROL MODULE

Features

- High current H-Bridge Motor Driver for use with DC motors
- 20 Amp Continuous, 53 Amp Momentary Surge for handling motor startup current demand
- Full MOSFET H-Bridge with low 16.5mΩ (per bridge half) DC on resistance
- Motor supply voltage up to 55V
- Integral heatsink system and thermal potting compound eliminate need for an auxiliary heatsink or fan
- Quad 3 Amp Schottky clamp diodes for enhanced noise suppression and inductive-spike elimination
- Internal optically-isolated interface protects drive circuitry from motor noise
- Inputs may be PWM driven for varying motor torque and drive signal duty cycle
- MOSFET drive circuit prevents bridge shorting during switching and eliminates 'shorted mode' typical of conventional H-Bridges
- Standard 24 pin DIP pin spacing for easy PCB placement & prototyping
- Threaded mounting coupler allows secure mount to PCB in rugged-duty applications

Overview

The EDE16020 DC motor control module offers designers a compact, robust DC motor control system. Engineered with internal and external heatsinks and a highly thermally-conductive potting compound, the need for cooling fans (known for their short lifetimes) or a large heatsink plate is eliminated. An integrated MOSFET H-Bridge provides bi-directional motor control with drive currents up to 20 Amps sustained. Optically isolated inputs and integral clamping diodes protect sensitive drive circuitry from motor coil noise, while the charge boost circuit provides the necessary MOSFET gate drive voltages without the need for external components. Inputs may be driven with a PWM signal (up to 100kHz) to provide soft motor starts, ramped acceleration, and adjustable motor torque capabilities. The highly efficient design of the EDE16020 drive circuitry combined with its unique PowerCube™ package make it the ideal motor control solution for nearly any DC motor application.



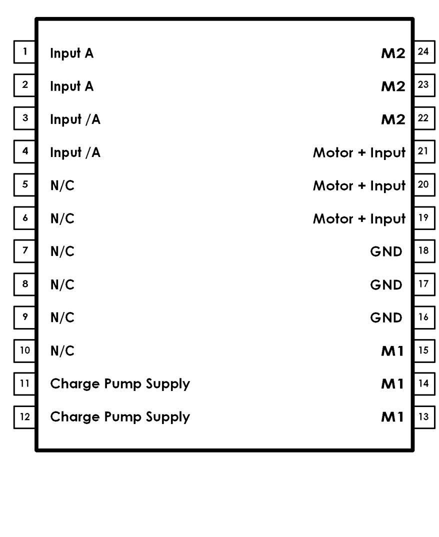
Specification Summary

Max. motor voltage: 55V
Max. current: 20 Amps
Control Voltage: 3 to 12VDC
Dual polarity for bi-directional control
Complete DC motor control unit
Built with HEXFET™ Power MOSFET technology
Maximum operating temp: 105 °C

Typical Applications

Robotics
Industrial Equipment
Remote-Positioning Equipment
Scientific Apparatus
Encoder Feedback Systems

Module Pinout



Pin#	Pin Name	Description
1	A Input	Input pin used in conjunction with /A Input to control motor operation. When A Input and /A Input are in opposite states the motor coil will be energized. Input range 5 to 15VDC.
2	A Input	Internally connected to pin 1. Input range 5 to 15VDC.
3	/A Input	Input pin used in conjunction with A Input to control motor operation. When /A Input and A Input are in opposite states the motor coil will be energized. Input range 5 to 15VDC.
4	/A Input	Internally connected to pin 3. Input range 5 to 15VDC.
5	N/C	No Connection.
6	N/C	No Connection.
7	N/C	No Connection.
8	N/C	No Connection.
9	N/C	No Connection.
10	N/C	No Connection.
11	Charge Pump Supply	Provide a supply voltage between 5V and 15V to this input to power the MOSFET switch circuitry.
12	Charge Pump Supply	Internally connected to pin 11. Input range 5 to 15VDC.
13	M1	Motor connection. Connects to motor lead opposite M2.
14	M1	Internally connected to pins 13 and 15.
15	M1	Internally connected to pins 13 and 14.
16	GND	Motor and module common Ground connection.
17	GND	Motor and module common Ground connection.
18	GND	Motor and module common Ground connection.
19	Motor + Input	Motor and module power input. Maximum 55V, minimum 3V.
20	Motor + Input	Internally connected to pins 19 and 21.
21	Motor + Input	Internally connected to pins 19 and 20.
22	M2	Motor connection. Connects to motor lead opposite M1.
23	M2	Internally connected to pins 22 and 24.
24	M2	Internally connected to pins 22 and 23.

Table One: Pin Definitions

Introduction

The EDE16020 DC Motor Controller is built using a full H-Bridge made from four discrete IRFZ46N HEXFET™ Power MOSFET devices manufactured by International Rectifier Corporation. Internal circuitry allows this H-Bridge to power a motor (or other DC-type load), at either polarity, based upon the state of the input pins A and /A. For further details on the IRFZ46N device please visit the E-Lab website (www.elabinc.com), the International Rectifier Corporation website (www.irf.com), or the E-Lab Datasheet CD.

The following table depicts the correlation between the two inputs (A and /A) and the motor outputs M1 and M2. Please note that the labels 'clockwise' and 'counter-clockwise' are relative terms that are dependent upon physical connection of the motor's two leads to the EDE16020.

A Input	/A Input	Function
0	0	Motor free-spin
0	1	Motor rotates clockwise (M1 low, M2 high)
1	0	Motor rotates counter-clockwise (M1 high, M2 low)
1	1	Motor free-spin

Table Two: Input Functionality

Operational Overview

The EDE16020 contains all necessary circuitry for controlling a DC motor at operating currents up to 20 Amps. The heart of the module is a full H-Bridge circuit, consisting of two half-bridge drive segments. Current is caused to flow through the motor coil in two circumstances: [1] when the left side of the bridge is 'high' (at Motor + Input potential) and the right side is 'low' (at Ground potential)or [2] when the left side of the bridge is low and the right side of the bridge is high. The direction of motor rotation is determined by the direction of current flow (polarity) through the coil. The block diagram below illustrates the major sections of the EDE16020 module.

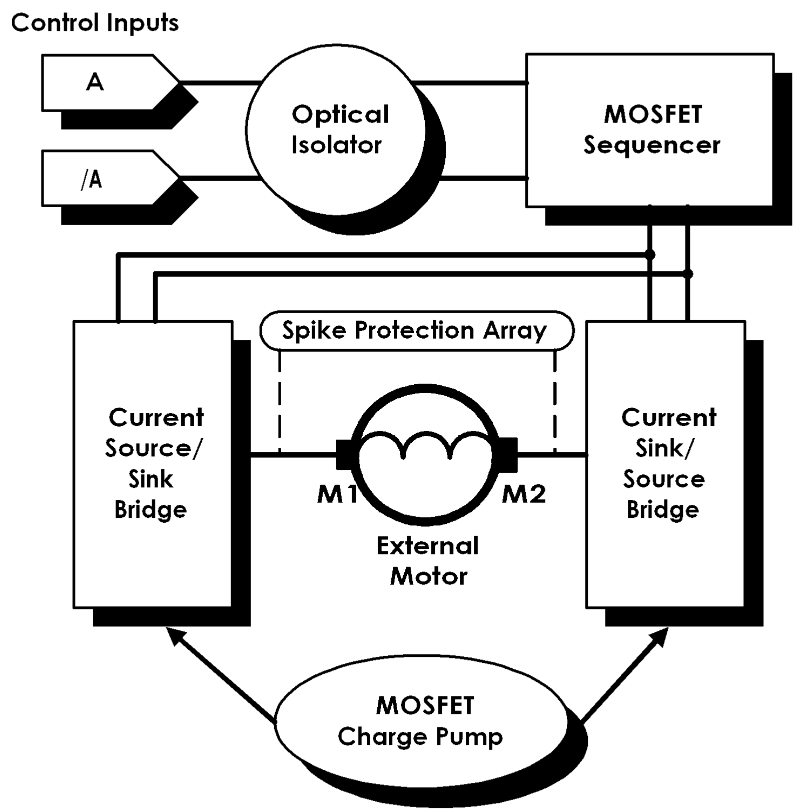


Figure One: Internal Block Diagram

An overview of the major sections within the EDE16020 module:

Optical Isolator:
From the input ports A and /A, the input signals pass through a NEC PS2501-4 quad optical isolator to protect the host microcontroller or other control device from motor voltage spikes as well as isolating the host controller from motor electrical noise. The control signal inputs should be between 3V and 48 Volts DC. Note: Due to the optical isolation, the control input voltage does not need to be equal to the motor voltage being controlled; for example, 5V signals from a microcontroller are sufficient to control a motor operating up to 55V.

MOSFET Sequencer:
The outputs from the control input optocouplers are translated into drive signals for the H-Bridge drivers by the sequencer. This provides the drive functionality detailed in Table Two. It should be noted that when both inputs (A and /A) are high the motor drive module provides the same output as it does when

both inputs are low. This contrasts with conventional H-Bridge circuits in which the input state having both A and /A both is forbidden because the H-Bridge then provides a short between the motor positive input voltage and Ground (sometimes jokingly referred to as a 'fuse-test'). The EDE16020 prevents this harmful situation from occurring.

Current Source/Sink Bridge:
These two half-bridges form the full H-Bridge driver. Implemented using International Rectifier Corp.'s IRFZ46N MOSFET devices, the driver provides a low-resistance push-pull drive arrangement with a resistance of only 16.5mΩ per half bridge.

MOSFET Charge Pump:
To operate in the most efficient manner possible, the bridge MOSFET devices are driven with a control voltage higher than the motor voltage that they are conducting. The charge pump circuit produces a voltage 11V higher than the motor + input voltage by means of an inductive charge pump. This voltage is then routed to the Current Source/Sink Bridge by the MOSFET Sequencer. The Charge Pump driver must be supplied with a DV voltage between 5V and 15VDC regardless of the motor drive voltage.

Spike Protection Array:
Electric motors, because of their inductive nature, attempt to counteract any change in current by altering the voltage across their leads using the magnetic energy stored in their windings. Because typical operation of a DC motor involves frequent changes in coil current, the generation of voltage spikes must be anticipated. The EDE16020 spike protection array is a series of 3 Amp fast-acting Schottky diodes designed to clamp these spikes (on both the positive and negative power supply rails), keeping system noise to a minimum and ensuring long life from the bridge components.

PWM Drive Fundamentals

In many instances it is not desirable to have the motor driven at full speed. Speed can be reduced by decreasing the Motor + Input voltage, however an alternative (and oftentimes more convenient) method of speed control exists: pulse width modulation (PWM). Utilizing PWM control, the host microcontroller or circuit generates control pulses that activate and deactivate the H-Bridge very quickly, resulting in a variable motor current (and corresponding speed/power level). Typically one EDE16020 input is used for the PWM input and the other EDE16020 input is used to control the direction of motor rotation (see Table Two).

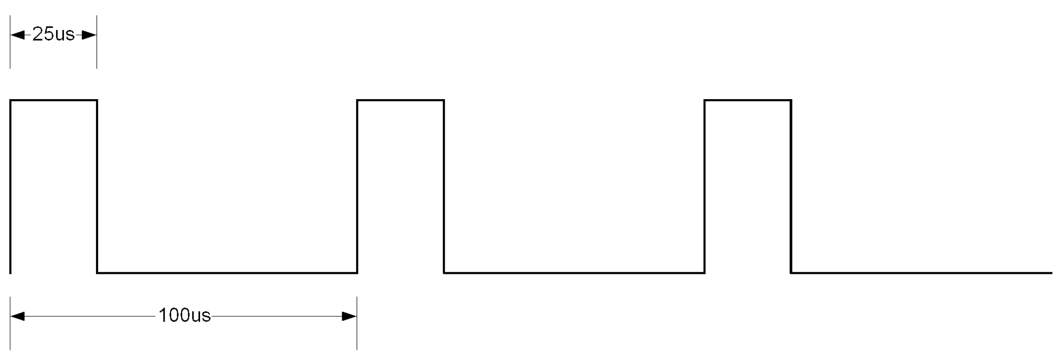


Figure Two: Typical PWM Signal

Figure Two illustrates an example PWM control signal. In this instance the on time is ¼ the total period time, so the PWM duty cycle is said to be 25%, having a pulse width of 25us and a period of 100us. (*Note: 1us = .000001 second*). Using the equation *period = 1 / frequency*, it is easily determined that the above PWM signal operates at 10KHz.

In a typical control application, one control input (for instance, the A Input) is used as the PWM input and the other control input (/A Input) is used to determine the direction of motor rotation. In the above PWM scenario, if the /A input were low, the motor would rotate in a counter-clockwise direction at approximately 25% of full speed. If, however, the /A input were held high, the motor would rotate in a clockwise direction at 75% of full power (because the low period of the PWM pulse becomes the 'on time'). One simple means of keeping the duty cycle from inverting when rotation may be in either direction is to simply invert the PWM output pin (A) when the direction control output (/A) is high. When this is done, the PWM signal in Figure Two would produce an approximately 25% power level of the motor in either rotation direction.

Typical Application

Connection to the EDE16020 module is straightforward. The two control inputs, Input A and Input /A, are driven by a microcontroller or some other control circuit. Input A connects to the EDE16020 module pins 1 and 2, and input /A connects to module pins 3 and 4. Two pins are used for each control input for convenience of board layout. Three pins are used for the power, ground, and motor connections (as described below) for greater current-carrying capabilities.

Motor (and module) power input is through the Motor + Input (pins 19, 20, and 21) and Ground (pins 16, 17, and 18). The motor connections are through M1 (pins 13, 14, and 15) and M2 (pins 22, 23, and 24). Multiple pins are used for motor and power connections to provide enhanced current-carrying capabilities. For each set of three pins the pins are connected internal to the module, and should also all three be connected externally by the mounting PC board. Wide traces should be used if high motor currents are expected; as an example, a standard 1oz. copper PCB trace capable of carrying a current of 10 Amps with a 50°C temperature rise would need to be 108 mils in width. Consult a PCB trace width table for trace widths appropriate to your design. If the EDE16020 is not board mounted but is used with the terminal block adapter, the connection wire chosen for motor and power wires should be adequate to carry the maximum motor current expected.

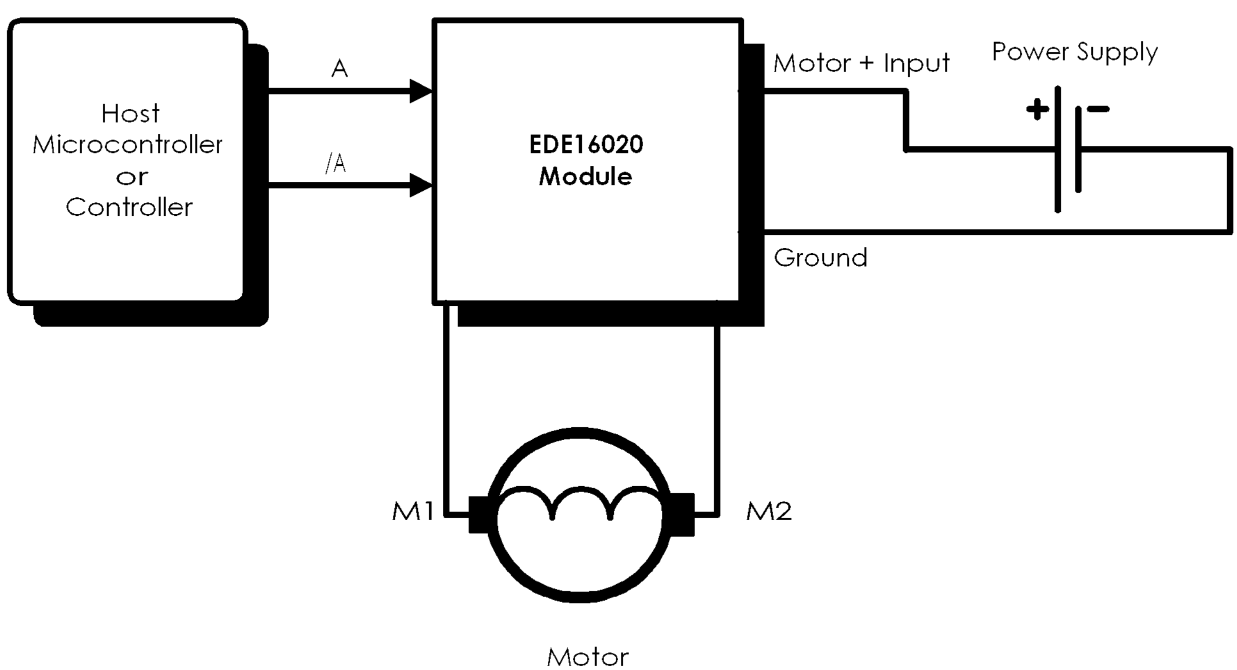
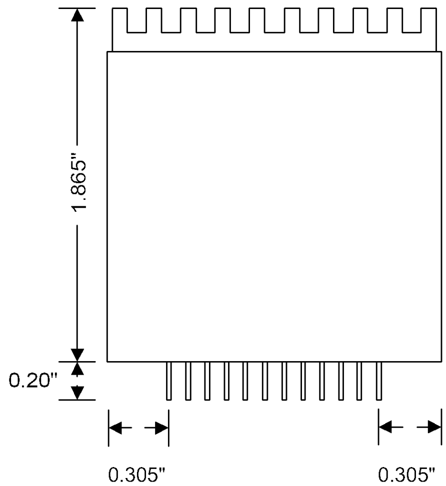
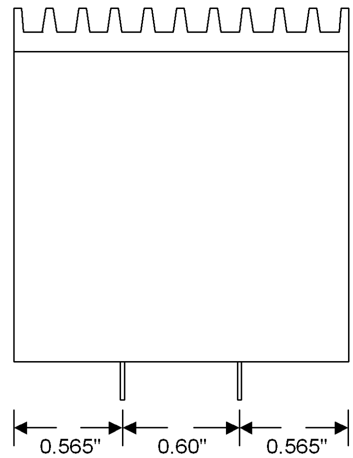


Figure Three: Hookup Diagram

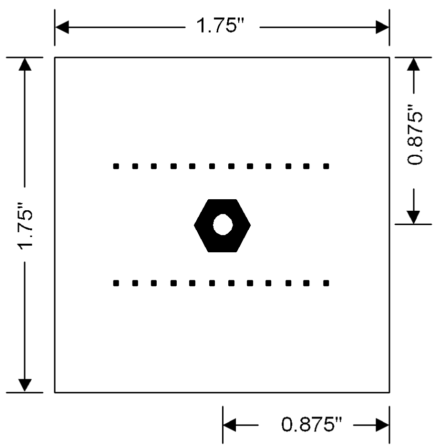
Module Mechanical Dimensions



Front View



Side View



Bottom View

Notes: 1. Connection pins are in a standard 24 pin wide DIP arrangement, 600 (0.6") mil wide.

2. Pin spacing is 100 mil (0.1")

3. Pins require 45 mil (0.45") diameter PCB hole

4. Allow minimum 1/8" clearance on all four sides of module for ventilation.

5. Center mounting coupler is female 4-40 thread,1/4" deep.

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