EVB90401

MLX90401 Demo Board

Introduction

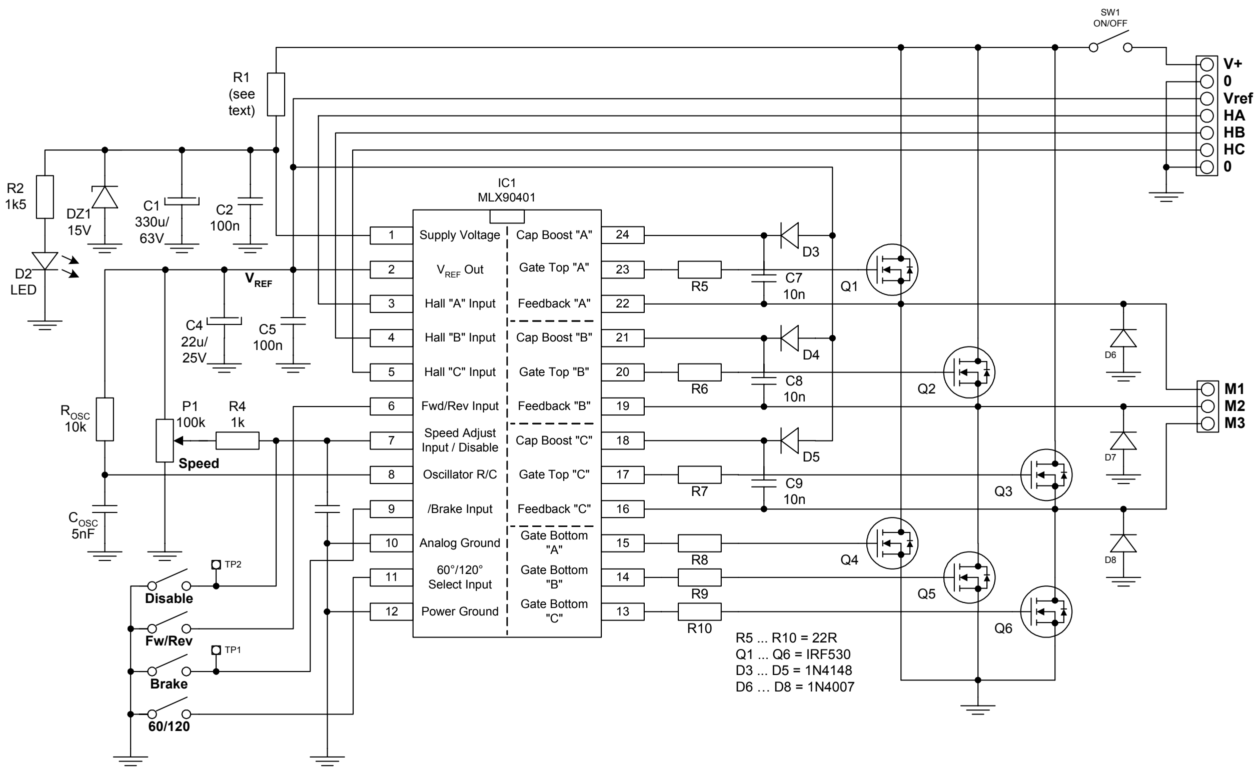
The MLX90401 Demo Board described in this document is designed to show the operation and performance of the Brushless DC Motor Controller and to simplify the design of new applications.
The Demo Board provides the necessary external components to facilitate evaluation of the MLX90401 without having to design and construct external circuitry. Several control switches and a potentiometer are available on the Board. A regulated DC power supply is the only input signal.
A brushless DC motor with Hall effect sensors is NOT included with the Demo Board, but any can be used.

Ordering Information

Part No.	Power supply range of target application
EVB90401A	12V to 24V
EVB90401B	20V to 40V

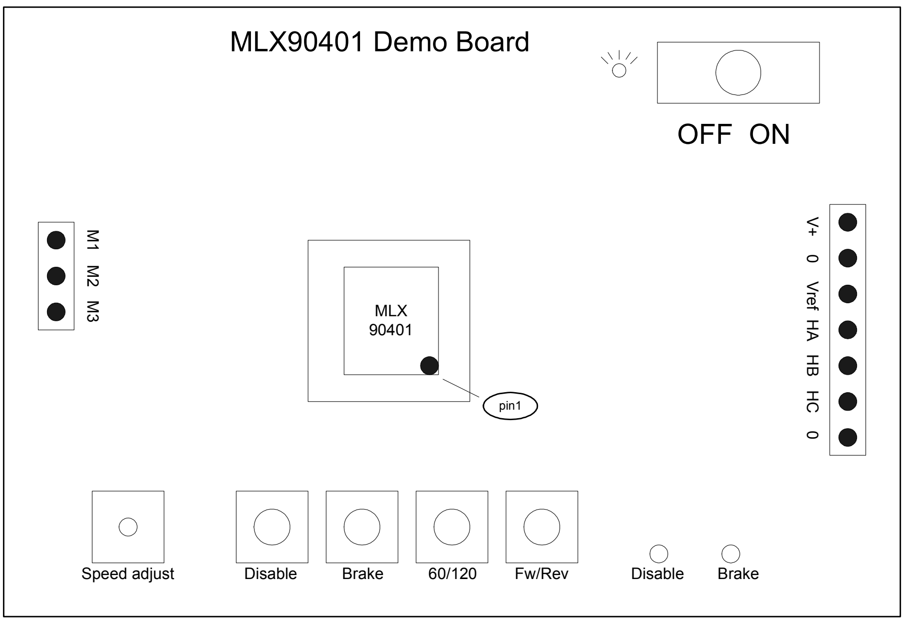
1 Demo Board description

1.1 Schematic



1.2 Board layout

The following diagram shows a schematic overview of the most important parts of the Demo Board:



1.3 Functional Description

The Demo Board mainly consists of the following *blocks*:

- 15V regulator with an On/Off switch and a power-on indication LED
- Connectors for power supply, Hall effect sensors and brushless DC motor
- Three push button switches for controlling the motor: Brake, Forward/Reverse (Fw/Rev) and Disable
- One push button switch for setting 60° or 120° sensor electrical phasing of the motor (60/120)
- A potentiometer to control motor speed (Speed adjust)
- 1 on-board MLX90401 Brushless DC Motor Controller
- External components for oscillator, charge boost and protection.

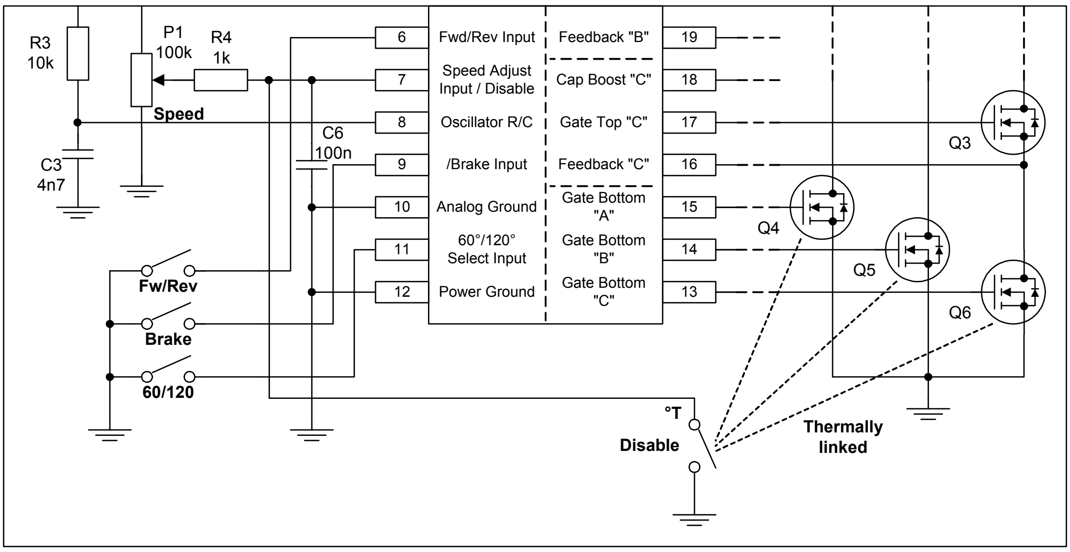
The main *purpose* of the board is to demonstrate the functionality and capabilities of the MLX90401. With a power supply and a brushless DC motor connected, the buttons and potentiometer can be used to fully control the motor.

An on-board *zener diode regulator* provides a voltage of 15V for the chip. That way the external power supply – which is also supplied to the motor - can be as high as 40V. R1 (and if necessary also the zener diode) can be optimized for a specific power supply voltage (see Remarks below). Two versions of the Demo Board can be ordered, each for a specific power supply voltage range. (See Order Information for more details.)

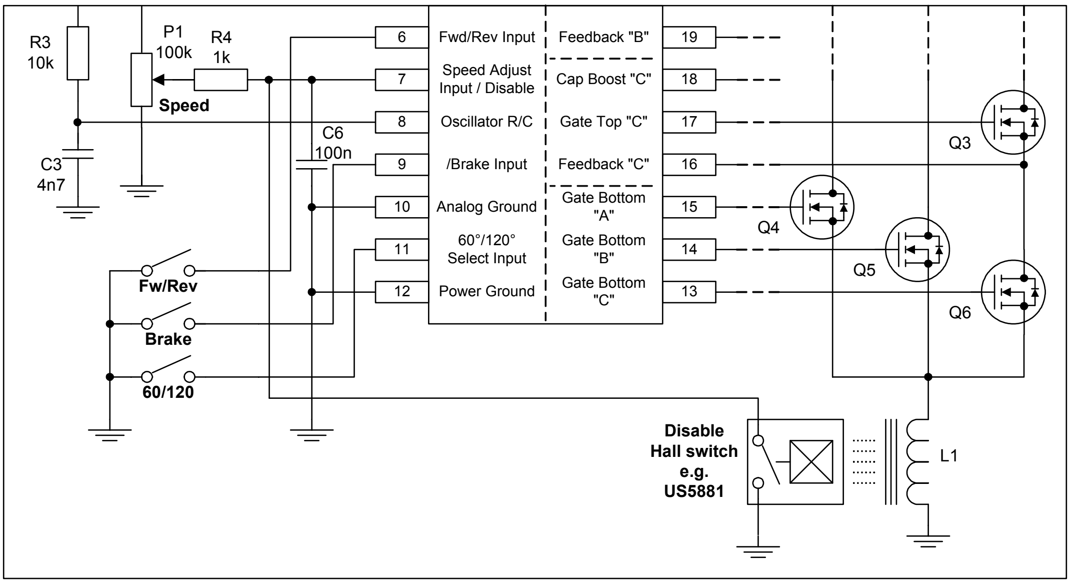
The *Vref pin* (output of the MLX90401) serves as a 12V supply for the Hall effect sensors.

The *Disable* input can be used for protection purposes. Pulling the Disable input low turns off all drivers. When the motor is disabled in such a way, it will come to a standstill due to friction. No active braking is applied.
Any sort of switch can be used to pull the Disable input low.

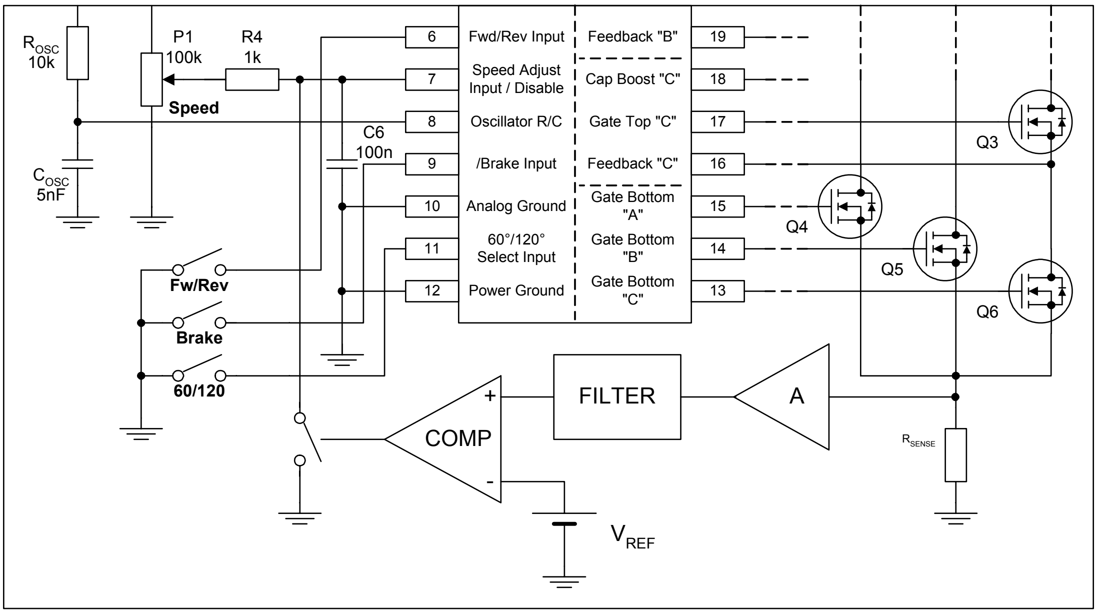
An option is the use of a *thermal switch*. This thermal switch can be used to monitor the temperature of the drivers MOSFETs. If the MOSFETs get too hot, the thermal switch will pull the Disable input low.



Another possibility is the use of a *Hall effect switch*. When the current through the driver MOSFETs reaches a certain threshold, the magnetic field induced in the sense coil will exceed the Hall effect switch threshold. The Hall effect switch should then switch to the “ON” state, and in that way pull the Disable input low. This in turn switches off all drivers.



Also, a *sense resistor* can be used to measure the current through the motor. The current will produce a voltage drop across the sense resistor. This voltage, amplified and filtered, can be compared with a reference voltage. If the voltage (proportional to the current) exceeds the reference voltage, the Disable pin is pulled low and drivers are switched off.



A Test Pin is available on the Demo Board as a connection point for the Disable signal.

A Test Pin is also available on the *Brake* signal.

1.4 Bill of Materials for the Demo

- A Demo Board with on-board MLX90401
- A regulated power supply (laboratory power supply, battery etc.)
- A brushless DC motor
- (Oscilloscope)

1.5 Operation

To operate the Demo Board the following steps are necessary:

- Connect the motor windings and Hall effect sensors.
- Select 60° or 120° sensor electrical phasing depending on the motor used, with the push button switch 60/120.
- Connect the power supply.
- Use the push button switches and potentiometer to control the motor.

2 Remarks

2.1 Using standard power supplies

When using normal power supplies that are normally found in laboratories, there is one thing to keep in mind. Most of these power supplies cannot sink current. When an electrical motor is braked it acts as a generator. This causes reverse currents to flow out of the motor. This energy cannot be absorbed by the power supply, and the supply voltage can be raised by a large degree. **The supply voltage may even go higher than the breakdown voltage of certain components, including the MLX90401, and by doing so destroy the circuit.**

The ***solution*** for this issue is the following:

- Connect a high-power zener diode (5 Watt) across the power supply, with a zener voltage of a few volts above the normal operating supply voltage.
- This zener diode will start to conduct if the supply voltage is raised above its zener voltage by the motor. That way a path is created for the excessive current to flow.
- The supply voltage will also be limited to the zener voltage.

When a battery (e.g. a 12V car battery) is used, this problem does not occur, since the battery can absorb the fly back energy from the motor with significantly raising the battery voltage.

2.2 Power off

When the board is powered off (e.g. using the On/Off switch) the MLX90401 is no longer powered. However as in many applications the motor is still rotating after power off the motor generates a voltage that is not clamped or limited. **If this voltage exceeds the maximum voltage rating the MLX90401 could be destroyed.**

The ***solution*** is either:

- To disable or brake the motor until standstill before powering off the board or application.
- Or to solder a power zener diode behind the switch between supply and ground that can drain the motor fly back power after opening the switch. Mind that zener diode DZ1 is not suitable to drain the motor power.

2.3 Optimum value of R1

The minimum value of resistor R1 is determined by the minimum power supply voltage available for the chip. $V_{CHIP,MIN}$ should be at least 8V (undervoltage V_{UV}) for the drivers to work.

$$V_{CHIP,MIN} = V_{SUPPLY,MIN} – R1 \times I_{CHIP}$$

For example:

$$V_{CHIP,MIN} = 24V – 220R \times 35mA = 16.3V$$

The maximum value of the resistor determines the power dissipation of the resistor:

$$P_{R1} = (V_{SUPPLY} – V_{CHIP}) \times I_{CHIP}$$

For example:

$$P_{R1} = (24V – 15V) \times 35mA = 315mW$$

For instance, if a standard 12V battery is used, make R1=100R.

$$V_{CHIP} = 12V – 100R \times 35mA = 8.5V > V_{UV} = 8V$$

$$P_{R1} = (12V – 8.5V) \times 35mA = 122.5mW$$

V_{SUPPLY} (V)	V_{CHIP} (V)	R1 (Ohm)	P_{R1} (W)
> 23.0	15	220	> 0.37
16.0	8.3	220	0.27
12.0	8.5	100	0.13
8.0	8.0	0	0.00

Table 1: Recommended value of R1 in function of supply voltage (with DZ1 = 15V zener diode)

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