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Motor Control Shield for Arduino with BTN7030-1EPA

About this document

Scope and purpose

This document describes how to use the Motor Control Shield with BTN7030-1EPA for Arduino.

Intended audience

Engineers, hobbyists and students who want to add a powerful Motor Control to Arduino projects.

Related information

Table 1 Supplementary links and document references

Reference	Description
BTN7030-1EPA Reference Manuals	Product page which contains reference information for the half-bridge BTN7030-1EPA
Arduino Home Page	All information on Arduino
Arduino Uno Product Page	Arduino Uno R3 description
XMC-for-Arduino	Instruction on how to install SEGGER J-Link
XMC1100 Boot Kit	Product page which contains reference information for the XMC1100 Boot Kit
uIO Stick	Product page

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1 Motor Control Shield introduction

1.1 Motor Control Shield overview

The Motor Control Shield adds powerful motor control to the Arduino projects. The shield can be controlled with the general logic IO-Ports of a microcontroller. Either an Arduino Uno R3 or the XMC1100 Boot Kit from Infineon can be used as the master. Another way to control this board is via uIO Port using Infineon uIO Stick.

The device is a monolithic chip integrated in SMART7 technology. BTN7030-1EPA is a protected half-bridge with integrated driver, providing protection and diagnosis functions. The high side power stage is built using a N-channel vertical power MOSFET with charge pump, while the low side power stage uses no charge pump. This device has an exposed pad which ensures better cooling.

The BTN7030-1EPA half-bridge is easy to control by applying logic level signals to the IN and EN pin. When applying a PWM to the IN pin the current provided to the motor can be controlled with the duty cycle of the PWM. BTN7030-1EPA NovalithIC™ Lite are intended to be used for frequencies up to 2kHz.

1.2 Key features

The Motor Control Shield has the following features:

- An Arduino Uno R3 or XMC1100 Boot Kit can control the two BTN7030-1EPA devices via the general IO pins.
- 6 – 18 V nominal input voltage (max. 3.8 – 28 V)
- Typical nominal current 7 A (current limitation is temperature dependent - 14 A @150°C)
- Drives either one brushed bi-directional DC motor or two uni-directional DC motors.
- Capable of PWM up to 2 kHz
- Status flag diagnosis with current sense capability
- Current sense accuracy ~ 5%
- Protection against overtemperature, overcurrent, cross current, undervoltage
- Voltage clamping
- OFF state diagnosis (missing load and short circuit to battery or ground)

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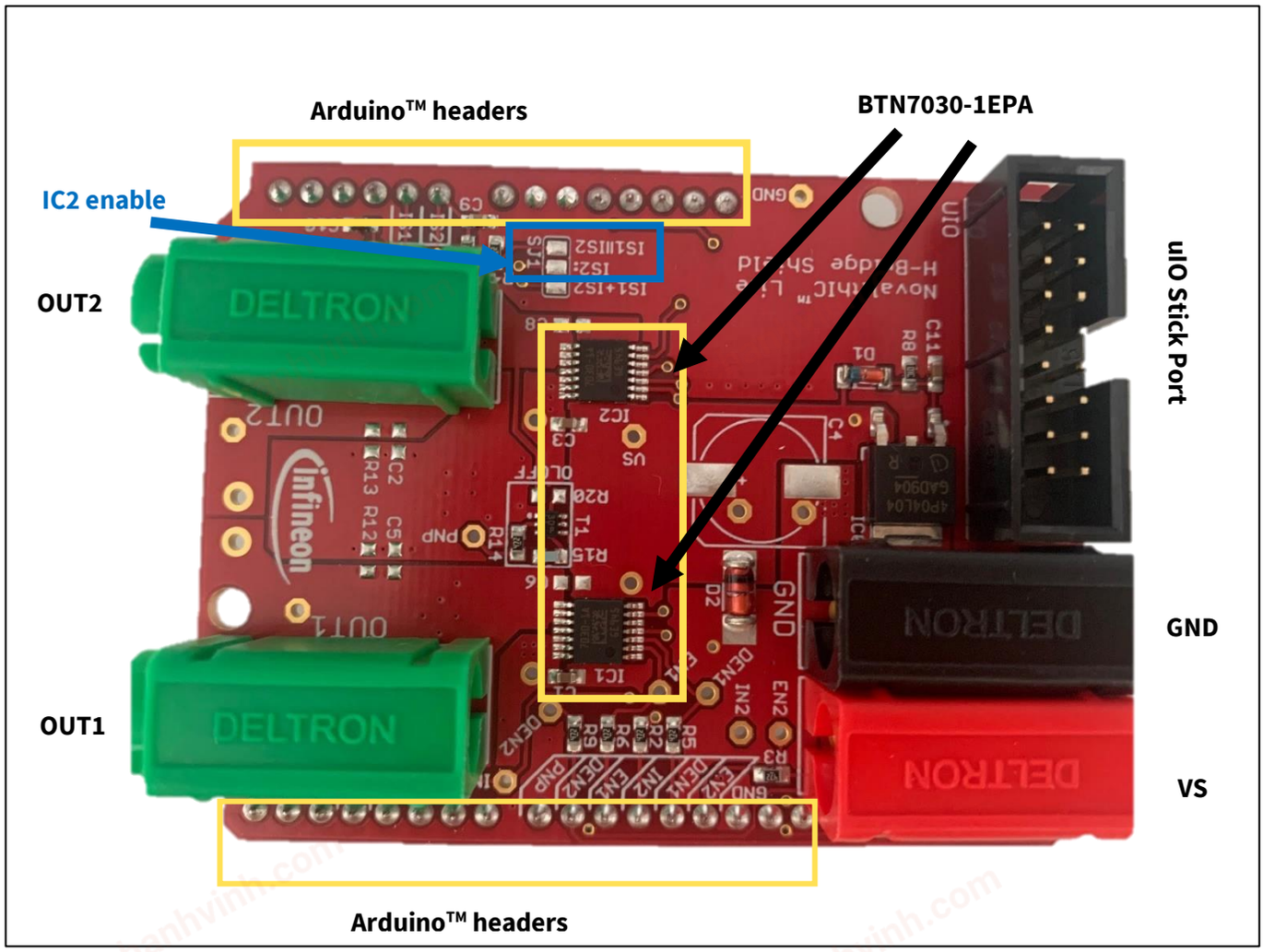


Figure 1 Motor Control Shield photo

As shown in **Figure 1** in order to enable the usage of IC2 it is necessary to solder together the two pads marked in blue frame.

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1.3 Block diagram of a full-bridge Motor Control

As a starting point for the Motor Control Shield, the application block diagram shown in **Figure 2** was used. To be flexible in the usage of the Motor Control Shield each IN, EN and DEN of the two half-bridges is connected to a separate IO pin.

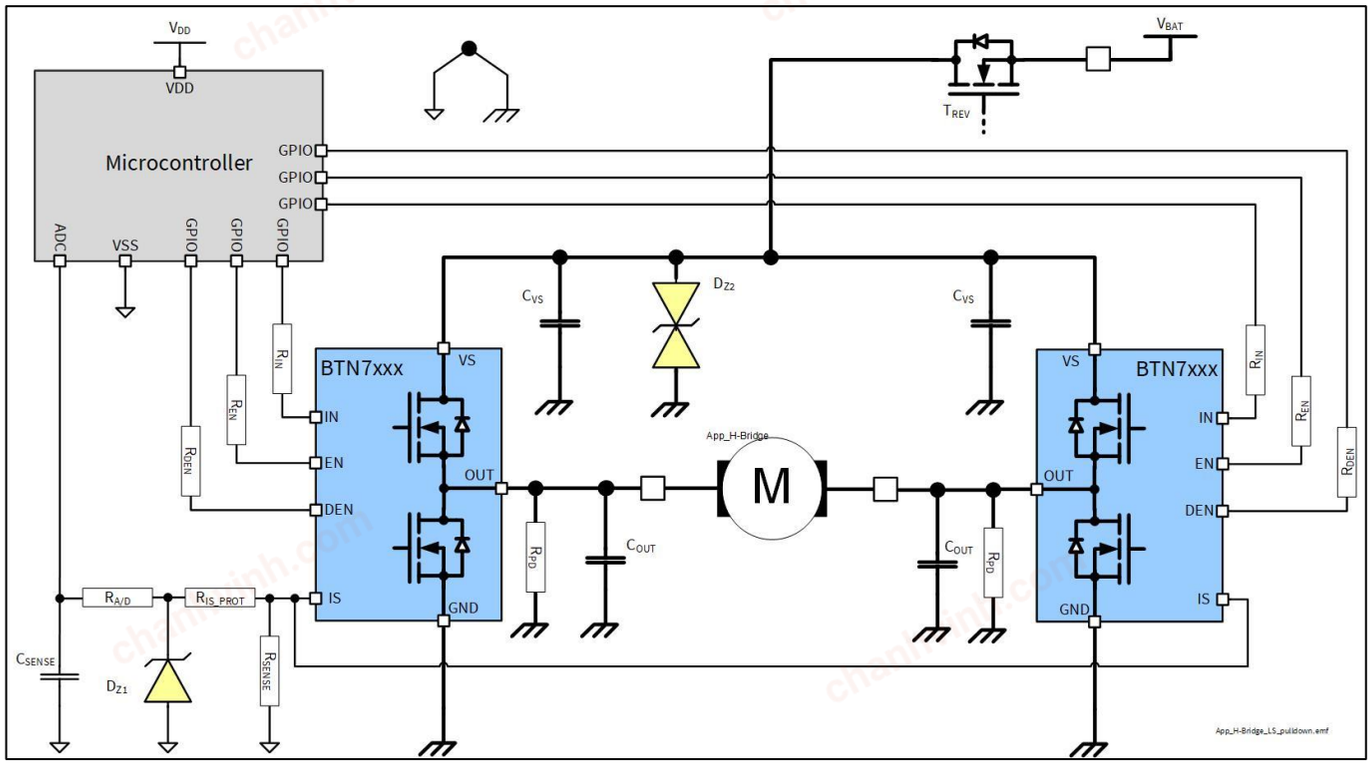


Figure 2 Application circuit for a bi-directional motor control with BTN7030-

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2 Motor Control Shield board description

For a safe and sufficient motor control design, discrete components are needed. Some of them must be dedicated to the motor application and some to the NovalithIC™ Lite.

Figure 3, Figure 4 show the schematics plus the corresponding layout of the Motor Control Shield.

2.1 Schematics

In **Figure 3** the schematics of the Motor Control Shield is shown. The schematics are based on the application circuit in the BTN7030-1EPA Data Sheet.

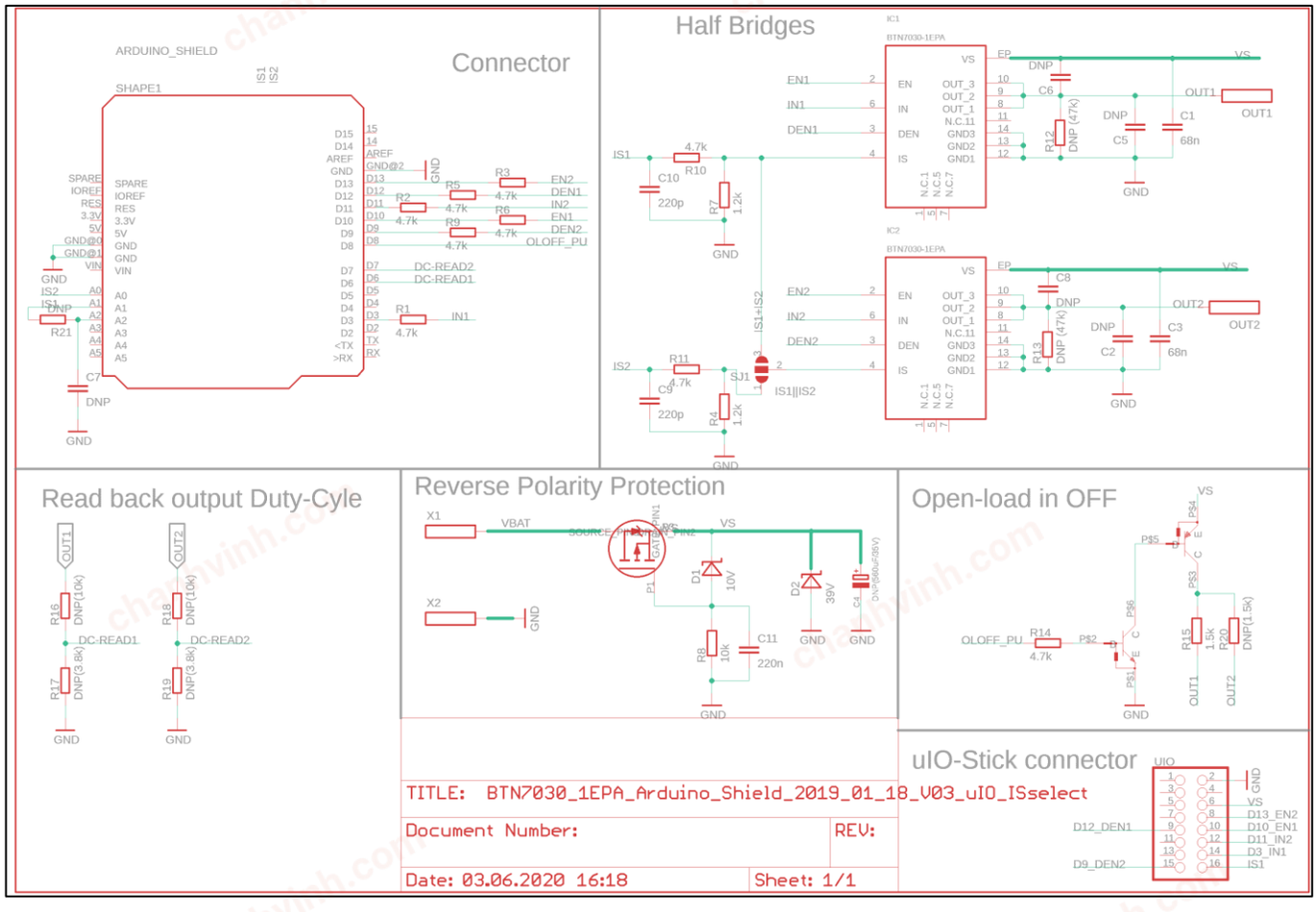


Figure 3 Schematics Motor Control Shield for Arduino with BTN7030-1EPA

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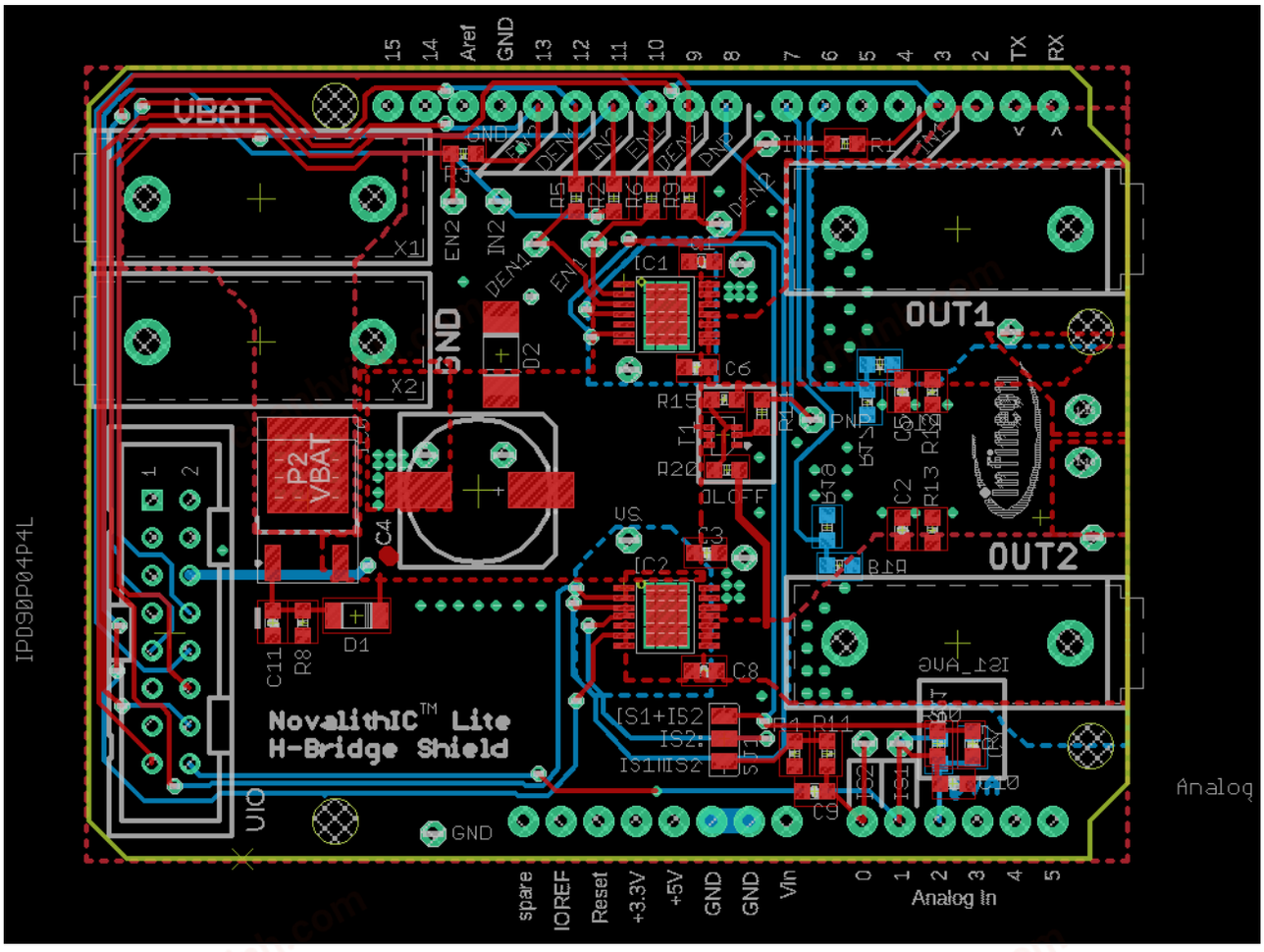


Figure 4 Motor Control Shield for Arduino with BTN7030-1EPA – Layout

2.2 External components

All the external components shown in **Figure 2** are described in the BTN7030-1EPA Design and PCB guideline Application Note. Besides these components there are some others placed on this Arduino Shield in order to insure the proper functioning.

- C4, so called DC-link capacitor: This electrolytic capacitor is required to keep the voltage ripple at the VS-pin low during switching operation. It is usually recommended that the voltage ripple at the Vs-pin to the GND-pin is kept below 1 V peak to peak. The value of C4 must be aligned accordingly. Most electrolytic capacitors are less effective at cold temperatures. It must be assured that C4 is also effective under the worst case conditions of the application. The layout is very important too. As shown in **Figure 4**, the capacitor C4 must be positioned with very short wiring close to the NovalithIC™ Lite chip. This must be done to keep the parasitic inductors of the PCB-wires as small as possible. On this shield capactior of 330 uF is mounted.

$$C_{DC-Link} = \frac{I_{nom} * T_{PWM} * duty_cycle}{\Delta V_S} = \frac{7A * 0.00025s\ (1kHz) * 0.5(50\%)}{1V} = 875uF$$

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- C1/C3: This ceramic capacitors support C4 to keep the supply voltage ripple low and cover the fast transients between the Vs-pin and the GND-pin. The layout wiring for C1/C3 must be shorter than for C4 to the NovalithIC™ Lite to keep the parasitic PCB-wire inductance as small as possible. In addition the parasitic inductance could be kept low by placing at least two vias for the connection to the GND-layer. On this shield capactiors of 68 nF are mounted.
- C6/C8: These ceramic capacitors are important for EMI. Good results have been achieved with a value of 220 nF. In terms of layout, it is important to place these capacitors between “OUT” and “Vs” without significant additional wiring from C6/C8 to the Vs- and OUT-line. These capacitors are not mounted on this shield.
- C5/C2: These ceramic capacitor help to improve the EMC immunity and the ESD performance of the application. Good results have been achieved with a value of 220 nF. To keep the EMC and ESD out of the board, the capacitor is most effective when positioned directly next to the board connector. In addition, the parasitic inductance could be kept low by placing at least two vias for the connection to the GND-layer. These capacitors are not mounted on this shield.

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3 BTN7030-1EPA overview

The BTN7030-1EPA used in the Motor Control Shield is an integrated high current half-bridge for motor drive applications. Interfacing to a microcontroller is made easy by the integrated driver IC which features logic level inputs, diagnosis with current sense, dead time generation, short circuit detection and protection against overtemperature, undervoltage, overcurrent and cross current.

The BTN7030-1EPA provides a cost optimized solution targeting low power (<15 A) DC motor applications with 0 – 2 kHz.

3.1 Key features of the BTN7030-1EPA Novalith IC™

- Path resistance of max. 62 mΩ @ 150°C (typ. 32 mΩ @ 25°C)
- High side: max. 25.5 mΩ @ 150°C (typ. 12 mΩ @ 25°C)
- Low side: max. 36.5 mΩ @ 150°C (typ. 20 mΩ @ 25°C)
- Current limitation level of 14 A @ 150°C, 17 A @ 25°C
- Status flag diagnosis with current sense capability
- Overtemperature shut down with latch behavior
- Undervoltage shut down
- Cross current protection
- Open load in ON and OFF detection
- Short circuit to GND and VBAT detection
- Driver circuit with logic level inputs
- Operation up to 28 V (normal operation 6V – 18V)
- Green Product (RoHS compliant)
- AEC Qualified in PG-TSDSO-14 package

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3.2 Block diagram

The device is a monolithic chip integrated in SMART7 technology. BTN7030-1EPA is a protected half-bridge with integrated driver, providing protection and diagnosis functions. The high side power stage is built using a N-channel vertical power MOSFET with charge pump, while the low side power stage uses no charge pump. This device has an exposed pad which ensures better cooling.

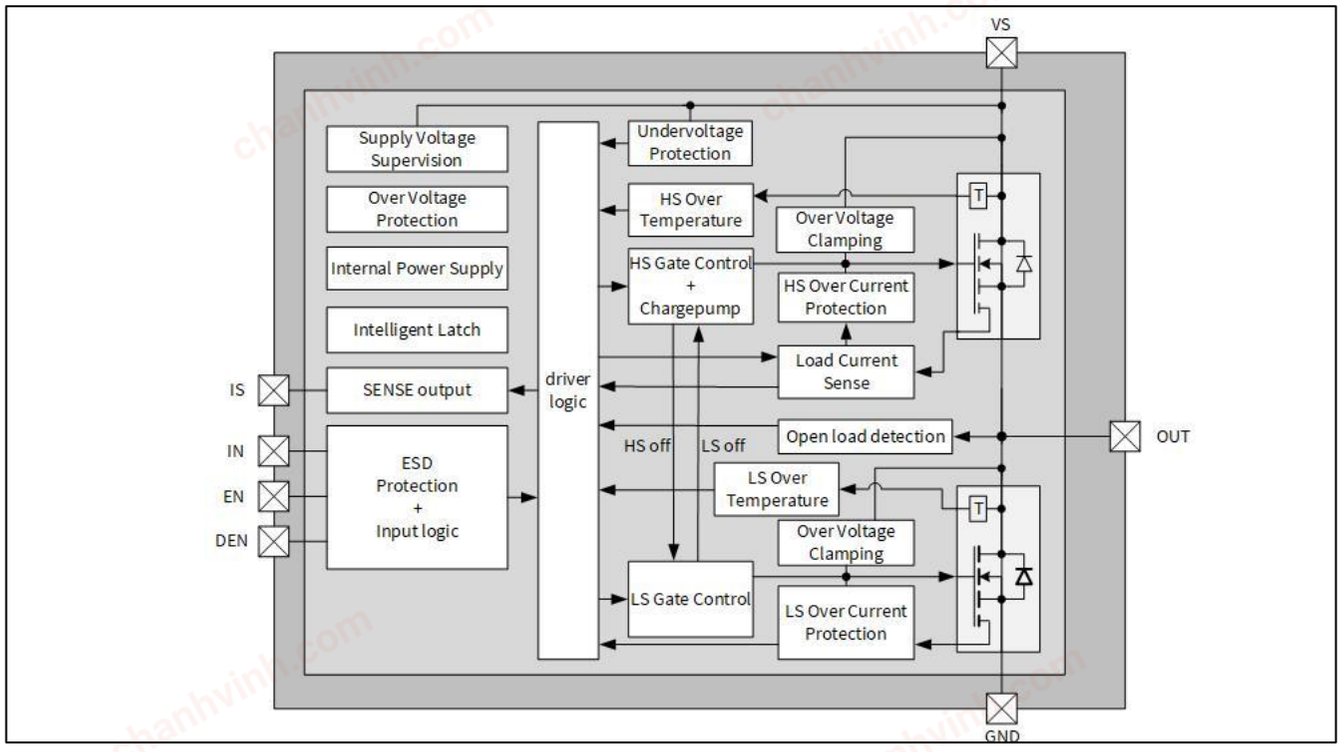


Figure 5 Block diagram BTN7030-1EPA

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3.3 Pin assignment

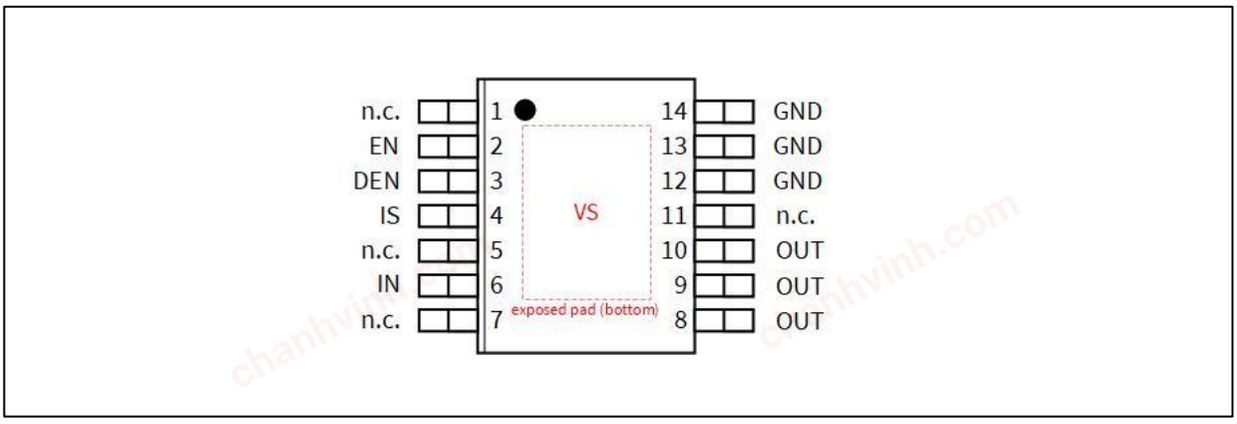


Figure 6 Pin assignment BTN7030-1EPA (top view)

3.4 Pin definitions and functions BTN7030-1EPA

Table 1

Pin	Symbol	I/O	Function
EP	**VS**	**-**	Supply Voltage Battery voltage
2	**EN**	**I**	Enable Digital signal to enable the normal operational mode (active mode) of the BTN7030-1EPA and to clear the protection latch
3	**DEN**	**I**	Diagnosis enable Digital signal to enable device diagnosis ("high" active) and to clear the protection latch. If not used: connect to GND pin or to module ground with a 10 kΩ resistor
4	**IS**	**I**	Sense current output Analog/digital signal for diagnosis If not used: left open
6	**IN**	**I**	Input Digital signal to switch ON either the low-side or high-side output stage of the half-bridge
8-10	**OUT**	**O**	Output Protected half-bridge power output
12-14	**GND**	**-**	Ground Signal ground and ground connection for the low-side switch
1,5,7,11	**n.c.**	**-**	Not connected, internally not bonded

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4 Getting started

4.1 Target applications

The application targeted by the BTN7030-1EPA devices is brushed DC Motor Control (door lock, trunk lock, cinching latch), but also solenoids and pumps. Besides Motor Control any other inductive, resistive and capacitive load within the electrical characteristics of the NovalithIC™ Lite can be driven by this device.

With the Motor Control Arduino Shield either uni-directional DC-brushed motors or one bi-directional brushed motor (with the two half-bridges used in full-bridge configuration) can be driven. The half-bridges are controlled via the IN (Input) and EN (enable) pins. The BTN7030-1EPA also provides a sense current at the IS pin, which is enabled by setting the DEN (diagnosis enable) pin.

4.1.1 Getting started: Arduino Shield

- Choose a brushed DC motor.
- Choose a DC adapter. The nominal input of the Power Shield is 6 – 18 V DC. Maximum Voltage is 2 V
- Mount the Power Shield onto Arduino Uno R3 or XMC1100 Boot Kit.
- Connect power supply (5 V) to the Arduino Uno R3 or XMC1100 Boot Kit (Micro USB).

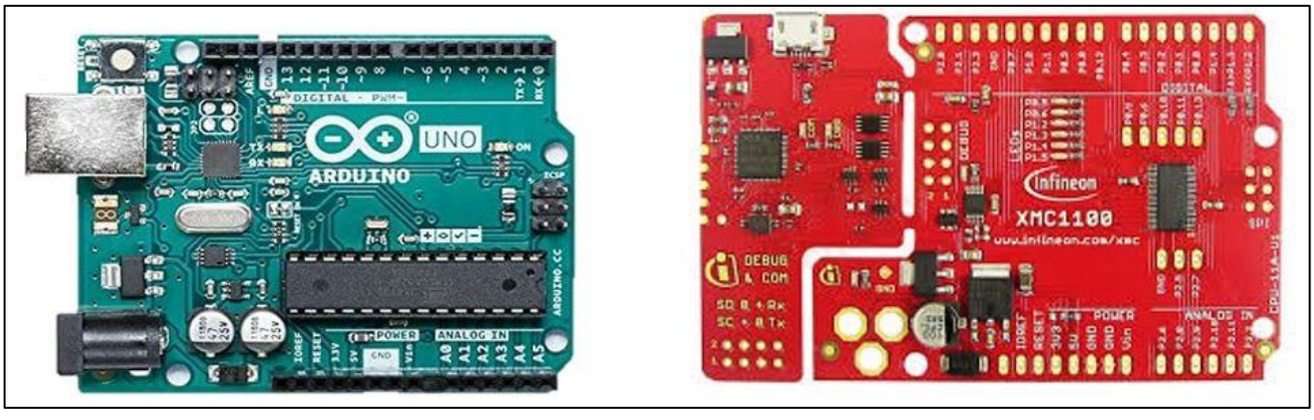


Figure 7 Arduino Uno and XMC1100 boards

- Program the controller board with the motor control software (Arduino – example Software).
  - In order to use the Arduino code on XMC1100 Boot Kit it is necessary to install SEGGER J-Link.
- For bi-directional applications connect the motor to OUT1 and OUT2 (full-bridge). For uni-directional use, the motor can be placed between an output OUT1/OUT2 and either GND or VBAT (half-bridge).
- Connect the Power supply to the Power Shield (VBAT, GND).
- Turn on the power.

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4.1.2 Getting started: uIO Stick Software

- Install Infineon Toolbox or lightweight Launcher
- Connect the uIO Stick between the USB port of your PC and Infineon uIO Stick port (**Figure 1**) on the Arduino shield.



Figure 8 uIO Stick

- Under **Manage Tools** find **Config Wizard for Single Half-Bridges** and install it
- When you open this Config Wizard you can configure the Shield according to your preferences and see SENSE and OUT current waveforms, **Figure 9**.
- Important to remember is that it is only possible to plot SENSE and OUT current of the IC1 on the board. This limitation exists due to the configuration of the 16-pin uIO Stick port.

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Figure 9 Config Wizards (GUI) for uIO Stick

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5 Revision history

Document version	Date of release	Description of change
1.0	2021-01-21	First release

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