

# BTN9970 / BTN9990 Motor control shield

## Arduino shield for evaluation

### About this document

#### Scope and purpose

This document describes the usage of the Motor control shield for BTN9970 and BTN9990 V1.2. The board can be connected to an Arduino UNO board.

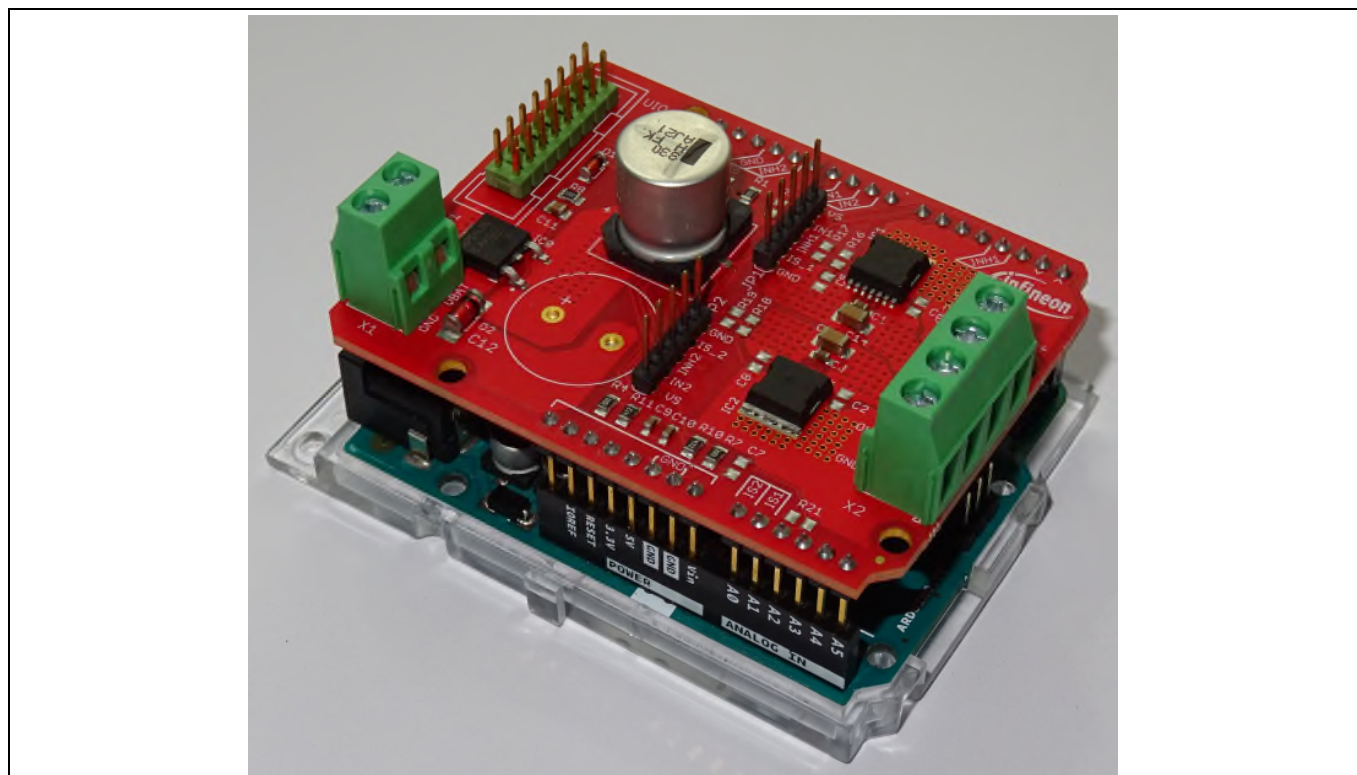
#### Intended audience

This document is intended for electronic engineers who want to evaluate a high current PMOS / NMOS half bridge with integrated driver.

#### Evaluation board

This board can be used during design in phase for customer projects, for evaluation and measurement of BTN9970 / BTN9990 device behavior.

PCB and auxiliary circuits are not optimized for final customer design.



**Figure 1** BTN9970 / BTN9990 motor control shield stacked on Arduino UNO board

### Important notice

### Important notice

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**Safety precautions****Safety precautions**

*Note:* Please note the following warnings regarding the hazards associated with development systems.

**Table 1 Safety precautions**

	<b>Caution</b>
	The heat sink and device surfaces of the evaluation or reference board may become hot during testing. Hence, necessary precautions are required while handling the board. Failure to comply may cause injury.
	Only personnel familiar with the drive, power electronics and associated machinery should plan, install, commission and subsequently service the system. Failure to comply may result in personal injury and/or equipment damage.
	The evaluation or reference board contains parts and assemblies sensitive to electrostatic discharge (ESD). Electrostatic control precautions are required when installing, testing, servicing or repairing the assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with electrostatic control procedures, refer to the applicable ESD protection handbooks and guidelines.
	A drive that is incorrectly applied or installed can lead to component damage or reduction in product lifetime. Wiring or application errors such as undersizing the motor, supplying an incorrect or inadequate AC supply, or excessive ambient temperatures may result in system malfunction.

**Warnings**

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## 1 The board at a glance

### 1.1 Delivery content

The carton box includes one BTN9970/BTN9990 motor control board with marking:

BTN99xx

NovalithIC+

V 1.2

The Arduino UNO board and a power supply are not included. Information about the Arduino controller board can be found under: [Arduino - Home](#).

### 1.2 Block diagram

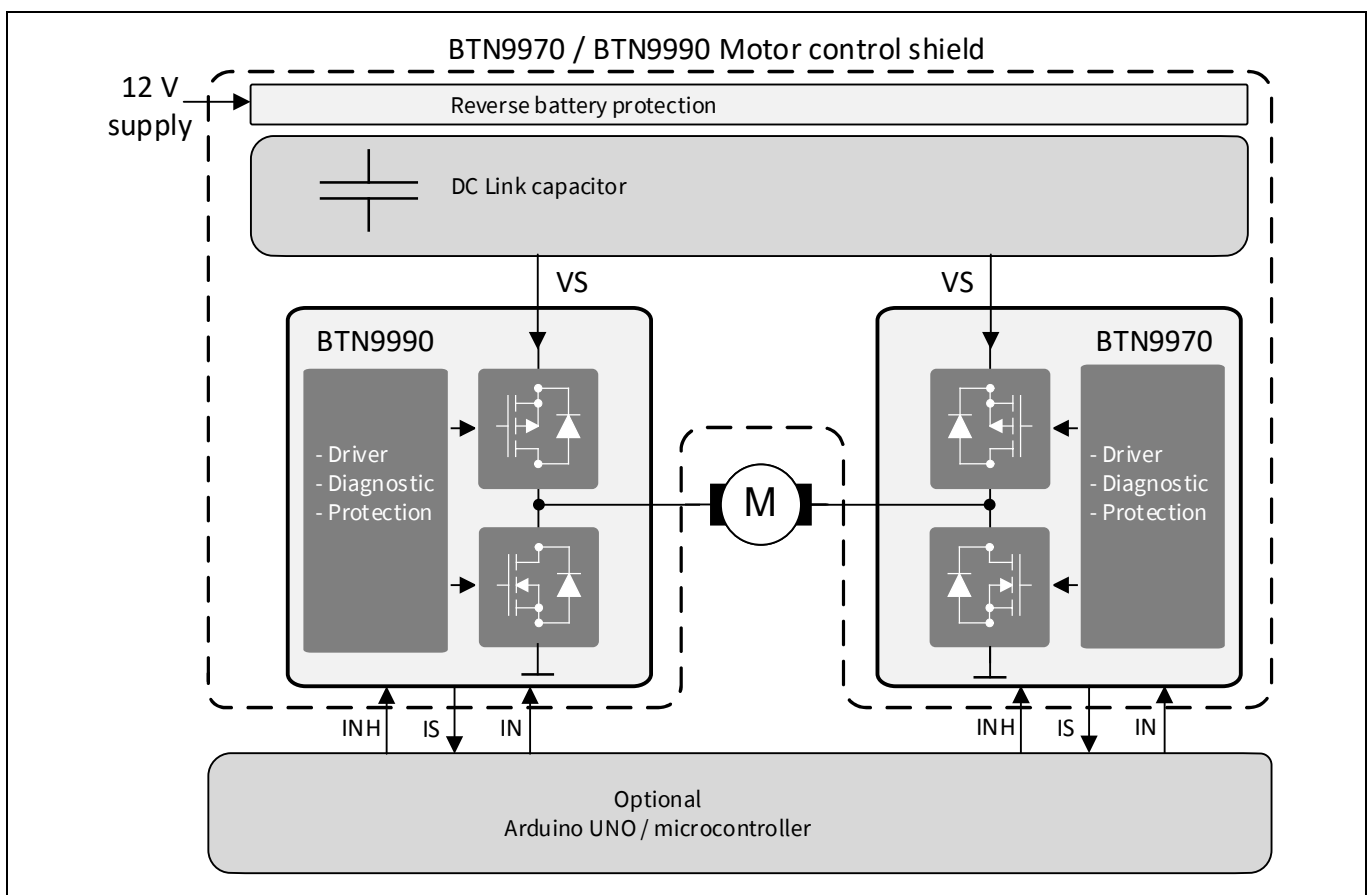


Figure 2 Block diagram

### 1.3 Main features

The board includes two NovalithIC+™ high current half bridges with integrated driver BTN9970LV and BTN9990LV.

The board features:

- Operating voltage: 8 V – 18V
- Average motor current up to ~ 10 A. Restricted by the value and size of DC-link capacitor and power dissipation of PCB (current limitation of BTN9970LV is min. 60A and for BTN9990 min. 75A)

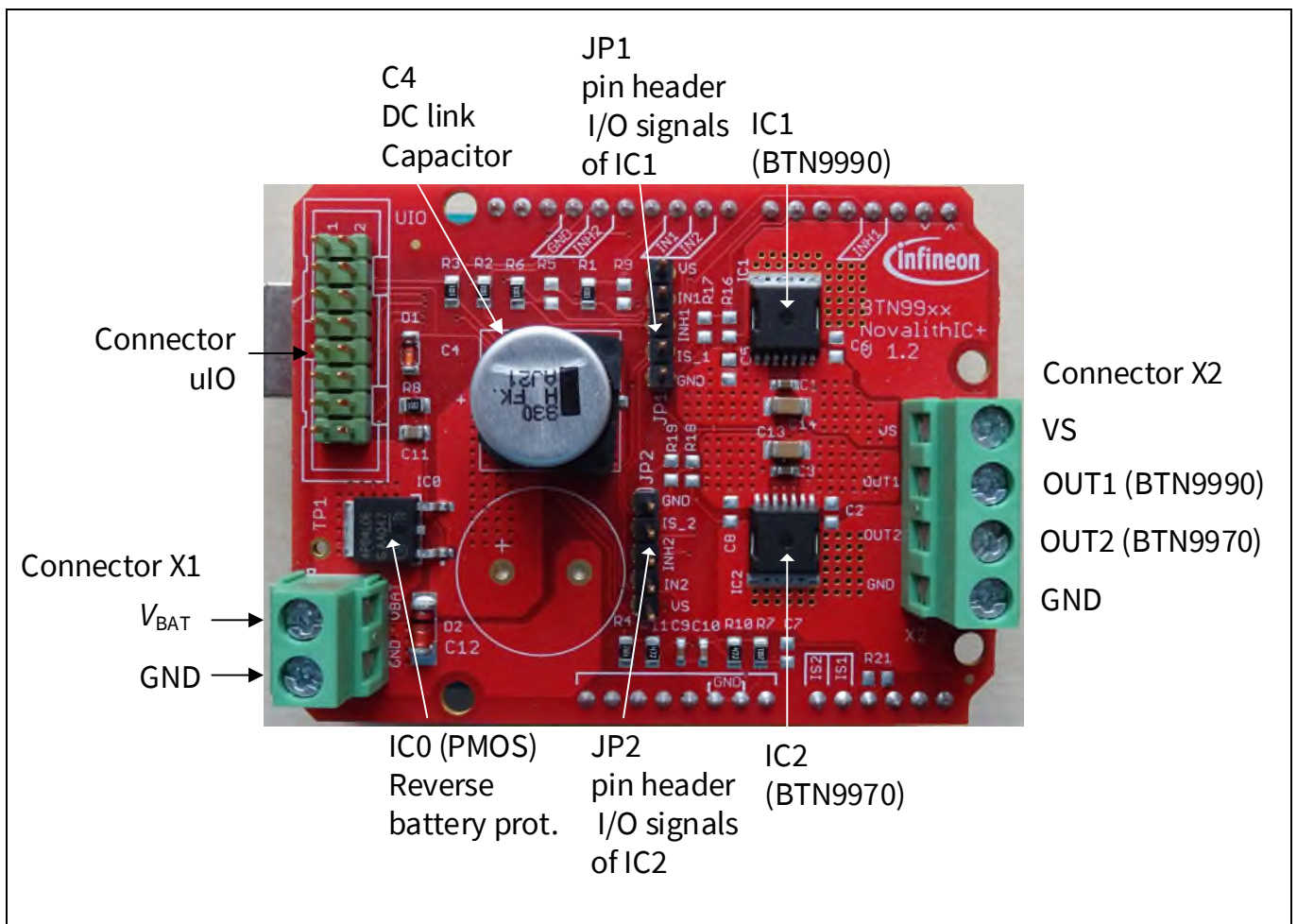
### Hardware description

- Two independent single half-bridges to operate two DC brushed motors unidirectional either in motor to GND or motor to  $V_s$  configuration
- Single H (full) bridge to operate a DC brush motor bidirectional. In this case, the motor needs to be connected between the outputs OUT1 and OUT2.
- A 16 pin connector to interface via a uIO-stick to a PC or Notebook with installed Infineon's Toolbox software.
- Connectors to stack the BTN9970 / BTN9990 motor control shield directly on top of an Arduino UNO controller board.
- A demo software code for the Arduino UNO to operate a motor in H (full) bridge configuration can be downloaded from BTN9970 / BTN9990 web folder [Single Half-Bridge ICs](#).
- PWM operation, controlled by Arduino UNO board
- Reverse polarity protection by IC0 (PMOS transistor)

## 2 Hardware description

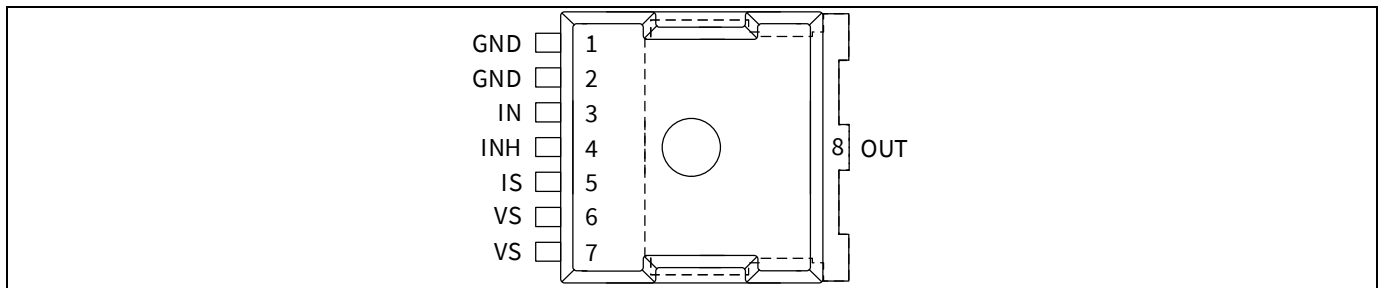
### 2.1 Board overview and connectors

**Figure 3** below describes the BTN9970 / BTN9990 motor control shield with its connectors.



**Figure 3 Board Top view with connectors**

## 2.2 BTN9970 / BTN9990 pin assignment, definition and functions



**Figure 4** Pin assignment BTN9970LV / BTN9990LV top view

**Table 1: Pin definitions and functions**

Pin	Symbol	I/O	Function
<b>1,2</b>	<b>GND</b>	–	<b>Ground 1)</b>
3	IN	I	Input Defines whether high- or low-side switch is activated. An internal pull-down resistor is connected to this pin.
4	INH	I	Inhibit When set to low device goes in tristate. An internal pull-down resistor is connected to this pin.
5	IS	O	Current sense, temperature sense, slew rate level and diagnostics
<b>6,7</b>	<b>VS</b>	–	<b>Supply 1)</b>
<b>8(EP)</b>	<b>OUT</b>	<b>O</b>	<b>Power output of the bridge</b>

1) All terminal pins must be connected together on the PCB. All terminal pins are internally connected together. PCB traces have to be designed to withstand the maximum current which can flow

**Bold type: pin needs power wiring**



# 3 Board Design

## 3.1 Schematics

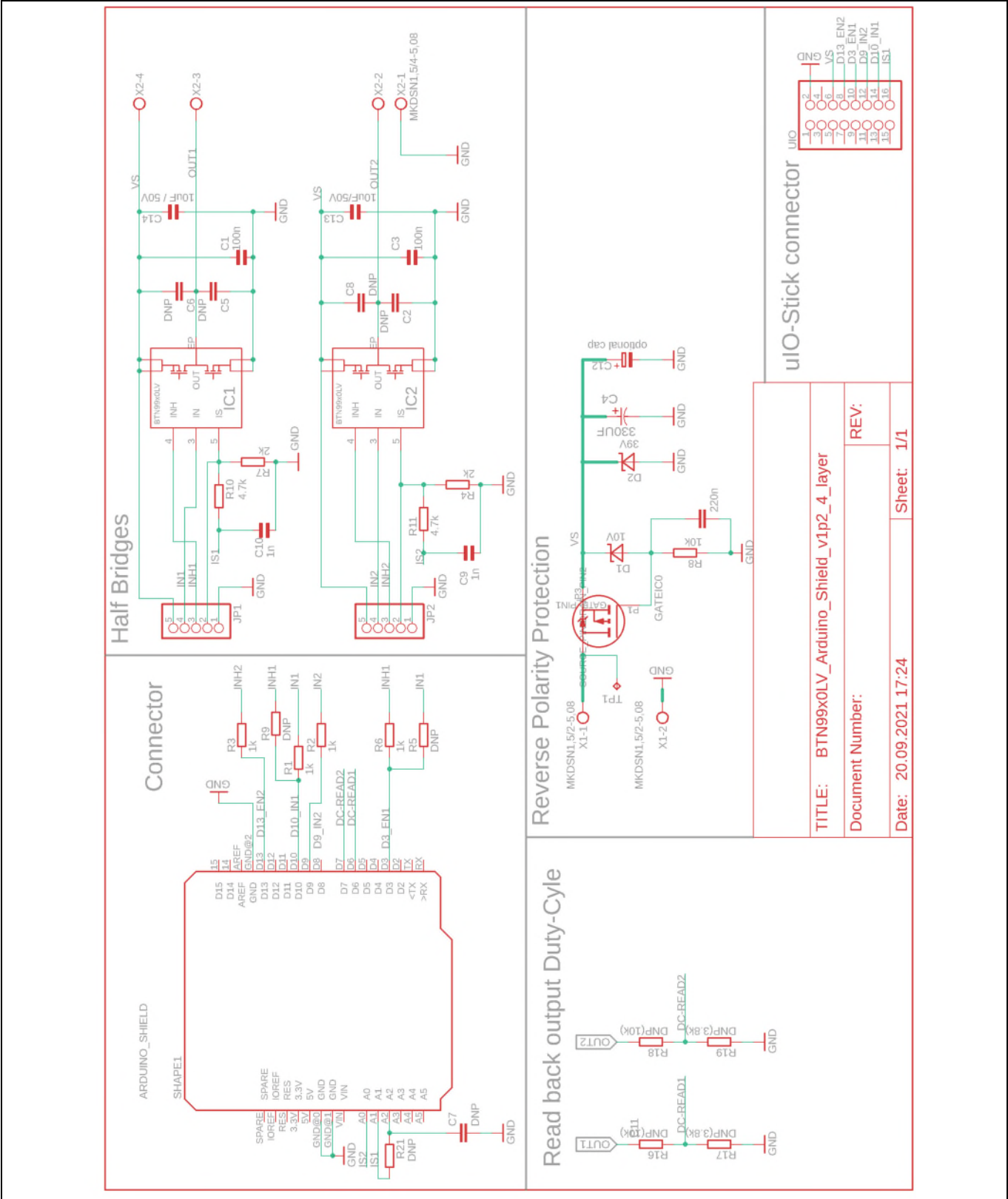


Figure 5 Motor control board schematics



### Board Design

## 3.2 Layout

The board is a 4-layer design.

Material: FR4

Dimensions: 53 mm x 70 mm, 1.6mm thickness

Layer stack: 4 layers 70 / 35 / 35 / 70  $\mu\text{m}$

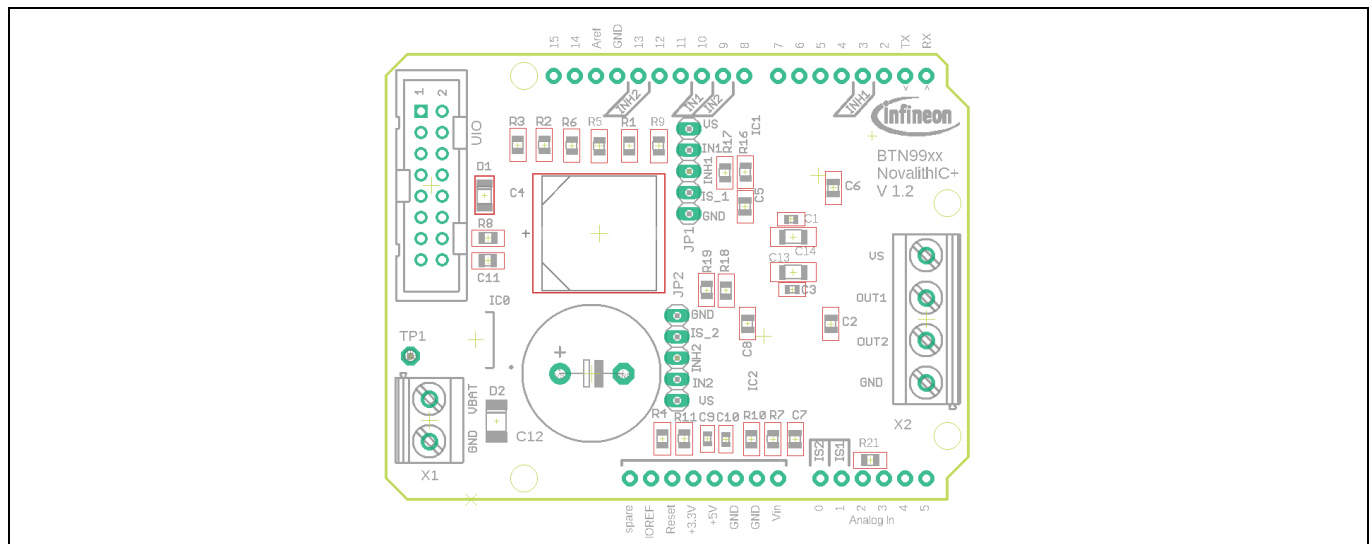


Figure 6 Components top side

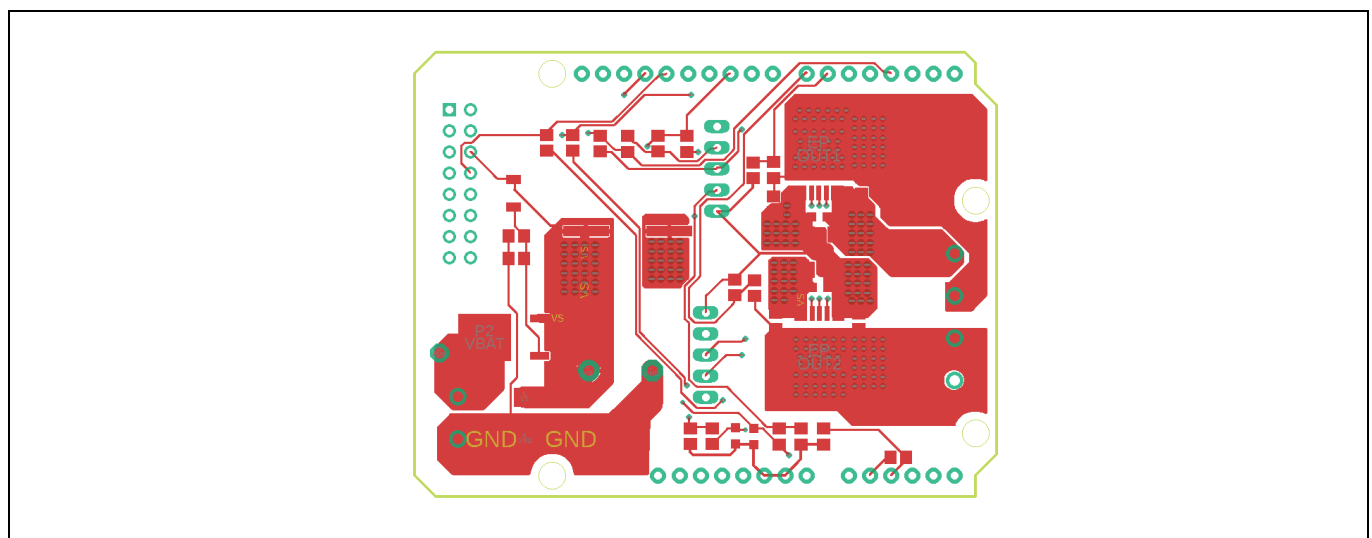
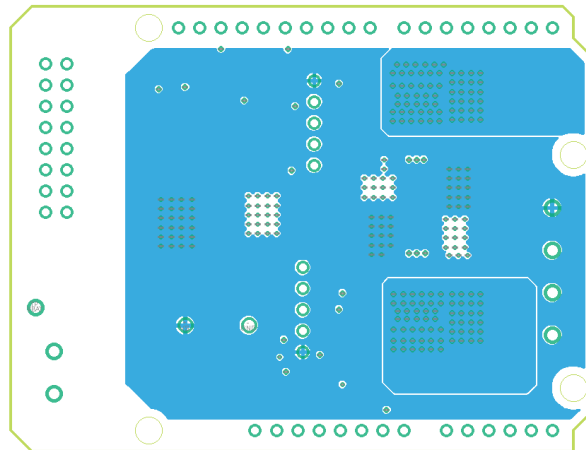
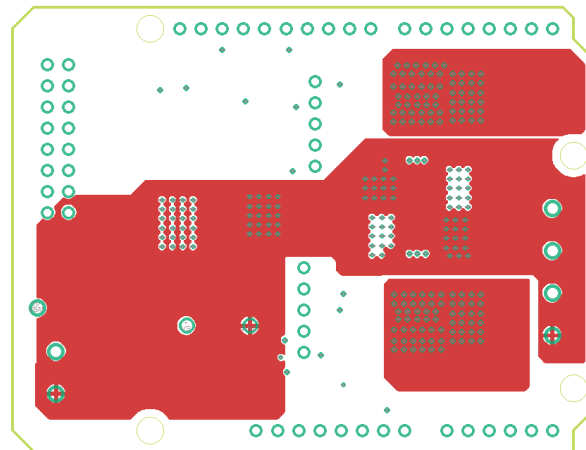


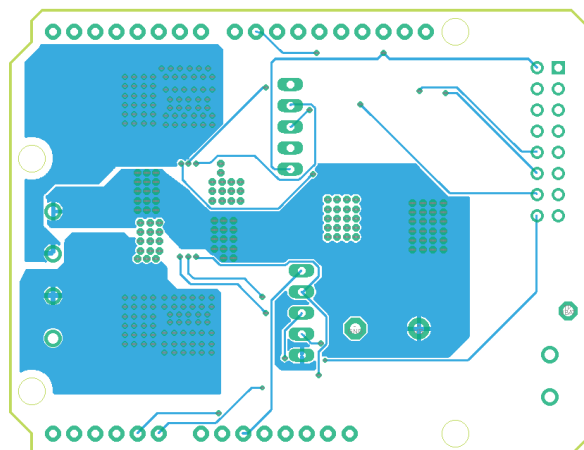
Figure 7 Top Layer, top view



**Figure 8** Inner1 layer, top view



**Figure 9** Inner2 layer, top view



**Figure 10** Bottom layer, bottom view

### 3.3 Bill of material

**Table 2 BOM of the most important parts of the board**

Part	Value	Mounted	Package	Description	Part number	Supplier
C1	100n	yes	603	AEC Q200, Ceramic capacitor	GCJ188R71H104 KA12D	Murata
C2	DNP	no	C0805	AEC Q200, Ceramic capacitor		Murata , TDK
C3	100n	yes	603	AEC Q200, Ceramic capacitor	GCJ188R71H104 KA12D	Murata
C4	330UF or 390uF	yes	CAPAE1350X1400N	AECQ200, Aluminum Electrolytic Capacitor, SMD	EEV-TG1H331Q EEE-FK1H331AQ EEE-FK1H391AV UCD1H331MNQ1 MS 50SEV330M12	Panasonic / Rubycon / Nichicon
C5	DNP	no	C0805	AEC Q200, Ceramic capacitor		Murata , TDK
C6	DNP	no	C0805	AEC Q200, Ceramic capacitor		Murata , TDK
C7	DNP	no	C0805	AEC Q200, Ceramic capacitor		Murata , TDK
C8	DNP	no	C0805	AEC Q200, Ceramic capacitor		Murata , TDK
C9	1n	yes	C0603	AEC Q200, Ceramic capacitor	GCM188R71H10 2KA37D	Murata , TDK
C10	1n	yes	C0603	AEC Q200, Ceramic capacitor	GCM188R71H10 2KA37D	Murata , TDK
C11	220n	yes	C0805	AEC Q200, Ceramic capacitor	GCM21BR71H22 4KA37K	Murata , TDK
C12	1000uF	no	E7,5-16	POLARIZED ELECTROLYTIC/ TANTALUM, AECQ200	B41888D6108M	TDK
C13	10uF/50V	yes	C-1206	AEC Q200, Ceramic capacitor	GRT31CR61H106 ME01L	Murata

### Board Design

Part	Value	Mounted	Package	Description	Part number	Supplier
C14	10uF / 50V	yes	C-1206	AEC Q200, Ceramic capacitor	GRT31CR61H106 ME01L	Murata
D1	10V	yes	SMD-SOD80		BZV55-B10	NXP
D2	39V	yes	SMD-MELF-D		ZMY39-GS08	Vishay
IC0	IPD90P04P4 L-04	yes	TO-252-3-313-L	IPD90P04P4L-04 Alternative: IPD85P04P4L06A TMA2		Infineon
IC1	BTN9990LV	yes	HSOF-7	High current PN half-bridge with integrated driver		Infineon
IC2	BTN9970LV	yes	HSOF-7	High current PN half-bridge with integrated driver		Infineon
JP1	1x5pin	yes	1x5 pin header 2,54mm pitch	single row pin strip header	5-146277-5	TE Connectivity
JP2	1x5pin	yes	1x5 pin header 2,54mm pitch	single row pin strip header	5-146277-5	TE Connectivity
R1	1k	yes	R0805	AEC Q200, resistor		
R2	1k	yes	R0805	AEC Q200, resistor		
R3	1k	yes	R0805	AEC Q200, resistor		
R4	2k	yes	R0805	AEC Q200, resistor		
R5	DNP	no				
R6	1k	yes	R0805	AEC Q200, resistor		
R7	2k	yes	R0805	AEC Q200, resistor		
R8	10k	yes	R0805	AEC Q200, resistor		
R9	DNP	no				
R10	4.7k	yes	R0805	AEC Q200, resistor		
R11	4.7k	yes	R0805	AEC Q200, resistor		
R16	DNP(10k)	no	R0805	AEC Q200, resistor		
R17	DNP(3.8k)	no	R0805	AEC Q200, resistor		
R18	DNP(10k)	no	R0805	AEC Q200, resistor		
R19	DNP(3.8k)	no	R0805	AEC Q200, resistor		

**Board Design**

<b>Part</b>	<b>Value</b>	<b>Mounted</b>	<b>Package</b>	<b>Description</b>	<b>Part number</b>	<b>Supplier</b>
R21	DNP	no	R0805	AEC Q200, resistor		
TP1	TPPAD1-13	no	P1-13	Test pad		
UIO	2x8 pin	yes	2,54mm pitch	dual row header without isolation	826656-8	TE
X1	2 terminal screw connector	yes	5,08mm pitch	MKDSN series, AWG 12-30	1888687	Phonix Contact
X2	4 terminal screw connector	yes	5,08mm pitch	MKDSN series, AWG 12-30	1888700	Phonix Contact

## **4 References and appendices**

### **4.1 Abbreviations and definitions**

**Table 3 Abbreviations**

<b>Abbreviation</b>	<b>Meaning</b>
CE	Conformité Européenne
EMI	Electromagnetic interference
UL	Underwriters Laboratories

### **4.2 References**

- [1] Infineon Technologies AG, Datasheet: BTN9970LV NovalithIC+™
- [2] Infineon Technologies AG, Datasheet: BTN9990LV NovalithIC+™
- [3] Arduino UNO web page [Online] [store.arduino.cc/arduino-uno-rev3](https://store.arduino.cc/arduino-uno-rev3)
- [4] Arduino home page [Online] [www.arduino.cc](https://www.arduino.cc)
- [5] Web folder of Infineon's [Single Half-Bridge ICs](#)

## 5 Revision history

**Table 4** Revision history

Revision number	Date of release	Description of changes
Rev. 1.00	2021-02-09	Initial document created, based on board 1.1
Rev. 1.10	2021-09-30	Board changed to Ver 1.2 with 4 layers PCB, optimized board layout, larger screw headers and test pins to analyze I/O signals of half-bridges



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