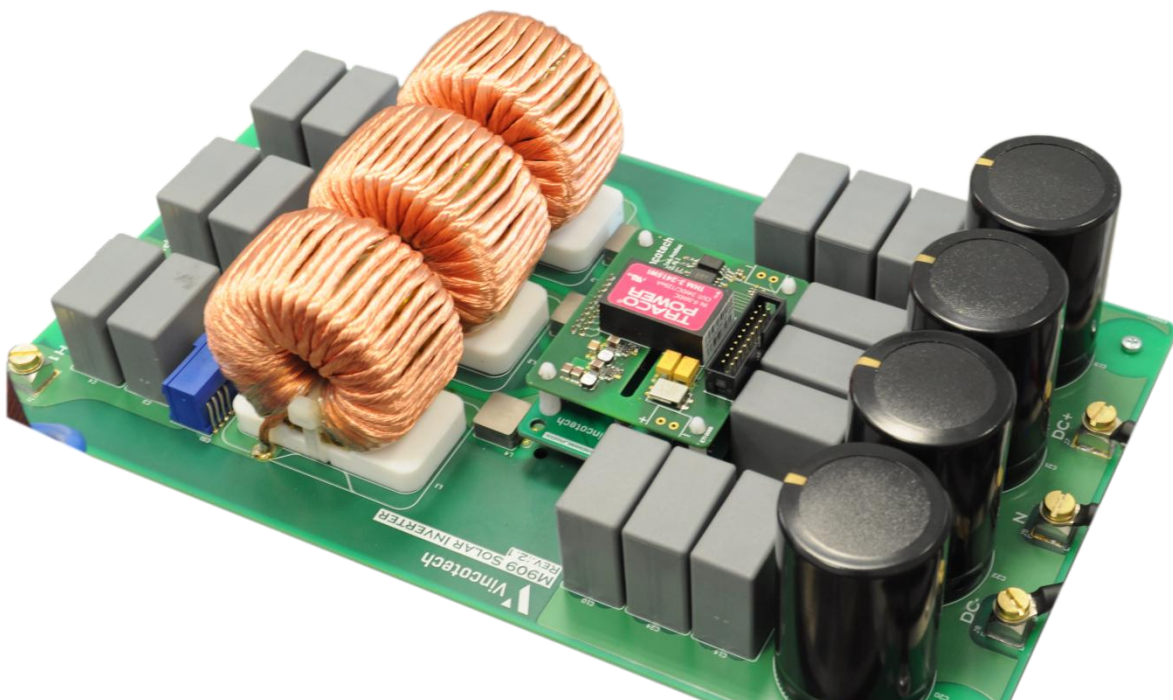


# Reference Design for M909-F18 SiC Modules

## Quick Start Guide for M909-F18 SiC Modules





## Table of Contents

1	Abstract .....	4
2	An introduction to the EVA board .....	5
3	Gate driver .....	9
4	ISO PCB .....	15
5	Harware .....	23

## Revision History

<b>Date</b>	<b>Revision Level</b>	<b>Description</b>	<b>Page Number(s)</b>
2015 - May	1	First release	7

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## 1 Abstract

This application note describes the Evaluation Driver Board for the M909 SiC power modules. To learn more about Vincotech modules, please visit [www.vincotech.com](http://www.vincotech.com). This board provides a plug-and-play solution for identifying this family of module's switching behavior and efficiency.

## 2 An introduction to the EVA board

M909 SiC features:

- flow0 package
- 1200 V SiC 3 phase pseudo halfbridge
- 80 mΩ at 25 °C, 140 mΩ at 125 °C
- reverse current capability
- zero recovery charge
- up to 1000 V DC-link

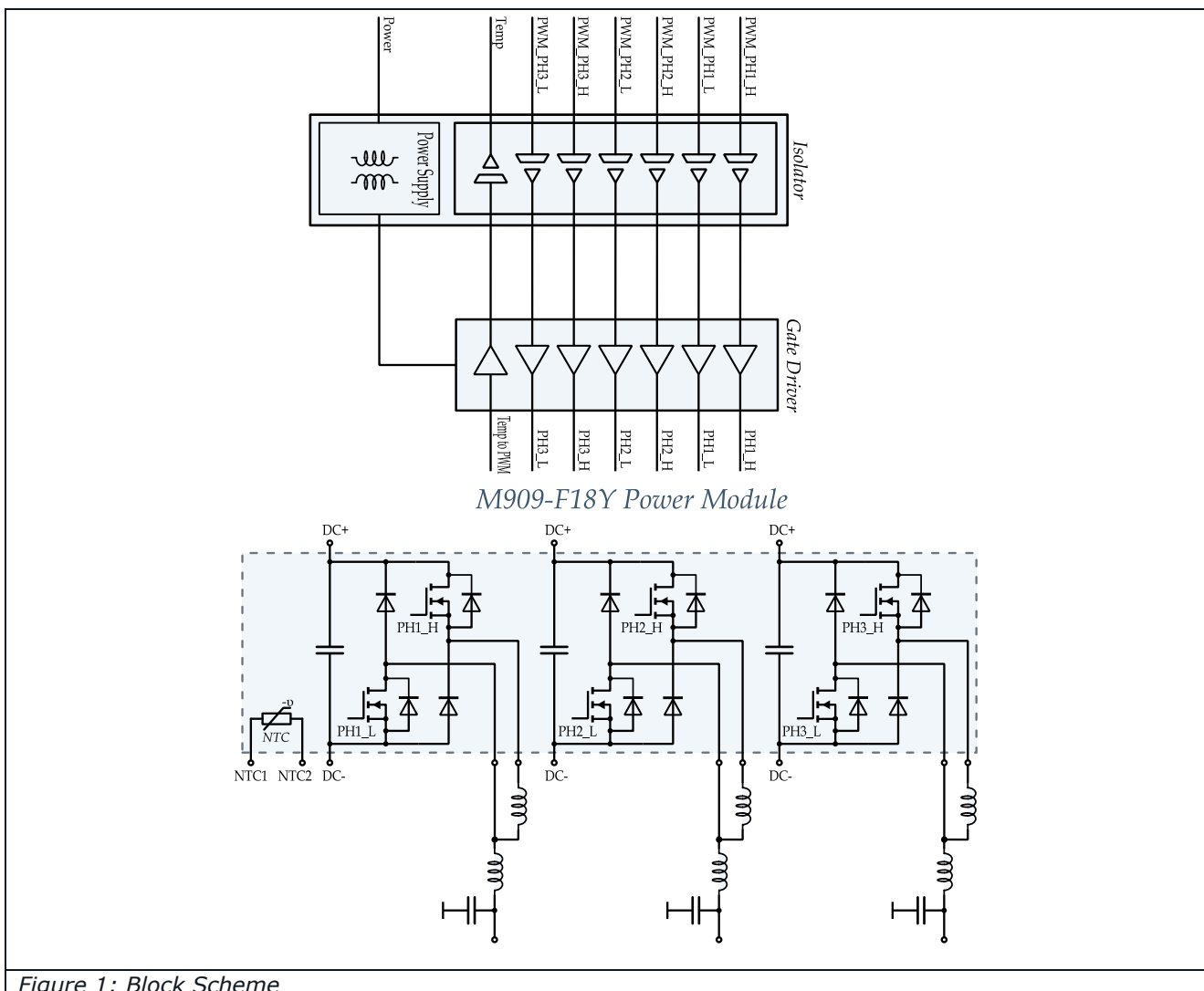


Figure 1: Block Scheme

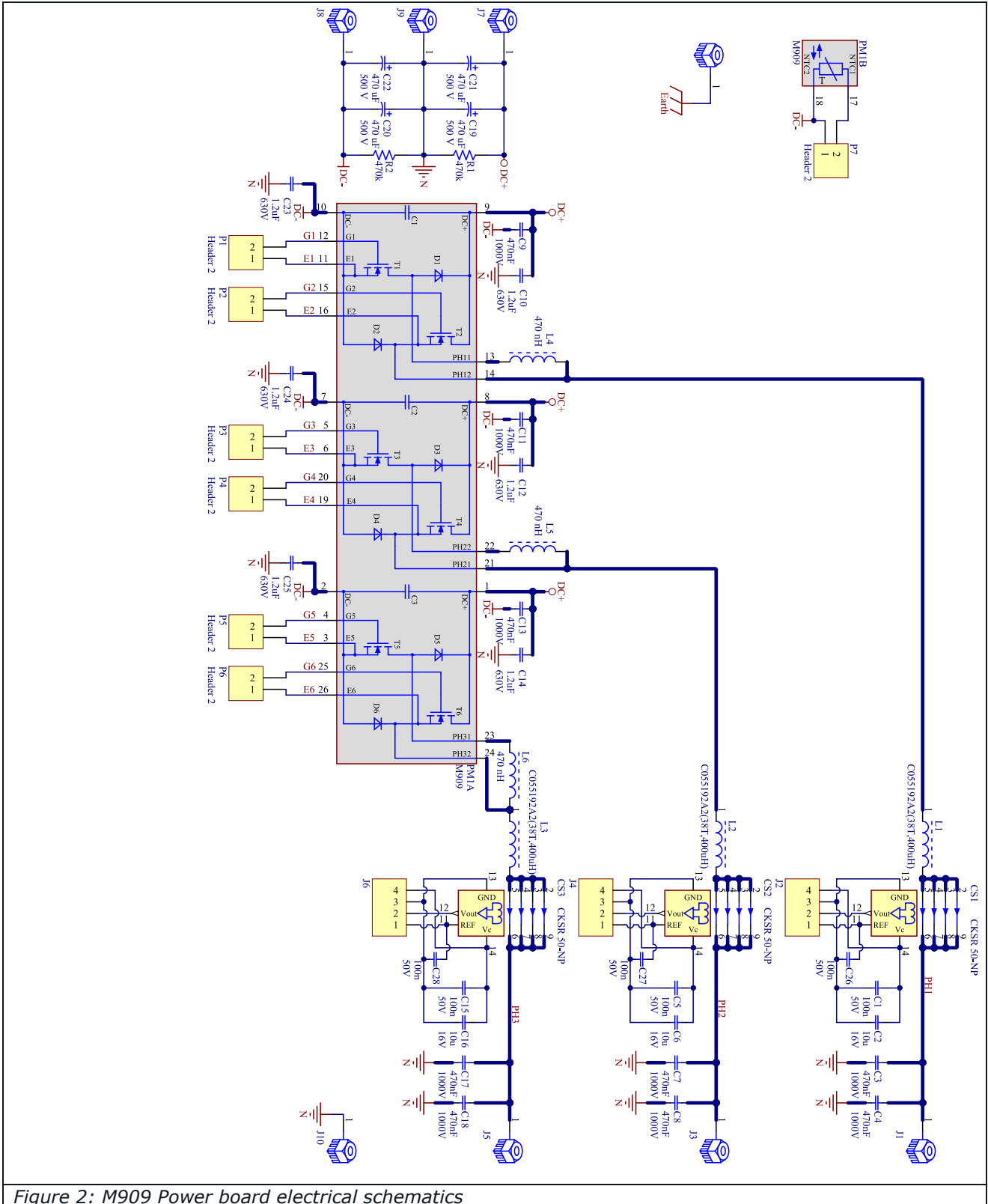


Figure 2: M909 Power board electrical schematics

Designator	Part type	Manufacture/Part number	Qty
C1, C5, C15, C26, C27, C28	SMD Capacitor, X7R, 0603, 100 nF, 50 V	Kemet/C0603C104K5RACTU	6
C2, C6, C16	SMD Capacitor, X5R, 0805, 10 $\mu$ F, 16 V	Murata/GRM219R61C106KA73 D	3
C3, C4, C7, C8, C9, C11, C13, C17, C18	Film Capacitor, 470 nF, 1000 V	Faratronic/C823A474KB3F750	9
C10, C12, C14, C23, C24, C25	Film Capacitor, 1.2 $\mu$ F, 630 V	Faratronic/C822J125KB1F550	6
C19, C20, C21, C22	Electrolytic Capacitor, 470 $\mu$ F, 500 V, D40mm	Kemet/ALC10A471EH500	4
CS1, CS2, CS3	Current Transducer CKSR series 50 A	LEM/CKSR 50-NP	3
J1, J3, J5, J7, J8, J9, J10, J11	Connector, Bushing, M5	Würth/7460408	8
J2, J4, J6	Wire-To-Board Connector, VERTICAL, SINGLE ROW, 4 WAY	Molex/22-11-2042	3
L1, L2, L3	Inductor, 400 $\mu$ H	Magnetics/C055192A2	6
L4, L5, L6	Fixed Inductors 0.47 $\mu$ H 20%	Vishay/Dale/IHLP5050FDERR4 7M01	3
P1, P2, P3, P4, P5, P6, P7	Board-To-Board Connector, Vertical, Through Hole, Header, 2 Way, 2.54 mm	Multicomp/2211S-02G	7
R1, R2	THT Resistor, 470 k $\Omega$ , 3 W, 5 %	VISHAY BC COMPONENTS/ PR03000204703JAC00	2
PM1	PM Modul, SiC Power MOSFET's and Schottky Diodes, 3 phase inverter topology with split output	Vincotech/10-PZ126PA080ME-M909F18Y	1

Table 1: The Power board's Bill of material

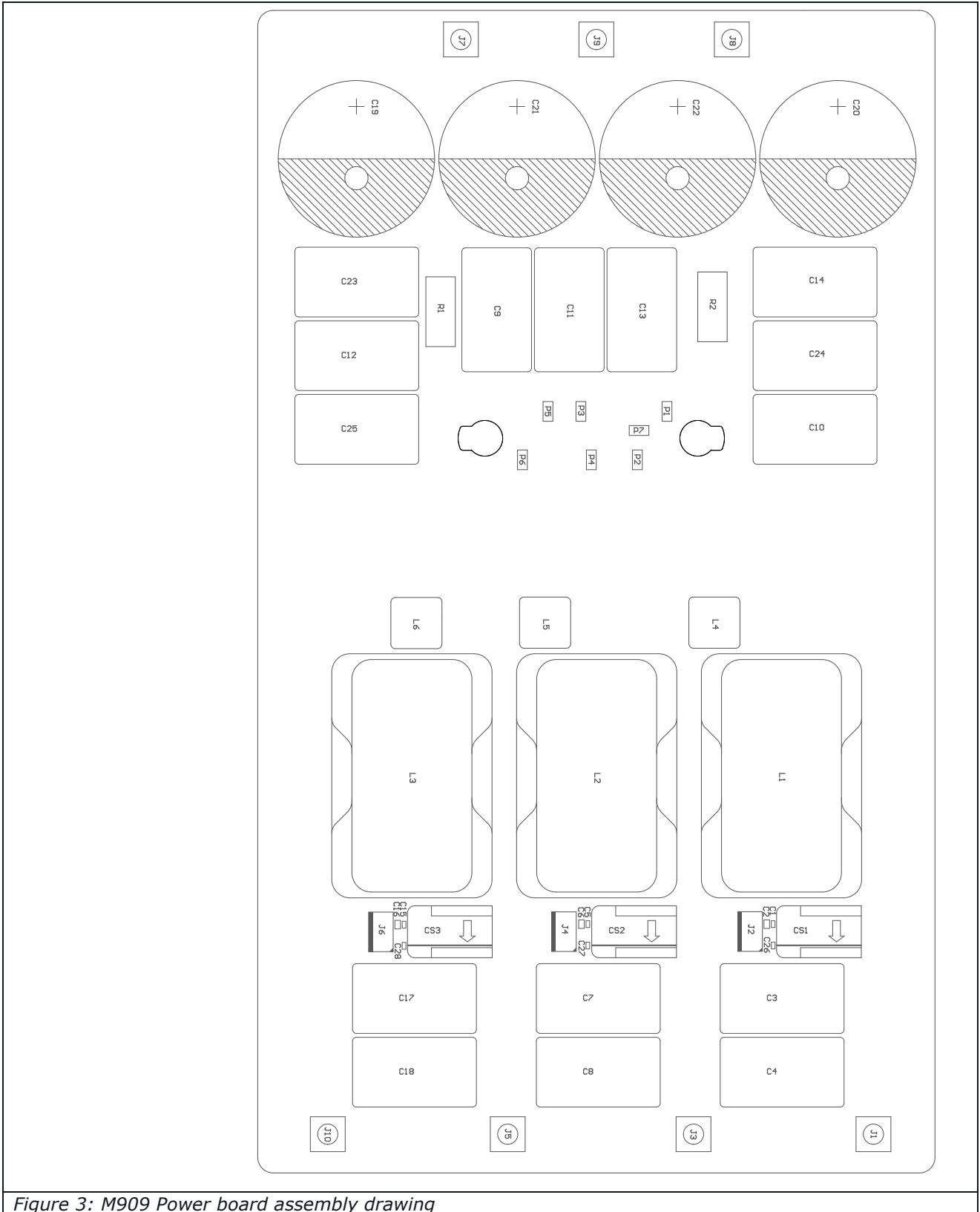


Figure 3: M909 Power board assembly drawing



### 3 Gate driver

- sandwich construction
- triple pseudo halfbridge driver (bootstrap)
- switching frequency up to 500 kHz
- up to 1000 V DC-link

Parameter	Symbol	Values		Unit	Note/Test Condition
		Min.	Max.		
Power Supply Logic	VDD	3.3	10	V	-
Power Supply Driver	VCC	10	30	V	-
High Level Input Voltages PWM	V <sub>INH</sub>	70	-	%	of VDD
Low Level Input Voltages PWM	V <sub>INL</sub>	-	30	%	of VDD
Switching frequency PWM	f <sub>SW</sub>	-	500	kHz	-
High Level Output Voltages Temp	V <sub>OH</sub>	VDD-0.5	-	V	I <sub>OH</sub> = -2 mA
Low Level Output Voltages Temp	V <sub>OL</sub>	-	0.4	V	I <sub>OL</sub> = 2 mA
Switching frequency Temp	f <sub>SW</sub>	90	110	kHz	-
UVLO Threshold Logic	V <sub>UVLOHVDD</sub>	-	3.1	V	-
	V <sub>UVLOLVDD</sub>	2.55	-	V	-
UVLO Threshold Driver	V <sub>UVLOHVCC</sub>	-	10	V	-
	V <sub>UVLOLVCC</sub>	8	-	V	-
Quiescent Current Logic	I <sub>QVDD</sub>	14	20	mA	VDD = 5 V, VCC = 18 V, all inputs = Low
Quiescent Current Driver	I <sub>QVCC</sub>	13	22	mA	VDD = 5 V, VCC = 18 V, all inputs = Low

*Table 2: The Gate Driver's electrical parameters*

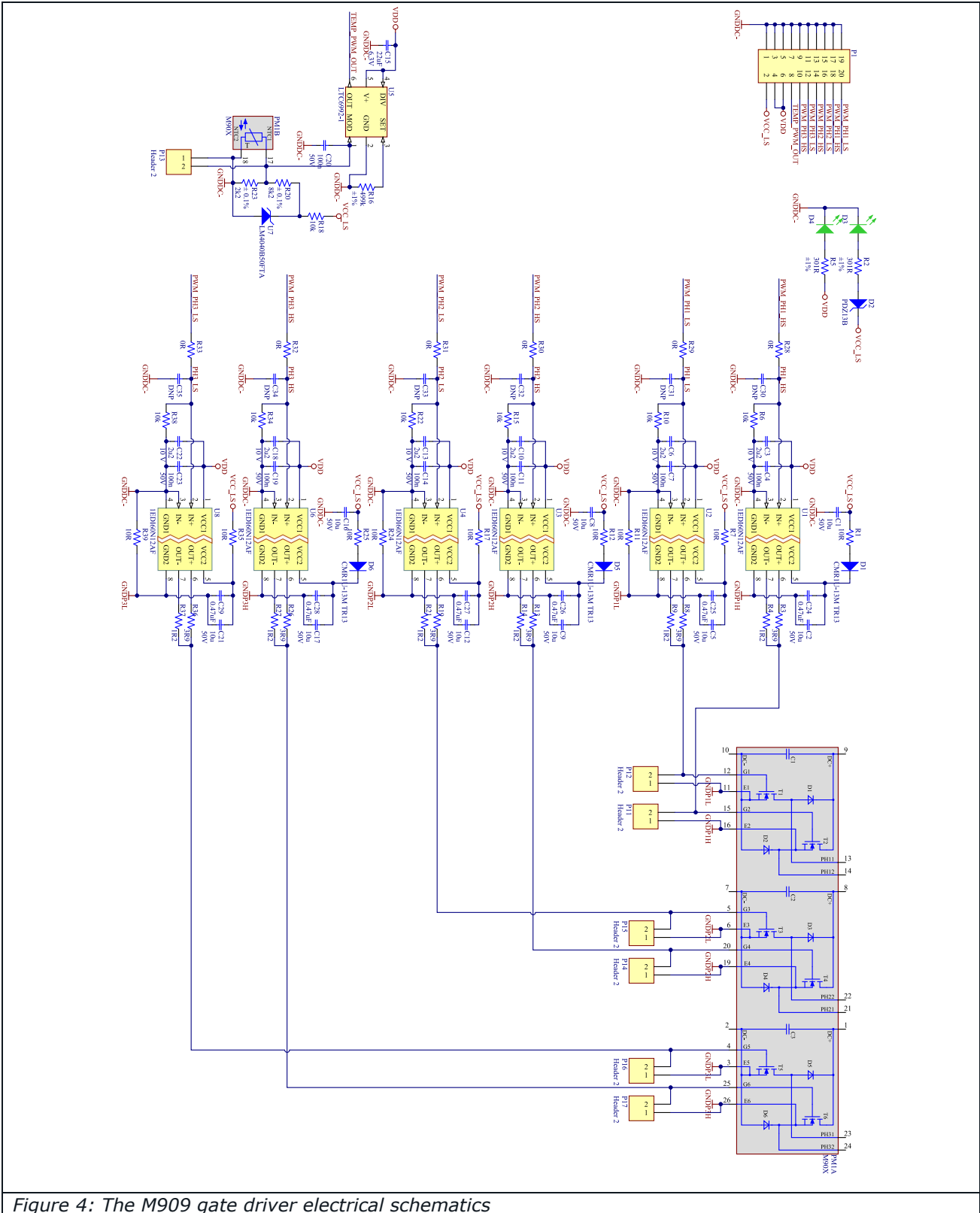


Figure 4: The M909 gate driver electrical schematics



Designator	Part type	Manufacture/Part number	Qty
C1, C2, C5, C8, C9, C12, C16, C17, C21	SMD Capacitor, X7S, 1210, 10 $\mu$ F, 50 V	TDK/C3225X7S1H106M250AB	9
C3, C6, C10, C13, C18, C22	SMD Capacitor, X7R, 0603, 2.2 $\mu$ F, 10 V	Murata/GRM188R71A225KE15D	6
C4, C7, C11, C14, C19, C20, C23	SMD Capacitor, X7R, 0603, 100 nF, 50 V	Kemet/C0603C104K5RACTU	7
C15	SMD Capacitor, X5R, 0805, 22 $\mu$ F, 6.3 V	Murata/GRM21BR60J226ME39L	1
C24, C25, C26, C27, C28, C29	SMD Capacitor, X7R, 0805, 470 nF, 50 V	TDK/CGA4J3X7R1H474K125AB	6
C30, C31, C32, C33, C34, C35	DNP	DNP	-
D1, D5, D6	Surface mount silicon ultra fast recovery rectifier 1.0 A, 1300 V	Central Semiconductor/CMR1U-13M TR13	3
D2	Voltage regulator diodes 13 V	NXP/PDZ13B	1
D3, D4	LED, SMD, SIDE VIEW, GREEN	Kingbright/KA-4040CGSK	2
P1	Straight box header 20 pins	E-TEC/SLS-020-S920	1
P11, P12, P13, P14, P15, P16, P17	Board-To-Board Connector, Vertical, 2212S Series, Through Hole, Receptacle, 2, 2.54 mm	Multicomp/2212S-02SG-85	7
R1, R7, R11, R12, R17, R24, R25, R35, R39	SMD Resistor, 0805, 10 $\Omega$ , 1 %	VISHAY DRALORIC/CRCW080510R0JNEAIF	9
R2 ,R5	SMD Resistor, 0603, 301 $\Omega$ , 1 %	VISHAY DRALORIC/CRCW0603301RFKEA	2
R3, R8, R13, R19, R26, R36	SMD Resistor, 0805, 3.9 $\Omega$ , 1 %	VISHAY DRALORIC/CRCW08053R90JNEAIF	6
R4, R9, R14, R21, R27, R37	SMD Resistor, 0805, 1.2 $\Omega$ , 1 %	VISHAY DRALORIC/CRCW08051R20JNEAIF	6
R6, R10, R15, R18, R22, R34, R38	SMD Resistor, 0603, 10 k $\Omega$ , 1 %	MULTICOMP/MCWR06X1002FTL	7
R16	SMD Resistor, 0603, 499 k $\Omega$ , 1 %	VISHAY DRALORIC / CRCW0603499KFKEA	1



R20	SMD Resistor, 0603, 8.2 k $\Omega$ , 0.1 %	Panasonic/ERA3AEB822V	1
R23	SMD Resistor, 0603, 2.2 k $\Omega$ , 0.1 %	Panasonic/ERA3AEB222V	1
R28, R29, R30, R31, R32, R33	SMD Resistor, 0603, 0 $\Omega$ , 1 %	YAGEO/RC0603JR-070RL	6
U5	Voltage-Controlled Pulse Width Modulator (PWM)	Linear Technology/LTC6992CS6- 1#TRMPBF	1
U7	Shunt voltage references	DIODES/LM4040B50FTA	1
U1, U2, U3, U4, U6, U8	Single Channel MOSFET Gate Driver IC	Infineon/1EDI60N12AF	6

Table 3: The Gate Driver's Bill of material

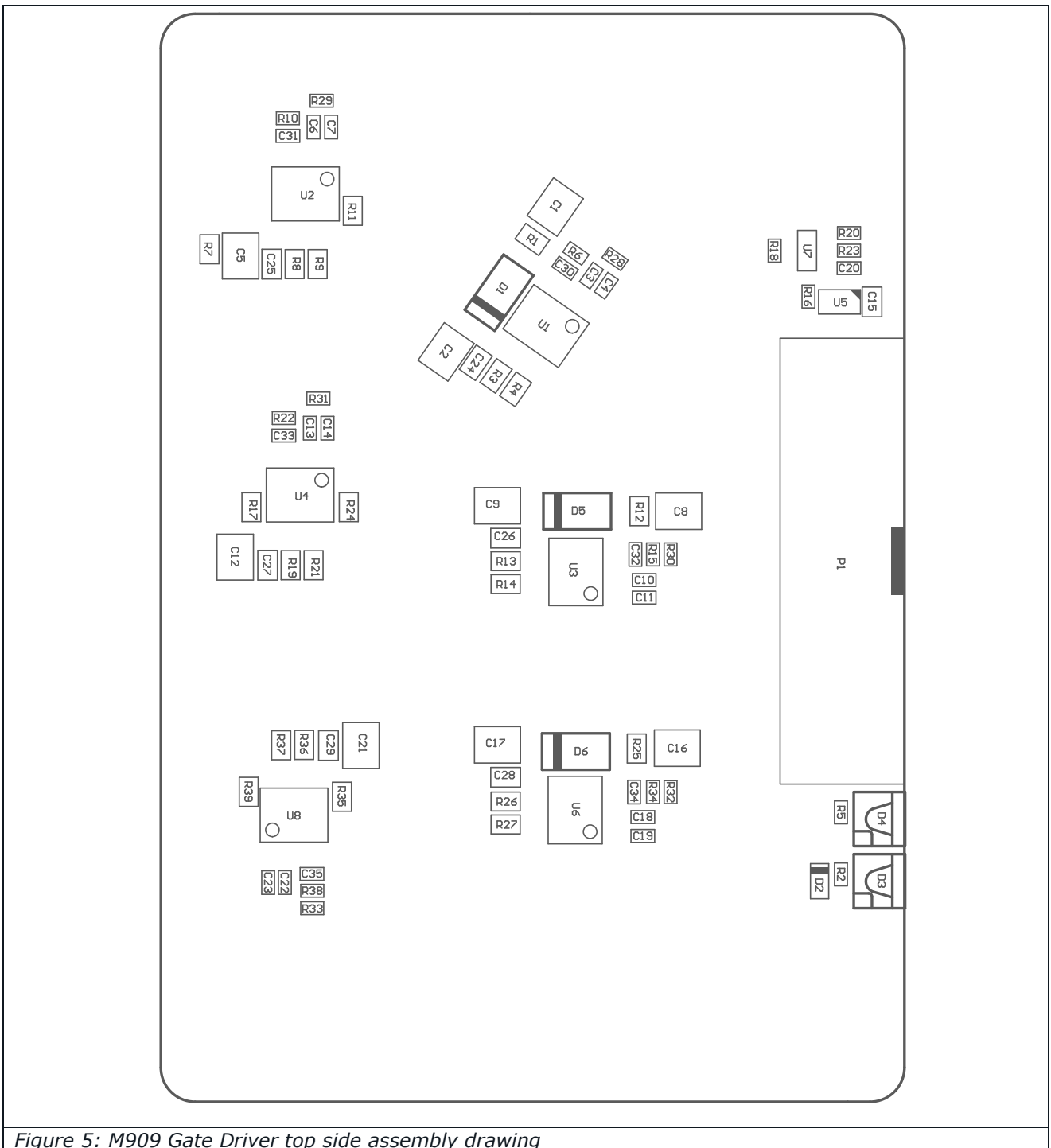


Figure 5: M909 Gate Driver top side assembly drawing

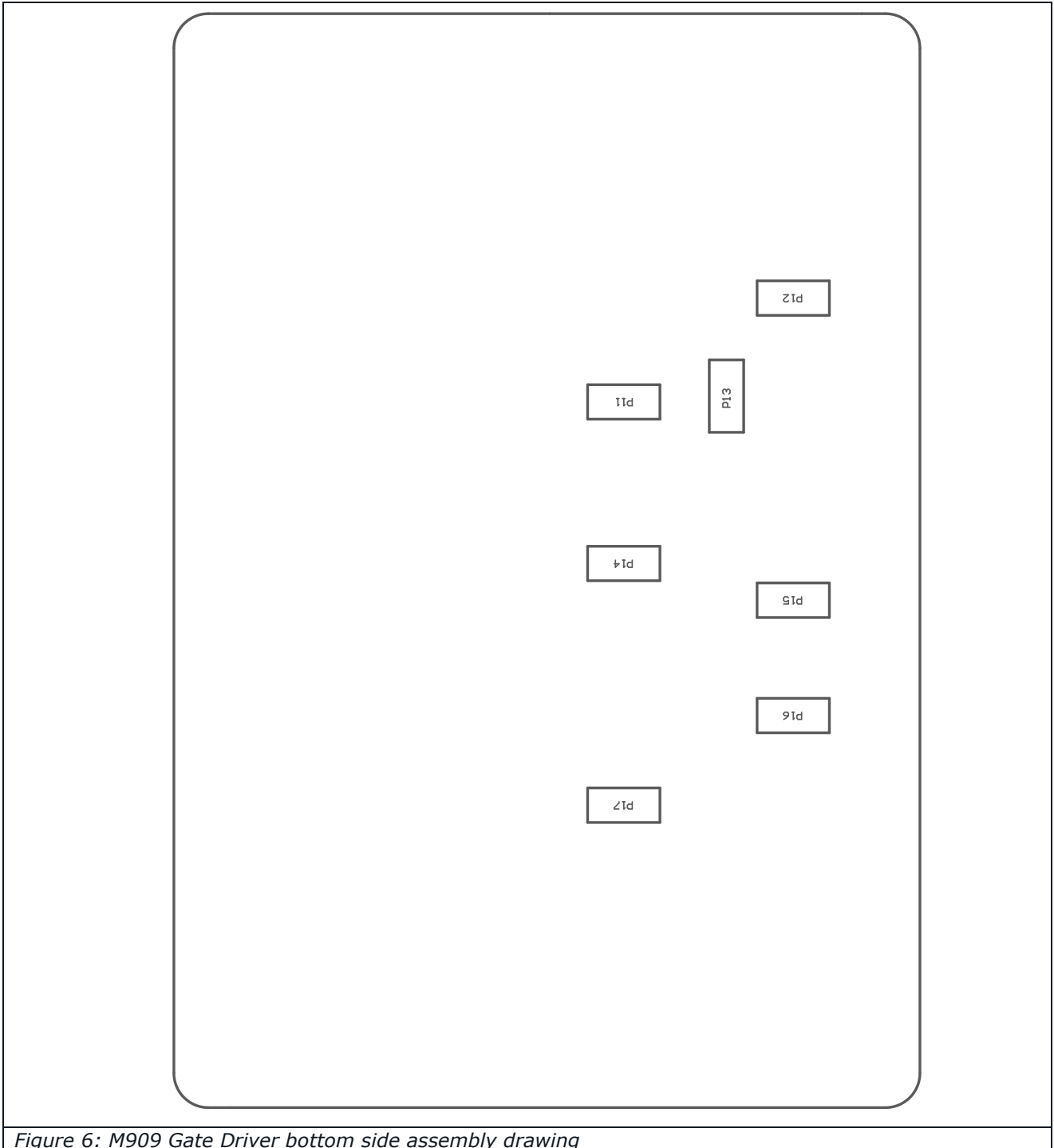


Figure 6: M909 Gate Driver bottom side assembly drawing

## 4 ISO PCB

- sandwich construction
- isolated power and gate drivers
- 5000 V<sub>AC</sub> isolation
- 3.3 or 5 V logic level compatible PWM input
- 9..36 V power input

Parameter	Symbol	Values		Unit	Note/Test Conditional
		Min.	Max.		
Power Supply Logic In	VDD_IN	3	5.5	V	-
Power Supply Driver In	VCC_IN	9	36	V	-
Power Supply Logic Out	VDD	4.5	5.3	V	-
Power Supply Driver Out	VCC	17.8	18.7	V	-
High Level Input Voltages Temp	V <sub>INH</sub>	3.3	-	V	-
Low Level Input Voltages Temp	V <sub>INL</sub>	-	2	V	-
High Level Output Voltages Temp	V <sub>OH</sub>	VDD-0.4		V	I <sub>OH</sub> = -2 mA
Low Level Output Voltages Temp	V <sub>OL</sub>		0.4	V	I <sub>OL</sub> = 2 mA
High Level Input Voltages PWM	V <sub>INH</sub>	2		V	-
Low Level Input Voltages	V <sub>INL</sub>		0.8	V	-



PWM					
High Level Output Voltages PWM	$V_{OH}$	$V_{DD}-0.4$		V	$I_{OH} = -2 \text{ mA}$
Low Level Output Voltages PWM	$V_{OL}$		0.4	V	$I_{OL} = 2 \text{ mA}$
Switching frequency Temp	$f_{sw}$	-	5	MHz	
Switching frequency PWM	$f_{sw}$	-	5	MHz	
Quiescent Current Logic	$I_{QVDD}$	1	3	mA	VDD = 5 V, VCC = 12 V, all inputs = Floating
Quiescent Current Driver	$I_{QVCC}$	6	10	mA	VDD = 5 V, VCC = 12 V, all inputs = Floating
<i>Table 1: The Isolator's electrical parameters</i>					



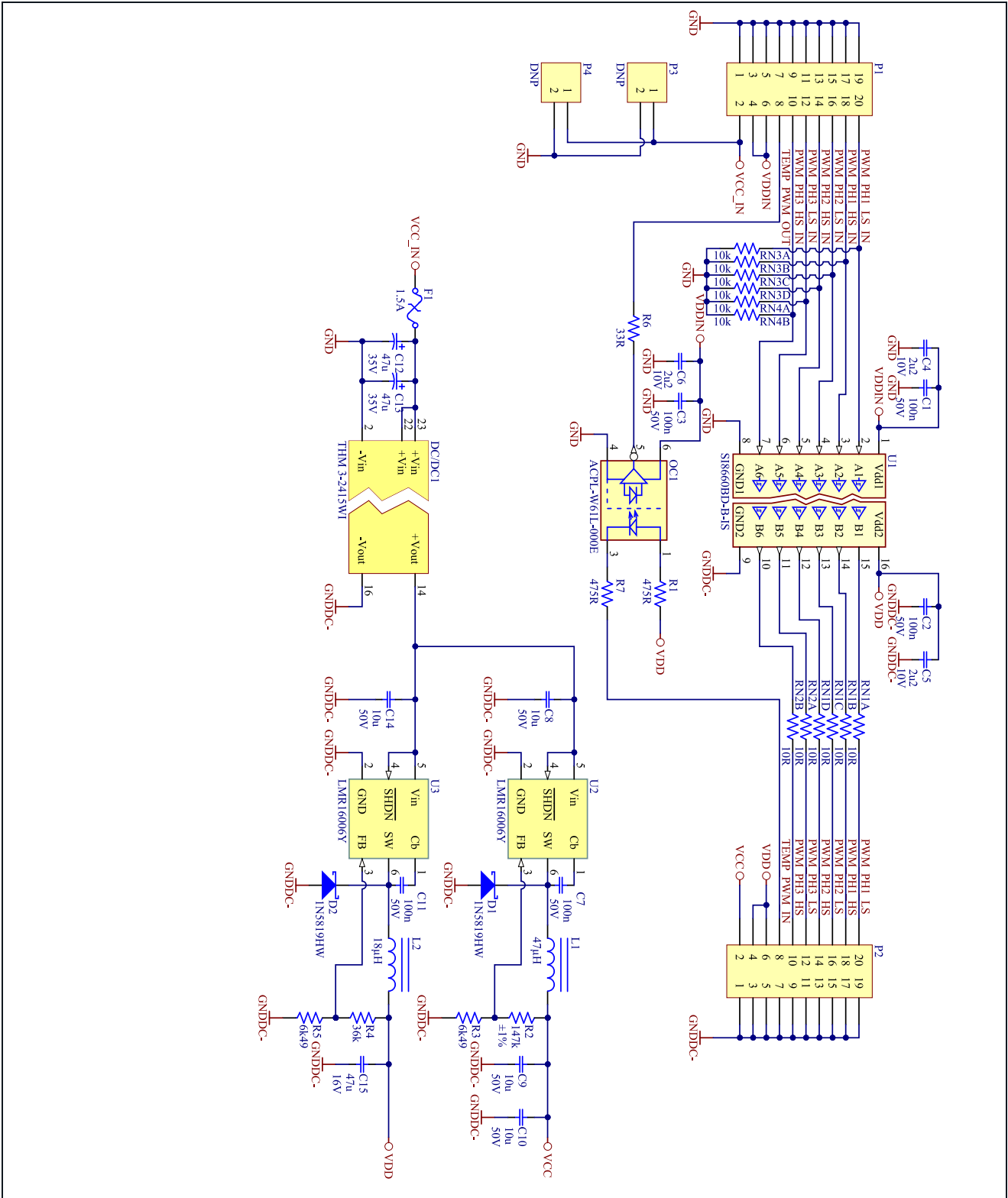


Figure 7: The M909 ISO board electrical schematics



Designator	Part type	Manufacture/Part number	Qty
C1, C2, C3, C7, C11	SMD Capacitor, X7R, 0603, 100 nF, 50 V	KEMET/C0603C104K5RACTU	5
C4, C5, C6	SMD Capacitor, X7R, 0603, 2.2 $\mu$ F, 10 V	MURATA/GRM188R71A225KE15D	3
C8, C9, C10, C14	SMD Capacitor, X7S, 1210, 10 $\mu$ F, 50 V	TDK/C3225X7S1H106M250AB	4
C12, C13	SMD Capacitor, Tantalum, Size D, 47 $\mu$ F, 35 V	KEMET/T495X476K035ATE300	2
C15	SMD Capacitor, X5R, 1210, 47 $\mu$ F, 16 V	MURATA/GRM32ER61C476KE15L	1
D1, D2	1.0 A SURFACE MOUNT SCHOTTKY BARRIER RECTIFIER	DIODES/1N5819HW-7-F	2
DC/DC1	DC/DC Converter 3 W, 9-36 V Input, 24 V Output	TRACO POWER/THM 3-2415WI	1
F1	PolySwitch 1.5 A	TE CONNECTIVITY/RAYCHEM/SMD150F/33-2	1
L1	Surface Mount Power Inductor 47 $\mu$ H 450 mA	COILCRAFT/LPS4018-473MRB	1
L2	Surface Mount Power Inductor 18 $\mu$ H 700 mA	COILCRAFT/LPS4018-183MRB	1
OC1	Optocoupler, CMOS, 5 kV <sub>rms</sub>	AVAGO/ACPL-W61L-000E	1
P1	Straight box header 20 pins	E-TEC/SLS-020-S920	1
P2	Straight box female header 20 pins	E-TEC/BW 2-020-S850-55/P	1
P3, P4	DNP	DNP	-



R1, R7	SMD Resistor, 0603, 475 $\Omega$ , 1 %	VISHAY DRALORIC/ CRCW0603475RFKEA	2
R2	SMD Resistor, 0603, 147 k $\Omega$ , 1 %	VISHAY DRALORIC/ CRCW0603147KFKEA	1
R3, R5	SMD Resistor, 0603, 6.49 k $\Omega$ , 1 %	PANASONIC/ERJ3EKF6491V	2
R4	SMD Resistor, 0603, 36 k $\Omega$ , 1 %	VISHAY DRALORIC/ CRCW0603147KFKEA	1
R6	SMD Resistor, 0603, 33 $\Omega$ , 5 %	YAGEO/RC0603JR-0733RL	1
RN1, RN2	SMD Resistor Array, 1206, 10 $\Omega$ , 5 %	YAGEO/YC164-JR-0710RL	2
RN3, RN4	SMD Resistor Array, 1206, 10 k $\Omega$ , 5 %	BOURNS/CAY16-103J4LF	2
U1	Digital Isolator 6Ch	SILICON LABS/Si8660BD-B-IS	1
U2, U3	Buck Regulator 2.1 MHz	TEXAS INSTRUMENTS/ LMR16006YDDCT	2

Table 2: The Isolator's Bill of material

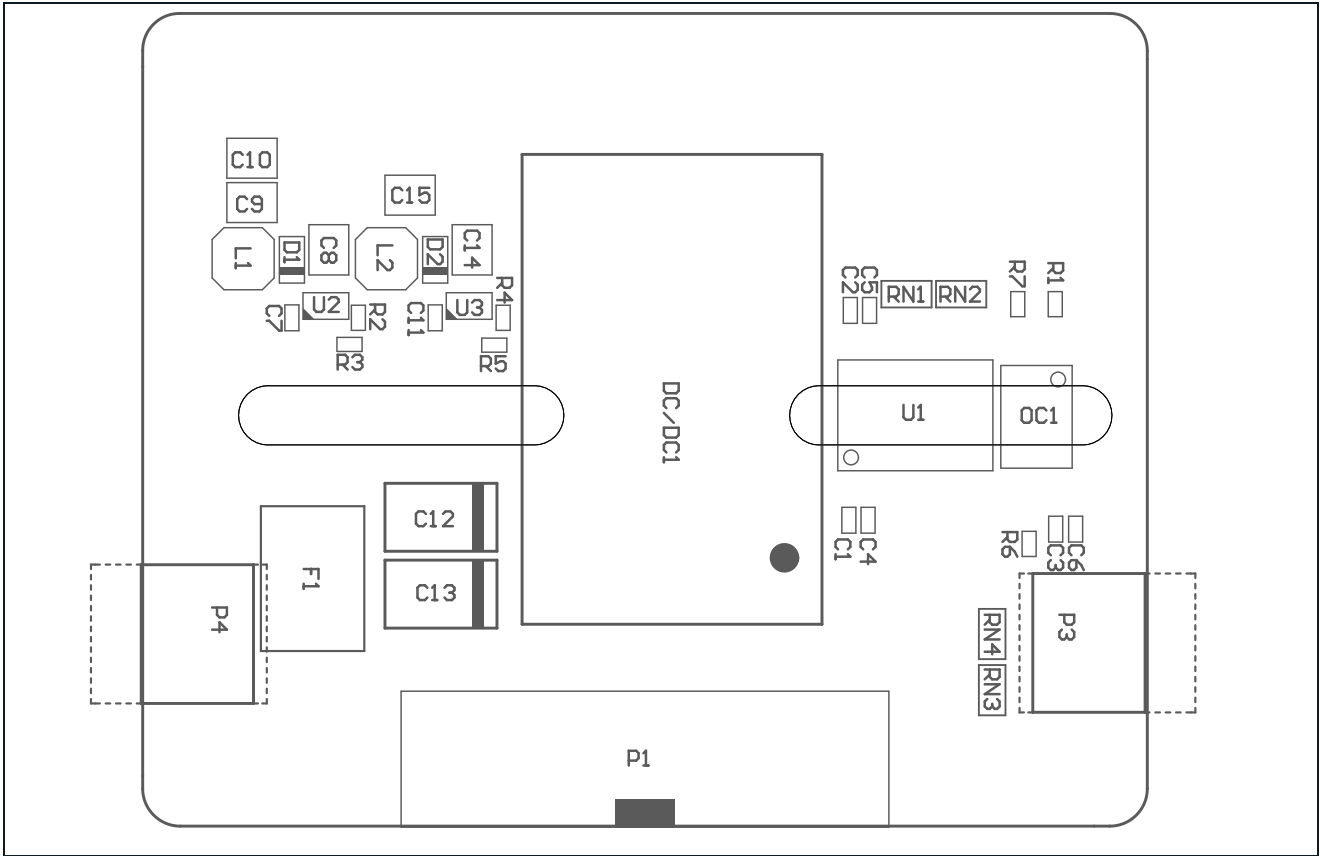


Figure 8: M909 Isolator top side assembly drawing

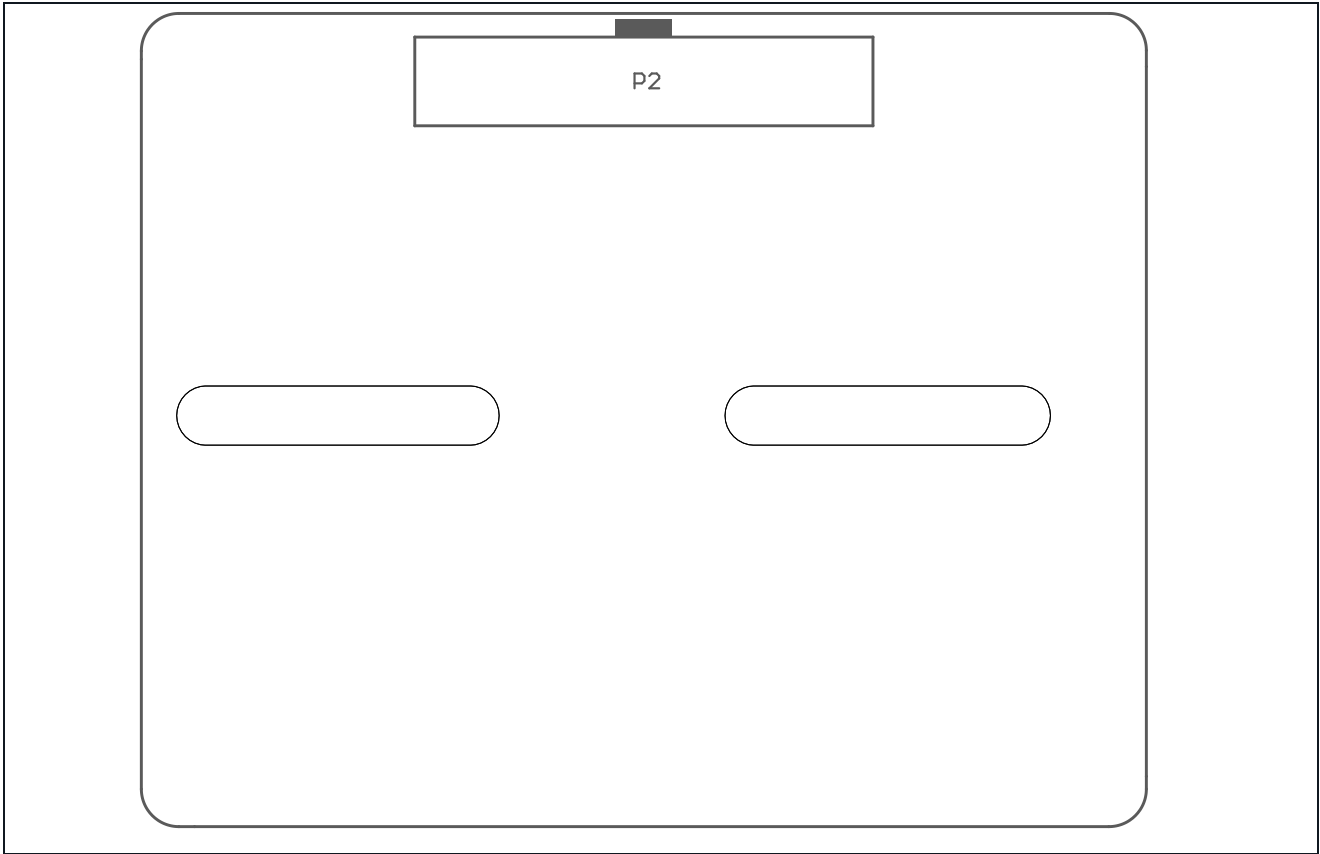


Figure 9: M909 Isolator bottom side assembly drawing

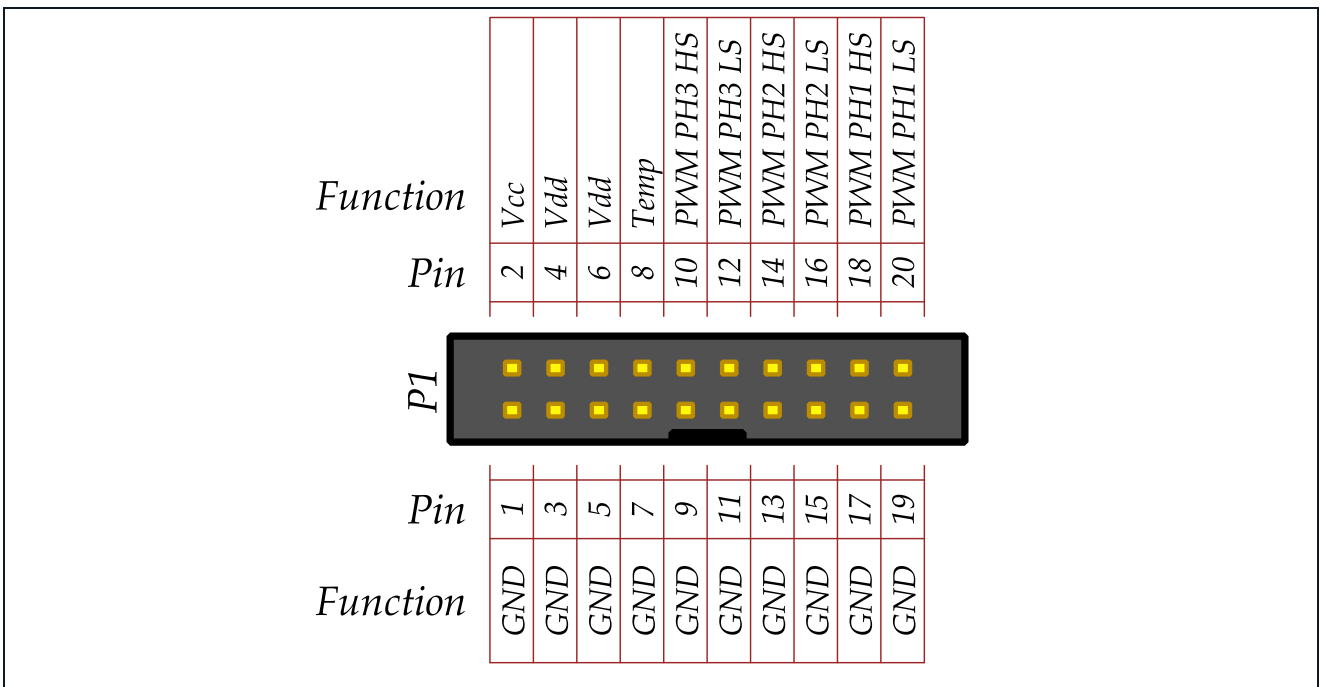


Figure 10: A map of the P1 connectors' pins of Gate Driver and Isoboard

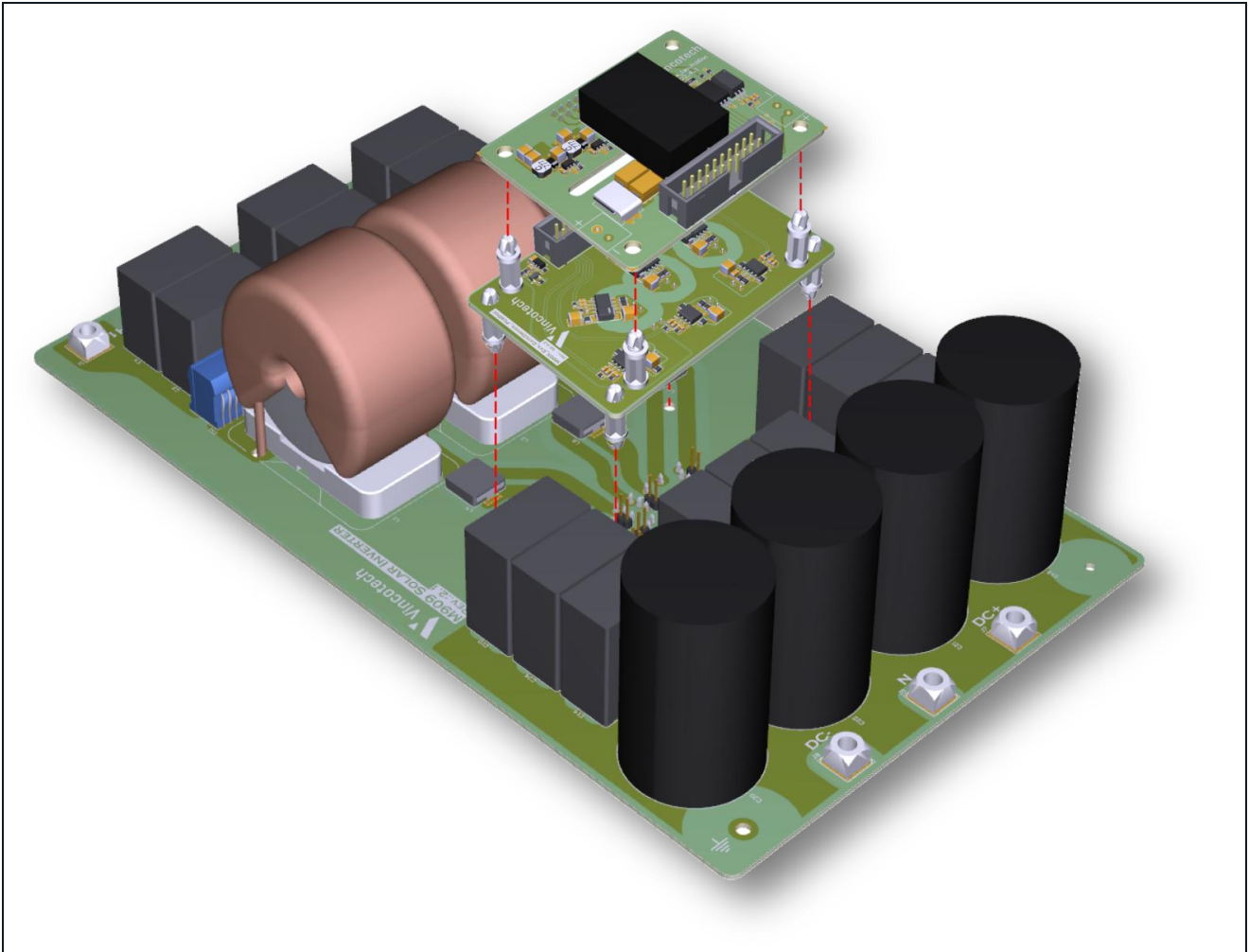


Figure 11: Assembly of the Iso board and Gate driver

## 5 Hardware

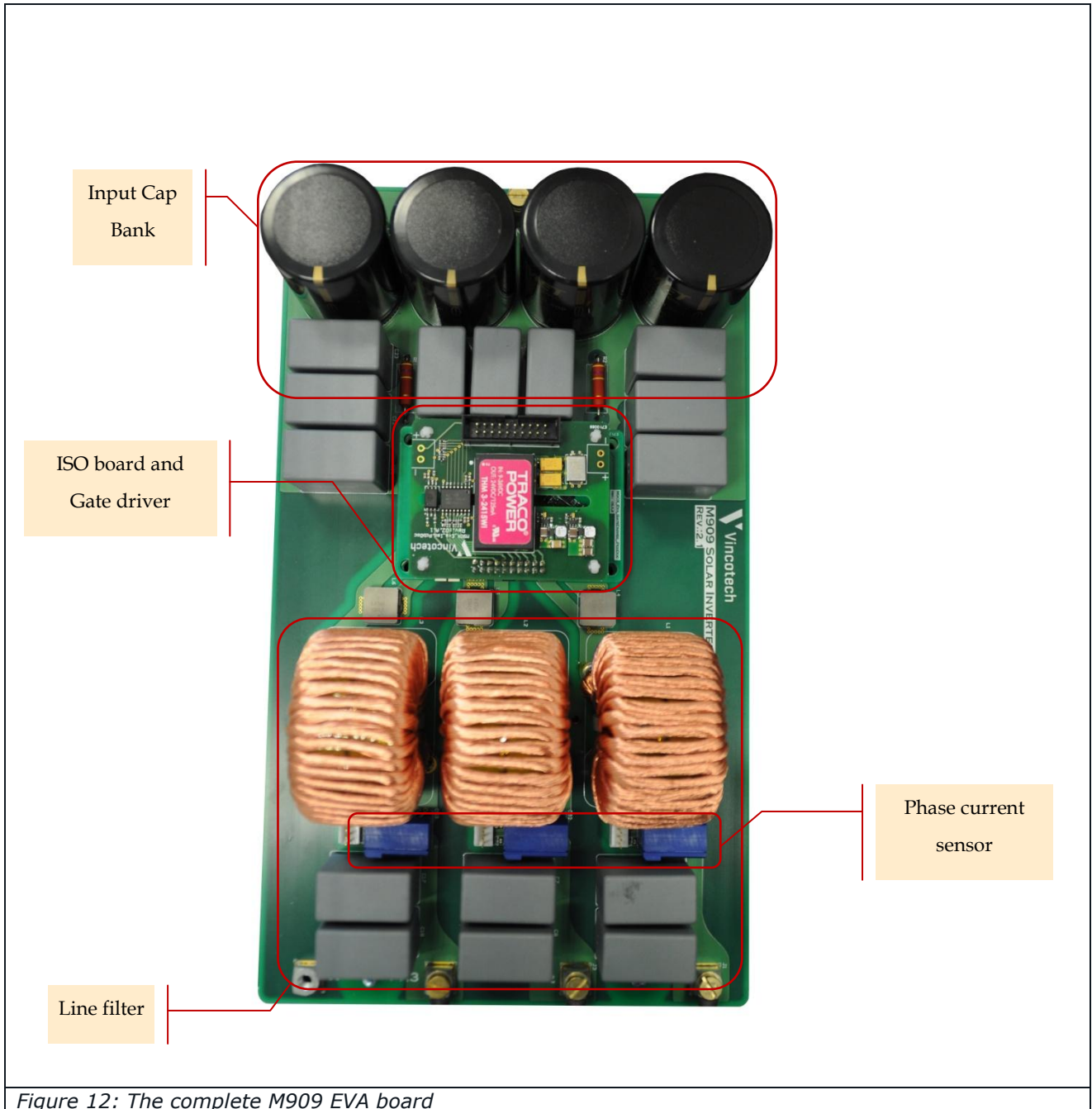


Figure 12: The complete M909 EVA board

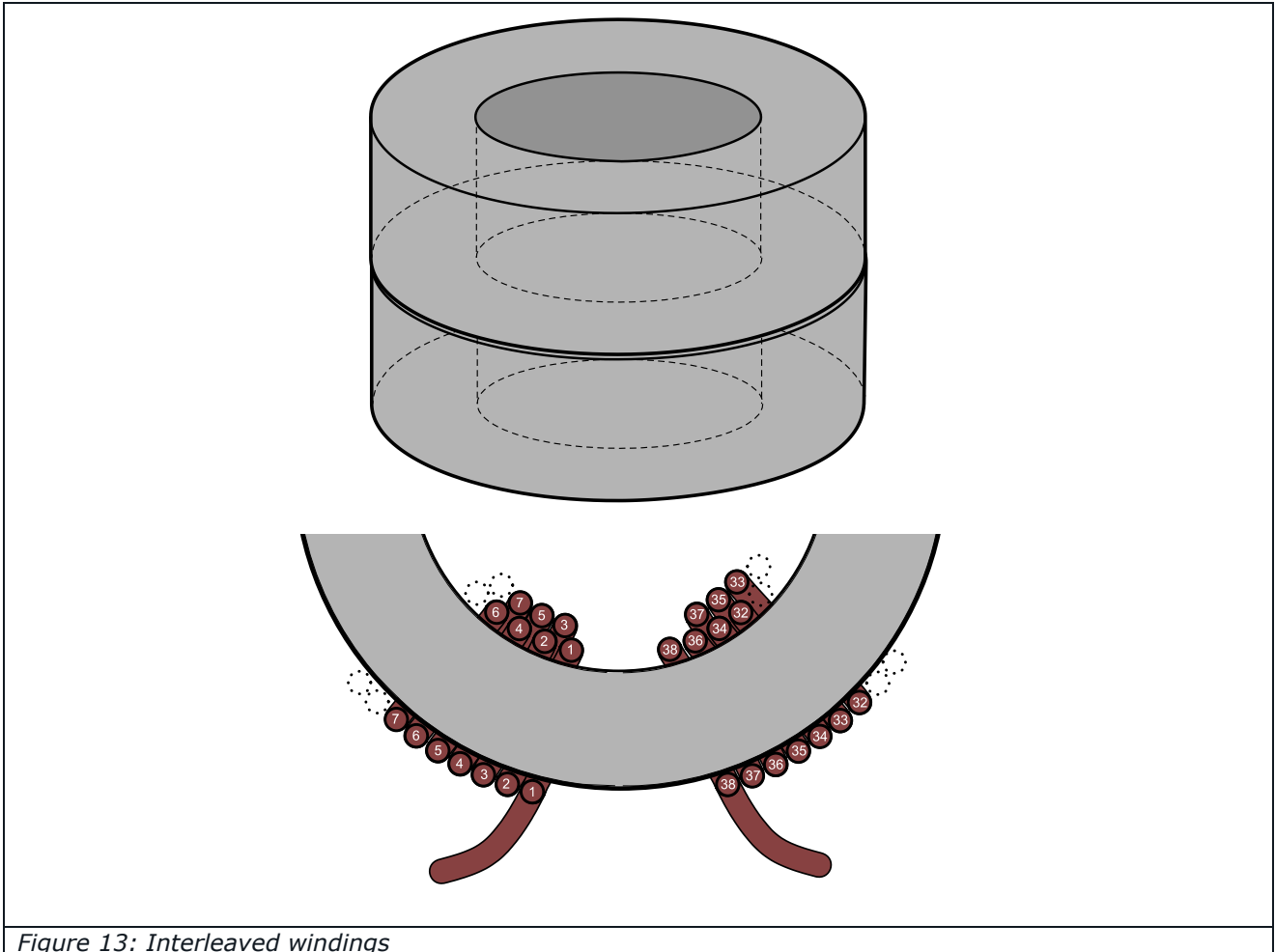


Figure 13: Interleaved windings

The filter inductor core type is Magnetics C055192A2. Two stacked cores was used.

Wire used in the coil is HF litz wire(eg.:420\*0.1mm). The number of turns from this type of wire is 38.