

# Reference Board User's Manual for SiC461, SiC462, SiC471, and SiC472 Synchronous Buck Regulators



## DESCRIPTION

This reference board allows the user to evaluate the SiC461, SiC462, SiC471, and SiC472 microBUCK® regulators for their features and functionalities. It can also be a reference design for a user's application. The board is configured for 4.5 V to 50 V input. Output current capability is model dependent. The operating range may be modified by changing components such as the inductor, feedback resistor, and ripple injection networks.

The SiC46x and SiC47x family of microBUCK regulators is a wide input voltage high efficiency synchronous buck regulator with integrated high side and low side power MOSFETs. Its power stage is capable of supplying up to 10 A continuous current at up to 2 MHz switching frequency. These regulators produce an adjustable output voltage down to 0.8 V from 4.5 V to 60 V input rail to accommodate a variety of applications, including computing, consumer electronics, telecom, and industrial.

SiC461, SiC462, SiC471, and SiC472 control architecture delivers ultrafast transient response with minimum output capacitance and tight ripple regulation at very light load. The device is stable with any type of output capacitor. The device also incorporates a power saving scheme that significantly increases light load efficiency.

This board has UVLO capability on the input rail and a user programmable soft start.

## FEATURES

- Versatile
  - Single supply operation from 4.5 V to 60 V input voltage for SiC461 and SiC462, and 55 V for SiC471 and SiC472
  - Adjustable output voltage down to 0.8 V
  - Scalable solution from 2 A to 12 A
  - Support start-up with pre-bias output voltage
  - $\pm 1\%$  output voltage accuracy at  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Highly efficient
  - 98 % peak efficiency
  - 5  $\mu\text{A}$  supply current at shutdown
  - 250  $\mu\text{A}$  operating current not switching
- Highly configurable
  - Adjustable switching frequency from 100 kHz to 2 MHz
  - Adjustable soft start and adjustable current limit
  - 3 modes of operation, forced continuous conduction, power save or ultrasonic
- Robust and reliable
  - Output over-voltage protection
  - Output under-voltage / short circuit protection with auto retry
  - Power good flag and over temperature protection
- Design support tool
  - PowerCAD online design simulation  
<https://vishay.transim.com/landing.aspx>
  - Inductor selection tool  
[www.vishay.com/inductors/calculator/calculator/](http://www.vishay.com/inductors/calculator/calculator/)

## APPLICATIONS

- Industrial and automation
- Home automation
- Industrial computing
- Base station power supplies
- Wall transformer regulation
- Robotics
- Drones
- Battery management systems
- Power tools
- Vending, ATM, and slot machine

## SPECIFICATIONS

This reference board allows the end user to evaluate the SiC461, SiC462, SiC471, and SiC472 microBUCK regulators for their features and functionalities. It can also be a reference design for a user's application. The board is configured for 4.5 V to 50 V input with different output voltages depending on the model number of the board. The operating range may be modified by changing components such as the inductor, feedback resistor, and ripple injection networks.

ORDERING INFORMATION		
BOARD PART NUMBER	MAXIMUM OUTPUT CURRENT	BOARD MARKING
SiC461EVB-A	10 A	UB46A
SiC462EVB-A	6 A	UB46A
SiC471EVB-A	12 A	UB46A
SiC472EVB-A	8 A	UB46A

## BOARD CONFIGURATION TABLE

SiC461, SiC471 EVB TYPICAL PRE-DEFINED OPERATING CONFIGURATIONS				
V <sub>IN</sub> (V)	V <sub>OUT</sub> (V)	f <sub>sw</sub> (kHz)	L (μH)	MAXIMUM I <sub>OUT</sub> (A) SiC461 / SiC471
48.0	3.3	300	3.3	10 / 12
48.0	5.0	300	5.6	10 / 12
48.0	12.0	300	10	10 / 12

SiC462, SiC472 EVB TYPICAL PRE-DEFINED OPERATING CONFIGURATIONS				
V <sub>IN</sub> (V)	V <sub>OUT</sub> (V)	f <sub>sw</sub> (kHz)	L (μH)	MAXIMUM I <sub>OUT</sub> (A) SiC462 / SiC472
48.0	3.3	300	5.6	6 / 8
48.0	5.0	300	8.2	6 / 8
48.0	12.0	300	15.0	6 / 8

## CONNECTION AND SIGNAL / TEST POINTS

### Power Terminals (J4)

V<sub>IN</sub>, GND (J4, pin 1 and pin 2): (see Fig. 1)

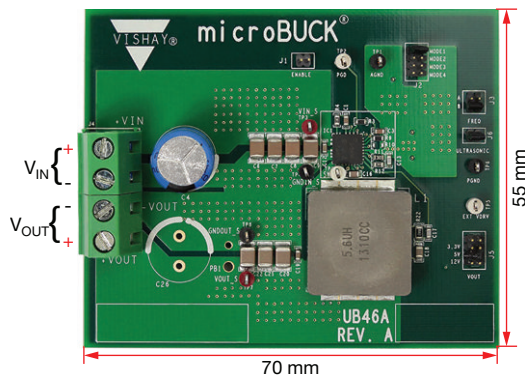


Fig. 1 - PCB Showing Power Terminal Connections

Connect to a voltage source: 4.5 V to 50 V. Input voltage's under-voltage lockout (V<sub>IN</sub> UVLO) function can be instituted by inserting a suitable value resistor for R2. The minimum input voltage will be 4.5 V when R2 is not inserted

V<sub>OUT</sub>, GND (J4, pin 3 and pin 4): (see Fig. 1)

Connect to a load that draws no more than:

SiC461 - 10 A, SiC462 - 6 A

SiC471 - 12 A, SiC472 - 8 A

The output voltage is selectable on J5

## Warning

The output capacitors are rated to 25 V. Should a higher output voltage be required, the output capacitors must be changed to ones with an appropriate higher voltage rating.

## SELECTION JUMPERS

### Operation Mode Select Using J2 and J6

J2 allows the user to select modes of power saving and whether using an internal LDO regulator or an external power supply as V<sub>DRV</sub> for operation.

J6 allows the user to further select the ultrasonic mode of power saving. In ultrasonic mode the minimum frequency of operation is 20 kHz, above the audible range. When not in ultrasonic mode the frequency can drop below 20 kHz.

The table below lists all modes of operation and their related jumper setup.

OPERATION MODES					
MODE	POWER SAFE MODE	V <sub>DRV</sub> SUPPLY	J2 SETUP	ULTRASONIC ENABLED	J6 SETUP
1	Enabled	Internal LDO	Pin 1 to 2 shorted	Yes	Shorted
				No	Open
2	Disabled	Internal LDO	Pin 3 to 4 shorted	n/a	Open
3	Disabled	External supply	Pin 5 to 6 shorted	n/a	Open
4	Enabled	External supply	Pin 7 to 8 shorted	Yes	Shorted
				No	Open

### External V<sub>DRV</sub> Supply

5 V (TP5), GND (TP6): this is the terminal that enables the user to use an external 5 V<sub>DC</sub> supply as MOSFET gate driver supply when mode 3 or mode 4 in table "Operation Modes" is selected. This should only be used in mode 3 and mode 4.

### Enable

J1 this is a 2 pin header crossing EN pin to ground.

The EN pin has an internal high impedance pull down resistor and requires an DC voltage higher than 1.35 V to enable chip operation. Shorting J1 with a jumper will disable the chip operation.

### Output Voltage V<sub>OUT</sub> Setting

J5 allows the user to choose four options of output voltage divider to set different output voltage V<sub>OUT</sub>. J5 is a 4 x 2 eight pin header and table "Output Voltage Setting" lists the available voltage setting and related jumper setup. The user can use equation in datasheet to calculate required resistance for a designated output voltage.



OUTPUT VOLTAGE SETTING		
V <sub>OUT</sub> DESIRED (V)	J5 SETUP	RESISTANCE BETWEEN V <sub>OUT</sub> AND FB PIN (kΩ)
Customized	Pin 1 to 2 shorted	Not populated; customized R18 following datasheet
3.3	Pin 3 to 4 shorted	31.6
5.0	Pin 5 to 6 shorted	52.3
12.0	Pin 7 to 8 shorted	140

### Switching Frequency f<sub>sw</sub> Setting

**J3** allows the user to choose correct resistance to achieve 300 kHz switching frequency after the users set up output voltage following table “Output Voltage Setting”. J3 is a 2 x 2 four pin header and it generates logic level of input pins of U1 (DG2034, multiplexers). Table “Switching Frequency Setting” lists the related logic level of U1 matching different output voltages in table “Output Voltage Setting” and related J3 jumper setup. The user can use equation in datasheet to calculate required resistance to achieve a desired switching frequency with a designated output voltage.

SWITCHING FREQUENCY SETTING				
SWITCHING FREQUENCY DESIRED (kHz)	V <sub>OUT</sub> (V) <sup>(1)</sup>	U1 INPUT LOGIC	J3 JUMPER SETUP	RESISTANCE BETWEEN f <sub>sw</sub> AND GND (kΩ)
300	3.3	2'b01	Pin 1 to 2 shorted	57.6
	5.0	2'b10	Pin 3 to 4 shorted	88.7
	12.0	2'b11	Pin 1 to 2 and 3 to 4 shorted	210.0
Others		2'b00	All pins leave open	Not populated; customized R10 following datasheet

### Note

<sup>(1)</sup> V<sub>OUT</sub> set in table “Output Voltage Setting”

## SIGNALS AND TEST LEADS

### Input Voltage Sense

**V<sub>IN\_SENSE</sub> (TP3), GND<sub>IN\_SENSE</sub> (TP4):** this allows the user to measure the voltage directly at the input of the regulator bypassing any losses generated by connections to the board. These test points can also be as a remote sense port of a power source with remote sense capability.

### Output Voltage Sense

**V<sub>OUT\_SENSE</sub> (TP7), GND<sub>OUT\_SENSE</sub> (TP8):** this allows the user to measure the output voltage directly at the sense point of the regulator bypassing any losses generated by connections to the board. These test points can also be as a remote sense port of an external load with remote sense capability.

### Power Good Indicator

**P<sub>GOOD</sub>:** is an open drain output and is pulled up with a 102 kΩ resistor, R3, to V<sub>DD</sub> (5 V). When FB or V<sub>OUT</sub> are within -10 % to +20 % of the set voltage this pin will go HI to indicate the output is okay.

### Power Up Procedure

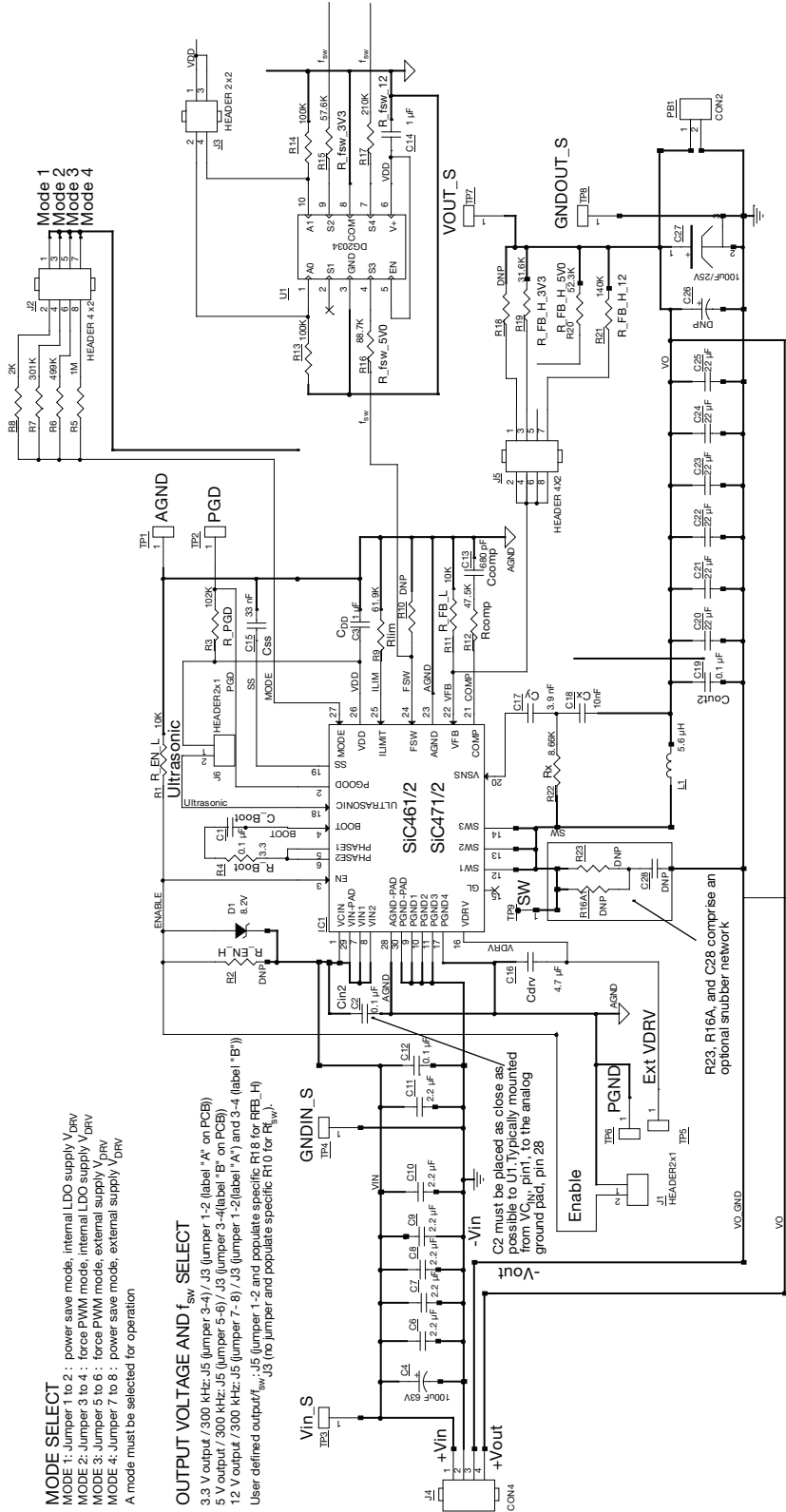
Before turning on the reference board, the user needs to select one of the four modes by shorting one jumper (see section on mode selection). If mode 3 or mode 4 is selected, make sure V<sub>DRV</sub> pin is supplied by external 5 V. There is no specific power sequence requirement to power up the board.

### Snubber Circuit

Snubber may be used when the user desire to decrease the peak voltage of switching node SW during turn on of the high side switch. There are place holders on the reference board, R16A1, R23, and C28, for the snubber.



SCHEMATIC FOR SiC461, SiC462, SiC471, AND SiC472





## PCB LAYOUT FOR SiC461, SiC462, SiC471, AND SiC472

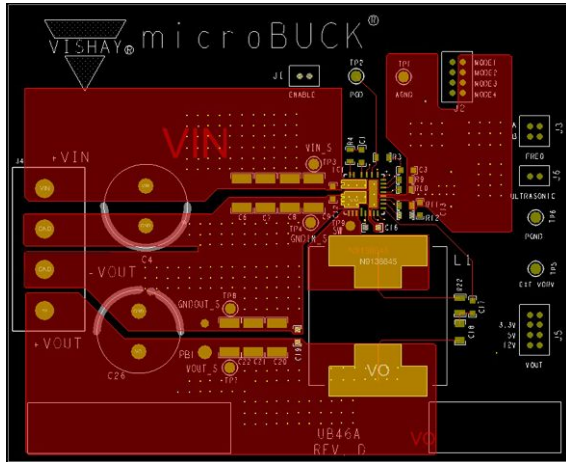


Fig. 2 - Top Layer

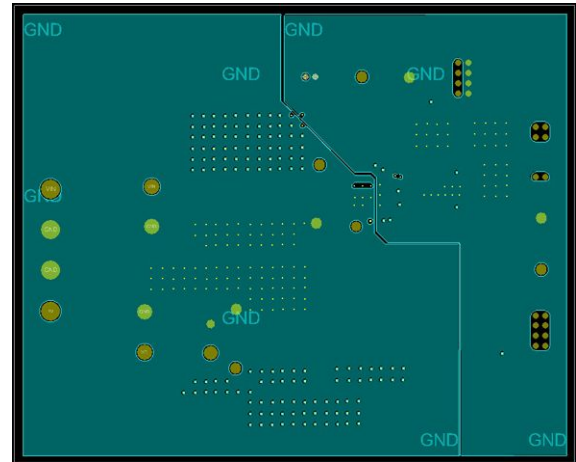


Fig. 5 - Inner Layer 2

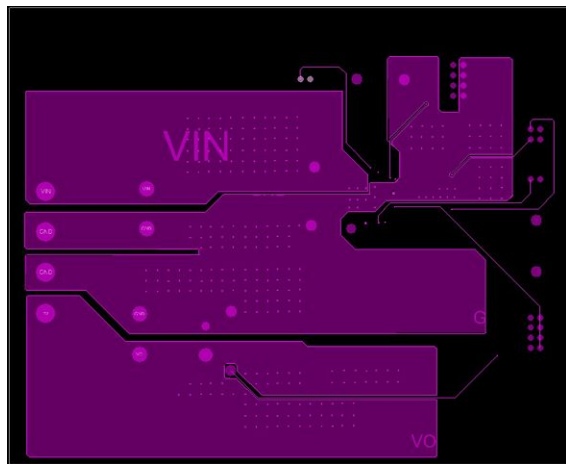


Fig. 3 - Inner Layer 3

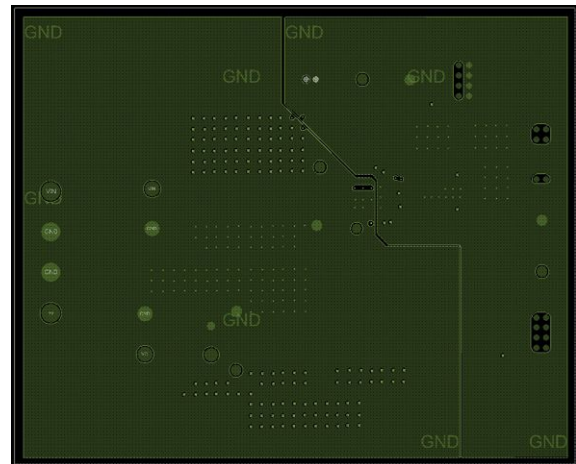


Fig. 6 - Inner Layer 4

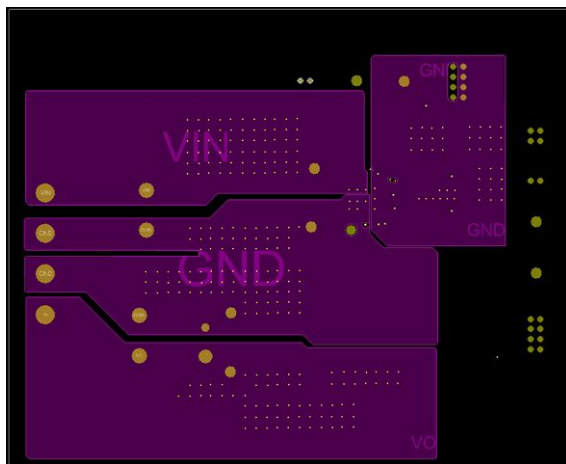


Fig. 4 - Inner Layer 5

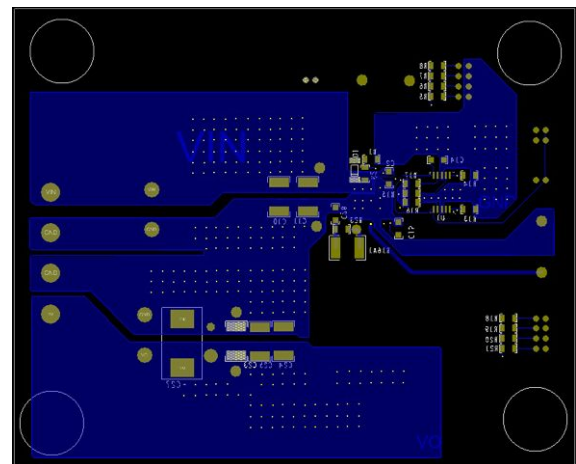


Fig. 7 - Bottom Layer





BILL OF MATERIAL REPORT FOR SiC461, SiC462, SiC471, AND SiC472				
SYM_NAME	BOM FOR SiC461, SiC471	BOM FOR SiC462, SiC472	QTY	REFDES
1210	DNP	DNP	1	R16A1
0603	0.1 $\mu$ F $\pm$ 10 % 50 V X7R 0603	0.1 $\mu$ F $\pm$ 10 % 50 V X7R 0603	2	C1; C19
0603	0.1 $\mu$ F $\pm$ 10 % 100 V X7R 0603	0.1 $\mu$ F $\pm$ 10 % 100 V X7R 0603	2	C2; C12
0603	1 $\mu$ F $\pm$ 10 % 25 V X7R 0603	1 $\mu$ F $\pm$ 10 % 25 V X7R 0603	2	C3, C14
0603	680 pF $\pm$ 5 % 50 V C0G/NP0 0603	680 pF $\pm$ 5 % 50 V C0G/NP0 0603	1	C13
0603	33 nF $\pm$ 10 % 25 V X7R 0603	33 nF $\pm$ 10 % 25 V X7R 0603	1	C15
0603	4.7 $\mu$ F $\pm$ 10 % 10 V X7S 0603	4.7 $\mu$ F $\pm$ 10 % 10 V X7S 0603	1	C16
0603	3.9 nF $\pm$ 5 % 50 V C0G/NP0 0603	3.9 nF $\pm$ 5 % 50 V C0G/NP0 0603	1	C17
0603	DNP	DNP	1	C28
0805	10 nF $\pm$ 5 % 50 V C0G/NP0 0805	10 nF $\pm$ 5 % 50 V C0G/NP0 0805	1	C18
1210	2.2 $\mu$ F $\pm$ 10 % 100 V X7R 1210	2.2 $\mu$ F $\pm$ 10 % 100 V X7R 1210	6	C6; C7; C8; C9; C10; C11
1210	22 $\mu$ F $\pm$ 10 % 25 V X7R 1210	22 $\mu$ F $\pm$ 10 % 25 V X7R 1210	6	C20; C21; C22; C23; C24; C25
CAP10P5	100 $\mu$ F $\pm$ 20 % 63 V	100 $\mu$ F $\pm$ 20 % 63 V	1	C4
CAP10P5	DNP	DNP	1	C26
D3L	100 $\mu$ F 25 V	100 $\mu$ F 25 V	1	C27
ED120-4DS2	CON4	CON4	1	J4
	IHLP5050FDER5R6M01 5.6 $\mu$ H, 20 %, 9.3 m $\Omega$ DCR, 13.5 A I <sub>RMS</sub> , 32 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	IHLP6767GZER8R2M11 8.2 $\mu$ H, 20 %, 7.71 m $\Omega$ DCR, 21 A I <sub>RMS</sub> , 18 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	1	L1 (recommended for V <sub>OUT</sub> = 5.0 V)
	IHLP5050FDER3R3M01 3.3 $\mu$ H, 20 %, 5.7 m $\Omega$ DCR, 18 A I <sub>RMS</sub> , 35 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	IHLP5050FDER5R6M01 5.6 $\mu$ H 20 %, 9.30 m $\Omega$ DCR, 13.5 A I <sub>RMS</sub> , 32 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	1	L1 (DNP) (recommended for V <sub>OUT</sub> = 3.3 V)
	IHLP6767GZER100M01 10 $\mu$ H 20 %, 11.6 m $\Omega$ DCR, 16.5 A I <sub>RMS</sub> , 25 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	IHLP6767GZER150M01 15 $\mu$ H, 20 %, 18.8 m $\Omega$ DCR, 15.5 A I <sub>RMS</sub> , 25 A I <sub>SAT 1</sub> at 25 °C (20 % roll off)	1	L1 (DNP) (recommended for V <sub>OUT</sub> = 12.0 V)
MINIJUMPER2	HEADER 2 x 1	HEADER 2 x 1	2	J1, J6
MINIJUMPER2X2	HEADER 2 x 2	HEADER 2 x 2	1	J3
MINIJUMPER2X4	HEADER 4 x 2	HEADER 4 x 2	2	J2; J5
MSOP10	DG2034	DG2034	1	U1
0603	10 k $\Omega$ $\pm$ 1%	10 k $\Omega$ $\pm$ 1%	2	R1, R11
0603	DNP	DNP	4	R2; R10; R18; R23
0603	102 k $\Omega$ $\pm$ 1%	102 k $\Omega$ $\pm$ 1%	1	R3
0603	3.3 $\Omega$ $\pm$ 1%	3.3 $\Omega$ $\pm$ 1%	1	R4
0603	1 M $\Omega$ $\pm$ 1%	1 M $\Omega$ $\pm$ 1%	1	R5
0603	499 k $\Omega$ $\pm$ 1%	499 k $\Omega$ $\pm$ 1%	1	R6
0603	301 k $\Omega$ $\pm$ 1%	301 k $\Omega$ $\pm$ 1%	1	R7
0603	2 k $\Omega$ $\pm$ 1%	2 k $\Omega$ $\pm$ 1%	1	R8
0603	61.9 k $\Omega$ $\pm$ 1%	61.9 k $\Omega$ $\pm$ 1%	1	R9
0603	47.5 k $\Omega$ $\pm$ 1%	47.5 k $\Omega$ $\pm$ 1%	1	R12
0603	100 k $\Omega$ $\pm$ 1%	100 k $\Omega$ $\pm$ 1%	2	R13; R14
0603	57.6 k $\Omega$ $\pm$ 1%	57.6 k $\Omega$ $\pm$ 1%	1	R15
0603	88.7 k $\Omega$ $\pm$ 1%	88.7 k $\Omega$ $\pm$ 1%	1	R16
0603	210 k $\Omega$ $\pm$ 1%	210 k $\Omega$ $\pm$ 1%	1	R17
0603	31.6 k $\Omega$ $\pm$ 1%	31.6 k $\Omega$ $\pm$ 1%	1	R19
0603	52.3 k $\Omega$ $\pm$ 1%	52.3 k $\Omega$ $\pm$ 1%	1	R20
0603	140 k $\Omega$ $\pm$ 1%	140 k $\Omega$ $\pm$ 1%	1	R21
0805	8.66 k $\Omega$ $\pm$ 1%	8.66 k $\Omega$ $\pm$ 1%	1	R22
	SiC461, SiC471	SiC462, SiC472	1	IC1
SOD323	8.2 V	8.2 V	1	D1
	Test point, red	Test point, red	2	TP3, TP7
	Test point, black	Test point, black	4	TP4, TP8, TP1, TP6
	Test point, white	Test point, white	2	TP9, TP5
	DNP	DNP	1	TP2
JUMPER			5	OFF BOARD x 5
	UB46A	UB46A	1	PCB