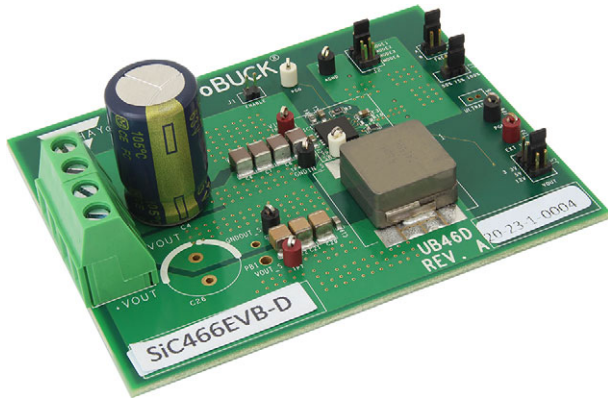




Reference Board User's Manual for SiC466, SiC467, SiC476, and SiC477 Synchronous Buck Regulators



DESCRIPTION

The SiC46x and SiC47x are families of wide input voltage high efficiency synchronous buck regulator with integrated high side and low side power MOSFETs. Its power stage is capable of supplying high 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 voltage for SiC46x, and 55 V for SiC47x input rail to accommodate a variety of applications, including computing, consumer electronics, telecom, and industrial.

SiC46x's and SiC47x's architecture delivers ultrafast transient response with minimum output capacitance and tight ripple regulation at very light load. The device is internally compensated and is stable with any capacitor. No external ESR network is required for loop stability purpose. The device also incorporate a power saving scheme that significantly increases light load efficiency. The regulators integrates a full protection set, including over current protection (OCP), output overvoltage protection (OVP), short circuit protection (SCP), output undervoltage protection (UVP) and thermal shutdown (OTP). They also have UVLO for input rail and a user programmable soft start.

SiC46x family is available in 2 A, 4 A, 6 A, 10 A pin compatible and SiC47x family is available in 3 A, 5 A, 8 A, 12 A pin compatible 5 mm by 5 mm lead (Pb)-free power enhanced MLP55-27L package.

ORDERING INFORMATION		
BOARD PART NUMBER	MAX. OUTPUT CURRENT	BOARD MARKING
SiC466EVB-D	10 A	UB46D
SiC467EVB-D	6 A	UB46D
SiC476EVB-D	12 A	UB46D
SiC477EVB-D	8 A	UB46D

FEATURES

- Versatile
 - Single supply operation from 4.5 V to 60 V input voltage for SiC466 and SiC467, and 55 V for SiC476 and SiC477
 - Adjustable output voltage down to 0.8 V
 - Scalable solution from 6 A to 12 A
 - Support start-up with pre-bias output voltage
 - $\pm 1\%$ output voltage accuracy at $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Internal compensation
- Highly efficient
 - 98 % peak efficiency
 - 4 μA supply current at shutdown
 - 156 μA operating current not switching
- Highly configurable
 - Adjustable switching frequency from 100 kHz to 2 MHz
 - Adjustable soft start and selectable present 100 %, 75 % and 50 % current limit
 - 2 modes of operation, forced continuous conduction, power save
- Robust and reliable
 - Output over-voltage protection
 - Output under-voltage / short circuit protection with auto retry
 - Power good flag and over temperature protection
 - Supported by Vishay PowerCAD online design simulation
- Design support tools
 - PowerCAD online design simulation <https://vishay.transim.com>
 - Inductor selection tool: www.vishay.com/inductors/calculator/calculator
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

APPLICATIONS

- Industrial and automation
- Home automation
- Industrial and server computing
- Networking, telecom, and base station power supplies
- Wall transformer regulation
- Robotics
- High end hobby electronics: remote control cars, planes, and drones
- Battery management systems
- Power tools
- Vending, ATM, and slot machine

SPECIFICATIONS

This reference board allows the user to evaluate the SiC466, SiC467, SiC476, and SiC477 microBUCK® regulators for their features and functionalities. It can also be a reference design for users 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, and feedback resistor.

BOARD CONFIGURATION TABLE

SiC466, SiC476 EVB TYPICAL PRE-DEFINED OPERATING CONFIGURATIONS				
V _{IN} (V)	V _{OUT} (V)	f _{sw} (kHz)	L (μH)	MAXIMUM I _{OUT} (A) SiC466 / SiC476
48.0	3.3	300	3.3	10 / 12
48.0	5.0	300	5.6	10 / 12
48.0	12.0	300	10.0	10 / 12

SiC467, SiC477 EVB TYPICAL PRE-DEFINED OPERATING CONFIGURATIONS				
V _{IN} (V)	V _{OUT} (V)	f _{sw} (kHz)	L (μH)	MAXIMUM I _{OUT} (A) SiC467 / SiC477
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_{IN}, GND (J4, pin 1 and pin 2): (see Fig. 1)

Fig. 1

Connect to a voltage source: 36 V to 50 V. This reference board configures 32 V as the minimal value of input voltage to enable the chip, and 27 V as the input voltage's under-voltage lockout (V_{IN} UVLO) voltage.

Both values can be modified by changing resistance of R2 using the equation in (1) and (2).

$$R2 = \frac{(PVIN_{EN} - 1.4) \times R1}{1.4} \quad (1)$$

where PVIN_{EN} is the level of input voltage, in volts, enabling the chip, R1 is the resistance of resistor R1 populated as 2 kΩ on this reference board.

$$PVIN_{UVLO} = 1.2 \times \frac{(R1 + R2)}{R1} \quad (2)$$

where PVIN_{UVLO} is the level of input voltage, in volts, applying V_{IN} UVLO protection.

EVB provides another option to configure V_{IN} UVLO by removing R2 and populate a Zener diode D1 on board. In this case, PVIN_{EN} will be 1.4 V above reverse breakdown voltage of D1.

The minimum value of PVIN_{EN} has to be 4.4 V, which shall be higher than VDD UVLO threshold voltage.

- V_{OUT}, GND (J4, pin 3 and pin 4): (see Fig. 1)

Connect to a load that draws no more than:

SiC466 - 10 A, SiC467 - 6 A

SiC476 - 12 A, SiC477 - 8 A

the output voltage is selectable on J5

Note

- The output capacitors are rated to 25 V. Should a higher output voltage be required, the output capacitors should 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_{DRV} for operation.

J6 is reserved for future use, please always leave the jumper open.

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

OPERATION MODES				
MODE	POWER SAVE MODE	V _{DRV} SUPPLY	J2 JUMPER SETUP (FOLLOWING SILKSCREEN LABEL)	J6 JUMPER SETUP
1	Enabled	Internal LDO	Pin 1 to 2 shorted	Open
2	Disabled	Internal LDO	Pin 3 to 4 shorted	Open
3	Disabled	External supply	Pin 5 to 6 shorted	Open
4	Enabled	External supply	Pin 7 to 8 shorted	Open

V_{DRV} External Supply

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

**Enable**

J1 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

1.4 V to enable chip operation.

Shorting J1 with a jumper will disable the chip operation

Output voltage V_{out} setting

J5 allows the user to choose four options of output voltage divider to set different output voltage V_{OUT}. **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 _{OUT} DESIRED (V)	J5 JUMPER SETUP (FOLLOWING SILKSCREEN LABEL)	RESISTANCE BETWEEN V _{OUT} 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	53.6
12.0	Pin 7 to 8 shorted	143

Switching Frequency f_{sw} 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 _{OUT} (V) ⁽¹⁾	U1 INPUT LOGIC	J3 JUMPER SETUP	RESISTANCE BETWEEN f _{sw} AND GND (kΩ)
300	3.3	2'b01	Pin 1-3 shorted	57.6
	5.0	2'b10	Pin 2-4 shorted	88.7
	12.0	2'b11	Pin 1-3 and 2-4 shorted	210.0
Others		2'b00	All pins leave open	Not populated. Customized R10 following datasheet

Note

⁽¹⁾ V_{OUT} set in table “Output Voltage Setting”

Maximum inductor valley current limit ILM setting

J7 allows the user to choose three options of the maximum inductor valley current limit. J7 is a 3 x 1 three pins header and its middle pin (pin 2) connects to number 25 pin I_{LIMIT} of IC1 (SiC466, SiC467, SiC476, or SiC477). Pin 1 of J7 is facing the EVB edge with silkscreen label “100 %”, and pin 3 of **J7** is facing IC1 with silkscreen label “50 %”. Table “Maximum Valley Current Limit” lists the three optional values of the maximum valley current limit and their related jumper setup.

MAXIMUM VALLEY CURRENT LIMIT SETTING					
I _{OCF} (A)				J7 JUMPER SETUP	IC1 I _{LIMIT} PIN CONNECTION
SiC466	SiC467	SiC476	SiC477		
13	10	13	10	Pin 1 to 2 shorted	I _{LIMIT} tied to V _{DD}
9.75	7.5	9.75	7.5	Three pins leave open	I _{LIMIT} is not connected
6.5	5	6.5	5	Pin 2 to 3 shorted	I _{LIMIT} tied to A _{GND}

SIGNALS AND TEST LEADS**Input Voltage Sense**

V_{IN_SENSE} (TP3), GND_{IN_SENSE} (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_{OUT_SENSE} (TP7), GND_{OUT_SENSE} (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_{GOOD}: is an open drain output and is pulled up with a 102 kΩ resistor, R3, to V_{DD1} (≈ 5 V). When FB or V_{OUT} 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 4 is selected, make sure V_{DRV} 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 SiC466, SiC467, SiC476, AND SiC477

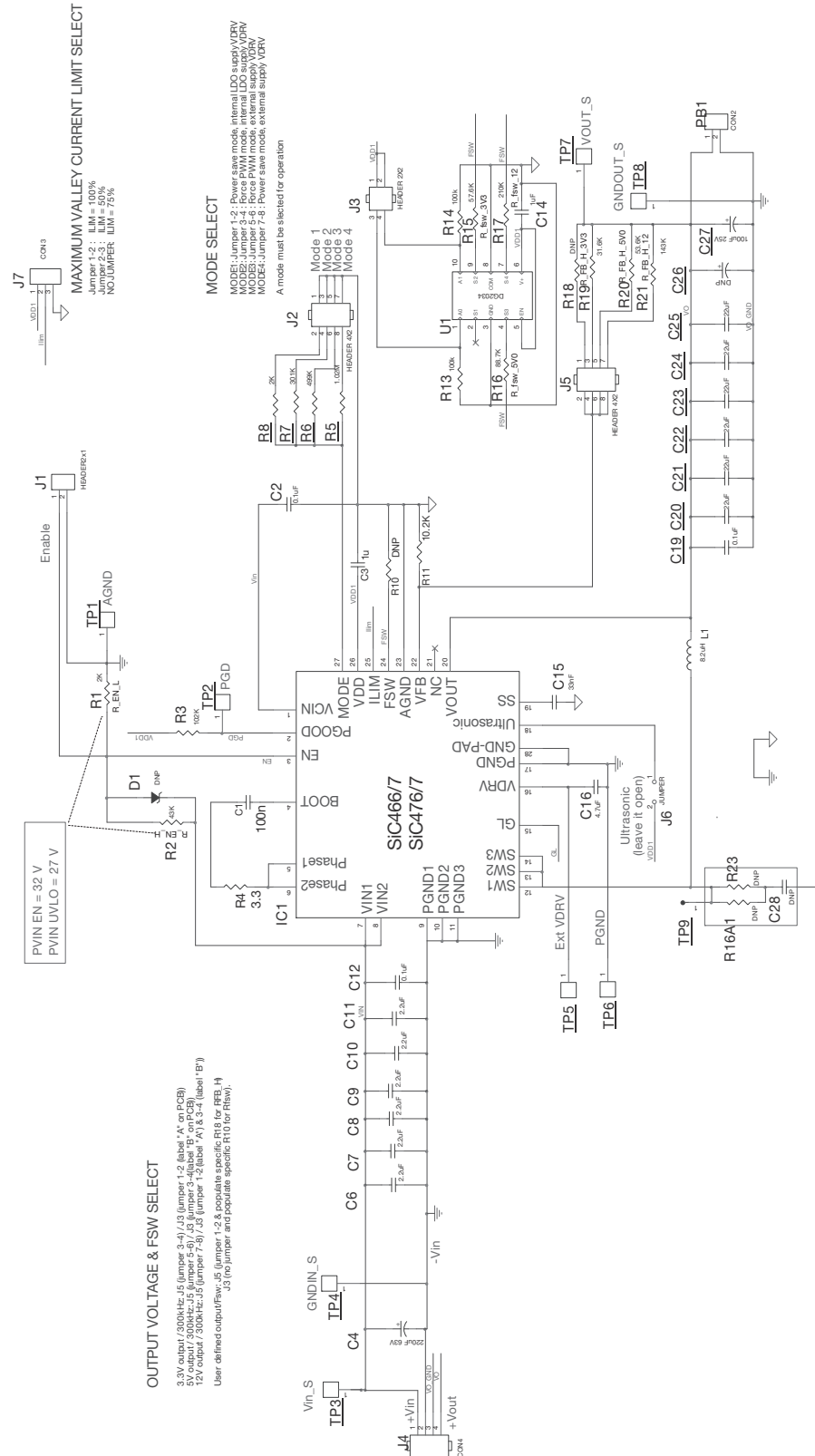


Fig. 2



PCB LAYOUT FOR SiC463/4 AND SiC473/4

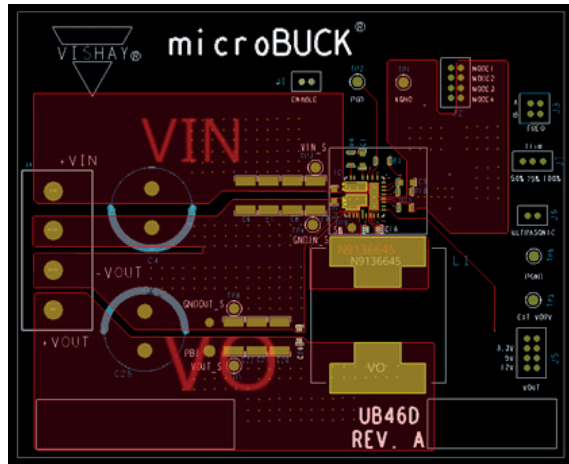


Fig. 3 - Top Layer

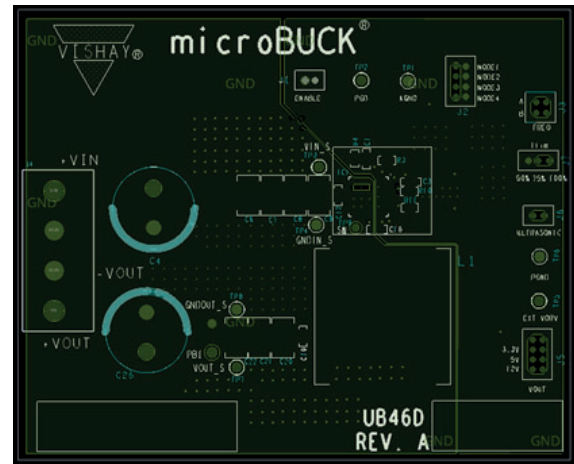


Fig. 6 - Inner Layer 4

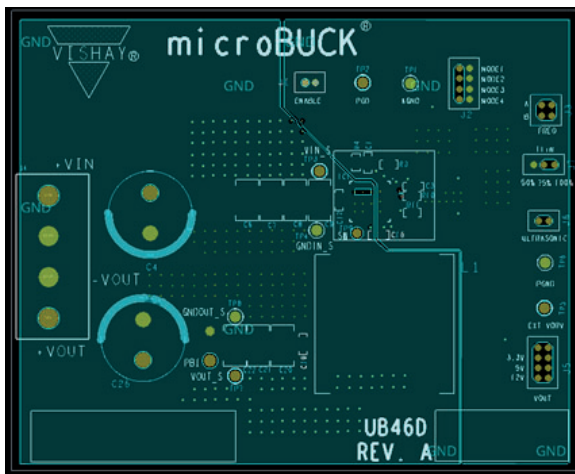


Fig. 4 - Inner Layer 2

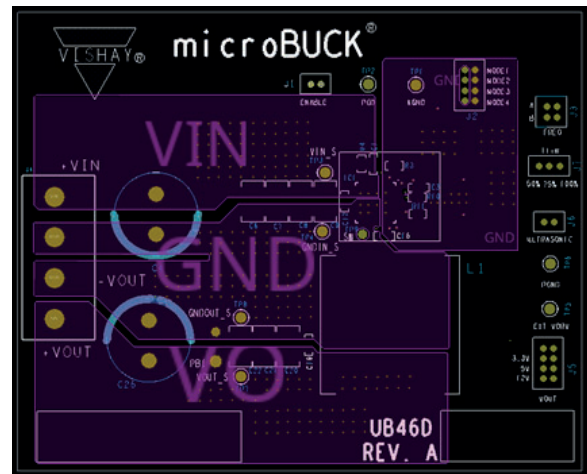


Fig. 7 - Inner Layer 5

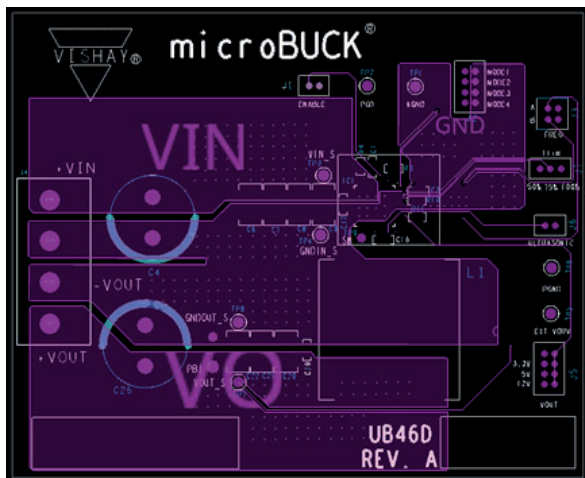


Fig. 5 - Inner Layer 3

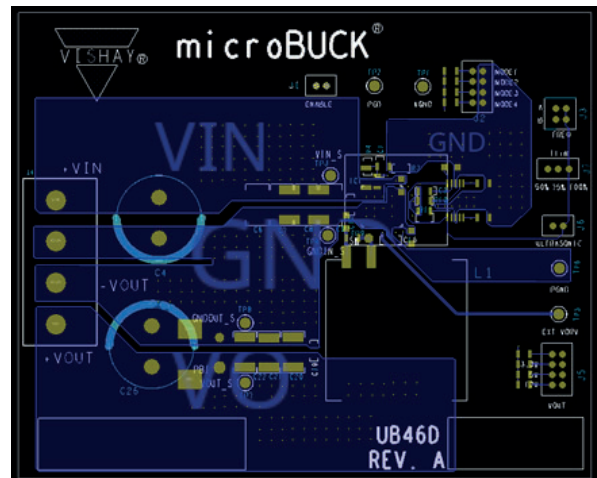


Fig. 8 - Bottom Layer



BILL OF MATERIAL REPORT FOR SiC466, SiC467, SiC476, AND SiC477					
BOM FOR SiC466, SiC476		BOM FOR SiC467, SiC477		QTY	REFERENCE DESIGNATOR
PART NUMBER	DESCRIPTION	PART NUMBER	DESCRIPTION		
VJ0603Y104KXAAC	0.1 $\mu\text{F} \pm 10\%$ 50 V X7R 0603	VJ0603Y104KXAAC	0.1 $\mu\text{F} \pm 10\%$ 50 V X7R 0603	2	C1, C19
GRM188R72A104MA35D	0.1 $\mu\text{F} \pm 10\%$ 100 V X7R 0603	GRM188R72A104MA35D	0.1 $\mu\text{F} \pm 10\%$ 100 V X7R 0603	2	C2, C12
GCM188R71E105KA64D	1 $\mu\text{F} \pm 10\%$ 25 V X7R 0603	GCM188R71E105KA64D	1 $\mu\text{F} \pm 10\%$ 25 V X7R 0603	2	C3, C14
EEU-FC1J221S	CAP ALUM 220 μF 20 % 63V RADIAL	EEU-FC1J221S	CAP ALUM 220 μF 20 % 63 V RADIAL	1	C4
GCJ32DR72A225KA01L	2.2 $\mu\text{F} \pm 10\%$ 100 V X7R 1210	GCJ32DR72A225KA01L	2.2 $\mu\text{F} \pm 10\%$ 100 V X7R 1210	6	C6, C7, C8, C9, C10, C11
VJ0603Y333KXXAC	33 $\mu\text{F} \pm 10\%$ 25 V X7R 0603	VJ0603Y333KXXAC	33 nF $\pm 10\%$ 25 V X7R 0603	1	C15
VJ0603G475KXJCW1BC	4.7 $\mu\text{F} \pm 10\%$ 16 V X5R 0603	VJ0603G475KXJCW1BC	4.7 $\mu\text{F} \pm 10\%$ 16 V X5R 0603	1	C16
GRM32ER71E226KE15L	22 $\mu\text{F} \pm 10\%$ 25 V X7R 1210	GRM32ER71E226KE15L	22 $\mu\text{F} \pm 10\%$ 25 V X7R 1210	6	C20, C21, C22, C23, C24, C25
	DNP		DNP	0	C26, C28
T521D107M025ATE040	CAP TANT POLY 100UF 25 V 7343	T521D107M025ATE040	CAP TANT POLY 100 μF 25 V 7343	1	C27
	DNP		DNP	0	D1
SiC466, SiC476	microBUCK 60 V DC/DC converter 10 A, micro BUCK 55 V DC/DC converter 12 A	SiC467, SiC477	microBUCK 60 V DC/DC converter 6 A, micro BUCK 55 V DC/DC converter 8 A	1	IC1
GRPB021VWVN-RC	CONN HEADER VERT 2POS 1.27 mm	GRPB021VWVN-RC	CONN HEADER VERT 2POS 1.27 mm	1	J1
GRPB042VWVN-RC	CONN HEADER VERT 8POS 1.27 mm	GRPB042VWVN-RC	CONN HEADER VERT 8POS 1.27 mm	2	J2, J5
GRPB022VWVN-RC	CONN HEADER VERT 4POS 1.27 mm	GRPB022VWVN-RC	CONN HEADER VERT 4POS 1.27 mm	1	J3
ED120/4DS	TERM BLK 4P SIDE ENT 5.08 mm PCB	ED120/4DS	TERM BLK 4P SIDE ENT 5.08 mm PCB	1	J4
	DNP		DNP	0	J6
GRPB031VWVN-RC	CONN HEADER VERT 3POS 1.27 mm	GRPB031VWVN-RC	CONN HEADER VERT 3POS 1.27MM	1	J7
IHLP5050FDER5R6M01	5.6 μH , 20 %, 9.30 m Ω DCR, 13.5 A I _{RMS} , 32 A I _{SAT1} at 25 °C (20 % roll off)	IHLP6767GZER8R2M11	8.2 μH , 20 %, 7.71 m Ω DCR, 21 A I _{RMS} , 18 A I _{SAT1} at 25 °C (20 % roll off)	1	L1 (recommended for V _{out} =5V)
IHLP5050FDER3R3M01	DNP, 3.3 μH , 20 %, 5.7 m Ω DCR, 18 A I _{RMS} , 35 A I _{SAT1} at 25 °C (20 % roll off)	IHLP5050FDER5R6M01	DNP, 5.6 μH , 20 %, 9.30 m Ω DCR, 13.5 A I _{RMS} , 32 A I _{SAT1} at 25 °C (20 % roll off)	0	L1 (DNP) (off board, recommended for V _{out} =3.3 V)
IHLP6767GZER100M01	DNP, 10 μH , 20 %, 11.6 m Ω DCR, 16.5 A I _{RMS} , 25 A I _{SAT1} at 25 °C (20% roll off)	IHLP6767GZER150M01	DNP, 15 μH , 20 %, 18.8 m Ω DCR, 12.5 A I _{RMS} , 25 A I _{SAT1} at 25 °C (20 % roll off)	0	L1 (DNP) (off board, recommended for V _{out} =12 V)
CRCW06032K00FKEAC	RES SMD 2 k Ω 1 % 1/10W 0603	CRCW06032K00FKEAC	RES SMD 2 k Ω 1 % 1/10 W 0603	2	R1, R8
CRCW060343K0FKEA	RES SMD 43 k Ω 1 % 1/10W 0603	CRCW060343K0FKEA	RES SMD 43 k Ω 1 % 1/10 W 0603	2	R2
CRCW0603102KFKEA	RES SMD 102 k Ω 1 % 1/10 W 0603	CRCW0603102KFKEA	RES SMD 102 k Ω 1 % 1/10 W 0603	1	R3
CRCW06033R30FKEA	RES SMD 3.3 Ω 1 % 1/10 W 0603	CRCW06033R30FKEA	RES SMD 3.3 Ω 1 % 1/10 W 0603	1	R4



BILL OF MATERIAL REPORT FOR SiC466, SiC467, SiC476, AND SiC477					
BOM FOR SiC466, SiC476		BOM FOR SiC467, SiC477		QTY	REFERENCE DESIGNATOR
PART NUMBER	DESCRIPTION	PART NUMBER	DESCRIPTION		
CRCW06031M02FKEA	RES SMD 1.02 MΩ 1 % 1/10 W 0603	CRCW06031M02FKEA	RES SMD 1.02 mΩ 1 % 1/10 W 0603	1	R5
CRCW0603499KFKEA	RES SMD 1.02 mΩ 1 % 1/10 W 0603	CRCW0603499KFKEA	RES SMD 499 kΩ 1 % 1/10 W 0603	1	R6
CRCW0603301KFKEA	RES SMD 301 kΩ 1 % 1/10 W 0603	CRCW0603301KFKEA	RES SMD 301 kΩ 1 % 1/10 W 0603	1	R7
	DNP		DNP	0	R10, R16A1, R18, R23
CRCW060310K2FKEA	RES SMD 10.2 kΩ 1 % 1/10 W 0603	CRCW060310K2FKEA	RES SMD 10.2 kΩ 1 % 1/10 W 0603	1	R11
CRCW0603100KFKEA	RES SMD 100 kΩ 1 % 1/10 W 0603	CRCW0603100KFKEA	RES SMD 100 kΩ 1 % 1/10 W 0603	2	R13; R14
CRCW060357K6FKEA	RES SMD 57.6 kΩ 1 % 1/10 W 0603	CRCW060357K6FKEA	RES SMD 57.6 kΩ 1 % 1/10 W 0603	1	R15
CRCW060388K7FKEA	RES SMD 88.7 kΩ 1 % 1/10W 0603	CRCW060388K7FKEA	RES SMD 88.7 kΩ 1 % 1/10 W 0603	1	R16
CRCW0603210KFKEA	RES SMD 210 kΩ 1 % 1/10W 0603	CRCW0603210KFKEA	RES SMD 210 kΩ 1 % 1/10 W 0603	1	R17
CRCW060331K6FKEA	RES SMD 31.6 kΩ 1 % 1/10W 0603	CRCW060331K6FKEA	RES SMD 31.6 kΩ 1 % 1/10 W 0603	1	R19
CRCW060353K6FKEA	RES SMD 53.6 kΩ 1 % 1/10W 0603	CRCW060353K6FKEA	RES SMD 53.6 kΩ 1 % 1/10 W 0603	1	R20
CRCW0603143KFKEA	RES SMD 143 kΩ 1 % 1/10W 0603	CRCW0603143KFKEA	RES SMD 143 kΩ 1 % 1/10 W 0603	1	R21
36-5001-ND	Test point, black	36-5001-ND	Test point, black	4	TP1, TP4, TP6, TP8
36-5002-ND	Test point, white	36-5002-ND	Test point, white	2	TP2, TP9
36-5000-ND	Test point, red	36-5000-ND	Test point, red	3	TP3, TP5, TP7
DG2034EDQ-T1-GE3	IC SWITCH SP4T SINGLE 10MSOP	DG2034EDQ-T1-GE3	IC SWITCH SP4T SINGLE 10 MSOP	1	U1
NPB02SVFN-RC	IC SWITCH SP4T SINGLE 10MSOP	NPB02SVFN-RC	CONN JUMPER SHORTING 1.27 mm	6	Off board x 6
UB46D	JAAW HP EVB	UB46D	JAAW HP EVB	1	PCB