AEY58-D1-0009-2

DC/DC Converter Application Information

IC Product Name	BD9611MUV
Topology	Buck (Step-Down) Switching Regulator
Type	Non-Isolation

No	Vin[V]	Vo	Operating Frequency[kHz]	Output Capacitor
1	16-48	5V, 10A	150	Aluminum capacitor 220uF Ceramic capacitor 10uF x 4pcs
2	19-32	5V, 10A	250	Ceramic capacitor 47uF x 4pcs
3	16-36	12V, 6A	250	Ceramic capacitor 10uF x 8pcs
4	16-48	12V, 10A	250	Aluminum capacitor 220uF Ceramic capacitor 10uF x 4pcs
5	42	18V, 10A	250	Aluminum capacitor 220uF Ceramic capacitor 10uF x 4pcs
6	24-28	20V, 5A	250	Ceramic capacitor 10uF x 8pcs
7	36-52	24V, 7A	250	Aluminum capacitor 220uF Ceramic capacitor 10uF x 4pcs
8	40	29.4V, 7.5	100	Aluminum capacitor 220uF Ceramic capacitor 10uF x 4pcs

■ Application circuit

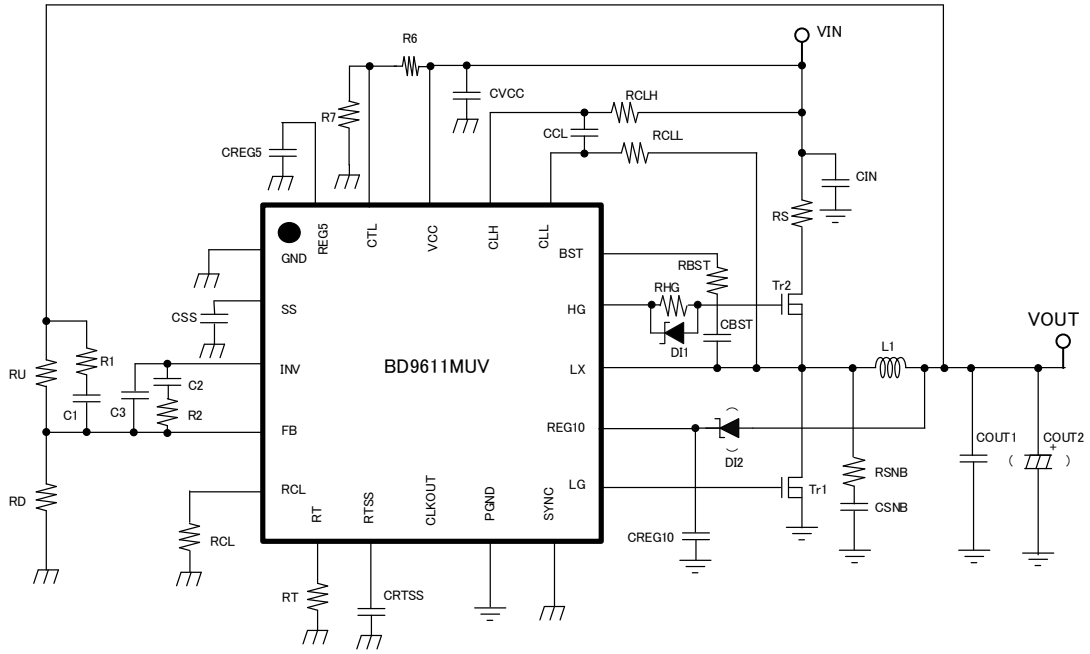


Fig.1 Application circuit

■ RT terminal setting（6-pin）

Terminal State	Operating Frequency setting
External resistor	$\mathrm{Fosc} = 15900 \times \mathrm{RRT}^{-0.955}[kHz]$ RRT：RT resistor [kΩ]

■ SS terminal setting（2-pin）

Terminal State	Soft start setting
External capacitor	$\mathrm{tss} = \frac{\mathrm{CSS} \times \mathrm{VNON}}{\mathrm{ISS}}[\mathrm{s}]$ CSS:SS capacitor、VNON：0.8[V]、ISS:1uA

■ CLL terminal setting（16-pin）、CLH terminal setting (17-pin)

Terminal State	OCP setting
Current sense resistor	$\mathrm{IOCP} = \frac{\mathrm{VOCPTH}}{\mathrm{Rs}}[\mathrm{s}]$ IOCP：OCP trigger current、 VOCPTH：OCP threshold voltage between CLH and CLL configured using RCL Rs：Current sense resistor
RCL resistor	$\mathrm{VOCPTH} = \frac{0.8}{\mathrm{RRCL}} \times 1850[\mathrm{mV}]$ RRCL:RCL resistor

■ CTL terminal setting（19-pin）

Terminal State	IC Operating condition
≥ 2.6V	Normal operating
≤ 2.6V	Power off

■UVLO detect voltage setting with CTL terminal external resistor

$$R1 = \frac{Vhys}{IUVHYS}[\Omega]$$

$$R2 = \frac{VEXUTH \times R1}{Vuv - VEXUTH}[\Omega]$$

(IUVHYS:CTL pin source current 20uA(typ) VEXUTH:CTL pin output on threshold 2.6V(typ), VUV:UVLO detect voltage)

■Output voltage setting

$$V_{OUT} = \frac{RU + RD}{RD} \times 0.8\ [V]$$

Input/output voltage conditions are required to satisfy the following equations:

$$V_{OUT} = 1.0V \sim V_{IN} \times 0.8[V]$$

The available output voltage is restricted by the following.

This IC's programmable output voltage is limited to the available area shown on Figure 2. In application, the programmable output voltage is restricted from the unavailable area on the graphs due to input-voltage, frequency, high-side minimum off pulse and load current.

◆Relation Between Frequency and Input-Output Voltage Ratio

This IC has a limitation in programmed output voltage as shown on the following graphs due to the minimum pulse available for feedback control and programmed OCP detect voltage.

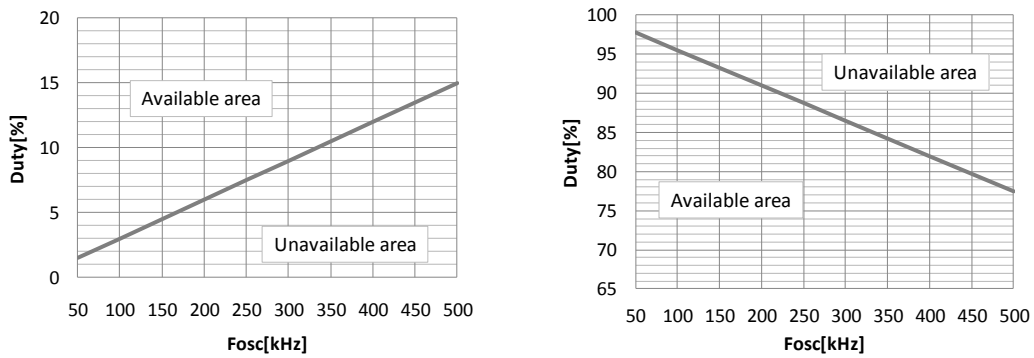


Fig.2 Frequency vs Input-Output Voltage Ratio (Duty)

◆High-side (HG) Minimum Off Pulse

This IC has a limitation in programmed output voltage due to the Hi-side Minimum Off Pulse for charging BST capacitor (CBST) which adopts the Bootstrap system.
Consider toff=450ns as the OFF duty pulse.
In cases where the configured output voltage is near the input value, the output voltage gets affected by this off pulse.
Take into consideration the reduced output voltage limit when the programmed output voltage is near input value.
For example:

(ex.) Programmed output voltage: Vo = 12V, Frequency: f = 250kHz (T = 1/f = 4us)

OFF_Duty = 1 – (Vo / Vin), Minimum OFF pulse: toff_min = T × OFF_Duty

toff_min = T × (1 - Vo /Vin) = 4us × (1 – 12V / Vin) ≧ 450ns → Vin ≧14.95V

It is necessary that the condition Vin ≧ 14.95V is satisfied to ensure that the programmed output Vo = 12V is reached.

Additionally, take into consideration the Ron voltage drop of the high-side FET, the DCR of coil and the PCB pattern impedance.

◆Load current

There are no limitations on the load current when the programmed output voltage holds the condition Vo ≧ 10V. However, certain limitations are imposed when Vout is under 10V because of the Pre-bias sequence.
Please refer to PRE-BIAS as the following..

◆PRE-BIAS

This IC is designed not to sink large current from Vout, even if Vout had been biased at high voltage upon startup. However, there is a potential of an increase in output voltage through Body-Di of BST, during the charge cycle of switching. This happens when the programmed output voltage is under 10V.
To prevent this, connect a load resistor between Vo and PGND to serve as discharge path when using Vo<10V. Please use the table in Figure 3 as reference in choosing the discharge resistance value.
This issue does not exist when Vo≧10V.

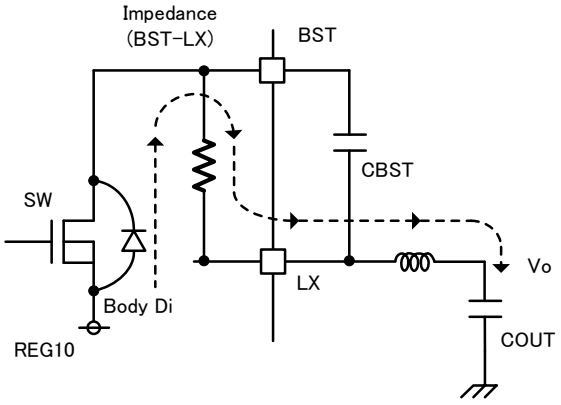
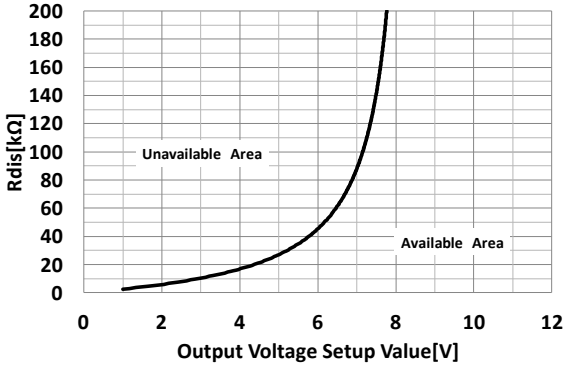


Fig.3 Current Passes Through PRE-BIAS at Low Output Voltage Setting



Vo[V]	Rdis[kΩ]
1.0	2.5
2.0	6.5
3.0	10.5
3.3	12.0
4.0	17.0
5.0	27.0
6.0	45.5
7.0	88.5
8.0	302.0

Fig.4 Output Voltage Setting vs Load Resistance

◆LX terminal snubber circuit

We recommend to connect the snubber circuit RSNB and CSNB to prevent from exceeding the maximum operating voltage 56V. When LX terminal voltage is achieved the maximum operating voltage 56V, it has the possibility to destroy the IC.

■ Evaluation board schematic

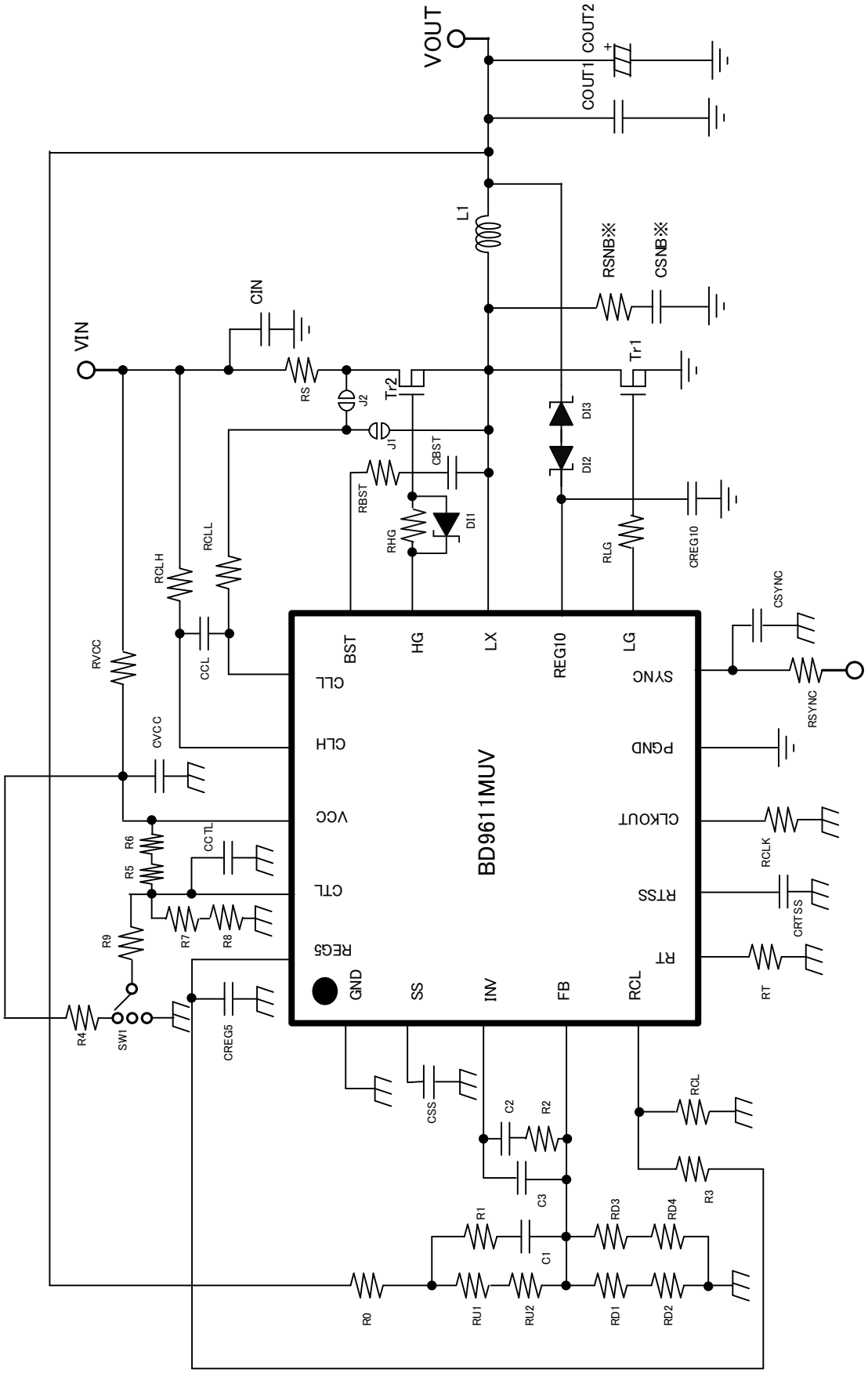


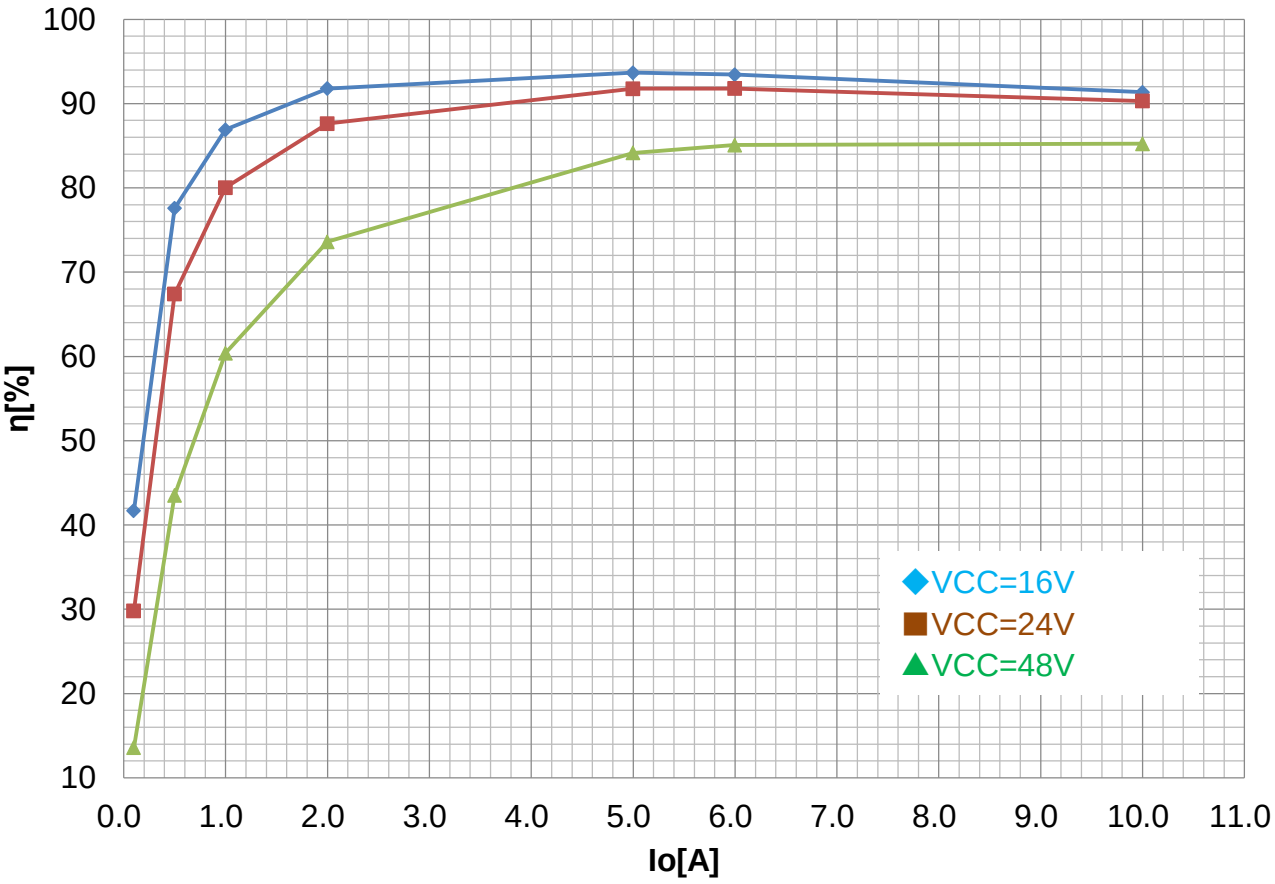
Fig.5 Evaluation board schematic

※There is no layout pattern of RSNB and CSNB. We recommend to connect the RSNB and CSNB to prevent from the ringing voltage of LX terminal.

■Bill of Materials

1. VO=5V 10A (VIN=16-48V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	1000pF	50V, B1, ±10%	GRM188B11H102KA01D	MURATA	1608
1	C2	Ceramic Capacitor	0.047uF	50V, B1, ±10%	GRM188B11H473KA01D	MURATA	1608
1	C3	Ceramic Capacitor	100pF	50V, B1, ±10%	GRM188B11H101KA01D	MURATA	1608
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
1	COUT2	Ceramic Capacitor	220uF	50V	UVR1H221MPD1TD	nichicon	ϕ10
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.1uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS, CSS	Ceramic Capacitor	0.01uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	7.7uH	± 20%,9.85m Ω (max),10A	CDEP147NP-7R7MC-95	SUMIDA	14.9×14.9
1	R1, R2	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R5	Resistor	27kΩ	0.1W,50V,0.5%	MCR03EZPD2702	ROHM	1608
1	R7	Resistor	5.1kΩ	0.1W,50V,0.5%	MCR03EZPD5101	ROHM	1608
1	R8	Resistor	430Ω	0.1W,50V,0.5%	MCR03EZPD4300	ROHM	1608
1	RCL	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
1	RD1	Resistor	3.6kΩ	0.1W,50V,0.5%	MCR03EZPD3601	ROHM	1608
1	RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RS	Resistor	10mΩ	1W,1%	PMR50HZPFU10L0	ROHM	5025
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPD22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	15kΩ	0.1W,50V,0.5%	MCR03EZPD1502	ROHM	1608
1	RU2	Resistor	3.9kΩ	0.1W,50V,0.5%	MCR03EZPD3901	ROHM	1608
2	Tr1,Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
11	CSYNC,J2,R0,R6,R8,RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	C3,CCL,DI2,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	

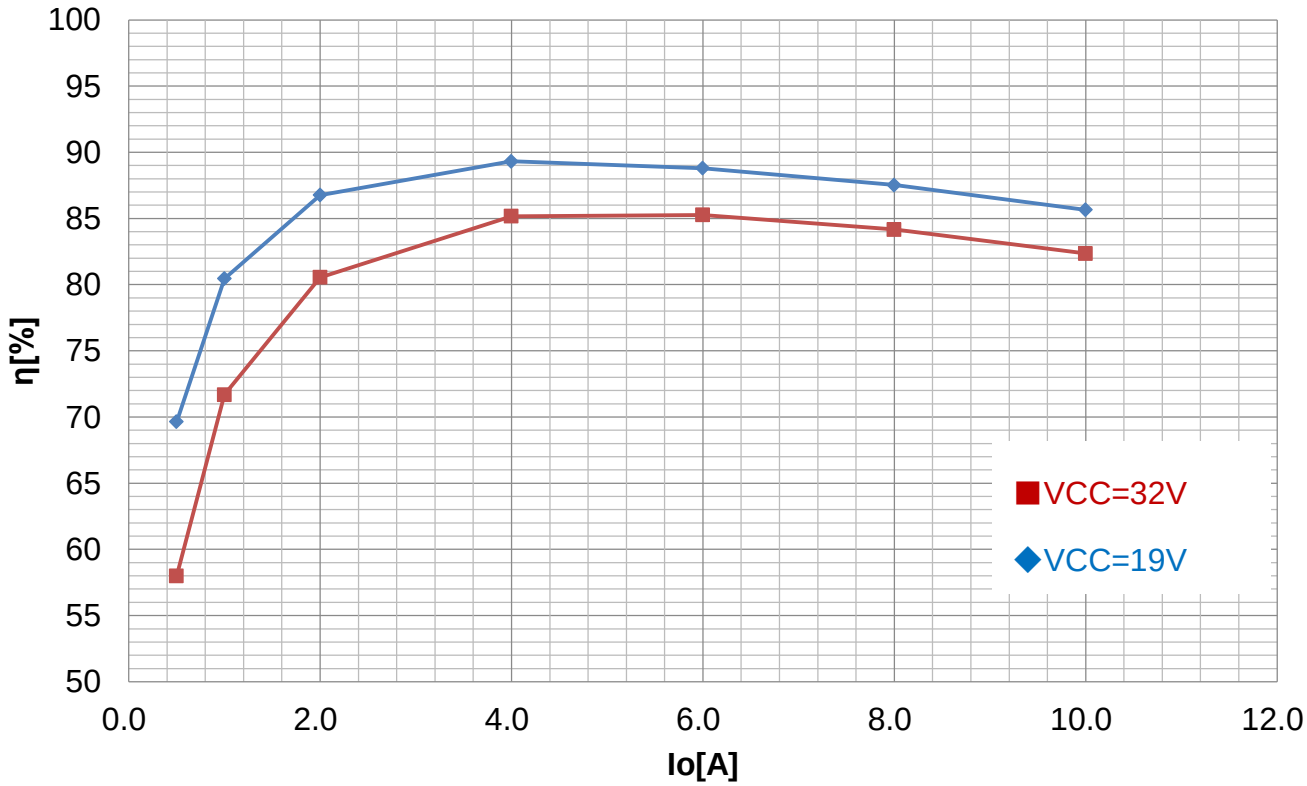


■Bill of Materials (continued)

2. VO=5V 10A (VIN=19-32V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	1000pF	50V, B1, ±10%	GRM188B11H102KA01D	MURATA	1608
1	C2	Ceramic Capacitor	0.033uF	50V, B1, ±10%	GRM188B11H333KA61D	MURATA	1608
1	C3	Ceramic Capacitor	330pF	50V, CH, ±5%	GRM1552C1H331JA01	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	47uF	16V, B, ±10%	GRM32EB31C476KE15L	MURATA	3225
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.10uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS, CSS	Ceramic Capacitor	0.010uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB ※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	4.7uH	± 20%,15m Ω (max),10A	SRP1235-4R7M	Bourns	13.9×13.5
1	R1, R2	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608

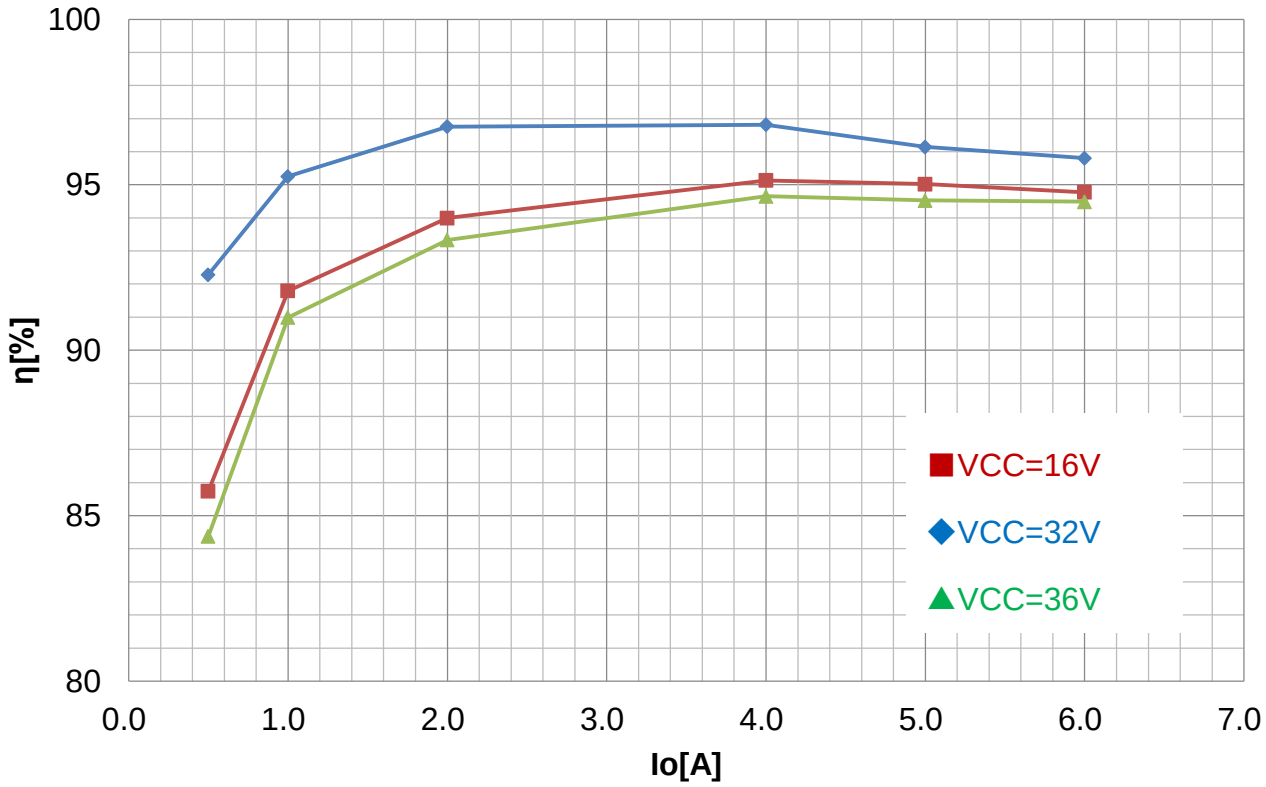
1	R5	Resistor	27kΩ	0.1W,50V,0.5%	MCR03EZPD2702	ROHM	1608
1	R7	Resistor	5.1kΩ	0.1W,50V,0.5%	MCR03EZPD5101	ROHM	1608
1	R8	Resistor	430Ω	0.1W,50V,0.5%	MCR03EZPD4300	ROHM	1608
1	RCL	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
1	RD1	Resistor	3.6kΩ	0.1W,50V,0.5%	MCR03EZPD3601	ROHM	1608
1	RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RS	Resistor	10mΩ	2W,1%	PMR100HZPFU10L0	ROHM	6432
1	RSNB ※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPD22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	15kΩ	0.1W,50V,0.5%	MCR03EZPD1502	ROHM	1608
1	RU2	Resistor	3.9kΩ	0.1W,50V,0.5%	MCR03EZPD3901	ROHM	1608
2	Tr1,Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
11	CSYNC,J2,R0,R6,R8,RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
13	C3,CCL,DI2,COUT2, DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	



■Bill of Materials (continued)

3. VO=12V 6A (VIN=16V/32V/36V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	180pF	50V, CH, ±5%	GRM1882C1H181JA01	MURATA	1608
1	C2	Ceramic Capacitor	0.022uF	50V, B1, ±10%	GRM155B11H223KA61	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, B, ±10%	GRM188B31E474KA75	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, X7R, ±10%	GRM32ER71H106KA12L	MURATA	3225
8	COUT1	Ceramic Capacitor	10uF	50V, X7R, ±10%	GRM32ER71H106KA12L	MURATA	3225
1	CREG10	Ceramic Capacitor	1.0uF	16V, B, ±10%	GRM188B31C105KA92	MURATA	1608
1	CREG5	Ceramic Capacitor	0.10uF	25V, B, ±10%	GRM155B31E104KA87D	MURATA	1005
2	CRTSS,CSS	Ceramic Capacitor	0.010uF	16V, B1, ±10%	GRM188B11C103KA01	MURATA	1608
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
2	DI1,DI2	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	6.8uH	±20%,22.0mΩ(max),Irms 9A	SRP1235-6R8	Bourns	13.9×13.5
1	R1	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R2	Resistor	2.2kΩ	0.1W,50V,1%	MCR03EZPFX2201	ROHM	1608
1	R5	Resistor	27kΩ	0.1W,50V,0.5%	MCR03EZPD2702	ROHM	1608
1	R7	Resistor	5.1kΩ	0.1W,50V,0.5%	MCR03EZPD5101	ROHM	1608
1	R8	Resistor	430Ω	0.1W,50V,0.5%	MCR03EZPD4300	ROHM	1608
3	RBST,RHG,RLG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RCL	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
1	RD1	Resistor	10kΩ	0.1W,50V,0.5%	MCR03EZPD1002	ROHM	1608
1	RS	Resistor	5mΩ	2W,1%	PMR100HZPFU5L00	ROHM	6432
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	RT	Resistor	39kΩ	0.1W,50V,0.5%	MCR03EZPD3902	ROHM	1608
1	RU1	Resistor	120kΩ	0.1W,50V,0.5%	MCR03EZPD1203	ROHM	1608
1	RU2	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
2	Tr1、Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
9	CSYNC,DI3,J2,R0,R6,RCLH,RCLL,RD2,RVCC					Short	
13	C3,CCL,COUT2,CSNB,J1,R3,R4,R9,RCLK,RD3,RD4,RSNB,RSYNC					Open	

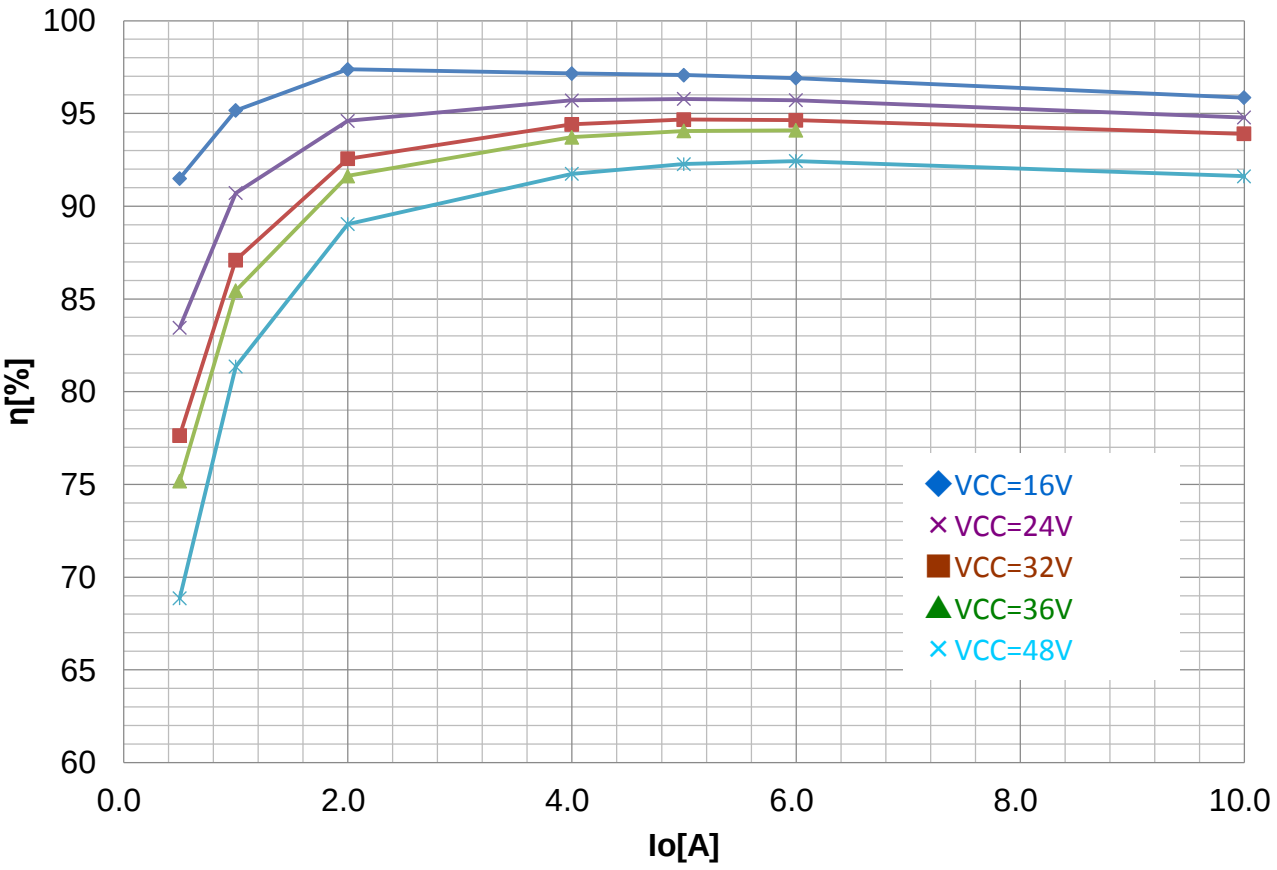


■Bill of Materials (continued)

4. VO=12V 10A(VIN=16V-48V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	100pF	50V, CH, ±5%	GRM1552C1H101JA01	MURATA	1005
1	C2	Ceramic Capacitor	4700pF	50V, B1, ±10%	GRM155B11H472KA01	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
1	COUT2	Ceramic Capacitor	220uF	50V	UVR1H221MPD1TD	nichicon	φ10
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.10uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS、CSS	Ceramic Capacitor	0.010uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
2	DI1, DI2	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	4.7uH	±20%,14mΩ(max),13A	CDEP1411NP-4R7MC-95	SUMIDA	14.9×14.9
1	R1	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R2	Resistor	5.1kΩ	0.1W,50V,1%	MCR03EZPFX5101	ROHM	1608
1	R5	Resistor	27kΩ	0.1W,50V,0.5%	MCR03EZPD2702	ROHM	1608

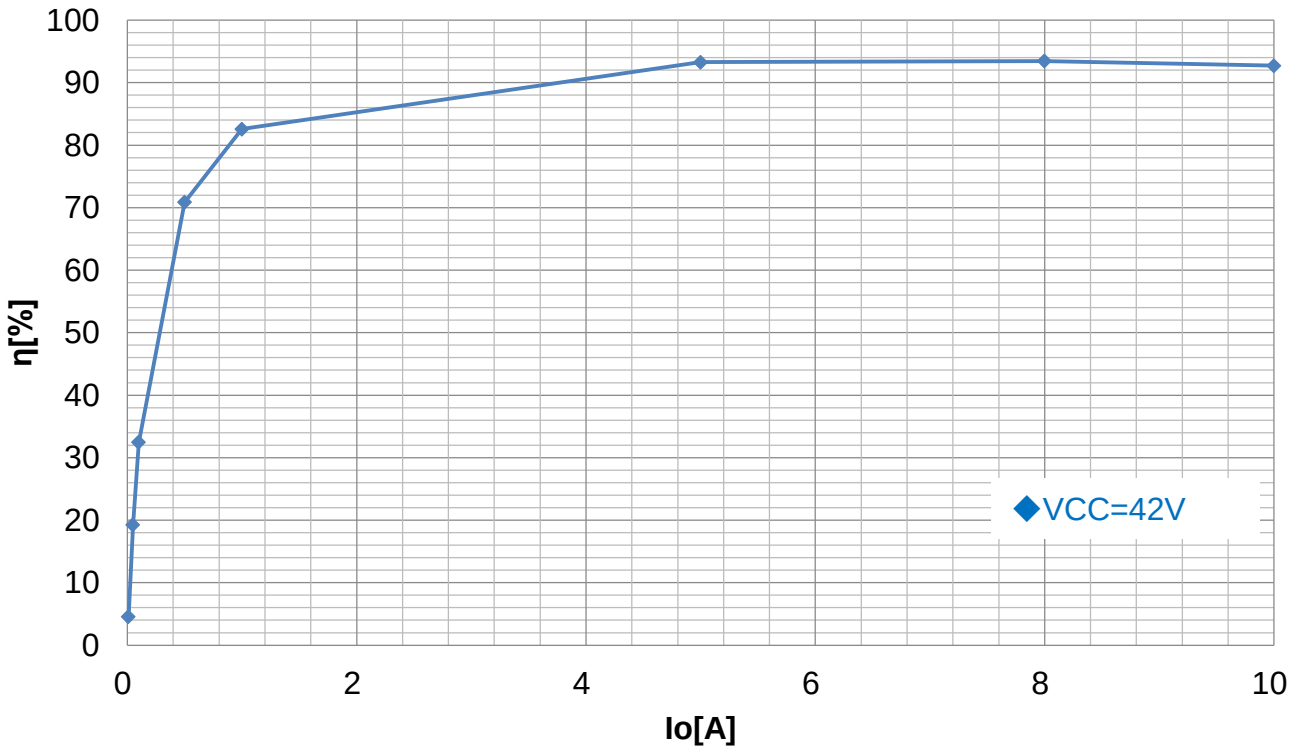
1	R7	Resistor	5.1kΩ	0.1W,50V,0.5%	MCR03EZPD5101	ROHM	1608
1	R8	Resistor	430Ω	0.1W,50V,0.5%	MCR03EZPD4300	ROHM	1608
1	RCL	Resistor	18kΩ	0.1W,50V,0.5%	MCR03EZPD1802	ROHM	1608
1	RD1	Resistor	10kΩ	0.1W,50V,0.5%	MCR03EZPD1002	ROHM	1608
1	RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RS	Resistor	5mΩ	2W,1%	PMR100HZPFU5L00	ROHM	6432
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPF22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	120kΩ	0.1W,50V,0.5%	MCR03EZPD1203	ROHM	1608
1	RU2	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
2	Tr1、Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
11	CSYNC,J2,R0, R6, R8,RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	C3,CCL,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	



■Bill of Materials (continued)

5. VO=18V 10A(VIN=42V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	100pF	50V, CH, ±5%	GRM1552C1H101JA01	MURATA	1005
1	C2	Ceramic Capacitor	4700pF	50V, B1, ±10%	GRM155B11H472KA01	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
1	COUT2	Ceramic Capacitor	220uF	50V	UVR1H221MPD1TD	nichicon	φ10
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.1uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS、CSS	Ceramic Capacitor	0.01uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Ｄｉｏｄｅ	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	6.8uH	±20%,14mΩ(max),11.5A	IHLP5050FDER6R8M01	VISHAY	13.2×12.9
1	R1	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R2	Resistor	5.1kΩ	0.1W,50V,1%	MCR03EZPFX5101	ROHM	1608
1	R5	Resistor	22kΩ	0.1W,50V,0.5%	MCR03EZPD2202	ROHM	1608
1	R6	Resistor	560Ω	0.1W,50V,0.5%	MCR03EZPD5600	ROHM	1608
1	R7	Resistor	3kΩ	0.1W,50V,0.5%	MCR03EZPD3001	ROHM	1608
1	RCL	Resistor	18kΩ	0.1W,50V,0.5%	MCR03EZPD1802	ROHM	1608
1	RD1	Resistor	10kΩ	0.1W,50V,0.5%	MCR03EZPD1002	ROHM	1608
1	RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RS	Resistor	5mΩ	2W,1%	PMR100HZPFU5L00	ROHM	6432
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPF22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	200kΩ	0.1W,50V,0.5%	MCR03EZPD2003	ROHM	1608
1	RU2	Resistor	15kΩ	0.1W,50V,0.5%	MCR03EZPD1502	ROHM	1608
2	Tr1、Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
10	CSYNC,J2,R0,R8,RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	C3,CCL,DI2,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	

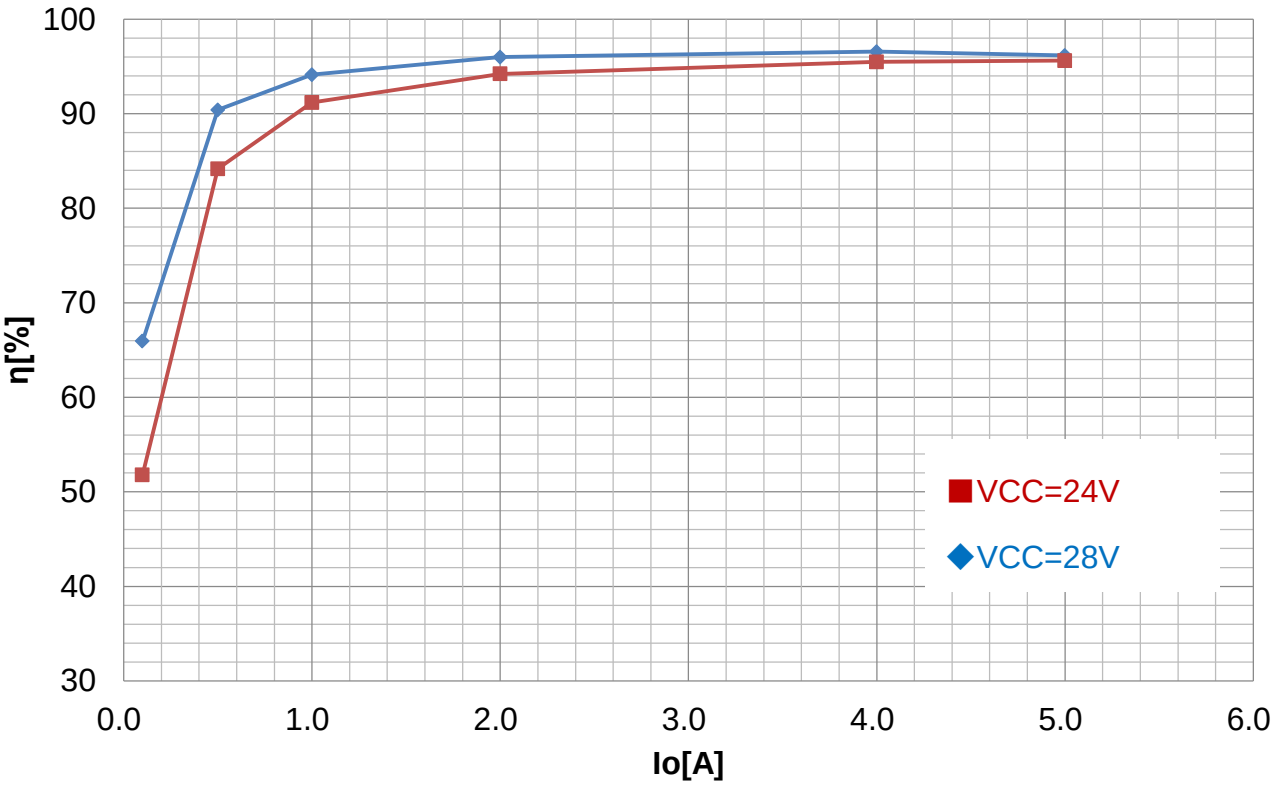


■Bill of Materials (continued)

6. VO=20V 5A (VIN=24V/28V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
2	C1,C3	Ceramic Capacitor	220pF	100V, CH, ±5%	GRM1882C2A221JA01	MURATA	1608
1	C2	Ceramic Capacitor	0.022uF	50V, B1, ±10%	GRM155B11H223KA61	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, B, ±10%	GRM188B31E474KA75	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, X7R, ±10%	GRM32ER71H106KA12L	MURATA	3225
8	COUT1	Ceramic Capacitor	10uF	50V, X7R, ±10%	GRM32ER71H106KA12L	MURATA	3225
1	CREG10	Ceramic Capacitor	1.0uF	16V, B, ±10%	GRM188B31C105KA92	MURATA	1608
1	CREG5	Ceramic Capacitor	0.10uF	25V, B, ±10%	GRM155B31E104KA87D	MURATA	1005
2	CRTSS, CSS	Ceramic Capacitor	0.010uF	16V, B1, ±10%	GRM188B11C103KA01	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	6.8uH	±20%,22.0mΩ(max),Irms 9A	SRP1235-6R8	Bourns	13.9×13.5
1	R1	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R2	Resistor	680Ω	0.1W,50V,1%	MCR03EZPFX6800	ROHM	1608

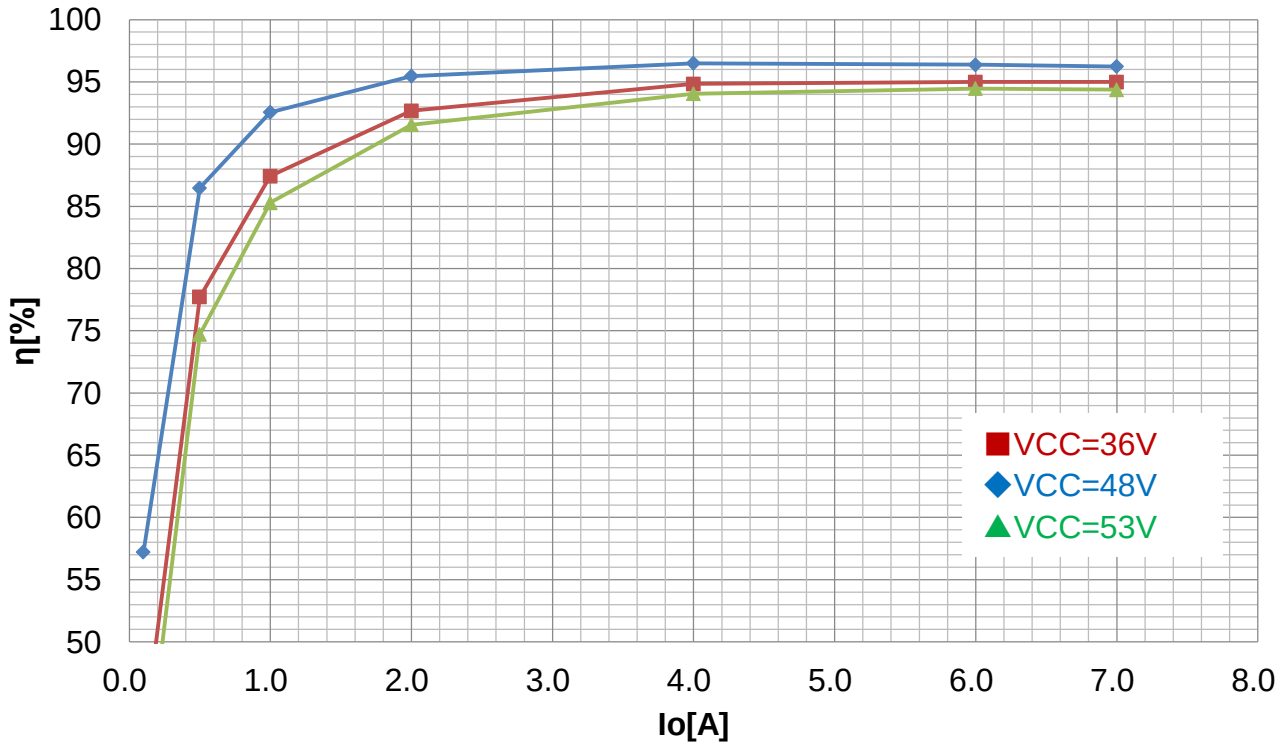
1	R5	Resistor	22kΩ	0.1W,50V,0.5%	MCR03EZPD2202	ROHM	1608
1	R6	Resistor	620Ω	0.1W,50V,0.5%	MCR03EZPD6200	ROHM	1608
1	R7	Resistor	3kΩ	0.1W,50V,0.5%	MCR03EZPD3001	ROHM	1608
2	RBST,RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RCL	Resistor	15kΩ	0.1W,50V,0.5%	MCR03EZPD1502	ROHM	1608
1	RD1	Resistor	7.5kΩ	0.1W,50V,0.5%	MCR03EZPD7501	ROHM	1608
1	RS	Resistor	10mΩ	1W,1%	PMR50HZPFU10L0	ROHM	5025
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPD22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	180kΩ	0.1W,50V,0.5%	MCR03EZPD1803	ROHM	1608
2	Tr1,Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
9	CSYNC,J2,R0,R8,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	CCL,DI2,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC,RU2					Open	



■Bill of Materials (continued)

7. VO=24V 7A (VIN=36V/48V/53V,fosc=250kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	180pF	50V, C0G, ±5%	GRM1885C1H181JA01D	MURATA	1608
1	C2	Ceramic Capacitor	0.033uF	50V, X7R, ±10%	GRM188R71H333KA01D	MURATA	1608
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
1	COUT2	Ceramic Capacitor	220uF	50V	UVR1H221MPD1TD	nichicon	ϕ10
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.10uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS, CSS	Ceramic Capacitor	0.010uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	R1	Resistor	1.5kΩ	0.1W,50V,1%	MCR03EZPFX1501	ROHM	1608
1	R2	Resistor	30kΩ	0.1W,50V,1%	MCR03EZPFX3002	ROHM	1608
1	R5	Resistor	43kΩ	0.1W,50V,0.5%	MCR03EZPD4302	ROHM	1608
1	R7	Resistor	4.3kΩ	0.1W,50V,0.5%	MCR03EZPD4301	ROHM	1608
1	R8	Resistor	330Ω	0.1W,50V,0.5%	MCR03EZPD3300	ROHM	1608
1	RCL	Resistor	20kΩ	0.1W,50V,0.5%	MCR03EZPD2002	ROHM	1608
1	RD1	Resistor	5.6kΩ	0.1W,50V,0.5%	MCR03EZPD5601	ROHM	1608
1	RHG	Resistor	10Ω	0.1W,50V,1%	MCR03EZPFX10R0	ROHM	1608
1	RS	Resistor	5mΩ	2W,1%	PMR100HZPFU5L00	ROHM	6432
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPD22R0	ROHM	1608
1	RT	Resistor	75kΩ	0.1W,50V,0.5%	MCR03EZPD7502	ROHM	1608
1	RU1	Resistor	160kΩ	0.1W,50V,0.5%	MCR03EZPD1603	ROHM	1608
1	RU2	Resistor	2.4kΩ	0.1W,50V,0.5%	MCR03EZPD2401	ROHM	1608
2	Tr1,Tr2	FET	60V/22A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
1	L1	Inductor	7.7uH	±20%,9.85mΩ(max),12.4A	CDEP147NP-7R7MC-95	Sumida	14.9×14.9
10	CSYNC,J2,R0,R6,RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	C3,CCL,DI2,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	

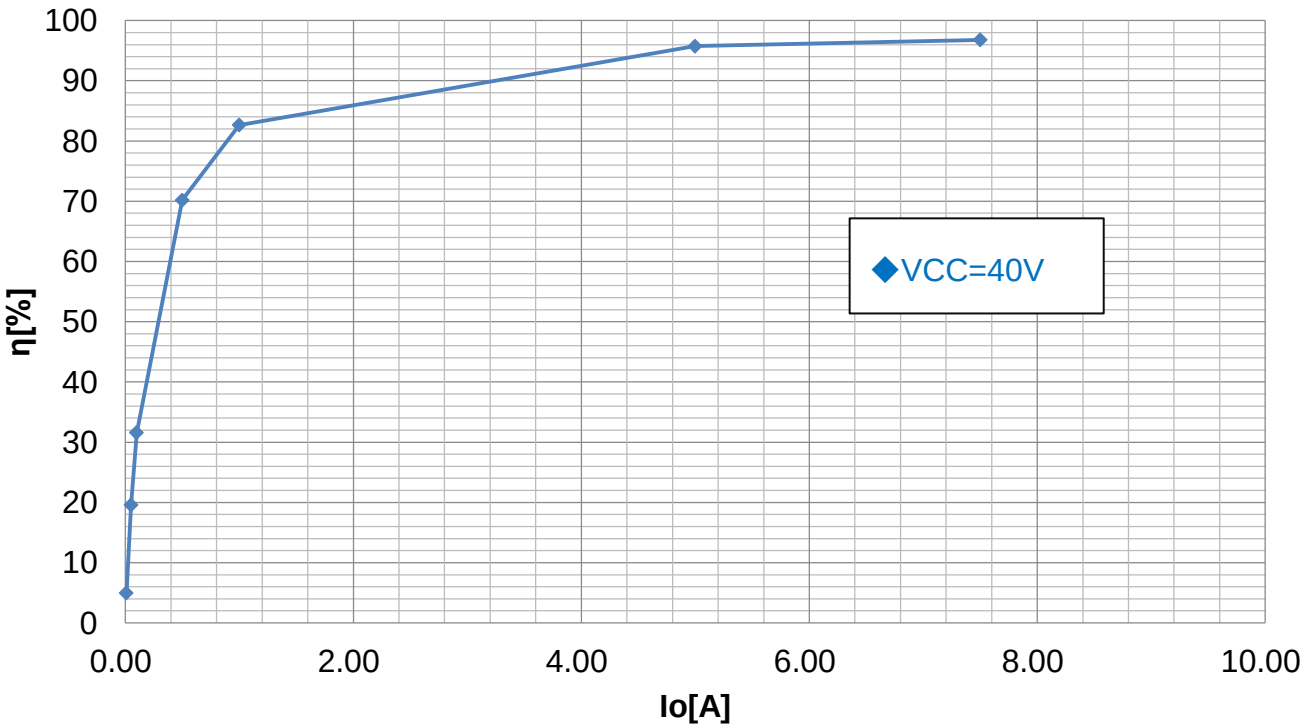


■Bill of Materials (continued)

8. VO=29.4V 7.5A (VIN=40,fosc=100kHz)

Count	Reference Designator	Type	Value	Description	Manufacturer Part Number	Manufacturer	Configuration (mm)
1	C1	Ceramic Capacitor	100pF	50V, CH, ±5%	GRM1552C1H101JA01	MURATA	1005
1	C2	Ceramic Capacitor	4700pF	50V, B1, ±10%	GRM155B11H472KA01	MURATA	1005
1	CBST	Ceramic Capacitor	0.47uF	25V, X7R, ±10%	GRM188R71E474KA12D	MURATA	1608
4	CIN	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
4	COUT1	Ceramic Capacitor	10uF	50V, B, ±10%	GRM32EB31H106KA12L	MURATA	3225
1	COUT2	Ceramic Capacitor	220uF	50V	UVR1H221MPD1TD	nichicon	φ10
1	CREG10	Ceramic Capacitor	1.0uF	16V, X7R, ±10%	GRM188R71C105KA01D	MURATA	1608
1	CREG5	Ceramic Capacitor	0.1uF	25V, X5R, ±10%	GRM155R61E104KA87D	MURATA	1005
2	CRTSS, CSS	Ceramic Capacitor	0.01uF	16V, X7R, ±10%	GRM188R71C103KA01D	MURATA	1608
1	CSNB※	Ceramic Capacitor	680pF	50V, CH, ±5%	GRM1552C1H681JA01	MURATA	1005
1	CVCC	Ceramic Capacitor	1.0uF	50V, B, ±10%	GRM21BB31H105KA12L	MURATA	2012
1	DI1	Diode	-	20V,1A	RB161VA-20	ROHM	2513
1	L1	Inductor	4.7uH	±20%,4.44mΩ(max), 13A	CDEP1411NP-4R7MC-95MC	SUMIDA	14.9×14.9
1	R1	Resistor	1kΩ	0.1W,50V,1%	MCR03EZPFX1001	ROHM	1608
1	R2	Resistor	5.1kΩ	0.1W,50V,1%	MCR03EZPFX5101	ROHM	1608
1	R5	Resistor	22kΩ	0.1W,50V,0.5%	MCR03EZPD2202	ROHM	1608

1	R6	Resistor	560Ω	0.1W,50V,0.5%	MCR03EZPD5600	ROHM	1608
1	R7	Resistor	3kΩ	0.1W,50V,0.5%	MCR03EZPD3001	ROHM	1608
1	RCL	Resistor	16kΩ	0.1W,50V,0.5%	MCR03EZPD1602	ROHM	1608
1	RD1	Resistor	11kΩ	0.1W,50V,0.5%	MCR03EZPD1101	ROHM	1608
1	RHG	Resistor	2.2Ω	0.1W,50V,1%	MCR03EZPFX2R20	ROHM	1608
1	RS	Resistor	5mΩ	2W,1%	PMR100HZPFU5L00	ROHM	6432
1	RSNB※	Resistor	22Ω	0.2W,50V,0.5%	ESR03EZPF22R0	ROHM	1608
1	RT	Resistor	200kΩ	0.1W,50V,0.5%	MCR03EZPD2003	ROHM	1608
1	RU1	Resistor	390kΩ	0.1W,50V,0.5%	MCR03EZPD3903	ROHM	1608
1	RU2	Resistor	3.3kΩ	0.1W,50V,0.5%	MCR03EZPD3301	ROHM	1608
1	Tr1	FET	60V/22 A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
3	Tr2	FET	60V/22 A	60V,26m Ω max, 22A, 20W	RSD221N06	ROHM	6595
1	U1	IC	-	Buck DC/DC Converter, QFN 16pin	BD9611MUV	ROHM	3030
10	CSYNC,J2,R0 ,R8, RBST,RCLH,RCLL,RD2,RLG,RVCC					Short	
12	C3,CCL,DI2,DI3,J1,R3,R4,R9,RCLK,RD3,RD4,RSYNC					Open	



■ Precautions for use

(1) This document provides the BOM for evaluation boards. Small parts can also be selected for resistor, capacitor, and coil.
(2) When miniaturizing a resistor, consider decrease in rated power and withstand voltage.
(3) When miniaturizing a ceramic capacitor, consider decrease in withstand voltage. In addition, the capacity may be decreased by DC bias characteristics, and the desired characteristics may not be obtained.
(4) If ceramic capacitor models differ even when they have the same capacity and withstand voltage, the capacity may be decreased by DC bias characteristics depending on the model, and desired characteristics may not be obtained. Be sure to check the DC bias characteristics.
(5) When miniaturizing a coil, consider increase in direct current resistance and decrease in rated current. An increase in DC resistance can cause a deterioration of power conversion efficiency. A decrease in rated current can saturate the coil when outputting a large current, which may deteriorate efficiency or make it impossible to obtain the desired output current.
(6) If there is a possibility that the output will short-circuit, use a coil with a rated current that is larger than the maximum IC output current. For example, even when up to 100 mA is actually used for an IC that can output 1 A, select a coil whose rated current is larger than 1 A. If a coil with a small rated current is used, it will be saturated by a large current in the event of output short-circuiting, resulting in a steep increase in output voltage. The IC may be broken down because the processing speed of the overcurrent protecting function of the IC cannot keep up with the increase in voltage.
(7) This circuit constant is the value for our evaluation board. It may be necessary to adjust the constant for the actual board. Carry out suitable evaluations.

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment (Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   [a] Installation of protection circuits or other protective devices to improve system safety
   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   [f] Sealing or coating our Products with resin or other coating materials
   [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   - [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   - [b] the temperature or humidity exceeds those recommended by ROHM
   - [c] the Products are exposed to direct sunshine or condensation
   - [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

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