MB39A112EVB-01

Power Supply Application Evaluation Board Datasheet

The MB39A112 evaluation board is a surface mount circuit board with 3 channels of down conversion circuit. This evaluation board outputs voltage of 1.2 V, 3.3 V and 5.0 V from the output terminals of 3 systems, and supplying a current of Max 1.5 A. More ever, when the under voltage lockout protection circuit do operation or the short-circuit protection is detected by the protection function, the FET is turned off and the output is stopped. In addition, each channel can be controlled to be turned on and off, and can be set for a soft-start.

Evaluation Board Specifications

(Ta = + 25 °C)

Parameter		Terminal	Value			Unit
			Min	Typ	Max	
Input voltage		VIN	7	12	20	V
Oscillation frequency		—	2115	2350	2585	kHz
Output voltage	CH1	VO1	1.14	1.2	1.26	V
	CH2	VO2	3.13	3.3	3.47	V
	CH3	VO3	4.75	5.0	5.25	V
Ripple voltage	CH1	VO1	6	12	24	mV
	CH2	VO2	16	33	64	mV
	CH3	VO3	25	50	100	mV
Output current	CH1	VO1	800	1200	1500	mA
	CH2	VO2	150	500	1000	mA
	CH3	VO3	150	200	300	mA
Soft-start time	CH1	—	6.3	10	18.6	ms
	CH2	—	7.8	12	22.8	ms
	CH3	—	7.8	12	22.8	ms
Short-circuit detection time		—	430	720	1420	µs

Contents

1. Terminal Description

Symbol	Description
VIN	Power supply terminal V_{IN} = 7 V to 25 V (Typ 12 V)
VOX	DC/DC converter output terminal
GND	GND terminal
GNDX	DC/DC converter GND terminal
ICGND	MB39A112 GND terminal

2. Switch Description

SW	Name	Function	OPEN	L
1	CS1	CH1 control	Output ON	Output OFF
2	CS2	CH2 control	Output ON	Output OFF
3	CS3	CH3 control	Output ON	Output OFF

3. Setup and Checkup

3.1 Setup

- Connect power-supply terminals side to the VIN and GND, and connect the VO side to required loading device or measuring instrument.
- Set SW1 to SW3 (CS1 to CS3) to OFF (output OFF) .

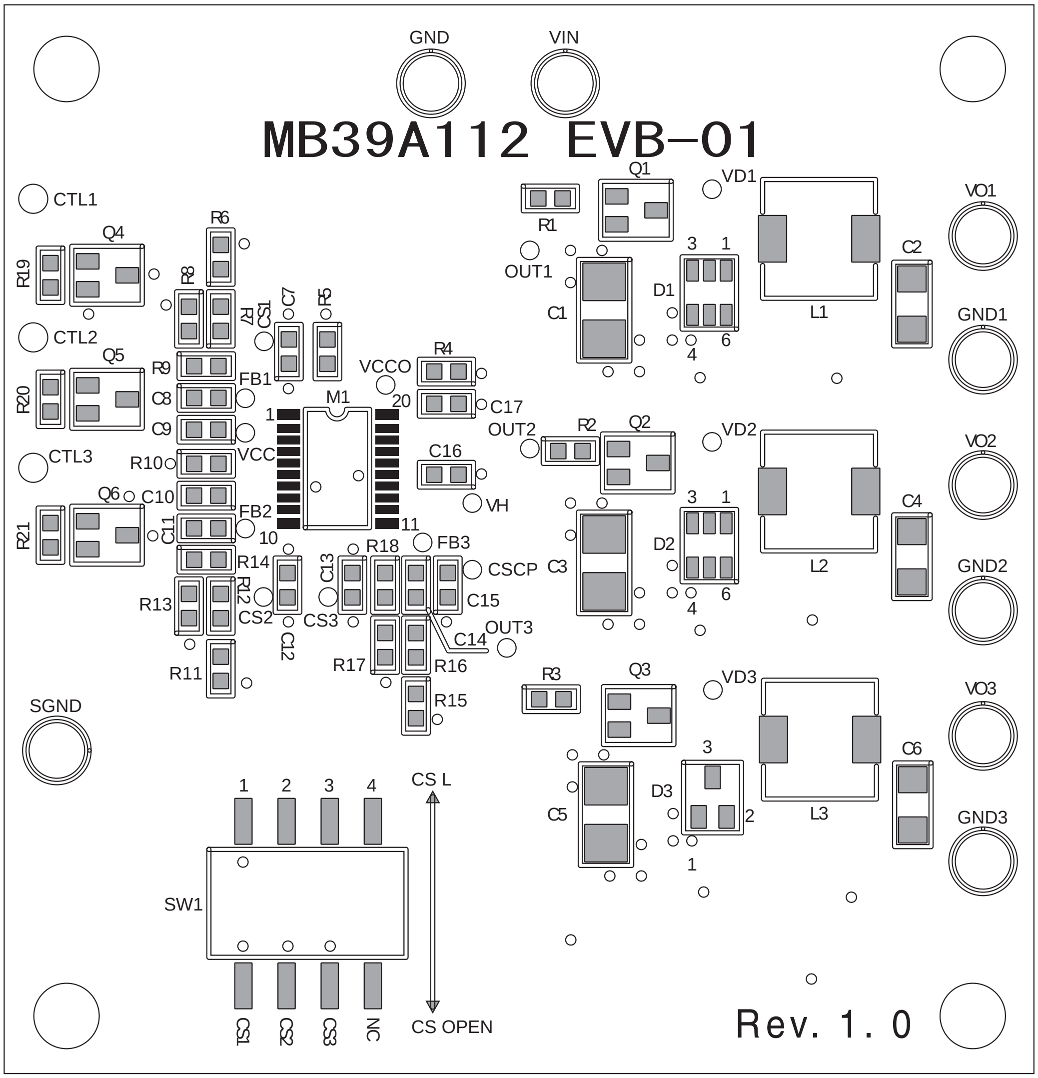
3.2 Checkup

- Turn on VIN (power supply) , set SW1 to SW3 to ON (output ON) .

  The IC works normally with the following outputs :
  $V_{O}1$ = 1.2 V (Typ) , $V_{O}2$ = 3.3 V (Typ) , $V_{O}3$ = 5 V (Typ)

4. Component Layout

■ On-board Component Layout



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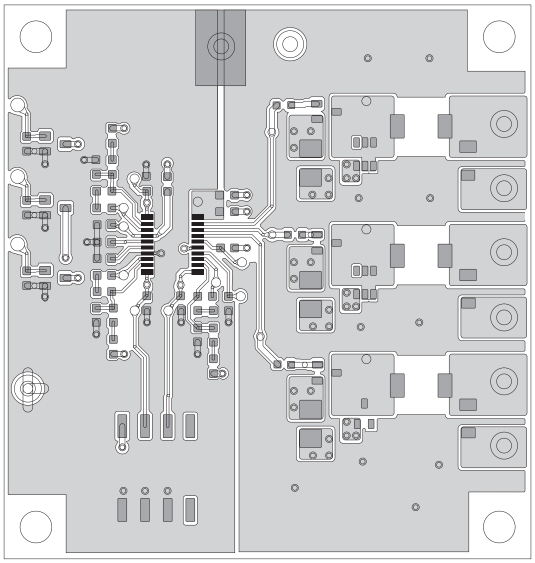
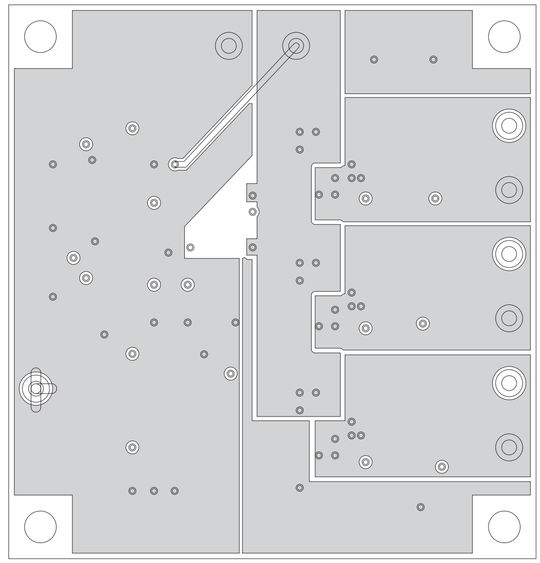
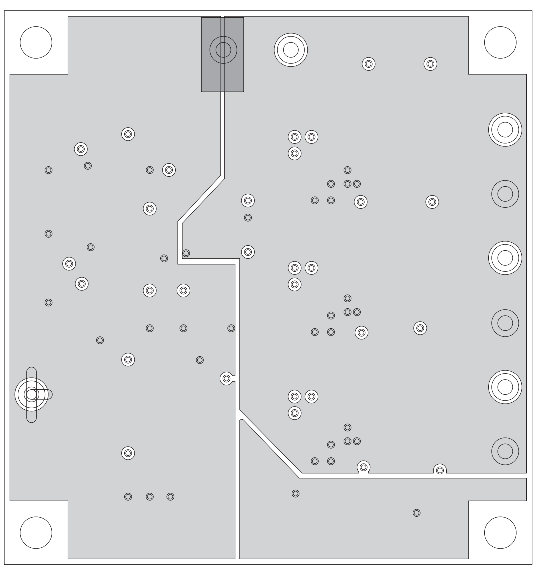
Board Layout



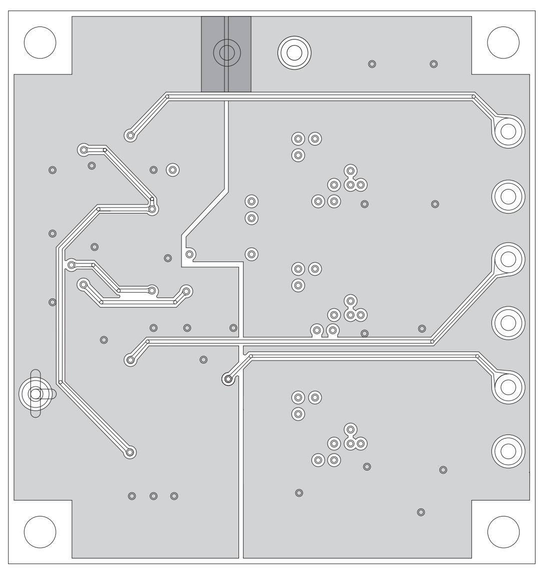
Top Side



Inside GND (Layer2)

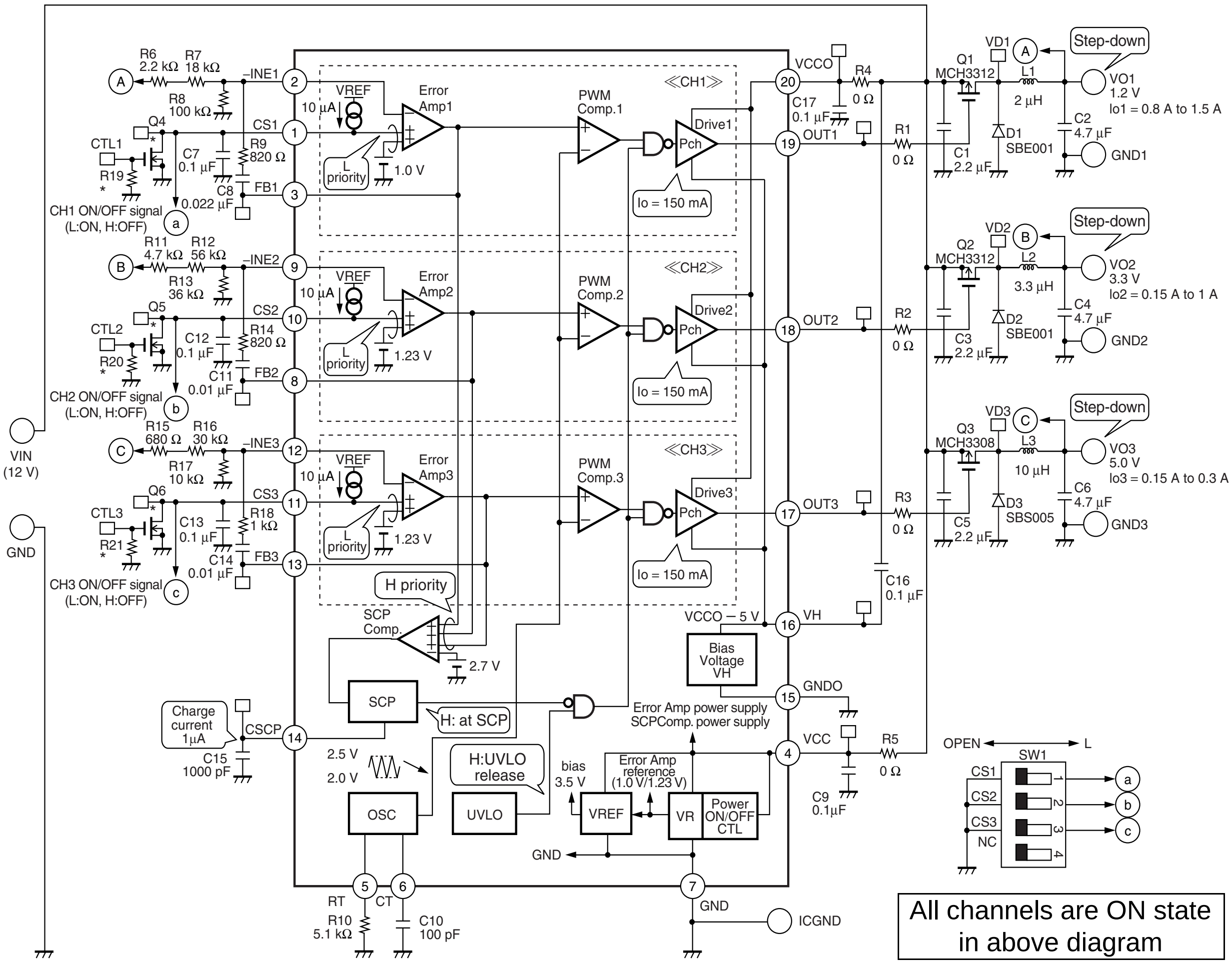


Inside VIN (Layer3)



Bottom Side

5. Connection Diagram



<20 Pin>

* : Not mounted

6. Parts List

No.	Symbol (Circuit diagram mark)	Part name	Model name	Specification						Package	Manu-facturer	Remarks
				Rating 1	Rating 2	Rating 3	Value	Devia-tion	Features			
1	M1	IC	MB39A 112PFT	—	—	—	—	—	—	FPT-20P-M06	Cypress	
2	Q1	Pch FET	MCH3312	PD = 1 W	VGSS = 20 V	ID = 2.0 A	—	—	—	MCPH3	SANYO	
3	Q2	Pch FET	MCH3312	PD = 1 W	VGSS = 20 V	ID = 2.0 A	—	—	—	MCPH3	SANYO	
4	Q3	Pch FET	MCH3308	PD = 0.8 W	VGSS = 20 V	ID = 1.0 A	—	—	—	MCPH3	SANYO	
5	Q4	Nch FET	—	—	—	—	—	—	—	—	—	Not mounted
6	Q5	Nch FET	—	—	—	—	—	—	—	—	—	Not mounted
7	Q6	Nch FET	—	—	—	—	—	—	—	—	—	Not mounted
8	D1	SBD	SBE001	IF(AV) = 2 A	VRRM = 30 V	—	—	—	—	CPH6	SANYO	
9	D2	SBD	SBE001	IF(AV) = 2 A	VRRM = 30 V	—	—	—	—	CPH6	SANYO	
10	D3	SBD	SBS005	IF(AV) = 1 A	VRRM = 30 V	—	—	—	—	CPH3	SANYO	
11	L1	Coil	A916CY-2R0M	IDC1= 3 A	IDC2 = 3.31 A	—	2 μ	±20%	RDC = 16 mΩ	—	TOKO	
12	L2	Coil	A916CY-3R3M	IDC1= 2.57 A	IDC2 = 2.81 A	—	3.3 μ	±20%	RDC = 21.4 mΩ	—	TOKO	
13	L3	Coil	A916CY-100M	IDC1= 1.49 A	IDC2 = 1.97 A	—	10 μ	±20%	RDC = 41.2 mΩ	—	TOKO	
14	C1	Ceramic condenser	C3216-JB1E225K	25 V	—	—	2.2 μ	±10%	Temperature characteristics B	3216	TDK	
15	C2	Ceramic condenser	C3216-JB1C475M	16 V	—	—	4.7 μ	±20%	Temperature characteristics B	3216	TDK	
16	C3	Ceramic condenser	C3216-JB1E225K	25 V	—	—	2.2 μ	±10%	Temperature characteristics B	3216	TDK	
17	C4	Ceramic condenser	C3216-JB1C475M	16 V	—	—	4.7 μ	±20%	Temperature characteristics B	3216	TDK	
18	C5	Ceramic condenser	C3216-JB1E225K	25 V	—	—	2.2 μ	±10%	Temperature characteristics B	3216	TDK	

No.	Symbol (Circuit diagram mark)	Part name	Model name	Specification						Package	Manu-facturer	Remarks
				Rating 1	Rating 2	Rating 3	Value	Devia-tion	Features			
19	C6	Ceramic condenser	C3216-JB1C475M	16 V	—	—	4.7 µ	±20%	Temperature characteristics B	3216	TDK	
20	C7	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
21	C8	Ceramic condenser	C1608-JB1H223K	50V	—	—	0.022 µ	±10%	Temperature characteristics B	1608	TDK	
22	C9	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
23	C10	Ceramic condenser	C1608CH1H101J	50V	—	—	100 p	±5%	Temperature characteristics CH	1608	TDK	
24	C11	Ceramic condenser	C1608-JB1H103K	50V	—	—	0.01 µ	±10%	Temperature characteristics B	1608	TDK	
25	C12	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
26	C13	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
27	C14	Ceramic condenser	C1608-JB1H103K	50V	—	—	0.01 µ	±10%	Temperature characteristics B	1608	TDK	
28	C15	Ceramic condenser	C1608-JB1H102K	50V	—	—	1000 p	±10%	Temperature characteristics B	1608	TDK	
29	C16	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
30	C17	Ceramic condenser	C1608-JB1H104K	50V	—	—	0.1 µ	±10%	Temperature characteristics B	1608	TDK	
31	R1	Jumper	RK73Z1J	1 A	—	—	0 Ω	Max 50 mΩ	—	1608	KOA	
32	R2	Jumper	RK73Z1J	1 A	—	—	0 Ω	Max 50 mΩ	—	1608	KOA	

No.	Symbol (Circuit diagram mark)	Part name	Model name	Specification						Package	Manu-facturer	Remarks
				Rating 1	Rating 2	Rating 3	Value	Devia-tion	Features			
33	R3	Jumper	RK73Z1J	1 A	—	—	0 Ω	Max 50 mΩ	—	1608	KOA	
34	R4	Jumper	RK73Z1J	1 A	—	—	0 Ω	Max 50 mΩ	—	1608	KOA	
35	R5	Jumper	RK73Z1J	1 A	—	—	0 Ω	Max 50 mΩ	—	1608	KOA	
36	R6	Resistor	PR0816P -222-D	1/16 W	—	—	2.2 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
37	R7	Resistor	PR0816P -183-D	1/16 W	—	—	18 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
38	R8	Resistor	PR0816P -104-D	1/16 W	—	—	100 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
39	R9	Resistor	PR0816P -821-D	1/16 W	—	—	820 Ω	±0.5 %	±25 ppm/ °C	1608	ssm	
40	R10	Resistor	PR0816P -512-D	1/16 W	—	—	5.1 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
41	R11	Resistor	PR0816P -472-D	1/16 W	—	—	4.7 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
42	R12	Resistor	PR0816P -563-D	1/16 W	—	—	56 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
43	R13	Resistor	PR0816P -363-D	1/16 W	—	—	36 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
44	R14	Resistor	PR0816P -821-D	1/16 W	—	—	820 Ω	±0.5 %	±25 ppm/ °C	1608	ssm	
45	R15	Resistor	PR0816P -681-D	1/16 W	—	—	680 Ω	±0.5 %	±25 ppm/ °C	1608	ssm	
46	R16	Resistor	PR0816P -303-D	1/16 W	—	—	30 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
47	R17	Resistor	PR0816P -103-D	1/16 W	—	—	10 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
48	R18	Resistor	PR0816P -102-D	1/16 W	—	—	1 kΩ	±0.5 %	±25 ppm/ °C	1608	ssm	
49	R19	Resistor	—	—	—	—	—	—	—	—	—	Not mounted
50	R20	Resistor	—	—	—	—	—	—	—	—	—	Not mounted
51	R21	Resistor	—	—	—	—	—	—	—	—	—	Not mounted
52	SW1	Switch	DMS-4H	—	—	—	—	—	—	—	MAT-SUKYU	

No.	Symbol (Circuit diagram mark)	Part name	Model name	Specification						Package	Manu-facturer	Remarks
				Rating 1	Rating 2	Rating 3	Value	Devia-tion	Features			
53	—	Terminal pin	WT-2-1	—	—	—	—	—	—	—	MacEight	

SANYO	SANYO Electric Co., Ltd.
TOKO	TOKO, Inc.
TDK	TDK Corporation
KOA	KOA Corporation
ssm	SUSUMU CO., LTD.
MATSUKYU	Matsukyu Co., Ltd.
MacEight	MacEight Co., Ltd.

7. Initial Settings

7.1 Output voltage

$$\text{CH1}: V_{O1}(V) = \frac{R6 + R7 + R8}{R8} \times 1.0 \cong 1.2\ V$$

$$\text{CH2}: V_{O2}(V) = \frac{R11 + R12 + R13}{R13} \times 1.23 \cong 3.3\ V$$

$$\text{CH3}: V_{O3}(V) = \frac{R15 + R16 + R17}{R17} \times 1.23 \cong 5\ V$$

7.2 Oscillation frequency

$$f_{OSC}(kHz) = \frac{1200000}{C10(pF) \times R10(k\Omega)} \cong 2350\ (kHz)$$

7.3 Soft-start time

$$\text{CH1}: ts1(s) = 1.0 \times C7(\mu F) \cong 10\ (ms)$$

$$\text{CH2}: ts2(s) = 0.123 \times C12(\mu F) \cong 12\ (ms)$$

$$\text{CH3}: ts3(s) = 0.123 \times C13(\mu F) \cong 12\ (ms)$$

7.4 Short-circuit detection time

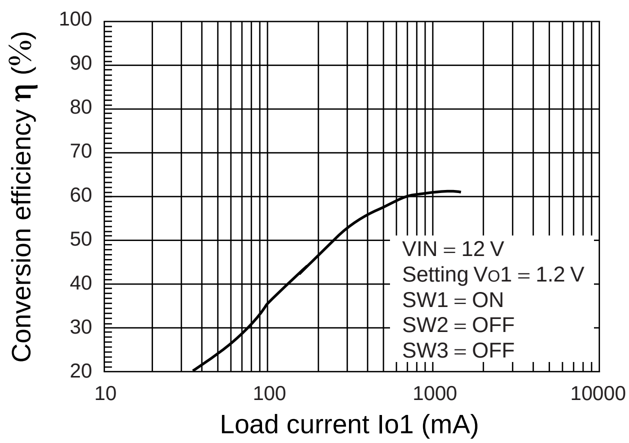
$$tscp(s) = 0.72 \times C15(\mu F) \cong 720\ (\mu s)$$

8. Reference Data

8.1 Conversion efficiency vs. Input voltage

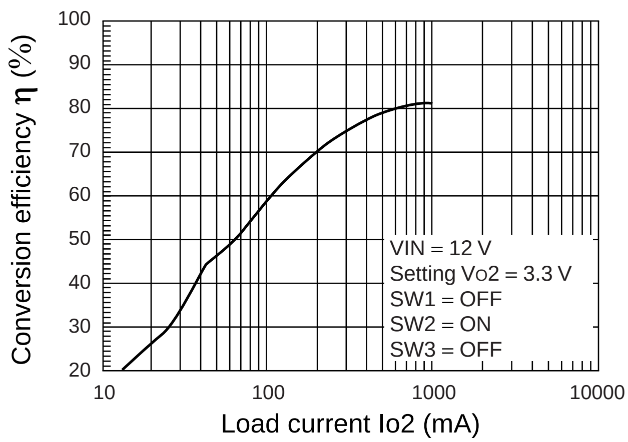
- CH1

Conversion Efficiency vs. Load Current (CH1)



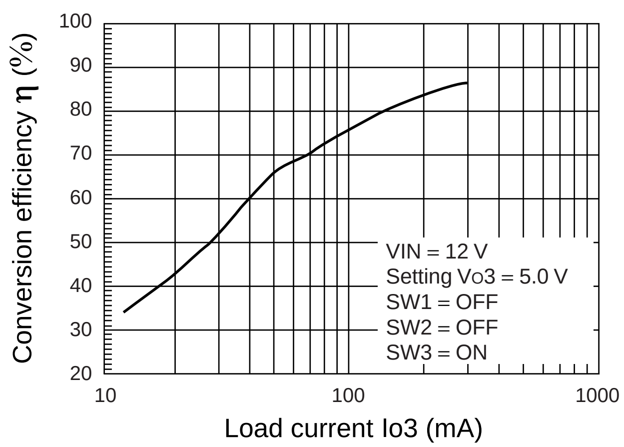
- CH2

Conversion Efficiency vs. Load Current (CH2)



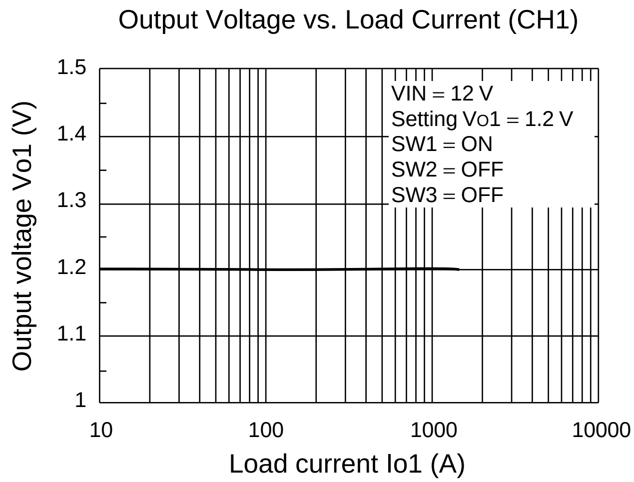
- CH3

Conversion Efficiency vs. Load Current (CH3)

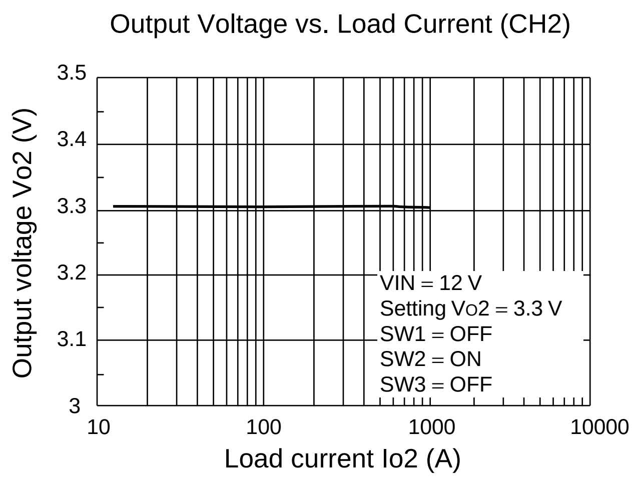


8.2 Load Reguration (V_{IN} = 12 V)

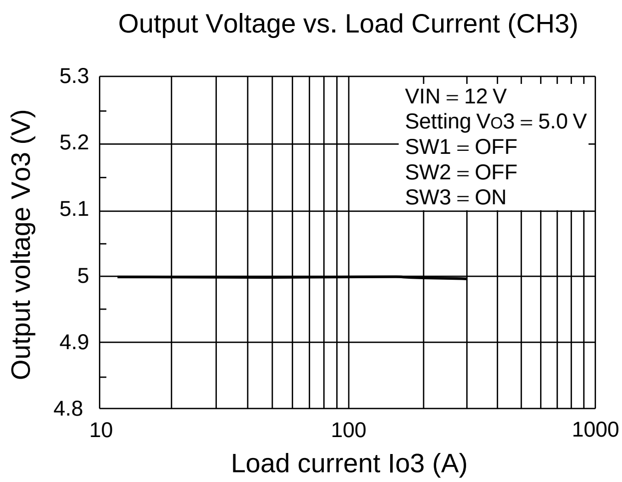
- CH1



- CH2

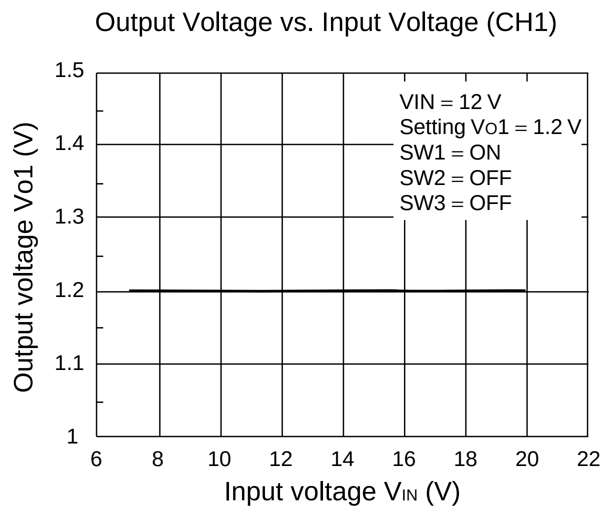


- CH3

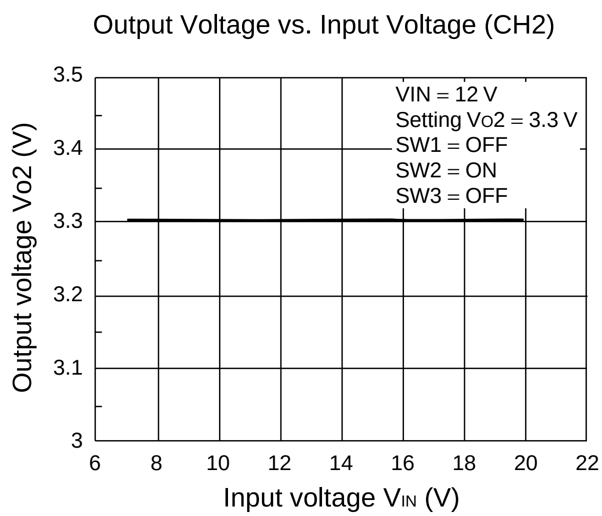


8.3 Line regulation

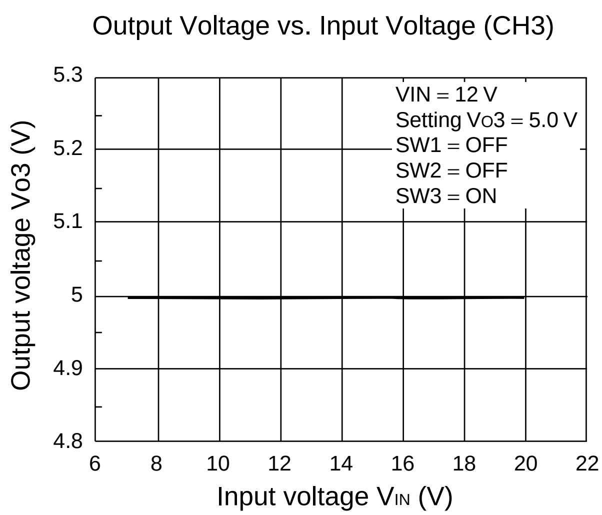
- CH1



- CH2

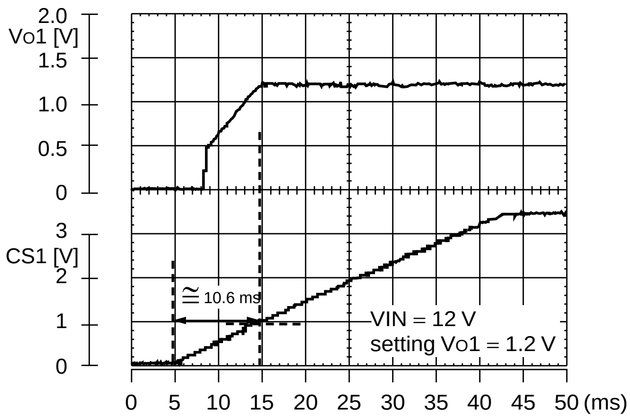


- CH3

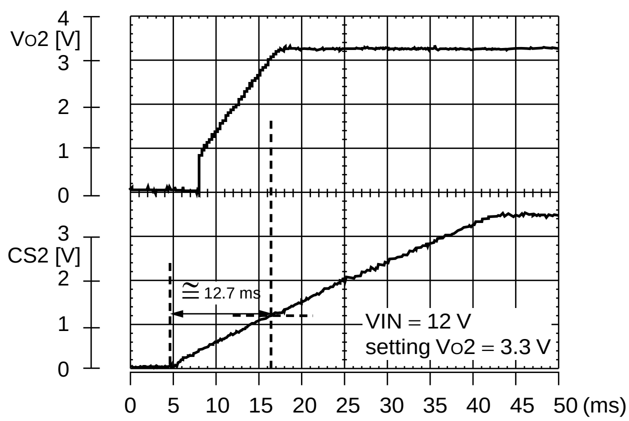


8.4 Soft-start operation waveforms

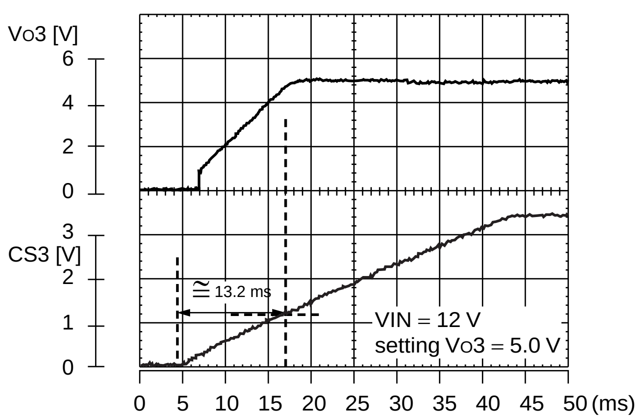
- CH1



- CH2

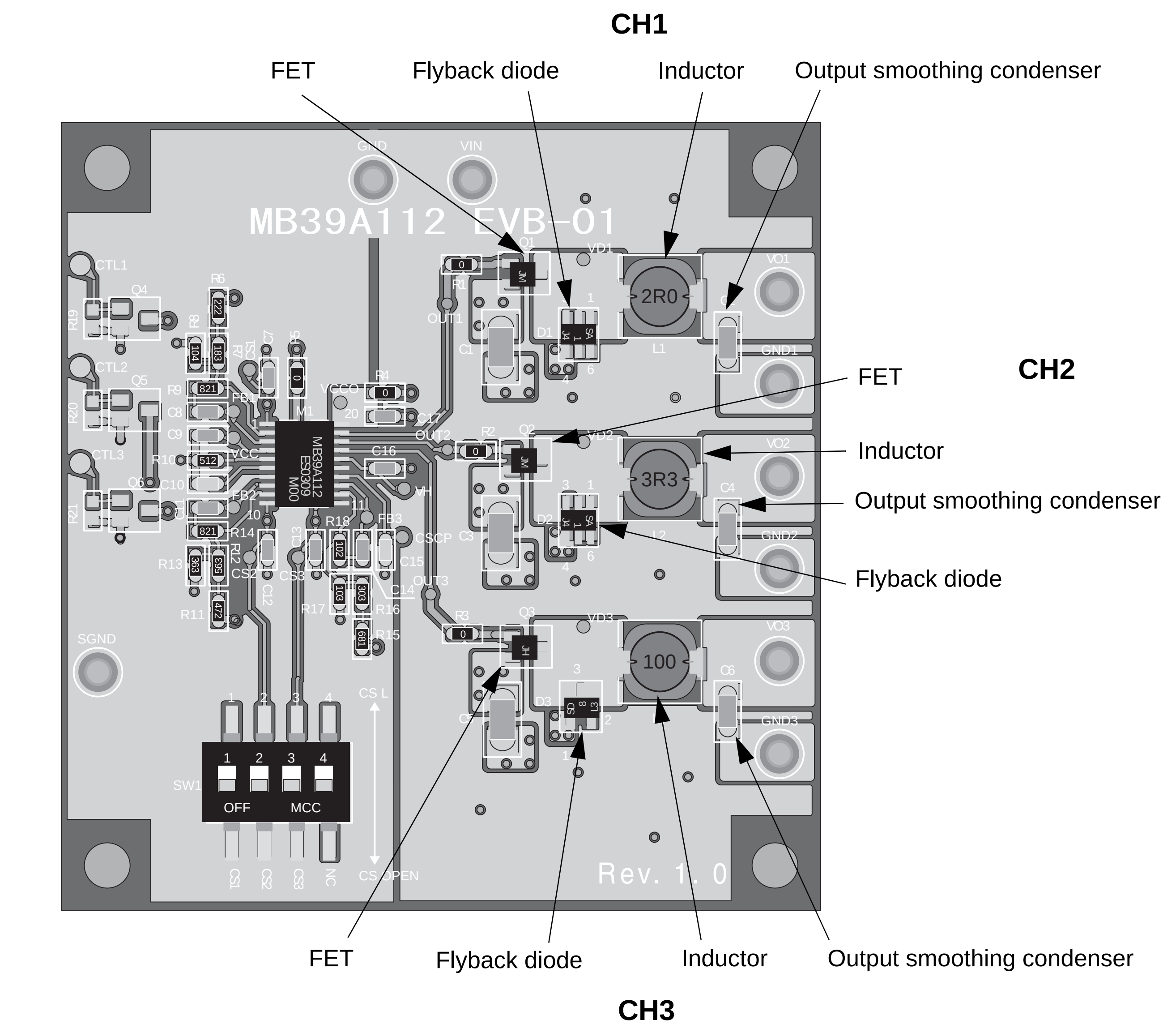


- CH3



9. Component Selection Methods

Figure 1. Board Photograph



9.1 CH1 1.2 V output

V_{IN} = 12 V (Typ) , Vo1 = 1.2 V, Io = 1.5 A, f_{OSC} = 2300 kHz

9.1.1 P-ch MOS FET (MCH3312 (SANYO product))

V_{DS} = –30 V, V_{GS} = ±20 V, I_D = –2 A, $R_{DS\,(ON)}$ = 205 mΩ (Typ) , Qg = 5.5 nC (Typ)

Drain current : Peak value

The peak drain current of this FET must be within its rated current.

If the FET's peak drain current is I_D, it is obtained by the following formula.

$$I_D \geq I_O + \frac{V_{IN} - Vo1}{2L} t_{ON}$$

$$\geq 1.5 + \frac{12 - 1.2}{2 \times 2 \times 10^{-6}} \times \frac{1}{2300 \times 10^{3}} \times 0.1$$

$$\geq \underline{1.62\ \text{A}}$$

9.1.2 Inductor (A916CY-2R0M : TOKO product)

2.0 µH (tolerance ±20%) , rated current = 3.0 A

The L value for all load current conditions

It is set so that the peak to peak value of the ripple current is 1/2 of the load current or less.

$$L \geq \frac{2\,(V_{IN} - Vo1)}{I_O} t_{ON}$$

$$\geq \frac{2 \times (12 - 1.2)}{1.5} \times \frac{1}{2300 \times 10^{3}} \times 0.1$$

$$\geq \underline{0.63\ \mu\text{H}}$$

The load current satisfying the continuous current condition

$$I_O \geq \frac{Vo1}{2L} t_{OFF}$$

$$\geq \frac{1.2}{2 \times 2.0 \times 10^{-6}} \times \frac{1}{2300 \times 10^{3}} \times (1 - 0.1)$$

$$\geq \underline{0.12\ \text{A}}$$

Ripple current : Peak value

The peak ripple current must be within the rated current of the inductor.

If the peak ripple current is I_L, it is obtained by the following formula.

$$I_L \geq I_O + \frac{V_{IN} - Vo1}{2L} t_{ON}$$

$$\geq 1.5 + \frac{12 - 1.2}{2 \times 2.0 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.1$$

$$\geq \underline{1.62\ A}$$

Ripple current : peak-to-peak value

If the peak-to-peak ripple current is ΔI_L, it is obtained by the following formula.

$$\Delta I_L = \frac{V_{IN} - Vo1}{L} t_{ON}$$

$$= \frac{12 - 1.2}{2.0 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.1$$

$$\cong \underline{0.23\ A}$$

9.1.3 Flyback diode (SBE001 : SANYO product)

V_R (DC reverse voltage) = 30 V, average output current = 2.0 A, peak surge current = 20 A

V_F (forward voltage) = 0.55 V, at I_F = 2.0 A

V_R : The value enough to satisfy the input voltage → 30 V

On time of the diode is assumed to be t_D (Max) , the diode mean current I_{Di} is obtained by the following formula.

$$I_{Di} \geq Io \times (1 - \frac{Vo1}{V_{IN}}) = 1.5 \times (1 - 0.1) \cong \underline{1.35\ A}$$

On time of the diode is assumed to be t_D (Max) , the diode peak current I_{Dip} is obtained by the following formula.

$$I_{Dip} \geq (Io + \frac{Vo1}{2L} t_{OFF}) \cong \underline{1.62\ A}$$

9.2 CH2 3.3 V output

V_{IN} = 12 V (Typ) , Vo2 = 3.3 V, Io = 1.0 A, f_{OSC} = 2300 kHz

9.2.1 P-ch MOS FET (MCH3312 (SANYO product))

V_{DS} = –30 V, V_{GS} = ±20 V, I_D = –2 A, $R_{DS\,(ON)}$ = 205 mΩ (Typ) , Qg = 5.5 nC (Typ)

Drain current : Peak value

The peak drain current of this FET must be within its rated current.

If the FET's peak drain current is I_D, it is obtained by the following formula.

$$I_D \geq I_O + \frac{V_{IN} - Vo2}{2L} t_{ON}$$

$$\geq 1.0 + \frac{12 - 3.3}{2 \times 3.3 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.275$$

$$\geq \underline{1.16\ A}$$

9.2.2 Inductor (A916CY-3R3M : TOKO product)

3.3 µH (tolerance ±20%) , rated current = 2.57 A

The L value for all load current conditions

It is set so that the peak to peak value of the ripple current is 1/2 of the load current or less.

$$L \geq \frac{2\,(V_{IN} - Vo2)}{I_O} t_{ON}$$

$$\geq \frac{2 \times (12 - 3.3)}{1.0} \times \frac{1}{2300 \times 10^3} \times 0.275$$

$$\geq \underline{2.08\ \mu H}$$

The load current satisfying the continuous current condition

$$I_O \geq \frac{Vo2}{2L} t_{OFF}$$

$$\geq \frac{3.3}{2 \times 3.3 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times (1 - 0.275)$$

$$\geq \underline{0.16\ A}$$

Ripple current : Peak value

The peak ripple current must be within the rated current of the inductor.

If the peak ripple current is I_L, it is obtained by the following formula.

$$I_L \geq I_O + \frac{V_{IN} - Vo2}{2L} t_{ON}$$

$$\geq 1.0 + \frac{12 - 3.3}{2 \times 3.3 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.275$$

$$\geq \underline{1.16\ A}$$

Ripple current : peak-to-peak value

If the peak-to-peak ripple current is ΔI_L, it is obtained by the following formula.

$$\Delta I_L = \frac{V_{IN} - Vo2}{L} t_{ON}$$

$$= \frac{12 - 3.3}{3.3 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.275$$

$$\cong \underline{0.315\ A}$$

9.2.3 Flyback diode (SBE001 : SANYO product)

V_R (DC reverse voltage) = 30 V, average output current = 2.0 A, peak surge current = 20 A

V_F (forward voltage) = 0.55 V, at I_F = 2.0 A

V_R : The value enough to satisfy the input voltage → 30 V

On time of the diode is assumed to be t_D (Max) , the diode mean current I_{Di} is obtained by the following formula.

$$I_{Di} \geq Io \times \left(1 - \frac{Vo2}{V_{IN}}\right) = 1.0 \times (1 - 0.275) \cong \underline{0.725\ A}$$

On time of the diode is assumed to be t_D (Max) , the diode peak current I_{Dip} is obtained by the following formula.

$$I_{Dip} \geq \left(Io + \frac{Vo2}{2L} t_{OFF}\right) \cong \underline{1.16\ A}$$

9.3 CH3 5 V output

V_{IN} = 12 V (Typ) , Vo3 = 5 V, Io = 0.3 A, f_{OSC} = 2300 kHz

9.3.1 P-ch MOS FET (MCH3308 (SANYO product))

V_{DS} = –30 V, V_{GS} = ±20 V, I_D = –1 A, $R_{DS\,(ON)}$ = 720 mΩ (Typ) , Qg = 2.6 nC (Typ)

Drain current : Peak value

The peak drain current of this FET must be within its rated current.

If the FET's peak drain current is I_D, it is obtained by the following formula.

$$I_D \geq I_O + \frac{V_{IN} - Vo3}{2L} t_{ON}$$

$$\geq 0.3 + \frac{12 - 5}{2 \times 10 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.417$$

$$\geq \underline{0.36\ A}$$

9.3.2 Inductor (A916CY-100M : TOKO product)

10 µH (tolerance ±20%) , rated current = 1.49 A

The L value for all load current conditions

It is set so that the peak to peak value of the ripple current is 1/2 of the load current or less.

$$L \geq \frac{2\,(V_{IN} - Vo3)}{I_O} t_{ON}$$

$$\geq \frac{2 \times (12 - 5)}{0.3} \times \frac{1}{2300 \times 10^3} \times 0.417$$

$$\geq \underline{8.46\ \mu H}$$

The load current satisfying the continuous current condition

$$I_O \geq \frac{Vo3}{2L} t_{OFF}$$

$$\geq \frac{5}{2 \times 10 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times (1 - 0.417)$$

$$\geq \underline{63.4\ mA}$$

Ripple current : Peak value

The peak ripple current must be within the rated current of the inductor.

If the peak ripple current is I_L, it is obtained by the following formula.

$$I_L \geq I_O + \frac{V_{IN} - Vo3}{2L} t_{ON}$$

$$\geq 0.3 + \frac{12 - 5}{2 \times 10 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.417$$

$$\geq \underline{0.36\ A}$$

Ripple current:Peak-to-peak value

If the peak-to-peak ripple current is ΔI_L, it is obtained by the following formula.

$$\Delta I_L = \frac{V_{IN} - Vo3}{L} t_{ON}$$

$$= \frac{12 - 5}{10 \times 10^{-6}} \times \frac{1}{2300 \times 10^3} \times 0.417$$

$$\cong \underline{0.127\ A}$$

9.3.3 Flyback diode (SBS005 : SANYO product)

V_R (DC reverse voltage) = 30 V, average output current = 1.0 A, peak surge current = 10 A

V_F (forward voltage) = 0.35 V, at I_F = 0.5 A

V_R : The value enough to satisfy the input voltage → 30 V

On time of the diode is assumed to be t_D (Max) , the diode mean current I_{Di} is obtained by the following formula.

$$I_{Di} \geq Io \times (1 - \frac{Vo3}{V_{IN}}) = 0.3 \times (1 - 0.417) \cong \underline{0.175\ A}$$

On time of the diode is assumed to be t_D (Max) , the diode peak current I_{Dip} is obtained by the following formula.

$$I_{Dip} \geq (Io + \frac{Vo2}{2L} t_{OFF}) \cong \underline{0.36\ A}$$

10. Ordering Information

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