XC9242/XC9243 Series

ETR05021-013

2A Synchronous Step-Down DC/DC Converters

☆Green Operation Compatible

■GENERAL DESCRIPTION

The XC9242/XC9243 series is a group of synchronous-rectification step-down DC/DC converters with a built-in 0.11Ω P-channel MOS driver transistor and 0.12Ω N-channel MOS switching transistor, designed to allow the use of ceramic capacitors. The small on-resistances of these two internal driver transistors enable a high efficiency, stable power supply with an output current up to 2A. The XC9242/XC9243 series has operating voltage range of 2.7V~6.0V and a 0.8V (±2.0%) reference voltage, and using externally connected resistors, the output voltage can be set freely from 0.9V. With an internal switching frequency of 1.2MHz or 2.4MHz, small external components can be used.

The XC9242 series is PWM control, and the XC9243 series is PWM/PFM, which automatically switches from PWM to PFM during light loads and provides high efficiency, high load response, low voltage ripple, can be achieved over a wide range of load conditions.

The integrated C_L discharge function which enables the electric charge at the output capacitor C_L to be discharged via the internal discharge switch located between the L_X and V_{SS} pins. Due to C_L discharge function, malfunction on L_X is prevented when Stand-by mode.

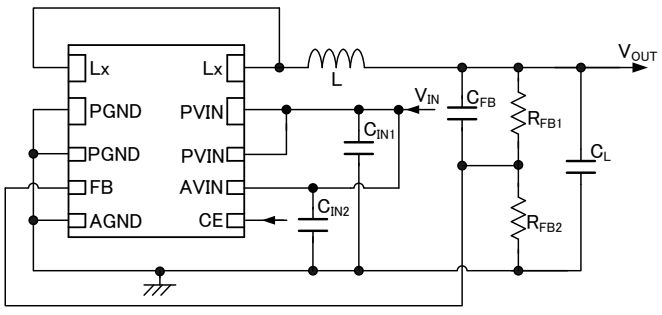
■APPLICATIONS

- Smart phones / Mobile phones
- Bluetooth
- Mobile devices / terminals
- Portable game consoles
- Digital still cameras / Camcorders

■FEATURES

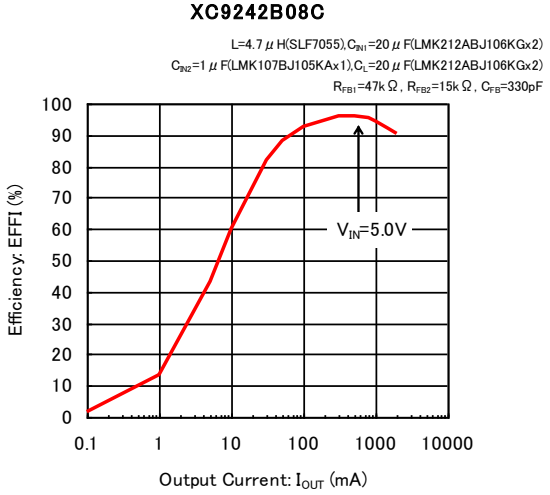
Driver Transistor	:	0.11Ω P-ch Driver Transistor 0.12Ω N-ch Switching Transistor
Input Voltage Range	:	2.7V ~ 6.0V
Output Voltage Setting	:	0.9V ~ V_{IN}
FB Voltage	:	0.8V ± 2.0%
High Efficiency	:	95%
Output Current	:	2.0A
Oscillation Frequency	:	1.2MHz±15%, 2.4MHz±15%
Maximum Duty Cycle	:	100%
Functions	:	Soft-Start C_L Discharge Current Limit Circuit (automatic return) Thermal Shutdown UVLO
Output Capacitor	:	Low ESR Ceramic Capacitor
Control Methods	:	PWM control (XC9242) PWM/PFM Auto (XC9243)
Operating Ambient Temperature	:	-40℃ ~ 85℃
Packages	:	USP-10B, SOP-8FD
Environmentally Friendly	:	EU RoHS Compliant, Pb Free

■TYPICAL APPLICATION CIRCUIT

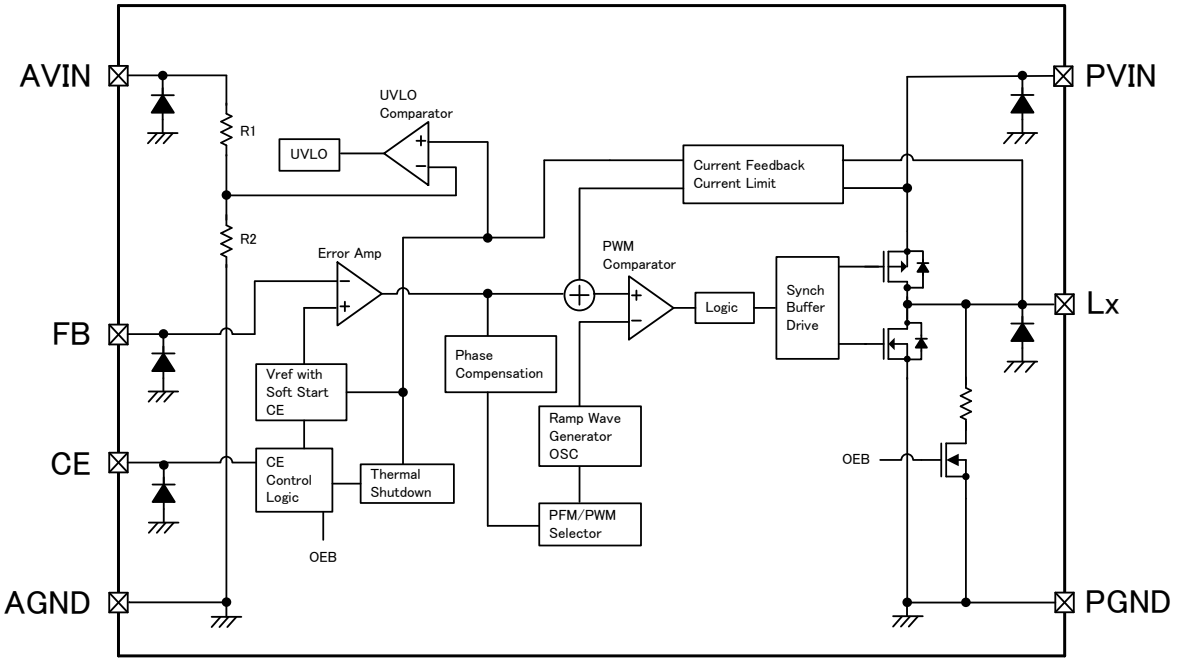


■TYPICAL PERFORMANCE CHARACTERISTICS

●Efficiency vs. Output Current (fosc=1.2MHz, V_{OUT}=3.3V)



■BLOCK DIAGRAM



* Diodes inside the circuits are ESD protection diodes and parasitic diodes.

■ PRODUCT CLASSIFICATION

●Ordering Information

XC9242①②③④⑤⑥-⑦(*1) Fixed PWM control

XC9243①②③④⑤⑥-⑦(*1) PWM / PFM automatic switching control

DESIGNATOR	ITEM	SYMBOL	DESCRIPTION
①	Functional Selection	B	C_L Discharge
②③	FB Voltage	08	0.8V
④	Oscillation Frequency	C	1.2MHz
		D	2.4MHz
⑤⑥-⑦(*1)	Package (Order Unit)	DR-G	USP-10B (3,000pcs/Reel)(*2)
		QR-G	SOP-8FD (1,000pcs/Reel)

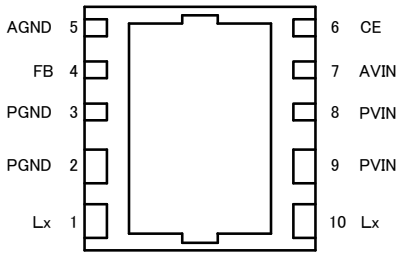
(*1) The “-G” suffix denotes Halogen and Antimony free as well as being fully EU RoHS compliant.

(*2) The USP-10B reels are shipped in a moisture-proof packing.

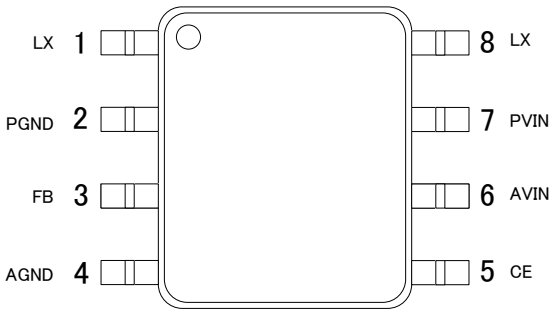
Selection Guide

TYPE	SOFT-START TIME	CHIP ENABLE	CURRENT LIMITER	THERMAL SHUTDOWN	UVLO	C_L AUTO-DISCHARGE
B	Fixed	Yes	Yes	Yes	Yes	Yes

■PIN CONFIGURATION



USP-10B
(BOTTOM VIEW)



SOP-8FD
(TOP VIEW)

USP-10B
* Please connect the power input pins (No.8 and No.9) and analog input pin (No.7) when operating.
* Please connect the two Lx pins (No.1 and 10).
* Please connect the power ground pins (No.2 and 3) and analog ground pin (No.5) when operating.
* It is recommended that the heat dissipation pad of the USP-10B package is soldered by using the reference mount pattern and metal mask pattern for mounting strength. The mount pattern should be electrically opened or connected to AGND pin (No.5) and PGND pin (No.2, and 3).

SOP-8FD
* Please connect the power input pin (No.7) and analog input pin (No.6) when operating.
* Please connect the two Lx pins (No.1 and 8).
* Please connect the two power ground pins (No.2 and 4).
* It is recommended that the heat dissipation pad of the SOP-8FD package is soldered by using the reference mount pattern and metal mask pattern for mounting strength. The mount pattern should be electrically opened or connected to AGND pin (No.6) and PGND pin (No.7).

■ PIN ASSIGNMENT

PIN NUMBER		PIN NAME	FUNCTIONS
USP-10B	SOP-8FD		
1,10	1,8	Lx	Switching Output
2,3	2	PGND	Power Ground
4	3	FB	Output Voltage Monitor
5	4	AGND	Analog Ground
6	5	CE	Chip Enable
7	6	AVIN	Analog Input
8,9	7	PVIN	Power Input

■ CE PIN FUNCTION

PIN NAME	SIGNAL	STATUS
CE	H	Active
	L	Stand-by

* Please do not leave the CE pin open.

■ ABSOLUTE MAXIMUM RATINGS

Ta=25℃

PARAMETER		SYMBOL	RATINGS	UNIT
PVIN Pin Voltage		V_{PVIN}	-0.3 ~ 7.0(*1)	V
AVIN Pin Voltage		V_{AVIN}		
CE Pin Voltage		V_{CE}	-0.3 ~ 7.0	V
FB Pin Voltage		V_{FB}	-0.3 ~ 7.0	V
Lx Pin Voltage		V_{Lx}	-0.3 ~ 7.0 or V_{PVIN} +0.3 (*2)	V
Lx Pin Current		I_{Lx}	±6.0 (*3)	A
Power Dissipation	USP-10B	Pd	150 (IC only)	mW
			1000 (40mm x 40mm standard board) (*4)	
	SOP-8FD		300 (IC only)	
			2500 (JESD51-7 board) (*4)	
Operating Ambient Temperature		Topr	-40 ~ 85	℃
Storage Temperature		T_{stg}	-55 ~ 125	℃

All voltages are described based on the ground voltage of AGND and PGND.

(*1) Please connect PVIN pin and AVIN pin for use.

(*2) The maximum value should be either 7.0V or V_{PVIN}+0.3V in the lowest.

(*3) It is measured when the two Lx pins (USP-10B No.1 and 10, SOP-8FD No.1 and 8) are tied up to each other.

(*4) The power dissipation figure shown is PCB mounted and is for reference only.
Please refer to PACKAGING INFORMATION for the mounting condition.

■ ELECTRICAL CHARACTERISTICS

●XC9242/XC9243, f_{OSC}=1.2MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP.	MAX.	UNIT	CIRCUIT
FB Voltage	V_{FB}	V_{IN}= 5.0V, V_{CE} =5.0V Voltage to start oscillation while V_{FB}=0.72V → 0.88V	0.784	0.800	0.816	V	③
Operating Voltage Range	V_{IN}	When connected to external components	2.7	-	6.0	V	①
Maximum Output Current	I_{OUTMAX}	V_{IN}=V_{CE}=5.0V (*1,*2) When connected to external components	2.0	-	-	A	①
UVLO Voltage	V_{UVLO}	V_{CE}=5.0V, V_{FB}=0.72V Voltage which Lx pin holding "L" level (*3)	2.00	-	2.68	V	③
Quiescent Current	I_q	V_{IN}=V_{CE}=5.0V, V_{FB}=0.88V	-	41	78	μA	②
Stand-by Current	I_{STB}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.88V	-	0.01	1.00	μA	②
Oscillation Frequency	f_{OSC}	V_{IN}=V_{CE}=5.0V, I_{OUT}=300mA When connected to external components	1020	1200	1380	kHz	①
PFM Switch Current (*4)	I_{PFM}	V_{IN}=V_{CE}=4.0V, I_{OUT}=1mA When connected to external components	-	280	-	mA	①
PFM Duty Limit (*4)	DTY_{LIMIT_PFM}	V_{IN}=V_{CE}=2.7V, I_{OUT}=1mA When connected to external components	-	180	250	%	①
Maximum Duty Limit	D_{MAX}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.72V	100	-	-	%	③
Minimum Duty Limit	D_{MIN}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.88V	-	-	0	%	③
Efficiency	EFFI	V_{IN}=V_{CE}=5.0V, I_{OUT}=500mA (*5) R_{FB1}=47kΩ, R_{FB2}=15kΩ, C_{FB}=330pF	-	95	-	%	①
LXSW"H"ON Resistance	R_{LxH}	V_{IN}=V_{CE}=4.0V, V_{FB}=0.72V (*6)	-	0.11	0.21	Ω	④
LXSW"L"ON Resistance	R_{LxL}		-	0.12	0.30(*7)	Ω	-
LXSW"H" Leakage Current	I_{LeakH}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.88V, V_{Lx}=0V	-	0.01	1.00(*8)	μA	⑤
Current Limit	I_{LIM}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.72V (*9)	-	4.0	-	A	④
Output Voltage Temperature Characteristics	ΔV_{OUT}/(V_{OUT}・Δtopr)	I_{OUT}=100mA -40℃≦Topr≦85℃ When connected to external components	-	±100	-	ppm/℃	①
CE"H" Voltage	V_{CEH}	V_{IN}=5.0V, V_{FB}=0.72V Applied voltage to V_{CE} Voltage changes Lx to "H" level	1.2	-	V_{IN}	V	③
CE"L" Voltage	V_{CEL}	V_{IN}=5.0V, V_{FB}=0.72V Applied to V_{CE} Voltage changes Lx to "L" level	AGND	-	0.4	V	③
CE"H" Current	I_{CEH}	V_{IN}=5.0V, V_{CE}=5.0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
CE"L" Current	I_{CEL}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
FB"H" Current	I_{FBH}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=5.0V	-0.1	-	0.1	μA	⑤
FB"L" Current	I_{FBL}	VI_N=5.0V, V_{CE}=0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
Soft-Start Time	t_{SS}	V_{IN}=5.0V, V_{CE}=0V→5.0V, I_{OUT}=1mA When connected to external components	0.3	1.0	2.0	ms	①
Thermal Shutdown Temperature	T_{TSD}		-	150	-	℃	-
Hysteresis Width	T_{HYS}		-	20	-	℃	-
C_L Discharge	R_{DCHG}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.72V, V_{Lx}=1.0V	80	130	160	Ω	⑥

NOTE:

External Components: C_{IN1}=20μF(ceramic), C_{IN2}=1μF(ceramic), L=4.7μH(SLF7055T-4R7 TDK), C_L=20μF(ceramic)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

Condition: Unless otherwise stated, "H"=V_{IN} ~ V_{IN} - 1.2V, "L"=+ 0.1V ~ -0.1V

(*1) Mount conditions affect heat dissipation. Maximum output current is not guaranteed when T_{TSD} starts to operate earlier.

(*2) When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.

(*3) These values include UVLO detect voltage, UVLO release voltage and hysteresis operating voltage range. UVLO release voltage is defined as the V_{IN} voltage which makes Lx pin "H".

(*4) XC9242 series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control's functions.

(*5) EFFI = { (output voltage × output current) ／ (input voltage × input current) } × 100

(*6) On resistance = (V_{IN} – Lx pin measurement voltage) / 100mA

(*7) Design value

(*8) When temperature is high, a current of approximately 20μA (maximum) may leak.

(*9) Current limit denotes the level of detection at peak of coil current.

■ ELECTRICAL CHARACTERISTICS (Continued)

●XC9242/XC9243, f_{OSC}=2.4MHz, Ta=25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
FB Voltage	V_{FB}	V_{IN}= V_{CE} =5.0V Voltage to start oscillation while V_{FB}=0.72V → 0.88V	0.784	0.800	0.816	V	③
Operating Voltage Range	V_{IN}	When connected to external components	2.7	-	6.0	V	①
Maximum Output Current	I_{OUTMAX}	V_{IN}=V_{CE}=5.0V (*1,*2) When connected to external components	2.0	-	-	A	①
UVLO Voltage	V_{UVLO}	V_{CE}=5.0V, V_{FB}=0.72V Voltage which Lx pin holding "L" level(*3)	2.00	-	2.68	V	③
Quiescent Current	I_q	V_{IN}=V_{CE}=5.0V, V_{FB}=0.88V	-	53	92	μA	②
Stand-by Current	I_{STB}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.88V	-	0.01	1.00	μA	②
Oscillation Frequency	f_{OSC}	V_{IN}=V_{CE}=5.0V, I_{OUT}=1000mA When connected to external components	2040	2400	2760	kHz	①
PFM Switch Current (*4)	I_{PFM}	V_{IN}=V_{CE}=6.0V, I_{OUT}=1mA When connected to external components	-	680	-	mA	①
PFM Duty Limit (*4)	DTY_{LIMIT_PFM}	V_{IN}=V_{CE}=2.7V, I_{OUT}=1mA When connected to external components	-	180	250	%	①
Maximum Duty Limit	D_{MAX}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.72V	100	-	-	%	③
Minimum Duty Limit	D_{MIN}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.88V	-	-	0	%	③
Efficiency	EFFI	V_{IN}=V_{CE}=5.0V, I_{OUT}=500mA (*5) R_{FB1}=47kΩ, R_{FB2}=15kΩ, C_{FB}=330pF	-	95	-	%	①
LXSW"H"ON Resistance	R_{LXH}	V_{IN}=V_{CE}=4.0V, V_{FB}=0.72V (*6)	-	0.11	0.21	Ω	④
LXSW"L"ON Resistance	R_{LXL}		-	0.12	0.30(*7)	Ω	-
LXSW"H" Leakage Current	I_{LeakH}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.88V, V_{LX}=0V	-	0.01	1.00(*8)	μA	⑤
Current Limit	I_{LIM}	V_{IN}=V_{CE}=5.0V, V_{FB}=0.72V (*9)	-	4.0	-	A	④
Output Voltage Temperature Characteristics	ΔV_{OUT}/(V_{OUT}・Δtopr)	I_{OUT}=100mA -40℃≦Topr≦85℃ When connected to external components	-	±100	-	ppm/℃	①
CE"H" Voltage	V_{CEH}	V_{IN}=5.0V, V_{FB}=0.72V Applied voltage to V_{CE} Voltage changes Lx to "H" level	1.2	-	V_{IN}	V	③
CE"L" Voltage	V_{CEL}	V_{IN}=5.0V, V_{FB}=0.72V Applied voltage to V_{CE} Voltage changes Lx to "L" level	AGND	-	0.4	V	③
CE"H" Current	I_{CEH}	V_{IN}=5.0V, V_{CE}=5.0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
CE"L" Current	I_{CEL}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
FB"H" Current	I_{FBH}	V_{IN}=5.0V,V_{CE}=0V, V_{FB}=5.0V	-0.1	-	0.1	μA	⑤
FB"L" Current	I_{FBL}	VI_N=5.0V,V_{CE}=0V, V_{FB}=0V	-0.1	-	0.1	μA	⑤
Soft-Start Time	t_{SS}	V_{IN}=5.0V, V_{CE}=0V→5.0V, I_{OUT}=1mA When connected to external components	0.3	1.0	2.0	ms	①
Thermal Shutdown Temperature	T_{TSD}		-	150	-	℃	-
Hysteresis Width	T_{HYS}		-	20	-	℃	-
C_L Discharge	R_{DCHG}	V_{IN}=5.0V, V_{CE}=0V, V_{FB}=0.72V, V_{LX}=1.0V	80	130	160	Ω	⑥

NOTE:

External Components: C_{IN1}=20μF(ceramic), C_{IN2}=1μF(ceramic), L=2.2μH(SLF7055T-2R2 TDK), C_L=20μF(ceramic)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

Condition: Unless otherwise stated, "H"= V_{IN} ~ VI_N - 1.2V, "L"= + 0.1V ~ -0.1V

(*1) Mount conditions affect heat dissipation. Maximum output current is not guaranteed when T_{TSD} starts to operate earlier.

(*2) When the difference between the input and the output is small, some cycles may be skipped completely before current maximizes. If current is further pulled from this state, output voltage will decrease because of P-ch driver ON resistance.

(*3) These values include UVLO detect voltage, UVLO release voltage and hysteresis operating voltage range. UVLO release voltage is defined as the V_{IN} voltage which makes Lx pin "H".

(*4) XC9242 series exclude I_{PFM} and DTY_{LIMIT_PFM} because those are only for the PFM control's functions.

(*5) EFFI = { (output voltage × output current) ／ (input voltage × input current) } × 100

(*6) On resistance = (V_{IN} – Lx pin measurement voltage) / 100mA

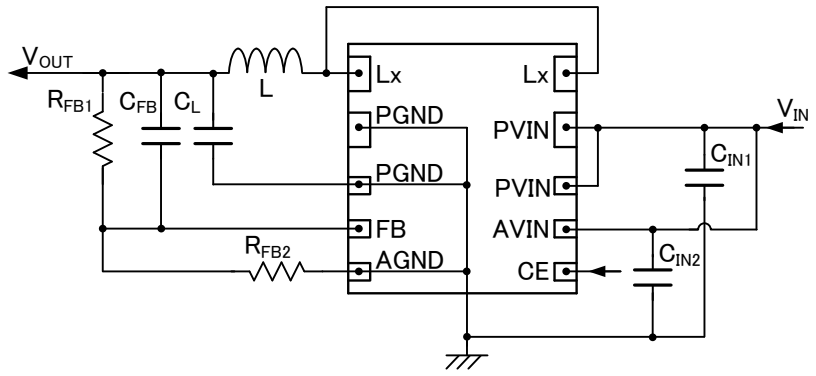
(*7) Design value

(*8) When temperature is high, a current of approximately 20μA (maximum) may leak.

(*9) Current limit denotes the level of detection at peak of coil current.

■TYPICAL APPLICATION CIRCUIT

●XC9242/XC9243 Series



External Components

	1.2MHz		2.4MHz
L:	4.7μH(SLF7055T-4R7)	L:	2.2μH(SLF7055T-2R2)
	4.7μH(SPM6530T-4R7)		2.2μH(SPM6530T-2R2)
C_{IN1}:	20μF (LMK212ABJ106KG 10V/10μF x2)	C_{IN1}:	20μF (LMK212ABJ106KG 10V/10μF x2)
C_{IN2}	1μF (LMK107BJ105KA 10V/1μF x1)	C_{IN2}	1μF (LMK107BJ105KA 10V/1μF x1)
C_L:	20μF (LMK212ABJ106KG 10V/10μF x2)	C_L:	20μF (LMK212ABJ106KG 10V/10μF x2)

<Output Voltage Setting>

Output voltage can be set by adding external split resistors. Output voltage is determined by the following equation, based on the values of RFB1 and RFB2. The sum of RFB1 and RFB2 should normally be 100kΩ or less. Output voltage range is 0.9V~5.5V by a 0.8V (±2.0%) reference voltage. When input voltage (V_{IN}) ≦setting output voltage, output voltage (V_{OUT}) can not output the power more than input voltage (V_{IN}).

$$VOUT = 0.8 \times (RFB1 + RFB2) / RFB2$$

The value of C_{FB}, speed-up capacitor for phase compensation, should be $f_{ZFB} = 1 / (2 \times \pi \times CFB \times RFB1)$ which is equal to 10kHz. Adjustments are required from 1kHz to 10kHz depending on the application, value of inductance (L), and value of load capacitance (C_L).

[Example of calculation]

When R_{FB1}=47kΩ, R_{FB2}=15kΩ, $V_{OUT} = 0.8 \times (47k\Omega + 15k\Omega) / 15k\Omega = 3.3V$

When C_{FB}=330pF, $fzfb = 1/(2 \times \pi \times 330pF \times 47\ k\Omega) = 10.26kHz$

V_{OUT} (V)	R_{FB1} (kΩ)	R_{FB2} (kΩ)	C_{FB} (pF)	V_{OUT} (V)	R_{FB1} (kΩ)	R_{FB2} (kΩ)	C_{FB} (pF)
1.0	7.5	30	2000	2.5	51	24	300
1.2	15	30	1000	3.0	33	12	470
1.5	26	30	560	3.3	47	15	330
1.8	30	24	510	5.0	43	8.2	390

■OPERATIONAL DESCRIPTION

The XC9242/XC9243 series consists of a reference voltage source, ramp wave circuit, error amplifier, PWM comparator, phase compensation circuit, output voltage adjustment resistors, P-channel MOS driver transistor, N-channel MOS switching transistor for the synchronous switch, current limiter circuit, UVLO circuit and others. (See the block diagram above.) The series ICs compare, using the error amplifier, the voltage of the internal voltage reference source with the feedback voltage from the FB pin. Phase compensation is performed on the resulting error amplifier output, to input a signal to the PWM comparator to determine the turn-on time during PWM operation. The PWM comparator compares, in terms of voltage level, the signal from the error amplifier with the ramp wave from the ramp wave circuit, and delivers the resulting output to the buffer driver circuit to cause the Lx pin to output a switching duty cycle. This process is continuously performed to ensure stable output voltage.

The current feedback circuit monitors the P-channel MOS driver transistor current for each switching operation, and modulates the error amplifier output signal to provide multiple feedback signals. This enables a stable feedback loop even when a low ESR capacitor such as a ceramic capacitor is used ensuring stable output voltage.

<Reference Voltage Source>

The reference voltage source provides the reference voltage to ensure stable output voltage of the DC/DC converter.

<Ramp Wave Circuit>

The ramp wave circuit determines switching frequency. The frequency is fixed internally and can be selected from 1.2MHz or 2.4MHz. Clock pulses generated in this circuit are used to produce ramp waveforms needed for PWM operation, and to synchronize all the internal circuits.

<Error Amplifier>

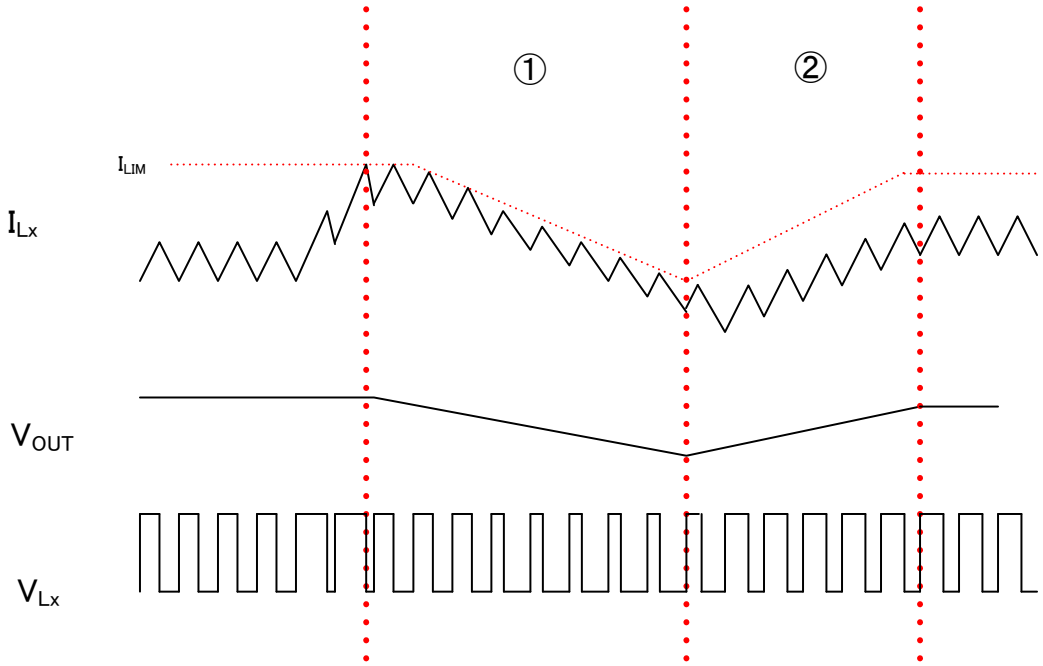
The error amplifier is designed to monitor output voltage. The amplifier compares the reference voltage with the feedback voltage divided by the external split resistors, R1 and R2. When a voltage lower than the reference voltage is fed back, the output voltage of the error amplifier increases. The gain and frequency characteristics of the error amplifier output are fixed internally to deliver an optimized signal to the mixer.

<Current Limit>

The XC9242/XC0243 series includes a fold-back circuit, which aids the operation of the current limiter and circuit protection. The XC9242/XC9243 series monitors the current flowing through the P-channel MOS driver transistor.

①When current flowing through P-channel MOS driver transistor reaches current limit I_{LIM}, the current limiter circuit operates to limit the inductor current I_{LX}. If this state continues, the fold-back circuit operates and limit the output current in order to protect the IC from damage.

②The output voltage is automatically resumed if the load goes light. When it is resumed, the soft-start function operates.



■OPERATIONAL DESCRIPTION (Continued)

<Thermal Shutdown>

For protection against heat damage, the thermal shutdown function monitors chip temperature. When the chip's temperature reaches 150°C (TYP.), the thermal shutdown circuit starts operating and the P-channel driver transistor will be turned off. At the same time, the output voltage decreases. When the temperature drops to 130°C (TYP.) after shutting off the current flow, the IC performs the soft start function to initiate output startup operation.

< Function of CE pin >

The XC9242/9243 series will enter into stand-by mode by inputting a low level signal to the CE pin. During a stand-by mode, the current consumption of the IC becomes 0 μA (TYP.). The IC starts its operation by inputting a high level signal to the CE pin. The input of the CE pin is a CMOS input and the sink current is 0 μA (TYP.).

<UVLO>

When the VIN pin voltage becomes 2.4V (TYP.) or lower, the P-channel MOS driver transistor output driver transistor is forced OFF to prevent false pulse output caused by unstable operation of the internal circuitry. When the V_{IN} pin voltage becomes 2.68V (MAX.) or higher, switching operation takes place. By releasing the UVLO function, the IC performs the soft start function to initiate output startup operation. The soft start function operates even when the VIN pin voltage falls momentarily below the UVLO operating voltage. The UVLO circuit does not cause a complete shutdown of the IC, but causes pulse output to be suspended; therefore, the internal circuitry remains in operation.

<Soft Start>

The XC9242/XC9243 series provide 1.0ms (TYP). Soft start time is defined as the time interval to reach 90% of the output voltage from the time when the V_{CE} is turned on.

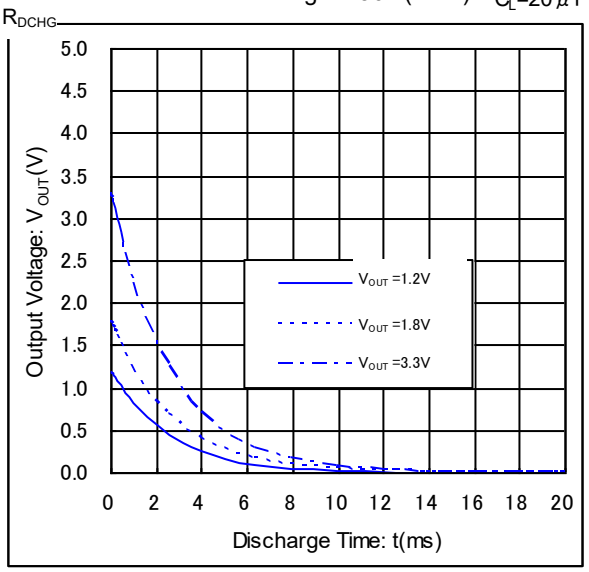
<C_L High Speed Discharge>

The XC9242/XC9243 series can quickly discharge the electric charge at the output capacitor (C_L) when a low signal to the CE pin which enables a whole IC circuit put into OFF state, is inputted via the N-channel MOS switch transistor located between the L_X pin and the V_{GND} pin. When the IC is disabled, electric charge at the output capacitor (C_L) is quickly discharged so that it may avoid application malfunction. Discharge time of the output capacitor (C_L) is set by the C_L auto-discharge resistance (R) and the output capacitor (C_L). By setting time constant of a C_L auto-discharge resistance value [R] and an output capacitor value (C_L) as τ (τ =C x R), discharge time of the output voltage after discharge via the N-channel transistor is calculated by the following formulas.

$$V = V_{OUT(E)} \times e^{-t/\tau} \quad or \quad t = \tau \, ln\,(V_{OUT(E)}/V)$$

V : Output voltage after discharge
$V_{OUT(E)}$: Output voltage
t: Discharge time
τ : $C_L \times R_{DCHG}$
C_L : Capacitance of Output capacitor
R_{DCHG} : C_L auto-discharge resistance

Output Voltage Dischage characteristics
Rdischg = 130Ω(TYP.) C_L=20 μF



■OPERATIONAL DESCRIPTION (Continued)

<PFM Switch Current> (*1)

In PFM control operation, until coil current reaches to a specified level (IPFM), the IC keeps the P-channel MOS driver transistor on. In this case, time that the P-channel MOS driver transistor is kept on (t_{ON}) can be given by the following formula. Please refer to I_{PFM}①

$$t_{ON} = L \times I_{PFM} / (V_{IN} - V_{OUT})$$

< PFM Duty Limit > (*1)

In PFM control operation, the PFM duty limit (DTY_{LIMIT_PFM}) is set to 200% (TYP.). Therefore, under the condition that the duty increases (e.g. the condition that the step-down ratio is small), it's possible for P-channel MOS driver transistor to be turned off even when coil current doesn't reach to IPFM. Please refer to I_{PFM}②

(*1) XC9242 Series is excluded.

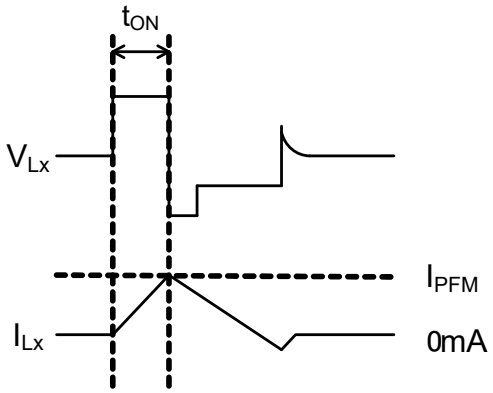


Fig. 1 I_{PFM}①

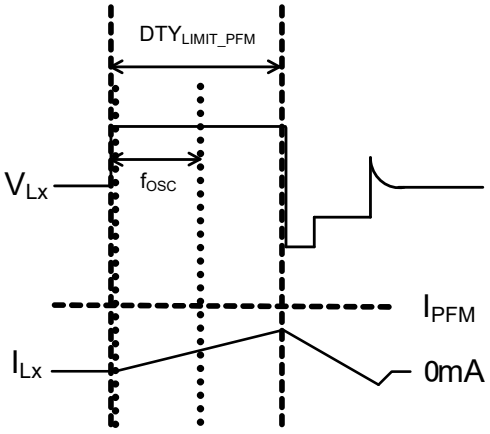


Fig. I_{PFM}②

■NOTE ON USE

1. Please use this IC within the stated maximum ratings. For temporary, transitional voltage drop or voltage rising phenomenon, the IC is liable to malfunction should the ratings be exceeded.

2. Where wiring impedance is high, operations may become unstable due to noise and/or phase lag depending on output current. Please wire the input capacitor (C_{IN}) and the output capacitor (C_L) as close to the IC as possible.

3. When the difference between V_{IN} and V_{OUT} is large in PWM control, very narrow pulses will be outputted, and there is the possibility that some cycles may be skipped completely.

4. When the difference between V_{IN} and V_{OUT} is small, and the load current is heavy, very wide pulses will be outputted and there is the possibility that some cycles may be skipped completely.

5. With the IC, the peak current of the coil is controlled by the current limit circuit. Since the peak current increases when dropout voltage or load current is high, current limit starts operation, and this can lead to instability. When peak current becomes high, please adjust the coil inductance value and fully check the circuit operation. In addition, please calculate the peak current according to the following formula:

$$Ipk = (V_{IN}-V_{OUT})\times OnDuty / (2\times L\times f_{OSC}) + I_{OUT}$$

L : Coil Inductance Value
f_{OSC}: Oscillation Frequency

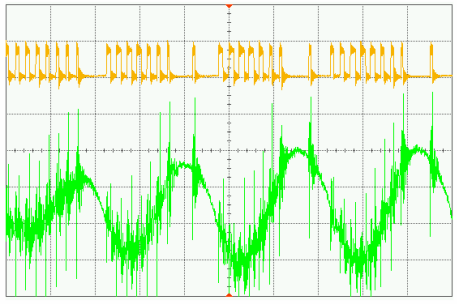
6. Use of the IC at voltages below the recommended voltage range may lead to instability.

7. This IC should be used within the stated absolute maximum ratings in order to prevent damage to the device.

8. When the IC is used in high temperature, output voltage may increase up to input voltage level at no load because of the leak current of the P-channel driver transistor.

9. The XC9242/XC9243 uses fold-back circuit limiter. However, fold-back may become “droop” affected by the wiring conditions. Care must be taken especially for C_{IN} distance and position.

10. If C_L capacitance reduction happens such as in the case of low temperature, the IC may enter unstable operation. Care must be taken for C_L capacitor selection and its capacitance value.



Ta = - 50℃
V_{IN} = 3.6V, V_{OUT} = 0.9V, f_{OSC} = 2.4MHz
C_{IN} = 20μF(Ceramic)
C_L = 14.7μF(Ceramic)
I_{OUT} = 300mA

11. Torex places an importance on improving our products and its reliability. However, by any possibility, we would request user fail-safe design and post-aging treatment on system or equipment.

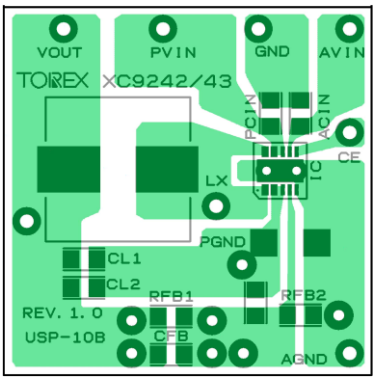
■NOTE ON USE (Continued)

●Instructions of pattern layouts

1. In order to stabilize V_{IN} voltage level, we recommend that a by-pass capacitor (C_{IN}) be connected as close as possible to the PVIN & PGND pins and the AVIN & AGND pins.
2. Make sure to avoid noise from the PVIN pin to the AVIN pin. Please connect the AGND pin and PGND pin in the shortest length for wiring.
3. Please mount each external component as close to the IC as possible.
4. Wire external components as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance.
5. This series' internal driver transistors bring on heat because of the output current and ON resistance of P-channel and N-channel MOS driver transistors.
6. Make sure that the PCB GND traces are as thick as possible, as variations in ground potential caused by high ground currents at the time of switching may result in instability of the IC.

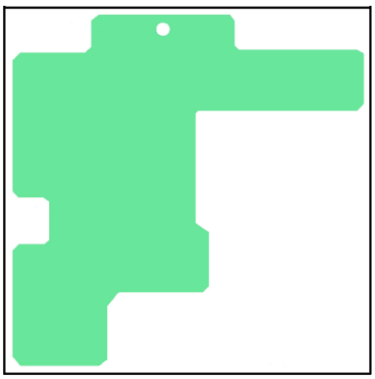
●Recommended Pattern Layout（USP-10B)

1st Layer(USP-10B)

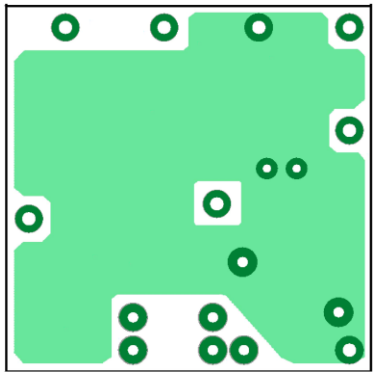


2nd Layer(USP-10B)

3rd Layer(USP-10B)

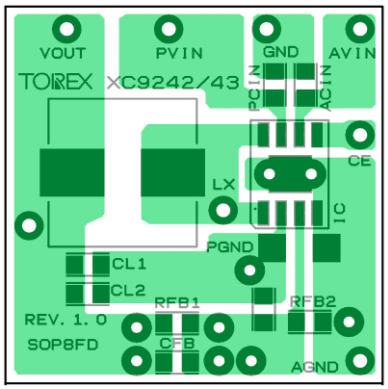


4th Layer(USP-10B)



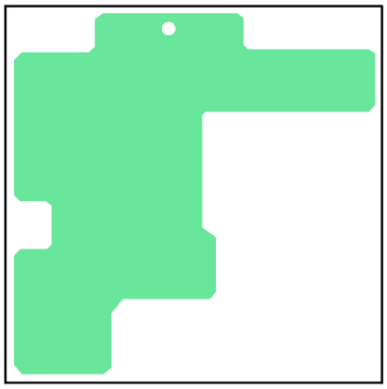
■NOTE ON USE (Continued)

1st Layer(SOP-8FD)

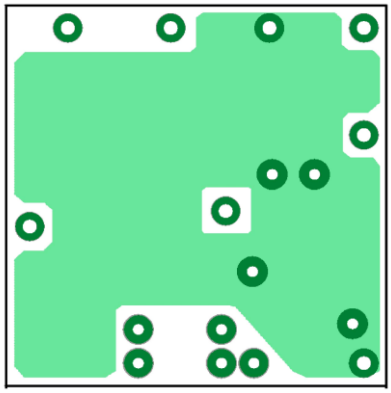


2nd Layer(SOP-8FD)

3rd Layer(SOP-8FD)

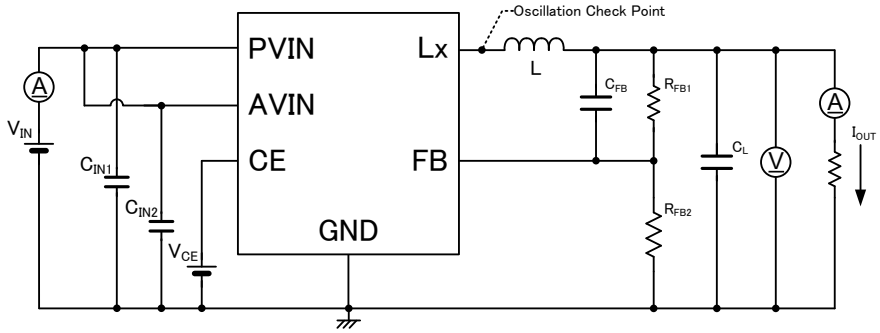


4th Layer(SOP-8FD)



■TEST CIRCUITS

1) CIRCUIT ①

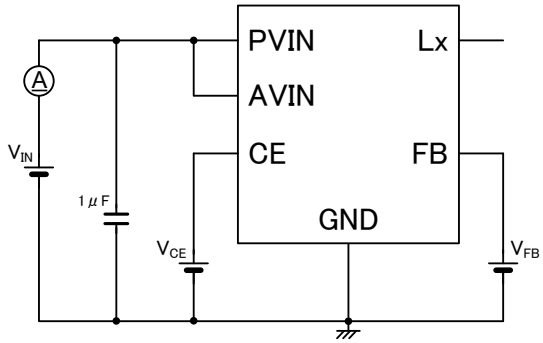


※External components
C_{IN1} : 20μF(ceramic)
C_{IN2} : 1μF(ceramic)
C_L : 20μF(ceramic)
R_{FB1} : 15kΩ
R_{FB2} : 30kΩ
C_{FB} : 1000pF

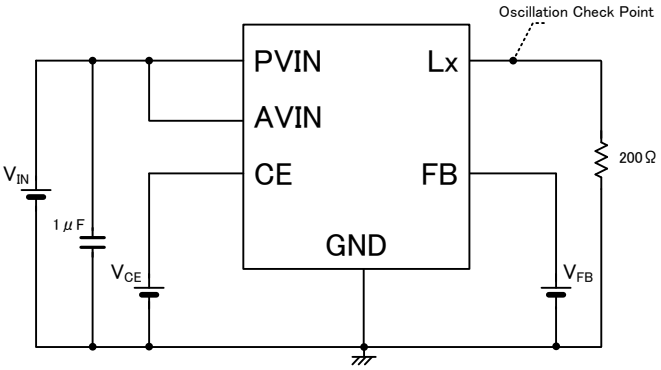
(*1)XC924xB08C TYPE
L : 4.7μH (SLF7055T-4R7 : TDK)
XC924xB08D TYPE
L : 2.2μH (SLF7055T-2R2 : TDK)

※The condtion to measure EFFI
R_{FB1} : 47kΩ
R_{FB2} : 15kΩ
C_{FB} : 330pF

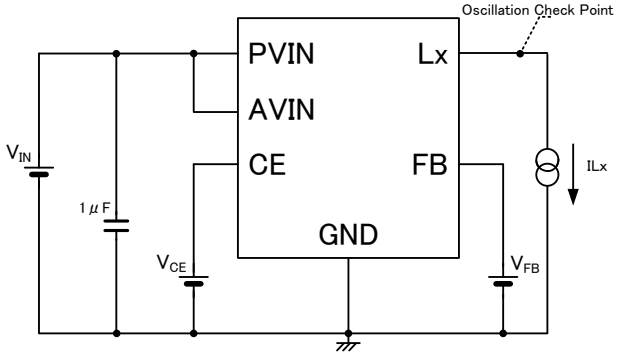
2) CIRCUIT ②



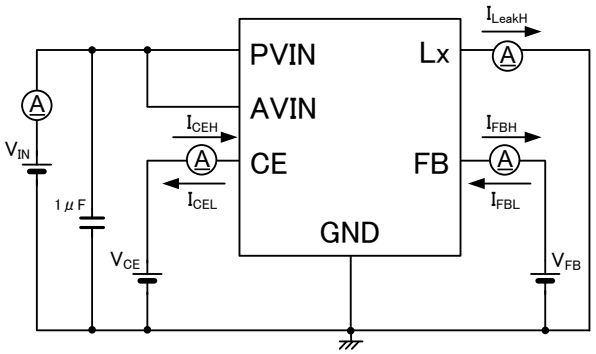
3) CIRCUIT ③



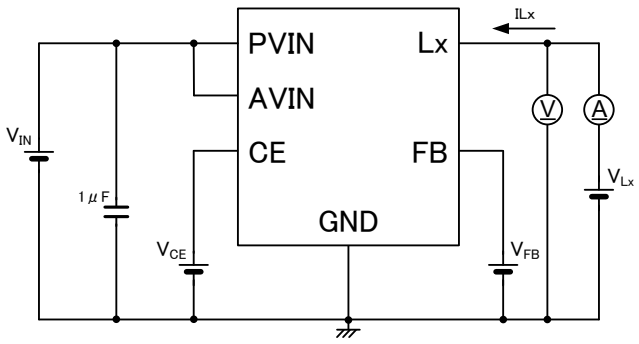
4) CIRCUIT ④



5) CIRCUIT ⑤



6) CIRCUIT ⑥

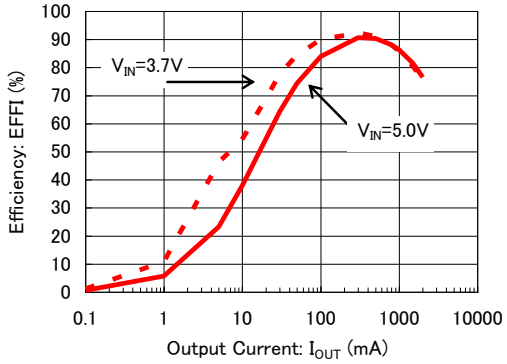


■TYPICAL PERFORMANCE CHARACTERISTICS

(1) Efficiency vs. Output Current

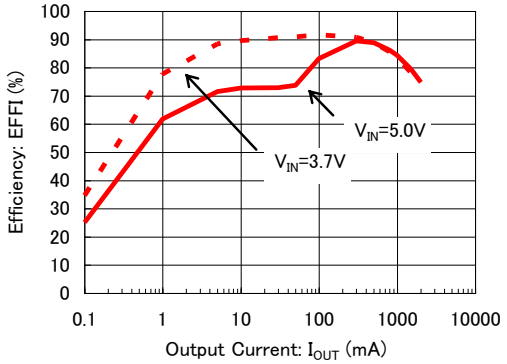
XC9242B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



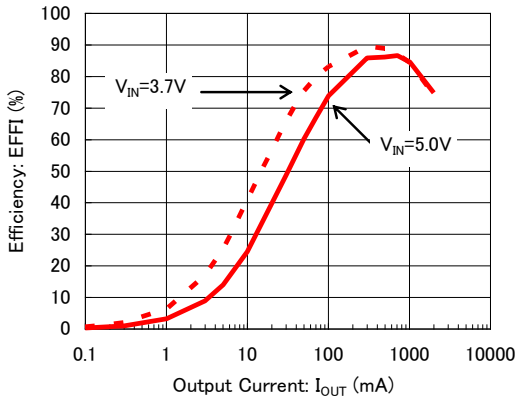
XC9243B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



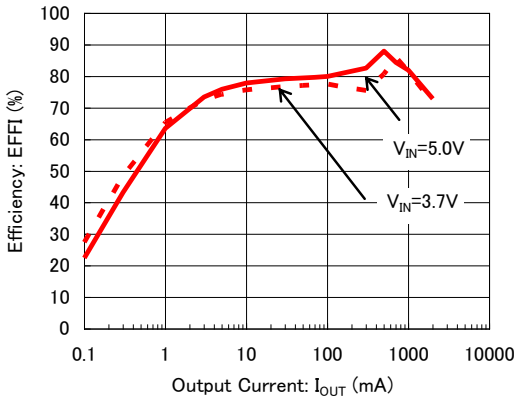
XC9242B08D (V_{OUT}=1.2V)

L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



XC9243B08D (V_{OUT}=1.2V)

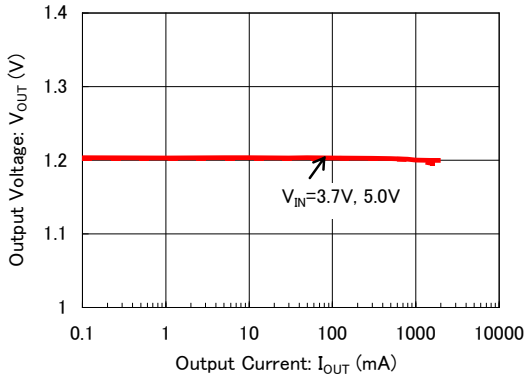
L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



(2) Output Voltage vs. Output Current

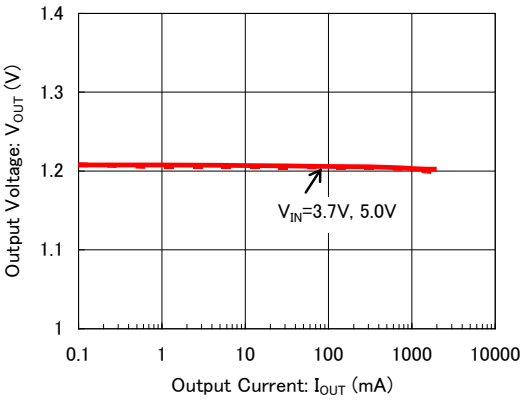
XC9242B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



XC9243B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

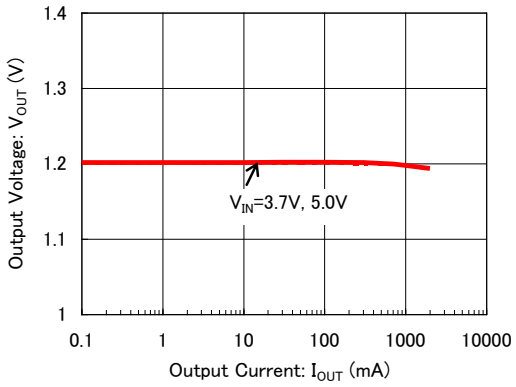


■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Output Current

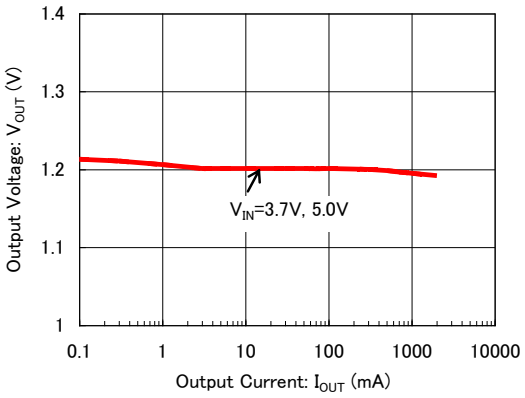
XC9242B08D (V_{OUT}=1.2V)

L=2.2μH(SLF7055),CIN=20μF(LMK212ABJ106KGx2)
CIN=1μF(LMK107BJ105KAx1),CL=20μF(LMK212ABJ106KGx2)
RFB1=15kΩ, RFB2=30kΩ, CFB=1000pF



XC9243B08D (V_{OUT}=1.2V)

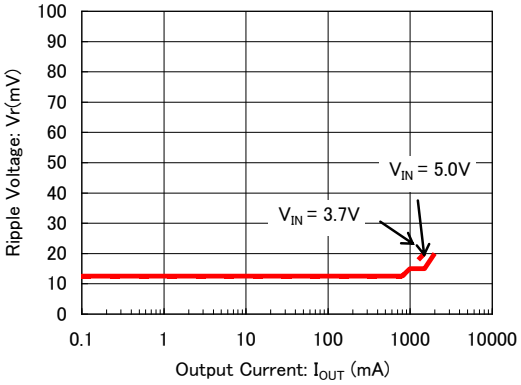
L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



(3) Ripple Voltage vs. Output Current

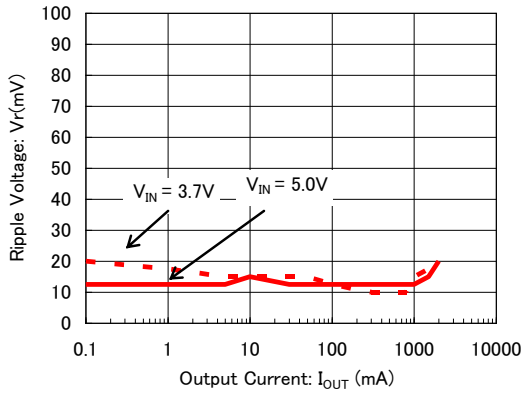
XC9242B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



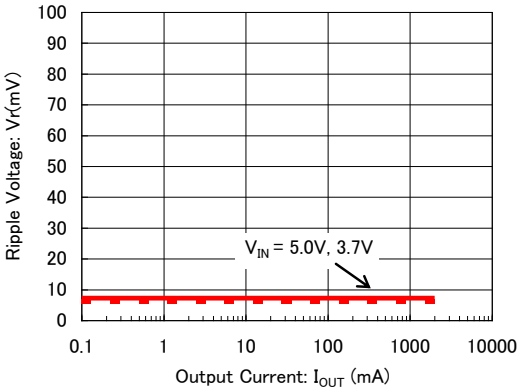
XC9243B08C (V_{OUT}=1.2V)

L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



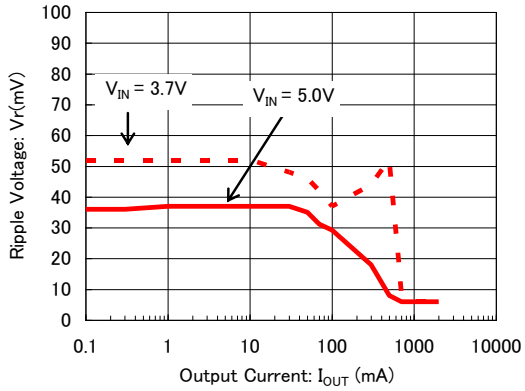
XC9242B08D (V_{OUT}=1.2V)

L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



XC9243B08D (V_{OUT}=1.2V)

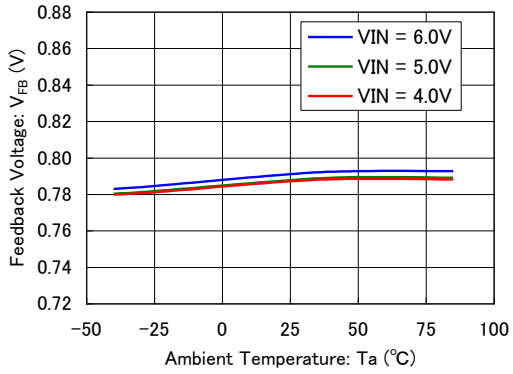
L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

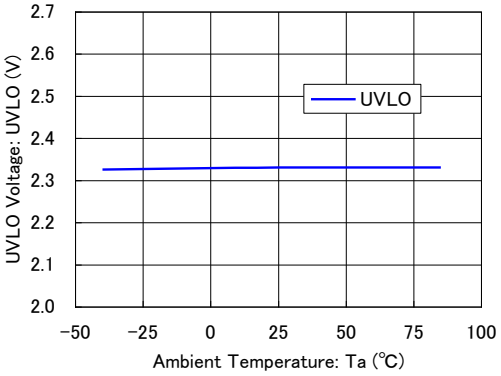
(4) FB Voltage vs. Ambient Temperature

XC9242B08C



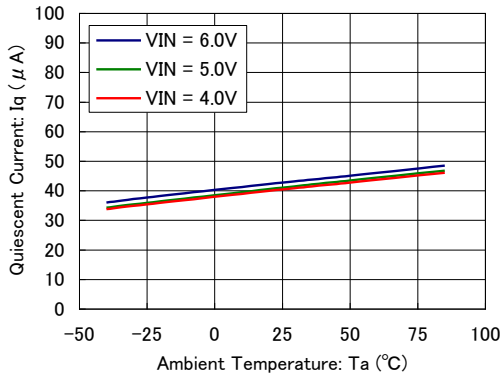
(5) UVLO Voltage vs. Ambient Temperature

XC9242B08C

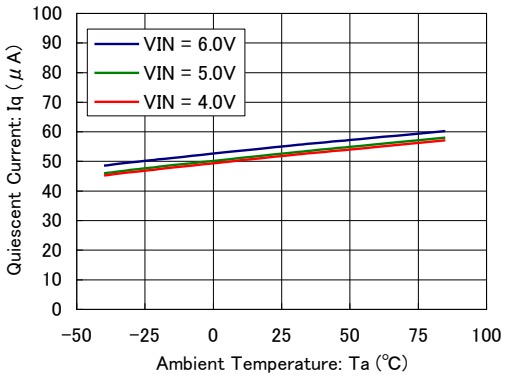


(6) Quiescent Current vs. Ambient Temperature

XC9242B08C

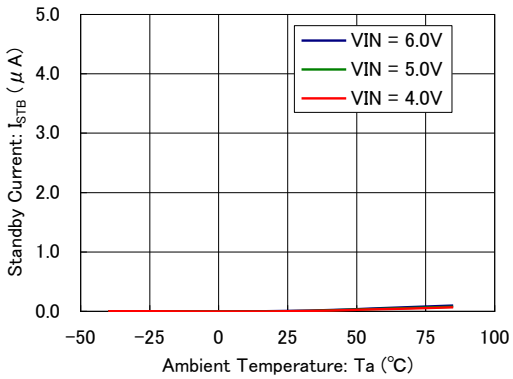


XC9242B08D

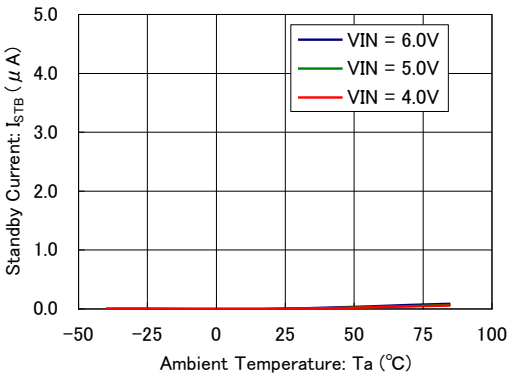


(7) Stand-by Current vs. Ambient Temperature

XC9242B08C



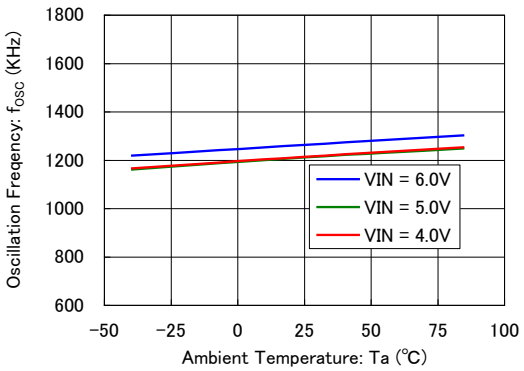
XC9242B08D



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Oscillation Frequency vs. Ambient Temperature

XC9242B08C



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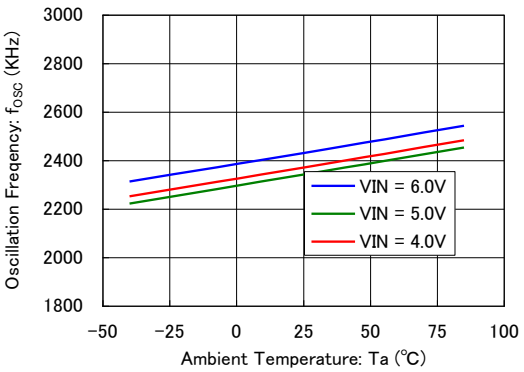
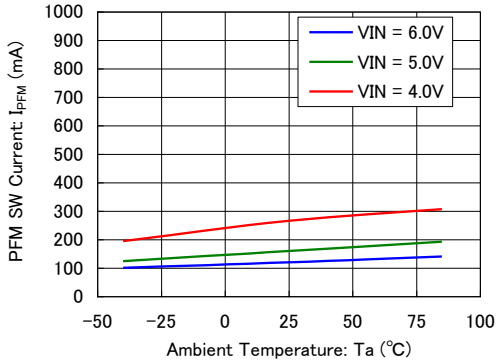


(9) PFM Switching Current vs. Ambient Temperature

XC9243B08C



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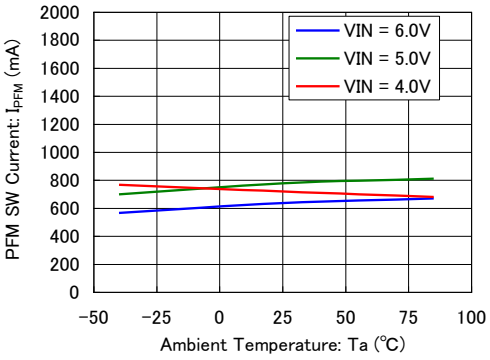
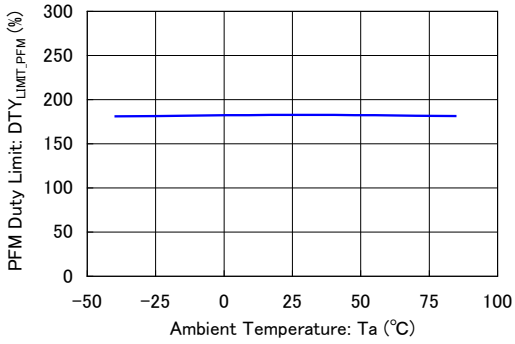
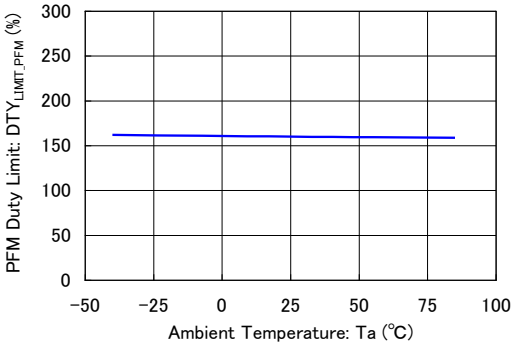


(10) PFM Duty Limit vs. Ambient Temperature

XC9243B08C



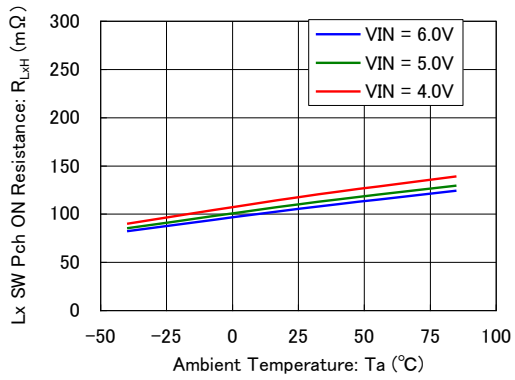
XC9243B08D



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

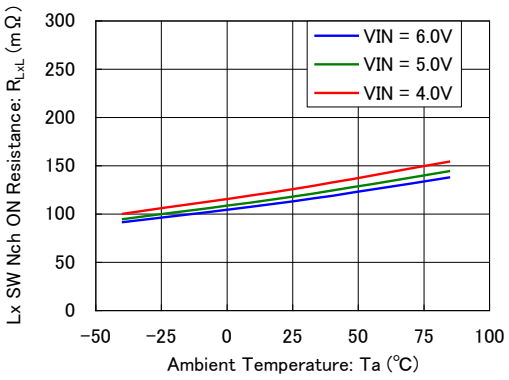
(11) Pch Driver ON Resistance vs. Ambient Temperature

XC9242B08C



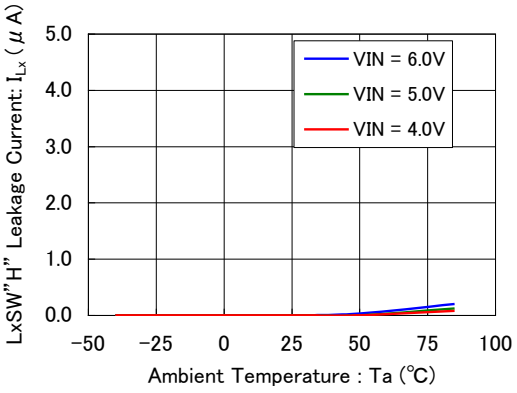
(12) Nch Driver ON Resistance vs. Ambient Temperature

XC9242B08C



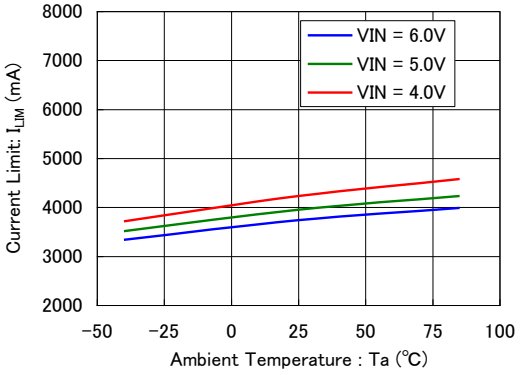
(13) LxSW"H" Leakage Current vs. Ambient Temperature

XC9242B08C



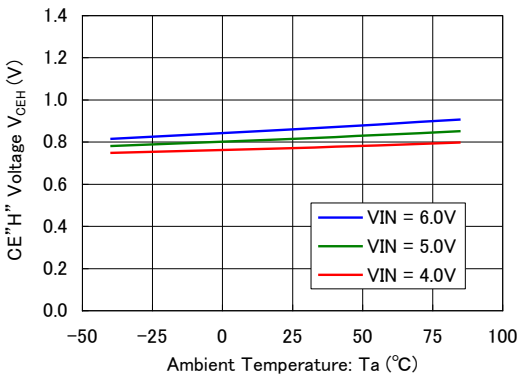
(14) Current Limit vs. Ambient Temperature

XC9242B08C



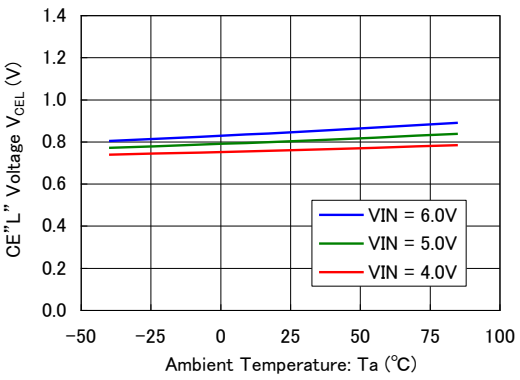
(15) CE"H" Voltage vs. Ambient Temperature

XC9242B08C



(16) CE"L" Voltage vs. Ambient Temperature

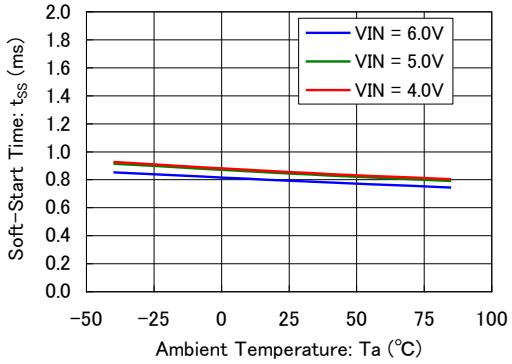
XC9242B08C



■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

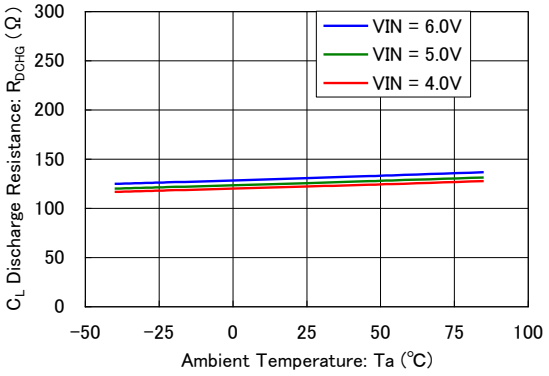
(17) Soft-Start Time vs. Ambient Temperature

XC9242B08C



(18) C_L Discharge Resistance vs. Ambient Temperature

XC9242B08C



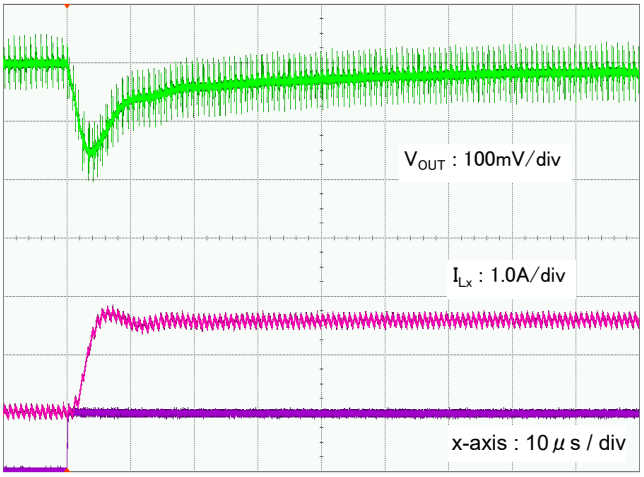
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(19) Load Transient Response

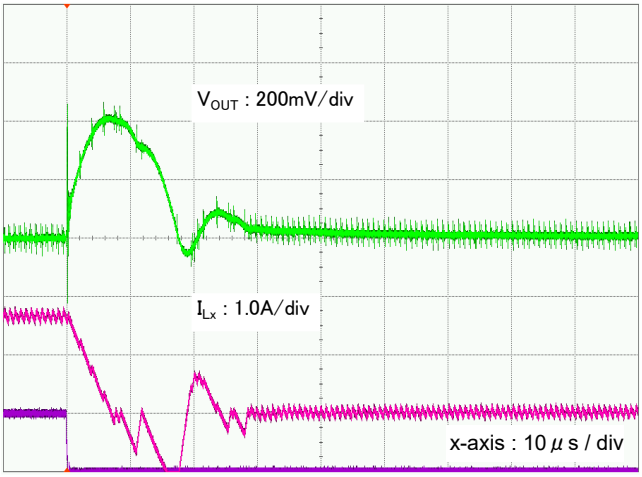
XC9242B08C

L=4.7μH(SLF7055),C_{IN1}=20μF(LMK212ABJ106KGx2)
C_{IN2}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1mA ⇒ 1.5A



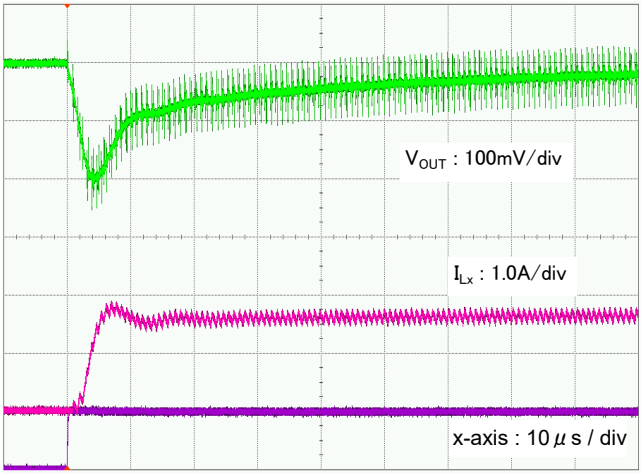
V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1.5A ⇒ 1mA



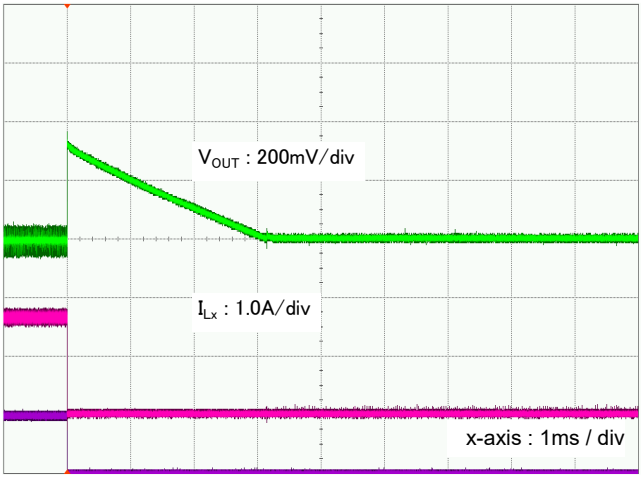
XC9243B08C

L=4.7μH(SLF7055),C_{IN1}=20μF(LMK212ABJ106KGx2)
C_{IN2}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1mA ⇒ 1.5A



V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1.5A ⇒ 1mA



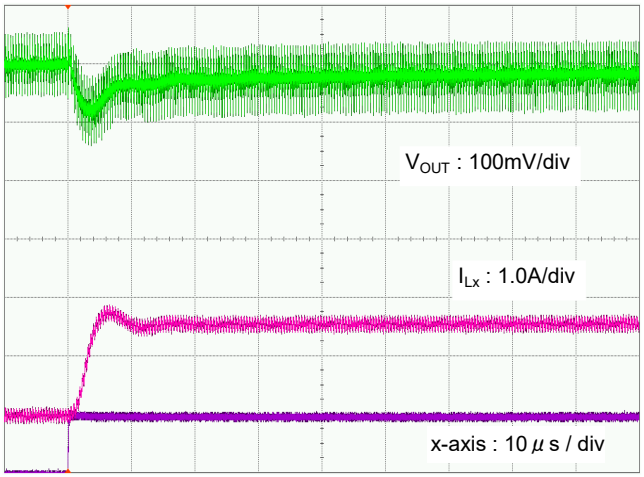
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(19) Load Transient Response

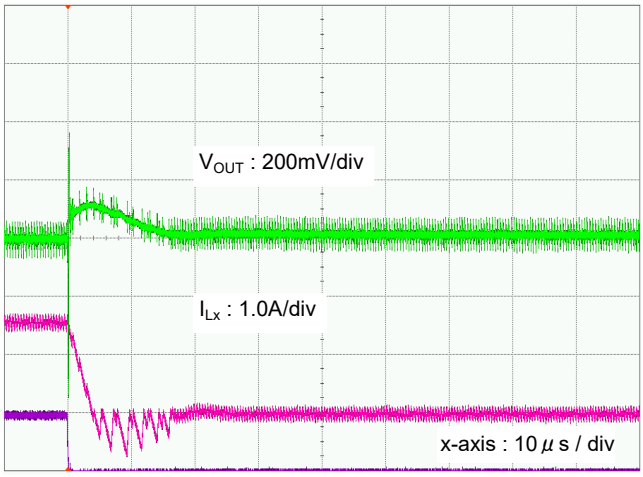
XC9242B08D

L=2.2μH(SLF7055),C_{IN1}=20μF(LMK212ABJ106KGx2)
C_{IN2}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1mA ⇒ 1.5A



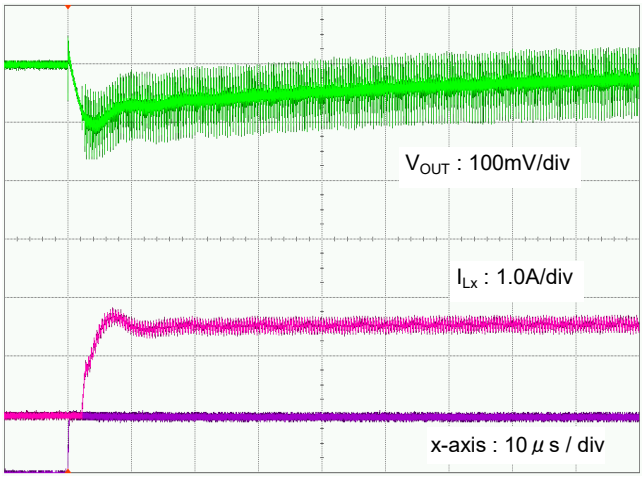
V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1.5A ⇒ 1mA



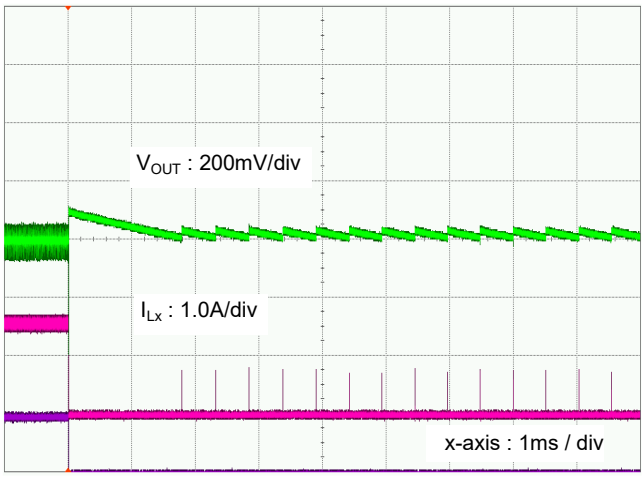
XC9243B08D

L=2.2μH(SLF7055),C_{IN1}=20μF(LMK212ABJ106KGx2)
C_{IN2}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF

V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1mA ⇒ 1.5A



V_{IN} = 5.0V, V_{OUT} = 1.2V, I_{OUT} = 1.5A ⇒ 1mA



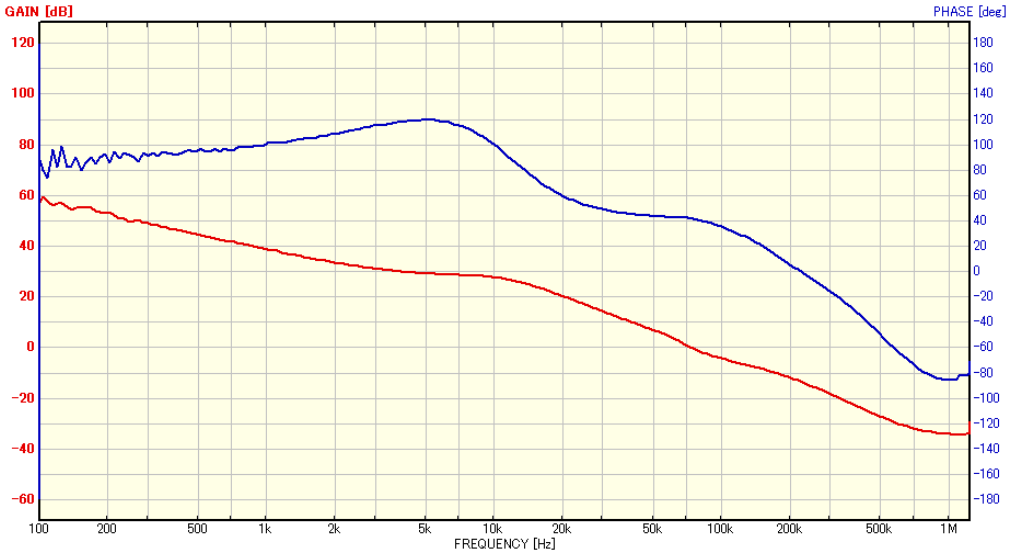
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(20) Frequency Response

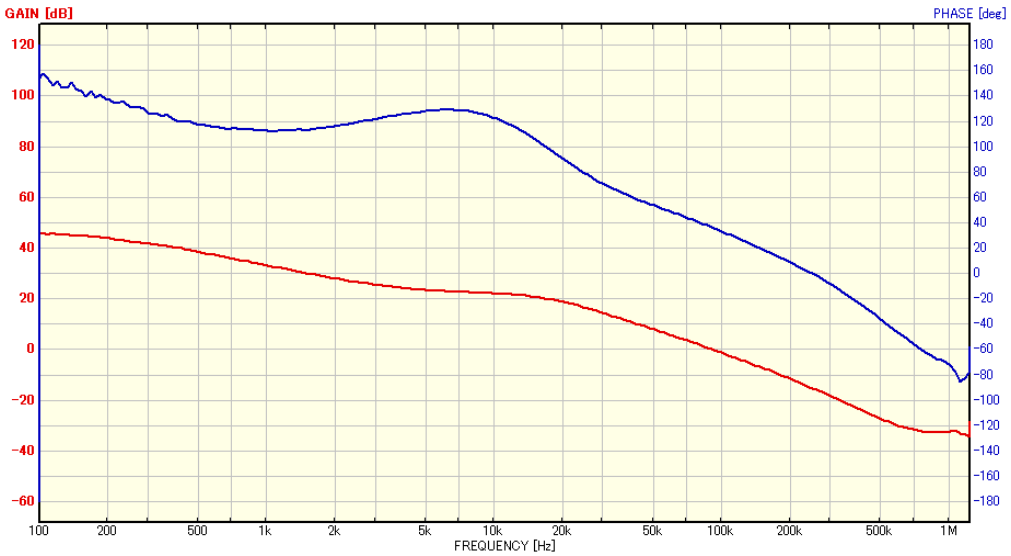
Test Condition:
Measurement equipment:NF FRA5097 Version:3.00
OSC amplitude=20.0mVpeak OSC.Dcbias=0.00V
OSC waveform:SIN, Sweep minimum frequency=1Hz
Sweep maximum frequency=15MHz
Sweep resolution=300steps/sweep
Integration period=100cycle, Delay time=0cycle
Order of harmonic analysis=1, Measure mode:CH1&CH2
Auto integration:OFF, Amplitude compression:OFF
Slow sweep:OFF

XC9242B08CDR

L=4.7μH(SLF7055), C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF
V_{IN}=5.0V, V_{CE}=V_{IN}, V_{OUT}=1.2V, I_{OUT}=1mA



L=4.7μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF
V_{IN}=5.0V, V_{CE}=V_{IN}, V_{OUT}=1.2V, I_{OUT}=1000mA



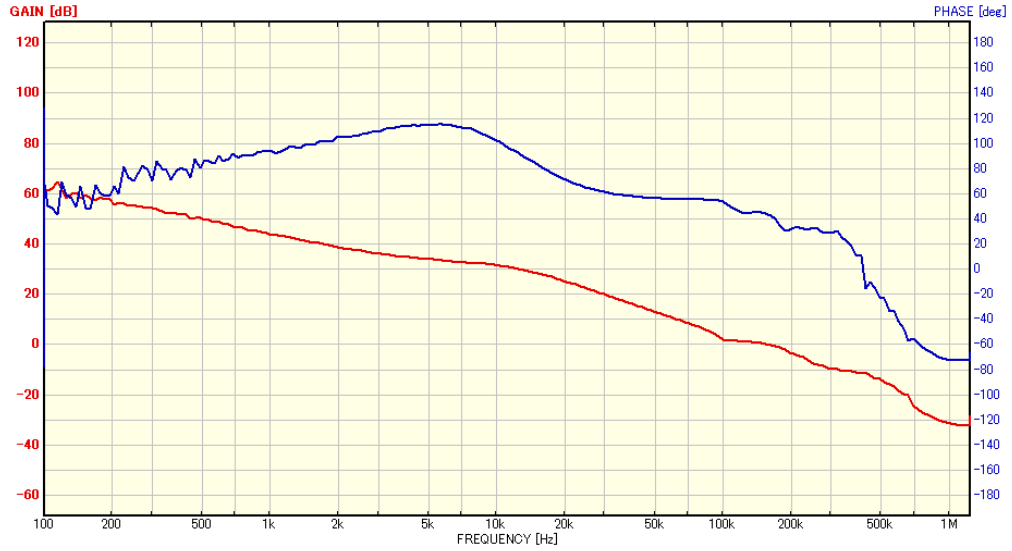
■TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(20) Frequency Response (Continued)

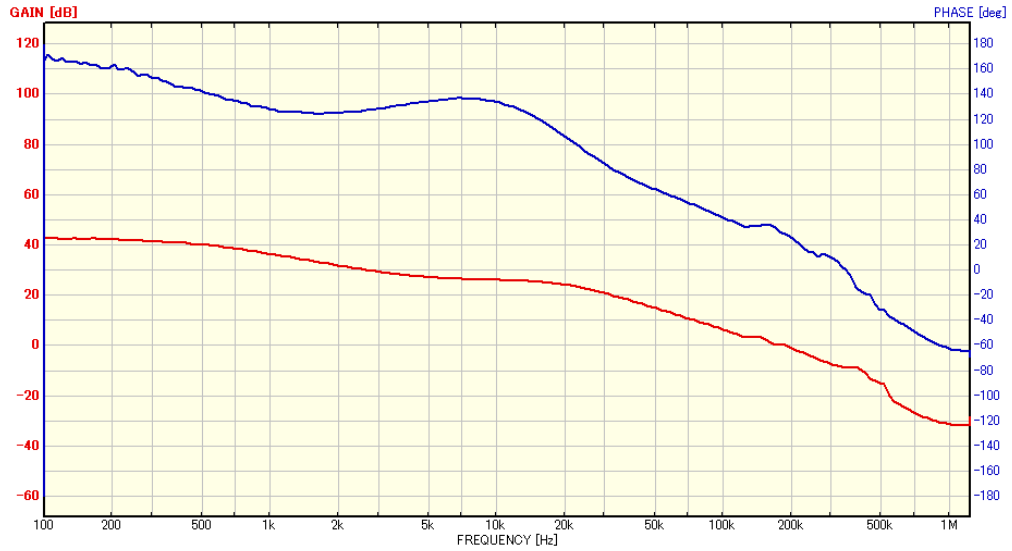
Test Condition:
Measurement equipment:NF FRA5097 Version:3.00
OSC amplitude=20.0mVpeak OSC.Dcbias=0.00V
OSC waveform:SIN, Sweep minimum frequency=1Hz
Sweep maximum frequency=15MHz
Sweep resolution=300steps/sweep
Integration period=100cycle, Delay time=0cycle
Order of harmonic analysis=1, Measure mode:CH1&CH2
Auto integration:OFF, Amplitude compression:OFF
Slow sweep:OFF

XC9242B08DDR

L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF
V_{IN}=5.0V, V_{CE}=V_{IN}, V_{OUT}=1.2V, I_{OUT}=1mA



L=2.2μH(SLF7055),C_{IN}=20μF(LMK212ABJ106KGx2)
C_{IN}=1μF(LMK107BJ105KAx1),C_L=20μF(LMK212ABJ106KGx2)
R_{FB1}=15kΩ, R_{FB2}=30kΩ, C_{FB}=1000pF
V_{IN}=5.0V, V_{CE}=V_{IN}, V_{OUT}=1.2V, I_{OUT}=1000mA



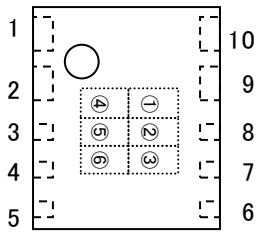
■PACKAGING INFORMATION

For the latest package information go to, www.torexsemi.com/technical-support/packages

PACKAGE	OUTLINE / LAND PATTERN	THERMAL CHARACTERISTICS
SOP-8FD	SOP-8FD PKG	SOP-8FD Power Dissipation
USP-10B	USP-10B PKG	USP-10B Power Dissipation

■MARKING RULE

●USP-10B



① represents product series

MARK	PRODUCT SERIES
B	XC9242******-G
C	XC9243******-G

② represents product function

MARK	FUNCTION	PRODUCT SERIES
B	C_L High Speed Discharge	XC924*B*****-G

③ represents reference voltage

MARK	OUTPUT VOLTAGE (V)	PRODUCT SERIES
8	0.8	XC924*B08***-G

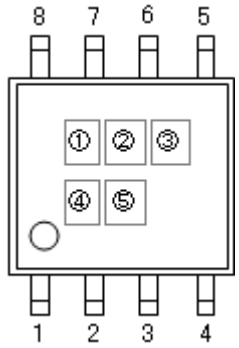
④ represents oscillation frequency

MARK	OSCILLATION FREQUENCY (MHz)	PRODUCT SERIES
C	1.2	XC924*B**C**-G
D	2.4	XC924*B**D**-G

⑤⑥ represents production lot number
01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to AZ, B1 to ZZ repeated
(G, I, J, O, Q, W excluded)
*No character inversion used.

■MARKING RULE (Continued)

●SOP-8FD



① represents product series

MARK	PRODUCT SERIES
B	XC9242******-G
C	XC9243******-G

② represents product function

MARK	FUNCTION	PRODUCT SERIES
B	C_L High Speed Discharge	XC924*B*****-G

③ represents oscillation frequency

MARK	OSCILLATION FREQUENCY (MHz)	PRODUCT SERIES
C	1.2	XC924*B**C**-G
D	2.4	XC924*B**D**-G

④⑤ represents production lot number
01 to 09, 0A to 0Z, A1 to A9, AA to AZ, B1 to ZZ repeated
(G, I, J, O, Q, W excluded)
*No character inversion used.

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