XC6216/XE6216 Series

Voltage Regulators with Stand-by Function - Input Voltage: 30V

TOREX

Preliminary

◆Input Voltage Range : 2.0V~25.0V
◆Output Voltage Range : 2.0V~12.0V
(XC6216B/XE6216B)
2.0V~23.0V
(XC6216C/XE6216C)
2.0v~12.0V
(XC6216D/XE6216D)
◆Output Current : 150mA~($V_{OUT(T)}$≧3.0V)
: 100mA~($V_{OUT(T)}$<3.0V)
(V_{IN}=$V_{OUT(T)}$+3.0V)
◆Current Limit Circuit Built-In
◆Thermal Shutdown Circuit Built-In
◆Ceramic Capacitor Compatible

* XC6216B and C types are preliminary.

■APPLICATIONS

- Car audio, Car navigation systems
- Note book computers, PDAs
- Home appliances
- AV equipment (Cameras, VCRs, etc.)
- Wireless communication equipment (Cordless phones, etc.)

■GENERAL DESCRIPTION

XC6216/XE6216 series are highly precise, low noise, positive regulator ICs. The series consists of a voltage reference, an error amplifier, a current limiter, a thermal shutdown circuit and a phase compensation circuit plus a driver transistor.

The output voltage is selectable in 100mV increments within the range of 2.0V to 12V using laser trimming technologies (XC6216B/XE6216B series). Furthermore, with external resistors, the output voltage can be set from 2.0V to 23V (XC6216C/XE6216E series). The series' output stabilization capacitor (C_L) is also compatible with low ESR ceramic capacitors.

The over current protection circuit and the thermal shutdown circuit are built-in. These two protection circuits will operate when the output current reaches current limit level or the junction temperature reaches temperature limit level.

The CE function enables the output to be turned off and the IC becomes a stand-by mode resulting in greatly reduced power consumption.

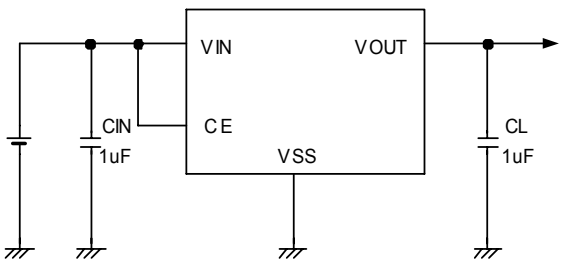
■FEATURES

Maximum Output Current	: More than 150mA (Up to 200mA) (V_{IN}=$V_{OUT(T)}$+3.0V)
Dropout Voltage	: 300mV@I_{OUT}=20mA
Input Voltage Range	: 2.0V~25.0V
Output Voltage Setting Range	: 2.0V~12.0V (100mV increments) (With external resistors: 2.0V~23.0V)
High Accuracy	: Setting Voltage Accuracy±2% (Setting Voltage Accuracy±1% Possible)
Low Power Consumption	: 5μA
Stand-by Current	: Less than 0.1μA
High Ripple Rejection	: 40dB@1kHz
Operating Temperature Range	: -40℃~+85℃
External Capacitor	: 0.1uF~1.0uF capacitor recommended (Internal phase compensation)
Packages	: SOT-25, SOT-89, SOT-89-5, USP-6C, SOT-223, TO-252

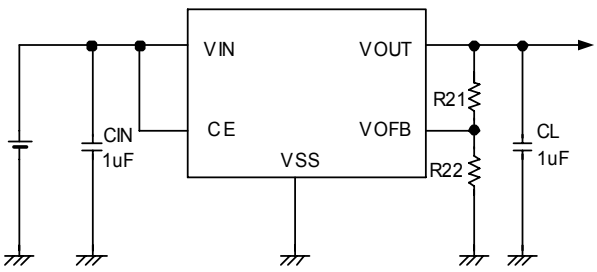
* XE series is the series corresponding to automotive applications, and is assuring all temperature between – 40℃ to +85 ℃.

■ TYPICAL APPLICATION CIRCUITS

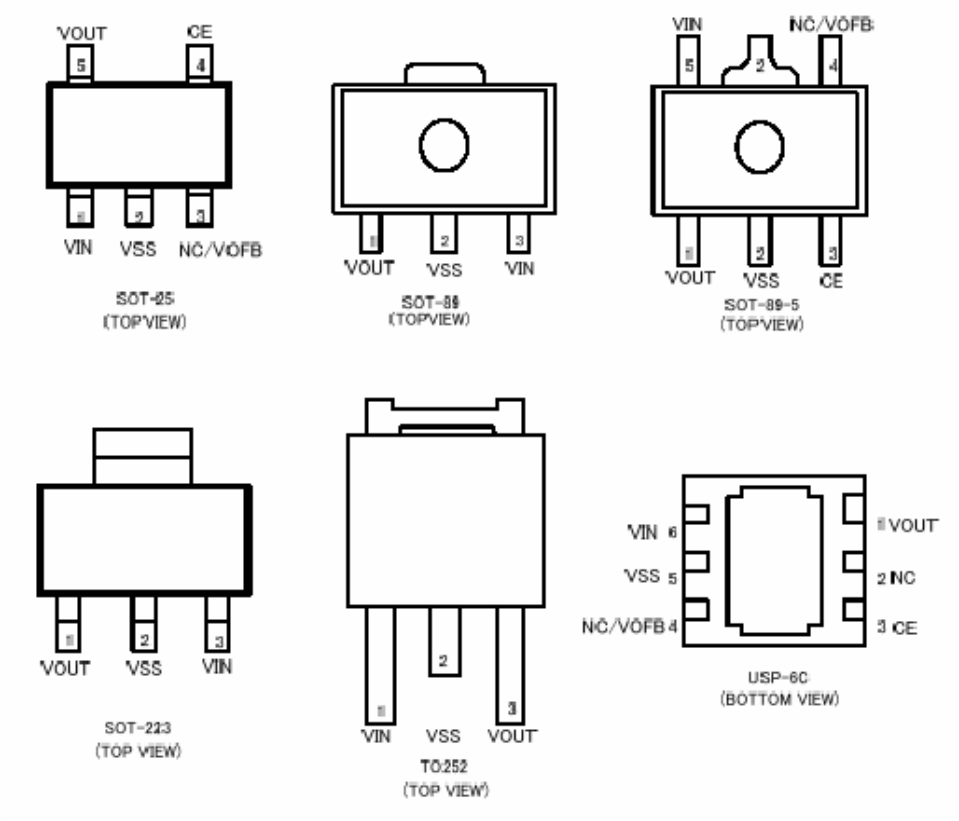
●XC6216B/XE6216B Series
(Fixed Output Voltage)



●XC6216C/XE6216C Series
(Output Voltage Externally Set)



■PIN CONFIGURATION



* The dissipation pad for the USP-6C package should be solder-plated in recommended mount pattern and metal masking so as to enhance mounting strength and heat release. If the pad needs to be connected to other pins, it should be connected to the Vss (PIN # 5).

■PIN ASSIGNMENT

●XC6216B/XE6216B Series (Preliminary)

PIN NUMBER			PIN NAME	FUNCTIONS
SOT-25	SOT-89-5	USP-6C		
1	5	6	VIN	Power Input
2	2	5	Vss	Ground
3	4	4	NC	No connection
4	3	3	CE	ON/OFF Control
5	1	1	VOUT	Output
-	-	2	NC	No connection

●XC6216C/XE6216C Series (Preliminary)

PIN NUMBER			PIN NAME	FUNCTIONS
SOT-25	SOT-89-5	USP-6C		
1	5	6	VIN	Power Input
2	2	5	Vss	Ground
3	4	4	VOFB	Output Voltage Adjustment
4	3	3	CE	ON/OFF Control
5	1	1	VOUT	Output
-	-	2	NC	No connection

●XC6216D Series

PIN NUMBER			PIN NAME	FUNCTIONS
SOT-89	SOT-223	TO-252		
3	3	1	VIN	Power Input
2	2	2	Vss	Ground
1	1	3	VOUT	Output

■ PRODUCT CLASSIFICATION

●Ordering Information

XC6216①②③④⑤⑥

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type and Options of Regulators	B	: Fixed output voltage, High Active
		C	: Output voltage externally set, High Active
		D	: Fixed output voltage, No CE function
②③	Output Voltage	20 ~ 99	: For the voltage within 2.0V ~9.9V; e.g. 2.5V ⇒ 25 5.0V ⇒ 5.
		A, B, C	: For the voltage above 10.0V; e.g. 10.6V ⇒ A6 11.2V ⇒ B2 12.0V ⇒ C0
		20	: For C type (output voltage externally set), V_{OFB}=2.0V only
④	Output Voltage Accuracy	2	: Output voltage 100mV increments, Within ±2% accuracy e.g. 2.5V ⇒ ②=2, ③=5, ④=2
		1	: Output voltage 100mV increments, Within ±1% accuracy e.g. 5.0V ⇒ ②=5, ③=0, ④=1
⑤	Package	M	: SOT-25 (for B and C types only)
		P	: SOT-89 (for D type only)
		P	: SOT-89-5 (for B and C types only)
		E	: USP-6C (for B and C types only)
		F	: SOT-223 (for D type only)
		J	: TO-252 (for D type only)
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

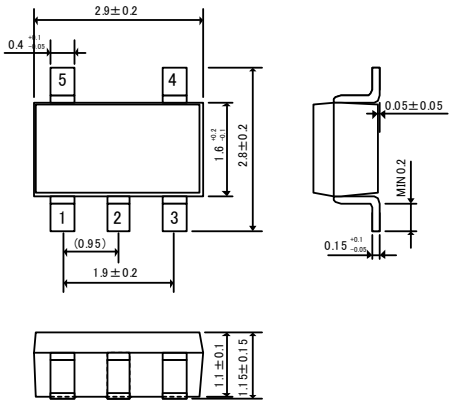
XE6216①②③④⑤⑥

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type and Options of Regulators	B	: Fixed output voltage, High Active
		C	: Output voltage externally set, High Active
②③	Output Voltage	20 ~ 99	: For the voltage within 2.0V ~9.9V; e.g. 2.5V ⇒ 25 5.0V ⇒ 5.
		A, B, C	: For the voltage above 10.0V; e.g. 10.6V ⇒ A6 11.2V ⇒ B2 12.0V ⇒ C0
		20	: For C type (output voltage externally set), V_{OFB}=2.0V only
④	Output Voltage Accuracy	2	: Output voltage 100mV increments, Within ±2% accuracy e.g. 2.5V ⇒ ②=2, ③=5, ④=2
		1	: Output voltage 100mV increments, Within ±1% accuracy e.g. 5.0V ⇒ ②=5, ③=0, ④=1
⑤	Package	M	: SOT-25 (for B and C types only)
		P	: SOT-89 (for D type only)
		P	: SOT-89-5 (for B and C types only)
		E	: USP-6C (for B and C types only)
⑥	Device Orientation	R	: Embossed tape, standard feed
		L	: Embossed tape, reverse feed

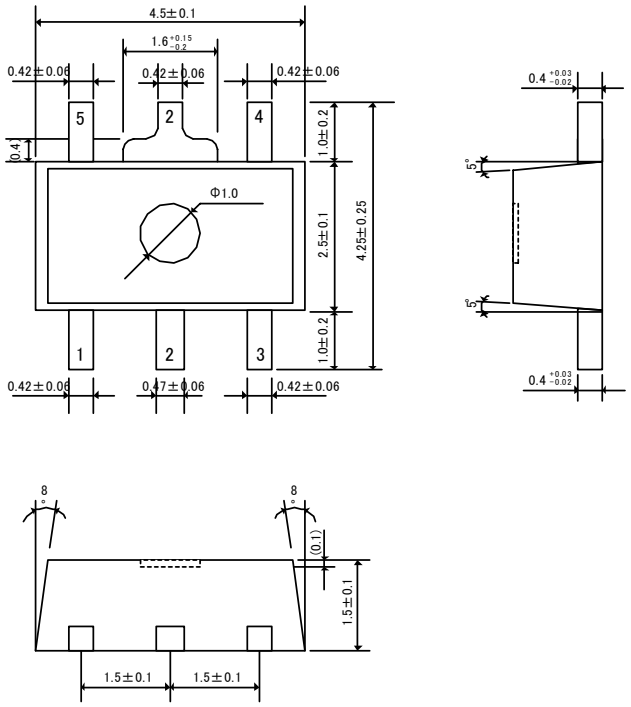
*1: The B and c types are preliminary.
*2: The XE products are preliminary.

■PACKAGING INFORMATION

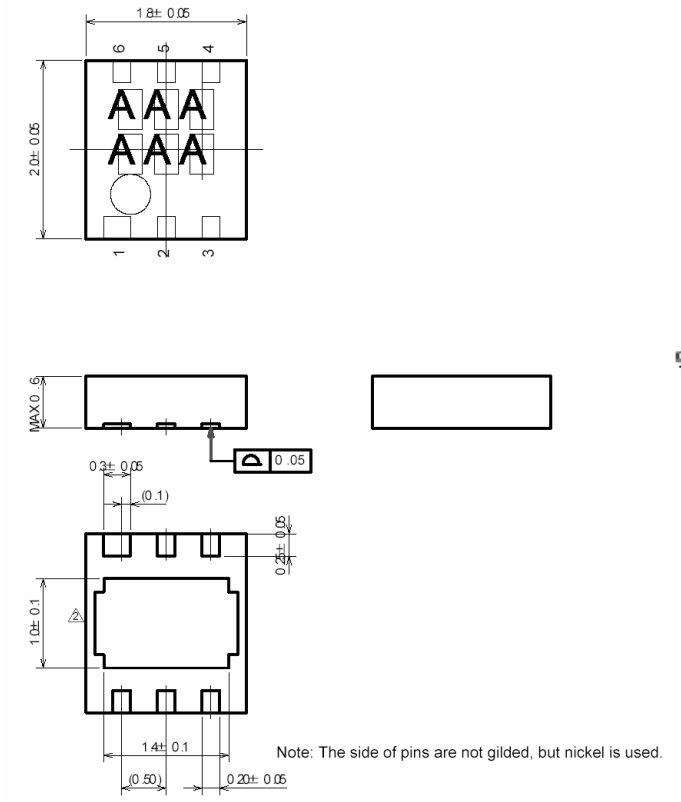
●SOT-25



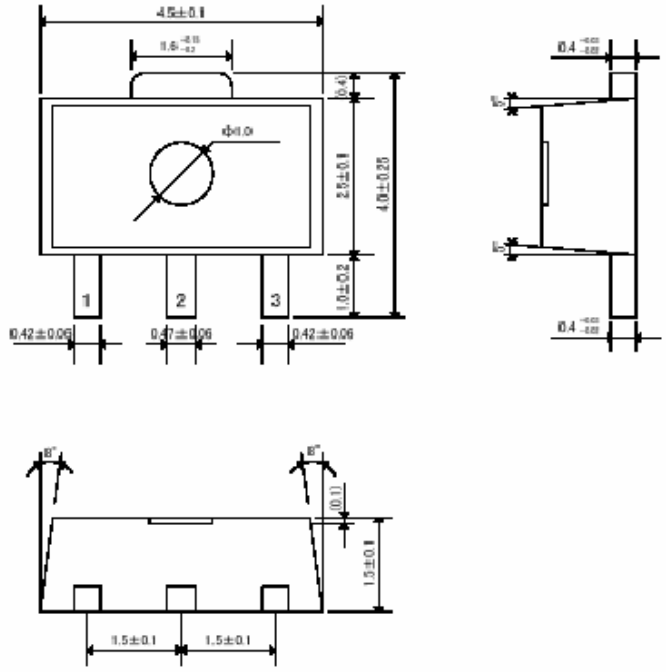
●SOT-89-5



●USP-6C

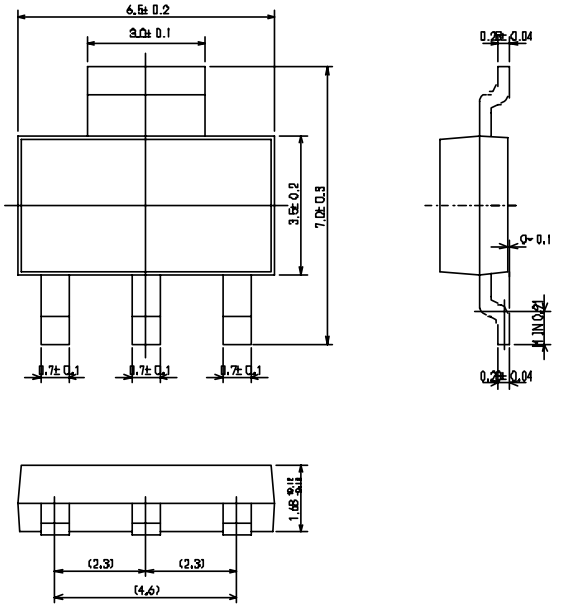


●SOT-89

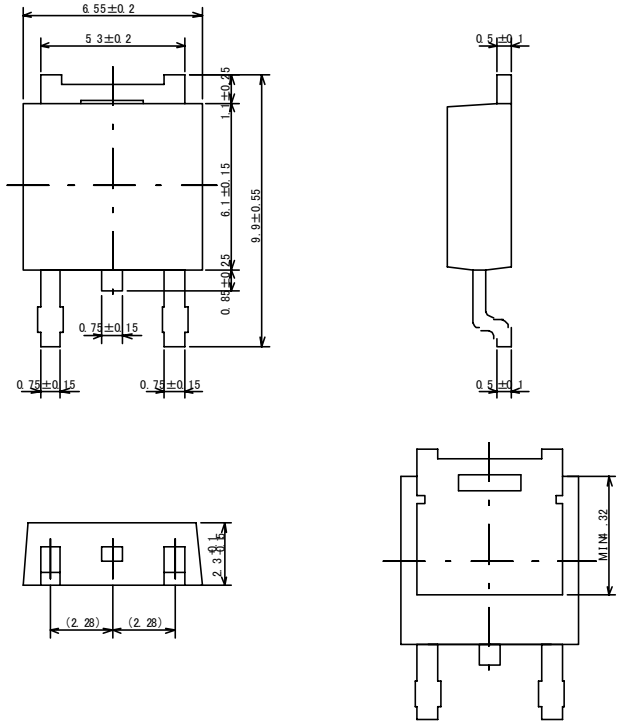


■PACKAGING INFORMATION (Continued)

●SOT-223

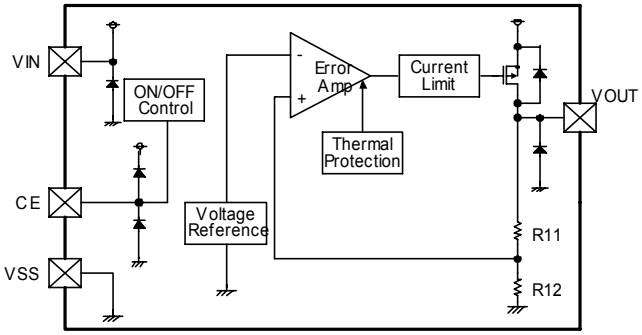


●TO-252

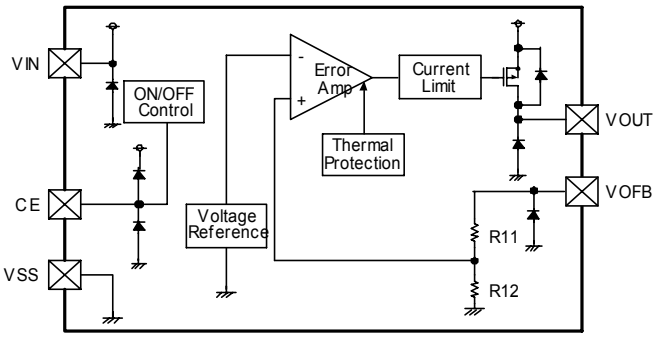


■ BLOCK DIAGRAMS

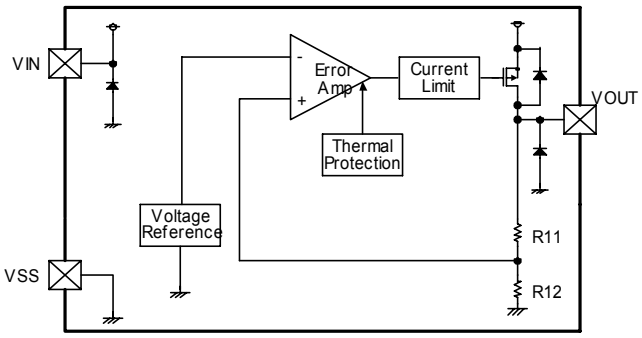
●XC6216B/XE6216B Series
(SOT-25, SOT-89-5, USP-6C)



●XC6216C/XE6216C Series
(SOT-25, SOT-89-5, USP-6C)



●XC6216D Series
(SOT-89, SOT-223, TO-252)



■ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNIT
Input Voltage		V_{IN}	V_{SS}-0.3~30	V
Output Current		I_{OUT}	300 (*1)	mA
Output Voltage		V_{OUT}	V_{SS}-0.3~V_{IN}+0.3	V
CE Input Voltage		V_{CE}	V_{SS}-0.3~V_{IN}+0.3	V
FB Voltage		V_{OFB}	V_{SS}-0.3～30	V
Power Dissipation	SOT-25	Pd	250	mW (T_J=25°C)
	SOT-89		500	
	SOT-89-5		500	
	USP-6C		100 (1100 *2)	
	SOT-223		300 (1900 *2)	
	TO-252		T.B.D. (*3)	
Operating Temperature Range		Topr	-40~+85	°C
Storage Temperature Range		Tstg	-55~+125	°C

*1: $I_{OUT} \leqq Pd / (V_{IN}-V_{OUT})$

*2: When mounting on glass epoxy.
Mounting board area: 1600mm^2 (40mm × 40mm)
Copper plate area: 800mm^2

■ELECTRICAL CHARACTERISTICS

●XC6216B Series

Ta = 25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Output Voltage	$V_{OUT(E)}$	I_{OUT}=20mA, V_{CE}=V_{IN}	x 0.98	$V_{OUT(T)}$	x 1.02	V	①
Maximum Output Current	I_{OUTMAX}	V_{IN}=$V_{OUT(T)}$+3.0V, V_{CE}=V_{IN} ($V_{OUT(T)}$≧3V)	150	-	-	mA	①
		V_{IN}=V_{OUT}(T)+3.0V, V_{CE}=V_{IN} ($V_{OUT(T)}$＜3V)	100	-	-	mA	①
Load Regulation	△V_{OUT}	V_{IN}=$V_{OUT(T)}$+2.0V 1mA≦I_{OUT}≦100mA V_{CE}=V_{IN}	-	40	-	mV	①
Dropout Voltage 1	Vdif1	I_{OUT}=20mA, V_{CE}=V_{IN}	-	300	-	mV	①
Dropout Voltage 2	Vdif2	I_{OUT}=100mA, V_{CE}=V_{IN}	-	1000	-	mV	①
Supply Current	I_{SS}	V_{CE}=V_{IN}	-	5	-	uA	②
Stand-by Current	Istby	V_{CE}=V_{SS}	-	0.01	0.10	uA	②
Line Regulation 1	△V_{OUT} / △V_{IN}·$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=5mA, V_{CE}=V_{IN}	0.01	0.05	0.10	%/V	①
Line Regulation 2	△V_{OUT} / △V_{IN}·$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=13mA, V_{CE}=V_{IN}	0.03	0.15	0.30	%/V	①
Input Voltage	V_{IN}		2.0	-	25.0	V	-
Output Voltage Temperature Characteristics	△V_{OUT} / △Topr·$V_{OUT(T)}$	I_{OUT}=20mA, V_{CE}=V_{IN} -40℃≦Topr≦85℃	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	V_{IN}=[$V_{OUT(T)}$+2.0]V+0.5V_{p-pAC} I_{OUT}=20mA, f=1kHz, V_{CE}=V_{IN}	-	40	-	dB	③
Short Current	Ishort	V_{IN}=$V_{OUT(T)}$+2.0V, V_{CE}=V_{IN}	-	30	-	mA	①
CE "H" Level Voltage	V_{CEH}		1.0	-	V_{IN}	V	①
CE "L" Level Voltage	V_{CEL}		0	-	0.5	V	①
CE "H" Level Current	I_{CEH}	V_{IN}=V_{CE}=25.0V	-0.1	-	0.1	uA	①
CE "L" Level Current	I_{CEL}	V_{IN}=25.0V, V_{CE}=V_{SS}	-0.1	-	0.1	uA	①

Thermal Shutdown Detect Temperature	T_{TSD}	Junction Temperature	-	150	-	℃	-
Thermal Shutdown Release Temperature	T_{TSR}	Junction Temperature	-	125	-	℃	-
Hysteresis Range	T_{TSD}-T_{TSR}		-	25	-	℃	-

NOTE:

*1: $V_{OUT(T)}$: Specified output voltage

*2: $V_{OUT(E)}$: Effective output voltage

(i.e. the output voltage when "$V_{OUT(T)}$+2.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.)

*3: Vdif={V_{IN1} {Note 5} - V_{OUT1} {Note 4}}

*4: V_{OUT1}: A voltage equal to 98% of the output voltage whenever an amply stabilized I_{OUT}{$V_{OUT(T)}$+2.0V} is input.

*5: V_{IN1}: The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

*6: Unless otherwise stated, V_{IN}=$V_{OUT(T)}$+2.0V.

●XC6216C Series

Ta = 25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Output Voltage	$V_{OUT(E)}$	I_{OUT}=20mA, V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	1.96	2.00	2.04	V	①
Divided Resistor	RFB	V_{IN}=V_{OUT}=5.0V, V_{CE}=V_{SS} V_{OFB}=V_{OUT}	-	2.09	-	Mohm	④
Maximum Output Current	I_{OUTMAX}	V_{IN}=$V_{OUT(T)}$+3.0V, V_{CE}=V_{IN} , V_{OFB}=V_{OUT}	100	-	-	mA	①
Load Regulation	$\triangle V_{OUT}$	V_{IN}=$V_{OUT(T)}$+2.0V 1mA≦I_{OUT}≦100mA V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	-	40	-	mV	①
Dropout Voltage1	Vdif1	I_{OUT}=20mA, V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	-	450	-	mV	①
Dropout Voltage2	Vdif2	I_{OUT}=100mA, V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	-	2000	-	mV	①
Supply Current	I_{SS}	V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	-	5	-	uA	②
Stand-by Current	Istby	V_{CE}=V_{SS}, V_{OFB}=V_{OUT}	-	0.01		uA	②
Line Regulation1	$\triangle V_{OUT}$ / $\triangle V_{IN}$・$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=5mA, V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	0.01	0.05	0.10	%/V	①
Line Regulation2	$\triangle V_{OUT}$ / $\triangle V_{IN}$・$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=13mA, V_{CE}=V_{IN}, V_{OFB}=V_{OUT}	0.03	0.15	0.30	%/V	①
Input Voltage	V_{IN}		2.0	-	25.0	V	-
Output Voltage Temperature Characteristics	$\triangle V_{OUT}$ / $\triangle$Topr・$V_{OUT(T)}$	I_{OUT}=20mA, V_{CE}=V_{IN} -40℃≦Topr≦85℃	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	V_{IN}=[$V_{OUT(T)}$+2.0]V+0.5$V_{p\text{-}pAC}$ I_{OUT}=20mA, f=1kHz, V_{CE}=V_{IN} V_{OFB}=V_{OUT}	-	40	-	dB	③
Short Current	Ishort	V_{IN}=$V_{OUT(T)}$+2.0V, V_{CE}=V_{IN} V_{OFB}=V_{OUT}	-	30	-	mA	①
CE "H" Level Voltage	V_{CEH}	V_{OFB}=V_{OUT}	1.0	-	V_{IN}	V	①
CE "L" Level Voltage	V_{CEL}	V_{OFB}=V_{OUT}	0	-	0.5	V	①
CE "H" Level Current	I_{CEH}	V_{IN}=V_{CE}=25.0V, V_{OFB}=V_{OUT}	-0.1	-	0.1	uA	①
CE "L" Level Current	I_{CEL}	V_{IN}=25.0V, V_{CE}=V_{SS} V_{OFB}=V_{OUT}	-0.1	-	0.1	uA	①

Thermal Shutdown Detect Temperature	T_{TSD}	Junction Temperature	-	150	-	℃	-
Thermal Shutdown Release Temperature	T_{TSR}	Junction Temperature	-	125	-	℃	-
Hysteresis Range	T_{TSD}-T_{TSR}		-	25	-	℃	-

NOTE:

*1: $V_{OUT(T)}$: Specified output voltage

*2: $V_{OUT(E)}$: Effective output voltage

(i.e. the output voltage when "$V_{OUT(T)}$+2.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.)

*3: $V_{OFB(E)}$: Effective V_{OFB} pin voltage

*4: Vdif={V_{IN1} {Note 5} - V_{OUT1} {Note 4}}

*5: V_{OUT1}: A voltage equal to 98% of the output voltage whenever an amply stabilized I_{OUT}{$V_{OUT(T)}$+2.0V} is input.

*6: V_{IN1}: The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

*7: Unless otherwise stated, V_{IN}=$V_{OUT(T)}$+2.0V.

■ELECTRICAL CHARACTERISTICS (Continued)

●XC6216D Series

Ta = 25℃

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Output Voltage	$V_{OUT(E)}$	I_{OUT}=20mA	x 0.98	$V_{OUT(T)}$	x 1.02	V	①
Maximum Output Current	I_{OUTMAX}	V_{IN}=$V_{OUT(T)}$+3.0V ($V_{OUT(T)}$≧3.0V)	150	-	-	mA	①
		V_{IN}=$V_{OUT(T)}$+3.0V ($V_{OUT(T)}$＜3.0V)	100	-	-	mA	①
Load Regulation	△V_{OUT}	V_{IN}=$V_{OUT(T)}$+2.0V 1mA≦I_{OUT}≦100mA	-	40	-	mV	①
Dropout Voltage1	Vdif1	I_{OUT}=20mA	-	200	-	mV	①
Dropout Voltage2	Vdif2	I_{OUT}=100mA	-	1000	-	mV	①
Supply Current	I_{SS}		-	5	-	uA	②
Line Regulation1	△V_{OUT} / △V_{IN}・$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=5mA	0.01	0.05	0.10	%/V	①
Line Regulation2	△V_{OUT} / △V_{IN}・$V_{OUT(T)}$	$V_{OUT(T)}$+2.0V≦V_{IN}≦25.0V I_{OUT}=13mA	0.03	0.15	0.30	%/V	①
Input Voltage	V_{IN}		2.0	-	25.0	V	-
Output Voltage Temperature Characteristics	△V_{OUT} / △Topr・$V_{OUT(T)}$	I_{OUT}=20mA, V_{CE}=V_{IN} -40℃≦Topr≦85℃	-	±100	-	ppm/℃	①
Ripple Rejection Rate	PSRR	V_{IN}=[$V_{OUT(T)}$+2.0]V+0.5V_{p-pAC} I_{OUT}=20mA, f=1kHz	-	40	-	dB	③
Short Current	Ishort	V_{IN}=$V_{OUT(T)}$+2.0V	-	30	-	mA	①

Thermal Shutdown Detect Temperature	T_{TSD}	Junction Temperature	-	150	-	℃	-
Thermal Shutdown Release Temperature	T_{TSR}	Junction Temperature	-	125	-	℃	-
Hysteresis Range	T_{TSD}-T_{TSR}		-	25	-	℃	-

NOTE:

*1: $V_{OUT(T)}$: Specified output voltage

*2: $V_{OUT(E)}$: Effective output voltage

(i.e. the output voltage when "$V_{OUT(T)}$+2.0V" is provided at the V_{IN} pin while maintaining a certain I_{OUT} value.)

*3: Vdif={V_{IN1} {Note 5} - V_{OUT1} {Note 4}}

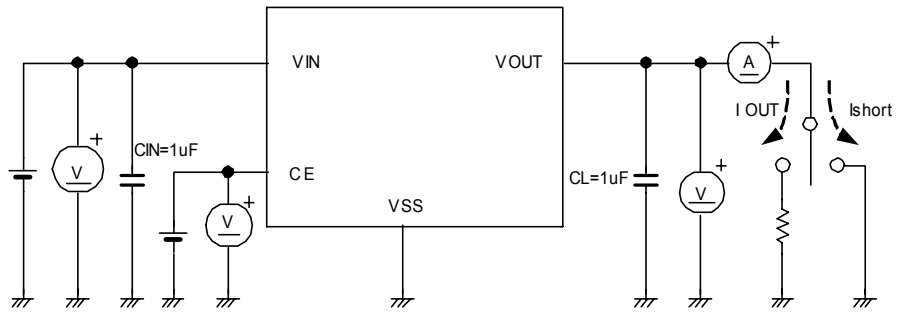
*4: V_{OUT1}: A voltage equal to 98% of the output voltage whenever an amply stabilized I_{OUT}{$V_{OUT(T)}$+2.0V} is input.

*5: V_{IN1}: The input voltage when V_{OUT1} appears as input voltage is gradually decreased.

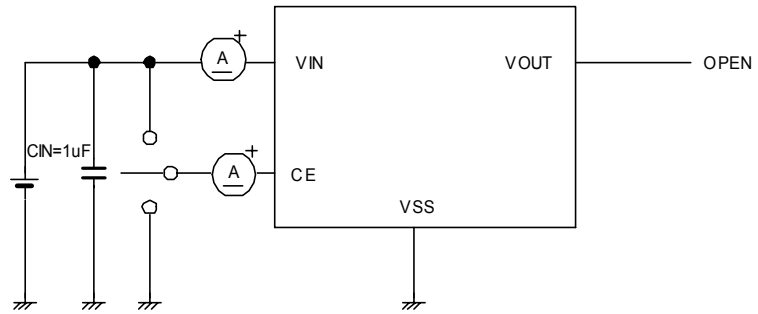
*6: Unless otherwise stated, V_{IN}=$V_{OUT(T)}$+2.0V.

■ TEST CIRCUITS

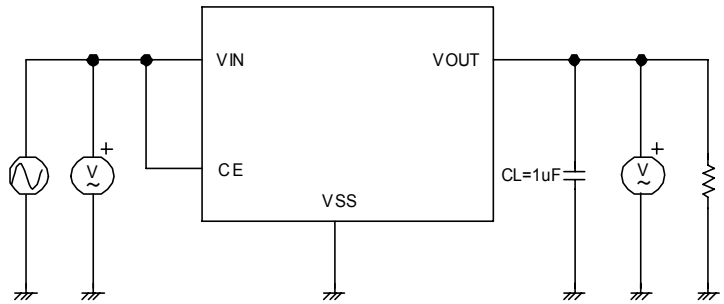
Circuit ①



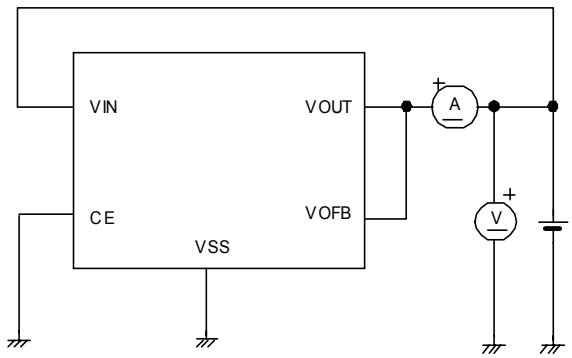
Circuit ②



Circuit ③



Circuit ④

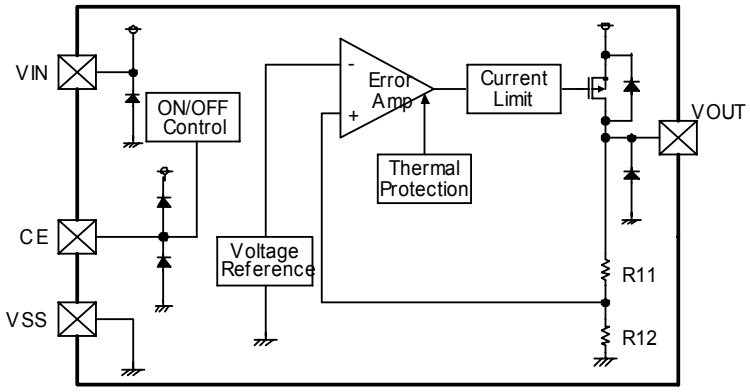


* For testing the XC6216C series, please set V_{OFB}=V_{OUT}.

■ OPERATIONAL EXPLANATION

<Output Voltage Control>

The voltage divided by resistors R11 & R12 is compared with the internal reference voltage by the error amplifier. The P-channel MOSFET, which is connected to the VOUT pin, is then driven by the subsequent output signal. The output voltage at the VOUT pin is controlled and stabilized by a system of negative feedback. The current limit circuit and short protect circuit operate in relation to the level of output current and heat dissipation. Further, the IC's internal circuitry can be shutdown via the CE pin's signal.



<Current Limiter, Short-Circuit Protection>

The XC6216/XE6216 series includes a current limit circuit, which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. The output voltage drops further and output current decreases. When the output pin is shorted, a current of about 30mA flows.

<CE Pin>

The IC's internal circuitry can be shutdown via the signal from the CE pin with the XC6216/XE6216 series. In shutdown mode, output at the VOUT pin will be pulled down by R11 and R12 to the VSS level. Note that as the standard XC6216/XE6216 series is 'High Active/No pull down', operations will become unstable with the CE pin open. We suggest that you use this IC with either a VIN voltage or a VSS voltage input at the CE pin. If this IC is used with the correct specifications for the CE pin, the operational logic is fixed and the IC will operate normally. However, supply current may increase as a result of through current in the IC's internal circuitry if a medium voltage is applied.

<Thermal Shutdown>

When the junction temperature of the built-in driver transistor reaches the temperature limit level (150°C TYP.), the thermal shutdown circuit operates and the driver transistor will be set to OFF. The IC resumes its operation when the thermal shutdown function is released and the IC's operation is automatically restored because the junction temperature drops to the level of the thermal shutdown release voltage.

<Minimum Operating Voltage>

For the stable operation of the IC, over 2.0V of input voltage is necessary. The output voltage may not be generated normally if the input voltage is less than 2.0V.

■ NOTES ON USE

1. Please use this IC within the stated absolute maximum ratings. The IC is liable to malfunction should the ratings be exceeded.
2. Where wiring impedance is high, operations may become unstable due to the noise and/or phase lag depending on output current. Please strengthen VIN and VSS wiring in particular.
3. Phase compensation inside the IC is performed in the XC6216/XE6216 series. Therefore, an abnormal oscillation does not occur even if there is no output capacitor CL. An input capacitor CIN around 0.1uF~1.0uF between the VIN pin and the VSS pin is required for input stability. Also, the output voltage fluctuation such as under shoot or over shoot, which occurs because of the load change can be controlled by placing the output capacitor CL around 0.1uF~1.0uF between the VOUT pin and VSS pin. The input capacitor (CIN) and the output capacitor (CL) should be placed to the IC as close as possible with a shorter wiring.

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