28 V, 150 mA Voltage Regulator with Stand-by Mode

FEATURES

- Operating Voltage Range 2.0 V – 28.0 V
- Output Voltage Range from 2.0 V to 12.0 V with 0.1 V increments (B series) or 2.0 V – 23 V with external resistors (C series)
- Output Voltage Accuracy ± 2%
- Dropout Voltage 300 mV @ I_{OUT} = 20 mA
- Temperature Stability ± 30 ppm/^{0}C
- Low Power Consumption of 5 µA at V_{OUT} = 5.0 V
- Output Current up to 150 mA (200 mA limit) at $V_{IN} = V_{OUT} + 3$ V
- Standby Current less than 0.1 µA typical
- Power Supply Ripple Rejection 30 dB at 1 kHz
- Current Limit and Short Circuit Protection
- Low ESR Ceramic Capacitor compatible
- ON/OFF switch,
- Thermal shutdown
- Operating Ambient Temperature - 40 + 85^{0}C
- Packages : SOT-25, SOT- 89, SOT-89-5, SOP-8FD, USP-6C, SOT-223, and TO-252
- EU RoHS Compliant, Pb Free

APPLICATIONS

- Mobile phones
- Car Audio and Navigation Systems
- Cameras, VCRs
- Various portable equipment

DESCRIPTION

The IXD1216 is positive voltage regulator with operation voltage up to 28V, manufactured by CMOS process.

The IC consists of a voltage reference, an error amplifier, a current limiter, a thermal protection, a phase compensation circuit, and a driver transistor.

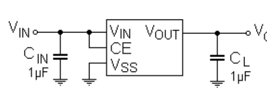
The output voltage is selectable in 0.1 V increments within the range from 2.0 V to 12 V for B and D series and from 2.0 V to 23 V with external resistors for C series. High precision output voltage achieved by laser trimming technology.

The IXD1216 is stable with low ESR ceramic output capacitor (C_L). The over current protection circuit and the thermal shutdown are built-in. These two protection circuits operate when the output current reaches current limit level or the junction temperature reaches temperature limit.

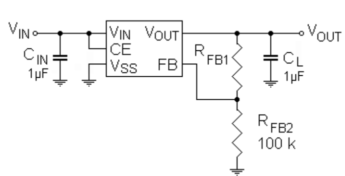
The Chip Enable (CE) function allows set IXD1216 into standby mode, reducing current consumption to less than 0.1 µA typically.

The IXD1216 is available in SOT-25, SOT-89, SOT-89-5, SOP-8FD, USP-6C, SOT-223, and TO-252 packages.

TYPICAL APPLICATION CIRCUIT



The IXD1216B with C

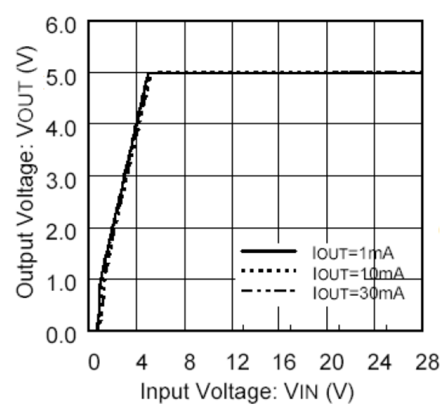


The IXD1216C series

TYPICAL PERFORMANCE CHARACTERISTIC

Output Voltage vs. Input Voltage (IXD1216B/D502)

$C_{IN} = C_L = 1$ µF, Ta = 25^{0}C,



ABSOLUTE MAXIMUM RATINGS

PARAMETER		SYMBOL	RATINGS	UNITS
Input Voltage		V_{IN}	– 0.3 ~ +30	V
Output Current		I_{OUT}	300[1]	mA
Output Voltage		V_{OUT}	– 0.3 ~ V_{IN} + 0.3 or +30[2]	V
CE Input Voltage (IXD1216B/C version only)		V_{CE}	– 0.3 ~ V_{IN} + 0.3 or +30[2]	V
FB Voltage (IXD1216C version only)		V_{FB}	– 0.3 ~ V_{IN} + 0.3 or +30[2]	V
Power Dissipation[2]	SOT-25	P_D	250	mW
			600 (PCB mounted)	
	SOT-89		500	
			1000 (PCB mounted)	
	SOT-89-5		500	
			1300 (PCB mounted)	
	USP-6C		120	
			1000 (PCB mounted)	
	SOT223		300	
			1500 (PCB mounted)	
	TO-252		500	
			1800 (PCB mounted)	
	SOP-8FD		300	
			1500 (PCB mounted)	
Operating Temperature Range		T_{OPR}	– 40 ~ + 85	^{0}C
Storage Temperature Range		T_{STG}	– 55 ~ +125	^{0}C

All voltages are in respect to V_{SS}

1) $I_{OUT} \leq Pd/(V_{IN}-V_{OUT})$
2) The lowest value between V_{IN} + 0.3 and 30 V
3) This is a reference data taken by using the test board. Please refer to page 24 to 30 for details

ELECTRICAL OPERATING CHARACTERISTICS

Ta = 25 °C

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT	CIRCUIT
Input Voltage	V_{IN}		2.0		28.0	V	①
Output Voltage	$V_{OUT(E)}$ 1)	$V_{CE} = V_{IN}$, I_{OUT} = 20 mA 5)	E-0			V	①
		$V_{FB} = V_{CE} = V_{IN}$ = 4.0 V, I_{OUT} = 20 mA 6); 2% accuracy	1.96	2.00	2.04		
		$V_{FB} = V_{CE} = V_{IN}$ = 4.0 V, I_{OUT} = 20 mA 6); 1 % accuracy	1.98	2.00	2.02		
Maximum Output Current	I_{OUT_MAX}	$V_{CE} = V_{IN} = V_{OUT(T)}$ + 3 V; $V_{OUT(T)} \geq 3$ V	150			mA	①
		$V_{CE} = V_{IN} = V_{OUT(T)}$ + 3 V; $V_{OUT(T)} < 3$ V	100				
Load Regulation	ΔV_{OUT}	$V_{CE} = V_{IN}$, 1 mA ≤ I_{OUT} ≤ 50 mA; 2.0 V ≤ $V_{OUT(T)}$ ≤ 7.0 V		50	90	mV	①
		$V_{CE} = V_{IN}$, 1 mA ≤ I_{OUT} ≤ 50 mA; 7.1 V ≤ $V_{OUT(T)}$ ≤ 12.0 V		110	140		
Dropout Voltage 2)	V_{DIF1}	$V_{CE} = V_{IN}$, I_{OUT} = 20 mA	E-1 4)			mV	①
		$V_{CE} = V_{IN}$, $V_{FB} = V_{OUT}$, I_{OUT} = 20 mA 6)		450	600		
	V_{DIF2}	$V_{CE} = V_{IN}$, I_{OUT} = 100 mA	E-2 4)				
		$V_{CE} = V_{IN}$, $V_{FB} = V_{OUT}$, I_{OUT} = 100 mA 6)		1900	2600		
Supply Current	I_{SS}	$V_{CE} = V_{IN}$	1	5	9	µA	②
Standby Current	I_{STB}	V_{CE} = 0 V		0.01	0.10	µA	②
Line Regulation	$\frac{\Delta V_{OUT}}{V_{OUT} * \Delta V_{IN}}$	$V_{OUT(T)}$ + 2 V ≤ V_{IN} ≤ 28 V, $V_{CE} = V_{IN}$; I_{OUT} = 5 mA		0.05	0.10	%/V	①
		$V_{OUT(T)}$ + 2 V ≤ V_{IN} ≤ 28 V, $V_{CE} = V_{IN}$; I_{OUT} = 13 mA		0.15	0.30		
Output Voltage Temperature Characteristics	$\frac{\Delta V_{OUT}}{V_{OUT} * \Delta T_{OPR}}$	$V_{CE} = V_{IN}$, I_{OUT} = 30 mA - 40 °C ≤ T_{OPR} ≤ 85 °C		± 100		ppm/°C	①
Power Supply Rejection Ratio	PSRR	$V_{CE} = V_{IN}$, I_{OUT} = 20 mA, f = 1 kHz V_{IN} = ($V_{OUT)T)}$ + 2) V_{DC} + 0.5 V p-p_{AC}		30		dB	③
Short Circuit Current	I_{SHORT}	$V_{CE} = V_{IN}$, $V_{IN} = V_{OUT)T)}$ + 2 V		30		mA	①
Thermal Shutdown Detect Temperature	T_{TSD}	Junction Temperature		150		°C	
Thermal Shutdown Hystetresis	T_{HYS}			25		°C	
CE “H” Level Voltage 5)	V_{CEH}		1.1		V_{IN}	V	①
CE “L” Level Voltage 5)	V_{CEL}		0		0.35	V	①
CE “H” Level Current 5)	I_{CEH}	$V_{CE} = V_{IN}$ = 28.0 V	-0.1		0.1	µA	①
CE “L” Level Current 5)	I_{CEL}	V_{IN} = 28.0 V, $V_{CE} = V_{SS}$	-0.1		0.1	µA	①
FB Pin Resistance	R_{FB}	$V_{FB} = V_{IN} = V_{OUT}$ = 5.0 V, $V_{CE} = V_{SS}$	1.70	4.10	6.30	MΩ	

NOTE:

Unless otherwise stated, $V_{IN} = V_{CE} = V_{OUT\ (T)}$ +2.0 V

1) $V_{OUT\ (T)}$ is Nominal output voltage and $V_{OUT\ (E)}$ is Effective output voltage, (I.e. the output voltage when "$V_{OUT\ (T)}$ +1.0V" is provided at the V_{IN} pin, while maintaining a certain I_{OUT} value).
2) V_{DIF} = {V_{IN}-V_{OUT}}, where V_{IN1} is the input voltage when V_{OUT} = 0.98 $V_{OUT(T)}$ appears, while input voltage gradually decreases
3) Refer to the Table “Voltage Chart, Output Voltage”
4) Refer to the Table “Voltage Chart, Dropout Voltage”
5) IXD1216B/C versions only
6) IXD1216C version only

ELECTRICAL OPERATING CHARACTERISTICS (CONTINUED)

Voltage Chart

Ta = 25^{0}C

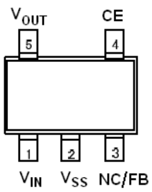
SYMBOL	E-0				E-1		E-2	
OUTPUT VOLTAGE	OUTPUT VOLTAGE, V				DROPOUT VOLTAGE, mV		DROPOUT VOLTAGE, mV	
	$V_{OUT (E)}$				I_{OUT} = 20 mA		I_{OUT} = 100 mA	
$V_{OUT(T)}$	2% accuracy		1% accuracy		Vdif1		Vdif2	
(V)	MIN.	MAX.	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
2.0	1.960	2.040	1.980	2.020	450	600	1900	2600
2.1	2.058	2.142	2.079	2.121	450	600	1900	2600
2.2	2.156	2.244	2.178	2.222	390	520	1700	2200
2.3	2.254	2.346	2.277	2.323	390	520	1700	2200
2.4	2.352	2.448	2.376	2.424	390	520	1700	2200
2.5	2.450	2.550	2.475	2.525	310	450	1500	1900
2.6	2.548	2.652	2.574	2.626	310	450	1500	1900
2.7	2.646	2.754	2.673	2.727	310	450	1500	1900
2.8	2.744	2.856	2.772	2.828	310	450	1500	1900
2.9	2.842	2.958	2.871	2.929	310	450	1500	1900
3.0	2.940	3.060	2.970	3.030	260	360	1300	1700
3.1	3.038	3.162	3.069	3.131	260	360	1300	1700
3.2	3.136	3.264	3.168	3.232	260	360	1300	1700
3.3	3.234	3.366	3.267	3.333	260	360	1300	1700
3.4	3.332	3.468	3.366	3.434	260	360	1300	1700
3.5	3.430	3.570	3.465	3.535	260	360	1300	1700
3.6	3.528	3.672	3.564	3.636	260	360	1300	1700
3.7	3.626	3.774	3.663	3.737	260	360	1300	1700
3.8	3.724	3.876	3.762	3.838	260	360	1300	1700
3.9	3.822	3.978	3.861	3.939	260	360	1300	1700
4.0	3.920	4.080	3.960	4.040	220	320	1100	1500
4.1	4.018	4.182	4.059	4.141	220	320	1100	1500
4.2	4.116	4.284	4.158	4.242	220	320	1100	1500
4.3	4.214	4.386	4.257	4.343	220	320	1100	1500
4.4	4.312	4.488	4.356	4.444	220	320	1100	1500
4.5	4.410	4.590	4.455	4.545	220	320	1100	1500
4.6	4.508	4.692	4.554	4.646	220	320	1100	1500
4.7	4.606	4.794	4.653	4.747	220	320	1100	1500
4.8	4.704	4.896	4.752	4.848	220	320	1100	1500
4.9	4.802	4.998	4.851	4.949	220	320	1100	1500
5.0	4.900	5.100	4.950	5.050	190	280	1000	1300
5.1	4.998	5.202	5.049	5.151	190	280	1000	1300
5.2	5.096	5.304	5.148	5.252	190	280	1000	1300
5.3	5.194	5.406	5.247	5.353	190	280	1000	1300
5.4	5.292	5.508	5.346	5.454	190	280	1000	1300
5.5	5.390	5.610	5.445	5.555	190	280	1000	1300
5.6	5.488	5.712	5.544	5.656	190	280	1000	1300
5.7	5.586	5.814	5.643	5.757	190	280	1000	1300
5.8	5.684	5.916	5.742	5.916	190	280	1000	1300
5.9	5.782	6.018	5.841	5.959	190	280	1000	1300
6.0	5.880	6.120	5.940	6.060	190	280	1000	1300
6.1	5.978	6.222	6.039	6.161	190	280	1000	1300
6.2	6.076	6.324	6.138	6.262	190	280	1000	1300
6.3	6.174	6.426	6.237	6.363	190	280	1000	1300
6.4	6.272	6.528	6.336	6.464	190	280	1000	1300
6.5	6.370	6.630	6.435	6.565	170	230	800	1150
6.6	6.468	6.732	6.534	6.666	170	230	800	1150
6.7	6.566	6.834	6.633	6.767	170	230	800	1150
6.8	6.664	6.936	6.732	6.868	170	230	800	1150
6.9	6.762	7.038	6.831	6.969	170	230	800	1150
7.0	6.860	7.140	6.930	7.070	170	230	800	1150

ELECTRICAL OPERATING CHARACTERISTICS (CONTINUED)

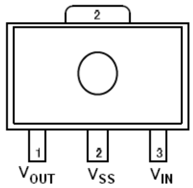
Voltage Chart (Continued)

SYMBOL	E-0				E-1		E-2	
OUTPUT VOLTAGE $V_{OUT(T)}$	OUTPUT VOLTAGE, V $V_{OUT (E)}$				DROPOUT VOLTAGE, mV I_{OUT} = 20 mA		DROPOUT VOLTAGE, mV I_{OUT} = 100 mA	
	2% accuracy		1% accuracy		Vdif1		Vdif2	
(V)	MIN.	MAX.	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
7.1	6.958	7.242	7.029	7.171	170	230	800	1150
7.2	7.056	7.344	7.128	7.272	170	230	800	1150
7.3	7.154	7.446	7.227	7.373	170	230	800	1150
7.4	7.252	7.548	7.326	7.474	170	230	800	1150
7.5	7.350	7.650	7.425	7.575	170	230	800	1150
7.6	7.448	7.752	7.524	7.676	170	230	800	1150
7.7	7.546	7.854	7.623	7.777	170	230	800	1150
7.8	7.644	7.956	7.722	7.878	170	230	800	1150
7.9	7.742	8.058	7.821	7.979	170	230	800	1150
8.0	7.840	8.160	7.920	8.080	170	230	800	1150
8.1	7.938	8.262	8.019	8.181	130	190	700	950
8.2	8.036	8.364	8.118	8.282	130	190	700	950
8.3	8.134	8.466	8.217	8.383	130	190	700	950
8.4	8.232	8.568	8.316	8.484	130	190	700	950
8.5	8.330	8.670	8.415	8.585	130	190	700	950
8.6	8.428	8.772	8.514	8.686	130	190	700	950
8.7	8.526	8.874	8.613	8.787	130	190	700	950
8.8	8.624	8.976	8.712	8.888	130	190	700	950
8.9	8.722	9.078	8.811	8.989	130	190	700	950
9.0	8.820	9.180	8.910	9.090	130	190	700	950
9.1	8.918	9.282	9.009	9.191	130	190	700	950
9.2	9.016	9.384	9.108	9.292	130	190	700	950
9.3	9.114	9.486	9.207	9.393	130	190	700	950
9.4	9.212	9.588	9.306	9.494	130	190	700	950
9.5	9.310	9.690	9.405	9.595	130	190	700	950
9.6	9.408	9.792	9.504	9.696	130	190	700	950
9.7	9.506	9.894	9.603	9.797	130	190	700	950
9.8	9.604	9.996	9.702	9.898	130	190	700	950
9.9	9.702	10.098	9.801	9.999	130	190	700	950
10.0	9.800	10.200	9.900	10.100	130	190	700	950
10.1	9.898	10.302	9.999	10.201	120	160	650	850
10.2	9.996	10.404	10.098	10.302	120	160	650	850
10.3	10.094	10.506	10.197	10.403	120	160	650	850
10.4	10.192	10.608	10.296	10.504	120	160	650	850
10.5	10.290	10.710	10.395	10.605	120	160	650	850
10.6	10.388	10.812	10.494	10.706	120	160	650	850
10.7	10.486	10.914	10.593	10.807	120	160	650	850
10.8	10.584	11.016	10.692	10.908	120	160	650	850
10.9	10.682	11.118	10.791	11.009	120	160	650	850
11.0	10.780	11.220	10.890	11.110	120	160	650	850
11.1	10.878	11.322	10.989	11.211	120	160	650	850
11.2	10.976	11.424	11.088	11.312	120	160	650	850
11.3	11.074	11.526	11.187	11.413	120	160	650	850
11.4	11.172	11.628	11.286	11.514	120	160	650	850
11.5	11.270	11.730	11.385	11.615	120	160	650	850
11.6	11.368	11.832	11.484	11.716	120	160	650	850
11.7	11.466	11.934	11.583	11.817	120	160	650	850
11.8	11.564	12.036	11.682	11.918	120	160	650	850
11.9	11.662	12.138	11.781	12.019	120	160	650	850
12.0	11.760	12.240	11.880	12.120	120	160	650	850

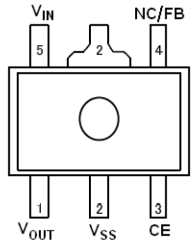
PIN CONFIGURATION



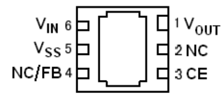
SOT-25 (TOP VIEW)



SOT-89 (TOP VIEW)

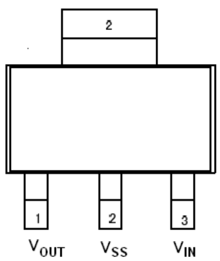


SOT-89-5 (TOP VIEW)

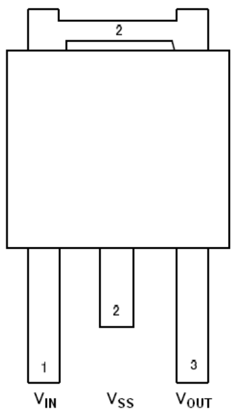


USP-6C (BOTTOM VIEW)

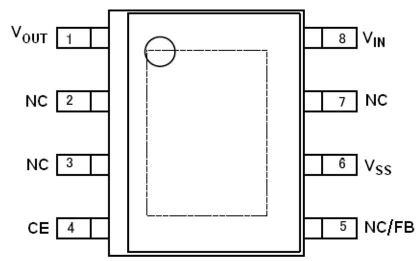
The dissipation pad for the USP-6C package should be solder-plated in respect with mounting pattern and metal mask to improve heat dissipation and. mounting strength. If the pad needs to be connected to other pins, it should be connected to the V_{SS} (No. 5) pin.



SOT-223 (TOP VIEW)



TO-252 (TOP VIEW)



SOP-8FD (TOP VIEW)

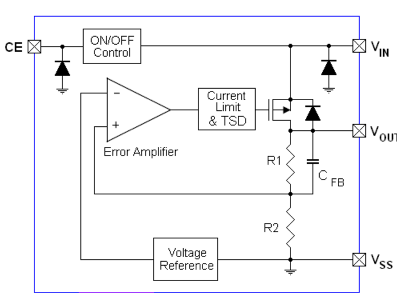
PIN ASSIGNMENT

PIN NUMBER							PIN NAME	FUNCTIONS
SOT-25	SOT-89	SOT-89-5	USP-6C	SOT-223	TO-252	SOP-8FD		
1	3	5	6	3	1	8	V_{IN}	Power Input
2	2	2	5	2	2	6	V_{SS}	Ground
5	1	1	1	1	3	1	V_{OUT}	Output Voltage
4		3	3			4	CE	ON/OFF Control LOW – Standby mode, HIGH – Active[1)]
			2			2, 3, 7	NC	No Connection
3		4	4			5		No Connection (B series)/FB (C series)

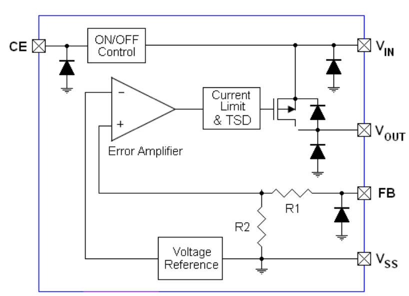
1) CE pin does not have internal pull-down resistor. IC state is undefined, if this pin is open.

BLOCK DIAGRAMS

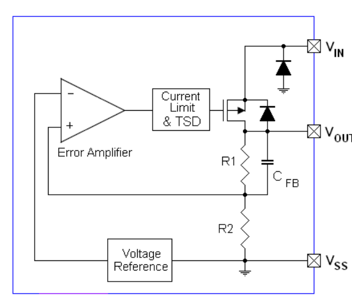
IXD1216B



IXD1216C



IXD1216D



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

BASIC OPERATION

The Error Amplifier of the IXD1216 series monitors output voltage divided by internal resistors R1 & R2 and compares it with the internal Reference Voltage (see Block Diagram above). The output signal from error amplifier drives gate of the P-channel MOSFET, which is connected to the V_{OUT} pin and operates as a series voltage regulator.

The Current Limit/Short Protection circuits monitor level of the output current, and Thermal shutdown circuit monitors MOSFET junction temperature to prevent IC damage by excessive current.

The CE pin allows shutdown internal circuitry to minimize power consumption.

Current Limiter, Short-Circuit Protection

The IXD1216 series have a current limiter circuit & a fold back 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 activates and output voltage drops. Because of this drop, the fold back circuit activates too, and output voltage drops further decreasing output current. When the output pin is shorted, a current of about 30 mA flows.

Thermal Shutdown

When the junction temperature of the built-in transistor reaches the temperature limit, the thermal shutdown circuit activates and turns transistor OFF. The IC resumes normal operation when the junction temperature falls below value determined by Thermal Shutdown Hysteresis.

CE Pin

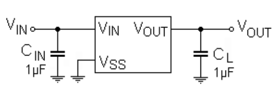
The CE pin allows shutdown internal circuitry to minimize power consumption. In shutdown mode, output at the V_{OUT} pin is pulled down to the V_{SS} level by resistors R1 and R2 connected in series.

Note that the CE input is active HIGH and has no pull down resistor. IC will be in undefined state, if CE pin is open. CE pin should be connected to either V_{IN} or ground. IC current consumption may increase, if voltage applied to this pin is ~ 0.5 of V_{IN}.

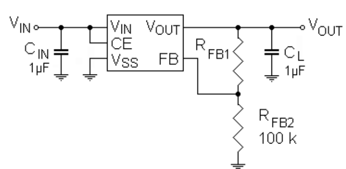
Minimum Operating Voltage

The input voltage should be above 2.0 V for the stable IC operation.

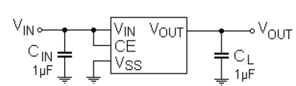
TYPICAL APPLICATION CIRCUIT



IXD1216B version



IXD1216C version



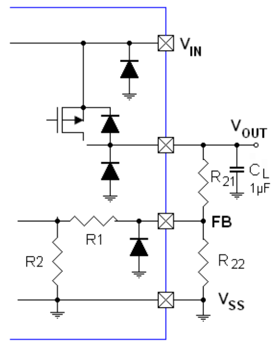
IXD1216D version

LAYOUT AND USE CONSIDERATIONS

1. Mount external component as close to the IC as possible and use thick, short connecting traces to reduce the circuit impedance.
2. The IC may malfunction if absolute maximum ratings are exceeded.
3. If power source of this regulator is a high impedance device, an input capacitor $C_{IN} \geq 0.1\mu F$ should be used to prevent oscillations.
4. The internal phase compensation guarantees the IXD1216 stable operations even without load capacitor C_L. However, load capacitor $C_L = 0.1 – 1.0\ \mu F$ located as close to V_{OUT} and V_{SS} pins may improve regulator's dynamic characteristics, reducing over/undershoot at heavy load.
5. In case of high output current, increasing the input capacitor value can stabilize operations.
6. Please ensure that output current I_{OUT} is less than $P_D / (V_{IN} - V_{OUT})$, where P_D is a rated power dissipation value of the package shown at ABSOLUTE MAXIMUM RATING table to not exceed it.
7. The IXD1216C version requires external resistive divider to set output voltage above 2.0 V. Output voltage determined by resistors R_{21}/R_{22} as well as resistance of the internal resistive divider R_{FB}, which is in the range from 1.7 MΩ to 6.3 MΩ.

$$V_{OUT} = 2.0\text{V x} \left(\frac{R_{21} + R_{22}}{R_{22}} + \frac{R_{21}}{R_{FB}}\right)$$

Component R_{21}/R_{FB} determines error in voltage setting and it should be taken into considerations, if R_{21} value is close to value of R_{FB}. If R_{21} is less than 10 kΩ, this error is negligible.



Example:
If R_{21} = 64.9 kΩ and R_{22} = 100 kΩ, output voltage may vary from part to part due difference in R_{FB} from 3.318 V to 3.374 V.
If R_{21} = 6.49 Ω and R_{22} = 10 kΩ, output voltage will vary from part to part due difference in R_{FB} from 3.300 V to 3.306 V.

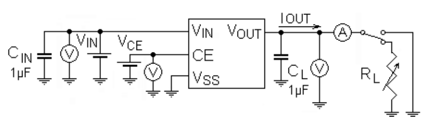
TEST CIRCUITS

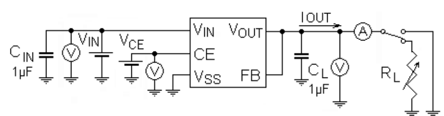
Circuit ①

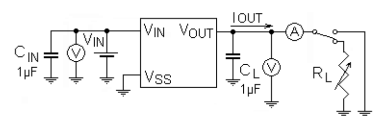
IXD1216B IXD1216C IXD1216D

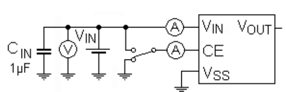
Circuit ②

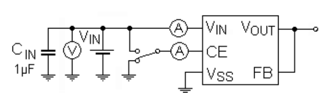
IXD1216B IXD1216C IXD1216D

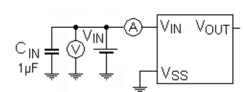








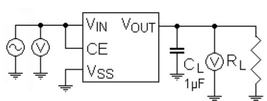


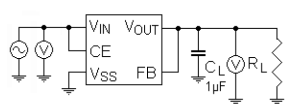


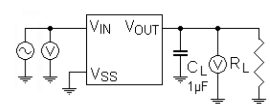
Circuit ③

IXD1216B

IXD2116C IXD1216D

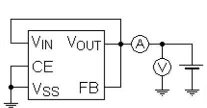






Circuit ④

IXD1216C

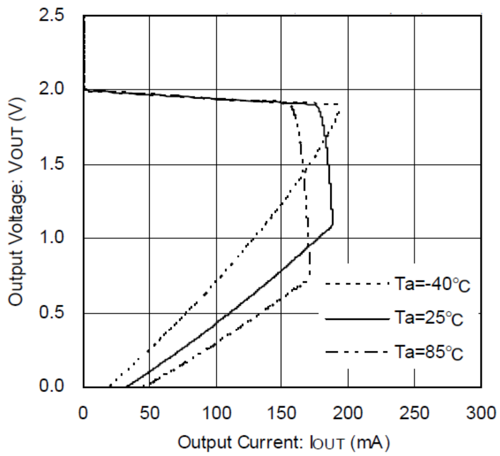


Unless otherwise stated, Ta = 25^{0}C, $V_{CE} = V_{IN}$, $C_{IN} = C_L$ = 1 µF (ceramic)
The IXD1216D has CE pin connected to V_{IN} internally.

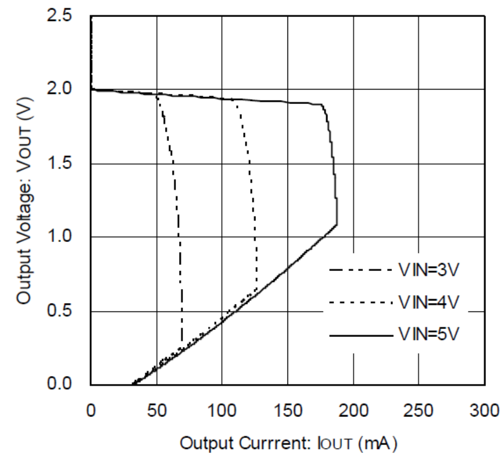
TYPICAL PERFORMANCE CHARACTERISTICS

(1) Output Voltage vs. Output Current

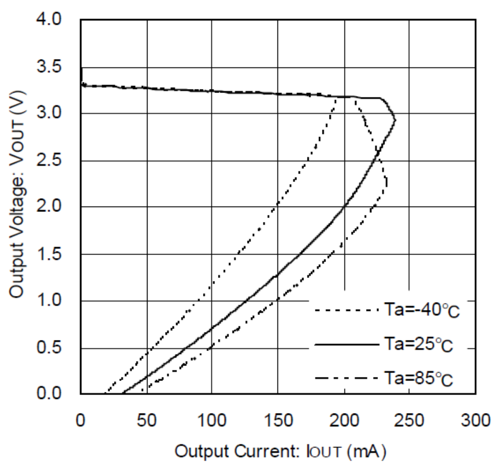
IXD1216x202xx
$V_{IN} = V_{CE} = 5.0$ V



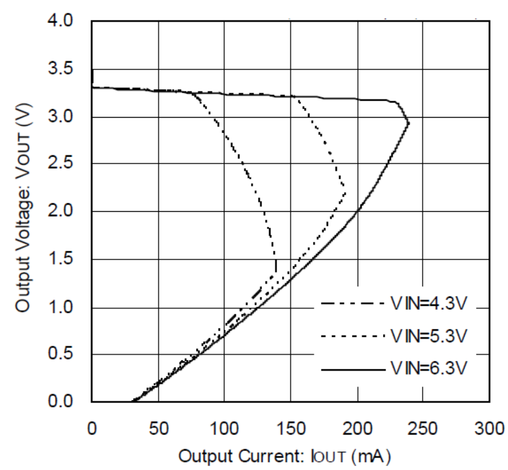
IXD1216x202xx
$V_{IN} = V_{CE}$, Ta = 25°C



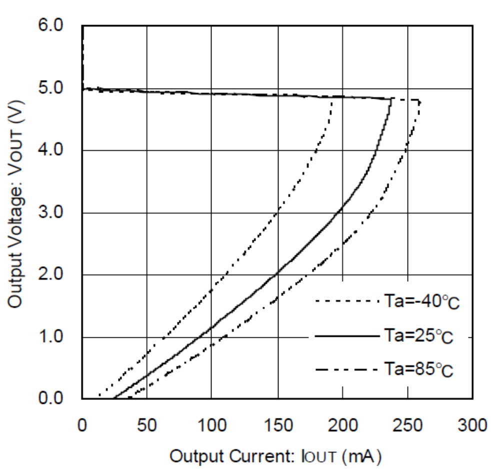
IXD1216B/D 332xx
$V_{IN} = V_{CE} = 6.3$ V



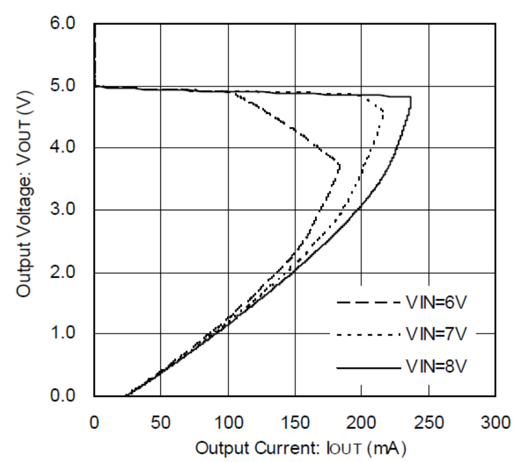
IXD1216B/D 332xx
$V_{IN} = V_{CE}$, Ta = 25°C



IXD1216B/D 502xx
$V_{IN} = V_{CE} = 8.0$ V



IXD1216B/D 502xx
$V_{IN} = V_{CE}$, Ta = 25°C

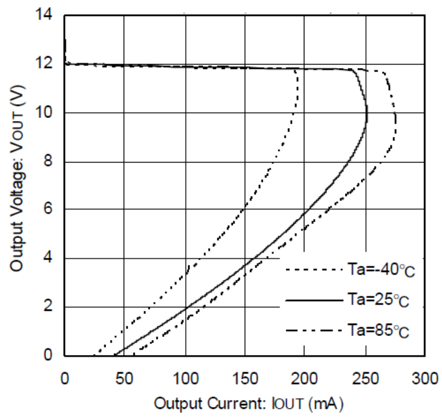


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

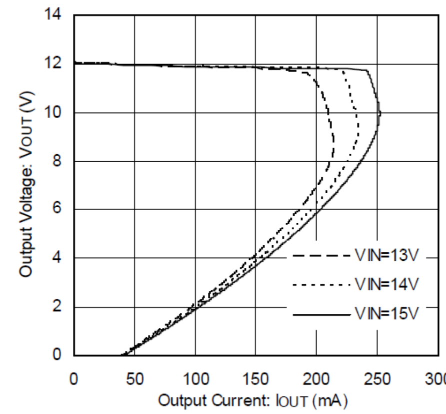
(1) Output Voltage vs Output Current (Continue)

Topr = 25 ^{0}C

IXD1216B/D C02xx
$V_{IN} = V_{CE} = 15.0$ V

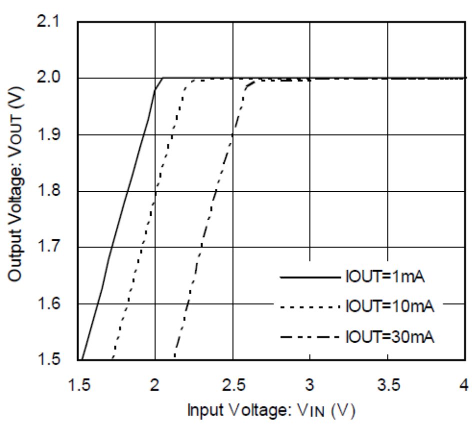


IXD1216B/D C02xx
$V_{IN} = V_{CE}$, Ta = 25^{0}C

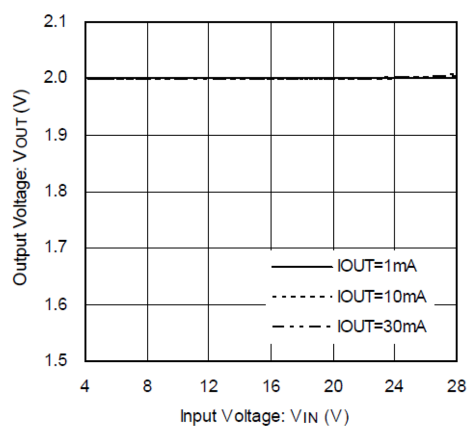


(2) Output Voltage vs. Input Voltage

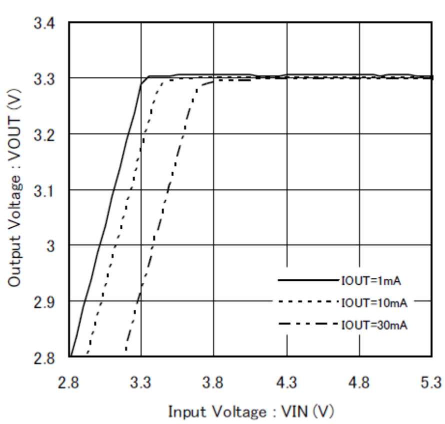
IXD1216x202xx
$V_{IN} = V_{CE}$, Ta = 25^{0}C



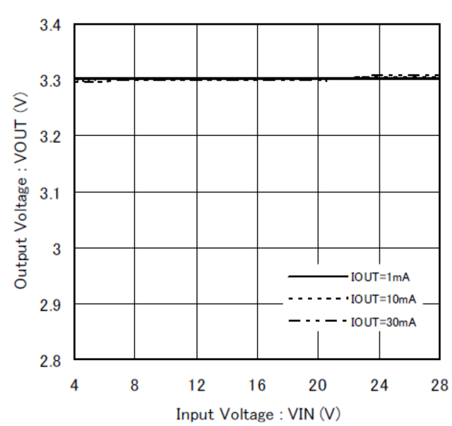
IXD1216x202xx
$V_{IN} = V_{CE}$, Ta = 25^{0}C



IXD1216B/D 332xx
$V_{IN} = V_{CE}$, Ta = 25^{0}C



IXD1216B/D 332xx
$V_{IN} = V_{CE}$, Ta = 25^{0}C

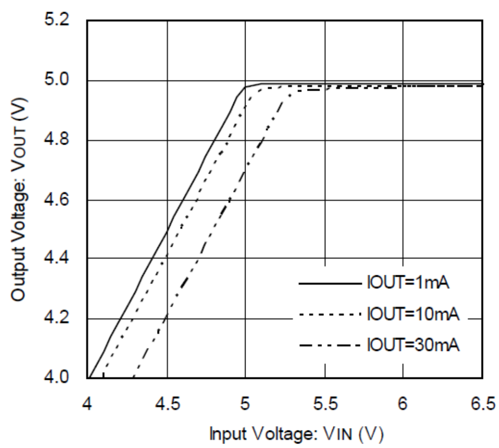


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(2) Output Voltage vs. Input Voltage

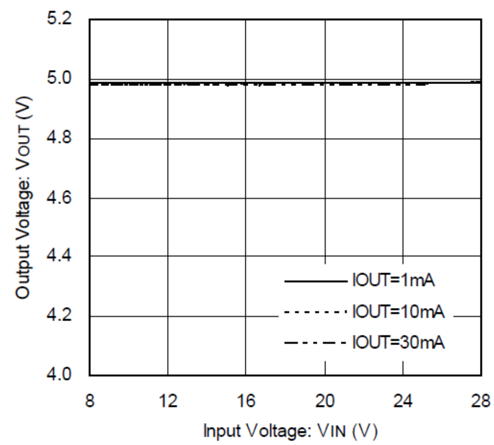
IXD1216B/D 502xx

$V_{IN} = V_{CE}$, Ta = 25^0C



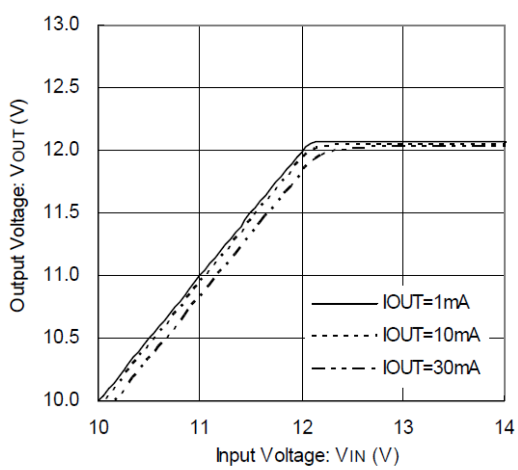
IXD1216B/D 502xx

$V_{IN} = V_{CE}$, Ta = 25^0C



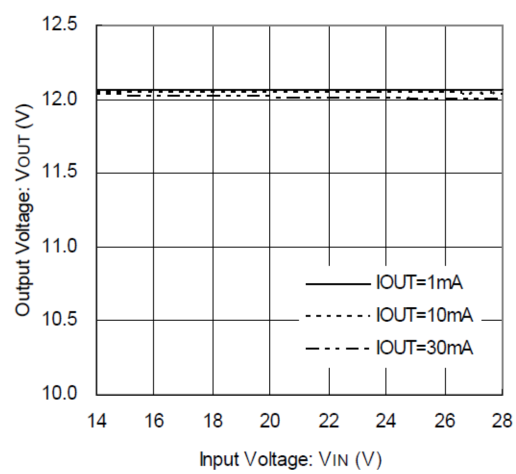
IXD1216B/D C02xx

$V_{IN} = V_{CE}$, Ta = 25^0C



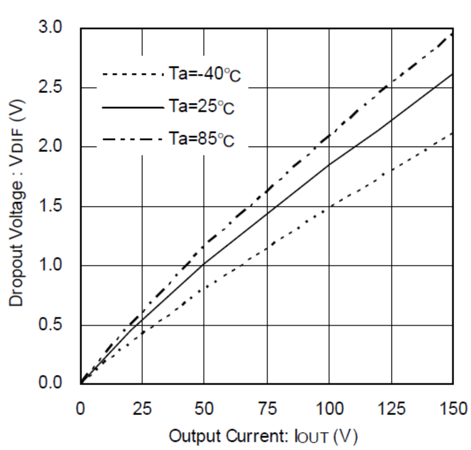
IXD1216B/D C02xx

$V_{IN} = V_{CE}$, Ta = 25^0C

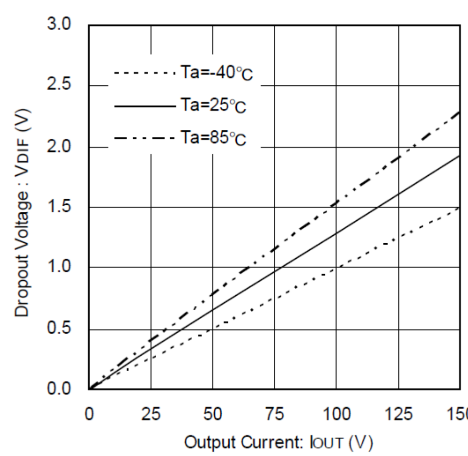


(3) Dropout Voltage vs. Output Current

IXD1216x202xx



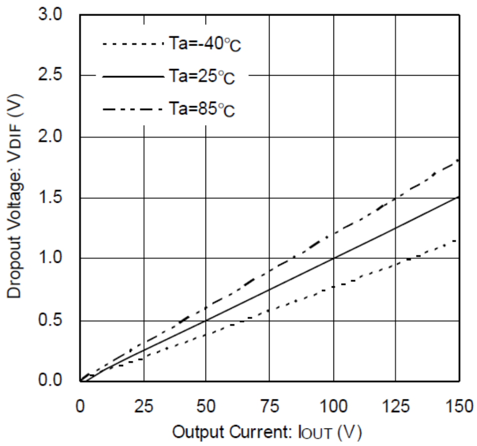
IXD1216B/D 332xx



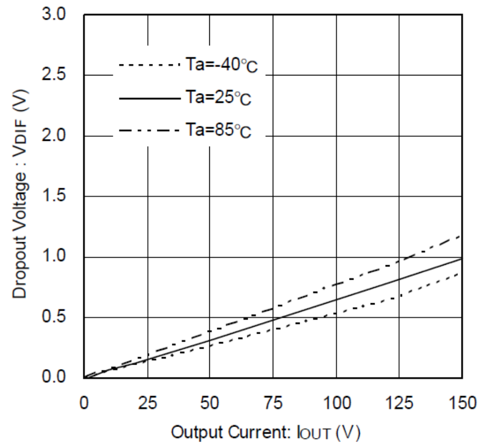
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(3) Dropout Voltage vs. Output Current (Continued)

IXD1216B/D 502xx

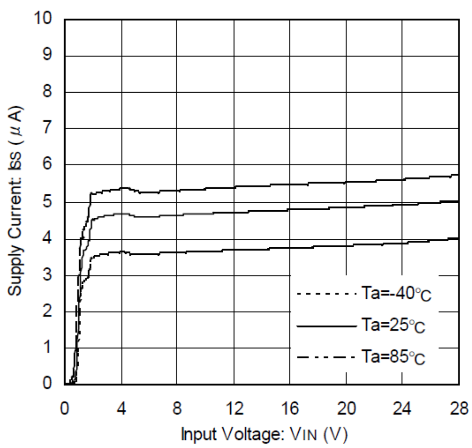


IXD1216B/D C02xx

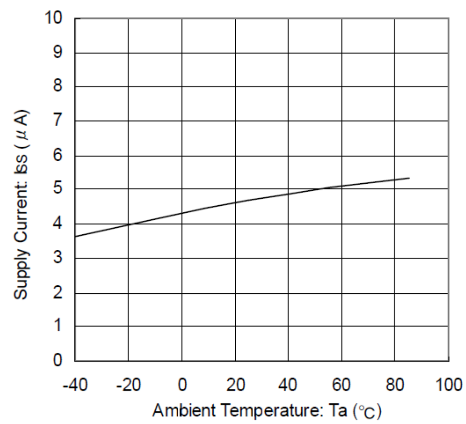


(4) Supply Current vs. Input Voltage

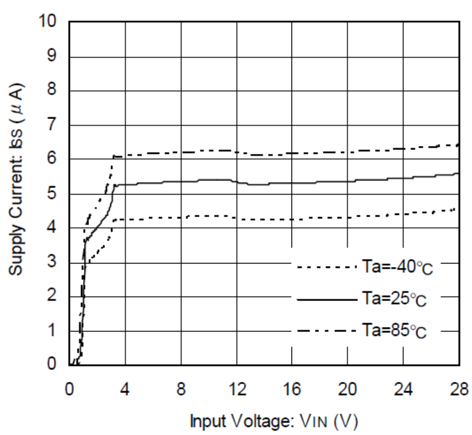
IXD1216x202xx
$V_{IN} = V_{CE}$



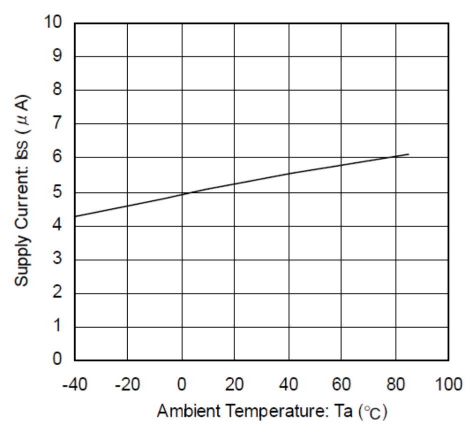
IXD1216x202xx
$V_{IN} = V_{CE} = 4.0$ V



IXD1216B/D 332xx
$V_{IN} = V_{CE}$



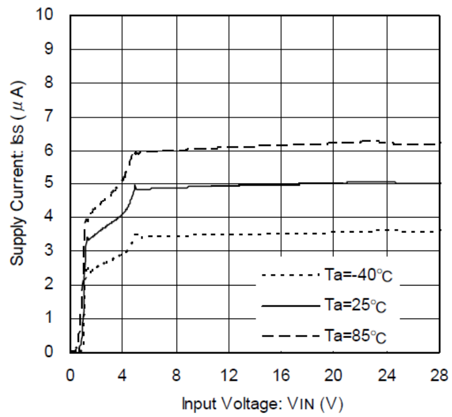
IXD1216B/D 332xx
$V_{IN} = V_{CE} = 5.3$ V



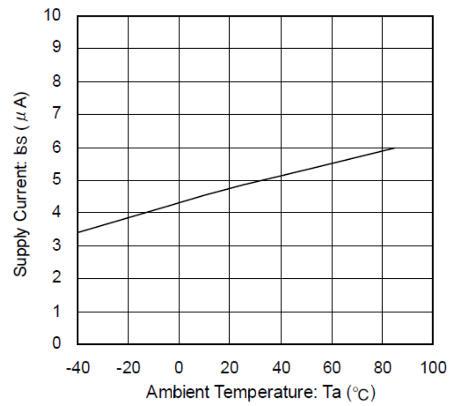
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(4) Supply Current vs. Input Voltage (Continued)

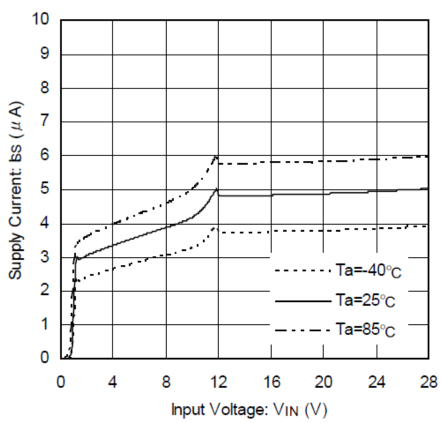
IXD1216B/D 502xx
$V_{IN} = V_{CE}$



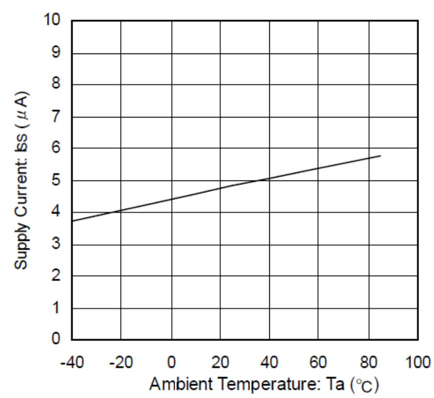
IXD1216B/D 502xx
$V_{IN} = V_{CE} = 7.0$ V



IXD1216B/D C02xx
$V_{IN} = V_{CE}$

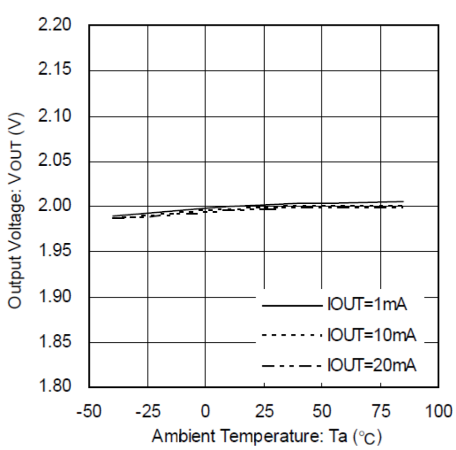


IXD1216B/D C02xx
$V_{IN} = V_{CE} = 14.0$ V

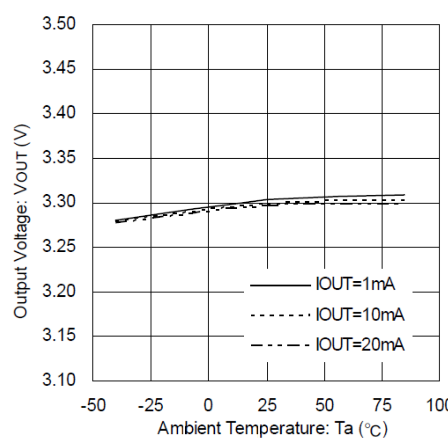


(5) Output Voltage vs. Ambient Temperature

IXD1216x202xx
$V_{IN} = V_{CE} = 4.0$ V



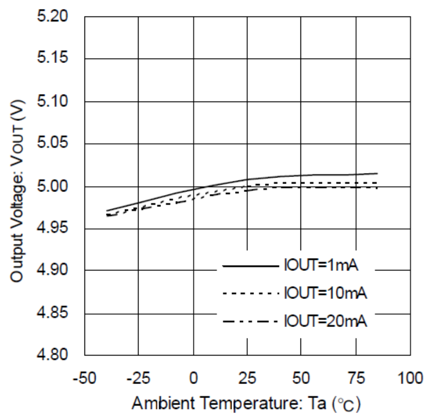
IXD1216B/D 332xx
$V_{IN} = V_{CE} = 5.3$ V



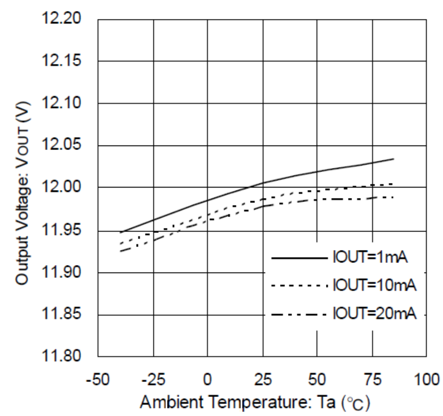
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(5) Output Voltage vs. Ambient temperature (Continued)

IXD1216B/D 502xx
$V_{IN} = V_{CE} = 7.0$ V

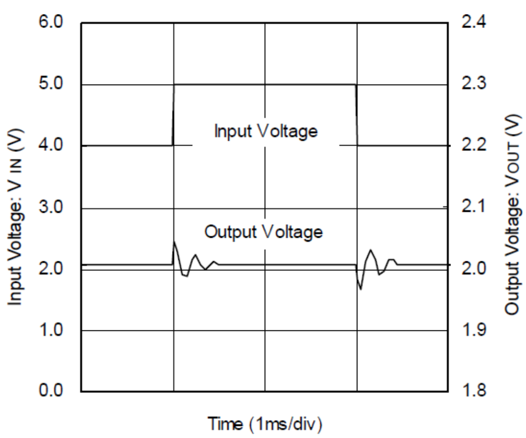


IXD1216B/D C02xx
$V_{IN} = V_{CE} = 14.0$ V

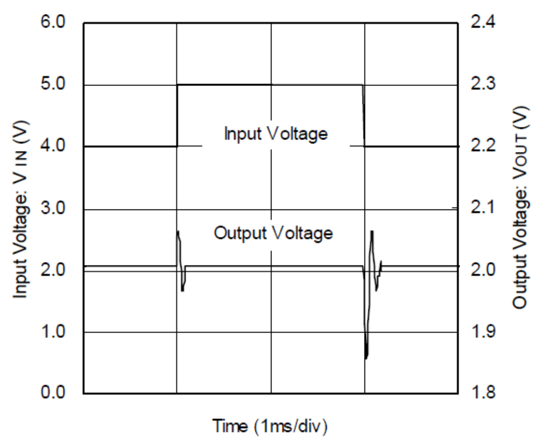


(6) Input Voltage Transient Response

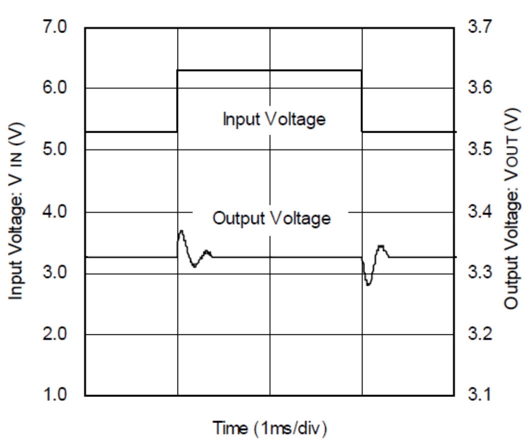
IXD1216x202xx
I_{OUT} = 1 mA, Ta = 25^{0}C, $t_R = t_F$ = 5 µs, V_{IN} = 4.0 V ↔ 5.0 V



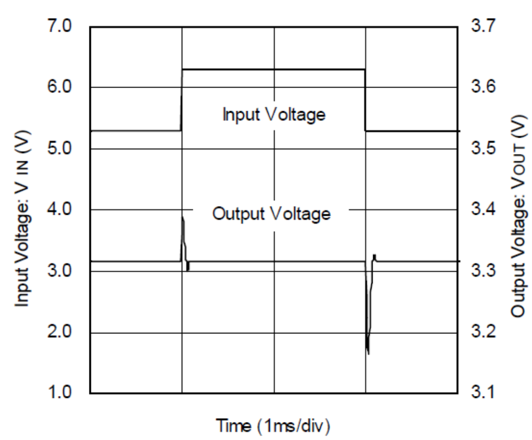
IXD1216x202xx
I_{OUT} = 30 mA, Ta = 25^{0}C, $t_R = t_F$ = 5 µs, V_{IN} = 4.0 V ↔ 5.0 V



IXD1216B/D 332xx
I_{OUT} = 1 mA, Ta = 25^{0}C, $t_R = t_F$ = 5 µs, V_{IN} = 5.3 V ↔ 6.3 V



IXD1216B/D 332xx
I_{OUT} = 30 mA, Ta = 25^{0}C, $t_R = t_F$ = 5 µs, V_{IN} = 5.3 V ↔ 6.3 V

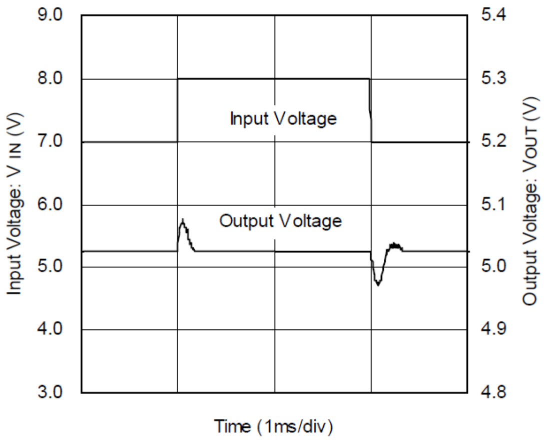


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(6) Input Voltage Transient Response (Continued)

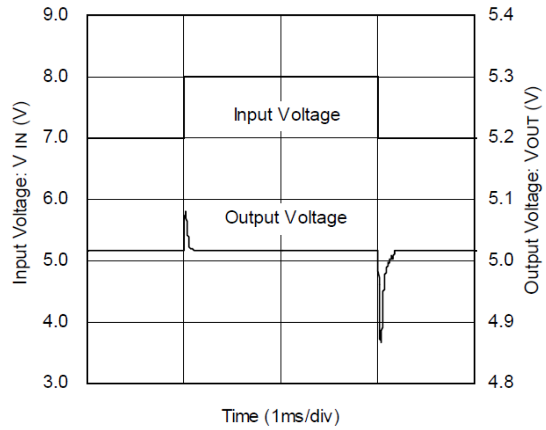
IXD1216B/D 502xx

I_{OUT} = 1 mA, Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 7.0 V ↔ 8.0 V



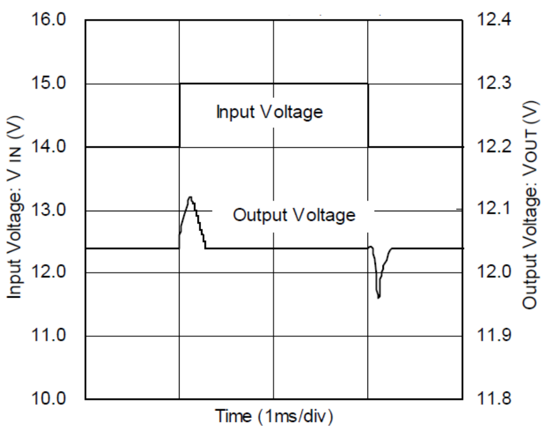
IXD1216B/D 502xx

I_{OUT} = 30 mA, Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 7.0 V ↔ 8.0 V



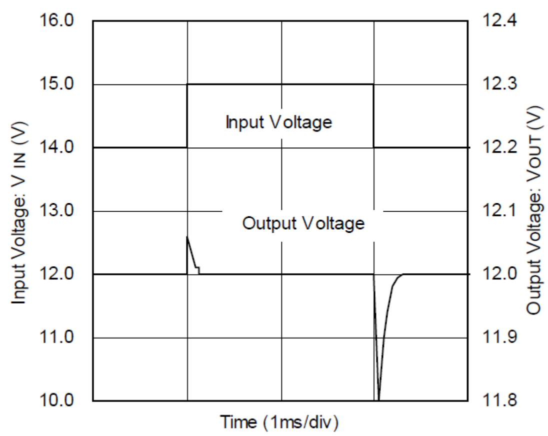
IXD1216B/D C02xx

I_{OUT} = 1 mA, Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 14.0 V ↔ 15.0 V



IXD1216B/D C02xx

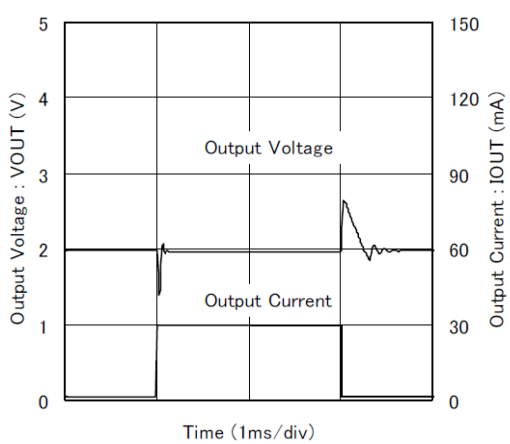
I_{OUT} = 30 mA, Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 14.0 V ↔ 15.0 V



(7) Load Transient Response

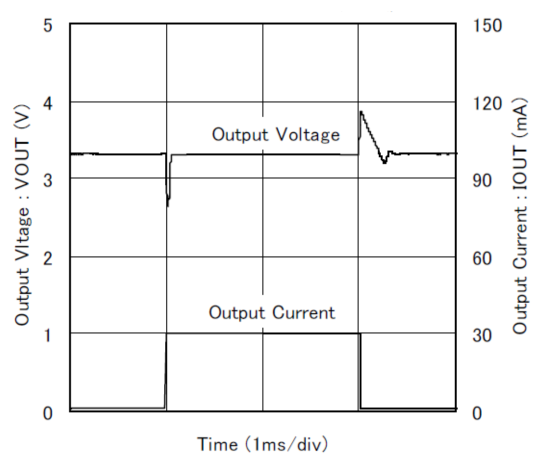
IXD1216x202xx

Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 4.0 V I_{OUT} = 1 mA, ↔ 30 mA



IXD1216B/D 332xx

Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 4.0 V I_{OUT} = 1 mA, ↔ 30 mA

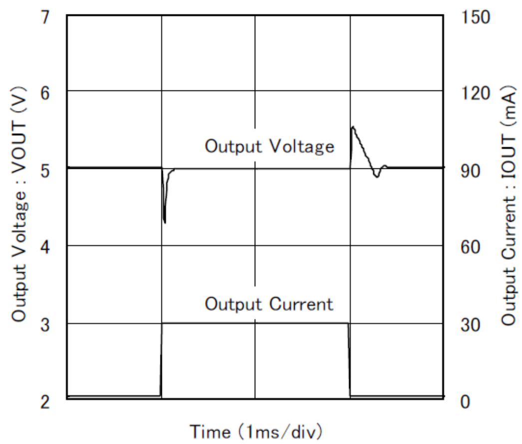


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(7) Load Transient Response (Continued)

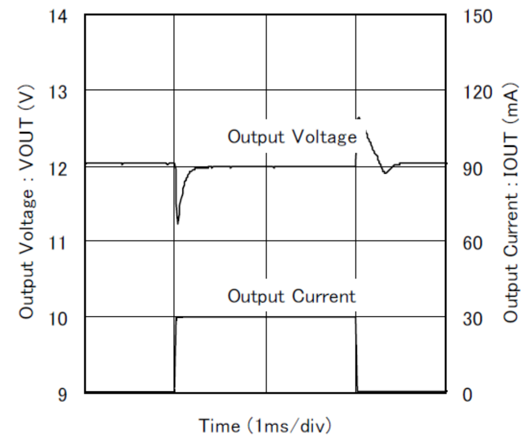
IXD1216B/D 502xx

Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 7.0 V I_{OUT} = 1 mA, ↔ 30 mA



IXD1216B/D C02xx

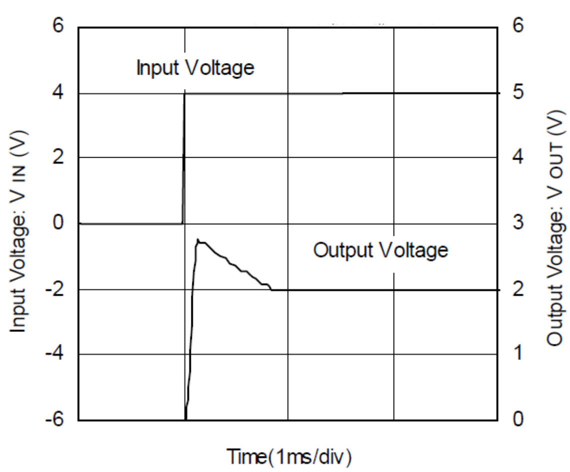
Ta = 25^{0}C, t_R = t_F = 5 µs, V_{IN} = 14.0 V I_{OUT} = 1 mA, ↔ 30 mA



(8) Input Voltage Rising Response Time

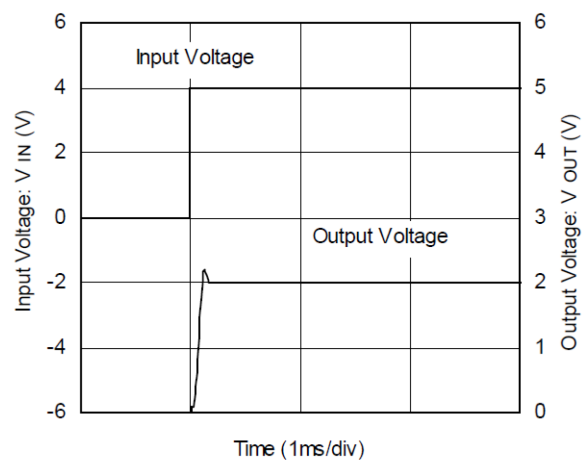
IXD1216x202xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 4.0 V I_{OUT} = 1 mA,



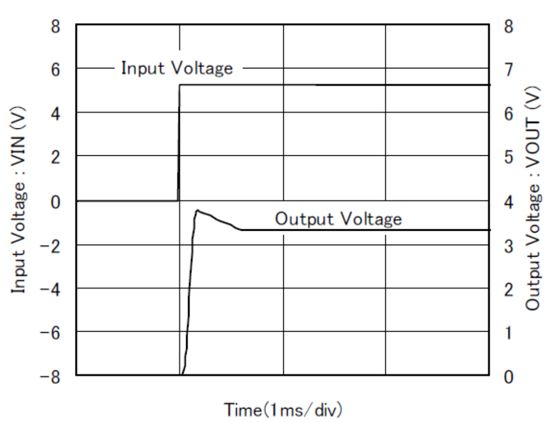
IXD1216x202xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 4.0 V I_{OUT} = 30 mA,



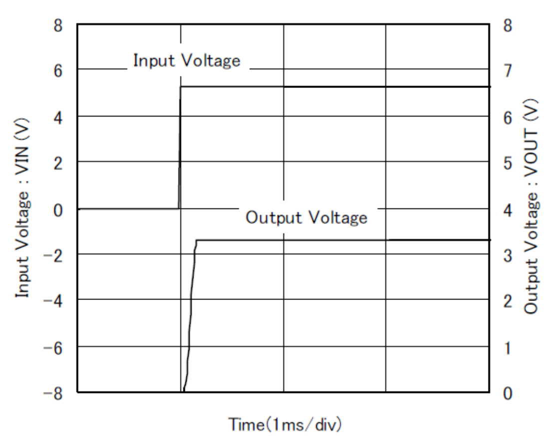
IXD1216B/D 332xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 5.3 V I_{OUT} = 1 mA,



IXD1216B/D 332xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 5.3 V I_{OUT} = 30 mA,

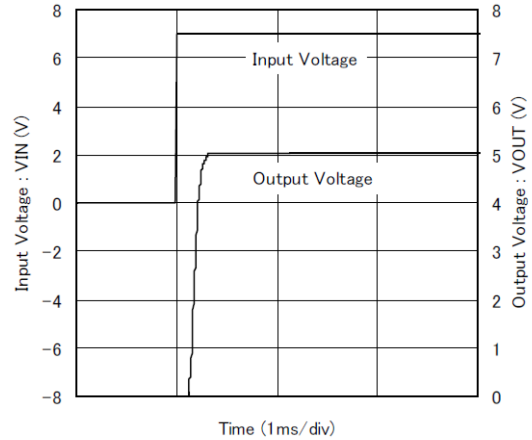


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(8) Input Voltage Rising Response Time (Continued)

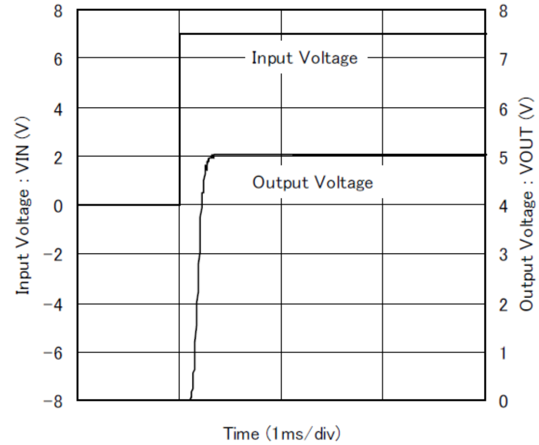
IXD1216B/D 502xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 7.0 V I_{OUT} = 1 mA,



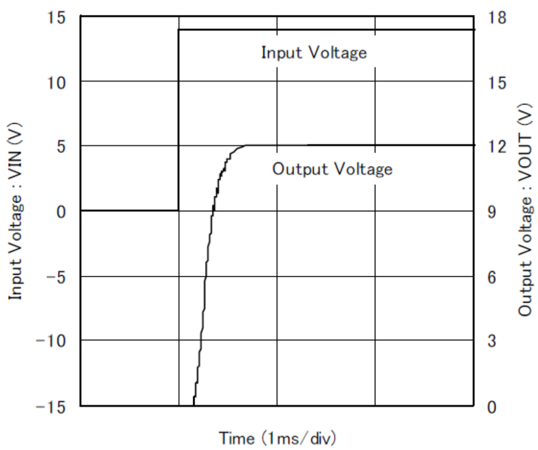
IXD1216B/D 502xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 7.0 V I_{OUT} = 30 mA



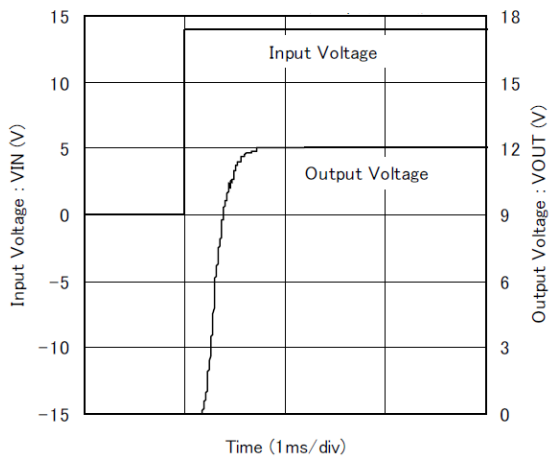
IXD1216B/D C02xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 14.0 V I_{OUT} = 1 mA,



IXD1216B/D C02xx

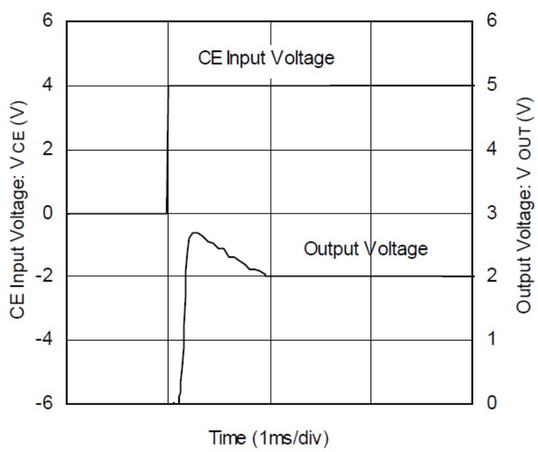
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 0 → 14.0 V I_{OUT} = 30 mA



(9) CE Rising Response Time

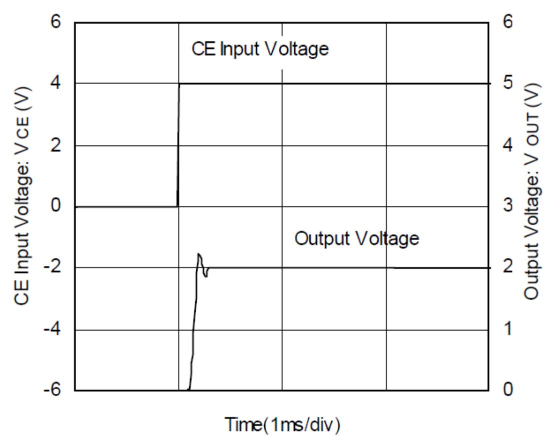
IXD1216x202xx

Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 4.0 V, V_{CE} = 0 → 4.0 V I_{OUT} = 1 mA



IXD1216x202xx

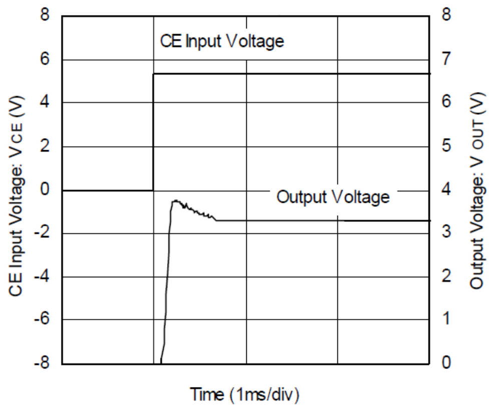
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 4.0 V, V_{CE} = 0 → 4.0 V I_{OUT} = 30 mA



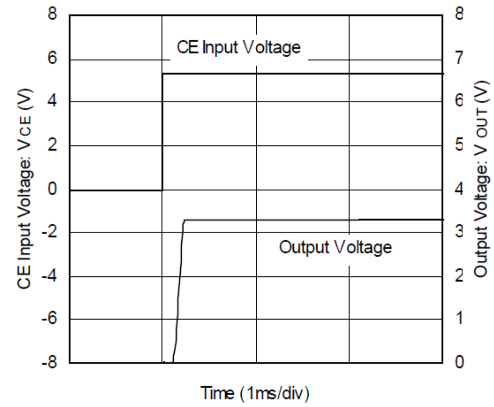
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(9) CE Rising Response Time (Continued)

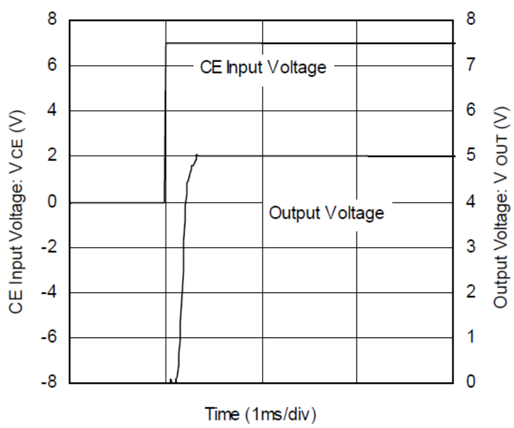
IXD1216B/D 332xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 5.3 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 1 mA,



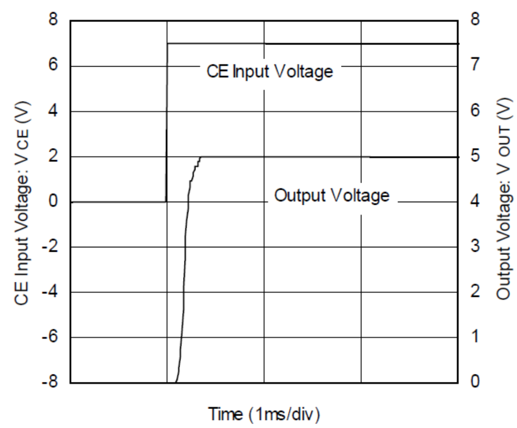
IXD1216B/D 332xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 5.3 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 30 mA



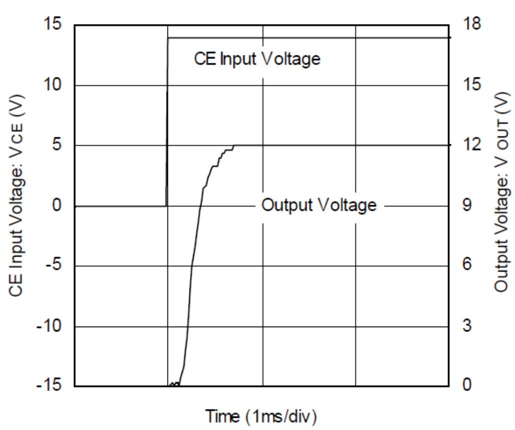
IXD1216B/D 502xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 7.0 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 1 mA,



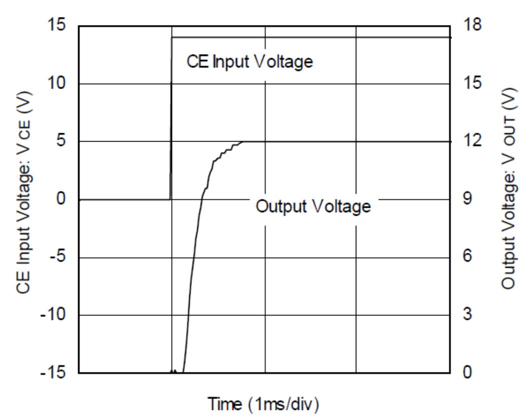
IXD1216B/D 502xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 7.0 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 30 mA



IXD1216B/D C02xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 14.0 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 1 mA,



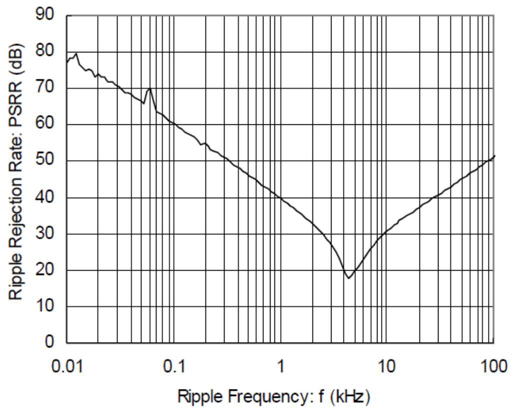
IXD1216B/D C02xx
Ta = 25^{0}C, t_R = 5 µs, V_{IN} = 14.0 V, V_{CE} = 0 → V_{IN}, I_{OUT} = 30 mA



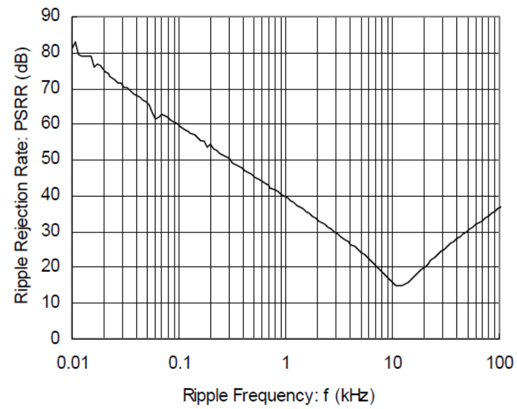
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Power Supply Ripple Rejection

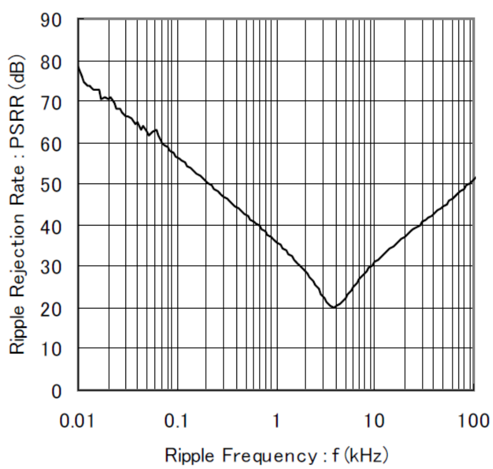
IXD1216x202xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 4.0$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 1$ mA,



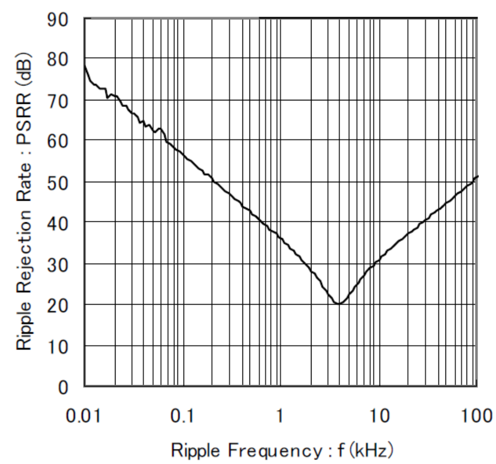
IXD1216x202xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 4.0$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 30$ mA,



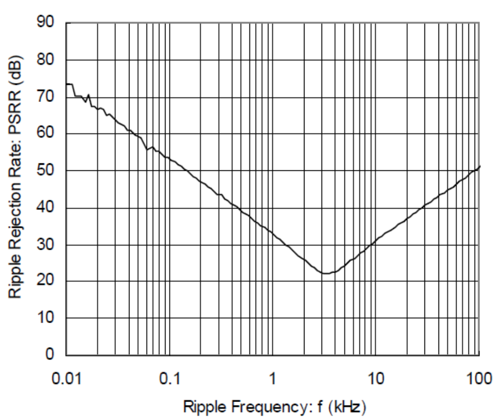
IXD1216B/D 332xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 5.3$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 1$ mA,



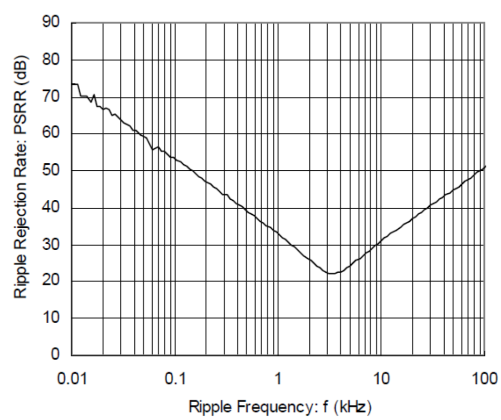
IXD1216B/D 332xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 5.3$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 1$ mA,



IXD1216B/D 502xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 7.0$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 1$ mA,



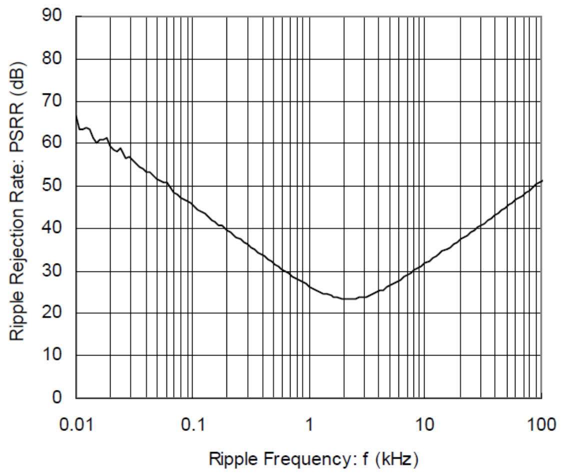
IXD1216B/D 502xx
Ta = 25^{0}C, $V_{IN} = V_{CE} = 7.0$ V+ 0.5 Vp-p_{AC}, $I_{OUT} = 1$ mA,



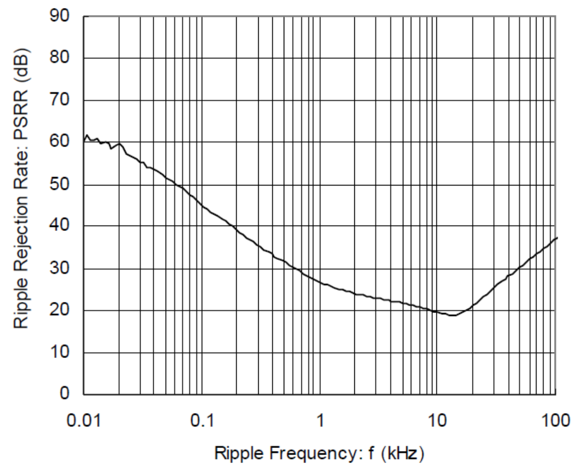
TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

(10) Power Supply Ripple Rejection (Continued)

IXD1216B/D C02xx
Ta = 25°C, V_{IN} = V_{CE} = 7.0 V+ 0.5 Vp-p_{AC}, I_{OUT} = 1 mA,



IXD1216B/D C02xx
Ta = 25°C, V_{IN} = V_{CE} = 7.0 V+ 0.5 Vp-p_{AC}, I_{OUT} = 30 mA,



ORDERING INFORMATION

IXD1216①②③④⑤⑥-⑦

DESIGNATOR	DESCRIPTION	SYMBOL	DESCRIPTION
①	Type and Options	B	Fixed Output Voltage 2.0 – 12.0 V in 0.1 V increments, CE Function
		C	Output Voltage Set Externally (V_{FB} = 2.0 V), CE Function
		D	Fixed Output Voltage 2.0 – 12.0 V in 0.1 V increments, No CE function (3-pin regulator)
②③	Output Voltage	20 – C0	For voltages from 2.0 V to 9.9 V, e.g. 2.5 V - ① = 2, ② = 5; 5.0 V - ① = 5, ② = 0 For voltages from 10.0 V to 12.0 V, e.g. 10.6 V - ① = A ② = 6; 12.0 V - ① = C, ② = 0
④	Output Voltage Accuracy	2	Accuracy: ±2%
		1	Accuracy: ±1%
⑤⑥-⑦ (*)	Packages[1)] (Order Limit)	MR	SOT-25 (3000/Reel)
		MR-G	SOT-25 (3000/Reel)
		PR	SOT-89, SOT-89-5 (1000/Reel)
		PR-G	SOT-89, SOT-89-5 (1000/Reel)
		ER	USP-6C (3000/Reel)
		ER-G	USP-6C (3000/Reel)
		FR	SOT-223 (1000/Reel)
		FR-G	SOT-223 (1000/Reel)
		JR	TO-252 (2500/reel)
		JR-G	TO-252 (2500/reel)
		QR-G	SOP-8FD (1000/reel)

NOTE:

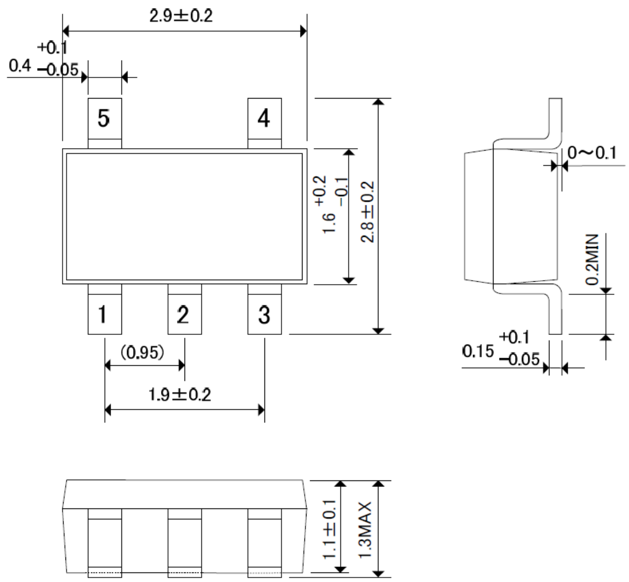
The "-G" suffix denotes Halogen and Antimony free as well as being fully RoHS compliant.

1) IXD1216B/C versions are available in SOT-25, SOT-89-5, USP-6C, and SOP-8FD packages only; IXD1216D version is available in SOT-89, SOT-223, and TO-252 packages only.

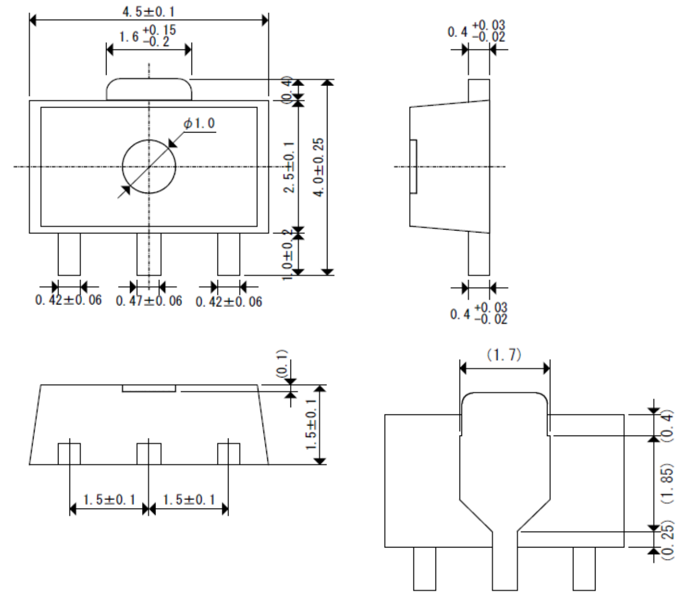
PACKAGE DRAWING AND DIMENSIONS

Units: mm

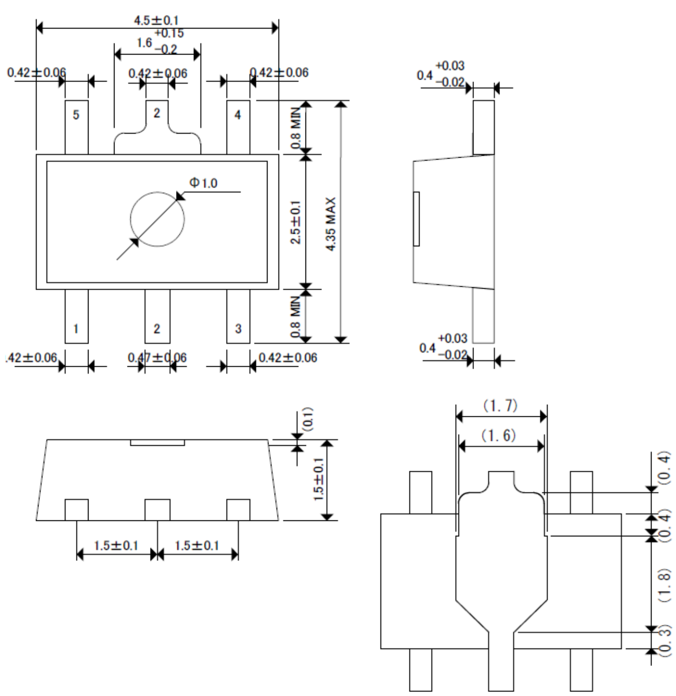
SOT-25



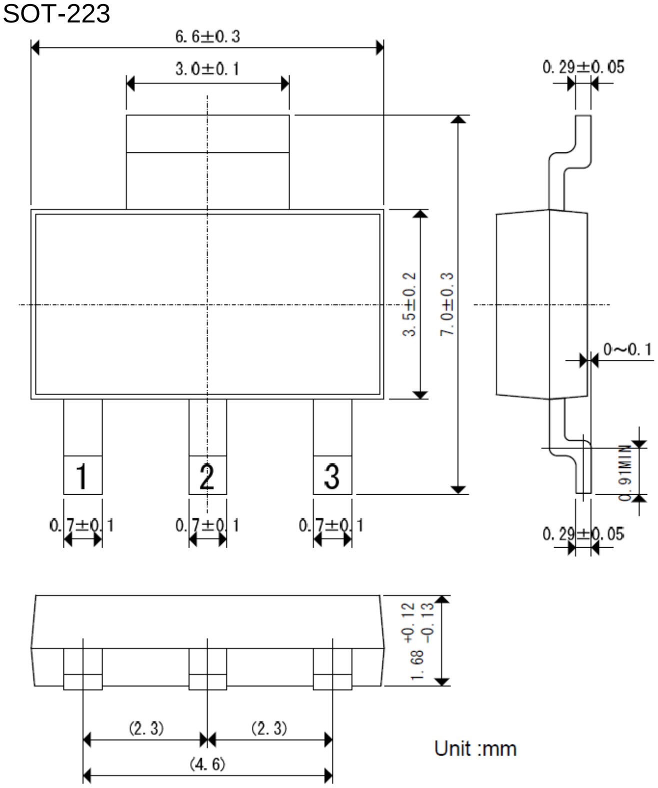
SOT-89



SOT-89-5



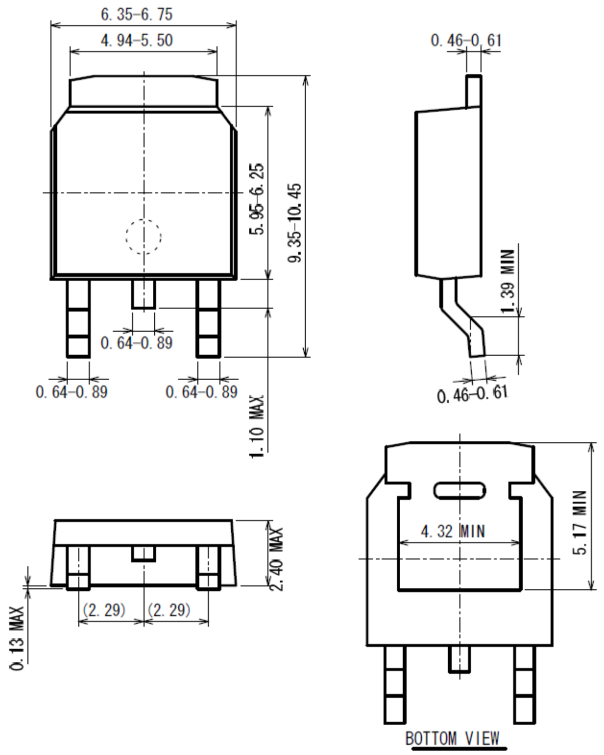
SOT-223



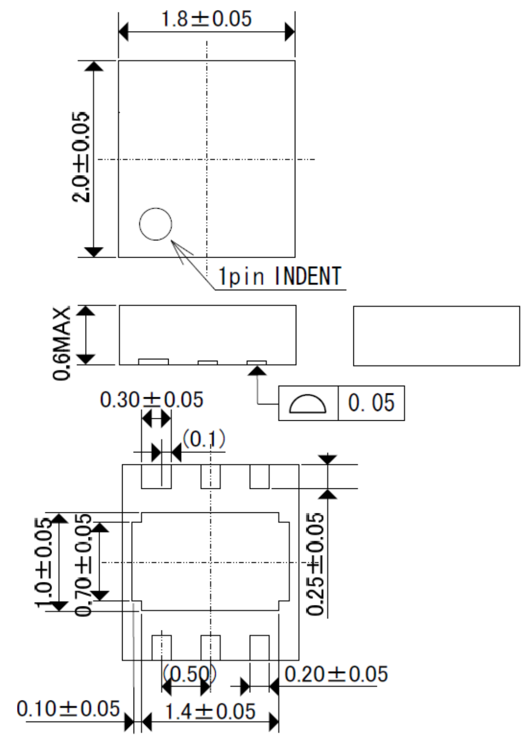
PACKAGE DRAWING AND DIMENSIONS (CONTINUED)

Units: mm

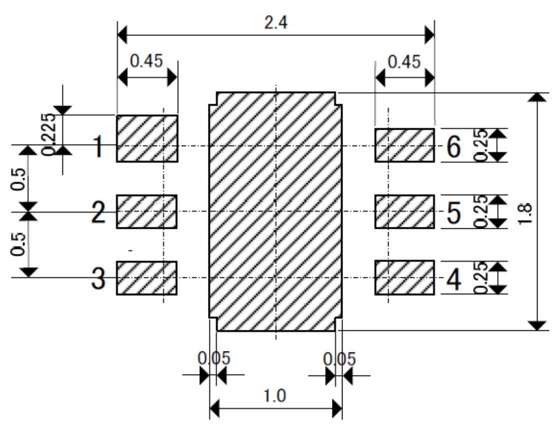
TO-252



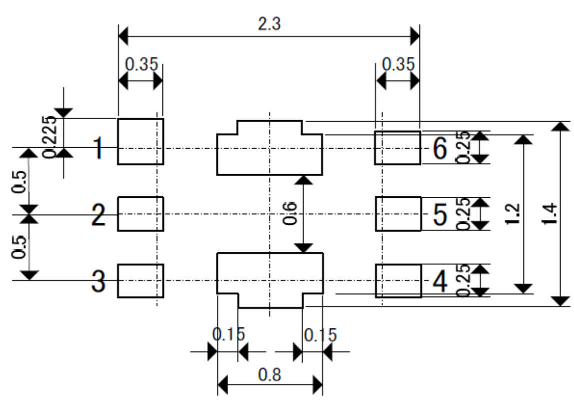
USP-6C



USP-6C Reference Pattern Layout



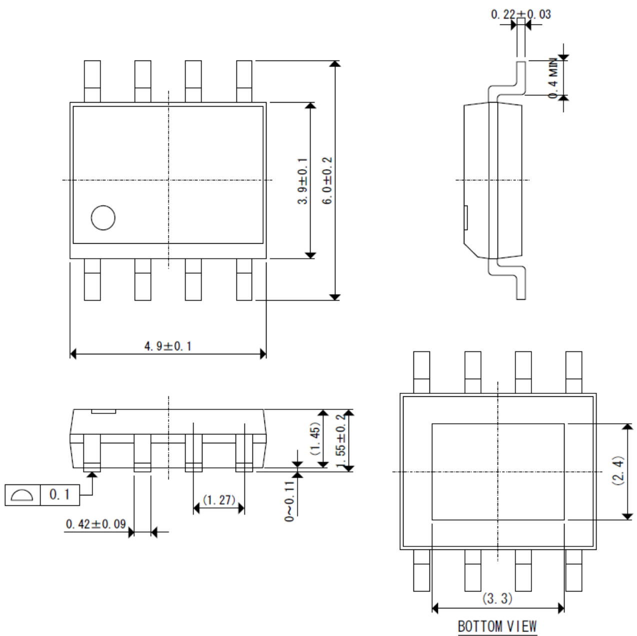
USP-6C Reference Metal Mask Design



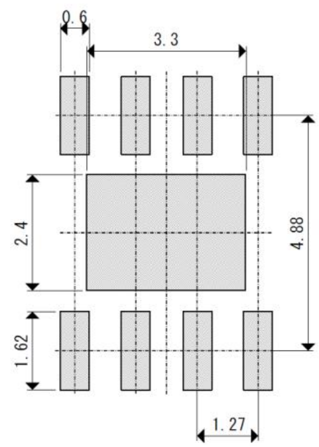
PACKAGE DRAWING AND DIMENSIONS (CONTINUED)

Units: mm

SOP-8FD



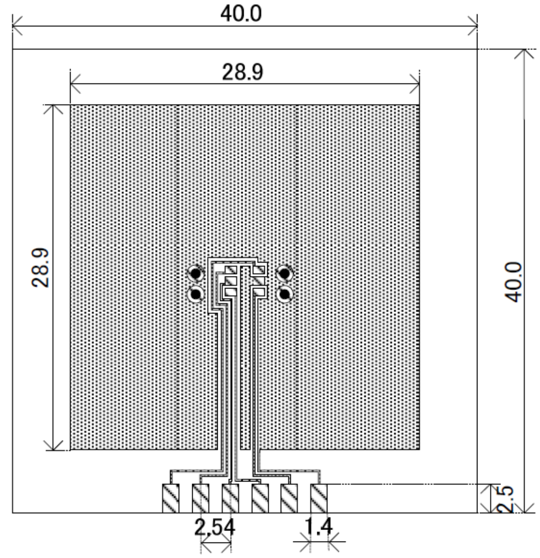
SOP-8FD Reference Pattern Layout



PACKAGE POWER DISSIPATION

SOT-25 Power Dissipation

The power dissipation varies with the mount board conditions.
Please use this data as a reference only.



Evaluation Board (unit: mm)

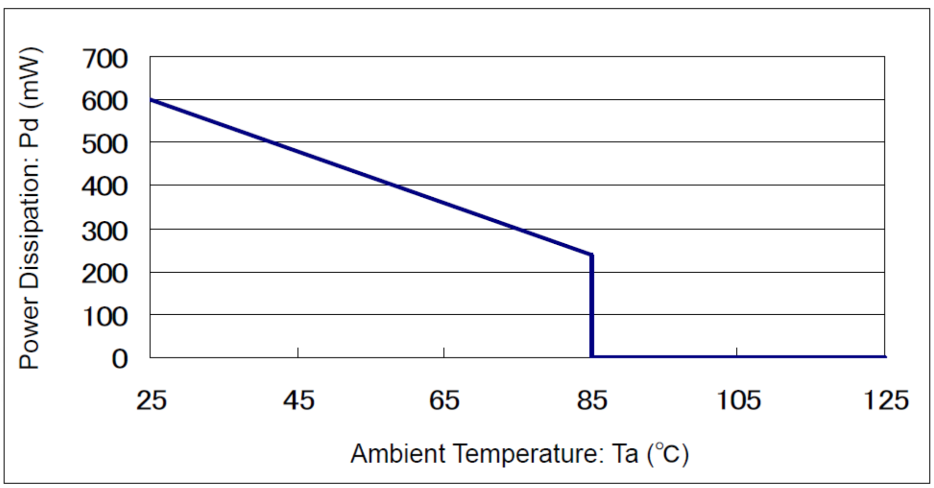
1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces. (Board of SOT-26 is used)
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	4 x 0.8 Diameter

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	600	166.67
85	240	



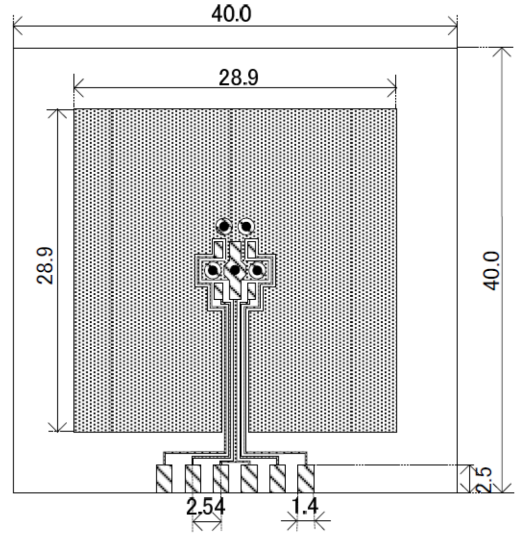
PACKAGE POWER DISSIPATION (CONTINUED)

SOT-89 Power Dissipation

The power dissipation varies with the mount board conditions. Please use this data as a reference only.

1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces.
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	5 x 0.8 Diameter

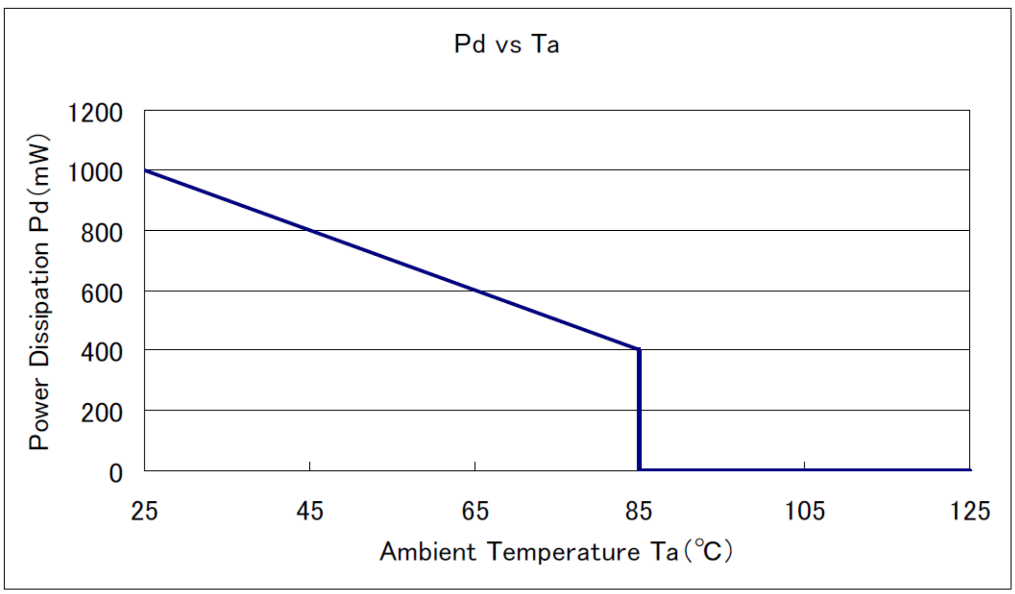


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1000	100.00
85	400	



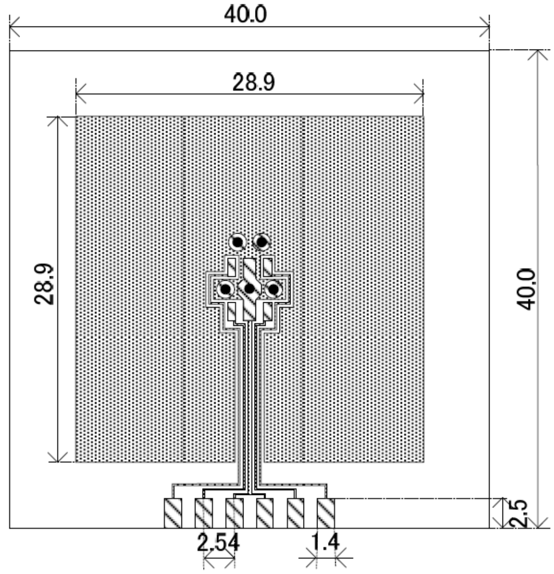
PACKAGE POWER DISSIPATION (CONTINUED)

SOT-89-5 Power Dissipation

The power dissipation varies with the mount board conditions. Please use this data as a reference only.

1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces.
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	5 x 0.8 Diameter

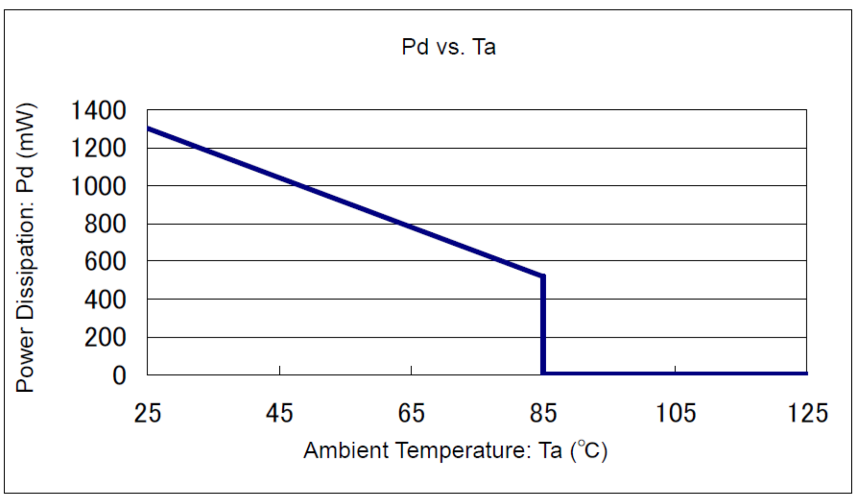


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1300	76.92
85	500	



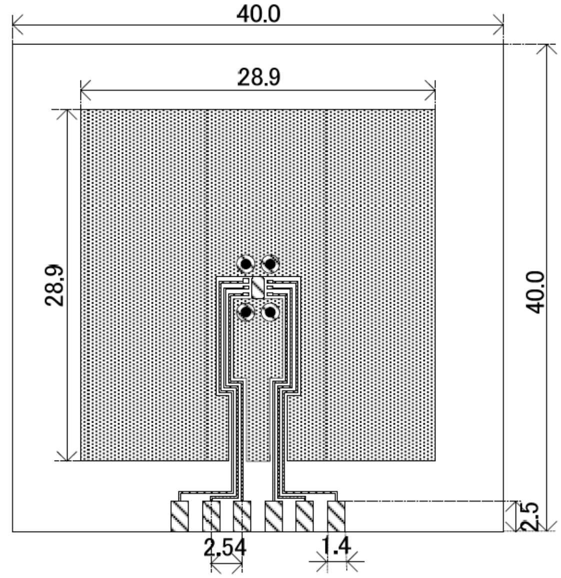
PACKAGE POWER DISSIPATION (CONTINUED)

USP-6C Power Dissipation

The power dissipation varies with the mount board conditions. Please use this data as a reference only.

1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side)
	Copper (Cu) traces occupy 50% of the board area
	on top and bottom layers
	Package heat sink teed to copper traces
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	4 x 0.8 Diameter

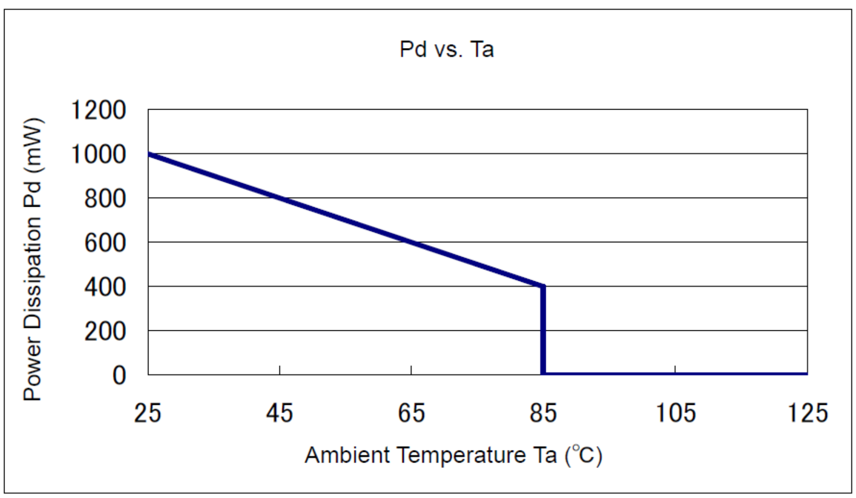


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

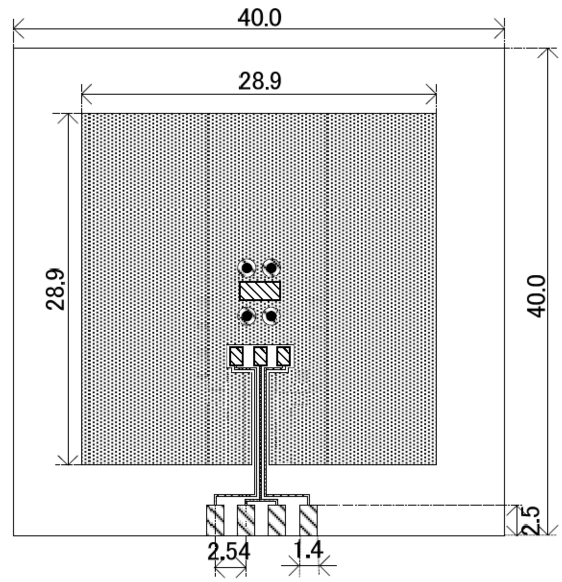
Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1000	100.00
85	400	



PACKAGE POWER DISSIPATION (CONTINUED)

SOT-223 Power Dissipation

The power dissipation varies with the mount board conditions.
Please use this data as a reference only.



Evaluation Board (Unit: mm)

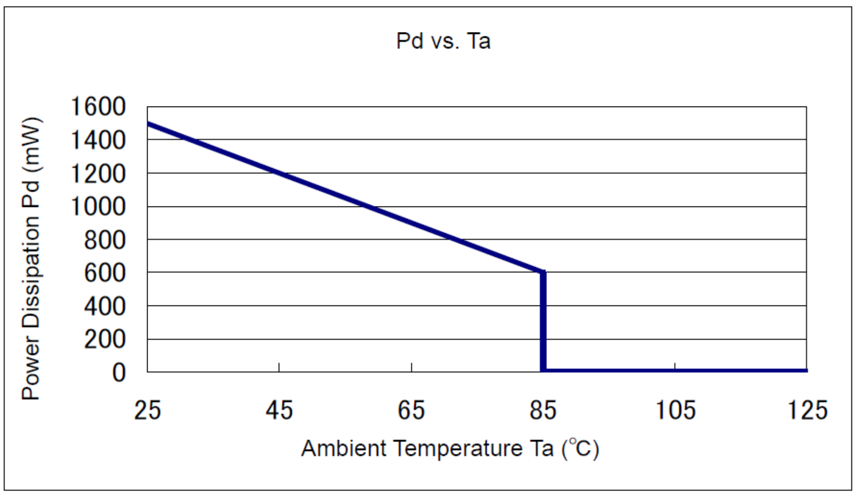
1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces.
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	4 x 0.8 Diameter

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1500	66.67
85	600	



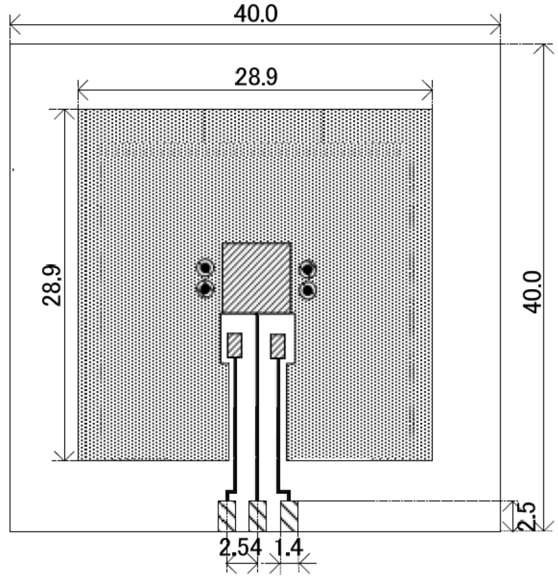
PACKAGE POWER DISSIPATION (CONTINUED)

TO-252 Power Dissipation

The power dissipation varies with the mount board conditions. Please use this data as a reference only.

1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces.
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	4 x 0.8 Diameter

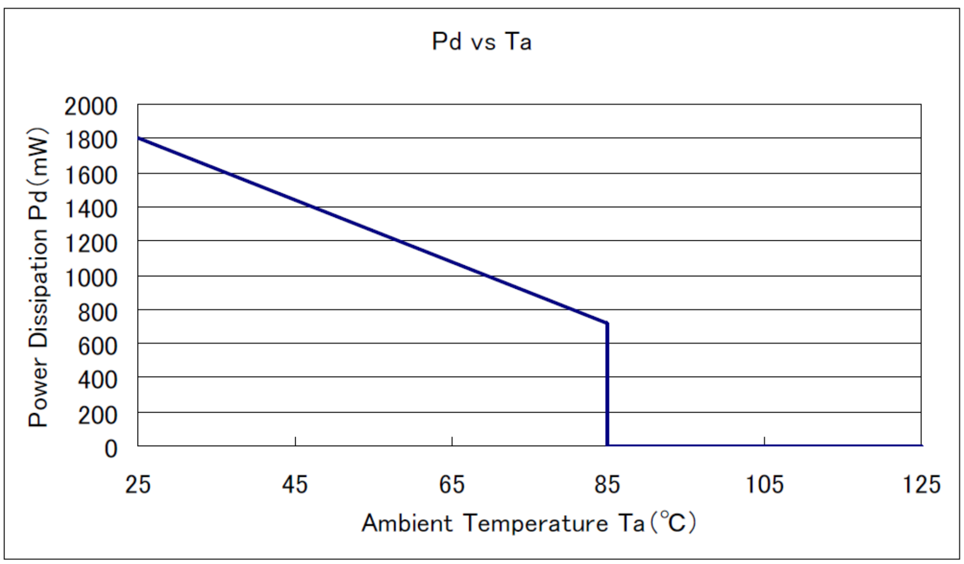


Evaluation Board (Unit: mm)

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

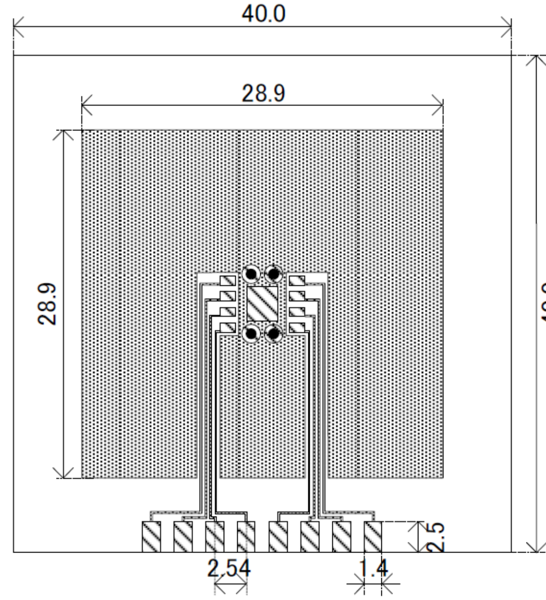
Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1800	55.56
85	720	



PACKAGE POWER DISSIPATION (CONTINUED)

SOP-8FD Power Dissipation

The power dissipation varies with the mount board conditions.
Please use this data as a reference only.



Evaluation Board (Unit: mm)

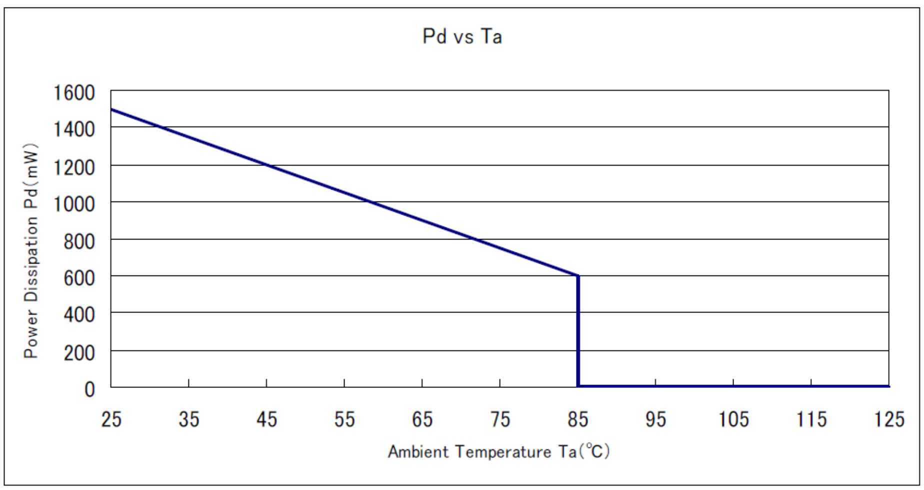
1. Measurement Conditions:

Condition:	Mount on a board
Ambient:	Natural convection
Soldering:	Lead (Pb) free
Board:	Dimensions 40×40 mm (1600 mm^2 in one side) Copper (Cu) traces occupy 50% of the board area on top and bottom layers Package heat sink tied to the copper traces.
Material:	Glass Epoxy (FR-4)
Thickness:	1.6 mm
Through-hole:	4 x 0.8 Diameter

2. Power Dissipation vs. Ambient Temperature

Board Mount (Tjmax = 125 ^{0}C)

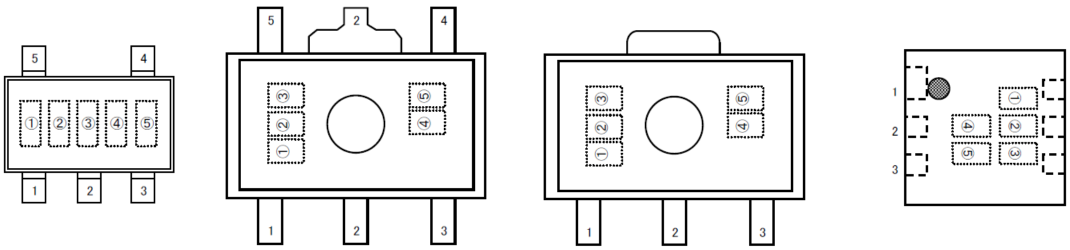
Ambient Temperature, ^{0}C	Power Dissipation Pd, mW	Thermal Resistance, ^{0}C/W
25	1500	66.67
85	600	



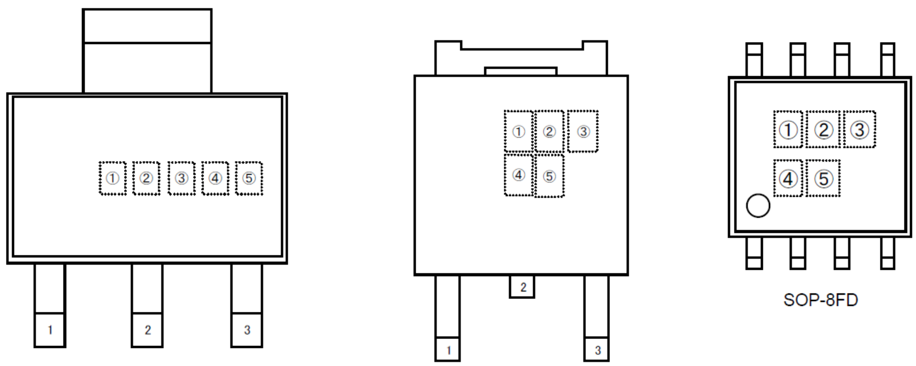
MARKING

SOT-25, SOT-89, SOT89-5, USP-4

SOT-25 SOT-89-5 SOT-89 USP-6C



SOT-223 TO-252 SOP-8FD



① - represents product series

MARK	PRODUCT SERIES
2	IXD1216xxxxxx

② - represents type of regulator and output voltage range

MARK	TYPE	OUTPUT VOLTAGE, V	PRODUCT SERIES
0	B	2.0 – 3.0	IXD1216Bxxxx
1		3.1 – 6.0	
2		6.1 – 9.0	
3		9.1 - 12.0	
4	D	2.0 – 3.0	IXD1216Dxxxx
5		3.1 – 6.0	
6		6.1 – 9.0	
7		9.1 - 12.0	
8	C	2.0	IXD1216Cxxxx

MARKING (CONTINUED)

③ - represents output voltage

MARK	OUTPUT VOLTAGE, V							MARK	OUTPUT VOLTAGE, V			
0	-	3.1	6.1	9.1	12.1	15.1		F	-	4.6	7.6	10.6
1	-	3.2	6.2	9.2	12.2	15.2		H	-	4.7	7.7	10.7
2	-	3.3	6.3	9.3	12.3	15.3		K		4.8	7.8	10.8
3	-	3.4	6.4	9.4	12.4	15.4		L		4.9	7.9	10.9
4	-	3.5	6.5	9.5	12.5	15.5		M	2.0	5.0	8.0	11.0
5	-	3.6	6.6	9.6	12.6	15.6		N	2.1	5.1	8.1	11.1
6	-	3.7	6.7	9.7	12.7	15.7		P	2.2	5.2	8.2	11.2
7	-	3.8	6.8	9.8	12.8	15.8		R	2.3	5.3	8.3	11.3
8	-	3.9	6.9	9.9	12.9	15.9		S	2.4	5.4	8.4	11.4
9	-	4.0	7.0	10.0	13.0	16.0		T	2.5	5.5	8.5	11.5
A	-	4.1	7.1	10.1	13.1	16.1		U	2.6	5.6	8.6	11.6
B	-	4.2	7.2	10.2	13.2	16.2		V	2.7	5.7	8.7	11.7
C	-	4.3	7.3	10.3	13.3	16.3		X	2.8	5.8	8.8	11.8
D	-	4.4	7.4	10.4	13.4	16.4		Y	2.9	5.9	8.9	11.9
E	-	4.5	7.5	10.5	13.5	16.5		Z	3.0	6.0	9.0	12.0

④⑤ - represents production lot number
01～09, 0A～0Z, 11～9Z, A1～A9, AA～AZ, B1～ZZ in order, (G, I, J, O, Q, W excluded)

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