APPLICATION MANUAL

LDO REGULATOR WITH ON/OFF SWITCH
TK112xxCM/U

AsahiKASEI
ASAHI KASEI TOKO POWER DEVICES

Features

- Very low Dropout Voltage. (Vdrop=105mV at 100mA)
- Very good stability (CL=0.1μF is stable for any type capacitor with 2.5V ≤ Vout)
- High Precision output Voltage (±1.5% or ±50mV)
- Good ripple rejection ratio (80dB at 1kHz)
- Wide operating voltage range (1.8V ~ 14.5V)
- Peak output current is 480mA.(10% down point)
- Built-in Short circuit protection
- Built-in Thermal Shutdown
- Suitable for Very Low Noise Applications
- Built-in on/off Control (0.1μA Max Standby current) High On
- Very Small Surface Mount Packages SOT23L / SOT89 package
- Built-in reverse bias over current protection

Description

The TK112xxC is an integrated circuit with a silicon monolithic bipolar structure. The regulator is of the low saturation voltage output type with very little quiescent current (65μA).
The PNP power transistor is built-in. The I/O voltage difference is 0.17V (typical) when a current of 200mA is supplied to the system. Because of the low voltage drop, the voltage source can be effectively used; this makes it very suitable for battery powered equipment.
The on/off function is built into the IC. The current during standby mode becomes very small (pA level).
The output voltage is available from 1.5 to 10.0V in 0.1V steps. The output voltage is trimmed with high accuracy. This allows the optimum voltage to be selected for the equipment.
The over current sensor circuit and the reverse-bias protection circuit are built-in.
It is a very rugged design because the ESD protection is high. Therefore, the TK112xxC can be used with confidence.
When mounted on the PCB, the power dissipation rating becomes about 600mW/ 900mW, even though the packages are very small.
The TK112xxC features very high stability in both DC and AC.
The capacitor on the output side provides stable operation with 0.1μF with 2.5V ≤ Vout. A capacitor of any type can be used; however, the larger this capacitor is, the better the overall characteristics are.

ORDERING INFORMATION

T K 1 1 2 □□ C □□□ - □□

Voltage Code
(Refer to the following table)

Version
C

Package Code
M : SOT23L-6
U : SOT89-5

Environment Code
-GH : Lead Free and Halogen Free (SOT23L-6)
-G : Lead Free (SOT89-5)

Tape / Reel Code
L : Left Type (SOT23L-6)
B : Back Type (SOT89-5)

Rank Code
C : C Rank
I : I Rank

Voltage Code

V OUT	V CODE	V OUT	V CODE	V OUT	V CODE	V OUT	V CODE
1.5	15	2.5	25	3.5	35	4.5	45
1.6	16	2.6	26	3.6	36	4.6	46
1.7	17	2.7	27	3.7	37	4.7	47
1.8	18	2.8	28	3.8	38	4.8	48
1.9	19	2.9	29	3.9	39	4.9	49
2.0	20	3.0	30	4.0	40	5.0	50
2.1	21	3.1	31	4.1	41		
2.2	22	3.2	32	4.2	42		
2.3	23	3.3	33	4.3	43		
2.4	24	3.4	34	4.4	44		

Absolute Maximum Ratings

Ta=25°C

Parameter	Symbol	Rating	Units	Conditions
Absolute Maximum Ratings				
Supply Voltage	Vcc_{MAX}	-0.4 ~ 16	V	
Reverse Bias	$Vrev_{MAX}$	-0.4 ~ 6	V	Vout ≤ 2.0V
		-0.4 ~ 12	V	2.1V ≤ Vout
Np pin Voltage	Vnp_{MAX}	-0.4 ~ 5	V	
Control pin Voltage	$Vcont_{MAX}$	-0.4 ~ 16	V	
Storage Temperature Range	T_{stg}	-55 ~ 150	°C	
Power Dissipation	P_D	SOT23L-6: 600 SOT89-5: 900	mW	Internal Limited Tj=150°C *
Operating Condition				
Operating Temperature Range	T_{OP}	-40 ~ 85	°C	
Operating Voltage Range	V_{OP}	2.1 ~ 14.5	V	T_{OP} =-40 ~ 85°C
		1.8 ~ 14.5	V	T_{OP} =-30 ~ 80°C
Short Circuit Current	Ishort	500	mA	

* P_D must be decreased at rate of 4.8mW/°C(SOT23L-6), 7.2mW/°C(SOT89-5) for operation above 25°C.
The maximum ratings are the absolute limitation values with the possibility of the IC being damaged.
If the operation exceeds any of these standards, quality cannot be guaranteed.

Electrical Characteristics

(1) C rank

The operation between -40 ~ 85°C is guaranteed by design. The parameter with limit value will be guaranteed with test when manufacturing or SQC (Statistical Quality Control) technique.

$Vin=Vout_{TYP}+1V, Vcont=1.8V, Ta=25°C$

Parameter	Symbol	Value			Units	Conditions	
		MIN	TYP	MAX			
Output Voltage	Vout	**Refer to TABLE 1**			V	Iout = 5mA	
Line Regulation	LinReg	-	0.0	6.0	mV	ΔVin = 5V	
Load Regulation	LoaReg	**Refer to TABLE 1**			mV	Iout = 5mA ~ 100mA	
		Refer to TABLE 1			mV	Iout = 5mA ~ 200mA	
		Refer to TABLE 1			mV	Iout = 5mA ~ 300mA	
Dropout Voltage ***1**	Vdrop	-	105	170	mV	Iout = 100mA	
		-	170	270	mV	Iout = 200mA	
		-	235	370	mV	Iout = 270mA (2.1V ≤ Vout ≤ 2.3V)	
		-	235	370	mV	Iout = 300mA (2.4V ≤ Vout)	
Maximum Output Current ***2**	$Iout_{MAX}$	380	480	-	mA	When ($Vout_{TYP}$×0.9)	
Supply Current	Iq	-	65	90	µA	Iout = 0mA	
Standby Current	Istandby	-	0.0	0.1	µA	Vcont = 0V	
Quiescent Current	Ignd	-	1.8	3.0	mA	Iout = 100mA	
Control Terminal							
Control Current	Icont	-	5.0	10	µA	Vcont = 1.8V	
Control Voltage	Vcont	1.8	-	-	V	Vout ON state	T_{OP}=-40~85°C
		-	-	0.35	V	Vout OFF state	
		1.6	-	-	V	Vout ON state	T_{OP}=-30~80°C
		-	-	0.6	V	Vout OFF state	

***1**: For Vout ≤ 2.0V , no regulations.
***2**: The maximum output current is limited by power dissipation.

TABLE 1. Output Voltage , Load Regulation

Part Number	Output Voltage			Load Regulation					
				Iout = 100mA		Iout = 200mA		Iout = 300mA	
	MIN	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX
	V	V	V	mV	mV	mV	mV	mV	mV
TK11213C	1.250	1.300	1.350	11	24	21	49	34	77
TK11214C	1.350	1.400	1.450	11	24	22	49	34	78
TK11215C	1.450	1.500	1.550	11	24	22	50	35	79
TK11216C	1.550	1.600	1.650	11	24	22	50	35	80
TK11217C	1.650	1.700	1.750	11	25	22	51	36	82
TK11218C	1.750	1.800	1.850	11	25	23	51	36	83
TK11219C	1.850	1.900	1.950	11	25	23	52	37	84
TK11220C	1.950	2.000	2.050	11	25	23	53	37	85
TK11221C	2.050	2.100	2.150	11	26	23	53	38	86
TK11222C	2.150	2.200	2.250	12	26	24	54	38	88
TK11223C	2.250	2.300	2.350	12	26	24	54	39	89
TK11224C	2.350	2.400	2.450	12	26	24	55	39	90
TK11225C	2.450	2.500	2.550	12	27	24	55	40	91
TK11226C	2.550	2.600	2.650	12	27	25	56	40	92
TK11227C	2.650	2.700	2.750	12	27	25	56	41	93
TK11228C	2.750	2.800	2.850	12	27	25	57	41	95
TK11229C	2.850	2.900	2.950	12	27	25	58	42	96
TK11230C	2.950	3.000	3.050	12	28	26	58	42	97
TK11231C	3.050	3.100	3.150	12	28	26	59	43	98
TK11232C	3.150	3.200	3.250	12	28	26	59	44	99
TK11233C	3.250	3.300	3.350	13	28	26	60	44	101
TK11234C	3.349	3.400	3.451	13	29	27	60	45	102
TK11235C	3.447	3.500	3.553	13	29	27	61	45	103
TK11236C	3.546	3.600	3.654	13	29	27	62	46	104
TK11237C	3.644	3.700	3.756	13	29	27	62	46	105
TK11238C	3.743	3.800	3.857	13	29	28	63	47	107
TK11239C	3.841	3.900	3.959	13	30	28	63	47	108
TK11240C	3.940	4.000	4.060	13	30	28	64	48	109
TK11241C	4.038	4.100	4.162	13	30	28	64	48	110
TK11242C	4.137	4.200	4.263	13	30	29	65	49	111
TK11243C	4.235	4.300	4.365	14	31	29	66	49	112
TK11244C	4.334	4.400	4.466	14	31	29	66	50	114
TK11245C	4.432	4.500	4.568	14	31	29	67	50	115
TK11246C	4.531	4.600	4.669	14	31	30	67	51	116
TK11247C	4.629	4.700	4.771	14	31	30	68	51	117
TK11248C	4.728	4.800	4.872	14	32	30	68	52	118
TK11249C	4.826	4.900	4.974	14	32	30	69	52	120
TK11250C	4.925	5.000	5.075	14	32	31	70	53	121

TABLE 1. Output Voltage , Load Regulation (continue)

Part Number	Output Voltage			Load Regulation					
				Iout = 100mA		Iout = 200mA		Iout = 300mA	
	MIN	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX
	V	V	V	mV	mV	mV	mV	mV	mV
TK11251C	5.023	5.100	5.177	14	32	31	70	53	121
TK11253C	5.220	5.300	5.380	15	33	31	71	54	124
TK11254C	5.319	5.400	5.481	15	33	32	72	55	125
TK11255C	5.417	5.500	5.583	15	33	32	72	55	127
TK11260C	5.910	6.000	6.090	15	34	33	75	58	133
TK11280C	7.880	8.000	8.120	17	39	38	87	68	156

(2) I rank

The operation between -40 ~ 85°C is guaranteed with normal test. The parameter with limit value will be guaranteed with test when manufacturing or SQC(Statistical Quality Control) technique.

$Vin=Vout_{TYP}+1V, Vcont=1.8V, Ta=-40 \sim 85°C$

Parameter	Symbol	Value			Units	Conditions
		MIN	TYP	MAX		
Output Voltage	Vout	**Refer to TABLE 1**			V	Iout = 5mA
Line Regulation	LinReg		0.0	8.0	mV	ΔVin = 5V
Load Regulation	LoaReg	**Refer to TABLE 1**			mV	Iout = 5mA ~ 100mA
		Refer to TABLE 1			mV	Iout = 5mA ~ 200mA
		Refer to TABLE 1			mV	Iout = 5mA ~ 300mA
Dropout Voltage ***1**	Vdrop		105	200	mV	Iout = 100mA (2.2V ≤ Vout)
			170	320	mV	Iout = 200mA (2.2V ≤ Vout)
			235	440	mV	Iout = 300mA (2.4V ≤ Vout)
Maximum Output Current ***2**	$Iout_{MAX}$	340	480		mA	When ($Vout_{TYP}$×0.9)
Supply Current	Iq		65	100	µA	Iout = 0mA
Standby Current	Istandby		0.0	0.5	µA	Vcont = 0V
Quiescent Current	Ignd		1.8	3.6	mA	Iout = 100mA
Control Terminal						
Control Current	Icont		5.0	12	µA	Vcont = 1.8V
Control Voltage	Vcont	1.8			V	Vout ON state
				0.35	V	Vout OFF state

***1**: For Vout ≤ 2.1V , no regulations.
***2**: The maximum output current is limited by power dissipation.

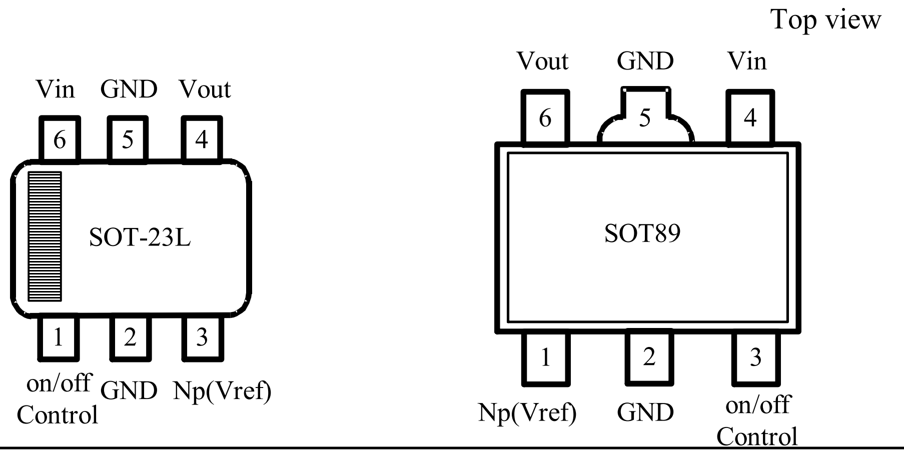
TABLE 1. Output Voltage , Load Regulation

Part Number	Output Voltage			Load Regulation					
				Iout = 100mA		Iout = 200mA		Iout = 300mA	
	MIN	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX
	V	V	V	mV	mV	mV	mV	mV	mV
TK11213C	1.220	1.300	1.380	11	29	21	60	34	95
TK11214C	1.320	1.400	1.480	11	29	22	61	34	96
TK11215C	1.420	1.500	1.580	11	29	22	61	35	97
TK11216C	1.520	1.600	1.680	11	29	22	62	35	98
TK11217C	1.620	1.700	1.780	11	30	22	63	36	100
TK11218C	1.720	1.800	1.880	11	30	23	63	36	118
TK11219C	1.820	1.900	1.980	11	30	23	64	37	120
TK11220C	1.920	2.000	2.080	11	30	23	65	37	122
TK11221C	2.020	2.100	2.180	11	31	23	65	38	124
TK11222C	2.120	2.200	2.280	12	31	24	66	38	126
TK11223C	2.220	2.300	2.380	12	31	24	67	39	127
TK11224C	2.320	2.400	2.480	12	31	24	68	39	129
TK11225C	2.420	2.500	2.580	12	31	24	68	40	131
TK11226C	2.520	2.600	2.680	12	32	25	69	40	133
TK11227C	2.620	2.700	2.780	12	32	25	70	41	135
TK11228C	2.720	2.800	2.880	12	32	25	70	41	137
TK11229C	2.820	2.900	2.980	12	32	25	71	42	139
TK11230C	2.920	3.000	3.080	12	33	26	72	42	141
TK11231C	3.020	3.100	3.180	12	33	26	73	43	143
TK11232C	3.120	3.200	3.280	12	33	26	73	44	145
TK11233C	3.217	3.300	3.383	13	33	26	74	44	147
TK11234C	3.315	3.400	3.485	13	33	27	75	45	149
TK11235C	3.412	3.500	3.588	13	34	27	75	45	151
TK11236C	3.510	3.600	3.690	13	34	27	76	46	153
TK11237C	3.607	3.700	3.793	13	34	27	77	46	155
TK11238C	3.705	3.800	3.895	13	34	28	77	47	157
TK11239C	3.802	3.900	3.998	13	34	28	78	47	159
TK11240C	3.900	4.000	4.100	13	35	28	79	48	161
TK11241C	3.997	4.100	4.203	13	35	28	80	48	162
TK11242C	4.095	4.200	4.305	13	35	29	80	49	164
TK11243C	4.192	4.300	4.408	14	35	29	81	49	166
TK11244C	4.290	4.400	4.510	14	36	29	82	50	168
TK11245C	4.387	4.500	4.613	14	36	29	82	50	170
TK11246C	4.485	4.600	4.715	14	36	30	83	51	172
TK11247C	4.582	4.700	4.818	14	36	30	84	51	174
TK11248C	4.680	4.800	4.920	14	36	30	84	52	176
TK11249C	4.777	4.900	5.023	14	37	30	85	52	178
TK11250C	4.875	5.000	5.125	14	37	31	86	53	180

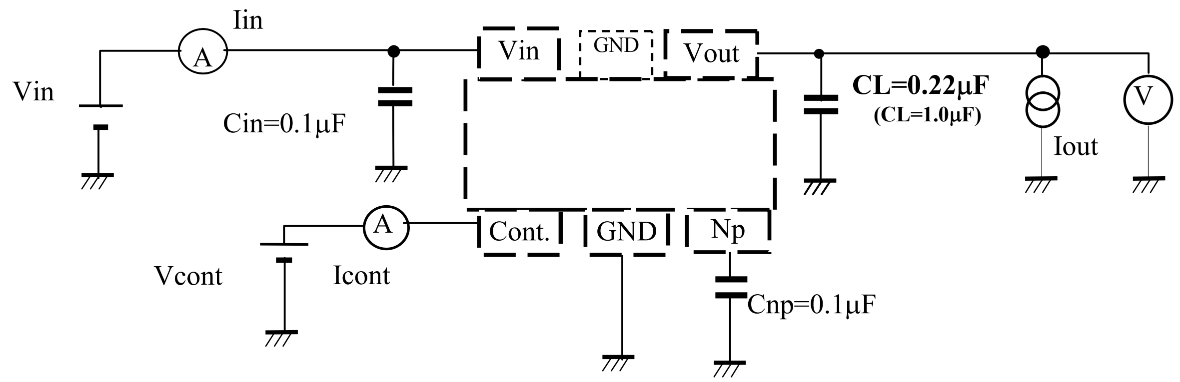
TABLE 1. Output Voltage , Load Regulation (continue)

Part Number	Output Voltage			Load Regulation					
				Iout = 100mA		Iout = 200mA		Iout = 300mA	
	MIN	TYP	MAX	TYP	MAX	TYP	MAX	TYP	MAX
	V	V	V	mV	mV	mV	mV	mV	mV
TK11255C	5.362	5.500	5.638	15	38	32	89	55	190
TK11257C	5.557	5.700	5.843	15	38	32	91	56	194
TK11260C	5.850	6.000	6.150	15	39	33	93	58	199
TK11280C	7.800	8.000	8.200	17	43	38	107	68	238

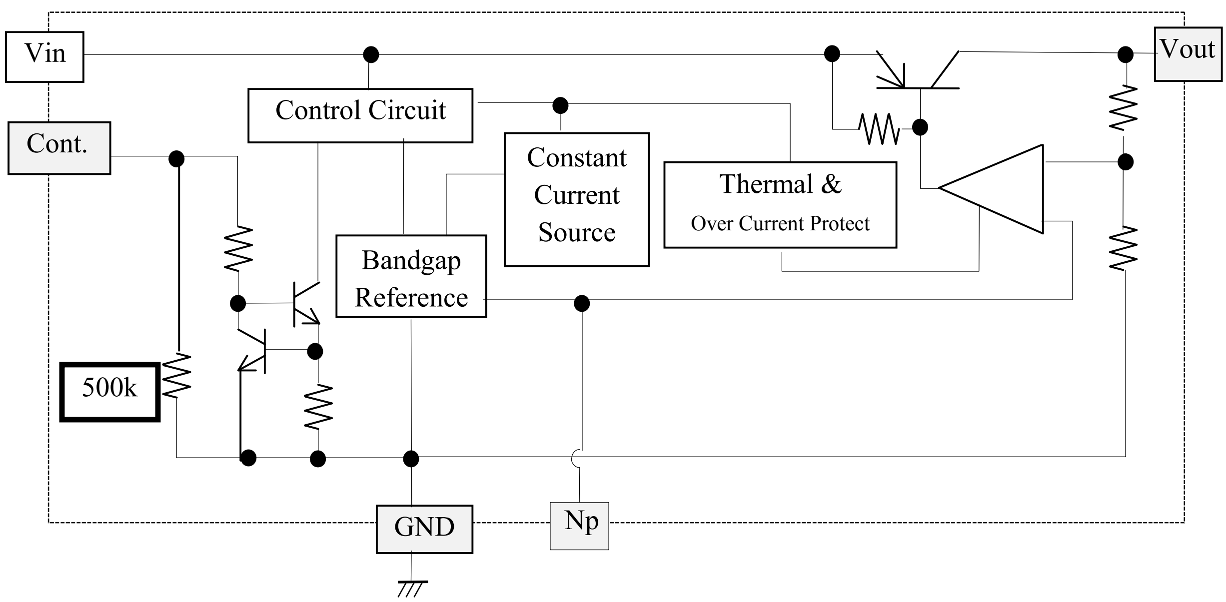
Pin Layout



Application



Block Diagram

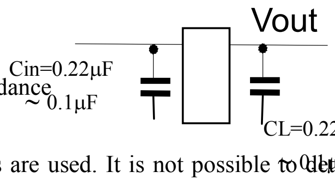


Input /Output Capacitors

Linear regulators require input and output capacitors in order to maintain the regulator's loop stability. If a 0.1µF capacitor is connected to the output side, the IC provides stable operation at any voltage in the practical current region. However, increase the CL capacitance when using the IC in the low current region and low voltage. Otherwise, the IC oscillates.

The equivalent series resistance (ESR) of the output capacitor must be in the stable operation area. However, it is recommended to use as large a value of capacitance as is practical. The output noise and the ripple noise decrease as the capacitance value increases. ESR values vary widely between ceramic and tantalum capacitors. However, tantalum capacitors are assumed to provide more ESR damping resistance, which provides greater circuit stability. This implies that a higher level of circuit stability can be obtained by using tantalum capacitors when compared to ceramic capacitors with similar values.

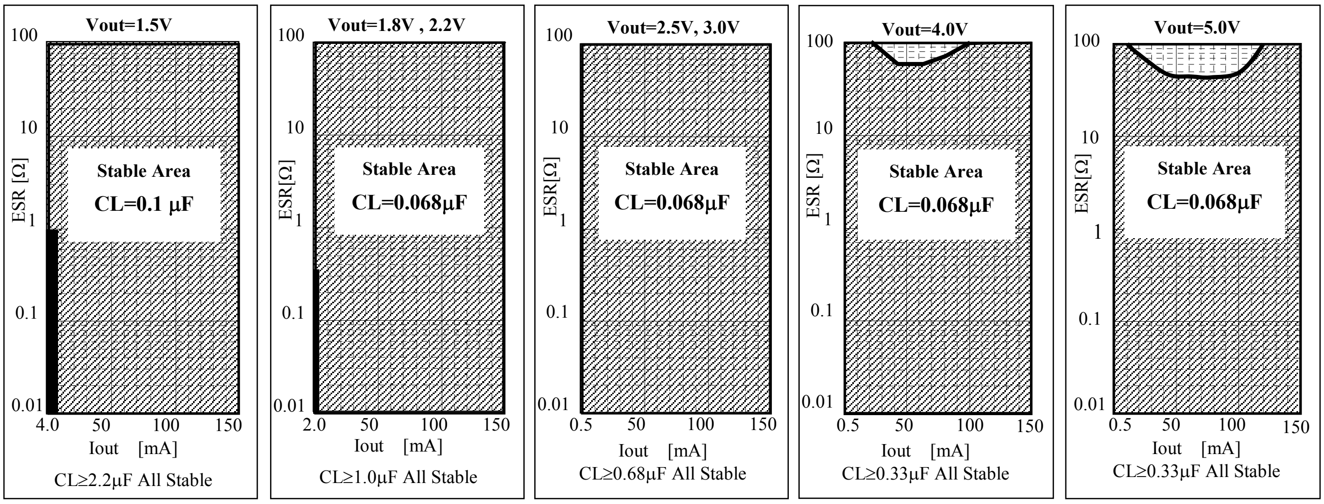
The recommended value : Cin=CL=0.22µF(MLCC) Iout ≥ 0.5mA.



The input capacitor is necessary when the battery is discharged, the power supply impedance increases, or the line distance to the power supply is long.

This capacitor might be necessary on each individual IC even if two or more regulator ICs are used. It is not possible to determine this indiscriminately. Please confirm the stability while mounted. The IC provides stable operation with an output side capacitor of 0.1µF (Vout ≥ 2.5V). If it is 0.1µF or more over the full range of temperature, either a ceramic capacitor or tantalum capacitor can be used without considering ESR. It is not possible to say indiscriminately. Please confirm stability while mounted.

Output voltage, Output current vs. Stable Operation Area

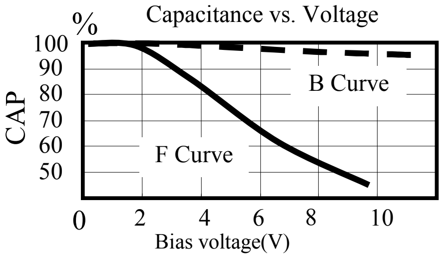


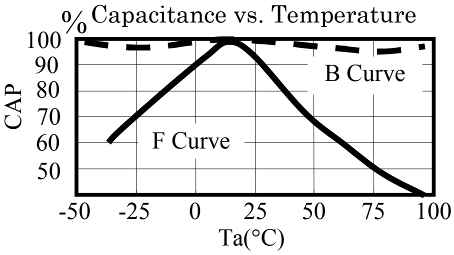
The above graphs show stable operation with a ceramic capacitor of 0.1uF (excluding the low current region). If the capacitance is not increased in the low voltage, low current area, stable operation may not be achieved. Please select the best output capacitor according to the voltage and current used. The stability of the regulator improves if a big output side capacitor is used (the stable operation area extends.) Please use as large a capacitance as is practical. Although operation above 150 mA has not been described, stability is equal to or better than operation at 150 mA.

For evaluation

Kyocera :CM05B104K10AB , CM05B224K10AB , CM105B104K16A , CM105B224K16A , CM21B225K10A

Murata :GRM36B104K10 , GRM42B104K10 , GRM39B104K25 , GRM39B224K10 , GRM39B105K6.3



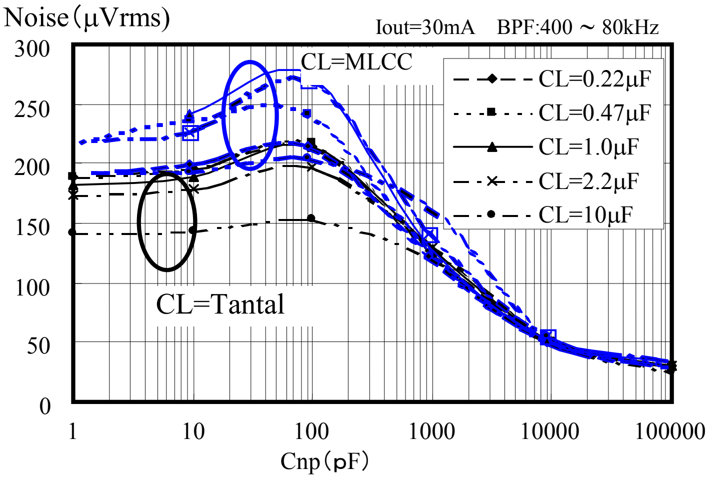


Generally, a ceramic capacitor has both a temperature characteristic and a voltage characteristic. Please consider both characteristics when selecting the part. The B curves are the recommend characteristics.

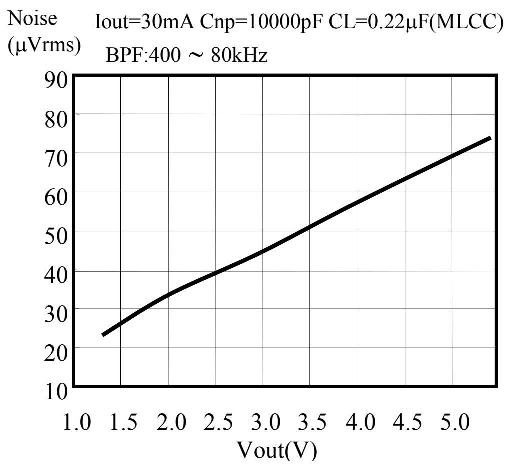
Output noise

TK11230C Cnp vs. Noise Iout=30mA BPF=400Hz ~ 80kHz

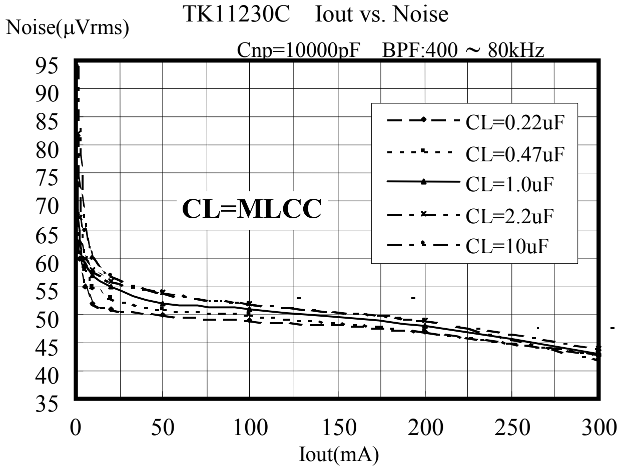
TK11230C Cnp vs Noise



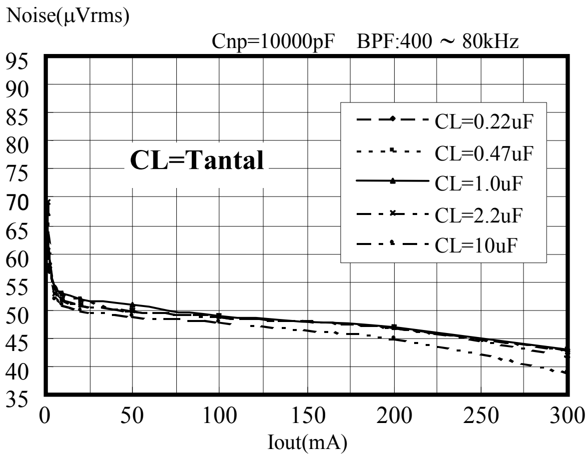
TK112xxC Vout vs Noise



TK11230C Iout vs. Noise

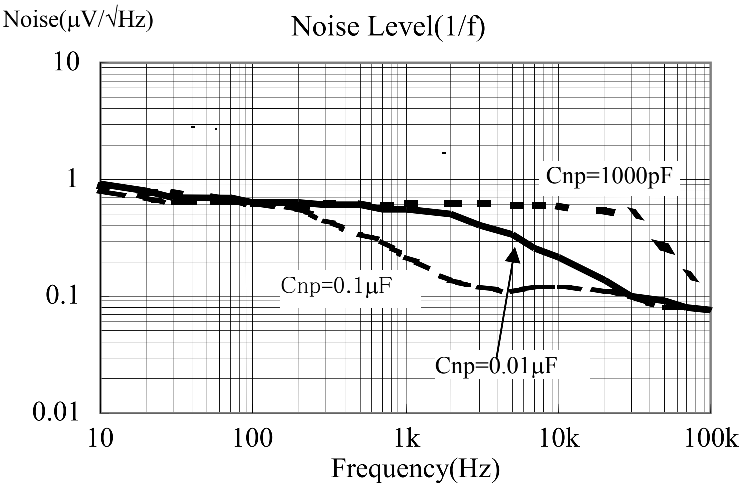


TK11230C Iout vs Noise



Increase Cnp to decrease the noise. The recommended Cnp capacitance is 6800pF(682) ~ 0.22µF(224).
The amount of noise increases with the higher output voltages.

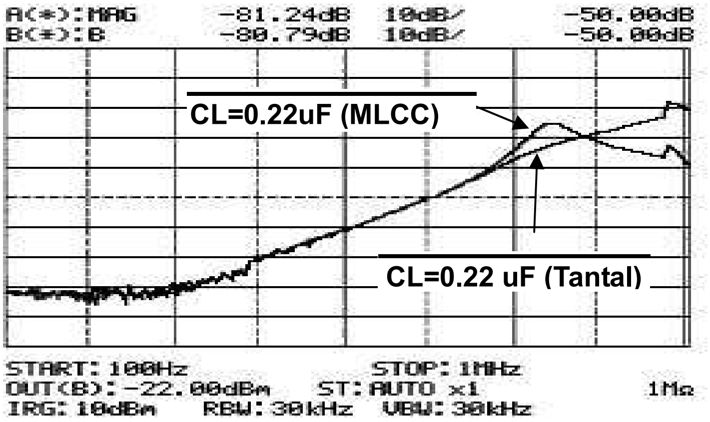
Noise Level(1/f)



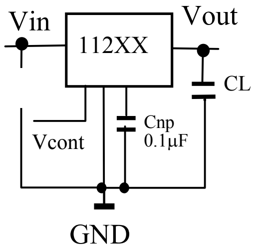
TK11230CM Cin=10µF Iout=10mA

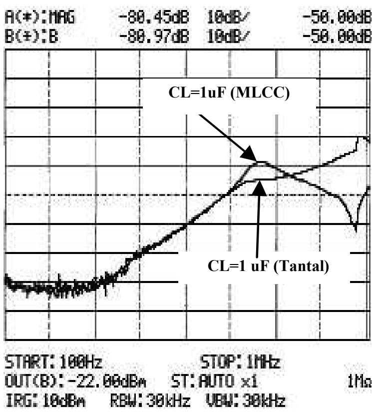
CL=0.22µF (Ceramic)

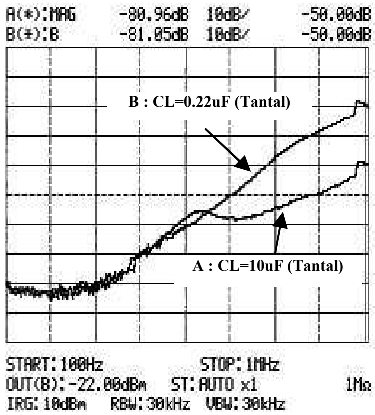
Ripple rejection

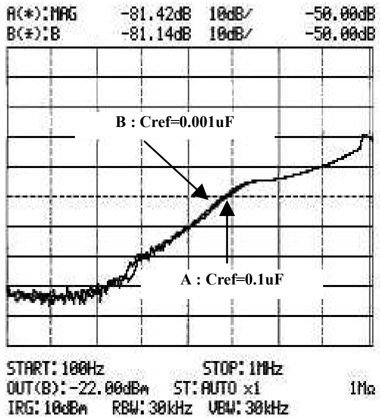


Vin=5.0V Vout=3.0V Iout=10mA
VR=500mVp-p f=100 ~ 1MHz Cnp=0.1uF



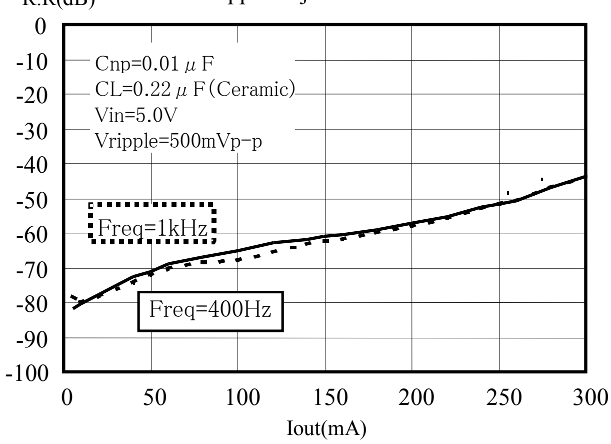




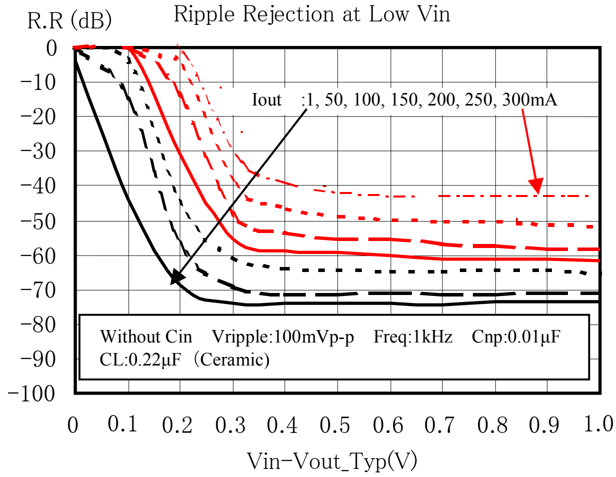


The ripple rejection characteristic depends on the characteristic and the capacitance value of the capacitor connected to the output side. The RR characteristic of 50KHz or more varies greatly with the capacitor on the output side and PCB pattern. If necessary, please confirm stability while operating.

Ripple Rejection vs. Iout

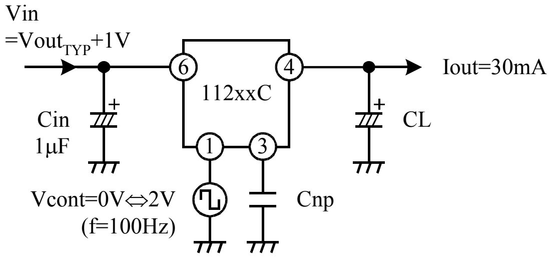


Ripple Rejection at Low Vin

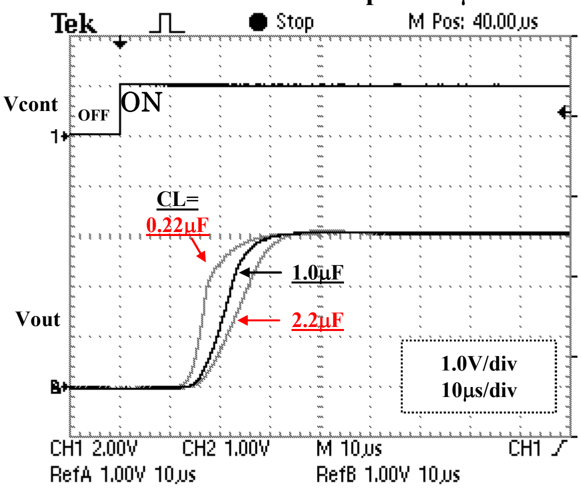


TK112xxC Transient

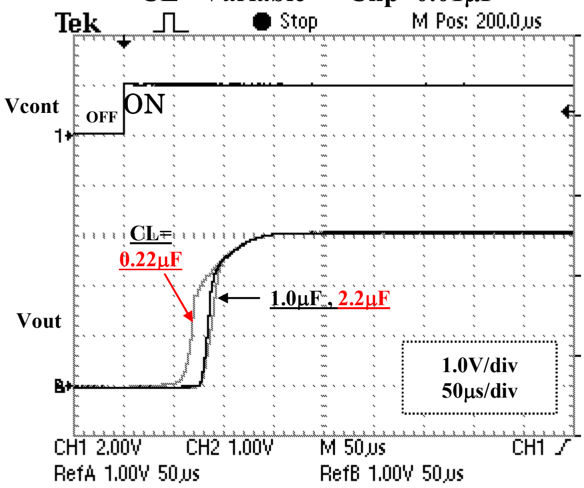
• ON / OFF Transient



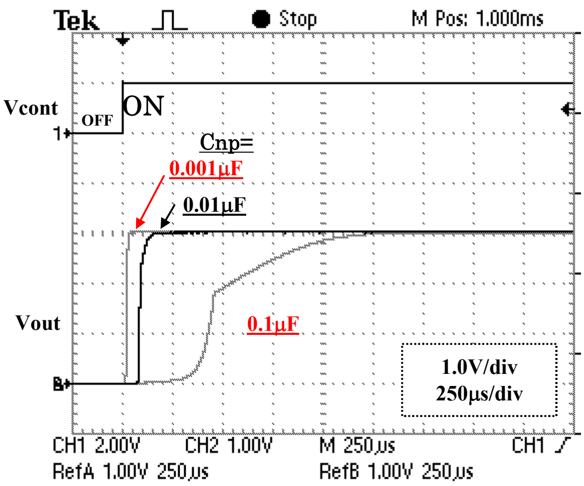
CL= Variable Cnp=0.001µF



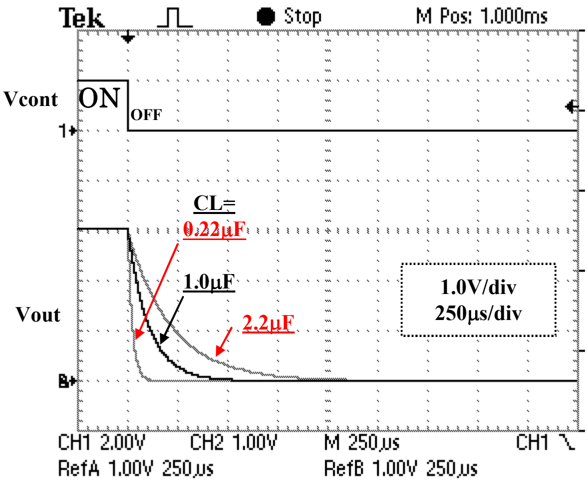
CL= Variable Cnp=0.01µF



Cnp= Variable CL=1µF



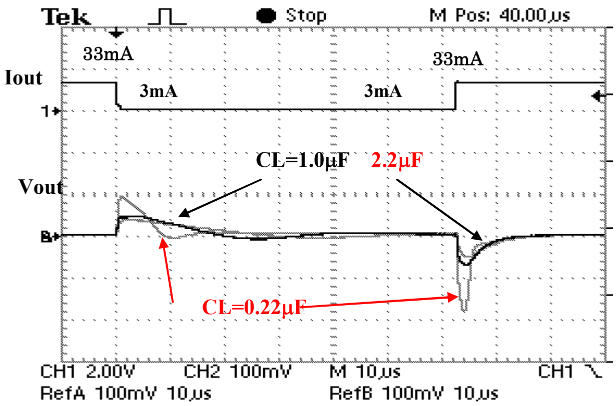
CL= Variable Cnp=0.01µF Io=30mA

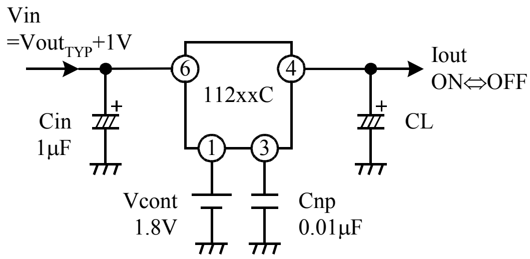


The rise time of the regulator depends on CL and Cnp; the fall time depends on CL.

• LOAD Transient

CL= Variable Cnp=0.01µF

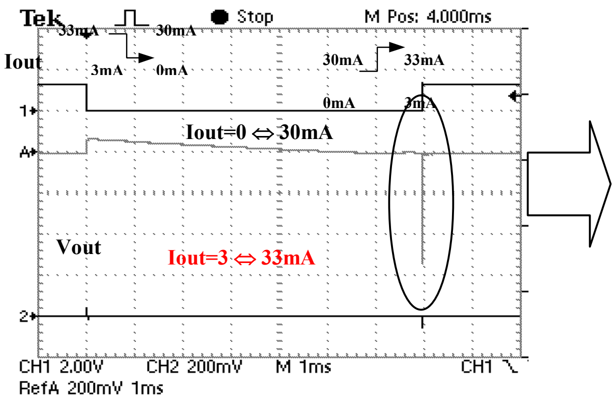


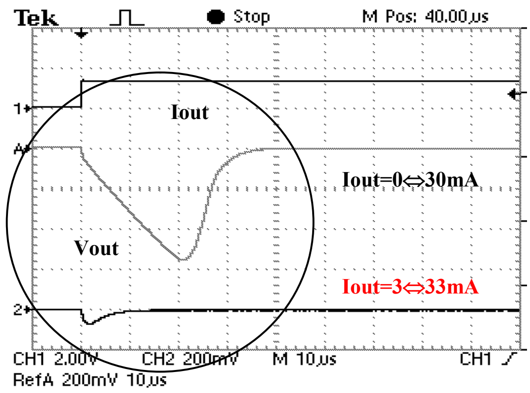


When the capacitor on the load side is increased, the load change becomes smaller.

Iout=0 ⇔ 30mA , 3 ⇔ 33mA

Magnification



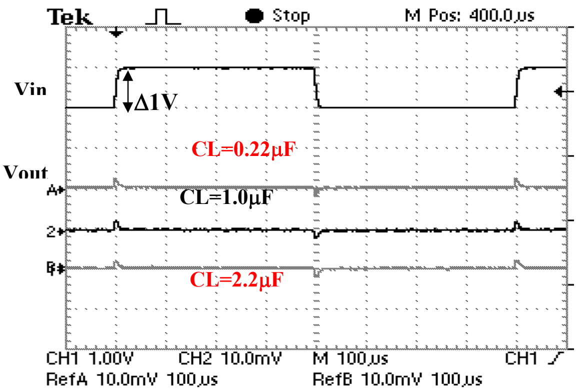


The no load voltage change can be greatly improved by delivering a little load current to ground (see right curve above).

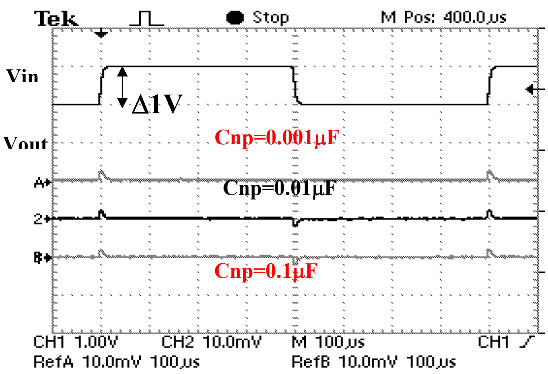
Increase the load side capacitor when the load change is fast or when there is a large current change. In addition, at no load, the voltage change can be reduced by delivering a little load current to ground.

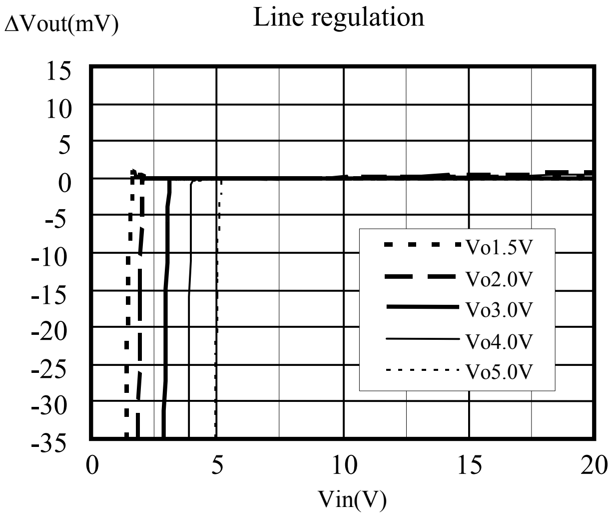
• Line Transient

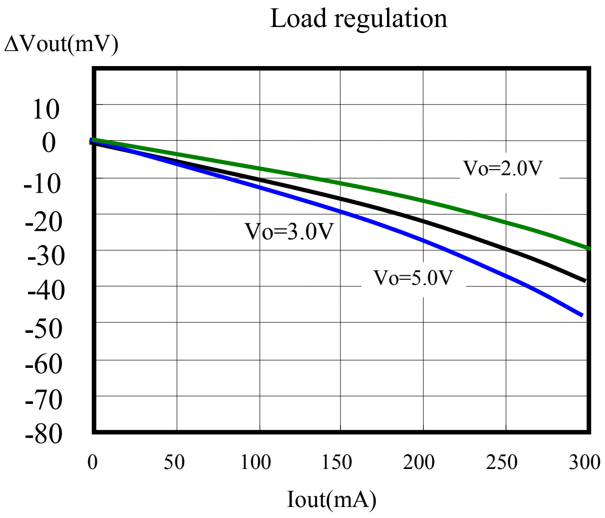
CL= Variable Cnp=0.01µF

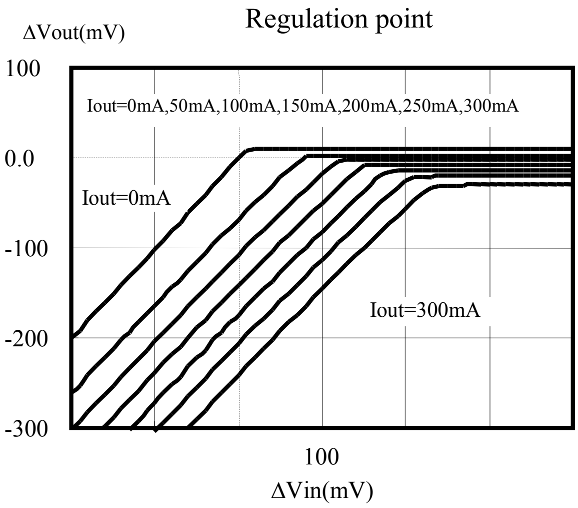


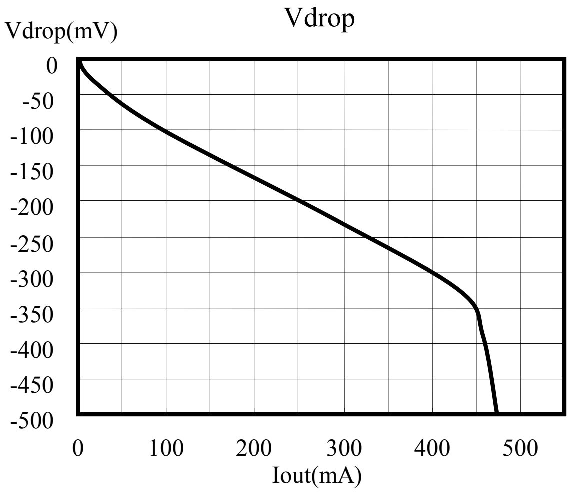
Cnp= Variable CL=1µF

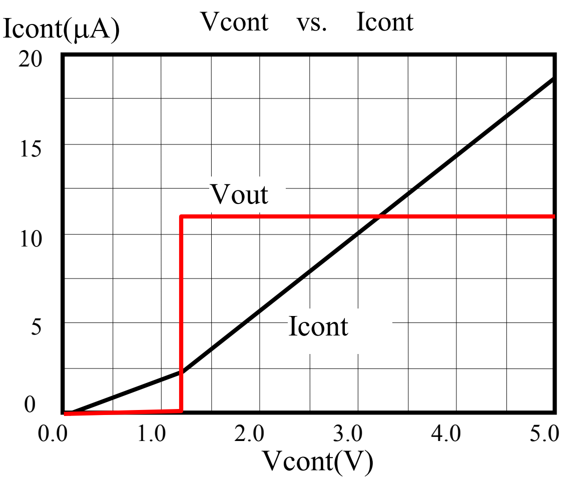


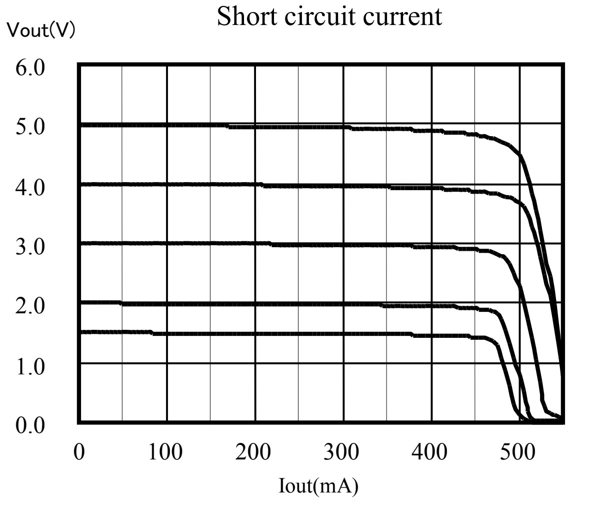

ΔVout(mV)
Line regulation
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
0
5
10
15
20
Vin(V)
Vo1.5V
Vo2.0V
Vo3.0V
Vo4.0V
Vo5.0V

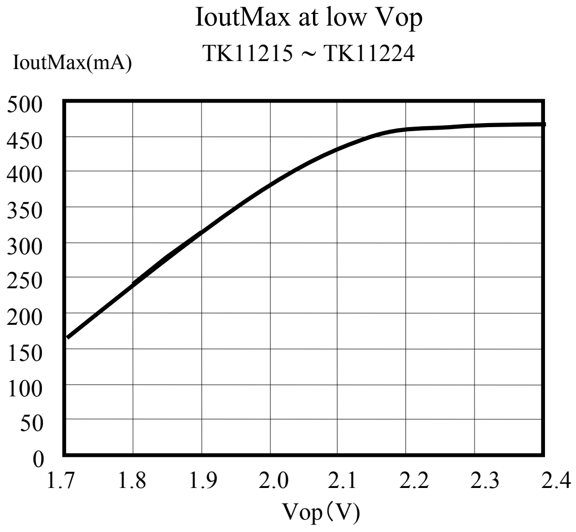

Load regulation
ΔVout(mV)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
0
50
100
150
200
250
300
Iout(mA)
Vo=2.0V
Vo=3.0V
Vo=5.0V

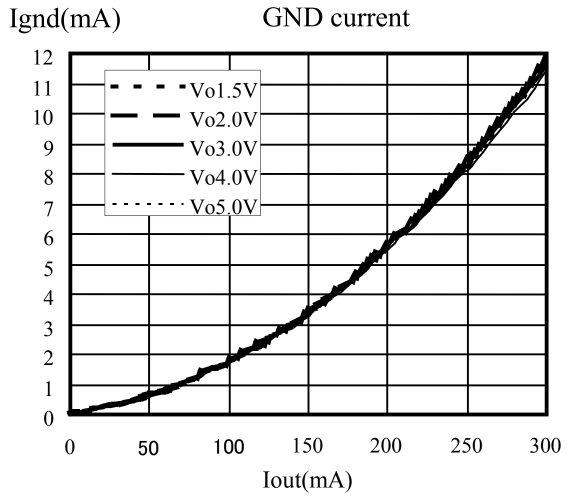

ΔVout(mV)
Regulation point
100
0.0
-100
-200
-300
Iout=0mA,50mA,100mA,150mA,200mA,250mA,300mA
Iout=0mA
Iout=300mA
100
ΔVin(mV)

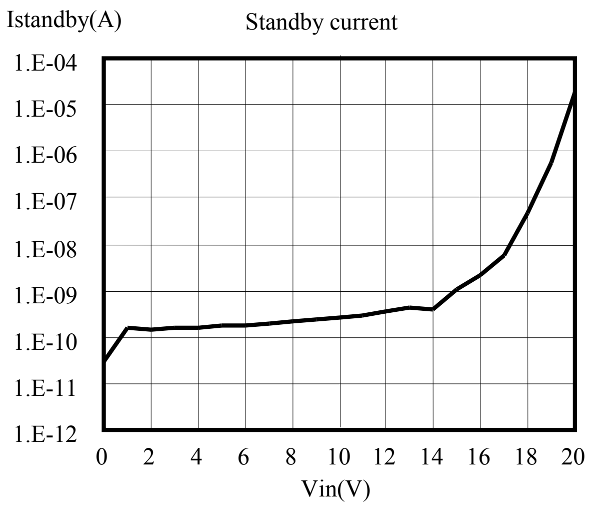

Vdrop(mV)
Vdrop
0
-50
-100
-150
-200
-250
-300
-350
-400
-450
-500
0
100
200
300
400
500
Iout(mA)

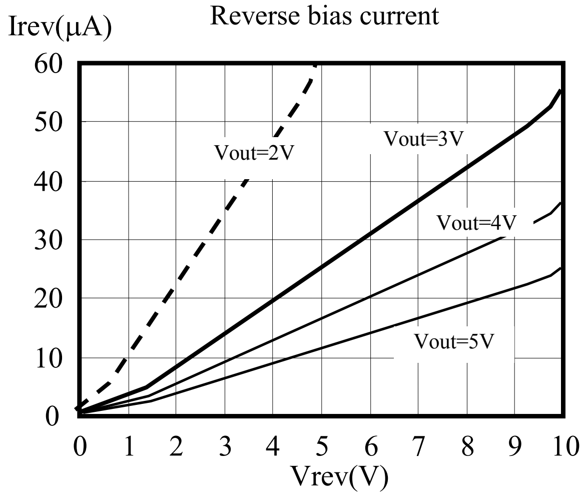

Icont(μA)
Vcont vs. Icont
20
15
10
5
0
Vout
Icont
0.0
1.0
2.0
3.0
4.0
5.0
Vcont(V)


Short circuit current
Vout(V)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
100
200
300
400
500
Iout(mA)

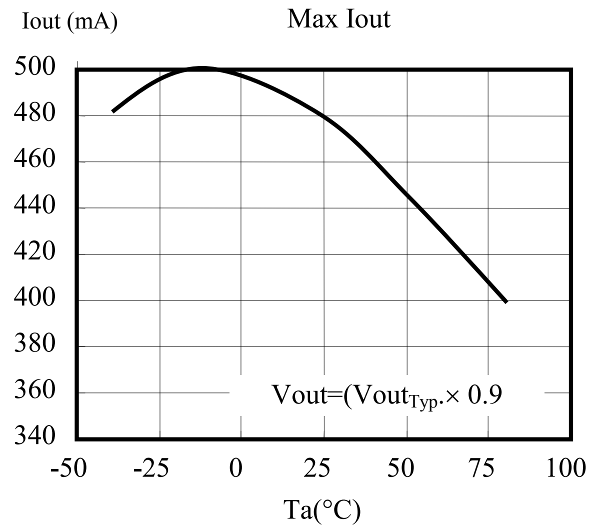

IoutMax at low Vop
TK11215 ~ TK11224
IoutMax(mA)
500
450
400
350
300
250
200
150
100
50
0
1.7
1.8
1.9
2.0
2.1
2.2
2.3
2.4
Vop(V)

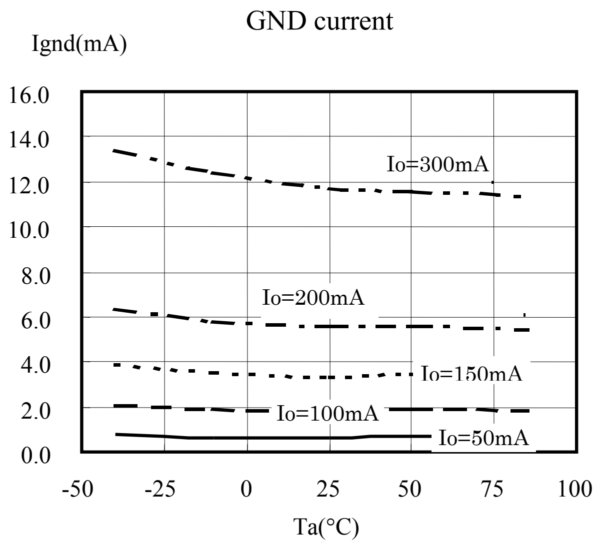

Ignd(mA)
GND current
12
11
10
9
8
7
6
5
4
3
2
1
0
Vo1.5V
Vo2.0V
Vo3.0V
Vo4.0V
Vo5.0V
0
50
100
150
200
250
300
Iout(mA)

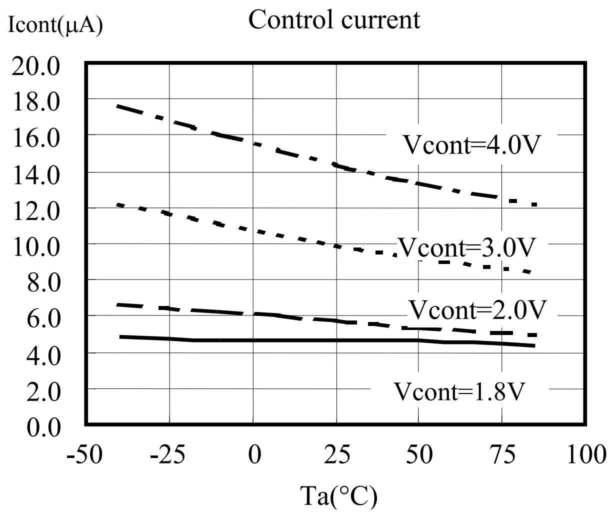

Istandby(A)
Standby current
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
1.E-11
1.E-12
0
2
4
6
8
10
12
14
16
18
20
Vin(V)

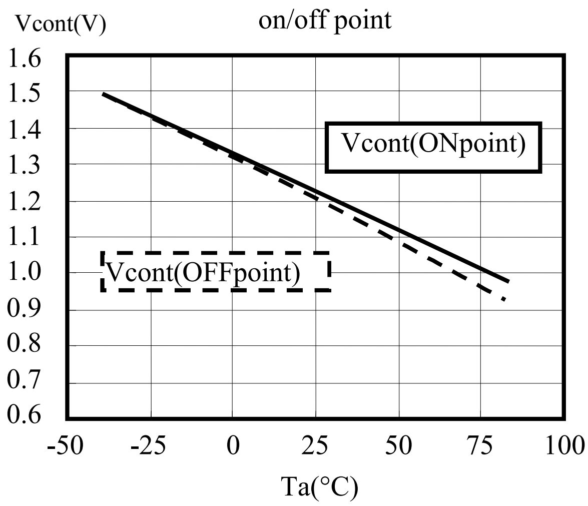

Irev(μA)
Reverse bias current
60
50
40
30
20
10
0
Vout=2V
Vout=3V
Vout=4V
Vout=5V
0
1
2
3
4
5
6
7
8
9
10
Vrev(V)

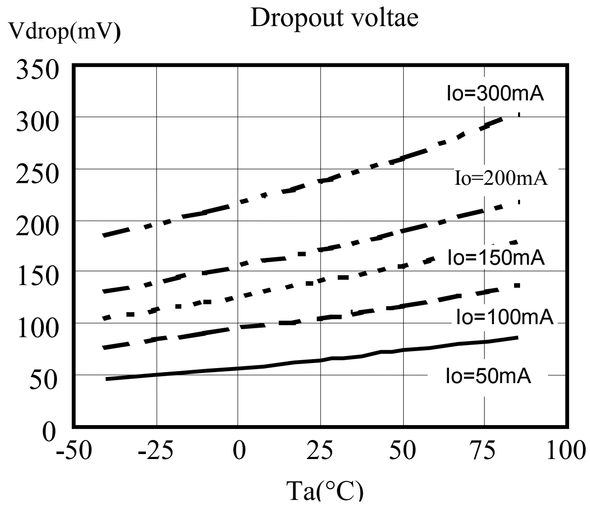
Temperature Characteristics (Ta: Ambient temperature)

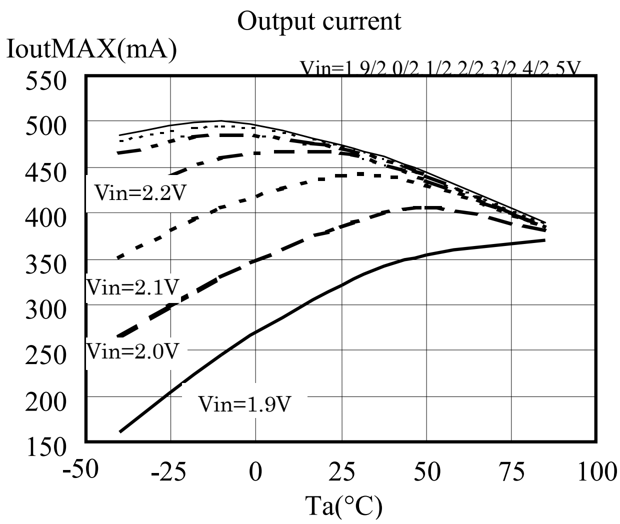




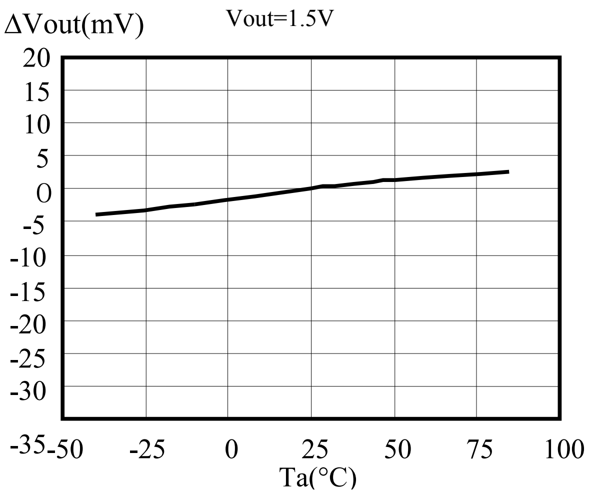


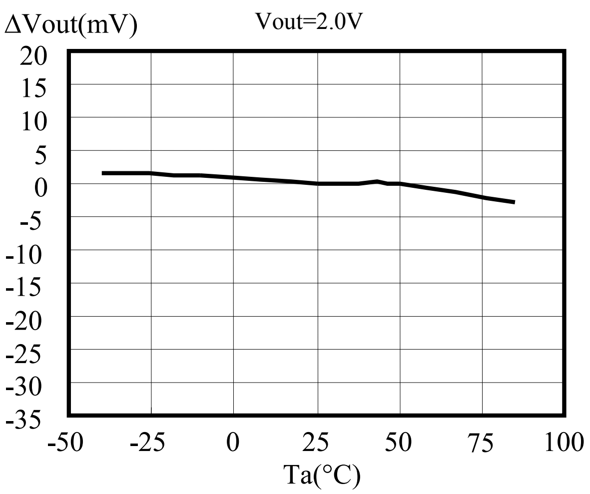


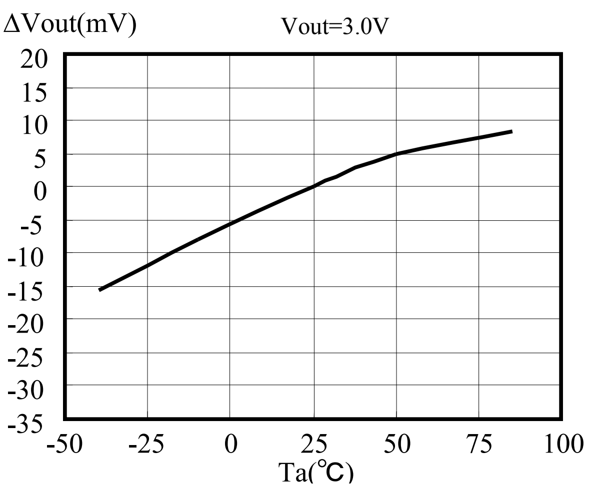


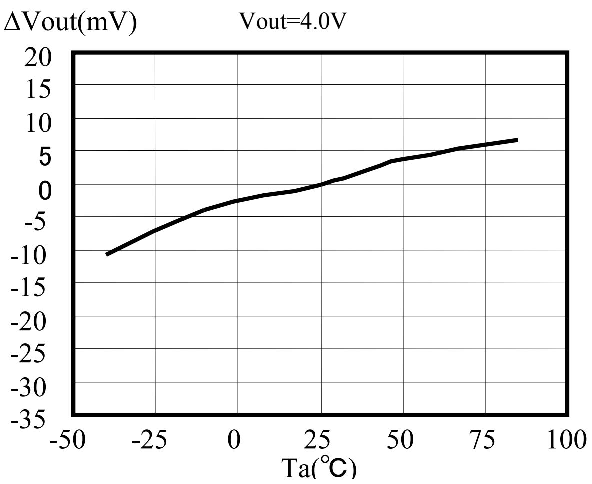


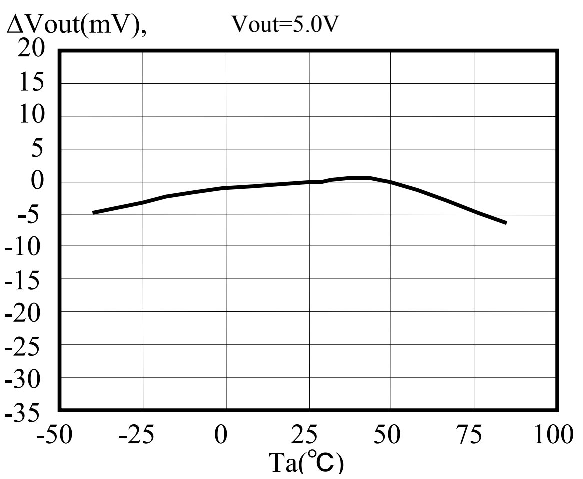
Output voltage vs. Temperature characteristics





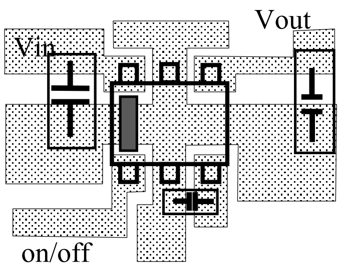


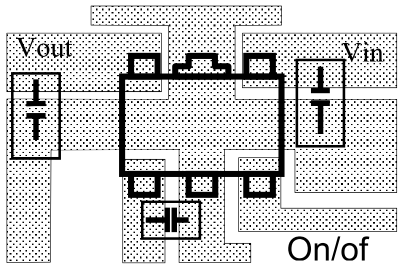




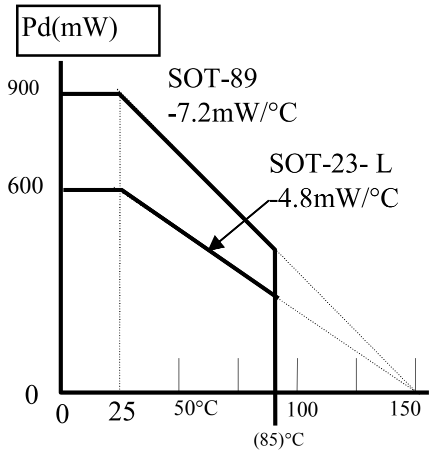
Layout PCB Material : Glass epoxy t=0.8mm

SOT-23L	SOT-89
Please do derating with 4mW/°C at Pd=500mW and 25°C or more. Thermal resistance is (θja=250°C / W).	Please do derating with 7.2mW/°C at Pd=900mW and 25°C or more. Thermal resistance is (θja=138°C / W)





Derating Curve



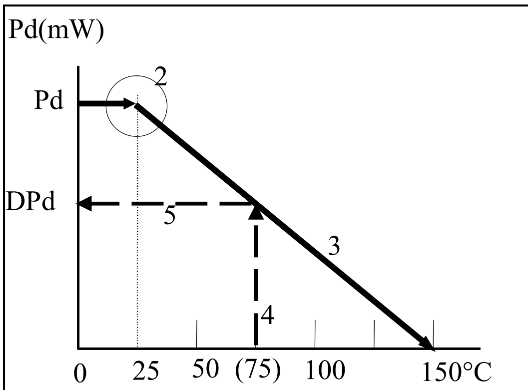
The package loss is limited at the temperature that the internal temperature sensor works (about 150°C). Therefore, the package loss is assumed to be an internal limitation. There is no heat radiation characteristic of the package unit assumed because of the small size. Heat is carried away by the device being installed on the PCB. This value changes by the material and the copper pattern etc. of the PCB. The losses are approximately 600mW (SOT-23L) : 900mW(SOT-89). Enduring these losses becomes possible in a lot of applications operating at 25°C.

Determining the thermal resistance when mounted on a PCB.
The operating chip junction temperature is shown by
Tj=θja × Pd + Ta. Tj of the IC is set to about 150°C.
Pd is a value when the overtemperature sensor is made to work.

Ta (Ta=25°C)
150 = θja × pd + 25
θja × Pd = 125
θja = (125/ pd) (°C / mW)

Pd is easily obtained.
Mount the IC on the PCB. Pd becomes Vin × Iin when the output side of the IC is short-circuited.
The input current decreases gradually by the temperature rise of the chip.
Please use the value when the current is steady (thermal equilibrium is reached).
In many cases, heat radiation is good, and Pd becomes 600mW/900 mW or more.

Pd is obtained by the normal temperature in degrees. The current that can be used at the highest operating temperature is obtained from the graph of the figure below.



Procedure (Do when PCB mounted).

1. Pd is obtained (Vin × Iin when the output side is short-circuited).
2. Pd is plotted on the horizontal line to 25°C.
3. Pd is connected with the point of 150°C by the straight line (bold face line).
4. A line is extended vertically above the point of use temperature in the design. For instance, 75°C is assumed (broken line).
5. Extend the intersection of the derating curve (fat solid line) and (broken line) to the left and read the Pd value.
6. DPd ÷ (Vinmax – Vout)=Iout (at 75°C)

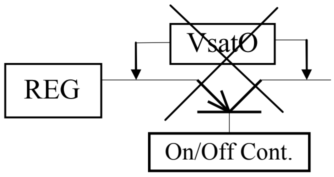
The maximum current that can be used at the highest operating temperature is:

Iout ≅ DPd ÷ (Vinmax – Vout).

Application hint

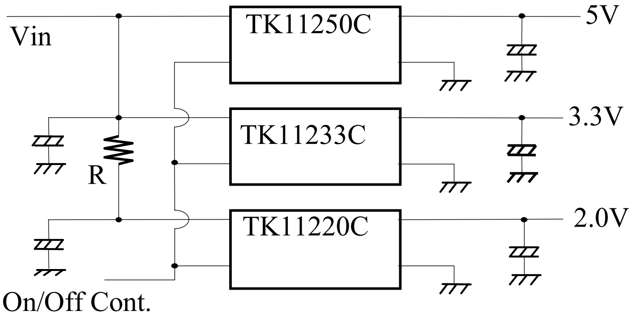
On/Off Control

It is recommended to turn the regulator Off when the circuit following the regulator is non-operating. A design with little electric power loss can be implemented. We recommend the use of the on/off control of the regulator without using a high side switch to provide an output from the regulator. A highly accurate output voltage with low voltage drop is obtained.



Because the control current is small, it is possible to control it directly by CMOS logic.
The PULLDOWN resistance (500KΩ) is built into the control terminal.
The noise and the ripple rejection characteristics depend on the capacitance on the Vref terminal.
The ripple rejection characteristic of the low frequency region improves by increasing the capacitance of Cnp.
A standard value is Cnp=0.068μF. Increase Cnp in a design with important output noise and ripple rejection requirements. The IC will not be damaged if the capacitor value is increased.
The on/off switching speed changes depending on the Np terminal capacitance. The switching speed slows when the capacitance is large.

Parallel connected ON/OFF Control



The figure at the left illustrates multiple regulators being controlled by a single On/Off control signal. There is a possibility of overheating because the power loss of the low voltage side IC (TK11220C) is large. The series resistor (R) is put in the input line of the low output voltage regulator in order to prevent over-dissipation. The voltage dropped across the resistor reduces the large input-to-output voltage across the regulator, reducing the power dissipation in the device. When the thermal sensor works, a decrease of the output voltage, oscillation, etc. may be observed.

Definition of Terms

The output voltage tables are specified with a test voltage of Vin=Output Voltage (Typ.) + 1V.

Output Voltage (Vout)

The output voltage is specified with (Vin = Output Voltage (Typ.) + 1V) and output current (Iout=5mA).

Maximum Output Current (Iout Max)

The output current is measured when the output voltage decreases to ($Vout_{Typ.}$ x 0.9). The input voltage is (Output Voltage (Typ.) + 1V). The maximum output current is measured in a short time so that it is not influenced by the temperature of the chip. The output current decreases with low voltage operation.
Please refer to the "Low input voltage-output current" graph for 2.1V or less.

Dropout Voltage (Vdrop)

The dropout voltage is the difference between the input voltage and the output voltage at which point the regulator starts to fall out of regulation. Below this value, the output voltage will fall as the input voltage is reduced. It is dependent upon the load current (Iout) and the junction temperature (Tj). The input voltage is gradually decreased below the test voltage. It is the voltage difference between the input and the output when the output voltage decreases by 100mV.

Line Regulation (Lin Reg)

Line regulation is the ability of the regulator to maintain a constant output voltage as the input voltage changes. The line regulation is specified as the input voltage is changed from (Output Voltage (Typ.) + 1V) to (Output Voltage (Typ.) + 6V). This measurement is not influenced by the temperature of the IC and is measured in a short time.

Load Regulation (Load Reg)

Load regulation is the ability of the regulator to maintain a constant output voltage as the load current changes. The input voltage is set to (Output Voltage (Typ.) + 1V). The output voltage change is measured as the load current changes from to 5 to 100mA and from 5 to 200mA. This measurement is not influenced by the temperature of the IC and is measured in a short time.

Quiescent Current (Iq)

The quiescent current is the current which flows through the ground terminal under no load conditions (Io=0mA).

Ripple Rejection (RR)

Ripple rejection is the ability of the regulator to attenuate the ripple content of the input voltage at the output. It is specified with the input voltage = (Vout + 1.5V) , Iout=10mA, CL=1.0μF and C_{np}=0.01μF An Alternating Current source of (f=1kHz and $200mV_{RMS}$) is superimposed to the power-supply voltage. Ripple rejection is the ratio of the ripple content of the output vs. the input and is expressed in dB. It is typically about 80dB at 1KHz. The ripple rejection improves when the value of the capacitor at the noise bypass terminal in the circuit is large. However, the on/off response worsens.

Standby Current.(Istandby)

Standby current is the current which flows into the regulator when the control voltage is made 0 volts. It is measured with an input voltage of 8V.

PROTECTION CIRCUITS

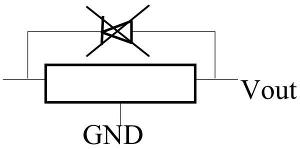
Thermal Sensor

The thermal sensor protects the device if the junction temperature exceeds the safe value (Tj=150 °C). This temperature rise can be caused by extreme heat, excessive power dissipation caused by large output voltage drops, or excessive output current. The regulator will shut off when the temperature exceeds the safe value. As the junction temperature decreases, the regulator will begin to operate again. Under sustained fault conditions, the regulator output will oscillate as the device turns off then resets. Please improve heat radiation or lower the input electric power. When heat radiation is poor, the forecast package loss is not obtained.

* In the case that the power, Vin × Ishort(Short Circuit Current), becomes more than twice of the maximum rating of its power dissipation in a moment, there is a possibility that the IC is destroyed before internal thermal protection works.

Reverse Bias Current

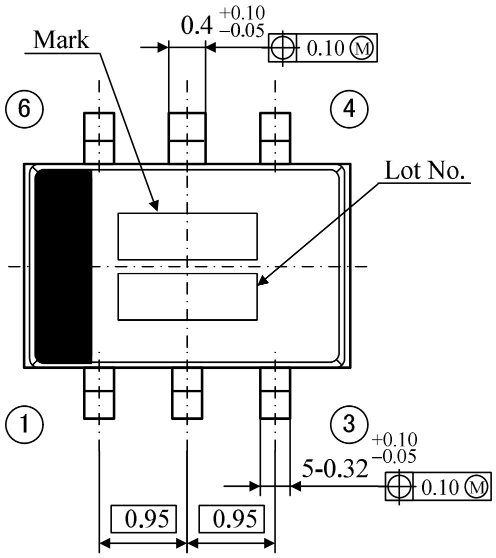
The reverse bias protection prevents excessive current from flowing through the IC even if the input voltage becomes 0 with voltage impressed on the output side (input short-circuited to GND). The maximum reverse bias voltage is 6V.

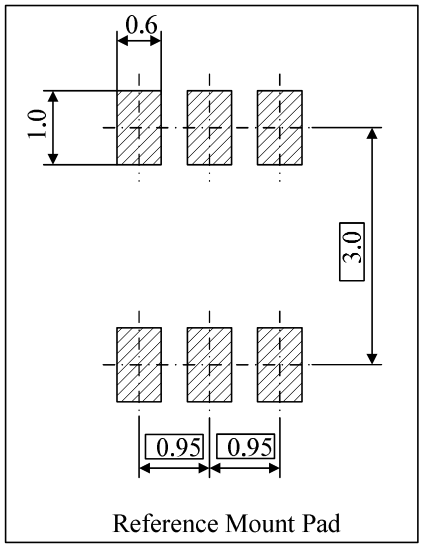


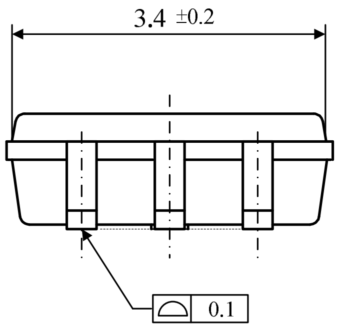
- ESD .... MM 200pF 0Ω 200V Min
  HBM 100pF 1.5kΩ 2000V Min

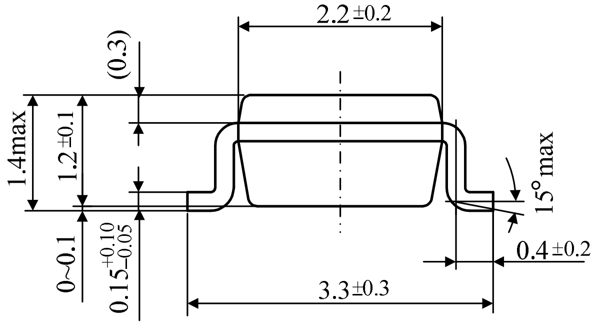
Outline ; PCB ; Stamps

SOT23L-6



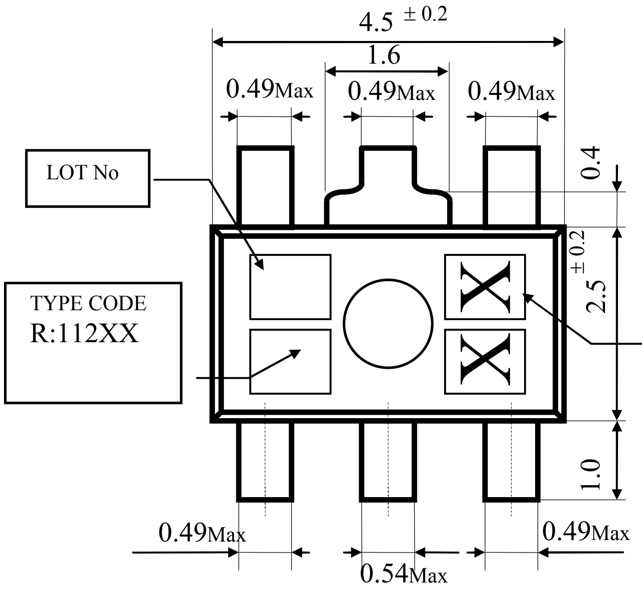


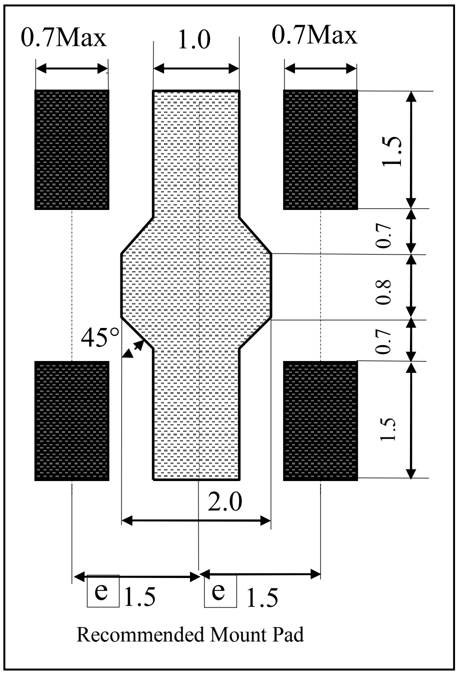


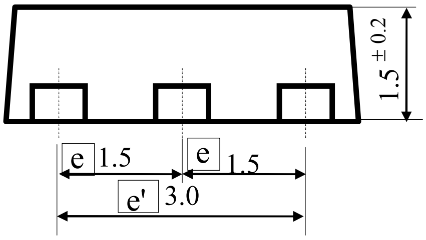


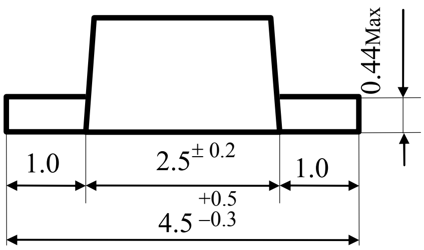
Unit : mm
General tolerance : ± 0.2

SOT89-5









Unit : mm
General tolerance : ± 0.2

1. NOTES

■ Please be sure that you carefully discuss your planned purchase with our office if you intend to use the products in this application manual under conditions where particularly extreme standards of reliability are required, or if you intend to use products for applications other than those listed in this application manual.

- Power drive products for automobile, ship or aircraft transport systems; steering and navigation systems, emergency signal communications systems, and any system other than those mentioned above which include electronic sensors, measuring, or display devices, and which could cause major damage to life, limb or property if misused or failure to function.
- Medical devices for measuring blood pressure, pulse, etc., treatment units such as coronary pacemakers and heat treatment units, and devices such as artificial organs and artificial limb systems which augment physiological functions.
- Electrical instruments, equipment or systems used in disaster or crime prevention.

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■ None of the ozone depleting substances(ODS) under the Montreal Protocol are used in our manufacturing process.

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