APPLICATION MANUAL

LDO Regulator IC
TK705xxS/TK707xxS,TK706xxH/TK708xxH

CONTENTS

TK705xxS/TK707xxS,TK706xxH/TK708xxH

1. DESCRIPTION

TK705xxS/TK707xxS and TK706xxH/TK708xxH is a low dropout linear regulator with ON/OFF control, which can supply 100mA load current.

The IC is an integrated circuit with a silicon monolithic bipolar structure.

The output voltage, trimmed with high accuracy, is available from 1.5 to 5.0V in 0.1V steps.

The packages are the small and thin SON2017-6, and the extremely versatile SOT23-5. The IC is designed for portable applications with space requirements, battery powered system and any electronic equipment.

Two kinds of pin configuration can be selected for each package.

The over current, over heat sensor and reverse bias over current protection circuits are built-in.

ESD is also high, so it won't break easily. It is possible to use at ease.

2. FEATURES

- Output current: 100mA, Peak 200mA
- Active high on/off control
- Excellent Ripple rejection ratio: 80dB (f=1kHz)
70dB (f=10kHz)
- Output capacitance: Cout ≥ 0.47µF(Ceramic)
- Output voltage accuracy: ±1.5% or ±50mV
- Short circuit protection (Over current protection)
- Internal thermal shutdown (Over heat protection)
- Reverse bias protection

3. APPLICATIONS

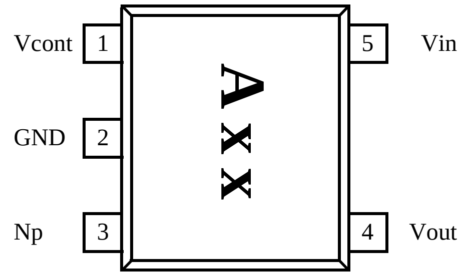
- Any Electronic Equipment
- Battery Powered Systems
- Mobile Communication

4. PIN CONFIGURATION

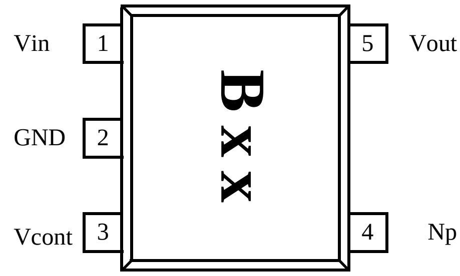
Top View

· **SOT23-5**

TK705xxS

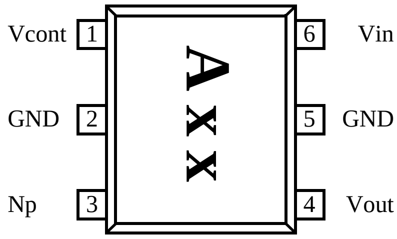


TK707xxS



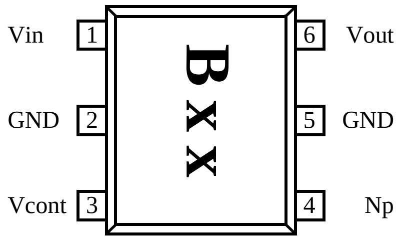
· **SON2017-6**

TK706xxH



*2pin,5pin are connected in the IC.

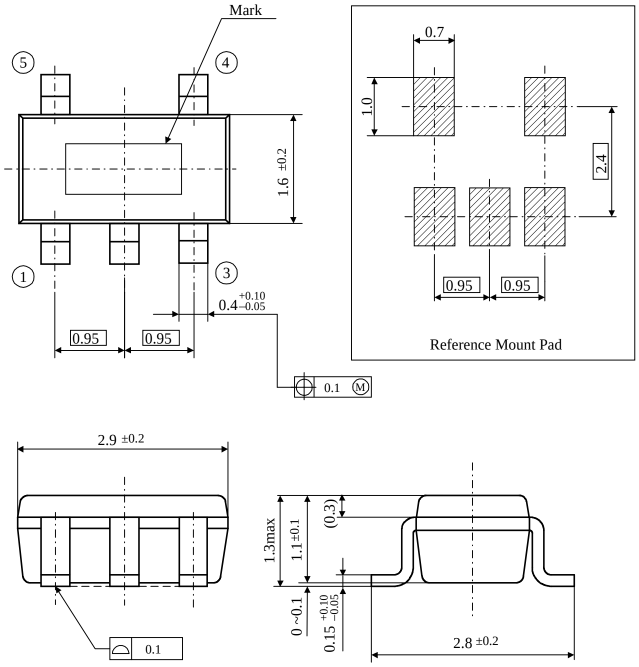
TK708xxH



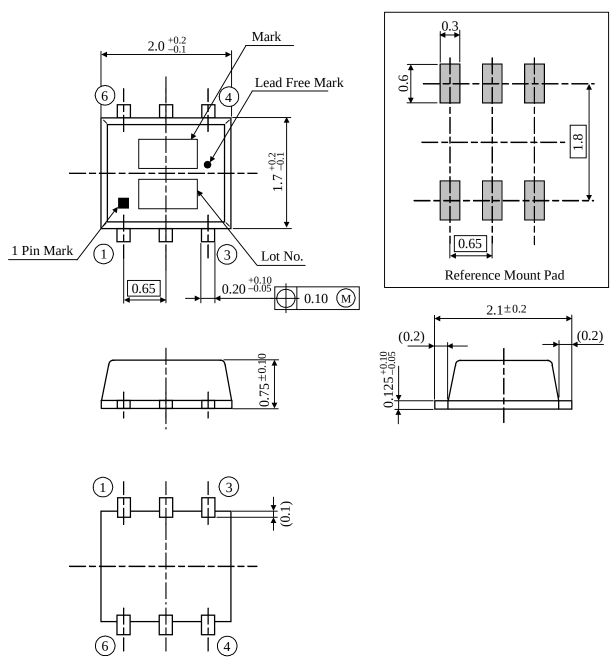
*2pin,5pin are connected in the IC.

5. PACKAGE OUTLINE

■ SOT23-5



■ SON2017-6



6. ORDERING INFORMATION

T K 7 0 □ □ □ □ C L

Pin Configuration
5 or 7 : SOT23-5
6 or 8 : SON2017-6

Voltage Code
ex 28 : 2.8V
30 : 3.0V

Package Code
S : SOT23-5
H : SON2017-6

Rank Code
C : C Rank

Tape / Reel Code

Marking

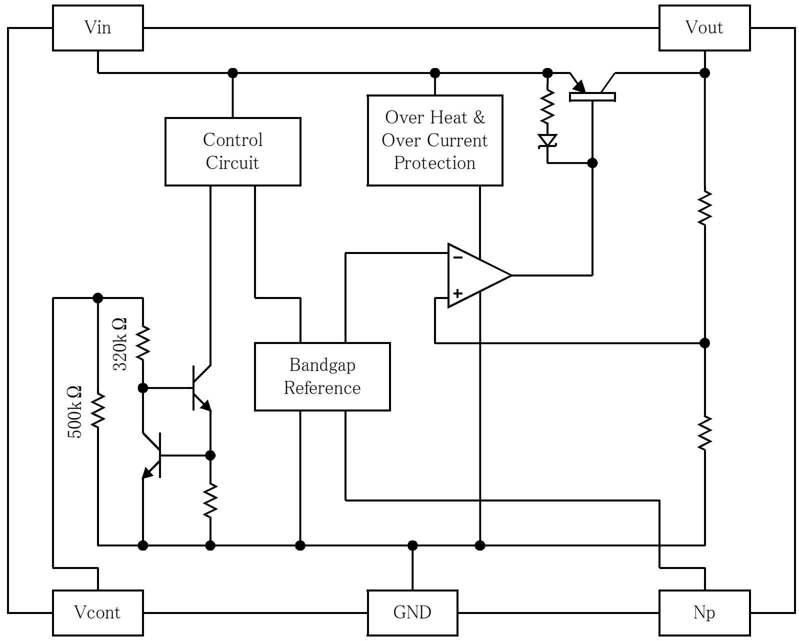
TK705xxS/TK706xxH : Axx

Part Number	Mark	Part Number	Mark	Part Number	Mark	Part Number	Mark
TK70513SC TK70613HC	A13	TK70523SC TK70623HC	A23	TK70533SC TK70633HC	A33	TK70543SC TK70643HC	A43
TK70514SC TK70614HC	A14	TK70524SC TK70624HC	A24	TK70534SC TK70634HC	A34	TK70544SC TK70644HC	A44
TK70515SC TK70615HC	A15	TK70525SC TK70625HC	A25	TK70535SC TK70635HC	A35	TK70545SC TK70645HC	A45
TK70516SC TK70616HC	A16	TK70526SC TK70626HC	A26	TK70536SC TK70636HC	A36	TK70546SC TK70646HC	A46
TK70517SC TK70617HC	A17	TK70527SC TK70627HC	A27	TK70537SC TK70637HC	A37	TK70547SC TK70647HC	A47
TK70518SC TK70618HC	A18	TK70528SC TK70628HC	A28	TK70538SC TK70638HC	A38	TK70548SC TK70648HC	A48
TK70519SC TK70619HC	A19	TK70529SC TK70629HC	A29	TK70539SC TK70639HC	A39	TK70549SC TK70649HC	A49
TK70520SC TK70620HC	A20	TK70530SC TK70630HC	A30	TK70540SC TK70640HC	A40	TK70550SC TK70650HC	A50
TK70521SC TK70621HC	A21	TK70531SC TK70631HC	A31	TK70541SC TK70641HC	A41		
TK70522SC TK70622HC	A22	TK70532SC TK70632HC	A32	TK70542SC TK70642HC	A42		

TK707xxS/TK708xxH : Bxx

Part Number	Mark	Part Number	Mark	Part Number	Mark	Part Number	Mark
TK70713SC TK70813HC	B13	TK70723SC TK70823HC	B23	TK70733SC TK70833HC	B33	TK70743SC TK70843HC	B43
TK70714SC TK70814HC	B14	TK70724SC TK70824HC	B24	TK70734SC TK70834HC	B34	TK70744SC TK70844HC	B44
TK70715SC TK70815HC	B15	TK70725SC TK70825HC	B25	TK70735SC TK70835HC	B35	TK70745SC TK70845HC	B45
TK70716SC TK70816HC	B16	TK70726SC TK70826HC	B26	TK70736SC TK70836HC	B36	TK70746SC TK70846HC	B46
TK70717SC TK70817HC	B17	TK70727SC TK70827HC	B27	TK70737SC TK70837HC	B37	TK70747SC TK70847HC	B47
TK70718SC TK70818HC	B18	TK70728SC TK70828HC	B28	TK70738SC TK70838HC	B38	TK70748SC TK70848HC	B48
TK70719SC TK70819HC	B19	TK70729SC TK70829HC	B29	TK70739SC TK70839HC	B39	TK70749SC TK70849HC	B49
TK70720SC TK70820HC	B20	TK70730SC TK70830HC	B30	TK70740SC TK70840HC	B40	TK70750SC TK70850HC	B50
TK70721SC TK70821HC	B21	TK70731SC TK70831HC	B31	TK70741SC TK70841HC	B41		
TK70722SC TK70822HC	B22	TK70732SC TK70832HC	B32	TK70742SC TK70842HC	B42		

7. BLOCK DIAGRAM



8. 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	460 ***1**	mW	SOT23-5
		400 ***2**	mW	SON2017-6
Operating Condition				
Operating Temperature Range	T_{OP}	-40 ~ 85	°C	
Operating Voltage Range	V_{OP}	2.1 ~ 14	V	
Short Circuit Current	Ishort	200	mA	Over Current Protection

***1 :** Internal Limited Tj=140°C. P_D must be decreased at rate of 4.0 mW/°C for operation above 25°C.
***2 :** Internal Limited Tj=140°C. P_D must be decreased at rate of 3.5 mW/°C for operation above 25°C.
The maximum ratings are the absolute limitation values with the possibility of the IC breakage.
When the operation exceeds this standard, quality cannot be guaranteed.

9. ELECTRICAL CHARACTERISTICS

The parameters with min. or max. values will be guaranteed at Ta=Tj=25°C with test when manufacturing or SQC(Statistical Quality Control) methods. The operation between -40 ~ 85°C is guaranteed when design.

Vin=$Vout_{TYP}$+1V,Vcont=1.8V,Ta=Tj=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	5.0	mV	ΔVin = 5V
Load Regulation	LoaReg	**Refer to TABLE 1**			mV	Iout = 5mA ~ 50mA
		Refer to TABLE 1			mV	Iout = 5mA ~ 100mA
Dropout Voltage ***1**	Vdrop		90	160	mV	Iout = 50mA
			160	280	mV	Iout = 100mA
Output Current ***2**	Iout			100	mA	
Peak Output Current ***2**	$Iout_{PEAK}$	150	200		mA	When ($Vout_{TYP}$×0.9)
Quiescent Current	Iq		75	120	µA	Iout = 0mA
Standby Current	Istandby		0.0	0.1	µA	Vcont = 0V
Ground Pin Current	Ignd		1.5	2.7	mA	Iout = 50mA
Control Terminal *3						
Control Current	Icont		5.0	15.0	µA	Vcont = 1.8V
Control Voltage	Vcont	1.8			V	Vout ON state
				0.35	V	Vout OFF state
Reference Value						
Np Terminal Voltage	Vnp		1.26		V	
Output Voltage / Temp.	Vout/Ta		35		ppm /°C	
Output Noise Voltage ($Vout_{TYP}$=3.0V)	Vnoise		38		µVrms	Cout=1.0µF, Cnp=0.01µF Iout=30mA
Ripple Rejection ($Vout_{TYP}$=3.0V)	R.R		80		dB	Cout=1.0µF, Cnp=0.001µF Iout=10mA, f=1kHz
			70		dB	f=10kHz
Rise Time ($Vout_{TYP}$=3.0V)	tr		35		µs	Cout=1.0µF, Cnp=0.001µF Vcont: Pulse Wave (100Hz) Vcont ON → Vout×95% point

***1**: For Vout ≤ 2.0V , no regulations.
***2**: The output current is limited by power dissipation.
***3**: The input current decreases to pA level when control terminal is connected to GND (Off state).

General Note: Parameter with only typical value is for reference only.

TABLE 1. Output Voltage, Load Regulation

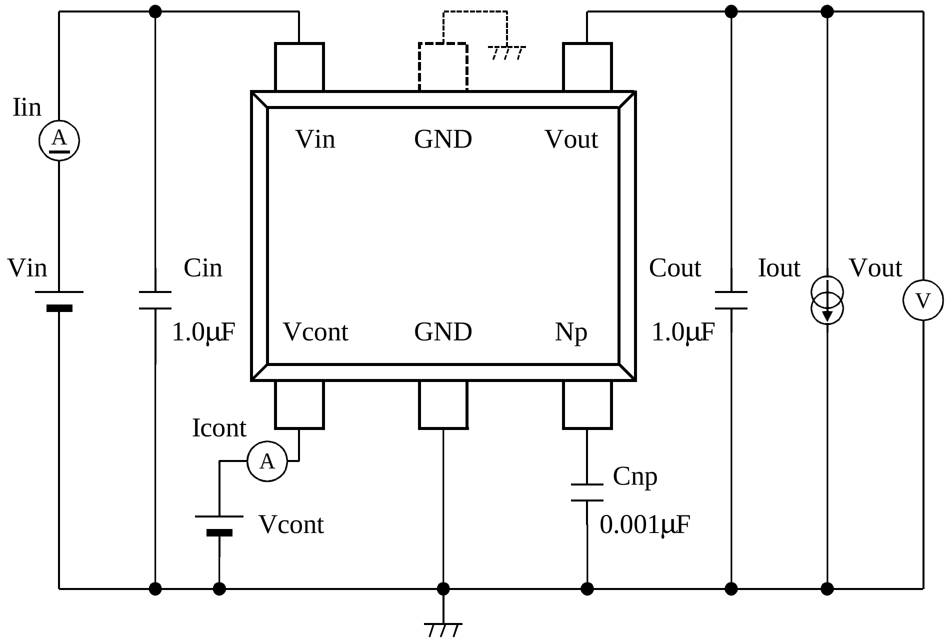
Part Number		Output Voltage			Load Regulation			
					Iout = 50mA		Iout = 100mA	
		MIN	TYP	MAX	TYP	MAX	TYP	MAX
		V	V	V	mV	mV	mV	mV
$Vout_{TYP}$=1.3V ~ 2.0V								
TK70513/ 70713SC	TK70613/ 70813HC	1.250	1.300	1.350	5.0	10.0	10.0	22.0
TK70514/ 70714SC	TK70614/ 70814HC	1.350	1.400	1.450	5.0	10.0	10.0	23.0
TK70515/ 70715SC	TK70615/ 70815HC	1.450	1.500	1.550	5.0	11.0	10.0	24.0
TK70516/ 70716SC	TK70616/ 70816HC	1.550	1.600	1.650	5.0	11.0	11.0	25.0
TK70517/ 70717SC	TK70617/ 70817HC	1.650	1.700	1.750	5.0	11.0	11.0	25.0
TK70518/ 70718SC	TK70618/ 70818HC	1.750	1.800	1.850	5.0	12.0	11.0	26.0
TK70519/ 70719SC	TK70619/ 70819HC	1.850	1.900	1.950	5.0	12.0	11.0	27.0
TK70520/ 70720SC	TK70620/ 70820HC	1.950	2.000	2.050	5.0	12.0	12.0	28.0
$Vout_{TYP}$=2.1V ~ 3.0V								
TK70521/ 70721SC	TK70621/ 70821HC	2.050	2.100	2.150	5.0	12.0	12.0	28.0
TK70522/ 70722SC	TK70622/ 70822HC	2.150	2.200	2.250	6.0	13.0	12.0	29.0
TK70523/ 70723SC	TK70623/ 70823HC	2.250	2.300	2.350	6.0	13.0	13.0	30.0
TK70524/ 70724SC	TK70624/ 70824HC	2.350	2.400	2.450	6.0	13.0	13.0	31.0
TK70525/ 70725SC	TK70625/ 70825HC	2.450	2.500	2.550	6.0	14.0	13.0	31.0
TK70526/ 70726SC	TK70626/ 70826HC	2.550	2.600	2.650	6.0	14.0	14.0	32.0
TK70527/ 70727SC	TK70627/ 70827HC	2.650	2.700	2.750	6.0	14.0	14.0	33.0
TK70528/ 70728SC	TK70628/ 70828HC	2.750	2.800	2.850	6.0	14.0	14.0	34.0
TK70529/ 70729SC	TK70629/ 70829HC	2.850	2.900	2.950	6.0	15.0	15.0	34.0
TK70530/ 70730SC	TK70630/ 70830HC	2.950	3.000	3.050	6.0	15.0	15.0	35.0
$Vout_{TYP}$=3.1V ~ 4.0V								
TK70531/ 70731SC	TK70631/ 70831HC	3.050	3.100	3.150	7.0	15.0	15.0	36.0
TK70532/ 70732SC	TK70632/ 70832HC	3.150	3.200	3.250	7.0	15.0	16.0	37.0
TK70533/ 70733SC	TK70633/ 70833HC	3.250	3.300	3.350	7.0	16.0	16.0	37.0
TK70534/ 70734SC	TK70634/ 70834HC	3.349	3.400	3.451	7.0	16.0	16.0	38.0
TK70535/ 70735SC	TK70635/ 70835HC	3.447	3.500	3.553	7.0	16.0	16.0	39.0
TK70536/ 70736SC	TK70636/ 70836HC	3.546	3.600	3.654	7.0	17.0	17.0	40.0
TK70537/ 70737SC	TK70637/ 70837HC	3.644	3.700	3.756	7.0	17.0	17.0	40.0
TK70538/ 70738SC	TK70638/ 70838HC	3.743	3.800	3.857	7.0	17.0	17.0	41.0
TK70539/ 70739SC	TK70639/ 70839HC	3.841	3.900	3.959	8.0	17.0	18.0	42.0
TK70540/ 70740SC	TK70640/ 70840HC	3.940	4.000	4.060	8.0	18.0	18.0	43.0

TABLE 1. Output Voltage, Load Regulation (continue)

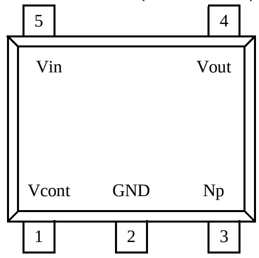
Part Number		Output Voltage			Load Regulation			
					Iout = 50mA		Iout = 100mA	
		MIN	TYP	MAX	TYP	MAX	TYP	MAX
		V	V	V	mV	mV	mV	mV
Vout$_{TYP}$=4.1V ~ 5.0V								
TK70541/ 70741SC	TK70641/ 70841HC	4.038	4.100	4.162	8.0	18.0	18.0	43.0
TK70542/ 70742SC	TK70642/ 70842HC	4.137	4.200	4.263	8.0	18.0	19.0	44.0
TK70543/ 70743SC	TK70643/ 70843HC	4.235	4.300	4.365	8.0	18.0	19.0	45.0
TK70544/ 70744SC	TK70644/ 70844HC	4.334	4.400	4.466	8.0	19.0	19.0	46.0
TK70545/ 70745SC	TK70645/ 70845HC	4.432	4.500	4.568	8.0	19.0	20.0	46.0
TK70546/ 70746SC	TK70646/ 70846HC	4.531	4.600	4.669	8.0	19.0	20.0	47.0
TK70547/ 70747SC	TK70647/ 70847HC	4.629	4.700	4.771	8.0	20.0	20.0	48.0
TK70548/ 70748SC	TK70648/ 70848HC	4.728	4.800	4.872	9.0	20.0	21.0	49.0
TK70549/ 70749SC	TK70649/ 70849HC	4.826	4.900	4.974	9.0	20.0	21.0	49.0
TK70550/ 70750SC	TK70650/ 70850HC	4.925	5.000	5.075	9.0	20.0	21.0	50.0

10. TEST CIRCUIT

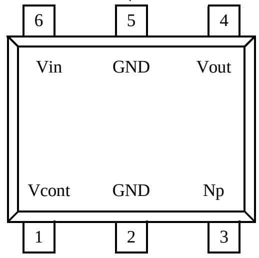
10-1. TK705xxS/TK706xxH



TK705xxS (SOT23-5)

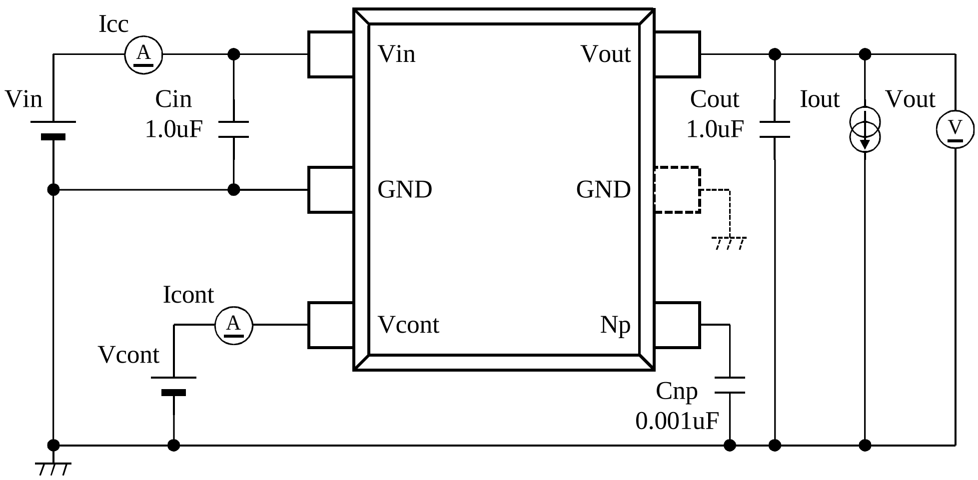


TK706xxH (SON2017-6)

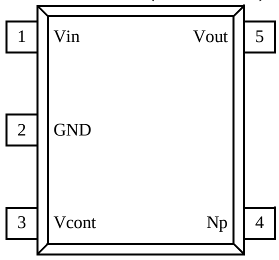


*2pin and 5pin are connected in the IC.

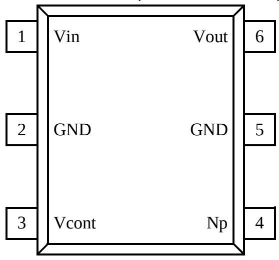
10-2. TK707xxS/TK708xxH



TK707xxS (SOT23-5)



TK708xxH (SON2017-6)

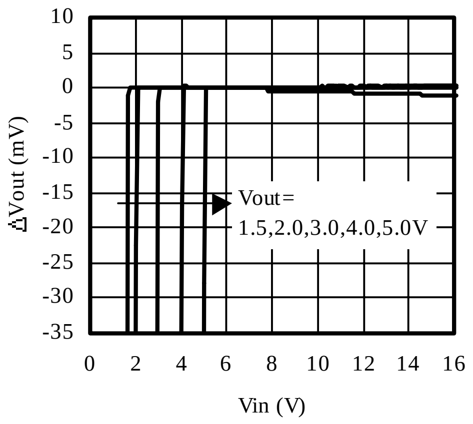


*2pin and 5pin are connected in the IC.

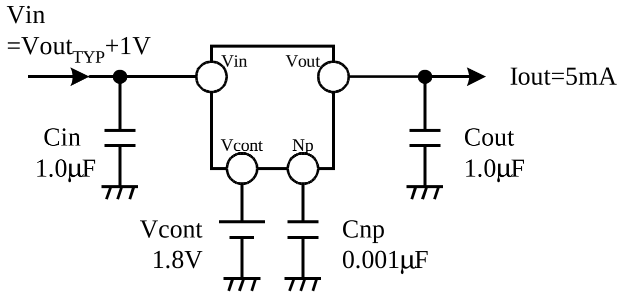
11. TYPICAL CHARACTERISTICS

11-1-1. DC CHARACTERISTICS

■ Line Regulation

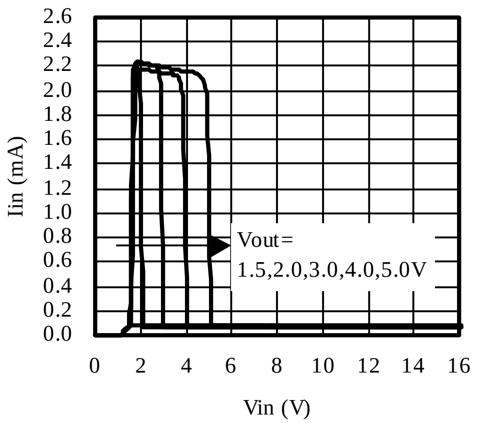


Test conditions



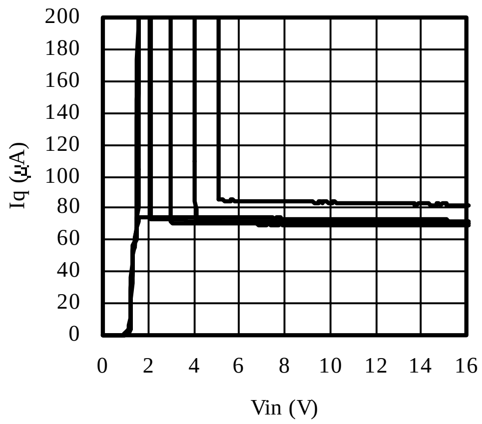
■ Iin vs Vin

Iout=0mA

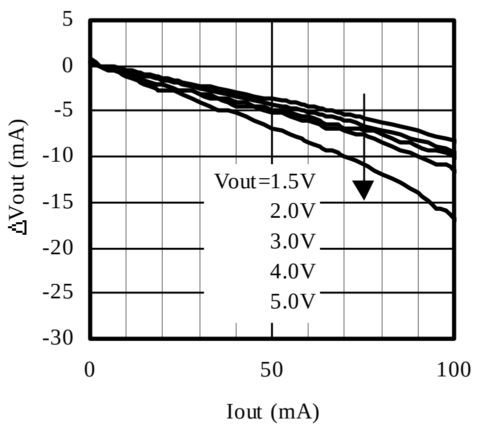


■ Quiescent Current

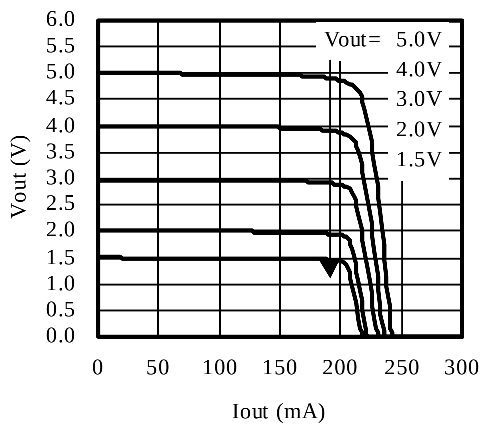
Iout=0mA



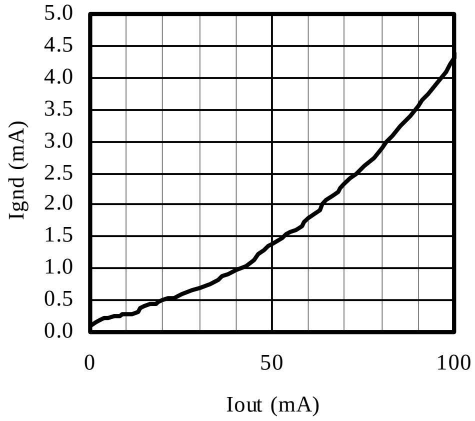
■ Load Regulation



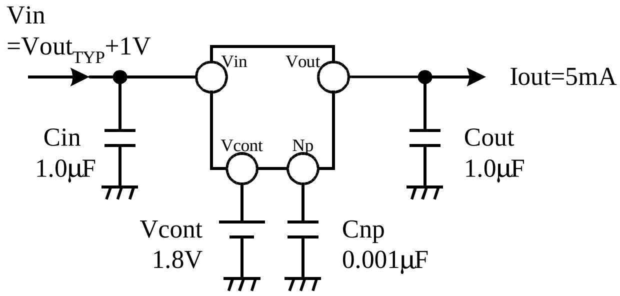
■ Peak Output Current



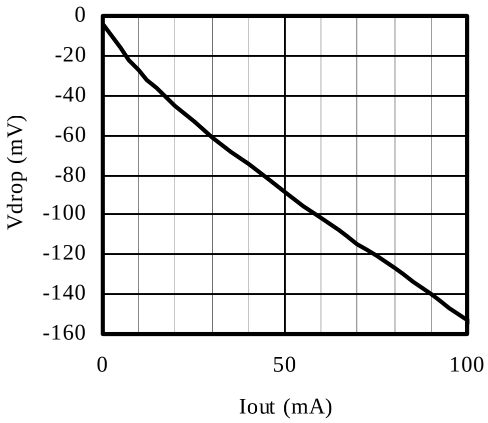
■ GND Pin Current



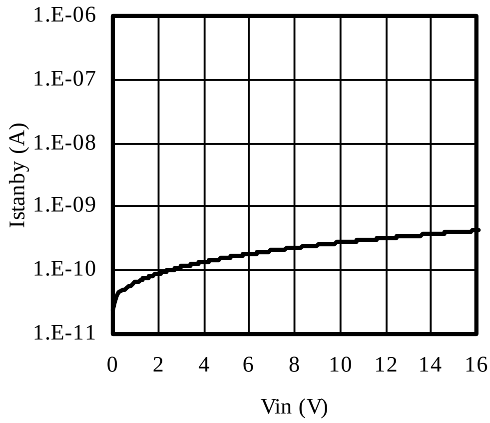
Test conditions



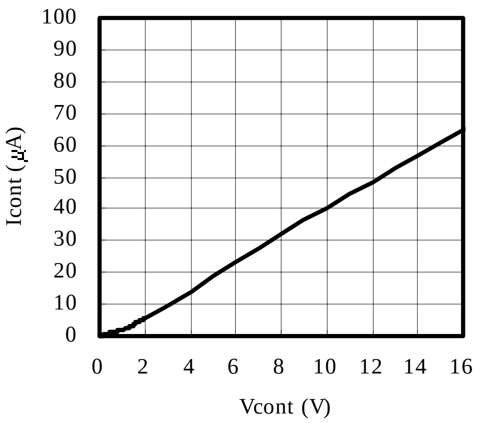
■ Dropout Voltage
2.1V ≤ Vout$_{TYP}$



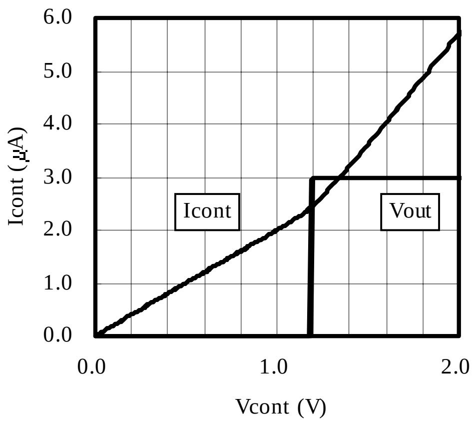
■ Standby Current (Off state)
Vcont=0V



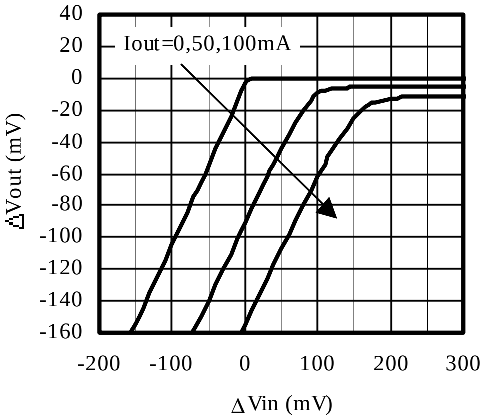
■ Control Current



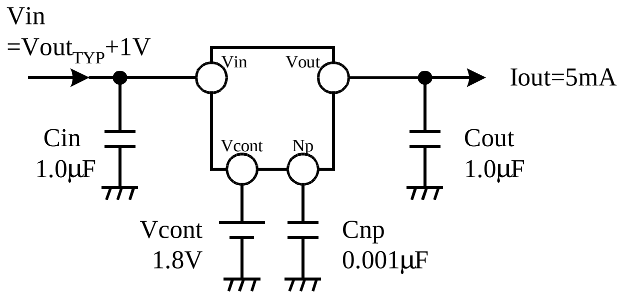
■ Control Current, ON/OFF Point



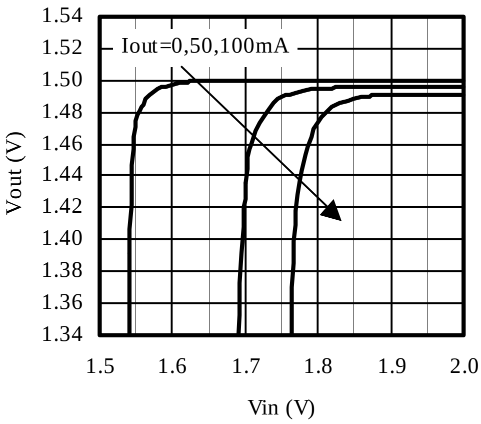
■ Vout vs Vin Regulation Point
2.1V ≤ $Vout_{TYP}$



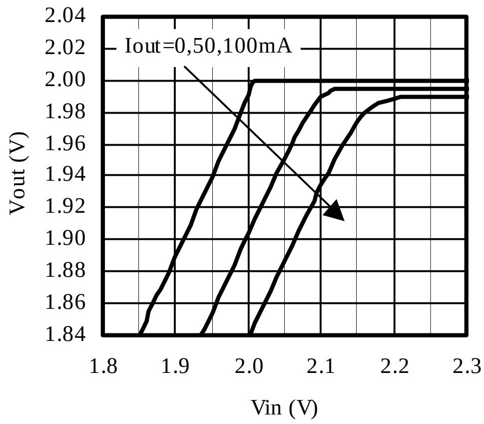
Test conditions



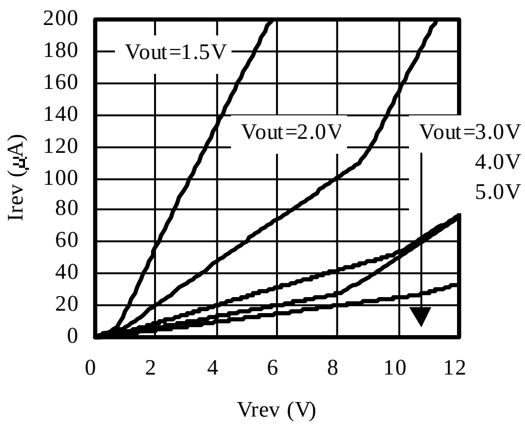
■ Vout vs Vin Regulation Point
$Vout_{TYP}$=1.5V



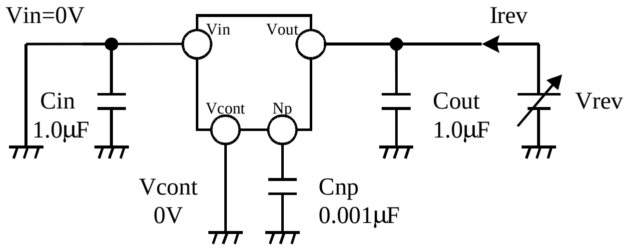
■ Vout vs Vin Regulation Point
$Vout_{TYP}$=2.0V



■ Reverse Bias Current
Vin=0V, Vcont=0V



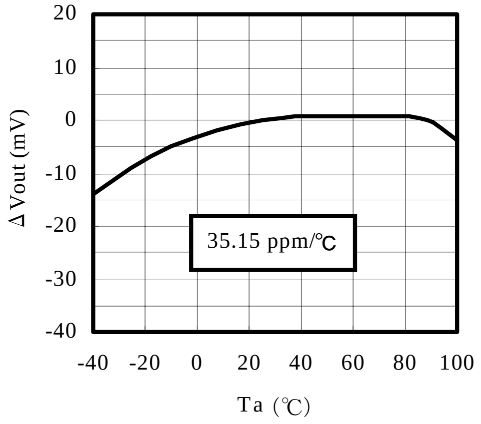
Test conditions



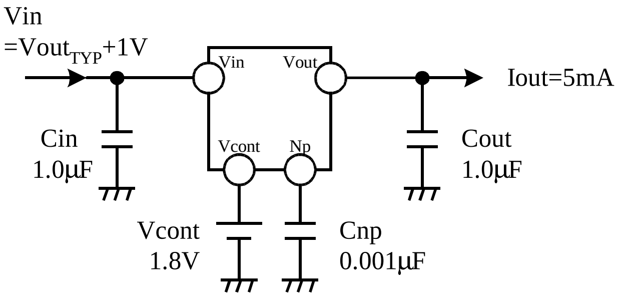
11-1-2. Temperature Characteristics

■ Vout

$Vout_{TYP}$=3.0V

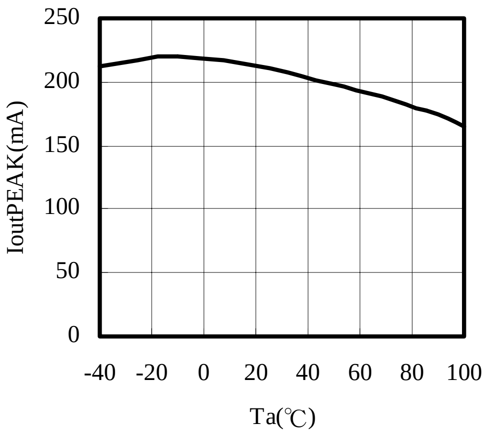


Test conditions

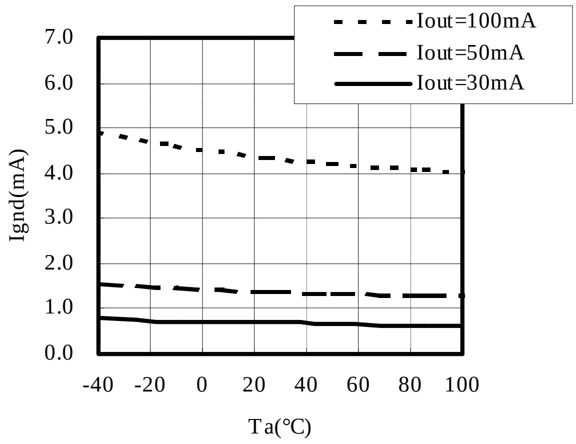


■ Peak Output Current

Vout=$Vout_{TYP}$ × 0.9

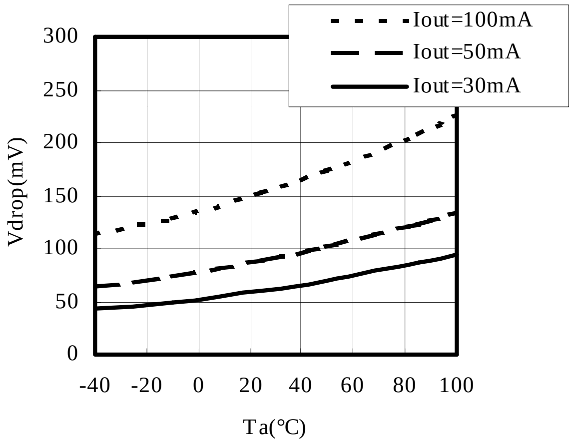


■ GND Pin Current



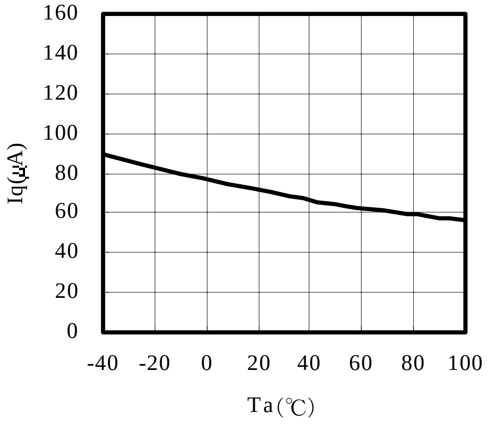
■ Dropout Voltage

2.1V ≤ $Vout_{TYP}$

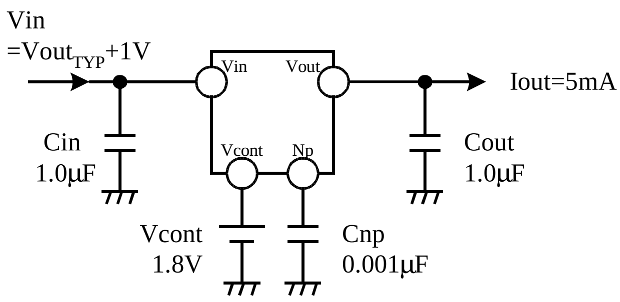


■ Quiescent Current

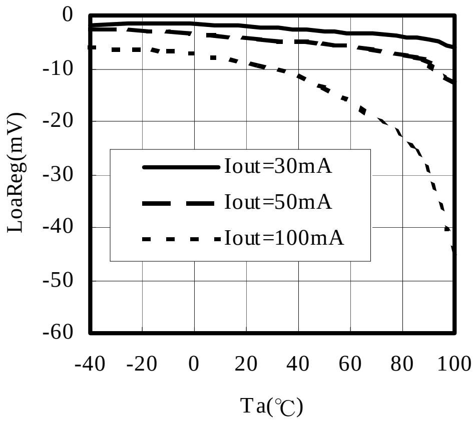
Iout=0mA



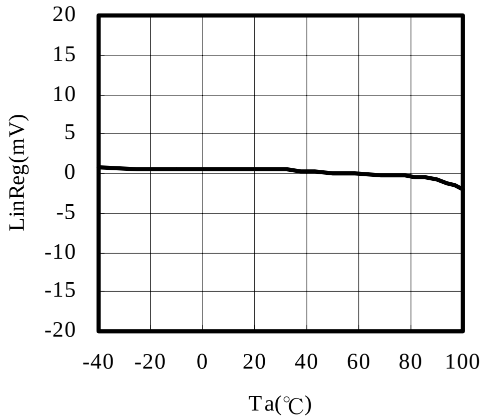
Test conditions



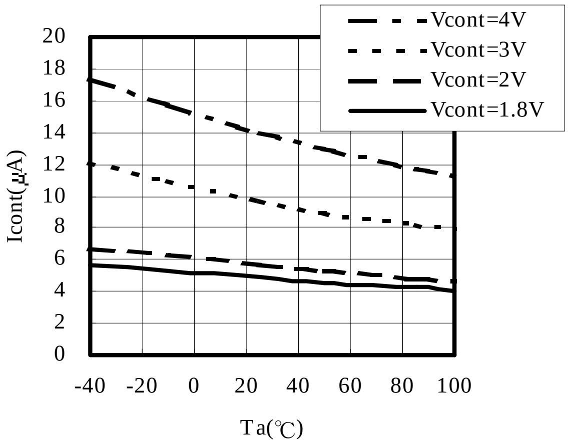
■ Load Regulation
$Vout_{TYP}$=3.0V



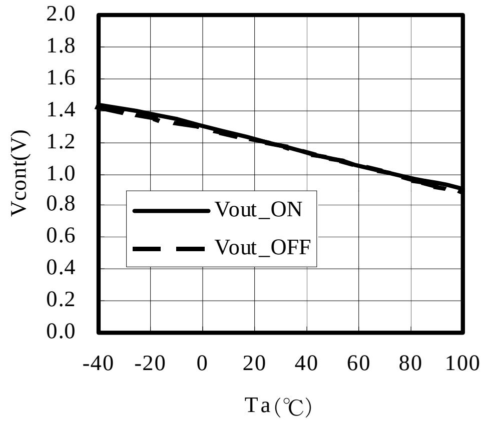
■ Line Regulation
ΔVin = 5V



■ Control Current



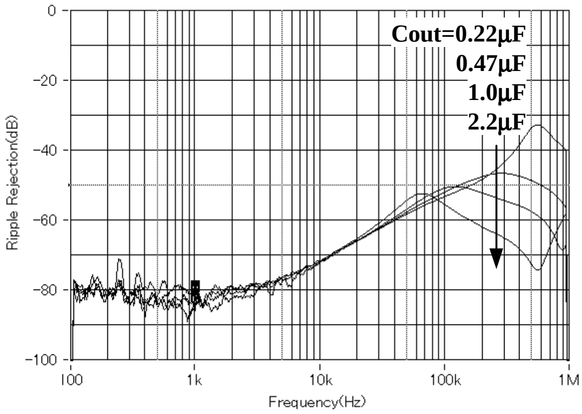
■ ON/OFF Point



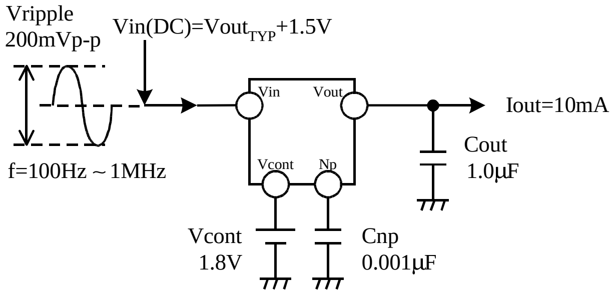
11-2. AC CHARACTERISTICS ($Vout_{TYP}$=3.0V)

Ripple Rejection

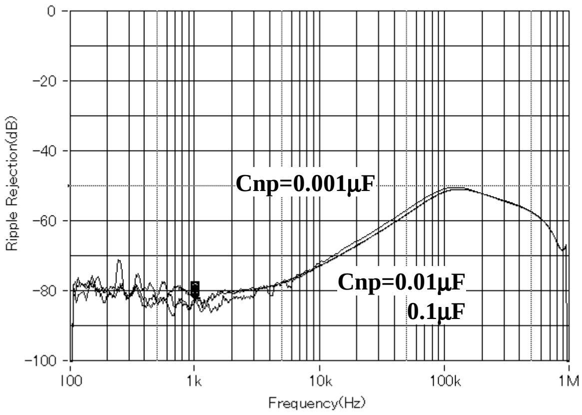
■ Cout=0.22µF, 0.47µF, 1.0µF, 2.2µF



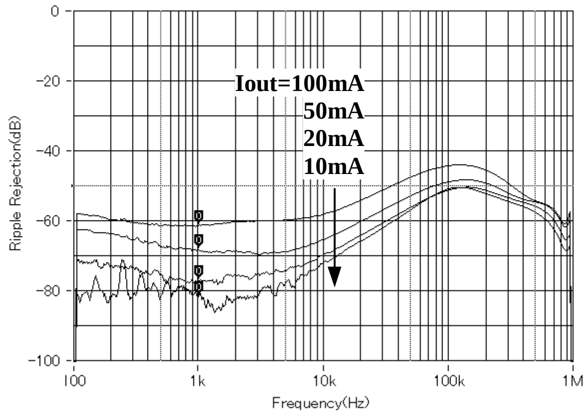
Test conditions



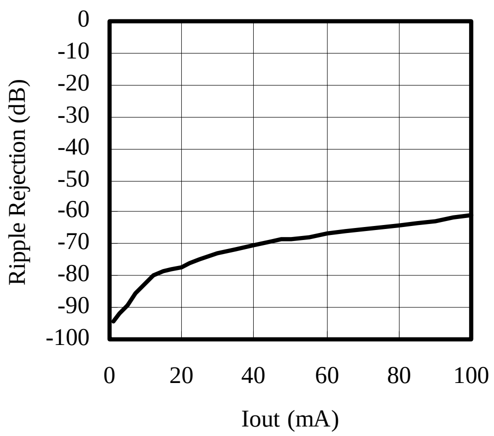
■ Cnp=0.001µF, 0.01µF, 0.1µF



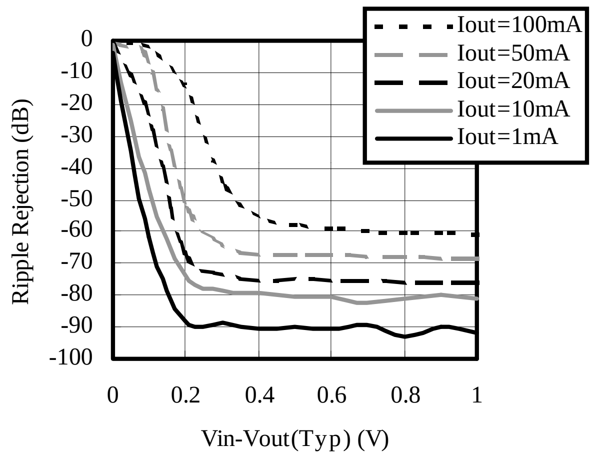
■ Iout=10mA, 20mA, 50mA, 100mA



■ R.R vs Iout : Frequency=1kHz

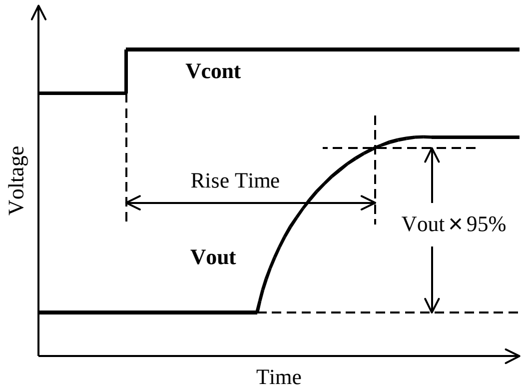


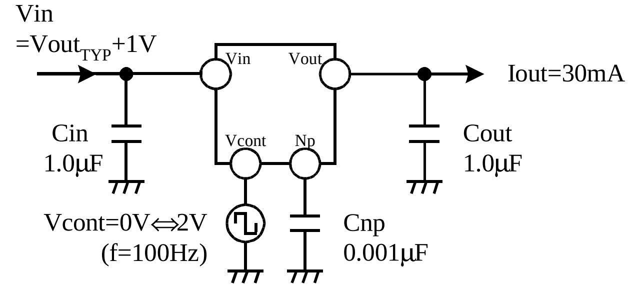
■ R.R vs Low Vin : Frequency=1kHz



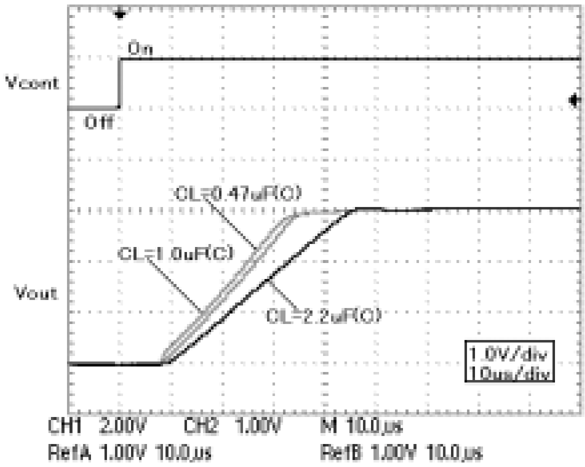
The ripple rejection (R.R) characteristic depends on the characteristic and the capacitance of the capacitor connected at the output side. Also it depends on the output voltage. The R.R characteristic at 50kHz or more varies greatly with the capacitor on the output side and PCB pattern. If necessary, please check stability during operation.

ON/OFF Transient

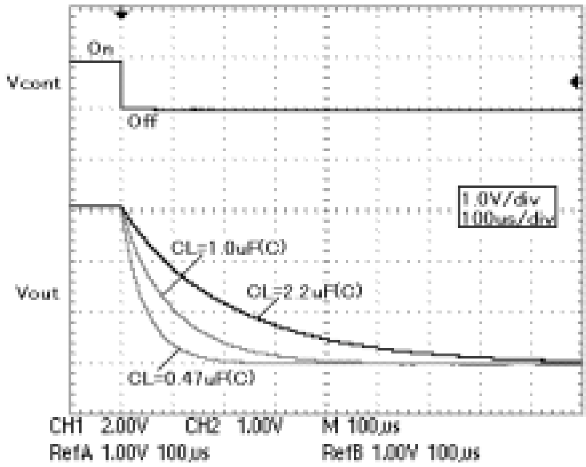




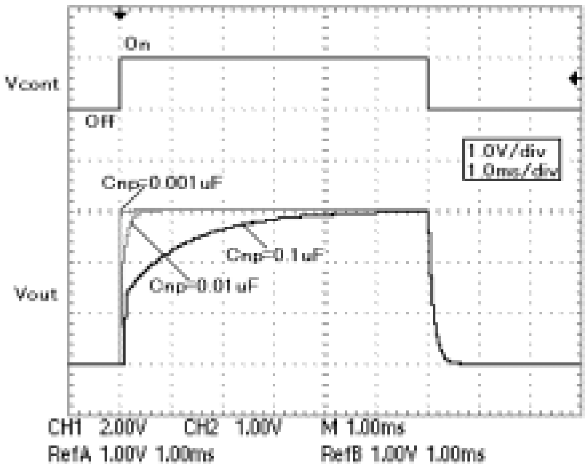
■ Cout=0.47µF, 1.0µF, 2.2µF



■ Cout=0.47µF, 1.0µF, 2.2µF



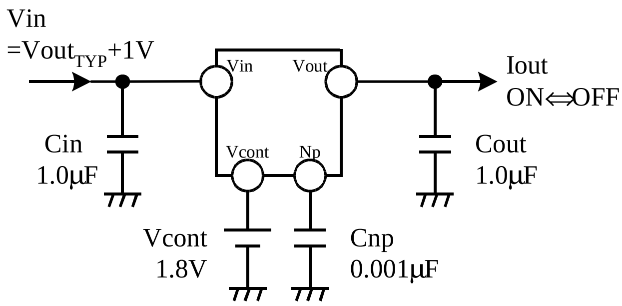
■ Cnp=0.001µF, 0.01µF, 0.1µF



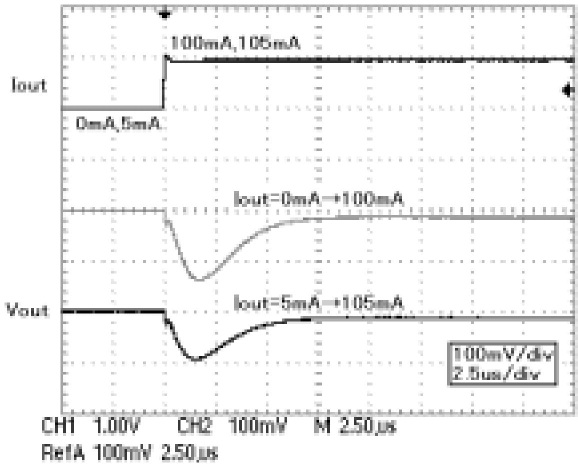
The rise time of the regulator depends on Cout and Cnp.
The fall time depends on Cout.

LOAD Transient

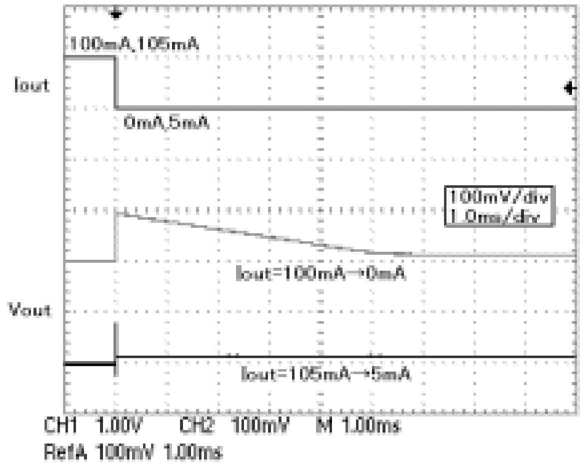
Test conditions



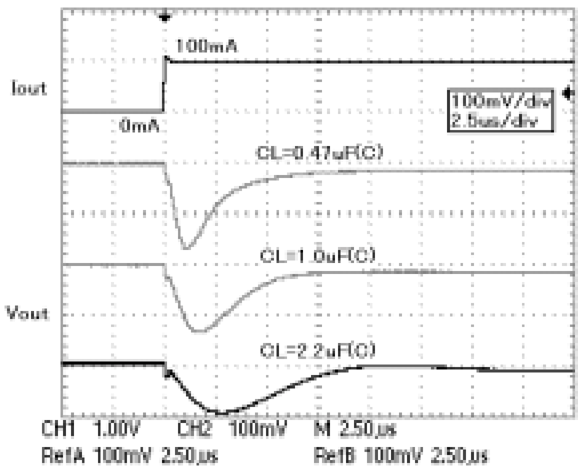
■ Iout=0⇒100mA, 5⇒105mA



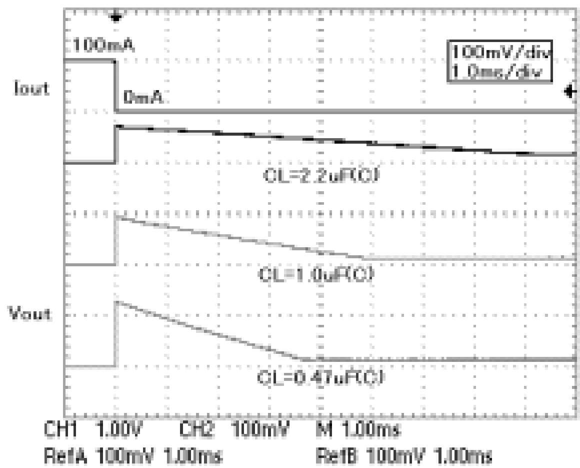
■ Iout=100mA⇒0mA, 105mA⇒5mA



■ Cout=0.47µF, 1.0µF, 2.2µF : Iout=0mA⇒100mA



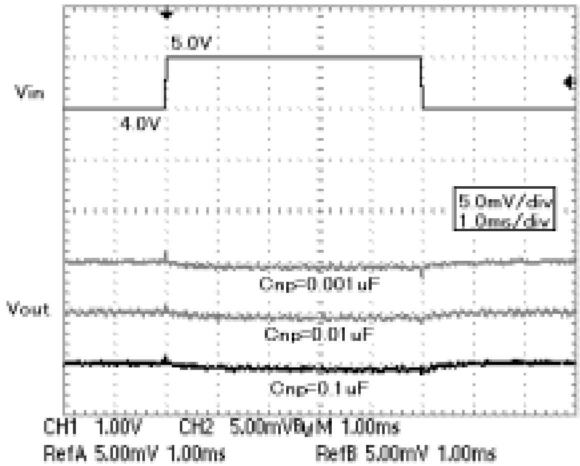
■ Cout=0.47µF, 1.0µF, 2.2µF : Iout=100mA⇒0mA



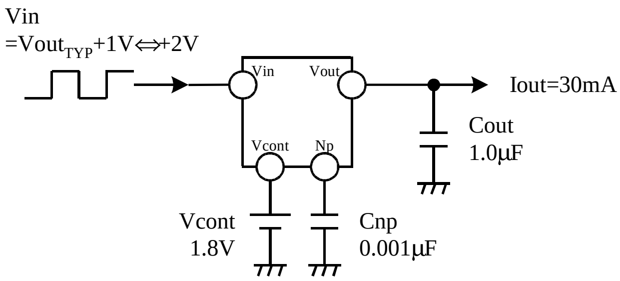
Increase the load side capacitor when the load change is fast or when there is a large current change. In addition, at no load, supplying small load current to ground can reduce the voltage change.

LINE Transient

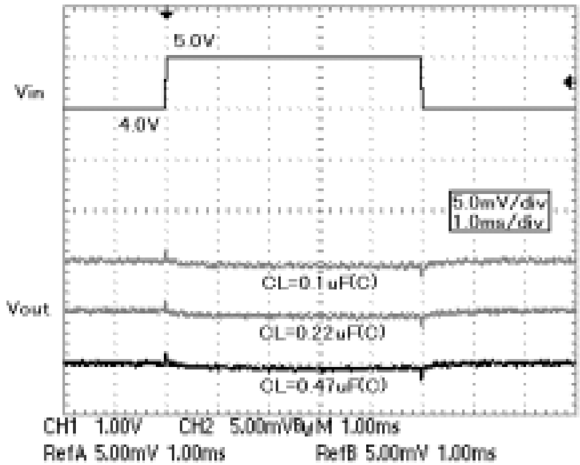
■ Cnp=0.001µF, 0.01µF, 0.1µF



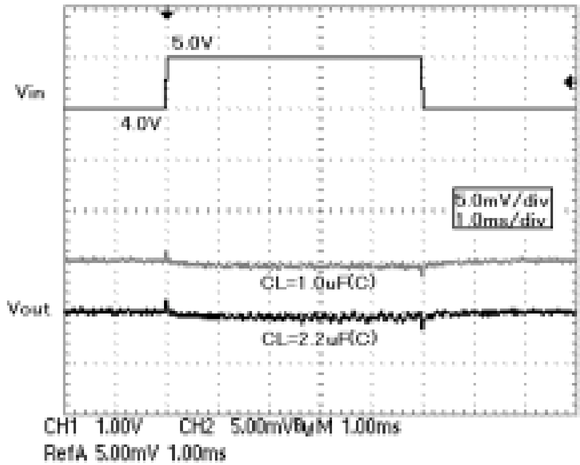
Test conditions



■ Cout=0.1µF, 0.22µF, 0.47µF

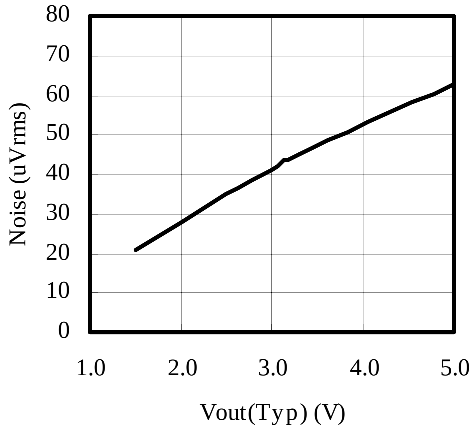


■ Cout=1.0µF, 2.2µF

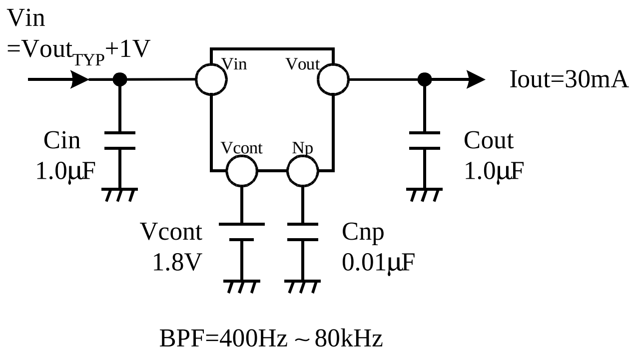


Output Noise Characteristics

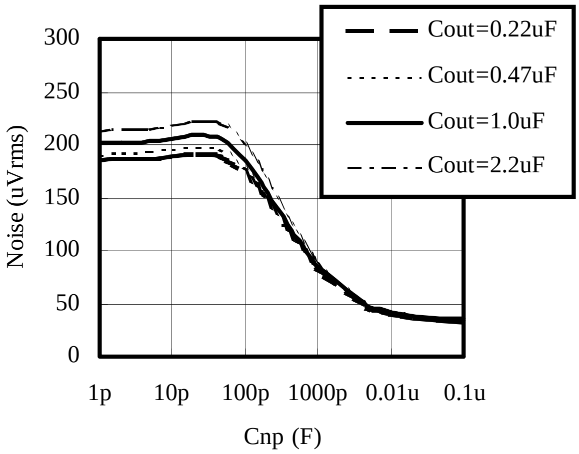
■ Vout vs Noise



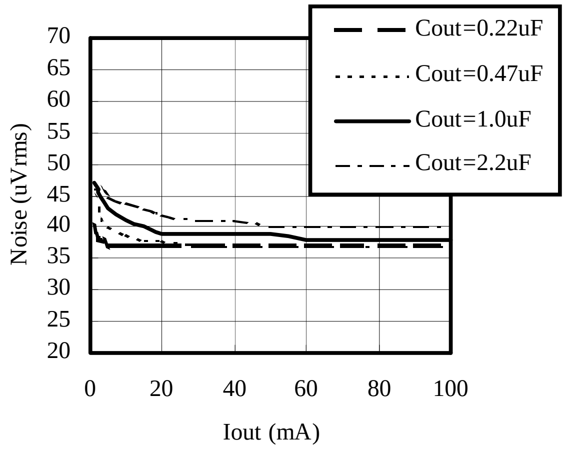
Test conditions



■ Cnp vs Noise

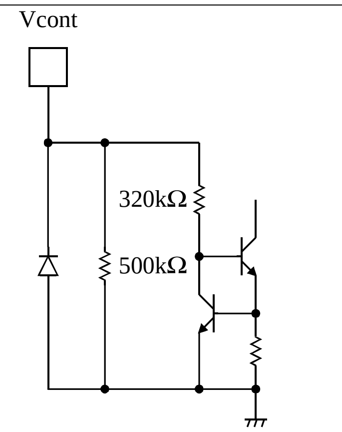
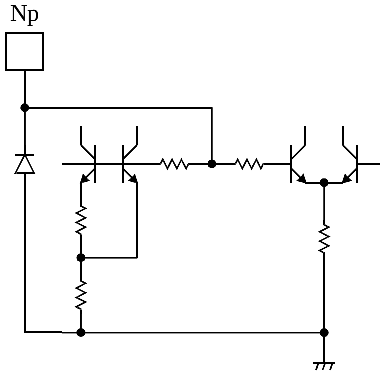
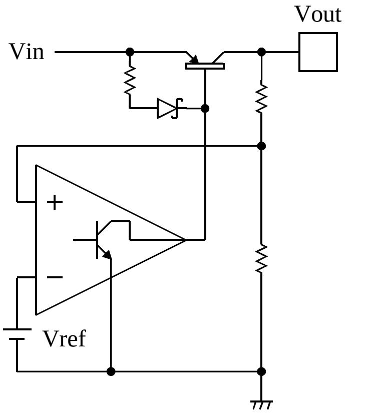


■ Iout vs Noise



Increase Cnp to decrease the noise. The recommended Cnp capacitance is 0.01μF ~ 0.1μF.
The amount of noise increases with the higher output voltages.

12. PIN DESCRIPTION

Pin No.	Pin Description	Internal Equivalent Circuit	Description
TK705xxS : 1 TK707xxS : 3 TK706xxH : 1 TK708xxH : 3	Vcont		On/Off Control Terminal V_{CONT} > 1.8V : ON V_{CONT} < 0.35V : OFF The pull-down resister (500kΩ) is built-in.
TK705xxS : 2 TK707xxS : 2 TK706xxH : 2,5 TK708xxH : 2,5	GND		GND Terminal
TK705xxS : 3 TK707xxS : 4 TK706xxH : 3 TK708xxH : 4	Np		Noise Bypass Terminal Connect a bypass capacitor between GND.
TK705xxS : 4 TK707xxS : 5 TK706xxH : 4 TK708xxH : 6	Vout		Output Terminal
TK705xxS : 5 TK707xxS : 1 TK706xxH : 6 TK708xxH : 1	Vin		Input Terminal

13. APPLICATIONS INFORMATION

13-1. Definition of Technical Terms

Relating Characteristic

Note Each characteristics will be measured in a short period not to be influenced by joint temperature (Tj).

♦Output voltage (Vout)
The output voltage is specified with Vin= $Vout_{TYP}$+1V and Iout=5mA

♦Output current (Iout)
Output current, which can be used continuously (It is the range where overheating protection of the IC does not operate.)

♦Peak maximum output current ($Iout_{PEAK}$)
The rated output current is specified under the condition where the output voltage drops 90% by increasing the output current, compared to the value specified at Vin=$Vout_{TYP}$+1V.

♦Dropout voltage (Vdrop)
It is an I/O voltage difference when the circuit stops the stable operation by decreasing the input voltage.
It is measured when the output voltage drops 100mV from its nominal value by decreasing the input voltage gradually.

♦Line Regulation (LinReg)
It is the fluctuations of the output voltage value when the input voltage is changed.

♦Load Regulation (LoaReg)
It is the fluctuations of the output voltage value when the input voltage is assumed to be $Vout_{TYP}$ +1V, and the load current is changed.

♦Ripple Rejection (R.R)
Ripple rejection is the ability of the regulator to attenuate the ripple content of the input voltage at the output. It is measured with the condition of Vin=Vout+1.5V. Ripple rejection is the ratio of the ripple content between the output vs. input and is expressed in dB.

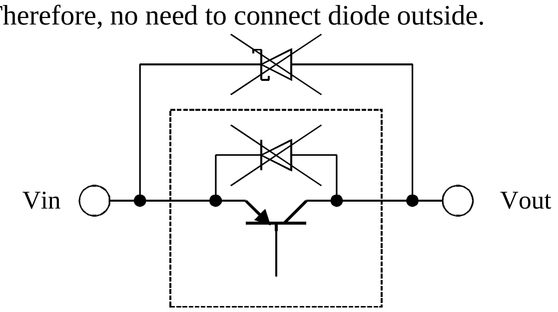
♦Standby current (Istandby)
It is an input current, which flows to the control terminal, when the IC is turned off.

Relating Protection Circuit

♦Over Current Protection
It is a function to protect the IC by limiting the output current when excessive current flows to IC, such as the output is connected to GND, etc.

♦Thermal Protection
It protects the IC not to exceed the permissible power consumption of the package in case of large power loss inside the regulator.
The output is turned off when the chip reaches around 140°C, but it turns on again when the temperature of the chip decreases.

♦Reverse Voltage Protection
Reverse voltage protection prevents damage due to the output voltage being higher than the input voltage. This fault condition can occur when the output capacitor remains charged and the input is reduced to zero, or when an external voltage higher than the input voltage is applied to the output side
Generally, a LDO regulator has a diode in the input direction from an output. If an input falls from an output in an input-GND short circuit etc. and this diode turns on, current will flow for an input terminal from an output terminal. In the case of excessive current, IC may break.
In order to prevent this, it is necessary to connect an Schottky Diode etc. outside.
This product is equipped with reverse bias over-current prevention, and excessive current does not flow in to IC. Therefore, no need to connect diode outside.



♦ESD
It is tested by connecting charged capacitor to GND pin and Vin pin.

MM 200pF 0Ω 200Vmin
HBM 100pF 1.5kΩ 2000Vmin

13-2. ESR Stability

Linear regulators require input and output capacitors in order to maintain the regulator's loop stability. If 0.22µF or larger capacitor is connected to the output side, the IC provides stable operation at any voltage ($1.3V \leq Vout_{TYP} \leq 5.0V$). (The capacitor must be larger then 0.22µF at all temperature and voltage range) If the capacitor with high Equivalent Series Resistance (ESR) (several ohms) is used, such as tantalum capacitor etc., the regulator may oscillate. Please select parts with low ESR.

Due to the parts are uneven, please enlarge the capacitance as much as possible. With larger capacity, the output noise decreases more. In addition, the response to the load change, etc. can be improved. The IC won't be damaged by enlarging the capacity.

A recommended value of the application is as follows.

Cin=Cout≥0.47µF Ceramic Capacitance

Fig.13-1

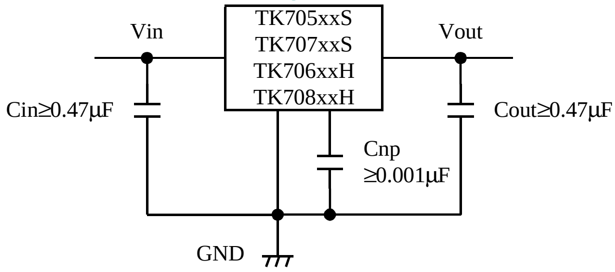
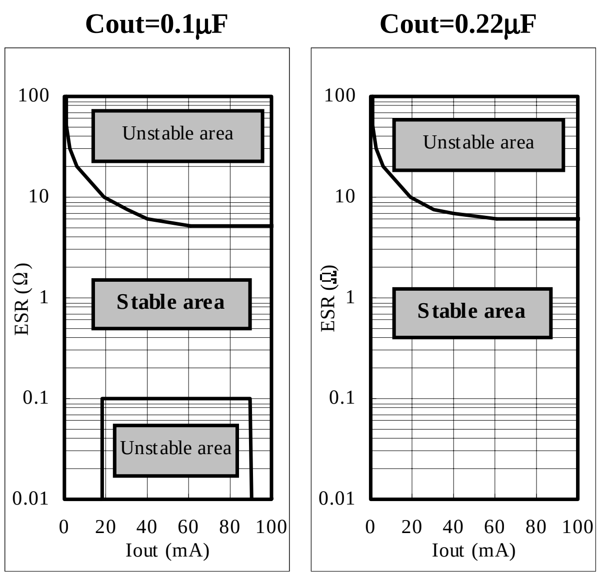


Fig.13-2
Output Voltage, Output Current vs.Stable Operation Area



$1.5V \leq Vout_{TYP} \leq 5.0V$

Fig.13-2 shows stable operation with a ceramic capacitor of 0.22µF. Since it may oscillate if ESR is large, we recommend using ceramic capacitor.

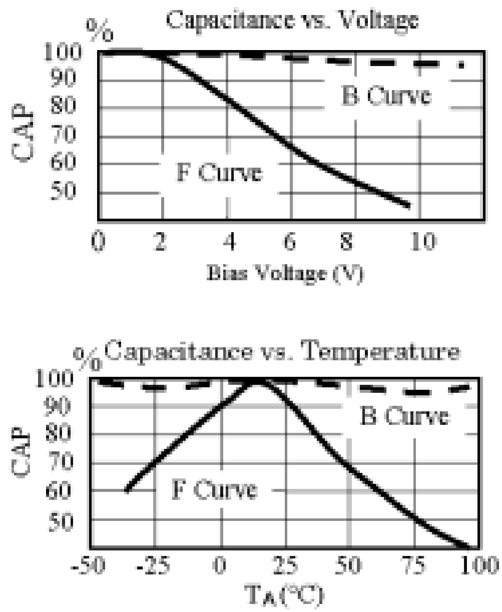
The stability of the regulator improves with larger output capacitor (the stable operation area extends.) Please use the capacitor with larger capacitance as possible.

For evaluation

Kyocera:	CM05B104K10AB, CM05B224K10AB, CM105B104K16A, CM105B224K16A, CM21B225K10A
Murata:	GRM36B104K10, GRM42B104K10, GRM39B104K25, GRM39B224K10, GRM39B105K6.3

The input capacitor is necessary in case the battery voltage drops, the power supply impedance increases, or the distance to the power supply is far. 1 input capacitor might be necessary for each IC or for several ICs. It depends on circuit condition. Please confirm the stability by each circuit.

Fig.13-3
ex. Ceramic Capacitance vs. Voltage, Temperature



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

13-3. Operating Region and Power Dissipation

The power dissipation of the device depends on the junction temperature. Therefore, the package dissipation is assumed to be an internal limitation. The package itself does not have enough heat radiation characteristic due to the small size. Heat runs away by mounting IC on PCB. This value changes by the material, copper pattern etc. of PCB.

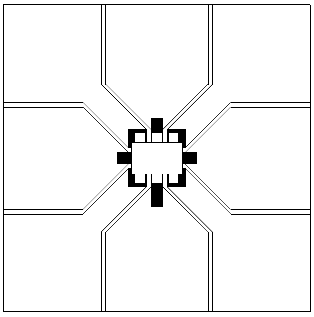
The overheating protection operates when there is a lot of loss inside the regulator (Ambient temperature high, heat radiation bad, etc.). The output current and the output voltage will drop when the protection circuit operates. When joint temperature (Tj) reaches the set temperature, IC stops the operation. However, operation begins at once when joint temperature (Tj) decreases.

The thermal resistance when mounted on PCB

The chip joint temperature during operation is shown by Tj=θja×Pd+Ta. Joint part temperature (Tj) of TK705xxS/TK707xxS/TK706xxH/TK708xxH is limited around 140°C with the overheating protection circuit. Pd is the value when the overheating protection circuit starts operation.

When you assume the ambient temperature to be 25°C,
140=θ ja × Pd(W)+25
θ ja × Pd=115
θ ja=115/Pd (°C /W)

Example of mounting substrate



PCB Material: Two layer glass epoxy substrate (x=30mm,y=30mm,t=1.0mm,Copper pattern thickness 35um)

<u>**TK705xxS/TK707xxS (SOT23-5)**</u>
Please do the derating with 5.9mW/°C at Pd=677mW and 25°C or higher. Thermal resistance (θ ja) is 170°C/W.
<u>**TK706xxH/TK708xxH (SON2017-6)**</u>
Please do the derating with 4.9mW/°C at Pd=560mW and 25°C or higher. Thermal resistance (θ ja) is 205°C/W.

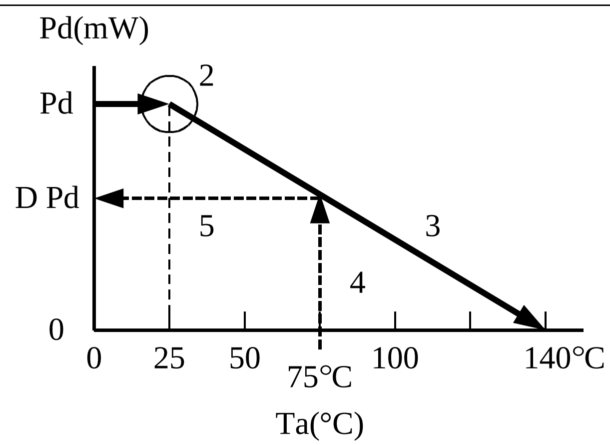
Method of obtaining Pd easily

Connect output terminal to GND(short circuited), and measure the input current by increasing the input voltage gradually up to 10V. The input current will reach the maximum output current, but will decrease soon according to the chip temperature rising, and will finally enter the state of thermal equilibrium (natural air cooling).
The input current and the input voltage of this state will be used to calculate the Pd.

$$Pd(mW) \cong Vin\ (V) \times Iin\ (mA)$$

When the device is mounted, mostly achieve
TK705xxS/TK707xxS (SOT23-5): **580mW** or more
TK706xxH/TK708xxH (SON2017-6): **500mW** or more

*In case that the power, Vin × Ishort(Short Circuit Current), becomes more than the maximum rating of its power dissipation, the IC may damaged before internal thermal protection works.



Procedure (When mounted on PCB).

1.Find Pd (Vin×Iin when the output is short-circuited).
2. Plot Pd against 25°C.
3. Connect Pd to the point corresponding to the 140°C with a straight line.
4. Pull a vertical line from the maximum operating temperature in your design (e.g., 75°C).
5. Read the value of Pd against the point at which the vertical line intersects the derating curve(DPd).
6.DPd÷(Vinmax-Vout)=Iout (at 75°C)

The maximum output current at the highest operating temperature will be **Iout ≅ DPd ÷ (Vinmax-Vout).**
Please use the device at low temperature with better radiation. The lower temperature provides better quality.

13-4. ON/OFF Control

It is recommended to turn the regulator off when the circuit following the regulator is not operating. A design with small electric power loss can be implemented.

Because the control current is small, it is possible to control it directly by CMOS logic.

Control Terminal Voltage (Vcont)	ON/OFF State
Vcont > 1.8V	ON
Vcont < 0.35V	OFF

Parallel Connected ON/OFF Control

Fig.13-4

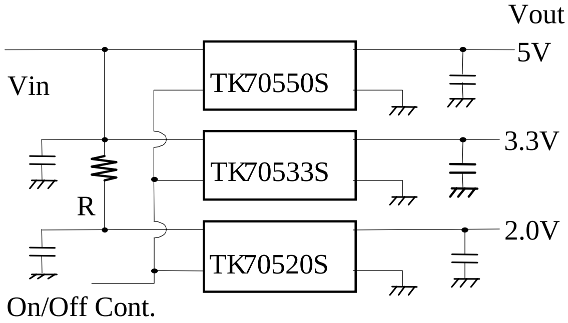


Fig.13-4 shows the multiple regulators being controlled by a single ON/OFF control signal. There is fear of overheating, because the power loss of the low voltage side (TK70520S) is large. The series resistor (R) is put in the input line of the low output voltage regulator in order to prevent over-dissipation. 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.

13-5. Noise Bypass

The noise characteristics depend on the capacitance on the Np terminal.

A standard value is Cnp=0.001μF. Increase Cnp in a design with important output noise requirements. The IC will not be damaged even 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.

13-6. The notes of the evaluation when output terminal is short-circuit to GND

By the resonance phenomenon by Cout (C ingredient) and the short circuit line (L ingredient), which are attached to an output terminal, an output terminal changes with minus potential. In order that Parasitism Tr arises within Bip IC, and a latch rise phenomenon may occur within IC when the worst if it goes into an output terminal's minus side, it results in damage by fire (white smoke) and breakage of a package. ($f_0 = 1 / 2\pi\sqrt{(L C)}$)

The above-mentioned resonance phenomenon appears notably in a ceramic capacitor with the small ESR value, etc. A resonance phenomenon can be reduced by connecting resistance (around 2ohms or more) in series with a short circuit line. Thereby, the latch rise phenomenon within IC can be prevented.

Generally, when using tantalum or large electrolysis capacitor, the influence of resonance phenomenon can be reduced due to the large ESR (2ohms or more).

14. NOTES

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

15. OFFICES

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