

Features

- Low power consumption
- Low voltage drop
- Low temperature coefficient
- High input voltage – up to 30V
- Output voltage accuracy: tolerance $\pm 2\%$
- Over current protection
- Over temperature protection
- Chip enable/disable function
- Package types: 8-pin SOP-EP, SOT89-3 and TO92-3

Applications

- Battery-powered equipment
- Communication equipment
- Audio/Video equipment

General Description

The HT73xx-7 is a low power high voltage series of regulators implemented in CMOS technology which has the advantages of low voltage drop and low quiescent current. They allow input voltages as high as 30V and are available with several fixed output voltages ranging from 2.1V to 5.0V.

When the CE input is low, a fast discharge path pulls the output voltage low via an internal pull-down resistor. An internal over-current protection circuit prevents the device from damage even if the output is shorted to ground. An over-temperature protection circuit ensures the device junction temperature will not exceed a temperature of 150°C.

Selection Table

Part No.	Output Voltage	Packages	Markings
HT7321-7	2.1V	8SOP-EP TO92-3, SOT89-3	HT73xx-7 for the 8SOP-EP type. 73xx-7 marking for the TO92-3, SOT89-3 types.
HT7323-7	2.3V		
HT7325-7	2.5V		
HT7327-7	2.7V		
HT7330-7	3.0V		
HT7333-7	3.3V		
HT7336-7	3.6V		
HT7340-7	4.0V		
HT7344-7	4.4V		
HT7350-7	5.0V		

Note: "xx" stands for output voltages.

The diagram shows the internal components of the TPS25930-SP in buck converter mode. The input voltage V_{IN} is connected to the SW pin. The output voltage OUT is taken from the SW pin. The ground reference is GND . The diagram includes a soft start block, an enable pin (CE) connected to an enable pin (En), a reference voltage pin (V_{ref}), an overcurrent protection pin (OCP), and an output pin (OTP). The output filter consists of an inductor and a capacitor (C_{OUT}) connected to OUT . The output voltage is regulated by a feedback loop consisting of a divider network (resistors) and a feedback pin (FB) connected to the inverting input of an op-amp. The op-amp's non-inverting input is connected to V_{ref} . The op-amp's output drives the gate of the MOSFET, which is connected to the SW pin. The MOSFET's source is connected to GND . The diode (D) is connected between the SW pin and GND . The output voltage is V_{OUT} .

The image shows three pin configuration diagrams for the 73xx-7 series:

- HT73xx-7 8 SOP-A (Exposed Pad):** An 8-pin package with pins 1-4 on the left and 5-8 on the right. Pin 1 is OUT, pin 2 is NC, pin 3 is NC, pin 4 is NC, pin 5 is GND, pin 6 is NC, pin 7 is CE, and pin 8 is VIN. A dashed box labeled '9 VIN' is shown on the top surface.
- SOT89-3:** A package with three pins: 1 (GND), 2 (VIN), and 3 (OUT).
- TO92-3:** A package with three pins: 1 (GND), 2 (VIN), and 3 (OUT).

Pin No.			Pin Name	Pin Description
8SOP-EP	SOT89-3	TO92-3		
5	1	1	GND	Ground pin
8, 9	2	2	VIN	Input pin
1	3	3	OUT	Output pin
7	—	—	CE	Chip enable pin, high enable
2, 3, 4, 6	—	—	NC	No connection

Absolute Maximum Ratings

Parameter		Value	Unit
V_{IN}		-0.3 to +33	V
V_{CE}		-0.3 to ($V_{IN}+0.3$)	V
Operating Temperature Range, T_a		-40 to +85	°C
Maximum Junction Temperature, $T_{J(MAX)}$		+150	°C
Storage Temperature Range		-65 to +165	°C
Junction-to-Ambient Thermal Resistance, θ_{JA}	8SOP-EP	125	°C/W
	SOT89-3	200	°C/W
	TO92-3	200	°C/W
Power Dissipation, P_D	8SOP-EP	0.80	W
	SOT89-3	0.50	W
	TO92-3	0.50	W

Note: P_D is measured at $T_a=25^\circ\text{C}$.

Recommended Operating Range

Parameter	Value	Unit
V_{IN}	$V_{OUT}+2$ to 30	V
V_{CE}	0 to V_{IN}	V

Electrical Characteristics

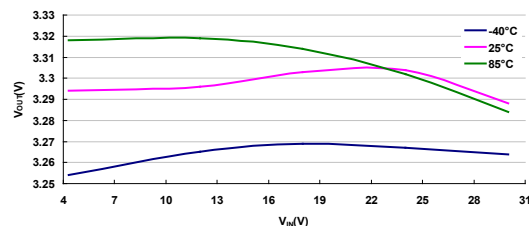
$V_{IN}=V_{OUT}+2\text{V}$, $V_{CE}=V_{IN}$, $T_a=25^\circ\text{C}$ and $C_{IN}=C_{OUT}=10\mu\text{F}$, unless otherwise specified

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	—	—	—	30	V
V_{OUT}	Output Voltage Range	—	2.1	—	5.0	V
V_O	Output Voltage Accuracy	$I_{OUT}=10\text{mA}$	-2	—	2	%
I_{OUT}	Output Current	—	250	—	—	mA
$ \Delta V_{OUT} $	Load Regulation	$1\text{mA} \leq I_{OUT} \leq 100\text{mA}$	—	45	90	mV
V_{DIF}	Dropout Voltage	$I_{OUT}=1\text{mA}$, V_{OUT} Change=2% (Note)	—	6	15	mV
		$I_{OUT}=30\text{mA}$, V_{OUT} Change=2% (Note)	—	120	300	mV
I_{SS1}	Quiescent Current	$I_{OUT}=0\text{mA}$	—	2.5	4.0	μA
I_{SS2}		$V_{CE}=2.0\text{V}$, $V_{IN}=30\text{V}$, $I_{OUT}=0\text{mA}$	—	3.0	5.0	μA
I_{SHD}	Shutdown Current	$V_{CE}=0\text{V}$	—	0.1	0.5	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN} \times \Delta V_{OUT}}$	Line Regulation	$(V_{OUT}+1\text{V}) \leq V_{IN} \leq 30\text{V}$, $I_{OUT}=1\text{mA}$	—	0.1	0.2	%/V
$\frac{\Delta V_{OUT}}{\Delta T_a \times \Delta V_{OUT}}$	Temperature Coefficient	$I_{OUT}=40\text{mA}$, $-40^\circ\text{C} < T_a < 85^\circ\text{C}$	—	± 100	—	ppm/°C
I_{SHORT}	Output Short Current	$V_{IN}=12\text{V}$, force $V_{OUT}=0\text{V}$	—	250	—	mA
T_{SHD}	Shutdown Temperature	—	—	150	—	°C
T_{REC}	Recovery Temperature	—	—	25	—	°C
V_{IH}	Enable High Threshold	CE pin, $V_{OUT}+1\text{V} \leq V_{IN} \leq 30\text{V}$	2.0	—	—	V
V_{IL}	Enable Low Threshold	CE pin, $V_{OUT}+1\text{V} \leq V_{IN} \leq 30\text{V}$	—	—	0.6	V
R_{DIS}	Discharge Resistor	CE=0V, measure at V_{OUT}	—	300	—	Ω

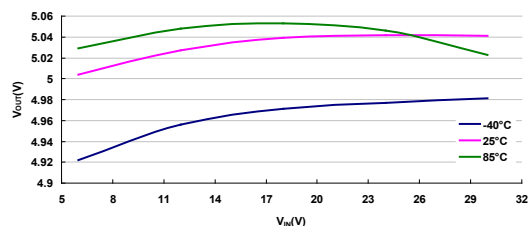
Note: The dropout voltage is defined as the input voltage minus the output voltage that produces a 2% change in the output voltage from the value at $V_{IN}=V_{OUT}+2\text{V}$ with a fixed load.

Typical Performance Characteristic

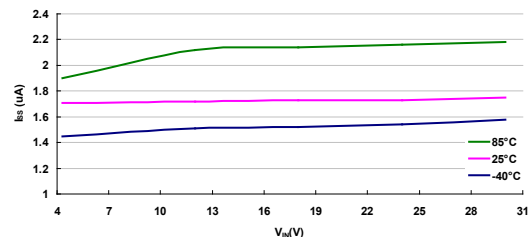
Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^\circ C$, unless otherwise noted.



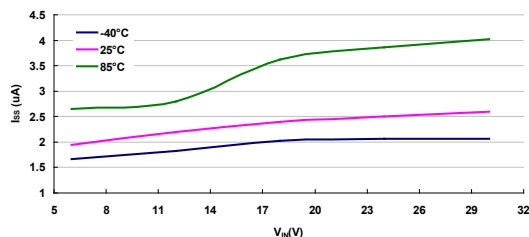
Line Regulation: HT7333-7 ($I_{OUT}=10mA$)



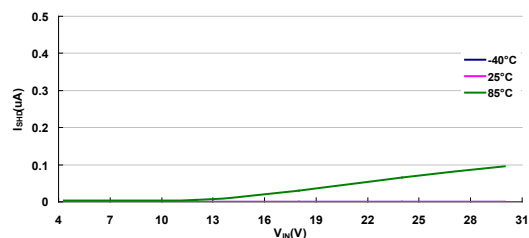
Line Regulation: HT7350-7 ($I_{OUT}=10mA$)



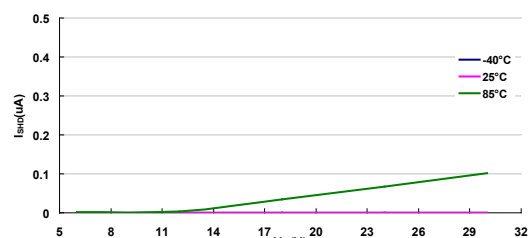
I_{SS} vs V_{IN} : HT7333-7 ($I_{OUT}=0mA$)



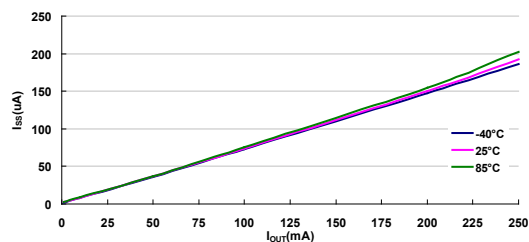
I_{SS} vs V_{IN} : HT7350-7 ($I_{OUT}=0mA$)



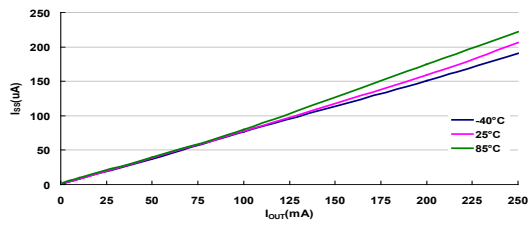
I_{SHD} vs V_{IN} : HT7333-7 ($I_{OUT}=0mA$)



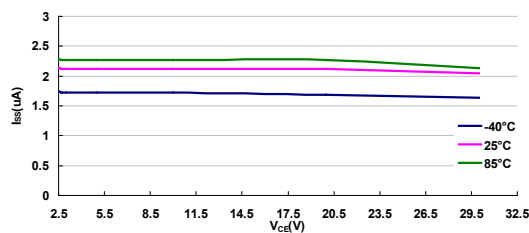
I_{SHD} vs V_{IN} : HT7350-7 ($I_{OUT}=0mA$)



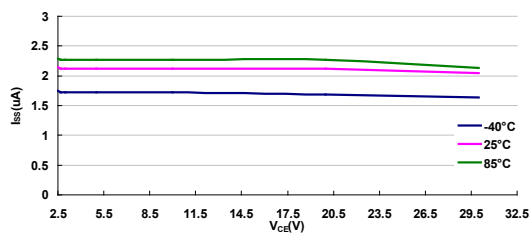
I_{SS} vs I_{OUT} : HT7333-7 ($V_{IN}=5.3V$)



I_{SS} vs I_{OUT} : HT7350-7 ($V_{IN}=7.0V$)

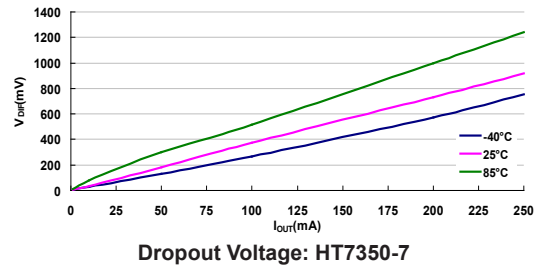
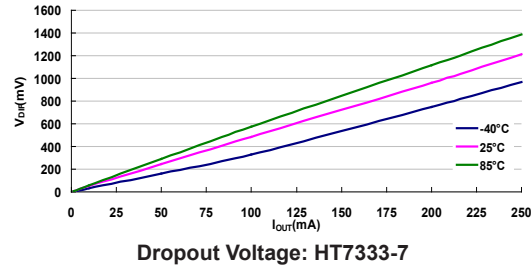
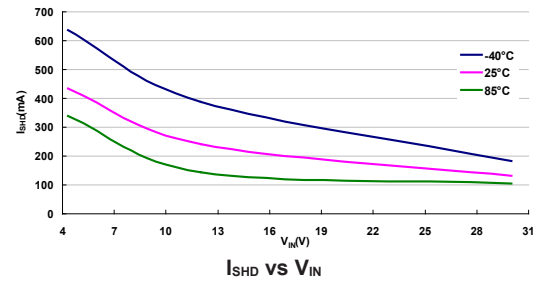
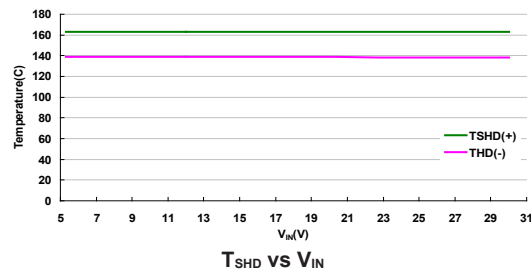


I_{SS} vs V_{CE} : HT7333-7 ($I_{OUT}=0mA$)

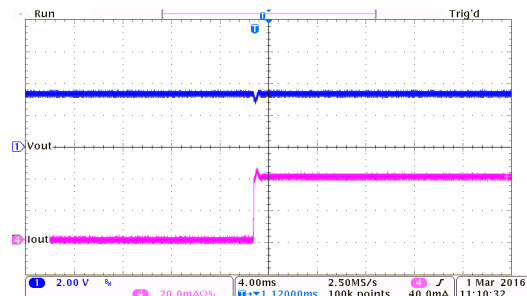


I_{SS} vs V_{CE} : HT7350-7 ($I_{OUT}=0mA$)

Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^{\circ}C$, unless otherwise noted

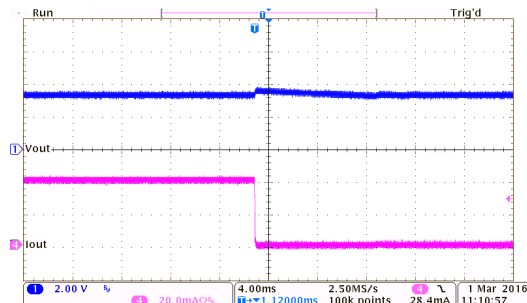


Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^\circ C$, unless otherwise noted.



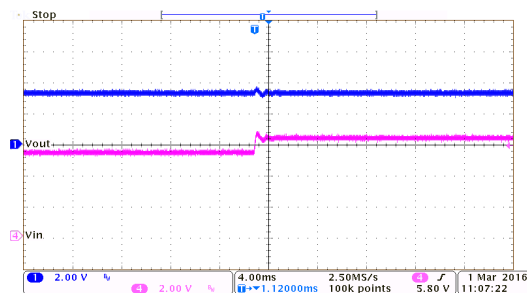
Load Transient Response:

HT7333-7 ($V_{IN}=5.3V$, $I_{OUT}=0mA$ to $40mA$)

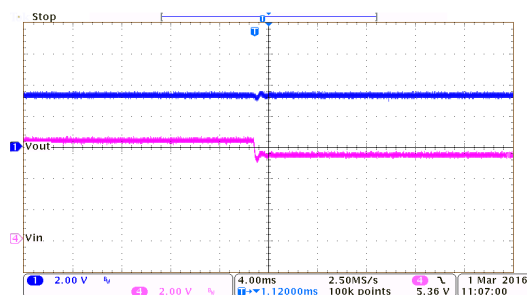


Load Transient Response:

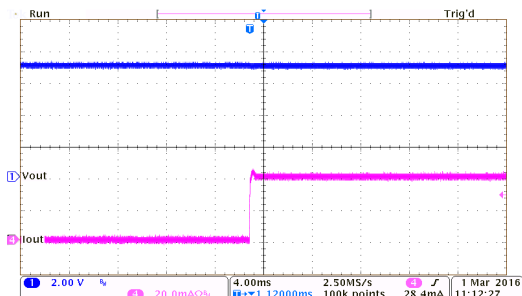
HT7333-7 ($V_{IN}=5.3V$, $I_{OUT}=40mA$ to $0mA$)



Line Transient Response: HT7333-7 ($I_{OUT}=10mA$)

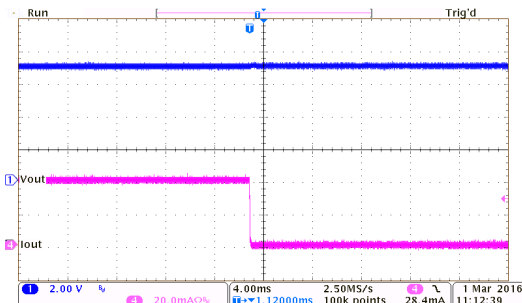


Line Transient Response: HT7333-7 ($I_{OUT}=10mA$)



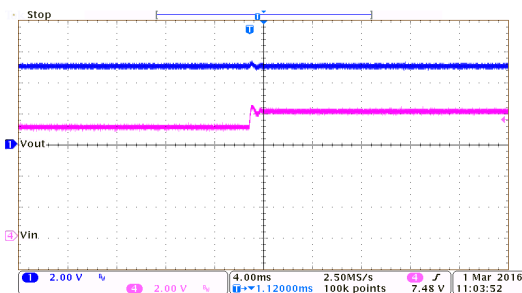
Load Transient Response:

HT7350-7 ($V_{IN}=7.0V$, $I_{OUT}=0mA$ to $40mA$)

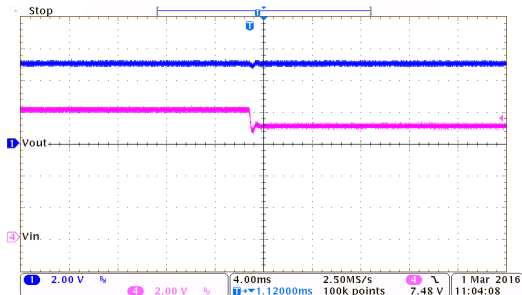


Load Transient Response:

HT7350-7 ($V_{IN}=7.0V$, $I_{OUT}=40mA$ to $0mA$)

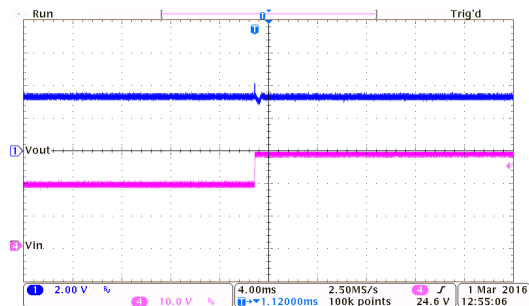


Line Transient Response: HT7350-7 ($I_{OUT}=10mA$)

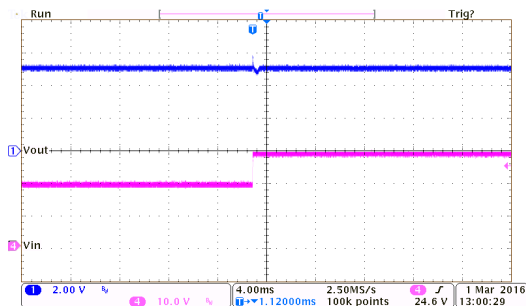


Line Transient Response: HT7350-7 ($I_{OUT}=10mA$)

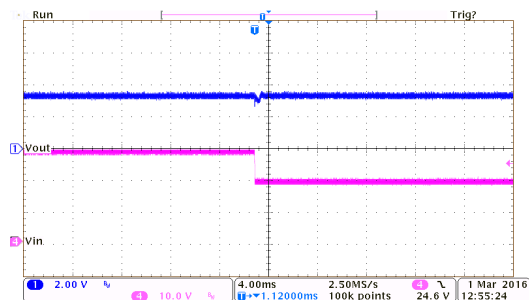
Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^\circ C$, unless otherwise noted.



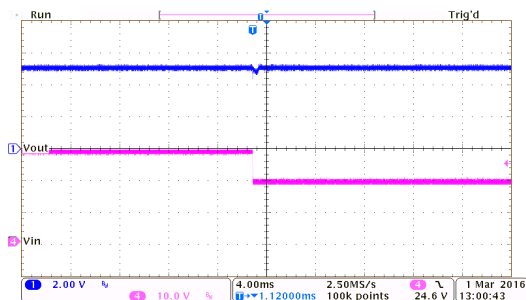
Line Transient Response: HT7333-7 ($I_{OUT}=10mA$)



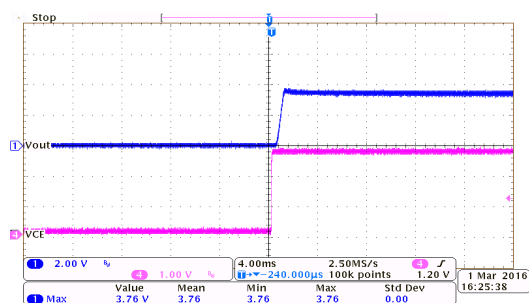
Line Transient Response: HT7350-7 ($I_{OUT}=10mA$)



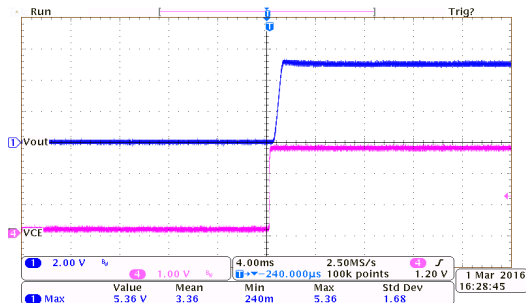
Line Transient Response: HT7333-7 ($I_{OUT}=10mA$)



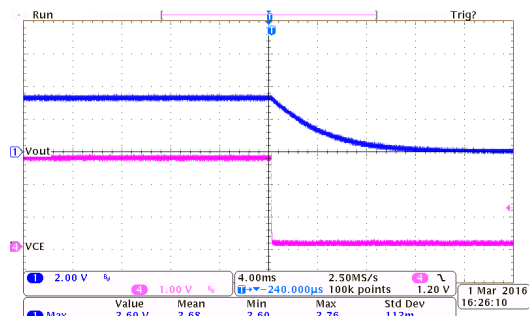
Line Transient Response: HT7350-7 ($I_{OUT}=10mA$)



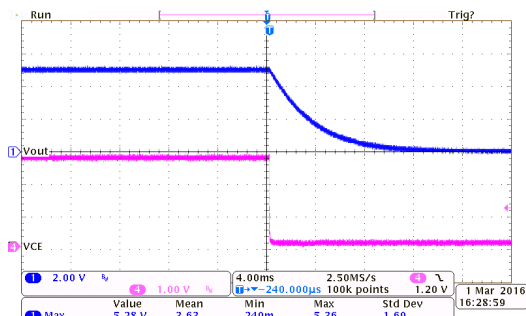
Power On Response:
HT7333-7 ($I_{OUT}=0mA$, $V_{CE}=0V$ to 2.7V)



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HT7350-7 ($I_{OUT}=0mA$, $V_{CE}=0V$ to 2.7V)

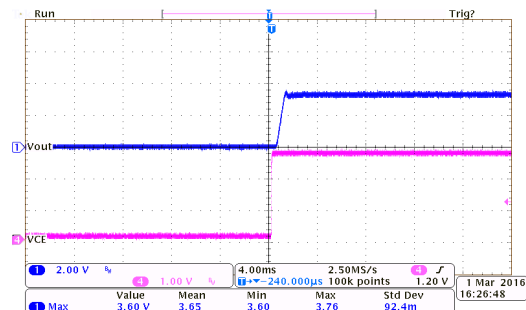


Power Off Response:
HT7333-7 ($I_{OUT}=0mA$, $V_{CE}=2.7V$ to 0V)



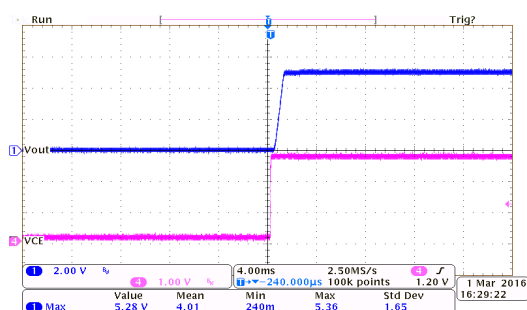
Power Off Response:
HT7350-7 ($I_{OUT}=0mA$, $V_{CE}=2.7V$ to 0V)

Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^\circ C$, unless otherwise noted.



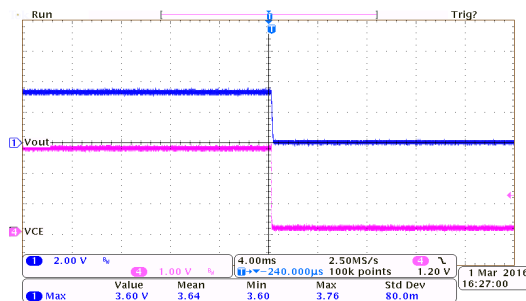
Power On Response:

HT7333-7 ($I_{OUT}=250mA$, $V_{CE}=0V$ to $2.7V$)



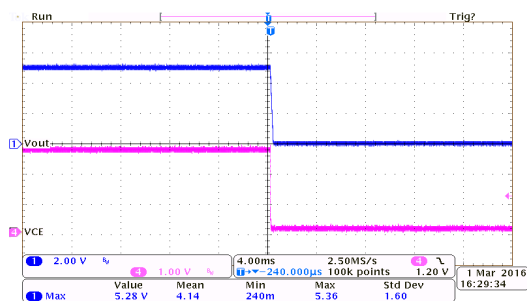
Power On Response:

HT7350-7 ($I_{OUT}=250mA$, $V_{CE}=0V$ to $2.7V$)



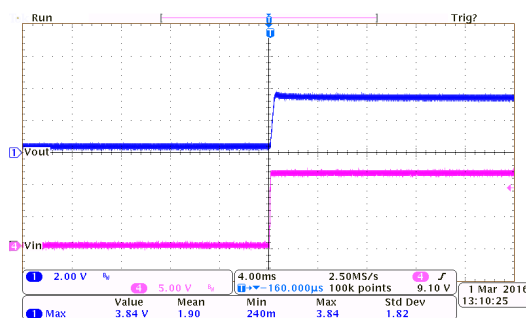
Power Off Response:

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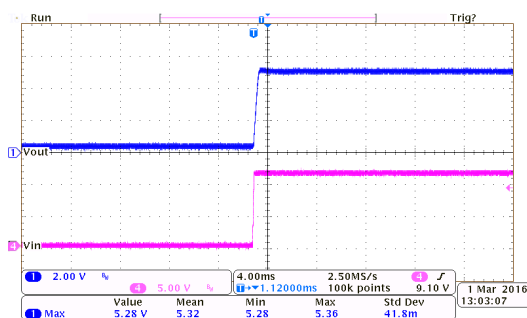
Power Off Response:

HT7350-7 ($I_{OUT}=250mA$, $V_{CE}=2.7V$ to $0V$)



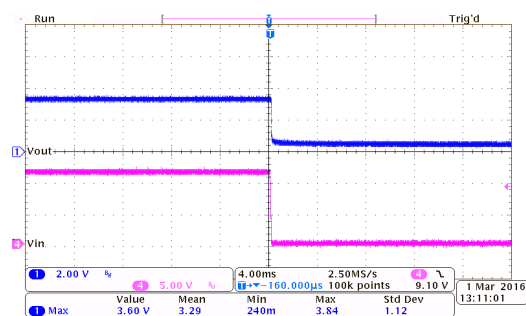
Power On Response:

HT7333-7 ($I_{OUT}=0mA$, $T_{RISE}=0.1ms$)



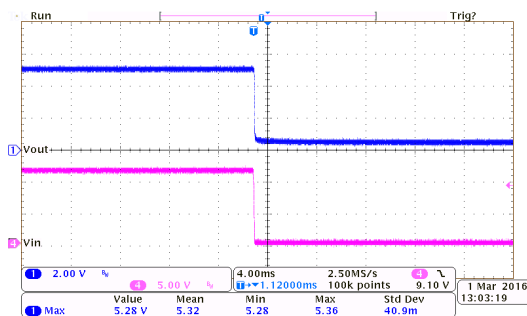
Power On Response:

HT7350-7 ($I_{OUT}=0mA$, $T_{RISE}=0.1ms$)



Power Off Response:

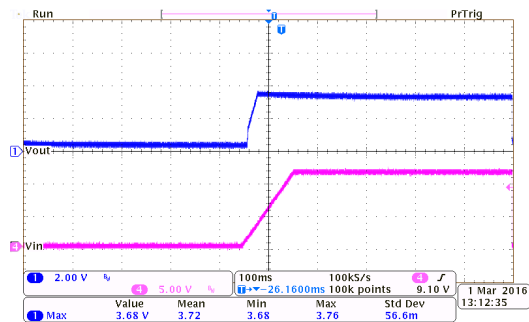
HT7333-7 ($I_{OUT}=0mA$, $T_{FALL}=0.1ms$)



Power Off Response:

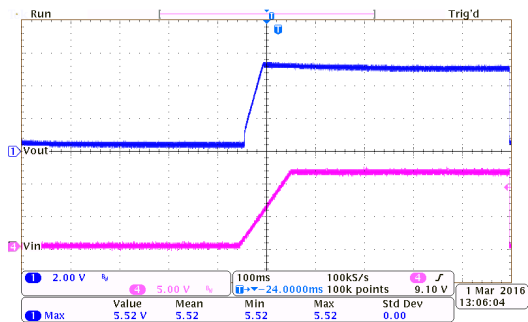
HT7350-7 ($I_{OUT}=0mA$, $T_{FALL}=0.1ms$)

Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^{\circ}C$, unless otherwise noted.



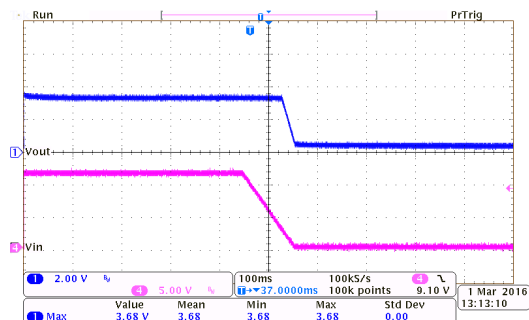
Power On Response:

HT7333-7 ($I_{OUT}=0mA$, $T_{RISE}=100ms$)



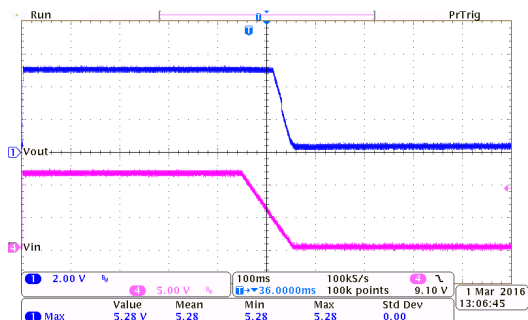
Power On Response:

HT7350-7 ($I_{OUT}=0mA$, $T_{RISE}=100ms$)



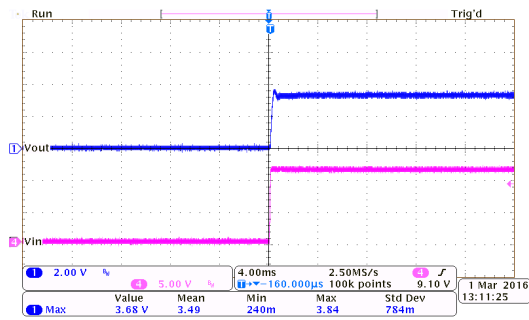
Power Off Response:

HT7333-7 ($I_{OUT}=0mA$, $T_{FALL}=100ms$)



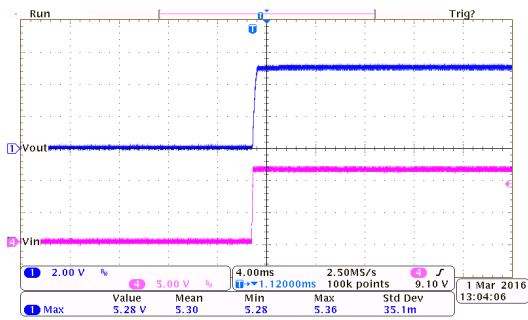
Power Off Response:

HT7350-7 ($I_{OUT}=0mA$, $T_{FALL}=100ms$)



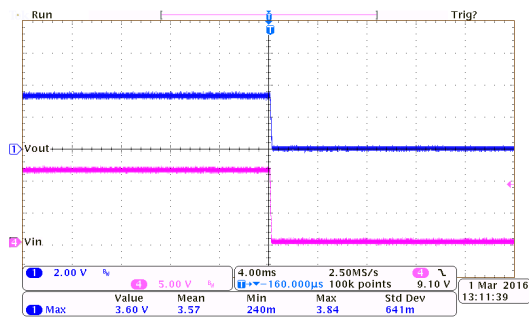
Power On Response:

HT7333-7 ($I_{OUT}=250mA$, $T_{RISE}=0.1ms$)



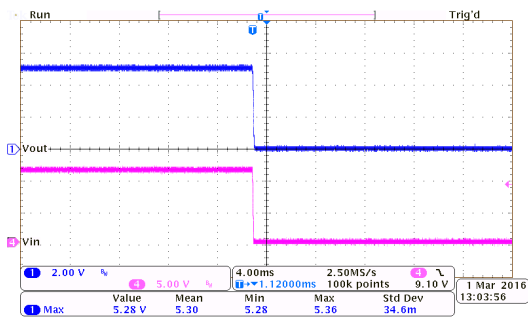
Power On Response:

HT7350-7 ($I_{OUT}=250mA$, $T_{RISE}=0.1ms$)



Power Off Response:

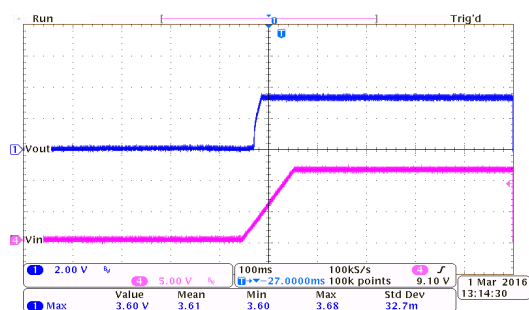
HT7333-7 ($I_{OUT}=250mA$, $T_{FALL}=0.1ms$)



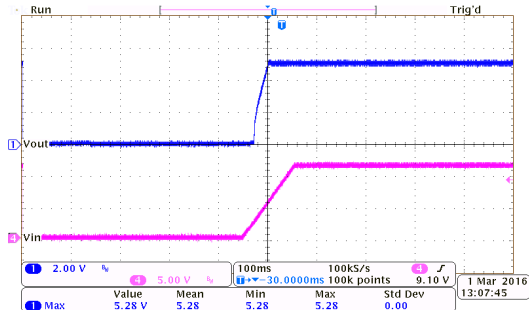
Power Off Response:

HT7350-7 ($I_{OUT}=250mA$, $T_{FALL}=0.1ms$)

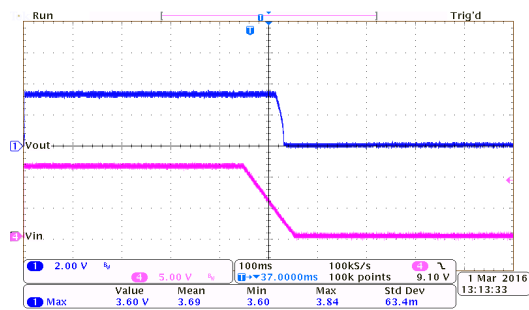
Test Condition: $V_{IN}=V_{OUT}+2V$, $V_{CE}=V_{IN}$, $I_{OUT}=10mA$, $C_{IN}=10\mu F$, $C_{OUT}=10\mu F$ and $T_a=25^{\circ}C$, unless otherwise noted.



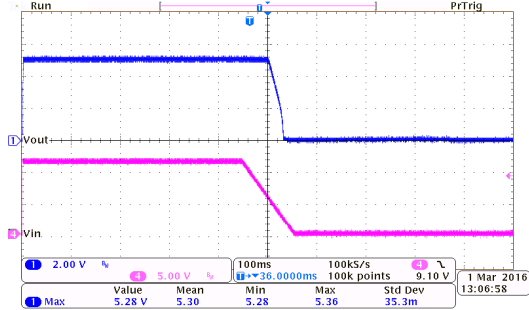
Power On Response:
HT7333-7 ($I_{OUT}=250mA$, $T_{RISE}=100ms$)



Power On Response:
HT7350-7 ($I_{OUT}=250mA$, $T_{RISE}=100ms$)



Power Off Response:
HT7333-7 ($I_{OUT}=250mA$, $T_{FALL}=100ms$)



Power Off Response:
HT7350-7 ($I_{OUT}=250mA$, $T_{FALL}=100ms$)

Application Information

When using the HT73xx-7 regulators, it is important that the following application points are noted if correct operation is to be achieved.

External Circuit

It is important that external capacitors are connected to both the input and output pins. For the input pin suitable bypass capacitors as shown in the application circuits should be connected especially in situations where a battery power source is used which may have a higher impedance. For the output pin, a suitable capacitor should also be connected especially in situations where the load is of a transient nature, in which case larger capacitor values should be selected to limit any output transient voltages.

Thermal Considerations

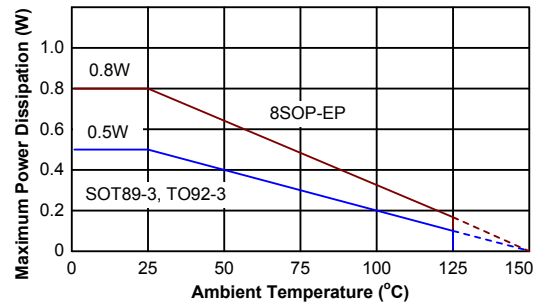
The maximum power dissipation depends on the thermal resistance of the package, the PCB layout, the rate of the surrounding airflow and the difference between the junction and ambient temperature. The maximum power dissipation can be calculated using the following formula:

$$P_{D(MAX)} = (T_{J(MAX)} - T_a) / \theta_{JA}$$

where $T_{J(MAX)}$ is the maximum junction temperature, T_a is the ambient temperature and θ_{JA} is the junction-to-ambient thermal resistance of the IC package in degrees per watt. The following table shows the θ_{JA} values for various package types.

Package	θ_{JA} value °C/W
SOT89-3	200°C/W
TO92-3	200°C/W
8SOP-EP	125°C/W

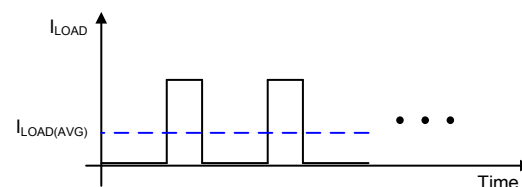
For maximum operating rating conditions, the maximum junction temperature is 150°C. However, it is recommended that the maximum junction temperature does not exceed 125°C during normal operation to maintain an adequate margin for device reliability. The derating curves of different packages for maximum power dissipation are as follows:



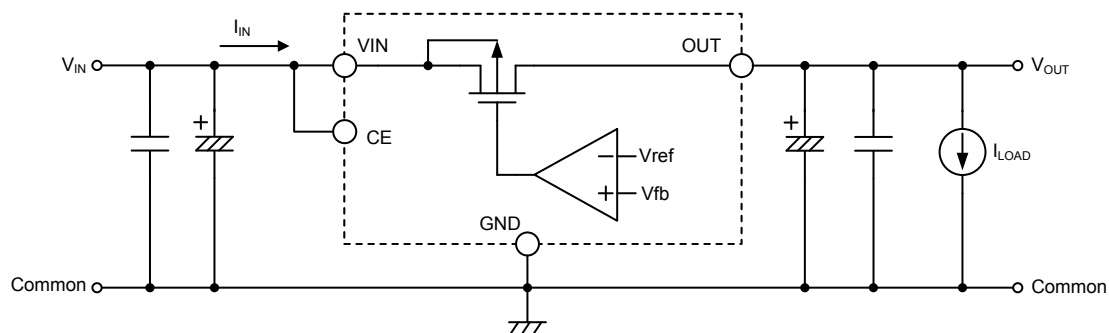
Power Dissipation Calculation

In order to keep the device within its operating limits and to maintain a regulated output voltage, the power dissipation of the device, given by P_D , must not exceed the Maximum Power Dissipation, given by $P_{D(MAX)}$. Therefore $P_D \leq P_{D(MAX)}$. From the diagram it can be seen that almost all of this power is generated across the pass transistor which is acting like a variable resistor in series with the load to keep the output voltage constant. This generated power which will appear as heat, must never allow the device to exceed its maximum junction temperature.

In practical applications the regulator may be called upon to provide both steady state and transient currents due to the transient nature of the load. Although the device may be working well within its limits with its steady state current, care must be taken with transient loads which may cause the current to rise close to its maximum current value. Care must be taken with transient loads and currents as this will result in device junction temperature rises which must not exceed the maximum junction temperature. With both steady state and transient currents, the important current to consider is the average or more precisely the RMS current which is the value of current that will appear as heat generated in the device. The following diagram shows how the average current relates to the transient currents.

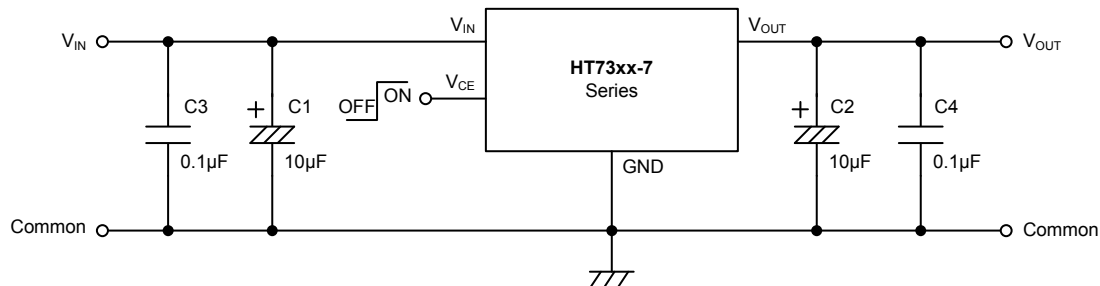


As the quiescent current of the device is very small it can generally be ignored and as a result the input current can be assumed to be equal to the output current. Therefore the power dissipation of the device, P_D , can be calculated as the voltage drop across the input and output multiplied by the current, given by the equation, $P_D = (V_{IN} - V_{OUT}) \times I_{IN}$. As the input current is also equal to the load current the power dissipation $P_D = (V_{IN} - V_{OUT}) \times I_{LOAD}$. However, with transient load currents, $P_D = (V_{IN} - V_{OUT}) \times I_{LOAD(AVG)}$ as shown in the figure.

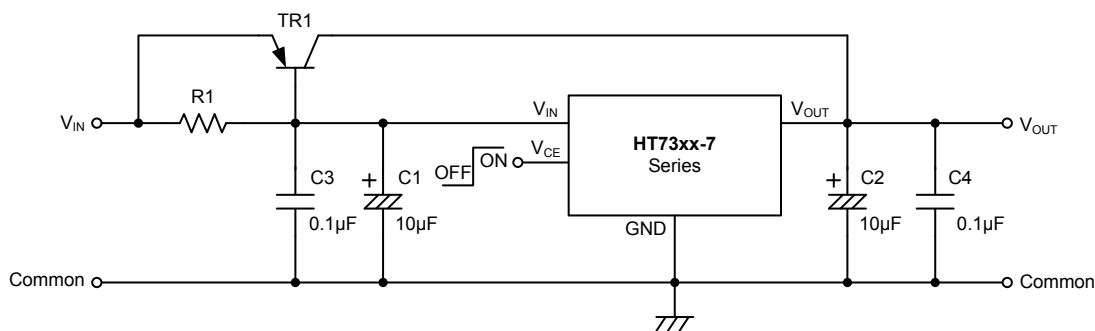


Application Circuits

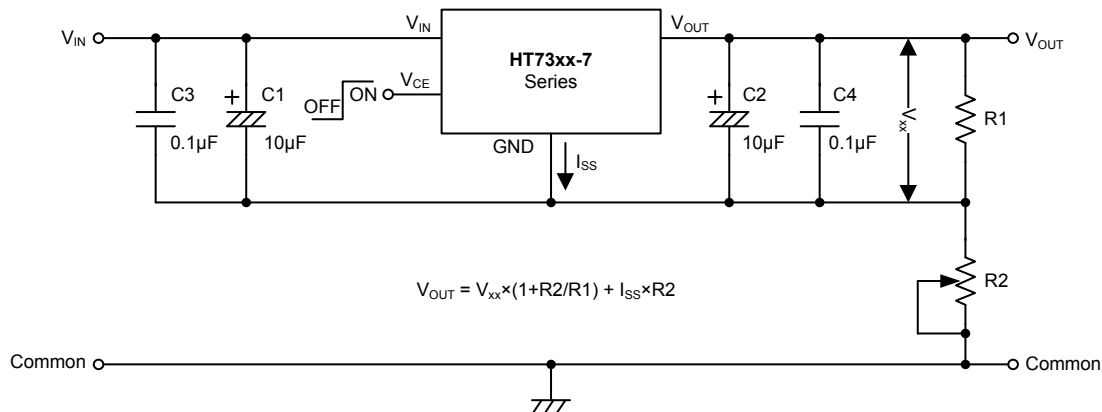
Basic Circuits



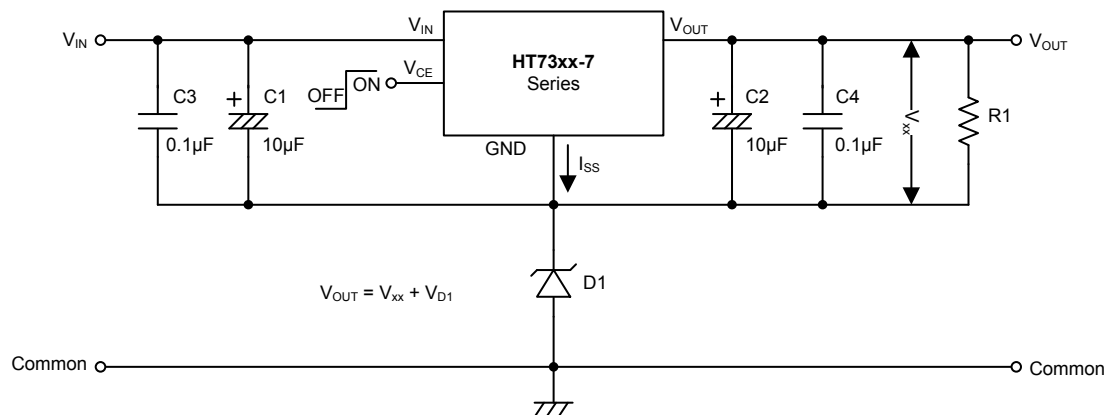
High Output Current Positive Voltage Regulator



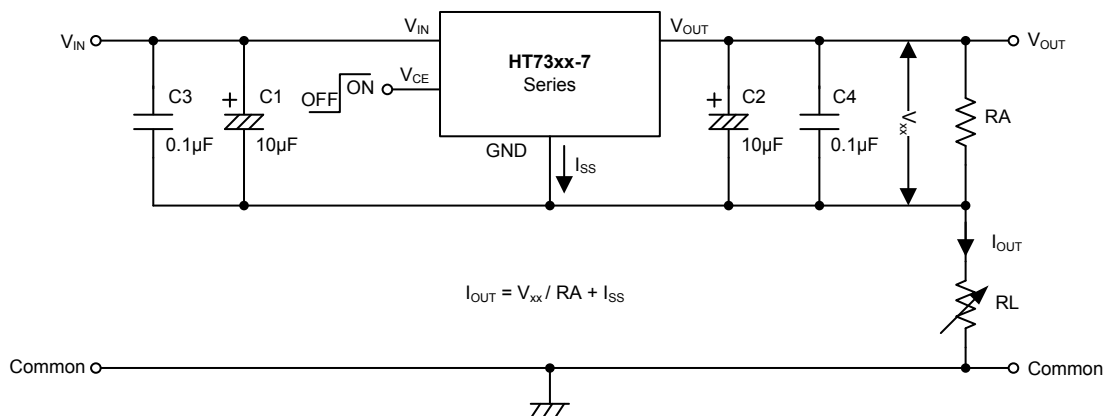
Circuit for Increasing Output Voltage



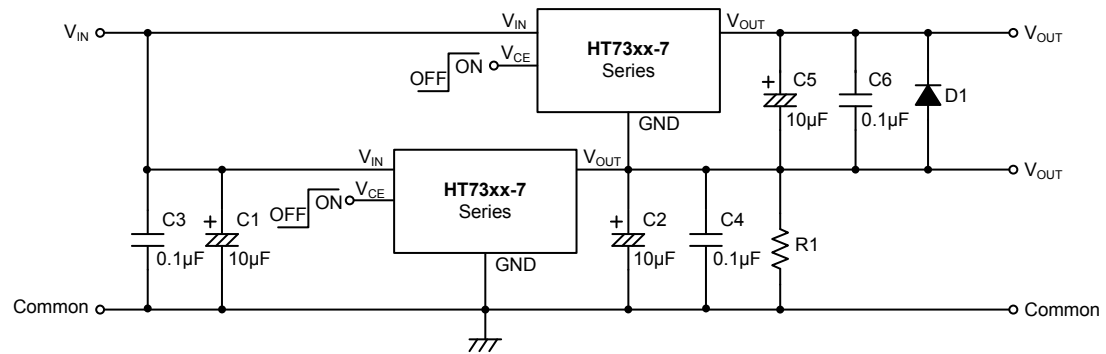
Circuit for Increasing Output Voltage



Constant Current Regulator



Dual Supply

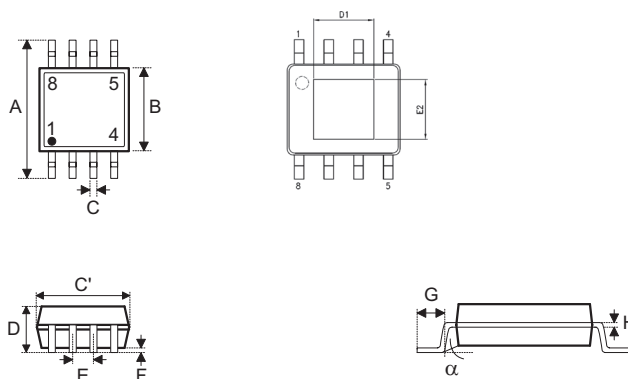


Package Information

Note that the package information provided here is for consultation purposes only. As this information may be updated at regular intervals users are reminded to consult the [Holtek website](#) for the latest version of the [Package/ Carton Information](#).

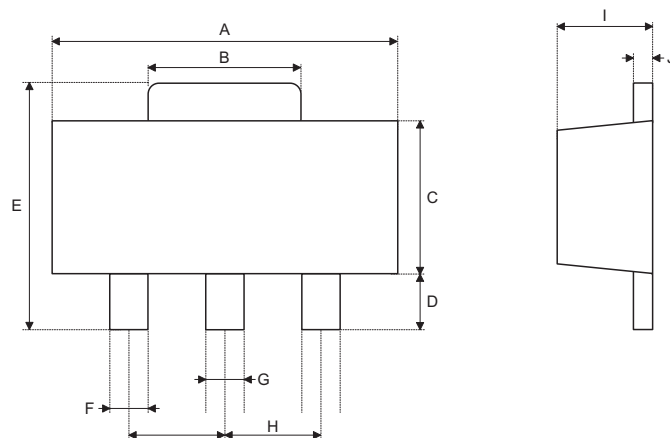
Additional supplementary information with regard to packaging is listed below. Click on the relevant section to be transferred to the relevant website page.

- Further Package Information (include Outline Dimensions, Product Tape and Reel Specifications)
- Packing Materials Information
- Carton information

8-pin SOP-EP Outline Dimensions


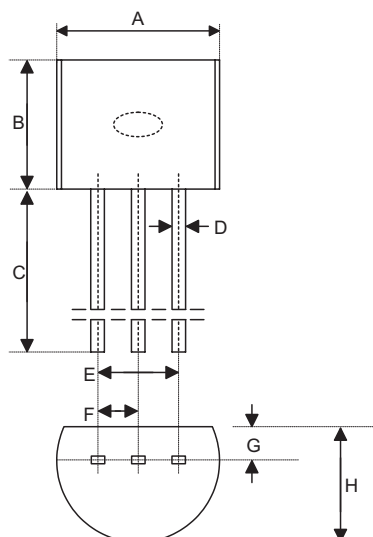
Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	0.236 BSC	—
B	—	0.154 BSC	—
C	0.012	—	0.020
C'	—	0.193 BSC	—
D	—	—	0.069
D1	0.059	—	—
E	—	0.050 BSC	—
E2	0.039	—	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.004	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	6.00 BSC	—
B	—	3.90 BSC	—
C	0.31	—	0.51
C'	—	4.90 BSC	—
D	—	—	1.75
D1	1.50	—	—
E	—	1.27 BSC	—
E2	1.00	—	—
F	0.10	—	0.25
G	0.40	—	1.27
H	0.10	—	0.25
α	0°	—	8°

3-pin SOT89-3 Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.173	—	0.181
B	0.053	—	0.072
C	0.090	—	0.102
D	0.035	—	0.047
E	0.155	—	0.167
F	0.014	—	0.019
G	0.017	—	0.022
H	—	0.059 BSC	—
I	0.055	—	0.063
J	0.014	—	0.017

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	4.40	—	4.60
B	1.35	—	1.83
C	2.29	—	2.60
D	0.89	—	1.20
E	3.94	—	4.25
F	0.36	—	0.48
G	0.44	—	0.56
H	—	1.50 BSC	—
I	1.40	—	1.60
J	0.35	—	0.44

3-pin TO92-3 Outline Dimensions


Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.173	0.180	0.205
B	0.170	—	0.210
C	0.500	0.580	—
D	—	0.015 BSC	—
E	—	0.010 BSC	—
F	—	0.050 BSC	—
G	—	0.035 BSC	—
H	0.125	0.142	0.165

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	4.39	4.57	5.21
B	4.32	—	5.33
C	12.70	14.73	—
D	—	0.38 BSC	—
E	—	2.54 BSC	—
F	—	1.27 BSC	—
G	—	0.89 BSC	—
H	3.18	3.61	4.19

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