HT77xxBA
5V/200mA PFM
Asynchronous Step-up Converter

Features

- Low startup voltage: 0.85V (Typical)
- High efficiency up to 85%
- Ultra low no load input current
- High output voltage accuracy: ±2.5%
- Fixed output voltage: 2.7V, 3.0V, 3.3V, 3.7V and 5.0V
- Ultra low shutdown current: 0.1μA (Typical)
- Package type: 3-pin SOT89, 3-pin SOT23 and 5-pin SOT23

Applications

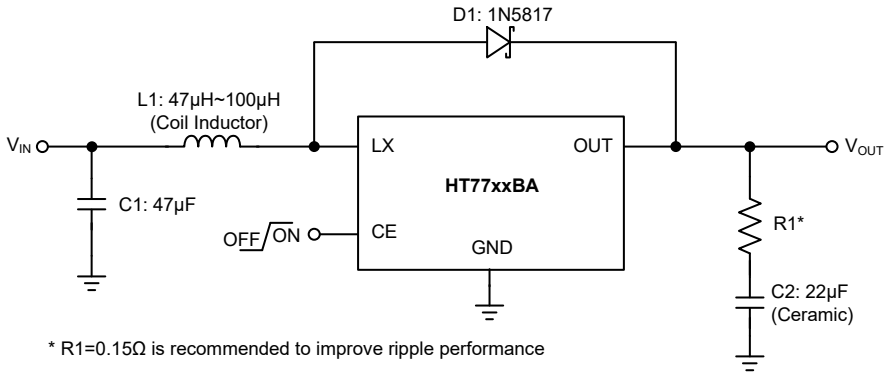
- One, two and three cell alkaline and NiMH/NiCd bettery powered portable products
- Portable equipment/handheld devices

General Description

The HT77xxBA series is a set of PFM step-up DC/DC converters with high efficiency and low ripple. The series features extremely low start-up voltage and high output voltage accuracy. They require only few external components to provide a fixed output voltage of 2.7V, 3.0V, 3.3V, 3.7V and 5.0V. CMOS technology ensures low supply current and makes them ideal for battery-operated applications powered from one or more cells.

The HT77xxBA series consist of an oscillator, a PFM control circuit, a driver transistor, a reference voltage unit and a high speed comparator. They employ pulse frequency modulation (PFM) for minimum supply current and ripple at light output loading. These devices are available in space saving 3-pin SOT89, 3-pin SOT23 and 5-pin SOT23 packages. For the 5-pin SOT23 package, it also contains a chip enable function to reduce power consumption during shutdown mode.

Typical Application Circuits

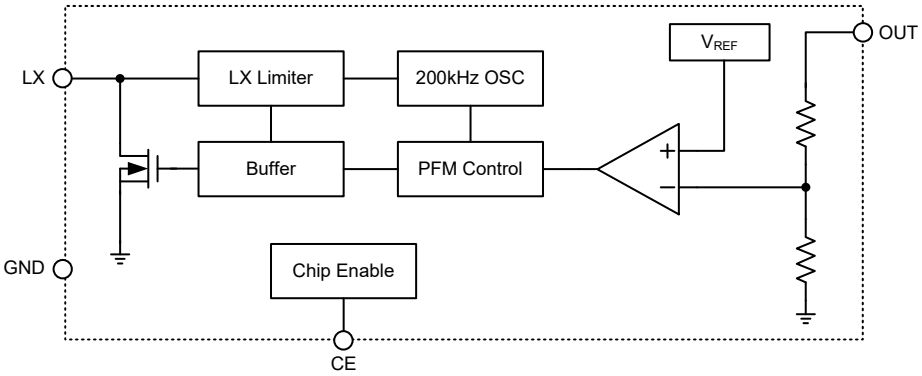


Selection Table

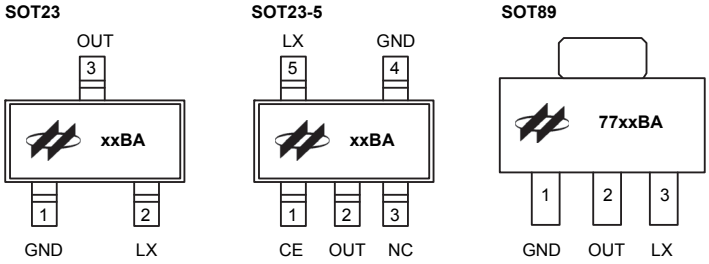
Part No.	Output Voltage	Packages	Markings
HT7727BA	2.7V	SOT89 SOT23 SOT23-5	77xxBA marking for SOT89 type xxBA marking for SOT23 and SOT23-5 types
HT7730BA	3.0V		
HT7733BA	3.3V		
HT7737BA	3.7V		
HT7750BA	5.0V		

Note: "xx" stands for output voltages.

Block Diagram



Pin Assignment



Pin Description

Pin No.			Pin Name	Pin Description
SOT89	SOT23	SOT23-5		
—	—	1	CE	Chip enable pin, high active.
2	3	2	OUT	Output voltage pin
—	—	3	NC	No connection
1	1	4	GND	Ground pin
3	2	5	LX	Switching pin

Absolute Maximum Ratings

Parameter		Value	Unit
OUT		-0.3 to +6.0	V
LX and CE		-0.3 to +6.0	V
Maximum Junction Temperature		+150	˚C
Storage Temperature Range		-65 to +150	˚C
Lead Temperature (Soldering 10sec)		+260	˚C
ESD Susceptibility	Human Body Mode	5000	V
	Machine Mode	400	V
Junction-to-Ambient Thermal Resistance, θ_{JA}	SOT89	200	˚C/W
	SOT23	500	
	SOT23-5	500	
Power Dissipation, P_D	SOT89	0.625	W
	SOT23	0.25	
	SOT23-5	0.25	

Recommended Operating Ratings

Parameter	Value	Unit
V_{IN}	0.85 to 5	V
Operating Temperature Range	-40 to +85	˚C

Note that Absolute Maximum Ratings indicate limitations beyond which damage to the device may occur. Recommended Operating Ratings indicate conditions for which the devices are intended to be functional, but do not guarantee specified performance limits.

Electrical Characteristics

V_{IN}=0.6×V_{OUT}, I_{OUT}=10mA and Ta=25°C, unless otherwise specified

Symbol	Parameter	Test Condition		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage Range	—		—	—	5.5	V
ΔV_{OUT}	Output Voltage Accuracy	—		-2.5	—	+2.5	%
V_{ST}	Startup Voltage (Fig.1)	V_{IN}: 0V → 2V, I_{OUT}=1mA		—	0.85	1	V
V_{HOLD}	Hold on Voltage (Fig.1)	V_{IN}: 2V → 0V, I_{OUT}=1mA		—	—	0.7	V
I_{IN}	No Load Input Current (Fig.1)	I_{OUT}=0A		8	10	20	μA
I_{DD}	Non-switching Current (Fig.2)	V_{DD}=V_{OUT}+0.5V, V_X=floating		—	5	10	μA
I_{SHDN}	Shutdown Current (Fig.1)	CE=GND		—	0.1	1	μA
$R_{DS(ON)}$	On Resistance (Fig.3)	V_{DD}=2.6V, I_{LX}=300mA	V_{OUT}=2.7V	—	0.39	—	Ω
		V_{DD}=2.9V, I_{LX}=300mA	V_{OUT}=3.0V	—	0.38	—	
		V_{DD}=3.2V, I_{LX}=300mA	V_{OUT}=3.3V	—	0.37	—	
		V_{DD}=3.6V, I_{LX}=300mA	V_{OUT}=3.7V	—	0.35	—	
		V_{DD}=4.85V, I_{LX}=300mA	V_{OUT}=5.0V	—	0.33	—	
I_{OCP}	Over Current Protection Threshold	V_{OUT}=2.7V		—	1.0	—	A
		V_{OUT}=3.0V		—	1.0	—	
		V_{OUT}=3.3V		—	1.1	—	
		V_{OUT}=3.7V		—	1.1	—	
		V_{OUT}=5.0V		—	1.6	—	
V_{IH}	CE High Threshold	—		1.6	—	—	V
V_{IL}	CE Low Threshold	—		—	—	0.4	V
I_{LEAK}	LX Leakage Current (Fig.2)	V_{DD}=V_X=V_{OUT}+0.5V, measured at LX pin		—	—	1	μA
f_{OSC}	Maximum Oscillator Frequency (Fig.2)	V_{DD}=0.9×V_{OUT}, V_X=5.5V, measured at LX pin		—	200	—	kHz
D_{OSC}	Oscillator Duty Cycle (Fig.2)	V_{DD}=0.9×V_{OUT}, V_X=5.5V, measured at LX pin		65	75	85	%
η	Efficiency	—		—	85	—	%

Note: Absolute maximum ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the devices are intended to be functional, but do not guarantee specific performance limits. The guaranteed specifications apply only for the test conditions listed.

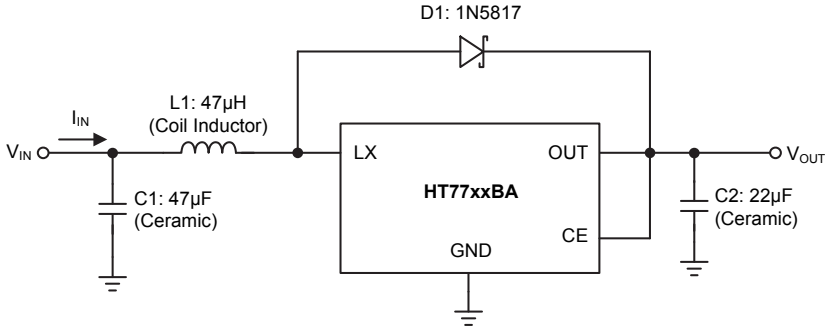


Fig.1

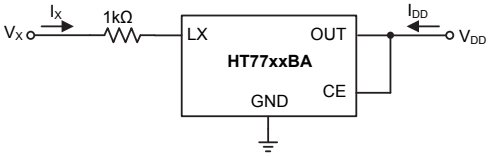


Fig. 2

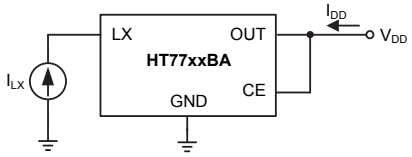
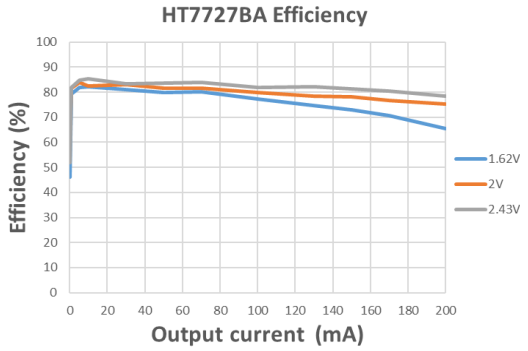
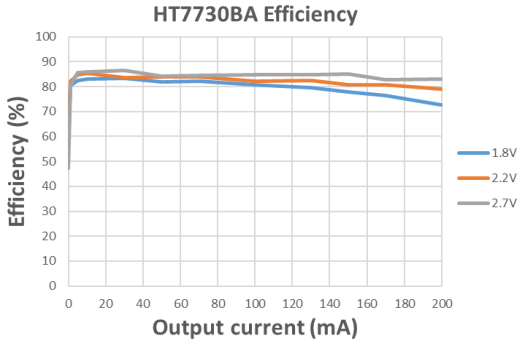


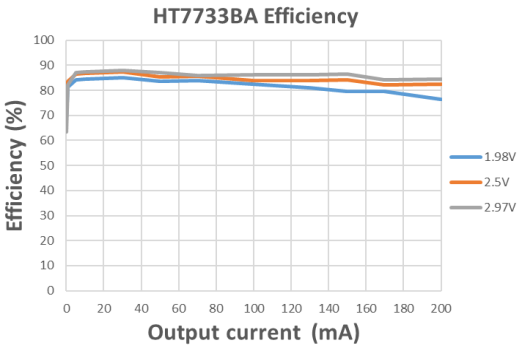
Fig. 3

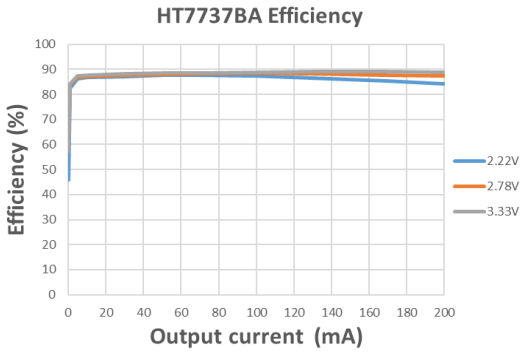
Typical Performance Characteristics

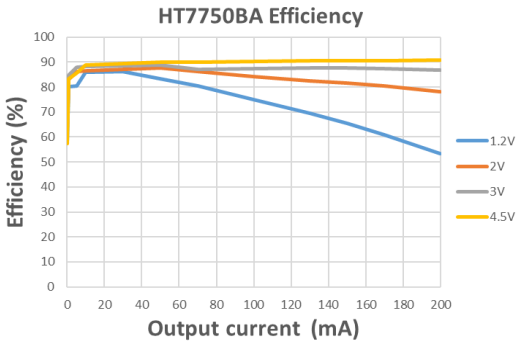
V_{IN}=0.6×V_{OUT}, C_{IN}=47μF, C_{OUT}=22μF, L=47μH, Ta=25°C, unless otherwise specified

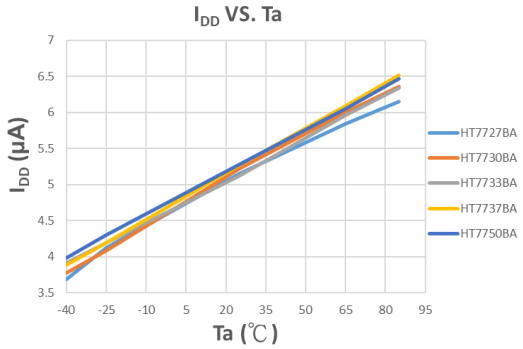






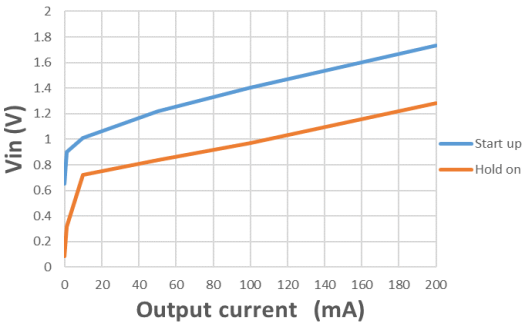




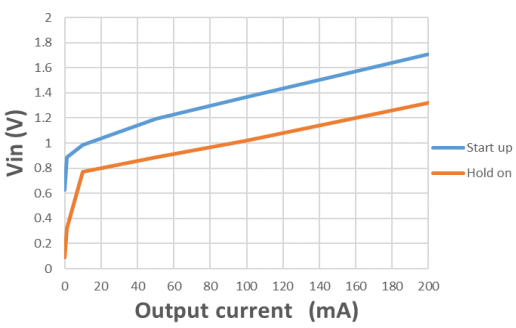


V_{IN}=0.6×V_{OUT}, C_{IN}=47μF, C_{OUT}=22μF, L=47μH, Ta=25°C, unless otherwise specified

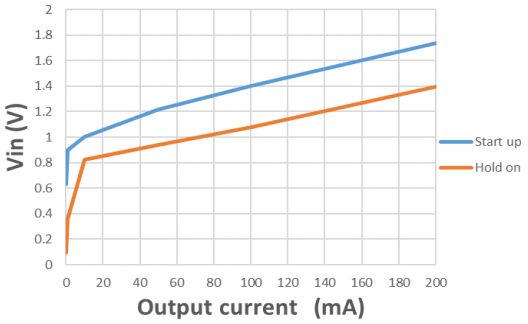
HT7727BA Startup/Hold-on Voltage



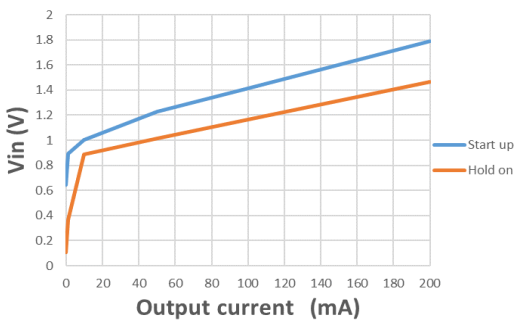
HT7730BA Startup/Hold-on Voltage



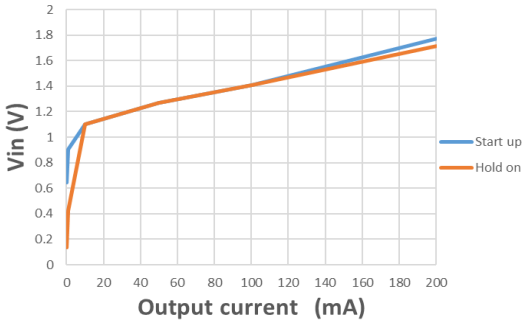
HT7733BA Startup/Hold-on Voltage



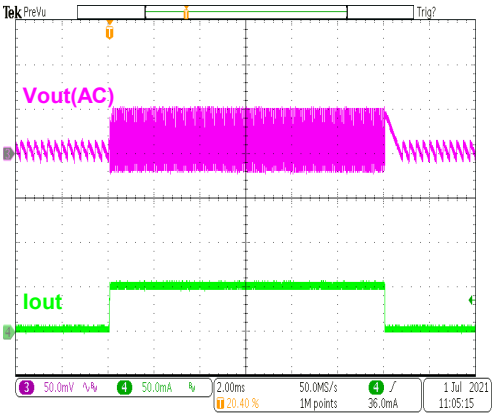
HT7737BA Startup/Hold-on Voltage



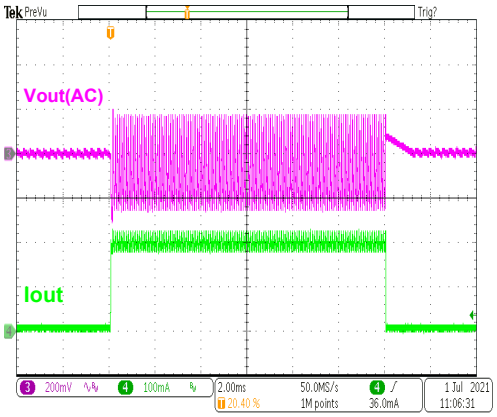
HT7750BA Startup/Hold-on Voltage



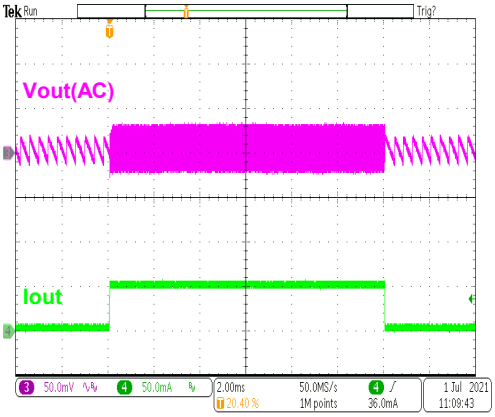
V_{IN}=0.6×V_{OUT}, C_{IN}=47μF, C_{OUT}=22μF, L=47μH, Ta=25°C, R1=0.15Ω, unless otherwise specified



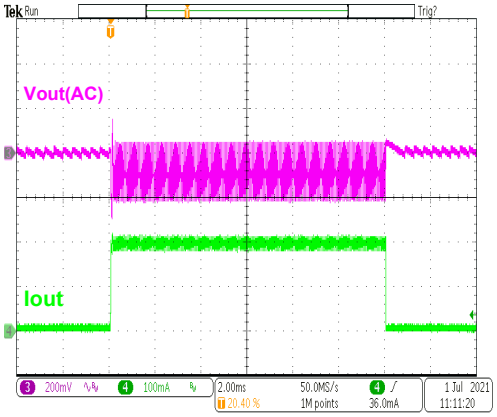
HT7727BA Load Transient (1mA to 50mA)



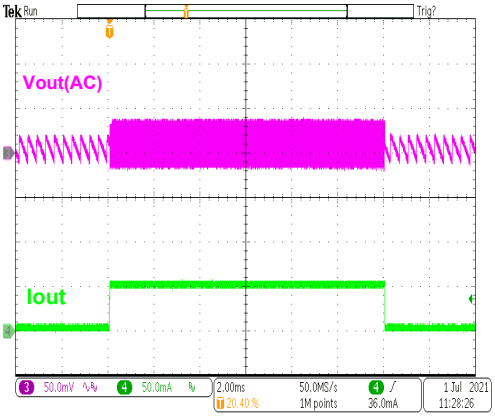
HT7727BA Load Transient (1mA to 200mA)



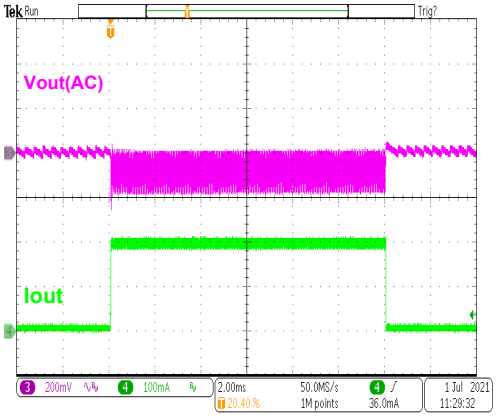
HT7730BA Load Transient (1mA to 50mA)



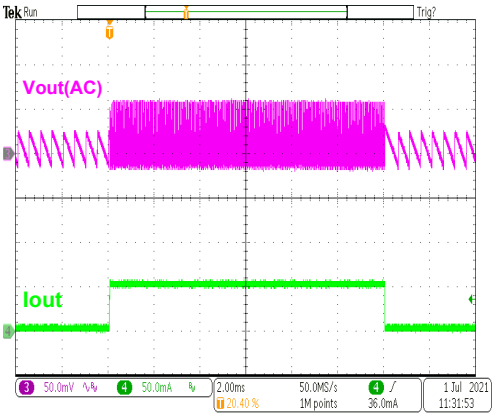
HT7730BA Load Transient (1mA to 200mA)



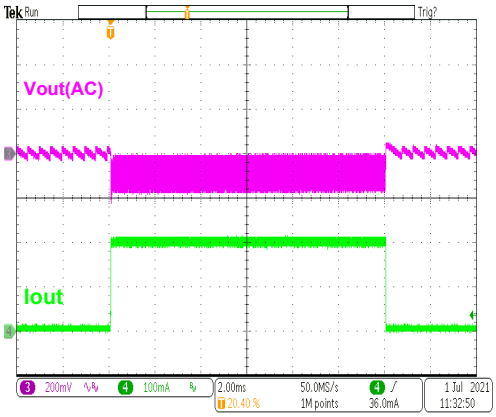
HT7733BA Load Transient (1mA to 50mA)



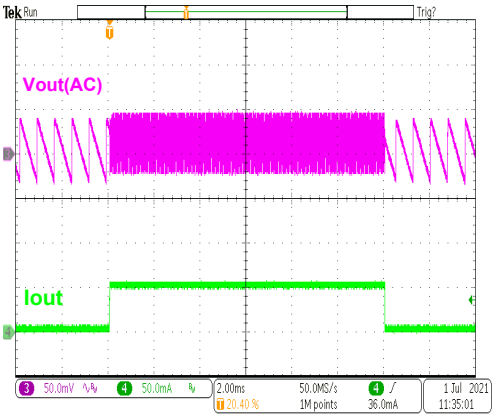
HT7733BA Load Transient (1mA to 200mA)



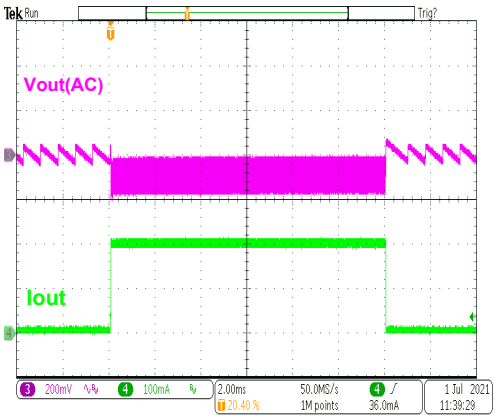
HT7737BA Load Transient (1mA to 50mA)



HT7737BA Load Transient (1mA to 200mA)

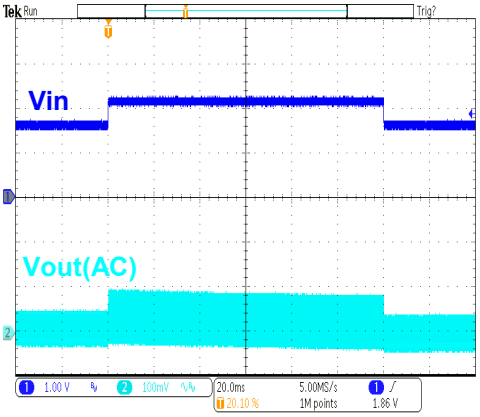


HT7750BA Load Transient (1mA to 50mA)



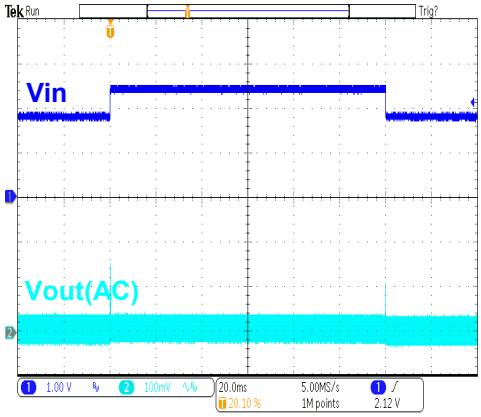
HT7750BA Load Transient (1mA to 200mA)

V_{IN}=0.6×V_{OUT}, C_{IN}=47μF, C_{OUT}=22μF, L=47μH, Ta=25°C, R1=0.15Ω, unless otherwise specified



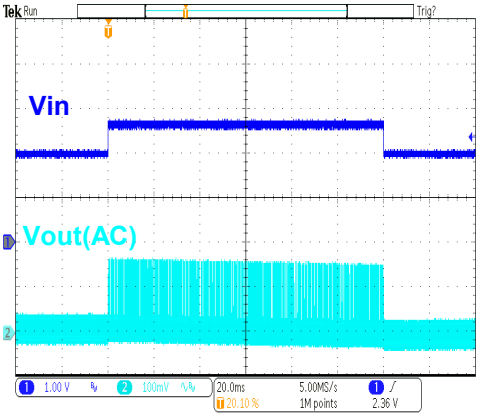
HT7727BA Line Transient

(1.62V~2.16V, I_{OUT}=50mA)



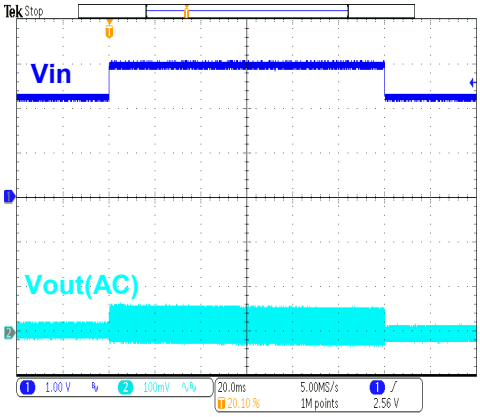
HT7730BA Line Transient

(1.8V~2.4V, I_{OUT}=50mA)



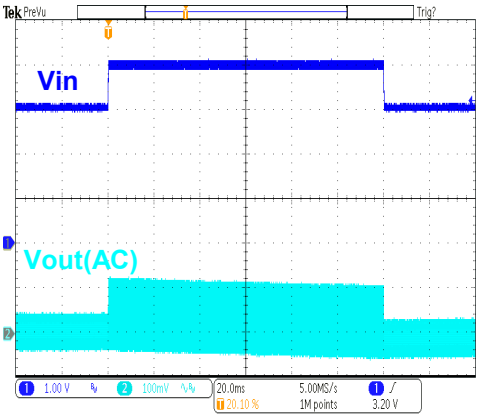
HT7733BA Line Transient

(1.98V~2.64V, I_{OUT}=50mA)



HT7737BA Line Transient

(2.22V~2.96V, I_{OUT}=50mA)



HT7750BA Line Transient

(3V~4V, I_{OUT}=50mA)

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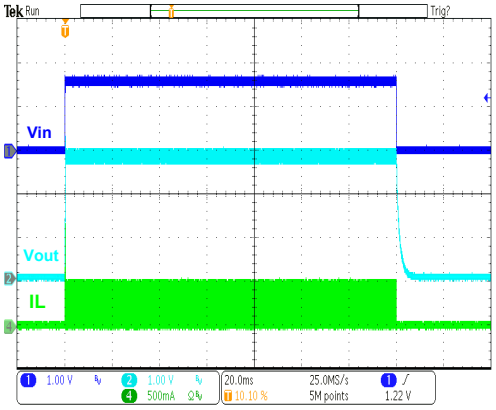
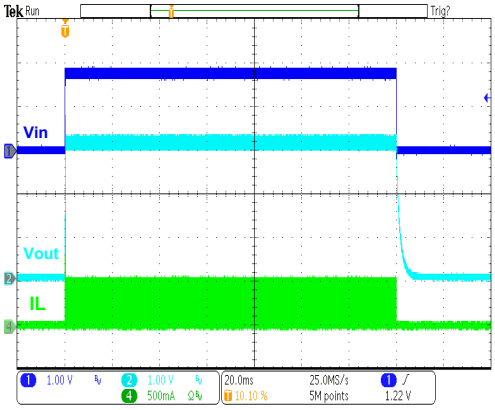


HT7727BA Power On/Off
(V_{IN}=1.62V, I_{OUT}=50mA)



HT7733BA Power On/Off
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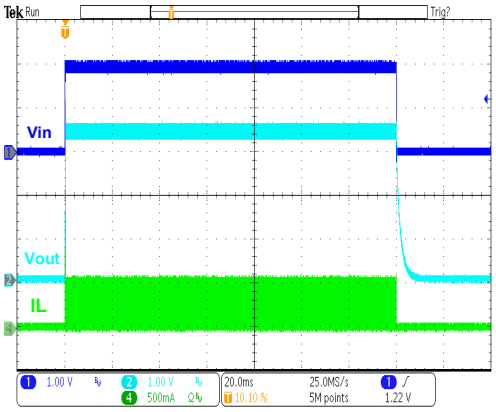
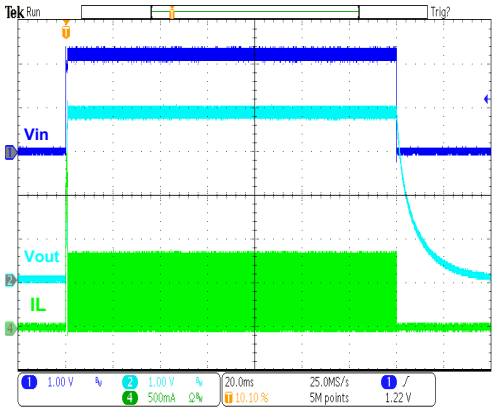
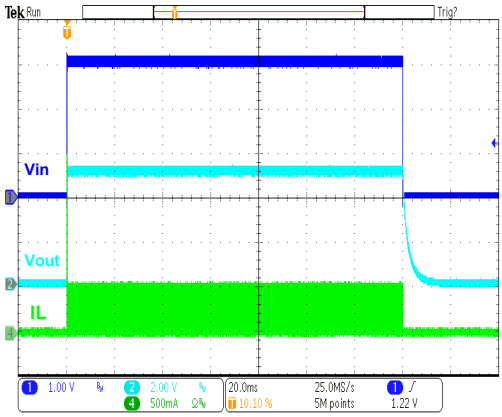


HT7733BA Power On/Off
(V_{IN}=1.98V, I_{OUT}=50mA)



HT7737BA Power On/Off
(V_{IN}=2.22V, I_{OUT}=50mA)



HT7750BA Power On/Off
(V_{IN}=3V, I_{OUT}=50mA)

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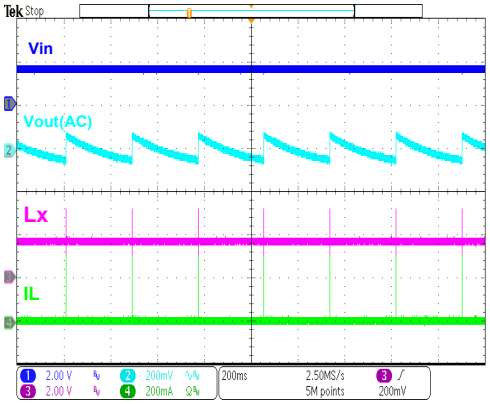
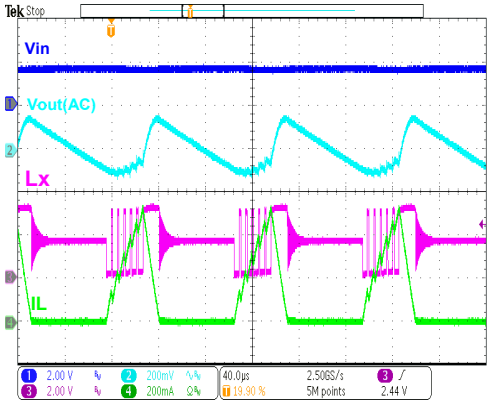
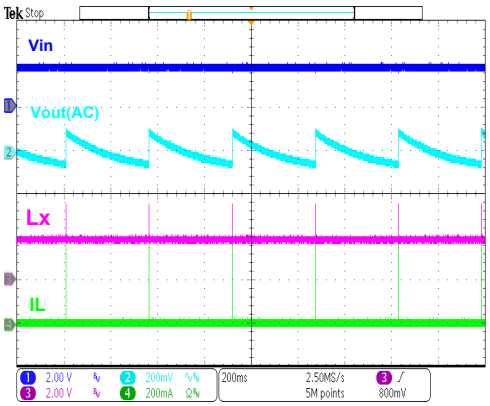


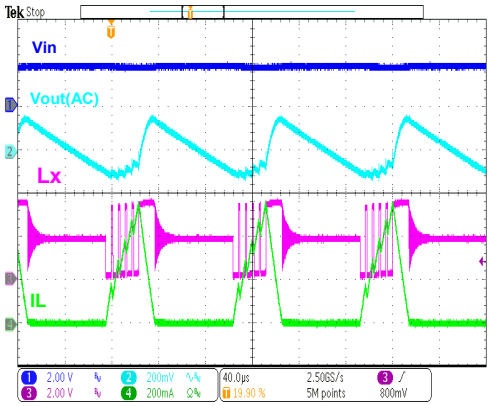
HT7727BA Operation (I_{OUT}=0mA)



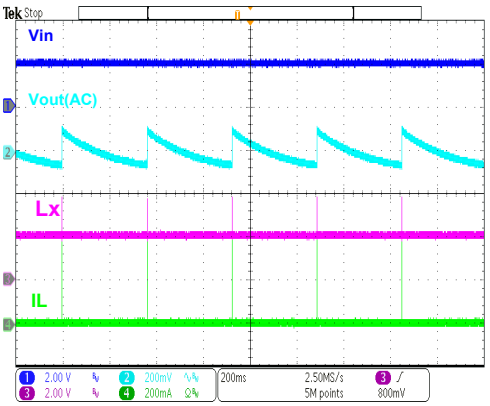
HT7727BA Operation (I_{OUT}=50mA)



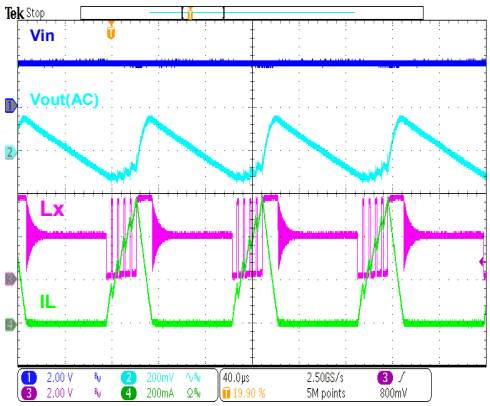
HT7730BA Operation (I_{OUT}=0mA)



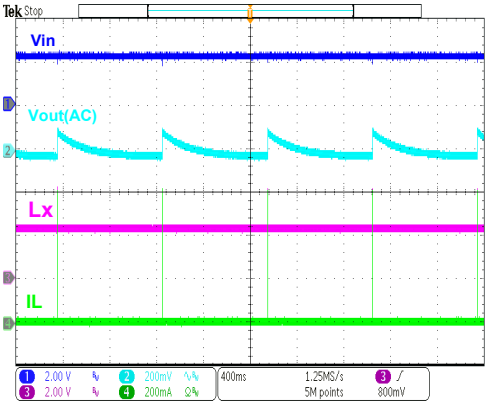
HT7730BA Operation (I_{OUT}=50mA)



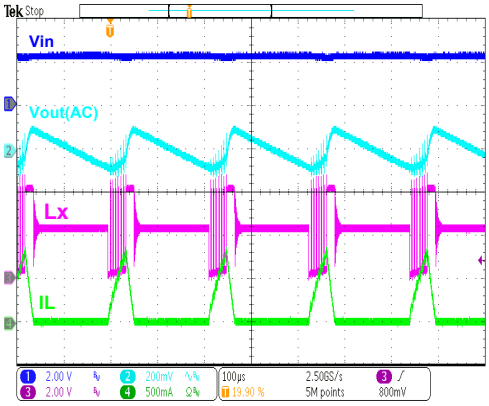
HT7733BA Operation (I_{OUT}=0mA)



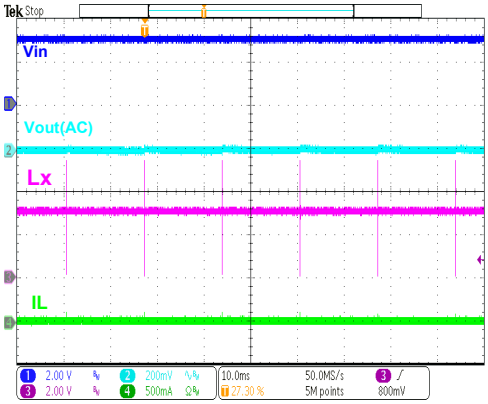
HT7733BA Operation (I_{OUT}=50mA)



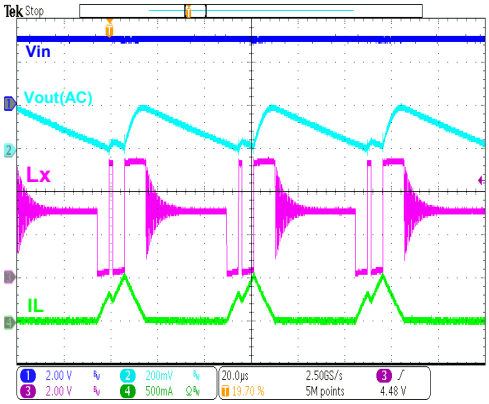
HT7737BA Operation (I_{OUT}=0mA)



HT7737BA Operation (I_{OUT}=50mA)

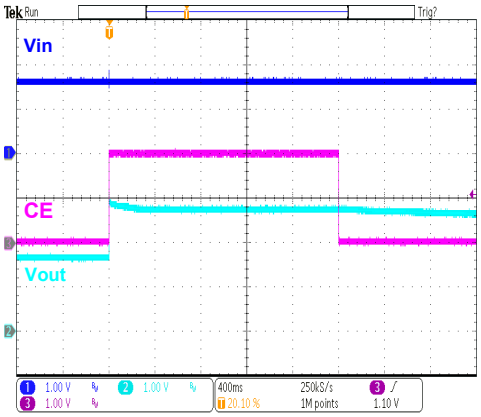


HT7750BA Operation (I_{OUT}=0mA)

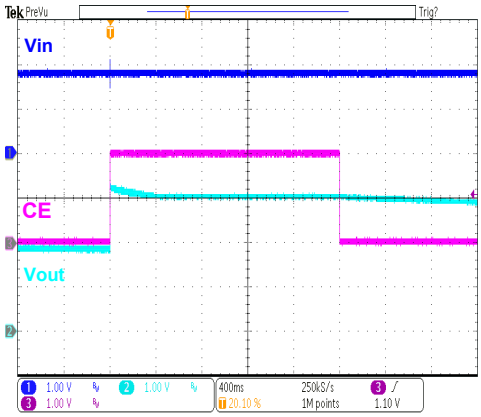


HT7750BA Operation (I_{OUT}=50mA)

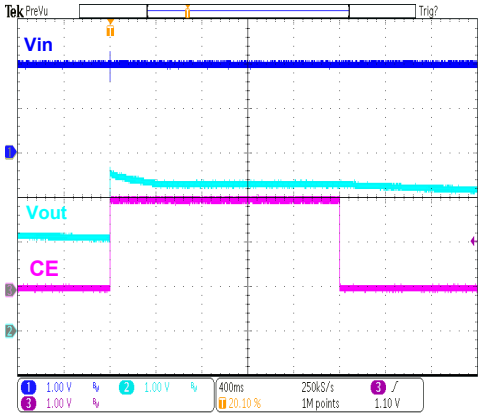
V_{IN}=0.6×V_{OUT}, C_{IN}=47μF, C_{OUT}=22μF, L=47μH, Ta=25°C, R1=0.15Ω, unless otherwise specified



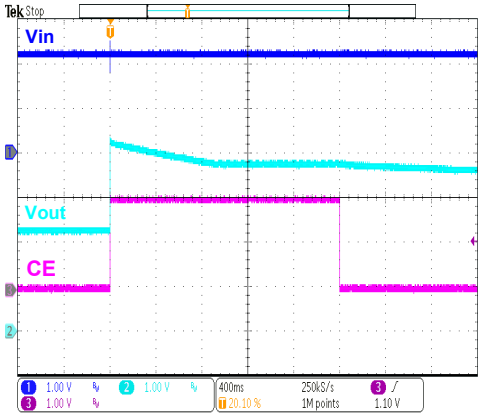
HT7727BA Chip Enable/Disable



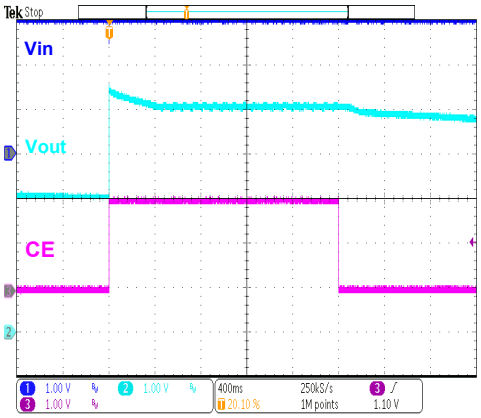
HT7730BA Chip Enable/Disable



HT7733BA Chip Enable/Disable



HT7737BA Chip Enable/Disable



HT7750BA Chip Enable/Disable

Component Selection

Power Inductor

It is recommended to use a 47μH or higher inductance to remain low output ripple voltage in most applications. Increasing the inductance will result in lower output ripple voltage. It is suggested to choose a lower DCR with a typical value less than 1Ω to reduce the efficiency loss. Otherwise, the chosen inductor saturation current should be greater than its peak current with a typical value of 1A or higher in applications.

Schottky Diode

The diode breakdown voltage rating should be higher than the maximum output voltage. The diode current rating equal to or greater than 1A is suggested.

Input Capacitor

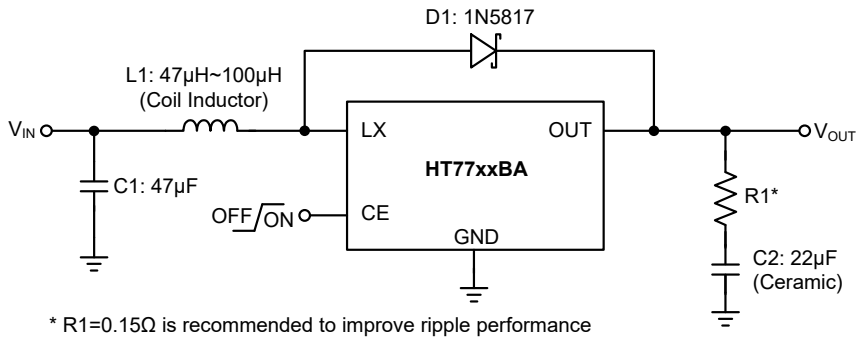
A low ESR ceramic capacitor, C_{IN}, is needed between the VIN and GND pins. Use ceramic capacitors with X5R or X7R dielectrics for their low ESRs and small temperature coefficients. For most applications, a 47μF capacitor will be a proper selection.

Output Capacitor

The output capacitor, C_{OUT}, selection is determined by the maximum allowable output voltage ripple. Use ceramic capacitors with X5R or X7R dielectrics for their low ESR characteristics. Capacitors in the range of 22μF to 100μF are a good starting point. It is usually suggested to use a 22μF capacitor in most applications.

Ripple Improved Resistor with a No Load Condition

It is strongly recommended to add a ripple improved resistor, R1, to keep the switching stability with a no load condition. It is recommended to set R1 to 0.15Ω. Note that this extra resistor improves the ripple performance under no load conditions, but induces higher ripple voltage when the load is heavy.

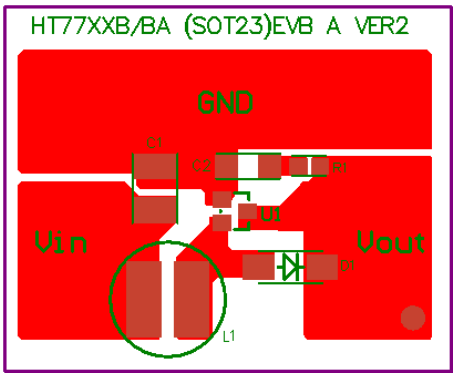


* R1=0.15Ω is recommended to improve ripple performance

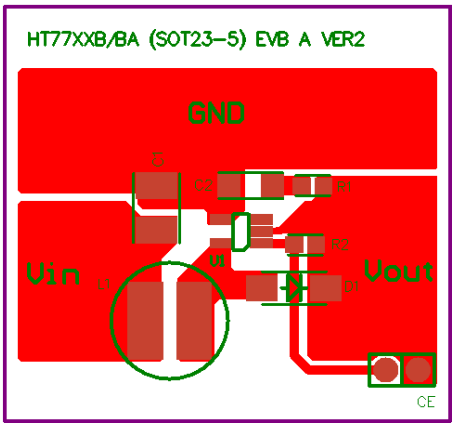
PCB Layout Suggestion

To reduce problems with conducted noise, there are some important points to note on the PCB layout.

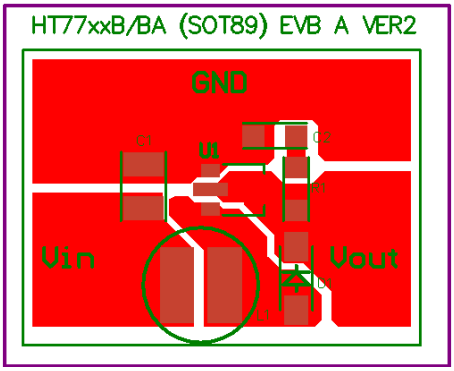
- The input bypass capacitor must be placed close to the inductor.
- The inductor, schottky diode and output capacitor trace should be as short as possible to reduce the conducted and radiated noise and increase overall efficiency.
- A wide ground plane should be used to reduce ground noise.



SOT23 PCB Layout Example



SOT23-5 PCB Layout Example



SOT89 PCB Layout Example

Thermal Consideration

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

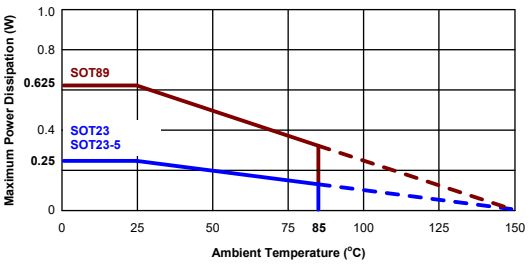
$$P_{D(MAX)} = (T_{J(MAX)} - Ta) / \theta_{JA} \text{.....(W)}$$

Where $T_{J(MAX)}$ is the maximum junction temperature, Ta is the ambient temperature and θ_{JA} is the junction to ambient thermal resistance.

For maximum operating rating conditions, the maximum junction temperature is 150°C. However, it's recommended that the maximum junction temperature does not exceed 125°C during normal operation to maintain high reliability. The de-rating curve of the maximum power dissipation is show below:

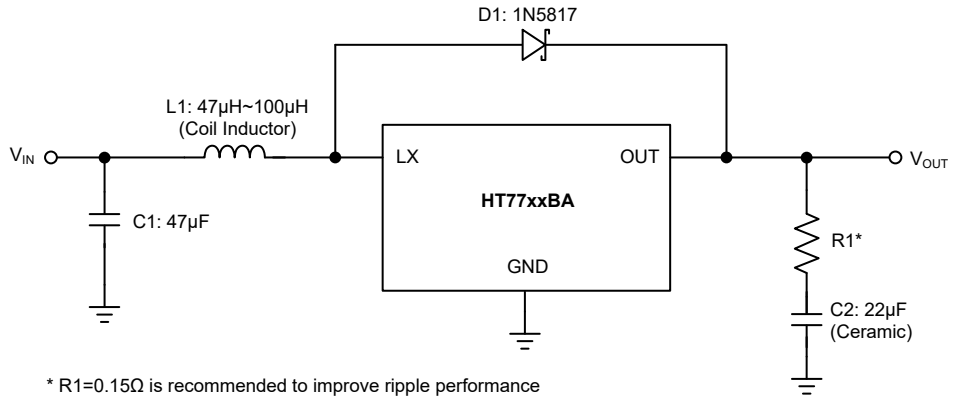
$$P_{D(MAX)} = (150°C - 25°C) / (500°C/W) = 0.25W$$

For a fixed $T_{J(MAX)}$ of 150°C, the maximum power dissipation depends upon the operating ambient temperature and the package's thermal resistance, θ_{JA}. The de-rating curve below shows the effect of rising ambient temperature on the maximum recommended power dissipation.



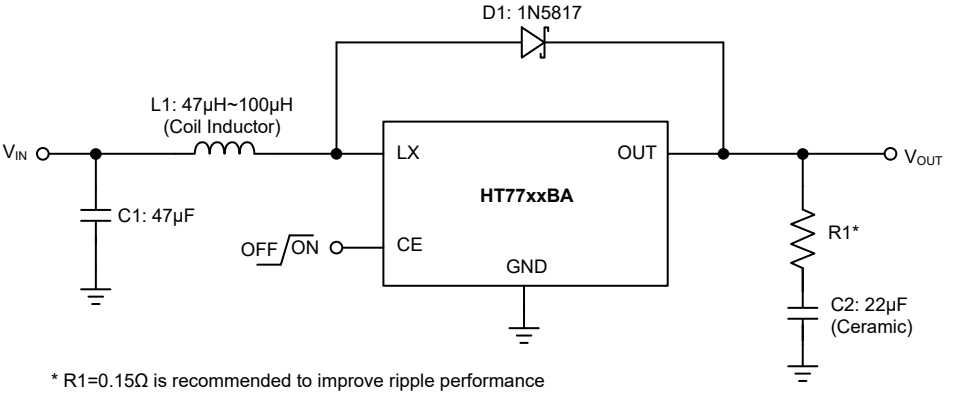
Application Circuits

Without CE Pin Application Circuits



* R1=0.15Ω is recommended to improve ripple performance

With CE Pin Application Circuits



* R1=0.15Ω is recommended to improve ripple performance

Note: 1. When CE='0', the device internal circuits such as the bandgap reference, gain block and all feedback and control circuitry will be switched off.

2. When CE='0', the output voltage, V_{OUT}, is almost equal to V_{IN}.

3. If the CE pin is not used, it should be externally connected to the OUT pin.

Recommended Component Values

Reference	Package	Description	Part Number	Mfgr.
C1	SMD 1210	CAP 47μF/10V/X5R	LMK325BJ476MM8P	Taiyo Yuden
C2	SMD 1206	CAP 22μF/10V/X5R	LMK316ABJ226KL-T	Taiyo Yuden
L1	9mm×9.5mm×5.4mm	47μH/DCR 0.17Ω/DCI 1.28A	GS105 – 470K	GANG SONG
D1	SMA	1A 20V	SM5817A	GOODWORK
*R1	SMD 0806	0.15Ω	—	—

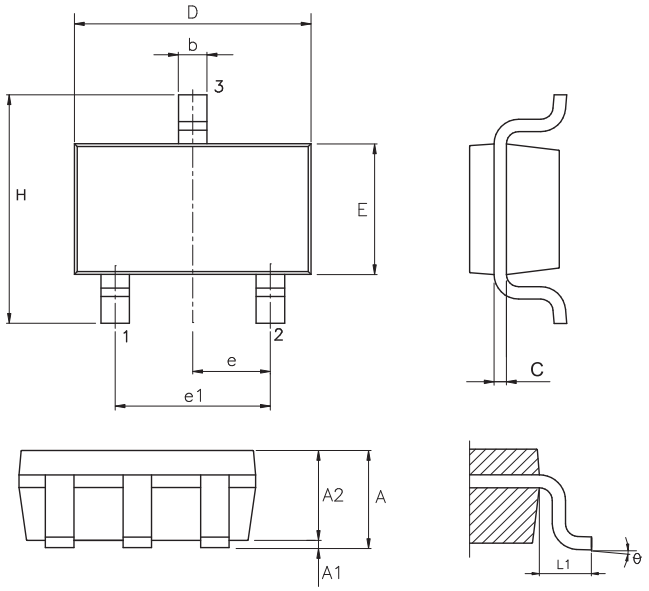
Package Information

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 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 Meterials Information
- Carton information

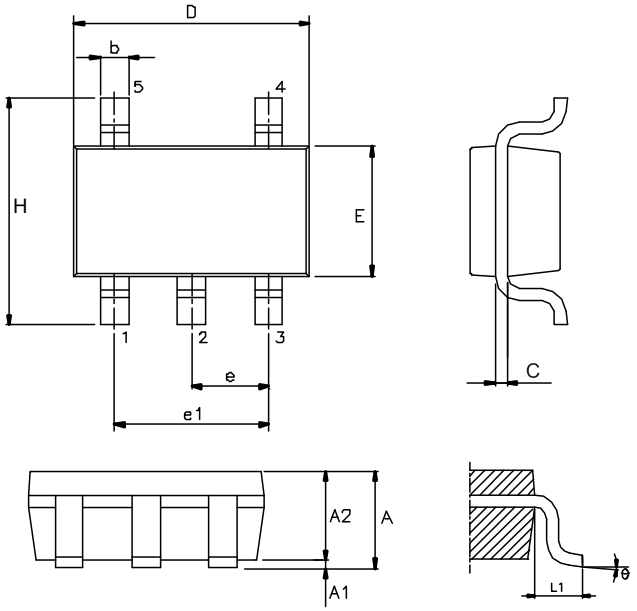
3-pin SOT23 Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	—	0.057
A1	—	—	0.006
A2	0.035	0.045	0.051
b	0.012	—	0.020
C	0.003	—	0.009
D	—	0.114 BSC	—
E	—	0.063 BSC	—
e	—	0.037 BSC	—
e1	—	0.075 BSC	—
H	—	0.110 BSC	—
L1	—	0.024 BSC	—
θ	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	—	1.45
A1	—	—	0.15
A2	0.90	1.15	1.30
b	0.30	—	0.50
C	0.08	—	0.22
D	—	2.90 BSC	—
E	—	1.60 BSC	—
e	—	0.95 BSC	—
e1	—	1.90 BSC	—
H	—	2.80 BSC	—
L1	—	0.60 BSC	—
θ	0°	—	8°

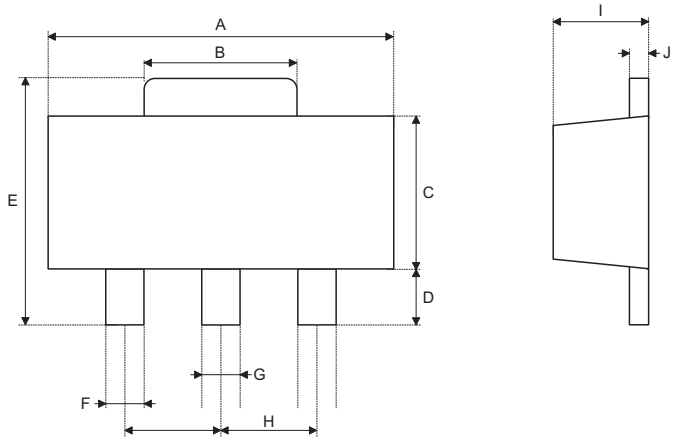
5-pin SOT23 Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	—	0.057
A1	—	—	0.006
A2	0.035	0.045	0.051
b	0.012	—	0.020
C	0.003	—	0.009
D	—	0.114 BSC	—
E	—	0.063 BSC	—
e	—	0.037 BSC	—
e1	—	0.075 BSC	—
H	—	0.110 BSC	—
L1	—	0.024 BSC	—
θ	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	—	1.45
A1	—	—	0.15
A2	0.90	1.15	1.30
b	0.30	—	0.50
C	0.08	—	0.22
D	—	2.90 BSC	—
E	—	1.60 BSC	—
e	—	0.95 BSC	—
e1	—	1.90 BSC	—
H	—	2.80 BSC	—
L1	—	0.60 BSC	—
θ	0°	—	8°

3-pin SOT89 Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.173	—	0.185
B	0.053	—	0.072
C	0.090	—	0.106
D	0.031	—	0.047
E	0.155	—	0.173
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	—	4.70
B	1.35	—	1.83
C	2.29	—	2.70
D	0.80	—	1.20
E	3.94	—	4.40
F	0.36	—	0.48
G	0.44	—	0.56
H	—	1.50 BSC	—
I	1.40	—	1.60
J	0.35	—	0.44