HT77xxSA 200mA PFM Synchronous Step-up DC/DC Converter

Features

- Low start-up voltage: 0.7V (Typ.)
- High efficiency: 2.7V ≤ V_{OUT} ≤ 5.0V upper 90% (Typ.)
- High output voltage accuracy: ±2.5%
- Output voltage: 2.7V, 3.0V, 3.3V, 3.7V, 5.0V
- Output current up to 200mA
- Ultra low supply current I_{DD}: 5μA (Typ.)
- Low ripple and low noise
- Low shutdown current: 0.1μA (Typ.)
- Package types: 3-pin SOT89, 3-pin SOT23 and 5-pin SOT23

Applications

- Palmtops/PDAs
- Portable communicators/Smartphones
- Cameras/Camcorders
- Battery-powered equipment

General Description

The HT77xxSA devices are a high efficiency PFM synchronous step-up DC-DC converter series which are designed to operate with both wire wound chip power inductors and also with multi-layered chip power inductors. The device series have the advantages of extremely low start-up voltage as well as high output voltage accuracy. Being manufactured using CMOS technology ensures ultra low supply current. Because of their higher operating frequency, up to 500 kHz, the devices have the benefits of requiring smaller outline type lower value external inductors and capacitors. The higher operating frequency also offers the advantages of much reduced audio frequency noise. The devices require only three external components to provide a fixed output voltage of 2.7V, 3.0V, 3.3V, 3.7V or 5.0V.

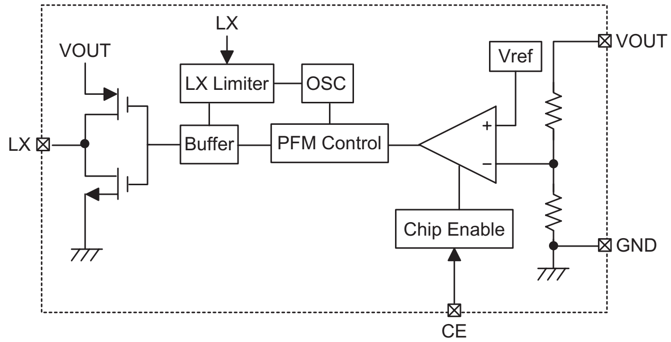
The HT77xxSA devices include an internal oscillator, PFM control circuit, driver transistor, reference voltage unit and a high speed comparator. They employ pulse frequency modulation techniques, to obtain minimum supply current and ripple at light output loading. These devices are available in space saving 3-pin SOT89, 3-pin SOT23 and 5-pin SOT23 packages. For 5-pin SOT23 package types, they also include an internal chip enable function to reduce power consumption when in the shutdown mode.

Selection Table

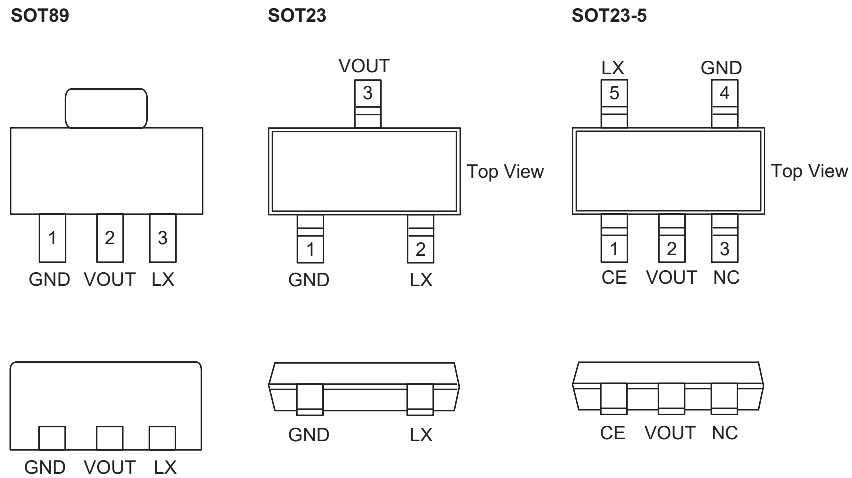
Part No.	Output Voltage	Package	Marking
HT7727SA	2.7V	SOT89 SOT23 SOT23-5	77xxSA (for SOT89) xxSA (for SOT23) xxSA (for SOT23-5)
HT7730SA	3.0V		
HT7733SA	3.3V		
HT7737SA	3.7V		
HT7750SA	5.0V		

Note: ″xx″ stands for output voltages.

Block Diagram



Pin Assignment



Pin Description

Pin No.			Pin Name	Description
SOT89	SOT23	SOT23-5		
—	—	1	CE	Chip enable pin, high active
2	3	2	VOUT	DC/DC converter output monitoring pin
—	—	3	NC	No connection
1	1	4	GND	Ground pin
3	2	5	LX	Switching pin

Absolute Maximum Ratings

Maximum Input Supply Voltage 6.5V

Ambient Temperature Range .... -40°C to 85°C

Storage Temperature .... -50°C to 125°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Thermal Information

Symbol	Parameter	Package	Max.	Unit
θ_{JA}	Thermal Resistance (Junction to Ambient) (Assume no ambient airflow, no heat sink)	SOT89	300	°C/W
		SOT23	330	°C/W
		SOT23-5	320	°C/W
P_D	Power Dissipation	SOT89	0.33	W
		SOT23	0.30	W
		SOT23-5	0.31	W

Note: P_D is measured at Ta=25°C

Electrical Characteristics

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

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage	—	—	—	6.0	V
ΔV_{OUT}	Output Voltage Tolerance		-2.5	—	+2.5	%
V_{START}	Starting Voltage(Fig.1)	V_{IN} : 0 to 2V, I_{OUT}=1mA	—	0.7	0.9	V
V_{HOLD}	Voltage Hold(Fig.1)	V_{IN} : 2 to 0V, I_{OUT}=1mA	—	—	0.7	V
I_{DD1}	Supply Current (Fig.2)	Measured at VOUT pin when V_{OUT}+0.5V	—	5.0	—	μA
I_{DD2}	Un-load Supply Current (Fig.1)	V_{IN}=V_{OUT}×0.6, I_{OUT}=0mA Measurement at V_{IN}	—	13	26	μA
I_{SHDN}	Shutdown Current	CE=GND	—	0.1	—	μA
I_{Limit}	Current Limit (Fig.1)	V_{OUT} ≤ 5.0V	650	800	—	mA
		2.7V ≤ V_{OUT} ≤ 3.3V	500	650	—	mA
V_{IH}	CE High Threshold	—	2.0	—	—	V
V_{IL}	CE Low Threshold		—	—	0.4	V
I_{LEAK}	LX Leakage Current (Fig.3)	Add 5.5V at VOUT pin, 4V at LX pin. Measured at LX pin.	—	0.05	—	μA
f_{OSC}	Oscillator Frequency (Fig.3)	Measured at LX pin when V_{OUT}×0.95	—	500	—	kHz
D_{OSC}	Oscillator Duty Cycle (Fig.3)		—	80	—	%
η	Efficiency	2.7V ≤ V_{OUT} ≤ 5.0V, I_{OUT}=10mA	—	90	—	%

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

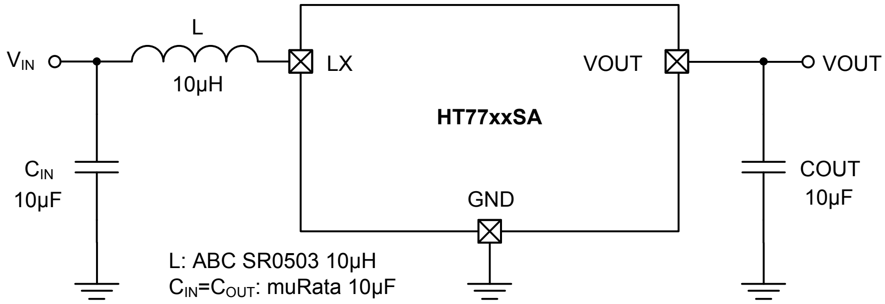


Fig.1

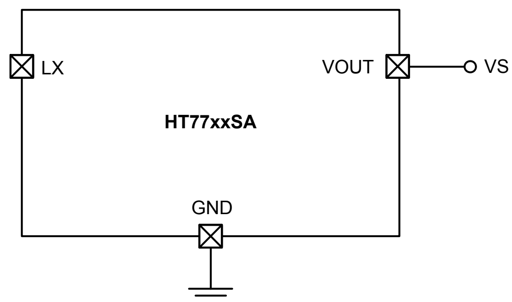


Fig.2

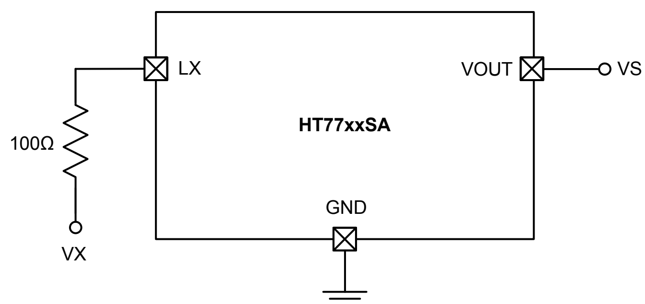
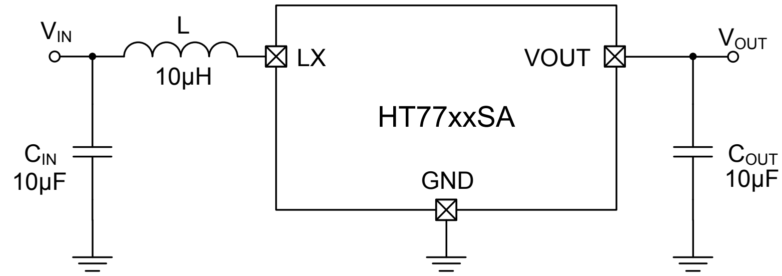


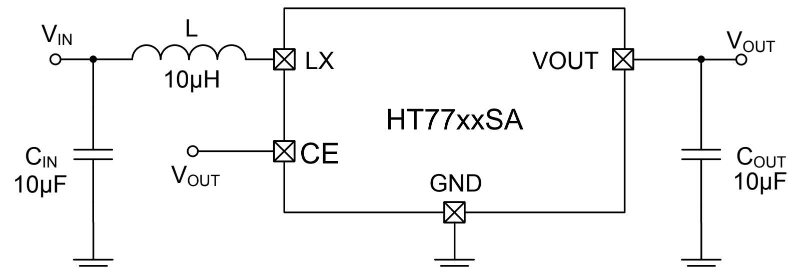
Fig.3

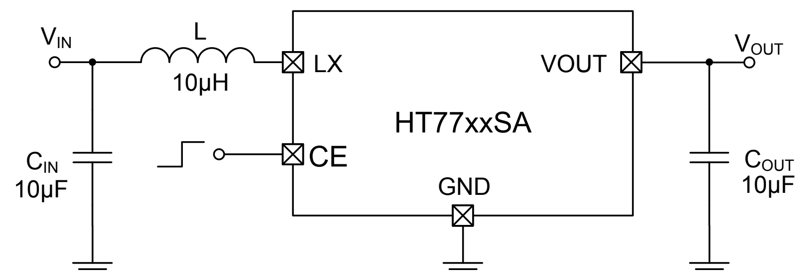
Application Circuits

Without CE Pin



With CE Pin





Functional Description

The HT77xxSA is a constant on time synchronous step-up converter, which uses a pulse frequency modulation (PFM) controller scheme. The PFM control scheme is inherently stable. The required input/output capacitor and inductor selections will not create situations of instability.

The device includes a fully integrated synchronous rectifier which reduces costs (includes reduce L and C sizes, eliminates Schottky diode cost etc.) and board area.

Low Voltage Start-up

The devices have a very low start up voltage down to 0.7V. When power is first applied, the synchronous switch will be initially off but energy will be transferred to the load through its intrinsic body diode.

Shutdown

During normal device operation, the CE pin should be either high or connected to the VOUT pin or the VIN power source. When the device is in the shutdown mode, that is when the CE pin is pulled low, the internal circuitry will be switched off. During shutdown, the PMOS power transistor will be switched off.

Synchronous Rectification

A dead time exists between the N channel and P channel MOSFET switching operations. In synchronous rectification, the P channel is replaced by a Schottky diode. Here the P channel switch must be completely off before the N channel switch is switched on. After each cycle, a 30ns delay time is inserted to ensure the N channel switch is completely off before the P channel switch is switched on to maintain a high efficiency over a wide input voltage and output power range.

Application Information

Inductor Selection

Selecting a suitable inductor is an important consideration as it is usually a compromise situation between the output current requirements, the inductor saturation limit and the acceptable output voltage ripple. Lower values of inductor values can provide higher output currents but will suffer from higher ripple voltages and reduced efficiencies. Higher inductor values can provide reduced output ripple voltages and better efficiencies, but will be limited in their output current capabilities. For all inductors it must be noted however that lower core losses and lower DC resistance values will always provide higher efficiencies.

The peak inductor current can be calculated using the following equation:

$$I_{L(PEAK)} = \frac{V_{OUT} \times I_O}{V_{IN} \times \eta} + \frac{V_{IN} \times (V_{OUT} - V_{IN})}{2 \times V_{OUT} \times L \times f_{OSC}}$$

Where

V_{IN} = Input Voltage
V_{OUT} = Output Voltage
I_O = Output Current
η = Efficiency
L = Inductor

Capacitor Selection

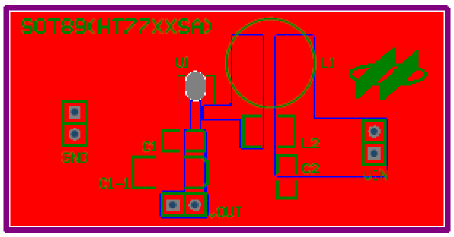
As the output capacitor selected affects both efficiency and output ripple voltage, it must be chosen with care to achieve best results from the converter. Output voltage ripple is the product of the peak inductor current and the output capacitor equivalent series resistance or ESR for short. It is important that low ESR value capacitors are used to achieve optimum performance. One method to achieve low ESR values is to connect two or more filter capacitors in parallel. The capacitors values and rated voltages are only suggested values.

Layout Considerations

Circuit board layout is a very important consideration for switching regulators if they are to function properly.

Poor circuit layout may result in related noise problems. In order to minimise EMI and switching noise, note the following guidelines:

- All tracks should be as wide as possible.
- The input and output capacitors should be placed as close as possible to the VIN, VOUT and GND pins.
- A full ground plane is always helpful for better EMI performance.



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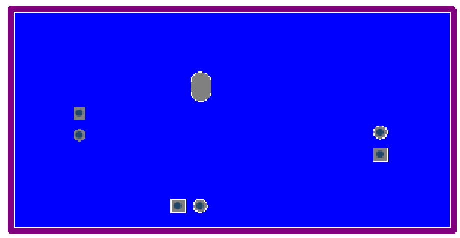

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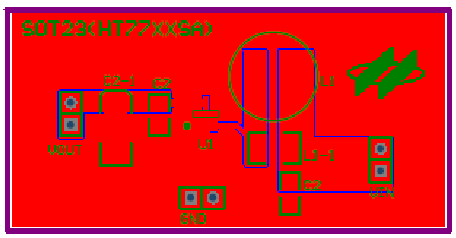

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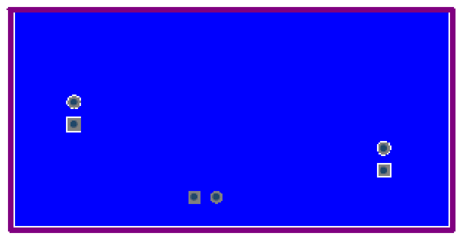

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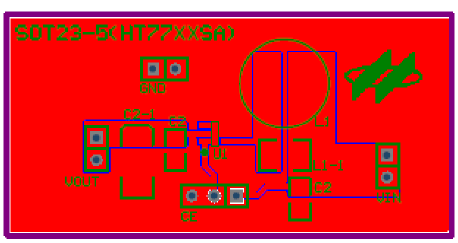

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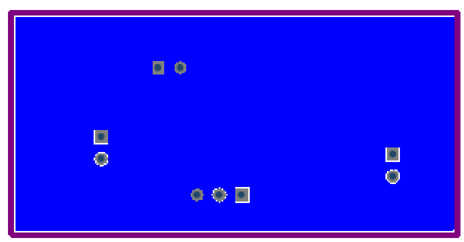

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Typical Performance Characteristics

HT7750SA

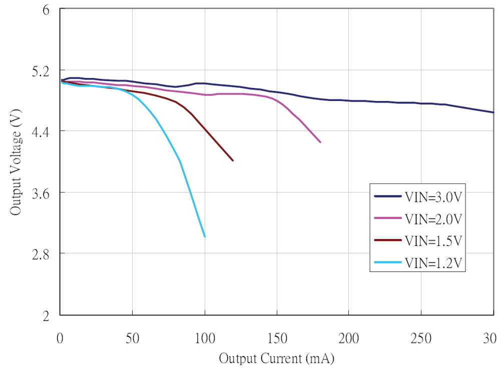


Fig 1. Output Voltage vs. Output Current

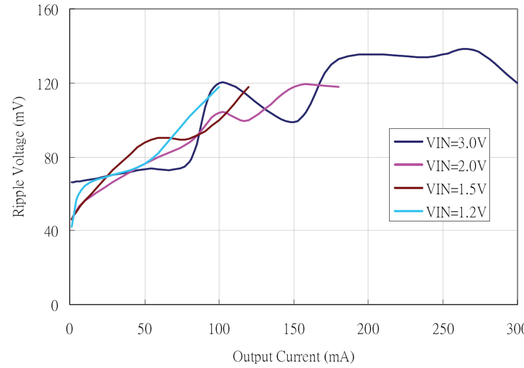


Fig 4. Ripple Voltage vs. Output Current

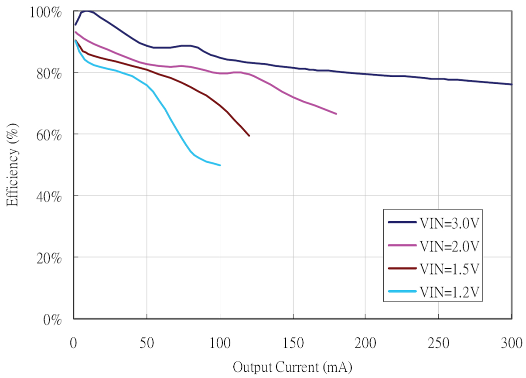


Fig 2. Efficiency vs. Output Current

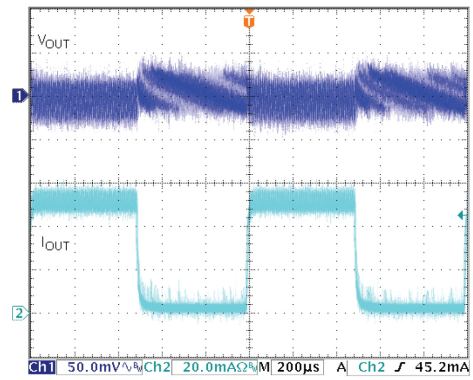


Fig 5. Load Transient Response
(L=10µH, C_{IN}=C_{OUT}=10µF, V_{IN}=3.0V)

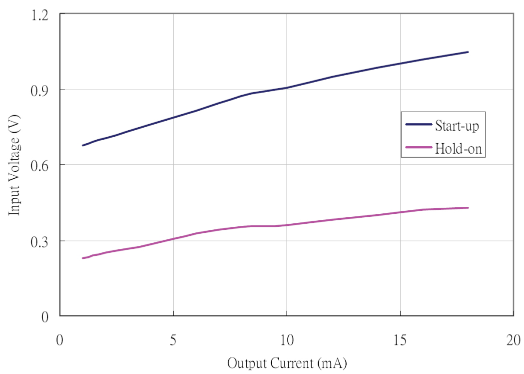


Fig 3. Start-up & Hold-on Voltage

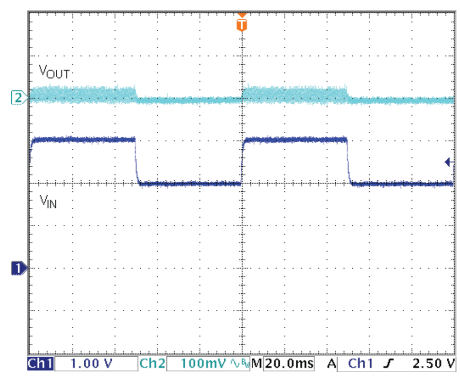


Fig 6. Line Transient Response
(L=10µH, C_{IN}=C_{OUT}=10µF, V_{IN}=3.0V)

HT7750SA

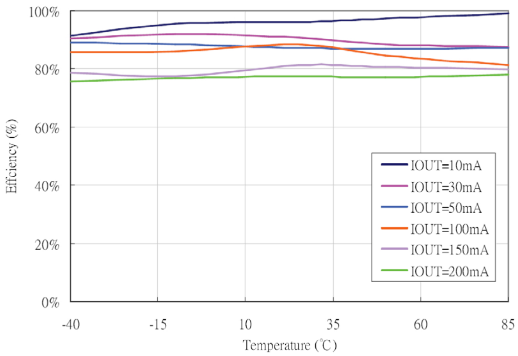


Fig 7. Efficiency & Temperature

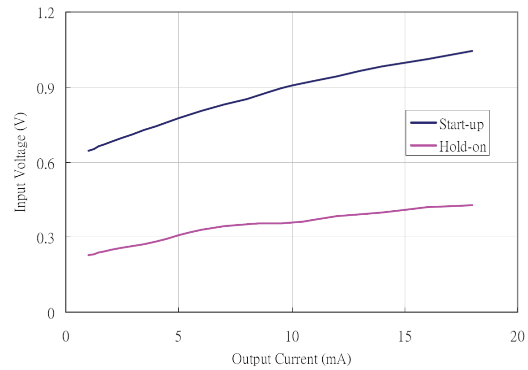


Fig 10. Start-up & Hold-on Voltage

HT7733SA

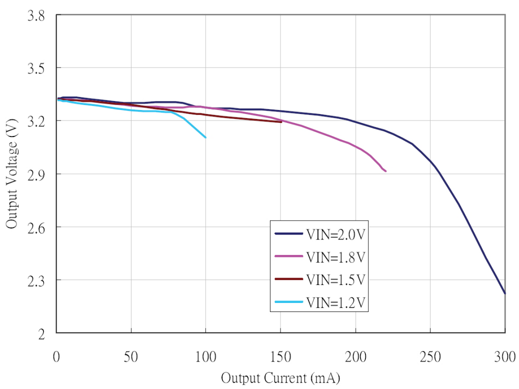


Fig 8. Output Voltage vs. Output Current

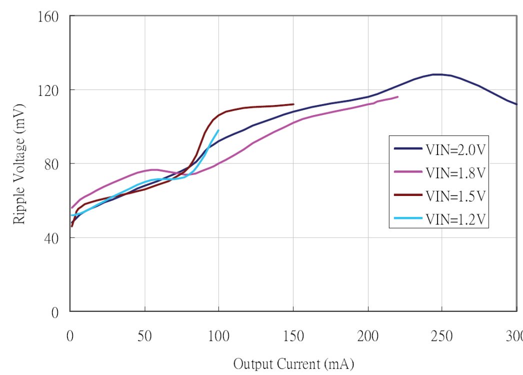


Fig 11. Ripple Voltage vs. Output Current

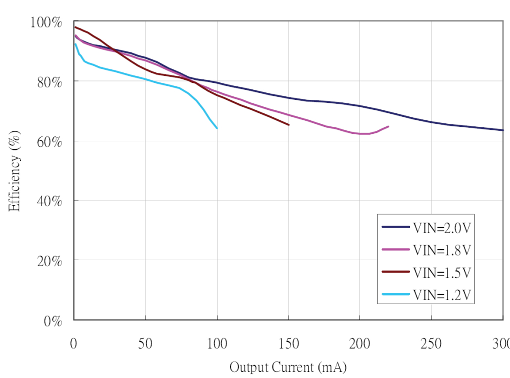


Fig 9. Efficiency vs. Output Current

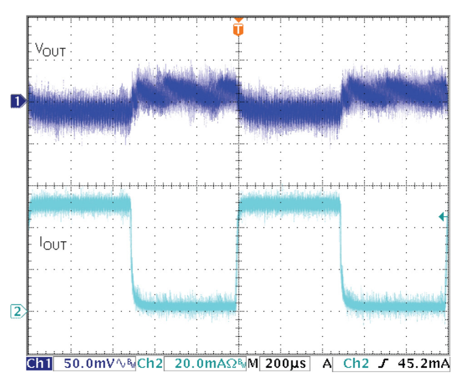


Fig 12. Load Transient Response
(L=10μH, C_{IN}=C_{OUT}=10μF, V_{IN}=1.98V)

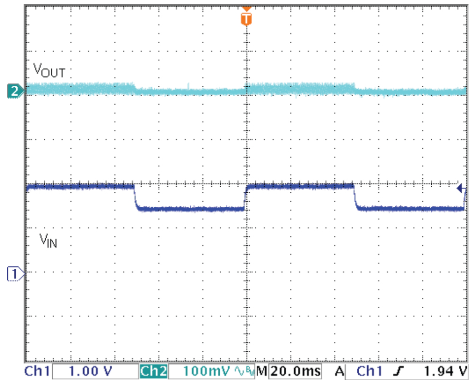


Fig 13. Line Transient Response
(L=10μH, C_{IN}=C_{OUT}=10μF, V_{IN}=1.98V)

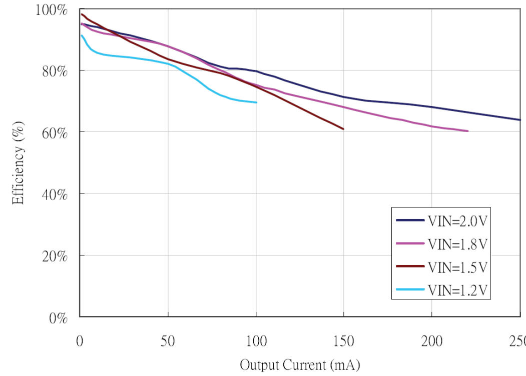


Fig 16. Efficiency vs. Output Current

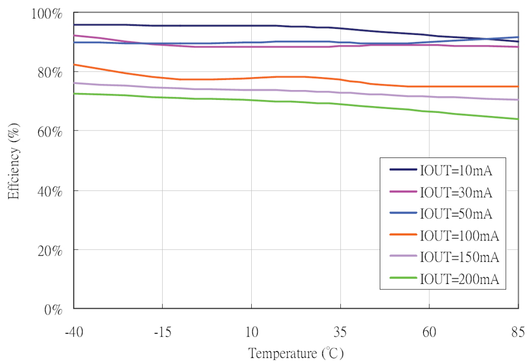


Fig 14. Efficiency & Temperature

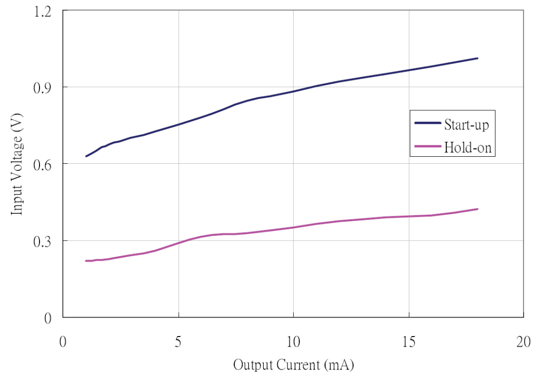


Fig 17. Start-up & Hold-on Voltage

HT7730SA

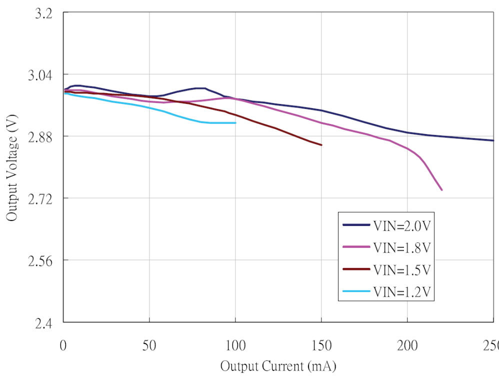


Fig 15. Output Voltage vs. Output Current

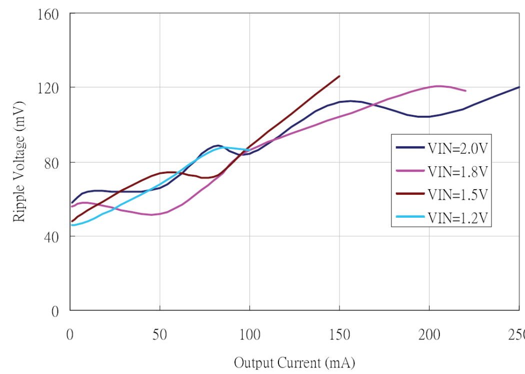


Fig 18. Ripple Voltage vs. Output Current

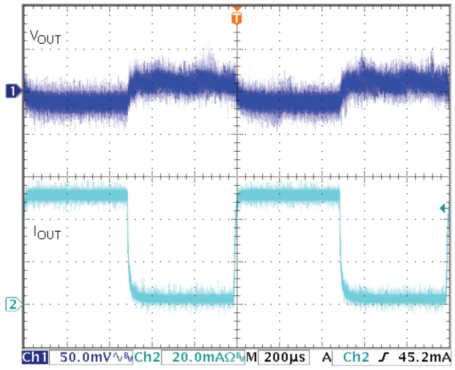


Fig 19. Load Transient Response
(L=10µH, C_{IN}=C_{OUT}=10µF, V_{IN}=1.8V)

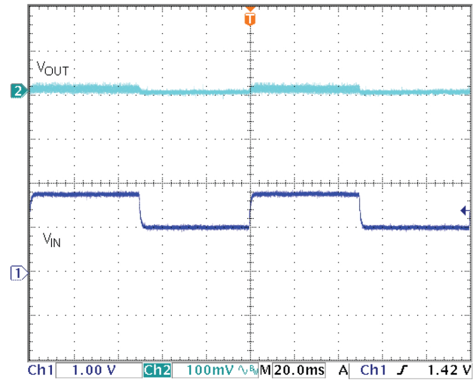


Fig 20. Line Transient Response
(L=10µH, C_{IN}=C_{OUT}=10µF, V_{IN}=1.8V)

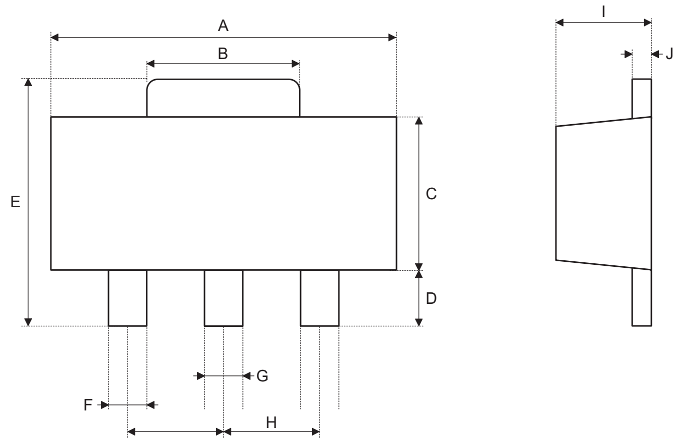
Package Information

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.

- Package Information (include Outline Dimensions, Product Tape and Reel Specifications)
- The Operation Instruction of Packing Materials
- Carton information

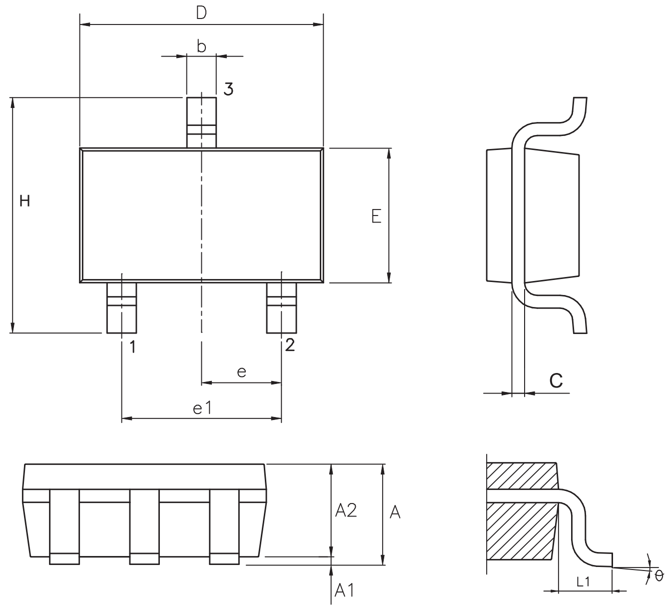
3-pin SOT89 Outline Dimensions



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

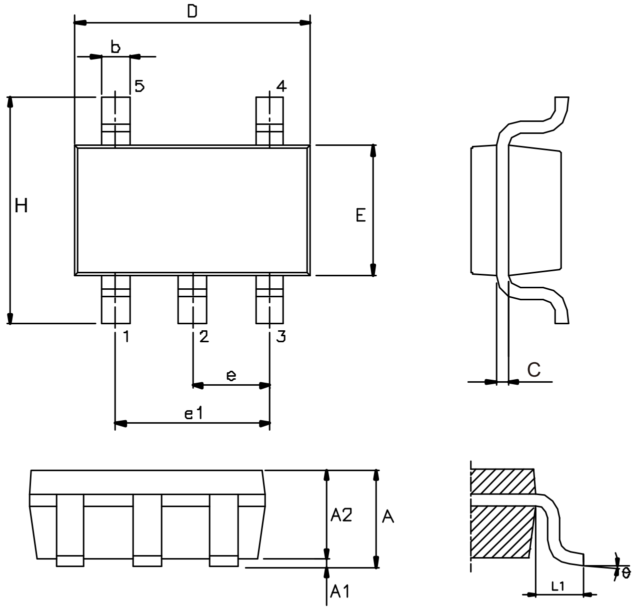
3-pin SOT23 Outline Dimensions



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°