HOLTEK

HT7991

2.5A Peak Current, 1MHz Asynchronous Step-up PWM Converter

Features

- InputVoltagefrom2.6Vto5.5V
- AdjustableOutputVoltageUpto12V
- Internal0.2ΩLowPowerSwitch
- FixedPWMSwitchingFrequency:1MHz
- PrecisionFeedbackReferenceVoltage:0.6V(±2%)
- UltraLowShutdownCurrent:0.1μA
- EmbeddedLoopFrequencyCompensation
- ProgrammableOCPThresholdviaExternal Resistor,ROC
- CompleteProtections:SoftStart,UVLO,OCP, OTPandOVP
- PackageType:SOT23-6

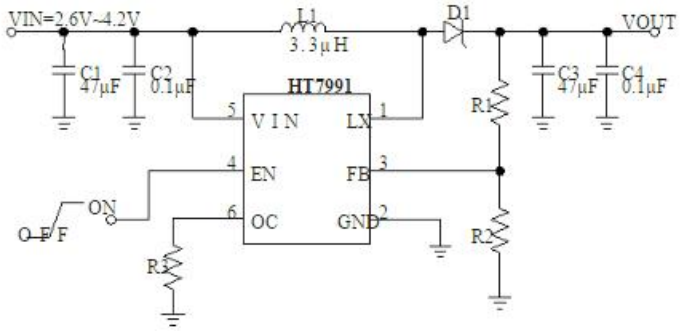
Applications

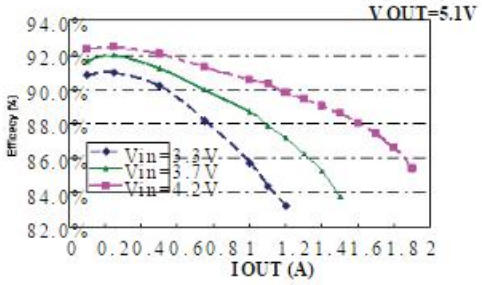
- AllSingleCellLiorDualCellBatteryApplication
- PortableEquipment/HandheldDevices

General Description

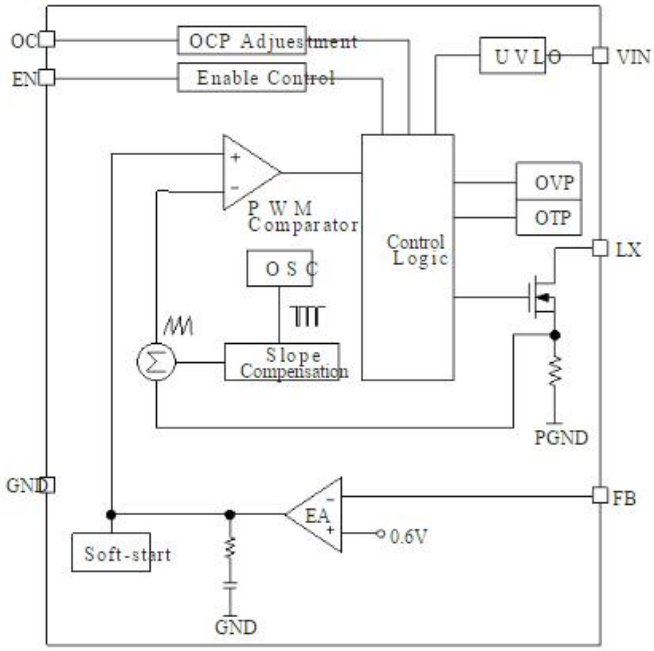
TheHT7991isacurrentmodeasynchronousstep-upDC-DCconverter.Thefullyintegratedpower MOSFET transistor, with its 0.2Ω drain source resistance,ensuresahighlevelofdevicepower efficiency.Afixed1MHzswitchingfrequencyhas beenchosentopermitsmallerinductorstobeused intheapplicationcircuit.Theerroramplifiernon-invertinginputamplifierisconnectedtoaninternal precision 0.6V/±2% reference voltage while an integratedsoft-startfunctionreducesthe inrush currentduringtheconverterstartupperiod.The deviceisavailableinaSOT23-6packagetype.

Application Circuit

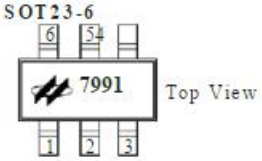




Block Diagram



Pin Assignment



Pin Description

Pin Order	Name	Type	Pin Description
1	LX	O	Power switch output
2	GND	G	Ground terminal
3	FB	I	Error amplifier inverting input
4	EN	I	Enable control - High active
5	VIN	P	Power supply input
6	OC	I	Adjustment current limit via an external resistor to ground

Absolute Maximum Ratings

Parameter		Value	Unit
VIN		-0.3 to +6	V
LX		-0.3 to +17	V
Other Pins		+6	V
Power Dissipation		455	mW
Maximum Junction Temperature		+150	°C
Storage Temperature Range		-65 to +150	°C
Lead Temperature (Soldering 10sec)		+260	°C
ESD Susceptibility	Human Body Model	2000	V
	Machine Model	200	V
Junction-to-Ambient Thermal Resistance, θJA		220	°C/W

Recommended Operating Range

Parameter	Value	Unit
VIN	2.6 to 5.5	V
Operating Temperature Range	-40 to +85	°C

NotethatAbsoluteMaximumRatingsindicatelimitationsbeyondwhichdamagetothedevicemayoccur.
RecommendedOperatingRatingsindicateconditionsforwhichthedeviceisintendedtobefunctional,butdonot guaranteespecifiedperformancelimits.

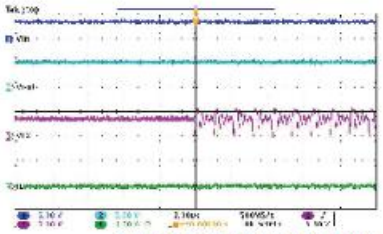
Electrical Characteristics

(VIN=3.3V and TA=+25°C, unless otherwise specified)

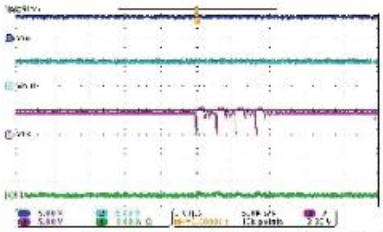
Symbol	Parameter	Test Condition	Min	Typ	Max	Unit
Supply Voltage						
VIN	Input Voltage Range	—	2.6	—	5.5	V
IQ	Quiescent Current – Non-switching	VFB=0.66V	—	210	—	μA
IIN	Supply Current – Switching	VFB=0.55V	—	1.5	—	mA
ISHDN	Shutdown Current	VIN=2.4V, VEN=0V	—	0.1	1	μA
Boost Converter						
VOUT	Output Voltage Range	—	3	—	12	V
fSW	Switching Frequency	VFB=0.5V	0.8	1.0	1.2	MHz
	Switching Frequency Variation	VIN=2.6V to 5.5V	—	5	—	%
DMAX	Maximum Duty Cycle	—	—	90	—	%
RDS	Internal Power MOSFET Drain Source Resistance – RDS(ON)	ILX=1A	—	0.2	—	Ω
ISWL	Driver Leakage Current	VEN=0V, VLX=12V	—	0.1	1	μA
VFB	Feedback Voltage	—	0.588	0.6	0.612	V
	Output Voltage Line Regulation	VIN=2.6V to 5.5V	—	0.2	—	%/V
VEN	EN High Voltage Threshold	—	1.2	—	—	V
VEN	EN Low Voltage Threshold	—	—	—	0.4	V
Protections						
VUVLO	Input Supply Turn On Voltage Level	UVLO+	—	2.2	—	V
	UVLO Hysteresis	—	—	100	—	mV
IOCP	Over Current Protection Threshold	OC is floating (default)	—	2.5	—	A
VOVP	Output Over Voltage Threshold	OVP	—	—	17	V
tOTP	Thermal Shutdown Threshold	OTP	—	150	—	°C
tR	Thermal Recovery Temperature	—	—	125	—	°C

Typical Performance Characteristics

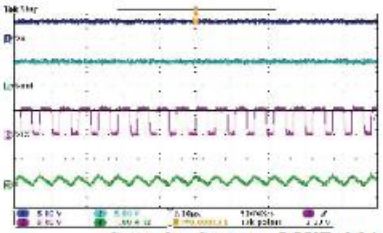
VIN=3.3V,VOUT=5V,CIN=22μF+22μF,COUT=22μF+22μF,L=3.3μH,TA=25°C,unlessotherwisenoted



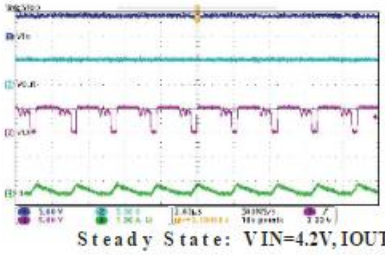
Steady State: IOUT=0A



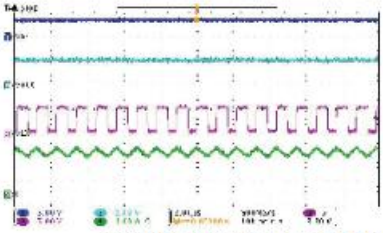
Steady State: VIN=4.2V, IOUT=0A



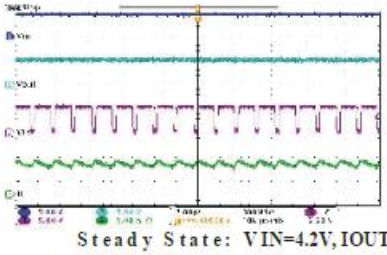
Steady State: IOUT=0.1A



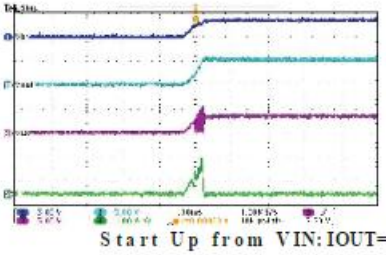
Steady State: VIN=4.2V, IOUT=0.1A



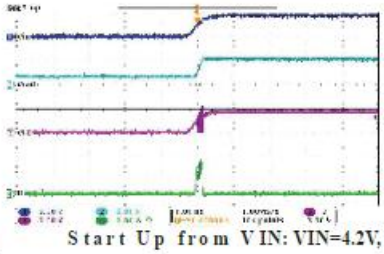
Steady State: IOUT=1.0A)



Steady State: VIN=4.2V, IOUT=1.0A

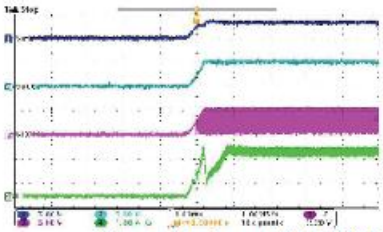


Start Up from VIN: IOUT=0A

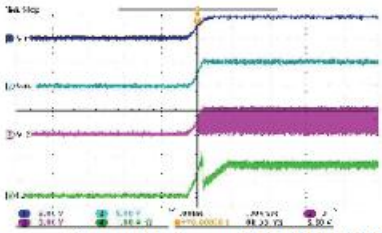


Start Up from VIN: VIN=4.2V, IOUT=0A

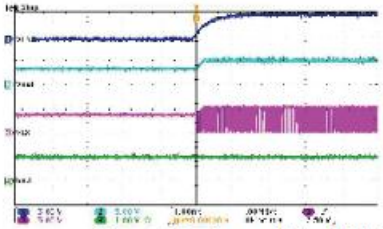
VIN=3.3V,VOUT=5V,CIN=22μF+22μF,COUT=22μF+22μF,L=3.3μH,TA=25°C,unlessotherwisenoted



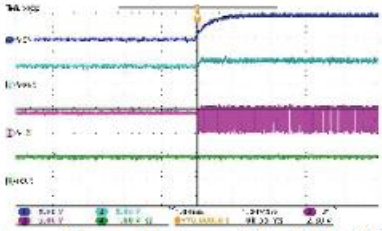
Start Up from VIN: IOUT=1A



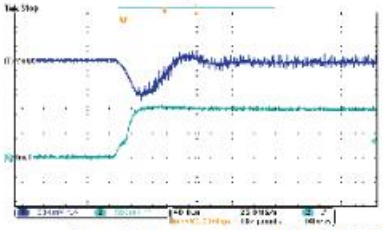
Start Up from VIN: VIN=4.2V, IOUT=1A



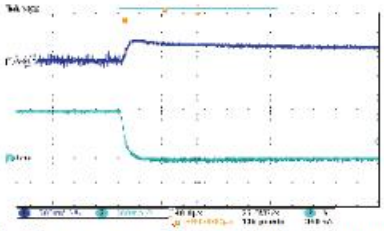
Start Up from EN: IOUT=1A



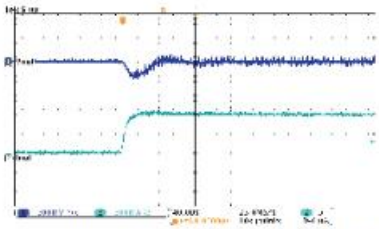
Start Up from EN: VIN=4.2V, IOUT=1A



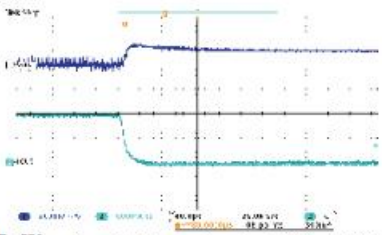
Load Transient: VIN=3.3V, VOUT=5V



Load Transient: VIN=3.3V, VOUT=5V

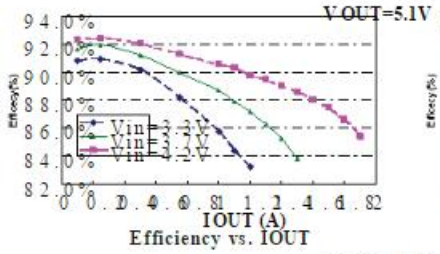


Load Transient: VIN=4.2V, VOUT=5V

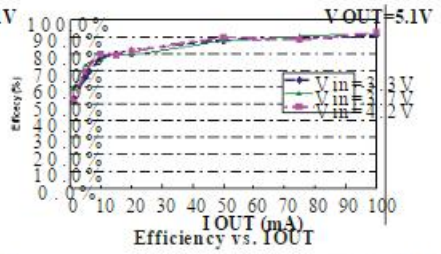


Load Transient: VIN=4.2V, VOUT=5V

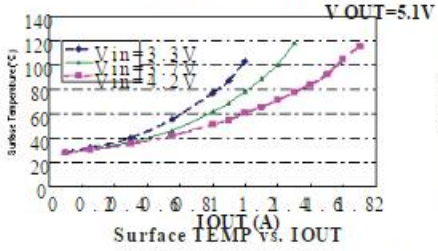
VIN=3.3V,VOUT=5V,CIN=22μF+22μF,COUT=22μF+22μF,L=3.3μH,TA=25°C,unlessotherwisenoted



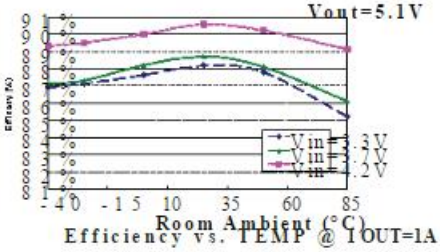
Efficiency vs. IOUT



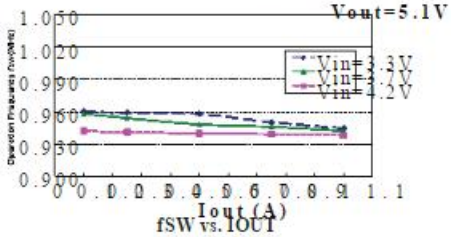
Efficiency vs. IOUT



Surface TEMP vs. IOUT



Efficiency vs. TEMP @ IOUT=1A



fSW vs. IOUT

Functional Description

Operation

The HT7991 is an asynchronous step-up dc/dc converter. With a wide input range from 2.6V to 5.5V, the HT7991 is suitable for portable Li-battery based applications such as power banks. Thanks for the high operation switching frequency, 1MHz, the HT7991 allows the use of small external components while still being able to have low output voltage ripple. The embedded loop frequency compensation circuitry simplifies the system design and reduces the external components.

Setting Output Voltage

The external resistor divider sets the output voltage (see Typical Application Circuit). The feedback resistor, R1, also sets the feedback loop bandwidth with the internal compensation capacitor. R1 and R2 are calculated in equation:

R1=R2/((VOUT/0.6V)–1)(Ω)

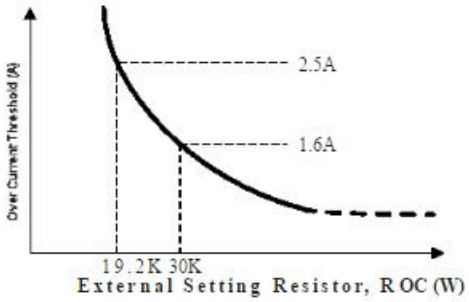
Protections

The HT7991 has dedicated protection circuitry running during normal operation to protect the IC. The Soft Start function (SS) is set around 1ms internally to prevent the inrush current during power-on period. The Over Current Protection (OCP) is illustrated in detail below. The Over Temperature Protection (OTP) turns off the power device when the die temperature reaches excessive levels. The Under Voltage Lock-Out comparator (UVLO) protects the power device during supply power startup and shutdown to prevent operation at voltages less than the minimum input voltage. HT7991 restricts 17V maximum output voltage (OVP) to avoid the burn-out of the internal components and the output devices.

Setting Over Current Threshold Via External Resistor

In default, HT7991 sets the maximum peak current passing through the internal power MOSFET restricted to 2.5A when OCP in keeps floating via a resistor. The ROC resistor value is normally set between 19.2kΩ and 30kΩ. The current limit will be set from 1.6A to 2.5A. Do not put the capacitor at this pin. The approximate OCP trippoint could be calculated according the equation:

IOCP=48000/ROC(A)



Component Selection Guide

Inductor

The selected inductor should have a saturation current that meets the maximum peak current of the converter. Another important inductor parameter is the dc resistance. The lower the dc resistance gains the higher the efficiency of the converter. For most applications, the inductor value can be calculated from the following equation:

$$L=(\frac{Vin}{Vout})\times\frac{2(Vout-Vin)}{Iripple\times fsw}$$

The higher value of ripple current reduces inductance but the conductance loss, core loss, and current stress of the inductor and switching devices increase. It's suggested that choosing the inductor ripple current to be 30% of the maximum load current.

Diode

The breakdown voltage rating of the diode is preferred to be higher than the maximum input voltage. The current rating for the diode should be equal to the maximum output current for best reliability in most applications. In this case, it is possible to use a diode with a lower average current. However the peak current should be higher than the maximum load current.

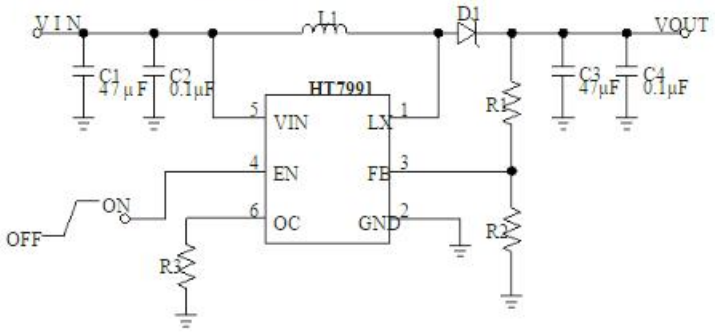
Input Capacitor

A low ESR ceramic capacitor is needed between the VIN pin and GND pin. Use ceramic capacitors with X5R or X7R dielectrics for its low ESR and small temperature coefficients. For most applications, the capacitance in the range of 2.2μF to 10μF capacitor is sufficient.

Output Capacitor

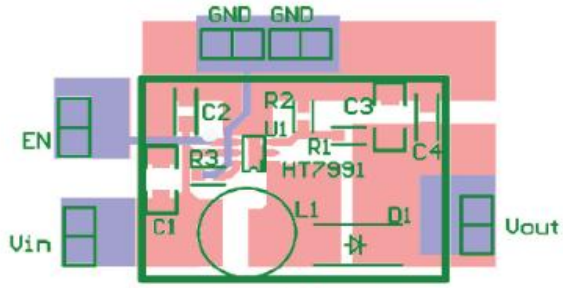
The selection of output capacitor is driven by the maximum allowable output voltage ripple. Using ceramic capacitors with X5R or X7R dielectrics for its low ESR characteristic is suggested. The capacitance in the range of 10μF to 100μF is sufficient.

Recommended Component Values



V OUT (V)	R1 (kΩ)	R2 (kΩ)	C3 (μF)	C4 (μF)	L1 (μH)
5.1	75 (1%)	10 (1%)	47	0.1	3.3
12.0	190 (1%)	10 (1%)	47	0.1	6.8

Layout Consideration Guide



Suggested Layout

To reduce problems with conducted noise, PCB layout is very important to stability. The layout recommendations are listed below:

(1) The input bypass capacitor must be placed close to the VIN pin.

(2) The inductor, schottky diode, and output capacitor traces should be as short as possible to reduce conducted and radiated noise and increase overall efficiency.

(3) Keep the power ground and supply paths as short and wide as possible.

Thermal Considerations

For continuous operation, do not exceed the absolute maximum junction temperature. The maximum power dissipation depends on the thermal resistance of the IC package, PCB layout, rate of surrounding airflow, and the allowed difference between the junction and ambient temperatures. The maximum power dissipation can be calculated by the following formula:

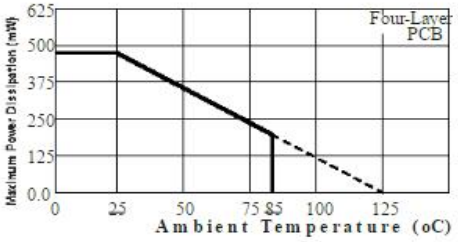
$$PD(MAX)=(TJ(MAX)-TA)/\theta JA(W)$$

Where TJ(MAX) is the maximum junction temperature, TA is the ambient temperature, and θJA is the junction to ambient thermal resistance.

The recommended operating conditions specify the maximum junction temperature is 125°C. The junction to ambient thermal resistance, θJA, is layout dependent. On a standard JEDEC 51-7 four-layer thermal test board, the thermal resistance, θJA, of the QFN-10 package is 50°C/W. The maximum power dissipation at TA=25°C can be calculated by the following formula.

$$PD(MAX)=(125oC-25oC)/(220oC/W)=455mW$$

For a fixed TJ(MAX) of 125oC, the maximum power dissipation depends on the operating ambient temperature and the package's thermal resistance, θJA. The de-rating curve below shows the effect of rising ambient temperature on the maximum recommended power dissipation.



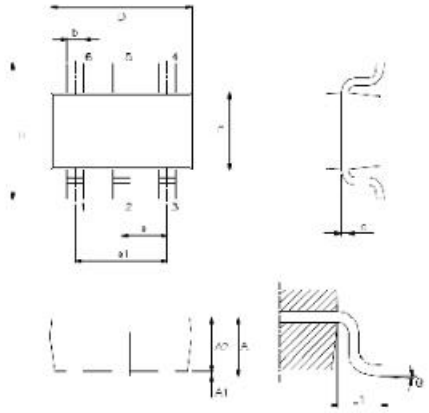
Package Information

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

6-pin SOT23-6 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	—
L	0.012	0.018	0.024
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	—
L	0.30	0.45	0.60
θ	0°	—	8°