3.5A, 65V, Asynchronous Step-Down Converter

FEATURES

- 4.5V to 65V operating input range 3.5A output current
- 0.8V±1% internal voltage(HCR3432)
- 0.75V±1% internal voltage(HCR3432S/P)
- Adjustable switching frequency
- Power Good Indicator (HCR3432/P)
- External Soft-start (HCR3432/S)
- Adjustable UVLO and hysteresis
- Current run-away protection
- Short circuit protection
- Thermal protection
- Available in DFN4x4-10 package(HCR3432)
- Available in SOP-8(EP) package (HCR3432S/P)

DESCRIPTION

The HCR3432 series are current mode monolithic buck switching regulators. Operating with an input range of 4.5V~65V, the HCR3432 series delivers 3.5A of continuous output current with an integrated high side N-Channel MOSFET. At light loads, the regulator operates in low frequency to maintain high efficiency. Current mode control provides tight load transient response and cycle-by-cycle current limit.

The HCR3432 series guarantees robustness with short-circuit protection, thermal protection, current run-away protection and input under voltage lockout.

The HCR3432 series is available in DFN4x4-10 package, the HCR3432S and HCR3432P are available in SOP-8(EP) package, which provides a compact solution with minimal external components.

APPLICATIONS

- Industrial Automation and Motor Control
- Vehicle Accessories: GPS Entertainment
- USB Dedicated Charging Ports and Battery Chargers
- 12-V, 24-V and 48-V Industrial, Automotive and Communications Power Systems

DFN-4X4-10 SOP-8(EP)

Figure 1. Package Type of HCR3432/S/P

PIN CONFIGURATION

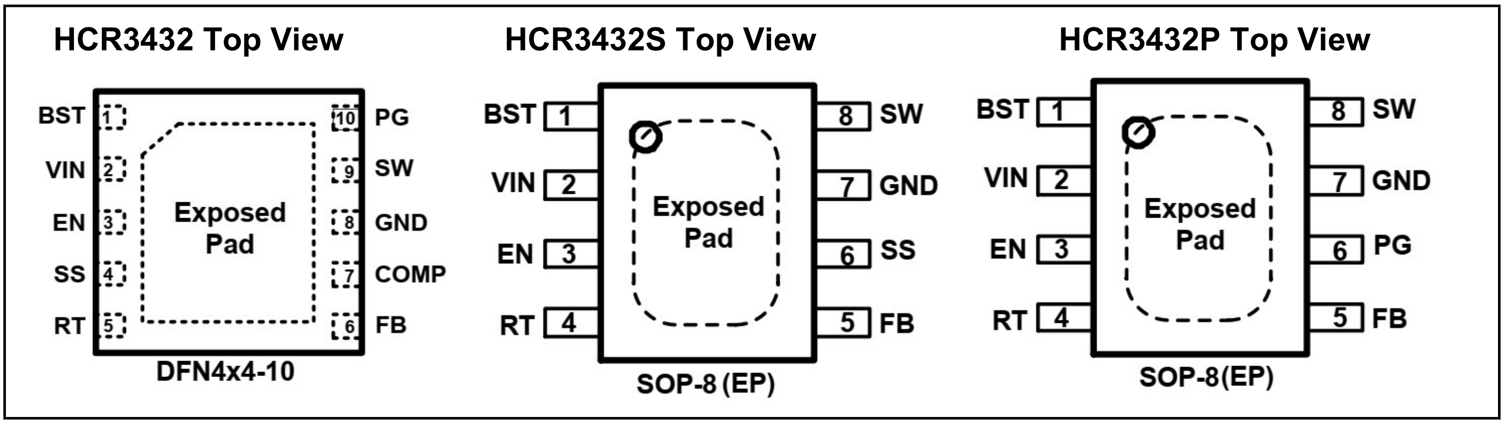

Figure 2. Pin Configuration of HCR3432/S/P (Top View)

PIN FUNCTION TABLE

HCR 3432	HCR 3432S	HCR 3432P	Pin Name	Function Description
1	1	1	BST	Bootstrap pin for top switch.
2	2	2	VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.5V to 65V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC
3	3	3	EN	Drive EN pin high or floating to turn on the regulator and low to turn off the regulator.
4	6		SS	Soft-start control pin. Leave floating for internal soft-start slew rate. Connect to a capacitor to extend soft start time.
5	4	4	RT	Switching frequency program. Connect an external resistor from RT pin to ground to set the switching frequency
6	5	5	FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to Vref. Connect a resistive divider at FB.
7			COMP	Error amplifier output and input to the output switch current(PWM) comparator. Connect frequency compensation components to this pin.
8	7	7	GND	Ground
9	8	8	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
10		6	PG	Open drain output for power-good flag. Use a 10kΩ to 100kΩ pull-up resistor to logic rail or other DC voltage no higher than 5V.
			Exposed Pad	GND pin must be electrically connected to the exposed pad on the printed circuit board for proper operation.

3.5A, 65V, Asynchronous Step-Down Converter

ORDER INFORMATION

HCR3432 □ / □ □ □

- Circuit Type: HCR3432
- Type: S, P
- ADJ : Adjustable Output Volts
- Package: DN10 : DFN4X4-10; M8E: SOP-8(EP)
- TR : Tape and Reel

ORDERING CODE

Part Number	Marking ID [a]	Package	Quantity per Reel
HCR3432S/ADJM8ETR	HCR3432S XXXX	SOP-8(EP)	4000pcs/TR
HCR3432P/ADJM8ETR	HCR3432P XXXX	SOP-8(EP)	4000pcs/TR
HCR3432/ADJDN10TR	HCR3432 XXXX	DFN4X4-10	3000pcs/TR

Note a. the HCR3432S&HCR3432P&HCR3432 is product model and the "XXXX" is Manufacturing Code.

Absolute Maximum Ratings [Note 1]

Parameter	Symbol	Value		Unit
		SOP-8(EP)	DFN4X4-10	
Input Supply Voltage Range	V_{IN}	-0.3 to +69		V
SW Voltage Range	V_{SW}	-0.6 to +69		V
EN Voltage Range	V_{EN}	-0.3 to +8.4		V
BST Voltage Range	V_{BST}	SW-0.3 to SW+6.0		V
COMP Voltage Range	V_{COMP}	-0.3 to +3		V
SS Voltage Range	V_{SS}	-0.3 to +4		V
All Other Pin Voltage Range	-	-0.3 to +6.0		V
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	42.5	35.1	'C/W
Thermal Resistance Junction to Case	$R_{\theta JC}$	3.8	2.2	'C/W
Junction Temperature	T_J	+150		'C
Storage Temperature Range	T_{STG}	-65 to 150		'C
Lead Temperature	T_{LEAD}	260		'C
Human Body Model for all pins	V_{ESD_HBM}	±2K		V
Charge Device Model for all pins	V_{ESD_CDM}	500		V

Recommended Operating Conditions [note2]

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Input Voltage Range	V_{IN}		4.5	-	65	V
Output Voltage Range	V_{OUT}		0.8	-	$D_{max}XV_{IN}$	V
Operating Junction Temperature Range	T_J		-40	-	+125	'C

Note 1: Stresses beyond those listed under"Absolute maximum Ratings" may damage the device.

2: The device is not guaranteed to function outside the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

(VIN=12V, TA=-40~+125'C, unless otherwise noted.)

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
VIN Under-voltage Lockout Threshold	VIN_MIN	VIN rising	4.1	4.25	4.48	V
VIN Under-voltage Lockout Hysteresis	VIN_MIN_HYST	VIN falling	-	310	-	mV
Shutdown Supply Current	ISHDN	VEN=0V or EN=GND	-	4	9	uA
Quiescent Current	IQ	VEN=5V, VFB=1V	-	179	228	uA
Regulated Feedback Voltage	VFB	4.5V<=VIN<=65V, HCR3432	792	800	808	mV
		4.5V<=VIN<=65V, HCR3432S/HCR3432P	742	750	758	mV
Power Switch Resistance	RDS(ON)	-	-	97	180	mΩ
Power Switch Leakage Current	ILEAK	VIN=65V, VEN=0V, VSW=0V@25'C	-	-	6	uA
Current Limit Threshold	ILIM	-	5	5.6	6.5	A
Error Amplifier Transconductance	gM	HCR3432	-	335	-	uA/V
Error Amplifier DC Gain	Gain	HCR3432	-	1000	-	V/V
Error Amplifier Source/Sink	IEA	HCR3432	-	±37	-	uA
Switch Frequency	FSW	RRT=200KΩ, HCR3432	370	414	456	KHz
		RRT=124KΩ, HCR3432S/HCR3432P	194	240	276	
Switch Frequency Range	-		100	-	2000	KHz
Minimum On-Time	TON_MIN		-	100	130	ns
Minimum Off-Time	TOFF_MIN	VFB=0.4V	-	165	-	ns
Soft Start Charge Current	ISS	HCR3432	-	1.7	-	uA
		HCR3432S	-	2.7	-	uA
Soft Start Time	TSS	HCR3432P; 10% to 90% VREF	-	0.95	-	ms
Power Good Lower Threshold	PGDLTH	FB rising HCR3432S/HCR3432P	-	93%	-	VREF
		FB falling HCR3432S/HCR3432P	-	90%	-	VREF
Power Good Upper Threshold	PGDUTH	FB rising HCR3432/HCR3432P	-	108%	-	VREF
		FB falling HCR3432/HCR3432P	-	106%	-	VREF
Power Good Sink Current	IPG	VPG=0.4V@25'C, HCR3432/HCR3432P	0.8	-	-	mA
EN shutdown threshold voltage	VEN-TH		1.1	1.22	1.34	V
EN shutdown hysteresis	VEN-HYST		-	150	-	mV
Thermal Shutdown [3]	TTSD		-	170	-	'C
Thermal Shutdown Hysteresis[3]	TTSD_HYST		-	20	-	'C

Note: 3) Guaranteed by design.

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BLOCK DIAGRAM

The block diagram of HCR3432

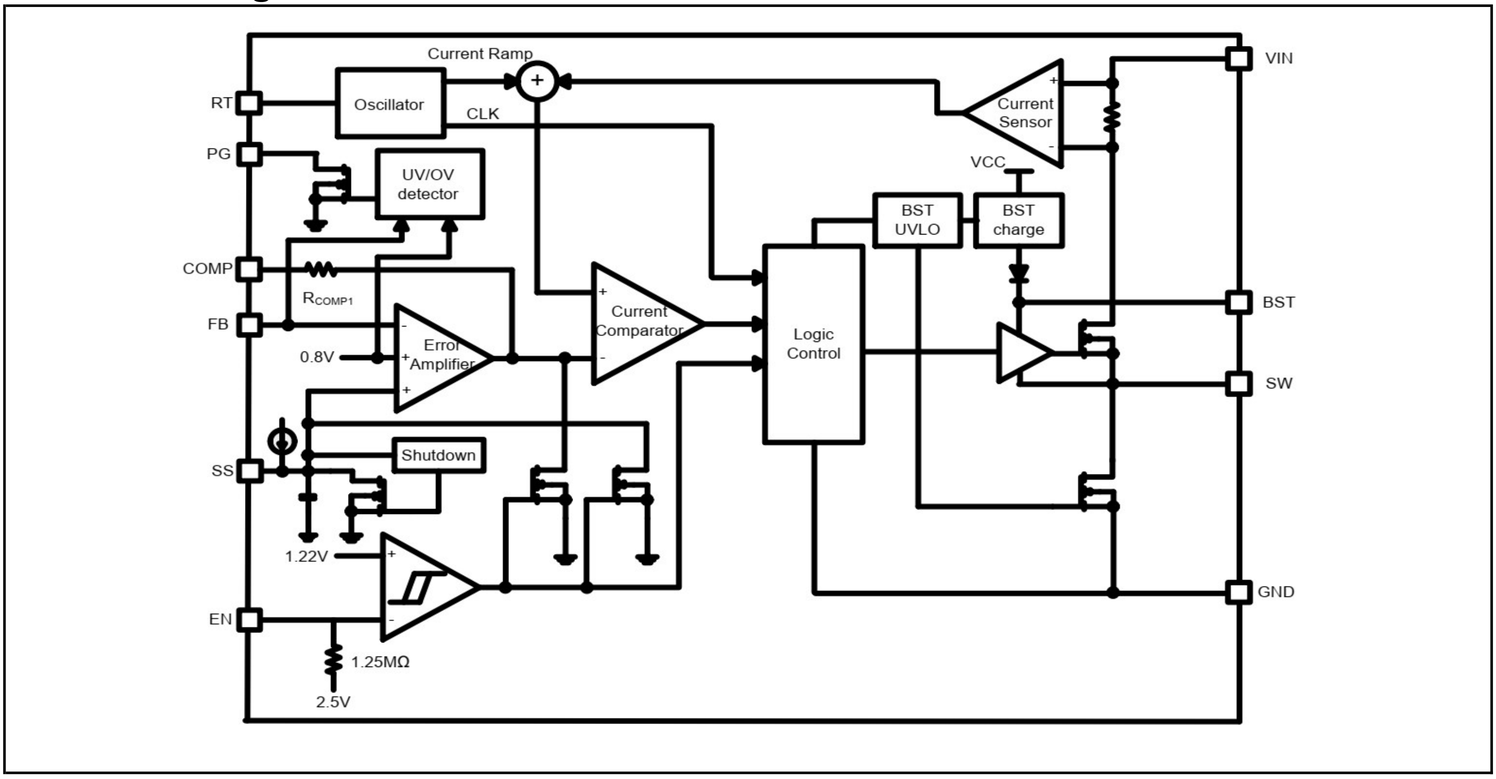


Figure 3. Block diagram of HCR3432

The block diagram of HCR3432S/HCR3432P

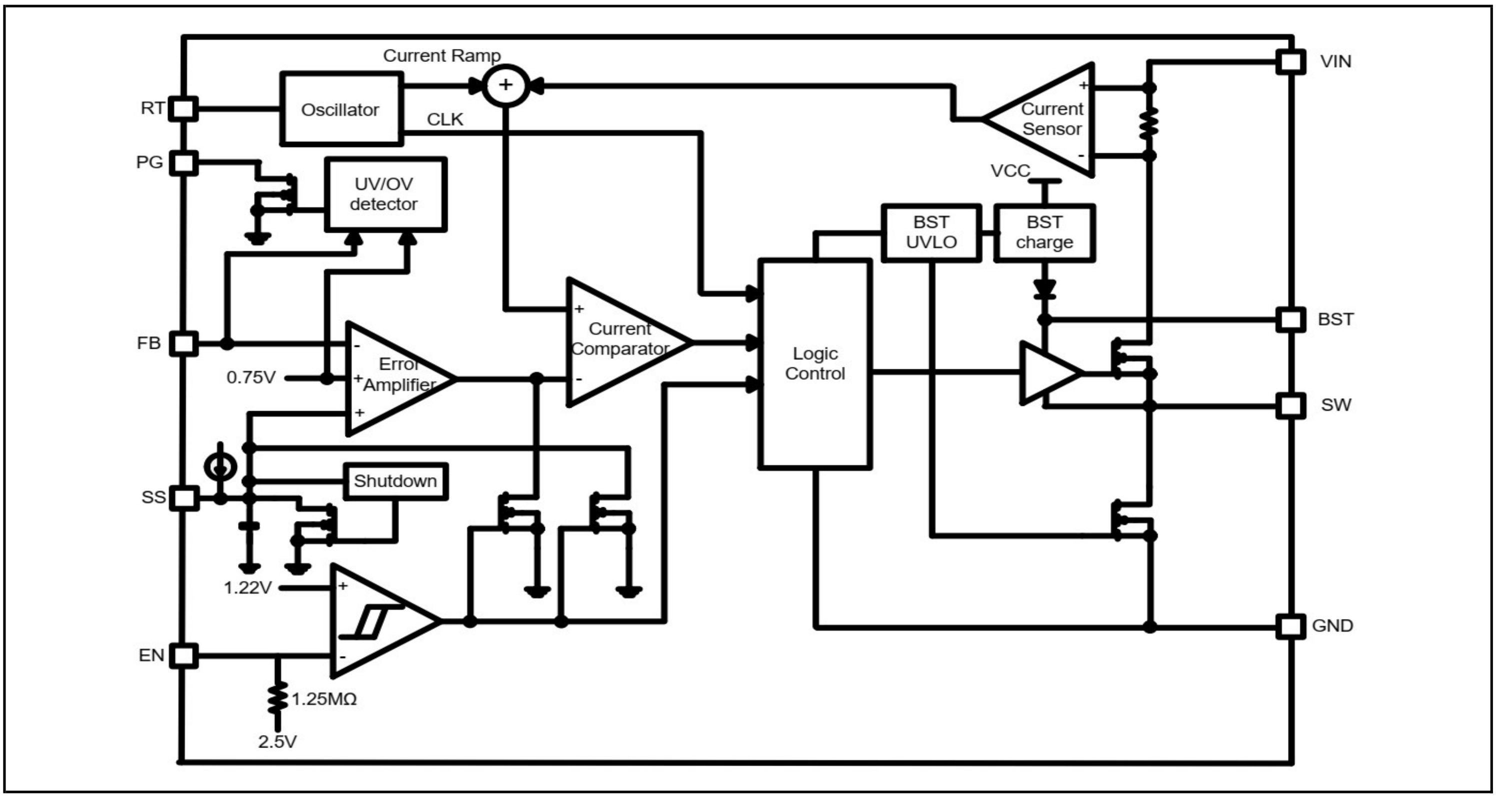
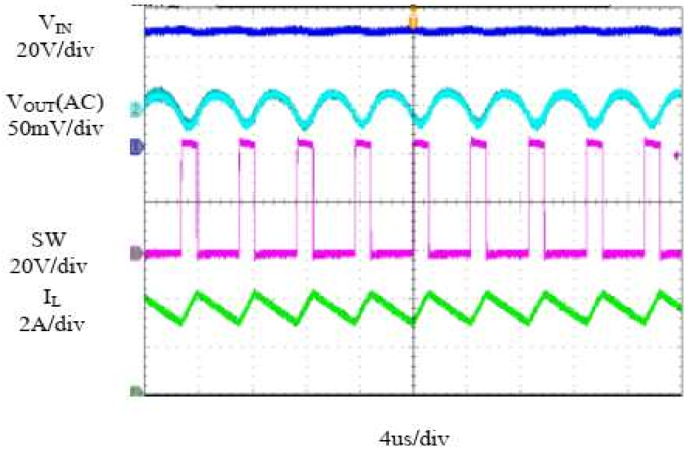


Figure 4. Block diagram of HCR3432S/HCR3432P

TYPICAL PERFORMANCE CHARACTERISTICS

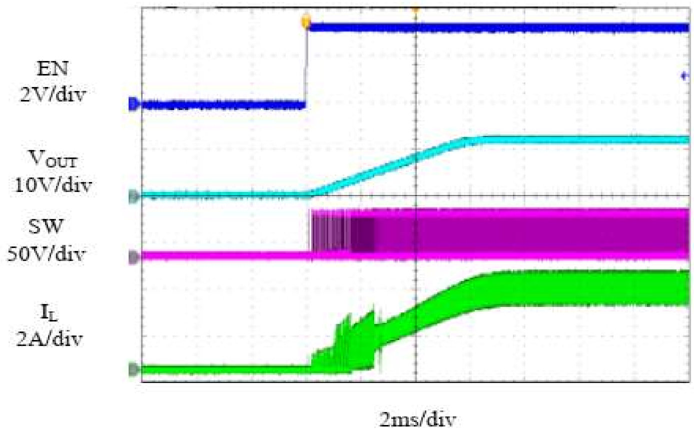
HCR3432S, V_{IN}=48V, V_{OUT}=12V, L=33uH, C_{OUT}=90uF, R_{RT}=124KΩ, T_A=+25'C, Unless Otherwise noted

V_{IN}=48V, V_{OUT}=12V, I_{OUT}=3.5A



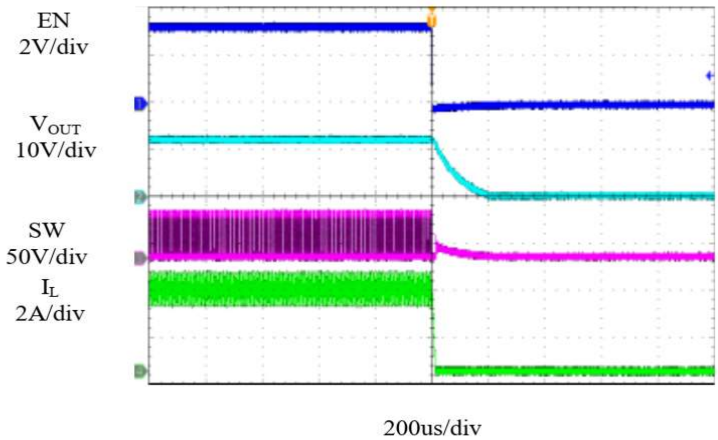
Steady State Test

V_{IN}=48V, V_{OUT}=12V, I_{OUT}=3.5A(Resistive load)



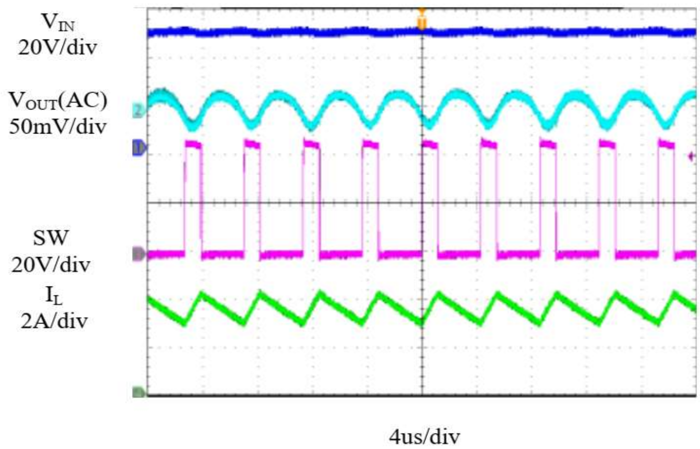
Starup through Enable

V_{IN}=48V, V_{OUT}=12V, I_{OUT}=3.5A(Resistive load)



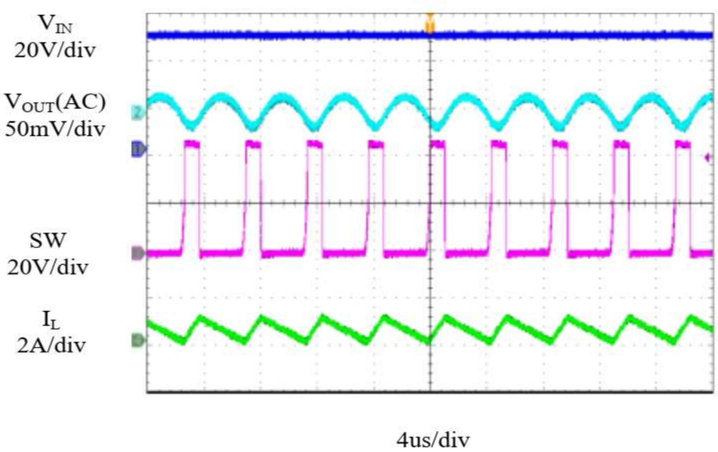
Shutdown through Enable

3.5A Load



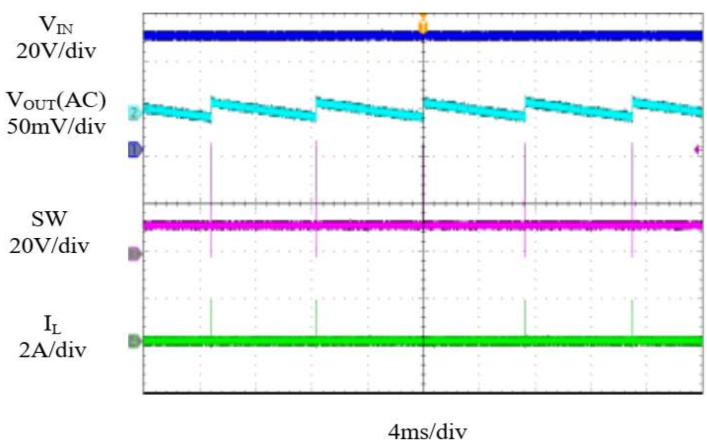
Heavy Load Operation

0.45A Load



Light Load Operation

0A Load



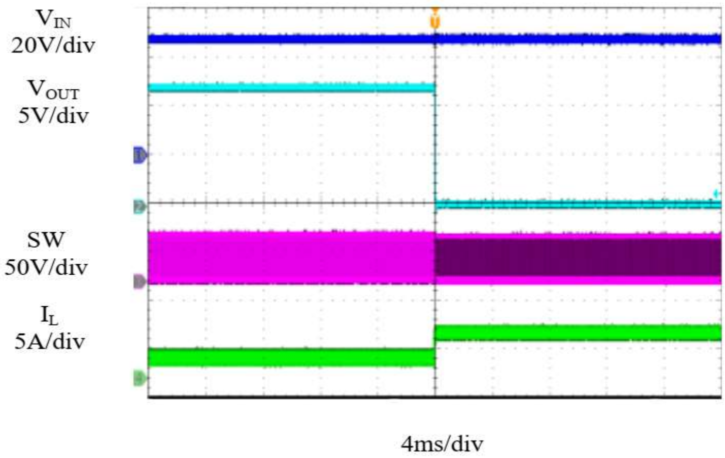
No Load Operation

3.5A, 65V, Asynchronous Step-Down Converter

TYPICAL PERFORMANCE CHARACTERISTICS(Con.)

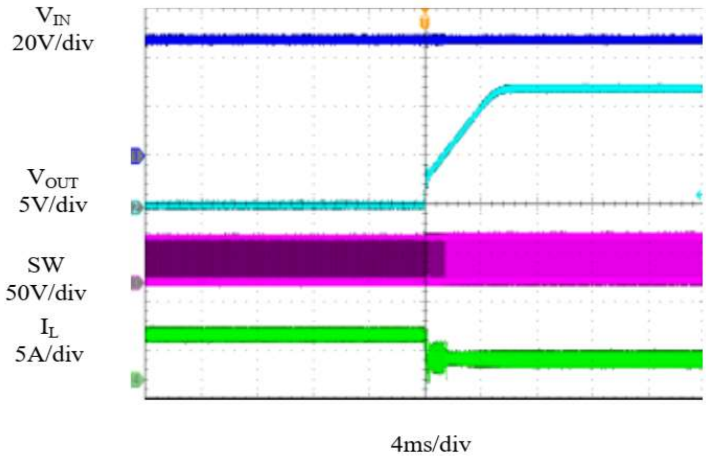
HCR3432S, VIN=48V, VOUT=12V, L=33uH, COUT=90uF, RRT=124KΩ, TA=+25'C, Unless Otherwise noted

VIN=48V, VOUT=12V, IOUT=2A - Short



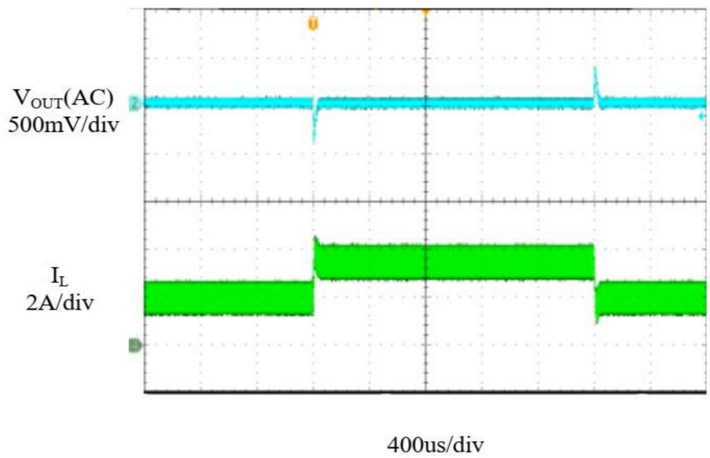
Short Circuit Protection

VIN=48V, VOUT=12V, IOUT=Short - 2A

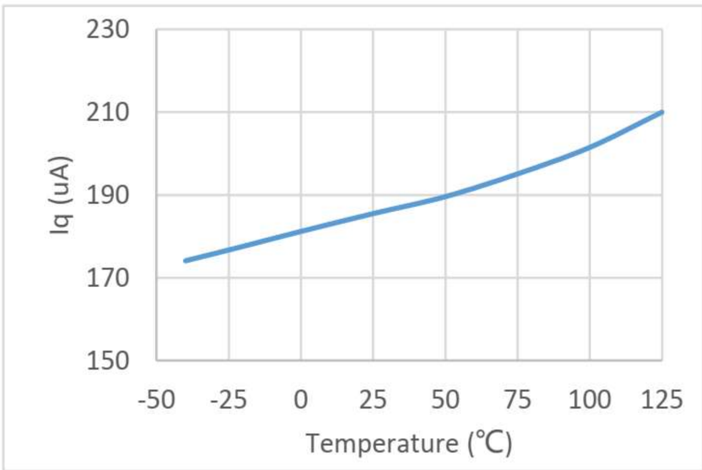


Short Circuit Recovery

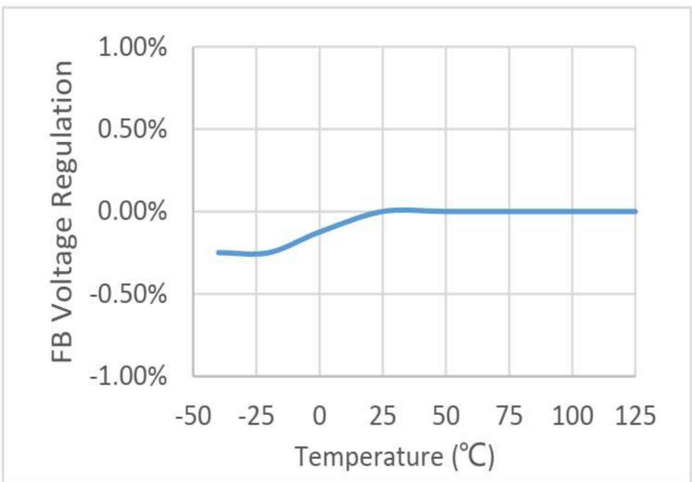
VIN=48V, VOUT=12V, IOUT=2A Load ->3.5A Load ->2A Load



Load Transient

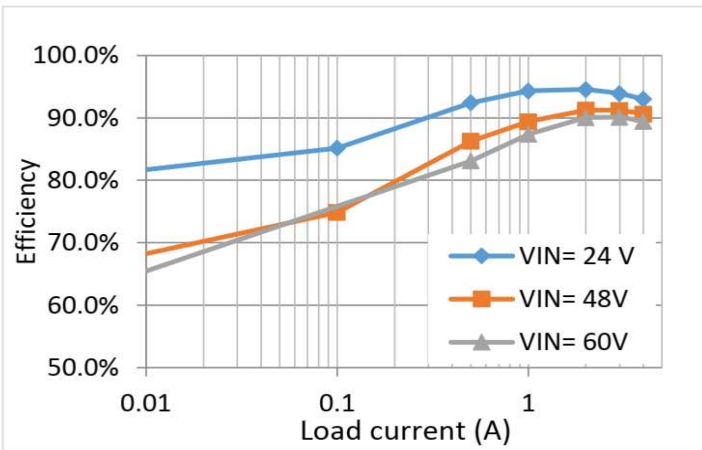


Supply Current vs Junction Temperature



FB Voltage Regulation vs Junction Temperature

HCR3432, VOUT=12V, L=18uH, fSW=350KHz



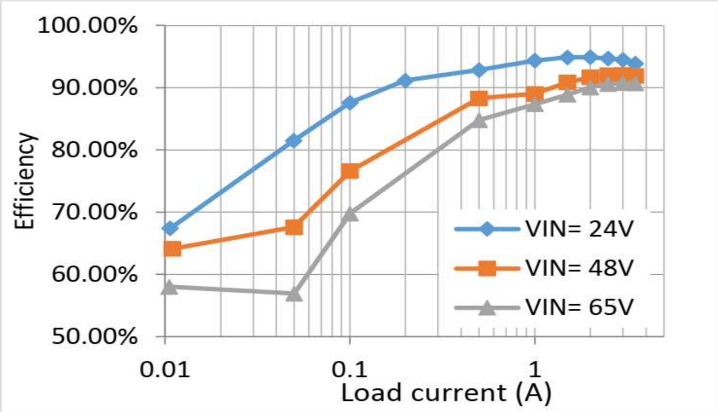
Efficiency vs Load Current

3.5A, 65V, Asynchronous Step-Down Converter

TYPICAL PERFORMANCE CHARACTERISTICS(Con.)

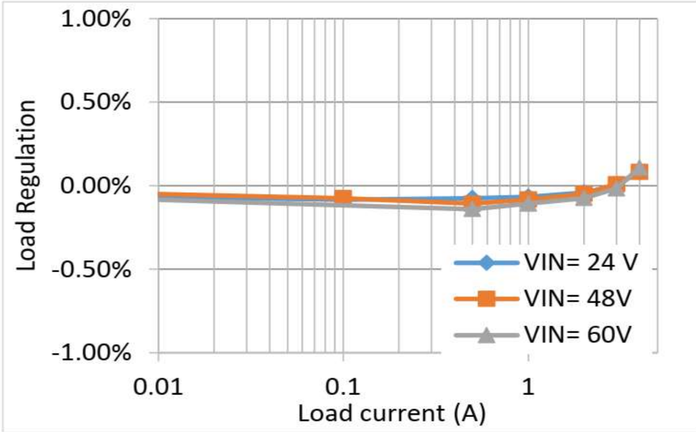
HCR3432S, VIN=48V, VOUT=12V, L=33uH, COUT=90uF, RRT=124KΩ, TA=+25'C, Unless Otherwise noted

HCR3432S/HCR3432P, VOUT=12V, L=18uH, fsw=240KHz



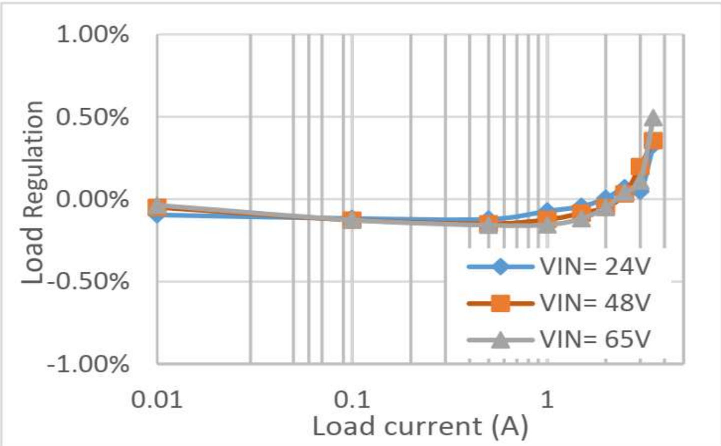
Efficiency vs Load Current

HCR3432, VOUT=12V, L=18uH, fSW=350KHz



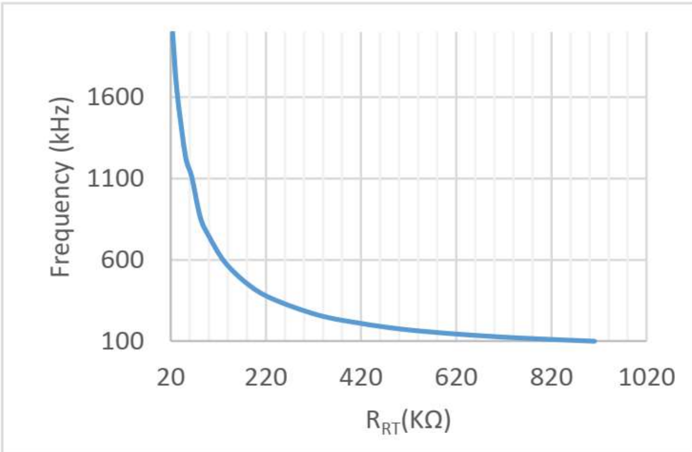
Load Regulation vs Load Current

HCR3432S/HCR3432P, VOUT=12V, L=18uH, fsw=240KHz



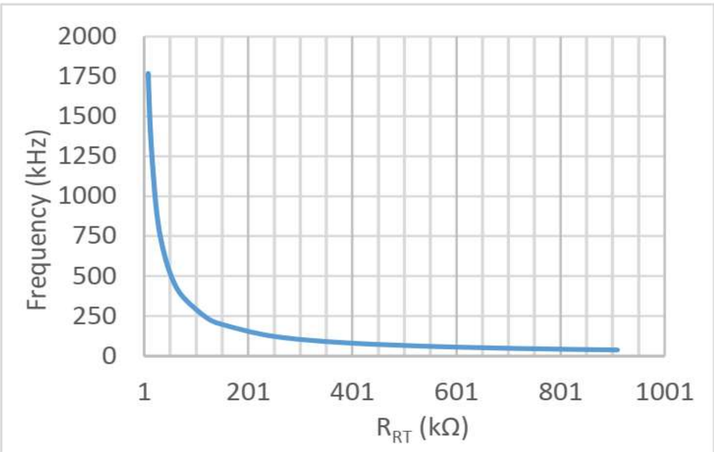
Load Regulation vs Load Current

HCR3432, VOUT=12V



Switch Frequency vs RRT

HCR3432S/HCR3432P, VOUT=12V



Switch Frequency vs RRT

TYPICAL APPLICATION

3.5A Step Down Regulators-HCR3432

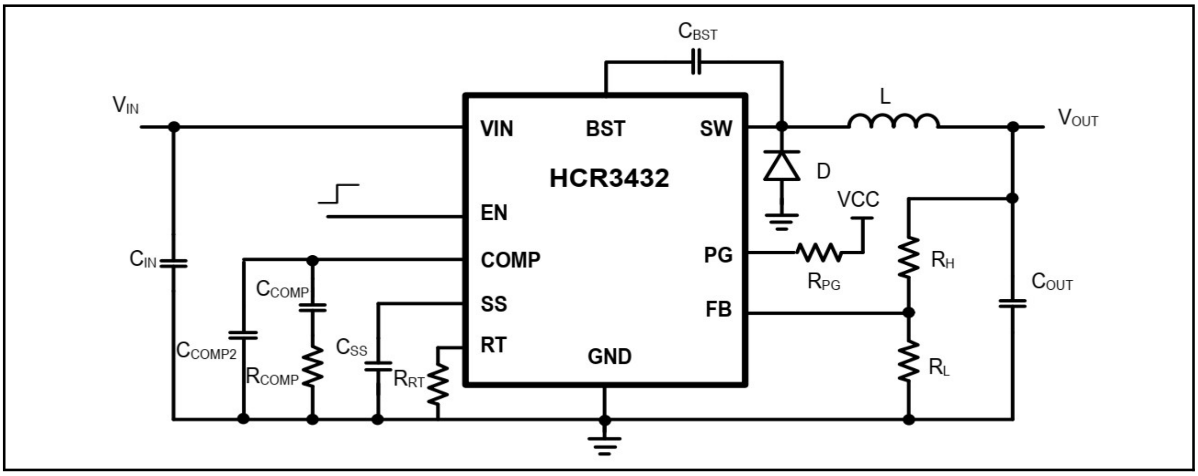


Figure 5. Typical Application Circuit of HCR3432

3.5A Step Down Regulators-HCR3432S

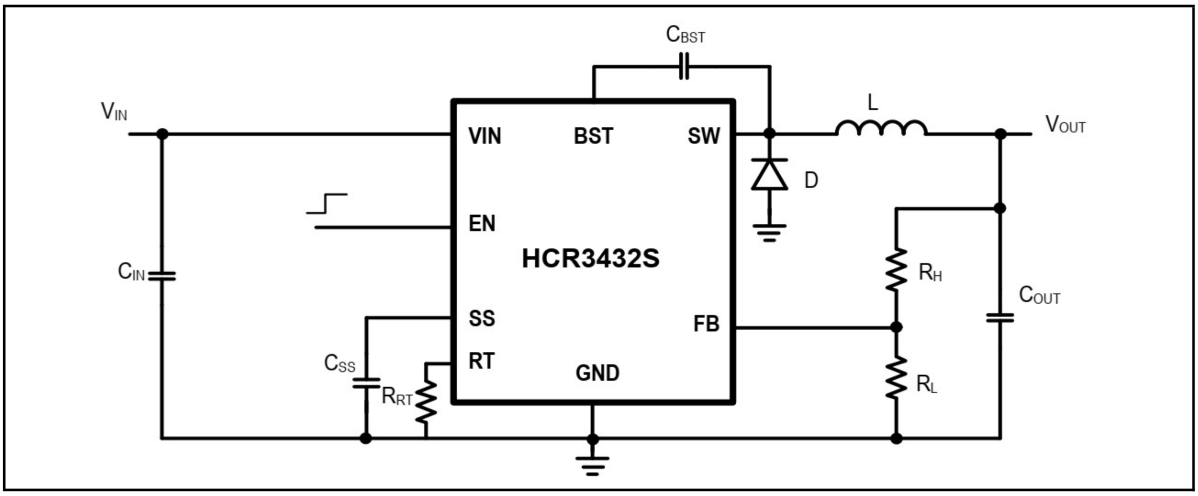


Figure 6. Typical Application Circuit of HCR3432S

3.5A Step Down Regulators-HCR3432P

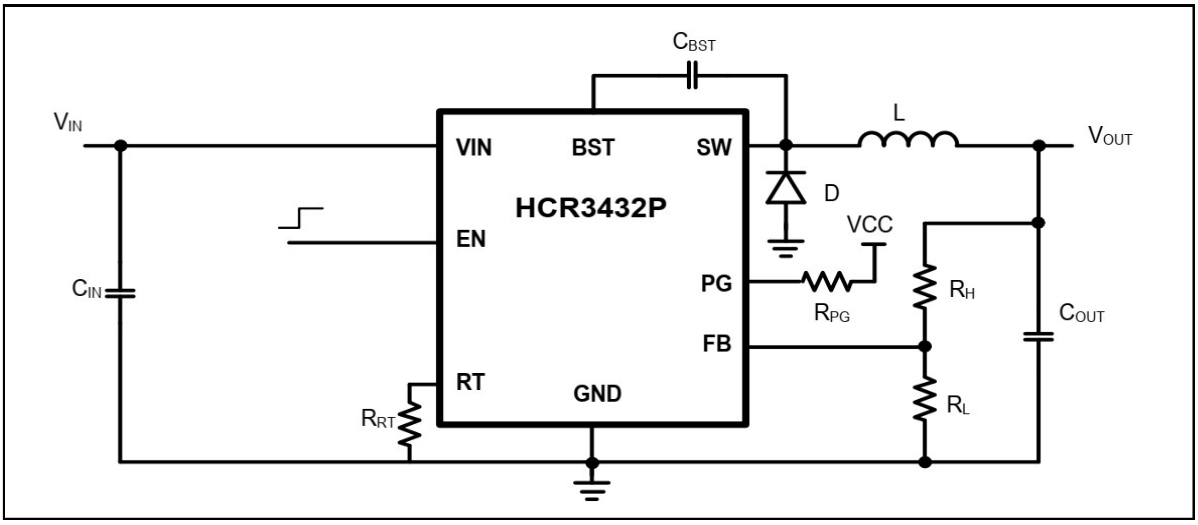


Figure 7. Typical Application Circuit of HCR3432P

Functional Description

The HCR3432 series are asynchronous, current -mode, step-down regulators. It regulates input voltages from 4.5V to 65V down to an output voltage as low as reference voltage, and is capable of supplying up to 3.5A of load current.

Power Switch

N-Channel MOSFET switch is integrated on the HCR3432 series to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 4.3V rail when SW is low.

Current-Mode Control

The HCR3432 series utilizes fixed frequency, peak current-mode control to regulate the output voltage. The output voltage is measured at the FB pin through a resistive voltage divider and the error is amplified by the internal transconductance error amplifier.

An internal oscillator initiates the turn on of the high side power switch, and the error amplifier output at the COMP pin controls the high side power switch current that when the high side MOSFET switch current reaches the threshold level set by the COMP voltage, the power switch is turned off.

The COMP voltage will increase and decrease as the output current increases and decreases. The device implements current limiting by clamping the COMP voltage to a maximum level. The PFM mode is implemented with a minimum voltage clamp on the COMP.

PFM Mode

The HCR3432seriesoperate in PFM mode at light load to improve efficiency by reducing switching and gate drive losses.

During PFM mode operation, the HCR3432 series sense and controls peak switch current, not the average load current. Therefore the load current at which the device enters PFM mode is dependent on the output inductor value.

Slope Compensation Output Current

The HCR3432 series add a compensating ramp to the COMP voltage to prevent sub-harmonic oscillations at duty cycles greater than 50%. The peak current limit of the high side switch will constant with duty cycle increases.

Shut-Down Mode

The HCR3432 series shut down when voltage at EN pin is below 0.3V. The entire regulator is off and the supply current consumed by the HCR3432 series drop below 4uA.

Enable and Adjustable UVLO Protection

The HCR3432 series are enabled when the VIN pin voltage rises above 4.3V and the EN pin voltage exceeds the enable threshold of 1.22V. The HCR3432 series are disabled when the VIN pin voltage falls below 4.0V or when the EN pin voltage is below 1.07V. The EN pin has an internal pull-up resistor that enables operation of the HCR3432 series when the EN pin floats. If an application requires a higher VIN under-voltage lockout (UVLO) threshold, use a resistive divider connected between VIN and ground with the central tap connected to EN to adjust the input voltage UVLO. (Shown in Figure 8). So that

Functional Description(Con.)

Enable and Adjustable UVLO Protection(Con.)

when VIN rises to the pre-set value, EN rises above 1.22V to enable the device and when VIN drops below the pre-set value, EN drops below 1.07V to trigger input under voltage lockout protection.

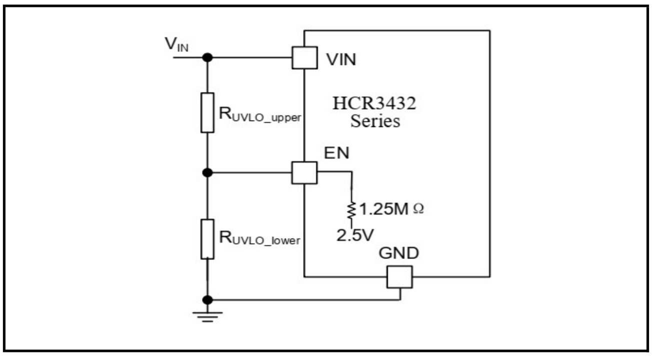


Figure 8. Adjustable UVLO

The input voltage UVLO threshold (VUVLO) and hysteresis (VUVLO_HYS) can be calculated by the following equation.

$$V_{UVLO} = \left(V_{EN\_TH} - \frac{2.5V}{1.25M\Omega * \frac{R_{UVLO\_upper} + R_{UVLO\_lower}}{R_{UVLO\_upper} * R_{UVLO\_lower}} + 1}\right) * \left(R_{UVLO\_upper} * \frac{1.25M\Omega + R_{UVLO\_lower}}{1.25M\Omega * R_{UVLO\_lower}} + 1\right)$$

$$V_{UVLO\_HYS} = \left(R_{UVLO\_upper} * \frac{1.25M\Omega + R_{UVLO\_lower}}{1.25M\Omega * R_{UVLO\_lower}} + 1\right) * V_{EN\_HYS}$$

When RUVLO_lower <=100kΩ， VUVLO can be calculated approximately according to the following equation.

$$V_{UVLO} = \frac{R_{UVLO\_upper} + R_{UVLO\_lower}}{R_{UVLO\_lower}} * V_{EN\_TH}$$

$$V_{UVLO\_HYS} = \frac{R_{UVLO\_upper} + R_{UVLO\_lower}}{R_{UVLO\_lower}} * V_{EN\_HYS}$$

where

VEN_TH is enable shutdown threshold (1.22V typ.)

VEN_HYS is enable shutdown hysteresis (150mV typ.);

External Soft-start(HCR3432/HCR3432S)

Soft-start is designed in HCR3432 and HCR3432S to prevent the converter output voltage from overshooting during startup and short-circuit recovery. An internal current source ISS is designed to charge the external soft-start capacitor (CSS) and generates a soft-start (SS) voltage ramping up from 0V to 3V. When it is less than internal reference voltage (VREF, typ. 0.8V), SS voltage overrides VREF and the error amplifier uses SS voltage as the reference. When SS exceeds VREF, VREF regains control. The soft start time (10% to 90%) TSS can be calculated by the following equation.

$$T_{SS}(ms) = \frac{C_{SS}(nF) * V_{REF}(V) * 0.8}{I_{SS}(uA)}$$

HCR3432 ISS=1.8uA； HCR3432S ISS=2.8uA

Switching Frequency

The switching frequency of HCR3432 series can be programmed by the resistor RRT from the RT pin and GND pin over a wide range from 100KHz to 2000 KHz. The RT pin voltage is typically 1.2V and must have a resistor to ground to set the switching frequency. The RRT resistance can be calculated by the following equation for a given switching frequency fSW.

$$R_{RT}(k\Omega) = \frac{92417}{f_{sw}(kHz)} - 23 \quad \text{(HCR3432)}$$

$$R_{RT}(k\Omega) = \frac{48000}{f_{sw}^{1.08}(kHz)} - 5 \quad \text{(HCR3432S/HCR3432P)}$$

To reduce the solution size one would typically set the switching frequency as high as possible, but tradeoffs of the conversion efficiency, maximum input voltage and minimum controllable on time should be considered. The minimum controllable on time is typically 100ns

Functional Description(Con.)

Switching Frequency(Con.)

which limit the maximum operating frequency in applications with high input to output step down ratios.

Power Good(HCR3432/HCR3432P)

The HCR3432 and HCR3432P has power-good (PG) output. When using this function, it is better to start up through Enable. The PG pin is the open drain of a MOSFET. Connect to a voltage voltage source (such as VOUT) through a resistor. When the output voltage becomes within +6% and -7% of the target value, internal comparators detect power good state and the power good signal becomes high. If the feedback voltage goes under -10% or higher +8% of the target value, the power good signal becomes low.

Over Current / Output Short Protection

To protect the converter in overload conditions at higher switching frequencies and input voltages, the HCR3432 series implements a frequency fold-back. The oscillator frequency is divided by 4 as the FB voltage drops from reference voltage to below 0.35V. When the FB voltage rise above 0.4V, the frequency exist fold-back state. The oscillator frequency is divided by 8 as the FB voltage drops to 0.18V. When the FB voltage rise above 0.2V, the frequency exist fold-back state.

When the output voltage is forced low by the shorted load, the inductor current decreases slowly during the switch off time. The frequency fold-back effectively increases the off time by increasing the period of the switching cycle providing more time for the inductor current to ramp down.

Over Current/Output Short Protection(Con.)

The frequency fold-back effectively increases the off time by increasing the period of the switching cycle providing more time for the inductor current to ramp down. The maximum frequency fold-back ratio is 8.

If the power FET current rises above the current limit by 1.5A， the oscillator frequency is divided by 2^X(X=0, 1, 2…7) in a minimum detection time. Once the power FET is turned off by the current limit instead of minimum on time, the frequency exist fold-back state. With a maximum frequency fold-back ratio of 128, there is a maximum frequency at which the inductor current can be controlled by frequency fold-back protection.

Overvoltage Protection

Output overvoltage protection (OVP) is designed in HCR3432 series to minimize voltage overshoot when recovering from output fault conditions or strong unload transients in designs with low output capacitance and the power supply output voltage increase faster than the response of the error amplifier output resulting in an output overshoot.

The OVP feature minimizes output overshoot when using a low value output capacitor by comparing the FB pin voltage to the rising OVP threshold which is nominally 108% of the internal voltage reference. If the FB pin voltage is greater than the rising OVP threshold, the high side MOSFET is immediately disabled to minimize output overshoot. When the FB voltage drops below the falling OVP threshold which is nominally 106% of the internal voltage reference, the high side MOSFET resumes normal operation.

Functional Description(Con.)

Thermal Protection(Con.)

When the temperature of the HCR3432 series rises above 170°C, it is forced into thermal shut-down.

Only when core temperature drops below 150°C can the regulator becomes active again.

Application Information

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

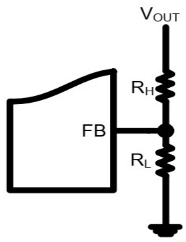
$$V_{FB} = V_{OUT} * \frac{R_L}{R_L + R_H}$$

where VFB is the feedback voltage and VOUT is the output voltage.

Choose RH, and then RL can be calculated by:

$$R_H = R_L * \left(\frac{V_{OUT}}{0.8} - 1\right)$$ for HCR3432

$$R_H = R_L * \left(\frac{V_{OUT}}{0.75} - 1\right)$$ for HCR3432S/HCR3432P



Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintain the DC input voltage. Estimate the RMS current in the input capacitor with:

$$I_{CIN} = I_{OUT} * \sqrt{\frac{V_{OUT}}{V_{IN}} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

where IOUT is the load current, VOUT is the output voltage, VIN is the input voltage

The input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$C_{IN} = \frac{I_{OUT}}{f_{SW} * \Delta V_{IN}} * \frac{V_{OUT}}{V_{IN}} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where CIN is the input capacitance value,fsw is the switching frequency, △VIN is the input ripple voltage.

Input Capacitor(Con.)

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1μF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 4.7μF*3/100V ceramic capacitor is recommended in typical application.

frequency at which the inductor current can be controlled by frequency fold-back protection.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_{SW} * L} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right) * \left(R_{ESR} + \frac{1}{8 * f_{SW} * C_{OUT}}\right)$$

where COUT is the output capacitance value and RESR is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage. The output capacitors also affect the system stability and transient response, and a 90μF ceramic capacitor is recommended in typical application.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is

Application Information(Con.)

Inductor(Con.)

typically allowed to be 40% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_{SW} * \Delta I_L} * \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where V_{IN} is the input voltage, V_{OUT} is the output voltage, f_{SW} is the switching frequency, and $\triangle I_L$ is the peak-to-peak inductor ripple current.

External Bootstrap Capacitor

The bootstrap capacitor is required to supply voltage to the top switch driver. A 0.1μF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

External Diode

The HCR3432 Series requires an external catch diode between the SW pin and GND. The selected diode must have a reverse voltage rating equal to or greater than VIN(max). The peak current rating of the diode must be greater than the maximum inductor current. Schottky diodes are typically a good choice for the catch diode due to their low forward voltage. The lower the forward voltage of the diode, the higher the efficiency of the regulator. Typically, diodes with higher voltage and current ratings have higher forward voltages. A diode with a minimum of 65 V reverse voltage is preferred to allow input voltage transients up to the rated voltage of the HCR3432 Series, The select forward voltage of Schottky Diode must be less than the restriction of forward voltage in Figure 9 at operating temperature range to avoid the IC malfunction.

For the example design, the PDS5100H Schottky diode is selected for its lower forward voltage and good thermal characteristics compared to

External Diode

smaller devices. The typical forward voltage of the PDS5100H is 0.67V at 5A.

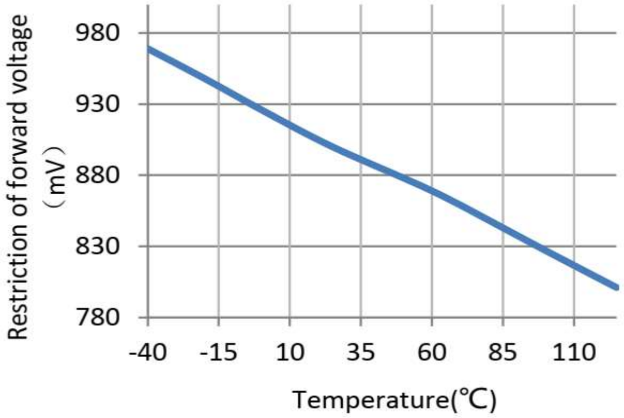


Figure 9. Restriction of Forward Voltage vs. Temperature

Compensation Network Design

In order to ensure stable operation while maximizing the dynamic performance, the appropriate loop compensation is important. Generally, follow the steps below to calculate the compensation components:

a-1, Set up the crossover frequency, fC. In general, one-twentieth to one-sixth of the switching frequency is recommended to be the crossover frequency.

a-2. RCOMP can be determined by:

$$R_{COMP} = \frac{2\pi * f_c * C_{OUT}}{g_M * g_{CS}} * \frac{R_L + R_H}{R_L} - R_{COMP1}$$

where gM=325uA/V, gCS=18A/V, R_{COMP1}=5KΩ

a-3. A compensation zero can be placed at or before the dominant pole of buck which is provided by output capacitor and maximum output loading (RL). Calculate CCOMP:

$$C_{COMP} = \frac{C_{OUT} * R_L}{R_{COMP} + R_{COMP1}}$$

a-4. The compensation pole is set to the frequency at the ESR zero or 1/2 of the operating frequency. Output capacitor and

Application Information(Con.)

Compensation Network Design(Con.)

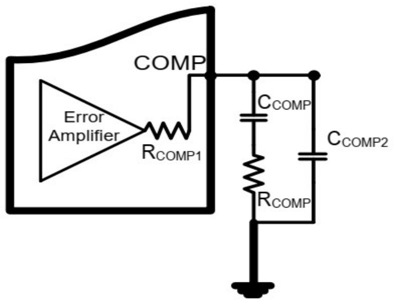
a-4-2. its ESR provide a zero, and optional CCOMP2 can be used to cancel this zero.

$$C_{COMP2} = \frac{C_{OUT} * R_{ESR}}{R_{COMP}}$$

If 1/2 of the operating frequency is lower than the ESR zero, the compensation pole is set at 1/2 of the operating frequency.

$$C_{COMP2} = \frac{1}{2\pi * \frac{f_{SW}}{2} * R_{COMP}}$$

a-5. Generally, C_{COMP2} is an optional component used to enhance noise immunity.



PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

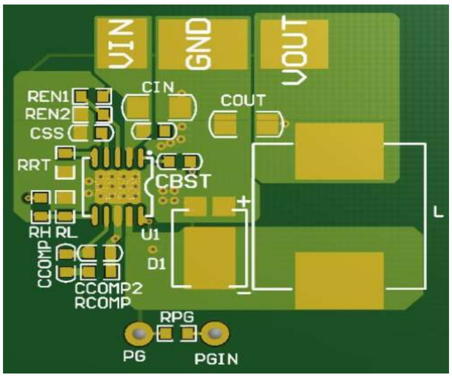
b-1. Place the input decoupling capacitor as close to HCR3432 Series (VIN pin and GND pin) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized

b-2. Put the feedback trace as short as possible, and far away from the inductor and noisy power traces like SW node.

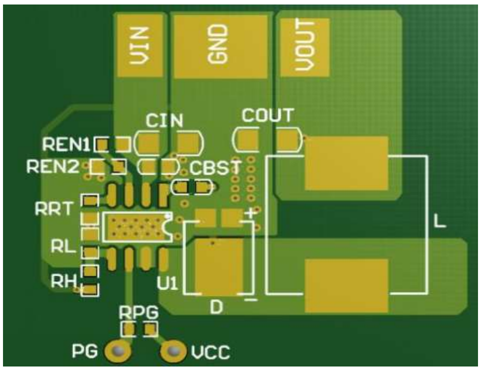
b-3. Keep the switching node SW short to prevent excessive capacitive coupling

b-4.Make V_{IN}, V_{OUT} and ground bus connections as wide as possible. This reduces any voltage drops on the input or output paths of the converter and maximizes efficiency.

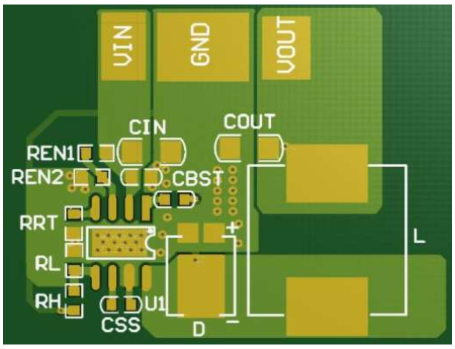
Refer to PCB Layout Bottom level



HCR3432 - DEMO board Bottom level



HCR3432P - DEMO board Bottom level



HCR3432S - DEMO board Bottom level

Reference Design

VIN: 14V~65V

VOUT: 12V

IOUT: 0~3.5A

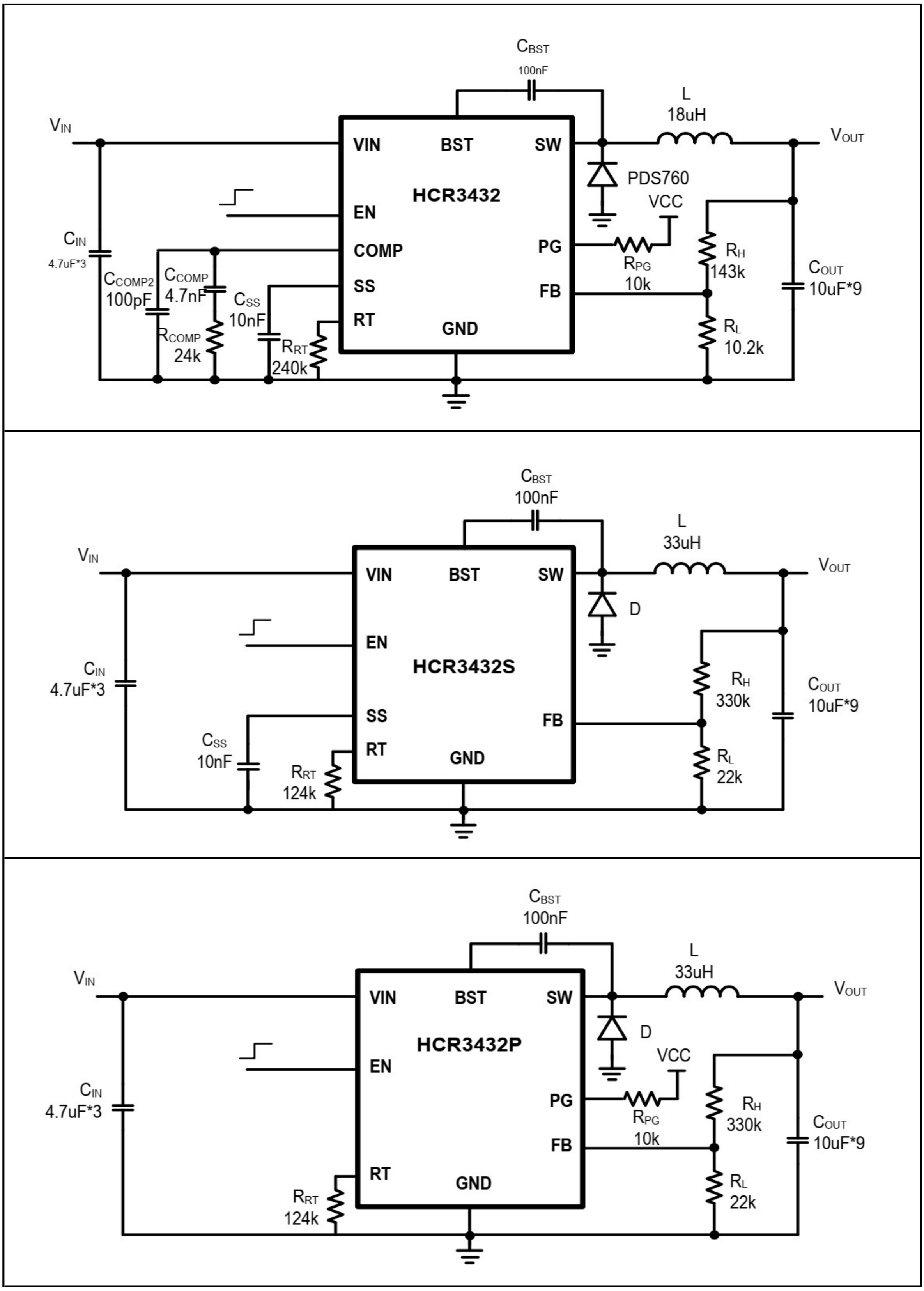


Figure 10. Typical Application Circuit of HCR3432/S/P

Reference Design (Con.)

VIN: 8V~65V

VOUT: 5V

IOUT: 0~3.5A

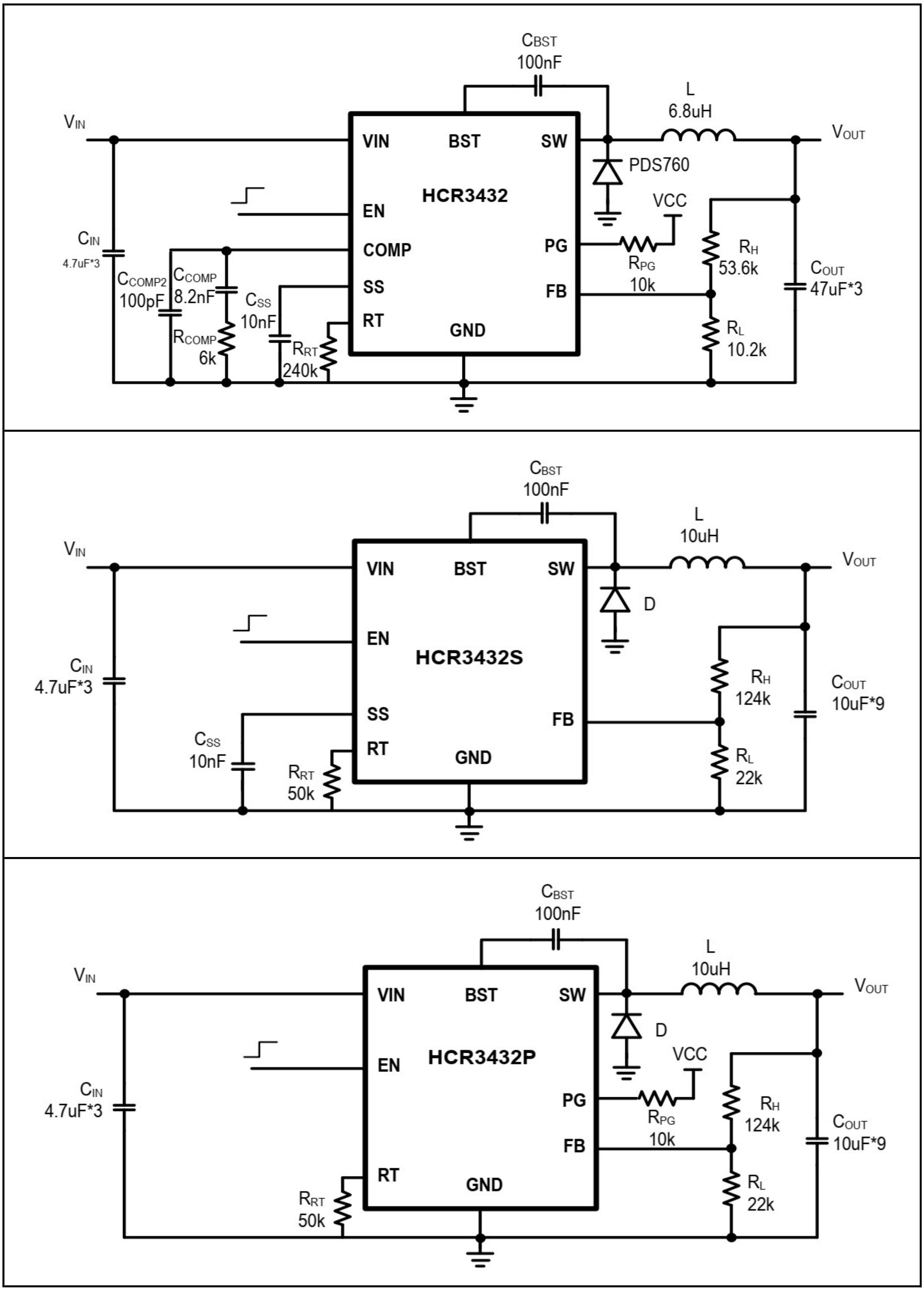
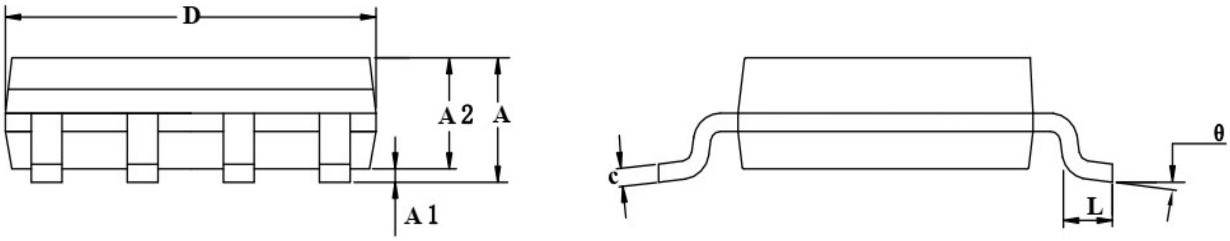


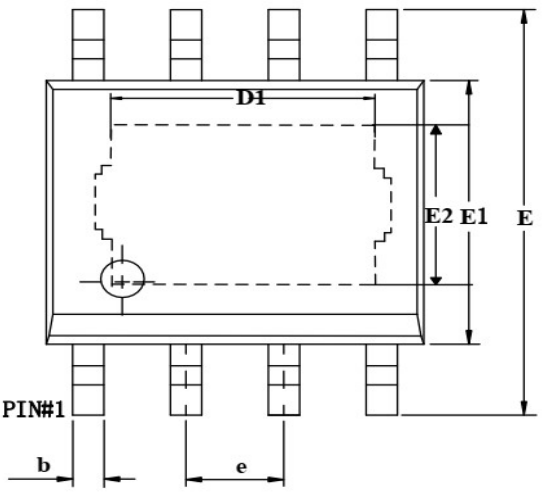
Figure 11. Typical Application Circuit of HCR3432/S/P

Mechanical Dimensions

M8E PKG: SOP-8(EP)

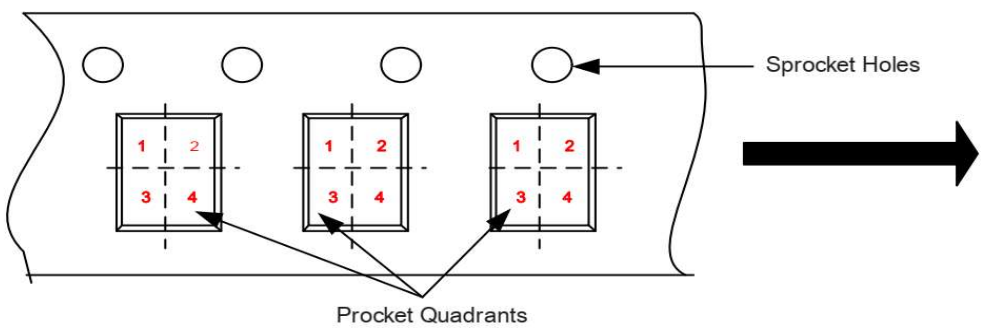
Unit: mm(inch)





Symbol	MILLIMETER		
	MIN	NOM	MAX
A	1.30	—	1.70
A1	0.00	—	0.10
A2	1.35	—	1.60
b	0.33	—	0.51
c	0.17	—	0.25
D	4.70	—	5.10
E	5.80	6.00	6.20
E1	3.75	3.90	4.15
D1	3.05	—	3.40
E2	2.16	—	2.50
e	1.27BSC		
L	0.40	—	1.27
θ	0°	—	8°

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE

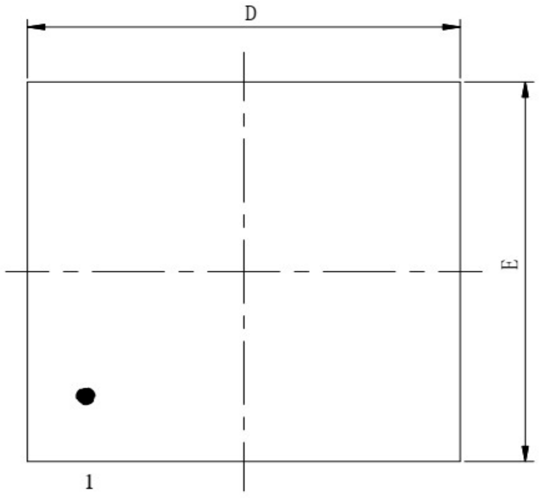


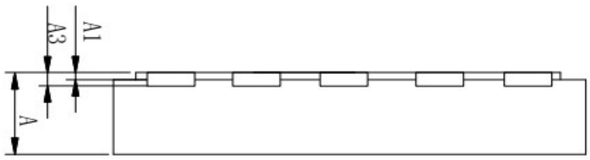
Package Type	Pin1 Quadrant
SOP-8(EP)	1

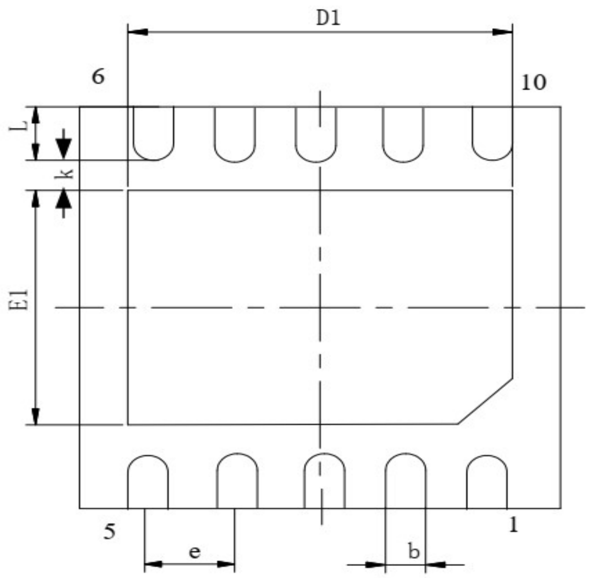
Mechanical Dimensions(Con.)

DN10 PKG: DFN4X4-10

Unit: mm(inch)

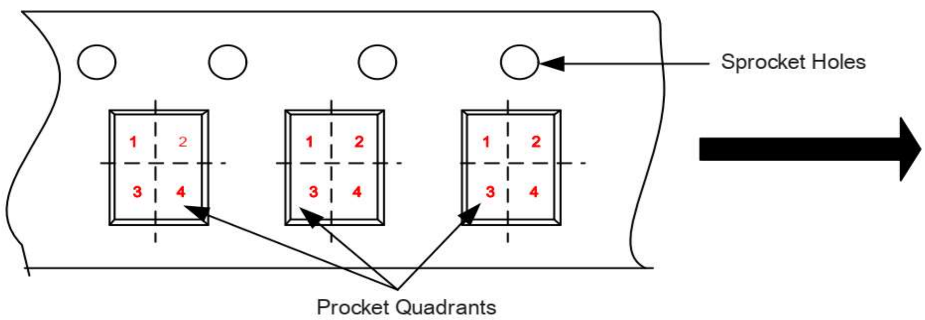






SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A3	0.203REF		
D	4.00BSC		
E	4.00BSC		
D1	2.90	3.00	3.10
E1	2.50	2.60	2.70
k	0.30REF		
b	0.25	0.30	0.35
e	0.80BCS		
L	0.30	0.40	0.50

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPAE

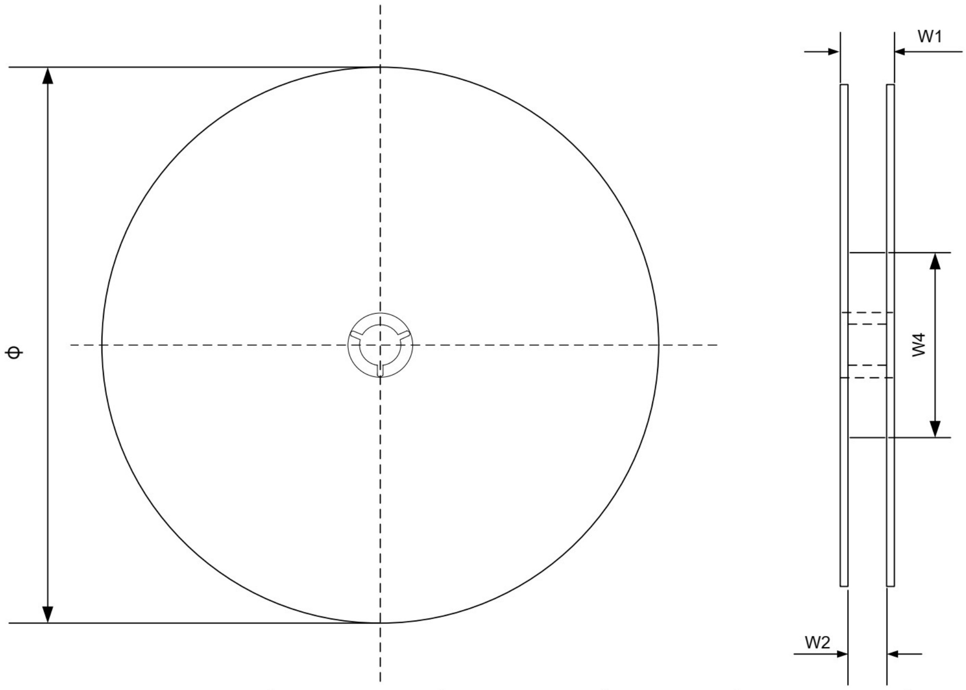


Package Type	Pin1 Quadrant
DFN4x4-10	1

TAPE AND REEL INFORMATION

Reel

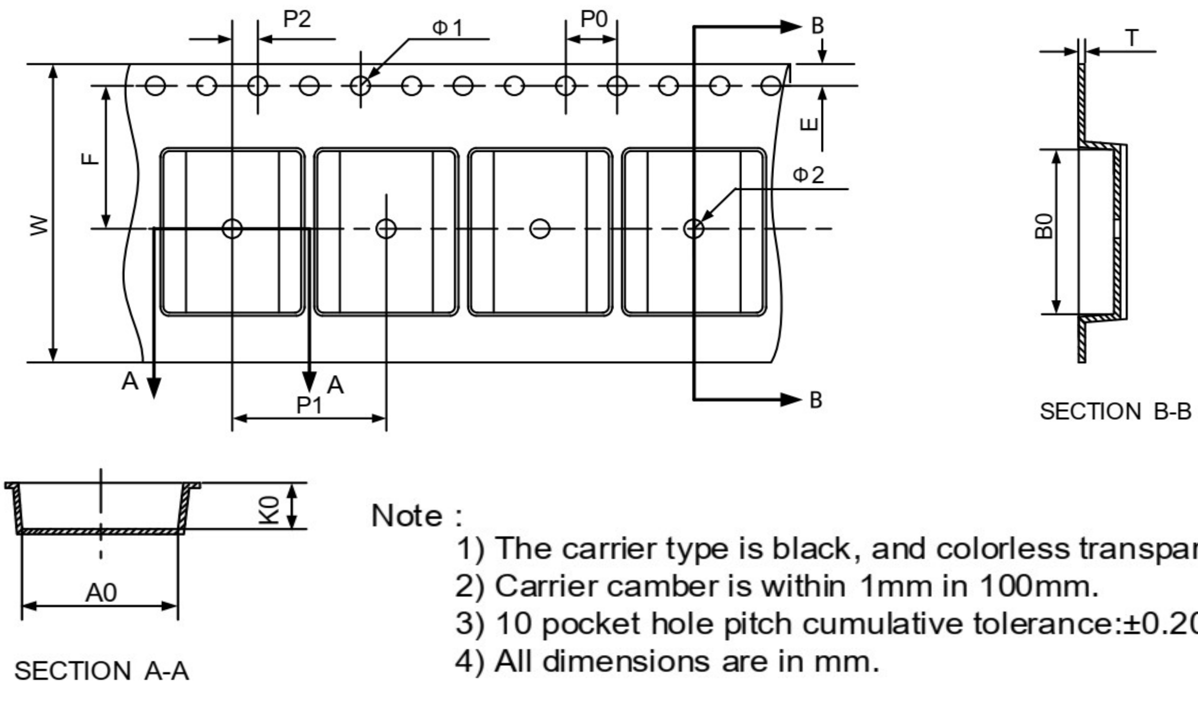
UNIT: mm



Package	Diameter Φ	Thickness W1	Width W2	W4
DFN4x4-10/ESOP8	330±2	17.6±2	12.4±2	100±2

Carrier Tape

UNIT: mm



Note :

1) The carrier type is black, and colorless transparent.
2) Carrier camber is within 1mm in 100mm.
3) 10 pocket hole pitch cumulative tolerance:±0.20.
4) All dimensions are in mm.

封装形式	关键尺寸控制标准（单位：mm）											
	P0	P2	P1	A0	B0	W	T	K0	Φ1	Φ2	E	F
SOP-8(EP)	4.0±0.1	2.0±0.1	8.0±0.1	6.40±0.3	5.35±0.3	12.0±0.3	0.25±0.2	2.00±0.2	1.50min	1.50min	1.75±0.1	5.50±0.10
DFN4X4-10	4.0±0.1	2.0±0.1	8±0.1	4.3±0.1	4.3±0.1	12±0.3	0.25±0.10	1.1±0.1	1.50±0.10	1.50±0.25	1.75±0.1	5.50±0.10