3A, 30V, 680KHz Synchronous Step-Down Converter

Features

- 3A Continuous output Current
- Integrated 120mΩ/90mΩ DMOS Switches
- 4.0V to 30V Input Operating Range
- Output Adjustable from 0.92V
- Up to 95% Efficiency
- 3uA Shutdown Current
- Fixed 680KHz Frequency
- Short Protection with Hiccup-Mode
- Integrated internal Soft-Start
- Thermal Shutdown
- COT Mode
- MSL3 Package Level
- RoHS Compliant and 100% Lead(pb)-Free
  Halogen-Free

Applications

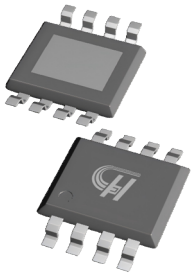
- Automotive Entertainment
- Wireless and DSL Modems
- Computer Entertainment
- IoT Applications and Portable Instruments
- Digital Still and Video Cameras

General Description

The HCR3233C is a synchronous current mode buck regulator capable of driving 3A continuous load current with excellent line and load regulation. The HCR3233C can operate with an input range 4.0V to 30V and the output can be externally set from 0.92V starting with a resistor driver.

Fault condition protection includes cycle-by-cycle current limiting and thermal shutdown, in shutdown mode the regulator draws 3uA of supply current. Programmable soft-start minimizes the inrush supply current and the output overshoot at initial startup. Automatic pulse skipping mode operation increase efficiency at light loads.

The HCR3233C require a minimum number of external components. It is available in SOP-8(EP) Pacakge.



SOP-8(EP)

Figure 1. Package Type of HCR3233C

3A, 30V, 680KHz Synchronous Step-Down Converter

Pin Configuration

SOP-8(EP) (Top View)

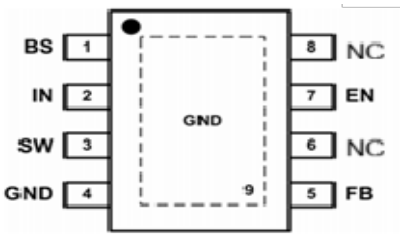
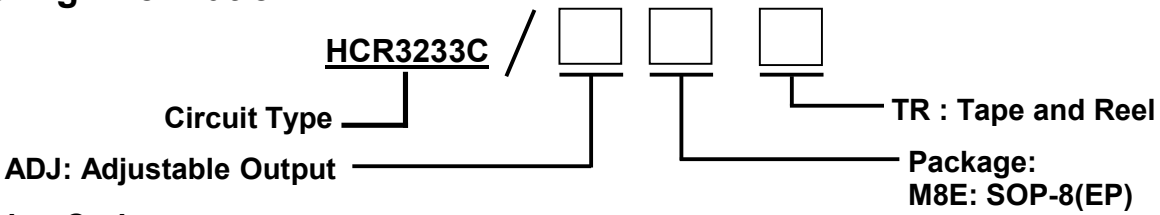


Figure 2. Pin Configuration of HCR3233C (Top View)

Pin Function Table

Pin Number	Pin Name	Function
1	BS	Bootstrap. A capacitor connected between SW and BS pins is required to form a floating supply across the high-side switch driver.
2	IN	Input Supply Pin. IN supplies the power to the IC, as well as the step-down converter switches. Drive IN with a 4.0V to 30V power source. Bypass IN to GND with a suitably large capacitor to minimize input ripple to the IC.
3	SW	Power Switching Output. Connect the output LC filter from SW to the output load.
4 9(Exposed Pad)	GND	Ground. GND Pin should be connected to the exposed thermal pad for proper operation. This power thermal pad should be connected to PCB ground plane using multiple vias for good thermal performance.
5	FB	Output Feedback Input. FB senses the output voltage and regulates it. Drive FB with a resistive voltage divider connected to it from the output voltage. The feedback threshold is 0.925V.
6	NC	Non function Pin
7	EN	Enable Input. Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode.
8	NC	Non function Pin

Ordering Information



Ordering Code

Part Number	Marking ID [2]	Temperature Range	Package	Quantity per Reel
HCR3233C/ADJM8ETR	HCR3233CXXX	-40'C to +85'C	SOP-8(EP)	4000pcs/TR

Note2: the HCR3233C is type and "XXX" is date code.

Absolute Maximum Ratings Note 1,2

Parameter	Symbol	Value	Unit
Supply Voltage	V_{IN}	-0.3 to +33	V
Enable Voltage	V_{EN}	-0.3 to +33	V
Switch Voltage	V_{SW}	-3(-5V<10nS) to VIN +0.5(+36V<10nS)	V
Boot Voltage	V_{BS}	Vsw-0.3 to Vsw +5	V
All Other Pins	-	-0.3 to +6.5	V
Maximum Power Dissipation	P_D	1.75	W
Operating Junction Temperature	T_J	-40 to 150	'C
Storage Temperature Range	T_{STG}	-65 to 150	'C
Lead Temperature (Soldering, 10s)	T_{LEAD}	260	'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.

Recommend Operating Conditions note3

Parameter	Symbol	Min.	Max.	Unit
Input Voltage	V_{IN}	4.0	30	V
Output Current	I_O	0	3.0	A
Operating junction temperature	T_J	-40	+125	'C
Operating temperature range	T_A	-40	+85	'C

Note 3: All limits specified at room temperature (TA = 25°C) unless otherwise specified. All room temperature limits are 100% production tested. All limits at temperature extremes are ensured through correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Thermal Information

Parameter	Symbol	Value	Unit
Junction-to-ambient thermal resistance 4,5	$R_{\theta JA}$	48.7	'C/W
Junction-to-case (top) thermal resistance	$R_{\theta JC(top)}$	52.4	'C/W
Junction-to-board thermal resistance	$R_{\theta JB}$	25.5	'C/W
Junction-to-top characterization parameter	ψ_{JT}	8.4	'C/W
Junction-to-board characterization parameter	ψ_{JB}	25.2	'C/W

Note 4: The package thermal impedance is calculated in accordance to JESD 51-7.

5: Thermal Resistances were simulated on a 4-layer, JEDEC board

Electrical Characteristics [6,7]

The specifications which apply over the full operating temperature range, otherwise specification are VIN=12V, (Ta=25'C; unless otherwise specified)

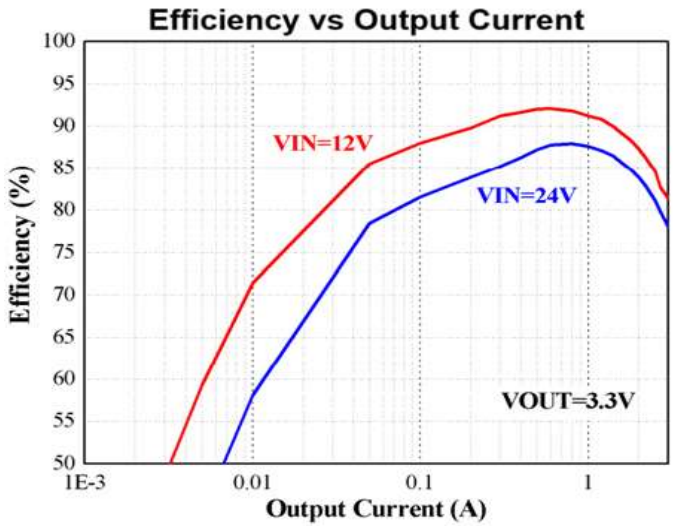
Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Input Operation Voltage	V_{in}		4.0	-	30	V
Over Voltage Protection Threshold	V_{OVPT}		-	33	-	V
Shutdown Current into VIN pin	I_{STBY}	V_{EN}=0V, V_{IN}=12V	-	-	3	uA
Quiescent Current into VIN pin	I_q	V_{IN}=12V, Out=5V, I_{load}=0A	300	400	600	uA
Regulated Feedback Voltage	V_{FB}	V_{IN}=12V	0.910	0.925	0.940	V
Output Voltage Line Regulation		V_{IN}=4.5V to 30V	-	-	1.0	%
Output Voltage Load Regulation		V_{IN}=12V, Out=5V, ΔV_{LOAD}(0-3A)	-	-	1.0	%
High-side Switch On-Resistance	R_{HS}	I_{SW}=1000mA	-	120	-	mΩ
Low-side Switch On-Resistance	R_{LS}	I_{SW}=1000mA	-	90	-	mΩ
High-side Switch Current Limit	I_{H-LIM}	V_{IN}=12V, FB=90%	3.5	-	-	A
Low-side Switch Current Limit	I_{L-LIM}	V_{IN}=12V, FB=90%	3.5	-	-	A
VIN Under-voltage Lockout Threshold	V_{ULT}	-	-	3.7	-	V
VIN Under-voltage Lockout Threshold-Hysteresis	V_{ULTH}	-	-	300	-	mV
Oscillator Frequency 1	F_{OSC}	V_{IN}=12V, Out=5V, I_{LOAD}=1A	500	680	1000	KHz
Maximum Duty Cycle	D_{MAX}	V_{FB}=0.7V	-	95	-	%
EN Input Voltage	V_{EN}	EN High Threshold	1.5	-	-	V
		EN Low Threshold	-	-	0.4	
EN Threshold Hysteresis	V_{ENTH}		-	200	-	mV
EN Leakage Current	I_{ENLC}		-	-	1.0	uA
SW Leakage Current	I_{SWLC}	V_{EN}=0V, V_{IN}=V_{SW}=24V	-	-	1.0	uA
Soft-start	ton		0.5	1	1.5	mS
Thermal Shutdown	Tstdn		-	160	-	'C
Thermal Hysteresis	T_{THY}		-	30	-	'C

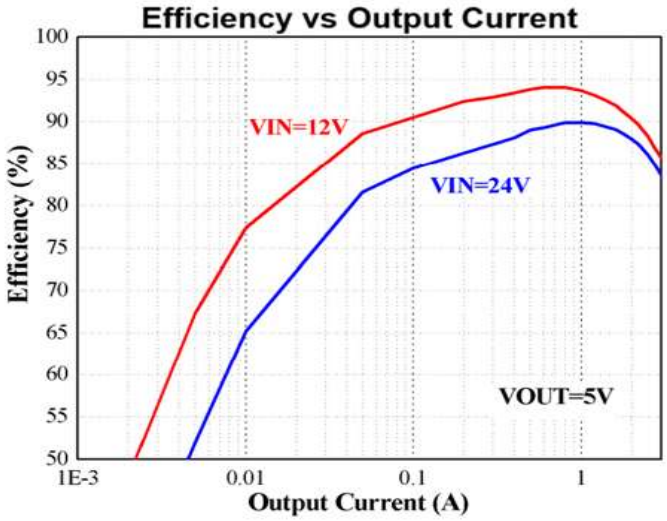
Note 6. MOSFET on-resistance specifications are guaranteed by correlation to wafer level measurements.

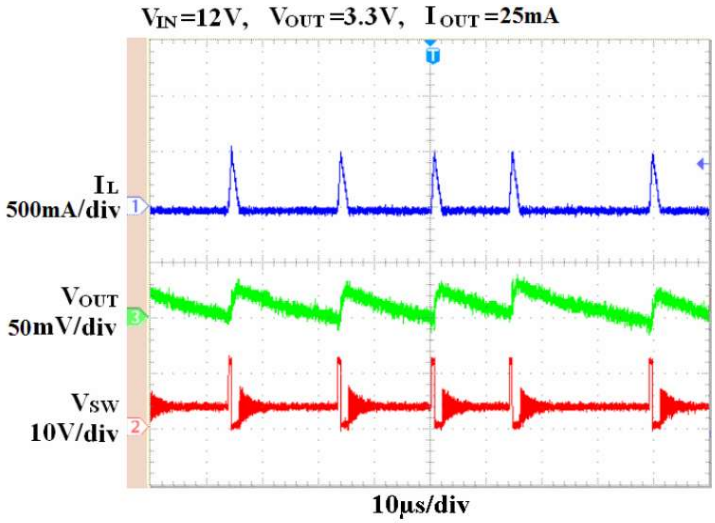
7. Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

Typical Performance Characteristics

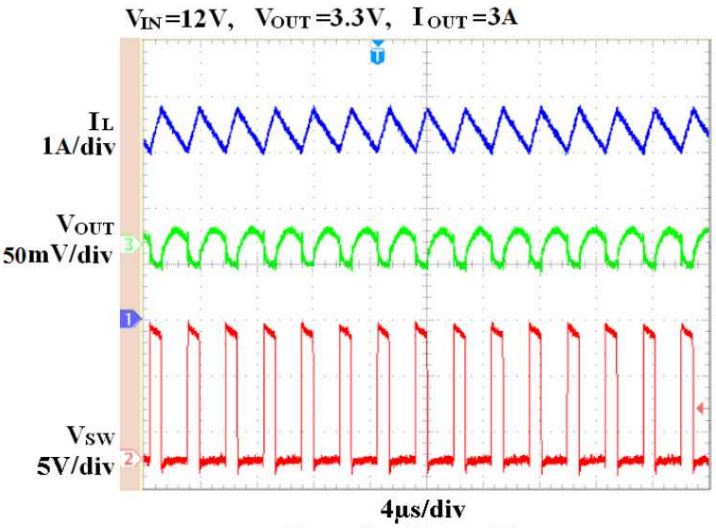
(See Figure 4, C1=10uF, C2=22uFX2, L=10uH, TA=+25'C)



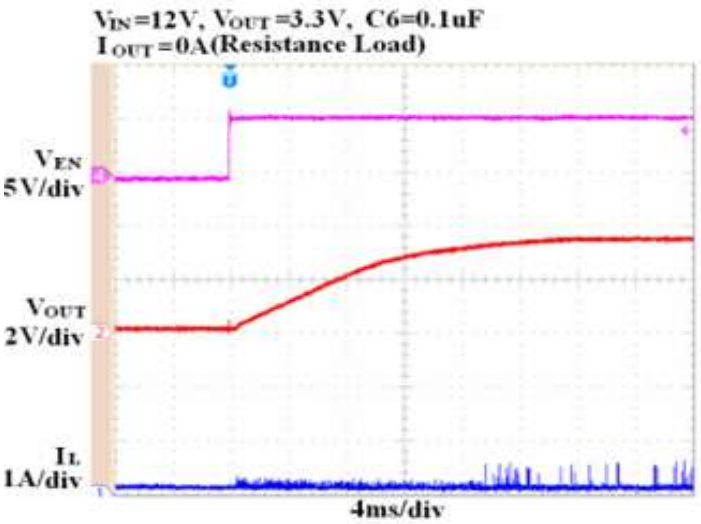




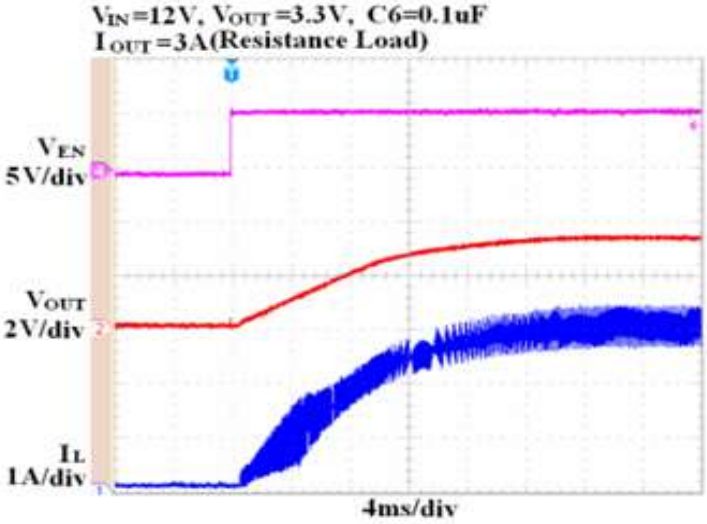
Steady State Test



Steady State Test



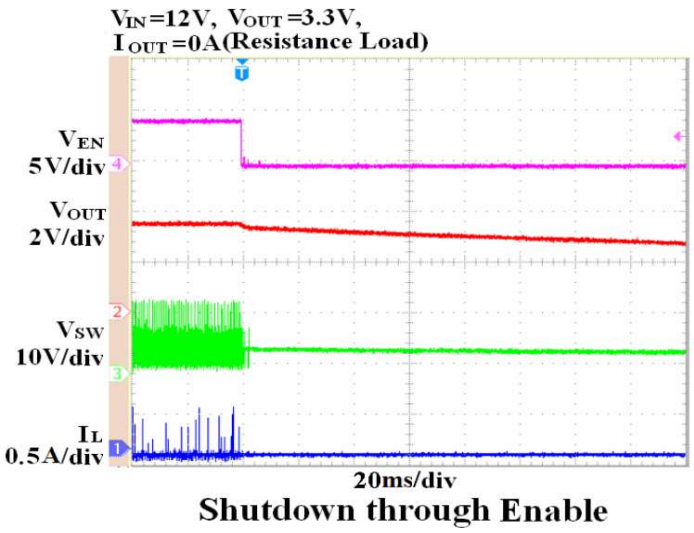
Startup through Enable



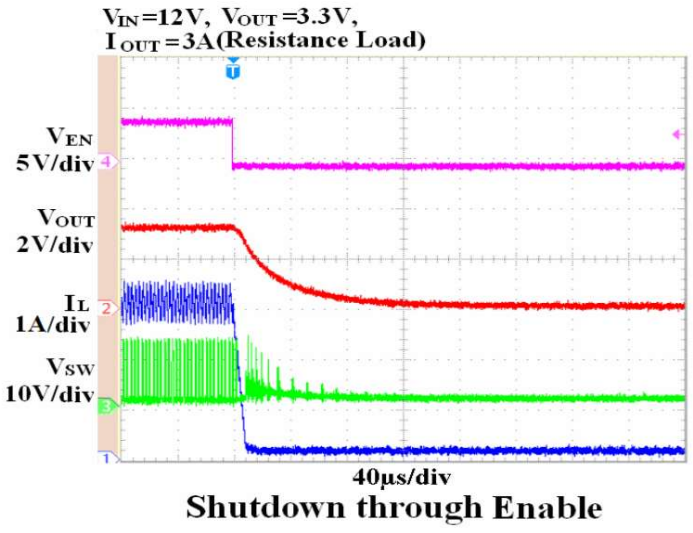
Startup through Enable

Typical Performance Characteristics (continued)

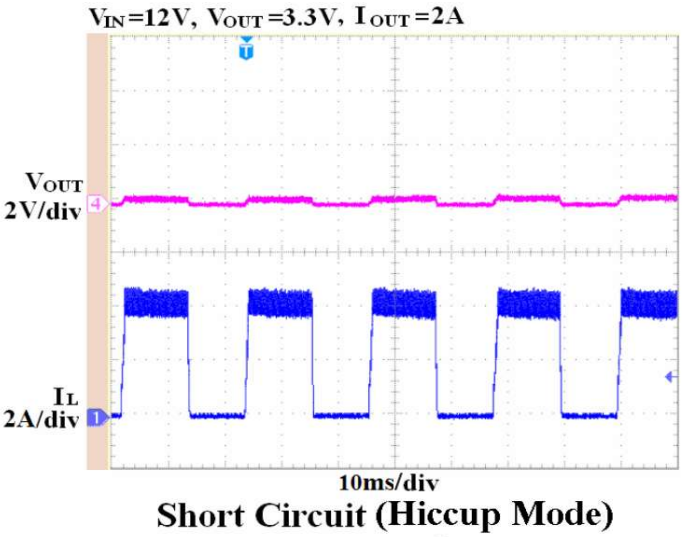
(See Figure 4, C1=10uF, C2=22uFX2, L=10uH, TA=+25'C)



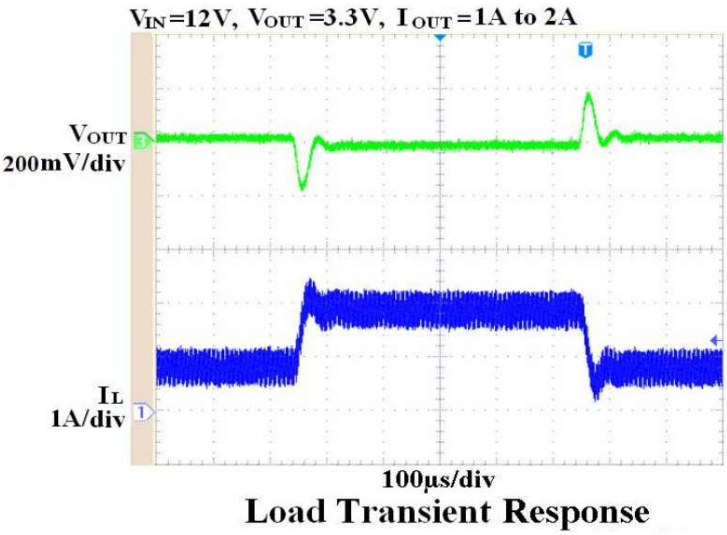
Shutdown through Enable



Shutdown through Enable



Short Circuit (Hiccup Mode)



Load Transient Response

Functional Block Diagram

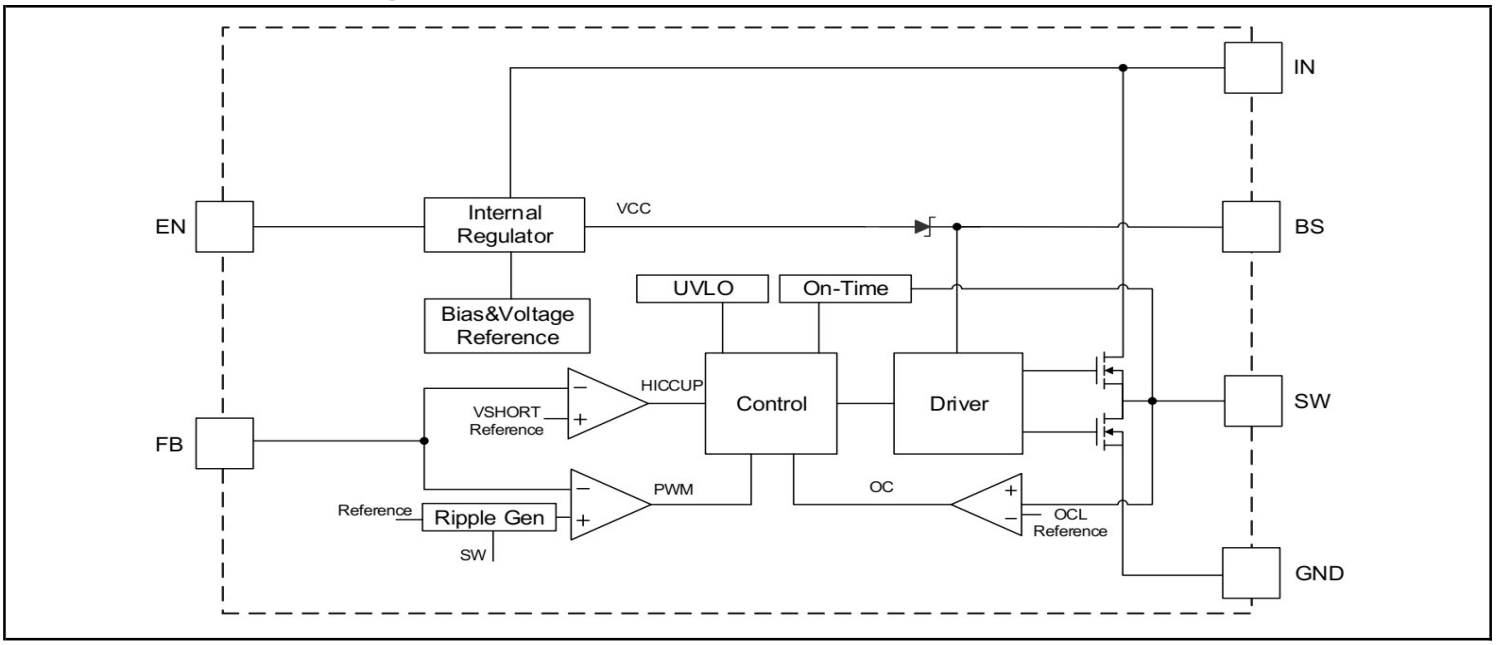


Figure 3. Functional Block Diagram of HCR3233C

Typical Application Circuit

Input Voltage and Output Voltage 3.3V or 5.0V / 3A Application Circuit, Pls refer to Table-1

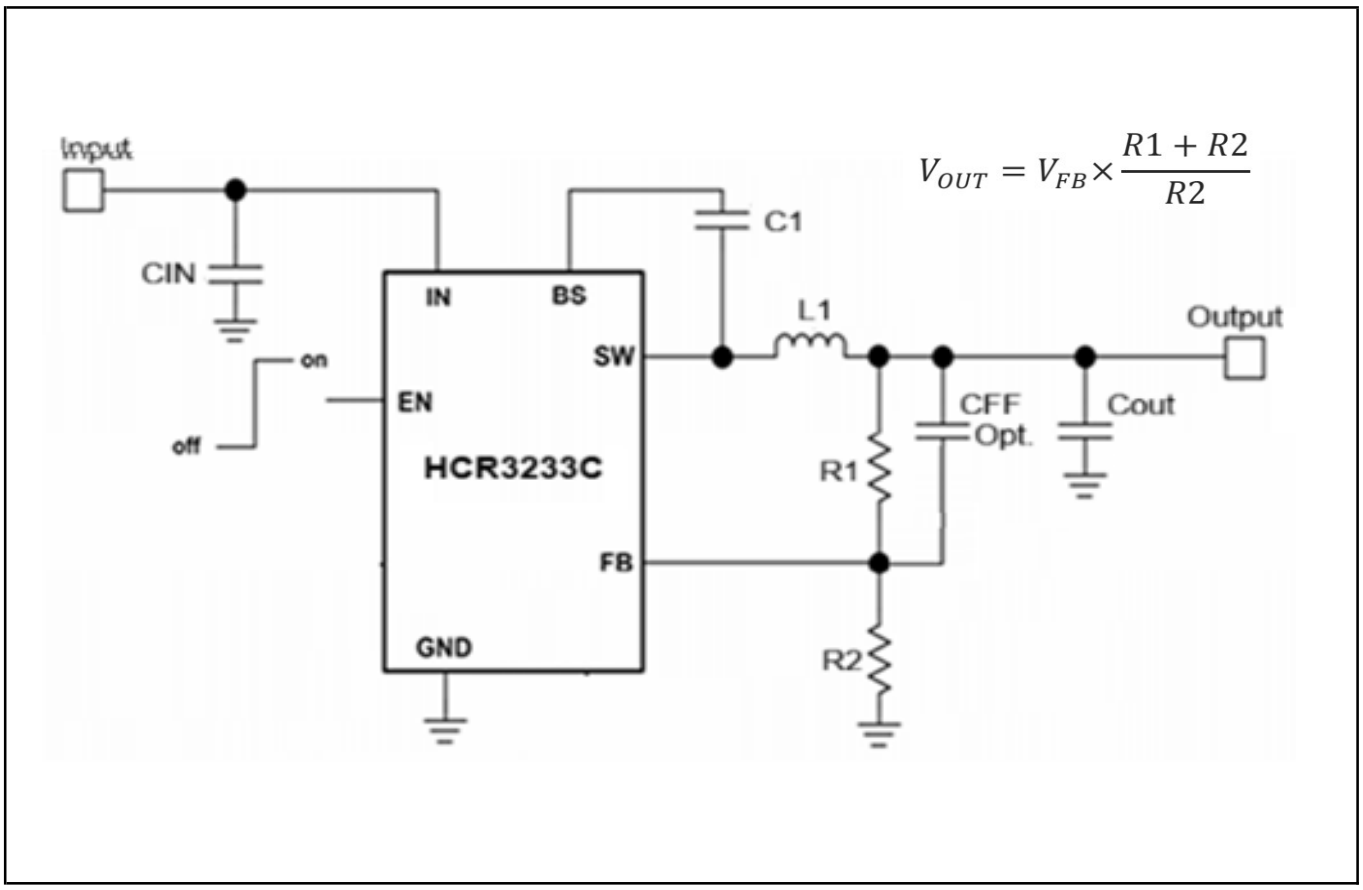


Figure 4. Adjustable Output Voltage of HCR3233C

Table-1

Vout	R1	R2	L1	C1	CIN	Cout	CFF Opt.
3.3V	26.1KΩ, 1%	10KΩ, 1%	2.2-10uH, 4A	>10V, 0.1uF X5R	10uF X5R	22uF X5R	10-100pF
5.0V	50KΩ, 1%	11.3KΩ, 1%	2.2-10uH, 4A	>10V, 0.1uF X5R	10uF X5R	22uF X5R	10-100pF

Note: The HCR3233C is not adjustable to output voltgae 12V as application.

Function Description

Internal Regulator

The HCR3233C is a COT mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 680KHz operating frequency to ensure a compact, high efficiency design with excellent AC & DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (VFB) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network, which is used to control the power MOSFET current. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Under-Voltage Lockout (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insufficient supply voltage. UVLO protection monitors the internal regulator voltage. When the voltage is lower than UVLO threshold voltage, the device is shut off. When the voltage is higher than UVLO threshold voltage, the device is enabled again.

Thermal Shutdown

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon die temperature exceeds 160°C, it shuts down the whole chip. When the temperature falls below its lower threshold (Typ. 160°C) the chip is enabled again.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.925V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally max to 1.5ms.

Startup and Shutdown

If both VIN and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Three events can shut down the chip: EN low, VIN low and thermal shutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering.The comp voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

Applications Information

Setting the Output Voltage

The HCR3233C require an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device.The HCR3233C are internally compensated and do not require external components to achieve stable operation. The output voltage can be programmed by resistor divider Please refer to the Figure 4 and Table-1

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$

V_{FB}=0.925V

Selecting the Inductor

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductor core does not saturate during any foreseeable operational situation. The inductor should be rated to handle the peak load current plus the ripple current: Care should be taken when reviewing the different saturation current ratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25°C, so ratings at maximum ambient temperature of the application should be requested from the manufacturer

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Applications Information (con.)

Selecting the Inductor

Where ΔIL is the inductor ripple current. Choose inductor ripple current to be approximately 30% if the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Selecting the Output Capacitor

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitor specifications table. The ceramic capacitor's actual capacitance can vary with temperature. The capacitor type X7R, which operates over a temperature range of -55°C to +125°C, will only vary the capacitance to within ±15%. The capacitor type X5R has a similar tolerance over a reduced temperature range of -55°C to +85°C. Many large value ceramic capacitors, larger than 1uF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by more than 50% as the temperature varies from 25°C to 85°C. Therefore X5R or X7R is recommended over Z5U and Y5V in applications where the ambient temperature will change significantly above or below 25°C. Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensive when comparing

Selecting the Output Capacitor(con.)

equivalent capacitance and voltage ratings in the 0.47uF to 44uF range. Another important consideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means that while it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have to be larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR value It should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from 25°C down to -40°C, so some guard band must be allowed.

PC Board Layout Example & Guidelines

The PCB layout is an important step to maintain the high performance of the HCR3233C device.

1.1)-The input/output capacitors and the inductor should be placed as close as possible to the IC. This keeps the power traces short. Routing these power traces direct and wide results in low trace resistance and low parasitic inductance.

1.2)-The low side of the input and output capacitors must be connected properly to the power GND to avoid a GND potential shift.

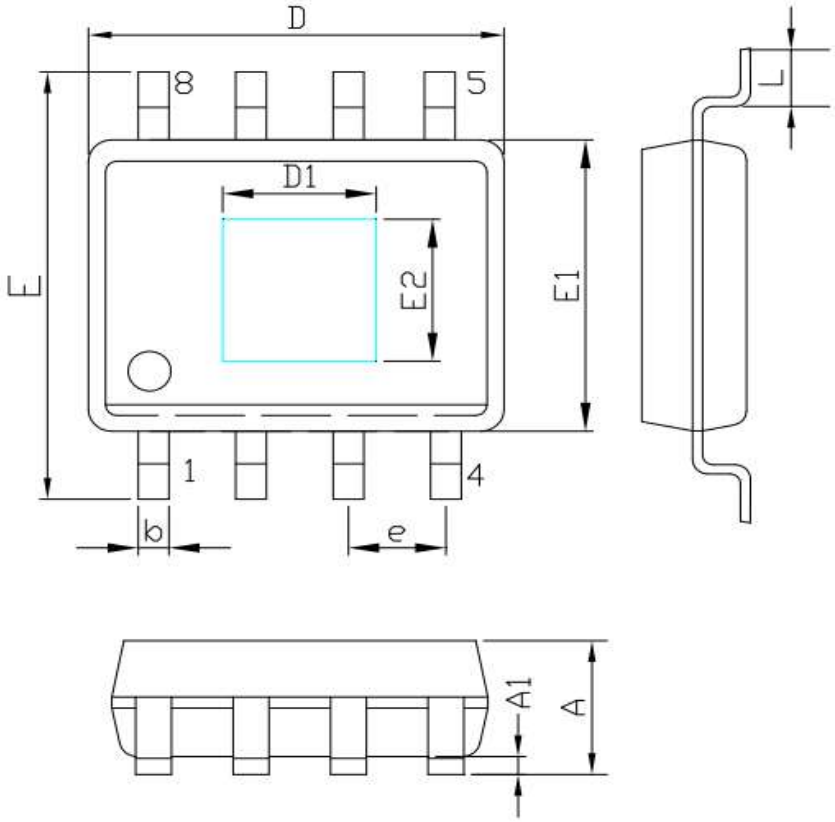
1.3)-The sense traces connected to FB are signal traces. Special care should be taken to avoid noise being

1.4)-GND layers might be used for shielding.

Mechanical Dimensions

M8E PKG: SOP-8(EP)

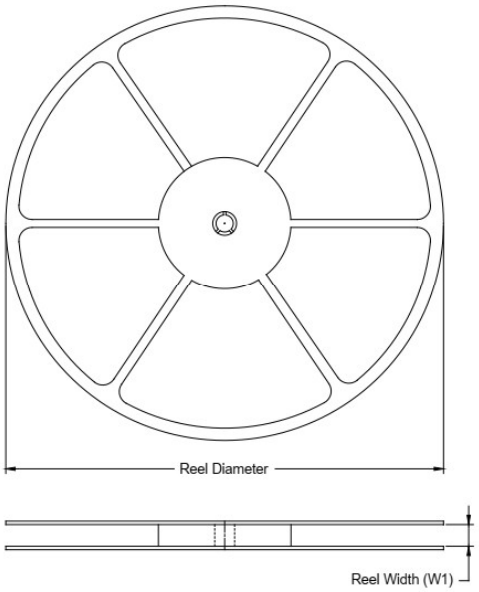
Unit: mm(inch)



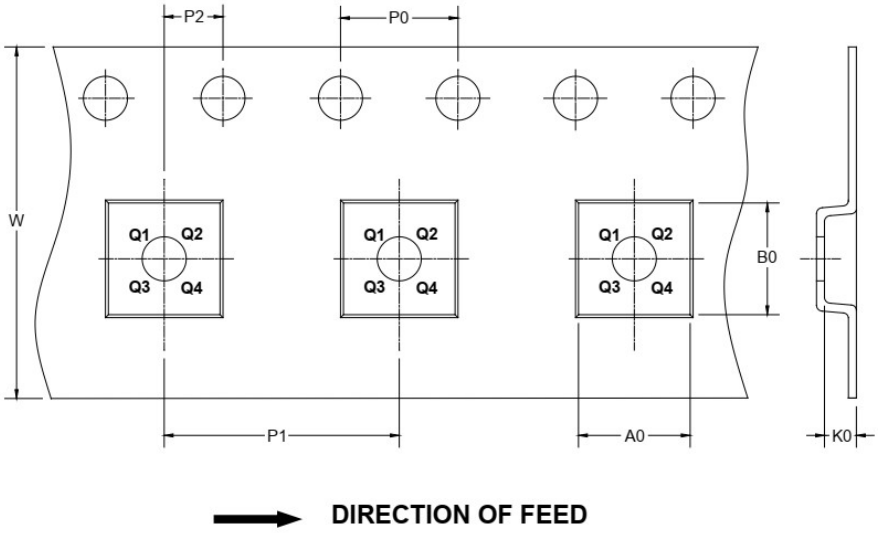
SYMBOLS	MILLIMETERS			INCHES		
	MIN.	Normal	MAX.	MIN.	Normal	MAX.
A	1.35	-	1.75	0.053	-	0.069
A1	0.00	-	0.25	0.000	-	0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
E1	3.70	3.90	4.00	0.146	0.154	0.157
D1	2.67	2.97	3.50	0.105	0.117	0.138
E2	1.78	2.18	2.60	0.070	0.086	0.102
E	5.80	6.00	6.20	0.228	0.236	0.244
L	0.40	-	1.27	0.016	-	0.050
b	0.31	-	0.51	0.012	-	0.020
e	1.27 REF			0.050 REF		

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

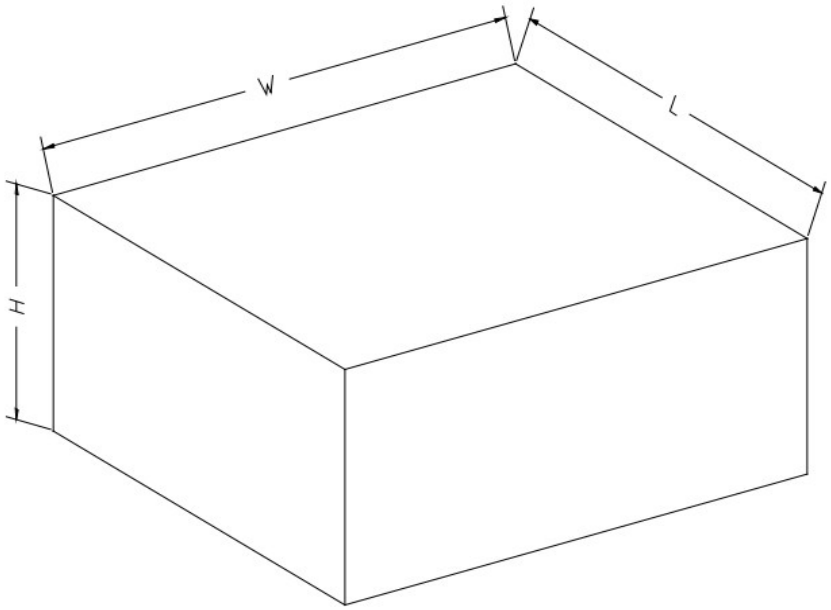


NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF TAPE AND REEL

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOP-8(EP)	13"	12.4	6.40	5.40	2.10	4.0	8.0	2.0	12.0	Q1

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13″	386	280	370	5