

## 3A 150KHz 40V Buck DC to DC Converter

### Features

- Wide 4.5V to 40V Input Voltage Range
- 3.3V, 5V, 12V and adjustable versions
- Output Adjustable from 1.23V to 37V
- Maximum Duty Cycle 100%
- Minimum Drop Out 1.5V
- Fixed 150KHz Switching Frequency
- 3A Constant Output Current Capability
- Internal Optimize Power Transistor
- High efficiency
- Excellent line and load regulation
- TTL shutdown capability
- EN pin with hysteresis function
- Built in thermal shutdown function
- Built in current limit function
- Built in second current limit function
- Available in TO-263-5L package

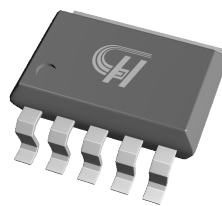
### Applications

- LCD Monitor and LCD TV
- Digital Photo Frame
- Set-up Box
- ADSL Modem
- Telecom / Networking Equipment

### General Description

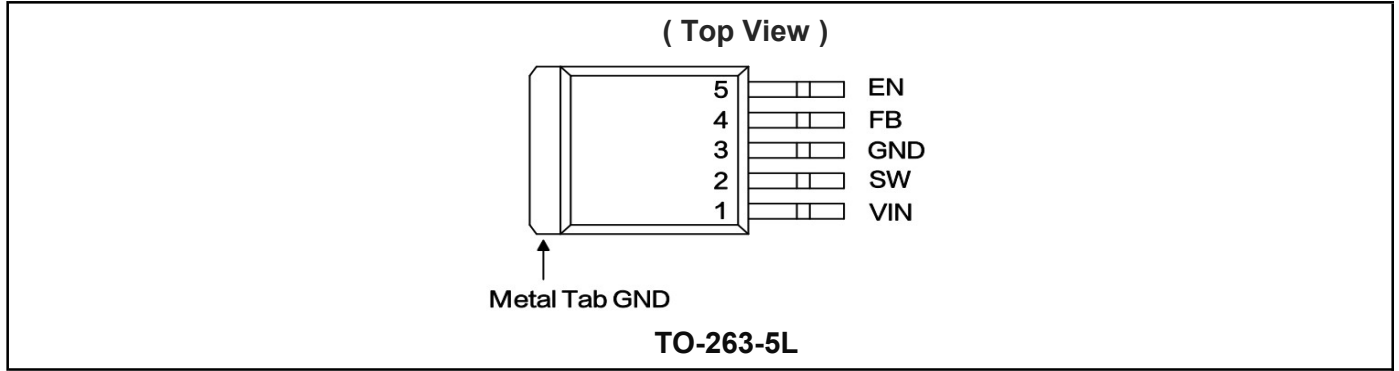
The HCR3396 is a 150 KHz fixed frequency PWM buck (step-down) DC/DC converter, capable of driving a 3A load with high efficiency, low ripple and excellent line and load regulation. Requiring a minimum number of external components, the regulator is simple to use and include internal frequency compensation and a fixed-frequency oscillator.

The PWM control circuit is able to adjust the duty ratio linearly from 0 to 100%. An enable function, an over current protection function is built inside. When second current limit function happens, the operation frequency will be reduced from 150KHz to 50KHz. An internal compensation block is built in to minimize external component count.

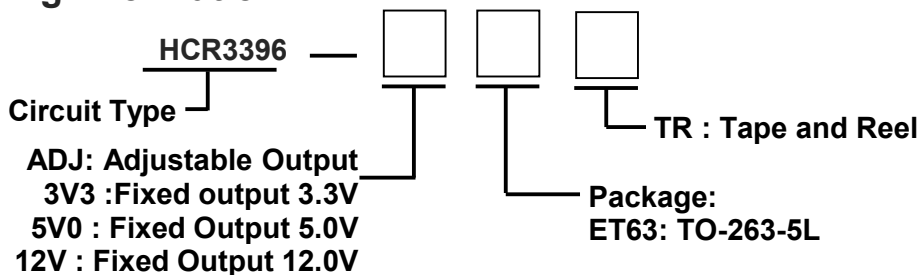


TO-263-5L

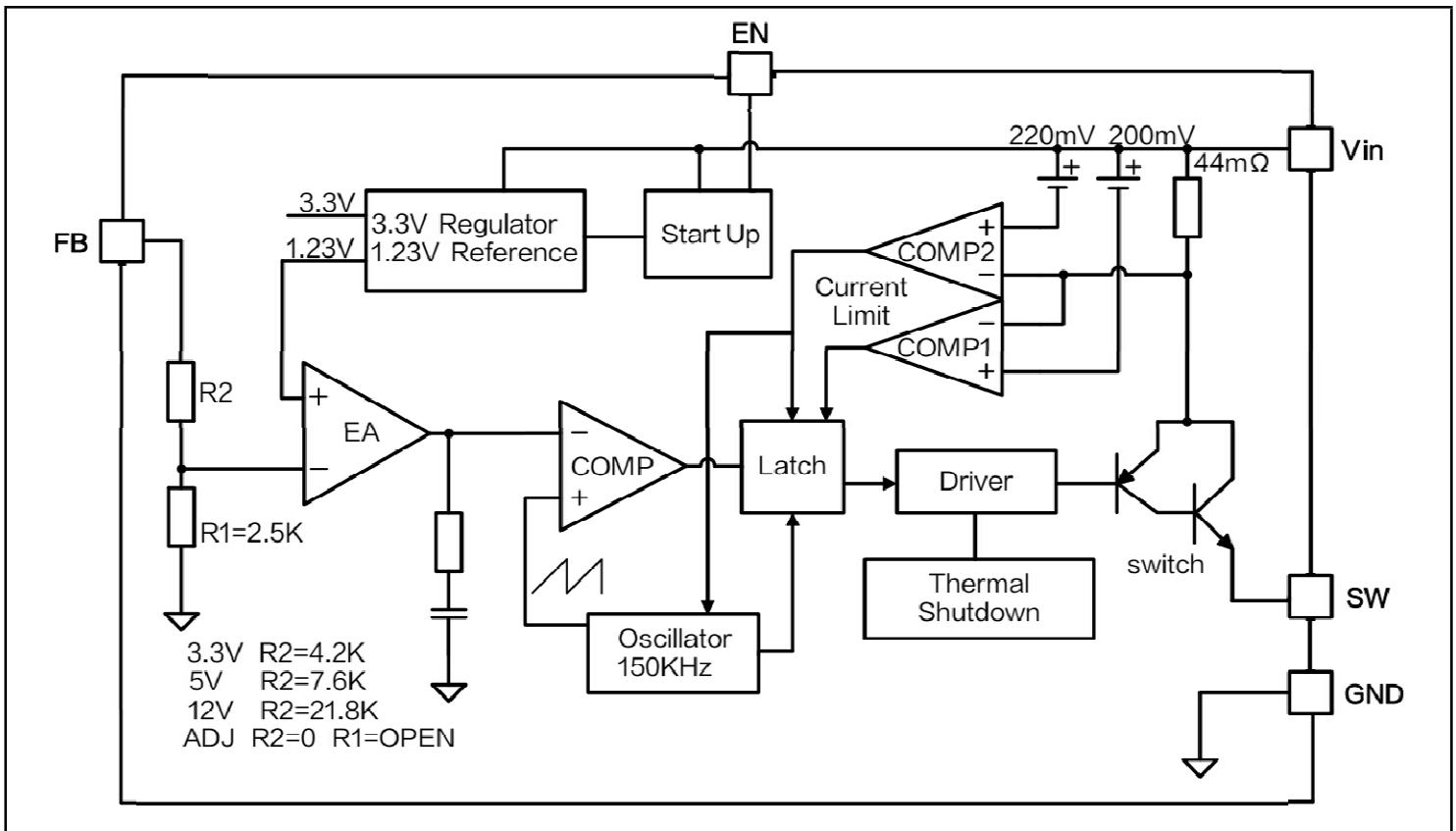
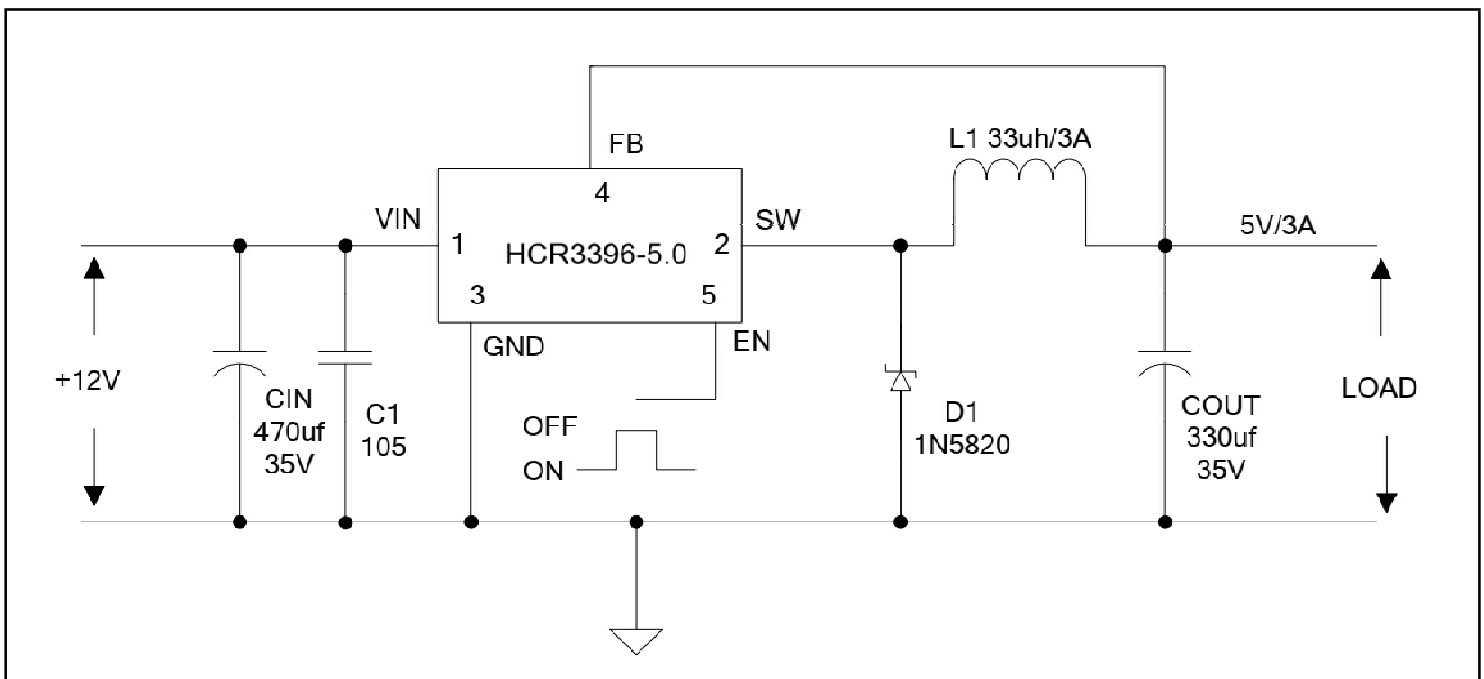
Figure 1. Package Type of HCR3396

**3A 150KHz 40V Buck DC to DC Converter**
**Pin Configuration**

**Figure 2. Pin Configuration of HCR3396 (Top View )**
**Pin Function Table**

Pin Number	Pin Name	Function
1	VIN	Supply Voltage Input Pin. HCR3396 operates from a 4.5V to 40V DC voltage. Bypass Vin to GND with a suitable large capacitor to eliminate noise on the input.
2	SW	Power Switch Output Pin (SW). Output is the switch node that supplies power to the output.
3	Gnd	Ground Pin. Care must be taken in layout. This pin should be placed outside of the Schottky Diode to output capacitor ground path to prevent switching current spikes from inducing voltage noise into HCR3396
4	FB	Feedback Pin(FB). Through an external resistor divider network. Feedback senses the output voltage and regulates it. The feedback threshold voltage is 1.23V
5	EN	Enable Pin. Drive EN pin low to turn on the device, drive it high to turn it off. Floating is default low.

**Ordering Information**

**Ordering Code**

Part Number	Marking ID	Temperature Range	Package	Package Type
HCR3396-ADJET63TR	HCR3396-ADJ	-40°C to +85°C	TO-263-5L	8000, Tape&Reel
HCR3396-3V3ET63TR	HCR3396-3.3	-40°C to +85°C	TO-263-5L	8000, Tape&Reel
HCR3396-5V0ET63TR	HCR3396-5.0	-40°C to +85°C	TO-263-5L	8000, Tape&Reel
HCR3396-12VET63TR	HCR3396-12	-40°C to +85°C	TO-263-5L	8000, Tape&Reel

**3A 150KHz 40V Buck DC to DC Converter**
**Functional Block Diagram**

**Figure 3. Functional Block Diagram of HCR3396**
**Typical Application Circuit**

**Figure 4. HCR3396 Typical Application Circuit 12V-5V/3A**

**3A 150KHz 40V Buck DC to DC Converter**
**Absolute Maximum Ratings** <sup>Note 1</sup>

Parameter		Symbol	Value	Unit
Input Voltage		V <sub>IN</sub>	-0.3 to 45	V
Feedback (FB) Pin Voltage		V <sub>FB</sub>	-0.3 to V <sub>IN</sub>	V
ON/OFF Pin Voltage		V <sub>EN</sub>	-0.3 to V <sub>IN</sub>	V
Output Switch Pin Voltage		V <sub>SW</sub>	-0.3 to V <sub>IN</sub>	V
Power Dissipation		P <sub>D</sub>	Internally limited	mW
Thermal Resistance Junction to Ambient (No Heatsink, Free Air)	TO-263-5L	R <sub>θJA</sub>	30	'C/W
Thermal Resistance Junction to Case	TO-263-5L	R <sub>θJC</sub>	6	'C/W
Storage Temperature Range		T <sub>STG</sub>	-65 to 150	'C
Operating Junction Temperature <sup>note 2</sup>		T <sub>J</sub>	-40 to 125	'C
Lead Temperature (Soldering, 10s)		T <sub>LEAD</sub>	260	'C
Human Body Model ESD Protection		ESD HBM	2	KV
Machine Model ESD Protection		ESD MM	200	V

Note 1: Stresses greater than those listed under Maximum Ratings may cause permanent damage to the device.

This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Parameter	Symbol	Min.	Max.	Unit
Input Operation Voltage	V <sub>IN</sub>	4.5	40	V
Operation Junction Temperature	T <sub>J</sub>	-40	+125	'C
Operation Working Temperature	T <sub>A</sub>	-40	+85	'C

**3A 150KHz 40V Buck DC to DC Converter**
**Electrical Characteristics( DC Parameters )**

Vin=12V, for the 3.3V, 5V and Adjustable Versions and Vin=24V for the 12V version, GND=0V, Vin&GND parallel connect a 220uF/50V capacitor; Iout=500mA, ( Ta=25°C; unless otherwise specified )

Parameter	Symbol	Test Condition	Min	Type	Max	Unit
Input Operation Voltage	Vin		4.5	-	40	V
Output Voltage refer to figure-7	VOUT	Vin=4.75V to 40V Iload=0.2A to 3A	3.168	3.3	3.432	V
Efficiency	$\eta$	Vin=12V, Vout=3.3V Iout=3A	-	75	-	%
Output Voltage refer to figure-8	VOUT	Vin=7V to 40V Iload=0.2A to 3A	4.8	5.0	5.2	V
Efficiency	$\eta$	Vin=12V, Vout=5.0V Iout=3A	-	82	-	%
Output Voltage refer to figure-9	VOUT	Vin=15V to 40V Iload=0.2A to 3A	11.52	12.0	12.48	V
Efficiency	$\eta$	Vin=25V, Vout=12V Iout=3A	-	91	-	%
Output Voltage refer to figure-10	VOUT	Vin=4.5V to 40V Iload=0.2A to 3A	1.193	1.23	1.267	V
Efficiency	$\eta$	Vin=12V, Vout=3V Iout=3A	-	75	-	%
Shutdown Supply Current	IS	VON/OFF=5V	-	80	200	uA
Quiescent Supply Current	Iq	VON/OFF=0V, VFB=Vin	-	2	10	mA
Oscillator Frequency	FOSC		127	150	173	KHz
Switch Current Limit	IL	VFB=0	3.6	4.8	6.9	A
ON/OFF Pin Threshold	VEN	High (Regulator OFF)	-	1.4	-	V
		Low (Regulator ON)	-	0.8	-	
ON/OFF Pin Input leakage Current	IH	VON/OFF=2.5V(OFF)	-	5	15	uA
	IL	VON/OFF=0.5V(ON)	-	0.2	5.0	
Output Saturation Voltage	VCE	VFB=0, Iout=3A	-	1.3	1.5	V
Max. Duty Cycle	DMAX	VFB=0	-	100	-	%

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## Test Circuit and Layout guidelines

### Fixed Output Voltage Versions

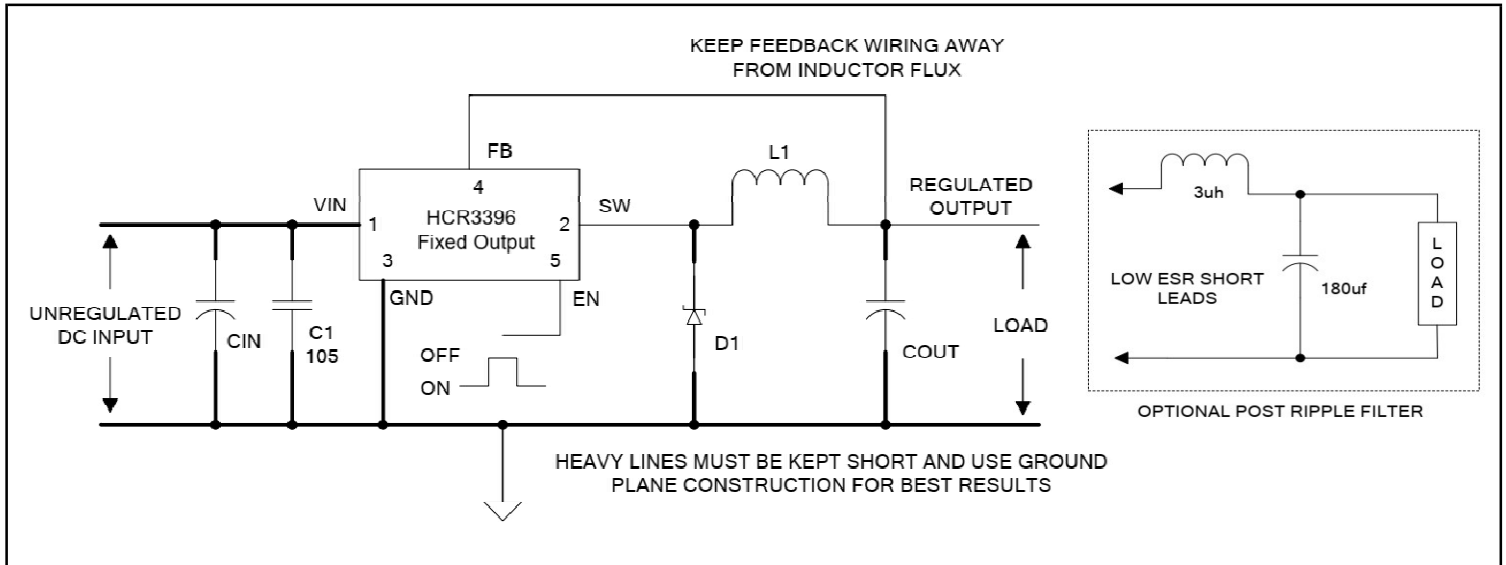


Figure 5. Fixed Output Voltage of HCR3396

### Adjustable Output Voltage Versions.

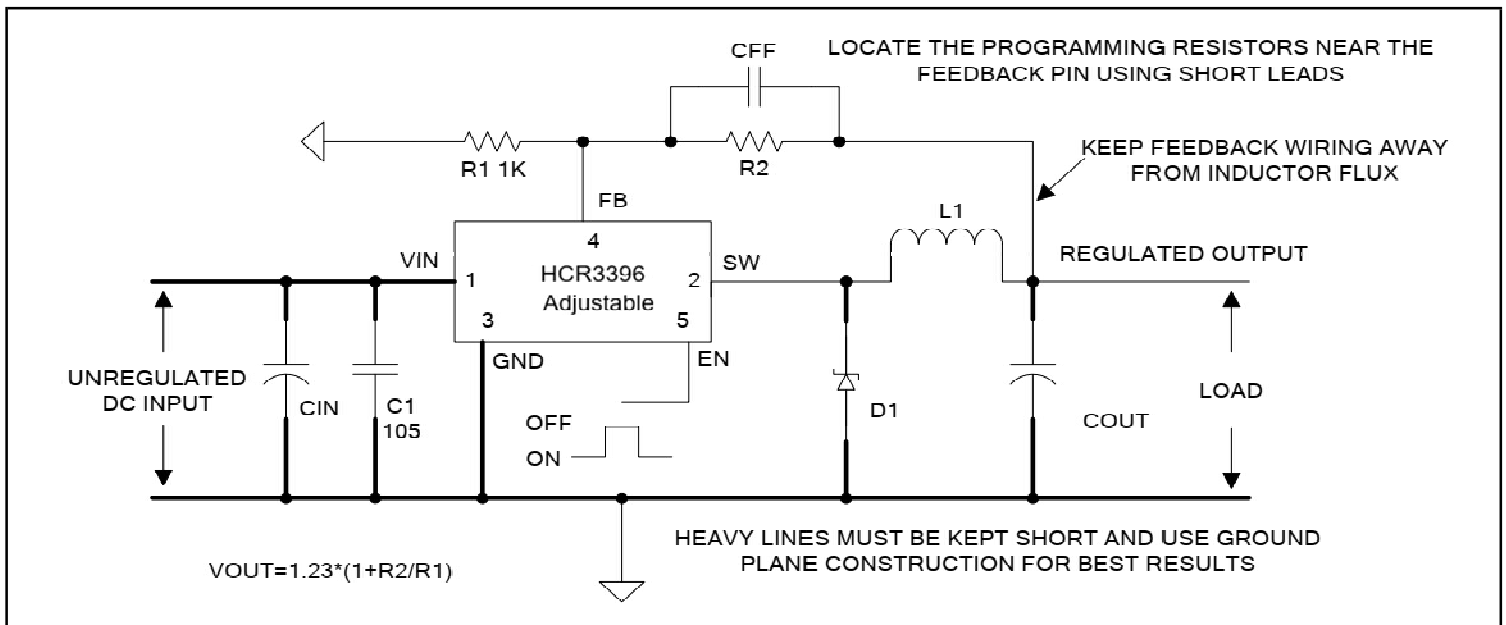


Figure 6. Adjustable Output Voltage of HCR3396-ADJ

Select R1 to be approximately 1KΩ, use a +/-1% resistor for best stability. C1 and CFF are optional; in order to increase stability and reduce the input power line noise, C1N and C1 must be placed near to PIN1 and PIN3; for output voltages greater than approximately 10V, an additional capacitor CFF is required. The compensation capacitor is typically between 100pF and 33nF, and is wired in parallel with the output voltage setting resistor R2. It provides additional stability for high output voltage, low input-output voltages, and/or very low ESR output capacitors, such as solid tantalum capacitors.  $CFF=1/(31*1000*R2)$ ; This capacitor type can be ceramic, Plastic, silver mica, etc (Because of the unstable characteristics of ceramic capacitors made with Z5U material, They are not recommended.)

**3A 150KHz 40V Buck DC to DC Converter**
**Buck Regulator Design Procedure (Fixed Output) of HCR3396**

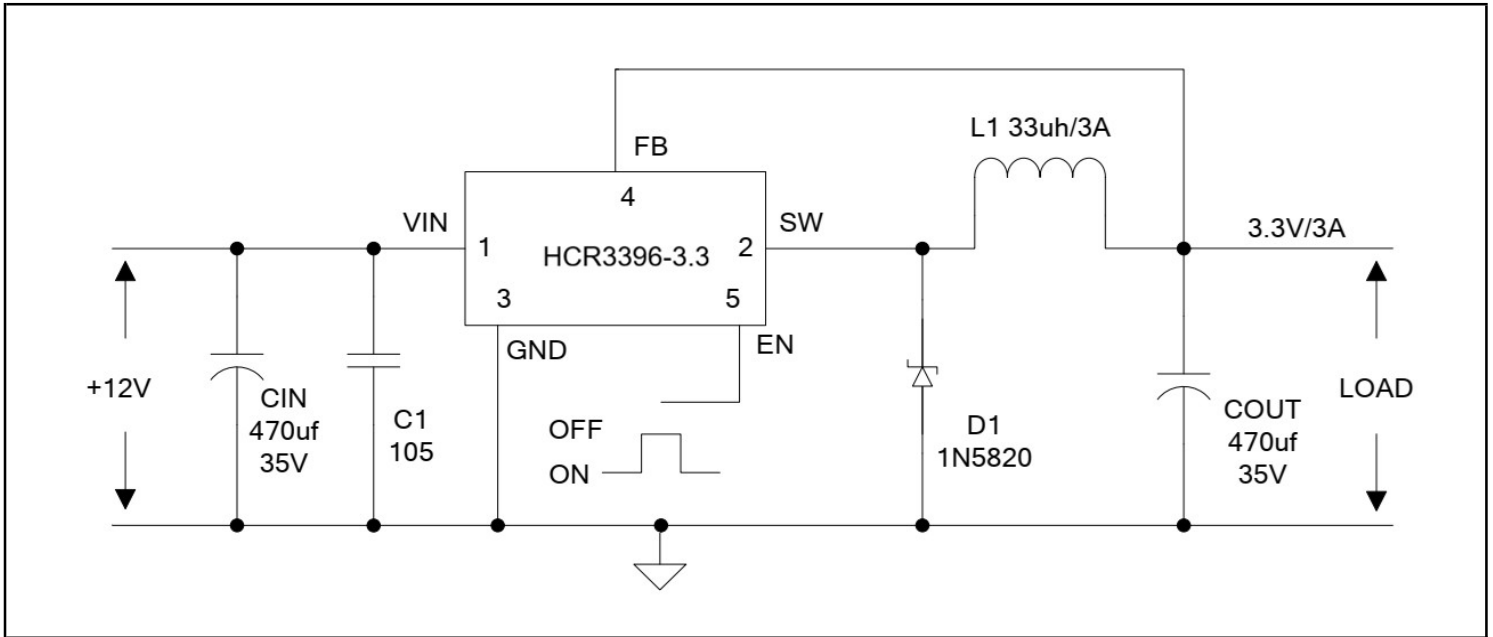
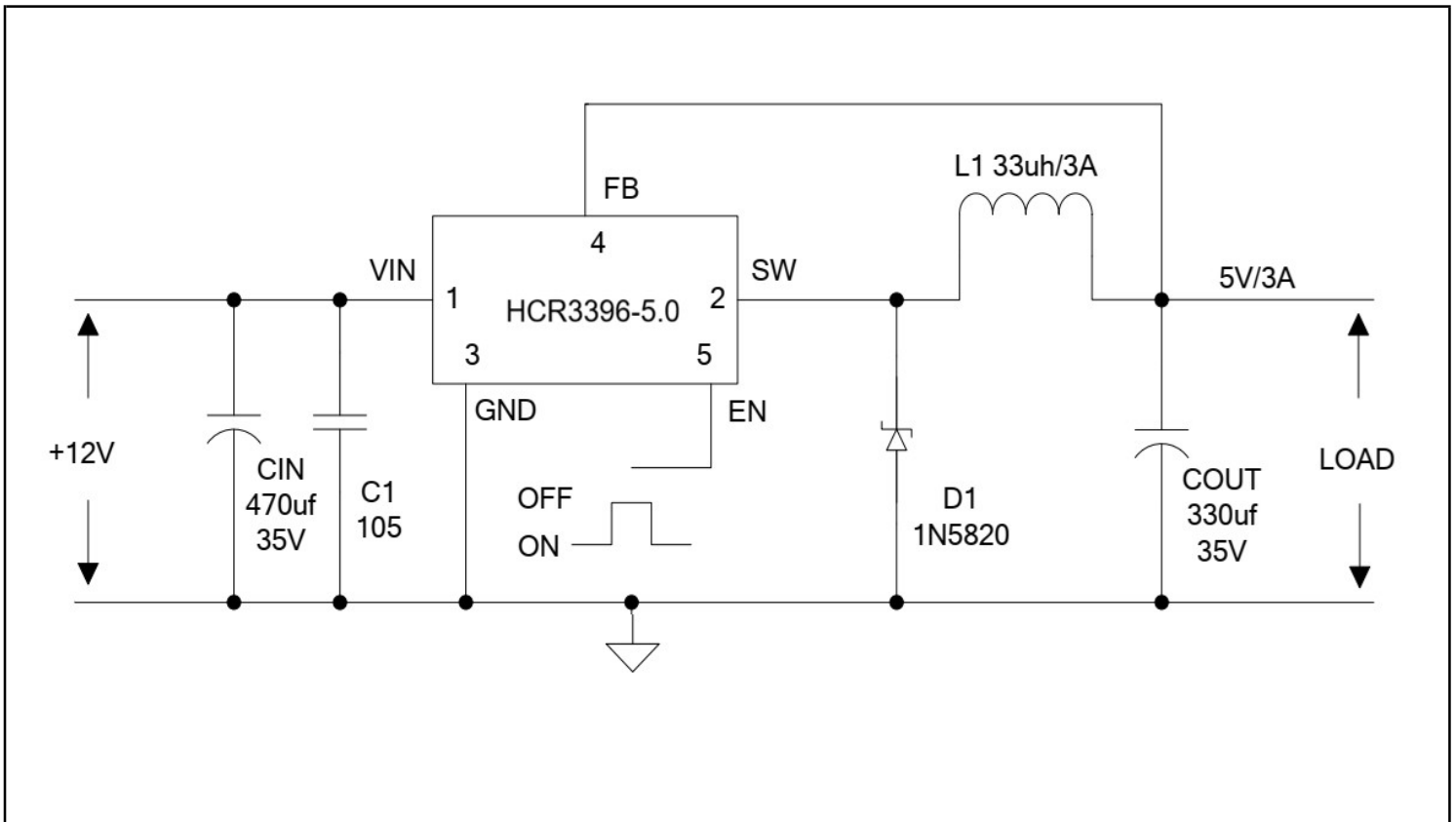
Conditions			Inductor	Output Capacitor ( COUT )			
			( L1 )	Through Hole Electrolytic		Surface Mount Tantalum	
Output Voltage	Load Current	Max Input Voltage	Inductance	Panasonic HFQ Series	Nichicon PL Series	AVX TPS Series	Sprague 595D Series
( V )	( A )	( V )	( uH )	( uF/V )	( uF/V )	( uF/V )	( uF/V )
3.3	3.0	5	22	470 / 25	560 / 16	330 / 6.3	390 / 6.3
		7	22	560 / 35	560 / 35	330 / 6.3	390 / 6.3
		10	22	680 / 35	680 / 35	330 / 6.3	390 / 6.3
		40	33	560 / 35	470 / 35	330 / 6.3	390 / 6.3
	2.0	6	22	470 / 25	470 / 35	330 / 6.3	390 / 6.3
		10	33	330 / 35	330 / 35	330 / 6.3	390 / 6.3
		40	47	330 / 35	270 / 35	220 / 10	330 / 10
5.0	3.0	8	22	470 / 25	560 / 16	220 / 10	330 / 10
		10	22	560 / 35	560 / 25	220 / 10	330 / 10
		15	33	330 / 35	330 / 35	220 / 10	330 / 10
		40	47	330 / 35	270 / 35	220 / 10	330 / 10
	2.0	9	22	470 / 25	560 / 16	220 / 10	330 / 10
		20	68	180 / 35	180 / 35	100 / 10	270 / 10
		40	68	180 / 35	180 / 35	100 / 10	270 / 10
12.0	3.0	15	22	470 / 25	470 / 25	100 / 16	180 / 16
		18	33	330 / 25	330 / 25	100 / 16	180 / 16
		30	68	180 / 25	180 / 25	100 / 16	120 / 20
		40	68	180 / 35	180 / 25	100 / 16	120 / 20
	2.0	15	33	330 / 25	330 / 25	100 / 16	180 / 16
		20	68	180 / 25	180 / 35	100 / 16	120 / 20
		40	150	82 / 25	82 / 25	68 / 20	68 / 25

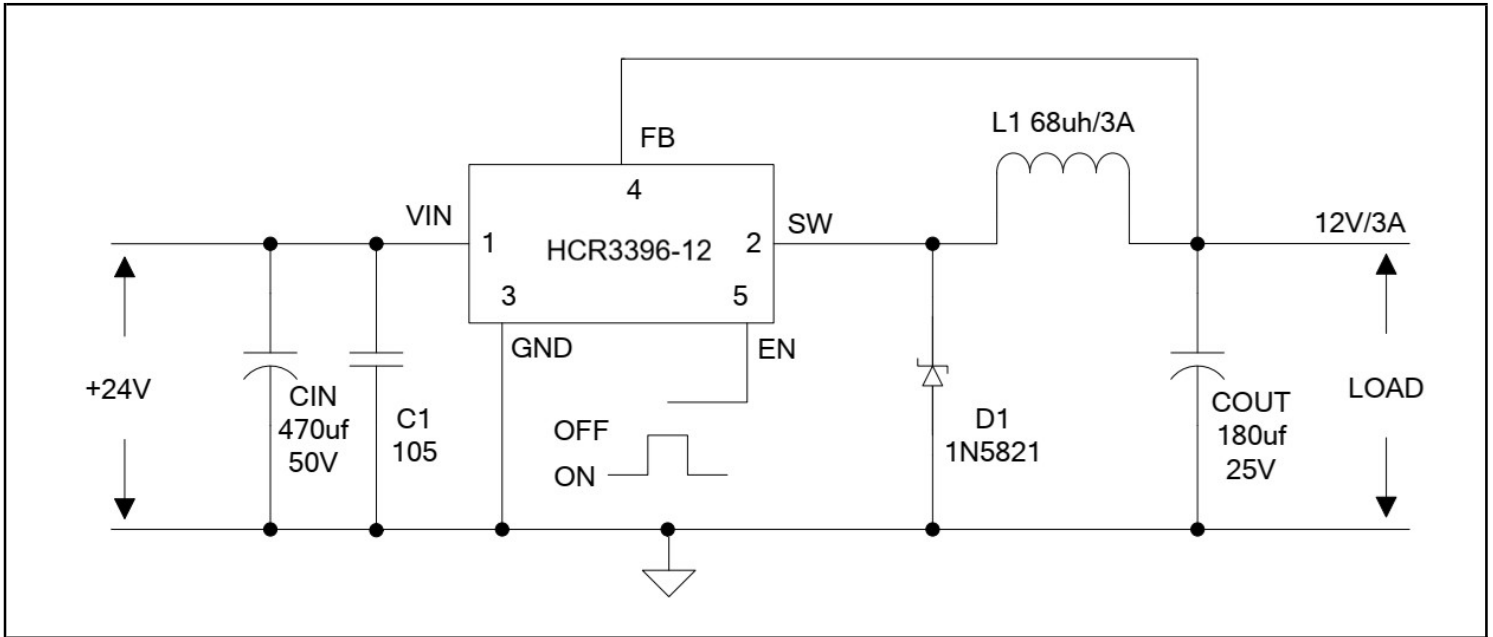
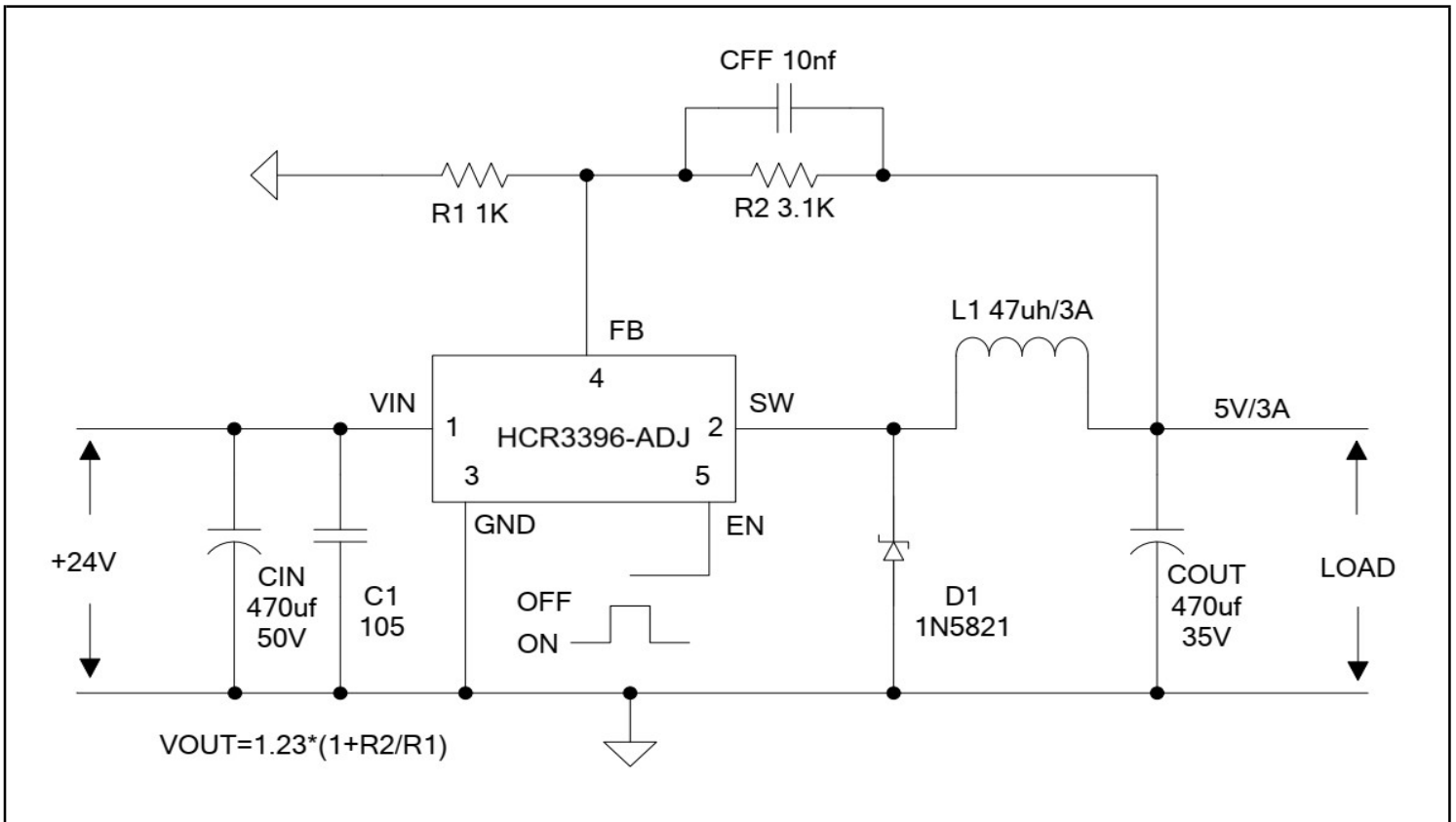
**3A 150KHz 40V Buck DC to DC Converter**
**Buck Regulator Design Procedure (Adjustable Output) of HCR3396 Series**

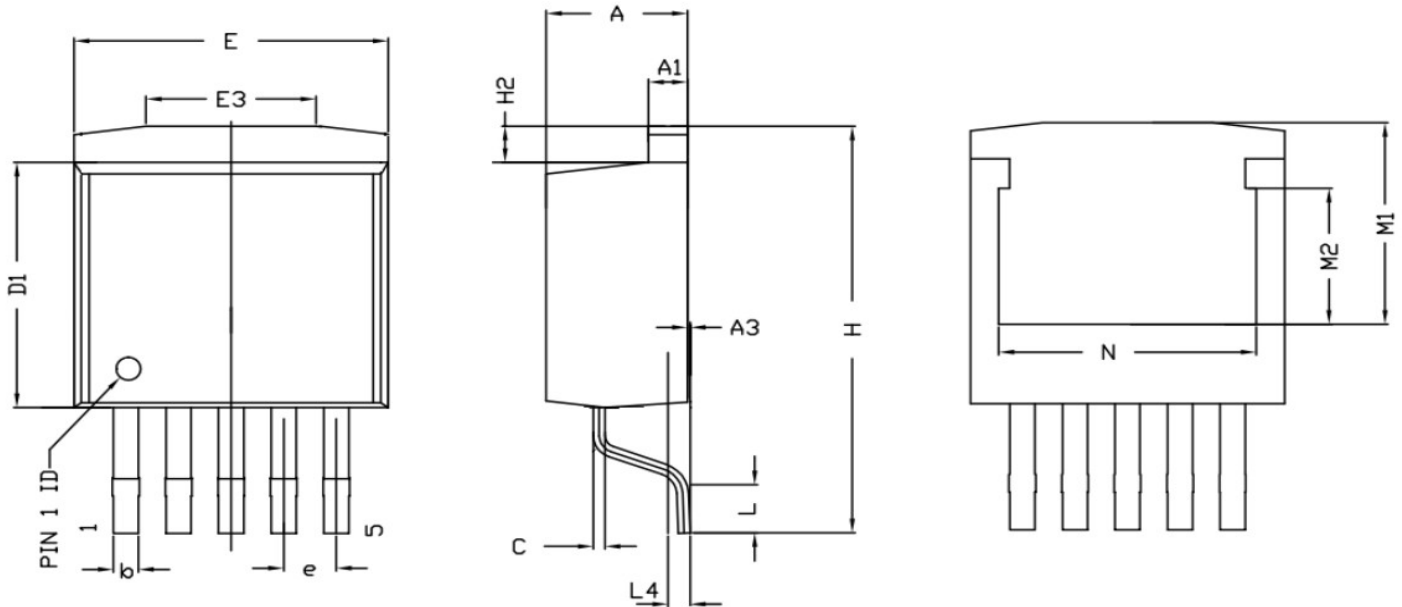
Output Voltage ( V )	Through Hole Electrolytic			Surface Mount Tantalum		
	Panasonic HFQ Series ( uF/V )	Nichicon PL Series ( uF/V )	Feedforward Capacitor	AVX TPS Series ( uF/V )	Sprague 595D Series ( uF/V )	Feedforward Capacitor
2.0	820 / 35	820 / 35	33nF	330 / 6.3	470 / 4.0	33nF
4.0	560 / 35	470 / 35	10nF	330 / 6.3	390 / 6.3	10nF
6.0	470 / 25	470 / 35	3.3nF	220 / 10	330 / 10	3.3nF
9.0	330 / 25	330 / 25	1.5nF	100 / 16	180 / 16	1.5nF
12.0	330 / 25	330 / 25	1nF	100 / 16	180 / 16	1nF
15.0	220 / 25	220 / 35	680pF	68 / 20	120 / 20	680pF
24.0	220 / 35	150 / 35	560pF	33 / 25	33 / 25	220pF
28.0	100 / 50	100 / 50	390pF	10 / 35	15 / 50	220pF

**Schottky Diode Selection Table**

Current	Surface Mount	Through Hole	VR ( The same as system maximum input voltage )				
			20V	30V	40V	50V	60V
1A		√	1N5817	1N5818	1N5819		
3A		√	1N5820	1N5821	1N5822		
		√	MBR320	MBR330	MBR340	MBR350	MBR360
	√		SK32	SK33	SK34	SK35	SK36
	√			30WQ03	30WQ04	30WQ05	
		√		31DQ03	31DQ04	31DQ05	
		√		SR302	SR303	SR304	SR305
5A		√	1N5823	1N5824	1N5825		
		√	SR502	SR503	SR504	SR505	SR506
		√	SB520	SB530	SB540	SB550	SB560
	√			50WQ03	50WQ04	50WQ05	

**3A 150KHz 40V Buck DC to DC Converter**
**Typical System Application for 3.3V Version**

**Figure 7. HCR3396-3.3 System Parameters Test Circuit**
**Typical System Application for 5.0V Version**

**Figure 8. HCR3396-5.0 System Parameters Test Circuit**

**3A 150KHz 40V Buck DC to DC Converter**
**Typical System Application for 12V Version**

**Figure 9. HCR3396-12V System Parameters Test Circuit**
**Typical System Application for ADJ Version**

**Figure 10. HCR3396-ADJ System Parameters Test Circuit**

**3A 150KHz 40V Buck DC to DC Converter**
**Mechanical Dimensions**
**PKG: TO-263-5L ( ET63 )**
**Unit: mm( inch )**


Symbol	Dimensions In Millimeters			Dimensions In Inches		
	Min.	Nom.	Max.	Min.	Nom.	Max.
A	4.37	4.57	4.77	0.172	0.180	0.188
A1	1.17	1.27	1.42	0.046	0.050	0.056
A3	0.00	0.13	0.25	0.000	0.005	0.010
b	0.71	0.81	0.97	0.028	0.032	0.038
c	0.33	0.38	0.76	0.013	0.015	0.030
D1	8.38	8.70	9.00	0.330	0.343	0.354
E	9.90	10.16	10.39	0.390	0.400	0.410
E3	5.00	6.50	8.00	0.197	0.256	0.315
e	1.70 REF.			0.067 REF.		
H	13.00	13.85	14.35	0.511	0.545	0.565
H2	0.90	1.27	1.42	0.035	0.050	0.056
L	1.68	1.98	2.28	0.066	0.078	0.090
L4	0.56	0.76	0.96	0.022	0.030	0.038
M1	6.00	7.11	8.00	0.236	0.280	0.315
M2	-	4.80	-	-	0.189	-
N	7.30	8.33	9.30	0.287	0.328	0.366