24V, 500mA Low Dropout Voltage Linear Regulator

Features

- Wide Input Voltage Range: 2V to 24V
- 1.5uA Ground Current at no Load
- ±1% Output Accuracy
- 500mA Output Current
- 100nA Disable Current
- Dropout Voltage:0.35V at 100mA / VOUT 5V
- Fixed Output Voltage:1.8V, 3.3V and 5V
- Adjustable Output Voltage Available by Specific Application
- Stable with Ceramic or Tantalum Capacitor
- Current Limit Protection
- Over-Temperature Protection
- SOT23-5 package Available

Applications

- Prtable, Battery Powered Equipement
- Low Power Microcontrollers
- Laptop, Palmtops and PDAs
- Wireless Communication Equipment
- Audio/Video Equipment
- Car Navigation Systems
- Industrial Controls
- Weigh Scales
- Meters and Home Automation

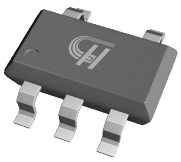
General Description

The HCR2416 series are a group of low-dropout (LDO) voltage regulators offering the benefits of wide input voltage range, low dropout voltage,low power consumption, and miniaturized packaging.

Quiescent current of only 1.5μA makes these devices ideal for powering the battery powered, always on systems that require very little idle-state power dissipation to a longer service life. There is a shutdown mode by pulling the EN pin low. The shutdown current in this mode goes down to only 100nA (typical).

The HCR2416 series of linear regulators are stable with the ceramic output capacitor over its wide input range from 2V to 24V and the entire range of output load current (0mA to 500mA). The HCR2416 has 1.8V, 3.3V and 5.0V fixed voltage versions and adjustable voltage version.

The HCR2416 is available in the SOT23-5 packages. It operates over an ambient temperature range of -40'C to +85'C.



SOT23-5

Figure 1. Package Type of HCR2416

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Pin Configuration

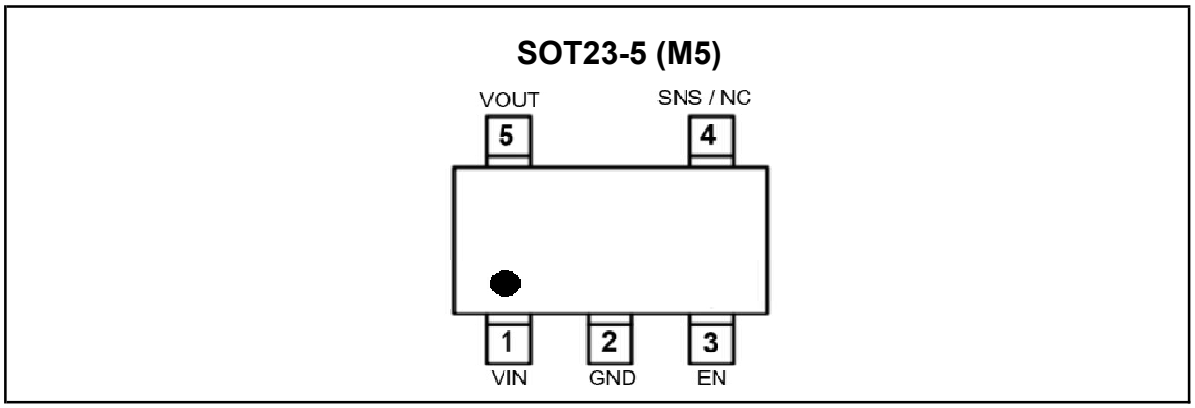

Figure 2. Pin Configuration of HCR2416 (Top View)

Pin Description

Pin Number	Pin Name	Pin Function
1	VIN	Input of Supply Voltage
2	GND	Ground
3	EN	Enable Control Input
4	NC	No internal Connected for fixed Version
	SNS	Adjust Output for ADJ Version, VOUT=(R1+R2)/R2X1.8V, And R2<36KΩ.
5	VOUT	Regulated Output Voltages

Ordering Information

HCR2416 / □ □ □

Circuit Type

ADJ: Adjustable Output
1V8: Fixed Output 1.8V
3V3: Fixed Output 3.3V
5V0: Fixed Output 5.0V

Package:
M5: SOT23-5.

TR : Tape and Reel

Standard	Voltage	Marking ID	Package	Tape & Reel
HCR2416/ADJM5TR note1	ADJ	AADU **	SOT23-5	3000pcs, Tape&Reel
HCR2416/1V8M5TR	1.8V	AADU **	SOT23-5	3000pcs, Tape&Reel
HCR2416/3V3M5TR	3.3V	AADV **	SOT23-5	3000pcs, Tape&Reel
HCR2416/5V0M5TR	5.0V	AADX **	SOT23-5	3000pcs, Tape&Reel

Note1. ADJ =(R1+R2)/R2X1.8V, and R2<36KΩ, The ** is Year and week code

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Absolute Maximum Ratings Note 2

Parameter		Symbol	Value		Unit
Supply Input Voltage		V_{IN}	-0.3V to 28V		V
Enable Input Voltage		V_{EN}	-0.3V to 28V		V
SNS to GND		V_{SNS}	-0.3V to 6.5V		V
VOUT to GND	HCR2416/1V8	V_{OUT}	-0.3V to 6.5V		V
	HCR2416/3V3				
	HCR2416/5V0				
VOUT to VIN		-	-27V to 0.3V		V
Lead Temperature(Soldering, 10sec)		T_{LEAD}	260		`C
Operating Junction Temperature		T_J	150		`C
ESD (Machine Mode)			200		V
ESD (Human Body Mode)			2000		V
Storage Temperature Range		T_{STG}	-40 to 150		`C
Thermal Resistance (No Heatsink)		θ_{JA} note3	SOT-23-5	220	`C / W

Note 2: Stresses greater than those listed under " Absolute Maximum Ratings " may cause permanent damage to the device. There are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under " Recommended Operating Conditions " is not implied. Exposure to " Absolute Maximum Ratings "for extended periods may affect device reliability .

3: θ_{JA} is measured with the component mounted on a 2-Layer FR-4 PCB board with 1.5cmX1.5cm thermal sink pad in free air.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Unit
Supply Input Voltage	V_{IN}	2.0	24.0	V
Junction Ambient Temperature	T_J	-40	+125	`C
Operating Ambient Temperature	T_J	-40	+85	`C

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Electrical Characteristics

(Vin=12V , VEN=5V, TA=25 `C, unless other-wise specified.)

Parameter	Symbol	Condition	Min	Type	Max	Unit
Input Voltage	VIN		2.0	-	24	V
DC Output Voltage Accuracy	VOUT	ILOAD=0.1mA	VOUT X 99%	-	VOUT X 101%	V
Output Peak Load Current	IOUT	VIN=VOUT+1.8V	-	500	-	mA
Output Current Limit	ILIM	VOUT=0	501	700	-	mA
Line Regulation	ΔLINE	ILOAD=1mA, 10V<=VIN<=20V	-	0.5	-	%
Load Regulation	ΔLOAD	10mA<=ILOAD<=200mA	-	0.3	-	%
Dropout Voltage	VDROP	VOUT>=5V, ILOAD=100mA	-	350	-	mV
		VOUT=3.3V, ILOAD=100mA	-	420	-	
		VOUT=1.8V, ILOAD=100mA	-	500	-	
Ground Current note4	IQ	VIN>VOUT, ILOAD=0mA	-	1.5	-	uA
Shutdown Ground Current	ISD	VOUT= 0V VEN=0V	-	0.1	0.5	uA
SNS Input Current	ISNS	SNS=VOUT VOUT<=5V	-	0.7	-	uA
Power Supply Rejection Ration	PSRR	VOUT=5V, ILOAD=30mA, VIN=12V, f=1KHz	-	70	-	dB
EN Input Current	IEN	VEN=23V	-	10	100	nA
Enable Threshold Voltage	VIH	EN Rising	1.1	-	-	V
	VIL	EN Falling	-	-	0.4	V
Thermal Shutdown Temperature	TSD	ILOAD=10mA	-	160	-	`C
Thermal Shutdown Hysteresis	ΔTSD		-	15	-	`C

Note 4. When VIN > VOUT, the quiescent current is the normal specification value, but when VIN<=VOUT, the quiescent current will be greater than the specification value.

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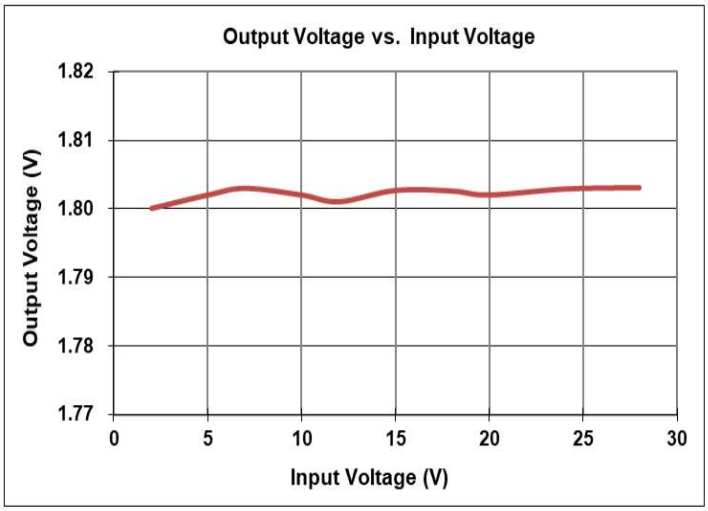
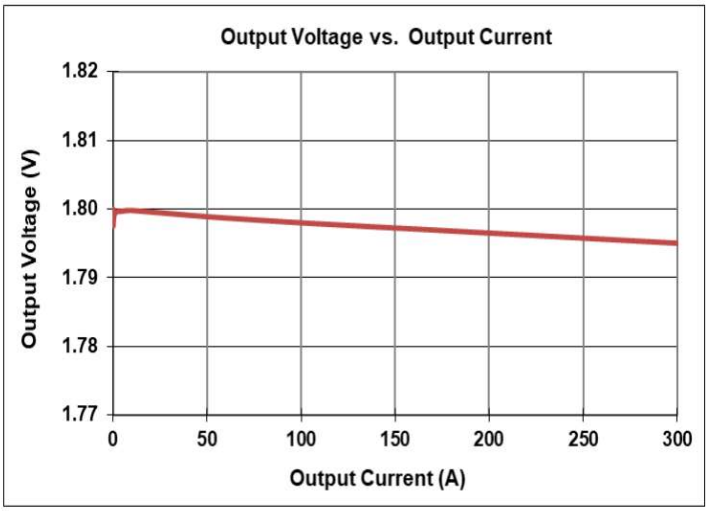
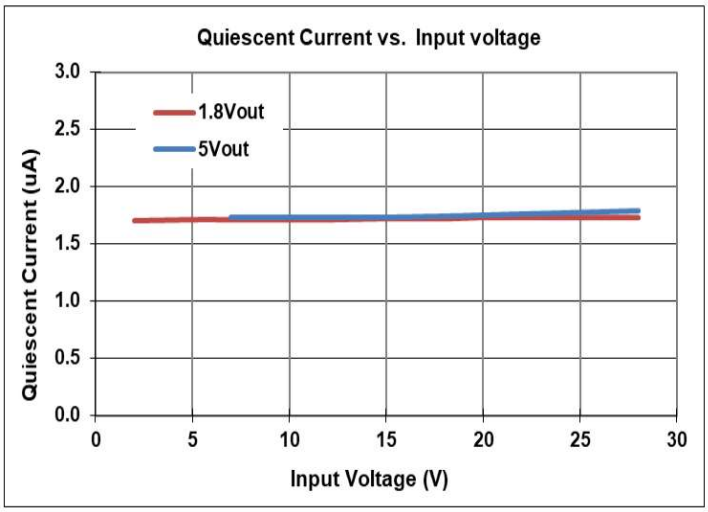
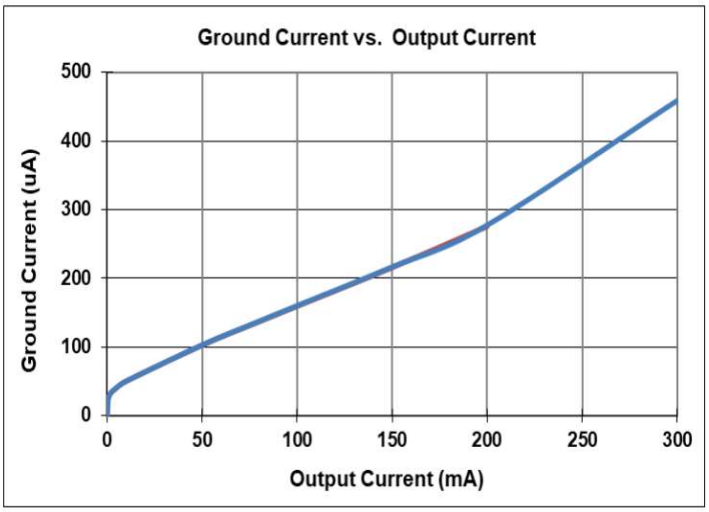
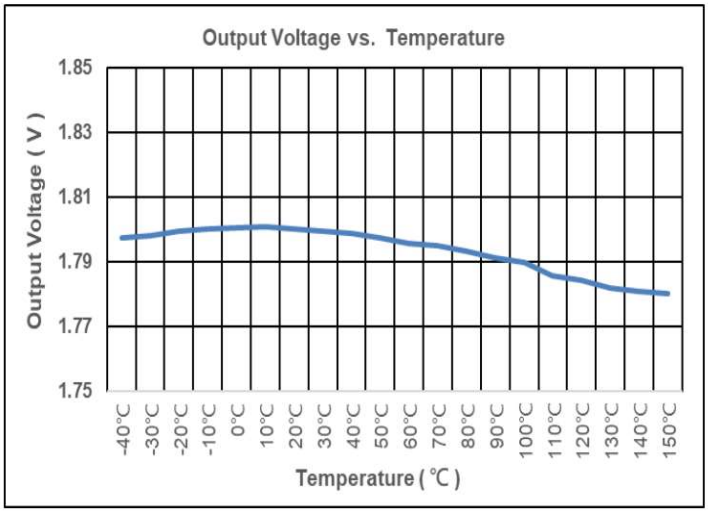
Electrical Characteristics

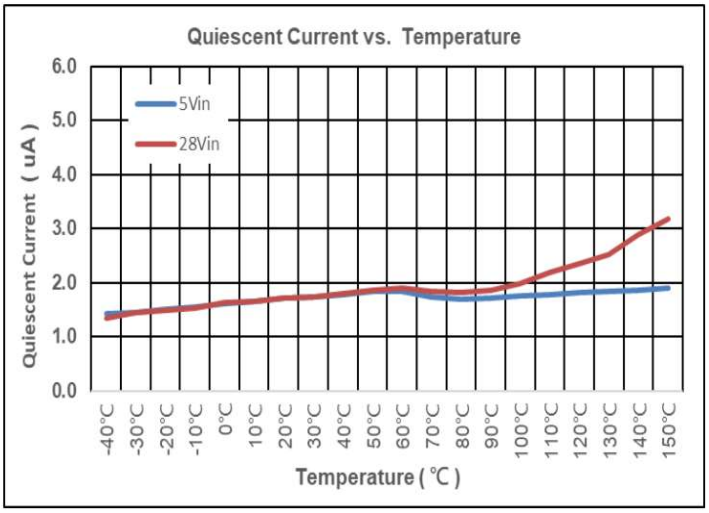












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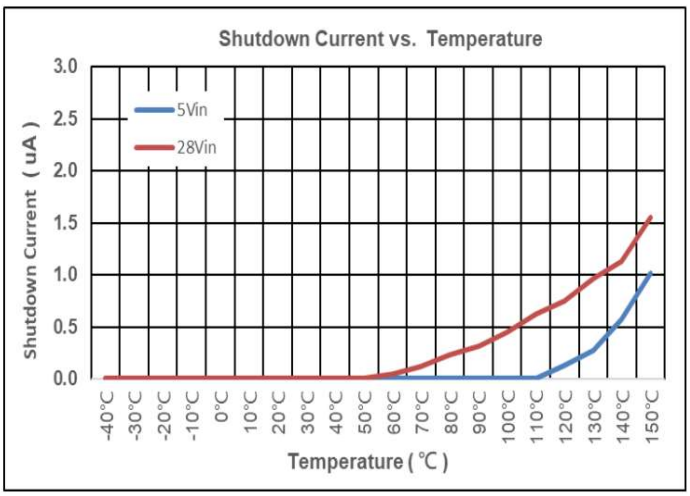
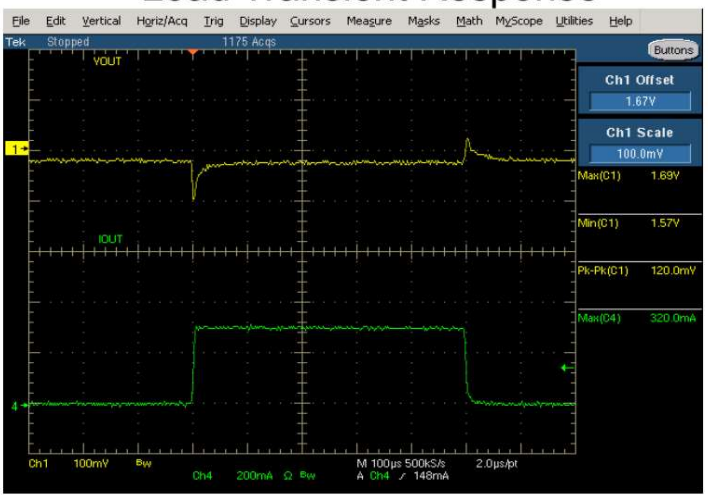
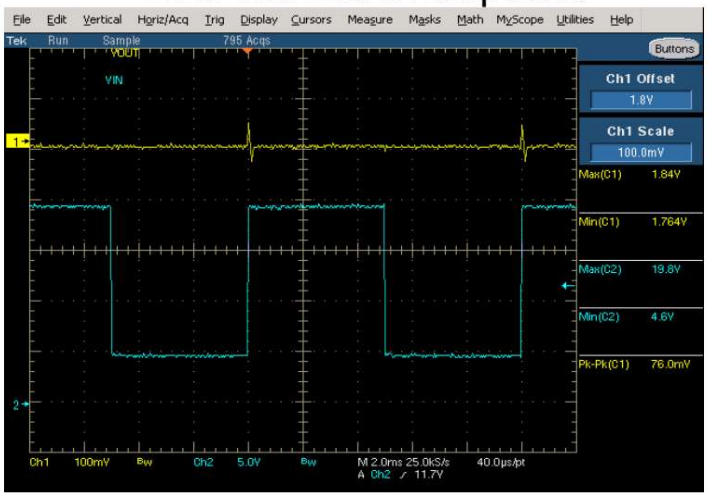
Electrical Characteristics(Con.)



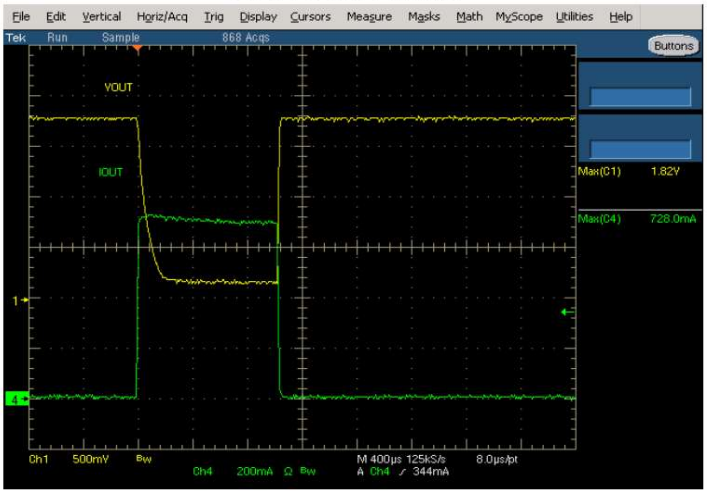
Load Transient Response

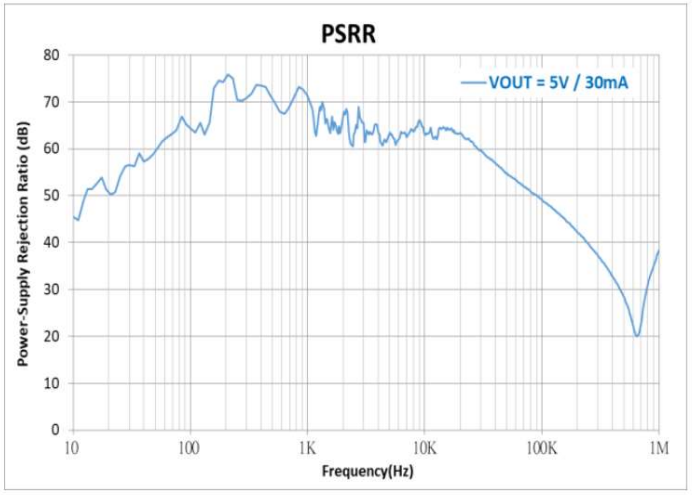


Line Transient Response



Current Limit





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Functional Block Diagrams

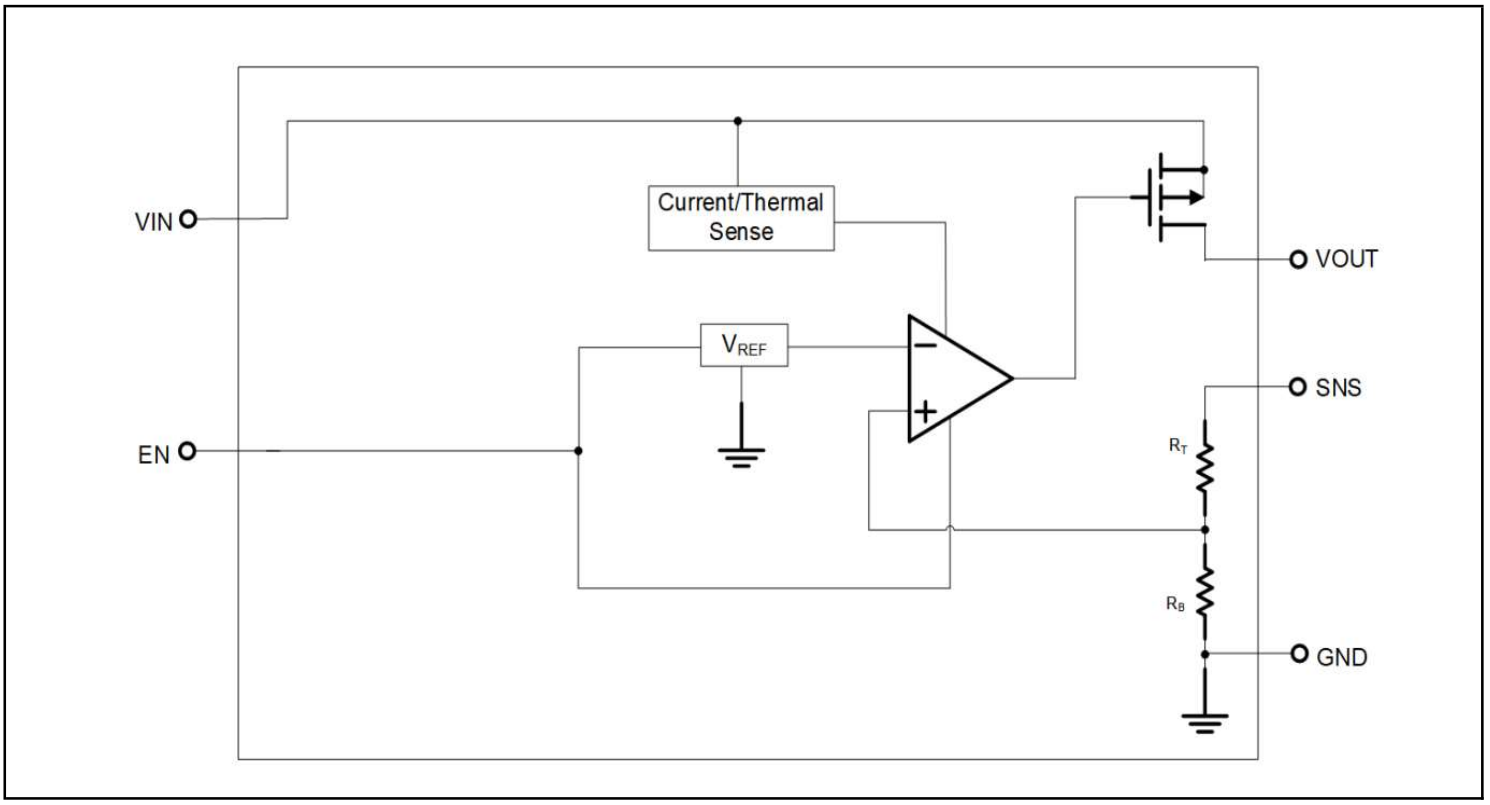


Figure 3. Functional Block Diagrams

Typical Application Circuits

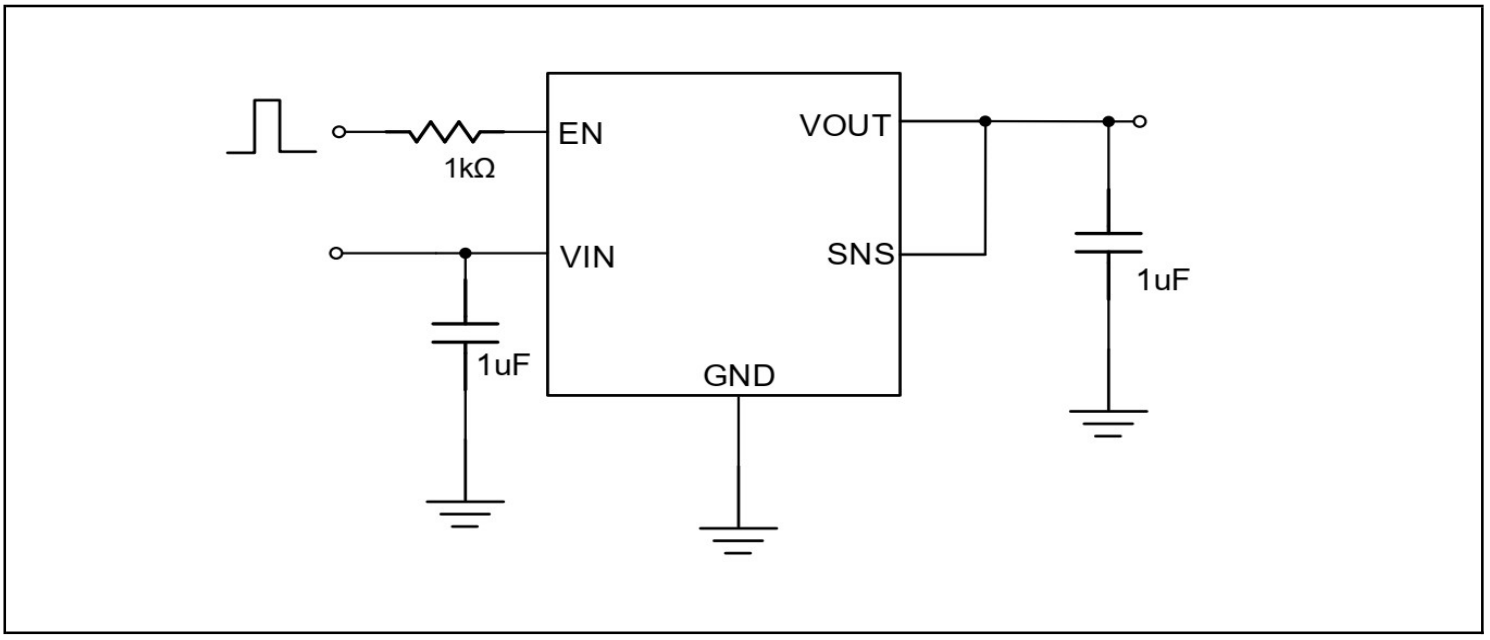


Figure 4. Application circuit of Fixed VOUT LDO with enable and sense functions

Typical Application Circuits(Con.)

Adjustable Output Voltage LDO Application Circuit

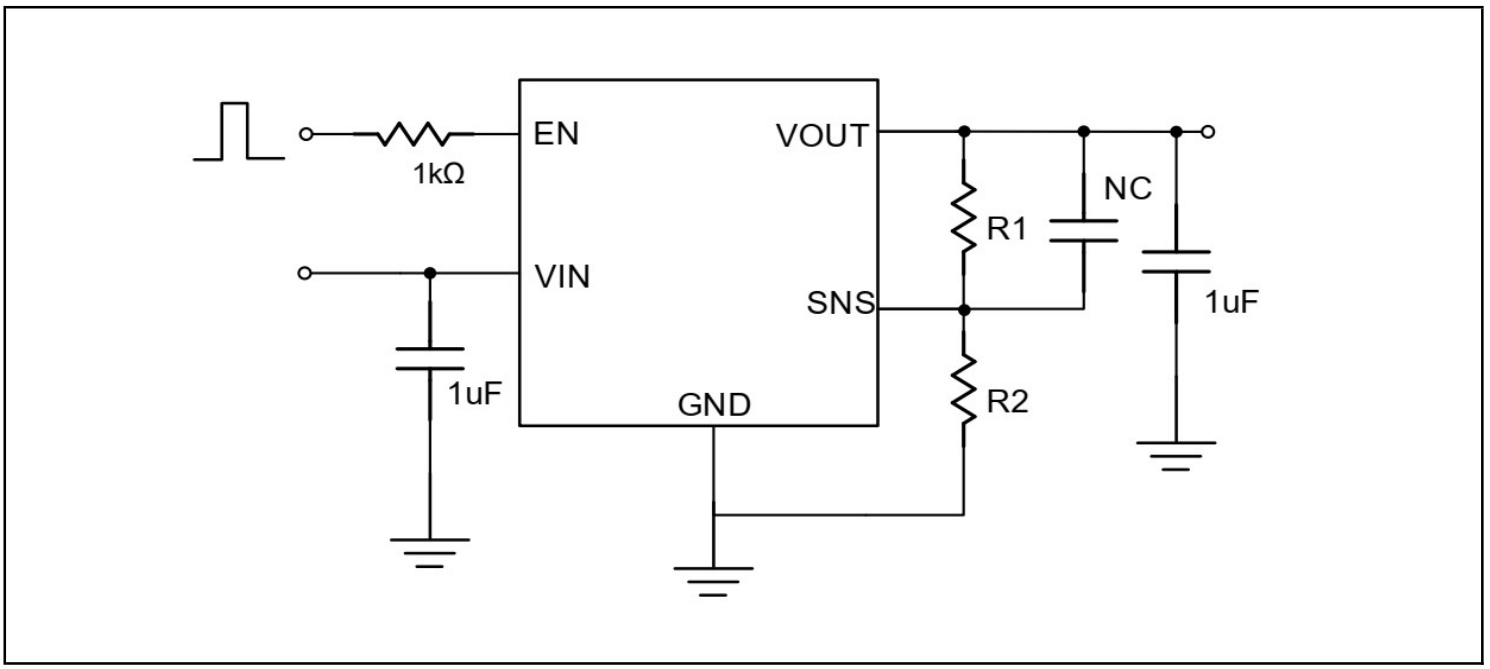


Figure 5. Adjustable output voltage LDO application circuit by HCR2416

Fixed VOUT LDO with enable function

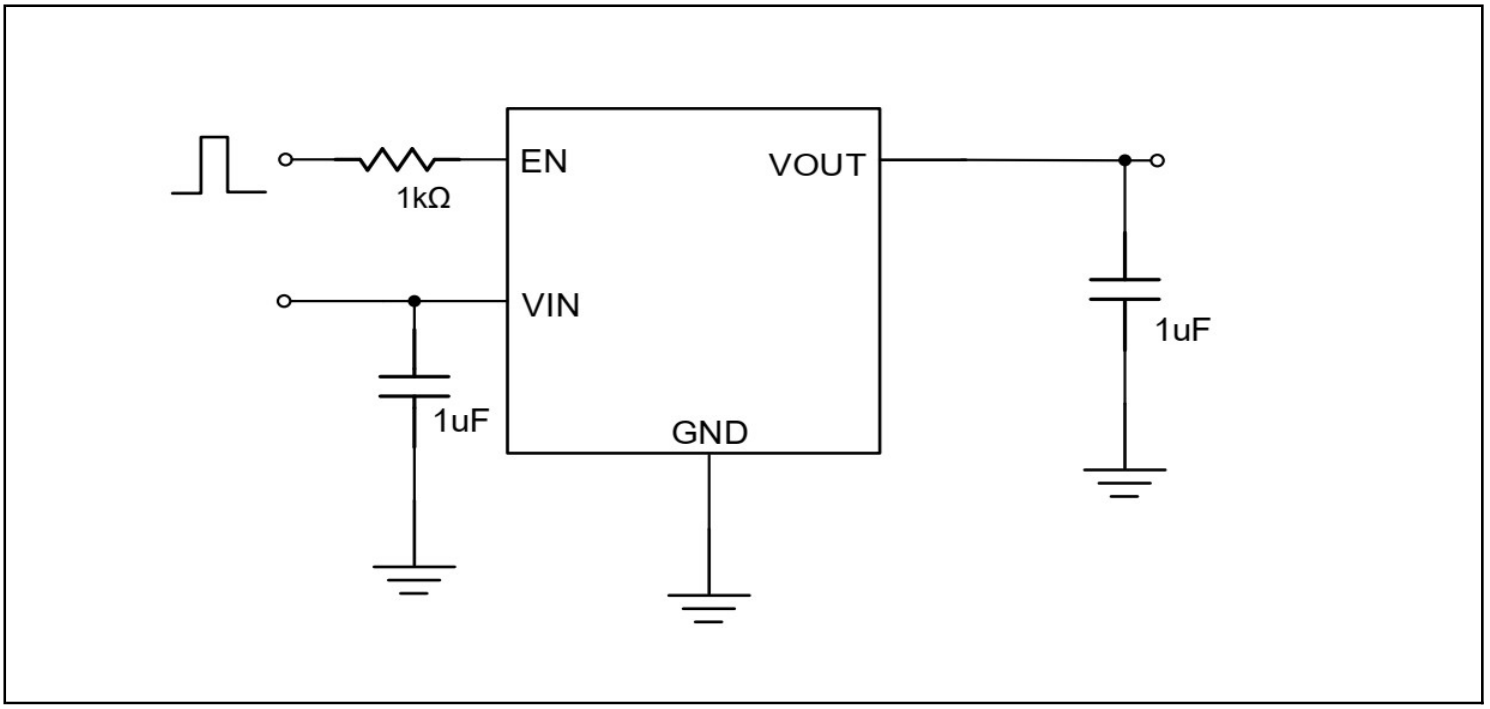


Figure 6. Application circuit of Fixed VOUT LDO with enable function

Application Guideline

Input and Output Capacitor Requirements

The external input and output capacitors of HCR2416 series must be properly selected for stability and performance. Use a 1μF or larger input capacitor and place it close to the IC's VIN and GND pins. Any output capacitor meeting the minimum 1mΩ ESR (Equivalent Series Resistance) and effective capacitance between 1μF and 22μF requirement may be used. Place the output capacitor close to the IC's VOUT and GND pins. Increasing capacitance and decreasing ESR can improve the circuit's PSRR and line transient response.

Current Limit

The HCR2416 series contain the current limiter of output power transistor, which monitors and controls the transistor, limiting the output current to 700mA (typical). The output can be shorted to ground indefinitely without damaging the part.

Dropout Voltage

The HCR2416 series use a PMOS pass transistor to achieve low dropout. When (VIN – VOUT) is less than the dropout voltage (V_{DROP}), the PMOS pass device is in the linear region of operation and the input-to-output resistance is the RDS(ON) of the PMOS pass element. V_{DROP} scales approximately with the output current because the PMOS device behaves as a resistor in dropout condition.

As any linear regulator, PSRR and transient response are degraded as (VIN – VOUT) approaches dropout condition.

Adjustable Output Voltage Application

The HCR2416 with SNS pin also can work as an adjustable output voltage LDO. Figure 2 gives the connections for the adjustable output voltage application. The resistor divider from VOUT to SNS sets the output voltage when in regulation.

The voltage on the SNS pin sets the output voltage and is determined by the values of R1 and R2. In order to keep a good temperature coefficient of output voltage, the values of R1 and R2 should be selected carefully to ignore the temperature effect of input current at the SNS pin. A current greater than 50μA in the resistor divider is recommended to meet the above requirement. The adjustable output voltage can be calculated using the formula given in equation 1:

$$V_{OUT} = \frac{R1+R2}{R2} \times V_{SNS} \quad (1)$$

where V_{SNS} is determined by the output voltage selections in the ordering information of HCR2416/1V8

The maximum adjustable output voltage is 5V. Generally, to maximize the available adjustable output voltage range, HCR2416/1V8 is recommended (V_{SNS} is 1.8V in formula 1 now).

The minimum recommended 50μA in the resistor divider makes the application no longer a 1.5μA low quiescent LDO.

OTP (Over Temperature Protection)

The over temperature protection function of HCR2416 series will turn off the P-MOSFET when the junction temperature exceeds 160°C (typ.). Once the junction temperature cools down by approximately 15°C, the regulator will automatically resume operation.

Thermal Application

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 difference between junction and ambient temperature. The maximum power dissipation can be calculated as below:

T_A=25°C, DSTECH PCB,

The max PD (Max)= (125°C − 25°C) / (220°C/W) = 0.45W for SOT-23-5 packages.

Power dissipation (PD) is equal to the product of the output current and the voltage drop across the output pass element, as shown in the equation below:

PD = (VIN – VOUT) × IOUT

Layout Consideration

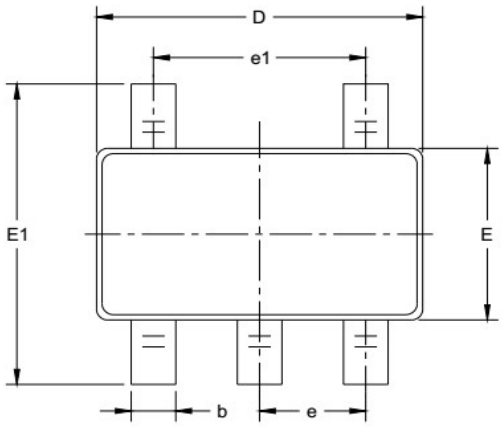
By placing input and output capacitors on the same side of the PCB as the LDO, and placing them as close as is practical to the package can achieve the best performance. The ground connections for input and output capacitors must be back to the HCR2416 ground pin using as wide and as short of a copper trace as is practical.
Connections using long trace lengths, narrow trace widths, and/or connections through via must be avoided. These add parasitic inductances and resistance that results in worse performance especially during transient conditions.

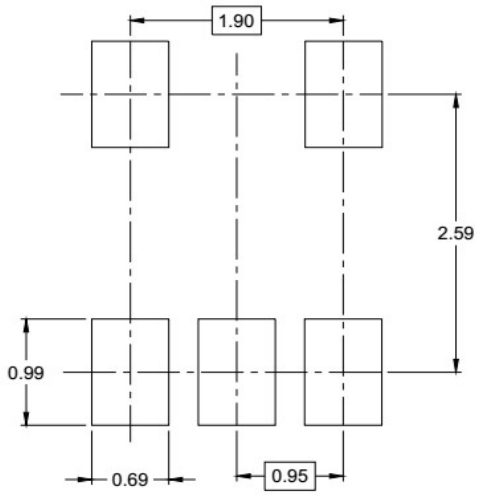
24V, 500mA Low Dropout Voltage Linear Regulator

Mechanical Dimensions

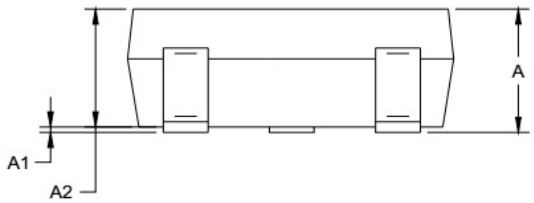
Package: SOT23-5 (M5)

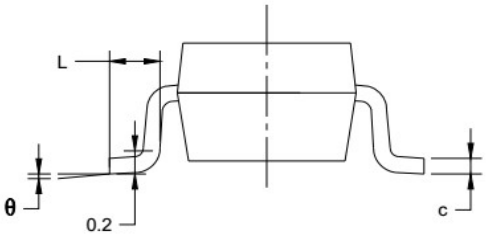
unit: mm (inch)





RECOMMENDED LAND PATTERN (Unit: mm)

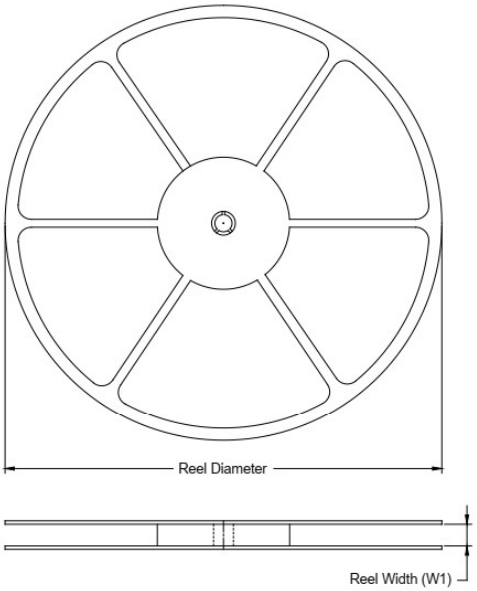




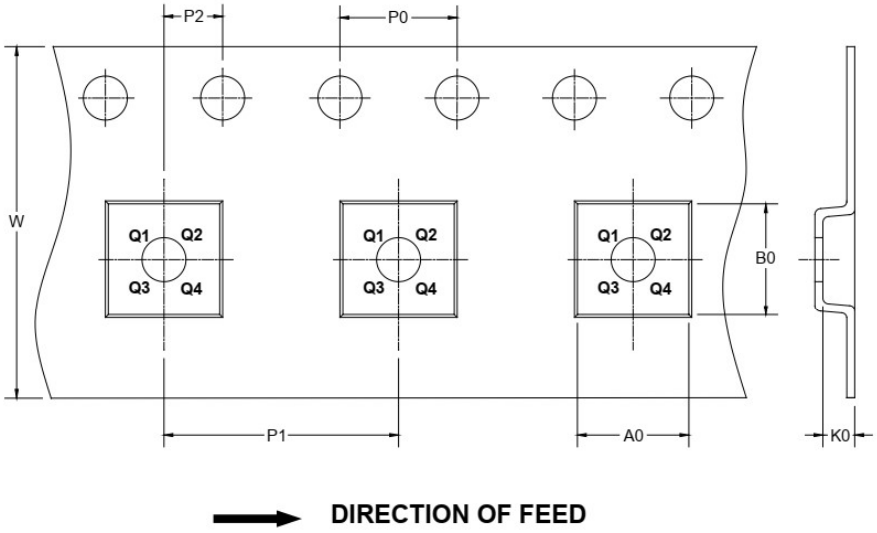
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950 BSC		0.037 BSC	
e1	1.900 BSC		0.075 BSC	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS

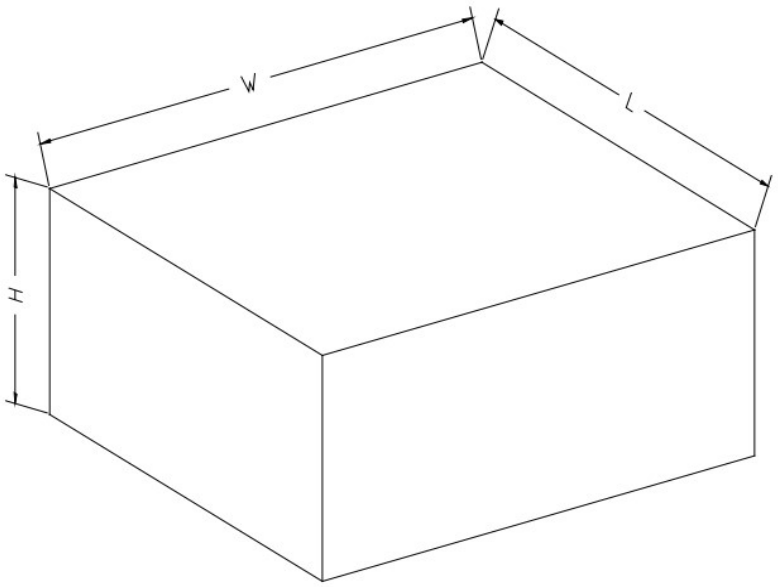


NOTE: The picture is only for reference. Please make the object as the standard.

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
SOT23-5	7″	9.5	3.17	3.23	1.37	4.0	4.0	2.0	8.0	Q3

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
7″ (Option)	368	227	224	8
7″	442	410	224	18