



# LC9202

## 600KHz, 16V 1.5A High Stability Step-down Converter

### DESCRIPTION

The LC9202 is a fully integrated, high stability 1.5A synchronous rectifier step-down converter. The LC9202 has excellent stable performance in a wide input voltage and output current load range. It has super good dynamic response characteristics.

LC9202 series are a group of positive voltage output, high precise, and low power consumption voltage converter. Voltages are selectable in 100mV steps within a range of 1.2V to 5.0V. It also can be customized on command.

LC9202 has excellent load and line transient response and good temperature characteristics, which can assure the stability of chip and power system. And it uses trimming technique to guarantee output voltage accuracy within  $\pm 2\%$ .

LC9202 is available in lead (Pb)-free ESOP-8(with exposed pad for heat dissipation) package.

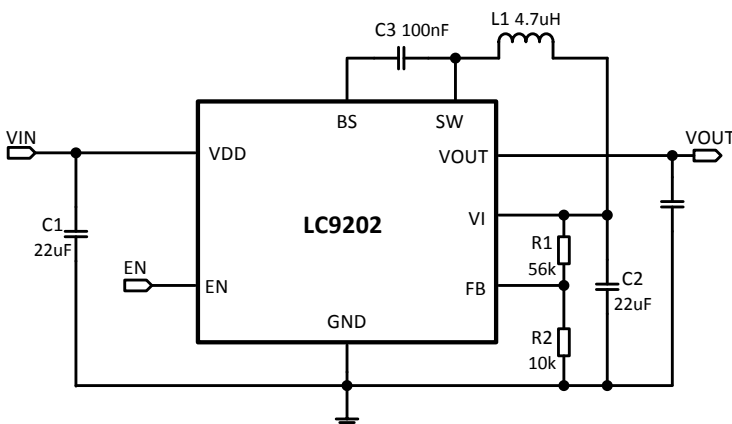
### FEATURES

- High Efficiency: Up to 80%
- High PSRR: 70dB range to 1KHz
- Excellent Line and Load Transient Response
- 600KHz Frequency Operation
- Max.1.5A Output Current
- 4V to 16V Input Voltage Range
- 0.6V Reference
- Integrated internal compensation
- Stable with Low ESR Ceramic Output Capacitors
- Over Current Protection
- Thermal Shutdown
- Inrush Current Limit and Soft Start
- Available in ESOP8
- -40°C to +85°C Temperature Range

### APPLICATIONS

- Distributed Power Systems
- Digital Set Top Boxes
- Flat Panel Television and Monitors
- Wireless and DSL Modems
- Notebook Computer

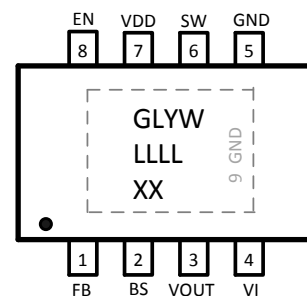
### TYPICAL APPLICATION



**Note:** the recommended value of R1 and R2

R1(KΩ)	R2(KΩ)	Efficiency (%)	Max. I <sub>OUT</sub> (A)
51	10	80	1
56	10	75	1.5

### PIN OUT & MARKING



ESOP8

GL: Product Code

YW: Date code (Year & Week)

LLLL: Lot No.

XX: Output Voltage

e.g. 33=3.3V

## ORDERING INFORMATION

PART No.	PACKAGE	Tape&Reel
LC9202CS8TR	ESOP8	2500/Reel

## ABSOLUTE MAXIMUM RATING

Parameter		Value
Supply Voltage VDD		-0.3V to 20V
Switch Node Voltage V <sub>SW</sub>		-0.3V to (VDD+0.5V)
Boost Voltage V <sub>BS</sub>		V <sub>SW</sub> -0.3V to V <sub>SW</sub> +5V
Enable Voltage V <sub>EN</sub>		-0.3V to VDD
All Other Pins		-0.3V to 6V
Package Thermal Resistance (θ <sub>jc</sub> )	ESOP8	10°C / W
Package Thermal Resistance (θ <sub>ja</sub> )		60°C / W
Operating Temperature Range		-40°C to 85°C
Storage Temperature Range		-65°C to 150°C
Lead Temperature (Soldering, 10s)		260°C

## ELECTRICAL CHARACTERISTICS

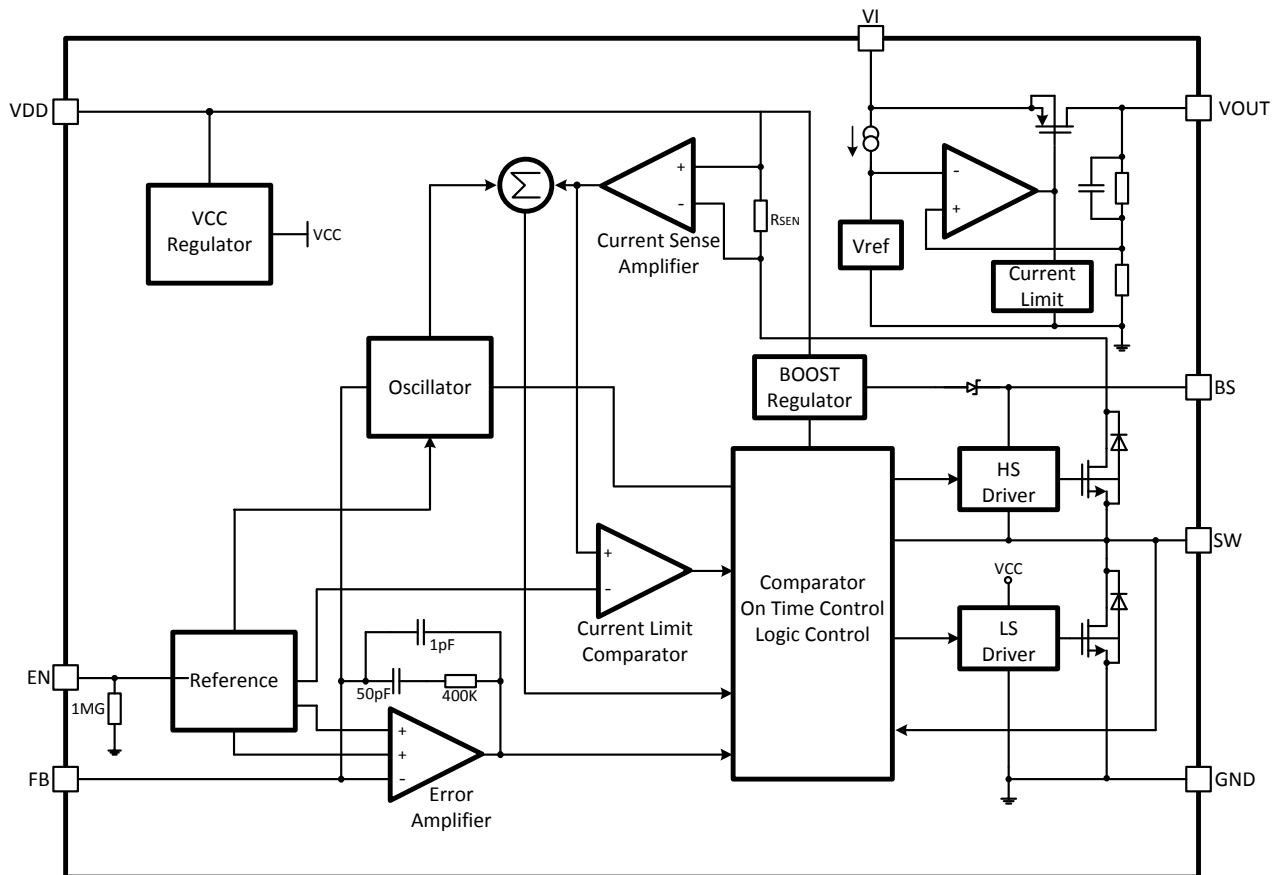
(VDD=12V, V<sub>OUT</sub>=3.3V, T<sub>A</sub>=25°C, unless otherwise stated)

Parameter	Conditions	Min	Typ	Max	Unit
Input Voltage Range		4		16	V
UVLO Threshold			2		V
Output Voltage	1mA ≤ I <sub>OUT</sub> ≤ 10mA	V <sub>OUT</sub> > 1.5	V <sub>OUT</sub> × 0.98	V <sub>OUT</sub>	V <sub>OUT</sub> × 1.02
		V <sub>OUT</sub> ≤ 1.5	V <sub>OUT</sub> - 0.03		V <sub>OUT</sub> + 0.03
Maximum Output Current	R1=51KΩ, R2=10KΩ	1			A
	R1=56KΩ, R2=10KΩ	1.5			A
Line Regulation	I <sub>OUT</sub> =10mA, 4V ≤ VDD ≤ 16V		1	5	mV
Load Regulation	1mA ≤ I <sub>OUT</sub> ≤ 1A		20	35	mV
	1mA ≤ I <sub>OUT</sub> ≤ 1.5A		30	50	mV
Supply Current in Operation	V <sub>EN</sub> = 2.0V, V <sub>FB</sub> = 1.1V		0.5	0.8	mA
Supply Current in Shutdown	V <sub>EN</sub> = 0V or V <sub>EN</sub> = GND		5	10	uA
Regulated Feedback Voltage	4V ≤ VDD ≤ 16V	0.588	0.6	0.612	V
High-side Switch On Resistance			90		mΩ
Low-side Switch On Resistance			70		mΩ
High-side Switch Leakage Current	V <sub>EN</sub> = 0V, V <sub>SW</sub> = 0V		0.1	10	uA
Oscillation Frequency			600		KHz
Maximum Duty Cycle	V <sub>FB</sub> = 0.6V		92		%
Minimum On Time			60		ns
Ripple Rejection	F=100Hz, Ripple=0.5Vp-p		70		dB
EN Input Voltage "H"		1.8		VDD	V
EN Input Voltage "L"				0.8	V
Thermal Shutdown			180		°C
Output Noise	BW=10Hz~100KHz		44		uVrms

## PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	FB	Adjustable version feedback input. Connect FB to the center point of the external resistor divider.
2	BS	Bootstrap. A capacitor connected between SW and BS pins is required to form a floating supply across the high-side switch driver.
3	VOUT	Output Voltage
4	VI	BUCK Voltage
5	GND	Ground
6	SW	Switching Pin
7	VDD	Power supply Pin
8	EN	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.

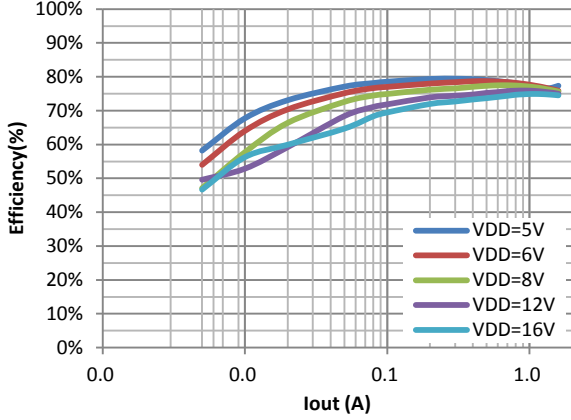
## BLOCK DIAGRAM



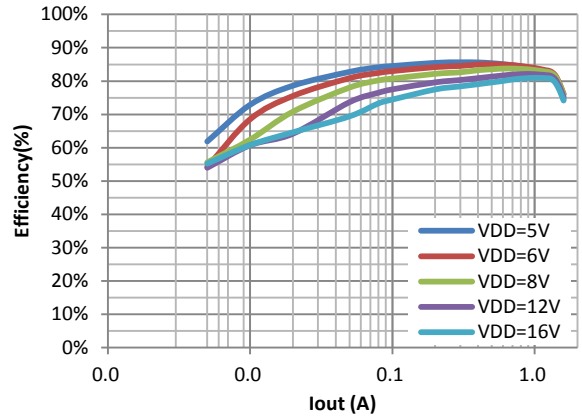
## ELECTRICAL PERFORMANCE

Tested under,  $L=4.7\mu H$ ,  $T_A=25^\circ C$ , unless otherwise specified

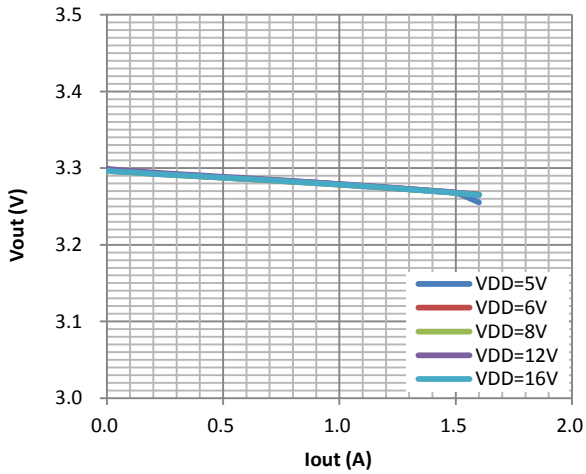
**Efficiency vs. IOUT**  
( $V_{OUT}=3.3V$ , Max.IOUT=1.5A)  
( $R1=56K\Omega$ ,  $R2=10K\Omega$ )



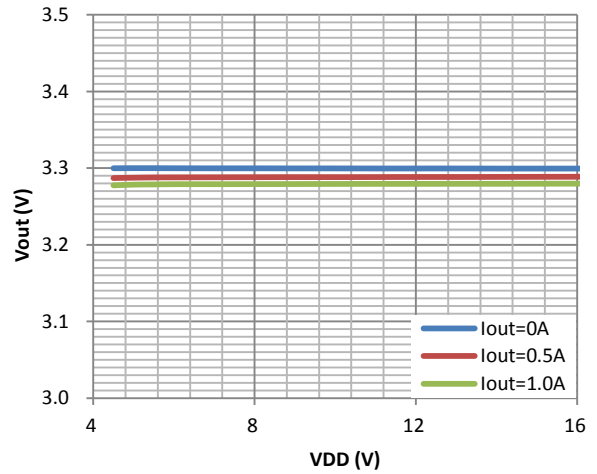
**Efficiency vs. IOUT**  
( $V_{OUT}=3.3V$ , Max.IOUT=1A)  
( $R1=51K\Omega$ ,  $R2=10K\Omega$ )



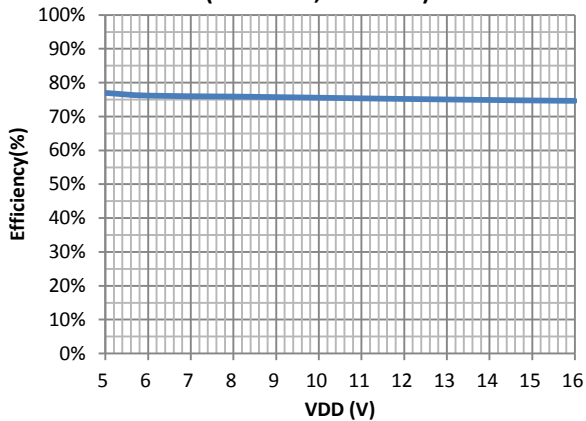
**VOUT vs. IOUT**



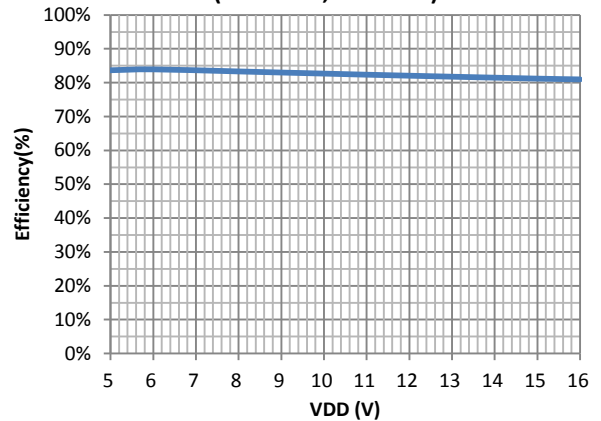
**VOUT vs. VDD**



**Efficiency vs. VDD**  
( $V_{OUT}=3.3V$ , IOUT=1.5A)  
( $R1=56K\Omega$ ,  $R2=10K\Omega$ )

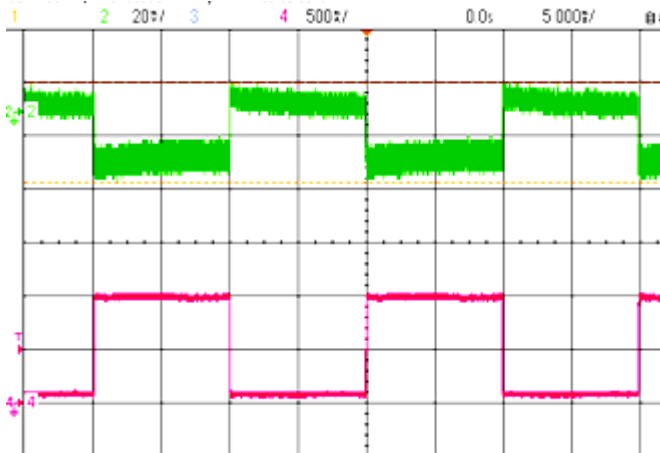


**Efficiency vs. VDD**  
( $V_{OUT}=3.3V$ , IOUT=1A)  
( $R1=51K\Omega$ ,  $R2=10K\Omega$ )



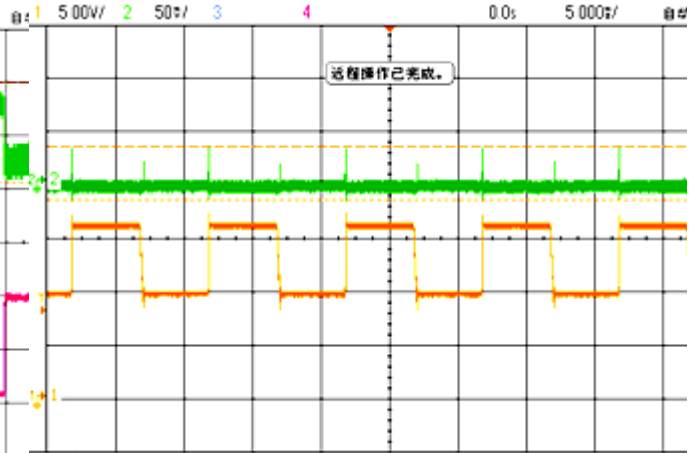
## Load Transient Response (VDD=12V, V<sub>OUT</sub>=3.3V)

C<sub>IN</sub>=22uF, C<sub>OUT</sub>=4.7uf, C<sub>VI</sub>=22uF, L=4.7uH, I<sub>OUT</sub>=10mA-1A  
CH2(Green)—V<sub>OUT</sub>, CH4(Pink)—I<sub>OUT</sub>



## Line Transient Response (I<sub>OUT</sub>=1A, V<sub>OUT</sub>=3.3V)

C<sub>IN</sub>=22uF, C<sub>OUT</sub>=4.7uf, C<sub>VI</sub>=22uF, L=4.7uH, VDD=10V-16V  
CH1(Orange)—VDD, CH2(Green)—V<sub>OUT</sub>



## DETAILED DESCRIPTION

### Internal Regulator

The LC9202 is a current 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 600K operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

### Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (V<sub>FB</sub>) 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 to form the COMP voltage, 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.

### 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 0.6V. 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 fixed to 1ms.

### Over-Current-Protection

The LC9202 has over current limit when the output current peak value exceeds the set current limit threshold. Chip output short circuit to the ground, will not be burned.

### Startup and Shutdown

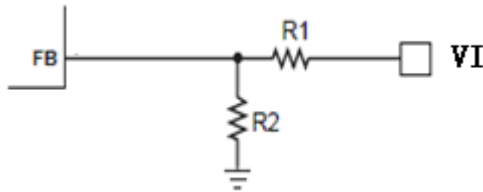
If VDD and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Three events can shut down the chip: EN low, VDD 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 VI Voltages

The external resistor divider is used to set the VI voltage (see Typical Application on page 1). The feedback resistor R1 can also set the feedback loop bandwidth with the internal compensation capacitor. Choose R1 to be around 50kΩ~100kΩ for optimal transient response. R2 is then given by:

$$R_2 = \frac{R_1}{VI/V_{FB} - 1}$$



If VI is set to 3.66V (R1=51KΩ, R2=10KΩ), the output load current can be more than 1A, and if VI is set to 3.96V (R1=56KΩ, R2=10KΩ), the chip's load current can be 1.5A. VI pin can be used as chip's second output, the total current of I<sub>VI</sub> and I<sub>OUT</sub> should not exceed 2A. The maximum voltage of VI should not exceed 5V.

### Selecting the Inductor

A 4.7μH to 22μH inductor with a DC current rating of at least 25% percent higher than the maximum load current is recommended for most applications. For highest efficiency, the inductor DC resistance should be less than 15mΩ.

### Selecting the Capacitor

The input and output capacitors are required to maintain the DC output voltage. Ceramic, tantalum, or low ESR electrolytic capacitors are recommended. Low ESR capacitors are preferred to keep the output voltage ripple low.

### THERMAL CONSIDERATIONS

Thermal consideration has to be taken into account to ensure proper function of the device. Power dissipation of LC9202 can be calculated as:

$$P_L = (VI - V_{OUT}) \times I_{OUT}$$

$$P_B = V_{DD} \times I_{VDD} \times 10\%$$

$$P_T = P_L + P_B$$

P<sub>T</sub>: Total Power Dissipation, P<sub>L</sub>: LDO Power Dissipation, P<sub>B</sub>: BUCK Power Dissipation  
For proper function and safe operation of the device, total power dissipation is recommended to be limited within 2W. Due to the overall power consumption and heat of the chip, the individual pathway may not reach the maximum current due to temperature protection.

### PACKAGE OUTLINE

Package	ESOP8	Devices per reel	2500	Unit	mm																																																																																																								
Package specification:																																																																																																													
				<table border="1"> <caption>COMMON DIMENSIONS (UNITS OF MEASURE=MILLIMETER)</caption> <thead> <tr> <th>SYMBOL</th> <th>MIN</th> <th>NOM</th> <th>MAX</th> </tr> </thead> <tbody> <tr><td>A</td><td>1.35</td><td>1.55</td><td>1.75</td></tr> <tr><td>A1</td><td>0</td><td>0.10</td><td>0.15</td></tr> <tr><td>A2</td><td>1.25</td><td>1.40</td><td>1.65</td></tr> <tr><td>A3</td><td>0.50</td><td>0.60</td><td>0.70</td></tr> <tr><td>b</td><td>0.38</td><td>-</td><td>0.51</td></tr> <tr><td>b1</td><td>0.37</td><td>0.42</td><td>0.47</td></tr> <tr><td>c</td><td>0.17</td><td>-</td><td>0.25</td></tr> <tr><td>e1</td><td>0.17</td><td>0.20</td><td>0.23</td></tr> <tr><td>D</td><td>4.80</td><td>4.90</td><td>5.00</td></tr> <tr><td>D1</td><td>3.10</td><td>3.30</td><td>3.50</td></tr> <tr><td>E</td><td>5.80</td><td>6.00</td><td>6.20</td></tr> <tr><td>E1</td><td>3.80</td><td>3.90</td><td>4.00</td></tr> <tr><td>E2</td><td>2.20</td><td>2.40</td><td>2.60</td></tr> <tr><td>e</td><td colspan="3">1.27BSC</td></tr> <tr><td>L</td><td>0.45</td><td>0.60</td><td>0.80</td></tr> <tr><td>L1</td><td colspan="3">1.04REF</td></tr> <tr><td>L2</td><td colspan="3">0.25BSC</td></tr> <tr><td>R</td><td>0.07</td><td>-</td><td>-</td></tr> <tr><td>R1</td><td>0.07</td><td>-</td><td>-</td></tr> <tr><td>h</td><td>0.30</td><td>0.40</td><td>0.50</td></tr> <tr><td>θ</td><td>0°</td><td>-</td><td>8°</td></tr> <tr><td>θ1</td><td>15°</td><td>17°</td><td>19°</td></tr> <tr><td>θ2</td><td>11°</td><td>13°</td><td>15°</td></tr> <tr><td>θ3</td><td>15°</td><td>17°</td><td>19°</td></tr> <tr><td>θ4</td><td>11°</td><td>13°</td><td>15°</td></tr> </tbody> </table>		SYMBOL	MIN	NOM	MAX	A	1.35	1.55	1.75	A1	0	0.10	0.15	A2	1.25	1.40	1.65	A3	0.50	0.60	0.70	b	0.38	-	0.51	b1	0.37	0.42	0.47	c	0.17	-	0.25	e1	0.17	0.20	0.23	D	4.80	4.90	5.00	D1	3.10	3.30	3.50	E	5.80	6.00	6.20	E1	3.80	3.90	4.00	E2	2.20	2.40	2.60	e	1.27BSC			L	0.45	0.60	0.80	L1	1.04REF			L2	0.25BSC			R	0.07	-	-	R1	0.07	-	-	h	0.30	0.40	0.50	θ	0°	-	8°	θ1	15°	17°	19°	θ2	11°	13°	15°	θ3	15°	17°	19°	θ4	11°	13°	15°
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