

CMOS Voltage Regulator

HL7209 series is a high voltage (up to 18V) ultra-low quiescent current low dropout voltage regulator (LDO) manufactured in CMOS processes. It can deliver up to 0.5A of current while consuming 14uA of quiescent current. It consists of a reference voltage generator, an error amplifier, a current foldback circuit, and a phase compensation circuit plus a driver transistor. The HL7209 series is designed specifically for applications where very-low I_Q is a critical parameter. This device maintains low quiescent current consumption even in dropout mode to further increase the battery life.

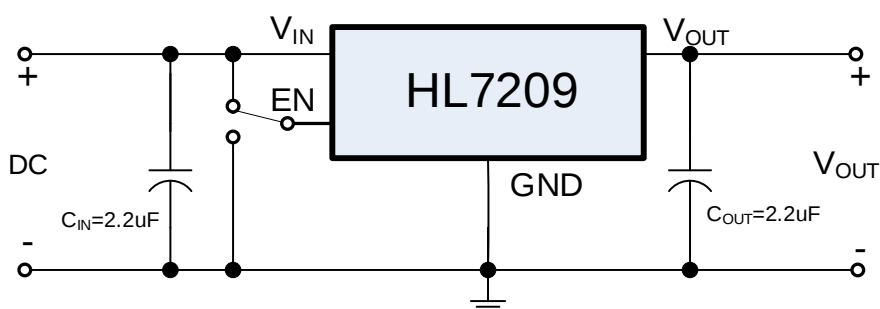
Features:

- Ultra-low Quiescent Current: 14uA
- Maximum Input Voltage: 18V
- Output Voltage Highly Accurate: $\pm 2\%$
- Maximum Output Current: 0.5A
- Dropout Voltage: 500mV@ $V_{OUT}=3.3V/0.5A$
- Temperature Stability: $\pm 50\text{ppm}/^\circ\text{C}$
- ON/OFF Logic = Enable High
- Protections Circuits: Current Limiter, Foldback, Thermal shutdown
- Output Capacitor: Low ESR Ceramic Capacitor Compatible

Applications:

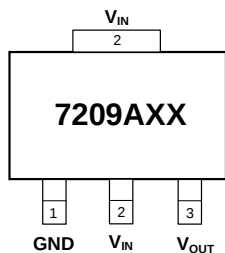
- Smart wearer
- Long-life battery-powered devices
- Portable mobile devices, such as mobile phones, cameras, and so on
- Wireless communication equipment

Typical Application:

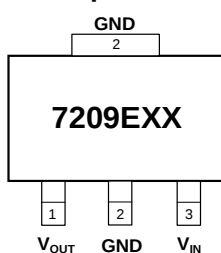


● Pin Configuration (Top View):

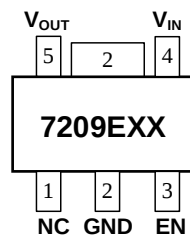
SOT89-3L(A_Type)
Top View



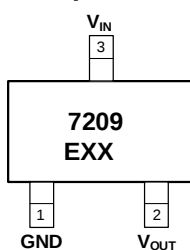
SOT89-3L(E_Type)
Top View



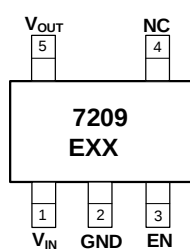
SOT89-5L
Top View



SOT23-3L
Top View



SOT23-5L
Top View



● Product Selections

Product Name	V _{OUT} (V)	Package	Ordering Name	Marking	Package Information
HL7209A30	3.0	SOT89-3L	HL7209A30PA1	7209A30	Tape and Reel, 1000pcs
HL7209A33	3.3	SOT89-3L	HL7209A33PA1	7209A33	
HL7209A36	3.6	SOT89-3L	HL7209A36PA1	7209A36	
HL7209A40	4.0	SOT89-3L	HL7209A40PA1	7209A40	
HL7209A50	5.0	SOT89-3L	HL7209A50PA1	7209A50	
HL7209AC0	12.0	SOT89-3L	HL7209AC0PA1	7209AC0	
HL7209E30	3.0	SOT89-3L	HL7209E30PA1	7209E30	
HL7209E33	3.3	SOT89-3L	HL7209E33PA1	7209E33	
HL7209E36	3.6	SOT89-3L	HL7209E36PA1	7209E36	
HL7209E40	4.0	SOT89-3L	HL7209E40PA1	7209E40	
HL7209E50	5.0	SOT89-3L	HL7209E50PA1	7209E50	
HL7209EC0	12.0	SOT89-3L	HL7209EC0PA1	7209EC0	
HL7209E30	3.0	SOT89-5L	HL7209E30PC1	7209E30	
HL7209E33	3.3	SOT89-5L	HL7209E33PC1	7209E33	
HL7209E36	3.6	SOT89-5L	HL7209E36PC1	7209E36	
HL7209E40	4.0	SOT89-5L	HL7209E40PC1	7209E40	
HL7209E50	5.0	SOT89-5L	HL7209E50PC1	7209E50	
HL7209E55	5.5	SOT89-5L	HL7209E55PC1	7209E55	Tape and Reel, 3000pcs
HL7209E18	1.8	SOT23-5L	HL7209E18QC3	7209E18	
HL7209E25	2.5	SOT23-5L	HL7209E25QC3	7209E25	
HL7209E30	3.0	SOT23-5L	HL7209E30QC3	7209E30	
HL7209E33	3.3	SOT23-5L	HL7209E33QC3	7209E33	
HL7209E35	3.5	SOT23-5L	HL7209E35QC3	7209E35	
HL7209E36	3.6	SOT23-5L	HL7209E36QC3	7209E36	
HL7209E38	3.8	SOT23-5L	HL7209E38QC3	7209E38	
HL7209E40	4.0	SOT23-5L	HL7209E40QC3	7209E40	

HL7209E44	4.4	SOT23-5L	HL7209E44QC3	7209E44	Tape and Reel, 3000pcs
HL7209E50	5.0	SOT23-5L	HL7209E50QC3	7209E50	
HL7209E12	1.2	SOT23-3L	HL7209E12QA3	7209E12	
HL7209E15	1.5	SOT23-3L	HL7209E15QA3	7209E15	
HL7209E18	1.8	SOT23-3L	HL7209E18QA3	7209E18	
HL7209E21	2.1	SOT23-3L	HL7209E21QA3	7209E21	
HL7209E25	2.5	SOT23-3L	HL7209E25QA3	7209E25	
HL7209E27	2.7	SOT23-3L	HL7209E27QA3	7209E27	
HL7209E28	2.8	SOT23-3L	HL7209E28QA3	7209E28	
HL7209E30	3.0	SOT23-3L	HL7209E30QA3	7209E30	
HL7209E33	3.3	SOT23-3L	HL7209E33QA3	7209E33	
HL7209E36	3.6	SOT23-3L	HL7209E36QA3	7209E36	
HL7209E38	3.8	SOT23-3L	HL7209E38QA3	7209E38	
HL7209E40	4.0	SOT23-3L	HL7209E40QA3	7209E40	
HL7209E44	4.4	SOT23-3L	HL7209E44QA3	7209E44	
HL7209E50	5.0	SOT23-3L	HL7209E50QA3	7209E50	
HL7209EC0	12.0	SOT23-3L	HL7209EC0QA3	7209EC0	

Notes:

1* Customer can request to customize the output voltage ranged from 1.8V to 12V, if desired voltage is not found in the selections.

2* Customer can request customization of package choice.

3* Please pay attention to the MARKING of the product package type.

● **Absolute Maximum Ratings (Unless otherwise indicated: $T_a=25^{\circ}\text{C}$)**

PARAMETER	SYMBOL	RATINGS		UNITS
Input Voltage	V _{IN}	-0.3 ~ 20		V
Output Voltage	V _{OUT}	V _{SS} -0.3 ~ V _{IN} +0.3V		
Power Dissipation	P _D	SOT89-3L	1000	mW
		SOT89-5L	1000	
		SOT23-5L	250	
		SOT23-3L	250	
Thermal Resistance	R _{θJA}	SOT89-3L	100	°C/W
		SOT89-5L	100	
		SOT23-5L	180	
		SOT23-3L	200	
Operating Ambient Temperature	T _{opr}	-40 ~ +85		°C
Storage Temperature	T _{stg}	-40 ~ +125		
ESD Protection	ESD HBM	4000		V

Note: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device.

● **Electrical Characteristics:**

HL7209 Series (Unless otherwise indicated: $T_a=25^{\circ}\text{C}$)

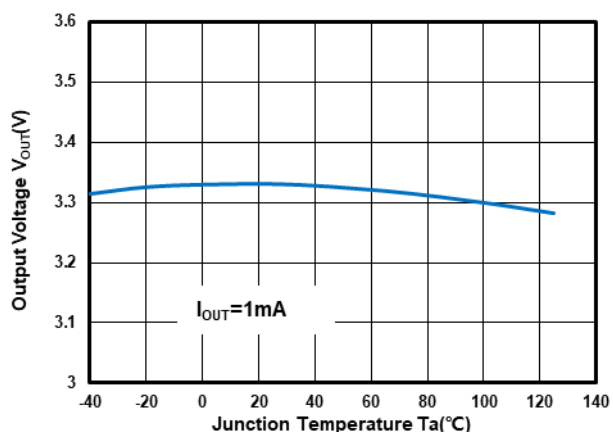
PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Output Voltage ^{*1}	$V_{OUT(S)}$	$V_{IN}=V_{OUT(S)}+2V$, $I_{OUT}=1mA$	$V_{OUT(S)} \times 0.98$	$V_{OUT(S)}$	$V_{OUT(S)} \times 1.02$	V
Dropout Voltage ^{*2}	V_{DROP}	$V_{OUT(S)}=3.3V$	$I_{OUT}=1mA$	3	8	mV
			$I_{OUT}=0.5A$	500	900	
Line Regulation	$\frac{\Delta V_{OUT}}{\Delta V_{IN} \cdot V_{OUT(S)}}$	$V_{OUT(S)}+2V \leq V_{IN} \leq 18V$ $I_{OUT}=1mA$		0.01	0.02	%/V
Load Regulation	ΔV_{OUT2}	$V_{IN}=V_{OUT(S)}+2V$ $1mA \leq I_{OUT} \leq 0.5A$	$V_{OUT(S)} \leq 5.0V$	60		mV
			$V_{OUT(S)} > 5.0V$	70		
Temperature Stability	$\frac{\Delta V_{OUT}}{\Delta T_a \cdot V_{OUT(S)}}$	$V_{IN}=V_{OUT(S)}+2V$, $I_{OUT}=1mA$ $-40^{\circ}\text{C} \leq T_a \leq 125^{\circ}\text{C}$		± 50		ppm/ $^{\circ}\text{C}$
GND Current	I_{GND}	no load	$V_{OUT(S)} \leq 5.0V$	14	30	μA
			$V_{OUT(S)} > 5.0V$	20	40	
		$I_{OUT}=100mA$		420		
Shutdown Current	I_{SHUT}	$V_{IN}=18V$, $V_{EN}=0$		0.1	1	
Input Voltage	V_{IN}	---	2.2		18	V
Maximum Output Current	I_{OUTMAX}		0.5			A
Current Limit ^{*3}	I_{LIM}	$V_{IN}=V_{OUT(S)}+2V$, $V_{OUT}=0.95 \times V_{OUT(S)}$		0.6		
Power Supply Rejection Ratio ^{*4}	PSRR	$f=10Hz$, $I_{OUT}=10mA$		72		dB
		$f=100Hz$, $I_{OUT}=10mA$		80		
		$f=1kHz$, $I_{OUT}=10mA$		75		
Short Circuit Current ^{*5}	I_{SHORT}	$V_{IN}=V_{EN}=V_{OUT(S)}+2.0V$ $V_{OUT}=0V$		40		mA
EN 'H' Level Voltage	V_{ENH}		1.6		18	V
EN 'L' Level Voltage	V_{ENL}		0		0.5	
EN 'H' Level Current	I_{ENH}	$V_{IN}=18V$, $V_{EN}=V_{IN}$	-0.1		0.1	μA
EN 'L' Level Current	I_{ENL}	$V_{IN}=18V$, $V_{EN}=0$	-0.1		0.1	
Over Temperature Protection	OTP	$I_{OUT}=1mA$		150		$^{\circ}\text{C}$

Notes:

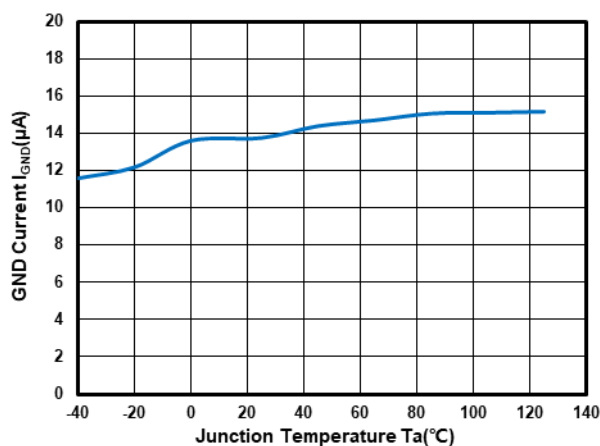
- $V_{OUT(S)}$: Output voltage when $V_{IN}=V_{OUT}+2V$, $I_{OUT}=1mA$.
- $V_{DROP}=V_{IN1} - (V_{OUT(S)} \times 0.98)$ where V_{IN1} is the input voltage when $V_{OUT} = V_{OUT(S)} \times 0.98$.
- I_{LIM} : Output current when $V_{IN}=V_{OUT(S)}+2V$ and $V_{OUT} = 0.95 \times V_{OUT(S)}$.
- PSRR was measured for $V_{OUT(S)} = 3.3V$ and $V_{IN} = 5.3V$.
- V_{OUT} pin should be shorted to GND pin, and the impedance between them is less than 0.1 ohm.

Typical Performance Characteristics:

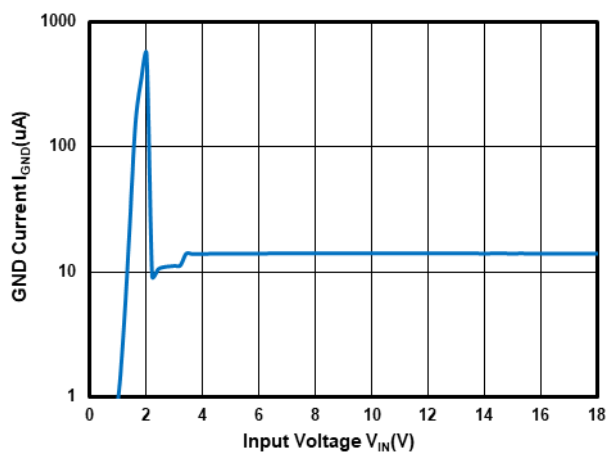
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



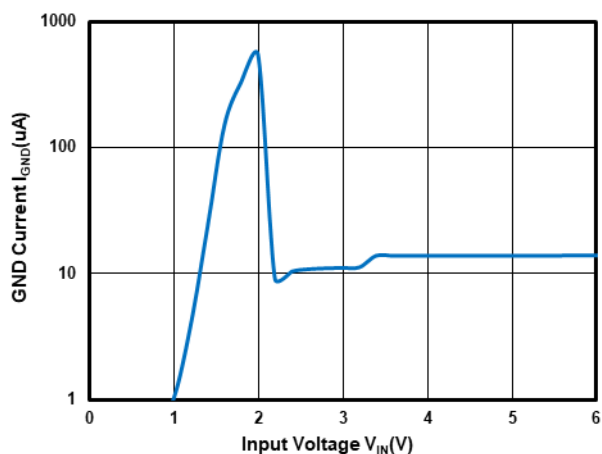
Output Voltage vs Temperature at $V_{OUT}=3.3V$



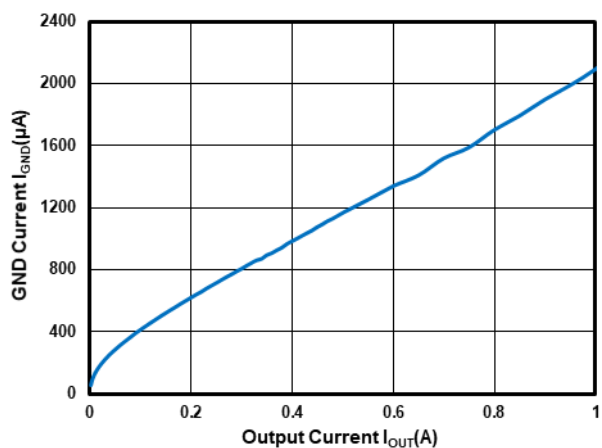
GND Current vs Temperature at $V_{OUT}=3.3V$



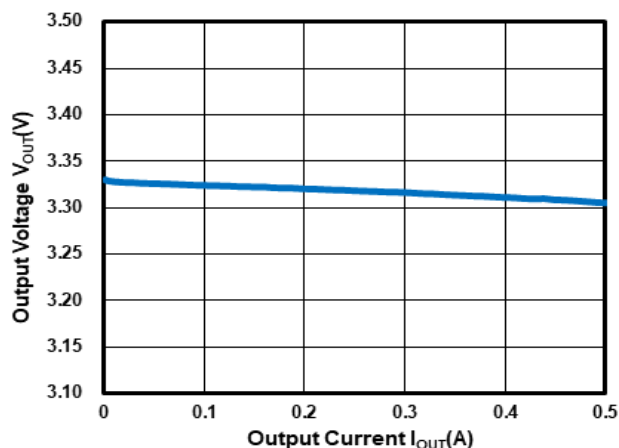
GND Current vs Input Voltage at $V_{OUT}=3.3V$



GND Current vs Input Voltage at $V_{OUT}=3.3V$



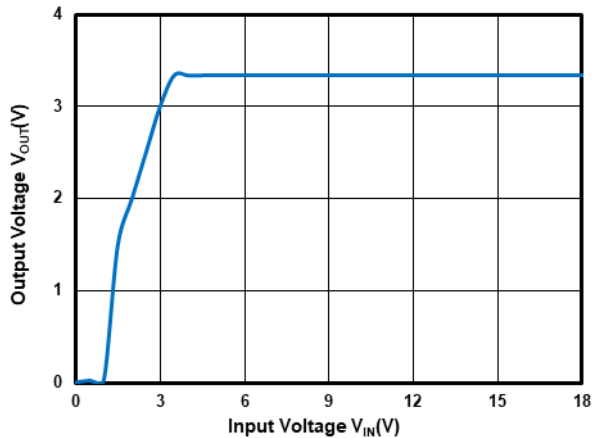
GND Current vs Output Current at $V_{OUT}=3.3V$



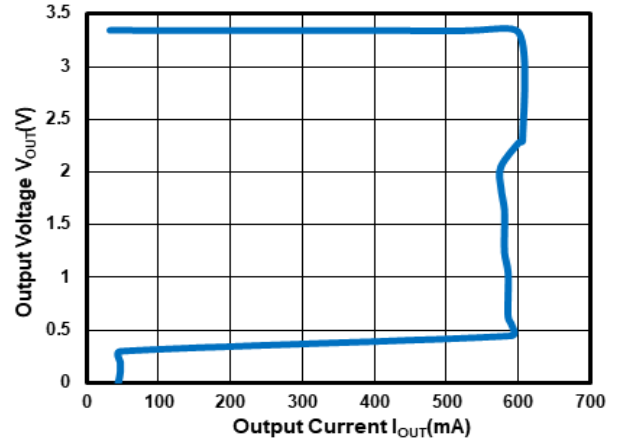
Output Voltage vs Output Current at $V_{OUT}=3.3V$

● Typical Performance Characteristics (Continued):

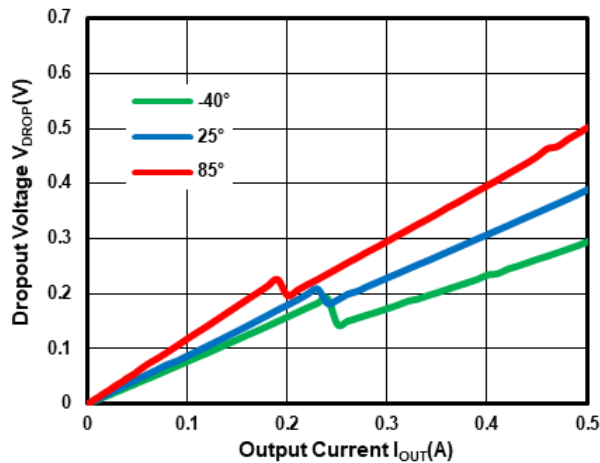
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



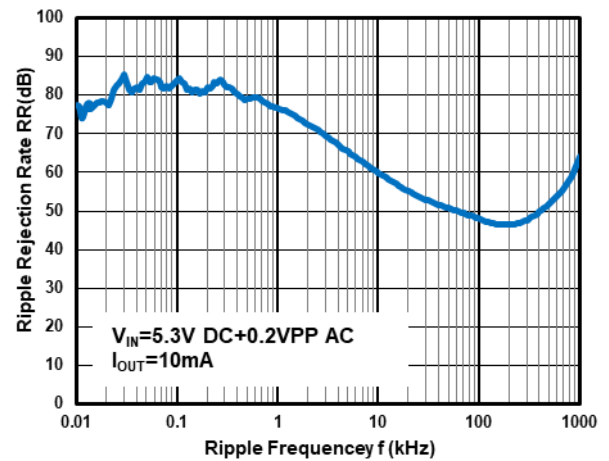
Output Voltage vs Input Voltage at $V_{OUT}=3.3V$



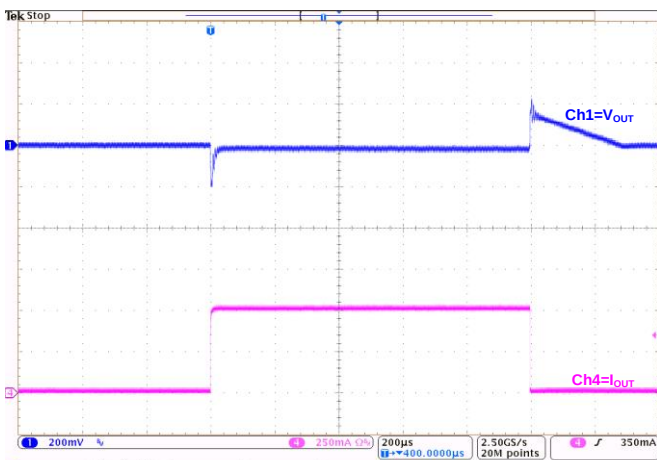
Output Current Fold-back at $V_{OUT}=3.3V$



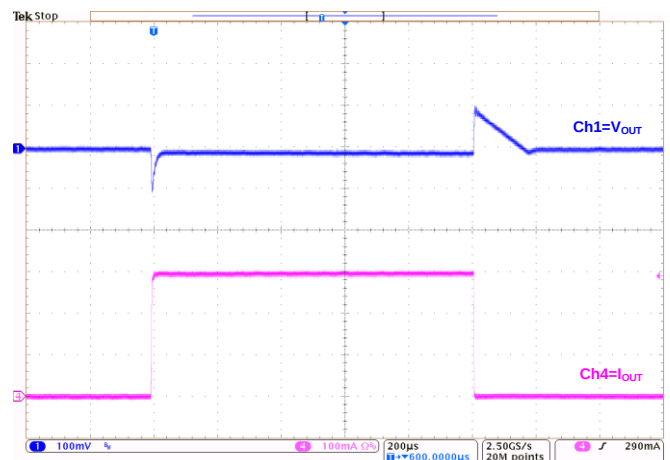
Dropout Voltage vs Temperature at $V_{OUT}=3.3V$



Power Supply Rejection Ratio at $V_{OUT}=3.3V$



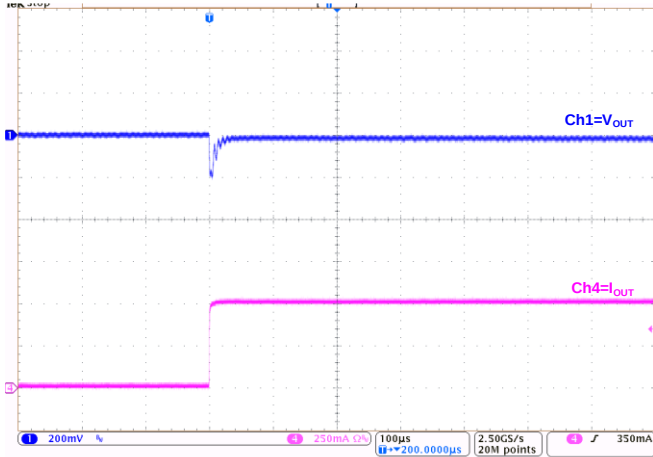
Load Transient at $V_{OUT}=3.3V$
($I_{OUT}=1mA \sim 0.5A \sim 1mA$)



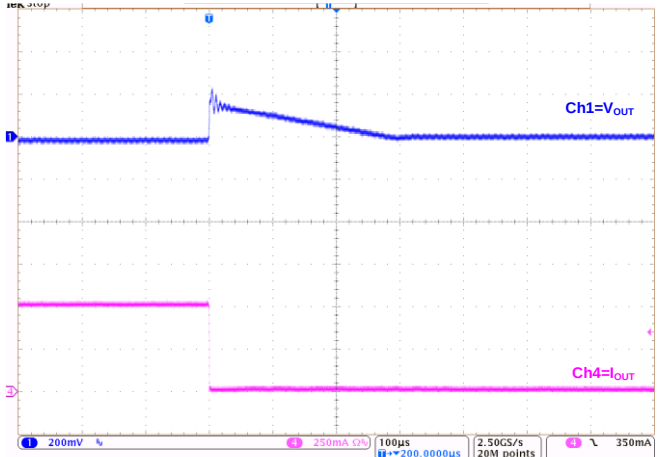
Load Transient at $V_{OUT}=3.3V$
($I_{OUT}=1mA \sim 300mA \sim 1mA$)

Typical Performance Characteristics (Continued):

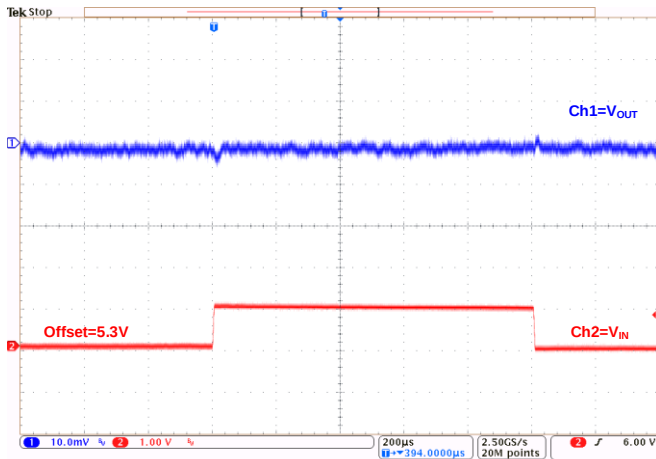
Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



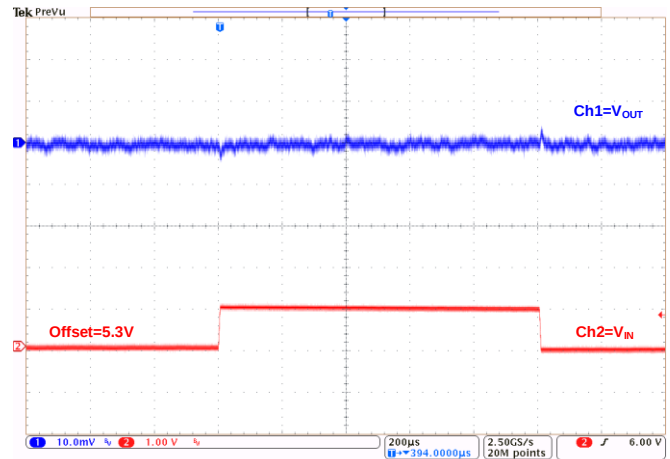
Load Transient at $V_{OUT}=3.3V$
($I_{OUT}=0mA\sim0.5A$)



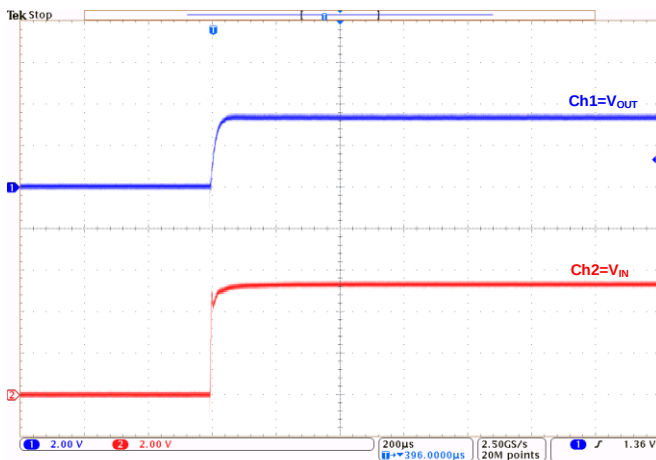
Load Transient at $V_{OUT}=3.3V$
($I_{OUT}=0.5A\sim0mA$)



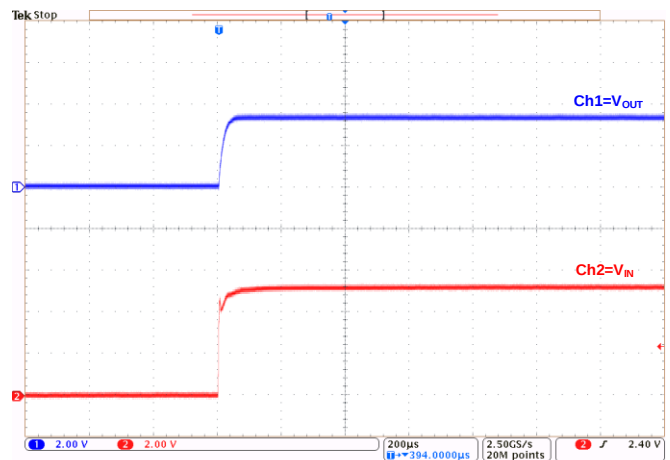
Line Transient at $V_{OUT}=3.3V$
($I_{OUT}=1mA$)



Line Transient at $V_{OUT}=3.3V$
($I_{OUT}=10mA$)



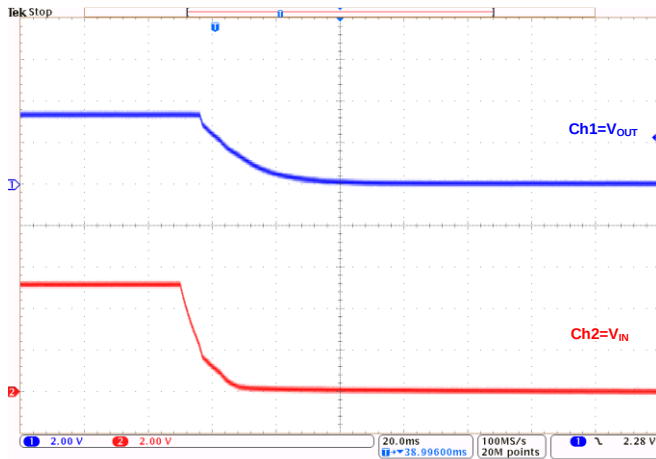
Power-Up at $V_{OUT}=3.3V$:
($I_{OUT}=1mA$)



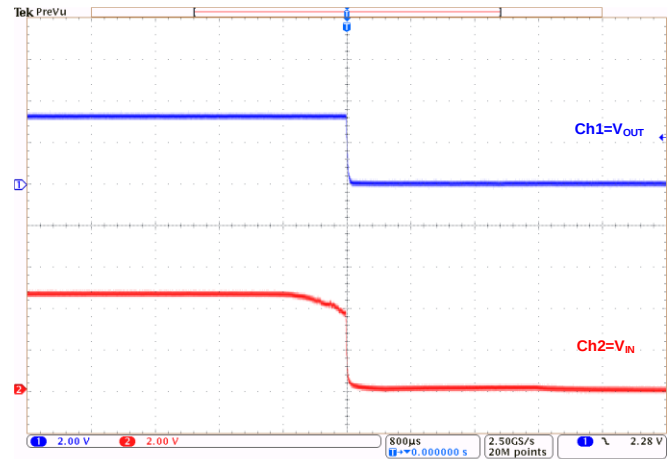
Power-Up at $V_{OUT}=3.3V$:
($I_{OUT}=0.5A$)

• Typical Performance Characteristics (Continued):

Test Conditions: $V_{IN}=V_{OUT}+2.0V$, $C_{IN}=2.2\mu F$, $C_{OUT}=2.2\mu F$, unless otherwise indicated.



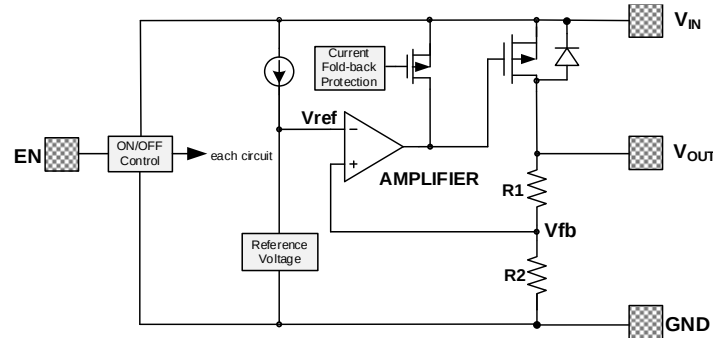
Power-Down at $V_{OUT}=3.3V$:
($I_{OUT}=1mA$)



Power-Down at $V_{OUT}=3.3V$:
($I_{OUT}=0.5A$)

- **Operational Explanation**
- **Output voltage control**

The voltage divided by resistors R1 and R2 is compared with the internal reference voltage by the error amplifier. The amplifier output then drives the P-channel MOSFET connected to the V_{OUT} pin. The output voltage at the V_{OUT} pin is regulated by this negative feedback system. The current limit circuit and short protect circuit operate in relation to output current level. Further, the IC's internal circuitry can be in operation or shutdown modes controlled by the CE pin's signal.



- **Pass transistor**

The pass transistor with low turn-on resistance used in HL7209 is a P-channel MOSFET. If the potential on V_{OUT} pin is higher than V_{IN} , it is possible that IC will be destroyed due to reverse current which is caused by parasitic diodes between V_{IN} and V_{OUT} . Therefore, the V_{OUT} pin potential exceeds $V_{IN}+0.3V$ is not allowed.

- **Current limit, over temperature protection**

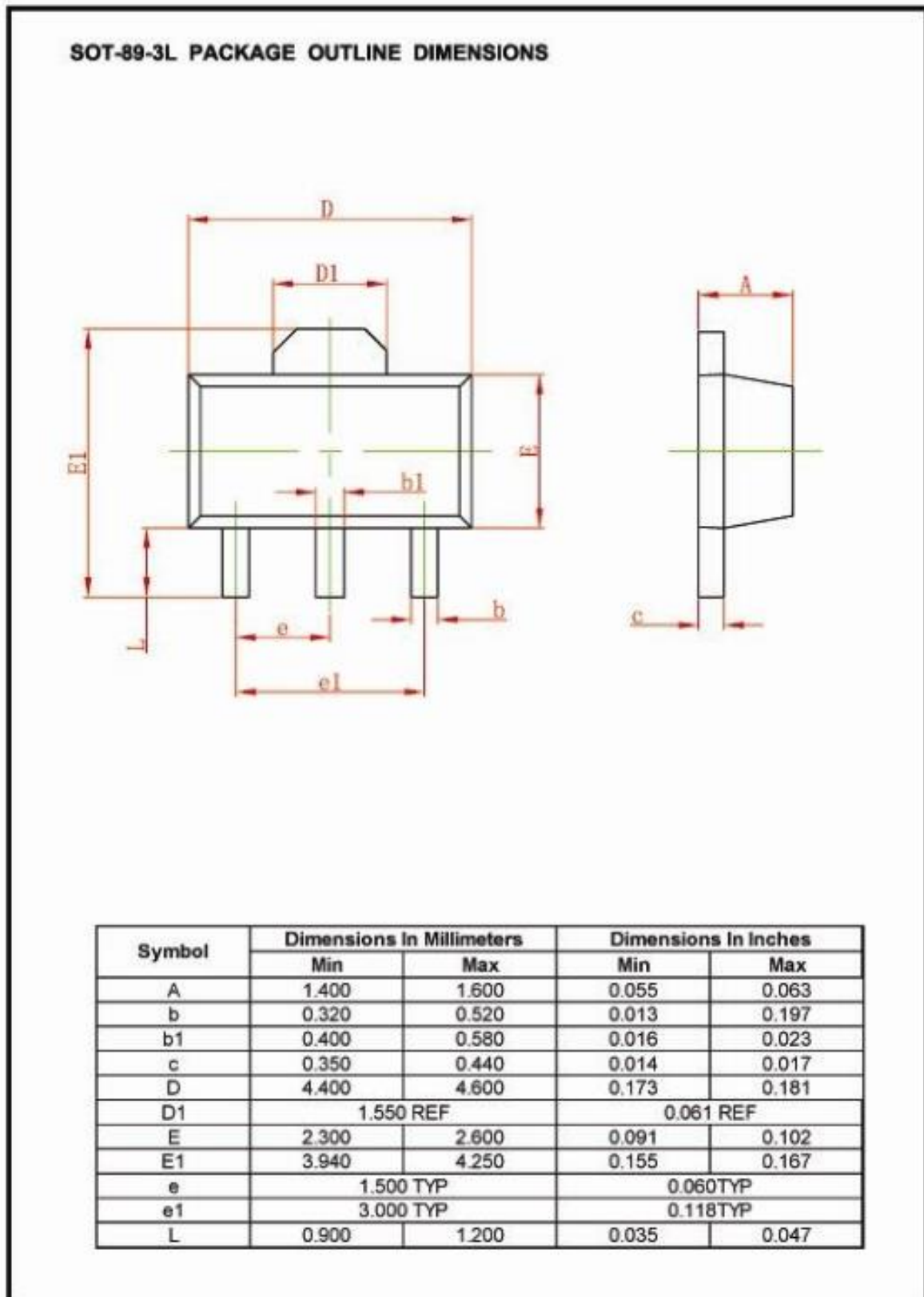
The HL7209 series includes a combination of a fixed current limiter circuit which aid the operations of the current limiter and circuit protection. When the load current reaches the current limit level, the fixed current limiter circuit operates and output voltage drops. As a result of this drop in output voltage, the foldback circuit operates, output voltage drops further and output current decreases.

Special attention should be paid to that the product of the dropout voltage on the chip and the output current must be smaller than the heat dissipation. If power consumption on the chip is more than the heat dissipation, OTP will protect the chip from damaging due to over temperature.

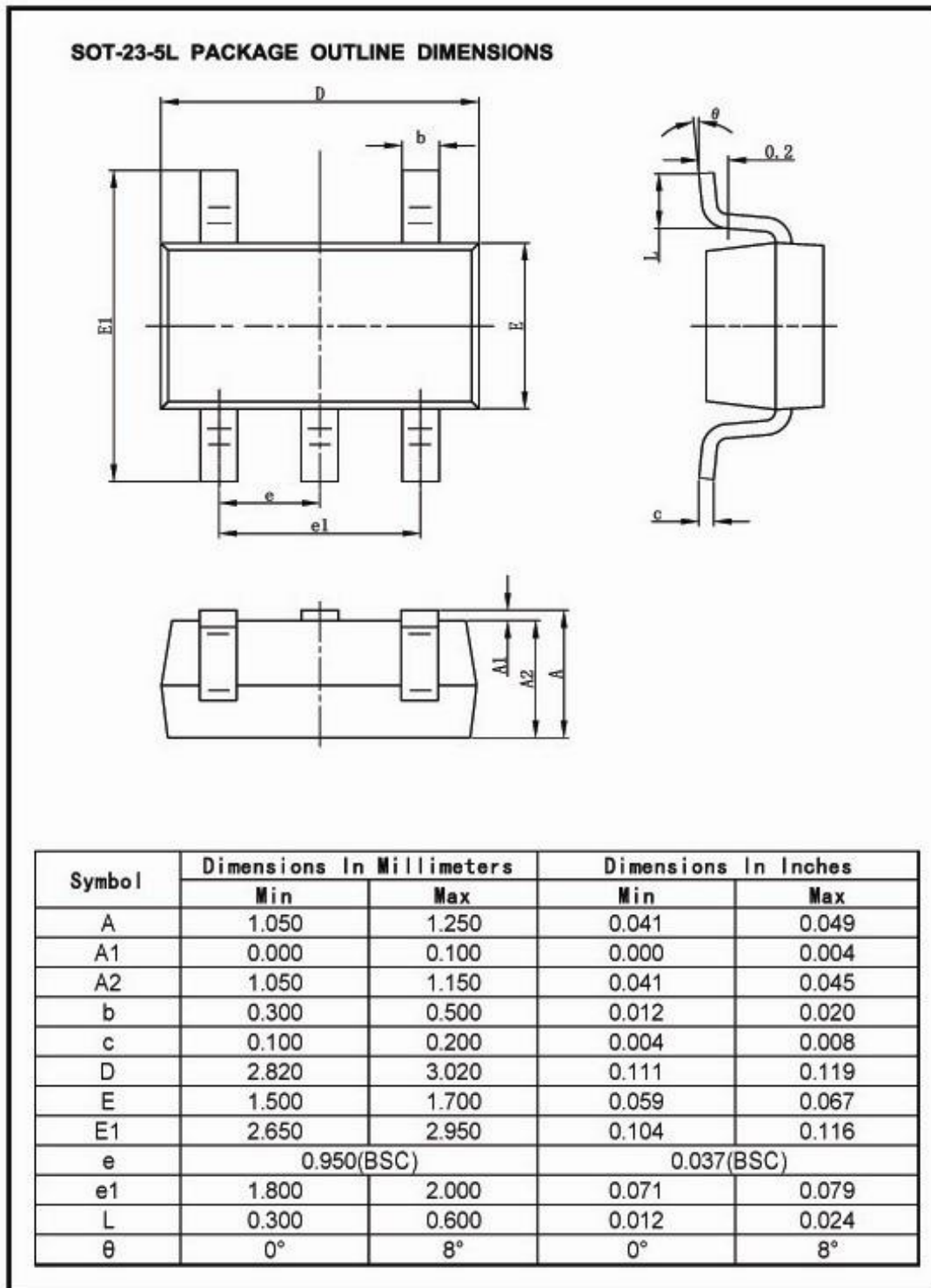
- **Notes:**

1. The input and output capacitors should be placed as close as possible to the IC.
2. If the impedance of the power supply is high, which is caused by forgetting installing input capacitor or installing too small value capacitor, the oscillation may occur.
3. Pay attention to the operation conditions of input and output voltage and load current, such that the power consumption in the IC should not exceed the allowable power consumption of the package even though the chip has short circuit protection.
4. IC has a built-in anti-static protection (ESD) circuit, but please do not add excessive stress to the IC.

- Packaging Information

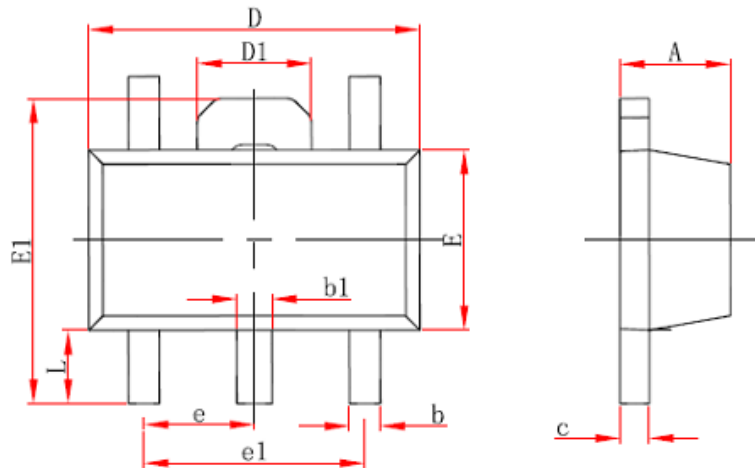


• Packaging Information (Continued)



• Packaging Information (Continued)

SOT-89-5L PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	1.400	1.600	0.055	0.063
b	0.320	0.520	0.013	0.020
b1	0.380	0.580	0.015	0.023
c	0.350	0.440	0.014	0.017
D	4.400	4.600	0.173	0.181
D1	1.550 REF.		0.061 REF.	
E	2.300	2.600	0.091	0.102
E1	3.940	4.250	0.155	0.167
e	1.500 TYP.		0.060 TYP.	
e1	3.000 TYP.		0.118 TYP.	
L	0.900	1.200	0.035	0.047

• Packaging Information (Continued)

