

# NCP4589

## Product Preview

# 300 mA, Tri-Mode, LDO Linear Voltage Regulator

The NCP4589 is a CMOS 300 mA LDO which switches to a low power mode under light current loads. The device automatically switches back to a fast response mode as the output load increases above 3 mA (typ.). The device can be placed in permanent fast mode through a mode select pin. The family is available in a variety of packages: SC-70, SOT23 and a small, ultra thin 1.2 x 1.2 x 0.4 mm XDFN.

### Features

- Operating Input Voltage Range: 1.4 V to 5.25 V
- Output Voltage Range: 0.8 to 4.0 V (available in 0.1 V steps)
- Supply Current: Low Power Mode – 1.0  $\mu$ A at  $V_{OUT} < 1.85$  V  
Fast Mode – 55  $\mu$ A  
Standby Mode – 0.1  $\mu$ A
- Dropout Voltage: 230 mV Typ. at  $I_{OUT} = 300$  mA,  $V_{OUT} = 2.8$  V
- $\pm 1\%$  Output Voltage Accuracy ( $V_{OUT} > 2$  V,  $T_J = 25$  °C)
- High PSRR: 70 dB at 1 kHz (Fast response mode)
- Line Regulation 0.02%/V Typ.
- Current Fold Back Protection
- Stable with Ceramic Capacitors
- Available in 1.2x1.2 XDFN, SC-70 and SOT23 Package
- These are Pb-free Devices

### Typical Applications

- Battery Powered Equipments
- Portable Communication Equipments
- Cameras, Image Sensors and Camcorders

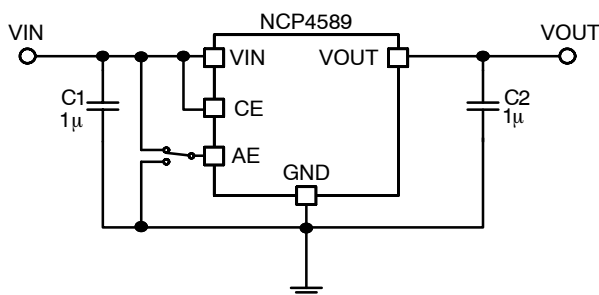


Figure 1. Typical Application Schematic

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.



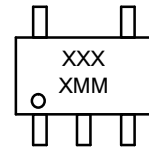
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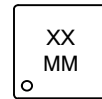
### MARKING DIAGRAMS



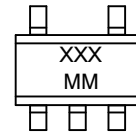
SC-70  
CASE 419A



XDFN6  
CASE 711AA



SOT-23-5  
CASE 1212



XXXX = Specific Device Code  
MM = Date Code

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 5 of this data sheet.

# NCP4589

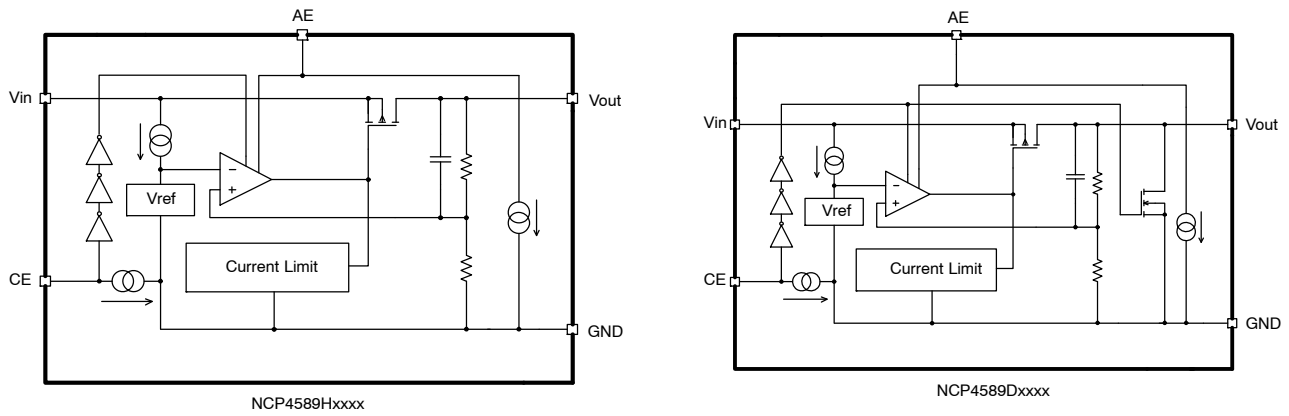


Figure 2. Simplified Schematic Block Diagram

## PIN FUNCTION DESCRIPTION

Pin No. XDFN	Pin No. SC-70	Pin No. SOT23	Pin Name	Description
4	4	1	VIN	Input pin
2	2	2	GND	Ground
3	5	3	CE	Chip enable pin
6	3	5	VOUT	Output pin
1	1	4	AE	Auto Eco Pin
5	-	-	NC	No connection

## ABSOLUTE MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage (Note 1)	$V_{IN}$	6.0	V
Output Voltage	$V_{OUT}$	-0.3 to $V_{IN} + 0.3$	V
Chip Enable Input	$V_{CE}$	-0.3 to 6.0	V
Auto Eco Input	$V_{AE}$	-0.3 to 6.0	V
Output Current	$I_{OUT}$	400	mA
Power Dissipation XDFN	$P_D$	400	mW
Power Dissipation SC70		380	
Power Dissipation SOT23		420	
Junction Temperature	$T_J$	-40 to 150	°C
Storage Temperature	$T_{STG}$	-55 to 125	°C
ESD Capability, Human Body Model (Note 2)	$ESD_{HBM}$	2000	V
ESD Capability, Machine Model (Note 2)	$ESD_{MM}$	200	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Refer to ELECTRICAL CHARACTERISTICS and APPLICATION INFORMATION for Safe Operating Area.
2. This device series incorporates ESD protection and is tested by the following methods:  
 ESD Human Body Model tested per AEC-Q100-002 (EIA/JESD22-A114)  
 ESD Machine Model tested per AEC-Q100-003 (EIA/JESD22-A115)  
 Latchup Current Maximum Rating tested per JEDEC standard: JESD78.

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## THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Characteristics, XDFN Thermal Resistance, Junction-to-Air	$R_{\theta JA}$	250	$^{\circ}\text{C}/\text{W}$
Thermal Characteristics, SOT23 Thermal Resistance, Junction-to-Air	$R_{\theta JA}$	238	$^{\circ}\text{C}/\text{W}$
Thermal Characteristics, SC-70 Thermal Resistance, Junction-to-Air	$R_{\theta JA}$	263	$^{\circ}\text{C}/\text{W}$

## ELECTRICAL CHARACTERISTICS

$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ;  $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ ;  $I_{OUT} = 1\text{ mA}$ ;  $C_{IN} = C_{OUT} = 1\text{ }\mu\text{F}$ ; unless otherwise noted. Typical values are at  $T_A = +25^{\circ}\text{C}$ .

Parameter	Test Conditions		Symbol	Min	Typ	Max	Unit
Operating Input Voltage	(Note 3)		$V_{IN}$	1.4		5.25	V
Output Voltage (Fast Mode)	$T_A = +25^{\circ}\text{C}$ , $I_{OUT} = 5\text{ mA}$	$V_{OUT} > 2\text{ V}$	$V_{OUT}$	x0.99		x1.01	V
		$V_{OUT} \leq 2\text{ V}$		-20		20	mV
	$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ , $I_{OUT} = 5\text{ mA}$	$V_{OUT} > 2\text{ V}$		x0.975		x1.015	V
		$V_{OUT} \leq 2\text{ V}$		-50		30	mV
Output Voltage Temp. Coefficient	$T_A = -40\text{ to }85^{\circ}\text{C}$				$\pm 50$		ppm/ $^{\circ}\text{C}$
Line Regulation	$V_{IN} = V_{OUT} + 0.5\text{ V to }5\text{ V}$ $V_{IN} \geq 1.4\text{ V}$	$I_{OUT} = 1\text{ mA}$ , (Low Power Mode)	$Line_{Reg}$			0.50	%/V
		$I_{OUT} = 10\text{ mA}$ , (Fast Mode)			0.02	0.20	
Load Regulation	$I_{OUT} = 1\text{ mA to }10\text{ mA}$	$V_{OUT} > 2.0\text{ V}$	$Line_{Reg}$	-1.0		1.0	%
		$V_{OUT} \leq 2.0\text{ V}$		-20		20	mV
	$I_{OUT} = 10\text{ mA to }300\text{ mA}$					35	80
Dropout Voltage	$I_{OUT} = 300\text{ mA}$	$0.8\text{ V} \leq V_{OUT} < 0.9\text{ V}$	$V_{DO}$		0.62	0.85	V
		$0.9\text{ V} \leq V_{OUT} < 1.0\text{ V}$			0.55	0.78	
		$1.0\text{ V} \leq V_{OUT} < 1.5\text{ V}$			0.48	0.70	
		$1.5\text{ V} \leq V_{OUT} < 2.6\text{ V}$			0.34	0.50	
		$2.6\text{ V} \leq V_{OUT} < 4.0\text{ V}$			0.23	0.35	
Output Current			$I_{OUT}$	300			mA
Short Current Limit	$V_{OUT} = 0\text{ V}$		$I_{SC}$		50		mA
Quiescent Current	$I_{OUT} = 0\text{ mA}$ , Low Power Mode (Note 4)	$V_{OUT} \leq 1.85\text{ V}$	$I_Q$		1.0	4.0	$\mu\text{A}$
		$V_{OUT} > 1.85\text{ V}$			1.5	4.0	
Supply Current	$I_{OUT} = 10\text{ mA}$ , Fast Mode		$I_{GND}$		55		$\mu\text{A}$
Standby Current	$V_{CE} = 0\text{ V}$ , $T_A = 25^{\circ}\text{C}$		$I_{STB}$		0.1	1	$\mu\text{A}$
Fast Mode Switch-Over Current	$I_{OUT} = \text{light to heavy load}$		$I_{OUTH}$			8.0	mA
Low Power Switch-Over Current	$I_{OUT} = \text{heavy to light load}$		$I_{OUTL}$	1.0	2.0		mA
CE Pin Threshold Voltage	CE Input Voltage "H"		$V_{CEH}$	1.0			V
	CE Input Voltage "L"		$V_{CEL}$			0.4	
CE Pull Down Current			$I_{CEPD}$		0.1		$\mu\text{A}$

3. The maximum Input Voltage of the ELECTRICAL CHARACTERISTICS is 5.25 V. In case of exceeding this specification, the IC must be operated on condition that the Input Voltage is up to 5.5 V and the total operating time is within 500hrs.

4. The value of supply current is excluding the Pull-down constant current of CE and AE Pin

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## ELECTRICAL CHARACTERISTICS

$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$ ;  $V_{\text{IN}} = V_{\text{OUT(NOM)}} + 1\text{ V}$ ;  $I_{\text{OUT}} = 1\text{ mA}$ ;  $C_{\text{IN}} = C_{\text{OUT}} = 1\text{ }\mu\text{F}$ ; unless otherwise noted. Typical values are at  $T_A = +25^{\circ}\text{C}$ .

Parameter	Test Conditions	Symbol	Min	Typ	Max	Unit
AE Pin Threshold Voltage	AE Input Voltage "H"	$V_{\text{AEH}}$	1.0			V
	AE Input Voltage "L"	$V_{\text{AEL}}$			0.4	
AE Pull Down Current		$I_{\text{AEPD}}$		0.1		$\mu\text{A}$
Power Supply Rejection Ratio	$V_{\text{IN}} = V_{\text{OUT}} + 1\text{ V}$ or $2.2\text{ V}$ whichever is higher, $\Delta V_{\text{IN}} = 0.2\text{ V}_{\text{pk-pk}}$ , $I_{\text{OUT}} = 30\text{ mA}$ , $f = 1\text{ kHz}$ , Fast Mode	PSRR		70		dB
Output Noise Voltage	$V_{\text{OUT}} = 1.0\text{ V}$ , $I_{\text{OUT}} = 30\text{ mA}$ , $f = 10\text{ Hz}$ to $100\text{ kHz}$	$V_{\text{N}}$		90		$\mu\text{V}_{\text{rms}}$
Low Output N-channel Tr. On Resistance	$V_{\text{IN}} = 4\text{ V}$ , $V_{\text{CE}} = 0\text{ V}$	$R_{\text{LOW}}$		50		$\Omega$

- The maximum Input Voltage of the ELECTRICAL CHARACTERISTICS is 5.25 V. In case of exceeding this specification, the IC must be operated on condition that the Input Voltage is up to 5.5 V and the total operating time is within 500hrs.
- The value of supply current is excluding the Pull-down constant current of CE and AE Pin

## APPLICATION INFORMATION

A typical application circuit for NCP4589 series is shown in Figure 3.

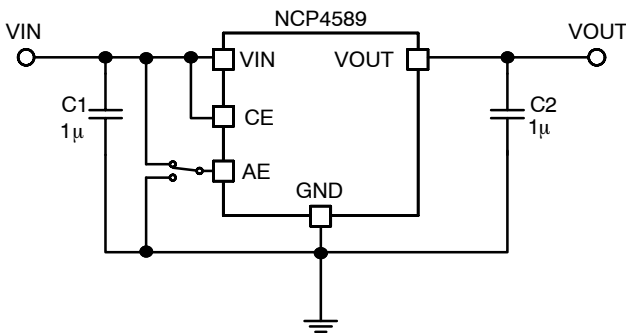


Figure 3. Typical Application Schematic

### Input Decoupling Capacitor (C1)

A 1  $\mu\text{F}$  ceramic input decoupling capacitor should be connected as close as possible to the input and ground pin of the NCP4589. Higher values and lower ESR improves line transient response.

### Output Decoupling Capacitor (C2)

A 1  $\mu\text{F}$  ceramic output decoupling capacitor is sufficient to achieve stable operation of the IC. If tantalum capacitor is used, and its ESR is high, the loop oscillation may result. If output capacitor is composed from few ceramic capacitors in parallel, the operation can be unstable. The capacitor should be connected as close as possible to the output and ground pin. Larger values and lower ESR improves dynamic parameters.

### Enable Operation

The enable pin CE may be used for turning the regulator on and off. The regulator is switched on when CE pin voltage

is above logic high level. The enable pin has internal pull down current source. If enable function is not needed connect CE pin to  $V_{\text{IN}}$ .

### Output Discharger

The D version includes a transistor between  $V_{\text{OUT}}$  and GND that is used for faster discharging of the output capacitor. This function is activated when the IC goes into disable mode.

### Auto ECO and Fast Mode

The NCP4589 has two operation modes that have impact on supply current and transient response at low output current. These two modes can be selected by AE pin. If AE pin is at low level Auto ECO mode is available. Please, see supply current vs. output current charts.

### Thermal

As power across the IC increases, it might become necessary to provide some thermal relief. The maximum power dissipation supported by the device is dependent upon board design and layout. Mounting pad configuration on the PCB, the board material, and also the ambient temperature affect the rate of temperature rise for the part. That is to say, when the device has good thermal conductivity through the PCB, the junction temperature will be relatively low with high power dissipation applications.

### PCB layout

Make  $V_{\text{IN}}$  and GND line sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect capacitors C1 and C2 as close as possible to the IC, and make wiring as short as possible.

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## ORDERING INFORMATION

Device	Nominal Output Voltage	Description	Marking	Package	Shipping <sup>†</sup>
NCP4589DSQ12T1G	1.2 V	Auto discharge	D012	SC-70 (Pb-Free)	3000 / Tape & Reel
NCP4589DSQ18T1G	1.8 V	Auto discharge	D018	SC-70 (Pb-Free)	3000 / Tape & Reel
NCP4589DSQ25T1G	2.5 V	Auto discharge	D025	SC-70 (Pb-Free)	3000 / Tape & Reel
NCP4589DSQ30T1G	3.0 V	Auto discharge	D030	SC-70 (Pb-Free)	3000 / Tape & Reel
NCP4589DSQ33T1G	3.3 V	Auto discharge	D033	SC-70 (Pb-Free)	3000 / Tape & Reel
NCP4589DSN12T1G	1.2 V	Auto discharge	P1E	SOT-23-5 (Pb-Free)	3000 / Tape & Reel
NCP4589DSN18T1G	1.8 V	Auto discharge	P1L	SOT-23-5 (Pb-Free)	3000 / Tape & Reel
NCP4589DSN25T1G	2.5 V	Auto discharge	P1T	SOT-23-5 (Pb-Free)	3000 / Tape & Reel
NCP4589DSN30T1G	3.0 V	Auto discharge	P1Y	SOT-23-5 (Pb-Free)	3000 / Tape & Reel
NCP4589DSN33T1G	3.3 V	Auto discharge	Q1B	SOT-23-5 (Pb-Free)	3000 / Tape & Reel
NCP4589DMX12T1G	1.2 V	Auto discharge	7E	XDFN (Pb-Free)	5000 / Tape & Reel
NCP4589DMX18TCG	1.8 V	Auto discharge	7L	XDFN (Pb-Free)	5000 / Tape & Reel
NCP4589DMX28TCG	2.8 V	Auto discharge	7W	XDFN (Pb-Free)	5000 / Tape & Reel
NCP4589DMX30TCG	3.0 V	Auto discharge	7Y	XDFN (Pb-Free)	5000 / Tape & Reel
NCP4589DMX33TCG	3.3 V	Auto discharge	8B	XDFN (Pb-Free)	5000 / Tape & Reel

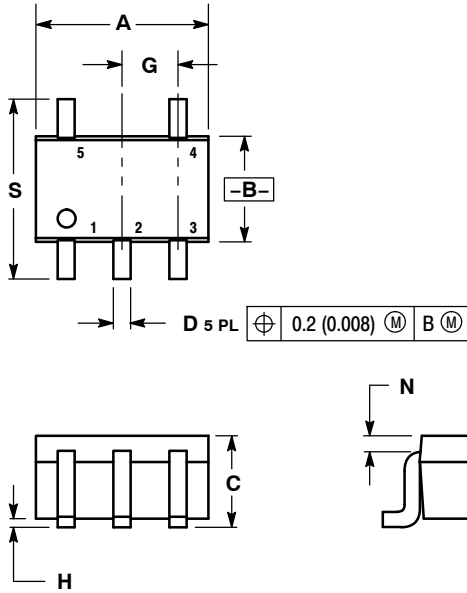
<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

NOTE: To order other package and voltage variants, please contact your ON Semiconductor sales representative.

# NCP4589

## PACKAGE DIMENSIONS

SC-88A (SC-70-5/SOT-353)  
CASE 419A-02  
ISSUE K



NOTES:

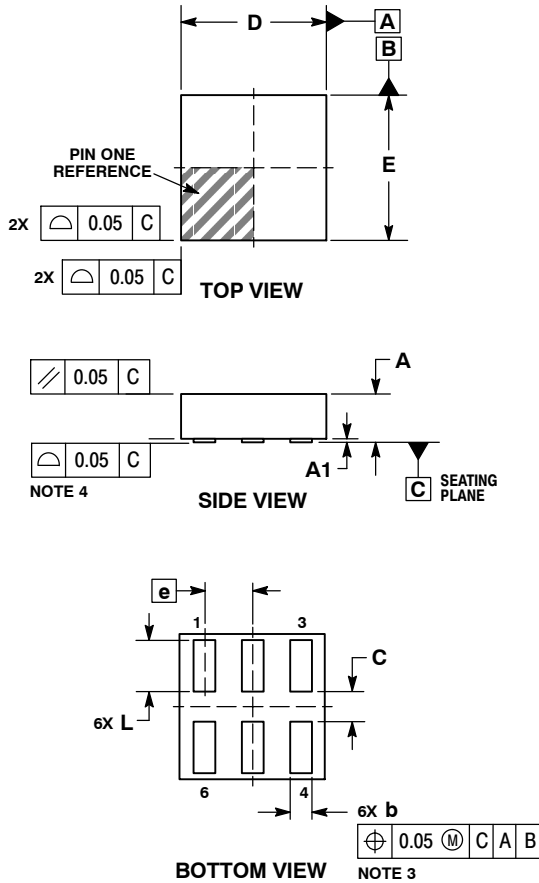
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. 419A-01 OBSOLETE. NEW STANDARD 419A-02.
4. DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS, OR GATE BURRS.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.071	0.087	1.80	2.20
B	0.045	0.053	1.15	1.35
C	0.031	0.043	0.80	1.10
D	0.004	0.012	0.10	0.30
G	0.026 BSC		0.65 BSC	
H	---	0.004	---	0.10
J	0.004	0.010	0.10	0.25
K	0.004	0.012	0.10	0.30
N	0.008 REF		0.20 REF	
S	0.079	0.087	2.00	2.20

# NCP4589

## PACKAGE DIMENSIONS

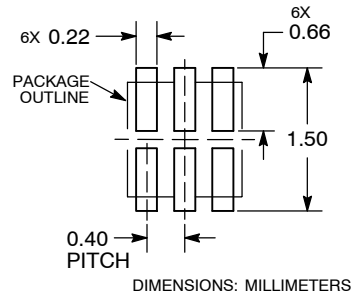
**XDFN6 1.2x1.2, 0.4P**  
CASE 711AA-01  
ISSUE O



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.25mm FROM TERMINAL TIPS.
  4. COPLANARITY APPLIES TO ALL OF THE TERMINALS.

DIM	MILLIMETERS	
	MIN	MAX
A	---	0.40
A1	0.00	0.05
b	0.13	0.23
C	0.20	0.30
D	1.20 BSC	
E	1.20 BSC	
e	0.40 BSC	
L	0.37	0.48

### RECOMMENDED MOUNTING FOOTPRINT\*

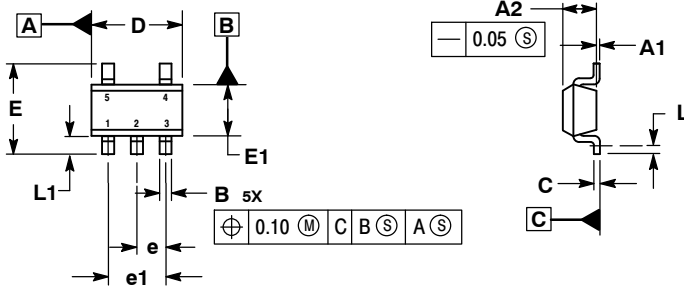


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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## PACKAGE DIMENSIONS

SOT-23-5  
CASE 1212-01  
ISSUE O



NOTES:

1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DATUM C IS A SEATING PLANE.

MILLIMETERS		
DIM	MIN	MAX
A1	0.00	0.10
A2	1.00	1.30
B	0.30	0.50
C	0.10	0.25
D	2.80	3.00
E	2.50	3.10
E1	1.50	1.80
e	0.95 BSC	
e1	1.90 BSC	
L	0.20	---
L1	0.45	0.75

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