High Performance Rail-to-Rail Quad Operational Amplifiers

EC5614

FEATURES

- Wide Supply Voltage Range 4.5V to 20V
- Input range 500mV beyond the rails
- Rail-to-Rail Output Swing
- Large DC Voltage Gain 90dB (Typical)
- High slew rate 40V/μs
- Protection Function
  - Over Temperature Protection (OTP)
  - Over Current Protection (OCP)
- -3dB Bandwidth (unit gain) 30MHz
- ±350mA Output Short Circuit Current
- Unity-gain stable
- Ultra-small Package TSSOP-14

APPLICATIONS

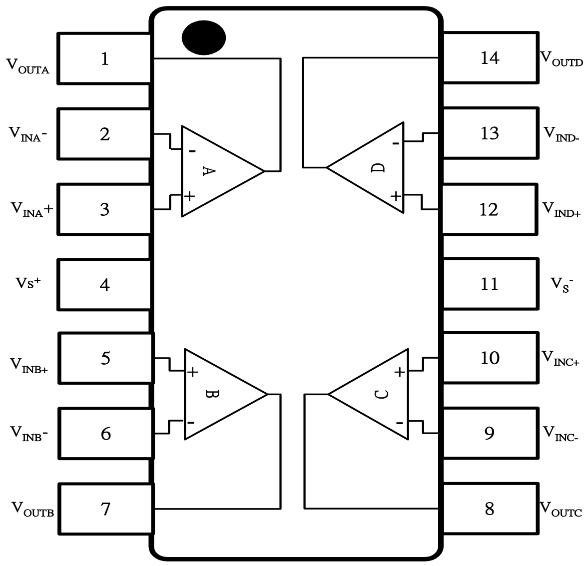
- TFT-LCD Reference Driver
- Touch-Screen Display
- Wireless LANs
- Personal Communication Devices
- Direct Access Arrangement
- Personal Digital Assistant (PDA)
- Active Filter
- Sampling ADC Amplifier
- ADC/DAC Buffer
- Electronic Notebook
- Office Automation

GENERAL DESCRIPTION

The EC5614 is a 100mA output current rail-to-rail quad channels operational amplifier with wide supply range from 4.5V to 20V while consumes only 2.0mA per channel. It provides 0.5V beyond the supply rails of common mode input range and capability of rail-to-rail output swing as well. This enables the amplifier to offer maximum dynamic range at any supply voltage among many applications. A 20MHz gain bandwidth product allows EC5614 to perform more stable than other devices in Internet applications.

With features of 40V/μs high slew rate and 500ns of fast settling time, as well as 100mA (sink and source) of high output driving capability, the EC5614 is ideal for the requirements of flat panel Thin Film Transistor Liquid Crystal Displays (TFT-LCD) panel reference buffers application. Due to insensitive to power supply variation, EC5614 offers flexibility of use in multitude of applications such as battery power, portable devices and anywhere low power consumption is concerned. With standard operational amplifier pin assignment, the EC5614 is offered in space saving 14-Pin TSSOP package and specified over the -40°C to +85°C temperature range.

PIN ASSIGNMENT



TSSOP-14

ABSOLUTE MAXIMUM RATINGS (TA = 25 °C)

Values beyond absolute maximum ratings may cause permanent damage to the device. These are stress ratings only; functional device operation is not implied. Exposure to AMR conditions for extended periods may affect device reliability.

Supply Voltage between V_{S+} and V_{S-}	+20V
Input Voltage	V_{S-} -0.5V, V_{S+} +0.5V
Maximum Continuous Output Current	100mA
Maximum Die Temperature	+125°C
Storage Temperature	-65°C to +150°C
Operating Temperature	-40°C to +85°C
Lead Temperature	260°C
ESD Voltage	2kV

Important Note:
All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: TJ = TC = TA

ELECTRICAL CHARACTERISTICS

V_{S+}= +5V, V_{S-} = -5V, R_L = 10kΩ and C_L = 10pF to 0V, T_A = 25°C unless otherwise specified.

Parameter	Description	Condition	Min	Typ	Max	Units
Input Characteristics						
V_{OS}	Input Offset Voltage	V_{CM}= 0V		2	12	mV
TCV_{OS}	Average Offset Voltage Drift	[1]		5		µV/°C
I_B	Input Bias Current	V_{CM}= 0V		2	50	nA
R_{IN}	Input Impedance			1		G
C_{IN}	Input Capacitance			1.35		pF
CMIR	Common-Mode Input Range		-0.5		+5.5	V
CMRR	Common-Mode Rejection Ratio	for V_{IN} from -0.5V to 5.5V	50	70		dB
A_{VOL}	Open-Loop Gain	-4.5V≦V_{OUT}≦4.5V	75	90		dB
Output Characteristics						
V_{OL}	Output Swing Low	I_L=-5mA		-4.92	-4.85	mV
V_{OH}	Output Swing High	I_L=5mA	4.85	4.92		V
I_{SC}	Short Circuit Current			±350		mA
I_{OUT}	Output Current			±100		mA
I_{PK}	Peak Output Current	V_{S+}=18V, V_{IN}= V_{S+}/2, V_{S-}=0V; Source Current: I load V_{OUT} to GND		550		mA
		V_{S+}=18V, V_{IN}= V_{S+}/2, V_{S-}=0V; Sink Current: I load V_{OUT} to V_{S+}				
Power Supply Performance						
PSRR	Power Supply Rejection Ratio	V_S is moved from ±2.25V to ±7.75V	60	80		dB
I_S	Supply Current (Per Amplifier)	No Load,		2		mA
Dynamic Performance						
SR	Slew Rate [2]	-4.0V≦V_{OUT}≦4.0V, 20% to 80%		40		V/µs
t_S	Settling to +0.1% (AV = +1)	(AV = +1), V_O=2V Step		500		ns
BW	-3dB Bandwidth	R_L = 10kΩ , C_L=10pF		30		MHz
GBWP	Gain-Bandwidth Product	R_L = 10kΩ , C_L =10pF		20		MHz
PM	Phase Margin	R_L = 10kΩ , C_L = 10 pF		50		Degrees
CS	Channel Separation	f = 1 MHz		75		dB
TSD	Thermal Shutdown			150		°C

1. Measured over operating temperature range
2. Slew rate is measured on rising and falling edges

TYPICAL PERFORMANCE CURVES

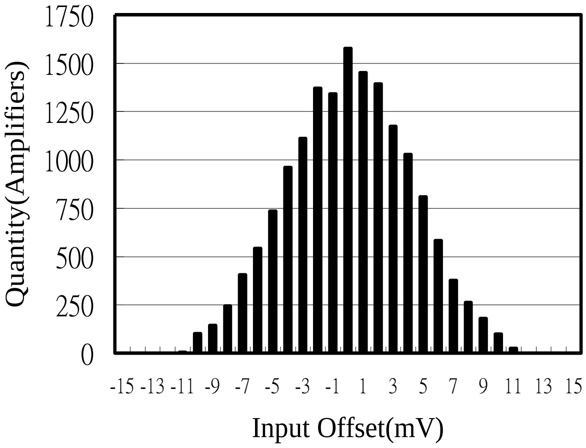


Figure (a) Input Offset Voltage Distribution

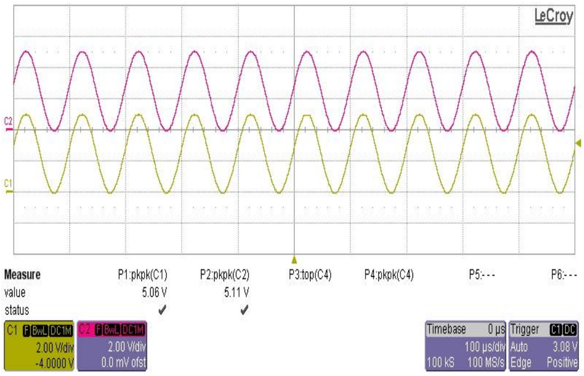


Figure (b) Rail to Rail Capability

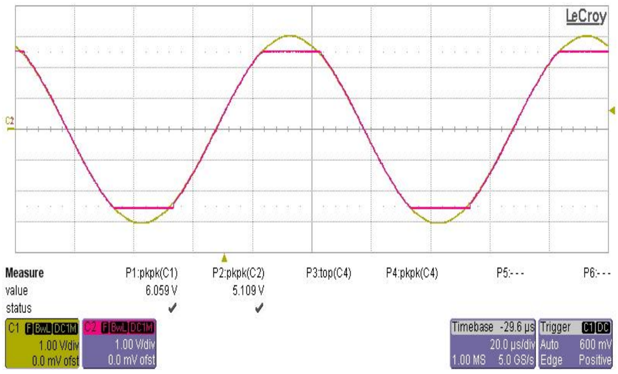


Figure (c) Input beyond the rails

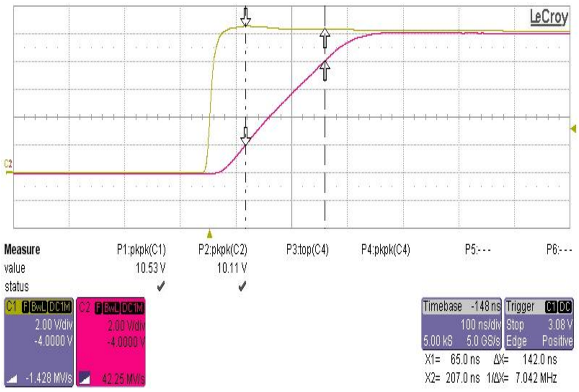


Figure (d) Large Signal Transient Response

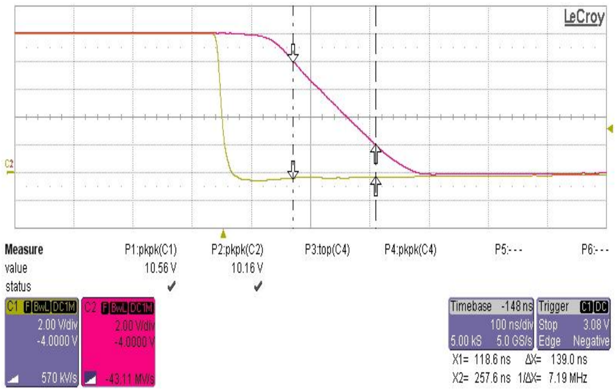


Figure (e) Large Signal Transient Response

APPLICATIONS INFORMATION

Product Description

The EC5614 rail-to-rail quad channels amplifier is built on an advanced high voltage CMOS process. It's beyond rails input capability and full swing of output range made itself an ideal amplifier for use in a wide range of general-purpose applications. The features of 40V/µS high slew rate, fast settling time, 20MHz of GBWP as well as high output driving capability have proven the EC5614 a good voltage reference buffer for TFT-LCD for applications. High phase margin make the EC5614 ideal for Connected in voltage follower mode for high drive applications

Supply Voltage, Input Range and Output Swing

The EC5614 can be operated with a single nominal wide supply voltage ranging from 4.5V to 20V with stable performance over operating temperatures of -40 °C to +85 °C.

With 500mV greater than rail-to-rail input common mode voltage range and 80dB of Common Mode Rejection Ratio, the EC5614 allows a wide range sensing among many applications without having any concerns over exceeding the range and no compromise in accuracy. The output swings of the EC5614 typically extend to within 80mV of positive and negative supply rails with load currents of 5mA. The output voltage swing can be even closer to the supply rails by merely decreasing the load current. Figure 1 shows the input and output waveforms for the device in the unity-gain configuration. The amplifier is operated under ±5V supply with a 10k . load connected to GND. The input is a 10Vp-p sinusoid. An approximately 9.985 Vp-p of output voltage swing can be easily achieved.

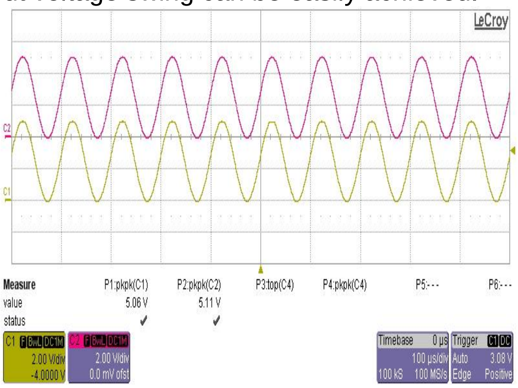


Figure 1. Operation with Rail-to-Rail Input and Output.

Output Short Circuit Current Limit

A +/-350mA short circuit current will be limited by the EC5614 if the output is directly shorted to the positive or the negative supply. For an indefinitely output short circuit, the power dissipation could easily increase such that the device may be damaged. The internal metal interconnections are well designed to prevent the output continuous current from exceeding +/-100mA such that the maximum reliability can be well maintained.

Output Phase Reversal

The EC5614 is designed to prevent its output from being phase reversal as long as the input voltage is limited from V_{S-} -0.5V to V_{S+} +0.5V. Figure 2 shows a photo of the device output with its input voltage driven beyond the supply rails. Although the phase of the device's output will not be reversed, the input's over-voltage should be avoided. An improper input voltage exceeds supply range by more than 0.6V may result in an over stress damage.

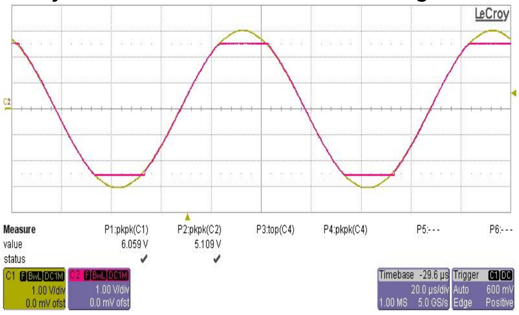


Figure 2. Operation with Beyond-the Rails Input

Power Dissipation

The EC5614 is designed for maximum output current capability. Even though momentary output shorted to ground causes little damage to the device.

For the high drive amplifier EC5614, it is possible to exceed the 'absolute-maximum junction temperature' under certain load current conditions. Therefore, it is important to calculate the maximum junction temperature for the application to determine if load conditions need to be modified for the amplifier to remain in the safe operating area. The maximum power dissipation allowed in a package is determined according to:

$$P_{D\,max} = \frac{T_{J\,max} - T_{A\,max}}{\Theta_{JA}}$$

Where:

T_{Jmax} = Maximum Junction Temperature

T_{Amax}= Maximum Ambient Temperature

Θ_{JA} = Thermal Resistance of the Package

P_{Dmax} = Maximum Power Dissipation in the Package.

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the loads, or:

$P_{Dmax} = \sum_i[V_S \times I_{Smax} + (V_{S+} - V_O) \times I_L]$

When sourcing, and

$\mathbf{P_{Dmax}} = \sum_i[\mathbf{V_S} \times \mathbf{I_{Smax}} + (\mathbf{V_O} - \mathbf{V_{S-}}) \times \mathbf{I_L}]$
When sinking.
Where:
i = 1 to 4

$\mathbf{V_S}$ = Total Supply Voltage

$\mathbf{I_{Smax}}$ = Maximum Supply Current Per Amplifier

$\mathbf{V_O}$ = Maximum Output Voltage of the Application

$\mathbf{I_L}$= Load current

$\mathbf{R_L}$= Load Resistance = $(\mathbf{V_{S+}} - \mathbf{V_O})/\mathbf{I_L} = (\mathbf{V_O} - \mathbf{V_{S-}})/\mathbf{I_L}$

Package	θja (℃/W)
TSSOP14	165
TSSOP14 1.98x2.23	75
TSSOP14 3x3	59

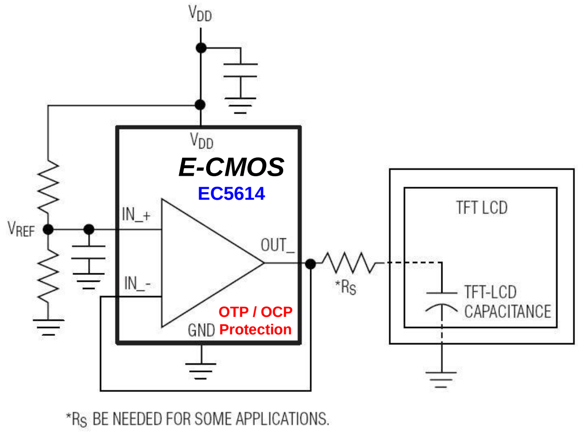


Figure 3. Typical Application Configuration.

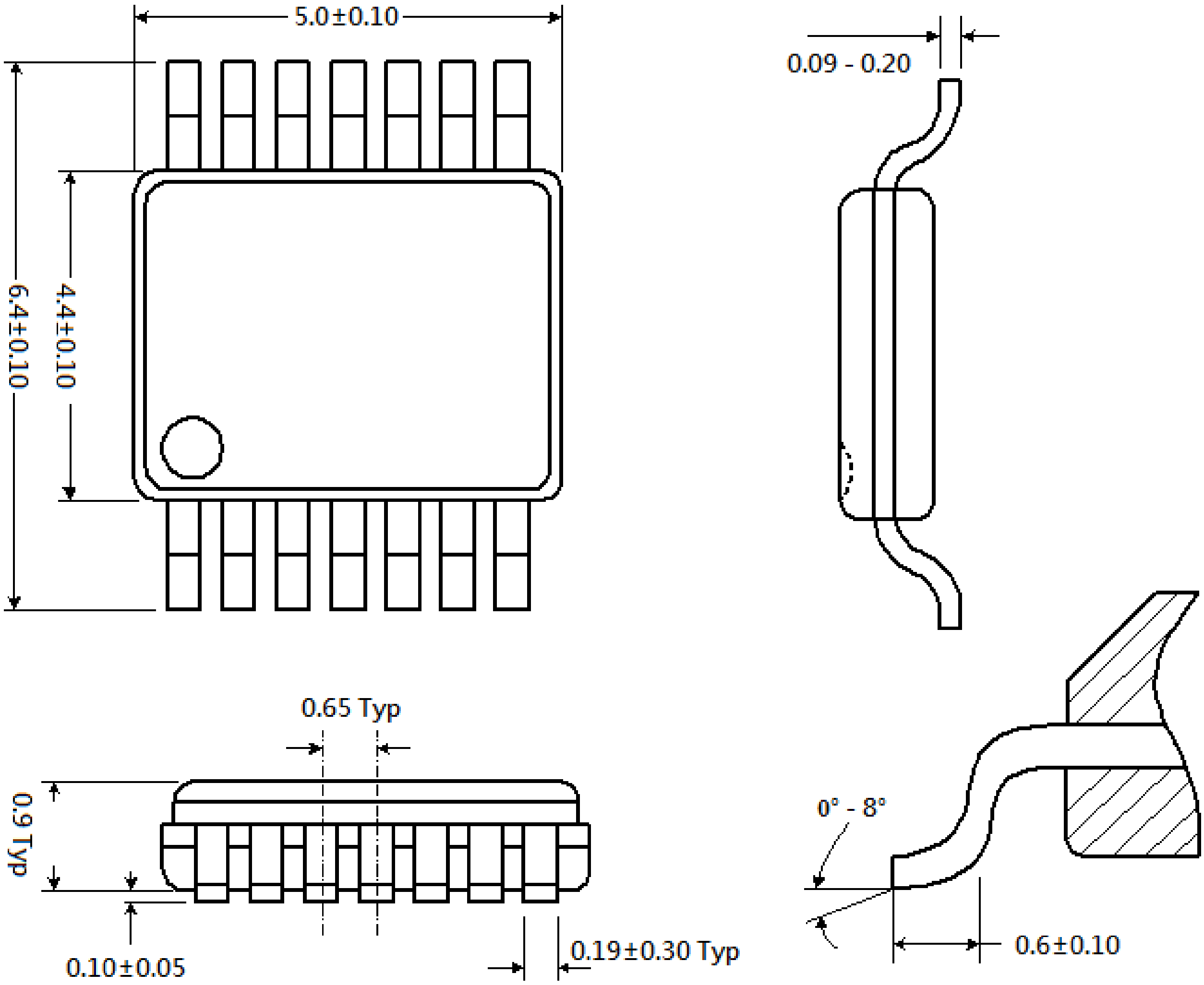
Driving Capacitive Loads
The EC5614 is designed to drive a wide range of capacitive loads. In addition, the output current handling capability of the device allows for good slewing characteristics even with large capacitive loads. The combination of these features make the EC5614 ideally for applications such as TFT LCD panel buffers, ADC input amplifiers, etc.

As load capacitance increases on the device output, resulting in additional pole in the op amp's feedback loop. Depending on the application, a small value of series resistance must be placed in series with the output (usually between 5 Ω and 50 Ω). However, the op amp remains stable because the load capacitance and the series resistance create a zero that cancels the effect of this pole. It improves the performance of the device to ensure stability and fast settling with very large capacitive loads. Figure3. shows the typical application configuration.

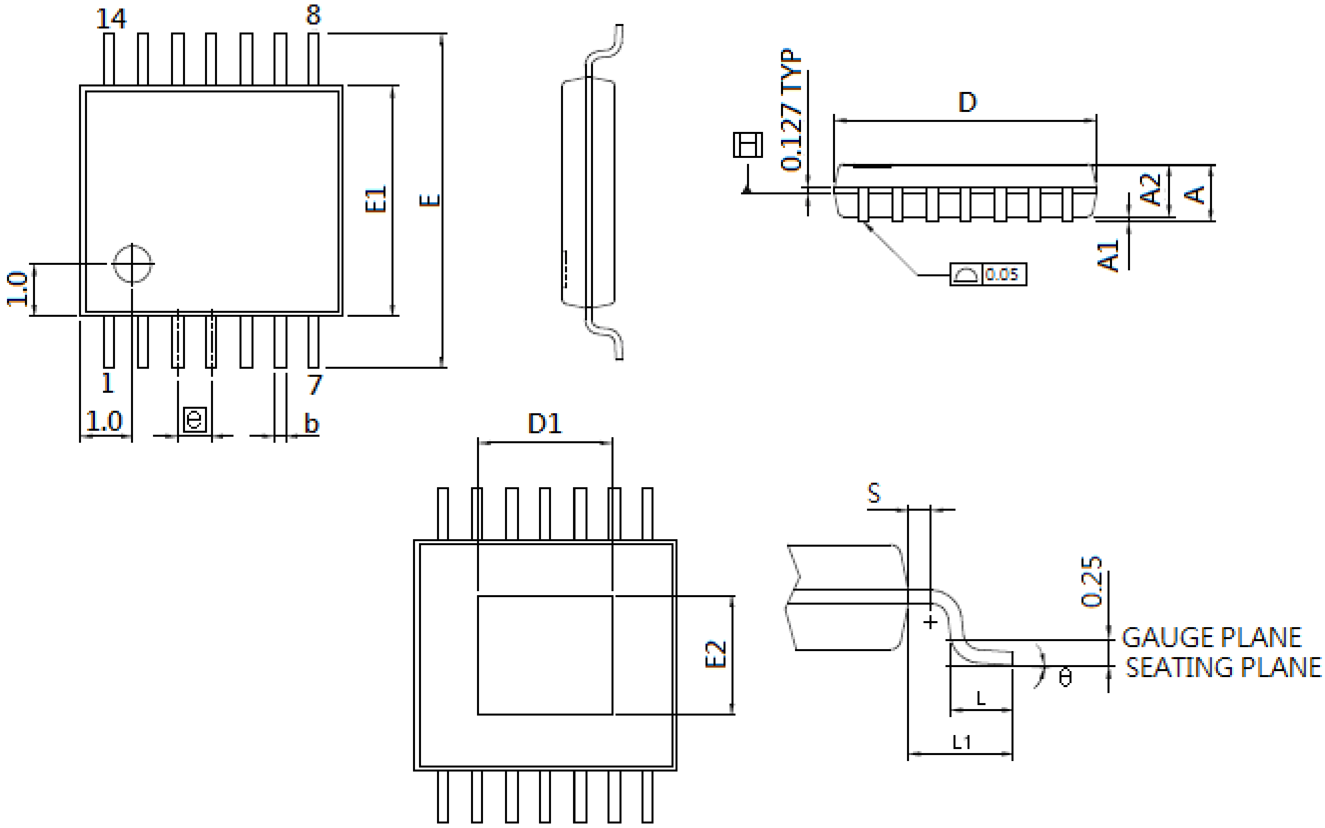
Power Supply Bypassing and Printed Circuit Board Layout
With high phase margin, the EC5614 performs stable gain at high frequency. Like any high-frequency device, good layout of the printed circuit board usually comes with optimum performance. Ground plane construction is highly recommended, lead lengths should be as short as possible and the power supply pins must be well bypassed to reduce the risk of oscillation. For normal single supply operation, where the V_{S-} pin is connected to ground, a 0.1µF ceramic capacitor should be placed from V_{S+} pin to V_{S-} pin as a bypassing capacitor. A 4.7µF tantalum capacitor should then be connected in parallel, placed in the region of the amplifier. One 4.7µF capacitor may be used for multiple devices. This same capacitor combination should be placed at each supply pin to ground if split supplies are to be used.

OUTLINE DIMENSIONS (Dimensions shown in millimeters)

TSSOP (Thin-Shrink Small Outline Package)



TSSOP (Thin-Shrink Small Outline Package, Exposed Pad)



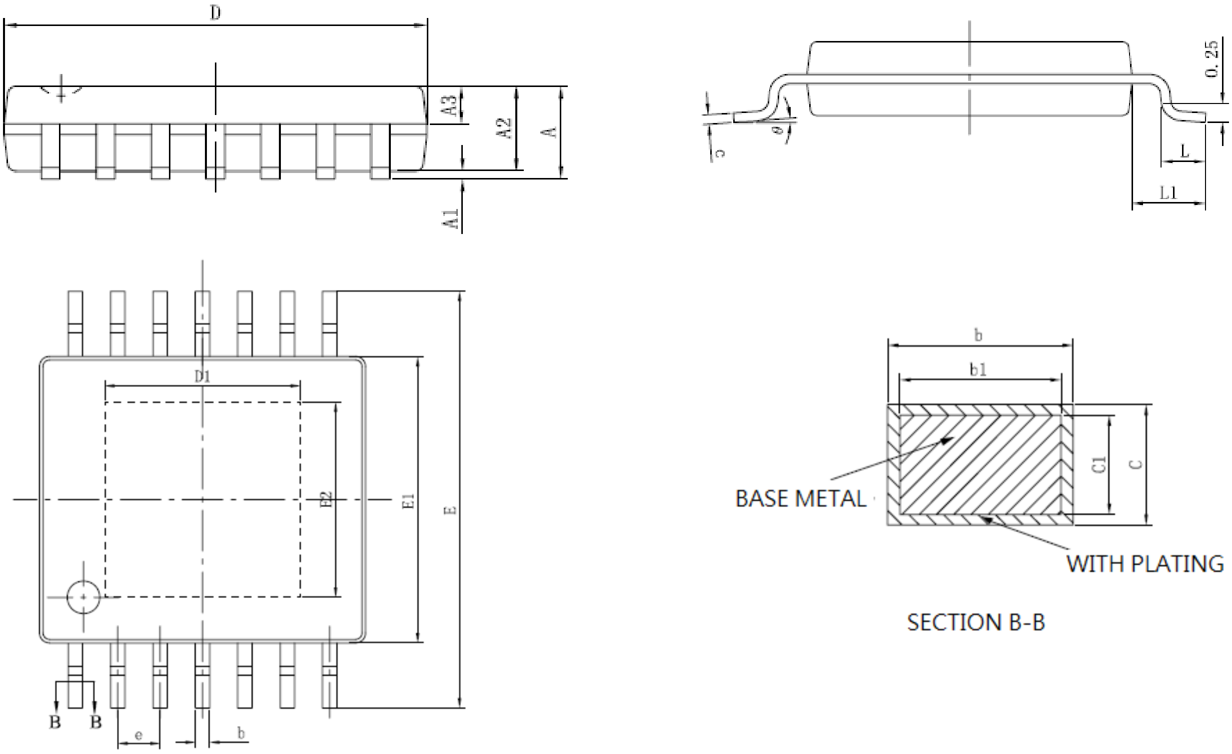
VARIATIONS (ALL DIMENSIONS SHOWN IN MM)

	SYMBOLS		MIN.	NOM.	MAX.
	A		-	-	1.20
△2	A1	STANDARD	0.05	-	0.15
		THERMALLY ENHANCED	0.00	-	0.15
	A2		0.80	1.00	1.05
	b		0.19	-	0.30
	D		4.90	5.00	5.10
	D1		1.92	2.23	2.54
	E2		1.67	1.98	2.29
	E1		4.30	4.40	4.50
△1	E		6.40 BSC		
	e		0.65 BSC		
	L1		1.00 BSC		
	L		0.50	0.60	0.75
	S		0.20	-	-
	θ		0°	-	8°

NOTES:

1. JEDEC OUTUNE
   STANDARD: MO-153 AB-1
   THERMALLY ENHANCED: MO-153 ABT-1
2. DIMENSION 'D'DOES NGAOT INCLUDE MOLD FLASH. PROTRUSION OR GATE BURRS. MOLD FLASH. PROTRUSIONS OR GADE BURRS SHALL NOT EXCEED 0.15 PER SIDE.
3. DIMENSION 'E1' DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 PER SIDE.
4. DIMENSION 'B' DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08MM TOTAL IN EXCESS OF THE 'B' DIMENSION AT MAXIMUM
   MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THELOWER RADIUS OF THE FOOT. MNMUM SPACE BETWEEN PROTRUSION AND ADJACENT LEAD IS 0.07 MM.
5. DIMENSIONS 'D' AND 'E1' TO BE BETERMNED AT DATUM PLANE E

TSSOP (Thin-Shrink Small Outline Package, Exposed Pad)



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
A3	0.39	0.44	0.49
b	0.20	-	0.30
b1	0.19	0.22	0.25
c	0.13	-	0.19
c1	0.12	0.13	0.14
D	4.86	4.96	5.06
D1	2.90	3.00	3.10
E2	2.90	3.00	3.10
E1	4.30	4.40	4.50
E	6.25	6.40	6.55
e		0.65BSC	
L	0.45	-	0.75
L1		1.00BSC	
θ	0	-	8°

ORDERING INFORMATION

PART NUMBER	TOP MARK	PACKAGE
EC5614I-G	EC5614-G	Green mode TSSOP-14
EC5614I-HG	EC5614HG	Green mode TSSOP-14(EP Size: 1.98mm x 2.23mm)
EC5614I-H1G	EC5614H1	Green mode TSSOP-14(EP Size: 3mm x 3mm)