High Slew Rate Rail-to-Rail Single Operational Amplifiers with OTP

EC5601C

General Description

The EC5601 is a rail-to-rail one channel operational amplifier with wide supply range from 6V to 14V. 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 EC5601 to perform more stable than other devices in Internet applications.

With features of 20V/µs high slew rate and 200ns of fast settling time, as well as 60mA (sink and source) of high output Driving capability, the EC5601is ideal for the requirements of flat panel Thin Film Transistor Liquid Crystal Displays (TFT-LCD) panel gray scale reference buffers application. Due to insensitive to power supply variation, EC5601 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 EC5601 is offered in a space saving 6-Pin SOT-26 package and specified over the -40°C to +100°C temperature range.

Features

◆Wide supply voltage range 6V ~ 14V
◆Input range 500mV beyond the rails
◆Unity-gain stable
◆Rail-to-rail output swing
◆High slew rate 20V/µs
◆GBWP 20MHz
◆30MHz -3dB Bandwidth
◆Ultra-small Package SOT-26

Application

◆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
◆Portable Electronics

Pin Assignment

SOT26
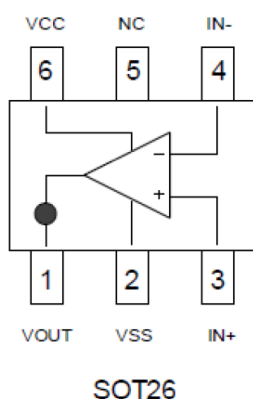
Functional Pin Description

Pin Name	Pin Function
OUT	Operational Amplifier Output
VSS	IC GROUND or Negative power supply
IN+	Operational Amplifier Non-Inverting Input
IN-	Operational Amplifier Inverting Input
VCC	Supply Voltage VCC can range from 6V to 18V

Absolute Maximum Ratings (T_A = 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 VS+ and VS-	+18V	Storage Temperature	-65°C to +150°C
Input Voltage	VS- - 0.5V, VS +0.5V	Maximum Die Temperature	+125°C
Maximum Continuous Output Current	100mA	Operating Temperature	-40°C to +100°C
		Lead Temperature	260°C

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						
VOS	Input Offset Voltage	VCM= 0V		2	12	mV
TCVOS	Average Offset Voltage Drift	[1]		5		µV/°C
IB	Input Bias Current	VCM= 0V		2	50	nA
RIN	Input Impedance			1		GΩ
CIN	Input Capacitance			1.35		pF
CMIR	Common-Mode Input Range		-5.0		+5.5	V
CMRR	Common-Mode Rejection Ratio	for V_{IN} from -5.5V to 5.5V	50	70		dB
AVOL	Open-Loop Gain	0.5V≤VOUT≤4.5V	75	90		dB
Output Characteristics						
VOL	Output Swing Low-	Vs+=8V,Vs=-8V,IL=-5mA		-7.92	-7.85	V
VOH	Output Swing High	Vs+=8V,Vs=-8V,IL=5mA	7.85	7.92		V
ISC	Short Circuit Current			130		mA
IOUT	Output Current			±100		mA
Power Supply Performance						
PSRR	Power Supply Rejection Ratio	VS is moved from ±2.25V to ±7.75V	60	80		dB
IS	Supply Current	No Load		3		mA

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
Dynamic Performance						
SR	Slew Rate [2]	Vs+=7V,Vs-=-7V, -3.5V≤V$_{OUT}$≤3.5V, 20% to 80%		4020		V/µs
tS	Settling to +0.1% (AV = +1)	(AV = +1), VO=2V Step		500		Ns
BW	-3dB Bandwidth	RL = 10kΩ, CL=10pF		30		MHz
GBWP	Gain-Bandwidth Product	RL = 10kΩ, CL=10pF		20		MHz
PM	Phase Margin	RL = 10kΩ, CL = 10 pF		50		Degrees
CS	Channel Separation	f = 1 MHz		75		dB
Temperature Performance						
Temp	Thermal Shutdown			150		℃
1. Measured over operating temperature range 2. Slew rate is measured on rising and falling edges						

Typical Performance Curves
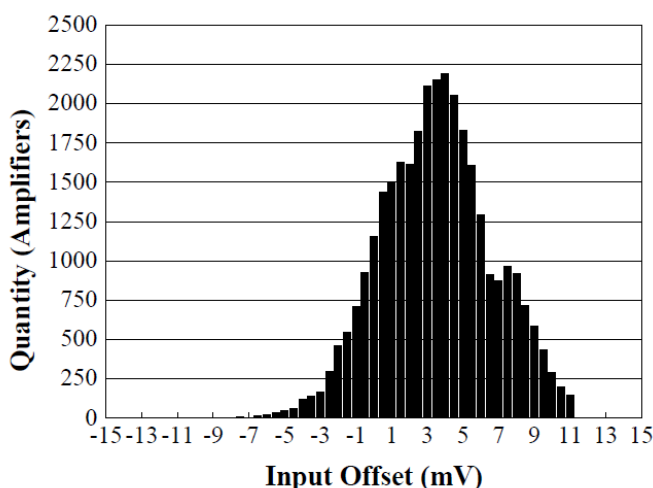
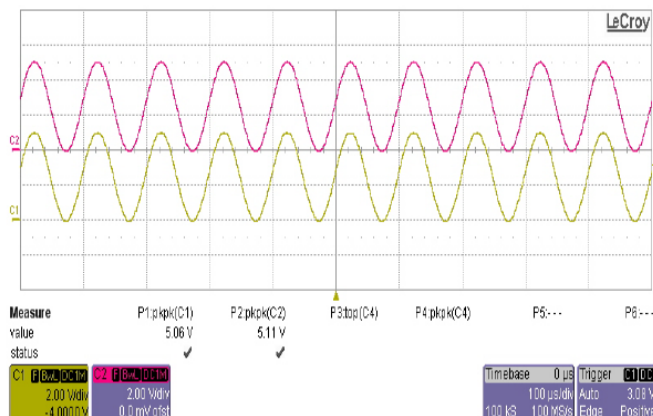Figure (a) Input Offset Voltage Distribution

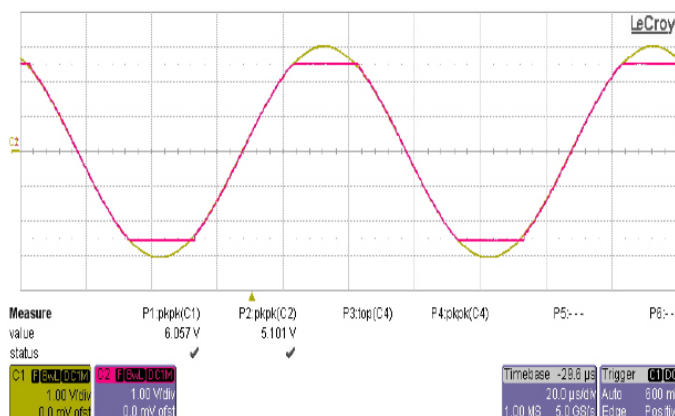Figure (b) Rail to Rail Capability
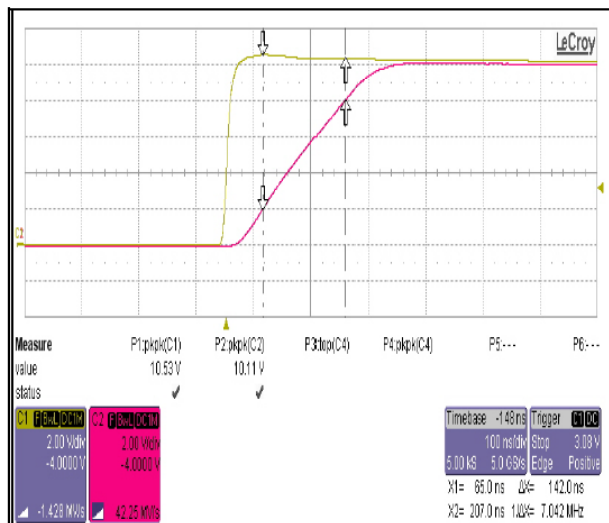

Figure (c) Input Beyond the Rails Signal
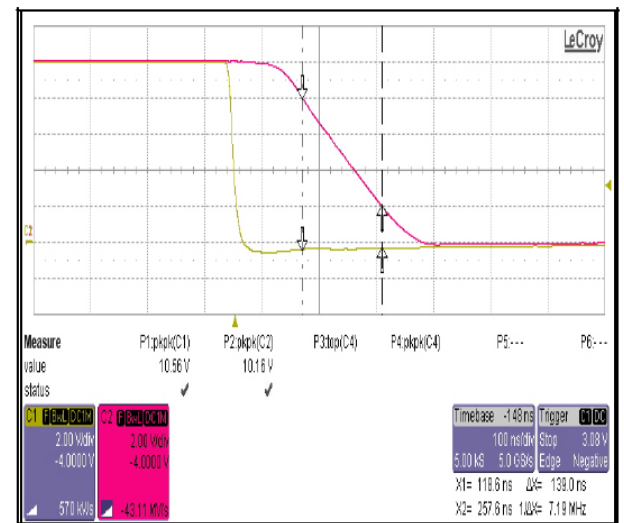
Figure (d) Large Signal Transient Response

Figure (e) Large Signal Transient Response

Applications Information

Product Description

The EC5601 rail-to-rail one channel amplifier is built on an advanced high voltage CMOS process. It's beyond rails input capability and full swing of output range makes 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, 30MHz of GBWP as well as high output driving capability have proven the EC5601 a good voltage reference buffer in TFT-LCD for gray scale reference applications. High phase margin and extremely low power consumption make the EC5601 ideal for connected in voltage follower mode for low power high drive applications.

Supply Voltage, Input Range and Output Swing

The EC5601 can be operated with a single nominal wide supply voltage ranging from 6V to 18V with stable performance Over operating temperature of -40°C to +100°C. With 500mV greater than rail-to-rail input common mode voltage range and 70dB of Common Mode Rejection Ratio, the EC5601 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 EC5601 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 10KΩ 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.
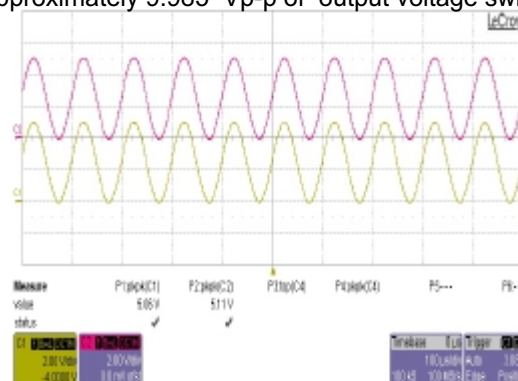

Figure 1. Operation with Rail-to-Rail Input and Output

Output Short Circuit Current Limit

A +/-350mA short circuit current will be limited by the EC5601 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 EC5601 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.
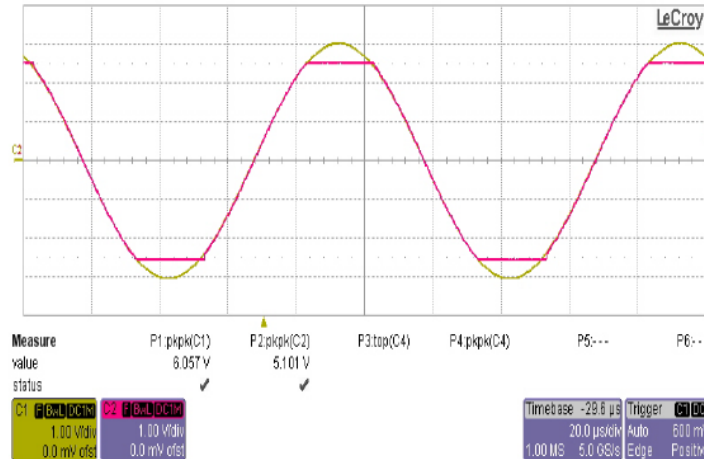

Figure 2. Operation with Beyond-the Rails Input

Power Dissipation

The EC5601 is designed for maximum output current capability. Even though momentary output shorted to ground causes little damage to device. For the high drive amplifierEC5601,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:

$$P_{Dmax} = \frac{T_{Jmax} - T_{Amax}}{\Theta_{JA}}$$

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:

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

When sourcing, and

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

When sinking.

Where:

i = 1 to 1

V_S = Total Supply Voltage

I_{Smax} = Maximum Supply Current Per Amplifier

V_O = Maximum Output Voltage of the Application

I_L = Load current

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

A calculation for R_L to prevent device from overheat can be easily solved by setting the two P_{Dmax} equations equal to each other.

Driving Capacitive Loads

The EC5601 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 EC5601 ideally for applications such as TFT LCD panel gray scale reference voltage buffers, ADC input amplifiers, etc.

As load capacitance increases, however, the -3dB bandwidth of the device will decrease and the peaking increase. Depending on the application, it must be necessary to reduce peaking and to improve device stability. To improve device stability, a small value of series resistor (usually between 5Ω and 50Ω) must be placed in series with the output. The advantage is that it improves the settling and overshooting performance with very large capacitive loads. Figure 3. shows the typical application configuration.
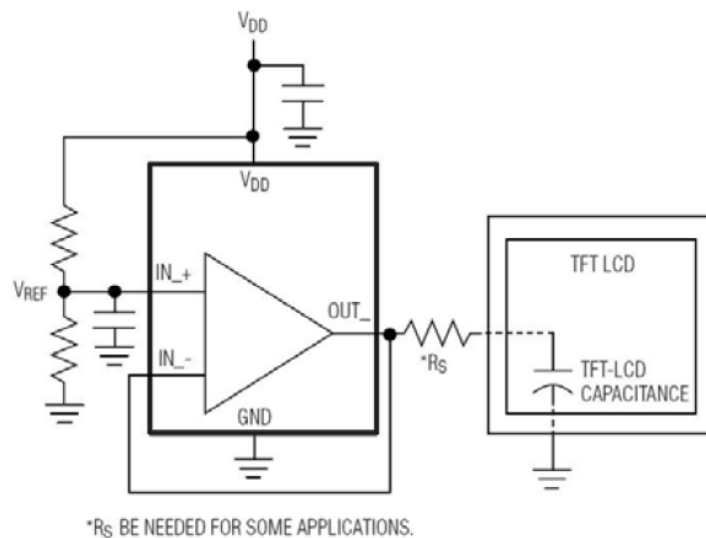

*RS BE NEEDED FOR SOME APPLICATIONS.

Figure 3. Typical Application Configuration.

## Power Supply Bypassing and Printed Circuit Board Layout

With high phase margin, the EC5601 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 0.1 μF 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.

Ordering Information

PART NO	TOP MARK	PACKAGE TYPE
EC5601CB3-G	EC5601 XXXXX	SOT-26 GREEN PACKAGE "XXXX" is lot code

Outline Dimensions (Dimensions shown in millimeters)
SOT-26
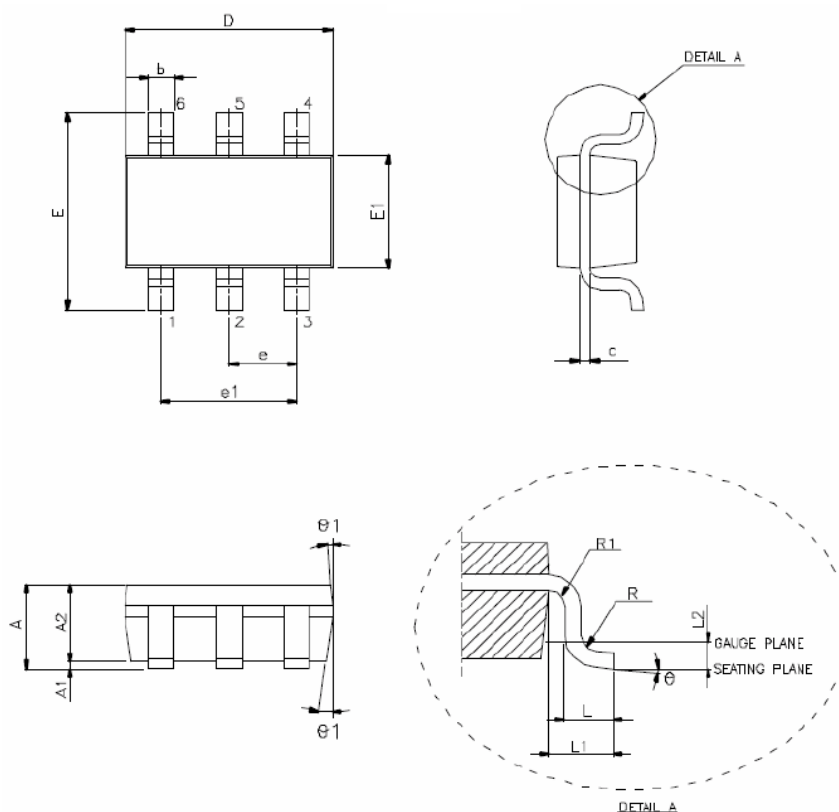
VARIATION(ALL DIMENSIONS SHOWN IN MM)			
SYMBOL	MIN.	NOM.	MAX.
A	–	–	1.45
A1	–	–	0.15
A2	0.90	1.15	1.30
b	0.30	–	0.50
c	0.08	–	0.22
D	2.90 BSC.		
E	2.80 BSC.		
E1	1.60 BSC.		
e	0.95 BSC		
e1	1.90 BSC.		
L	0.30	0.45	0.60
L1	0.60 REF.		
L2	0.25 BSC.		
R	0.10	–	–
R1	0.10	–	0.25
θ	0°	4°	8°
θ1	5°	10°	15°