elantec
HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

EL2029/EL2029C

0.01% 200 ns Op Amp—Gain of 5 Stable

Features

- Settling time for 10V swings to 0.1% of 100 ns; to 0.01% of 200 ns
- High slew rate—900 V/μs
- Large power bandwidth—5 MHz
- Large open loop gain—104 dB
- Low input offset voltage—500 μV
- Low input bias current—250 nA
- Inputs tolerant of overload
- Uses standard ±5V to ±15V supplies
- Output tolerant of load capacitance
- MIL-STD-883 Rev. C Compliant

Applications

- 12-bit DAC output amplifiers
- Fast-settling instrumentation amplifiers
- Driving 12-bit A/D converters
- Radar systems
- Replacement of costly hybrids

Ordering Information

Part No.	Temp. Range	Pkg.	Outline*
EL2029CJ	0°C to +75°C	CerDIP	MDP0014
EL2029CN	0°C to +75°C	P-DIP	MDP0031
EL2029J	−55°C to +125°C	CerDIP	MDP0014
EL2029J/883B	−55°C to +125°C	CerDIP	MDP0014

General Description

The EL2029 monolithic operational amplifier is designed for extremely fast and clean settling with millivolt accuracy. It settles to 0.01% from a 10V step in 200 ns but has no thermal tail nor input slew overload penalities. The EL2029 is a true operational amplifier with low bias currents and large voltage gain, and is compensated for closed-loop gains of five or more.

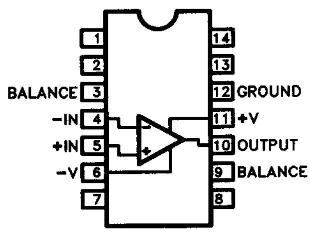
The inputs of the EL2029 are capable of 10V of differential overload without damage nor increased bias current. The amplifier does not exhibit slew aberrations even for signals beyond the output slew limit of 900 V/μs. The output is capable of large currents and is current-limited, and can drive as much as 100 pF stably.

The EL2029 can be used in circuits where current-feedback amplifiers were previously required for adequate speed, while offering at least a tenfold accuracy improvement.

Elantec's EL2029/883B complies with MIL-STD-883 Revision C in all aspects, including burn-in at 125°C. Elantec's facilities comply with MIL-I-45208A and other applicable quality specifications. For information on Elantec's military processing, see the Elantec document QRA-2: *Elantec's Military processing-Monolithic Products.*

Connection Diagram

14-Pin DIP Package



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Top View

July 1991 Rev B

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Absolute Maximum Ratings (T_A = 25°C)

Voltage between V+ and V−	35V
Voltage at GND Pin	V+ to V−
Voltage between −IN and +IN Pins	10V
Voltage at −IN or +IN Pins	V+ to V−
Output Current	50 mA (Peak) 30 mA (Continuous)
Current into +IN, −IN, GND, or Balance Pins	5 mA
Internal Power Dissipation	See Curves
Operating Ambient Temperature Range	
EL2029	−55°C to +125°C
EL2029C	0°C to +75°C
Operating Junction Temperature	
CerDIP	175°C
Plastic DIP	150°C
Lead Temperature (Soldering 5 seconds)	300°C
Storage Temperature Range	−65°C to +150°C

Important Note:
All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefore $T_J = T_C = T_A$.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at T_A = 25°C and QA sample tested at T_A = 25°C, T_{MAX} and T_{MIN} per QA test plan QCX0002.
III	QA sample tested per QA test plan QCX0002.
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data.
V	Parameter is typical value at T_A = 25°C for information purposes only.

DC Electrical Characteristics V_S = ±15V; R_F = 820Ω; R_G = 200Ω; T_A = 25°C unless otherwise specified

Parameter	Description	Temp	Min	Typ	Max	EL2029 Test Level	EL2029C Test Level	Units
V_{OS}	Input Offset Voltage EL2029	25°C		0.15	1.0	I		mV
	EL2029C	25°C		0.15	0.5		I	mV
	EL2029	Full			1.5	I		mV
	EL2029C	Full			1.5		III	mV
TCV_{OS}	Average Offset Voltage Drift	Full		3		V	V	μV/C
I_B	Input Bias Current	25°C		250	500	I	I	nA
		Full			800	I	III	nA
I_{OS}	Input Offset Current	25°C		120	250	I	I	nA
		Full			350	I	III	nA
$R_{IN, DIFF}$	Input Differential Resistance	25°C		5		V	V	MΩ
$R_{IN, COMM}$	Input Common-Mode Resistance	25°C		120		V	V	MΩ
C_{IN}	Input Capacitance	25°C		2		V	V	pF
V_{CM}	Common-Mode Input Range	Full	±11	±12		I	II	V
E_{IN}	Input Noise Voltage (f = 1 kHz, R_G = 0Ω)	25°C		7		V	V	nV/√hz
A_{VOL}	Large Signal Voltage Gain	25°C	60	140		I	I	V/mV
	(V_O = ±10V)	Full	40			I	III	V/mV
CMRR	Common-Mode Rejection Ratio (Note 1)	Full	80	95		I	II	dB

DC Electrical Characteristics

V_S = ±15V; R_F = 820Ω; R_G = 200Ω; T_A = 25°C unless otherwise specified — Contd.

Parameter	Description	Temp	Min	Typ	Max	EL2029 Test Level	EL2029C Test Level	Units
PSRR	Power-Supply Rejection Ratio (Note 2)	Full	80	95		I	II	dB
V_O	Output Voltage Swing	Full	±11	±12		I	II	V
I_O	Output Current (Note 3)	Full	±25	±50		I	II	mA
I_S	Supply Current	Full		14	17	I	II	mA

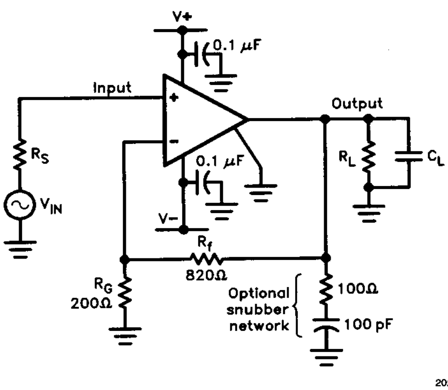
AC Electrical Characteristics

V_S = ±15V; R_F = 820Ω; R_G = 200Ω; C_L = 25 pF; T_A = 25°C unless otherwise specified

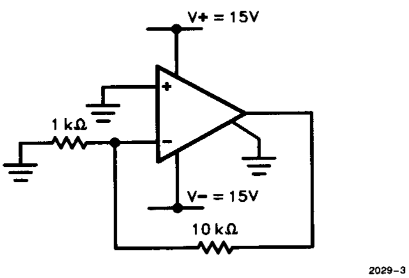
Parameter	Description	Min	Typ	Max	EL2029 Test Level	EL2029C Test Level	Units
GBW	Gain-Bandwidth Product (Note 4)		100		V	V	MHz
FPBW	Full-Power Bandwidth (V_O = ±10V)		5		V	V	MHz
SR	Slew Rate (V_O = ±10V)		900		V	V	V/μs
tr	Rise Time (Notes 4, 5)		8		V	V	ns
OS	Overshoot (Notes 4, 5)		15		V	V	%
ts	Settling Time (Note 4) to 0.1% 10V Step to 0.01%		100 200		V V	V V	ns ns

Note 1: Two tests are performed with V_{CM} = 0V to −11V and V_{CM} = 0V to 11V.
Note 2: Two tests are performed with V+ = 15V, V− changed from −5V to −15V; V− = −15V, V+ changed from 5V to 15V.
Note 3: The inputs are overdriven by ±5V and the output R_L = 100Ω.
Note 4: A 100Ω + 100 pF snubber is used to load the output—see Applications section.
Note 5: V_{IN} = 100 mV peak-to-peak.

Test Circuit

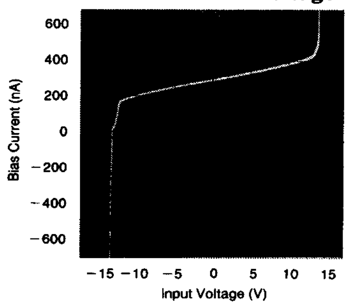


Burn-In Circuit



Typical Performance Curves

Input Bias Current vs Common-Mode Voltage



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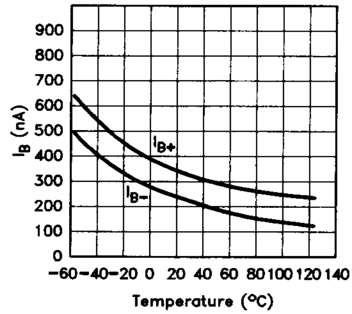
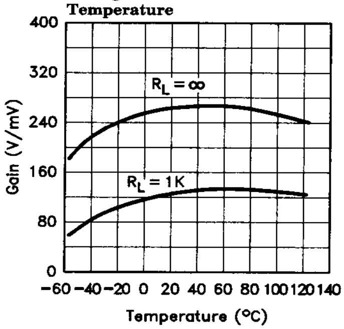
Input Bias Current vs Temperature



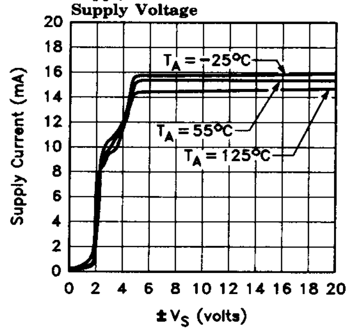
2029-5

Voltage Gain vs Temperature



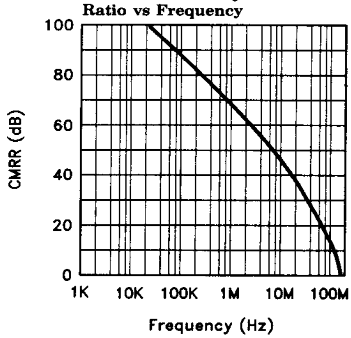
2029-6

Supply Current vs Supply Voltage



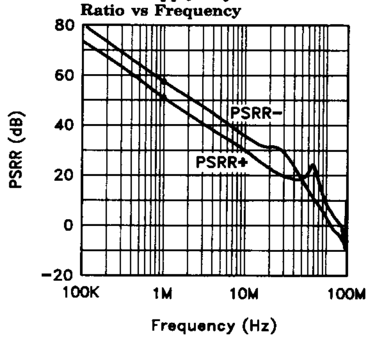
2029-7

Common-Mode Rejection Ratio vs Frequency



2029-8

Power Supply Rejection Ratio vs Frequency



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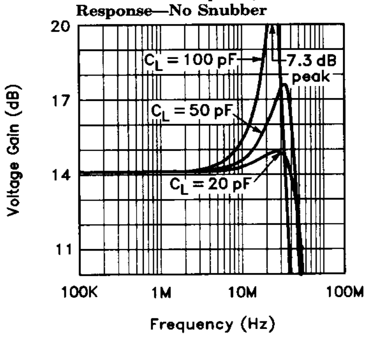
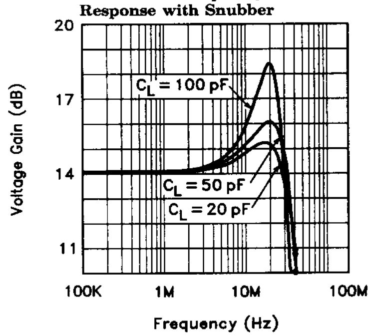
Typical Performance Curves — Contd.

Gain of +5 Frequency Response—No Snubber



2029-10

Gain of +5 Frequency Response with Snubber



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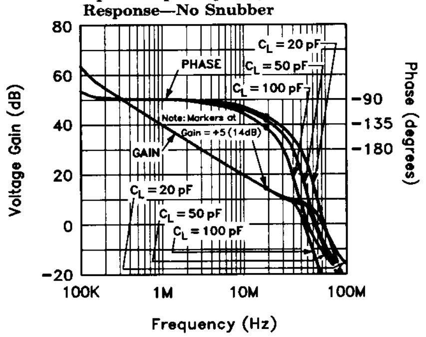
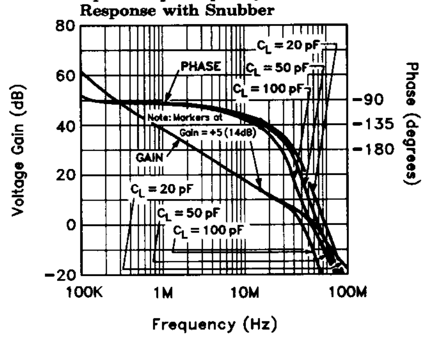
Open-Loop Frequency Response—No Snubber



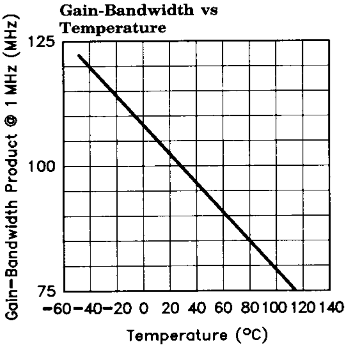
2029-12

Open-Loop Frequency Response with Snubber



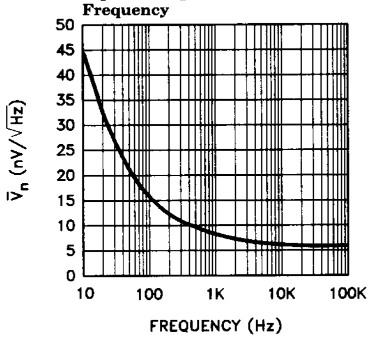
2029-13

Gain-Bandwidth vs Temperature



2029-14

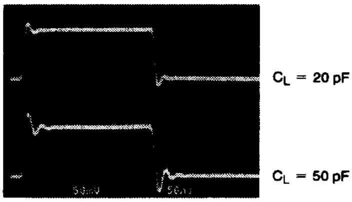
Input Voltage Noise vs Frequency



2029-15

Typical Performance Curves — Contd.

Small-Signal Pulse Response—No Snubber



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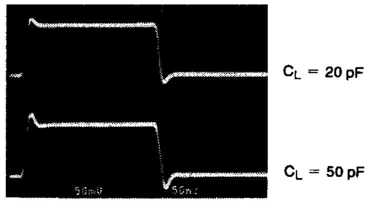
Small-Signal Pulse Response—100Ω + 100 pF Snubber



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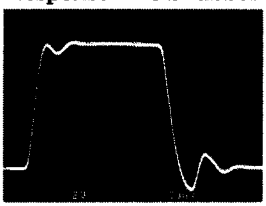
Large-Signal Pulse Response—No Snubber



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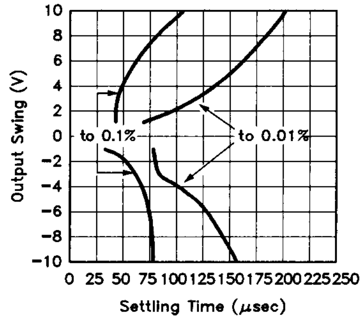
Settling Time vs Output Swing



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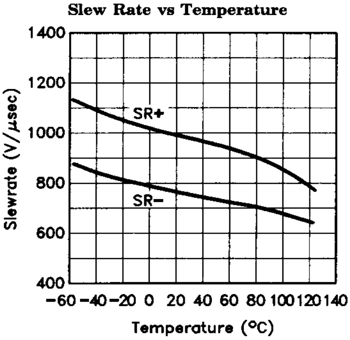
Slew Rate vs Temperature



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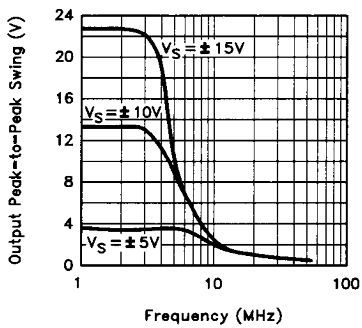
Output Swing vs Frequency for 5% Distortion



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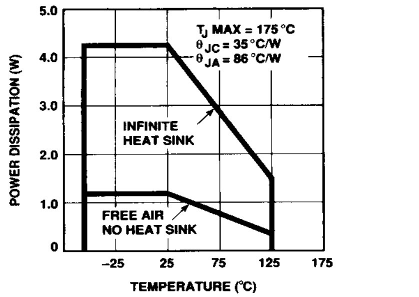
Typical Performance Curves — Contd.

14-Lead CerDIP
Maximum Power Dissipation
vs Ambient Temperature



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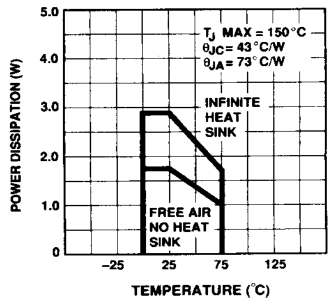
14-Lead Plastic DIP
Maximum Power Dissipation
vs Ambient Temperature



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Applications Information

The EL2029 is a conventional high-accuracy operational amplifier with the speeds and bandwidths normally found only in current-feedback amplifiers. All the usual op amp configurations may be applied. The EL2029 will work well with a wide variety of loads and power supplies.

Power Supplies and Grounding

As with all high-frequency amplifiers, it is necessary to bypass the supply pins to ground close to the part. 0.01 μF capacitors of the ceramic type will suffice, although tantalum capacitors of any available value are perhaps the best choice. Tantalum capacitors have low series inductance yet are not high-Q in nature, helping to damp supply variations caused by load currents.

The EL2029 will work well from $\pm$5V supplies, with the input and output swings reduced to $\pm$1V over temperature, $\pm$2V nominally. At higher supplies, the part's dissipation must be maintained within package limits when the device and any load-related dissipations are calculated. Clip-on heatsinks are effective in reducing die temperature. Note that the device will warm approximately 36 degrees centigrade upon power-up: any accurate DC tests should either be done within 1 second or after 1 minute of turn-on at maximum supplies.

Although the part is current-limited at its output, that current can cause enough dissipation such that the maximum die temperature specification will be exceeded.

The EL2029 has a unique ground pin connection. The compensation capacitor returns to this pin rather than ground to aid in noise and settling characteristics. The input bias current compensation circuitry is also referred to this pin, so it cannot be connected to a voltage outside the input common-mode range.

Input Circuitry

The input appears as a high impedance even when the amplifier is overloaded. The input will not be damaged by transient nor continuous overloads, although an additional supply current of 4 mA per volt of overload will result. This should be considered in the device thermal calculations.

Like many other high-speed amplifiers, the input circuitry can resonate or even oscillate when driven by high-impedance inputs. The worst situation is when the device looks into an unterminated coaxial cable or a large inductance. Normal circuit interconnects cause no trouble. If the source impedance is difficult, a snubber similar to the output snubber can be added in parallel with the input.

High values of feedback impedance can sacrifice loop stability. The main point is that the pole caused by any stray capacitance and the feedback network impedance should be several times greater than the EL2029's gain-bandwidth product divided by the noise gain of the feedback loop. If this condition cannot be met, the feedback resistor can have a small (1–2 pF) capacitor in parallel to improve closed-loop phase margin.

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Applications Information — Contd.

Output Circuitry

The output circuitry was designed to deliver more current than the device can safely continuously output so that the transient currents caused by fast slews can be developed. For instance, a 50 pF load will draw 45 mA in response to a 900 V/μs output transient. The snubber network will draw similar currents, and it may not be useable if the amplifier is called upon to deliver large outputs continuously at high frequencies. In any event, the device is rated at 30 mA continuously.

The output circuit will resonate with capacitive loads if it is not damped. The output impedance of all amplifiers is approximately modeled as an inductor in series with a DC resistance. The equivalent component values for the EL2029 are 300 nH and 20Ω. To reduce the output stage resonance with capacitive loads, the snubber network can be added to de-Q the load. The EL2029 will comfortably drive 100 pF with the snubber values of 100 pF and 100Ω.

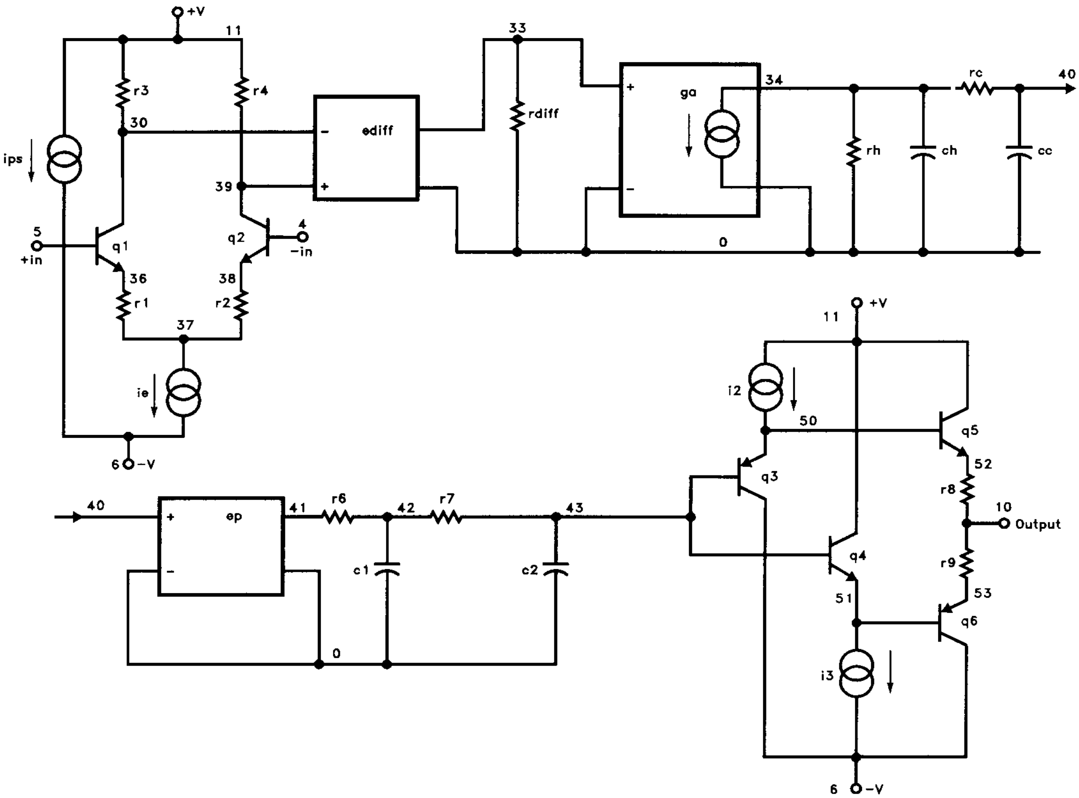
Offset Adjust

To effect input offset voltage adjustment, a 10k to 100k potentiometer is connected to the balance pins with the wiper connected to V−. ±1.4 mV of adjustment is possible.

EL2029 Macromodel

```
* Connections:   +input
*                 |    -input
*                 |     |    +Vsupply
*                 |     |     |    -Vsupply
*                 |     |     |     |    output
*                 |     |     |     |     |
.subckt M2029     5     4     11    6     10
* Input Stage
il 37 6 2mA
r1 36 37 800
r2 38 37 800
r3 11 30 800
r4 11 39 800
q1 30 5 36 qn
q2 39 4 38 qna
e1 33 0 39 30 1
r5 33 0 1Meg
* Compensation Section
ga 0 34 33 0 2m
rh 34 0 80Meg
ch 34 0 2pF
rc 34 40 100
cc 40 0 1pF
* Poles
ep 41 0 40 0 1
r6 41 42 150
c1 42 0 10pF
r7 42 43 150
c2 43 0 10pF
* Output Stage
i2 11 50 1.25mA
i3 51 6 1.25mA
q3 6 43 50 qp
q4 11 43 51 qn
q5 11 50 52 qn
q6 6 51 53 qp
r8 52 10 5
r9 10 53 5
* Power Supply Current
ips 11 6 9mA
* Models
.model qn npn(is=800e-18 bf=2000 tf=0.1nS)
.model qna npn(is=824e-18 bf=2700 tf=0.1nS)
.model qp pnp(is=800e-18 bf=260 tf=0.1nS)
.ends
```

EL2029 Macromodel — Contd.



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