EL2002/EL2002C
Low Power, 180 MHz Buffer Amplifier

élantec HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

ELANTEC INC T-52-07

Features
- 180 MHz bandwidth
- 2000 V/μs slew rate
- Low bias current, 3 μA typical
- 100 mA output current
- 5 mA supply current
- Short circuit protected
- Low cost
- Stable with capacitive loads
- Wide supply range ±5V to ±15V
- No thermal runaway

Applications
- Op amp output current booster
- Cable/line driver
- A/D input buffer
- Isolation buffer

Ordering Information

Part No.	Temp. Range	Package	Outline #
EL2002ACJ	0°C to +75°C	CerDIP	MDP0010
EL2002ACN	0°C to +75°C	P-DIP	MDP0031
EL2002AJ	−55°C to +125°C	CerDIP	MDP0010
EL2002AJ/883B	−55°C to +125°C	CerDIP	MDP0010
EL2002AL	−55°C to +125°C	20-Pad LCC	MDP0007
EL2002AL/883B	−55°C to +125°C	20-Pad LCC	MDP0007
EL2002CJ	0°C to +75°C	CerDIP	MDP0010
EL2002CM	0°C to +75°C	20-Lead SOL	MDP0027
EL2002CN	0°C to +75°C	P-DIP	MDP0031
EL2002J	−55°C to +125°C	CerDIP	MDP0010
EL2002J/883B	−55°C to +125°C	CerDIP	MDP0010
EL2002L	−55°C to +125°C	20-Pad LCC	MDP0007
EL2002L/883B	−55°C to +125°C	20-Pad LCC	MDP0007

5962-9050901/2 are the SMD versions of this device.

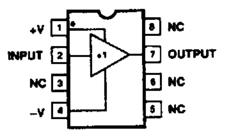
General Description
The EL2002 is a low cost monolithic, high slew rate, buffer amplifier. Built using the Elantec monolithic Complementary Bipolar process, this patented buffer has a −3 dB bandwidth of 180 MHz, and delivers 100 mA, yet draws only 5 mA of supply current. It typically operates from ±15V power supplies but will work with as little as ±5V.

This high speed buffer may be used in a wide variety of applications in military, video and medical systems. Typical examples include fast op-amp output current boosters, coaxial cable drivers and A/D converter input buffers.

Elantec's products and facilities comply with MIL-STD-883 Revision C, 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 Integrated Circuits.*

Connection Diagrams

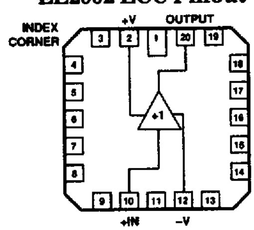
EL2002 DIP Pinout



2002-1

Top View

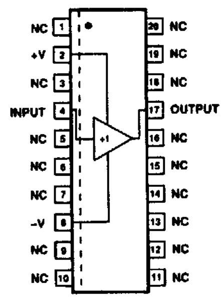
EL2002 LCC Pinout



2002-3

Top View

EL2002 SOL Pinout



2002-2

Top View

Manufactured Under U.S. Patent No. 4,833,424

EL2002/EL2002C

ELANTEC INC

Low Power, 180 MHz Buffer Amplifier

Absolute Maximum Ratings

V_S	Supply Voltage ($V^+ - V^-$)	±18V or 36V
V_{IN}	Input Voltage (Note 1)	±15V or V_S
I_{IN}	Input Current (Note 1)	±50 mA
P_D	Power Dissipation (Note 2)	See Curves
	Output Short Circuit Duration (Note 3)	Continuous
T_A	Operating Temperature Range:	
	EL2002A/EL2002	−55°C to +125°C
	EL2002AC/EL2002C	0°C to +75°C
T_J	Operating Junction Temperature	
	Ceramic Packages	175°C
	Plastic Packages	150°C
T_{ST}	Storage Temperature	−65°C to +150°C
	Lead Temperature	
	DIP Package (soldering, <10 seconds)	300°C
	SOL Package	
	Vapor Phase (60 seconds)	215°C
	Infrared (15 seconds)	220°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.

Electrical Characteristics V_S = ±15V, R_S = 50Ω, unless otherwise specified

Parameter	Description	Test Conditions			Limits			EL2002A EL2002	EL2002AC EL2002C	Units
		V_{IN}	Load	Temp	Min	Typ	Max	Test Level	Test Level	
V_{OS}	Offset Voltage EL2002A/EL2002AC	0	∞	25°C	−15	5	+15	I	I	mV
				T_{MIN}, T_{MAX}	−20		+20	I	III	mV
	EL2002/EL2002C	0	∞	25°C	−40	10	+40	I	I	mV
				T_{MIN}, T_{MAX}	−50		+50	I	III	mV
I_{IN}	Input Current EL2002A/EL2002AC	0	∞	25°C	−10	3	+10	I	I	μA
				T_{MIN}, T_{MAX}	−15		+15	I	III	μA
	EL2002/EL2002C	0	∞	25°C	−15	5	+15	I	I	μA
				T_{MIN}, T_{MAX}	−20		+20	I	III	μA
R_{IN}	Input Resistance	+12V	100Ω	25°C	1	3		I	I	MΩ
				T_{MIN}, T_{MAX}	0.1			I	III	MΩ
A_{V1}	Voltage Gain	±12V	∞	25°C	0.990	0.998		I	I	V/V
				T_{MIN}, T_{MAX}	0.985			I	III	V/V
A_{V2}	Voltage Gain	±10V	100Ω	25°C	0.85	0.93		I	I	V/V
				T_{MIN}, T_{MAX}	0.83			I	III	V/V

Electrical Characteristics $V_S = \pm 15V, R_S = 50\Omega$, unless otherwise specified — Contd.

Parameter	Description	Test Conditions			Limits			EL2002A EL2002	EL2002AC EL2002C	Units
		V_{IN}	Load	Temp	Min	Typ	Max	Test Level	Test Level	
A_{V3}	Voltage Gain with $V_S = \pm 5V$	±3V	100Ω	25°C	0.83	0.91		I	I	V/V
				T_{MIN}, T_{MAX}	0.80			I	III	V/V
V_O	Output Voltage Swing	±12V	100Ω	25°C	±10	±11		I	I	V
				T_{MIN}, T_{MAX}	±9.5			I	III	V
R_{OUT}	Output Resistance	±2V	100Ω	25°C		8	13	I	I	Ω
				T_{MIN}, T_{MAX}			15	I	III	Ω
I_{OUT}	Output Current	±12V	(Note 4)	25°C	+100	+160		I	I	mA
				T_{MIN}, T_{MAX}	±95			I	III	mA
I_S	Supply Current	0	∞	25°C		5	7.5	I	II	mA
				T_{MIN}, T_{MAX}			10	I	III	mA
PSRR	Supply Rejection, (Note 5)	0	∞	25°C	60	75		I	I	dB
				T_{MIN}, T_{MAX}	50			I	III	dB
t_r	Rise Time	0.5V	100Ω	25°C		2.8		V	V	ns
t_d	Propagation Delay	0.5V	100Ω	25°C		1.5		V	V	ns
SR	Slew Rate, (Note 6)	±10V	100Ω	25°C	1200	2000		IV	IV	V/μs

Note 1: If the input exceeds the ratings shown (or the supplies) or if the input to output voltage exceeds ±7.5V then the input current must be limited to ±50 mA. See the applications section for more information.

Note 2: The maximum power dissipation depends on package type, ambient temperature and heat sinking. See the characteristic curves for more details.

Note 3: A heat sink is required to keep the junction temperature below the absolute maximum when the output is short circuited.

Note 4: Force the input to +12V and the output to +10V and measure the output current. Repeat with −12 V_{IN} and −10V on the output.

Note 5: V_{OS} is measured at $V_S+ = +4.5V$, $V_S- = -4.5V$ and $V_S+ = +18V$, $V_S- = 18V$. Both supplies are changed simultaneously.

Note 6: Slew rate is measured between $V_{OUT} = +5V$ and $-5V$.

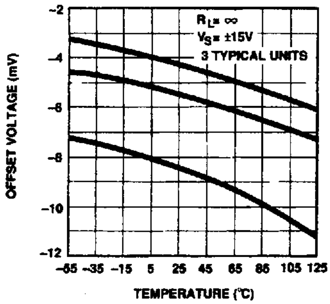
EL2002/EL2002C

ELANTEC INC

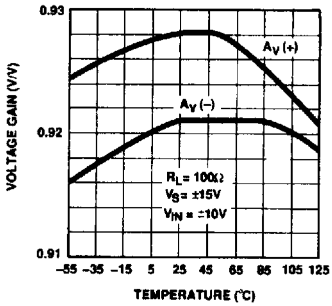
Low Power, 180 MHz Buffer Amplifier

Typical Performance Curves

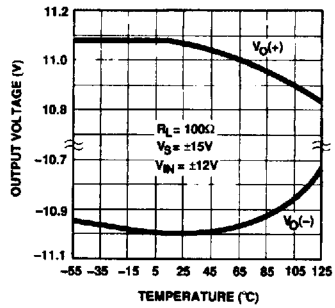
Offset Voltage vs Temperature



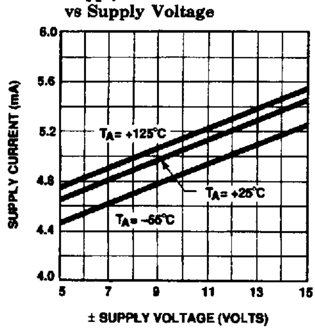
Voltage Gain vs Temperature



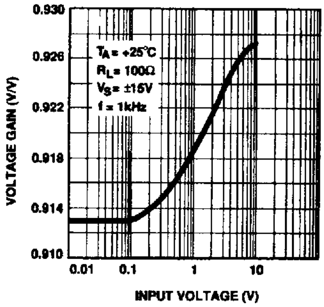
Output Voltage Swing vs Temperature



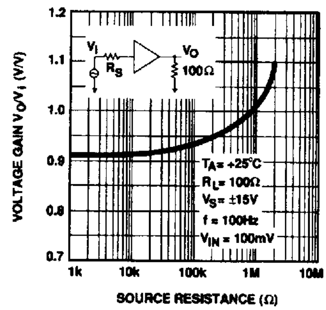
Supply Current vs Supply Voltage



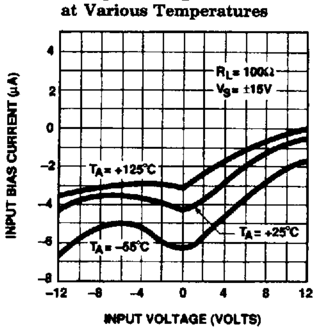
Voltage Gain vs Input Voltage



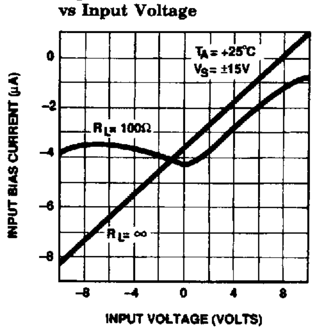
Voltage Gain vs Source Resistance



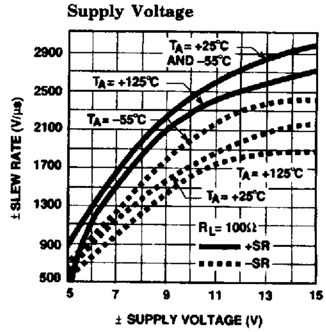
Input Bias Current vs Input Voltage at Various Temperatures



Input Bias Current vs Input Voltage



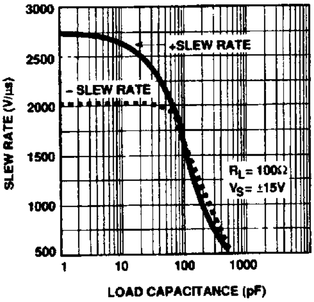
±Slew Rate vs Supply Voltage



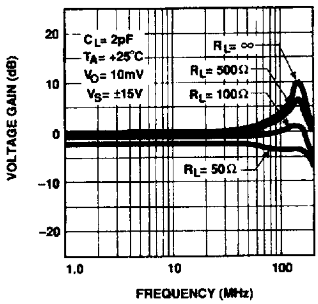
2002-4

Typical Performance Curves — Contd.

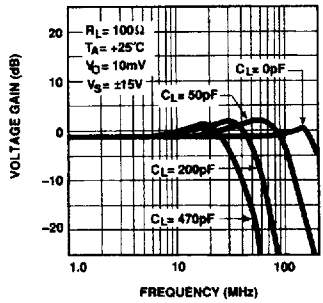
Slew Rate vs Load Capacitance



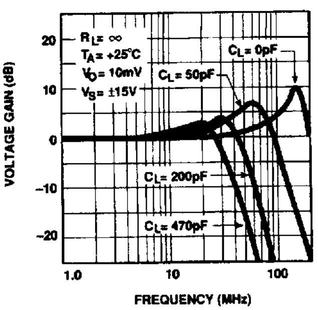
Voltage Gain vs Frequency for Various Resistive Loads



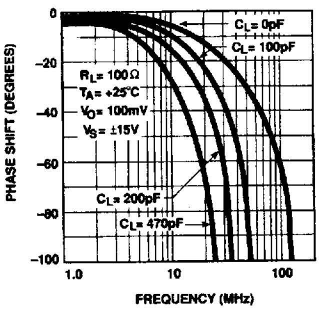
Voltage Gain vs Frequency for Various Capacitive Loads; R_L = 100Ω



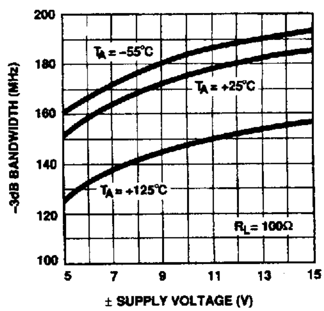
Voltage Gain vs Frequency for Various Capacitive Loads; R_L = ∞



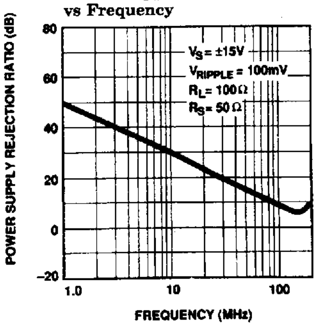
Phase Shift vs Frequency for Various Capacitive Loads



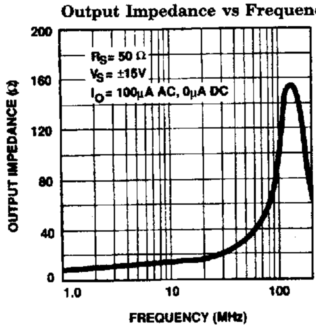
−3 dB Bandwidth vs Supply Voltage



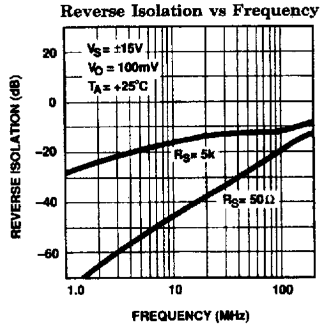
Power Supply Rejection Ratio vs Frequency



Output Impedance vs Frequency



Reverse Isolation vs Frequency



2002-5

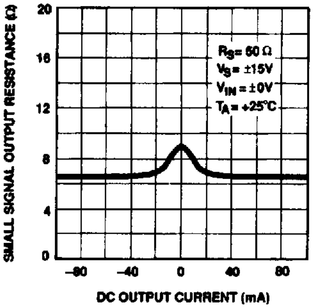
EL2002/EL2002C

ELANTEC INC

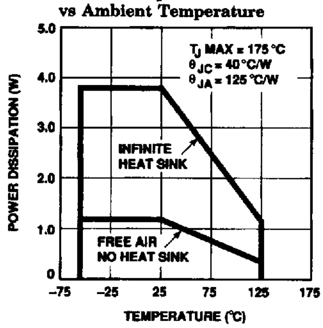
Low Power, 180 MHz Buffer Amplifier

Typical Performance Curves — Contd.

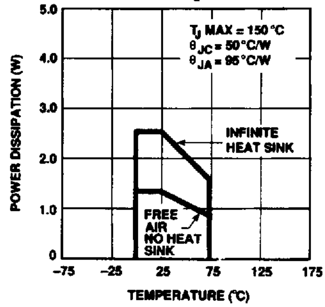
Small Signal Output Resistance vs Output Current



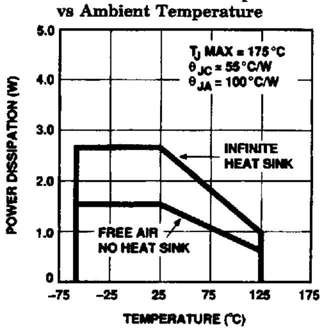
8-Lead CerDIP Maximum Power Dissipation vs Ambient Temperature



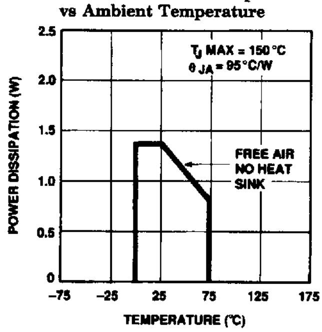
8-Lead Plastic DIP Maximum Power Dissipation vs Ambient Temperature



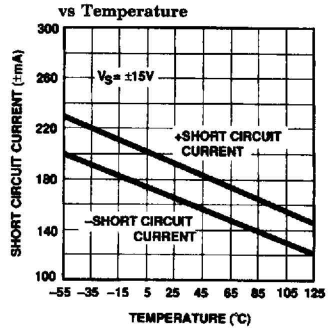
20-Pad LCC Maximum Power Dissipation vs Ambient Temperature



20-Lead SOL Maximum Power Dissipation vs Ambient Temperature

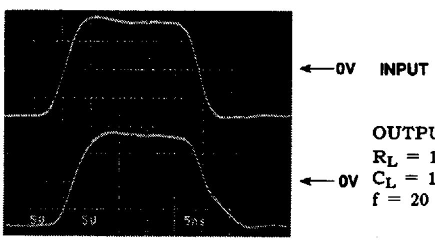


Short Circuit Current vs Temperature



2002-6

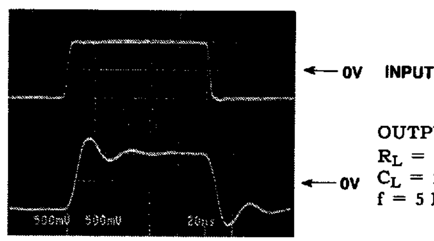
Large Signal Response



OUTPUT
R_L = 100Ω
C_L = 10 pF
f = 20 MHz

2002-8

Small Signal Response



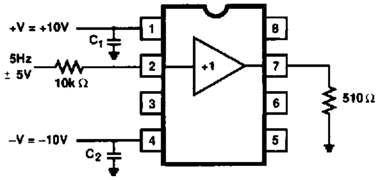
OUTPUT
R_L = ∞
C_L = 220 pF
f = 5 MHz

2002-9

EL2002/EL2002C

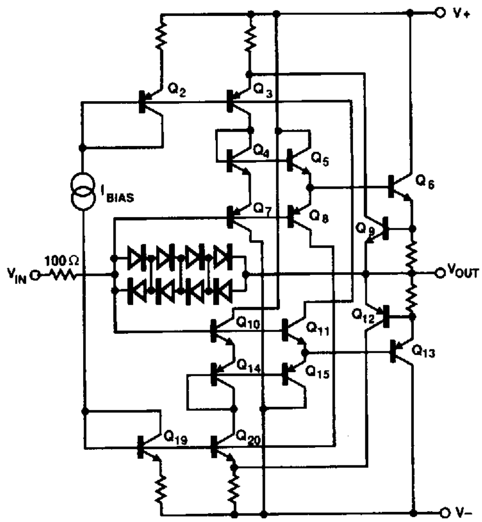
Low Power, 180 MHz Buffer Amplifier

Burn-In Circuit



2002-10

Simplified Schematic



2002-11

Application Information

The EL2002 is a monolithic buffer amplifier built on Elantec's proprietary Complementary Bipolar process that produces NPN and PNP transistors with essentially identical DC and AC characteristics. The EL2002 takes full advantage of the complementary process with a unique circuit topology.

Elantec has applied for two patents based on the EL2002's topology. The patents relate to the base drive and feedback mechanism in the buffer. This feedback makes 2000 V/μs slew rates with 100Ω loads possible with very low supply current.

Power Supplies

The EL2002 may be operated with single or split supplies with total voltage difference between 10V (±5V) and 36V (±18V). It is not necessary to use equal split value supplies. For example −5V and +12V would be excellent for signals from −2V to +9V.

Bypass capacitors from each supply pin to ground are highly recommended to reduce supply ringing and the interference it can cause. At a minimum, 1 μF tantalum capacitor with short leads should be used for both supplies.

Input Characteristics

The input to the EL2002 looks like a resistance in parallel with about 3.5 pF in addition to a DC bias current. The DC bias current is due to the miss-match in beta and collector current between the NPN and PNP transistors connected to the input pin. The bias current can be either positive or negative. The change in input current with input voltage (R_{IN}) is affected by the output load, beta and the internal boost. R_{IN} can actually appear negative over portions of the input range; typical input current curves are shown in the characteristic curves. Internal clamp diodes from the input to the output are provided. These diodes protect the transistor base emitter junctions and limit the boost current during slew to avoid saturation of internal transistors. The diodes begin conduction at about ±2.5V input to output differential. When that happens the input resistance drops dramatically. The diodes are rated at 50 mA. When conducting they have a series resistance of about 20Ω. There is also 100Ω in series with the input that limits input current. Above ±7.5V differential input to output, additional series resistance should be added.

Source Impedance

The EL2002 has good input to output isolation. When the buffer is not used in a feedback loop, capacitive and resisitive sources up to 1 MHz present no oscillation problems. Care must be used in board layout to minimize output to input coupling. CAUTION: When using high source impedances (R_S > 100 kΩ), significant gain errors can be observed due to output offset, load resistor, and the action of the boost circuit. See typical performance curves.

EL2002/EL2002C

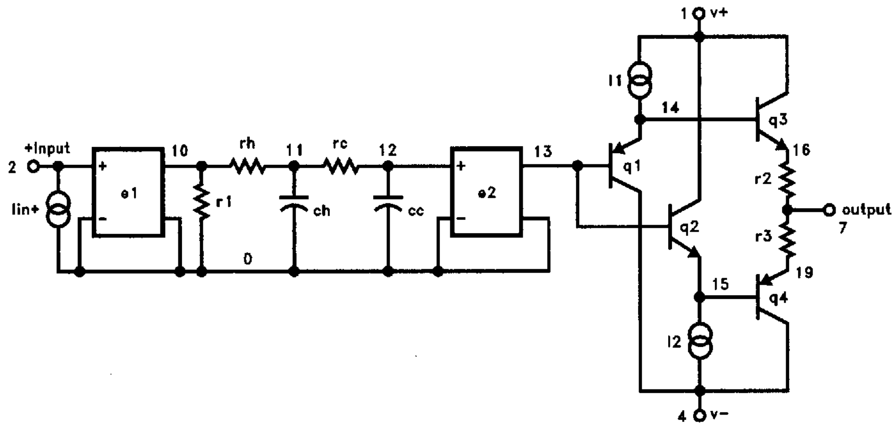
ELANTEC INC

Low Power, 180 MHz Buffer Amplifier

EL2002 Macromodel

```
* Connections:    +input
*                 |     +Vsupply
*                 |     |     -Vsupply
*                 |     |     |     output
*                 |     |     |     |
.subckt M2002     2     1     4     7
* Input Stage
e1 10 0 2 0 1.0
r1 10 0 1K
rh 10 11 150
ch 11 0 2pF
rc 11 12 100
cc 12 0 3pF
e2 13 0 12 0 1.0
* Output Stage
q1 4 13 14 qp
q2 1 13 15 qn
q3 1 14 16 qn
q4 4 15 19 qp
r2 16 7 1
r3 19 7 1
i1 1 14 2mA
i2 15 4 2mA
* Bias Current
iin+ 2 0 3uA
* Models
.model qn npn(is=5e-15 bf=150 rb=200 ptf=45 tf=0.1nS)
.model qp pnp(is=5e-15 bf=150 rb=200 ptf=45 tf=0.1nS)
.ends
```

EL2002 Macromodel — Contd.



2002-12