

Features

- Stable at gain of 2 and 100MHz gain_bandwidth product (EL2211C, EL2311C, & EL2411C)
- Stable at gain of 1 and 50MHz gain_bandwidth product (EL2210C, EL2310C, & EL2410C)
- 130V/ μ s slew rate
- Drives 150 Ω load to video levels
- Inputs and outputs operate at negative supply rail
- $\pm 5V$ or $+10V$ supplies
- -60dB isolation at 4.2MHz

Applications

- Consumer video amplifiers
- Active filters/integrators
- Cost-sensitive applications
- Single supply amplifiers

Ordering Information

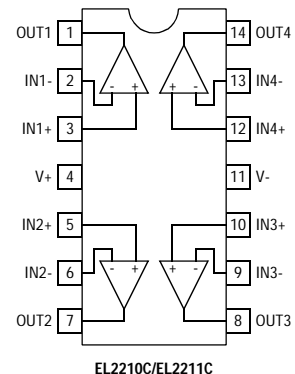
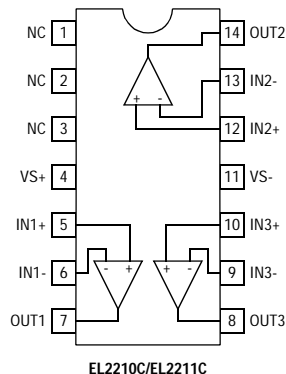
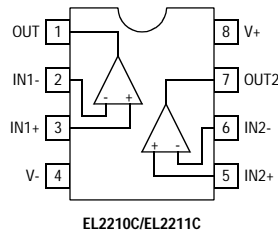
| Part No | Package | Tape & Reel | Outline # |
|--------------|-------------|-------------|-----------|
| EL2210CN | 8-Pin PDIP | - | MDP0031 |
| EL2210CS | 8-Pin SO | - | MDP0027 |
| EL2210CS-T7 | 8-Pin SO | 7" | MDP0027 |
| EL2210CS-T13 | 8-Pin SO | 13" | MDP0027 |
| EL2211CN | 8-Pin PDIP | - | MDP0031 |
| EL2211CS | 8-Pin SO | - | MDP0027 |
| EL2310CN | 8-Pin PDIP | - | MDP0031 |
| EL2310CS | 8-Pin SO | - | MDP0027 |
| EL2311CN | 8-Pin PDIP | - | MDP0031 |
| EL2311CS | 8-Pin SO | - | MDP0027 |
| EL2410CN | 14-Pin PDIP | - | MDP0031 |
| EL2410CS | 14-Pin SO | - | MDP0027 |
| EL2410CS-T7 | 14-Pin SO | 7" | MDP0027 |
| EL2410CS-T13 | 14-Pin SO | 13" | MDP0027 |
| EL2411CN | 14-Pin PDIP | - | MDP0031 |
| EL2411CS | 14-Pin SO | - | MDP0027 |

General Description

This family of dual, triple, and quad operational amplifiers built using Elantec's Complementary Bipolar process offers unprecedented high frequency performance at a very low cost. They are suitable for any application such as consumer video, where traditional DC performance specifications are of secondary importance to the high frequency specifications. On $\pm 5V$ supplies at a gain of +1 the EL2210C, EL2310C, and EL2410C will drive a 150 Ω load to +2V, -1V with a bandwidth of 50MHz and a channel-to-channel isolation of 60dB or more. At a gain of +2, the EL2211C, EL2311C, and EL2411C will drive a 150 Ω load to +2V, -1V with a bandwidth of 100MHz with the same channel-to-channel isolation. All four achieve 0.1dB bandwidth at 5MHz.

The power supply operating range is fixed at $\pm 5V$ or $+10/0V$. In single supply operation the inputs and outputs will operate to ground. Each amplifier draws only 7mA of supply current.

Connection Diagrams



Note: All information contained in this data sheet has been carefully checked and is believed to be accurate as of the date of publication; however, this data sheet cannot be a "controlled document". Current revisions, if any, to these specifications are maintained at the factory and are available upon your request. We recommend checking the revision level before finalization of your design documentation.

EL2210C/11C, EL2310C/11C, EL2410C/11C

Low Cost, Dual, Triple and Quad Video Op Amps

Absolute Maximum Ratings (T_A = 25°C)

| | | | |
|----------------------------|----------------------|-----------------------------|-----------------|
| Total Voltage Supply | 18V | Power Dissipation | See Curves |
| Input Voltage | ±V _S | Storage Temperature Range | -65°C to +150°C |
| Differential Input Voltage | 6V | Operating Temperature Range | -40°C to +85°C |
| Peak Output Current | 75mA (per amplifier) | Die Junction Temperature | +150°C |

Important Note:

All parameters having Min/Max specifications are guaranteed. Typ values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: T_J = T_C = T_A.

EL2210C, EL2310C, EL2410C - DC Electrical Characteristics

V_S = ±5V, R_L = 1kΩ, T_A = 25°C unless otherwise noted.

| Parameter | Description | Conditions | Min | Typ | Max | Unit |
|-------------------|---|---|-------|-----------|------|-------|
| V _{OS} | Input Offset Voltage | | | 10 | 20 | mV |
| | | EL2310C only | | 10 | 25 | mV |
| | | EL2311C only | | 5 | 25 | mV |
| TCV _{OS} | Average Offset Voltage Drift ^[1] | | | -25 | | μV/°C |
| I _B | Input Bias Current | | -15 | -7 | -3 | μA |
| I _{OS} | Input Offset Current | | | 0.5 | 1.5 | μA |
| TCI _{OS} | Average Offset Current Drift ^[1] | | | -7 | | nA/°C |
| A _{VOL} | Open-Loop Gain | V _{OUT} = ±2V, R _L = 1kΩ | 160 | 250 | | V/V |
| | | V _{OUT} = +2V/0V, R _L = 150Ω | 160 | 250 | | |
| PSRR | Power Supply Rejection | V _S = ±4.5V to ±5.5V | 50 | 60 | | dB |
| CMRR | Common Mode Rejection | V _{CM} = ±2.4V, V _{OUT} = 0V | 60 | 80 | | dB |
| CMIR | Common Mode Input Range | V _S = ±5V | | -5/+3 | | V |
| V _{OUT} | Output Voltage Swing | R _L = R _F = 1kΩ R _L to GND | -2.5 | -3, 3 | 2.7 | V |
| | | R _L = R _F = 1kΩ +150% to GND | -0.45 | -0.6, 2.9 | 2.5 | |
| | | R _L = R _F = 1kΩ R _L to V _{EE} | -4.95 | | 3 | |
| I _{SC} | Output Short Circuit Current | Output to GND (Note 1) | 75 | 125 | | mA |
| I _S | Supply Current | No Load (per channel) | 5.5 | 6.8 | 10 | mA |
| R _{IN} | Input Resistance | Differential | | 150 | | kΩ |
| | | Common Mode | | 1.5 | | MΩ |
| C _{IN} | Input Capacitance | A _V = +1 @ 10MHz | | 1 | | pF |
| R _{OUT} | Output Resistance | | | 0.150 | | Ω |
| PSOR | Power Supply Operating Range | Dual Supply | ±4.5 | | ±6.5 | V |
| | | Single Supply | 9 | | 13 | |

1. A heat-sink is required to keep junction temperature below absolute maximum when an output is shorted

EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2210C/11C, EL2310C/11C, EL2410C/11C

EL2211C, EL2311C, EL2411C - DC Electrical Characteristics

$V_S = \pm 5V$, $R_L = 1k\Omega$, $A_V = +2$, $T_A = 25^\circ C$ unless otherwise noted.

| Parameter | Description | Conditions | Min | Typ | Max | Unit |
|------------|---|--|-----------|-----------|-----------|------------------|
| V_{OS} | Input Offset Voltage | | | 5 | 12 | mV |
| TCV_{OS} | Average Offset Voltage Drift ^[1] | | | -25 | | $\mu V/^\circ C$ |
| I_B | Input Bias Current | | -15 | -7 | -3 | μA |
| I_{OS} | Input Offset Current | | | 0.5 | 1.5 | μA |
| TCI_{OS} | Average Offset Current Drift ^[1] | | | -7 | | $nA/^\circ C$ |
| A_{VOL} | Open-Loop Gain | $V_{OUT} = \pm 2V$, $R_L = 1k\Omega$ | 250 | 380 | | V/V |
| | | $V_{OUT} = +2V/0V$, $R_L = 150\Omega$ | 250 | 380 | | |
| PSRR | Power Supply Rejection | $V_S = \pm 4.5V$ to $\pm 5.5V$ | 55 | 68 | | dB |
| CMRR | Common Mode Rejection | $V_{CM} = \pm 2.5V$, $V_{OUT} = 0V$ | 70 | 90 | | dB |
| CMIR | Common Mode Input Range | $V_S = \pm 5V$ | | -5/+3 | | V |
| V_{OUT} | Output Voltage Swing | $R_L = R_F = 1k\Omega$ R_L to GND | 2.5 | -3.5, 3.3 | 2.7 | V |
| | | $R_L = R_F = 1k\Omega$ +150% to GND | -0.45 | -0.6, 2.9 | 2.5 | |
| | | $R_L = R_F = 1k\Omega$ R_L to V_{EE} | -4.95 | | 3 | |
| I_{SC} | Output Short Circuit Current | Output to GND (Note 1) | 75 | 125 | | mA |
| I_S | Supply Current | No Load | 5.5 | 6.8 | 10 | mA |
| R_{IN} | Input Resistance | Differential | | 150 | | k Ω |
| | | Common Mode | | 1.5 | | M Ω |
| C_{IN} | Input Capacitance | $A_V = +1$ @ 10MHz | | 1 | | pF |
| R_{OUT} | Output Resistance | | | 0.150 | | Ω |
| PSOR | Power Supply Operating Range | Dual Supply | ± 4.5 | | ± 6.5 | V |
| | | Single Supply | 9 | | 13 | |

1. A heat-sink is required to keep junction temperature below absolute maximum when an output is shorted

EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2210C, EL2310C, EL2410C - Closed-Loop AC Characteristics

V_S = ±5V, AC Test Figure 1, T_A = 25°C unless otherwise noted.

| Parameter | Description | Conditions | Min | Typ | Max | Unit |
|---------------------------------|--|-------------------------------|-----|-----|-----|--------|
| BW | -3dB Bandwidth (V _{OUT} = 0.4V _{pp}) | A _V = +1 | | 110 | | MHz |
| BW | ±0.1 dB Bandwidth (V _{OUT} = 0.4V _{pp}) | A _V = +1 | | 12 | | MHz |
| GBWP | Gain Bandwidth Product | | | 55 | | MHz |
| PM | Phase Margin | | | 60 | | °C |
| SR | Slew Rate | | 85 | 130 | | V/μs |
| FBWP | Full Power Bandwidth ^[1] | | 8 | 11 | | MHz |
| t _r , t _f | Rise Time, Fall Time | 0.1V Step | | 2 | | ns |
| OS | Overshoot | 0.1V Step | | 15 | | % |
| t _{PD} | Propagation Delay | | | 3.5 | | ns |
| t _S | Settling to 0.1% (A _V = 1) | V _S = ±5V, 2V Step | | 80 | | ns |
| d _G | Differential Gain ^[2] | NTSC/PAL | | 0.1 | | % |
| d _P | Differential Phase ^[2] | NTSC/PAL | | 0.2 | | °C |
| e _N | Input Noise Voltage | 10kHz | | 15 | | nV/√Hz |
| i _N | Input Noise Current | 10kHz | | 1.5 | | pA/√Hz |
| CS | Channel Separation | P = 5MHz | | 55 | | dB |

1. For V_S = ±5V, V_{OUT} = 4 V_{pp}. Full power bandwidth is based on slew rate measurement using: FPBW = SR/(2π * V_{peak})
2. Video performance measured at V_S = ±5V, A_V = +2 with 2 times normal video level across R_L = 150Ω

EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2210C/11C, EL2310C/11C, EL2410C/11C

EL2211C, EL2311C, EL2411C - Closed-Loop AC Characteristics

$V_S = \pm 5V$, AC Test Figure 1, $T_A = 25^\circ C$ unless otherwise noted.

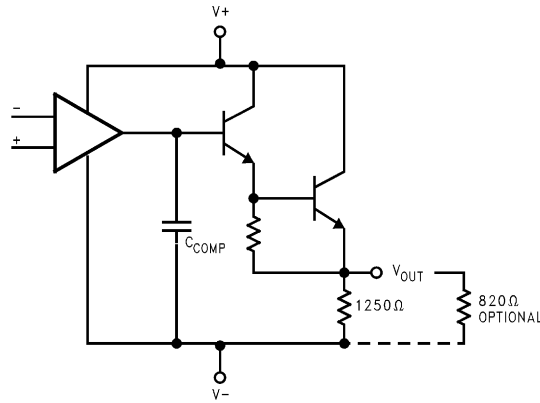
| Parameter | Description | Conditions | Min | Typ | Max | Unit |
|------------|--|-------------------------|-----|------|-----|-----------------|
| BW | -3dB Bandwidth ($V_{OUT} = 0.4 V_{PP}$) | $A_V = +2$ | | 100 | | MHz |
| BW | $\pm 0.1dB$ Bandwidth ($V_{OUT} = 0.4 V_{PP}$) | $A_V = +2$ | | 8 | | MHz |
| GBWP | Gain Bandwidth Product | | | 130 | | MHz |
| PM | Phase Margin | | | 60 | | $^\circ C$ |
| SR | Slew Rate | | 100 | 140 | | V/ μs |
| FBWP | Full Power Bandwidth ^[1] | | 8 | 11 | | MHz |
| t_r, t_f | Rise Time, Fall Time | 0.1V Step | | 2.5 | | ns |
| OS | Overshoot | 0.1V Step | | 6 | | % |
| t_{PD} | Propagation Delay | | | 3.5 | | ns |
| t_S | Settling to 0.1% ($A_V = 1$) | $V_S = \pm 5V, 2V$ Step | | 80 | | ns |
| d_G | Differential Gain ^[2] | NTSC/PAL | | 0.04 | | % |
| d_P | Differential Phase ^[2] | NTSC/PAL | | 0.15 | | $^\circ C$ |
| e_N | Input Noise Voltage | 10kHz | | 15 | | nV/ \sqrt{Hz} |
| i_N | Input Noise Current | 10kHz | | 1.5 | | pA/ \sqrt{Hz} |
| CS | Channel Separation | $P = 5MHz$ | | 55 | | dB |

1. For $V_S = \pm 5V, V_{OUT} = 4 V_{PP}$. Full power bandwidth is based on slew rate measurement using: $FPBW = SR/(2\pi * V_{peak})$
2. Video performance measured at $V_S = \pm 5V, A_V = +2$ with 2 times normal video level across $R_L = 150\Omega$.

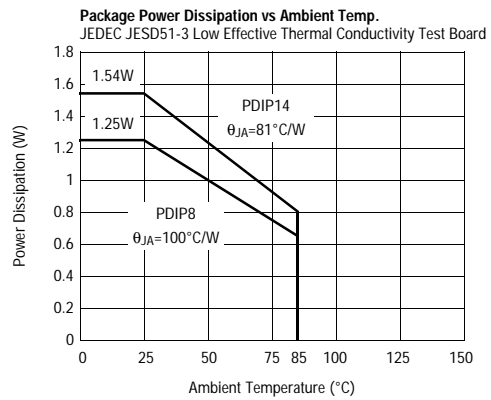
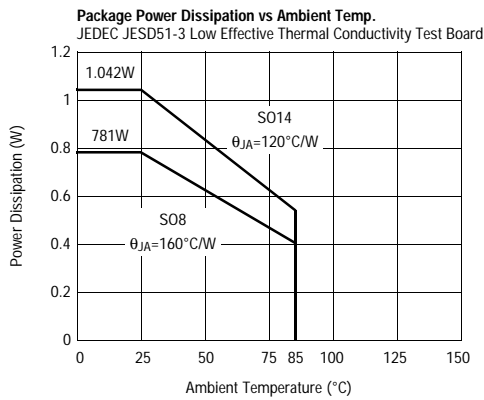
EL2210C/11C, EL2310C/11C, EL2410C/11C

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Simplified Block Diagram



Typical Performance Curves



EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2210C/11C, EL2310C/11C, EL2410C/11C

Application Information

Product Description

The EL2210C, EL2310C, and EL2410C are dual, triple, and quad operational amplifiers stable at a gain of 1. The EL2211C, EL2311C, and EL2411C are dual, triple, and quad operational amplifiers stable at a gain of 2. All six are built on Elantec's proprietary complimentary process and share the same voltage mode feedback topology. This topology allows them to be used in a variety of applications where current mode feedback amplifiers are not appropriate because of restrictions placed on the feedback elements. These products are especially designed for applications where high bandwidth and good video performance characteristics are desired but the higher cost of more flexible and sophisticated products are prohibitive.

Power Supplies

These amplifiers are designed to work at a supply voltage difference of 10V to 12V. These amplifiers will work on any combination of \pm supplies. All electrical characteristics are measured with $\pm 5V$ supplies. Below 9V total supply voltage the amplifiers' performance will degrade dramatically. The quiescent current is a direct function of total supply voltage. With a total supply voltage of 12V the quiescent supply current will increase from a typical 6.8mA per amplifier to 10mA per amplifier.

Output Swing vs Load

Please refer to the simplified block diagram. These amplifiers provide an NPN pull-up transistor output and a passive 1250 Ω pull-down resistor to the most negative supply. In an application where the load is connected to V_{S-} the output voltage can swing to within 200mV of V_{S-} . In split supply applications where the DC load is connected to ground the negative swing is limited by the voltage divider formed by the load, the internal 1250 Ω resistor and any external pull-down resistor. If R_L were 150 Ω then it and the 1250 Ω internal resistor limit the maximum negative swing to

$$V_{EE} = \frac{150}{1250 + 150}$$

Or -0.53V

The negative swing can be increased by adding an external resistor of appropriate value from the output to the negative supply. The simplified block diagram shows an 820 Ω external pull-down resistor. This resistor is in parallel with the internal 1250 Ω resistor. This will increase the negative swing to

$$V_{EE} = 150 \div \frac{1250 \times 820}{1250 + 820} + 150$$

Or -1.16V

Power Dissipation and Loading

Without any load and a 10V supply difference the power dissipation is 70mW per amplifier. At 12V supply difference this increases to 105mW per amplifier. At 12V this translates to a junction temperature rise above ambient of 33 $^{\circ}C$ for the dual and 40 $^{\circ}C$ for the quad amplifier. When the amplifiers provide load current the power dissipation can rapidly rise.

In $\pm 5V$ operation each output can drive a grounded 150 Ω load to more than 2V. This operating condition will not exceed the maximum junction temperature limit as long as the ambient temperature is below 85 $^{\circ}C$, the device is soldered in place, and the extra pull-down resistor is 820 Ω or more.

If the load is connected to the most negative voltage (ground in single supply operation) you can easily exceed the absolute maximum die temperature. For example the maximum die temperature should be 150 $^{\circ}C$. At a maximum expected ambient temperature of 85 $^{\circ}C$, the total allowable power dissipation for the SO8 package would be:

$$P_D = \frac{150 - 85}{160^{\circ}C/W} = 361mW$$

At 12V total supply voltage each amplifier draws a maximum of 10mA and dissipates 12V * 10mA = 120mW or 240mW for the dual amplifier. Which leaves 121mW of increased power due to the load. If the load were 150 Ω connected to the most negative voltage and the maximum voltage out were $V_{S-} + 1V$ the load current would be 6.67mA. Then an extra 146mW ((12V - 1V) * 6.67mA * 2) would be dissipated in the EL2210C or

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EL2211C. The total dual amplifier power dissipation would be $146\text{mW} + 240\text{mW} = 386\text{mW}$, more than the maximum 361mW allowed. If the total supply difference were reduced to 10V , the same calculations would yield 200mW quiescent power dissipation and 120mW due to loading. This results in a die temperature of 143°C ($85^\circ\text{C} + 58^\circ\text{C}$).

In the above example, if the supplies were split $\pm 6\text{V}$ and the 150Ω loads were connected to ground, the load induced power dissipation would drop to 66.7mW ($6.67\text{mA} * (6 - 1) * 2$) and the die temperature would be below the rated maximum.

Video Performance

Following industry standard practices (see EL2044C applications section) these six devices exhibit good differential gain (dG) and good differential phase (dP) with $\pm 5\text{V}$ supplies and an external 820Ω resistor to the negative supply, in a gain of 2 configuration. Driving 75Ω back terminated cables to standard video levels (1.428V at the amplifier) the EL2210C, EL2310C, and EL2410C have dG of 0.1% and dP of 0.2° . The EL2211C, EL2311C, and EL2411C have dG of 0.04% and dP of 0.15° .

Due to the negative swing limitations described above, inverted video at a gain of 2 is just not practical. If swings below ground are required then changing the extra 820Ω resistor to 500Ω will allow reasonable dG and dP to approximately -0.75mV . The EL2211C, EL2311C, and EL2411C will achieve approximately $0.1\%/0.4^\circ$ between 0V and -0.75V . Beyond -0.75V dG and dP get worse by orders of magnitude.

Differential gain and differential phase are fairly constant for all loads above 150Ω . Differential phase performance will improve by a factor of 3 if the supply voltage is increased to $\pm 6\text{V}$.

Output Drive Capability

None of these devices have short circuit protection. Each output is capable of more than 100mA into a shorted output. Care must be used in the design to limit the output current with a series resistor.

Printed-Circuit Layout

The EL2210C/EL2211C/EL2310C/EL2311C/EL2410C/EL2411C are well behaved, and easy to apply in most applications. However, a few simple techniques will help assure rapid, high quality results. As with any high-frequency device, good PCB layout is necessary for optimum performance. Ground-plane construction is highly recommended, as is good power supply bypassing. A $0.1\mu\text{F}$ ceramic capacitor is recommended for bypassing both supplies. Lead lengths should be as short as possible, and bypass capacitors should be as close to the device pins as possible. For good AC performance, parasitic capacitances should be kept to a minimum at both inputs and at the output. Resistor values should be kept under $5\text{k}\Omega$ because of the RC time constants associated with the parasitic capacitance. Metal-film and carbon resistors are both acceptable, use of wire-wound resistors is not recommended because of their parasitic inductance. Similarly, capacitors should be low-inductance for best performance.

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EL2210C/11C, EL2310C/11C, EL2410C/11C

EL2210/EL2310/EL2410 Macromodel

* Revision A, June 1994

* Application Hints:

*

* A pull down resistor between the output and V- is recommended

* to allow output voltages to swing close to V-. See datasheet

* for recommended values.

* Connections:
* +In
* -In V+
* V-
* V_{out}
*

```
.subckt EL2210/EL 3 2 8 4 1
q1 20 3 24 qp
q2 21 2 25 qp
q3 10 10 26 qp
q4 12 10 11 qp
q5 14 10 13 qp
q6 19 19 20 qn
q7 14 19 21 qn
q8 8 14 15 qn
q9 8 16 17 qn 10
r1 24 12 350
r2 12 25 350
r3 8 26 250
r4 8 11 150
r5 8 13 240
r6 20 4 150
r7 21 4 150
r8 15 17 700
r9 1 4 1250
r10 15 16 40
r11 17 1 15
r12 10 19 10K
r13 14 22 20
c1 22 4 0.45pF
c2 22 19 1pF
d1 1 14 dcap
.model qn npn(bf=150 tf=0.05nS)
.model qp pnp(bf=90 tf=0.05nS)
.model dcap d(rs=200 cjo=1e-12 vj=0.8 tt=100e-9)
.ends
```

EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2211/EL2311/EL2411 Macromodel

* Revision A, June 1994

* Application Hints:

*

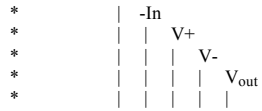
* A pull down resistor between the output and V- is recommended

* to allow output voltages to swing close to V-. See datasheet

* for recommended values.

*

* Connections:



```
.subckt EL2211/EL 3 2 8 4 1
```

```
q1 20 3 24 qp
```

```
q2 21 2 25 qp
```

```
q3 10 10 26 qp
```

```
q4 12 10 11 qp
```

```
q5 14 10 13 qp
```

```
q6 19 19 20 qn
```

```
q7 14 19 21 qn
```

```
q8 8 14 15 qn
```

```
q9 8 16 17 qn 10
```

```
r1 24 12 175
```

```
r2 12 25 175
```

```
r3 8 26 250
```

```
r4 8 11 150
```

```
r5 8 13 240
```

```
r6 20 4 150
```

```
r7 21 4 150
```

```
r8 15 17 700
```

```
r9 1 4 1250
```

```
r10 15 16 40
```

```
r11 17 1 15
```

```
r12 10 19 10K
```

```
r13 14 22 20
```

```
c1 22 4 0.42pF
```

```
c2 22 19 1pF
```

```
d1 1 14 dcap
```

```
.model qn npn(bf=150 tf=0.05nS)
```

```
.model qp pnp(bf=90 tf=0.05nS)
```

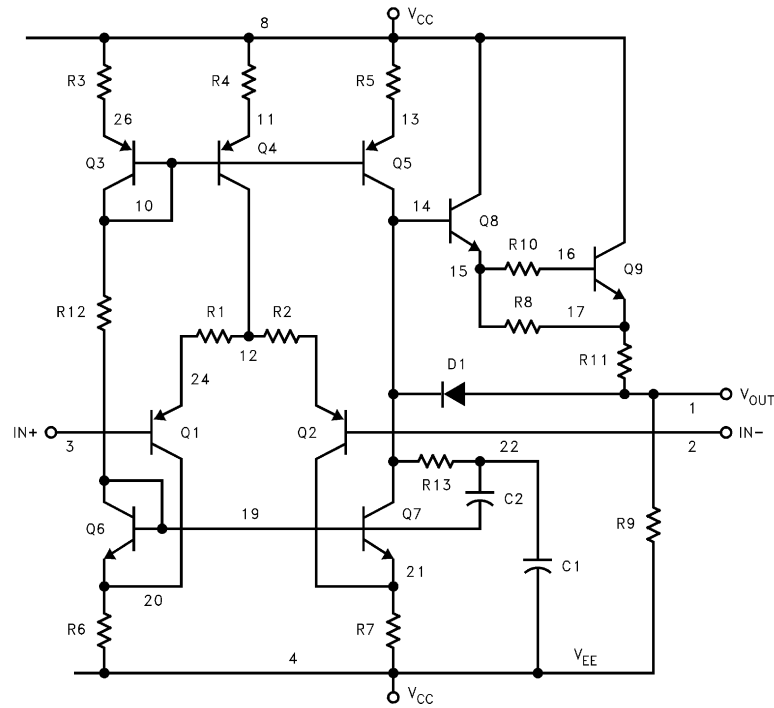
```
.model dcap d(rs=200 cjo=1e-12 vj=0.8 tt=100e-9)
```

```
.ends
```

EL2210C/11C, EL2310C/11C, EL2410C/11C

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EL2210C/11C, EL2310C/11C, EL2410C/11C



EL2210C/11C, EL2310C/11C, EL2410C/11C

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General Disclaimer

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HIGH PERFORMANCE ANALOG INTEGRATED CIRCUITS

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