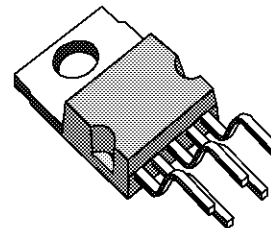


## 3A POWER OPERATIONAL AMPLIFIER

- OUTPUT CURRENT UP TO 3A
- LARGE COMMON-MODE AND DIFFERENTIAL MODE RANGES
- SOA PROTECTION
- THERMAL PROTECTION
- $\pm 18V$  SUPPLY

### DESCRIPTION

The L165 is a monolithic integrated circuit in Pentawatt® package, intended for use as power operational amplifier in a wide range of applications, including servo amplifiers and power supplies. The high gain and high output power capability provide superior performance wherever an operational amplifier/power booster combination is required.



Pentawatt®

ORDERING NUMBER : L165V

### ABSOLUTE MAXIMUM RATINGS

| Symbol            | Parameter                                    | Value      | Unit       |
|-------------------|----------------------------------------------|------------|------------|
| $V_s$             | Supply voltage                               | $\pm 18$   | V          |
| $V_5$ $V_4$       | Upper power transistor $V_{CE}$              | 36         | V          |
| $V_4$ $V_3$       | Lower power transistor $V_{CE}$              | 36         | V          |
| $V_i$             | Input voltage                                | $V_s$      |            |
| $V_j$             | Differential input voltage                   | $\pm 15$   | V          |
| $I_o$             | Peak output current (internally limited)     | 3.5        | A          |
| $P_{tot}$         | Power dissipation at $T_{case} = 90^\circ C$ | 20         | W          |
| $T_{stg}$ , $T_j$ | Storage and junction temperature             | -40 to 150 | $^\circ C$ |

### APPLICATION CIRCUITS

Figure 1. Gain > 10.

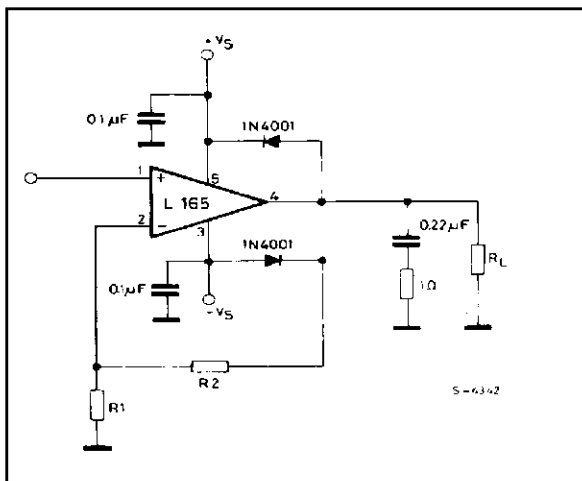
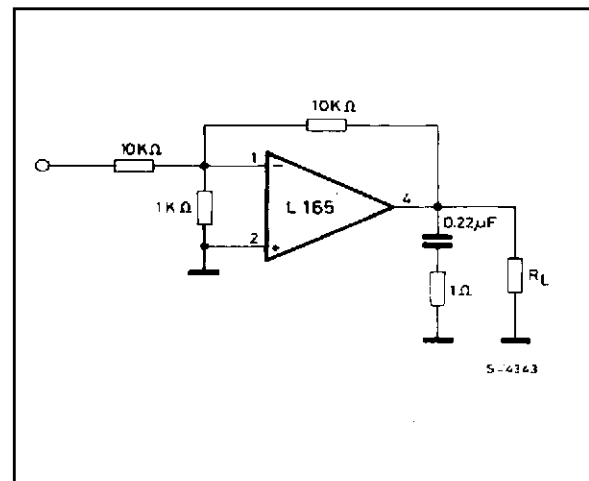
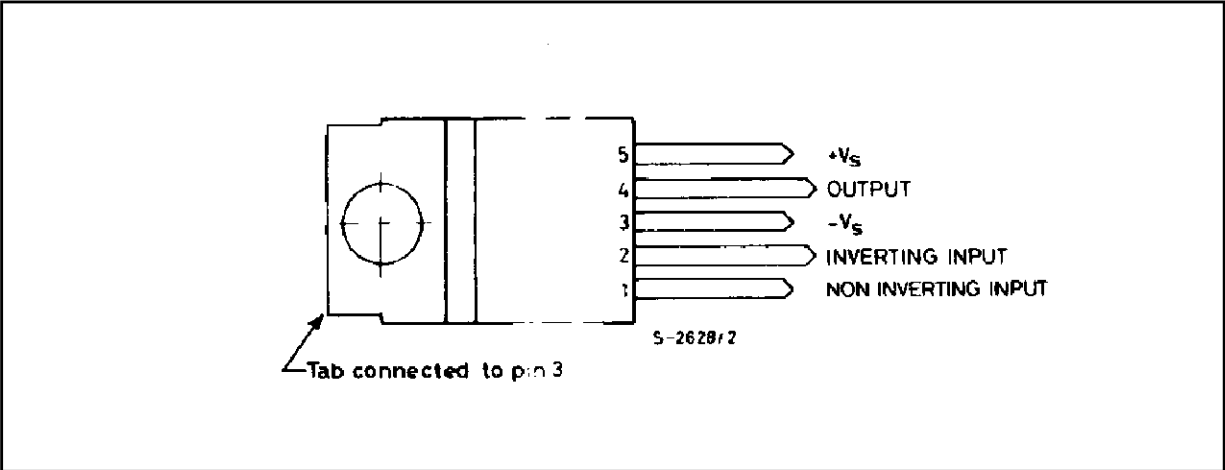


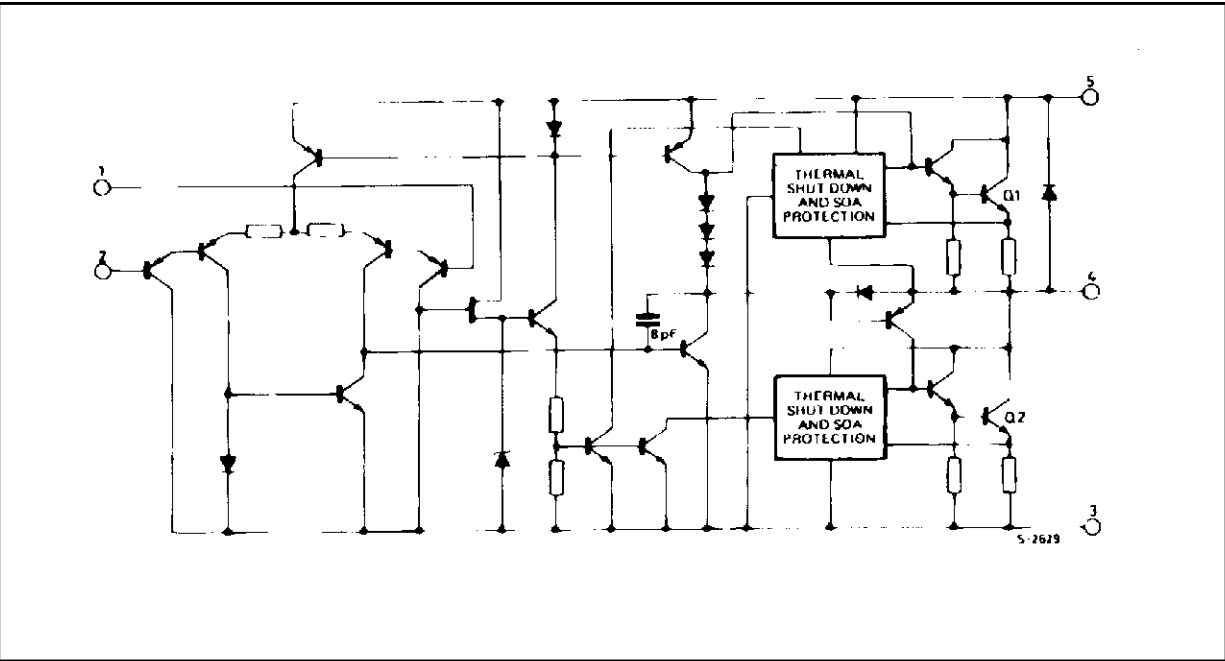
Figure 2. Unity gain configuration.



PIN CONNECTION (top view)



SCHEMATIC DIAGRAM



THERMAL DATA

| Symbol                 | Parameter                        | Value | Unit |
|------------------------|----------------------------------|-------|------|
| R <sub>th-j-case</sub> | Thermal resistance junction-case | max 3 | °C/W |

**ELECTRICAL CHARACTERISTICS** ( $V_s = \pm 15\text{ V}$ ,  $T_j = 25\text{ }^\circ\text{C}$  unless otherwise specified)

| Symbol   | Parameter                          | Test Conditions                                                                                                     | Min.                                   | Typ.     | Max.      | Unit             |
|----------|------------------------------------|---------------------------------------------------------------------------------------------------------------------|----------------------------------------|----------|-----------|------------------|
| $V_s$    | Supply Voltage                     |                                                                                                                     | $\pm 6$                                |          | $\pm 18$  | V                |
| $I_d$    | Quiescent Drain Current            | $V_s = \pm 18\text{ V}$                                                                                             |                                        | 40       | 60        | mA               |
| $I_b$    | Input Bias Current                 |                                                                                                                     |                                        | 0.2      | 1         | $\mu\text{A}$    |
| $V_{os}$ | Input Offset Voltage               |                                                                                                                     |                                        | $\pm 2$  | $\pm 10$  | mV               |
| $I_{os}$ | Input Offset Current               |                                                                                                                     |                                        | $\pm 20$ | $\pm 200$ | nA               |
| SR       | Slew-rate                          | $G_v = 10$                                                                                                          |                                        | 8        |           | V/ $\mu\text{s}$ |
|          |                                    | $G_v = 1\text{ }(^{\circ})$                                                                                         |                                        | 6        |           |                  |
| $V_o$    | Output Voltage Swing               | $f = 1\text{ kHz}$ $I_p = 0.3\text{ A}$<br>$I_p = 3\text{ A}$                                                       |                                        | 27<br>24 |           | $V_{pp}$         |
|          |                                    | $f = 10\text{ kHz}$ $I_p = 0.3\text{ A}$<br>$I_p = 3\text{ A}$                                                      |                                        | 27<br>23 |           | $V_{PP}$         |
| R        | Input Resistance (pin 1)           | $f = 1\text{ KHz}$                                                                                                  | 100                                    | 500      |           | K $\Omega$       |
| $G_v$    | Voltage Gain (open loop)           |                                                                                                                     |                                        | 80       |           | dB               |
| $e_N$    | Input Noise Voltage                | $B = 10\text{ to }10\,000\text{ Hz}$                                                                                |                                        | 2        |           | $\mu\text{V}$    |
| $i_N$    | Input Noise Current                |                                                                                                                     |                                        | 100      |           | pA               |
| CMR      | Common-mode Rejection              | $R_g \leq 10\text{ K}\Omega$ $G_v = 30\text{ dB}$                                                                   |                                        | 70       |           | dB               |
| SVR      | Supply Voltage Rejection           | $R_g = 22\text{ K}\Omega$<br>$V_{\text{ripple}} = 0.5\text{ V}_{\text{rms}}$<br>$f_{\text{ripple}} = 100\text{ Hz}$ | $G_v = 10$                             | 60       |           | dB               |
|          |                                    |                                                                                                                     | dB $G_v = 100$                         | 40       |           | dB               |
|          | Efficiency                         | $f = 1\text{ kHz}$<br>$R_L = 4\text{ }\Omega$                                                                       | $I_p = 1.6\text{ A}; P_o = 5\text{ W}$ | 70       |           | %                |
|          |                                    |                                                                                                                     | $I_p = 3\text{ A}; P_o = 18\text{ W}$  | 60       |           | %                |
| $T_{sd}$ | Thermal Shut-down Case Temperature | $P_{\text{tot}} = 12\text{ W}$                                                                                      |                                        | 110      |           | $^\circ\text{C}$ |
|          |                                    | $P_{\text{tot}} = 6\text{ W}$                                                                                       |                                        | 130      |           |                  |

Figure 3. Open loop frequency response.

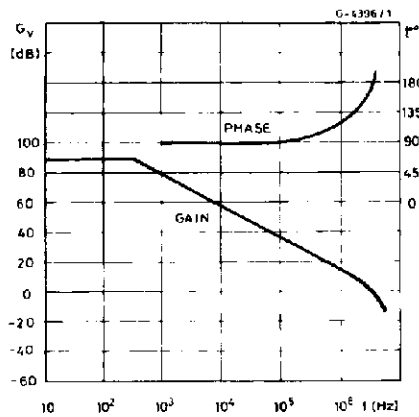


Figure 4. Closed loop frequency response (circuit of figure 2).

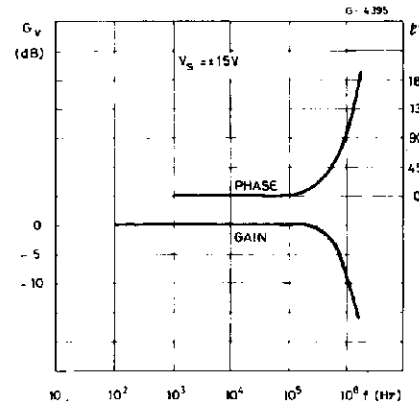


Figure 5. Large signal frequency response.

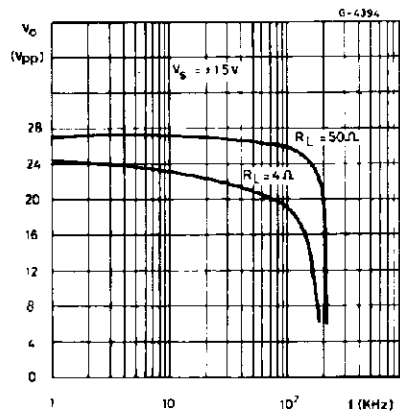


Figure 6. Maximum output current vs. voltage [VCE] across each output transistor.

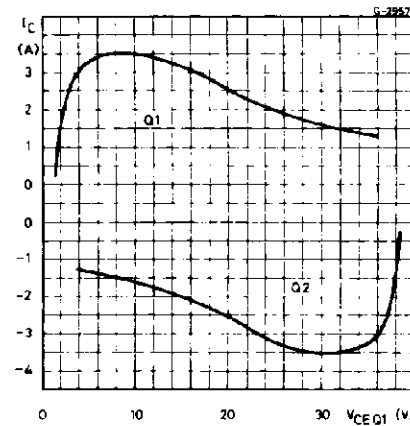


Figure 7. Safe operating area and collector characteristics of the protected power transistor.

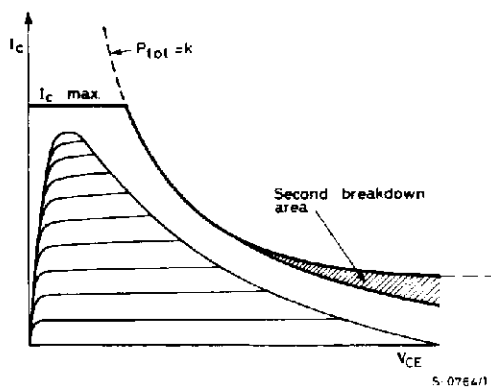


Figure 8. Maximum allowable power dissipation vs. ambient temperature.

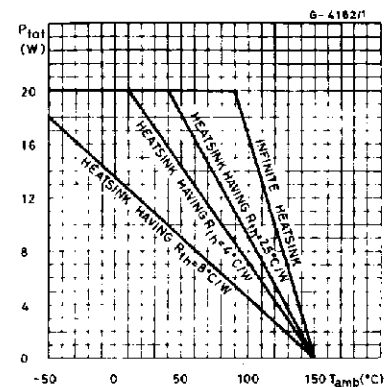
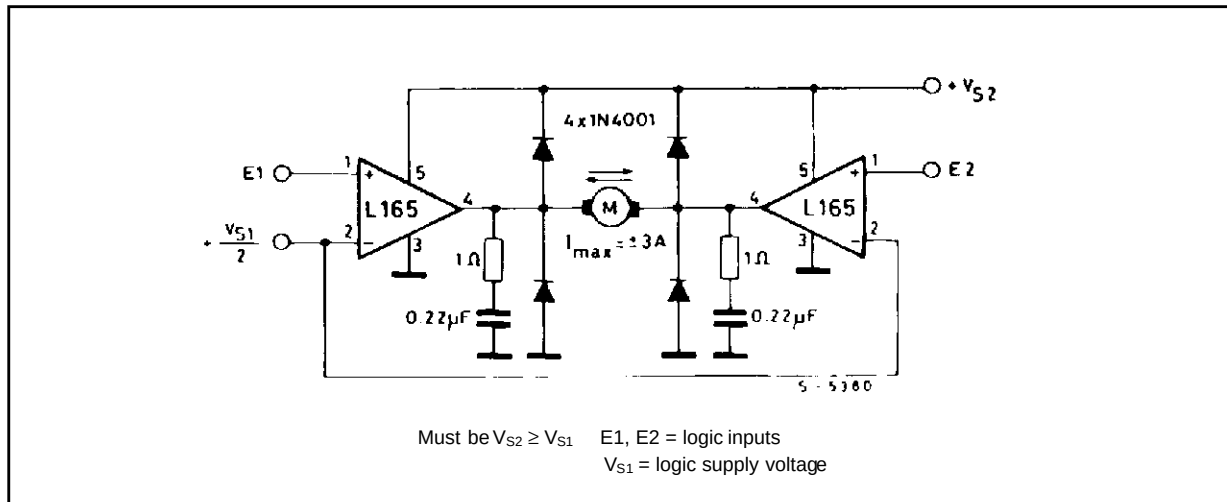
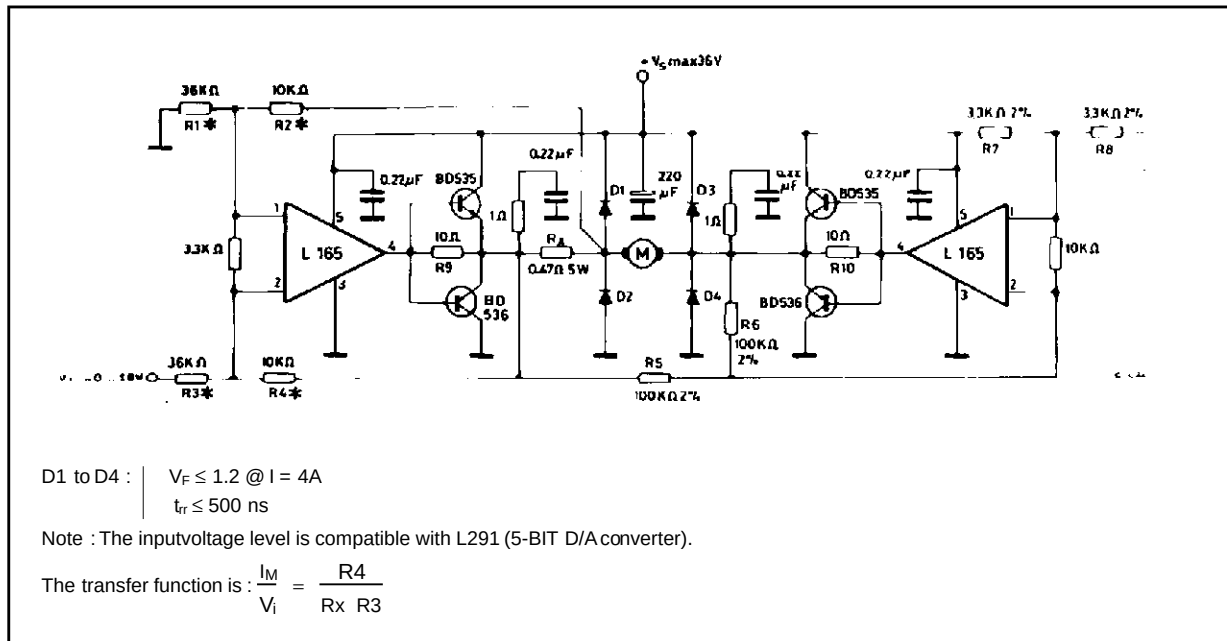
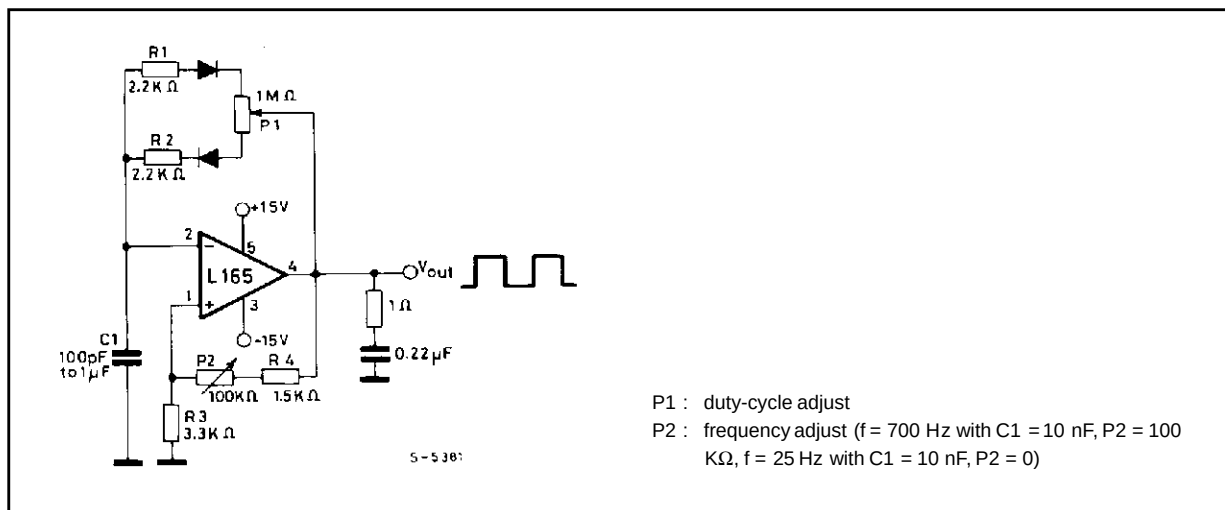


Figure 9. Bidirectional DC motor control with TTL/CMOS/ $\mu$ P compatible inputs.Figure 10. Motor current control circuit with external power transistors ( $I_{\text{motor}} > 3.5\text{A}$ ).

The diagram shows a speed feedback control circuit. A potentiometer P1 is connected between +15V and -15V, with its wiper connected to the non-inverting input (pin 1) of the L165 op-amp. The inverting input (pin 2) is connected to the output (pin 4) through a 1KΩ feedback resistor. The op-amp is powered by +15V and -15V rails, each with a 0.1μF decoupling capacitor. The output (pin 4) drives a 2A DC motor (M) through a 0.22μF capacitor and a 1Ω resistor. The motor's speed is monitored by a tachometer (T), which provides a feedback signal to a resistor (RT) connected to the non-inverting input (pin 1). Diodes D1 and D2 are connected between the output and the input to prevent back-EMF from damaging the op-amp. Component values are: 1KΩ, 0.1μF, 0.22μF, 1Ω, 10KΩ, and 0.1μF. The tachometer is labeled 'TACHO' and the motor is labeled '2A DC MOTOR'. The op-amp is labeled 'L165'.

The diagram shows a precision half-wave rectifier circuit. The input signal  $V_i$  (ranging from  $-8$  to  $+36$  V) is applied to a differential input stage consisting of two  $47\text{K}\Omega$  resistors and a  $100\mu\text{F}$  capacitor. The output of this stage is connected to the non-inverting input (pin 1) of the L165 op-amp. The inverting input (pin 2) is connected to the output (pin 4) through a  $1\Omega$  resistor and a  $0.22\mu\text{F}$  capacitor. The op-amp is powered by  $+V_O$  and  $-V_O$  rails, with a common-mode voltage  $V_O = \pm 4$  to  $\pm 18$  V. The output of the op-amp is filtered by a  $47\mu\text{F}$  capacitor. The circuit is labeled with the part number 5-5379/1.

Figure 14. Power squarewave oscillator with independent adjustments for frequency and duty-cycle.







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