



## High Current - High Power OPERATIONAL AMPLIFIER

### FEATURES

- HIGH OUTPUT POWER  
100 Watts Peak  
40 Watts Continuous
- WIDE SUPPLY RANGE  
 $\pm 10$  to  $\pm 34$  Volts
- HIGH OUTPUT CURRENT  
 $\pm 5$  Amps Peak  
 $\pm 2$  Amps Continuous
- SMALL SIZE: TO-3 PACKAGE
- LOW COST

### APPLICATIONS

- DC MOTORS
- AC MOTORS
- ACTUATORS
- ELECTRONIC VALVES
- SYNCROS

### DESCRIPTION

If you need to supply 100 watts peak or 40 watts continuous, yet must choose a small, easy to use op amp, you'll find the 3573 a logical solution. This hybrid IC delivers  $\pm 5A$  peak minimum at  $\pm 20V$  minimum to the load when operated from  $\pm 28V$  power supplies. The design of this op amp has been optimized for low cost while preserving moderately good input and distortion characteristics.

Output circuitry provides for external current limiting resistors for both positive and negative currents. This allows current limits to be set to values dictated by the op amp's application. 3573 is

internally frequency compensated and is unconditionally stable with capacitive loads to 3300pF.

Housed in a small, rugged, hermetically sealed 8-lead TO-3 package, 3573 will withstand severe environments far better than discrete component amplifiers. The metal case is completely electrically isolated from the amplifier circuitry. Thus, mounting is easier (no isolation washers or spacers) and the hazards of a case connected to the output or supply voltage is eliminated.

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# ELECTRICAL SPECIFICATIONS

At  $T_{case} = 25^{\circ}\text{C}$  and  $\pm V_{cc} = \pm 28\text{VDC}$  unless otherwise noted.

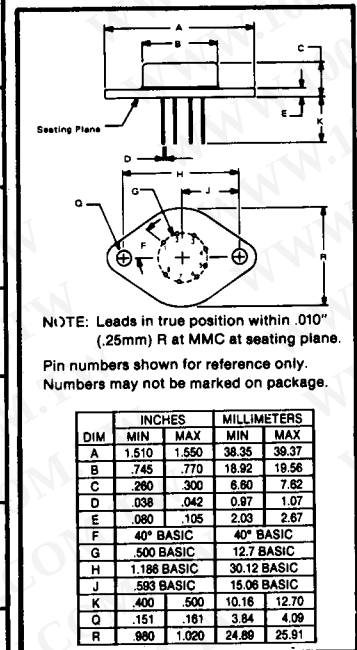
| PARAMETER                                                                                                                    | CONDITIONS                                                                                                                                                   | 3573AM                |                                 |                      | UNITS                                                                       |
|------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------|----------------------|-----------------------------------------------------------------------------|
|                                                                                                                              |                                                                                                                                                              | MIN                   | TYP                             | MAX                  |                                                                             |
| OPEN LOOP GAIN, DC                                                                                                           | $R_i \geq 30\Omega$                                                                                                                                          | 94                    | 115                             |                      | dB                                                                          |
| RATED OUTPUT<br>Power to Load <sup>(1)</sup><br>Continuous<br>Peak<br>Output Current<br>Continuous<br>Peak<br>Output Voltage | $I_{out} = \pm 5\text{A}^{(4)}$                                                                                                                              | 40                    |                                 |                      | W                                                                           |
|                                                                                                                              |                                                                                                                                                              | 100                   |                                 |                      | W                                                                           |
|                                                                                                                              |                                                                                                                                                              | $\pm 2$               |                                 |                      | A                                                                           |
|                                                                                                                              |                                                                                                                                                              | $\pm 5$               |                                 |                      | A                                                                           |
|                                                                                                                              |                                                                                                                                                              | $\pm 20$              | $\pm 23$                        |                      | V                                                                           |
| DYNAMIC RESPONSE<br>Bandwidth, Unity Gain<br>Full Power Bandwidth<br>Slew Rate                                               | Small Signal                                                                                                                                                 | 15<br>1.35            | 1<br>23<br>1.5                  |                      | MHz<br>kHz<br>V $\mu\text{s}$                                               |
| INPUT OFFSET VOLTAGE<br>Initial Offset<br>vs Temperature<br>vs Supply Voltage                                                | $-25^{\circ}\text{C} \leq T_{case} \leq 85^{\circ}\text{C}$                                                                                                  |                       | $\pm 5$<br>$\pm 10$<br>$\pm 35$ | $\pm 10$<br>$\pm 65$ | mV<br>$\mu\text{V}/^{\circ}\text{C}$<br>$\mu\text{V}/\text{V}$              |
| INPUT BIAS CURRENT<br>Initial<br>vs Temperature<br>vs Supply Voltage                                                         | $T_{case} = 25^{\circ}\text{C}$                                                                                                                              |                       | 15<br>$\pm 0.05$<br>$\pm 0.02$  | 40                   | nA<br>nA $^{\circ}\text{C}$<br>nA V                                         |
| INPUT DIFFERENCE CURRENT<br>Initial<br>vs Temperature                                                                        | $T_{case} = 25^{\circ}\text{C}$<br>$-25^{\circ}\text{C} \leq T_{case} \leq 85^{\circ}\text{C}$                                                               |                       | $\pm 5$<br>$\pm 0.01$           | $\pm 10$             | nA<br>nA $^{\circ}\text{C}$                                                 |
| INPUT IMPEDANCE<br>Differential<br>Common-mode                                                                               |                                                                                                                                                              |                       | 10<br>250                       |                      | M $\Omega$<br>M $\Omega$                                                    |
| INPUT NOISE<br>Voltage Noise<br>Current Noise                                                                                | $f_n = 0.3\text{Hz to } 10\text{Hz}$<br>$f_n = 10\text{Hz to } 10\text{kHz}$<br>$f_n = 0.3\text{Hz to } 10\text{Hz}$<br>$f_n = 10\text{Hz to } 10\text{kHz}$ |                       | 3<br>5<br>20<br>4.5             |                      | $\mu\text{V p-p}$<br>$\mu\text{Vrms}$<br>$\text{pA p-p}$<br>$\text{pA rms}$ |
| INPUT VOLTAGE RANGE<br>Common-mode Voltage<br>Common-mode Rejection                                                          | Linear Operation<br>$f = \text{DC}, V_{cm} = \pm 22$                                                                                                         | $\pm(V_{cc}-6)$<br>70 | $\pm(V_{cc}-3)$<br>110          |                      | V<br>dB                                                                     |
| POWER SUPPLY<br>Rated Voltage<br>Voltage Range, derated<br>Current, quiescent                                                |                                                                                                                                                              | $\pm 10$              | $\pm 28$<br>$\pm 2.6$           | $\pm 34$<br>$\pm 5$  | V<br>V<br>mA                                                                |
| TEMPERATURE RANGE<br>Specification<br>Operating, derated performance<br>Storage                                              |                                                                                                                                                              | -25<br>-25<br>-65     |                                 | +85<br>+85<br>+150   | $^{\circ}\text{C}$<br>$^{\circ}\text{C}$<br>$^{\circ}\text{C}$              |

## ABSOLUTE MAXIMUM RATINGS

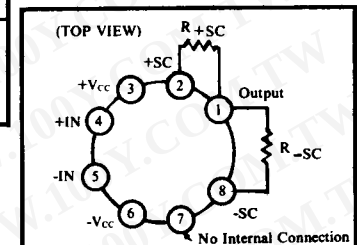
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|----------------------------------------------|-----------------------------------------------|
| Supply Voltage Range                         | $\pm 34\text{VDC}$                            |
| Internal Power Dissipation <sup>(1)</sup>    | 45W                                           |
| Differential Input Voltage <sup>(2)</sup>    | $\pm 62\text{VDC}$                            |
| Input Voltage Range <sup>(3)</sup>           | $\pm 31\text{VDC}$                            |
| Storage Temperature Range                    | $-65^{\circ}\text{C to } 150^{\circ}\text{C}$ |
| Lead Temperature (soldering, 10 sec)         | $300^{\circ}\text{C}$                         |
| Output Short-Circuit Duration <sup>(3)</sup> | Continuous                                    |
| Junction Temperature                         | $150^{\circ}\text{C}$                         |

- Package must be derated based on a junction to case thermal resistance of  $2.8^{\circ}\text{C}/\text{W}$ , or a junction to ambient thermal resistance of  $30^{\circ}\text{C}/\text{W}$ .
- For supply voltages less than  $\pm 34\text{VDC}$ , the absolute maximum voltage is three volts less than supply voltage.
- Safe Operating Area and Power Derating Curves must be observed.
- With  $R_{SC} = 0$ .

## MECHANICAL

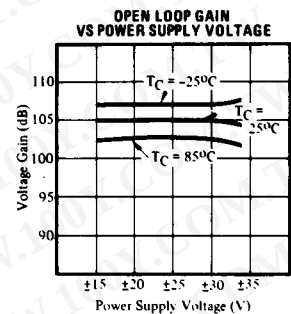
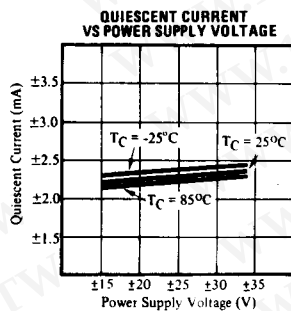
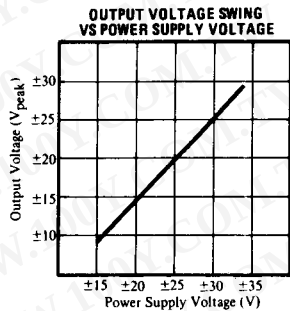
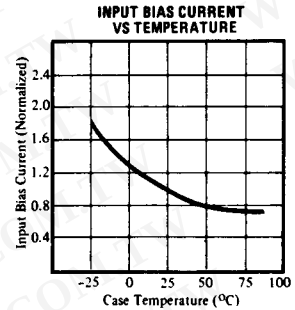
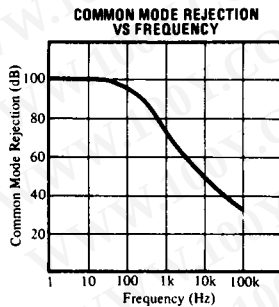
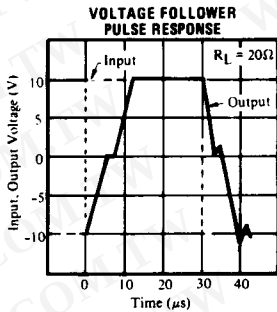
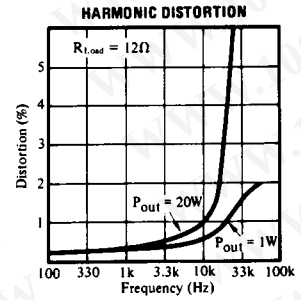
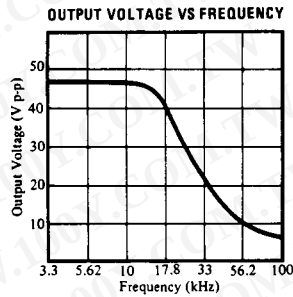
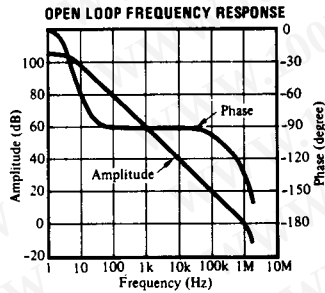
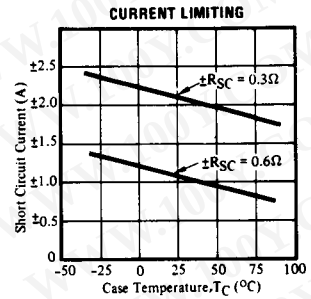
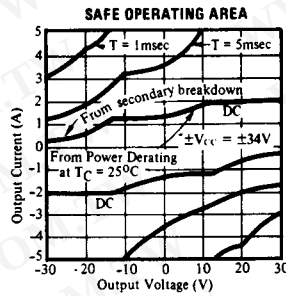
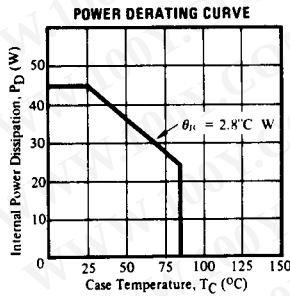


## CONNECTION DIAGRAM



# TYPICAL PERFORMANCE CURVES

(Typical at 25°C Case and  $\pm V_{CC} = \pm 28$  VDC unless otherwise noted.)



# INSTALLATION AND OPERATING INSTRUCTIONS

## GENERAL PRECAUTIONS

### CURRENT LIMITING

It is recommended that during initial amplifier setup, particularly in breadboarding and when a lack of familiarity with the amplifier exists, that the current limit be set at about 250mA ( $R_{sc} \approx 2.6\Omega$ ). This will allow verification of the circuit and will minimize the possibility of damaging the amplifier. Later, when the circuit configuration and connections have been proven, the current limits can be raised to the desired value.

### PROPER GROUNDING & POWER SUPPLY BYPASSING

Particular attention should be given to proper grounding practices because the large output currents can cause significant ground loop errors. Figure 1 illustrates proper connections.

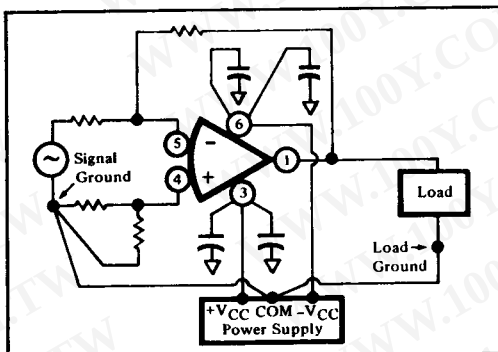


FIGURE 1. Proper Power Supply Connections.

Note that the connections are such that the load current does not flow through the wire connecting the signal ground point to the power supply common. Also, power supply and load leads should be run physically separated from the amplifier input and signal leads.

The amplifier should be power supply bypassed with 50μF tantalum capacitors connected in parallel with 0.01 μF ceramic capacitors connected as close to pins 3 and 6 as possible. The capacitors should be connected to the load ground rather than the signal ground.

### CURRENT LIMITS

The amplifier is designed so that both the positive and negative load current limits can be adjusted with external resistors,  $R_{sc}$  and  $R_{sc}$  respectively. The value of the resistors are given by the following equation:

$$R_{sc} = \frac{0.65 \text{ (volts)}}{I_{\text{limit}} \text{ (amps)}}$$

$I_{\text{limit}}$  is the desired maximum current. The maximum power dissipation of the resistors is  $P_{\text{max}} = R_{sc} (I_{\text{limit}})^2$ . The current limits determined by the equations above are accurate to about  $\pm 10\%$ . The variation of  $I_{\text{limit}}$  vs temperature is shown in the Typical Performance Curves.

The amplifier should be used with as low a current limit as possible for the particular application. This will minimize the chance of damaging the amplifier under abnormal load conditions and increase reliability by limiting the internal power dissipation of the amplifier.

## THERMAL CONSIDERATIONS

The 3573AM is rated for 150°C maximum junction temperature. The thermal resistance from junction to case ( $\theta_{jc}$ ) is 2.8°C/W per watt. The corresponding Power Derating Curve is given in the Typical Performance Curves section.

The internal power dissipation of the amplifier is given by the equation  $P_D = P_{DQ} + P_{DL}$ , where  $P_{DQ}$  is the quiescent power dissipation and  $P_{DL}$  is the power dissipated in the output stage due to the load.

The thermal resistance of the required heat sink ( $\theta_{hs}$ ) can be determined from the equation:

$$\theta_{hs} = \frac{T_J - T_A}{P_D} - \theta_{jc}$$

where  $T_J$  is the desired amplifier junction temperature (+150°C max),  $T_A$  is the ambient temperature,  $P_D$  is the amplifier's dissipation,  $P_D = P_{DQ} + P_{DL}$ , and  $\theta_{jc}$  is the junction to case thermal resistance of the amplifier.

The electrically isolated case of the 3573AM simplifies mounting the amplifiers to the heat sink (and the heat sink to any other assemblies) since there is no need for electrical insulation. Thermal joint compound and lock washers should be used to prevent mechanical relaxation due to thermal stresses.

### SAFE OPERATING AREA

There are additional constraints on the output voltage and current other than those just due to the maximum internal power dissipation of the amplifiers. These are related to the prevention of secondary breakdown in the output stage transistors. These restrictions are shown in the SAFE OPERATING AREA CURVES in the Typical Performance Curves.