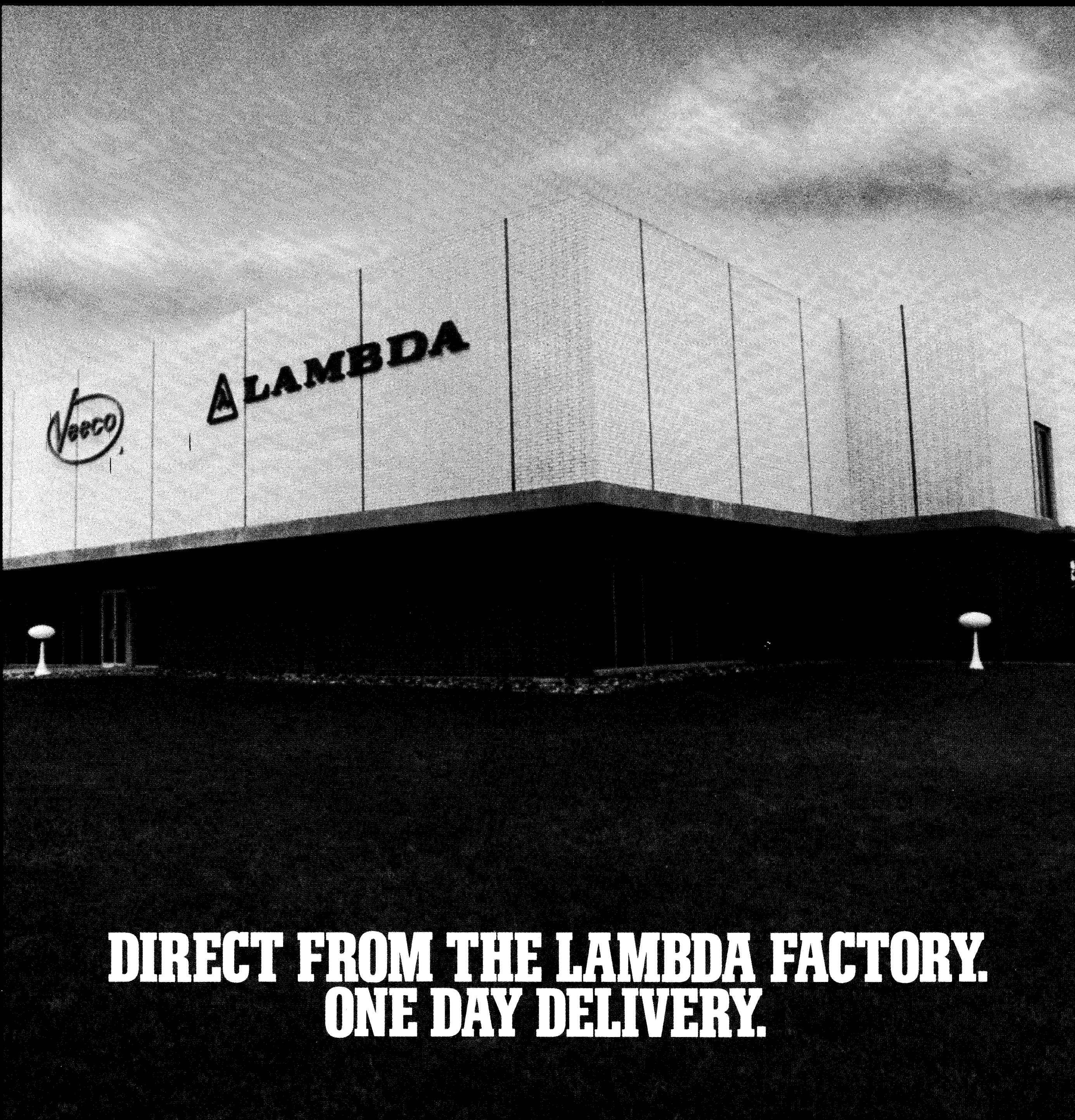
# LAMBDA FOR DEMANDING SEMICONDUCTOR POWER DESIGNS.

New line of high speed switching transistors.

Now Lambda control circuits for switching power supplies.

# 1982 SEMICONDUCTOR CATALOG

# LAMBDA CORPUS CHRISTI.
# DEDICATED TO THE DESIGN AND MANUFACTURE OF SEMICONDUCTORS.



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# PART I – SWITCHING COMPONENTS
# SECTION I – SWITCHING REGULATORS

## LAMBDA LAS 3800

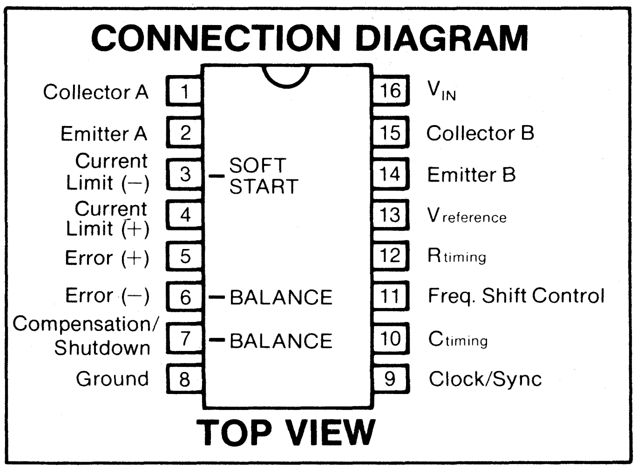
### FEATURES

- 12-40 volt operation
- 1.65 volt reference
- DC to 500 KHz oscillator
- Programmable dead time
- Programmable frequency shift
- Multiple device synchronization
- Linear pulse width modulator
- Double pulse suppression
- Uncommitted error amplifier
- High speed current limit comparator
- Current limit frequency shift
- Dual .5 ampere output transistors
- Output over-current protection
- Overvoltage shutdown
- Thermal shutdown
- Soft start capability

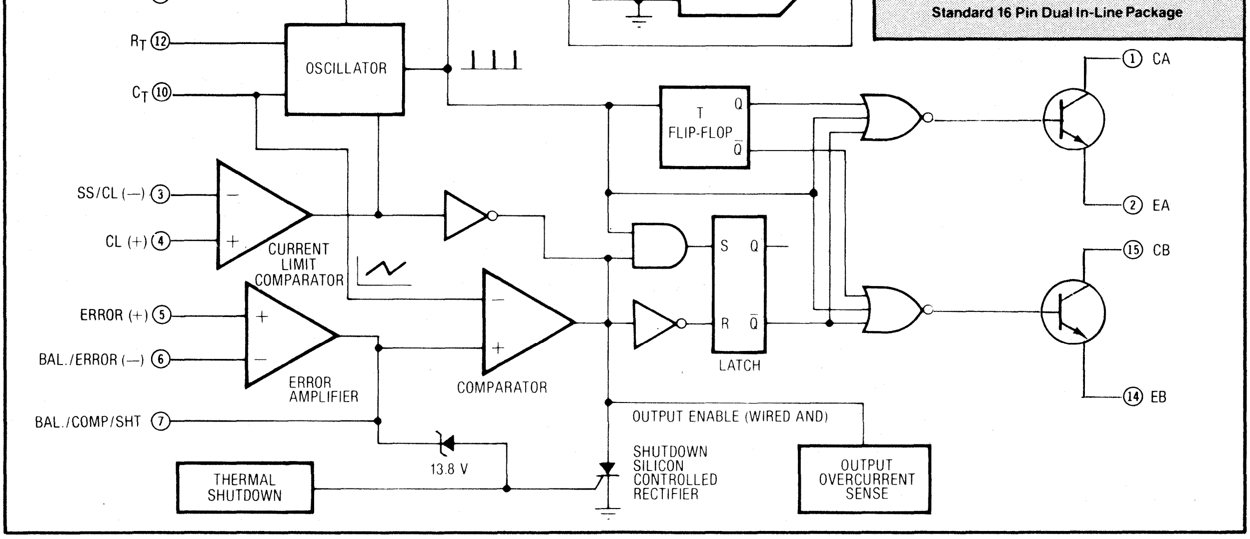
### DESCRIPTION

The LAS 3800 is a high performance monolithic integrated circuit switching regulator designed for use in fixed frequency power control applications such as switching power supplies and motor controls. Included in the hermetically sealed Dual in Line package are a temperature compensated voltage reference, sawtooth oscillator with overcurrent frequency shift, linear 'trailing edge' pulse width modulator with double pulse suppression logic, error amplifier, high speed current limit comparator, two symmetrical NPN output devices with overcurrent protection, shutdown logic and provision for dynamic volt-time symmetry correction in double ended systems. This circuit can be used to implement switching regulators of either polarity, transformer coupled DC to DC converters, transformerless voltage doublers, polarity converters, and DC/AC motor controls. The LAS 3800 has been characterized for operation over the −55°C to 125°C temperature range.

### PIN CONFIGURATION




### BLOCK DIAGRAM




Standard 16 Pin Dual In-Line Package

# ABSOLUTE MAXIMUM RATINGS

| PARAMETER | RATING | UNIT |
|---|---|---|
| Input Voltage Range | 12 — 40 | Volts |
| Collector Supply Voltage | 40 | Volts |
| Operating Temperature Range | −55 to 125 | °C |
| Thermal Resistance; junction/ambient | 100 | °C/Watt |
| Minimum Timing Resistor | 5000 | Ohms |

# ELECTRICAL CHARACTERISTICS

Unless otherwise stated, these specifications apply for $T_j = 0°C$ to 125°C, $V_{IN} = 15$ volts, and f = 20 KHz (see Test Circuit)

| PARAMETER | TEST CONDITIONS | TEST LIMITS | | |
|---|---|---|---|---|
| **REFERENCE SECTION** | | **MIN** | **MAX** | **UNITS** |
| Reference Voltage | $T_j$=25°C | 1.56 | 1.74 | V |
| Line Regulation | $V_{IN}$ = 12 to 40 volts; $T_j$=25°C | — | .01 | %/V |
| Temperature Coefficient | | — | .01 | %/°C |
| **OSCILLATOR SECTION** | | | | |
| Initial Frequency Accuracy | $T_j$=25°C | — | ±6 | % |
| Line Regulation of Frequency | $V_{IN}$ =12 to 40 volts, $T_j$=25°C | — | .036 | %/V |
| Frequency T.C. | | — | .05 | %/°C |
| Maximum Frequency | | — | 500 | KHz |
| Dead Time Initial Accuracy | $T_j$=25°C | — | ±20% | % |
| Dead Time T.C. | | — | +.33 | %/°C |
| Minimum Dead Time | | 1.5 | — | μS |
| **ERROR AMPLIFIER SECTION** | | | | |
| Input Offset Voltage | $T_j$=25°C | — | ±25 | mV |
| DC Voltage Gain | | 60 | — | dB |
| Slew Rate | $T_j$=25°C | .4 | .7 | v/μs |
| Output Source Current | | — | 10 | mA |
| Output Sink Current | | — | .8 | mA |
| Input Common Mode Range | | .6 | 11 | V |
| Output Common Mode Range | | .4 | 8 | V |
| Supply Rejection | | 70 | — | dB |
| **CURRENT LIMIT COMPARATOR** | | | | |
| Threshold Voltage | $T_j$=25°C | 2.28 | 2.52 | V |
| Threshold Voltage T.C. | | −.3 | −.4 | %/°C |
| Common Mode Range | | 0 | $V_{IN}$−5 | V |
| Input Bias Current | | — | −.6 | mA |
| Time Delay to Outputs Off | | — | .9 | μs |
| **OUTPUT SECTION** | | | | |
| Collector-Emitter Voltage | | | 40 | V |
| Output Current Limit | | .5A | 1.4 | A |
| On Voltage | $I_{OUT}$=.5A, $T_j$= 25°C | — | 2 | V |
| Leakage Current | $V_{CE}$=40V | — | .5 | mA |
| Rise Time | $I_{OUT}$=.5A | | .2 | μs |
| Fall Time | $I_{OUT}$=.5A | | .1 | μs |
| **SHUTDOWN LOGIC** | | | | |
| Shutdown Temperature | | 150 | 200 | °C |
| Over-Voltage Threshold | $T_j$=25°C | 13 | 14.5 | V |
| **POWER CONSUMPTION** | | | | |
| Standby Current (IQ) | Test Circuit, $T_j$=25°C | 7 | 13 | mA |

# ESSENTIAL DESIGN FEATURES THAT SEPARATE LAMBDA FROM THE REST

## DYNAMIC VOLT-TIME BALANCING

Dynamic volt-time balancing is essential in double-ended switching power supply systems to prevent transformer saturation. Saturation can occur whenever a net DC voltage exists across the switching transformer. This voltage reduces primary inductance causing switching transistor current to increase rapidly. Excessive peak transistor current reduces maximum system power and can result in switching transistor failure when available drive current is not sufficient to cause transistor saturation. Transformer saturation is eliminated by forcing alternate half-cycle volt-time products to be equal. (Volt-time = Transformer voltage X pulse width "ON" time). Equal volt-time products eliminate transformer unbalance and results in maximum power transmitted by the system. Volt-time balancing is accomplished during steady-state and transient load conditions thereby assuring circuit and component reliability for all operating conditions.

## CURRENT LIMIT/FREQUENCY SHIFT

A high-speed current limit circuit is required in switching converters to protect the device from destructive peak currents. The LAS 3800's instantaneous peak current limiting guarantees current limiting in all overload conditions, including transients, by using trailing edge modulation. In some switching converter systems excessive power dissipation occurs in the switching devices (transistors and rectifiers) during current limit. The LAS 3800 reduces current limit power consumption by shifting the device oscillator down in frequency. Detection of an overcurrent condition terminates the device output pulse and reduces the slope of the LAS 3800 ramp for the duration of the timing interval, thus decreasing the timing frequency. Duty cycle (power consumption) is reduced and the user is alerted by an audible switching frequency. Frequency shift may be programmed with one resistor. The current limit frequency shift feature offered in the LAS 3800 enables the design engineer to operate switching transistors at maximum power with excellent reliability.

## OUTPUT CURRENT CAPABILITY

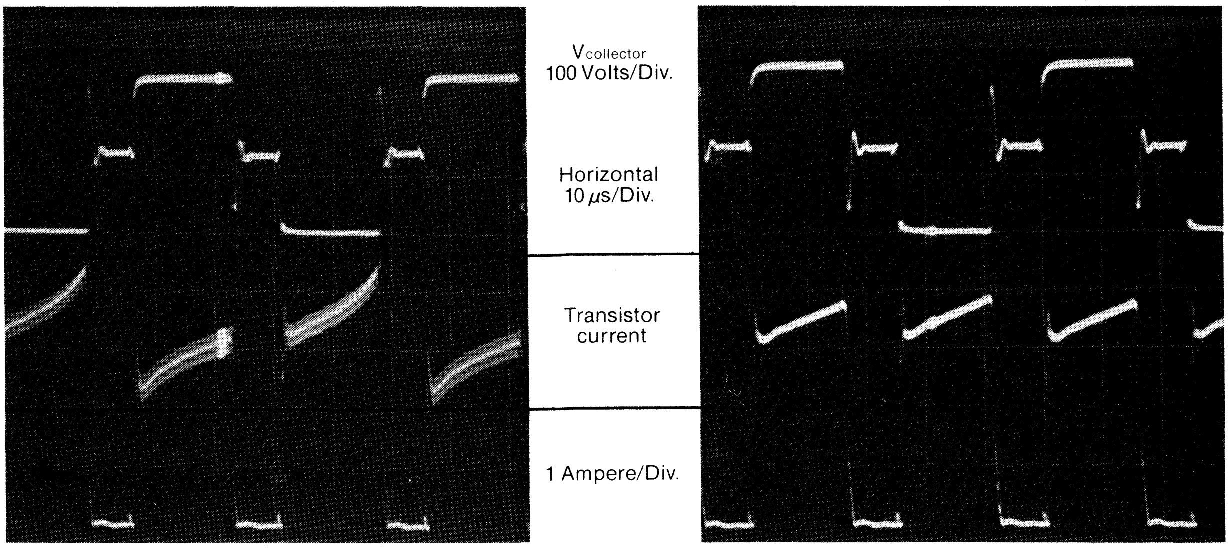
Output drive capability of 0.5 Amps will directly drive most high-voltage switching transistors. An internal current limit circuit protects the device from accidental short circuit or overload conditions by terminating the output pulse.

## OVERVOLTAGE PROTECTION

Destructive output overvoltage conditions may be sensed with a LAMBDA overvoltage protector which crowbars the output of the power supply. With auxiliary circuitry the LAS 3800 can also be shut down simultaneously which protects the switching system and user load from destructive overvoltage conditions.

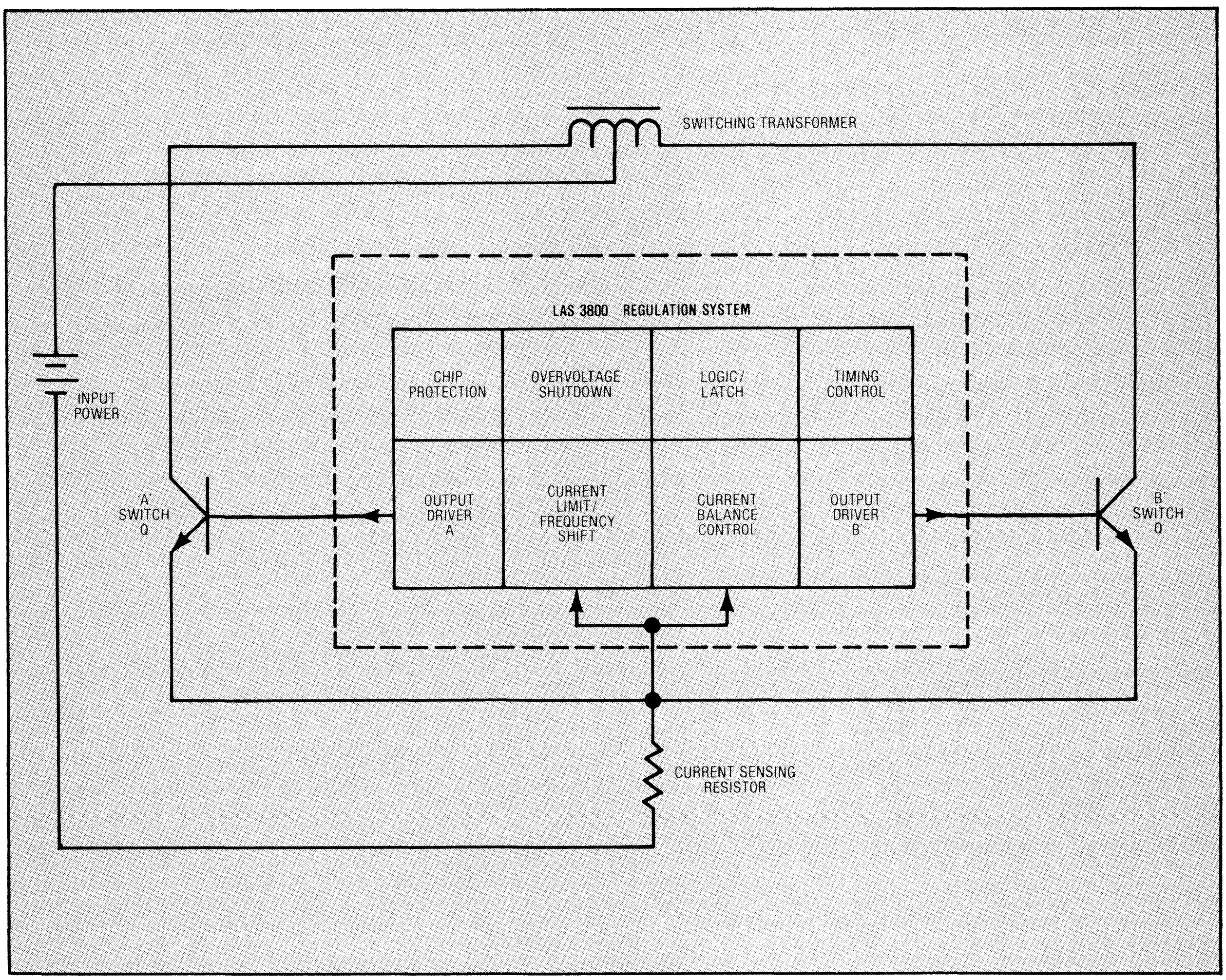
## INVERTER WITH BALANCE DISCONNECTED

## INVERTER WITH LAS 3800 BALANCE CIRCUIT CONNECTED

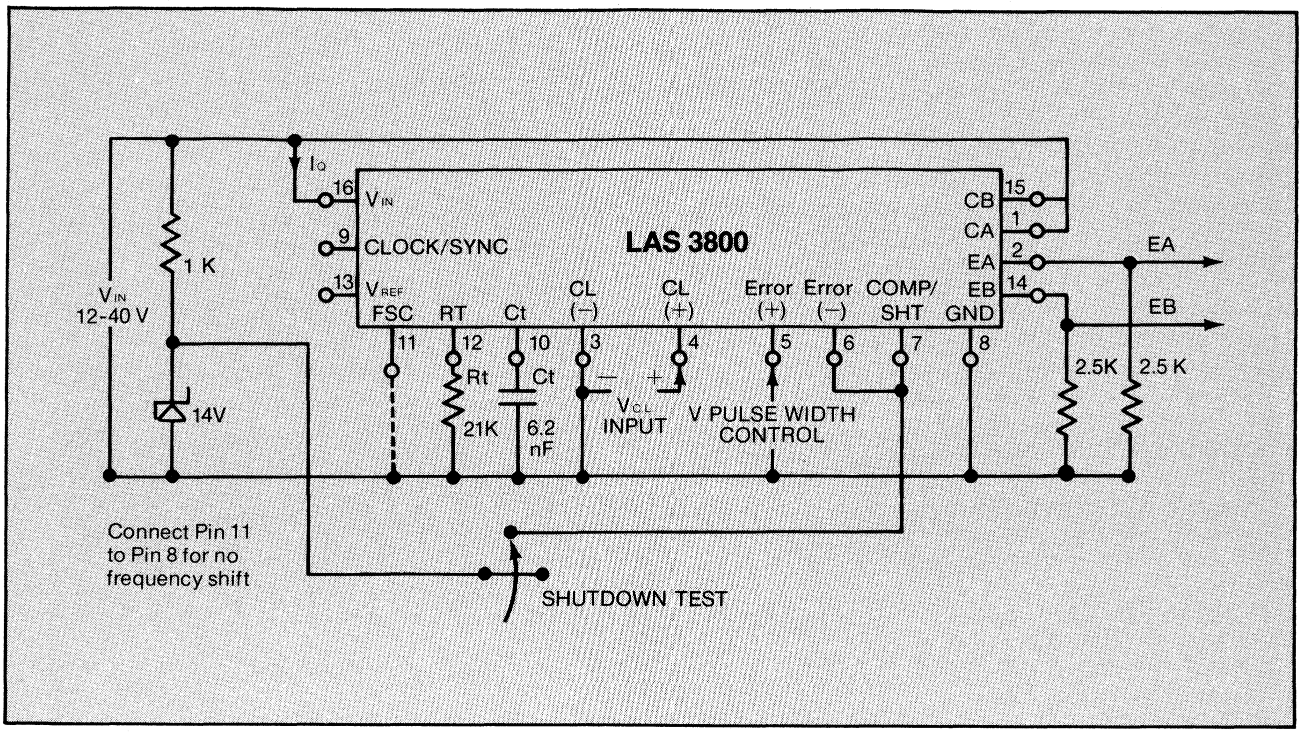



The same inverter operated with/without current balancing. Both systems are delivering maximum power (4 amperes of transistor current). The LAS 3800 system using Dynamic current balance produces 33% more peak output power.

## SWITCHING INVERTER SYSTEM WITH LAMBDA LAS 3800



# TEST CIRCUIT




# APPLICATIONS

## OSCILLATOR

The LAS 3800 uses a sawtooth oscillator to generate a linear ramp for the pulse width comparator and system timing. Capacitor charging current is controlled by the timing resistor. Current limit inhibits device outputs and reduces the positive slope of the oscillator ramp. Thus, frequency shifting reduces system power by reducing maximum duty cycle and is a function of the severity of the over current fault condition (maximum occurs at short circuit). Dead time is set by discharging the timing capacitor with a constant current. This timing pulse is used to synchronize all logic and provides output blanking to insure both chip outputs are not on at the same time during the dead time interval. A minimum dead time pulse width of 1.5$\mu$s should be used to guarantee proper device operation over line and temperature extremes. After selection of (a) system frequency, (b) dead time, and (c) short circuit frequency shift, select the proper external device components as follows: 1) using graph #1 select a timing capacitor for proper dead time, 2) using graph #2 select the proper timing resistor, 3) using graph #3 determine the proper frequency shift control resistor.

## VOLTAGE REFERENCE

The voltage reference is a precision temperature compensated zener circuit. A 7K ohm output impedence allows the user to bypass system switching noise; a .1$\mu$F capacitor is usually sufficient.

## CURRENT LIMIT

The current limit circuit is a high speed 2.4 volt differential comparator designed to minimize output turnoff delay and is operated on a cycle-by-cycle basis via trailing edge modulation. Turnoff delay is less than .9$\mu$s under all conditions to minimize any current overshoot. Common-mode range extends from ground to $V_{in}$ −5 volts. Automatic system thermal derating is accomplished by a −8mv/°C threshold temperature coefficient. Frequency shift in current limit mode is energized under the following condition:

$$V_{SECONDARY}\frac{T_{ON(MIN)}}{T_{ON(MIN)}+T_{OFF}} > I_{MAX}\,(R_{LOAD}+R_{LOSSES})$$

where, $T_{ON(MIN)} = (T_{DELAY})_{3800} + (T_{MIN})_{SW.\,TR.}$

For a practical system $T_{ON(MIN)}$ will be approximately 2$\mu$s. As $R_{LOAD}$ is decreased, $T_{OFF}$ is increased keeping the output current at some preset limit (Imax). In the 3800 chip, $T_{ON(MIN)}$ is never increased during frequency shift so that the volt-time requirements on the inverter transformer are never greater than normal constant voltage operation.

# ERROR AMPLIFIER

The error amplifier is a slightly modified operational amplifier with low input offset and high slew rate necessary in dynamic volt-time balancing.

Modifications include a constant-current sink to insure smooth operation of the overvoltage shutdown circuit and limiting current sourcing capability so that the pulse width modulator can be inhibited by shorting chip pin #7 to ground (soft-start) with no damage to the error amplifier. The gain of the current balance circuit is selectable by means of external resistors.

# OUTPUT TRANSISTORS

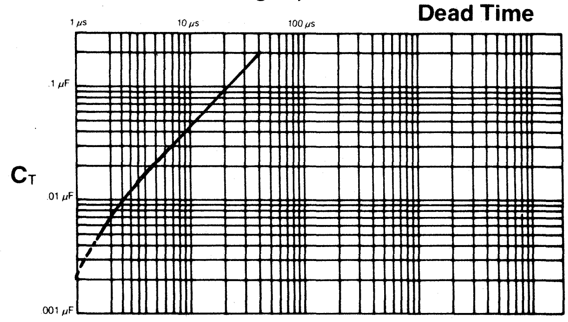
LAS 3800 outputs are two NPN power transistors with collector and emitter uncommitted. Output current limiting of 1.4 amperes is provided and coupled directly to the pulse width logic. The uncommitted collectors are intended to enable the user to reduce device power dissipation if output currents greater than .5 ampere are required.

# SHUTDOWN LOGIC

Shutdown logic causes the chip to disable outputs until $V_{in}$ is reduced below 3 volts. Thus, conditions in the system considered dangerous by the user may be detected and used to shutdown the power conversion system. Forcing internal junction temperature above 165° C causes shutdown. External shutdown is accomplished by biasing device pin #7 above 13.8 volts for 10μs. Normal output range of the error amplifier is .2—8 volts and cannot initiate shutdown.

graph #1

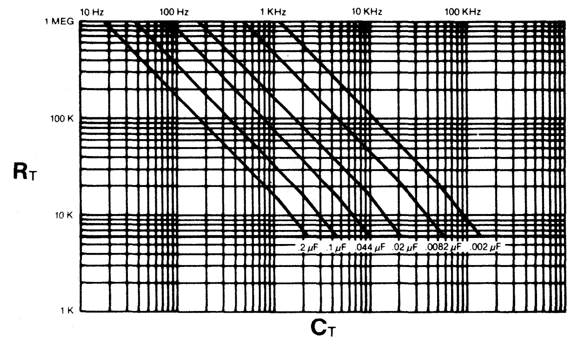
**Dead Time**




**DEAD TIME VS TIMING CAPACITOR**

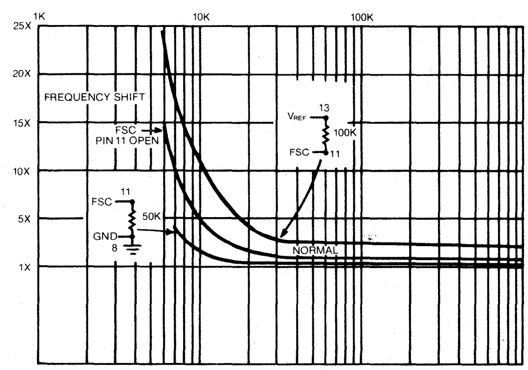
graph #2

**Frequency Oscillator**




**FREQUENCY VS TIMING RESISTOR-CAPACITOR**

graph #3




**FREQUENCY SHIFT VS TIMING RESISTOR**

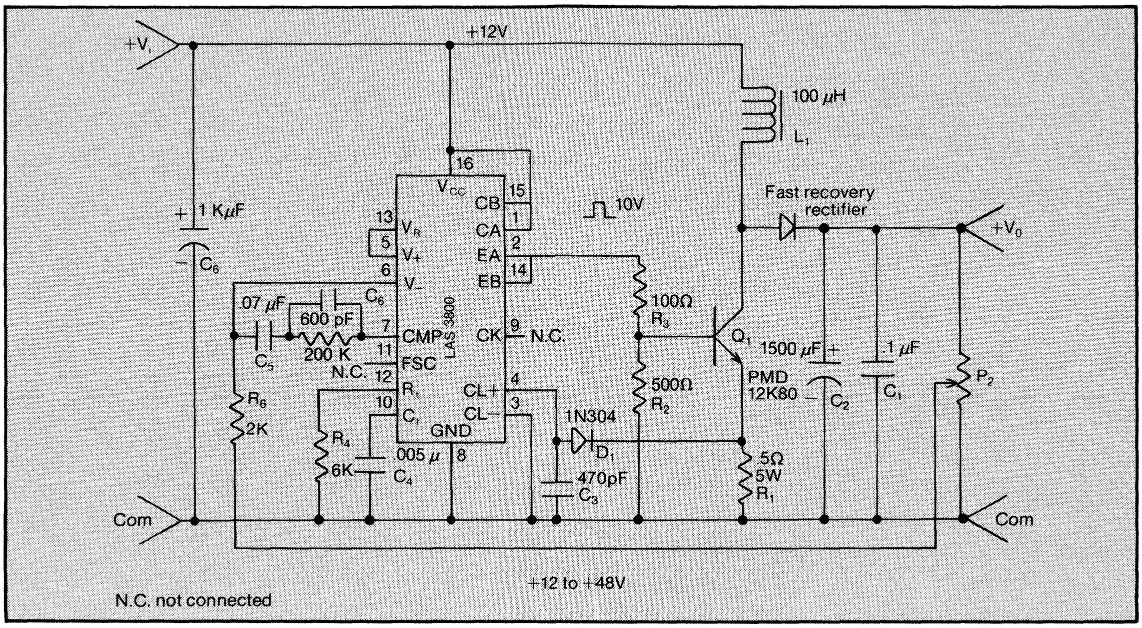
# ORDERING INFORMATION

| DEVICE TYPE | PRICE & QUANTITY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
| LAS 3800 | $9.95 | $7.95 | $7.95 | $6.95 | $6.95 | $6.95 | $6.20 | $5.95 |

**Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.**

# TYPICAL APPLICATIONS

## LAS 3800 STEP UP DC-DC CONVERTER




**The above circuit is a simple 12 to 48 volt DC/DC using a PMD12K80 as the power switch.**

Frequency—58 KHz  
Load regulation—13 mv  
Line regulation—10 mv (10-14 V)  
Full load current—.25 A  
Max. Switch Current—3 A  
Short circuit frequency shift—14X

The following LAS 3800 features are used:

1. Error amplifier is voltage control
2. Internal reference
3. Current limit to protect 12K80; $C_3$, $D_1$ eliminate inductive spike across $R_1$
4. Frequency shift
5. Timing Control

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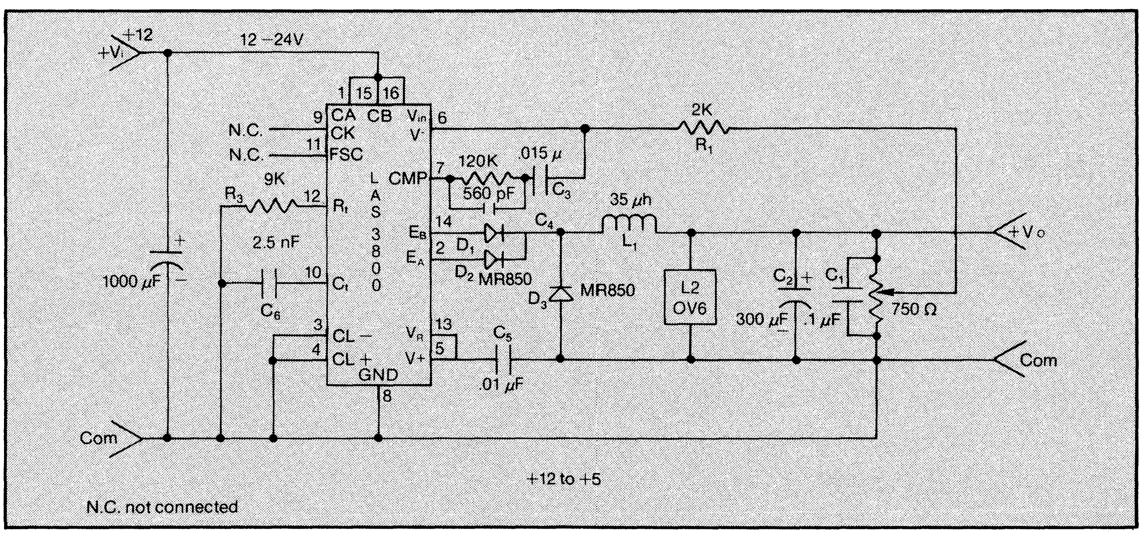
## LAS 3800 STEP DOWN DC-DC CONVERTER




**The above circuit is a 2.5 watt stand alone 12-5 volt DC/DC converter.**

Frequency—90 KHz  
Load regulation—5 mv ($V_{CC}$=15 V)  
Line regulation—13 mv (FL, 12-24 V)  
Full load output current—.5 A  
Short circuit current—1.4 A  
Short circuit frequency shift—6X

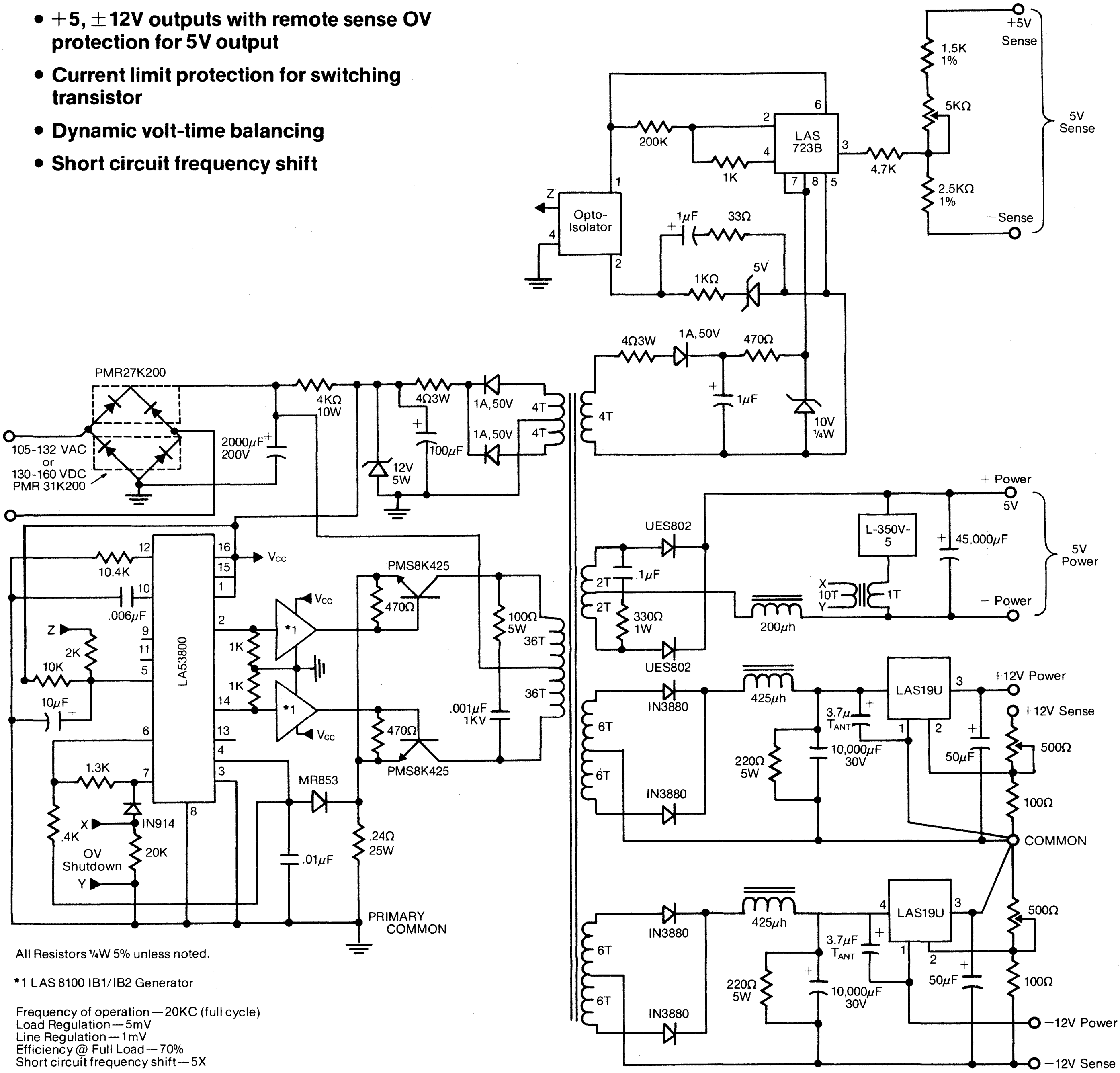
The following LAS 3800 features are used:

1. Error amplifier is voltage control
2. Internal reference
3. Internal current limit protection
4. Frequency shift
5. Timing Control

# 5 VOLT AT 40A
# ±12 VOLT AT 5A SWITCHING POWER SUPPLY

## FEATURES

- **+5, ±12V outputs with remote sense OV protection for 5V output**
- **Current limit protection for switching transistor**
- **Dynamic volt-time balancing**
- **Short circuit frequency shift**




All Resistors ¼W 5% unless noted.

*1 LAS 8100 IB1/IB2 Generator

Frequency of operation—20KC (full cycle)
Load Regulation—5mV
Line Regulation—1mV
Efficiency @ Full Load—70%
Short circuit frequency shift—5X

# LAMBDA LAS 6300 PRELIMINARY

## MONOLITHIC SWITCHING REGULATOR

## FEATURES

- 5-35 volt operation
- 2.00 volt reference
- DC to 200KHz oscillator
- Linear pulse width modulator
- Double pulse suppression
- Shutdown latch
- Uncommitted error amplifier
- Uncommitted output transistor
- 5 ampere output current
- High speed internal current limit
- Thermal shutdown
- Inherit Soft Start

## DESCRIPTION

The LAS 6300 is a high performance monolithic integrated circuit switching regulator designed for use in fixed frequency power control applications such as switching power supplies and motor controls. Included in the hermetically sealed eight pin TO-3 or 10 pin TO-96 packages are a temperature compensated voltage reference, saw-tooth oscillator with over current frequency shift, linear trailing edge pulse width modulator with double pulse suppression logic, error amplifier, and a 5 ampere output transistor with internal current limit protection. The LAS 6300 is characterized for use over the −55° to 125° C operating temperature range.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | RATING | UNIT |
|---|---|---|
| Input Voltage Range | 5-20 | Volts (TO-96 pack) |
| Input Voltage Range | 5-40 | Volts (TO-3 pack) |
| Collector Supply Voltage | 40 | Volts |
| Operating Temperature Range | —55 to 125 | °C |
| Thermal Resistance | 3.5 | °C/W TO-3 |

UNLESS OTHERWISE STATED THESE SPECIFICATIONS APPLY FOR $T_J$=25°C, $V_{IN}$=12 VOLTS, F=40KHz, AND TO-3 PACKAGE.

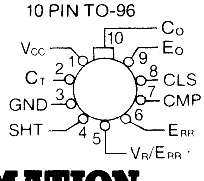
## ELECTRICAL CHARACTERISTICS

| PARAMETER | TEST CONDITIONS | TEST LIMITS MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **REFERENCE SECTION** | | MIN | TYP | MAX | UNITS |
| Reference Voltage | | 1.9 | 2 | 2.1 | Volts |
| Line Regulation | $V_{CC}$=6 to 35 Volts | | 0.055 | | %/V |
| Temperature Coefficient | $T_J$=0°C to 125°C | | 0.005 | | %/°C |
| **OSCILLATOR SECTION** | | | | | |
| Initial Frequency Accuracy | | | ±10 | | % |
| Line Regulation of Frequency | $V_{CC}$=6 to 35 Volts | | 0.06 | | %/Volt |
| Frequency Temperature Coefficient | $T_J$=0°C to 125°C | | 0.015 | | %/°C |
| Maximum Frequency | | | | 200 | KHz |
| Sawtooth Duty Cycle | | | 85 | | % |
| **ERROR AMPLIFIER SECTION** | | | | | |
| Input Offset Voltage | | | | 10 | mVolt |
| Transconductance | | | 10 | | mA/Volt |
| Output Sink/Source Current | | | 2 | | mA |
| Input Common Mode Range | | 1.5 | | 3.0 | Volts |
| **OUTPUT SECTION** | | | | | |
| Collector-Emitter Voltage | | | | 40 | Volts |
| Output Current | | 5 | | | Amperes |
| Saturation Voltage | Emitter grounded $I_O$=5A | | | 1 | Volts |
| Rise/Fall Time | $I_{OUT}$=5 amperes | | | 1 | μsec |
| Current Limit Sense Voltage | | | 1.7 | | Volts |
| Shutdown Threshold | | | 0.8 | | Volts |
| **POWER CONSUMPTION** | | | | | |
| Standby Current | | | 20 | | mA |

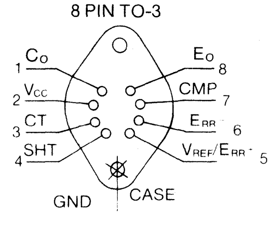
## PACKAGE OUTLINES

**(Top View)**

LAS 6300L
10 PIN TO-96



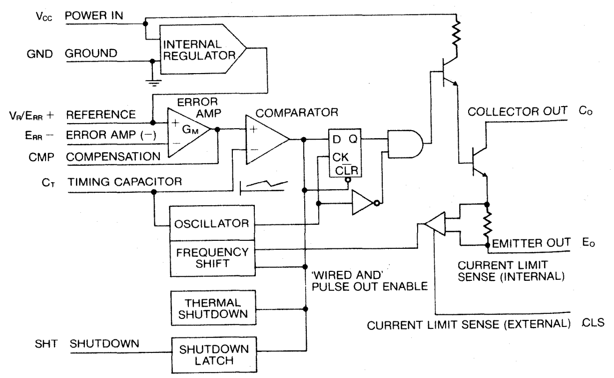

LAS 6300K
8 PIN TO-3



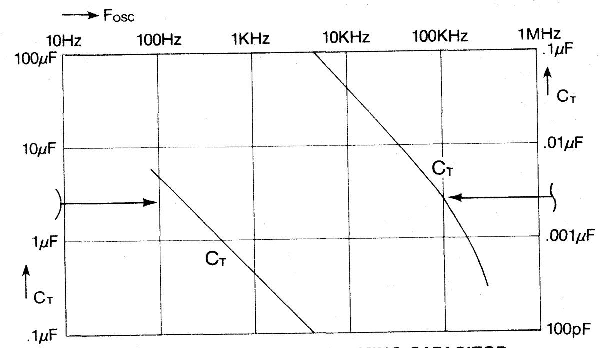

## ORDERING INFORMATION

| DEVICE TYPE | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|
| **LAS 6300K** | $13.00 | $11.50 | $10.25 | $9.50 | $8.75 | $7.50 | $7.00 | $6.60 |
| **LAS 6300L** | 10.00 | 9.25 | 8.50 | 8.00 | 7.50 | 6.75 | 5.90 | 5.35 |

# BLOCK DIAGRAM




# OPERATIONAL DATA




**OSCILLATOR FREQUENCY VS TIMING CAPACITOR**

# TYPICAL APPLICATIONS

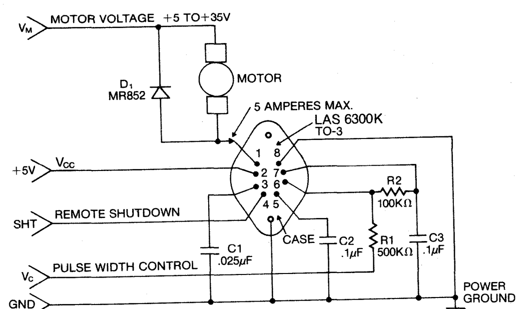



FIGURE 1: A FRACTIONAL HORSE POWER D.C. MOTOR SPEED CONTROL.

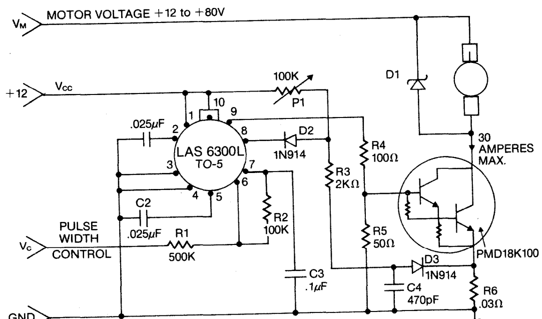
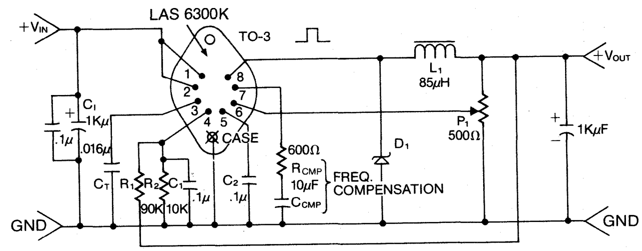



FIGURE 2: AN INTEGRAL HORSE POWER D.C. MOTOR SPEED CONTROL UTILIZING PMC63 AS CONTROL AND PMD18K100 AS THE POWER SWITCH.

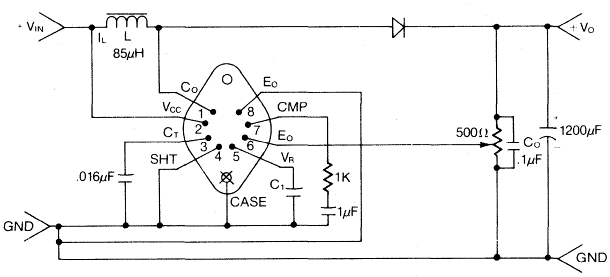
### 6300 APPLICATIONS STEP-DOWN CONVERTER




$F_{OSC}$ 30KC   $R_1/R_2$ $C_1$ OUTPUT OV SHUTDOWN

PIN 1, 2— $+V_{CC}$ INPUT 40 VOLTS MAX.
PIN 3—TIMING CAP. = .01µF FOR 30KC SWX FREQ.
PIN 4—SHUTDOWN INPUT, THRESHOLD—.7V, GROUNDING PIN ENABLES DEV. OUTPUT OVERVOLTAGE THRESHOLD IS .7V $(1+R_1/R_2)=7V$  $C_1$ DECOUPLES SWX NOISE
PIN 5— $V_{ERR}+/V_{REF}$—2V VOLTAGE REFERENCE FOR OUTPUT VOLTAGE  $C_2$ DECOUPLES SWX NOISE.
PIN 6—VOLTAGE FEEDBACK VOLTAGE = $V_{REF}$ IN EQ.
PIN 7—VOLTAGE LOOP COMPENSATION, UNITY GAIN CROSSOVER GOES AS $\frac{1}{R_{CMP}C_{CMP}}$ THIS SYSTEM IS VERY STABLE $F_O$=26HZ
PIN 8—EMITTER OUT (POWER OUT)
OUTPUT FILTER POLE=545HZ: TWO DECADES BELOW $F_{SWX}$

### STEP-UP DC/DC CONVERTER




PIN 1—POWER DEVICE COLLECTOR OUT
PIN 2—DEVICE $V_{CC}$
PIN 3—TIMING CAP. $F_{OSC}$=30KC for $C_T$=.016µF
PIN 4—SHUTDOWN (NOT USED)
PIN 5— $V_{ERR}+/V_{REF}$: VOLTAGE REFERENCE (2V); C BY PASSES SWX NOISE
PIN 6— $V_{ERR}-$: OUTPUT VOLTAGE FEEDBACK
PIN 7—VOLTAGE LOOP COMPENSATION
PIN 8—POWER DEVICE EMITTER OUT (GROUNDED)
OUTPUT FILTER POLE =500Hz

# APPLICATIONS DESCRIPTION

Figures 1 and 2 show variable speed D.C. motor control systems using the Lambda LAS 6300 switching regulator. Speed is controlled by pulse width modulating the average applied motor voltage at a frequency sufficient such that the motor's self inductance is the energy storage element (25 KHz in these applications). Motor frequency is described by the equation;

$F\ (motor) = K_e\ (T_{on}/T)\ V_m$ where,

$K_e$— relates frequency to motor D.C. voltage
$T_{on}/T$— pulse width modulation duty cycle (DC)
$V_m$— motor voltage.

The LAS 6300 controls the duty cycle ratio according to the equation;

$T_{on}/T = 2\ (V_{ref}\ (1+A_v) - 1.225V - V_c(A_v))$ where;

$T_{on}$— pulse width modulator 'on' time
T— system switching period (4.0µs in these applications)
$A_v$—error amplifier gain (R2/R1) of LAS 6300
$V_{ref}$— LAS 6300 reference voltage
1.225V— LAS 6300 lower oscillator ramp voltage
$V_C$— pulse width control voltage

Thus, control of $V_c$ will modulate the motor frequency (C3 is a high frequency by pass for the LAS 6300 error amplifier).

Current limit protection and remote shutdown have been implemented to protect the power switches and motors. In figure 1, currrent limit is internal to the LAS 6300 and no user programming is necessary. In figure 2 switch current is sensed by R6 (D3 and C4 remove the effect of R6's inductance) and feed to the LAS 6300's current limit sense pin via P1, R3 voltage divider ratio. When the voltage on pin 8 of the LAS 6300 reaches 1.7 volts the device output pulse will be terminated and frequency shift initiated (Note: D2 is necessary to allow the LAS 6300's internal current limit to functional in parallel with external sensing). In both applications current limit frequency shift limits average power dissipation in the power switch and alerts the user to fault conditions. Current limit is also useful for limiting maximum motor torque. Remote shutdown/restart may be implemented using the LAS 6300 SHT pin. Driving this pin's voltage above .8V will actuate the internal shutdown latch that inhibits device output pulses until power is removed or the SHT pin is shorted to common. If the D.C. resistance of Pin 1 (shutdown) to common, is less than 5000 ohms, operation of shutdown will be inhibited.

# SECTION II – SWITCHING TRANSISTORS

# LAMBDA PMS SERIES

## FEATURES

- Guaranteed and 100% tested for Is/b (second breakdown current) insuring maximum performance at high energy levels.
- Guaranteed and 100% tested for Es/b (second breakdown energy). Truly the most rugged and superior switching transistors available today.
- Guaranteed collector to emitter break-down sustaining voltage of 425 volts on all switching transitors.
- Guaranteed DC current gain greater than or equal to 5 on all the three switching transistors.
- Excellent thermal resistance on all switching transistors providing for more usable power and lower operating temperatures.
- All switching transistors are hermetically sealed and are subject to leak testing.
- Full CVD Glass Passivation on all switching transistors.

## DESCRIPTION

The PMS series of switching transistors are NPN Silicon Power Transistors particularly suited for line operated switching applications such as switching regulators, inverters, solenoid and relay drivers, motor controls and other high voltage power switching applications.

The devices are fabricated on a passivated epitaxial double diffused structure. The unique structure of the device incorporates multiple emitters which are connected to a common emitter electrode through dielectrically isolated polysilicon ballast resistors. These ballast resistors insure uniform current density in each emitter region and prevent hot spots, thus providing exceptional Is/b and Es/b ratings necessary for high-speed power switching applications.

Lambda'a switching transistors feature greatly enhanced forward and reverse second breakdown characteristics. However, successful application of these devices will require the use of proper negative base drive ($I_{B2}$) commensurate with adequate device fall time and storage time characteristics. Presumptions of interchangeability of these devices with any other similar devices should be approached with caution. Device characteristics with regard to switching speed and reverse energy capability are compromises, which are met with large variation in design goals from one manufacturer's part number to another. When in doubt, consult the factory for specific information regarding either device parametric performance or application information.

## ABSOLUTE MAXIMUM RATINGS

| RATING | SYMBOL | PMS3K425 | PMS5K425 | PMS8K425 | UNIT |
|---|---|---|---|---|---|
| Collector Emitter Voltage | $V_{CEO}$ | 425 | 425 | 425 | $V_{dc}$ |
| Collector Base Voltage | $V_{CBO}$ | 470 | 470 | 470 | $V_{dc}$ |
| Emitter Base Voltage | $V_{EBO}$ | 7 | 7 | 7 | $V_{dc}$ |
| Collector Current—Continuous | $I_C$ | 3 | 5 | 8 | $A_{dc}$ |
| Collector Current—Peak | $I_C$ | 3 | 5 | 8 | $A_{dc}$ |
| Base Current | $I_B$ | 1 | 2 | 3 | $A_{dc}$ |
| Total Internal Power Dissipation | $P_D$ @ $T_C = 0°C$ | 150 | 150 | 225 | Watts |
| | Derate $T_C > 0°C$ | 1 | 1 | 1.49 | W/°C |
| Temperature Range | | | | | |
| Operating | $T_J$ | −65 to +150 | −65 to +150 | −65 to +150 | °C |
| Storage | $T_{STG}$ | −65 to +200 | −65 to +200 | −65 to +200 | °C |
| Thermal Resistance | $R_{\theta JC}$ | 1 | 1 | 0.67 | °C/W |

## ORDERING INFORMATION

| DEVICE TYPE | VOLTAGE RATING Volts | CURRENT RATING Amps | PRICE & QUANTITY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|
| PMS3K425 | 425 | 3 | $3.35 | $2.70 | $2.40 | $2.35 |
| PMS5K425 | 425 | 5 | 4.30 | 3.45 | 3.10 | 3.05 |
| PMS8K425 | 425 | 8 | 9.30 | 7.45 | 6.70 | 6.55 |

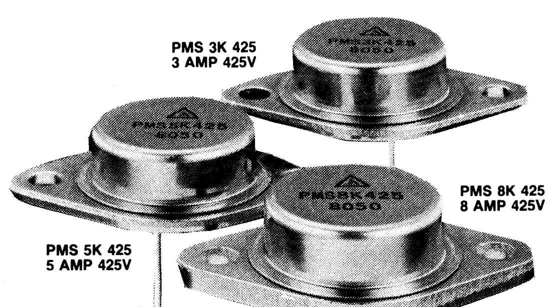
Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.

# ELECTRICAL CHARACTERISTICS

All parameters are guaranteed at $T_J$ of 0° C to 150° C, unless otherwise specified.

| DEVICE TYPE | TEST | | SYMBOL | TEST CONDITIONS | | MIN. | MAX. | UNITS | NOTES |
|---|---|---|---|---|---|---|---|---|---|
| PMS3K425<br>PMS5K425<br>PMS8K425 | Collector Emitter Saturation Voltage | ON CHARACTERISTICS | $V_{CE(Sat)}$ | $\frac{I_C}{I_B}=5$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | | 2.5 | Vdc | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Base Emitter Saturation Voltage | ON CHARACTERISTICS | $V_{BE(Sat)}$ | $\frac{I_C}{I_B}=5$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | | 3.0 | Vdc | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | DC Current Gain | ON CHARACTERISTICS | $h_{FE}$ | $V_{CE}$=3Vdc | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | 5 | 25 | | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Forward Bias Second Breakdown Current | ON CHARACTERISTICS | $I_{s/b}$ | $V_{CE}$=100 Vdc 1 second nonrepetitive pulse | | 1 | | Adc | 3 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Second Breakdown Energy | ON CHARACTERISTICS | $E_{s/b}$ | $V_{CC}$=400Vdc<br>$\frac{I_C}{I_{B1}}=5$<br>L=1mH<br>$I_{B1}=I_{B2}$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | 4.5<br>12.5<br>32 | | mJ | 3 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Collector Emitter Breakdown Voltage (Base Open) | | $V_{(BR)CEO}$ | $I_C$=100mAdc | | 425 | | Vdc | 1, 2 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Collector Emitter Sustaining Voltage | OFF CHARACTERISTICS | $V_{(BR)\,CER}$ | $I_C$=100mAdc<br>$R_{BE}$=100Ω | | 425 | | Vdc | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Base Emitter Leakage Current | OFF CHARACTERISTICS | $I_{EBO}$ | $V_{EB}$=7Vdc | | | 1 | mAdc | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Collector Emitter Leakage Current | OFF CHARACTERISTICS | $I_{CER}$ | $V_{CE}$=450Vdc<br>$R_{BE}$=100Ω | | | 3 | mAdc | 1 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Rise Time $R_L$ is non-inductive | DYNAMIC CHARACTERISTICS | $t_r$ | $V_{CC}$=400Vdc<br>$\frac{I_C}{I_{B1}}=5$<br>$I_{B1}=I_{B2}$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | | 0.75 | µs | 4 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Storage Time $R_L$ is non-inductive | DYNAMIC CHARACTERISTICS | $t_s$ | $V_{CC}$=400Vdc<br>$\frac{I_C}{I_{B1}}=5$<br>$I_{B1}=I_{B2}$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | | 1.5 | µs | 4 |
| PMS3K425<br>PMS5K425<br>PMS8K425 | Fall Time $R_L$ is non-inductive | DYNAMIC CHARACTERISTICS | $t_f$ | $V_{CC}$=400Vdc<br>$\frac{I_C}{I_{B1}}=5$<br>$I_{B1}=I_{B2}$ | $I_C$=3Adc<br>$I_C$=5Adc<br>$I_C$=8Adc | | 0.3 | µs | 4 |

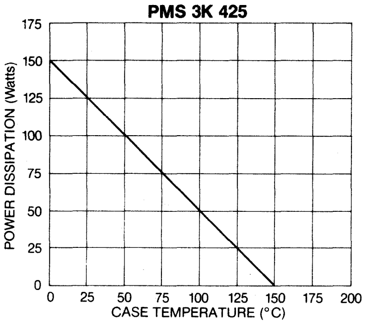
NOTES:
1. Pulse tested: pulse width is less than or equal to 300 microseconds and duty cycle is less than or equal to 2%.
2. Tj = 25° C
3. Ta = 25° C
4. Tc = 25° C



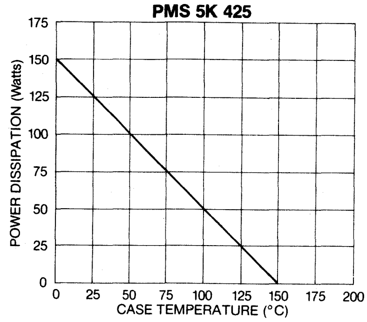
# OPERATIONAL DATA

## POWER DERATING

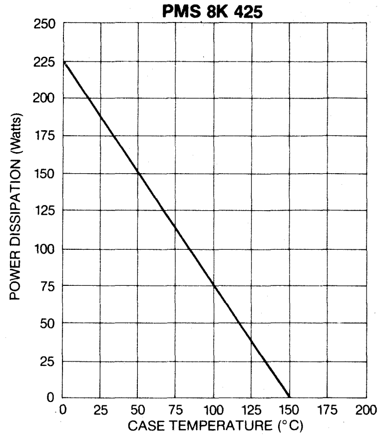
PMS 3K 425




PMS 5K 425

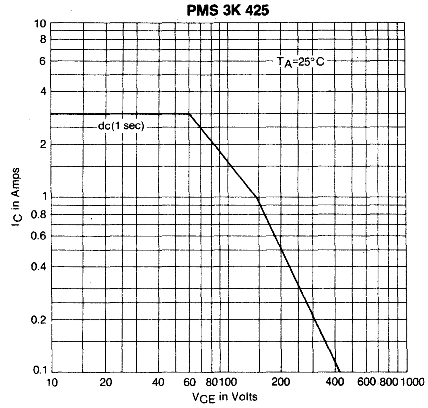



PMS 8K 425




## SAFE OPERATING AREA

PMS 3K 425

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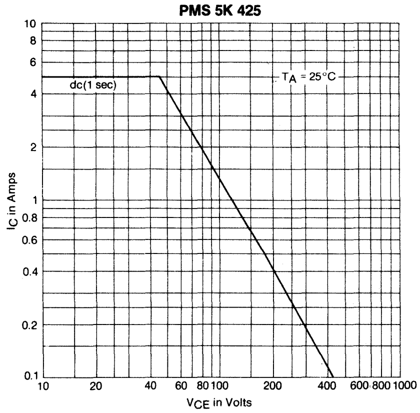


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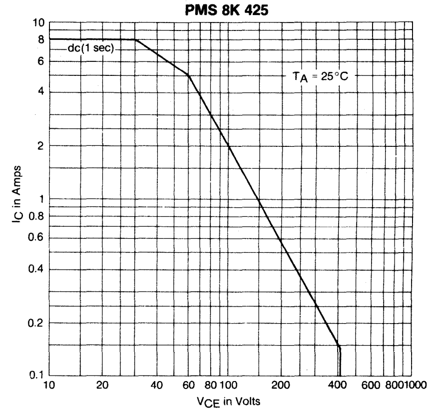
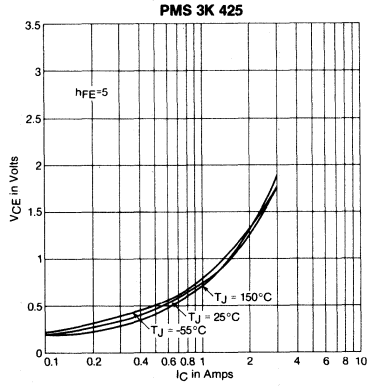
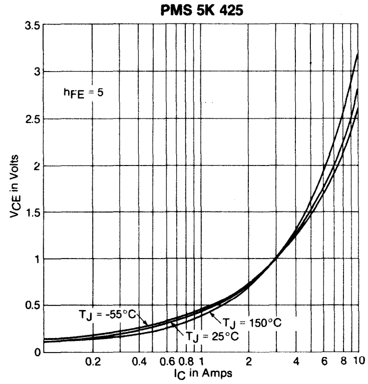



## $V_{CE}$ (Sat) VERSUS COLLECTOR CURRENT

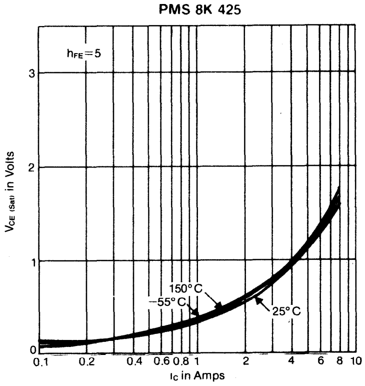
PMS 3K 425




PMS 5K 425

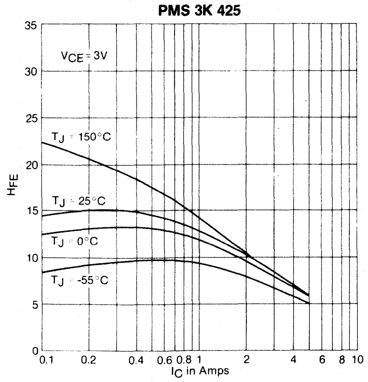



PMS 8K 425

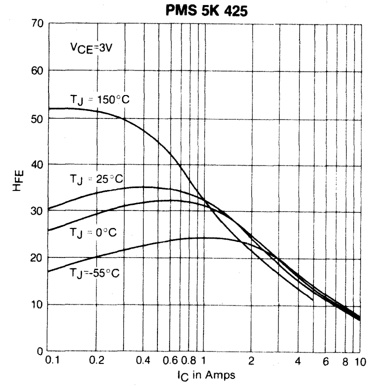



## DC COLLECTOR CURRENT GAIN VERSUS COLLECTOR CURRENT

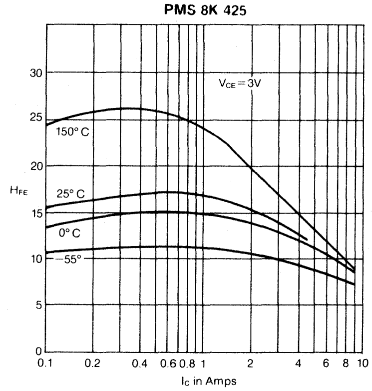
PMS 3K 425




PMS 5K 425

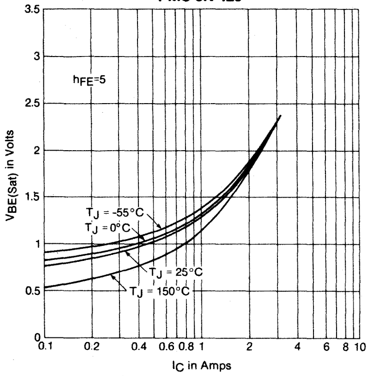



PMS 8K 425

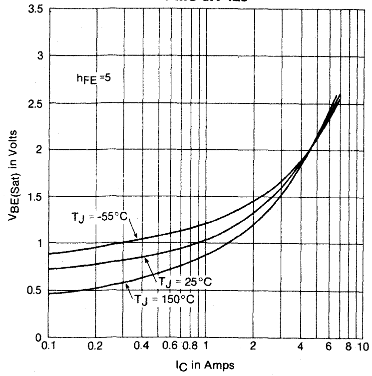


# $V_{BE}$ (Sat) VERSUS COLLECTOR CURRENT

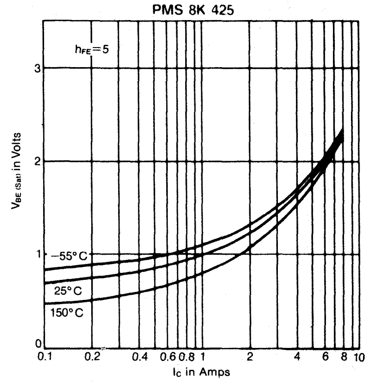
PMS 3K 425




PMS 5K 425

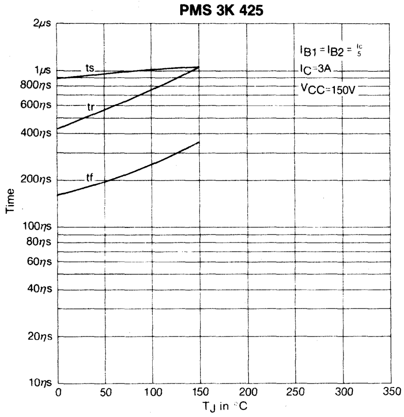



PMS 8K 425

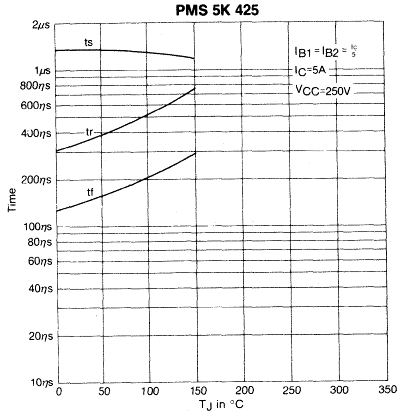



# DYNAMIC CHARACTERISTICS VERSUS JUNCTION TEMPERATURE

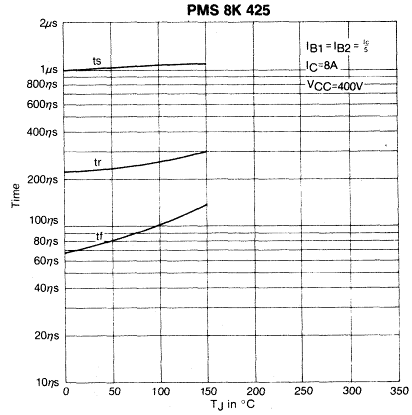
PMS 3K 425




PMS 5K 425

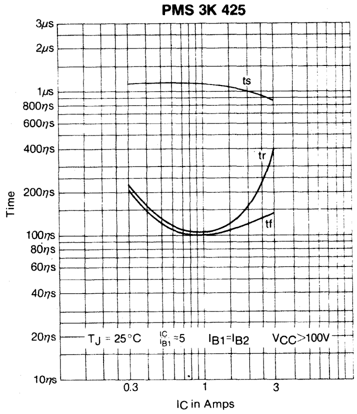



PMS 8K 425

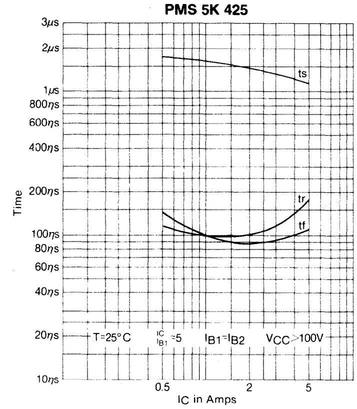



# DYNAMIC CHARACTERISTICS VERSUS COLLECTOR CURRENT

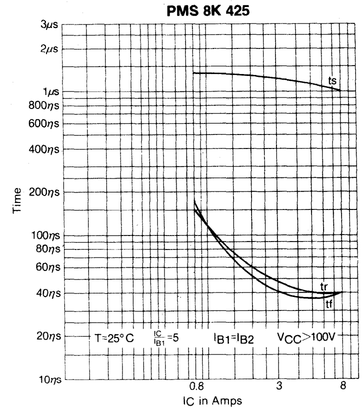
PMS 3K 425




PMS 5K 425

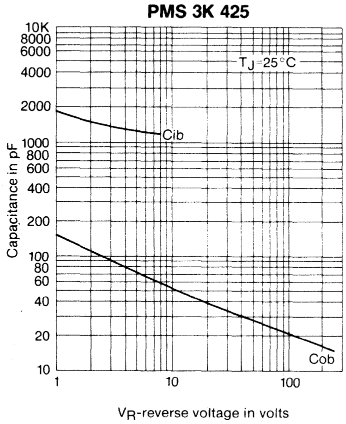



PMS 8K 425

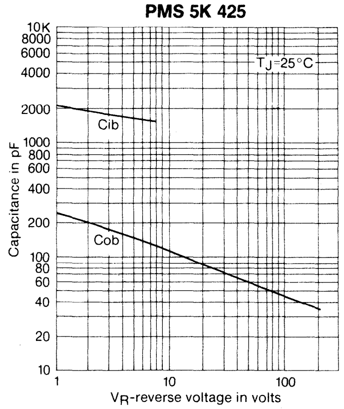



# CAPACITANCE VERSUS REVERSE VOLTAGE

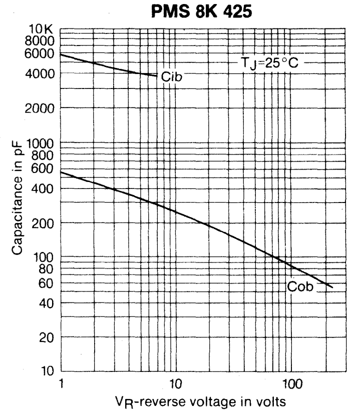
PMS 3K 425



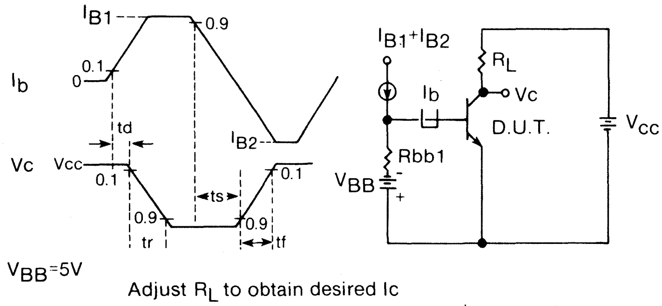

PMS 5K 425




PMS 8K 425



## SWITCHING TEST CIRCUIT

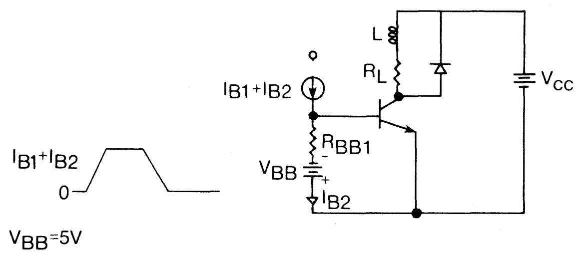



Adjust $R_L$ to obtain desired Ic

Adjust $I_{B1}+I_{B2}$, $R_{BB1}$ to obtain $I_{b1}=\frac{I_c}{5}=I_{B2}$

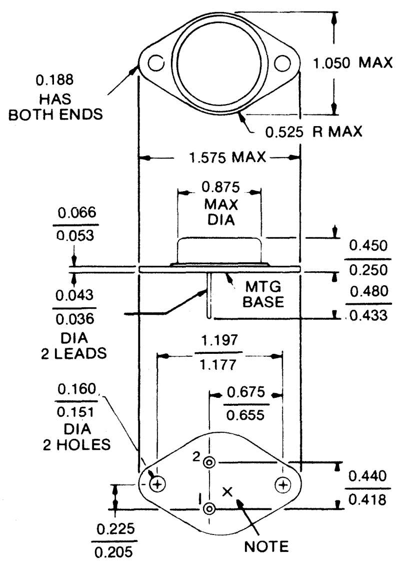
Adjust $I_{B1}+I_{B2}$ to 0.5% Duty cycle with Pulse Rise and fall times less than 100 ηs

## $E_{S/B}$ TEST CIRCUIT




# PACKAGE OUTLINE

### PMS 3K 425, PMS 5K 425

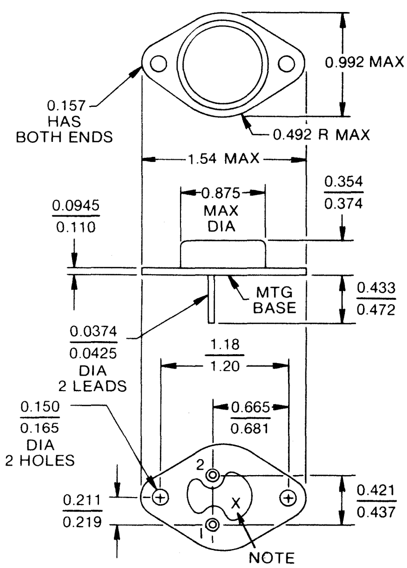



### TO-3
### 3 TERMINAL (STEEL)

| PIN | FUNCTION |
|---|---|
| 1 | BASE |
| 2 | EMITTER |
| CASE | COLLECTOR |

NOTE (X): CASE TEMPERATURE MEASURED AT THIS POINT

### PMS 8K 425



# SECTION III – SWITCHING DARLINGTONS

# LAMBDA PMD 20K & 25K SERIES

## SWITCHING POWER DARLINGTONS

## FEATURES

- Full CVD glass passivation on all Switching Darlingtons.
- Guaranteed $h_{FE}$ greater than 300 at 10 amps.
- Guaranteed collector to emitter breakdown sustaining voltages of 200, 150, and 120 Volts for 5 and 10 amp Switching Darlingtons.
- Guaranteed and 100% tested for $I_{s/b}$ (Secondary Breakdown Current) insuring Maximum performance at high energy levels.
- Guaranteed secondary energy of 1.6 millijoules with a Baker Clamp Circuit.
- Excellent thermal resistance ($\theta_{JC}$) on all NPN Switching Darlingtons providing for more usable power and lower operating temperatures.
- Built-in speed up diode for fast turn-off with negative base drive.
- All NPN Switching Darlingtons are hermetically sealed TO-3 packages and subject to fine and gross leak testing.

## DESCRIPTION

The PMD-20K and PMD-25K series of devices are three terminal NPN silicon Switching Power Darlingtons. These monolithic devices are double-diffused epitaxial structures with built-in base-emitter shunt resistors, and they have been designed to switch at frequencies up to 30kHz. These devices are CVD glass passivated to improve reliability.

These darlingtons are designed to be used in power applications such as in Switching Regulators and Inverters, and can be driven directly by IC's with no negative base drive required for turn off. Internal diode protection (D1) of the darlington configuration is built into the structure to limit the device power dissipation during negative overshoot. Diode D2 is built-in to assist the reduction of device turn-off when negative base drive is used.

The two different series of Switching Power Darlington devices are available in sustaining voltages of 120, 150, and 200 volts at a power dissipation level of 150 watts. The devices feature high current gain (typically 1000 at $I_C = 10$ amps for the PMD-20K, and 1000 at $I_C = 5$ amps for the PMD-25K). All darlington devices are hermetically sealed in steel TO-3 packages, providing high reliability and low thermal resistance when used with appropriate heat sinks.

## ABSOLUTE MAXIMUM RATINGS

| RATING | SYMBOL | PMD 20K 200 | PMD 25K 200 | PMD 20K 150 | PMD 25K 150 | PMD 20K 120 | PMD 25K 120 | UNIT |
|---|---|---|---|---|---|---|---|---|
| Collector-Emitter Voltage | $V_{CEO}$ | 200 | | 150 | | 120 | | $V_{dc}$ |
| Collector-Base Voltage | $V_{CBO}$ | 200 | | 150 | | 120 | | $V_{dc}$ |
| Emitter-Base Voltage | $V_{EBO}$ | 2 | | 2 | | 2 | | $V_{dc}$ |
| Collector Current Cont. | $I_C$ | 14 | 9 | 14 | 9 | 14 | 9 | $A_{dc}$ |
| Peak | $I_C$ | 20 | 12 | 20 | 12 | 20 | 12 | $A_{dc}$ |
| Base Current | $I_B$ | 0.5 | 0.2 | 0.5 | 0.2 | 0.5 | 0.2 | $A_{dc}$ |
| Total Internal Power Dissipation | $P_D$ @ $T_C = 0°C$ | 150 | | 150 | | 150 | | WATTS |
| | >0°C | Derate at 1 Watt/°C | | | | | | |
| Temp. Range Oper. | Tj | −65 to + 150 | | | | | | °C |
| Storage | $T_{stg}$ | −65 to + 200 | | | | | | °C |
| Thermal Resistance | $R_{\theta JC}$ | 1.0 | | 1.0 | | 1.0 | | °C/WATT |

## ORDERING INFORMATION

| DEVICE TYPE | VOLTAGE RATING | CURRENT RATING | QTY 1-24 | QTY 25-49 | QTY 50-99 | QTY 100-249 | QTY 250-499 | QTY 500-999 | QTY 1000-2499 | QTY 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| PMD 20K 120 | 120V | 14A | $8.10 | $7.20 | $6.61 | $6.39 | $5.76 | $4.85 | $4.41 | $3.97 |
| PMD 20K 150 | 150V | 14A | 9.00 | 8.00 | 7.35 | 7.10 | 6.40 | 5.39 | 4.90 | 4.41 |
| PMD 20K 200 | 200V | 14A | 11.00 | 9.90 | 9.00 | 8.70 | 7.80 | 6.60 | 6.00 | 5.40 |
| PMD 25K 120 | 120V | 9A | 5.40 | 4.80 | 4.45 | 4.32 | 3.87 | 3.27 | 2.97 | 2.67 |
| PMD 25K 150 | 150V | 9A | 6.00 | 5.45 | 4.95 | 4.80 | 4.30 | 3.63 | 3.30 | 2.97 |
| PMD 25K 200 | 200V | 9A | 7.20 | 6.60 | 6.00 | 5.80 | 5.20 | 4.40 | 4.00 | 3.60 |

Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.

# PMD 20K, 25K SERIES

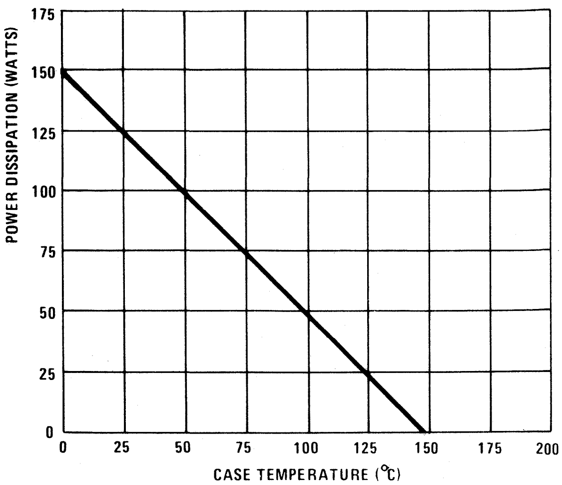
## PERFORMANCE SPECIFICATIONS

**PMD-20K AND 25K SERIES**
**ALL PARAMETERS ARE GUARANTEED AT A $T_J$ OF 0°C TO 150°C, UNLESS OTHERWISE NOTED**

| DEVICE TYPE | TEST | SYMBOL | | TEST CONDITIONS | MIN. | MAX. | UNITS | NOTE |
|---|---|---|---|---|---|---|---|---|
| PMD-20K-SERIES<br>PMD-25K-SERIES | Collector Emitter Saturation Voltage | $V_{CE(Sat)}$ | ON Characteristics | $I_C$=10Adc; $I_B$=50MAdc<br>$I_C$=5Adc; $I_B$=25MAdc | | 1.7 | Vdc | 1,2 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | | | | $I_C$=10Adc; $I_B$=50MAdc<br>$I_C$=5Adc; $I_B$=25MAdc | | 1.8 | | 1 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Base Emitter Turn-On Voltage | $V_{BE(On)}$ | | $I_C$=10Adc<br>$I_C$=5Adc; $V_{CE}$=3Vdc | | 2.6 | Vdc | 1,2 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | | | | $I_C$=10Adc<br>$I_C$=5Adc; $V_{CE}$=3Vdc | | 2.8 | | 1 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Base-Emitter Saturation Voltage | $V_{BE(Sat)}$ | | $I_C$=10Adc; $I_B$=50MAdc<br>$I_C$=5Adc; $I_B$=25MAdc | | 2.6 | Vdc | 1,2 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | | | | $I_C$=10Adc; $I_B$=50MAdc<br>$I_C$=5Adc; $I_B$=25MAdc | | 2.8 | | 1 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | DC Current Gain | $h_{FE}$ | | $I_C$=10Adc; $V_{CE}$=3Vdc<br>$I_C$=5Adc; $V_{CE}$=3Vdc | 300 | | | 1 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Forward Bias Second Breakdown Collector Current | $I_{s/b}$ | | $V_{CE}$=26V<br>1 Second, non-repetitive pulse<br>$T_A$=25°C | 5.8 | | Adc | 1 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Second Breakdown Energy | $E_{s/b}$<br>$T_A$=25°C | | $I_C$=8.43Adc<br>$I_C$=6.7Adc; L=45uH | 1.6 | | Milli-Joule | |
| PMD-20K-120<br>PMD-25K-120 | Collector Emitter Breakdown Voltage (Base Open) | $V_{(BR)CEO}$ | OFF Characteristics | $I_C$=100MAdc<br>$I_B$=0 | 120 | | Vdc | 1,2 |
| PMD-20K-150<br>PMD-25K-150 | | | | | 150 | | | |
| PMD-20K-200<br>PMD-25K-200 | | | | | 200 | | | |
| PMD-20K-120<br>PMD-25K-120 | Collector Emitter Sustaining Voltage | $V_{(BR)CER}$ (Sus) | | $I_C$=100MAdc<br>$R_{BE}$=2.2K ohms | 120 | | Vdc | 1 |
| PMD-20K-150<br>PMD-25K-150 | | | | | 150 | | | |
| PMD-20K-200<br>PMD-25K-200 | | | | | 200 | | | |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Emitter Base Leakage Current | $I_{EBO}$ | | $V_{EB}$=0.9Vdc; $I_C$=0 | | 70 | MAdc | 1 |
| PMD-20K-120<br>PMD-25K-120 | Collector Emitter Leakage Current (Base Open) | $I_{CEO}$ | | $V_{CE}$=80Vdc | | 0.5 | MAdc | 2 |
| PMD-20K-150<br>PMD-25K-150 | | | | $V_{CE}$=100Vdc | | | | |
| PMD-20K-200<br>PMD-25K-200 | | | | $V_{CE}$=150Vdc | | | | |
| PMD-20K-120<br>PMD-25K-120 | Collector Emitter Leakage Current | $I_{CER}$ | | $V_{CE}$=80Vdc; $R_{BE}$=2.2K ohms | | 5 | MAdc | 1 |
| PMD-20K-150<br>PMD-25K-150 | | | | $V_{CE}$=100Vdc; $R_{BE}$=2.2K ohms | | | | |
| PMD-20K-200<br>PMD-25K-200 | | | | $V_{CE}$=150Vdc; $R_{BE}$=2.2K ohms | | | | |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Non-Saturated Switching Times Rise Time | $t_r$ | DYNAMIC Characteristics | $I_C$=10Adc, $V_{CC}$=30V<br>$I_C$=5Adc, $V_{CC}$=30V | | 0.3 | uS | 2,3 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Turn-On Time | $t_{on}$ | | $I_C$=10Adc, $V_{CC}$=30V<br>$I_C$=5Adc, $V_{CC}$=30V | | 0.5 | uS | 2,3 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Fall Time | $t_{fall}$ | | $I_C$=10Adc, $V_{CC}$=30V<br>$I_C$=5Adc, $V_{CC}$=30V | | 0.8 | uS | 2,3 |
| PMD-20K-SERIES<br>PMD-25K-SERIES | Turn-Off Time | $t_{off}$ | | $I_C$=10Adc, $V_{CC}$=30V<br>$I_C$=5Adc, $V_{CC}$=30V | | 1.0 | uS | 2,3 |

NOTES: (1) Pulse Tested: Pulse Width is less than or equal to 300 uSec. and Duty Cycle is less than or equal to 2.0%.
(2) $T_J$=25°C
(3) See A.C. test circuit.

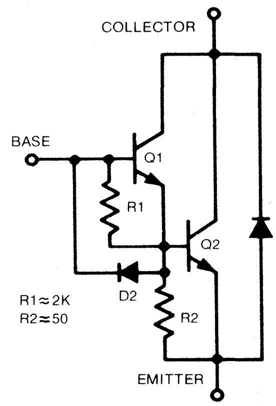
# PMD 20K, 25K SERIES
## SWITCHING POWER DARLINGTONS




**POWER DERATING**

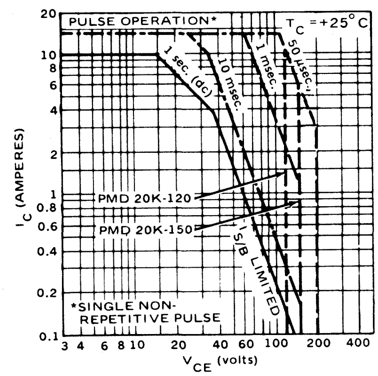
## SCHEMATIC DIAGRAM

MONOLITHIC CONSTRUCTION

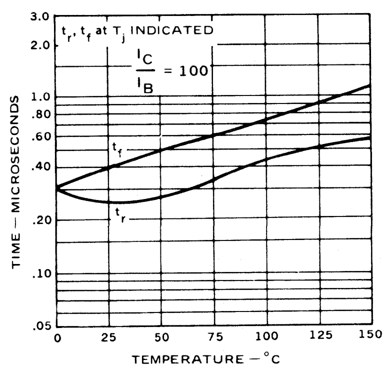



For higher efficiencies in DC-DC switching converters, an external fast recovery diode should be connected in parallel to D1.

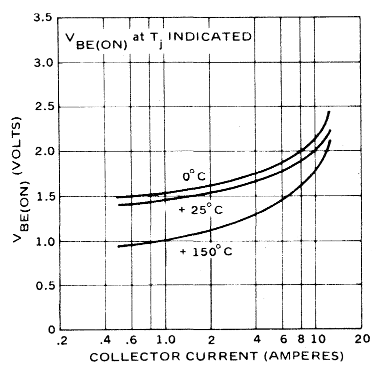
## PMD 20K SERIES



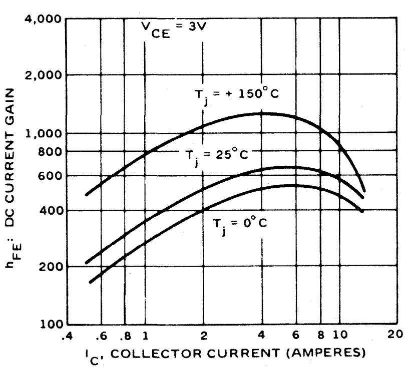

**SAFE OPERATING AREA**



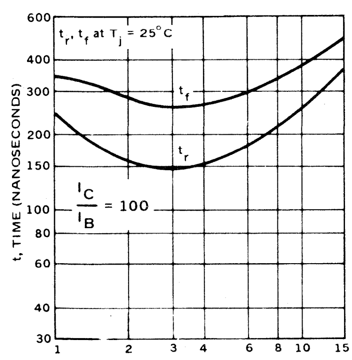

**DYNAMIC CHARACTERISTICS VERSUS JUNCTION TEMPERATURE**



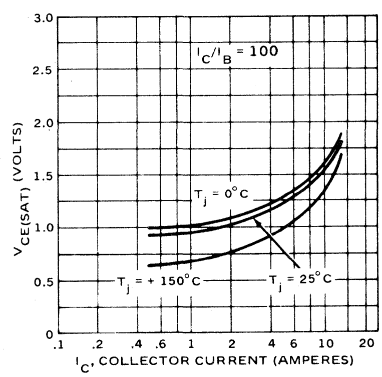

**$V_{BE(ON)}$ VERSUS COLLECTOR CURRENT AND JUNCTION TEMP**




**DC CURRENT GAIN VERSUS COLLECTOR CURRENT**




**DYNAMIC CHARACTERISTICS VERSUS COLLECTOR CURRENT**

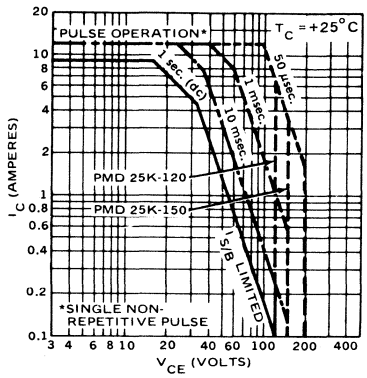



**$V_{CE(SAT)}$ VERSUS COLLECTOR CURRENT AND JUNCTION TEMP**

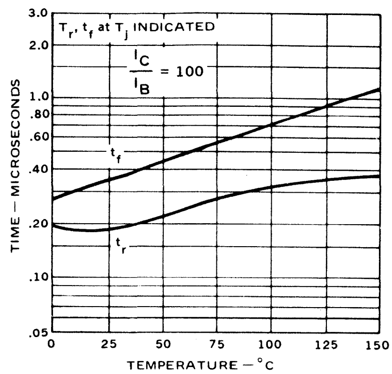
# PMD 20K, 25K SERIES

## SWITCHING POWER DARLINGTONS

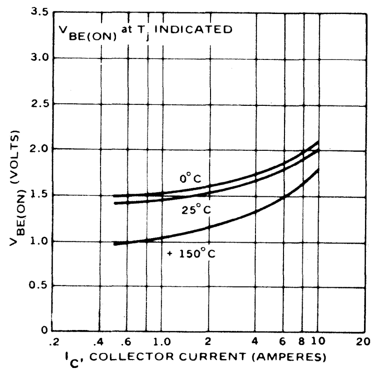
### PMD 25K SERIES



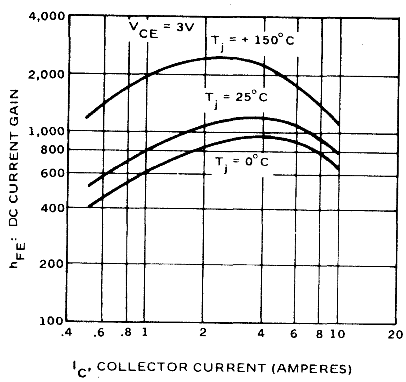

SAFE OPERATING AREA



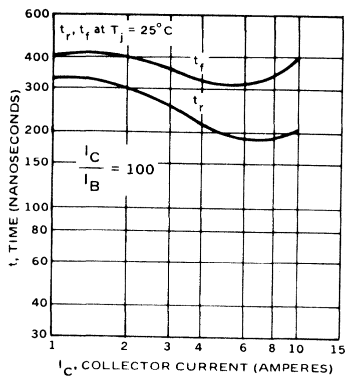

DYNAMIC CHARACTERISTICS VERSUS JUNCTION TEMPERATURE



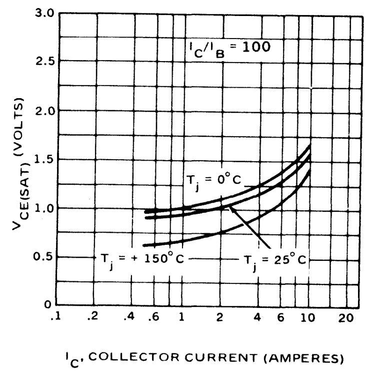

$V_{BE(ON)}$ VERSUS COLLECTOR CURRENT AND JUNCTION TEMP



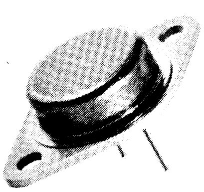

$V_{CE(SAT)}$ VERSUS COLLECTOR CURRENT

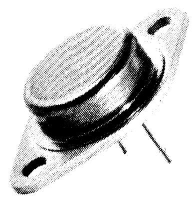



DYNAMIC CHARACTERISTICS VERSUS COLLECTOR CURRENT

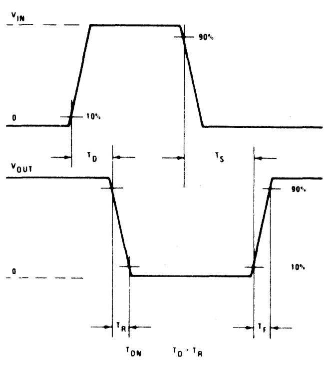


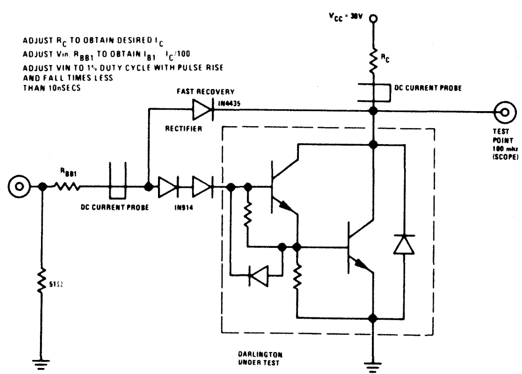

DC CURRENT GAIN VERSUS COLLECTOR CURRENT





## A.C. TEST CIRCUIT



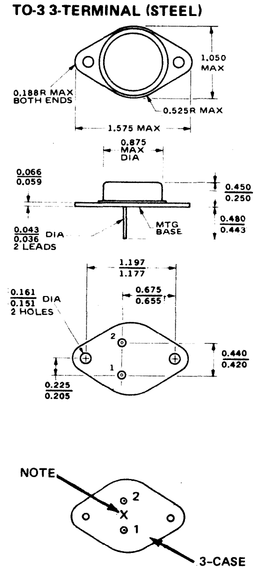




SWITCHING TIMES TEST CIRCUIT

Switching times are specified only under the condition that the device under test is not allowed to enter classical saturation. This condition is insured by the use of a Baker Clamp as shown above. A Baker Clamp insures that the base-collector junciton of the D.U.T. is never forward biased, under worst case temperature and drive conditions.

# OUTLINE DRAWING

**PMD 20K, 25K SERIES**
**TO-3 3-TERMINAL (STEEL)**




| PIN | FUNCTION |
|---|---|
| 1 | BASE |
| 2 | EMITTER |
| CASE | COLLECTOR |

NOTE (X): Case temperature measured at this point.

# PART II – LINEAR COMPONENTS
# SECTION I – VOLTAGE REGULATORS

# LAS 723, 723B SERIES

## FEATURES

- The only low-noise, temperature-compensated diode reference voltage in the industry 2.5V ±5%.
- Guaranteed line regulation:
  - LAS-723: 0.020% $V_O$/V
  - LAS-723B: 0.008% $V_O$/V
- Guaranteed load regulation:
  - LAS-723: 0.05% $V_O$ @ 25mA
  - LAS-723B: 0.05% $V_O$ @ 25mA
- Guaranteed input-output differential: +2.0 volts
- Guaranteed temperature coefficient: 0° C to +125° C—0.015% $V_O$/° C
- Guaranteed ripple attenuation:
  - LAS-723: 60dB
  - LAS-723B: 69dB
- Guaranteed thermal resistance, junction to ambient: 150° C/W

## DESCRIPTION

The LAS-723 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 150 milliamperes of load variation, internal current limiting, and thermal shutdown on the chip under most operating conditions. Hermetically sealed TO-96 packages are employed for high reliability and low thermal resistance. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-723 series. This, coupled to a very low output impedance, insures superior performance and load regulation. A very low reference voltage of +2.5 volts ±5% compared to +7.0 volts ±5%, which is standard for similar devices, allows the LAS-723 series a much greater output voltage range without the use of external components.

The LAS-723 series of ten-terminal regulators is available in an input voltage range from +5 to +40 volts, and an output voltage of +2.63 to +38 volts. The high voltage version of this device, the LAS-723B, is available in input voltage ranges from +5 to +50 volts, and output voltage ranges from +2.63 to +48 volts. Both devices offer low standby current drain, and high ripple rejection. When additional current capability is required, series NPN or PNP transistors may be added.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage<br>LAS-723<br>LAS-723B | $V_{IN}$ | <br>0<br>0 | <br>40[1]<br>50[1] | Volts |
| Input/Output Differential<br>LAS-723<br>LAS-723B | $V_{IN}$-$V_{OUT}$ | <br>0<br>0 | <br>38[1]<br>48[1] | Volts |
| Power Dissipation @ $T_c \leq 25°C$ | $P_D$ | | 0.8[1] [2] | Watts |
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | | 150 | ° C/Watt |
| Operating Junction Temperature Range | $T_J$ | 0 | 150 | ° C |
| Storage Temperature Range | $T_{STG}$ | .65 | 150 | ° C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | ° C |

[1] The maximum input voltage of the LAS-723 Series is limited by the maximum input-output differential, maximum power dissipation, and the maximum current limit-safe operating area, whichever is less.
[2] For operation above 25° C $T_{CASE}$, derate @ 6.7 mW/° C.

## REGULATOR PERFORMANCE SPECIFICATIONS – LAS 723, 723B

$V_{IN}$=+V=10 VOLTS; —V=0 VOLTS; $V_O$=+5 VOLTS; $I_O$=1MA; $R_{SC}$=0; UNLESS OTHERWISE SPECIFIED.

| PARAMETER | SYMBOL | TEST CONDITIONS $V_{IN}$ | TEST CONDITIONS $I_O$ | TEST CONDITIONS $T_J$ | LAS 723 MIN. | LAS 723 MAX. | LAS 723B MIN. | LAS 723B MAX. | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Output Voltage | $V_O$ | $V_{IN}$=$V_O$+2.0V | 25mA | 0-125° C | 2.63[1] | 38 | 2.63[1] | 48 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | $V_{IN}$=$V_O$+2.0V | 150mA | 0-125° C | 2.0 | | 2.0 | | volts |
| Output Current | $I_O$ | | | 25° C | | 150 | | 150 | mA |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_O$=+3.0V | | 0-125° C | | 0.020 | | 0.008[7] | % $V_O$/V[3] |
| | | $V_{IN}$=+5 to +40V | | | | | | 0.02[8] | % $V_O$/V[3] |
| Load Regulation[2] | $REG_{(LOAD)}$ | | 1 to 25mA | 0-125° C | | 0.05 | | 0.05 | % $V_O$ |
| | | | 1 to 100mA | 0-125° C | | 0.15 | | 0.15 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_{IN}$=40V | | 25° C | | 4.2 | | 4.2[9] | mA |
| Reference Voltage | $V_R$ | | | 25° C | 2.375 | 2.625 | 2.375 | 2.625 | volts |
| Reference Output Current | $I_R$ | $V_O$=10V | | 25° C | | 3 | | 3 | mA |
| Temperature Coefficient | $T_C$ | | | 0-125° C | | 0.015 | | 0.015 | % $V_O$/° C[4] |
| Ripple Attenuation | $R_A$ | $V_{IN}$=+10V+1Vrms | | 0-125° C | 60 | | 69 | | dB |
| Output Noise Voltage[5] | $V_N$ | | | 0-125° C | | 50 | | 50 | μVrms |
| Current Limit Sense Voltage[6] | $V_S$ | | | 25° C | 0.62 | 0.74 | 0.62 | 0.73 | volts |
| Error Amplifier Voltage Gain | $A_V$ | | | 25° C | 4000 | | 4000 | | V/V |

[1] $V_O = V_R (1 + R1/R2)$
R1 = Resistance from output to inverting input.
R2 = Resistance from inverting input to common.
[2] Instantaneous measurement, average chip temperature changes must be accounted for separately.
[3] Percentage times $V_O$; per volt change in $V_{IN}$.
[4] Percentage times $V_O$; per ° C change in temperature.
[5] BW = 10Hz – 100KHz.
[6] $R_{SC}$ = 1KΩ
[7] $V_{IN}$ = +5 to 50 volts
[8] $V_{IN}$ = +10 to 20 volts; $I_{OUT}$ = 25mA
[9] $V_{IN}$ = 50 volts

## ORDERING INFORMATION

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-99 | 100-249 | 250-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|
| **LAS 723** | 2.63-38 | 150mA | $1.15 | $1.04 | $ .98 | $ .92 | $ .86 |
| **LAS 723B** | 2.63-48 | 150mA | 1.19 | 1.08 | 1.02 | .96 | .90 |
| **LAS 1000** | 2.63-38 | 150mA | 1.39 | 1.24 | 1.17 | 1.10 | 1.03 |
| **LAS 1100** | 2.63-48 | 150mA | 1.64 | 1.43 | 1.40 | 1.33 | 1.23 |

# LAS 1000, 1100 SERIES

## 150 mA POSITIVE REGULATORS

## FEATURES

- The only low-noise, temperature-compensated diode reference voltage in the industry 2.5V ± 5%.
- Guaranteed line regulation:
  LAS-1000: 0.020% $V_O$/V
  LAS-1100: 0.008% $V_O$/V
- Guaranteed load regulation:
  LAS-1000: 0.05% $V_O$ @ 25mA
  LAS-1100: 0.05% $V_O$ @ 25mA
- Guaranteed input-output differential: +2.0 volts
- Guaranteed temperature coefficient:
  0° C to +125° C—0.015% $V_O$/° C
- Guaranteed ripple attenuation:
  LAS-1000: 60dB
  LAS-1100: 69dB
- Guaranteed thermal resistance, junction to ambient: 150° C/W

## DESCRIPTION

The LAS-1000 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 150 milliamperes of load variation, internal current limiting, and thermal shutdown on the chip under most operating conditions. Hermetically sealed TO-96 packages are employed for high reliability and low thermal resistance. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-1000 series. This, coupled to a very low output impedance, insures superior performance and load regulation. A very low reference voltage of +2.5 volts ±5% compared to +7.0 volts±5%, which is standard for similar devices allows the LAS-1000 series a much greater output voltage range without the use of external components. The addition of remote electronic/shutdown on this device type allows the designer a great deal of flexibility in design and applications.

The LAS-1000 series of ten-terminal regulators is available in an input voltage range from +5 to +40 volts, and an output voltage of +2.63 to +38 volts. The high voltage version of this device, the LAS-1100, is available in input voltage ranges from +5 to +50 volts, and output voltage ranges from +2.63 to +48 volts. Both devices offer low standby current drain, and high ripple rejection. When additional current capability is required, series NPN or PNP transistors may be added.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage<br>LAS-1000<br>LAS-1100 | $V_{IN}$ | 0<br>0 | 40[1]<br>50[1] | Volts |
| Input/Output Differential<br>LAS-1000<br>LAS-1100 | $V_{IN}$-$V_{OUT}$ | 0<br>0 | 38[1]<br>48[1] | Volts |
| Power Dissipation<br>@ $T_c \leq 25°$ C | $P_D$ | | 0.8[1] [2] | Watts |
| Thermal Resistance<br>Junction to Ambient | $\theta_{JA}$ | | 150 | ° C/Watt |
| Operating Junction<br>Temperature Range | $T_J$ | 0 | 150 | ° C |
| Storage Temperature<br>Range | $T_{STG}$ | —65 | 150 | ° C |
| Lead Temperature<br>(Soldering, 60 Seconds<br>Time Limit) | $T_{LEAD}$ | | 300 | ° C |

[1] The maximum input voltage of the LAS-1000 Series is limited by the maximum input-output differential, maximum power dissipation, and the maximum current limit-safe operating area, whichever is less.
[2] For operation above 25° C $T_{CASE}$, derate @ 6.7 mW/° C.

## REGULATOR PERFORMANCE SPECIFICATIONS – LAS 1000, 1100

$V_{IN}$=+V=10 VOLTS; —V=0 VOLTS; $V_O$=+5 VOLTS; $I_O$=1MA; $R_{SC}$=0; UNLESS OTHERWISE SPECIFIED.

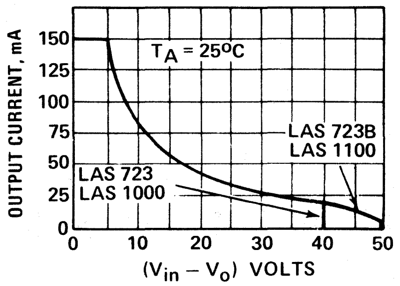
| LAS 1000, 1100 | | TEST CONDITIONS | | | LAS-1000 TEST LIMITS | | LAS-1100 TEST LIMITS | | |
|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_O$+2.0 volts | 25mA | 0-125° C | 2.63[1] | 38 | 2.63[1] | 48 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | $V_O$+2.0 volts | 150mA | 0-125° C | 2.0 | | 2.0 | | volts |
| Output Current | $I_O$ | | | 25° C | | 150 | | 150 | mA |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_O$+3.0 volts | | 0-125° C | | 0.020 | | 0.008[7] | % $V_O$/V[3] |
| | | $V_{IN}$=+5 to +40V | | | | | | 0.02[8] | % $V_O$/V[3] |
| Load Regulation[2] | $REG_{(LOAD)}$ | | 1 to 25mA | 0-125° C | | 0.05 | | 0.05 | % $V_O$ |
| | | | 1 to 100mA | | | 0.15 | | 0.15 | % $V_O$ |
| Quiescent Current | $I_Q$ | 40 volts | | 25° C | | 4.2 | | 4.2[9] | mA |
| Reference Voltage | $V_R$ | | | 25° C | 2.375 | 2.625 | 2.375 | 2.625 | volts |
| Reference Output Current | $I_R$ | $V_O$=10volts | | 25° C | | 3 | | 3 | mA |
| Temperature Coefficient | $T_C$ | | | 0-125° C | | 0.015 | | 0.015 | % $V_O$/° C[4] |
| Ripple Attenuation | $R_A$ | 10 volts+1Vrms | | 0-125° C | 60 | | 69 | | dB |
| Output Noise Voltage[5] | $V_N$ | | | 0-125° C | | 50 | | 50 | μVrms |
| Current Limit Sense Voltage[6] | $V_S$ | | | 25° C | 0.060 | 0.110 | 0.060 | 0.110 | volts |
| Error Amplifier Voltage Gain | $A_V$ | | | 25° C | 4000 | | 4000 | | V/V |
| Shutdown Voltage Threshold | V | | | 25° C | 0.65 | 0.75 | 0.65 | 0.75 | volts |
| Shutdown Source Current | I | | | 25° C | 140 | 260 | 140 | 260 | μA |
| Current Limit Source Current | I | | | 25° C | 70 | 130 | 70 | 130 | μA |

[1] $V_O = V_R (1 + R1/R2)$
R1 = Resistance from output to inverting input.
R2 = Resistance from inverting input to common.
[2] Instantaneous measurement, average chip temperature changes must be accounted for separately.
[3] Percentage times $V_O$; per volt change in $V_{IN}$.
[4] Percentage times $V_O$; per ° C change in temperature.
[5] BW = 10Hz – 100KHz.
[6] $R_{SC}$ = 100Ω
[7] $V_{IN}$ = +5 to +50 volts
[8] $V_{IN}$ = +10 to +20 volts; $I_{OUT}$ = 25mA
[9] $V_{IN}$ = +50 volts

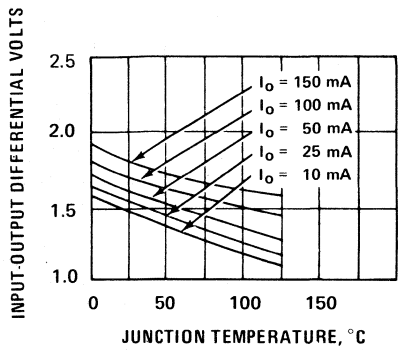
# LAS 723, 723B, 1000, 1100 SERIES

## 150 mA POSITIVE REGULATORS

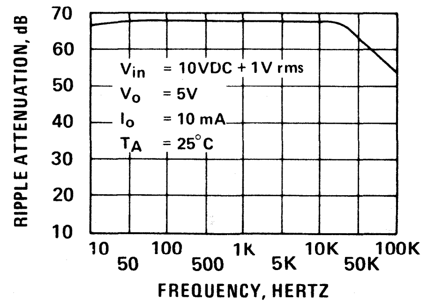
## OPERATIONAL DATA



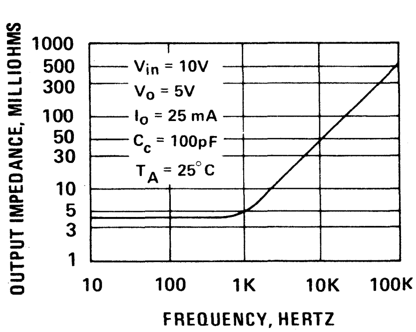

OUTPUT CURRENT VERSUS INPUT-OUTPUT VOLTAGE DIFFERENTIAL



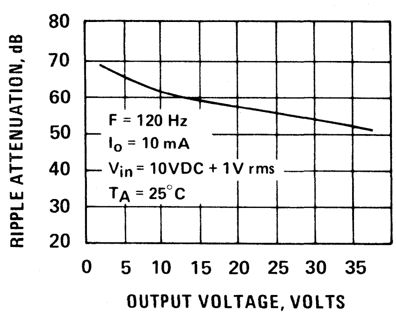

INPUT-OUTPUT DIFFERENTIAL VERSUS JUNCTION TEMPERATURES



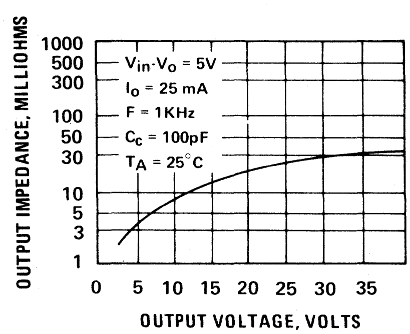

TYPICAL RIPPLE ATTENUATION VS FREQUENCY




OUTPUT IMPEDANCE VERSUS FREQUENCY

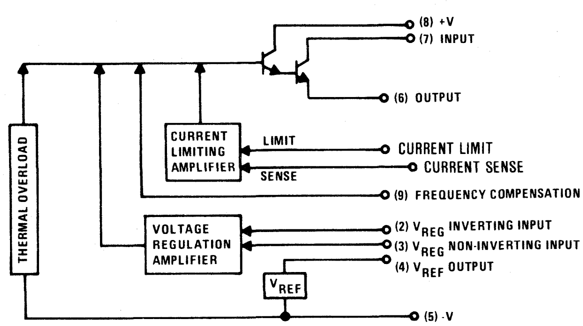



RIPPLE ATTENUATION VERSUS OUTPUT VOLTAGE

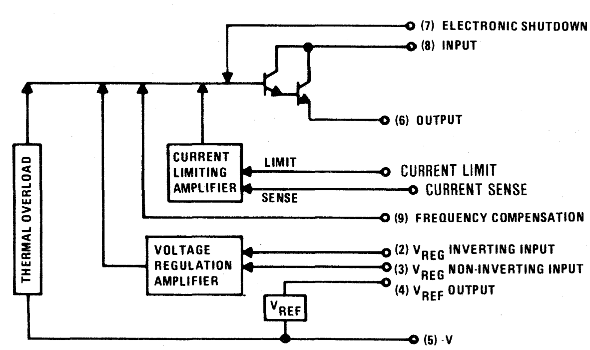



OUTPUT IMPEDANCE VERSUS OUTPUT VOLTAGE

## FUNCTIONAL BLOCK DIAGRAMS

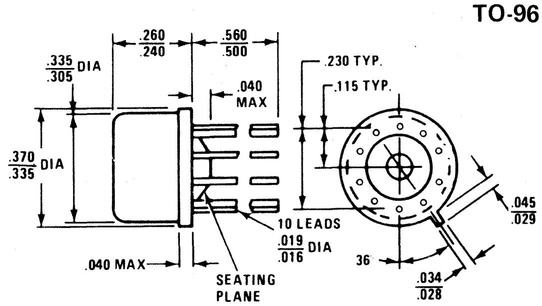


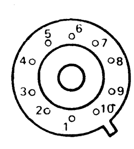

LAS 723, LAS 723B




LAS 1000, LAS 1100

### TO-96 10-TERMINAL



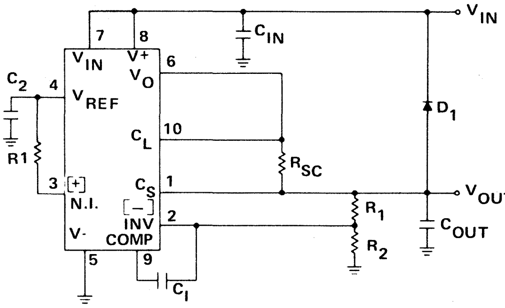

Bottom View

| Pin | Function |
|---|---|
| 1 | Current Sense |
| 2 | Inverting Input |
| 3 | Non-Inverting ınput |
| 4 | $V_{REF}$ |
| 5 | -V |
| 6 | $V_{OUT}$ |
| 7 | $V_{IN}$ (LAS 723), Electronic Shutdown (LAS 1000) |
| 8 | +V (LAS 723), Input (LAS 1000) |
| 9 | Frequency Compensation |
| 10 | Current Limit |

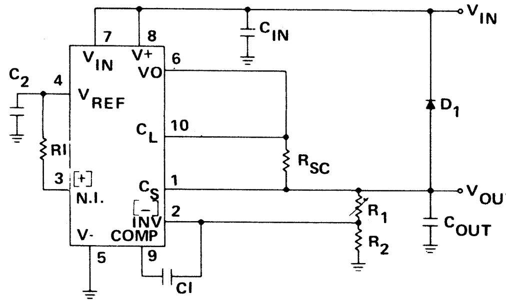
# LAS 723, 723B, 1000, 1100 SERIES

## TYPICAL APPLICATIONS

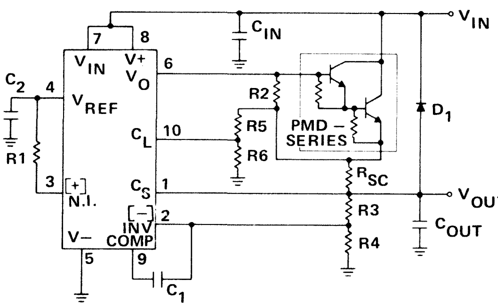
### LAS 723, 723B



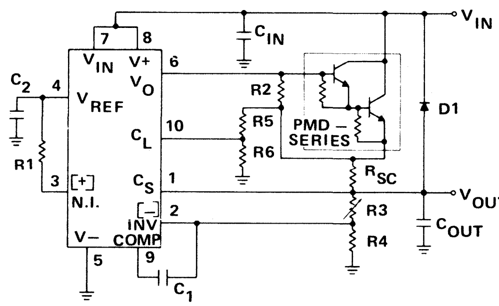

BASIC FIXED POSITIVE REGULATOR, LAS 723, LAS 723B




BASIC ADJUSTABLE POSITIVE REGULATOR, LAS 723, LAS 723B

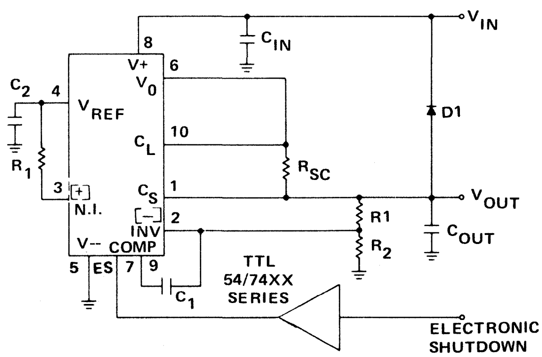



BASIC FIXED POSITIVE REGULATOR WITH AN EXTERNAL NPN PASS DARLINGTON FOR HIGH-CURRENT APPLICATIONS, LAS 723, LAS 723B

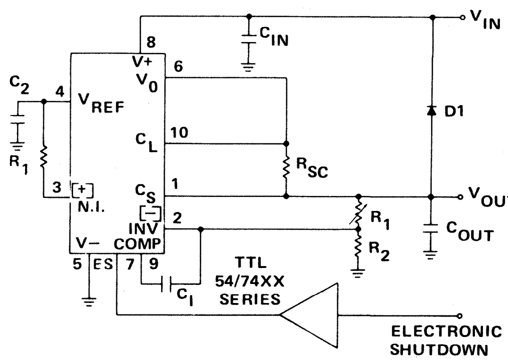



BASIC ADJUSTABLE POSITIVE REGULATOR WITH AN EXTERNAL NPN PASS DARLINGTON FOR HIGH-CURRENT APPLICATIONS, LAS 723, LAS 723B

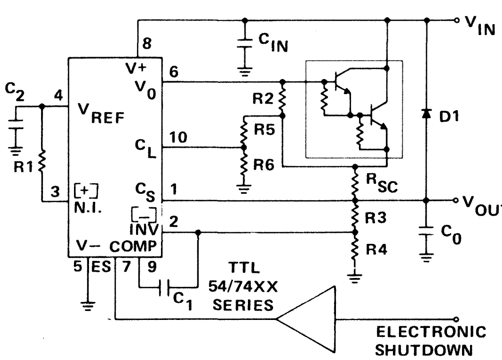
### LAS 1000, 1100



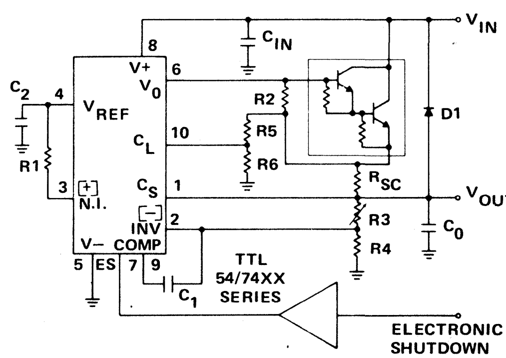

BASIC FIXED POSITIVE REGULATOR WITH ELECTRONIC SHUTDOWN LAS 1000, LAS 1100




BASIC ADJUSTABLE POSITIVE REGULATOR WITH ELECTRONIC SHUTDOWN LAS 1000, LAS 1100




BASIC FIXED POSITIVE REGULATOR WITH AN EXTERNAL NPN PASS DARLINGTON FOR HIGH-CURRENT APPLICATIONS WITH ELECTRONIC SHUTDOWN LAS 1000, LAS 1100




BASIC ADJUSTABLE POSITIVE REGULATOR WITH AN EXTERNAL NPN PASS DARLINGTON FOR HIGH-CURRENT APPLICATIONS WITH ELECTRONIC SHUTDOWN LAS 1000, LAS 1100

# LAS 1500, 15U, 15A00 SERIES

## 1.5 AMP POSITIVE REGULATORS

## FEATURES

- **Guaranteed input-output differential:** **+2.4 volts (LAS 1500 series)**
- **Guaranteed line regulation:** **2.0% $V_{OUT}$ @ $\Delta V_{IN}$=10 volts (LAS 1500 series)**
- **Guaranteed temperature coefficient:** **0 to 125° C—0.03% $V_{OUT}$/° C**
- **Guaranteed load regulation:** **0.6% $V_{OUT}$ @ 10mA to 1.5 amps (LAS 1500 series)**
- **Guaranteed ripple attenuation:** **58dB (LAS 1500 series)**
- **Guaranteed thermal resistance, junction to case: 3° C/W**

## DESCRIPTION

The LAS-1500 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 1.5 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on the chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-1500 series. This coupled to a very low output impedance insures superior performance and load regulation.

The LAS-1500 series of three-terminal regulators are available in fixed output voltage tolerances of ±5% with nominal output voltages ranging from +5 to +28 volts. The LAS-15A00 three-terminal regulators are available in fixed output voltage tolerances of ±2% with nominal output voltages available of +5, +12, and +15 volts. The LAS-15U, a four-terminal adjustable regulator, is available with an output range from +4 to +30 volts, adjustable with a single potentiometer.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 0 | 35 (40)[1] | Volts |
| Input/Output Differential | $V_{IN}$-$V_{OUT}$ | 0 | 30[1] | Volts |
| Power Dissipation @ $T_C \leq 105°C$ | $P_D$ | | 15[1, 2] | Watts |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | 3 | ° C/Watt |
| Operating Junction Temperature Range | $T_J$ | —55 | 150 | ° C |
| Storage Temperature Range | $T_{STG}$ | —65 | 150 | ° C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | ° C |

(1) The maximum input voltage of the LAS-1500 Series is limited by the maximum input-output differential, maximum power dissipation, or the maximum current limit-safe operating area, whichever is less. Values of +35V apply to $V_O$ of +4V to +12V. Values of +40V apply to $V_O$ of 13.8V to +28V.

(2) For operation above 105° C $T_{CASE}$, derate @ 333 mW/° C.

## REGULATOR PERFORMANCE SPECIFICATIONS—LAS 1500, 15U

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1=V_O+5$ VOLTS, $V_2=V_O+15$ VOLTS, $V_3=V_O+20$ VOLTS, OR THE MAXIMUM INPUT WHICHEVER IS LESS.

| | | TEST CONDITIONS | | | LAS-1500 TEST LIMITS | | LAS-15U TEST LIMITS | | |
|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 1.0A | 25° C | 0.95\|$V_O$\|[1] | 1.05/$V_O$ | 4.0[6] | 30 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 1.0A | 0-125° C | 2.4 | | 2.4 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25° C | 10mA | 1.5 | 10mA | 1.5 | amps |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_1$ to $V_2$ | 1.0A | 25° C | | 2.0 | | 2.0 | % $V_O$ |
| Load Regulation[2] | $REG_{(LOAD)}$ | $V_1$ | 10mA to 1.5A | 25° C | | 0.6 | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25° C | | 10 | | 10 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_3$[5] | 10mA | 25° C | | 3.0 | | 3.0 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 1.5A | 25° C | | 3.0 | | 3.0 | mA |
| Current Limit | $I_{LIM}$ | $V_1$ | | 25° C | | 3.5 | | 3.5 | amps |
| Short Circuit Current | $I_S$ | $V_1$ | | 25° C | | 3.5 | | 3.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125° C | | 0.03 | | 0.03 | % $V_O$/° C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125° C | | 10[3] | | 10[3] | μVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 1.0A | 0-125° C | 58[4] | | 58[4] | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 25° C | | | 3.5 | 4.0 | volts |

(1) Nominal output voltages are specified under ordering information.

(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.

(3) BW=10Hz−100KHz.

(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 58dB at a 5 volt output, and is 1dB less for each volt increase in the output voltage.

(5) The maximum input voltage of the LAS-1500 series is limited by maximum input-output differential voltage, maximum power dissipation, or the current limit-SOA, whichever is less.

(6) $V_O=V_C(1+R1/R2)$
R1=Resistance from output to control.
R2=Resistance from control to common.

# LAS 1500, 15U, 15A00 SERIES
## 1.5 AMP POSITIVE REGULATORS

# REGULATOR PERFORMANCE SPECIFICATIONS – LAS 15A00

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1=V_O+5$ VOLTS, $V_2=V_O+15$ VOLTS, $V_3=V_O+20$ VOLTS, OR THE MAXIMUM INPUT WHICHEVER IS LESS.

| PARAMETER | SYMBOL | TEST CONDITIONS $V_{IN}$ | $I_O$ | $T_J$ | LAS-15A00 TEST LIMITS MIN. | MAX. | UNITS |
|---|---|---|---|---|---|---|---|
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 1.0A | 25°C | 0.98 $\|V_O\|$ [1] | 1.02 $\|V_O\|$ | volts |
| Input-Output Differential | $V_{IN}-V_O$ | | 1.0A | 0-125°C | 2.4 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25°C | 10 | 1.5 | mA |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_1$ to $V_2$ | 1.0A | 25°C | | 2.0 | % $V_O$ |
| Load Regulation[2] | $REG_{(LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25°C | | 10 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_3$ | 10mA | 25°C | | 3.0 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 3.0 | mA |
| Current Limit | $I_{LIM}$ | $V_1$ | | 25°C | | 3.5 | amps |
| Short Circuit Current | $I_S$ | $V_1$ | | 25°C | | 3.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125°C | | 0.03 | % $V_O$/°C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125°C | | 10[3] | µVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 1.0A | 0-125°C | 58[4] | | dB |

[1] Nominal output voltages are specified under ordering information.
[2] Instantaneous regulation, average chip temperature changes must be accounted for separately.
[3] BW=10Hz–100KHz.
[4] Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 58dB at a 5 volt output, and is 1dB less for each volt increase in the output voltage.
[5] The maximum input voltage of the LAS-1500 series is limited by maximum input-output differential voltage, maximum power dissipation, or the current limiting-SOA, whichever is less.

# ORDERING INFORMATION

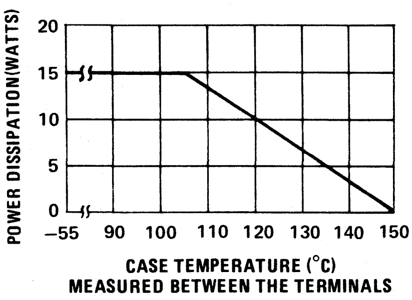
### LAS 1500 SERIES 1.5 AMPS, 15 WATTS

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 1505 | 5 | $2.05 | $1.88 | $1.73 | $1.61 | $1.50 | $1.43 | $1.35 | $1.28 |
| LAS 15A05 | 5 | 2.75 | 2.50 | 2.30 | 2.15 | 2.00 | 1.90 | 1.80 | 1.70 |
| LAS 1506 | 6 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1508 | 8 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1510 | 10 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1512 | 12 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 15A12 | 12 | 2.75 | 2.50 | 2.30 | 2.15 | 2.00 | 1.90 | 1.80 | 1.70 |
| LAS 15CB | 13.8 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1515 | 15 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 15A15 | 15 | 2.75 | 2.50 | 2.30 | 2.15 | 2.00 | 1.90 | 1.80 | 1.70 |
| LAS 1518 | 18 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1520 | 20 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1524 | 24 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1528 | 28 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 15U | 4 to 30 | 4.25 | 3.86 | 3.55 | 3.33 | 3.09 | 2.94 | 2.78 | 2.63 |

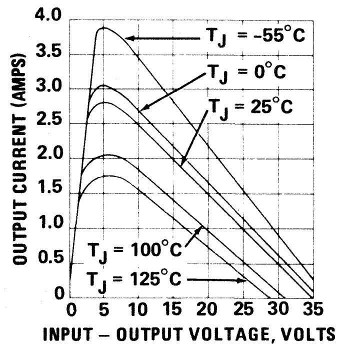
# LAS 1500, 15U, 15A00 SERIES

## 1.5 AMP POSITIVE REGULATORS

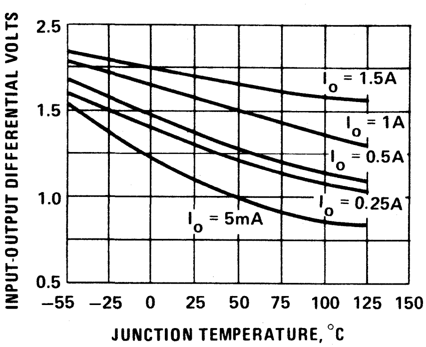
## OPERATIONAL DATA



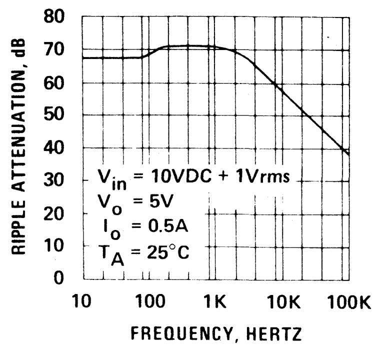

POWER DERATING



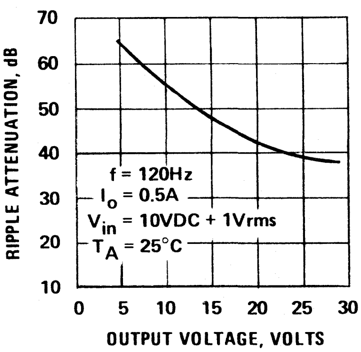

TYPICAL CURRENT LIMIT VS
INPUT-OUTPUT VOLT. DIFF.



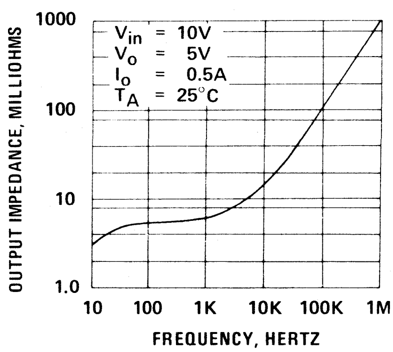

TYPICAL MINIMUM INPUT-OUTPUT
DIFFERENTIAL VOLTAGE VS
JUNCTION TEMPERATURE



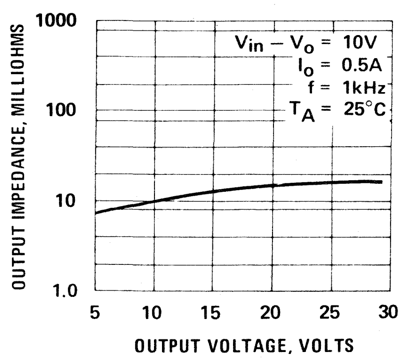

TYPICAL RIPPLE ATTENUATION
VS FREQUENCY




TYPICAL RIPPLE ATTEN-
UATION VS OUTPUT
VOLTAGE

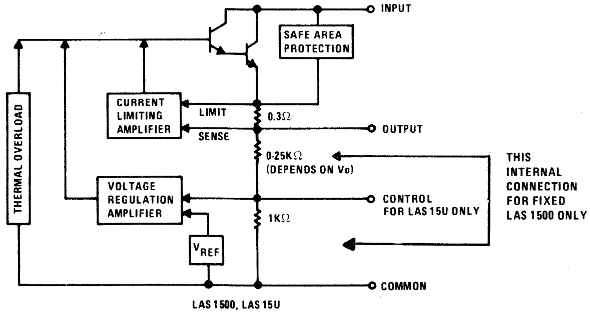



TYPICAL OUTPUT IM-
PEDANCE VS FRE-
QUENCY



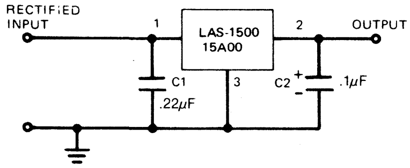

TYPICAL OUTPUT IM-
PEDANCE VS OUTPUT
VOLTAGE

## FUNCTIONAL BLOCK DIAGRAM



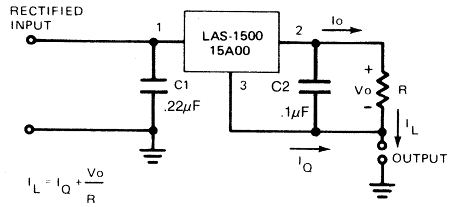
# LAS 1500, 15U, 15A00 SERIES

## TYPICAL APPLICATIONS



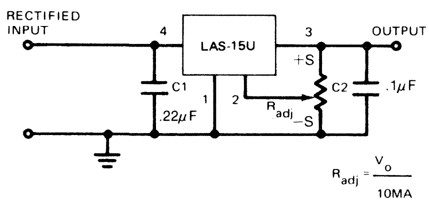

C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP

**1.5 AMP POSITIVE REGULATOR CIRCUIT**



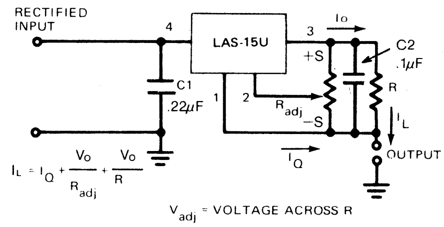

C1 and C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP FIXED CURRENT REGULATOR**



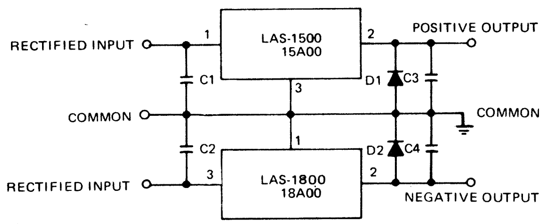

PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP POSITIVE ADJUSTABLE REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP POSITIVE ADJUSTABLE CURRENT REGULATOR**



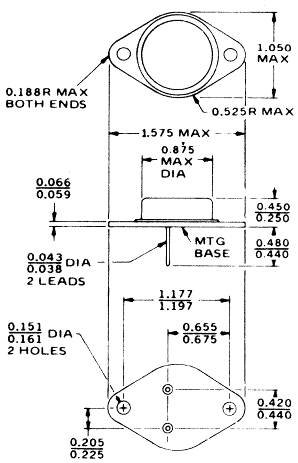

DIODES D1 & D2 SHOULD BE LOW $V_F$, HIGH CURRENT DIODES FOR OPTIMUM PROTECTION.
C1, C2, C3 AND C4 TO BE PLACED AS CLOSE TO DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000 μ F/AMP

**1.5 AMP FIXED DUAL REGULATOR**

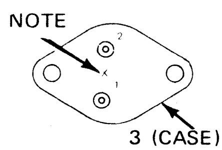
## OUTLINE DRAWING

### TO-3 3-TERMINAL (STEEL)

**LAS-1500**
**LAS-15A00**




NOTE

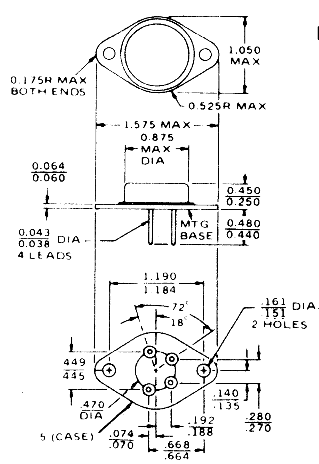



| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | OUTPUT |
| 3 | COMMON |

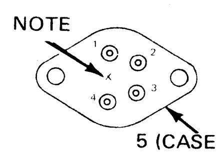
NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

### TO-3 4-TERMINAL (STEEL)

**LAS-15U**




NOTE




| PIN | FUNCTION |
|---|---|
| 1 | COMMON (ELEC) |
| 2 | CONTROL |
| 3 | OUTPUT |
| 4 | INPUT |
| 5 | COMMON |

NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

# LAS 1800, 18U, 18A00 SERIES

## 1.5 AMP NEGATIVE REGULATORS

## FEATURES

- **Guaranteed input-output differential:** **+2.1 volts (LAS 1800 series)**
- **Guaranteed line regulation:** **2.0% $V_{OUT}$ @ $\Delta V_{IN}=-15$ volts (LAS 1800 series)**
- **Guaranteed temperature coefficient:** **0 to 125°C—0.03% $V_{OUT}$/°C**
- **Guaranteed load regulation:** **0.6% $V_{OUT}$ @ 10mA to 1.5 amps (LAS 1800 series)**
- **Guaranteed ripple attenuation:** **59dB (LAS 1800 series)**
- **Guaranteed thermal resistance, junction to case: 3°C/W**

## DESCRIPTION

The LAS-1800 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated negative output voltage. Outstanding features include full power usage up to 1.5 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on the chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-1800 series. This coupled to a very low output impedance insures superior performance and load regulation.

The LAS-1800 series of three-terminal regulators are available in fixed output voltage tolerances of ±5% with nominal output voltages ranging from −2 to −28 volts. The LAS-18A00 three-terminal regulators are available in fixed output voltage tolerances of ±2% with nominal output voltages available of −5, −12, and −15 volts. The LAS-18U, a four-terminal adjustable regulator, is available with an output range from −2.6 to −30 volts, adjustable with a single potentiometer.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | −35[1]<br>−40 | 0 | Volts |
| Input/Output Differential | $V_{IN}$-$V_{OUT}$ | 0 | 30[1] | Volts |
| Power Dissipation @ $T_C \leq 105°C$ | $P_D$ | | 15[1, 2] | Watts |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | 3 | °C/Watt |
| Operating Junction Temperature Range | $T_J$ | −55 | 150 | °C |
| Storage Temperature Range | $T_{STG}$ | −65 | 150 | °C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | °C |

(1) The maximum input voltage of the LAS-1800 Series is limited by the maximum input-output differential, maximum power dissipation, and the maximum current limit-safe operating area, whichever is less. Values of −35V apply to LAS-1802—LAS-1812. Values of −40V apply to LAS-1815—LAS-1828, and LAS-18U.

(2) For operation above 105°C $T_{CASE}$, derate @ 333 mW/°C.

## REGULATOR PERFORMANCE SPECIFICATIONS – LAS 1800, 18U

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1=V_O+(-5)$VOLTS, $V_2=V_O+(-15)$ VOLTS, $V_3=V_O+(-20)$ VOLTS,[5] OR THE MINIMUM INPUT WHICHEVER IS LESS.

| PARAMETER | SYMBOL | TEST CONDITIONS $V_{IN}$ | TEST CONDITIONS $I_O$ | TEST CONDITIONS $T_J$ | LAS-1800 TEST LIMITS MIN. | LAS-1800 TEST LIMITS MAX. | LAS-18U TEST LIMITS MIN. | LAS-18U TEST LIMITS MAX. | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 1.0A | 25°C | 0.95\|$V_O$\|[1] | 1.05\|$V_O$\| | −30[6] | −2.6 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 1.0A | 0-125°C | −2.1 | | −2.1 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25°C | 10mA | 1.5 | 10mA | 1.5 | amps |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_1$ to $V_2$ | 1.0A | 25°C | | 2.0 | | 2.0 | % $V_O$ |
| Load Regulation[2] | $REG_{(LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 0.6 | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25°C | | 10 | | 10 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_3$[5] | 10mA | 25°C | | 1.3 | | 1.3 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 0.75 | | 0.75 | mA |
| Current Limit | $I_{LIM}$ | $V_1$ | | 25°C | | 3.5 | | 3.5 | amps |
| Short Circuit Current | $I_S$ | $V_1$ | | 25°C | | 3.5 | | 3.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125°C | | 0.03 | | 0.03 | % $V_O$/°C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125°C | | 10[3] | | 10[3] | μVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 1.0A | 0-125°C | 59[4] | | 59[4] | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 0-125°C | | | −2.6 | −2.25 | volts |

(1) Nominal output voltages are specified under ordering information.

(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.

(3) BW=10Hz−100KHz.

(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 59dB at a 5 volt output, and is 1dB less for each volt increase in the output voltage.

(5) The value of V3 is constrained to $V_O+(-20)$ volts or applicable absolute maximum input voltage rating, whichever is smaller in magnitude.

(6) $V_O=V_C\,(1+R1/R2)$
R1=Resistance from output to control.
R2=Resistance from control to common.

# LAS 1800, 18U, 18A00 SERIES

## 1.5 AMP NEGATIVE REGULATORS

## REGULATOR PERFORMANCE SPECIFICATIONS, LAS 18A00

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1 = V_O + (-5)$ VOLTS, $V_2 = V_O + (-15)$ VOLTS, $V_3 = V_O + (-20)$ VOLTS,[5] OR THE MINIMUM INPUT WHICHEVER IS LESS.

| | | TEST CONDITIONS | | | LAS-18A00 TEST LIMITS | | |
|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 1.0A | 25°C | 0.98\|$V_O$\|[1] | 1.02\|$V_O$\| | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 1.0A | 0-125°C | 2.1 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25°C | 10mA | 1.5 | amps |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_1$ to $V_2$ | 1.0A | 25°C | | 2.0 | % $V_O$ |
| Load Regulation[2] | $REG_{(LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25°C | | 10 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_3$[5] | 10mA | 25°C | | 1.3 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 1.5A | 25°C | | 0.75 | mA |
| Current Limit | $I_{LIM}$ | $V_1$ | | 25°C | | 3.5 | amps |
| Short Circuit Current | $I_S$ | $V_1$ | | 25°C | | 3.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125°C | | 0.02 | % $V_O$/°C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125°C | | 10[3] | μVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 1.0A | 0-125°C | 59[4] | | dB |

[1] Nominal output voltages are specified under ordering information.
[2] Instantaneous regulation, average chip temperature changes must be accounted for separately.
[3] BW = 10Hz – 100KHz.
[4] Ripple attenuation is specified for a 1Vrms, 120Hz input ripple. Ripple attenuation is a minimum of 59dB at a 5 volt output, and is 1dB less for each volt increase in the output voltage.
[5] The value of V3 is constrained to $V_O + (-20)$ volts or applicable absolute maximum input voltage rating, whichever is smaller in magnitude.

## ORDERING INFORMATION

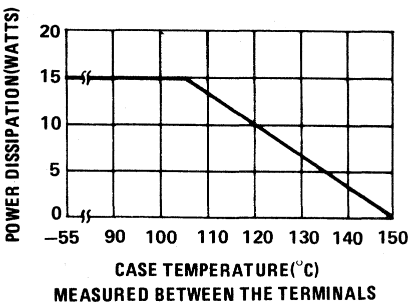
### LAS 1800 SERIES 1.5 AMPS, 15 WATTS

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 1802 | −2 | $2.95 | $2.70 | $2.47 | $2.30 | $2.10 | $1.95 | $1.80 | $1.60 |
| LAS 1805 | −5 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 18A05 | −5 | 3.60 | 3.35 | 3.15 | 3.00 | 2.85 | 2.70 | 2.55 | 2.40 |
| LAS 18052 | −5.2 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1806 | −6 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1808 | −8 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1810 | −10 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1812 | −12 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 18A12 | −12 | 3.60 | 3.35 | 3.15 | 3.00 | 2.85 | 2.70 | 2.55 | 2.40 |
| LAS 1815 | −15 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 18A15 | −15 | 3.60 | 3.35 | 3.15 | 3.00 | 2.85 | 2.70 | 2.55 | 2.40 |
| LAS 1818 | −18 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1820 | −20 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1824 | −24 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 1828 | −28 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 18U | −30 to −2.6 | 5.40 | 5.03 | 4.73 | 4.50 | 4.28 | 4.05 | 3.82 | 3.60 |

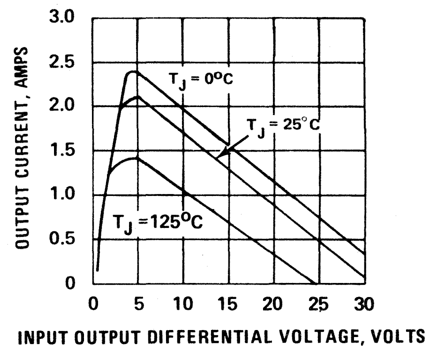
# LAS 1800, 18U, 18A00 SERIES

## 1.5 AMP NEGATIVE REGULATORS

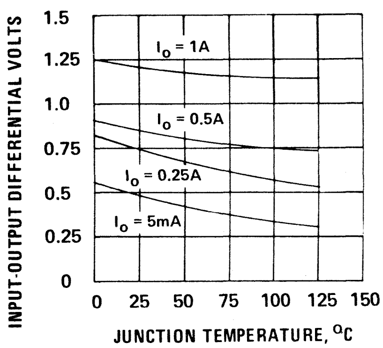
## OPERATIONAL DATA



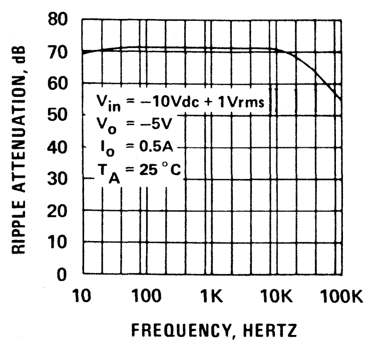

POWER DERATING



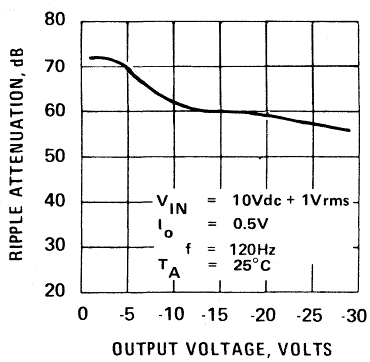

TYPICAL CURRENT LIMIT VS INPUT-OUTPUT VOLTAGE DIFFERENTIAL



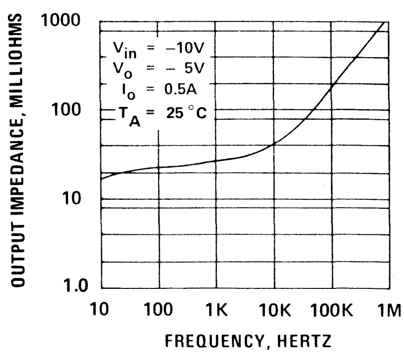

TYPICAL INPUT-OUTPUT DIFFERENTIAL VOLTAGE VS JUNCTION TEMPERATURE



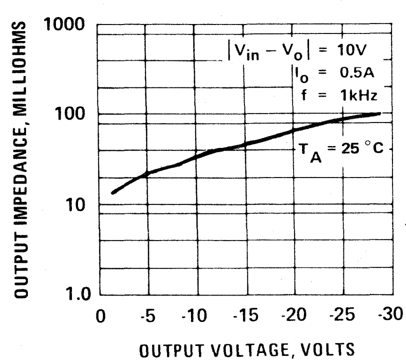

TYPICAL RIPPLE ATTENUATION VS FREQUENCY




TYPICAL RIPPLE ATTENUATION VS OUTPUT VOLTAGE

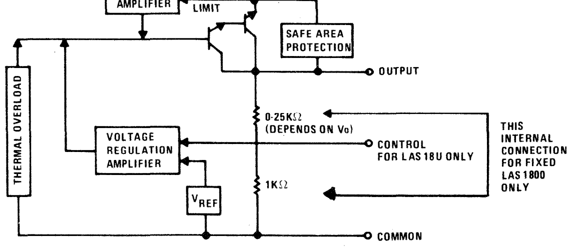



TYPICAL OUTPUT IMPEDANCE VS FREQUENCY



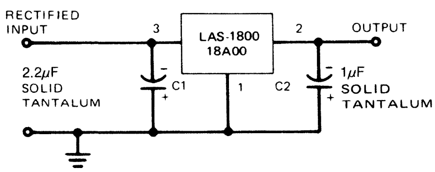

TYPICAL OUTPUT IMPEDANCE VS OUTPUT VOLTAGE

## FUNCTIONAL BLOCK DIAGRAM



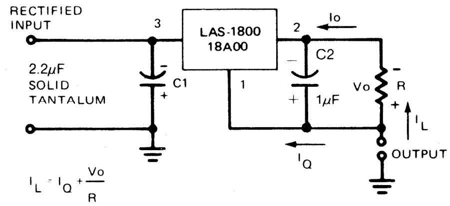
# LAS 1800, 18U, 18A00 SERIES

## TYPICAL APPLICATIONS



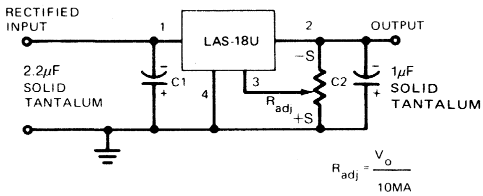

C1 AND C2 TO BE AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP

**1.5 AMP NEGATIVE REGULATOR CIRCUIT**



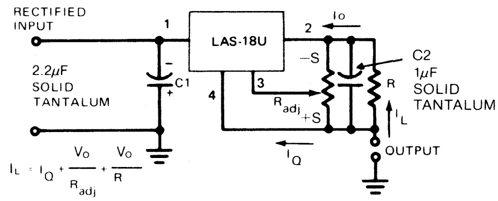

C1 TO BE AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP FIXED CURRENT REGULATOR**



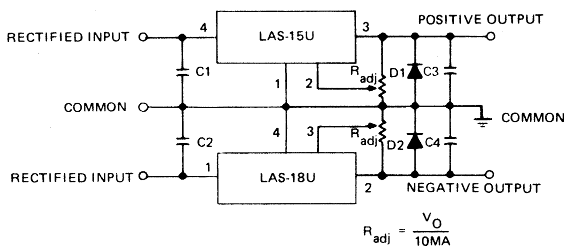

PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP NEGATIVE ADJUSTABLE REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 TO BE AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**1.5 AMP NEGATIVE ADJUSTABLE CURRENT REGULATOR**



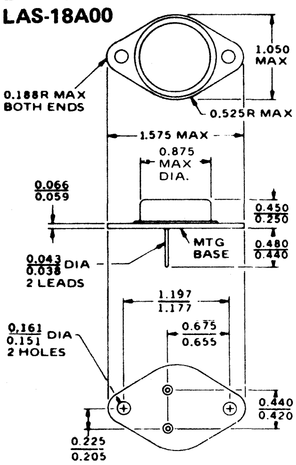

DIODES D1 & D2 SHOULD BE LOW $V_F$, HIGH CURRENT DIODES FOR OPTIMUM PROTECTION.
C1, C2, C3 AND C4 TO BE PLACED AS CLOSE TO DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

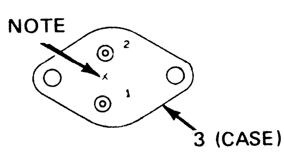
**1.5 AMP DUAL ADJUSTABLE REGULATOR**

## OUTLINE DRAWING

### TO-3 3-TERMINAL (STEEL)

**LAS-1800**
**LAS-18A00**



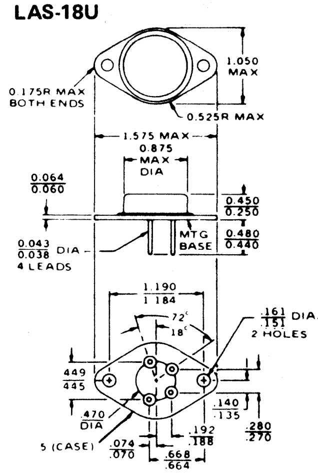

| PIN | FUNCTION |
|---|---|
| 1 | COMMON |
| 2 | OUTPUT |
| 3 | INPUT |

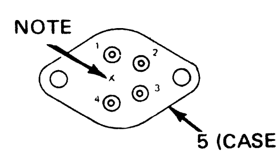
NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

### TO-3 4-TERMINAL (STEEL)

**LAS-18U**

FOR METRIC DIMENSIONS SEE PAGE 114-115




| PIN | FUNCTION |
|---|---|
| 1 | INPUT (ELEC) |
| 2 | OUTPUT |
| 3 | CONTROL |
| 4 | COMMON |
| 5 | INPUT |

NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT

# LAMBDA LLM 317

## 1.5 AMP 3-TERMINAL ADJUSTABLE REGULATOR

## FEATURES

- **Adjustable output down to 1.2V**
- **Guaranteed 1.5A output current**
- **Line regulation typically 0.01%/V**
- **Load regulation typically 0.1%**
- **Current limit constant with temperature**
- **Eliminates the need to stock many voltages**
- **Standard 3-lead transistor package**
- **70 dB ripple rejection**

## DESCRIPTION

The LLM317 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 1.5A over a 1.2V to 37V output range. This voltage regulator is easy to use and requires only two external resistors to get the output voltage. Outstanding features include internal current limiting, thermal shutdown and safe area protection on the chip. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink.

The LLM317 serves a wide variety of applications including local, on card regulation. This device also makes a simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LLM317 can be used as a precision current regulator.

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Power Dissipation | Internally limited |
| Input—Output Voltage Differential | 40V |
| Operating Junction Temperature Range | |
| LLM317 | 0°C to + 125°C |
| Storage Temperature | —65°C to + 150°C |
| Lead Temperature (Soldering, 10 seconds) | 300°C |

## ELECTRICAL CHARACTERISTICS (NOTE 1)

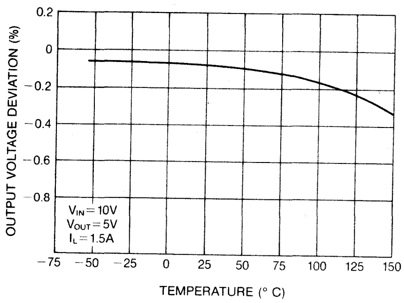
| PARAMETER | CONDITIONS | LLM317 MIN | LLM317 TYP | LLM317 MAX | UNITS |
|---|---|---|---|---|---|
| Line Regulation | $T_A = 25°C$, $3V \leq V_{IN} - V_{OUT} \leq 40V$ (Note 2) | | 0.01 | 0.04 | %/V |
| Load Regulation | $T_A = 25°C$, $10\ mA \leq I_{OUT} \leq I_{MAX}$ | | | | |
| | $V_{OUT} \leq 5V$, (Note 2) | | 5 | 25 | mV |
| | $V_{OUT} \geq 5V$, (Note 2) | | 0.1 | 0.5 | % |
| Thermal Regulation | $T_A = 25°C$, 20 ms Pulse | | 0.04 | 0.07 | %/W |
| Adjustment Pin Current | | | 50 | 100 | μA |
| Adjustment Pin Current Change | $10\ mA \leq I_L \leq I_{MAX}$, $2.5V \leq (V_{IN}-V_{OUT}) \leq 40V$ | | 0.2 | 5 | μA |
| Reference Voltage | $3 \leq (V_{IN}-V_{OUT}) \leq 40V$, $10\ mA \leq I_{OUT} \leq I_{MAX}$, $P \leq P_{MAX}$ | 1.20 | 1.25 | 1.30 | V |
| Line Regulation | $3V \leq V_{IN}-V_{OUT} \leq 40V$, (Note 2) | | 0.02 | 0.07 | %/V |
| Load Regulation | $10\ mA \leq I_{OUT} \leq I_{MAX}$, (Note 2) | | | | |
| | $V_{OUT} \leq 5V$ | | 20 | 70 | mV |
| | $V_{OUT} \geq 5V$ | | 0.3 | 1.5 | % |
| Temperature Stability | $T_{MIN} \leq Tj \leq T_{MAX}$ | | 1 | | % |
| Minimum Load Current | $V_{IN}-V_{OUT} = 40V$ | | 3.5 | 10 | mA |
| Current Limit | $V_{IN}-V_{OUT} \leq 15V$ | 1.5 | 2.2 | | A |
| RMS Output Noise, % of $V_{OUT}$ | $T_A = 25°C$, $10\ Hz \leq f \leq 10\ kHz$ | | 0.003 | | % |
| Ripple Rejection Ratio | $V_{OUT} = 10V$, f = 120 Hz | | 65 | | dB |
| | $C_{ADJ} = 10\mu F$ | 66 | 80 | | dB |
| Thermal Resistance, Junction to Case | | | 2.3 | 3 | °C/W |

**Note 1:** Unless otherwise specified, these specifications apply: $0°C \leq Tj \leq +125°C$ for the LLM317; $V_{IN}-V_{OUT} = 5V$ and $I_{OUT} = 0.5A$. Although power dissipation is internally limited, these specifications are applicable for power dissipations of 20W. $I_{MAX}$ is 1.5A.

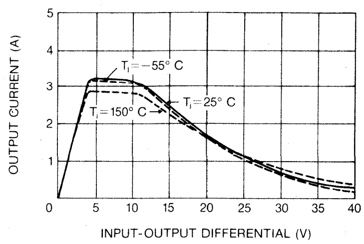
**Note 2:** Regulation is measured at constant junction temperature, using pulse testing with a low duty cycle. Changes in output voltage due to heating effects are covered under the specification for thermal regulation.

# TYPICAL PERFORMANCE CHARACTERISTICS

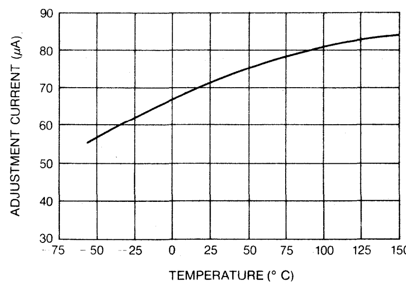
Load Regulation



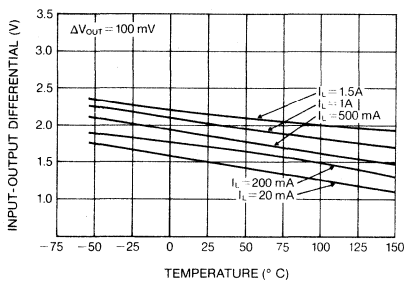

Current Limit



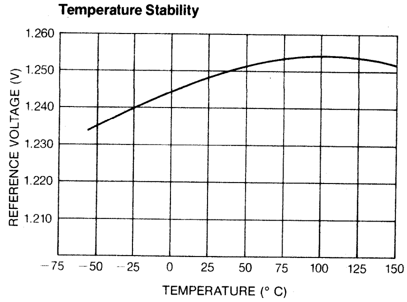

Adjustment Current



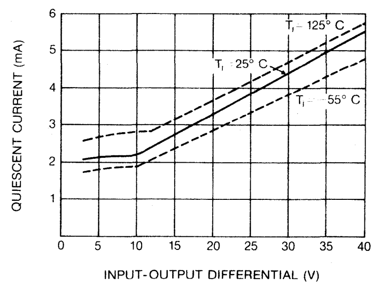

Dropout Voltage



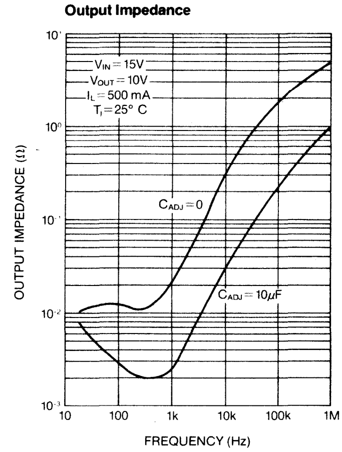

Temperature Stability



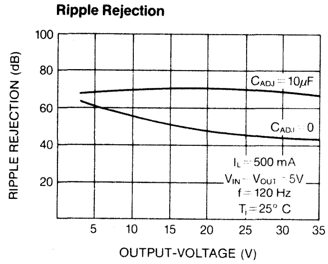

Minimum Operating Current



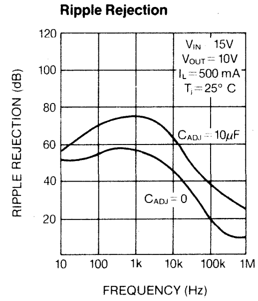

Output Impedance




Ripple Rejection

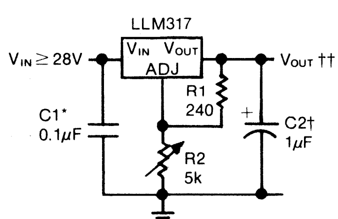



Ripple Rejection




# TYPICAL APPLICATIONS

**1.2V—25V Adjustable Regulator**



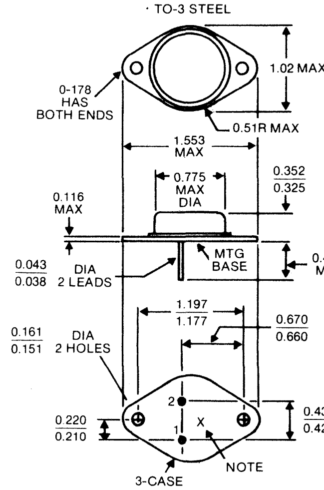

†Optional—improves transient response

*Needed if device is far from filter capacitors

$$††V_{OUT} = 1.25V \left(1 + \frac{R2}{R1}\right)$$

# PACKAGE OUTLINE

· TO-3 STEEL




| PIN | FUNCTION |
|---|---|
| 1 | ADJUSTMENT |
| 2 | $V_{IN}$ |
| CASE | OUTPUT |

**NOTE (X): CASE TEMPERATURE MEASURED AT THIS POINT**

# ORDERING INFORMATION

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| **LLM 317** | 1.2-37.0 | 1.5A | $3.75 | $3.10 | $3.10 | $2.65 | $2.65 | $2.65 | $2.00 | $1.90 |

# LAS 1600, 16U SERIES

## 2.0 AMP POSITIVE REGULATORS

## FEATURES

- **Guaranteed input-output differential:** **+2.60 volts**
- **Guaranteed line regulation:** **2.0% $V_{OUT}$ @ $\Delta V_{IN}=7$ volts**
- **Guaranteed load regulation:** **0.6% $V_{OUT}$ @ 10mA to 2.0 amps**
- **Guaranteed temperature coefficient:** **0 to 125°C — 0.02% $V_{OUT}$/°C**
- **Guaranteed ripple attenuation: 60dB**
- **Guaranteed thermal resistance, junction to case:**
  **LAS-1600/2.5°C/W**
  **LAS-16U/2.5°C/W**

## DESCRIPTION

The LAS-1600 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 2.0 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on the chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-1600 series. This coupled to a very low output impedance insures superior performance and load regulation.

The LAS-1600 series of three-terminal regulators are available in fixed output voltage tolerances of ±5% with nominal output voltages ranging from +5 to +15 volts. The LAS-16U, a four-terminal adjustable regulator, is available with an output range from +4 to +30 volts, adjustable with a single potentiometer.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 0 | 30 (35)(1) | Volts |
| Input/Output Differential | $V_{IN}$-$V_{OUT}$ | 0 | 25(1) | Volts |
| Power Dissipation @ $T_C \leq 100°C$ | $P_D$ | | 20(1, 2) | Watts |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | 2.5 | °C/Watt |
| Operating Junction Temperature Range | $T_J$ | −55 | 150 | °C |
| Storage Temperature Range | $T_{STG}$ | −65 | 150 | °C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | °C |

(1) The maximum input voltage of the LAS-1600 Series is limited by the maximum input-output differential, maximum power dissipation, or the maximum current limit-safe operating area, whichever is less. Value of +30V applies to $V_O$ of +5 to +12V. Value of +35 volts applies to $V_O$ of +13.8V and +15V.

(2) For operation above 100°C $T_{CASE}$, derate @ 400 mW/°C.

## REGULATOR PERFORMANCE SPECIFICATIONS

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1=V_O+3$ VOLTS, $V_2=V_O+10$ VOLTS, $V_3=V_O+12$ VOLTS, OR THE MAXIMUM INPUT WHICHEVER IS LESS.

| | | TEST CONDITIONS | | | LAS-1600 TEST LIMITS | | LAS-16U TEST LIMITS | | |
|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 2.0A | 25°C | 0.95\|$V_O$\|(1) | 1.05\|$V_O$\| | 4.0(5) | 30 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 2.0A | 0-125°C | 2.6 | | 2.6 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25°C | 10mA | 2.0 | 10mA | 2.0 | amps |
| Line Regulation(2) | $REG_{(LINE)}$ | $V_1$ to $V_2$ | 1.0A | 25°C | | 2.0 | | 2.0 | % $V_O$ |
| Load Regulation(2) | $REG_{(LOAD)}$ | $V_O+5V$ | 10mA to 2.0A | 25°C | | 0.6 | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25°C | | 15.0 | | 15.0 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_2$ | 10mA | 25°C | | 5.0 | | 5.0 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 2.0A | 25°C | | 5.0 | | 5.0 | mA |
| Current Limit | $I_{LIM}$ | $V_O+5V$ | | 25°C | | 4.5 | | 4.5 | amps |
| Short Circuit Current | $I_S$ | $V_O+5V$ | | 25°C | | 4.5 | | 4.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125°C | | 0.02 | | 0.02 | % $V_O$/°C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125°C | | 10(3) | | 10(3) | μVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 1.0A | 0-125°C | 60(4) | | 60(4) | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 25°C | | | 3.6 | 4.0 | volts |

(1) Nominal output voltages are specified under ordering information.

(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.

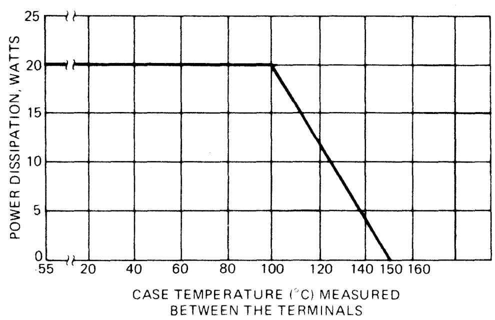
(3) BW=10Hz−100KHz.

(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a maximum of 60dB (60dB for LAS-16U) at a 5 volt output, and is 1dB less for each volt increase in the output voltage. $V_{IN}=V_O+5$.

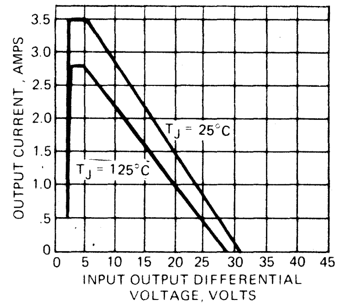
(6) $V_O=V_C\,(1+R1/R2)$
R1=Resistance from output to control.
R2=Resistance from control to common.

# LAS 1600, 16U SERIES
## 2.0 AMP POSITIVE REGULATORS

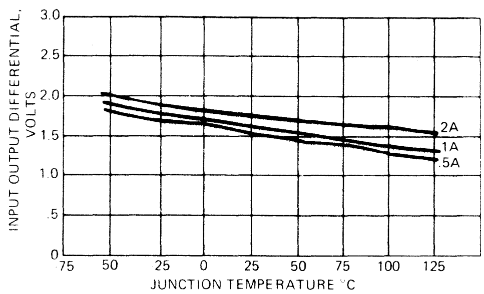
## OPERATIONAL DATA



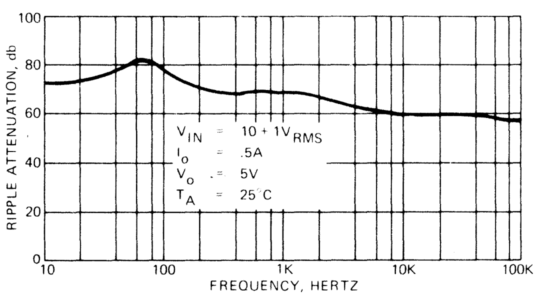

POWER DERATING



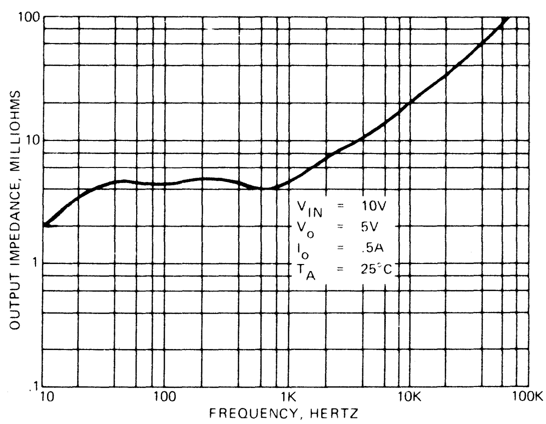

TYPICAL CURRENT LIMIT VS INPUT-OUTPUT VOLTAGE DIFFERENTIAL




TYPICAL INPUT-OUTPUT DIFFERENTIAL VOLTAGE VS JUNCTION TEMPERATURE




RIPPLE ATTENUATION VS FREQUENCY




TYPICAL OUTPUT IMPEDANCE VS FREQUENCY

## ORDERING INFORMATION

### LAS 1600 SERIES 2.0 AMPS, 20 WATTS

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 1605 | 5 | $3.00 | $2.80 | $2.60 | $2.40 | $2.24 | $2.15 | $2.05 | $1.90 |
| LAS 1608 | 8 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 1612 | 12 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 16CB | 13.8 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 1615 | 15 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 16U | 4 to 30 | 4.50 | 4.20 | 3.90 | 3.60 | 3.40 | 3.25 | 3.08 | 2.85 |

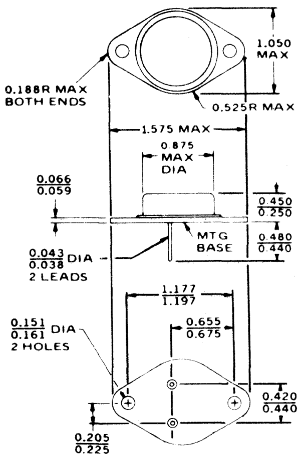
# LAS 1600, 16U SERIES

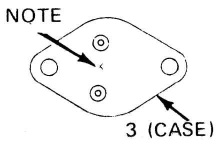
## 2.0 AMP POSITIVE REGULATORS

## OUTLINE DRAWING

TO-3 3-TERMINAL (STEEL)

**LAS-1600 SERIES**



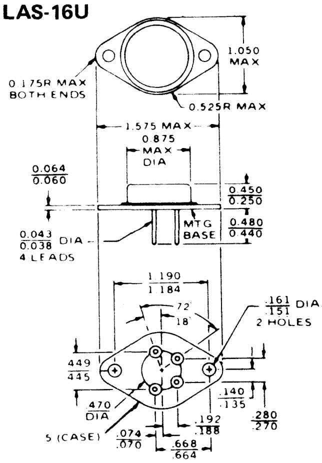




| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | OUTPUT |
| 3 | COMMON |

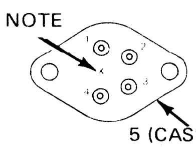
NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

TO-3 4-TERMINAL (STEEL)

**LAS-16U**



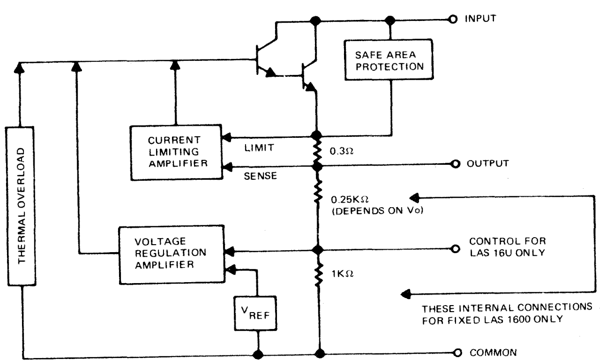

FOR METRIC DIMENSIONS SEE PAGE 114-115




| PIN | FUNCTION |
|---|---|
| 1 | COMMON (ELEC) |
| 2 | CONTROL |
| 3 | OUTPUT |
| 4 | INPUT |
| 5 | COMMON |

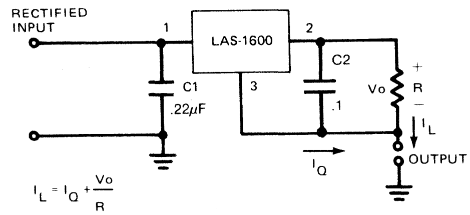
NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

## FUNCTIONAL BLOCK DIAGRAM



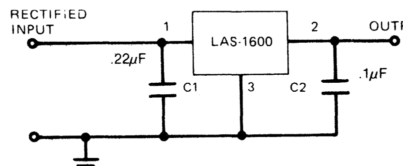

LAS 1600, LAS 16U

## TYPICAL APPLICATIONS



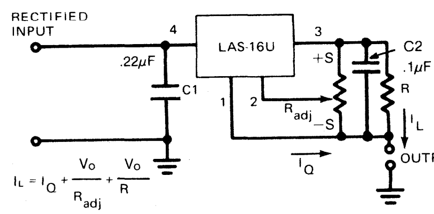

C1 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**2.0 AMP FIXED CURRENT REGULATOR**



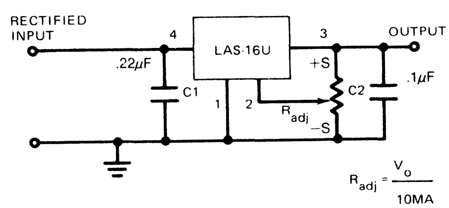

C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP

**2.0 AMP POSITIVE REGULATOR CIRCUIT**




PIN 1 IS CONNECTED TO CASE.
C1 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**2.0 AMP POSITIVE ADJUSTABLE CURRENT REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**2.0 AMP POSITIVE ADJUSTABLE REGULATOR**

# LAMBDA LAS 1400, 14AU SERIES

## 3 AMP POSITIVE VOLTAGE REGULATOR

## FEATURES

- **Guaranteed input-output differential:**
  **LAS01400/+2.50 volts**
  **LAS014AU/+2.30 volts**
- **Guaranteed line regulation:**
  **LAS-1400/1.0% $V_{OUT}$ @ Δ $V_{IN}$ = 10 volts**
  **LAS-14AU/1.0% $V_{OUT}$ @ Δ $V_{IN}$ = 9 volts**
- **Guaranteed load regulation:**
  **0.6% $V_{OUT}$ @ 10mA to 3.0 Amps output current**
- **Guaranteed temperature coefficient:**
  **LAS-1400/0° C to +125° C: 0.02% Vo/° C**
  **LAS-14AU/0° C to +125° C: 0.02% Vo/° C**
- **Guaranteed ripple attenuation:**
  **LAS-1400/60dB min**
  **LAS-14AU/66dB min**
- **Guaranteed thermal resistance junction to case:**
  **LAS-1400/2.25° C/W**
  **LAS-14AU/1.5° C/W**

## DESCRIPTION

The LAS-1400 series and the LAS-14AU voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 3.0 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on the chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation. This coupled to a very low output impedance insures superior performance and load regualtion.

The LAS-1400 series of three-terminal regulators are available in fixed output voltage tolerances of ±5% with nominal output voltages ranging from +5 to +15 volts. The LAS-14AU, a four-terminal adjustable positive voltage regulator, is available with an output voltage that can be adjusted over a 4.0 to 35 volt range by the use of a single potentiometer.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|---|
| Input Voltage | | $V_{IN}$ | 0 | 35 (40)[1] | Volts |
| Input/Output Differential | | $V_{IN}$-$V_{OUT}$ | 0 | 25[1] | Volts |
| Power Dissipation @ $T_C$≤105°C | 14AU | $P_D$ | — | 30[1,2] | Watts |
| @ $T_C$≤80°C | 1400 | | | | |
| Thermal Resistance | 14AU | $\theta_{JC}$ | — | 1.5 | °C/Watt |
| Junction to Case | 1400 | | | 2.25 | |
| Operating Junction Temperature Range | | $T_J$ | −55 | 150 | °C |
| Storage Temperature Range | | $T_{STG}$ | −65 | 150 | °C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | | $T_{LEAD}$ | | 300 | °C |

(1) The maximum input voltage of the LAS-1400 Series is limited by the maximum input-output differential, maximum power dissipation, or the maximum current limit-safe operating area, whichever is less. $V_{IN}$ (MAX) for LAS-1405, 1406, 1408, 1410, and 1412 is +35V. $V_{IN}$ (MAX) for LAS-14CB, 1415 and 14AU is 40V.

(2) For operation above 80° C $T_{CASE}$, derate @ 444 mW/° C for LAS-1405-1415. Above 105° C $T_{CASE}$, derate @ 667 mW/° C for LAS-14AU.

## ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1$ = Vo +5 VOLTS, $V_2$ = Vo +10 VOLTS $V_3$ = Vo +15 VOLTS, OR THE MAXIMUM INPUT WHICHEVER IS LESS. [FOR LAS-14AU, $V_1$ = Vo +3 VOLTS, $V_2$ = Vo +10 VOLTS $V_3$ = Vo +12 VOLTS]

| PARAMETER | SYMBOL | TEST CONDITIONS | | | LAS-1400 TEST LIMITS | | LAS-14AU TEST LIMITS | | UNITS |
|---|---|---|---|---|---|---|---|---|---|
| | | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 3.0A | 25° C | 0.95\|Vo\|[1] | 1.05\|Vo\| | 4.0 | 35[5] | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 3.0A | 0-125° C | 2.5 | | 2.3 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25° C | 0 | 3.0 | 0 | 3.0 | amps |
| Line Regulation[2] | $REG_{(LINE)}$ | $V_1$ to $V_3$ | 2.0A | 25° C | | 1.0 | | 1.0 | % $V_O$ |
| Load Regulation[2] | $REG_{(LOAD)}$ | $V_1$ | 10mA to 3.0A | 25° C | | 0.6 | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25° C | | 18 | | 21 | mA |
| Quiescent Current Line | $I_{Q(LINE)}$ | $V_1$ to $V_2$ | 5mA | 25° C | | 1.3 | | 5.0[6] | mA |
| Quiescent Current Load | $I_{Q(LOAD)}$ | $V_1$ | 5mA to 3.0A | 25° C | | 1.5 | | 5.0[7] | mA |
| Current Limit | $I_{LIM}$ | $V_O$+5V | | 25° C | | 5.2 | | 5.5 | amps |
| Short Circuit Current | $I_S$ | $V_O$+5V | | 25° C | | 5.2 | | 5.5 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 5mA | 0-125° C | | 0.02 | | 0.02 | % $V_O$/° C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125° C | | 10[3] | | 10[3] | μVrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 2.0A | 0-125° C | 60[4] | | 60[4] | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 25° C | | | 3.6 | 4.0 | volts |

(1) Nominal output voltages are specified under ordering information.

(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.

(3) BW = 10Hz − 100KHz.

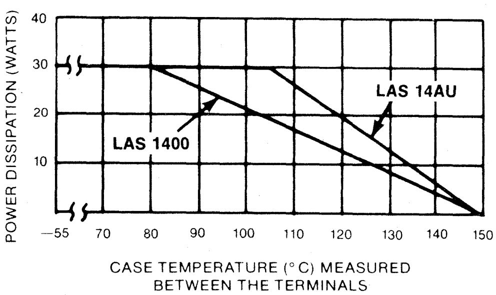
(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 60dB (60dB for LAS-14AU) at a 5 volt output, and is 1dB less for each volt increase in the output voltage. $V_{IN} = V_O + 5$

(5) $V_O = V_C(1 + R1/R2)$
R1 = Resistance from output to control.
R2 = Resistance from control to common.

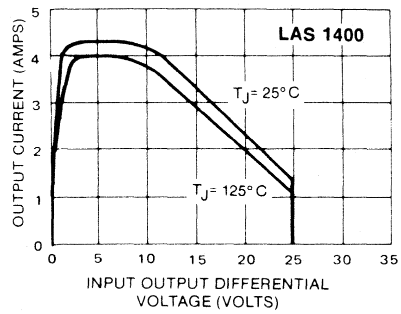
(6) $I_O$ = 10mA for LAS-14AU

(7) $I_O$ = 10mA to 3A for LAS-14AU

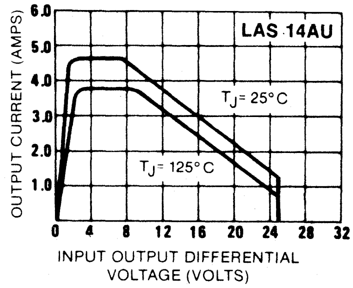
# OPERATIONAL DATA



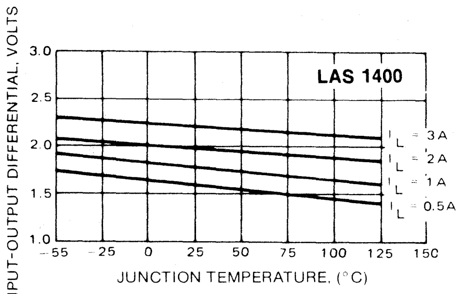

**POWER DERATING**



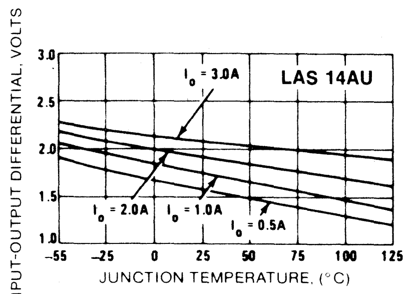

**TYPICAL CURRENT LIMIT VS INPUT-OUTPUT VOLTAGE DIFFERENTIAL**



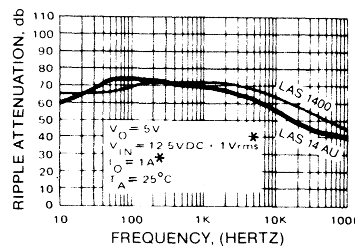

**TYPICAL CURRENT LIMIT VS INPUT-OUTPUT VOLTAGE DIFFERENTIAL**




**TYPICAL INPUT-OUTPUT DIFFERENTIAL VOLTAGE VS JUNCTION TEMPERATURE**

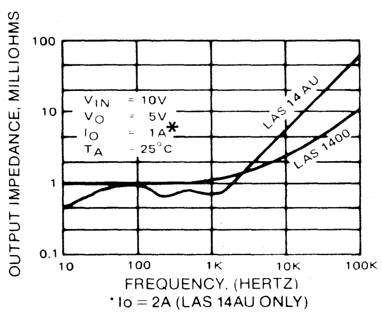



**TYPICAL INPUT-OUTPUT DIFFERENTIAL VOLTAGE VS JUNCTION TEMPERATURE**



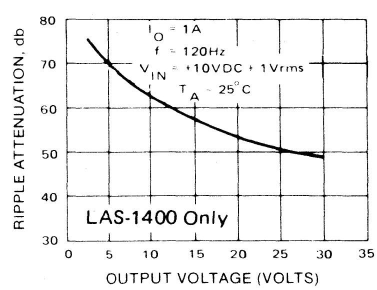

*VIN = 1.0V +2 Vrms.
*Io = 2A (LAS-14AU ONLY)

**TYPICAL RIPPLE ATTENUATION VS FREQUENCY**

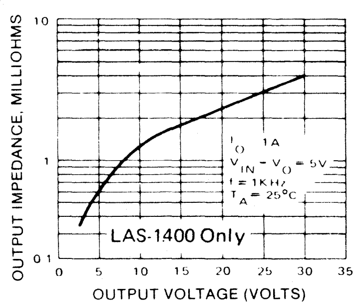



* Io = 2A (LAS 14AU ONLY)

**TYPICAL OUTPUT IMPEDANCE VS FREQUENCY**




**TYPICAL RIPPLE ATTENUATION VS OUTPUT VOLTAGE**



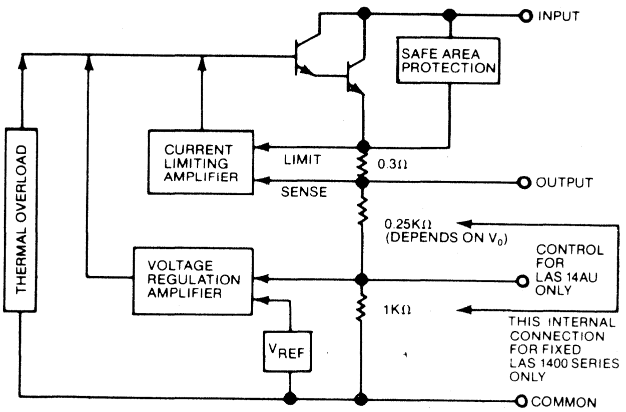

**TYPICAL OUTPUT IMPEDANCE VS OUTPUT VOLTAGE**

# ORDERING INFORMATION

## LAS 1400 SERIES 3.0 AMPS, 30 WATTS

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 1405 | 5 | $5.00 | $4.75 | $4.50 | $4.30 | $4.10 | $3.90 | $3.70 | $3.40 |
| LAS 1406 | 6 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 1412 | 12 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 1415 | 15 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 14AU | 4 to 35 | 9.00 | 8.00 | 7.50 | 7.25 | 6.22 | 5.55 | 4.95 | 4.60 |

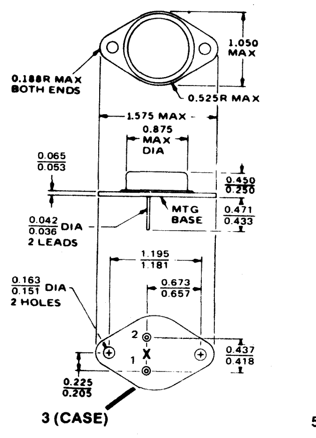
# FUNCTIONAL BLOCK DIAGRAM




**LAS-1400 Series, LAS 14AU**

# PACKAGE OUTLINE

**LAS 1400 SERIES**

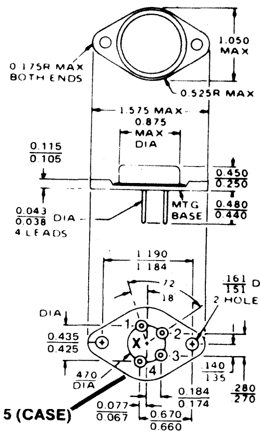



TO-3 3-TERMINAL (STEEL)

| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | OUTPUT |
| 3 | COMMON |

NOTE (X)=CASE TEMPERATURE MEASURED AT THIS POINT.

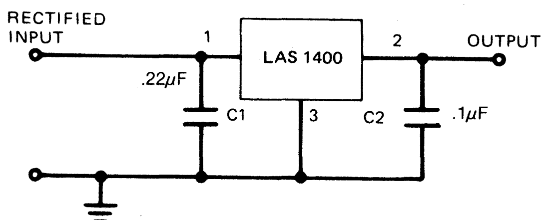
**LAS 14AU**




TO-3 4-TERMINAL (STEEL)

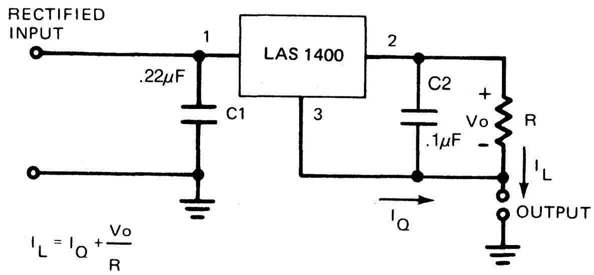
| PIN | FUNCTION |
|---|---|
| 1 | COMMON (ELEC) |
| 2 | CONTROL |
| 3 | OUTPUT |
| 4 | INPUT |
| 5 | COMMON |

# TYPICAL APPLICATIONS



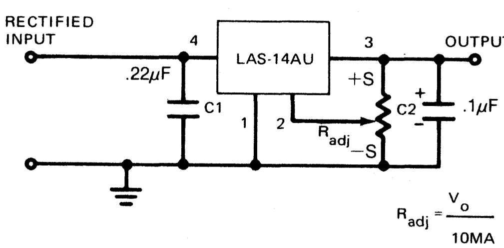

C1 AND C2 TO BE PLACED AS CLOSE AS POSSIBLE TO DEVICE.
FILTER CAPACITOR = 2000μF/AMP.

**3.0 AMP POSITIVE REGULATOR CIRCUIT**



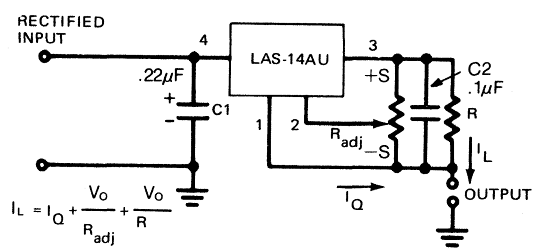

PIN 3 IS CONNECTED TO CASE.
C1 TO BE PLACED AS CLOSE AS POSSIBLE TO DEVICE.
FILTER CAPACITOR = 2000μF/AMP.

**3.0 AMP FIXED CURRENT REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**3.0 AMP POSITIVE ADJUSTABLE CURRENT REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**3.0 AMP POSITIVE ADJUSTABLE REGULATOR**

# LAMBDA LLM 350

## 3 AMP 3-TERMINAL ADJUSTABLE REGULATOR

## FEATURES

- **Adjustable output down to 1.2V**
- **Guaranteed 3A output current**
- **Line regulation typically 0.005%/V**
- **Load regulation typically 0.1%**
- **Guaranteed thermal regulation**
- **Current limit constant with temperature**
- **Eliminates the need to stock many voltages**
- **Standard 3-lead transistor package**
- **80 dB ripple rejection**

## DESCRIPTION

The LLM350 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 3A over a 1.2V to 33V output range. This voltage regulator is easy to use and requires only two external resistors to get the output voltage. Outstanding features include internal current limiting, thermal shutdown and safe area protection on the chip. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink.

The LLM350 serves a wide variety of applications including local, on card regulation. This device also makes a simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LLM350 can be used as a precision current regulator.

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Power Dissipation | Internally limited |
| Input—Output Voltage Differential | 35V |
| Operating Junction Temperature Range | |
| LLM350 | 0° C to + 125° C |
| Storage Temperature | −65° C to + 150° C |
| Lead Temperature (Soldering, 10 second) | 300° C |

## ELECTRICAL CHARACTERISTICS (NOTE 1)

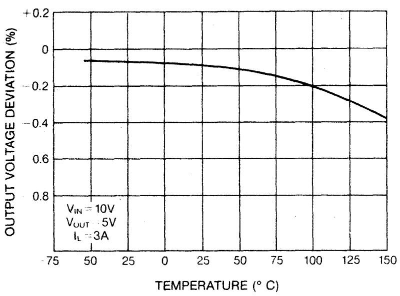
| PARAMETER | CONDITIONS | LLM350 MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Line Regulation | $T_A = 25°C$, $3V \leq V_{IN} - V_{OUT} \leq 35V$, (Note 2) | | 0.005 | 0.03 | %/V |
| Load Regulation | $T_A = 25°C$, $10 mA \leq I_{OUT} \leq 3A$ | | | | |
| | $V_{OUT} \leq 5V$, (Note 2) | | 5 | 25 | mV |
| | $V_{OUT} \geq 5V$, (Note 2) | | 0.1 | 0.5 | % |
| Thermal Regulation | Pulse = 20 ms | | 0.002 | 0.03 | %/W |
| Adjustment Pin Current | | | 50 | 100 | $\mu A$ |
| Adjustment Pin Current Change | $10 mA \leq I_L \leq 3A$<br>$3V \leq (V_{IN}-V_{OUT}) \leq 35V$ | | 0.2 | 5 | $\mu A$ |
| Reference Voltage | $3 \leq (V_{IN}-V_{OUT}) \leq 35V$,<br>$10 mA \leq I_{OUT} \leq 3A$, $P \leq 30W$ | 1.20 | 1.25 | 1.30 | V |
| Line Regulation | $3V \leq V_{IN}-V_{OUT} \leq 35V$, (Note 2) | | 0.02 | 0.07 | %/V |
| Load Regulation | $10 mA \leq I_{OUT} \leq 3A$, (Note 2) | | | | |
| | $V_{OUT} \leq 5V$ | | 20 | 70 | mV |
| | $V_{OUT} \geq 5V$ | | 0.3 | 1.5 | % |
| Temperature Stability | $T_{MIN} \leq Tj \leq T_{MAX}$ | | 1 | | % |
| Minimum Load Current | $V_{IN}-V_{OUT} = 35V$ | | 3.5 | 10 | mA |
| Current Limit | $V_{IN}-V_{OUT} \leq 10V$ | 3.0 | 4.5 | | A |
| | $V_{IN}-V_{OUT} = 30V$ | | 1 | | A |
| RMS Output Noise, % of $V_{OUT}$ | $T_A = 25°C$, $10 Hz \leq f \leq 10 kHz$ | | 0.003 | | % |
| Ripple Rejection Ratio | $V_{OUT} = 10V$, $f = 120 Hz$ | | 65 | | dB |
| | $C_{ADJ} = 10 \mu F$ | 66 | 86 | | dB |
| Thermal Resistance, Junction to Case | | | | 1.5 | °C/W |

**Note 1:** Unless otherwise specified, these specifications apply: $0°C \leq Tj \leq +125°C$ for the LLM350; $V_{IN}-V_{OUT} = 5V$ and $I_{OUT} = 1.5A$. Although power dissipation is internally limited, these specifications are applicable for power dissipations up to 30W.

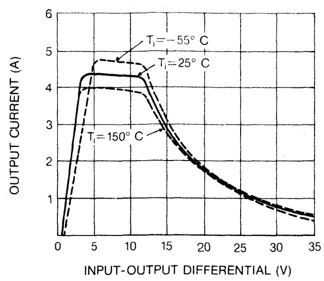
**Note 2:** Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.

# TYPICAL PERFORMANCE CHARACTERISTICS

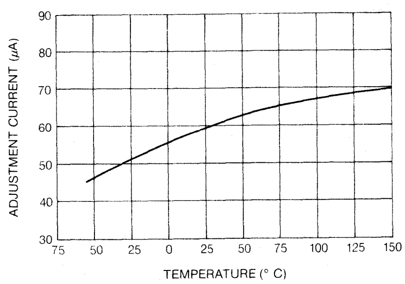
Load Regulation



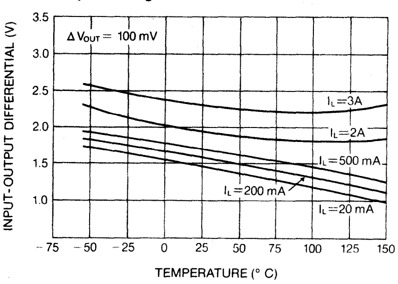

Current Limit



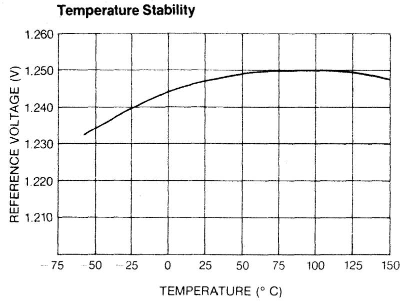

Adjustment Current



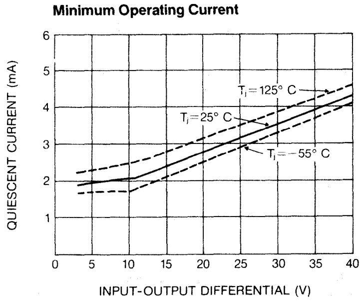

Dropout Voltage



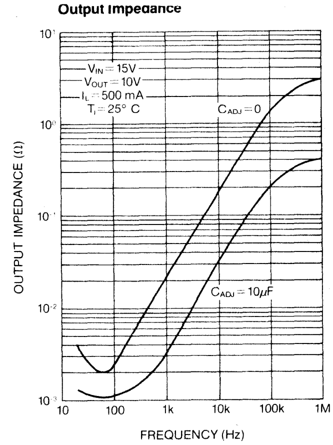

Temperature Stability



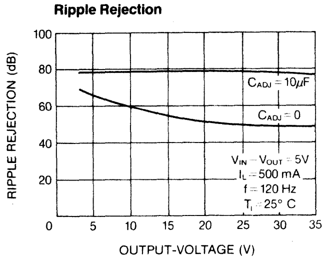

Minimum Operating Current



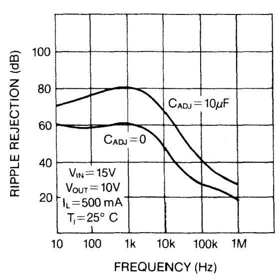

Output Impeaance




Ripple Rejection

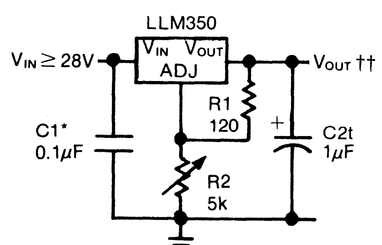



Ripple Rejection




# TYPICAL APPLICATIONS

**1.2V—25V Adjustable Regulator**

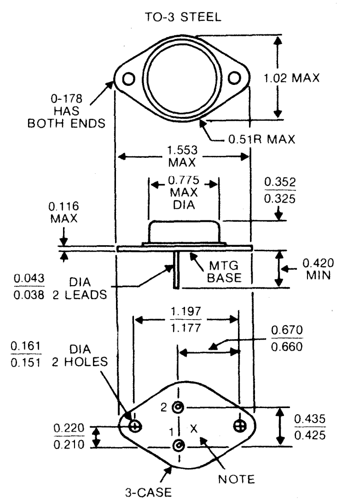



†Optional—improves transient response

*Needed if device is far from filter capacitors

$$\dagger\dagger V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right)$$

# PACKAGE OUTLINE




| PIN | FUNCTION |
|---|---|
| 1 | ADJUSTMENT |
| 2 | $V_{IN}$ |
| CASE | OUTPUT |

**NOTE (X): CASE TEMPERATURE MEASURED AT THIS POINT**

# ORDERING INFORMATION

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| LLM 350 | 1.2-33.0 | 3.0A | $5.75 | $4.80 | $4.80 | $4.00 | $4.00 | $4.00 | $3.35 | $3.20 |

# LAMBDA LAS 1900, 19U SERIES

## 5 AMP POSITIVE VOLTAGE REGULATOR

## FEATURES

- Guaranteed input—output differential: +2.6 Volts
- Guaranteed line regulation: 2.0% $V_{OUT}$ @ $\Delta V_{IN}$ = 9 Volts
- Guaranteed load regulation: 0.6% $V_{OUT}$ @ 10mA to 5 Amps
- Guaranteed temperature coefficient:
  LAS-1900/0° C to +125° C: 0.03% $V_O$/° C
  LAS-19U/0° C to +125° C: 0.02% $V_O$/° C
- Guaranteed ripple attenuation:
  LAS-1900/60dB min
  LAS-19U/62dB min
- Guaranteed thermal resistance junction to case:
  LAS-1900/0.9° C/W
  LAS-19U/0.9° C/W

## DESCRIPTION

The LAS-1900 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 5.0 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on the chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed copper TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-1900 series. This coupled to a very low output impedance insures superior performance and load regulation.

The LAS-1900 series of three-terminal regulators are available in fixed output voltage tolerances of ±5% with nominal output voltages ranging from +5 to +15 volts. The LAS-19U, a four terminal adjustable, regulator is available with an output range from +4 to +30 volts, adjustable with a single potentiometer.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 0 | 30 (35)(1) | Volts |
| Input/Output Differential | $V_{IN}$-$V_{OUT}$ | 0 | 25(1) | Volts |
| Power Dissipation @$T_C \leq 90°$ C | $P_D$ | | 50(1 2) | Watts |
| Thermal Resistance Junction To Case | $\theta_{JC}$ | | 0.9 | ° C/Watt |
| Operating Junction Temperature Range | $T_J$ | −55 | 135 | ° C |
| Storage Temperature Range | $T_{STG}$ | −65 | 150 | ° C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | ° C |

(1) The maximum input voltage of the LAS-1900 Series is limited by the maximum input-output differential, maximum power dissipation, or the maximum current limit-safe operating area, whichever is less. Value of 30V applies to Vo of +5V to +12V. Value of 35V applies to Vo of 13.8V, 15V, and LAS-19U.

(2) For operation above 90° C $T_{CASE}$, derate @ 1.111 watt/° C.

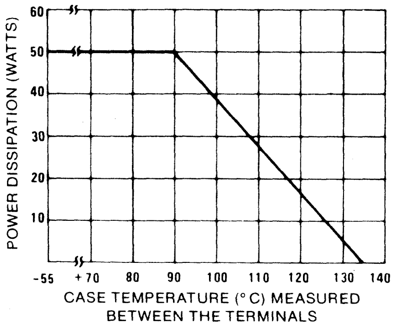
## ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1 = V_O + 3$ VOLTS, $V_2 = V_O + 10$ VOLTS, $V_3 = V_O + 12$ VOLTS OR THE MAXIMUM INPUT WHICHEVER IS LESS.

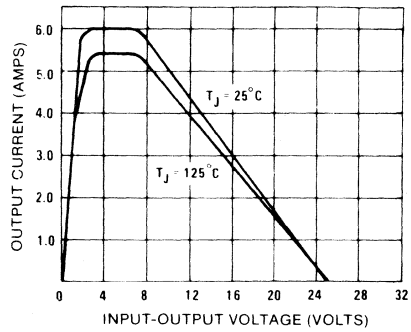
| | | TEST CONDITIONS | | | LAS-1900 TEST LIMITS | | LAS-19U TEST LIMITS | | |
|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 5.0A | 25° C | 0.95\|$V_O$\|(1) | 1.05\|$V_O$\| | 4.0(5) | 30 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 5.0A | 0-125° C | 2.6 | | 2.6 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25° C | 10mA | 5.0 | 10mA | 5.0 | amps |
| Line Regulation(2) | $REG_{(LINE)}$ | $V_1$ to $V_3$ | 3.0A | 25° C | | 2.0 | | 1.0 | % $V_O$ |
| Load Regulation(2) | $REG_{(LOAD)}$ | $V_1$ | 10mA to 5.0A | 25° C | | 0.6 | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | 10mA | 25° C | | 20.0 | | 25.0 | mA |
| Quiescent Current Line | $I_{Q\,(LINE)}$ | $V_1$ to $V_2$ | 10mA | 25° C | | 5.0 | | 5.0 | mA |
| Quiescent Current Load | $I_{Q\,(LOAD)}$ | $V_1$ | 10mA to 5.0A | 25° C | | 5.0 | | 5.0 | mA |
| Current Limit | $I_{LIM}$ | $V_O$+5V | | 25° C | | 12.0 | | 12.0 | amps |
| Short Circuit Current | $I_S$ | $V_O$+5V | | 25° C | | 12.0 | | 12.0 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125° C | | 0.03 | | 0.02 | % $V_O$/° C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125° C | | 10(3) | | 10(3) | $\mu$Vrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 2.0A | 0-125° C | 60(4) | | 60(4) | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 25° C | | | 3.6 | 4.0 | volts |

(1) Nominal output voltages are specified under ordering information.
(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.
(3) BW = 10Hz − 100KHz.
(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 60dB (60dB for LAS-19U) at a 5 volt output, and is 1dB less for each volt increase in the output voltage. $V_{IN} = V_O + 5$
(5) $V_O = V_C\,(1 + R1/R2)$
R1 = Resistance from output to control.
R2 = Resistance from control to common.

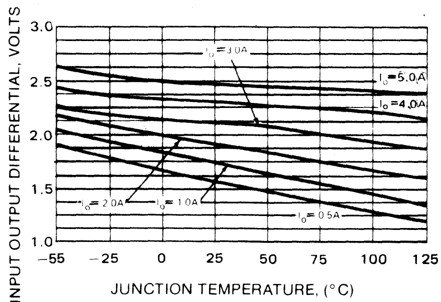
# OPERATIONAL DATA



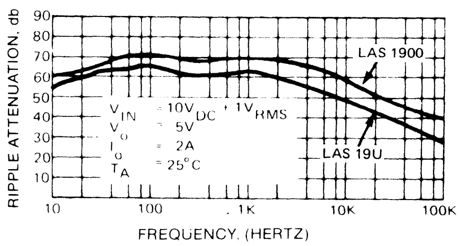

**POWER DERATING**



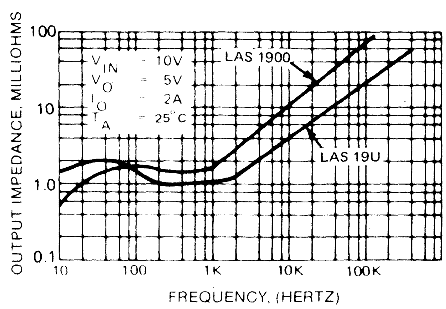

**TYPICAL CURRENT LIMIT VS INPUT-OUTPUT VOLTAGE DIFFERENTIAL**




**TYPICAL INPUT-OUTPUT DIFFERENTIAL VOLTAGE VS JUNCTION TEMPERATURE**




**TYPICAL RIPPLE ATTENUATION VS FREQUENCY**



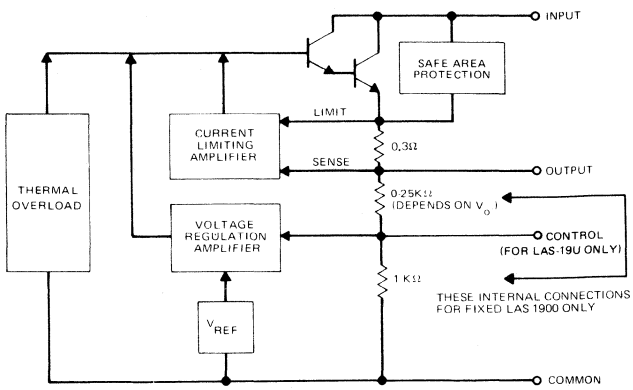

**TYPICAL OUTPUT IMPEDANCE VS FREQUENCY**

# ORDERING INFORMATION

## LAS 1900 SERIES 5.0 AMPS, 50 WATTS

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| **LAS 1905** | 5 | $14.00 | $12.50 | $11.75 | $10.00 | $7.85 | $7.85 | $7.00 | $6.85 |
| **LAS 1912** | 12 | 14.00 | 12.50 | 11.75 | 10.00 | 7.85 | 7.85 | 7.00 | 6.85 |
| **LAS 1915** | 15 | 14.00 | 12.50 | 11.75 | 10.00 | 7.85 | 7.85 | 7.00 | 6.85 |
| **LAS 19U** | 4-30 | 16.00 | 14.50 | 13.75 | 10.25 | 9.75 | 9.00 | 8.50 | 8.00 |

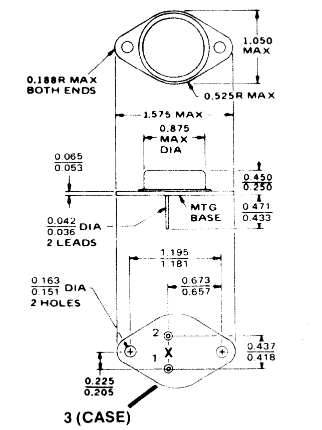
# BLOCK DIAGRAM




LAS-1900 Series, LAS 19U

# PACKAGE OUTLINE

**LAS 1900 SERIES**

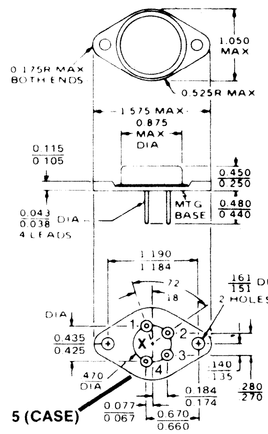



TO-3 3-TERMINAL (COPPER)

| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | OUTPUT |
| 3 | COMMON |

NOTE (X)–CASE TEMPERATURE MEASURED AT THIS POINT.

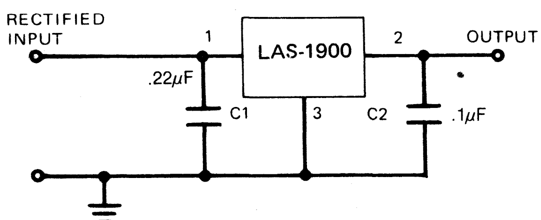
**LAS 19U**




TO-3 4-TERMINAL (COPPER)

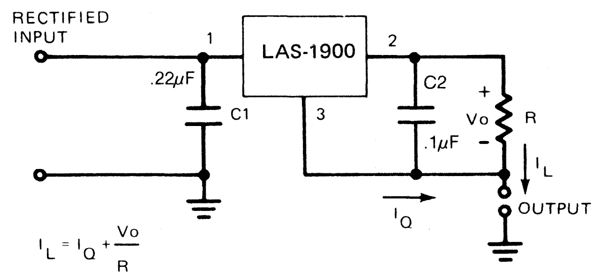
| PIN | FUNCTION |
|---|---|
| 1 | COMMON (ELEC) |
| 2 | CONTROL |
| 3 | OUTPUT |
| 4 | INPUT |
| 5 | COMMON |

# TYPICAL APPLICATIONS



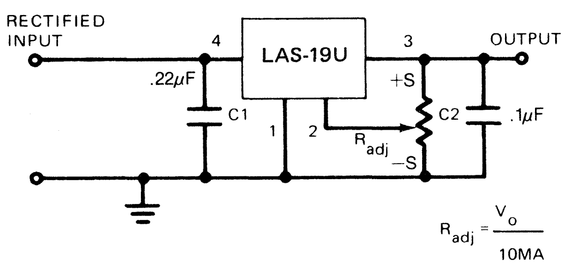

C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**5.0 AMP POSITIVE REGULATOR CIRCUIT**



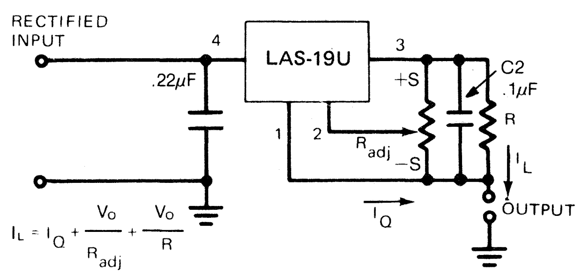

C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**5.0 AMP FIXED CURRENT REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**5.0 AMP POSITIVE ADJUSTABLE REGULATOR**




PIN 1 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 2000μF/AMP.

**5.0 AMP POSITIVE ADJUSTABLE CURRENT REGULATOR**

# LAMBDA LLM 338

## 5 AMP 3-TERMINAL ADJUSTABLE REGULATOR

## FEATURES

- Guaranteed 7A peak output current
- Guaranteed 5A output current
- Adjustable output down to 1.2V
- Line regulation typically 0.005%/V
- Load regulation typically 0.1%
- Guaranteed thermal regulation
- Current limit constant with temperature
- Standard 3-lead transistor package

## DESCRIPTION

The LLM338 is an adjustable 3-terminal positive voltage regulator capable of supplying in excess of 5A over a 1.2V to 32V output range. This voltage regulator is easy to use and requires only two external resistors to get the output voltage. Outstanding features include internal current limiting, thermal shutdown and safe area protection on the chip. Hermetically sealed steel TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink.

The LLM338 serves a wide variety of applications including local, on card regulation. This device also makes a simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LLM338 can be used as a precision current regulator.

## ABSOLUTE MAXIMUM RATINGS

| | |
|---|---|
| Power Dissipation | Internally limited |
| Input—Output Voltage Differential | 35V |
| Operating Junction Temperature Range | |
| LLM338 | 0°C to + 125°C |
| Storage Temperature | −65°C to + 150°C |
| Lead Temperature (Soldering, 10 second) | 300°C |

## ELECTRICAL CHARACTERISTICS (NOTE 1)

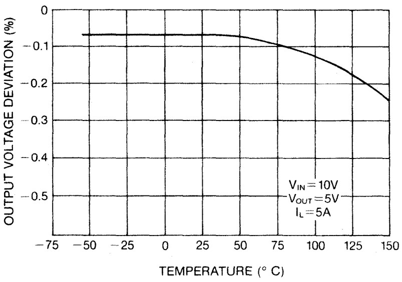
| PARAMETER | CONDITIONS | LLM338 MIN | LLM338 TYP | LLM338 MAX | UNITS |
|---|---|---|---|---|---|
| Line Regulation | $T_A = 25°C$, $3V \leq V_{IN} - V_{OUT} \leq 35V$, (Note 2) | | 0.005 | 0.03 | %/V |
| Load Regulation | $T_A = 25°C$, $10\ mA \leq I_{OUT} \leq 5A$ | | | | |
| | $V_{OUT} \leq 5V$, (Note 2) | | 5 | 25 | mV |
| | $V_{OUT} \geq 5V$, (Note 2) | | 0.1 | 0.5 | % |
| Thermal Regulation | Pulse = 20 ms | | 0.002 | 0.02 | %/W |
| Adjustment Pin Current | | | 45 | 100 | μA |
| Adjustment Pin Current Change | $10\ mA \leq I_L \leq 5A$<br>$3V \leq (V_{IN}-V_{OUT}) \leq 35V$ | | 0.2 | 5 | μA |
| Reference Voltage | $3 \leq (V_{IN}-V_{OUT}) \leq 35V$,<br>$10\ mA \leq I_{OUT} \leq 5A$, $P \leq 50W$ | 1.19 | 1.24 | 1.29 | V |
| Line Regulation | $3V \leq V_{IN}-V_{OUT} \leq 35V$, (Note 2) | | 0.02 | 0.06 | %/V |
| Load Regulation | $10\ mA \leq I_{OUT} \leq 5A$, (Note 2) | | | | |
| | $V_{OUT} \leq 5V$ | | 20 | 50 | mV |
| | $V_{OUT} \geq 5V$ | | 0.3 | 1.0 | % |
| Temperature Stability | $T_{MIN} \leq T_j \leq T_{MAX}$ | | 1 | | % |
| Minimum Load Current | $V_{IN}-V_{OUT} = 35V$ | | 3.5 | 10 | mA |
| Current Limit | $V_{IN}-V_{OUT} \leq 10V$ | | | | |
| | DC | 5.0 | 8 | | A |
| | 0.5 ms Peak | 7 | 12 | | A |
| | $V_{IN}-V_{OUT} = 30V$ | | 1 | | A |
| RMS Output Noise, % of $V_{OUT}$ | $T_A = 25°C$, $10\ Hz \leq f \leq 10\ kHz$ | | 0.003 | | % |
| Ripple Rejection Ratio | $V_{OUT} = 10V$, $f = 120\ Hz$ | | 60 | | dB |
| | $C_{ADJ} = 10\ \mu F$ | 60 | 75 | | dB |
| Thermal Resistance, Junction to Case | | | | 1.0 | °C/W |

**Note 1:** Unless otherwise specified, these specifications apply: $0°C \leq T_j \leq +125°C$ for the LLM338; $V_{IN}-V_{OUT} = 5V$ and $I_{OUT} = 2.5A$. Although power dissipation is internally limited, these specifications are applicable for power dissipations up to 50W.

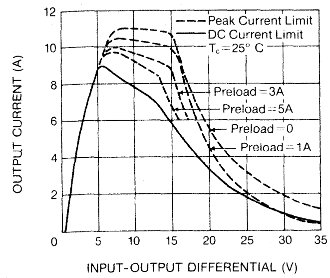
**Note 2:** Regulation is measured at constant junction temperature. Changes in output voltage due to heating effects must be taken into account separately by thermal regulation.

# TYPICAL PERFORMANCE CHARACTERISTICS

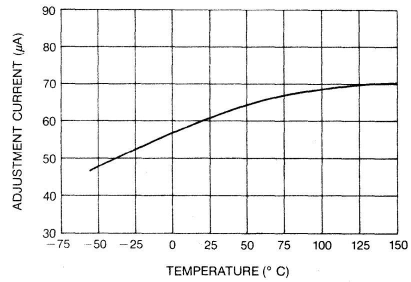
**Load Regulation**



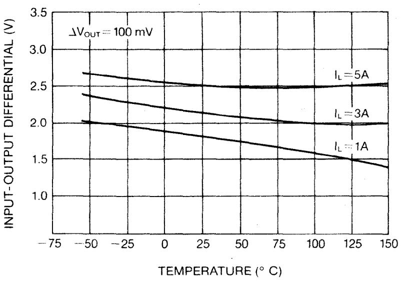

**Current Limit**



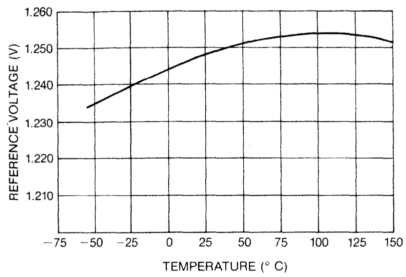

**Adjustment Current**



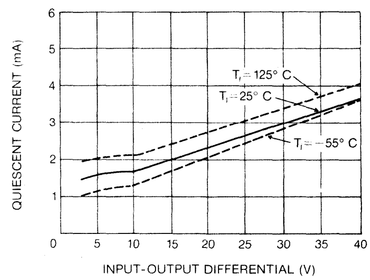

**Dropout Voltage**



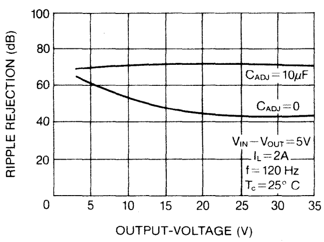

**Temperature Stability**



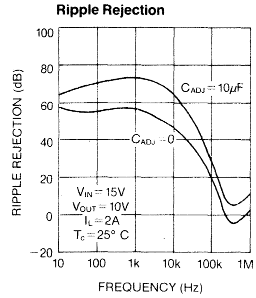

**Minimum Operating Current**



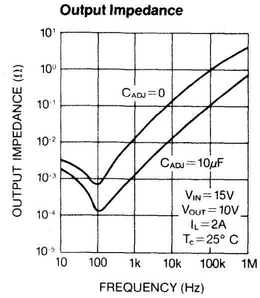

**Ripple Rejection**




**Ripple Rejection**

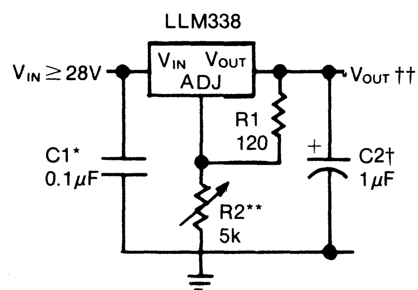



**Output Impedance**




# TYPICAL APPLICATIONS

**1.2V—25V Adjustable Regulator**

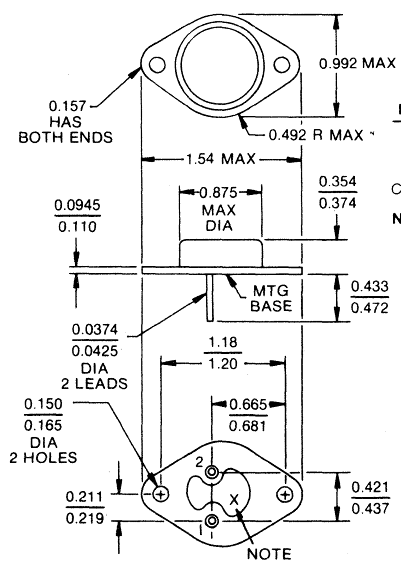



†Optional—improves transient response

*Needed if device is far from filter capacitors

$$††V_{OUT} = 1.25V\left(1 + \frac{R2}{R1}\right)$$

# PACKAGE OUTLINE




| PIN | FUNCTION |
|---|---|
| 1 | ADJUSTMENT |
| 2 | $V_{IN}$ |
| CASE | OUTPUT |

**NOTE (X): CASE TEMPERATURE MEASURED AT THIS POINT**

# ORDERING INFORMATION

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| LLM 338 | 1.2-32.0 | 5.0A | $7.60 | $6.39 | $6.39 | $5.00 | $5.00 | $5.00 | $4.15 | $4.00 |

# LAMBDA LAS 3900

## 8 AMP POSITIVE VOLTAGE REGULATOR

## FEATURES

- **Guaranteed input-output differential: +2.6 Volts**
- **Guaranteed line regulation: 2.0% $V_{OUT}$, $\Delta V_{IN}$ = 12 Volts**
- **Guaranteed load regulation: 0.6% $V_{OUT}$ @10MA to 8.0 Amps**
- **Guaranteed ripple attenuation: 60 dB @ 120 Hz**
- **Guaranteed temperature coefficient: 0 to 125° C – 0.03% $V_{OUT}$/° C**
- **Guaranteed thermal resistance junction to case: 0.7° C/W**
- **100% power cycled under load**
- **Sense terminal pin eliminates line drop problems**

## DESCRIPTION

The LAS-3900 series voltage regulators are monolithic integrated circuits designed for use in applications requiring a well regulated positive output voltage. Outstanding features include full power usage up to 3.0 amperes of load current, internal current limiting, thermal shutdown, and safe area protection on tha chip, providing protection of the series pass darlington, under most operating conditions. Hermetically sealed copper TO-3 packages are utilized for high reliability and low thermal resistance when used with an appropriate heat sink. A low-noise temperature stable diode reference is the key design factor insuring excellent temperature regulation of the LAS-3900 series. This coupled to a very low output impedance insures superior performance and load regulation.

| Device | Pins | $V_{OUT}$ Tolerance |
|---|---|---|
| LAS 3905 | 4 | ±5% |
| LAS 39U | 4 | Adjustable |
| LAS 3905K | 2 | +5%, −3% |

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{IN}$ | 0 | 25(1) | Volts |
| Input/Output Differential | $V_{IN}$-$V_{OUT}$ | 0 | 20(1) | Volts |
| Power Dissipation @$T_C \leq$ 94° C | $P_D$ | | 80(1 2 3) | Watts |
| Thermal Resistance Junction To Case | $\theta_{JC}$ | | 0.7 | ° C/Watt |
| Operating Junction Temperature Range | $T_J$ | −55 | 150 | ° C |
| Storage Temperature Range | $T_{STG}$ | −65 | 150 | ° C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | ° C |

(1) The maximum input voltage of the LAS-3900 Series is limited by the maximum input-output differential, maximum power dissipation, or the maximum current limit safe operating area, whichever is less.

(2) For operation above 94° C $T_{CASE}$, derate @ 1.42 watt/° C.

(3) In case of a short circuit, with input-ouptut voltages approaching the maximum input-output differential, this regulator may require the removal of the input voltage to restart.

## ELECTRICAL CHARACTERISTICS

INPUT VOLTAGE TEST CONDITIONS ARE AS FOLLOWS: $V_1 = V_O + 3$ VOLTS, $V_2 = V_O + 10$ VOLTS, $V_3 = V_O + 15$ VOLTS, OR THE MAXIMUM INPUT WHICHEVER IS LESS.

| | | TEST CONDITIONS | | | LAS 3905,3905K | | LAS 39U | | |
|---|---|---|---|---|---|---|---|---|---|
| PARAMETER | SYMBOL | $V_{IN}$ | $I_O$ | $T_J$ | MIN. | MAX. | MIN. | MAX. | UNITS |
| Output Voltage | $V_O$ | $V_1$ to $V_2$ | 10mA to 8.0A | 25° C | 0.95\|$V_O$\|(1)(6) | 1.05\|$V_O$\| | 4.0(5) | 16 | volts |
| Input-Output Differential | $V_{IN}$-$V_O$ | | 8.0A | 0-125° C | 2.6 | | 2.6 | | volts |
| Output Current | $I_O$ | $V_1$ | | 25° C | .10 | 8.0 | 10mA | 8.0 | amps |
| Line Regulation(2) | $REG_{(LINE)}$ | $V_1$ to $V_3$ | 5A | 25° C | | 2.0 | | 2.0 | % $V_O$ |
| Load Regulation(2) | $REG_{(LOAD)}$ | $V_1$ | 10mA to 8.0A | 25° C | | 0.6(6) | | 0.6 | % $V_O$ |
| Quiescent Current | $I_Q$ | $V_1$ | | 25° C | | 20 | | 25.0 | mA |
| Quiescent Current Line | $I_{Q\ (LINE)}$ | $V_1$ to $V_2$ | 10mA | 25° C | | 5 | | 5.0 | mA |
| Quiescent Current Load | $I_{Q\ (LOAD)}$ | $V_1$ | 10mA to 8.0A | 25° C | | 5 | | 5.0 | mA |
| Current Limit | $I_{LIM}$ | $V_O$+5V | | 25° C | | 14 | | 14.0 | amps |
| Short Circuit Current | $I_S$ | $V_O$+5V | | 25° C | | 14 | | 14.0 | amps |
| Temperature Coefficient | $T_C$ | $V_1$ | 0.1A | 0-125° C | | 0.03 | | 0.03 | % $V_O$/° C |
| Output Noise Voltage | $V_N$ | $V_1$ | 0.1A | 0-125° C | | 10(3) | | 10(3) | $\mu$Vrms/V |
| Ripple Attenuation | $R_A$ | $V_1$ | 2.0A | 0-125° C | 60(4) | | 60(4) | | dB |
| Control Voltage | $V_C$ | $V_1$ to $V_2$ | 10mA | 25° C | | | 3.6 | 4.0 | volts |

(1) Nominal output voltages are specified under ordering information.

(2) Instantaneous regulation, average chip temperature changes must be accounted for separately.

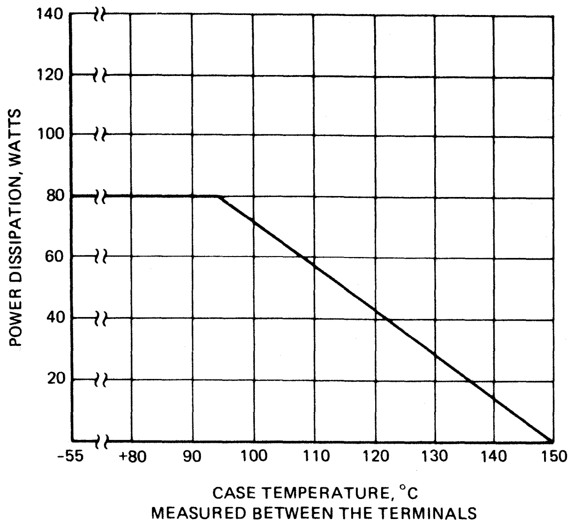
(3) BW=10Hz—100KHz.

(4) Ripple attenuation is specified for a 1Vrms, 120 Hz input ripple. Ripple attenuation is a minimum of 60 dB (60 dB for LAS-39U) at a 5 volt output, and is .1dB less for each volt increase in the output voltage. $V_{IN} = V_O + 5$

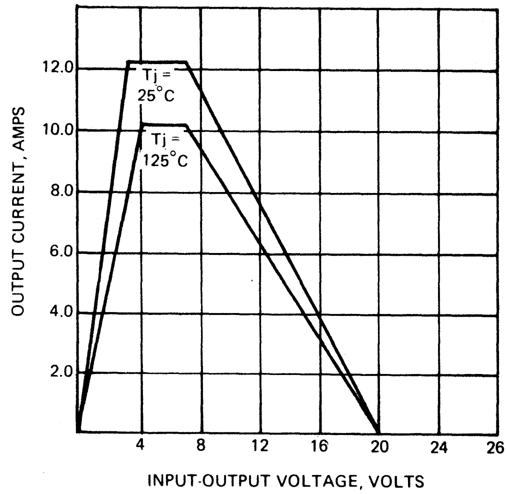
(5) $V_O = V_C(1 + \frac{R_1}{R_2})$
R1=Resistance from output to control.
R2=Resistance from control to common.

(6) LAS 3905K $V_{O\ MIN} = 0.97\ V_O$, $REG_{(LOAD)\ MAX} = 2\%$

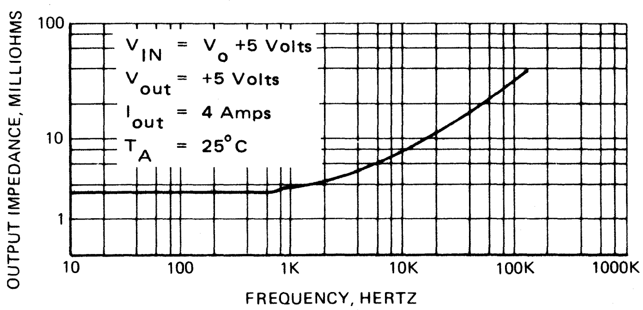
# OPERATIONAL DATA



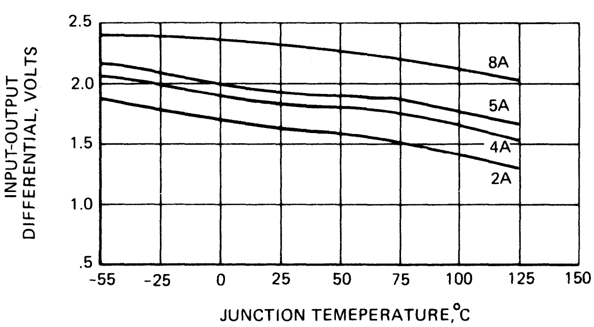

POWER DERATING



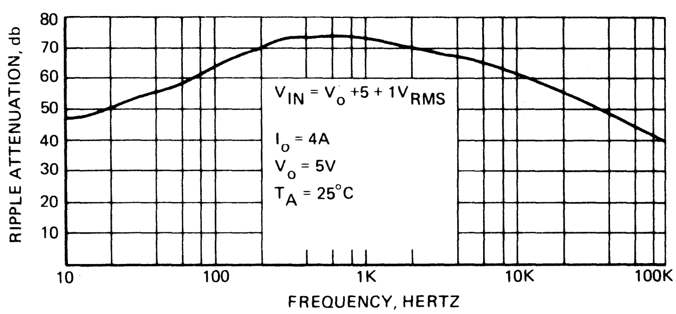

TYPICAL CURRENT LIMIT
VS INPUT-OUTPUT
VOLTAGE DIFFERENTIAL




TYPICAL OUTPUT IMPEDANCE
vs FREQUENCY




TYPICAL INPUT-OUTPUT
DIFFERENTIAL VOLTAGE vs
JUNCTION TEMPERATURE




TYPICAL RIPPLE ATTENUATION
vs FREQUENCY

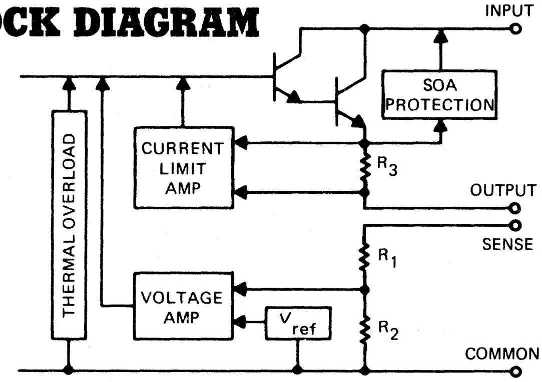
# ORDERING INFORMATION

| MODEL | NOMINAL $V_O$ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 3905 | 5 | $18.00 | $16.50 | $15.75 | $13.00 | $13.00 | $11.90 | $10.65 | $10.00 |
| LAS 3905K | 5 | 16.00 | 14.25 | 13.80 | 11.65 | 10.75 | 9.85 | 9.50 | 9.25 |
| LAS 39U | 4-16 | 19.00 | 17.50 | 16.75 | 14.00 | 14.00 | 12.90 | 11.65 | 11.00 |

# LAMBDA LAS 3900 SERIES

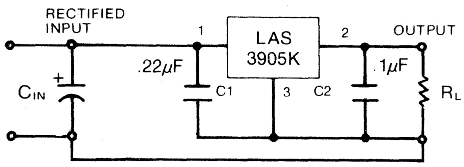
## 8 AMP, 80 WATT MONOLITHIC POSITIVE VOLTAGE REGULATORS

### BLOCK DIAGRAM

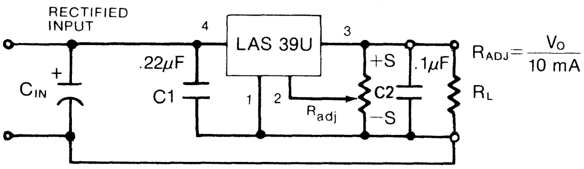



LAS-3905

### TYPICAL APPLICATIONS

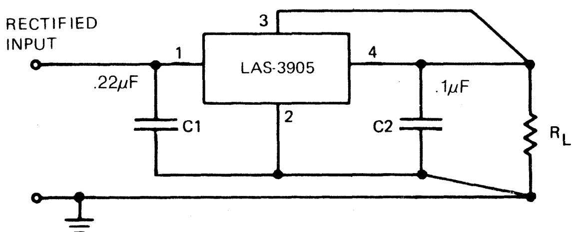



**8 AMP POSITIVE REGULATOR CIRCUIT**



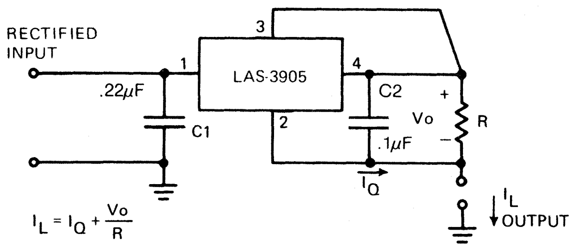

PIN 1 IS ELECTRICAL COMMON
CASE IS MECHANICAL COMMON

**8 AMP POSITIVE ADJUSTABLE REGULATOR**




PIN 2 IS CONNECTED TO CASE.
C1 AND C2 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE
FILTER CAPACITOR = 2000μF/AMP

**8.0 AMP POSITIVE REGULATOR CIRCUIT**

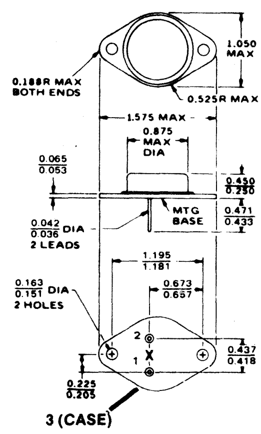



PIN 2 IS CONNECTED TO CASE.
C1 TO BE PLACED AS CLOSE TO THE DEVICE AS POSSIBLE.
FILTER CAPACITOR = 200μF/AMP

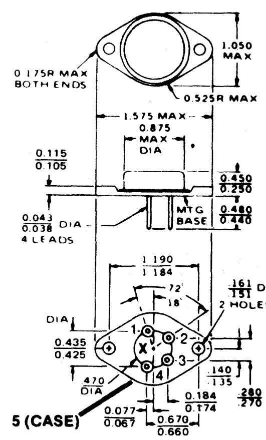
**8.0 AMP FIXED CURRENT REGULATOR**

### OUTLINE DRAWING

**LAS 3905K SERIES**




**LAS 39U**




**TO-3 3-TERMINAL (COPPER)**

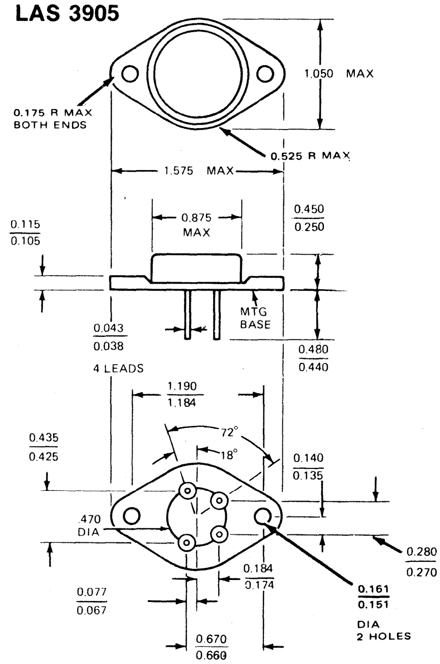
| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | OUTPUT |
| 3 | COMMON |

**NOTE (X)=CASE TEMPERATURE MEASURED AT THIS POINT.**

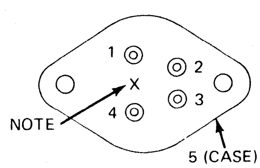
**TO-3 4-TERMINAL (COPPER)**

| PIN | FUNCTION |
|---|---|
| 1 | COMMON (ELEC) |
| 2 | CONTROL |
| 3 | OUTPUT |
| 4 | INPUT |
| 5 | COMMON |

**LAS 3905**




COPPER
4 TERMINAL/TO-3




NOTE (X) = Case temperature measured at this point.

| PIN | FUNCTION |
|---|---|
| 1 | INPUT |
| 2 | COMMON (ELEC) |
| 3 | SENSE |
| 4 | OUTPUT |
| 5 | COMMON |

# LAMBDA LAS 3700

## FLOATING REGULATOR

## FEATURES

- Voltage/current regulation with automatic crossover
- Load regulation—.003% ±1mV
- Line regulation—.01% ±1mV $V_{IN}$=15-25V
- Short circuit protection
- On chip stabilized heater
- Adjustable current source for programming voltage
- Fixed current source for current regulator
- Hermetic TO5 package

## DESCRIPTION

The LAS 3700 floating regulator is designed for applications requiring "laboratory" power supply performance at voltages limited only by the external series pass transistor. Both output voltage and output current are adjustable. A unique feature of the LAS 3700 is the incorporation of an on chip heater which maintains a constant junction temperature of 115C. This feature is responsible for the excellent temperature performance of the regulator.

## ABSOLUTE MAXIMUM RATINGS

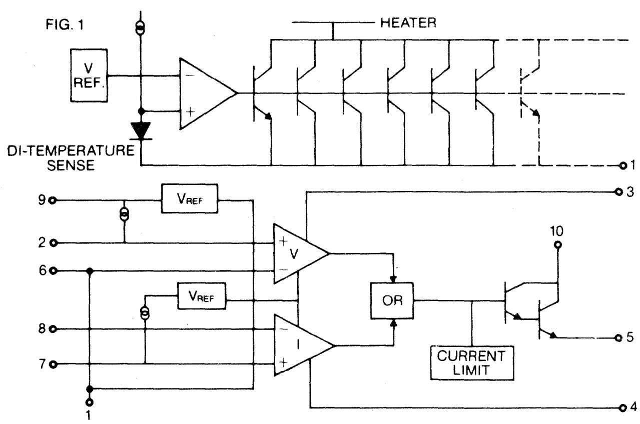
| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Input Voltage | $V_{AUX}$ | 0 | 40 | Volts |
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | | 220 | °C/Watt |
| Operating Ambient Temperature Range | $T_{AMB}$ | −30 | 115 | °C |
| Storage Temperature | $T_{STG}$ | −65 | 150 | °C |
| Lead Soldering Temperature | | | 300 | °C |

## ELECTRICAL CHARACTERISTICS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Auxilary Input Voltage[1] | $V_{AUX}$ | 14 | 40 | Volts |
| Auxilary Input Current[2, 6] | $I_{AUX}$ | 8 | 150 | mA |
| Reference Current-Voltage Loop[3] | $I_{REF-V}$ | | 1 | mA |
| Reference Current-Current Loop[4] | $I_{REF-C}$ | | 1.5 | mA |
| Thermal Resistance | $\theta_{JA}$ | | 220 | C/Watt |
| Output Current | $I_{OUT}$ | | 1 | mA |
| Output Short Circuit Current | $I_{SC}$ | | 3 | mA |
| Regulation—Line for a 5V Change in $V_{AUX}$ | $REG_{(LINE)}$ | | .05% ±1 | mV |
| Regulation—Load for a 0-1 mA Change in Output Current | $REG_{(LOAD)}$ | | .003% $V_{AUX}$ ±1 | mV |
| Temperature Coefficient | $T_C$ | | .005% $V_{OUT}$ | Volts / °C |
| Common Mode Rejection | | 60 | | dB |
| Input Offset Voltage[5] (Voltage Amp) | | | 40 | mV |
| Input Offset Voltage[5] (Current Amp) | | | 40 | mV |

## FUNCTIONAL BLOCK DIAGRAM

FIG. 1



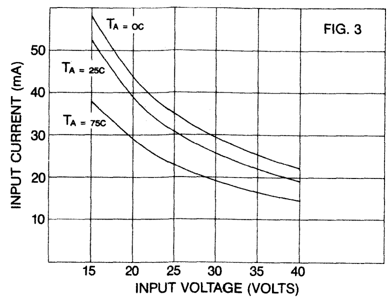

PIN CONNECTIONS
1. $V_{AUX}$ COMMON
2. $V_{ADJ}$
3. VOLTAGE LOOP COMPENSATION
4. CURRENT LOOP COMPENSATION
5. OUTPUT
6. VOLTAGE SENSE
7. CURRENT OFFSET
8. CURRENT SENSE
9. VOLTAGE REFERENCE CURRENT ADJUST
10. $V_{AUX}$ POSITIVE

## ORDERING INFORMATION

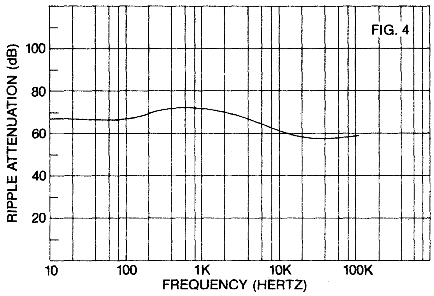
| MODEL | PRICE QTY | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
| LAS 3700 | $14.00 | $13.75 | $13.15 | $12.05 | $11.65 | $10.75 | $9.80 | $9.00 |

# OPERATIONAL DATA

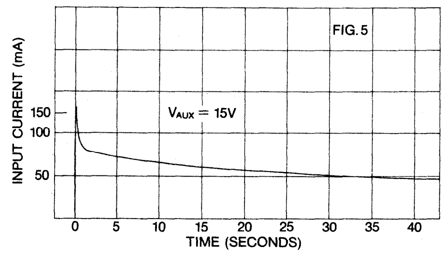
TYPICAL INPUT CURRENT VS INPUT VOLTAGE



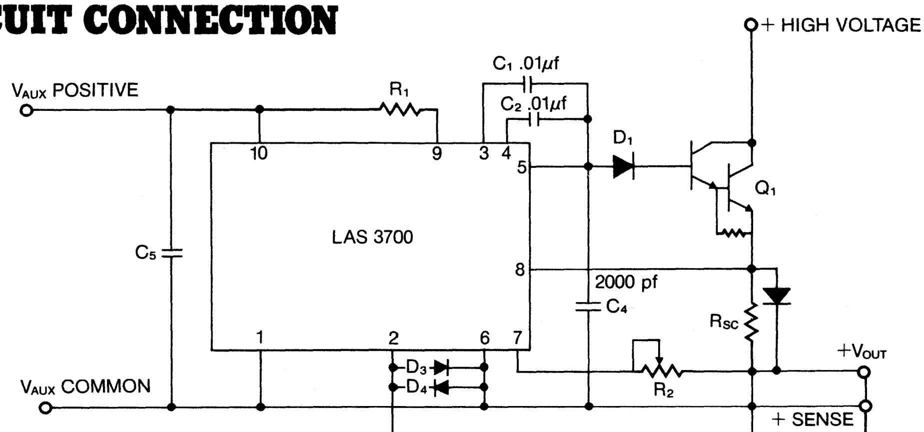

TYPICAL RIPPLE ATTENUATION VS FREQUENCY




TYPICAL INPUT CURRENT VS TIME




# TYPICAL CIRCUIT CONNECTION



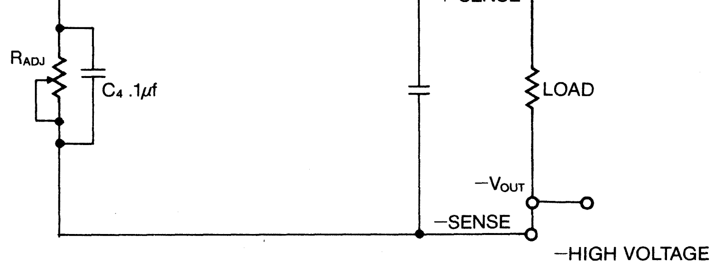



FIG. 2

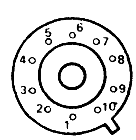
**NOTES**

1. THE AUXILIARY INPUT VOLTAGE MUST FLOAT AND BE ELECTRICALLY ISOLATED FROM THE UNREGULATED HIGH VOLTAGE SUPPLY.
2. THE AUXILIARY INPUT CURRENT IS THE SUM OF THE REGULATOR BIAS CURRENT AND THE ON CHIP HEATER CURRENT. SINCE HEATER CURRENT IS A FUNCTION OF AMBIENT CONDITIONS, THE AUXILIARY INPUT CURRENT WILL VARY OVER A WIDE RANGE. REFER TO FIG. 3 FOR $I_{AUX}$ DEPENDENCE ON TEMP. AND VOLTAGE.
3. $I_{REF}$ IS PROGRAMMED BY $R_1$ VIA THE RELATIONSHIP $I_{REF} = \frac{7.9}{R_1\ (K)}$. $I_{REF}$ IS LIMITED TO 1 mA TO MINIMIZE ON CHIP TEMPERATURE GRADIENTS.
4. THERMAL RESISTANCE IS PURPOSEFULLY SET TO 220°C/WATT TO MINIMIZE THE POWER REQUIREMENTS OF THE ON-CHIP HEATER.
5. AN OFFSET IS PROGRAMMED INTO BOTH THE CURRENT AND VOLTAGE AMPLIFIER TO INSURE BOTH OUTPUT VOLTAGE AND CURRENT CAN BE ADJUSTED TO ZERO.
6. THE AUXILIARY CURRENT SUPPLY SHOULD BE CAPABLE OF SUPPLYING A 150 mA TRANSIENT AT TURN ON TO INSURE RAPID HEATER TEMPERATURE STABILIZATION.

**DESIGN CONSIDERATIONS**

1. CONSTANT VOLTAGE—SELECT $R_1$ ACCORDING TO THE RELATIONSHIP $I_{REF_1} = \frac{7.9}{R_1\ (K)}$ $V_{OUT} = (I_{REF})\ (R_{ADJ})$ $I_{REF}$ IS LIMITED TO 1 mA MAX.
2. CONSTANT CURRENT—SELECT $R_2$ TO GIVE A DESIRED OFFSET ACCORDING TO THE RELATIONSHIP $V_{OFFSET} = (1\ mA)\ (R_2)$—SELECT $R_{SC}$ ACCORDING TO THE RELATIONSHIP $I_{LOAD}\ R_{SC} = V_{OFFSET}$ WHERE $I_{LOAD}$ IS THE DESIRED CONSTANT CURRENT ($R_2$ IN KΩ).
3. $D_1$, $D_3$, AND $D_4$ ARE NECESSARY TO PROTECT THE LAS 3700 FROM TRANSIENT OR SHORT CIRCUIT CONDITIONS.
4. $D_2$ IS NECESSARY TO PROTECT THE 3700 FROM A FAILURE OF THE SERIES PASS ELEMENT.
5. $C_1$, $C_2$, AND $C_4$ ARE COMPENSATION CAPACITORS FOR THE VOLTAGE AND CURRENT AMPLIFIERS.
6. FOR OPTIMUM REGULATION, LIMIT THE CURRENT FROM PIN 5 TO AS LOW A VALUE AS POSSIBLE (1 mA MAX) TO PREVENT REGULATION DEGRADATION DUE TO THERMAL GRADIENT EFFECTS.
7. TO PREVENT EXCESSIVE ON CHIP HEATER CURRENTS, THE LAS 3700 SHOULD BE LOCATED IN AN AREA PROTECTED FROM AIR CURRENTS SUCH AS CAUSED BY COOLING FANS.
8. $Q_1$ MAY BE REPLACED BY A TRIPLE DARLINGTON OR OTHER GAIN CONFIGURATION IF MORE CURRENT IS REQUIRED. THE REGULATOR OUTPUT VOLTAGE IS LIMITED BY THE $BV_{CEO}$ OF $Q_1$.
9. $C_4$ IS NECESSARY IN APPLICATIONS REQUIRING VERY LOW OUTPUT NOISE.

**TO-96 10-TERMINAL**




Bottom View

# LAS 2000 SERIES REGULATORS

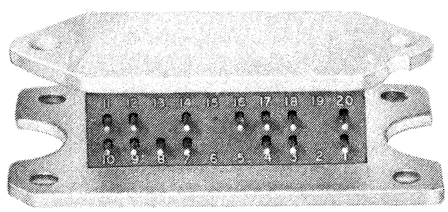
## 5 AMP, 85 WATT POSITIVE AND NEGATIVE

## FEATURES

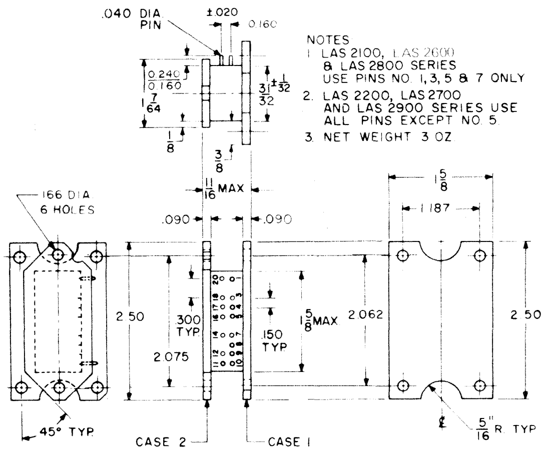
- 0.01% regulation — line
- 0.2% regulation — load
- 0.007%/° C temperature coefficient
- Short circuit and overload protection
- Thermal protection
- Remote programming
- Remote sensing
- Electrically isolated case
- Dual-tracking connection
- Increased power loading capability with external

## DESCRIPTION

The LAS 2100, 2200 and 2700-2800 Series of Power Hybrid Voltage Regulators is designed for applications requiring a well regulated output voltage for load current variations up to 5.0 amperes. A key feature of the LAS series of Power Hybrid Voltage Regulators is its construction. A high degree of thermal isolation between the heat generating power elements and the heat sensitive control and reference elements is achieved by the placing of the power section on the heat-dissipating base of the unit, and the control stage on the heat-dissipating upper surface. This thermal isolation results in extremely low thermal drift characteristics for changes in power levels. In addition, a unique thermal power limiting circuit is built into the power section of the unit for increased operational reliability. This reliability is accentuated by a demonstrated MTBF of 100,000 hrs.




## OUTLINE DRAWING




**OUTLINE DRAWING, POWER HYBRID REGULATOR, LAS 2000 SERIES**

## ELECTRICAL CHARACTERISTICS

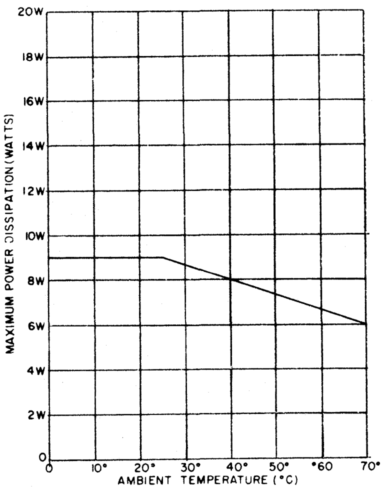
| PARAMETER | SYMBOL | CONDITIONS | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Input voltage | $V_{IN}$ | | 9.6 | 40.0 | volts |
| Output voltage[1] | $V_O$ | | 2.5 | 28.0 | volts |
| Input-output differential[2][9] | $V_{IN}$-$V_O$ | | 4.6[10] | 37.5V | volts |
| *Input-output differential[3][9] | $V_{IN}$-$V_O$ | | 2.5 | 37.5V | volts |
| Output current[1] | $I_O$ | | 0 | 5.0 | amps |
| Standby current | $I_Q$ | | | 10.0 | mA |
| Power dissipation | $P_D$ | Plate #1 @ 25° C | | 85 | watts |
| Power dissipation[8] | $P_D$ | Free Air @ 25° C | | 9.0 | watts |
| Thermal resistance junction—Case #1 | $\theta_J$—C1 | | | 2.0 | ° C/watt |
| Thermal resistance junction—Free Air | $\theta_J$—FA | | | 15.0 | ° C/watt |
| Storage temperature[4] | $T_S$ | | −55 | +125 | ° C |
| Power transistor junction temperature | $T_J$ | | | +200 | ° C |
| Regulation line[5] | | | | 0.01 | %/$^\Delta V_{IN}$ |
| Regulation load[6] | | | | 0.2 | % |
| *Programming resistance | | | | 1000 nominal | ohms/volt |
| *Programming voltage | | | | one/one | volt/volt |
| Temperature coefficient | T.C. | | | 0.007 | %/° C |
| Ripple attenuation[7] | | $V_{IN}$ minimum $I_O$ maximum | 60 | | dB |

**NOTES:**
[1] Varies with model number.
[2] Single DC input voltage.
*[3] Separate DC input voltages for power circuit (pin 1) and control circuit (pin 20) $V_{IN}$ minimum = 9.5 volts at pin 20.
[4] Maximum storage temperature limited by tantalum capacitor.
[5] $I_O$ constant for entire range from $V_{IN}$ minimum to $V_{IN}$ maximum.
[6] $V_{IN}$ constant for entire range from 0 to full load.
[7] Ripple attenuation is 54dB minimum for 20V, 24V, and 28V models.
[8] See figures on following pages.
[9] Minimum input-output differential based on $T_J \geq 25°C$.
[10] 5.2 for Model LAS 2700 and LAS 2800 series.
[11] Voltages and currents are negative for models LAS 2700 and LAS 2800 series.

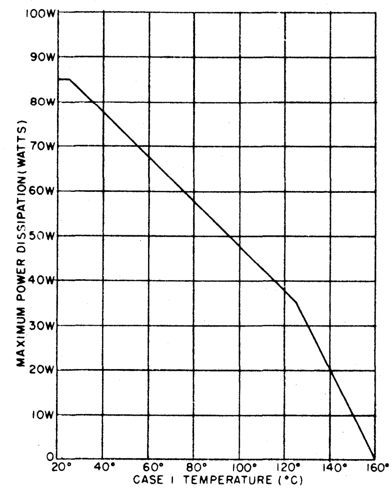
*This parameter or note applies only to LAS 2200 and 2700 series.

# LAS 2000 SERIES

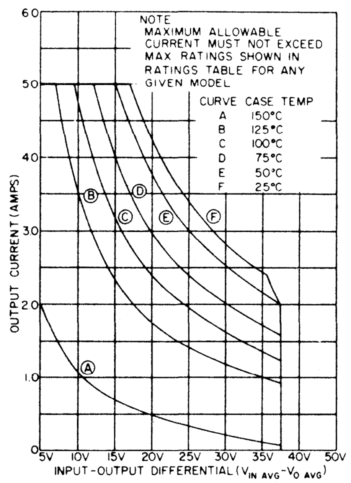
## OPERATIONAL DATA



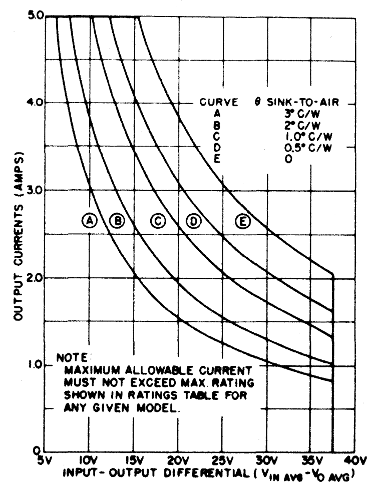

FREE AIR DERATING CURVE



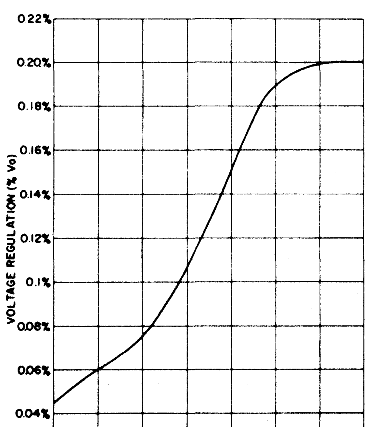

POWER DERATING CURVE AS A FUNCTION OF CASE 1 TEMPERATURE



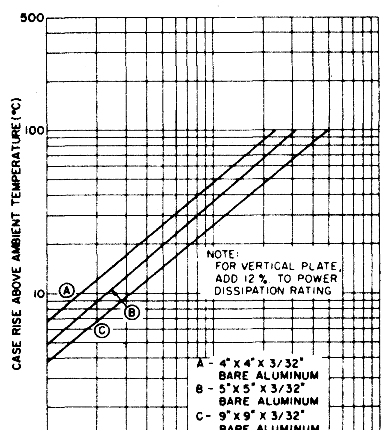

DC SAFE OPERATING AREA AS A FUNCTION OF MODULE CASE TEMPERATURE, FOR LAS 2100, LAS 2200, LAS 2600, LAS 2700, LAS 2800 AND LAS 2900 MODELS




DC SAFE OPERATING AREA AS A FUNCTION OF HEATSINK THERMAL RESISTANCE TO AIR AT 40°C AMBIENT TEMPERATURE, FOR LAS 2100, LAS 2200, LAS 2600, LAS 2700, LAS 2800, AND LAS 2900 MODELS



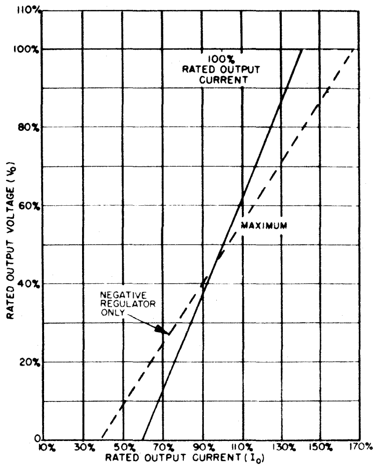

LOAD REGULATION IN % (VOLT) VS LOAD CHANGE



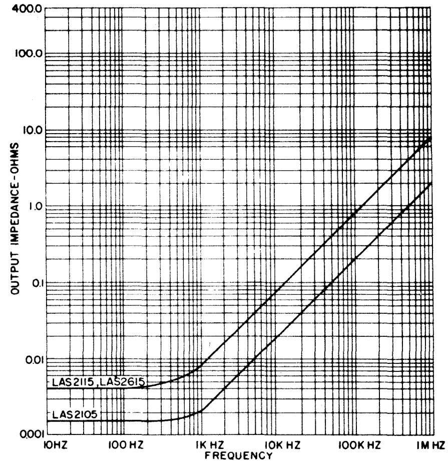

TYPICAL HEAT SINKING DATA FOR HORIZONTAL PLATE

# LAS 2000 SERIES

## OPERATIONAL DATA




SHORT CIRCUIT PROTECTION CHARAC-
TISTIC




TYPICAL OUTPUT IMPEDANCE VS
FREQUENCY

# ORDERING INFORMATION

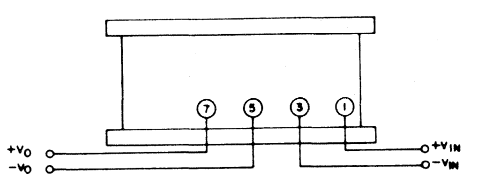
## LAS 2100, LAS 2200 SERIES 5 AMPS, 85 WATTS POSITIVE REGULATOR

| MODEL | $V_O$ VOLTS | PRICE QTY | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 |
| LAS 2105 | 5 fixed | $47.00 | $47.00 | $35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 2205 | 5 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2206 | 6 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2112 | 12 fixed | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2212 | 12 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2115 | 15 fixed | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2215 | 15 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2124 | 24 fixed | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2224 | 24 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |
| LAS 2228 | 28 ADJ | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 |

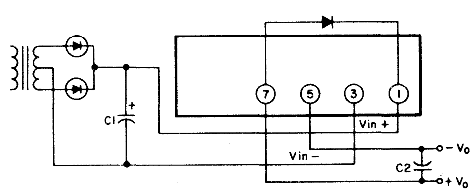
## LAS 2700, LAS 2800 SERIES 5 AMPS, 85 WATTS NEGATIVE REGULATOR

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| LAS 2705 | − 5 ADJ | $47.00 | $44.00 | $36.00 | $32.00 | $32.00 | $28.00 | $26.00 |
| LAS 2812 | −12 fixed | 47.00 | 44.00 | 36.00 | 32.00 | 32.00 | 28.00 | 26.00 |
| LAS 2712 | −12 ADJ | 47.00 | 44.00 | 36.00 | 32.00 | 32.00 | 28.00 | 26.00 |
| LAS 2715 | −15 ADJ | 47.00 | 44.00 | 36.00 | 32.00 | 32.00 | 28.00 | 26.00 |
| LAS 2724 | −24 ADJ | 47.00 | 44.00 | 36.00 | 32.00 | 32.00 | 28.00 | 26.00 |

# CONNECTION DIAGRAMS
# POSITIVE REGULATOR



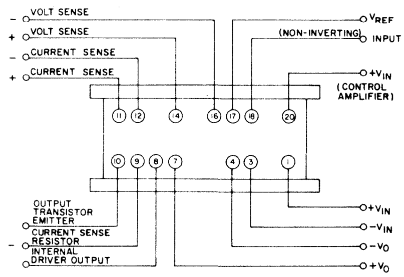

4 PIN POWER HYBRID VOLTAGE REGULATOR



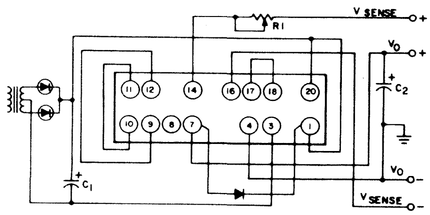

4 PIN POWER HYBRID VOLTAGE REGULATOR CIRCUIT

# LAS 2000 SERIES

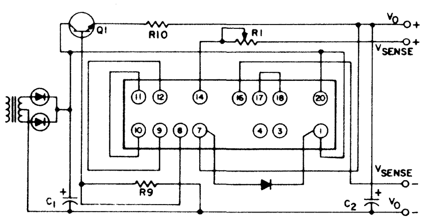
## CONNECTION DIAGRAMS POSITIVE REGULATOR



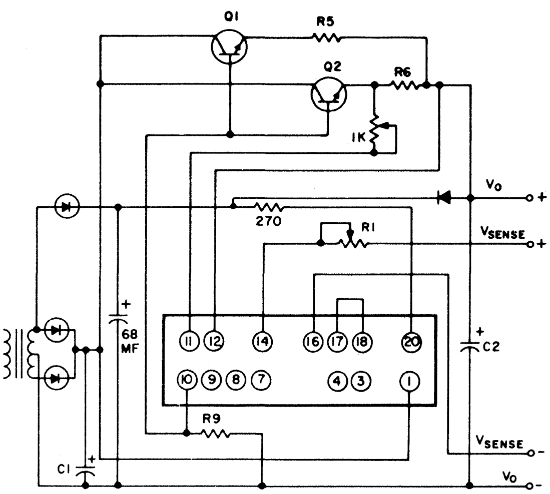

**14 PIN POWER HYBRID VOLTAGE REGULATOR**



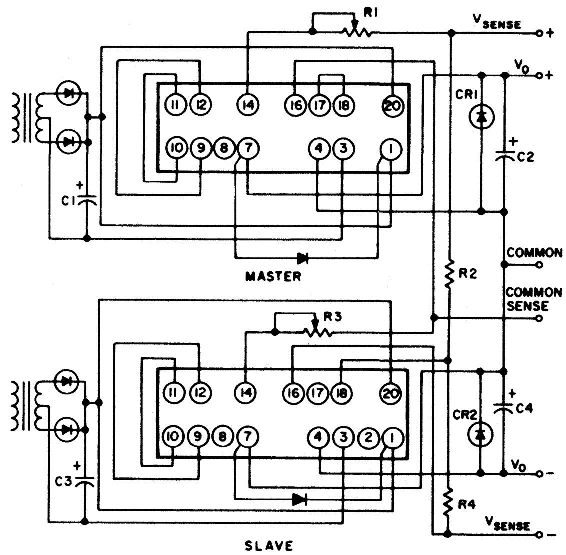
**POSITIVE POWER HYBRID VOLTAGE REGULATOR CIRCUIT**



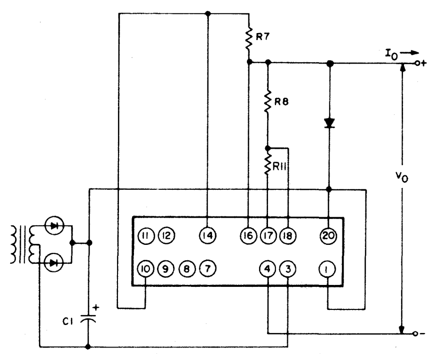
**POWER HYBRID VOLTAGE REGULATOR USED WITH PARALLEL PASS TRANSISTOR FOR HIGHER OUTPUT CURRENT**




**POWER HYBRID VOLTAGE REGULATOR USED AS A DRIVER FOR HIGHER CURRENT OUTPUTS USING PEAK DETECTOR FOR CONTROL AMPLIFIER INPUT VOLTAGE**



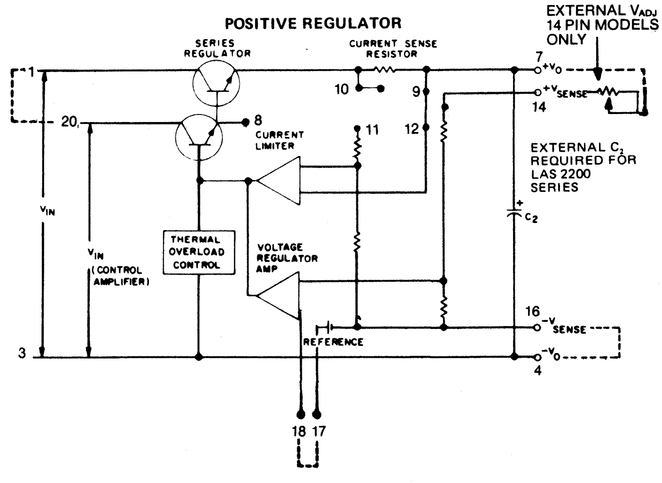

**DUAL TRACKING POWER HYBRID VOLTAGE REGULATOR CIRCUIT**




NOTE: $V_{IN}$ MIN = 9.5V + $V_O$

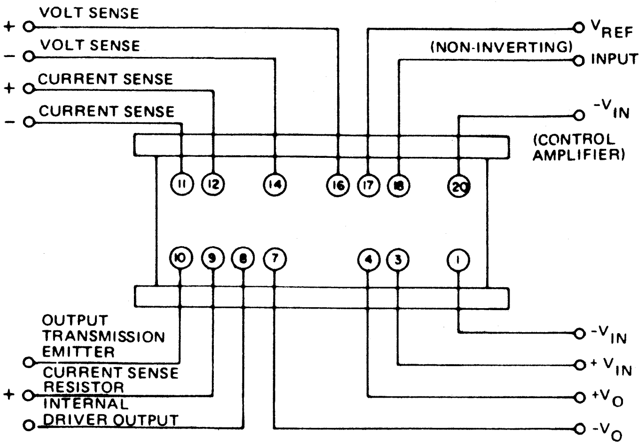
**POWER HYBRID CURRENT REGULATOR CIRCUIT**

# FUNCTIONAL BLOCK DIAGRAM

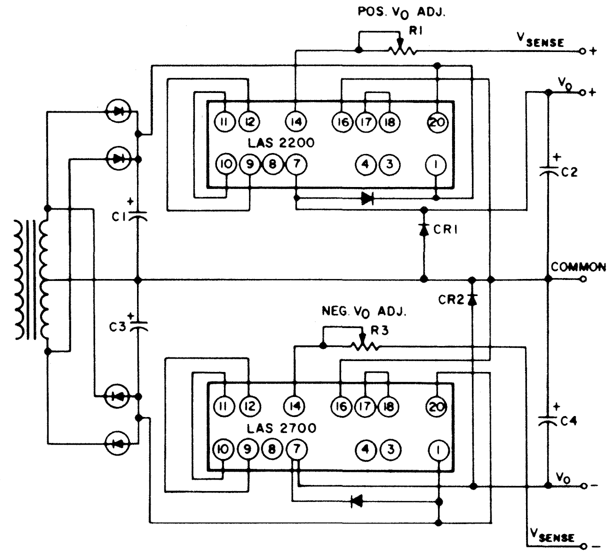


# LAS 2000 SERIES

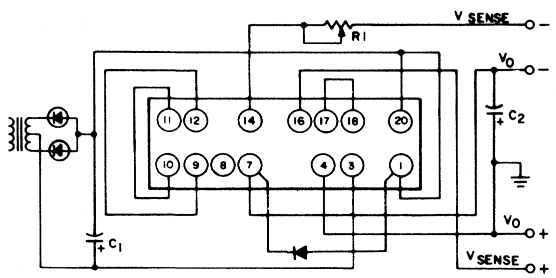
## NEGATIVE REGULATORS CONNECTION DIAGRAMS



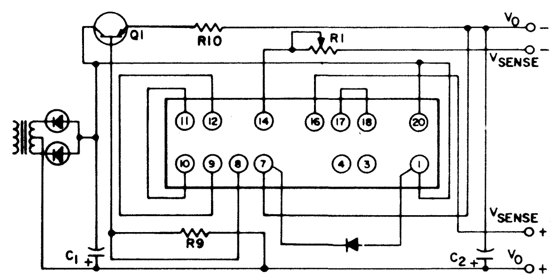

**14 PIN POWER HYBRID VOLTAGE REGULATOR**




**DUAL, POS/NEG REGULATORS USING COMPLEMENTARY REGULATOR WITH COMMON INPUT**

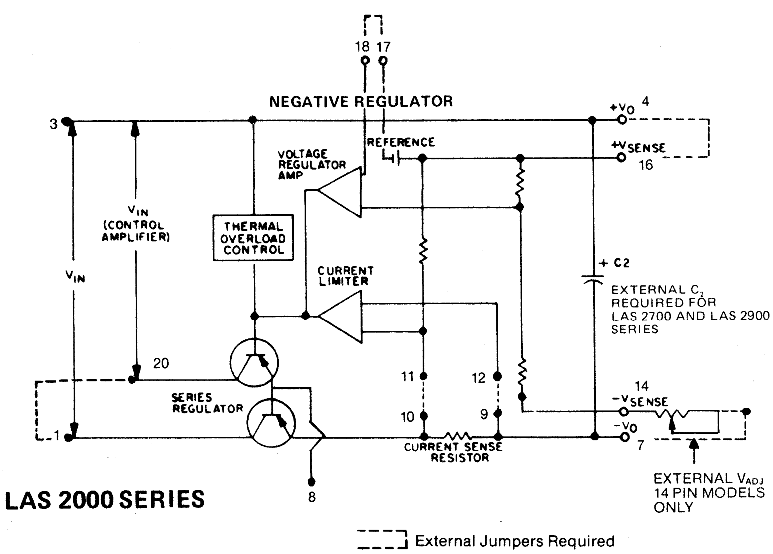



**NEGATIVE POWER HYBRID VOLTAGE REGULATOR CIRCUIT**



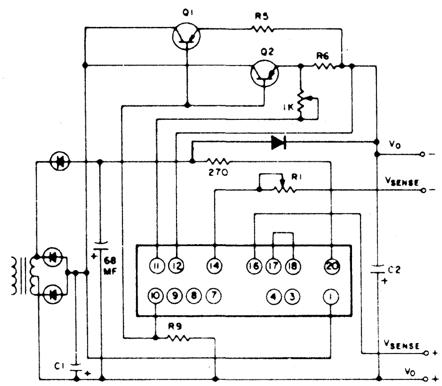

**POWER HYBRID VOLTAGE REGULATOR USED WITH PARALLEL PASS TRANSISTOR FOR HIGHER OUTPUT CURRENT**

## FUNCTIONAL BLOCK DIAGRAM

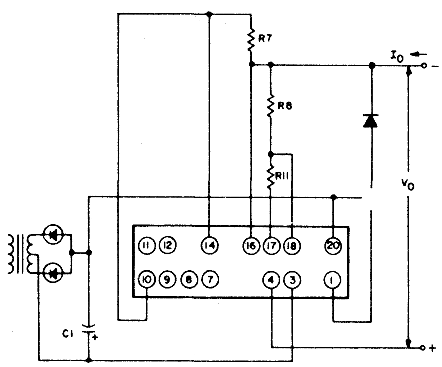


# LAS 2000 SERIES

## CONNECTION DIAGRAMS NEGATIVE REGULATORS




**POWER HYBRID VOLTAGE REGULATOR USED AS A DRIVER FOR HIGHER CURRENT OUTPUTS USING PEAK DETECTOR FOR CONTROL AMPLIFIER INPUT VOLTAGE**




NOTE: $V_{IN}$ MIN = 9.5V + $V_O$

**POWER HYBRID CURRENT REGULATOR CIRCUIT**

### NOTES

1. Minimum value of input filter capacitors C1 and C3 is determined by: C1, C3 = $I_O$ (1000 mfd/amp) recommended.
2. Minimum value of output capacitors C2 and C4 is determined by C2, C4 = $I_O$ (100mfd/amp).
3. Minimum value of output voltage adjust resistors R1 and R3 for LAS 2205 and LAS2905 is 3K ohms. See note 4 to determine value for all other models.
4. Minimum value of output voltage adjust resistros R1 and R3 is determined by: R1, R3 = (0.25$V_O$ x 1000Ω/V) ohms wirewound. Use next highest standard value.
5. Values of tracking reference voltage divider resistors R2 and R4 for all models except LAS 2205, and 2206 are determined by:
   a) R2 = (2000$V_O$ –7150) ohms, ± 1%, ½W film
   b) R4 = 7.15K ohms, ± 1%, ½W film
6. Value of tracking reference voltage divider resistor R2 and R4 for LAS 2205 is:
   a) R2 = 7.50K ± 1% ½W film
   b) R4 = 2.43K ± 1% ½W film
7. Value of tracking reference voltage divider resistor R2 and R4 for LAS 2206 and LAS 2406 is:
   a) R2 = 8.06K ± 1% ½W film
   b) R4 = 4.02K ± 1% ½W film
8. Values of current sharing resistors R5 and R6 are determined by: R5, R6 = (N x 0.5V)/MAX Io ohms ± 3% wirewound where N = number of emitter current sharing resistors required.
9. Nominal value of the current sharing resistor R10 for Figs. 58 & 64 is determined from table below:

| R10 | Model |
|---|---|
| .100Ω | LAS 2205, 2206, 2212, 2215, 2705, 2712, 2715 |
| .150Ω | LAS 2220 |
| .200Ω | LAS 2224, 2724 |
| .250Ω | LAS 2228, 2728 |

10. Value of current sensing resistor R7 is determined by R7 = (2.4V)/$I_O$ ohms, nominal, wirewound.
11. R8 (part of reference voltage divider) = 750 ohms nominal, 1/2 W film resistor for all models except LAS 2205 and 2206.
12. R8 for LAS 2206 is 3.2K nominal, 1/2W film.
13. R8 for LAS 2205 is not required.
14. Rectifiers CR1 and CR2 should be rated at peak inverse voltage of 50 V and forward current equal at least to maximum rated Io.
15. Value of $I_{cbo}$ drain resistor R9, is determined by: R9 = ($V_O$)/(N x MAX $I_{cbo}$) ohms, ± 5% composition where N = number of external series pass transistors.
16. All fixed resistors shown on diagrams with given values in ohms are ¼W composition.
17. Temperature rise of case 2, $\Delta TC_2$, is given by the following:
   a) For no external heat sink on case 2.
   $\Delta TC_2 = 0.25 P_D \theta_{J\,1-A}$
   b) For an external heat sink on case 2 with thermal resistance $\theta$

$$\Delta TC_2 = \frac{\theta \text{ - } HS_2}{50^\circ \text{ C/W} + \theta \text{ } HS_2} \times P_D \, \theta_{J1\text{-}A}$$

18. Nominal values of R8 and R11 1/2W film resistors (Fig. 66):

| R8 Ohms | R11 Ohms | Model |
|---|---|---|
| ∞(open) | 0(short) | LAS 2705, |
| 15,500 | 4,500 | LAS 2706; |
| 9,700 | 12,300 | LAS 2712, |
| 9,700 | 11,700 | LAS 2715, |
| 9,700 | 10,700 | LAS 2724 |
| 9,700 | 10,300 | LAS 2728 |

# LAS 3000 SERIES REGULATOR

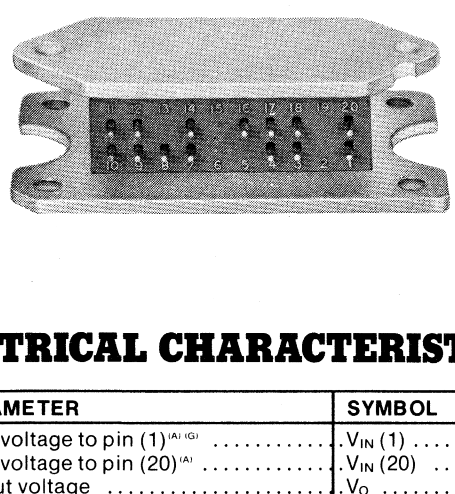
## 10 AMP, 140 WATT POSITIVE REGULATOR

## FEATURES

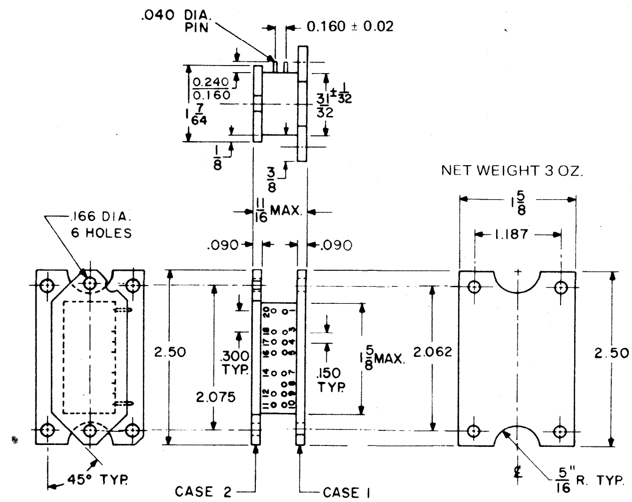
- 0.01% regulation line
- 0.2% regulation load
- 0.015%/° C temperature coefficient
- Short circuit and overload protection
- Remote programming
- Remote sensing
- Electrically isolated case
- Dual-tracking connection

## DESCRIPTION

The LAS 3200 Series of Power Hybrid Voltage Regulators is designed for applications requiring a well regulated output voltage for load current variations up to 10 amperes. A key feature of the LAS series of Power Hybrid Voltage Regulators is its construction. A high degree of thermal isolation between the heat generating power elements and the heat sensitive control and reference elements is achieved by the placing of the power section on the heat-dissipating base of the unit, and the control stage on the heat-dissipating upper surface. This thermal isolation results in extremely low thermal drift characteristics for changes in power levels.



## OUTLINE DRAWING




OUTLINE DRAWING, POWER HYBRID REGULATOR, LAS 3000 SERIES

## ELECTRICAL CHARACTERISTICS

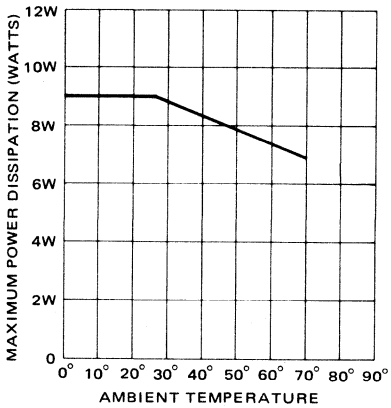
| PARAMETER | SYMBOL | CONDITION | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Input voltage to pin (1)[A][G] | $V_{IN}$ (1) | | 5.2 | 40.0 | volts |
| Input voltage to pin (20)[A] | $V_{IN}$ (20) | | 7.9 | 40.0 | volts |
| Output voltage | $V_O$ | | 2.7 | 29.4 | volts |
| Input-output differential[A][F] | ($V_{IN}$ (1)-$V_O$) | | 2.5 | 28.6 | volts |
| Input-output differential[B][F] | ($V_{IN}$ (20)-$V_O$) | | 5.2 | 28.6 | volts |
| Output current | $I_O$ | | | 10.0 | amps |
| Standby current | $I_Q$ (1) | | | 20.0 | mA |
| Standby current | $I_Q$ (20) | | | 7.0 | mA |
| Power dissipation | $P_D$ | Plate #1 @ 25° C | | 140 | watts |
| Power dissipation | $P_D$ | Free Air @ 25° C Amb | | 9 | watts |
| Thermal resistance junction — Case #1 | $\theta_J$-C1 | | | 1.25 | ° C/watt |
| Thermal resistance junction — Free Air | $\theta_J$-FA | | | 15 | ° C/watt |
| Storage temperature | $T_S$ | | −55 | +150 | ° C |
| Power transistor junction temperature | $T_J$ | | | +200 | ° C |
| Regulation line[C] | | | | 0.01 | %/$\Delta V_{IN}$ |
| Regulation load[D] | | | | 0.2 | % |
| Programming resistance | | | | 1000 nominal | ohms/volt |
| Programming voltage | | | | one/one | volt/volt |
| Temperature coefficient | | | | 0.015 | %/° C |
| Ripple attenuation[E] | | $V_{in}$ (1) minimum $I_O$ maximum | 60 | | dB |

**NOTES:**

[A] Separate DC input voltages for power circuit (pin 1) and control circuit pin (20).
[B] Common input voltages for power circuit (pin 1) and control pin (20).
[C] $I_O$ constant for entire input voltage range from [$V_{IN}$ (1) & $V_{IN}$ (20) min.] to [$V_{in}$(1) (20) max.]
[D] $V_{IN}$ constant for entire range from 0 to full load.
[E] Ripple attenuation is 54 dB min. for 24V and 28V models.
[F] Minimum input-output differential based on $T_J$, > 25° C.
[G] Maximum input voltage is 30V for LAS 3205 and LAS 3206.

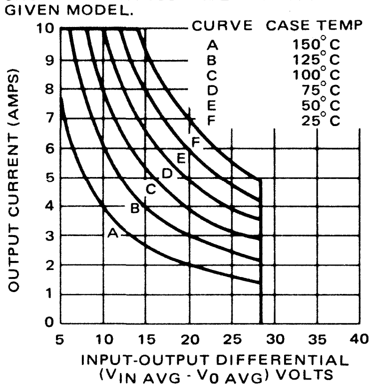
# LAS 3000 SERIES

## OPERATIONAL DATA

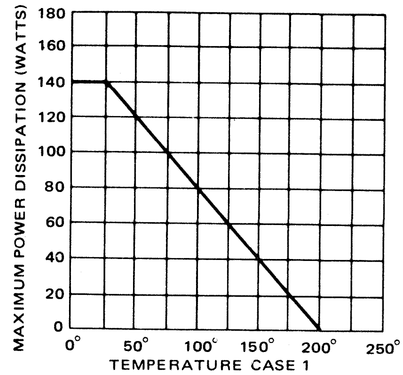



**FREE AIR DERATING CURVE**

NOTE: MAXIMUM ALLOWABLE CURRENT MUST NOT EXCEED MAX. RATINGS SHOWN IN RATINGS TABLE FOR ANY GIVEN MODEL.

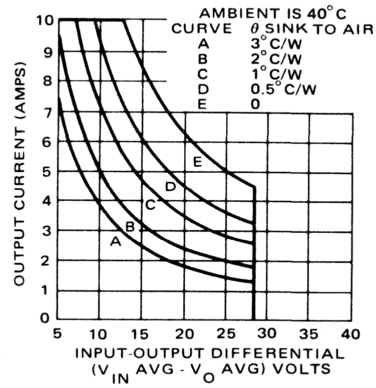



**DC SAFE OPERATING AREA AS A FUNCTION OF MODULE CASE TEMPERATURE, FOR LAS 3000 SERIES**

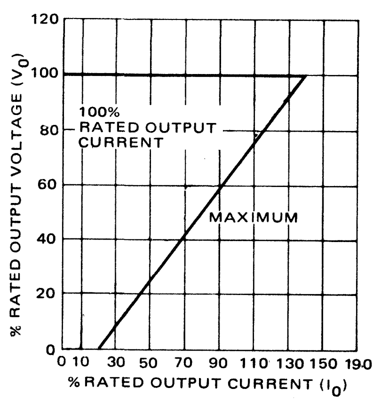



**POWER DERATING CURVE AS A FUNCTION OF CASE 1 TEMPERATURE**

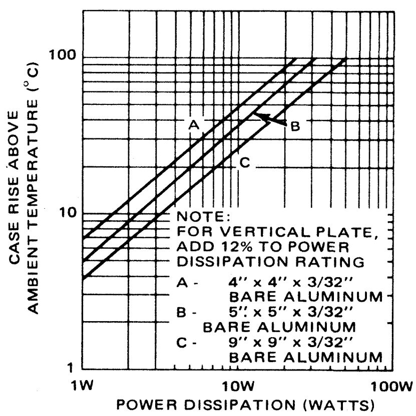
NOTE: MAXIMUM ALLOWABLE CURRENT MUST NOT EXCEED MAX. RATINGS SHOWN IN RATINGS TABLE FOR ANY GIVEN MODEL.




**DC SAFE OPERATING AREA AS A FUNCTION OF HEATSINK THERMAL RESISTANCE TO AIR AT 40°C AMBIENT TEMPERATURE FOR LAS 3000 SERIES**




**SHORT CIRCUIT PROTECTION CHARACTERISTIC**




**TYPICAL HEAT SINKING DATA FOR HORIZONTAL PLATE**

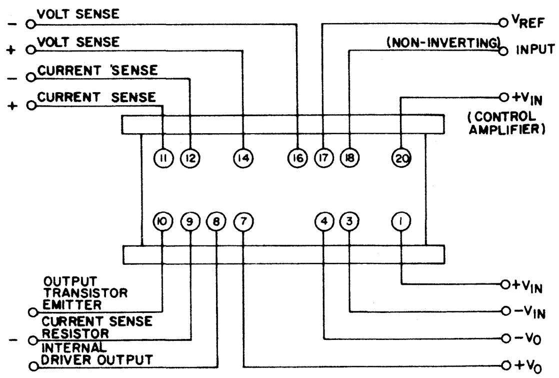
# ORDERING INFORMATION

## LAS 3200 10 AMPS 140 WATTS

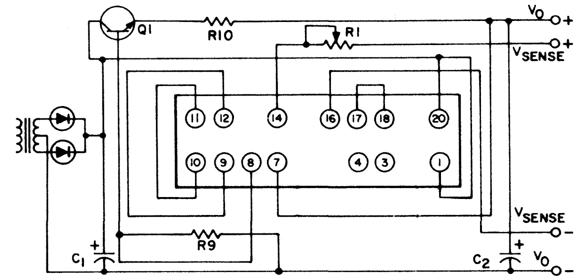
| MODEL | $V_O$—ADJ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 |
|---|---|---|---|---|---|---|---|---|
| LAS 3205 | 5 | $54.00 | $47.00 | $41.00 | $35.00 | $35.00 | $30.00 | $29.00 |
| LAS 3212 | 12 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 3215 | 15 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 3224 | 24 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 3228 | 28 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |

# LAS 3000 SERIES

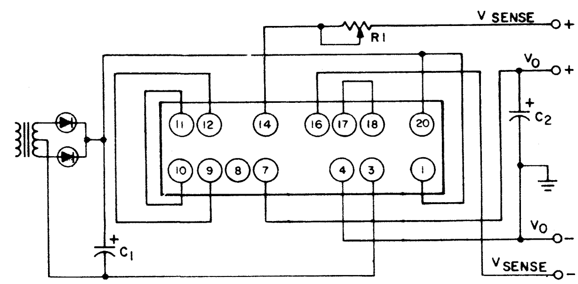
## CONNECTION DIAGRAMS



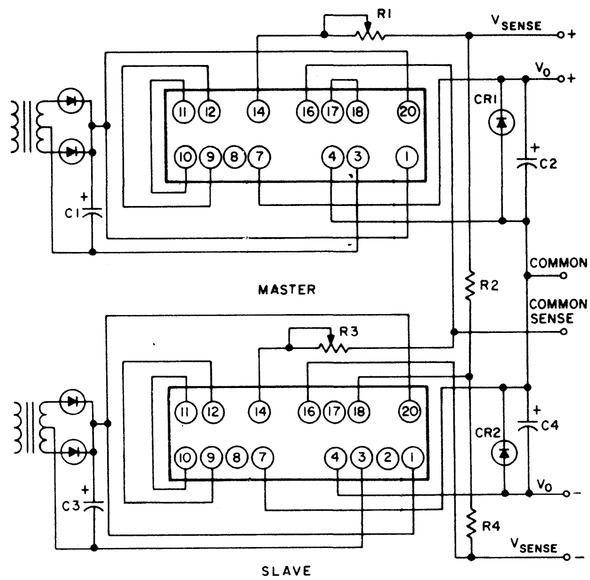

14 PIN POWER HYBRID VOLTAGE REGULATOR




POWER HYBRID VOLTAGE REGULATOR USED WITH PARALLEL PASS TRANSISTOR FOR HIGHER OUTPUT CURRENT

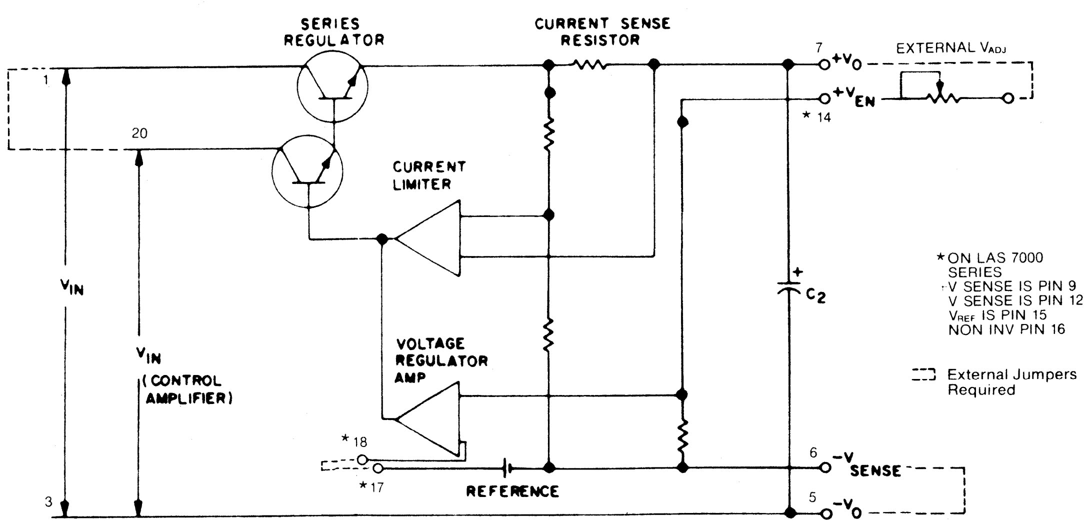



POSITIVE POWER HYBRID VOLTAGE REGULATOR CIRCUIT




DUAL TRACKING POWER HYBRID VOLTAGE REGULATOR CIRCUIT

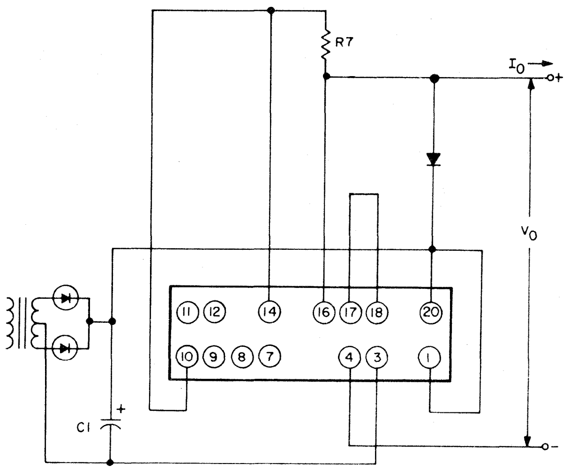
## FUNCTIONAL BLOCK DIAGRAM




**LAS 3000, LAS 5000 AND LAS 7000**
**SEE LAS 2000 SERIES FOR LAS 3000 PIN CORRECTION.**

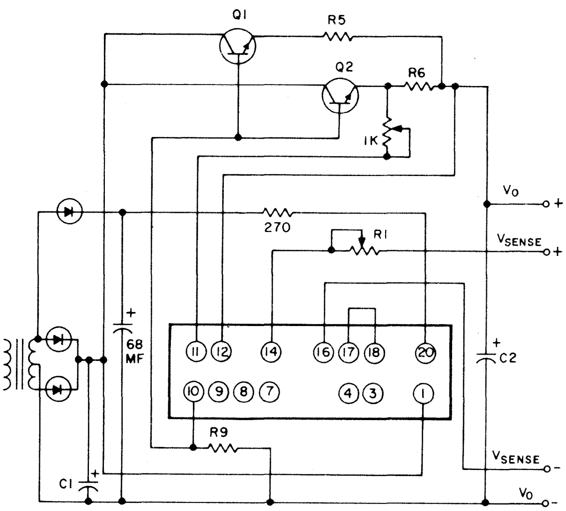
# LAS 3000 SERIES

## CONNECTION DIAGRAMS




NOTE: $V_{IN}$ MIN = 7.9 + $V_O$

**POWER HYBRID CURRENT REGULATOR CIRCUIT**




**POWER HYBRID VOLTAGE REGULATOR USED AS A DRIVER FOR HIGHER CURRENT OUTPUTS USING PEAK DETECTOR FOR CONTROL AMPLIFIER INPUT VOLTAGE**

### NOTES

1. Minimum value of input filter capacitors C1 and C3 is determined by: C1, C3 = $I_O$X (1000mfd/amp) recommended.
2. Minimum value of output capacitors C2 and C4 is determined by: C2, C4 = $I_O$X (100 mfd/amp).
3. Minimum value of output voltage adjust resistors R1 and R3 for LAS 3205 is 3K ohms. See note 4 to determine value for all other models.
4. Minimum value of output voltage adjust resistors R1 and R3 is determined by: R1, R3 = (0.25$V_O$ x 1000Ω/V) ohms
5. Values of tracking reference voltage divider resistors R2 and R4 for all models are determined by:
   a) R2 = (2000$V_O$ − 2490) ohms ± 1%, ½W film
   b) R4 = 2.49K ohms, ± 1%, ½W film
6. Values of current sharing resistors R5 and R6 are determined by: R5, R6 = (N x 0.5V)/MAX Io ohms ± 3% wirewound where N = number of emitter current sharing resistors required.
7. Nominal value of the current sharing resistor R10 for Fig. 85 is determined from table below:

| R10 | Model |
|---|---|
| .05Ω | LAS 3205, 3206 |
| .064Ω | LAS 3212, 3215, 3224 |
| .075Ω | LAS 3228 |

8. Value of current sensing resistor R7 is determined by R7 = 2.5V/$I_O$ ohms, nominal, wirewound.
9. Rectifiers CR1 and CR2 should be rated at peak inverse voltage of 50V and forward current equal at least to maximum rated Io.
10. Value of $I_{cbo}$ drain resistor R9, is determined by R9 = ($V_O$)/(N x MAX $I_{cbc}$) ohms, ±5% composition where N = number of external series pass transistors.
11. All fixed resistors shown on diagrams with given values in ohms are ¼W composition.
12. Temperature rise of Case 2, $\Delta TC_2$, is given by the following:
    a) For no external heat sink on case 2.
    $\Delta TC_2 = 0.25 P_D \theta_{J1-A}$
    b) For an external heat sink on case 2 with thermal resistance θ

$$\Delta TC_2 = \frac{\theta - HS_2}{50^\circ\ C/W + \theta HS_2} \times P_D\, \theta_{J1\text{-}A}$$

# LAS 5000 SERIES REGULATOR

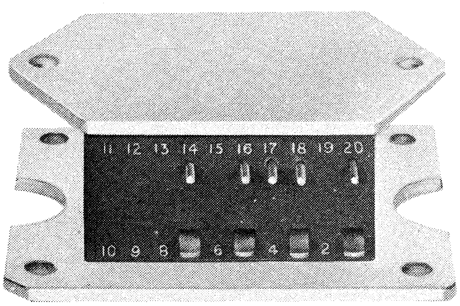
## 20 AMP, 270 WATT POSITIVE

## FEATURES

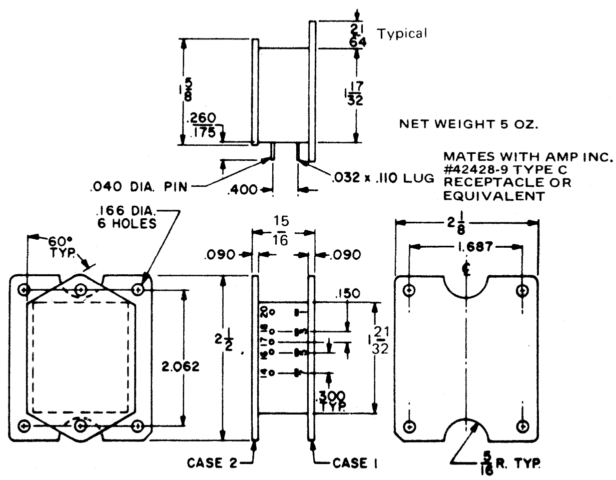
- 0.01% regulation line
- 0.2% regulation load
- 0.015%/° C temperature coefficient
- Short circuit and overload protection
- Remote programming
- Remote sensing
- Electrically isolated case
- Dual-tracking connection

## DESCRIPTION

The LAS 5200 Series of Power Hybrid Voltage Regulators is designed for applications requiring a well regulated output voltage for load current variations up to 20 amperes. A key feature of the LAS series of Power Hybrid Voltage Regulators is its construction. A high degree of thermal isolation between the heat generating power elements and the heat sensitive control and reference elements is achieved by the placing of the power section on the heat-dissipating base of the unit, and the control stage on the heat-dissipating upper surface. This thermal isolation results in extremely low thermal drift characteristics for changes in power levels.




## OUTLINE DRAWING




OUTLINE DRAWING, POWER HYBRID VOLTAGE REGULATOR, LAS 5000 SERIES

## ELECTRICAL CHARACTERISTICS

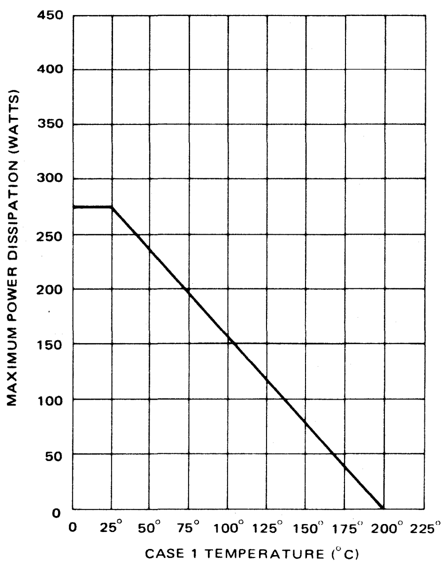
| PARAMETER | SYMBOL | CONDITION | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Input voltage to pin (1)[A][H] | $V_{IN}$ (1) | | 7.25 | 40.0 | volts |
| Input voltage to pin (20)[A][G] | $V_{IN}$ (20) | | 11.9 | 40.0 | volts |
| Output voltage | $V_O$ | | 4.75 | 29.4 | volts |
| Input-output differential[A][F] | ($V_{IN}$ (1)-$V_O$) | | 2.5 | 28.6 | volts |
| Input-output differential[B][F] | ($V_{IN}$ (20)-$V_O$) | | 7.20 | 28.6 | volts |
| Output current | $I_O$ | | | 20.0 | amps |
| Standby current | $I_Q$ (1) | | | 30.0 | mA |
| Standby current | $I_Q$ (20) | | | 7.0 | mA |
| Power dissipation | $P_D$ | Plate #1 @ 25° C | | 270 | watts |
| Power dissipation | $P_D$ | Free Air @ 25° C Amb | | 11 | watts |
| Thermal resistance junction—Case #1 | $\theta_J$-C1 | | | 0.65 | °C/watt |
| Thermal resistance junction—Free Air | $\theta_J$-FA | | | 12.0 | °C/watt |
| Storage temperature | $T_S$ | | −55 | +125 | °C |
| Power transistor junction temperature | $T_J$ | | | +200 | °C |
| Regulation line[C] | | | | 0.014 | %/$^{\Delta}V_{IN}$ |
| Regulation load[D] | | | | 0.2 | % |
| Programming resistance | | | | 1000 nominal | ohms/volt |
| Programming voltage | | | | one/one | volt/volt |
| Temperature coefficient | | | | 0.015 | %/° C |
| Ripple attenuation[E] | | $V_{in}$ (1) minimum $I_O$ maximum | 60 | | dB |

**NOTES:**

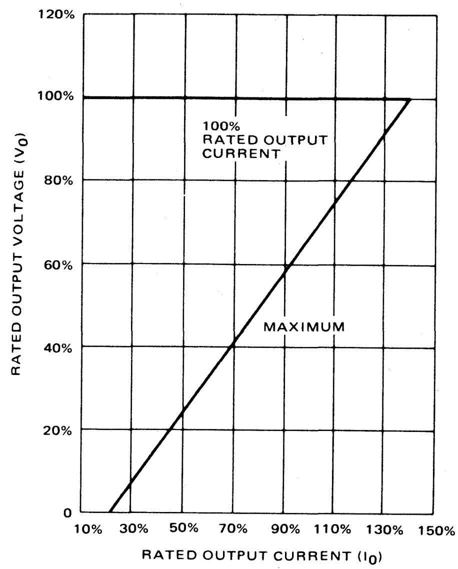
[A] Separate DC input voltages for power circuit (pin 1) and control circuit pin (20).
[B] Common input voltages for power circuit (pin 1) and control pin (20).
[C] $I_O$ constant for entire input voltage range from [$V_{IN}$ (1) & $V_{IN}$ (20) min.] to [$V_{in}$(1) (20) max.]
[D] $V_{IN}$ constant for entire range from 0 to full load.
[E] Ripple attenuation is 54 dB min. for 24V and 28V models.
[F] Minimum input-output differential based on $T_J$, > 25° C.
[G] For AC source to Pin 20 with source resistance less than 10 ohms, minimum VAC = 12V rms. For other conditions consult factory.
[H] Maximum input voltage is 30V for LAS 5205 and 5206.

# LAS 5000 SERIES

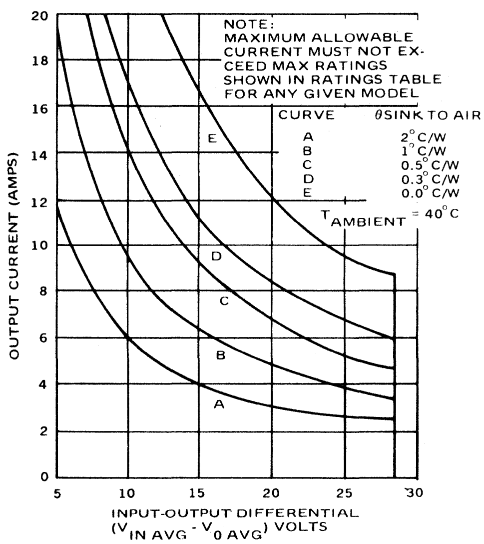
## OPERATIONAL DATA



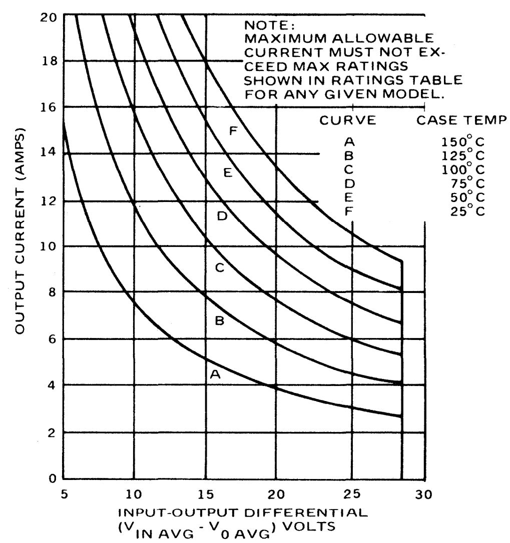

POWER DERATING CURVE AS A FUNCTION OF CASE 1 TEMPERATURE




SHORT CIRCUIT PROTECTION CHARACTERISTIC, LAS 5000 SERIES




DC SAFE OPERATING AREA AS A FUNCTION OF HEATSINK THERMAL RESISTANCE TO AIR AT 40° AMBIENT TEMPERATURE FOR LAS 5000 SERIES




DC SAFE OPERATING AREA AS A FUNCTION OF MODULE CASE TEMPERATURE FOR LAS 5000 SERIES

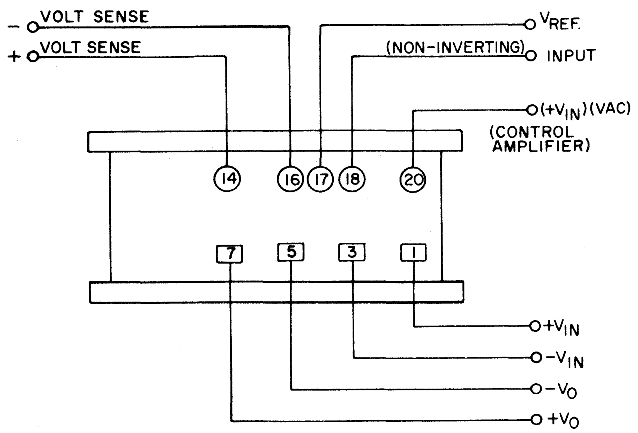
# ORDERING INFORMATION

**LAS 5200 20 AMPS, 270 WATTS**

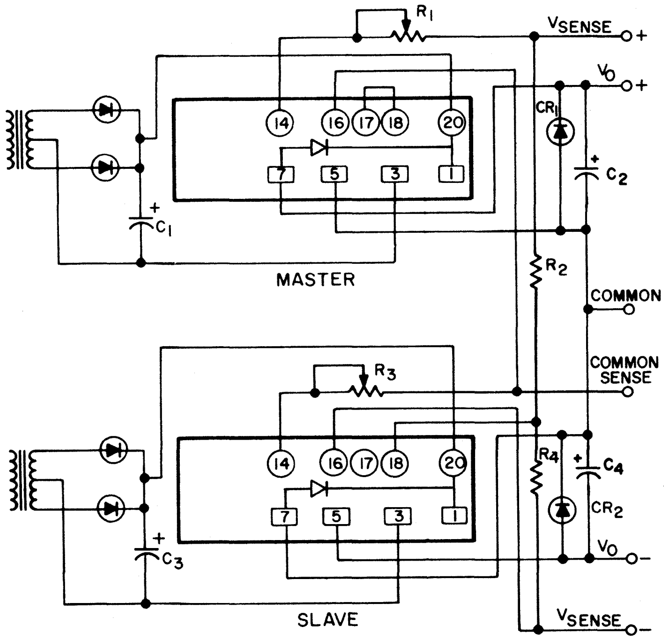
| MODEL | $V_O$—ADJ VOLTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 |
|---|---|---|---|---|---|---|---|---|
| LAS 5205 | 5 | $112.00 | $91.00 | $77.00 | $65.00 | $65.00 | $58.00 | $54.00 |
| LAS 5212 | 12 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |
| LAS 5224 | 24 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |

# LAS 5000 SERIES

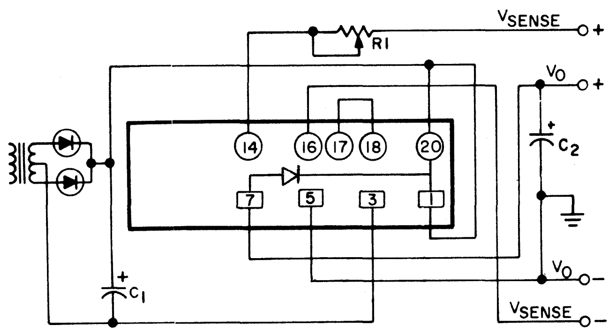
## CONNECTION DIAGRAMS




9-PIN POWER HYBRID VOLTAGE REGULATOR




DUAL TRACKING POWER HYBRID VOLTAGE REGULATOR CIRCUIT

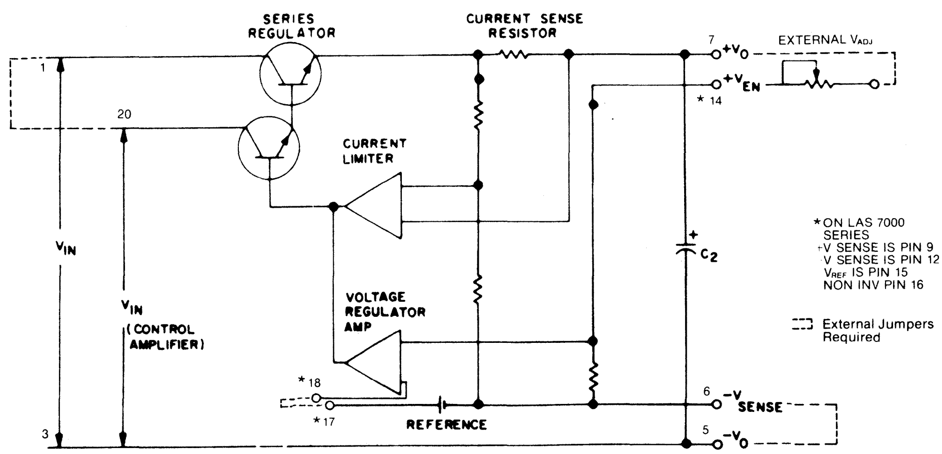



POSITIVE POWER HYBRID VOLTAGE REGULATOR CIRCUIT

## NOTES

1. Minimum value of input filter capacitors C1 and C3 is determined by: C1, C3 = $I_O$X (1000 mfd/amp) recommended.
2. Minimum value of output capacitors C2 and C4 is determined by: C2, C4 = $I_O$X (100 mfd/amp):
4. Minimum value of output voltage adjust resistors R1 and R3 is determined by: R1, R3 = (0.25$V_O$ x 1000Ω/V) ohms wirewound. Use next highest standard value.
5. Values of tracking reference voltage divider resistors R2 and R4 for all models are determined by:
   a) R2 = (2000$V_O$ – 2490) ohms, ± 1%, ½W film
   b) R4 = 2.49K ohms, ± 1%, ½W film
6. Rectifiers CR1 and CR2 should be rated at peak inverse voltage of 50V and forward current equal at least to maximum rated $I_O$.

# FUNCTIONAL BLOCK DIAGRAM




LAS 3000, LAS 5000 AND LAS 7000
SEE LAS 2000 SERIES FOR LAS 3000 PIN CORRECTION.

# LAS 7000 SERIES REGULATOR

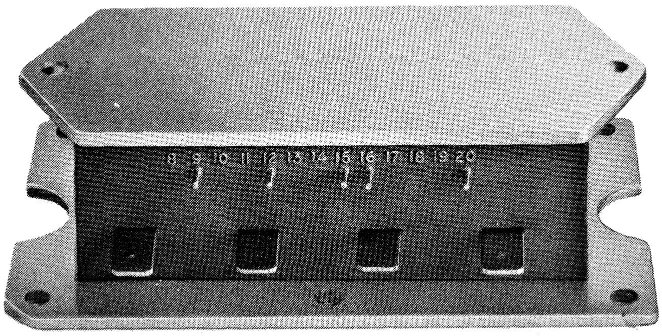
## 30 AMP 400 WATT POSITIVE REGULATOR

## FEATURES

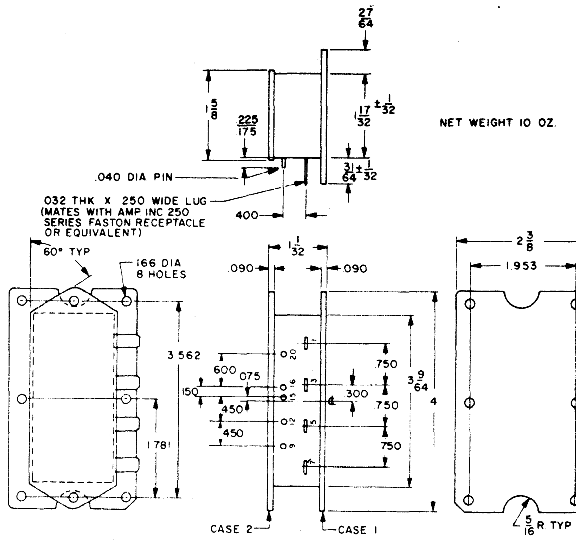
- 0.016% regulation line
- 0.2% regulation load
- 0.015%/° C temperature coefficient
- Short circuit and overload protection
- Remote programming
- Remote sensing
- Electrically isolated case
- Dual-tracking connection

## DESCRIPTION

The LAS 7200 Series of Power Hybrid Voltage Regulators is designed for applications requiring a well regulated output voltage for load current variations up to 30 amperes. A key feature of the LAS series of Power Hybrid Voltage Regulators is its construction. A high degree of thermal isolation between the heat generating power elements and the heat sensitive control and reference elements is achieved by the placing of the power section on the heat-dissipating base of the unit, and the control stage on the heat-dissipating upper surface. This thermal isolation results in extremely low thermal drift characteristics for changes in power levels.




## OUTLINE DRAWING




OUTLINE DRAWING, POWER HYBRID VOLTAGE REGULATOR, LAS 7000 SERIES

## ELECTRICAL CHARACTERISTICS

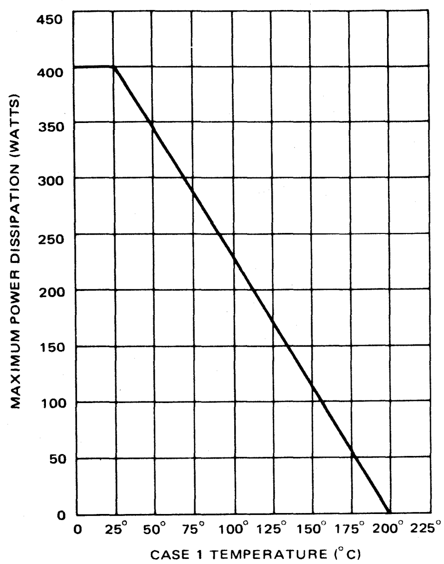
| PARAMETER | SYMBOL | CONDITION | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Input voltage to pin (1)[A,H] | $V_{IN}$ (1) | | 7.25 | 40.0 | volts |
| Input voltage to pin (20)[A,G] | $V_{IN}$ (20) | | 12.3 | 40.0 | volts |
| Output voltage | $V_O$ | | 4.75 | 29.4 | volts |
| Input-output differential[A,F] | ($V_{IN}$ (1)-$V_O$) | | 2.5 | 28.6 | volts |
| Input-output differential[B,F] | ($V_{IN}$ (20)-$V_O$) | | 7.60 | 28.6 | volts |
| Output current | $I_O$ | | | 30.0 | amps |
| Standby current | $I_Q$ (1) | | | 40.0 | mA |
| Standby current | $I_Q$ (20) | | | 7.0 | mA |
| Power dissipation | $P_D$ | Plate #1 @ 25° C | | 400 | watts |
| Thermal resistance junction—Case #1 | $\theta_J$-C1 | | | 0.44 | °C/watt |
| Storage temperature | $T_S$ | | −55 | +125 | °C |
| Power transistor junction temperature | $T_J$ | | | +200 | °C |
| Regulation line[C] | | | | 0.016 | %/$^{\Delta}V_{IN}$ |
| Regulation load[D] | | | | 0.2 | % |
| Programming resistance | | | | 1000 nominal | ohms/volt |
| Programming voltage | | | | one/one | volt/volt |
| Temperature coefficient | | | | 0.015 | %/° C |
| Ripple attenuation[E] | | $V_{in}$ (1) minimum<br>$I_O$ maximum | 60 | | dB |

**NOTES:**

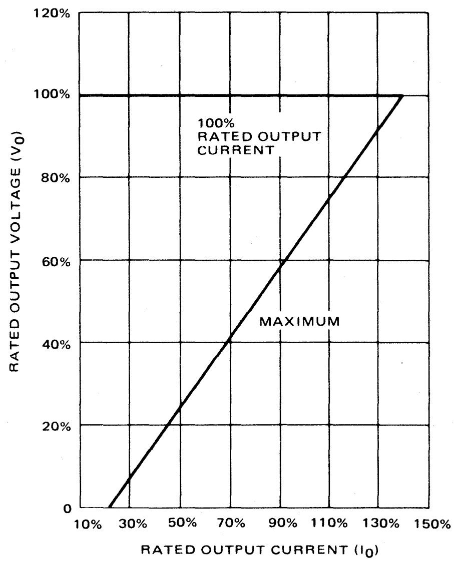
[A] Separate DC input voltages for power circuit (pin 1) and control circuit pin (20).
[B] Common input voltages for power circuit (pin 1) and control pin (20).
[C] $I_O$ constant for entire input voltage range from [$V_{IN}$ (1) & $V_{IN}$ (20) min.] to [$V_{in}$(1) (20) max. ]
[D] $V_{IN}$ constant for entire range from 0 to full load.
[E] Ripple attenuation is 54 dB min. for 24V and 28V models.
[F] Minimum input-output differential based on $T_J$, > 25°C.
[G] For AC source to Pin 20 with source resistance less than 10 ohms, minimum VAC = 12V rms. For other conditions consult factory.
[H] Maximum input voltage is 30V for LAS 7205 and 7206.

# LAS 7000 SERIES

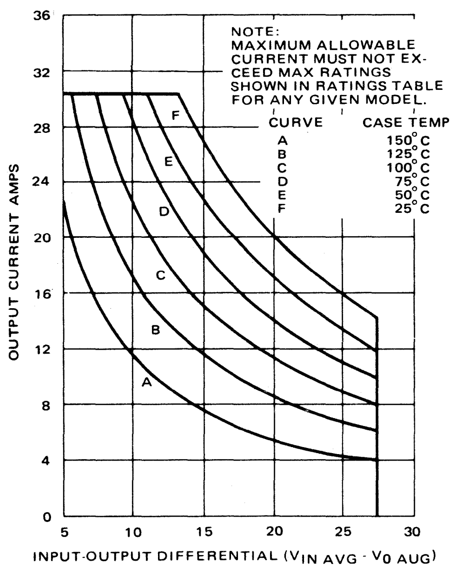
## OPERATIONAL DATA



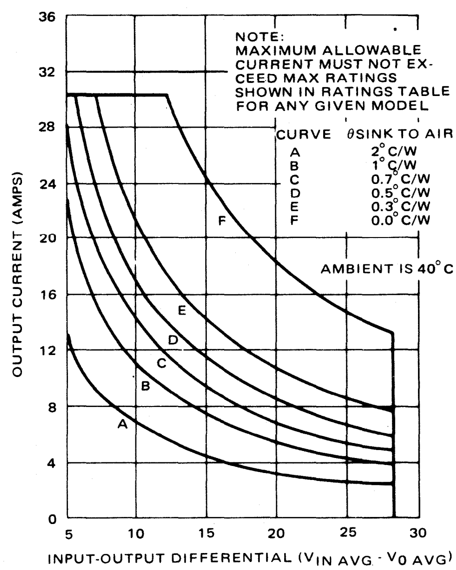

**POWER DERATING CURVE AS A FUNCTION OF CASE 1 TEMPERATURE**




**SHORT CIRCUIT PROTECTION CHARACTERISTIC LAS 7000 SERIES**




**DC SAFE OPERATING AREA AS A FUNCTION OF MODULE CASE TEMPERATURE FOR LAS 7000 SERIES**




**DC SAFE OPERATING AREA AS A FUNCTION OF HEATSINK THERMAL RESISTANCE TO AIR AT 40° AMBIENT TEMPERATURE FOR LAS 7000 SERIES**

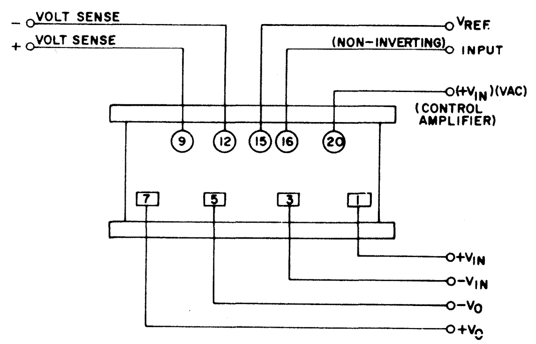
# ORDERING INFORMATION

## LAS 7200 30 AMPS, 400 WATTS

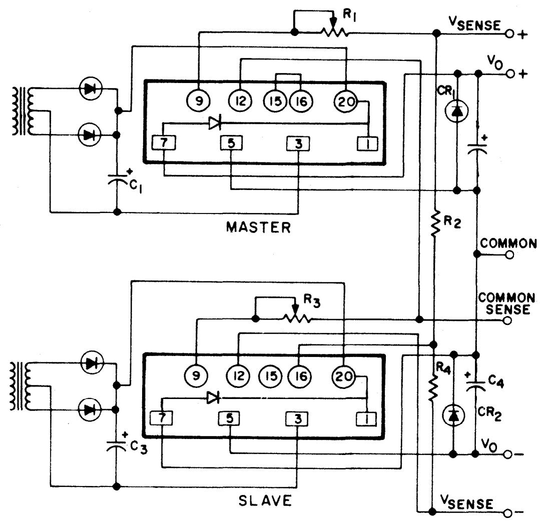
| MODEL | $V_O$—ADJ VOLTS | PRICE QTY | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 |
| LAS 7205 | 5 | $161.00 | $132.00 | $112.00 | $95.00 | $95.00 | $90.00 | $78.00 |
| LAS 7215 | 15 | 161.00 | 132.00 | 112.00 | 95.00 | 95.00 | 90.00 | 78.00 |
| LAS 7224 | 24 | 161.00 | 132.00 | 112.00 | 95.00 | 95.00 | 90.00 | 78.00 |

# LAS 7000 SERIES

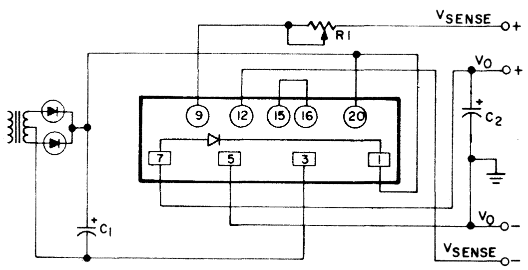
## CONNECTION DIAGRAMS




9-PIN POWER HYBRID VOLTAGE REGULATOR




DUAL TRACKING POWER HYBRID VOLTAGE REGULATOR

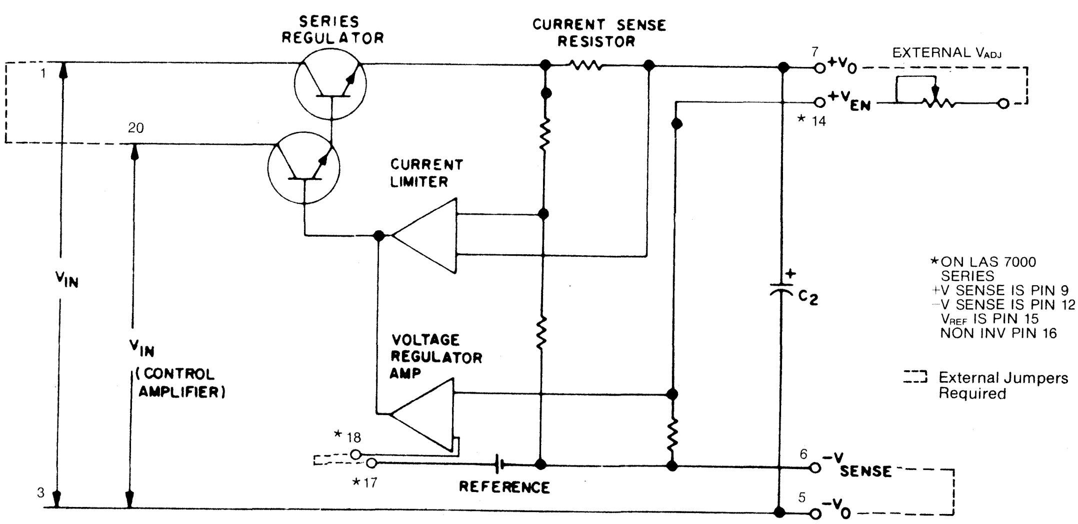



POSITIVE POWER HYBRID VOLTAGE REGULATOR CIRCUIT

**NOTES:**

1. Minimum value of input filter capacitors C1 and C3 is determined by: C1, C3 = $I_O$X (2000 mfd/amp) recommended.
2. Minimum value of output capacitors C2 and C4 is determined by: C2, C4 = $I_O$X (100 mfd/amp):
4. Minimum value of output voltage adjust resistors R1 and R3 is determined by: R1, R3 = (0.25$V_O$ x 1000Ω/V) ohms wirewound. Use next highest standard value.
5. Values of tracking reference voltage divider resistors R2 and R4 for all models are determined by:
   a) R2 = (2000$V_O$ – 2490) ohms, ± 1%, ½W film
   b) R4 = 2.49K ohms, ± 1%, ½W film
6. Rectifiers CR1 and CR2 should be rated at peak inverse voltage of 50V and forward current equal at least to maximum rated $I_O$.

# FUNCTIONAL BLOCK DIAGRAM




**LAS 3000, LAS 5000 AND LAS 7000**
**SEE LAS 2000 SERIES FOR LAS 3000 PIN CORRECTION.**

# SECTION II – POWER DARLINGTONS

## FEATURES

- **The only 200° C operating junction temperature Darlington power transistors available in the industry.**
- **The only hard glass passivated 200° C Darlington power transistors available in the industry.**
- **Guaranteed leakage current stability at 200° C — $I_{CER}$ is equal to 5mA or less, up to 150 watts; $I_{CER}$ is equal to 7mA or less, at 225 watts; $I_{CER}$ is equal to 10mA or less, at 240 watts.**
- **All Darlington power transistors are hermetically sealed and subject to leak testing.**
- **Guaranteed DC current gain greater than or equal to 1000 for NPN and 800 for PNP at collector currents of 4, 6, 10, and 15 amps.**
- **All Darlington power transistors are guaranteed and 100% tested for $I_{s/b}$ (Secondary breakdown Current) insuring maximum performance at high energy levels.**
- **Excellent thermal resistance ($R_{\theta JC}$) on all Darlington power transistors providing for more usable power and lower operating temperatures.**

## DESCRIPTION

The PMD-10K, 12K, 16K, 1600K, and 18K series of devices are three-terminal NPN Darlington Power Transistors. The PMD-11K, 13K, 17K, 1700K, and 19K series of devices are three-terminal PNP Darlington Power Transistors. These devices are monolithic epitaxial base structures with built-in base to emitter shunt resistors. The devices are CVD glass passivated to increase reliability and provide reduced high temperature reverse leakage current. This important feature helps to enable this series of Darlington devices to meet guaranteed operating junction temperatures of 200°C. Internal diode protection (D1) of the Darlington configuration is built into the structure to limit the device power dissipation during negative overshoot.

The five different series of NPN and five different series of PNP Darlington Power Transistors are available in sustaining voltages ranging from +40 to +100 volts, and power dissipation levels from 100 to 240 watts. All Darlington devices are hermetically sealed steel or copper TO-3 packages, depending on power dissipation requirements, providing high reliability and low thermal resistance, when used with appropriate heat sinks.

## ABSOLUTE MAXIMUM RATINGS

| RATING | SYMBOL | 12K 40<br>13K 40 | 12K 60<br>13K 60 | 12K 80<br>13K 80 | 12K 100<br>13K 100 | 10K 40<br>11K 40 | 10K 60<br>11K 60 | 10K 80<br>11K 80 | 10K 100<br>11K 100 | 1601K<br>1701K | 1602K<br>1702K | 1603K<br>1703K | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Collector Emitter Voltage | $V_{CEO}$ | 40 | 60 | 80 | 100 | 40 | 60 | 80 | 100 | 60 | 80 | 100 | Vdc |
| Collector Base Voltage | $V_{CBO}$ | 40 | 60 | 80 | 100 | 40 | 60 | 80 | 100 | 60 | 80 | 100 | Vdc |
| Emitter Base Voltage | $V_{EBO}$ | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | Vdc |
| Collector Current<br>Cont.<br>Peak | <br>$I_C$<br>$I_C$ | <br>8<br>16 | <br>8<br>16 | <br>8<br>16 | <br>8<br>16 | <br>12<br>20 | <br>12<br>20 | <br>12<br>20 | <br>12<br>20 | <br>20<br>40 | <br>20<br>40 | <br>20<br>40 | Adc |
| Base Current | $I_B$ | 0.12 | 0.12 | 0.12 | 0.12 | 0.2 | 0.2 | 0.2 | 0.2 | 0.5 | 0.5 | 0.5 | Adc |
| Thermal Resistance | $R\theta_{JC}$ | 1.5 | 1.5 | 1.5 | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | .83 | .83 | .83 | °C/W |
| Total Internal Dissipation | $P_D$ @$T_C$ = 50°C | 100 | 100 | 100 | 100 | 150 | 150 | 150 | 150 | 180 | 180 | 180 | Watts |
| | Derate | Derate at 0.667 W/°C, $T_A \geq 50°C$ | | | | Derate at 1 W/°C, $T_A \geq 50°C$ | | | | Derate at 1.2 W/°C $T_A \geq 50°C$ | | | |
| Temp. Range<br>Operating<br>Storage | <br>$T_J$<br>$T_{STG}$ | −65° to +200°C | | | | −65° to +200°C | | | | −65° to +200°C | | | °C |

| RATING | SYMBOL | 16K 60<br>17K 60 | 16K 80<br>17K 80 | 16K 100<br>17K 100 | 18K 60<br>19K 60 | 18K 80<br>19K 80 | 18K 100<br>19K 100 | UNITS |
|---|---|---|---|---|---|---|---|---|
| Collector Emitter Voltage | $V_{CEO}$ | 60 | 80 | 100 | 60 | 80 | 100 | Vdc |
| Collector Base Voltage | $V_{CBO}$ | 60 | 80 | 100 | 60 | 80 | 100 | Vdc |
| Emitter Base Voltage | $V_{EBO}$ | 5 | 5 | 5 | 5 | 5 | 5 | Vdc |
| Collector Current<br>Cont.<br>Peak | <br>$I_C$<br>$I_C$ | <br>20<br>40 | <br>20<br>40 | <br>20<br>40 | <br>30<br>60 | <br>30<br>60 | <br>30<br>60 | Adc |
| Base Current | $I_B$ | 0.5 | 0.5 | 0.5 | .75 | .75 | .75 | Adc |
| Thermal Resistance | $R\theta_{JC}$ | 0.67 | 0.67 | 0.67 | .625 | .625 | .625 | °C/W |
| Total Internal Power Dissipation | $P_D$ @ $T_C$ = 50°C | 225 | 225 | 225 | 240 | 240 | 240 | Watts |
| | Derate | Derate at 1.5 W/°C $T_A \geq 50°C$ | | | Derate at 1.6 W/°C $T_A \geq 50°C$ | | | |
| Temp. Range<br>Operating<br>Storage | <br>$T_J$<br>$T_{STG}$ | −65° to +200°C | | | −65° to +200°C | | | |

# ORDERING INFORMATION

| Type | Voltage Rating | Rated Power (watts) | Price—Quantity 1-99 | 100-999 | 1000-2499 | 2500-4999 | Type | Voltage Rating | Rated Power (watts) | Price—Quantity 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PMD 10K 40 | 40V | 150 | $1.90 | $1.55 | $1.39 | $1.33 | PMD 11K 40 | 40V | 150 | $1.90 | $1.55 | $1.39 | $1.33 |
| PMD 10K 60 | 60V | 150 | 2.10 | 1.68 | 1.50 | 1.44 | PMD 11K 60 | 60V | 150 | 2.10 | 1.68 | 1.50 | 1.44 |
| PMD 10K 80 | 80V | 150 | 2.32 | 1.86 | 1.67 | 1.60 | PMD 11K 80 | 80V | 150 | 2.32 | 1.86 | 1.67 | 1.60 |
| PMD 10K 100 | 100V | 150 | 2.70 | 2.16 | 1.94 | 1.86 | PMD 11K 100 | 100V | 150 | 2.70 | 2.16 | 1.94 | 1.86 |
| PMD 12K 40 | 40V | 100 | 1.10 | .88 | .81 | .78 | PMD 13K 40 | 40V | 100 | 1.10 | .88 | .81 | .78 |
| PMD 12K 60 | 60V | 100 | 1.14 | .91 | .84 | .81 | PMD 13K 60 | 60V | 100 | 1.14 | .91 | .84 | .81 |
| PMD 12K 80 | 80V | 100 | 1.20 | .95 | .87 | .85 | PMD 13K 80 | 80V | 100 | 1.20 | .95 | .87 | .85 |
| PMD 12K 100 | 100V | 100 | 1.25 | 1.00 | .92 | .89 | PMD 13K 100 | 100V | 100 | 1.25 | 1.00 | .92 | .89 |
| PMD 1601 K | 60V | 180 | 2.95 | 2.35 | 2.10 | 2.02 | PMD 1701 K | 60V | 180 | 2.95 | 2.35 | 2.10 | 2.02 |
| PMD 1602 K | 80V | 180 | 3.35 | 2.67 | 2.40 | 2.30 | PMD 1702 K | 80V | 180 | 3.35 | 2.67 | 2.40 | 2.30 |
| PMD 1603 K | 100V | 180 | 3.90 | 3.10 | 2.78 | 2.66 | PMD 1703 K | 100V | 180 | 3.90 | 3.10 | 2.78 | 2.66 |
| PMD 16K 60 | 60V | 225 | 4.68 | 3.78 | 3.42 | 3.33 | PMD 17K 60 | 60V | 225 | 5.20 | 4.20 | 3.80 | 3.70 |
| PMD 16K 80 | 80V | 225 | 5.05 | 4.15 | 3.50 | 3.42 | PMD 17K 80 | 80V | 225 | 5.60 | 4.60 | 3.90 | 3.80 |
| PMD 16K 100 | 100V | 225 | 5.60 | 4.60 | 3.90 | 3.80 | PMD 17K 100 | 100V | 225 | 6.16 | 5.06 | 4.30 | 4.18 |
| PMD 18K 60 | 60V | 240 | 5.38 | 4.35 | 3.93 | 3.83 | PMD 19K 60 | 60V | 240 | 5.92 | 4.78 | 4.33 | 4.21 |
| PMD 18K 80 | 80V | 240 | 5.80 | 4.77 | 4.03 | 3.93 | PMD 19K 80 | 80V | 240 | 6.38 | 5.25 | 4.43 | 4.37 |
| PMD 18K 100 | 100V | 240 | 6.44 | 5.29 | 4.49 | 4.37 | PMD 19K 100 | 100V | 240 | 7.08 | 5.82 | 4.93 | 4.81 |

Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.

# CROSS REFERENCE GUIDE FOR IMPROVED EQUIVALENTS

| MOTOROLA PART NUMBER | LAMBDA EQUIVALENT | LAMBDA IMPROVED REPLACEMENT |
|---|---|---|
| MJ 3000 | LMJ 3000 | PMD 10K 60 |
| MJ 4033 | LMJ 4033 | PMD 10K 60 |
| MJ 3001 | LMJ 3001 | PMD 10K 80 |
| MJ 4034 | LMJ 4034 | PMD 10K 80 |
| MJ 4035 | LMJ 4035 | PMD 10K 100 |
| MJ 2500 | LMJ 2500 | PMD 11K 60 |
| MJ 4030 | LMJ 4030 | PMD 11K 60 |
| MJ 2501 | LMJ 2501 | PMD 11K 80 |
| MJ 4031 | LMJ 4031 | PMD 11K 80 |
| MJ 4032 | LMJ 4032 | PMD 11K 100 |
| MJ 1000 | LMJ 1000 | PMD 12K 60 |
| MJ 1001 | LMJ 1001 | PMD 12K 80 |
| MJ 900 | LMJ 900 | PMD 13K 60 |
| MJ 901 | LMJ 901 | PMD 13K 80 |
| 2N 6282 | 2N 6282 | PMD 1601K |
| 2N 6283 | 2N 6283 | PMD 1602K |
| 2N 6284 | 2N 6284 | PMD 1603K |
| 2N 6282 | 2N 6282 | PMD 16K 60 |
| 2N 6283 | 2N 6283 | PMD 16K 80 |
| 2N 6284 | 2N 6284 | PMD 16K 100 |
| 2N 6285 | 2N 6285 | PMD 1701K |
| 2N 6286 | 2N 6286 | PMD 1702K |
| 2N 6287 | 2N 6287 | PMD 1703K |
| 2N 6285 | 2N 6285 | PMD 17K 60 |
| 2N 6286 | 2N 6286 | PMD 17K 80 |
| 2N 6287 | 2N 6287 | PMD 17K 100 |

| FAIRCHILD PART NUMBER | LAMBDA EQUIVALENT | LAMBDA IMPROVED REPLACEMENT |
|---|---|---|
| 2N 6057 | 2N 6057 | PMD 10K 60 |
| SE 9303 | LSE 9303 | PMD 10K 60 |
| SE 9304 | LSE 9304 | PMD 10K 80 |
| SE 9305 | LSE 9305 | PMD 10K 100 |
| 2N 6050 | 2N 6050 | PMD 11K 60 |
| SE 9403 | LSE 9403 | PMD 11K 60 |
| SE 9404 | LSE 9404 | PMD 11K 80 |
| SE 9405 | LSE 9405 | PMD 11K 100 |
| SE 9303 | LSE 9303 | PMD 12K 60 |
| SE 9304 | LSE 9304 | PMD 12K 80 |
| SE 9305 | LSE 9305 | PMD 12K 100 |
| SE 9403 | LSE 9403 | PMD 13K 60 |
| SE 9404 | LSE 9404 | PMD 13K 80 |
| SE 9405 | LSE 9405 | PMD 13K 100 |
| 2N 6282 | 2N 6282 | PMD 1601K |
| 2N 6283 | 2N 6283 | PMD 1602K |
| 2N 6284 | 2N 6284 | PMD 1603K |
| 2N 6282 | 2N 6282 | PMD 16K 60 |
| 2N 6283 | 2N 6283 | PMD 16K 80 |
| 2N 6284 | 2N 6284 | PMD 16K 100 |
| 2N 6285 | 2N 6285 | PMD 1701K |
| 2N 6286 | 2N 6286 | PMD 1702K |
| 2N 6287 | 2N 6287 | PMD 1703K |
| 2N 6285 | 2N 6285 | PMD 17K 60 |
| 2N 6286 | 2N 6286 | PMD 17K 80 |
| 2N 6287 | 2N 6287 | PMD 17K 100 |

| RCA PART NUMBER | LAMBDA EQUIVALENT | LAMBDA IMPROVED REPLACEMENT |
|---|---|---|
| RCA 8350 | LCA 8350 | PMD 11K 40 |
| RCA 8350A | LCA 8350A | PMD 11K 60 |
| RCA 8350B | LCA 8350B | PMD 11K 80 |
| RCA 1000 | LCA 1000 | PMD 12K 60 |
| RCA 1001 | LCA 1001 | PMD 12K 80 |
| RCA 8350 | LCA 8350 | PMD 13K 40 |
| RCA 8350A | LCA 8350A | PMD 13K 60 |
| RCA 8350B | LCA 6350B | PMD 13K 80 |
| 2N 6282 | 2N 6282 | PMD 1601K |
| 2N 6283 | 2N 6283 | PMD 1602K |
| 2N 6284 | 2N 6284 | PMD 1603K |
| 2N 6282 | 2N 6282 | PMD 16K 60 |
| 2N 6283 | 2N 6283 | PMS 16K 80 |
| 2N 6284 | 2N 6284 | PMD 16K 100 |
| 2N 6285 | 2N 6285 | PMD 1701K |
| 2N 6286 | 2N 6286 | PMD 1702K |
| 2N 6287 | 2N 6287 | PMD 1703K |
| 2N 6285 | 2N 6285 | PMD 17K 60 |
| 2N 6286 | 2N 6286 | PMD 17K 80 |
| 2N 6287 | 2N 6287 | PMD 17K 100 |

| TEXAS INSTRUMENTS PART NUMBER | LAMBDA EQUIVALENT | LAMBDA IMPROVED REPLACEMENT |
|---|---|---|
| TIP 640 | LTIP 640 | PMD 10K 60 |
| TIP 641 | LTIP 641 | PMD 10K 80 |
| TIP 641 | LTIP 642 | PMD 10K 100 |
| TIP 645 | LTIP 645 | PMD 11K 60 |
| TIP 646 | LTIP 646 | PMD 11K 80 |
| TIP 647 | LTIP 647 | PMD 11K 100 |

| STANDARD COMMERCIAL PART NUMBER | LAMBDA EQUIVALENT | LAMBDA IMPROVED REPLACEMENT |
|---|---|---|
| 2N 6057 | 2N 6057 | PMD 10K 60 |
| 2N 6058 | 2N 6058 | PMD 10K 80 |
| 2N 6059 | 2N 6059 | PMD 10K 100 |
| 2N 6050 | 2N 6050 | PMD 11K 60 |
| 2N 6051 | 2N 6051 | PMD 11K 80 |
| 2N 6052 | 2N 6052 | PMD 11K 100 |
| 2N 6055 | 2N 6055 | PMD 12K 60 |
| 2N 6056 | 2N 6056 | PMD 12K 80 |
| 2N 6053 | 2N 6053 | PMD 13K 60 |
| 2N 6054 | 2N 6054 | PMD 13K 80 |
| 2N 6383 | 2N 6383 | PMD 12K 40 |
| 2N 6384 | 2N 6384 | PMD 12K 60 |
| 2N 6385 | 2N 6385 | PMD 12K 80 |

# LAMBDA

# POWER DARLINGTON NPN SERIES– PMD 10K, 12K, 16K, 1600K, 18K

## ELECTRICAL CHARACTERISTICS

**ALL PARAMETERS ARE GUARANTEED AT Tj of 0° C to 200° C, UNLESS OTHERWISE SPECIFIED**

| DEVICE TYPE | TEST | SYMBOL | | TEST CONDITIONS | MIN. | MAX. | UNITS | NOTE |
|---|---|---|---|---|---|---|---|---|
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Collector Emitter Saturation Voltage | $V_{CE}$ (Sat) | ON Characteristics | $I_C$ = 6Adc; $I_B$ = 24mAdc<br>$I_C$ = 4Adc; $I_B$ = 16mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 5Adc; $I_B$ = 60mAdc | | 2.0 | Vdc | 1 |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Base Emitter Turn-on Voltage | $V_{BE}$ (on) | ON Characteristics | $I_C$ = 6Adc<br>$I_C$ = 4Adc<br>$I_C$ = 10Adc<br>$I_C$ = 10Adc<br>$I_C$ = 15Adc<br>$V_{CE}$ = 3Vdc | | 2.8 | Vdc | 1 |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Base Emitter Saturation Voltage | $V_{BE}$ (Sat) | ON Characteristics | $I_C$ = 6Adc; $I_B$ = 24mAdc<br>$I_C$ = 4Adc; $I_B$ = 16mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 15Adc; $I_B$ = 60mAdc | | 2.8 | Vdc | 1 |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | DC Current Gain | $h_{FE}$ | ON Characteristics | $I_C$ = 6Adc<br>$I_C$ = 4Adc<br>$I_C$ = 10Adc<br>$I_C$ = 10Adc<br>$I_C$ = 15Adc<br>$V_{CE}$ = 3Vdc<br>* $T_J$ = 25° C | 1000<br>1000<br>1000<br>750<br>1000 | 20,000* | | 1 |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Forward Bias Second Breakdown current | $I_{s/b}$ | ON Characteristics | $T_A$ = 25° C<br>$V_{CE}$ = 30Vdc<br>1 second nonrepetitive pulse | 5.0<br>3.0<br>7.5<br>6.0<br>8.0 | | Adc | |
| PMD 10K, 12K-40<br>PMD 10K, 12K 16K, 18K-60 PMD 1601K<br>PMD 10K, 12K, 16K, 18K-80 PMD 1602<br>PMD 10K, 12K 16K, 18K-100 PMD 1603K | Collector Emitter Breakdown Voltage (Base Open) | $V_{(BR)\,CEO}$ | OFF Characteristics | $I_{CE}$ = 100mAdc<br>$T_J$ = 25° C | 40<br>60<br>80<br>100 | | Vdc | 1 |
| PMD 10K, 12K-40<br>PMD 10K, 12K, 16K, 18K-60 PMD 1601K<br>PMD 10K, 12K 16K, 18K-80 PMD 1602K<br>PMD 10K, 12K, 16K, 18K-100 PMD 1603K | Collector Emitter Sustaining Voltage | $V_{(BR)\,CEO}$ | OFF Characteristics | $I_{CE}$ = 100mAdc<br>$R_{BE}$ = 2.2K ohms | 40<br>60<br>80<br>100 | | Vdc | 1 |
| All NPN Series | Emitter Base Leakage Current | $I_{EBO}$ | OFF Characteristics | $V_{EB}$ = 5Vdc<br>$I_C$ = 0A | | 3.0 | mAdc | 1 |
| PMD 10K, 12K-40<br>PMD 10K, 12K-60<br>PMD 10K, 12K-80<br>PMD 10K, 12K-100 | Collector Emitter Leakage Current | $I_{CER}$ | OFF Characteristics | $V_{CE}$ = 20Vdc<br>$V_{CE}$ = 40Vdc<br>$V_{CE}$ = 54Vdc<br>$V_{CE}$ = 67Vdc<br>$R_{BE}$ = 2.2Kohms | | 5.0<br>5.0<br>5.0<br>5.0 | mAdc | 1 |

continued on next page

# ELECTRICAL CHARACTERISTICS (continued)

| DEVICE TYPE | TEST | SYMBOL | | TEST CONDITIONS | | MIN. | MAX. | UNITS | NOTE |
|---|---|---|---|---|---|---|---|---|---|
| PMD 16K-60<br>PMD 1601K<br>PMD 16K-80<br>PMD 1602K<br>PMD 16K-100<br>PMD 1603K | Collector Emitter Leakage Current | $I_{CER}$ | OFF Characteristics | $V_{CE} = 40Vdc$<br>$V_{CE} = 54Vdc$<br>$V_{CE} = 67Vdc$ | $R_{BE} =$ 2.2Kohms | | 7.0 | mAdc | 1 |
| PMD 18K-60<br>PMD 18K-80<br>PMD 18K-100 | | | | $V_{CE} = 40Vdc$<br>$V_{CE} = 54Vdc$<br>$V_{CE} = 67Vdc$ | | | 10.0 | | |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Output Capacitance | Cobo | Dynamic Characteristics | $V_{CB} = 10Vdc$; $I_E = 0Adc$<br>$f = 1MHz$<br>$T_J = 25° C$ | | | 300<br>200<br>400<br>400<br>600 | pf | |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Small Signal Current Gain | $h_{fe}$ | | $I_C = 5Adc$<br>$I_C = 3Adc$<br>$I_C = 7Adc$<br>$I_C = 7Adc$<br>$I_C = 9Adc$ | $V_{CE} = 3Vdc$<br>$f = 1kHz$<br>$T_J = 25° C$ | 300 | | | 1 |
| PMD 10K SERIES<br>PMD 12K SERIES<br>PMD 16K SERIES<br>PMD 1600K SERIES<br>PMD 18K SERIES | Common Emitter Short-Circuit Forward Transfer Ratio | $h_{fe}$ | | $I_C = 5Adc$<br>$I_C = 3Adc$<br>$I_C = 7Adc$<br>$I_C = 7Adc$<br>$I_C = 9Adc$ | $V_{CE} = 3Vdc$<br>$f = 1MHz$<br>$T_J = 25° C$ | 4 | | | 1 |

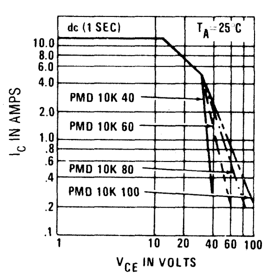
NOTES:

1. Pulse Tested: Pulse Width is less than or equal to 300$\mu$Sec. and the Duty Cycle is less than or equal to 2.0%.

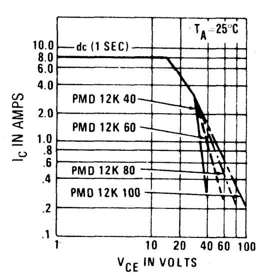
DEVICE PRICES, SPECIFICATIONS, AND CONFIGURATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

# OPERATIONAL DATA
## Safe Operating Area

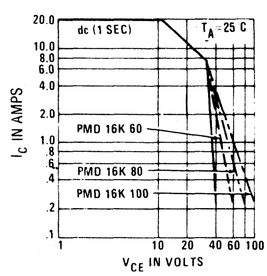
PMD 10K SERIES



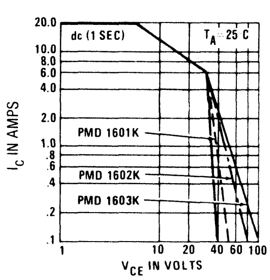

PMD 12K SERIES



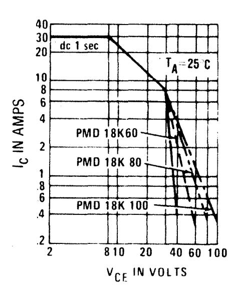

PMD 16K SERIES



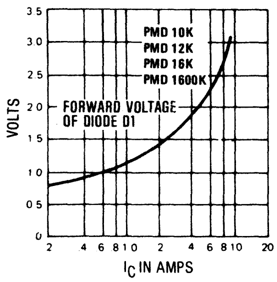

PMD 1600K SERIES

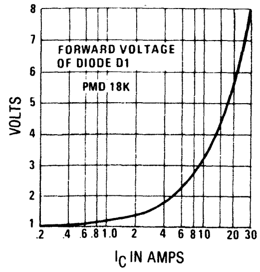



PMD 18K SERIES

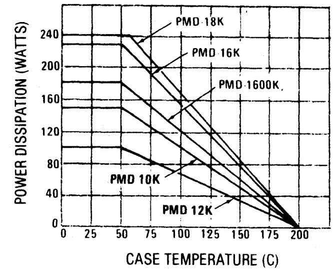


# OPERATIONAL DATA (continued)

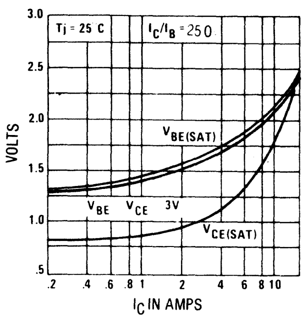


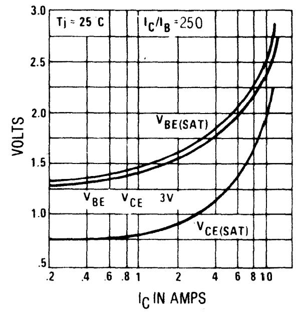

## POWER DERATING



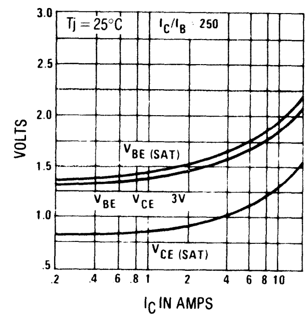

## "ON" VOLTAGES VERSUS COLLECTOR CURRENT



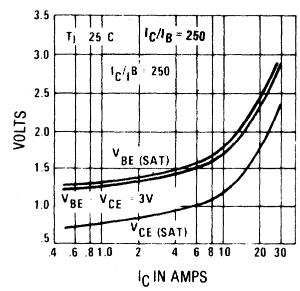

PMD 10K SERIES




PMD 12K SERIES

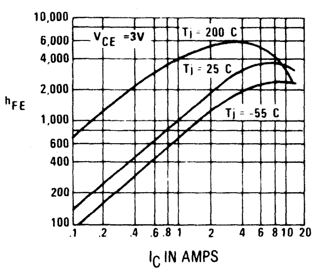



PMD 16K, 1600K SERIES

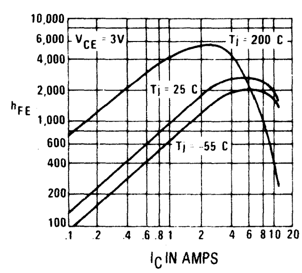



PMD 18K SERIES

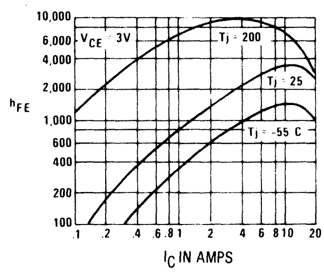
## DC COLLECTOR CURRENT GAIN VERSUS COLLECTOR CURRENT



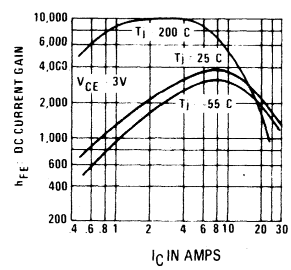

PMD 10K SERIES




PMD 12K SERIES

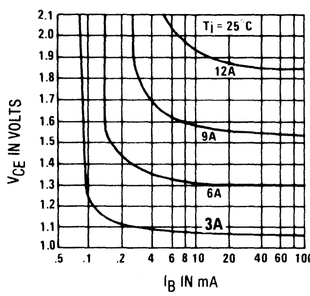



PMD 16K, 1600K SERIES

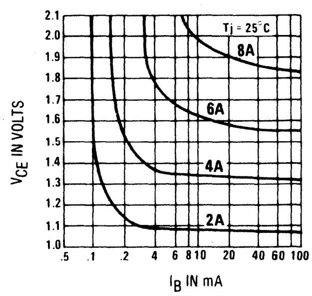



PMD 18K SERIES

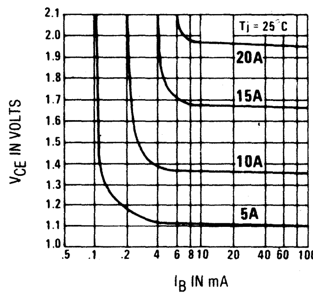
## COLLECTOR SATURATION REGION



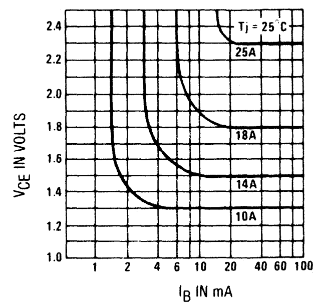

PMD 10K SERIES




PMD 12K SERIES




PMD 16K, 1600K SERIES




PMD 18K SERIES

# LAMBDA
# POWER DARLINGTON PNP SERIES– PMD 11K, 13K, 17K, 1700K, 19K

## ELECTRICAL CHARACTERISTICS

**ALL PARAMETERS ARE GUARANTEED AT Tj of 0° C to 200° C, UNLESS OTHERWISE SPECIFIED**

| DEVICE TYPE | TEST | SYMBOL | | TEST CONDITIONS | MIN. | MAX. | UNITS | NOTE |
|---|---|---|---|---|---|---|---|---|
| PMD 11K SERIES<br>PMD 13K SERIES<br>PMD 17K SERIES<br>PMD 1700K SERIES<br>PMD 19K SERIES | Collector Emitter Saturation Voltage | $V_{CE}$ (Sat) | ON Characteristics | $I_C$ = 6Adc; $I_B$ = 24mAdc<br>$I_C$ = 4Adc; $I_B$ = 16mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 15Adc; $I_B$ = 60mAdc | | 2.0 | Vdc | 1 |
| PMD 11K SERIES<br>PMD 13K SERIES<br>PMD 17K SERIES<br>PMD 1700K SERIES<br>PMD 19K SERIES | Base Emitter Turn-on Voltage | $V_{BE}$ (on) | | $I_C$ = 6Adc<br>$I_C$ = 4Adc<br>$I_C$ = 10Adc<br>$I_C$ = 10Adc<br>$I_C$ = 15Adc<br>$V_{CE}$ = 3Vdc | | 2.8 | Vdc | 1 |
| PMD 11K SERIES<br>PMD 13K SERIES<br>PMD 17K SERIES<br>PMD 1700K SERIES<br>PMD 19K SERIES | Base Emitter Saturation | $V_{BE}$ (Sat) | | $I_C$ = 6Adc; $I_B$ = 24mAdc<br>$I_C$ = 4Adc; $I_B$ = 16mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 10Adc; $I_B$ = 40mAdc<br>$I_C$ = 15Adc; $I_B$ = 60mAdc | | 2.8 | Vdc | 1 |
| PMD 11K SERIES<br>PMD 13K SERIES<br>PMD 17K SERIES<br>PMD 1700K SERIES<br>PMD 19K SERIES | DC Current Gain | $h_{FE}$ | | $I_C$ = 6Adc<br>$I_C$ = 4Adc<br>$I_C$ = 10Adc<br>$I_C$ = 10Adc<br>$I_C$ = 15Adc<br>$V_{CE}$ = 3Vdc<br>* $T_J$ = 25°C | 800<br>800<br>800<br>750<br>800 | 20,000* | | 1 |
| PMD 11K SERIES<br>PMD 13K SERIES<br>PMD 17K SERIES<br>PMD 1700K SERIES<br>PMD 19K SERIES | Forward Bias Second Breakdown current | $I_{s/b}$ | | $T_A$ = 25° C<br>$V_{CE}$ = 30Vdc<br>1 second nonrepetitive pulse | 5.0<br>3.0<br>7.5<br>6.0<br>8.0 | | Adc | |
| PMD 11K, 13K-40<br>PMD 11K, 13K 17K, 19K-60<br>PMD 1701K<br>PMD 11K, 13K, 17K, 19K-80<br>PMD 1702<br>PMD 11K, 13K 17K, 19K-100<br>PMD 1703K | Collector Emitter Breakdown Voltage (Base Open) | $V_{(BR)\,CEO}$ | OFF Characteristics | $I_{CE}$ = 100mAdc<br>$T_J$ = 25° C | 40<br>60<br>80<br>100 | | Vdc | 1 |
| PMD 11K, 13K-40<br>PMD 11K, 13K, 17K, 19K-60<br>PMD 1701K<br>PMD 11K, 13K 17K, 19K-80<br>PMD 1702K<br>PMD 11K, 13K, 17K, 19K-100<br>PMD 1703K | Collector Emitter Sustaining Voltage | $V_{(BR)\,CER}$ (sus) | | $I_{CE}$ = 100mAdc<br>$R_{BE}$ = 2.2K ohms | 40<br>60<br>80<br>100 | | Vdc | 1 |
| All PNP Series | Emitter Base Leakage Current | $I_{EBO}$ | | $V_{EB}$ = 5Vdc<br>$I_C$ = 0A | | 3.0 | mAdc | 1 |
| PMD 11K, 13K-40<br>PMD 11K, 13K-60<br>PMD 11K, 13K-80<br>PMD 11K, 13K-100 | Collector Emitter Leakage Current | $I_{CER}$ | | $V_{CE}$ = 20Vdc<br>$V_{CE}$ = 40Vdc<br>$V_{CE}$ = 54Vdc<br>$V_{CE}$ = 67Vdc<br>$R_{BE}$ = 2.2Kohms | | 5.0<br>5.0<br>5.0<br>5.0 | mAdc | 1 |

continued on next page

# ELECTRICAL CHARACTERISTICS (continued)

| DEVICE TYPE | TEST | SYMBOL | | TEST CONDITIONS | | MIN. | MAX. | UNITS | NOTE |
|---|---|---|---|---|---|---|---|---|---|
| PMD 17K-60<br>PMD 1701K | Collector Emitter Leakage Current | $I_{CER}$ | Off Characteristics | $V_{CE}$ = 40Vdc | $R_{BE}$ = 2.2Kohms | | 7.0 | mAdc | 1 |
| PMD 17K-80<br>PMD 1702K | | | | $V_{CE}$ = 54Vdc | | | | | |
| PMD 17K-100<br>PMD 1703K | | | | $V_{CE}$ = 67Vdc | | | | | |
| PMD 19K-40 | | | | $V_{CE}$ = 20Vdc | | | 10.0 | | |
| PMD 19K-60 | | | | $V_{CE}$ = 40Vdc | | | | | |
| PMD 19K-80 | | | | $V_{CE}$ = 54Vdc | | | | | |
| PMD 19K-100 | | | | $V_{CE}$ = 67Vdc | | | | | |
| PMD 11K SERIES | Output Capacitance | Cobo | Dynamic Characteristics | $V_{CB}$ = 10Vdc; $I_E$ = 0Adc<br>$f$ = 1MHz<br>$T_J$ = 25° C | | | 300 | pf | |
| PMD 13K SERIES | | | | | | | 200 | | |
| PMD 17K SERIES | | | | | | | 400 | | |
| PMD 1700K SERIES | | | | | | | 400 | | |
| PMD 19K SERIES | | | | | | | 600 | | |
| PMD 11K SERIES | Small Signal CurrentGain | $h_{fe}$ | | $I_C$ = 5Adc | $V_{CE}$ = 3Vdc<br>$f$ = 1kHz<br>$T_J$ = 25° C | 300 | | | 1 |
| PMD 13K SERIES | | | | $I_C$ = 3Adc | | | | | |
| PMD 17K SERIES | | | | $I_C$ = 7Adc | | | | | |
| PMD 1700K SERIES | | | | $I_C$ = 7Adc | | | | | |
| PMD 19K SERIES | | | | $I_C$ = 9Adc | | | | | |
| PMD 11K SERIES | Common Emitter Short-Circuit Forward Transfer Ratio | $h_{fe}$ | | $I_C$ = 5Adc | $V_{CE}$ = 3Vdc<br>$f$ = 1MHz<br>$T_J$ = 25° C | 4 | | | 1 |
| PMD 13K SERIES | | | | $I_C$ = 3Adc | | | | | |
| PMD 17K SERIES | | | | $I_C$ = 7Adc | | | | | |
| PMD 1700K SERIES | | | | $I_C$ = 7Adc | | | | | |
| PMD 19K SERIES | | | | $I_C$ = 9Adc | | | | | |

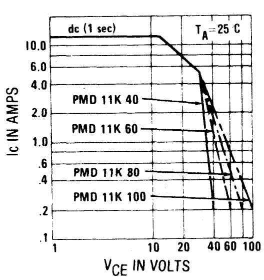
NOTES:

1. Pulse Tested: Pulse Width is less than or equal to 300$\mu$Sec. and the Duty Cycle is less than or equal to 2.0%.

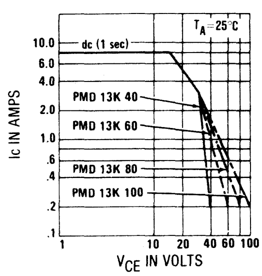
DEVICE PRICES, SPECIFICATIONS, AND CONFIGURATIONS ARE SUBJECT TO CHANGE WITHOUT NOTICE.

# OPERATIONAL DATA
## Safe Operating Area

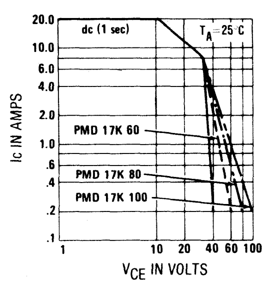
**PMD 11K SERIES**



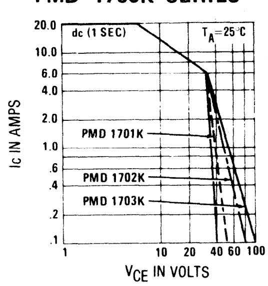

**PMD 13K SERIES**



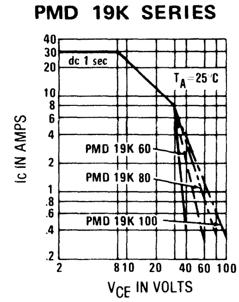

**PMD 17K SERIES**



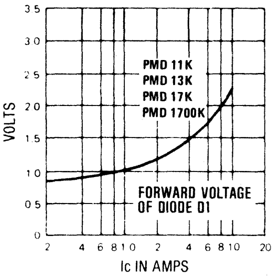

**PMD 1700K SERIES**

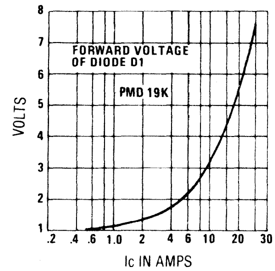



**PMD 19K SERIES**

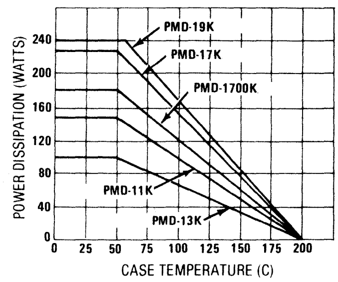


# OPERATIONAL DATA (continued)

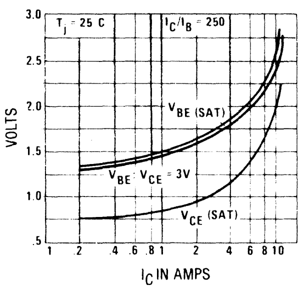


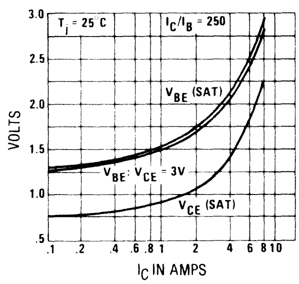

## POWER DERATING



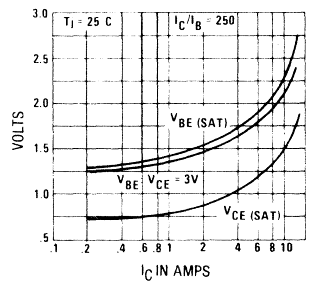

## "ON" VOLTAGES VERSUS COLLECTOR CURRENT



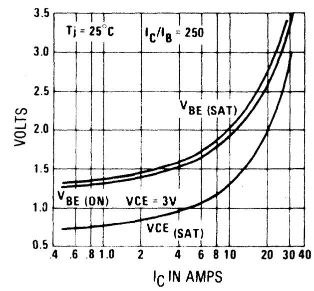

PMD 11K SERIES




PMD 13K SERIES

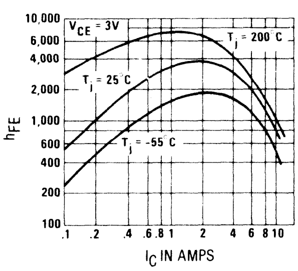



PMD 17K, 1700K SERIES

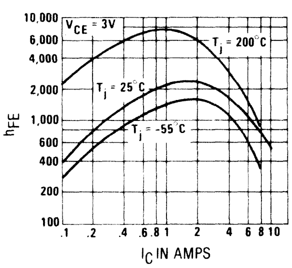



PMD 19K SERIES

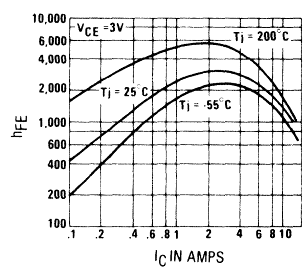
## DC COLLECTOR CURRENT GAIN VERSUS COLLECTOR CURRENT



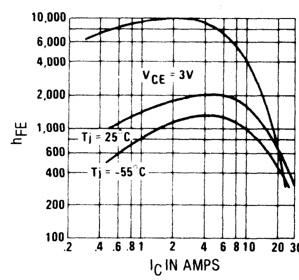

PMD 11K SERIES




PMD 13K SERIES

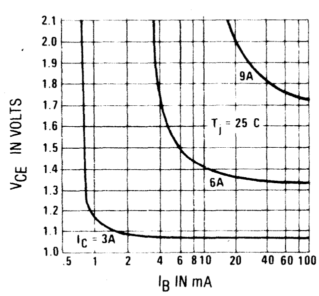



PMD 17K, 1700K SERIES

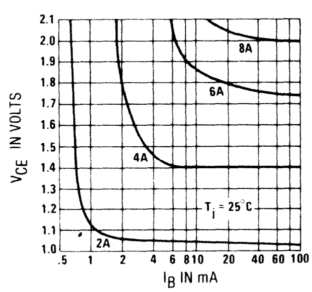



PMD 19K SERIES

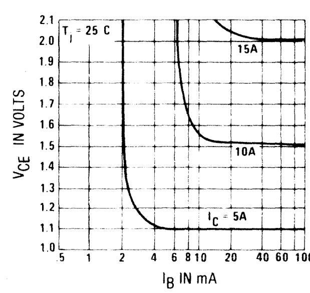
## COLLECTOR SATURATION REGION



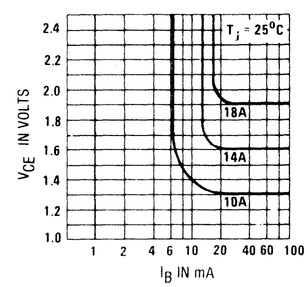

PMD 11K SERIES




PMD 13K SERIES

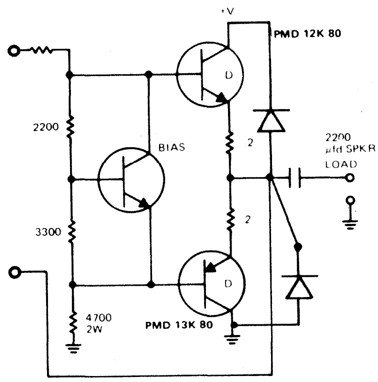



PMD 17K, 1700K SERIES

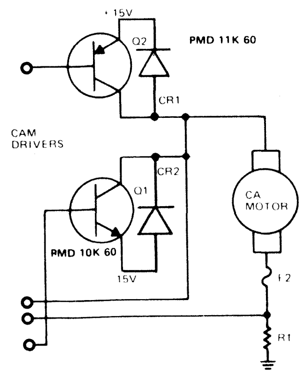



PMD 19K SERIES

# TYPICAL APPLICATIONS

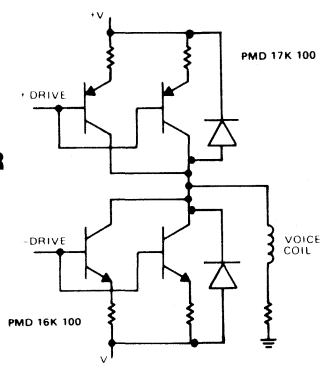



**CLASS AB AMPLIFIER**

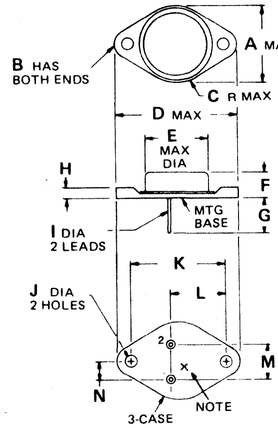



**MOTOR DRIVE**

**DISC DRIVE FOR COMPUTERS**




# OUTLINE DRAWINGS



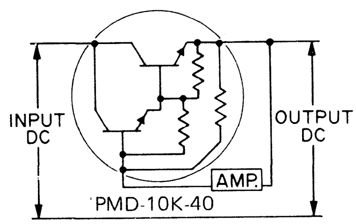

| TO-3/3 TERMINAL COPPER | | |
|---|---|---|
| | INCHES | |
| DIM | MIN. | MAX. |
| A | — | 1.050 |
| B | — | 0.188 |
| C | — | 0.525 |
| D | — | 1.575 |
| E | — | 0.875 |
| F | 0.250 | 0.450 |
| G | 0.400 | 0.480 |
| H | 0.060 | 0.115 |
| I | 0.035 | 0.045 |
| J | 0.150 | 0.160 |
| K | 1.175 | 1.195 |
| L | 0.655 | 0.675 |
| M | 0.420 | 0.440 |
| N | 0.210 | 0.220 |

| TO-3/3 TERMINAL STEEL | | |
|---|---|---|
| | INCHES | |
| DIM. | MIN. | MAX. |
| A | — | 1.050 |
| B | — | 0.188 |
| C | — | 0.525 |
| D | — | 1.575 |
| E | — | 0.875 |
| F | 0.250 | 0.450 |
| G | 0.400 | 0.480 |
| H | 0.050 | 0.070 |
| I | 0.035 | 0.045 |
| J | 0.150 | 0.160 |
| K | 1.175 | 1.195 |
| L | 0.655 | 0.675 |
| M | 0.420 | 0.440 |
| N | 0.210 | 0.220 |

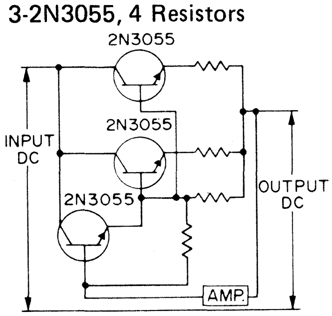
| PIN | FUNCTION | |
|---|---|---|
| 1 | BASE | NOTE (X): CASE TEMPERATURE MEASURED AT THIS POINT |
| 2 | EMITTER | |
| CASE | COLLECTOR | |

# TYPICAL COST SAVINGS WITH LAMBDA DARLINGTONS

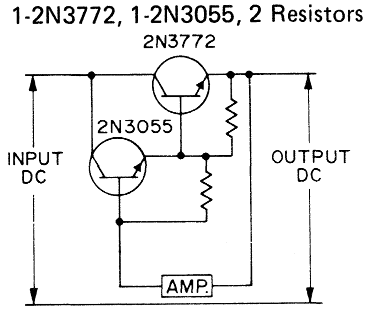
1PMD-10-K-40 Darlington



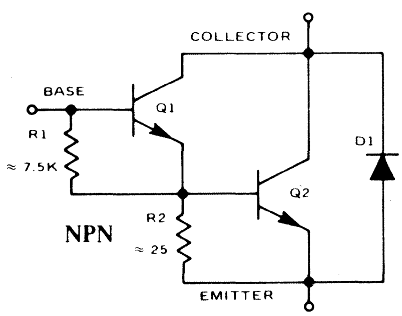

3-2N3055, 4 Resistors



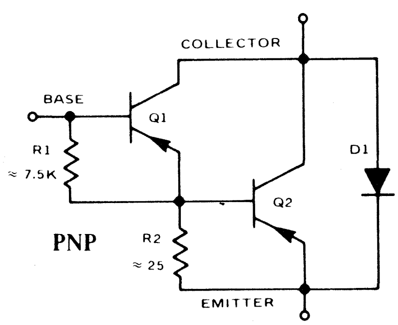

1-2N3772, 1-2N3055, 2 Resistors




# BLOCK DIAGRAMS




**NPN**




**PNP**

# SECTION III—OVERVOLTAGE PROTECTORS

## FEATURES

- True temperature compensated overvoltage protection—2A, 6A, 12A, 20A, 35A
- Complete overvoltage protectors in single package

## DESCRIPTION

The L-2-OV and the L-6-OV series of devices are monolithic overvoltage protectors. These two-terminal devices are available in 2 amp and 6 amp versions. The L-12-OV, L-20-OV and the L-35-OV series of devices are hybrid overvoltage protectors. These devices are available in 12 amp, 20 amp and 35 amp versions. They have been designed to prevent damage to a load caused by excessive power supply output voltage, improper connection, a disconnected sense lead, or failure of the power supply.

Load protection is accomplished by effectively short circuiting the ouptut terminals of the power supply when the trip point voltage limit of the overvoltage protector is exceeded. All overvoltage protectors in each series have fixed trip point voltage values and cannot be adjusted. To reset the overvoltage protector, interrupt power to the overvoltage protector, allow the overvoltage protector to cool below 71°C, and reconnect the power.

Both the L-2-OV and the L-6-OV series are available for applications in nominal supply voltage ranges from +5 to +28 volts. The steel TO-3 and TO-66 packages that are used for these device series are hermetically sealed and offer low thermal resistance characteristics. The L-12-OV and the L-20-OV series are available for applications in nominal supply voltage range from +5 to +30 volts. The L-35-OV series are available for applications in nominal supply voltage range from +5 to +12 volts.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | L-2-OV SERIES | | L-6-OV SERIES | | L-12-OV SERIES | | L-20-OV SERIES | | L-35-OV SERIES | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX |
| On State Current | $I_{DC}$ | — | 2A | — | 6A | — | 12A | — | 20A | — | 35A |
| On State Voltage | $V_{DC}$ | — | 2.6V | — | 2.6V | — | 1.6V | — | 1.75V | — | 2.2V |
| Non-Repetitive Peak Surge Current* | $I_P$ | — | 20A | — | 70A | — | 200A | — | 260A | — | 350A |
| Standby Current | $I_S$ | — | 35mA | — | 25mA | — | 30mA | — | 30mA | — | 30mA |
| Operating Temperature (Blocking)** | $T_{CB}$ | -40°C | +100°C | -40°C | +100°C | -40°C | +100°C | -40°C | +100°C | -40°C | +100°C |
| Operating Temperature (Conducting)*** | $T_{CC}$ | -40°C | +150°C | -40°C | +150°C | -40°C | +140°C | -40°C | +140°C | -40°C | +140°C |
| Storage Temperature | $T_S$ | -40°C | +150°C | -40°C | +150°C | -40°C | +125°C | -40°C | +125°C | -40°C | +125°C |
| Power Dissipation @ $T_C$=25°C Derate above 50°C | $P_D$ | | 30 Watts @0.6w/°C | | 150 Watts @1.5w/°C | | | | | | |
| Thermal Resistance | $R_{\theta JC}$ | | 5.0°C/W | | 1.0°C/W | | | | | | |

*For sinusoidal current duration of 8.3 milliseconds max.
**Case temperature for overvoltage protector in nonconducting or "OFF" state.
***Case temperature for overvoltage protector in conducting or "ON" state. Power must be removed and case temperature allowed to drop to 71°C before application of output voltage.

The overvoltage protector requires an external heat sink to maintain case temperature below rated limit. When the overvoltage protector is used with a Lambda power supply the power supply chassis acts as the heat sink. The L-12-OV, L-20-OV, L-35-OV, overvoltage protector is supplied with mating connectors for pins on overvoltage protector (+V and −V engraved on unit).

## ORDERING INFORMATION

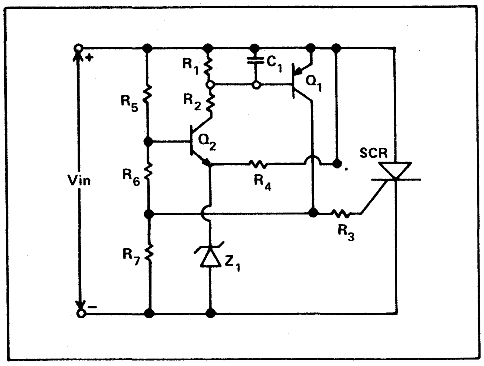
| NOM SUPPLY VOLTAGE (VOLTS) | TRIP POINT VOLTAGE* (VOLTS) | 2 AMP MODELS | PRICE QTY 1 | 100 | 250 | 1000 | 6 AMP MODELS | PRICE QTY 1 | 100 | 250 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 6.6±0.2 | L-2-OV-5 | $2.50 | $2.00 | $1.90 | $1.70 | L-6-OV-5 | $5.00 | $4.00 | $3.75 | $3.40 |
| 6 | 7.3±0.2 | L-2-OV-6 | 2.50 | 2.00 | 1.90 | 1.70 | L-6-OV-6 | 5.00 | 4.00 | 3.75 | 3.40 |
| 12 | 13.7±0.4 | L-2-OV-12 | 2.50 | 2.00 | 1.90 | 1.70 | L-6-OV-12 | 5.00 | 4.00 | 3.75 | 3.40 |
| 15 | 17.0±0.5 | L-2-OV-15 | 2.50 | 2.00 | 1.90 | 1.70 | L-6-OV-15 | 5.00 | 4.00 | 3.75 | 3.40 |
| 18 | 20.5±1.0 | L-2-OV-18 | 2.50 | 2.00 | 1.90 | 1.70 | | | | | |
| 20 | 22.8±0.7 | L-2-OV-20 | 2.50 | 2.00 | 1.90 | 1.70 | | | | | |
| 24 | 27.3±0.8 | L-2-OV-24 | 2.50 | 2.00 | 1.90 | 1.70 | L-6-OV-24 | 5.00 | 4.00 | 3.75 | 3.40 |
| 28 | 31.9±1.0 | | | | | | L-6-OV-28 | 5.00 | 4.00 | 3.75 | 3.40 |

| NOM SUPPLY VOLTAGE (VOLTS) | TRIP POINT VOLTAGE* (VOLTS) | 12 AMP MODELS | PRICE QTY 1 | 100 | 250 | 1000 | 20 AMP MODELS | PRICE QTY 1 | 100 | 250 | 1000 | 35 AMP MODELS | PRICE QTY 1 | 100 | 250 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5 | 6.6±0.3 | L-12-OV-5 | $15.30 | $11.10 | $10.45 | $9.50 | L-20-OV-5 | $22.20 | $15.60 | $14.50 | $13.20 | L-35-OV-5 | $27.80 | $20.13 | $18.90 | $16.90 |
| 6 | 7.4±0.2 | L-12-OV-6 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-6 | 22.20 | 15.60 | 14.50 | 13.20 | L-35-OV-6 | 27.80 | 20.13 | 18.90 | 16.90 |
| 9 | 10.5±0.5 | L-12-OV-9 | 15.30 | 11.10 | 10.45 | 9.50 | | | | | | | | | | |
| 12 | 13.8±0.5 | L-12-OV-12 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-12 | 22.20 | 15.60 | 14.50 | 13.20 | L-35-OV-12 | 27.80 | 20.13 | 18.90 | 16.90 |
| 15 | 17.0±0.5 | L-12-OV-15 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-15 | 22.20 | 15.60 | 14.50 | 13.20 | | | | | |
| 20 | 22.8±0.7 | L-12-OV-20 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-20 | 22.20 | 15.60 | 14.50 | 13.20 | | | | | |
| 24 | 27.3±0.8 | L-12-OV-24 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-24 | 22.20 | 15.60 | 14.50 | 13.20 | | | | | |
| 28 | 31.9±1.0 | L-12-OV-28 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-28 | 22.20 | 15.60 | 14.50 | 13.20 | | | | | |
| 30 | 33.5±1.0 | L-12-OV-30 | 15.30 | 11.10 | 10.45 | 9.50 | L-20-OV-30 | 22.20 | 15.60 | 14.50 | 13.20 | | | | | |

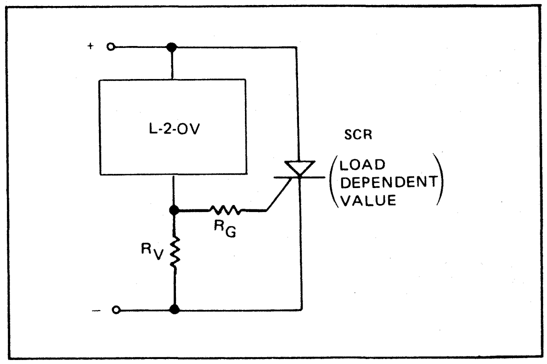
***TRIP POINT VOLTAGE TOLERANCE SPECIFIED OVER A TEMPERATURE RANGE OF 0°C TO 71°C**

**Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.**

# OVERVOLTAGE PROTECTORS



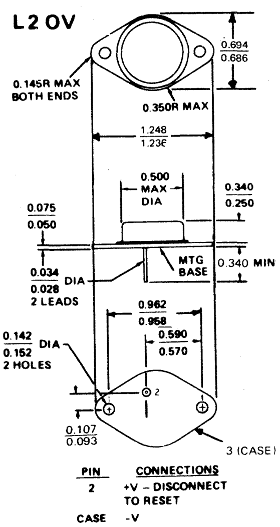

HYBRID OVERVOLTAGE PROTECTOR
SCHEMATIC DIAGRAM



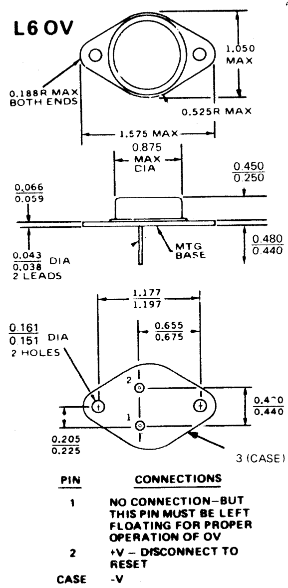

LAMBDA L-2-OV USED TO BUILD HIGHER
CURRENT LEVEL OV PROTECTOR.

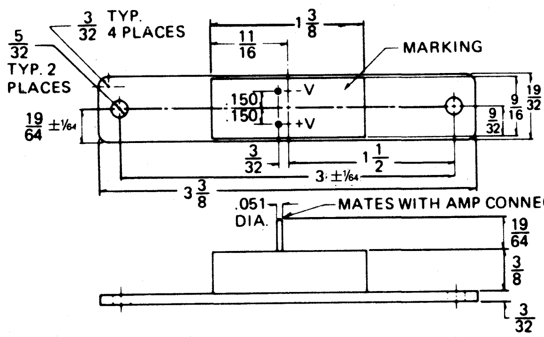
# OUTLINE DRAWING

TO-66 (STEEL)

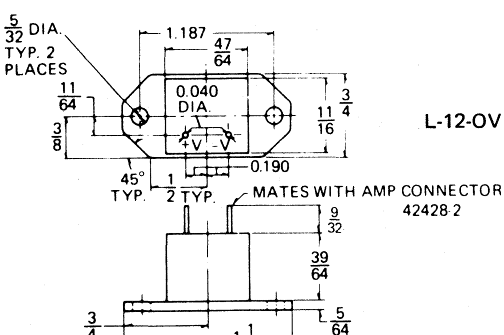



TO-3 (STEEL)

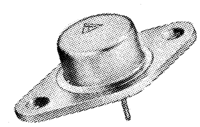


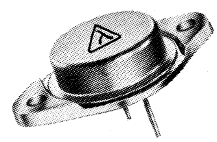

**L-20-OV**
**L-35-OV**



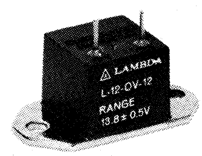

L-12-OV



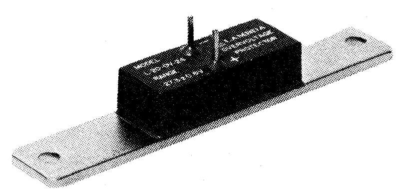
MONOLITHIC
L-2-OV
2 AMP



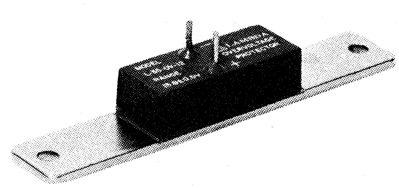
MONOLITHIC
L-6-OV
6 AMP




HYBRID
L-12-OV
12 AMP



HYBRID
L-20-OV
20 AMP



HYBRID
L-35-OV
35 AMP

# SECTION IV – POWER DRIVERS

# LPD 4100 SERIES

## 2.0 AMP POWER DRIVERS

## FEATURES

- Two drivers per TO-3 package.
- Full 2 amperes of output current on each driver.
- Six dual 2 input logic configurations available. Dual AND, dual NAND, dual OR, dual NOR, Buffer, and Inverter
- Full 4 amperes of output current in a parallel mode of operation.
- 100% compatible interface with TTL, low power SCHOTTKY TTL, and CMOS
- Duty cycle up to 100% (DC)—both outputs.

## DESCRIPTION

The LPD—4100 Series of Dual Power Drivers are monolithic bipolar integrated circuits capable of switching load currents up to two (2) Amperes per output. The input characteristics of these power drivers are fully compatible with TTL, Low Power Schottky-TTL, and CMOS when operated at an appropriate power supply level. The six functions available in the LPD—4100 Series include Dual 2 input AND, Dual 2 input NAND, Dual 2 input OR, Dual 2 input NOR, Dual INVERTER, and Dual BUFFER. The output of each power driver consists of an open collector transistor which is capable of sustaining 40 volts. The devices are specifically designed to interface TTL logic levels to high current, high voltage output drive requirements, such as relay drivers, lamp drivers, solenoid drivers, and stepper motors. The devices are assembled in a hermetic 8-pin TO-3 package for high reliability and low thermal resistance. Each output may be operated up to 2 Amperes at a 100% duty cycle. The outputs of the dual power driver may be paralleled to achieve a load current capability of 4 Amperes.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | MINIMUM | MAXIMUM | UNITS |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | 0 | 10 | Volts |
| High Level Output Voltage | $V_{OH}$ | | 40 | Volts |
| Input Voltage | $V_{IN}$ | −1.5 | 30 | Volts |
| Low Level Output Current | $I_{OL}$ | | 2.0 | Amps |
| Power Dissipation (Each Driver) | $P_D$ | | 3.0 | Watts |
| Power Dissipation (Total)(1) | $P_D$ (Total) | | 6.0 | Watts |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | 3.5 | °C/Watt |
| Operating Junction Temperature Range | $T_J$ | −55 | 150 | °C |
| Storage Temperature Range | $T_{STG}$ | −55 | 200 | °C |
| Lead Temperature (Soldering, 60 Seconds Time Limit) | $T_{LEAD}$ | | 300 | °C |

(1) For operation above 104°C $T_{CASE}$, derate @ 285mW/°C.

## ELECTRICAL CHARACTERISTICS

| CHARACTERISTIC | SYMBOL | JUNCTION TEMPERATURE | $V_{CC}$ | LPD-4101 LPD-4104 LPD-4106 DRIVEN INPUT | LPD-4102 LPD-4103 LPD-4105 DRIVEN INPUT | OUTPUT | LIMITS MIN. | LIMITS MAX. | LIMITS UNITS | OTHER INPUT LPD-4101 DUAL AND | OTHER INPUT LPD-4104 DUAL OR | OTHER INPUT LPD-4102 DUAL NAND | OTHER INPUT LPD-4103 DUAL NOR | OTHER INPUT LPD-4105* LPD-4106** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "1" Input Voltage | $V_{IH}$ | 0-125°C | Min | | | | 2.0 | — | V | | | | | NA |
| "0" Input Voltage | $V_{IL}$ | 0-125°C | Min | | | | — | 0.8 | V | | | | | NA |
| "1" Input Current | $I_{IH}$ | 0-125°C | Max | 2.7V | 2.7V | | — | 20 | μA | 0V | 0V | 0V | 0V | NA |
| "0" Input Current | $I_{IL}$ | 0-125°C | Max | 0.4V | 0.4V | | — | −50 | μA | 0V | 0V | 0V | 0V | NA |
| Input Clamp Diode Voltage | $V_{CD}$ | 0-125°C | Min | −12mA | −12mA | | — | −1.5 | V | | | | | NA |
| "1" Output Reverse Current | $I_{OH}$ | 0-125°C | Min | 2.0V | 0V | 40V | — | 100 | μA | 2.0V | 0V | 2.0V | 0V | NA |
| "0" Output Voltage | $V_{OL}$ | +25°C | Min | 0.8V | 2.0V | 0.5A | — | 0.5 | V | $V_{CC}$ | 0.8V | 2.0V | 0.8V | NA |
| "0" Output Voltage | $V_{OL}$ | +25°C | Min | 0.8V | 2.0V | 1.0A | — | 0.8 | V | $V_{CC}$ | 0.8V | 2.0V | 0.8V | NA |
| "0" Output Voltage | $V_{OL}$ | +25°C | Min | 0.8V | 2.0V | 2.0A | — | 1.5 | V | $V_{CC}$ | 0.8V | 2.0V | 0.8V | NA |
| "1" Output Level Supply Current | $I_{CCH}$ | 0-125°C | Max | $V_{CCN}$ | 0V | | — | 30 | mA | $V_{CCN}$ | $V_{CCN}$ | 0V | 0V | NA |
| "0" Output Level Supply Current | $I_{CCL}$ | 0-125°C | Max | 0V | 2.0V | | — | 400 | mA | 0V | 0V | 2.0V | 2.0V | NA |
| Turn-On Delay | TPD− | +25°C | $V_{CCN}$ | See Test Figure | | | — | 350 | n Sec | | | | | |
| Turn-Off Delay | TPD+ | +25°C | $V_{CCN}$ | See Test Figure | | | — | 2.0 | μ Sec | | | | | |

*Dual INVERTER **Dual BUFFER

## SWITCHING CHARACTERISTICS

$V_{CC}$=5 VOLTS, $V_{OH}$=40 VOLTS, $T_J$=25°C

| PARAMETER | SYMBOL | TEST CONDITIONS | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Turn—on Delay | TPD− | See "Switching Test Circuit" | — | 350 | nS |
| Turn—off Delay | TPD+ | See "Switching Test Circuit" | — | 2.0 | uS |

## RECOMMENDED OPERATING CONDITIONS

| | |
|---|---|
| Supply Voltage Maximum (VCC MAX) | + 5.5 Volts |
| Supply Voltage Nominal (VCCN) | + 5.0 Volts |
| Supply Voltage Minimum (VCC MIN) | + 4.5 Volts |

# LPD 4100 SERIES

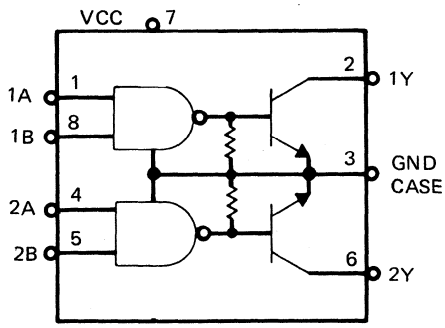
## ORDERING INFORMATION

| DEVICE NO. | LOGIC FUNCTION | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|
| LPD-4101 | Dual AND | $6.00 | $4.00 | $3.50 | $3.25 |
| LPD-4102 | Dual NAND | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4103 | Dual NOR | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4104 | Dual OR | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4105 | Dual INVERTER | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4106 | Dual BUFFER | 6.00 | 4.00 | 3.50 | 3.25 |

Contact your area sales representative for higher quantity prices. Device configurations, specifications, and prices subject to change without notice.

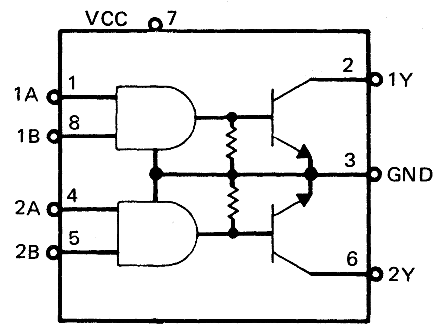
## FUNCTIONAL BLOCK DIAGRAMS

LPD-4101



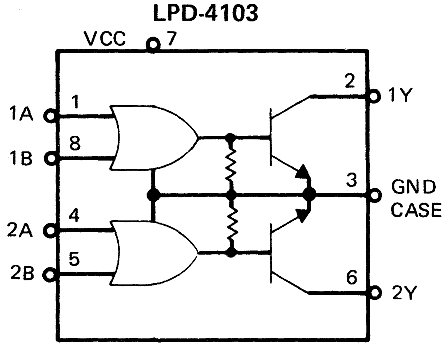

DUAL "AND" DRIVER
POSITIVE LOGIC Y=AB

LPD-4102



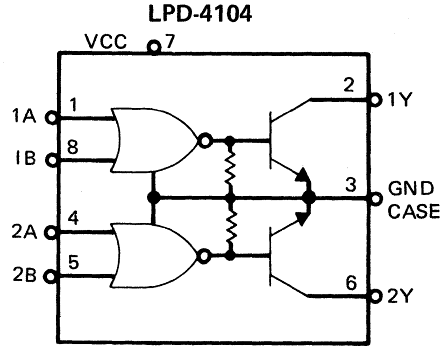

DUAL "NAND" DRIVER
POSITIVE LOGIC Y = $\overline{AB}$

LPD-4103



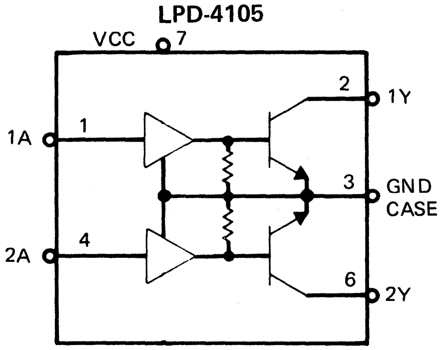

DUAL "NOR" DRIVER
POSITIVE LOGIC Y = $\overline{A+B}$

LPD-4104



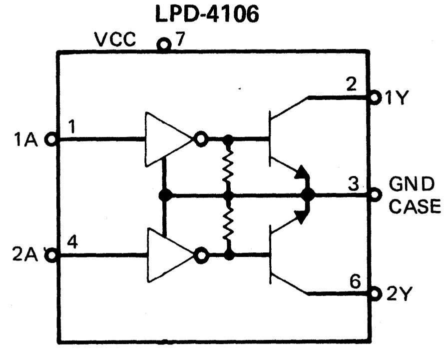

DUAL "OR" DRIVER
POSITIVE LOGIC Y = A+B

LPD-4105




DUAL "INVERTER"
POSITIVE LOGIC Y = $\overline{A}$

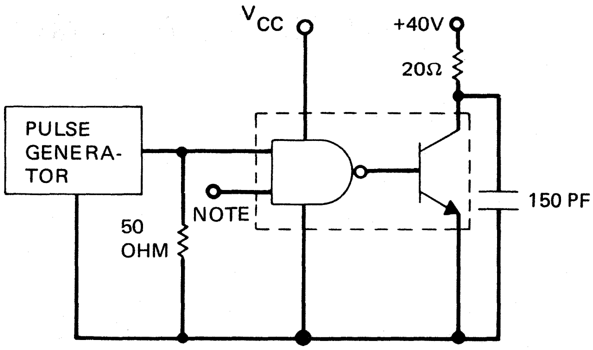
LPD-4106



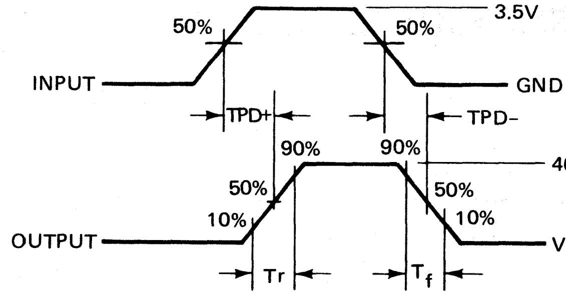

DUAL "BUFFER"
POSITIVE LOGIC Y = A

# LPD 4100 SERIES

SWITCHING TEST CIRCUIT




SWITCHING WAVEFORMS
(NON-INVERTING FUNCTIONS)




INPUT WAVEFORM: TR = TF ⩽ 100 NS
DUTY CYCLE = 10%

NOTE: ALL INPUTS ARE AT EITHER LOW OR HIGH LEVELS, DEPENDING ON THE CORRECT LOGIC STATES REQUIRED IN THE TRUTH TABLES.

## TRUTH TABLES

**LPD-4101 "AND"**

| INPUTS A | INPUTS B | OUTPUT Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

**LPD-4102 "NAND"**

| INPUTS A | INPUTS B | OUTPUT Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

**LPD-4103 "NOR"**

| INPUTS A | INPUTS B | OUTPUT Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

**LPD-4104 "OR"**

| INPUTS A | INPUTS B | OUTPUT Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

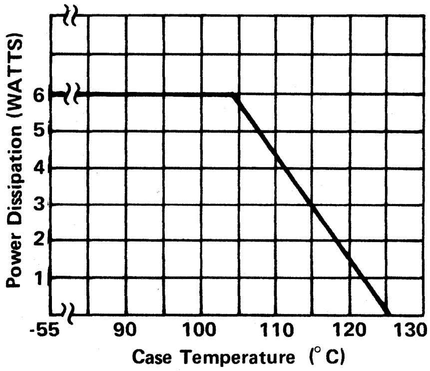
**LPD-4105 "INVERTER"**

| INPUT A | OUTPUT Y |
|---|---|
| 0 | 1 |
| 1 | 0 |

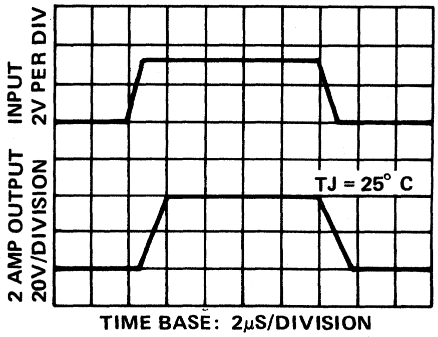
**LPD-4106 "BUFFER"**

| INPUT A | OUTPUT Y |
|---|---|
| 0 | 0 |
| 1 | 1 |

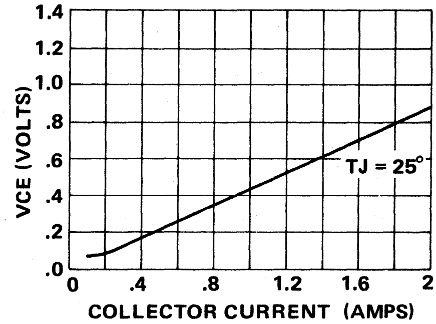
## OPERATIONAL DATA




POWER DERATING



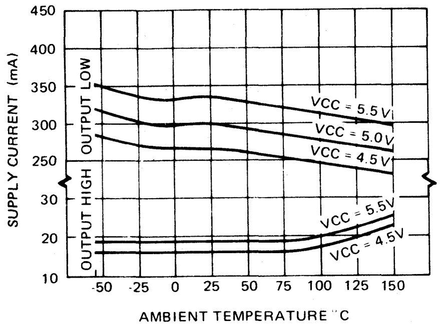

TYPICAL SWITCHING SPEED WAVEFORMS
(NON-INVERTING FUNCTION)



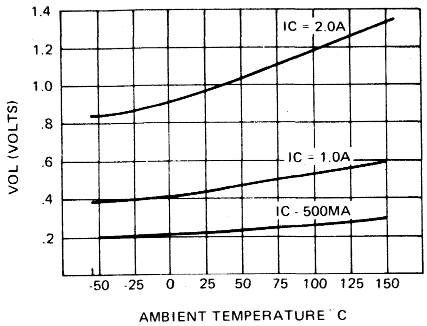

TYPICAL COLLECTOR EMITTER SATURATION VOLTAGE VS COLLECTOR CURRENT (VOL)

# LPD 4100 SERIES

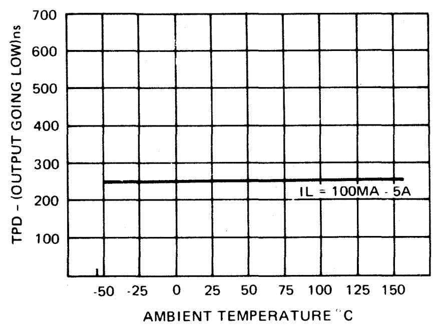
## OPERATIONAL DATA



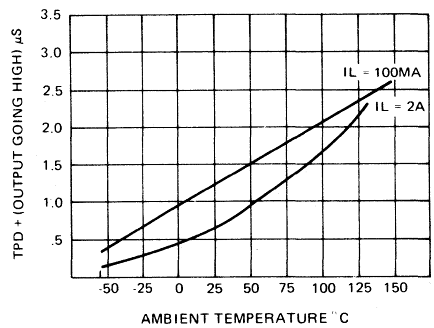

TYPICAL SUPPLY CURRENT VS AMBIENT TEMPERATURE




TYPICAL COLLECTOR-EMITTER SATURATION VOLTAGE VS AMBIENT TEMPERATURE (VOL)

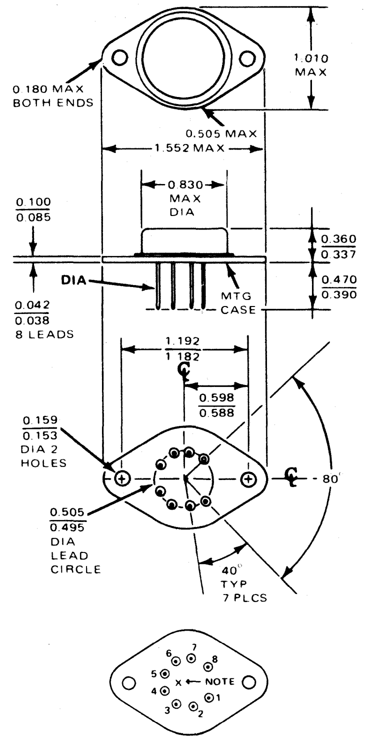



TYPICAL PROPAGATION DELAY VS TEMPERATURE




TYPICAL PROPAGATION DELAY VS TEMPERATURE

## OUTLINE DRAWING

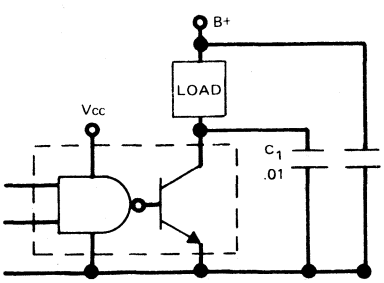



| PIN | FUNCTION |
|---|---|
| 1 | INPUT 1 |
| 2 | OUTPUT 1 |
| 3 | GROUND (CASE) |
| 4 | INPUT 3 |
| 5 | INPUT 4, NC FOR 4105 & 4106 |
| 6 | OUTPUT 2 |
| 7 | $V_{CC}$ |
| 8 | INPUT 2, NC FOR 4105 & 4106 |

NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT
NC = NO CONNECTION

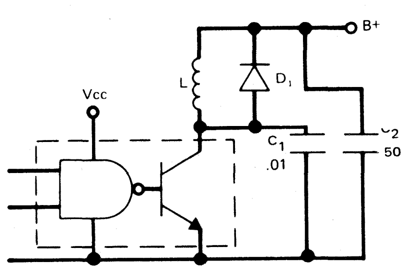
## TYPICAL APPLICATIONS

### BASIC DRIVING CIRCUIT




$C_1$ may be necessary to slow the 4100 slew rate during turn off to prevent overvoltages due to stray inductance. $C_2$ should be added to prevent ringing in applications where long B+ lines are used or when the B+ supply has poor transient load regulation.

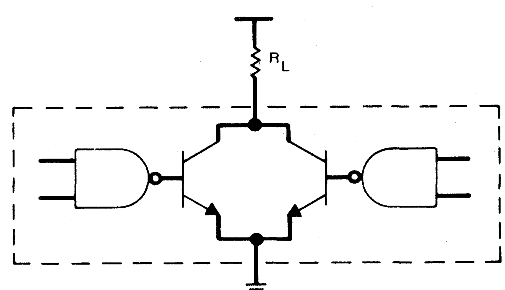
### INDUCTIVE DRIVE CIRCUIT




L is an inductive load such as a relay solenoid or DC motor.

Diode $D_1$ is necessary to protect the 4100 output transistor from overvoltage switching transients during turnoff. $D_1$ should be a fast switching diode.

### PARALLEL CONNECTION OF DRIVER OUTPUTS




Outputs from each driver may be connected in parallel to increase load current to 4 amps.

# SECTION V – RECTIFIERS

# LAMBDA PMR-27K, 31K, 35K, 36K SERIES MONOLITHIC FULL-WAVE, CENTER-TAP POWER RECTIFIERS

## FEATURES

- Replaces two stud mount rectifiers
- Available in 15 and 30 Amperes per diode in each rectifier

## DESCRIPTION

Four series of three-terminal monolithic Center Tap Rectifiers have been designed for use in power supplies. The PMR-27K and PMR-35K devices are a common cathode configuration; the PMR-31K and PMR-36K are a common anode configuration. Both configurations are available in average forward current ratings of 15 and 30 amperes. Peak reverse voltage ranges of 50, 100 and 200 volts are available in the PMR-27K, 31K series; 50, 100, and 200 volts are available in the PMR-35K, 36K series. All power rectifiers are hermetically sealed in either steel or copper TO-3 packages, depending on the power dissipation requirement; providing high reliability and low thermal resistance, when used with appropriate heat sinks.

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | PMR27K050 PMR31K050 | PMR27K100 PMR31K100 | PMR27K200 PMR31K200 | PMR35K050 PMR36K050 | PMR35K100 PMR36K100 | PMR35K200 PMR36K300 | UNITS |
|---|---|---|---|---|---|---|---|---|
| Maximum Repetitive Peak Reverse Voltage | $V_{RRM}$ | 50 | 100 | 200 | 50 | 100 | 200 | VOLTS |
| Maximum RMS Reverse Voltage | $V_{R(RMS)}$ | 35 | 70 | 141 | 35 | 70 | 141 | VOLTS |
| Average Rectified Forward Current | $I_O$ | 15 | 15 | 15 | 30 | 30 | 30 | AMPS |
| Peak-Repetitive Surge Current (½ cyc) | $I_{FSM}$ | 250 | 250 | 250 | 400 | 400 | 400 | AMPS |
| RATING-Non-Repetitive for 1mS<t<8.3mS | $I^2T$ | 240 | 240 | 240 | 600 | 600 | 600 | $A_{RMS}2$ S |
| Power Dissipation Total Package[(1)] | $P_D$ | 150 | 150 | 150 | 150 | 150 | 150 | WATTS |
| Operating and Storage Temperature | $T_J$, $T_{STG}$ | −65 to 200 | | | | | | °C |
| Thermal Resistance Junction to Case | $R\theta_{JC}$ | 1.0 | 1.0 | 1.0 | 0.67 | 0.67 | 0.67 | °C/WATT |

(1) For PMR-27K & 31K Series, derate @ 1W/°C above 50°C ($T_C$).
For PMR-35K & 36K Series, derate @ 1.5W/°C above 100°C ($T_C$).

## ELECTRICAL CHARACTERISTICS

$T_J$ = 0°C to 200°C

| TEST | SYMBOL | TEST CONDITIONS | MIN. | MAX. | UNITS |
|---|---|---|---|---|---|
| Full Cycle Average Forward Voltage Drop | $V_{F(AV)}$ | $I_O$=15A (PMR27/31) $I_O$=30A (PMR35/36) f=30Hz, each diode | | 1.4 | VOLTS |
| Maximum Reverse Current | $I_{RM}$ | $V_{RRM}$, each diode | | 10 | MAdc |

## CROSS REFERENCE GUIDE

| | | | | | |
|---|---|---|---|---|---|
| R711 | PMR27K100 | UES2601 | PMR27K050 | NSR8140 | PMR27K100 |
| R711A | PMR31K100 | UES2601R | PMR31K050 | NSR8140A | PMR31K100 |
| R712 | PMR27K200 | UES2602 | PMR27K100 | NSR8141 | PMR31K200 |
| R712A | PMR31K200 | UES2602R | PMR31K100 | NSR8141A | PMR31K200 |
| | | UES2603 | PMR27K200 | | |
| | | UES2603R | PMR31K200 | | |

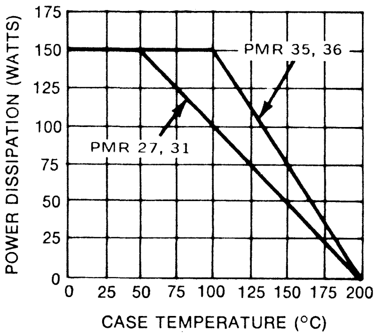
## ORDERING INFORMATION

| COMMON CATHODE | COMMON ANODE | $V_{RRM}$ | $I_O$ | PRICE QTY 1-99 | 100-249 | 250-999 | 1000-2499 | 2500<5K |
|---|---|---|---|---|---|---|---|---|
| **PMR 27K 050** | **PMR 31K 050** | 50 | 15 | $2.08 | $1.25 | $1.10 | $ .95 | $ .91 |
| **PMR 27K 100** | **PMR 31K 100** | 100 | 15 | 2.15 | 1.30 | 1.15 | 1.00 | .96 |
| **PMR 27K 200** | **PMR 31K 200** | 200 | 15 | 2.25 | 1.35 | 1.20 | 1.05 | 1.00 |
| **PMR 35K 050** | **PMR 36K 050** | 50 | 30 | 4.75 | 2.85 | 2.57 | 2.18 | 2.10 |
| **PMR 35K 100** | **PMR 36K 100** | 100 | 30 | 5.00 | 3.00 | 2.70 | 2.30 | 2.20 |
| **PMR 35K 200** | **PMR 36K 200** | 200 | 30 | 5.25 | 3.15 | 2.83 | 2.42 | 2.30 |

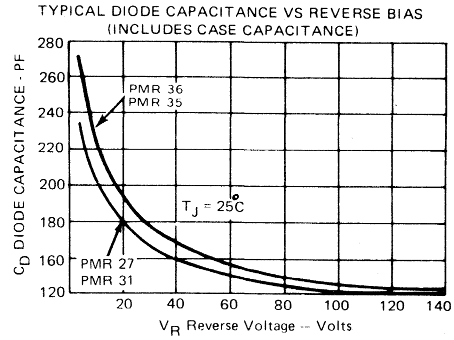
Contact your area sales representative for higher quantity prices.
Device configurations, specifications, and prices subject to change without notice.

# PMR 27K, 31K, 35K, 36K SERIES

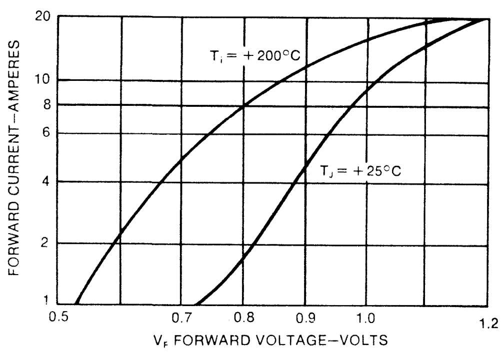
## OPERATIONAL DATA



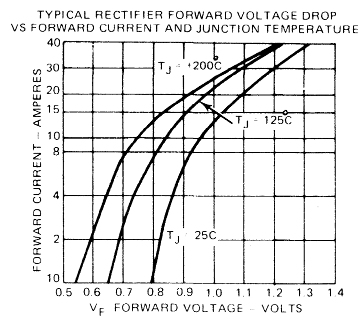

**POWER DERATING**




**TYPICAL DIODE CAPACITANCE VS REVERSE BIAS (INCLUDES CASE CAPACITANCE)**



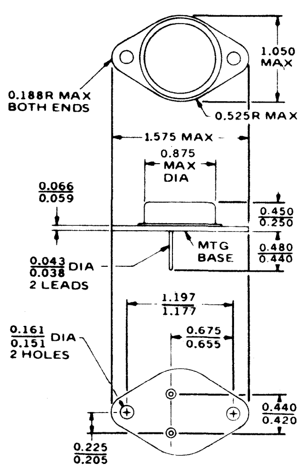

**TYPICAL FORWARD VOLTAGE VS CURRENT: PMR 27,31**



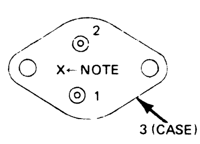

**TYPICAL RECTIFIED FORWARD VOLTAGE DROP VS FORWARD CURRENT AND JUNCTION TEMPERATURE: PMR 35,36**

## OUTLINE DRAWINGS

**TO-3 3-TERMINAL**
**PMR 27K, 31K**



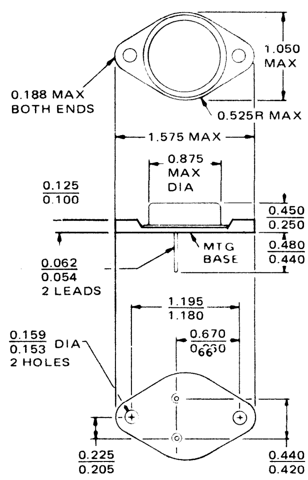

**PMR-27K, 35K**



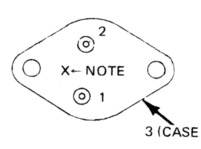

| PIN | FUNCTION |
|---|---|
| 1 | ANODE |
| 2 | ANODE |
| 3 | COMMON CATHODE |

NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

**TO-3 3-TERMINAL**
**PMR 35K, 36K**




**PMR-31K, 36K**




| PIN | FUNCTION |
|---|---|
| 1 | CATHODE |
| 2 | CATHODE |
| 3 | COMMON ANODE |

NOTE (X) = CASE TEMPERATURE MEASURED AT THIS POINT.

# PART III – DEFINITION OF TERMS

**Cobo: Common base open-circuit output capacitance**
The capacitance measured across the output terminals of the collector and base.

**$E_{s/b}$: Reverse biased second breakdown energy**
The maximum quantity of stored energy which can be non-destructively dissipated by a transistor during turn-off under the specified turn-off conditions.

**$h_{FE}$: Static common emitter forward current transfer ratio**
The ratio of the dc output current to the dc input current.

**$h_{fe}$: Small-signal common emitter short-circuit forward current transfer ratio**
The ratio of the ac output current to the small-signal ac input current with the output short-circuited to dc.

**$I_B$: dc base-terminal current**
The value of the dc current into the base terminal.

**$I_C$: dc collector-terminal current**
The value of the dc current into the collector terminal.

**$I_{CER}$: Collector cutoff current, dc with a resistance between base and emitter.**
The dc current into the collector terminal when it is biased into the reverse direction* with respect to the emitter terminal and the base terminal is returned to the emitter terminal through a specified resistance [$R_{BE}$]
*for NPN transistors – collector more positive than emitter.
*for PNP transistors – collector more negative than emitter.

**$I_{EBO}$: Emitter cutoff current dc, collector open**
The dc current into the emitter terminal when it is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited.

**$I_F$: Forward current**
The respective value of current that flows through a semiconductor diode or rectifier diode in the forward direction.

**$I_{FSM}$: Forward current, surge peak**
The maximum (peak) surge forward current having a specified waveform and a short specified time interval.

**$I^2T$: I squared T**
The measure of the maximum forward non-recurring overcurrent capability for very short pulse durations. The value is valid only for the pulse duration specified. I is in RMS AMPERES and T is in seconds.

**$I_O$: Average forward current, 180° conduction angle, 60-Hz, half sine wave**
The value of the forward current averaged over a full cycle.

**$I_{O\ PK}$: Average forward current-peak**
The maximum specified value of the forward current averaged over a full cycle.

**$I_Q$: Bias current or quiescent current**
Input current of the regulator that is not delivered to the load.

**$i_{R(REC)}$: Reverse recovery current**
The transient reverse current associated with a change from forward current condition to reverse condition.

**$I_S$: Standby Current**
The input current drawn by a regulator with no output load and no reference voltage load.

**$I_{SC}$: Short-circuit current**
The output current drawn with the output shorted to common.

**$I_{s/b}$: Forward bias second breakdown collector current**
The maximum amount of collector current which can be safely handled by an "ON" transistor for a specified time (usually 1 Sec.) under specified VCE conditions.

**$P_D$: Power Dissipation**
The maximum amount of power that a device can safely dissipate consistent with other device specifications limit.

**$P_T$: Total non-reactive power input to all terminals**
The sum of the products of the dc input current and voltages or the sum of the products of the instantaneous input currents and voltages.

**$P_{T(max)}$: Total maximum non-reactive power input to all terminals**
The maximum specified sum of the products of the dc input currents and voltages or the maximum specified sum of the products of the instantaneous input currents and voltages.

**$R_A$: Ripple attenuation**
The ratio of peak to peak input ripple voltage (unregulated) to the peak to peak output ripple voltage.

**$REG_{IN}$: Line regulation**
The maximum amount of output voltage change as a result of a change in the input voltage with load current and ambient temperature held constant.

**$REG_L$: Load regulation**
The maximum amount of output voltage change due to a change in the load, from no-load to full load or for a specified load change with line voltage and ambient temperature held constant.

**$R\theta_{JC}$: Thermal resistance junction to case**
The steady-state thermal resistance from the semiconductor or IC's junction to the case with infinite heat sink.

**$T_A$: Ambient temperature**
The temperature of ambient under operating conditions.

**$T_C$: Temperature coefficient of regulator voltage, temperature coefficient at reference voltage**
The ratio of the change in the respective regulator voltage or reference voltage, usually expressed as a percentage of the regulator or reference voltage, to the change in temperature. This ratio is the average value for the total temperature change.

**$T_{CASE}$: Case temperature**
The temperature measured at a specific location on the case of the device.

**$T_{CB}$: Case temperature, blocking mode**
The temperature measured at a specific location on the case of the device when the junction in question is reversed biased.

**$T_{CC}$: Case temperature, conducting**
The temperature measured at a specific location on the case of the device when the junction in question is forward biased.

**$T_J$: Junction temperature**
The temperature of a semiconductor junction.

**Tstg: Storage temperature**
The temperature at which the device, without any power applied, is stored.

**$t_d$: Delay time**
The time interval from the point at which the leading edge of the input pulse has reached 10% of its maximum amplitude to the point at which the leading edge of the output pulse has reached 10% of its maximum amplitude.

**$t_f$: Fall time**
The time duration during which the trailing edge of pulse is decreasing from 90% to 10% of its maximum amplitude.

**$t_{off}$: Turn-off time**
The sum of ts + tf.

**$t_{on}$: Turn-on time**
The sum of td + tr.

**$t_r$: Rise time**
The time duration during which the leading edge of a pulse is increasing from 10% to 90% of its maximum amplitude.

**$t_s$: Storage time**
The time interval from a point 90% of the maximum amplitude on the trailing edge of the input pulse to a point 90% of the maximum amplitude on the trailing edge of the output pulse.

**$V_{(BR)CBO}$: Breakdown voltage, Collector-to-base, emitter open**
The breakdown voltage between the collector terminal and the base terminal when the collector terminal is biased in the reverse direction with respect to the base terminal and the emitter terminal is open circuited.

**$V_{(BR)CEO}$: Breakdown voltage, Collector-to-emitter with base open**
The breakdown voltage between the collector terminal and the emitter terminal when the collector terminal is biased in the reverse direction* with respect to the emitter terminal and the base terminal is open-circuited.
*for NPN transistors—collector more positive than emitter.
*for PNP transistors—collector more negative than emitter.

**$V_{CER(sus)}$: Sustaining voltage, collector-to-emitter, resistance between base and emitter**
The collector-to-emitter breakdown voltage at relatively high values of collector current where the breakdown voltage is relatively insensitive to changes in collector current. The base terminal is returned to the emitter terminal through a specified resistance.

**$V_{(BR)EBO}$: Breakdown voltage, emitter-to-base, collector open**
The breakdown voltage between the emitter and base terminals when the emitter terminal is biased in the reverse direction with respect to the base terminal and the collector terminal is open-circuited.

**$V_{BE(on)}$: Base-emitter turn-on voltage**
The dc voltage between the base and emitter terminals measured in the common-emitter connections at a specified collector to emitter voltage and specified collector current.

**$V_{BE(sat)}$: Saturation voltage, dc, base-to-emitter**
The dc voltage between the base and emitter terminals for specified base-current conditions which are intended to insure that the collector junction is forward biased.

**$V_{CE(sat)}$: Saturation voltage, dc, collector-to-emitter**
The dc voltage between the collector and emitter terminals for specified saturation conditions.

**$V_{DC}$: On-state voltage**

**$V_{DO}$: Dropout voltage**
The minimum voltage between the input terminal and the output terminal at which the device ceases to regulate within specifications.

**$V_F$: Forward voltage, dc**
The dc voltage across a semiconductor diode associated with the flow of forward current.

**$V_{IN}$: Input Voltage**
The dc voltage measured between the input terminal and the common terminal.

**$V_N$: Output noise voltage**
The rms value of the random noise voltage measured between the output terminal and common with a constant load current and a dc input voltage.

**$V_{IN}$-$V_O$: Input-Output differential**
The voltage measured between the input terminal and the output terminal.

**$V_O$: Output voltage**
The dc voltage measured between the output terminal and the common terminal.

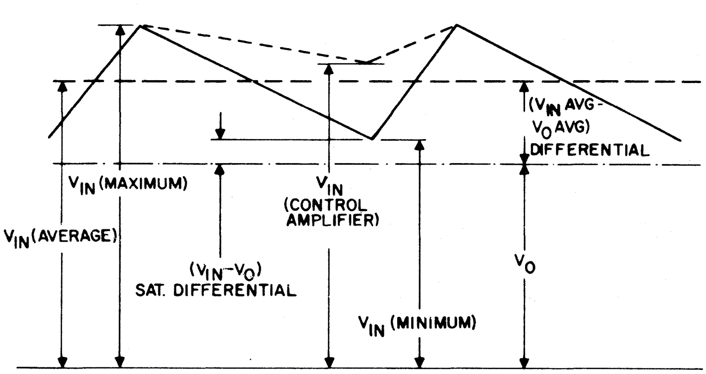
**$V_R$: Reverse voltage**
The voltage applied to a semiconductor diode or rectifier diode which causes the respective current to flow in the reverse direction.

**$V_{REF}$: Reference voltage**
The value of the internal voltage standard which is compared to the sense voltage during regulation.

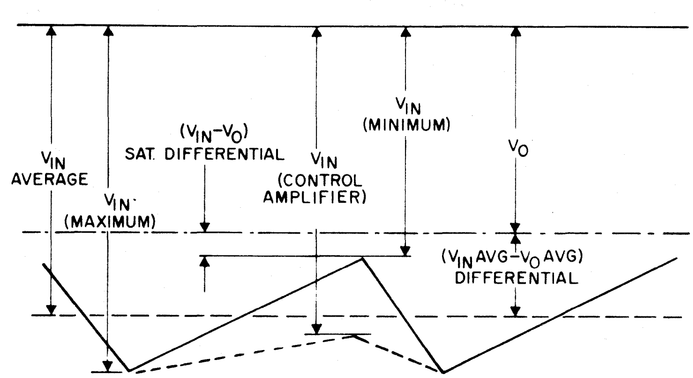
**$V_{RRM}$: Repetitive peak reverse voltage**
The maximum instantaneous value of the reverse voltage, including all repetitive transient voltages but excluding all non-repetitive transient voltages, which occurs across a semiconductor rectifier diode.

**$V_S$: Sense voltage**
Voltage that is a function of the output voltage and is used for feed back control of the regulator.

**POSITIVE REGULATOR**




**NEGATIVE REGULATOR**



# GENERAL ORDERING INFORMATION

### PRICES
U.S.—All prices F.O.B. Melville, N.Y.; Corpus Christi, Texas.
Canada—Please contact Montreal office for prices and handling charges of units shipped from Montreal, Canada. All prices are effective Oct. 15, 1981 and are in U.S. funds.

### TERMS
Net 30 days.

### TAXES
All applicable taxes, federal, state and local, are extra.

### DISCOUNTS
Available to quantity buyers. For details consult with the Lambda Sales Department or Field Sales Engineer.

### QUOTATIONS
All written quotations will be honored for 30 days from the date on which they are made.

### DISTRIBUTION POINTS
Lambda power semiconductors are shipped from three distribution points for minimum shipping costs.

### DISTRIBUTION CENTERS
1. Melville, New York
2. Corpus Christi, Texas
3. Montreal, Canada

### SHIPMENT
Express truck shipment in our experience has provided the fastest and safest delivery of power devices. Unless you specifically request otherwise, your order will be forwarded in the best manner. Urgent needs can be accommodated by air express or air freight in accordance with your instructions. If devices are received damaged, it is the customer's responsibility to contact the carrier and file a claim for damages.

### TESTING
Each Lambda power device is electrically tested to insure conformance with applicable specifications.

### WARRANTY
We warrant each product manufactured by us, and sold by us or our authorized agents, to be free from defects in material and workmanship, and that, upon delivery, it will perform within applicable specifications. Our obligation under this warranty is limited to replacing products determined to be defective, and returned to us, in accordance with the provisions set forth below under the heading "Shipments To Factory."

**This warranty is in lieu of all other warranties, express or implied** and constitutes fulfillment of all our liabilities to purchaser. **We do not warrant that the products can be used for any particular purpose other than those covered by the applicable specifications.** We assume no liability, in any event, for consequential damages; for anticipated or lost profits, incidental damages or loss of time or other losses incurred by purchaser or any third party in connection with products covered by this warranty or otherwise.

We reserve the right to discontinue products without notice, and to make modifications in design without incurring any obligation to make such modifications to products previously sold.

### SHIPMENTS TO FACTORY
If the customer notifies Lambda within 30 days after receipt of shipment that our parts have failed incoming inspection, the parts may be returned for replacement. Replacement will be issued subject to Lambda's inspection and verification of D.O.A. part. D.O.A. replacements require authorization prior to returning devices. Contact the originating factory for a return authorization number as shipments to the factory cannot be accepted without reference to this number.

All returned devices must be new, unused and in the original carton. Returned devices must be shipped to the factory within 30 days after receipt of return authorization number. Shipments must be prepaid, contain return authorization number and reason for return plus instructions for return shipment, and be packed in a manner to preclude shipping damage. Any shipping damage will be the responsibility of the customer.

# PRODUCT/PRICE INDEX

## VOLTAGE REGULATORS, POSITIVE MODELS

### WIDE RANGE

| MODEL | PAGE | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAS 3700 | 51 | 0-* | 6mA | $14.00 | $13.75 | $13.15 | $12.05 | $11.65 | $10.75 | $ 9.80 | $ 9.00 |
| LAS 723 | 21 | 2.63-38 | 150mA | 1.15 | 1.15 | 1.15 | 1.04 | .98 | .98 | .92 | .86 |
| LAS 723B | 21 | 2.63-48 | 150mA | 1.19 | 1.19 | 1.19 | 1.08 | 1.02 | 1.02 | .96 | .90 |
| LAS 1000 | 21 | 2.63-38 | 150mA | 1.39 | 1.39 | 1.39 | 1.24 | 1.17 | 1.17 | 1.10 | 1.03 |
| LAS 1100 | 21 | 2.63-48 | 150mA | 1.64 | 1.64 | 1.64 | 1.43 | 1.40 | 1.40 | 1.33 | 1.23 |
| LAS 15U | 25 | 4-30 | 1.5A | 4.25 | 3.86 | 3.55 | 3.33 | 3.09 | 2.94 | 2.78 | 2.63 |
| LLM 317 | 33 | 1.2-37.0 | 1.5A | 3.75 | 3.10 | 3.10 | 2.65 | 2.65 | 2.65 | 2.00 | 1.90 |
| LAS 16U | 35 | 4-30 | 2.0A | 4.50 | 4.20 | 3.90 | 3.60 | 3.40 | 3.25 | 3.08 | 2.85 |
| LAS 14AU | 38 | 4-35 | 3.0A | 9.00 | 8.00 | 7.50 | 7.25 | 6.22 | 5.55 | 4.95 | 4.60 |
| LLM 350 | 41 | 1.2-33.0 | 3.0A | 5.75 | 4.80 | 4.80 | 4.00 | 4.00 | 4.00 | 3.35 | 3.20 |
| LAS 19U | 43 | 4-30 | 5.0A | 16.00 | 14.50 | 13.75 | 10.25 | 9.75 | 9.00 | 8.50 | 8.00 |
| LLM 338 | 46 | 1.2-32.0 | 5.0A | 7.60 | 6.39 | 6.39 | 5.00 | 5.00 | 5.00 | 4.15 | 4.00 |
| LAS 39U | 48 | 4-16 | 8.0A | 19.00 | 17.50 | 16.75 | 14.00 | 14.00 | 12.90 | 11.65 | 11.00 |

*Limited only by external components

### FIXED

| MODEL | PAGE | $I_O$ AMPS | $P_D$ WATTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **5V** | | | | | | | | | | | |
| LAS 15A05 | 25 | 1.5 | 15 | $ 2.75 | $ 2.50 | $ 2.30 | $ 2.15 | $ 2.00 | $ 1.90 | $ 1.80 | $ 1.70 |
| LAS 1505 | 25 | 1.5 | 15 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1605 | 35 | 2.0 | 20 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 1405 | 38 | 3.0 | 30 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 1905 | 43 | 5.0 | 50 | 14.00 | 12.50 | 11.75 | 10.00 | 7.85 | 7.85 | 7.00 | 6.85 |
| LAS 2105 | 53 | 5.0 | 85 | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 | — |
| LAS 3905 | 48 | 8.0 | 80 | 18.00 | 16.50 | 15.75 | 13.00 | 13.00 | 11.90 | 10.65 | 10.00 |
| LAS 3905K | 48 | 8.0 | 80 | 16.00 | 14.25 | 13.80 | 11.65 | 10.75 | 9.85 | 9.50 | 9.25 |
| **6V** | | | | | | | | | | | |
| LAS 1506 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| LAS 1406 | 38 | 3.0 | 30 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| **8V** | | | | | | | | | | | |
| LAS 1508 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| LAS 1608 | 35 | 2.0 | 20 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| **10V** | | | | | | | | | | | |
| LAS 1510 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| **12V** | | | | | | | | | | | |
| LAS 15A12 | 25 | 1.5 | 15 | $ 2.75 | $ 2.50 | $ 2.30 | $ 2.15 | $ 2.00 | $ 1.90 | $ 1.80 | $ 1.70 |
| LAS 1512 | 25 | 1.5 | 15 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1612 | 35 | 2.0 | 20 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 1412 | 38 | 3.0 | 30 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 1912 | 43 | 5.0 | 50 | 14.00 | 12.50 | 11.75 | 10.00 | 7.85 | 7.85 | 7.00 | 6.85 |
| LAS 2112 | 53 | 5.0 | 85 | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 | — |
| **13.8V** | | | | | | | | | | | |
| LAS 15CB | 25 | 1.5 | 15 | $ 2.75 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| LAS 16CB | 35 | 2.0 | 20 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| **15V** | | | | | | | | | | | |
| LAS 15A15 | 25 | 1.5 | 15 | $ 2.75 | $ 2.50 | $ 2.30 | $ 2.15 | $ 2.00 | $ 1.90 | $ 1.80 | $ 1.70 |
| LAS 1515 | 25 | 1.5 | 15 | 2.05 | 1.88 | 1.73 | 1.61 | 1.50 | 1.43 | 1.35 | 1.28 |
| LAS 1615 | 35 | 2.0 | 20 | 3.00 | 2.80 | 2.60 | 2.40 | 2.24 | 2.15 | 2.05 | 1.90 |
| LAS 1415 | 38 | 3.0 | 30 | 5.00 | 4.75 | 4.50 | 4.30 | 4.10 | 3.90 | 3.70 | 3.40 |
| LAS 1915 | 43 | 5.0 | 50 | 14.00 | 12.50 | 11.75 | 10.00 | 7.85 | 7.85 | 7.00 | 6.85 |
| LAS 2115 | 53 | 5.0 | 85 | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 | — |
| **18V** | | | | | | | | | | | |
| LAS 1518 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| **20V** | | | | | | | | | | | |
| LAS 1520 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| **24V** | | | | | | | | | | | |
| LAS 1524 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |
| LAS 2124 | 53 | 3.0 | 85 | 47.00 | 43.00 | 35.00 | 31.00 | 31.00 | 26.00 | 24.00 | — |
| **28V** | | | | | | | | | | | |
| LAS 1528 | 25 | 1.5 | 15 | $ 2.05 | $ 1.88 | $ 1.73 | $ 1.61 | $ 1.50 | $ 1.43 | $ 1.35 | $ 1.28 |

## LAMBDA IMPROVED SECOND SOURCE PRODUCTS

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| LMC 7805CK | 5.0 | 1.5 | $2.15 | $2.00 | $1.88 | $1.50 | $1.50 | $1.50 | $1.45 | $1.40 |
| LMC 7806CK | 6.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LMC 7808CK | 8.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LMC 7812CK | 12.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LMC 7815CK | 15.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LMC 7818CK | 18.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LMC 7824CK | 24.0 | 1.5 | 2.15 | 2.00 | 1.88 | 1.50 | 1.50 | 1.50 | 1.45 | 1.40 |
| LLM 340K-5 | 5.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-6 | 6.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-8 | 8.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-12 | 12.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-15 | 15.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-18 | 18.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 340K-24 | 24.0 | 1.5 | 2.05 | 1.90 | 1.75 | 1.45 | 1.45 | 1.45 | 1.40 | 1.35 |
| LLM 323K | 3.0 | 30 | 4.50 | 4.25 | 4.00 | 3.80 | 3.60 | 3.40 | 3.20 | 2.90 |

# VOLTAGE REGULATORS

## ADJUSTABLE

| MODEL | PAGE | $I_O$ AMPS | $P_D$ WATTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| **5V±5%** | | | | | | | | | | |
| LAS 2205 | 53 | 5.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 3205 | 59 | 10.0 | 140 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 5205 | 63 | 20.0 | 270 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |
| LAS 7205 | 66 | 30.0 | 400 | 161.00 | 132.00 | 112.00 | 95.00 | 95.00 | 90.00 | 78.00 |
| **6V±5%** | | | | | | | | | | |
| LAS 2206 | 53 | 5.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| **12V±5%** | | | | | | | | | | |
| LAS 2212 | 53 | 5.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 3212 | 59 | 8.5 | 140 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 5212 | 63 | 15.0 | 270 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |
| **15V±5%** | | | | | | | | | | |
| LAS 2215 | 53 | 5.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 3215 | 59 | 8.0 | 140 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 5212 | 63 | 15.0 | 270 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |
| LAS 7215 | 66 | 22.0 | 400 | 161.00 | 132.00 | 112.00 | 95.00 | 95.00 | 90.00 | 78.00 |
| **24V±5%** | | | | | | | | | | |
| LAS 2224 | 53 | 3.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 3224 | 59 | 7.5 | 140 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |
| LAS 5224 | 63 | 14.0 | 270 | 112.00 | 91.00 | 77.00 | 65.00 | 65.00 | 58.00 | 54.00 |
| LAS 7224 | 66 | 21.0 | 400 | 161.00 | 132.00 | 112.00 | 95.00 | 95.00 | 90.00 | 78.00 |
| **28V±5%** | | | | | | | | | | |
| LAS 2228 | 53 | 2.0 | 85 | $ 47.00 | $ 43.00 | $ 35.00 | $31.00 | $31.00 | $26.00 | $24.00 |
| LAS 3228 | 59 | 7.0 | 140 | 54.00 | 47.00 | 41.00 | 35.00 | 35.00 | 30.00 | 29.00 |

# NEGATIVE MODELS

## WIDE RANGE

| MODEL | PAGE | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LAS 18U | 29 | −30 to −2.6 | 1.5A | $ 5.40 | $ 5.03 | $ 4.73 | $ 4.50 | $ 4.28 | $ 4.05 | $ 3.82 | $ 3.60 |

## FIXED

| MODEL | PAGE | $I_O$ AMPS | $P_D$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **−2V** | | | | | | | | | | | |
| LAS 1802 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−5V** | | | | | | | | | | | |
| LAS 18A05 | 29 | 1.5 | 15 | $ 3.60 | $ 3.35 | $ 3.15 | $ 3.00 | $ 2.85 | $ 2.70 | $ 2.55 | $ 2.40 |
| LAS 1805 | 29 | 1.5 | 15 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| **−5.2V** | | | | | | | | | | | |
| LAS 18052 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−6V** | | | | | | | | | | | |
| LAS 1806 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−8V** | | | | | | | | | | | |
| LAS 1808 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−10V** | | | | | | | | | | | |
| LAS 1810 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−12V** | | | | | | | | | | | |
| LAS 18A12 | 29 | 1.5 | 15 | $ 3.60 | $ 3.35 | $ 3.15 | $ 3.00 | $ 2.85 | $ 2.70 | $ 2.55 | $ 2.40 |
| LAS 1812 | 29 | 1.5 | 15 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| LAS 2812 | 53 | 2.5 | 85 | 47.00 | 44.00 | 36.00 | 32.00 | 32.00 | 28.00 | 26.00 | — |
| **−15V** | | | | | | | | | | | |
| LAS 18A15 | 29 | 1.5 | 15 | $ 3.60 | $ 3.35 | $ 3.15 | $ 3.00 | $ 2.85 | $ 2.70 | $ 2.55 | $ 2.40 |
| LAS 1815 | 29 | 1.5 | 15 | 2.95 | 2.70 | 2.47 | 2.30 | 2.10 | 1.95 | 1.80 | 1.60 |
| **−18V** | | | | | | | | | | | |
| LAS 1818 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−20V** | | | | | | | | | | | |
| LAS 1820 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−24V** | | | | | | | | | | | |
| LAS 1824 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |
| **−28V** | | | | | | | | | | | |
| LAS 1828 | 29 | 1.5 | 15 | $ 2.95 | $ 2.70 | $ 2.47 | $ 2.30 | $ 2.10 | $ 1.95 | $ 1.80 | $ 1.60 |

# VOLTAGE REGULATORS

## ADJUSTABLE

| MODEL | PAGE | $I_O$ AMPS | $P_D$ WATTS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000 |
|---|---|---|---|---|---|---|---|---|---|---|
| **−5V±5%** | | | | | | | | | | |
| LAS 2705 | 53 | 5.0 | 85 | $47.00 | $44.00 | $36.00 | $32.00 | $32.00 | $28.00 | $26.00 |
| **−12V±5%** | | | | | | | | | | |
| LAS 2712 | 53 | 5.0 | 85 | $47.00 | $44.00 | $36.00 | $32.00 | $32.00 | $28.00 | $26.00 |
| **−15V±5%** | | | | | | | | | | |
| LAS 2715 | 53 | 5.0 | 85 | $47.00 | $44.00 | $36.00 | $32.00 | $32.00 | $28.00 | $26.00 |
| **−24V±5%** | | | | | | | | | | |
| LAS 2724 | 53 | 3.0 | 85 | $47.00 | $44.00 | $36.00 | $32.00 | $32.00 | $28.00 | $26.00 |

# LAMBDA IMPROVED SECOND SOURCE PRODUCTS

| MODEL | $V_O$ VOLTS | $I_O$ | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|
| LMC 7905CK | 5.0 | 1.5 | $2.90 | $2.80 | $2.52 | $2.00 | $2.00 | $2.00 | $1.90 | $1.80 |
| LMC 7906CK | 6.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LMC 7908CK | 8.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LMC 7912CK | 12.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LMC 7915CK | 15.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LMC 7918CK | 18.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LMC 7924CK | 24.0 | 1.5 | 2.90 | 2.80 | 2.52 | 2.00 | 2.00 | 2.00 | 1.90 | 1.80 |
| LLM 320K-5 | 5.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-6 | 6.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-8 | 8.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-12 | 12.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-15 | 15.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-18 | 18.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |
| LLM 320K-24 | 24.0 | 1.5 | 3.30 | 3.00 | 2.75 | 2.35 | 2.35 | 2.35 | 2.15 | 2.00 |

# MONOLITHIC SWITCHING REGULATORS

| DEVICE TYPE | PAGE | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|
| LAS 3800 | 2 | $ 9.95 | $ 7.95 | $ 7.95 | $6.95 | $6.95 | $6.95 | $6.20 | $5.95 |
| LAS 6300K | 10 | 13.00 | 11.00 | 10.25 | 9.50 | 8.75 | 7.50 | 7.00 | 6.60 |
| LAS 6300L | 10 | 10.00 | 9.25 | 8.50 | 8.00 | 7.50 | 6.75 | 5.75 | 5.00 |

# POWER TRANSISTOR DARLINGTONS

| MODEL | PAGE | VOLTAGE RATING VOLTS | RATED POWER WATTS | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|
| PMD10K40 | 69 | 40 | 150 | $1.90 | $1.55 | $1.39 | $1.33 |
| PMD10K60 | 69 | 60 | 150 | 2.10 | 1.68 | 1.50 | 1.44 |
| PMD10K80 | 69 | 80 | 150 | 2.32 | 1.86 | 1.67 | 1.60 |
| PMD10K100 | 69 | 100 | 150 | 2.70 | 2.16 | 1.94 | 1.86 |
| PMD11K40 | 69 | 40 | 150 | 1.90 | 1.55 | 1.39 | 1.33 |
| PMD11K60 | 69 | 60 | 150 | 2.10 | 1.68 | 1.50 | 1.44 |
| PMD11K80 | 69 | 80 | 150 | 2.32 | 1.86 | 1.67 | 1.60 |
| PMD11K100 | 69 | 100 | 150 | 2.70 | 2.16 | 1.94 | 1.86 |
| PMD12K40 | 69 | 40 | 100 | 1.10 | .88 | .81 | .78 |
| PMD12K60 | 69 | 60 | 100 | 1.14 | .91 | .84 | .81 |
| PMD12K80 | 69 | 80 | 100 | 1.20 | .95 | .87 | .85 |
| PMD12K100 | 69 | 100 | 100 | 1.25 | 1.00 | .92 | .89 |
| PMD13K40 | 69 | 40 | 100 | 1.10 | .88 | .81 | .78 |
| PMD13K60 | 69 | 60 | 100 | 1.14 | .91 | .84 | .81 |
| PMD13K80 | 69 | 80 | 100 | 1.20 | .95 | .87 | .85 |
| PMD13K100 | 69 | 100 | 100 | 1.25 | 1.00 | .92 | .89 |
| PMD1601K | 69 | 60 | 180 | 2.95 | 2.35 | 2.10 | 2.02 |
| PMD1602K | 69 | 80 | 180 | 3.35 | 2.67 | 2.40 | 2.30 |
| PMD1603K | 69 | 100 | 180 | 3.90 | 3.10 | 2.78 | 2.66 |
| PMD1701K | 69 | 60 | 180 | 2.95 | 2.35 | 2.10 | 2.02 |
| PMD1702K | 69 | 80 | 180 | 3.35 | 2.67 | 2.40 | 2.30 |
| PMD1703K | 69 | 100 | 180 | 3.90 | 3.10 | 2.78 | 2.66 |
| PMD16K60 | 69 | 60 | 225 | 4.68 | 3.78 | 3.42 | 3.33 |
| PMD16K80 | 69 | 80 | 225 | 5.05 | 4.15 | 3.50 | 3.42 |
| PMD16K100 | 69 | 100 | 225 | 5.60 | 4.60 | 3.90 | 3.80 |
| PMD17K60 | 69 | 60 | 225 | 5.20 | 4.20 | 3.80 | 3.70 |
| PMD17K80 | 69 | 80 | 225 | 5.60 | 4.60 | 3.90 | 3.80 |
| PMD17K100 | 69 | 100 | 225 | 6.16 | 5.06 | 4.30 | 4.18 |
| PMD18K60 | 69 | 60 | 240 | 5.38 | 4.35 | 3.93 | 3.83 |
| PMD18K80 | 69 | 80 | 240 | 5.80 | 4.77 | 4.03 | 3.93 |
| PMD18K100 | 69 | 100 | 240 | 6.44 | 5.29 | 4.49 | 4.37 |
| PMD19K60 | 69 | 60 | 240 | 5.92 | 4.78 | 4.33 | 4.21 |
| PMD19K80 | 69 | 80 | 240 | 6.38 | 5.25 | 4.43 | 4.37 |
| PMD19K100 | 69 | 100 | 240 | 7.08 | 5.82 | 4.93 | 4.81 |

| MODEL | VOLTAGE RATING VOLTS | RATED POWER WATTS | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|
| 2N6050 | 60 | 150 | $3.04 | $2.25 | $2.10 | $1.75 |
| 2N6051 | 80 | 150 | 3.38 | 2.50 | 2.25 | 1.94 |
| 2N6052 | 100 | 150 | 3.78 | 2.80 | 2.50 | 2.25 |
| 2N6053 | 60 | 100 | 1.96 | 1.45 | 1.35 | 1.05 |
| 2N6054 | 80 | 100 | 2.30 | 1.70 | 1.53 | 1.13 |
| 2N6055 | 60 | 100 | 1.38 | 1.05 | 1.05 | 1.05 |
| 2N6056 | 80 | 100 | 1.69 | 1.25 | 1.18 | 1.13 |
| 2N6057 | 60 | 150 | 2.50 | 1.85 | 1.80 | 1.75 |
| 2N6058 | 80 | 150 | 2.70 | 2.00 | 1.97 | 1.94 |
| 2N6059 | 100 | 150 | 3.17 | 2.35 | 2.30 | 2.25 |
| 2N6282 | 60 | 160 | 3.38 | 2.50 | 2.35 | 2.20 |
| 2N6283 | 80 | 160 | 3.65 | 2.70 | 2.53 | 2.32 |
| 2N6284 | 100 | 160 | 4.05 | 3.00 | 2.90 | 2.75 |
| 2N6285 | 60 | 160 | 4.05 | 3.00 | 2.92 | 2.80 |
| 2N6286 | 80 | 160 | 4.32 | 3.20 | 3.10 | 3.00 |
| 2N6287 | 100 | 160 | 4.73 | 3.50 | 3.40 | 3.30 |
| 2N6383 | 40 | 100 | 1.51 | 1.12 | 1.09 | 1.05 |
| 2N6384 | 60 | 100 | 1.69 | 1.25 | 1.19 | 1.13 |
| 2N6385 | 80 | 100 | 1.82 | 1.35 | 1.28 | 1.19 |
| 2N6648 | 40 | 100 | 1.51 | 1.12 | 1.09 | 1.05 |
| 2N6649 | 60 | 100 | 1.69 | 1.25 | 1.19 | 1.13 |
| 2N6650 | 80 | 100 | 1.82 | 1.35 | 1.28 | 1.19 |

| MODEL | VOLTAGE RATING VOLTS | RATED POWER WATTS | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|
| LMJ 900 | 60 | 90 | $1.69 | $1.25 | $1.18 | $1.05 |
| LMJ 901 | 80 | 90 | 1.96 | 1.45 | 1.36 | 1.12 |
| LMJ 1000 | 60 | 90 | 1.49 | 1.10 | 1.08 | 1.05 |
| LMJ 1001 | 80 | 90 | 1.76 | 1.30 | 1.22 | 1.12 |
| LMJ 2500 | 60 | 150 | 3.30 | 2.50 | 2.35 | 1.70 |
| LMJ 2501 | 80 | 150 | 3.70 | 2.80 | 2.63 | 1.85 |
| LMJ 3000 | 60 | 150 | 2.70 | 2.05 | 1.93 | 1.65 |
| LMJ 3001 | 80 | 150 | 3.20 | 2.40 | 2.26 | 1.85 |
| LMJ 4030 | 60 | 150 | 5.00 | 3.75 | 3.53 | 2.40 |
| LMJ 4031 | 80 | 150 | 5.50 | 4.15 | 3.90 | 3.00 |
| LMJ 4032 | 100 | 150 | 6.50 | 4.85 | 4.56 | 3.12 |
| LMJ 4033 | 60 | 150 | 4.30 | 3.25 | 3.06 | 2.40 |
| LMJ 4034 | 80 | 150 | 4.85 | 3.60 | 3.38 | 3.00 |
| LMJ 4035 | 100 | 150 | 5.55 | 4.20 | 3.95 | 3.12 |
| LMJ 11011 | 60 | 200 | 6.05 | 4.50 | 4.41 | 4.33 |
| LMJ 11012 | 60 | 200 | 5.40 | 4.00 | 3.92 | 3.87 |
| LMJ 11013 | 90 | 200 | 6.61 | 4.90 | 3.86 | 4.81 |
| LMJ 11014 | 90 | 200 | 5.86 | 4.35 | 4.28 | 4.23 |

# SWITCHING POWER DARLINGTONS

| MODEL | PAGE | VOLTAGE RATING VOLTS | CURRENT RATING AMPS | PRICE QTY 1-24 | 25-49 | 50-99 | 100-249 | 250-499 | 500-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PMD20K120 | 17 | 120 | 14 | $ 8.10 | $7.20 | $6.61 | $6.39 | $5.76 | $4.85 | $4.41 | $3.97 |
| PMD20K150 | 17 | 150 | 14 | 9.00 | 8.00 | 7.35 | 7.10 | 6.40 | 5.39 | 4.90 | 4.41 |
| PMD20K200 | 17 | 200 | 14 | 11.00 | 9.90 | 9.00 | 8.70 | 7.80 | 6.60 | 6.00 | 5.40 |
| PMD25K120 | 17 | 120 | 9 | 5.40 | 4.80 | 4.45 | 4.32 | 3.87 | 3.27 | 2.97 | 2.67 |
| PMD25K150 | 17 | 150 | 9 | 6.00 | 5.45 | 4.95 | 4.80 | 4.30 | 3.63 | 3.30 | 2.97 |
| PMD25K200 | 17 | 200 | 9 | 7.20 | 6.60 | 6.00 | 5.80 | 5.20 | 4.40 | 4.00 | 3.60 |

# HIGH SPEED SWITCHING TRANSISTORS

| MODEL | PAGE | VOLTAGE RATING VOLTS | CURRENT RATING AMPS | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|
| PMS3K425 | 12 | 425 | 3 | $3.35 | $2.70 | $2.40 | $2.35 |
| PMS5K425 | 12 | 425 | 5 | 4.30 | 3.45 | 3.10 | 3.05 |
| PMS8K425 | 12 | 425 | 8 | 9.30 | 7.45 | 6.70 | 6.55 |

# DUAL POWER DRIVERS

| MODEL | PAGE | LOGIC FUNCTION | PRICE QTY 1-99 | 100-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|
| LPD-4101 | 80 | Dual AND | $6.00 | $4.00 | $3.50 | $3.25 |
| LPD-4102 | 80 | Dual NAND | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4103 | 80 | Dual NOR | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4104 | 80 | Dual OR | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4105 | 80 | Dual INVERTER | 6.00 | 4.00 | 3.50 | 3.25 |
| LPD-4106 | 80 | Dual BUFFER | 6.00 | 4.00 | 3.50 | 3.25 |

# OVERVOLTAGE PROTECTORS

| MODEL | PAGE | NON SUPPLY VOLTAGE VOLTS | TRIP POINT VOLTAGE VOLTS | PRICE QTY 1-99 | 100-249 | 250-999 | 1000 |
|---|---|---|---|---|---|---|---|
| L-2-OV-5 | 78 | 5 | 6.6±0.2 | $ 2.50 | $ 2.00 | $ 1.90 | $ 1.70 |
| L-2-OV-6 | 78 | 6 | 7.3±0.2 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-2-OV-12 | 78 | 12 | 13.7±0.4 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-2-OV-15 | 78 | 15 | 17.0±0.5 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-2-OV-18 | 78 | 18 | 20.5±1.0 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-2-OV-20 | 78 | 20 | 22.8±0.7 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-2-OV-24 | 78 | 24 | 27.3±0.8 | 2.50 | 2.00 | 1.90 | 1.70 |
| L-6-OV-5 | 78 | 5 | 6.6±0.2 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-6-OV-6 | 78 | 6 | 7.3±0.2 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-6-OV-12 | 78 | 12 | 13.7±0.4 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-6-OV-15 | 78 | 15 | 17.0±0.5 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-6-OV-24 | 78 | 24 | 27.3±0.8 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-6-OV-28 | 78 | 28 | 31.9±1.0 | 5.00 | 4.00 | 3.75 | 3.40 |
| L-12-OV-5 | 78 | 5 | 6.6±0.3 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-6 | 78 | 6 | 7.4±0.2 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-9 | 78 | 9 | 10.5±0.5 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-12 | 78 | 12 | 13.8±0.5 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-15 | 78 | 15 | 17.0±0.5 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-20 | 78 | 20 | 22.8±0.7 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-24 | 78 | 24 | 27.3±0.8 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-28 | 78 | 28 | 31.9±1.0 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-12-OV-30 | 78 | 30 | 33.5±1.0 | 15.30 | 11.10 | 10.45 | 9.50 |
| L-20-OV-5 | 78 | 5 | 6.6±0.3 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-6 | 78 | 6 | 7.4±0.2 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-12 | 78 | 12 | 13.8±0.5 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-15 | 78 | 15 | 17.0±0.5 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-20 | 78 | 20 | 22.8±0.7 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-24 | 78 | 24 | 27.3±0.8 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-28 | 78 | 28 | 31.0±1.0 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-20-OV-30 | 78 | 30 | 33.5±1.0 | 22.20 | 15.60 | 14.50 | 13.20 |
| L-35-OV-5 | 78 | 5 | 6.6±0.3 | 27.80 | 20.13 | 18.90 | 16.90 |
| L-35-OV-6 | 78 | 6 | 7.4±0.2 | 27.80 | 20.13 | 18.90 | 16.90 |
| L-35-OV-12 | 78 | 12 | 13.8±0.5 | 27.80 | 20.13 | 18.90 | 16.90 |

# FULL-WAVE, CENTER-TAP RECTIFERS

| MODEL | PAGE | $V_{RRM}$ VOLTS | $I_O$ AMPS | PRICE QTY 1-99 | 100-249 | 250-999 | 1000-2499 | 2500-4999 |
|---|---|---|---|---|---|---|---|---|
| COMMON CATHODE | | | | | | | | |
| PMR27K050 | 84 | 50 | 15 | $2.08 | $1.25 | $1.10 | $ .95 | $ .91 |
| PMR27K100 | 84 | 100 | 15 | 2.15 | 1.30 | 1.15 | 1.00 | .96 |
| PMR27K200 | 84 | 200 | 15 | 2.25 | 1.35 | 1.20 | 1.05 | 1.00 |
| PMR35K050 | 84 | 50 | 30 | 4.75 | 2.85 | 2.57 | 2.18 | 2.10 |
| PMR35K100 | 84 | 100 | 30 | 5.00 | 3.00 | 2.70 | 2.30 | 2.20 |
| PMR35K200 | 84 | 200 | 30 | 5.25 | 3.15 | 2.83 | 2.42 | 2.30 |
| COMMON ANODE | | | | | | | | |
| PMR31K050 | 84 | 50 | 15 | $2.08 | $1.25 | $1.10 | $ .95 | $ .91 |
| PMR31K100 | 84 | 100 | 15 | 2.15 | 1.30 | 1.15 | 1.00 | .91 |
| PMR31K200 | 84 | 200 | 15 | 2.25 | 1.35 | 1.20 | 1.05 | 1.00 |
| PMR36K050 | 84 | 50 | 30 | 4.75 | 2.85 | 2.57 | 2.18 | 2.10 |
| PMR36K100 | 84 | 100 | 30 | 5.00 | 3.00 | 2.70 | 2.30 | 2.20 |
| PMR36K200 | 84 | 200 | 30 | 5.25 | 3.15 | 2.83 | 2.42 | 2.30 |

# NOTES

# NOTES

# LAMBDA SEMICONDUCTORS

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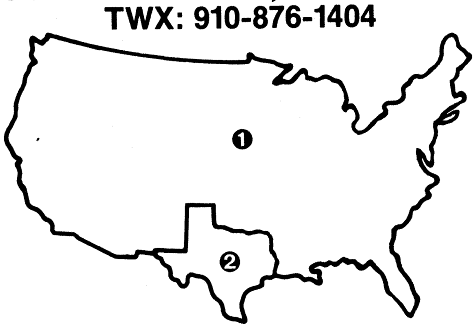


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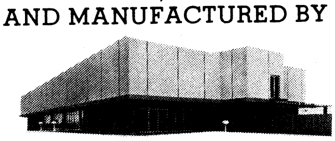

LAMBDA SEMICONDUCTORS

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