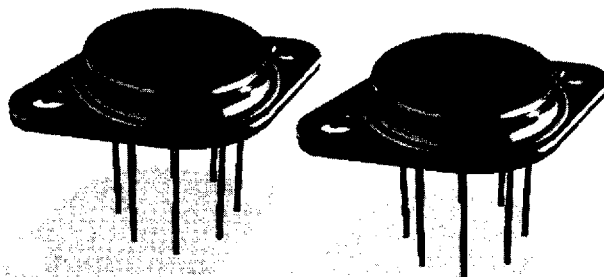


PA01 • PA73

APEX MICROTECHNOLOGY CORPORATION • APPLICATIONS HOTLINE 800 546-APEX (800-546-2739)

FEATURES

- LOW COST, ECONOMY MODEL — PA01
- SECOND SOURCEABLE — PA73
- HIGH OUTPUT CURRENT — Up to $\pm 5A$ PEAK
- EXCELLENT LINEARITY — PA01
- HIGH SUPPLY VOLTAGE — Up to $\pm 34V$
- ISOLATED CASE — 300V



APPLICATIONS

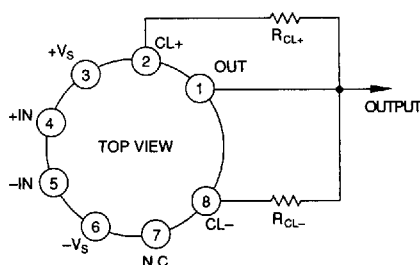
- MOTOR, VALVE AND ACTUATOR CONTROL
- MAGNETIC DEFLECTION CIRCUITS UP TO 4A
- POWER TRANSDUCERS UP TO 20kHz
- TEMPERATURE CONTROL UP TO 180W
- PROGRAMMABLE POWER SUPPLIES UP TO 56V
- AUDIO AMPLIFIERS UP TO 50W RMS

DESCRIPTION

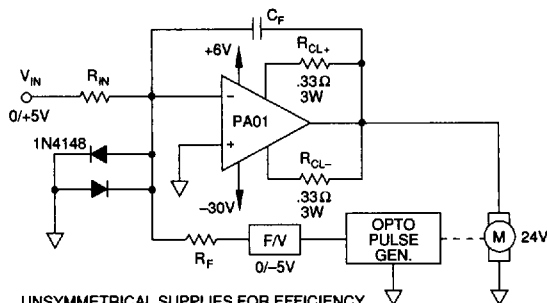
The PA01 and PA73 are high voltage, high output current operational amplifiers designed to drive resistive, inductive and capacitive loads. All three have a complementary darlington emitter follower output stage protected against transient inductive kickback or back EMF. For optimum linearity, the PA01 has a class A/B output stage. The PA73 has a simple class C output stage (see Note 1) to reduce cost for motor control and other applications where crossover distortion is not critical and to provide interchangeability with type 3573 amplifiers. The safe operating area (SOA) can be observed for all operating conditions by selection of user programmable current limit resistors. These amplifiers are internally compensated for all gain settings. For continuous operation under load, a heatsink of proper rating is recommended.

This hybrid integrated circuit utilizes thick film (cermet) resistors, ceramic capacitors and semiconductor chips to maximize reliability, minimize size and give top performance. Ultrasonically bonded aluminum wires provide reliable interconnections at all operating temperatures. The 8-pin TO-3 package is hermetically sealed and electrically isolated. The use of compressible thermal washers and/or improper mounting torque will void the product warranty. Please see "General Operating Considerations".

EXTERNAL CONNECTIONS



TYPICAL APPLICATION

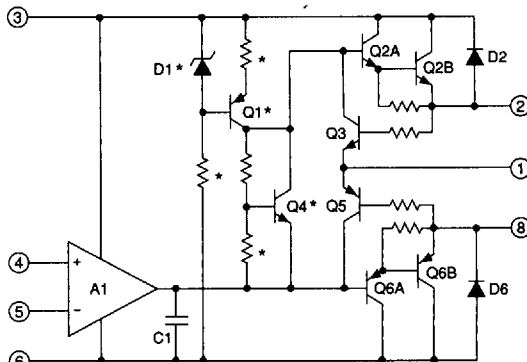


UNSYMMETRICAL SUPPLIES FOR EFFICIENCY

Unidirectional Optical Speed Control

The pulse output of a non-contact optical sensor drives a voltage-to-frequency converter which generates feedback for the op amp. With the loop closed in this manner, the op amp corrects for any variations in the speed due to changing load. Because of operation in only one direction, an unsymmetrical supply is used to maximize efficiency of both power op amp and power supply. High speed diodes at the input protect the op amp from commutator noise which may be generated by the motor.

EQUIVALENT SCHEMATIC



NOTE 1: * Indicates not used in PA73. Open base of Q2A connected to output of A1.

PA01 • PA73

ABSOLUTE MAXIMUM RATINGS
SPECIFICATIONS

ABSOLUTE MAXIMUM RATINGS

	PA01	PA73
SUPPLY VOLTAGE, $+V_S$ to $-V_S$	60V	68V
OUTPUT CURRENT, within SOA	5A	5A
POWER DISSIPATION, internal	67W	67W
INPUT VOLTAGE, differential	$\pm V_S - 3V$	$\pm V_S - 3V$
INPUT VOLTAGE, common-mode	$\pm V_S$	$\pm V_S$
TEMPERATURE, junction ¹	200°C	200°C
TEMPERATURE, pin solder -10s	300°C	300°C
TEMPERATURE RANGE, storage	-65 to +150°C	-65 to +150°C
OPERATING TEMPERATURE RANGE, case	-25 to +85°C	-25 to +85°C

SPECIFICATIONS

SPECIFICATIONS		PA01			PA73			
PARAMETER	TEST CONDITIONS ²	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
INPUT								
OFFSET VOLTAGE, initial	T _C = 25°C		±5	±12		*	±10	mV
OFFSET VOLTAGE, vs. temperature	Full temperature range		±10	±65		*	*	μV/°C
OFFSET VOLTAGE, vs. supply	T _C = 25°C		±35			*	±200	μV/V
OFFSET VOLTAGE, vs. power	T _C = 25°C		±20			*		μV/W
BIAS CURRENT, initial	T _C = 25°C		±15	±50		*	±40	nA
BIAS CURRENT, vs. temperature	Full temperature range		±.05	±.4		*	*	nA/°C
BIAS CURRENT, vs. supply	T _C = 25°C		±.02			*		nA/V
OFFSET CURRENT, initial	T _C = 25°C		±5	±15		*	±10	nA
OFFSET CURRENT, vs. temperature	Full temperature range		±.01			*		nA/°C
INPUT IMPEDANCE, common-mode	T _C = 25°C		200			*		MΩ
INPUT IMPEDANCE, differential	T _C = 25°C		10			*		MΩ
INPUT CAPACITANCE	T _C = 25°C		3			*		pF
COMMON MODE VOLTAGE RANGE ³	Full temperature range	±V _S -6	±V _S -3		*	*		V
COMMON MODE REJECTION, DC ³	T _C = 25°C, V _{CM} = V _S -6V	70	110		*	*		dB
GAIN								
OPEN LOOP GAIN at 10Hz	Full temp. range, full load	91	113		*	*		dB
GAIN BANDWIDTH PRODUCT @ 1MHz	T _C = 25°C, full load		1			*		MHz
POWER BANDWIDTH	T _C = 25°C, I _O = 4A, V _O = 40V _{PP}	15	23		*	*		kHz
PHASE MARGIN	Full temperature range		45			*		°
OUTPUT								
VOLTAGE SWING ³	T _C = 25°C, I _O = 5A	±V _S -10	±V _S -5		±V _S -8	*		V
VOLTAGE SWING ³	Full temp. range, I _O = 2A	±V _S -6	±V _S -5			*		V
VOLTAGE SWING ³	Full temp. range, I _O = 46mA	±V _S -5			*	*		V
CURRENT, peak	T _C = 25°C	±5			*	*		A
SETTLING TIME to .1%	T _C = 25°C, 2V step		2		*	*		μs
SLEW RATE	T _C = 25°C, R _L = 2.5Ω	1.0	2.6		*	*		V/μs
CAPACITIVE LOAD, unity gain	Full temperature range			3.3			*	nF
CAPACITIVE LOAD, gain > 4	Full temperature range			SOA			*	
POWER SUPPLY								
VOLTAGE	Full temperature range	±10	±28	±28	*	*	±30	V
CURRENT, quiescent	T _C = 25°C		20	50		2.6	5	mA
THERMAL								
RESISTANCE, AC, junction to case ⁴	F > 60Hz		1.9	2.1		*	*	°C/W
RESISTANCE, DC, junction to case	F < 60Hz		2.4	2.6		*	*	°C/W
RESISTANCE, junction to air			30			*	*	°C/W
TEMPERATURE RANGE, case	Meets full range specifications	-25	25	+85	*	*	*	°C

NOTES: * The specification of PA73 is identical to the specification for PA01 in applicable column to the left.

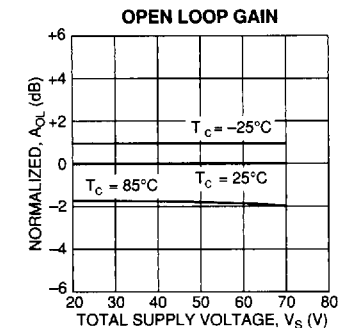
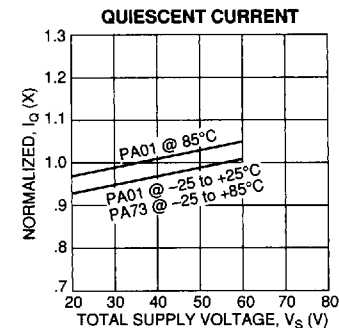
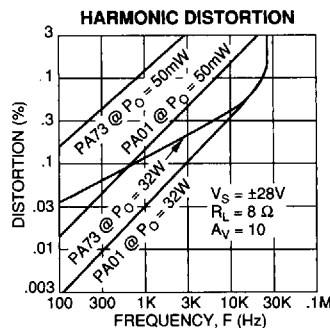
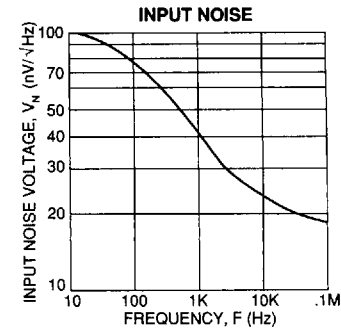
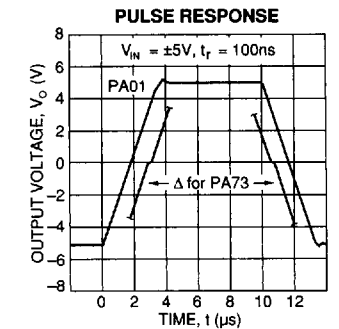
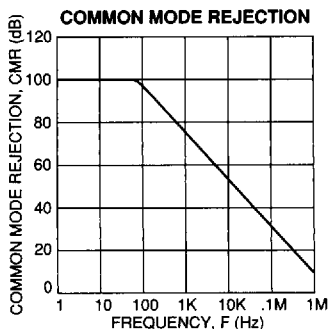
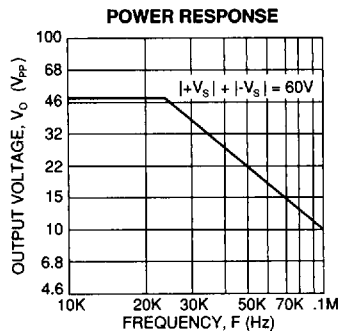
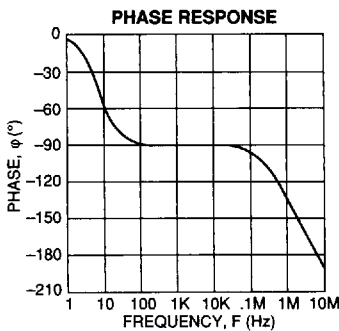
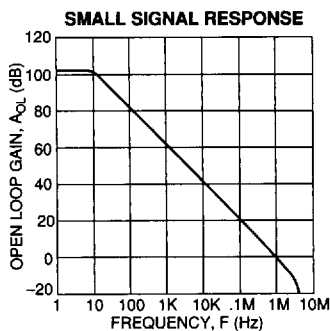
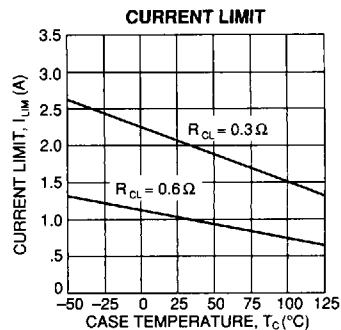
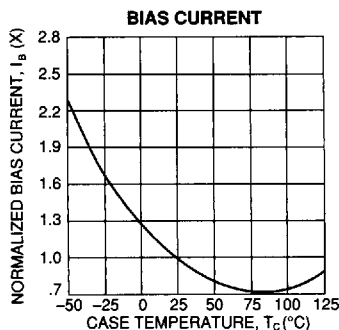
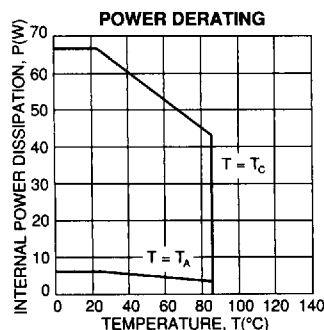
- Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.
- The power supply voltage specified under the TYP rating applies unless otherwise noted as a test condition.
- $+V_S$ and $-V_S$ denote the positive and negative supply rail respectively. Total V_S is measured from $+V_S$ to $-V_S$.
- Rating applies if the output current alternates between both output transistors at a rate faster than 60Hz.

CAUTION

The internal substrate contains beryllia (BeO). Do not break the seal. If accidentally broken, do not crush, machine, or subject to temperatures in excess of 850°C to avoid generating toxic fumes.

TYPICAL PERFORMANCE
GRAPHS

PA01 • PA73



PA01 • PA73

OPERATING
CONSIDERATIONS

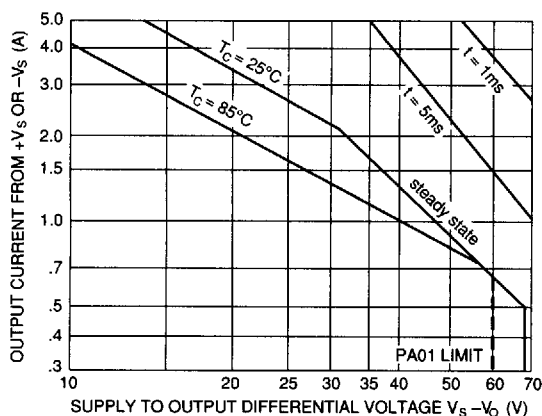
GENERAL

Please read the "General Operating Considerations" section, which covers stability, supplies, heatsinking, mounting, current limit, SOA interpretation, and specification interpretation. Additional information can be found in the application notes. For information on the package outline, heatsinks, and mounting hardware, consult the "Accessory and Package Mechanical Data" section of the handbook.

SAFE OPERATING AREA (SOA)

The output stage of most power amplifiers has three distinct limitations:

1. The current handling capability of the transistor geometry and the wire bonds.
2. The second breakdown effect which occurs whenever the simultaneous collector current and collector-emitter voltage exceeds specified limits.
3. The junction temperature of the output transistors.



The SOA curves combine the effect of these limits. For a given application, the direction and magnitude of the output current should be calculated or measured and checked against the SOA curves. This is simple for resistive loads but more complex for reactive and EMF generating loads. The following guidelines may save extensive analytical efforts.

1. Capacitive and dynamic* inductive loads up to the following maximums are safe with the current limits set as specified:

CAPACITIVE LOAD			INDUCTIVE LOAD	
$\pm V_s$	$I_{LIM} = 2A$	$I_{LIM} = 5A$	$I_{LIM} = 2A$	$I_{LIM} = 5A$
30V	1,200 μ F	500 μ F	250mH	24mH
25V	4000 μ F	1,600 μ F	400mH	38mH
20V	20,000 μ F	5,000 μ F	1,500mH	75mH
15V	**	25,000 μ F	**	100mH

- * If the inductive load is driven near steady state conditions, allowing the output voltage to drop more than 8V below the

supply rail with $I_{LIM} = 5A$ or 20V below the supply rail with $I_{LIM} = 2A$ while the amplifier is current limiting, the inductor should be capacitively coupled or the current limit must be lowered to meet SOA criteria.

- ** Second breakdown effect imposes no limitation but thermal limitations must still be observed.

2. EMF generating or reactive load and short circuits to the supply rail or shorts to common are safe if the current limits are set as follows at $T_c = 85^\circ C$.

$\pm V_s$	SHORT TO $\pm V_s$ C, L, OR EMF LOAD	SHORT TO COMMON
34V	.50A	1.2A
30V	.60A	1.3A
25V	.75A	1.6A
20V	1.0A	2.1A
15V	1.3A	2.8A

These simplified limits may be exceeded with further analysis using the operating conditions for a specific application.

3. The output stage is protected against transient flyback. However, for protection against sustained, high energy flyback, external fast-recovery diodes should be used.

CURRENT LIMIT

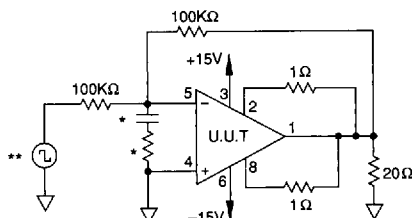
Proper operation requires the use of two current limit resistors, connected as shown, in the external connection diagram. The minimum value for R_{CL} is 0.12 ohm; however, for optimum reliability it should be set as high as possible. Refer to the "General Operating Considerations" section of the handbook for current limit adjust details.

PA73M

APEX MICROTECHNOLOGY CORPORATION • APPLICATIONS HOTLINE 800 546-APEX (800-546-2739)

SG	PARAMETER	SYMBOL	TEMP.	POWER	TEST CONDITIONS	MIN	MAX	UNITS
1	Quiescent Current	I_Q	25°C	±28V	$V_{IN} = 0, A_V = 100$		5	mA
1	Input Offset Voltage	V_{OS}	25°C	±28V	$V_{IN} = 0, A_V = 100$		±10	mV
1	Input Offset Voltage	V_{OS}	25°C	±10V	$V_{IN} = 0, A_V = 100$		±17.2	mV
1	Input Offset Voltage	V_{OS}	25°C	±30V	$V_{IN} = 0, A_V = 100$		±10.8	mV
1	Input Bias Current, +IN	$+I_B$	25°C	±28V	$V_{IN} = 0$		±40	nA
1	Input Bias Current, -IN	$-I_B$	25°C	±28V	$V_{IN} = 0$		±40	nA
1	Input Offset Current	I_{OS}	25°C	±28V	$V_{IN} = 0$		±10	nA
3	Quiescent Current	I_Q	-55°C	±28V	$V_{IN} = 0, A_V = 100$		5	mA
3	Input Offset Voltage	V_{OS}	-55°C	±28V	$V_{IN} = 0, A_V = 100$		±15.2	mV
3	Input Offset Voltage	V_{OS}	-55°C	±10V	$V_{IN} = 0, A_V = 100$		±22.4	mV
3	Input Offset Voltage	V_{OS}	-55°C	±30V	$V_{IN} = 0, A_V = 100$		±16	mV
3	Input Bias Current, +IN	$+I_B$	-55°C	±28V	$V_{IN} = 0$		±72	nA
3	Input Bias Current, -IN	$-I_B$	-55°C	±28V	$V_{IN} = 0$		±72	nA
3	Input Offset Current	I_{OS}	-55°C	±28V	$V_{IN} = 0$		±26	nA
2	Quiescent Current	I_Q	125°C	±28V	$V_{IN} = 0, A_V = 100$		7	mA
2	Input Offset Voltage	V_{OS}	125°C	±28V	$V_{IN} = 0, A_V = 100$		±16.5	mV
2	Input Offset Voltage	V_{OS}	125°C	±10V	$V_{IN} = 0, A_V = 100$		±23.7	mV
2	Input Offset Voltage	V_{OS}	125°C	±30V	$V_{IN} = 0, A_V = 100$		±17.3	mV
2	Input Bias Current, +IN	$+I_B$	125°C	±28V	$V_{IN} = 0$		±80	nA
2	Input Bias Current, -IN	$-I_B$	125°C	±28V	$V_{IN} = 0$		±80	nA
2	Input Offset Current	I_{OS}	125°C	±28V	$V_{IN} = 0$		±30	nA
4	Output Voltage, $I_O = 5A$	V_O	25°C	±18.3V	$R_L = 2.07\Omega$	10.3		V
4	Output Voltage, $I_O = 50mA$	V_O	25°C	±30V	$R_L = 500\Omega$	25		V
4	Output Voltage, $I_O = 2A$	V_O	25°C	±30V	$R_L = 12\Omega$	24		V
4	Current Limits	I_{CL}	25°C	±16V	$R_L = 2.07\Omega, R_{CL} = .2\Omega$	2.6	3.9	A
4	Stability/Noise	E_N	25°C	±28V	$R_L = 500\Omega, A_V = 1, C_L = 10nF$		1	mV
4	Slew Rate	SR	25°C	±28V	$R_L = 500\Omega$	1	10	V/ μ s
4	Open Loop Gain	A_{OL}	25°C	±28V	$R_L = 500\Omega, F = 10Hz$	91		dB
4	Common Mode Rejection	CMR	25°C	±15V	$R_L = 500\Omega, F = DC, V_{CM} = \pm 9V$	70		dB
6	Output Voltage, $I_O = 5A$	V_O	-55°C	±18.3V	$R_L = 2.07\Omega$	10.3		V
6	Output Voltage, $I_O = 50mA$	V_O	-55°C	±30V	$R_L = 500\Omega$	25		V
6	Output Voltage, $I_O = 2A$	V_O	-55°C	±30V	$R_L = 12\Omega$	24		V
6	Stability/Noise	E_N	-55°C	±30V	$R_L = 500\Omega, A_V = 1, C_L = 10nF$		1	mV
6	Slew Rate	SR	-55°C	±28V	$R_L = 500\Omega$	1	10	V/ μ s
6	Open Loop Gain	A_{OL}	-55°C	±28V	$R_L = 500\Omega, F = 10Hz$	91		dB
6	Common Mode Rejection	CMR	-55°C	±15V	$R_L = 500\Omega, F = DC, V_{CM} = \pm 9V$	70		dB
5	Output Voltage, $I_O = 3A$	V_O	125°C	±11.3V	$R_L = 2.07\Omega$	6.3		V
5	Output Voltage, $I_O = 50mA$	V_O	125°C	±30V	$R_L = 500\Omega$	25		V
5	Output Voltage, $I_O = 2A$	V_O	125°C	±30V	$R_L = 12\Omega$	24		V
5	Stability/Noise	E_N	125°C	±28V	$R_L = 500\Omega, A_V = 1, C_L = 10nF$		1	mV
5	Slew Rate	SR	125°C	±28V	$R_L = 500\Omega$	1	10	V/ μ s
5	Open Loop Gain	A_{OL}	125°C	±28V	$R_L = 500\Omega, F = 10Hz$	91		dB
5	Common Mode Rejection	CMR	125°C	±15V	$R_L = 500\Omega, F = DC, V_{CM} = \pm 9V$	70		dB

BURN IN CIRCUIT



* These components are used to stabilize device due to poor high frequency characteristics of burn in board.

** Input signals are calculated to result in internal power dissipation of approximately 2.1W at case temperature = 125°C.