BURR - BROWN®

OPA2541

Dual High Power OPERATIONAL AMPLIFIER

FEATURES

- OUTPUT CURRENTS TO 5A
- POWER SUPPLIES TO ±40V
- FET INPUT
- ELECTRICALLY ISOLATED CASE

APPLICATIONS

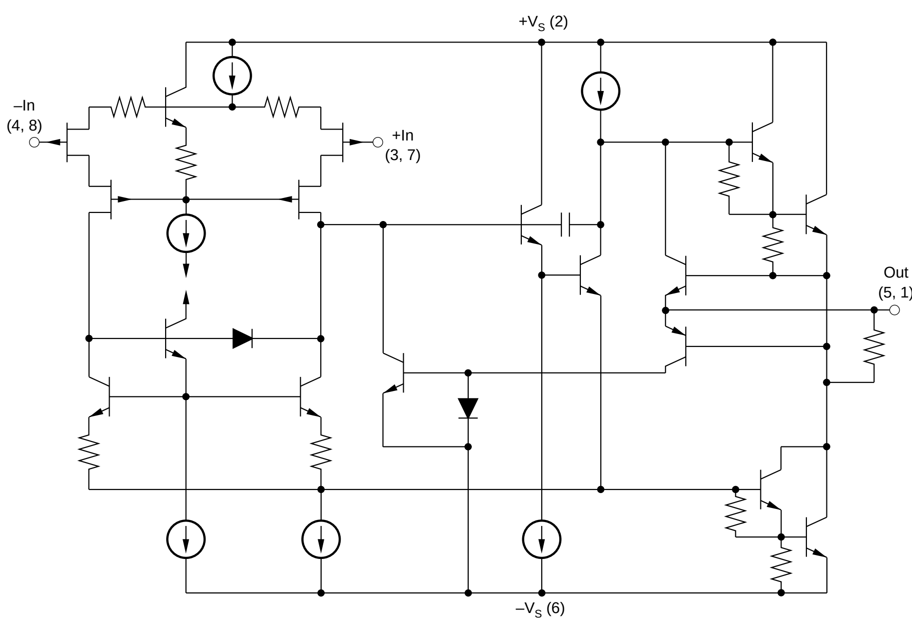
- MOTOR DRIVER
- SERVO AMPLIFIER
- SYNCRO/RESOLVER EXCITATION
- VOICE COIL DRIVER
- BRIDGE AMPLIFIER
- PROGRAMMABLE POWER SUPPLY
- AUDIO AMPLIFIER

DESCRIPTION

The OPA2541 is a dual power operational amplifier capable of operation from power supplies up to ±40V and output currents of 5A continuous. With two monolithic power amplifiers in a single package it provides unequaled functional density.

The industry-standard 8-pin TO-3 package is isolated from all internal circuitry allowing it to be mounted directly to a heat sink without insulators which degrade thermal performance. Internal circuitry limits output current to approximately 6A.

The OPA2541 is available in both industrial and military temperature range versions.



International Airport Industrial Park • Mailing Address: PO Box 11400 • Tucson, AZ 85734 • Street Address: 6730 S. Tucson Blvd. • Tucson, AZ 85706
Tel: (520) 746-1111 • Twx: 910-952-1111 • Cable: BBRCORP • Telex: 066-6491 • FAX: (520) 889-1510 • Immediate Product Info: (800) 548-6132

 PDS-768B Printed in U.S.A. October, 1993

SBOS157

SPECIFICATIONS

ELECTRICAL

At T_C = +25°C and V_S = ±35VDC, unless otherwise noted.

		OPA2541AM			OPA2541BM, SM			
PARAMETER	**CONDITIONS**	**MIN**	**TYP**	**MAX**	**MIN**	**TYP**	**MAX**	**UNITS**
INPUT OFFSET VOLTAGE								
V_{OS}			±2	±10		±0.25	±1	mV
vs Temperature	Specified Temperature Range		±20	±40		±15	±30	µV/°C
vs Supply Voltage	V_S = ±10V to $±V_{MAX}$		±2.5	±10		*	*	µV/V
vs Power			±20	±60		*	*	µV/W
INPUT BIAS CURRENT								
I_B			15	50		*	*	pA
	Specified Temperature Range		Note 1			*		
INPUT OFFSET CURRENT								
I_{OS}			±5	±30		*	*	pA
	Specified Temperature Range		Note 1			*		
INPUT CHARACTERISTICS								
Common-Mode Voltage Range	Specified Temperature Range	$±(\|V_S\| -6)$	$±(\|V_S\| -3)$		*	*		V
Common-Mode Rejection	$V_{CM} = (\|±V_S\| -6V)$	95	106		*	*		dB
Input Capacitance			5			*		pF
Input Impedance, DC			1			*		$10^{12}\Omega$
GAIN CHARACTERISTICS								
Open Loop Gain at 10Hz	$R_L = 6\Omega$	90	96		*	*		dB
Gain-Bandwidth Product			1.6			*		MHz
OUTPUT								
Voltage Swing	I_O = 5A	$±(\|V_S\| -5.5)$	$±(\|V_S\| -4.5)$		*	*		V
	I_O = 2A	$±(\|V_S\| -4.5)$	$±(\|V_S\| -3.6)$		*	*		V
	I_O = 0.5A	$±(\|V_S\| -4)$	$±(\|V_S\| -3.2)$		*	*		V
Current, Continuous	+25°C	5	7.0		*	*		A
	+85°C	4	5.0		*			A
	+125°C (SM grade only)				3	3.5		A
AC PERFORMANCE								
Slew Rate		6	8		*	*		V/µs
Power Bandwidth	$R_L = 8\Omega$, V_O = 20Vrms	45	55		*	*		kHz
Settling Time to 0.1%	2V Step		2			*		µs
Capacitive Load	Specified Temperature Range, G = 1			3.3			*	nF
	Specified Temperature Range, G >10			SOA			*	
Phase Margin	Specified Temperature Range, $R_L = 8\Omega$		40			*		Degrees
Channel Separation	1kHz, $R_L = 6\Omega$		80			*		dB
POWER SUPPLY								
Power Supply Voltage, $±V_S$	Specified Temperature Range	±10	±30	±35	*	±35	±40	V
Current, Quiescent	Total—Both Amplifiers		40	50		*	*	mA
THERMAL RESISTANCE								
θ_{JC}, (Junction-to-Case)	Both Amplifiers(2), AC Output f > 60Hz		0.8	1.0		*	*	°C/W
θ_{JC}	Both Amplifiers(2), DC Output		0.9	1.2		*	*	°C/W
θ_{JC}	One Amplifier, AC Output f > 60Hz		1.25	1.5		*	*	°C/W
θ_{JC}	One Amplifier, DC Output		1.4	1.9		*	*	°C/W
θ_{JA}, (Junction-to-Ambient)	No Heat Sink		30			*		°C/W
TEMPERATURE RANGE								
Case	AM, BM	–25		+85	*		*	°C
	SM				–55		+125	°C

*Specification same as OPA2541AM.

NOTES: (1) Input bias and offset current approximately doubles for every 10°C increase in temperature. (2) Assumes equal dissipation in both amplifiers.

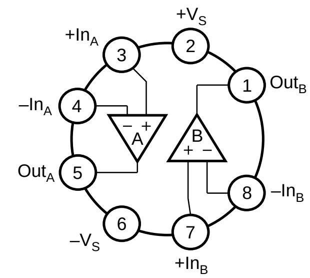
ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $+V_S$ to $-V_S$	80V
Output Current	see SOA
Power Dissipation, Internal(1)	125W
Input Voltage: Differential	$\pm V_S$
Common-mode	$\pm V_S$
Temperature: Pin Solder, 10s	+300°C
Junction(1)	+150°C
Temperature Range:	
Storage	–65°C to +150°C
Operating (Case)	–55°C to +125°C

NOTE: (1) Long term operation at the maximum junction temperature will result in reduced product life. Derate internal power dissipation to achieve high MTTF.

CONNECTION DIAGRAM

Top View **TO-3**



PACKAGE INFORMATION

MODEL	PACKAGE	PACKAGE DRAWING NUMBER(1)
OPA2541AM	TO-3	030
OPA2541BM	TO-3	030
OPA2541SM	TO-3	030

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.

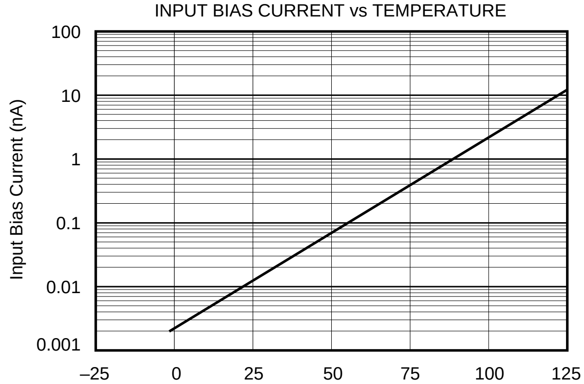
ORDERING INFORMATION

MODEL	PACKAGE	TEMPERATURE RANGE
OPA2541AM	TO-3	–25°C to +85°C
OPA2541BM	TO-3	–25°C to +85°C
OPA2541SM	TO-3	–55°C to +125°C

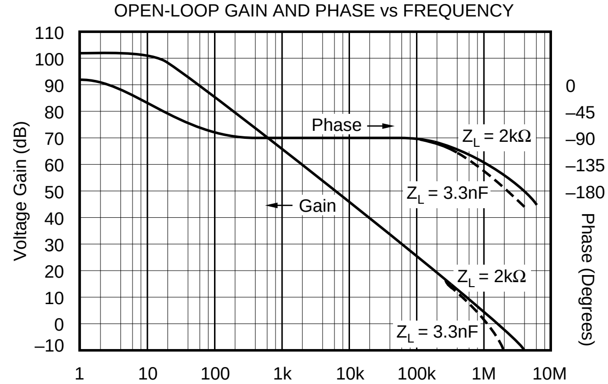
TYPICAL PERFORMANCE CURVES

T_A = +25°C and V_S = ±35VDC, unless otherwise noted.

INPUT BIAS CURRENT vs TEMPERATURE



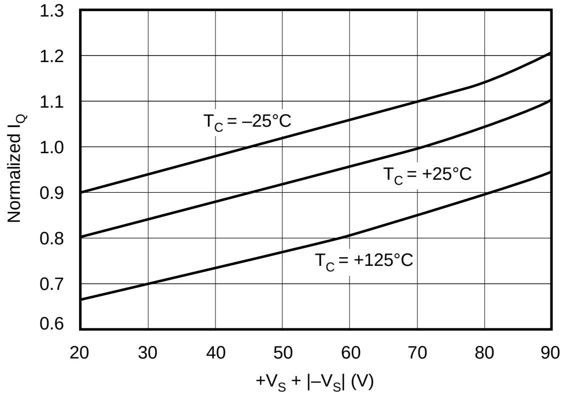
OPEN-LOOP GAIN AND PHASE vs FREQUENCY



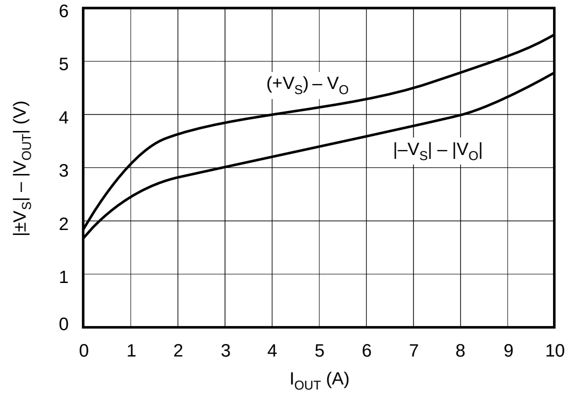
TYPICAL PERFORMANCE CURVES (CONT)

T_A = +25°C and V_S = ±35VDC, unless otherwise noted.

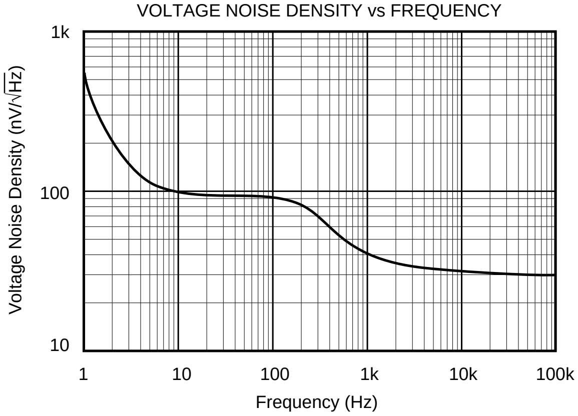
NORMALIZED QUIESCENT CURRENT
vs TOTAL POWER SUPPLY VOLTAGE



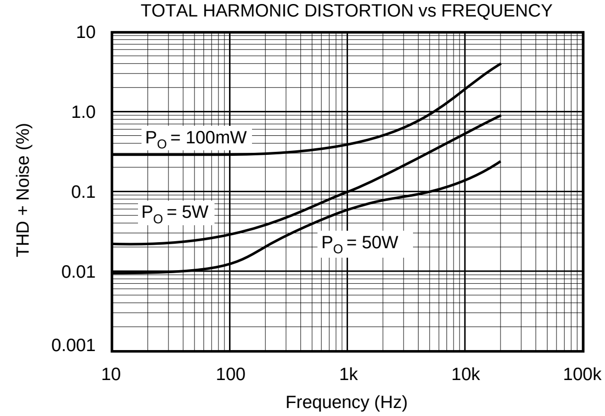
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT



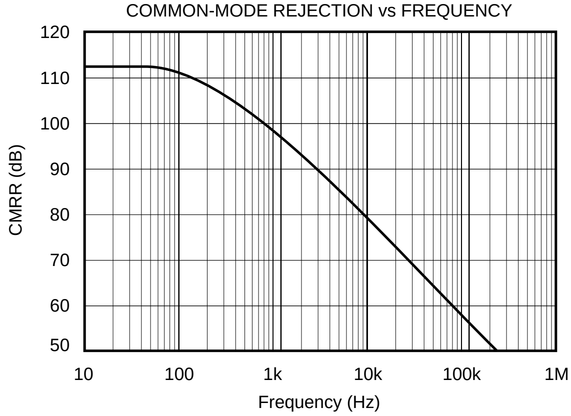
VOLTAGE NOISE DENSITY vs FREQUENCY



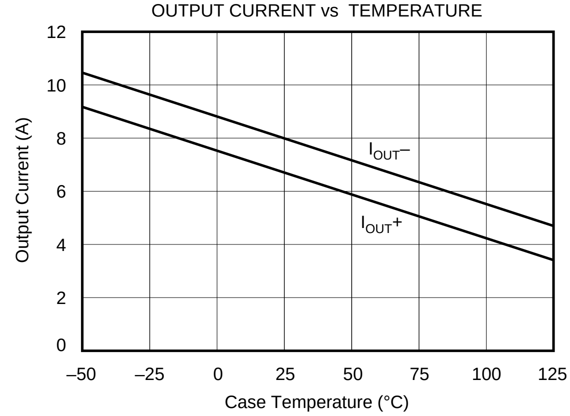
TOTAL HARMONIC DISTORTION vs FREQUENCY



COMMON-MODE REJECTION vs FREQUENCY



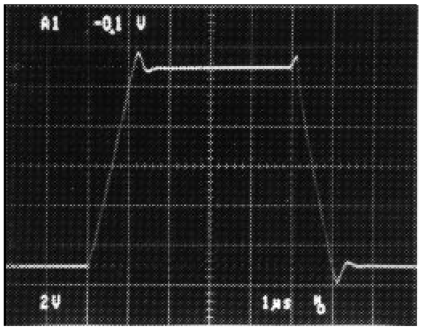
OUTPUT CURRENT vs TEMPERATURE



TYPICAL PERFORMANCE CURVES (CONT)

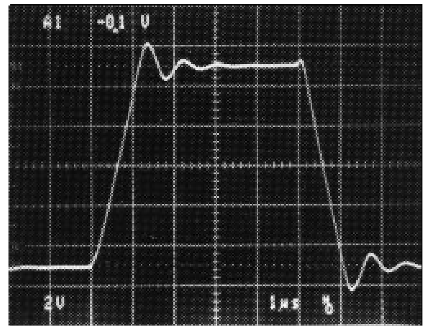
T_A = +25°C and V_S = ±35VDC, unless otherwise noted.

DYNAMIC RESPONSE



Z_{LOAD} = ∞, V_S = ±35V, A_V = +1

DYNAMIC RESPONSE



Z_{LOAD} = 4700pF, V_S = ±35V, A_V = +1

INSTALLATION INSTRUCTIONS

POWER SUPPLIES

The OPA2541 is specified for operation from power supplies up to ±40V. It can also be operated from an unbalanced or a single power supply so long as the total power supply voltage does not exceed 80V (70V for "AM" grade). The power supplies should be bypassed with low series impedance capacitors such as ceramic or tantalum. These should be located as near as practical to the amplifier's power supply pins. Good power amplifier circuit layout is, in general, like good high-frequency layout. Consider the path of large power supply and output currents. Avoid routing these connections near low-level input circuitry to avoid waveform distortion and instability.

Signal dependent load current can modulate the power supply voltage with inadequate power supply bypassing. This can affect both amplifiers' outputs. Since the second amplifier's signal may not be related to the first, this will degrade the inherent channel separation of the OPA2541.

HEAT SINKING

Most applications will require a heat sink to prevent junction temperatures from exceeding the 150°C maximum rating. The type of heat sink required will depend on the output signals, power dissipation of each amplifier, and ambient temperature. The thermal resistance from junction-to-case, θ_{JC}, depends on how the power dissipation is distributed on the amplifier die.

DC output concentrates the power dissipation in one output transistor. AC output distributes the power dissipation equally between the two output transistors and therefore has lower thermal resistance. Similarly, the power dissipation may be all in one amplifier (worst case) or equally distributed between the two amplifiers (best case). Thermal resistances are provided for each of these possibilities. The case-to-junction temperature rise is the product of the power dissipation (total of both amplifiers) times the appropriate thermal resistance—

$$\Delta\ T_{JC} = (P_D \text{ total})\ (\theta_{JC}).$$

Sufficient heat sinking must be provided to keep the case temperature within safe limits for the maximum ambient temperature and power dissipation. The thermal resistance of the heat sink required may be calculated by:

$$\theta_{HS} = (150°C - \Delta\ T_{JC} - T_A)/P_D.$$

Commercially available heat sinks usually specify thermal resistance. These ratings are often suspect, however, since they depend greatly on the mounting environment and air flow conditions. Actual thermal performance should be verified by measurement of case temperature under the required load and environmental conditions.

No insulating hardware is required when using the OPA2541. Since mica and other similar insulators typically add 0.7°C/W thermal resistance, this is a significant advantage. See Burr-Brown Application Note AN-83 for further details on heat sinking.

SAFE OPERATING AREA

The Safe Operating Area (SOA) curve provides comprehensive information on the power handling abilities of the OPA2541. It shows the allowable output current as a function of the voltage across the conducting output transistor (see Figure 1). This voltage is equal to the power supply voltage minus the output voltage. For example, as the amplifier output swings near the positive power supply voltage, the voltage across the output transistor decreases and the device can safely provide large output currents demanded by the load.

The internal current limit will not provide short-circuit protection in most applications. When the amplifier output is shorted to ground, the full power supply voltage is impressed across the conducting output transistor. For instance, with $V_S = \pm 35V$, a short circuit to ground would impress 35V across the conducting power transistor. The maximum safe output current at this voltage is 1.8A, so the internal current limit would not protect the amplifier. The unit-to-unit variation and temperature dependence of the internal current limit suggest that it be used to handle abnormal conditions and not activated in commonly encountered circuit operation.

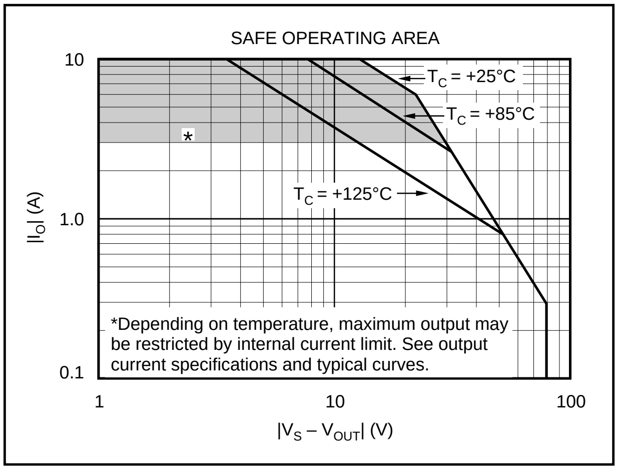


FIGURE 1. Safe Operating Area.

Reactive, or EMF generating loads such as DC motors can present demanding SOA requirements. With a purely reactive load, output voltage current occurs when the output voltage is zero and the voltage across the conducting transistor is equal to the full power supply voltage. See Burr-Brown Application Note AN-123 for further information on evaluating SOA.

Applications with inductive or EMF-generating loads which can produce “kick back” voltage surges to the amplifiers should include clamp diodes from the output terminals to the power supplies. These diodes should be chosen to limit the peak amplifier output voltage surges to less than 2V beyond the power supply rail voltage. Common 1A rated rectifier diodes will suffice in most applications.

APPLICATIONS CIRCUITS

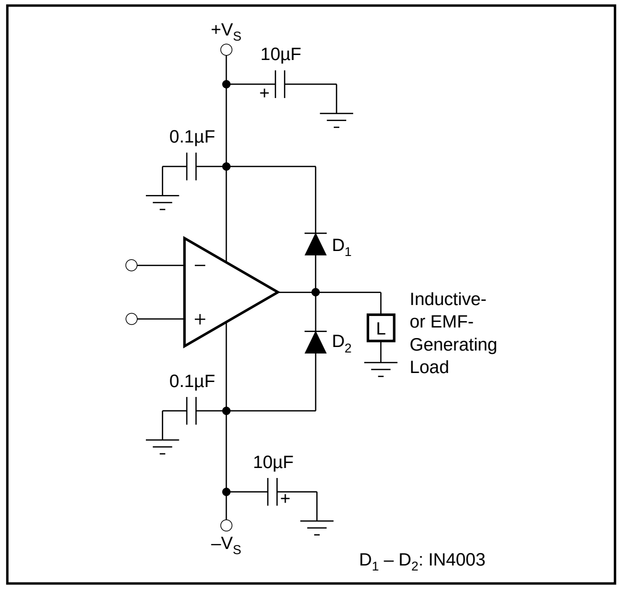


FIGURE 2. Clamping Output for EMF-Generating Loads.

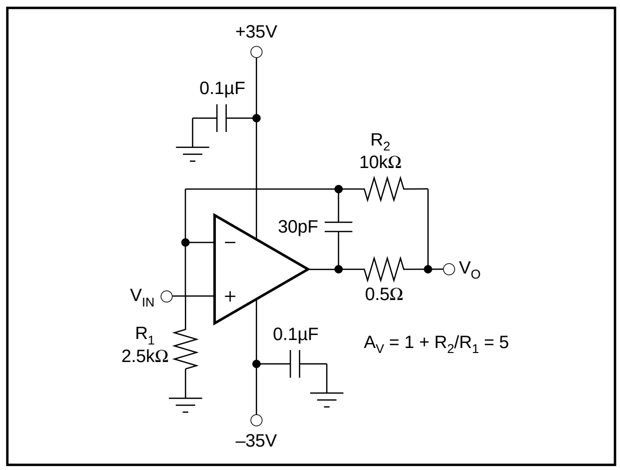


FIGURE 3. Isolating Capacitive Loads.

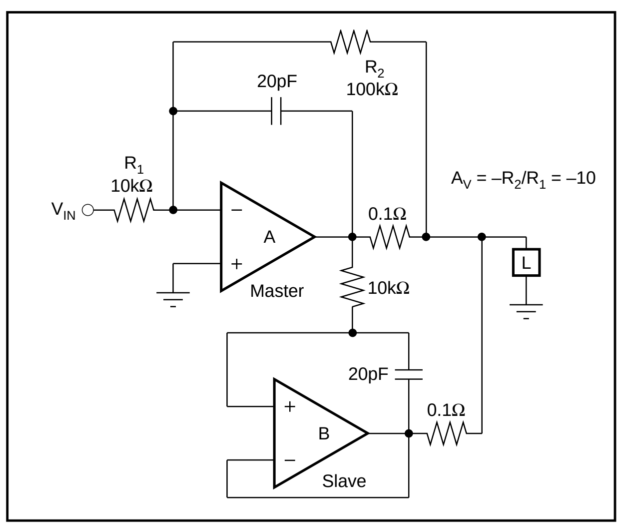


FIGURE 4. Paralleled Operation, Extended SOA.

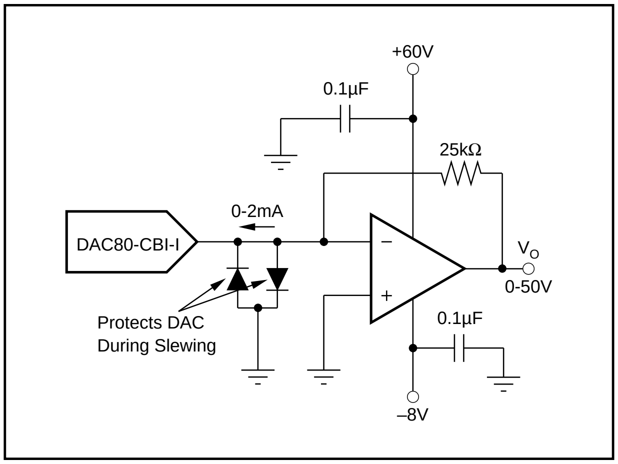


FIGURE 5. Programmable Voltage Source.

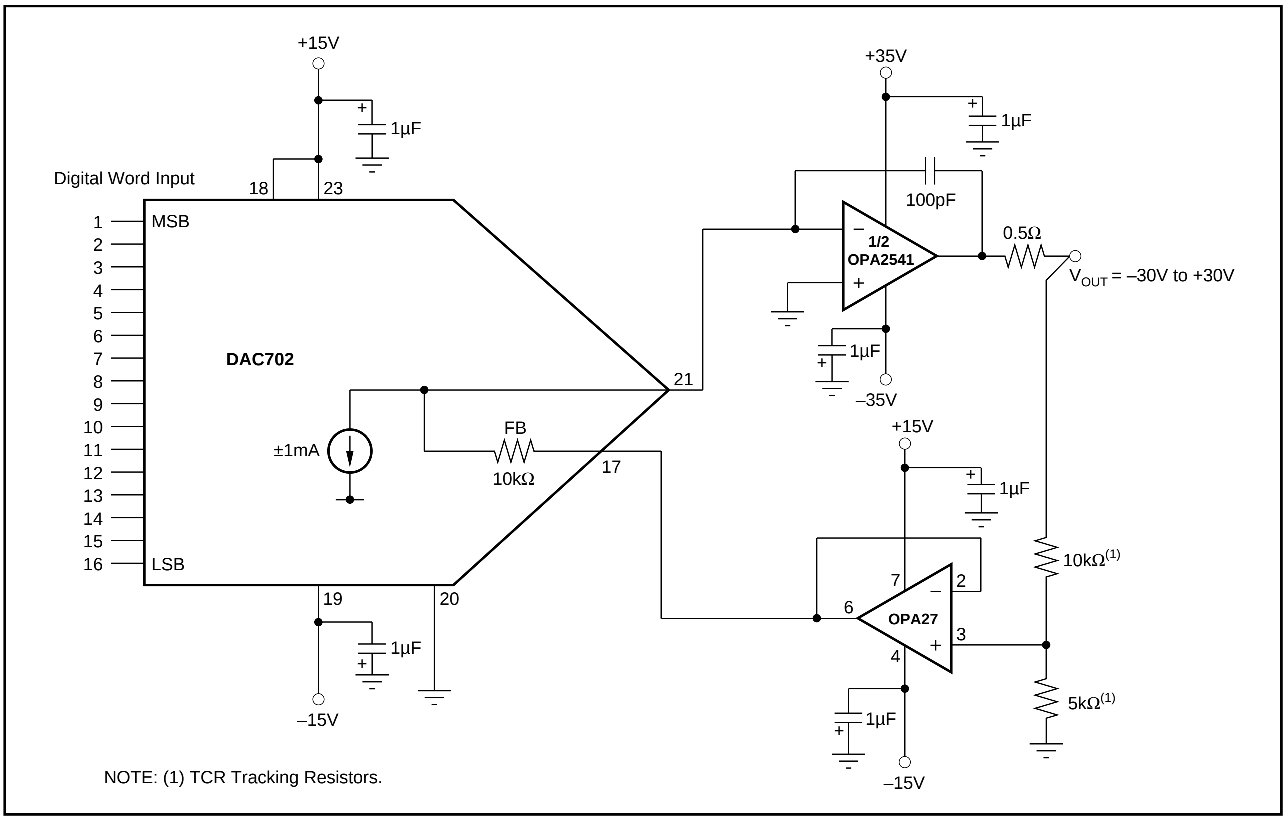


FIGURE 6. 16-Bit Programmable Voltage Source.

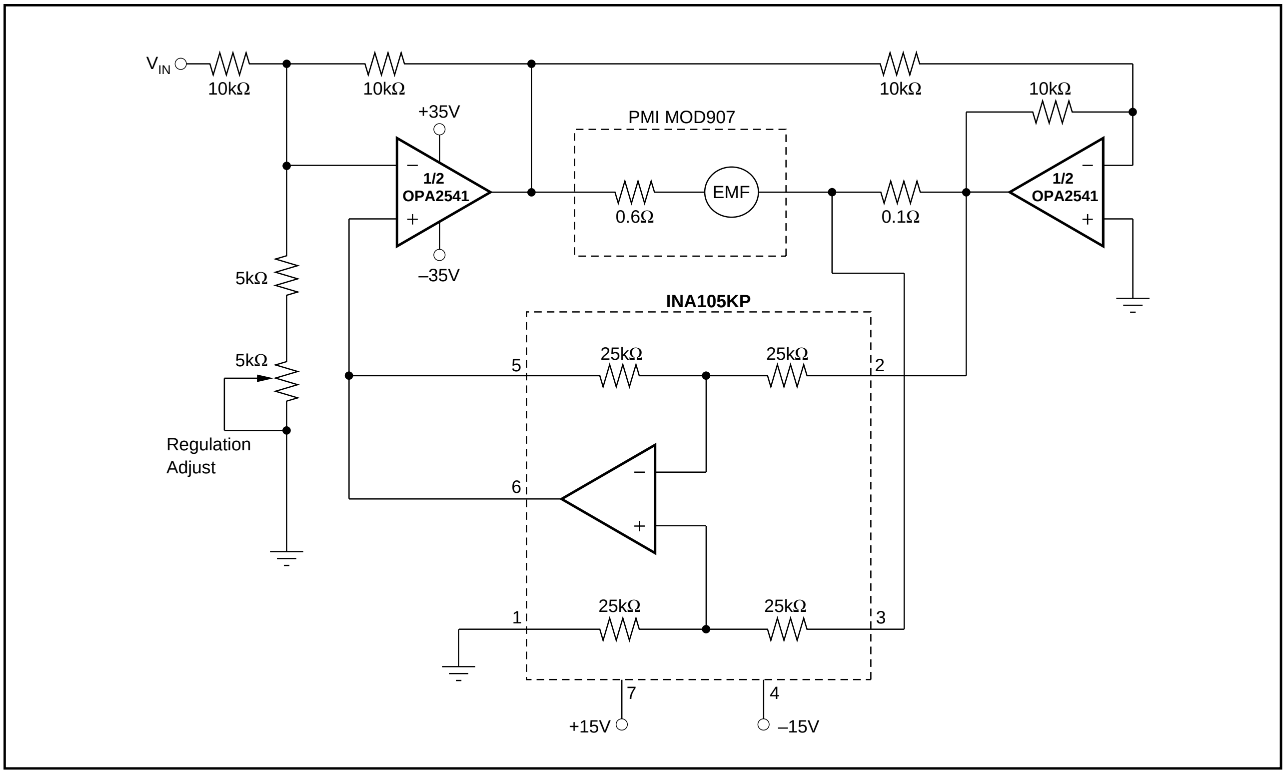


FIGURE 7. Bridge Amplifier Motor-Speed Controller.

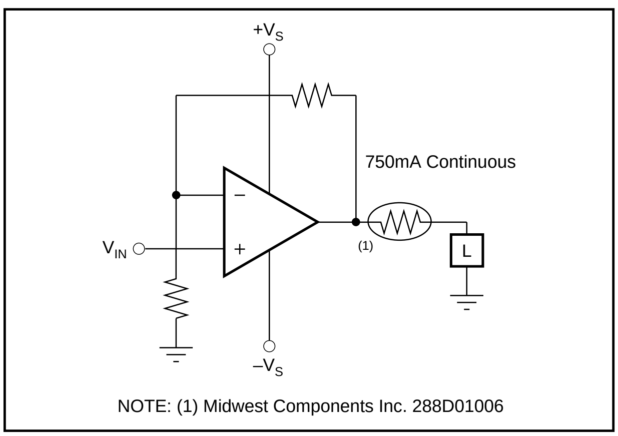


FIGURE 8. Limiting Output Current.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
OPA2541AM	ACTIVE	TO-3	LMF	8	18	RoHS-Exempt & Green	Call TI	N / A for Pkg Type	-55 to 125	OPA2541AM	Samples
OPA2541BM	ACTIVE	TO-3	LMF	8	18	Non-RoHS & Green	NI	N / A for Pkg Type	-55 to 125	OPA2541BM	Samples
OPA2541SM	ACTIVE	TO-3	LMF	8	18	RoHS & Green	Call TI	N / A for Pkg Type	-55 to 125	OPA2541SM	Samples
OPA2541SMQ	ACTIVE	TO-3	LMF	8	18	RoHS & Green	NI	N / A for Pkg Type	-40 to 125	OPA2541 OPA2541SMQ	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

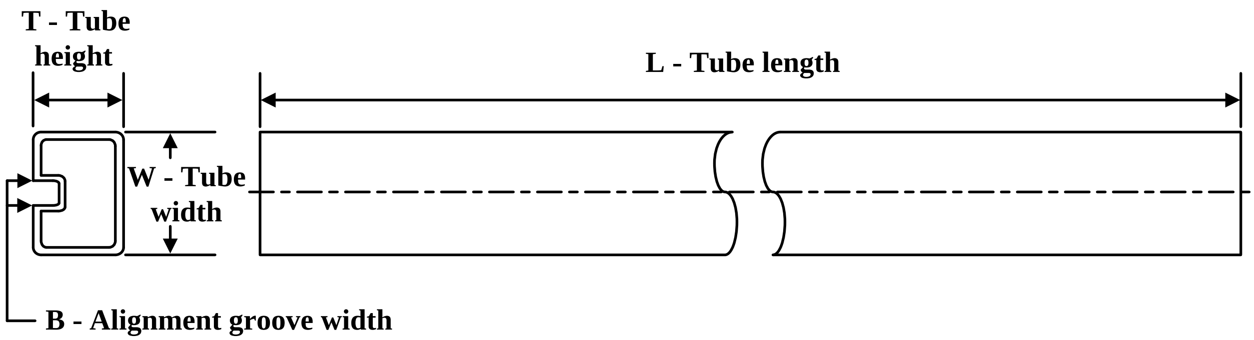
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

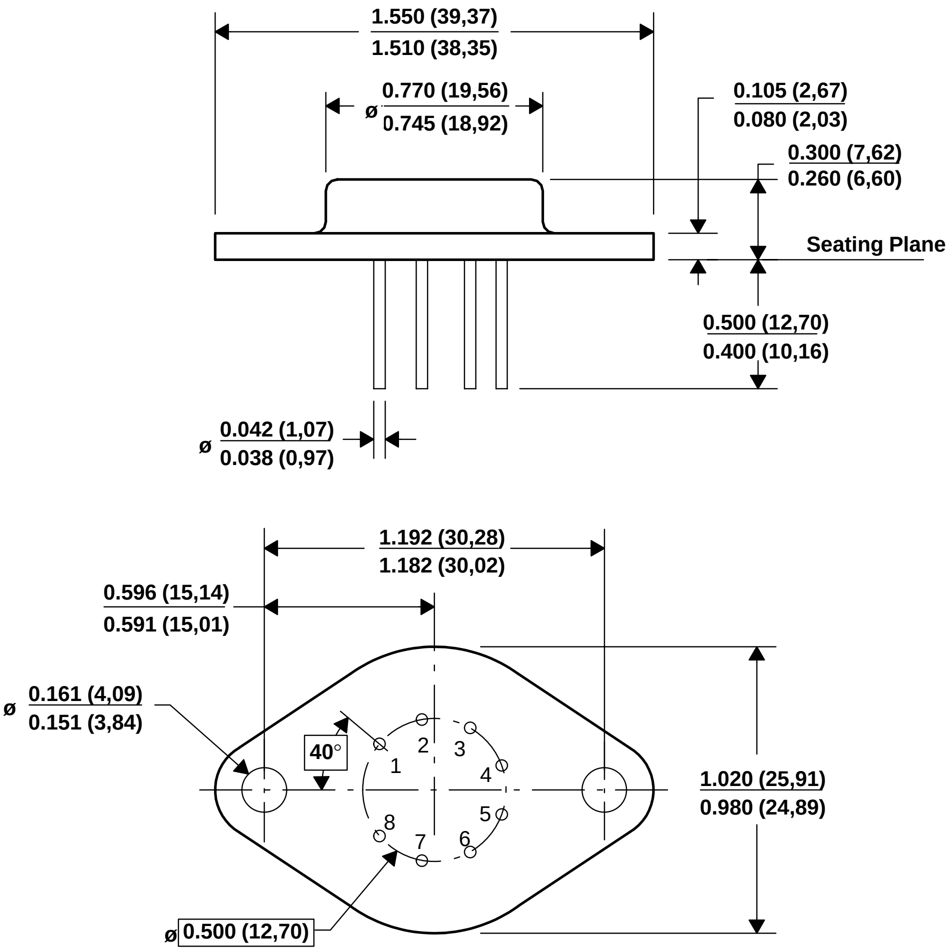
TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
OPA2541AM	LMF	TO-CAN	8	18	532.13	21.59	889	NA
OPA2541BM	LMF	TO-CAN	8	18	532.13	21.59	889	NA
OPA2541SM	LMF	TO-CAN	8	18	532.13	21.59	889	NA
OPA2541SMQ	LMF	TO-CAN	8	18	532.13	21.59	889	NA

LMF (O–MBCY–W8) **METAL CYLINDRICAL PACKAGE**



4202491/A 03/01

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Leads in true position within 0.010 (0,25) R @ MMC at seating plane.
D. Pin numbers shown for reference only. Numbers may not be marked on package.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265