BURR - BROWN ®

OPA2541

Dual High Power OPERATIONAL AMPLIFIER

FEATURES

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

APPLICATIONS

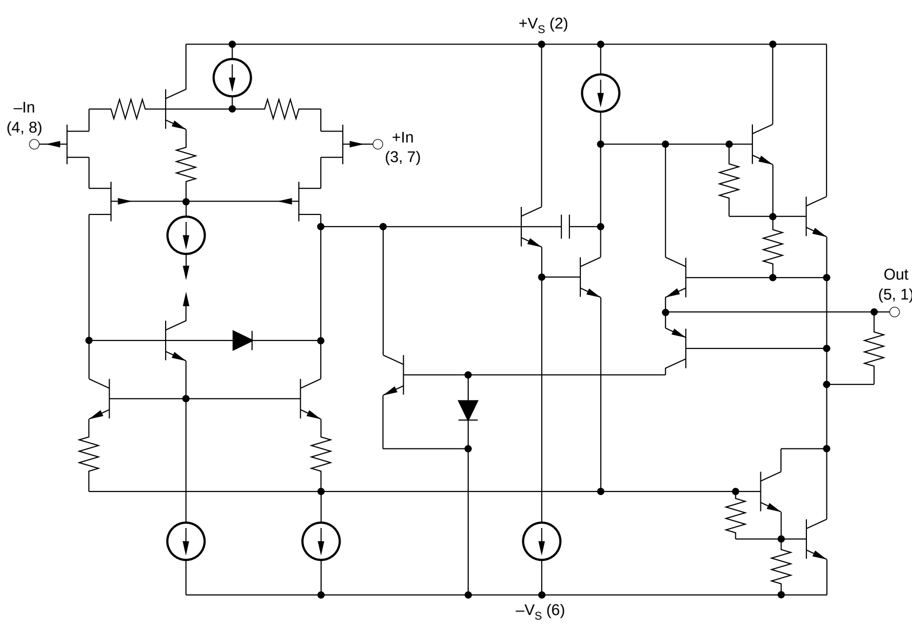
- MOTOR DRIVER
- SERVO AMPLIFIER
- SYNCRO/RESOLVER EXCITATION
- VOICE COIL DRIVER
- BRIDGE AMPLIFIER
- PROGRAMMABLE POWER SUPPLY
- AUDIO AMPLIFIER

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.



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SPECIFICATIONS

ELECTRICAL

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

PARAMETER	CONDITIONS	OPA2541AM			OPA2541BM, SM			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
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			*		$10^{12}Ω$
GAIN CHARACTERISTICS								
Open Loop Gain at 10Hz	R_L = 6Ω	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 = 8Ω, 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 = 8Ω		40			*		Degrees
Channel Separation	1kHz, R_L = 6Ω		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.

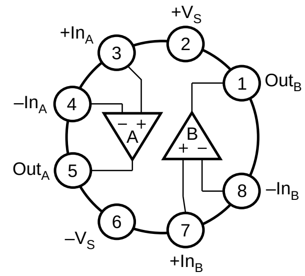
ABSOLUTE MAXIMUM RATINGS

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.

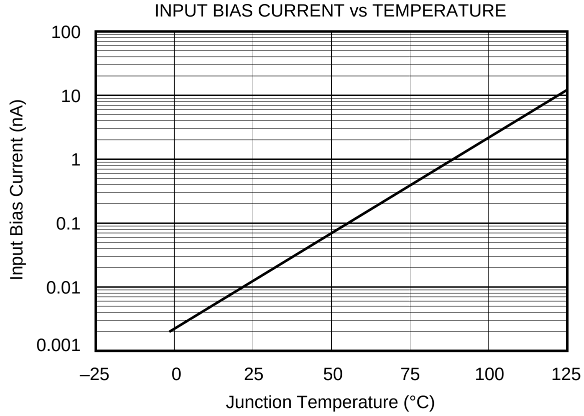
ORDERING INFORMATION

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

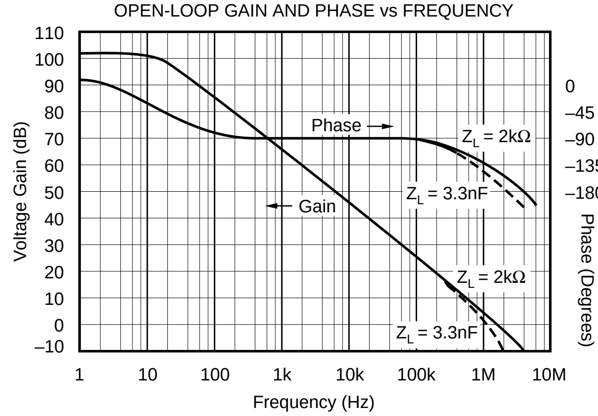
TYPICAL PERFORMANCE CURVES

$T_A = +25°C$ and $V_S = \pm 35VDC$, unless otherwise noted.

INPUT BIAS CURRENT vs TEMPERATURE

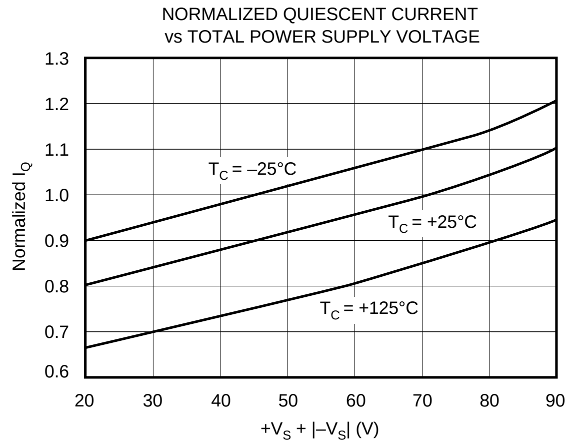


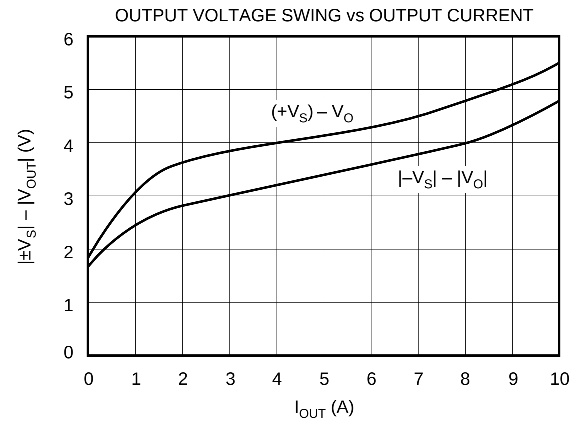
OPEN-LOOP GAIN AND PHASE vs FREQUENCY

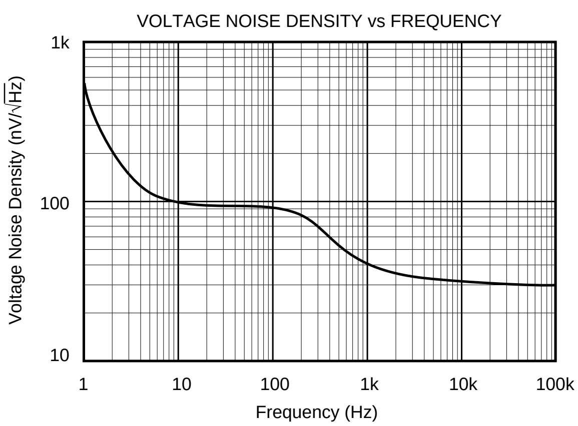


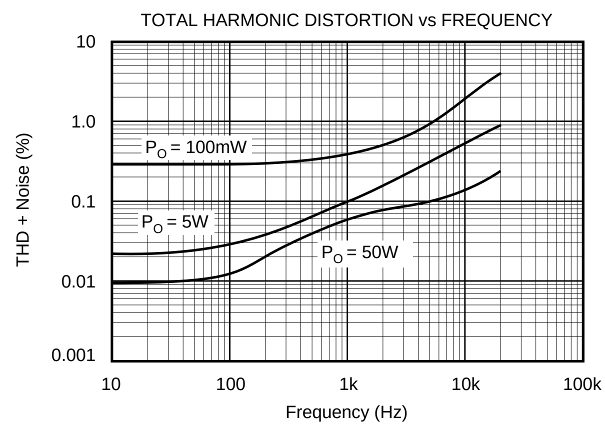
TYPICAL PERFORMANCE CURVES (CONT)

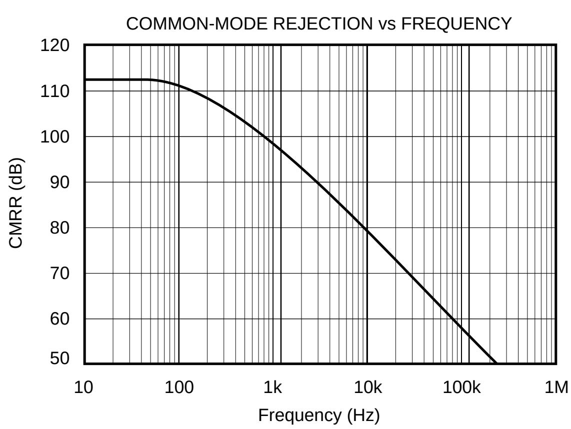
$T_A = +25°C$ and $V_S = ±35VDC$, unless otherwise noted.

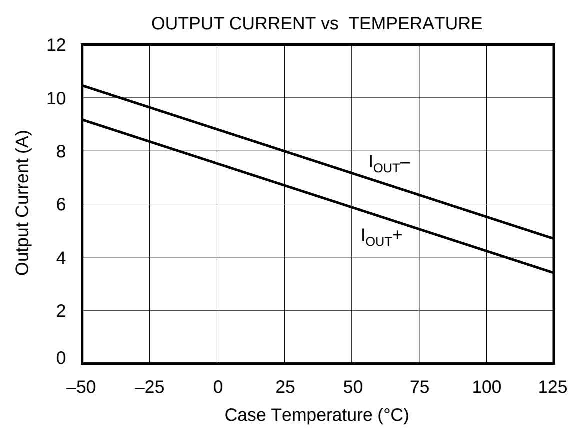








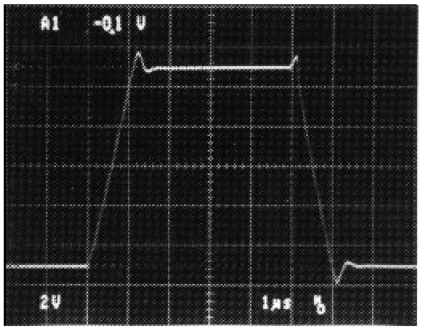




TYPICAL PERFORMANCE CURVES (CONT)

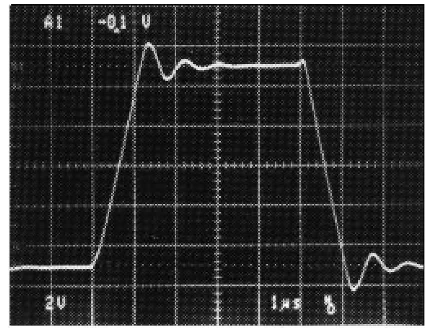
T_A = +25°C and V_S = ±35VDC, unless otherwise noted.

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 = ±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.

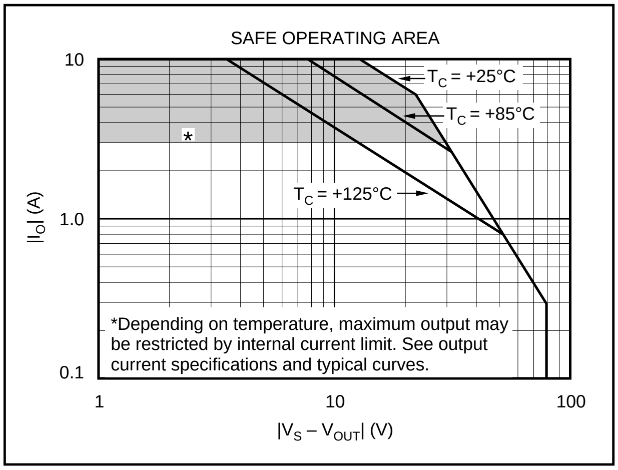


FIGURE 1. Safe Operating Area.

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

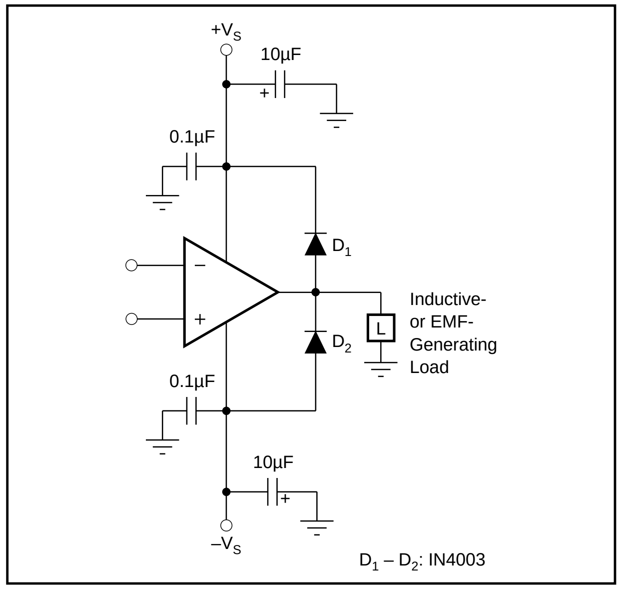


FIGURE 2. Clamping Output for EMF-Generating Loads.

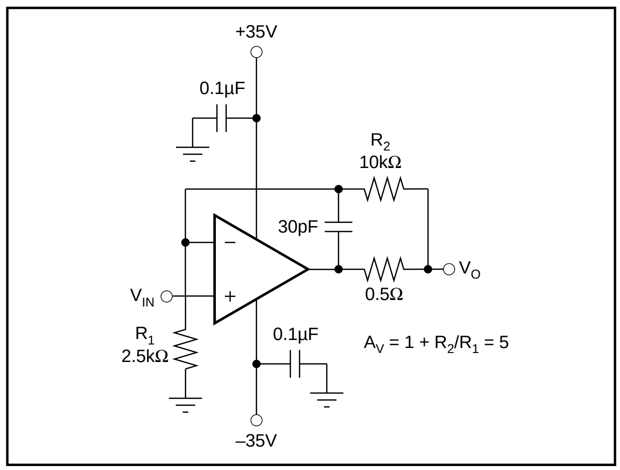


FIGURE 3. Isolating Capacitive Loads.

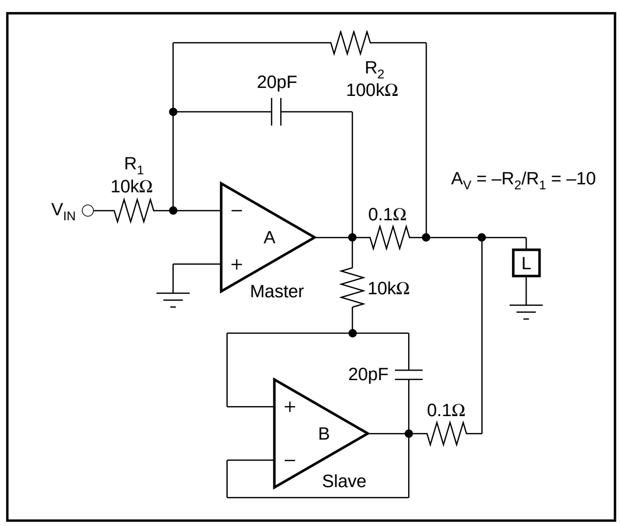


FIGURE 4. Paralleled Operation, Extended SOA.

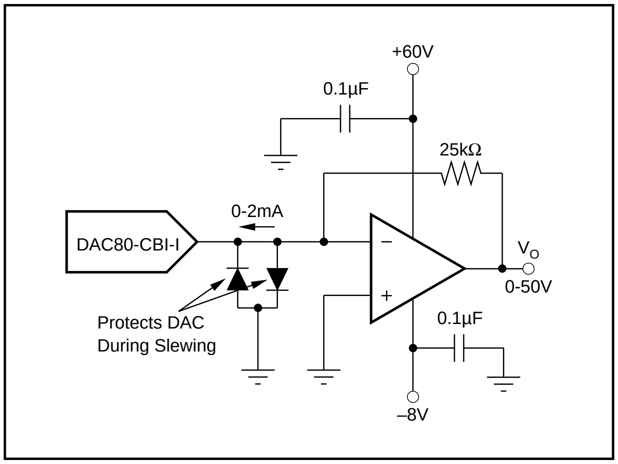


FIGURE 5. Programmable Voltage Source.

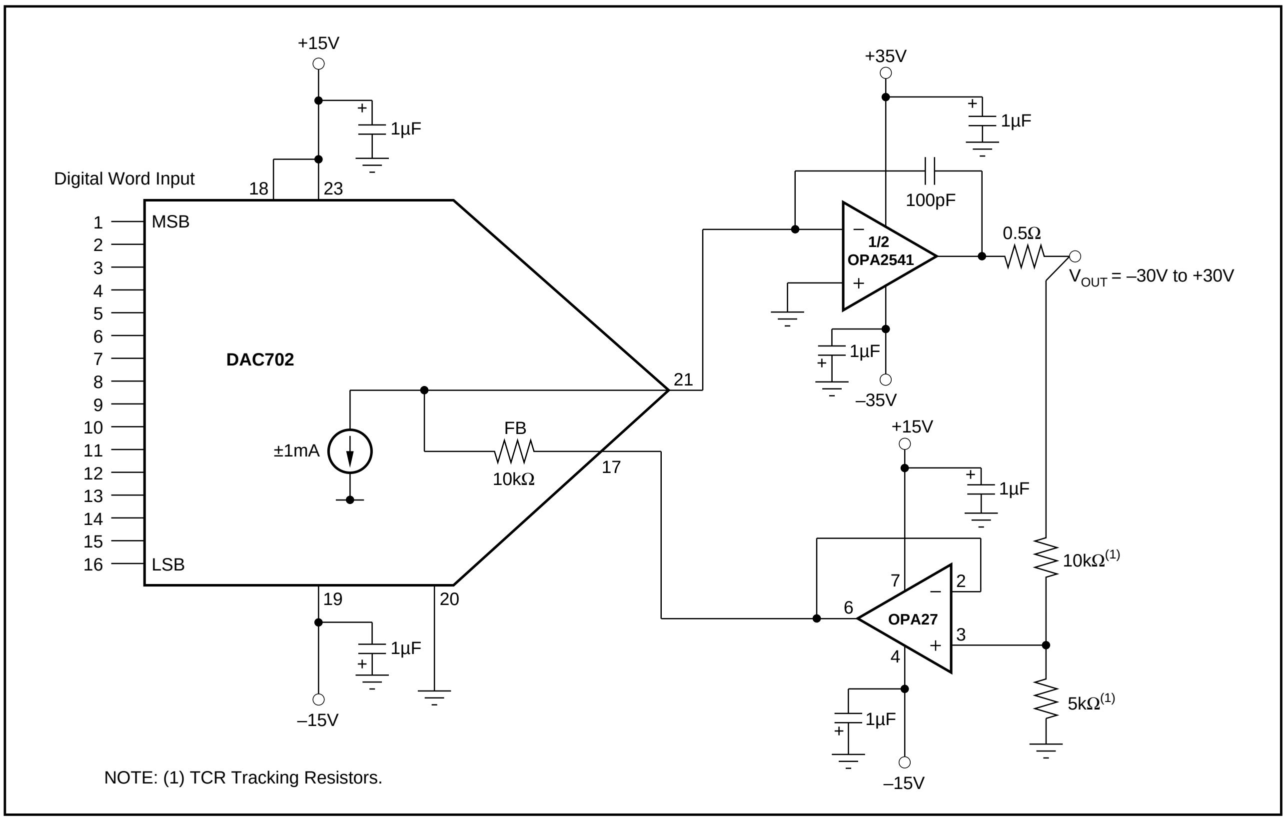


FIGURE 6. 16-Bit Programmable Voltage Source.

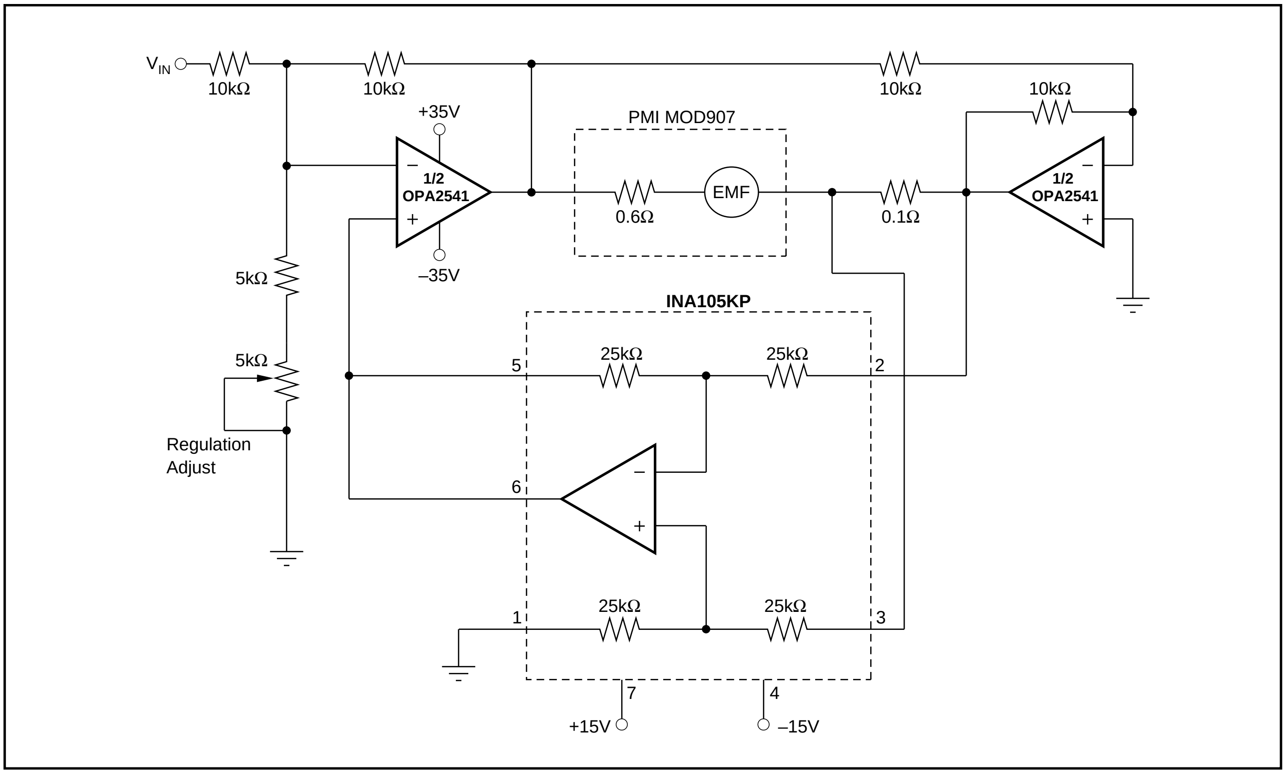


FIGURE 7. Bridge Amplifier Motor-Speed Controller.

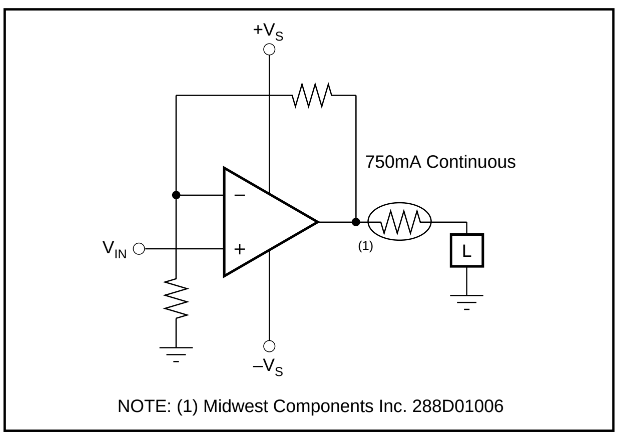


FIGURE 8. Limiting Output Current.