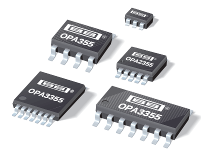
Burr-Brown Products
from Texas Instruments



OPA355
OPA2355
OPA3355

SBOS195D – MARCH 2001 – REVISED JANUARY 2004

200MHz, CMOS OPERATIONAL AMPLIFIER WITH SHUTDOWN

FEATURES

- UNITY-GAIN BANDWIDTH: 450MHz
- WIDE BANDWIDTH: 200MHz GBW
- HIGH SLEW RATE: 360V/µs
- LOW NOISE: 5.8nV/$\sqrt{Hz}$
- EXCELLENT VIDEO PERFORMANCE:
  DIFF GAIN: 0.02%, DIFF PHASE: 0.05°
  0.1dB GAIN FLATNESS: 75MHz
- INPUT RANGE INCLUDES GROUND
- RAIL-TO-RAIL OUTPUT (within 100mV)
- LOW INPUT BIAS CURRENT: 3pA
- LOW SHUTDOWN CURRENT: 3.4µA
- ENABLE/DISABLE TIME: 100ns/30ns
- THERMAL SHUTDOWN
- SINGLE-SUPPLY OPERATING RANGE: 2.5V to 5.5V
- *Micro*SIZE PACKAGES

APPLICATIONS

- VIDEO PROCESSING
- ULTRASOUND
- OPTICAL NETWORKING, TUNABLE LASERS
- PHOTODIODE TRANSIMPEDANCE AMPS
- ACTIVE FILTERS
- HIGH-SPEED INTEGRATORS
- ANALOG-TO-DIGITAL (A/D) CONVERTER INPUT BUFFERS
- DIGITAL-TO-ANALOG (D/A) CONVERTER OUTPUT AMPLIFIERS
- BARCODE SCANNERS
- COMMUNICATIONS

DESCRIPTION

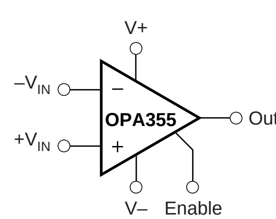
The OPA355 series high-speed, voltage-feedback CMOS operational amplifiers are designed for video and other applications requiring wide bandwidth. The OPA355 is unity-gain stable and can drive large output currents. In addition, the OPA355 has a digital shutdown (Enable) function. This feature provides power savings during idle periods and places the output in a high-impedance state to support output multiplexing. Differential gain is 0.02% and differential phase is 0.05°. Quiescent current is only 8.3mA per channel.

The OPA355 is optimized for operation on single or dual supplies as low as 2.5V (±1.25V) and up to 5.5V (±2.75V). Common-mode input range for the OPA355 extends 100mV below ground and up to 1.5V from V+. The output swing is within 100mV of the rails, supporting wide dynamic range.

The OPA355 series is available in single (SOT23-6 and SO-8), dual (MSOP-10), and triple (TSSOP-14 and SO-14) versions. Multichannel versions feature completely independent circuitry for lowest crosstalk and freedom from interaction. All are specified over the extended –40°C to +125°C range.

OPA355 RELATED PRODUCTS

FEATURES	PRODUCT
200MHz, Rail-to-Rail Output, CMOS, No Shutdown	OPA356
38MHz, Rail-to-Rail Input/Output, CMOS	OPAx350
75MHz, Rail-to-Rail Output	OPAx631
150MHz, Rail-to-Rail Output	OPAx634
Differential Input/Output, 3.3V Supply	THS412x



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

ABSOLUTE MAXIMUM RATINGS(1)

Supply Voltage, V+ to V–	7.5V
Signal Input Terminals, Voltage(2)	(V–) – 0.5V to (V+) + 0.5V
Current(2)	10mA
Enable Input	(V–) – 0.5V to (V+) + 0.5V
Output Short-Circuit(3)	Continuous
Operating Temperature	–55°C to +150°C
Storage Temperature	–65°C to +150°C
Junction Temperature	+160°C
Lead Temperature (soldering, 10s)	+300°C

NOTES: (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied. (2) Input terminals are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less. (3) Short-circuit to ground, one amplifier per package.

ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGE/ORDERING INFORMATION(1)

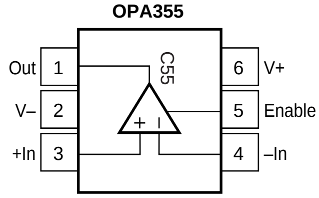
PRODUCT	PACKAGE-LEAD	PACKAGE MARKING
OPA355 "	SOT23-6 "	C55 "
OPA355 "	SO-8 "	OPA355UA "
OPA2355 "	MSOP-10 "	D55 "
OPA3355 "	TSSOP-14 "	OPA3355EA "
OPA3355 "	SO-14 "	OPA3355UA "

NOTE: (1) For the most current package and ordering information, see the Package Option Addendum located at the end of this data sheet.

PIN CONFIGURATIONS

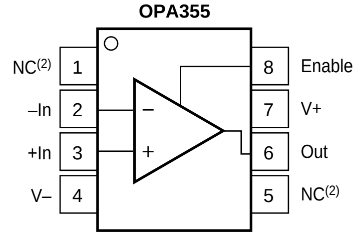
Top View

OPA355



SOT23-6(1)

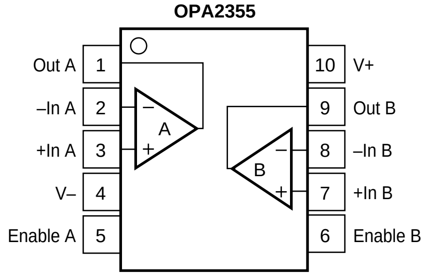
OPA355



SO-8

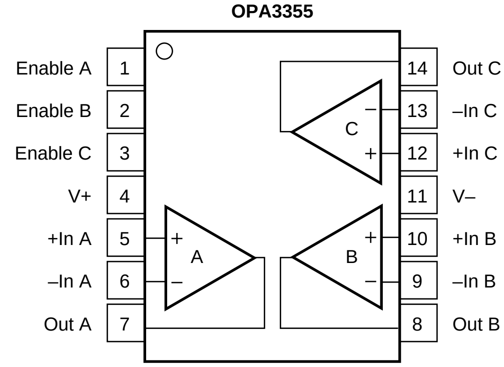
NOTES: (1) Pin 1 of the SOT23-6 is determined by orienting the package marking as indicated in the diagram. (2) NC indicates no internal connection.

OPA2355



MSOP-10

OPA3355



SO-14
TSSOP-14

ELECTRICAL CHARACTERISTICS: V_S = +2.7V to +5.5V Single-Supply

Boldface limits apply over the specified temperature range, T_A = –40°C to +125°C.

At T_A = +25°C, R_F = 604Ω, R_L = 150Ω, and connected to V_S/2, unless otherwise noted.

PARAMETER		CONDITION	OPA355 OPA2355 OPA3355 MIN	TYP	MAX	UNITS
OFFSET VOLTAGE						
Input Offset Voltage	V_{OS}	V_S = +5V		±2	±9	mV
		Specified Temperature Range			**±15**	**mV**
vs Temperature	**dV_{OS}/dT**	**Specified Temperature Range**		**±7**		**μV/°C**
vs Power Supply	PSRR	V_S = +2.7V to +5.5V, V_{CM} = V_S/2 – 0.15V		±80	±350	μV/V
INPUT BIAS CURRENT						
Input Bias Current	I_B			3	±50	pA
Input Offset Current	I_{OS}			±1	±50	pA
NOISE						
Input Noise Voltage Density	e_n	f = 1MHz		5.8		$nV/\sqrt{Hz}$
Current Noise Density	i_n	f = 1MHz		50		$fA/\sqrt{Hz}$
INPUT VOLTAGE RANGE						
Common-Mode Voltage Range	V_{CM}		(V–) – 0.1		(V+) – 1.5	V
Common-Mode Rejection Ratio	CMRR	V_S = +5.5V, –0.1V < V_{CM} < +4.0V	66	80		dB
		Specified Temperature Range	**66**			**dB**
INPUT IMPEDANCE						
Differential				10^{13} || 1.5		Ω || pF
Common-Mode				10^{13} || 1.5		Ω || pF
OPEN-LOOP GAIN		V_S = +5V, 0.3V < V_O < 4.7V	84	92		dB
	OPA355	**V_S = +5V, 0.3V < V_O < 4.7V**	**80**			**dB**
	OPA2355, OPA3355	**V_S = +5V, 0.4V < V_O < 4.6V**	**80**			**dB**
FREQUENCY RESPONSE						
Small-Signal Bandwidth	f_{-3dB}	G = +1, V_O = 100mVp-p, R_F = 0Ω		450		MHz
	f_{-3dB}	G = +2, V_O = 100mVp-p, R_L = 50Ω		100		MHz
	f_{-3dB}	G = +2, V_O = 100mVp-p, R_L = 150Ω		170		MHz
	f_{-3dB}	G = +2, V_O = 100mVp-p, R_L = 1kΩ		200		MHz
Gain-Bandwidth Product	GBW	G = +10, R_L = 1kΩ		200		MHz
Bandwidth for 0.1dB Gain Flatness	$f_{0.1dB}$	G = +2, V_O = 100mVp-p, R_F = 560Ω		75		MHz
Slew Rate	SR	V_S = +5V, G = +2, 4V Output Step		300/–360		V/μs
Rise-and-Fall Time		G = +2, V_O = 200mVp-p, 10% to 90%		2.4		ns
		G = +2, V_O = 2Vp-p, 10% to 90%		8		ns
Settling Time, 0.1%		V_S = +5V, G = +2, 2V Output Step		30		ns
0.01%		V_S = +5V, G = +2, 2V Output Step		120		ns
Overload Recovery Time		V_{IN} • Gain = V_S		8		ns
Harmonic Distortion						
2nd-Harmonic		G = +2, f = 1MHz, V_O = 2Vp-p, R_L = 200Ω		–81		dBc
3rd-Harmonic		G = +2, f = 1MHz, V_O = 2Vp-p, R_L = 200Ω		–93		dBc
Differential Gain Error		NTSC, R_L = 150Ω		0.02		%
Differential Phase Error		NTSC, R_L = 150Ω		0.05		degrees
Channel-to-Channel Crosstalk	OPA2355	f = 5MHz		–90		dB
	OPA3355	f = 5MHz		–70		dB
OUTPUT						
Voltage Output Swing from Rail		V_S = +5V, R_L = 150Ω, A_{OL} > 84dB		0.2	0.3	V
Voltage Output Swing from Rail		V_S = +5V, R_L = 1kΩ		0.1		V
Output Current, Continuous(1)	I_O			±60		mA
Output Current, Peak(1)	I_O	V_S = +5V		±100		mA
Output Current, Peak(1)	I_O	V_S = +3V		±80		mA
Closed-Loop Output Impedance		f < 100kHz		0.02		Ω
POWER SUPPLY						
Specified Voltage Range	V_S		2.7		5.5	V
Operating Voltage Range				2.5 to 5.5		V
Quiescent Current (per amplifier)	I_Q	V_S = +5V, Enabled, I_O = 0		8.3	11	mA
		Specified Temperature Range			**14**	**mA**

NOTES: (1) See typical characteristic *Output Voltage Swing vs Output Current*. (2) Logic LOW and HIGH levels are CMOS logic compatible. They are referenced to V–.

ELECTRICAL CHARACTERISTICS: V_S = +2.7V to +5.5V Single-Supply (Cont.)

Boldface limits apply over the specified temperature range, **T_A = –40°C to +125°C.**

At T_A = +25°C, R_F = 604Ω, R_L = 150Ω, and connected to V_S/2, unless otherwise noted.

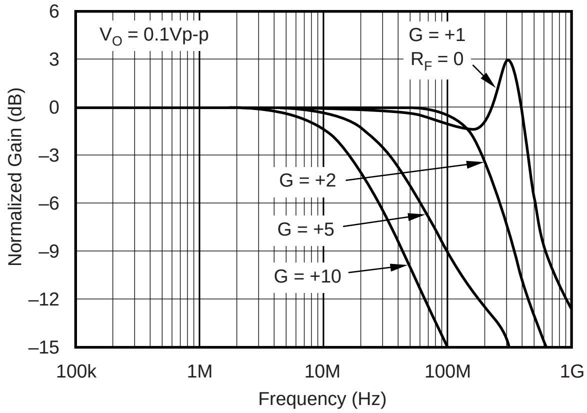
PARAMETER		CONDITION	OPA355 OPA2355 OPA3355 MIN	TYP	MAX	UNITS
SHUTDOWN						
Disabled (Logic-LOW Threshold)(2)					0.8	V
Enabled (Logic-HIGH Threshold)(2)			2			V
Enable Time				100		ns
Disable Time				30		ns
Shutdown Current (per amplifier)		V_S = +5V, Disabled		3.4	6	μA
THERMAL SHUTDOWN						
Junction Temperature						
Shutdown				160		°C
Reset from Shutdown				140		°C
TEMPERATURE RANGE						
Specified Range			–40		125	°C
Operating Range			–55		150	°C
Storage Range			–65		150	°C
Thermal Resistance	θ_{JA}					°C/W
SOT-23-6, MSOP-10				150		°C/W
SO-8				125		°C/W
SO-14, TSSOP-14				100		°C/W

NOTES: (1) See typical characteristic *Output Voltage Swing vs Output Current.* (2) Logic LOW and HIGH levels are CMOS logic compatible. They are referenced to V–.

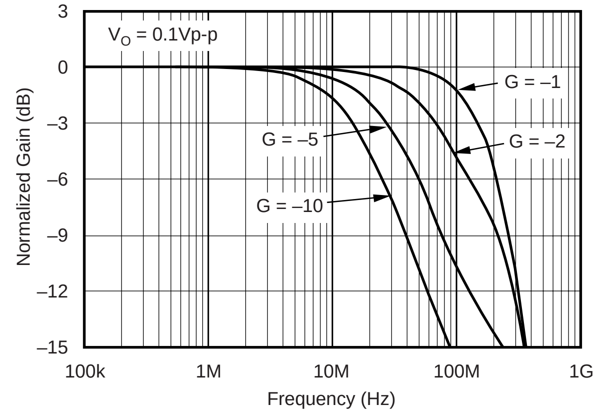
TYPICAL CHARACTERISTICS

At T_A = +25°C, V_S = 5V, G = +2, R_F = 604Ω, and R_L = 150Ω connected to V_S/2, unless otherwise noted.

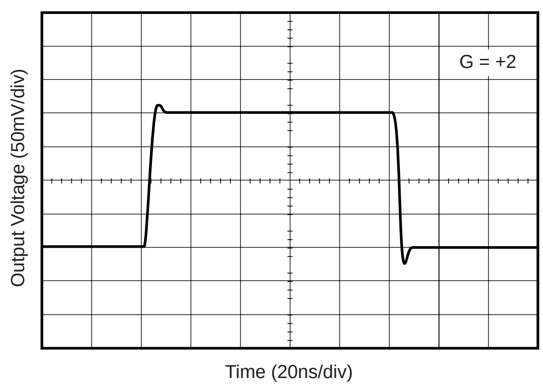
NONINVERTING SMALL-SIGNAL FREQUENCY RESPONSE



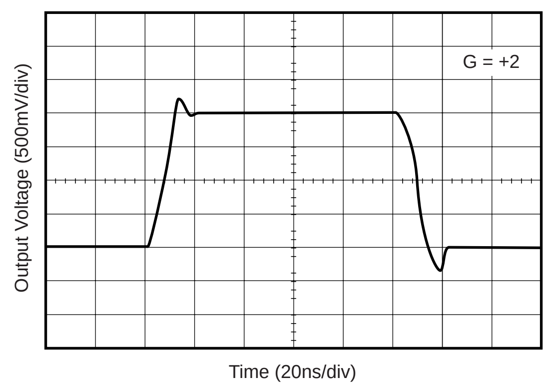
INVERTING SMALL-SIGNAL FREQUENCY RESPONSE



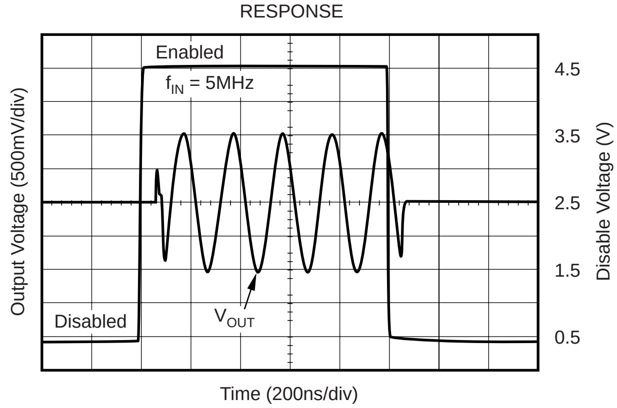
NON-INVERTING SMALL-SIGNAL STEP RESPONSE



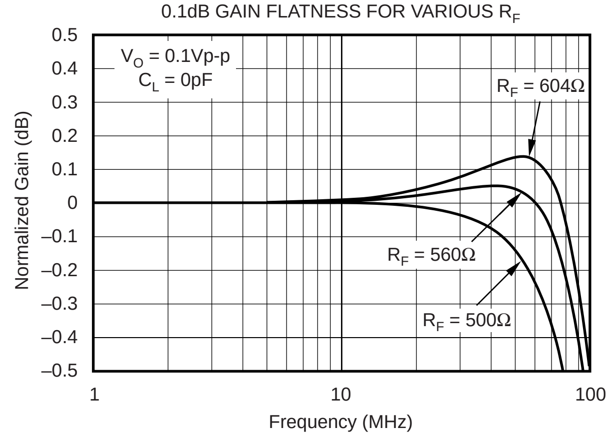
NONINVERTING LARGE-SIGNAL STEP RESPONSE



LARGE-SIGNAL DISABLE/ENABLE RESPONSE



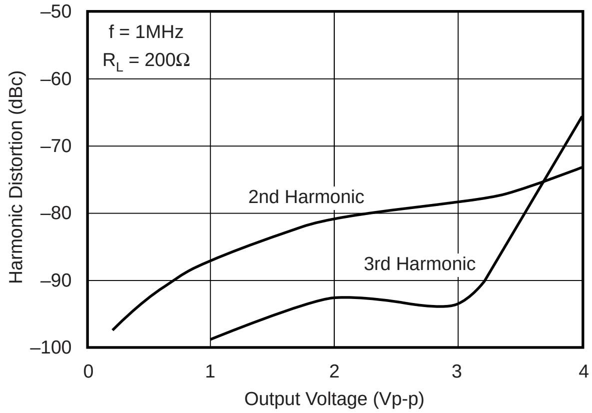
0.1dB GAIN FLATNESS FOR VARIOUS R_F



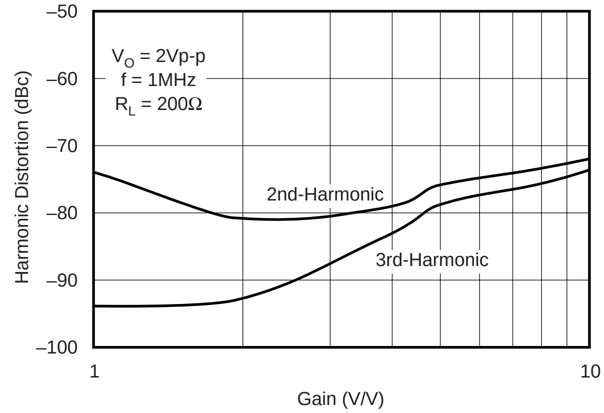
TYPICAL CHARACTERISTICS (Cont.)

At $T_A = +25°C$, $V_S = 5V$, $G = +2$, $R_F = 604\Omega$, and $R_L = 150\Omega$ connected to $V_S/2$, unless otherwise noted.

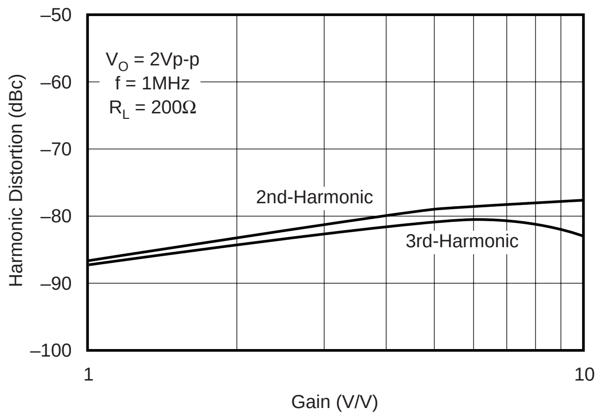
HARMONIC DISTORTION vs OUTPUT VOLTAGE



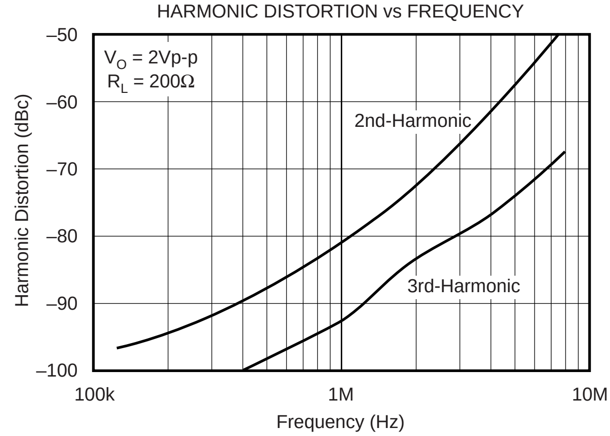
HARMONIC DISTORTION vs NONINVERTING GAIN



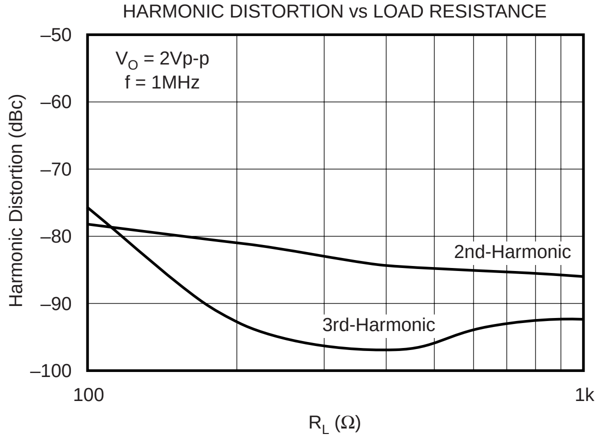
HARMONIC DISTORTION vs INVERTING GAIN



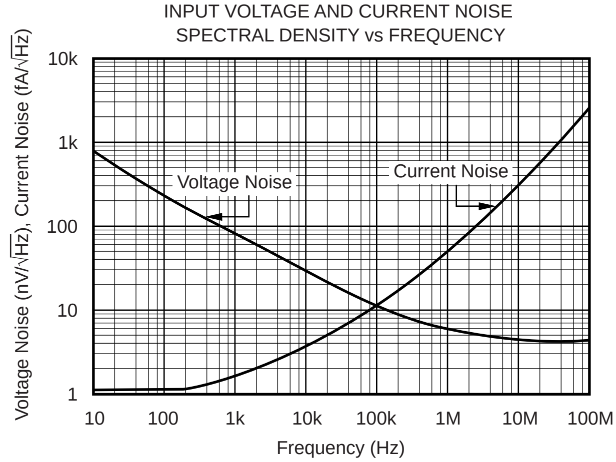
HARMONIC DISTORTION vs FREQUENCY



HARMONIC DISTORTION vs LOAD RESISTANCE



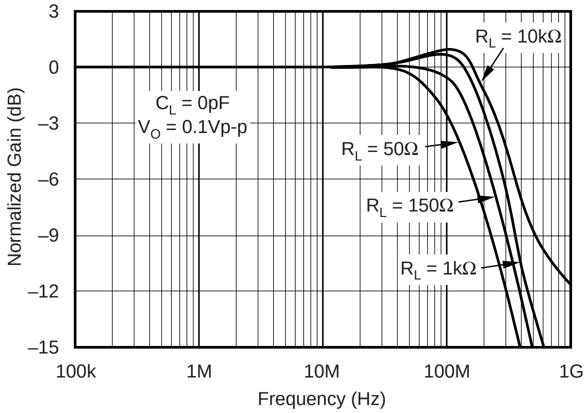
INPUT VOLTAGE AND CURRENT NOISE SPECTRAL DENSITY vs FREQUENCY



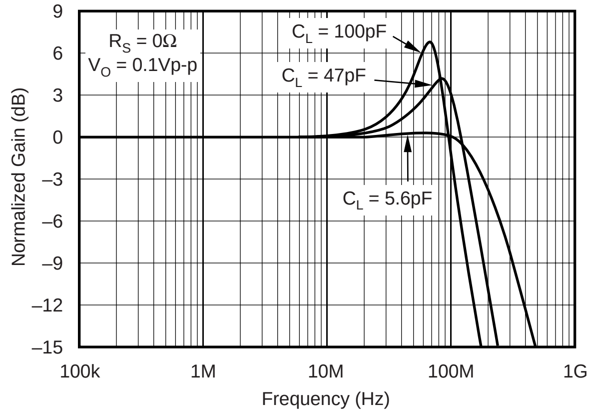
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = 5V, G = +2, R_F = 604Ω, and R_L = 150Ω connected to V_S/2, unless otherwise noted.

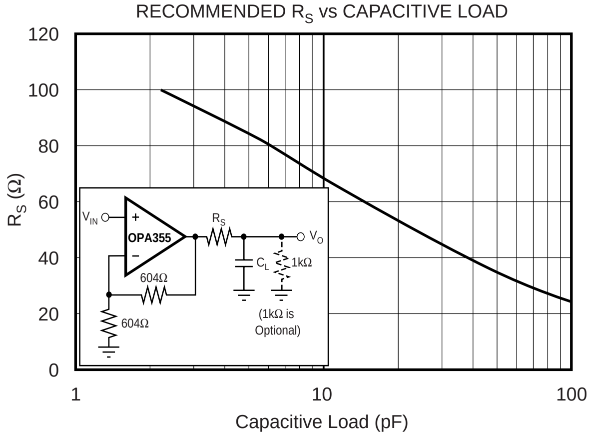
FREQUENCY RESPONSE FOR VARIOUS R_L



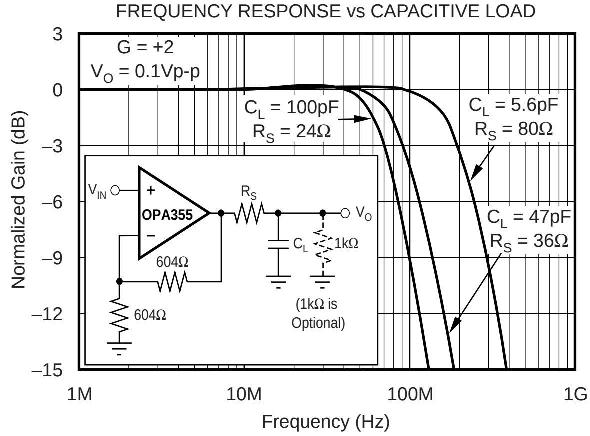
FREQUENCY RESPONSE FOR VARIOUS C_L



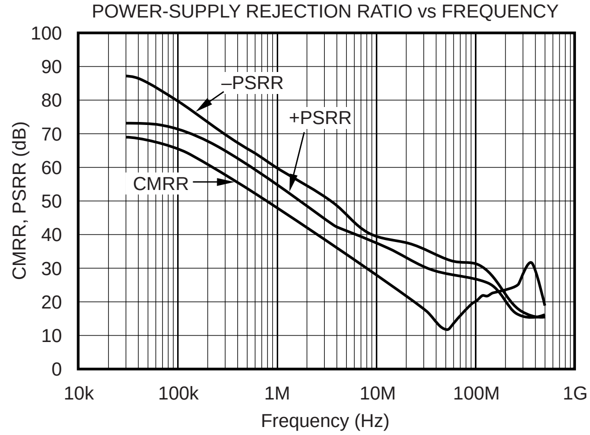
RECOMMENDED R_S vs CAPACITIVE LOAD



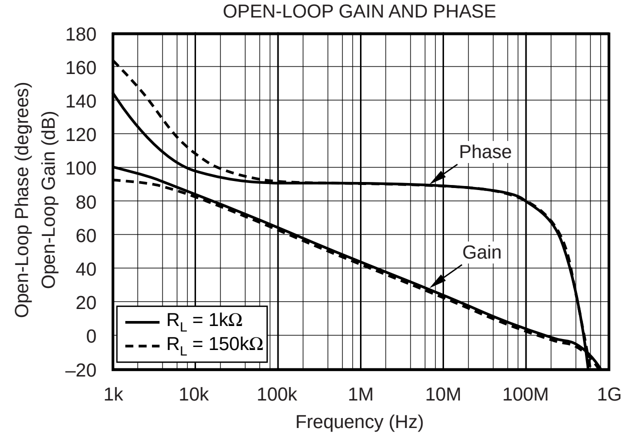
FREQUENCY RESPONSE vs CAPACITIVE LOAD



COMMON-MODE REJECTION RATIO AND POWER-SUPPLY REJECTION RATIO vs FREQUENCY



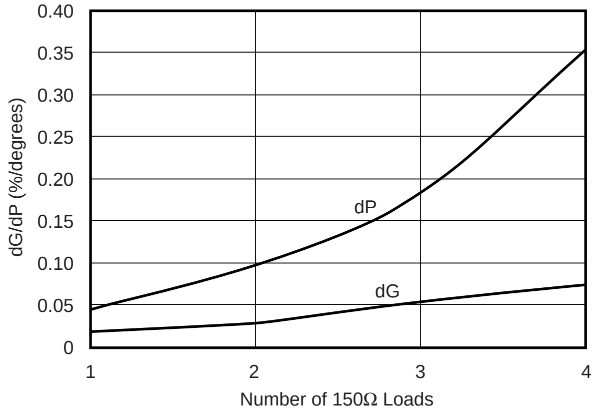
OPEN-LOOP GAIN AND PHASE



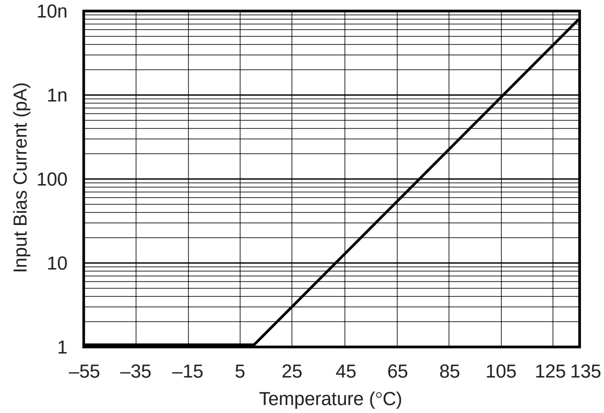
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = 5V, G = +2, R_F = 604Ω, and R_L = 150Ω connected to V_S/2, unless otherwise noted.

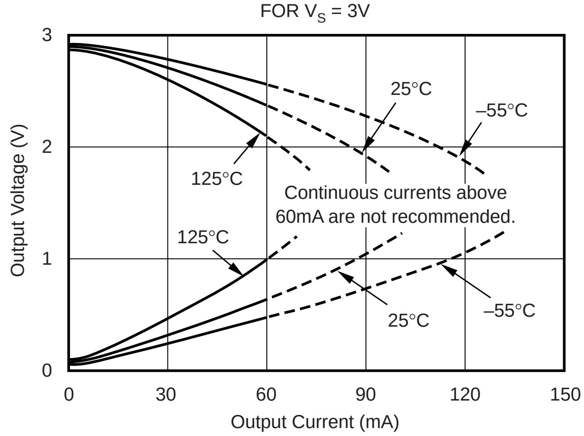
COMPOSITE VIDEO
DIFFERENTIAL GAIN AND PHASE



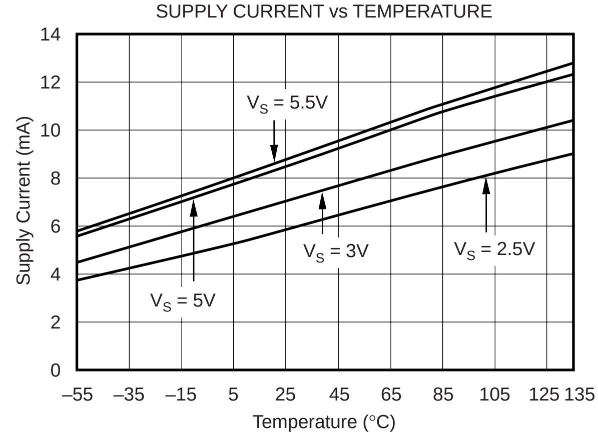
INPUT BIAS CURRENT vs TEMPERATURE



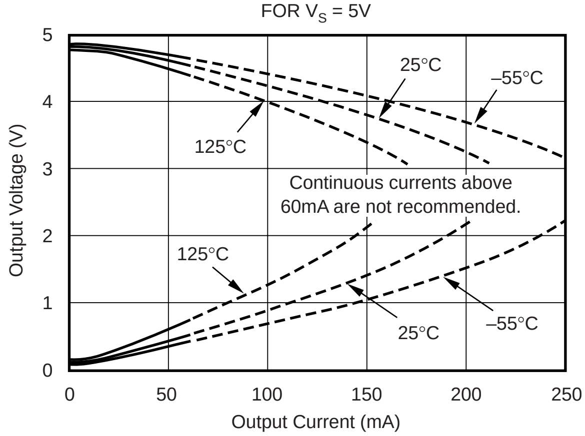
OUTPUT VOLTAGE SWING vs OUTPUT CURRENT
FOR V_S = 3V



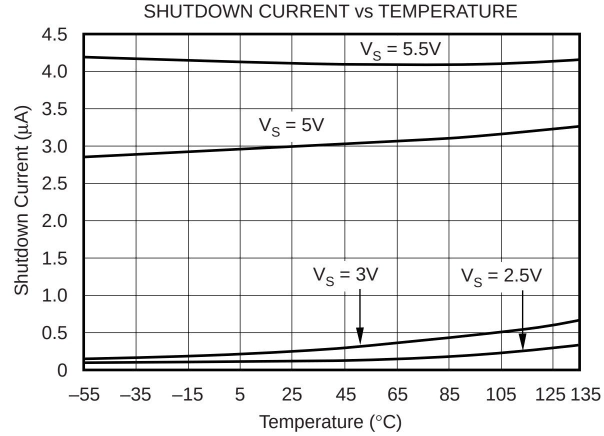
SUPPLY CURRENT vs TEMPERATURE



OUTPUT VOLTAGE SWING vs OUTPUT CURRENT
FOR V_S = 5V



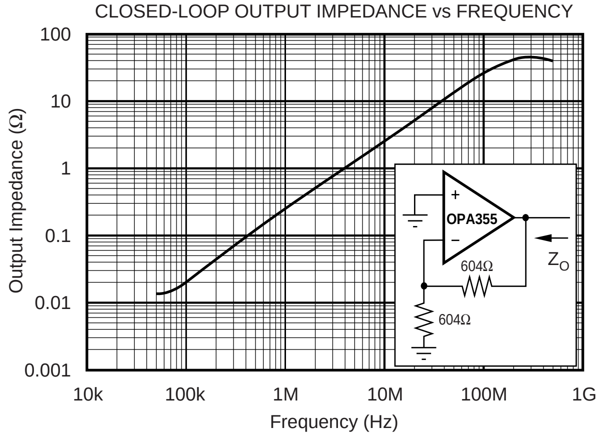
SHUTDOWN CURRENT vs TEMPERATURE



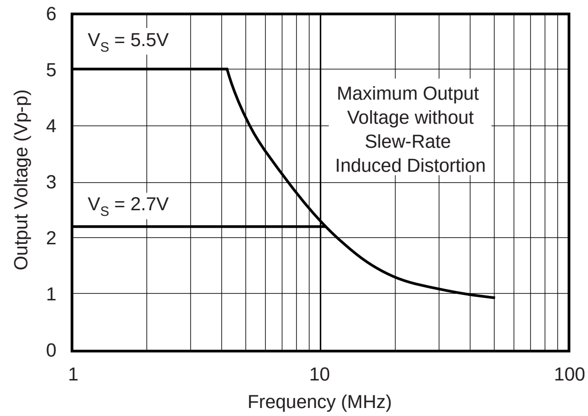
TYPICAL CHARACTERISTICS (Cont.)

At T_A = +25°C, V_S = 5V, G = +2, R_F = 604Ω, and R_L = 150Ω connected to V_S/2, unless otherwise noted.

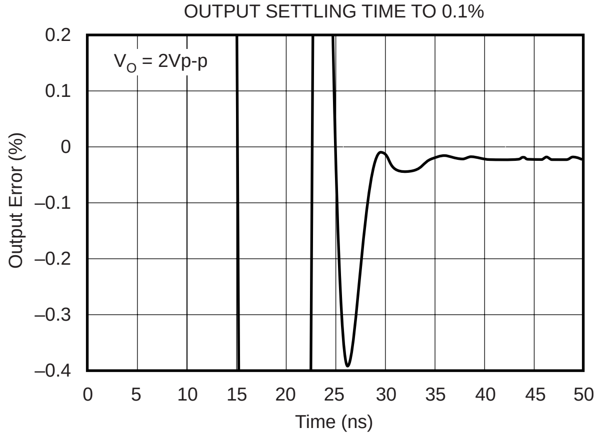
CLOSED-LOOP OUTPUT IMPEDANCE vs FREQUENCY



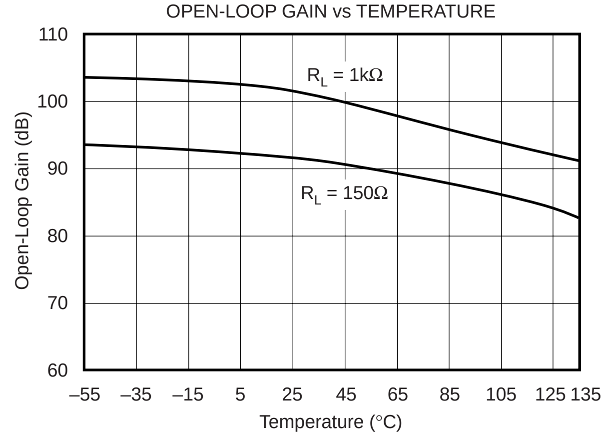
MAXIMUM OUTPUT VOLTAGE vs FREQUENCY



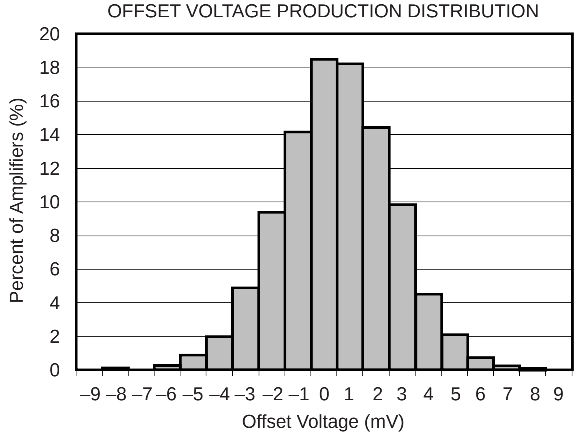
OUTPUT SETTLING TIME TO 0.1%



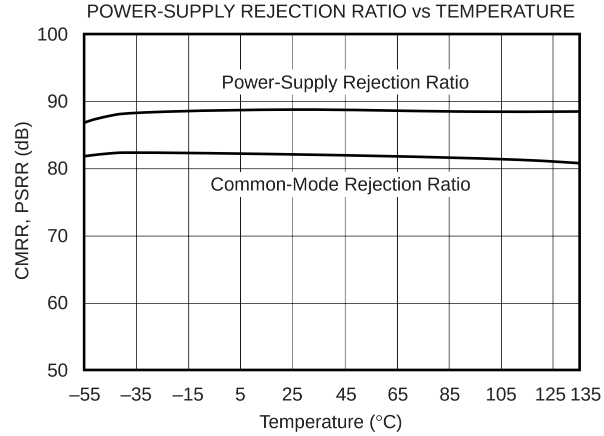
OPEN-LOOP GAIN vs TEMPERATURE



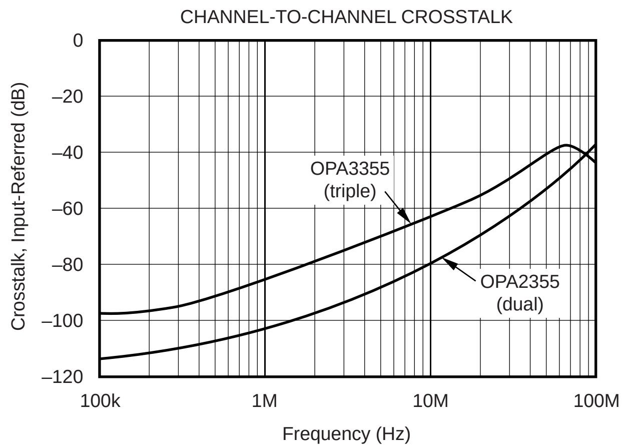
OFFSET VOLTAGE PRODUCTION DISTRIBUTION



COMMON-MODE REJECTION RATIO AND
POWER-SUPPLY REJECTION RATIO vs TEMPERATURE



At T_A = +25°C, V_S = 5V, G = +2, R_F = 604Ω, and R_L = 150Ω connected to V_S/2, unless otherwise noted.



APPLICATIONS INFORMATION

The OPA355 series is a CMOS, high-speed, voltage-feedback, operational amplifier designed for video and other general-purpose applications. It is available as a single, dual, or triple op amp.

The amplifier features a 200MHz gain bandwidth and 360V/µs slew rate, but it is unity-gain stable and can be operated as a +1V/V voltage follower.

Its input common-mode voltage range includes ground, allowing the OPA355 to be used in virtually any single-supply application up to a supply voltage of +5.5V.

PCB LAYOUT

Good high-frequency PC board layout techniques should be employed for the OPA355. Generous use of ground planes, short direct signal traces, and a suitable bypass capacitor located at the V+ pin will assure clean, stable operation. Large areas of copper also provide a means of dissipating heat that is generated within the amplifier in normal operation.

Sockets are definitely not recommended for use with any high-speed amplifier.

A 10nF ceramic bypass capacitor is the minimum recommended value; adding a 1µF or larger tantalum capacitor in parallel can be beneficial when driving a low-resistance load. Providing adequate bypass capacitance is essential to achieving very low harmonic and intermodulation distortion.

OPERATING VOLTAGE

The OPA355 is specified over a power-supply range of +2.7V to +5.5V (±1.35V to ±2.75V). However, the supply voltage may range from +2.5V to +5.5V (±1.25V to ±2.75V). Supply voltages higher than 7.5V (absolute maximum) can permanently damage the amplifier.

Parameters that vary significantly over supply voltage or temperature are shown in the Typical Characteristics section of this data sheet.

ENABLE FUNCTION

The OPA355 can be enabled by applying a TTL HIGH voltage level to the Enable pin. Conversely, a TTL LOW voltage level will disable the amplifier, reducing its supply current from 8.3mA to only 3.4µA per amplifier. This pin voltage is referenced to single-supply ground. When using a split-supply, such as ±2.5V, the enable/disable voltage levels will be referenced to V–. Independent Enable pins are available for each channel, providing maximum design flexibility. For portable battery-operated applications, this feature can be used to greatly reduce the average current and thereby extend battery life.

The Enable input can be modeled as a CMOS input gate with a 100kΩ pull-up resistor to V+. Left open, the Enable pin will assume a logic HIGH, and the amplifier will be on.

The Enable time is 100ns and the disable time is only 30ns. This allows the OPA355 to be operated as a "gated" amplifier, or to have its output multiplexed onto a common output bus. When disabled, the output assumes a high-impedance state.

OUTPUT DRIVE

The output stage can supply high short-circuit current (typically over 200mA). Therefore, an on-chip thermal shutdown circuit is provided to protect the OPA355 from dangerously high junction temperatures. At 160°C, the protection circuit will shut down the amplifier. Normal operation will resume when the junction temperature cools to below 140°C.

NOTE: it is not recommended to run a continuous DC current in excess of ±60mA. Refer to the Typical Characteristics, *Output Voltage Swing vs Output Current*.

VIDEO

The OPA355 output stage is capable of driving a standard back-terminated 75Ω video cable. By back-terminating a transmission line, it does not exhibit a capacitive load to its driver. A properly back-terminated 75Ω cable does not appear as capacitance; it presents only a 150Ω resistive load to the OPA355 output.

The OPA355 can be used as an amplifier for RGB graphic signals, which have a voltage of zero at the video black level, by offsetting and AC-coupling the signal, as shown in Figure 1.

WIDEBAND VIDEO MULTIPLEXING

One common application for video speed amplifiers which include an enable pin is to wire multiple amplifier outputs together, then select which one of several possible video inputs to source onto a single line. This simple *Wired-OR Video Multiplexer* can be easily implemented using the OPA357; see Figure 2.

INPUT AND ESD PROTECTION

All OPA355 pins are static protected with internal ESD protection diodes tied to the supplies; see Figure 3.

These diodes will provide overdrive protection if the current is externally limited to 10mA by the source or by a resistor.

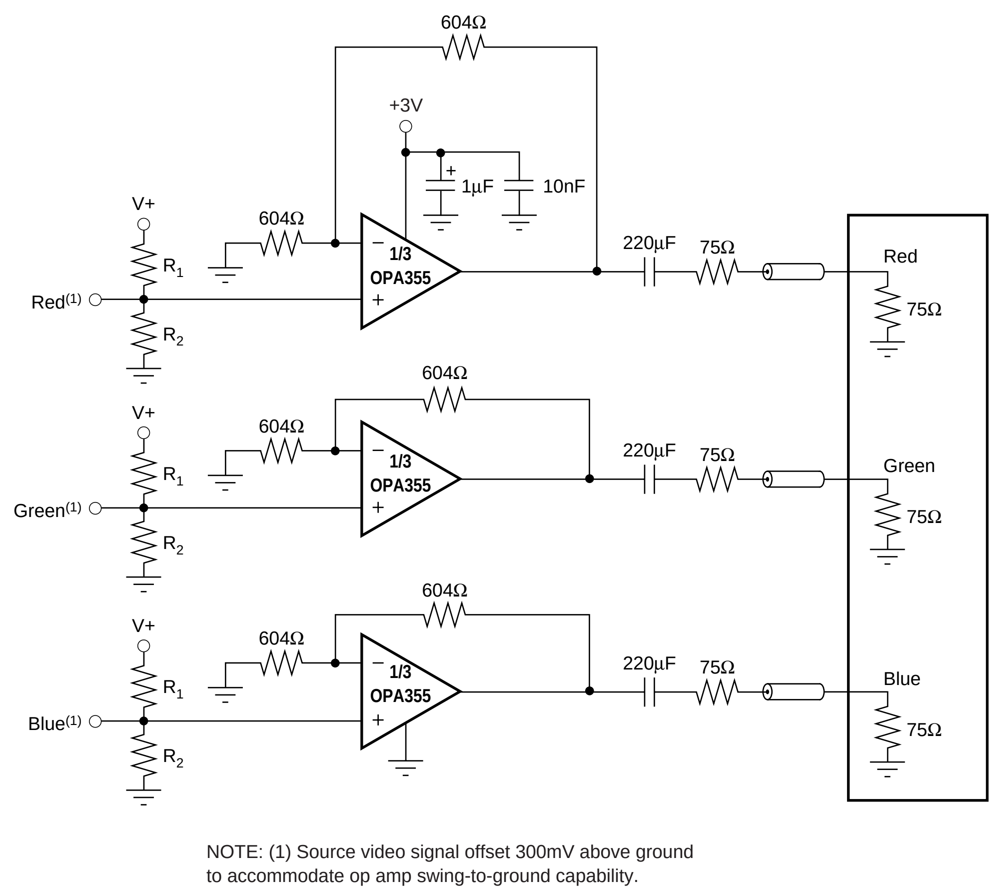


FIGURE 1. RGB Cable Driver.

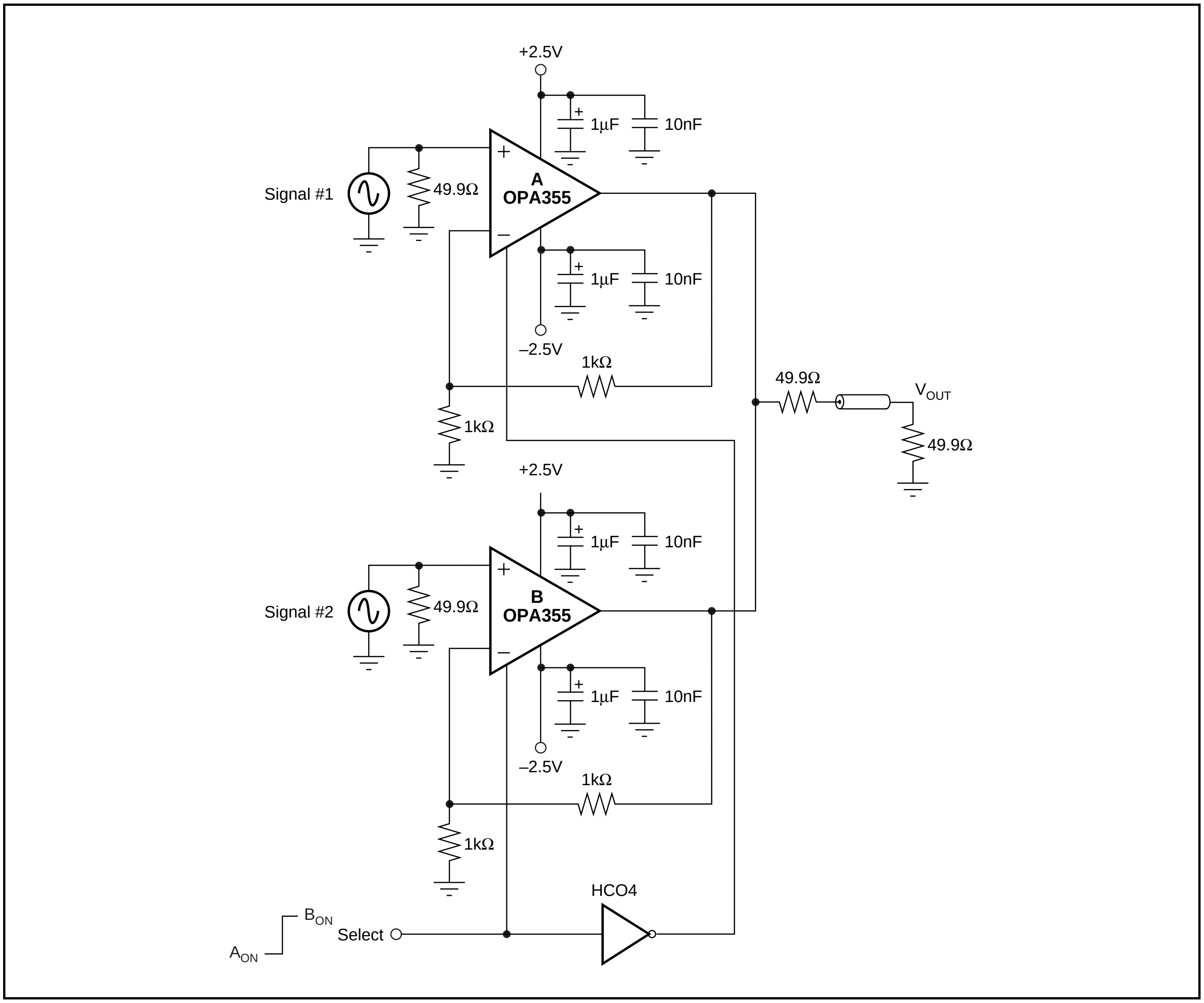


FIGURE 2. Multiplexed Output.

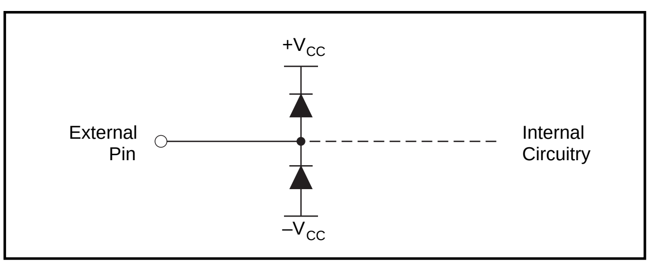


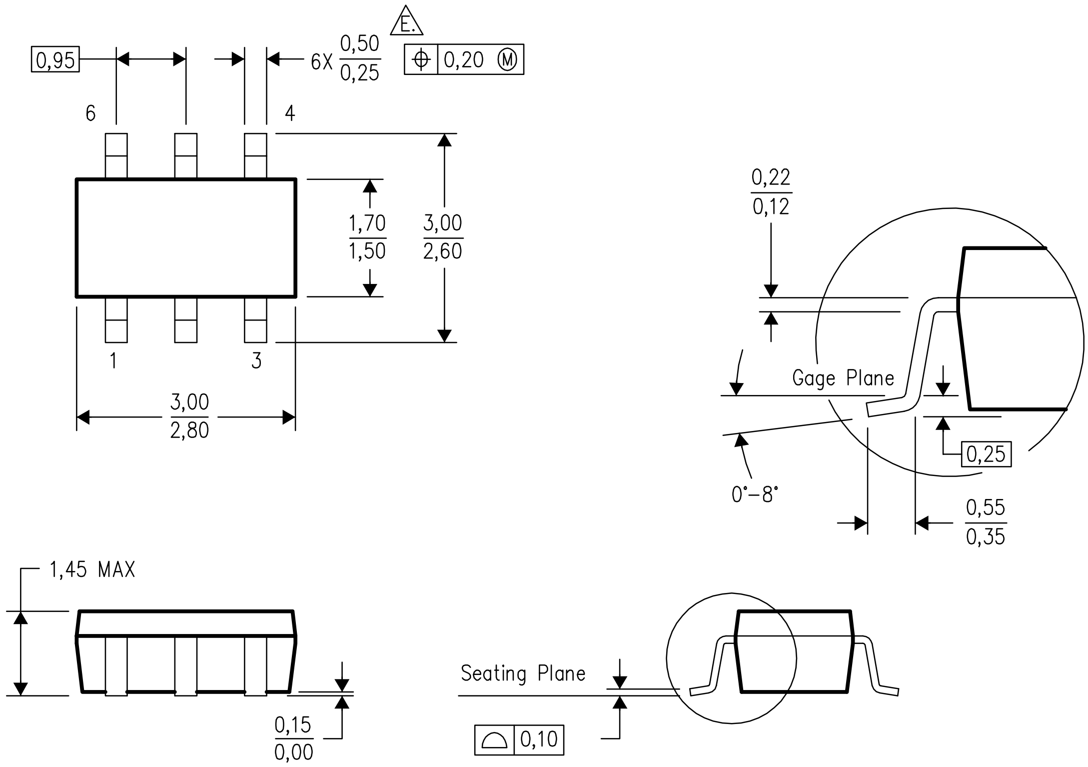
FIGURE 3. Internal ESD Protection.

PACKAGING INFORMATION

ORDERABLE DEVICE	STATUS(1)	PACKAGE TYPE	PACKAGE DRAWING	PINS	PACKAGE QTY
OPA2355DGSA/250	ACTIVE	VSSOP	DGS	10	250
OPA2355DGSA/2K5	ACTIVE	VSSOP	DGS	10	2500
OPA3355EA/250	ACTIVE	TSSOP	PW	14	250
OPA3355EA/2K5	ACTIVE	TSSOP	PW	14	2500
OPA3355UA	ACTIVE	SOIC	D	14	58
OPA3355UA/2K5	ACTIVE	SOIC	D	14	2500
OPA355NA/250	ACTIVE	SOP	DBV	6	250
OPA355NA/3K	ACTIVE	SOP	DBV	6	3000
OPA355UA	ACTIVE	SOIC	D	8	100
OPA355UA/2K5	ACTIVE	SOIC	D	8	2500

(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.

DBV (R-PDSO-G6) PLASTIC SMALL-OUTLINE PACKAGE



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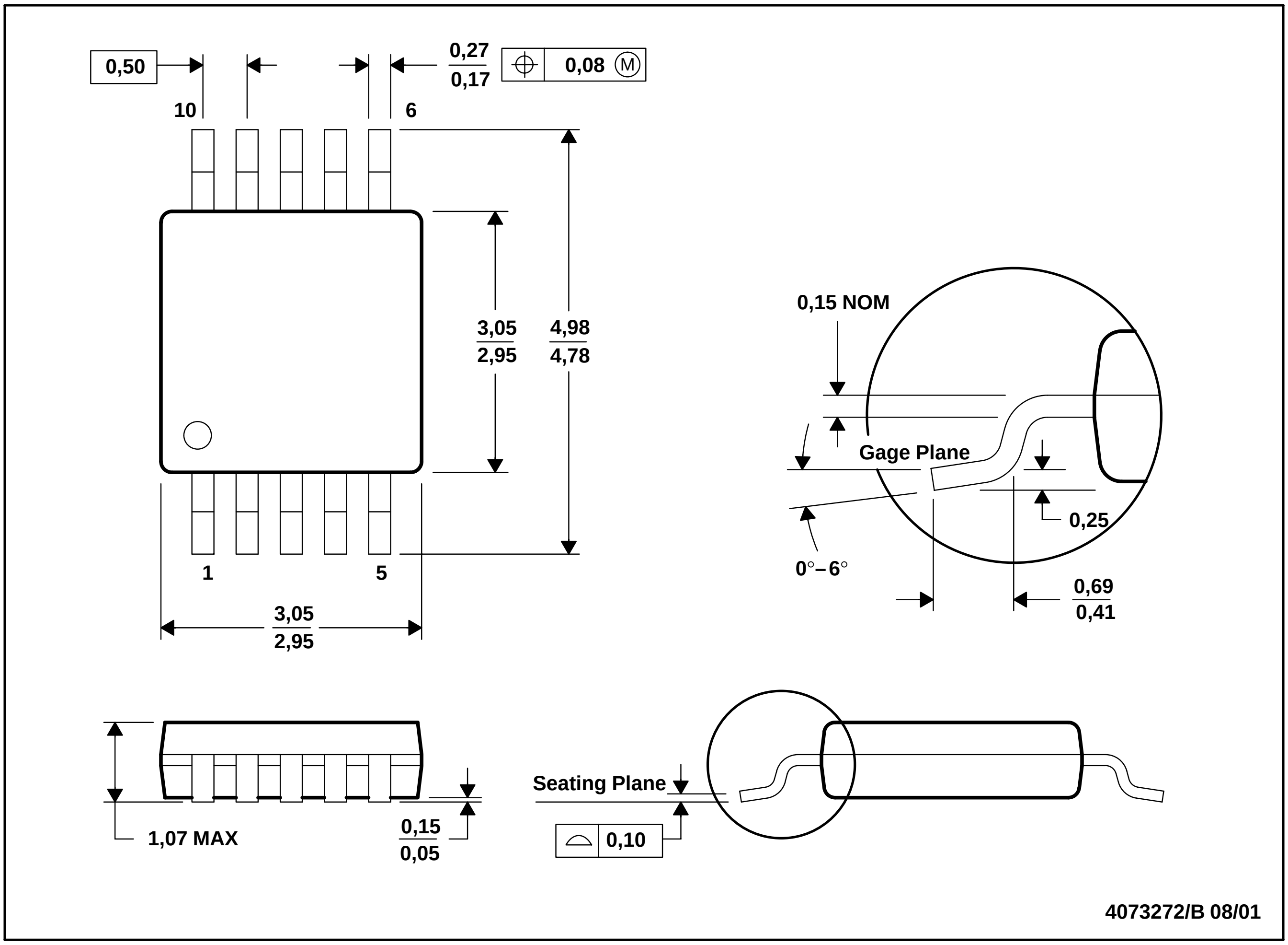
NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion.
- D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
- E. Falls within JEDEC MO-178 Variation AB, except minimum lead width.

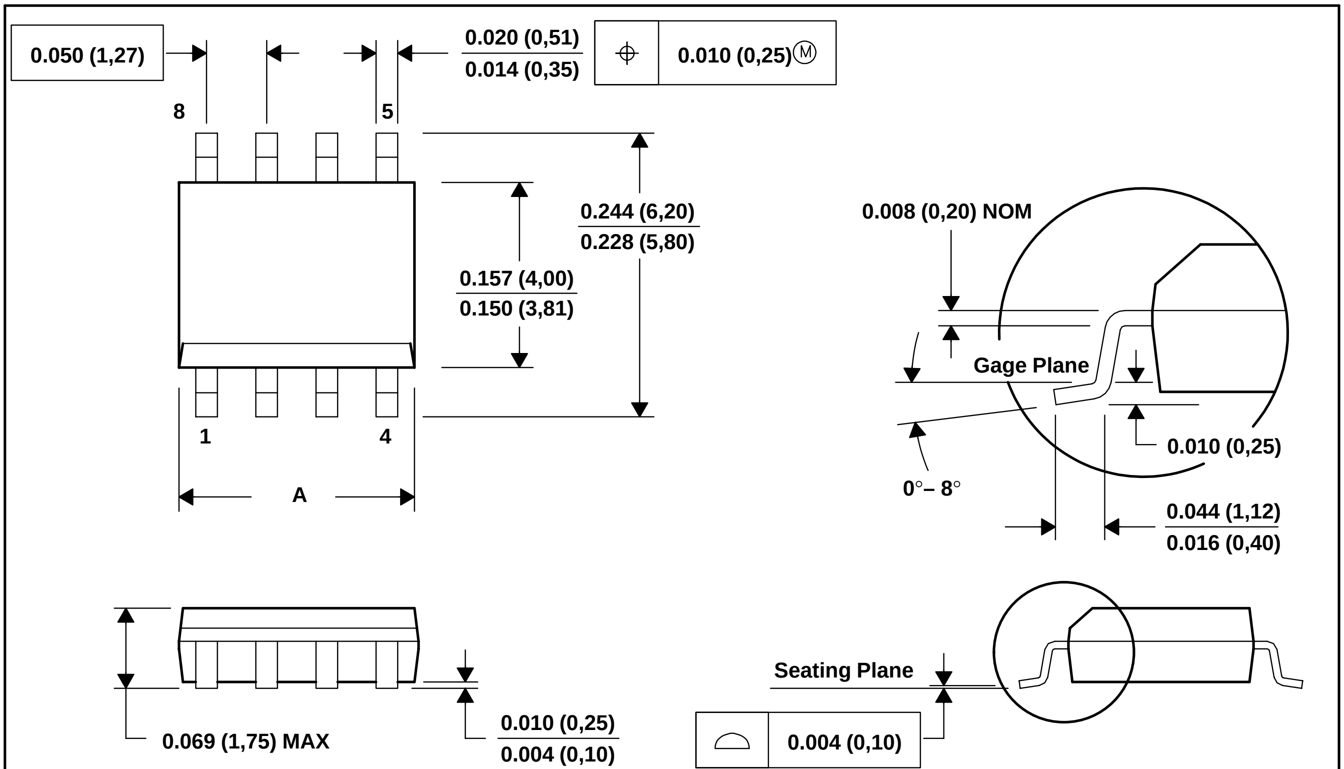
DGS (S-PDSO-G10) **PLASTIC SMALL-OUTLINE PACKAGE**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion.
D. Falls within JEDEC MO-187

D (R-PDSO-G**)   PLASTIC SMALL-OUTLINE PACKAGE

8 PINS SHOWN



DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

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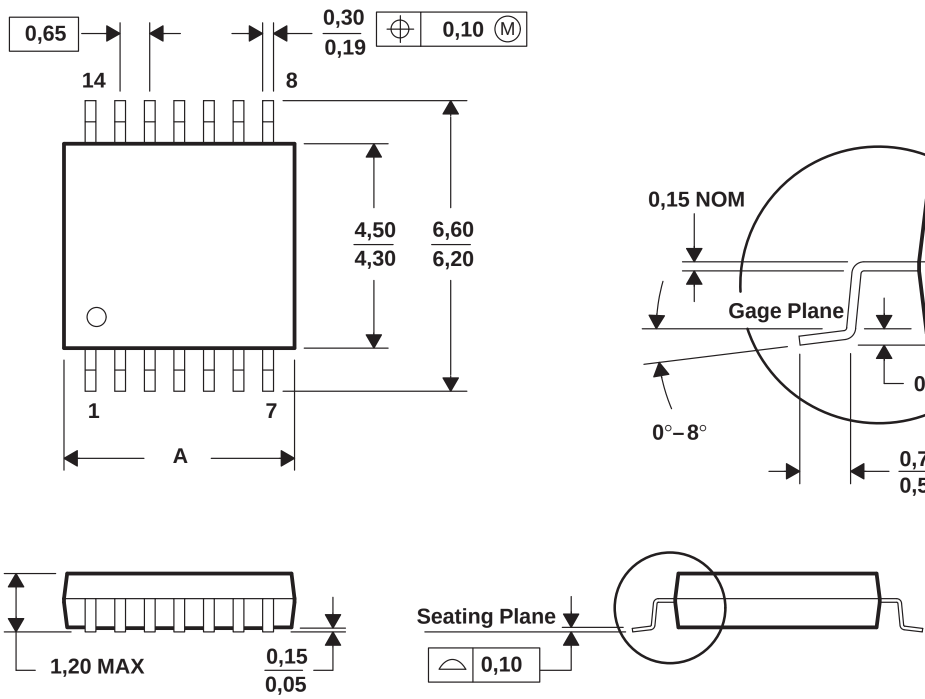
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PINS SHOWN



PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

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NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
- D. Falls within JEDEC MO-153

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Logic	logic.ti.com	Military	www.ti.com/military
Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
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