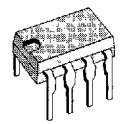
SGS-THOMSON MICROELECTRONICS

LF155 - LF255 - LF355
LF156 - LF256 - LF356
LF157 - LF257 - LF357

WIDE BANDWIDTH SINGLE J-FET OPERATIONAL AMPLIFIERS

- REPLACE HYBRID AND MODULE FET OP AMPs
- RUGGED J-FETs ALLOW BLOW-OUT FREE-HANDLING COMPARED WITH MOSFET INPUT DEVICES
- EXCELLENT FOR LOW NOISE APPLICATIONS USING EITHER HIGH OR LOW SOURCE IMPEDANCE (VERY LOW I/F CORNER)
- OFFSET VOLTAGE ADJUST DOES NOT DEGRADE DRIFT OR COMMON-MODE REJECTION AS IN MOST MONOLITHIC AMPLIFIERS
- INTERNAL COMPENSATION AND LARGE DIFFERENTIAL INPUT VOLTAGE CAPABILITY (UP TO V_{CC}^+)



N
DIP8
(Plastic Package)

D
SO8
(Plastic Micropackage)

H
TO99
(Metal Can)

TYPICAL APPLICATIONS

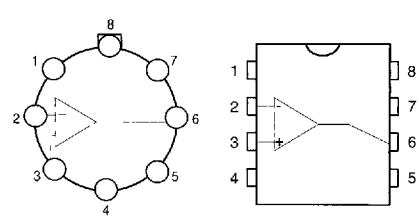
- PRECISION HIGH SPEED INTEGRATORS
- FAST D/A AND A/D CONVERTERS
- HIGH IMPEDANCE BUFFERS
- WIDEBAND, LOW NOISE, LOW DRIFT AMPLIFIERS
- LOGARITHMIC AMPLIFIERS
- PHOTOCELL AMPLIFIERS
- SAMPLE AND HOLD CIRCUITS

ORDER CODES

Part Number	Temperature Range	Package		
		H	N	D
LF355, LF356, LF357	0°C, +70°C	•	•	•
LF255, LF256, LF257	-40°C, +105°C	•	•	•
LF155, LF156, LF157	-55°C, +125°C	•	•	•
Examples : LF355N, LF155H				

155-01 TBL

PIN CONNECTIONS (top views)



1 - Offset null 1
2 - Inverting input
3 - Non-inverting input
4 - V_{CC}^-
5 - Offset null 2
6 - Output
7 - V_{CC}^+
8 - N.C.

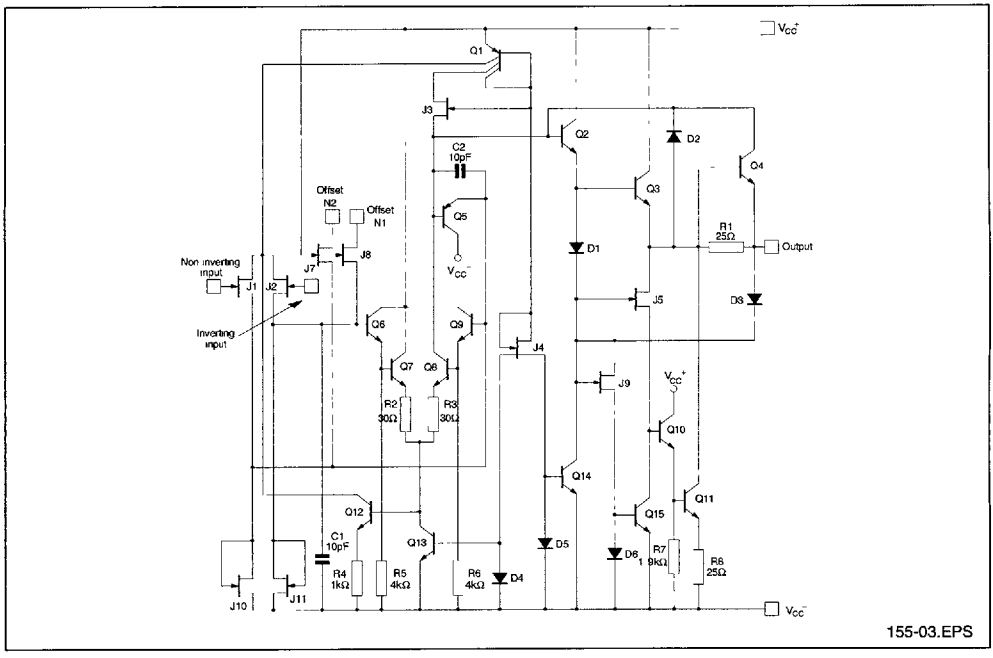
DESCRIPTION

These circuits are monolithic J-FET input operational amplifiers incorporating well matched, high voltage J-FET on the same chip with standard bipolar transistors.

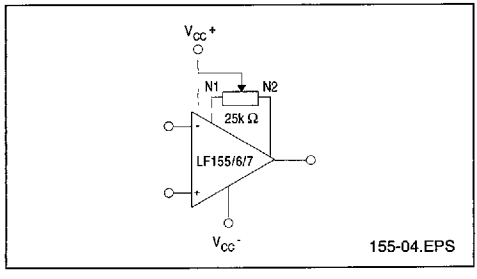
This amplifiers feature low input bias and offset currents, low input offset voltage and input offset voltage drift, coupled with offset adjust which does not degrade drift or common-mode rejection.

The devices are also designed for high slew rate, wide bandwidth, extremely fast settling time, low voltage and current noise and a low I/f noise corner.

SCHEMATIC DIAGRAM



V_{io} ADJUSTMENT



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
V_{CC}	Supply Voltage		±22	V
V_i	Input Voltage - (note 1)		±20	V
V_{id}	Differential Input Voltage		±40	V
P_{tot}	Power Dissipation		570	mW
	Output Short-circuit Duration		Infinite	
T_{oper}	Operating Free Air Temperature Range	LF155-LF156-LF157 LF255-LF256-LF257 LF355-LF356-LF357	–55 to +125 –40 to +105 0 to +70	°C
T_{stg}	Storage Temperature Range		–65 to 150	°C

155-02 TBL

ELECTRICAL CHARACTERISTICS

LF155, LF156, LF157 $-55^{\circ}C \leq T_{amb} \leq +125^{\circ}C$ $\pm 15V \leq V_{CC} \leq \pm 20V$
LF255, LF256, LF257 $-40^{\circ}C \leq T_{amb} \leq +105^{\circ}C$ $\pm 15V \leq V_{CC} \leq \pm 20V$
(unless otherwise specified)

Symbol	Parameter	LF155 - LF156 - LF157 LF255 - LF256 - LF257			Unit
		Min.	Typ.	Max.	
V_{io}	Input Offset Voltage ($R_S = 50\Omega$) $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$ LF155, LF156, LF157 LF255, LF256, LF257		3	5 7 6.5	mV
I_{io}	Input Offset Current - (note 3) $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$ LF155, LF156, LF157 LF255, LF256, LF257		3	20 20 1	pA nA nA
I_{ib}	Input Bias Current - (note 3) $T_{amb} = 25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$ LF155, LF156, LF157 LF255, LF256, LF257		20	100 50 5	pA nA nA
A_{vd}	Large Signal Voltage Gain ($R_L = 2k\Omega$, $V_o = \pm 10V$, $V_{CC} = \pm 15V$) $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	50 25	200		V/mV
SVR	Supply Voltage Rejection Ratio - (note 4)	85	100		dB
I_{CC}	Supply Current, ($V_{CC} = \pm 15V$, no load) $T_{amb} = +25^{\circ}C$ LF155, LF255 LF156, LF256 LF157, LF257		2 5 5	4 7 7	mA
DV_{io}	Input Offset Voltage Drift ($R_S = 50\Omega$)		5		$\mu V/^{\circ}C$
DV_{io}/V_{io}	Change in Average Temperature Coefficient with V_{IO} adjust ($R_S = 50\Omega$) - (note 2)		0.5		$\mu V/^{\circ}C$ per mV
V_{icm}	Input Common Mode Voltage Range ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$)	± 11	+15.1 -12		V
CMR	Common Mode Rejection Ratio	85	100		dB
$\pm V_{OPP}$	Output Voltage Swing ($V_{CC} = \pm 15V$) $R_L = 10k\Omega$ $R_L = 2k\Omega$	± 12 ± 10	± 13 ± 12		V
GBP	Gain Bandwidth Product ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$) LF155, LF255 LF156, LF256 LF157, LF257		2.5 5 20		MHz
SR	Slew Rate ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$) $A_V = 1$ LF155, LF255 LF156, LF256 $A_V = 5$ LF157, LF257	 7.5 30	 5 12 50		V/µs
R_i	Input Resistance ($T_{amb} = +25^{\circ}C$)		10^{12}		Ω
C_i	Input Capacitance ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$)		3		pF
e_n	Equivalent Input Noise Voltage ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$, $R_S = 100\Omega$) f = 1000Hz LF155, LF255 LF156, LF256 LF157, LF257 f = 100Hz LF155, LF255 LF156, LF256 LF157, LF257		 20 12 12 25 15 15		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent Input Noise Current ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$, f = 100Hz or f = 1000Hz)		0.01		$\frac{pA}{\sqrt{Hz}}$
t_s	Settling Time ($V_{CC} = \pm 15V$, $T_{amb} = 25^{\circ}C$) - (note 5) LF155, LF255 LF156, LF256 LF157, LF257		 4 1.5 1.5		µs

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ELECTRICAL CHARACTERISTICS

LF355, LF356, LF357 $0°C \leq T_{amb} \leq +70°C$ $V_{CC} = \pm 15V$

(unless otherwise specified)

Symbol	Parameter		LF355 - LF356 - LF357 Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage ($R_S = 50\Omega$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$			3	10 13	mV
I_{io}	Input Offset Current - (note 3) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$			3	50 2	pA nA
I_{ib}	Input Bias Current - (note 3) $T_{amb} = 25°C$ $T_{min} \leq T_{amb} \leq T_{max}$			20	200 8	pA nA
A_{vd}	Large Signal Voltage Gain ($R_L = 2k\Omega$, $V_o = \pm 10V$) $T_{amb} = +25°C$ $T_{min} \leq T_{amb} \leq T_{max}$		25 15	200		V/mV
SVR	Supply Voltage Rejection Ratio - (note 4)		80	100		dB
I_{CC}	Supply Current, no Load $T_{amb} = 25°C$	LF355 LF356, LF357		2 5	4 10	mA
DV_{io}	Input Offset Voltage Drift ($R_S = 50\Omega$) - (note 2)			5		µV/°C
DV_{io}/V_{io}	Change in Average Temperature Coefficient with V_{IO} adjust ($R_S = 50\Omega$)			0.5		µV/°C per mV
V_{icm}	Input Common Mode Voltage Range ($T_{amb} = 25°C$)		±10	+15.1 -12		V
CMR	Common Mode Rejection Ratio		80	100		dB
$\pm V_{OPP}$	Output Voltage Swing	$R_L = 10k\Omega$ $R_L = 2k\Omega$	±12 ±10	±13 ±12		V
GBP	Gain Bandwidth Product ($T_{amb} = 25°C$)	LF355 LF356 LF357		2.5 5 20		MHz
SR	Slew Rate ($T_{amb} = 25°C$) $A_V = 1$ $A_V = 5$	 LF355 LF356 LF357		 5 12 50		V/µs
R_i	Input Resistance ($T_{amb} = +25°C$)			10^{12}		Ω
C_i	Input Capacitance ($T_{amb} = 25°C$)			3		pF
e_n	Equivalent Input Noise Voltage ($T_{amb} = 25°C$, $R_S = 100\Omega$) f = 1000Hz f = 100Hz	 LF355 LF356, LF357 LF355 LF356, LF357		 20 12 25 15		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent Input Noise Current ($T_{amb} = 25°C$, f = 100Hz or f = 1000Hz)			0.01		$\frac{pA}{\sqrt{Hz}}$
t_s	Settling Time ($T_{amb} = 25°C$) - (note 5)	LF355 LF356, LF357		4 1.5		µs

155-04.TBL

Notes :

1. Unless otherwise specified the absolute maximum negative input voltage is equal to the negative power supply voltage.
2. The temperature coefficient of the adjusted input offset voltage changes only a small amount (0.5µV/°C typically) for each mV of adjustment from its original unadjusted value. Common-mode rejection and open loop voltage gain are also unaffected by offset adjustment.
3. The input bias currents are junction leakage currents which approximately double for every 10°C increase in the junction temperature T_{amb}. Due to limited production test time, the input bias current measured is correlated to junction temperature. In a normal operation the junction temperature rises above the ambient temperature as a result of internal power dissipation, P_{tot}. $T_{amb} = T_{amb} + R_{th(j-a)} \times P_{tot}$ where $R_{th(j-a)}$ is the thermal resistance from junction to ambient. Use of a heatsink is recommended if input currents are to be kept to a minimum.
4. Supply voltage rejection is measured for both supply magnitudes increasing or decreasing simultaneously, in accordance with common practise.
5. Settling time is defined here, for a unity gain inverter connection using 2kΩ resistors for the LF155, LF156 series. It is the time required for the error voltage (the voltage at the inverting input pin on the amplifier) to settle to within 0.01% of its final value from the time a 10V step input is applied to the inverter. For the LF157 series $A_V = -5$, the feedback resistor from output to input is 2kΩ and the output step is 10V.

APPLICATION HINTS

The LF155, LF156, LF157 series are op amps with J-FET input transistors. These JFETs have large reverse breakdown voltages from gate to source or drain eliminating the need of clamps across the inputs. Therefore large differential input voltages can easily be accommodated without a large increase of input currents. The maximum differential input voltage is independent of the supply voltage. However, neither of the negative input voltages should be allowed to exceed the negative supply as this will cause large currents to flow which can result in a destroyed unit.

Exceeding the negative common-mode limit on either input will cause a reversal of the phase to the output and force the amplifier output to the corresponding high or low state. Exceeding the negative common-mode limit on both inputs will force the amplifier output to a high state. In neither case does a latch occur since raising the input back within the common-mode range again puts the input stage and thus the amplifier in a normal operating mode.

Exceeding the positive common-mode limit on a single input will not change the phase of the output however, if both inputs exceed the limit, the output of the amplifier will be forced to a high state.

These amplifiers will operate with the common-mode input voltage equal to the positive supply. In fact, the common-mode voltage can exceed the positive supply by approximately 100 mV independent of supply voltage and over the full operating temperature range. The positive suplly can therefore be used as a reference on an input as, for example, in a supply current monitor and/or limiter.

Precautions should be taken to ensure that the power supply for the integrated circuit never becomes reversed in polarity or that the unit is not inadvertently installed backwards in a socket as an unilimited current surge through the resulting forward diode within the IC could cause fusing of the internal conductors and result in a destroyed unit.

Because these amplifiers are JFET rather than MOS-FET input op amps they do not require special handling.

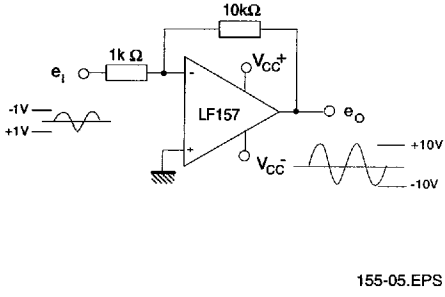
All of the bias currents in these amplifiers are set by FET current sources. The drain currents for the amplifiers are therefore essentially independent of supply voltages.

As with most amplifiers, care should be taken with lead dress, components placement and supply decoupling in order to ensure stability. For example, resistors from the output to an input should be placed with the body close to the input to minimiz "pickup" and maximize the frequency of the feedback pole by minimizing the capacitance from the input to ground.

A feedback pole is created when the feedback around any amplifier is resistive. The parallel resistance and capacitance from the input of the device (usually the inverting input) to ac ground set the frequency of the pole. In many instances the frequency of this pole is much greater than the expected 3 dB frequency of the closed loop gain and consequently there is negligible effect on stability margin. However, if the feedback pole is less than approximately six time the expected 3 dB frequency a lead capacitor should be placed from the output to the input of the op amp. The value of that added capacitor should be such that the RC time constant of this capacitor and the resistance it parallels is greater than or equal to the original feedback pole time constant.

TYPICAL CIRCUITS

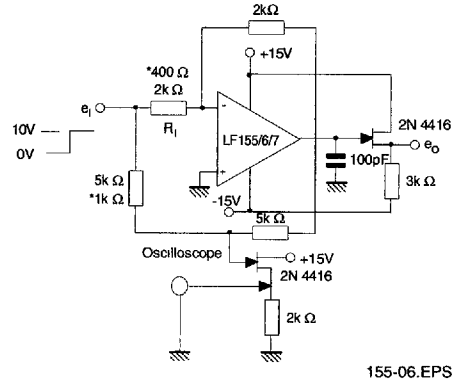
LARGE POWER BW AMPLIFIER



155-05.EPS

For distortion < 1% and a 20 V_{PP} V_O swing, power bandwidth is : 500kHz.

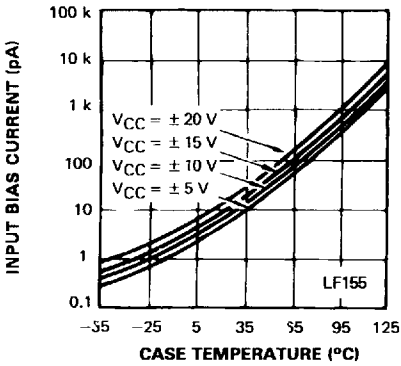
SETTLING TIME TEST CIRCUIT



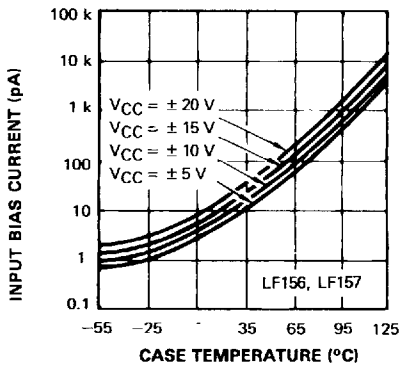
155-06.EPS

Settling time is tested with the LF155, LF156 connected as unity gain converter R_i = 2kΩ and LF157 connected for A_V = -5, R_i = 0.4kΩ

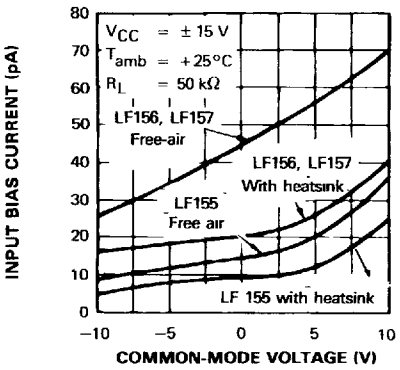
INPUT BIAS CURRENT



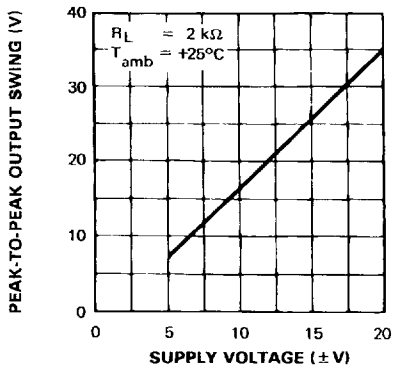
INPUT BIAS CURRENT



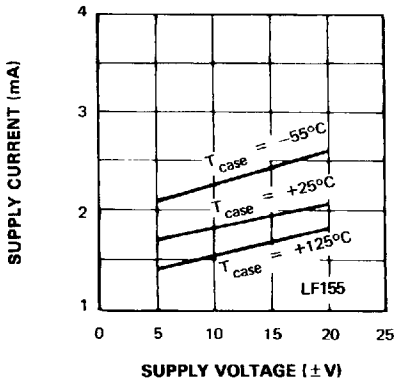
INPUT BIAS CURRENT



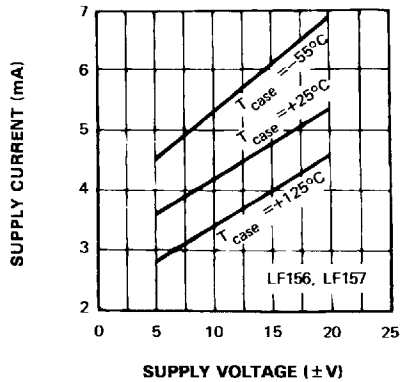
VOLTAGE SWING



SUPPLY CURRENT

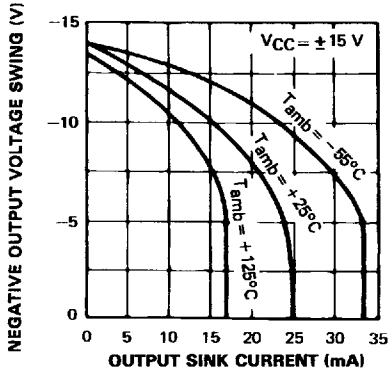


SUPPLY CURRENT

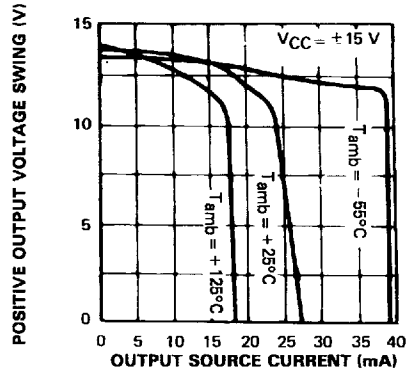


155-07.EPS

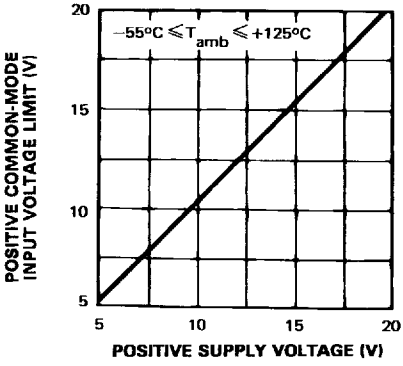
MAXIMUM NEGATIVE CURRENT



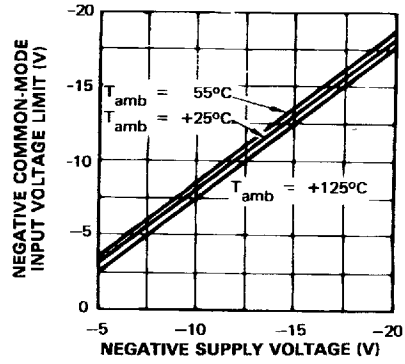
MAXIMUM POSITIVE CURRENT



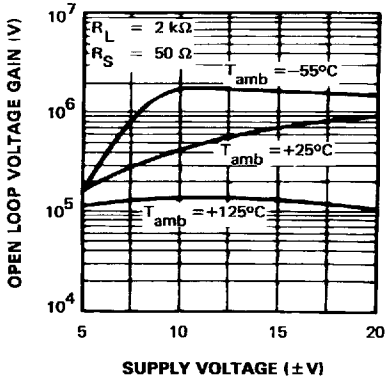
MAXIMUM POSITIVE COMMON-MODE INPUT VOLTAGE



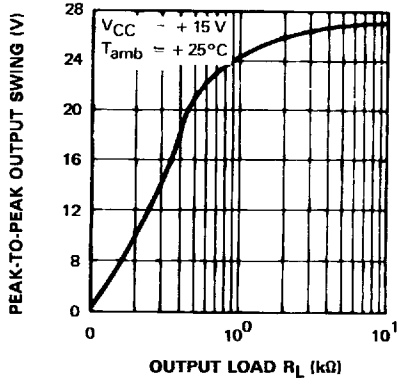
MAXIMUM NEGATIVE COMMON-MODE INPUT VOLTAGE



OPEN LOOP VOLTAGE GAIN

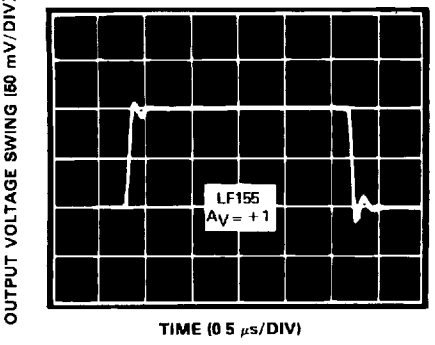


OUTPUT VOLTAGE SWING

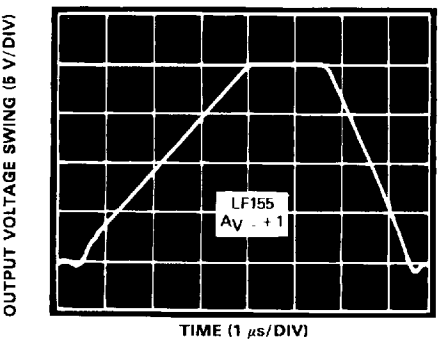


155-08 EPS

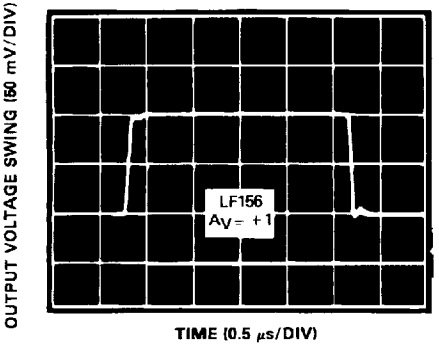
SMALL SIGNAL PULSE RESPONSE



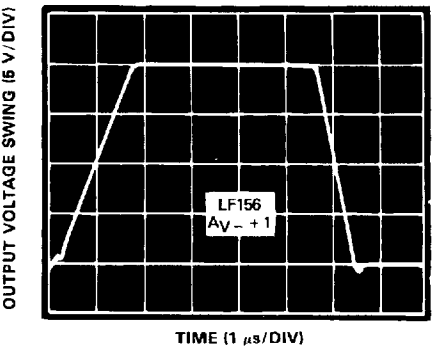
LARGE SIGNAL PULSE RESPONSE



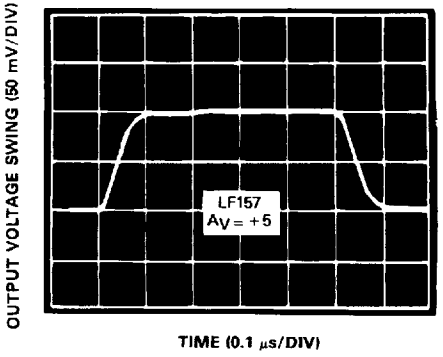
SMALL SIGNAL PULSE RESPONSE



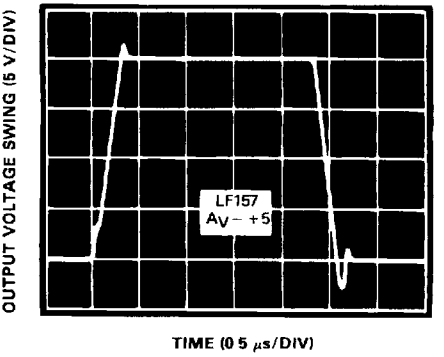
LARGE SIGNAL PULSE RESPONSE



SMALL SIGNAL PULSE RESPONSE

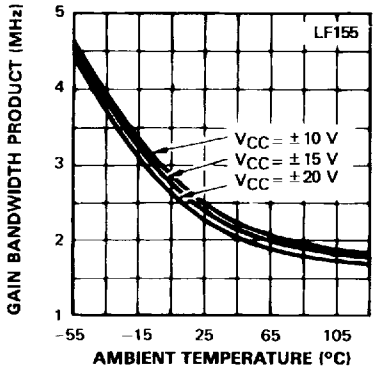


LARGE SIGNAL PULSE RESPONSE

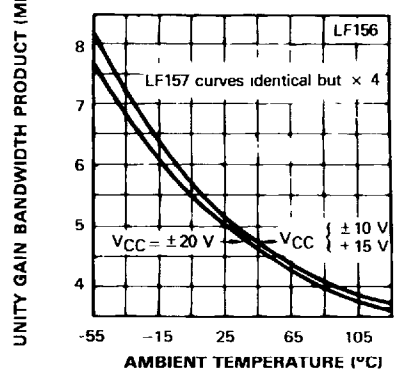


155-09 EPS

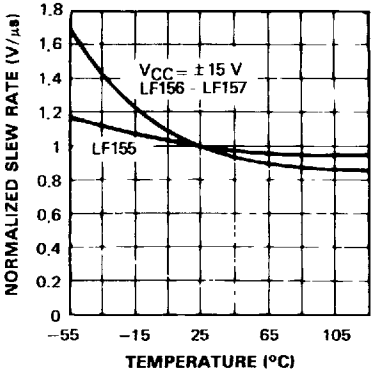
GAIN BANDWIDTH PRODUCT



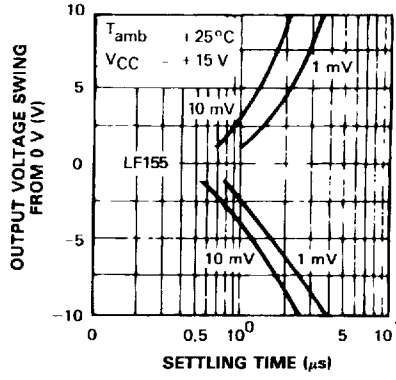
GAIN BANDWIDTH PRODUCT



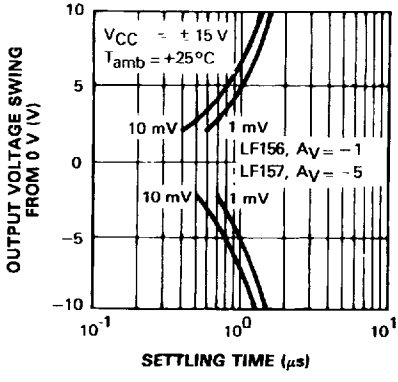
NORMALIZED SLEW RATE



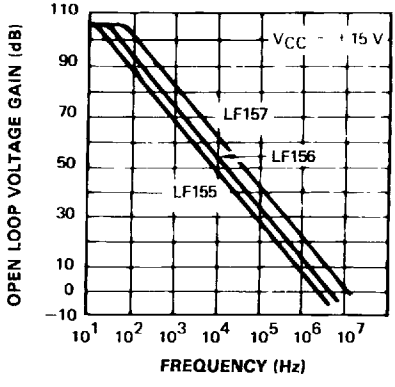
INVERTER SETTLING TIME



INVERTER SETTLING TIME

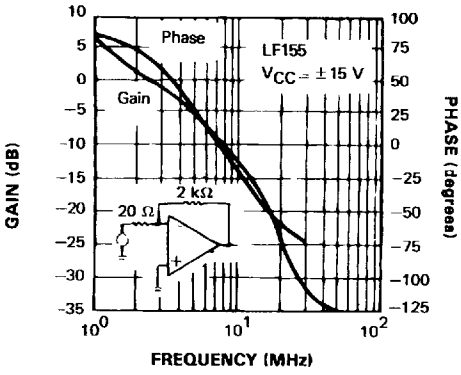


OPEN LOOP FREQUENCY RESPONSE

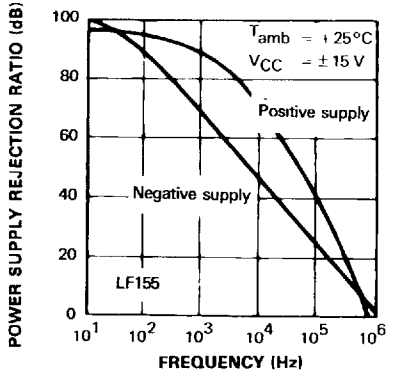


155-10.EPS

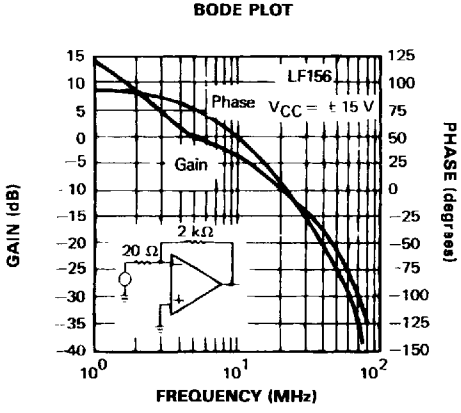
BODE PLOT



POWER SUPPLY REJECTION RATIO



BODE PLOT



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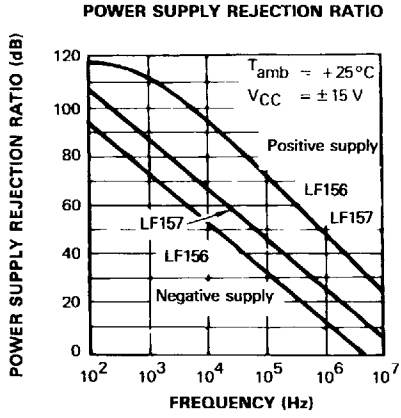
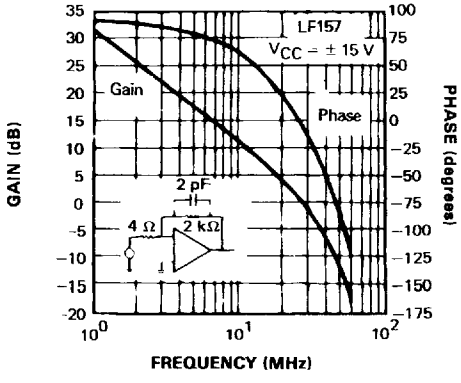
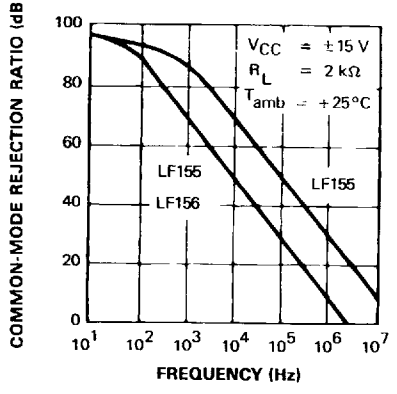


BODE PLOT

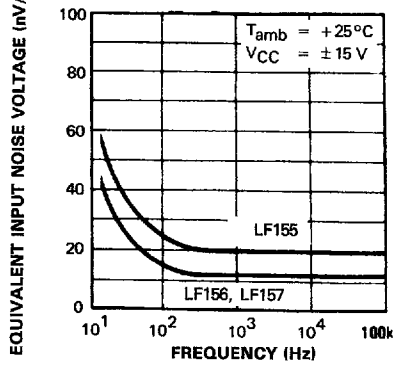


COMMON-MODE REJECTION RATIO

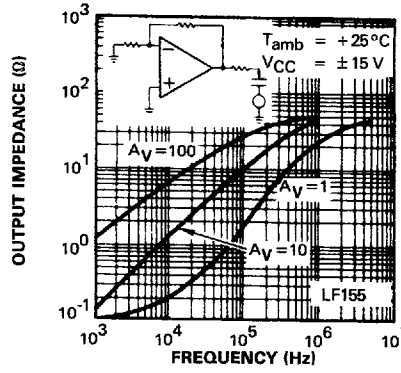


155-11.EPS

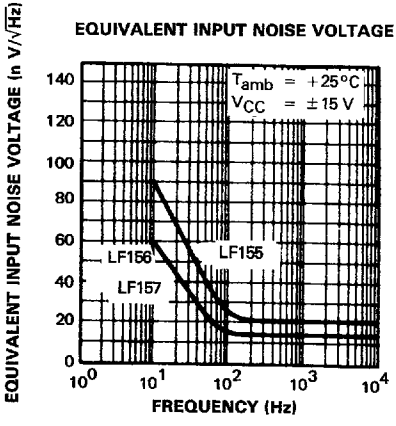
EQUIVALENT INPUT NOISE VOLTAGE (EXPANDED SCALE)



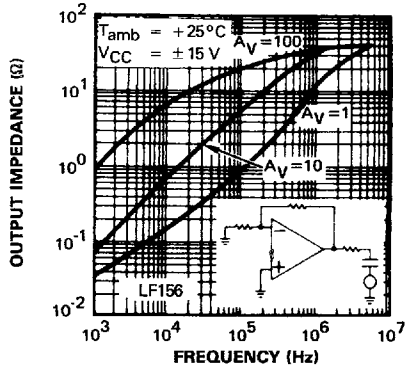
OUTPUT IMPEDANCE



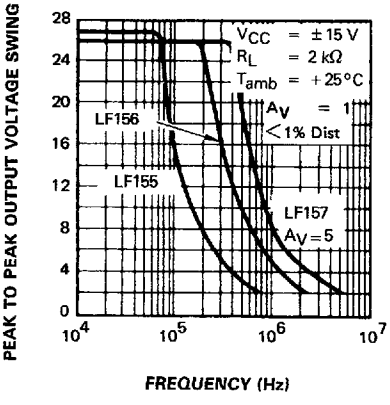
EQUIVALENT INPUT NOISE VOLTAGE



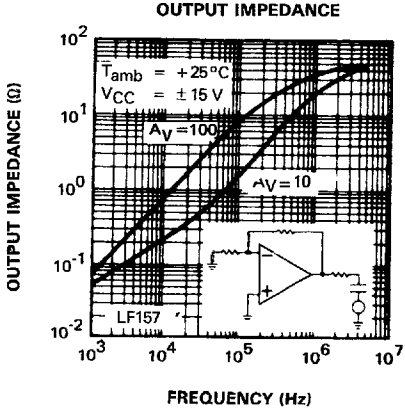
OUTPUT IMPEDANCE



UNDISTORTED OUTPUT VOLTAGE SWING



OUTPUT IMPEDANCE



155-12 EPS