- **Supply Current . . . 300 μA Max**
- **High Unity-Gain Bandwidth . . . 2 MHz Typ**
- **High Slew Rate . . . 0.45 V/μs Min**
- **Supply-Current Change Over Military Temp Range . . . 10 μA Typ at $V_{CC\pm} = \pm 15$ V**
- **Specified for Both 5-V Single-Supply and ±15-V Operation**
- **Phase-Reversal Protection**
- **High Open-Loop Gain . . . 6.5 V/μV (136 dB) Typ**
- **Low Offset Voltage . . . 100 μV Max**
- **Offset Voltage Drift With Time 0.005 μV/mo Typ**
- **Low Input Bias Current . . . 50 nA Max**
- **Low Noise Voltage . . . 19 nV/$\sqrt{\text{Hz}}$ Typ**

description

The TLE202x, TLE202xA, and TLE202xB devices are precision, high-speed, low-power operational amplifiers using a new Texas Instruments Excalibur process. These devices combine the best features of the OP21 with highly improved slew rate and unity-gain bandwidth.

The complementary bipolar Excalibur process utilizes isolated vertical pnp transistors that yield dramatic improvement in unity-gain bandwidth and slew rate over similar devices.

The addition of a bias circuit in conjunction with this process results in extremely stable parameters with both time and temperature. This means that a precision device remains a precision device even with changes in temperature and over years of use.

This combination of excellent dc performance with a common-mode input voltage range that includes the negative rail makes these devices the ideal choice for low-level signal conditioning applications in either single-supply or split-supply configurations. In addition, these devices offer phase-reversal protection circuitry that eliminates an unexpected change in output states when one of the inputs goes below the negative supply rail.

A variety of available options includes small-outline and chip-carrier versions for high-density systems applications.

The C-suffix devices are characterized for operation from 0°C to 70°C. The I-suffix devices are characterized for operation from –40°C to 85°C. The M-suffix devices are characterized for operation over the full military temperature range of –55°C to 125°C.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

TLE2021 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES						CHIP FORM§ (Y)
		SMALL OUTLINE† (D)	SSOP‡ (DB)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP‡ (PW)	
0°C to 70°C	200 µV 500 µV	TLE2021ACD TLE2021CD	TLE2021CDBLE	—	—	TLE2021ACP TLE2021CP	— TLE2021CPWLE	— TLE2021Y
–40°C to 85°C	200 µV 500 µV	TLE2021AID TLE2021ID	—	—	—	TLE2021AIP TLE2021IP	—	—
–55°C to 125°C	100 µV 200 µV 500 µV	— TLE2021AMD TLE2021MD	—	TLE2021BMFK TLE2021AMFK TLE2021MFK	TLE2021BMJG TLE2021AMJG TLE2021MJG	— TLE2021AMP TLE2021MP	—	—

† The D packages are available taped and reeled. To order a taped and reeled part, add the suffix R (e.g., TLE2021CDR).
‡ The DB and PW packages are only available left-end taped and reeled.
§ Chip forms are tested at 25°C only.

TLE2022 AVAILABLE OPTIONS

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES						CHIP FORM§ (Y)
		SMALL OUTLINE† (D)	SSOP‡ (DB)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)	TSSOP‡ (PW)	
0°C to 70°C	150 µV 300 µV 500 µV	TLE2022BCD TLE2022ACD TLE2022CD	— — TLE2022CDBLE	—	—	— TLE2022ACP TLE2022CP	— — TLE2022CPWLE	— — TLE2022Y
–40°C to 85°C	150 µV 300 µV 500 µV	TLE2022BID TLE2022AID TLE2022ID	—	—	—	— TLE2022AIP TLE2022IP	—	—
–55°C to 125°C	150 µV 300 µV 500 µV	— TLE2022AMD TLE2022MD	—	— TLE2022AMFK TLE2022MFK	TLE2022BMJG TLE2022AMJG TLE2022MJG	— TLE2022AMP TLE2022MP	—	—

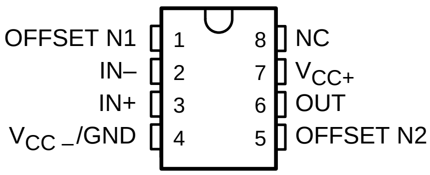
† The D packages are available taped and reeled. To order a taped and reeled part, add the suffix R (e.g., TLE2022CDR).
‡ The DB and PW packages are only available left-end taped and reeled.
§ Chip forms are tested at 25°C only.

TLE2024 AVAILABLE OPTIONS

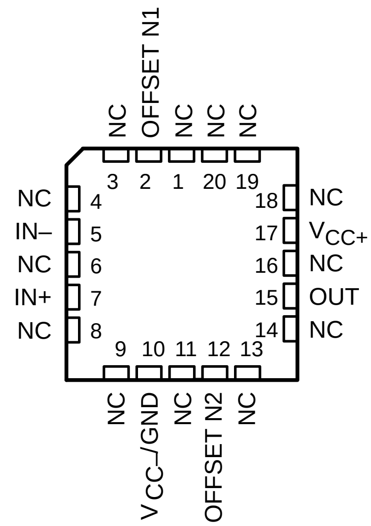
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES				CHIP FORM§ (Y)
		SMALL OUTLINE (DW)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	
0°C to 70°C	500 µV 750 µV 1000 µV	TLE2024BCDW TLE2024ACDW TLE2024CDW	—	—	TLE2024BCN TLE2024ACN TLE2024CN	— — TLE2024Y
–40°C to 85°C	500 µV 750 µV 1000 µV	TLE2024BIDW TLE2024AIDW TLE2024IDW	—	—	TLE2024BIN TLE2024AIN TLE2024IN	—
–55°C to 125°C	500 µV 750 µV 1000 µV	TLE2024BMDW TLE2024AMDW TLE2024MDW	TLE2024BMFK TLE2024AMFK TLE2024MFK	TLE2024BMJ TLE2024AMJ TLE2024MJ	TLE2024BMN TLE2024AMN TLE2024MN	—

§ Chip forms are tested at 25°C only.

TLE2021
D, DB, JG, P, OR PW PACKAGE
(TOP VIEW)

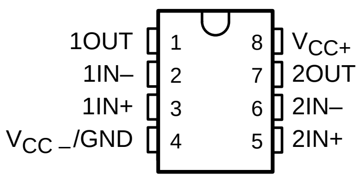


TLE2021
FK PACKAGE
(TOP VIEW)

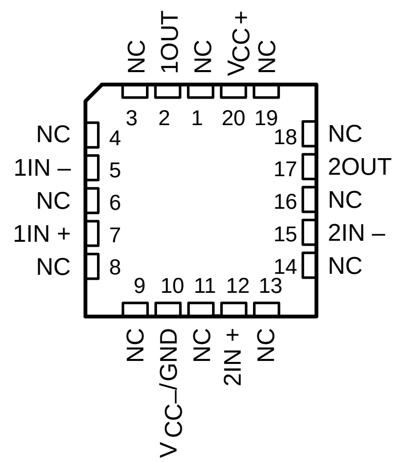


NC – No internal connection

D, DB, JG, P, OR PW PACKAGE
(TOP VIEW)

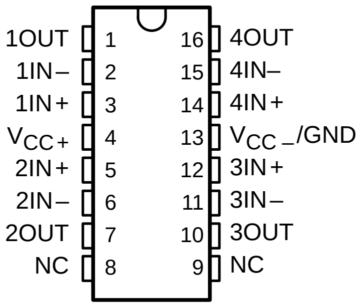


FK PACKAGE
(TOP VIEW)

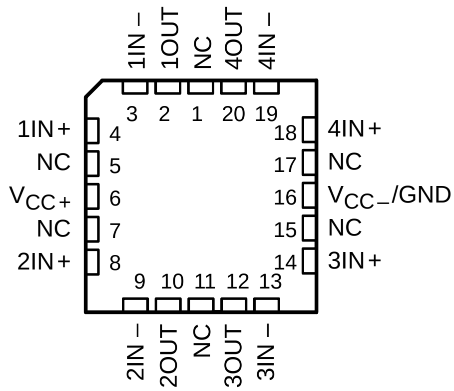


NC – No internal connection

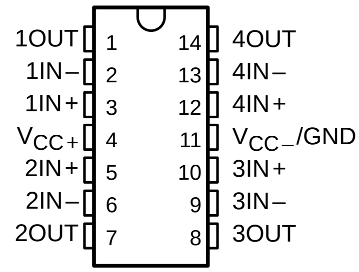
DW PACKAGE (TOP VIEW)



FK PACKAGE (TOP VIEW)



J OR N PACKAGE (TOP VIEW)

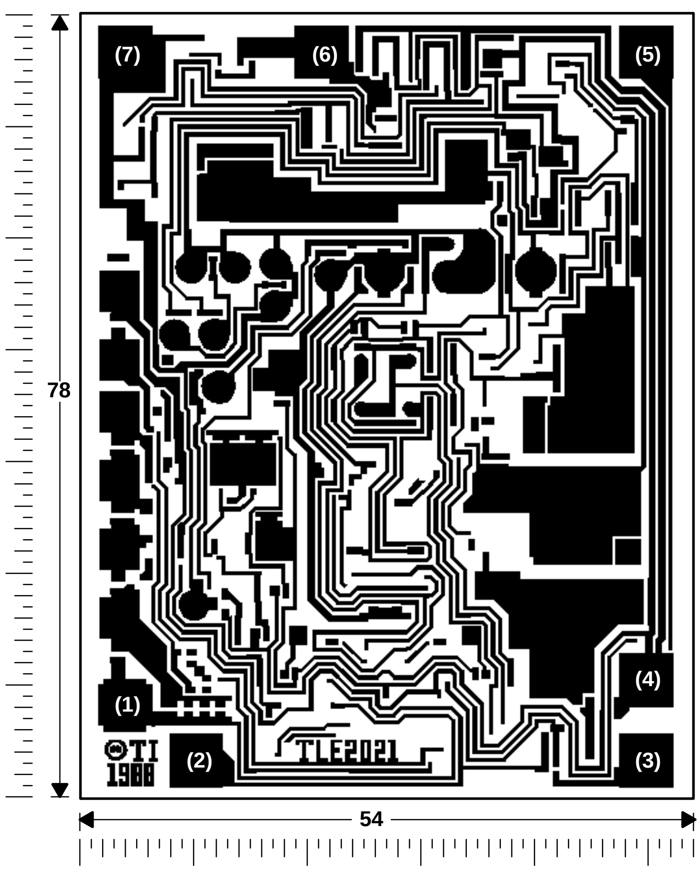


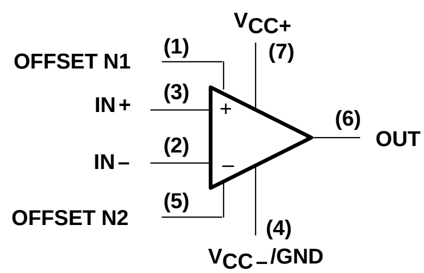
NC – No internal connection

TLE2021Y chip information

This chip, when properly assembled, display characteristics similar to the TLE2021. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 MILS TYPICAL

BONDING PADS: 4 × 4 MILS MINIMUM

T_{Jmax} = 150°C

TOLERANCES ARE ±10%.

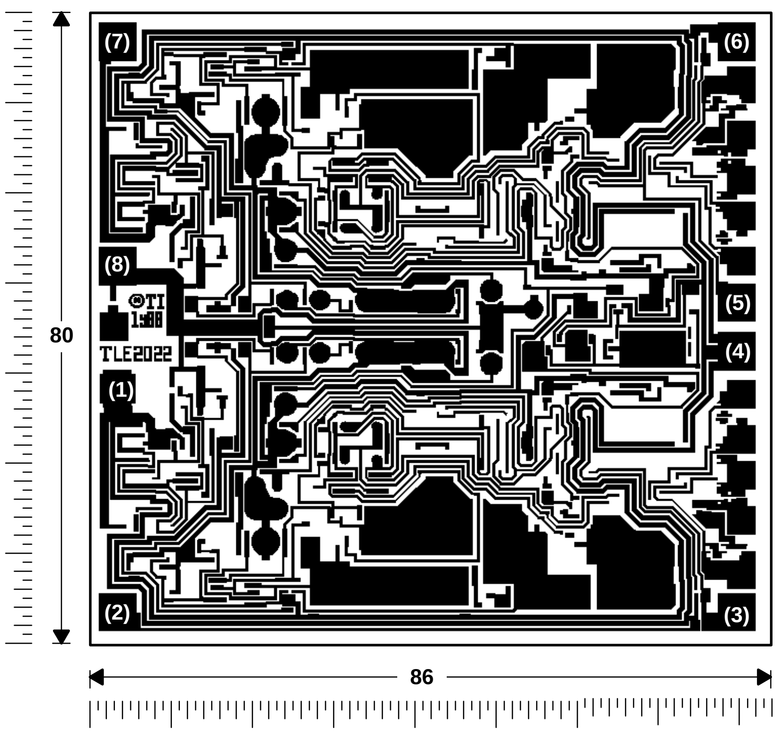
ALL DIMENSIONS ARE IN MILS.

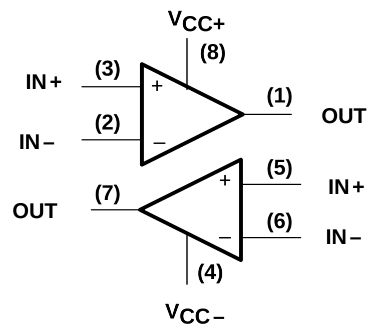
PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

TLE2022Y chip information

This chip, when properly assembled, displays characteristics similar to TLE2022. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 MILS TYPICAL

BONDING PADS: 4 × 4 MILS MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%.

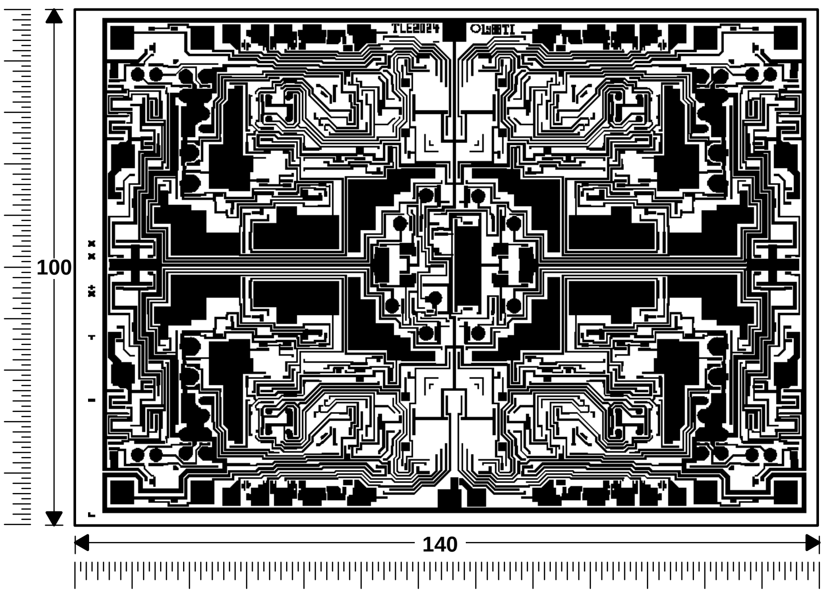
ALL DIMENSIONS ARE IN MILS.

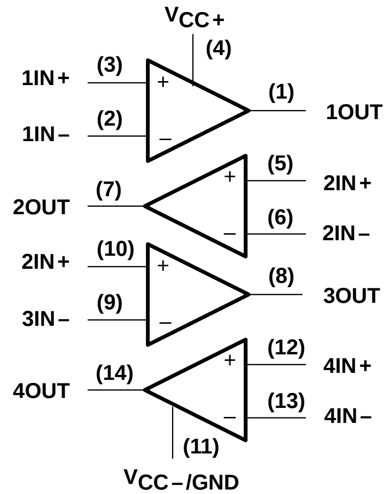
PIN (4) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

TLE2024Y chip information

This chip, when properly assembled, displays characteristics similar to the TLE2024. Thermal compression or ultrasonic bonding may be used on the doped aluminum-bonding pads. This chip may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





CHIP THICKNESS: 15 MILS TYPICAL

BONDING PADS: 4 × 4 MILS MINIMUM

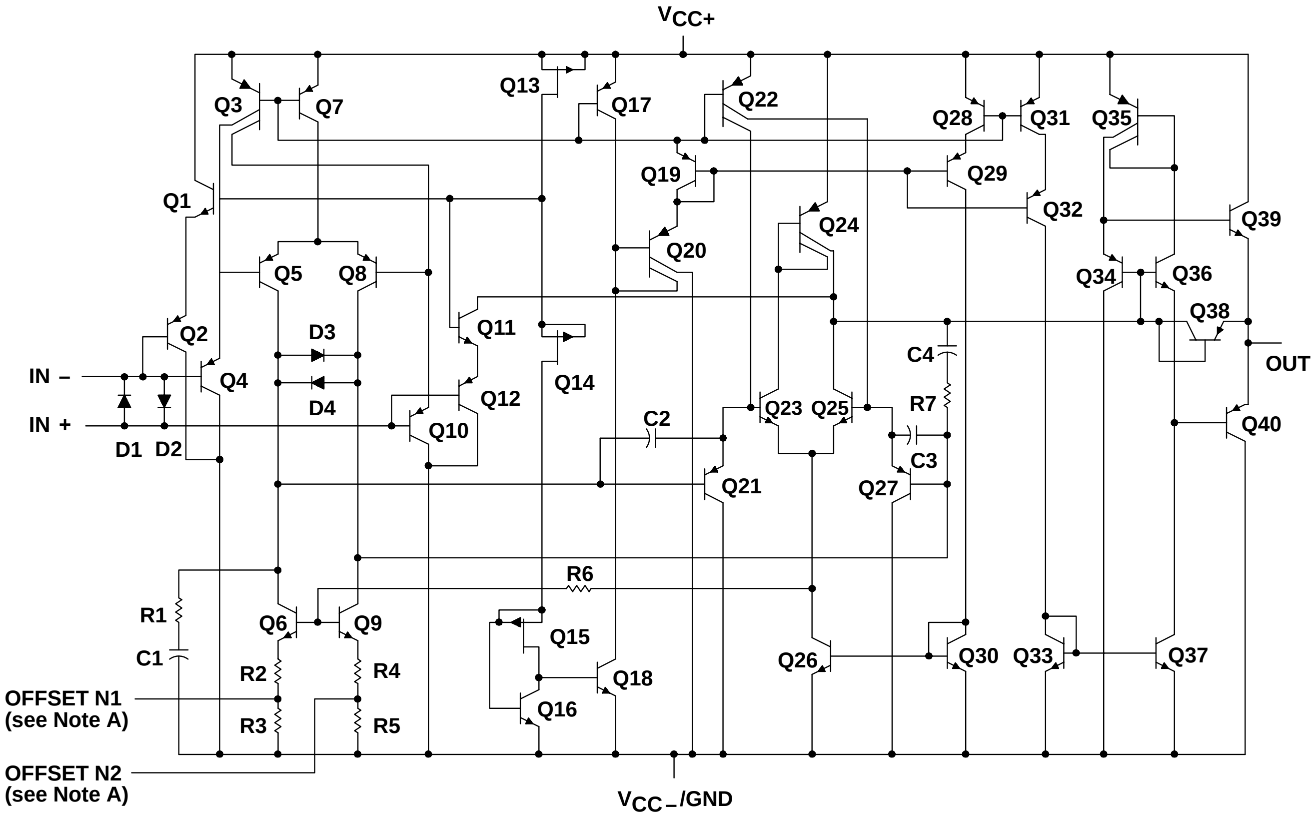
$T_J$max = 150°C

TOLERANCES ARE ±10%.

ALL DIMENSIONS ARE IN MILS.

PIN (11) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

equivalent schematic (each amplifier)



ACTUAL DEVICE COMPONENT COUNT			
COMPONENT	TLE2021	TLE2022	TLE2024
Transistors	40	80	160
Resistors	7	14	28
Diodes	4	8	16
Capacitors	4	8	16

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC+} (see Note 1) .... 20 V
Supply voltage, V_{CC-} (see Note 1) .... –20 V
Differential input voltage, V_{ID} (see Note 2) .... ±0.6 V
Input voltage range, V_I (any input, see Note 1) .... $\pm V_{CC}$
Input current, I_I (each input) .... ±1 mA
Output current, I_O (each output): TLE2021 .... ±20 mA
TLE2022 .... ±30 mA
TLE2024 .... ±40 mA
Total current into V_{CC+} .... 80 mA
Total current out of V_{CC-} .... 80 mA
Duration of short-circuit current at (or below) 25°C (see Note 3) .... unlimited
Continuous total power dissipation .... See Dissipation Rating Table
Operating free-air temperature range, T_A: C suffix .... 0°C to 70°C
I suffix .... –40°C to 85°C
M suffix .... –55°C to 125°C
Storage temperature range, T_{stg} .... –65°C to 150°C
Case temperature for 60 seconds, T_C: FK package .... 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: D, DP, P, or PW package .... 260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: JG package .... 300°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to the midpoint between V_{CC+}, and V_{CC-}.
2. Differential voltages are at IN+ with respect to IN–. Excessive current flows if a differential input voltage in excess of approximately ±600 mV is applied between the inputs unless some limiting resistance is used.
3. The output may be shorted to either supply. Temperature and/or supply voltages must be limited to ensure that the maximum dissipation rating is not exceeded.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE T_A = 25°C	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING	T_A = 125°C POWER RATING
D–8	725 mW	5.8 mW/°C	464 mW	377 mW	145 mW
DB–8	525 mW	4.2 mW/°C	336 mW	—	—
DW–16	1025 mW	8.2 mW/°C	656 mW	533 mW	205 mW
FK	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
J–14	1375 mW	11.0 mW/°C	880 mW	715 mW	275 mW
JG–8	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
N–14	1150 mW	9.2 mW/°C	736 mW	598 mW	230 mW
P–8	1000 mW	8.0 mW/°C	640 mW	520 mW	200 mW
PW–8	525 mW	4.2 mW/°C	336 mW	—	—

recommended operating conditions

		C SUFFIX MIN	C SUFFIX MAX	I SUFFIX MIN	I SUFFIX MAX	M SUFFIX MIN	M SUFFIX MAX	UNIT
Supply voltage, V_{CC}		±2	±20	±2	±20	±2	±20	V
Common-mode input voltage, V_{IC}	V_{CC} = ± 5 V	0	3.5	0	3.2	0	3.2	V
	$V_{CC\pm}$ = ±15 V	–15	13.5	–15	13.2	–15	13.2	
Operating free-air temperature, T_A		0	70	–40	85	–55	125	°C

TLE2021 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021C			TLE2021AC			TLE2021BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		120	600		100	300		80	200	µV
			Full range			850			600			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		µV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	– 0.3 to 4		0 to 3.5	– 0.3 to 4		0 to 3.5	– 0.3 to 4		V
			Full range	0 to 3.5			0 to 3.5			0 to 3.5			
V_{OH}	High-level output voltage	R_L= 10 kΩ	25°C	4	4.3		4	4.3		4	4.3		V
			Full range	3.9			3.9			3.9			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.85			0.85			0.85	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.3	1.5		0.3	1.5		0.3	1.5		V/µV
			Full range	0.3			0.3			0.3			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	85	110		85	110		85	110		dB
			Full range	80			80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		200	300		200	300		200	300	µA
			Full range			300			300			300	
ΔI_{CC}	Supply-current change over operating temperature range		Full range		5			5			5		µA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 electrical characteristics at specified free-air temperature, V_{CC} = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021C			TLE2021AC			TLE2021BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		120	500		80	200		40	100	µV
			Full range			750			500			200	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.5			–15 to 13.5			–15 to 13.5			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.9			13.9			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.7			–13.7			–13.7			
A_{VD}	Large-signal differential voltage amplification	V_O = ± 10 V, R_L = 10 kΩ	25°C	1	6.5		1	6.5		1	6.5		V/µV
			Full range	1			1			1			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, R_S = 50 Ω	25°C	100	115		100	115		100	115		dB
			Full range	96			96			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	$V_{CC\pm}$ = ± 2.5 V to ± 15 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	V_O = 0, No load	25°C		240	350		240	350		240	350	µA
			Full range			350			350			350	
ΔI_{CC}	Supply-current change over operating temperature range		Full range		6			6			6		µA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A†	TLE2022C			TLE2022AC			TLE2022BC			UNIT
					MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0,	R_S = 50 Ω	25°C			600			400			250	μV
				Full range			800			550			400	
α_{VIO}	Temperature coefficient of input offset voltage			Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)			25°C		0.005			0.005			0.005		μV/mo
I_{IO}	Input offset current			25°C		0.5	6		0.4	6		0.3	6	nA
				Full range			10			10			10	
I_{IB}	Input bias current			25°C		35	70		33	70		30	70	nA
				Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω		25°C	0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		V
				Full range	0 to 3.5			0 to 3.5			0 to 3.5			
V_{OH}	High-level output voltage	R_L = 10 kΩ		25°C	4	4.3		4	4.3		4	4.3		V
				Full range	3.9			3.9			3.9			
V_{OL}	Low-level output voltage			25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
				Full range			0.85			0.85			0.85	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V,	R_L = 10 kΩ	25°C	0.3	1.5		0.4	1.5		0.5	1.5		V/μV
				Full range	0.3			0.4			0.5			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min,	R_S = 50 Ω	25°C	85	100		87	102		90	105		dB
				Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V		25°C	100	115		103	118		105	120		dB
				Full range	95			98			100			
I_{CC}	Supply current	V_O = 2.5 V,	No load	25°C		450	600		450	600		450	600	μA
				Full range			600			600			600	
ΔI_{CC}	Supply current change over operating temperature range			Full range		7			7			7		μA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2022C			TLE2022AC			TLE2022BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		150	500		120	300		70	150	μV
			Full range			700			450			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		μV/mo
I_{IO}	Input offset current		25°C		0.5	6		0.4	6		0.3	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		35	70		33	70		30	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.5			–15 to 13.5			–15 to 13.5			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.9			13.9			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.7			–13.7			–13.7			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 10 kΩ	25°C	0.8	4		1	7		1.5	10		V/μV
			Full range	0.8			1			1.5			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	95	106		97	109		100	112		dB
			Full range	91			93			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V	25°C	100	115		103	118		105	120		dB
			Full range	95			98			100			
I_{CC}	Supply current	V_O = 0, No load	25°C		550	700		550	700		550	700	μA
			Full range			700			700			700	
ΔI_{CC}	Supply current change over operating temperature range		Full range		9			9			9		μA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024C			TLE2024AC			TLE2024BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C			1100			850			600	µV
			Full range			1300			1050			800	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		µV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		45	70		40	70		35	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		V
			Full range	0 to 3.5			0 to 3.5			0 to 3.5			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	3.9	4.2		3.9	4.2		4	4.3		V
			Full range	3.7			3.7			3.8			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.95			0.95			0.95	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.2	1.5		0.3	1.5		0.4	1.5		V/µV
			Full range	0.1			0.1			0.1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	80	90		82	92		85	95		dB
			Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		800	1200		800	1200		800	1200	µA
			Full range			1200			1200			1200	
ΔI_{CC}	Supply current change over operating temperature range		Full range		15			15			15		µA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, $V_{CC} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024C			TLE2024AC			TLE2024BC			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	25°C			1000			750			500	µV
			Full range			1200			950			700	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		50	70		45	70		40	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.5			–15 to 13.5			–15 to 13.5			
V_{OM+}	Maximum positive peak output voltage swing	$R_L = 10\ k\Omega$	25°C	13.8	14.1		13.9	14.2		14	14.3		V
			Full range	13.7			13.8			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L = 10\ k\Omega$	25°C	0.4	2		0.8	4		1	7		V/µV
			Full range	0.4			0.8			1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $R_S = 50\ \Omega$	25°C	92	102		94	105		97	108		dB
			Full range	88			90			93			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 2.5$ V to ± 15 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	$V_O = 0$, No load	25°C		1050	1400		1050	1400		1050	1400	µA
			Full range			1400			1400			1400	
ΔI_{CC}	Supply current change over operating temperature range		Full range		20			20			20		µA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150°C$ extrapolated to $T_A = 25°C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021I			TLE2021AI			TLE2021BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		120	600		100	300		80	200	μV
			Full range			950			600			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		μV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		0 to 3.5	– 0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	4	4.3		4	4.3		4	4.3		V
			Full range	3.9			3.9			3.9			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.9			0.9			0.9	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.3	1.5		0.3	1.5		0.3	1.5		V/μV
			Full range	0.25			0.25			0.25			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, R_S = 50 Ω	25°C	85	110		85	110		85	110		dB
			Full range	80			80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		200	300		200	300		200	300	μA
			Full range			300			300			300	
ΔI_{CC}	Supply-current change over operating temperature range		Full range		6			6			6		μA

† Full range is – 40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 electrical characteristics at specified free-air temperature, V_{CC} = ± 15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021I			TLE2021AI			TLE2021BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		120	500		80	200		40	100	µV
			Full range			850			500			200	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.2			–15 to 13.2			–15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.9			13.9			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	V_O = 10 V, R_L = 10 kΩ	25°C	1	6.5		1	6.5		1	6.5		V/µV
			Full range	0.75			0.75			0.75			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min, R_S = 50 Ω	25°C	100	115		100	115		100	115		dB
			Full range	96			96			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	$V_{CC\pm}$ = ± 2. 5 V to ± 15 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	V_O = 0 V, No load	25°C		240	350		240	350		240	350	µA
			Full range			350			350			350	
ΔI_{CC}	Supply-current change over operating temperature range		Full range		7			7			7		µA

† Full range is – 40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2022I			TLE2022AI			TLE2022BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C			600			400			250	μV
			Full range			800			550			400	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		μV/mo
I_{IO}	Input offset current		25°C		0.5	6		0.4	6		0.3	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		35	70		33	70		30	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	4	4.3		4	4.3		4	4.3		V
			Full range	3.9			3.9			3.9			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.9			0.9			0.9	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.3	1.5		0.4	1.5		0.5	1.5		V/μV
			Full range	0.2			0.2			0.2			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	85	100		87	102		90	105		dB
			Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	100	115		103	118		105	120		dB
			Full range	95			98			100			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		450	600		450	600		450	600	μA
			Full range			600			600			600	
ΔI_{CC}	Supply current change over operating temperature range		Full range		15			15			15		μA

† Full range is –40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = ± 15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2022I			TLE2022AI			TLE2022BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		150	500		120	300		70	150	μV
			Full range			700			450			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		μV/mo
I_{IO}	Input offset current		25°C		0.5	6		0.4	6		0.3	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		35	70		33	70		30	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	– 15 to 13.5	–15.3 to 14		– 15 to 13.5	–15.3 to 14		– 15 to 13.5	–15.3 to 14		V
			Full range	– 15 to 13.2			– 15 to 13.2			– 15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.9			13.9			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	– 13.7	– 14.1		– 13.7	– 14.1		– 13.7	– 14.1		V
			Full range	– 13.6			– 13.6			– 13.6			
A_{VD}	Large-signal differential voltage amplification	V_O = ± 10 V, R_L = 10 kΩ	25°C	0.8	4		1	7		1.5	10		V/μV
			Full range	0.8			1			1.5			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	95	106		97	109		100	112		dB
			Full range	91			93			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = ±2.5 V to ±15 V	25°C	100	115		103	118		105	120		dB
			Full range	95			98			100			
I_{CC}	Supply current	V_O = 0, No load	25°C		550	700		550	700		550	700	μA
			Full range			700			700			700	
ΔI_{CC}	Supply current change over operating temperature range		Full range		30			30			30		μA

† Full range is –40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024I			TLE2024AI			TLE2024BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C			1100			850			600	μV
			Full range			1300			1050			800	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		μV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		45	70		40	70		35	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	3.9	4.2		3.9	4.2		4	4.3		V
			Full range	3.7			3.7			3.8			
V_{OM-}	Maximum negative peak output voltage swing		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.95			0.95			0.95	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.2	1.5		0.3	1.5		0.4	1.5		V/μV
			Full range	0.1			0.1			0.1			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	80	90		82	92		85	95		dB
			Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	V_O = 0, No load	25°C		800	1200		800	1200		800	1200	μA
			Full range			1200			1200			1200	
ΔI_{CC}	Supply current change over operating temperature range		Full range		30			30			30		μA

† Full range is −40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, $V_{CC} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024I			TLE2024AI			TLE2024BI			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	25°C			1000			750			500	µV
			Full range			1200			950			700	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		50	70		45	70		40	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.2			–15 to 13.2			–15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	$R_L = 10\ k\Omega$	25°C	13.8	14.1		13.9	14.2		14	14.3		V
			Full range	13.7			13.7			13.8			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V, $R_L = 10\ k\Omega$	25°C	0.4	2		0.8	4		1	7		V/µV
			Full range	0.4			0.8			1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}\text{min}$, $R_S = 50\ \Omega$	25°C	92	102		94	105		97	108		dB
			Full range	88			90			93			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm2.5$ V to ±15 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	$V_O = 0$, No load	25°C		1050	1400		1050	1400		1050	1400	µA
			Full range			1400			1400			1400	
ΔI_{CC}	Supply current change over operating temperature range		Full range		50			50			50		µA

† Full range is –40°C to 85°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150°C$ extrapolated to $T_A = 25°C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021M MIN	TLE2021M TYP	TLE2021M MAX	TLE2021AM MIN	TLE2021AM TYP	TLE2021AM MAX	TLE2021BM MIN	TLE2021BM TYP	TLE2021BM MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		120	600		100	300		80	200	μV
			Full range			1100			600			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		μV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		μV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		0 to 3.5	–0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	4	4.3		4	4.3		4	4.3		V
			Full range	3.8			3.8			3.8			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.95			0.95			0.95	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.3	1.5		0.3	1.5		0.3	1.5		V/μV
			Full range	0.1			0.1			0.1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	85	110		85	110		85	110		dB
			Full range	80			80			80			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		170	230		170	230		170	230	μA
			Full range			230			230			230	
ΔI_{CC}	Supply current change over operating temperature range		Full range		9			9			9		μA

† Full range is –55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 electrical characteristics at specified free-air temperature, $V_{CC} = \pm15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2021M			TLE2021AM			TLE2021BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	25°C		120	500		80	200		40	100	µV
			Full range			1000			500			200	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.2	6		0.2	6		0.2	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		25	70		25	70		25	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.2			–15 to 13.2			–15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	$R_L = 10\ k\Omega$	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.8			13.8			13.8			
$V_{OM–}$	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm10$ V, $R_L = 10\ k\Omega$	25°C	1	6.5		1	6.5		1	6.5		V/µV
			Full range	0.5			0.5			0.5			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}min$, $R_S = 50\ \Omega$	25°C	100	115		100	115		100	115		dB
			Full range	96			96			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm$ 2.5 V to $\pm$15 V	25°C	105	120		105	120		105	120		dB
			Full range	100			100			100			
I_{CC}	Supply current	$V_O = 0$, No load	25°C		200	300		200	300		200	300	µA
			Full range			300			300			300	
ΔI_{CC}	Supply current change over operating temperature range		Full range		10			10			10		µA

† Full range is –55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150°C$ extrapolated to $T_A = 25°C$ using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2022M			TLE2022AM			TLE2022BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C			600			400			250	µV
			Full range			800			550			400	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		µV/mo
I_{IO}	Input offset current		25°C		0.5	6		0.4	6		0.3	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		35	70		33	70		30	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OH}	High-level output voltage	R_L = 10 kΩ	25°C	4	4.3		4	4.3		4	4.3		V
			Full range	3.8			3.8			3.8			
V_{OL}	Low-level output voltage		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.95			0.95			0.95	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.3	1.5		0.4	1.5		0.5	1.5		V/µV
			Full range	0.1			0.1			0.1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	85	100		87	102		90	105		dB
			Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V	25°C	100	115		103	118		105	120		dB
			Full range	95			98			100			
I_{CC}	Supply current	V_O = 2.5 V, No load	25°C		450	600		450	600		450	600	µA
			Full range			600			600			600	
ΔI_{CC}	Supply current change over operating temperature range		Full range		37			37			37		µA

† Full range is −55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022 electrical characteristics at specified free-air temperature, V_{CC} = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2022M MIN	TLE2022M TYP	TLE2022M MAX	TLE2022AM MIN	TLE2022AM TYP	TLE2022AM MAX	TLE2022BM MIN	TLE2022BM TYP	TLE2022BM MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C		150	500		120	300		70	150	µV
			Full range			700			450			300	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.5	6		0.4	6		0.3	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		35	70		33	70		30	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.2			–15 to 13.2			–15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	14	14.3		14	14.3		14	14.3		V
			Full range	13.9			13.9			13.9			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	V_O = ±10 V, R_L = 10 kΩ	25°C	0.8	4		1	7		1.5	10		V/µV
			Full range	0.8			1			1.5			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, R_S = 50 Ω	25°C	95	106		97	109		100	112		dB
			Full range	91			93			96			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm} / \Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V	25°C	100	115		103	118		105	120		dB
			Full range	95			98			100			
I_{CC}	Supply current	V_O = 0, No load	25°C		550	700		550	700		550	700	µA
			Full range			700			700			700	
ΔI_{CC}	Supply current change over operating temperature range		Full range		60			60			60		µA

† Full range is 0°C to 70°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024M			TLE2024AM			TLE2024BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0, R_S = 50 Ω	25°C			1100			850			600	µV
			Full range			1300			1050			800	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.005			0.005			0.005		µV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		45	70		40	70		35	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω	25°C	0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		0 to 3.5	−0.3 to 4		V
			Full range	0 to 3.2			0 to 3.2			0 to 3.2			
V_{OM+}	Maximum positive peak output voltage swing	R_L = 10 kΩ	25°C	3.9	4.2		3.9	4.2		4	4.3		V
			Full range	3.7			3.7			3.8			
V_{OM-}	Maximum negative peak output voltage swing		25°C		0.7	0.8		0.7	0.8		0.7	0.8	V
			Full range			0.95			0.95			0.95	
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V, R_L = 10 kΩ	25°C	0.2	1.5		0.3	1.5		0.4	1.5		V/µV
			Full range	0.1			0.1			0.1			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR}min, R_S = 50 Ω	25°C	80	90		82	92		85	95		dB
			Full range	80			82			85			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm}$ = ±2.5 V to ±15 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	V_O = 0, No load	25°C		800	1200		800	1200		800	1200	µA
			Full range			1200			1200			1200	
ΔI_{CC}	Supply current change over operating temperature range		Full range		50			50			50		µA

† Full range is –55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024 electrical characteristics at specified free-air temperature, $V_{CC} = \pm 15$ V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	TLE2024M			TLE2024AM			TLE2024BM			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{IC} = 0$, $R_S = 50\ \Omega$	25°C			1000			750			500	µV
			Full range			1200			950			700	
α_{VIO}	Temperature coefficient of input offset voltage		Full range		2			2			2		µV/°C
	Input offset voltage long-term drift (see Note 4)		25°C		0.006			0.006			0.006		µV/mo
I_{IO}	Input offset current		25°C		0.6	6		0.5	6		0.4	6	nA
			Full range			10			10			10	
I_{IB}	Input bias current		25°C		50	70		45	70		40	70	nA
			Full range			90			90			90	
V_{ICR}	Common-mode input voltage range	$R_S = 50\ \Omega$	25°C	–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		–15 to 13.5	–15.3 to 14		V
			Full range	–15 to 13.2			–15 to 13.2			–15 to 13.2			
V_{OM+}	Maximum positive peak output voltage swing	$R_L = 10\ k\Omega$	25°C	13.8	14.1		13.9	14.2		14	14.3		V
			Full range	13.7			13.7			13.8			
V_{OM-}	Maximum negative peak output voltage swing		25°C	–13.7	–14.1		–13.7	–14.1		–13.7	–14.1		V
			Full range	–13.6			–13.6			–13.6			
A_{VD}	Large-signal differential voltage amplification	$V_O = \pm 10$ V, $R_L = 10\ k\Omega$	25°C	0.4	2		0.8	4		1	7		V/µV
			Full range	0.4			0.8			1			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min, $R_S = 50\ \Omega$	25°C	92	102		94	105		97	108		dB
			Full range	88			90			93			
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	$V_{CC\pm} = \pm 2.5$ V to ± 15 V	25°C	98	112		100	115		103	117		dB
			Full range	93			95			98			
I_{CC}	Supply current	$V_O = 0$, No load	25°C		1050	1400		1050	1400		1050	1400	µA
			Full range			1400			1400			1400	
ΔI_{CC}	Supply current change over operating temperature range		Full range		85			85			85		µA

† Full range is –55°C to 125°C.

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at $T_A = 150$°C extrapolated to $T_A = 25$°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021 operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	T_A	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1 V to 3 V, See Figure 1	25°C		0.5			0.5			0.5		V/μs
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz	25°C		21	50		21	50		21		nV/Hz
		f = 1 kHz	25°C		17	30		17	30		17		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.16			0.16			0.16		μV
		f = 0.1 to 10 Hz	25°C		0.47			0.47			0.47		
I_n	Equivalent input noise current		25°C		0.09			0.09			0.9		pA/Hz
B_1	Unity-gain bandwidth	See Figure 3	25°C		1.2			1.2			1.2		MHz
ϕ_m	Phase margin at unity gain	See Figure 3	25°C		42°			42°			42°		

TLE2021 operating characteristics at specified free-air temperature, V_{CC} = ±15 V

PARAMETER		TEST CONDITIONS	T_A†	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1V to 3 V, See Figure 1	25°C	0.45	0.65		0.45	0.65		0.45	0.65		V/μs
			Full range	0.45			0.42			0.45			
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz	25°C		19	50		19	50		19		nV/Hz
		f = 1 kHz	25°C		15	30		15	30		15		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.16			0.16			0.16		μV
		f = 0.1 to 10 Hz	25°C		0.47			0.47			0.47		
I_n	Equivalent input noise current		25°C		0.09			0.09			0.09		pA/Hz
B_1	Unity-gain bandwidth	See Figure 3	25°C		2			2			2		MHz
ϕ_m	Phase margin at unity gain	See Figure 3	25°C		46°			46°			46°		

† Full range is 0°C to 70°C for the C-suffix devices, –40°C to 85°C for the I-suffix devices, and –55°C to 125°C for the M-suffix devices.

TLE2022 operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1 V to 3 V, See Figure 1		0.5			0.5			0.5		V/µs
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz		21	50		21	50		21		nV/√Hz
		f = 1 kHz		17	30		17	30		17		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		0.16			0.16			0.16		µV
		f = 0.1 to 10 Hz		0.47			0.47			0.47		
I_n	Equivalent input noise current			0.1			0.1			0.1		pA/√Hz
B_1	Unity-gain bandwidth	See Figure 3		1.7			1.7			1.7		MHz
ϕ_m	Phase margin at unity gain	See Figure 3		47°			47°			47°		

TLE2022 operating characteristics at specified free-air temperature, V_{CC} = ±15 V

PARAMETER		TEST CONDITIONS	T_A†	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = ±10 V, See Figure 1	25°C	0.45	0.65		0.45	0.65		0.45	0.65		V/µs
			Full range	0.45			0.42			0.4			
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz	25°C		19	50		19	50		19		nV/√Hz
		f = 1 kHz	25°C		15	30		15	30		15		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.16			0.16			0.16		µV
		f = 0.1 to 10 Hz	25°C		0.47			0.47			0.47		
I_n	Equivalent input noise current		25°C		0.1			0.1			0.1		pA/√Hz
B_1	Unity-gain bandwidth	See Figure 3	25°C		2.8			2.8			2.8		MHz
ϕ_m	Phase margin at unity gain	See Figure 3	25°C		52°			52°			52°		

† Full range is 0°C to 70°C.

TLE2024 operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1 V to 3 V, See Figure 1		0.5			0.5			0.5		V/μs
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz		21	50		21	50		21		nV/√Hz
		f = 1 kHz		17	30		17	30		17		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		0.16			0.16			0.16		μV
		f = 0.1 to 10 Hz		0.47			0.47			0.47		
I_n	Equivalent input noise current			0.1			0.1			0.1		pA/√Hz
B_1	Unity-gain bandwidth	See Figure 3		1.7			1.7			1.7		MHz
ϕ_m	Phase margin at unity gain	See Figure 3		47°			47°			47°		

TLE2024 operating characteristics at specified free-air temperature, V_{CC} = ±15 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS	T_A†	C SUFFIX			I SUFFIX			M SUFFIX			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = ±10 V, See Figure 1	25°C	0.45	0.7		0.45	0.7		0.45	0.7		V/μs
			Full range	0.45			0.42			0.4			
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz	25°C		19	50		19	50		19		nV/√Hz
		f = 1 kHz	25°C		15	30		15	30		15		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz	25°C		0.16			0.16			0.16		μV
		f = 0.1 to 10 Hz	25°C		0.47			0.47			0.47		
I_n	Equivalent input noise current		25°C		0.1			0.1			0.1		pA/√Hz
B_1	Unity-gain bandwidth	See Figure 3	25°C		2.8			2.8			2.8		MHz
ϕ_m	Phase margin at unity gain	See Figure 3	25°C		52°			52°			52°		

† Full range is 0°C to 70°C.

TLE2021Y electrical characteristics at V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2021Y			UNIT
				MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{IC} = 0,	R_S = 50 Ω		150		μV
	Input offset voltage long-term drift (see Note 4)	V_{IC} = 0,	R_S = 50 Ω		0.005		μV/mo
I_{IO}	Input offset current	V_{IC} = 0,	R_S = 50 Ω		0.5		nA
I_{IB}	Input bias current	V_{IC} = 0,	R_S = 50 Ω		35		nA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω			– 0.3 to 4		V
V_{OH}	Maximum high-level output voltage	R_L = 10 kΩ			4.3		V
V_{OL}	Maximum low-level output voltage	R_L = 10 kΩ			0.7		V
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 to 4 V,	R_L = 10 kΩ		1.5		V/μV
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min,	R_S = 50 Ω		100		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V			115		dB
I_{CC}	Supply current	V_O = 2.5 V,	No load		400		μA

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2021Y operating characteristics at V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TLE2021Y			UNIT
			MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1 V to 3 V		0.5		V/μs
V_n	Equivalent input noise voltage	f = 10 Hz		21		nV/√Hz
		f = 1 kHz		17		nV/√Hz
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		0.16		μV
		f = 0.1 to 10 Hz		0.47		μV
I_n	Equivalent input noise current			0.1		pA/√Hz
B_1	Unity-gain bandwidth			1.7		MHz
ϕ_m	Phase margin at unity gain			47°		

TLE2022Y electrical characteristics, V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TLE2022Y MIN	TLE2022Y TYP	TLE2022Y MAX	UNIT
V_{IO}	Input offset voltage	V_{IC} = 0,	R_S = 50 Ω		150	600	µV
	Input offset voltage long-term drift (see Note 4)	V_{IC} = 0,	R_S = 50 Ω		0.005		µV/mo
I_{IO}	Input offset current	V_{IC} = 0,	R_S = 50 Ω		0.5		nA
I_{IB}	Input bias current	V_{IC} = 0,	R_S = 50 Ω		35		nA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω			– 0.3 to 4		V
V_{OH}	Maximum high-level output voltage	R_L = 10 kΩ			4.3		V
V_{OL}	Maximum low-level output voltage	R_L = 10 kΩ			0.7		V
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 to 4 V,	R_L = 10 kΩ		1.5		V/µV
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min,	R_S = 50 Ω		100		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V			115		dB
I_{CC}	Supply current	V_O = 2.5 V,	No load		450		µA

NOTE 4: Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2022Y operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS		TLE2022Y MIN	TLE2022Y TYP	TLE2022Y MAX	UNIT
SR	Slew rate at unity gain	V_O = 1 V to 3 V,	See Figure 1		0.5		V/µs
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz			21		nV/√Hz
		f = 1 kHz			17		nV/√Hz
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz			0.16		µV
		f = 0.1 to 10 Hz			0.47		µV
I_n	Equivalent input noise current				0.1		pA/√Hz
B_1	Unity-gain bandwidth	See Figure 3			1.7		MHz
ϕ_m	Phase margin at unity gain	See Figure 3			47°		

TLE2024Y electrical characteristics, V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

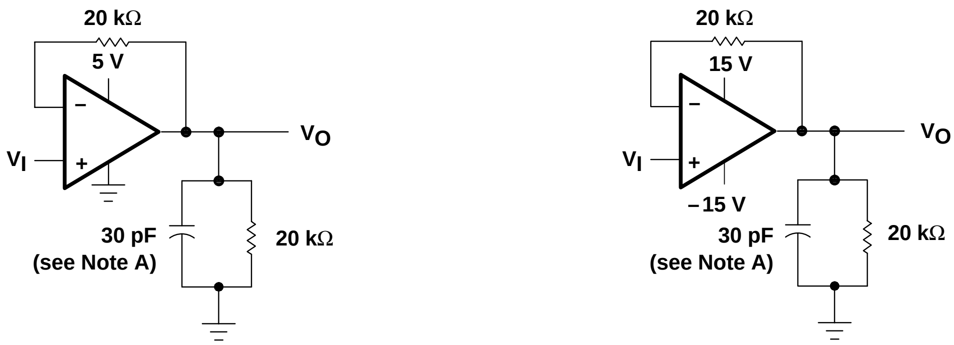
PARAMETER		TEST CONDITIONS		TLE2024Y			UNIT
				MIN	TYP	MAX	
	Input offset voltage long-term drift (see Note 4)	V_{IC} = 0,	R_S = 50 Ω		0.005		µV/mo
I_{IO}	Input offset current				0.6		nA
I_{IB}	Input bias current				45		nA
V_{ICR}	Common-mode input voltage range	R_S = 50 Ω			–0.3 to 4		V
V_{OH}	High-level output voltage	R_L = 10 kΩ			4.2		V
V_{OL}	Low-level output voltage				0.7		V
A_{VD}	Large-signal differential voltage amplification	V_O = 1.4 V to 4 V,	R_L = 10 kΩ		1.5		V/µV
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min,	R_S = 50 Ω		90		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	V_{CC} = 5 V to 30 V			112		dB
I_{CC}	Supply current	V_O = 2.5 V,	No load		800		µA

NOTE 4. Typical values are based on the input offset voltage shift observed through 168 hours of operating life test at T_A = 150°C extrapolated to T_A = 25°C using the Arrhenius equation and assuming an activation energy of 0.96 eV.

TLE2024Y operating characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TLE2024Y			UNIT
			MIN	TYP	MAX	
SR	Slew rate at unity gain	V_O = 1 V to 3 V, See Figure 1		0.5		V/µs
V_n	Equivalent input noise voltage (see Figure 2)	f = 10 Hz		21		$nV/\sqrt{Hz}$
		f = 1 kHz		17		
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	f = 0.1 to 1 Hz		0.16		µV
		f = 0.1 to 10 Hz		0.47		
I_n	Equivalent input noise current			0.1		$pA/\sqrt{Hz}$
B_1	Unity-gain bandwidth	See Figure 3		1.7		MHz
ϕ_m	Phase margin at unity gain	See Figure 3		47°		

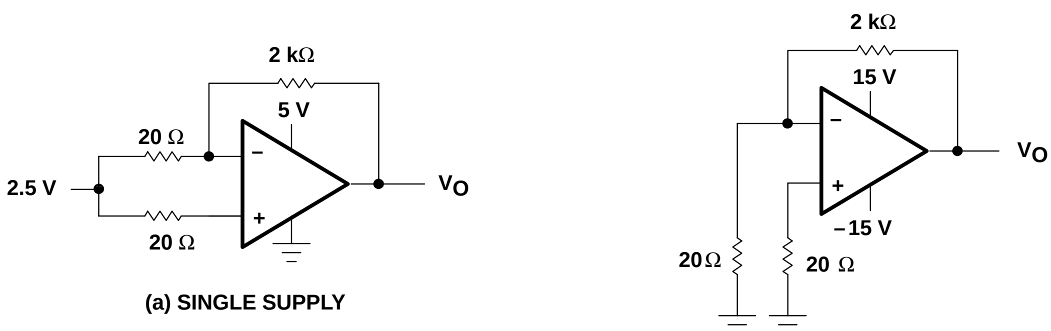
PARAMETER MEASUREMENT INFORMATION



(a) SINGLE SUPPLY **(b) SPLIT SUPPLY**

NOTE A: C_L includes fixture capacitance.

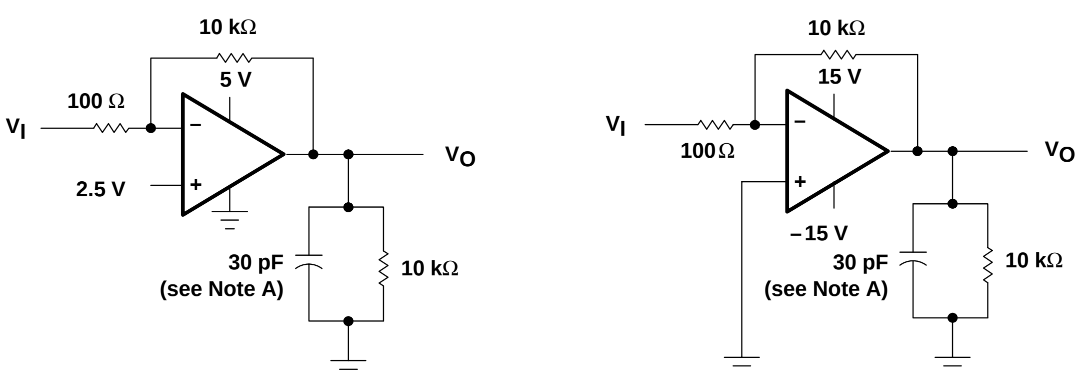
Figure 1. Slew-Rate Test Circuit



(a) SINGLE SUPPLY

(b) SPLIT SUPPLY

Figure 2. Noise-Voltage Test Circuit

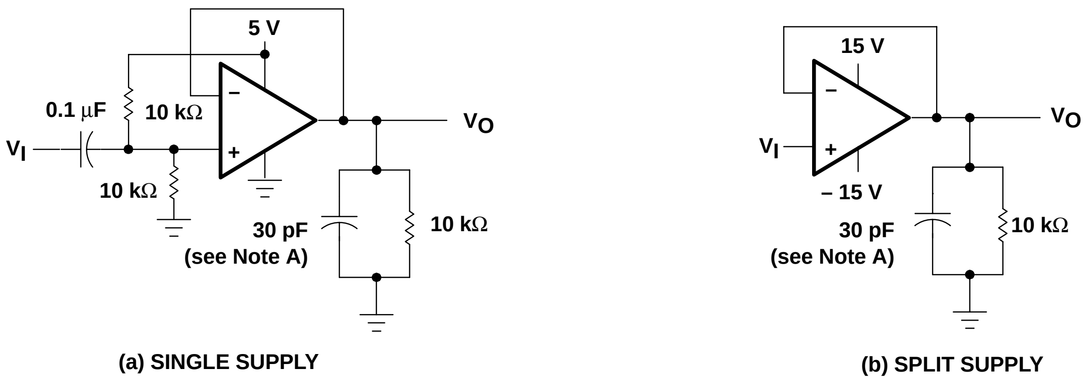


(a) SINGLE SUPPLY **(b) SPLIT SUPPLY**

NOTE A: C_L includes fixture capacitance.

Figure 3. Unity-Gain Bandwidth and Phase-Margin Test Circuit

PARAMETER MEASUREMENT INFORMATION



NOTE A: C_L includes fixture capacitance.

Figure 4. Small-Signal Pulse-Response Test Circuit

typical values

Typical values presented in this data sheet represent the median (50% point) of device parametric performance.

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
V_{IO}	Input offset voltage	Distribution	5, 6, 7
I_{IB}	Input bias current	vs Common-mode input voltage vs Free-air temperature	8, 9, 10 11, 12, 13
I_I	Input current	vs Differential input voltage	14
V_{OM}	Maximum peak output voltage	vs Output current vs Free-air temperature	15, 16, 17 18
V_{OH}	High-level output voltage	vs High-level output current vs Free-air temperature	19, 20 21
V_{OL}	Low-level output voltage	vs Low-level output current vs Free-air temperature	22 23
$V_{O(PP)}$	Maximum peak-to-peak output voltage	vs Frequency	24, 25
A_{VD}	Large-signal differential voltage amplification	vs Frequency vs Free-air temperature	26 27, 28, 29
I_{OS}	Short-circuit output current	vs Supply voltage vs Free-air temperature	30 – 33 34 – 37
I_{CC}	Supply current	vs Supply voltage vs Free-air temperature	38, 39, 40 41, 42, 43
CMRR	Common-mode rejection ratio	vs Frequency	44, 45, 46
SR	Slew rate	vs Free-air temperature	47, 48, 49
	Voltage-follower small-signal pulse response		50, 51
	Voltage-follower large-signal pulse response		52 – 57
$V_{N(PP)}$	Peak-to-peak equivalent input noise voltage	0.1 to 1 Hz 0.1 to 10 Hz	58 59
V_n	Equivalent input noise voltage	vs Frequency	60
B_1	Unity-gain bandwidth	vs Supply voltage vs Free-air temperature	61, 62 63, 64
ϕ_m	Phase margin	vs Supply voltage vs Load capacitance vs Free-air temperature	65, 66 67, 68 69, 70
	Phase shift	vs Frequency	26

TYPICAL CHARACTERISTICS

DISTRIBUTION OF TLE2021
INPUT OFFSET VOLTAGE

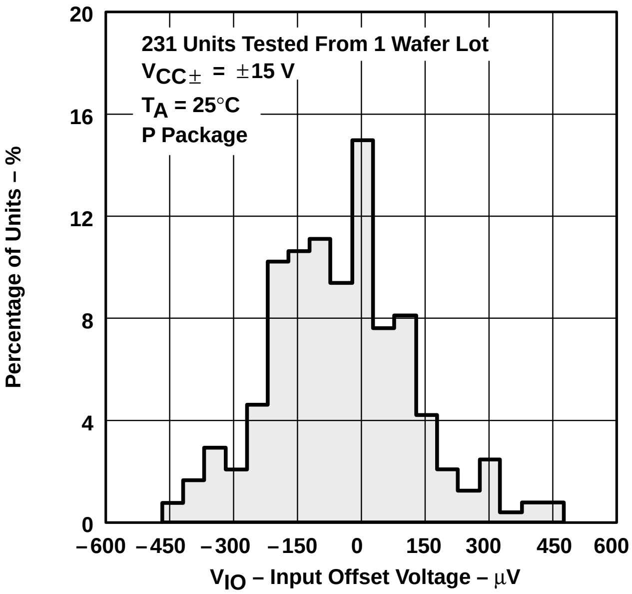


Figure 5

DISTRIBUTION OF TLE2022
INPUT OFFSET VOLTAGE

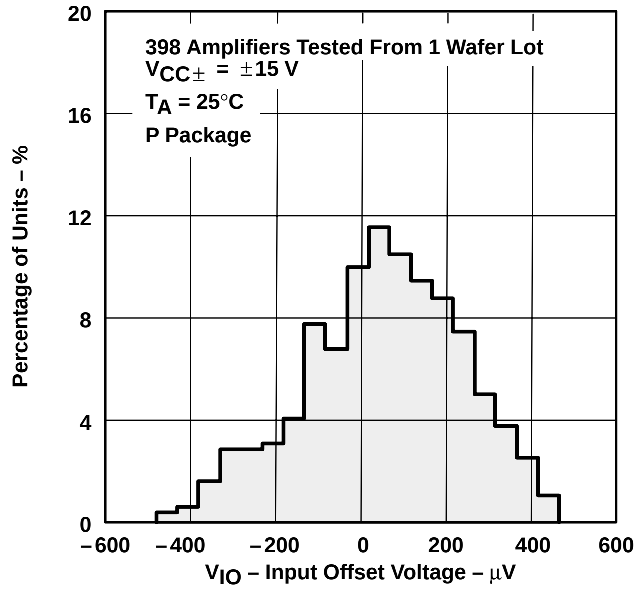


Figure 6

DISTRIBUTION OF TLE2024
INPUT OFFSET VOLTAGE

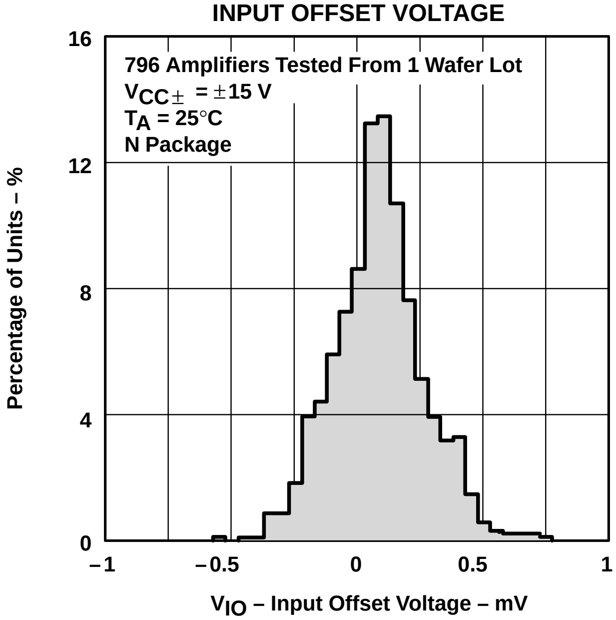


Figure 7

TLE2021
INPUT BIAS CURRENT
vs
COMMON-MODE INPUT VOLTAGE

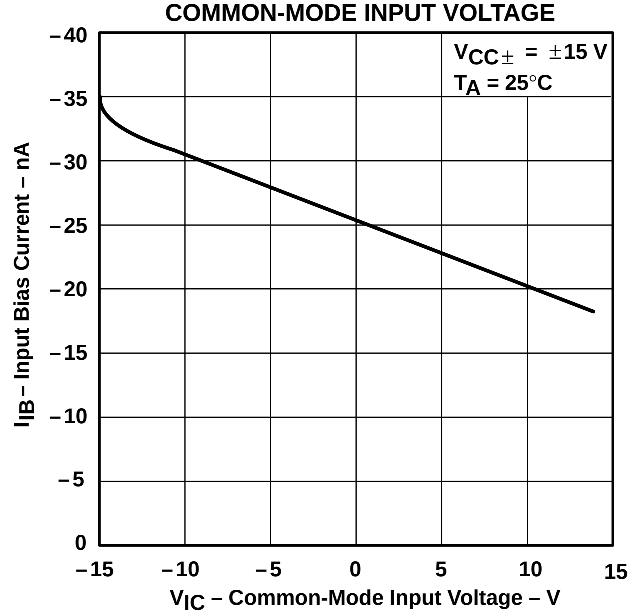


Figure 8

TYPICAL CHARACTERISTICS

TLE2022
INPUT BIAS CURRENT
vs
COMMON-MODE INPUT VOLTAGE

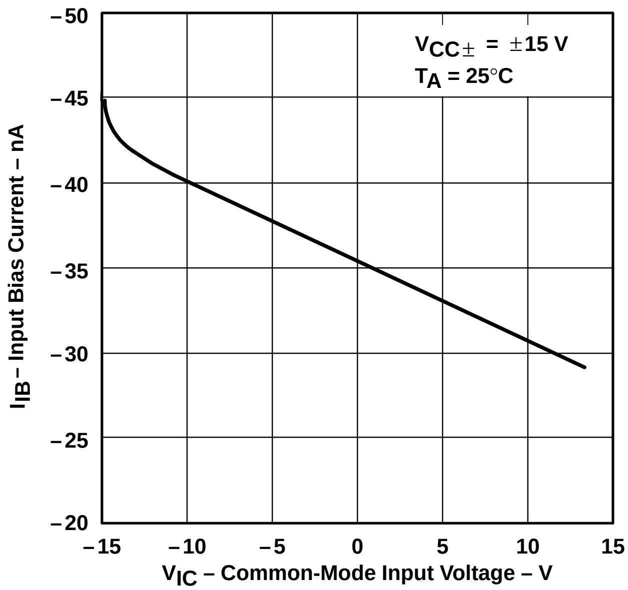


Figure 9

TLE2024
INPUT BIAS CURRENT
vs
COMMON-MODE INPUT VOLTAGE

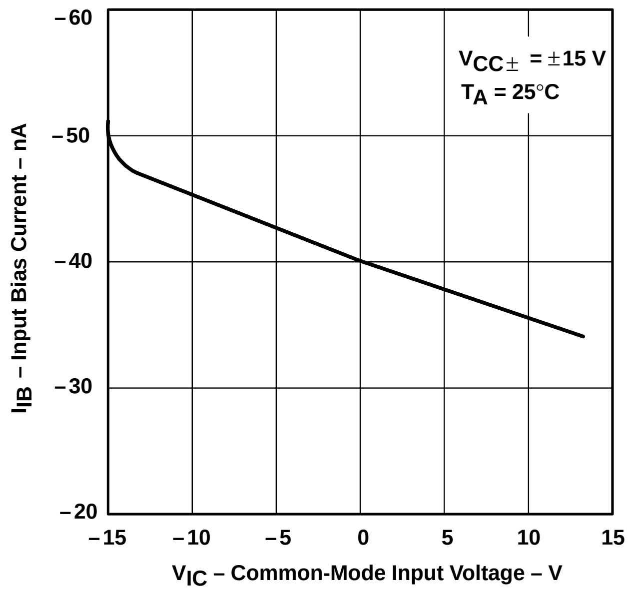


Figure 10

TLE2021
INPUT BIAS CURRENT†
vs
FREE-AIR TEMPERATURE

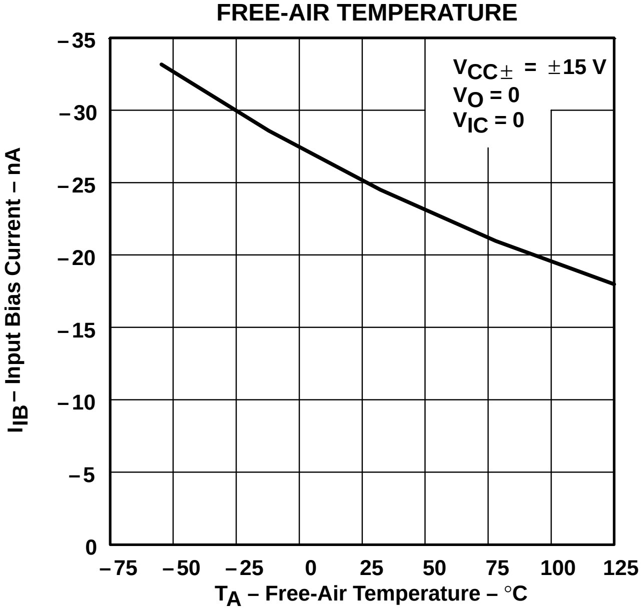


Figure 11

TLE2022
INPUT BIAS CURRENT†
vs
FREE-AIR TEMPERATURE

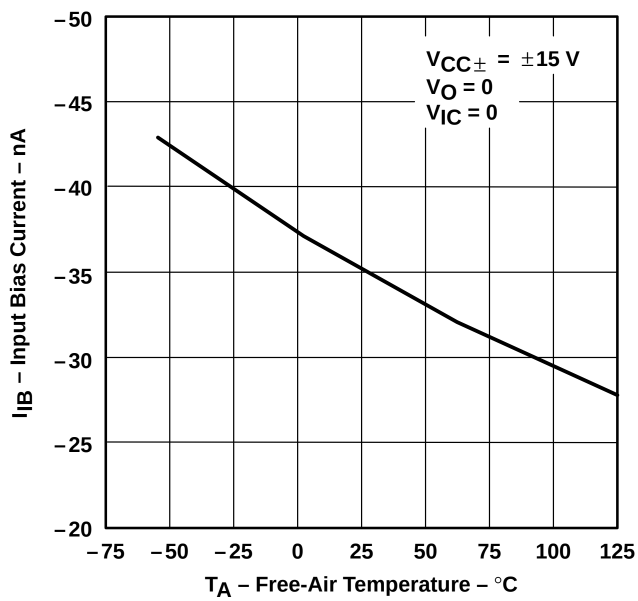


Figure 12

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

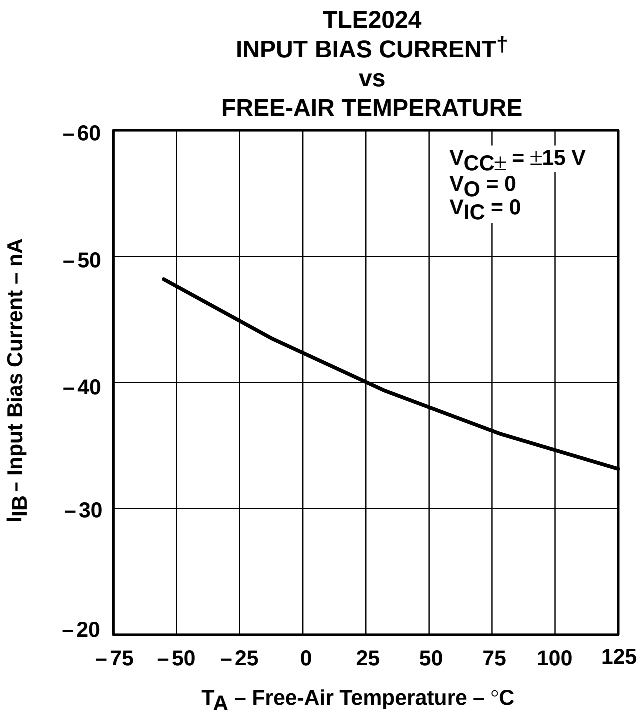


Figure 13

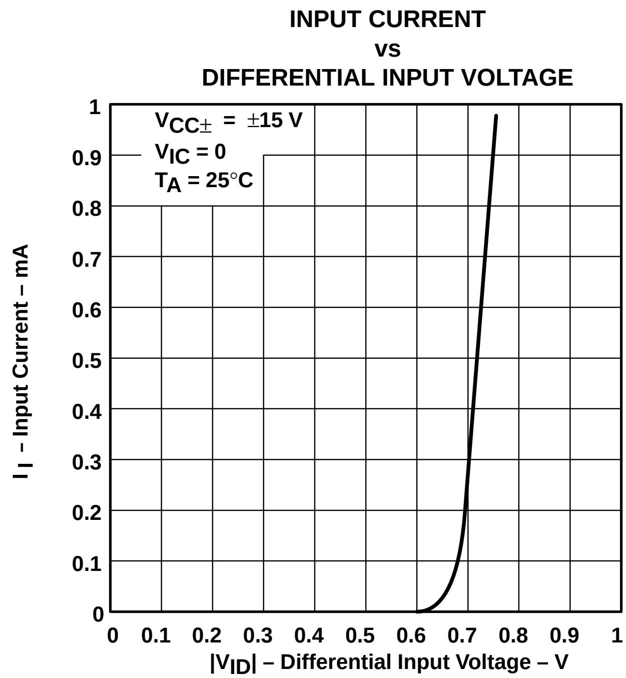


Figure 14

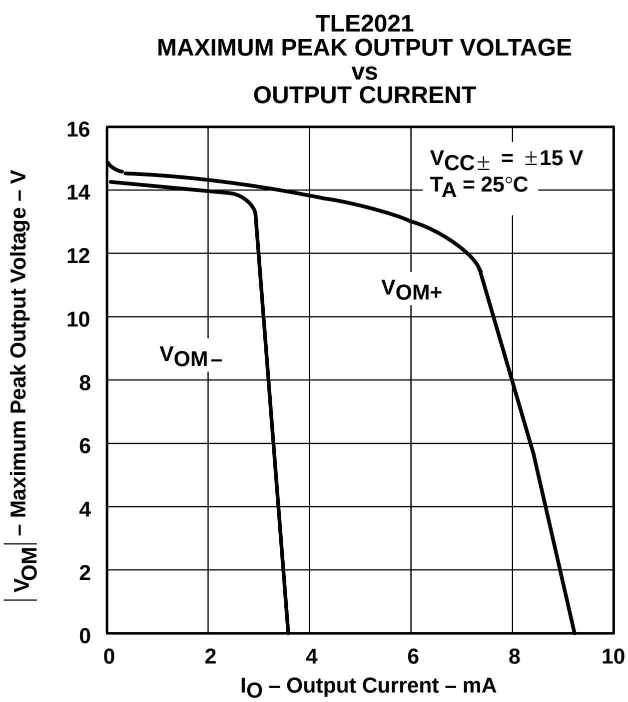


Figure 15

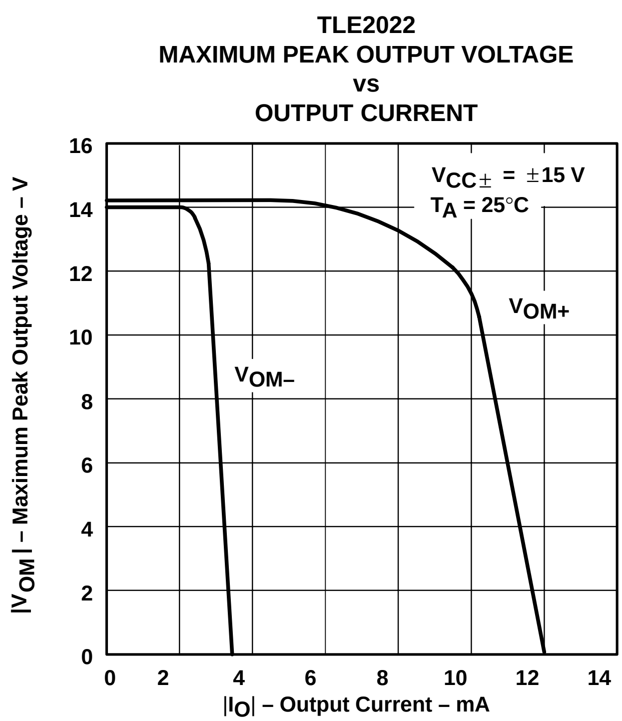


Figure 16

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLE2024
MAXIMUM PEAK OUTPUT VOLTAGE
vs
OUTPUT CURRENT

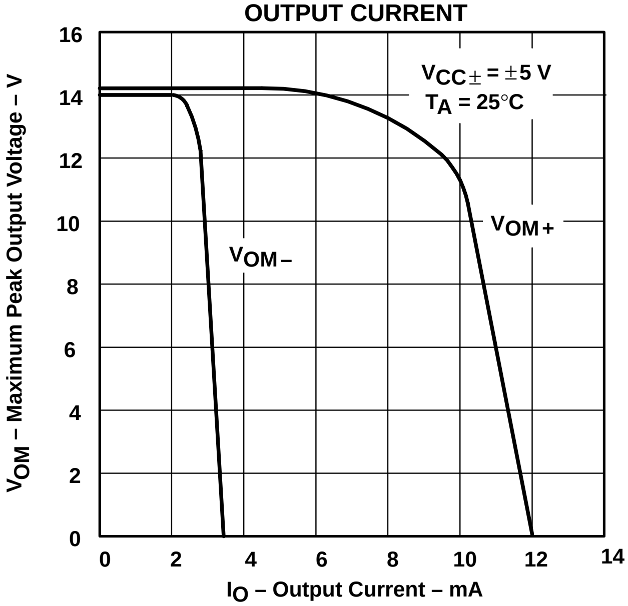


Figure 17

MAXIMUM PEAK OUTPUT VOLTAGE†
vs
FREE-AIR TEMPERATURE

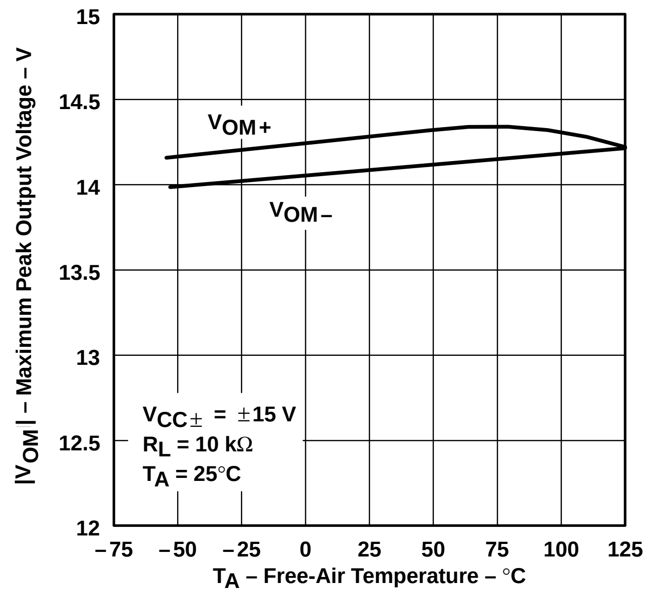


Figure 18

TLE2021
HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

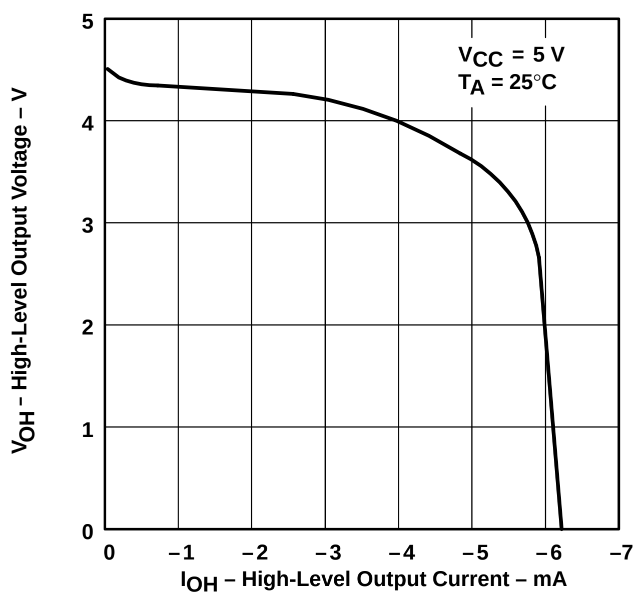


Figure 19

TLE2022 AND TLE2024
HIGH-LEVEL OUTPUT VOLTAGE
vs
HIGH-LEVEL OUTPUT CURRENT

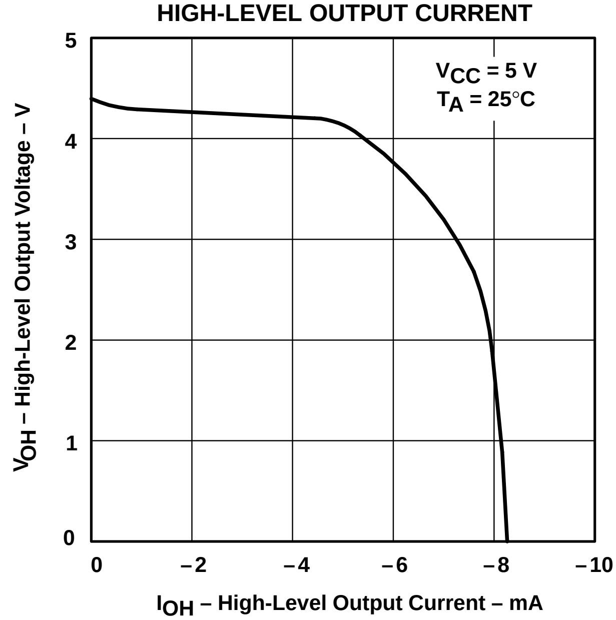


Figure 20

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

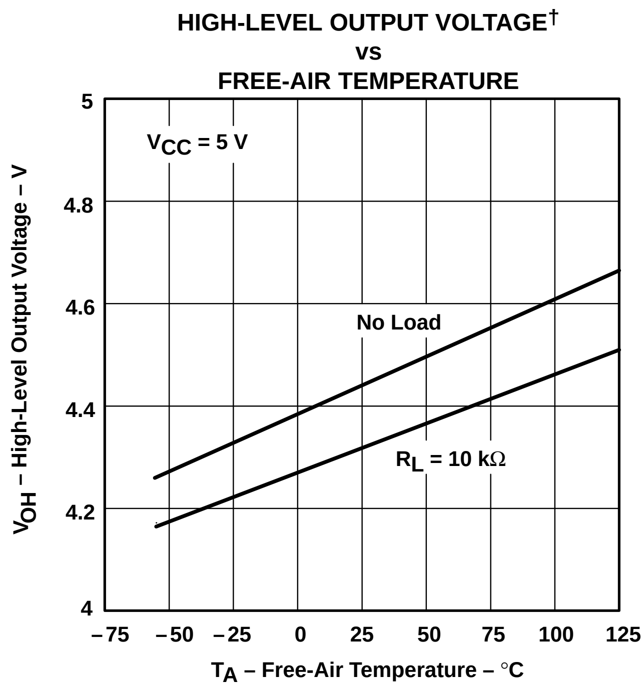


Figure 21

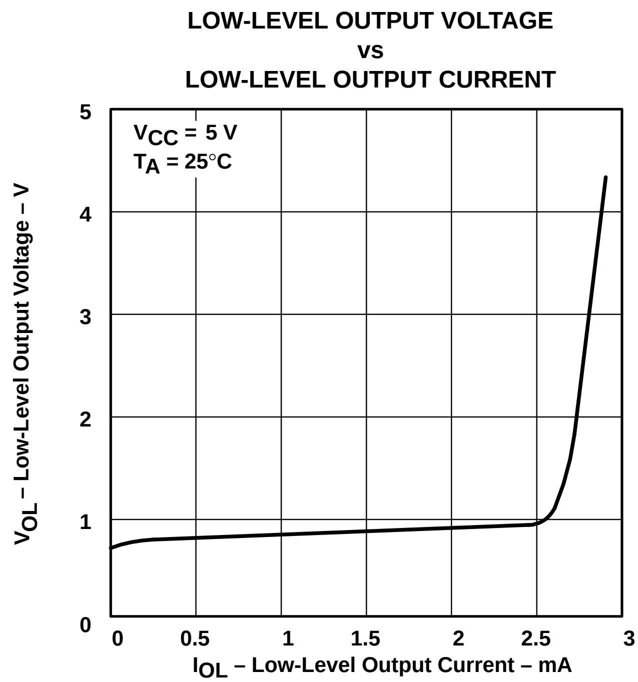


Figure 22

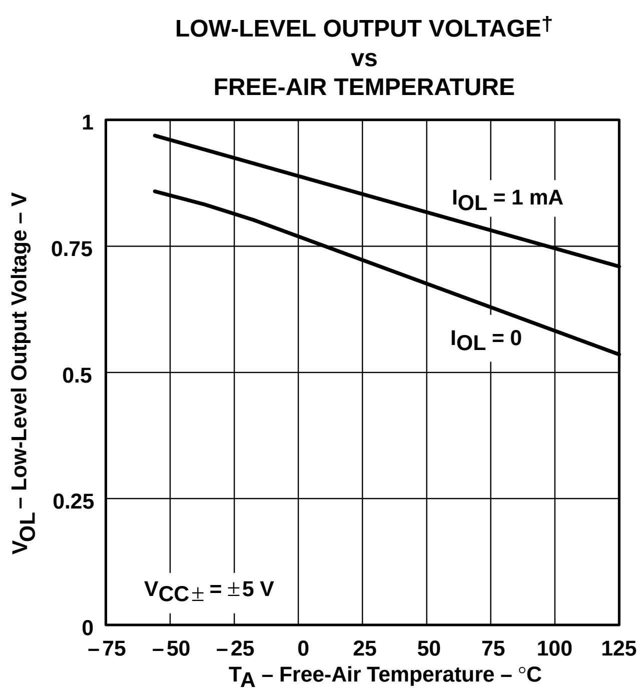


Figure 23

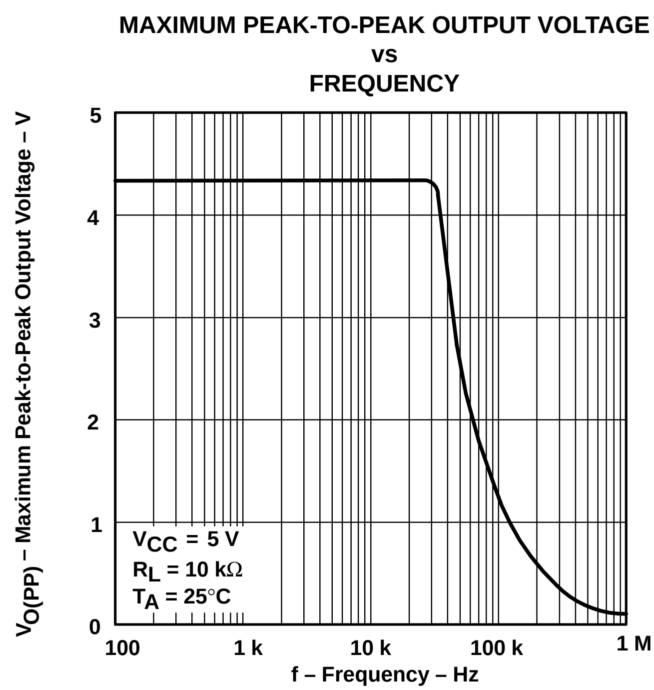


Figure 24

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

MAXIMUM PEAK-TO-PEAK OUTPUT VOLTAGE
vs
FREQUENCY

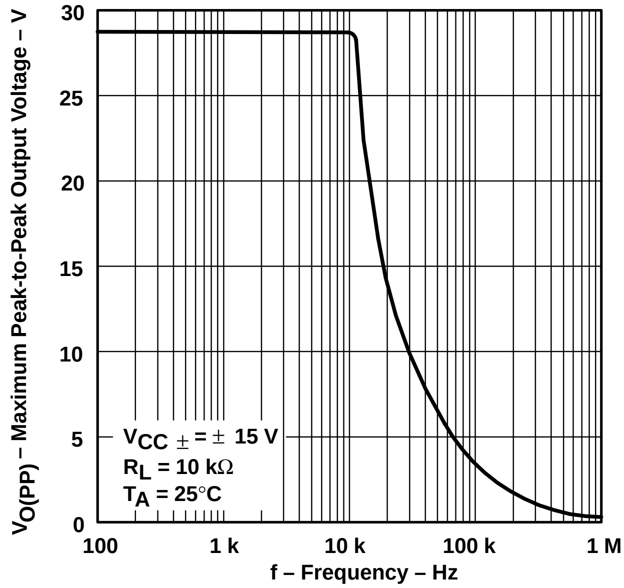


Figure 25

LARGE-SIGNAL DIFFERENTIAL VOLTAGE
AMPLIFICATION AND PHASE SHIFT
vs
FREQUENCY

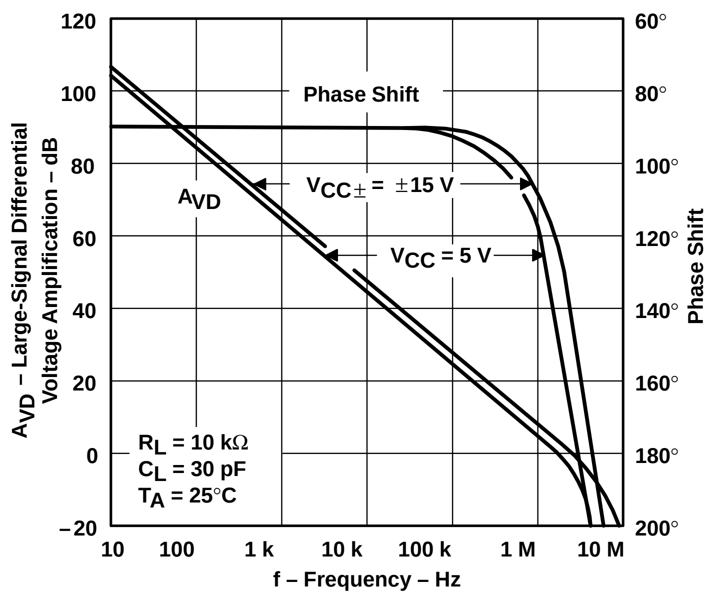


Figure 26

TYPICAL CHARACTERISTICS

TLE2021
LARGE-SCALE DIFFERENTIAL VOLTAGE AMPLIFICATION†
vs
FREE-AIR TEMPERATURE

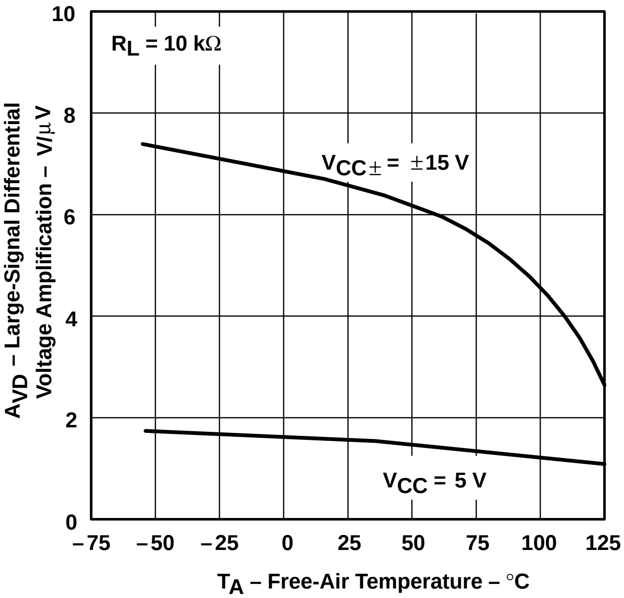


Figure 27

TLE2022
LARGE-SIGNAL DIFFERENTIAL VOLTAGE AMPLIFICATION†
vs
FREE-AIR TEMPERATURE

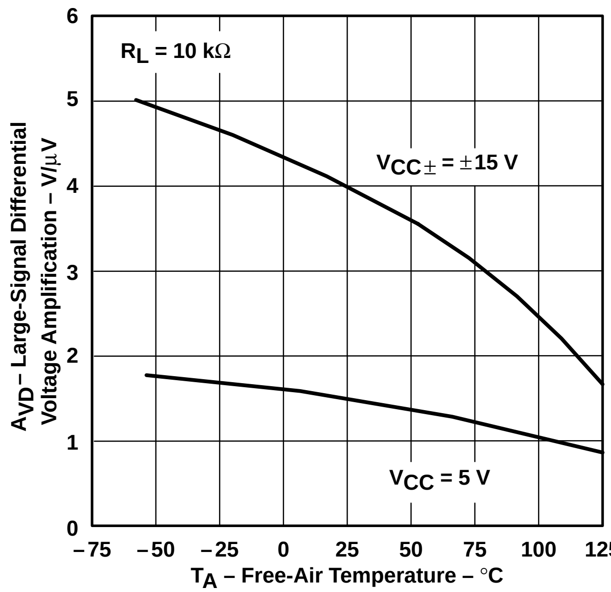


Figure 28

TLE2024
LARGE-SCALE DIFFERENTIAL VOLTAGE AMPLIFICATION†
vs
FREE-AIR TEMPERATURE

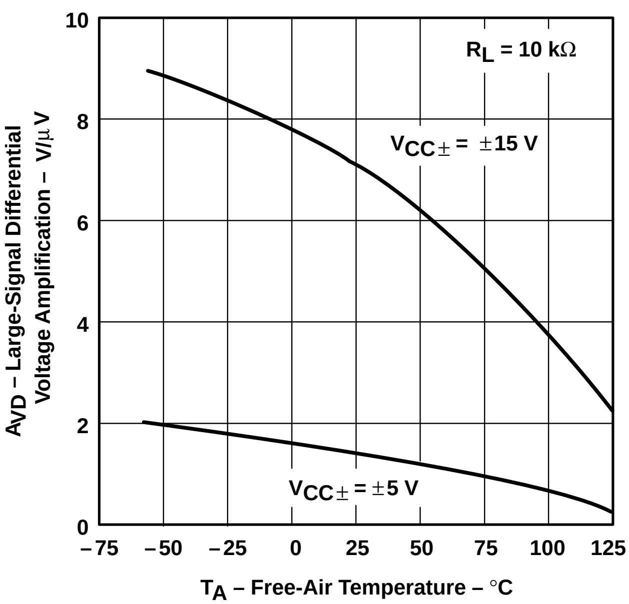


Figure 29

TLE2021
SHORT-CIRCUIT OUTPUT CURRENT
vs
SUPPLY VOLTAGE

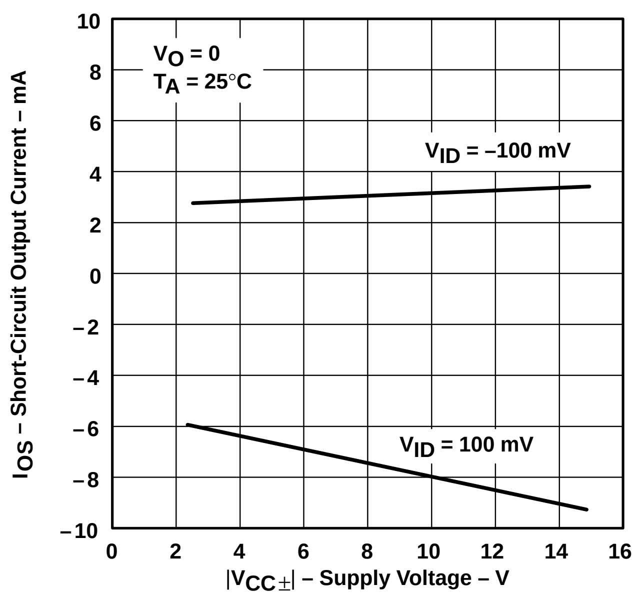


Figure 30

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

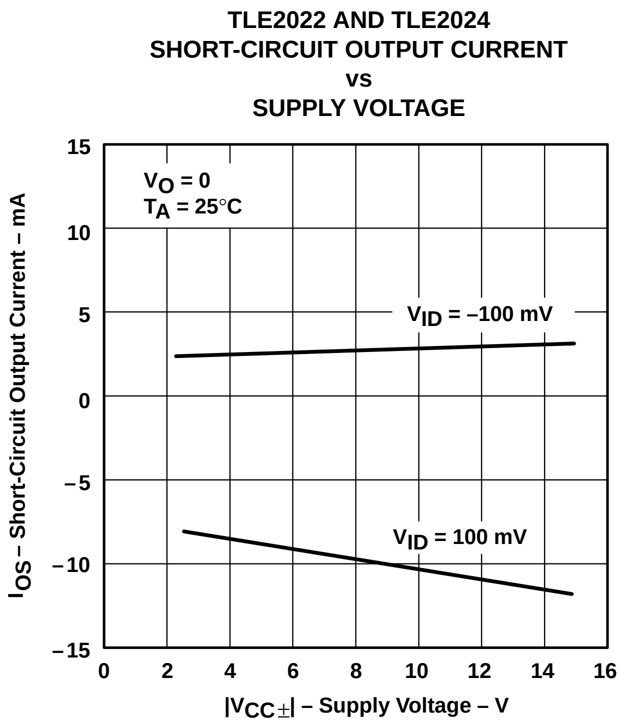


Figure 31

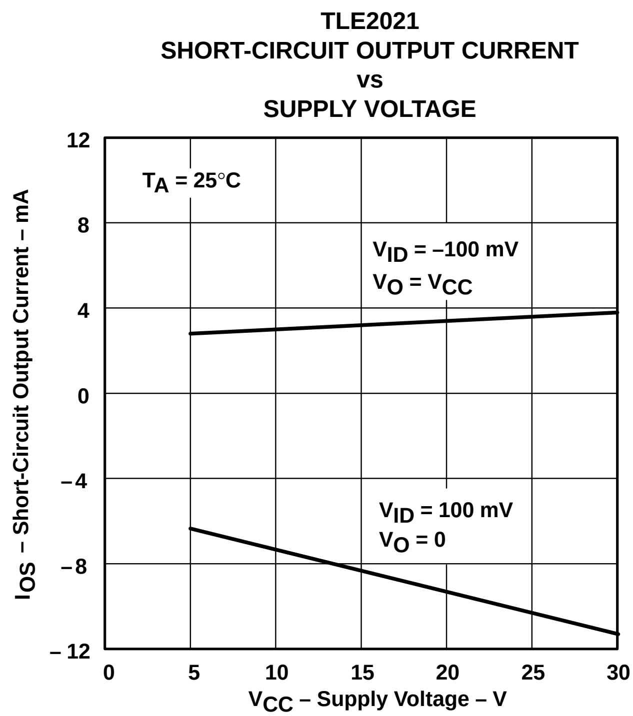


Figure 32

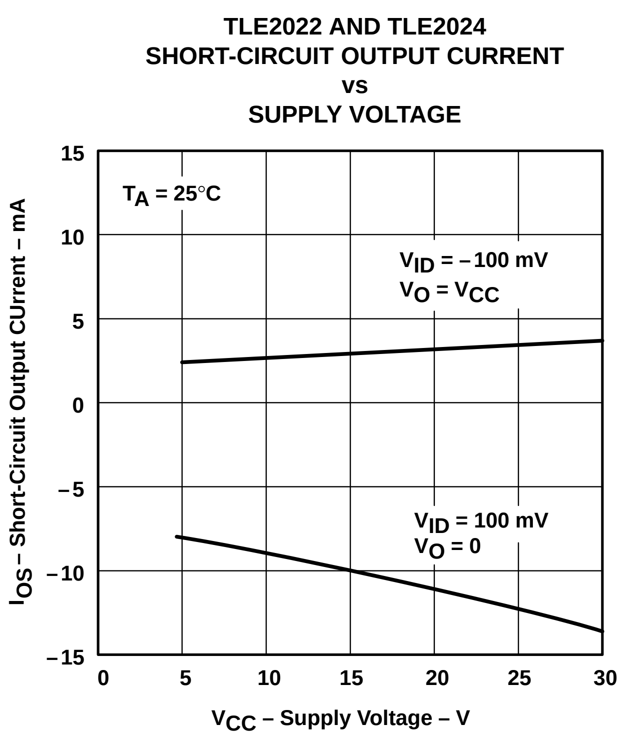


Figure 33

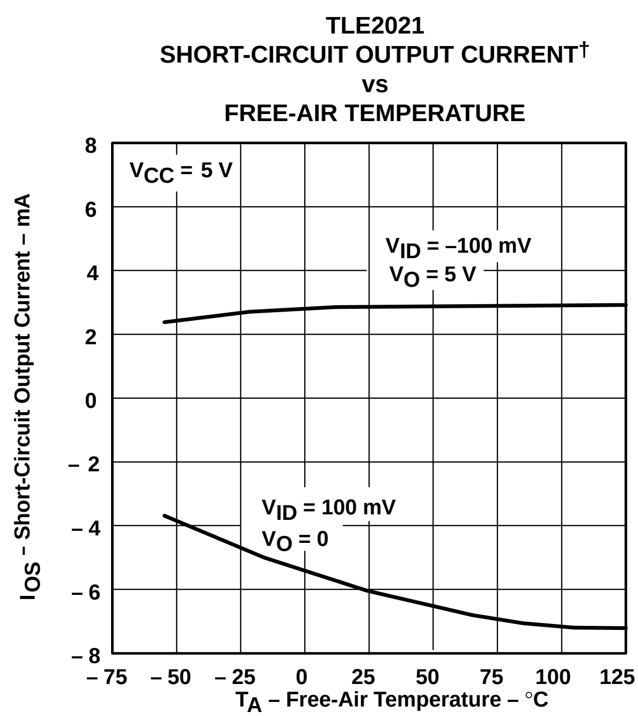


Figure 34

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLE2022 AND TLE2024
SHORT-CIRCUIT OUTPUT CURRENT†
vs
FREE-AIR TEMPERATURE

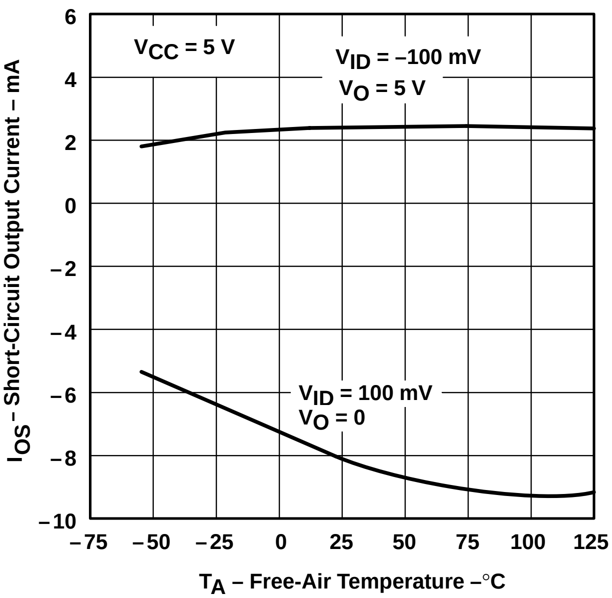


Figure 35

TLE2021
SHORT-CIRCUIT OUTPUT CURRENT†
vs
FREE-AIR TEMPERATURE

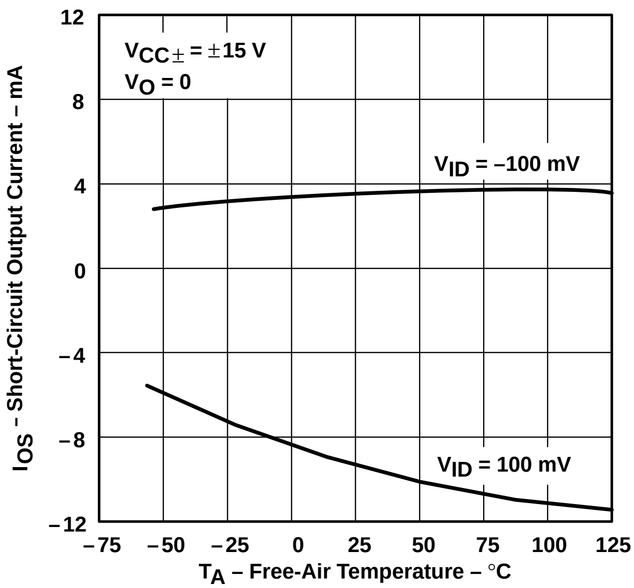


Figure 36

TLE2022 AND TLE2024
SHORT-CIRCUIT OUTPUT CURRENT†
vs
FREE-AIR TEMPERATURE

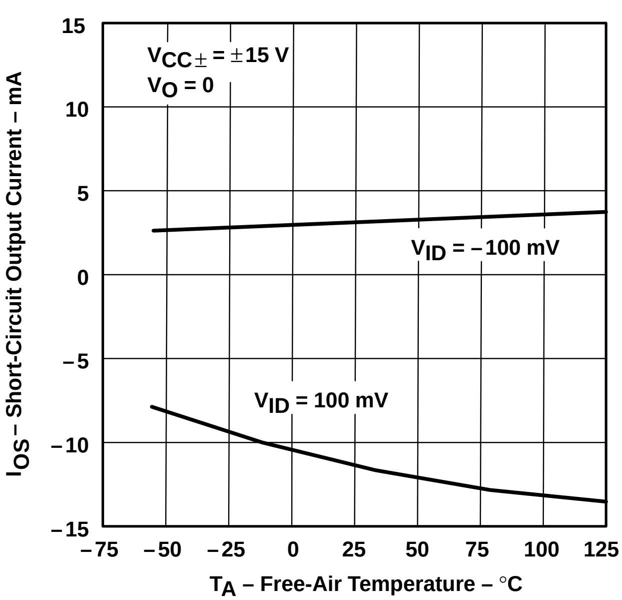


Figure 37

TLE2021
SUPPLY CURRENT
vs
SUPPLY VOLTAGE

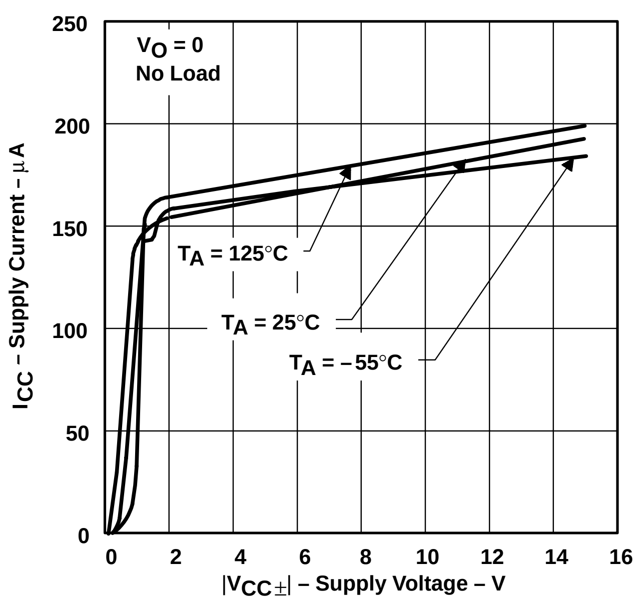


Figure 38

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

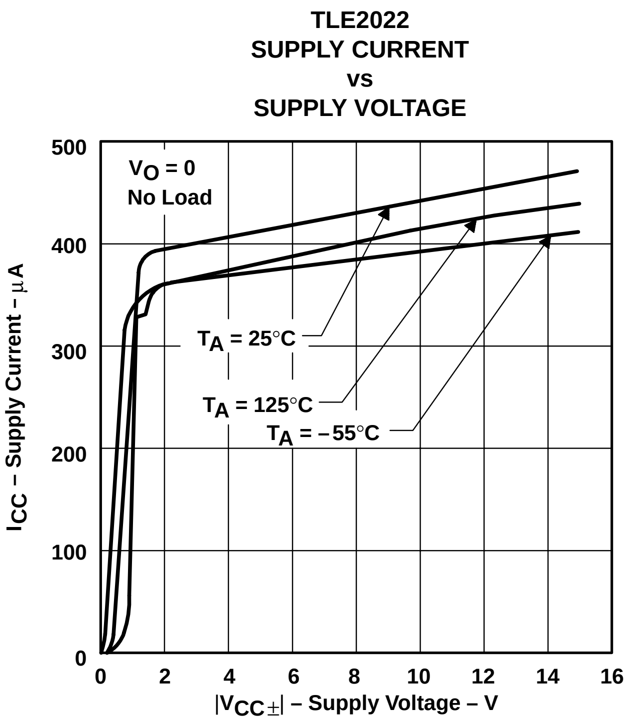


Figure 39

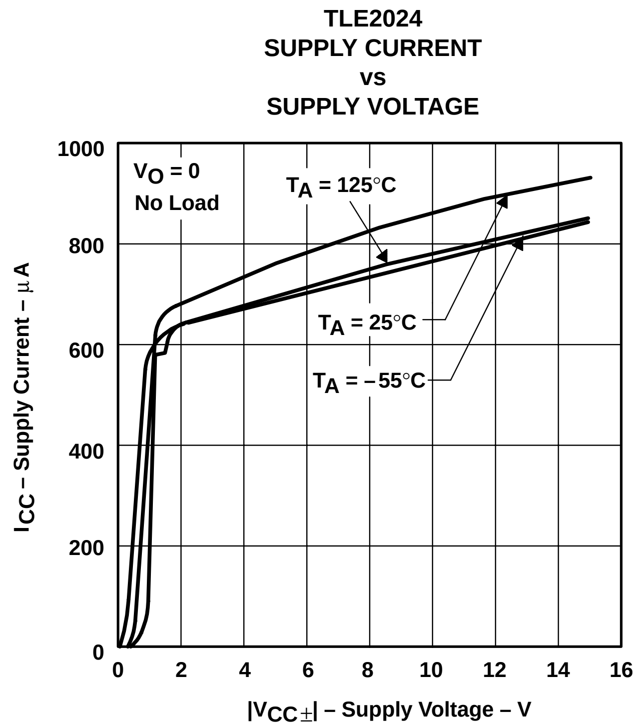


Figure 40

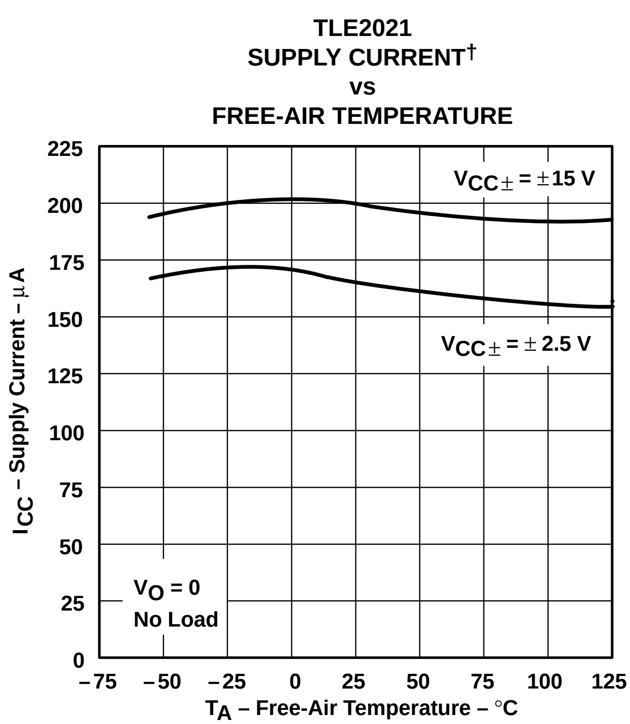


Figure 41

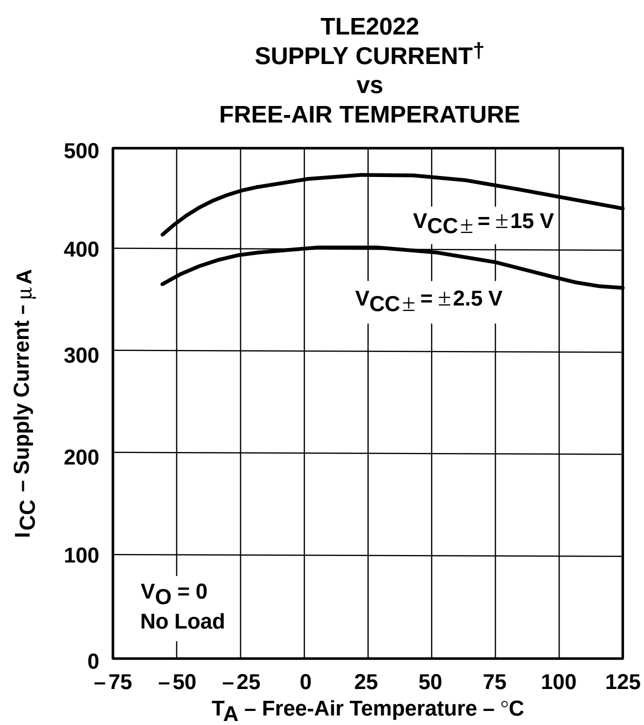


Figure 42

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLE2024
SUPPLY CURRENT†
vs
FREE-AIR TEMPERATURE

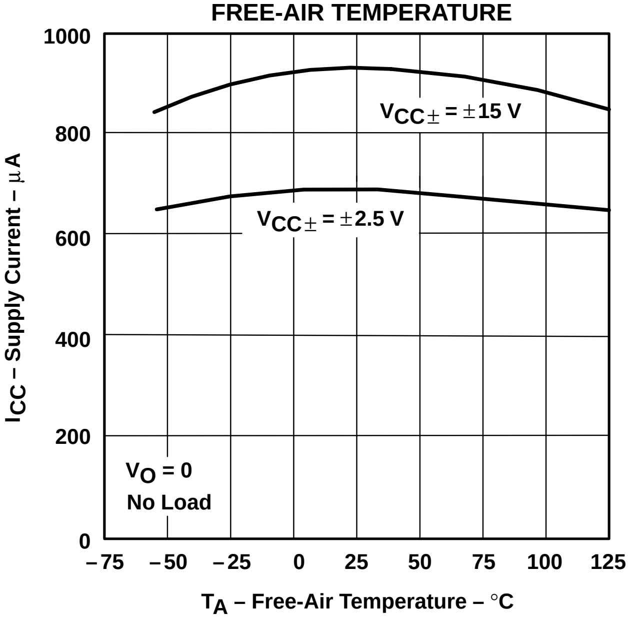


Figure 43

TLE2021
COMMON-MODE REJECTION RATIO
vs
FREQUENCY

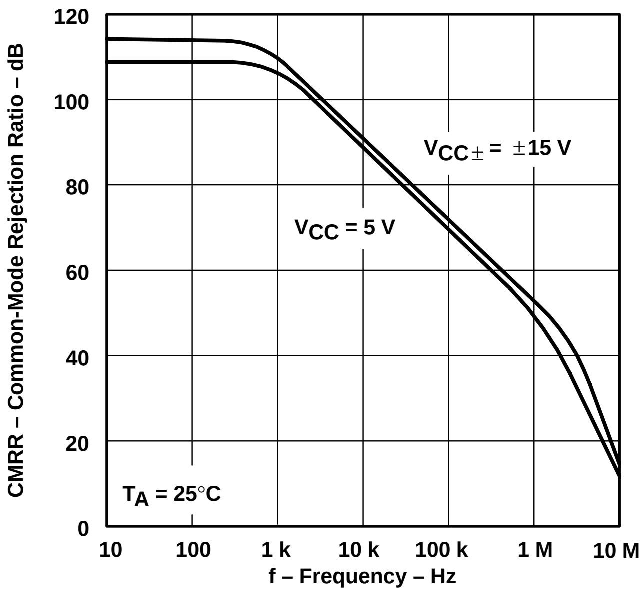


Figure 44

TLE2022
COMMON-MODE REJECTION RATIO
vs
FREQUENCY

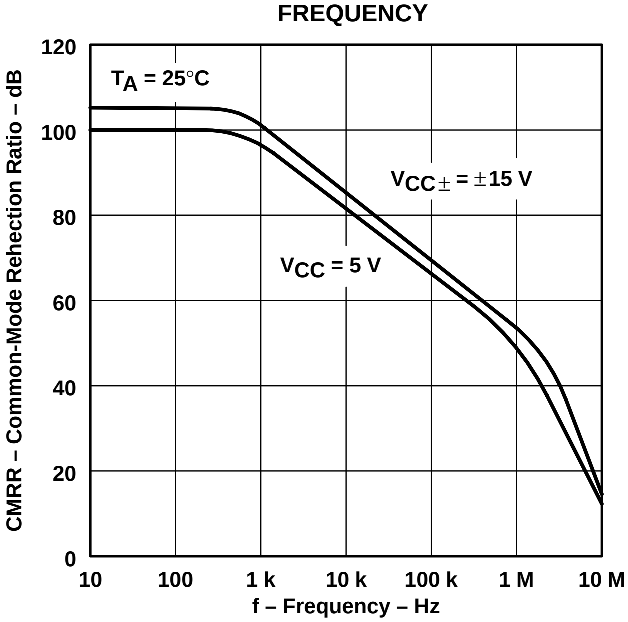


Figure 45

TLE2024
COMMON-MODE REJECTION RATIO
vs
FREQUENCY

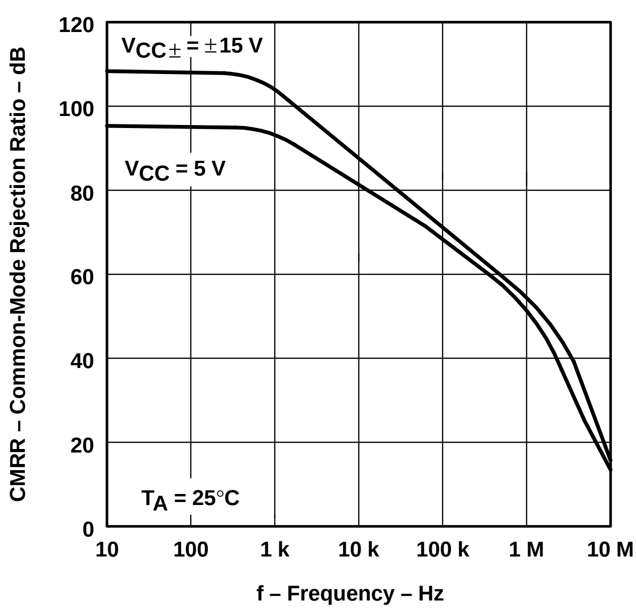


Figure 46

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLE2021
SLEW RATE†
vs
FREE-AIR TEMPERATURE

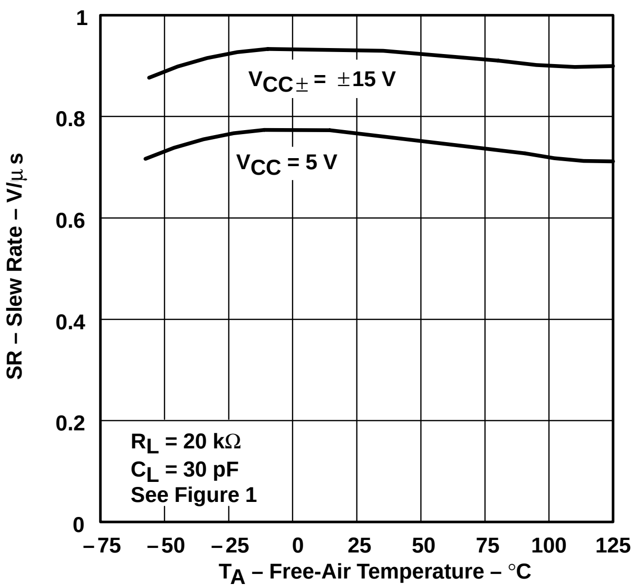


Figure 47

TLE2022
SLEW RATE†
vs
FREE-AIR TEMPERATURE

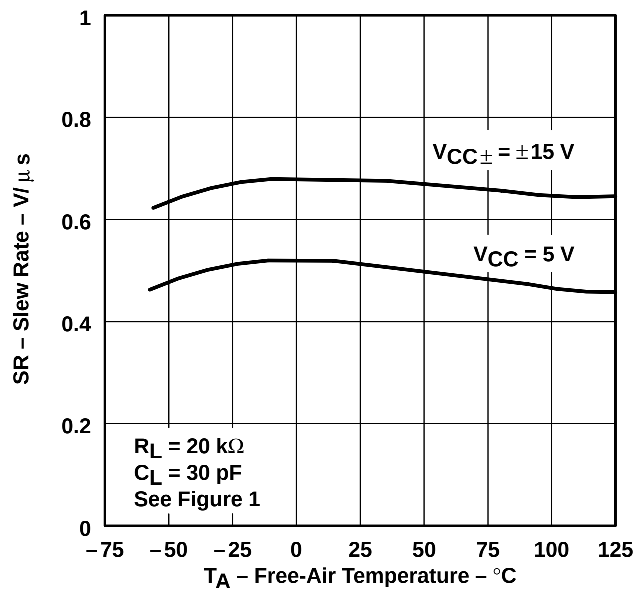


Figure 48

TLE2024
SLEW RATE†
vs
FREE-AIR TEMPERATURE

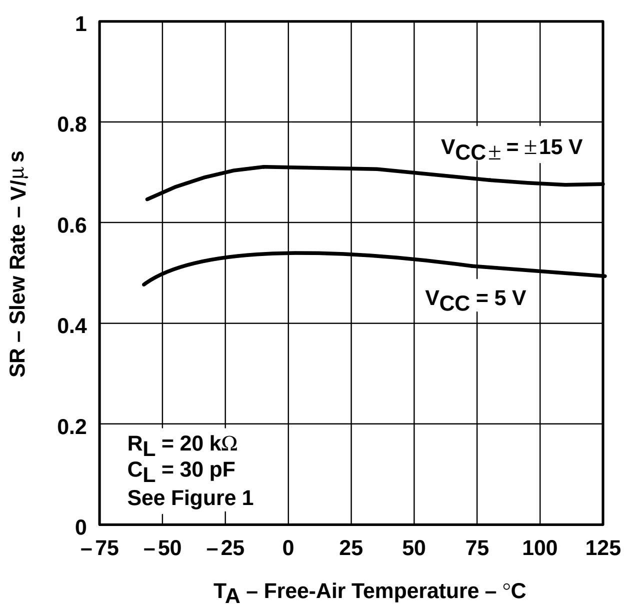


Figure 49

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

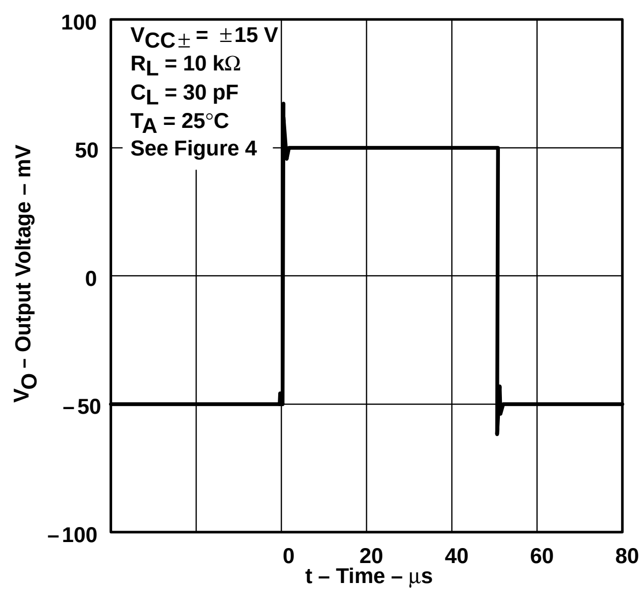


Figure 50

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

VOLTAGE-FOLLOWER
SMALL-SIGNAL
PULSE RESPONSE

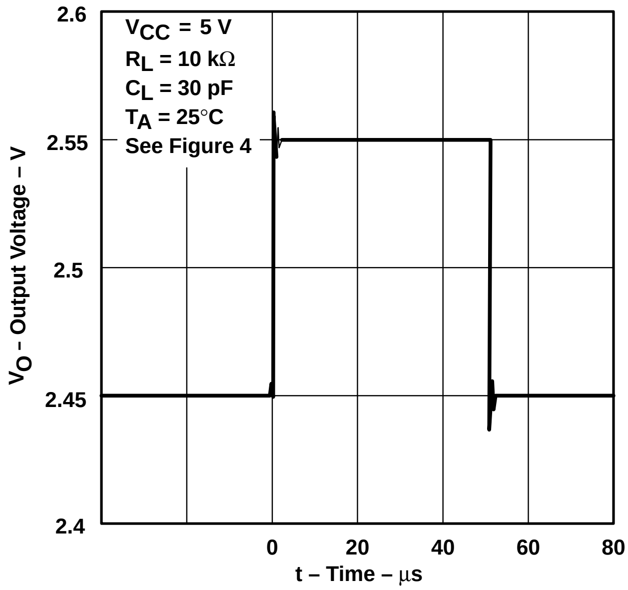


Figure 51

TLE2021
VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE

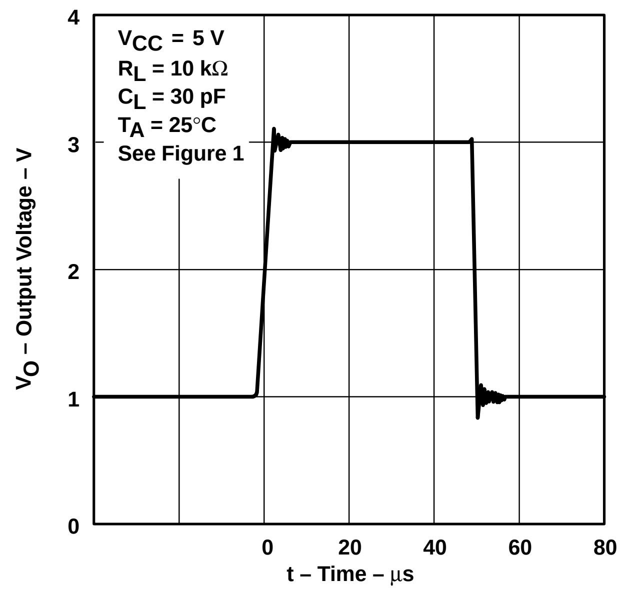


Figure 52

TLE2022
VOLTAGE-FOLLOWER LARGE-SIGNAL
PULSE RESPONSE

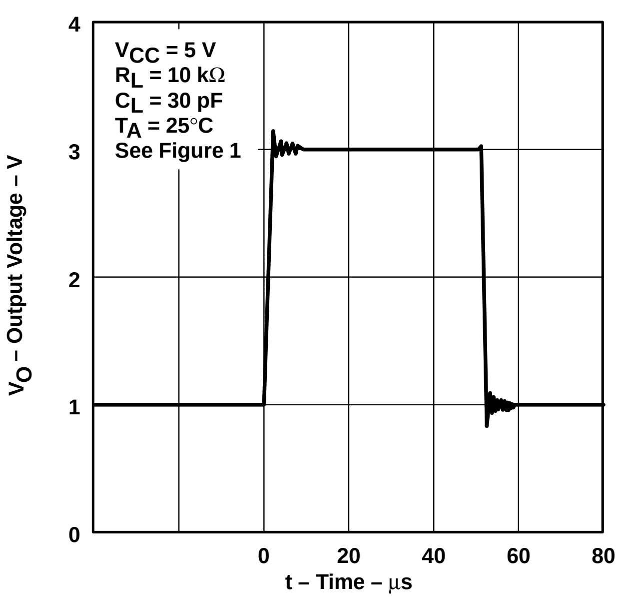


Figure 53

TLE2024
VOLTAGE-FOLLOWER LARGE-SCALE
PULSE RESPONSE

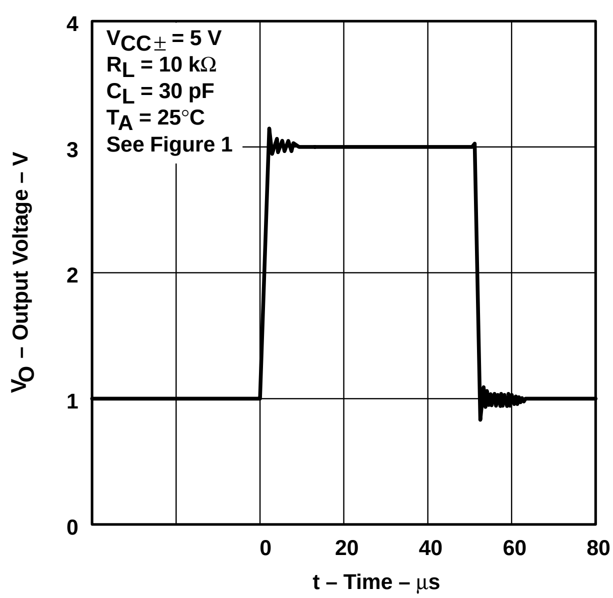


Figure 54

TYPICAL CHARACTERISTICS

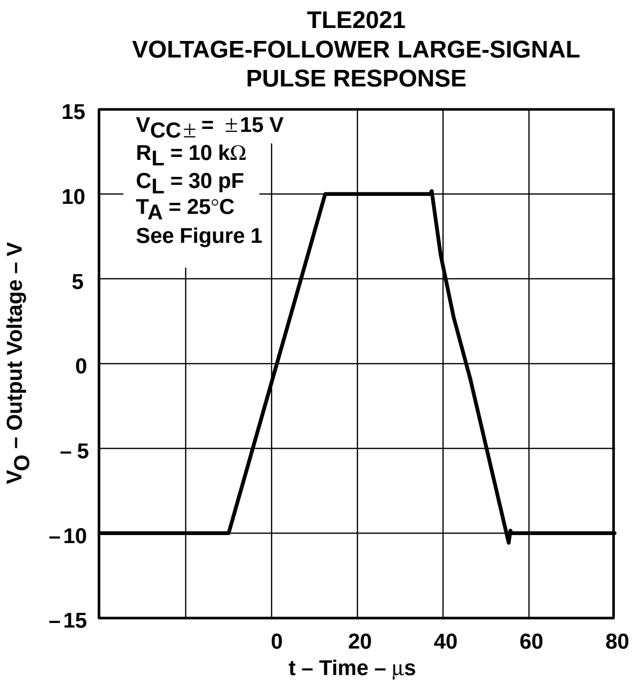


Figure 55

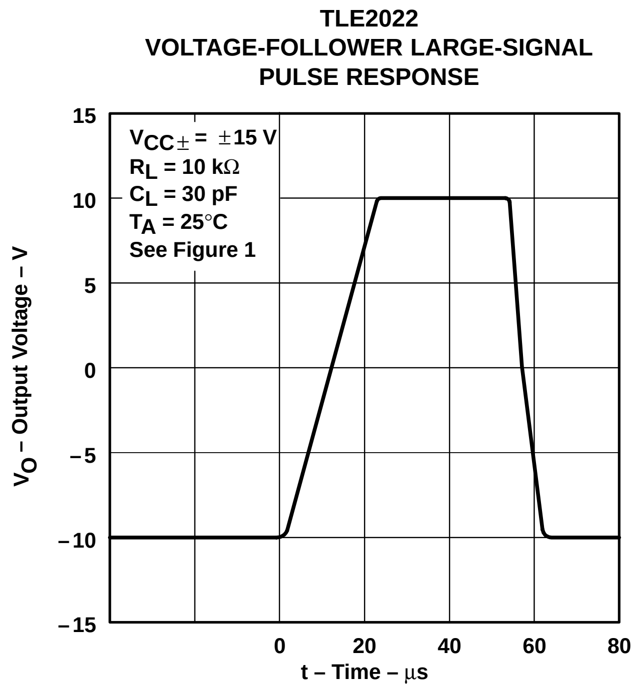


Figure 56

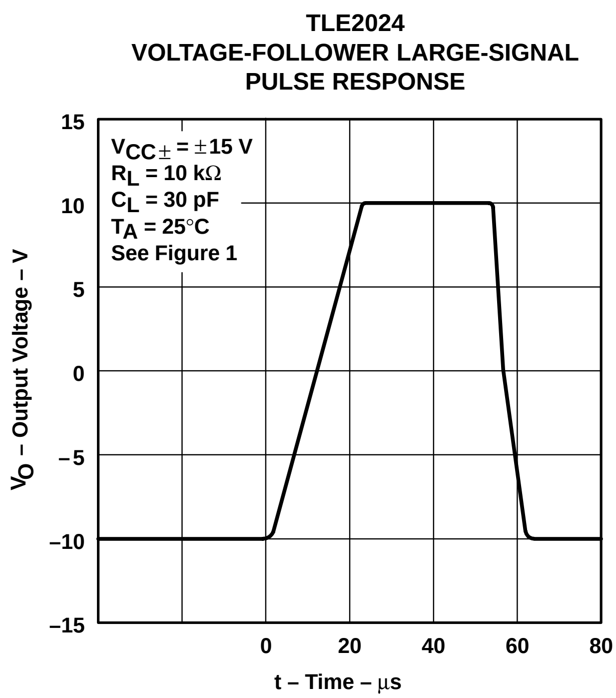


Figure 57

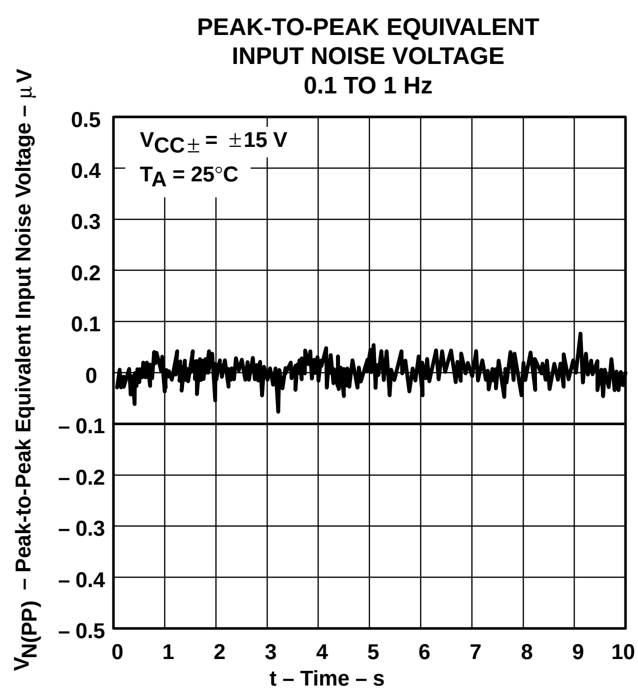


Figure 58

TYPICAL CHARACTERISTICS

PEAK-TO-PEAK EQUIVALENT INPUT NOISE VOLTAGE 0.1 TO 10 Hz

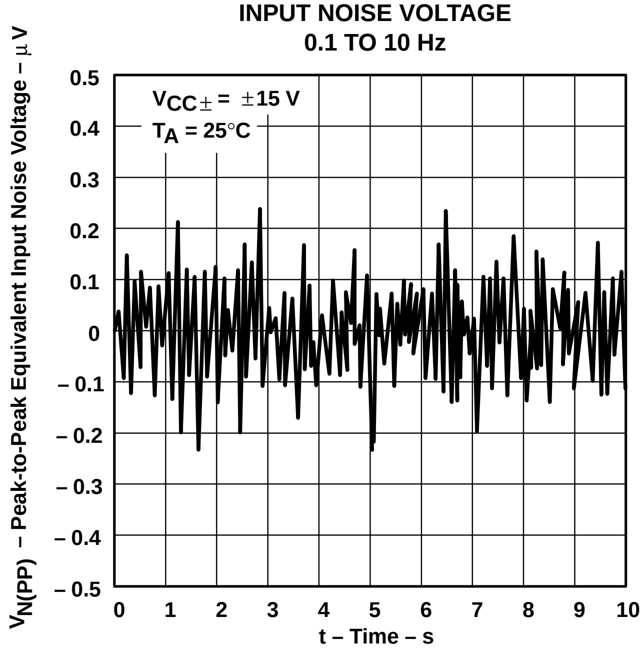


Figure 59

EQUIVALENT INPUT NOISE VOLTAGE vs FREQUENCY

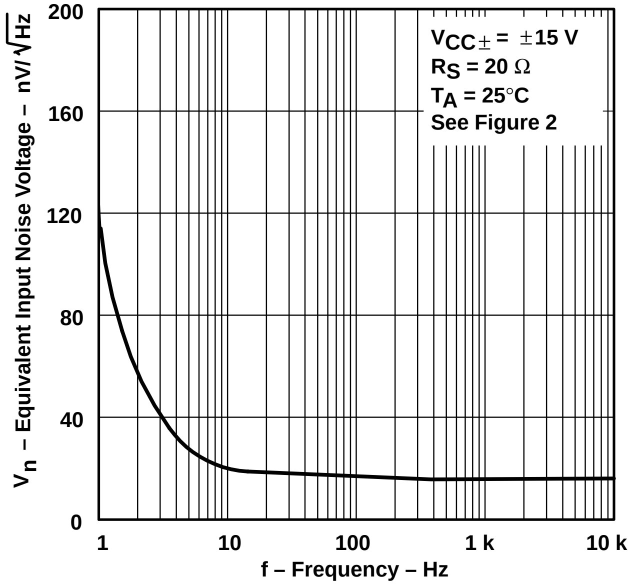


Figure 60

TLE2021 UNITY-GAIN BANDWIDTH vs SUPPLY VOLTAGE

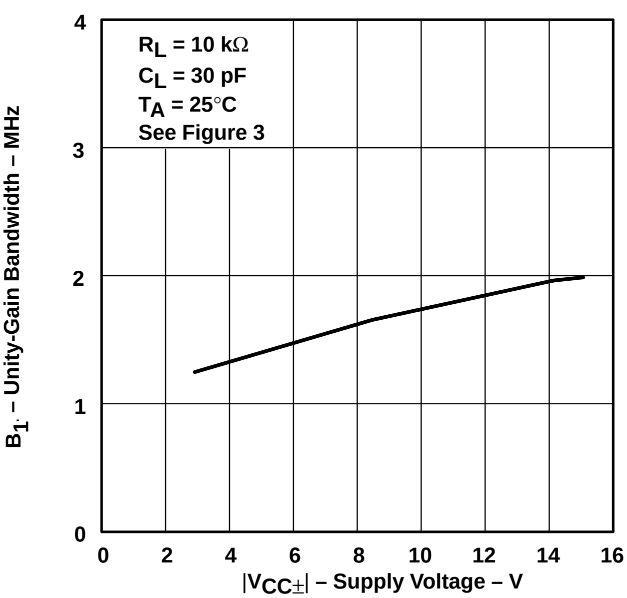


Figure 61

TLE2022 AND TLE2024 UNITY-GAIN BANDWIDTH vs SUPPLY VOLTAGE

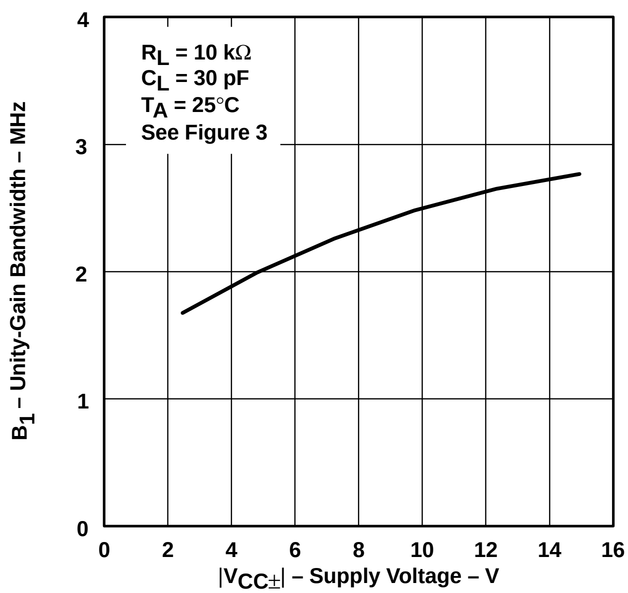


Figure 62

TYPICAL CHARACTERISTICS

TLE2021
UNITY-GAIN BANDWIDTH†
vs
FREE-AIR TEMPERATURE

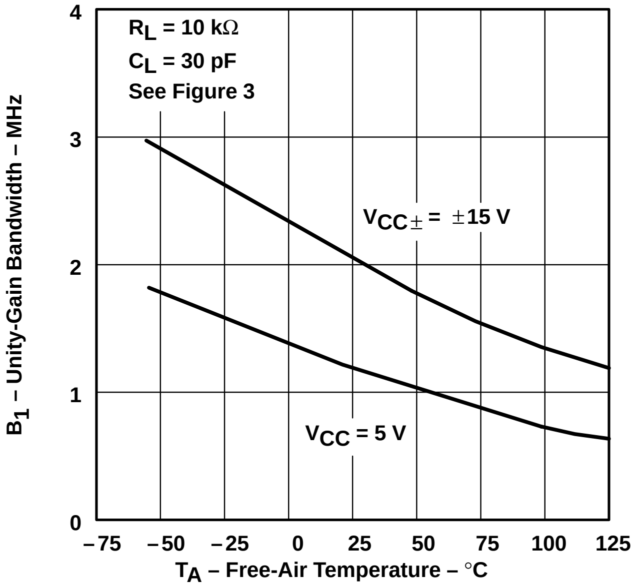


Figure 63

TLE2022 AND TLE2024
UNITY-GAIN BANDWIDTH†
vs
FREE-AIR TEMPERATURE

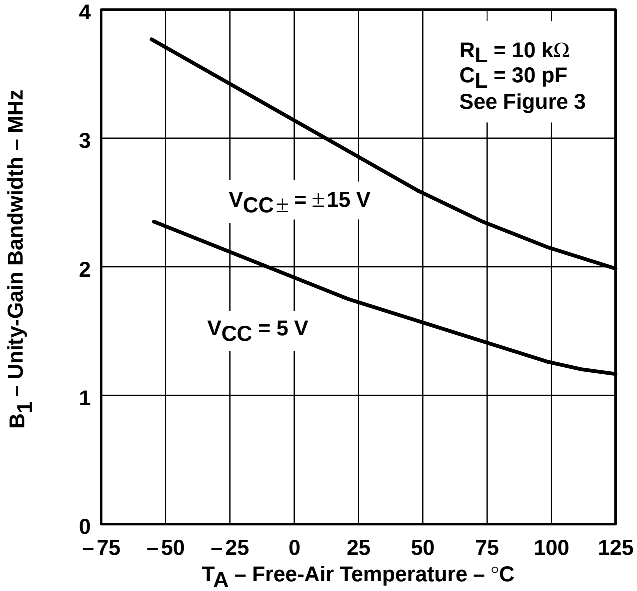


Figure 64

TLE2021
PHASE MARGIN
vs
SUPPLY VOLTAGE

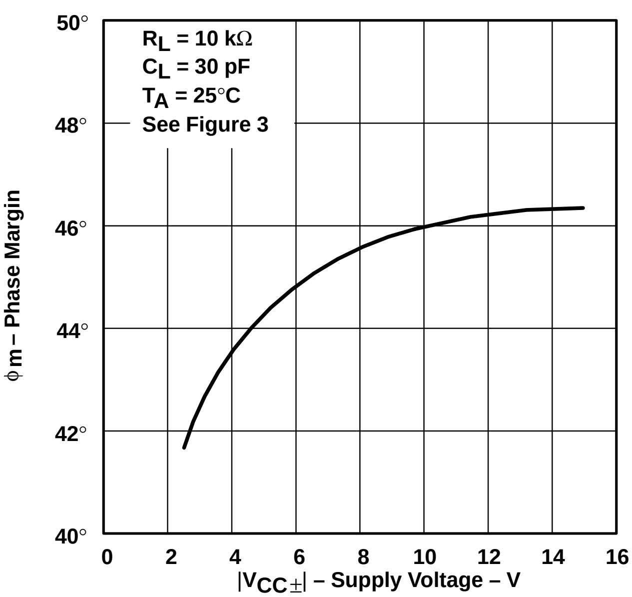


Figure 65

TLE2022 AND TLE2024
PHASE MARGIN
vs
SUPPLY VOLTAGE

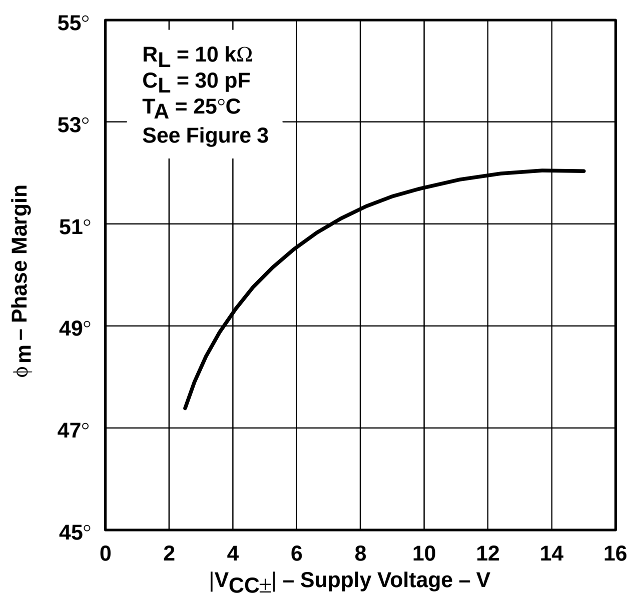


Figure 66

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

TYPICAL CHARACTERISTICS

TLE2021
PHASE MARGIN
vs
LOAD CAPACITANCE

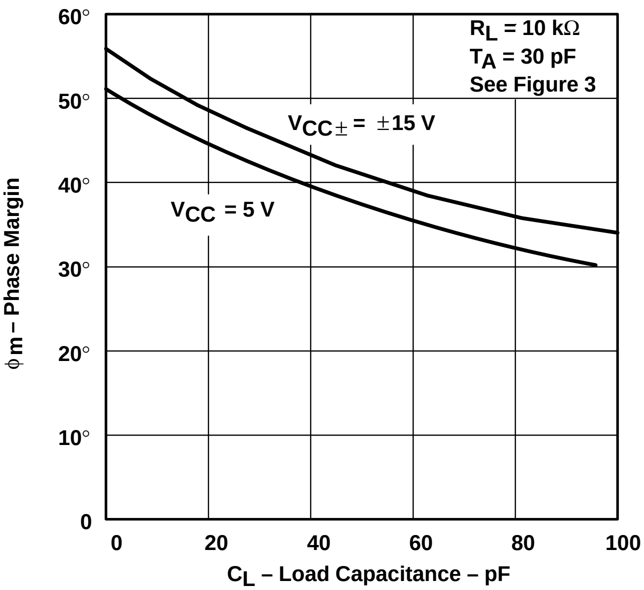


Figure 67

TLE2022 AND TLE2024
PHASE MARGIN
vs
LOAD CAPACITANCE

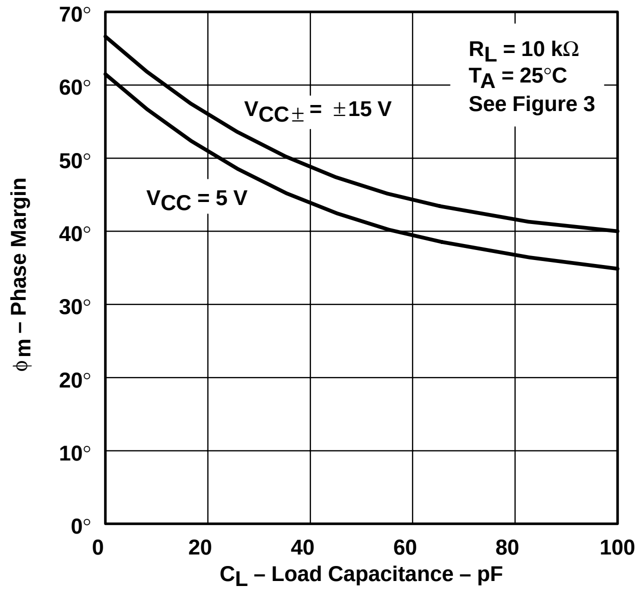


Figure 68

TLE2021
PHASE MARGIN†
vs
FREE-AIR TEMPERATURE

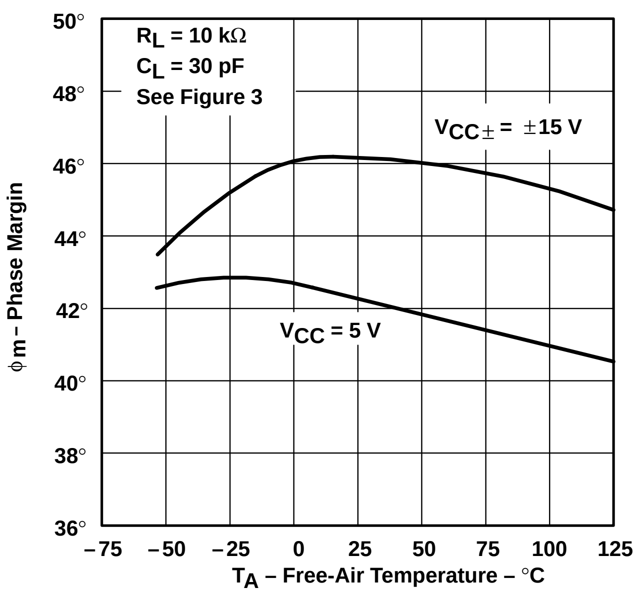


Figure 69

TLE2022 AND TLE2024
PHASE MARGIN†
vs
FREE-AIR TEMPERATURE

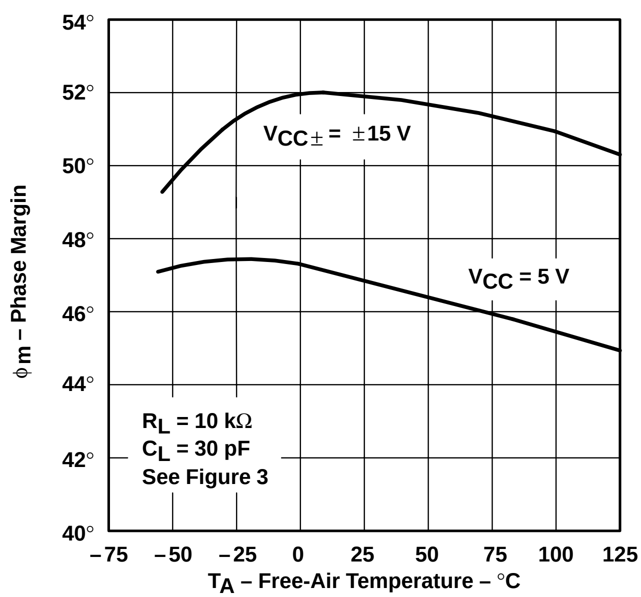


Figure 70

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.

APPLICATION INFORMATION

voltage-follower applications

The TLE202x circuitry includes input-protection diodes to limit the voltage across the input transistors; however, no provision is made in the circuit to limit the current if these diodes are forward biased. This condition can occur when the device is operated in the voltage-follower configuration and driven with a fast, large-signal pulse. It is recommended that a feedback resistor be used to limit the current to a maximum of 1 mA to prevent degradation of the device. This feedback resistor forms a pole with the input capacitance of the device. For feedback resistor values greater than 10 kΩ, this pole degrades the amplifier phase margin. This problem can be alleviated by adding a capacitor (20 pF to 50 pF) in parallel with the feedback resistor (see Figure 71).

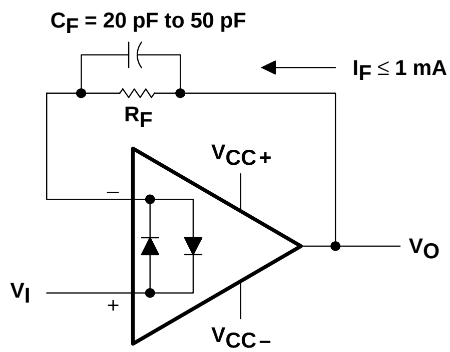


Figure 71. Voltage Follower

Input offset voltage nulling

The TLE202x series offers external null pins that further reduce the input offset voltage. The circuit in Figure 72 can be connected as shown if this feature is desired. When external nulling is not needed, the null pins may be left disconnected.

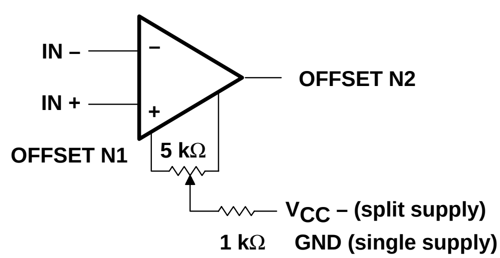


Figure 72. Input Offset Voltage Null Circuit

APPLICATION INFORMATION

macromodel information

Macromodel information provided was derived using Microsim *Parts*™, the model generation software used with Microsim *PSpice*™. The Boyle macromodel (see Note 5) and subcircuit in Figure 73, Figure 74, and Figure 75 were generated using the TLE202x typical electrical and operating characteristics at 25°C. Using this information, output simulations of the following key parameters can be generated to a tolerance of 20% (in most cases):

- Maximum positive output voltage swing
- Maximum negative output voltage swing
- Slew rate
- Quiescent power dissipation
- Input bias current
- Open-loop voltage amplification
- Unity-gain frequency
- Common-mode rejection ratio
- Phase margin
- DC output resistance
- AC output resistance
- Short-circuit output current limit

NOTE 5: G. R. Boyle, B. M. Cohn, D. O. Pederson, and J. E. Solomon, “Macromodeling of Integrated Circuit Operational Amplifiers”**,** *IEEE Journal of Solid-State Circuits*, SC-9, 353 (1974).

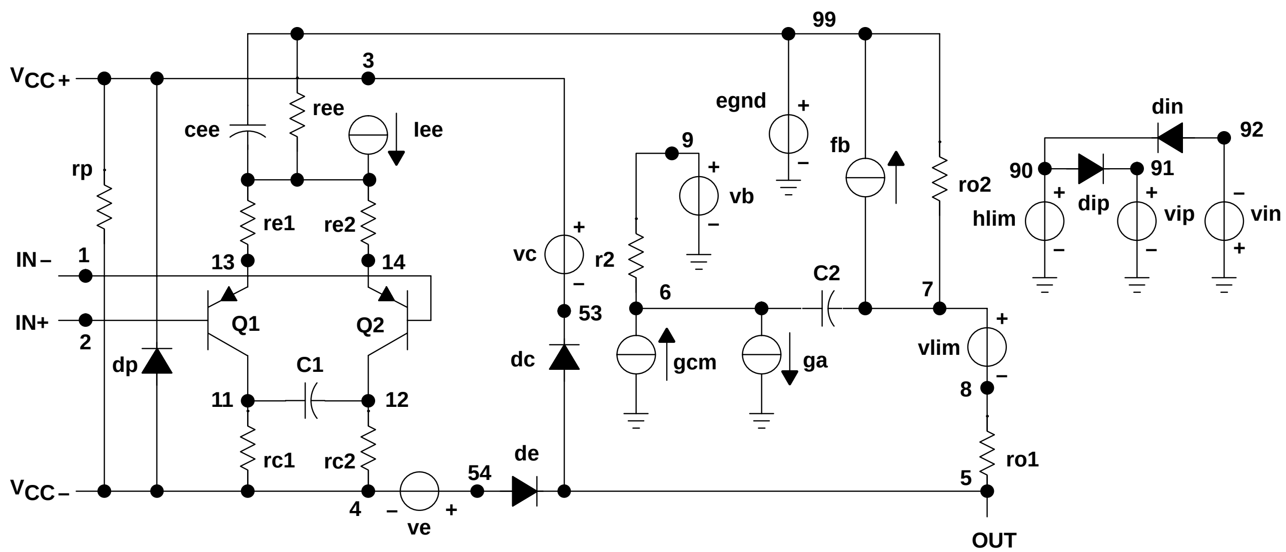


Figure 73. Boyle Subcircuit

PSpice and *Parts* are trademarks of MicroSim Corporation.

```
.SUBCKT TLE2021  1 2 3 4 5
*
   c1     11   12 6.244E–12
   c2     6    7  13.4E–12
   c3     87   0  10.64E–9
   cpsr   85   86 15.9E–9
   dcm+   81   82 dx
   dcm–   83   81 dx
   dc     5    53 dx
   de     54   5  dx
   dlp    90   91 dx
   dln    92   90 dx
   dp     4    3  dx
   ecmr   84   99 (2 99) 1
   egnd   99   0  poly(2) (3,0) (4,0) 0 .5 .5
   epsr   85   0  poly(1) (3,4) –60E–6  2.0E–6
   ense   89   2  poly(1) (88,0) 120E–6  1
   fb     7    99 poly(6) vb vc ve vlp vln vpsr 0 547.3E6
   + –50E7 50E7 50E7 –50E7 547E6
   ga     6    0  11 12 188.5E–6
   gcm    0    6  10 99 335.2E–12
   gpsr   85   86 (85,86) 100E–6
   grc1   4    11 (4,11) 1.885E–4
   grc2   4    12 (4,12) 1.885E–4
   gre1   13   10 (13,10) 6.82E–4
   gre2   14   10 (14,10) 6.82E–4
   hlim   90   0  vlim 1k
   hcmr   80   1  poly(2) vcm+ vcm– 0 1E2 1E2
   irp    3    4  185E–6
   iee    3    10 dc 15.67E–6
   iio    2    0  2E–9
   i1     88   0  1E–21
   q1     11   89 13 qx
   q2     12   80 14 qx
   R2     6    9  100.0E3
   rcm    84   81 1K
   ree    10   99 14.76E6
   rn1    87   0  2.55E8
   rn2    87   88 11.67E3
   ro1    8    5  62
   ro2    7    99 63
   vcm+   82   99 13.3
   vcm–   83   99 –14.6
   vb     9    0  dc 0
   vc     3    53 dc 1.300
   ve     54   4  dc 1.500
   vlim   7    8  dc 0
   vlp    91   0  dc 3.600
   vln    0    92 dc 3.600
   vpsr   0    86 dc 0
.model dx d(is=800.0E–18)
.model qx pnp(is=800.0E–18 bf=270)
.ends
```

Figure 74. Boyle Macromodel for the TLE2021

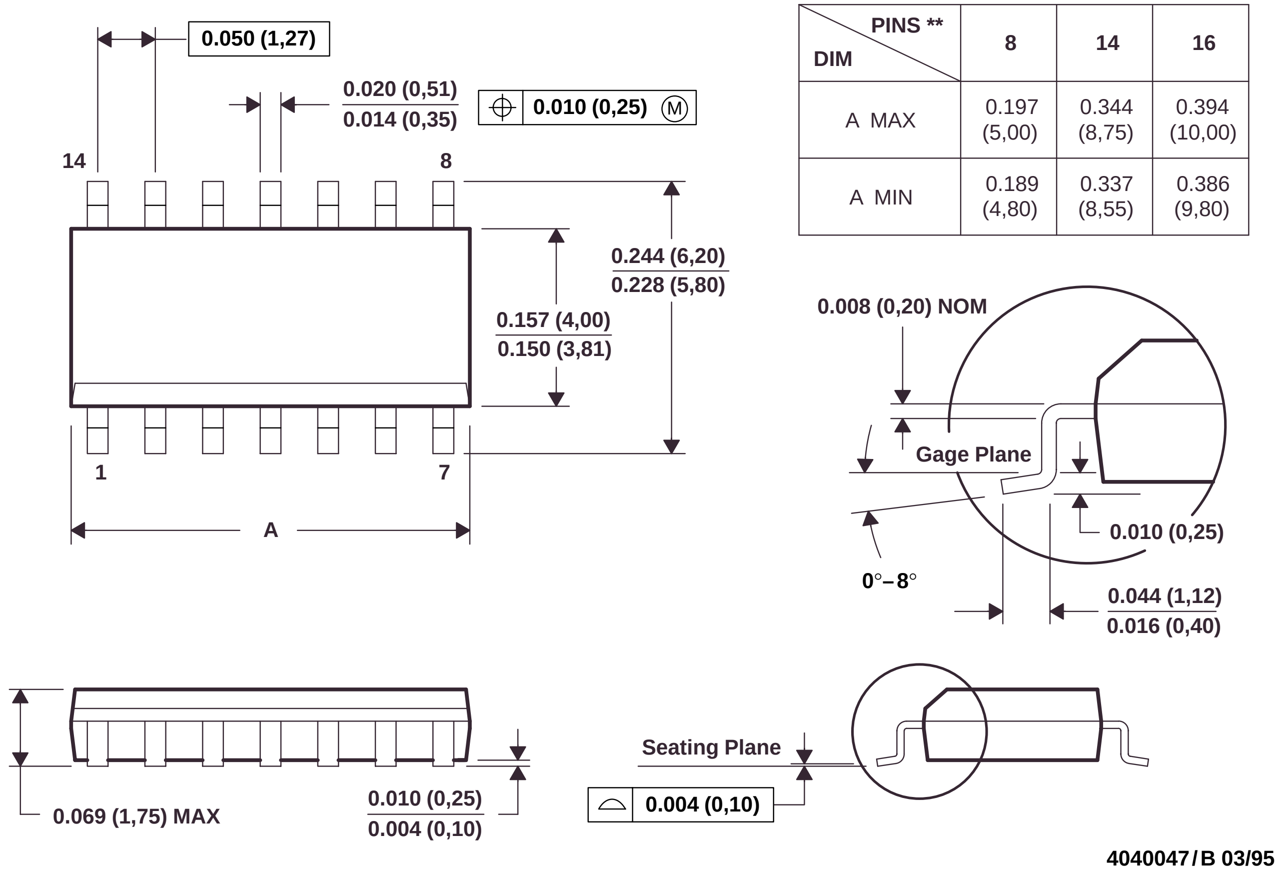
```
.SUBCKT TLE2022  1 2 3 4 5
*
  c1    11  12 6.814E–12
  c2    6   7  20.00E–12
  dc    5   53 dx
  de    54  5 dx
  dlp   90  91 dx
  dln   92  90 dx
  dp    4   3 dx
  egnd 99   0  poly(2) (3,0) (4,0) 0 .5 .5
  fb    7   99 poly(5) vb vc ve vlp vln 0
+ 45.47E6 –50E6 50E6 50E6 –50E6
  ga 6  0   11 12 377.9E–6
  gcm 0 6   10 99 7.84E–10
  iee   3   10 DC 18.07E–6
  hlim 90   0 vlim 1k
  q1    11  2 13 qx
  q2    12  1 14 qx
  r2    6   9 100.0E3
  rc1   4   11 2.842E3
  rc2   4   12 2.842E3
  ge1   13  10 (10,13) 31.299E–3
  ge2   14  10 (10,14) 31.299E–3
  ree   10  99 11.07E6
  ro1   8   5 250
  ro2   7   99 250
  rp    3   4 137.2E3
  vb    9   0 dc 0
  vc    3   53 dc 1.300
  ve    54  4 dc 1.500
  vlim 7    8 dc 0
  vlp   91  0 dc 3
  vln   0   92 dc 3
.model dx  d(is=800.0E–18)
.model qx  pnp(is=800.0E–18 bf=257.1)
.ends
```

Figure 75. Boyle Macromodel for the TLE2022

MECHANICAL INFORMATION

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

14 PIN SHOWN



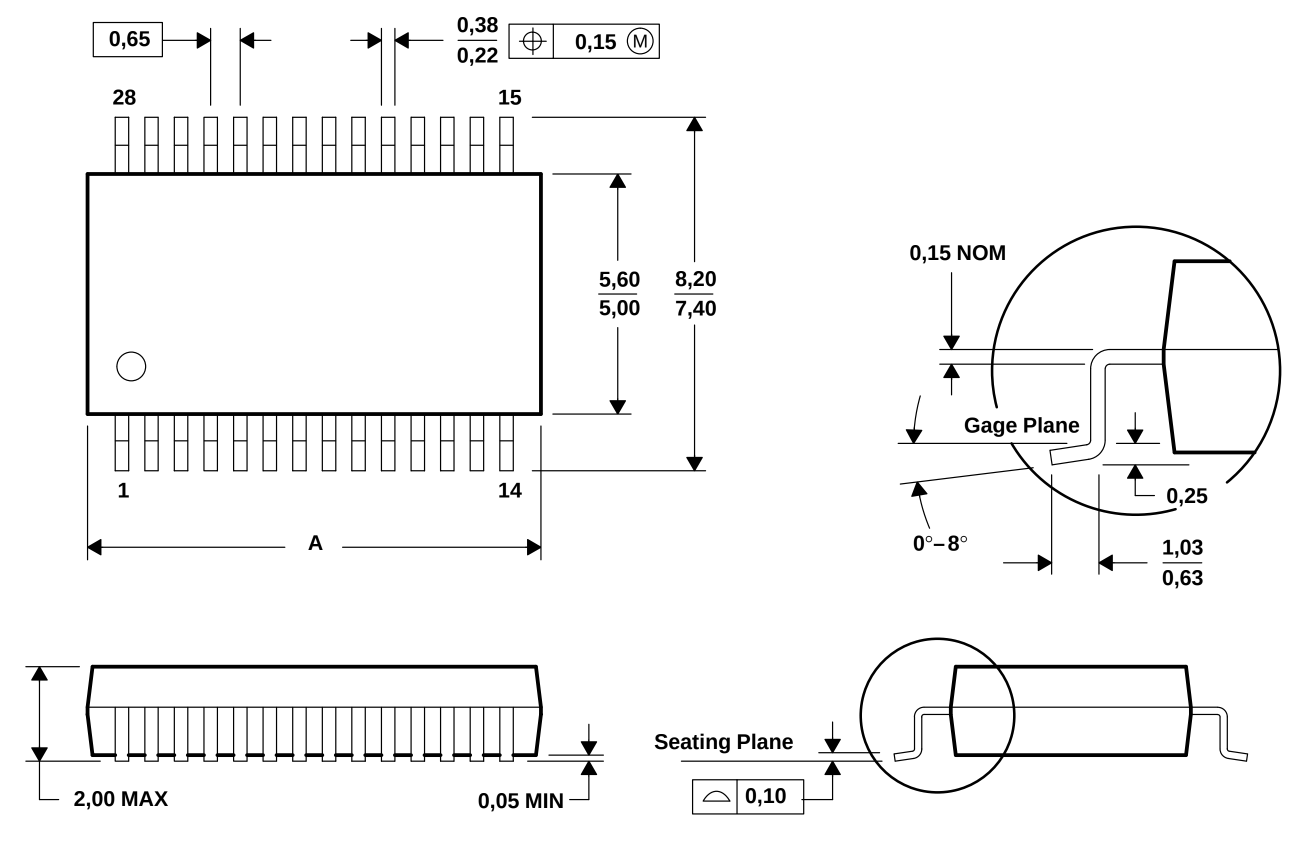
DIM \ PINS **	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

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. Four center pins are connected to die mount pad.
E. Falls within JEDEC MS-012

MECHANICAL INFORMATION

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

28 PIN SHOWN



PINS ** / DIM	8	14	16	20	24	28	30	38
A MAX	3,30	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	2,70	5,90	5,90	6,90	7,90	9,90	9,90	12,30

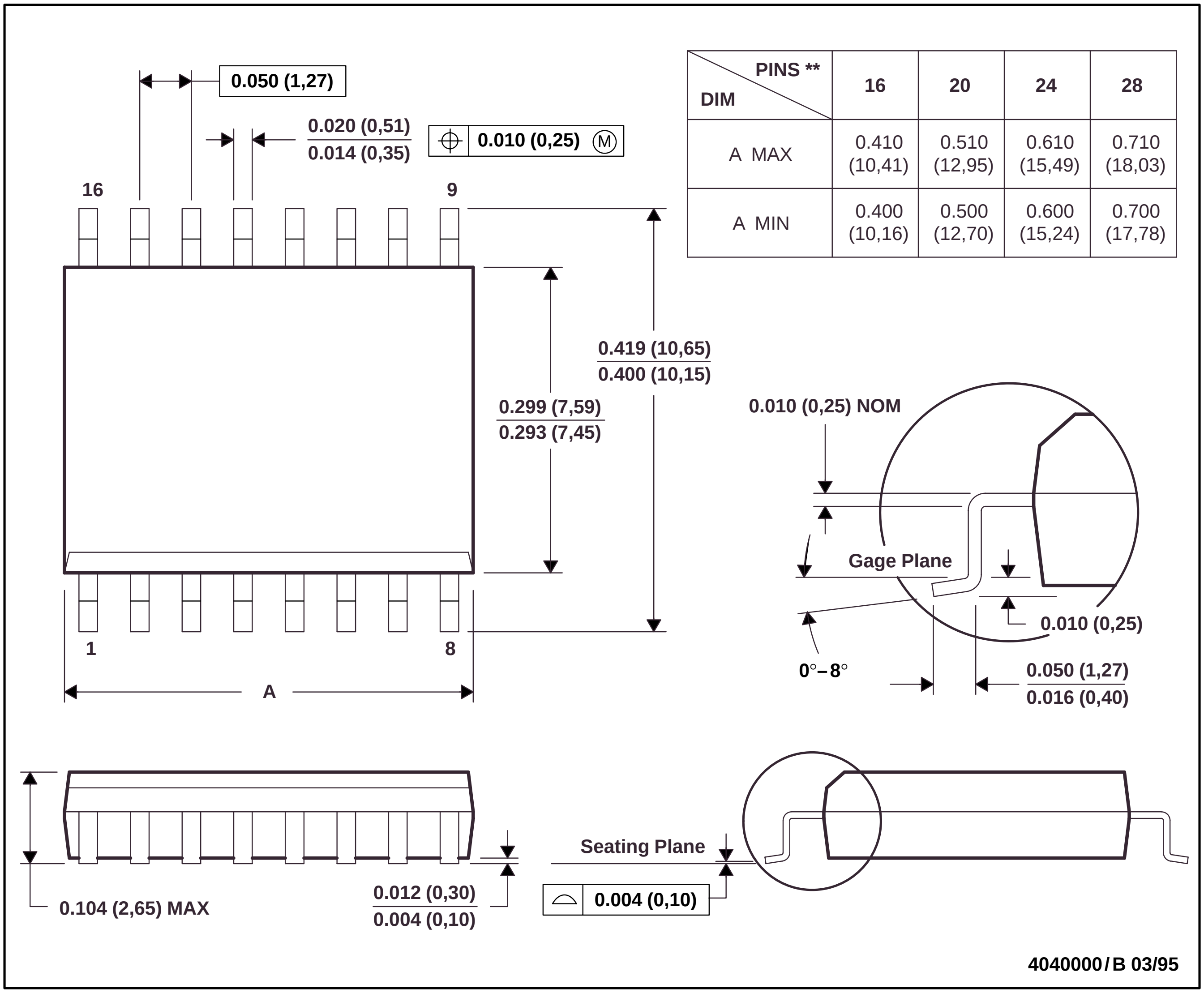
4040065 / C 10/95

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-150

MECHANICAL INFORMATION

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

16 PIN SHOWN



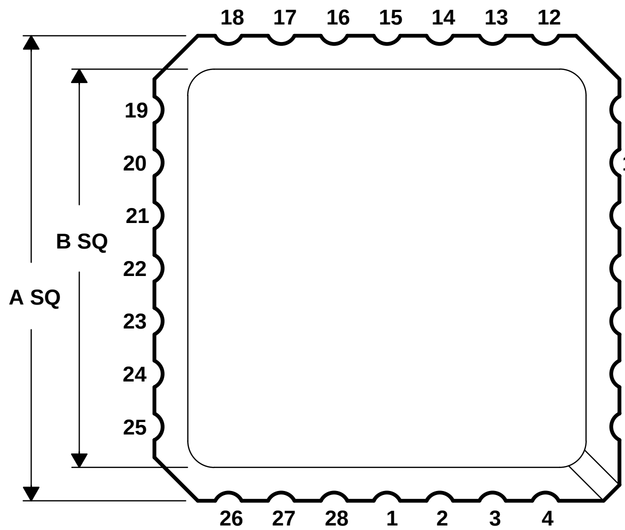
DIM \ PINS **	16	20	24	28
A MAX	0.410 (10,41)	0.510 (12,95)	0.610 (15,49)	0.710 (18,03)
A MIN	0.400 (10,16)	0.500 (12,70)	0.600 (15,24)	0.700 (17,78)

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-013

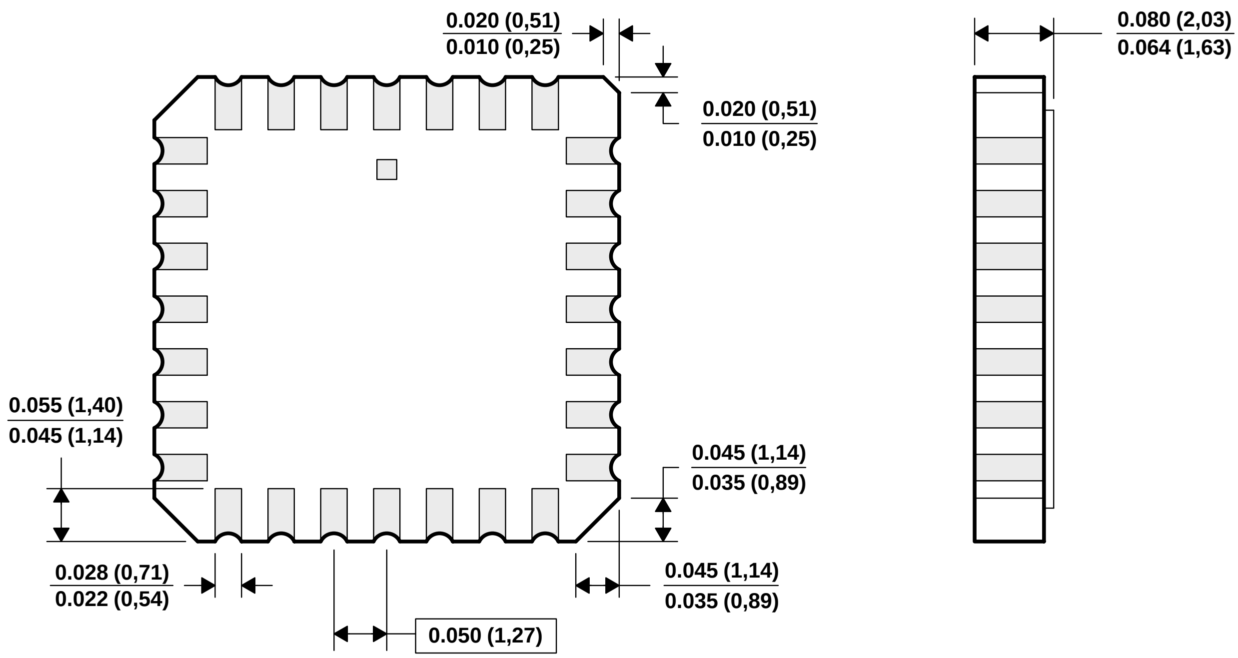
MECHANICAL INFORMATION

FK (S-CQCC-N)** **LEADLESS CERAMIC CHIP CARRIER**

28 TERMINAL SHOWN



NO. OF TERMINALS **	A		B	
	MIN	MAX	MIN	MAX
20	0.342 (8,69)	0.358 (9,09)	0.307 (7,80)	0.358 (9,09)
28	0.442 (11,23)	0.458 (11,63)	0.406 (10,31)	0.458 (11,63)
44	0.640 (16,26)	0.660 (16,76)	0.495 (12,58)	0.560 (14,22)
52	0.739 (18,78)	0.761 (19,32)	0.495 (12,58)	0.560 (14,22)
68	0.938 (23,83)	0.962 (24,43)	0.850 (21,6)	0.858 (21,8)
84	1.141 (28,99)	1.165 (29,59)	1.047 (26,6)	1.063 (27,0)



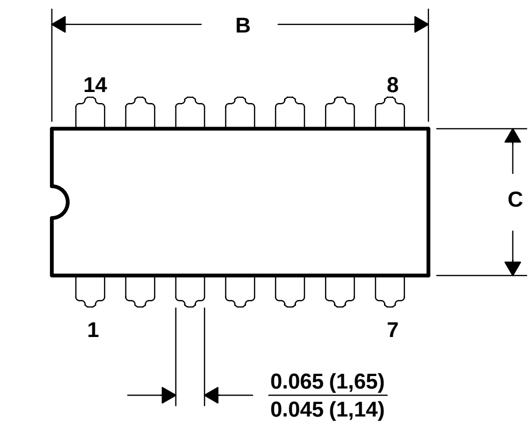
4040140 / D 10/96

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a metal lid.
D. The terminals are gold plated.
E. Falls within JEDEC MS-004

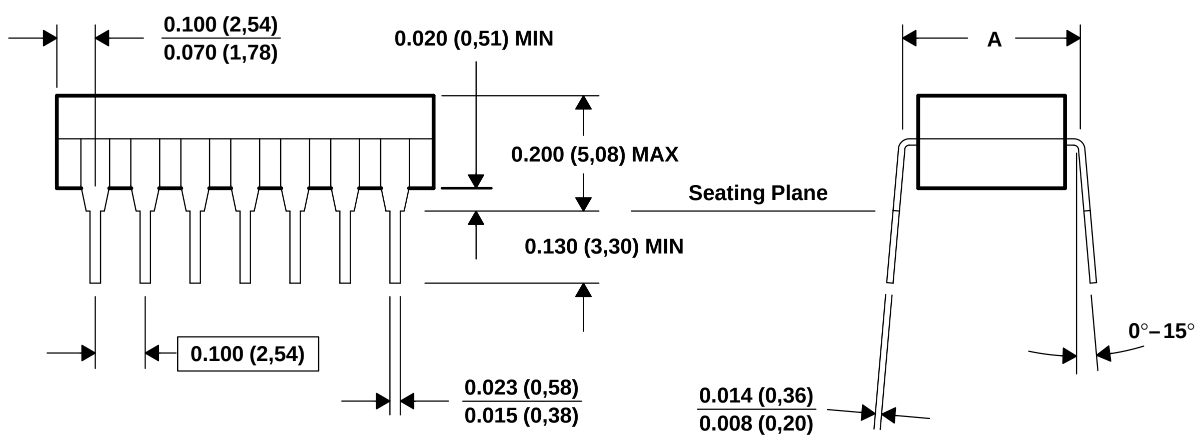
MECHANICAL INFORMATION

J (R-GDIP-T)** **CERAMIC DUAL-IN-LINE PACKAGE**

14 PIN SHOWN



DIM \ PINS **	14	16	18	20	22
A MAX	0.310 (7,87)	0.310 (7,87)	0.310 (7,87)	0.310 (7,87)	0.410 (10,41)
A MIN	0.290 (7,37)	0.290 (7,37)	0.290 (7,37)	0.290 (7,37)	0.390 (9,91)
B MAX	0.785 (19,94)	0.785 (19,94)	0.910 (23,10)	0.975 (24,77)	1.100 (28,00)
B MIN	0.755 (19,18)	0.755 (19,18)	—	0.930 (23,62)	—
C MAX	0.280 (7,11)	0.300 (7,62)	0.300 (7,62)	0.300 (7,62)	0.388 (9,65)
C MIN	0.245 (6,22)	0.245 (6,22)	0.245 (6,22)	0.245 (6,22)	—

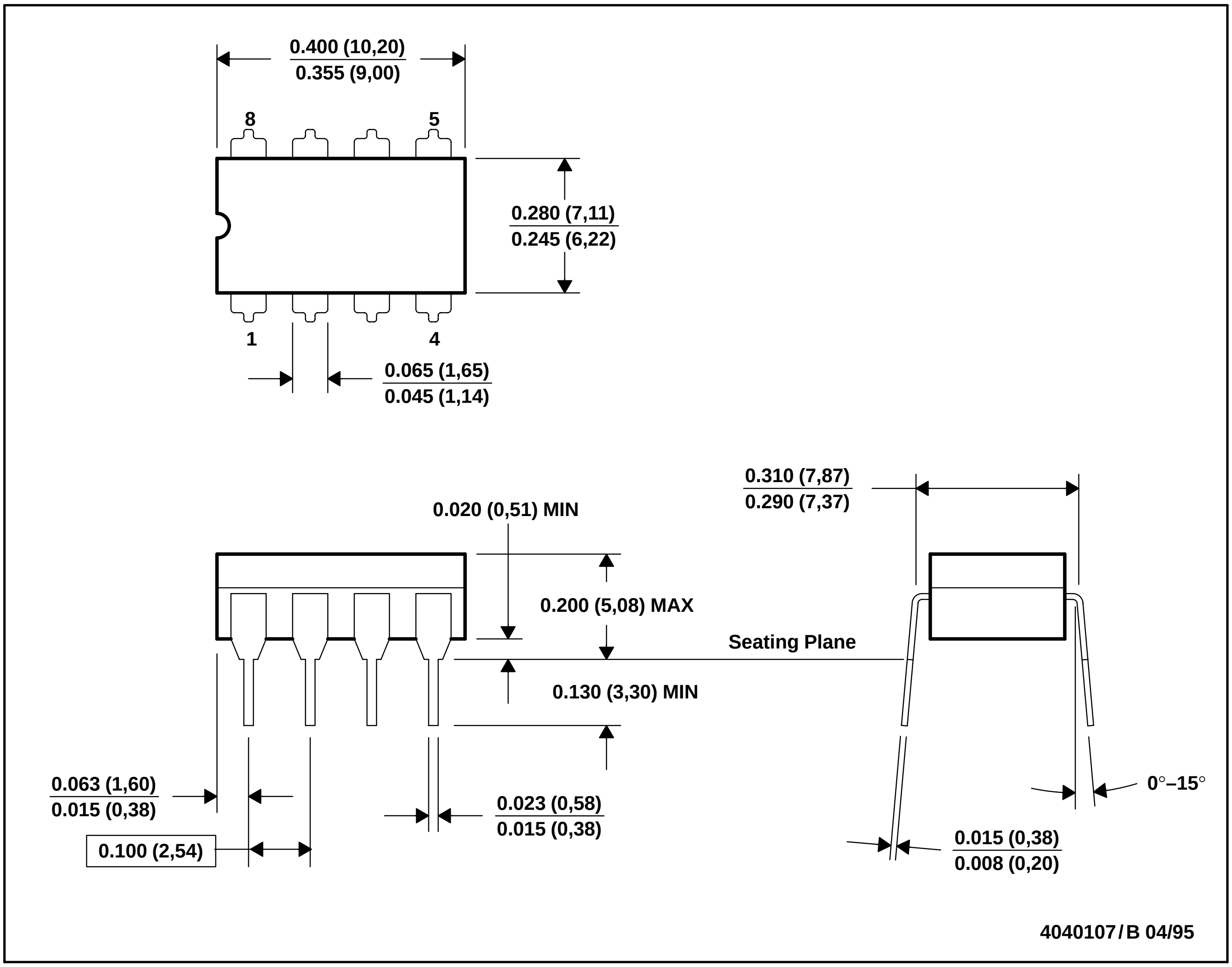


4040083/B 04/95

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
E. Falls within MIL-STD-1835 GDIP1-T14, GDIP1-T16, GDIP1-T18, GDIP1-T20, and GDIP1-T22

MECHANICAL INFORMATION

JG (R-GDIP-T8) **CERAMIC DUAL-IN-LINE PACKAGE**



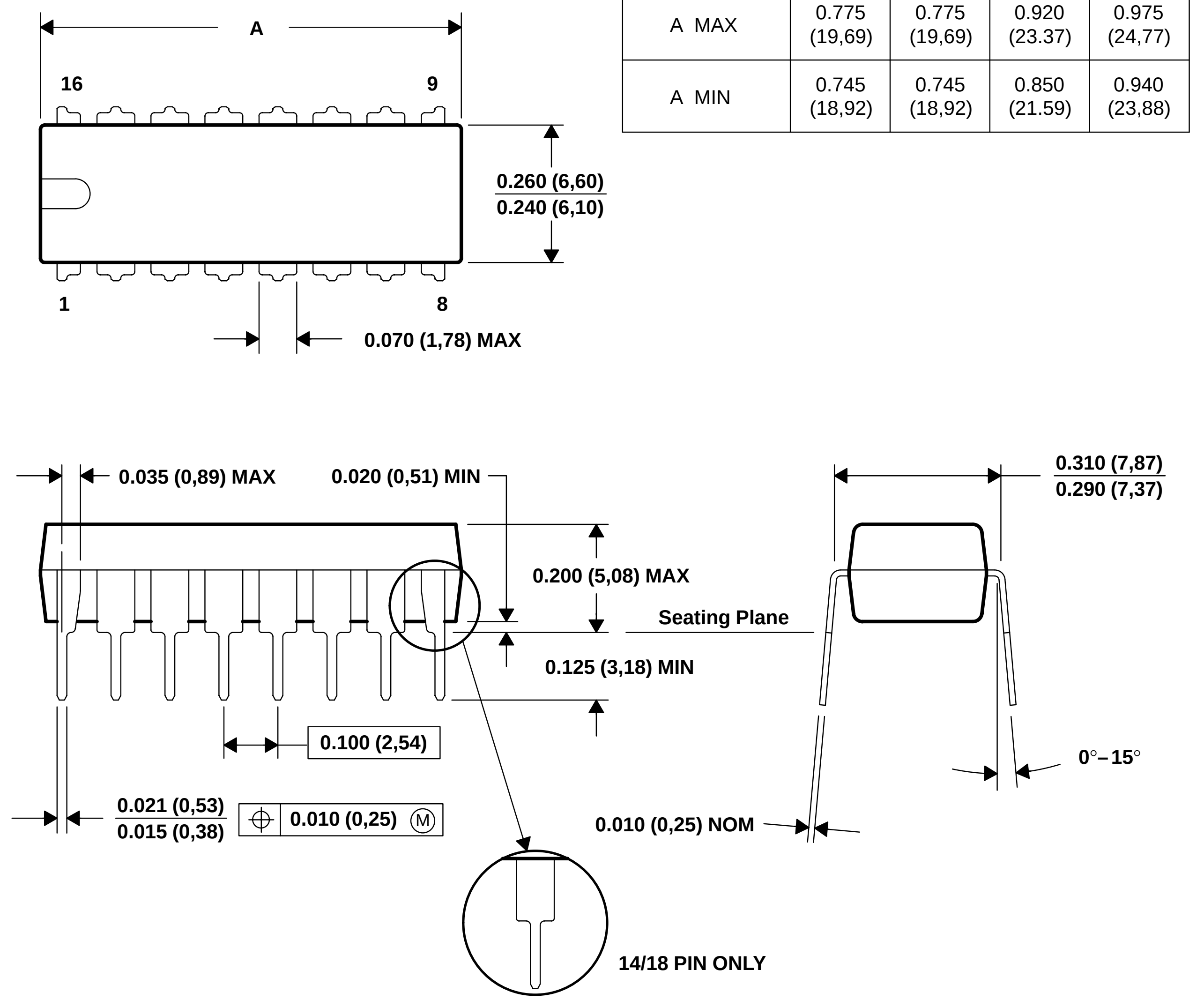
NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. This package can be hermetically sealed with a ceramic lid using glass frit.
D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only
E. Falls within MIL-STD-1835 GDIP1-T8

MECHANICAL INFORMATION

N (R-PDIP-T)** **PLASTIC DUAL-IN-LINE PACKAGE**

16 PIN SHOWN

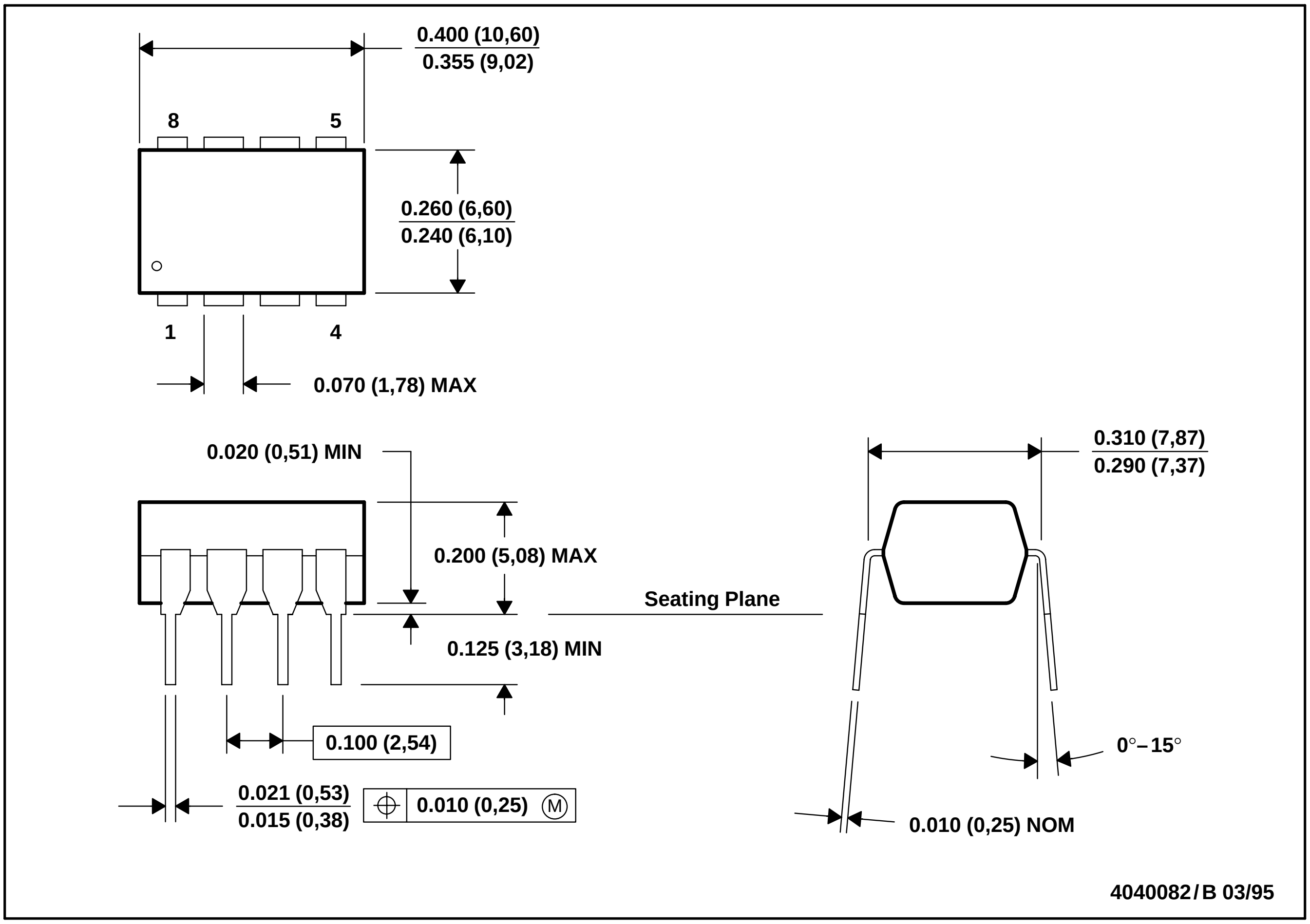
DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23.37)	0.975 (24,77)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21.59)	0.940 (23,88)



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001 (20 pin package is shorter then MS-001.)

MECHANICAL INFORMATION

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE PACKAGE**

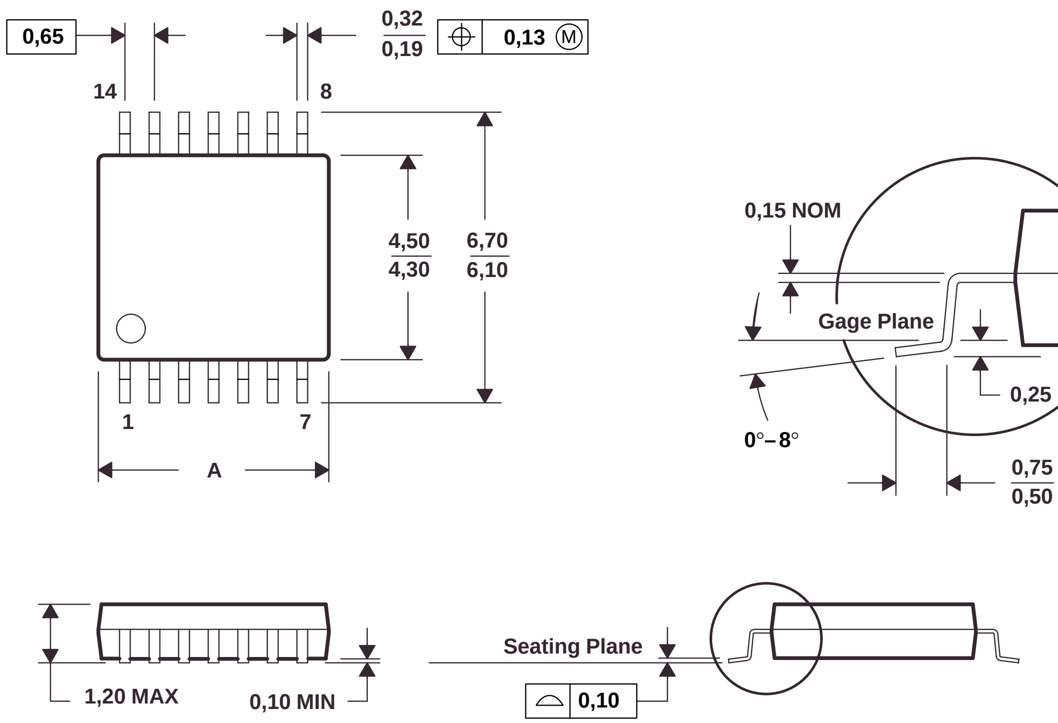


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

MECHANICAL INFORMATION

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

14 PIN 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

4040064/D 10/95

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

IMPORTANT NOTICE

Mailing Address:

Texas Instruments
Post Office Box 655303
Dallas, Texas 75265