DIO264X

Low Power, High Speed, Rail-to-Rail Input and Output CMOS Amplifiers

Features

- Rail-to-rail input and output
- Supply voltage range: 2.7 V to 13.2 V
- Supply current (no load):
  DIO2641: 7 mA
  DIO2642: 14 mA
  DIO2644: 28 mA
- Low offset voltage: ±11 mV (max)
- Output voltage swing: 20 mV from rails
- High gain-bandwidth product:
  105 MHz when V+ = 5 V
- Slew rate (V+ = 5 V, G = −1): 85 V/μs
- Settling time (V+ = 5 V, ±5 V) : 80 ns
- Input voltage noise (100 kHz) 30 nV/√Hz
- Output short protection
- Available packages:
  DIO2641: SOT23-5/SOIC-8
  DIO2642: SOIC-8/MSOP-8
  DIO2644: TSSOP-14/SOP-14

Descriptions

The DIO2641 (single), DIO2642 (dual), and DIO2644 (quad) are amplifiers with low noise, low voltage, and low power operation. The DIO2641/2/4 has a high gain-bandwidth product of 105 MHz, exceptionally high output current (approximately 50 mA) at low cost, and reduced power consumption when compared to existing devices with similar performance.

The DIO2641/2/4 is designed to provide optimal performance in low voltage and low noise systems. All these chips provide rail-to-rail output swing into heavy loads. Fast output Slew Rate (85 V/μs) ensures large peak-to-peak output swings can be maintained even at higher speeds.

They are specified over the extended industrial temperature range (-40°C to 125°C). The operating range is from 2.7 V to 13.2 V.

Applications

- Portable equipment
- Active filters
- Data acquisition
- Test equipment
- Broadband communication
- Industrial control
- Audio and video processing

Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIO2641ST5	WF4A	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000
DIO2641SO8	DIOBF4A	3	Green	-40 to 125°C	SOIC-8	Tape & Reel, 2500
DIO2642SO8	DIOBF4B	3	Green	-40 to 125°C	SOIC-8	Tape & Reel, 2500
DIO2642MP8	DIOBF4B	3	Green	-40 to 125°C	MSOP-8	Tape & Reel, 3000
DIO2644SO14	DIOBF4D	3	Green	-40 to 125°C	SOP-14	Tape & Reel, 2500
DIO2644TP14	DIOBF4D	3	Green	-40 to 125°C	TSSOP-14	Tape & Reel, 2500

Pin Assignments

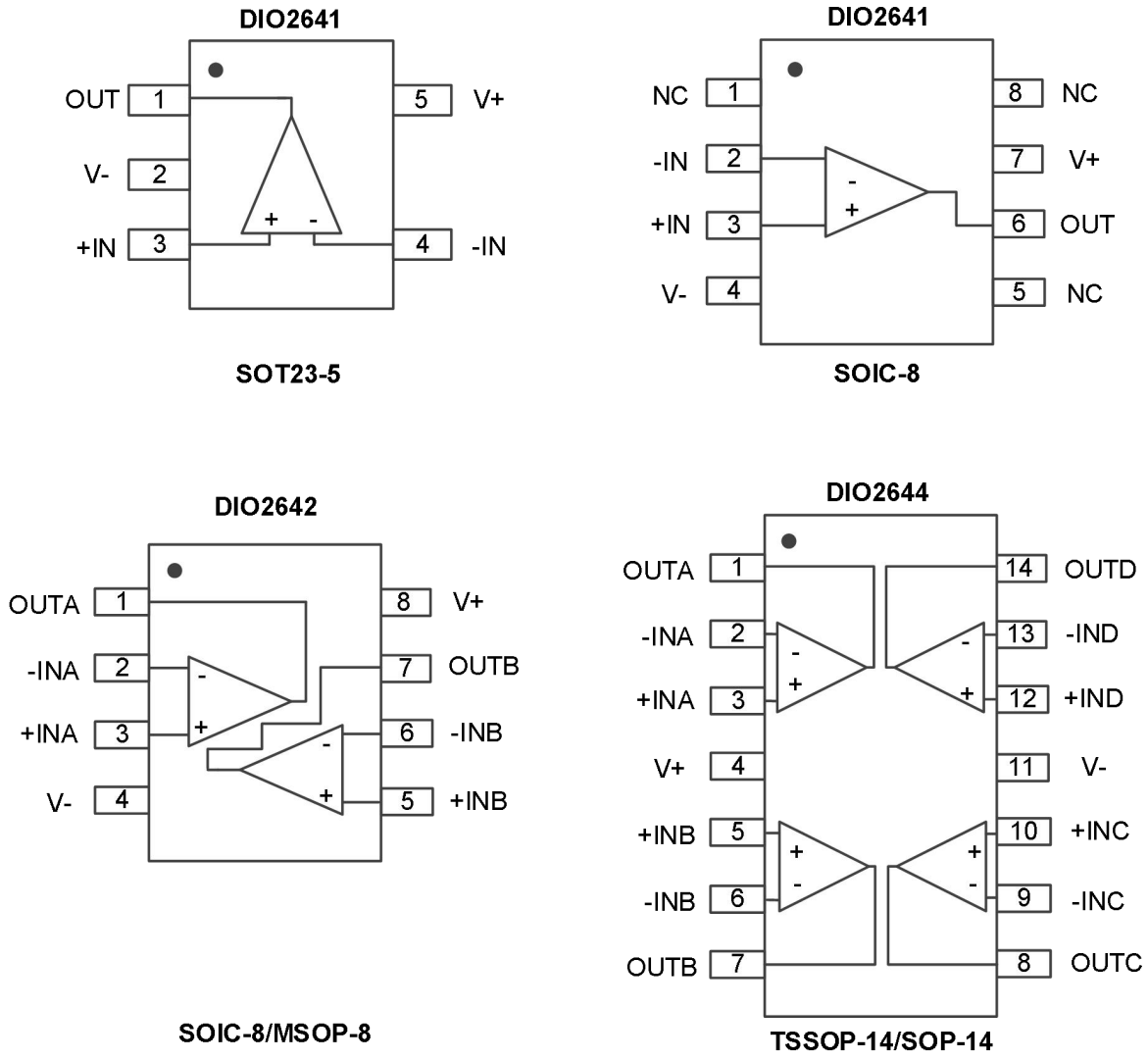


Figure 1. Pin assignment (Top view)

Pin Description

Pin name	Description
V+	Positive supply
V-	Negative supply
+IN (+INA/+INB/+INC/+IND)	Positive input (channel A/B/C/D)
-IN (-INA/-INB/-INC/-IND)	Negative input (channel A/B/C/D)
OUT (OUTA/OUTB/OUTC/OUTD)	Output (channel A/B/C/D)
NC	Do not connect

Absolute Maximum Ratings

Stresses beyond those listed under the Absolute Maximum Rating table may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter			Rating	Unit
V_{CC}	Supply voltage			up to 13.5	V
V_{IN}	Input voltage			(V-)-0.5 to (V+)+0.5	V
T_{STG}	Storage temperature range			-65 to 150	°C
T_J	Junction temperature			150	°C
T_L	Lead temperature range			260	°C
$R_{\theta JA}$	Junction-to-ambient thermal resistance	DIO2641	SOT23-5	265	°C/W
			SOIC-8	190	
		DIO2642	MSOP-8	235	
		DIO2644	SOP-14	145	
			TSSOP-14	155	
ESD	Human body model (HBM), JEDEC JS-001, all pins			±8	kV
	Charged device model (CDM), JEDEC specification JESD22-C101, all pins			±2	kV
Latch up				200	mA

Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. DIOO does not recommend exceeding them or designing to absolute maximum ratings.

Symbol	Parameter	Rating	Unit
V_{CC}	Supply voltage	2.7 to 13.2	V
T_A	Operating temperature range	-40 to 125	°C

3 V Electrical Characteristics

Typical value: T_A = 25°C, V+ = 3 V, V− = 0 V, V_{CM} = V+ /2, R_L = 2 kΩ to V+/2, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Power supply							
PSRR	Power supply rejection ratio	V+ = 3.0 V to 3.5 V, V_{CM} = 1.5 V			95		dB
I_S	Supply current	DIO2641	No load		7		mA
		DIO2642			14		
		DIO2644			28		
Input characteristics							
V_{OS}	Input offset voltage					±9.5	mV
C_{IN}	Common mode input capacitance				6		pF
V_{CM}	Input common-mode voltage range	Low rail			0		V
		High rail			3		V
CMRR	Common mode rejection ratio	V_{CM} stepped from 0 V to 1.5 V			90		dB
G	Open loop voltage gain	R_L = 2 kΩ to V+ /2			101		dB
$\Delta V_{OS}/\Delta T$	Input offset average drift	Offset voltage average drift determined by dividing the change in V_{OS} at temperature extremes by the total temperature change.			±10		μV/°C
Output characteristics							
I_{SC}	Output short circuit current	Sourcing to V-			110		mA
		Sinking to V+			110		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+			38		mA
		V_{OUT} = 0.5 V from V-			36		mA
V_{OUT}	Output swing high	R_L = 2 kΩ to V+ /2		2.98	2.985		V
	Output swing low	R_L = 2 kΩ to V+ /2		15	20		mV
Dynamic performance							
BW	−3 dB BW	G = +1, V_{OUT} = 200 mV_{PP}			90		MHz
		G = +2, V_{OUT} = 200 mV_{PP}			40		MHz
		G = −1, V_{OUT} = 200 mV_{PP}			39		MHz
PBW	Full power bandwidth	G = +1, −1 dB, V_{OUT} = 1 V_{PP}			20		MHz
X_{TALK}	Channel-to-channel crosstalk	f = 80 kHz, receiver: R_F = Rg = 510 Ω, G = +2			87		dB
SR	Slew rate	G = −1, V_I = 2 V_{PP}			65		V/μs
t_S	Settling time	V_{OUT} = 2 V_{PP}, ±0.1%, 8 pF load, V_{CC} = 5 V			85		ns

Noise performance						
THD	Total harmonic distortion	f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 100 Ω to V+ /2		80		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		95		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

5 V Electrical Characteristics

Typical value: T_A = 25°C, V+ = 5 V, V− = 0 V, V_{CM} = V+ /2, R_L = 2 kΩ to V+/2, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Power supply							
PSRR	Power supply rejection ratio	V+ = 4 V to 6 V			95		dB
I_S	Supply current	DIO2641	No load		7		mA
		DIO2642			14		
		DIO2644			28		
Input characteristics							
V_{OS}	Input offset voltage					±11	mV
C_{IN}	Common mode input capacitance				6		pF
V_{CM}	Input common-mode voltage range	Low rail			0		V
		High rail			5		V
CMRR	Common mode rejection ratio	V_{CM} stepped from 0 V to 3.5 V			90		dB
G	Open loop voltage gain	R_L = 2 kΩ to V+ /2			97		dB
$\Delta V_{OS}/\Delta T$	Input offset average drift	Offset voltage average drift determined by dividing the change in V_{OS} at temperature extremes by the total temperature change.			±10		µV/°C
Output characteristics							
I_{SC}	Output short circuit current	Sourcing to V-			110		mA
		Sinking to V+			120		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+			52		mA
		V_{OUT} = 0.5 V from V-			40		mA
V_{OUT}	Output swing high	R_L = 2 kΩ to V+ /2		4.98	4.985		V
	Output swing low	R_L = 2 kΩ to V+ /2		15	20		mV

Dynamic performance						
BW	−3 dB BW	G = +1, V_{OUT} = 200 mV_{PP}		100		MHz
		G = +2, V_{OUT} = 200 mV_{PP}		42		MHz
		G = −1, V_{OUT} = 200 mV_{PP}		42		MHz
PBW	Full power bandwidth	G = +1, −1 dB, V_{OUT} = 2 V_{PP}		20		MHz
X_{TALK}	Channel-to-channel crosstalk	f = 80 kHz, Receiver: R_F = Rg = 510 Ω, G = +2		87		dB
SR	Slew rate	G = −1, V_{IN} = 2 V_{PP}		85		V/μs
t_S	Settling time	V_{OUT} = 2 V_{PP}, ±0.1%, 8 pF Load		80		ns
Noise performance						
THD	Total harmonic distortion	f = 1 kHz, V_O = 2 V_{PP}, G = −1, R_L = 100 Ω to V+ /2		80		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		95		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

±5 V Electrical Characteristics

Typical value: T_A = 25°C, V+ = 5 V, V− = -5 V, V_{CM} = 0 V, R_L = 2 kΩ to ground, unless otherwise specified.

Symbol	Parameter	Conditions		Min	Typ	Max	Unit
Power supply							
PSRR	Power supply rejection ratio	V+ = 4 V to 6 V, V_{CM} = 0 V			95		dB
I_S	Supply current	DIO2641	No load		7		mA
		DIO2642			14		
		DIO2644			28		
Input characteristics							
V_{OS}	Input offset voltage					±11	mV
C_{IN}	Common mode input capacitance				6		pF
V_{CM}	Input common-mode voltage range	Low rail			-5		V
		High rail			5		V
CMRR	Common mode rejection ratio	V_{CM} stepped from 0 V to 3.5 V			90		dB
G	Open loop voltage gain	R_L = 2 kΩ			96		dB
$\Delta V_{OS}/\Delta T$	Input offset average drift	Offset voltage average drift determined by dividing the change in V_{OS} at temperature extremes by the total temperature change.			±10		μV/°C

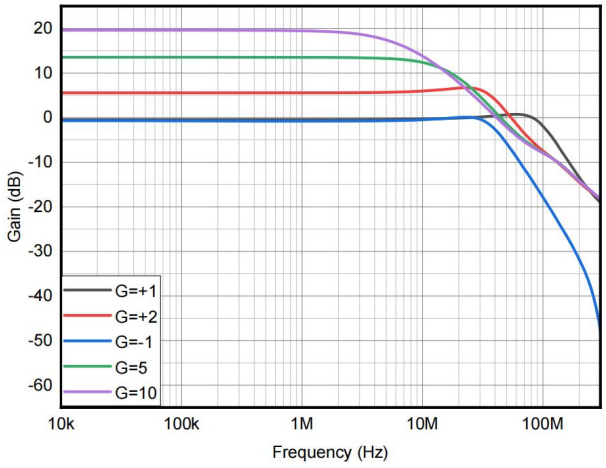
Output characteristics						
I_{SC}	Output short circuit current	Sourcing to V-		70		mA
		Sinking to V+		70		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+		54		mA
		V_{OUT} = 0.5 V from V-		40		mA
V_{OUT}	Output swing high	R_L = 2 kΩ	4.98	4.985		V
	Output swing low	R_L = 2 kΩ	15	20		mV
Dynamic performance						
BW	−3 dB BW	G = +1, V_{OUT} = 200 mV_{PP}		105		MHz
		G = +2, V_{OUT} = 200 mV_{PP}		46		MHz
		G = −1, V_{OUT} = 200 mV_{PP}		44		MHz
PBW	Full power bandwidth	G = +1, −1 dB, V_{OUT} = 2 V_{PP}		20		MHz
X_{TALK}	Channel-to-channel crosstalk	f = 1 kHz, receiver, R_F = Rg = 510 Ω, G = +2		87		dB
SR	Slew rate	G = −1, V_{IN} = 2 V_{PP}		85		V/μs
t_S	Settling time	V_{OUT} = 2 V_{PP}, ±0.1%, 8 pF load, V_{CC} = 5 V		80		ns
Noise performance						
THD	Total harmonic distortion	f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 100 Ω to V+ /2		80		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		95		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

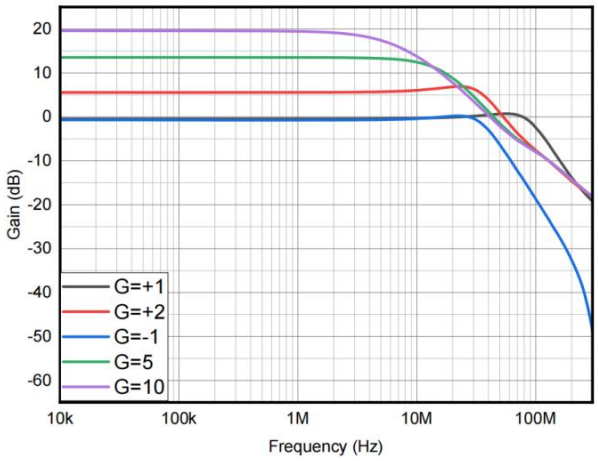
Typical Performance Characteristics

V+ = +5, V− = −5 V, R_F = R_L = 2 kΩ, unless otherwise specified.



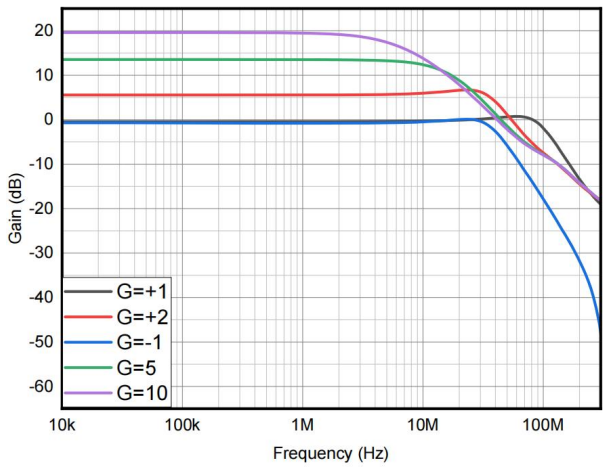
V_{CC} = 3 V, V_{OUT} = 0.2 V_{PP}

Figure 2. Closed loop gain vs. Frequency for various gains



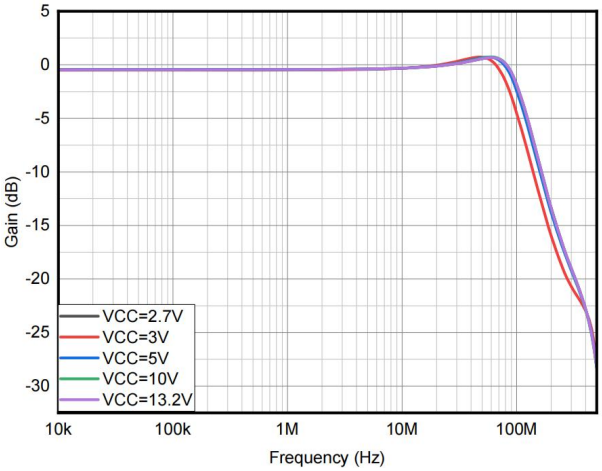
V_{CC} = 5 V, V_{OUT} = 0.2 V_{PP}

Figure 3. Closed loop gain vs. Frequency for various gains



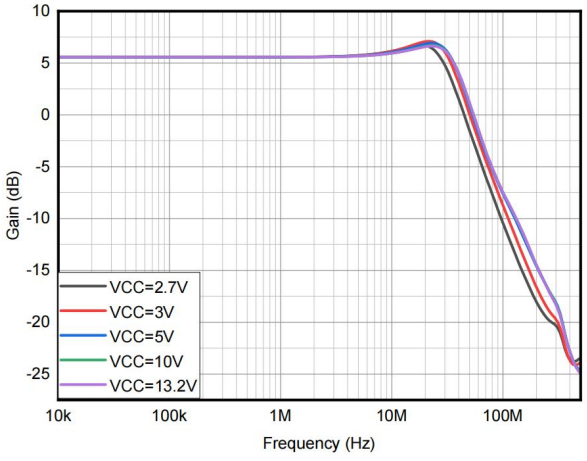
V_{CC} = 10 V, V_{OUT} = 0.2 V_{PP}

Figure 4. Closed loop gain vs. Frequency for various gains



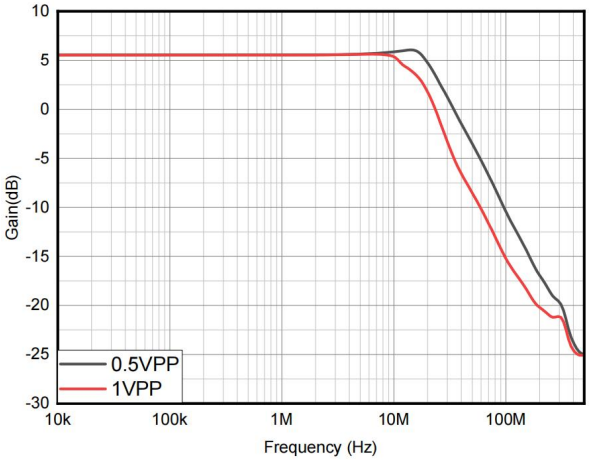
G = +1, V_{OUT} = 0.2 V_{PP}

Figure 5. Closed loop frequency response for various supplies



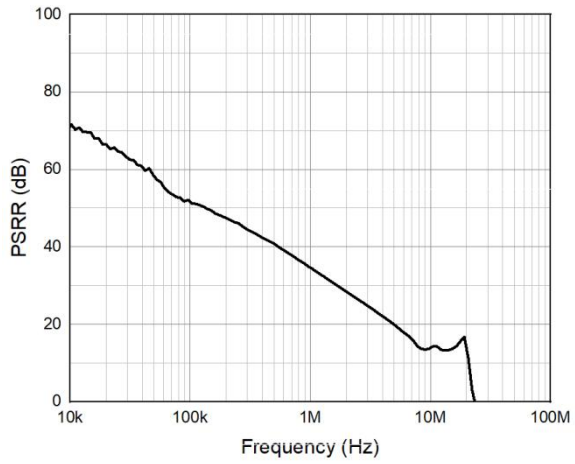
G = +2, V_{OUT} = 0.2 V_{PP}

Figure 6. Closed loop frequency response for various supplies



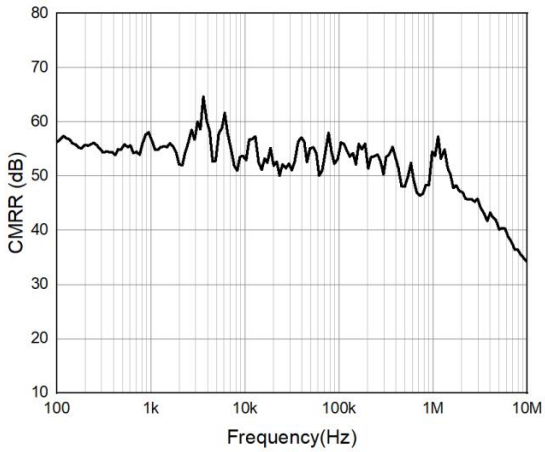
V_{CC} = 10 V, G = +2

Figure 7. Large signal frequency response



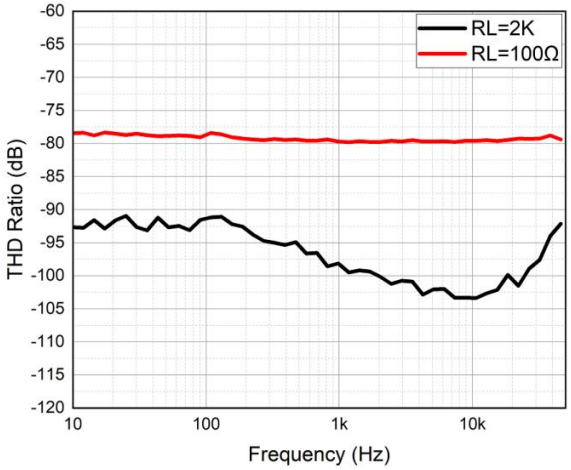
V_{CC} = 5 V, G = +1

Figure 8. PSRR vs. Frequency



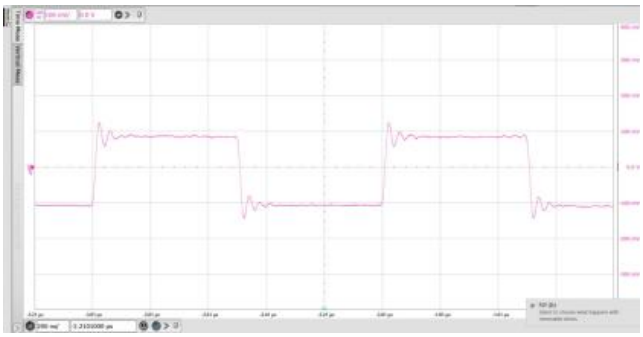
V_{CC} = 5 V, G = +2

Figure 9. CMRR vs. Frequency



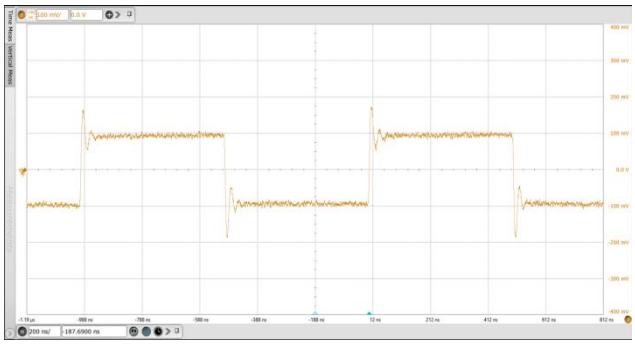
V_{CC} = ±5 V, V_{IN} = 2 V_{PP}, G = -1

Figure 10. THD Ratio vs. Frequency



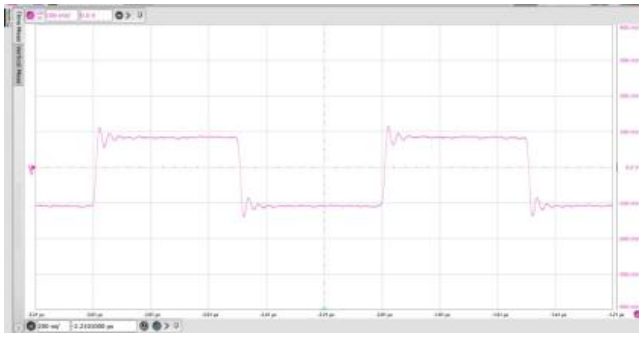
V_{CC} = 3 V, V_{OUT} = 0.2 V_{PP}, G = -1

Figure 11. Small signal step response



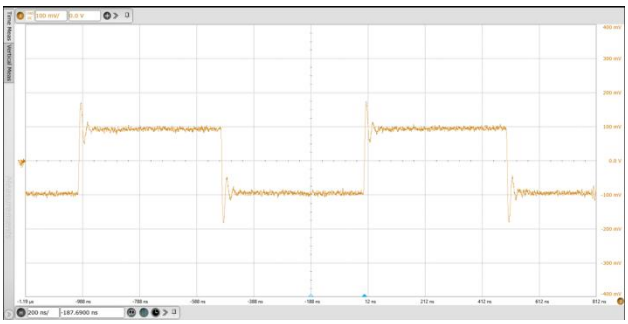
V_{CC} = 3 V, V_{OUT} = 0.2 V_{PP}, G = +2

Figure 12. Small signal step response



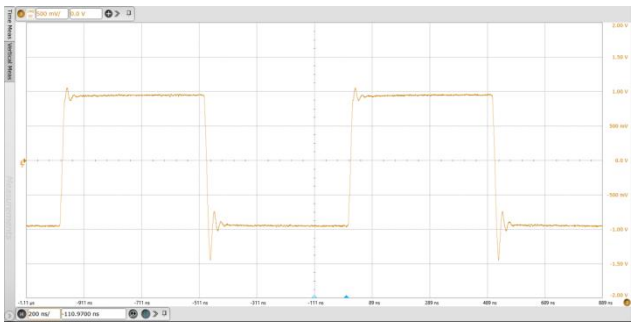
V_{CC} = 10 V, V_{OUT} = 0.2 V_{PP}, G = -1

Figure 13. Small signal step response



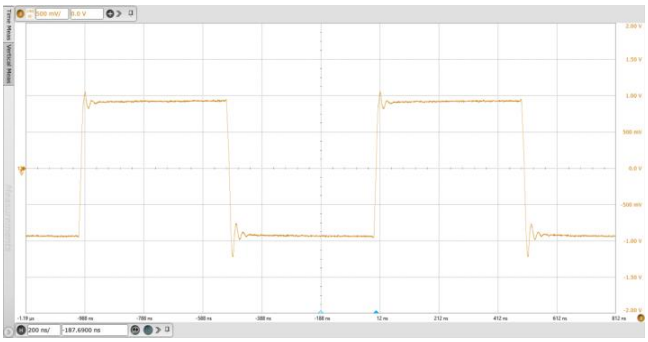
V_{CC} = 10 V, V_{OUT} = 0.2 V_{PP}, G = +2

Figure 14. Small signal step response



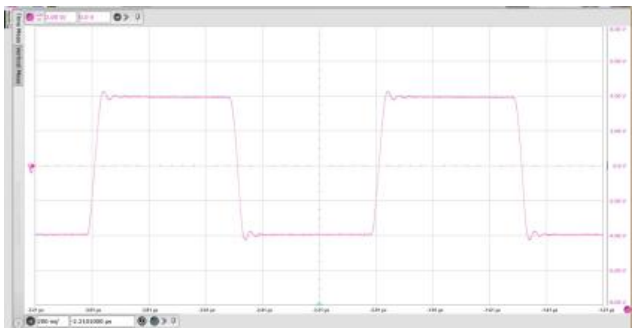
V_{CC} = 10 V, V_{OUT} = 2 V_{PP}, G = +2

Figure 15. Large signal step response



V_{CC} = 10 V, V_{OUT} = 2 V_{PP}, G = -1

Figure 16. Large signal step response



V_{CC} = 10 V, V_{OUT} = 8 V_{PP}, G = -1

Figure 17. Large signal step response

Typical Application

The DIO264X series is designed for high-voltage, high-speed amplifier applications. The DIO264X has low power dissipation, due to the lower supply current. Push-pull output stage is capable of approximately 50 mA output current (at 0.5 V from the supply rails). As high-performance devices, due to the subtleties of applications, it is recommended to evaluate performance under actual operating conditions to ensure the chip meets all specifications.

As a rail-to-rail output Op Amp, the DIO264X has a wide power supply voltage range from 2.7 V to 13.2 V. Even when the device is supplied with 3 V, the -3 dB BW (at G = +1) is typically 90 MHz. Production testing guarantees that process variations will not compromise speed.

Layout and grounding

The DIO264X can operate from either a single supply or with dual supplies. Supplies should be decoupled with low inductance, often ceramic capacitors to ground less than 1.5 cm from the device pins. The use of the ground plane is recommended, and as in most high-speed devices, it is advisable to remove the ground plane close to device-sensitive pins such as the inputs.

Amplifier with bypass capacitors

The DIO264X can operate from either a single supply or with dual supplies. The input CM capability of the parts (CMVR) extends down to the V- rail to simplify single supply applications. For single-supply operation, bypass the power supply $+V_S$ with a 0.1 µF ceramic capacitor. For dual-supply operation, both the $+V_S$ and the $-V_S$ supplies should be bypassed to ground with separate 0.1 µF ceramic capacitors. For better performance, a 10 µF tantalum capacitor can be added. The details are shown in Figure 18.

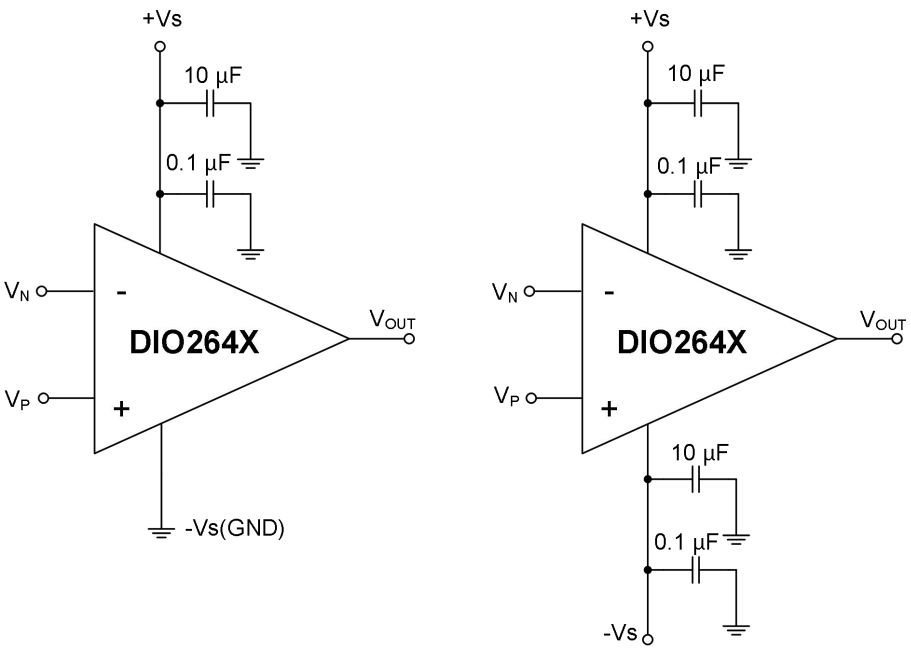


Figure 18. Amplifier with bypass capacitors

Differential amplifier

Figure 19 shows the circuits that performs the difference function.

In the application of Figure 19, if R4/R3 = R2/R1, then V_{OUT} can be calculated by the equation (1):

$$V_{OUT} = (V_P - V_N) \times V_{REF} \quad (1)$$

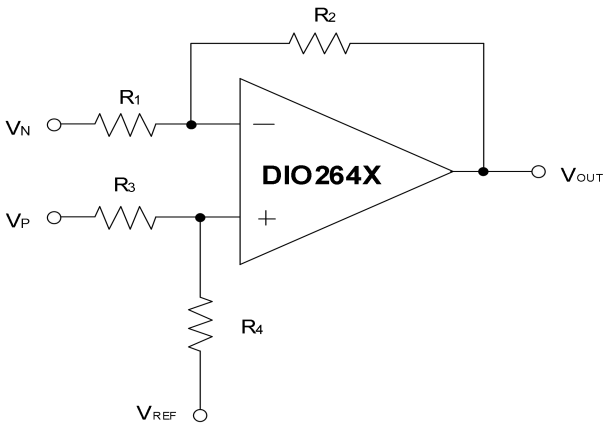


Figure 19. Differential amplifier

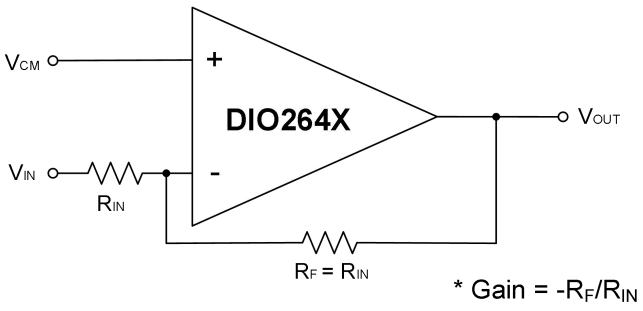


Figure 20. Gain = -1

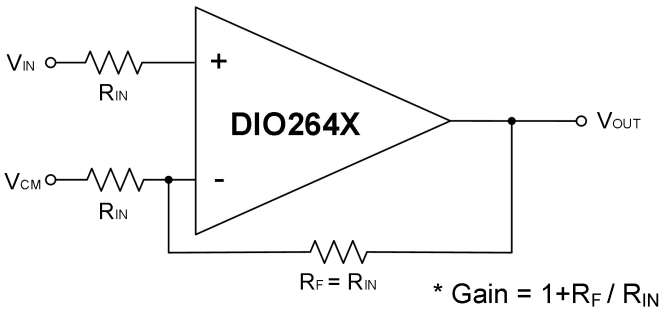


Figure 21. Gain = 2

Active low-pass filter

Figure 22 shows the low-pass filter detail. It has a DC gain of (-R2/R1) with the -3 dB corner frequency of $1/2\pi R_2C$. Please noted that the filter bandwidth should be within the bandwidth of the filter.

If the value of feedback resistors is large, then it can couple with parasitic capacitance, resulting undesired consequence. For resistor values, It is recommended to maintain it as low as feasible while keeping output loading in consideration.

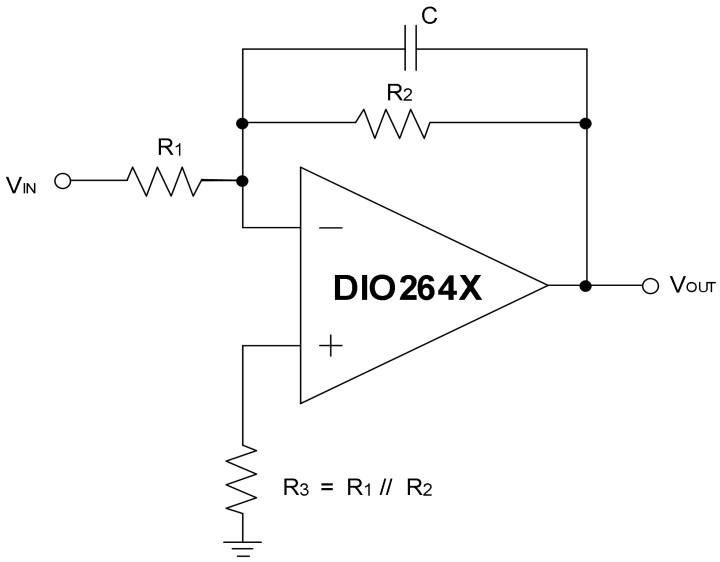
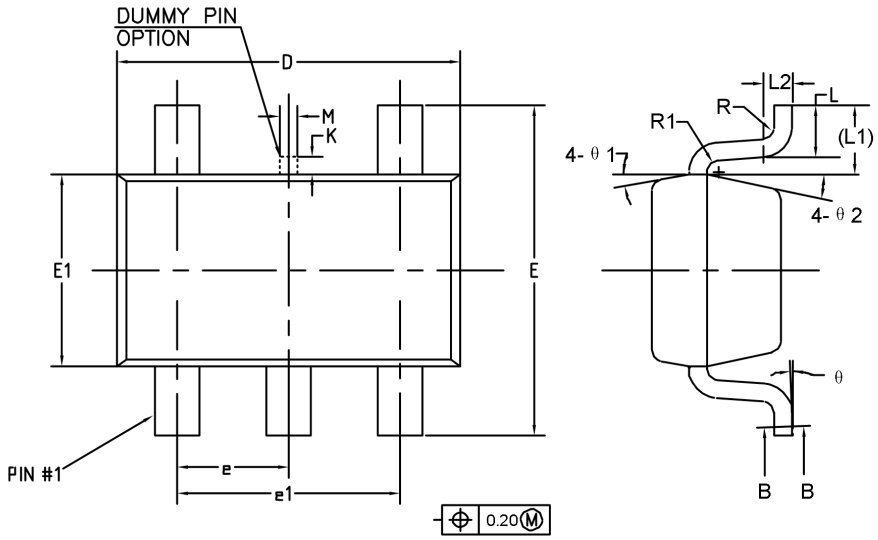
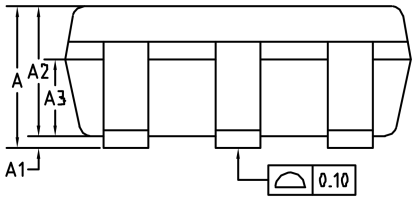
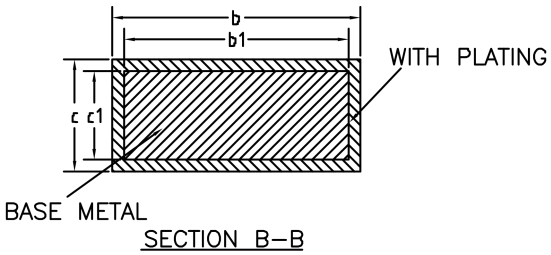


Figure 22. Active low-pass filter

Physical Dimensions: SOT23-5

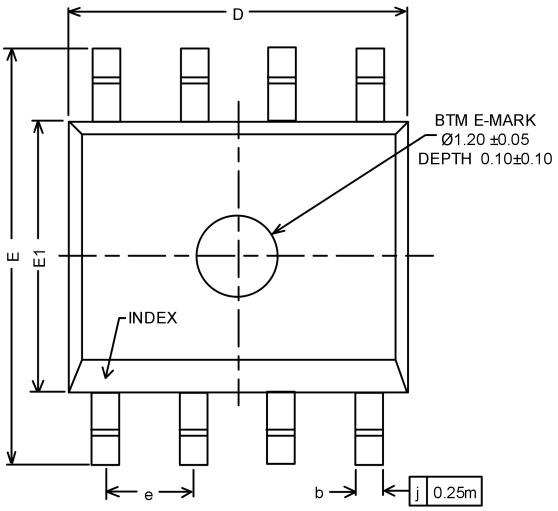


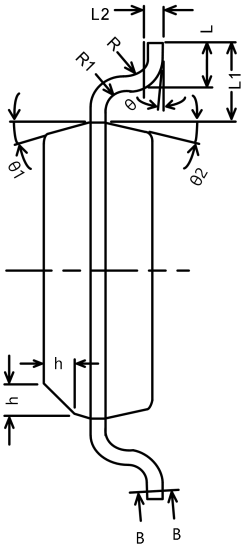


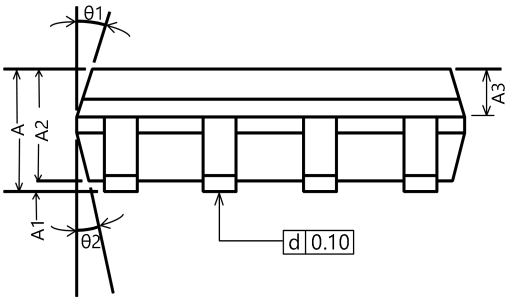


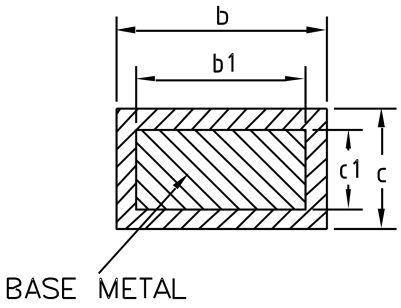
Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.25
A1	0	-	0.15
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.36	-	0.45
b1	0.35	0.38	0.41
c	0.14	-	0.20
c1	0.14	0.15	0.16
D	2.826	2.926	3.026
E	2.60	2.80	3.00
E1	1.526	1.626	1.726
e	0.90	0.95	1.00
e1	1.80	1.90	2.00
K	0	-	0.25
L	0.30	0.40	0.60
L1	0.59 REF		
L2	0.25 BSC		
M	0.10	0.15	0.25
R	0.05	-	0.20
R1	0.05	-	0.20
Θ	0°	-	8°
Θ1	8°	10°	12°
Θ2	10°	12°	14°

Physical Dimensions: SOIC-8





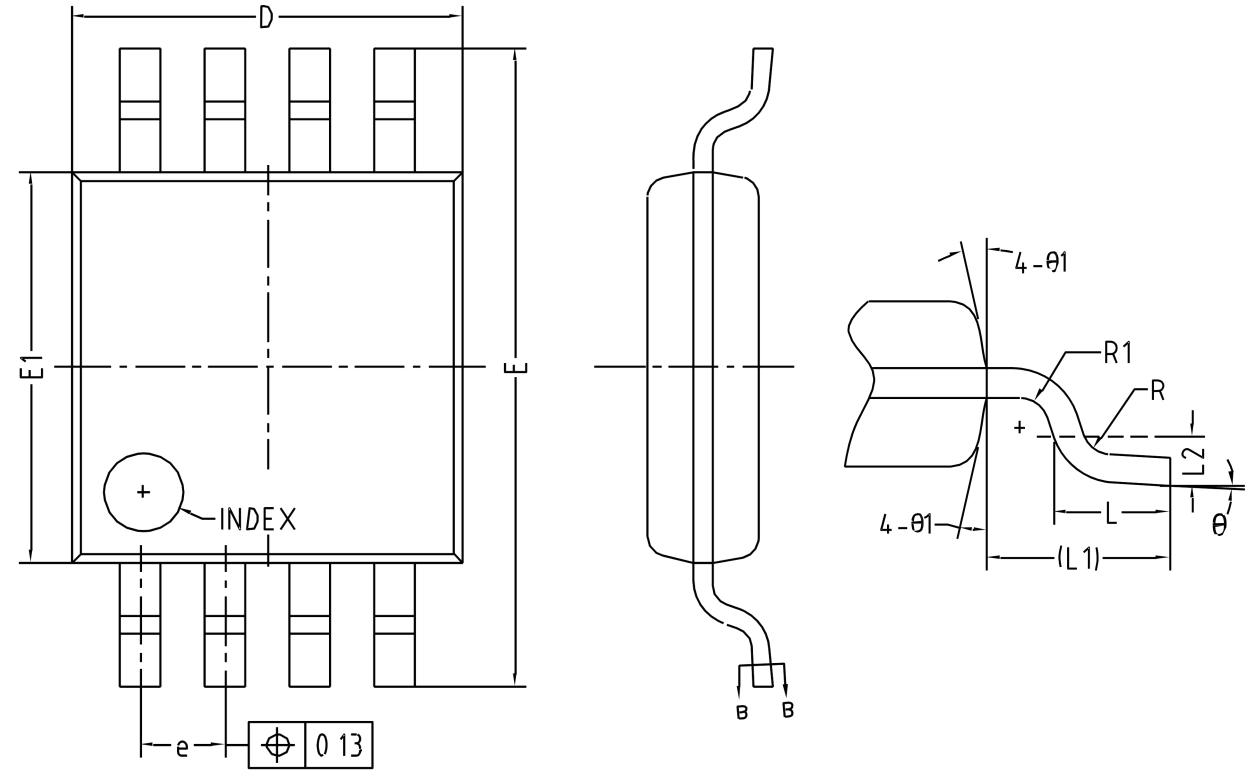


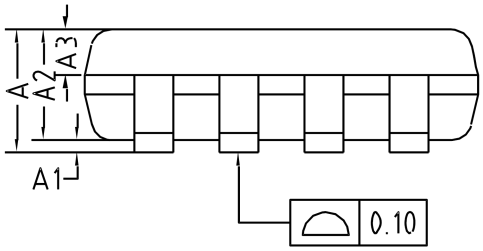


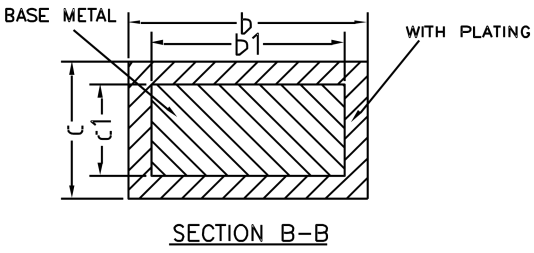
SECTION B–B

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	1.35	1.55	1.75
A1	0.10	-	0.25
A2	1.30	1.40	1.50
A3	0.50	0.60	0.70
b	0.38	-	0.47
b1	0.37	0.40	0.43
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.17	1.27	1.37
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
Θ	0°	-	8°
Θ1	15°	17°	19°
Θ2	11°	13°	15°

Physical Dimensions: MSOP-8



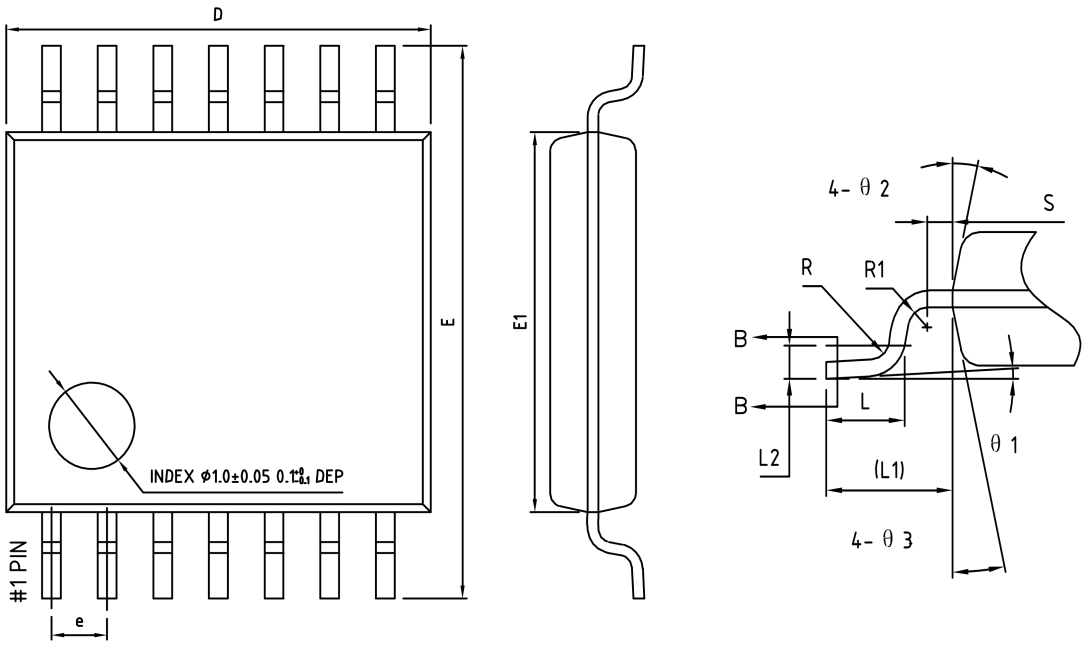


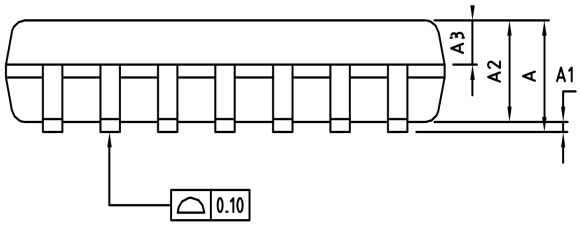


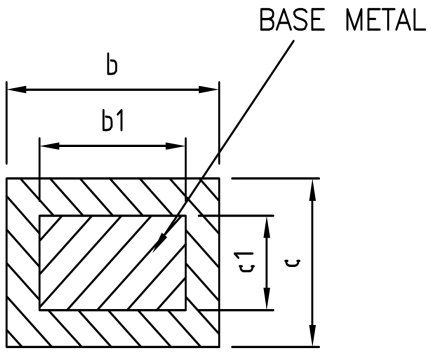
SECTION B–B

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.10
A1	0.05	0.10	0.15
A2	0.75	0.85	0.95
A3	0.30	0.35	0.40
b	0.25	-	0.38
b1	0.24	0.30	0.33
c	0.15	-	0.20
c1	0.14	0.15	0.16
D	2.90	3.00	3.10
E	4.75	4.90	5.05
E1	2.90	3.00	3.10
e	0.55	0.65	0.75
L	0.40	0.55	0.70
L1	0.95 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
Θ	0°	-	8°
Θ1	9°	12°	15°

Physical Dimensions: TSSOP-14



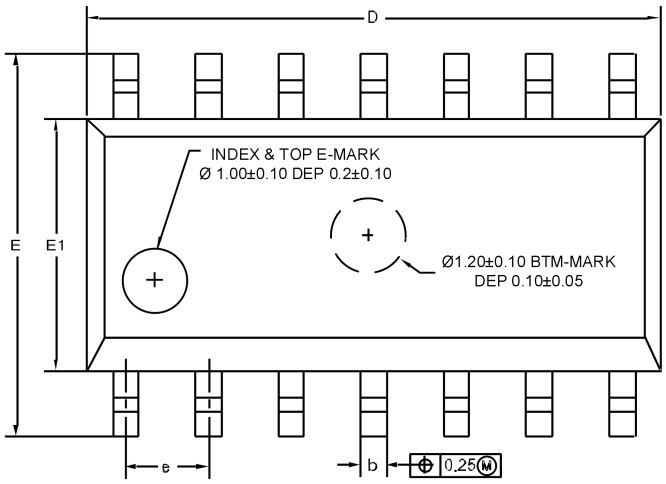


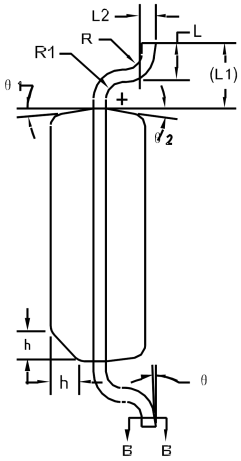


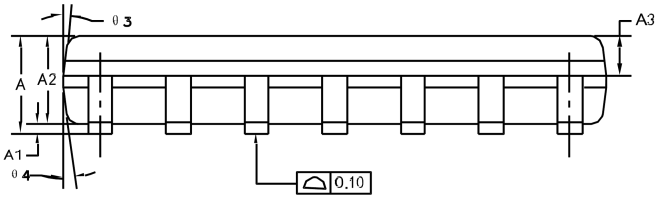
SECTION B–B

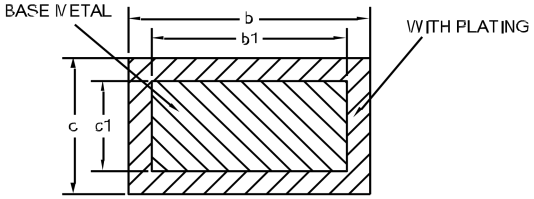
Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	-	-	1.20
A1	0.05	-	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	-	0.28
b1	0.20	0.22	0.24
c	0.10	-	0.19
c1	0.10	0.13	0.15
D	4.86	4.96	5.06
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e	0.65 BSC		
L	0.45	0.60	0.75
L1	1.00 REF		
L2	0.25 BSC		
R	0.09	-	-
R1	0.09	-	-
S	0.20	-	-
Θ1	0°	-	8°
Θ2	10°	12°	14°
Θ3	10°	12°	14°

Physical Dimensions: SOP-14









SECTION B-B

Common Dimensions (Units of measure = Millimeter)			
Symbol	**Min**	**Nom**	**Max**
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	1.45	1.65
A3	0.55	0.65	0.75
b	0.36	-	0.49
b1	0.35	0.40	0.45
c	0.17	-	0.25
c1	0.17	0.20	0.23
D	8.53	8.63	8.73
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.45	0.60	0.80
L1	1.04 REF		
L2	0.25 BSC		
R	0.07	-	-
R1	0.07	-	-
h	0.30	0.40	0.50
Θ	0°	-	8°
Θ1	6°	8°	10°
Θ2	6°	8°	10°
Θ3	5°	7°	9°
Θ4	5°	7°	9°

CONTACT US

Dioo is a professional design and sales corporation for high-quality performance analog semiconductors. The company focuses on industry markets, such as cell phones, handheld products, laptops, medical equipment, and so on. Dioo's product families include analog signal processing and amplifying, LED drivers, and charger ICs. Go to http://www.dioo.com for a complete list of Dioo product families.

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