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): 7 mA per channel
- Low offset voltage: ±9.5 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): 100 V/μs
- Settling time (V+ = 5 V, ±5 V): 80 ns
- Input voltage noise (100 kHz): 30 nV/√Hz
- Output short protection
- Available packages:
  DIO2641B: SOT23-5/SOIC-8
  DIO2642B: SOIC-8/MSOP-8
  DIO2644B: TSSOP-14/SOP-14

Applications

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

Package Information

Part Number	Package	Body Size
DIO2641B	SOT23-5	1.626 mm × 1.926 mm
	SOIC-8	4.90 mm × 3.90 mm
DIO2642B	SOIC-8	4.90 mm × 3.90 mm
	MSOP-8	3.00 mm × 3.00 mm
DIO2644B	TSSOP-14	4.96 mm × 4.40 mm
	SOP-14	8.63 mm × 3.90 mm

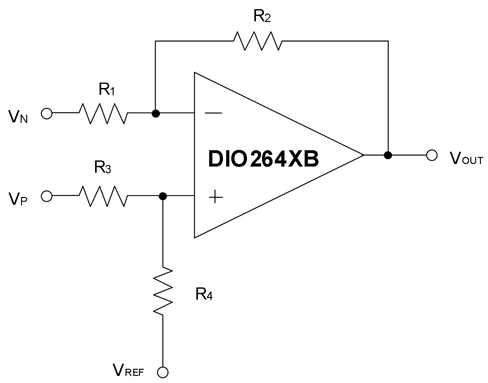
Description

The DIO2641B (single), DIO2642B (dual), and DIO2644B (quad) are amplifiers with low noise, low voltage, and low power operation. The DIO2641/2/4B 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 DIO2641/2/4B 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 (100 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.

Simplified Schematic



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Ordering Information

Ordering Part No.	Top Marking	MSL	RoHS	T_A	Package	
DIO2641BST5	YWDAB	3	Green	-40 to 125°C	SOT23-5	Tape & Reel, 3000
DIO2641BSO8	DIOF4AB	3	Green	-40 to 125°C	SOIC-8	Tape & Reel, 2500
DIO2642BSO8	DIOF4BB	3	Green	-40 to 125°C	SOIC-8	Tape & Reel, 2500
DIO2642BMP8	DIOF4BB	3	Green	-40 to 125°C	MSOP-8	Tape & Reel, 3000
DIO2644BSO14	DIOBF4B	3	Green	-40 to 125°C	SOP-14	Tape & Reel, 2500
DIO2644BTP14	DIOBF4B	3	Green	-40 to 125°C	TSSOP-14	Tape & Reel, 2500

If you encounter any issue in the process of using the device, please contact our customer service at marketing@dioo.com or phone us at (+86)-21-62116882. If you have any improvement suggestions regarding the datasheet, we encourage you to contact our technical writing team at docs@dioo.com. Your feedback is invaluable for us to provide a better user experience.

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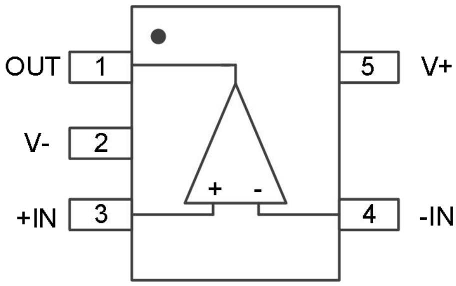
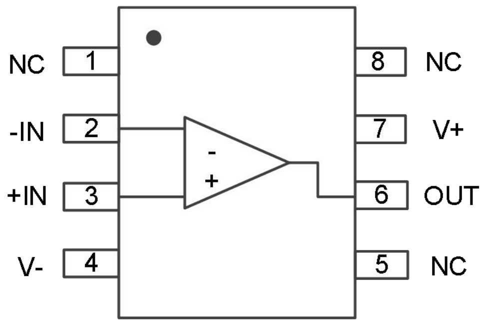
1. Pin Assignment and Functions

DIO2641B



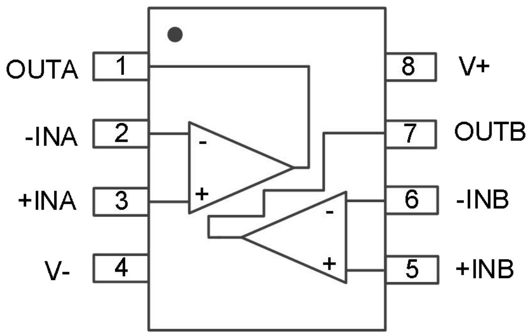
SOT23-5

DIO2641B



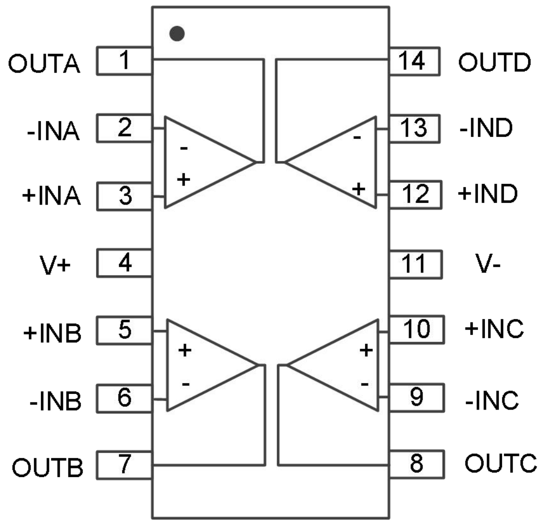
SOIC-8

DIO2642B



SOIC-8/MSOP-8

DIO2644B



TSSOP-14/SOP-14

Figure 1. Pin assignment (Top view)

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

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2. Absolute Maximum Ratings

Exceeding the maximum ratings listed under Absolute Maximum Ratings when designing is likely to damage the device permanently. Do not design to the maximum limits because long-time exposure to them might impact the device's reliability. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

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

3. Recommended Operating Conditions

Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. The ratings are obtained over an operating free-air temperature range unless otherwise specified.

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

4. ESD Ratings

When a statically-charged person or object touches an electrostatic discharge sensitive device, the electrostatic charge might be drained through sensitive circuitry in the device. If the electrostatic discharge possesses sufficient energy, damage might occur to the device due to localized overheating.

Model	Condition	Value	Unit
HBM	JEDEC JS-001, all pins	±8	kV
CDM	Per JEDEC specification JESD22-C101, all pins	±2	kV

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5. Thermal Considerations

The thermal resistance determines the heat insulation property of a material. The higher the thermal resistance is, the lower the heat loss. Accumulation of heat energy degrades the performance of semiconductor components.

<table>
<tr><th>Symbol</th><th colspan="3">Metric</th><th>Value</th><th>Unit</th></tr>
<tr><td rowspan="5">$R_{\theta JA}$</td><td rowspan="5">Junction-to-ambient thermal resistance</td><td rowspan="2">DIO2641B</td><td>SOT23-5</td><td>265</td><td>°C/W</td></tr>
<tr><td>SOIC-8</td><td>190</td><td>°C/W</td></tr>
<tr><td colspan="2">DIO2642B</td><td>235</td><td>°C/W</td></tr>
<tr><td rowspan="2">DIO2644B</td><td>SOP-14</td><td>145</td><td>°C/W</td></tr>
<tr><td>TSSOP-14</td><td>155</td><td>°C/W</td></tr>
</table>

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6. Electrical Characteristics

6.1. 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		65		dB
I_S	Supply current (per channel)	No load		7		mA
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		65		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-		65		mA
		Sinking to V+		70		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+		38		mA
		V_{OUT} = 0.5 V from V-		32		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}		75		V/µs
t_S	Settling time	V_{OUT} = 2 V_{PP}, ±0.1%, 8 pF load, V_{CC} = 5 V		85		ns

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Noise performance						
THD	Total harmonic distortion	f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 100 Ω to V+ /2		55		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		85		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

6.2. 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 (per channel)	No load		7		mA
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		75		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-		62		mA
		Sinking to V+		67		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+		52		mA
		V_{OUT} = 0.5 V from V-		32		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

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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}		100		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		55		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		85		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

6.3. ±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 (per channel)	No load		7		mA
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		85		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-		60		mA
		Sinking to V+		60		mA
I_{OUT}	Output current	V_{OUT} = 0.5 V from V+		54		mA
		V_{OUT} = 0.5 V from V-		30		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

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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}		100		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		55		dB
		f = 1 kHz, V_{OUT} = 2 V_{PP}, G = −1, R_L = 2 kΩ to V+ /2		85		dB
e_n	Input-referred voltage noise	f = 100 kHz		30		nV/√Hz

Note:

(1) Specifications subject to change without notice.

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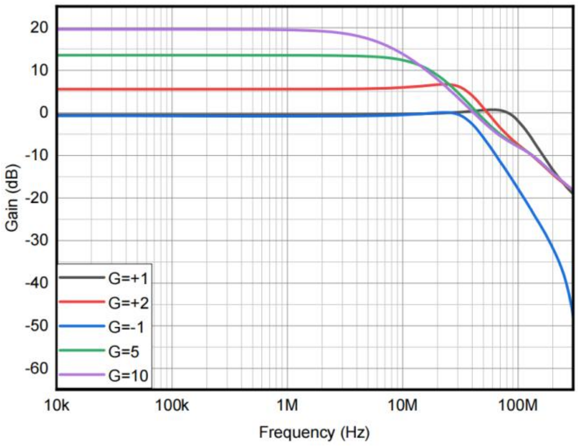
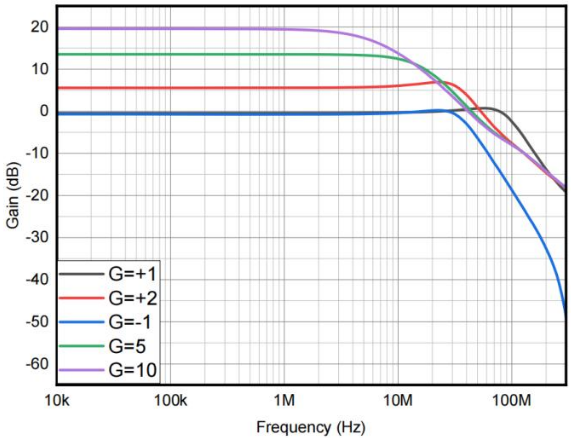
7. Typical Characteristics

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



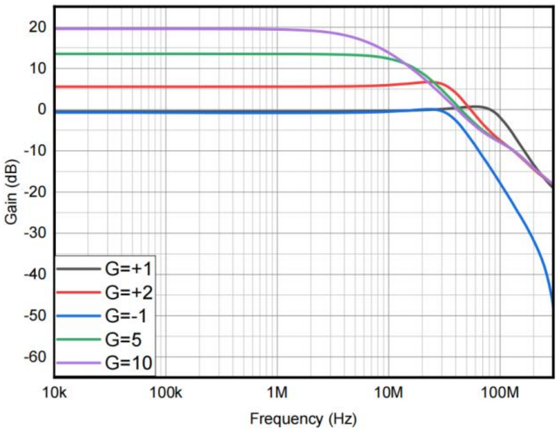
V_{CC} = 3 V, V_{OUT} = 0.2 V_{PP}

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



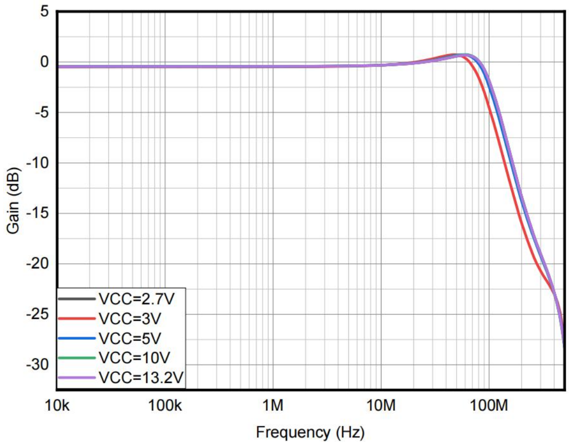
V_{CC} = 5 V, V_{OUT} = 0.2 V_{PP}

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



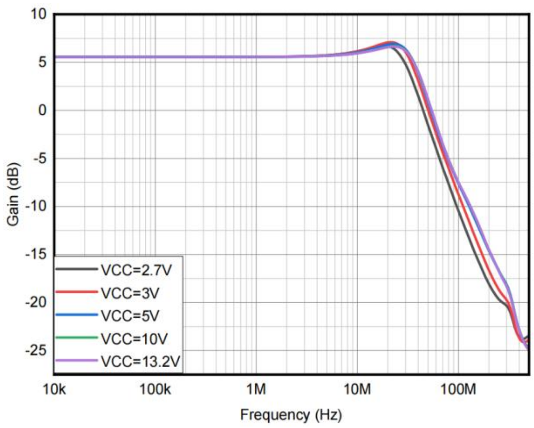
V_{CC} = 10 V, V_{OUT} = 0.2 V_{PP}

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



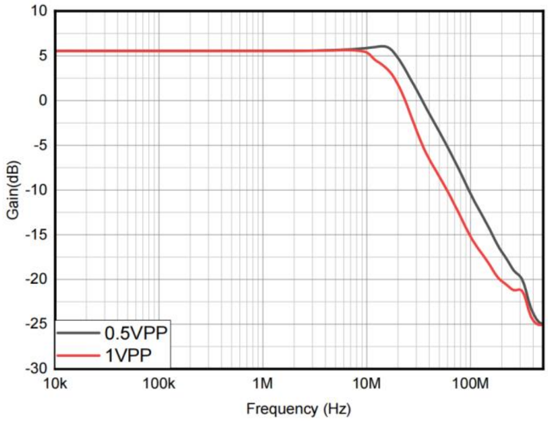
G = +1, V_{OUT} = 0.2 V_{PP}

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

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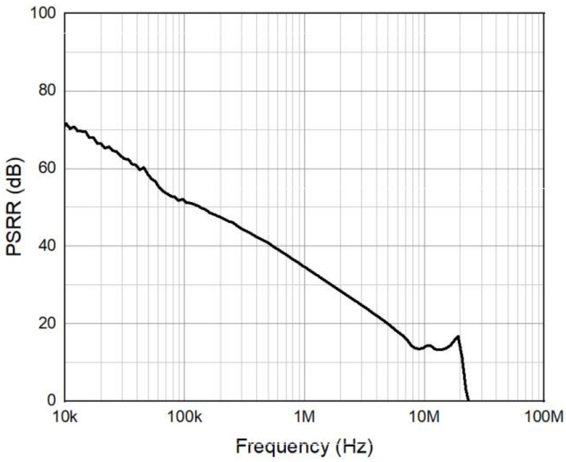
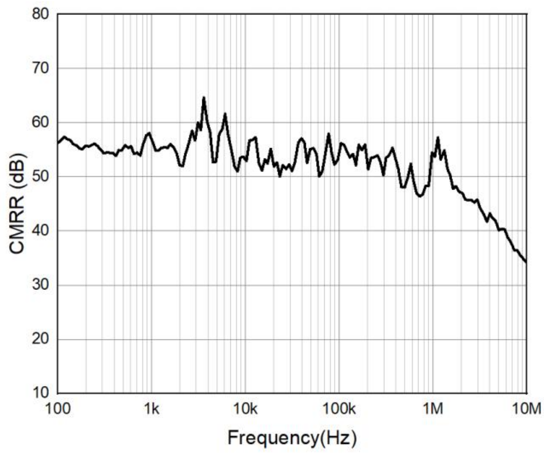


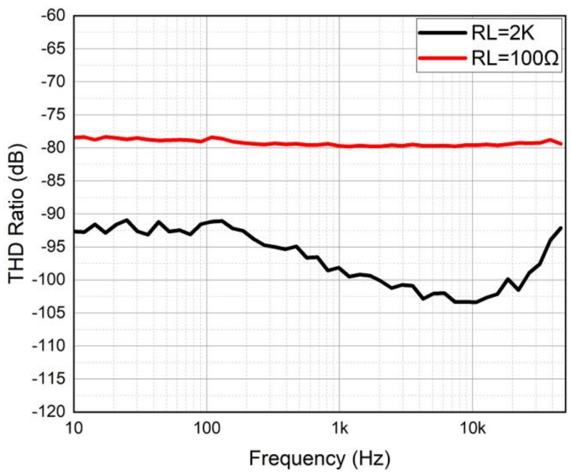
V_{CC} = 5 V, G = +1

Figure 8. PSRR vs. Frequency



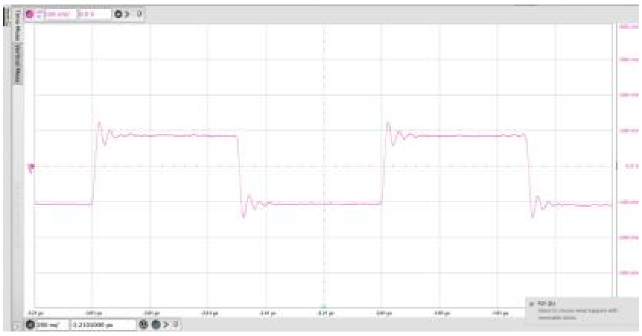
V_{CC} = 5 V, G = +2

Figure 9. CMRR vs. Frequency



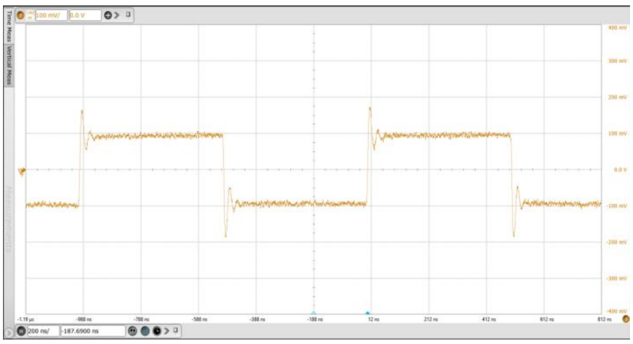
V_{CC} = ±5 V, V_{IN} = 2 V_{PP}, G = -1

Figure 10. THD Ratio vs. Frequency



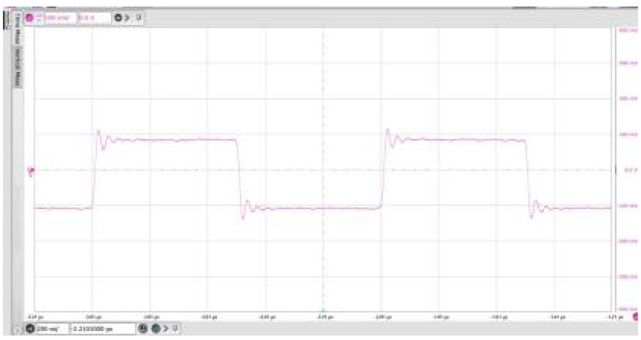
V_{CC} = 3 V, V_{OUT} = 0.2 V_{PP}, G = -1

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

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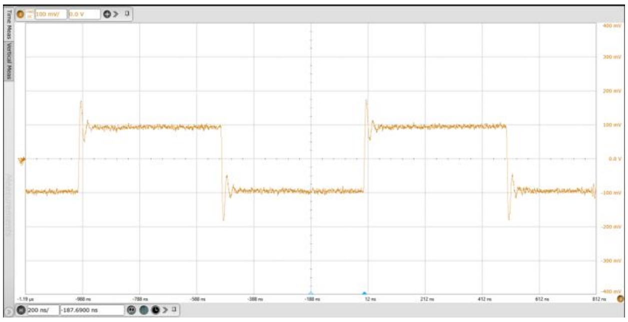
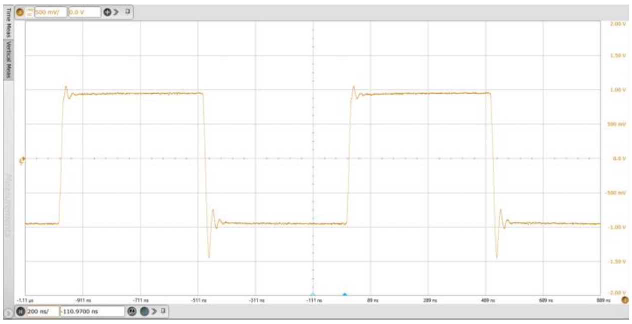


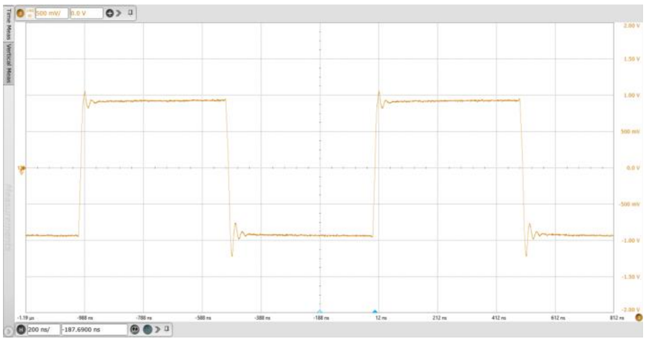
V_{CC} = 10 V, V_{OUT} = 0.2 V_{PP}, G = 2

Figure 14. Small signal step response



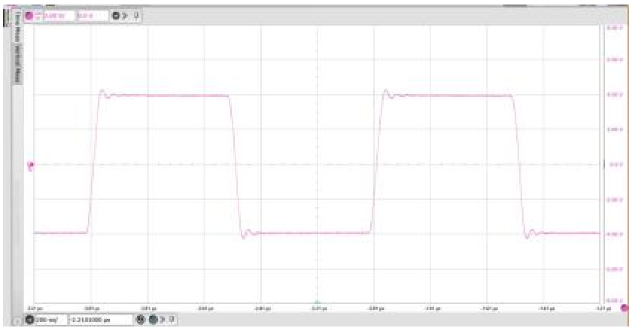
V_{CC} = 10 V, V_{OUT} = 2 V_{PP}, G = 2

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

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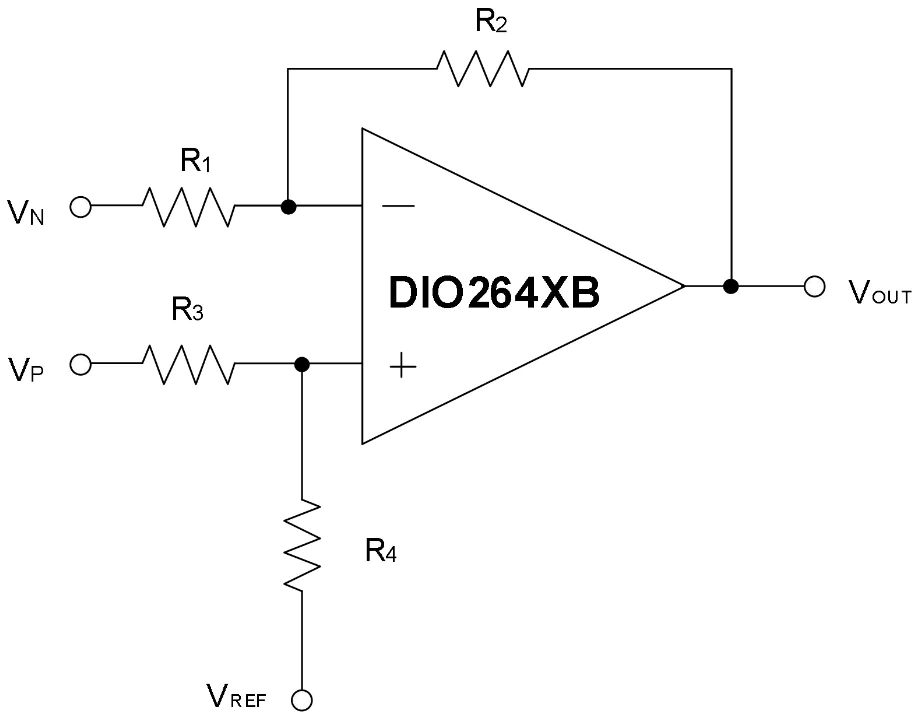
8. Block Diagram



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9. Application Information

Important notice: Validation and testing are the most reliable ways to confirm system functionality. The application information is not part of the specification and is for reference purposes only.

The DIO264XB series is designed for high-voltage, high-speed amplifier applications. The DIO264XB 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) while the device consumes only 7 mA of total supply current per channel. 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 DIO264XB 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.

9.1. Layout and grounding

The DIO264XB 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.

9.2. Amplifier with bypass capacitors

The DIO264XB 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.

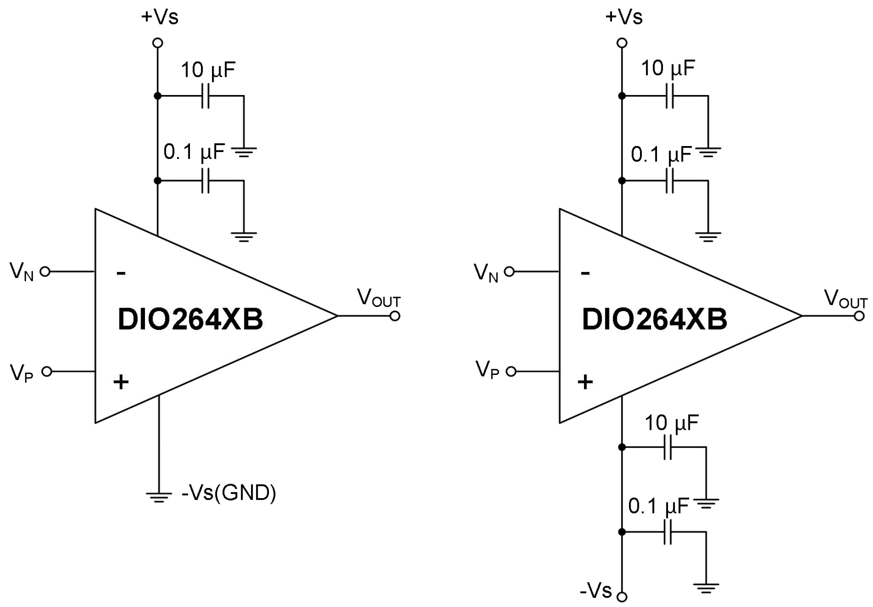

Figure 18. Amplifier with bypass capacitors

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9.3. 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):

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

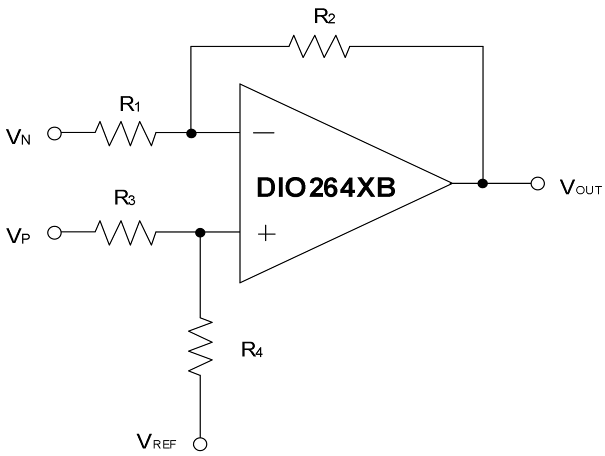

Figure 19. Differential amplifier

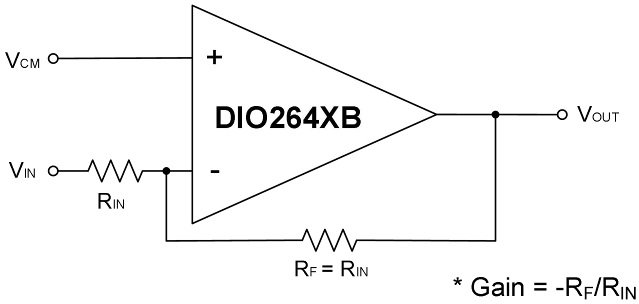

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Figure 20. Gain = -1

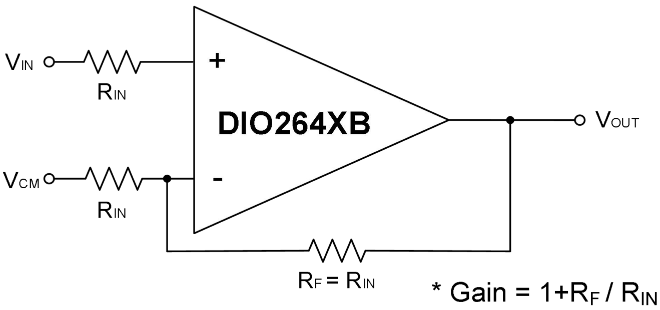

Figure 21. Gain = 2

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9.4. 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.

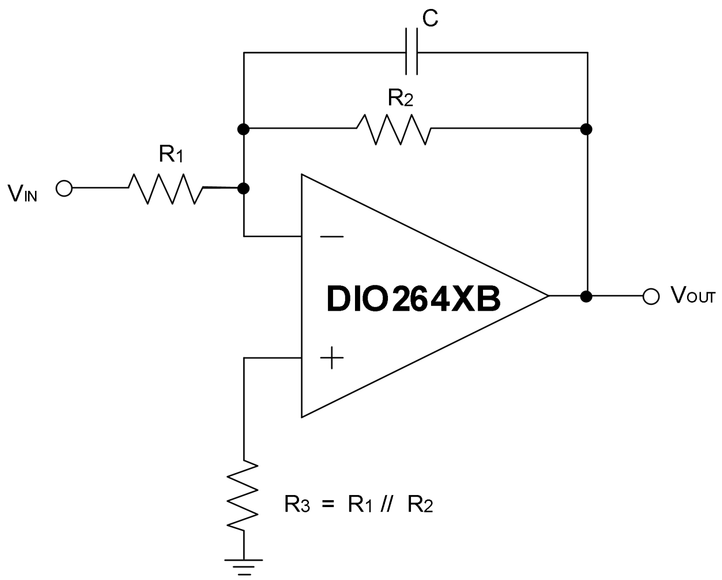

Figure 22. Active low-pass filter

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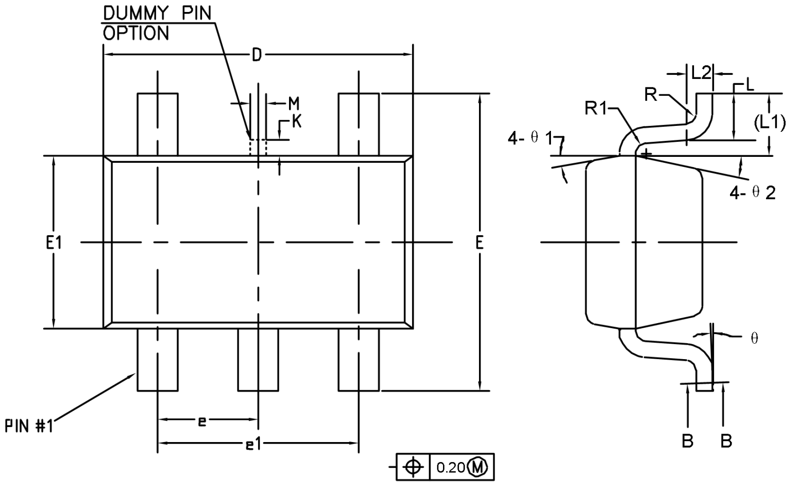
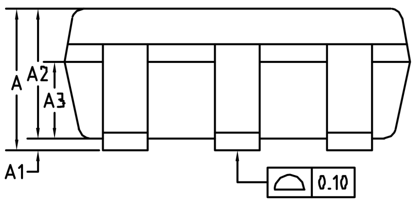
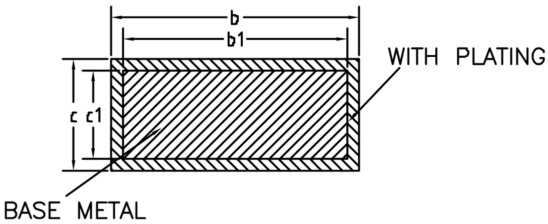
10. Physical Dimensions

10.1. SOT23-5







SECTION B–B

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°

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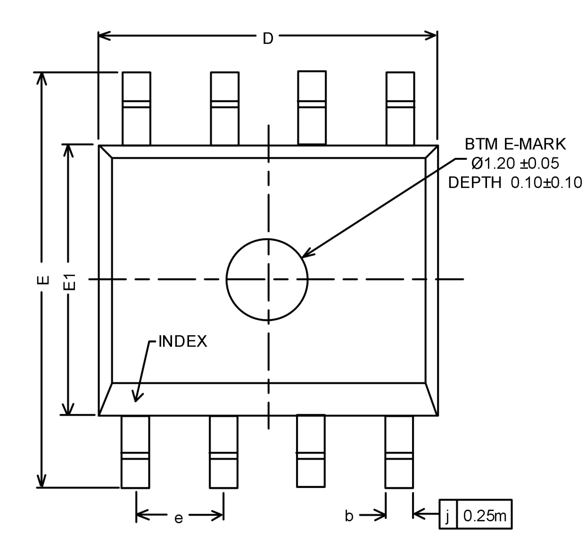
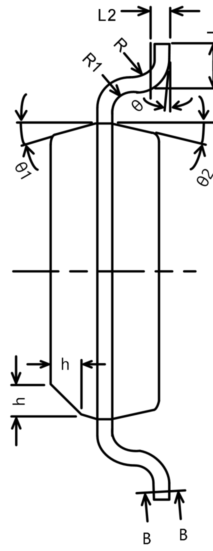
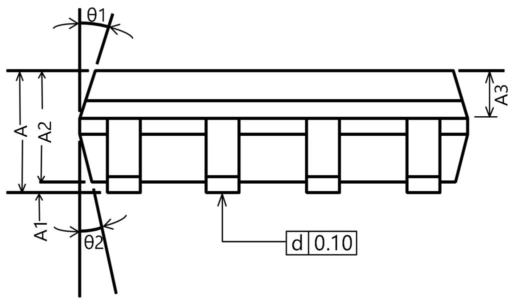
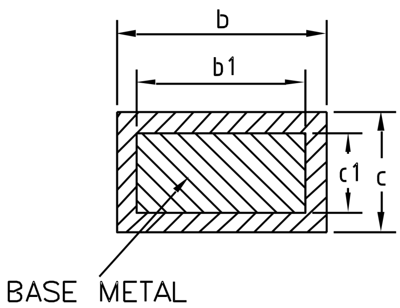
10.2. SOIC-8









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°

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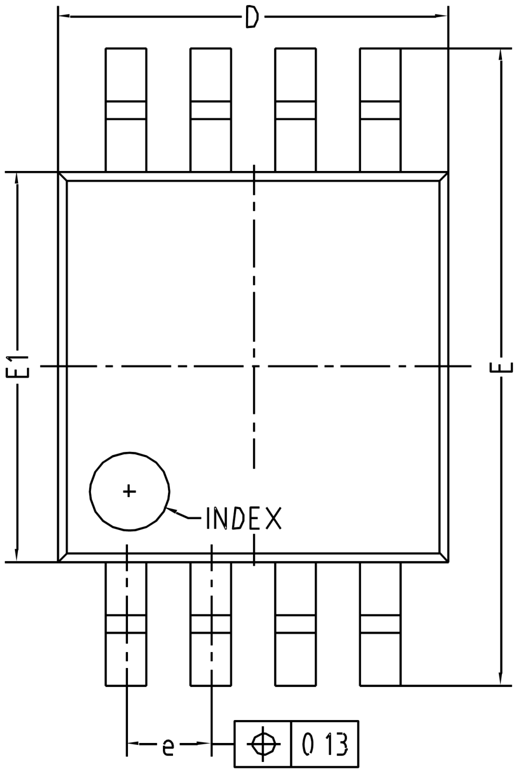
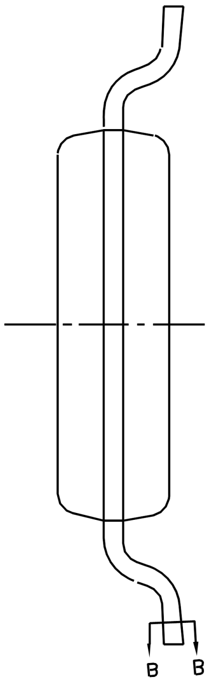
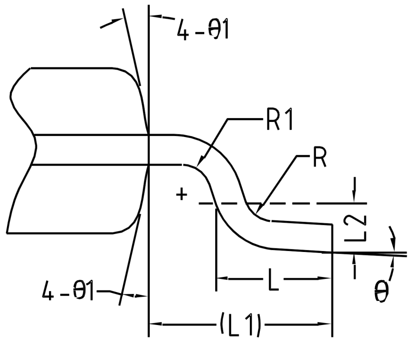
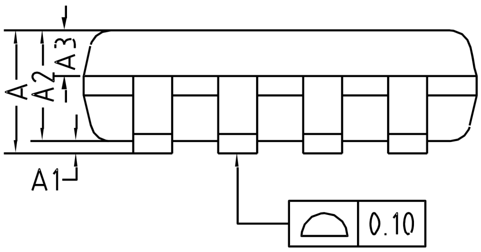
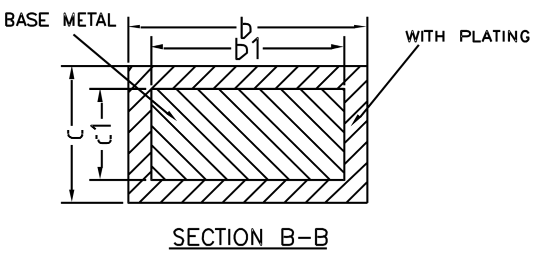
10.3. MSOP-8











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°

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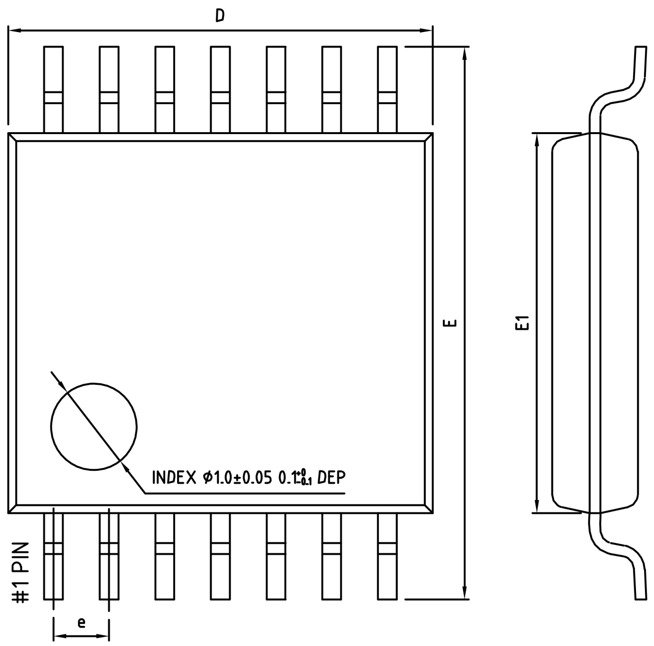
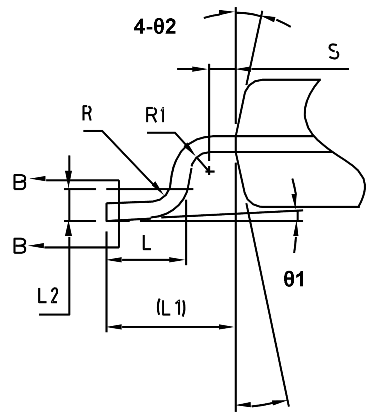
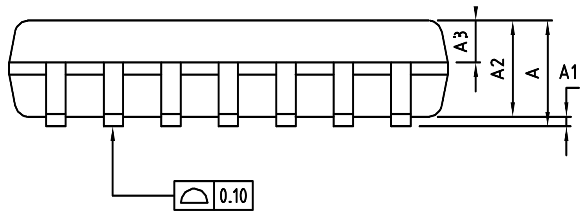
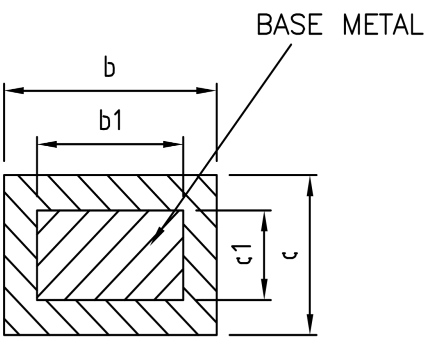
10.4. TSSOP-14









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°

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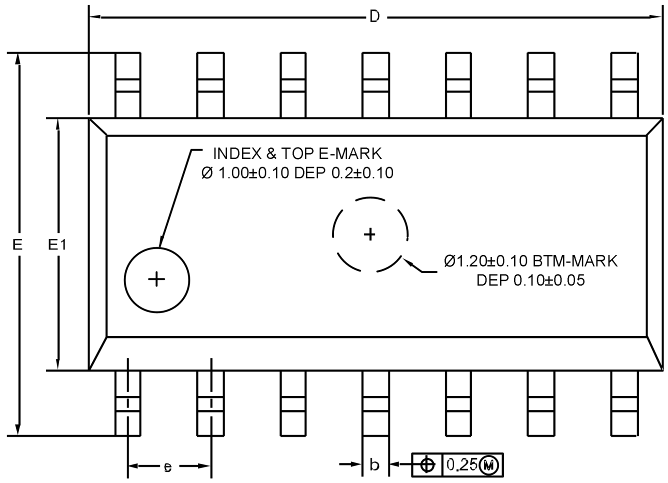
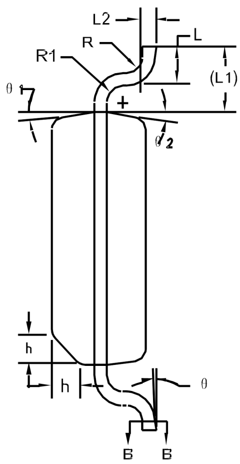
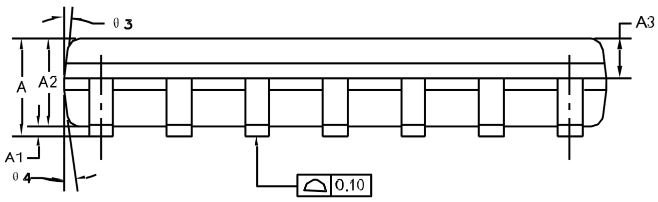
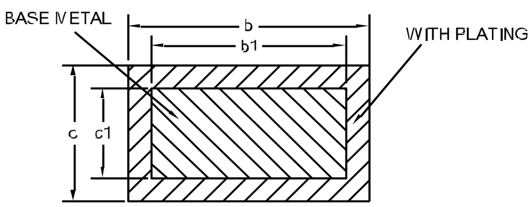
10.5. SOP-14









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°

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