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AUTOMOTIVE, 125°C OPERATION, CMOS OPERATIONAL AMPLIFIER

This IC incorporates a general purpose analog circuit in a small package. This is a CMOS type operational amplifier with phase compensation circuit, which operates at a low voltage and low current consumption.
The S-19610AB is a dual operational amplifier (2 circuits).

Caution **This product can be used in vehicle equipment and in-vehicle equipment. Before using the product in the purpose, contact to ABLIC Inc. is indispensable.**

■ Features

- Low input offset voltage: V_{IO} = +6.0 mV max. (Ta = −40°C to +125°C)
- Operation power supply voltage range: V_{DD} = 2.70 V to 5.50 V
- Low current consumption (Per circuit): I_{DD} = 1.00 mA typ.
- Internal phase compensation: No external parts required
- Operation temperature range: Ta = −40°C to +125°C
- Lead-free (Sn 100%), halogen-free
- AEC-Q100 qualified*1

***1.** Contact our sales office for details.

■ Applications

- Current sensing
- Signal amplification
- Buffer
- Active filter

■ Package

- TMSOP-8

■ Block Diagram

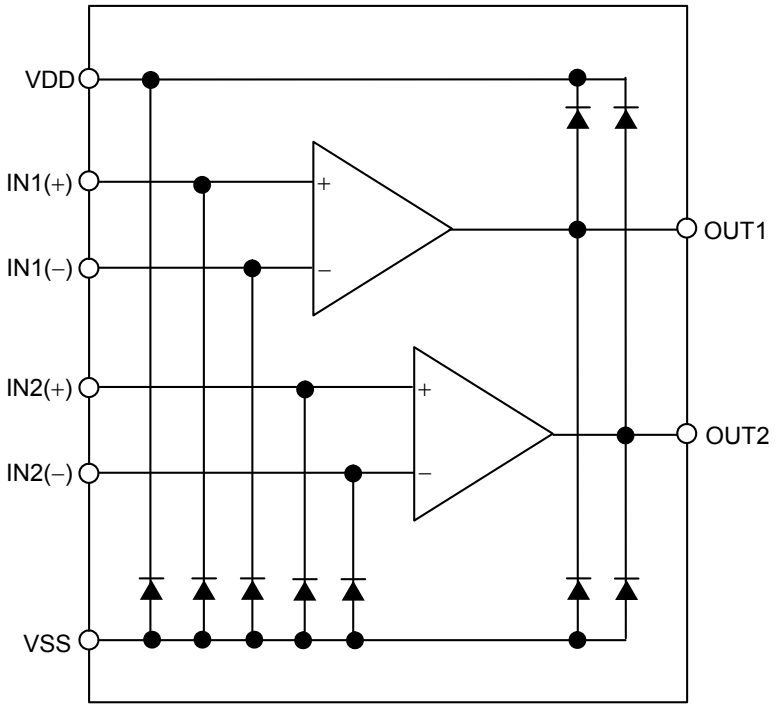


Figure 1

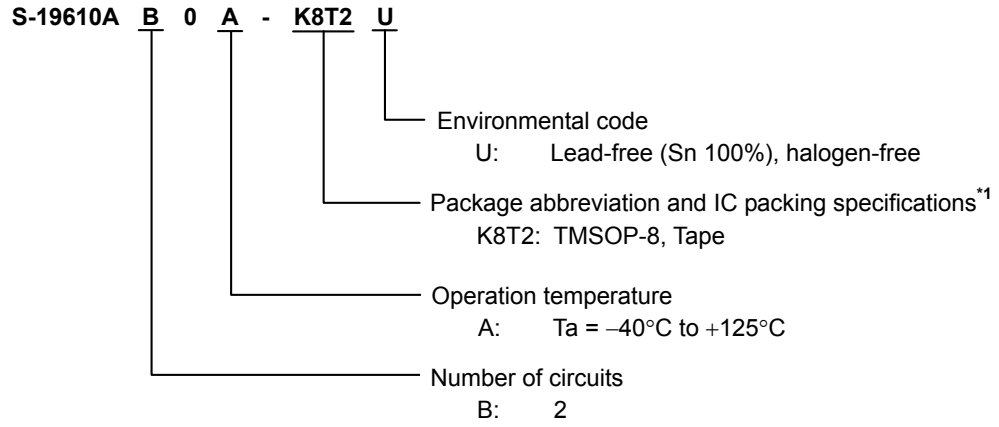
■ AEC-Q100 Qualified

This IC supports AEC-Q100 for the operation temperature grade 1.
Contact our sales office for details of AEC-Q100 reliability specification.

■ Product Name Structure

Refer to "**1. Product name**" regarding the contents of product name, "**2. Package**" regarding the package drawings and "**3. Product name list**" regarding the product type.

1. Product name



***1.** Refer to the tape drawing.

2. Package

Table 1 Package Drawing Codes

Package Name	Dimension	Tape	Reel
TMSOP-8	FM008-A-P-SD	FM008-A-C-SD	FM008-A-R-SD

3. Product name list

Table 2

Product Name	Package
S-19610AB0A-K8T2U	TMSOP-8

■ Pin Configuration

1. TMSOP-8

Top view

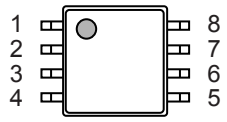


Figure 2

Table 3

Pin No.	Symbol	Description
1	OUT1	Output pin 1
2	IN1(−)	Inverted input pin 1
3	IN1(+)	Non-inverted input pin 1
4	VSS	GND pin
5	IN2(+)	Non-inverted input pin 2
6	IN2(−)	Inverted input pin 2
7	OUT2	Output pin 2
8	VDD	Positive power supply pin

■ Absolute Maximum Ratings

Table 4

(Ta = −40°C to +125°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Unit
Power supply voltage	V_{DD}	V_{SS} − 0.3 to V_{SS} + 7.0	V
Input voltage	$V_{IN(+)}$, $V_{IN(-)}$	V_{SS} − 0.3 to V_{SS} + 7.0	V
Output voltage	V_{OUT}	V_{SS} − 0.3 to V_{DD} + 0.3	V
Differential input voltage	V_{IND}	±7.0	V
Output pin current	I_{SOURCE}	20.0	mA
	I_{SINK}	20.0	mA
Operation ambient temperature	T_{opr}	−40 to +125	°C
Storage temperature	T_{stg}	−55 to +150	°C

Caution The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

■ Thermal Resistance Value

Table 5

Item	Symbol	Condition		Min.	Typ.	Max.	Unit
Junction-to-ambient thermal resistance*1	θ_{JA}	TMSOP-8	Board A	−	160	−	°C/W
			Board B	−	133	−	°C/W
			Board C	−	−	−	°C/W
			Board D	−	−	−	°C/W
			Board E	−	−	−	°C/W

***1.** Test environment: compliance with JEDEC STANDARD JESD51-2A

Remark Refer to "■ **Power Dissipation**" and "**Test Board**" for details.

■ Electrical Characteristics

1. Recommended operation condition

Table 6

(Ta = −40°C to +125°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation power supply voltage range	V_{DD}	−	2.70	5.00	5.50	V	−

2. V_{DD} = 5.0 V

Table 7

DC Electrical Characteristics (Ta = −40°C to +125°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Current consumption (2 circuits)	I_{DD}	$V_{CMR} = V_{OUT} = \frac{V_{DD}}{2}$, Ta = +25°C	−	2.00	2.50	mA	5
Input offset voltage	V_{IO}	$V_{CMR} = \frac{V_{DD}}{2}$	−6.0	±3.0	+6.0	mV	1
Input offset voltage drift	$\frac{\Delta V_{IO}}{\Delta Ta}$	$V_{CMR} = \frac{V_{DD}}{2}$	−	±3	−	μV/°C	1
Input bias current	I_{BIAS}	Ta = +25°C	−	1	−	pA	−
Input offset current	I_{IO}	Ta = +25°C	−	1	−	pA	−
Common-mode input voltage range	V_{CMR}	Ta = +25°C	−0.1	−	3.8	V	2
Voltage gain (open loop)	A_{VOL}	$V_{OUT} = V_{SS}$ + 0.5 V to V_{DD} − 0.5 V, $V_{CMR} = \frac{V_{DD}}{2}$, R_L = 1.0 MΩ, Ta = +25°C	88	110	−	dB	8
Maximum output swing voltage	V_{OH}	R_L = 1.0 MΩ	4.9	−	−	V	3
	V_{OL}	R_L = 1.0 MΩ	−	−	0.1	V	4
Common-mode input signal rejection ratio	CMRR	$V_{CMR} = V_{SS}$ − 0.1 V to V_{DD} − 1.2 V, Ta = +25°C	70	85	−	dB	2
Power supply voltage rejection ratio	PSRR	2.70 V ≤ V_{DD} ≤ 5.50 V, Ta = +25°C	70	90	−	dB	1
Source current	I_{SOURCE}	$V_{OUT} = V_{DD}$ − 0.12 V, Ta = +25°C	5.0	−	−	mA	6
Sink current	I_{SINK}	V_{OUT} = 0.12 V, Ta = +25°C	5.0	−	−	mA	7

Table 8

AC Electrical Characteristics (Ta = −40°C to +125°C unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Slew rate	SR	R_L = 1.0 MΩ, C_L = 15 pF (Refer to **Figure 11**)	−	2.00	−	V/μs
Gain-bandwidth product	GBP	C_L = 0 pF	−	3.00	−	MHz

■ Test Circuits (Per Circuit)

1. Power supply voltage rejection ratio, input offset voltage

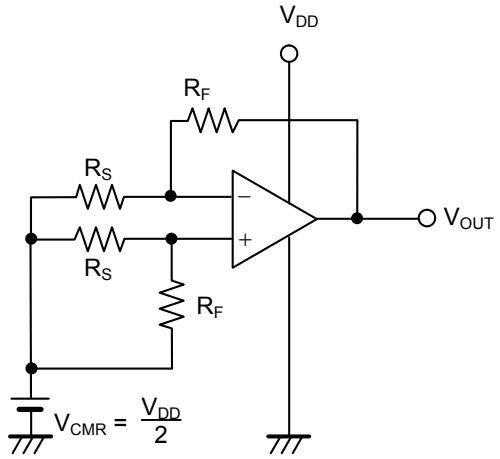


Figure 3 Test Circuit 1

- **Power supply voltage rejection ratio (PSRR)**

The power supply voltage rejection ratio (PSRR) can be calculated by the following expression, with V_{OUT} measured at each V_{DD}.

Test conditions:
V_{DD} = 2.70 V: $V_{DD} = V_{DD1}$, $V_{OUT} = V_{OUT1}$
V_{DD} = 5.50 V: $V_{DD} = V_{DD2}$, $V_{OUT} = V_{OUT2}$

$$PSRR = 20 \log \left(\left| \frac{V_{DD1} - V_{DD2}}{\left(V_{OUT1} - \frac{V_{DD1}}{2}\right) - \left(V_{OUT2} - \frac{V_{DD2}}{2}\right)} \right| \times \frac{R_F + R_S}{R_S} \right)$$

- **Input offset voltage (V_{IO})**

$$V_{IO} = \left(V_{OUT} - \frac{V_{DD}}{2}\right) \times \frac{R_S}{R_F + R_S}$$

2. Common-mode input signal rejection ratio, common-mode input voltage range

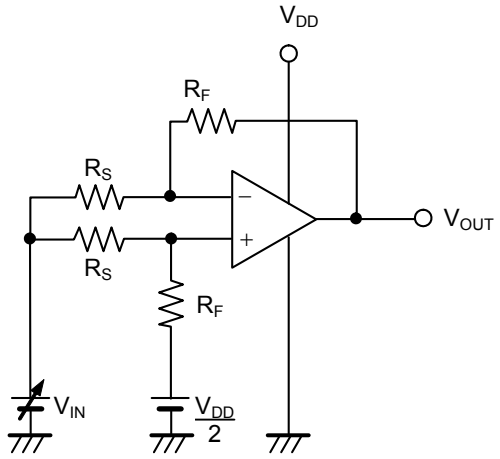


Figure 4 Test Circuit 2

- **Common-mode input signal rejection ratio (CMRR)**

The common-mode input signal rejection ratio (CMRR) can be calculated by the following expression, with V_{OUT} measured at each V_{IN}.

Test conditions:
$V_{IN} = V_{CMR\ Max.}$: $V_{IN} = V_{IN1}$, $V_{OUT} = V_{OUT1}$
$V_{IN} = V_{CMR\ Min.}$: $V_{IN} = V_{IN2}$, $V_{OUT} = V_{OUT2}$

$$CMRR = 20 \log \left(\left| \frac{V_{IN1} - V_{IN2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

- **Common-mode input voltage range (V_{CMR})**

The common-mode input voltage range is the range of V_{IN} in which V_{OUT} satisfies the common-mode input signal rejection ratio specifications when V_{IN} is changed.

3. Maximum output swing voltage (V_{OH})

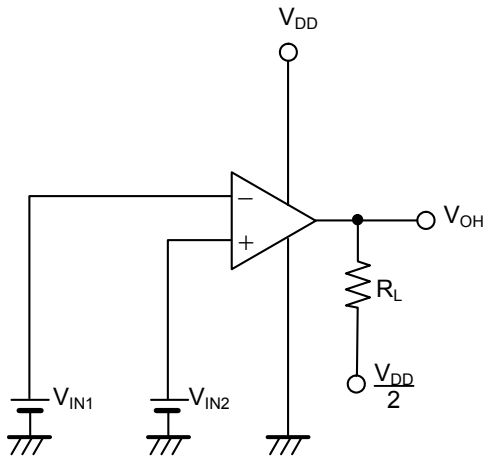


Figure 5 Test Circuit 3

- **Maximum output swing voltage (V_{OH})**

  Test conditions

  $V_{IN1} = \frac{V_{DD}}{2} - 0.1$ V

  $V_{IN2} = \frac{V_{DD}}{2} + 0.1$ V

  R_L = 1 MΩ

4. Maximum output swing voltage (V_{OL})

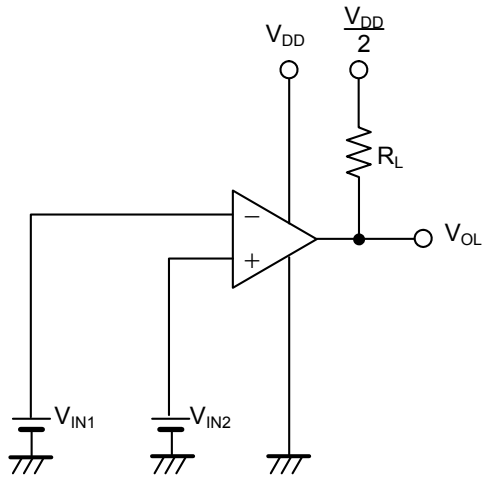


Figure 6 Test Circuit 4

- **Maximum output swing voltage (V_{OL})**

  Test conditions:

  $V_{IN1} = \frac{V_{DD}}{2} + 0.1$ V

  $V_{IN2} = \frac{V_{DD}}{2} - 0.1$ V

  R_L = 1 MΩ

5. Current consumption

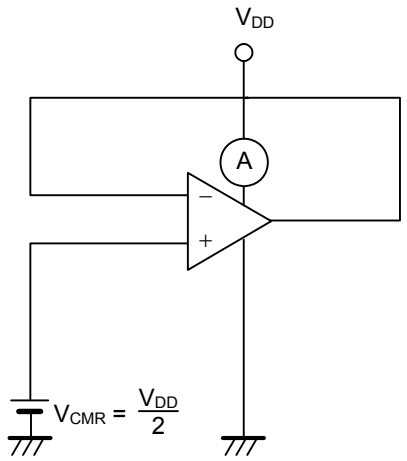


Figure 7 Test Circuit 5

- **Current consumption (I_{DD})**

6. Source current

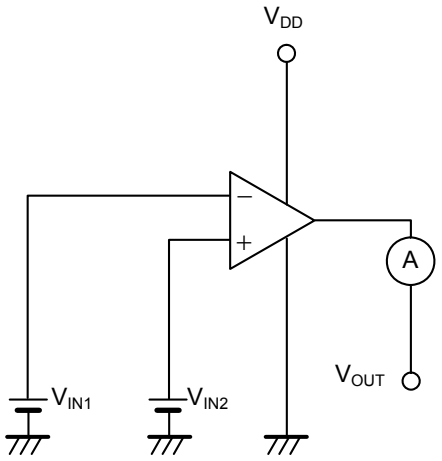


Figure 8 Test Circuit 6

- **Source current (I_{SOURCE})**

  Test conditions:

  $V_{OUT} = V_{DD} - 0.12$ V

  $V_{IN1} = \frac{V_{DD}}{2} - 0.1$ V

  $V_{IN2} = \frac{V_{DD}}{2} + 0.1$ V

7. Sink current

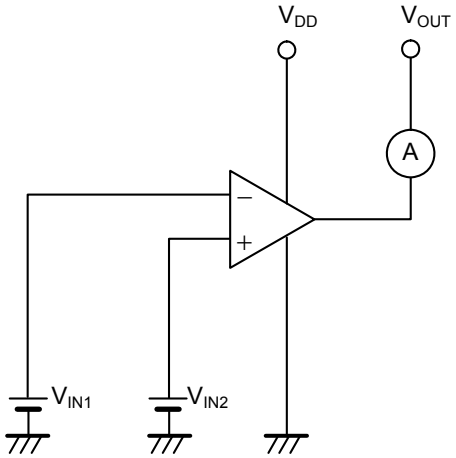


Figure 9 Test Circuit 7

- **Sink current (I_{SINK})**

  Test conditions:

  $V_{OUT} = V_{SS} + 0.12$ V

  $V_{IN1} = \frac{V_{DD}}{2} + 0.1$ V

  $V_{IN2} = \frac{V_{DD}}{2} - 0.1$ V

8. Voltage gain

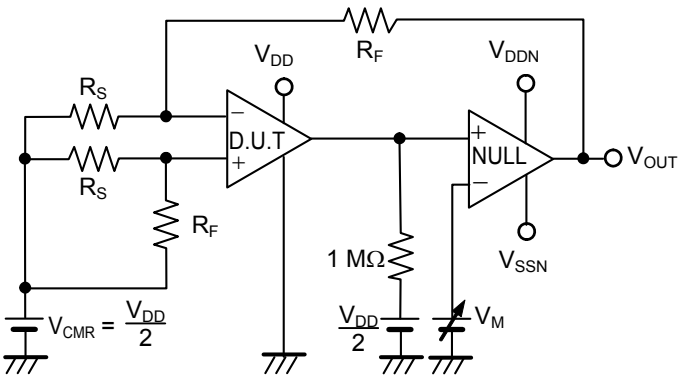


Figure 10 Test Circuit 8

- **Voltage gain (open loop) (A_{VOL})**

The voltage gain (A_{VOL}) can be calculated by the following expression, with V_{OUT} measured at each V_M.

Test conditions:
$V_M = V_{DD} - 0.5$ V: $V_M = V_{M1}$, $V_{OUT} = V_{OUT1}$
$V_M = 0.5$ V: $V_M = V_{M2}$, $V_{OUT} = V_{OUT2}$

$$A_{VOL} = 20 \log \left(\left| \frac{V_{M1} - V_{M2}}{V_{OUT1} - V_{OUT2}} \right| \times \frac{R_F + R_S}{R_S} \right)$$

9. Slew rate (SR)

Measured by the voltage follower circuit.

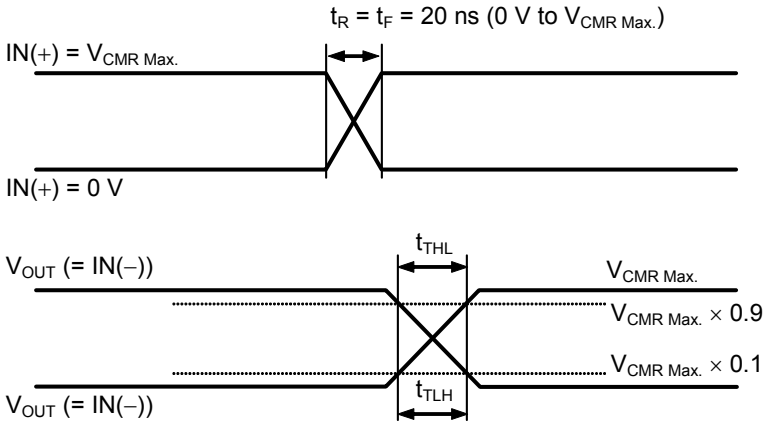


Figure 11

- **Slew rate (SR)**

$$SR = \frac{V_{CMR\ Max.} \times 0.8}{t_{TLH}}$$

$$SR = \frac{V_{CMR\ Max.} \times 0.8}{t_{THL}}$$

■ Precautions

- Do not apply an electrostatic discharge to this IC that exceeds performance ratings of the built-in electrostatic protection circuit.
- ABLIC Inc. claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.
- Use this IC with the output current of 20 mA or less.
- This IC operates stably even directly connecting a load capacitance of 100 pF or less to the output pin, as shown in **Figure 12**. When connecting a load capacitance of 100 pF or more, connect a resistor of 47 Ω or more as shown in **Figure 13**. In case of connecting a filter for noise prevention, and connecting a load capacitance of 100 pF or more, also connect a resistor of 47 Ω or more as shown in **Figure 14**.

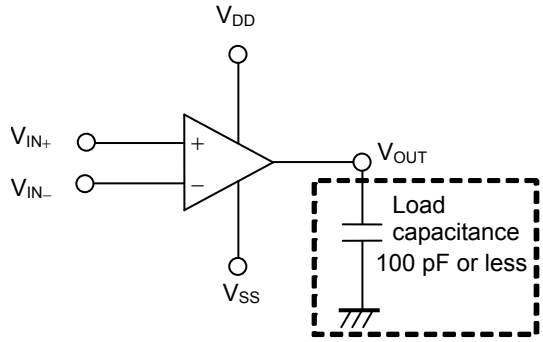


Figure 12

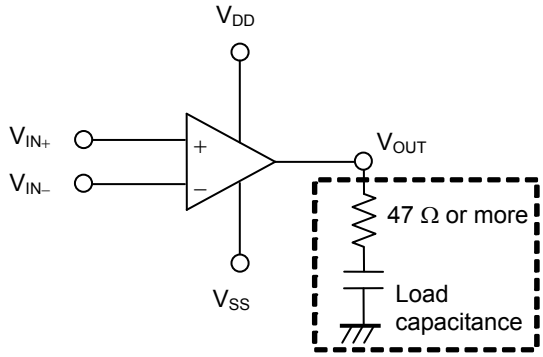


Figure 13

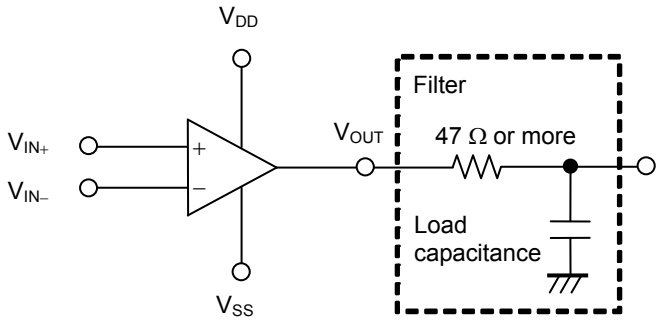
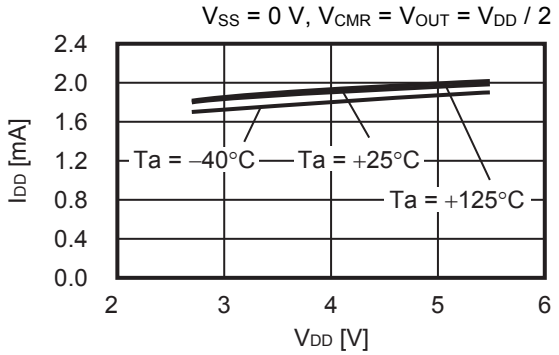


Figure 14

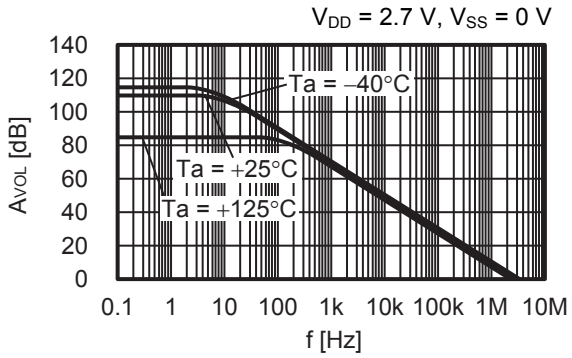
Caution The above connection diagrams and constants will not guarantee successful operation. Perform thorough evaluation using the actual application to set the constants.

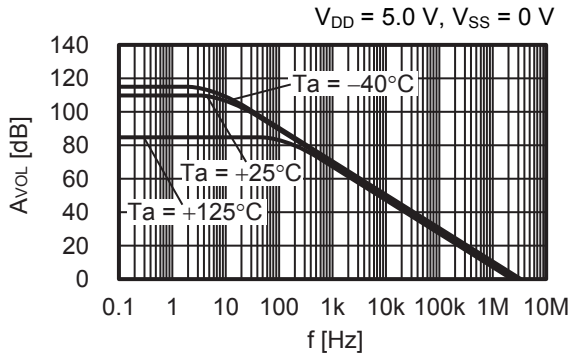
■ Characteristics (Typical Data)

1. Current consumption (I_{DD}) (2 circuits) vs. Power supply voltage (V_{DD})



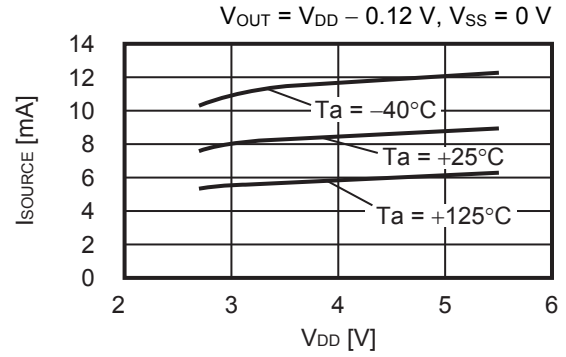
2. Voltage gain (A_{VOL}) vs. Frequency (f)



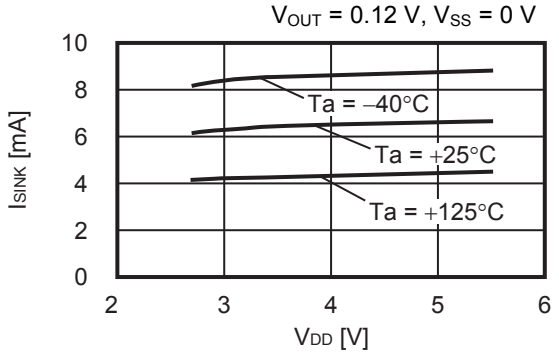


3. Output current

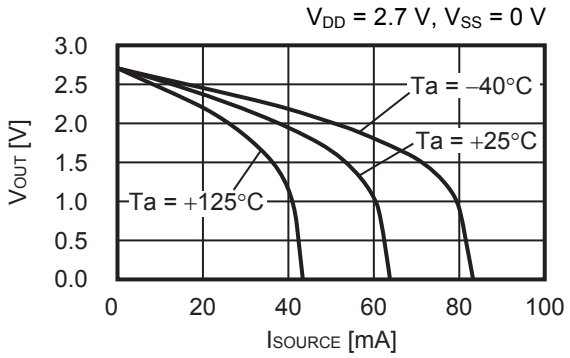
3. 1 Source current (I_{SOURCE}) vs. Power supply voltage (V_{DD})

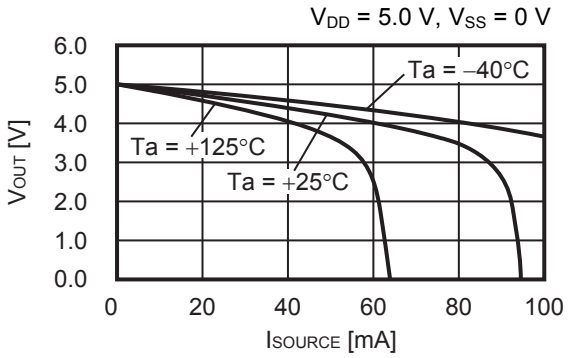


3. 2 Sink current (I_{SINK}) vs. Power supply voltage (V_{DD})

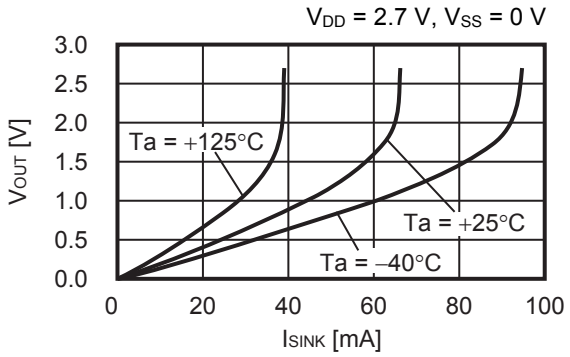


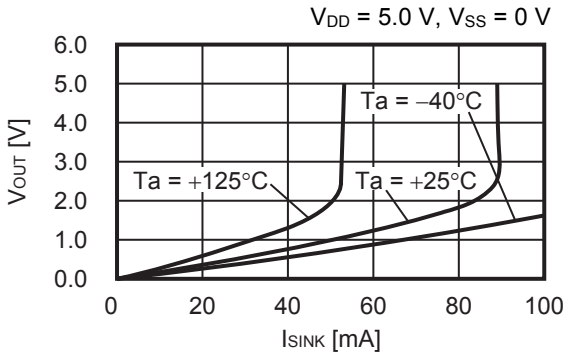
3. 3 Output voltage (V_{OUT}) vs. Source current (I_{SOURCE})



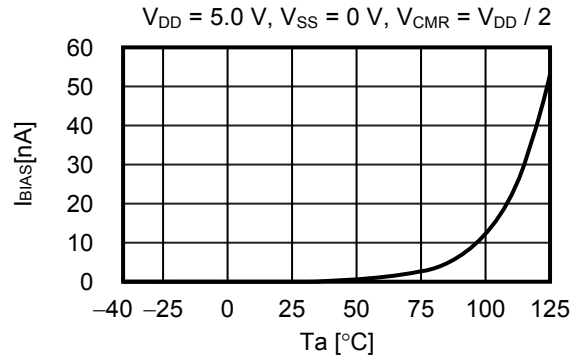


3. 4 Output voltage (V_{OUT}) vs. Sink current (I_{SINK})



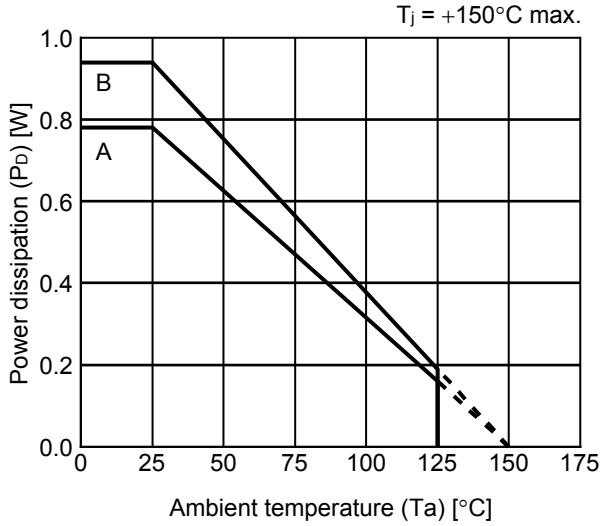


4. Input bias current (I_{BIAS}) vs. Temperature (Ta)



■ Power Dissipation

TMSOP-8

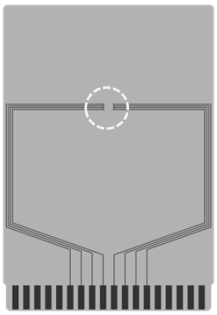


Board	Power Dissipation (P_D)
A	0.78 W
B	0.94 W
C	–
D	–
E	–

TMSOP-8 Test Board

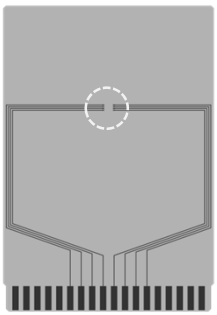
(1) Board A

IC Mount Area



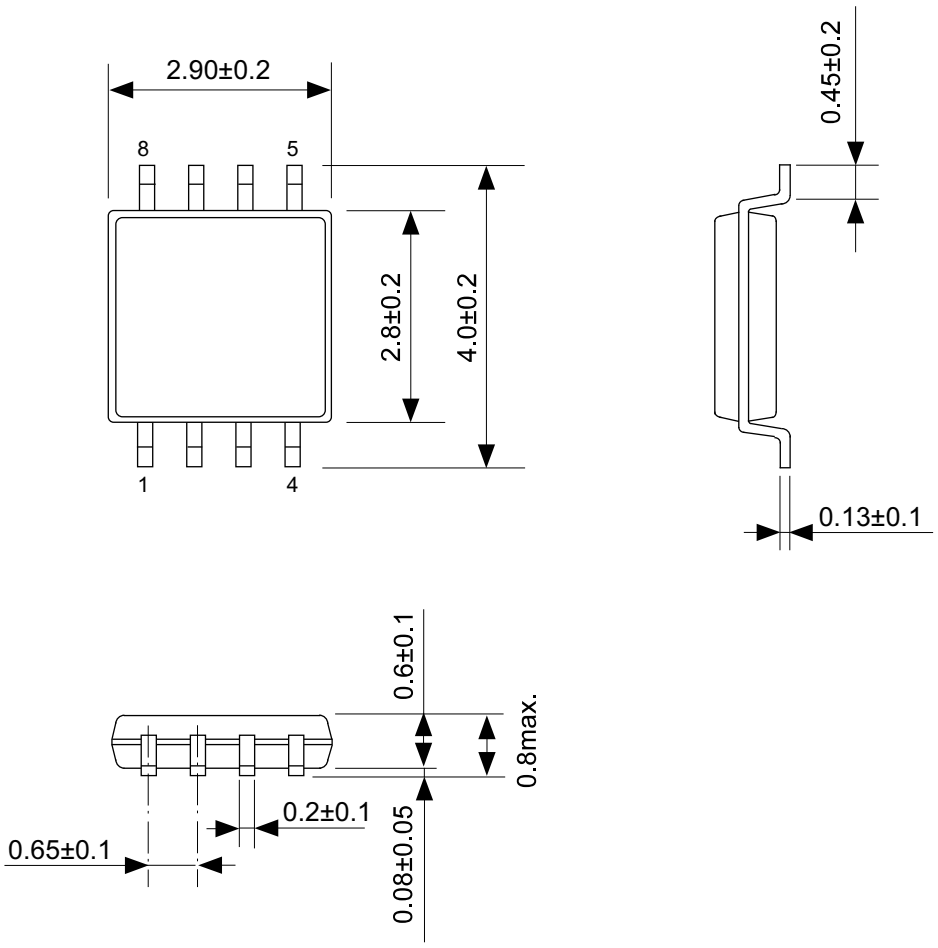
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



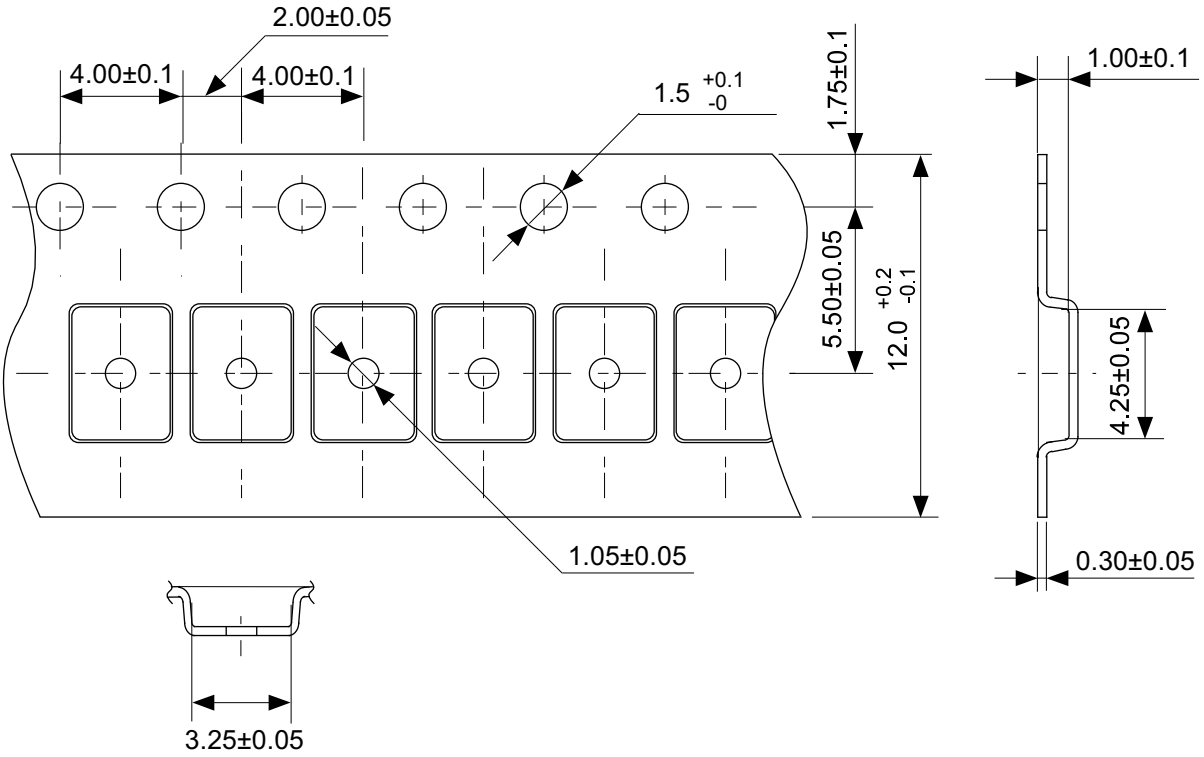
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

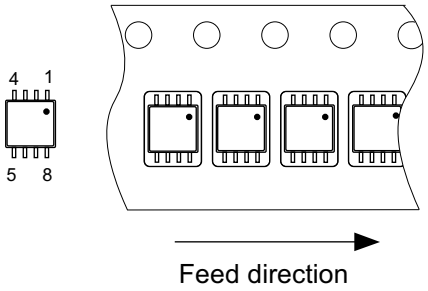
No. TMSOP8-A-Board-SD-1.0



No. FM008-A-P-SD-1.2

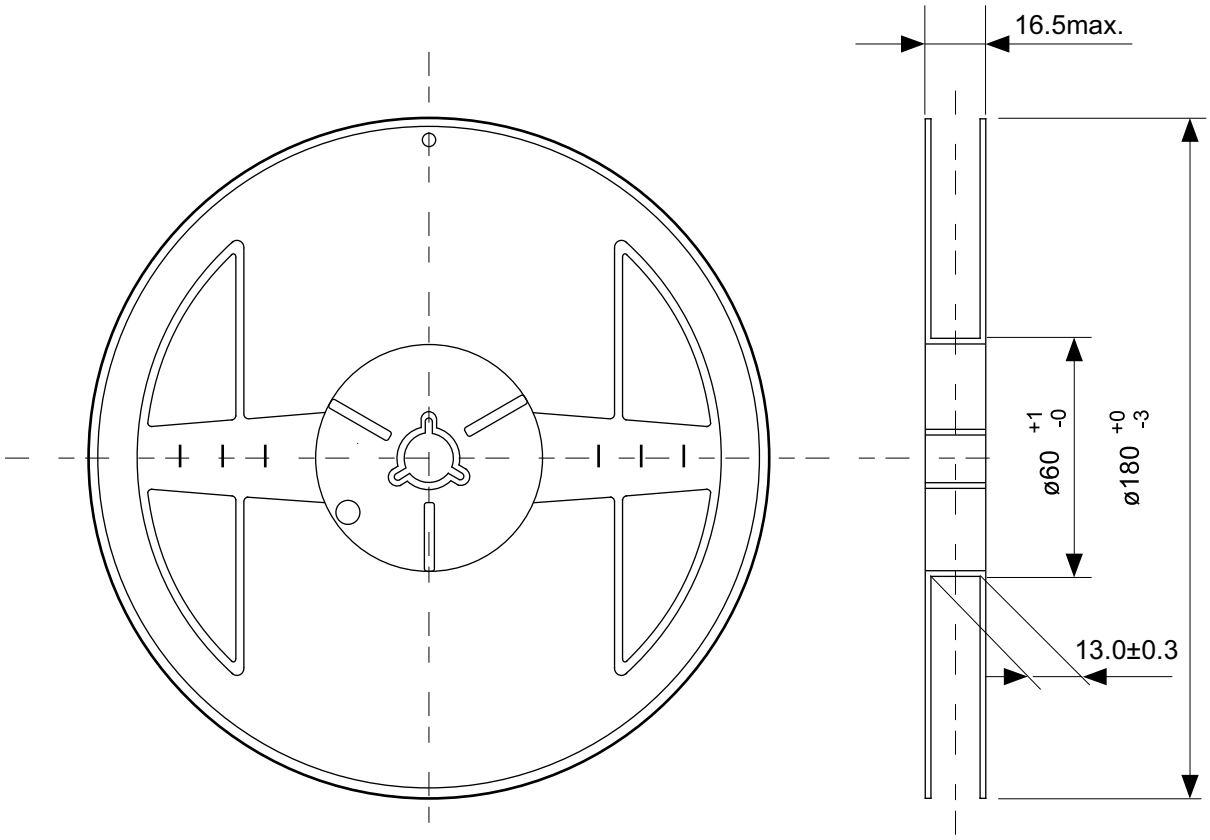
TITLE	TMSOP8-A-PKG Dimensions
No.	FM008-A-P-SD-1.2
ANGLE	
UNIT	mm
ABLIC Inc.	



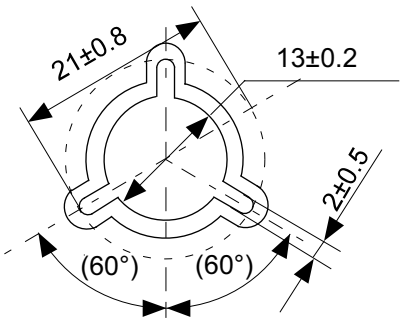


No. FM008-A-C-SD-2.0

TITLE	TMSOP8-A-Carrier Tape
No.	FM008-A-C-SD-2.0
ANGLE	
UNIT	mm
ABLIC Inc.	



Enlarged drawing in the central part



No. FM008-A-R-SD-1.0

TITLE	TMSOP8-A-Reel		
No.	FM008-A-R-SD-1.0		
ANGLE		QTY.	4,000
UNIT	mm		
ABLIC Inc.			

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2.4-2019.07