HT9281/HT9282/HT9284
Operation Amplifier

Features

- Operating Voltage: 2.0V to 5.5V
- Supply Current: 220μA/amplifier typical
- Rail-to-Rail Output
- Gain Bandwidth: 2.3MHz typical
- Unity Gain Stable
- Available in Single, Dual and Quad Op′s package types
- Package type:
  HT9281: TSOT23-5
  HT9282: 8-pin DIP/SOP
  HT9284: 14-pin DIP/SOP

Applications

- Automotive
- Portable Equipment
- Photodiode Amplifier
- Analog Filters
- Notebooks and PDAs
- Battery Powered Systems

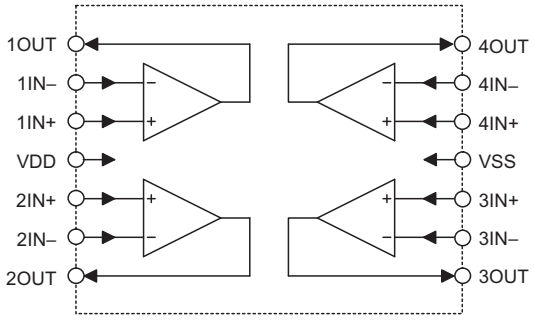
General Description

The Holtek HT9281/HT9282/HT9284 range of Operational Amplifiers operate with a single supply voltage as low as 2.0V and offer a low supply current of only 220μA/amplifier. In offering rail-to-rail output voltage the devices can operate with a maximum voltage range. The devices also provide a gain bandwidth product of 2.3MHz and are also unity gain stable. These products are suitable for a wide range of analog signal processing applications but especially suitable for the portable device and battery powered equipment application areas.

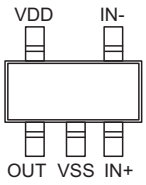
Selection Table

Part No.	Amplifiers	Package
HT9281	1	TSOT23-5
HT9282	2	8DIP/SOP
HT9284	4	14DIP/SOP

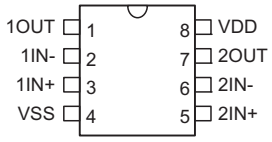
Block Diagram



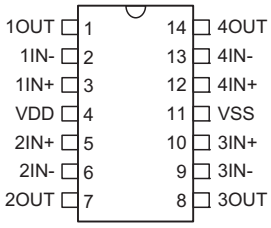
Pin Assignment



HT9281
TSOT23-5



HT9282
8 DIP-A/SOP-A



HT9284
14 DIP-A/SOP-A

Pin Descriptions

HT9281

Pin No.	Pin Name	Description
1	OUT	Analog output
2	VSS	Negative power supply
3	IN+	Non-inverting input
4	IN-	Inverting input
5	VDD	Positive power supply

HT9282

Pin No.	Pin Name	Description
1	1OUT	Analog output (operation amplifier 1)
2	1IN-	Inverting input (operation amplifier 1)
3	1IN+	Non-inverting input (operation amplifier 1)
4	VSS	Negative power supply
5	2IN+	Non-inverting input (operation amplifier 2)
6	2IN-	Inverting input (operation amplifier 2)
7	2OUT	Analog output (operation amplifier 2)
8	VDD	Positive power supply

HT9284

Pin No.	Pin Name	Description
1	1OUT	Analog output (operation amplifier 1)
2	1IN-	Inverting input (operation amplifier 1)
3	1IN+	Non-inverting input (operation amplifier 1)
4	VDD	Positive power supply
5	2IN+	Non-inverting input (operation amplifier 2)
6	2IN-	Inverting input (operation amplifier 2)
7	2OUT	Analog output (operation amplifier 2)
8	3OUT	Analog output (operation amplifier 3)
9	3IN-	Inverting input (operation amplifier 3)
10	3IN+	Non-inverting input (operation amplifier 3)
11	VSS	Negative power supply
12	4IN+	Non-inverting input (operation amplifier 4)
13	4IN-	Inverting input (operation amplifier 4)
14	4OUT	Analog output (operation amplifier 4)

Absolute Maximum Ratings

Supply Voltage 6.0V

Difference Input Voltage .....±(V_{DD}–V_{SS})

Storage Temperature .....–65°C to +150°C

Junction Temperature .....150°C

Input Voltage.....V_{SS}–0.3V ~ V_{DD}+0.3V

ESD protection on all pins (HBM;MM) .....≥4kV; 400V

Operating Temperature .....–40°C to +85°C

Note: These are stress ratings only. Stresses exceeding the range specified under "Absolute Maximum Ratings" may cause substantial damage to the device. Functional operation of this device at other conditions beyond those listed in the specification is not implied and prolonged exposure to extreme conditions may affect device reliability.

Electrical Characteristics

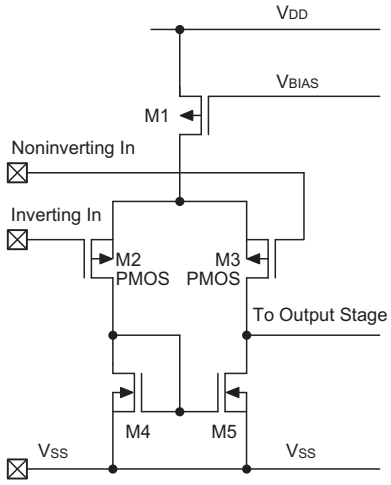
Unless otherwise indicated, V_{SS}=GND, Ta=25°C, V_{CM}=V_{DD}/2, V_L=V_{DD}/2, and R_L=10kΩ to V_L, C_L=60pF

Symbol	Parameter	Test Conditions		Min.	Typ.	Max.	Unit
		V_{DD}	Conditions				
V_{DD}	Supply Voltage	—	—	2.0	—	5.5	V
V_{OS}	Input Offset Voltage	5V	V_{IN}=V_{CM}/2	–5.0	—	5.0	mV
$\Delta V_{OS}/\Delta T$	Drift with Temperature	5V	V_{IN}=V_{CM}/2	—	±2	—	μV/°C
I_{OS}	Input Offset Current	5V	Ta=25°C	—	±5	—	pA
I_B	Input Bias Current	5V	Ta=25°C	—	±50	—	pA
V_{CM}	Input Common Mode Range	5V	—	0	—	V_{DD}–1.4	V
V_{OH} V_{OL}	Maximum Output Voltage Swing	5V	0.5V input overdrive R_L=10kΩ to V_L	V_{SS}+50	—	V_{DD}–50	mV
			0.5V input overdrive R_L=2kΩ to V_L	V_{SS}+150	—	V_{DD}–250	mV
A_{OL}	DC Open-Loop Gain (large signal)	5V	V_{OUT}=0.2V to V_{DD}-0.2V, V_{IN}=V_{CM}/2	70	100	—	dB
GBW	Gain BandWidth Product	5V	R_L=10kΩ, C_L=60pF V_{IN}=V_{CM}/2	—	2.3	—	MHz
Φm	Phase Margin	5V	R_L=10kΩ, C_L=60pF G=+1V/V, V_{IN+}= V_{DD}/2	—	63	—	°
CMRR	Common Mode Rejection Ratio	5V	V_{CM}=0V to V_{DD}-1.4V	60	90	—	dB
PSRR	Power Supply Rejection Ratio	5V	V_{CM}=0.2V	65	95	—	dB
I_{CC}	Supply Current Per Single Amplifier	5V	Io=0A	100	220	340	μA
SR	Slew Rate at Unity Gain	5V	R_L=10kΩ, C_L=60pF	—	2	—	V/ms
I_{O_SOURCE}	Output Short Circuit Source Current	5V	V_{IN+} – V_{IN-} ≥ 10mV	–5.0	–9.0	—	mA
I_{O_SINK}	Output Short Circuit Sink Current	5V	V_{IN-} – V_{IN+} ≥ 10mV	5.5	9.5	—	mA

Functional Description

Input stage

The input stage of op amps are nominal PMOS differential amplifiers (see the following diagram), therefore the common mode input voltage can extend to V_{SS}-0.6V. On the other hand the common mode input voltage has to be maintained below (V_{DD}–1.4)V to keep the input device (M2 and M3) active. This implies that when using HT9281/HT9282/HT9284 as a voltage follower, the input as well as output active range will be limited between V_{SS}~V_{DD}-1V (approx.). Avoid applying any voltage greater than V_{DD}+0.6V or less than V_{SS}-0.6V to the input pins, otherwise the internal input protection devices may be damaged.



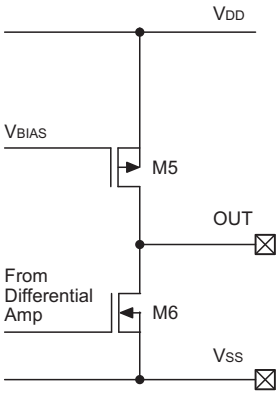
Since the input impedance of PMOS is inherently very high, it can directly couple to high impedance elements without loading effect. For example, coupling to ceramic transducers, integrating capacitor and resistor networks.

Actually the extremly high input impedance is its major advantage over the bipolar counterpart, in some application fields such as integrators where the input current of op amp can cause significant error.

Output stage

The HT9281/HT9282/HT9284 uses push-pull CMOS configuration as the output stage of op amps to minimize low power consumption and to provide adequate output driving current.

Note that the output is an unbuffered structure, therefore the open loop gain will be affected by the load resistor since the voltage gain of this stage can be expressed as (gm5+ gm6)×R_L.

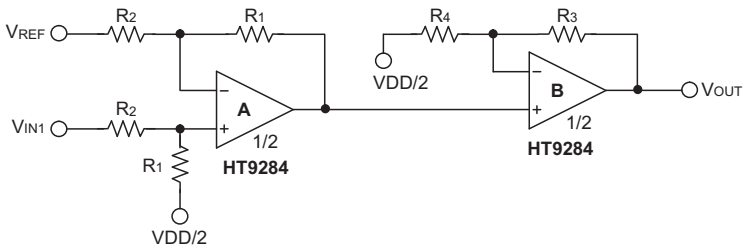


Because of the consideration for minimized power consumption, output short circuit current is limited to about -9mA for source drive and 9.5mA for sink drive. This is believed to be enough for most low power systems, however it is recommended to use the load resistor of >10kΩ for normal applications. In case of heavy load driving, an external buffer stage using bipolar transistors is recommended.

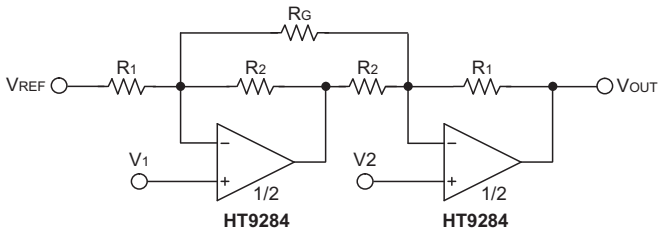
The HT9281/HT9282/HT9284 is internally compensated for AC stability and capable to withstand up to a 60pF capacitive load.

Application Circuits

Difference Amplifier Circuit



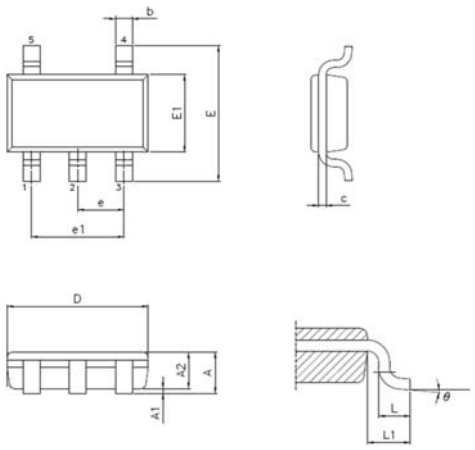
Two Op Amp Instrumentation Amplifier



$$V_{OUT} = (V_2 - V_1) \times \left(1 + \frac{R_1}{R_2} + \frac{2R_1}{R_G}\right) + V_{REF}$$

Package Information

5-pin TSOT23-5 Outline Dimensions

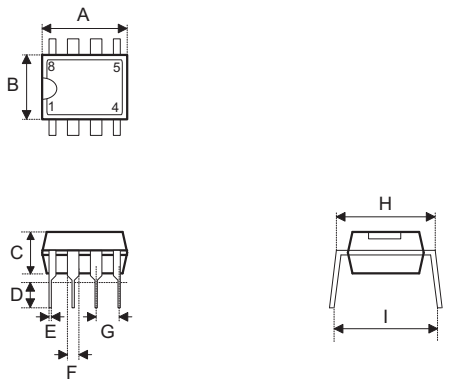


- MO-193C

Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	—	—	0.043
A1	0.000	—	0.004
A2	0.028	—	0.039
b	0.012	—	0.020
C	0.003	—	0.008
D	—	0.114	—
E	—	0.110	—
E1		0.063	
e	—	0.037	—
e1		0.075	
L	0.012	—	0.024
L1	—	0.024	—
θ	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	—	—	1.10
A1	0.00	—	0.10
A2	0.70	—	1.00
b	0.30	—	0.50
C	0.08	—	0.20
D	—	2.90	—
E	—	2.80	—
E1		1.60	
e	—	0.95	—
e1	—	1.90	
L	0.30	—	0.60
L1	—	0.60	—
θ	0°	—	8°

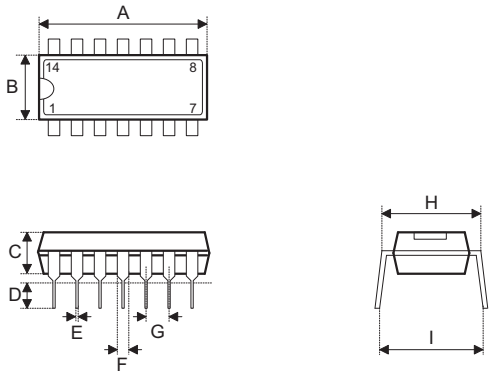
8-pin DIP (300mil) Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.355	—	0.375
B	0.240	—	0.260
C	0.125	—	0.135
D	0.125	—	0.145
E	0.016	—	0.020
F	0.050	—	0.070
G	—	0.100	—
H	0.295	—	0.315
I	—	0.375	—

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	9.02	—	9.53
B	6.10	—	6.60
C	3.18	—	3.43
D	3.18	—	3.68
E	0.41	—	0.51
F	1.27	—	1.78
G	—	2.54	—
H	7.49	—	8.00
I	—	9.53	—

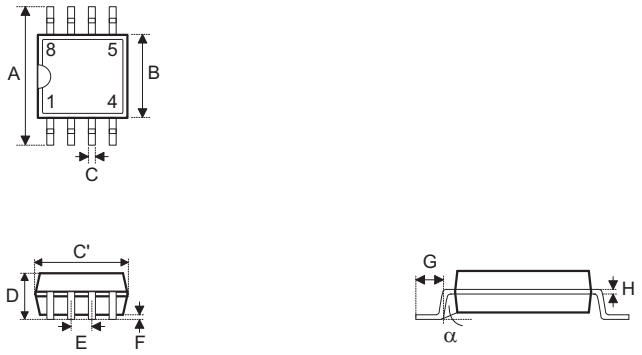
14-pin DIP (300mil) Outline Dimensions



Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.745	—	0.775
B	0.240	—	0.260
C	0.125	—	0.135
D	0.125	—	0.145
E	0.016	—	0.020
F	0.050	—	0.070
G	—	0.1100	—
H	0.295	—	0.315
I	—	0.375	—

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	18.92	—	19.69
B	6.10	—	6.60
C	3.18	—	3.43
D	3.18	—	3.68
E	0.41	—	0.51
F	1.27	—	1.78
G	—	2.54	—
H	7.49	—	8.00
I	—	9.53	—

8-pin SOP (150mil) Outline Dimensions

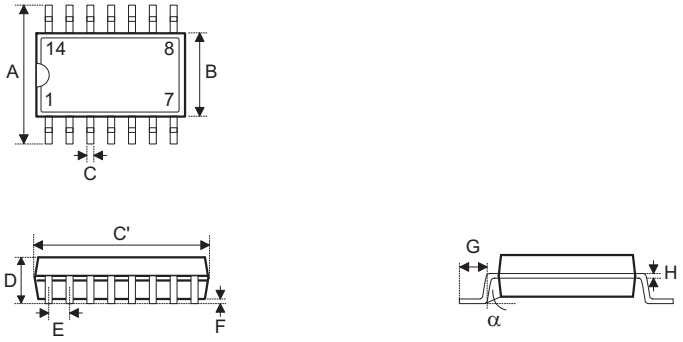


• MS-012

Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.228	—	0.244
B	0.150	—	0.157
C	0.012	—	0.020
C′	0.188	—	0.197
D	—	—	0.069
E	—	0.050	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.007	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	5.79	—	6.20
B	3.81	—	3.99
C	0.30	—	0.51
C′	4.78	—	5.00
D	—	—	1.75
E	—	1.27	—
F	0.10	—	0.25
G	0.41	—	1.27
H	0.18	—	0.25
α	0°	—	8°

14-pin SOP (150mil) Outline Dimensions

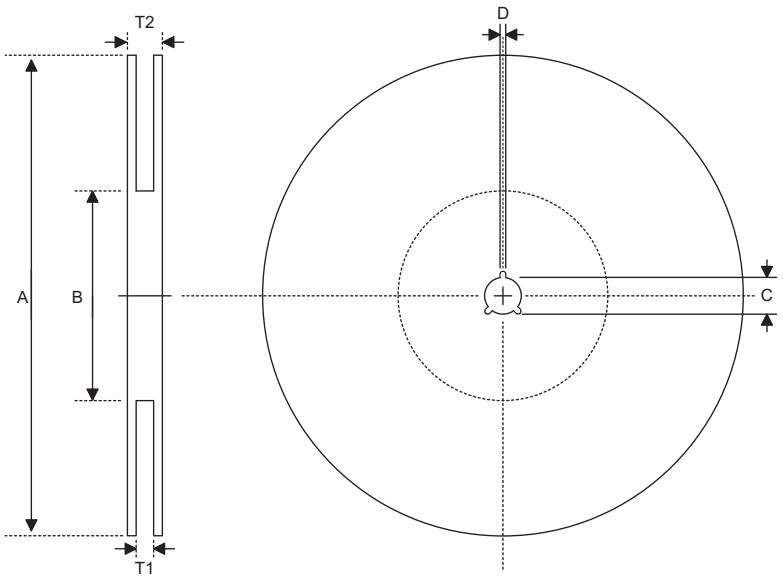


• MS-012

Symbol	Dimensions in inch		
	Min.	Nom.	Max.
A	0.228	—	0.244
B	0.150	—	0.157
C	0.012	—	0.020
C′	0.337	—	0.344
D	—	—	0.069
E	—	0.050	—
F	0.004	—	0.010
G	0.016	—	0.050
H	0.007	—	0.010
α	0°	—	8°

Symbol	Dimensions in mm		
	Min.	Nom.	Max.
A	5.79	—	6.20
B	3.81	—	3.99
C	0.30	—	0.51
C′	8.56	—	8.74
D	—	—	1.75
E	—	1.27	—
F	0.10	—	0.25
G	0.41	—	1.27
H	0.18	—	0.25
α	0°	—	8°

Product Tape and Reel Specifications



Reel Dimensions

SOP 8N

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	330.0±1.0
B	Reel Inner Diameter	100.0±1.5
C	Spindle Hole Diameter	13.0 $^{+0.5/-0.2}$
D	Key Slit Width	2.0±0.5
T1	Space Between Flange	12.8 $^{+0.3/-0.2}$
T2	Reel Thickness	18.2±0.2

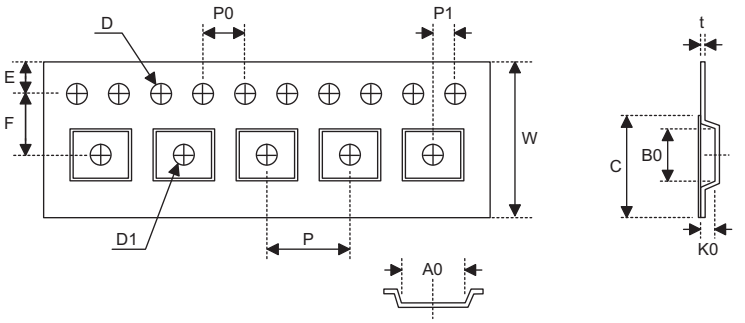
SOP 14N

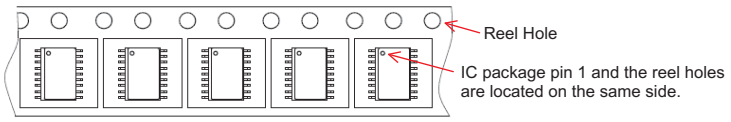
Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	330.0±1.0
B	Reel Inner Diameter	100.0±1.5
C	Spindle Hole Diameter	13.0 $^{+0.5/-0.2}$
D	Key Slit Width	2.0±0.5
T1	Space Between Flange	16.8 $^{+0.3/-0.2}$
T2	Reel Thickness	22.2±0.2

TSOT23-5

Symbol	Description	Dimensions in mm
A	Reel Outer Diameter	178.0±1.0
B	Reel Inner Diameter	60.0±1.0
C	Spindle Hole Diameter	13.0 $^{+0.5/-0.2}$
D	Key Slit Width	2.4±0.1
T1	Space Between Flange	9.0±0.5
T2	Reel Thickness	11.8±0.5

Carrier Tape Dimensions





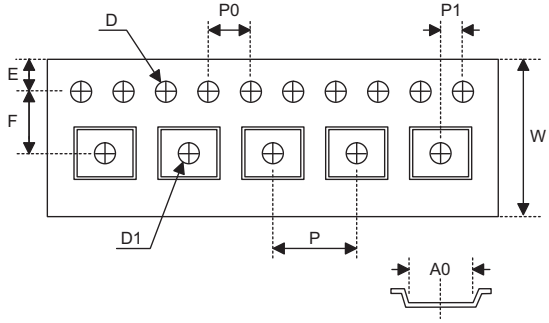
SOP 8N

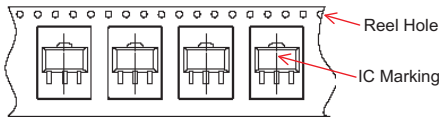
Symbol	Description	Dimensions in mm
W	Carrier Tape Width	12.0 +0.3/-0.1
P	Cavity Pitch	8.0±0.1
E	Perforation Position	1.75±0.1
F	Cavity to Perforation (Width Direction)	5.5±0.1
D	Perforation Diameter	1.55±0.1
D1	Cavity Hole Diameter	1.50 +0.25/-0.00
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.0±0.1
A0	Cavity Length	6.4±0.1
B0	Cavity Width	5.2±0.1
K0	Cavity Depth	2.1±0.1
t	Carrier Tape Thickness	0.30±0.05
C	Cover Tape Width	9.3±0.1

SOP 14N

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	16.0 +0.3/-0.1
P	Cavity Pitch	8.0±0.1
E	Perforation Position	1.75±0.1
F	Cavity to Perforation (Width Direction)	7.5±0.1
D	Perforation Diameter	1.5 +0.1/-0.0
D1	Cavity Hole Diameter	1.50 +0.25/-0.00
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.0±0.1
A0	Cavity Length	6.5±0.1
B0	Cavity Width	9.5±0.1
K0	Cavity Depth	2.1±0.1
t	Carrier Tape Thickness	0.30±0.05
C	Cover Tape Width	13.3±0.1

Carrier Tape Dimensions





TSOT23-5

Symbol	Description	Dimensions in mm
W	Carrier Tape Width	8.0±0.2
P	Cavity Pitch	4.0±0.1
E	Perforation Position	1.75±0.10
F	Cavity to Perforation (Width Direction)	3.50±0.05
D	Perforation Diameter	$1.5^{+0.1/-0.0}$
D1	Cavity Hole Diameter	$1.1^{+0.1/-0.0}$
P0	Perforation Pitch	4.0±0.1
P1	Cavity to Perforation (Length Direction)	2.00±0.05
A0	Cavity Length	3.2±0.1
B0	Cavity Width	3.2±0.1
K0	Cavity Depth	1.1±0.1
t	Carrier Tape Thickness	0.25±0.05
C	Cover Tape Width	5.3±0.1

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