

## **Features**

- Low Offset Voltage: 65 $\mu$ V (max)
- Low input bias currents: 1 pA (max)
- Low noise: 12 nV/ $\sqrt$ Hz
- Wide bandwidth: 8.7 MHz
- High open-loop gain: 1000 V/mV
- Unity gain stable
- Single-supply operation: 2.7 V to 5.5 V

## **Applications**

- Photodiode amplification
- Battery-powered instrumentation
- Multipole filters
- Sensors
- Barcode scanners
- Audio

## **Description**

The CBM8605, CBM8606, and CBM8608 are single, dual, and quad rail-to-rail input and output, single-supply amplifiers. They feature very low offset voltage, low input voltage and current noise, and gain bandwidth product characteristic of up to 8.7MHz.

The CBM8605, CBM8606, and CBM8608 are specified over the extended industrial temperature range ( $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ ). The CBM8605 single is available in 5-lead SOT-23 and 5-ball WLCSP packages. The CBM8606 dual is available in an 8-lead MSOP, an 8-ball WLSCP, and a narrow SOIC surface-mounted package. The CBM8608 quad is available in a 14-lead TSSOP package and a narrow 14-lead SOIC package. The 5-ball and 8-ball WLCSP offer the smallest available footprint for any surface-mounted operational amplifier. The WLCSP, SOT-23, MSOP, and TSSOP versions are available in tape-and-reel only.

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## Pin Configurations

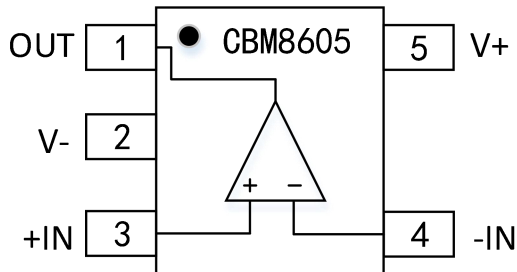


Figure1.

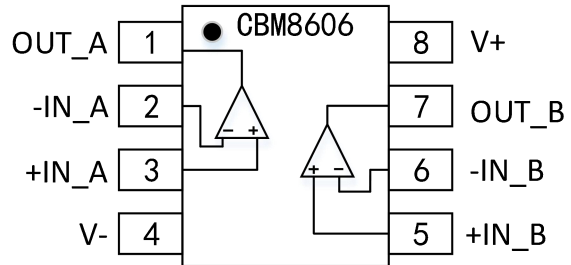
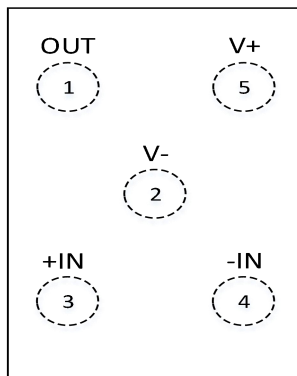


Figure2.

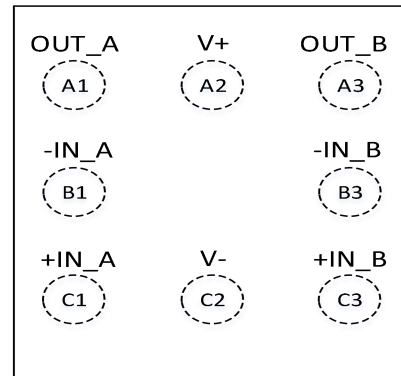
### SOT23 Pin Configuration



CBM8605  
(TOP VIEW)

Figure3.

### MSOP/SOP Pin Configuration



CBM8606  
(TOP VIEW)

Figure4.

### WLCSP Pin Configuration

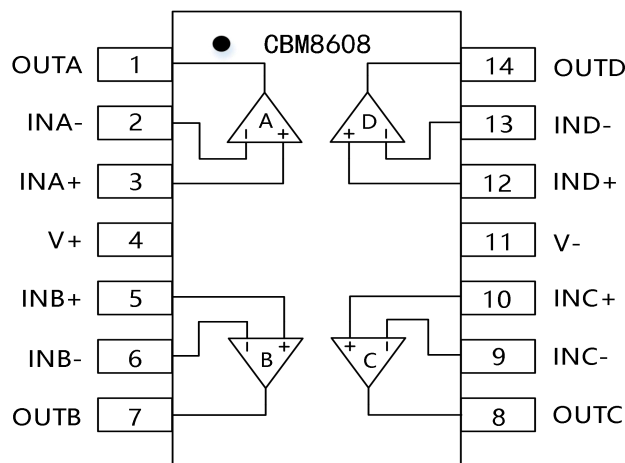


Figure5.

### TSSOP/SOP Pin Configuration

## Pin Descriptions

PIN_N	SYMBOL(CBM8605)	I/O	NAME AND FUNCTION
1	OUT	O	Output
2	V-	--	Negative power supply
3	+IN	I	None inverting input
4	-IN	I	inverting input
5	V+	--	Positive power supply
PIN_N	SYMBOL(CBM8606)	I/O	NAME AND FUNCTION
1	OUT_A	O	Output A
2	-IN_A	I	inverting input A
3	+IN_A	I	None inverting input A
4	V-	--	Negative power supply
5	+IN_B	I	None inverting input B
6	-IN_B	I	inverting input B
7	OUT_B	O	Output B
8	V+	--	Positive power supply
PIN_N	SYMBOL WLCSP(CBM8605)	I/O	NAME AND FUNCTION
1	OUT	O	Output
2	V-	--	Negative power supply
3	+IN	I	None inverting input
4	-IN	I	inverting input
5	V+	--	Positive power supply
PIN_N	SYMBOL WLCSP(CBM8606)	I/O	NAME AND FUNCTION
1	OUT_A	O	Output A
2	V+	--	Positive power supply
3	OUT_B	O	Output B
4	-IN_A	I	inverting input A
5	-IN_B	I	inverting input B

6	+IN_A	I	None inverting input A
7	V-	--	Negative power supply
8	+IN_B	I	None inverting input B
<b>PIN N</b>	<b>SYMBOL (CBM8608)</b>	<b>I/O</b>	<b>NAME AND FUNCTION</b>
1	OUT_A	O	Output A
2	-IN_A	I	inverting input A
3	+IN_A	I	None inverting input A
4	V+	--	Positive power supply
5	+IN_B	I	None inverting input B
6	-IN_B	I	inverting input B
7	OUT_B	O	Output B
8	OUT_C	O	Output C
9	-IN_C	I	inverting input C
10	+IN_C	I	None inverting input C
11	V-	--	Negative power supply
12	+IN_D	I	None inverting input D
13	-IN_D	I	inverting input D
14	OUT_D	O	Output D

## **Absolute Maximum Ratings <sup>(1)</sup>**

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- Supply Voltage: 6V
- Input Voltage : V- to V+
- Differential Input Voltage 6 V
- Storage Temperature Range All Packages :  
-65°C to +150°C
- Operating Temperature Range All  
Packages : -40°C to +125°C
- Junction Temperature Range All Packages :  
-65°C to +150°C
- SOT23-5: 240°C/W
- MSOP-8 : 206°C/W
- SOP-8 : 157°C/W
- Lead Temperature (Soldering, 60s) : 300°C

## Electrical Characteristics

( $V_S = 5\text{ V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

Table1.

PARAMETER	CONDITION	CBM8605,CBM8606,CBM8608			
		MIN	TYP	MAX	UNIT
<b>INPUT CHARACTERISTICS</b>					
Input Offset Voltage ( $V_{OS}$ )	$V_S = 3.5\text{ V}$ , $V_{CM} = 3\text{ V}$		20	65	$\mu\text{V}$
	$V_S = 2.7\text{ V}$ , $V_{CM} = 0\text{ V to } 2.7\text{ V}$		80	300	$\mu\text{V}$
Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )			1	4.5	$\mu\text{V}/^\circ\text{C}$
Input Bias Current ( $I_B$ )			0.2	1	$\text{pA}$
Input Offset Current ( $I_{OS}$ )			0.1	0.5	$\text{pA}$
Input Voltage Range		0		5	$\text{V}$
Common-Mode Rejection Ratio (CMRR)	$V_{CM} = 0\text{ V to } 5\text{ V}$	85	100		$\text{dB}$
Open-Loop Voltage Gain ( $A_{OL}$ )	$R_L = 2\text{K}\Omega$ , $V_O = 0.5\text{ V to } 4.5\text{ V}$	300	1000		$\text{dB}$
<b>INPUT CAPACITANCE</b>					
Differential ( $C_{DIFF}$ )			2.6		$\text{pF}$
Common-Mode ( $C_{COM}$ )			8.8		$\text{pF}$
<b>OUTPUT CHARACTERISTICS</b>					
Output Voltage High ( $V_{OH}$ )	$I_L = 1\text{ mA}$	4.96	4.98		$\text{V}$
	$I_L = 10\text{ mA}$	4.7	4.79		$\text{V}$
Output Voltage Low ( $V_{OL}$ )	$I_L = 1\text{ mA}$		20	40	$\text{mV}$
	$I_L = 10\text{ mA}$		170	210	$\text{mV}$
Output Current ( $I_{OUT}$ )			$\pm 80$		$\text{mA}$
<b>POWER SUPPLY</b>					
Power Supply Rejection Ratio (PSRR)	$V_{CM} = 2.7\text{ V to } 5.5\text{ V}$	75	89		$\text{dB}$
Supply Current/Amplifier ( $I_{SV}$ )	$I_{OUT} = 0\text{ mA}$		0.8	1.2	$\text{mA}$
<b>NOISE PERFORMANCE</b>					
Peak-to-Peak Noise ( $e_n$ p-p)	$f = 0.1\text{ Hz to } 10\text{ Hz}$		2.3	3.5	$\mu\text{Vp-p}$
Voltage Noise Density ( $e_n$ )	$f = 1\text{ kHz}$		8	12	$\text{nV}/\sqrt{\text{Hz}}$
Voltage Noise Density ( $e_n$ )	$f = 10\text{ kHz}$		6.5		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density ( $i_n$ )	$f = 1\text{ kHz}$		0.01		$\text{pA}/\sqrt{\text{Hz}}$

<b>DYNAMIC PERFORMANCE</b>					
Slew Rate (SR)	$R_L = 2\text{ k}\Omega, C_L = 16\text{ pF}$		5		V/ $\mu\text{s}$
Gain-Bandwidth Product (GBW)			8.7		MHz
Settling Time	To 0.01%, 0 V to 2 V step, $A_V = 1$		<1		$\mu\text{s}$

( $V_S = 2.7\text{V}$ ,  $V_{CM} = V_S/2$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise noted.)

**Table 2.**

PARAMETER	CONDITION	CBM8605,CBM8606,CBM8608			
		MIN	TYP	MAX	UNIT
<b>INPUT CHARACTERISTICS</b>					
Input Offset Voltage ( $V_{OS}$ )	$V_S = 3.5\text{ V}, V_{CM} = 3\text{ V}$		20	65	$\mu\text{V}$
	$V_S = 2.7\text{ V}, V_{CM} = 0\text{ V to }2.7\text{ V}$		80	300	$\mu\text{V}$
Offset Voltage Drift ( $\Delta V_{OS}/\Delta T$ )			1	4.5	$\mu\text{V}/^\circ\text{C}$
Input Bias Current ( $I_B$ )	$V_{CM} = V_S/2$		0.2	1	pA
Input Offset Current ( $I_{OS}$ )			0.1	0.5	pA
Input Voltage Range		0		2.7	V
Common-Mode Rejection Ratio (CMRR)	$V_{CM} = 0\text{V to }2.7\text{V}$	70	89		dB
Open-Loop Voltage Gain ( $A_{OL}$ )	$R_L=2\text{K}\Omega, V_O=0.5\text{V to }2.2\text{V}$	110	350		V/mV
<b>INPUT CAPACITANCE</b>					
Differential ( $C_{DIFF}$ )			2.6		pF
Common-Mode ( $C_{COM}$ )			8.8		pF
<b>OUTPUT CHARACTERISTICS</b>					
Output Voltage High ( $V_{OH}$ )	$I_L = 1\text{ mA}$	2.6	2.66		V
Output Voltage Low ( $V_{OL}$ )	$I_L = 1\text{ mA}$		25	40	mV
Output Current ( $I_{OUT}$ )			$\pm 30$		mA
<b>POWER SUPPLY</b>					
Power Supply Rejection Ratio (PSRR)	$V_{CM} = 2.7\text{V to }5.5\text{V}$	75	89		dB
Supply Current/Amplifier ( $I_{SV}$ )	$I_{OUT} = 0\text{ mA}$		0.8	1.4	mA
<b>NOISE PERFORMANCE</b>					
Peak-to-Peak Noise ( $e_n, p-p$ )	$f = 0.1\text{ Hz to }10\text{ Hz}$		2.3	3.5	$\mu\text{Vp-p}$
Voltage Noise Density ( $e_n$ )	$f = 1\text{ kHz}$		8	12	$\text{nV}/\sqrt{\text{Hz}}$
Voltage Noise Density ( $e_n$ )	$f = 10\text{ kHz}$		6.5		$\text{nV}/\sqrt{\text{Hz}}$
Current Noise Density ( $i_n$ )	$f = 1\text{ kHz}$		0.01		$\text{pA}/\sqrt{\text{Hz}}$



<b>DYNAMIC PERFORMANCE</b>					
Slew Rate (SR)	$R_L = 2\text{ k}\Omega, C_L = 16\text{ pF}$		5		V/ $\mu$ s
Gain-Bandwidth Product (GBW)			8.7		MHz
Settling Time	To 0.01%, 0 V to 1 V step, $A_V = 1$		<0.5		us

## Typical Characteristics

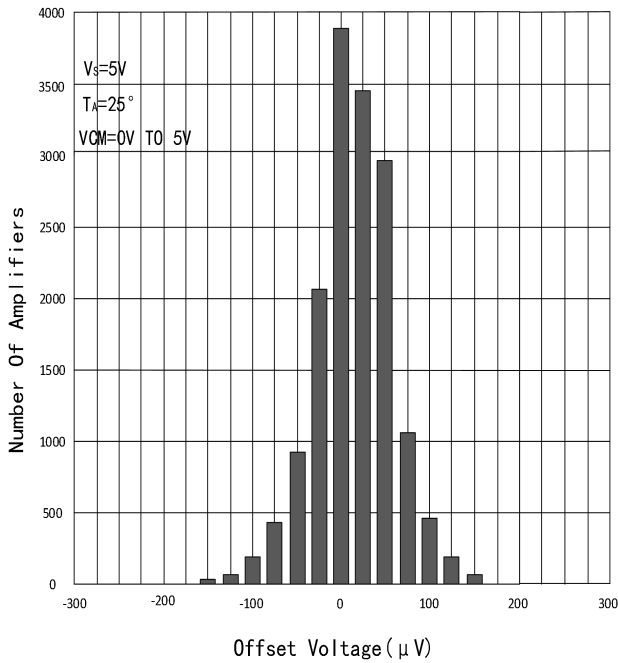


Figure6.Input Offset Voltage Distribution

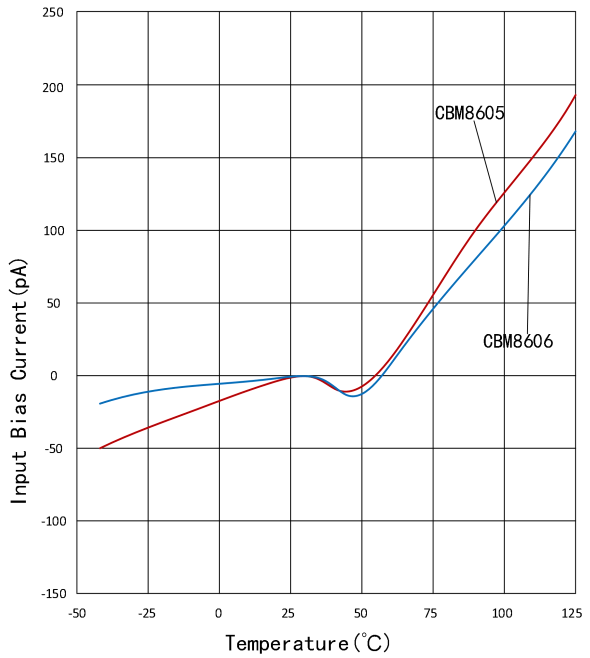


Figure7.Input Bias Current vs. Temperature

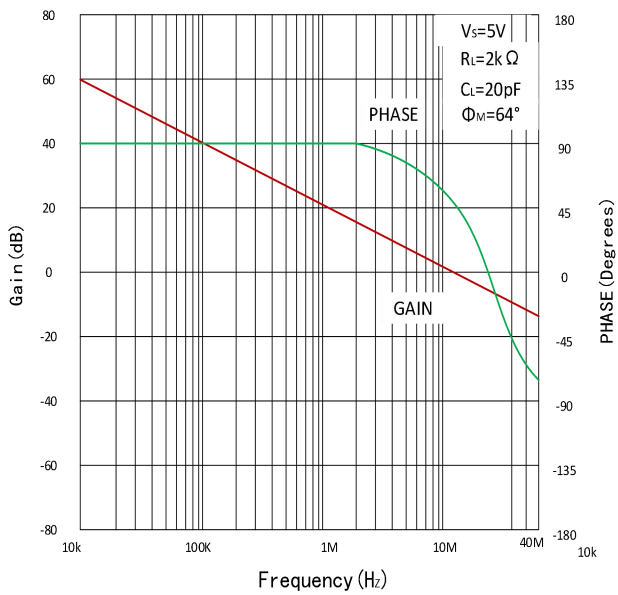


Figure8.Open-Loop Gain and Phase vs. Frequency

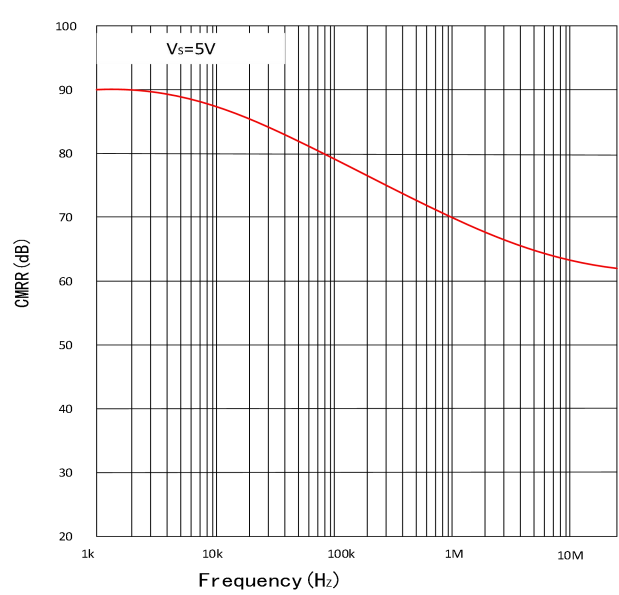
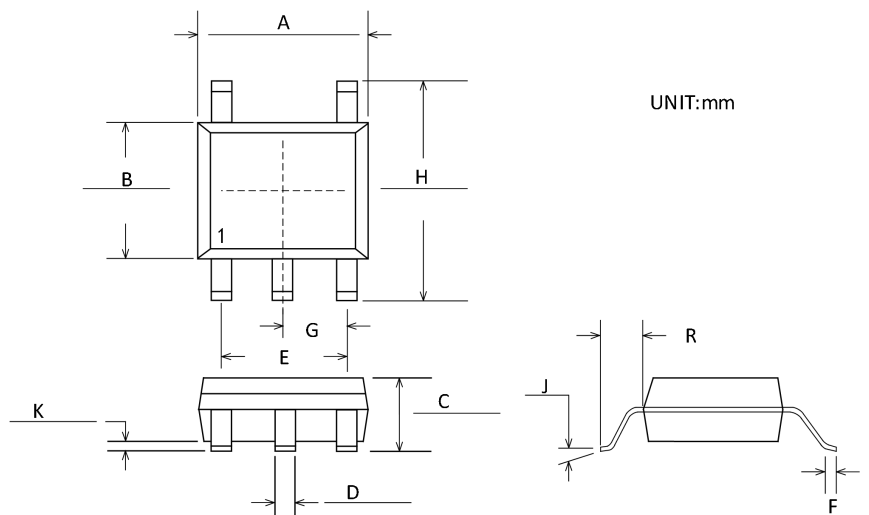


Figure9.Common-Mode Rejection Ratio (CMRR) vs. Frequency

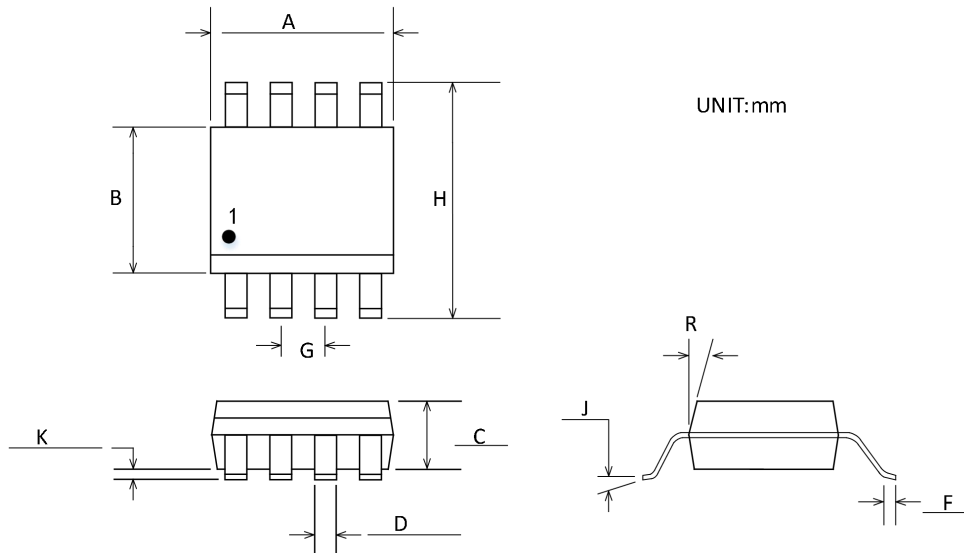
## Package Outline Dimensions

### SOT23-5



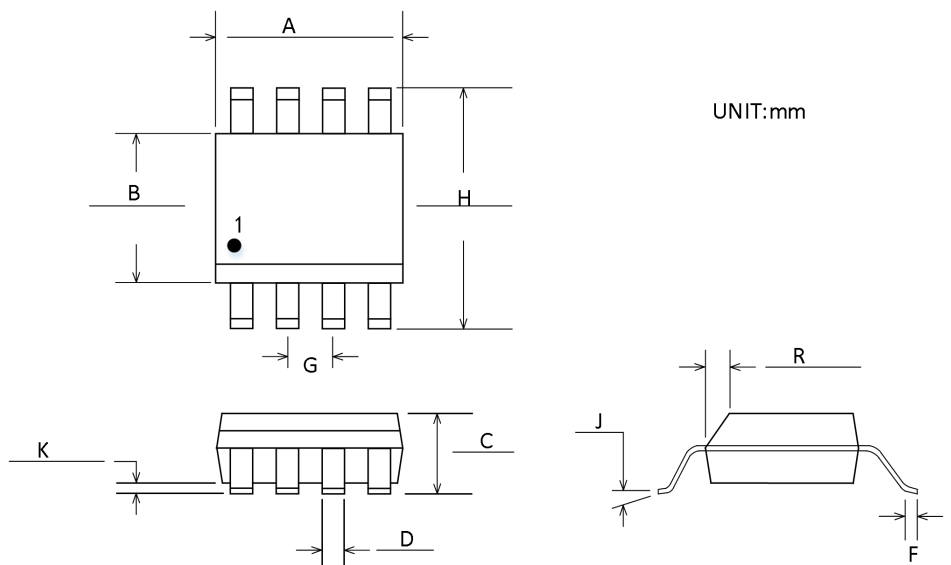
Symbol	Dimensions In Millimeters	
	Min	Max
A	2.80	3.00
B	1.50	1.70
C	0.95	1.45
D	0.35	0.50
E	1.90BSC	
F	0.35	0.55
G	0.95BSC	
H	2.60	3.00
J	0°	10°
K	0.05	0.15
R	0.60BSC	

## MSOP-8



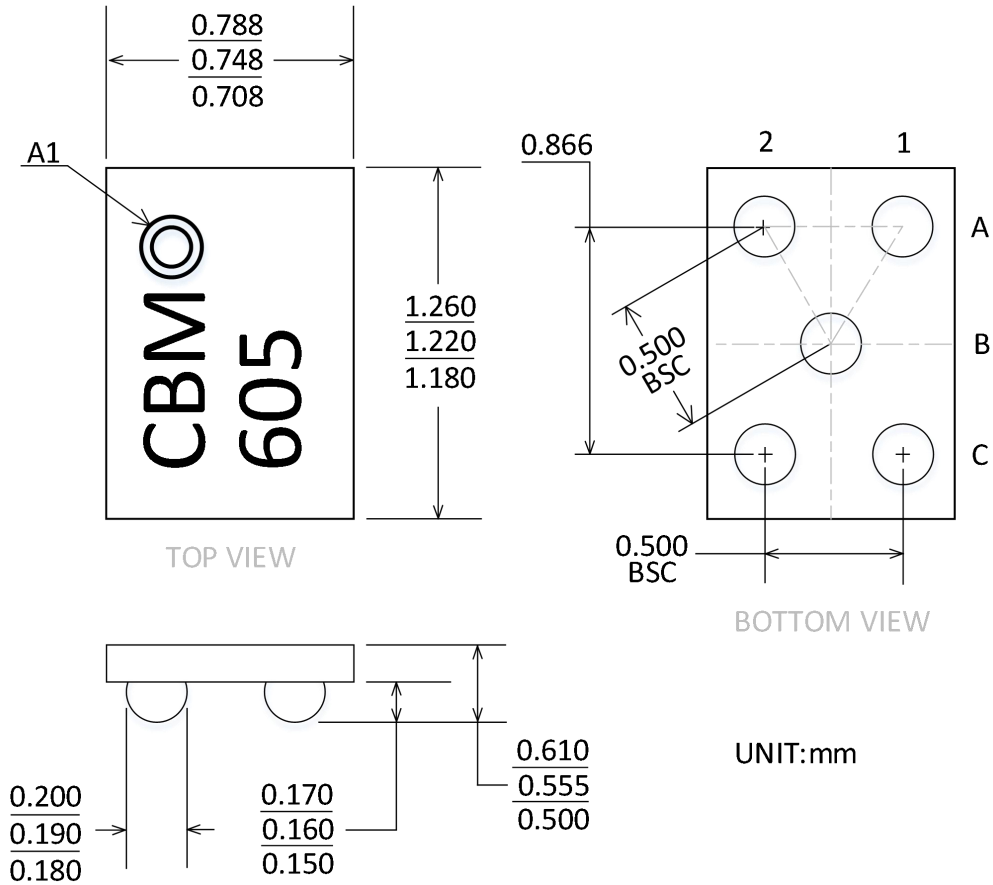
Symbol	Dimensions In Millimeters	
	Min	Max
A	2.80	3.20
B	2.80	3.20
B	1.10MAX	
D	0.25	0.40
F	0.40	0.80
G	0.65BSC	
H	4.65	5.15
J	0°	6°
K	0.05	0.15
R	15°MAX	

## SOP-8

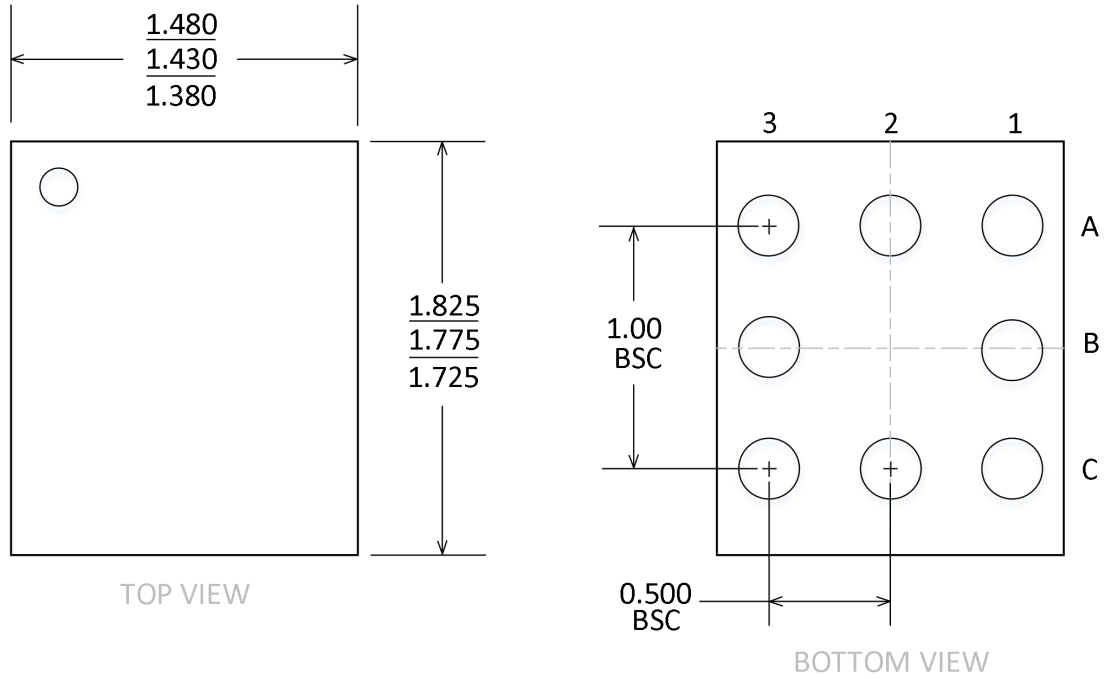


Symbol	Dimensions In Millimeters	
	Min	Max
A	4.80	5.00
B	3.80	4.00
C	1.35	1.75
D	0.31	0.51
F	0.40	1.27
G	1.27BSC	
H	5.80	6.20
J	0°	8°
K	0.10	0.25
R	0.25	0.50

### WLCSP-5 (8605)

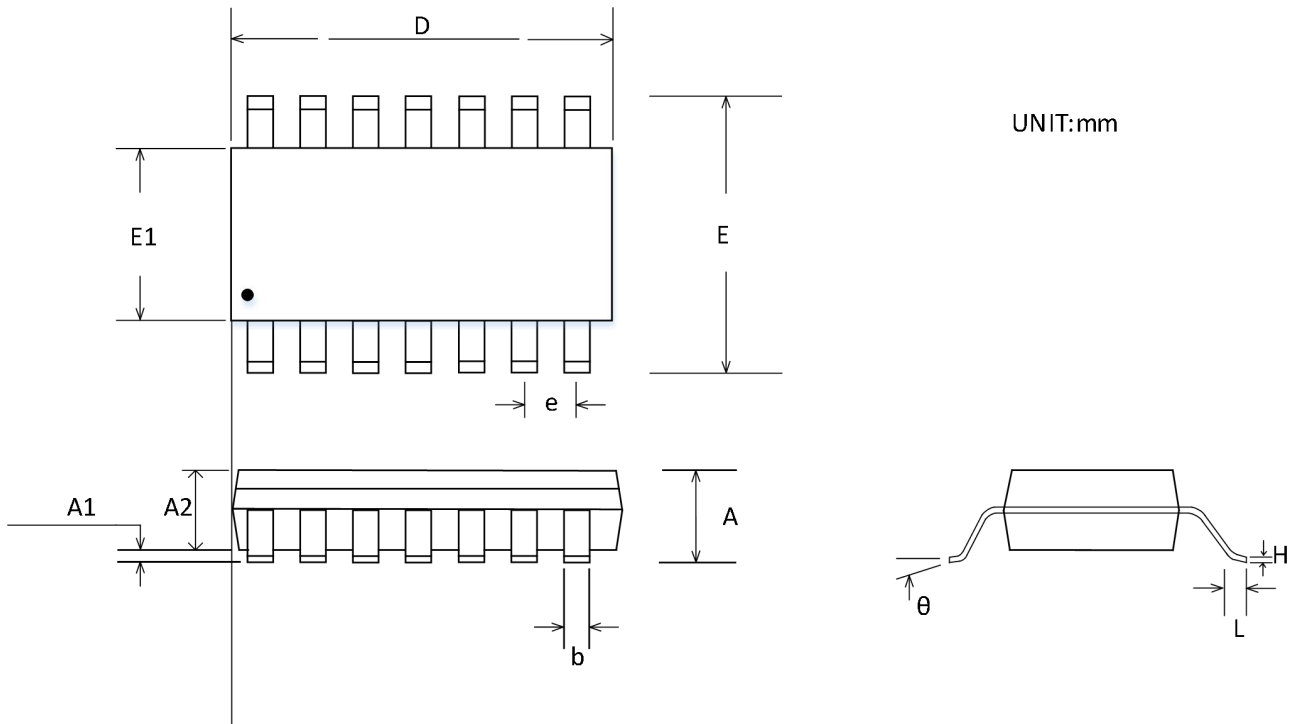


### WLCSP-8 (8606)



UNIT:mm

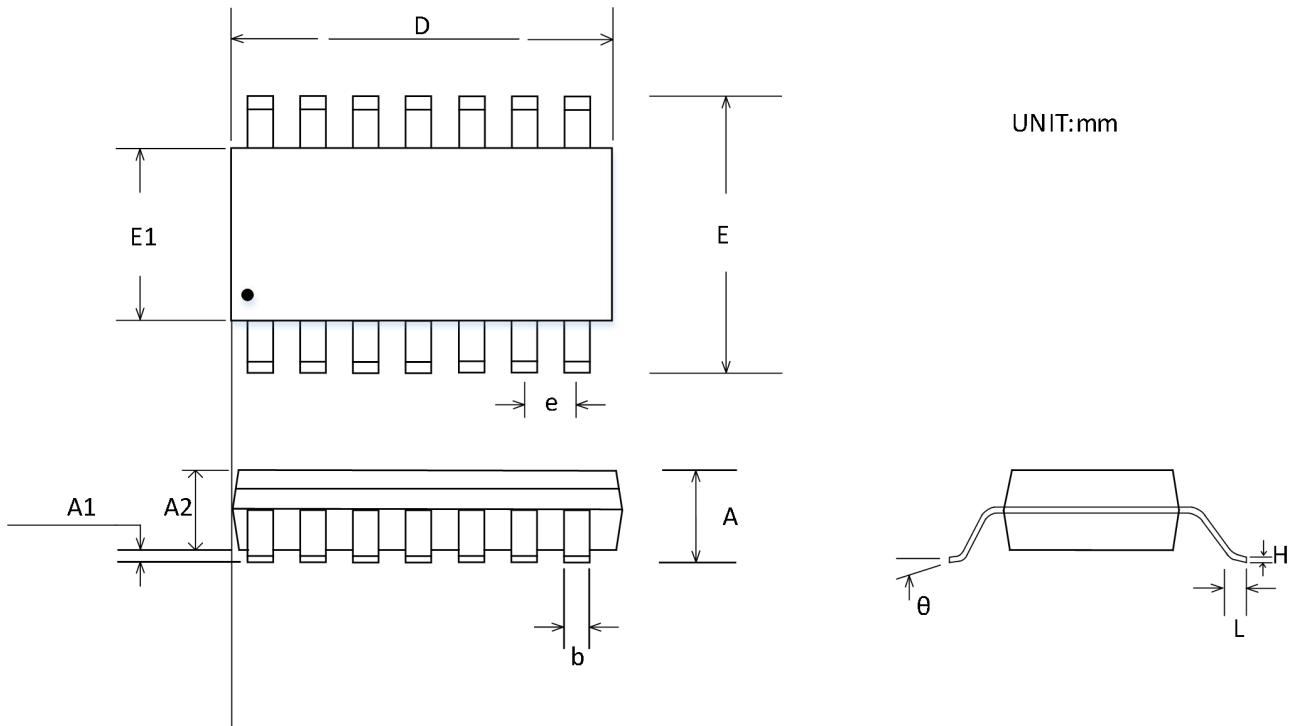
## TSSOP-14



Symbol	Dimensions In Millimeters	
	Min	Max
<b>A</b>	1.20MAX	
<b>A1</b>	0.05	0.15
<b>A2</b>	0.80	1.05
<b>b</b>	0.19	0.30
<b>D</b>	4.90	5.10
<b>E</b>	6.40BSC	
<b>E1</b>	4.30	4.50
<b>e</b>	0.65BSC	
<b>H</b>	0.09	0.20
<b>L</b>	0.45	0.75
<b>θ</b>	0°	8°



## SOP-14



Symbol	Dimensions In Millimeters	
	Min	Max
<b>A</b>	1.35	1.75
<b>A1</b>	0.10	0.25
<b>A2</b>	1.25	1.50
<b>b</b>	0.31	0.51
<b>D</b>	8.55	8.75
<b>E</b>	5.80	6.20
<b>E1</b>	3.80	4.00
<b>e</b>	1.27BSC	
<b>H</b>	0.17	0.25
<b>L</b>	0.40	1.27
<b>θ</b>	0°	8°

## Package/Ordering Information

PRODUCT TYPE	OPERATING TEMPERATURE	PACKAGE	PACKAGE MARKING	NUMBER OF PACKAGES
CBM8605AWS5	-40°C~125°C	WLCSP-5	AW05	Tape and Reel, 3000
CBM8605AST5	-40°C~125°C	SOT23-5	8605	Tape and Reel, 3000
CBM8606AMS8	-40°C~125°C	MSOP-8	8606M	Tape and Reel, 3000
CBM8606AS8	-40°C~125°C	SOP-8	CBM8606A	Tape and Reel, 2500
CBM8606AS8-RL	-40°C~125°C	SOP-8	CBM8606A	Tape and Reel, 3000
CBM8606AS8-REEL	-40°C~125°C	SOP-8	CBM8606A	Tape and Reel, 4000
CBM8606AWS8	-40°C~125°C	WLCSP-8	AW06	Tape and Reel, 3000
CBM8608ATS14	-40°C~125°C	TSSOP-14	CBM8608AT	Tape and Reel, 2500
CBM8608ATS14-RL	-40°C~125°C	TSSOP-14	CBM8608AT	Tape and Reel, 3000
CBM8608ATS14-REEL	-40°C~125°C	TSSOP-14	CBM8608AT	Tape and Reel, 4000
CBM8608AS14	-40°C~125°C	SOP-14	CBM8608AS	Tape and Reel, 2500
CBM8608AS14-RL	-40°C~125°C	SOP-14	CBM8608AS	Tape and Reel, 3000
CBM8608AS14-REEL	-40°C~125°C	SOP-14	CBM8608AS	Tape and Reel, 4000