For Gas Water Heaters Interface IC

BD88030FV

General Description

BD88030FV is a monolithic IC with two channel 4-bit D/A converters for water heaters, a pseudo-sine wave output circuit, and an external analog-signal detector.

Features

- Built-in 2 Channels of 4-bit D/A Converter
- Built-in Pseudo-sine Wave Output Circuit (Divided by 1/16 of the External Clock)
- External Analog Signal Detection Circuit
- Built-in Analog Switch 2 Channels
- Built-in Electrostatic Protection Circuit

Applications

- Water Heater

Key Specifications

- Operating Power Supply Voltage Range:
  4.5 V to 5.5 V
- Circuit Current: 2.5 mA (Typ)
- Detection Frequency: 250 kHz (Typ)
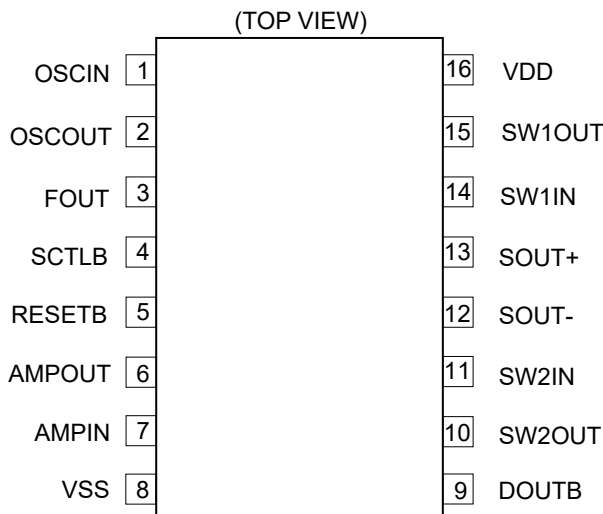- Operating Temperature Range: -20 °C to +80 °C
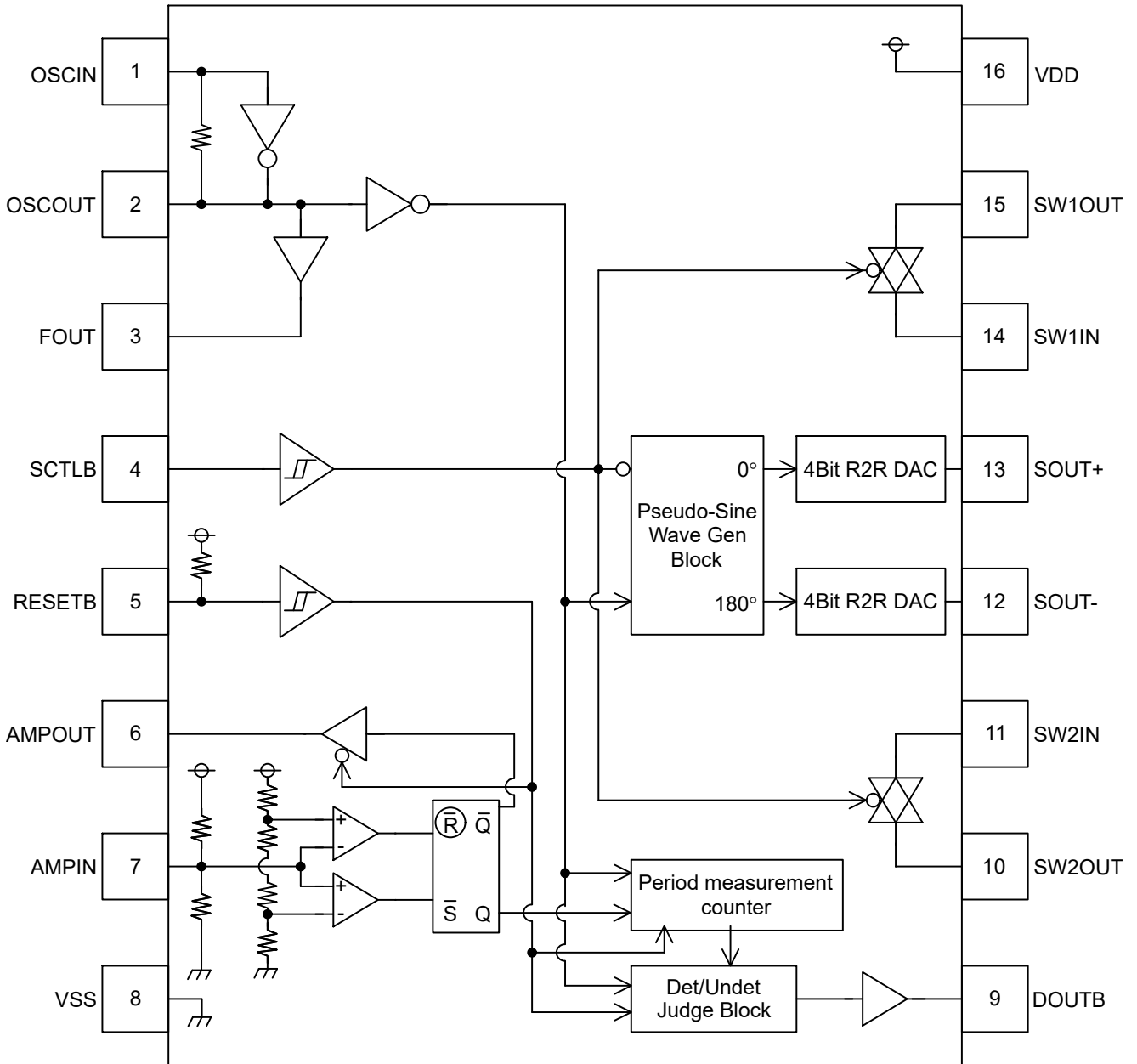
Package

	W (Typ) x D (Typ) x H (Max)
SSOP-B16	5.0 mm x 6.4 mm x 1.35 mm

Pin Configuration

(TOP VIEW)

Left	Pin		Pin	Right
OSCIN	1		16	VDD
OSCOUT	2		15	SW1OUT
FOUT	3		14	SW1IN
SCTLB	4		13	SOUT+
RESETB	5		12	SOUT-
AMPOUT	6		11	SW2IN
AMPIN	7		10	SW2OUT
VSS	8		9	DOUTB

Pin Description

Pin No.	Pin Name	Function
1	OSCIN	Resonator connection pin
2	OSCOUT	Resonator connection pin
3	FOUT	OSC buffer output
4	SCTLB	Modulation control signal input
5	RESETB	Reset signal input Normally set to "H"
6	AMPOUT	Amplifier signal output Used as a test pin Use it open.
7	AMPIN	Amplifier signal input
8	VSS	GND pin
9	DOUTB	Amplifier input signal detection output
10	SW2OUT	Analog switch 2 output
11	SW2IN	Analog switch 2 input
12	SOUT-	Pseudo-sinusoidal output (anti-phase outputting of SOUT+)
13	SOUT+	Pseudo-sinusoidal output
14	SW1IN	Analog switch 1 input
15	SW1OUT	Analog switch 1 output
16	VDD	Power supply pin

○Product structure : Silicon integrated circuit   ○This product has no designed protection against radioactive rays.

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Block Diagram

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Absolute Maximum Ratings (Ta = 25 °C)

Parameter	Symbol	Rating	Unit
Power Supply Voltage	V_{DD}	-0.3 to +7.0	V
Input Voltage	V_{IN}	-0.3 to V_{DD} + 0.3	V
Input Current	I_I	±1	mA
Storage Temperature Range	Tstg	-55 to +125	°C
Maximum Junction Temperature	Tjmax	125	°C

Caution 1: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Caution 2: Should by any chance the maximum junction temperature rating be exceeded the rise in temperature of the chip may result in deterioration of the properties of the chip. In case of exceeding this absolute maximum rating, design a PCB with thermal resistance taken into consideration by increasing board size and copper area so as not to exceed the maximum junction temperature rating.

Thermal Resistance[Note 1]

Parameter	Symbol	Thermal Resistance (Typ)		Unit
		1s[Note 3]	2s2p[Note 4]	
SSOP-B16				
Junction to Ambient	θ_{JA}	140.9	77.2	°C/W
Junction to Top Characterization Parameter[Note 2]	Ψ_{JT}	6	5	°C/W

[Note 1] Based on JESD51-2A(Still-Air).
[Note 2] The thermal characterization parameter to report the difference between junction temperature and the temperature at the top center of the outside surface of the component package.
[Note 3] Using a PCB board based on JESD51-3.
[Note 4] Using a PCB board based on JESD51-7.

Layer Number of Measurement Board	Material	Board Size
Single	FR-4	114.3 mm x 76.2 mm x 1.57 mmt

Top	
Copper Pattern	Thickness
Footprints and Traces	70 µm

Layer Number of Measurement Board	Material	Board Size
4 Layers	FR-4	114.3 mm x 76.2 mm x 1.6 mmt

Top		2 Internal Layers		Bottom	
Copper Pattern	Thickness	Copper Pattern	Thickness	Copper Pattern	Thickness
Footprints and Traces	70 µm	74.2 mm x 74.2 mm	35 µm	74.2 mm x 74.2 mm	70 µm

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Operating Supply Voltage	Vopr	4.5	5.0	5.5	V
Operating Temperature	Topr	-20	-	+80	°C

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Electrical Characteristic (V$_{DD}$ = 5 V, V$_{SS}$ = 0 V, Ta = 25 °C unless otherwise specified)

Parameter	Symbol	Limit			Unit	Conditions
		Min	Typ	Max		
Oscillation-frequency[Note 1]	f$_{OSC}$	1	4	10	MHz	
Supply Current	I$_{DD}$	-	2.5	10.0	mA	f$_{OSC}$ = 4 MHz, no load
OSCIN "H" Input-voltage	V$_{IHOSCIN}$	0.7V$_{DD}$	-	V$_{DD}$	V	
OSCIN "L" Input-voltage	V$_{ILOSCIN}$	V$_{SS}$	-	0.3V$_{DD}$	V	
OSCIN "H" Input Current	I$_{IHOSCIN}$	2	-	12	μA	V$_{IN}$ = V$_{DD}$
OSCIN "L" Input Current	I$_{ILOSCIN}$	-12	-	-2	μA	V$_{IN}$ = 0 V
OSCIN Feedback Resistor[Note 1]	R$_{OSCIN}$	525	700	875	kΩ	
"H" Input Current	I$_{IH1}$	-	-	0.5	μA	V$_{IN}$ = V$_{DD}$, (SCTLB)
"L" Input Current	I$_{IL1}$	-0.5	-	-	μA	V$_{IN}$ = 0 V, (SCTLB)
"H" Input Voltage	V$_{IH1}$	0.65V$_{DD}$	-	V$_{DD}$	V	(RESETB, SCTLB)
"L" Input Voltage	V$_{IL1}$	V$_{SS}$	-	0.35V$_{DD}$	V	(RESETB, SCTLB)
RESETB "H" Input Current	I$_{IHRESETB}$	-	-	0.5	μA	V$_{IN}$ = V$_{DD}$
RESETB "L" Input Current	I$_{ILRESETB}$	-455	-	-200	μA	V$_{DD}$ = 5 V, V$_{IN}$ = 0 V
"H" Output Voltage	V$_{OH}$	V$_{DD}$-0.5	-	V$_{DD}$	V	I$_{OH}$ = -1 mA, (FOUT, DOUTB)
"L" Output Voltage	V$_{OL}$	V$_{SS}$	-	V$_{SS}$ + 0.6	V	I$_{OL}$ = 1 mA, (FOUT, DOUTB)
AMPIN "H" Input Current	I$_{IHAMPIN}$	185	-	555	μA	V$_{IN}$ = V$_{DD}$
AMPIN "L" Input Current	I$_{ILAMPIN}$	-240	-	-100	μA	V$_{IN}$ = 0 V
AMP Input Biased Voltage[Note 1]	V$_B$	-	1.63	-	V	No load
AMP Input Sensitivity	V$_{PPIN}$	0.30	-	0.45	V	250 kHz, no load 0.3 Input voltage below V is not detected. 0.45 The input voltage of V or higher is detected.
Detection Frequency Range	f$_{DETON}$	236	250	266	kHz	f$_{OSC}$ = 4 MHz
Non-Detection Frequency Range (Low Frequency)	f$_{DETOFF1}$	-	-	216	kHz	f$_{OSC}$ = 4 MHz
Non-Detection Frequency Range (High Frequency)	f$_{DETOFF2}$	290	-	-	kHz	f$_{OSC}$ = 4 MHz
Analog Switch-off Leakage Current	I$_{OFFSW}$	-	-	1	μA	SWxIN = V$_{DD}$, SWxOUT = 0 V x = 1, 2
Analog Switch-on Resistance	R$_{ONSW}$	35	60	105	Ω	SWxIN = V$_{DD}$, SWxOUT = 0 V x = 1, 2
SOUT Maximum Output Amplitude	V$_{PPSOUT}$	0.85V$_{DD}$	-	V$_{DD}$	V	No load
Pseudo-Sine Wave Output Frequency	f$_{SOUT}$	-	250	-	kHz	f$_{OSC}$ = 4 MHz
Equivalent Output Impedance	Z$_{SOUT}$	2.8	-	5.2	kΩ	No load
Pseudo-Sine Wave Output-phase-variation[Note 1]	p$_{SOUT}$	-5	-	+5	Deg	

*(Note 1)* Not 100 % Tested

Function Description

1. Pseudo-Sine Wave Generation Circuit 4-Bit D/A Converter Block (Transmit Block)

    The pseudo-sine wave output pins (SOUT+ and SOUT-) output a pseudo-sine wave with a frequency of $f_{OSC}/16$.

    The SOUT+ and SOUT- pins are in the opposite phase.

    The pseudo-sine wave generator and 4-bit D/A converter are shown in the figure below (SOUT+ pin side).
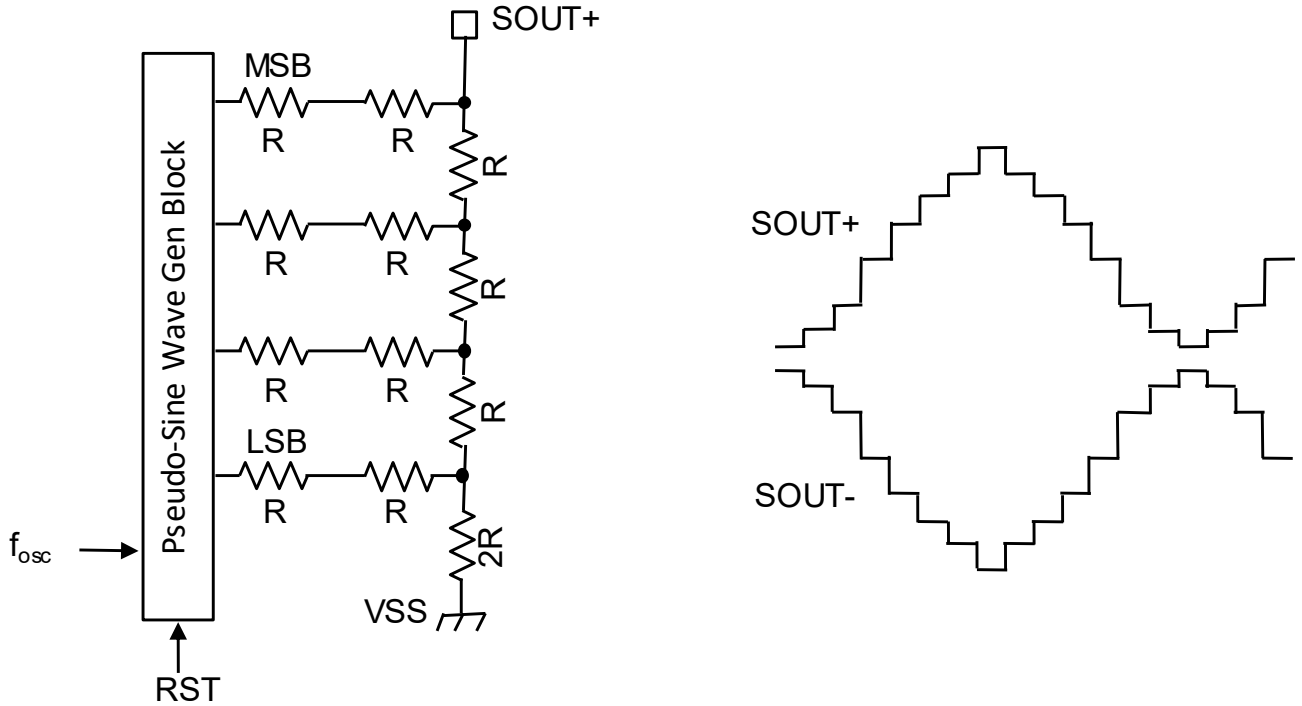
The data of the pseudo-sine wave generator is output in the sequence shown in the figure below.

0→1→3→6→9→C→E→F→F→E→C→9→6→3→1→0 (hexadecimal)
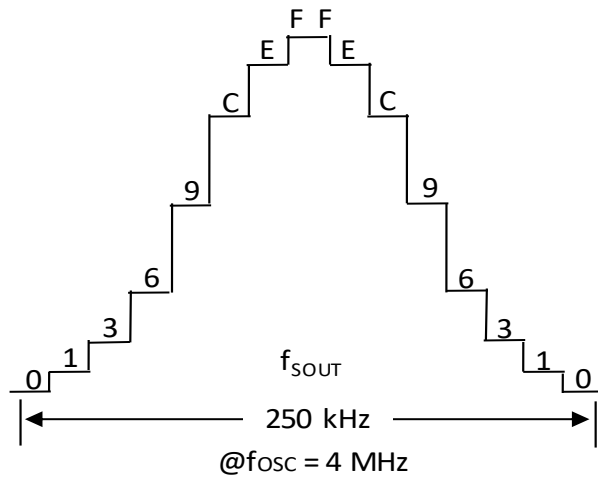
Therefore, the pseudo-sine waveform of the positive-phase output and negative-phase output at no load is stepped.

An analog switch is incorporated to connect the driver output buffer to the transmission line only when transmitting.

However, the driver output buffer connects an emitter follower circuit externally.

The phase difference between positive-phase output and negative-phase output is within 180 degrees ±5 degrees. (Pseudo-Sine Wave Output Phase Fluctuation)

Function Description - continued

2. Amplifier Input Circuit, Detection/Non-Detection Circuit (Receiver)

The modulation signal input section incorporates a high-low two-level comparator so that an external sine wave can detect only a specified amplitude or more, preventing false detection of signals (e.g., noise signals) with a specified amplitude or less.

The detection frequency range (frequency window) is determined by f_{OSC} from 1/18 to 1/14.

Detection/non-detection decision conditions control the signal when signals in the frequency window are detected (or not detected) continuously.

In this case, $f_{OSC}/16$ frequency is used as the reference (single wave) and the duration is 9 to 13 waves.

AMPIN Input Sine Wave Form

AMPOUT Output Timing (RESETB = L)
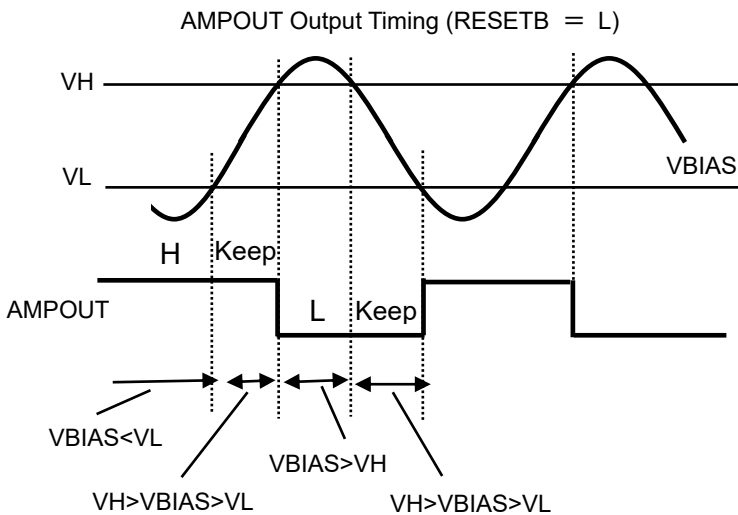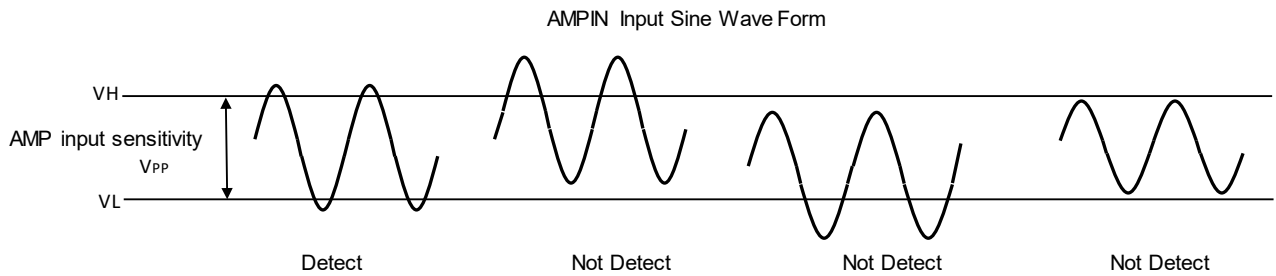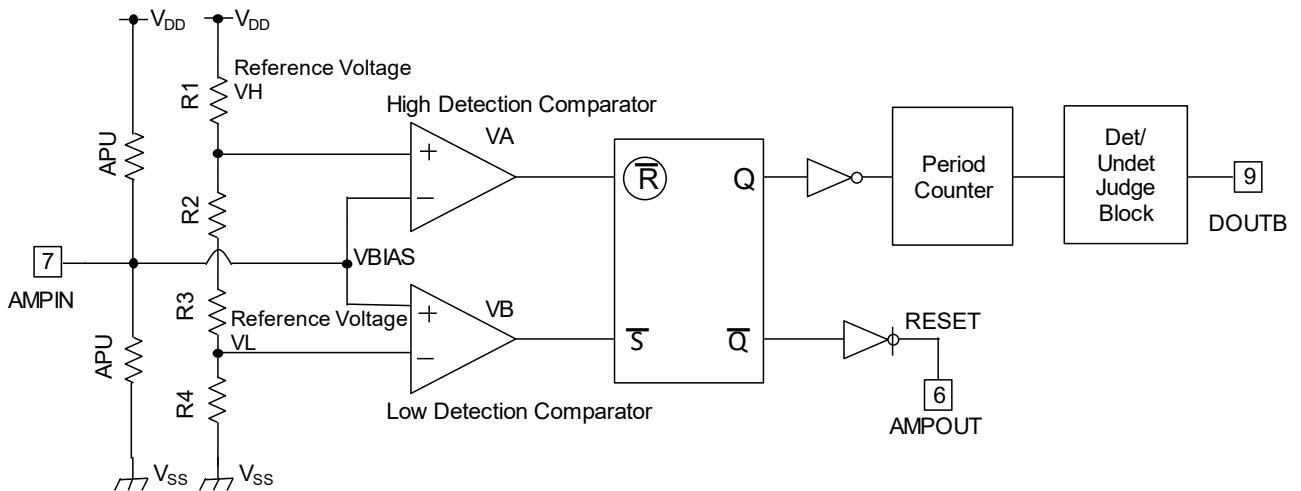
AMPOUT Output Table

	VA	VB	AMPOUT
VBIAS>VH	L	H	L
VH>VBIAS>VL	H	H	Keep
VBIAS<VL	H	L	H

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Function Description - continued

3. Transmitter Function Description and Timing Chart

When the modulation control inputs (SCTLB) are "H" level, the pseudo-sine wave outputs retain the level of the pseudo-sine wave at phase 0 degrees.

When the modulation control input is changed from "H" to "L" level, the output (SOUT+) of the pseudo-sine wave starts from -90 degrees (SOUT- starts from +90 degrees).

The time to turn ON at this time is td (ON) < 500 ns.

In addition, when the modulation control input is set from "L" to "H" level, the phase is forced regardless of where the phase of the pseudo-sine wave output is.

Hold at 0 degrees (pseudo-sine wave output stopped).

The time to turn OFF at this time is td (OFF) < 1 µs
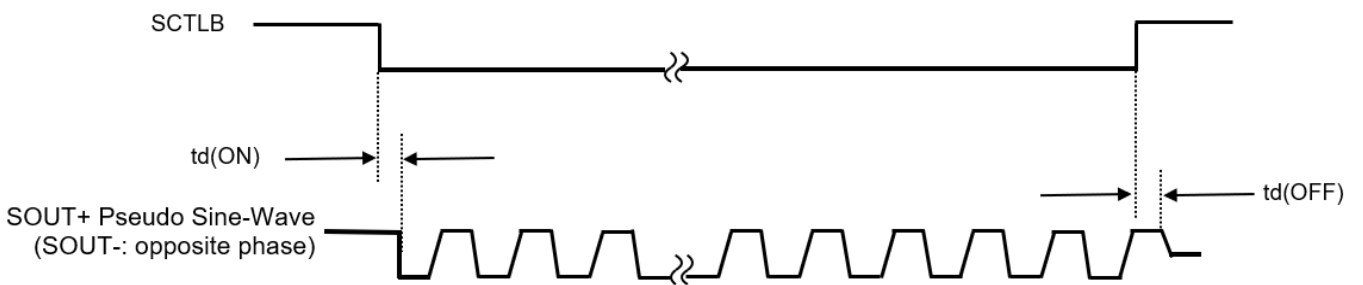
4. Receiver Function Description Timing Chart

Receive OK. DOUTB pin changes from "H" to "L". t_{DET} is 16CLK minutes of f_{OSC}.

It is defined as one wave, and it is within the time of 13 waves from 9 waves when it is considered as a reference. As set by the frequency window.

This condition is valid only when the input signal of the period of the range is detected (or not detected) continuously.
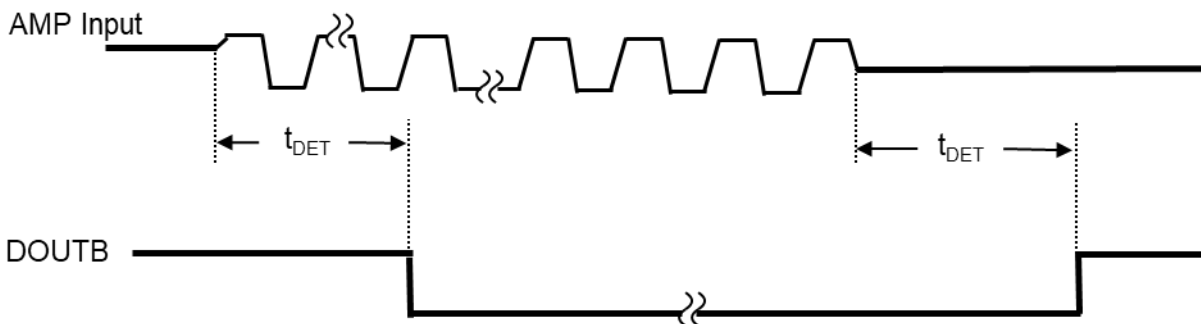
Note 1: Although the communication protocol is free, provide a time of at least 15 carrier waves for both no signal times.

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Timing Chart (SOUT+ = SW1IN, SW1OUT, SOUT− = SW2IN, SW2OUT)
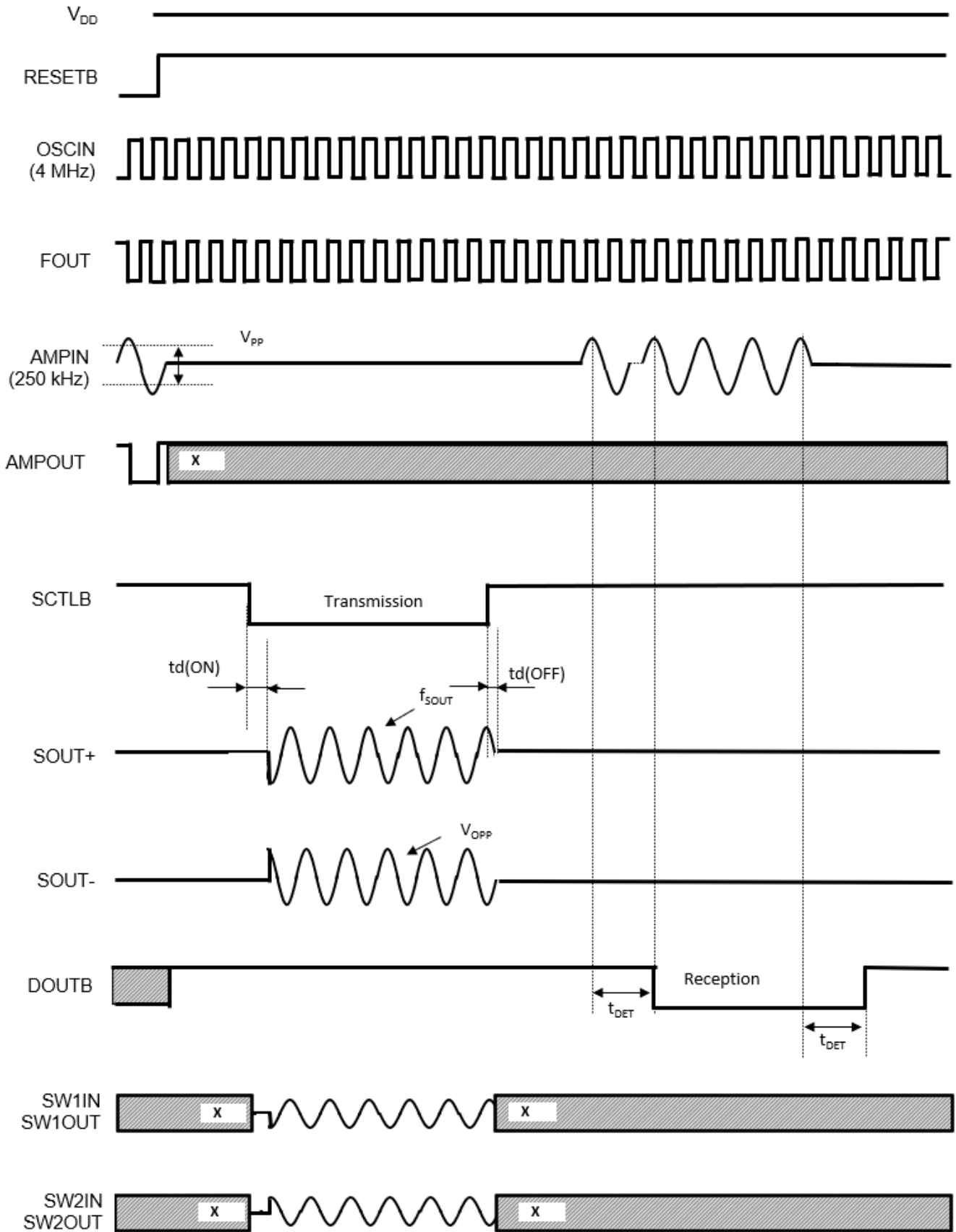
Typical Performance Curves

(Reference Data)
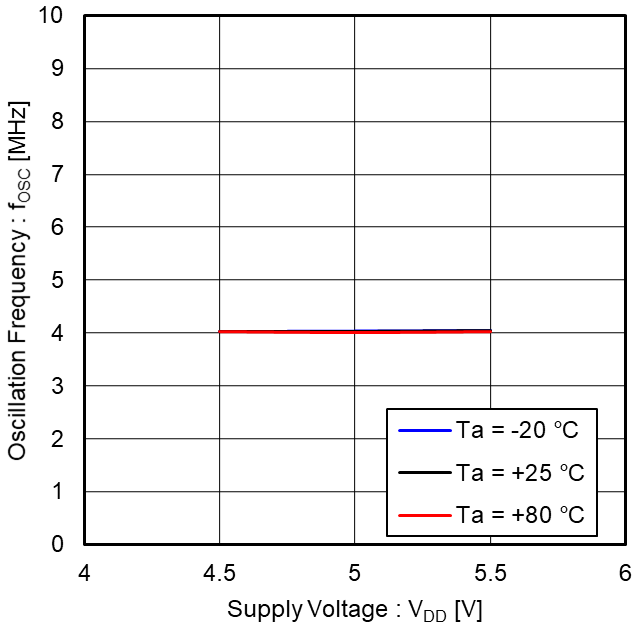
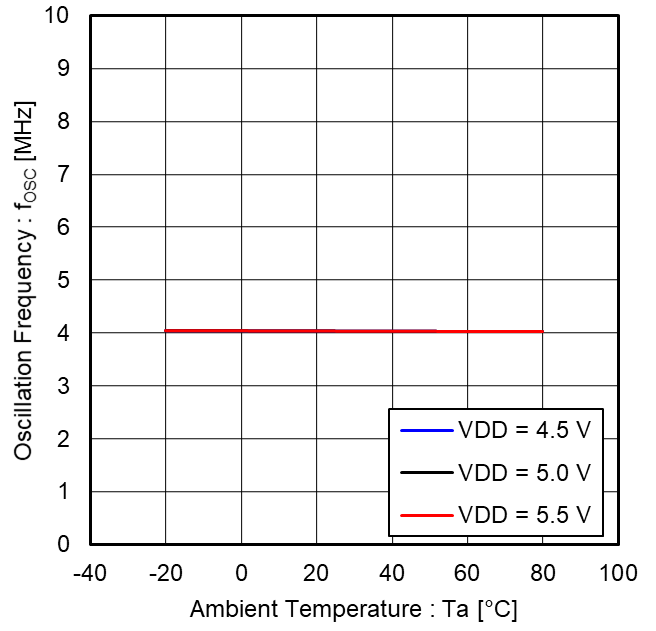Figure 1. Oscillation Frequency vs Supply Voltage

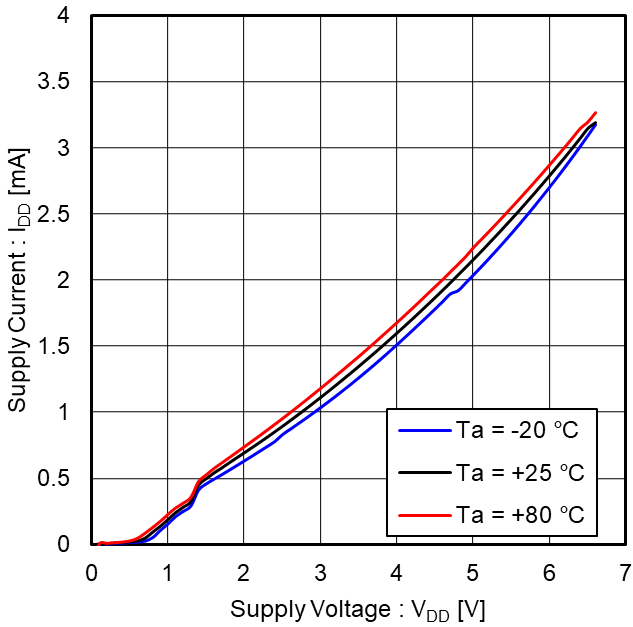Figure 2. Oscillation Frequency vs Ambient Temperature
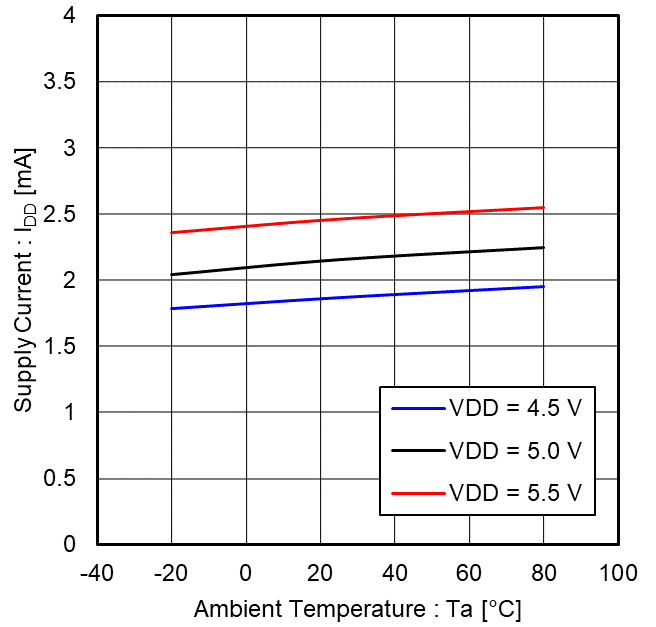

Figure 3. Supply Current vs Supply Voltage

Figure 4. Supply Current vs Ambient Temperature

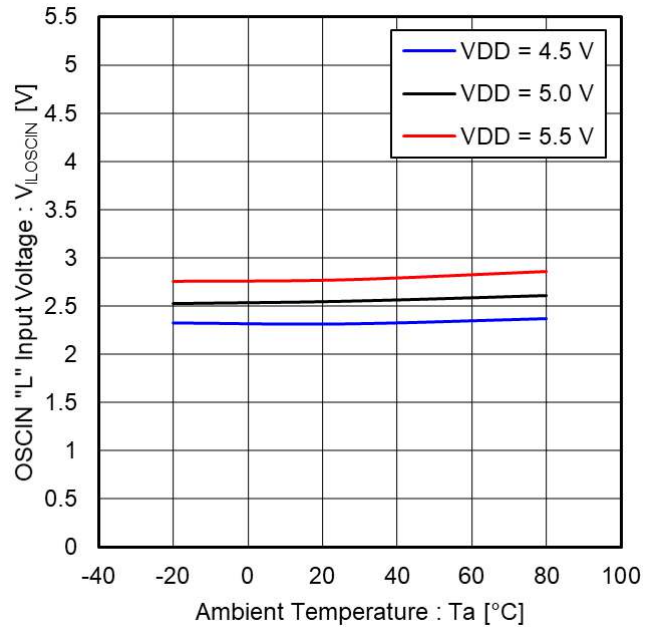*(Note) The above data are representative sample measurements and are not guaranteed.*

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Typical Performance Curves - continued
(Reference Data)
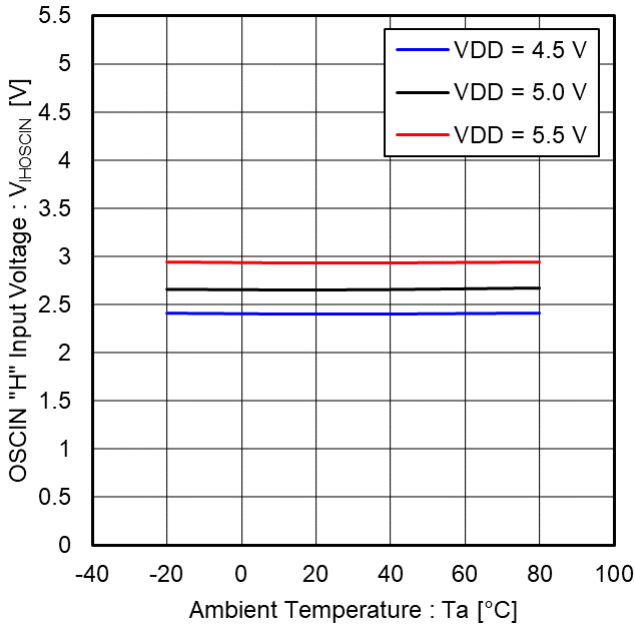
Figure 5. OSCIN "H" Input Voltage vs Ambient Temperature
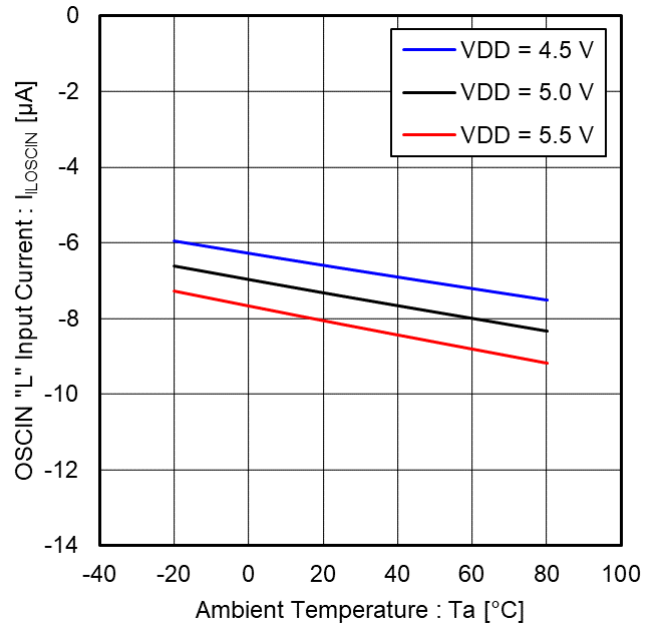
Figure 6. OSCIN "L" Input Current vs Ambient Temperature
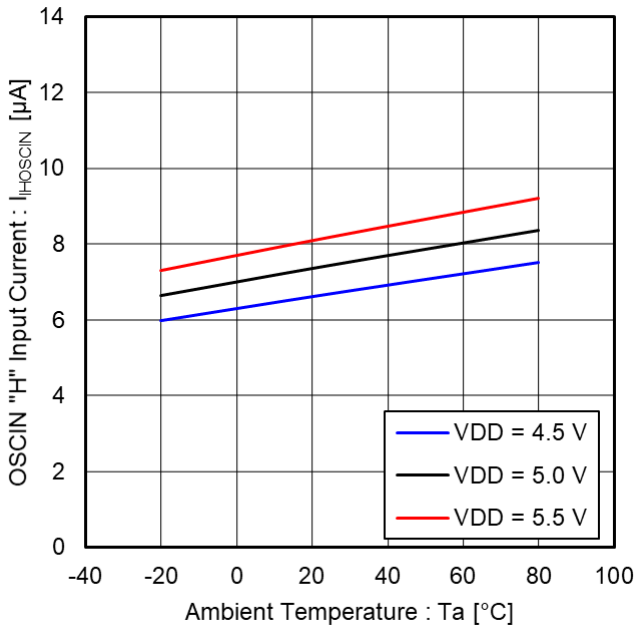
Figure 7. OSCIN "H" Input Current vs Ambient Temperature

Figure 8. OSCIN "L" Input Voltage vs Ambient Temperature

(Note) The above data are representative sample measurements and are not guaranteed.

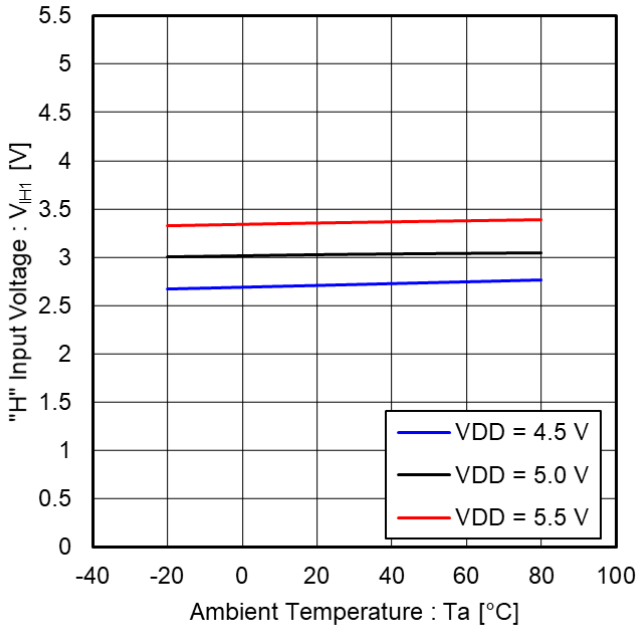## Typical Performance Curves - continued
(Reference Data)

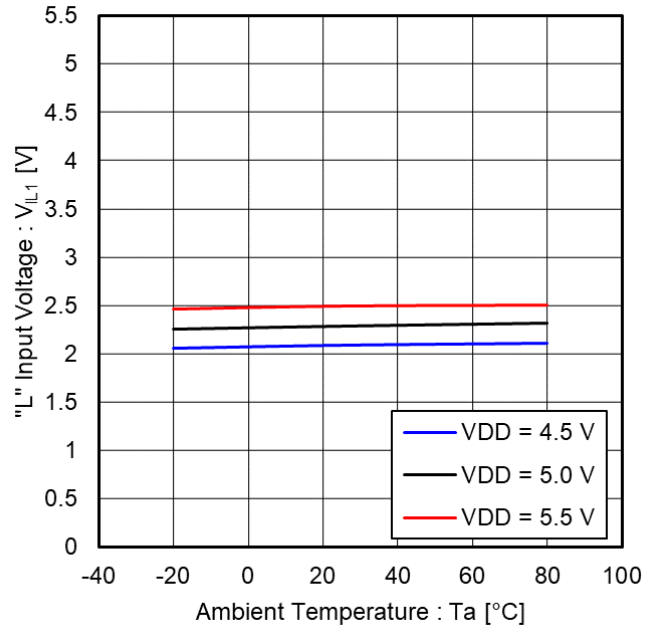Figure 9. "H" Input Voltage vs Ambient Temperature

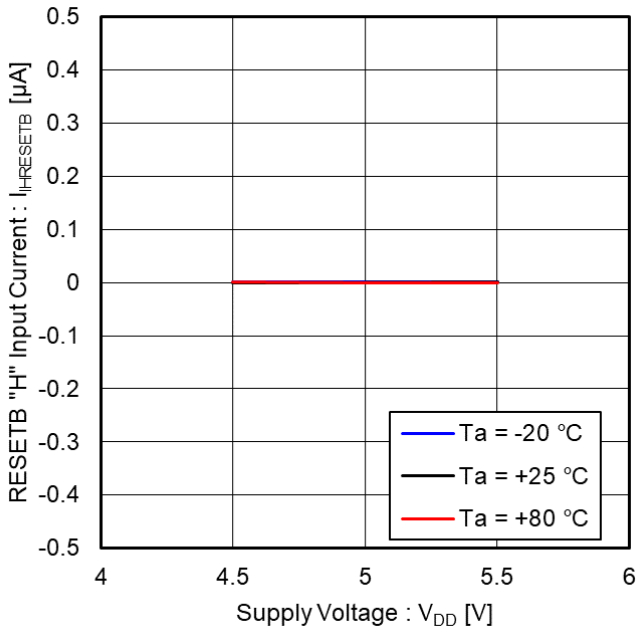Figure 10. "L" Input Voltage vs Ambient Temperature

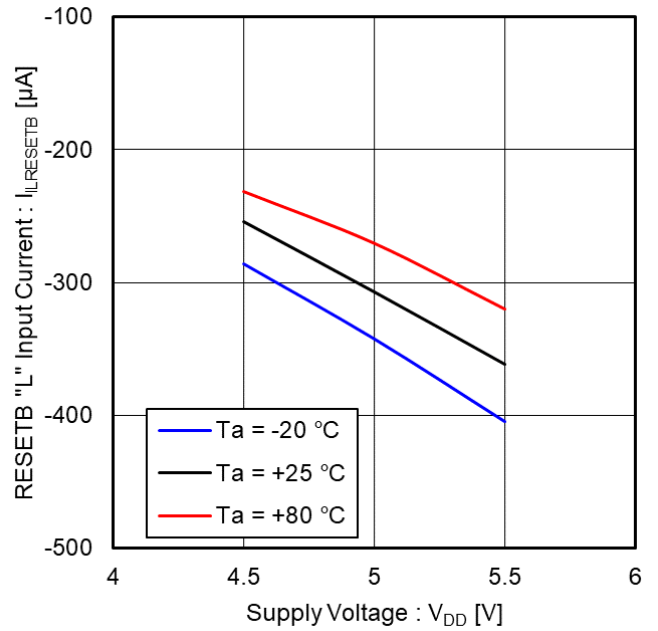Figure 11. RESETB "H" Input Current vs Supply Voltage

Figure 12. RESETB "L" Input Current vs Supply Voltage

(Note) The above data are representative sample measurements and are not guaranteed.

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Typical Performance Curves - continued
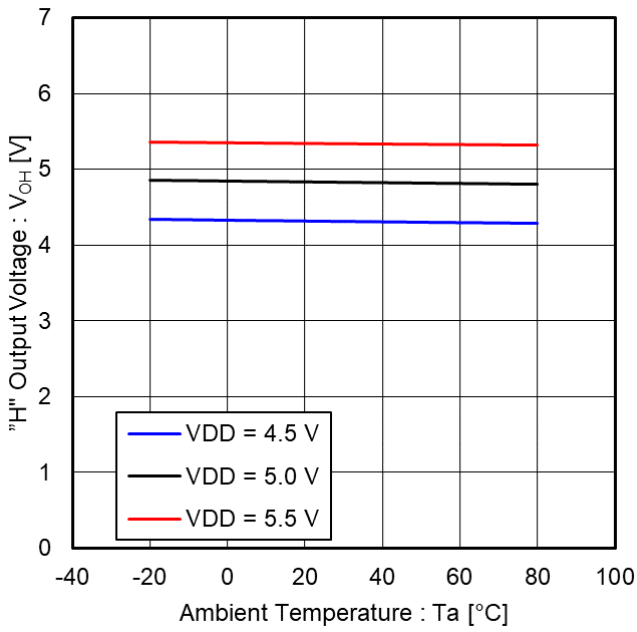(Reference Data)

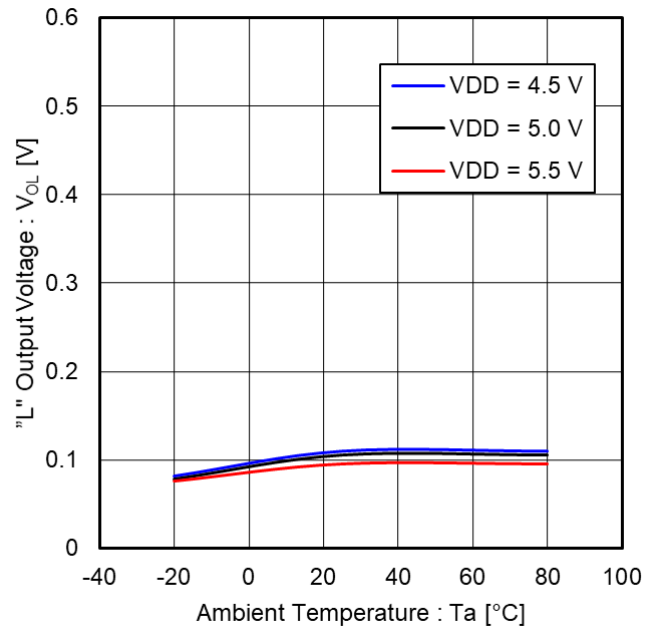Figure 13. "H" Output Voltage vs Ambient Temperature
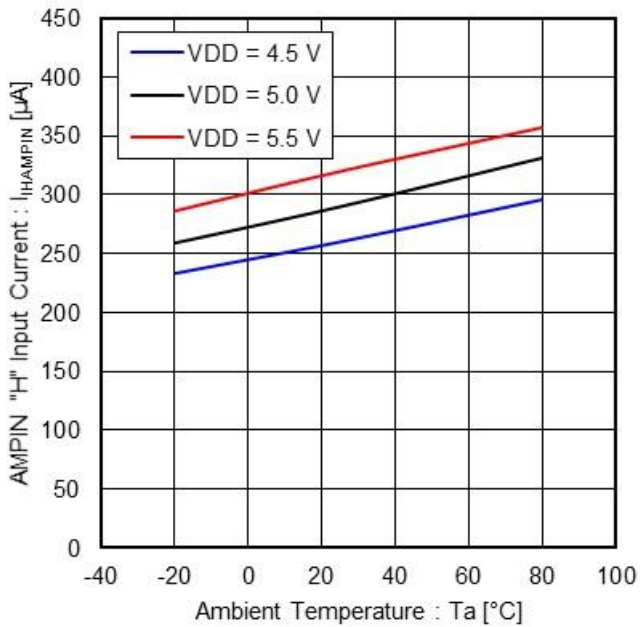

Figure 14. "L" Output Voltage vs Ambient Temperature
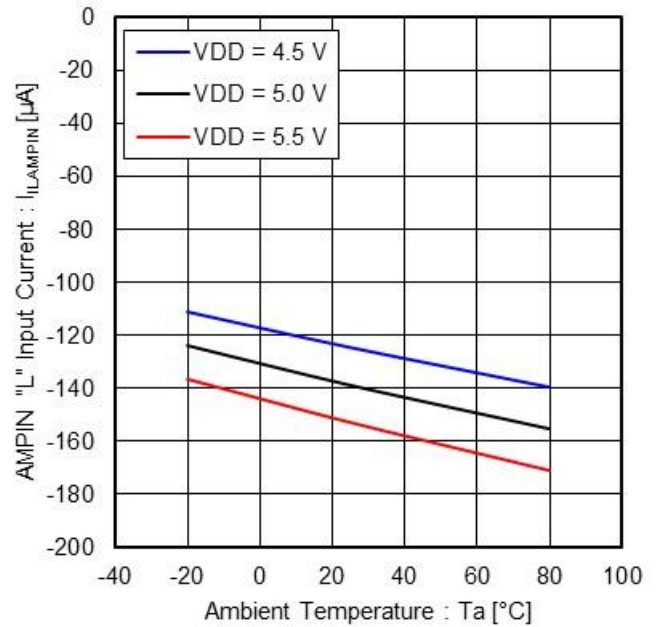

Figure 15. AMPIN "H" Input Current vs Ambient Temperature

Figure 16. AMPIN "L" Input Current vs Ambient Temperature

(Note) The above data are representative sample measurements and are not guaranteed.

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Typical Performance Curves - continued
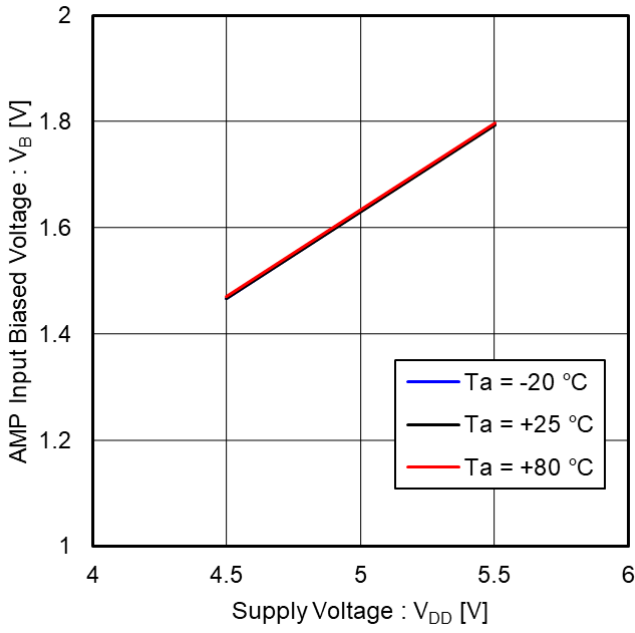(Reference Data)

Figure 17. AMP Input Biased Voltage vs Supply Voltage
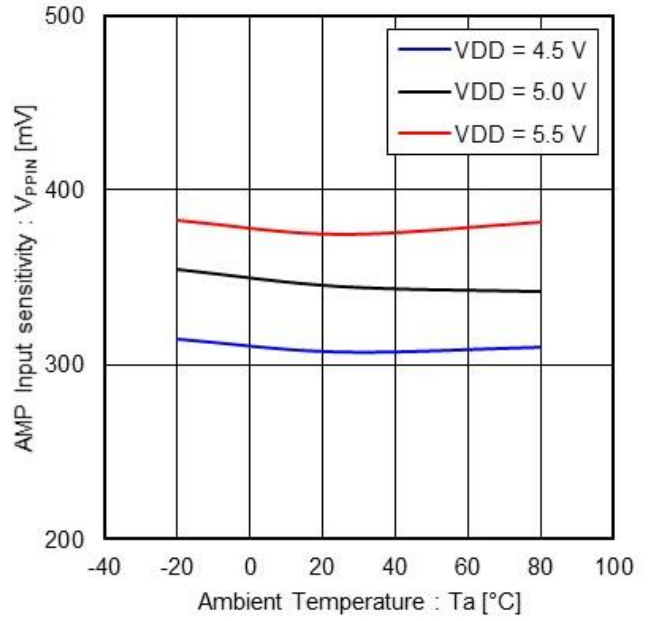

Figure 18. AMP Input sensitivity vs Ambient Temperature
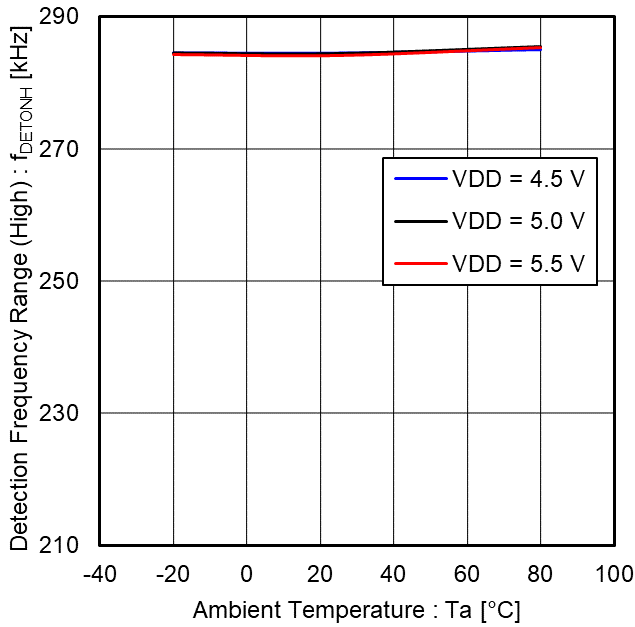
Figure 19. Detection Frequency Range (High) vs Ambient
Temperature

Figure 20. Detection Frequency Range (Low) vs Ambient
Temperature

(Note) The above data are representative sample measurements and are not guaranteed.

Typical Performance Curves - continued
(Reference Data)
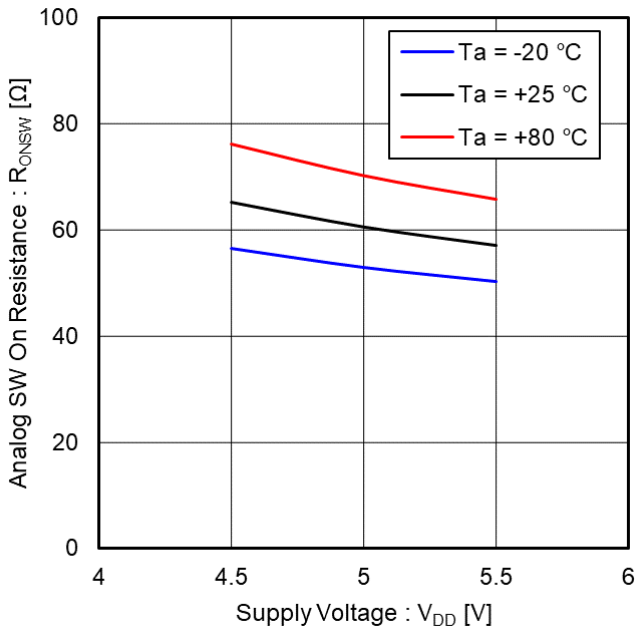
Figure 21. Analog SW On Resistance vs Supply Voltage

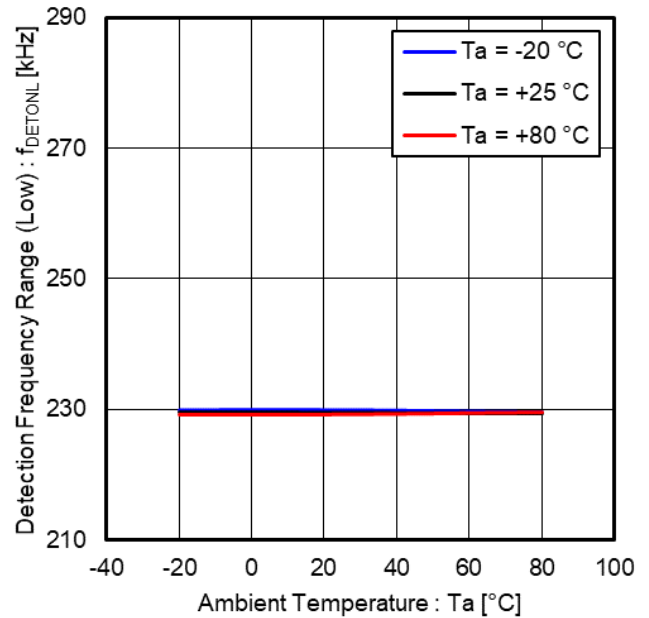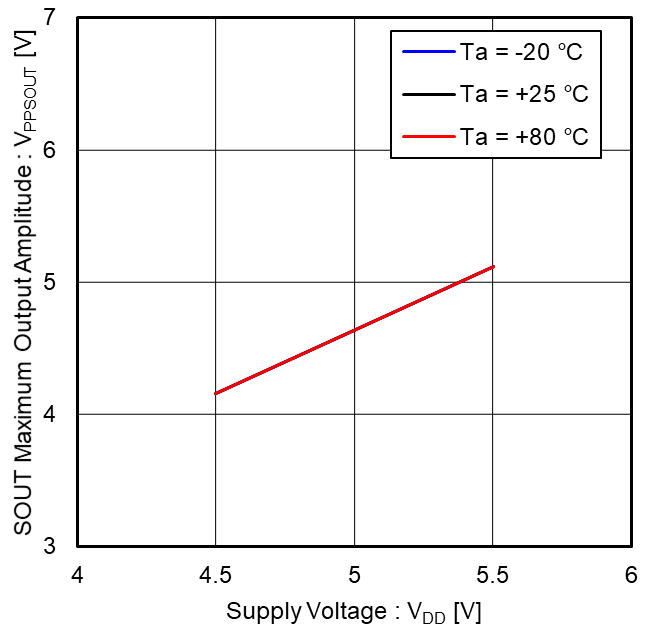Figure 22. SOUT Maximum Output Amplitude vs Supply Voltage
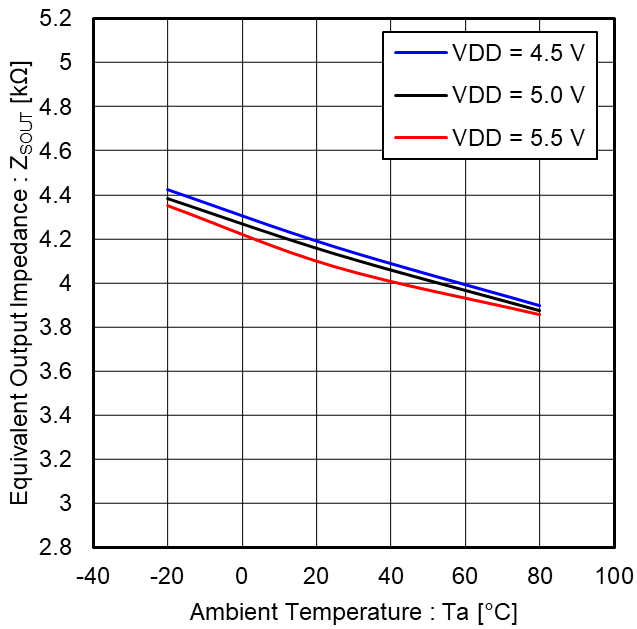
Figure 23. Equivalent Output Impedance vs Ambient Temperature

(Note) The above data are representative sample measurements and are not guaranteed.

Electrical Characteristics Measurement Circuit Diagram
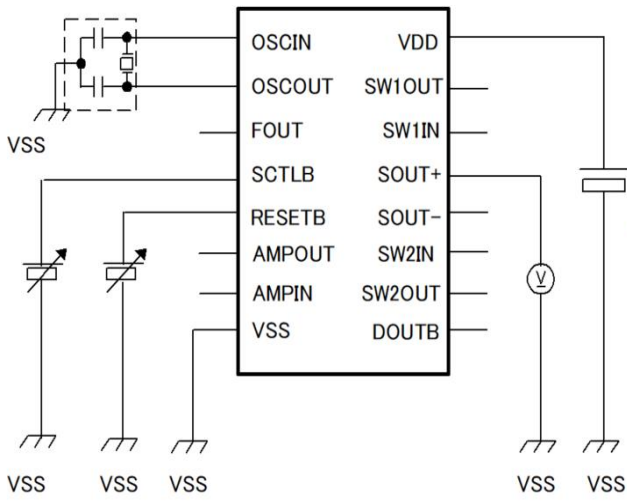
Figure 24. H, L Threshold Voltage (RESETB, SCTLB)
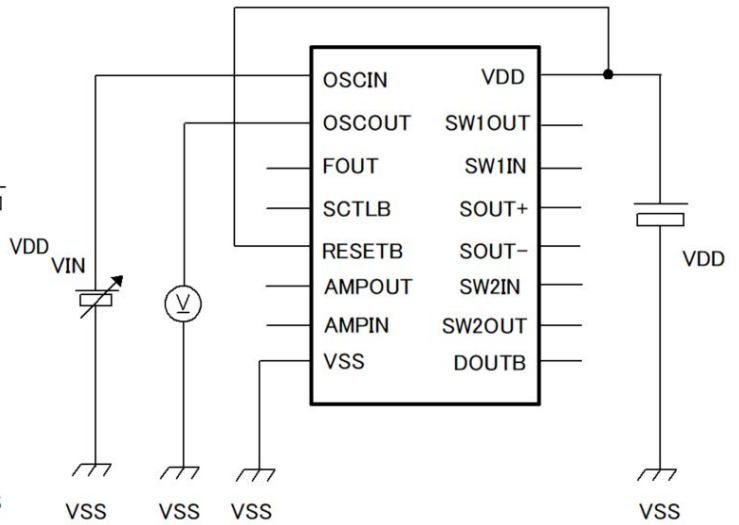
Figure 25. H, L-input-voltage (OSCIN)
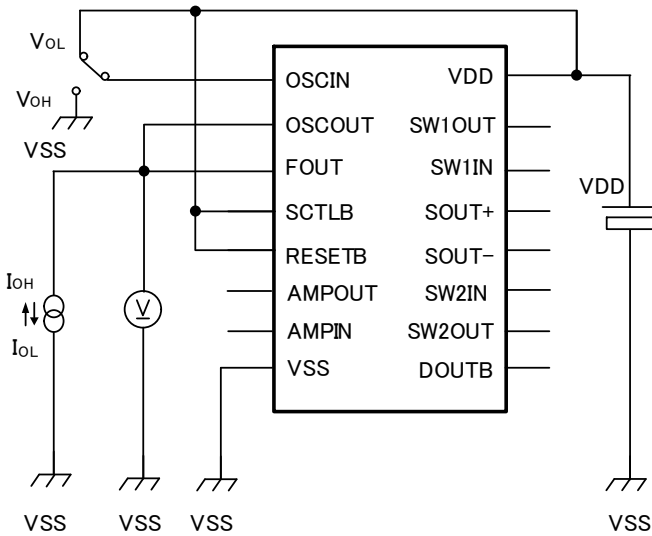
Figure 26. H, L Output Voltage (FOUT)
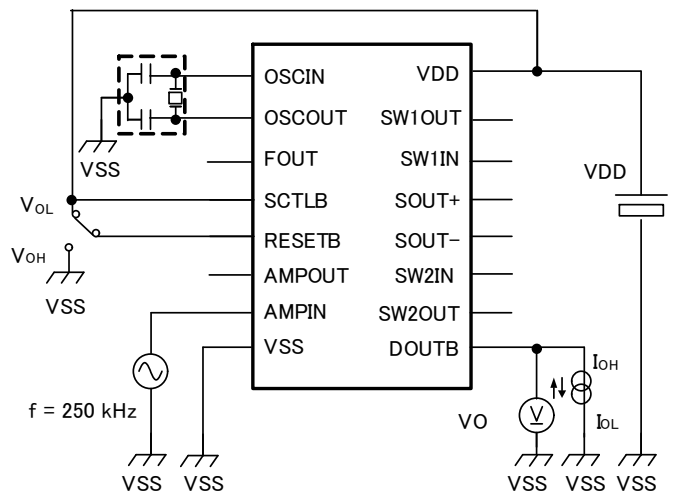
Figure 27. H, L Output Voltage (DOUTB)

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Electrical Characteristics Measurement Circuit Diagram - continued
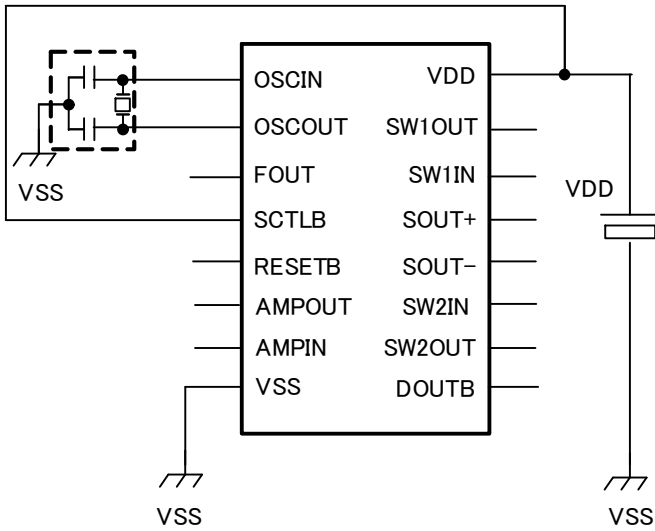
Figure 28. Oscillation Frequency
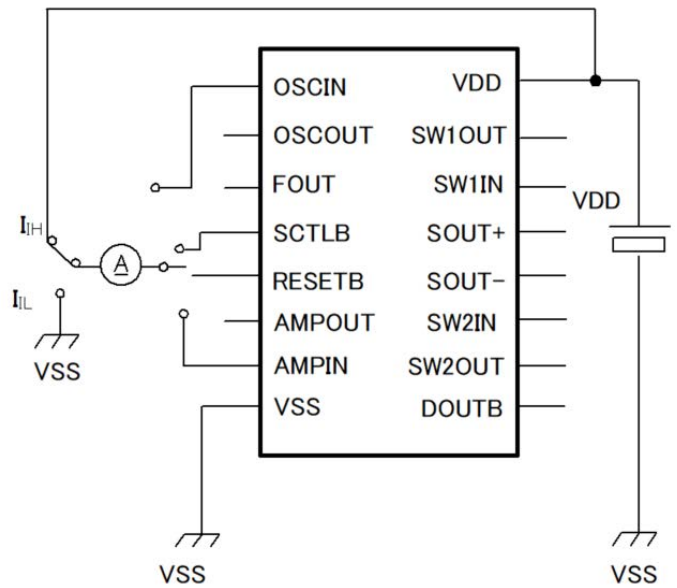
Figure 29. H, L Input Voltage
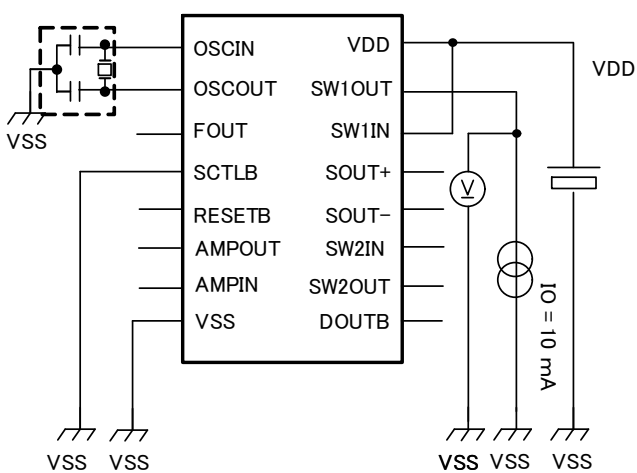
Figure 30. ON Resistance
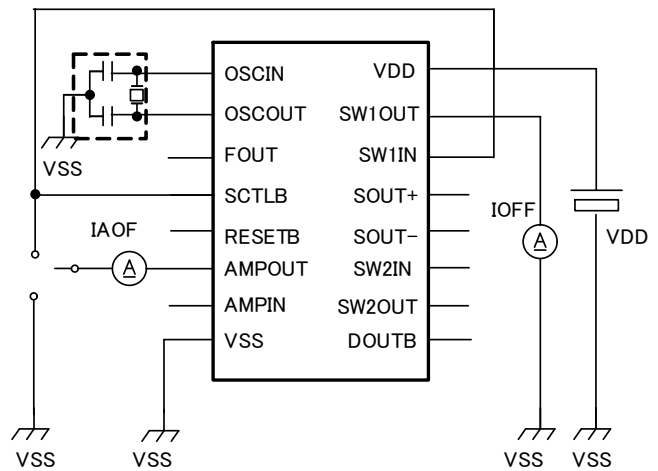
Figure 31. Leakage Current, AMPOUT Leakage Current

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Electrical Characteristics Measurement Circuit Diagram - continued
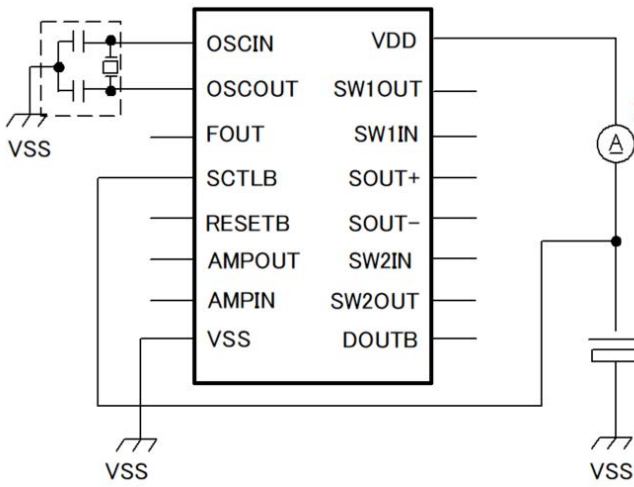
Figure 32. Current Consumption
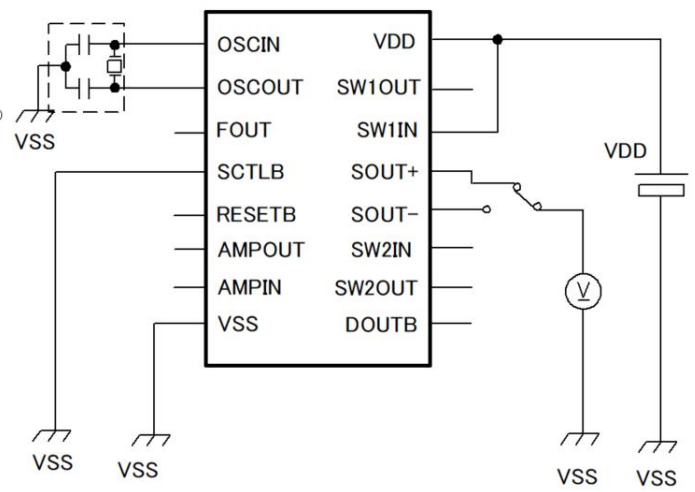
Figure 33. Maximum Output Amplitude
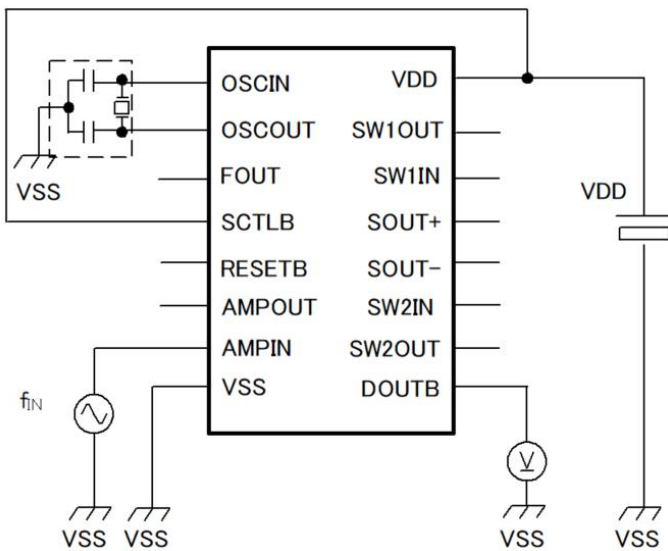
Figure 34. Amplifier Input Sensitivity, Detection Frequency
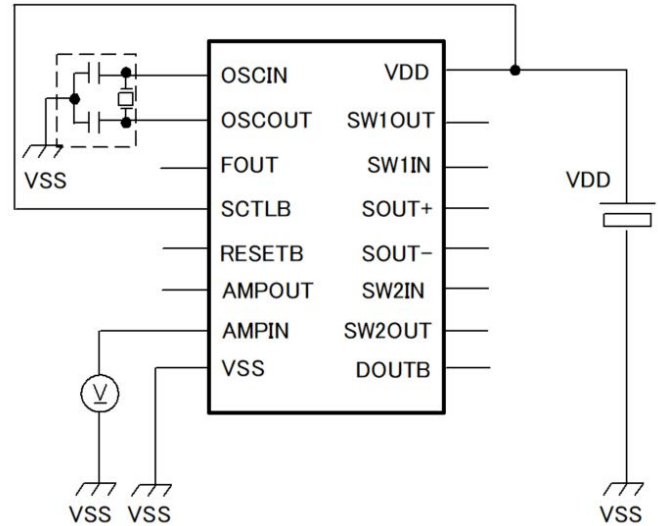
Figure 35. Amplifier Input Bias Voltage

Electrical Characteristics Measurement Circuit Diagram - continued
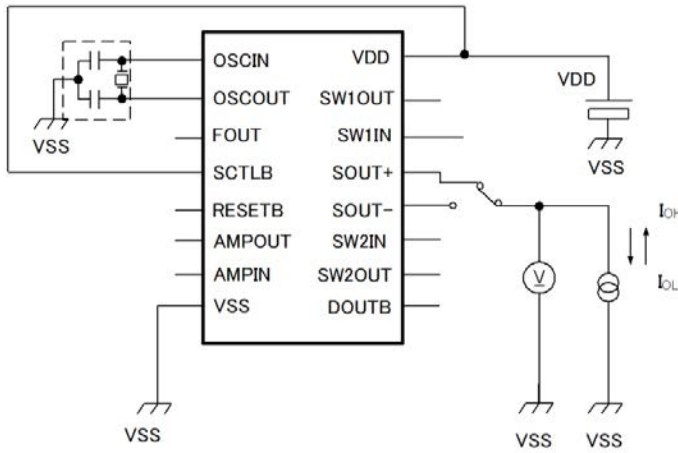
Figure 36. Equivalent Output Impedance
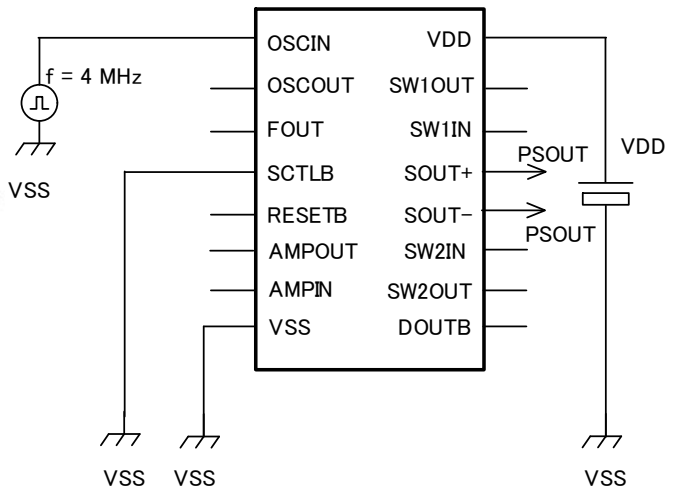
Figure 37. Pseudo-sinusoidal Output Phase Fluctuation

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Application Tips
  Precautions
   1. Handling of IC
      If stress is applied to the IC due to warping or bending of the board, the characteristics may fluctuate due to the piezo-resistance effect.
      Be careful not to warp or bend the board.

   2. Oscillation Circuit
      When using a CMOS inverter with a built-in IC to configure a common oscillator circuit of Figure 38, match the resonator to be used with this IC.
      Note that oscillation stop or abnormal oscillation may occur if matching is not performed.
      Each value of Rd (limiting resistor) and Rb (bias resistor) differs depending on the resonator.
      Contact the resonator manufacturer for matching between the IC and the resonator.
      In addition, since the oscillator circuit is susceptible to noise and other disturbances, take care not to place a pattern around the oscillator circuit on the board that is the source of noise.

      It can also be used by inputting clocks such as microcontrollers directly into ICs like Figure 39 without using resonators.
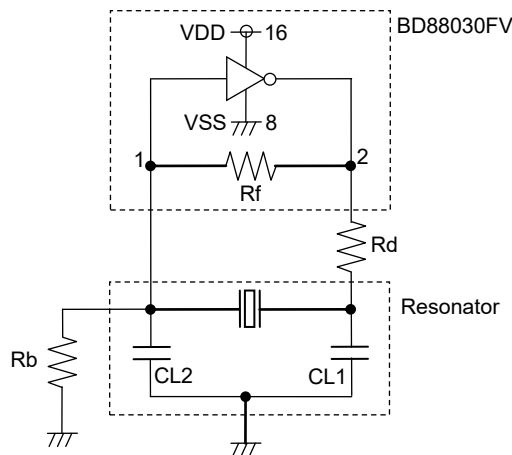
Figure 38. Oscillator Circuit Configuration Example
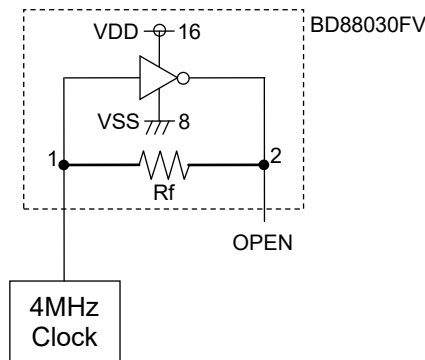
Figure 39. Example of External Clock Use Circuit

I/O Equivalence Circuits

Pin No.	Pin Name	Equivalent Circuit Diagram
1, 2	**OSCIN OSCOUT**	
3,6,9	**FOUT AMPOUT DOUTB**	
4	**SCTLB**	
5	**RESETB**	

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I/O Equivalence Circuits - continued

Pin No.	Pin Name	Equivalent Circuit Diagram
7	**AMPIN**	
11, 14 **10, 15**	**SW2IN, SW1IN** **SW2OUT, SW1OUT**	
12, 13	**SOUT-** **SOUT+**	

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Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply pins.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Recommended Operating Conditions**
   The function and operation of the IC are guaranteed within the range specified by the recommended operating conditions. The characteristic values are guaranteed only under the conditions of each item specified by the electrical characteristics.

6. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

7. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned off completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

8. **Inter-pin Short and Mounting Errors**
   Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

9. **Unused Input Pins**
   Input pins of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input pins should be connected to the power supply or ground line.

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Operational Notes – continued

10. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.
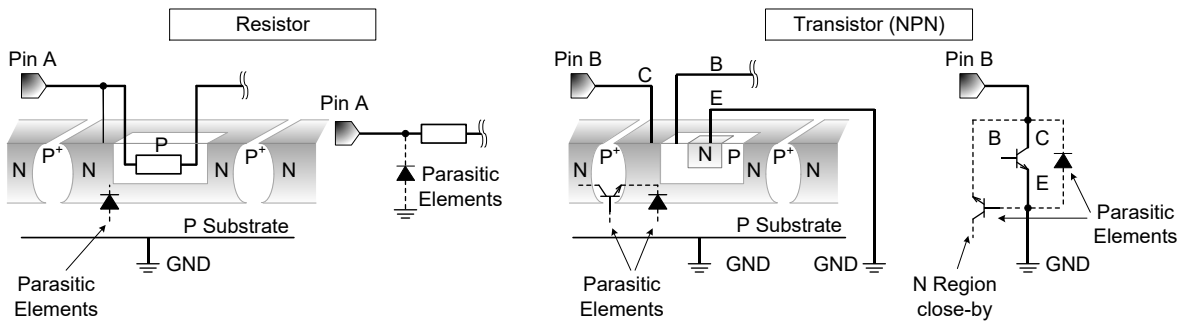
Figure 40. Example of Monolithic IC Structure

11. Ceramic Capacitor

When using a ceramic capacitor, determine a capacitance value considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

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Ordering Information

B	D	8	8	0	3	0	F	V	-	E	2

Package
FV: SSOP-B16

Packaging and forming specifications
E2: Reel-like embossed taping

Marking Diagram

SSOP-B16 (TOP VIEW)

88030

Part Number Marking

LOT Number

Pin 1 Mark

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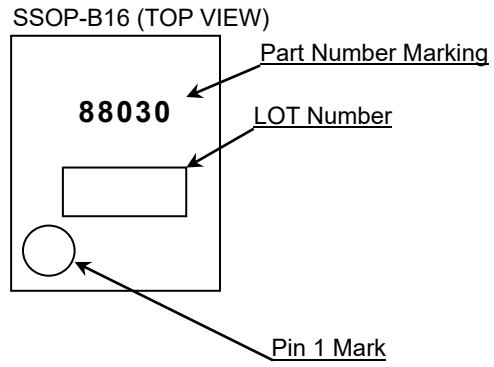
Physical Dimension and Packing Information

Package Name	SSOP-B16

5. 0±0. 2

16   9

6. 4±0. 3

4. 4±0. 2

1   8

0. 3MIN

0. 15±0. 1

1. 15±0. 1

0. 1

0. 65

0. 22±0. 1

0. 1
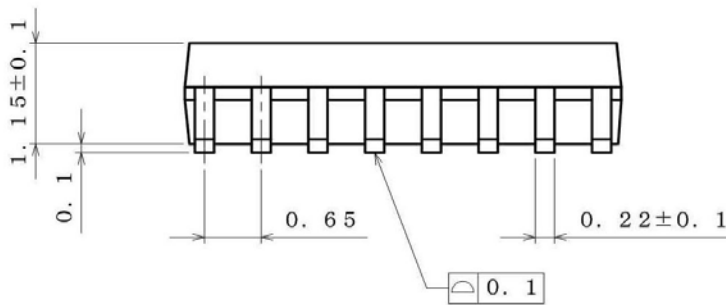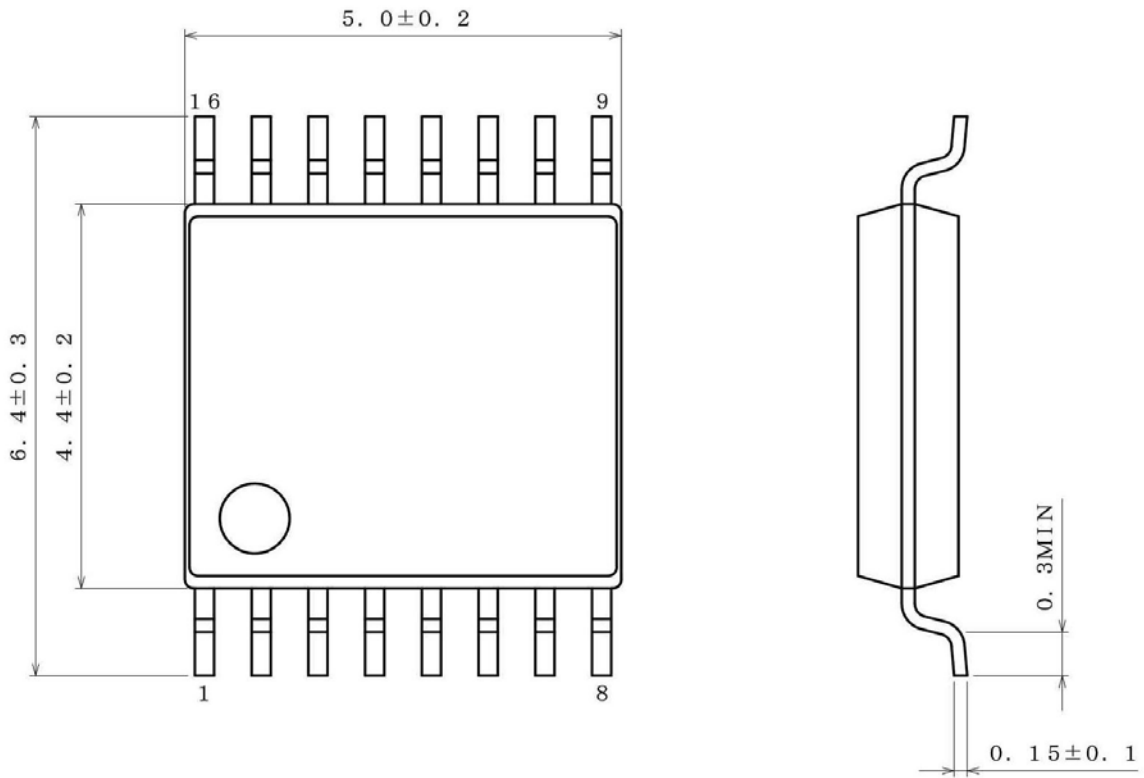
(UNIT : mm)
PKG : SSOP−B16
Drawing No. B0771

< Tape and Reel Information >

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2
	The direction is the pin 1 of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand

E2	TR
TL	E1

Pocket Quadrants

Direction of feed

Reel

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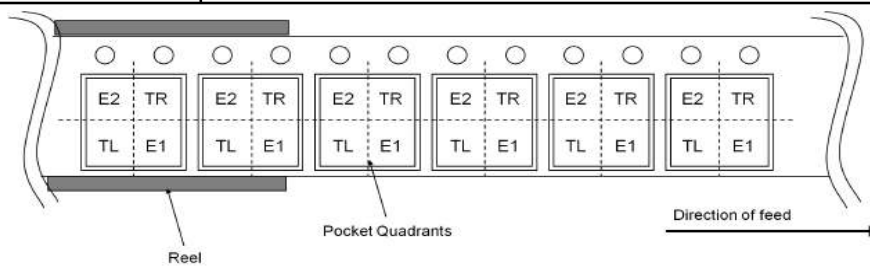
Revision History

Date	Revision	Details of revision
16.Feb.2022	001	New Release

Notice

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   - [f] Sealing or coating our Products with resin or other coating materials
   - [g] Use of our Products without cleaning residue of flux (Exclude cases where no-clean type fluxes is used. However, recommend sufficiently about the residue.) ; or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   - [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse, is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation depending on ambient temperature. When used in sealed area, confirm that it is the use in the range that does not exceed the maximum junction temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

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2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

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This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
    [a] the Products are exposed to sea winds or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
    [b] the temperature or humidity exceeds those recommended by ROHM
    [c] the Products are exposed to direct sunshine or condensation
    [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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