TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

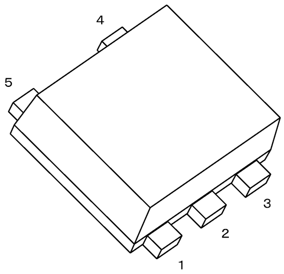
TC75S63TU

Single Operational Amplifier (Low Noise Operational Amplifier)

Features

- Low Noise. V_{NI} = 7.8nV/√Hz (typ.) @ V_{DD} = 3.3 V
- Small Phase Delay. -2.5 degrees @V_{DD} = 3.3 V (typ.), f = 2kHz
- Low-current supply. 500μA @ V_{DD} = 3.3 V (typ.)
- Ultra-compact package.

TC75S63TU



SON5-P-0202-0.65S

UFV

Weight: 7m g (typ.)

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{DD}, V_{SS}	6	V
Differential input voltage	DV_{IN}	±6	V
Input voltage	V_{IN}	V_{DD} to V_{SS}	V
Output current	I_{OUT}	±4	mA
Power dissipation	P_D	450(Note1)	mW
Operating temperature	T_{opr}	−40 to 85	°C
Storage temperature	T_{stg}	−55 to 125	°C

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note1: Mounted on a glass epoxy circuit board of 30 mm × 30 mm. Pad dimension of 35mm^2

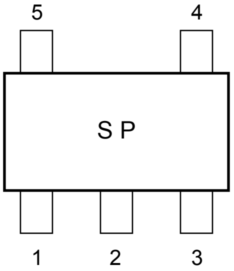
Operating Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{DD}, V_{SS}	2.2 to 5.5	V

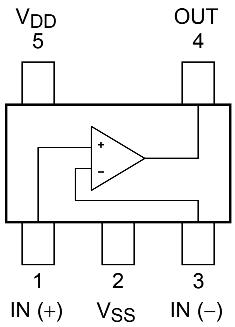
Note2: Do not use this product in a voltage follower circuit or outside the range of the common mode input voltage. (For the common mode input voltage, see DC Characteristics on Page 2). Failure to follow this instruction may cause voltage oscillation.
A higher load capacitance will increase the risk of voltage oscillation, even if this product is used within the range of the common mode input voltage. Allow sufficient capacitance value margin when designing your circuit and using this product to prevent voltage oscillation.

Start of commercial production
2009-09

Marking (top view)



Pin Connection (top view)



Electrical Characteristics

DC Characteristics (V_{DD} = 3.3 V, V_{SS} = GND, Ta = 25°C)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input offset voltage	V_{IO}	1	R_S = 1 kΩ, R_F = 100 kΩ	–	1	7	mV
Input offset current	I_{IO}	–	–	–	1	–	pA
Input bias current	I_I	–	–	–	1	–	pA
Common mode input voltage	CMV_{IN}	2	R_S = 1 kΩ, R_F = 100 kΩ	0	–	2.4	V
Voltage gain (open loop)	G_V	–	–	–	100	–	dB
Maximum output voltage	V_{OH}	3	R_L ≥ 100 kΩ	3.2	–	–	V
	V_{OL}	4	R_L ≥ 100 kΩ	–	–	0.1	
Common mode input signal rejection ratio	CMRR	2	V_{IN} = 0 to 2.4 V	60	80	–	dB
Supply voltage rejection ratio	SVRR	1	V_{DD} = 2.2 to 5.5 V	60	80	–	dB
Supply current	I_{DD}	5	–	–	500	650	μA
Source current	Isource	6	–	1500	–	–	μA
Sink current	Isink	7	–	1500	–	–	μA

AC Characteristics (V_{DD} = 3.3 V, V_{SS} = GND, Ta = 25°C)

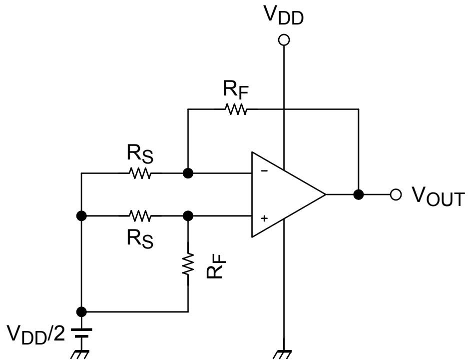
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Equivalent input Noise Voltage	V_{NI}	–	f = 1 kHz, G_V = 40 dB, RS = 100 Ω, Rf = 10 kΩ	–	7.8	–	nV/√Hz
Unity Gain Cross Frequency	f_T	–	G_V = 40 dB	–	3.5	–	MHz
Phase delay	ϕ_D	8	f = 2 kHz	–	-2.5	–	degrees

AC Characteristics (V_{DD} = 1.65 V, V_{SS} = -1.65V, Ta = 25°C)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Slew Rate	SR	9	G_V = 12 dB, V_{IN} = 0.4 V	–	1.0	–	V/μs

Test Circuit

1. SVRR, V_{IO}



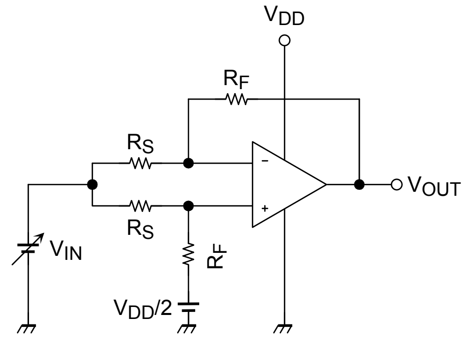
- SVRR
- For each of the two V_{DD} values, measure the V_{OUT} value, as indicated below, and calculate the value of SVRR using the equation shown.
  When $V_{DD} = 2.2$ V, $V_{DD} = V_{DD}1$ and $V_{OUT} = V_{OUT}1$
  When $V_{DD} = 5.5$ V, $V_{DD} = V_{DD}2$ and $V_{OUT} = V_{OUT}2$

$$\mathrm{SVRR} = 20 \log\left(\left|\frac{V_{OUT}1 - V_{OUT}2}{V_{DD}1 - V_{DD}2}\right| \times \frac{R_S}{R_F + R_S}\right)$$

- V_{IO}
  Measure the value of V_{OUT} and calculate the value of V_{IO} using the following equation.

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

2. CMRR, CMV_{IN}

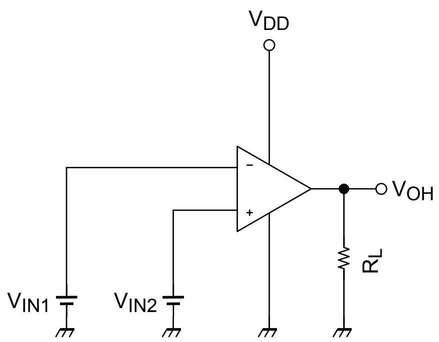


- CMRR
  Measure the V_{OUT} value, as indicated below, and calculate the value of the CMRR using the equation shown.
  When $V_{IN} = 0$ V, $V_{IN} = V_{IN}1$ and $V_{OUT} = V_{OUT}1$
  When $V_{IN} = 2.4$ V, $V_{IN} = V_{IN}2$ and $V_{OUT} = V_{OUT}2$

$$\mathrm{CMRR} = 20 \log\left(\left|\frac{V_{OUT}1 - V_{OUT}2}{V_{IN}1 - V_{IN}2}\right| \times \frac{R_S}{R_F + R_S}\right)$$

- CMV_{IN}
  Input range within which the CMRR specification guarantees V_{OUT} value (as varied by the V_{IN} value).

3. V_{OH}

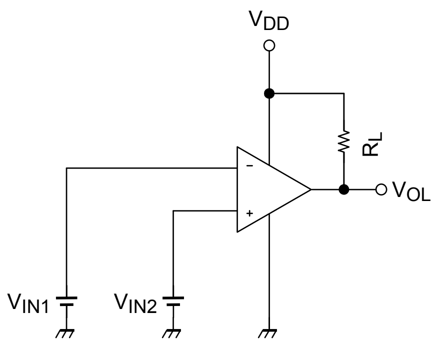


- V_{OH}

$$V_{IN1} = \frac{V_{DD}}{2} - 0.05\ \mathrm{V}$$

$$V_{IN2} = \frac{V_{DD}}{2} + 0.05\ \mathrm{V}$$

4. V_{OL}

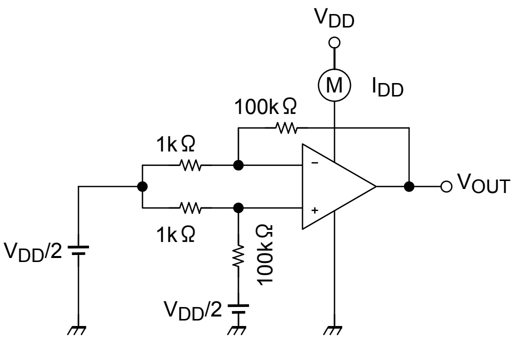


- V_{OL}

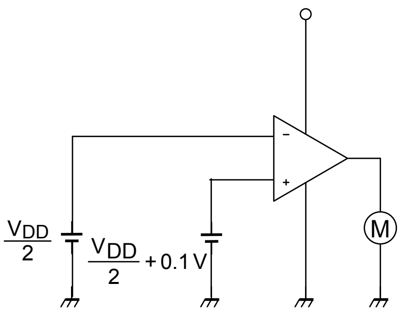
$$V_{IN1} = \frac{V_{DD}}{2} + 0.05\ \mathrm{V}$$

$$V_{IN2} = \frac{V_{DD}}{2} - 0.05\ \mathrm{V}$$

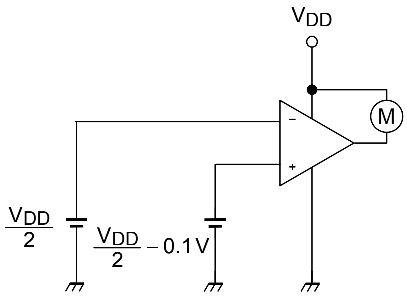
5. I_{DD}



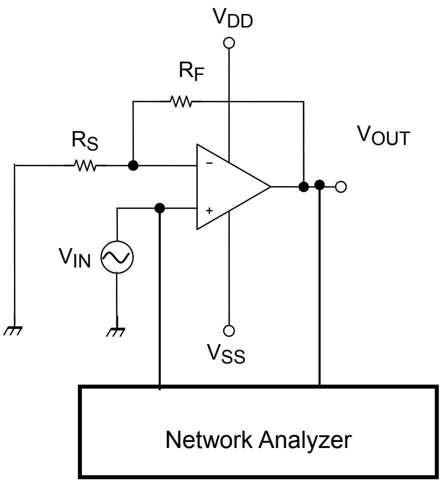
6. I_{source}

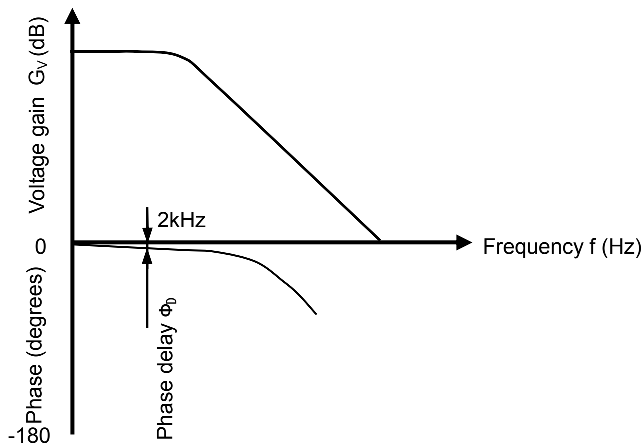


7. I_{sink}

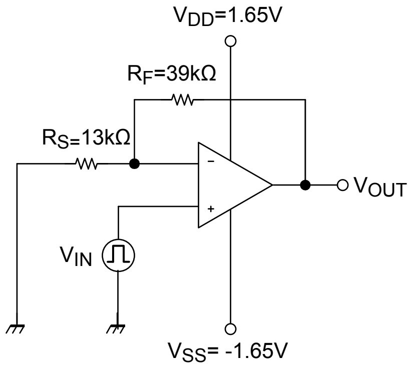


8. ϕ_D





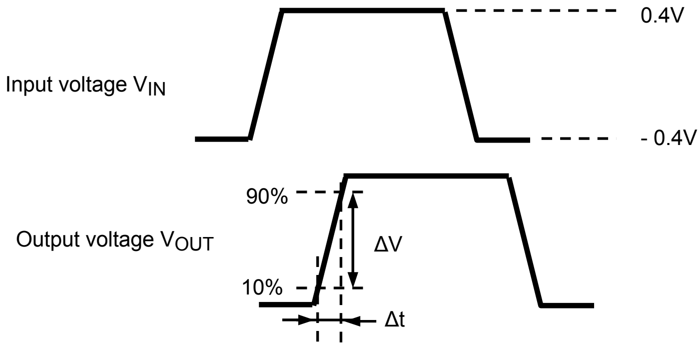
9.SR

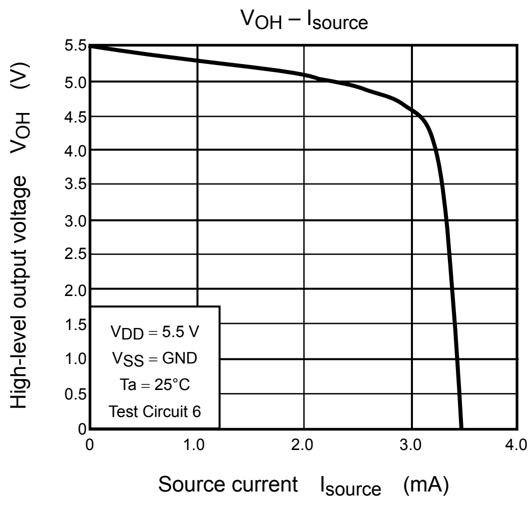


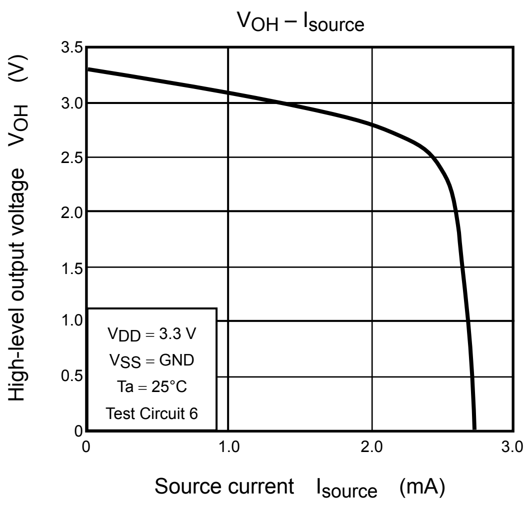
- SR

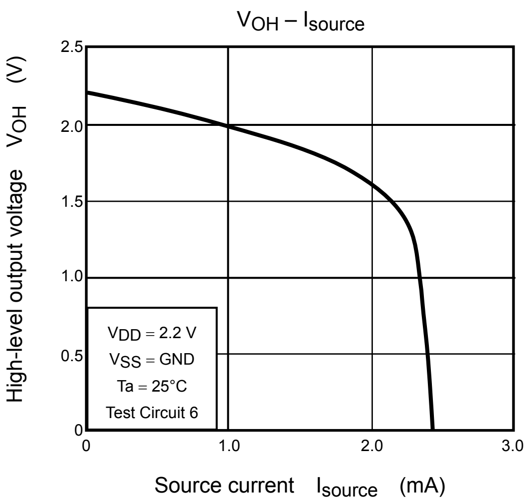
$$G_V = 1 + \frac{R_F}{R_S} = 12dB$$

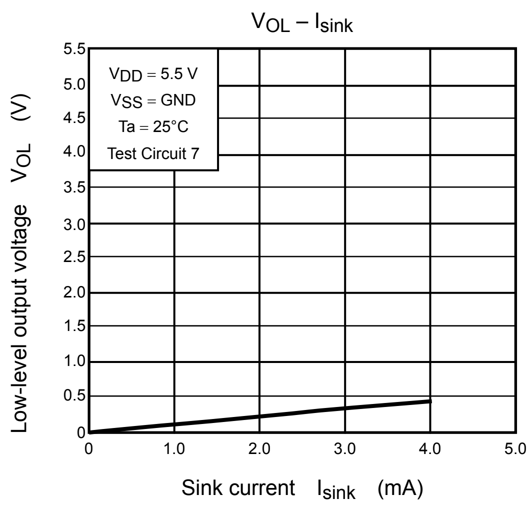
$$SR = \frac{\Delta t}{\Delta V}$$

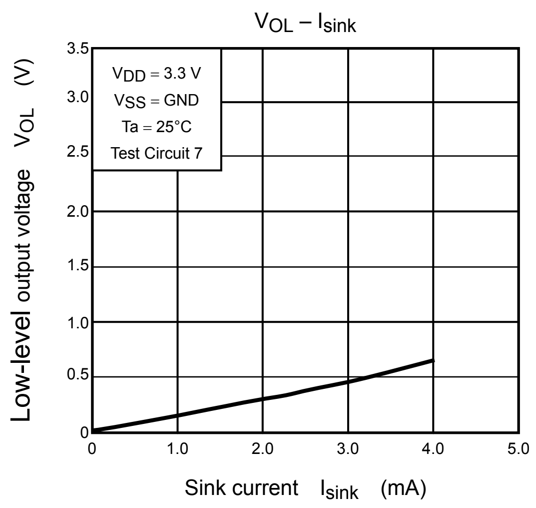


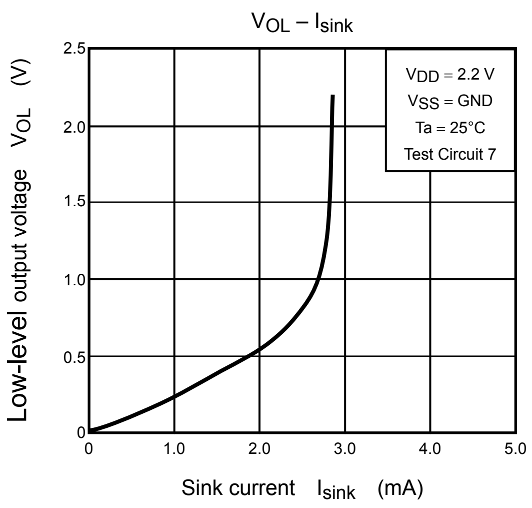

V_{OH} – I_{source}
High-level output voltage V_{OH} (V)
Source current I_{source} (mA)
V_{DD} = 5.5 V
V_{SS} = GND
Ta = 25°C
Test Circuit 6

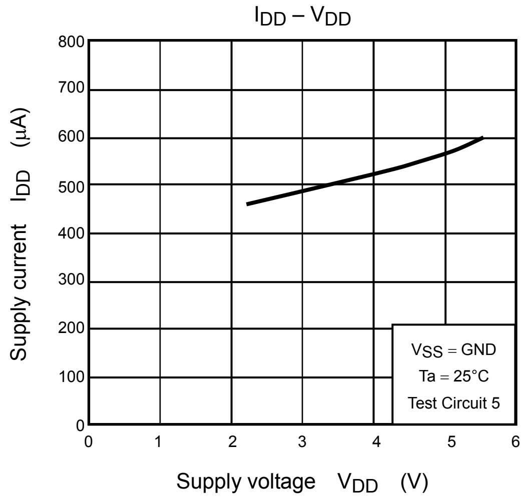

V_{OH} – I_{source}
High-level output voltage V_{OH} (V)
Source current I_{source} (mA)
V_{DD} = 3.3 V
V_{SS} = GND
Ta = 25°C
Test Circuit 6

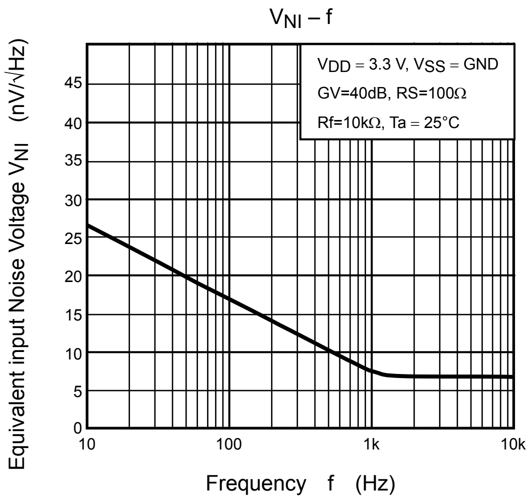

V_{OH} – I_{source}
High-level output voltage V_{OH} (V)
Source current I_{source} (mA)
V_{DD} = 2.2 V
V_{SS} = GND
Ta = 25°C
Test Circuit 6

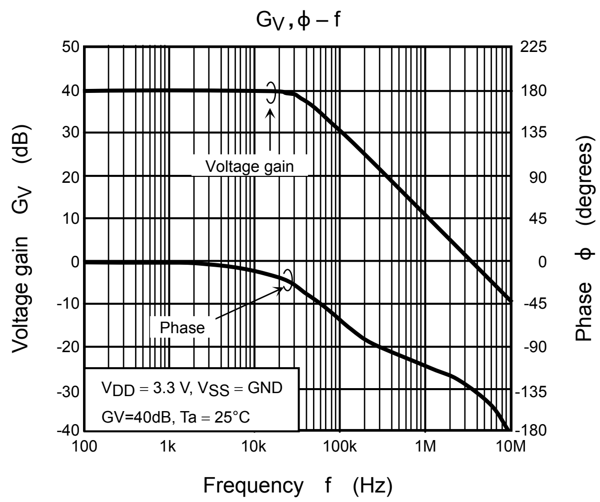

V_{OL} – I_{sink}
Low-level output voltage V_{OL} (V)
Sink current I_{sink} (mA)
V_{DD} = 5.5 V
V_{SS} = GND
Ta = 25°C
Test Circuit 7

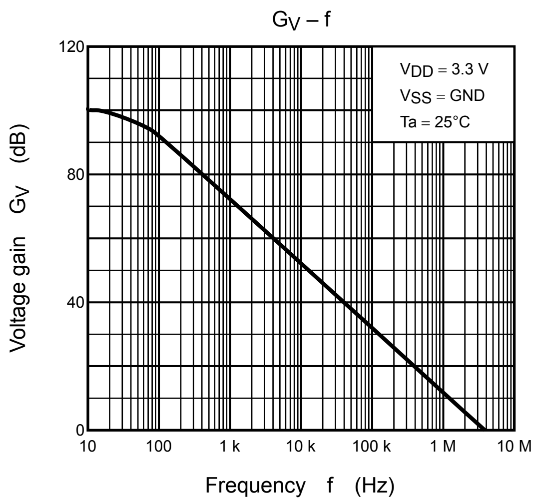

V_{OL} – I_{sink}
Low-level output voltage V_{OL} (V)
Sink current I_{sink} (mA)
V_{DD} = 3.3 V
V_{SS} = GND
Ta = 25°C
Test Circuit 7

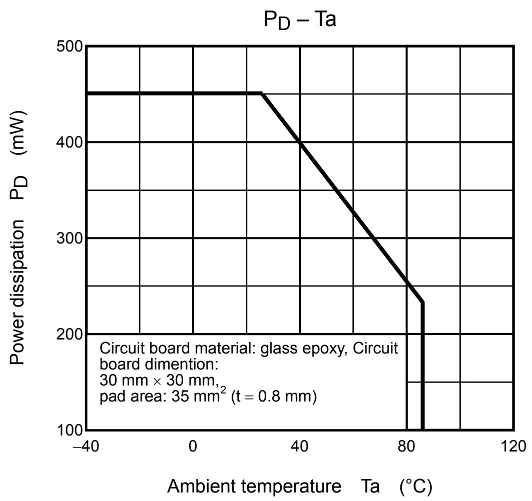

V_{OL} – I_{sink}
Low-level output voltage V_{OL} (V)
Sink current I_{sink} (mA)
V_{DD} = 2.2 V
V_{SS} = GND
Ta = 25°C
Test Circuit 7


IDD – VDD
Supply current IDD (μA)
800
700
600
500
400
300
200
100
0
0 1 2 3 4 5 6
Supply voltage VDD (V)
VSS = GND
Ta = 25°C
Test Circuit 5


VNI – f
Equivalent input Noise Voltage VNI (nV/√Hz)
VDD = 3.3 V, VSS = GND
GV=40dB, RS=100Ω
Rf=10kΩ, Ta = 25°C
45 40 35 30 25 20 15 10 5 0
10 100 1k 10k
Frequency f (Hz)

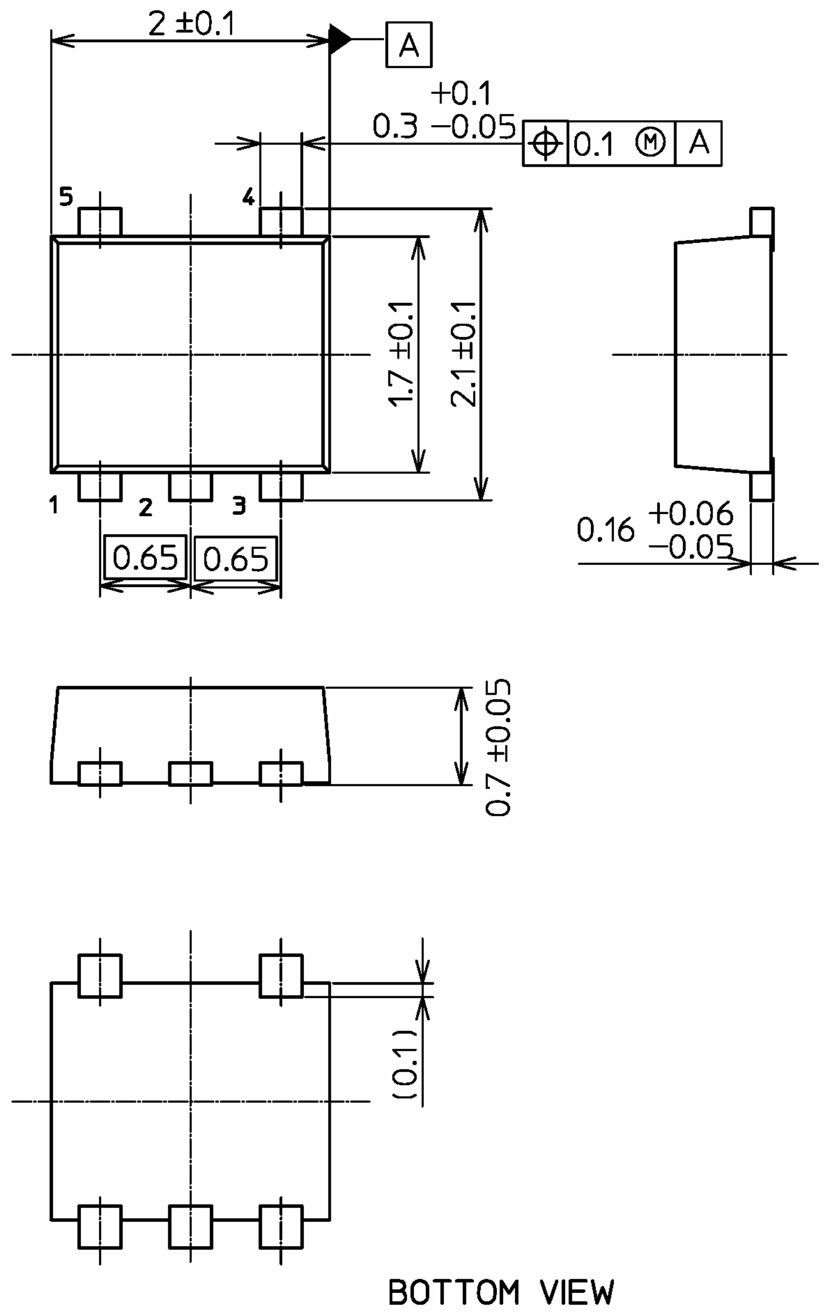

GV , ϕ – f
Voltage gain GV (dB)
Phase ϕ (degrees)
50 40 30 20 10 0 -10 -20 -30 -40
225 180 135 90 45 0 -45 -90 -135 -180
Voltage gain
Phase
VDD = 3.3 V, VSS = GND
GV=40dB, Ta = 25°C
100 1k 10k 100k 1M 10M
Frequency f (Hz)


GV – f
Voltage gain GV (dB)
VDD = 3.3 V
VSS = GND
Ta = 25°C
120 80 40 0
10 100 1 k 10 k 100 k 1 M 10 M
Frequency f (Hz)


PD – Ta
Power dissipation PD (mW)
500 400 300 200 100
Circuit board material: glass epoxy, Circuit board dimention:
30 mm × 30 mm,
pad area: 35 mm2 (t = 0.8 mm)
–40 0 40 80 120
Ambient temperature Ta (°C)

Package Dimension

SON5-P-0202-0.65S Unit:mm



Weight : 7m g (typ.)

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