

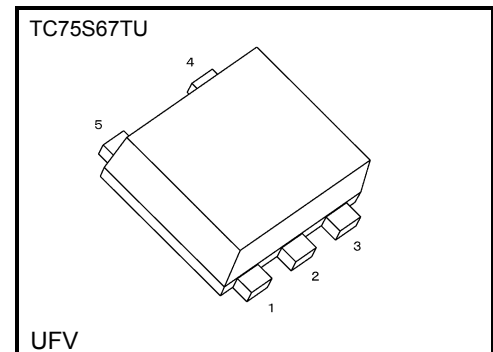
TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

TC75S67TU

Single Operational Amplifier (Ultra Low Noise Operational Amplifier)

Features

- Ultra Low Noise. $V_{NI} = 6 \text{ nV}/\sqrt{\text{Hz}}$ (typ.) @ $V_{DD} = 2.5 \text{ V}$
- Low-current supply. $430 \text{ }\mu\text{A}$ (typ.) @ $V_{DD} = 2.5 \text{ V}$
- Ultra-compact package.



Weight: 7 mg (typ.)

Absolute Maximum Ratings (Note) ($T_a = 25^\circ\text{C}$)

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 (Note 1)	P_D	450	mW
Operating temperature	T_{opr}	-40 to 85	$^\circ\text{C}$
Storage temperature	T_{stg}	-55 to 125	$^\circ\text{C}$

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

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).

Note 1: Mounted on a glass epoxy circuit board of 30 mm $\times$ 30 mm. Pad dimension of 35mm²

Operating Ratings (Note) ($T_a = 25^\circ\text{C}$)

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

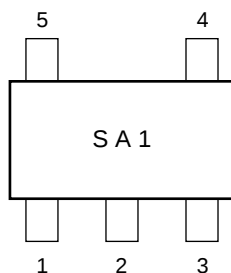
Note: Do not use this product in a voltage follower circuit or outside the range of the common mode input voltage.

(For the common mode input voltage, see DC Characteristics on Page 2). Failure to follow this instruction may cause a circuit oscillation.

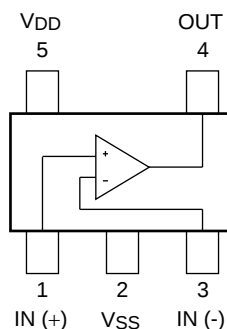
A higher load capacitance will increase the risk of voltage oscillation, even if this product is used within the range of the common mode input voltage. Allow sufficient capacitance value margin when designing your circuit and using this product to prevent a circuit oscillation.

Start of commercial production
2017-08

Marking (top view)



Pin Connection (top view)



Electrical Characteristics

DC Characteristics ($V_{DD} = 2.5\text{ V}$, $V_{SS} = \text{GND}$, $T_a = 25^\circ\text{C}$)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input offset voltage	V_{IO}	1	$R_S = 1\text{ k}\Omega$, $R_F = 100\text{ k}\Omega$	-	0.5	3	mV
Input offset voltage drift	$V_{IO\text{drift}}$	1	$R_S = 1\text{ k}\Omega$, $R_F = 100\text{ k}\Omega$	-	2	-	$\mu\text{V}/^\circ\text{C}$
Input offset current	I_{IO}	-	-	-	1	-	pA
Input bias current	I_I	-	-	-	1	-	pA
Common mode input voltage	CMV_{IN}	2	$R_S = 1\text{ k}\Omega$, $R_F = 100\text{ k}\Omega$	0	-	1.4	V
Voltage gain (open loop)	G_V	-	-	80	100	-	dB
Maximum output voltage	V_{OH}	3	$R_L \geq 100\text{ k}\Omega$	2.4	-	-	V
	V_{OL}	4	$R_L \geq 100\text{ k}\Omega$	-	-	0.1	
Common mode input signal rejection ratio	$CMRR$	2	$V_{IN} = 0\text{ to }1.4\text{ V}$	70	100	-	dB
Supply voltage rejection ratio	$SVRR$	1	$V_{DD} = 2.2\text{ to }5.5\text{ V}$	70	100	-	dB
Supply current	I_{DD}	5	-	-	430	700	μA
Source current	I_{source}	6	-	2000	2500	-	μA
Sink current	I_{sink}	7	-	2000	3500	-	μA

AC Characteristics ($V_{DD} = 2.5\text{ V}$, $V_{SS} = \text{GND}$, $T_a = 25^\circ\text{C}$)

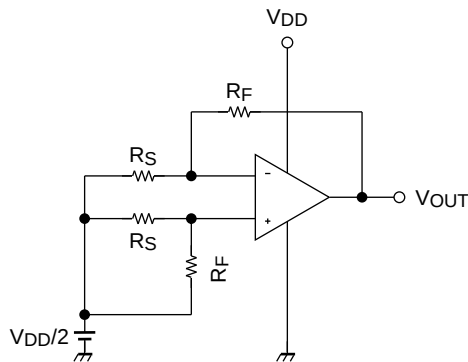
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Equivalent input Noise Voltage	V_{NI}	-	$f = 10\text{ Hz}$, $G_V = 40\text{ dB}$, $R_S = 100\text{ }\Omega$, $R_f = 10\text{ k}\Omega$	-	16	40	$\text{nV}/\sqrt{\text{Hz}}$
			$f = 1\text{ kHz}$, $G_V = 40\text{ dB}$, $R_S = 100\text{ }\Omega$, $R_f = 10\text{ k}\Omega$	-	6	10	
Unity Gain Cross Frequency	f_T	9	-	3.0	3.5	-	MHz
Phase delay	ϕ_D	8	$f = 10\text{ kHz}$	-	-10.5	-	degrees
Phase margin	ϕ_m	9	$G_V = 6\text{ dB}$ ($A_V = 2$)	-	55	-	degrees

AC Characteristics ($V_{DD} = 1.25\text{ V}$, $V_{SS} = -1.25\text{ V}$, $T_a = 25^\circ\text{C}$)

Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Slew Rate	SR	10	$G_V = 12\text{ dB}$, $V_{IN} = 0.25\text{ Vp-p}$	-	1.0	-	$\text{V}/\mu\text{s}$

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 $V_{DD} = 2.2\text{ V}$, $V_{DD} = V_{DD1}$ and $V_{OUT} = V_{OUT1}$

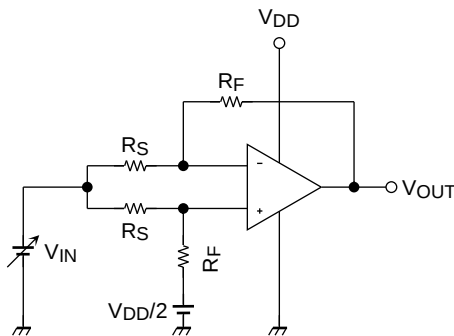
When $V_{DD} = 5.5\text{ V}$, $V_{DD} = V_{DD2}$ and $V_{OUT} = V_{OUT2}$

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

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

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

2. CMRR, CMV_{IN}



- CMRR
Measure the V_{OUT} value, as indicated below, and calculate the value of the CMRR using the equation shown.

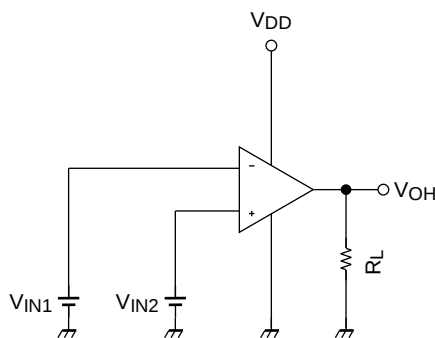
When $V_{IN} = 0\text{ V}$, $V_{IN} = V_{IN1}$ and $V_{OUT} = V_{OUT1}$

When $V_{IN} = 1.4\text{ V}$, $V_{IN} = V_{IN2}$ and $V_{OUT} = V_{OUT2}$

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

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

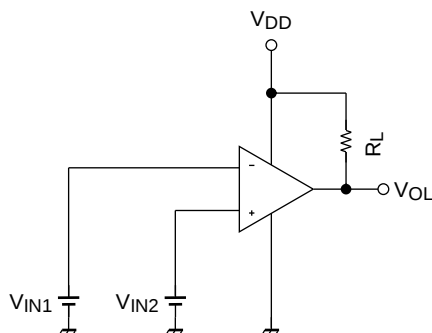
3. V_{OH}



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

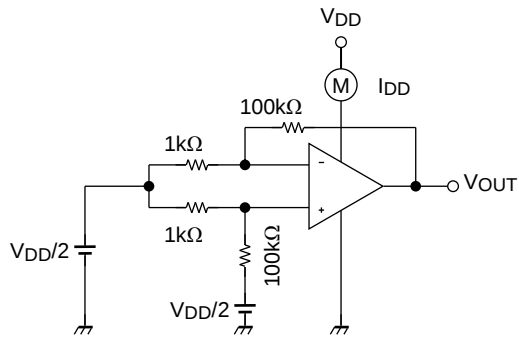
$$V_{IN2} = \frac{V_{DD}}{2}$$

4. V_{OL}

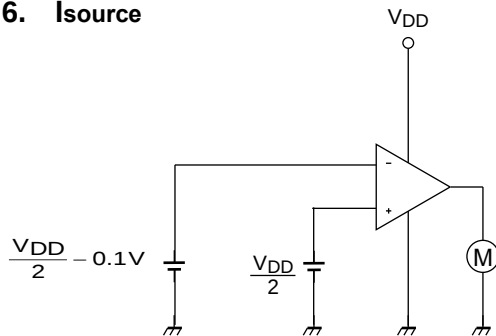


- V_{OL}
 $V_{IN1} = \frac{V_{DD}}{2}$
 $V_{IN2} = \frac{V_{DD}}{2} - 0.1\text{ V}$

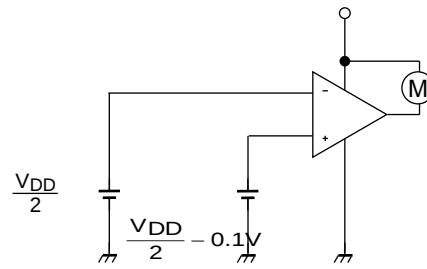
5. I_{DD}



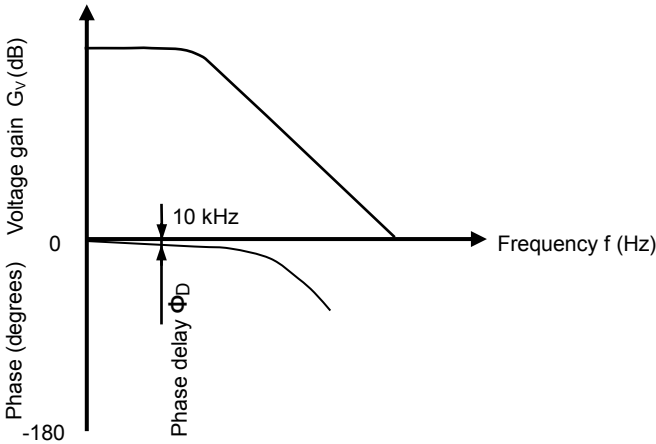
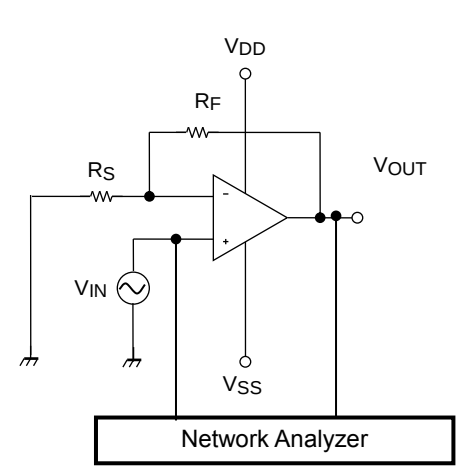
6. I_{source}



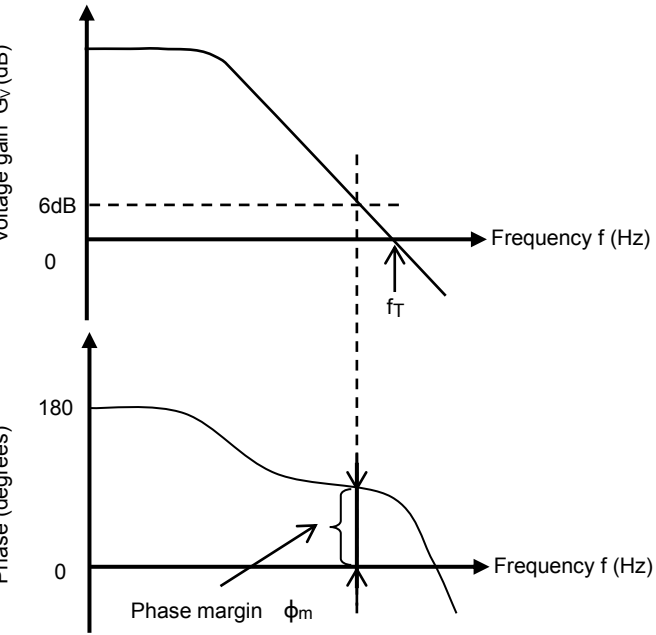
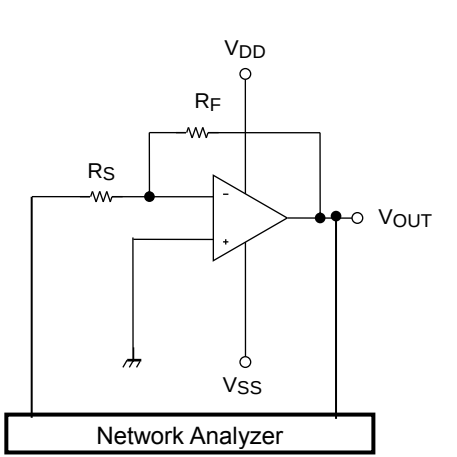
7. I_{sink}



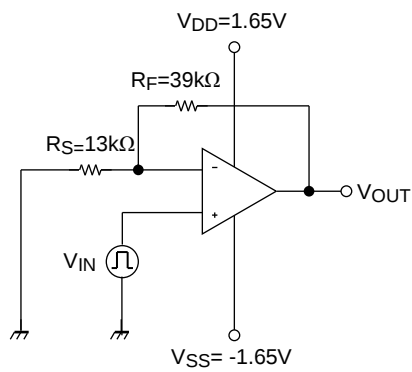
8. ϕ_D



9. f_T , ϕ_m



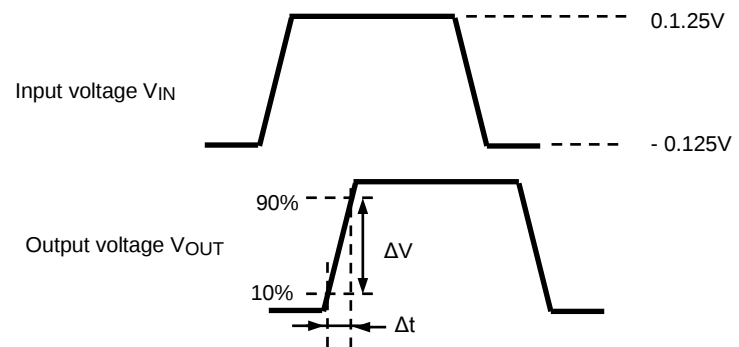
10. SR

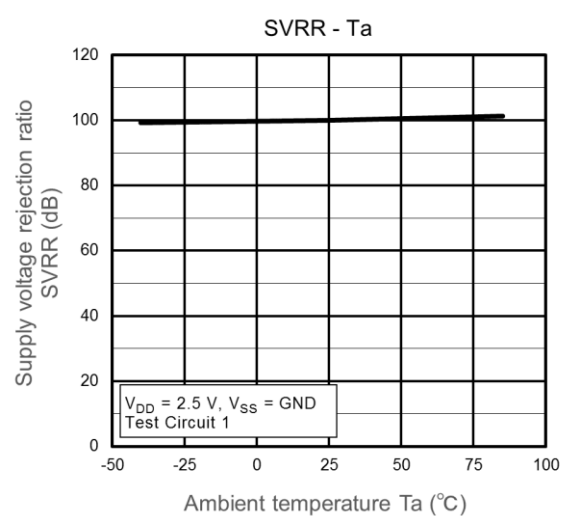
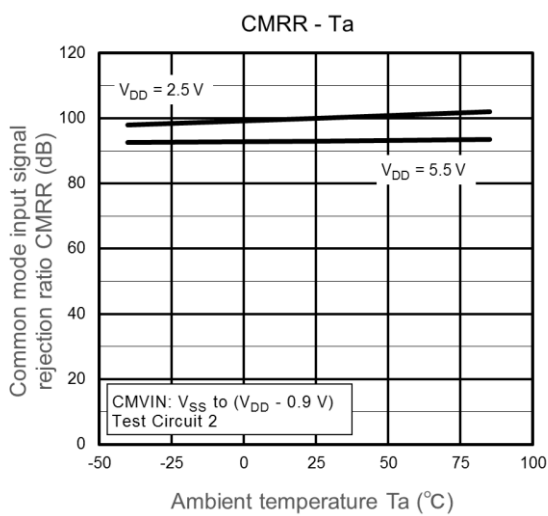
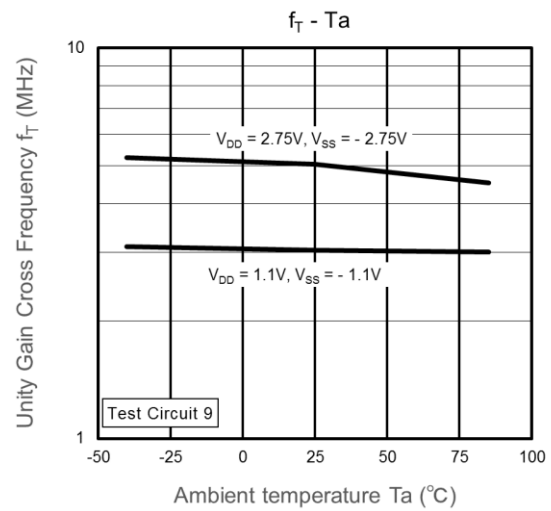
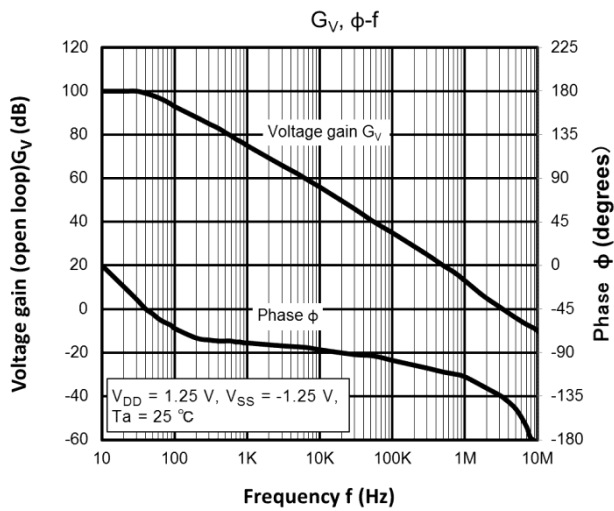
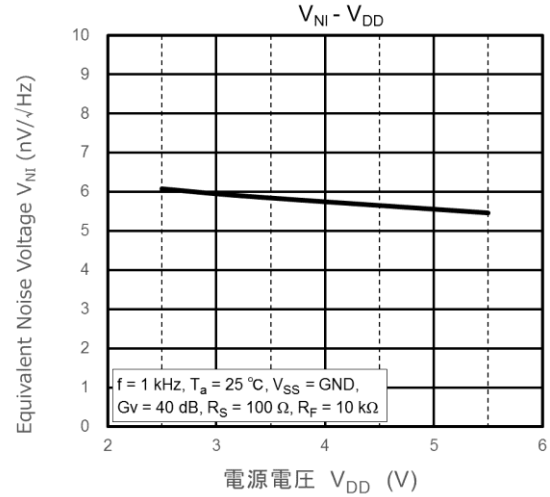
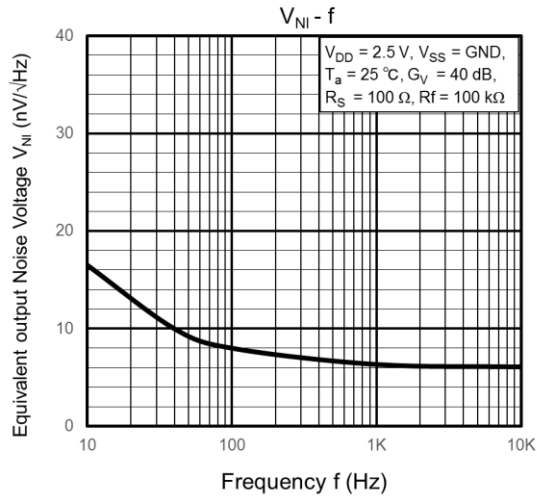


- SR

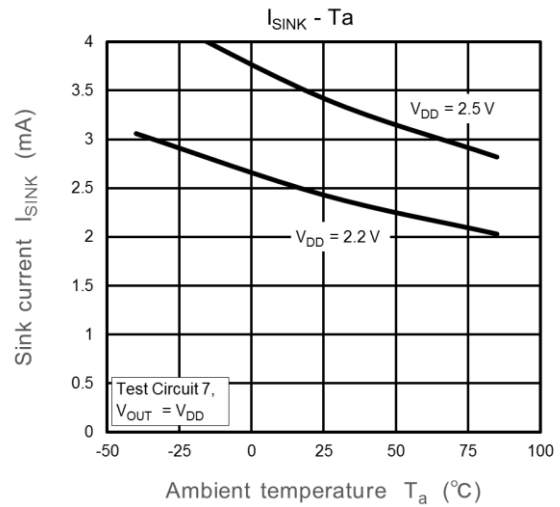
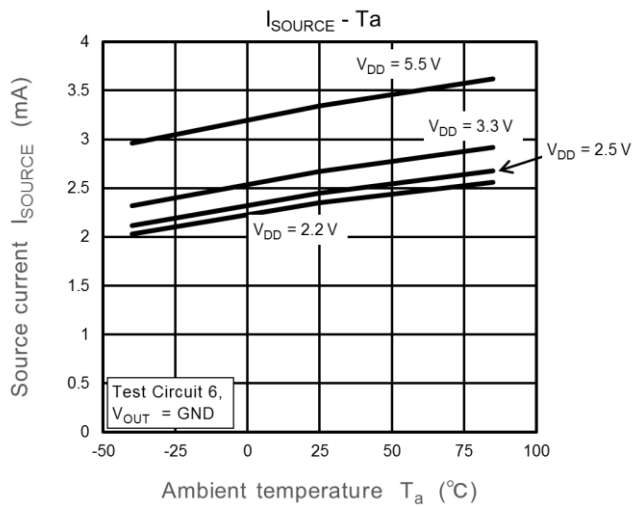
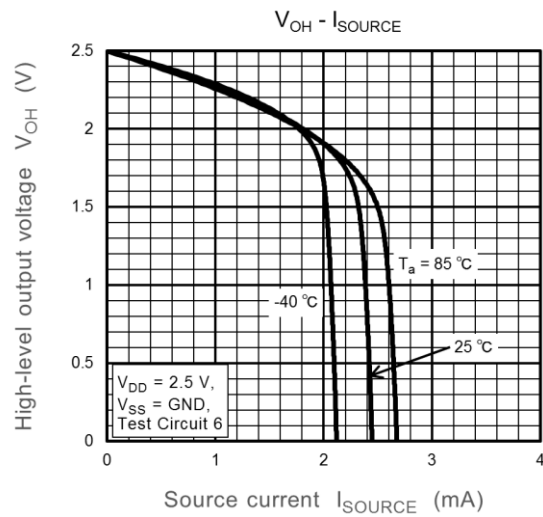
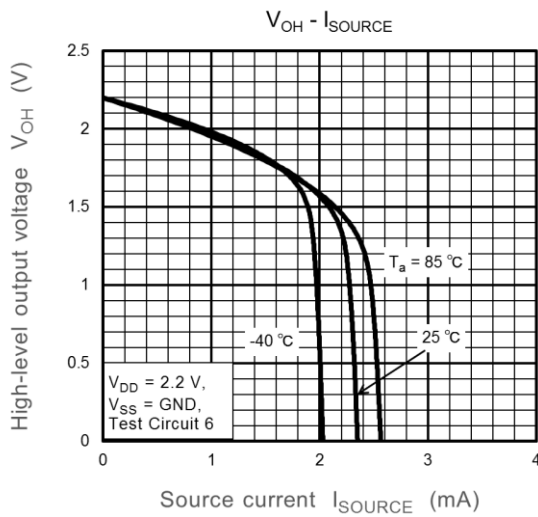
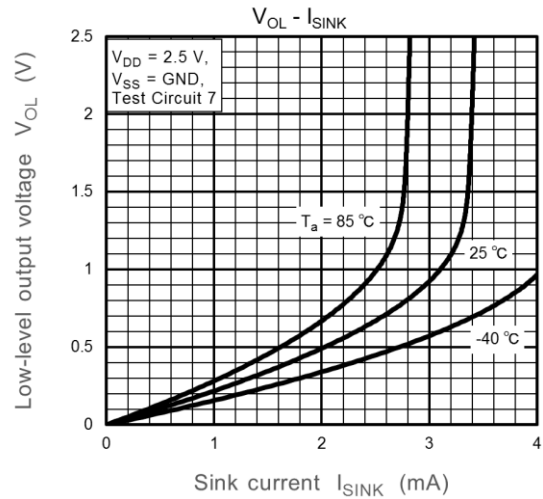
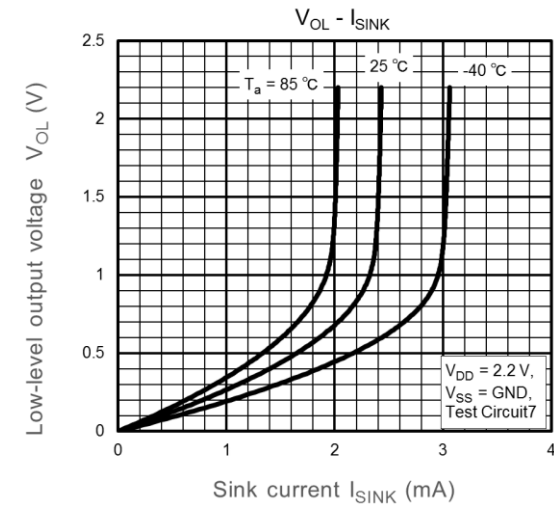
$$G_V = 1 + \frac{R_F}{R_S} = 12dB$$

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

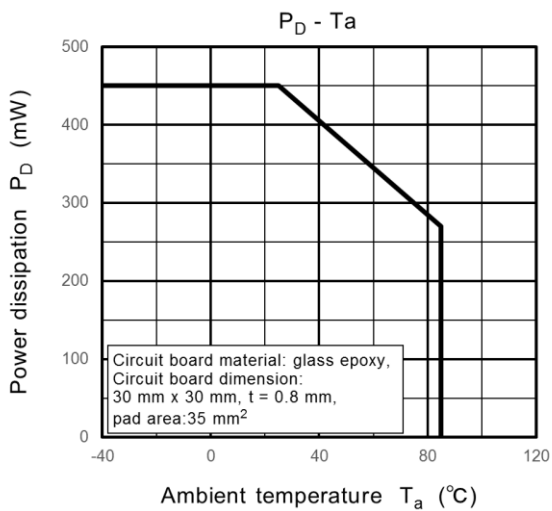
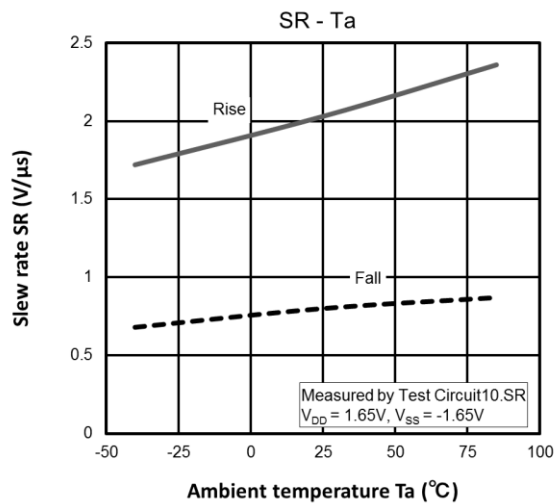
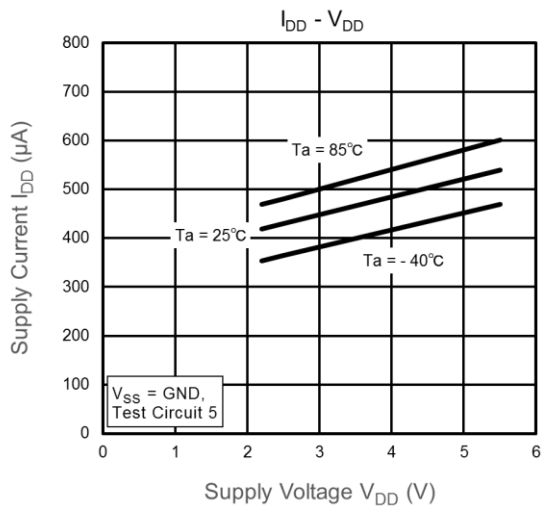




The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.



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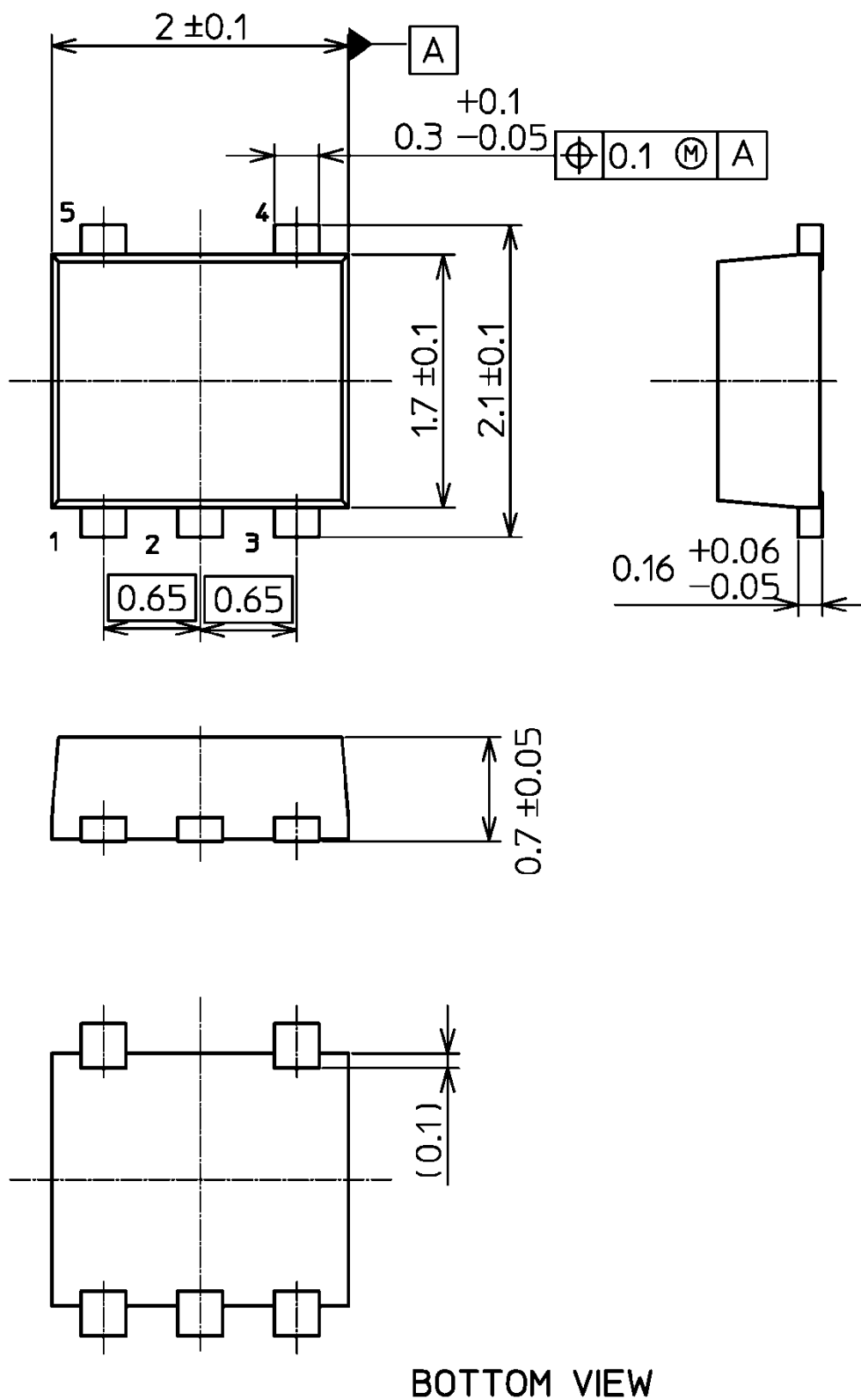


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Package Dimensions

UFV

Unit: mm



Weight: 7 mg (typ.)

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