TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

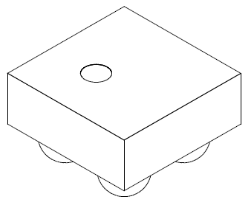
TCR4S12DWBG ~ TCR4S36DWBG

200 mA CMOS Low-Dropout Regulator

The TCR4S12DWBG to TCR4S36DWBG are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage and low quiescent bias current. The TCR4S12WBG to TCR4S36WBG can be enabled and disabled via the CONTROL pin.

These voltage regulators are available in fixed output voltages between 1.2 V and 3.6 V in 0.05-V steps and capable of driving up to 200 mA. They feature overcurrent protection and auto-discharge.

The TCR4S12DWBG to TCR4S36DWBG are offered in the compact WCSP (0.79 mm x 0.79 mm x 0.50 mm) and allow the use of small ceramic input and output capacitors. Thus, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



S-UFBGA4-0101-0.40A01

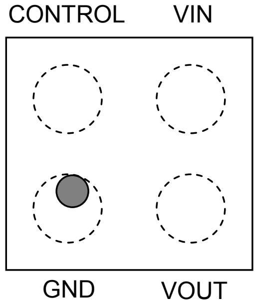
WCSP4

Weight: 0.7 mg (typ)

Features

- Low quiescent bias current (I_B = 50 μA (typ.) at I_{OUT} = 0 mA)
- Low stand-by current ($I_{B(OFF)}$ = 0.1 μA (typ.) at Stand-by mode)
- Low dropout voltage (V_{IN} - V_{OUT} = 90 mV (typ.) at TCR4S25DWBG, I_{OUT} = 50 mA)
- High ripple rejection ratio (R.R = 80 dB (typ) at I_{OUT} = 10 mA, f =1kHz)
- Low output noise voltage (V_{NO} = 30 μV_{rms} (typ.) at TCR4S25DWBG, I_{OUT} = 10 mA, 10 Hz ≤ f ≤ 100 kHz)
- Auto-discharge
- Control pull-down resistor
- Overcurrent protection
- Ceramic capacitors can be used (C_{IN} = 0.1 μF, C_{OUT} =1.0 μF)
- Very small package, WCSP (0.79 mm x 0.79 mm x 0.50 mm)

Pin Assignment (top view)



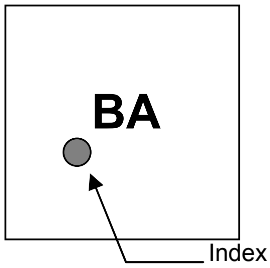
Start of commercial production
2010-07

List of Products Number and Marking

Products No.	Marking	Products No.	Marking
TCR4S12DWBG	B3	TCR4S26DWBG	BN
TCR4S13DWBG	B4	TCR4S27DWBG	BO
TCR4S14DWBG	B5	TCR4S28DWBG	BP
TCR4S15DWBG	BA	TCR4S285DWBG	B7
TCR4S16DWBG	BB	TCR4S29DWBG	BR
TCR4S17DWBG	BD	TCR4S295DWBG	B6
TCR4S18DWBG	BE	TCR4S30DWBG	BS
TCR4S19DWBG	BF	TCR4S31DWBG	BT
TCR4S20DWBG	BG	TCR4S32DWBG	BV
TCR4S21DWBG	BH	TCR4S33DWBG	BW
TCR4S22DWBG	BI	TCR4S34DWBG	BX
TCR4S23DWBG	BK	TCR4S35DWBG	BY
TCR4S24DWBG	BL	TCR4S36DWBG	BZ
TCR4S25DWBG	BM		

Marking (top view)

Example: TCR4S15DWBG (1.5 V output)



Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Input voltage	V_{IN}	6 (Note 1)	V
Control voltage	V_{CT}	-0.3 to V_{IN}	V
Output voltage	V_{OUT}	-0.3 to V_{IN} + 0.3	V
Output current	I_{OUT}	200	mA
Power dissipation	P_D	800 (Note 2)	mW
Operation temperature range	T_{opr}	−40 to 85	°C
Junction temperature	T_j	150	°C
Storage temperature range	T_{stg}	−55 to 150	°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).

(Note 1): V_{IN} for 1.2 V to 1.4V output product is 5.5 V.

(Note 2): Rating at mounting on a board
(Glass epoxy board dimension: 40mm x 40mm, both sides of board
Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
Through hole: diameter 0.5mm x 28)

Electrical Characteristics (Unless otherwise specified, $V_{IN} = V_{OUT} + 1$ V, $I_{OUT} = 50$ mA, $C_{IN} = 0.1$ μF, $C_{OUT} = 1.0$ μF, $T_j = 25$°C)(Note 3)

Characteristics	Symbol	Test Condition		Min	Typ.	Max	Unit
Output voltage	V_{OUT}	Please refer to the Output Voltage Accuracy table					
Line regulation	Reg·line	$V_{OUT} + 0.5$ V ≤ V_{IN} ≤ 6 V, $I_{OUT} = 1$ mA (Note 4)		—	1	15	mV
Load regulation	Reg·load	1 mA ≤ I_{OUT} ≤ 150 mA		—	5	30	mV
Quiescent current	I_B	$I_{OUT} = 0$ mA		—	50	75	μA
Stand-by current	$I_{B\ (OFF)}$	$V_{CT} = 0$ V		—	0.1	1.0	μA
Dropout voltage	$V_{IN}-V_{OUT}$	Please refer to the Dropout voltage table					
Temperature coefficient	T_{CVO}	–40°C ≤ T_{opr} ≤ 85°C		—	100	—	ppm/°C
Output noise voltage	V_{NO}	$V_{IN} = V_{OUT} + 1$ V, $I_{OUT} = 10$ mA, 10 Hz ≤ f ≤ 100 kHz, Ta = 25°C	TCR4S12DWBG to TCR4S20DWBG	—	25	—	μV_{rms}
			TCR4S21DWBG to TCR4S30DWBG	—	30	—	
			TCR4S31DWBG to TCR4S36DWBG	—	35	—	
Input voltage	V_{IN}	—	TCR4S12DWBG	1.8	—	5.5	V
			TCR4S13DWBG to TCR4S14DWBG	1.85	—	5.5	
			TCR4S15DWBG to TCR4S19DWBG	V_{OUT} + 0.35 V	—	6.0	
			TCR4S20DWBG to TCR4S21DWBG	V_{OUT} + 0.28 V	—	6.0	
			TCR4S22DWBG to TCR4S24DWBG	V_{OUT} + 0.25 V	—	6.0	
			TCR4S25DWBG to TCR4S36DWBG	V_{OUT} + 0.20 V	—	6.0	
Ripple rejection ratio	R.R.	$V_{IN} = V_{OUT} + 1$ V, $I_{OUT} = 10$ mA, f = 1 kHz, $V_{Ripple} = 500$ $mV_{p\text{-}p}$, Ta = 25°C		—	80	—	dB
Control voltage (ON)	$V_{CT\ (ON)}$	(Note 5)		1.1	—	6.0	V
Control voltage (OFF)	$V_{CT\ (OFF)}$	—		0	—	0.4	V

Note 3: Unless otherwise specified, V_{IN} for 1.2V to 1.4V output product is V_{OUT} □+ 0.5 V

Note 4: V_{IN} for 1.2V to 1.4V output product is V_{OUT} □+ 0.5 V ≤ V_{IN} ≤ 5.5 V

Note 5: $V_{CT\ (ON)}$ of 1.2V to 1.4V output product is 5.5V (max)

Output Voltage Accuracy
($V_{IN} = V_{OUT} + 1$ V, $I_{OUT} = 50$ mA, $C_{IN} = 0.1$ μF, $C_{OUT} = 1.0$ μF, $T_j = 25$°C)

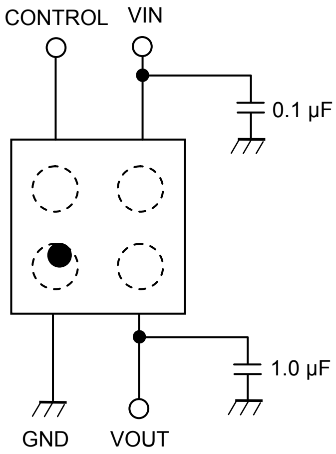
Product No.	Symbol	Min	Typ.	Max	Unit
TCR4S12DWBG	V_{OUT}	1.17	1.2	1.23	V
TCR4S13DWBG		1.27	1.3	1.33	
TCR4S14DWBG		1.37	1.4	1.43	
TCR4S15DWBG		1.47	1.5	1.53	
TCR4S16DWBG		1.56	1.6	1.64	
TCR4S17DWBG		1.66	1.7	1.74	
TCR4S18DWBG		1.76	1.8	1.84	
TCR4S19DWBG		1.86	1.9	1.94	
TCR4S20DWBG		1.96	2.0	2.04	
TCR4S21DWBG		2.05	2.1	2.15	
TCR4S22DWBG		2.15	2.2	2.25	
TCR4S23DWBG		2.25	2.3	2.35	
TCR4S24DWBG		2.35	2.4	2.45	
TCR4S25DWBG		2.45	2.5	2.55	
TCR4S26DWBG		2.54	2.6	2.66	
TCR4S27DWBG		2.64	2.7	2.76	
TCR4S28DWBG		2.74	2.8	2.86	
TCR4S285DWBG		2.79	2.85	2.91	
TCR4S29DWBG		2.84	2.9	2.96	
TCR4S295DWBG		2.89	2.95	3.01	
TCR4S30DWBG		2.94	3.0	3.06	
TCR4S31DWBG		3.03	3.1	3.17	
TCR4S32DWBG		3.13	3.2	3.27	
TCR4S33DWBG		3.23	3.3	3.37	
TCR4S34DWBG		3.33	3.4	3.47	
TCR4S35DWBG		3.43	3.5	3.57	
TCR4S36DWBG		3.52	3.6	3.68	

Dropout Voltage
($I_{OUT} = 50$ mA, $C_{IN} = 0.1$ μF, $C_{OUT} = 1.0$ μF, $T_j = 25$°C)

Product No.	Symbol	Min	Typ.	Max	Unit
TCR4S12DWBG	V_{IN}-V_{OUT}	—	400	600	mV
TCR4S13DWBG		—	350	550	
TCR4S14DWBG		—	300	450	
TCR4S15DWBG to TCR4S19DWBG		—	200	350	
TCR4S20DWBG to TCR4S21DWBG		—	150	280	
TCR4S22DWBG to TCR4S24DWBG		—	130	250	
TCR4S25DWBG to TCR4S36DWBG		—	90	200	

Application Note

1. Recommended Application (top view)



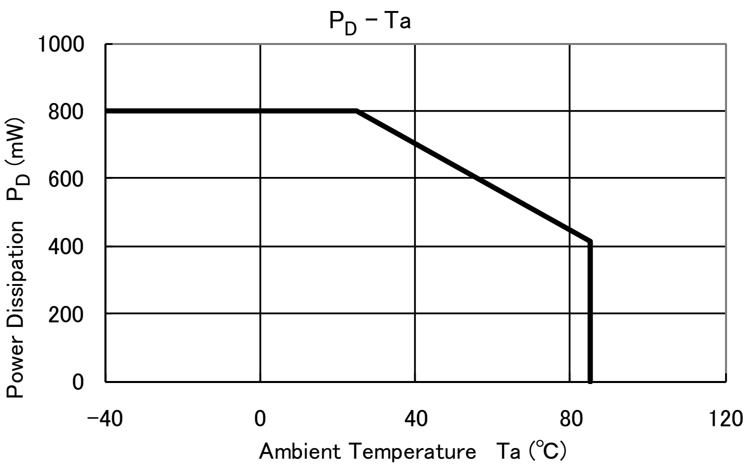
Control Level	Operation
HIGH	ON
LOW	OFF

The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor to V_{OUT} and V_{IN} for stable input/output operation. (ceramic capacitors can be used)

2. Power Dissipation

Power dissipation is measured on the board condition shown below.

[The Board Condition]
Board material: Glass epoxy
Board dimension: 40 mm x 40 mm, both sides of board , t=1.8 mm
Wireability: a surface approximately 50%
the reverse side approximately 50%
Through hole hall: diameter 0.5 mm x 28



Attention in Use

- Output Capacitors
  Ceramic capacitors can be used for these devices. However, because of the type of the capacitors, there might be unexpected thermal features. Please consider application condition for selecting capacitors. And Toshiba recommend the ESR of ceramic capacitor is under 10 Ω.

- Mounting
  The long distance between IC and output capacitor might affect phase assurance by impedance in wire and inductor. For stable power supply, output capacitor need to mount near IC as much as possible. Also GND pattern need to be large and make the wire impedance small as possible.

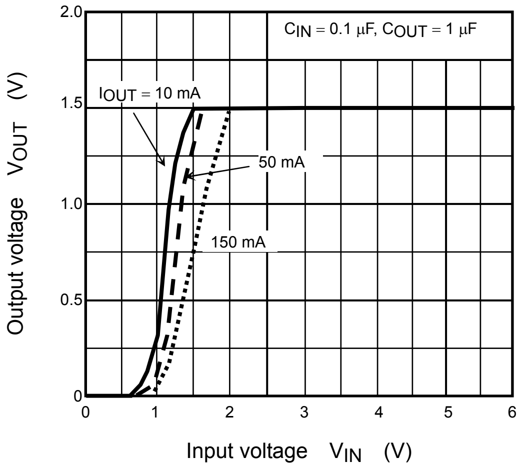
- Permissible Loss
  Please have enough board design patterns for expected maximum permissible loss. And under consideration of surrounding temperature, input voltage, and output current etc, please apply proper dissipation ratings for maximum permissible loss.

- Overcurrent Protection Circuit
  Overcurrent protection circuit is designed in these products, but this does not assure for the suppression of uprising device operation. If output pins and GND pins are shorted out, these products might be break down.
  In use of these products, please read through and understand dissipation idea for absolute maximum ratings from the above mention or our 'Semiconductor Reliability Handbook'. Then use these products under absolute maximum ratings in any condition. Furthermore, Toshiba recommend inserting failsafe system into the design.

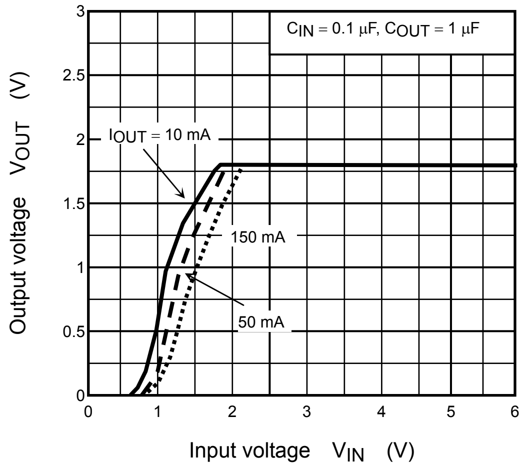
Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

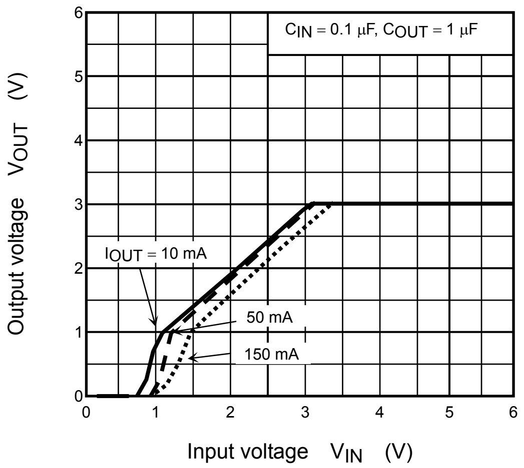
TCR4S15DWBG



TCR4S18DWBG

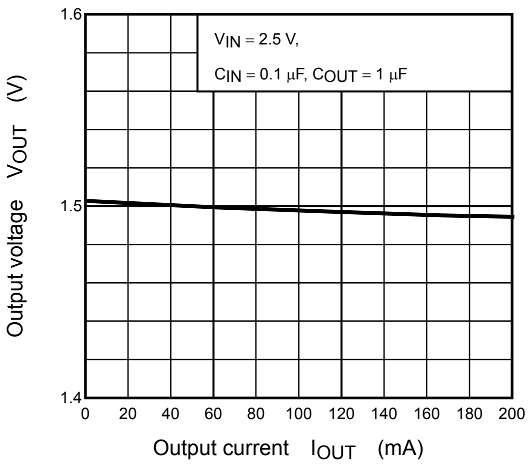


TCR4S30DWBG

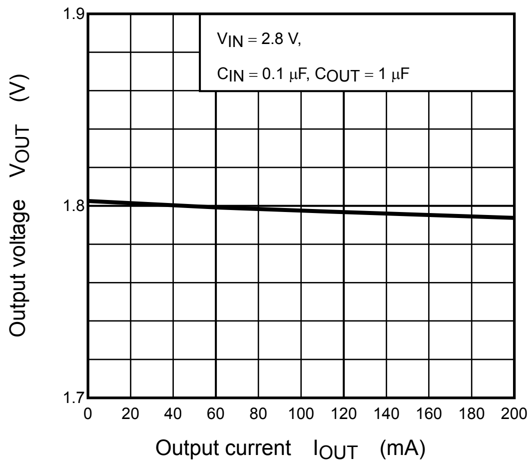


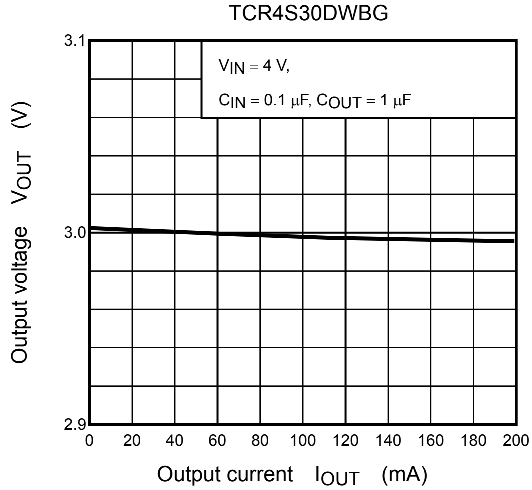
2) Output Voltage vs. Output Current

TCR4S15DWBG

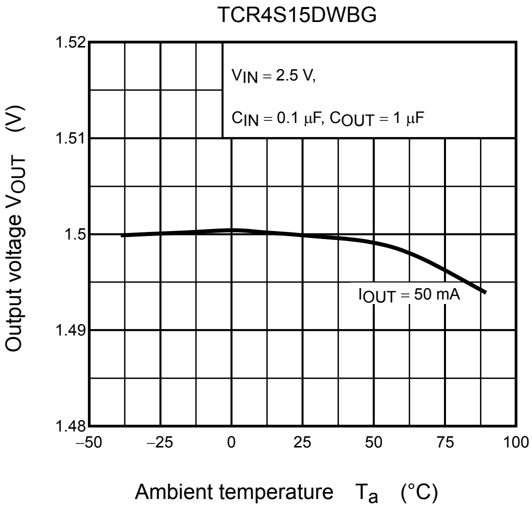


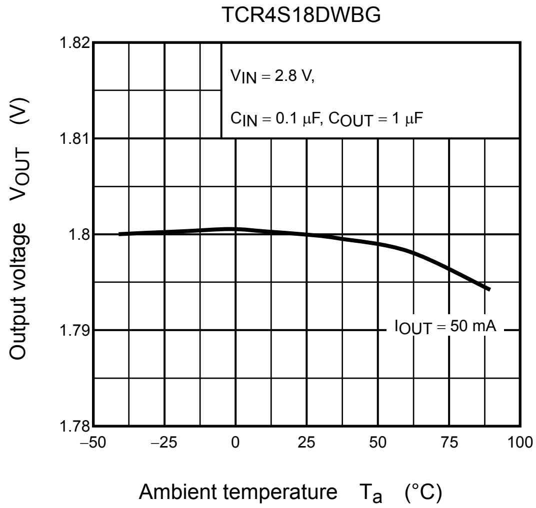
TCR4S18DWBG

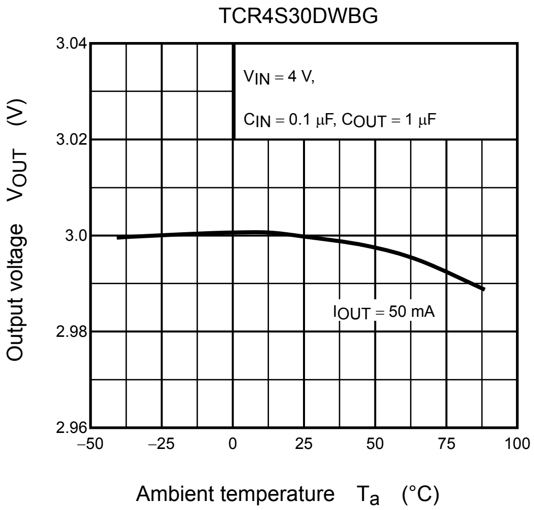




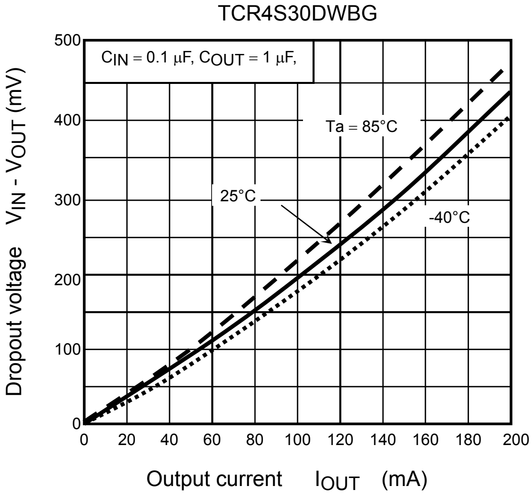
3) Output Voltage vs. Ambient temperature



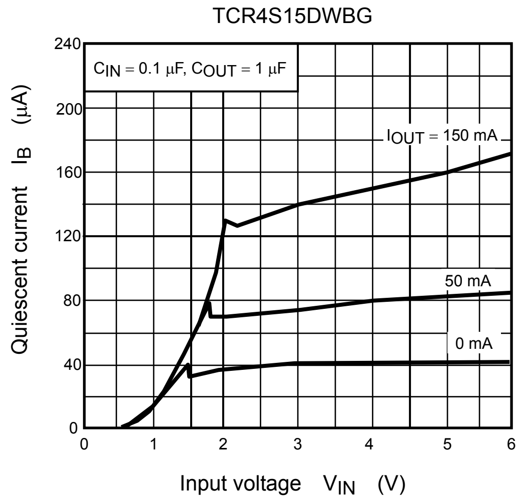


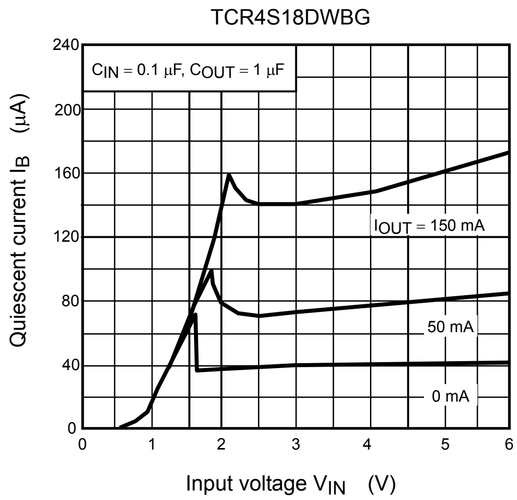


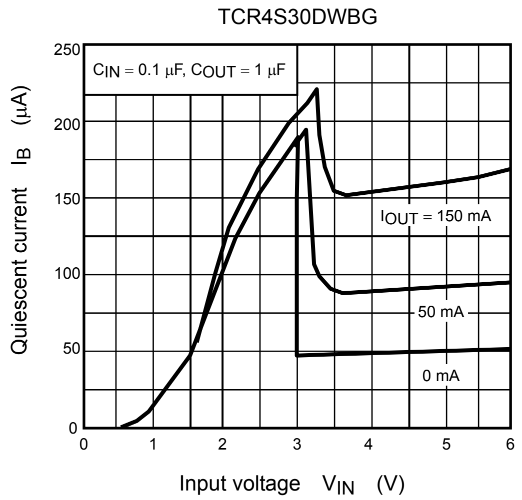
4) Dropout Voltage vs. Output Current



5) Quiescent Current vs. Input Voltage

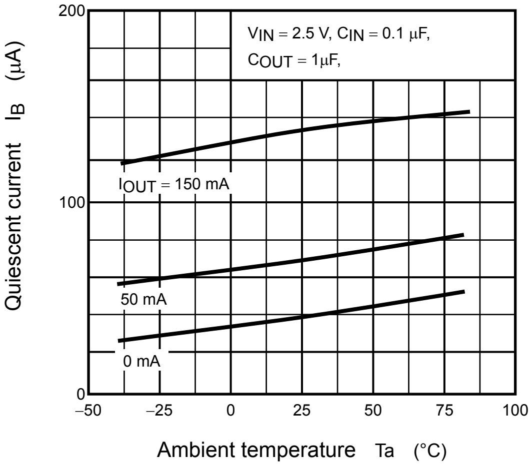




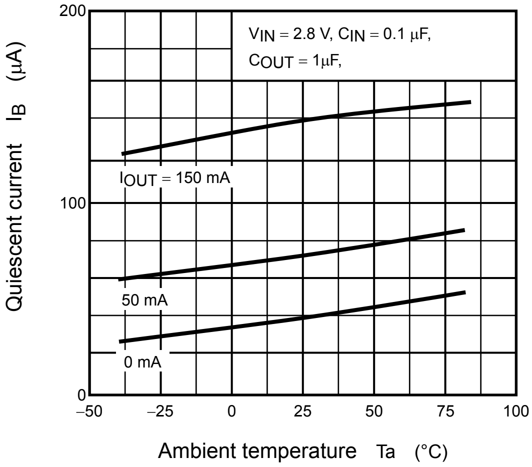


6) Quiescent current vs. Ambient temperature

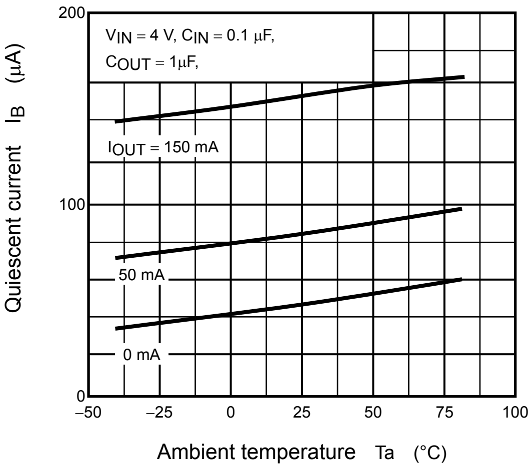
TCR4S15DWBG



TCR4S18DWBG

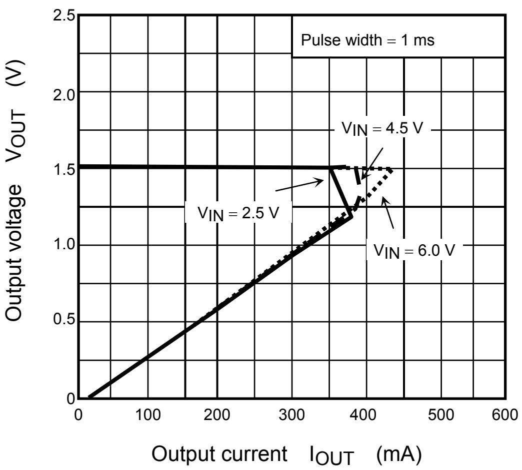


TCR4S30DWBG

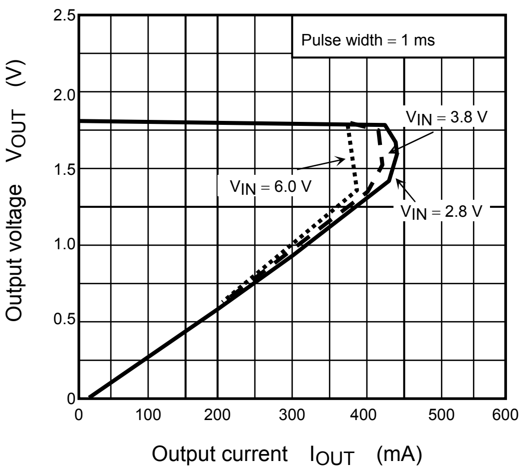


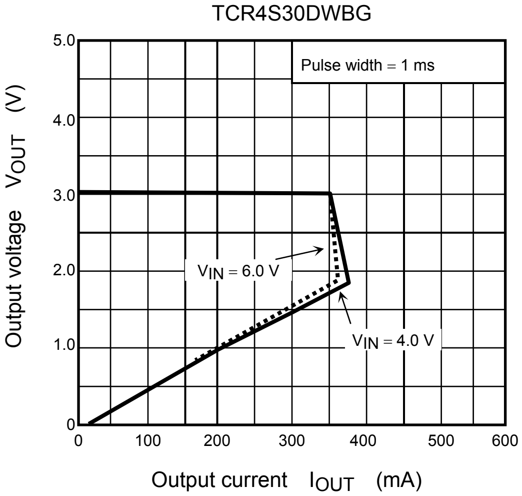
7) Overcurrent Protection Characteristics

TCR4S15DWBG

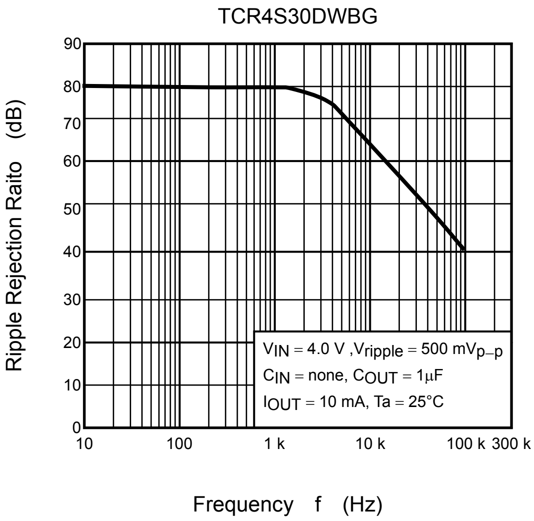


TCR4S18DWBG



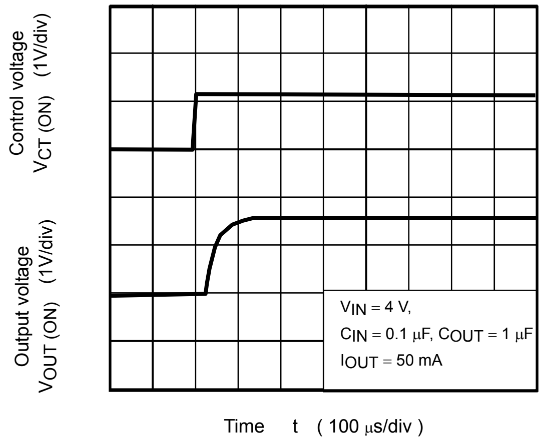


8) Ripple rejection Raito vs. Frequency

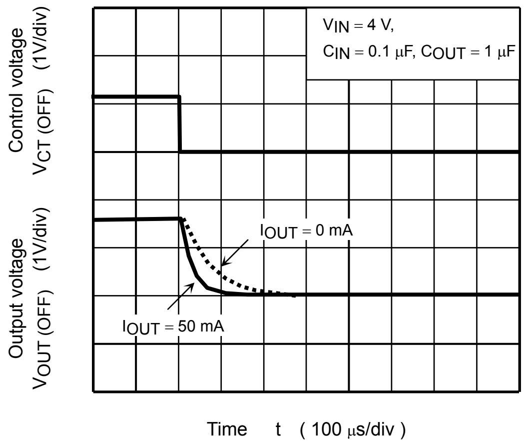


9) Control Transient Response (Auto-Discharge)

TCR4S18DWBG (Turn on waveform)

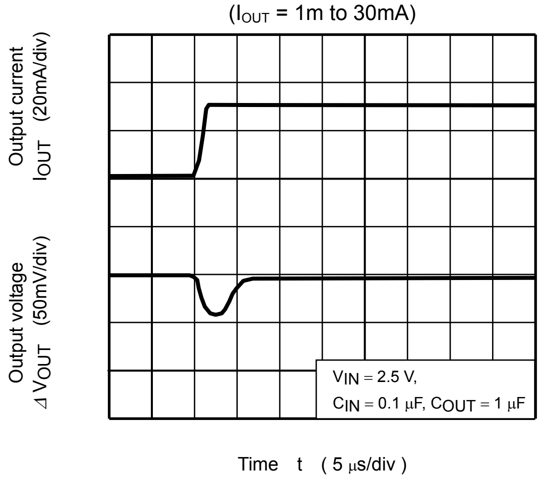


TCR4S18DWBG (Turn off waveform)

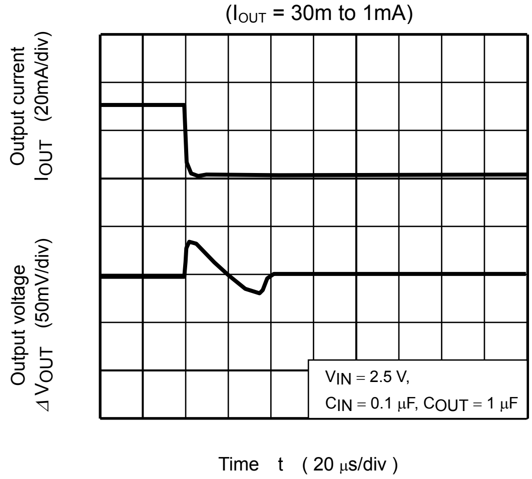


10) Load Transient Response

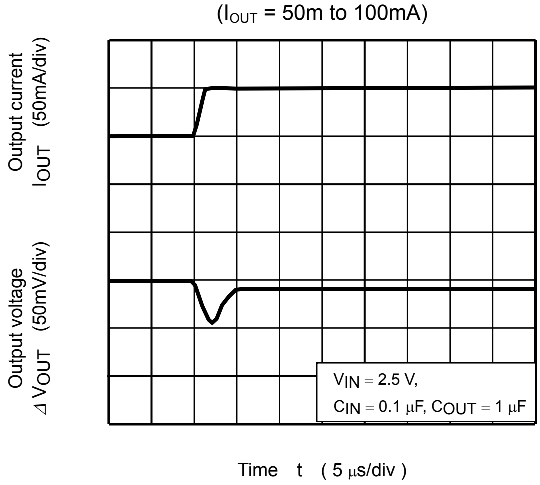
TCR4S15DWBG
(I_{OUT} = 1m to 30mA)



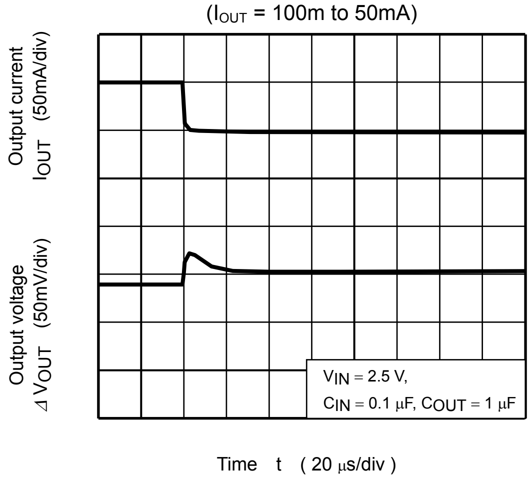
TCR4S15DWBG
(I_{OUT} = 30m to 1mA)



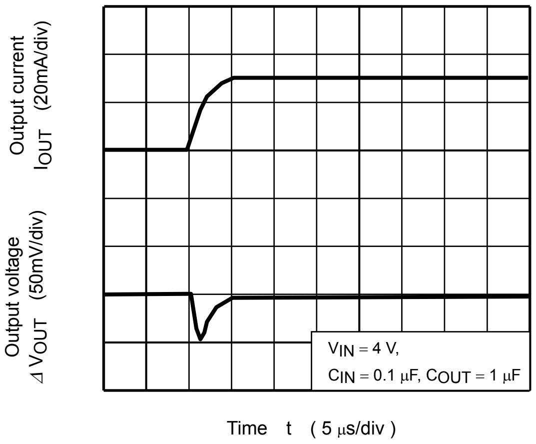
TCR4S15DWBG
(I_{OUT} = 50m to 100mA)



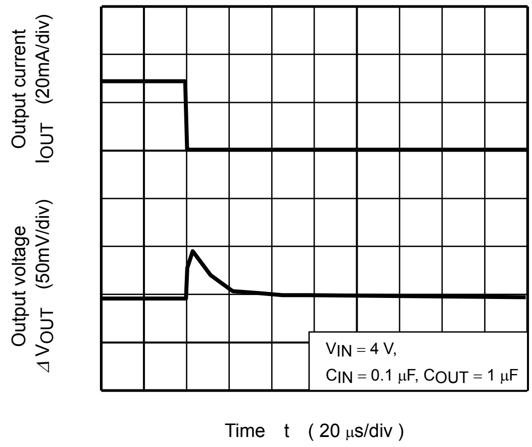
TCR4S15DWBG
(I_{OUT} = 100m to 50mA)



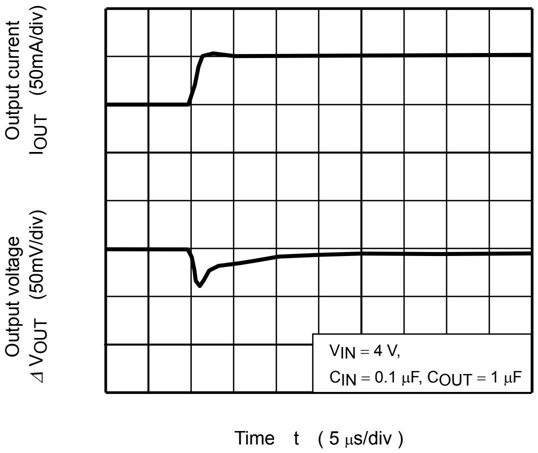
TCR4S30DWBG
(I_{OUT} = 1m to 30mA)



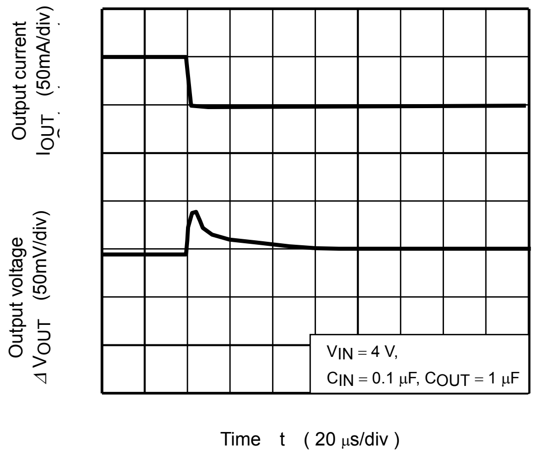
TCR4S30DWBG
(I_{OUT} =30m to 1mA)



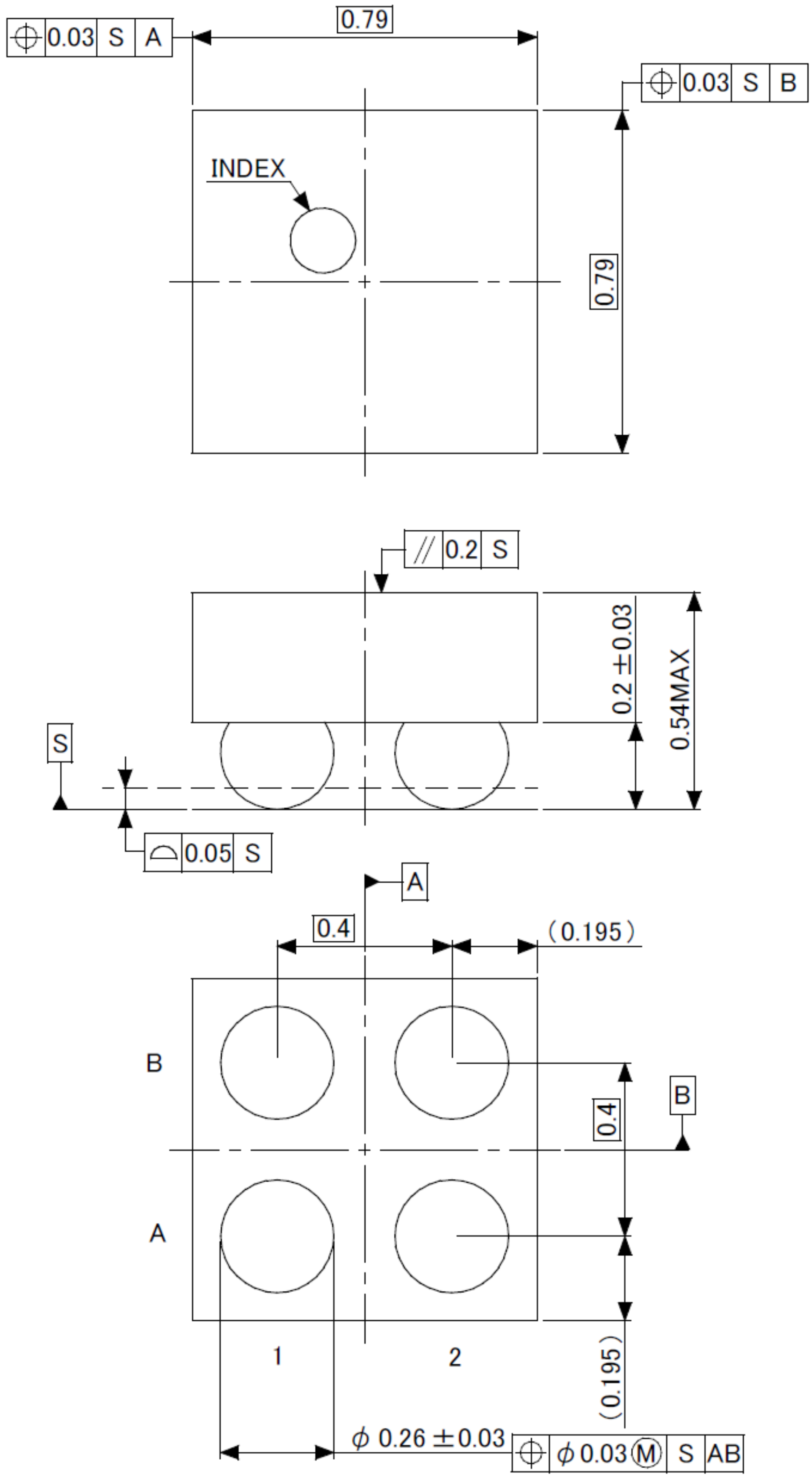
TCR4S30DWBG
(I_{OUT} = 50m to 100mA)



TCR4S30DWBG
(I_{OUT} = 100m to 50mA)



Package Dimensions **Unit: mm**



Weight: 0.7 mg (typ)

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