

# TCR5AM10A to TCR5AM18A

## 500 mA CMOS Ultra Low Drop-Out Voltage Regulator

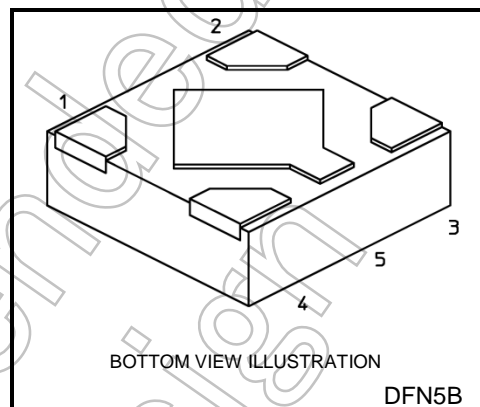
The TCR5AM10A to TCR5AM18A are CMOS single-output voltage regulators with an on/off control input, featuring Ultra low dropout voltage, low inrush current and fast load transient response.

A differentiating feature is the use of a secondary bias rail as a reference voltage that allows ultra-low drop-out of 90 mV (Typ.) at  $I_{OUT} = 300\text{ mA}$  ( 1.1 V output,  $V_{BAT} = 3.3\text{ V}$  ).

These voltage regulators are available in fixed output voltages between 1.0 V and 1.8 V, and capable of driving up to 500 mA. Other features include over-current protection, over-temperature protection, Under-voltage-lockout and Auto-discharge function.

The TCR5AM10A to TCR5AM18A are offered in the ultra small plastic mold package DFN5B (1.2 mm x 1.2 mm; t 0.38 mm).

As small ceramic input and output capacitors can be used with the TCR5AM10A to TCR5AM18A, these devices are ideal for portable applications that require high-density board assembly such as cellular phones.



Weight : 1.4 mg ( Typ. )

## Features

- Low Drop-Out voltage  
 $V_{IN}-V_{OUT} = 90\text{ mV}$  (Typ.) at 1.1 V output,  $V_{BAT} = 3.3\text{ V}$ ,  $I_{OUT} = 300\text{ mA}$
- Low stand-by current (  $I_{B(OFF)} = 2.0\text{ }\mu\text{A}$  (Max) at  $V_{BAT} = 5.5\text{ V}$ ,  $V_{CT} = 0\text{ V}$  )
- Low quiescent bias current (  $I_B = 38\text{ }\mu\text{A}$  (Typ.) at  $V_{BAT} = 4.2\text{ V}$ ,  $I_{OUT} = 0\text{ mA}$  )
- Wide range Output Voltage line up (  $V_{OUT} = 1.0\text{ to }1.8\text{ V}$  )
- Over-current protection
- Over-temperature protection
- Inrush current protection circuit
- Soft start function
- Under-voltage-lockout function
- Auto-discharge function
- Pull down connection between CONTROL and GND
- Ultra small package DFN5B (1.2 mm x 1.2 mm; t 0.38 mm )
- Stable with a 1.0  $\mu\text{F}$  Input capacitor, 1.0  $\mu\text{F}$  Bias capacitor and a 2.2  $\mu\text{F}$  output ceramic capacitor

Start of commercial production  
2016-07

## Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating		Unit
Bias voltage	V <sub>BAT</sub>	6.0		V
Input voltage	V <sub>IN</sub>	6.0		V
Control voltage	V <sub>CT</sub>	-0.3 to 6.0		V
Output voltage	V <sub>OUT</sub>	-0.3 to V <sub>IN</sub> + 0.3		V
Output current	I <sub>OUT</sub>	DC	500	mA
		Pulse	600 (Note 1)	
Power dissipation	P <sub>D</sub>	600 (Note 2)		mW
Operation temperature range	T <sub>opr</sub>	-40 to 85		°C
Junction temperature	T <sub>j</sub>	150		°C
Storage temperature range	T <sub>stg</sub>	-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: 100 ms pulse, 50% duty cycle

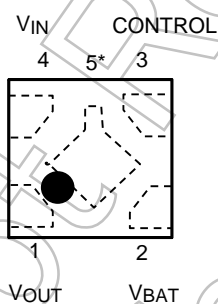
Note 2: Rating at mounting on a board

Glass epoxy (FR4) board dimension: 40 mm x 40 mm x 1.6 mm,

Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%

Through hole: diameter 0.5 mm x 24

## Pin Assignment (top view)



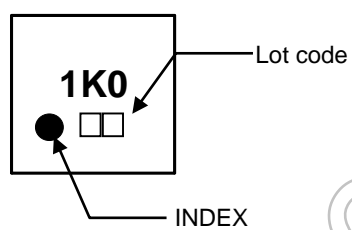
\*Center electrode is GND

**List of Products Number, Output voltage and Marking**

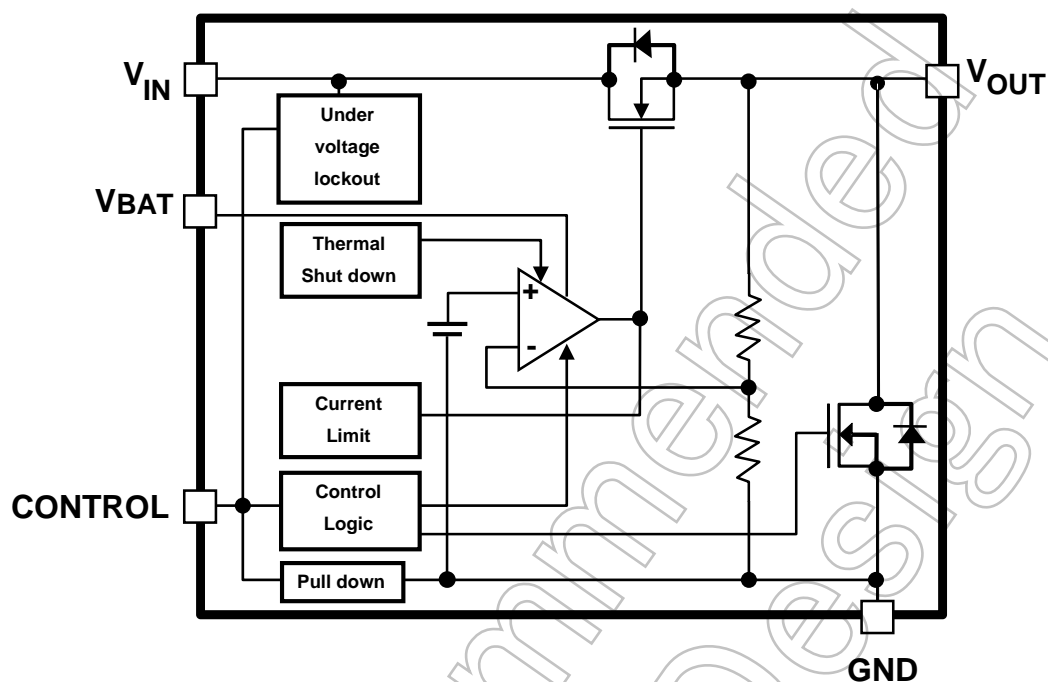
Product No.	V <sub>OUT</sub> (V)(typ.)	Marking
TCR5AM10A	1.0	1K0
TCR5AM105A	1.05	1KA
TCR5AM11A	1.1	1K1
TCR5AM12A	1.2	1K2
TCR5AM18A	1.8	1K8

**Top Marking (top view)**

Example: TCR5AM10A (1.0 V output)



## Block Diagram



## Electrical Characteristics

(Unless otherwise specified,  $V_{IN} = V_{OUT} + 0.5 \text{ V}$ ,  $I_{OUT} = 50 \text{ mA}$ ,  $C_{IN} = C_{BAT} = 1.0 \mu\text{F}$ ,  $C_{OUT} = 2.2 \mu\text{F}$ )

Characteristics	Symbol	Test Condition	$T_j = 25^\circ\text{C}$			$T_j = -40 \text{ to } 85^\circ\text{C}$ (Note 7)		Unit
			Min	Typ.	Max	Min	Max	
Output voltage accuracy	$V_{OUT}$	$I_{OUT} = 50 \text{ mA}$ (Note 3)	$V_{OUT} < 1.8 \text{ V}$	-18	—	+18	—	mV
			$1.8 \text{ V} \leq V_{OUT}$	-1.0	—	+1.0	—	%
Bias voltage	$V_{BAT}$	$V_{OUT} \leq 1.1 \text{ V}$ , $I_{OUT} = 1 \text{ mA}$		2.5	—	5.5	2.5	V
		$V_{OUT} > 1.1 \text{ V}$ , $I_{OUT} = 1 \text{ mA}$		$V_{OUT} + 1.4 \text{ V}$	—	5.5	$V_{OUT} + 1.4 \text{ V}$	V
Input voltage	$V_{IN}$	$I_{OUT} = 1 \text{ mA}$ ,		$V_{OUT} + 0.1 \text{ V}$	—	$V_{BAT}$	$V_{OUT} + 0.1 \text{ V}$	V
Line regulation	Reg·line	$V_{OUT} + 0.5 \text{ V} \leq V_{IN} \leq 5.5 \text{ V}$ , $I_{OUT} = 1 \text{ mA}$		—	1	15	—	mV
Load regulation	Reg·load	$1 \text{ mA} \leq I_{OUT} \leq 500 \text{ mA}$		—	15	70	—	mV
Quiescent current	$I_B$	$I_{OUT} = 0 \text{ mA}$ , $V_{BAT} = 4.2 \text{ V}$ (Note 4)		—	38	—	55	$\mu\text{A}$
Stand-by current	$I_B$ (OFF)	$V_{CT} = 0 \text{ V}$ , $V_{BAT} = 5.5 \text{ V}$		—	0.1	—	2.0	$\mu\text{A}$
Control pull down current	$I_{CT}$	—		—	0.1	—	—	$\mu\text{A}$
Drop-out voltage	$V_{IN}-V_{OUT}$	$I_{OUT} = 300 \text{ mA}$ , $V_{BAT} = 3.3 \text{ V}$ (Note 5)(Note 6)		—	90	—	150	mV
Under voltage lockout	$V_{UVLO}$	$V_{IN}$ voltage		—	0.5	—	0.65	V
Temperature coefficient	$T_{CVO}$	$-40^\circ\text{C} \leq T_{opr} \leq 85^\circ\text{C}$		—	60	—	—	ppm/ $^\circ\text{C}$
Output noise voltage	$V_{NO}$	$V_{BAT} = 2.5 \text{ V}$ , $V_{IN} = V_{OUT} + 1 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$ , $10 \text{ Hz} \leq f \leq 100 \text{ kHz}$ , $T_a = 25^\circ\text{C}$ (Note 5)		—	69	—	—	$\mu\text{V}_{rms}$
Ripple rejection ratio	R.R.	$V_{BAT} = 5.5 \text{ V}$ , $V_{IN} = V_{OUT} + 1 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$ , $f = 1 \text{ kHz}$ , $V_{IN}$ Ripple = $200 \text{ mV}_{p-p}$ , $T_a = 25^\circ\text{C}$ (Note 5)		—	90	—	—	dB
Control voltage (ON)	$V_{CT}$ (ON)	—		1.0	—	5.5	1.0	V
Control voltage (OFF)	$V_{CT}$ (OFF)	—		0	—	0.4	0	V
Output discharge on resistance	$R_{SD}$	—		—	20	—	—	$\Omega$

Note 3: Stable state with fixed  $I_{OUT}$  condition

Note 4: Except Control pull down current

Note 5: The 1.0 V output product.

Note 6:  $V_{IN}-V_{OUT} = V_{IN1} - (V_{OUT1} \times 0.98)$

$V_{OUT1}$  is the output voltage when  $V_{IN} = V_{OUT} + 0.5 \text{ V}$ .

$V_{IN1}$  is the input voltage at which the output voltage becomes 98% of  $V_{OUT1}$  after gradually decreasing the input voltage.

Note 7: This parameter is guaranteed by design.

**Drop-out voltage**

 (  $C_{IN} = 1.0 \mu F$ ,  $C_{OUT} = 2.2 \mu F$ ,  $C_{BAT} = 1.0 \mu F$ ,  $T_j = 25^\circ C$  )

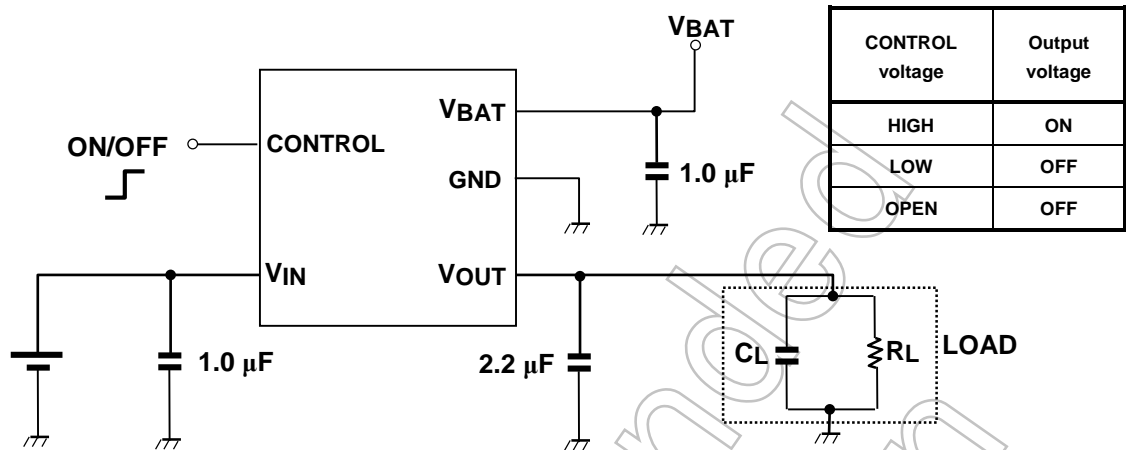
Output voltages	$V_{BAT}$ input voltage	$I_{OUT} = 300 \text{ mA}$			$I_{OUT} = 500 \text{ mA}$			Unit
		Min	Typ.	Max (Note 10)	Min	Typ.	Max (Note 10)	
$1.0 \text{ V} \leq V_{OUT} < 1.2 \text{ V}$	3.3 V	—	90	150	—	150	250	mV
$1.2 \text{ V} \leq V_{OUT} < 1.3 \text{ V}$	3.3 V	—	140	170	—	230	270	mV
1.8 V	3.5 V	—	190	250	—	330	430	mV

 Note 10:  $T_j = -40$  to  $85^\circ C$ . This parameter is guaranteed by design.

Not Recommended for New Design

Application Note

1. Recommended Application Circuit



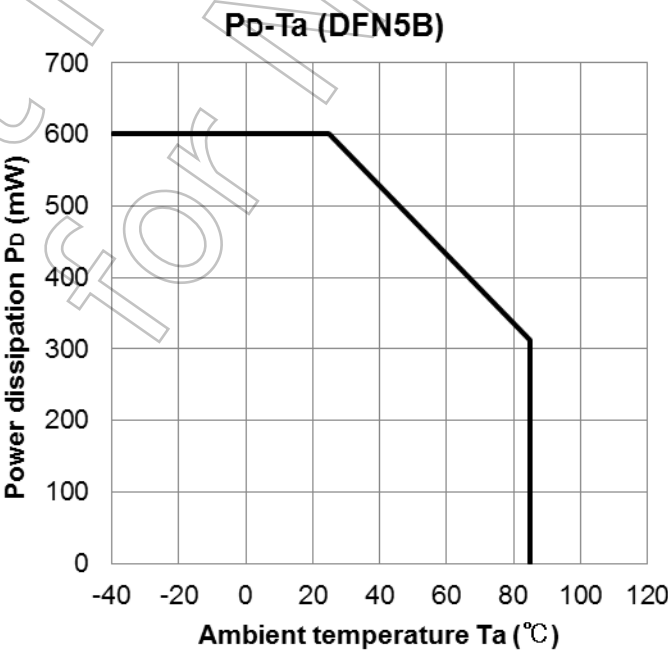
The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at VIN, VOUT and VBAT pins for stable input/output operation. (Ceramic capacitors can be used).

2. Power Dissipation

Board-mounted power dissipation ratings for TCR5AM10A to TCR5AM18A are available in the Absolute Maximum Ratings table.

Power dissipation is measured on the board condition shown below.

- [The Board Condition]
- Board material: Glass epoxy (FR4)
  - Board dimension: 40 mm x 40 mm, t = 1.6 mm
  - Metal pattern ratio: a surface approximately 50%, the reverse side approximately 50%
  - Through hole: diameter 0.5 mm x 24



**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  $\Omega$ . For stable operation, please use over 1.0  $\mu\text{F}$  Input capacitor, 1.0  $\mu\text{F}$  Bias capacitor and 2.2  $\mu\text{F}$  output ceramic capacitor.

● **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 VIN and GND pattern need to be large and make the wire impedance small as possible.

● **Permissible Loss**

Please have enough design patterns for expected maximum permissible loss. And under consideration of surrounding temperature, input voltage, and output current etc, we recommend proper dissipation ratings for maximum permissible loss; in general maximum dissipation rating is 70 to 80 percent.

● **Over current Protection and Thermal shut down function**

Over current protection and Thermal shut down function are designed in these products, but these are not designed to constantly ensure the suppression of the device within operation limits. Depending on the condition during actual usage, it could affect the electrical characteristic specification and reliability. Also note that if output pins and GND pins are not completely shorted out, these products might be break down.

When using these products, please read through and understand the concept of dissipation 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.

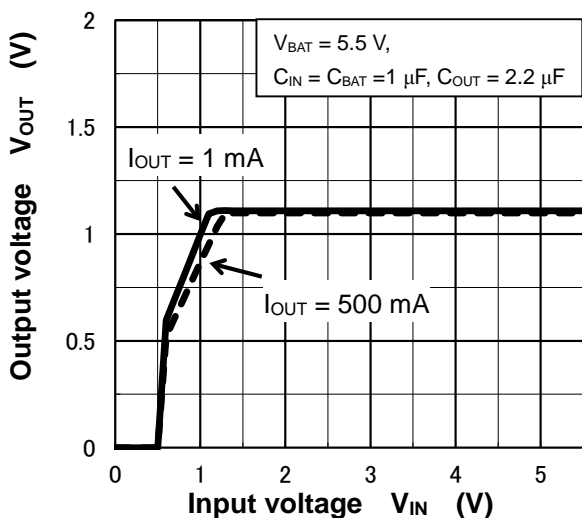
Not Recommended for New Design



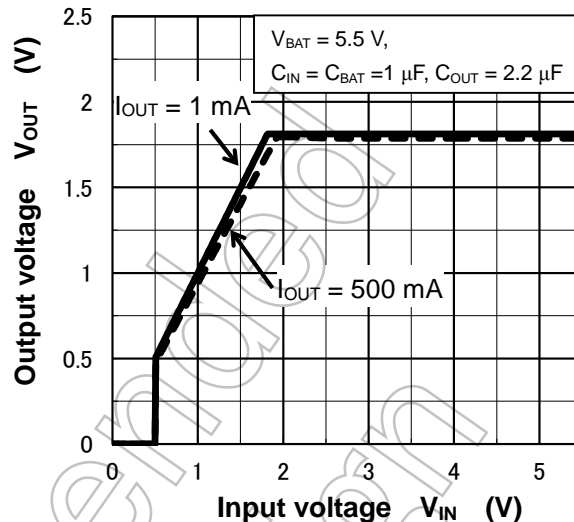
## Representative Typical Characteristics

### Output Voltage vs. Input Voltage

$V_{OUT} = 1.1 \text{ V}$

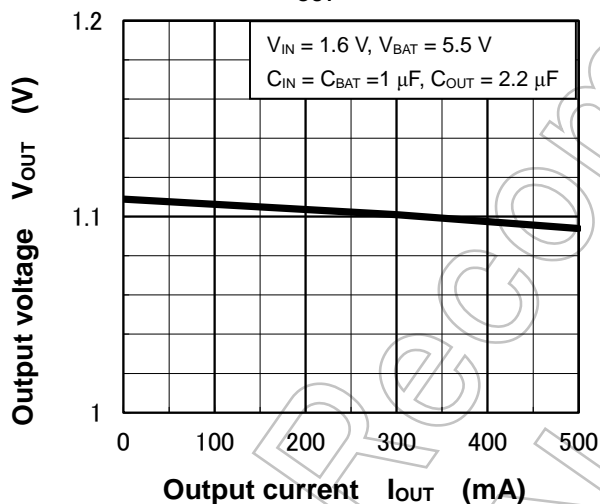


$V_{OUT} = 1.8 \text{ V}$

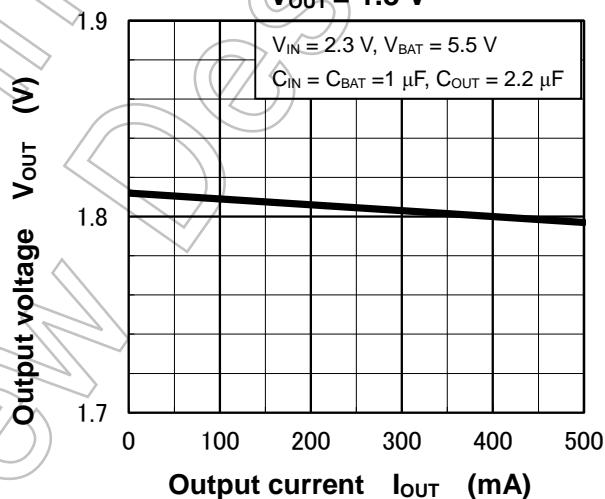


### Output Voltage vs. Output Current

$V_{OUT} = 1.1 \text{ V}$

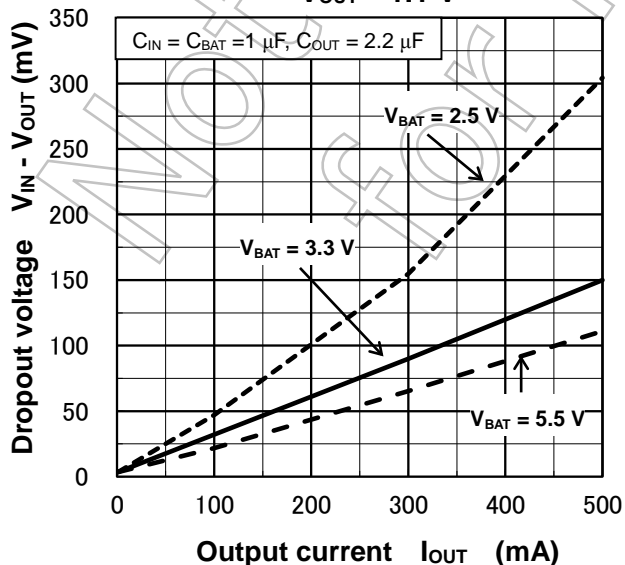


$V_{OUT} = 1.8 \text{ V}$

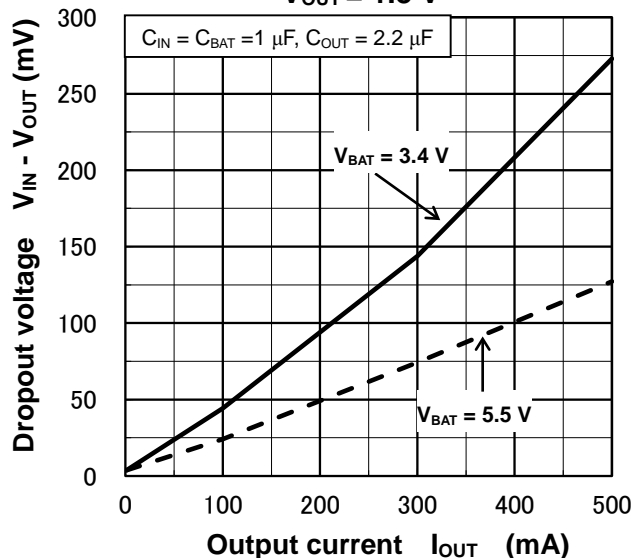


### Dropout Voltage vs. Output Current

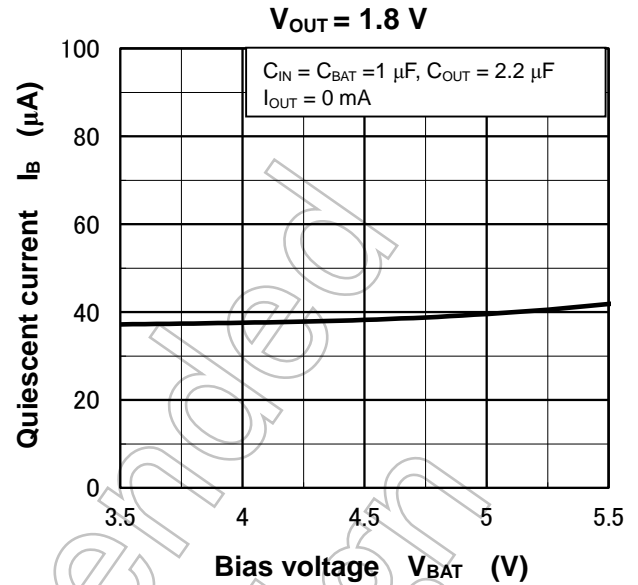
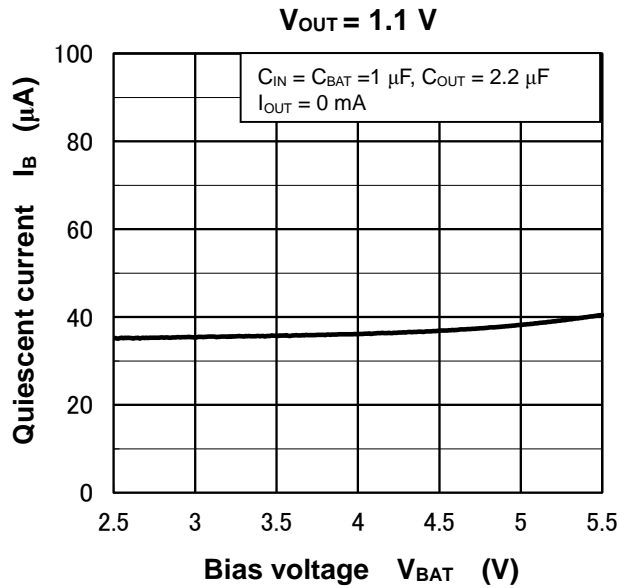
$V_{OUT} = 1.1 \text{ V}$



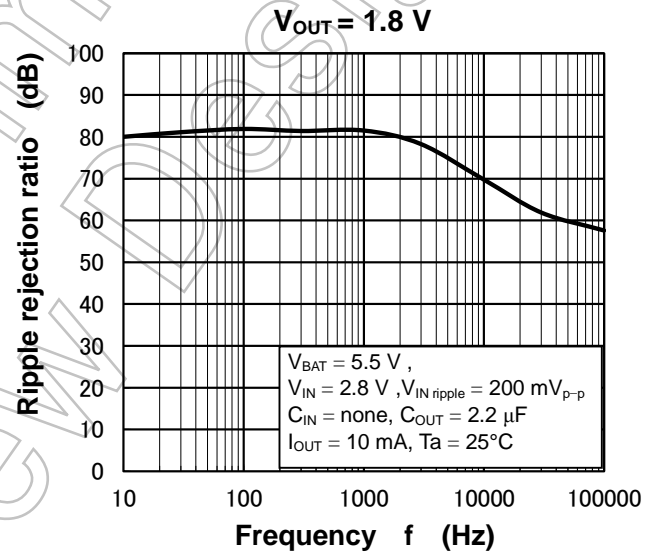
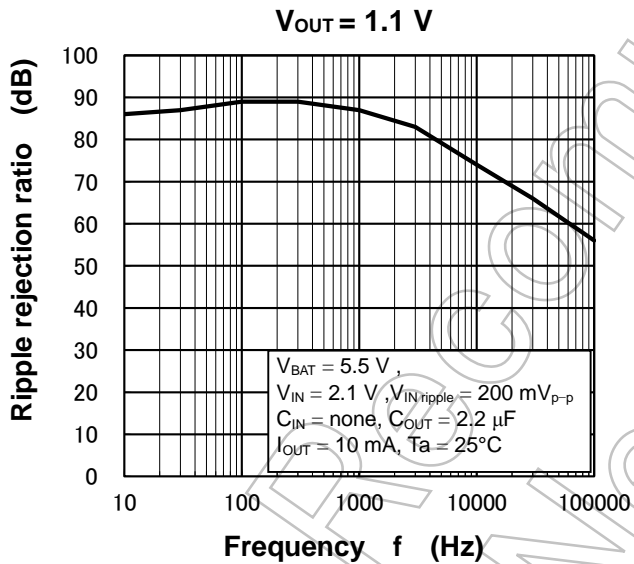
$V_{OUT} = 1.8 \text{ V}$



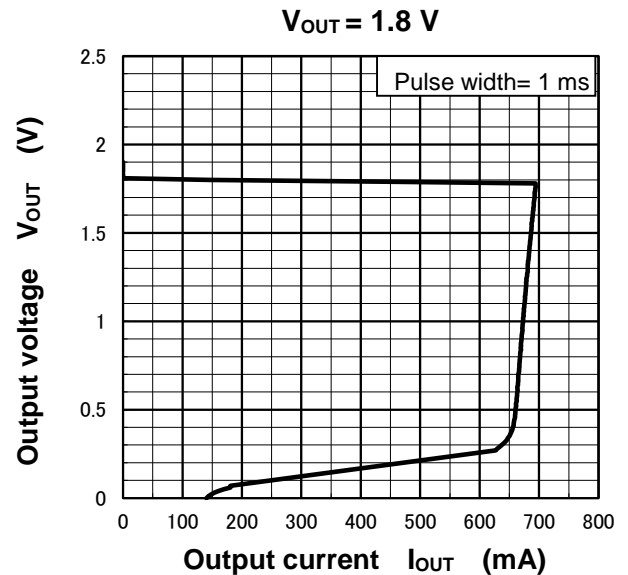
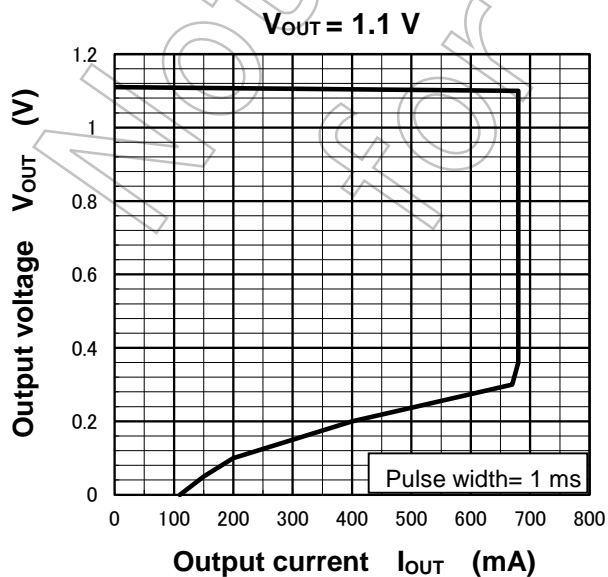
## Quiescent Current vs. Input Voltage



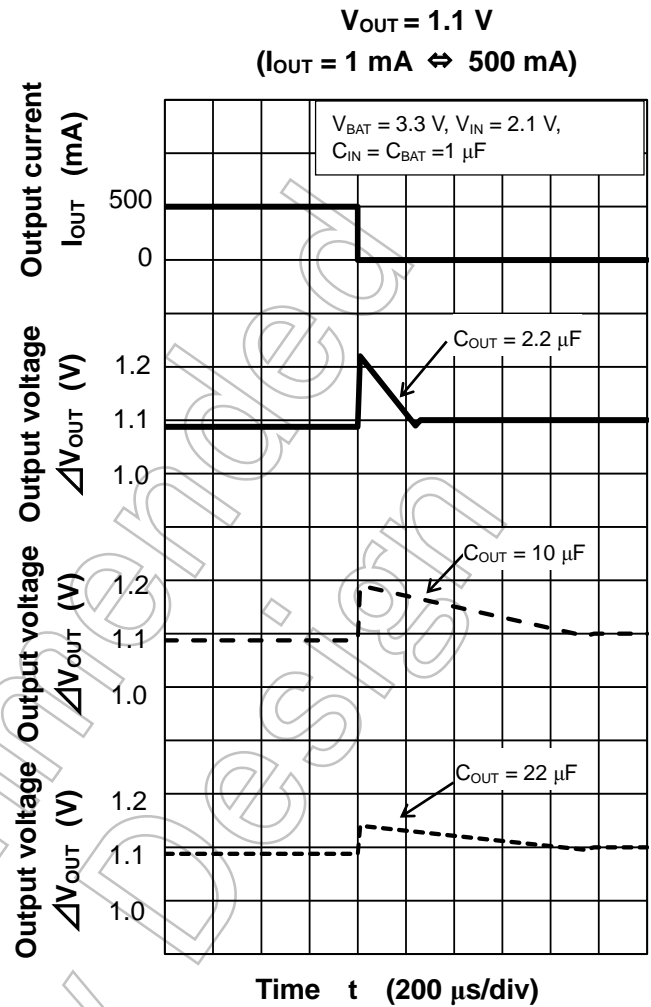
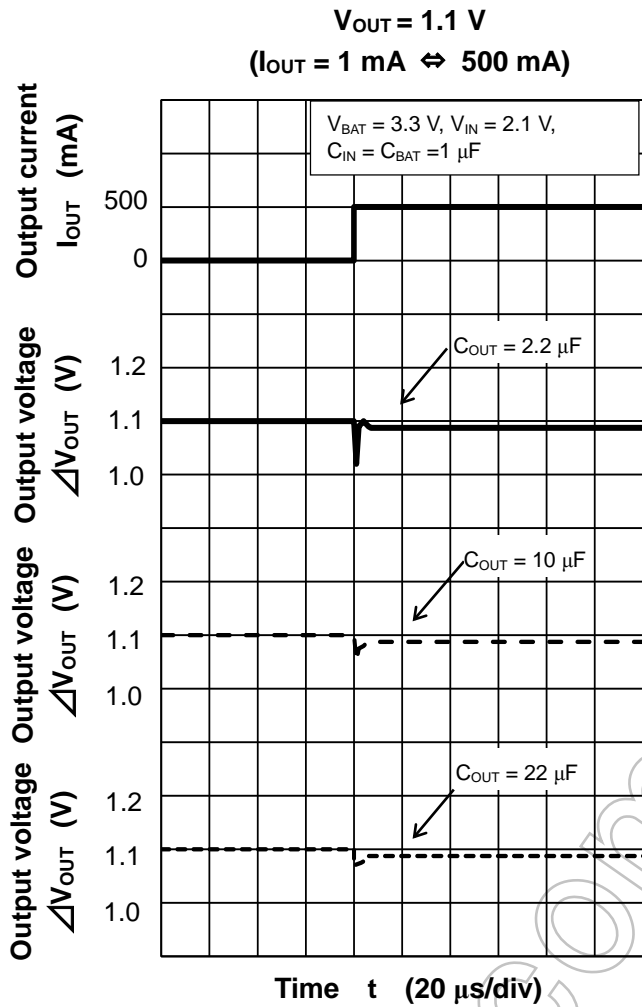
## Ripple Rejection Ratio vs. Frequency



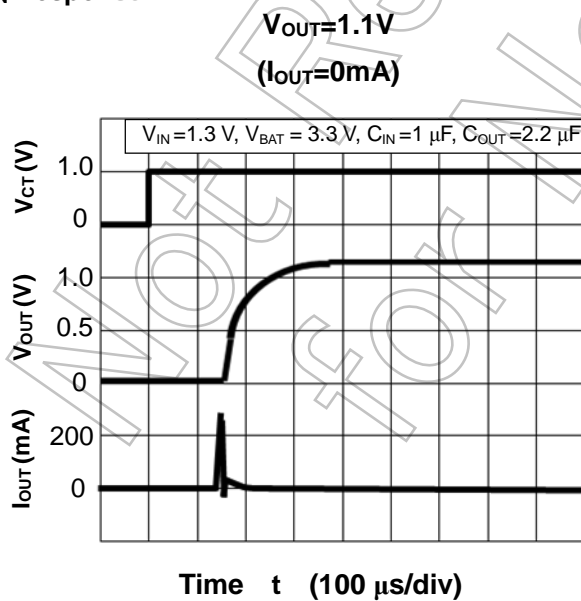
## Output Voltage vs. Output Current



## Load Transient Response



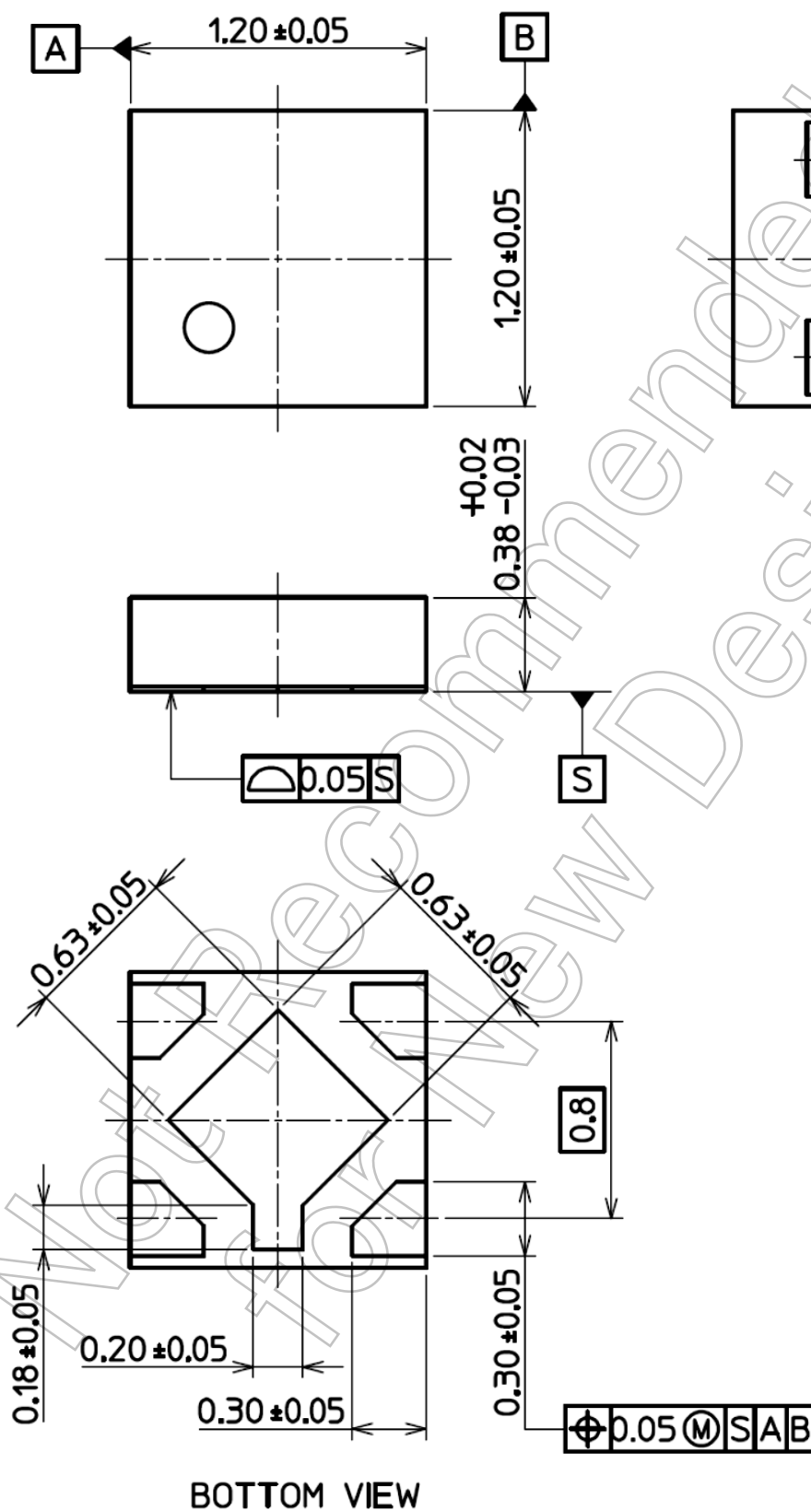
## $t_{ON}$ Response



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

## DFN5B

Unit: mm

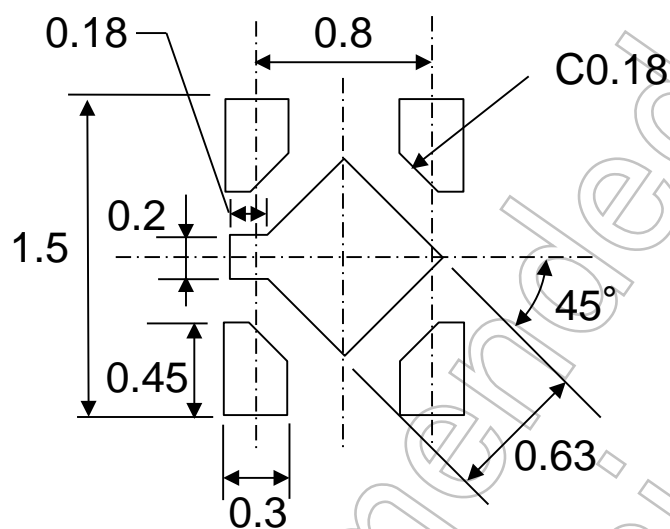


Weight : 1.4 mg ( Typ.)

## Land pattern dimensions for reference only

DFN5B

Unit: mm



Not Recommended for New Design

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