TOSHIBA CMOS Linear Integrated Circuit Silicon Monolithic

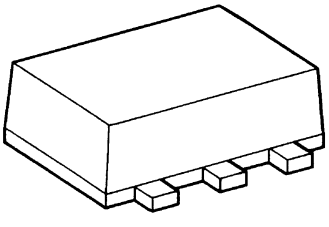
# TCR5SC15FE～TCR5SC36FE

## 150 mA CMOS Low-Dropout Regulator (Point regulator)

The TCR5SC15FE to TCR5SC36FE are CMOS general-purpose single-output voltage regulators with an on/off control input, featuring low dropout voltage and low quiescent bias current. The TCR5SC15FE to TCR5SC36FE can be enabled and disabled via the CONTROL pin.

These voltage regulators are available in fixed output voltages between 1.5 V and 3.6 V in 0.1-V steps and capable of driving up to 150 mA. They feature overcurrent protection.

The TCR5SC15FE to TCR5SC36FE are offered in the compact ESV (SOT-553) 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.



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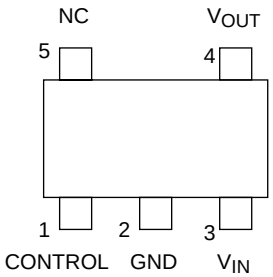
(ESV)

Weight: 0.003 g (typ.)

### Features

- Low quiescent bias current ( $I_B$ = 32 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 TCR5SC25FE, $I_{OUT}$ = 50 mA )
- High ripple rejection ratio ( R.R = 70 dB (typ) at $I_{OUT}$ = 10 mA, f =1kHz )
- Control voltage can be allowed from -0.3 to 6 V regardless of $V_{IN}$ voltage.
- Overcurrent protection
- Ceramic capacitors can be used ( $C_{IN}$ = 0.1μF, $C_{OUT}$ =1.0 μF )
- Wide range voltage listing (Please see Output Voltage Accuracy at page 4 for variety of the output voltage )
- Small package, ESV (SOT-553)

### Pin Assignment (top view)

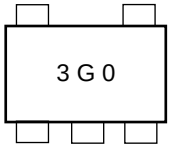


## List of Products Number and Marking

| Products No. | Marking | Products No. | Marking |
|---|---|---|---|
| TCR5SC15FE | 1G5 | TCR5SC26FE | 2G6 |
| TCR5SC16FE | 1G6 | TCR5SC27FE | 2G7 |
| TCR5SC17FE | 1G7 | TCR5SC28FE | 2G8 |
| TCR5SC18FE | 1G8 | TCR5SC29FE | 2G9 |
| TCR5SC19FE | 1G9 | TCR5SC30FE | 3G0 |
| TCR5SC20FE | 2G0 | TCR5SC31FE | 3G1 |
| TCR5SC21FE | 2G1 | TCR5SC32FE | 3G2 |
| TCR5SC22FE | 2G2 | TCR5SC33FE | 3G3 |
| TCR5SC23FE | 2G3 | TCR5SC34FE | 3G4 |
| TCR5SC24FE | 2G4 | TCR5SC35FE | 3G5 |
| TCR5SC25FE | 2G5 | TCR5SC36FE | 3G6 |

## Marking

Example: TCR5SC30FE (3.0 V output)




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

| Characteristics | Symbol | Rating | | Unit |
|---|---|---|---|---|
| Input voltage | $V_{IN}$ | 6 | | V |
| Control voltage | $V_{CT}$ | -0.3 to 6 | | V |
| Output voltage | $V_{OUT}$ | -0.3 to $V_{IN}$ + 0.3 | | V |
| Output current | $I_{OUT}$ | 150 | | mA |
| Power dissipation | $P_D$ | 150 | (Note1) | mW |
| | | 320 | (Note2) | |
| 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: Unit Ratintg

Note 2: Rating at mounting on a board
(Glass epoxy board dimension : 30 mm × 30 mm, Copper pad area : 20 $mm^2$)

## 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)

| 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 | | — | 1 | 15 | mV |
| Load regulation | Reg·load | 1 mA ≤ $I_{OUT}$ ≤ 100 mA | | — | 15 | 30 | mV |
| Quiescent current | $I_B$ | $I_{OUT}$ = 0 mA | | — | 32 | 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 |
| Input voltage | $V_{IN}$ | — | TCR5SC15FE | 2.0 | — | 6.0 | V |
| | | | TCR5SC16FE to TCR5SC17FE | 2.1 | — | 6.0 | |
| | | | TCR5SC18FE to TCR5SC19FE | $V_{OUT}$ + 0.35 V | — | 6.0 | |
| | | | TCR5SC20FE to TCR5SC21FE | $V_{OUT}$ + 0.28 V | — | 6.0 | |
| | | | TCR5SC22FE to TCR5SC24FE | $V_{OUT}$ + 0.25 V | — | 6.0 | |
| | | | TCR5SC25FE to TCR5SC36FE | $V_{OUT}$ + 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 $mV_{p-p}$, Ta = 25°C | | — | 70 | — | dB |
| Control voltage (ON) | $V_{CT\ (ON)}$ | — | | 1.1 | — | 6.0 | V |
| Control voltage (OFF) | $V_{CT\ (OFF)}$ | — | | 0 | — | 0.3 | V |
| Control current (ON) | $I_{CT\ (ON)}$ | $V_{CT}$ = 6.0 V | | — | — | 0.1 | μA |
| Control current (OFF) | $I_{CT\ (OFF)}$ | $V_{CT}$ = 0 V | | — | — | 0.1 | μA |

## 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 |
|---|---|---|---|---|---|
| TCR5SC15FE | $V_{OUT}$ | 1.47 | 1.5 | 1.53 | V |
| TCR5SC16FE | | 1.56 | 1.6 | 1.64 | |
| TCR5SC17FE | | 1.66 | 1.7 | 1.74 | |
| TCR5SC18FE | | 1.76 | 1.8 | 1.84 | |
| TCR5SC19FE | | 1.86 | 1.9 | 1.94 | |
| TCR5SC20FE | | 1.96 | 2.0 | 2.04 | |
| TCR5SC21FE | | 2.05 | 2.1 | 2.15 | |
| TCR5SC22FE | | 2.15 | 2.2 | 2.25 | |
| TCR5SC23FE | | 2.25 | 2.3 | 2.35 | |
| TCR5SC24FE | | 2.35 | 2.4 | 2.45 | |
| TCR5SC25FE | | 2.45 | 2.5 | 2.55 | |
| TCR5SC26FE | | 2.54 | 2.6 | 2.66 | |
| TCR5SC27FE | | 2.64 | 2.7 | 2.76 | |
| TCR5SC28FE | | 2.74 | 2.8 | 2.86 | |
| TCR5SC29FE | | 2.84 | 2.9 | 2.96 | |
| TCR5SC30FE | | 2.94 | 3.0 | 3.06 | |
| TCR5SC31FE | | 3.03 | 3.1 | 3.17 | |
| TCR5SC32FE | | 3.13 | 3.2 | 3.27 | |
| TCR5SC33FE | | 3.23 | 3.3 | 3.37 | |
| TCR5SC34FE | | 3.33 | 3.4 | 3.47 | |
| TCR5SC35FE | | 3.43 | 3.5 | 3.57 | |
| TCR5SC36FE | | 3.52 | 3.6 | 3.68 | |

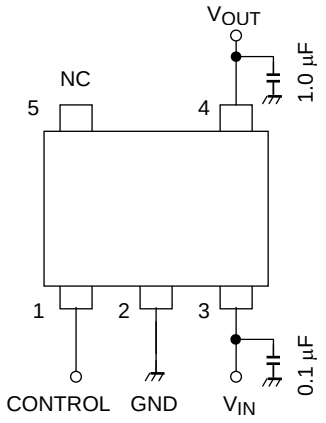
## Dropout Voltage

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

| Product No. | Symbol | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|
| TCR5SC15FE to TCR5SC16FE | $V_{IN}$ - $V_{OUT}$ | — | 300 | 500 | mV |
| TCR5SC17FE | | — | 250 | 400 | |
| TCR5SC18FE to TCR5SC19FE | | — | 200 | 350 | |
| TCR5SC20FE to TCR5SC21FE | | — | 150 | 280 | |
| TCR5SC22FE to TCR5SC24FE | | — | 130 | 250 | |
| TCR5SC25FE to TCR5SC36FE | | — | 90 | 200 | |

## Application Note

### 1. Recommended Application Circuit




| Control Level | Operation |
|---|---|
| HIGH | ON |
| LOW | OFF |

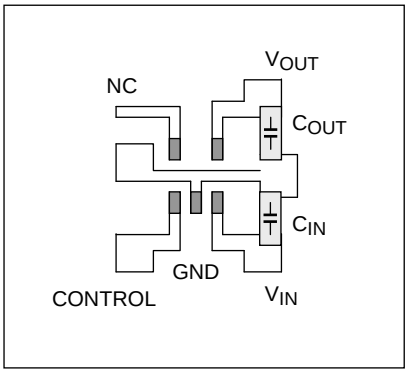
The figure above shows the recommended configuration for using a Low-Dropout regulator. Insert a capacitor at $V_{OUT}$ and $V_{IN}$ pins for stable input/output operation. (Ceramic capacitors can be used)

If the control function is not used, Toshiba recommend that the control pin is connected to the $V_{IN}$ pin.

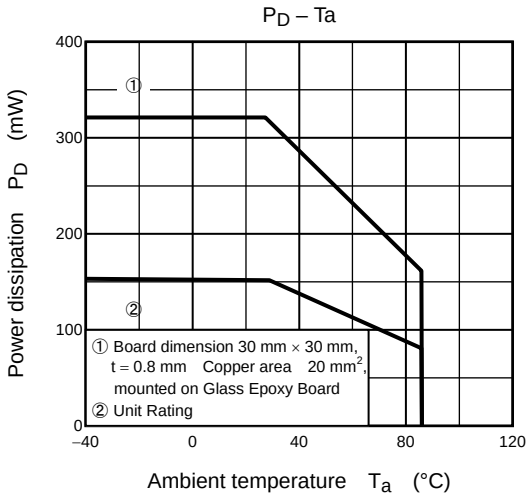
### 2. Power Dissipation

Power dissipation is measured on the board shown below.

## Testing Board of Thermal Resistance




Board material: Glass Epoxy, Board dimension 30 mm × 30 mm
Copper area: 20 $mm^2$, t = 0.8 mm



## 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 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.

- Overcurrent Protection Circuit

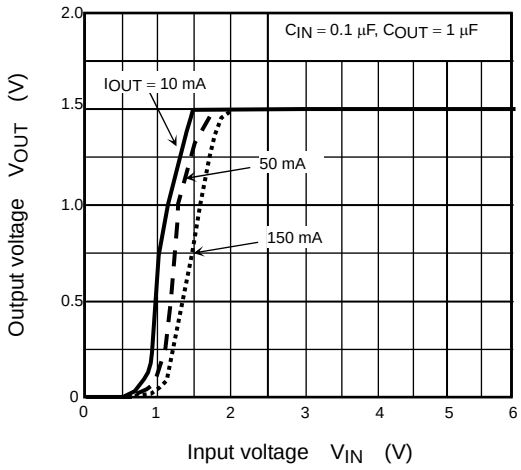
  Overcurrent protection circuit is designed in these products, but this does not assure for the suppression of uprising device operation. If output pins and GND pins are shorted out, these products might be break down.

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.

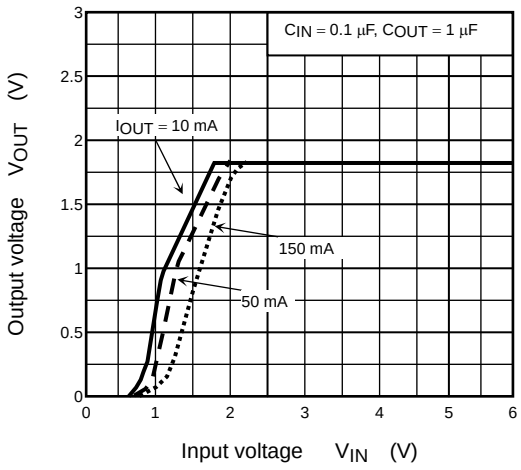
## Representative Typical Characteristics

1) Output Voltage vs. Input Voltage

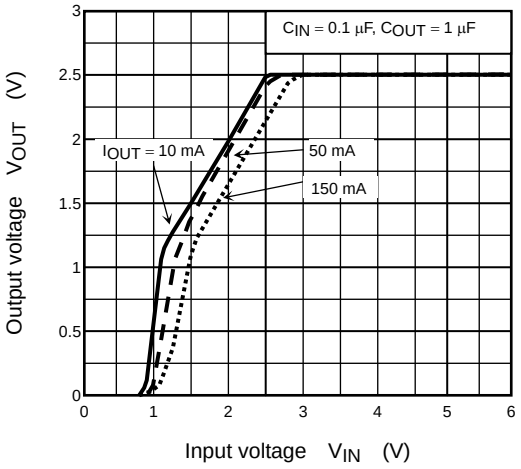
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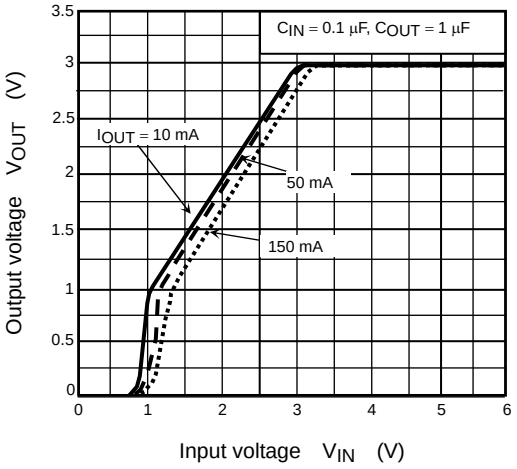

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TCR5SC25FE

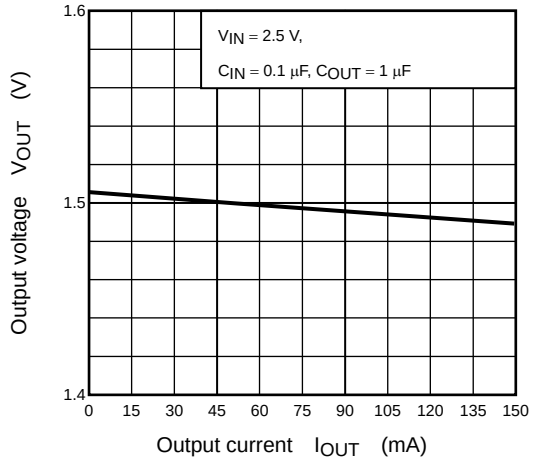



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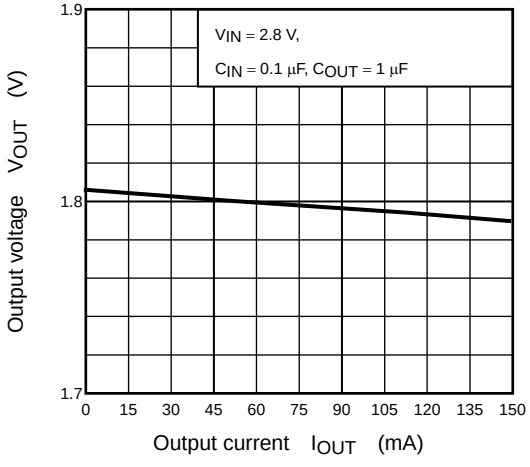



2) Output Voltage vs. Output Current

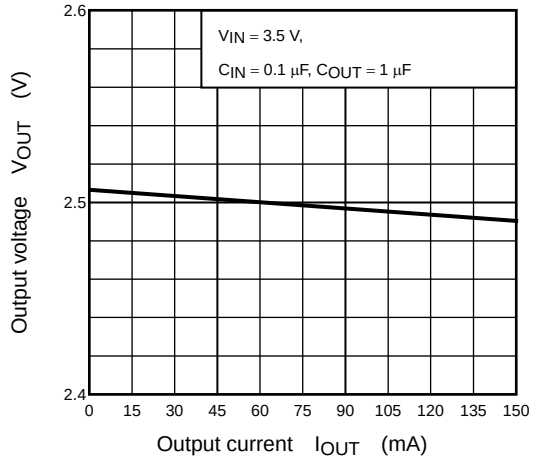
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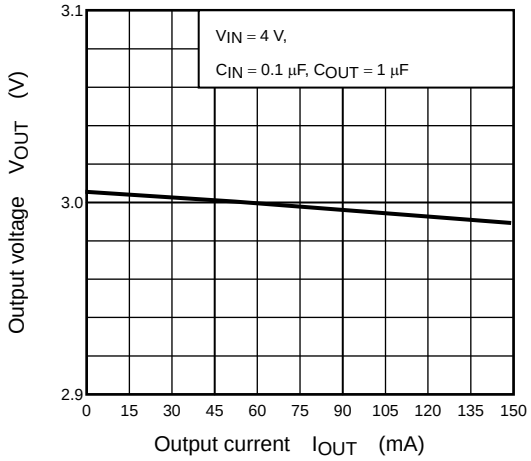

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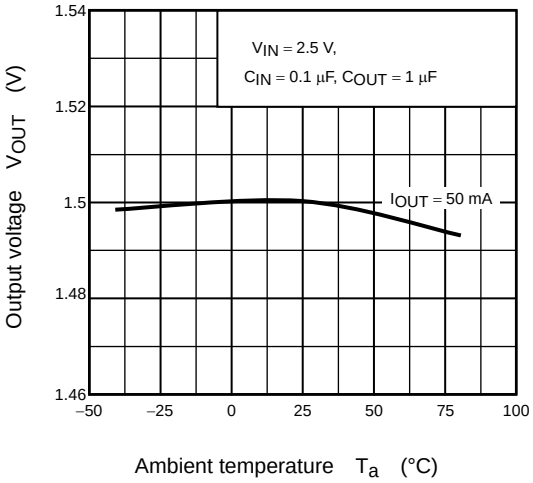



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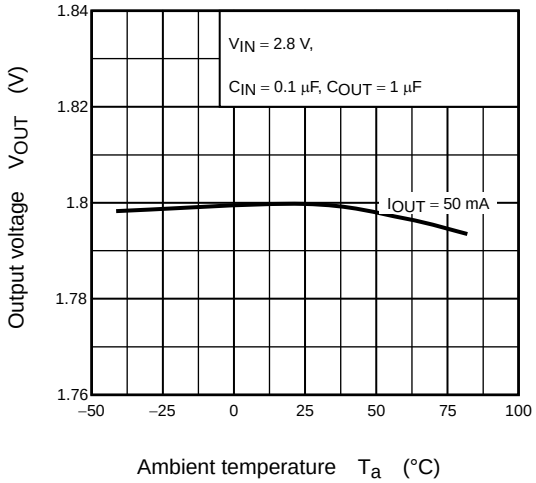



3）Output Voltage vs. Ambient temperature

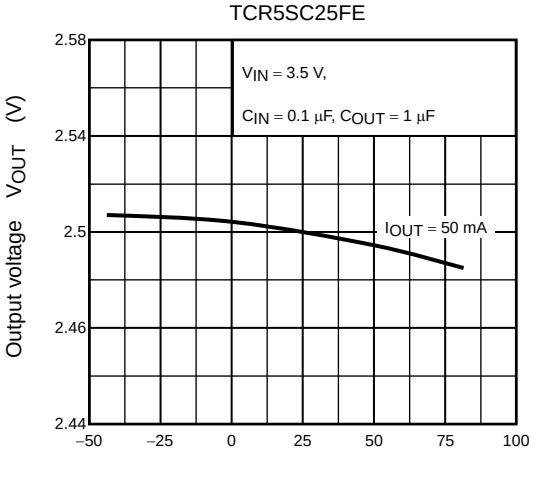
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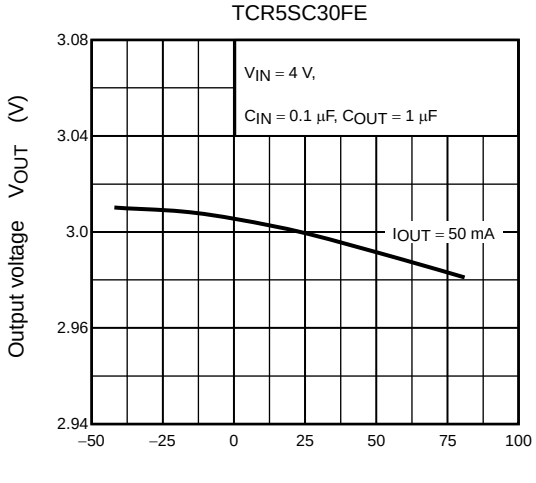

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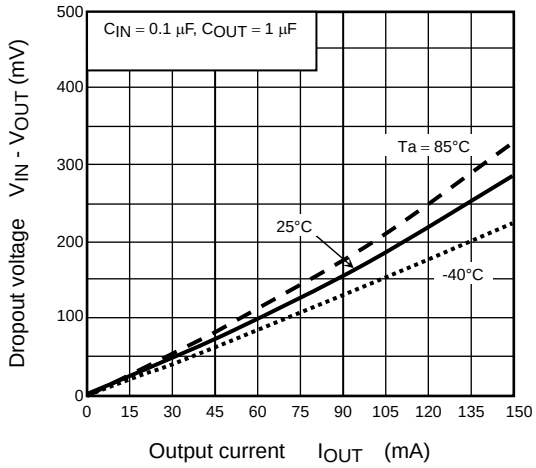



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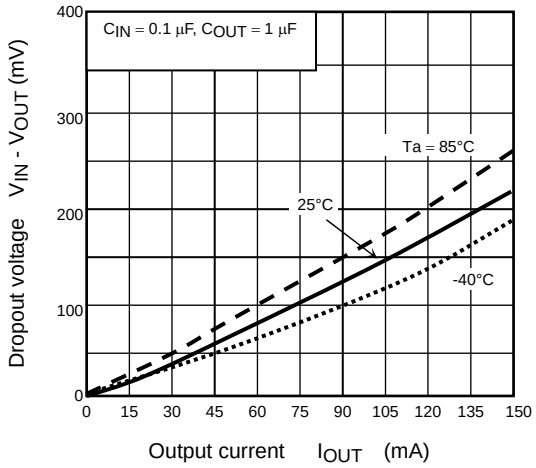


4) Dropout Voltage vs. Output Current

TCR5SC25FE

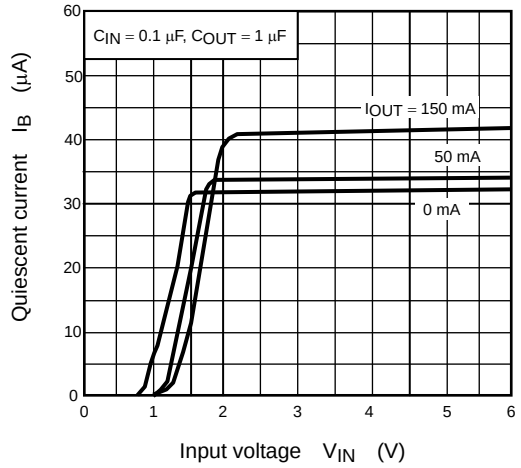



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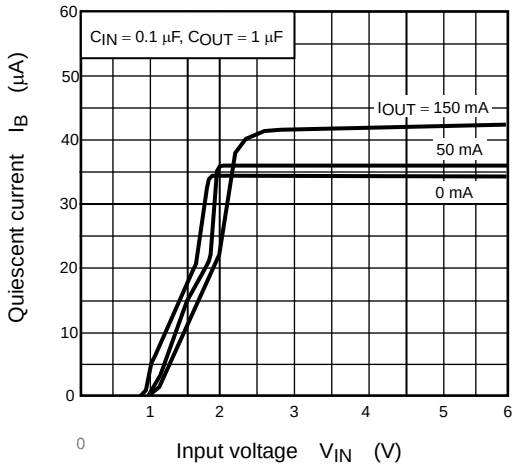



5) Quiessrnt Current vs. InputVoltage

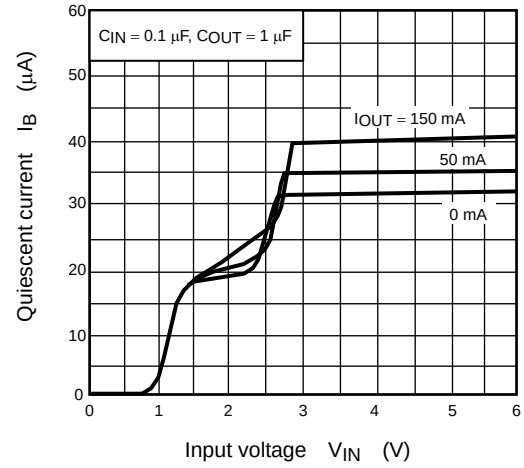
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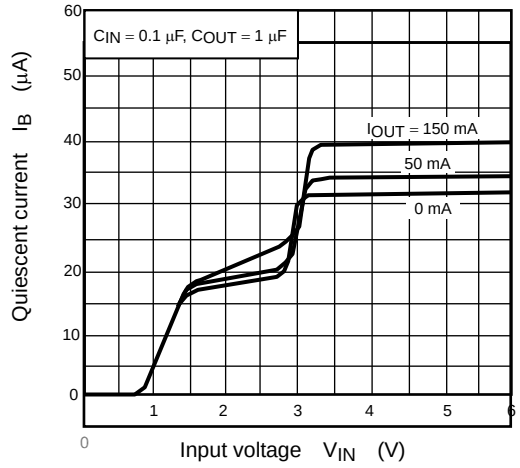

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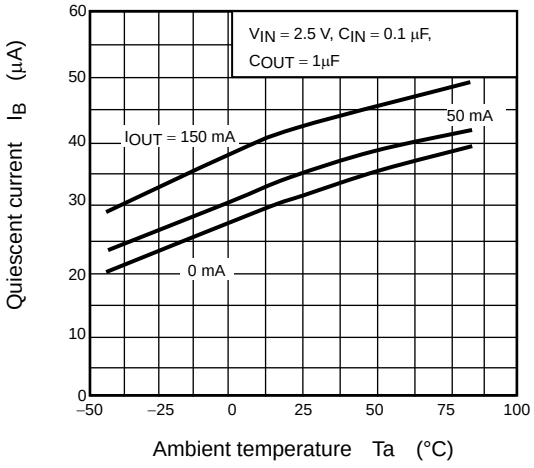



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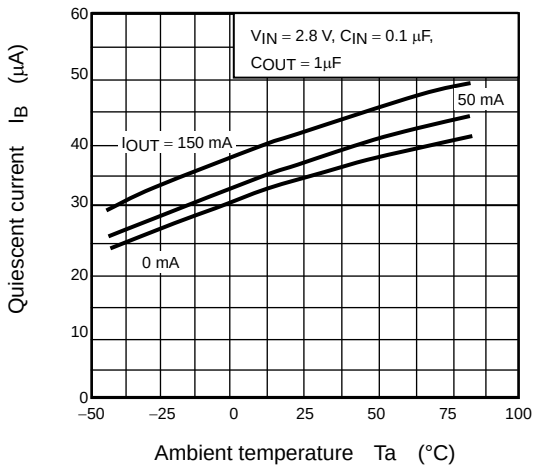


6) Quiessrnt Current vs. Ambient temperature

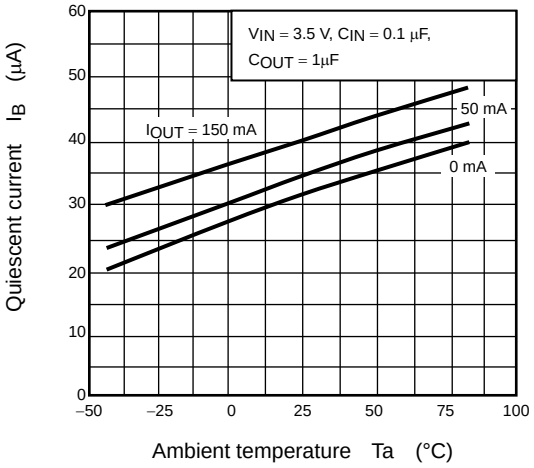
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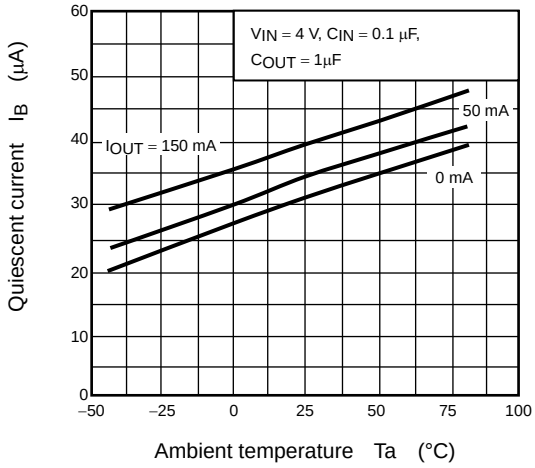

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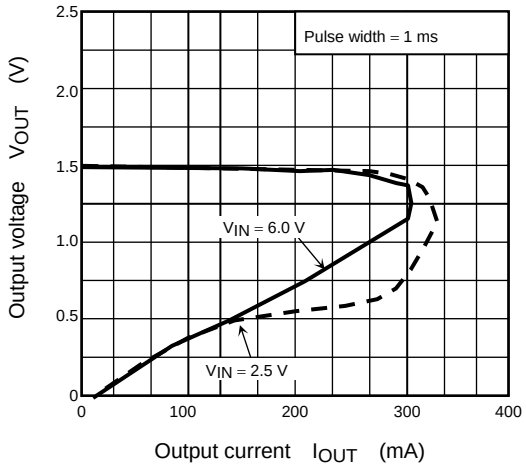



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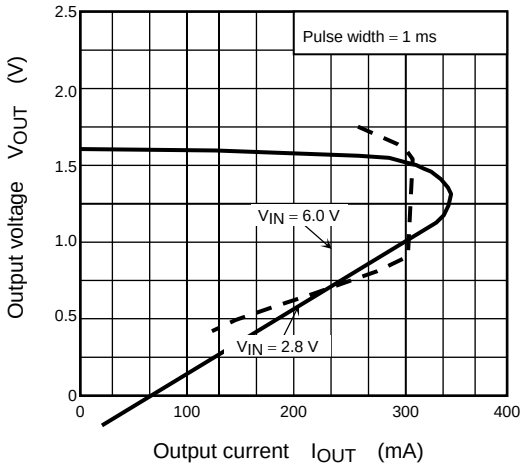


7) Overcurrent Protection Characteristics

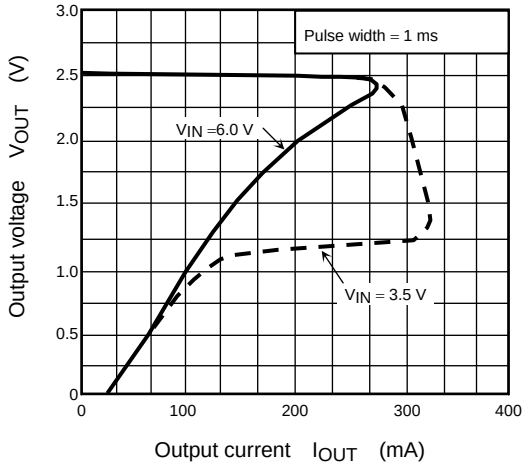
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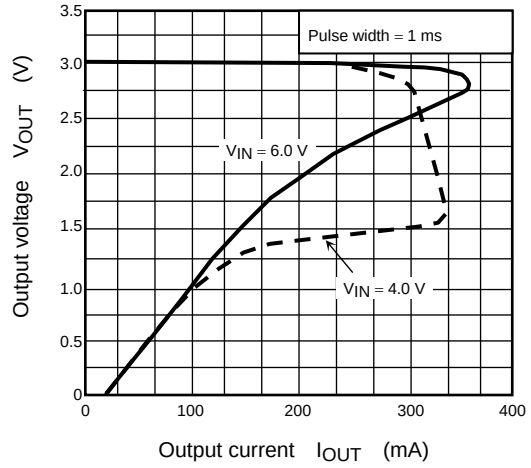

TCR5SC18FE




TCR5SC25FE

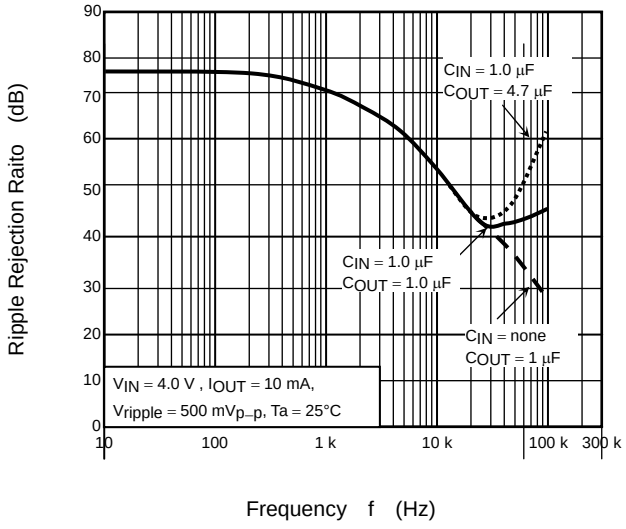



TCR5SC30FE



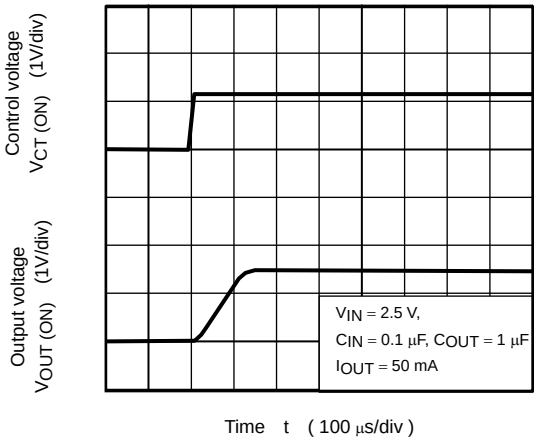

8) Ripple rejection Raito vs. Frequency（Dependence of Capacitors）

TCR5SC30FE

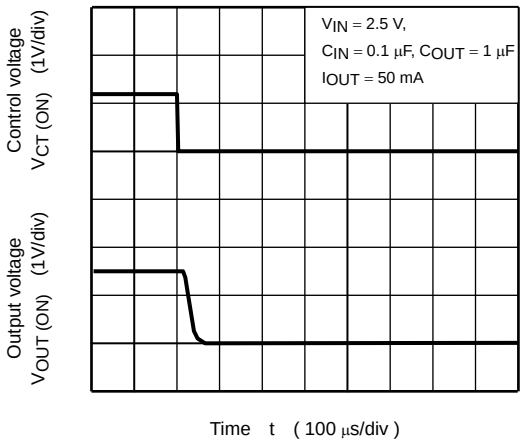


10) Control Transient Response

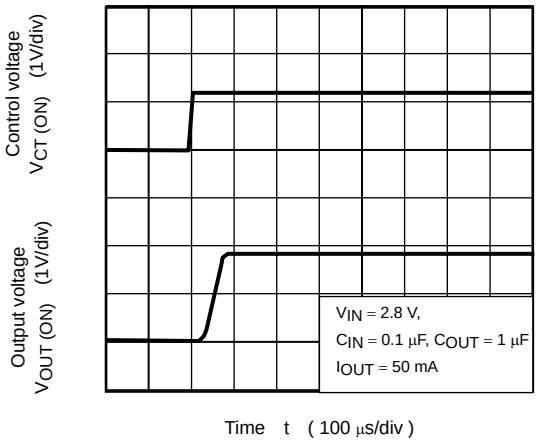
TCR5SC15FE (Turn on wave form)



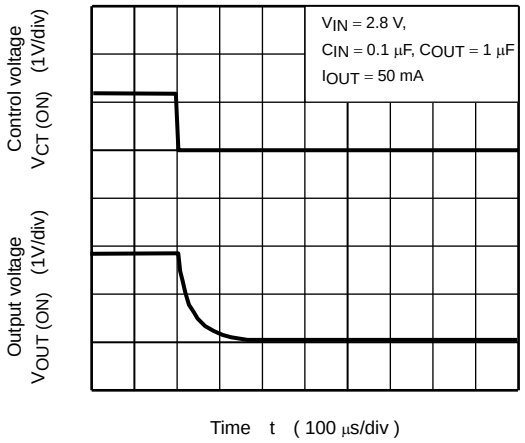

TCR5SC15FE (Turn off wave form)



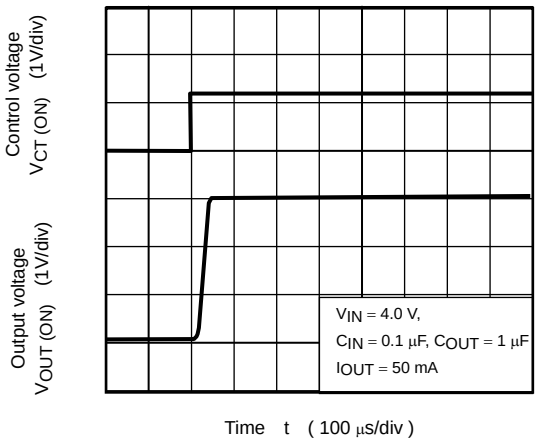

TCR5SC18FE (Turn on wave form)



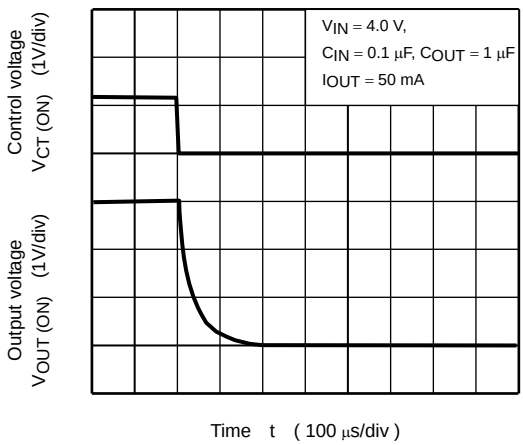

TCR5SC18FE (Turn off wave form)




TCR5SC30FE (Turn on wave form)

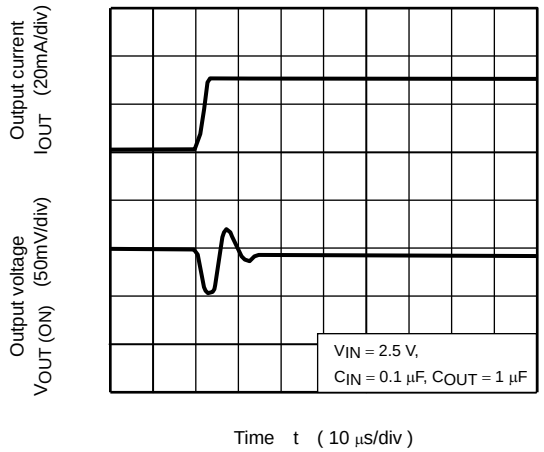



TCR5SC30FE (Turn off wave form)

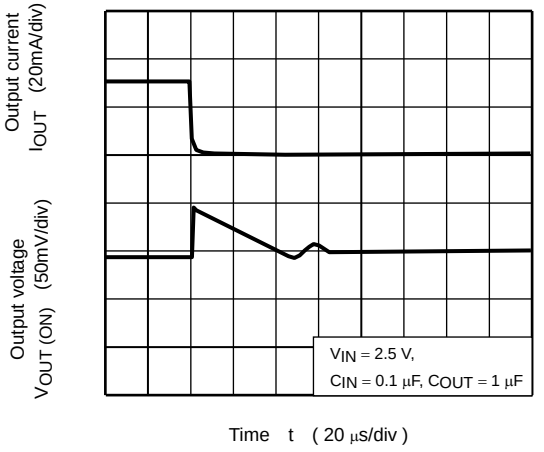


11) Load Transient Response

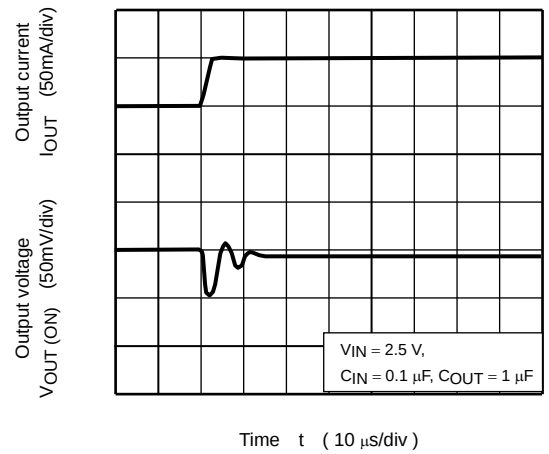
TCR5SC15FE ($I_{OUT}$ = 1m to 30mA)



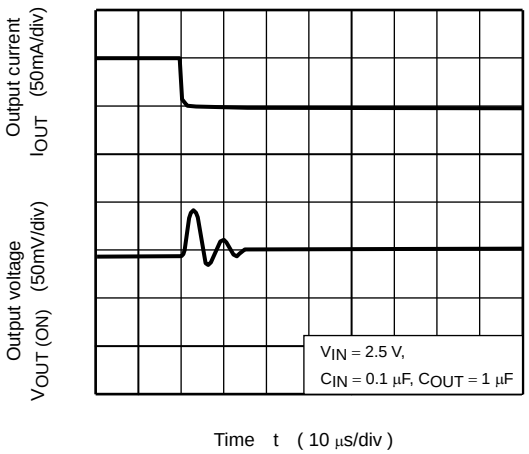

TCR5SC15FE ($I_{OUT}$ = 30m to 1mA)



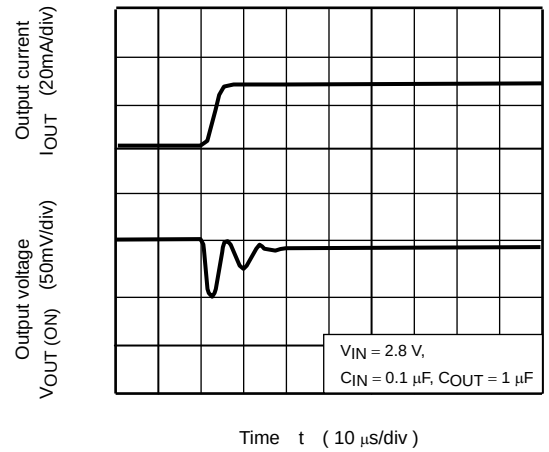

TCR5SC15FE ($I_{OUT}$ = 50m to 100mA)



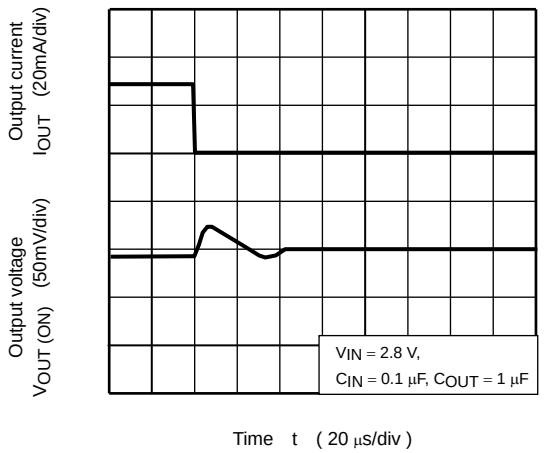

TCR5SC15FE ($I_{OUT}$ = 100m to 50mA)



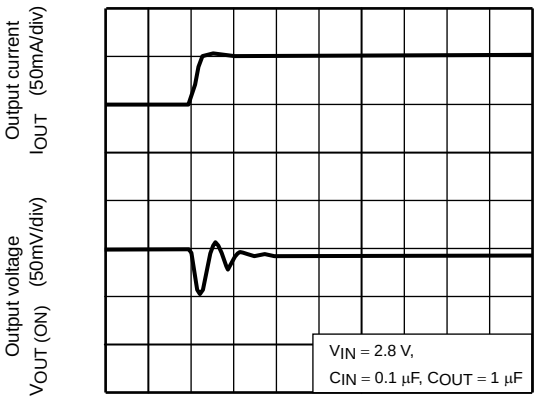

TCR5SC18FE ($I_{OUT}$ = 1m to 30mA)



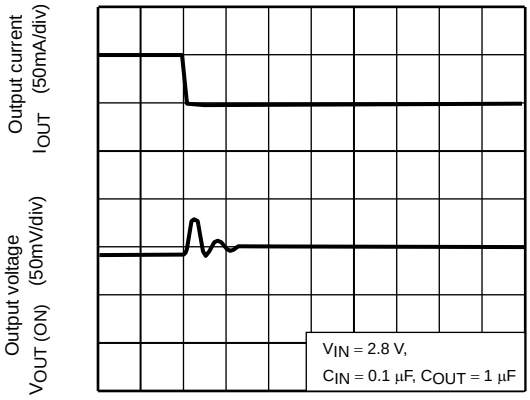

TCR5SC18FE ($I_{OUT}$ = 30m to 1mA)



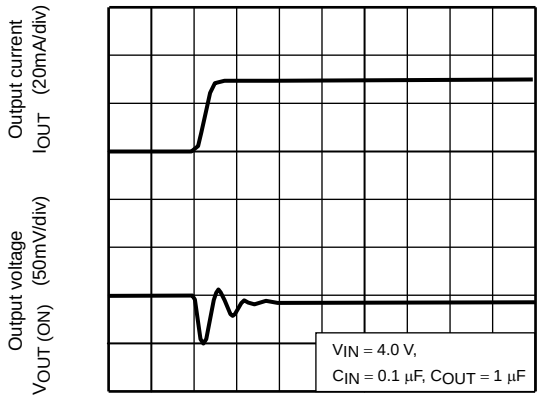
TCR5SC18FE ($I_{OUT}$ = 50m to 100mA)



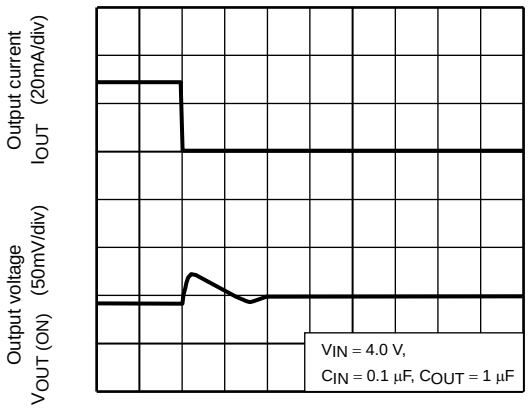

TCR5SC18FE ($I_{OUT}$ = 100m to 50mA)



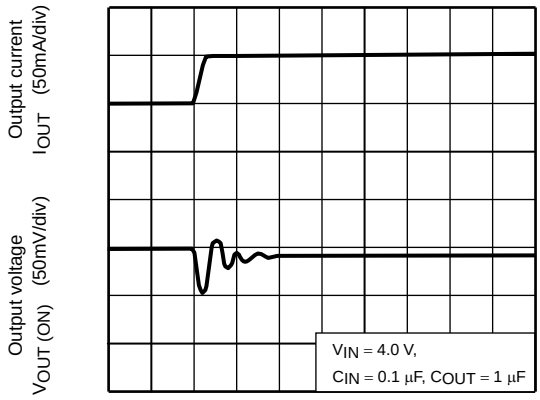

TCR5SC30FE ($I_{OUT}$ = 1m to 30mA)



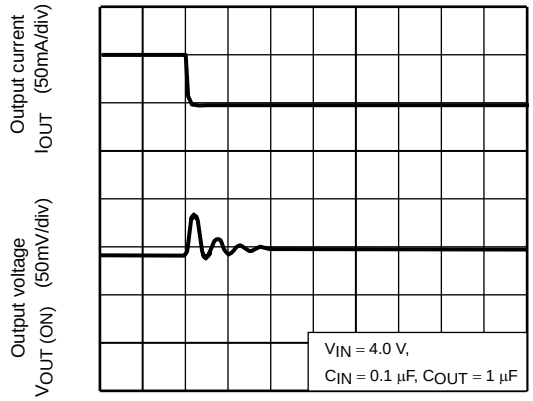

TCR5SC30FE ($I_{OUT}$ = 30m to 1mA)




TCR5SC30FE ($I_{OUT}$ = 50m to 100mA)

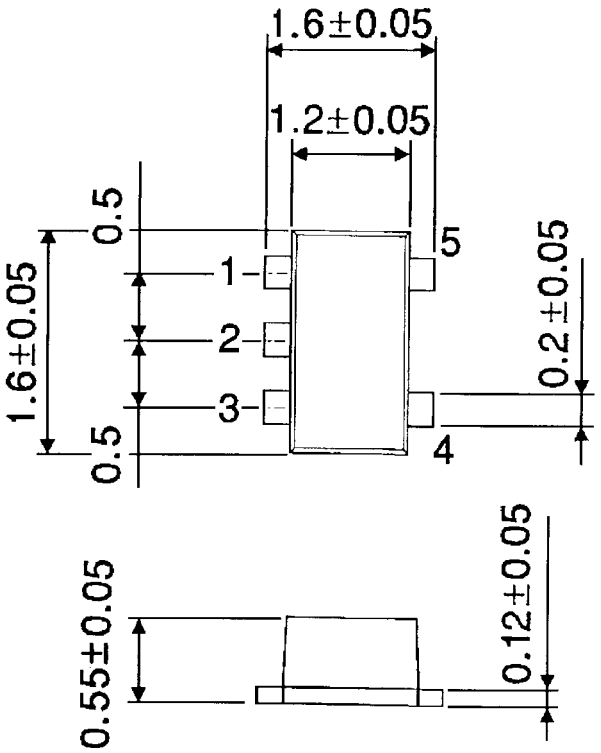



TCR5SC30FE ($I_{OUT}$ = 100m to 50mA)



**Package Dimensions**

SON5-P-0.50 Unit : mm




Weight: 0.003 g (typ)

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