

3-Terminal 100mA Positive Voltage Regulator

DESCRIPTION

The TS78L00 Series of positive voltage Regulators are inexpensive, easy-to-use devices suitable for a multitude of applications that require a regulated supply of up to 100mA. Like their higher power TS7800 and TS78M00 Series cousins, these regulators feature internal current limiting and thermal shutdown making them remarkably rugged. No external components are required with the TS78L00 devices in many applications. These devices offer a substantial performance advantage over the traditional zener diode-resistor combination, as output impedance and quiescent current are substantially reduced.

FEATURES

- Output Voltage Range 3.3V, 5V, 9V, 12V, 15V, 24V
- Output current up to 100mA
- No external components required
- Internal thermal overload protection
- Internal short-circuit current limiting
- Output transistor safe-area compensation
- Output voltage offered in 4% tolerance
- RoHS compliant
- Halogen-free according to IEC 61249-2-21

APPLICATION

- Switching power supply
- Home appliance


SOT-89

Pin Definition:
1. Output
2. Ground
3. Input


SOT-23

Pin Definition:
1. Output
2. Input
3. Ground


SOP-8

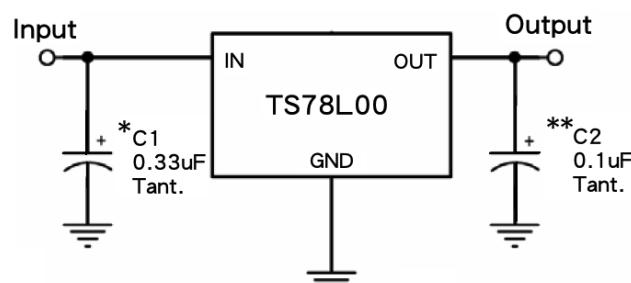
Pin Definition:
1. Output
2. Ground
3. Ground
4. N/C
5. N/A
6. Ground
7. Ground
8. Input

Notes:

SOT-23: MSL 1 (Moisture Sensitivity Level) per J-STD-020

SOT-89, SOP-8: MSL 3 (Moisture Sensitivity Level) per J-STD-020

TYPICAL APPLICATION CIRCUIT



A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0V above the output voltage even during the low point on the Input ripple voltage.

XX = these two digits of the type number indicate voltage.

* = Cin is required if regulator is located an appreciable distance from power supply filter.

** = Co is not needed for stability; however, it does improve transient response.

ABSOLUTE MAXIMUM RATINGS

| PARAMETER | SYMBOL | LIMIT | UNIT |
|--|-----------|--------------------|------|
| DC Input Voltage | V_{IN} | 30 | V |
| | | 35 | |
| | | 35 | |
| | | 35 | |
| | | 35 | |
| | | 40 | |
| Power Dissipation | P_D | Internally Limited | W |
| Operating Junction Temperature | T_J | +150 | °C |
| Recommended Operating Junction Temperature Range | T_J | -40 ~ +125 | °C |
| Operating Ambient Temperature Range | T_A | -40 ~ +85 | °C |
| Storage Temperature Range | T_{STG} | -65~+150 | °C |

THERMAL PERFORMANCE

| PARAMETER | SYMBOL | TYPICAL | | | UNIT |
|--|-----------|---------|--------|-------|------|
| | | SOT-23 | SOT-89 | SOP-8 | |
| Junction to Case Thermal Resistance | R_{eJC} | 120 | 15 | 20 | °C/W |
| Junction to Ambient Thermal Resistance | R_{eJA} | 330 | 55 | 55 | °C/W |

Notes: R_{eJA} is the sum of the junction-to-case and case-to-ambient thermal resistances. The case thermal reference is defined at the solder mounting surface of the drain pins. R_{eJA} is guaranteed by design while R_{eCA} is determined by the user's board design. R_{eJA} shown below for single device operation on FR-4 PCB in still air.

ELECTRICAL SPECIFICATIONS TS78L03

(V_{IN}=8.3V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|-------------------------------------|-------|------|-------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 3.173 | 3.3 | 3.432 | V |
| | 5.8V≤V _{IN} ≤20V, 5mA≤I _{OUT} ≤100mA | | | 3.142 | 3.3 | 3.465 | V |
| Line Regulation | T _J =25°C | 5.8V≤V _{IN} ≤20V I _{OUT} =40mA | REG _{LINE} | -- | 50 | 150 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | -- | 15 | 60 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | -- | 5 | 30 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 3 | 6 | mA |
| Quiescent Current Change | 5.8V≤V _{IN} ≤20V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 40 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 5.8V≤V _{IN} ≤20V | | RR | 41 | 49 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 2 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -0.2 | -- | mV/ °C |

ELECTRICAL SPECIFICATIONS TS78L05

(V_{IN}=10V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|--|-------------------------------------|------|-------|------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 4.80 | 5 | 5.20 | V |
| | 7.5V≤V _{IN} ≤20V, 5mA≤I _{OUT} ≤100mA | | | 4.75 | 5 | 5.25 | V |
| Line Regulation | T _J =25°C | 7.5V≤V _{IN} ≤20V I _{OUT} =100mA | REG _{LINE} | 50 | 150 | 150 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | 20 | 60 | 60 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | 10 | 30 | 30 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 3 | 6 | mA |
| Quiescent Current Change | 7.5V≤V _{IN} ≤20V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 40 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 7.5V≤V _{IN} ≤20V | | RR | 41 | 49 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 1.7 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -0.65 | -- | mV/ °C |

Note:

1. Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible, and thermal effects must be taken into account separately
2. This specification applies only for DC power dissipation permitted by absolute maximum ratings.

ELECTRICAL SPECIFICATIONS TS78L09

(V_{IN}=15V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|--|--|-------------------------------------|------|------|------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 8.65 | 9 | 9.36 | V |
| | 11.5V≤V _{IN} ≤23V, 5mA≤I _{OUT} ≤100mA | | | 8.57 | 9 | 9.45 | V |
| Line Regulation | T _J =25°C | 11.5V≤V _{IN} ≤23V I _{OUT} =40mA | REG _{LINE} | -- | 90 | 180 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | -- | 30 | 90 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | -- | 15 | 45 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 3 | 6 | mA |
| Quiescent Current Change | 11.5V≤V _{IN} ≤23V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 60 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 11.5V≤V _{IN} ≤23V | | RR | 37 | 57 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 1.7 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -0.9 | -- | mV/ °C |

ELECTRICAL SPECIFICATIONS TS78L12

(V_{IN}=19V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|--|--|-------------------------------------|-------|------|-------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 11.53 | 12 | 12.48 | V |
| | 14.5V≤V _{IN} ≤27V, 5mA≤I _{OUT} ≤100mA | | | 11.42 | 12 | 12.60 | V |
| Line Regulation | T _J =25°C | 14.5V≤V _{IN} ≤27V I _{OUT} =40mA | REG _{LINE} | -- | 120 | 240 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | -- | 40 | 120 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | -- | 20 | 60 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 3 | 6.5 | mA |
| Quiescent Current Change | 14.5V≤V _{IN} ≤27V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 80 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 14.5V≤V _{IN} ≤27V | | RR | 37 | 42 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 1.7 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -1.0 | -- | mV/ °C |

Note:

1. Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible, and thermal effects must be taken into account separately
2. This specification applies only for DC power dissipation permitted by absolute maximum ratings.

ELECTRICAL SPECIFICATIONS TS78L15

(V_{IN}=23V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|--|--|-------------------------------------|-------|------|-------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 14.42 | 15 | 15.60 | V |
| | 17.5V≤V _{IN} ≤30V, 5mA≤I _{OUT} ≤100mA | | | 14.28 | 15 | 15.75 | V |
| Line Regulation | T _J =25°C | 17.5V≤V _{IN} ≤30V I _{OUT} =40mA | REG _{LINE} | -- | 150 | 300 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | -- | 50 | 150 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | -- | 25 | 75 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 3 | 6.6 | mA |
| Quiescent Current Change | 17.5V≤V _{IN} ≤30V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 90 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 17.5V≤V _{IN} ≤30V | | RR | 34 | 39 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 1.7 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -1.3 | -- | mV/ °C |

ELECTRICAL SPECIFICATIONS TS78L24

(V_{IN}=33V, I_{OUT}=40mA, 0°C≤T_J≤125°C, C_{IN}=0.33μF, C_{OUT}=0.1μF, unless otherwise noted)

| PARAMETER | CONDITIONS | | SYMBOL | MIN | TYP | MAX | UNIT |
|---|--|--|-------------------------------------|-------|------|-------|--------|
| Output voltage | T _J =25°C | | V _{OUT} | 23.07 | 24 | 24.96 | V |
| | 27V≤V _{IN} ≤38V, 5mA≤I _{OUT} ≤100mA | | | 22.85 | 24 | 25.20 | V |
| Line Regulation | T _J =25°C | 27V≤V _{IN} ≤38V I _{OUT} =40mA | REG _{LINE} | -- | 200 | 400 | mV |
| Load Regulation | T _J =25°C | 5mA≤I _{OUT} ≤100mA | REG _{LOAD} | -- | 80 | 240 | mV |
| | | 5mA≤I _{OUT} ≤40mA | | -- | 40 | 120 | |
| Quiescent Current | I _{OUT} =0, T _J =25°C | | I _Q | -- | 4 | 7 | mA |
| Quiescent Current Change | 27V≤V _{IN} ≤38V | | ΔI _Q | -- | -- | 1.5 | mA |
| | 5mA≤I _{OUT} ≤40mA | | | -- | -- | 0.1 | |
| Output Noise Voltage | 10Hz≤f≤100kHz, T _J =25°C | | V _N | -- | 200 | -- | μV |
| Ripple Rejection Ratio | F=120Hz, 27V≤V _{IN} ≤38V | | RR | 31 | 45 | -- | dB |
| Voltage Drop | I _{OUT} =100mA, T _J =25°C | | V _{DROP} | -- | 1.7 | -- | V |
| Peak Output Current | T _J =25°C | | I _O peak | -- | 0.15 | -- | A |
| Temperature Coefficient of Output Voltage | I _{OUT} =5mA, 0°C≤T _J ≤150°C | | ΔV _{OUT} / ΔT _J | -- | -2.0 | -- | mV/ °C |

Note:

1. Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible, and thermal effects must be taken into account separately
2. This specification applies only for DC power dissipation permitted by absolute maximum ratings.

ORDERING INFORMATION

| OUTPUT VOLTAGE | PART NO. | PACKAGE | PACKING |
|-----------------------|-----------------|----------------|---------------------|
| 3.3V | TS78L03ACY RMG | SOT-89 | 1,000pcs / 7" Reel |
| | TS78L03CX RFG | SOT-23 | 3,000pcs / 7"Reel |
| | TS78L03CS RLG | SOP-8 | 2,500pcs / 13" Reel |
| 5V | TS78L05ACY RMG | SOT-89 | 1,000pcs / 7" Reel |
| | TS78L05CX RFG | SOT-23 | 3,000pcs / 7"Reel |
| | TS78L05CS RLG | SOP-8 | 2,500pcs / 13" Reel |
| 9V | TS78L09ACY RMG | SOT-89 | 1,000pcs / 7" Reel |
| | TS78L09CX RFG | SOT-23 | 3,000pcs / 7"Reel |
| | TS78L09CS RLG | SOP-8 | 2,500pcs / 13" Reel |
| 12V | TS78L12ACY RMG | SOT-89 | 1,000pcs / 7" Reel |
| | TS78L12CS RLG | SOP-8 | 2,500pcs / 13" Reel |
| 15V | TS78L15ACY RMG | SOT-89 | 1,000pcs / 7" Reel |
| | TS78L15CS RLG | SOP-8 | 2,500pcs / 13" Reel |
| 24V | TS78L24CS RLG | SOP-8 | 2,500pcs / 13" Reel |

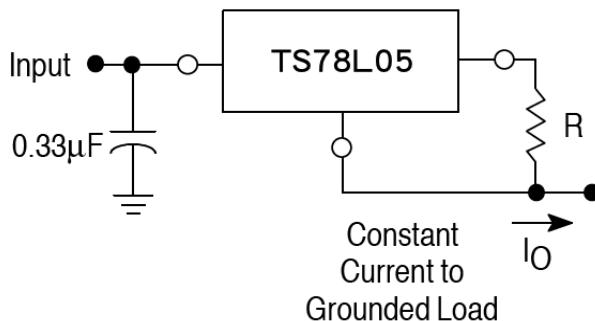
APPLICATION INFORMATION

Design Considerations

The TS78L00 Series of fixed voltage regulators are designed with Thermal Overload Protection that shuts down the circuit when subjected to an excessive power overload condition. Internal Short Circuit protection limits the maximum current the circuit will pass.

In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. The input bypass capacitor should be selected to provide good high-frequency characteristics to insure stable operation under all load conditions. A $0.33\mu F$ or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with the shortest possible leads directly across the regulators input terminals. Good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead. Bypassing the output is also recommended.

FIGURE 1 – Current Regulator



The TS78L00 regulators can also be used as a current source when connected as above. In order to minimize dissipation the TS78L05 is chosen in this application. Resistor R determines the current as follows:

$$I_O = \frac{5.0V}{R} + I_B$$

I_B=3.8mA over lined and load changes

For example, a 100mA current source would require R to be a 50Ω. 1/2W resistor and the output voltage compliance would be the input voltage less 7V.

FIGURE 2 – ±15V Tracking Voltage Regulator

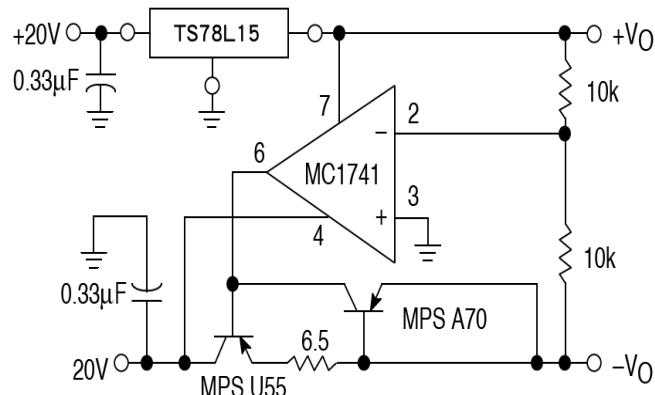
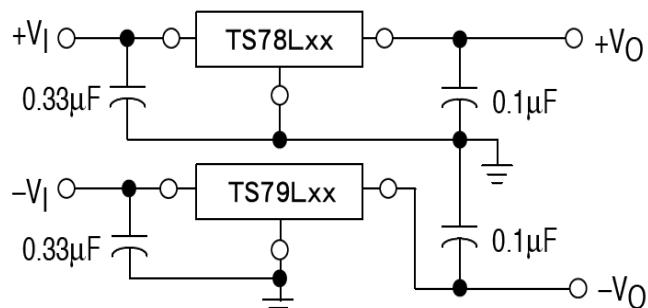


FIGURE 3 – ±15V Tracking Voltage Regulator



ELECTRICAL CHARACTERISTICS CURVE

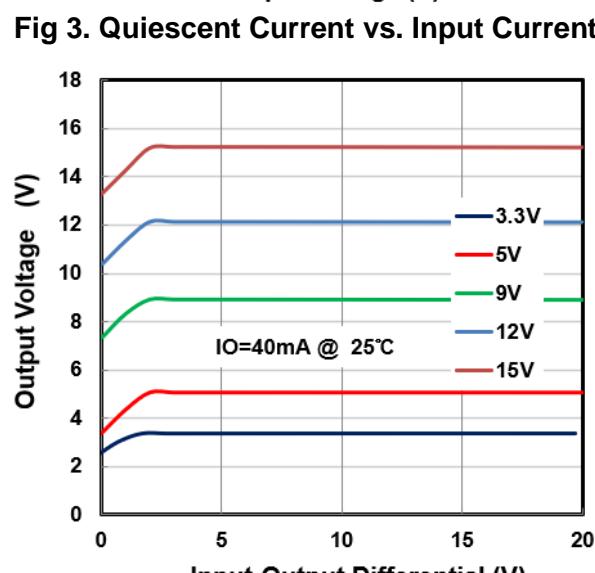
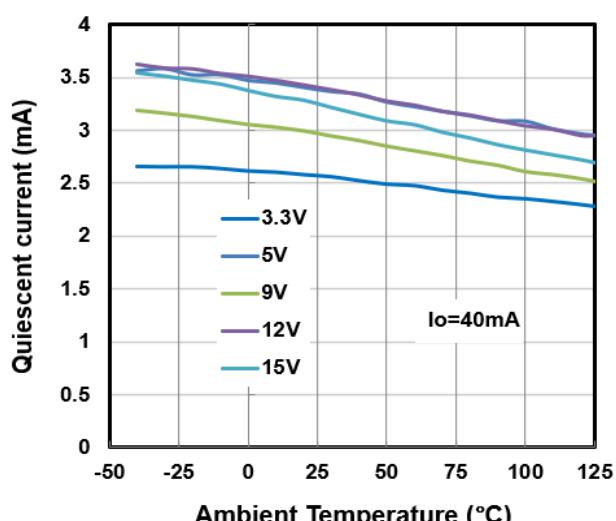
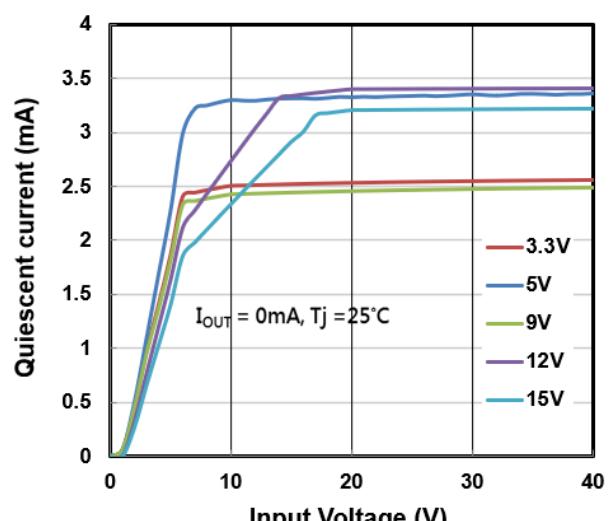
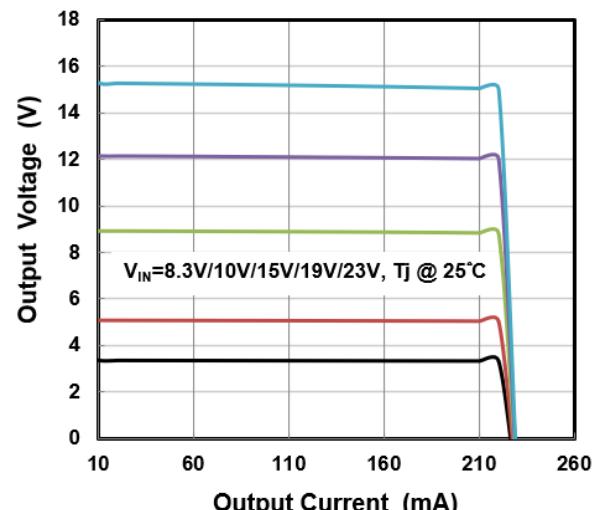
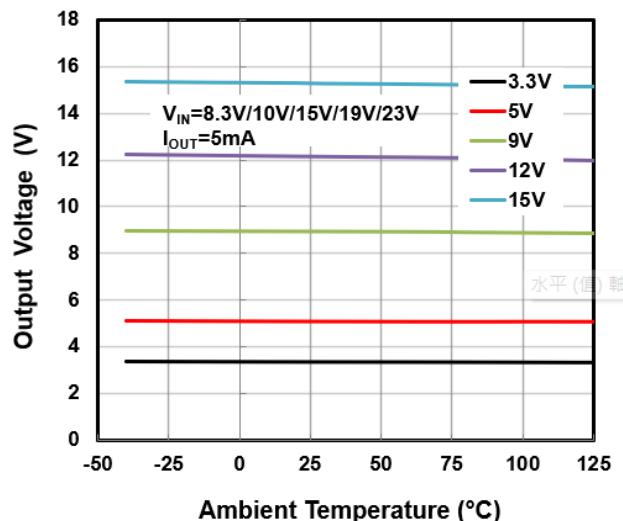
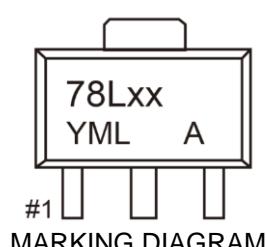
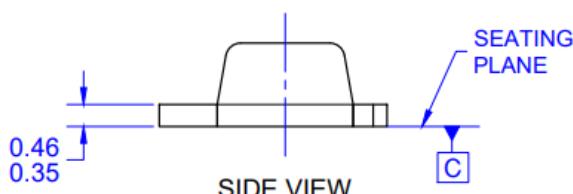
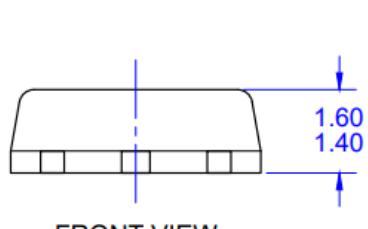
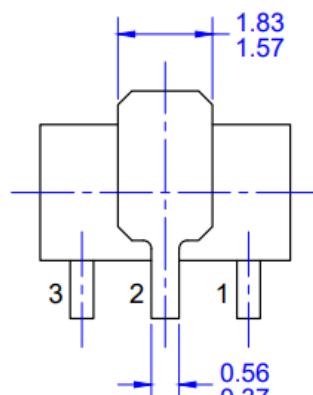
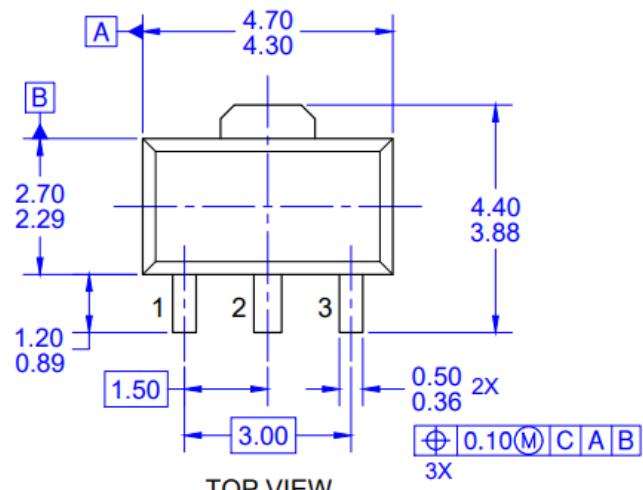


Fig 5. Output Voltage vs. $V_{IN}-V_{OUT}$ Diff.

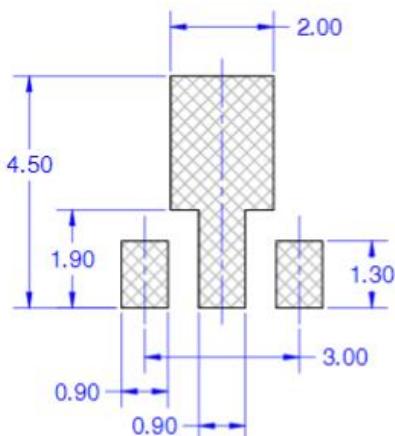
PACKAGE OUTLINE DIMENSIONS
SOT-89

XX = Output Voltage

03 = 3.3V **05** = 5.0V **09** = 9V **12** = 12V **15** = 15V

Y = Year Code

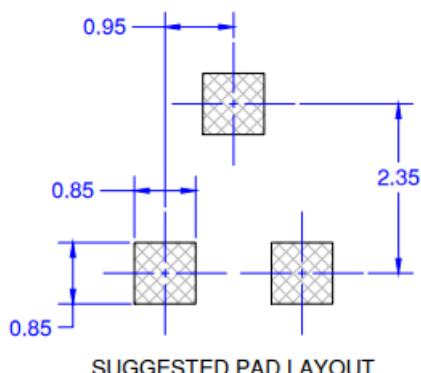
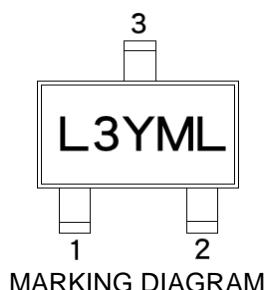
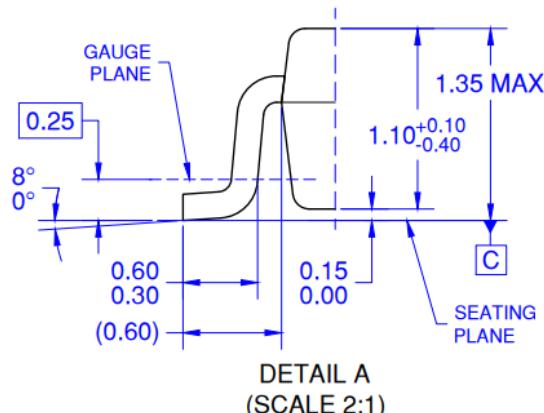
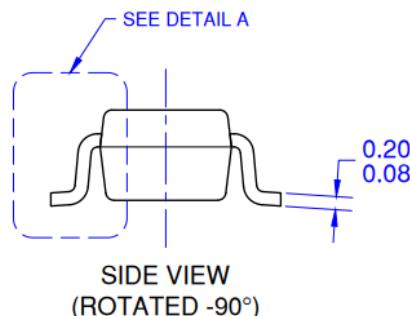
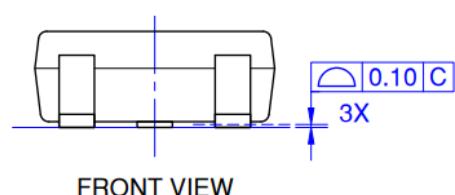
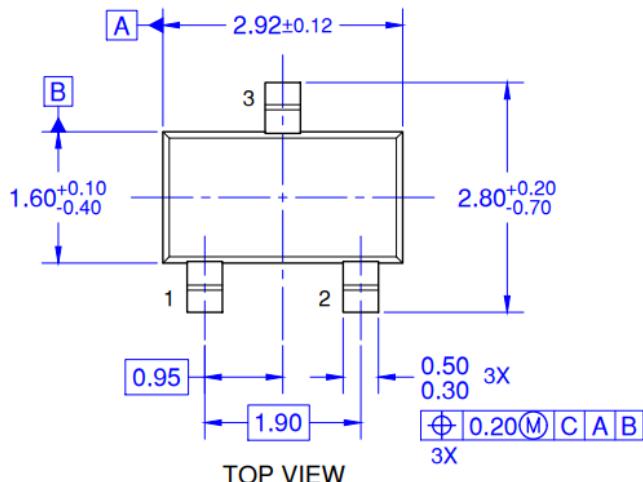
M = Month Code for Halogen Free Product

| | | | | | | | |
|----------|------|----------|------|----------|------|----------|------|
| O | =Jan | P | =Feb | Q | =Mar | R | =Apr |
| S | =May | T | =Jun | U | =Jul | V | =Aug |
| W | =Sep | X | =Oct | Y | =Nov | Z | =Dec |

L = Lot Code


NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PACKAGE OUTLINE REFERENCE: JEDEC TO-243, ISSUE C, VARIATION AA.
4. MOLDED PLASTIC BODY DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
5. DWG NO REF: HQ2SD07-024 REV A.

PACKAGE OUTLINE DIMENSIONS
SOT-23

XX = Output Voltage

L3 = 3.3V **L5** = 5.0V **L9** = 9V

Y = Year Code

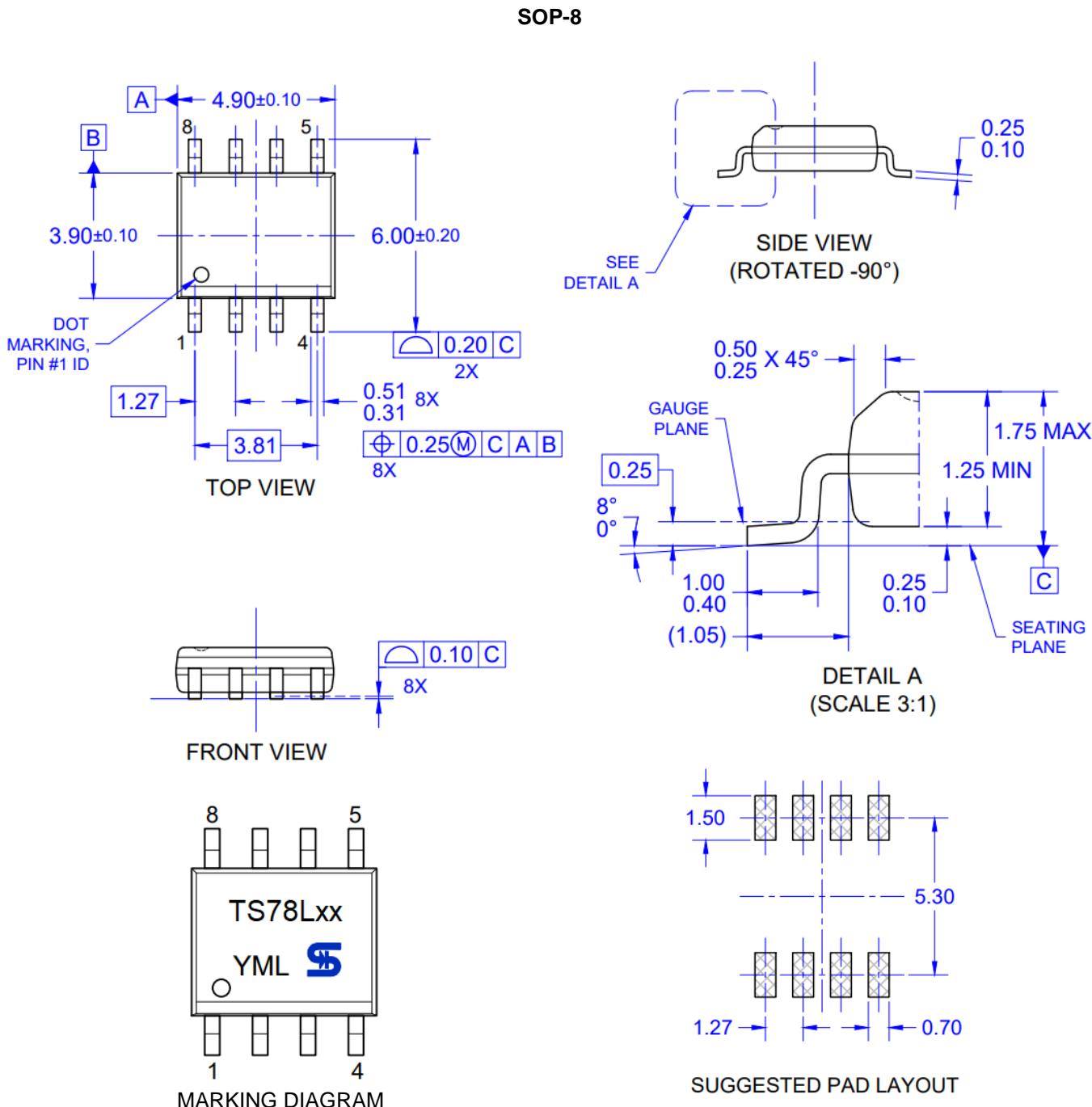
M = Month Code for Halogen Free Product

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|----------|------|----------|------|----------|------|----------|------|
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| S | =May | T | =Jun | U | =Jul | V | =Aug |
| W | =Sep | X | =Oct | Y | =Nov | Z | =Dec |

L = Lot Code

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PACKAGE OUTLINE REFERENCE: JEDEC TO-236, ISSUE H, VARIATION AA.
4. MOLDED PLASTIC BODY DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
5. DWG NO REF: HQ2SD07-025 REV A.

PACKAGE OUTLINE DIMENSIONS

XX = Output Voltage

03 = 3.3V **05** = 5.0V **09** = 9V **12** = 12V **15** = 15V
24 = 24V

Y = Year Code

M = Month Code for Halogen Free Product

O = Jan **P** = Feb **Q** = Mar **R** = Apr
S = May **T** = Jun **U** = Jul **V** = Aug
W = Sep **X** = Oct **Y** = Nov **Z** = Dec

L = Lot Code

NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.
3. PACKAGE OUTLINE REFERENCE: JEDEC MS-012, ISSUE G, VARIATION AA.
4. MOLDED PLASTIC BODY DIMENSIONS DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
5. DWG NO REF: HQ2SD07-SOP8STD-028 REV A.

Notice

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