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3-Termal 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
- Compliant to RoHS Directive 2011/65/EU and WEEE 2002/96/EC
- Halogen-free according to IEC 61249-2-21

APPLICATION

- Switching power supply
- Home appliance

TO-92

SOT-89

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

SOT-23

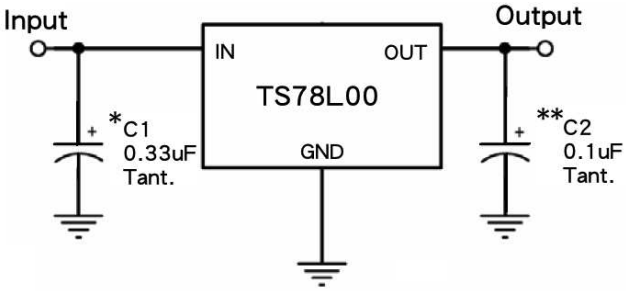
Pin Definition:
1. Output
2. Input
3. Ground

SOP-8

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

Notes: 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	TS78L03	V_{IN}	30	V
	TS78L05		35	
	TS78L09		35	
	TS78L12		35	
	TS78L15		35	
	TS78L24		40	
Power Dissipation		P_D	Internally Limited	W
Operating Junction Temperature Range		T_J	0 ~ +150	°C
Storage Temperature Range		T_{STG}	-65~+150	°C

THERMAL PERFORMANCE						
PARAMETER	**SYMBOL**	**LIMIT**				**UNIT**
		TO-92	**SOT-23**	**SOT-89**	**SOP-8**	
Junction to Case Thermal Resistance	$R_{\Theta JC}$	--	120	15	20	°C/W
Junction to Ambient Thermal Resistance	$R_{\Theta JA}$	230	330	55	55	°C/W

Notes: $R_{\Theta JA}$ 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. $R_{\Theta JC}$ is guaranteed by design while $R_{\Theta CA}$ is determined by the user's board design. $R_{\Theta JA}$ 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≤Vin≤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≤Vin≤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≤Vin≤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		Io 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≤Vin≤20V, 5mA≤I_{OUT}≤100mA			4.75	5	5.25	V
Line Regulation	T_J=25°C	7.5V≤Vin≤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≤Vin≤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≤Vin≤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		Io 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≤Vin≤23V, 5mA≤I_{OUT}≤100mA			8.57	9	9.45	V
Line Regulation	T_J=25°C	11.5V≤Vin≤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≤Vin≤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≤Vin≤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		Io 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≤Vin≤27V, 5mA≤I_{OUT}≤100mA			11.42	12	12.60	V
Line Regulation	T_J=25°C	14.5V≤Vin≤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≤Vin≤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≤Vin≤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		Io 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≤Vin≤30V, 5mA≤I_{OUT}≤100mA			14.28	15	15.75	V
Line Regulation	T_J=25°C	17.5V≤Vin≤30V I_{OUT}=40mA	REG_{LINE}	--	150	300	mV
Load Regulation	T_J=25°C	5mA≤I_{OUT}≤100mA	REG_{LOAD}	--	60	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≤Vin≤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≤Vin≤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		Io peak	--	0.15	--	A
Temperature Coefficient of Output Voltage	I_{OUT}=5mA, 0°C≤T_J≤150°C		ΔV_{OUT}/ ΔT_J	--	-1.7	--	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≤Vin≤38V, 5mA≤I_{OUT}≤100mA			22.85	24	25.20	V
Line Regulation	T_J=25°C	27≤Vin≤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≤Vin≤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≤Vin≤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		Io 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

OUTPYT VOLTAGE	PART NO.	PACKAGE	PACKING
3.3V	TS78L03CT B0G	TO-92	1,000pcs / Bulk
	TS78L03CT A3G	TO-92	2,000pcs / Ammo
	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	TS78L05CT B0G	TO-92	1,000pcs / Bulk
	TS78L05CT A3G	TO-92	2,000pcs / Ammo
	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	TS78L09CT B0G	TO-92	1,000pcs / Bulk
	TS78L09CT A3G	TO-92	2,000pcs / Ammo
	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	TS78L12CT B0G	TO-92	1,000pcs / Bulk
	TS78L12CT A3G	TO-92	2,000pcs / Ammo
	TS78L12ACY RMG	SOT-89	1,000pcs / 7" Reel
	TS78L12CS RLG	SOP-8	2,500pcs / 13" Reel
15V	TS78L15CT B0G	TO-92	1,000pcs / Bulk
	TS78L15CT A3G	TO-92	2,000pcs / Ammo
	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 0.33µF 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

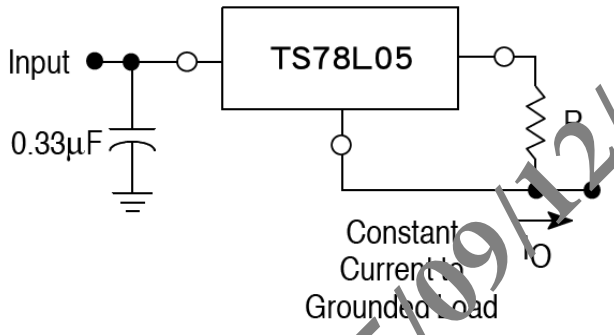
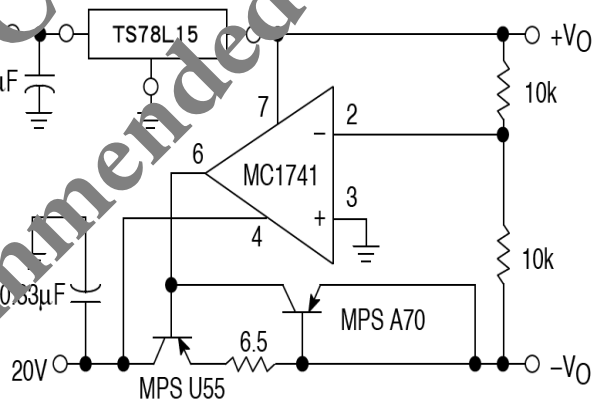


FIGURE 2 – ±15V Tracking Voltage Regulator



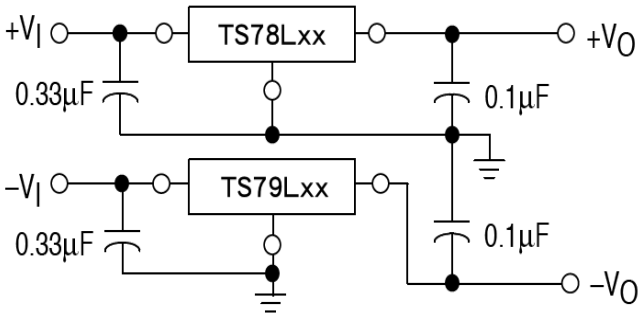
The TS78L00 regulators can also be used as a current source when connected as above. In order to minimize dissipation the TS78L05 is chosen in this application. Resistor R determines the current as follows:

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

I_{IB}=3.8mA over line and load changes

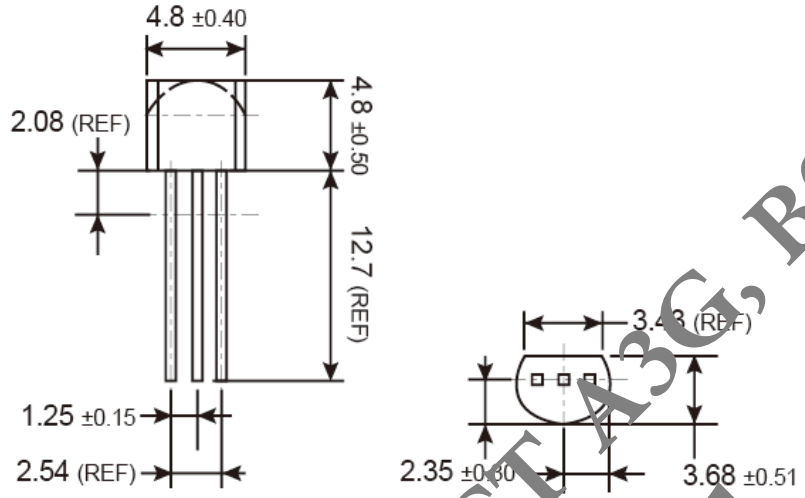
For example, a 100mA current source would require R to be a 50Ω. 1/2W resistor and the output voltage compliance would be the input voltage less 7V.

FIGURE 3 – ±15V Tracking Voltage Regulator



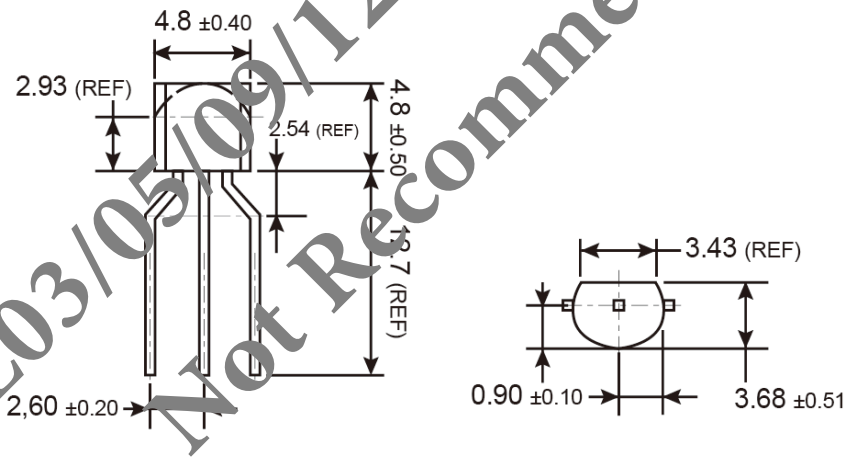
PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

TO-92

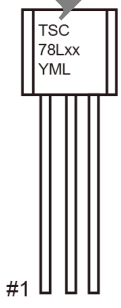


PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

TO-92 AMMO PACK



MARKING DIAGRAM



XX = Output Voltage

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

Y = Year Code

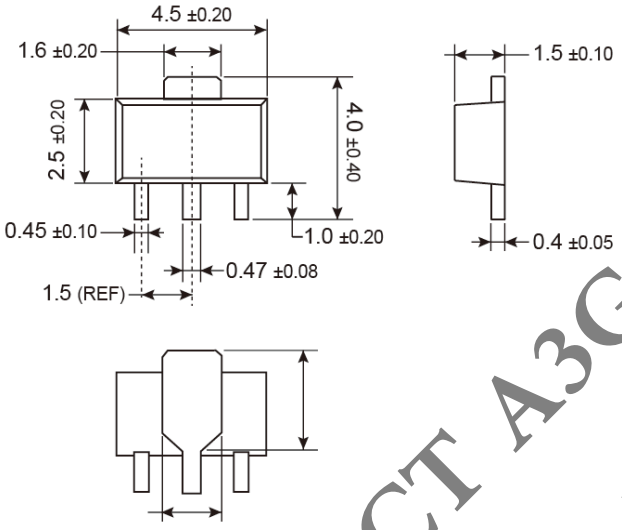
M = Month Code for Halogen Free Product

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

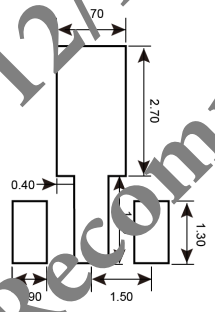
L = Lot Code

PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

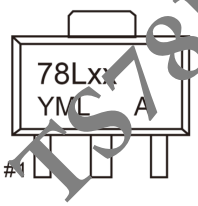
SOT-89



SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



XX = Output Voltage
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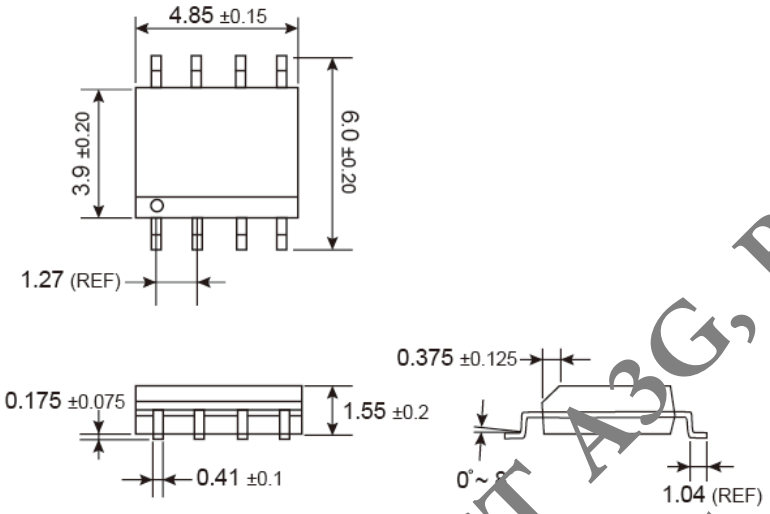
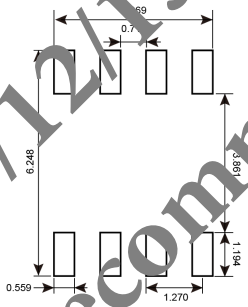
PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

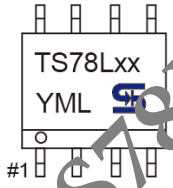
SOP-08



SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



XX = Output Voltage

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

Y = Year Code

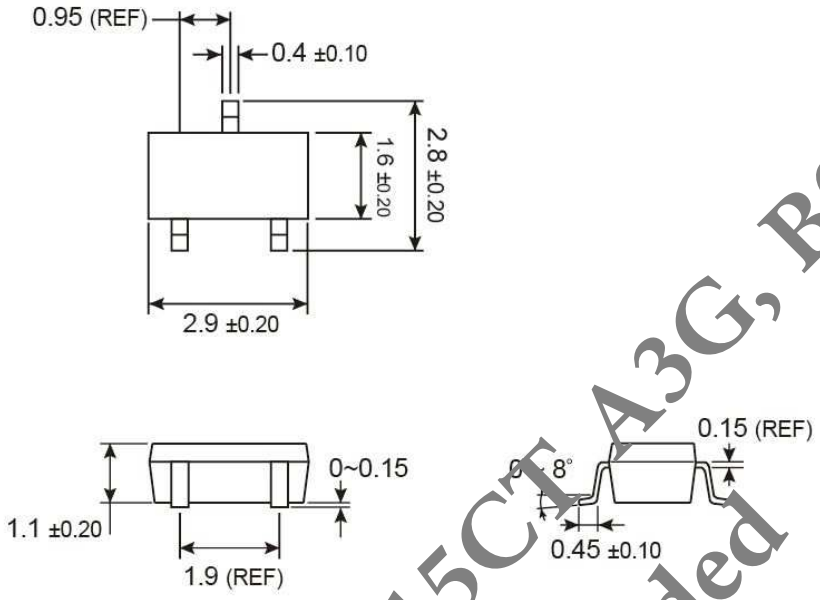
M = Month Code for Halogen Free Product

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

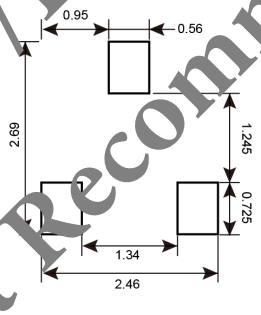
L = Lot Code

PACKAGE OUTLINE DIMENSIONS (Unit: Millimeters)

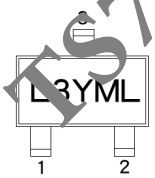
SOT-23



SUGGESTED PAD LAYOUT (Unit: Millimeters)



MARKING DIAGRAM



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

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