MCP1790/MCP1791

70 mA, High Voltage Regulator

Features

- 48V (43.5V ±10%) load dump protected for 180ms with a 30 second repetition rate (FORD Test Pulse G Loaded)
- Wide steady state supply voltage, 6.0V - 30.0V
- Extended Junction Temperature Range: -40 to +125°C
- Fixed output voltages: 3.0V, 3.3V, 5.0V
- Low quiescent current: 70 µA typical
- Low shutdown quiescent current: 10 µA typical
- Output Voltage Tolerances of ±2.5% over the temperature range
- Maximum output current of 70 mA @ +125°C Junction Temperature
- Maximum continuous input voltage of 30V
- Internal thermal overload protection, +157°C (typical) Junction Temperature
- Internal short circuit current limit, 120 mA (typical) for +5V option.
- Short Circuit Current Foldback
- Shutdown Input option (MCP1791)
- Power Good Output option (MCP1791)
- High PSRR, -90 dB@100 Hz (typical)
- Stable with 1 µF to 1000 µF Tantalum and Electrolytic Capacitors
- Stable with 4.7 µF to 1000 µF Ceramic Capacitors

Applications

- Low Voltage A/C powered (24VAC) Fire Alarms, CO_2 Sensors, HVAC Controls
- Automotive Electronics
- Automotive Accessory Power Adapters
- Electronic Thermostat Controls
- Microcontroller power

General Description

The MCP1790/MCP1791 regulator provides up to 70 mA of current. The input operating voltage range is specified from 6.0V to 30V continuous, 48V absolute max, making it ideal for automotive and commercial 12/24 VDC systems.

The MCP1790/MCP1791 has a tight tolerance output voltage load regulation of ±0.2% (typical) and a very good line regulation at ±0.0002%/V (typical). The regulator output is stable with ceramic, tantalum, and electrolytic capacitors. The MCP1790/MCP1791 regulator incorporates both thermal and short circuit protection.

The MCP1790 is the 3-pin version of the MCP1790/MCP1791 family. The MCP1791 is the 5-pin version and incorporates a Shutdown input signal and a Power Good output signal.

The regulator is specifically designed to operate in the automotive environment and will survive +48V (43.5V ±10%) load dump transients and double-battery jumps. The device is designed to meet the stringent quiescent current requirements of the automotive industry. The device is also designed for the commercial low voltage fire alarm/detector systems which use 24 VDC to supply the required alarms throughout buildings. The low ground current, 110 µA (typ.), of the CMOS device will provide a power cost savings to the end users over similar bipolar devices. Typical buildings using hundreds of 24V powered fire and smoke detectors can see substantial savings on energy consumption and wiring gage reduction compared to bipolar regulators.

The MCP1790 device will be offered in the 3-pin DD-PAK, and SOT-223 packages.

The MCP1791 device will be offered in the 5-pin DD-PAK, and SOT-223 packages.

The MCP1790/MCP1791 will have a junction temperature operating range of -40°C to +125°C.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Input Voltage, V_{IN} ....+48.0V
VIN, PWRGD, $\overline{SHDN}$ ....(GND-0.3V) to (V_{IN}+0.3V)
VOUT .... (GND-0.3V) to (+5.5V)
Internal Power Dissipation .... Internally-Limited **(Note 4)**
Output Short Circuit Current.................................Continuous
Storage temperature ....-55°C to +150°C
Maximum Junction Temperature.....................165°C **(Note 7)**
Operating Junction Temperature...................-40°C to +125°C
ESD protection on all pins..........≥ 6 kV HBM and ≥ 400V MM

† Notice: Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

AC/DC CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, $V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}$, **(Note 1)**, I_{OUT} = 1 mA, C_{OUT} = 4.7 µF (X7R Ceramic), C_{IN} = 4.7 µF (X7R Ceramic), T_A = +25°C, $\overline{SHDN}$ > 2.4V.
Boldface type applies for junction temperatures, T_J **(Note 5)** of **-40°C to +125°C.**

Parameters	Symbol	Min	Typ	Max	Units	Conditions
Input Operating Voltage	V_{IN}	**6.0**	—	**30.0**	V	+48V_{DC} Load Dump Peak < 500 ms
Input Quiescent Current	I_q	—	70	**130**	µA	I_L = 0 mA
Input Quiescent Current for $\overline{SHDN}$ Mode	$I_{\overline{SHDN}}$	—	10	**25**	µA	$\overline{SHDN}$ = GND
Ground Current	I_{GND}	—	110	**210**	µA	I_L = 70 mA
Maximum Output Current	I_{OUT}	**70**	—	—	mA	
Line Regulation	$\Delta V_{OUT}/(V_{OUT} X \Delta V_{IN})$	—	±0.0002	**±0.05**	%/V	6.0V < V_{IN} < 30V
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	**-0.45**	±0.2	**0.45**	%	I_{OUT} = 1 mA to 70 mA **(Note 3)**
Output Peak Short Circuit Current	I_{OUT_SC}	—	V_R/10	—	A	R_{LOAD} < 0.1 Ω, Peak Current
Output Voltage Regulation	V_{OUT}	**V_R-2.5%**	V_R	**V_R+2.5%**	V	6.0V < V_{IN} < 30V
V_{OUT} Temperature Coefficient	TCV_{OUT}	—	65	—	ppm/°C	**Note 9**
Input Voltage to Turn On Output	V_{ON}	—	5.5	**6.0**	V	Rising V_{IN}

Note 1: The minimum V_{IN}, $V_{IN(MIN)}$ must meet two conditions: $V_{IN} \geq 6.0V$ and $V_{IN} \geq V_{OUT(MAX)} + V_{DROPOUT(MAX)}$.
2: V_R is the nominal regulator output voltage.
3: Load regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 1 mA to the maximum specified output current.
4: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air. (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum 165°C rating. Sustained junction temperatures above 165°C can impact the device reliability.
5: The junction temperature is approximated by soaking the device under test at an ambient temperature equal to the desired Junction temperature. The test time is small enough such that the rise in the Junction temperature over the ambient temperature is not significant.
6: Dropout voltage is defined as the input-to-output voltage differential at which the output voltage drops 2% below its nominal value that was measured with an input voltage of $V_{IN} = V_R + V_{DROPOUT(MAX)}$.
7: Sustained junction temperatures above 165°C can impact the device reliability.
8: The Short Circuit Recovery Time test is done by placing the device into a short circuit condition and then removing the short circuit condition before the device die temperature reaches 125 °C. If the device goes into thermal shutdown, then the Short Circuit Recovery Time will depend upon the thermal dissipation properties of the package and circuit board.
9: $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW})$ *10^6 / (V_R * ΔTemperature), $V_{OUT-HIGH}$ = highest voltage measured over the temperaturerange. $V_{OUT-LOW}$ = lowest voltage measured over the temperature range.

AC/DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise noted, $V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}$, **(Note 1)**, I_{OUT} = 1 mA, C_{OUT} = 4.7 µF (X7R Ceramic), C_{IN} = 4.7 µF (X7R Ceramic), T_A = +25°C, SHDN > 2.4V.
Boldface type applies for junction temperatures, T_J **(Note 5)** of **-40°C to +125°C.**

Parameters	Symbol	Min	Typ	Max	Units	Conditions
Short Circuit Foldback Voltage Corner	$V_{FOLDBACK}$	—	4.2	—	V	V_R = 5.0V Falling V_{OUT}, R_{LOAD} < 0.1 Ω
		—	3.0	—	V	V_R = 3.3V Falling V_{OUT}, R_{LOAD} < 0.1 Ω
		—	2.7	—	V	V_R = 3.0V Falling V_{OUT}, R_{LOAD} < 0.1 Ω
Short Circuit Foldback Current		—	105	—	mA	V_{OUT} ~= 0V, R_{LOAD} < 0.1 Ω, V_R = 5.0V **(Note 2)**
		—	99	—	mA	V_R = 3.3V **(Note 2)**
		—	99	—	mA	V_R = 3.0V **(Note 2)**
Startup Voltage Overshoot	V_{OVER}	—	0.10	—	% V_{OUT}	V_{IN} = 0V to 6.0V
Dropout Voltage	$V_{DROPOUT}$	—	700	**1300**	mV	I_{OUT} = 70 mA, **(Note 6)**
Dropout Current I_{OUT} = 0 mA	I_{DO}	—	130	—	µA	V_R = 5.0V, V_{IN} = 4.500V
		—	75	—	µA	V_R = 3.3V, V_{IN} = 4.500V
		—	75	—	µA	V_R = 3.0V, V_{IN} = 4.500V
Shutdown Input						
Logic High Input	$V_{SHDN-HIGH}$	**2.4**	—	$V_{IN(MAX)}$	V	
Logic Low Input	$V_{SHDN-LOW}$	0	—	**0.8**	V	
Shutdown Input Leakage Current	$\overline{SHDN}_{ILK}$	— —	0.100 3.0	**0.500** **5.0**	µA	$\overline{SHDN}$ = GND $\overline{SHDN}$ = 6V
Power Good Characteristics						
PWRGD Input Voltage Operating Range	V_{PWRGD_VIN}	**2.8**	—	—	V	
PWRGD Threshold Voltage (Referenced to V_{OUT})	V_{PWRGD_TH}	**88**	90	**92**	%V_{OUT}	Falling Edge of V_{OUT}
PWRGD Threshold Hysteresis	V_{PWRGD_HYS}	**1.0**	2.0	**3.0**	%V_{OUT}	Rising Edge of V_{OUT}
PWRGD Output Voltage LOW	V_{PWRGD_L}	—	0.2	**0.4**	V	$I_{PWRGD\ SINK}$ = 5.0 mA, V_{OUT} = 0V
PWRGD Output Sink Current	I_{PWRGD_L}	5.0	—	—	mA	V_{PWRGD} <= 0.4V
PWRGD Leakage	I_{PWRGD_LK}	—	1.0	—	nA	$V_{PWRGD} = V_{IN}$ = 6.0V
PWRGD Time Delay	T_{PG}	—	30	—	µs	Rising Edge

Note 1: The minimum V_{IN}, $V_{IN(MIN)}$ must meet two conditions: $V_{IN} \geq 6.0$V and $V_{IN} \geq V_{OUT(MAX)} + V_{DROPOUT(MAX)}$.

2: V_R is the nominal regulator output voltage.

3: Load regulation is measured at a constant junction temperature using low duty cycle pulse testing. Load regulation is tested over a load range from 1 mA to the maximum specified output current.

4: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air. (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum 165°C rating. Sustained junction temperatures above 165°C can impact the device reliability.

5: The junction temperature is approximated by soaking the device under test at an ambient temperature equal to the desired Junction temperature. The test time is small enough such that the rise in the Junction temperature over the ambient temperature is not significant.

6: Dropout voltage is defined as the input-to-output voltage differential at which the output voltage drops 2% below its nominal value that was measured with an input voltage of $V_{IN} = V_R + V_{DROPOUT(\mathbf{MAX})}$.

7: Sustained junction temperatures above 165°C can impact the device reliability.

8: The Short Circuit Recovery Time test is done by placing the device into a short circuit condition and then removing the short circuit condition before the device die temperature reaches 125 °C. If the device goes into thermal shutdown, then the Short Circuit Recovery Time will depend upon the thermal dissipation properties of the package and circuit board.

9: $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW})$ *10^6 / (V_R * ΔTemperature), $V_{OUT-HIGH}$ = highest voltage measured over the temperaturerange. $V_{OUT-LOW}$ = lowest voltage measured over the temperature range.

AC/DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise noted, $V_{IN} = V_{OUT(MAX)} + V_{DROPOUT(MAX)}$, (Note 1), I_{OUT} = 1 mA, C_{OUT} = 4.7 µF (X7R Ceramic), C_{IN} = 4.7 µF (X7R Ceramic), T_A = +25°C, SHDN > 2.4V. **Boldface** type applies for junction temperatures, T_J **(Note 5)** of **-40°C to +125°C.**						
Parameters	**Symbol**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Detect Threshold to PWRGD Active Time Delay	$TV_{DET-PWRGD}$	—	235	—	µs	$V_{OUT} = V_{PWRGD\_TH}$ + 100 mV to V_{PWRGD_TH} - 100 mV
AC Performance						
Output Delay From $\overline{SHDN}$	T_{OR}	—	200	—	µs	$\overline{SHDN}$ = GND to V_{IN}, V_{OUT} = GND to 95% V_R, C_{OUT} = 1.0 µF
PWRGD Delay from $\overline{SHDN}$	T_{SHDN_PG}	—	400	—	ns	$\overline{SHDN}$ = V_{IN} to GND, C_{OUT} = 1.0 µF
Output Noise	e_N	—	1.2	—	µV/√Hz)	I_{OUT} = 50 mA, f = 1 kHz
Power Supply Ripple Rejection Ratio	PSRR				dB	V_{IN} = 7.0V, C_{IN} = 0 µF, I_{OUT} = 10 mA, V_{INAC} = 400 mVpp
		—	90	—		f = 100 Hz
		—	75	—		f = 1 kHz, V_R = 5.0V
		—	80	—		f = 1 kHz, V_R = < 5.0V
Thermal Shutdown Temperature	T_{SD}	—	157	—	°C	Rising Temperature
Thermal Shutdown Hysteresis	ΔT_{SD}	—	20	—	°C	Falling Temperature
Short Circuit Recovery Time	t_{THERM}	—	0	—	ms	**(Note 8)**

Note 1: The minimum V_{IN}, $V_{IN(MIN)}$ must meet two conditions: $V_{IN} \geq 6.0V$ and $V_{IN} \geq V_{OUT(MAX)} + V_{DROPOUT(MAX)}$.

2: V_R is the nominal regulator output voltage.

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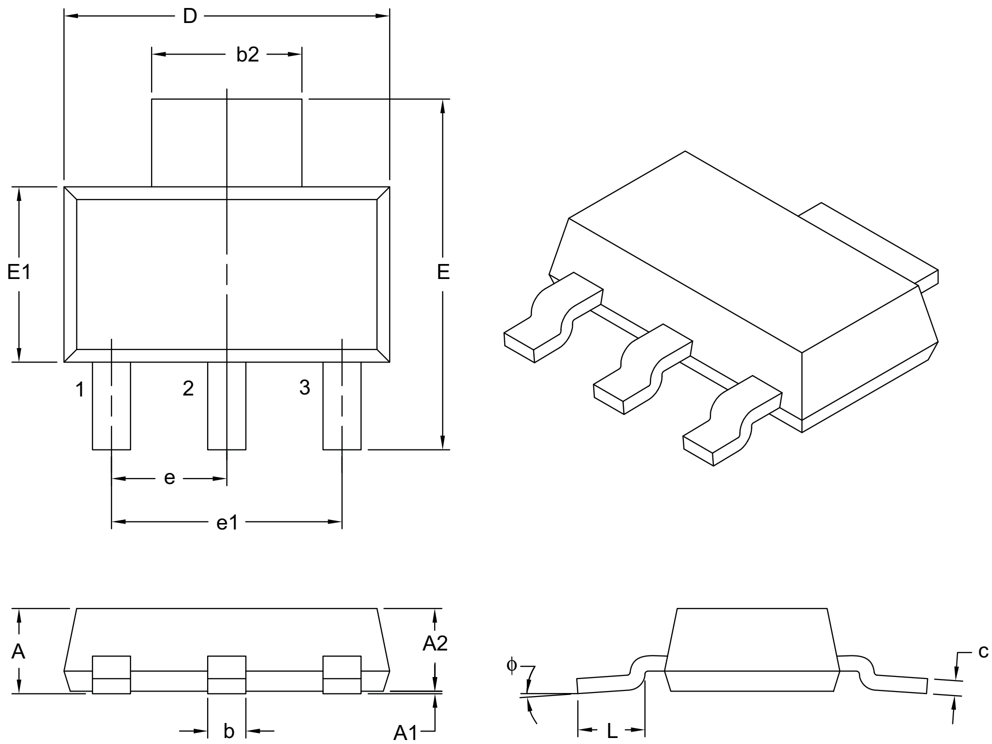
9: $TCV_{OUT} = (V_{OUT-HIGH} - V_{OUT-LOW})$ *10^6 / (V_R * ΔTemperature), $V_{OUT-HIGH}$ = highest voltage measured over the temperaturerange. $V_{OUT-LOW}$ = lowest voltage measured over the temperature range.

TEMPERATURE SPECIFICATIONS

Parameters	Symbol	Min	Typ	Max	Units	Conditions
Temperature Ranges						
Specified Temperature Range	T_J	-40		+125	°C	
Operating Temperature Range	T_J	-40		+125	°C	
Storage Temperature Range	T_J	-55		+150	°C	
Package Thermal Resistances						
Thermal Resistance, 3LD DDPAK	θ_{JA} θ_{JC}	—	31.4 3	—	°C/W	EIA/JEDEC JESD51-751-7 4 Layer Board
Thermal Resistance, 3LD SOT-223	θ_{JA} θ_{JC}	—	62 15	—	°C/W	EIA/JEDEC JESD51-751-7 4 Layer Board
Thermal Resistance, 5LD DDPAK	θ_{JA} θ_{JC}	—	31.4 3	—	°C/W	EIA/JEDEC JESD51-751-7 4 Layer Board
Thermal Resistance, 5LD SOT-223	θ_{JA} θ_{JC}	—	62 15	—	°C/W	EIA/JEDEC JESD51-751-7 4 Layer Board

3-Lead Plastic Small Outline Transistor (DB) [SOT-223]



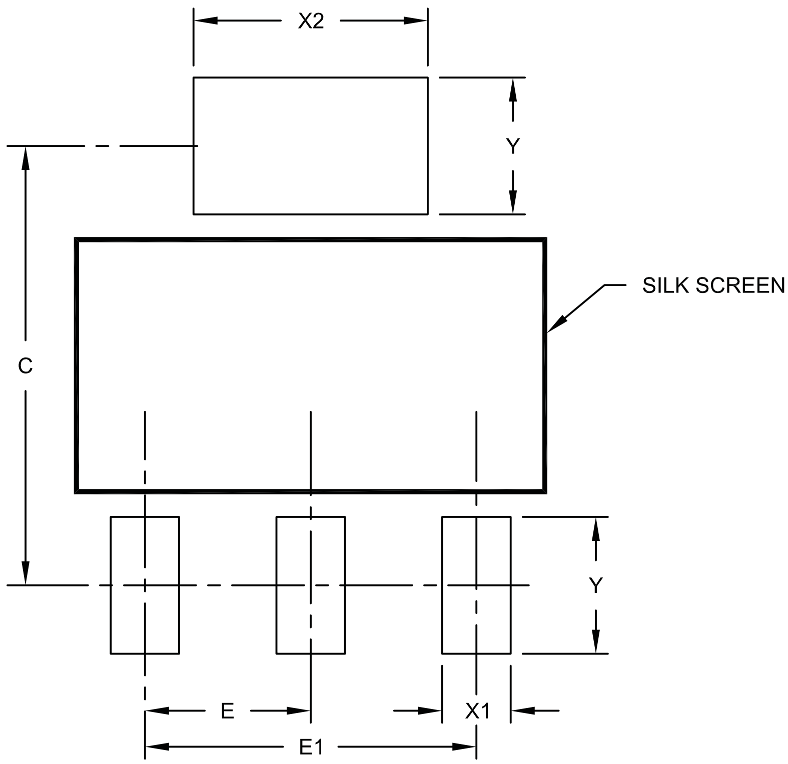
Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Leads	N	3		
Lead Pitch	e	2.30 BSC		
Outside Lead Pitch	e1	4.60 BSC		
Overall Height	A	–	–	1.80
Standoff	A1	0.02	–	0.10
Molded Package Height	A2	1.50	1.60	1.70
Overall Width	E	6.70	7.00	7.30
Molded Package Width	E1	3.30	3.50	3.70
Overall Length	D	6.30	6.50	6.70
Lead Thickness	c	0.23	0.30	0.35
Lead Width	b	0.60	0.76	0.84
Tab Lead Width	b2	2.90	3.00	3.10
Foot Length	L	0.75	–	–
Lead Angle	φ	0°	–	10°

Notes:
1. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.127 mm per side.
2. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-032B

3-Lead Plastic Small Outline Transistor (DB) [SOT-223]



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		2.30 BSC	
Overall Pitch	E1		4.60 BSC	
Contact Pad Spacing	C		6.10	
Contact Pad Width	X1			0.95
Contact Pad Width	X2			3.25
Contact Pad Length	Y			1.90

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2032A

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO.	XX	X	X	X/	XX
Device	Output Voltage	Feature Code	Tolerance	Temp.	Package

Device:	MCP1790:	70 mA High Voltage Regulator
	MCP1790T:	70 mA High Voltage Regulator Tape and Reel
	MCP1791:	70 mA High Voltage Regulator
	MCP1791T:	70 mA High Voltage Regulator Tape and Reel
Output Voltage *:	30	= 3.0V “Standard”
	33	= 3.3V “Standard”
	50	= 5.0V “Standard”
	*Contact factory for other output voltage options	
Extra Feature Code:	0	= Fixed
Tolerance:	2	= 2.5% (Standard)
Temperature:	E	= -40°C to +125°C
Package Type:	EB	= Plastic, DDPAK, 3-lead
	ET	= Plastic, DDPAK, 5-lead
	DB	= Plastic Transistor Outline, SOT-223, 3-lead
	DC	= Plastic Transistor Outline, SOT-223, 5-lead

Examples:

a) MCP1790-3002E/EB: 3.0V LDO Regulator, 3LD DDPAK

b) MCP1790-3302E/EB: 3.3V LDO Regulator, 3LD DDPAK

c) MCP1790-5002E/EB: 5.0V LDO Regulator, 3LD DDPAK

d) MCP1790-3002E/DB: 3.0V LDO Regulator, 3LD SOT-223

e) MCP1790-3302E/DB: 3.3V LDO Regulator, 3LD SOT-223

f) MCP1790-5002E/DB: 5.0V LDO Regulator, 3LD SOT-223

a) MCP1791-3002E/ET: 3.0V LDO Regulator 5LD DDPAK

b) MCP1791-3302E/ET 3.3V LDO Regulator 5LD DDPAK

c) MCP1791-5002E/ET: 5.0V LDO Regulator 5LD DDPAK

d) MCP1791-3002E/DC 3.0V LDO Regulator 5LD SOT-223

e) MCP1791-3302E/DC 3.3V LDO Regulator 5LD SOT-223

f) MCP1791-5002E/DC 5.0V LDO Regulator 5LD SOT-223