VS7900E Series Three Terminal Voltage Regulator

1 Introduction

The VS7900E series is a group of three terminal negative voltage linear regulators with multiple fixed output voltages. Under the condition of good heat dissipation, it can provide output current up to 1.5A, and has the functions of internal current limit, short circuit protection, thermal shutdown protection and output transistor SOA protection, which make it relatively difficult to damage. Although designed as fixed voltage regulators without external components, these devices can be used with external components to obtain adjustable voltage and current. Therefore, the VS7900E series is widely used as fixed voltage regulators, including local (on card) regulators, to eliminate noise and power distribution problems associated with single point regulation.

2 Available Packages

PART NUMBER	PACKAGE
VS7900E Series	TO-220-3L
	TO-220F
	TO-252-2L
	TO-263-2L

Note: For all available packages, please refer to the part *Orderable Information*.

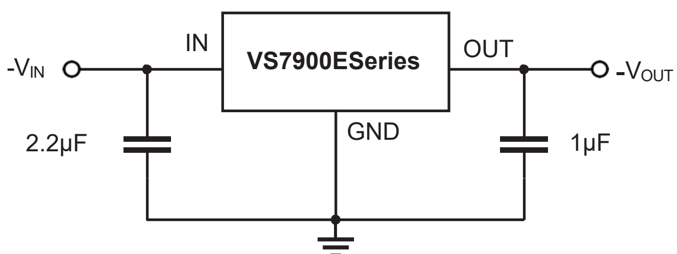


Figure 2-1. Typical Application Circuit

3 Features

- Available Fixed Output Voltage:
  - -5.0V: VS7905E
  - -6.0V: VS7906E
  - -8.0V: VS7908E
  - -9.0V: VS7909E
  - -12V : VS7912E
  - -15V : VS7915E
- Output Current:
  up to 1.5A at T_J = 25°C
- Output Voltage Tolerance at T_J = 25°C:
  ±2% for Conventional Device
  ±1% can be Customized
- Operating Junction Temperature:
  -40 ~ 125°C
- Output Voltage Tolerances of ±4% over the Temperature Range
- Dropout Voltage: 1.2V@1A
- Power Supply Rejection Ratio:
  75dB@120Hz (V_{OUT} = -5.0V)
- Output Transistor SOA Protection
- Internal Current Limit
- Short Circuit Protection
- Thermal Shutdown Protection

4 Applications

- AC Inventors
- DC Motor Drivers
- Household Electric Appliances
- HVAC Systems
- Industrial Power Supplies
- SMPS Post Regulation
- Solar Energy String Inventors
- Test and Measurement Equipment

6 Specifications

6.1 Absolute Maximum Ratings

(over operating free-air temperature range, unless otherwise specified)[(1)]

CHARACTERISTIC			SYMBOL	VALUE	UNIT
Maximum input voltage range[(2)]			$V_{IN\ MAX}$	-36	V
Maximum output current			$I_{OUT\ MAX}$	1.5	A
Maximum power dissipation	VS7900E Series	TO-220-3L	$P_{D\ Max}$	Internally Limited[(3)]	W
		TO-220F			
		TO-252-2L			
		TO-263-2L			
Maximum junction temperature			$T_{J\ Max}$	150	°C
Storage temperature			T_{stg}	-65 ~ 150	°C
Soldering temperature & time			T_{solder}	260°C, 10s	-

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum rated conditions for extended periods may affect device reliability.
(2) All voltages are with respect to network ground terminal.
(3) Refer to *Thermal Information* for details.

6.2 Recommend Operating Conditions

PARAMETER		SYMBOL	MIN.	NOM.	MAX.	UNIT
Input voltage range	VS7905E	V_{IN}	-	-	-30	V
	VS7906E		-	-	-30	
	VS7908E		-	-	-30	
	VS7909E		-	-	-30	
	VS7912E		-	-	-35	
	VS7915E		-	-	-35	
Operating junction temperature		T_J	-40	-	125	°C
Operating ambient temperature		T_A	-	-[(4)]	-	°C

(4) It is necessary to ensure that the operating junction temperature of the device does not exceed the rated value of the recommended operating conditions when using the device for design.

6 Specifications

6.3 ESD Ratings

ESD RATINGS		SYMBOL	VALUE	UNIT
Electrostatic discharge(5)	Human body model	$V_{ESD\text{-}HBM}$	6000	V

(5) ESD testing is conducted in accordance with the relevant specifications formulated by the Joint Electronic Equipment Engineering Commission (JEDEC). The human body model (HBM) electrostatic discharge test is based on the JESD22-114D test standard, using a 100pF capacitor and discharging to each pin of the device through a resistance of 1.5kΩ. The electrostatic discharge test in mechanical model (MM) is based on the JESD22-115-A test standard and uses a 200pF capacitor to discharge directly to each pin of the device.

6.4 Thermal Information

THERMAL METRIC(6)	SYMBOL	VS7900E Series		UNIT
Junction-to-ambient thermal resistance	$R_{\Theta JA}$	**TO-220-3L**	**TO-220F**	°C/W
		65.1	66.4	
		TO-252-2L	**TO-263-2L**	
		78.9	62.3	
Junction-to-case thermal resistance	$R_{\Theta JC}$	**TO-220-3L**	**TO-220F**	°C/W
		5.4	6.2	
		TO-252-2L	**TO-263-2L**	
		5.8	5.3	
Reference maximum power dissipation for continuous operation	$P_{D\ Ref}$	**TO-220-3L**	**TO-220F**	W
		1.53	1.51	
		TO-252-2L	**TO-263-2L**	
		1.25	1.60	

(6) T_A = 25°C, all numbers are typical, and apply for packages soldered directly onto a PCB board in still air without extra heat dissipation pads.

6 Specifications

6.5 Electrical Characteristics

VS7905E (V_{IN} = -10V, I_{OUT} = 500mA, C_{IN} =2.2μF, C_{OUT} = 1μF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS[7]		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade[8]	-4.90	-5.00	-5.10	V
			±1% grade[8]	-4.95		-5.05	
		I_{OUT}= 5mA to 1A, V_{IN} =- 6.5 to- 20V, P_D ≤ 15W		-4.80	-5.00	-5.20	
Line regulation	ΔV_{RLINE}	V_{IN} = -7 to -25V, T_J =25°C		-	15	50	mV
		V_{IN} = -8 to -12V, T_J =25°C			1	25	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	10	100	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			5	25	
Quiescent current	I_Q	T_J = 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -7 to -25V		-	-	0.5	
Output voltage temperature coefficient	$\Delta V_{OUT} / \Delta T$	-		-	0.4	-	mV/°C
	ΔV_{OUT} / (V_{OUT} × ΔT)			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	μV
Ripple rejection	RR	f = 120Hz， I_{OUT}=20mA		-	75	-	dB
Dropout voltage[9]	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

(8) ±2% for conventional device, ±1% can be customized.

(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

6 Specifications

6.5 Electrical Characteristics (continued)

VS7906E (V_{IN} = -11V, I_{OUT} = 500mA, C_{IN} =2.2μF, C_{OUT} = 1μF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS[7]		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade[8]	-5.88	-6.00	-6.12	V
			±1% grade[8]	-5.94		-6.06	
		I_{OUT}= 5mA to 1A, V_{IN} =- 7.5 to- 21V, $P_D \le$ 15W		-5.76	-6.00	-6.24	
Line regulation	ΔV_{RLINE}	V_{IN} = -8 to -25V, T_J =25°C		-	15	60	mV
		V_{IN} = -9 to -13V, T_J =25°C			1	36	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	10	120	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			5	36	
Quiescent current	I_Q	T_J= 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -8 to -25V		-	-	0.5	
Output voltage temperature coefficient	$\Delta V_{OUT} / \Delta T$	-		-	0.48	-	mV/°C
	$\Delta V_{OUT} / (V_{OUT} \times \Delta T)$			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	μV
Ripple rejection	RR	f = 120Hz, I_{OUT}=20mA		-	75	-	dB
Dropout voltage[9]	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

(8) ±2% for conventional device, ±1% can be customized.

(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

6 Specifications

6.5 Electrical Characteristics (continued)

VS7908E (V_{IN} = -14V, I_{OUT} = 500mA, C_{IN} =2.2μF, C_{OUT} = 1μF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS(7)		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade(8)	-7.84	-8.00	-8.16	V
			±1% grade(8)	-7.92		-8.08	
		I_{OUT}= 5mA to 1A, V_{IN} =- 9.5 to- 23V, P_D ≤ 15W		-7.68	-8.00	-8.32	
Line regulation	ΔV_{RLINE}	V_{IN} = -10.5 to -25V, T_J =25°C		-	24	80	mV
		V_{IN} = -11 to -17V, T_J =25°C			2	40	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	16	160	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			8	40	
Quiescent current	I_Q	T_J= 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -10.5 to -25V		-	-	0.5	
Output voltage temperature coefficient	ΔV_{OUT} / ΔT	-		-	0.64	-	mV/°C
	ΔV_{OUT} / (V_{OUT} × ΔT)			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	μV
Ripple rejection	RR	f = 120Hz, I_{OUT}=20mA		-	75	-	dB
Dropout voltage(9)	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

(8) ±2% for conventional device, ±1% can be customized.

(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

6 Specifications

6.5 Electrical Characteristics (continued)

VS7909E (V_{IN} -15V, I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1.0μF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS(7)		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade(8)	-8.82	-9.00	-9.18	V
			±1% grade(8)	-8.91		-9.09	
		I_{OUT}= 5mA to 1A, V_{IN} =- 10.5 to- 25V, P_D ≤ 15W		-8.64	-9.00	-9.36	
Line regulation	ΔV_{RLINE}	V_{IN} = -11.5 to -25V, T_J =25°C		-	27	90	mV
		V_{IN} = -12 to -18V, T_J =25°C			2	45	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	18	180	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			9	45	
Quiescent current	I_Q	T_J= 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -11.5 to -25V		-	-	0.5	
Output voltage temperature coefficient	$\Delta V_{OUT} / \Delta T$	-		-	0.72	-	mV/°C
	$\Delta V_{OUT} / (V_{OUT} \times \Delta T)$			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	μV
Ripple rejection	RR	f = 120Hz, I_{OUT}=20mA		-	75	-	dB
Dropout voltage(9)	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

(8) ±2% for conventional device, ±1% can be customized.

(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

6 Specifications

6.5 Electrical Characteristics (continued)

VS7912E (V_{IN} = -19V, I_{OUT} = 500mA, C_{IN} = 2.2µF, C_{OUT} = 1.0µF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS[7]		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade[8]	-11.76	-12.00	-12.24	V
			±1% grade[8]	-11.88		-12.12	
		I_{OUT}= 5mA to 1A, V_{IN} =- 13.5 to- 27V, $P_D \leq$ 15W		-11.52	-12.00	-12.48	
Line regulation	ΔV_{RLINE}	V_{IN} = -14.5 to -30V, T_J =25°C		-	36	120	mV
		V_{IN} = -16 to -22V, T_J =25°C			3	60	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	24	240	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			12	60	
Quiescent current	I_Q	T_J = 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -15 to -30V		-	-	0.5	
Output voltage temperature coefficient	ΔV_{OUT} / ΔT	-		-	0.96	-	mV/°C
	ΔV_{OUT} / ($V_{OUT} \times \Delta T$)			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	µV
Ripple rejection	RR	f = 120Hz, I_{OUT}=20mA		-	75	-	dB
Dropout voltage[9]	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

(8) ±2% for conventional device, ±1% can be customized.

(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

6 Specifications

6.5 Electrical Characteristics (continued)

VS7915E (V_{IN} = -23V, I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1.0μF, T_J = 25°C, unless otherwise specified)

CHARACTERISTIC	SYMBOL	TEST CONDITIONS(7)		MIN.	TYP.	MAX.	UNIT
Output voltage	V_{OUT}	T_J = 25°C	±2% grade(8)	-14.70	-15.00	-15.30	V
			±1% grade(8)	-14.85		-15.15	
		I_{OUT}= 5mA to 1A, V_{IN} =- 16.5 to- 30V,$P_D \leq$ 15W		-14.40	-15.00	-15.60	
Line regulation	ΔV_{RLINE}	V_{IN} = -17.5 to -30V, T_J =25°C		-	45	150	mV
		V_{IN} = -20 to -26V, T_J =25°C			3	75	
Load regulation	ΔV_{RLOAD}	I_{OUT} = 5mA to 1.5A, T_J =25°C		-	30	300	mV
		I_{OUT} = 250mA to 750mA, T_J =25°C			15	75	
Quiescent current	I_Q	T_J= 25°C, I_{OUT} =0mA		-	2.5	4.0	mA
Quiescent current change	ΔI_Q	I_{OUT} = 5mA to 1A		-	-	0.5	mA
		V_{IN} = -18.5 to -30V		-	-	0.5	
Output voltage temperature coefficient	ΔV_{OUT} / ΔT	-		-	1.2	-	mV/°C
	ΔV_{OUT} / (V_{OUT} × ΔT)			-	80	-	ppm/°C
Output noise voltage	V_N	f = 10 to 100k Hz, T_A = 25°C		-	40	-	μV
Ripple rejection	RR	f = 120Hz, I_{OUT}=20mA		-	75	-	dB
Dropout voltage(9)	V_D	I_{OUT} = 1A		-	1.2	-	V
Peak current	I_{PK}	-		-	2.2	-	A

Note:

(7) Pulse test technology is used to make T_J as close to T_A as possible. Thermal effects must be considered separately.

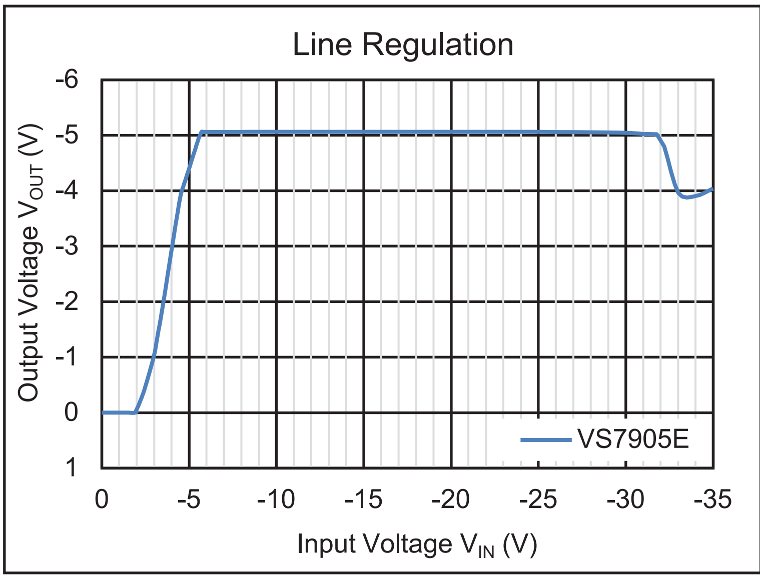
(8) ±2% for conventional device, ±1% can be customized.

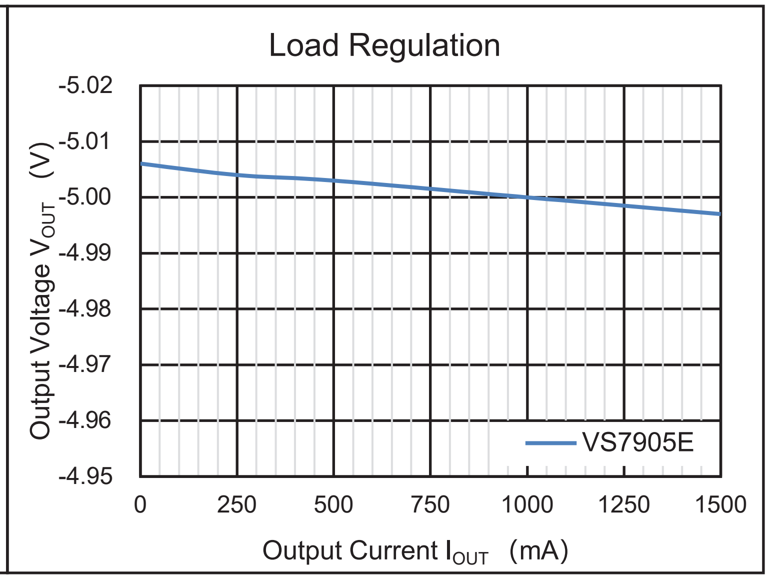
(9) The difference of output voltage and input voltage when input voltage is decreased gradually till output voltage equals to 95% of V_{OUT}.

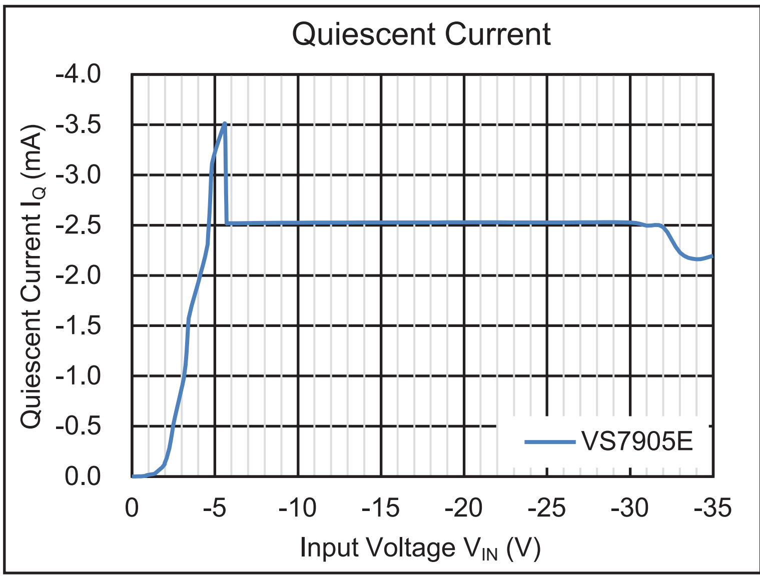
6 Specifications

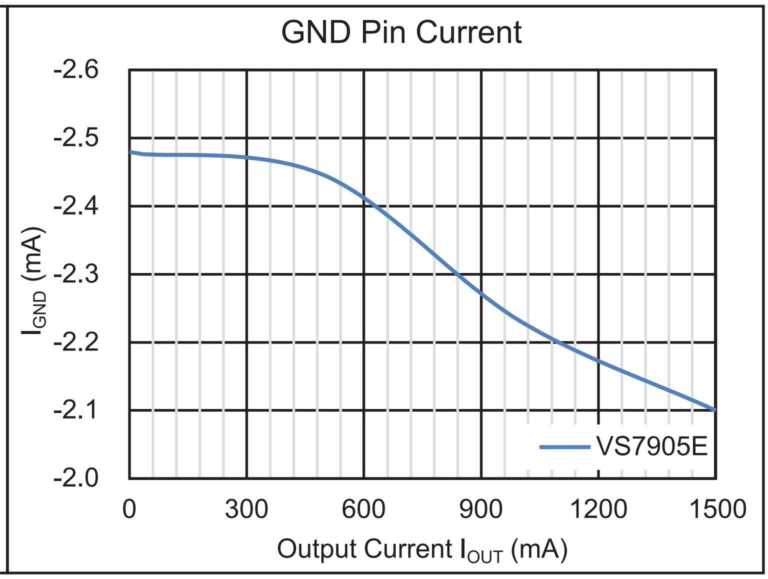
6.6 Typical Characteristics

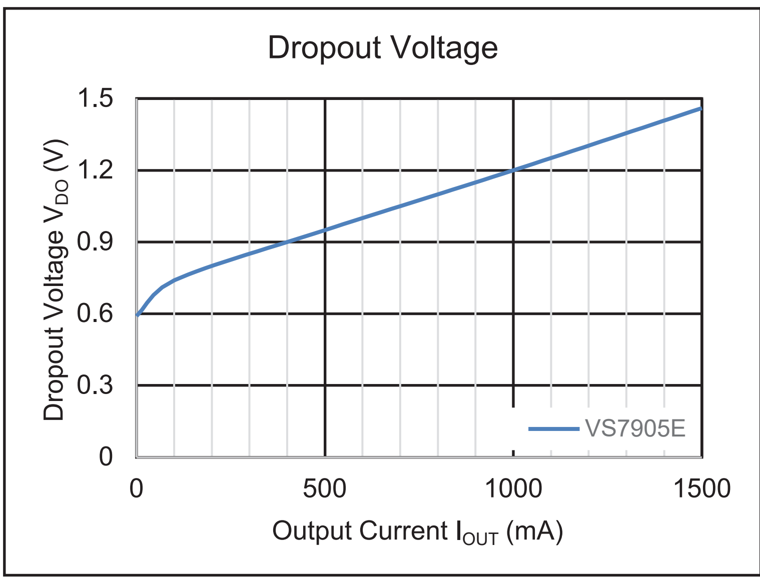
VS7905E Series (V_{IN} = -10V, I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified)

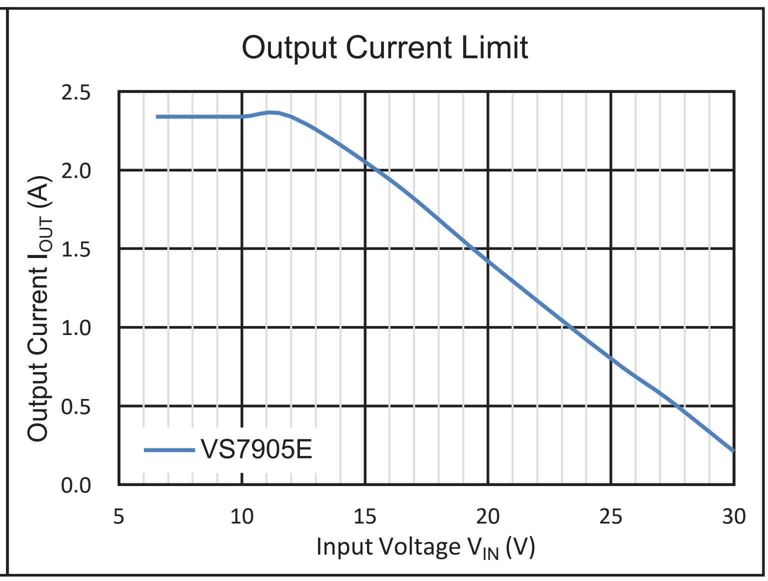








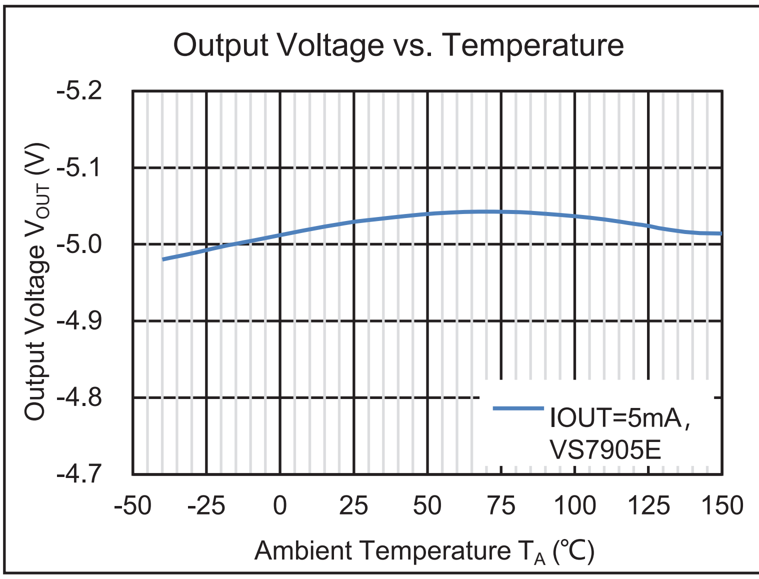


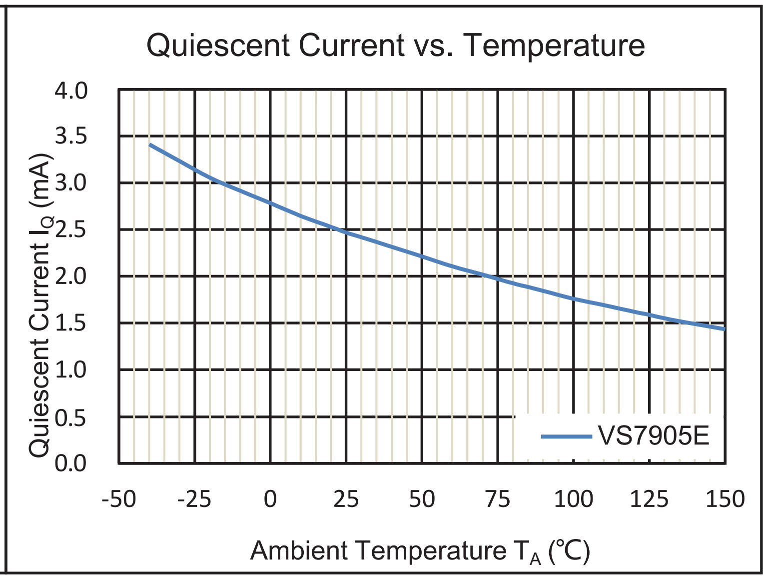


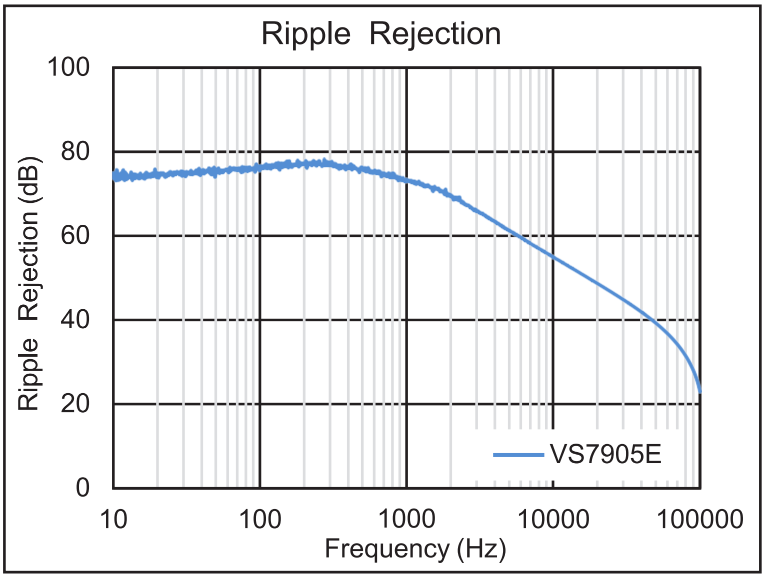
6 Specifications

6.6 Typical Characteristics (continued)

VS7905E Series (V_{IN} = -10V, I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified)







6 Specifications

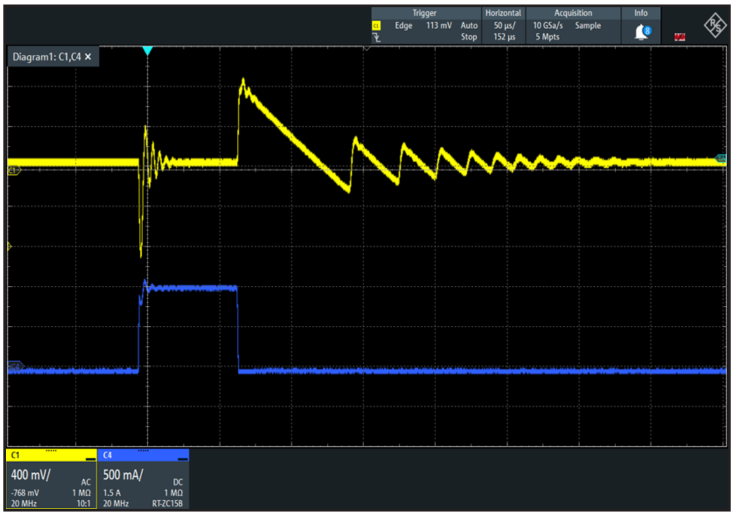
6.6 Typical Characteristics (continued)

VS7905E Series (V_{IN} = -10V, I_{OUT} = 500mA, C_{IN} = 2.2μF, C_{OUT} = 1μF, T_A = 25°C, unless otherwise specified)

Load Transient

VS7905E, V_{IN} = -10V, CH1: V_{OUT}, CH4: I_{OUT}

I_{OUT} = 10 to 1000mA

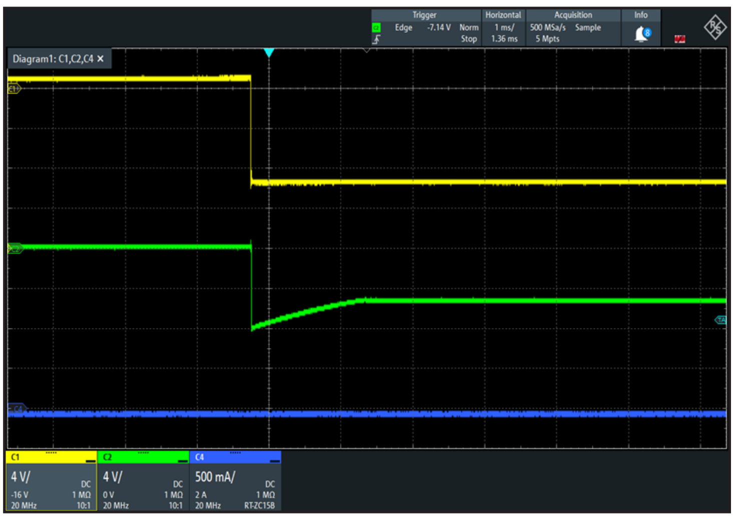


I_{OUT} = 10 to 1500mA

Power-up Response

VS7905E, V_{IN} = -10V, CH1: V_{OUT}, CH2: I_{OUT}

I_{OUT} = 0mA

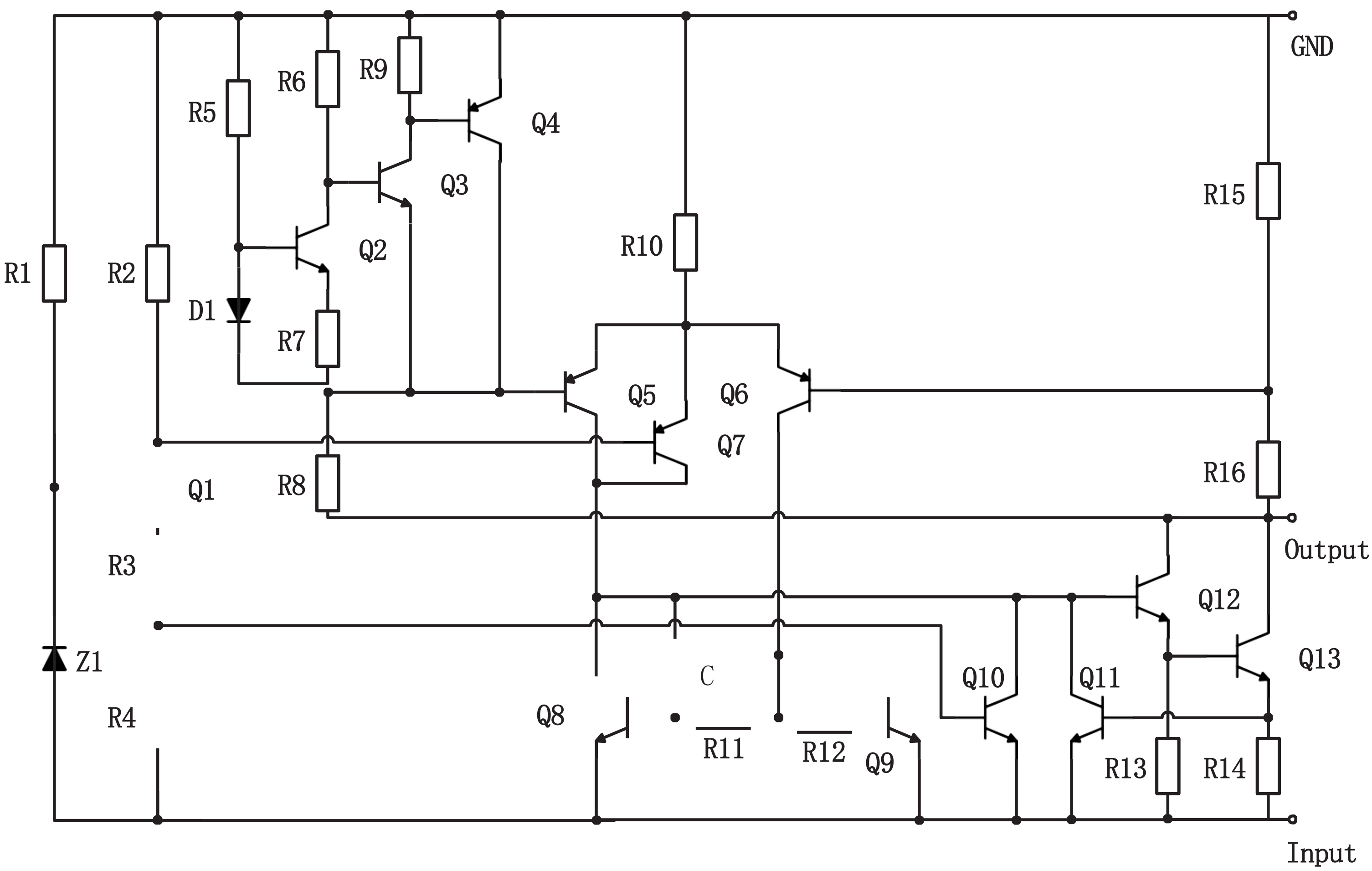


7 Detailed Description

7.1 Description

The VS7900E series is a group of fixed output negative voltage regulators. It integrates built-in current limit, short-circuit protection, thermal overload protection and safe operating area protection of output transistor, which makes it relatively difficult to be damaged. By setting the resistance value of peripheral resistance, the VS7900E series can also be used as adjustable voltage output regulator.

7.2 Representative Schematic Diagram



7.3 Feature Description

Input Voltage

When the input voltage is lower than the rated range of the data sheet, the device will lose the regulation function of stabilizing the output voltage, that is, it is unable to maintain the output voltage within the rated range. When the input voltage is higher than the rated range of the data sheet, the device may cause irreversible damage or failure due to exceeding the maximum rated range of electrical stress.

Built-in Current Limit & Short Circuit Protection

The VS7900E series has built-in current limit and short circuit protection. When the output current of the device is too high, the output of the device will be shut down. When the output of the device is short circuited to ground, the output of the device will also be shut down and the output current will be maintained within a certain range.
The typical current limits for the VS7900E series is 2.2A.

7 Detailed Description

7.3 Feature Description (continued)

Thermal Shutdown Protection

The VS7900E series has thermal shutdown protection. When the junction temperature exceeds the rated temperature range for normal operation in the data sheet, the device will enter the thermal shutdown state. At this time, the output voltage of the device will be reduced to prevent catastrophic damage to the chip due to accidental heat. When the junction temperature decreases and no longer remains too high, the device will release the thermal shutdown and output normally. To ensure reliable operation, please limit the junction temperature to the specified range of recommended operating conditions in the data sheet. Applications that exceed the recommended temperature range may cause the device to exceed its operating specifications.

Although the internal protection circuitry of the device is designed to protect against thermal overall conditions, this circuitry is not intended to replace proper heat sinking. Continuously running the device into thermal shutdown or above the maximum recommended junction temperature reduces long-term reliability.

Output Current

Due to the internal integration of thermal shutdown protection, in the case of large output current, the device may enter the thermal shutdown state because the junction temperature is higher than the rated value in the data sheet. Therefore, the appropriate package should be selected for circuit design according to the heat dissipation power consumption of the package and the effective connection thermal resistance with the environment, so as to make the device emit more heat energy, so as to ensure the maximum load current capacity of the device. If the circuit design is appropriate and the device has good heat dissipation conditions, the VS7900E series can output a current of up to 1.5A.

8 Application and Implementation

8.1 Risk Alert and Precautions

The VS7900E series is designed with thermal protection, output short circuit protection and output transistor SOA protection. However, like any IC regulator, precautions are necessary to reduce the possibility of accidental damage to the regulator. The following describes the possible causes of unit damage or failure:

Electrostatic Discharge (ESD) and Instantaneous Electrical Surge

Electrostatic discharge (ESD) is a common near-field hazard source. It comes from many sources, such as human body, mechanical equipment and electronic components themselves. ESD can cause phenomena such as high voltage and instantaneous high current in a very short time, resulting in damage or failure of the device due to electric shock.

In some applications, a short duration but high energy spike may occur in the circuit, including peak voltage and surge current. They may cause unstable operation of the regulator, accelerated aging and potential hazards, and even damage or malfunction of the regulator. These peaks are usually more likely to occur in hot-plug, switch inductance, heavy-load, and other types of circuits.

Precautions for ESD and Electrical Surge

In the practical application of the circuit, adopting the following suggestions can reduce the possibility of device failure due to the above reasons to a certain extent.

Using TVS:

Place a TVS between the IN and GND of the voltage regulator to absorb the peak voltage that may be generated due to ESD or other reasons. As shown in Figure 9-4;

Using Input Resistor:

Place a resistor with appropriate resistance in series before the IN of the voltage regulator, which can help the voltage regulator share part of the energy in case of surge. The resistance value of the resistance should not be too large. The specific resistance value depends on the application of the circuit. Generally, the resistance value of this resistance does not exceed 20Ω. As shown in Figure 9-5;

Using Electrolytic Capacitor:

For the application circuit using the low ESR multilayer ceramic capacitor (MLCC) type input capacitor, the LC resonant voltage spike caused by hot plugging or power transmission line inductance can be suppressed by using RC suppression circuit for parallel connection of the input capacitor. A very simple method is to parallel a suitable electrolytic capacitor to the input capacitor. As shown in Figure 9-6. For most 100μF/25V electrolytic capacitor has an ESR of about 0.2Ω at 100kHz. This can completely suppress the overshoot phenomenon of the input and minimize the possibility of IC damage due to input voltage spikes.

Figure 9-1 and Figure 9-2 show the impact of not using electrolytic capacitor [Test circuit is shown in Figure 9-3] and using 100μF/25V electrolytic capacitor parallel to the input capacitor [Test circuit is shown in Figure 9-6] on suppressing surge voltage. As shown in Figure 9-1., when the input is powered on from 0 to 10V, a peak voltage of up to 17V (shown in the RED part) is generated in front of the input terminal of the device. When the electrolytic capacitor is used, as shown in Figure 9-2., the peak voltage generated by power on is effectively suppressed (shown in the GREEN part).

8 Application and Implementation

8.1 Risk Alert and Precautions (continued)

Test Condition: VS7905E, C_{IN} = 10μF (MLCC), C_{OUT} = 100μF, V_{IN} = 0 ~ -10V, I_{OUT} = 100mA, CH_1: V_{IN}, CH_2: V_{OUT}.

Figure 9-1. Test with the conventional circuit

[Test Circuit is shown in Figure 9-3]

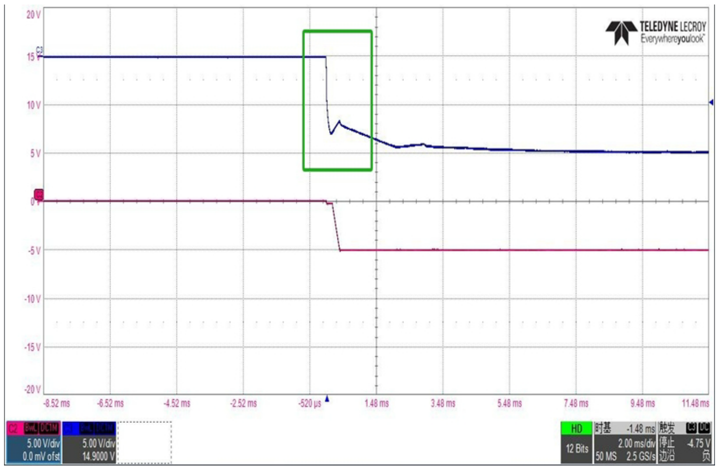


Figure 9-2. Test with the circuit that a 100μF/-25V electrolytic capacitor parallel to the C_{IN} [Test Circuit is shown in Figure 9-6]

For the VS7900E series, it is recommended that the input peak voltage should not exceed 36V. When the input voltage of the operating circuit may not meet the application conditions described above, it is recommended to adopt the circuit layout shown in Figure 9-5 in the circuit design.

Large Output Capacitance

The VS7900E series can obtain better transient response with the help of output capacitance. However, if the output capacitor is relatively large, the surge current generated by the charging of the output capacitor will also be large at the moment of power on of the regulator, and the large surge current passing through the regulator may damage the internal circuit. When the output capacitance is large, adopting the circuit design shown in Figure 9-5 will reduce the possibility of damage to the device due to large surge current to a certain extent. It is recommended that the selection of output capacitor should not exceed 20μF. **If the selection of output capacitor exceeds 20μF, it is recommended to adopt the circuit design in Figure 9-5 to reduce the possibility of accidental failure of the device due to large surge current during power on.**

8.2 Typical Application Circuits

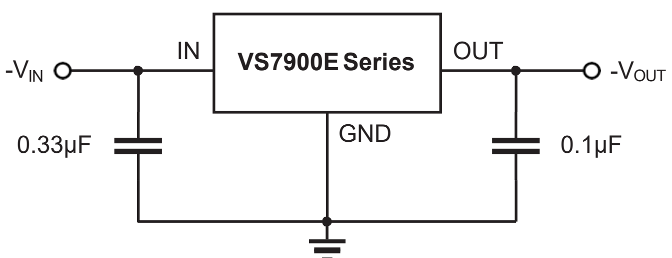


Figure 9-3. Conventional Circuit

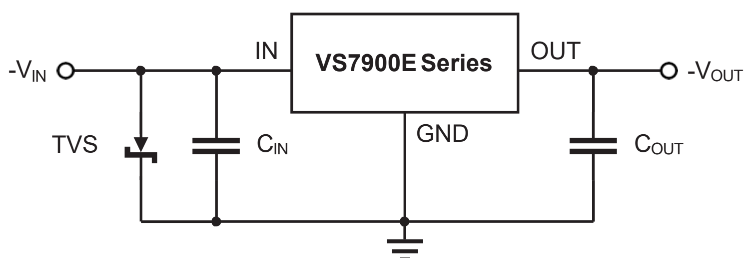
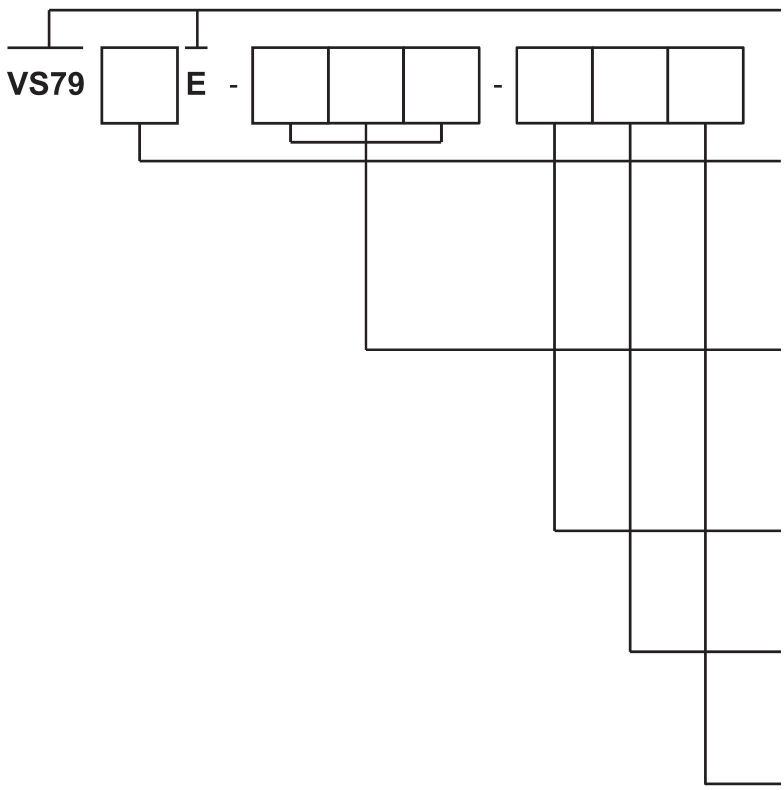


Figure 9-4. TVS is used at IN

Orderable Information



Device serial number.

Output voltage.
05: Fixed output 5.0V
06: Fixed output 6.0V
08: Fixed output 8.0V
09: Fixed output 9.0V
12: Fixed output 12V
15: Fixed output 15V

Package type.
TBN: TO-220-3L
TCN: TO-220F
TFN: TO-252-2L
TGN: TO-263-2L

Output voltage tolerances.
A: ±2% grade
B: ±1% grade

Outer package option.
R: Tape and reel
T: Tube

Eco-label.
G: Green device, halogen free and lead free

Figure a. VS78L00E Series Naming Convention

MODEL	DEVICE	PACKAGE	OP T_J	ECO PLAN	MSL	PACKING OPTION	SORT
Conventional Device							
VS7900E-5.0	VS7905E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	N / A for Pkg Type	Tube 50 Units / Rail	Active
VS7900E-6.0	VS7906E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	PkgN/ATyforpe	Tube 50 Units / Rail	Active
VS7900E-8.0	VS7908E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	ATyforpe PkgN/	Tube 50 Units / Rail	Active
VS7900E-9.0	VS7909E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	N / A for Pkg Type	Tube 50 Units / Rail	Active
VS7900E-12	VS7912E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	ATyforpe PkgN/	Tube 50 Units / Rail	Active
VS7900E-15	7915E-TBN-ATG	TO-220-3L	-40 ~ 125°C	RoHS & Green	PkgN/ATyforpe	Tube 50 Units / Rail	Active