CSC™ CHERRY SEMICONDUCTOR

CS-935

LOW DROPOUT DUAL REGULATOR

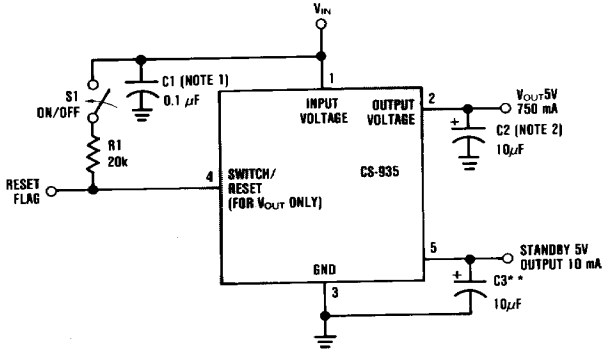
DESCRIPTION

The CS-935 is a low dropout, high current regulator. Also included is a standby 5V/10mA output for powering systems with standby memory. Quiescent current drain is less than 3mA when supplying 10mA loads from the standby regulator.

In automotive applications, the CS-935 and all regulated circuits are protected from reverse battery installations, as well as two-battery jumps. During line transients, such as a 60V load dump, the 0.75A regulator will automatically shut down to protect both internal circuits and the load, while the standby regulator will continue to power any standby load.

The CS-935 is packaged in a 5-lead TO-220, with copper tab for connection to a heat sink, if necessary.
NOTE: The CS-935 is pin-compatible with the LM2935.

TEST AND APPLICATION CIRCUIT

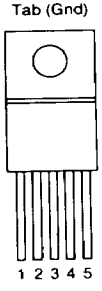


NOTES:
1. C1 required if regulator is located far from power supply filter.
2. C2 required for stability . . . value may be increased. Capacitor must operate at min. temp. expected.

FEATURES:

- Two regulated outputs
- Output current in excess of 750 mA
- Low quiescent current standby regulator
- Input-output differential less than 0.6V at 0.5A
- Reverse battery protection
- 60V load dump protection
- -50V reverse transient protection
- Short circuit protection
- Internal thermal overload protection
- ON/OFF switch for high current output
- Reset error flag

PIN CONNECTIONS



1. Input voltage
2. Output voltage
3. Ground
4. Switch/reset
5. Standby/Output

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ABSOLUTE MAXIMUM RATINGS

Input Voltage	
Operating Range	26V
Overvoltage Protection	60V
Internal Power Dissipation (Note 1)	Internally Limited
Operating Temperature Range	-40°C to +125°C
Maximum Junction Temperature	150°C
Storage Temperature Range	-65°C to +150°C

ELECTRICAL CHARACTERISTICS for V_{OUT} (V_{IN}=14V, I_O=500 mA, T_j=25°C unless otherwise specified)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	6V≤V_{IN}≤26V, I_O≤500 mA, -40°C≤T_j≤+125°C (Note 2)	4.75	5.00	5.25	V
Line Regulation	9V≤V_{IN}≤16V, I_O=5 mA 6V≤V_{IN}≤26V, I_O=5 mA		4 10	25 50	mV mV
Load Regulation	5 mA≤I_O≤500 mA		10	50*	mV
Output Impedance	500 mA_{DC} and 10 mArms, 100 Hz-10 kHz		200		mΩ
Quiescent Current	I_O≤10 mA, No Load on Standby I_O=500 mA, No Load on Standby I_O=750 mA, No Load on Standby		3 35 100	 100	mA mA mA
Output Noise Voltage	10 Hz-100 kHz		100		μVrms
Long Term Stability			20		mV/1000 hr
Ripple Rejection	f_O=120 Hz		66		dB
Dropout Voltage	I_O=500 mA I_O=750 mA		0.35 0.5	0.6	V V
Current Limit		0.75	1.4		A
Maximum Operational Input Voltage		26	31		V
Maximum Line Transient	V_O≤5.5V	60	90		V
Reverse Polarity Input Voltage, DC	V_O≥-0.6V, 10Ω Load	-15	-50		V
Reverse Polarity Input Voltage, Transient	1% Duty Cycle, τ≤100ms, V_O≥-6V, 10Ω Load	-50	-80		V
Reset Output Voltage Low High	 R1=20k, V_{IN}=4.5V R1=20k, V_{IN}=14V	 4.5	 0.8 5.0	 1 5.5	 V V
Reset Output Current	V_{IN}=4.5V, Reset in Low State		5		mA
ON/OFF Resistor	R1 (±10% Tolerance)		20	30	kΩ

Note 1: Thermal resistance without a heat sink for junction to case temperature is 4°C/W (TO-220). Thermal resistance for TO-220 case to ambient temperature is 50°C/W.

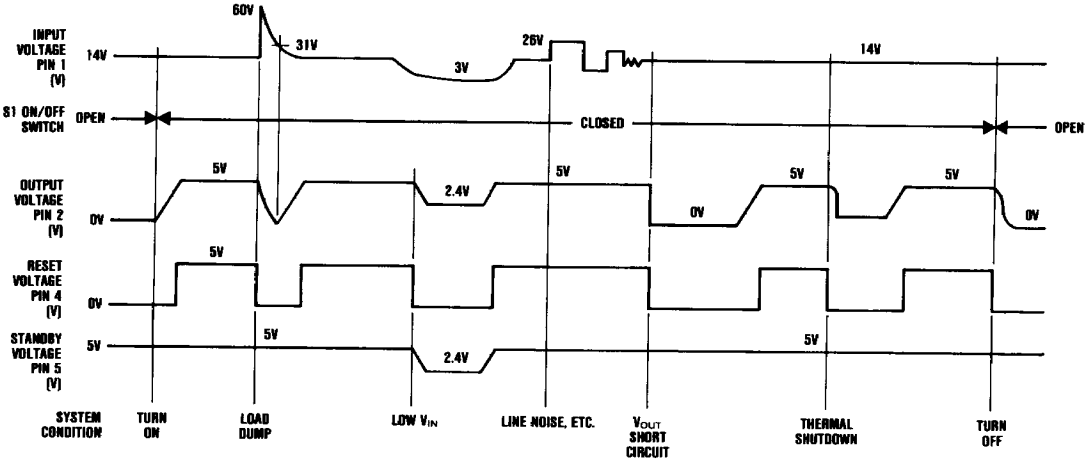
Note 2: The temperature extremes are guaranteed but not 100% production tested.

*End of life limit is 65mV.

ELECTRICAL CHARACTERISTICS FOR STANDBY OUTPUT (V_{IN}=14V, I_O=10 mA, T_j=25°C unless otherwise specified)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Output Voltage	$I_O \leq 10$ mA, $-40°C \leq T_j \leq 125°C$ $6V \leq V_{IN} \leq 26V$ (Note 2)	4.75	5.0	5.25	V
Tracking	V_{OUT}–Standby Output Voltage		50	200	mV
Line Regulation	$6V \leq V_{IN} \leq 26V$		4	50	mV
Load Regulation	$1\ mA \leq I_O \leq 10$ mA		10	50	mV
Output Impedance	10 mA_{DC} and 1 mArms, 100 Hz-10 kHz		1		Ω
Quiescent Current	$I_O \leq 10$ mA, $-40°C \leq T_j \leq +125°C$, V_{OUT} OFF (Note 2)		2	3	mA
Output Noise Voltage	10 Hz-100 kHz		300		μV
Long Term Stability			20		mV/1000 hr
Ripple Rejection	f_o=120 Hz		66		dB
Dropout Voltage	$I_O \leq 10$ mA		0.3	0.7	V
Current Limit		25	70		mA
Maximum Operational Input Voltage	$4.5V \leq V_O \leq 6V$	60	90		V
Reverse Polarity Input Voltage, DC	$V_O \leq -0.3V$, 510Ω Load	-15	-50		V
Reverse Polarity Input Voltage, Transient	1% Duty Cycle, $\tau \leq 100$ ms, $V_O \geq -6V$ 500Ω Load	-50	-80		V

TYPICAL CIRCUIT WAVEFORMS



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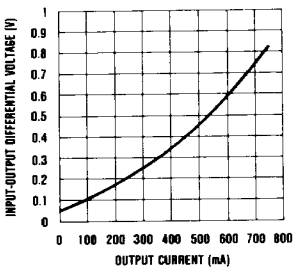
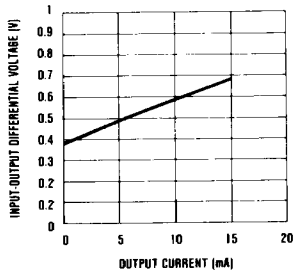
TYPICAL PERFORMANCE CHARACTERISTICS

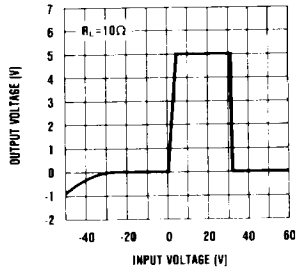
Dropout Voltage (V_{OUT})



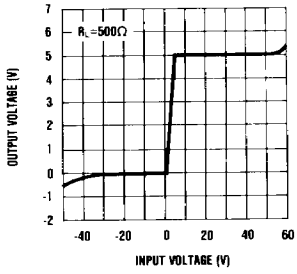
Dropout Voltage (V_{STBY})



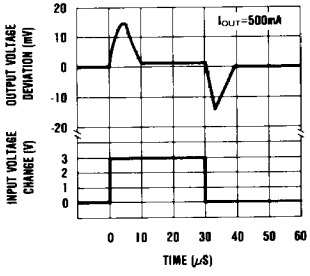
Output Voltage (V_{OUT})



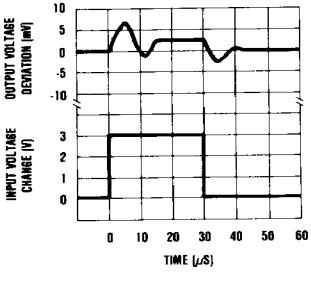
Output Voltage (V_{STBY})



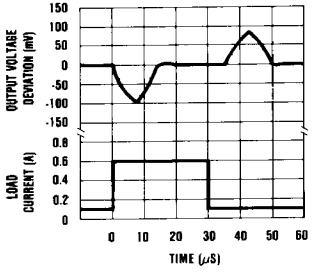
Line Transient Response (V_{OUT})



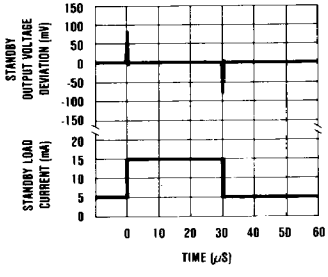
Line Transient Response (V_{STBY})



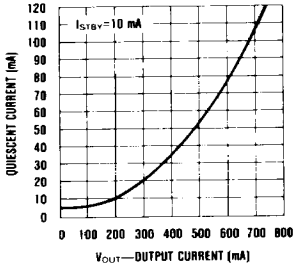
Load Transient Response (V_{OUT})



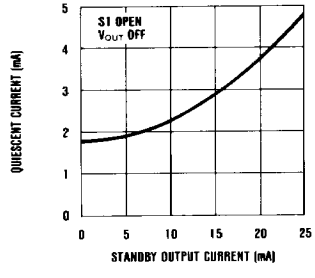
Load Transient Response (V_{STBY})



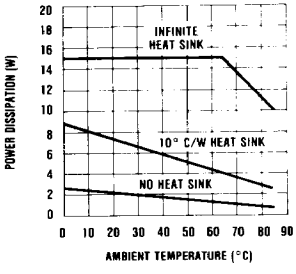
Quiescent Current (V_{OUT})



Quiescent Current (V_{STBY})



Maximum Power Dissipation (TO-220)



DEFINITION OF TERMS

Dropout Voltage: The input-output voltage differential at which the circuit ceases to regulate against further reduction in input voltage. Measured when the output voltage has dropped 100 mV from the nominal value obtained at 14V input, dropout voltage is dependent upon load current and junction temperature.

Input Voltage: The DC voltage applied to the input terminals with respect to ground.

Input-Output Differential: The voltage difference between the unregulated input voltage and the regulated output voltage for which the regulator will operate.

Line Regulation: The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Load Regulation: The change in output voltage for a change in load current at constant chip temperature.

Long Term Stability: Output voltage stability under accelerated life-test conditions after 1000 hours with maximum rated voltage and junction temperature.

Output Noise Voltage: The rms AC voltage at the output, with constant load and no input ripple, measured over a specified frequency range.

Quiescent Current: The part of the positive input current that does not contribute to the positive load current. The regulator ground lead current.

Ripple Rejection: The ratio of the peak-to-peak input ripple voltage to the peak-to-peak output ripple voltage.

Temperature Stability of V_O: The percentage change in output voltage for a thermal variation from room temperature to either temperature extreme.

Current Limit: Peak current that can be delivered to the output

APPLICATIONS HINTS

EXTERNAL CAPACITORS

The CS-935 output capacitors are required for stability. Without them, the regulator outputs will oscillate. The 10μF shown are the minimum recommended values. Actual size and type may vary depending upon the application load and temperature range. Capacitor effective series resistance (ESR) is also a factor in the IC stability. Worst-case is usually determined at the minimum ambient temperature and maximum load expected.

Output capacitors can be increased in size to any desired value above the minimum. One possible purpose of this would be to maintain the output voltages during brief conditions of negative input transients that might be characteristic of a particular system.

Capacitors must also be rated at all ambient temperatures expected in the system. To maintain regulator stability down to - 40°C, capacitors rated at that temperature (such as tantalums) must be used.

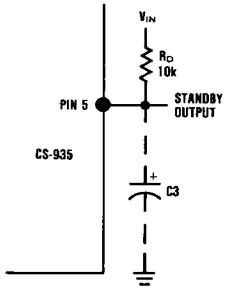
No capacitor should be attached to the ON/OFF and RESET FLAG pin. Due to the internal circuits of the IC, oscillation on this pin could result.

STANDBY OUTPUT

The CS-935 differs from most fixed voltage-regulators in that it is equipped with two regulator outputs instead of one. The additional output is intended for use in systems requiring standby memory circuits. While the high current regulator ouput can be controlled with the ON/OFF pin described below, the standby output remains on under all conditions as long as sufficient input voltage is applied to the IC. Thus, memory and other circuits powered by this output remain unaffected by positive line transients, thermal shutdown, etc.

The standby regulator circuit is designed so that the quiescent current to the IC is very low (<3 mA) when the other regulator output is off.

In applications where the standby output is not needed, it may be disabled by connecting a resistor from the standby output to the supply voltage. This eliminates the need for a capacitor on the output to prevent unwanted oscillations. The value of the resistor depends upon the minimum input voltage expected for a given system. Since the standby output is shunted with an internal 5.7V zener, the current through the external resistor should be sufficient to bias Pin 5 up to this point. Approximately 60μA will suffice, resulting in a 10k external resistor for most applications.



Disabling Standby Output to Eliminate C3

HIGH CURRENT OUTPUT

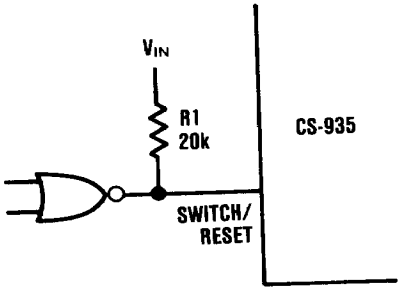
Unlike the standby regulated output, which must remain on whenever possible, the high current regulated output is fault protected against overvoltage and also incorporates thermal shutdown. If the input voltage rises above approximately 30V (e.g., load dump), this output will automatically shutdown. This protects the internal circuitry and enables the IC to survive higher voltage transients than would otherwise be expected. Thermal shutdown is effective against die overheating since the high current output is the dominant source of power dissipation in the IC.

ON/OFF AND RESET FLAG PIN

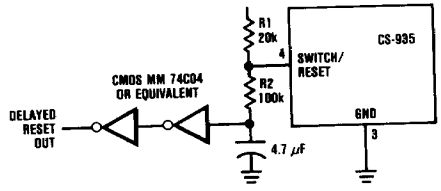
This pin has the ability to serve a dual purpose if desired. When controlled in the manner shown in the test circuit (common in automotive systems where S1 is the ignition switch), the pin also serves as an output flag that is active low whenever a fault condition is detected with the high current regulated output. In other words, under normal operating conditions, the output voltage of this pin is high (5V). This is set by an internal clamp. If the high current output becomes unregulated for any reason (line transients, short circuit, thermal shutdown, low input voltage, etc.) the pin switches to the active low state, and is capable of sinking several milliamps. This output signal can be used to initiate any reset or start-up procedure that may be required of the system.

Application Hints (Continued)

The ON/OFF pin can also be driven directly from logic circuits. The only requirement is that the 20k pull-up resistor remain in place. This will not affect the logic gate since the voltage on this pin is limited by the internal clamp to 5V. The error flag is sacrificed in this arrangement since the maximum sink capability of the pin in the active low state approximately 5 mA) is usually not sufficient to pull down the active high logic gate. Of course, the flag can be retained if the driving gate is open collector logic.



Controlling ON/OFF Terminal with a Typical CMOS or TTL Logic Gate



Reset Pulse on Power-Up (with approximately 300 ms delay)

ORDERING INFORMATION

PART NUMBER	DESCRIPTION
CS-935	TO220

CHERRY SEMICONDUCTOR

2000 South County Trail, East Greenwich, Rhode Island 02818
Tel: (401)885-3600 Telefax(401)885-5786 Telex WUI 6817157

Our Sales Representative in Your Area is: