

## QUAD VOLTAGE REGULATOR WITH INHIBIT AND RESET

- 4 OUTPUTS: 10V (300mA); 8V (400mA); 5V (600mA); 5V (100mA)
- ALL FOUR OUTPUTS ARE LOW DROP
- 5V (100mA) ST-BY OUTPUT VOLTAGE
- EARLY WARNING OUTPUT FOR SUPPLY UNDERVOLTAGE (LVW)
- THERMAL SHUTDOWN AND CURRENT LIMITATION (FOLDBACK)
- REVERSE BATTERY AND LOAD DUMP PROTECTION
- INHIBIT (ON/OFF) AND RESET FUNCTIONS

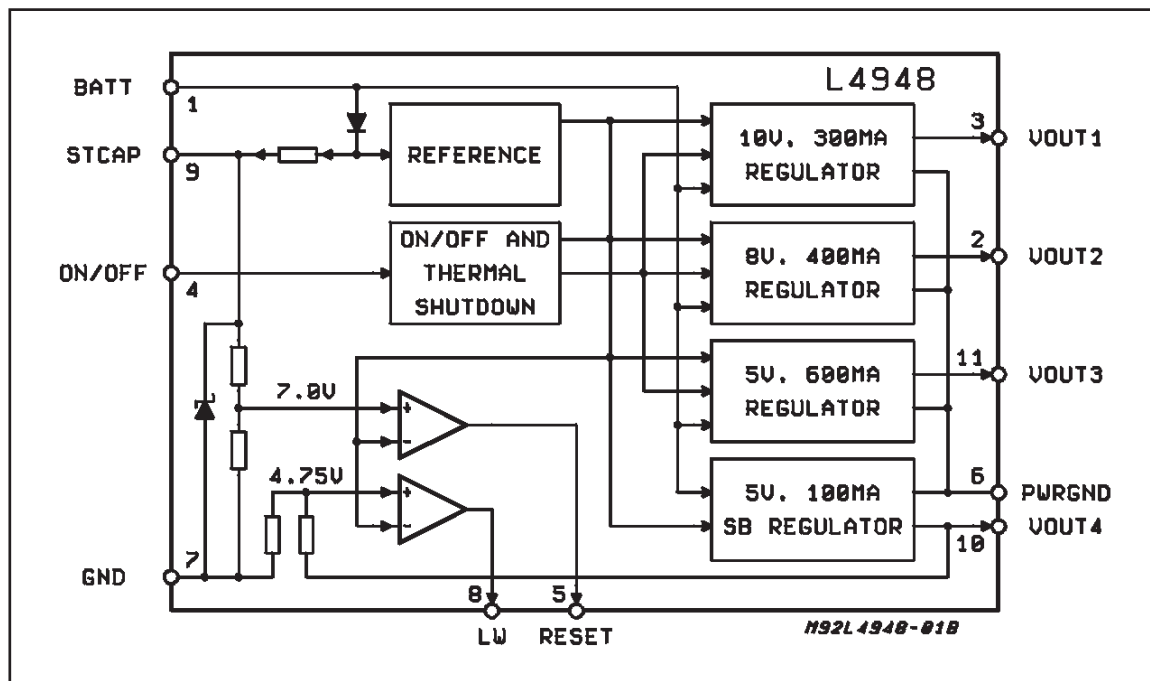
### DESCRIPTION

The L4948 is a quad output low drop voltage regulator. All four outputs are low drop: 10V at 300mA ( $V_{O1}$ ), 8V at 400mA ( $V_{O2}$ ), 5V at 600mA ( $V_{O3}$ ) and a 5V st-by line at 100mA ( $V_{O4}$ ).

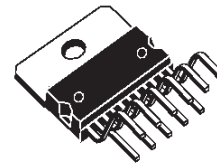
The IC includes a monitoring circuit to warn if a low voltage or no voltage condition is occurring.  $V_{O1,2,3}$  are off during st-by mode.

The STCAP pin allows the battery voltage to de-

### BLOCK DIAGRAM



### MULTIPOWER BCD TECHNOLOGY



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ORDERING NUMBER: L4948

may slowly giving the  $\mu\text{P}$  time to store data. This IC is designed for supplying microcomputer controlled systems specially in automotive applications.

# L4948

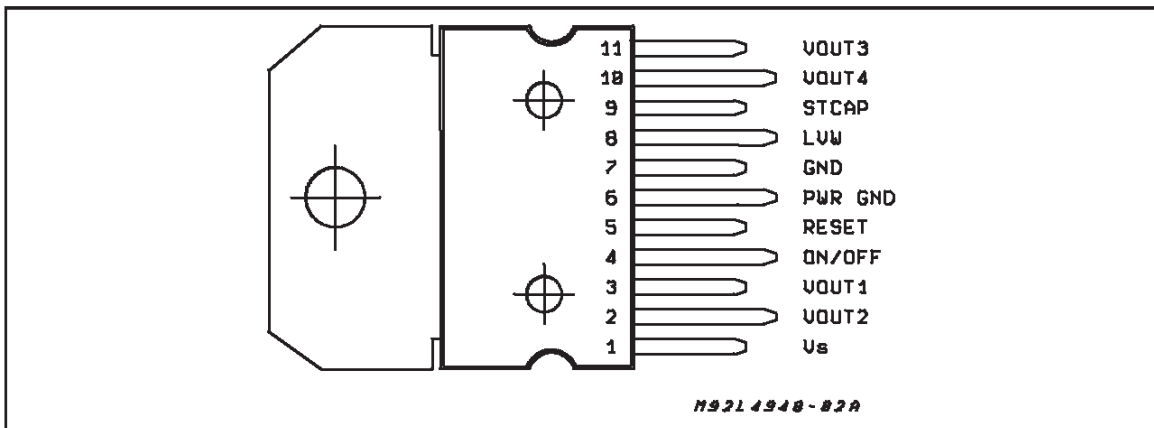
## OPERATING CONDITION

Symbol	Parameter	Value	Unit
$V_S$	Supply Voltage	-15 to 27	V
$I_L$	Load Current $I_{O1}$	300	mA
	$I_{O2}$	400	mA
	$I_{O3}$	600	mA
	$I_{O4}$	100	mA

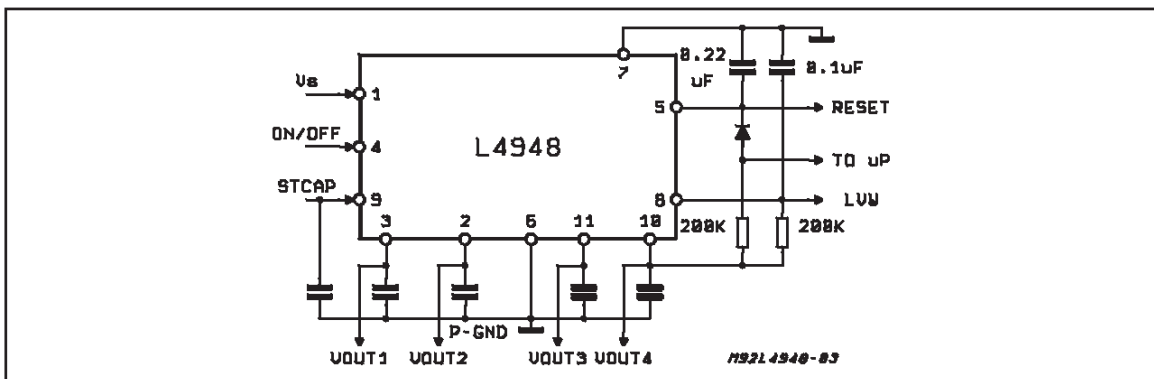
## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_S$	Supply Voltage	-35 to 60	V
$V_I$	Input Voltage (ON/OFF)	0 to 12	V
$V_O$	Output Voltage (LVW, Reset)	0 to 12	V
$T_{stg}$	Storage Temperature Range	-65 to 150	°C
$T_j$	Junction Temperature Range	max 150	°C
	Load Dump (5ms rise, 115ms decay)	60	V

## PIN CONNECTION



## APPLICATION CIRCUIT



## THERMAL DATA

Symbol	Parameter	Value	Unit
$R_{th\ j-case}$	Thermal Resistance Junction-case	max 2	°C/W

**ELECTRICAL CHARACTERISTICS** ( $V_S = 10.5$  to  $16V$ ;  $I_{O1} = 6mA$ ,  $I_{O2} = 8mA$ ,  $I_{O3} = 4mA$ ;  $I_{O4} = 0.4mA$ ;  $C_O = 10\mu F$  max;  $T_{amb} = -40$  to  $85^\circ C$ , unless otherwise specified.)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{O1}$	Output Voltage	$I_{O1} = 300mA$ ; $T_{amb} = 25^\circ C$ ; $11V < V_S < 16V$ all temps	9.7 9.5	10 10	10.3 10.5	V V
$\Delta V_{O1}$	Load Regulation	$I_{O1} = 6$ to $300mA$			150	mV
$I_Q$	Quiescent Current ( $\Delta I_S$ )	$V_S = 14V$ ; $I_{O1} = 6mA$ ; $V_S = 14V$ ; $I_{O1} = 300mA$ ;			10 30	mA mA
$V_S - V_{O1}$	Dropout Voltage	$I_{O1} = 300mA$  $T_{amb} = 25^\circ C$ ; all temps			400 600	mV mV
$I_L$	Current Limit (Foldback) note1	$V_{O1} = 0V$	360		800	mA
$V_{O1}$	Max Bat. Trans.	$R_O = 100\Omega$ Ramp $V_S$ from 14 to 60V in 3-5ms  Hold $V_S$ at 60V for 10ms Ramp $V_S$ from 60 to 14V in 3-5ms; $T_{amb} = 25^\circ C$ ; all temps			11 2	V V
$V_{O1}$	Rev. Voltage Trans.	$V_S = -35V$ ; $t \leq 1ms$ ; $R_O = 100\Omega$ Check $V_{O1}$ , $T_{amb} = 25^\circ C$ ; all temps	9.7 9.5	10 10	10.3 10.5	V V
$V_{O1}$	Rev. Voltage .	$V_S = -15V$ ; $R_O = 100\Omega$	-0.4		1	V
	Ripple rejection	$f_o = 1KHz$ ; $1V_{pp} AC$ ; $V_S = 14V$ $I_{O1} = 180mA$ ; $I_{O2} = 200mA$ ; $I_{O3} = 400mA$ ; $I_{O4} = 40mA$ ;  $f_o = 10KHz$ ; $1V_{pp} AC$ ; $V_S = 14V$ $I_{O1} = 180mA$ ; $I_{O2} = 200mA$ ; $I_{O3} = 400mA$ ; $I_{O4} = 40mA$ ;	50			dB dB
$\Delta V_{O1}$	Line Regulation $\Delta V_{O1}$ across $V_S$ range	$V_S = 11V$ to $26V$			50	mV
	Output Noise	Check Output for AC noise using a 100KHz LP filter Check Output for AC noise using an A weighted filter (20- 20KHz)			400 200	$\mu V$ $\mu V$
$V_{O2}$	Output Voltage	$I_{O2} = 400mA$ ; $T_{amb} = 25^\circ C$ ; all temps	7.75 7.60	8 8	8.25 8.40	V V
$\Delta V_{O2}$	Load Regulation	$I_{O2} = 8$ to $400mA$			150	mV
$\Delta I_Q$	Quiescent Current ( $\Delta I_S$ )	$V_S = 14V$ ; $I_{O2} = 8mA$ ; $V_S = 14V$ ; $I_{O2} = 400mA$ ;			10 35	mA mA
$V_S - V_{O2}$	Dropout Voltage	$I_{O2} = 400mA$ set $V_S = V_{O2} + 1V$ ; $T_{amb} = 25^\circ C$ ; set $V_S = V_{O2} + 1.5V$ ; all temps			400 600	mV mV
$I_L$	Current Limit (Foldback) note1	$V_{O2} = 0V$	480		960	mA
$V_{O2}$	Max Bat. Trans.	$R_O = 100\Omega$ Ramp $V_S$ from 14 to 60V in 3-5ms  Hold $V_S$ at 60V for 10ms Ramp $V_S$ from 60 to 14V in 3-5ms; $T_{amb} = 25^\circ C$ ; all temps			9 2	V V
			7.75 7.60	8 8	8.25 8.40	V V

## ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>O2</sub>	Rev. Voltage Trans.	V <sub>S</sub> = -35V; R <sub>O</sub> = 100Ω t ≤ 1ms Check V <sub>O2</sub> , standard T <sub>amb</sub> = 25°C; all temps	7.75	8	8.25	V
			7.60	8	8.40	V
V <sub>O2</sub>	Rev. Voltage .	V <sub>S</sub> = -15V; t = 30s; R <sub>O</sub> = 100Ω	-0.4		1	V
	Ripple rejection	f <sub>0</sub> = 1KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V I <sub>O1</sub> = 180mA; I <sub>O2</sub> = 200mA; I <sub>O3</sub> = 400mA; I <sub>O4</sub> = 40mA;	50			dB
		f <sub>0</sub> = 10KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V I <sub>O1</sub> = 180mA; I <sub>O2</sub> = 200mA; I <sub>O3</sub> = 400mA; I <sub>O4</sub> = 40mA;	50			dB
ΔV <sub>O2</sub>	Line Regulation ΔV <sub>O2</sub> across V <sub>S</sub> range	V <sub>S</sub> = 10.5V to 26V			40	mV
V <sub>O3</sub>	Output Voltage	I <sub>O3</sub> = 600mA; T <sub>amb</sub> = 25°C; all temps	4.85	5	5.15	V
			4.75	5	5.25	V
ΔV <sub>O3</sub>	Line Regulation	V <sub>S</sub> = 7V to 26V			40	mV
ΔV <sub>O3</sub>	Load Regulation	I <sub>O3</sub> = 4 to 600mA			100	mV
ΔI <sub>Q</sub>	Quiescent Current (ΔI <sub>S</sub> )	V <sub>S</sub> = 14V; I <sub>O3</sub> = 4mA; V <sub>S</sub> = 14V; I <sub>O3</sub> = 600mA;			8	mA
					40	mA
V <sub>S</sub> -V <sub>O3</sub>	Dropout Voltage	I <sub>O3</sub> = 600mA set V <sub>S</sub> = V <sub>O3</sub> +1V; T <sub>amb</sub> = 25°C; set V <sub>S</sub> = V <sub>O3</sub> +1.5V;all			400 600	mV mV
I <sub>L</sub>	Current Limit (Foldback) note 1	V <sub>O3</sub> = 0V	720		1440	mA
V <sub>O3</sub>	Max Bat. Trans.	R <sub>O</sub> = 100Ω Ramp V <sub>S</sub> from 14 to 60V in 3-5ms			6	V
		Hold V <sub>S</sub> at 60V for 10ms Ramp V <sub>S</sub> from 60 to 14V in 3-5ms; T <sub>amb</sub> = 25°C;			2	V
		all temps	4.85 4.75	5 5	5.15 5.25	V V
V <sub>O3</sub>	Rev. Voltage Trans.	V <sub>S</sub> = -35V; t ≤ 1ms; R <sub>O</sub> = 100Ω Check V <sub>O3</sub> , standard T <sub>amb</sub> = 25°C; all temps	4.85	5	5.15	V
			4.75	5	5.25	V
V <sub>O3</sub>	Rev. Voltage .	V <sub>S</sub> = -15V; R <sub>O</sub> = 100Ω	-0.4		1	V
	Ripple rejection	f <sub>0</sub> = 1KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V I <sub>O1</sub> = 180mA; I <sub>O2</sub> = 200mA; I <sub>O3</sub> = 400mA; I <sub>O4</sub> = 40mA;	50			dB
		f <sub>0</sub> = 10KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V	50			dB
	Output Noise	Check Output for AC noise using a 100KHz LP filter Check Output for AC noise using an A weighted filter (20- 20KHz)			400	μV
					200	μV
V <sub>O4</sub>	Output Voltage	I <sub>O4</sub> = 100mA; T <sub>amb</sub> = 25°C; all temps	4.85	5	5.15	V
			4.75	5	5.25	V
ΔV <sub>O4</sub>	Line Regulation	V <sub>S</sub> = 7V to 26V			40	mV
ΔV <sub>O4</sub>	Load Regulation	I <sub>O4</sub> = 0.4 to 100mA			80	mV
ΔI <sub>Q</sub>	Quiescent Current	V <sub>S</sub> = 14V; I <sub>O4</sub> = 2mA; V <sub>S</sub> = 14V; I <sub>O4</sub> = 100mA;			450	μA
					20	mA
V <sub>S</sub> -V <sub>O4</sub>	Dropout Voltage	I <sub>O4</sub> = 100mA set V <sub>S</sub> = V <sub>O4</sub> +0.5V; T <sub>amb</sub> = 25°C; set V <sub>S</sub> = V <sub>O4</sub> +0.8V;all temps			400 600	mV mV
I <sub>L</sub>	Current Limit (Foldback) note 1	V <sub>O4</sub> = 0V	150		300	mA

## ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>O4</sub>	Max Bat. Trans.	R <sub>O</sub> = 1000Ω Ramp V <sub>S</sub> from 14 to 60V in 3-5ms			6	V
		Hold V <sub>S</sub> at 60V for 10ms Ramp V <sub>S</sub> from 60 to 14V in 3-5ms; T <sub>amb</sub> = 25°C; all temps	4.85 4.75	5 5	6 5.15 5.25	V V V
V <sub>O4</sub>	Rev. Voltage Trans.	V <sub>S</sub> = -35V; t < 1ms; R <sub>O</sub> = 1000Ω Check V <sub>O4</sub> ; standard T <sub>amb</sub> = 25°C; all temps	4.85 4.75	5 5	5.15 5.25	V V
V <sub>O4</sub>	Rev. Voltage .	V <sub>S</sub> = -15V; R <sub>O</sub> = 1000Ω	-0.4		1	V
	Ripple rejection	f <sub>o</sub> = 1KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V I <sub>o1</sub> = 180mA; I <sub>o2</sub> = 200mA; I <sub>o3</sub> = 400mA; I <sub>o4</sub> = 40mA;	50			dB
		f <sub>o</sub> = 10KHz; 1V <sub>pp</sub> AC; V <sub>S</sub> = 14V I <sub>o1</sub> = 180mA; I <sub>o2</sub> = 200mA; I <sub>o3</sub> = 400mA; I <sub>o4</sub> = 40mA;	50			dB
	Output Noise	Check Output for AC noise using a 100KHz LP filter			400	μV
		Check Output for AC noise using an A weighted filter (20- 20KHz)			200	μV
ON/OFF	Input Current	V <sub>S</sub> = 14V; V <sub>IH</sub> = >2V; V <sub>S</sub> = 14V; V <sub>IL</sub> = <0.8V;	-10		1	μA μA
V <sub>I ON/OFF</sub>	Input Threshold	V <sub>S</sub> = 14V V <sub>IL</sub>	0		0.8	V
		V <sub>S</sub> = 14V V <sub>IH</sub>	2		12	V
V <sub>R</sub>	Reset Output Voltage Set	V <sub>S</sub> so that V <sub>O4</sub> < 4.5V; R <sub>O</sub> = 200KΩ to V <sub>O4</sub> ; V <sub>IL</sub> = "0"	0		0.75	V
		V <sub>S</sub> so that V <sub>O4</sub> -0.15V; R <sub>O</sub> = 200KΩ to V <sub>O4</sub> ; V <sub>IH</sub> = "1"	2.75		5	V
	LVW and Reset fall Time Set	Measured from 90% to 10%			150	μs
	LVW and Reset Rise Time	Measured from 90% to 100%			300	μs
	LVW Output Threshold	Ramp V <sub>S</sub> down until LVW switches from "1" to a "0"	7.0		8.2	V
	LVW Output Voltage	STCAP < 6.5V; R <sub>O</sub> = 200KΩ to V <sub>O4</sub> ; V <sub>IL</sub> = "0"	0		0.75	V
		STCAP > 7.5V; R <sub>O</sub> = 200KΩ to V <sub>O4</sub> ; V <sub>IH</sub> = "1"	2.75		50	V
	Reset Output Stability	V <sub>S</sub> is set such that 1 ≤ V <sub>O4</sub> ≤ 4V; I <sub>OUT4</sub> = 2mA; V <sub>ON/OFF</sub> = 0 meas reset variation			50	mV
I <sub>q</sub>	St-By Quiescent Current (ΔI <sub>S</sub> )	V <sub>ON/OFF</sub> = 0V; I <sub>o4</sub> = 100mA; V <sub>S</sub> = 14V; I <sub>o1,2,3</sub> = 0mA			20	mA
		V <sub>ON/OFF</sub> = 0V; I <sub>o4</sub> = 2mA; V <sub>bat</sub> = 14V; I <sub>o1,2,3</sub> = 0mA			500	μA
	Maximum Quiescent Current (ΔI <sub>S</sub> )	V <sub>S</sub> = 14V; I <sub>o1</sub> = 300mA; I <sub>o2</sub> = 400mA; I <sub>o3</sub> = 600mA; I <sub>o4</sub> = 100mA; V <sub>O</sub> = 5V			110	mA
	STCAP Output Voltage	V <sub>S</sub> = 24V;	15		17	V
		V <sub>S</sub> = 60V. 1ms			18	V

**Note 1:**

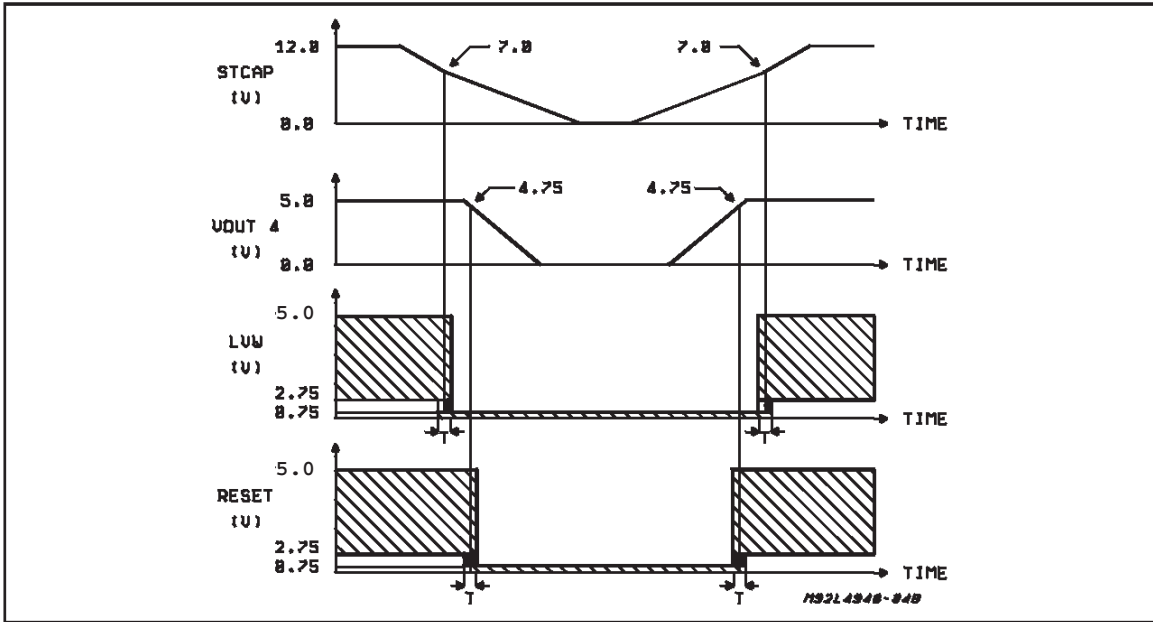
The L4948 has "Foldback" on its outputs during current limiting. As the output loading is increasing the current supplied by the L4948 increases until a threshold is reached. When the current limiting threshold is reached, the L4948 output current will start to decrease as the loading is continuing to increase. The point where the output current starts to decrease is the maximum output current.

**FUNCTIONAL DESCRIPTION**

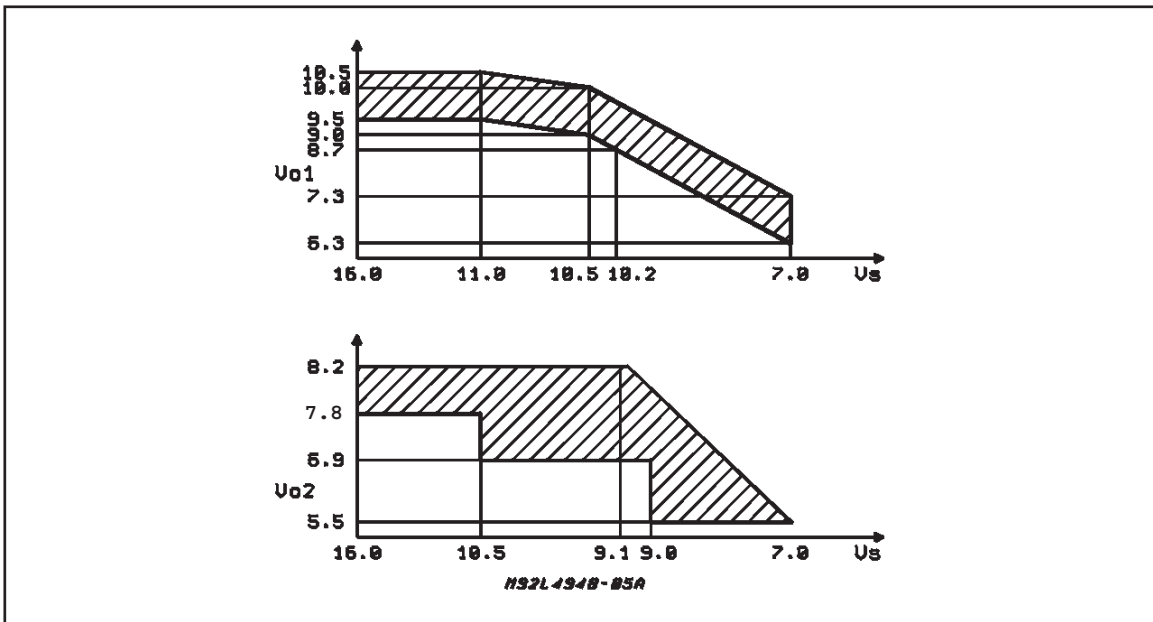
The L4948 includes a monitoring circuit to warn the microprocessor if a low voltage or no voltage condition is occurring. Between 6.5V and 7.5V on the STCAP pin, the LVW output will go low. This tells the microprocessor to stop executing code and save vital information. The reset output will go low when  $V_{04}$  drops 0.15V below its typical reading. A reset will occur between a minimum of

4.5 and a maximum of 5V on  $V_{04}$ . When the  $V_{04}$  drops between 4.5 and 5V the RESET output goes low. It is very important that the RESET output doesn't go above 0.75V until the  $V_{04}$  output has gone back above 4.75V (typical). The microprocessor looks for a rising edge. So, any spike will tell the microprocessor to start operating. Once the STCAP line passes 7V (typical), the LVW output will also return to high state.

**TIMING DIAGRAM**



Graphs of the Output Curves for  $V_{01,2,3}$  and 4

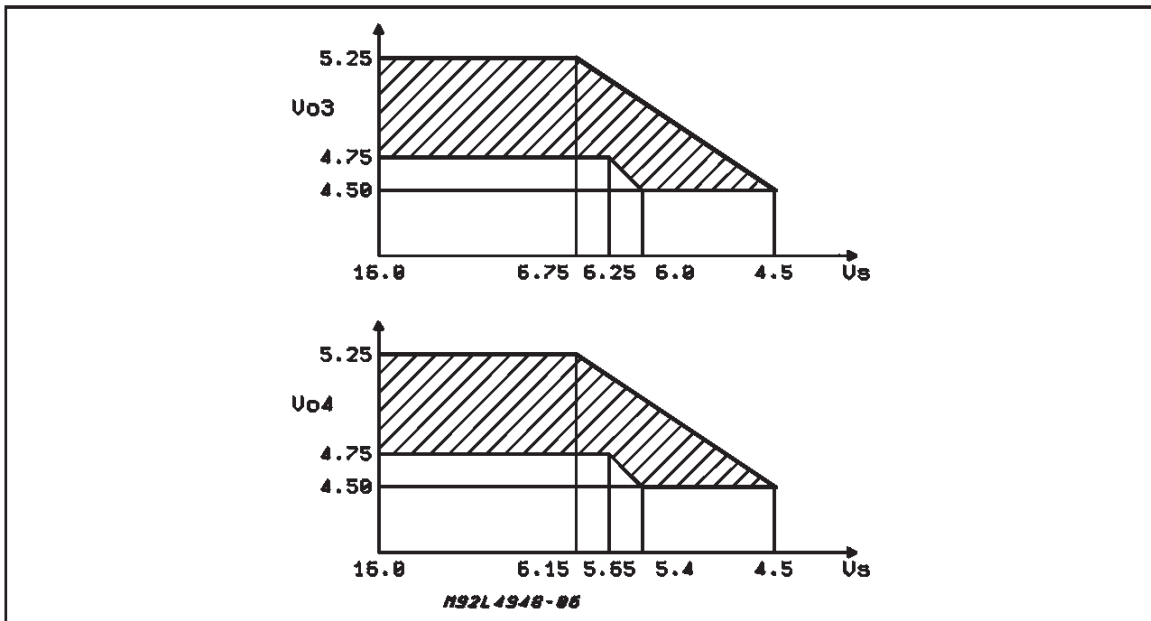


The STCAP pin acts like a delay circuit. Due to the large capacitor (470 $\mu$ F), the STCAP pin allows the battery voltage to decay slowly giving the microprocessor time to store data. Also, during short low voltage or negative voltage conditions, the STCAP pin protects the 5V st-by output from dropping below the RESET and LVW trip points. The four outputs are expected to follow the battery voltage down to 7V. At 7V typical the LVW tells the microprocessor to stop operation and

save operating data. Below 7V the outputs are expected to stay alive and ready for a return of battery.

The L4948 has a st-by mode to keep the microprocessor and memories alive during an ignition off conditions. The ON/OFF input pin is controlled by the microprocessor. An high on the ON/OFF pin places the part in normal mode. A low on the ON/OFF pin places the part in st-by mode.  $V_{01}$ ,  $V_{02}$ ,  $V_{03}$  will be off during st-by mode.

#### Graphs of the Output Curves for $V_{01,2,3}$ and 4 (Cont.)



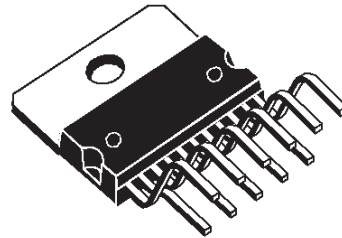
#### Notes and Information

The following information is for clarification, not for specification definition. Please use the information in this way.

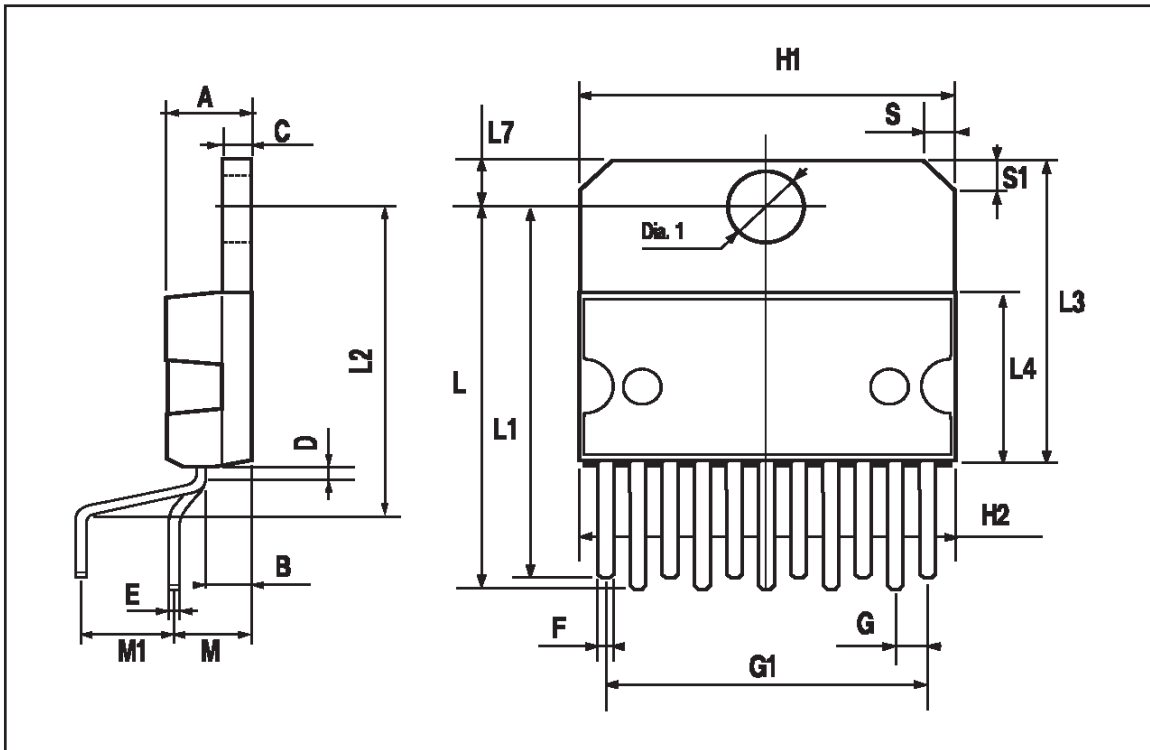
# L4948

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			5			0.197
B			2.65			0.104
C			1.6			0.063
D		1			0.039	
E	0.49		0.55	0.019		0.022
F	0.88		0.95	0.035		0.037
G	1.45	1.7	1.95	0.057	0.067	0.077
G1	16.75	17	17.25	0.659	0.669	0.679
H1	19.6			0.772		
H2			20.2			0.795
L	21.9	22.2	22.5	0.862	0.874	0.886
L1	21.7	22.1	22.5	0.854	0.87	0.886
L2	17.4		18.1	0.685		0.713
L3	17.25	17.5	17.75	0.679	0.689	0.699
L4	10.3	10.7	10.9	0.406	0.421	0.429
L7	2.65		2.9	0.104		0.114
M	4.25	4.55	4.85	0.167	0.179	0.191
M1	4.73	5.08	5.43	0.186	0.200	0.214
S	1.9		2.6	0.075		0.102
S1	1.9		2.6	0.075		0.102
Dia1	3.65		3.85	0.144		0.152

## OUTLINE AND MECHANICAL DATA



**Multiwatt11 V**





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