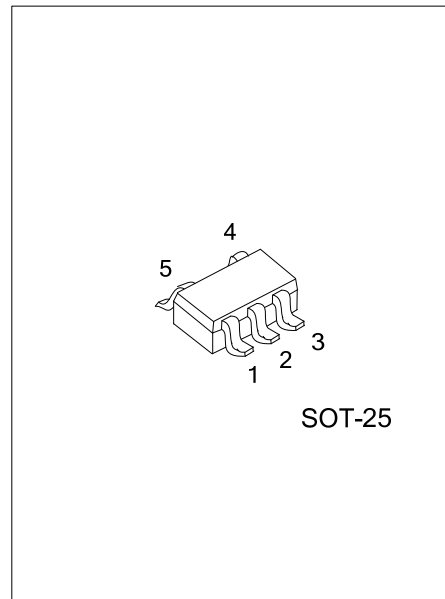


## L1136

Preliminary

CMOS IC

### HIGH RIPPLE-REJECTION LOW DROPOUT HIGH OUTPUT CURRENT CMOS VOLTAGE REGULATOR



#### DESCRIPTION

The UTC **L1136** is an extremely low dropout regulator providing designers with low current dissipation, high output voltage accuracy and it is developed based on CMOS technology.

The internal transistor with low-resistance provides small dropout voltage and the large output current. Various capacitors, as well as small ceramic capacitors, can be used for this IC more than for the conventional regulator ICs which have CMOS technology. The ON/OFF circuit can guarantee longer sure the battery life.

The over-current protection circuit is designed to protect the device from being damaged because of load current while exceeding the capacitance of output transistor. The thermal shutdown protection circuit protects against heat and the rush current control protection circuit and limits the excessive rush current during start-up.

The UTC **L1136** is universally suitable for power supply of battery-powered devices, power supply of TV, notebook PCs and home electric appliances, and constant-voltage power supply of portable equipment.

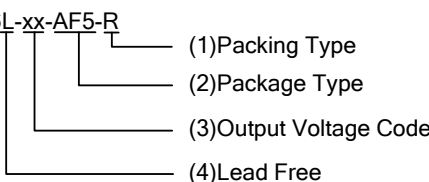
#### FEATURES

- \* Output Voltage Ranges from 1.0 to 5.0V Selectable in 0.05V Step
- \* Input Voltage Varies From 1.5 to 5.5V
- \* Low Equivalent Series Resistance Capacitor: Ceramic Capacitor of 4.7 $\mu$ F or More can be used as the I/O Capacitor
- \* High Accuracy Output Voltage:  $\pm 1.0\%$ (1.0~1.45V output product:  $\pm 15$ mV)
- \* Low Current Consumption: During operation: 70 $\mu$ A (TYP.), 90 $\mu$ A (MAX.) (3.0V output product)  
During shutdown: 0.1 $\mu$ A (TYP.), 1.0 $\mu$ A (MAX.)
- \* Low Dropout Voltage: 70mV (TYP.) (3.0V output product, at  $I_{OUT} = 200$ mA)
- \* Output current: 600mA (3.0V output product, at  $V_{IN} \geq V_{OUT(S)} + 1.0$ V)  
(Attention should be paid to the power dissipation of the package when the output current is large.)
- \* High ripple rejection: 70dB (TYP.) @ 1.0kHz,  $V_{OUT} = 1.0$ V
- \* Internal Protection Circuits: Over-Current Protection Circuit, Thermal Shutdown Circuit And Rush Current Control Circuit
- \* Internal Power On/Off Circuit Ensures Longer Battery Life
- \* Special Care should be Taken to the Power Consumption of the Package when the Output Current is Large.

#### ORDERING INFORMATION

Ordering Number		Package	Packing
Lead Free	Halogen Free		
L1136L-xx-AF5-R	L1136G-xx-AF5-R	SOT-25	Tape Reel

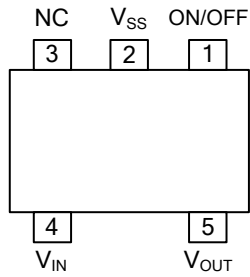
Note: xx: Output Voltage, refer to Marking Information.

<p>L1136L-xx-AF5-R</p> 	<ul style="list-style-type: none"> <li>(1) R: Tape Reel</li> <li>(2) AF5: SOT-25</li> <li>(3) xx: Refer to Marking Information</li> <li>(4) G: Halogen Free, L: Lead Free</li> </ul>
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MARKING INFORMATION

PACKAGE	VOLTAGE CODE	MARKING
SOT-25	33 :3.3V	

PIN CONFIGURATION

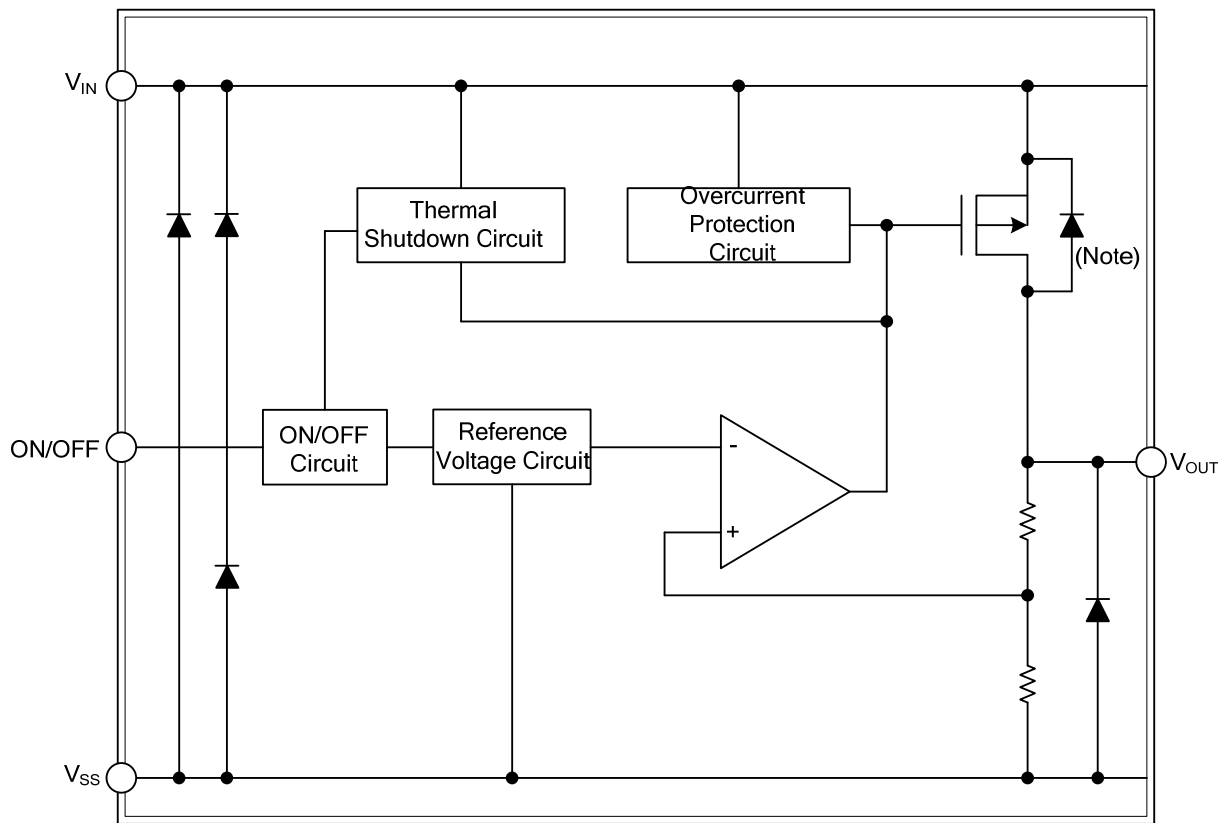


PIN DESCRIPTION

PIN NO.	PIN NAME	DESCRIPTION
1	ON/OFF	Shutdown pin
2	V <sub>SS</sub>	GND pin
3	NC (Note)	No connection
4	V <sub>IN</sub>	Input voltage pin
5	V <sub>OUT</sub>	Output voltage pin

Note: The NC pin is electrically open and it can be connected to V<sub>IN</sub> or V<sub>SS</sub>.

■ BLOCK DIAGRAM



Note : Parasitic diode

### ■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
Input Voltage	$V_{IN}$	$V_{SS}-0.3 \sim V_{SS}+6$	V
	$V_{ON/OFF}$	$V_{SS}-0.3 \sim V_{IN}+0.3$	V
Output Voltage	$V_{OUT}$	$V_{SS}-0.3 \sim V_{IN}+0.3$	V
Power Dissipation	$P_D$	1000	mW
Ambient Operating Temperature	$T_{OPR}$	-40 ~ +85	°C
Storage Temperature	$T_{STG}$	-40 ~ +125	°C

Note: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged. Absolute maximum ratings are stress ratings only and functional device operation is not implied.

### ■ ELECTRICAL CHARACTERISTICS ( $T_A=25^\circ\text{C}$ , unless otherwise specified.)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT	TEST CIRCUIT	
Output Voltage (Note 1)	$V_{OUT(E)}$	$V_{IN}=V_{OUT(S)}+1.0\text{V}$ , $I_{OUT}=100\text{mA}$	$1.0\text{V} \leq V_{OUT(S)} \leq 1.5\text{V}$	$V_{OUT(S)}$ -0.015	$V_{OUT(S)}$	$V_{OUT(S)}$ +0.015	V	1
			$1.5\text{V} \leq V_{OUT(S)} \leq 4.5\text{V}$	$V_{OUT(S)}$ $\times 0.99$	$V_{OUT(S)}$	$V_{OUT(S)}$ $\times 1.01$	V	1
		$V_{IN}=5.5\text{V}$ , $I_{OUT}=100\text{mA}$	$4.5\text{V} \leq V_{OUT(S)} \leq 5.0\text{V}$	$V_{OUT(S)}$ $\times 0.99$	$V_{OUT(S)}$	$V_{OUT(S)}$ $\times 1.01$	V	1
Output Current (Note 2)	$I_{OUT}$	$V_{IN} \geq V_{OUT(S)}+1.0\text{V}$	$1.0\text{V} \leq V_{OUT(S)} \leq 4.5\text{V}$	600 (Note 5)			mA	3
		$V_{IN}=5.5\text{V}$	$4.5\text{V} \leq V_{OUT(S)} \leq 5.0\text{V}$	600 (Note 5)			mA	3
Dropout Voltage (Note 3)	$V_{DROP}$	$I_{OUT}=200\text{mA}$	$1.1\text{V} \leq V_{OUT(S)} \leq 1.2\text{V}$		0.44	0.48	V	1
			$1.2\text{V} \leq V_{OUT(S)} \leq 1.3\text{V}$		0.34	0.38	V	1
			$1.4\text{V} \leq V_{OUT(S)} \leq 1.5\text{V}$		0.14	0.18	V	1
			$1.5\text{V} \leq V_{OUT(S)} \leq 2.6\text{V}$		0.10	0.15	V	1
			$2.6\text{V} \leq V_{OUT(S)} \leq 5.0\text{V}$		0.07	0.10	V	1
Output Voltage Temperature Coefficient (Note 4)	$\frac{\Delta V_{OUT}}{\Delta T_A \cdot V_{OUT}}$	$V_{IN}=V_{OUT(S)}+1.0\text{V}$ , $I_{OUT}=100\text{mA}$ $-40 \leq T_A \leq 85^\circ\text{C}$	$1.0\text{V} \leq V_{OUT(S)} \leq 4.5\text{V}$		$\pm 130$		ppm/°C	1
		$V_{IN}=5.5\text{V}$ , $I_{OUT}=100\text{mA}$ $-40 \leq T_A \leq 85^\circ\text{C}$	$4.5\text{V} \leq V_{OUT(S)} \leq 5.0\text{V}$		$\pm 130$		ppm/°C	1

Note: 1.  $V_{OUT(S)}$ : Specified output voltage;  $V_{OUT(E)}$ : Actual output voltage

The output voltage when fixing  $I_{OUT}$  (=100mA) and inputting  $V_{OUT(S)}+1.0\text{V}$  or  $5.5\text{V}$

- The output current at which the output voltage becomes 95% of  $V_{OUT(E)}$  after gradually increasing the output current
- $V_{DROP} = V_{IN1} - (V_{OUT3} \times 0.98)$   
 $V_{OUT3}$  is the output voltage when  $V_{IN} = V_{OUT(S)}+1.0\text{V}$  or  $5.5\text{V}$ , and  $I_{OUT} = 200\text{mA}$ .  
 $V_{IN1}$  is the input voltage at which the output voltage becomes 98% of  $V_{OUT3}$  after gradually decreasing the input voltage.
- The change in temperature [mV/°C] is calculated using the following equation.

$$\frac{\Delta V_{OUT}}{\Delta T_A} [\text{mV} / ^\circ\text{C}]^*1 = V_{OUT(S)} [\text{V}]^*2 \times \frac{\Delta V_{OUT}}{\Delta T_A \cdot V_{OUT}} [\text{ppm} / ^\circ\text{C}]^*3 \div 1000$$

- \*1. Change in temperature of the output voltage
- \*2. Specified output voltage
- \*3. Output voltage temperature coefficient

- The output current can be at least this value.

Due to limitation of the package power dissipation, this value may not be satisfied. Attention should be paid to the power dissipation of the package when the output current is large.

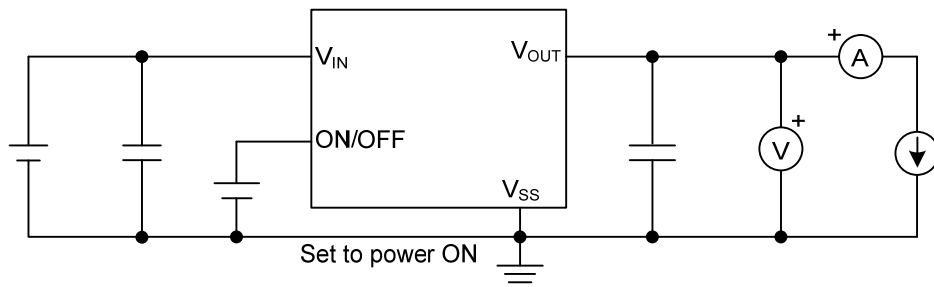
This specification is guaranteed by design.

## ■ ELECTRICAL CHARACTERISTICS (Cont.)

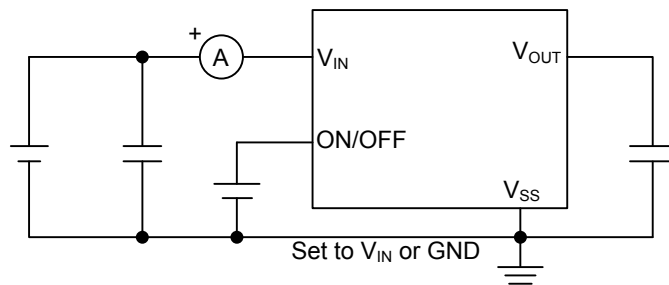
PARAMETER	SYMBOL	TEST CONDITIONS		MIN	TYP	MAX	UNIT	TEST CIRCUIT
Line Regulation	$\frac{\Delta V_{OUT1}}{\Delta V_{IN} \cdot V_{OUT}}$	$V_{OUT(S)}+0.5V \leq V_{IN} \leq 5.5V, I_{OUT}=100mA$	$1.0V \leq V_{OUT(S)} \leq 3.6V$		0.05	0.2	%/V	1
			$3.6V \leq V_{OUT(S)} \leq 4.8V$		2.5	10	mV	1
		$5.3V \leq V_{IN} \leq 5.5V, I_{OUT}=100mA$	$4.8V \leq V_{OUT(S)} \leq 5.0V$		2.5	10	mV	1
Load Regulation	$\Delta V_{OUT2}$	$V_{IN}=V_{OUT(S)}+1.0V, 1mA \leq I_{OUT} \leq 200mA$	$1.0V \leq V_{OUT(S)} \leq 4.5V$		15	30	mV	1
		$V_{IN}=5.5V, 1mA \leq I_{OUT} \leq 200mA$	$4.5V \leq V_{OUT(S)} \leq 5.0V$		15	30	mV	1
Current Consumption During Operation	$I_{SS1}$	$V_{IN}=V_{OUT(S)}+1.0V, ON/OFF \text{ pin}=ON, \text{ no load}, 1.0V \leq V_{OUT(S)} < 1.8V$			90	110	$\mu A$	2
		$V_{IN}=V_{OUT(S)}+1.0V, ON/OFF \text{ pin}=ON, \text{ no load}, 1.8V \leq V_{OUT(S)} < 4.5V$			70	90	$\mu A$	2
		$V_{IN}=5.5V, ON/OFF \text{ pin}=ON, \text{ no load}, 4.5V \leq V_{OUT(S)} < 5.0V$			70	90	$\mu A$	2
Current Consumption During Shutdown	$I_{SS2}$	$V_{IN}=V_{OUT(S)}+1.0V, ON/OFF \text{ pin}=OFF, \text{ no load}$	$1.0V \leq V_{OUT(S)} \leq 4.5V$		0.1	1.0	$\mu A$	2
		$V_{IN}=5.5V, ON/OFF \text{ pin}=OFF, \text{ no load}$	$4.5V \leq V_{OUT(S)} \leq 5.0V$		0.1	1.0	$\mu A$	2
Input Voltage	$V_{IN}$			1.5		5.5	V	
Shutdown Pin Input Voltage "H"	$V_{SH}$	$V_{IN}=V_{OUT(S)}+1.0V, R_L=1.0k\Omega, \text{ Determined by } V_{OUT} \text{ output level}$	$1.0V \leq V_{OUT(S)} \leq 4.5V$	1.5			V	4
		$V_{IN}=5.5V, R_L=1.0k\Omega, \text{ determined by } V_{OUT} \text{ output level}$	$4.5V \leq V_{OUT(S)} \leq 5.0V$	1.5			V	4
Shutdown Pin Input Voltage "L"	$V_{SL}$	$V_{IN}=V_{OUT(S)}+1.0V, R_L=1.0k\Omega, \text{ Determined by } V_{OUT} \text{ output level}$	$1.0V \leq V_{OUT(S)} \leq 4.5V$			0.3	V	4
		$V_{IN}=5.5V, R_L=1.0k\Omega, \text{ determined by } V_{OUT} \text{ output level}$	$4.5V \leq V_{OUT(S)} \leq 5.0V$			0.3	V	4
Shutdown Pin Input Current "H"	$I_{SH}$	$V_{IN}=5.5V, V_{ON/OFF}=5.5V$		-0.1		0.1	$\mu A$	4
Shutdown Pin Input Current "L"	$I_{SL}$	$V_{IN}=5.5V, V_{ON/OFF}=0V$		-0.1		0.1	$\mu A$	4
Ripple Rejection	RR	$V_{IN}=V_{OUT(S)}+1.0V, f=1kHz, \Delta V_{RIP}=0.5V_{rms}, I_{OUT}=100mA$	$1.0V \leq V_{OUT(S)} \leq 1.2V$		70		dB	5
			$1.2V \leq V_{OUT(S)} \leq 3.0V$		65		dB	5
			$3.0V \leq V_{OUT(S)} \leq 4.5V$		60		dB	5
		$V_{IN}=5.5V, f=1kHz, \Delta V_{RIP}=0.5V_{rms}, I_{OUT}=100mA$	$4.5V \leq V_{OUT(S)} \leq 5.0V$		60		dB	5
Short-Circuit Current	$I_{SHORT}$	$V_{IN}=V_{OUT(S)}+1.0V, ON/OFF \text{ pin}=ON, V_{OUT}=0V$	$1.0V \leq V_{OUT(S)} \leq 4.5V$		200		mA	3
		$V_{IN}=5.5V, ON/OFF \text{ pin}=ON, V_{OUT}=0V$	$4.5V \leq V_{OUT(S)} \leq 5.0V$		200		mA	3
Thermal Shutdown Detection Temperature	$T_{SD}$	Junction temperature			150		$^{\circ}C$	
Thermal Shutdown Release Temperature	$T_{SR}$	Junction temperature			120		$^{\circ}C$	

■ TEST CIRCUITS

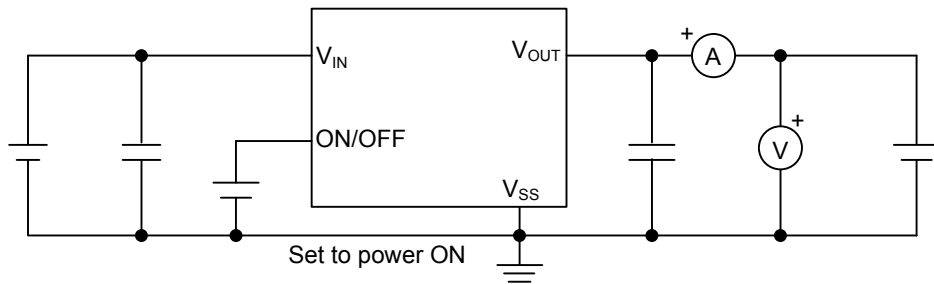
1.



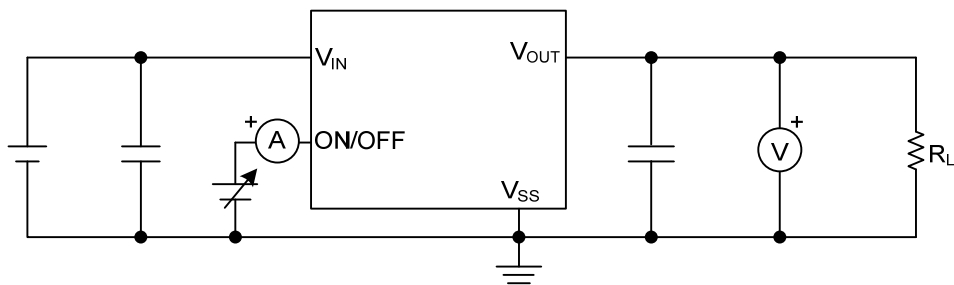
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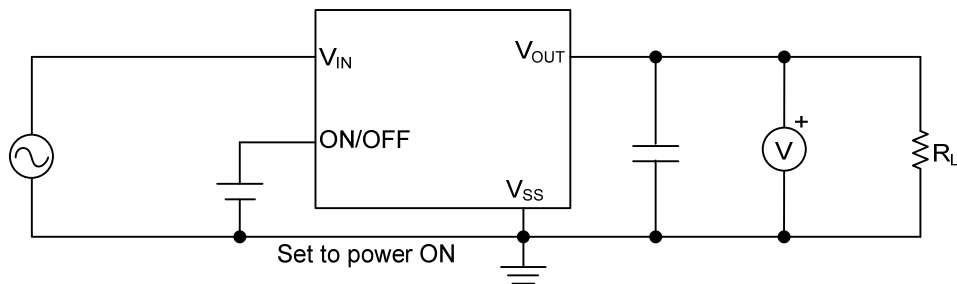
3.



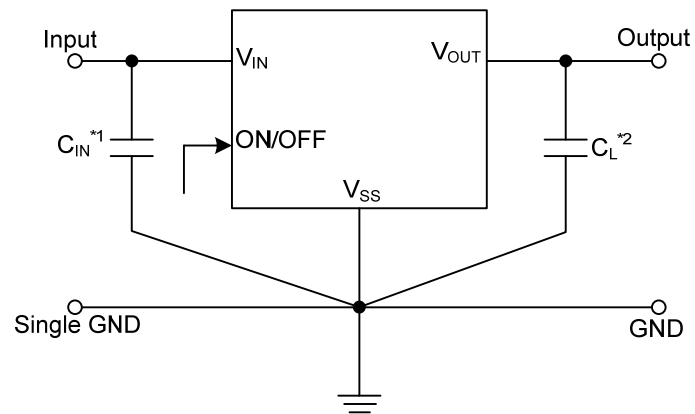
4.



5.



## ■ TYPICAL APPLICATION CIRCUIT



\*1.  $C_{IN}$  is a capacitor for stabilizing the input.

\*2. Ceramic capacitor of  $4.7\mu\text{F}$  or more can be used as  $C_L$ .

FUNCTIONAL DESCRIPTION

1. Basic Operation

The UTC L1136's block diagram is shown in the following. (Figure 1)

The UTC L1136 has an error amplifier, and it compares the reference voltage ( $V_{ref}$ ) with  $V_{fb}$ , which is the output voltage resistance-divided by feedback resistors  $R_S$  and  $R_F$ . It supplies the gate voltage necessary to maintain the constant output voltage which is not influenced by the input voltage and temperature change, to the output transistor.

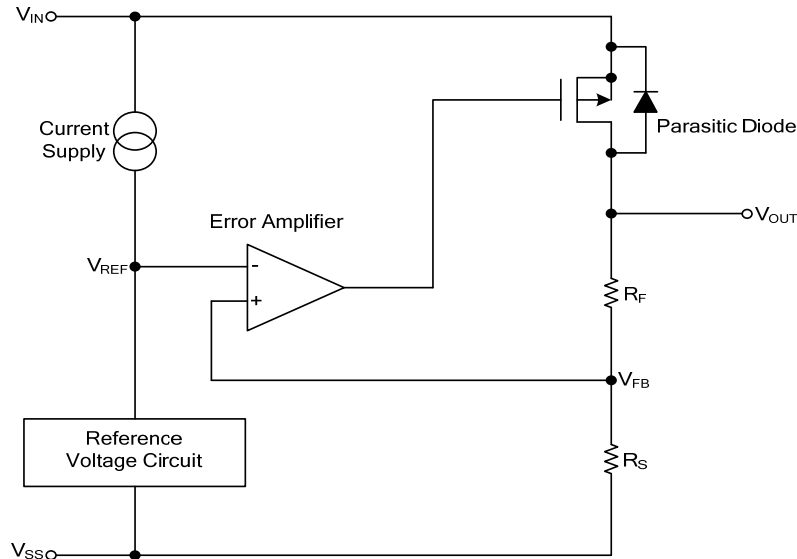


Figure 1

2. Output Transistor

For L1136, the output transistor is a P-channel MOSFET with low on-resistance.

In order to protect against inverse current, make sure that  $V_{OUT}$  does not exceed  $V_{IN}+0.3V$ , because of a parasitic diode between the  $V_{IN}$  and  $V_{OUT}$  pin, when the potential of  $V_{OUT}$  became higher than  $V_{IN}$ .

3. Shutdown Pin (ON/OFF pin)

The shutdown pin is used to turn on and turn off this regulator.

When the ON/OFF pin is set to the shutdown level, the entire internal circuit stops operating. For reducing the current dissipation, the internal P-channel MOS FET is shut down. The  $V_{OUT}$  pin is set to the  $V_{SS}$  level by the internal dividing resistor of several hundred  $k\Omega$  between the  $V_{OUT}$  and  $V_{SS}$  pin.

Note: When the ON/OFF pin voltage is in the range of 0.3V~1.0V, the current dissipation increases. The architecture of the ON/OFF pin can be seen in Figure 2. Since the ON/OFF pin is neither pulled down nor pulled up internally, do not use it in the floating state.

ON/OFF Pin	Internal Circuits	$V_{OUT}$ Pin Voltage	Current Consumption
“L”: Power off	Stop	$V_{SS}$ level	$I_{SS2}$
“H”: Power on	Operate	Set value	$I_{SS1}$

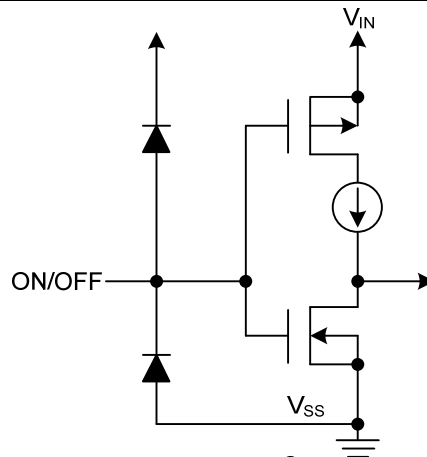


Figure 2



## ■ FUNCTIONAL DESCRIPTION (Cont.)

### 4. Over-current protection circuit

An over-current protection circuit is contained in the UTC L1136. It aims at preventing the output transistor from damage due to an excessive output current and short circuiting between the  $V_{OUT}$  and  $V_{SS}$  pin. The current ( $I_{SHORT}$ ) is internally-fixed to about typically 200mA when short-circuit condition is applied in output pin, and the initial value is restored for the output voltage, if releasing a short circuit once.

**Caution:** This over-current protection circuit does not work as for thermal protection. If this IC maintains short circuiting for a long time inside, take care to the conditions of input voltage and the load current, therefore, under the usage conditions including short circuit, the IC's consumption will not exceed power dissipation of the package.

### 5. Thermal shutdown circuit

A thermal shutdown circuit is included to prevent this device from being damaged for overheat. The thermal shutdown circuit operates to stop regulating when the junction temperature becomes higher than 150°C (TYP.), and it turns back to normal operation when the junction temperature is lower than 120°C (TYP.).

Due to self-heating of the UTC L1136, if the thermal shutdown circuit starts operating, it stops regulating so that the output voltage drops. When the regulating operation stops, the IC's temperature goes down due to the UTC L1136 does not generate heat itself. When the temperature drops, the thermal shutdown circuit is released to restart regulating, thus this IC generates heat again. Repeating this procedure makes waveform of the output voltage pulse-like form. Stop/Restart of regulation continues unless decreasing either/both of the input voltage and the output voltage for reducing the internal current consumption, or decreasing the ambient temperature.

Thermal Shutdown Circuit (Note)	$V_{OUT}$ Pin Voltage
Operation: 150°C (Typ.)	$V_{SS}$ level
Release: 120°C (Typ.)	Set value

Note: Junction Temperature

### 6. Rush current control circuit

The rush current control circuit is designed to protect against the rush current occurs during power-on or when the ON/OFF pin is ON. The rush current is specified to typically 400mA immediately after power-on or from the ON/OFF pin is ON until the specified time (100µs min.) which is set internally.

**Caution:** Due to the thermal shutdown protection circuit, the junction temperature drops to 120°C (TYP.), after stopping regulation, the circuit is released to restart regulation; in this case, pay attention to the period which is to limit rush current to be shorter (10µs min.).

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