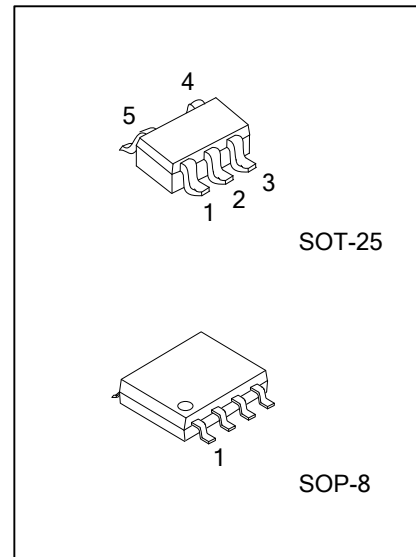# UNISONIC TECHNOLOGIES CO., LTD

L1136

CMOS IC

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

SOT-25

SOP-8

◼ 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.
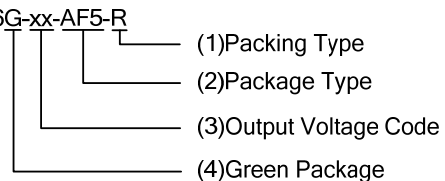
◼ FEATURES

* Output Voltage Ranges from 1.2 to 3.3V Selectable in 0.05V Step
* Input Voltage Varies From 1.5 to 5.5V
* Low Equivalent Series Resistance Capacitor: Ceramic Capacitor of 4.7μF or More can be used as the I/O Capacitor
* High Accuracy Output Voltage: ±1.0%(1.0~1.5V output product: ±15mV)
* Low Current Consumption: During operation: 70μA (TYP.), 90μA (MAX.)

　　　　　　　　　　　　　　During shutdown: 1.0μA (TYP.)
* Low Dropout Voltage: 70mV (TYP.)
* Output current: 600mA
  (Attention should be paid to the power dissipation of the package when the output current is large.)
* High ripple rejection: 70dB (TYP.) @ 1.0kHz
* 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

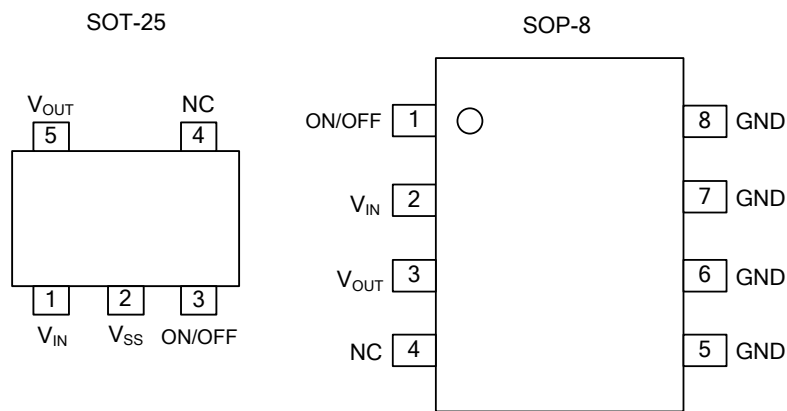| Ordering Number	Package	Packing
L1136G-xx-AF5-R	SOT-25	Tape Reel
L1136G-xx-S08-R	SOP-8	Tape Reel

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

L1136G-xx-AF5-R

(1)Packing Type   (1) R: Tape Reel

(2)Package Type   (2) AF5: SOT-25, S08: SOP-8

(3)Output Voltage Code   (3) xx: Refer to Marking Information

(4)Green Package   (4) G: Halogen Free and Lead Free

QW-R502-464.g

■ **MARKING INFORMATION**

PACKAGE	VOLTAGE CODE	MARKING
SOT-25	12: 1.2V 15: 1.5V 18: 1.8V 25 :2.5V 33 :3.3V	HXXFG → Voltage Code
SOP-8		UTC □□□□ → Date Code L1136G Output Voltage ← ● → Lot Code

■ **PIN CONFIGURATION**

SOT-25

V_{OUT} [5]	NC [4]
[1]	[2] [3]
V_{IN}	V_{SS} ON/OFF

SOP-8

ON/OFF [1]	[8] GND
V_{IN} [2]	[7] GND
V_{OUT} [3]	[6] GND
NC [4]	[5] GND

SOT-25

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

Note: The NC pin is electrically open and it can be connected to V_{IN} or V_{SS}.

SOP-8

PIN NO.	PIN NAME	DESCRIPTION
1	ON/OFF	Shutdown pin
2	V_{IN}	Input supply pin. Supply voltage can range from 2.9V to 6V. Bypass with a 1μF capacitor to GND.
3	V_{OUT}	Regulator Output. Sources up to 600mA. A small capacitor (2.2mF, typical) is needed from this pin to ground to assure stability.
4	NC	No connection
5, 6, 7, 8	GND	Ground.

■ **BLOCK DIAGRAM**

Note : Parasitic diode
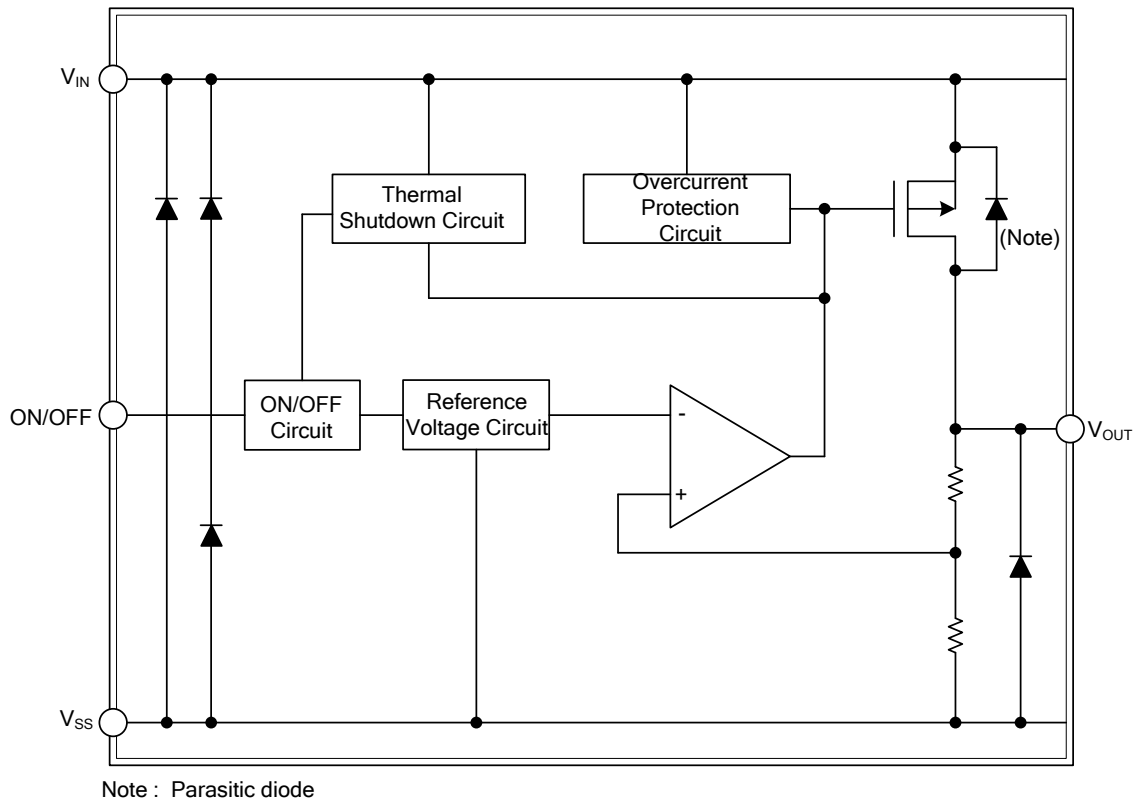
■ **ABSOLUTE MAXIMUM RATING**

PARAMETER		SYMBOL	RATINGS	UNIT
Input Voltage		V_{IN}	V_{SS} -0.3 ~ V_{SS} +6	V
		$V_{ON/OFF}$	V_{SS} -0.3 ~ V_{IN} +0.3	V
Output Voltage		V_{OUT}	V_{SS} -0.3 ~ V_{IN} +0.3	V
Power Dissipation	SOT-25	P_D	360	mW
	SOP-8		500	
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°C, unless otherwise specified.)

PARAMETER	SYMBOL	TEST CIRCUIT	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Output Voltage (Note 1)	$V_{OUT(E)}$	1	$V_{IN}=V_{OUT(S)}$+1.0V , I_{OUT}=100mA	1.0V≤$V_{OUT(S)}$≤1.5V	$V_{OUT(S)}$ -0.015	$V_{OUT(S)}$	$V_{OUT(S)}$ +0.015	V
		1		1.5V≤$V_{OUT(S)}$≤4.5V	$V_{OUT(S)}$ ×0.99	$V_{OUT(S)}$	$V_{OUT(S)}$ ×1.01	V
		1	V_{IN}=5.5V, I_{OUT}=100mA	4.5V≤$V_{OUT(S)}$≤5.0V	$V_{OUT(S)}$ ×0.99	$V_{OUT(S)}$	$V_{OUT(S)}$ ×1.01	V
Output Current (Note 2)	I_{OUT}	3	$V_{IN}≥V_{OUT(S)}$+1.0V	1.0V≤$V_{OUT(S)}$≤4.5V	600(Note 5)			mA
		3	V_{IN}=5.5V	4.5V≤$V_{OUT(S)}$≤5.0V	600(Note 5)			mA
Dropout Voltage (Note 3)	V_{DROP}	1	I_{OUT}=200mA	1.1V≤$V_{OUT(S)}$≤1.2V		0.44	0.48	V
		1		1.2V<$V_{OUT(S)}$≤1.3V		0.34	0.38	V
		1		1.3V<$V_{OUT(S)}$≤1.4V		0.24	0.28	V
		1		1.4V<$V_{OUT(S)}$≤1.5V		0.14	0.18	V
		1		1.5V<$V_{OUT(S)}$≤2.6V		0.10	0.15	V
		1		2.6V<$V_{OUT(S)}$≤5.0V		0.07	0.10	V
Output Voltage Temperature Coefficient (Note 4)	$\dfrac{\Delta V_{OUT}}{\Delta T_A \cdot V_{OUT}}$	1	$V_{IN}=V_{OUT(S)}$+1.0V , I_{OUT}=100mA -40≤T_A≤85°C	1.0V≤$V_{OUT(S)}$≤4.5V		±130		ppm/°C
		1	V_{IN}=5.5V, I_{OUT}=100mA -40≤T_A≤85°C	4.5V≤$V_{OUT(S)}$≤5.0V		±130		ppm/°C

Notes: 1. $V_{OUT(S)}$: Specified output voltage; $V_{OUT(E)}$: Actual output voltage
The output voltage when fixing I_{OUT} (=100mA) and inputting $V_{OUT(S)}$+1.0V or 5.5V
2. The output current at which the output voltage becomes 95% of $V_{OUT(E)}$ after gradually increasing the output current
3. V_{DROP} = V_{IN1}-(V_{OUT3}×0.98)
V_{OUT3} is the output voltage when V_{IN} = $V_{OUT(S)}$+1.0V or 5.5V, and I_{OUT} = 200mA.
V_{IN1} is the input voltage at which the output voltage becomes 98% of V_{OUT3} after gradually decreasing the input voltage.
4. The change in temperature [mV/°C] is calculated using the following equation.

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

*1. Change in temperature of the output voltage
*2. Specified output voltage
*3. Output voltage temperature coefficient
5. 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 CIRCUIT	TEST CONDITIONS		MIN	TYP	MAX	UNIT
Line Regulation	$\dfrac{\Delta V_{OUT1}}{\Delta V_{IN} \cdot V_{OUT}}$	1	$V_{OUT(S)}$+0.5V≤V_{IN}≤5.5V, I_{OUT}=100mA	1.0V≤$V_{OUT(S)}$≤3.6V		0.05	0.2	%/V
		1		3.6V≤$V_{OUT(S)}$≤4.8V		2.5	10	mV
		1	5.3V≤V_{IN}≤5.5V, I_{OUT}=100mA	4.8V≤$V_{OUT(S)}$≤5.0V		2.5	10	mV
Load Regulation	ΔV_{OUT2}	1	V_{IN}=$V_{OUT(S)}$+1.0V, 1mA≤I_{OUT}≤200mA	1.0V≤$V_{OUT(S)}$≤4.5V		15	30	mV
		1	V_{IN}=5.5V, 1mA≤I_{OUT}≤200mA	4.5V≤$V_{OUT(S)}$≤5.0V		15	30	mV
Current Consumption During Operation	I_{SS1}	2	V_{IN}=$V_{OUT(S)}$+1.0V, ON/OFF pin=ON, no load, 1.0V≤$V_{OUT(S)}$<1.8V			90	110	µA
		2	V_{IN}=$V_{OUT(S)}$+1.0V, ON/OFF pin=ON, no load, 1.8V≤$V_{OUT(S)}$<4.5V			70	90	µA
		2	V_{IN}=5.5V, ON/OFF pin=ON, no load, 4.5V≤$V_{OUT(S)}$<5.0V			70	90	µA
Current Consumption During Shutdown	I_{SS2}	2	V_{IN}=$V_{OUT(S)}$+1.0V, ON/OFF pin= OFF, no load	1.0V≤$V_{OUT(S)}$≤4.5V		1.0		µA
		2	V_{IN}=5.5V, ON/OFF pin= OFF, no load	4.5V≤$V_{OUT(S)}$≤5.0V		1.0		µA
Input Voltage	V_{IN}				1.5		5.5	V
Shutdown Pin Input Voltage "H"	V_{SH}	4	V_{IN}=$V_{OUT(S)}$+1.0V, R_L=1.0kΩ, Determined by V_{OUT} output level	1.0V≤$V_{OUT(S)}$≤4.5V	1.5			V
		4	V_{IN}=5.5V, R_L=1.0 kΩ, determined by V_{OUT} output level	4.5V≤$V_{OUT(S)}$≤5.0V	1.5			V
Shutdown Pin Input Voltage "L"	V_{SL}	4	V_{IN}=$V_{OUT(S)}$+1.0V, R_L=1.0kΩ, Determined by V_{OUT} output level	1.0V≤$V_{OUT(S)}$≤4.5V			0.3	V
		4	V_{IN}=5.5V, R_L=1.0kΩ, Determined by V_{OUT} output level	4.5V≤$V_{OUT(S)}$≤5.0V			0.3	V
Shutdown Pin Input Current "H"	I_{SH}	4	V_{IN}=5.5V, $V_{ON/OFF}$=5.5V		-0.1		0.1	µA
Shutdown Pin Input Current "L"	I_{SL}	4	V_{IN}=5.5V, $V_{ON/OFF}$=0V		-0.1		0.1	µA
Ripple Rejection	|RR|	5	V_{IN}=$V_{OUT(S)}$+1.0V, f=1kHz, I_{OUT}=100mA, ΔV_{RIP}=0.5Vrms	1.0V≤$V_{OUT(S)}$≤1.2V		70		dB
		5		1.2V≤$V_{OUT(S)}$≤3.0V		65		dB
		5		3.0V≤$V_{OUT(S)}$≤4.5V		60		dB
		5	V_{IN}=5.5V, f=1kHz, ΔV_{RIP}=0.5Vrms, I_{OUT}=100mA	4.5V≤$V_{OUT(S)}$≤5.0V		60		dB
Short-Circuit Current	I_{SHORT}	3	V_{IN}=$V_{OUT(S)}$+1.0V, ON/OFF pin=ON, V_{OUT}=0V	1.0V≤$V_{OUT(S)}$≤4.5V		200		mA
		3	V_{IN}=5.5V, V_{OUT}=0V, ON/OFF pin=ON	4.5V≤$V_{OUT(S)}$≤5.0V		200		mA
Thermal Shutdown Detection Temperature	T_{SD}		Junction temperature			150		°C
Thermal Shutdown Release Temperature	T_{SR}		Junction temperature			120		°C

■ TEST CIRCUITS

1.

Set to power ON

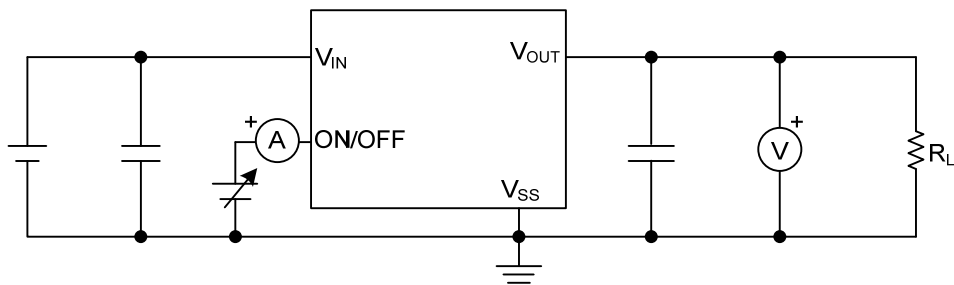2.

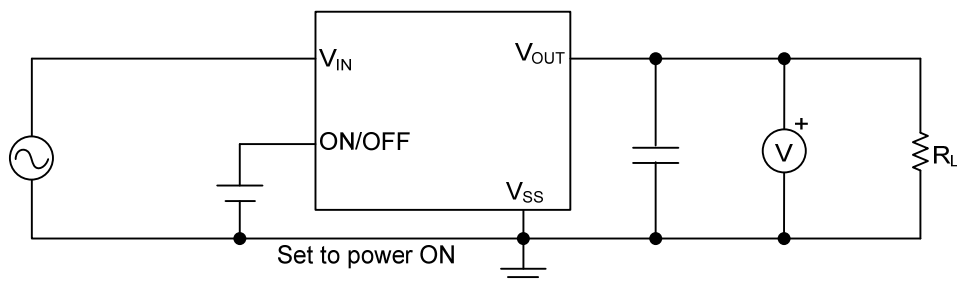

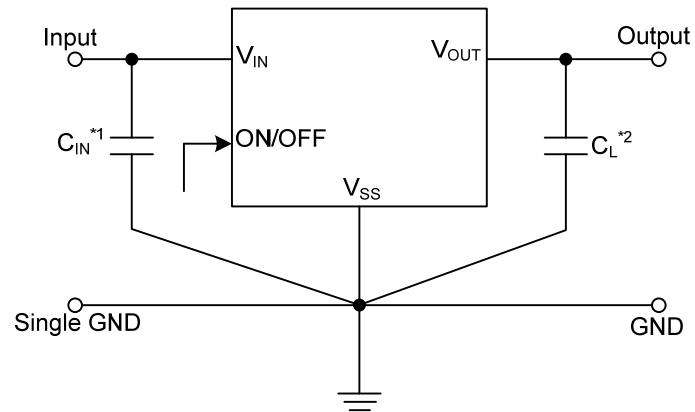Set to V_{IN} or GND

3.

Set to power ON

4.

5.

Set to power ON
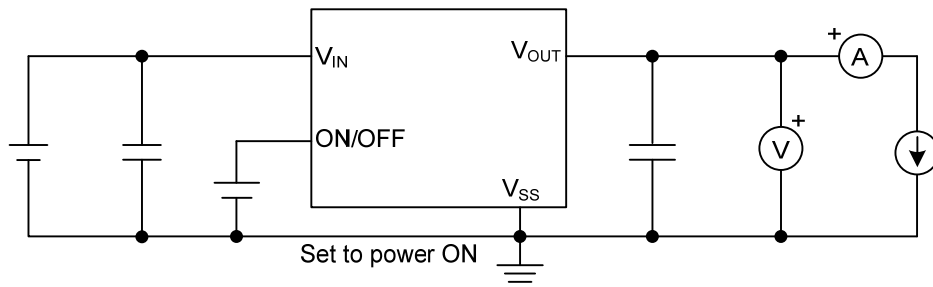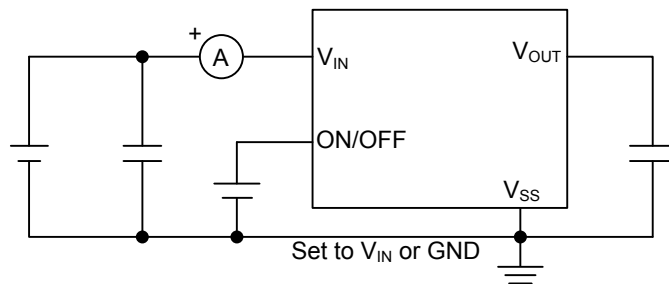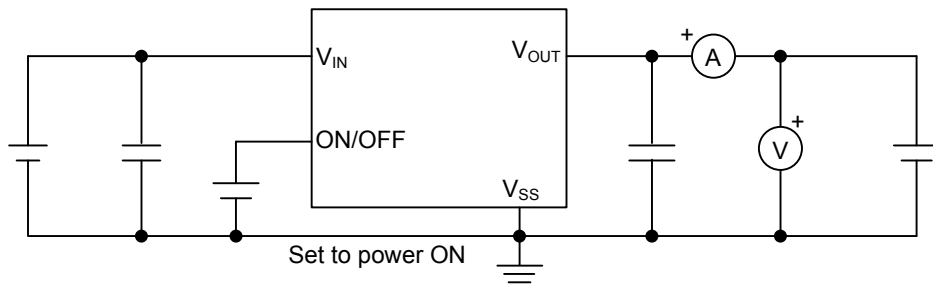
■ TYPICAL APPLICATION CIRCUIT

*1. C_{IN} is a capacitor for stabilizing the input.
*2. Ceramic capacitor of 4.7μF or more can be used as C_L.

■ FUNCTIONAL DESCRIPTION

1. Basic Operation

The UTC **L1136**'s block diagram is shown in the following. (Fig.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.
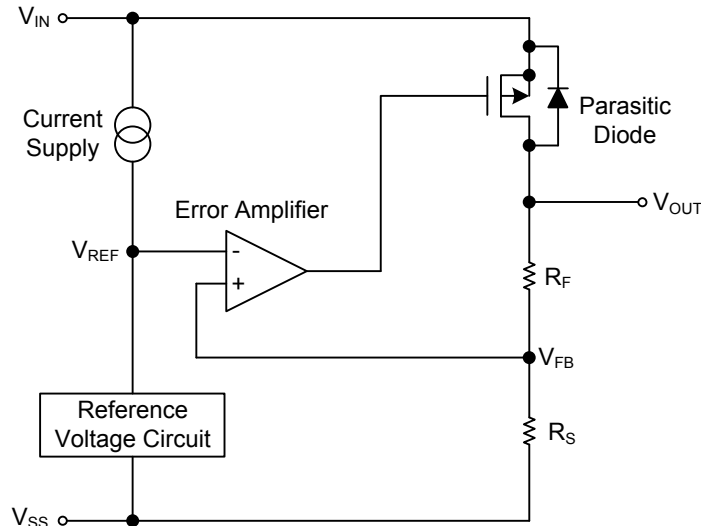

Fig.1

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 MOSFET is shut down. The V_{OUT} pin is set to the V_{SS} level by the internal dividing resistor of several hundred kΩ 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 Fig. 2 Since the ON/OFF pin is neither pulled down nor pulled up internally, do not use it in the floating state.

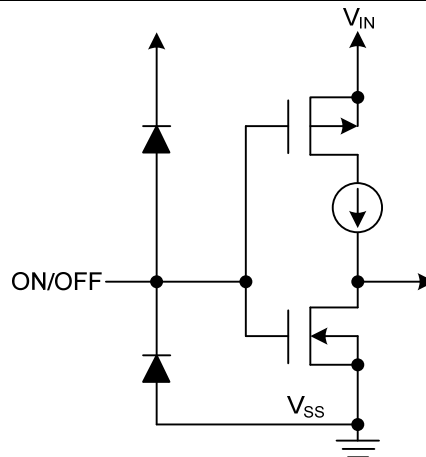| ON/OFF Pin	Internal Circuits	V_{OUT} Pin Voltage	Current Consumption
"L": Power off	Stop	V_{SS} level	I_{SS2}
"H": Power on	Operate	Set value	I_{SS1}

Fig. 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.).