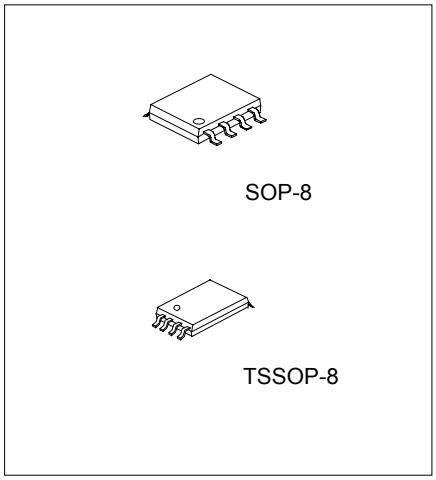
UTC L2800 LINEAR INTEGRATED CIRCUIT

SWITCHING REGULATOR CONTROLLER(LOW VOLTAGE)



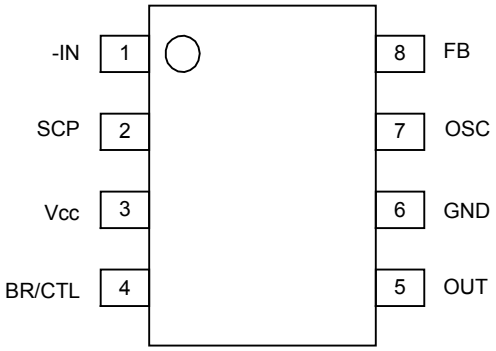
DESCRIPTION

The UTC L2800 is a single-channel switching regulator control IC for low voltage applications incorporating a soft start function and short circuit detection function. The device has a low minimum operating voltage of 1.8V and is ideal for the power supply of battery-operated electronic equipment.

FEATURES

*Wide supply voltage operating range: 1.8V~15V
*Low current consumption: Typically 5.5mA in operation,1μA or less in stand-by
*High speed operation is possible: Maximum 1MHz
*The error amplifier gain is set inside the IC,so peripheral components are minimized.
*Incorporates a soft start circuit.
*Incorporates a timer-latch type short circuit detection circuit (SCP).
*Totem-pole type output with adjustable on/off current (for NPN transistors)
*Incorporates a stand-by function.

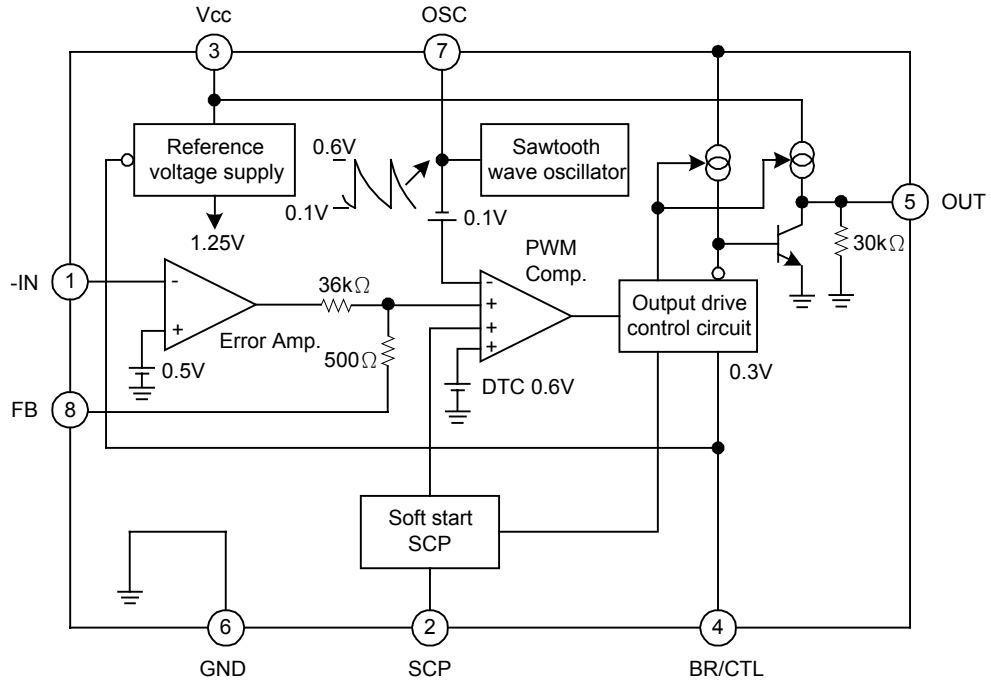
PIN CONFIGURATION



PIN DESCRIPTION

PIN NO.	SYMBOL	I/O	DESCRIPTION
1	-IN	I	Error amplifier inverting input pin
2	SCP	-	Soft start and SCP setting capacitor connection pin
3	VCC	-	Power supply pin
4	BR/CTL	I	Output current setting and control pin
5	OUT	O	Totem-pole type output pin
6	GND	-	Ground pin
7	OSC	-	Capacitor and resistor connection pin for setting the oscillation frequency
8	FB	O	Error amplifier output pin

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Ta=25℃)

PARAMETER	SYMBOL	RATINGS	UNIT
Power Supply Voltage	Vcc	16	V
Output Source Current	Io^+	-50	mA
Output Sink Current	Io^-	50	mA
Power Dissipation SOP-8 TSSOP-8	P_D	 570* 580*	mW
Storage Temperature	Tstg	-55 ~ +125	°C
Operating Temperature	Top	-30 ~ +85	°C

* When mounted on a 10cm square double-sided epoxy board.

RECOMMENDED OPERATING CONDITIONS (Ta=25°C)

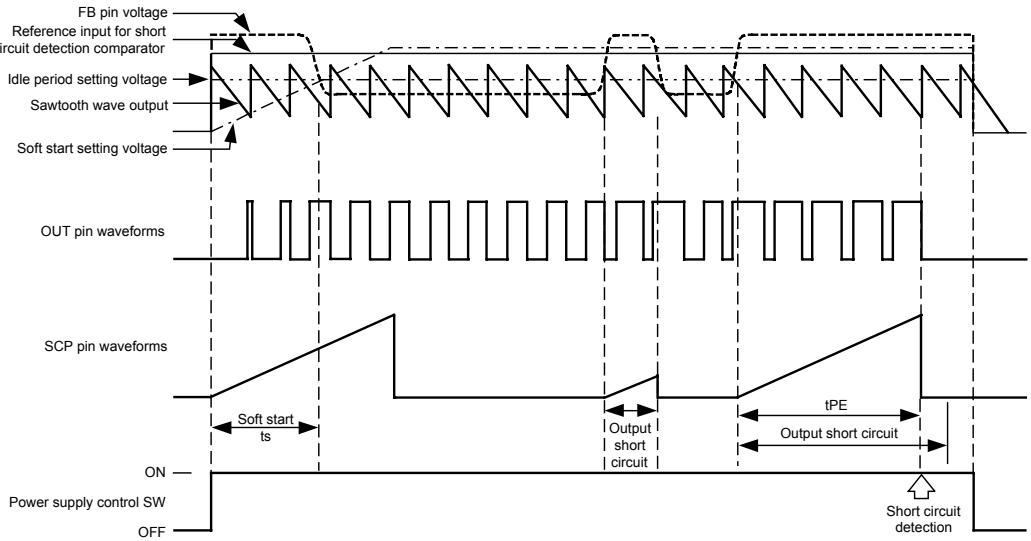
PARAMETER	SYMBOL	MIN	TYP	MAX	UNIT
Power Supply Voltage	Vcc	1.8		15	V
Error Amplifier Input Voltage	V_I	-0.2		1.0	V
BR/CTL Pin Input Voltage	V_{BR}	-0.2		Vcc	V
Output Source Current	I_O^+	-40			mA
Output Sink Current	I_O^-			40	mA
SCP Pin Capacitance	C_{PE}		0.1		μF
Phase Compensation Capacitance	C_P		0.1		μF
Output Current Setting Resistance	R_B	150	390	5000	Ω
Timing Resistance	R_T	1.0	3.0	10.0	kΩ
Timing Capacitance	C_T	100	270	10000	pF
Oscillation Frequency	fosc	10	500	1000	kHz
Operating Temperature	Top	-30	+25	+85	°C

ELECTRICAL CHARACTERISTICS (Ta=25°C, V_{CC}=+2V)

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Circuit to prevent malfuncition at low input oltage (U.V.L.O)	Reset Voltage	V_R				0.9	V
	Threshold Voltage	V_{TH}		1.1	1.3	1.5	V
Soft Start	Charging Current	Ics	V_{SCP}=0V	-1.5	-1.0	-0.7	μA
	Voltage at soft start completion	Vts		0.7	0.8	0.9	V
Short Circuit Detection(S.C.P.)	Charging Current	Icpc	V_{SCP}=0V	-1.5	-1.0	-0.7	μA
	Threshold Voltage	V_{tPC}		0.7	0.8	0.9	V
Sawtooth Wave Oscillator(OSC)	Oscillation Frequency	fosc	R_T=3.0kΩ, C_T=270pF	400	500	600	kHz
	Frequency Input Stability	f_{dV}	Vcc=2V ~ 15V		2	10	%
	Frequency Variation With Temperature	f_{dT}	Ta=-30°C ~ +85°C		5		%
Error Amplifier	Input Threshold Voltage	V_T	V_{FB}=450mV	480	500	520	mV
	V_T Input Stability	V_{TdV}	Vcc=2V ~ 15V		5	20	mV
	V_T Variation With Temperature	V_{TdT}	Ta=-30°C ~ +85°C		1		%
	Input Bias Current	I_B	V_{IN}=0V	-1.0	-0.2	1.0	μA
	Voltage Gain	Av		70	100	145	V/V
	Frequency Bandwidth	BW	A_V=0dB		6		MHz
	Maximum Output Voltage Range	V_{OM}^+		0.78	0.87		V
		V_{OM}^-			0.05	0.2	V
	Output Source Current	I_{OM}^+	V_{FB}=0.45V		-40	-24	μA
	Output Sink Current	I_{OM}^-		24	40		μA
Idle Period Adjustment Section	Maximum Duty Cycle	t_{DUTY}	R_T=3.0kΩ, C_T=270pF V_{FB}=0.8V	65	75	85	%
Output Section	Output Voltage	V_{OH1}	R_B=390Ω, Io=-15mA	1.0	1.2		V
		V_{OH2}	R_B=750Ω, Vcc=1.8V Io= -10mA	0.8	1.0		V
		V_{OL1}	R_B=390Ω, Io=15mA		0.1	0.2	V
		V_{OL2}	R_B=750Ω, Vcc=1.8V Io=10mA		0.1	0.2	V
	Output Source Current	I_O^+	R_B=390Ω, Vo=0.9V		-30	-20	mA
	Output Sink Current	I_O^-	R_B=390Ω, Vo=0.3V	30	60		mA
	Pull Down Resistance	R_O		20	30	40	kΩ

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Output Current Setting Section/Control Section	Pin Voltage	V_{BR}	R_B=390Ω	0.2	0.3	0.4	V
	Input Off Condition	I_{OFF}		-20		0	μA
	Input On Condition	I_{ON}				-45	μA
	Pin Current Range	I_{BR}		-1.8		-0.1	mA
Entire Device	Stand-by Current	I_{CCS}	BR/CTL pin open or Vcc			1	μA
	Average Supply Current	I_{CC}	R_B=390Ω		5.5	9.3	mA

DIAGRAM



HOW TO SET THE TIME CONSTANT FOR SOFT START AND SHORT CIRCUIT DETECTION

1.SOFT START

At power on, the capacitor C_{PE} connected to the SCP pin starts charging. The PWM comparator compares the soft start setting voltage as a proportion of the voltage at the SCP pin with the sawtooth waveform. The comparison controls the ON duty of the OUT pin, causing the soft start operation. On completion of soft start operation, the voltage at the SCP pin stays low, the soft start setting voltage stays high, and the circuit enters the output short circuit detection wait state.

Soft start time (The time until the output ON duty reaches approximately 50%)

$t_S[S] \fallingdotseq 0.35*C_{PE}[\mu F]$

2.SHORT CIRCUIT PROTECTION

If the switching regulator output suddenly drops due to load effect, the error amplifier output (FB pin) is fixed at VOM^+ and capacitor C_{PE} starts charging. When the voltage at the SCP pin reaches approximately 0.8V,the output pin is set low and the SCP pin stays low.

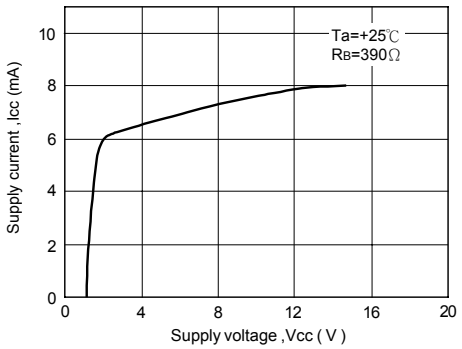
Once the protection circuit operates, the circuit can be restored by resetting the power supply.

- Short circuit detection time

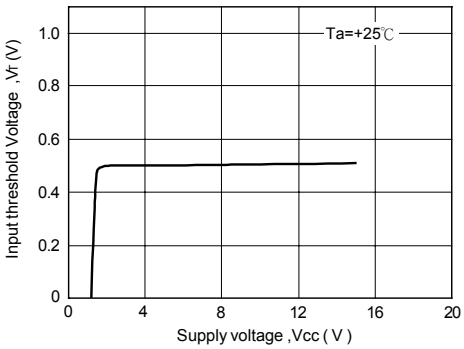
$t_{PE}[S] \fallingdotseq 0.8*C_{PE}[\mu F]$

TYPICAL CHARACTERISTICS

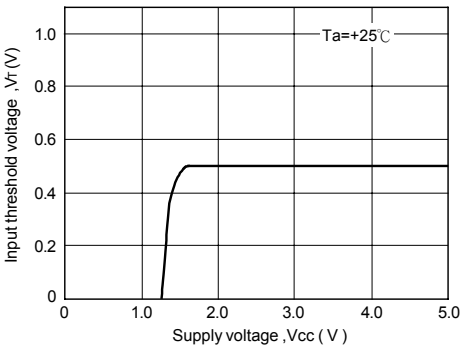
Supply Voltage vs.Supply Current



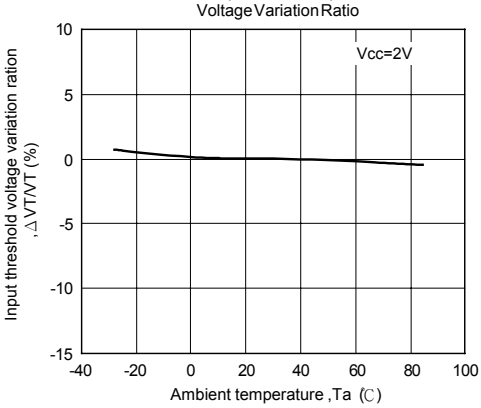
Supply Voltage vs.Input Threshold Voltage



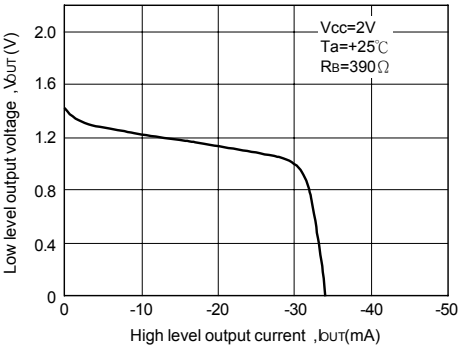
Supply Voltage vs.Input Threshold Voltage



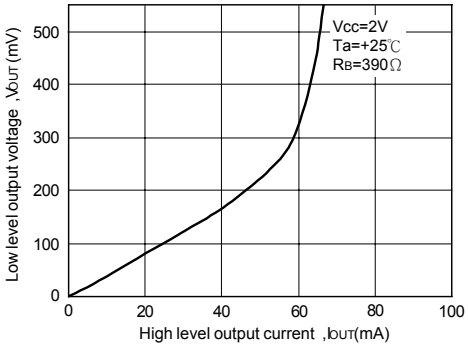
Ambient Temperature vs. Input Threshold Voltage Variation Ratio



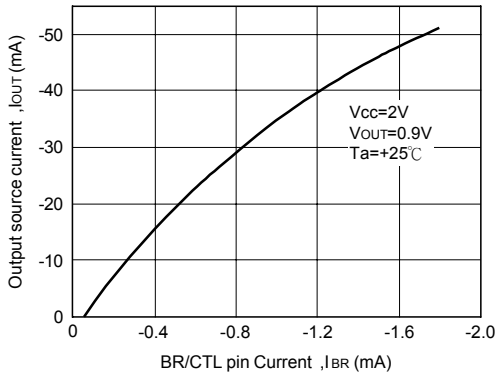
High Level Output



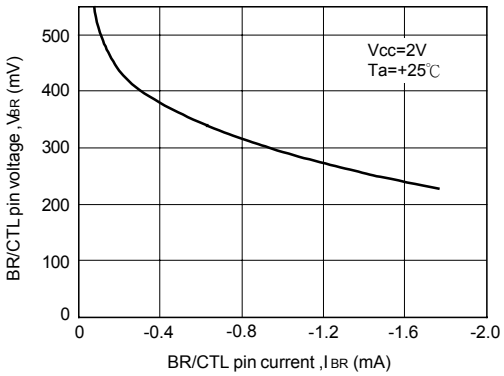
Low Level Output



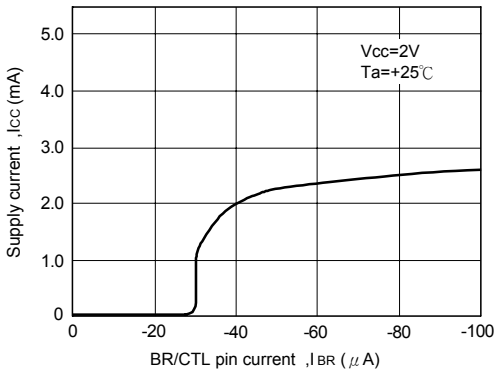
BR/CTL Pin Current vs. Output Source Current



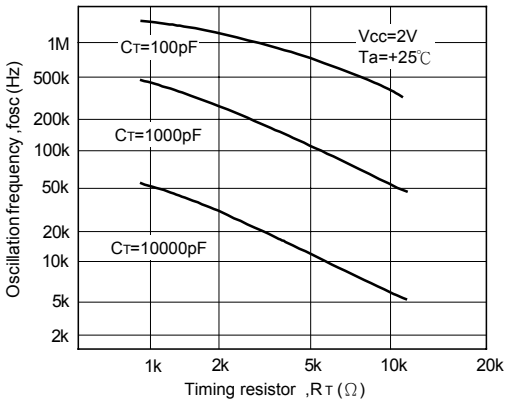
BR/CTL Pin Current vs. BR/CTL Pin Voltage



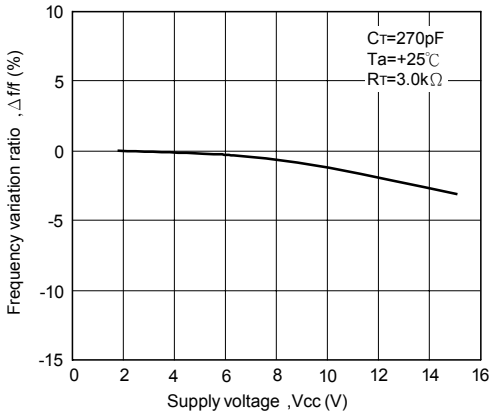
BR/CTL Pin Current vs. Supply Current



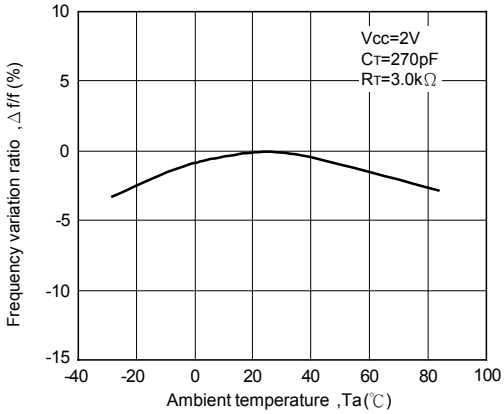
Timing Resistor vs. Oscillation Frequency



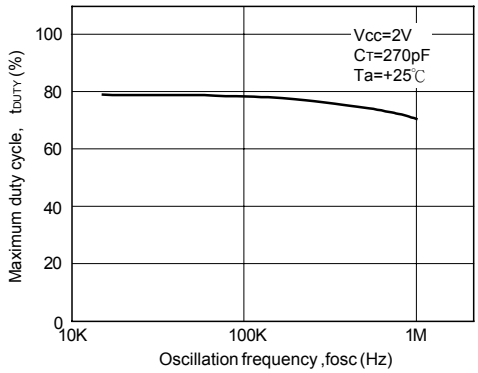
Supply Voltage vs. Frequency Variation Ratio



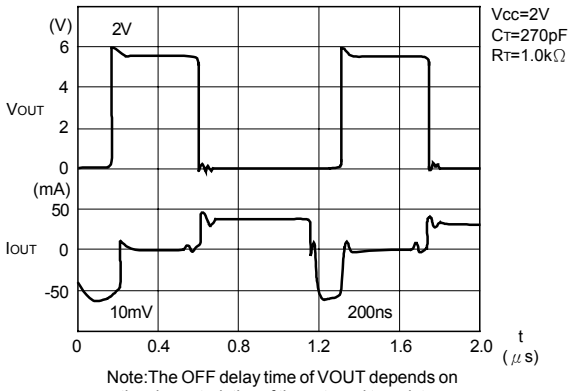
Ambient Temperature vs. Frequency Variation Ratio



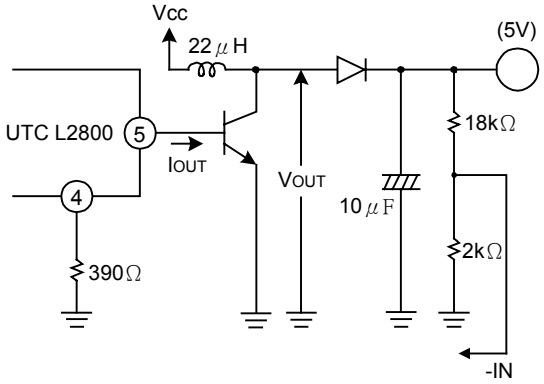
Oscillation Frequency vs. Maximum Duty Cycle



Output Pin Voltage and Current Waveforms (Reference Data)



Note: The OFF delay time of VOUT depends on the characteristics of the external transistor.



Measurement Circuit Diagram

FUNCTIONAL DESCRIPTION

1. SWITCHING REGULATOR FUNCTION

(1) REFERENCE VOLTAGE CIRCUIT

The reference voltage circuit generates a temperature-compensated reference voltage(≒1.25V)from voltage supplied from the power supply pin(pin 30).In addition to providing the reference voltage for the switching regulator, the circuit also sets the idle period.

(2) SAWTOOTH WAVE OSCILLATOR

The sawtooth oscillator generates a sawtooth wave(up to 1 MHz)that is stable with respect to the supply voltage and temperature. The capacitor and resistor that set the oscillation frequency are connected to the OSC pin(pin 7).

(3) ERROR AMPLIFIER (ERROR AMP.)

The error amplifier detects the output voltage of the switching regulator and outputs the PWM control signal. The voltage gain is fixed, and connecting a phase compensation capacitor to the FB pin(pin 8)provides stable phase compensation for the system.

(4) PWM COMPARATOR (PWM COMP.)

The voltage comparator has one inverting and three non-inverting inputs. The comparator is a voltage /pulse width converter that controls the ON time of the output pulse depending on the input voltage. The output level is high(H) when the sawtooth wave is lower than the error amplifier output voltage, soft start setting voltage, and idle period setting voltage.

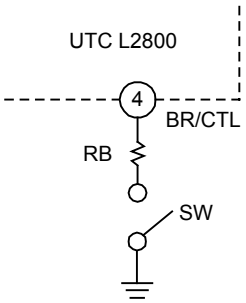
(5) OUTPUT CIRCUIT

The output circuit has a totem pole type configuration and can drive an external NPN transistor directly. The value of the ON/OFF current can be set by a resistor connected to the BR/CTL pin(pin 4).

2. POWER SUPPLY CONTROL FUNCTION

Stand-by mode(supply current 1μA or less) can be set by connecting the BR/CTL pin(pin 4) to Vcc or by making the pin open circuit.

SW	MODE
OFF	Stand-by mode
ON	Operating mode



3. OTHER FUNCTIONS

(1) SOFT START AND SHORT CIRCUIT DETECTION

Soft start operation is set by connecting capacitor C_{PE} to SCP pin(pin 2).Soft start prevents a current spike on start-up.

On completion of soft start operation, the SCP pin(pin 2) stays low and enters the short circuit detection wait state. When an output short circuit occurs, the error amplifier output is fixed at V_{OM}+ and capacitor C_{PE} starts charging. After charging to approximately 0.8V,the output pin(pin 5) is set low and the SCP pin(pin 2) stays low.

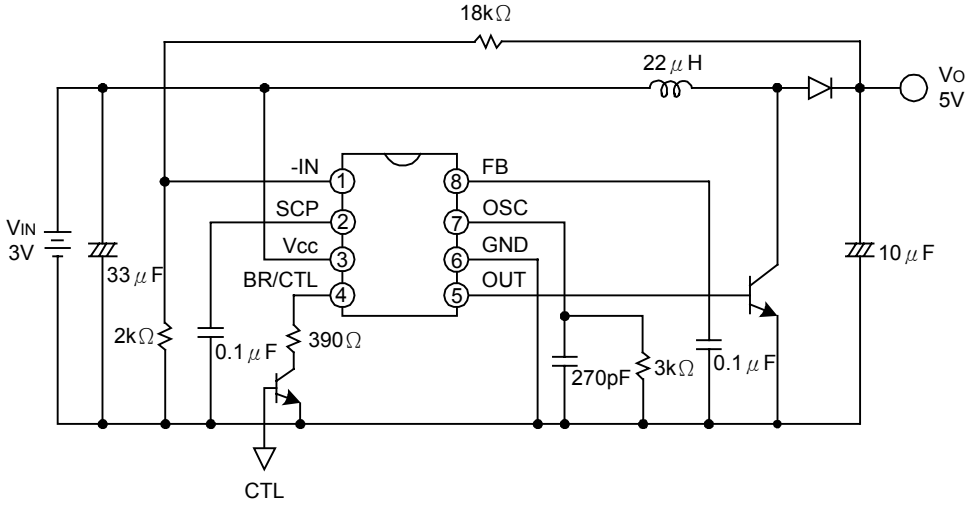
Once the protection circuit operates, the circuit can be restored by resetting the power supply.(See “HOW TO SET THE TIME CONSTANT FOR SOFT START AND SHORT CIRCUIT DETECTION”)

(2) CIRCUIT TO PREVENT MALFUNCTION AT LOW INPUT VOLTAGE

Transients when powering on or instantaneous glitches in the supply voltage can lead to malfunction of the control IC and cause system damage or failure. The circuit to prevent malfunction at low input voltage detects a low input voltage by comparing the supply voltage to the internal reference voltage. On detection, the circuit fixes the output pin to low.

The system recovers when the supply voltage rises back above the threshold voltage of the malfunction prevention circuit.

APPLICATION EXAMPLE



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