Ordering number : ENA0611

SANYO Semiconductors
DATA SHEET

Bi-CMOS LSI

LV5603T — Six-Channel Switching Regulator Controller

Overview

The LV5603T is a six-channel switching regulator controller.

Features

- Low-voltage (3V) operation
- Reference voltage precision : ±1%
- Independent standby functions for each of the six channels
- Is capable of driving MOS transistors
- Synchronous rectification: channels 1 and 2
- Supports inverting step-up operation.

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		-0.3 to 16	V
Allowable power dissipation	Pd max	Mounted on a circuit board.*	0.95	W
Operating temperature	Topr		-30 to +85	°C
Storage temperature	Tstg		-55 to +125	°C

* Specified circuit board : 114.3×76.1×1.6mm^3 : glass epoxy board

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC}		3 to 15	V
Supply voltage	VBIAS		3 to 15	V
Timing resistor	RT		7 to 30	kΩ
Timing capacitor	CT		100 to 1000	pF
Triangle wave frequency	fOSC		0.1 to 1.3	MHz

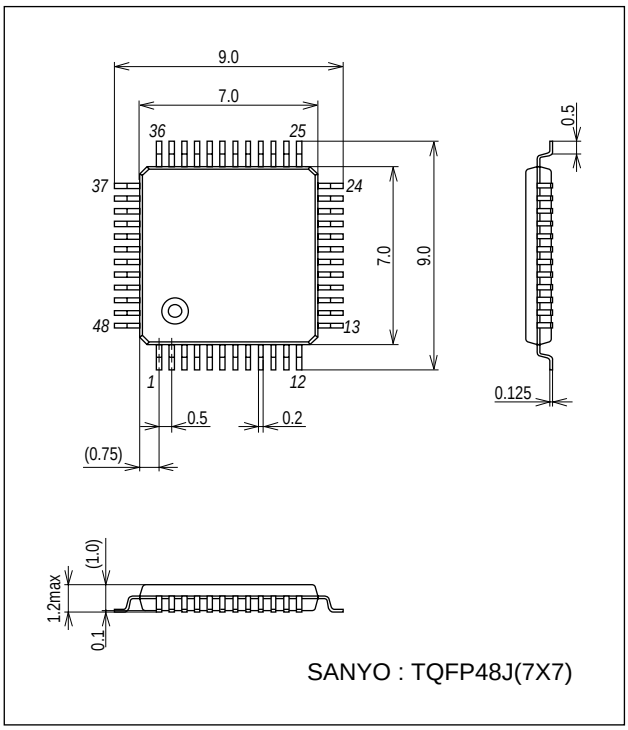
Electrical Characteristics at Ta = 25°C, V_{CC} = VBIAS = 3.6V, SCP = 0V

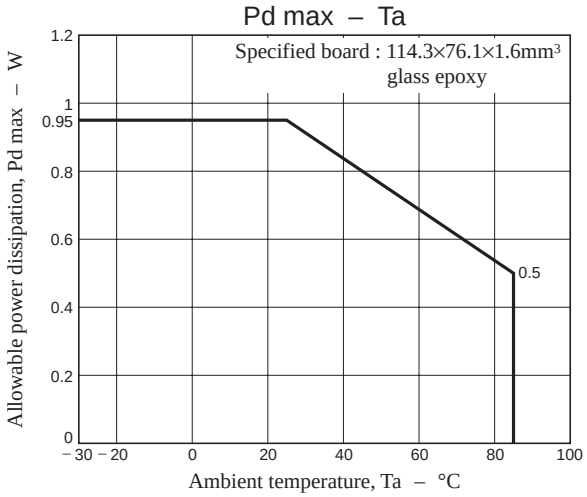
Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
Error amplifier 1							
IN^+ pin internal bias voltage		VB	Value added to the error amplifier offset at the error amplifier + side voltage	0.504	0.51	0.516	V
Output low voltage	CH1 to CH6	V_{Low} FB	$IN1^-$ = 2.0V, IFB = 20µA			0.2	V
Output High voltage	CH1 to CH6	V_{Hi} FB	$IN1^-$ = 0V IFB1 = -20µA	2.0			V
Error amplifier 2							
$IN4^-$RE pin offset voltage		VOF		-6		6	mV
Output low voltage		V_{Low} FB4RE	$IN4^-$ RE = 2.0V, IFB = 20µA			0.2	V
Output High voltage		V_{Hi} FB4RE	$IN4^-$ RE = -10mV, IFB = 500µA	2.0			V
Protection circuit							
Threshold voltage		V_{SCP}		1.1	1.25	1.4	V
SCP pin current		I_{SCP}			4		µA
Short circuit detection signal pin		VSCPOUT	Open collector ISCPOUT = 100µA			0.2	V
Software start block (CH1 to CH4)							
Soft start current	CH1 to CH6	I_{SF}	CSOFT = 0V	3.2	4	4.8	µA
Soft start resistance	CH1 to CH6	R_{SF}		160	200	240	kΩ
Fixed duty							
Maximum on duty 1	CH1 to CH3	Duty MAX1, 2, 3	Out monitor, IN^- = 0V	100			%
Maximum on duty 2	CH4	Duty MAX4	Out monitor, IN^- = 0V	75	80	85	%
Maximum on duty 3	CH5 to CH6	Duty MAX5,6	Out monitor, IN^- = 0V	80	85	90	%
Output block 1 to 6							
OUT pin high side on resistance		R_{OUT} SOUR	I_O = 10mA		25	60	Ω
OUT pin high side on resistance		R_{OUT} SINK	I_O = 10mA		10	24	Ω
Triangle wave oscillator block							
Current setting pin voltage		VT RT	RT = 10kΩ		0.57		V
Output current		I_{OH} CT			190		µA
Output current ratio		ΔI_O CT		0.8	1.0	1.2	
Oscillation frequency		$F_{OSC}1$	RT = 10kΩ, CT1, 2 = 560pF	360	450	520	kHz
Reference voltage block							
Reference voltage		VREF		1.227	1.240	1.253	V
Line regulation		V_{LN} REF	V_{CC} = 3V to 15V			10	mV
Control circuit							
On state voltage		V_{ON} CTL		2.0			V
OFF state voltage		V_{OFF} CTL				0.6	V
Pin input current		I_{IN} CTL	VCTL = 2V			60	µA
Standby circuit							
On voltage		V_{ON} STBY		2.0			V
Off voltage		V_{OFF} STBY				0.6	V
Pin input current		I_{IN} STBY	VSTBY = 2V			60	µA
All circuits							
VCC current consumption		I_{CC}	$IN1^-$ to $IN6^-$ = 1V		5	6.5	mA
Standby mode current consumption		I_{OFF}	VSTBY = VCTL = 0V $I_{OFF} = I_{CC} + I_{BIAS}$			1	µA

Package Dimensions

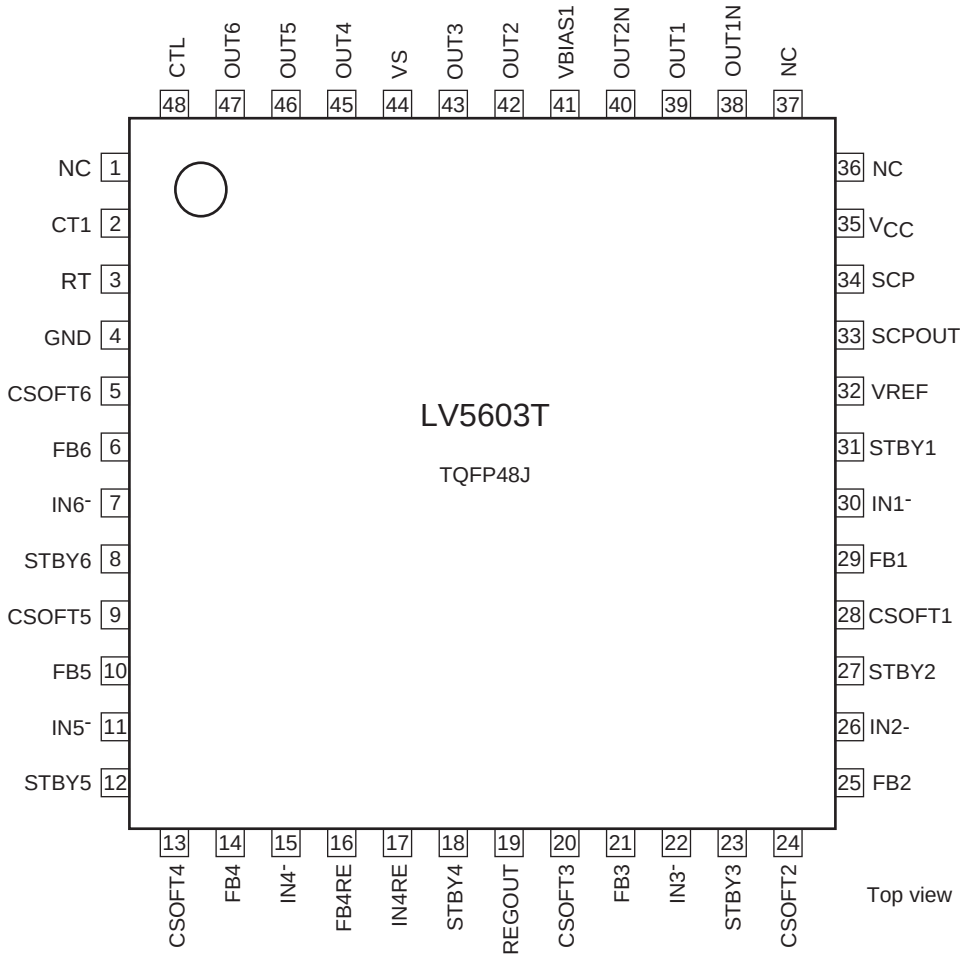
unit : mm (typ)

3288

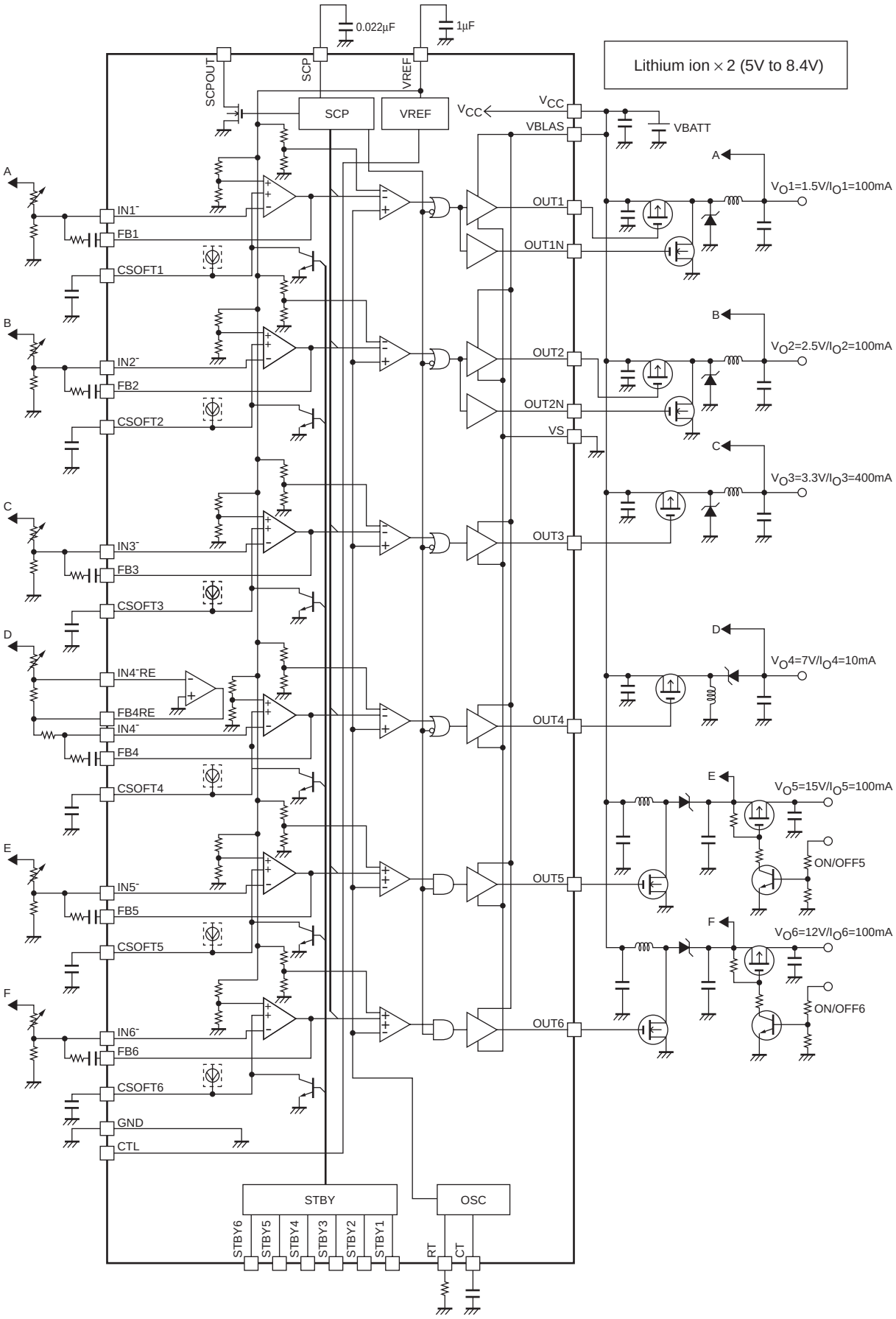




Pin Assignment



Block Diagram and Sample Application Circuit

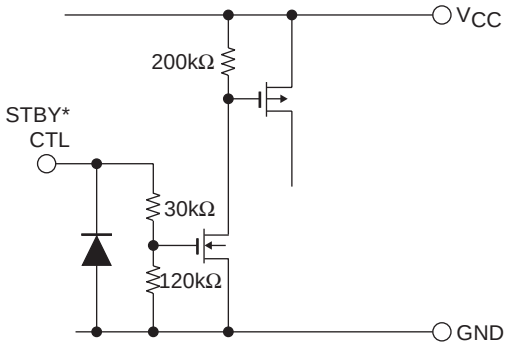
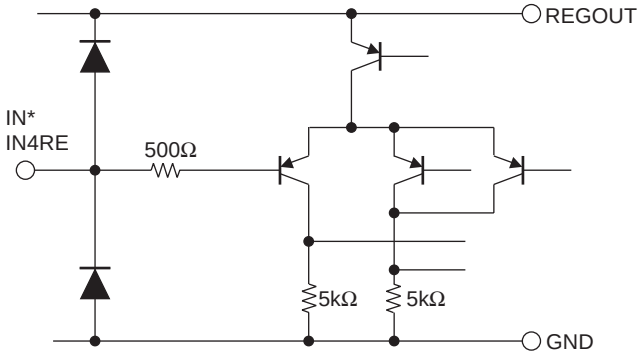
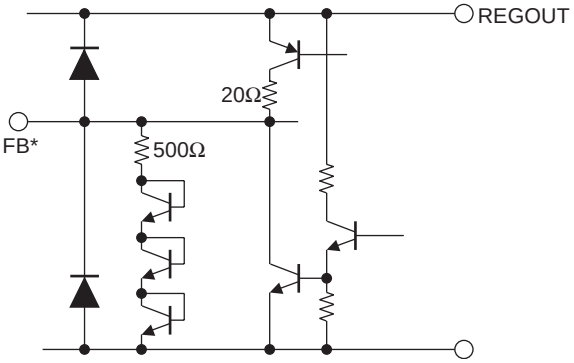
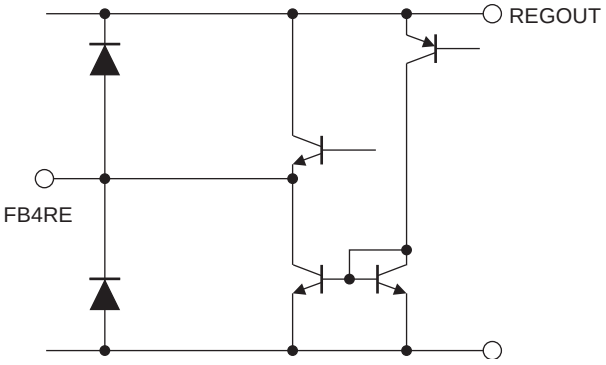


Pin Function

Block	Pin No.	Pin	Functions
ch1	31	STBY1	Standby input
	30	$IN1^-$	Error amplifier input
	29	FB1	Error amplifier output
	28	CSOFT1	Soft start setting capacitor connection
	39	OUT1	Output
	38	OUT1N	Synchronous rectification output
ch2	27	STBY2	Standby input
	26	$IN2^-$	Error amplifier input
	25	FB2	Error amplifier output
	24	CSOFT2	Soft start setting capacitor connection
	42	OUT2	Output
	40	OUT2N	Synchronous rectification output
ch3	23	STBY3	Standby input
	22	$IN3^-$	Error amplifier input
	21	FB3	Error amplifier output
	20	CSOFT3	Soft start setting capacitor connection
	43	OUT3	Output
ch4	18	STBY4	Standby input
	15	$IN4^-$	Error amplifier input
	14	FB4	Error amplifier output
	17	IN4RE	Inversion step-up error amplifier inverting input
	16	FB4RE	Inversion step-up error amplifier output
	13	CSOFT4	Soft start setting capacitor connection
	45	OUT4	Output
ch5	15	STBY5	Standby input
	11	$IN5^-$	Error amplifier input
	10	FB5	Error amplifier output
	9	CSOFT5	Soft start setting capacitor connection
	46	OUT5	Output
ch6	8	STBY6	Standby input
	7	$IN6^-$	Error amplifier input
	6	FB6	Error amplifier output
	5	CSOFT6	Soft start setting capacitor connection
	47	OUT6	Output
OSC	2	CT1	Triangle wave frequency setting capacitor connection
	3	RT	Triangle wave frequency setting resistor connection
Control	45	CTL	Power system control
	34	SCP	Short circuit detection circuit capacitor connection
	33	SCPOUT	Short circuit detection circuit output
Power	35	V_{CC}	Power supply voltage input
	41	VBIAS1	Output system power supply
	32	VREF	Reference voltage output
	4	GND	Ground
	44	VS	Output system ground
TEST	19	REGOUT	Internal circuit bias power supply
NC	1, 36, 37	NC	No connection

* : The REGOUT pin is the internal circuit bias power supply. This pin must be left open.

Equivalent Circuits

Pin No.	Pin	Equivalent Circuit
48 31 27 23 18 15 8	CTL STBY1 STBY2 STBY3 STBY4 STBY5 STBY6	
30 26 22 15 11 7 17	IN1- IN2- IN3- IN4- IN5- IN6- IN4RE	
29 25 21 14 10 6	FB1 FB2 FB3 FB4 FB5 FB6	
16	FB4RE	

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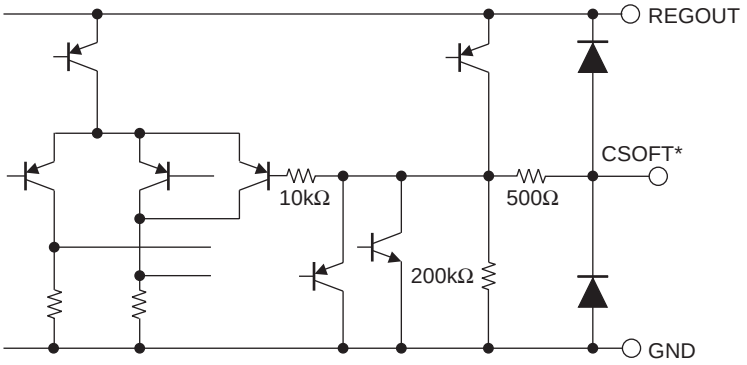
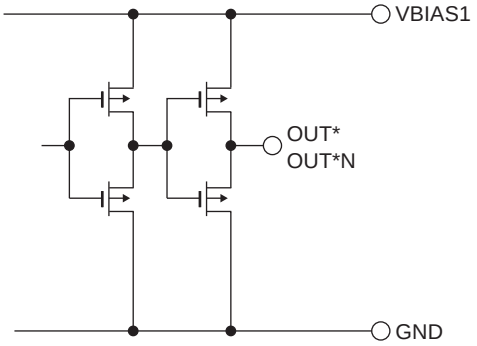
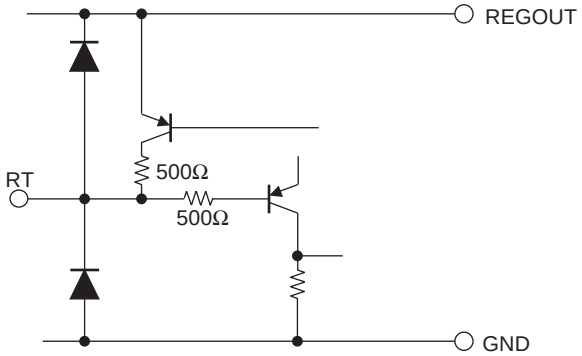
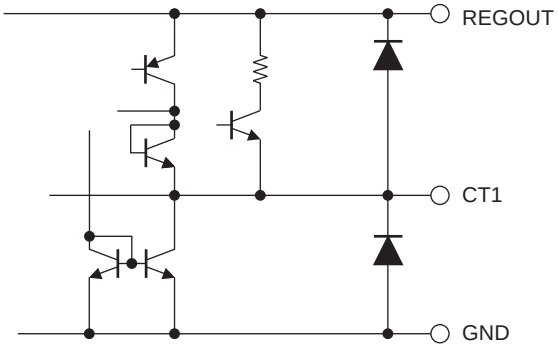
Pin No.	Pin	Equivalent Circuit
28 24 20 13 9 5	CSOFT1 CSOFT2 CSOFT3 CSOFT4 CSOFT5 CSOFT6	
39 42 43 45 46 47 38 40	OUT1 OUT2 OUT3 OUT4 OUT5 OUT6 OUT1N OUT2N	
3	RT	
2	CT1	

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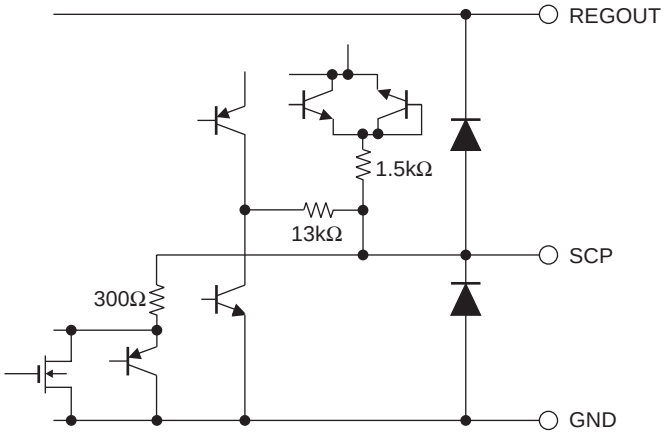
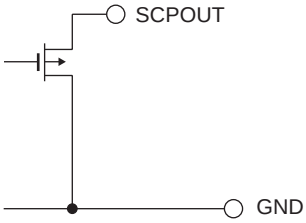
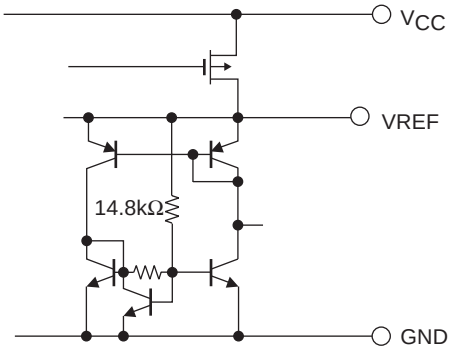
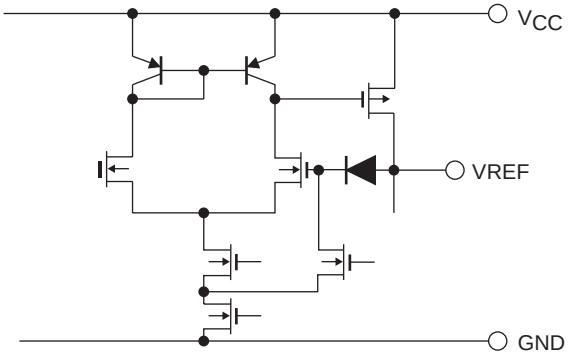
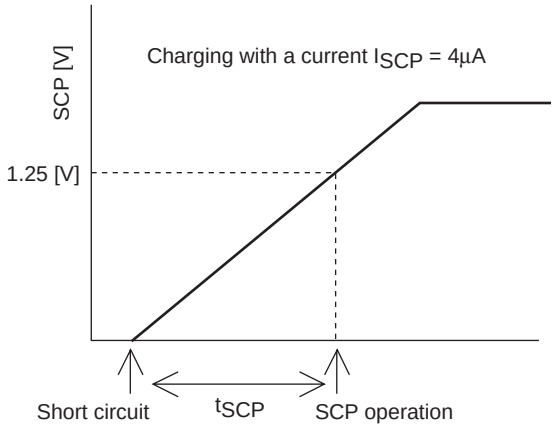
Pin No.	Pin	Equivalent Circuit
34	SCP	
33	SCPOUT	
32	VREF	
19	REGOUT	
35	V_{CC}	
41	VBIAS1	
4	GND	
44	VS	
1 36 37	NC	

STBY and CTL Pin Functions

The STBY and CTL pins function as active high control inputs.
There is no ESD protection diode inserted between the V_{CC} line and the STBY pin. This means that there is no magnitude relationship between the STBY and CTL pin voltage and the V_{CC} voltage.

SCP Pin

If of the FB1 to FB6 outputs goes to the high level due to the load being shorted, the SCP pin starts a charging operation and the protection circuit will operate if the shorted state is not resolved during the period tSCP. (If the protection circuit operates, all outputs are turned off.) If the application does not use this protection circuit, the SCP pin must be shorted to ground with a line that is as short as possible.

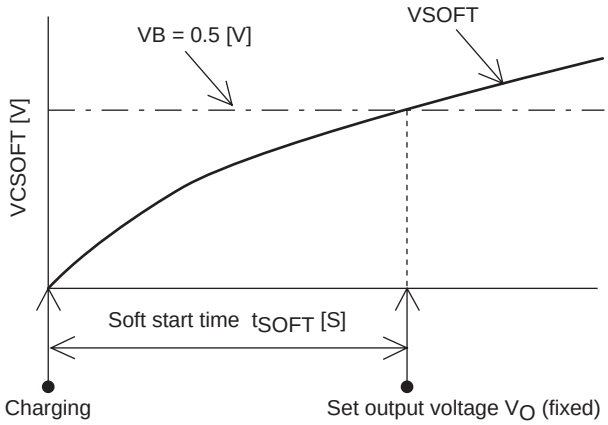


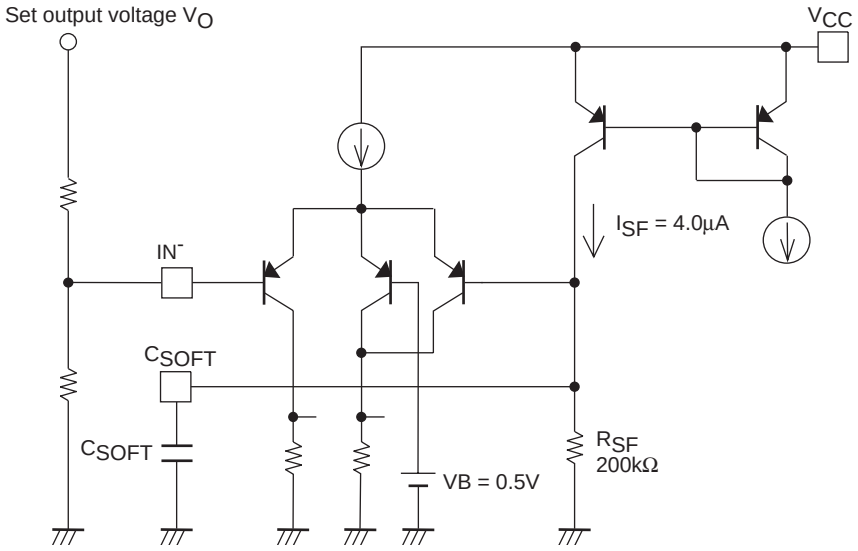
SCP Charging Operation

$$t_{SCP} = \frac{C_{SCP} \times V_{SCP}}{I_{SCP}} \text{ [s]}$$

Setting the Soft Start Time

- For channel 1 (Channels 2 through 6 are the same)
  The channel 1 soft start time is set with the capacitor connected between CSOFT1 (CSOFT2 through CSOFT6 for the other channels) and ground.





$$t_{SOFT} = -C_{SOFT} \times R_{SF}\ 1n(1-\frac{VB}{R_{SF} \times I_{SF}})\ [s]$$

$$=2.135 \times 10^{5} \times C_{SOFT}$$

Setting the Oscillator Frequency

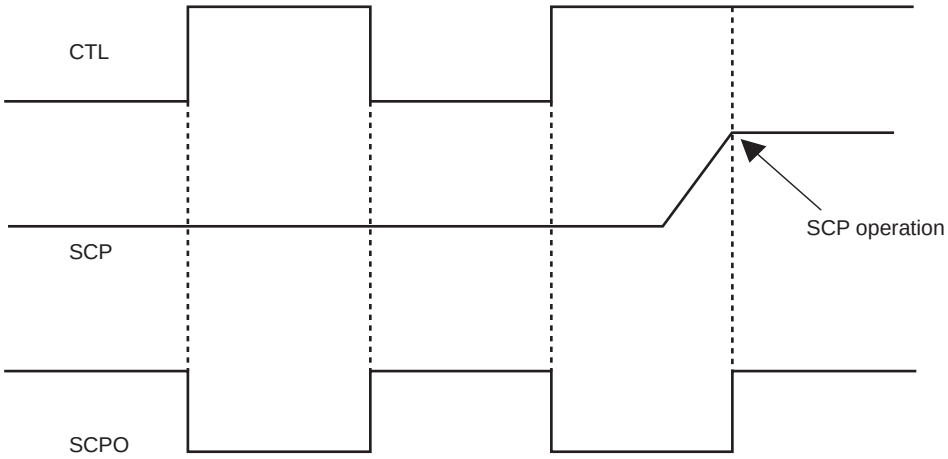
The oscillator frequency is set by the capacitor CT and the resistor RT connected to the CT pin. The oscillator produces a triangle wave with a frequency determined by CT and RT.
The oscillator frequency is expressed by the following equation.

$$f_{OSC} = 2.52 \times \frac{1}{CT \times RT} \ [Hz]$$

Since the actual oscillator frequency will differ somewhat from the value given by the above equation due to overshoot, undershoot, and other factors, it must be verified in the actual end product.

The SCPOUT Pin

This pin reports the SCP and CTL states to an external microcontroller or other device. The SCPOUT pin is an open drain output, and thus requires an external pull-up resistor. If this function is not used, the SCPOUT pin should be left open.



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