



LV5603T — Bi-CMOS LSI Six-Channel Switching Regulator Controller

Overview

The LV5603T is a six-channel switching regulator controller.

Features

- Low-voltage (3V) operation
- Reference voltage precision : $\pm 1\%$
- 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 $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		-0.3 to 16	V
Allowable power dissipation	P_d max	Mounted on a circuit board.*	0.95	W
Operating temperature	T_{opr}		-30 to +85	$^\circ\text{C}$
Storage temperature	T_{stg}		-55 to +125	$^\circ\text{C}$

* Specified circuit board : $114.3 \times 76.1 \times 1.6\text{mm}^3$: glass epoxy board

Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

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

■ Any and all SANYO Semiconductor Co.,Ltd. products described or contained herein are, with regard to "standard application", intended for the use as general electronics equipment (home appliances, AV equipment, communication device, office equipment, industrial equipment etc.). The products mentioned herein shall not be intended for use for any "special application" (medical equipment whose purpose is to sustain life, aerospace instrument, nuclear control device, burning appliances, transportation machine, traffic signal system, safety equipment etc.) that shall require extremely high level of reliability and can directly threaten human lives in case of failure or malfunction of the product or may cause harm to human bodies, nor shall they grant any guarantee thereof. If you should intend to use our products for applications outside the standard applications of our customer who is considering such use and/or outside the scope of our intended standard applications, please consult with us prior to the intended use. If there is no consultation or inquiry before the intended use, our customer shall be solely responsible for the use.

■ Specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein stipulate the performance, characteristics, and functions of the described products in the independent state, and are not guarantees of the performance, characteristics, and functions of the described products as mounted in the customer's products or equipment. To verify symptoms and states that cannot be evaluated in an independent device, the customer should always evaluate and test devices mounted in the customer's products or equipment.

LV5603T

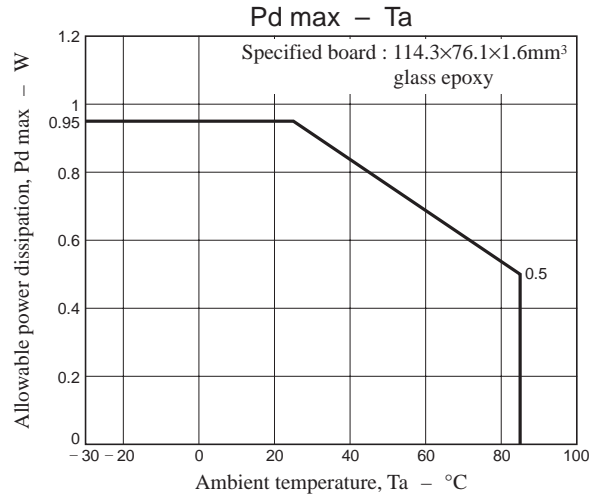
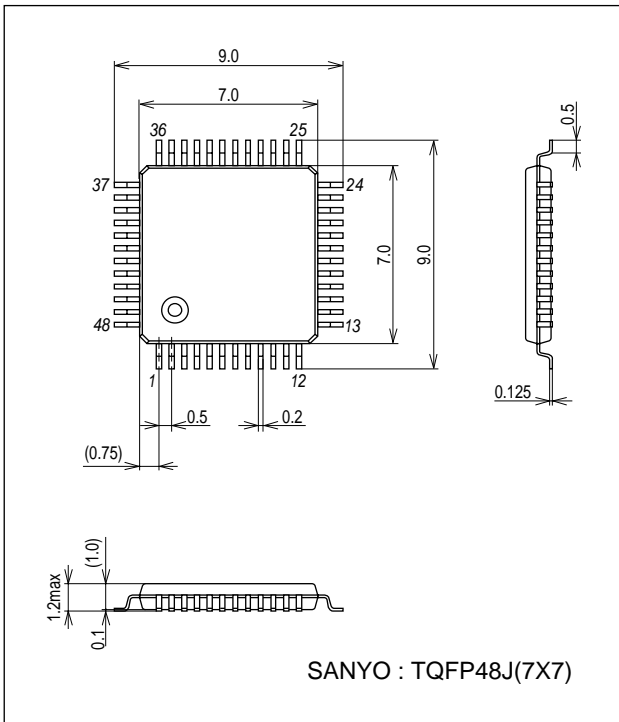
Electrical Characteristics at $T_a = 25^\circ\text{C}$, $V_{CC} = V_{BIAS} = 3.6\text{V}$, $SCP = 0\text{V}$

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	$V_{\text{Low FB}}$	IN ⁻ = 2.0V, IFB = 20 μA		0.2	V		
Output High voltage	CH1 to CH6	$V_{\text{Hi FB}}$	IN ⁻ = 0V IFB1 = -20 μA		2.0	V		
Error amplifier 2								
IN ⁺ RE pin offset voltage	VOF		-6		6	mV		
Output low voltage		$V_{\text{Low FB4RE}}$	IN ⁺ RE = 2.0V, IFB = 20 μA		0.2	V		
Output High voltage		$V_{\text{Hi FB4RE}}$	IN ⁺ RE = -10mV, IFB = 500 μA		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 ISCP = 100 μA		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		k Ω	
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		$R_{\text{OUT SOUR}}$	$I_{\text{O}} = 10\text{mA}$			25	60	Ω
OUT pin high side on resistance		$R_{\text{OUT SINK}}$	$I_{\text{O}} = 10\text{mA}$			10	24	Ω
Triangle wave oscillator block								
Current setting pin voltage		$V_{\text{T RT}}$	RT = 10k Ω			0.57		V
Output current		$I_{\text{OH CT}}$				190		μA
Output current ratio		$\Delta I_{\text{O CT}}$	0.8	1.0	1.2			
Oscillation frequency		F_{OSC1}	RT = 10k Ω , CT1, 2 = 560pF		360	450	520	kHz
Reference voltage block								
Reference voltage		V_{REF}	1.227	1.240	1.253			V
Line regulation		$V_{\text{LN REF}}$	$V_{\text{CC}} = 3\text{V to }15\text{V}$				10	mV
Control circuit								
On state voltage		$V_{\text{ON CTL}}$	2.0					V
OFF state voltage		$V_{\text{OFF CTL}}$			0.6			V
Pin input current		$I_{\text{IN CTL}}$	$V_{\text{CTL}} = 2\text{V}$				60	μA
Standby circuit								
On voltage		$V_{\text{ON STBY}}$	2.0					V
Off voltage		$V_{\text{OFF STBY}}$			0.6			V
Pin input current		$I_{\text{IN STBY}}$	$V_{\text{STBY}} = 2\text{V}$				60	μA
All circuits								
VCC current consumption		I_{CC}	IN ⁺ to IN ⁻ = 1V			5	6.5	mA
Standby mode current consumption		I_{OFF}	$V_{\text{STBY}} = V_{\text{CTL}} = 0\text{V}$ $I_{\text{OFF}} = I_{\text{CC}} + I_{\text{BIAS}}$				1	μA

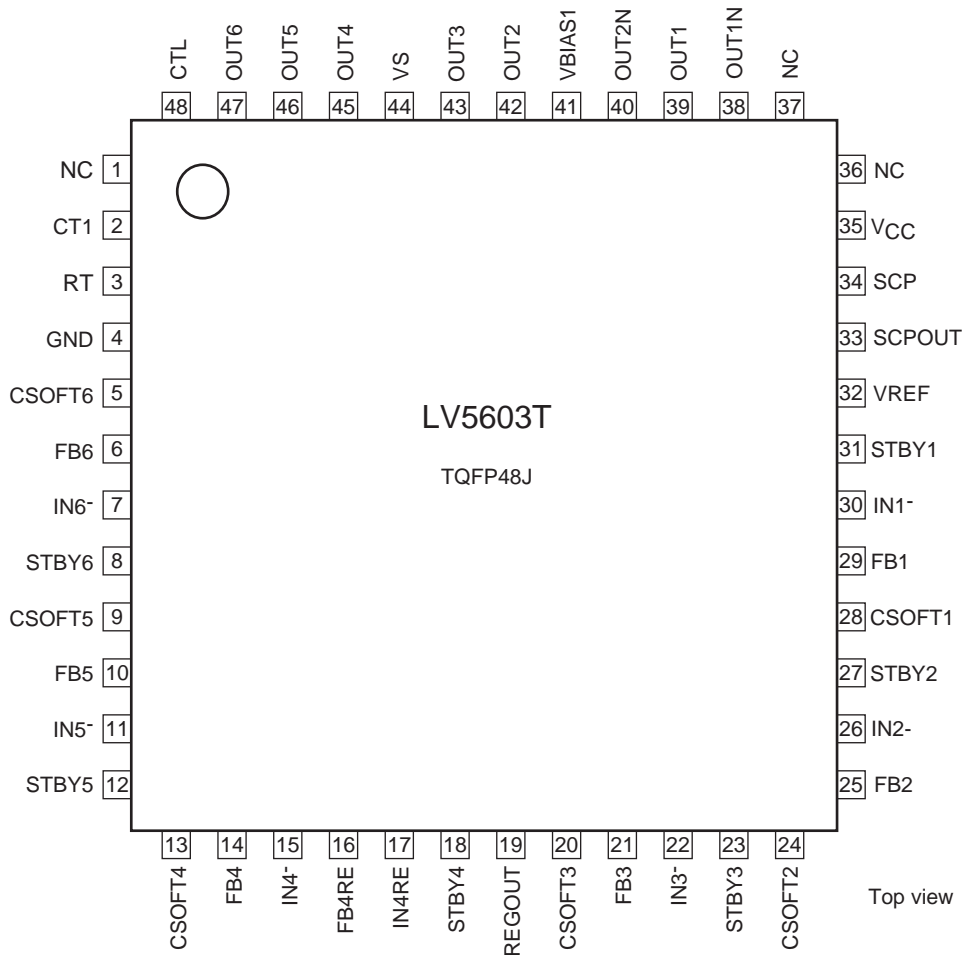
LV5603T

Package Dimensions

unit : mm (typ)
3288

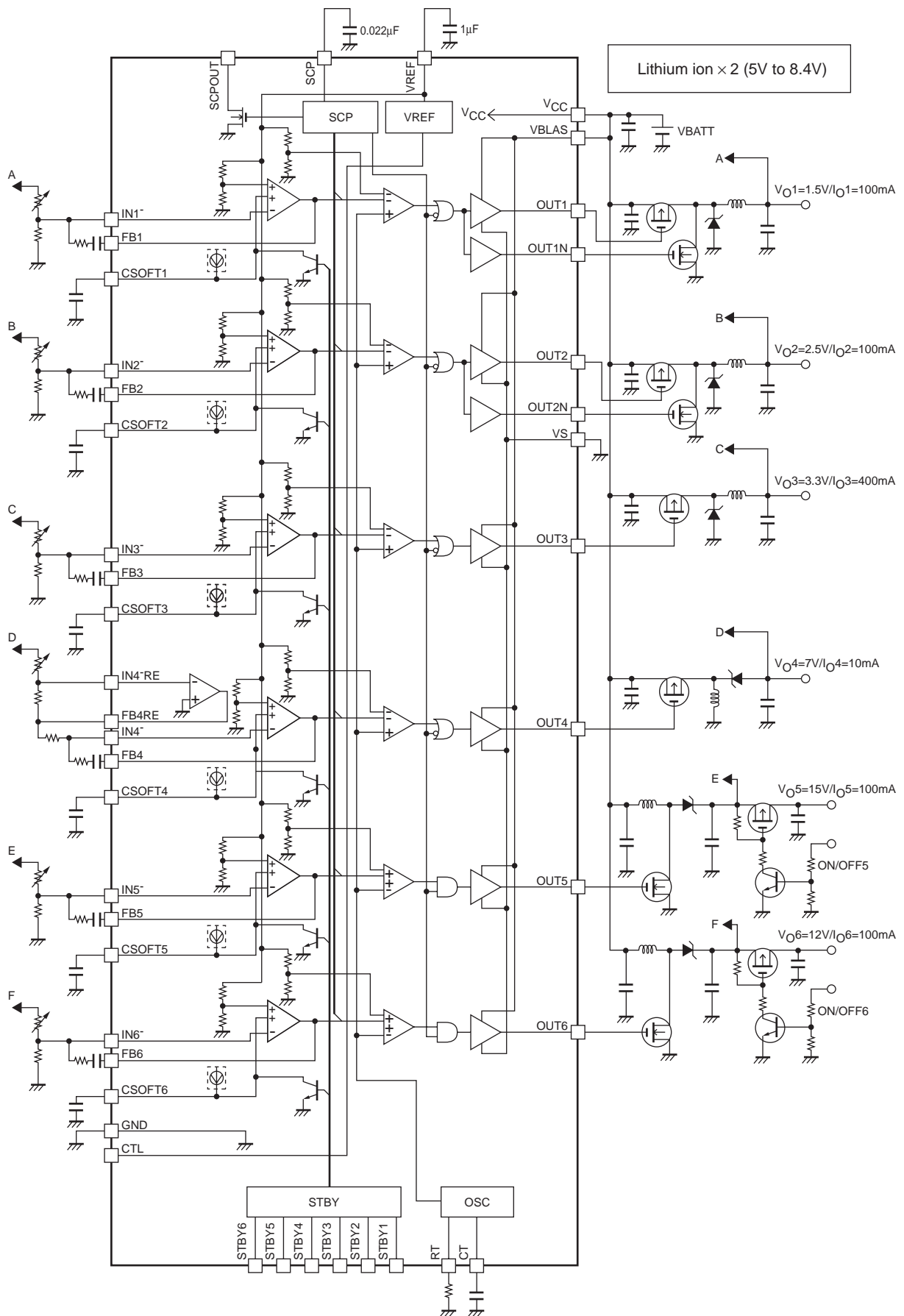


Pin Assignment



LV5603T

Block Diagram and Sample Application Circuit



LV5603T

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.

LV5603T

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	

Continued on next page.

LV5603T

Continued from preceding page.

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	

Continued on next page.

LV5603T

Continued from preceding page.

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

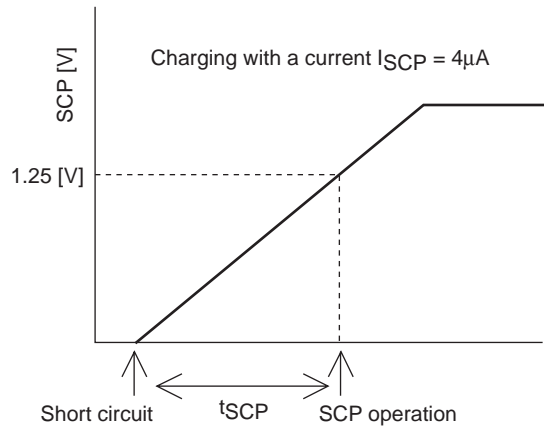
STBY and CTL Pin Functions

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 t_{SCP}. (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.



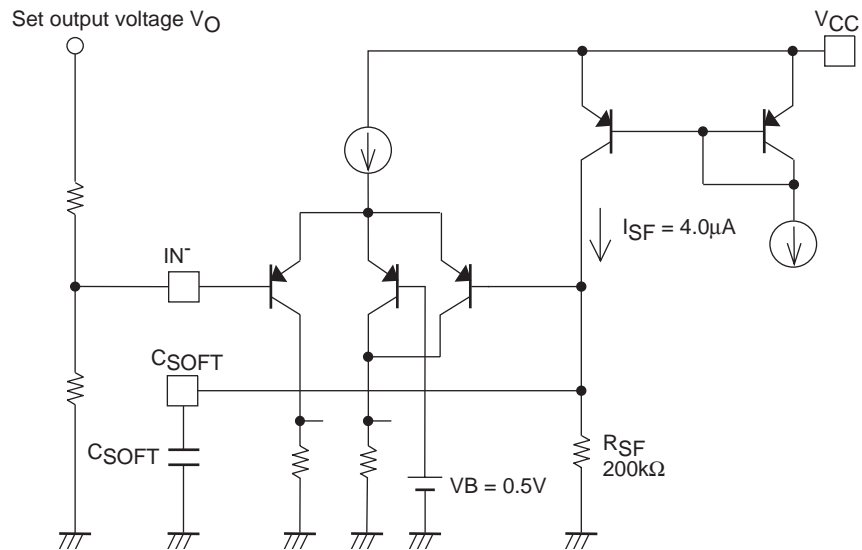
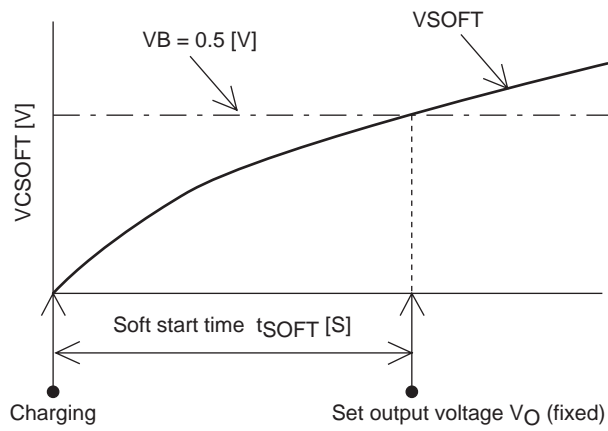
SCP Charging Operation

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

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.



$$t_{SOFT} = -C_{SOFT} \times R_{SF} \ln\left(1 - \frac{V_B}{R_{SF} \times I_{SF}}\right) [s]$$

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

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.

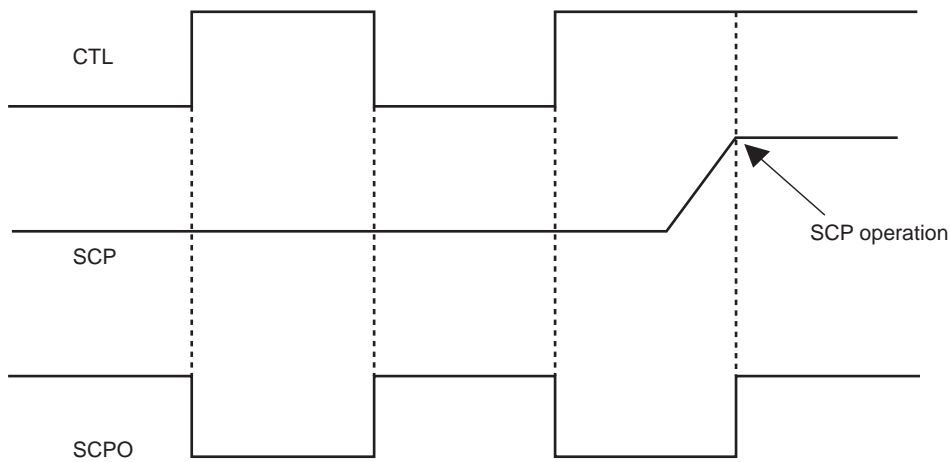
The oscillator frequency is expressed by the following equation.

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

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.



- SANYO Semiconductor Co.,Ltd. assumes no responsibility for equipment failures that result from using products at values that exceed, even momentarily, rated values (such as maximum ratings, operating condition ranges, or other parameters) listed in products specifications of any and all SANYO Semiconductor Co.,Ltd. products described or contained herein.
- SANYO Semiconductor Co.,Ltd. strives to supply high-quality high-reliability products, however, any and all semiconductor products fail or malfunction with some probability. It is possible that these probabilistic failures or malfunction could give rise to accidents or events that could endanger human lives, trouble that could give rise to smoke or fire, or accidents that could cause damage to other property. When designing equipment, adopt safety measures so that these kinds of accidents or events cannot occur. Such measures include but are not limited to protective circuits and error prevention circuits for safe design, redundant design, and structural design.
- In the event that any or all SANYO Semiconductor Co.,Ltd. products described or contained herein are controlled under any of applicable local export control laws and regulations, such products may require the export license from the authorities concerned in accordance with the above law.
- No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or any information storage or retrieval system, or otherwise, without the prior written consent of SANYO Semiconductor Co.,Ltd.
- Any and all information described or contained herein are subject to change without notice due to product/technology improvement, etc. When designing equipment, refer to the "Delivery Specification" for the SANYO Semiconductor Co.,Ltd. product that you intend to use.
- Information (including circuit diagrams and circuit parameters) herein is for example only; it is not guaranteed for volume production.
- Upon using the technical information or products described herein, neither warranty nor license shall be granted with regard to intellectual property rights or any other rights of SANYO Semiconductor Co.,Ltd. or any third party. SANYO Semiconductor Co.,Ltd. shall not be liable for any claim or suits with regard to a third party's intellectual property rights which has resulted from the use of the technical information and products mentioned above.

This catalog provides information as of January, 2007. Specifications and information herein are subject to change without notice.