



# SANYO Semiconductors

## DATA SHEET

### Monolithic Linear IC

# LA5683T — 4ch Switching Regulator Control IC

## Overview

The LA5683T is 4ch switching regulator control IC.

## Functions

- Low-voltage operation (minimum 1.8V).
- OUT1 and OUT2 can drive external PNP transistors.
- OUT3 and OUT4 can drive external NPN transistors.
- 4-independent-channel standby circuit built-in.
- $\pm 1\%$  accuracy reference voltage.
- Supports MOS transistor drive.
- Channel 2 dead time internally set fixed, duty cycle = 100%.  
(The dead time for channels 1, 3, and 4 are set externally.)

## Specifications

### Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V <sub>CC</sub> max		9	V
Allowable power dissipation	Pd max	Independent IC	0.4	W
Operating temperature	Topr		-20 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

### Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage 1	V <sub>CC</sub>		1.8 to 8	V
Supply voltage 2	V <sub>BIAS</sub>		1.8 to 8	V
Output sync current	I <sub>SINK</sub> max		0 to 30	mA
Reference voltage output current	I <sub>REF</sub>		0 to 1	mA
Timing resistor	RT		3 to 30	kΩ
Timing capacity	CT		100 to 1000	pF
Triangular wave frequency	f <sub>OSC</sub>		0.1 to 1	MHz

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# LA5683T

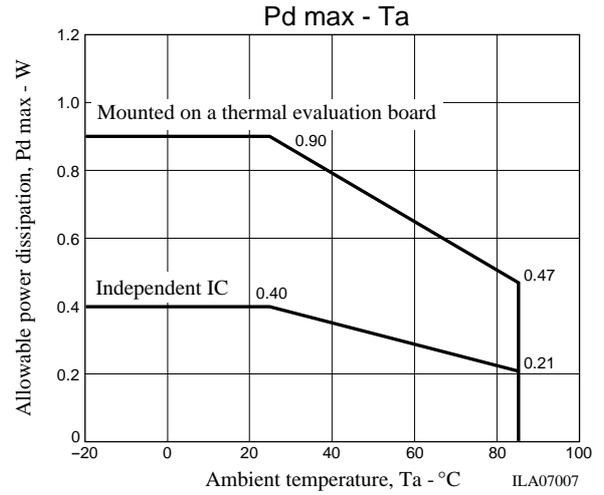
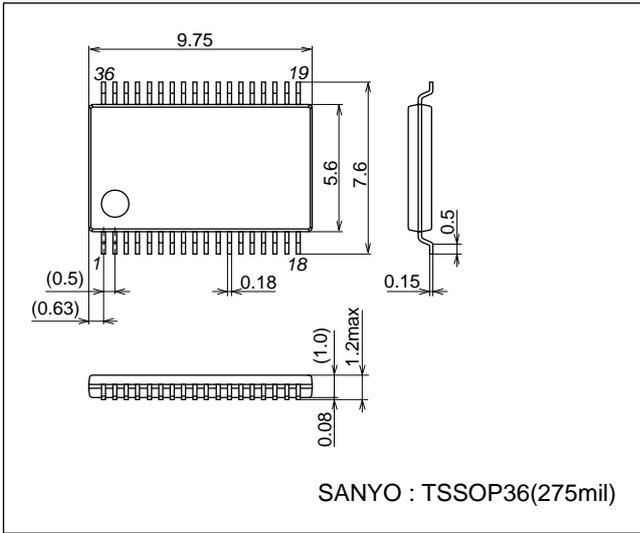
**Electrical Characteristics** at  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = V_{STBY1}$  to 4 = 3V,  $SCP = 0V$

Parameter		Symbol	Conditions	Ratings			Unit
				min	typ	max	
[Error amplifier]							
IN+ pin internal bias voltage		VB	Pins IN1 <sup>+</sup> , IN2 <sup>+</sup> , IN3 <sup>+</sup> , and IN4 <sup>+</sup>	0.500	0.506	0.512	V
Output L level voltage	CH1 to CH4	V <sub>Low_FB1</sub>	IN1 <sup>-</sup> = 2.0 IFB1 = 20μA			1	V
Output H level voltage	CH1 to CH4	V <sub>Hi_FB1</sub>	IN1 <sup>-</sup> = 0V IFB1 = -20μA	2.25			V
[Protection circuit]							
Threshold voltage		V <sub>SCP</sub>		1.1	1.25	1.4	V
SCP pin current		I <sub>SCP</sub>			3.9		μA
[Idle period adjustment block]							
Input bias current		I <sub>B_DTC</sub>		-15	-3		μA
Threshold voltage 1	CH1	V <sub>TH1_DTC</sub>	IN1 <sup>-</sup> = 0V, duty cycle = 100%	0.67	0.77	0.87	V
Threshold voltage 2	CH1	V <sub>TH2_DTC</sub>	IN1 <sup>-</sup> = 0V, duty cycle = 0%	0.35	0.4	0.45	V
Threshold voltage 3	CH3 to CH4	V <sub>TH3_DTC</sub>	IN3, IN4 <sup>-</sup> = 0V, duty cycle = 100%	0.72	0.8	0.88	V
Threshold voltage 4	CH3 to CH4	V <sub>TH4_DTC</sub>	IN3, IN4 <sup>-</sup> = 0V, duty cycle = 0%	0.4	0.45	0.5	V
[Software start block (CH1 to CH4)]							
Software start current	CH1 to CH4	I <sub>SF</sub>	CSOFT = 0V	3.16	3.95	4.74	μA
Software start resistance	CH1 to CH4	R <sub>SF</sub>		160	200	240	kΩ
[Output blocks 1 and 2 (CH1 and CH2)]							
OUT pin source current		I <sub>OUT12_SOUR</sub>	IN1, 2 <sup>-</sup> = 0V DTC1 = 0V V <sub>OUT1, 2</sub> = 2.7V ICAPH = 0.5mA	10			mA
OUT pin sink current		I <sub>OUT12_SINK</sub>	IN1, 2 <sup>-</sup> = 0V DTC1 = 1.0V V <sub>OUT1, 2</sub> = 2.3V	35	45	55	mA
[Output blocks and 4 (CH3 and CH4)]							
OUT pin source current		I <sub>OUT34_SOUR</sub>	V <sub>OUT3, 4</sub> = 0.9V DTC3, 4 = 1.0V IN3, 4 = 0V	20	30	40	mA
OUT pin sink current		I <sub>OUT34_SINK</sub>	V <sub>OUT3, 4</sub> = 0.3V DTC3, 4 = 1.0V IN3, 4 = 1.0V	30			mA
OUT pin high level voltage		V <sub>OUT34_Hi</sub>	I <sub>OUT3, 4</sub> = -10mA DTC3, 4 = 1.0V IN3, 4 = 0V	2			V
OUT pin low level voltage		V <sub>OUT34_Low</sub>	I <sub>OUT3, 4</sub> = 10mA DTC3, 4 = 0V IN3, 4 = 1.0V			0.2	V
[Triangular wave form generator block]							
Current setting pin voltage		V <sub>T_RT</sub>	RT = 5.6kΩ	1.190	1.260	1.330	V
Output current		I <sub>OH_CT</sub>	V <sub>CT</sub> = 0.5V, RT = 5.6kΩ		230		μA
Output current ratio		ΔI <sub>O_CT</sub>		0.8	1.0	1.2	
Oscillation frequency		f <sub>OSC1</sub>		380	440	500	kHz
[Reference voltage block]							
Reference voltage		V <sub>REF</sub>	I <sub>REF</sub> = -1mA	1.244	1.257	1.270	V
Line regulation		V <sub>LN_REF</sub>	V <sub>CC</sub> = 1.8V to 8V			10	mV
Load regulation		V <sub>LD_REF</sub>	I <sub>REF</sub> = -0.1mA to -1mA			10	mV
[STBY circuit]							
On voltage		V <sub>ON_STBY</sub>		1.15			V
Off voltage		V <sub>OFF_STBY</sub>				0.2	V
Pin input current		I <sub>IN_STBY</sub>	V <sub>STBY1</sub> to 4 = 3V			70	μA
[All circuits]							
Operating-time current drain		I <sub>CC1</sub>	FB1, 2, 3, 4 = 1.5V DTC1, 3, 4 = 1.5V		15	18	mA
Standby-time current drain		I <sub>CC2</sub>	V <sub>STBY1</sub> to 3 = 0V			1	μA

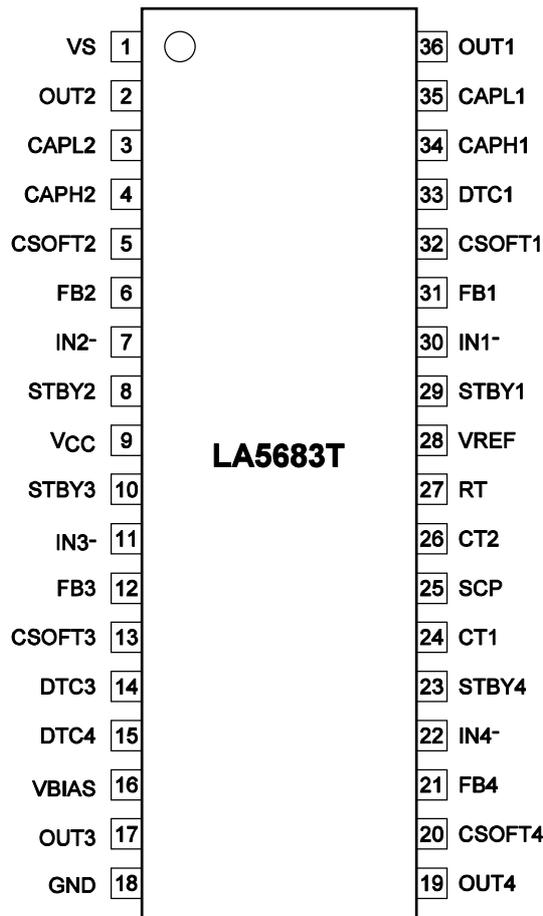
# LA5683T

## Package Dimensions

unit : mm  
3253B



## Pin Assignment

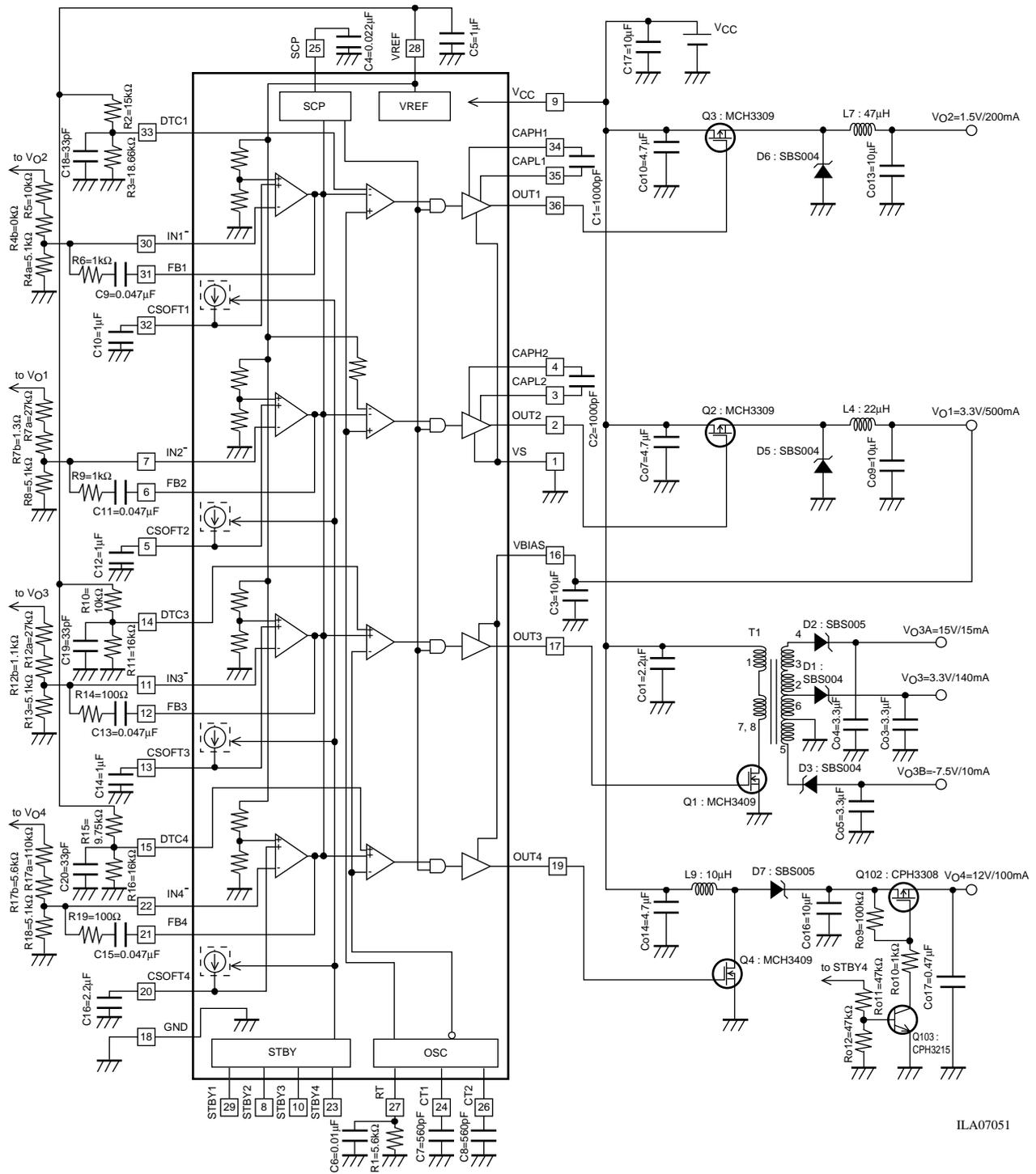


Top view



Application Circuit Examples 2

4-dry battery (3.5V to 6.5V) configuration

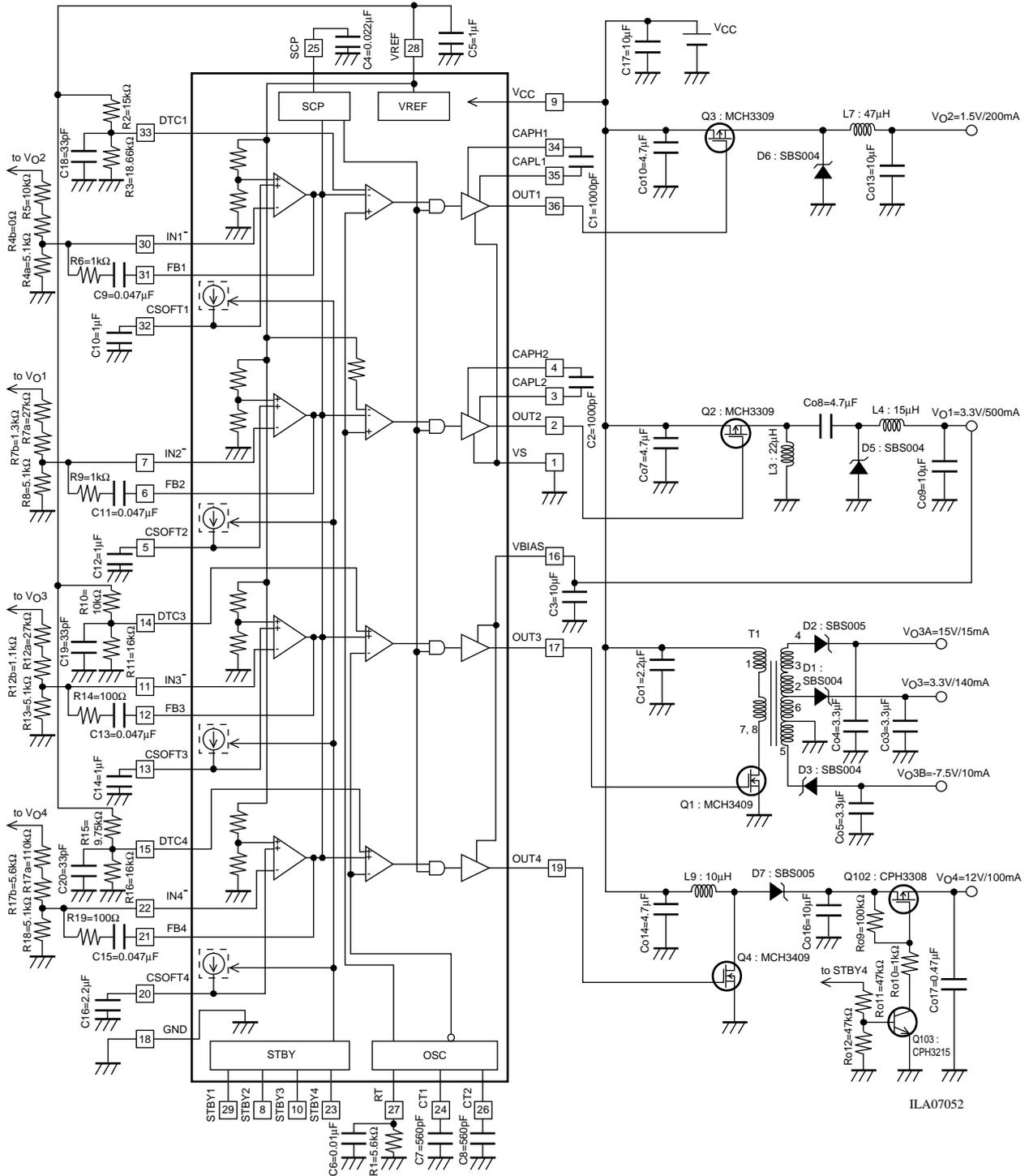


ILA07051

- T1 = Sumida product
- L4 = TDK product: RLF5018-220MR63
- L7 = Toko product: 636CY-470M
- L9 = Toko product: 636CY-100M

Application Circuit Examples 3

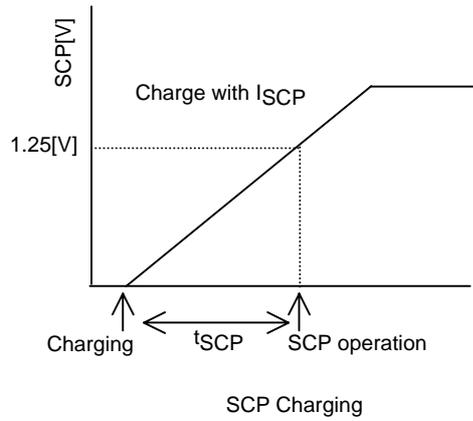
1-lithium ion battery (2.5V to 4.2V) configuration



- T1 = Sumida product
- L3 = TDK product: RLF5018-220MR63
- L4 = TDK product: RLF5018-150MR63
- L7 = Toko product: 636CY-470M
- L9 = Toko product: 636CY-100M

### SCP Pin

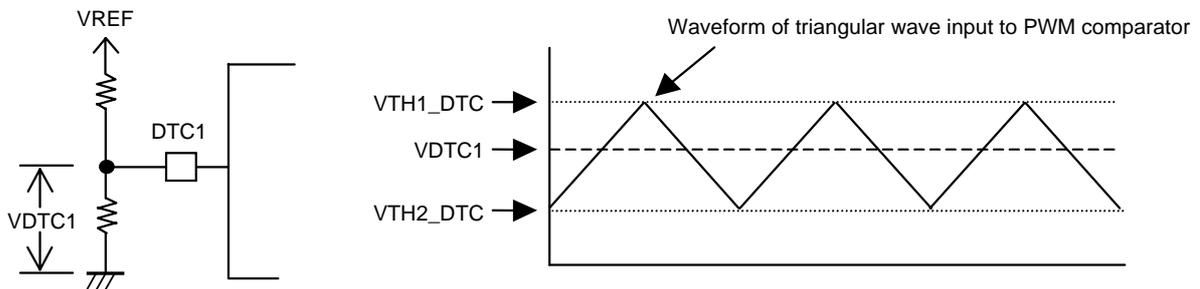
Charging of the SCP block starts when FB1 to FB4 are set to a low level due to a load shorting and the protection circuit is activated if the block does not reset itself within the preset time  $t_{SCP}$  (the protection circuit then turns off the whole OUT channels).



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

### Dead Time Setup

- The dead time of channel 1 can be set by the voltage at DTC1.



The duty cycle D1 is calculated as follows:

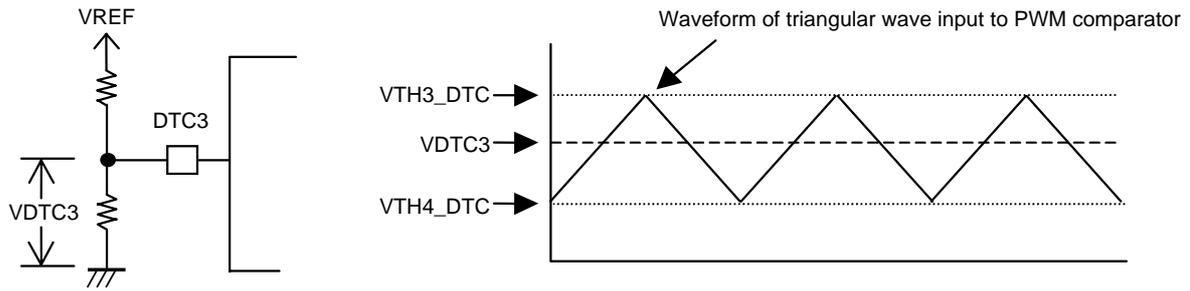
$$D1 = \frac{VDTC1 - VTH2\_DTC}{VTH1\_DTC - VTH2\_DTC} \times 100[\%]$$

- Channel 2

The dead time of channel 2 is fixed internally and the setting duty is 100%.

- Channel 3

The dead time of channel 3 can be set by the voltage at DTC3.



The duty cycle D3 is calculated as follows:

$$D3 = \frac{V DTC3 - VTH4\_DTC}{VTH3\_DTC - VTH4\_DTC} \times 100 [ \% ]$$

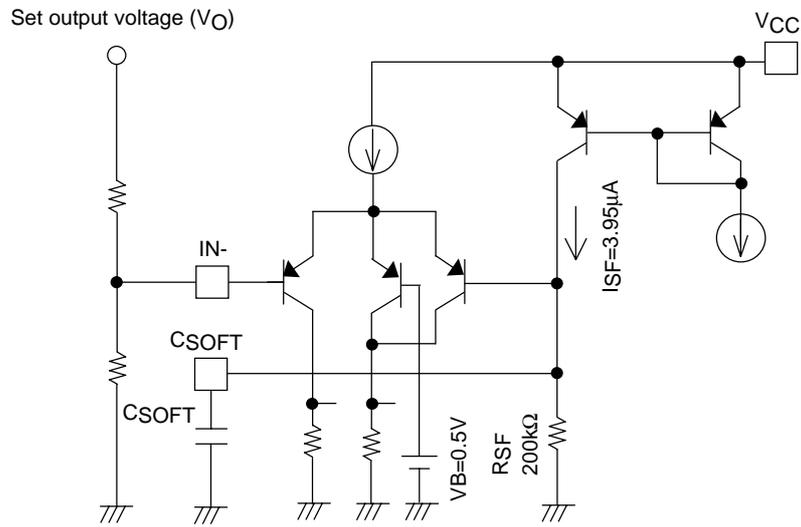
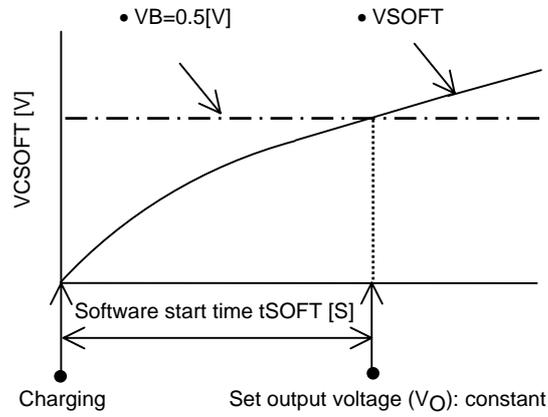
- Channel 4

The dead time of channel 4 can be set in the same manner as that of channel 3.

**Procedure for Setting the Software Start Time**

- Channel 1 (the procedure is the same for channels 2, 3, and 4.)

The software start time of channel 1 is set by the capacitance of the capacitor connected between pin CSOFT1 to CSOFT4 and GND.



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

\* The formula is for channel 1.

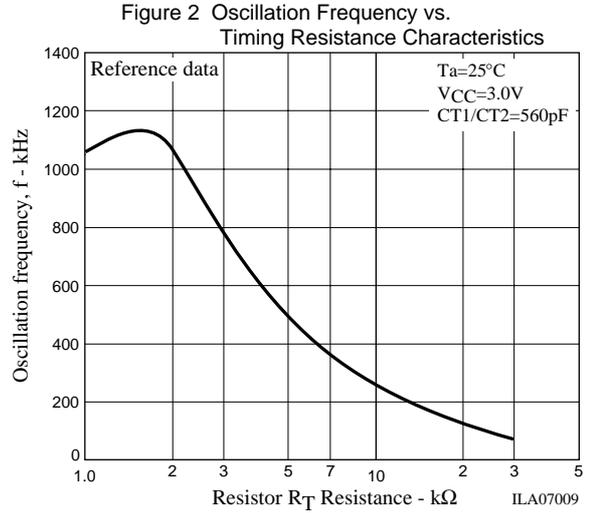
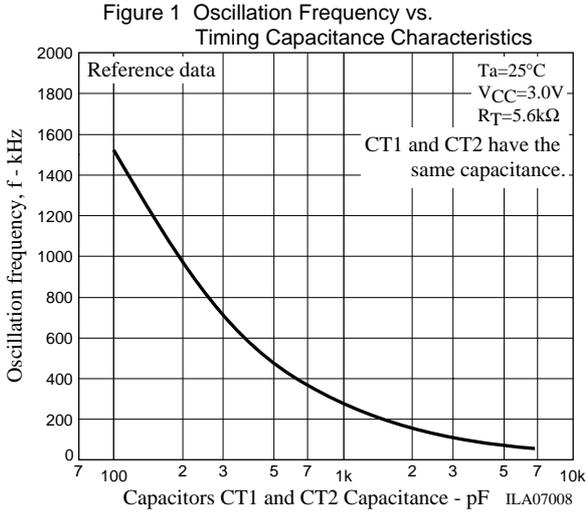
The software start time for channels 2 to 4 can be calculated in the same manner.

**CT1 and CT2**

The waveform of CT1 is 180 degrees out of phase with that of CT2. Their frequency cannot be set independently. The capacitance of the capacitors to be connected to pins CT1 and CT2 must be the same.

• Setting the oscillation frequency

- (1) The oscillation frequency of the oscillator can be set by selecting the capacitance of the capacitors connected to pins CT1 and CT2 (see Figure 1).
- (2) The oscillation frequency can also be determined by the resistance of the resistor connected to the RT pin (see Figure 2).

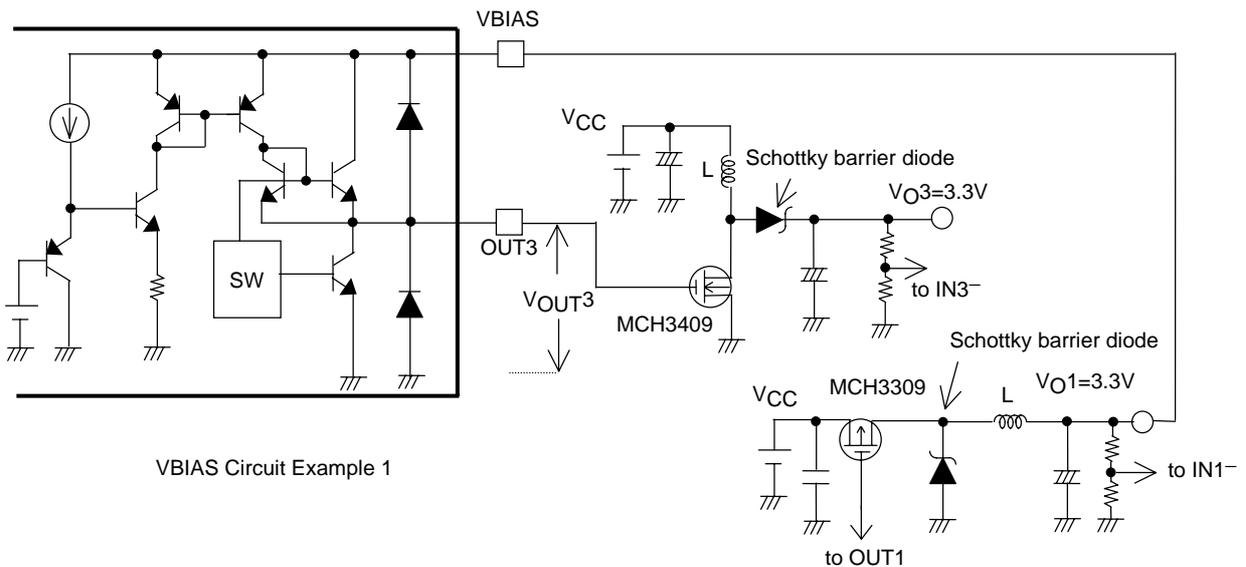


**Sample Circuits**

Sample Circuit That Makes Use of VBIAS (1)

This IC can be used to implement the circuit that is shown below since the power to the channels 3 and 4 output stages is supplied via VBIAS.

Apply  $V_{O1}$  that is dropped to 3.3V in channel 1 to VBIAS. A voltage of approx. VBIAS3-1 volt develops at  $V_{OUT3}$ , so that the IC can drive MOS transistors in a low-voltage environment like this sample circuit.



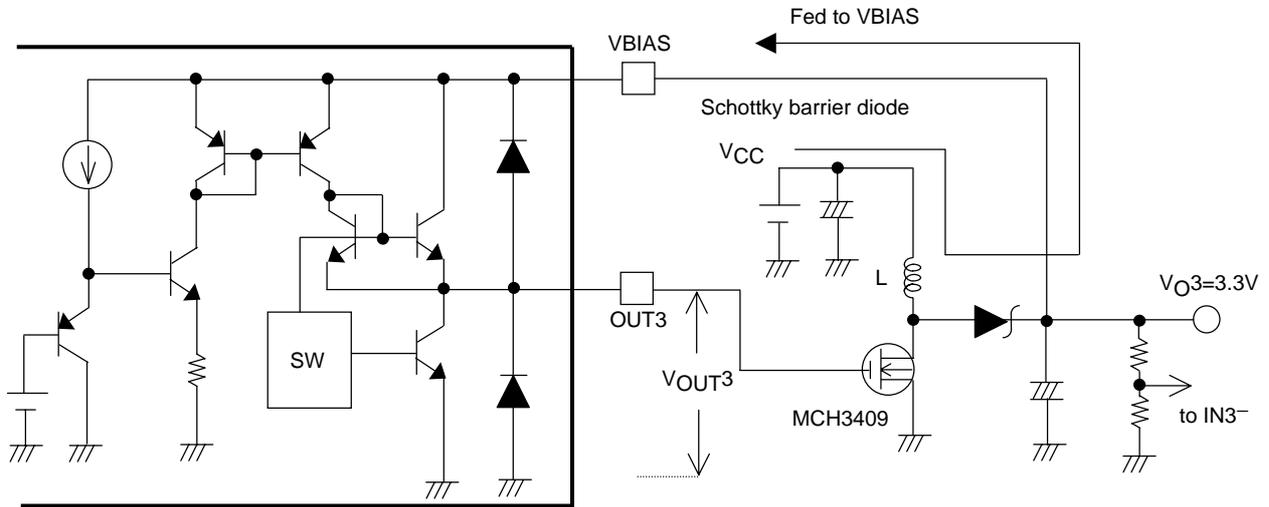
VBIAS Circuit Example 1

Sample Circuit That Makes Use of VBIAS (2)

This IC can be used to implement the circuit that is shown below since the power to the channels 3 and 4 output stages is supplied via VBIAS.

Apply the power voltage to VBIAS through the path that is made up of VCC, L to Schottky diode (through path formation). Then feed the stabilized voltage VO3 that is raised to 3.3V in channel 3 to VBIAS.

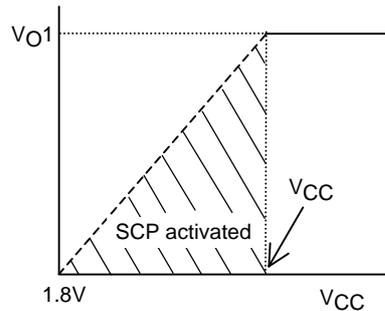
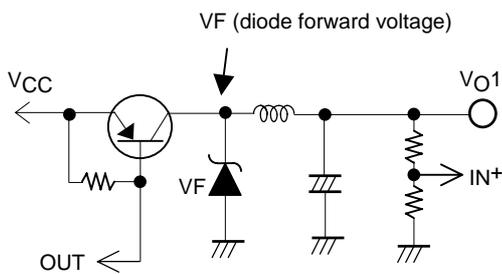
A voltage of approx. VBIAS3-1 volt develops at VOUT3, so that the IC can drive MOS transistors in a low-voltage environment like this sample circuit.



VBIAS Circuit Example 2

Using the IC in a Step-down Circuit (CH1 and CH2)

The IC detects a short-circuit condition and activates the SCP when VCC falls below the preset voltage VO+VF in such a step-down application as the one shown below.



When stepping down  $V_{CC} < V_0 + V_F$

**Using the IC in a Step-up Circuit (CH3 and CH4)**

In a step-up application like the one shown below, a through path consisting of  $V_{CC}$ , L, and D is formed when STBY is set off and a voltage normally remains present at  $V_O$ .

\* Although the STBY off-time through path in the application circuit example is cut by a MOSFET, a voltage remains present at  $V_O$  after an SCP operation performed with STBY set on.

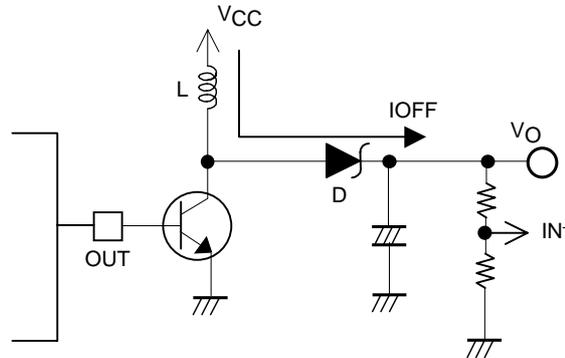


Figure Used with a Chopper Type Step-up Circuit

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