

## SANYO Semiconductors DATA SHEET

# 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 $Ta = 25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V <sub>CC</sub> 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

<sup>\*</sup> Specified circuit board : 114.3×76.1×1.6mm<sup>3</sup> : glass epoxy board

#### **Recommended Operating Conditions** at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V <sub>CC</sub>		3 to 15	V
Supply voltage	VBIAS		3 to 15	V
Timing resistor	RT		7 to 30	kΩ
Timing capacitor	СТ		100 to 1000	pF
Triangle wave frequency	fOSC		0.1 to 1.3	MHz

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#### LV5603T

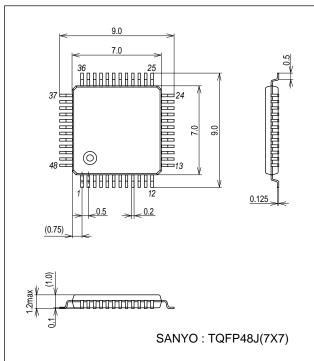
### **Electrical Characteristics** at Ta = 25°C, $V_{CC} = VBIAS = 3.6V$ , SCP = 0V

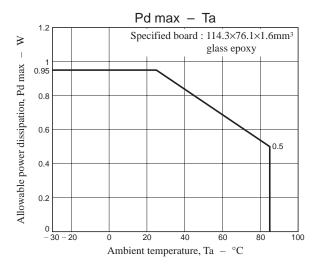
Parameter   Symbol   Conditions   min   typ   max	Parameter		Symbol	Conditions	Ratings			Unit	
N* pin internal bias voltage			Symbol		min	typ	max	Unit	
Output low voltage         CH1 to CH6         V <sub>Low</sub> FB         IN1* = 2VV, IFB = 20µA         2         0         2         V           Output low voltage         CH1 to CH6         V <sub>H</sub> FB         IN1* = 2VV, IFB = 20µA         2.0          V	Error amplifier 1			<u>,                                      </u>					
Output low voltage	IN+ pin internal bias voltage		VB	·	0.504	0.51	0.516	V	
Output High voltage         CH1 to CH6         V <sub>jH</sub> FB         IN1* = 0V IFB1 = 20jtA         2.0         V         V           Error amplifier 2         For amplifier 2         VOF         Set of the property of the p				· ·					
Internation   Process	Output low voltage	CH1 to CH6	V <sub>Low</sub> FB	IN1 <sup>-</sup> = 2.0V, IFB = 20μA			0.2	V	
NATRE pin offset voltage	Output High voltage	CH1 to CH6	V <sub>Hi</sub> FB	IN1 <sup>-</sup> = 0V IFB1 = -20μA	2.0			V	
Output flow voltage	Error amplifier 2					1	,		
Output High voltage         V <sub>Hi</sub> FB4RE         IN4* RE = -10mV, IFB = 500μA         2.0         V           Protection circuit           Threshold voltage         VSCP         1.1         1.25         1.4         V           SCP pin current         ISCP         1.1         1.25         1.4         V           Short circuit detection signal pin         VSCPOUT         Open collector (SCPOUT = 100µA         4         µA           Soft start current         CH1 to CH6         ISF         CSOFT = 0V         3.2         4         4.8         µA           Soft start current         CH1 to CH6         RSF         CSOFT = 0V         3.2         4         4.8         µA           Soft start current         CH1 to CH6         RSF         CSOFT = 0V         3.2         4         4.8         µA           Soft start current         CH1 to CH6         RSF         CSOFT = 0V         3.2         4         4.8         µA           Soft start current         CH1 to CH6         RSF         CSOFT = 0V         3.2         4         4.8         µA           Soft start current         CH1 to CH6         RSF         CSOFT = 0V         3.2         4         4.8 <td>IN4<sup>-</sup>RE pin offset voltage</td> <td></td> <td>VOF</td> <td></td> <td>-6</td> <td></td> <td>6</td> <td>mV</td>	IN4 <sup>-</sup> RE pin offset voltage		VOF		-6		6	mV	
Protection circuit   Threshold voltage	Output low voltage		V <sub>Low</sub> FB4RE	IN4 <sup>-</sup> RE = 2.0V, IFB = 20μA			0.2	V	
Threshold voltage	Output High voltage		V <sub>Hi</sub> FB4RE	$IN4^{-} RE = -10 mV, IFB = 500 \mu A$	2.0			V	
SCP pin current   ISCP   Short circuit detection signal pin   VSCPQUT   Open collector   SCPQUT	Protection circuit								
Short circuit detection signal pin   VSCPOUT   Open collector   ISCPOUT = 100µA	Threshold voltage		V <sub>SCP</sub>		1.1	1.25	1.4	V	
ISCPOUT = 100μA   Software start block (CH1 to CH4)   Soft start current   CH1 to CH6   ISF   CSOFT = 0V   3.2   4   4.8   μA   AS   Soft start current   CH1 to CH6   RSF   SOFT = 0V   3.2   4   4.8   μA   AS   Soft start current   CH1 to CH6   RSF   160   200   240   kΩ   EVENT   SOFT = 0V   SOFT = 0V	SCP pin current		ISCP			4		μΑ	
Soft start current   CH1 to CH6   ISF   CSOFT = 0V   3.2	Short circuit detection sign	al pin	VSCPOUT	· '			0.2	V	
Soft start resistance	Software start block (CH	1 to CH4)							
Fixed duty   Maximum on duty 1	Soft start current	CH1 to CH6	I <sub>SF</sub>	CSOFT = 0V	3.2	4	4.8	μА	
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         ROUT SOUR         IQ = 10mA         25         60         Ω           OUT pin high side on resistance         ROUT SINK         IQ = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Quipt current         IQH CT         190         µA           Allo CT         0.8         1.0         1.2           Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage         VREF         VCC = 3V to 15V         1.227         1.240         1.253         V <td col<="" td=""><td>Soft start resistance</td><td>CH1 to CH6</td><td>R<sub>SF</sub></td><td></td><td>160</td><td>200</td><td>240</td><td>kΩ</td></td>	<td>Soft start resistance</td> <td>CH1 to CH6</td> <td>R<sub>SF</sub></td> <td></td> <td>160</td> <td>200</td> <td>240</td> <td>kΩ</td>	Soft start resistance	CH1 to CH6	R <sub>SF</sub>		160	200	240	kΩ
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         %           Out put block 1 to 6           OUT pin high side on resistance         ROUT SINK         I <sub>O</sub> = 10mA         25         60         Ω           OUT pin high side on resistance         ROUT SINK         I <sub>O</sub> = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         I <sub>O</sub> H CT         190         µA           Output current ratio         ΔI <sub>O</sub> CT         RT = 10kΩ, CT1, 2 = 560pF         36         1.0         1.2           Reference voltage         VREF         RT = 10kΩ, CT1, 2 = 560pF         36         450         520         kHz           Reference voltage block           Reference voltage         VREF         VCC = 3V to 15V         10         mV           Current colspan="6">Current voltage         VON CTL         2.0         V         V	Fixed duty					•	•		
Maximum on duty 3         CH6 to CH6         Duty MAX5,6         Out monitor, IN* = 0V         80         85         90         %           Output block 1 to 6           OUT pin high side on resistance         ROUT SOUR         I <sub>O</sub> = 10mA         25         60         Ω           OUT pin high side on resistance         ROUT SINIK         I <sub>O</sub> = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         I <sub>O</sub> H CT         190         µA           Output current ratio         ΔI <sub>O</sub> CT         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Control circuit           On CTL         2.0         V         V           On FCT         0.6         V           Pin put current         I <sub>IN</sub> CTL         VCTL = 2V         0.6         V           On CTL	Maximum on duty 1	CH1 to CH3	Duty MAX1, 2, 3	Out monitor, IN <sup>-</sup> = 0V	100			%	
Output block 1 to 6         OUT pin high side on resistance         ROUT SOUR         I <sub>O</sub> = 10mA         25         60         Ω           OUT pin high side on resistance         ROUT SINK         I <sub>O</sub> = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         I <sub>O</sub> H CT         199         μA           Output current ratio         ΔI <sub>O</sub> CT         0.8         1.0         1.2           Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Control circuit           On state voltage         VON CTL         2.0         V         V           OFF State voltage         VOFF CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         0.6         V           Standby circuit           Off voltage         VOFF STBY         0.6	Maximum on duty 2	CH4	Duty MAX4	Out monitor, IN⁻ = 0V	75	80	85	%	
OUT pin high side on resistance         ROUT SOUR         I <sub>O</sub> = 10mA         25         60         Ω           OUT pin high side on resistance         ROUT SINK         I <sub>O</sub> = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         I <sub>OH</sub> CT         190         μA           Output current ratio         ΔI <sub>O</sub> CT         0.8         1.0         1.2           Oscillation frequency         F <sub>OSC</sub> 1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Control circuit           On state voltage         V <sub>ON</sub> CTL         2.0         V         V           OFF state voltage         V <sub>OFF</sub> CTL         2.0         0.6         V           OFF State voltage         V <sub>OFF</sub> CTL         VCTL = 2V         0.6 $\mu$ A           Standby circuit           Off Voltage         V <sub>OFF</sub> STBY         2.0 <t< td=""><td>Maximum on duty 3</td><td>CH5 to CH6</td><td>Duty MAX5,6</td><td>Out monitor, IN<sup>-</sup> = 0V</td><td>80</td><td>85</td><td>90</td><td>%</td></t<>	Maximum on duty 3	CH5 to CH6	Duty MAX5,6	Out monitor, IN <sup>-</sup> = 0V	80	85	90	%	
OUT pin high side on resistance         ROUT SINK         Io = 10mA         10         24         Ω           Triangle wave oscillator block           Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         IoH CT         190         μA           Output current ratio $\Delta I_O$ CT         0.8         1.0         1.2           Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block         VREF         1.227         1.240         1.253         V           Line regulation         VLN REF         VCC = 3V to 15V         10         mV           Control circuit           On state voltage         VON CTL         2.0         V         V           OFF state voltage         VOFF CTL         2.0         0.6         V           Pin input current         Inn CTL         VCTL = 2V         60         μA           Standby circuit           On voltage         VON STBY         2.0         V         V           Off voltage         VOFF STBY         0.6         V           Pin input current         Inn	Output block 1 to 6					•	•		
Triangle wave oscillator block         Current setting pin voltage         VT RT         RT = 10kΩ         0.57         V           Output current         I <sub>OH</sub> CT         190         μA           Output current ratio         ΔI <sub>O</sub> CT         0.8         1.0         1.2           Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Line regulation         VLN REF         VCC = 3V to 15V         10         mV           Control circuit           On state voltage         VON CTL         2.0         V           OFF state voltage         VOFF CTL         V         60         μA           Standby circuit           On voltage         VON STBY         2.0         V         V           Off voltage         VON STBY         2.0         V         V           Off voltage         VOFF STBY         0.6         V           Pin input current         I <sub>I</sub> N STBY         VSTBY = 2V         60         μA           All circu	OUT pin high side on resis	tance	R <sub>OUT</sub> SOUR	I <sub>O</sub> = 10mA		25	60	Ω	
Current setting pin voltage       VT RT       RT = 10kΩ       0.57       V         Output current       IOH CT       190       μA         Output current ratio $\Delta I_O$ 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 block         VREF       1.227       1.240       1.253       V         Control circuit         Control circuit         On state voltage       VON CTL       2.0       V       V         OFF state voltage       VOFF CTL       2.0       V       V         OFF state voltage       VOFF CTL       0.6       V         Pin input current       I <sub>IN</sub> CTL       VCTL = 2V       0.6       μA         Standby circuit         Or voltage       VOFF STBY       2.0       V         Off voltage       VOFF STBY       0.6       V         Pin input current       I <sub>IN</sub> STBY       VSTBY = 2V       0.6       μA         All circuits <t< td=""><td>OUT pin high side on resis</td><td>tance</td><td>R<sub>OUT</sub> SINK</td><td>I<sub>O</sub> = 10mA</td><td></td><td>10</td><td>24</td><td>Ω</td></t<>	OUT pin high side on resis	tance	R <sub>OUT</sub> SINK	I <sub>O</sub> = 10mA		10	24	Ω	
Output current         I <sub>OH</sub> CT         190         μA           Output current ratio $\Delta I_O$ CT         0.8         1.0         1.2           Oscillation frequency         F <sub>OSC</sub> 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 <sub>CN</sub> REF         V <sub>CC</sub> = 3V to 15V         10         mV           Control circuit           On state voltage         V <sub>ON</sub> CTL         2.0         V         V           OFF State voltage         V <sub>OFF</sub> CTL         2.0         V         V           Standby circuit         V         VCTL = 2V         0         60         μA           Standby circuit           On voltage         V <sub>ON</sub> STBY         2.0         V         V           Off voltage         V <sub>OFF</sub> STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         0         60         μA           All circuits           VCC current consumption	Triangle wave oscillator	block				•	'		
Output current ratio         ΔIO CT         0.8         1.0         1.2           Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Line regulation         VLN REF         VCC = 3V to 15V         10         mV           Control circuit           On state voltage         VON CTL         2.0         V         V           OFF state voltage         VOFF CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         0.6         V           Standby circuit           On voltage         VON STBY         2.0         V           Off voltage         VOFF STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         0.6         V           All circuits         VCC current consumption         I <sub>OFF</sub> VSTBY = VCTL = 0V         1         I <sub>I</sub> A	Current setting pin voltage		VT RT	RT = 10kΩ		0.57		V	
Oscillation frequency         FOSC1         RT = 10kΩ, CT1, 2 = 560pF         360         450         520         kHz           Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Line regulation         VLN REF         V <sub>CC</sub> = 3V to 15V         10         mV           Control circuit           On state voltage         VON CTL         2.0         V         V           OFF state voltage         VOFF CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         0         0         0         μA           Standby circuit           On voltage         VON STBY         2.0         V         V           Off voltage         VOFF STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         0         0         μA           All circuits         VCC current consumption         I <sub>CC</sub> IN1* to IN6* = 1V         5         6.5         mA           Standby mode current consumption         I <sub>OFF</sub> VSTBY = VCTL = 0V         1         1         μA	Output current		I <sub>OH</sub> CT			190		μΑ	
Reference voltage block           Reference voltage         VREF         1.227         1.240         1.253         V           Line regulation         V <sub>LN</sub> REF         V <sub>CC</sub> = 3V to 15V         10         mV           Control circuit           On state voltage         V <sub>ON</sub> CTL         2.0         V           OFF state voltage         V <sub>OFF</sub> CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         0.6         V           Standby circuit           On voltage         V <sub>ON</sub> STBY         2.0         V         V           Off voltage         V <sub>OFF</sub> STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         0.6         V           All circuits         VCC current consumption         I <sub>CC</sub> IN1* to IN6* = 1V         5         6.5         mA           Standby mode current consumption         I <sub>OFF</sub> VSTBY = VCTL = 0V         1         µA	Output current ratio		ΔI <sub>O</sub> CT		0.8	1.0	1.2		
Reference voltage         VREF         1.227         1.240         1.253         V           Line regulation         V <sub>LN</sub> REF         V <sub>CC</sub> = 3V to 15V         10         mV           Control circuit           On state voltage         V <sub>ON</sub> CTL         2.0         V           OFF state voltage         V <sub>OFF</sub> CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         60         μA           Standby circuit           On voltage         V <sub>ON</sub> STBY         2.0         V           Off voltage         V <sub>OFF</sub> STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         60         μA           All circuits           VCC current consumption         I <sub>CC</sub> IN1° to IN6° = 1V         5         6.5         mA           Standby mode current consumption         I <sub>OFF</sub> VSTBY = VCTL = 0V         1         μA	Oscillation frequency		Fosc1	RT = 10kΩ, CT1, 2 = 560pF	360	450	520	kHz	
Line regulation         V <sub>LN</sub> REF         V <sub>CC</sub> = 3V to 15V         10         mV           Control circuit         On state voltage         V <sub>ON</sub> CTL         2.0         V           OFF state voltage         V <sub>OFF</sub> CTL         0.6         V           Pin input current         I <sub>IN</sub> CTL         VCTL = 2V         60         μA           Standby circuit         On voltage           On voltage         V <sub>ON</sub> STBY         2.0         V           Off voltage         V <sub>OFF</sub> STBY         0.6         V           Pin input current         I <sub>IN</sub> STBY         VSTBY = 2V         60         μA           All circuits           VCC current consumption         I <sub>CC</sub> IN1* to IN6* = 1V         5         6.5         mA           Standby mode current consumption         I <sub>OFF</sub> VSTBY = VCTL = 0V         1         μA	Reference voltage block					•	'		
	Reference voltage		VREF		1.227	1.240	1.253	V	
	Line regulation		V <sub>LN</sub> REF	V <sub>CC</sub> = 3V to 15V			10	mV	
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Pin input current     I IN CTL     VCTL = 2V     60     μA       Standby circuit       On voltage     VON STBY     2.0     V       Off voltage     VOFF 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     1     μA	On state voltage		V <sub>ON</sub> CTL		2.0			V	
Pin input current     I IN CTL     VCTL = 2V     60     μA       Standby circuit       On voltage     VON STBY     2.0     V       Off voltage     VOFF 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     1     μA	OFF state voltage		V <sub>OFF</sub> CTL				0.6	V	
On voltage     VON STBY     2.0     V       Off voltage     VOFF STBY     0.6     V       Pin input current $I_{IN}$ STBY     VSTBY = 2V     60     μA       All circuits       VCC current consumption $I_{CC}$ $I_{N1^-}$ to $I_{N6^-}$ = 1V     5     6.5     mA       Standby mode current consumption $I_{OFF}$ $VSTBY = VCTL = 0V$ 1     μA	Pin input current		I <sub>IN</sub> CTL	VCTL = 2V			60	μΑ	
Off voltage     VOFF STBY     0.6     V       Pin input current     I <sub>IN</sub> STBY     VSTBY = 2V     60     μA       All circuits       VCC current consumption     I <sub>CC</sub> IN1⁻ to IN6⁻ = 1V     5     6.5     mA       Standby mode current consumption     I <sub>OFF</sub> VSTBY = VCTL = 0V     1     μA									
Pin input current $I_{IN}$ STBY $VSTBY = 2V$ 60 $\mu$ A All circuits $VCC$ current consumption $I_{CC}$ $IN1^-$ to $IN6^- = 1V$ 5 6.5 $m$ A Standby mode current consumption $I_{OFF}$ $VSTBY = VCTL = 0V$ 1 $\mu$ A	On voltage		V <sub>ON</sub> STBY		2.0			V	
All circuits  VCC current consumption $I_{CC}$ $I_{N1}$ to $I_{N6}$ = 1V $I_{CC}$ $I_{M1}$ to $I_{M2}$ $I_{M3}$ $I_{M4}$ $I_{M4}$	Off voltage		V <sub>OFF</sub> STBY				0.6	V	
VCC current consumption     I $_{CC}$ IN1^- to IN6^- = 1V     5     6.5     mA       Standby mode current consumption     I $_{OFF}$ VSTBY = VCTL = 0V     1 $_{\mu}A$	Pin input current		I <sub>IN</sub> STBY	VSTBY = 2V			60	μΑ	
Standby mode current consumption $I_{OFF}$ $VSTBY = VCTL = 0V$ 1 $\mu A$	All circuits								
Standby mode current consumption $I_{OFF}$ $VSTBY = VCTL = 0V$ 1 $\mu A$	VCC current consumption		Icc	IN1 <sup>-</sup> to IN6 <sup>-</sup> = 1V		5	6.5	mA	
	Standby mode current con	sumption	_	VSTBY = VCTL = 0V			1	μА	
				I <sub>OFF</sub> = I <sub>CC</sub> + I <sub>BIAS</sub>					

#### **Package Dimensions**

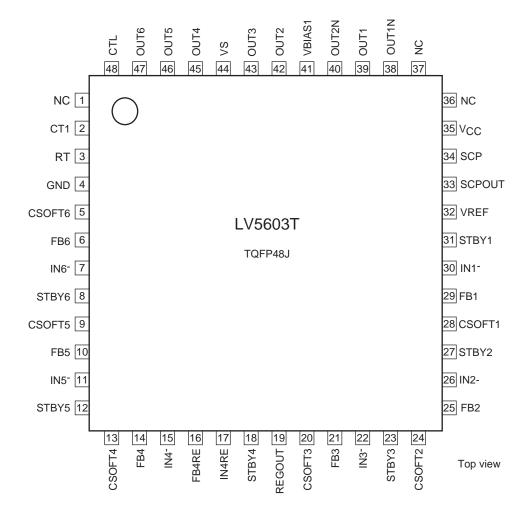
unit: mm (typ)



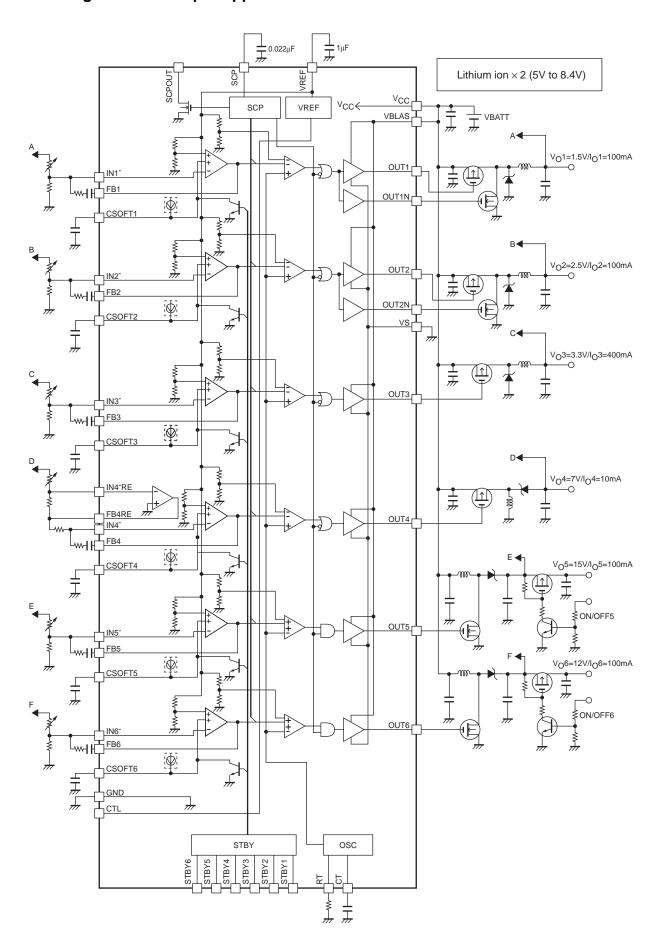




#### **Pin Assignment**



#### **Block Diagram and Sample Application Circuit**



#### **Pin Function**

Block	Pin No.	Pin	Functions
ch1	31	STBY1	Standby input
	30	IN1 <sup>-</sup>	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 <sup>-</sup>	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 <sup>-</sup>	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 <sup>-</sup>	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 <sup>-</sup>	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	Vcc	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	7 NC No connection	

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**

Equivalent		
Pin No.	Pin	Equivalent Circuit
48	CTL	
31	STBY1	
27	STBY2	
23	STBY3	200kΩ <del>\$</del>
18	STBY4	OTDV4
15	STBY5	STBY*
8	STBY6	CTL O-
	31510	
		<b>★ ↓ </b>
		A \( \frac{1}{2} \)
		\$120kΩ
		GND
		JOND
30	IN1 <sup>-</sup>	000000
26	IN2-	OREGOUT
22	IN3 <sup>-</sup>	<b>*</b>
15	IN4 <sup>-</sup>	T ('
11	IN5 <sup>-</sup>	IN*
7	IN6-	
17	IN4RE	IN4RE 500Ω W
		<b>T</b>
		$\Rightarrow 5k\Omega \Rightarrow 5k\Omega$
		GND
29	FB1	
25	FB2	→ → → ○ REGOUT
21	FB3	<u> </u>
14	FB4	
10	FB5	
6	FB6	
		<b>→ →</b>
16	FB4RE	
	1 DAILE	→ → → ○ REGOUT
		<u> </u>
		<u> </u>
		O +
		FB4RE
1	1	

Continued on next page.

Continued from precipin No.	eding page. Pin	Equivalent Circuit
28	CSOFT1	
24	CSOFT2	→ → → ○ REGOUT
20	CSOFT2	
13	CSOFT4	
9 5	CSOFT5 CSOFT6	
5	CSOFIG	CSOFT*
		10kΩ 500Ω
		200kΩ ξ
		GND
		0 0.12
39	OUT1	
42	OUT2	→ VBIAS1
43	OUT3	
45	OUT4	
46	OUT5	
47	OUT6	OUT* OUT*N
38	OUT1N	
40	OUT2N	
		GND
3	RT	
		REGOUT
		\ \{\chi_{000}\}
		RT \$500Ω W
		500Ω
		<b>—</b>
		<b>*</b>
		<b>T</b>
		GND
ļ		
2	CT1	→ ↑ ○ REGOUT
		T T KEGOUT
		O CT1
		— — GND

Continued on next page.

Continued from pre Pin No.	Pin	Equivalent Circuit
34	SCP	0 REGOUT $0$ SCP $0$ SCP $0$ GND
33	SCPOUT	SCPOUT
32	VREF	VCC VREF 14.8kΩ\$ O GND
19	REGOUT	VCC VCC VREF
35	Vcc	Vcc O
41	VBIAS1	VBIAS1 ()———
4	GND	———— GND
44	VS	——————————————————————————————————————
1 36 37	NC	○ NC

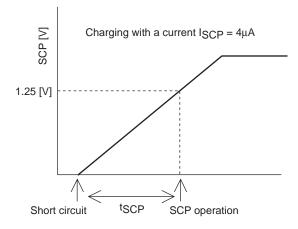
#### STBY and CTL Pin Functions

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.



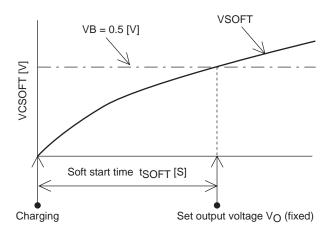
**SCP Charging Operation** 

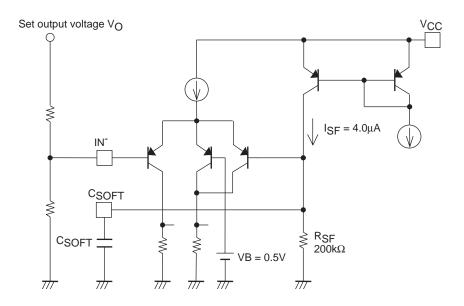
$$t_{SCP} = \frac{C_{SCP} \times V_{SCP}}{I_{SCP}} [s]$$

#### 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.





$$t_{SOFT} = -C_{SOFT} \times R_{SF} \ln(1 - \frac{VB}{R_{SF} \times I_{SF}}) [s]$$
$$= 2.135 \times 10^5 \times C_{SOFT}$$

#### 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.

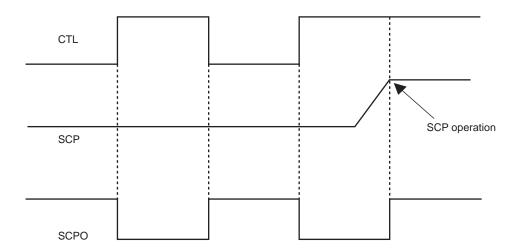
The oscillator frequency is expressed by the following equation.

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