4-channel switching regulator

BA9710KV

The BA9710KV, a 4-channel switching regulator that uses a pulse width modulation (PWM) system, can drive all channel PNP transistors directly. Channels 2 and 3 can be used for motor control because protection circuits are not built in.

●Applications

VCRs and other portable equipment

●Features

1) Reference voltage precision is ±1%.
2) Output stages are based on the push-pull method (resembling the totem-pole method), and ON and OFF currents can be set independently.
3) Triangular waves can be externally synchronized.
4) Pins allow ON/OFF control of channels 3 and 4, or all channels at once.

●Absolute maximum ratings (Ta = 25°C)

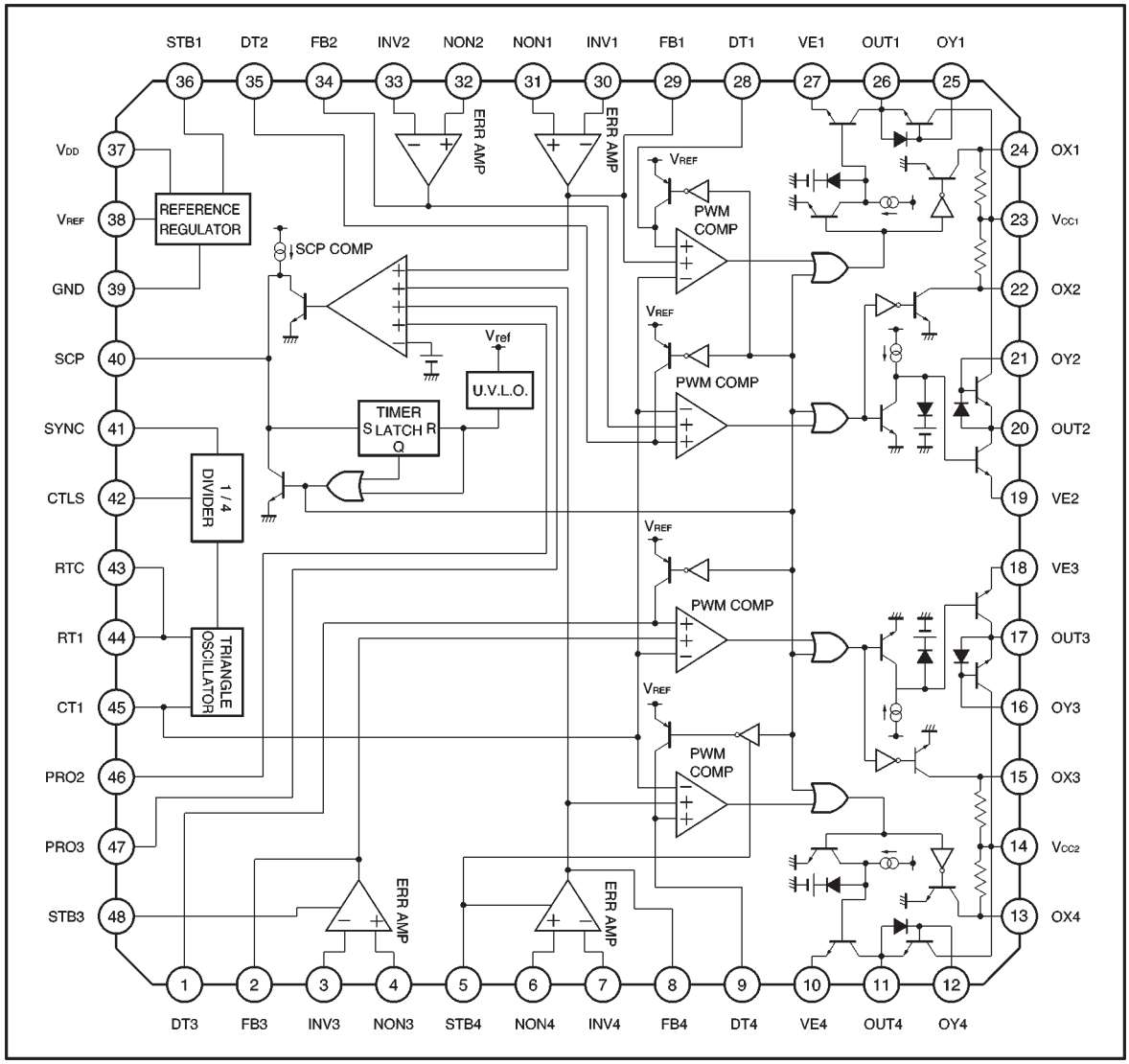
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	14	V
Power dissipation	Pd	400*	mW
Operating temperature	Topr	−25～+75	℃
Storage temperature	Tstg	−55～+125	℃

* Reduced by 4 mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	3.5	6	12	V

●Block diagram



●Pin descriptions

Pin No.	Pin name	Functions
1, 9, 28 35	DT	Rest period setting pin; the rest period is set by dividing the V_{REF} pin voltage with external resistors; a soft start is possible by connecting a capacitor between this pin and V_{REF}.
2, 8, 29 34	FB	Error amplifier output pin; gain setting and phase compensation are controlled by connecting a resistor and capacitor between this pin and the INV.
3, 7, 30 33	INV	Error amplifier inverted input
4, 6, 31 32	NON	Error amplifier non-inverted input
5	STB4	Channel 4 ON/OFF pin; channel 4 operates when the pin is HIGH level; this pin is valid when STB1 is LOW level.
10, 18, 19 27	VE	Output current setting pin; output current is set by connecting a resistor between this pin and GND.
11, 17, 20 26	OUT	Output
12, 13, 15 16, 21, 22 24, 25	OX, OY	Output off current setting pin; output off current is set by connecting a capacitor between the OX and OY.
14, 23	V_{CC}	Output power supply
36	STB1	ON/OFF pin for all channels; stops the reference voltage and all channel operations when the pin is HIGH level.
37	V_{DD}	Power supply
38	V_{REF}	Reference voltage output
39	GND	Ground
40	SCP	Pin for connecting a time-constant setting capacitor in the short-circuit protection circuit; time constant for the timer-latched, short-circuit protection circuit is set by connecting a capacitor between this pin and GND.
41	SYNC	Pin for triangular wave external synchronization input; capacitor-coupled AC wave is input, and the triangular wave is synchronized with the 1/4 subharmonic oscillation of the input.
42	CTLS	ON/OFF pin for triangular wave external synchronization input; external synchronization circuit operates when the pin is HIGH level.
43	RTC	Pin for connecting a capacitor to stabilize the triangular wave oscillator constant current; noise of the constant current is reduced by connecting a capacitor between this pin and GND.
44	RT1	Pin for connecting a resistor to set the triangular wave oscillator frequency; oscillation frequency is set by connecting a resistor between this pin and GND.
45	CT1	Pin for connecting a capacitor to set the triangular wave oscillator frequency; oscillation frequency is set by connecting a capacitor between this pin and GND.
46	PRO2	Pin to set short-circuit protection in an arbitrary way; connected to V_{REF} when not used.
47	PRO3	Pin to set short-circuit protection in an arbitrary way; connected to V_{REF} when not used.
48	STB3	Channel 3 ON/OFF; channel 3 operates when this pin is HIGH level; this pin is valid when STB1 is LOW level.

●Electrical characteristics (unless otherwise noted, Ta = 25°C and V_{CC} = 6V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Total device〉						
Average current dissipation 1	I_{CC1}	—	5	7.5	mA	CTLS=0V
Average current dissipation 2	I_{CC2}	—	6.5	10	mA	CTLS=6V
Standby current dissipation	I_{STB}	—	40	60	μA	STB1=6V
〈Control section〉						
STB1 ON condition	V_{SON}	—	—	2.8	V	
STB1 OFF condition	V_{SOF}	3.2	—	—	V	
STB1 pin current	I_{S1}	15	30	45	μA	STB1=6V
STB3, 4, CTLS ON condition	V_{CON}	2	—	—	V	
STB3, 4, CTLS OFF condition	V_{COF}	—	—	1	V	
STB3, 4, CTLS pin current	I_{SC}	50	100	150	μA	STB3, 4, CTLS=6V
〈Reference voltage section〉						
Output voltage	V_{REF}	2.346	2.37	2.394	V	CTLS=6V, I_{REF}=1mA
Input stability	V_{DLI}	—	5	10	mV	V_{CC}=3.5→12V, CTLS=3V
Load regulation	V_{DLO}	—	3	10	mV	I_{REF}=0→10mA, CTLS=0V
〈Triangular wave oscillator section〉						
Oscillation frequency 1	F_{OSC1}	370	435	500	kHz	RT=5.1k, CT=360P
Frequency variation 1 (V_{CC})	F_{DVC1}	—	—	1	%	↓ V_{CC}=3.5→12V
Oscillation waveform upper limit voltage 1	V_{OSH1}	1.73	1.83	1.93	V	↓
Oscillation waveform lower limit voltage 1	V_{OSL1}	1.23	1.33	1.43	V	↓
Oscillation frequency 2	F_{OSC2}	750	875	1000	kHz	RT=5.1k, CT=150P
Frequency variation 2 (V_{CC})	F_{DVC2}	—	—	1	%	↓ V_{CC}=3.5→12V
Oscillation waveform upper limit voltage 2	V_{OSH2}	1.79	1.89	1.99	V	↓
Oscillation waveform lower limit voltage 2	V_{OSL2}	1.22	1.32	1.42	V	↓
Oscillation frequency 3	F_{OSC3}	1.5	1.75	2	MHz	RT=5.1k, CT=47P
Frequency variation 3 (V_{CC})	F_{DVC3}	—	—	1	%	↓ V_{CC}=3.5→12V
Oscillation waveform upper limit voltage 3	V_{OSH3}	1.89	1.99	2.09	V	↓
Oscillation waveform lower limit voltage 3	V_{OSL3}	1.19	1.29	1.39	V	↓
〈Divider section〉						
SYNC pin maximum input frequency	F_{SYNC}	—	—	5	MHz	
SYNC pin input voltage	V_{SYNC}	0.2	—	0.8	V_{P-P}	
〈Error amplifier section〉						
Input offset voltage	V_{IO}	−1.7	1.3	4.3	mV	In reference to the inverted input pin
Input offset current	I_{IO}	—	2	30	nA	
Input bias current	I_{IB}	—	50	100	nA	
Open loop gain	A_V	60	80	—	dB	
Common-mode rejection ratio	CMRR	60	80	—	dB	
Common-mode input voltage	V_{OM}	0.3	—	1.6	V	
Maximum output voltage	V_{OH}	2.1	2.4	—	V	
Minimum output voltage	V_{OS}	—	700	850	mV	
Output sink current	I_{OI}	1.5	5	—	mA	
Output source current	I_{OO}	30	60	—	μA	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Protection circuit section〉						
Input threshold voltage	V_{IT}	1.6	1.75	1.9	V	
Input standby voltage	V_{STB}	—	10	80	mV	
Input latch voltage	V_{LT}	—	10	80	mV	
Input source current	I_{SCP}	1.1	2.1	3.1	μA	
Comparator threshold voltage	V_{TC}	0.9	1.0	1.1	V	
〈U.V.L.O circuit section〉						
Threshold voltage (V_{REF})	V_{UTR}	1.7	1.85	2.0	V	
Threshold voltage (V_{CC})	V_{UTC}	2.85	3.0	3.15	V	
〈Dead-time control section〉						
Input bias current	I_{DB}	—	0.3	1.0	μA	
Source current when channel 4 is OFF	I_{DF4}	350	700	—	μA	
Latch mode source current	I_{DL}	250	500	—	μA	
〈Output section〉						
Channel-1 pin voltage	V_{O1}	400	500	600	mV	RE=10Ω
Channel-1 pin voltage ($I_{Max.}$)	V_{OM1}	350	450	550	mV	RE=5Ω
Channel-2, 3, 4 pin voltage	V_O	450	550	650	mV	RE=20Ω
Channel-2, 3, 4 pin voltage ($I_{Max.}$)	V_{OM}	400	500	600	mV	RE=10Ω

◎Not designed for radiation resistance.

*Recommended operating power supply voltage: V_{CC} = 3.5-12 V at Ta = 25℃

* Recommended maximum oscillation frequency: $F_{Max.}$ = 1 MHz at Ta = 25℃

●Reference data (unless otherwise noted, Ta = 25°C and V_{CC} = 6V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Output section〉						
Channel-1 source peak current	I_{OP1}	—	150	—	mA	
Channel-2, 3, 4 source peak current	I_{OP}	—	120	—	mA	

●Electrical characteristic curves

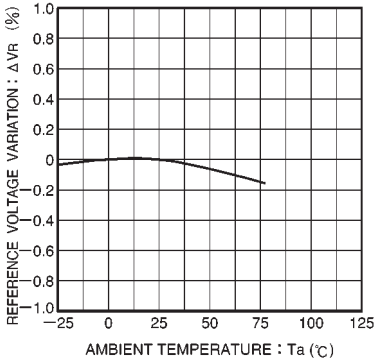


Fig.1 Reference voltage variation vs. ambient temperature

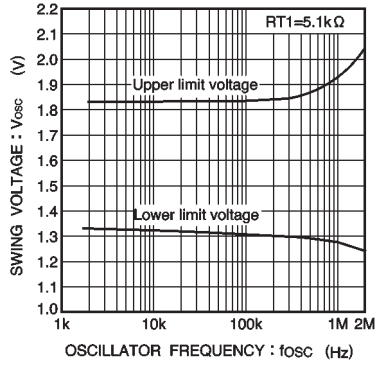


Fig.2 Swing voltage vs. oscillation frequency

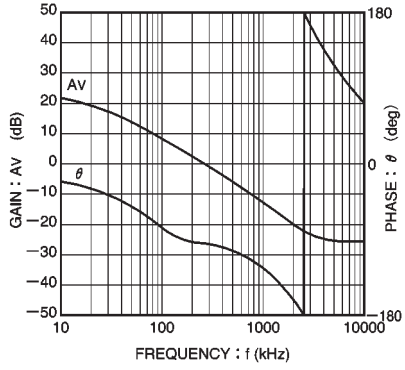


Fig.3 Gain and phase vs. frequency for the error amplifier

●External dimensions (Units: mm)