

# 4-channel switching regulator

## BA9707KV

The BA9707KV, a 4-channel switching regulator that uses a pulse width modulation (PWM) system, can drive all channel PNP transistors directly.

### ●Applications

VCRs and other portable equipment

### ●Features

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

### ●Absolute maximum ratings ( $T_a = 25^\circ\text{C}$ )

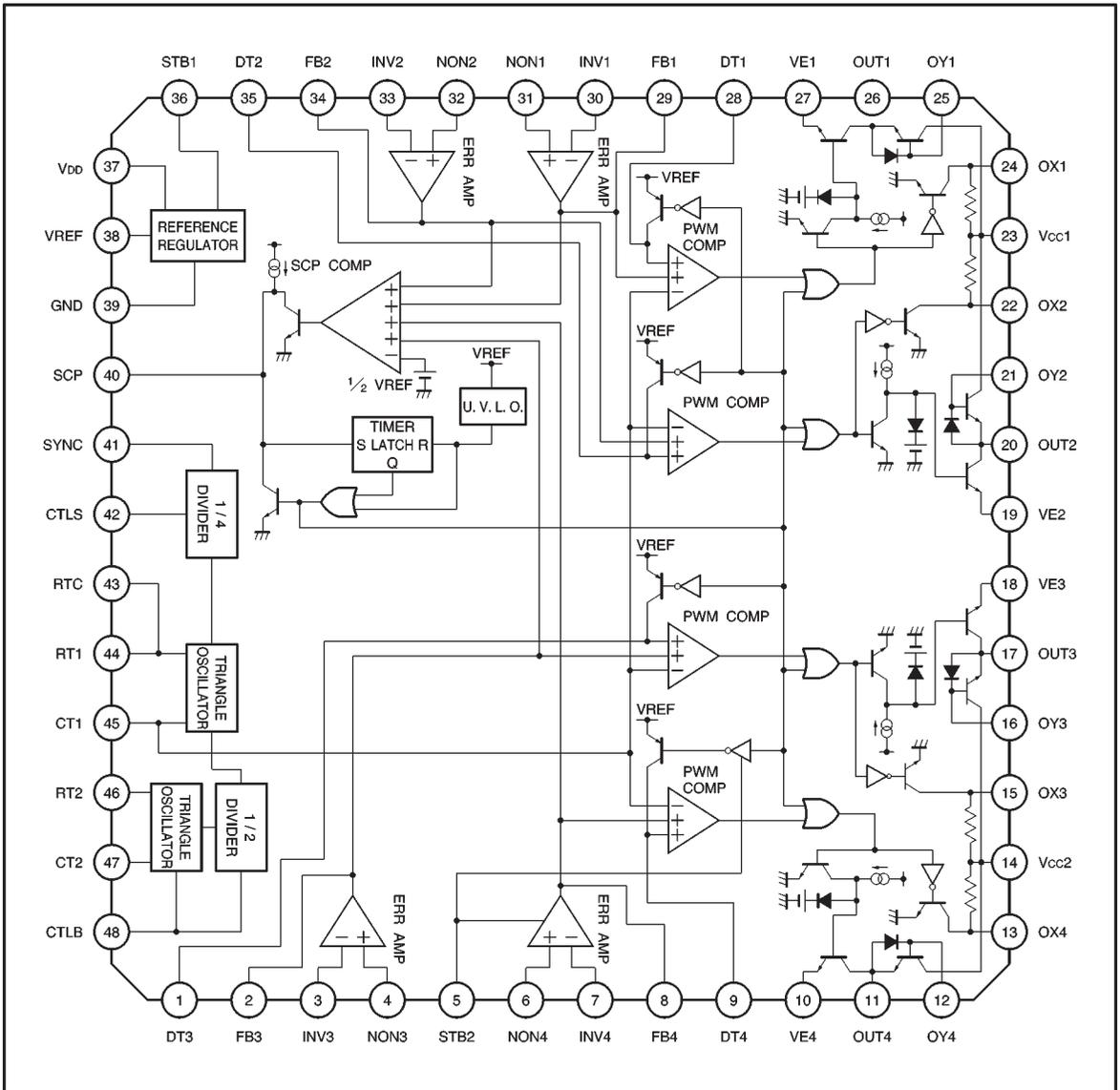
Parameter	Symbol	Limits	Unit
Power supply voltage	$V_{CC}$	14	V
Power dissipation	$P_d$	400*	mW
Operating temperature	$T_{opr}$	$-25 \sim +75$	$^\circ\text{C}$
Storage temperature	$T_{stg}$	$-55 \sim +125$	$^\circ\text{C}$

\* Reduced by 4 mW for each increase in  $T_a$  of  $1^\circ\text{C}$  over  $25^\circ\text{C}$ .

### ●Recommended operating conditions ( $T_a = 25^\circ\text{C}$ )

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

● Block diagram



## ● Pin descriptions

Pin No.	Pin name	Function
1, 9, 28 35	DT	Rest period setting pin; the rest period is set by dividing the VREF pin voltage with external resistors; a soft start is possible by connecting a capacitor between this pin and VREF.
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	STB2	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 <sub>CC</sub>	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 <sub>DD</sub>	Power supply
38	VREF	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	RT2	Pin for connecting a resistor to set the frequency of the triangular wave oscillator for motors; oscillation frequency is set by connecting a resistor between this pin and GND.
47	CT2	Pin for connecting a capacitor to set the frequency of the triangular wave oscillator for motors; oscillation frequency is set by connecting a capacitor between this pin and GND.
48	CTLB	ON/OFF pin for the triangular wave oscillator for motors; the triangular wave oscillator for motors operates when the pin is HIGH level.

●Electrical characteristics (unless otherwise noted, Ta = 25°C and V<sub>CC</sub> = 6V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Total device〉						
Average current dissipation 1	I <sub>CC1</sub>	—	6	9	mA	CTLS, B=0V
Average current dissipation 2	I <sub>CC2</sub>	—	7.5	11	mA	CTLS=6V, CTLSB=0V
Average current dissipation 3	I <sub>CC3</sub>	—	9	13.5	mA	CTLS, B=6V
Standby current dissipation	I <sub>STB</sub>	—	40	60	μA	STB1=6V
〈Control section〉						
STB1 ON condition	V <sub>SON</sub>	—	—	2.8	V	
STB1 OFF condition	V <sub>SOF</sub>	3.2	—	—	V	
STB1 pin current	I <sub>S1</sub>	15	30	45	μA	STB1=6V
STB2, CTLS, B ON condition	V <sub>CON</sub>	2	—	—	V	
STB2, CTLS, B OFF condition	V <sub>COF</sub>	—	—	1	V	
STB2, CTLS, B pin current	I <sub>SC</sub>	50	100	150	μA	STB2, CTLS, B=6V
〈Reference voltage section〉						
Output voltage	V <sub>REF</sub>	2.346	2.37	2.394	V	CTLS, B=6V I <sub>REF</sub> =1mA
Line regulation	V <sub>DL1</sub>	—	5	10	mV	V <sub>CC</sub> =3.5→12V CTLS, B=3V
Load regulation	V <sub>DLO</sub>	—	3	10	mV	I <sub>REF</sub> =0→10mA CTLS, B=0V
〈Triangular wave oscillator section〉						
Oscillation frequency 1	F <sub>Osc1</sub>	370	435	500	kHz	RT=5.1k, CT=360p
Frequency variation 1 (V <sub>CC</sub> )	F <sub>DVC1</sub>	—	—	1	%	↓ V <sub>CC</sub> =3.5→12V
Oscillation waveform upper limit voltage 1	V <sub>OSH1</sub>	1.73	1.83	1.93	V	↓
Oscillation waveform lower limit voltage 1	V <sub>OSL1</sub>	1.23	1.33	1.43	V	↓
Oscillation frequency 2	F <sub>Osc2</sub>	750	875	1000	kHz	RT=5.1k, CT=150p
Frequency variation 2 (V <sub>CC</sub> )	F <sub>DVC2</sub>	—	—	1	%	↓ V <sub>CC</sub> =3.5→12V
Oscillation waveform upper limit voltage 2	V <sub>OSH2</sub>	1.79	1.89	1.99	V	↓
Oscillation waveform lower limit voltage 2	V <sub>OSL2</sub>	1.22	1.32	1.42	V	↓
Oscillation frequency 3	F <sub>Osc3</sub>	1.5	1.75	2	MHz	RT=5.1k, CT=47p
Frequency variation 3 (V <sub>CC</sub> )	F <sub>DVC3</sub>	—	—	1	%	↓ V <sub>CC</sub> =3.5→12V
Oscillation waveform upper limit voltage 3	V <sub>OSH3</sub>	1.89	1.99	2.09	V	↓
Oscillation waveform lower limit voltage 3	V <sub>OSL3</sub>	1.19	1.29	1.39	V	↓
〈Divider section〉						
SYNC pin maximum input frequency	F <sub>SYNC</sub>	—	—	5	MHz	
SYNC pin input voltage	V <sub>SYNC</sub>	0.2	—	0.8	V <sub>P-P</sub>	
〈Error amplifier section〉						
Input offset voltage	V <sub>IO</sub>	-2.7	1.3	5.3	mV	In reference to the inverted input pin
Input offset current	I <sub>IO</sub>	—	2	30	nA	
Input bias current	I <sub>IB</sub>	—	50	100	nA	
Open loop gain	A <sub>V</sub>	60	80	—	dB	
Common-mode rejection ratio	CMRR	60	80	—	dB	
Common-mode input voltage	V <sub>OM</sub>	0.3	—	1.6	V	
Maximum output voltage	V <sub>OH</sub>	2.1	2.4	—	V	
Minimum output voltage	V <sub>OS</sub>	—	700	850	mV	
Output sink current	I <sub>OI</sub>	1.5	5	—	mA	
Output source current	I <sub>OO</sub>	30	60	—	μA	
〈Protection circuit section〉						
Input threshold voltage	V <sub>IT</sub>	1.6	1.75	1.9	V	
Input standby voltage	V <sub>STB</sub>	—	10	80	mV	
Input latch voltage	V <sub>LT</sub>	—	10	80	mV	
Input source current	I <sub>SCP</sub>	1.1	2.1	3.1	μA	
Comparator threshold voltage	V <sub>TC</sub>	0.9	1.0	1.1	V	
〈UVLO circuit section〉						
Threshold voltage (VREF)	V <sub>UTR</sub>	1.7	1.85	2.0	V	
Threshold voltage (V <sub>CC</sub> )	V <sub>UTC</sub>	2.85	3.00	3.15	V	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Dead-time control section〉						
Input bias current	I <sub>DB</sub>	—	0.3	1.0	μA	
Source current when channel-4 is OFF	I <sub>DF4</sub>	350	700	—	μA	
Latch mode source current	I <sub>DL</sub>	250	500	—	μA	
〈Output section〉						
Channel-1 pin voltage	V <sub>O1</sub>	400	500	600	mV	RE=10 Ω
Channel-1 pin voltage (I <sub>MAX</sub> )	V <sub>OM1</sub>	350	450	550	mV	RE=5 Ω
Channel-2, 3, 4 pin voltage	V <sub>O</sub>	450	550	650	mV	RE=20 Ω
Channel-2, 3, 4 pin voltage (I <sub>MAX</sub> )	V <sub>OM</sub>	400	500	600	mV	RE=10 Ω

©Not designed for radiation resistance.

\* Recommended operating power supply voltage: V<sub>CC</sub> = 3.5-12 V at Ta = 25°C

\* Recommended maximum oscillation frequency: F<sub>MAX</sub> = 1 MHz at Ta = 25°C

●Reference data (unless otherwise noted, Ta = 25°C and V<sub>CC</sub> = 6V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Output section〉						
Channel-1 source peak current	I <sub>OP1</sub>	—	150	—	mA	
Channel-2, 3, 4 source peak current	I <sub>OP</sub>	—	120	—	mA	

●Electrical characteristic curves

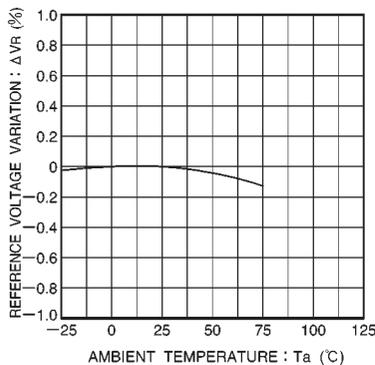


Fig.1 Reference voltage variation vs. ambient temperature

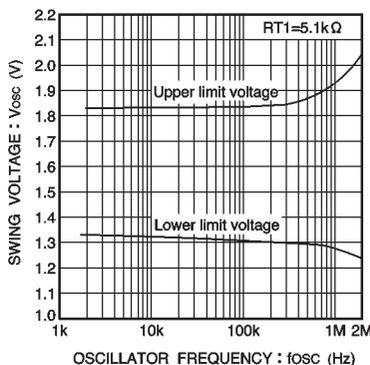


Fig.2 Swing voltage vs. oscillation frequency

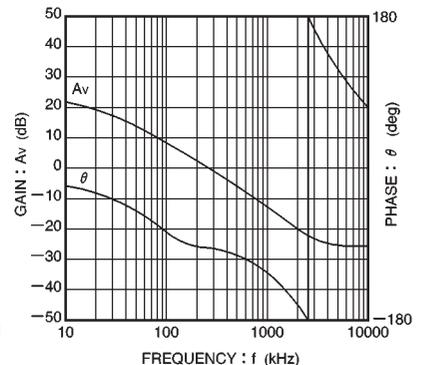


Fig.3 Gain and phase vs. frequency for the error amplifier (20dB.close)

