

# 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  $\pm 1\%$ .
- 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)

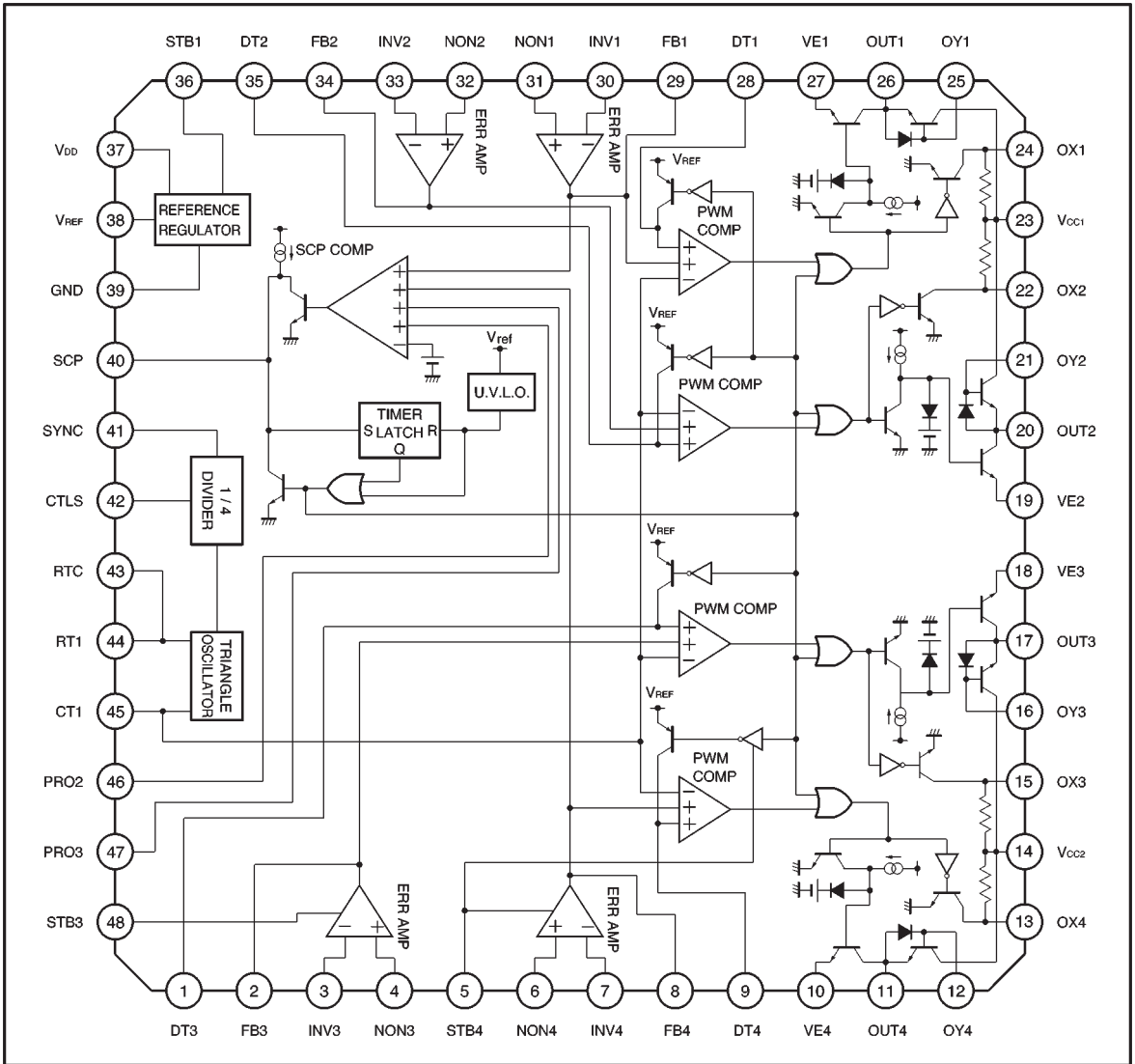
Parameter	Symbol	Limits	Unit
Power supply voltage	V <sub>CC</sub>	14	V
Power dissipation	P <sub>d</sub>	400*	mW
Operating temperature	T <sub>opr</sub>	-25~+75	°C
Storage temperature	T <sub>stg</sub>	-55~+125	°C

\* Reduced by 4 mW for each increase in Ta of 1°C over 25°C.

### ●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V <sub>CC</sub>	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<sub>CC</sub> = 6V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Total device〉						
Average current dissipation 1	I <sub>CC1</sub>	—	5	7.5	mA	CTLS=0V
Average current dissipation 2	I <sub>CC2</sub>	—	6.5	10	mA	CTLS=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
STB3, 4, CTLS ON condition	V <sub>CON</sub>	2	—	—	V	
STB3, 4, CTLS OFF condition	V <sub>COF</sub>	—	—	1	V	
STB3, 4, CTLS pin current	I <sub>SC</sub>	50	100	150	μA	STB3, 4, CTLS=6V
〈Reference voltage section〉						
Output voltage	V <sub>REF</sub>	2.346	2.37	2.394	V	CTLS=6V, I <sub>REF</sub> =1mA
Input stability	V <sub>DLI</sub>	—	5	10	mV	V <sub>CC</sub> =3.5→12V, CTLS=3V
Load regulation	V <sub>DLO</sub>	—	3	10	mV	I <sub>REF</sub> =0→10mA, CTLS=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>	-1.7	1.3	4.3	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	

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	$\mu A$	
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	$\mu A$	
Source current when channel 4 is OFF	$I_{DF4}$	350	700	—	$\mu A$	
Latch mode source current	$I_{DL}$	250	500	—	$\mu A$	
〈Output section〉						
Channel-1 pin voltage	$V_{O1}$	400	500	600	mV	RE=10 $\Omega$
Channel-1 pin voltage ( $I_{Max}$ )	$V_{OM1}$	350	450	550	mV	RE=5 $\Omega$
Channel-2, 3, 4 pin voltage	$V_O$	450	550	650	mV	RE=20 $\Omega$
Channel-2, 3, 4 pin voltage ( $I_{Max}$ )	$V_{OM}$	400	500	600	mV	RE=10 $\Omega$

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\*Recommended operating power supply voltage:  $V_{CC} = 3.5\text{--}12\text{ V}$  at  $T_a = 25^\circ\text{C}$

\* Recommended maximum oscillation frequency:  $F_{Max.} = 1\text{ MHz}$  at  $T_a = 25^\circ\text{C}$

●Reference data (unless otherwise noted,  $T_a = 25^\circ\text{C}$  and  $V_{CC} = 6\text{V}$ )

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

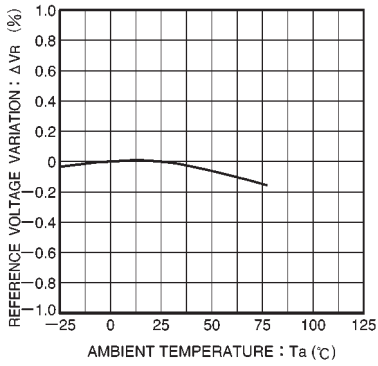


Fig.1 Reference voltage variation vs. ambient temperature

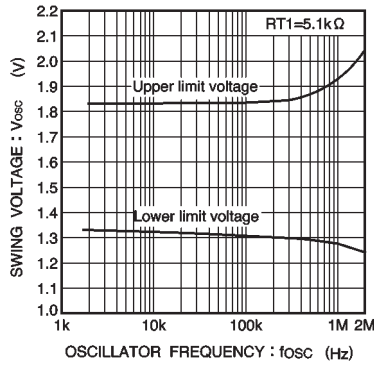


Fig.2 Swing voltage vs. oscillation frequency

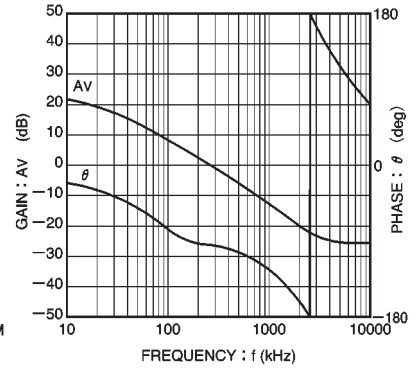


Fig.3 Gain and phase vs. frequency for the error amplifier

● External dimensions (Units: mm)

