

# 3-channel switching regulator

## BA9708K

The BA9708K, a 3-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 3 only, or all channels at once.

### ●Absolute maximum ratings (Ta = 25°C)

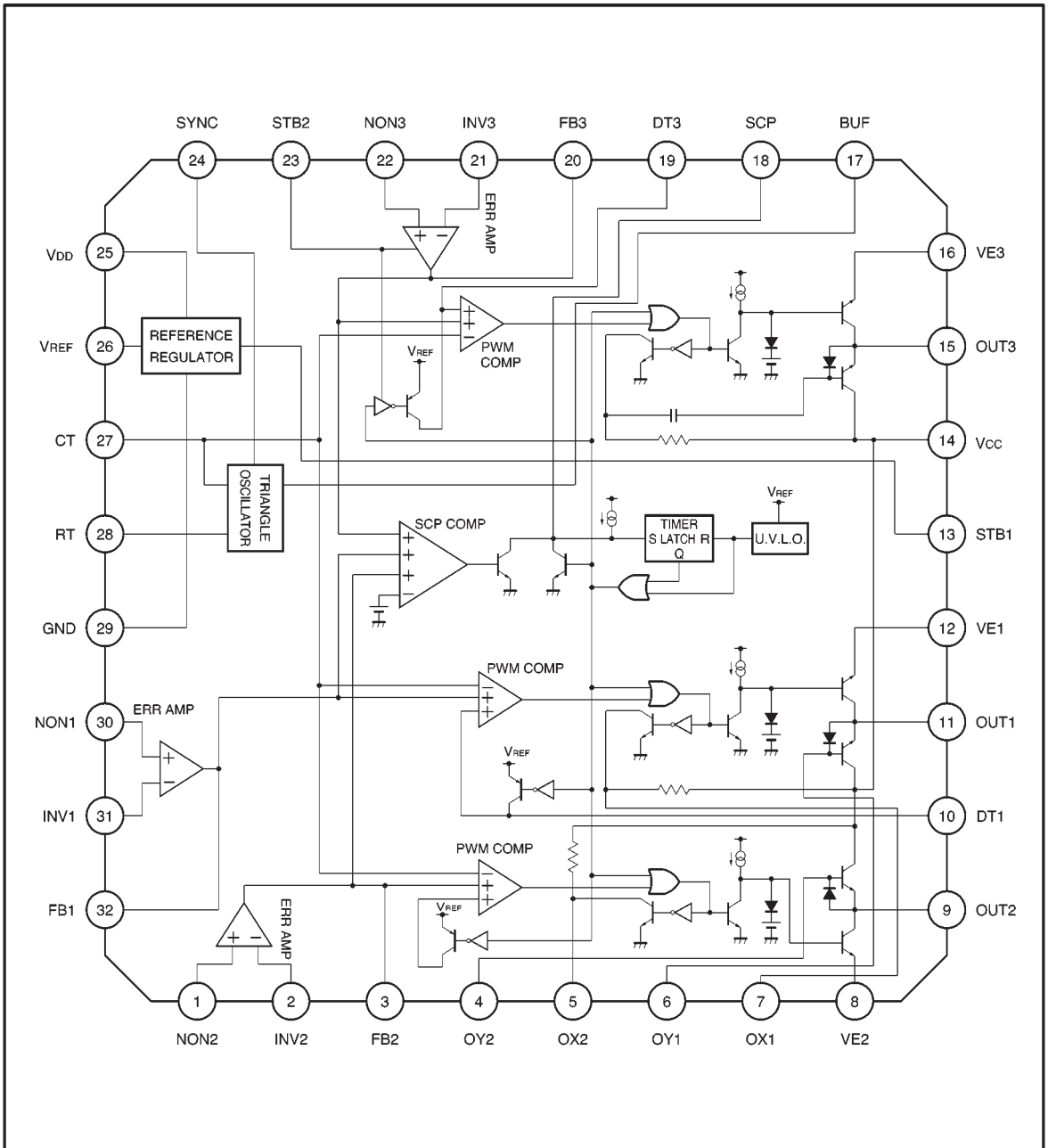
Parameter	Symbol	Limits	Unit
Power supply voltage	Vcc	14	V
Power dissipation	Pd	400*	mW
Operating temperature	Topr	-25~+75	°C
Storage temperature	Tstg	-55~+125	°C

\* 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	Vcc	3.5	6	12	V

● Block diagram



## ● Pin descriptions

Pin No.	Pin name	Function
1	NON2	Channel 2 error amplifier non-inverted input
2	INV2	Channel 2 error amplifier inverted input
3	FB2	Channel 2 error amplifier output pin; gain setting and phase compensation are controlled by connecting a resistor and capacitor between this pin and the INV2
4	OY2	Channel 2 output transistor off current setting pin; output transistor off current is set by connecting a capacitor between the OX2 and OY2
5	OX2	
6	OY1	Channel 1 output transistor off current setting pin; output transistor off current is set by connecting a resistor and capacitor
7	OX1	
8	VE2	Channel 2 output current setting pin; output current of OUT2 is set by connecting a resistor between this pin and GND
9	OUT2	Channel 2 output
10	DT1	Channel 1 rest period setting pin; the rest period of channel 3 is set by dividing the $V_{REF}$ voltage with external resistors; a soft start is possible by connecting a capacitor between this pin and $V_{REF}$
11	OUT1	Channel 1 output
12	VE1	Channel 1 output current setting pin; output current of OUT1 is set by connecting a resistor between this pin and GND
13	STB1	ON/OFF pin for all channels; stops the reference voltage and all channel operations when the pin is HIGH level
14	$V_{CC}$	Output power supply
15	OUT3	Channel 3 output
16	VE3	Channel 3 output current setting pin; output current of OUT3 is set by connecting a resistor between this pin and GND
17	BUF	Triangular wave external output pin, which makes triangular waves available to outside the IC
18	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
19	DT3	Channel 3 rest period setting pin; the rest period of channel 3 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 $V_{REF}$
20	FB3	Channel 3 error amplifier output pin; gain setting and phase compensation are controlled by connecting a resistor and capacitor between this pin and the INV3
21	INV3	Channel 3 error amplifier inverted input
22	NON3	Channel 3 error amplifier non-inverted input
23	STB2	Channel 3 ON / OFF pin; channel 3 operates when the pin is HIGH level, and ceases operation at LOW level; this pin is valid when CTL1 is LOW level
24	SYNC	Pin for triangular wave external synchronization input; capacitor-coupled AC wave is input, and the triangular wave is synchronized with the input frequency; the GND pin is used in the case of self-oscillation
25	$V_{DD}$	Power supply
26	$V_{REF}$	Reference voltage output ; 2.4 V (typical)
27	CT	Pin for connecting a frequency setting capacitor in the triangular wave oscillation circuit; triangular wave oscillation frequency is set by connecting a capacitor between this pin and GND
28	RT	Pin for connecting a frequency setting resistor in the triangular wave oscillation circuit; triangular wave oscillation frequency is set by connecting a resistor between this pin and GND

Pin No.	Pin name	Function
29	GND	Ground
30	NON1	Channel 1 error amplifier non-inverted input
31	INV1	Channel 1 error amplifier inverted input
32	FB1	Channel 1 error amplifier output pin; gain setting and phase compensation are controlled by connecting a resistor and capacitor between this pin and the INV1

● 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	I <sub>CC</sub>	—	6	9	mA	STB1=0V, STB2=6V
Standby current dissipation	I <sub>STB</sub>	—	40	60	μA	STB1=6V
〈Control section〉						
STB1 ON condition	V <sub>S1N</sub>	—	—	2.8	V	
STB1 OFF condition	V <sub>S1F</sub>	3.2	—	—	V	
STB1 pin current	I <sub>S1</sub>	15	30	45	μA	STB1=6V
STB2 ON condition	V <sub>S2N</sub>	2	—	—	V	
STB2 OFF condition	V <sub>S2F</sub>	—	—	1	V	
STB2 pin current	I <sub>S2</sub>	50	100	150	μA	STB2=6V
〈Reference voltage section〉						
Output voltage	V <sub>REF</sub>	2.376	2.400	2.424	V	I <sub>REF</sub> =1mA
Input stability	V <sub>DLI</sub>	—	5	10	mV	V <sub>CC</sub> =3.5→12V
Load regulation	V <sub>DLO</sub>	—	3	10	mV	I <sub>REF</sub> =0→10mA
〈Triangular wave oscillator section〉						
Oscillation frequency	F <sub>OSC</sub>	490	540	590	kHz	RT=7.5k, CT=220P
Frequency variation (V <sub>CC</sub> )	F <sub>DVC</sub>	—	—	1	%	↓ V <sub>CC</sub> =3.5→12V
Oscillation waveform upper limit voltage	V <sub>OSH</sub>	1.82	1.92	2.02	V	↓
Oscillation waveform lower limit voltage	V <sub>OSL</sub>	1.24	1.34	1.40	V	↓
〈Divider section〉						
SYNC pin maximum input frequency	F <sub>SYNC</sub>	—	—	1.5	MHz	
SYNC pin input voltage	V <sub>SYNC</sub>	0.2	—	0.8	V <sub>P-P</sub>	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Error amplifier section〉						
Input offset voltage	$V_{IO}$	-3.3	0.7	4.7	mV	Inverted pin standard
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	FB=1.0V
Output source current	$I_{OO}$	30	60	—	$\mu$ A	FB=1.0V
〈Protection circuit section〉						
Input threshold voltage	$V_{IT}$	1.6	1.8	1.9	V	
Input standby voltage	$V_{STB}$	—	10	80	mV	
Input latch voltage	$V_{LT}$	—	10	80	mV	
Input source current	$I_{SCP}$	200	400	600	nA	
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 ( $V_{CC}$ )	$V_{UTC}$	2.7	2.85	3.0	V	
〈Dead-time control section〉						
Input bias current	$I_{DB}$	—	0.3	1.0	$\mu$ A	$V_{DTC}=2.0V$
Source current when channel-3 is OFF	$I_{DF3}$	350	700	—	$\mu$ A	
Latch mode source current	$I_{DL}$	250	500	—	$\mu$ A	
〈Output section〉						
Channel-1 pin voltage	$V_{O1}$	450	550	650	mV	RE=15 $\Omega$ , $V_{CC}=6V$
Channel-1 pin voltage ( $I_{Max}$ )	$V_{OM1}$	350	450	550	mV	RE=3.3 $\Omega$ , $V_{CC}=6V$
Channel-2 pin voltage	$V_{O2}$	400	500	600	mV	RE=33 $\Omega$ , $V_{CC}=6V$
Channel-2 pin voltage ( $I_{Max}$ )	$V_{OM2}$	300	400	500	mV	RE=5.6 $\Omega$ , $V_{CC}=6V$
Channel-3 pin voltage	$V_{O3}$	400	500	600	mV	RE=47 $\Omega$ , $V_{CC}=6V$
Channel-3 pin voltage ( $I_{Max}$ )	$V_{OM3}$	300	400	500	mV	RE=8.2 $\Omega$ , $V_{CC}=6V$

©Not designed for radiation resistance.

\* 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	$I_{OP1}$	—	200	—	mA	
Channel-2 source peak current	$I_{OP2}$	—	130	—	mA	
Channel-3 source peak current	$I_{OP3}$	—	120	—	mA	

●Electrical characteristic curves

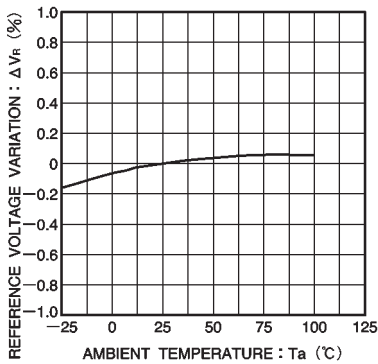


Fig.1 Reference voltage variation vs. ambient temperature

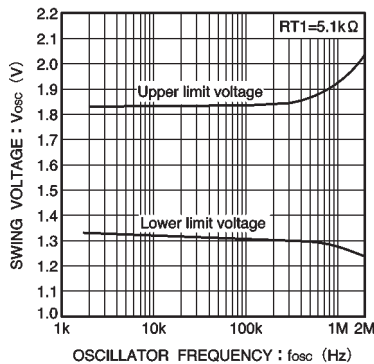


Fig.2 Swing voltage vs. oscillation frequency

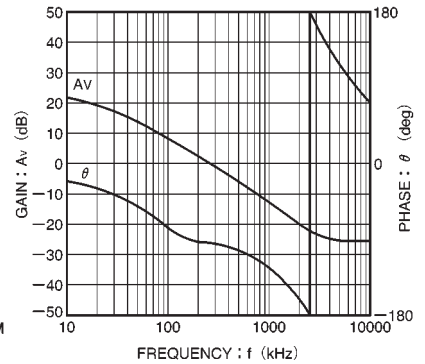


Fig.3 Gain and phase vs. frequency for the error amplifier (20 dB, close)

●External dimensions (Units: mm)

