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 ± 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)

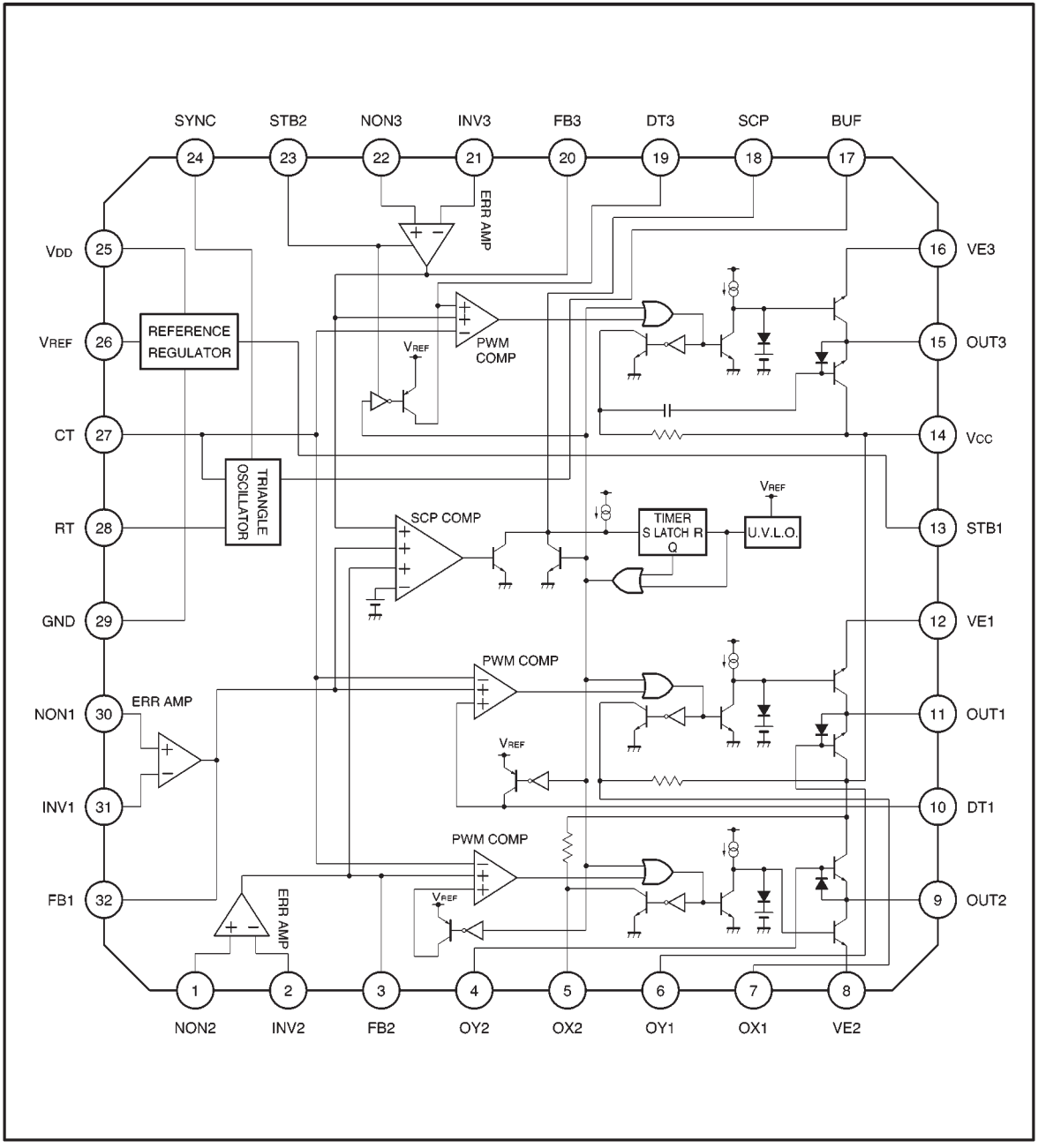
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	14	V
Power dissipation	Pd	400*	mW
Operating temperature	Topr	−25～+75	℃
Storage temperature	Tstg	−55～+125	℃

* 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	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 theV_{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_{CC} = 6V)

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

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	−	μA	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	μA	V_{DTC}=2.0V
Source current when channel-3 is OFF	I_{DF3}	350	700	−	μA	
Latch mode source current	I_{DL}	250	500	−	μA	
〈Output section〉						
Channel-1 pin voltage	V_{O1}	450	550	650	mV	RE=15Ω, V_{CC}=6V
Channel-1 pin voltage ($I_{Max.}$)	V_{OM1}	350	450	550	mV	RE=3.3Ω, V_{CC}=6V
Channel-2 pin voltage	V_{O2}	400	500	600	mV	RE=33Ω, V_{CC}=6V
Channel-2 pin voltage ($I_{Max.}$)	V_{OM2}	300	400	500	mV	RE=5.6Ω, V_{CC}=6V
Channel-3 pin voltage	V_{O3}	400	500	600	mV	RE=47Ω, V_{CC}=6V
Channel-3 pin voltage ($I_{Max.}$)	V_{OM3}	300	400	500	mV	RE=8.2Ω, V_{CC}=6V

◎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}	—	200	—	mA	
Channel-2 source peak current	I_{OP2}	—	130	—	mA	
Channel-3 source peak current	I_{OP3}	—	120	—	mA	

●Electrical characteristic curves

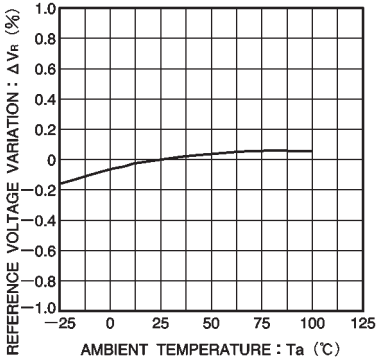


Fig.1 Reference voltage variation vs. ambient temperature

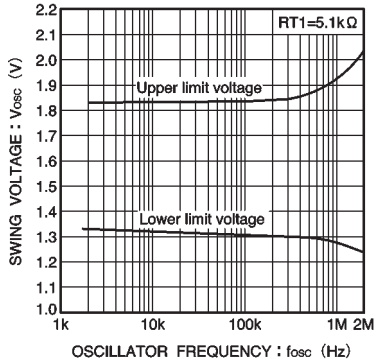


Fig.2 Swing voltage vs. oscillation frequency

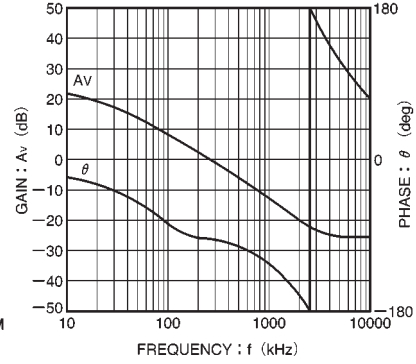


Fig.3 Gain and phase vs. frequency for the error amplifier (20 dB, close)

●External dimensions (Units: mm)