6-channel switching regulator controller

BA9736KV

The BA9736KV is a 6-channel controller that includes all of the circuits required to construct a switching regulator. The circuits on the chip include a triangular-wave generator, a reference voltage circuit, an error amplifier, a PWM comparator, a pseudo-totem-pole driver, and a variety of protection circuits.

●Applications

VCR / cameras, digital still cameras, and other portable equipment

●Features

1) The totem-pole driver can directly drive power transistors, and the on current can be set to the rating current using an external resistor.
2) Miss-operation prevention circuit for low-voltage input.
3) Output cutoff circuit (timer latch type) for overload protection.
4) Channels 1 and 4 employ FETs, and have totem-pole drivers that rectify synchronously with a chopper. The duty offset of the chopper can be adjusted externally.
5) For channel control, by making STB low level, all channels go off, and by making STB3 low level, channel 3 can be switched off independently.
6) Soft start is applied to all channels using an external capacitor, and is synchronized with the rising edges of STB and STB3.
7) VQFP64 package (0.5mm pitch).

●Absolute maximum ratings (Ta = 25°C)

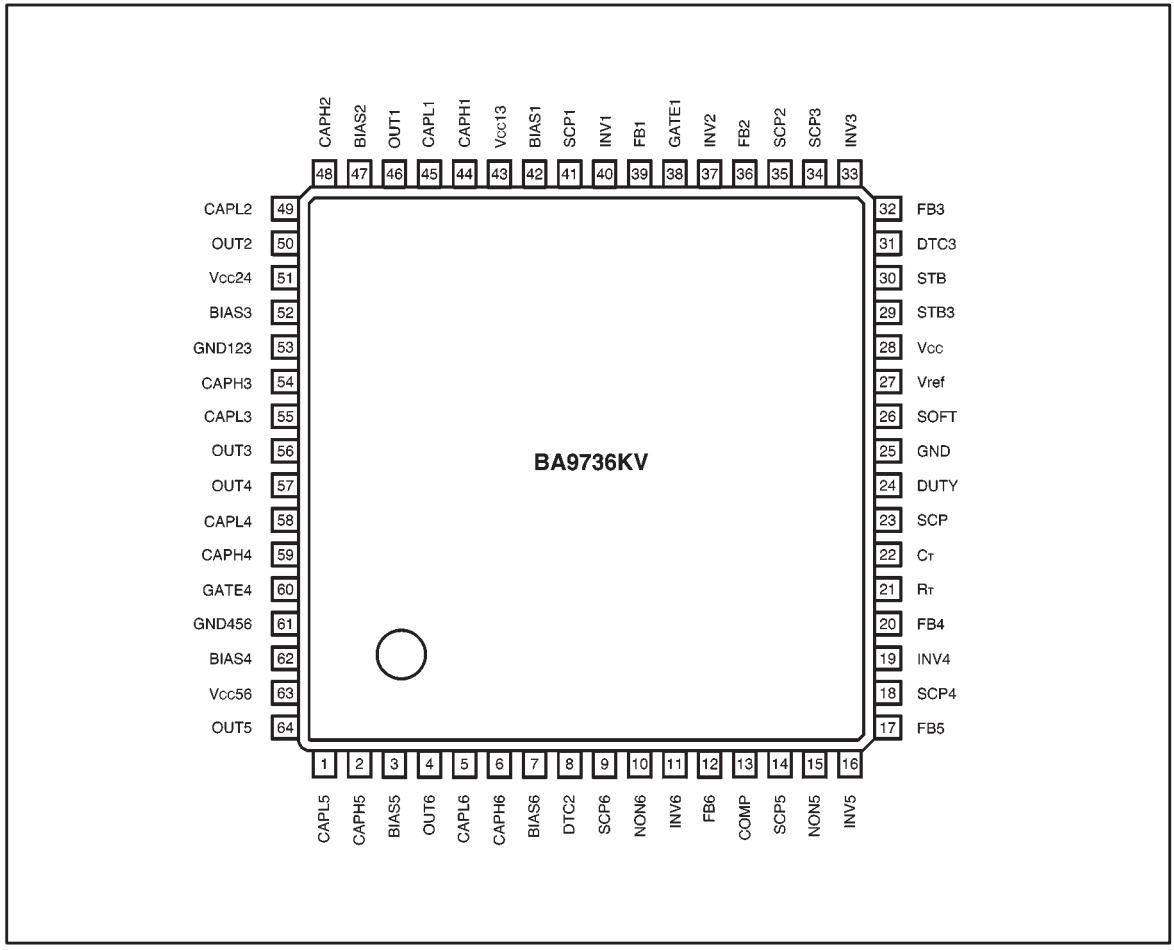
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	13.5	V
Output current	I_{OUT}	100	mA
Power dissipation	Pd	750*1	mW
		1000*2	mW
Operating temperature	Topr	−25～+85	℃
Storage temperature	Tstg	−55～+125	℃

*1 Reduced by 7.5mW for each increase in Ta of 1°C over 25°C(stand alone).
*2 When mounted on a 70mm × 70mm × 1.6mm PC board.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V_{CC}	2.8	–	13.5	V
OSC timing resistor	R_T	12	–	–	kΩ
OSC timing capacitor	C_T	100	–	10000	pF
OSC oscillator frequency	fosc	10	–	800	kHz
Output current setting resistor	R_{BIAS}	3.3	10	33	kΩ
Off-peak current setting capacitor	C_{OFF}	100	–	–	pF

●Block diagram



●Pin descriptions

Pin No.	Pin name	Function
1, 5, 45, 49, 55, 58	CAPL 5, 6, 1, 2, 3, 4	L connection for off transistor current-setting capacitor
2, 6, 44, 48, 54, 59	CAPH 5, 6, 1, 2, 3, 4	H connection for off transistor current-setting capacitor
3, 7, 42, 47, 52, 62	BIAS 5, 6, 1, 2, 3, 4	Output current setting
4, 46, 50, 56, 57, 64	OUT 6, 1, 2, 3, 4, 5	Power transistor base connection
9, 14, 18, 34, 35, 41	SCP 6, 5, 4, 3, 2, 1	Output voltage monitor for ch1 to ch6 protection
11, 16, 19, 33, 37, 40	INV6, 5, 4, 3, 2, 1	Inverting input for error amplifier
12, 17, 20, 32, 36, 39	FB 6, 5, 4, 3, 2, 1	Error amplifier output
13	COMP	Timer latch external trigger input
21	R_T	Connection for resistor for triangular-wave timing
22	C_T	Connection for capacitor for triangular-wave timing
23	SCP	Connection for capacitor for setting timing latch delay
24	DUTY	MOSFET duty control
25	GND	Ground
26	SOFT	Connection for capacitor for setting soft start
27	Vref	Reference voltage output
28	V_{CC}	Power supply input
29	STB3	Channel 3 on / off switch
30	STB	All channel on / off switches
8, 31	DTC 2, 3	Dead time control
38, 60	GATE1, 4	MOSFET gate connection
43	V_{CC}13	Power supply input for channels 1 and 3 output stages
51	V_{CC}24	Power supply input for channels 2 and 4 output stages
63	V_{CC}56	Power supply input for channels 5 and 6 output stages
53	GND123	Ground connection for channels 1, 2, and 3 output stages
61	GND456	Ground connection for channels 4, 5, and 6 output stages
10, 15	NON6, 5	Non-inverting input for error amplifier

●Electrical characteristics (unless otherwise noted, Ta = 25°C, V_{CC} = 7.2V, f_{OSC} = 700kHz and output voltage off)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
Standby current	I_{st}	—	70	120	μA	STB=0V	Fig.1
Circuit current	I_{cc}	—	7.5	10.2	mA	R_T=47kΩ	Fig.1
〈Reference voltage〉							
Output voltage	Vref	1.485	1.5	1.515	V	Iref=−1mA	Fig.1
Line regulation	DV_{LI}	—	2.0	12.5	mV	V_{CC}=2.8V∼13V, Iref=−1mA	Fig.1
Load regulation	DV_{LO}	—	1.0	7.5	mV	Iref=−0.1m∼−1mA	Fig.1
Short-circuit output current	I_{OS}	−4	−20	—	mA	Vref=0V	Fig.1
〈Low-voltage input monitor〉							
Threshold voltage 1	V_{UV1}	—	2.40	2.50	V	ON STATE	Fig.3
Threshold voltage 2	V_{UV2}	1.90	2.30	—	V	OFF STATE	Fig.3
Hysteresis width	V_{HYS}	0.05	0.1	0.6	V	—	Fig.3
〈Overload cutoff〉							
Channel 1 threshold	V_{SC1}	1.47	1.50	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 2 threshold	V_{SC2}	1.47	1.50	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 3 threshold	V_{SC3}	1.47	1.50	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 4 threshold	V_{SC4}	1.47	1.50	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 5 threshold Channel 6 threshold	V_{SC5} V_{SC6}	NON× 2.85/10 −0.07	NON ×3/10 −0.05	NON× 3.15/10 −0.03	V	—	Fig.2
〈Protection circuit〉							
Input threshold	V_{tsc}	1.42	1.50	1.58	V	—	Fig.2
Standby voltage	V_{ssc}	—	10	30	mV	—	Fig.2
Input source current	I_{SCP}	−4.0	−2.5	−1.0	μA	—	Fig.2
〈STB〉							
Input bias current	I_{ST}	—	190	—	μA	STB=5V	Fig.1
Threshold voltage	V_{STB}	0.4	—	2.0	V	—	Fig.1
〈STB3〉							
Input bias current	I_{ST3}	—	95	—	μA	STB3=5V	Fig.1
Threshold voltage	V_{STB3}	0.4	—	2.0	V	—	Fig.1
〈SCP trigger〉							
Input bias current	I_{BT}	—	−0.4	2.0	μA	COMP=1V	—
Threshold voltage	V_{TT}	1.45	1.5	1.55	V	—	—

◎Not designed for radiation resistance.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
〈Triangular wave oscillator〉							
Oscillation frequency	f_{OSC1}	385	430	475	kHz	R_T=47kΩ, C_T=100pF	Fig.1
	f_{OSC2}	630	700	770	kHz	R_T=27kΩ, C_T=100pF	Fig.1
Frequency deviation	Df	—	1	5	%	V_{CC}=2.8→13V	Fig.1
Upper limit voltage for the triangular wave	V_{CMA}	1.35	1.50	1.65	V	—	Fig.1
Lower limit voltage for the triangular wave	V_{CMI}	0.93	1.08	1.23	V	—	Fig.1
〈Error amplifier〉							
Channel 1 output setting voltage	V_{O1}	1.47	1.5	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 2 output setting voltage	V_{O2}	1.47	1.5	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 3 output setting voltage	V_{O3}	1.47	1.5	1.53	V	Including reference voltage (Vref) error	Fig.2
Channel 4 output setting voltage	V_{O4}	1.47	1.5	1.53	V	Including reference voltage (Vref) error	Fig.2
Non-inverting input voltage range for channels 5 and 6	V_{N56}	0	—	V_{CC} −1.7	V	NON5, 6	Fig.2
Inverting input voltage range for channels 5 and 6	V_{I56}	0	—	V_{CC} −1.7	V	INV5, 6	Fig.2
Channel 5 and channel 6 input offset voltage	V_{OS5} V_{OS6}	−15	—	15	mV	—	—
Output low level voltage	V_{OL}	—	—	0.2	V	—	Fig.2
Output high level voltage	V_{OH}	Vref −0.1	—	—	V	—	Fig.2
〈PWM comparator〉							
DTC input current	I_{DT}	—	−0.4	−6.0	μA	DTC2, 3=0.5V	Fig.4
0% DUTY threshold	V_{to}	0.53	0.63	0.73	V	—	Fig.4
100% DUTY threshold	V_{t100}	1.22	1.32	1.42	V	—	Fig.4
〈Soft start〉							
Input source current	I_{SO}	−1	−2.5	−4	μA	STB3=3V, SOFT=1V	Fig.1
〈MOS DUTY control〉							
ON DUTY1	D_1	—	20	—	%	VFB1, 4=1V, RD=5kΩ	Fig.4
ON DUTY2	D_2	—	40	—	%	VFB1, 4=1V, RD=25kΩ	Fig.4
〈Output stage〉							
Output sink current	I_{OUT}	4.3	5.8	7.3	mA	RB=10kΩ	Fig.3
MOS gate sink current	I_{GSI}	—	40	—	mA	GATE1, 4=1V	Fig.3
MOS gate sink current	I_{GSO}	—	−140	—	mA	GATE1, 4=2V	Fig.3
MOS gate high level output	V_{OH}	3.5	4.0	—	V	—	Fig.3
MOS gate low level output	V_{GL}	—	0.1	0.3	V	—	Fig.3

◎Not designed for radiation resistance.

Recommended maximum oscillator frequency (Ta=25°C), fMax.=800kHz.

●Measurement circuits

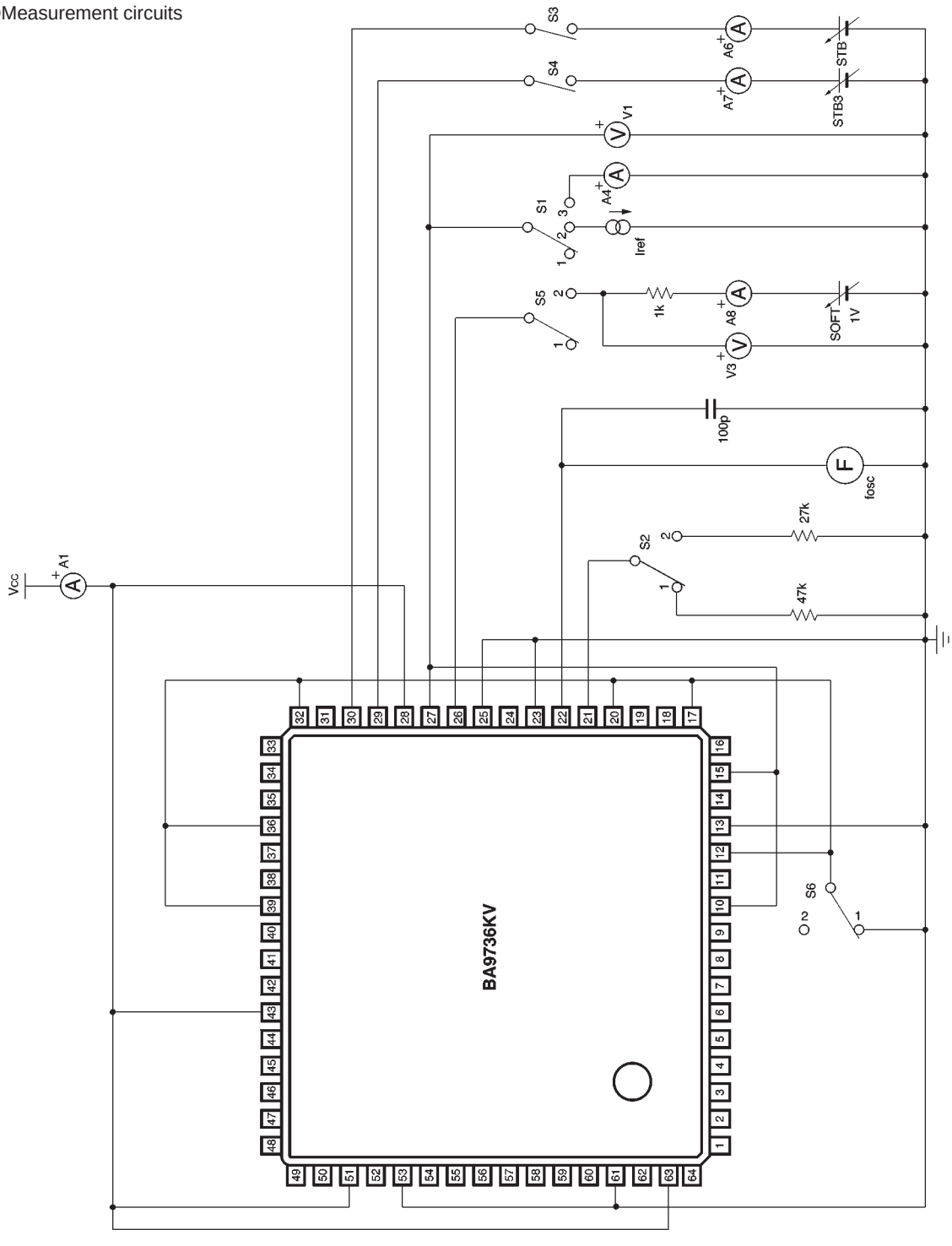


Fig.1

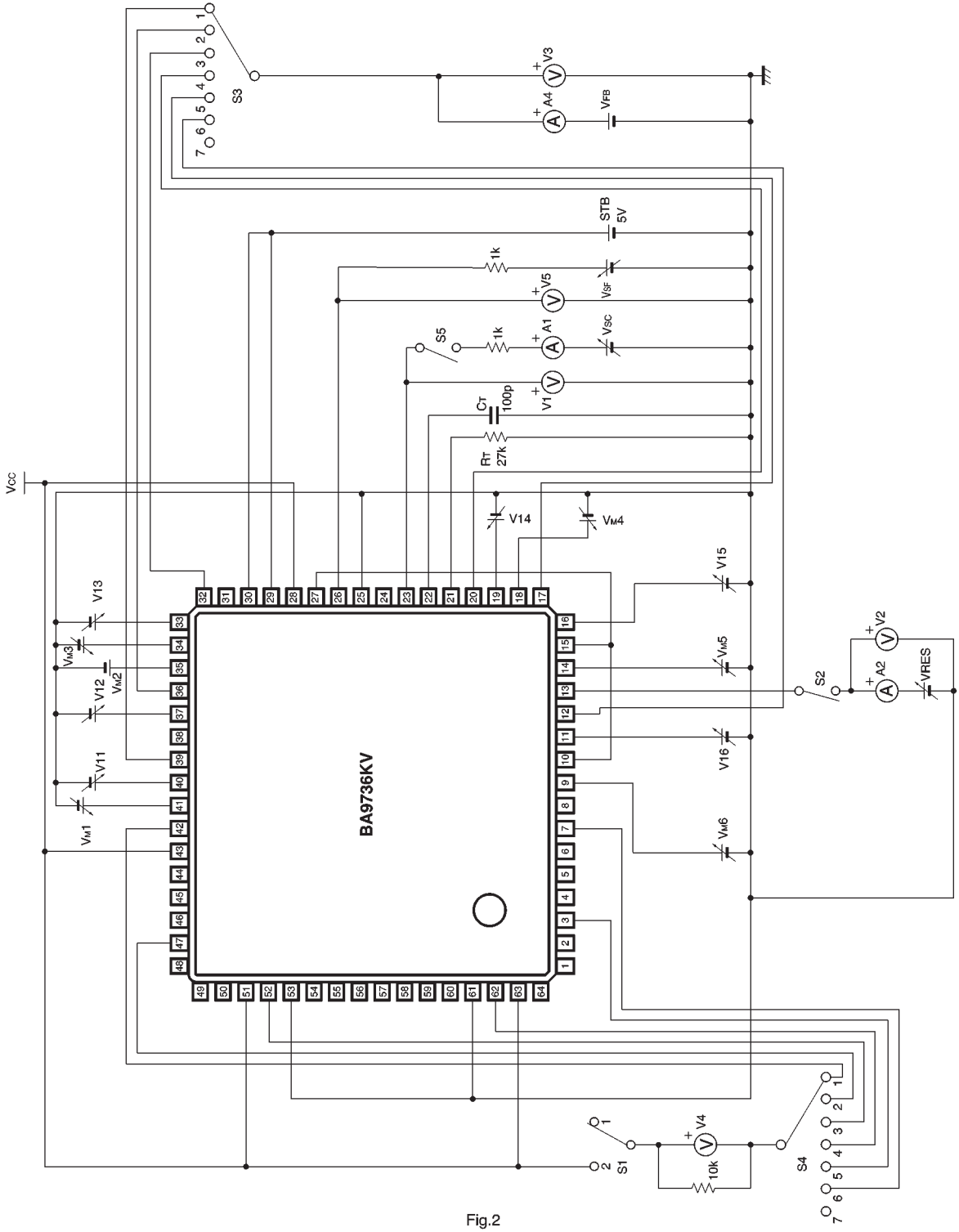

BA9736KV
S1
S2
S3
S4
S5
V1
V2
V3
V4
V5
A1
A2
A4
VFB
STB
5V
1k
VSF
VSC
CT
100p
RT
27k
VCC
V14
VM4
V15
V16
V13
VM3
V12
VM2
V11
VM1
VM5
VM6
VRES
10k

Fig.2

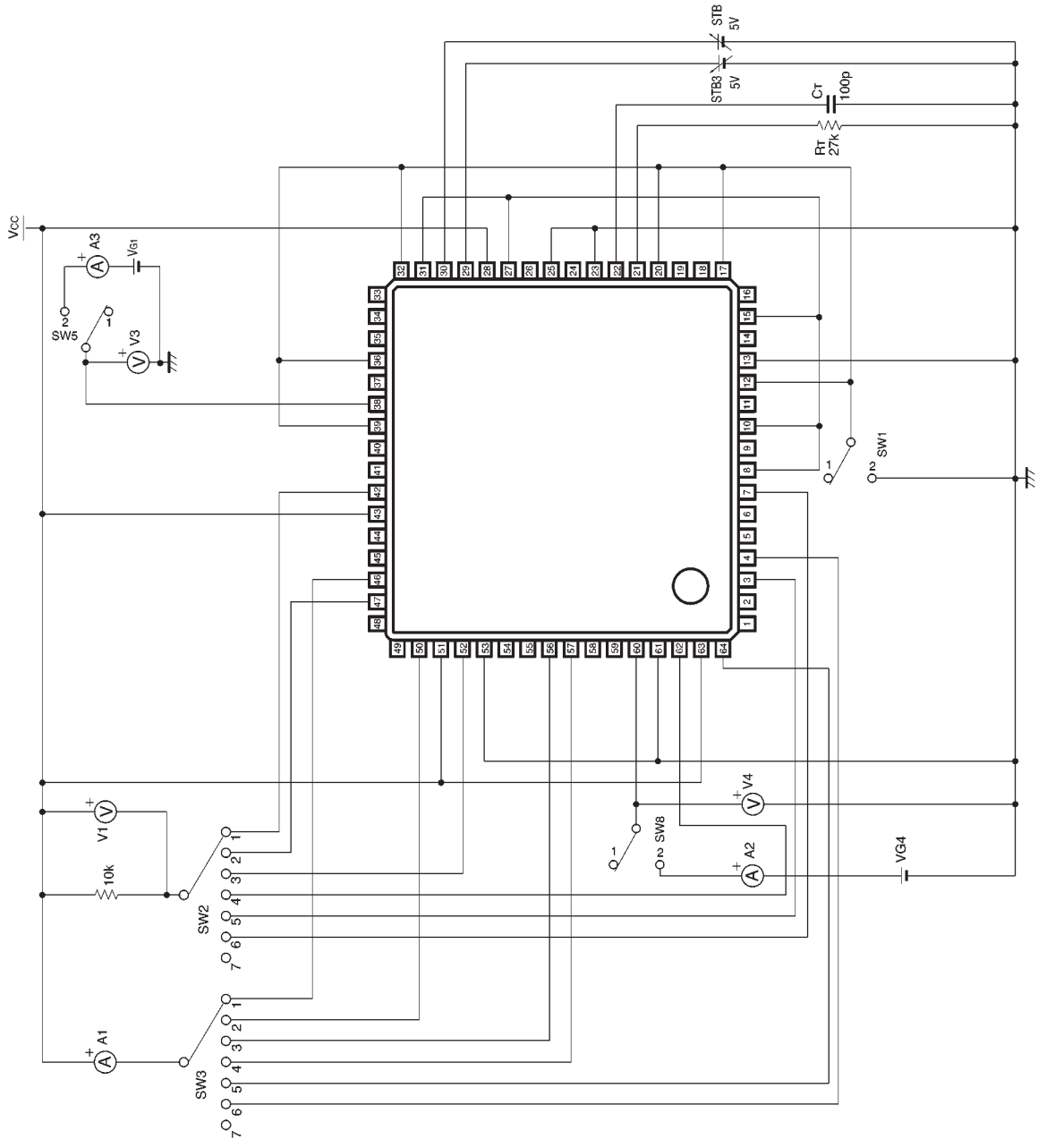

STB
5V
STB3
5V
Cт
100p
Rт
27k
VCC
A3
VG1
SW5
V3
SW1
V1
10k
SW2
A1
SW3
V4
SW8
A2
VG4

Fig.3

●Application example

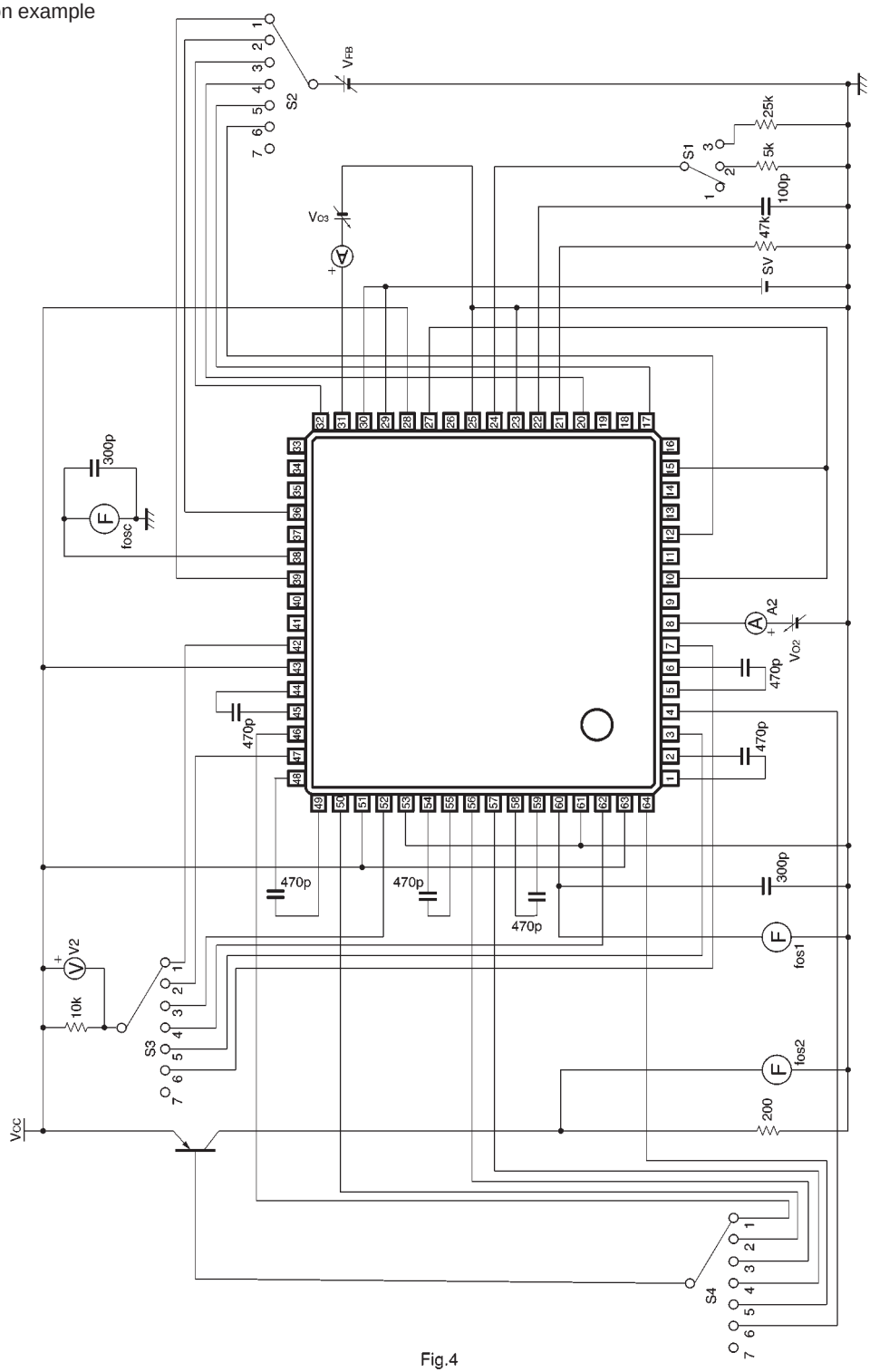


Fig.4

●Operation notes

(1) Set the dead-time input voltage to 0.73V or more.

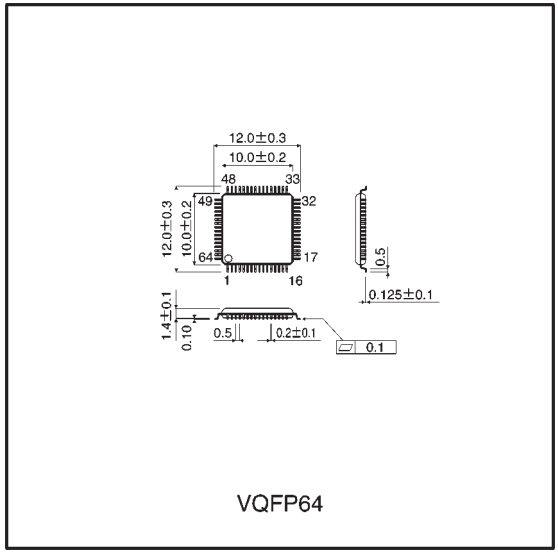
(2) Use short and wide wiring tracks for the power supply and ground to keep the mutual impedance as small as possible, and use inductors and capacitors to keep ripple to a minimum.

(3) Set R_{DUTY} so that the drive stage and the MOS drive stage for the synchronous rectifier channel are not on at the same time.

(4) If you are not using the external trigger input (pin 13) for overload output cutoff, pull it up to V_{CC} (pin 28).

(5) Great care has been paid to the quality of this component. However, if the absolute maximum ratings for temperature and applied voltage are exceeded, the IC may be destroyed. Since it is not possible to predict whether it will be in short mode or open mode if the IC is destroyed, if there is a chance that the maximum ratings of the IC will be exceeded, use appropriate physical protective measures (fuses etc.).

●External dimensions (Units: mm)



VQFP64