

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	P _d	750*1	mW
		1000*2	mW
Operating temperature	T _{opr}	-25~+85	°C
Storage temperature	T _{stg}	-55~+125	°C

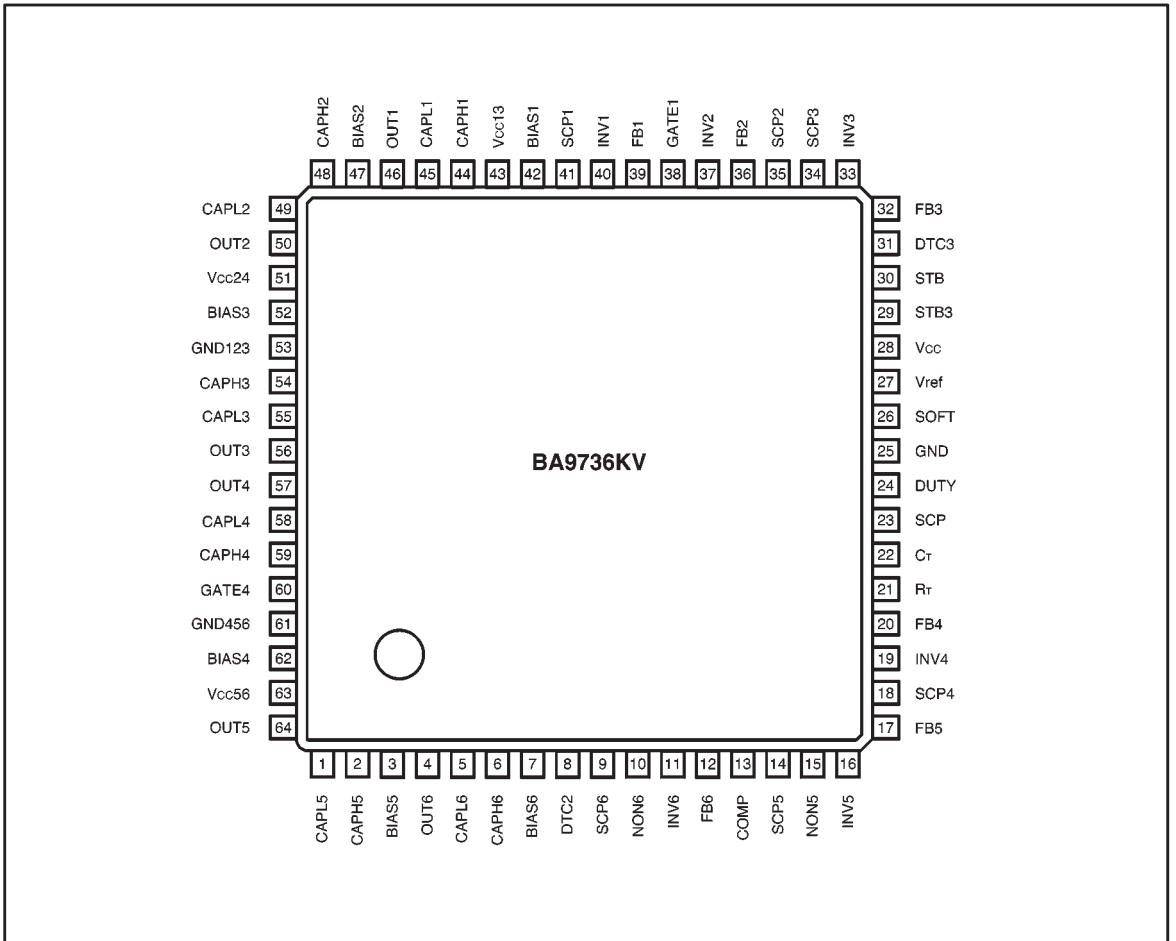
*1 Reduced by 7.5mW for each increase in Ta of 1°C over 25°C(stand alone).

*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	f _{osc}	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	V _{ref}	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	V _{ref}	1.485	1.5	1.515	V	I _{ref} =-1mA	Fig.1
Line regulation	DV _{Li}	—	2.0	12.5	mV	V _{CC} =2.8V~13V, I _{ref} =-1mA	Fig.1
Load regulation	DV _{Lo}	—	1.0	7.5	mV	I _{ref} =-0.1m~-1mA	Fig.1
Short-circuit output current	I _{os}	-4	-20	—	mA	V _{ref} =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 (V _{ref}) error	Fig.2
Channel 2 threshold	V _{SC2}	1.47	1.50	1.53	V	Including reference voltage (V _{ref}) error	Fig.2
Channel 3 threshold	V _{SC3}	1.47	1.50	1.53	V	Including reference voltage (V _{ref}) error	Fig.2
Channel 4 threshold	V _{SC4}	1.47	1.50	1.53	V	Including reference voltage (V _{ref}) error	Fig.2
Channel 5 threshold	V _{SC5}	NON×	NON	NON×	V	—	Fig.2
Channel 6 threshold	V _{SC6}	2.85/10 -0.07	×3/10 -0.05	3.15/10 -0.03			
〈Protection circuit〉							
Input threshold	V _{ts}	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	—	—

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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 _{CM1}	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 (V _{ref}) error	Fig.2
Channel 2 output setting voltage	V _{O2}	1.47	1.5	1.53	V	Including reference voltage (V _{ref}) error	Fig.2
Channel 3 output setting voltage	V _{O3}	1.47	1.5	1.53	V	Including reference voltage (V _{ref}) error	Fig.2
Channel 4 output setting voltage	V _{O4}	1.47	1.5	1.53	V	Including reference voltage (V _{ref}) 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}	V _{ref} -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 ₁₀	0.53	0.63	0.73	V	—	Fig.4
100% DUTY threshold	V ₁₁₀₀	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 _{GS1}	—	40	—	mA	GATE1, 4=1V	Fig.3
MOS gate sink current	I _{GS0}	—	-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

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Recommended maximum oscillator frequency (T_a=25°C), f_{Max.}=800kHz.

● Measurement circuits

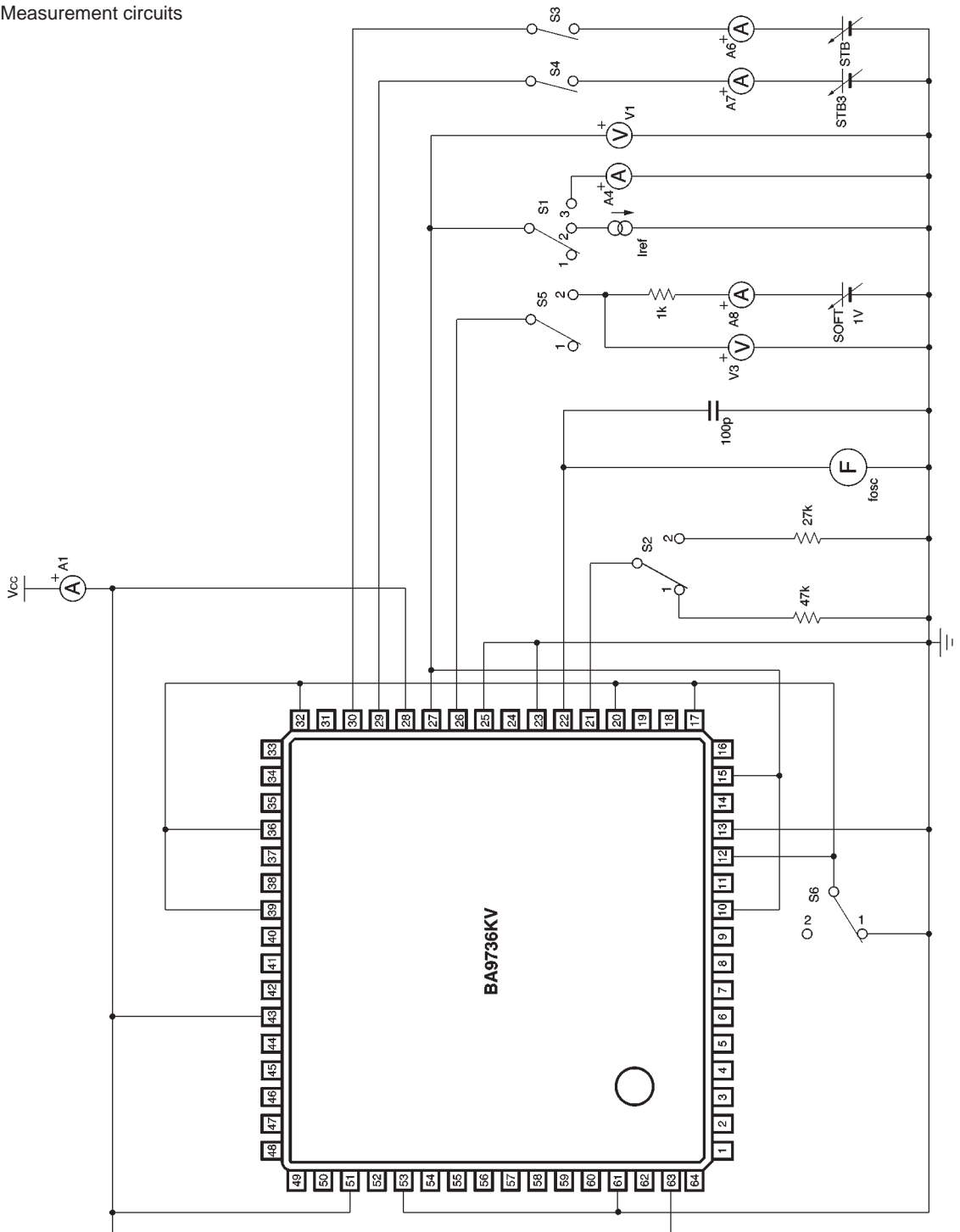


Fig.1

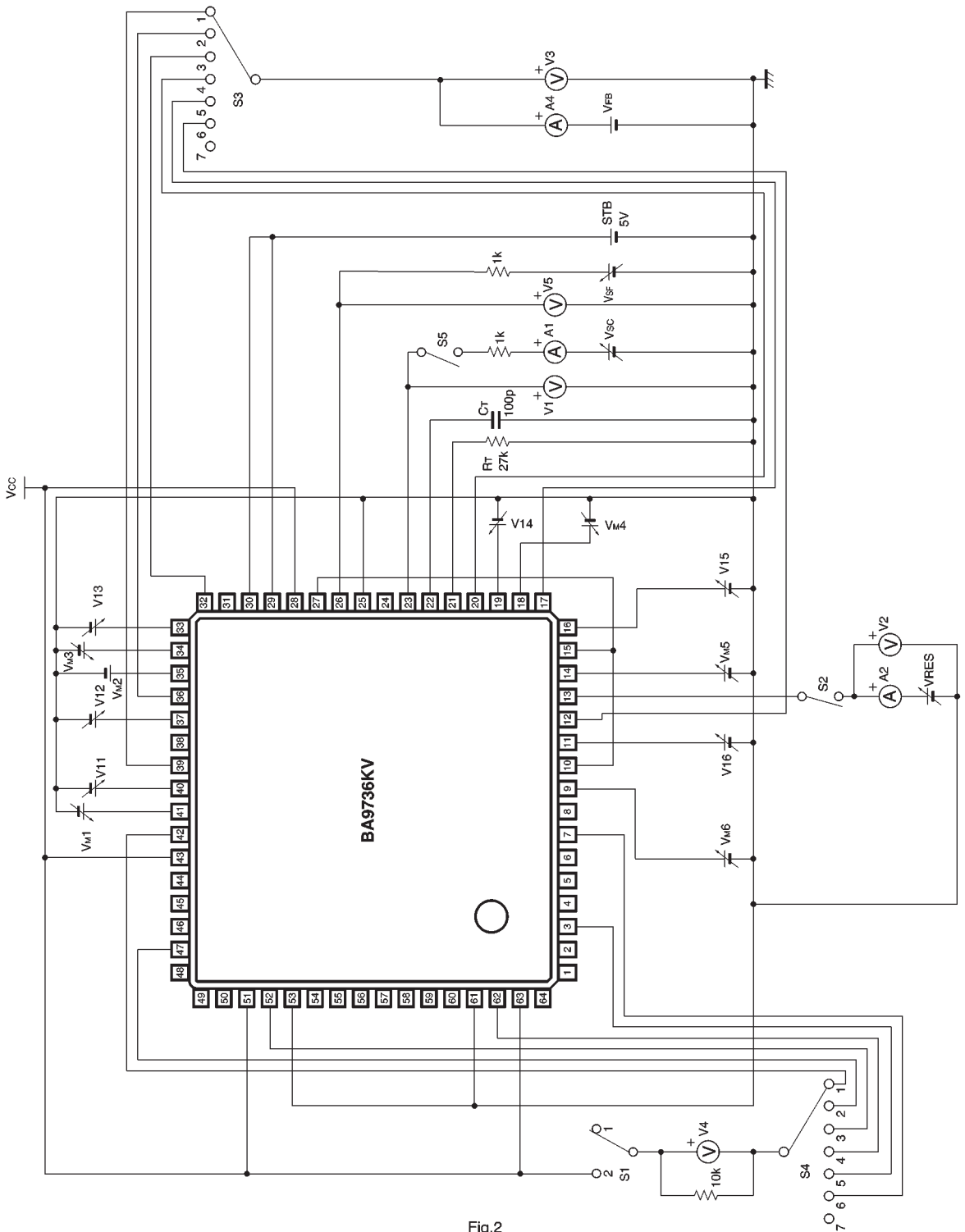


Fig.2

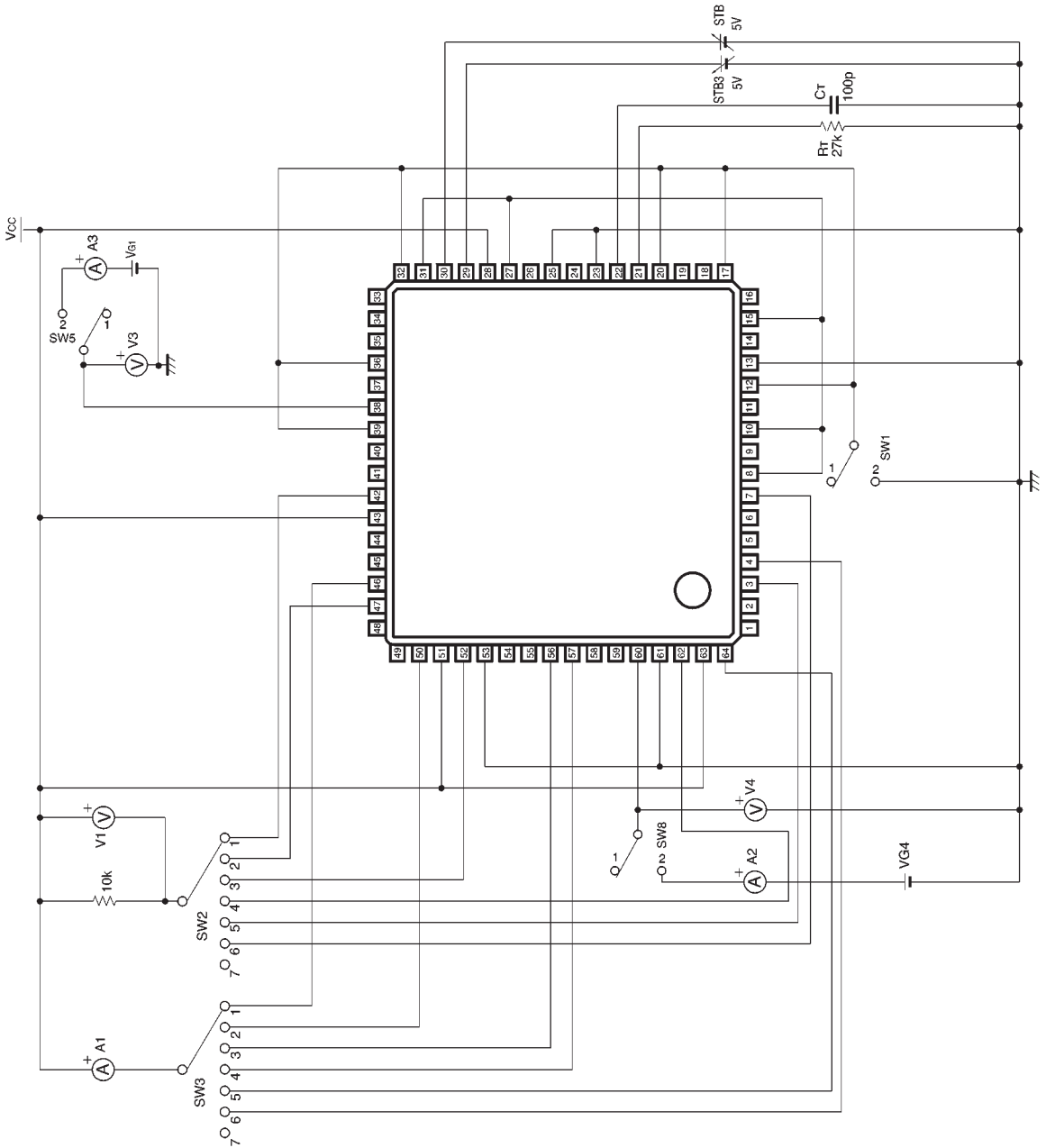


Fig.3

● Application example

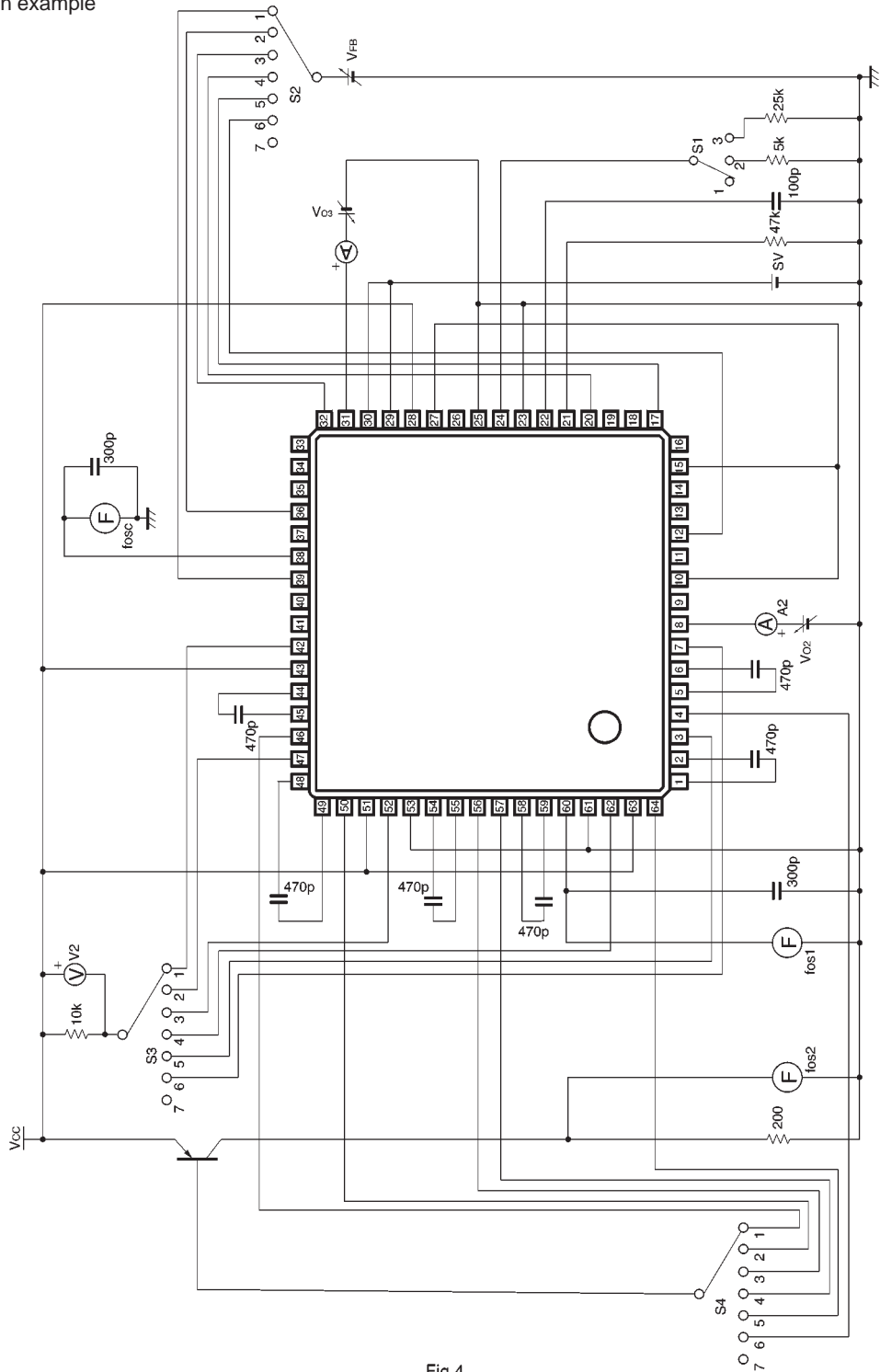


Fig.4

● 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)

