

# FA5301BP(N)

Bipolar IC  
For Switching Power Supply Control

## ■ Description

The FA5301BP(N) is a bipolar IC containing basic circuits necessary for PWM-type switching power supply control. This IC switches an external transistor according to external synchronizing pulses.

## ■ Features

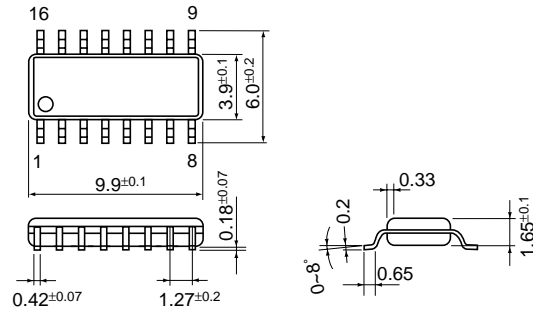
- External synchronization input terminal
- Wide supply voltage range ( $V_{CC} = 7$  to  $22V$ )
- Open-collector output
- Soft-start from standby mode
- Double protection of output transistor by overcurrent limiting and cutoff functions
- Output ON/OFF control function
- Not many external discrete components needed

## ■ Applications

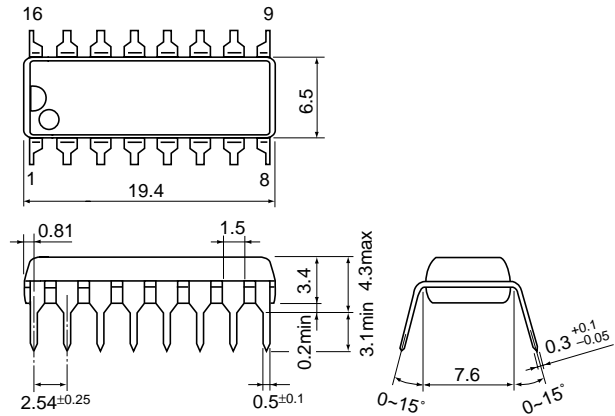
- Switching power supply for general equipment (Optimum for TV, display, and other monitor devices)

## ■ Dimensions, mm

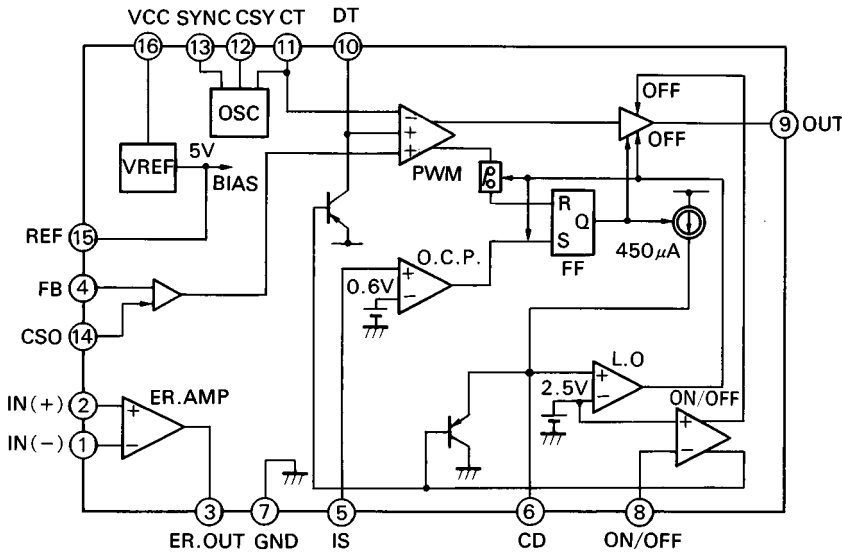
### ● SOP-16



### ● DIP-16



## ■ Block diagram



Pin No.	Pin symbol	Description
1	IN (-)	Inverting input to error amplifier
2	IN (+)	Non-inverting input to error amplifier
3	ER.OUT	Error amplifier output
4	FB	Feedback input
5	IS	Overcurrent detection
6	CD	Overcurrent cutoff delay capacitor
7	GND	Ground
8	ON/OFF	Output ON/OFF control
9	OUT	Output
10	DT	Dead time adjustment
11	CT	Oscillator timing capacitor
12	CSY	External synchronizing signal detection capacitor
13	SYNC	External synchronization input
14	CSO	PWM soft-start capacitor
15	REF	Reference voltage output (5V)
16	VCC	Power supply

### ■ Absolute maximum ratings

Item	Symbol	Rating	Unit
Supply voltage	V <sub>CC</sub>	22	V
Output voltage	V <sub>O</sub>	22	V
Error amplifier output current	I <sub>OM</sub>	5	mA
Error amplifier input voltage	V <sub>I</sub>	5	V
Overcurrent detection terminal input voltage	V <sub>IS</sub>	20	V
Feedback terminal input voltage	V <sub>FB</sub>	20	V
Output ON/OFF terminal input voltage	V <sub>ON/OFF</sub>	6	V
Synchronizing terminal input voltage	V <sub>SYNC</sub>	6	V
Total power dissipation	P <sub>d</sub>	1000 (DIP-16) *1	mW
		400 (SOP-16) *2	
Operating temperature	T <sub>opr</sub>	-20 to +85	°C
Storage temperature	T <sub>stg</sub>	-40 to +150	°C

### ■ Recommended operating conditions

Item	Symbol	Min.	Max.	Unit
Supply voltage	V <sub>CC</sub>	7	20	V
Error amplifier input voltage	V <sub>I</sub>	0	V <sub>REF</sub> -2	V
Output current	I <sub>O</sub>		20	mA
Error amplifier feedback resistor	R <sub>NF</sub>	33		kΩ
Oscillator timing capacitor	C <sub>T</sub>	100	10,000	pF
Oscillator timing resistor	R <sub>T</sub>	8.2	220	kΩ
Free run oscillation frequency	f <sub>OSC</sub>	1	200	kHz
Synchronized frequency	f <sub>SYNC</sub>	1	200	kHz
Frequency ratio $\frac{f_{OSC} - f_{SYNC}}{f_{SYNC}} \times 3$	CSY=OV	-35	-5	%
	CSY: Capacitor is connected to GND	-30	+10	%

Notes:

\*1 Derating factor Ta &gt; 25°C : 10.0mW/°C (on PC board)

\*2 Derating factor Ta &gt; 25°C : 4.0mW/°C (on PC board)

\*3 Consider the tolerance of  $\frac{f_{OSC} - f_{SYNC}}{f_{SYNC}}$ 

### ■ Electrical characteristics (Ta = 25°C, V<sub>CC</sub> = 9V, R<sub>T</sub> = 47kΩ, C<sub>T</sub> = 1000pF)

#### Reference voltage section

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Output voltage	V <sub>REF</sub>	I <sub>OR</sub> = 1mA	4.75	5.00	5.25	V
Line regulation	LINE	V <sub>CC</sub> = 8 to 20V		10	25	mV
Load current regulation	LOAD	I <sub>OR</sub> = 0.1 to 2mA		10	25	mV
Output voltage variation by temperature fluctuation	V <sub>TC1</sub>	Ta = -20 to +25°C		1		%
	V <sub>TC2</sub>	Ta = +25 to +85°C		1		%
Output current at output short-circuit	I <sub>OS</sub>			25		mA

#### Oscillator section

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Oscillation frequency	f <sub>OSC</sub>	C <sub>T</sub> = 1,000pF, R <sub>T</sub> = 47kΩ	20	21	22	kHz
Frequency variation by line voltage fluctuation	f <sub>dV</sub>	V <sub>CC</sub> = 8 to 20V			2	%
Frequency variation by temperature fluctuation	f <sub>dt1</sub>	Ta = +25 to -20°C	-2		+2	%
	f <sub>dt2</sub>	Ta = +25 to +85°C	-2		+2	%
Input current to synchronizing signal terminal	I <sub>SYNC1</sub>	V <sub>SYNC</sub> = 1V		300	600	μA
	I <sub>SYNC2</sub>	V <sub>SYNC</sub> = -0.5V		-60	-300	μA
Input current to synchronizing signal detection terminal	I <sub>CSY1</sub>	Pin 12 = 0V, V <sub>SYNC</sub> = -0.5V	-65	-130	-260	μA
	I <sub>CSY2</sub>	Pin 12 = 1V, V <sub>SYNC</sub> = 1V		200	400	μA
Threshold voltage of synchronizing signal detection terminal	V <sub>TH CSY</sub>			0.7	1.0	V

#### Error amplifier section

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Input offset voltage	V <sub>IO</sub>		-10		10	mV
Input bias current	I <sub>I</sub>				1	μA
Common-mode input voltage	V <sub>CM</sub>		0		V <sub>REF</sub> -2	V
Open-loop voltage gain	A <sub>V</sub>		70	95		dB
Unity-gain bandwidth	G <sub>B</sub>			0.8		MHz
Common-mode signal rejection ratio	CMRR			80		dB
Maximum output voltage	V <sub>OM+</sub>	I <sub>OM</sub> = -50μA		4		V
	V <sub>OM-</sub>	I <sub>OM</sub> = 50μA			0.5	V
Output sink current	I <sub>OM-</sub>	V <sub>OM</sub> = 1V	170	240		μA

**PWM comparator section**

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Input bias current (Pin 4)	I <sub>BFB</sub>	V <sub>FB</sub> = 1V		-2.0	-10.0	μA
Input threshold voltage (Pin 4)	V <sub>TH0</sub>	Duty cycle = 0%		3.3		V
	V <sub>TH100</sub>	Duty cycle = 100%		0.2		V
Soft-start signal pin input current	I <sub>CSO</sub>	Pin 14 = 3V, V <sub>FB</sub> = 0V		2.0	10.0	μA

**Dead time adjustment circuit section**

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Input bias current	I <sub>BDT</sub>	Pin 10 = 1V		-0.5	-5	μA
Input threshold voltage	V <sub>TH DT0</sub>	Duty cycle = 0%		3.2		V
	V <sub>TH DT100</sub>	Duty cycle = 100%		0.1		V
Reset saturation voltage	V <sub>SAT RS</sub>	Pin 10 = -100μA		0.25	0.8	V

**Overcurrent limiting circuit section**

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Input bias current (Pin 5)	I <sub>BIS</sub>	V <sub>IS</sub> = 0.3V			-1	μA
Input threshold voltage (Pin 5)	V <sub>TH IS</sub>		0.5	0.6	0.7	V
Source current of overcurrent cutoff terminal	I <sub>O CD</sub>	Pin 6 = 0V, V <sub>IS</sub> = 1V		-450	-700	μA
Latch-mode threshold voltage	V <sub>TH LA</sub>		1.8	2.2	2.6	V
Reset saturation voltage (Pin 6)	V <sub>SAT RS</sub>	Pin 6 = 100μA, V <sub>IS</sub> = 0V		0.75	1.0	V

**Output section**

Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Output leakage current	I <sub>LEAK</sub>	V <sub>O</sub> = 22V, output OFF			10	μA
L-level output voltage	V <sub>OL</sub>	I <sub>O</sub> = 10mA		0.4	0.7	V
Output sink current limit	I <sub>SINK</sub>	V <sub>O</sub> = 3V	25	40	55	mA

**Output ON/OFF control circuit section**

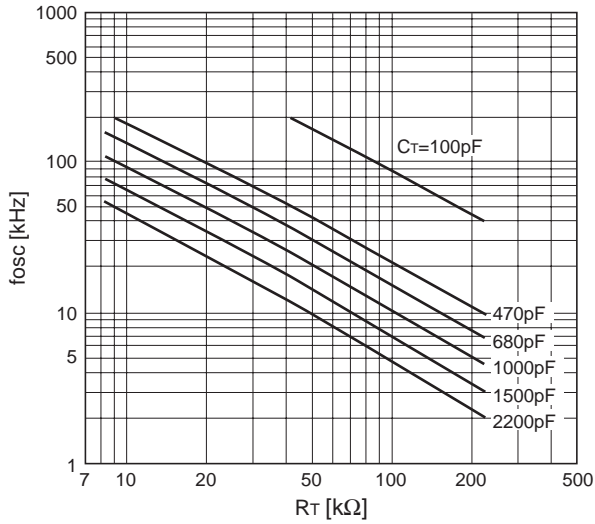
Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Input bias current (Pin 8)	I <sub>BON</sub>	Pin 8 = 0V		-60	-300	μA
OFF-to-ON threshold voltage	V <sub>TH ON</sub>	OFF→ON	2.13	2.50	2.87	V
ON-to-OFF threshold voltage	V <sub>TH OFF</sub>	ON→OFF	1.96	2.30	2.64	V
Voltage hysteresis	V <sub>HYS</sub>			0.2		V

**Overall device**

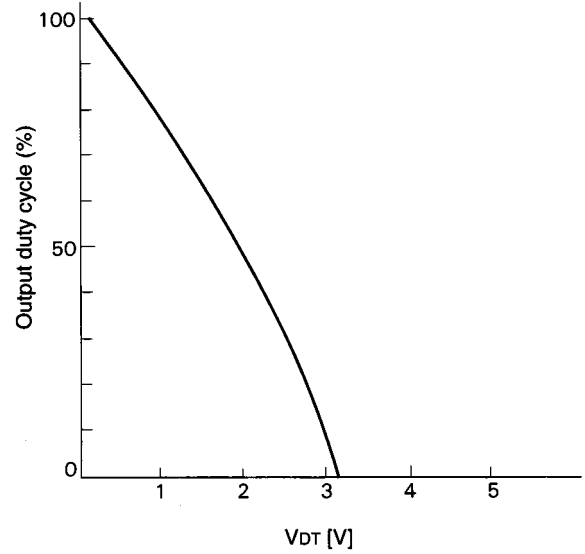
Item	Symbol	Test condition	Min.	Typ.	Max.	Unit
Supply current	I <sub>CC LA</sub>	R <sub>T</sub> = 47kΩ, latch mode		8.0	12.0	mA
Operating-state supply current	I <sub>CC AV</sub>	R <sub>T</sub> = 47kΩ, duty cycle = 50%		6.5	9.8	mA

■ Characteristic curves (Ta = 25°C)

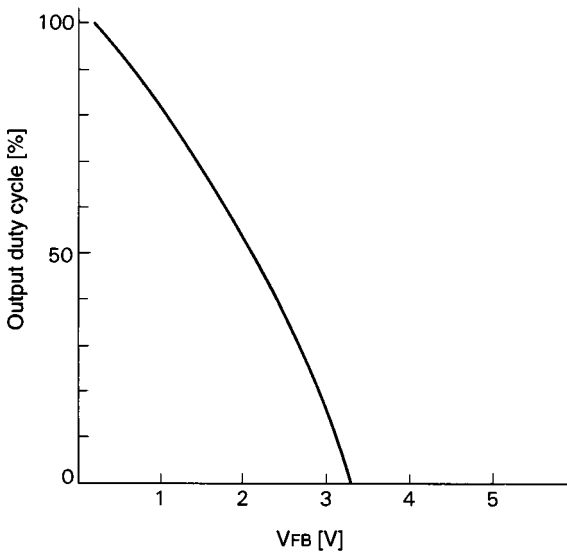
Oscillation frequency (fosc) vs. timing resistor resistance (RT)



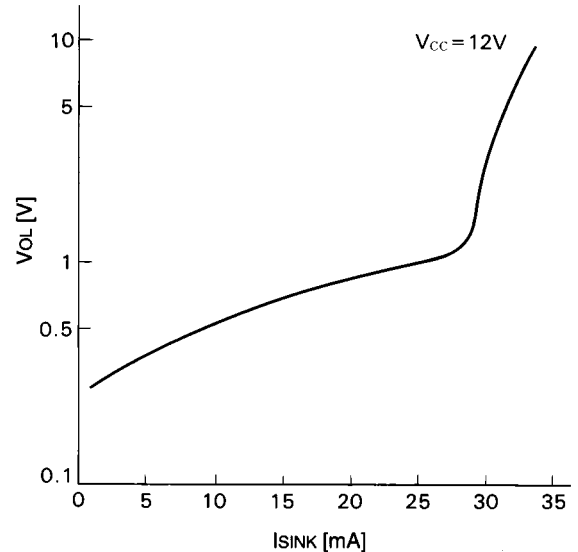
Output duty cycle vs. DT terminal voltage (VDT)



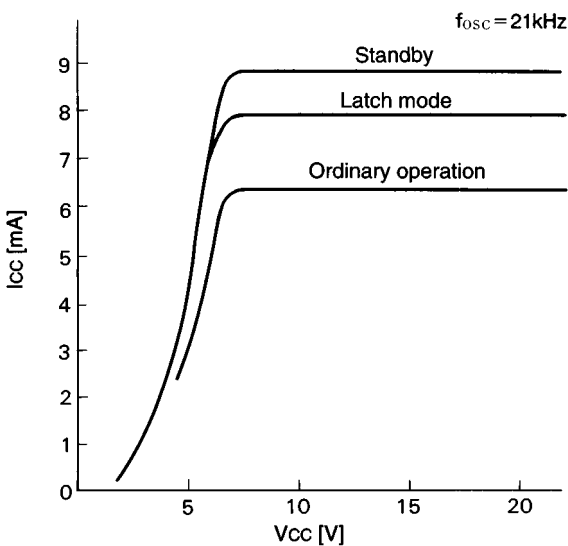
Output duty cycle vs. FB terminal voltage (VFB)



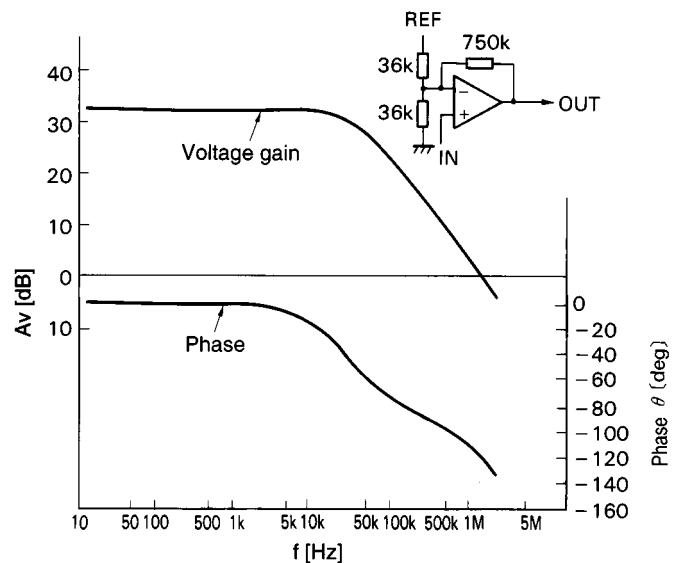
L-level output voltage vs. output sink current (ISINK)



Supply current (Icc) vs. supply voltage (Vcc)

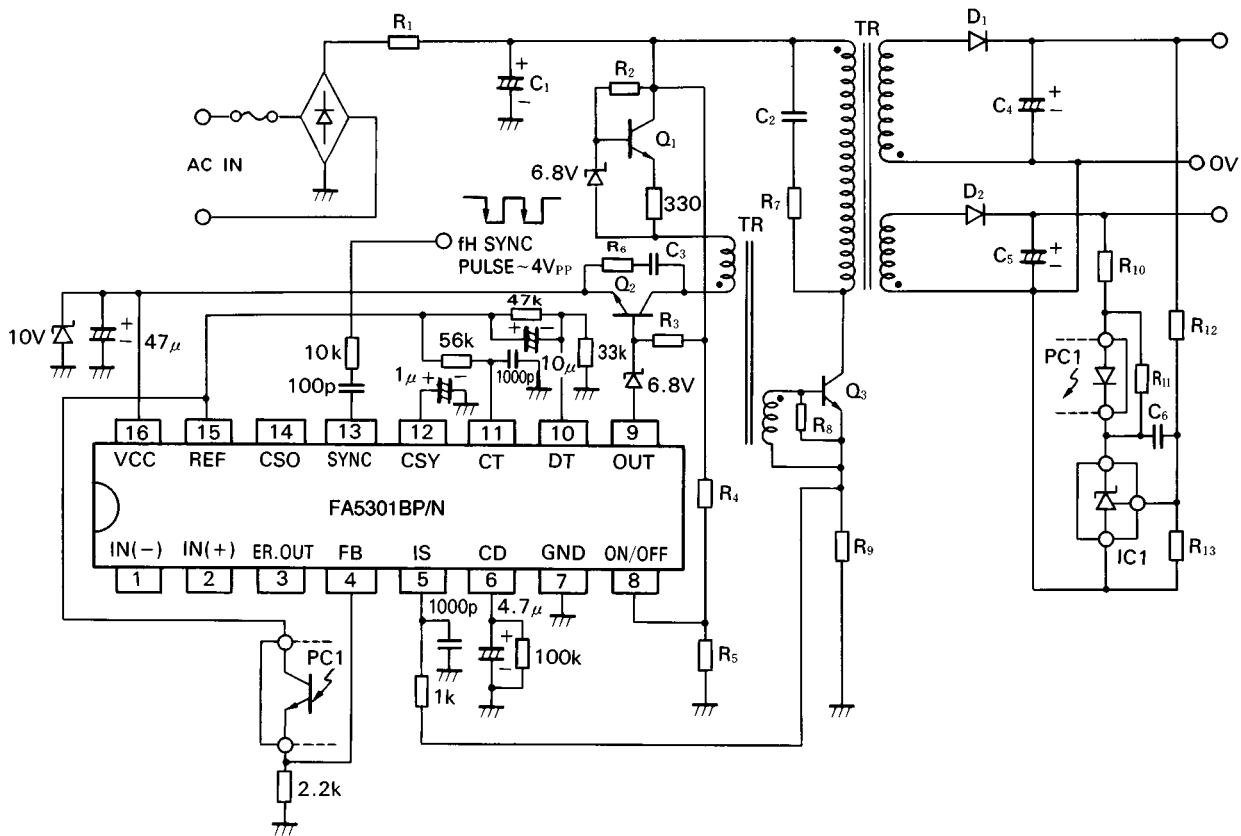


Error amplifier frequency (f) vs. voltage gain (Av) / phase (θ)



■ Application circuit

● Switching power supply (primary current control and insulated output type)



This circuit uses the following functions.

- Horizontal synchronizing function
- Overcurrent limiting function
- Overcurrent cutoff function
- Undervoltage input cutoff function
- Soft-start function

*Parts tolerances characteristics are not defined in the circuit design sample shown above. When designing an actual circuit for a product, you must determine parts tolerances and characteristics for safe and economical operation.*