

## ■ Description

The FA7610CP(N), 7612CP(N) and 7617CP(N) are bipolar ICs containing basic circuits necessary for PWM-type switching power supply control.

To minimize the number of external discrete components, the FA7610CP(N) is provided for a flyback or step-up power-supply circuit, the FA7612CP(N) for a step-down power-supply circuit and FA7617CP(N) for a flyback power supply circuit.

## ■ Features

### FA7610CP(N)

- For flyback transformer-type or step-up power-supply circuit (maximum output duty = 64% typical)
- Totem-pole predriver
- PWM-type switching power supply control
- Low-voltage operation ( $V_{CC} = 3.6$  to  $22V$ )
- Latch-mode short-circuit protection function (no malfunction by noise)
- Soft-start function
- Undervoltage lockout function
- One capacitor shared for short circuit protection and for soft-start to minimize the number of external discrete components

### FA7612CP(N)

- For step-down power-supply circuit (maximum output duty = up to 100%)
- Open collector output
- PWM-type switching power supply control
- Low-voltage operation ( $V_{CC} = 3.6$  to  $22V$ )
- Latch-mode short-circuit protection function (no malfunction by noise)
- Soft-start function
- Undervoltage lockout function
- One capacitor shared for short circuit protection and for soft-start to minimize the number of external discrete components

### FA7617CP(N)

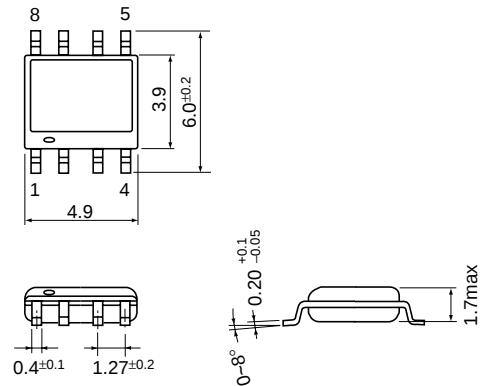
- For flyback transformer-type power-supply circuit (maximum output duty = 67% typical)
- Open collector output
- PWM-type switching power supply control
- Low-voltage operation ( $V_{CC} = 3.6$  to  $22V$ )
- Latch-mode short-circuit protection function (no malfunction by noise)
- Soft-start function
- Undervoltage lockout function
- One capacitor shared for short circuit protection and for soft-start to minimize the number of external discrete components

## ■ Applications

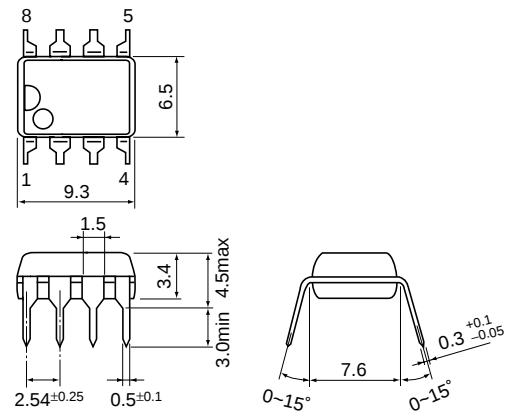
- Battery power supply for portable equipment

## ■ Dimensions, mm

### ● SOP-8

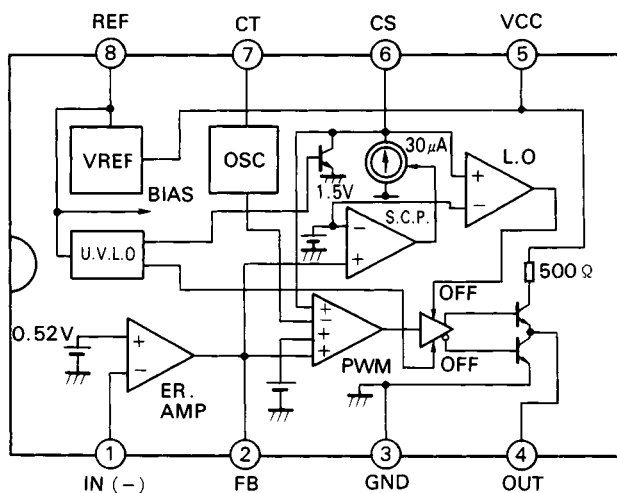


### ● DIP-8



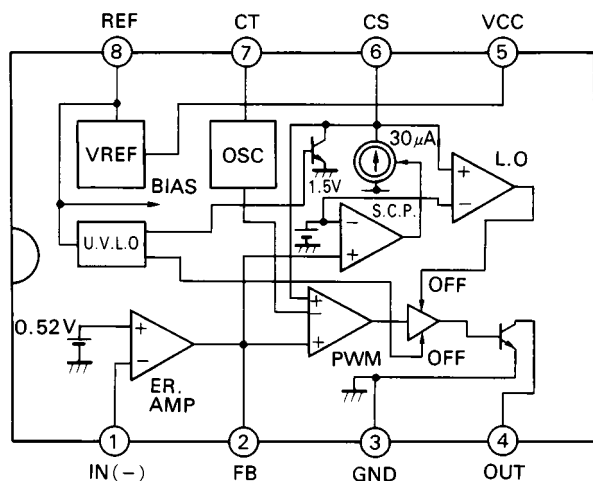
## ■ Block diagram

### ● FA7610CP(N)



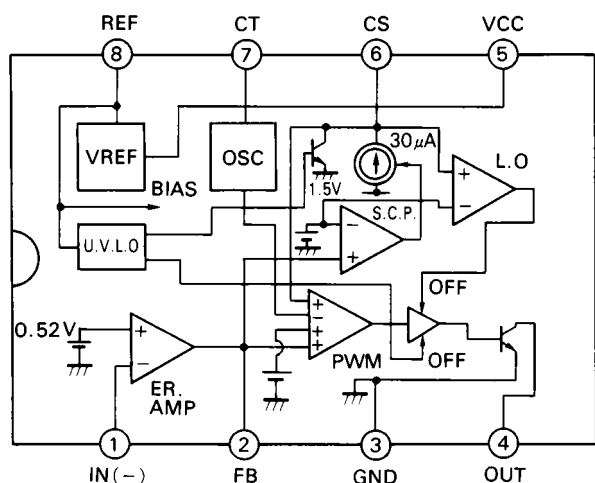
| Pin No. | Pin symbol | Description                                                  |
|---------|------------|--------------------------------------------------------------|
| 1       | IN (-)     | Inverting input to error amplifier                           |
| 2       | FB         | Error amplifier output                                       |
| 3       | GND        | Ground                                                       |
| 4       | OUT        | Output                                                       |
| 5       | VCC        | Power supply                                                 |
| 6       | CS         | Capacitor for soft-start, short-circuit protection and delay |
| 7       | CT         | Oscillator timing capacitor                                  |
| 8       | REF        | Reference voltage output (2.5V)                              |

### ● FA7612CP(N)



| Pin No. | Pin symbol | Description                                                  |
|---------|------------|--------------------------------------------------------------|
| 1       | IN (-)     | Inverting input to error amplifier                           |
| 2       | FB         | Error amplifier output                                       |
| 3       | GND        | Ground                                                       |
| 4       | OUT        | Output                                                       |
| 5       | VCC        | Power supply                                                 |
| 6       | CS         | Capacitor for soft-start, short-circuit protection and delay |
| 7       | CT         | Oscillator timing capacitor                                  |
| 8       | REF        | Reference voltage output (2.5V)                              |

### ● FA7617CP(N)



| Pin No. | Pin symbol | Description                                                  |
|---------|------------|--------------------------------------------------------------|
| 1       | IN (-)     | Inverting input to error amplifier                           |
| 2       | FB         | Error amplifier output                                       |
| 3       | GND        | Ground                                                       |
| 4       | OUT        | Output                                                       |
| 5       | VCC        | Power supply                                                 |
| 6       | CS         | Capacitor for soft-start, short-circuit protection and delay |
| 7       | CT         | Oscillator timing capacitor                                  |
| 8       | REF        | Reference voltage output (2.5V)                              |

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

| Item                             | Symbol           | Rating      |             | Unit |
|----------------------------------|------------------|-------------|-------------|------|
|                                  |                  | FA7610C     | FA7612C/17C |      |
| Supply voltage                   | V <sub>CC</sub>  | 22          | 22          | V    |
| Reference voltage output current | I <sub>OR</sub>  | 5           | 5           | mA   |
| Output current                   | I <sub>O</sub>   | ±50         | 80          | mA   |
| Total power dissipation          | P <sub>d</sub>   | 400         | 400         | mW   |
| Operating temperature            | T <sub>opr</sub> | −20 to +85  | −20 to +85  | °C   |
| Storage temperature              | T <sub>stg</sub> | −40 to +150 | −40 to +150 | °C   |

### ■ Recommended operating conditions

| Item                         | Symbol           | FA7610C |        | FA7612/17C |        | Unit |
|------------------------------|------------------|---------|--------|------------|--------|------|
|                              |                  | Min.    | Max.   | Min.       | Max.   |      |
| Supply voltage               | V <sub>CC</sub>  | 3.6     | 20     | 3.6        | 20     | V    |
| Feedback resistance          | R <sub>NF</sub>  | 100     |        | 100        |        | kΩ   |
| Oscillator timing capacitor  | C <sub>T</sub>   | 220     | 22,000 | 220        | 22,000 | pF   |
| Oscillator timing resistance | R <sub>T</sub>   | 10      | 100    | 10         | 100    | kΩ   |
| Oscillation frequency        | f <sub>osc</sub> | 5       | 200    | 5          | 500    | kHz  |

### ■ Electrical characteristics (Ta = 25°C, V<sub>CC</sub> = 6V, R<sub>T</sub> = 33kΩ, C<sub>T</sub> = 1000pF)

#### Reference voltage section Common to FA7610C/12C/17C

| Item                                               | Symbol           | Test condition                                      | Min.  | Typ.  | Max.  | Unit |
|----------------------------------------------------|------------------|-----------------------------------------------------|-------|-------|-------|------|
| Output voltage                                     | V <sub>REF</sub> | I <sub>OR</sub> = 1mA                               | 2.528 | 2.580 | 2.632 | V    |
| Line regulation                                    | LINE             | V <sub>CC</sub> = 3.6 to 20V, I <sub>OR</sub> = 1mA |       | 4     | 12    | mV   |
| Load regulation                                    | LOAD             | I <sub>OR</sub> = 0.1 to 1mA                        |       | 1     | 6     | mV   |
| Output voltage variation due to temperature change | V <sub>TC1</sub> | Ta = −20 to +25°C                                   | −1    |       | 1     | %    |
|                                                    | V <sub>TC2</sub> | Ta = +25 to +85°C                                   | −1    |       | 1     | %    |

#### Oscillator section Common to FA7610C/12C/17C

| Item                                                 | Symbol           | Test condition                                 | Min. | Typ. | Max. | Unit |
|------------------------------------------------------|------------------|------------------------------------------------|------|------|------|------|
| Oscillation frequency                                | f <sub>osc</sub> | C <sub>T</sub> = 1000pF, R <sub>T</sub> = 33kΩ | 100  | 111  | 122  | kHz  |
| Frequency variation 1 (due to supply voltage change) | f <sub>dV</sub>  | V <sub>CC</sub> = 3.6 to 20V                   |      | 1    |      | %    |
| Frequency variation 2 (due to temperature change)    | f <sub>dT</sub>  | Ta = −20 to +85°C                              |      | 5    |      | %    |

#### Error amplifier section Common to FA7610C/12C/17C

| Item                           | Symbol           | Test condition          | Min.                  | Typ.  | Max.  | Unit |
|--------------------------------|------------------|-------------------------|-----------------------|-------|-------|------|
| Reference voltage              | V <sub>B</sub>   |                         | 0.515                 | 0.525 | 0.535 | V    |
| Input bias current             | I <sub>B</sub>   |                         |                       | 5     | 100   | nA   |
| Open-loop voltage gain         | A <sub>v</sub>   |                         | 70                    |       |       | dB   |
| Unity-gain bandwidth           | G <sub>B</sub>   |                         |                       | 0.6   |       | MHz  |
| Maximum output voltage (Pin 2) | V <sub>OM+</sub> | R <sub>NF</sub> = 100kΩ | V <sub>REF</sub> −0.2 |       |       | V    |
|                                | V <sub>OM−</sub> | R <sub>NF</sub> = 100kΩ |                       |       | 200   | mV   |
| Output source current (Pin 2)  | I <sub>OM+</sub> | V <sub>OM</sub> = 1V    | 40                    | 85    | 200   | μA   |

#### PWM comparator section

| Item                            | Symbol            | Test condition   | FA7610C |      |      | FA7612C |      |      | FA7617C |      |      | Unit |
|---------------------------------|-------------------|------------------|---------|------|------|---------|------|------|---------|------|------|------|
|                                 |                   |                  | Min.    | Typ. | Max. | Min.    | Typ. | Max. | Min.    | Typ. | Max. |      |
| Input threshold voltage (pin 2) | V <sub>TH0</sub>  | Duty cycle = 0%  |         | 0.85 | 0.95 |         | 0.85 | 0.95 |         | 0.85 | 0.95 | V    |
| Input threshold voltage (pin 2) | V <sub>TH50</sub> | Duty cycle = 50% |         | 1.1  |      |         | 1.1  |      |         | 1.1  |      | V    |
| Maximum duty cycle              | α <sub>M</sub>    | (Pin 2 = 1.2V)   | 58      | 64   | 75   |         | 100  |      | 63      | 67   | 71   | %    |

**Soft-start circuit section** Common to FA7610C/12C/17C

| Item                            | Symbol               | Test condition   | Min. | Typ. | Max. | Unit |
|---------------------------------|----------------------|------------------|------|------|------|------|
| Input bias current (Pin 6)      | I <sub>BCS</sub>     |                  |      | 80   | 300  | nA   |
| Input threshold voltage (Pin 6) | V <sub>TH CS0</sub>  | Duty cycle = 0%  |      | 0.22 | 0.32 | V    |
| Input threshold voltage (Pin 6) | V <sub>TH CS50</sub> | Duty cycle = 50% |      | 0.46 |      | V    |

**Short-circuit protection circuit section** Common to FA7610C/12C/17C

| Item                                 | Symbol             | Test condition         | Min. | Typ. | Max. | Unit |
|--------------------------------------|--------------------|------------------------|------|------|------|------|
| Input threshold voltage (Pin 2)      | V <sub>TH PC</sub> |                        | 1.20 | 1.50 | 1.80 | V    |
| Charge current (Pin 6)               | I <sub>CHG</sub>   | Pin 6 = 0V, Pin 2 = 2V | 20   | 30   | 40   | μA   |
| Latch-mode threshold voltage (Pin 6) | V <sub>TH LA</sub> |                        | 1.20 | 1.50 | 1.80 | V    |

**Undervoltage lockout circuit section** Common to FA7610C/12C/17C

| Item                        | Symbol              | Test condition | Min. | Typ. | Max. | Unit |
|-----------------------------|---------------------|----------------|------|------|------|------|
| OFF-to-ON threshold voltage | V <sub>TH ON</sub>  |                |      | 2.70 |      | V    |
| ON-to-OFF threshold voltage | V <sub>TH OFF</sub> |                |      | 2.52 |      | V    |
| Voltage hysteresis          | V <sub>HYS</sub>    |                | 60   | 180  |      | mV   |

**Output section**

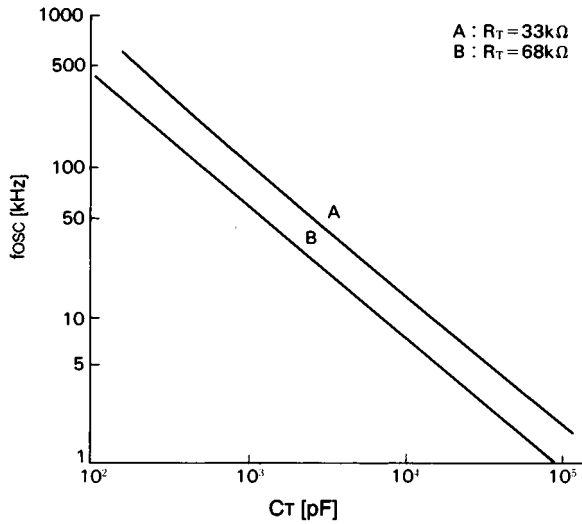
| Item                           | Symbol              | Test condition             | FA7610C |      |      | FA7612C/17C |      |      | Unit |
|--------------------------------|---------------------|----------------------------|---------|------|------|-------------|------|------|------|
|                                |                     |                            | Min.    | Typ. | Max. | Min.        | Typ. | Max. |      |
| H-level output voltage (Pin 4) | V <sub>OH</sub>     | R <sub>L</sub> = 10kΩ      | 3.5     | 4.0  |      | —           | —    | —    | V    |
| L-level output voltage (Pin 4) | V <sub>OL</sub>     | Output sink current = 20mA |         | 0.25 | 0.65 |             | 0.9  | 1.5  | V    |
| Output source current (Pin 4)  | I <sub>SOURCE</sub> | Pin 4 = 0V                 | 8       | 11   | 14   | —           | —    | —    | mA   |

**Overall device**

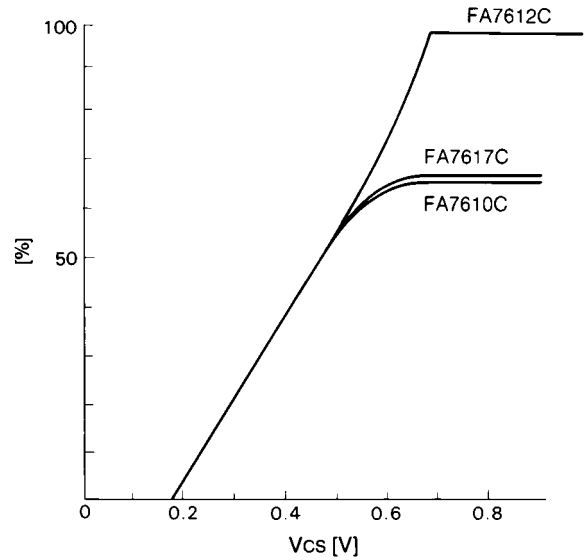
| Item                           | Symbol             | Test condition                         | FA7610C |      |      | FA7612C/17C |      |      | Unit |
|--------------------------------|--------------------|----------------------------------------|---------|------|------|-------------|------|------|------|
|                                |                    |                                        | Min.    | Typ. | Max. | Min.        | Typ. | Max. |      |
| Supply current                 | I <sub>CC LA</sub> | Latch mode                             |         | 1.6  | 2.2  |             | 1.5  | 2.2  | mA   |
| Operating-state supply current | I <sub>CC AV</sub> | R <sub>L</sub> = ∞<br>Duty cycle = 50% |         | 2.6  | 3.8  |             | 1.8  | 3.0  | mA   |

### ■ Characteristic curves ( $T_a = 25^\circ\text{C}$ )

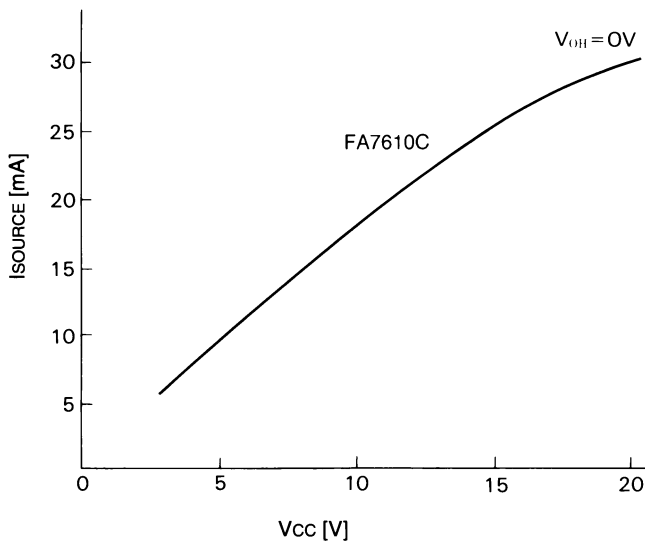
Oscillation frequency( $f_{osc}$ ) vs.  
timing capacitor capacitance( $C_T$ )



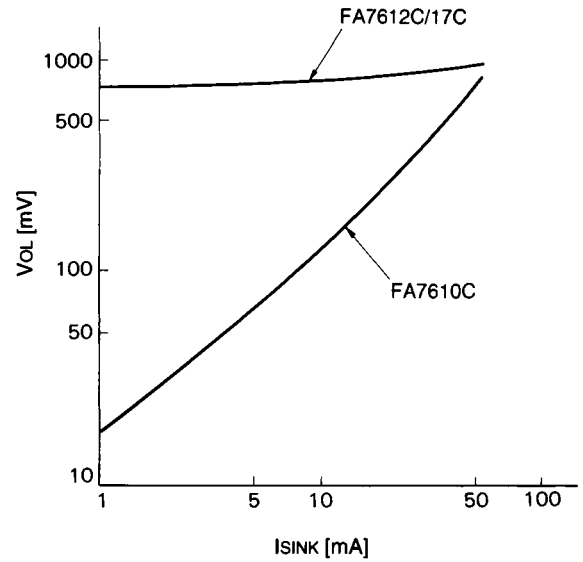
Output duty cycle vs. CS terminal voltage( $V_{CS}$ )



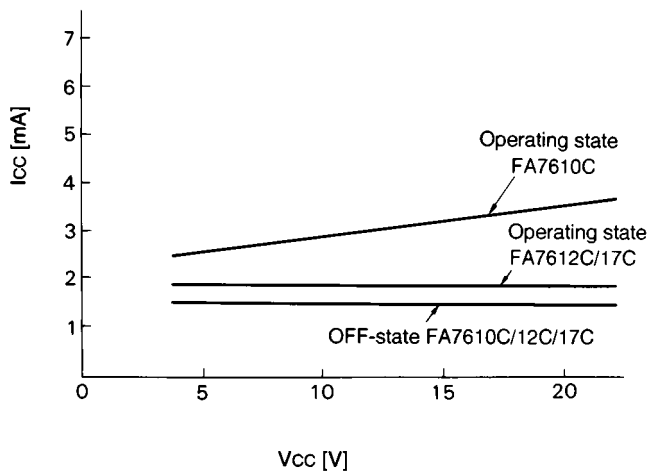
Output source current ( $I_{SOURCE}$ ) vs.  
supply voltage( $V_{CC}$ )



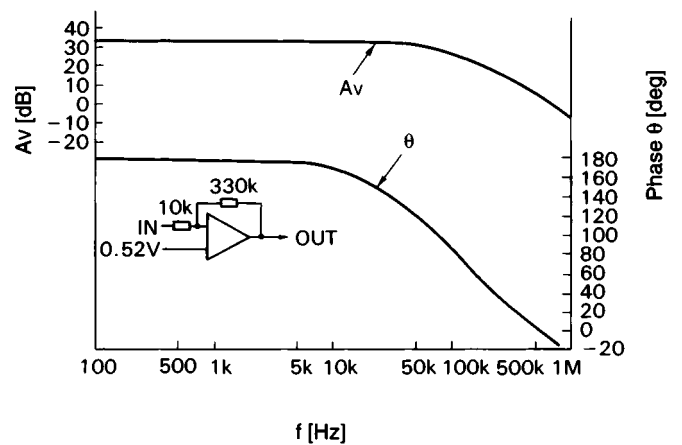
L-level output voltage( $V_{OL}$ ) vs. output sink current  
( $I_{SINK}$ )



Supply current( $I_{CC}$ ) vs. supply voltage( $V_{CC}$ )



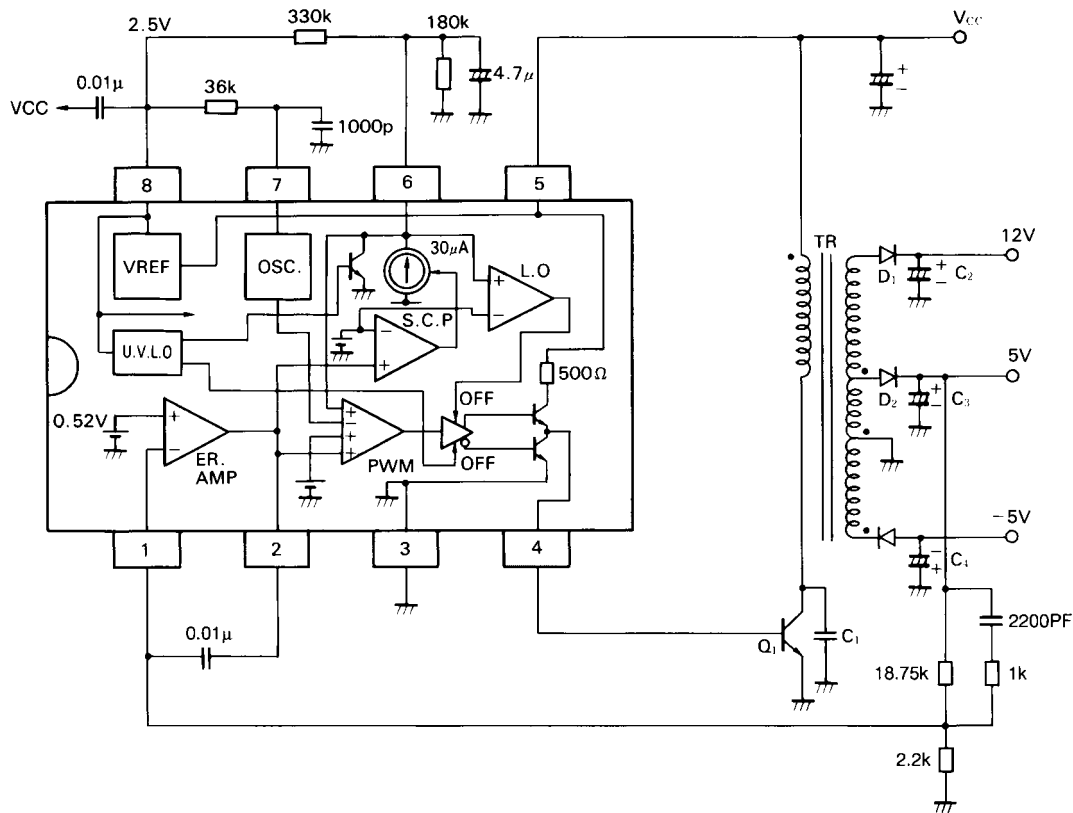
Error amplifier frequency( $f$ ) vs. voltage gain( $A_V$ ) / phase ( $\theta$ )



■ Application circuit

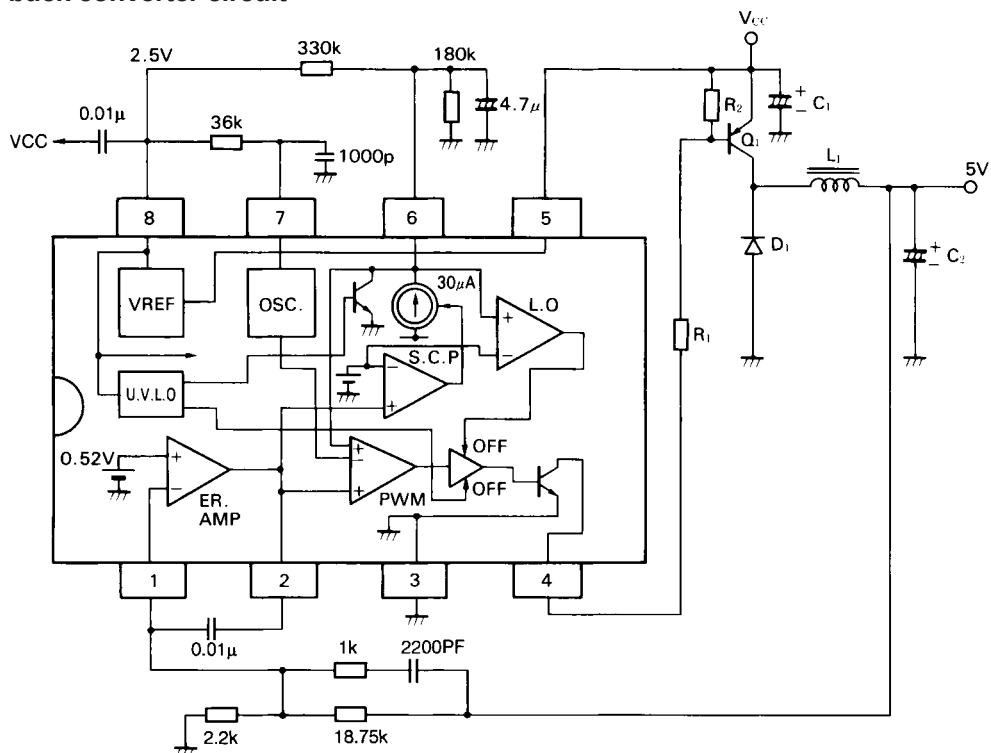
● FA7610CP(N)

Flyback-transformer type converter circuit



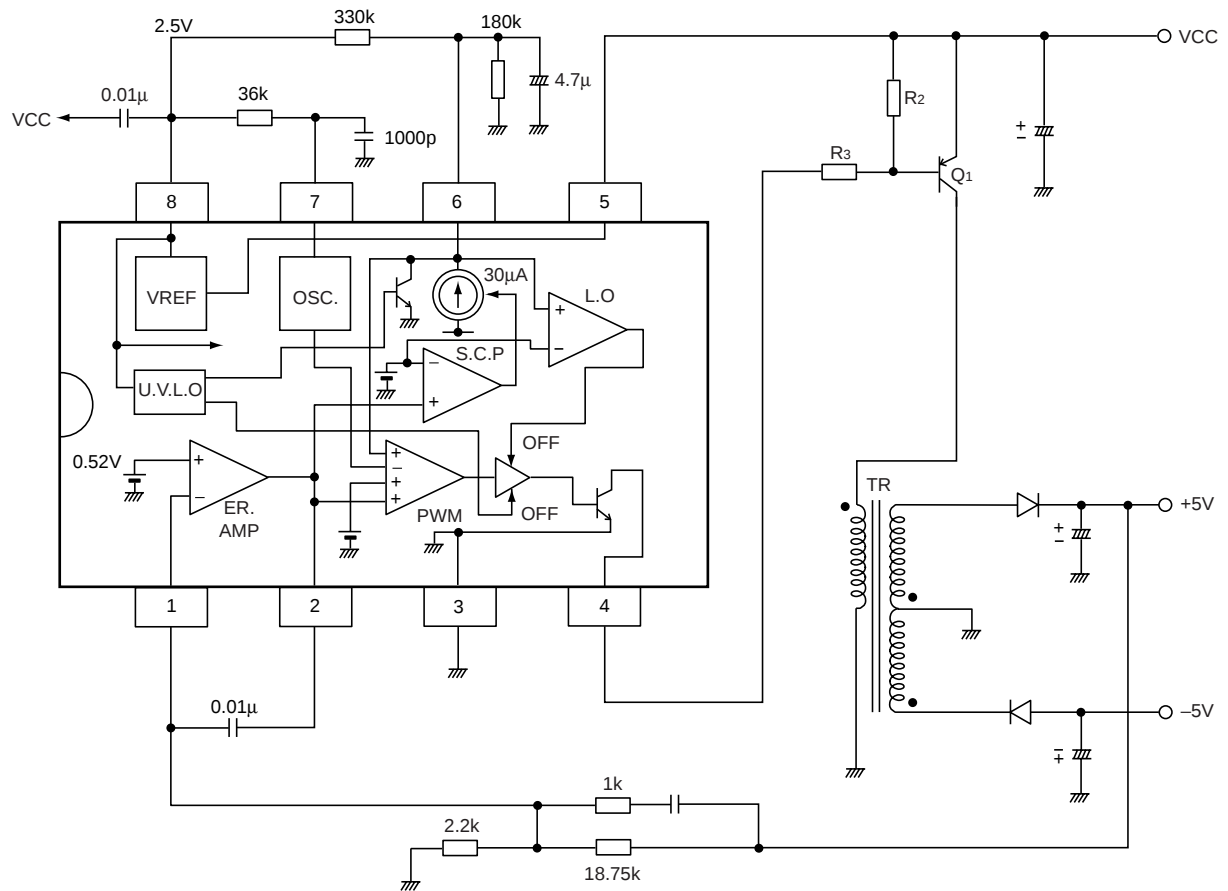
● FA7612CP(N)

Chopper type buck converter circuit



● FA7617CP(N)

Flyback-transformer type converter circuit



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.

Please connect a capacitor, which the value is about  $0.01\mu\text{F}$  to  $0.1\mu\text{F}$ , between VCC and REF terminals in order to prevent from irregular output pulse at start up.