

## ■ Description

FA3675F is a control IC for 6-channel DC-DC converter. This IC can directly drive a Nch/Pch-MOSFET. This IC is suitable to reduce converter size because it has many functions in a small package LQFP-48.

## ■ Features

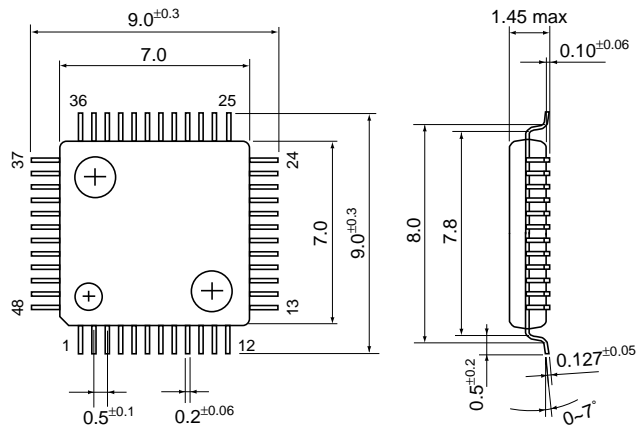
- 6-channel PWM control with MOSFET direct driving :  
5-channel for Pch-MOSFET, 1 channel for Nch-MOSFET
- Low input voltage: 2.5V to 20V
- $\pm 1.0\%$  high accuracy bandgap reference
- Low power consumption by means of CDMOS  
Standby mode: 20 $\mu$ A(max.)  
Operating mode: 10mA(max.)
- Soft start function for each channel
- ON/OFF function for each channel
- Timer latch for short protection
- Undervoltage lockout
- Wide range of operation frequency: 50kHz to 1MHz
- Package: LQFP-48(Thin and small)

## ■ Application

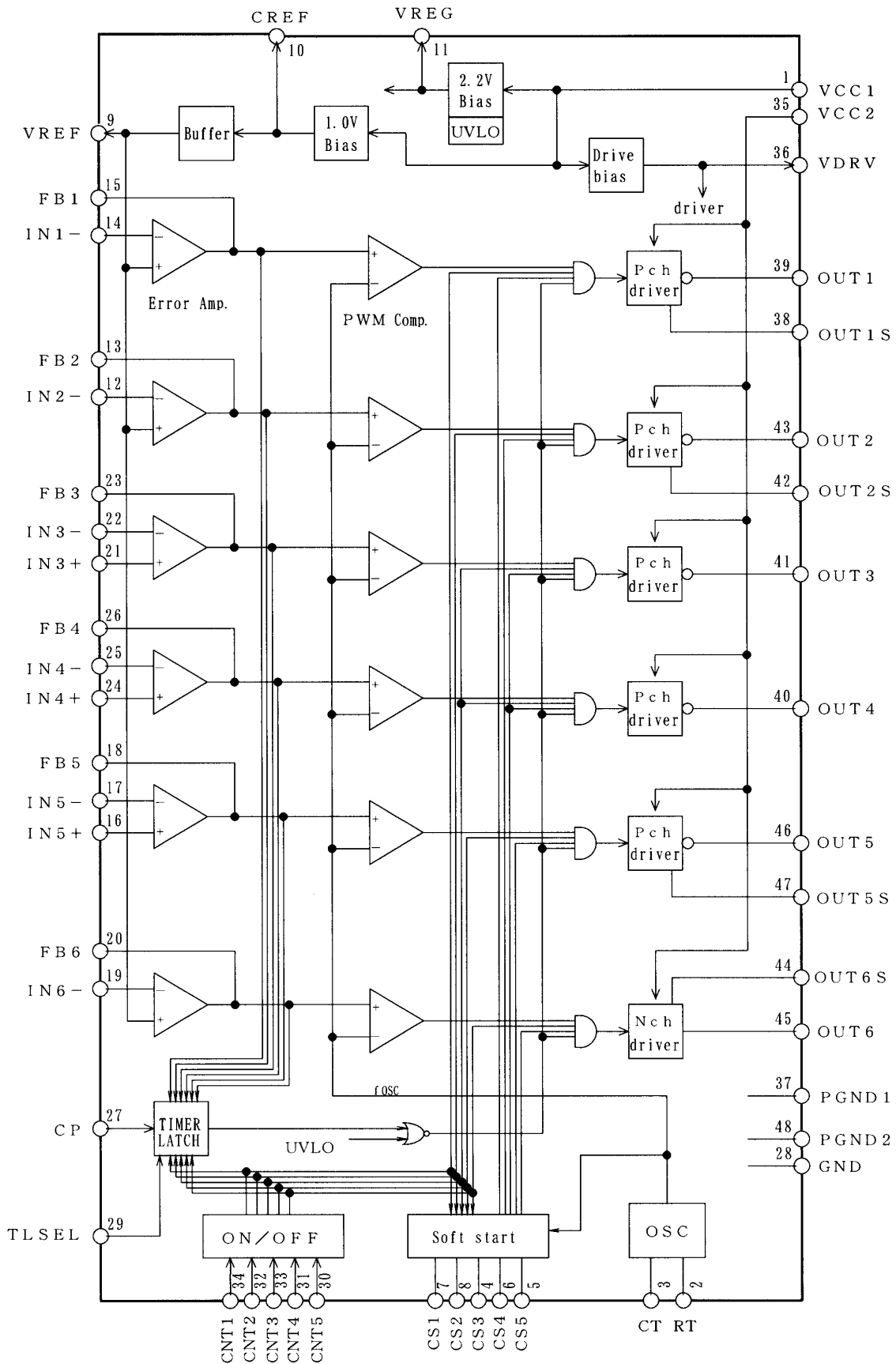
- VTR-camera, digital-steel-camera and portable equipment

## ■ Dimensions, mm

### ● LQFP-48



■ Block diagram



| Pin No. | Pin symbol | Description                                  |
|---------|------------|--|
| 1       | VCC1       | Power supply for control circuit             |
| 2       | RT         | Oscillator timing resistor                   |
| 3       | CT         | Oscillator timing capacitor                  |
| 4       | CS3        | Soft start for Ch. 3 & Ch. 4                 |
| 5       | CS5        | Soft start for Ch. 6                         |
| 6       | CS4        | Soft start for Ch. 5                         |
| 7       | CS1        | Soft start for Ch. 1                         |
| 8       | CS2        | Soft start for Ch. 2                         |
| 9       | VREF       | Reference voltage output                     |
| 10      | CREF       | Capacitor for reference voltage output       |
| 11      | VREG       | Regulated voltage output                     |
| 12      | IN2-       | Ch. 2 inverting input to error amplifier     |
| 13      | FB2        | Ch. 2 output of error amplifier              |
| 14      | IN1-       | Ch. 1 inverting input to error amplifier     |
| 15      | FB1        | Ch. 1 output of error amplifier              |
| 16      | IN5+       | Ch. 5 non-inverting input to error amplifier |
| 17      | IN5-       | Ch. 5 inverting input to error amplifier     |
| 18      | FB5        | Ch. 5 output of error amplifier              |
| 19      | IN6-       | Ch. 6 inverting input to error amplifier     |
| 20      | FB6        | Ch. 6 output of error amplifier              |
| 21      | IN3+       | Ch. 3 non-inverting input to error amplifier |
| 22      | IN3-       | Ch. 3 inverting input to error amplifier     |
| 23      | FB3        | Ch. 3 output of error amplifier              |
| 24      | IN4+       | Ch. 4 non-inverting input to error amplifier |

| Pin No. | Pin symbol | Description  |
|---------|------------|--|
| 25      | IN4-       | Ch. 4 inverting input to error amplifier           |
| 26      | FB4        | Ch. 4 output of error amplifier                    |
| 27      | CP         | Timing capacitor for timer latch delay             |
| 28      | GND        | Ground   |
| 29      | TLSEL      | Ch. 3 & Ch. 4 timer latch selection (Low: disable) |
| 30      | CNT5       | Ch. 6 ON/OFF function                              |
| 31      | CNT4       | Ch. 5 ON/OFF function                              |
| 32      | CNT2       | Ch. 2 ON/OFF function                              |
| 33      | CNT3       | Ch. 3 & Ch. 4 ON/OFF function                      |
| 34      | CNT1       | Ch. 1 ON/OFF function                              |
| 35      | VCC2       | Power supply for output stage                      |
| 36      | VDRV       | Bias for logic circuit of outputs                  |
| 37      | PGND1      | Power ground                                       |
| 38      | OUT1S      | Ch. 1 source electrode of output stage             |
| 39      | OUT1       | Ch. 1 output (for Pch-MOSFET)                      |
| 40      | OUT4       | Ch. 4 output (for Pch-MOSFET)                      |
| 41      | OUT3       | Ch. 3 output (for Pch-MOSFET)                      |
| 42      | OUT2S      | Ch. 2 source electrode of output stage             |
| 43      | OUT2       | Ch. 2 output (for Pch-MOSFET)                      |
| 44      | OUT6S      | Ch. 6 source electrode of output stage             |
| 45      | OUT6       | Ch. 6 output (for Nch-MOSFET)                      |
| 46      | OUT5       | Ch. 5 output (for Pch-MOSFET)                      |
| 47      | OUT5S      | Ch. 5 source electrode of output stage             |
| 48      | PGND2      | Power ground                                       |

### ■ Absolute maximum ratings

| Item                           | Symbol           | Rating   | Unit |
|--------------------------------|------------------|--|------|
| Power supply voltage           | V <sub>CC</sub>  | 20.0   | V    |
| Source peak current            | I <sub>OUT</sub> | -200   | mA   |
| Sink peak current              | I <sub>OUT</sub> | 200  | mA   |
| Input voltage for analog input | V <sub>ANA</sub> | -0.3 to +2.5   | V    |
| Input voltage for logic input  | V <sub>LOG</sub> | -0.3 to V <sub>CC</sub> +0.5 (V <sub>CC</sub> ≤ 5.0V)<br>-0.3 to +5.5 (V <sub>CC</sub> > 5.0V) | V    |
| Total power dissipation *      | P <sub>d</sub>   | 550  | mW   |
| Junction temperature           | T <sub>J</sub>   | 125  | °C   |
| Ambient temperature            | T <sub>OP</sub>  | -20 to +85   | °C   |
| Storage temperature            | T <sub>stg</sub> | -40 to +150  | °C   |

\* T<sub>a</sub> < 25°C

### ■ Recommended operating conditions

| Item                            | Symbol           | Min. | Max.                  | Unit |
|---------------------------------|------------------|------|-----------------------|------|
| Power supply voltage            | V <sub>CC</sub>  | 2.5  | 18.0                  | V    |
| Input voltage for logic input   | V <sub>LOG</sub> | 0.0  | V <sub>CC</sub> +0.25 | V    |
|                                 |                  | 0.0  | 5.25                  |      |
| Oscillation frequency           | f <sub>OSC</sub> | 50   | 1000                  | kHz  |
| Oscillator timing resistor      | R <sub>T</sub>   | 6.8  | 100                   | kΩ   |
| Oscillator timing capacitor     | C <sub>T</sub>   | 22   | 1000                  | pF   |
| CREF terminal by-pass capacitor | C <sub>REF</sub> | 0.01 |                       | μF   |

**Electrical characteristics** ( $T_a=25^\circ\text{C}$ ,  $V_{CC1}=V_{CC2}=6\text{V}$ ,  $C_T=100\text{pF}$ ,  $R_T=10\text{k}\Omega$ )

**Reference voltage section**

| Item   | Symbol      | Test condition                    | Min. | Typ.      | Max.      | Unit |
|--|-------------|-----------------------------------|------|-----------|-----------|------|
| Output voltage                                     | $V_{REF}$   | No load                           | 0.99 | 1.00      | 1.01      | V    |
| Load regulation                                    | $V_{RFLOD}$ | No load to $R_L=15\text{k}\Omega$ |      | 7         | 15        | mV   |
| Line regulation                                    | $V_{RFLIN}$ | $V_{CC}=2.5$ to 18V               |      | 3         | 10        | mV   |
| Output voltage variation due to temperature change | $V_{RTa}$   | $T_a=-20$ to $+85^\circ\text{C}$  |      | $\pm 0.5$ | $\pm 1.0$ | %    |

**Regulated voltage section**

| Item   | Symbol      | Test condition                     | Min.  | Typ.      | Max.      | Unit |
|--|-------------|------------------------------------|-------|-----------|-----------|------|
| Output voltage                                     | $V_{REG}$   | No load                            | 2.134 | 2.20      | 2.266     | V    |
| Load regulation                                    | $V_{RGLOD}$ | No load to $R_L=3.9\text{k}\Omega$ |       | 2         | 10        | mV   |
| Line regulation                                    | $V_{RGLIN}$ | $V_{CC}=2.5$ to 18V                |       | 6         | 20        | mV   |
| Output voltage variation due to temperature change | $V_{RGTa}$  | $T_a=-20$ to $+85^\circ\text{C}$   |       | $\pm 0.5$ | $\pm 1.0$ | %    |

**Oscillator section**

| Item   | Symbol         | Test condition   | Min. | Typ.               | Max.                | Unit |
|--|----------------|--|------|--------------------|---------------------|------|
| Oscillation frequency                            | $f_{OSC}$      | $R_T=10\text{k}\Omega$ , $C_T=100\text{pF}$                          | 432  | 480                | 528                 | kHz  |
| Frequency variation due to supply voltage change | $f_{\Delta V}$ | $V_{CC}=2.5$ to 18V  |      | $\pm 1$            | $\pm 3$             | %    |
| Frequency variation due to temperature change    | $f_{\Delta T}$ | $T_a=-20$ to $+25^\circ\text{C}$<br>$T_a=+25$ to $+85^\circ\text{C}$ |      | $\pm 3$<br>$\pm 7$ | $\pm 6$<br>$\pm 14$ | %    |

**Error amplifier section**

| Item                            | Symbol     | Test condition                | Min. | Typ.  | Max.  | Unit |
|---------------------------------|------------|-------------------------------|------|-------|-------|------|
| Input offset voltage            | $V_{IOF}$  |                               |      | 2     | 10    | mV   |
| Input common mode voltage range | $V_{ICOM}$ |                               | 0.2  |       | 1.5   | V    |
| Open-loop gain                  | $A_{VOL}$  |                               | 70   | 75    |       | dB   |
| Unity-gain bandwidth            | $f_T$      |                               |      | 1.0   |       | MHz  |
| Output sink current             | $I_{FBL}$  | $V_{FB}=V_{REF}+0.05\text{V}$ | 2.5  | 3.5   |       | mA   |
| Output source current           | $I_{FBH}$  | $V_{FB}=V_{REF}-0.05\text{V}$ |      | -0.18 | -0.14 | mA   |

**Soft-start circuit section 1 (CS1, CS2, CS3)**

| Item                    | Symbol      | Test condition     | Min. | Typ. | Max. | Unit          |
|-------------------------|-------------|--------------------|------|------|------|---------------|
| Input threshold voltage | $V_{CS0}$   | Duty cycle=0%      | 0.36 | 0.46 | 0.56 | V             |
|                         | $V_{CS100}$ | Duty cycle=100%    | 1.11 | 1.31 | 1.51 | V             |
| Charge current          | $I_{CS}$    | $V_{CS}=0\text{V}$ | -7.5 | -5.0 | -2.5 | $\mu\text{A}$ |

**Soft-start circuit section 2 (CS4, CS5)**

| Item                    | Symbol      | Test condition  | Min. | Typ. | Max. | Unit          |
|-------------------------|-------------|-----------------|------|------|------|---------------|
| Input threshold voltage | $V_{CS0}$   | Duty cycle=0%   | 0.36 | 0.46 | 0.56 | V             |
|                         | $V_{CS100}$ | Duty cycle=100% | 1.11 | 1.31 | 1.51 | V             |
| Charge current          | $I_{CS}$    |                 |      | 0    |      | $\mu\text{A}$ |

**Short-circuit protection section**

| Item  | Symbol             | Test condition | Min. | Typ. | Max. | Unit |
|---|--------------------|----------------|------|------|------|------|
| Threshold voltage at CP                     | V <sub>CP</sub> TH |                | 1.39 | 1.64 | 1.89 | V    |
| Charge current at CP                        | I <sub>CP</sub>    |                | -3.0 | -1.9 | -1.0 | μA   |
| Threshold voltage at error amplifier output | V <sub>FB</sub> TL |                | 1.36 | 1.56 | 1.76 | V    |

**ON/OFF logic input section**

| Item                       | Symbol          | Test condition         | Min. | Typ. | Max.                   | Unit |
|----------------------------|-----------------|------------------------|------|------|------------------------|------|
| Input voltage for ON mode  | V <sub>DH</sub> | V <sub>CC</sub> ≤ 5.0V | 1.0  |      | V <sub>CC</sub> + 0.25 | V    |
|                            |                 | V <sub>CC</sub> > 5.0V | 1.0  |      | 5.25                   |      |
| Input voltage for OFF mode | V <sub>DL</sub> |                        | 0    |      | 0.4                    | V    |

**Undervoltage lockout circuit section**

| Item                        | Symbol              | Test condition | Min. | Typ. | Max. | Unit |
|-----------------------------|---------------------|----------------|------|------|------|------|
| OFF to ON threshold voltage | V <sub>UV</sub> VCC |                | 1.52 | 1.72 | 1.92 | V    |
| Voltage hysteresis          | ΔV <sub>UV</sub> C  |                |      | 0.1  |      | V    |

**Output section 1 (OUT1)**

| Item                  | Symbol           | Test condition                        | Min. | Typ. | Max. | Unit |
|-----------------------|------------------|---------------------------------------|------|------|------|------|
| L-level ON resistance | R <sub>ONL</sub> | I <sub>O</sub> = 10mA, OUT1S:GND      |      | 6    | 10   | Ω    |
| H-level ON resistance | R <sub>ONH</sub> | I <sub>O</sub> = -10mA, OUT1S:GND     |      | 6    | 10   | Ω    |
| Rise time             | t <sub>r</sub>   | C <sub>LOAD</sub> = 1000pF, OUT1S:GND |      | 30   | 50   | ns   |
| Fall time             | t <sub>f</sub>   | C <sub>LOAD</sub> = 1000pF, OUT1S:GND |      | 60   | 85   | ns   |
| Sink current          | I <sub>OUT</sub> | OUT1S:R <sub>S1</sub> = 68Ω to GND    | 9    | 12   | 15   | mA   |

**Output section 2 (OUT2, OUT5)**

| Item                  | Symbol           | Test condition  | Min. | Typ. | Max. | Unit |
|-----------------------|------------------|---|------|------|------|------|
| L-level ON resistance | R <sub>ONL</sub> | I <sub>O</sub> = 10mA<br>OUT2S, OUT5S:GND                       |      | 10   | 15   | Ω    |
| H-level ON resistance | R <sub>ONH</sub> | I <sub>O</sub> = -10mA<br>OUT2S, OUT5S:GND                      |      | 10   | 15   | Ω    |
| Rise time             | t <sub>r</sub>   | C <sub>LOAD</sub> = 1000pF<br>OUT2S, OUT5S:GND                  |      | 40   | 60   | ns   |
| Fall time             | t <sub>f</sub>   | C <sub>LOAD</sub> = 1000pF<br>OUT2S, OUT5S:GND                  |      | 70   | 95   | ns   |
| Sink current          | I <sub>OUT</sub> | OUT2S, OUT5S:<br>R <sub>S2</sub> , R <sub>S5</sub> = 68Ω to GND | 8    | 11   | 14   | mA   |

**Output section 3 (OUT3, OUT4)**

| Item                  | Symbol           | Test condition             | Min. | Typ. | Max. | Unit |
|-----------------------|------------------|----------------------------|------|------|------|------|
| L-level ON resistance | R <sub>ONL</sub> | I <sub>O</sub> = 10mA      |      | 10   | 15   | Ω    |
| H-level ON resistance | R <sub>ONH</sub> | I <sub>O</sub> = -10mA     |      | 10   | 15   | Ω    |
| Rise time             | t <sub>r</sub>   | C <sub>LOAD</sub> = 1000pF |      | 40   | 60   | ns   |
| Fall time             | t <sub>f</sub>   | C <sub>LOAD</sub> = 1000pF |      | 70   | 95   | ns   |

**Output section 4 (OUT6)**

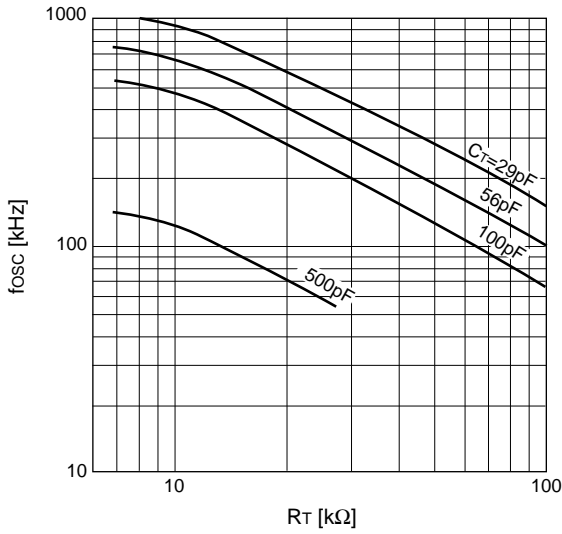
| Item                  | Symbol           | Test condition   | Min. | Typ. | Max. | Unit |
|-----------------------|------------------|--|------|------|------|------|
| L-level ON resistance | R <sub>ONL</sub> | I <sub>O</sub> = 10mA, OUT6S:VCC2                            |      | 10   | 15   | Ω    |
| H-level ON resistance | R <sub>ONH</sub> | I <sub>O</sub> = -10mA, OUT6S:VCC2                           |      | 10   | 15   | Ω    |
| Rise time             | t <sub>r</sub>   | C <sub>LOAD</sub> = 1000pF, OUT6S:VCC2                       |      | 40   | 60   | ns   |
| Fall time             | t <sub>f</sub>   | C <sub>LOAD</sub> = 1000pF, OUT6S:VCC2                       |      | 70   | 95   | ns   |
| Source current        | I <sub>OUT</sub> | OUT6S:R <sub>S6</sub> = 330Ω to VCC2<br>V <sub>CC</sub> = 7V | -14  | -11  | -8   | mA   |

**Overall device**

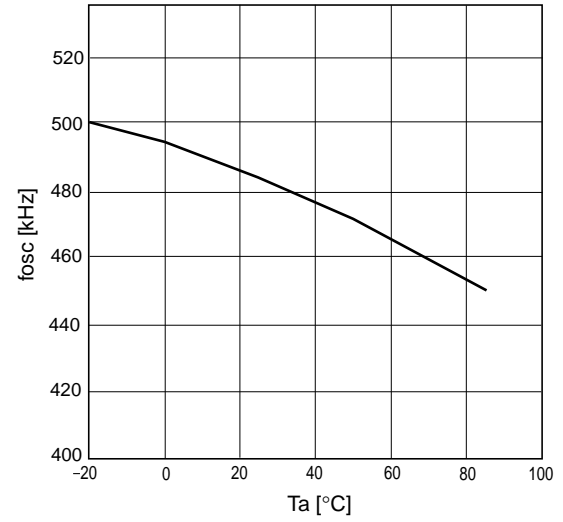
| Item                           | Symbol           | Test condition                      | Min. | Typ. | Max. | Unit |
|--------------------------------|------------------|-------------------------------------|------|------|------|------|
| Standby current                | I <sub>CCO</sub> |                                     |      | 12   | 20   | μA   |
| Operating-state supply current | I <sub>CC</sub>  | Duty cycle = 0%, R <sub>L</sub> = ∞ |      | 4    | 6    | mA   |

■ Characteristic curves (Ta = 25°C)

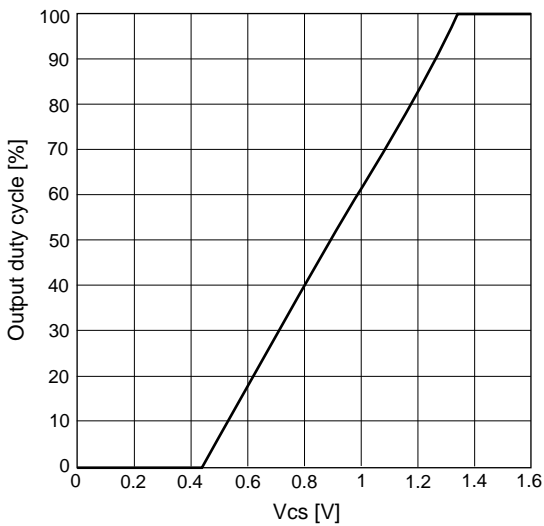
Oscillation frequency (fosc) vs. timing resistor resistance (RT)



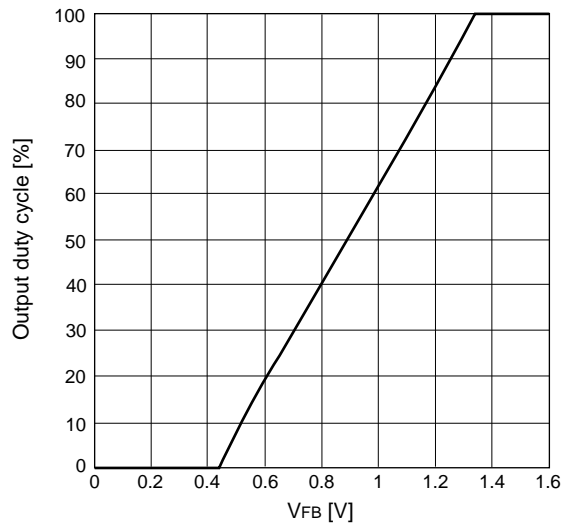
Oscillation frequency (fosc) vs. ambient temperature (Ta)



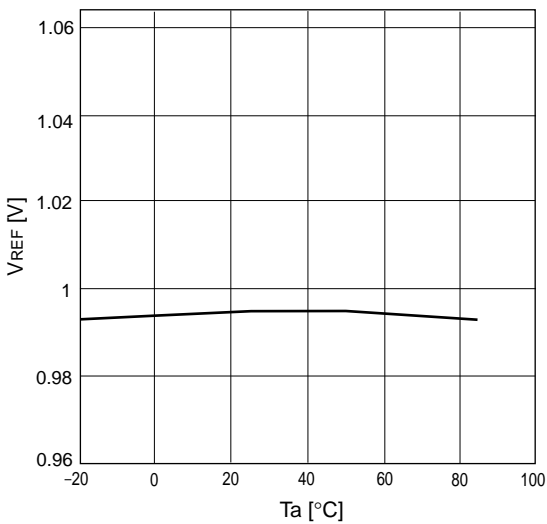
Output duty cycle vs. CS terminal voltage (Vcs)



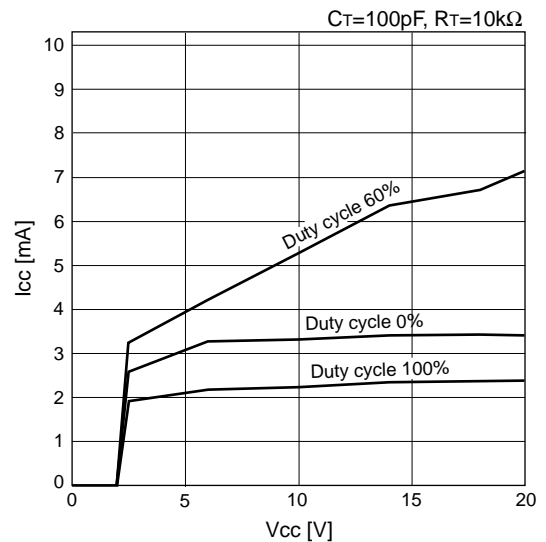
Output duty cycle vs. FB terminal voltage (VFB)



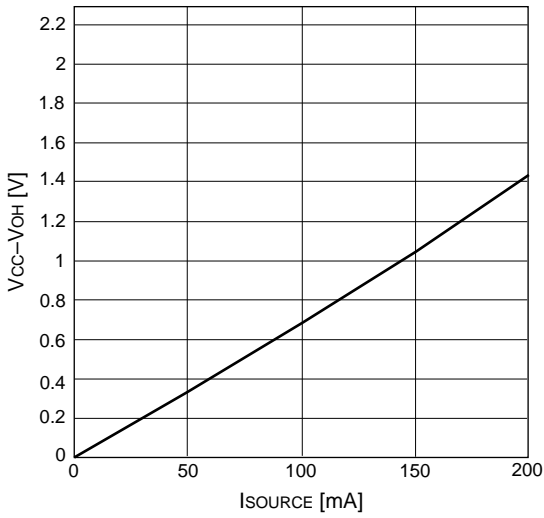
Reference voltage (VREF) vs ambient temperature (Ta)



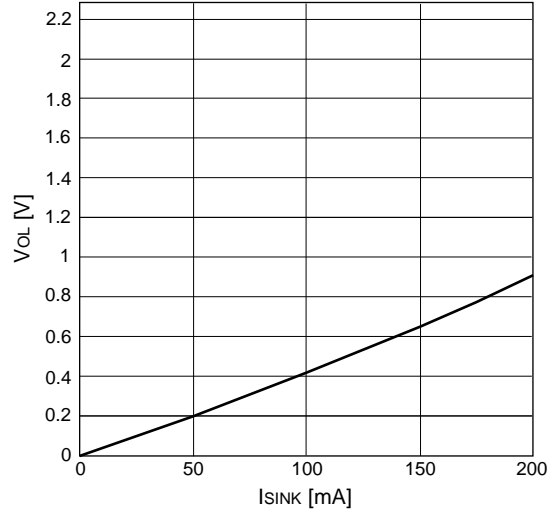
Supply current (Icc) vs supply voltage (Vcc)



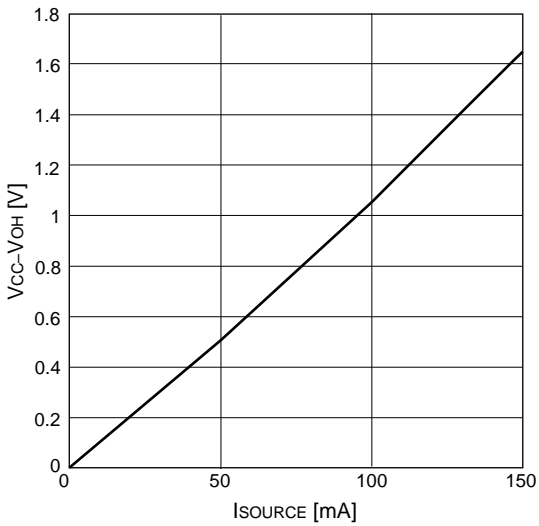
H-level output voltage ( $V_{CC}-V_{OH}$ ) vs. output source current ( $I_{SOURCE}$ ) for OUT1



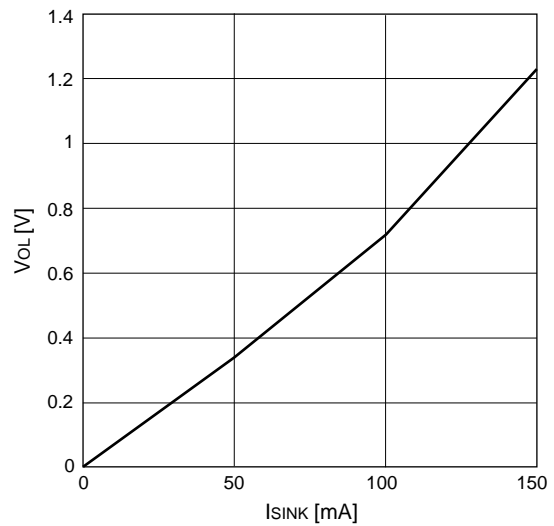
L-level output voltage ( $V_{OL}$ ) vs. output sink current ( $I_{SINK}$ ) for OUT1



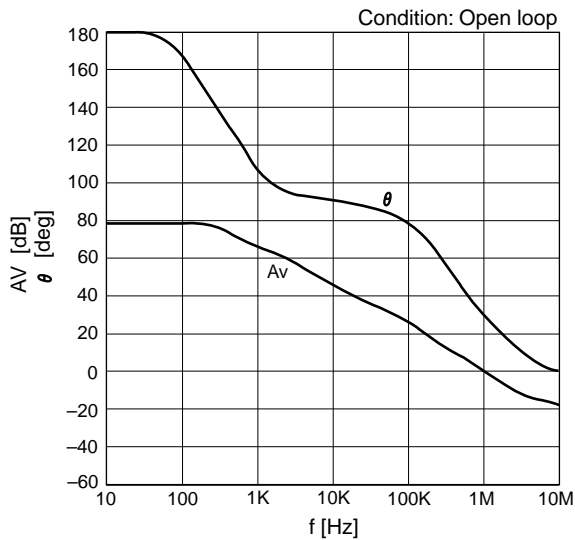
H-level output voltage ( $V_{CC}-V_{OH}$ ) vs. output source current ( $I_{SOURCE}$ ) for OUT2, 3, 4, 5, 6



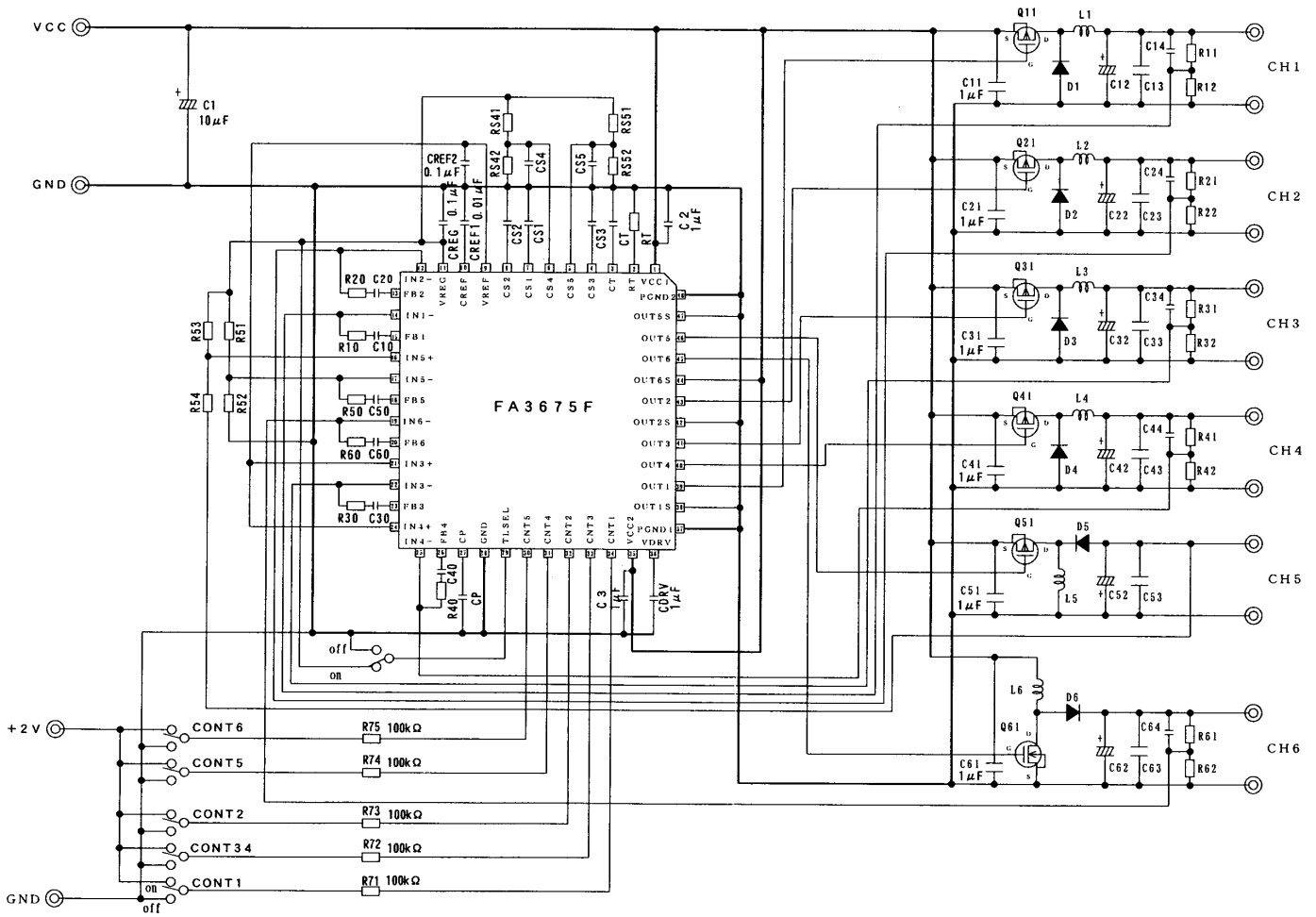
L-level output voltage ( $V_{OL}$ ) vs. output sink current ( $I_{SINK}$ ) for OUT2, 3, 4, 5, 6



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



■ Application 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.