

## ■ 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

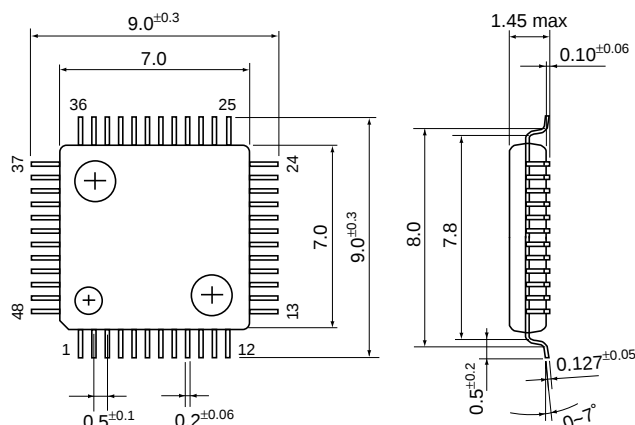
- 6-channel PWM control with MOSFET direct driving :  
5-channel for Pch-MOSFET, 1channel for Nch-MOSFET
- Low input voltage: 2.5V to 20V
- $\pm 1.0\%$  high accuracy bandgap reference
- Low power consumption by means of CDMOS  
Standby mode: 20 $\mu$ A(max.)  
Operating mode: 10mA(max.)
- Soft start 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

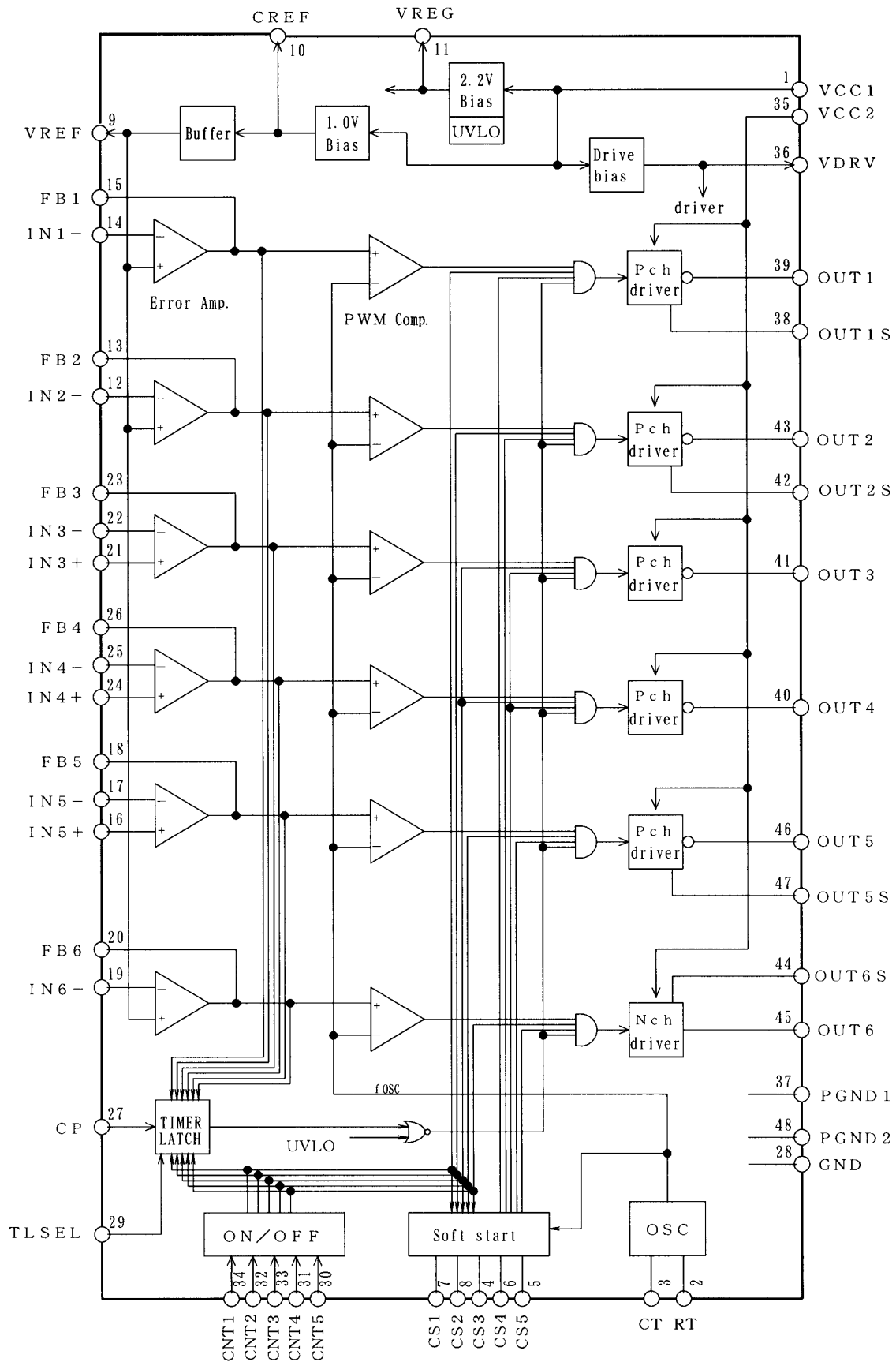
- VTR-camera, digital-steel-camera and portable equipment

## ■ 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<br>0.0 | V <sub>CC</sub> +0.25<br>5.25 | V    |
| 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 (Ta=25°C, Vcc1=Vcc2=6V, CT=100pF, RT=10kΩ)

### Reference voltage section

| Item                                               | Symbol | Test condition     | Min. | Typ. | Max. | Unit |
|----------------------------------------------------|--------|--------------------|------|------|------|------|
| Output voltage                                     | VREF   | No load            | 0.99 | 1.00 | 1.01 | V    |
| Load regulation                                    | VRFLD  | No load to RL=15kΩ |      | 7    | 15   | mV   |
| Line regulation                                    | VRFLIN | VCC=2.5 to 18V     |      | 3    | 10   | mV   |
| Output voltage variation due to temperature change | VRTa   | Ta=-20 to +85°C    |      | ±0.5 | ±1.0 | %    |

### Regulated voltage section

| Item                                               | Symbol  | Test condition      | Min.  | Typ. | Max.  | Unit |
|----------------------------------------------------|---------|---------------------|-------|------|-------|------|
| Output voltage                                     | VREG    | No load             | 2.134 | 2.20 | 2.266 | V    |
| Load regulation                                    | VRG LOD | No load to RL=3.9kΩ |       | 2    | 10    | mV   |
| Line regulation                                    | VRG LIN | VCC=2.5 to 18V      |       | 6    | 20    | mV   |
| Output voltage variation due to temperature change | VRGTa   | Ta=-20 to +85°C     |       | ±0.5 | ±1.0  | %    |

### Oscillator section

| Item                                             | Symbol | Test condition                     | Min. | Typ.     | Max.      | Unit |
|--------------------------------------------------|--------|------------------------------------|------|----------|-----------|------|
| Oscillation frequency                            | fOSC   | RT=10kΩ, CT=100pF                  | 432  | 480      | 528       | kHz  |
| Frequency variation due to supply voltage change | fΔV    | VCC=2.5 to 18V                     |      | ±1       | ±3        | %    |
| Frequency variation due to temperature change    | fΔT    | Ta=-20 to +25°C<br>Ta=+25 to +85°C |      | ±3<br>±7 | ±6<br>±14 | %    |

### Error amplifier section

| Item                            | Symbol | Test condition | Min. | Typ.  | Max.  | Unit |
|---------------------------------|--------|----------------|------|-------|-------|------|
| Input offset voltage            | VIOF   |                |      | 2     | 10    | mV   |
| Input common mode voltage range | VICOM  |                | 0.2  |       | 1.5   | V    |
| Open-loop gain                  | AVOL   |                | 70   | 75    |       | dB   |
| Unity-gain bandwidth            | fT     |                |      | 1.0   |       | MHz  |
| Output sink current             | IFBL   | VFB=VREF+0.05V | 2.5  | 3.5   |       | mA   |
| Output source current           | IFBH   | VFB=VREF-0.05V |      | -0.18 | -0.14 | mA   |

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

| Item                    | Symbol | Test condition  | Min. | Typ. | Max. | Unit |
|-------------------------|--------|-----------------|------|------|------|------|
| Input threshold voltage | VCs0   | Duty cycle=0%   | 0.36 | 0.46 | 0.56 | V    |
|                         | VCs100 | Duty cycle=100% | 1.11 | 1.31 | 1.51 | V    |
| Charge current          | Ics    | Vcs=0V          | -7.5 | -5.0 | -2.5 | μA   |

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

| Item                    | Symbol | Test condition  | Min. | Typ. | Max. | Unit |
|-------------------------|--------|-----------------|------|------|------|------|
| Input threshold voltage | VCs0   | Duty cycle=0%   | 0.36 | 0.46 | 0.56 | V    |
|                         | VCs100 | Duty cycle=100% | 1.11 | 1.31 | 1.51 | V    |
| Charge current          | Ics    |                 |      | 0    |      | μA   |

**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>F</sub> BT <sub>L</sub> |                | 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> V <sub>CC</sub> |                | 1.52 | 1.72 | 1.92 | V    |
| Voltage hysteresis          | ΔV <sub>UV</sub> CC             |                |      | 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)**

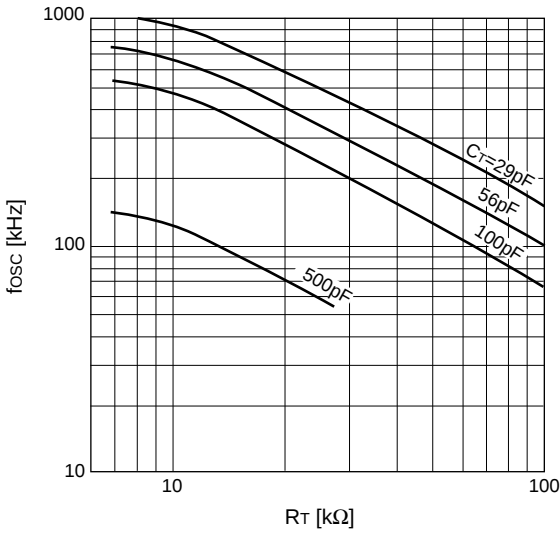
| Item                  | Symbol           | Test condition                                             | Min. | Typ. | Max. | Unit |
|-----------------------|------------------|------------------------------------------------------------|------|------|------|------|
| L-level ON resistance | R <sub>ONL</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**

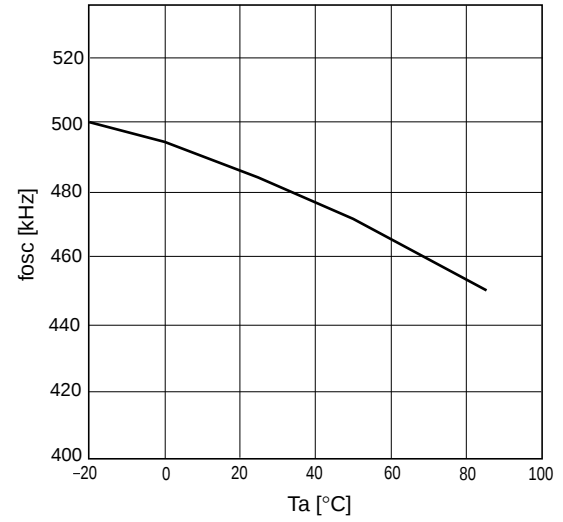
| Item                           | Symbol           | Test condition                    | Min. | Typ. | Max. | Unit |
|--------------------------------|------------------|-----------------------------------|------|------|------|------|
| Standby current                | I <sub>CCO</sub> |           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

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

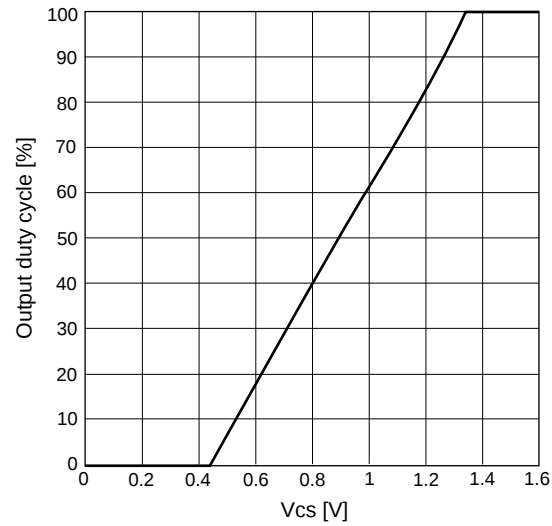
Oscillation frequency ( $f_{osc}$ ) vs. timing resistor resistance ( $R_T$ )



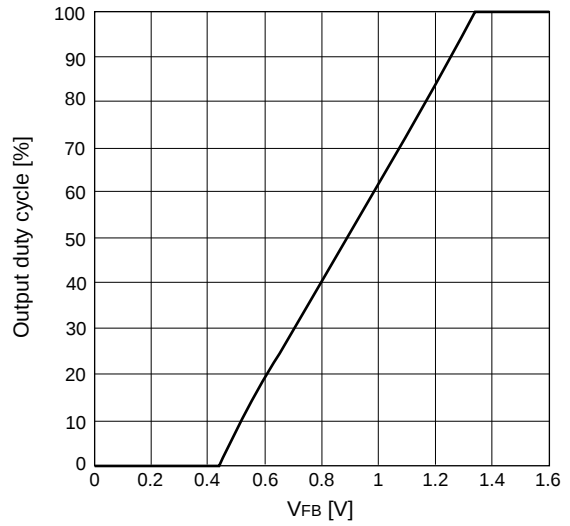
Oscillation frequency ( $f_{osc}$ ) vs. ambient temperature ( $T_a$ )



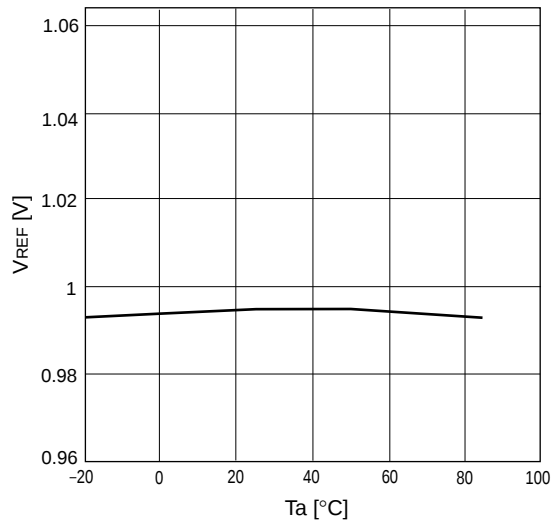
Output duty cycle vs. CS terminal voltage ( $V_{CS}$ )



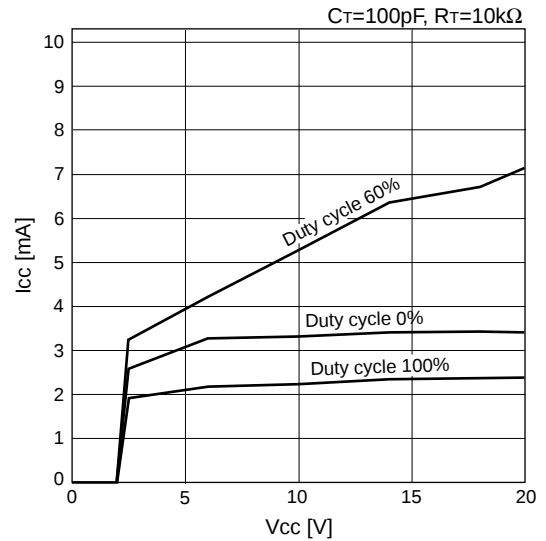
Output duty cycle vs. FB terminal voltage ( $V_{FB}$ )



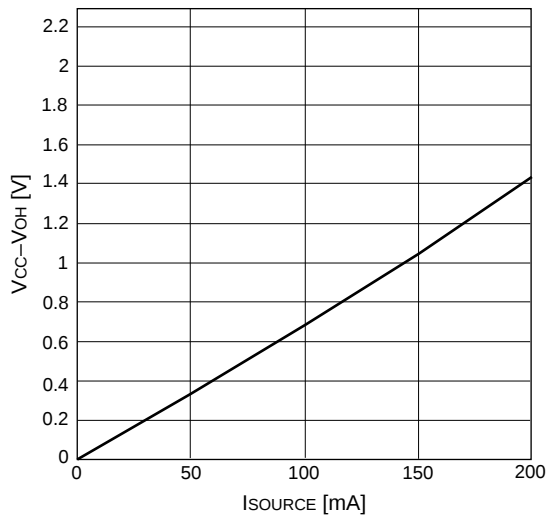
Reference voltage ( $V_{REF}$ ) vs ambient temperature ( $T_a$ )



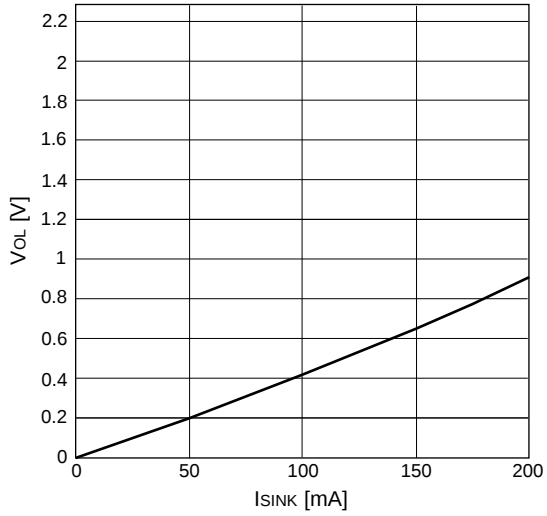
Supply current ( $I_{CC}$ ) vs supply voltage ( $V_{CC}$ )



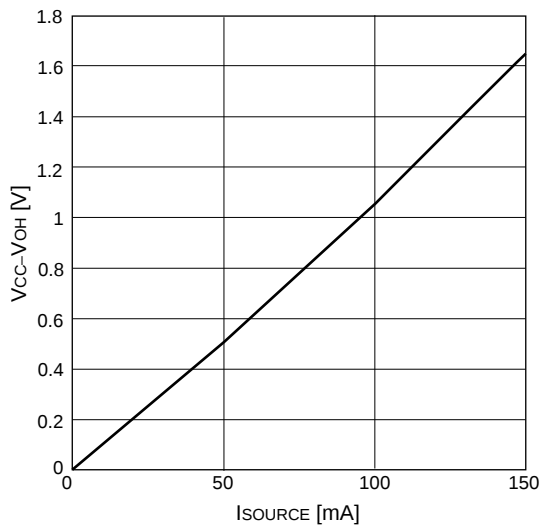
H-level output voltage ( $V_{CC}-V_{OH}$ ) vs. output source current ( $I_{SOURCE}$ ) for OUT1



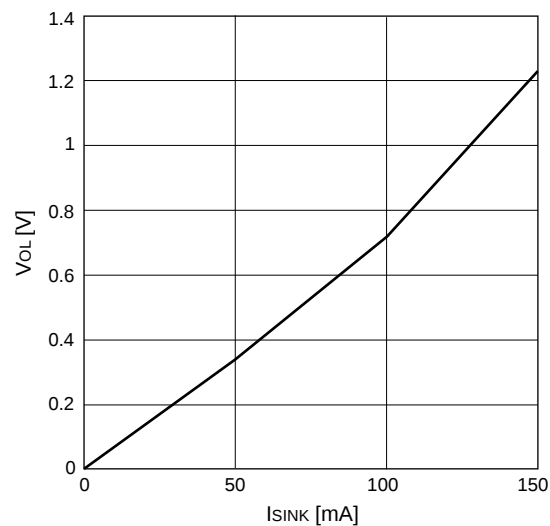
L-level output voltage( $V_{OL}$ ) vs. output sink current ( $I_{SINK}$ ) for OUT1



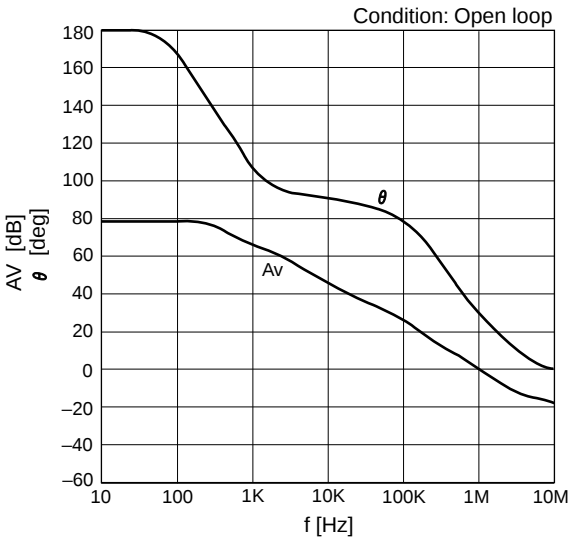
H-level output voltage ( $V_{CC}-V_{OH}$ ) vs. output source current ( $I_{SOURCE}$ ) for OUT2, 3, 4, 5, 6



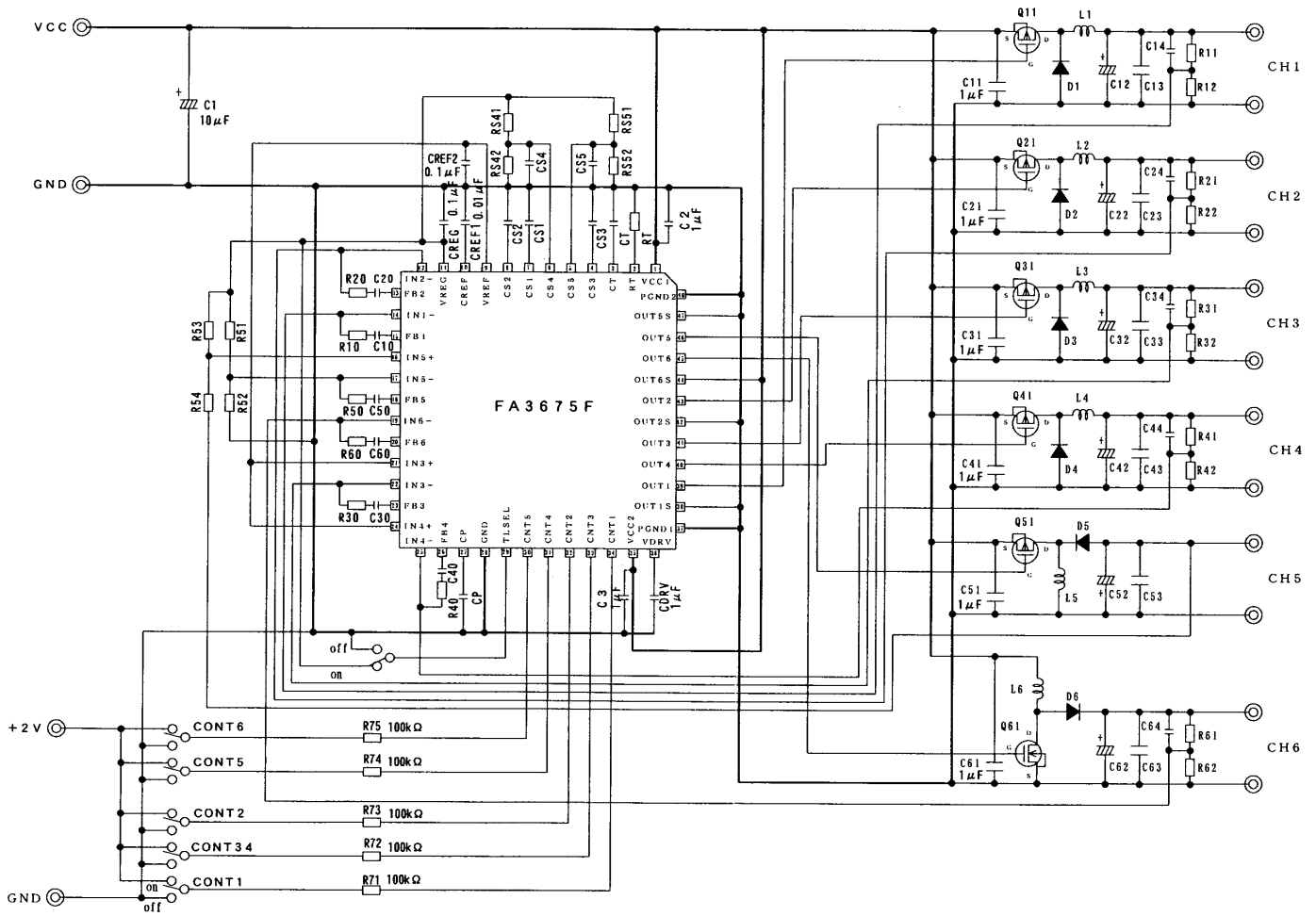
L-level output voltage( $V_{OL}$ ) vs. output sink current ( $I_{SINK}$ ) for OUT2, 3, 4, 5, 6



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.