# **Power Supply IC for LCD Panels**

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# 1. Introduction

With the widespread popularization of multimedia, electronic devices are increasing being required to be smaller, lighter, thinner and to have lower power consumption. Liquid crystal displays (LCDs), having these merits, account for the majority of display devices.

Three voltages are required in general for driving LCD panels. Among these voltages, the input voltage to the LCD panels, the voltage configuration required for driving them and the power supply sequence are various and depend upon the particular supplier and kind of panel.

Furthermore, to reduce the size of the power supply circuits, it is especially necessary to reduce the size of transformers and coils, which requires operating the power supply circuit at higher frequency.

Fuji Electric has successfully developed power supply ICs (integrated circuits) for LCD panels in the past, and has newly developed the FA3686V and FA3687V PWM (pulse width modulation) switching power supply controller ICs with 2 channels. An overview of this new series is introduced below.

#### 2. Product Outline

Use of the newly developed FA3686V or FA3687V, both power supply ICs for LCD panels, can be selected according to the different power supply configurations and applications required for the LCD panels.

Features common to both of these devices are as follows:

- TSSOP (thin shrink small out-line package) : 16pin packages are used.
- (2) Operating voltage: 2.5 to 18 V
- (3) Oscillation frequency : 300 kHz to 1.5 MHz, can be set with externally mounted resistor only
- (4) Accuracy of reference voltage and regulated voltage for internal control blocks : ±1 %
- (5) Built-in PWM control output with 2 channels
- (6) Built-in timer and latch type short circuit protection, undervoltage lockout circuit and soft start circuit

Table 1 Common ratings of the FA3686V and FA3687V

Item	Condition	Minimum	Typical	Maximum	Unit
Power supply voltage		2.5		18	v
Reference voltage		0.99	1.00	1.01	V
Regulated voltage for internal control blocks		2.178	2.200	2.222	v
Oscillation frequency	$RT = 12 \text{ k}\Omega$	435	500	565	kHz
Undervoltage lockout operating voltage		2.00	2.20	2.35	v
OUT1, 2 H-level on-state resistance	$I_{\rm out} = 50 \ {\rm mA}$		10	20	Ω
OUT1, 2 L-level on-state resistance	$I_{\rm out} = -50 \text{ mA}$		5	10	Ω

Note: The ratings are for the power supply voltage of 3.3 V and room temperature ( $25^{\circ}$ C) unless otherwise specified

(7) The externally mounted switching element can directly drive either a MOSFET (metal oxide semiconductor field effect transistor) or a bipolar transistor.

The main characteristics common to both the FA3686V and FA3687V are shown in Table 1.

## 3. Characteristics of FA3686V

The FA3686V is distinguished among power supply ICs for LCD panels as a device especially suited for use in power supplies with 3 outputs. It is designed so as to enable the easy configuration of a series regulator by adding an error amplifier in addition to a 2-channel PWM control block.

Figure 1 shows the internal circuit of the FA3686V. The features of the FA3686V are described below.

## 3.1 PWM control blocks

The non-inverted input to the error amplifier for each of channel 1 and channel 2 is connected to the reference voltage  $(1.00 \text{ V} \pm 1 \%)$  internally. The output of channel 1 can configure a boost converter at the n-

channel driver and the output of channel 2 can configure an inverting converter at the p-channel driver.

#### 3.2 Maximum duty limit circuit

When driving the boost converter and inverting converter, it is necessary to limit the maximum duty so as to prevent 100 % loading.

The FA3686V has a built-in maximum duty limiting circuit, which limits the duty within about 85% without requiring any external setting.

#### 3.3 Soft start circuit

The FA3686V is equipped with an independent soft start circuit for each channel. The CS1 and CS2 terminals for setting soft start are provided with

Fig.1 FA3686V circuit diagram



Fig.2 Example circuit application using the FA3686V

internal current sources and the function is realized by simply connecting capacitors externally.

# 3.4 Timer and latch circuit

The timer and latch type short circuit protection function monitors the output voltage of the error amplifier. If the error amplifier output exceeds the limit of the switching extension side for a certain delay time, the protection function judges that to be an abnormal condition and stops the switching. The FA3686V counts the oscillation period to determine the delay time. The time can be set as the oscillation period multiplied by either  $2^{16}$  or  $2^{17}$ , without requiring any externally mounted part.

## 3.5 PGS

FA3686V has a new function, PGS (power good signal). This function is for outputting fault signals of the power supply driven by FA3686V and is configured as an n-channel MOSFET open drain output.

If the input voltage is below a specified value (2.35 V when the voltage is rising and 2.25 V when the voltage is falling, if the undervoltage lockout circuit (UVLO) has been activated, or if the timer and latch circuit has been activated, the n-channel MOSFET has been turned on.

#### 3.6 Example circuit application

Figure 2 shows an example circuit application using the FA3686V.

Channel 1 drives the boost converter and channel 2 drives the inverting converter. Furthermore, the charge pump converter is configured using the switching of channel 1, which is subsequently combined with a series regulator to form another voltage.

Charge pump converters, which can be configured from capacitors and with a little load current, are seen



as advantageous with regard to part size and cost, and the FA3686V is suitable for driving them.

# 4. Characteristics of FA3687V

Among power supplies for LCD panels, the FA3687V places special emphasis on general-purpose applicability. All 2-channel PWM control blocks can switch between n-channel and p-channel driving, allowing configuration of a power supply capable of driving a wide range of applications.

Figure 3 shows the internal circuitry of the FA3687V. The features of the FA3687V are described below.

# 4.1 PWM control blocks

The non-inverted input of error amplifier for channel 1 is internally connected to the reference voltage  $(1.00 \text{ V} \pm 1 \%)$ . For the error amplifier of





Fig.4 Example circuit application using the FA3687V

channel 2, both the non-inverted input and the inverted input can be set externally. The drive output of either channel can be switched between n-channel and p-channel output. This allows the configuration of any type of circuit, including buck, boost, inverting, flyback and forward circuits.

#### 4.2 Soft start circuit

The FA3687V is equipped with an independent soft start circuit for each channel. The soft start function is set using resistors and capacitors at the CS1 and CS2 terminals. The maximum duty limit can also be set by setting the voltages at CS1 and CS2 terminals.

## 4.3 Timer and latch circuit

The FA3687V uses the capacitor charge method for determining the delay time until latching. By connecting a capacitor to the CP terminal, the capacitor is charged from the internal current source and the switching is stopped when a certain voltage is reached.

#### 4.4 Example circuit application

Figure 4 shows an example circuit application using the FA3687V. This is an example in which all channels are driving buck converters. As the FA3687V can switch between n-channel and p-channel driving, it is highly versatile and can be applied to any combination of circuits including buck, boost and inverting circuits.

# 5. Conclusion

An overview of the FA3686V and FA3687V power supply ICs for LCD panels has been presented above.

In the LCD panel industry, price reduction and downsizing have been progressing year after year. To meet market demands, Fuji Electric will further enrich its product line of power supply ICs for LCD panels and will develop products having appeal to the market.





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