FSC LCD Backlight Inverter IC Solution

Lighting Product Line
Power Conversion
# FSC Product Line - up

<table>
<thead>
<tr>
<th>Generation</th>
<th>Products</th>
<th>Description</th>
<th>Vcc (V)</th>
<th>Dimming</th>
<th>Soft Start</th>
<th>OLP</th>
<th>OLR(=OVP)</th>
<th>SCP</th>
<th>Vout(Max)</th>
<th>Iout(Max)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 G</td>
<td>FAN7547A</td>
<td>1Ch. Buck-Royer</td>
<td>6 ~ 30</td>
<td>Analog, Burst</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>Vcc</td>
<td>0.2A</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FAN7548</td>
<td>2Ch. Buck-Royer</td>
<td>9 ~ 30</td>
<td>Analog, Burst</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>13.5V</td>
<td>0.2A</td>
<td>S</td>
</tr>
<tr>
<td>1st G</td>
<td>FAN7311/A/B</td>
<td>P-N Full Bridge</td>
<td>5 ~ 25.5</td>
<td>Analog, Burst</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>8.5V</td>
<td>0.2A</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FAN7314/A</td>
<td>P-N Half Bridge</td>
<td>5 ~ 25.5</td>
<td>Analog, Burst</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>X</td>
<td>8.5V</td>
<td>0.2A</td>
<td>S</td>
</tr>
<tr>
<td>2nd G</td>
<td>FAN7313</td>
<td>Push-Pull</td>
<td>4.5 ~ 25.5</td>
<td>Analog, Burst</td>
<td>O</td>
<td>Internal (4)</td>
<td>O</td>
<td>O</td>
<td>6V</td>
<td>0.5A</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FAN7316</td>
<td>N-N Half Bridge</td>
<td>4.5 ~ 24</td>
<td>Analog, Burst</td>
<td>O</td>
<td>Internal (4)</td>
<td>O</td>
<td>O</td>
<td>6V</td>
<td>0.5A</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FAN7317</td>
<td>P-N Full Bridge</td>
<td>6 ~ 24</td>
<td>Burst</td>
<td>O</td>
<td>Internal (4)</td>
<td>Internal (4)</td>
<td>SLP</td>
<td>6V</td>
<td>0.2/0.3A</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td>FAN7318</td>
<td>P-N Half Bridge</td>
<td>6 ~ 30</td>
<td>Analog, Burst</td>
<td>O</td>
<td>Internal (4)</td>
<td>Internal (4)</td>
<td>SLP</td>
<td>8V</td>
<td>0.3/0.4A</td>
<td>D (P12)</td>
</tr>
<tr>
<td>3rd G</td>
<td>FAN7320</td>
<td>H/B Switch Integration</td>
<td>9 ~ 25.5</td>
<td>Analog, Burst</td>
<td>O</td>
<td>Internal (4)</td>
<td>Internal (4)</td>
<td>SLP</td>
<td>Ron=30mΩ</td>
<td>S</td>
<td></td>
</tr>
</tbody>
</table>

- **Features**
  - **Ron=30mΩ**
  - **1st G**
  - **2nd G**
  - **3rd G**
Product Introduction

- FAN7313 (Push-pull) / FAN7316 (N-N Half-Bridge)
- FAN7317 (Full-Bridge)

New Product

- FAN7318
FAN7313/6 Key Features

• **Reduce external components**
  → Wide Input Voltage Range: 4.5 ~ 25.5V (FAN7313), 4.5 ~ 24V (FAN7316)
  → Integrated OLP circuit

• **Various Protection**
  → OLP, OLR, SCP, TSD, Soft-start, Arc Protection

• **Design flexibility**
  → Selectable Dimming Polarity
  → N-N Half-bridge & Push-pull topology
  → Analog & Burst dimming
  → PWM dimming by external pulse signal
  → Wide input voltage range: 4.5 ~ 24V
Reduce External Components

• **Wide Input Voltage Range:** 4.5 ~ 24V
  - Can use common Vcc with IC input voltage
  - 1 TR, 1 Zenor D, 2 Resister

• **Integrated OLP Circuit**
  - No need open lamp detection circuit
  - Reduce Feedback rectifier diode
  - 1 TR, 5 Diode (3 BAV55, 2 BAV70)
  - 5 Capacitor, 1 Resister (@ 4Lamp)
Reduce External Components

FAN7316 – N-N Half-Bridge

Can delete this external OLP detection circuit

Can delete this external IC - Vcc regulation circuit

BOM
Dual N MOS 1
Control IC 1
Reduce External Components

FAN7314 – P-N Half-Bridge

FAN7316 – N-N Half-Bridge
Key Features

• **Reduce external components**
  → Wide Input Voltage Range : 4.5 ~ 24V
  → Integrated OLP circuit

• **Various Protection**
  → OLP, OLR, SCP, TSD, Soft-start, Arc Protection

• **Design flexibility**
  → Selectable Dimming Polarity
  → N-N Half-bridge & Push-pull topology
  → Analog & Burst dimming
  → PWM dimming by external pulse signal
  → Wide input voltage range : 4.5 ~ 24V
Various Protection

<table>
<thead>
<tr>
<th>Protection Item</th>
<th>Description</th>
<th>Protection Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCP</td>
<td>Short Circuit Protection</td>
<td>&gt; 2V (@ SCP)</td>
</tr>
<tr>
<td>OLR</td>
<td>Open Lamp Regulation</td>
<td>&gt; 1.75V (@ OLR)</td>
</tr>
<tr>
<td>Arc</td>
<td>Arc Protection</td>
<td>&gt; 3V (@ OLR)</td>
</tr>
<tr>
<td>OLP</td>
<td>Open Lamp Protection</td>
<td>&lt; 1.5V (@ OLP)</td>
</tr>
<tr>
<td>TSD</td>
<td>Thermal Shut Down</td>
<td>150°C (@ Tj)</td>
</tr>
</tbody>
</table>
Key Features

- **Reduce external components**
  - Wide Input Voltage Range: 4.5 ~ 24V
  - Integrated OLP circuit

- **Various Protection**
  - OLP, OLR, SCP, TSD, Soft-start, Arc Protection

- **Design flexibility**
  - Selectable Dimming Polarity
  - N-N Half-bridge, Push-pull topology, P-N Half-bridge, P-N Full-bridge
  - Analog & Burst dimming
  - PWM dimming by external pulse signal
  - Wide input voltage range: 4.5 ~ 24V
Design Flexibility

Selectable Dimming Polarity

1) Positive burst dimming polarity @ ADIM < 3.0V

2) Negative burst dimming polarity @ ADIM > 3.5V

1) Positive burst dimming polarity

2) Negative burst dimming polarity
Design Flexibility

N-N Half-bridge Application

Push-pull Application

P-N Half-bridge Application

P-N Full-bridge Application
Design Flexibility

Analog & Burst Dimming

1) ADIM>3.5V (hys. 0.5V) : Negative
2) ADIM<3.5V : Positive

Negative dimming polarity

Burst Dimming

Analog Dimming

Lamp current

0V
2V
3.3V
0V

3.5V
0V
2V
ADIM

Negative dimming polarity

Lamp current

0V
2V
3.3V
0V

3.5V
0V
2V
ADIM

www.fairchildsemi.com
Design Flexibility

**PWM dimming by external pulse signal**

This method can be applied to FAN7313, FAN7316 application

![Diagram showing PWM dimming by external pulse signal](image)
Design Flexibility

Wide Input Voltage Range : 4.5 ~ 24/25.5V

Can delete this external IC - Vcc regulation circuit
FAN7317 Key Features

- **Reduce external components**
  - Wide Input Voltage Range: 6.0 ~ 24V
  - Integrated OLP circuit
  - Integrated OLR circuit
  - Integrated P-MOS driving circuit

- **Various Protection**
  - OLP, OLR, SLP, CMP-high, FB-high, TSD, Soft-start, Arc Protection
FAN7317 Key Features

• **Reduce external components**
  → Wide Input Voltage Range: 6.0 ~ 24V
  → Integrated OLP circuit
  → Integrated OLR circuit
  → Integrated P-MOS driving circuit

• **Various Protection**
  → OLP, OLR, SLP, CMP-high, FB-high, TSD, Soft-start, Arc Protection

• **Design flexibility**
  → Selectable Dimming Polarity
  → N-N Half-bridge & Push-pull topology
  → Analog & Burst dimming
  → PWM dimming by external pulse signal
  → Wide input voltage range: 4.5 ~ 24V
Reduce External Components

- **Wide Input Voltage Range**: 6.0 ~ 24V
  - Can use common Vcc with IC input voltage
  - 1 TR, 1 Zenor D, 2 Resister

- **Integrated OLP Circuit**
  - No need open lamp detection circuit
  - Reduce Feedback rectifier diode
  - 1 TR, 5 Diode (3 BAV55, 2 BAV70)
  - 5 Capacitor, 1 Resister (@ 4Lamp)

- **Integrated OLR Circuit**
  - No need open lamp regulation circuit
  - No need feedback diode
  - 2 Capacitor, 4 Diode (BAV70)
  - 3 Resister (@ 4Lamp)

- **P-MOS Driving Circuit**
  - 2 Zenor D, 2 Capacitor, 2 Resistor
Reduce External Components

Can delete this external OLP detection circuit
Can delete this external IC - Vcc regulation circuit
Can delete this external P-MOSFET driving circuit
Can delete this OLR circuit
Key Features

• Reduce external components
  → Wide Input Voltage Range: 4.5 ~ 24V
  → Integrated OLP circuit

• System Reliability with Various Protection
  → OLP, OLR, SLP, CMP-high, FB-high, TSD, Soft-start, Arc Protection

• Design flexibility
  → Selectable Dimming Polarity
  → N-N Half-bridge & Push-pull topology
  → Analog & Burst dimming
  → PWM dimming by external pulse signal
  → Wide input voltage range: 4.5 ~ 24V
Various Protection

<table>
<thead>
<tr>
<th>Protection Item</th>
<th>Description</th>
<th>Protection Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLP</td>
<td>Short Lamp Protection</td>
<td>&lt; 0.3V (@ OLR)</td>
</tr>
<tr>
<td>OLR</td>
<td>Open Lamp Regulation</td>
<td>&gt; 2.0V (@ OLR)</td>
</tr>
<tr>
<td>Arc</td>
<td>Arc Protection</td>
<td>&gt; 3V (@ OLR)</td>
</tr>
<tr>
<td>CMP-High</td>
<td>Comparator high protection</td>
<td>&gt; 3V (@ CMP)</td>
</tr>
<tr>
<td>FB-High</td>
<td>Feedback high protection</td>
<td>&gt; 3.5V (@OLP)</td>
</tr>
<tr>
<td>OLP</td>
<td>Open Lamp Protection</td>
<td>&lt; 1/0.5V (@ OLP)</td>
</tr>
<tr>
<td>TSD</td>
<td>Thermal Shut Down</td>
<td>150°C (@ Tj)</td>
</tr>
</tbody>
</table>
Key Features

• **Reduce external components**
  → Wide Input Voltage Range: 4.5 ~ 24V
  → Integrated OLP circuit

• **Various Protection**
  → OLP, OLR, SLP, CMP-high, FB-high, TSD, Soft-start, Arc Protection

• **Design flexibility**
  → P-N Half-bridge, P-N Full-bridge
  → PWM dimming by external pulse signal
  → Wide input voltage range: 6.0 ~ 24V
Design Flexibility

PWM dimming by external pulse signal
This method can be applied to FAN7313, FAN7316 application

![Diagram of PWM dimming by external pulse signal](image)
Design Flexibility

Wide input voltage range 6 ~ 24V

Can delete this external IC - Vcc regulation circuit
New Product Introduction

- FAN7318 P-N Half Bridge Solution
FAN7318 Key Features

- **Reduce external components**
  - Wide Input Voltage Range: 6.0 ~ 30.0 V
  - Integrated OLP circuit
  - Internal OLR circuit
  - Internal feedback circuit
  - Internal P-MOS driving circuit

- **Various Protection**
  - OLP, OLR, SLP, OVP, COMP-Hi, Feedback-Hi, TSD, Soft-start

- **Design flexibility**
  - Adjustable Striking & Protection delay time
  - DCR mode operation
  - Analog & Burst dimming
  - PWM dimming by external pulse signal
  - Wide input voltage range: 6.0 ~ 30V
Reduce External Components

- **Wide Input Voltage Range**: 6.0 ~ 30V
  - Can use common Vcc with IC input voltage
  - 1 TR, 1 Zenor D, 2 Resister

- **Integrated OLP Circuit**
  - No need open lamp detection circuit
  - 1 TR, 3 Diode (BAW56)
    - 5 Capacitor, 5 Resister (@ 4Lamp)

- **Integrated OLR Circuit**
  - No need open lamp regulation circuit
  - 2 Capacitor, 2 Diode (BAV70)
    - 4 Resister (@ 4Lamp)

- **Integrated Feedback rectifier diode**
  - 4 Diode (BAV99) (@4Lamp)

- **P-MOS Driving Circuit**
  - 1 Zenor D, 1 Capacitor, 1 Resistor

---

<table>
<thead>
<tr>
<th>Device</th>
<th>Unit</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR</td>
<td>2</td>
<td>$0.014</td>
</tr>
<tr>
<td>ZD</td>
<td>1</td>
<td>$0.007</td>
</tr>
<tr>
<td>BAV D</td>
<td>9</td>
<td>$0.063</td>
</tr>
<tr>
<td>Capacitor</td>
<td>6</td>
<td>$0.012</td>
</tr>
<tr>
<td>Resistor</td>
<td>12</td>
<td>$0.005</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>30</td>
<td>$0.101</td>
</tr>
</tbody>
</table>
Reduce External Components

The diagram illustrates the FAN7318 IC, showing the connections for reducing external components. The IC integrates features such as a timer, comparators, and operational amplifiers, which can minimize the number of external components needed for certain applications.

Key components and connections include:
- **IC (FAN7318)**: Central to the circuit, integrating multiple functionalities.
- **Vcc**: Power supply for the IC.
- **P-MOSFET**: Gate connection, likely for power handling or switching.
- **ON/OFF**: Switch for controlling the power supply or output.
- **OLP**: Overload protection, critical for safety and reliability.
- **OLR**: Overload reset, enabling system recovery.
- **FB**: Feedback connections for voltage regulation and control.
- **CT**: Capacitor, integral for filtering or storing energy.
- **电阻 (Resistors)**: Essential for voltage division, current limitation, and stabilization.
- **电容 (Capacitors)**: Critical for energy storage, filtering, and regulation.
- **电感 (Inductors)**: Used for current limiting, filtering, and power factor correction.

The diagram highlights the integration and optimization of these components, likely aiming to reduce external hardware and complexity in applications requiring temperature regulation, power management, or control systems.
Reduce External Components

FAN7314 – P-N Half-Bridge

FAN7318 – P-N Half-Bridge
FAN7318 Key Features

- **Reduce external components**
  - Wide Input Voltage Range: 6.0 ~ 30.0 V
  - Integrated OLP circuit
  - Internal OLR circuit
  - Internal feedback circuit
  - Internal P-MOS driving circuit

- **Various Protection**
  - OLP, OLR, SLP, OVP, COMP-Hi, Feedback-Hi, TSD, Soft-start

- **Design flexibility**
  - Adjustable Striking & Protection delay time
  - DCR mode operation
  - Analog & Burst dimming
  - PWM dimming by external pulse signal
  - Wide input voltage range: 6.0 ~ 30V
FAN7318 Application Circuit

Vcc = 15V, P-N Half Bridge
Lamp Current = 7.0mA
Fm : 46.5KHz
Fstr : 65KHz
Fbus: 320Hz
Vstr : Over 1700V
Panel : M220EW01 (AUO 22")
Various Protection

<table>
<thead>
<tr>
<th>Protection</th>
<th>Description</th>
<th>Protection Condition</th>
<th>Delay Time @ 1uF</th>
</tr>
</thead>
<tbody>
<tr>
<td>SLP</td>
<td>Short Lamp Protection</td>
<td>U 0.3V @ OLR (min.)</td>
<td>20mS</td>
</tr>
<tr>
<td>OLP</td>
<td>Open Lamp Regulation</td>
<td>U 2V (@ OLR)</td>
<td></td>
</tr>
<tr>
<td>OVP</td>
<td>Over Voltage Protection</td>
<td>O 1.4V (@ OLR)</td>
<td>20mS</td>
</tr>
<tr>
<td>OLP</td>
<td>Open Lamp Protection</td>
<td>U 0.7/0.5V (@ OLP)</td>
<td>1.5/0.5S</td>
</tr>
<tr>
<td>CHP</td>
<td>Comparator High Protection</td>
<td>O 3.5V (@ CMP)</td>
<td>1.5/0.5S</td>
</tr>
<tr>
<td>FHP</td>
<td>Feedback High protection</td>
<td>O 3.5V (@ OLP)</td>
<td>80uS @50KHz</td>
</tr>
<tr>
<td>TSD</td>
<td>Thermal Shut Down</td>
<td>O 150°C (@ Tj)</td>
<td></td>
</tr>
</tbody>
</table>

O : Over / U : Under
Soft Start

- Soft start operated by BCT waveform
Open Lamp Protection

- Open Lamp Protection delay time is adjusted by C timer (@1uF)
- Open Lamp Protection disable for DCR Mode by ENA voltage

Normal Operation (ENA < 2.1V)

OLP delay time ≈ 500mS

Protection Condition
OLP <0.7/0.5V

OLP Disable (ENA > 2.5V)

Lamp 1 Open

OLP1
OLP2
OLP3
OLP4

Lamp 1 Open

OLP1
Timer
OLP3
OLP4
Short Lamp Protection

- Short Lamp Protection delay time is adjusted by C timer (@ 1uF)
- Short Lamp Protection disable for DCR Mode by ENA voltage

Normal Mode (ENA < 2.1V)

- SLP delay time ≈ 20mS

SLP Disable ENA > 2.5V

- Protection Condition
  - OLR <0.3V
Open Lamp Regulation & OVP

- OLR Voltage regulated at 2V
- Over Voltage Protection delay time is adjusted by C timer (@1uF)

Error Amp Source Current Change to protect overshoot:
- 22uA OLR<1.4V
- 3.2uA OLR>1.4V
- 0uA OLR>2.0V

@ Striking Mode

 CMP Slope Change

@ Normal Mode

 Timer

 OLR

 ≈ 1.4V

 ≈ 20mS

 ≈ 1.4V

 ≈ 2.0V

 Disabled

@ Striking Mode
CMP (Error Amp. Output) High Protection

- CMP High Protection operated over 3V
- CMP High Protection delay time is adjusted by C timer (@1uF)
- CMP source current decreases from 22uA to 3.2uA for CMP high protection disable

Normal Mode

CMP Hi P delay time ≈ 500mS

CMP-Hi P Disable

CMP-Hi Protection Disable Method
Feedback High Protection

- Feedback High Protection operated over OLP 3.5V
- Feedback High Protection delay time is decided by 8 cycle 3.5V OLP Voltage

Normal Mode (Disable @ Striking Mode)

8 Cycle ≈ 80uS @ 50Khz main frequency
**Key Features**

- **Reduce external components**
  - Wide Input Voltage Range: 6.0 ~ 30.0 V
  - Integrated OLP circuit
  - Internal OLR circuit
  - Internal feedback circuit
  - Internal P-MOS driving circuit

- **Various Protection**
  - OLP, OLR, SLP, OVP, COMP-Hi, Feedback-Hi, TSD, Soft-start

- **Design flexibility**
  - Adjustable Striking & Protection delay time
  - DCR mode operation
  - Analog & Burst dimming
  - PWM dimming by external pulse signal
  - Wide input voltage range: 6.0 ~ 30V
Adjustable Protection Delay & Striking Time

◆ Protection Delay Time

![Circuit Diagram]

\[ dt = \frac{C}{dV/I} \]

OVP, SLP  \( dt = \frac{1}{50} = 20mS \)
OLP, High_CMP  \( dt = \frac{1}{2} = 0.5S \) (Normal)

\[ dt = \frac{1}{2} X 3 = 1.5S \) (Striking) \]

◆ Striking Time

![Circuit Diagram]

\[ dt = \frac{C}{dV/I} \]

OLP  \( dt = \frac{1}{2} X 3 = 1.5S \) (Striking)

\[ T\text{ strike off} = t\text{ OLP} + 4\text{ OLP out} \]
\[ = 1.5 + 40u \text{ (at fmain = 50KHz)} \]
\[ \approx 1.5S \]
DCR Mode Operation

- DCR Mode Operated by ENA voltage (> 2.5V)
- Minimum lamp current = 0mA (Open lamp protection disabled)
- Open lamp protection operated by Over Voltage Protection (OLRv>1.4V, Tdelay = 20mS @ 1uF Ctimer)

OLP Disable @ OLP condition

Over Voltage Protection @ OLP condition

- Timer
- OLR
- Lamp Open
- @ Striking Mode
- Disabled

(Test condition : OVP disable)
**Analog & Burst Dimming**

**◆ Analog Dimming**

- **Polarity : Negative**

![Diagram showing Analog Dimming](image)

- **ADIM = 0V**
  - ILamp = 12mA

- **ADIM = 1V**
  - ILamp = 9mA

- **ADIM = 1.5V**
  - ILamp = 6mA

- **ADIM = 2V**
  - ILamp = 5mA

- **ADIM = 2.2V**
  - ILamp = 5mA

- **ADIM = 2.5V**
  - ILamp = 5mA

**◆ Burst Dimming**

- **Polarity : Negative**

![Diagram showing Burst Dimming](image)

- **CMP**
  - BCT = 1.8V
  - BDIM = 1.6V

- **CMP**
  - BCT = 1.7V
  - BDIM = 1.5V

- **CMP**
  - BCT = 1.6V
  - BDIM = 1.0V

- **CMP**
  - BCT = 0.95V
  - BDIM = 0.95V

**Duty**:
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 75%
Burst Dimming by external Pulse signal

◆ Burst Dimming implemented by external Pulse signal

Polarity : Negative

Burst Dimming implemented by external Pulse signal
Polarity : Positive

Burst signal to Error Amp.
External pulse signal
BDIM
BCT

Burst signal to Error Amp.
External pulse signal
BDIM
BCT

BDIM
BCT
I Lamp

BDIM
BCT
I Lamp
Product Roadmap - Backlight

2007
- P-N FB FAN7317
- N-N HB FAN7316

2008
- P-P FAN7313
- MOS Integrated (4Lamp) N-N HB FAN7320
- Low Cost (2 Lamp) P-N HB FAN7318

2009
- P-P FAN7313A
- MOS Integrated N-N HB FAN732X
- Protection Integrated P-N HB FAN7318A

2010
- Super IP Solution
- RGB 3Ch. FAN7344
- 8Ch WLED FAN7342

2011
- RGB LED FAN7344X
- WLED FAN7342X
- 8Ch WLED FAN7343
- WLED FAN7343X

- Channel Optimization
- High efficiency

CCFL
- P-P FAN7319
- N-N HB FAN732X

LED
- P-P FAN733X
- N-N HB FAN732X
- Customer optimized