

# **F72820**

---

## **Synchronous Buck PWM DC-DC Controller**

**Release Date: July, 2007**  
**Version: V0.24P**

**F72820 Datasheet Revision History**

| Version | Date     | Page | Revision History            |
|---------|----------|------|-----------------------------|
| 0.21P   | Mar/2005 |      | Preliminary version         |
| 0.22P   | Jun/2005 | 14   | Update application circuit  |
| 0.23P   | Mar/2006 | 15   | Correct application circuit |
| 0.24P   | Jul 2007 | 13   | Update company address      |

Please note that all data and specifications are subject to change without notice. All the trade marks of products and companies mentioned in this data sheet belong to their respective owners.

**LIFE SUPPORT APPLICATIONS**

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Fintek for any damages resulting from such improper use or sales.

## Table of Content

---

|     |   |    |
|-----|---|----|
| 1.  | General Description .....                 | 1  |
| 2.  | Feature List .....                        | 1  |
| 3.  | Pin Configuration .....                   | 2  |
| 4.  | Block Diagram.....                        | 2  |
| 5.  | Pin Description.....                      | 3  |
| 6.  | Function Description .....                | 4  |
| 6.1 | Bootstrap Operation .....                 | 4  |
| 6.2 | Dual Power Operation.....                 | 4  |
| 6.3 | Soft-Start .....                          | 5  |
| 6.4 | Over-current Protection.....              | 5  |
| 6.5 | Under-voltage Protection .....            | 6  |
| 6.6 | Output Voltage Selection.....             | 7  |
| 6.7 | Converter Shut Down.....                  | 7  |
| 6.8 | PWM Controller Feedback Compensation..... | 7  |
| 6.9 | Typical Characteristic .....              | 9  |
| 7.  | Electrical Characteristic.....            | 11 |
| 8.  | Ordering Information .....                | 12 |
| 9.  | Package Dimensions (8-SOP/150 mil).....   | 13 |
| 10. | Application Circuit .....                 | 14 |

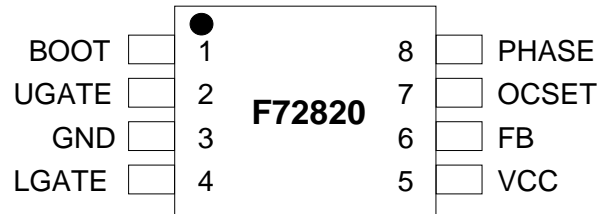
## 1. General Description

The F72820 is a single PWM DC-DC converter controller for application requiring high current such as motherboard, graphic card etc. The F72820 uses voltage mode PWM controller with fast transient response (driving two external N-channel MOSFETs in a synchronous rectified buck converter topology) and integrates some functions such as soft-start, over current and short circuit protections etc. Over current protection is achieved by monitoring the voltage drops across the high side MOSFET without the need for a current sensing resistor and short circuit condition is detected through FB pin. If fault conditions occur, the F72820 will initiate the soft start cycle. After three cycles and the fault conditions persist, the controller will go into shut down status. In shut down status, both gate drive signals will be low. To restart the controller, either recycling the Vcc supply or momentarily pulling OCSET pin below 1.25V. The F72820 is available in 8-SOP package.

## 2. Feature List

- ◆ Provides one synchronous rectified buck DC-DC PWM controller
  - Fast transient response (high bandwidth error amplifier; full 0~100% duty cycle)
  - Fixed operation frequency : 300KHz
  - Single loop voltage-mode control
  - Few external components
  - Output range adjustable down to 0.8V
- ◆ Operation is under 5V input
- ◆ Drives external N-channel MOSFETs
- ◆ Over current monitor is used by MOSFET  $R_{DS(ON)}$
- ◆ 0.8V internal reference voltage
  - $\pm 2\%$  accuracy over line, load and temperature
- ◆ Internal soft-start (typically 3 ms)
- ◆ Internal loop compensation
- ◆ Under voltage fault monitoring and protection
- ◆ Over voltage protection
- ◆ 8-SOP package (150 mil)

### 3. Pin Configuration



### 4. Block Diagram

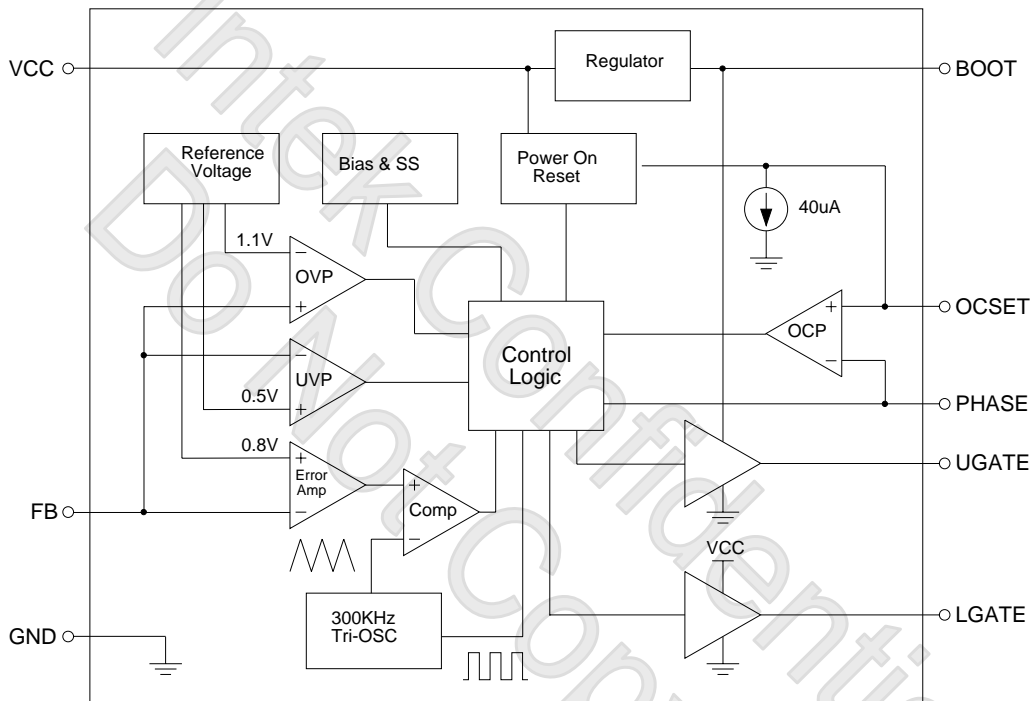
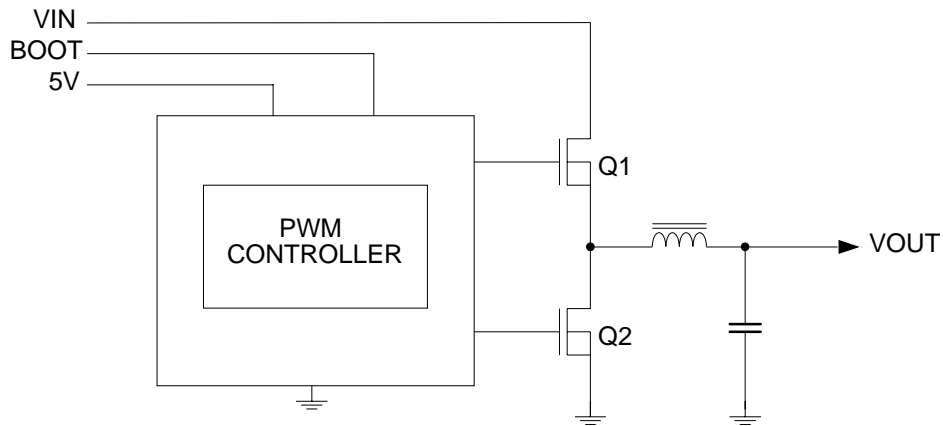


Figure 1: Block Diagram



**Figure 2:** Simplified power system diagram

## 5. Pin Description

- AIN - Input pin(Analog)  
 AOUT - Output pin(Analog)  
 P - Power

| Pin No | Pin Name | TYPE     | PWR  | Description  |
|--------|----------|----------|------|--|
| 1      | BOOT     | P        |      | Provide ground reference voltage for high side MOSFET by bootstrap circuit or ATX 12V.   |
| 2      | UGATE    | AOUT     | BOOT | Higher gate drive output. Connect this pin to gate of the high side MOSFET   |
| 3      | GND      | P        |      | Power ground pin for the chip  |
| 4      | LGATE    | AOUT     | VCC  | Lower gate drive output. Connect this pin to gate of the low side MOSFET   |
| 5      | VCC      | P        |      | IC supply voltage. This voltage is monitored for power-on-reset purpose.   |
| 6      | FB       | AIN      | VCC  | Inverting input of the error amplifier used to compensate the feedback loop of the PWM controller.   |
| 7      | OCSET/SD | AOUT/AIN | VCC  | This is multi-function pin. Connecting a resistor from this pin to drain of high side MOSFET and an internal 40uA current source to ground. OCSET voltage is reference for over current detect. When OCSET voltage is under 1.25V, shut down function will be enabled. |
| 8      | PHASE    | AIN      | VCC  | Connect to high side MOSFET source and monitor its voltage drop for over current protection.   |

## 6. Function Description

The F72820 is a single PWM DC-DC converter controller for application requiring high current such as motherboard, graphic card etc. The F72820 uses voltage mode PWM controller with fast transient response (driving two external N-channel MOSFETs in a synchronous rectified buck converter topology) and integrates some functions such as soft-start, over current and short circuit protections etc. Over current protection is achieved by monitoring the voltage drop across the high side MOSFET, eliminating the need for a current sensing resistor and short circuit condition is detected through the FB pin. If fault conditions occur, the F72820 would initiate the soft start cycle. After three cycles and the fault condition persist, the controller will go into shut down status. In shut down, both gate drive signals will be low. To restart the controller, either recycle the Vcc supply or momentarily pull the OCSET pin below 1.25V.

### 6.1 Bootstrap Operation

In single power supply system, the UGATE is powered by an external bootstrap circuit as Fig 3. The Boot capacitor,  $C_{BOOT}$  is charged and generated a floating reference voltage at phase pin. Typically a 0.1 $\mu$ F  $C_{BOOT}$  is enough for the most of applications. The  $C_{BOOT}$  capacitor is refreshed and charged to a voltage of "VCC – Diode Drop" while low side power MOS turning on.

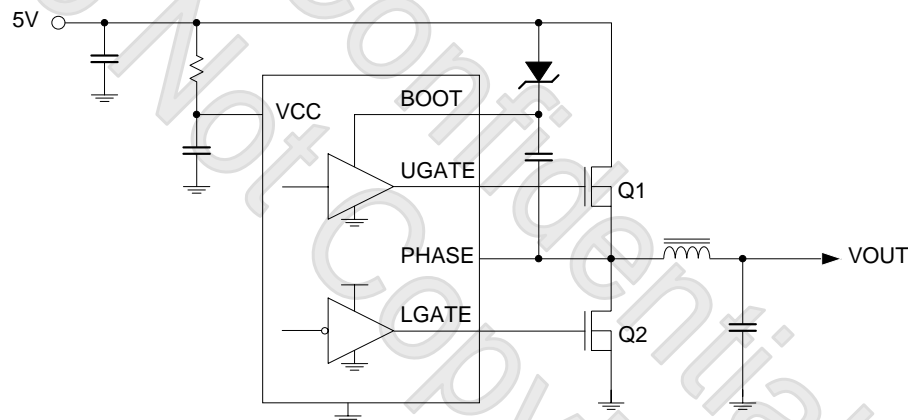


Fig 3. Single 5V Power Supply Operation.

### 6.2 Dual Power Operation

The F72820 Power-on-reset monitors VCC supply voltage and input voltage at the OCSET pin. POR level is 3.8V with 0.5V hysteresis at VCC voltage and 1.25V at OCSET voltage, The POR function initiates soft-start operation and reset control logic after these supply voltages exceed their POR threshold voltages.

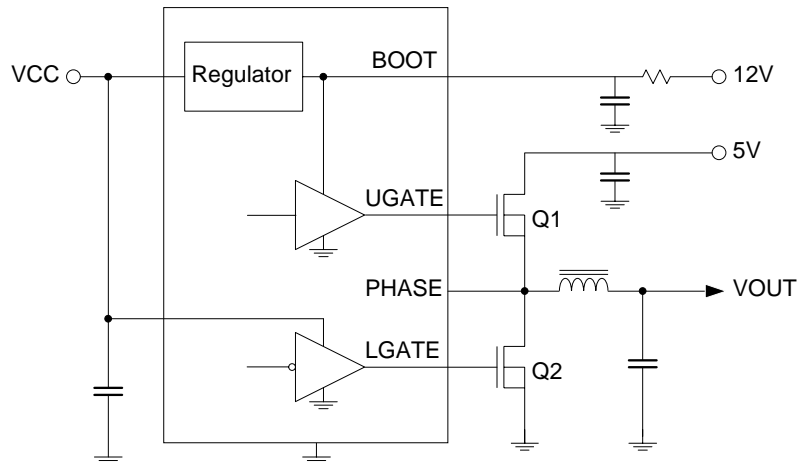


Figure 4

### 6.3 Soft-Start

The POR function initiates the digital soft-start sequence; the soft start function is used to prevent surge current from power supply input during power on. When soft start event, PWM error amplifier reference inputs are forced to track a voltage level proportional to the soft-start voltage. As the soft-start voltage slews up, the PWM comparator regulates the output relative to the tracked soft-start voltage, slowly charging the output capacitor(s), the soft start duration is 3mS in typical case.

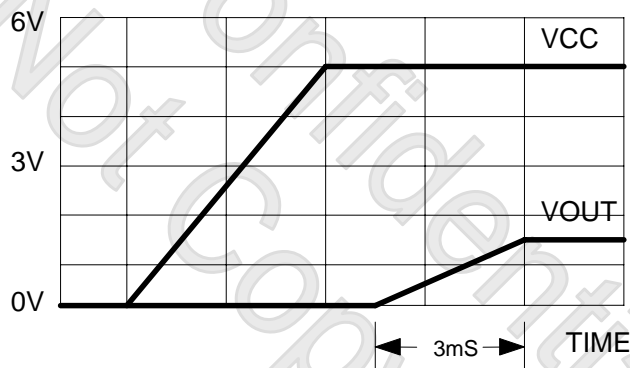


Figure 5

### 6.4 Over-current Protection

The over current protection function of the F72820 is trigger when the voltage across the RDS (ON) of upper side MOSFET the developed by drain current exceeds over-current tripping level. An external resistor (ROCSET) programs the over-current tripping level of the PWM converter. As show on Figure 6, the internal 40uA current sink develops a voltage across ROCSET that is reference to VIN. The over current comparator detect over current event when UGATE is high and PHASE voltage is under OCSET voltage. When OC be detected, over current protect function will soft start three times and check over current again. If over current event is true, the F72820 will be shut down.

OVER-CURRENT TRIP:

$$V_{DS} > V_{SET}$$

$$I_D \times R_{DS(ON)} > I_{OCSET} \times R_{OCSET}$$

$$V_{PHASE} = V_{IN} - V_{DS}$$

$$V_{OCSET} = V_{IN} - V_{SET}$$

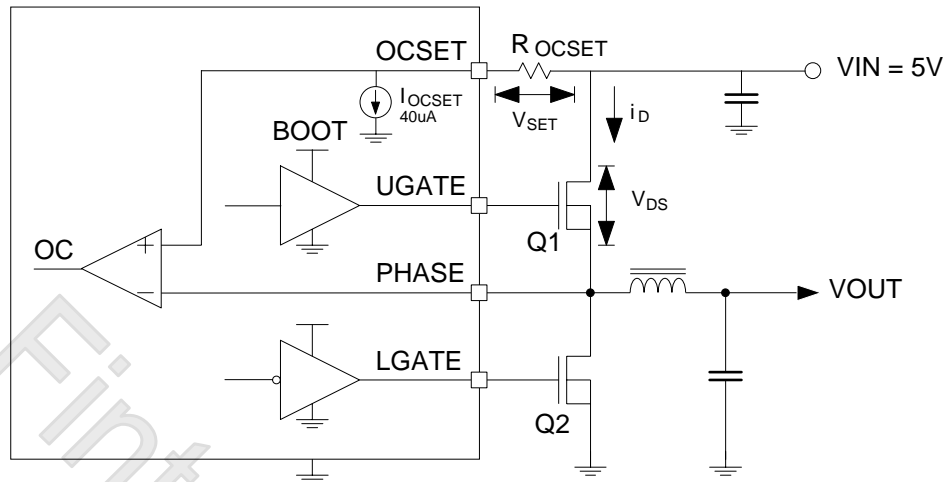


Figure 6

## 6.5 Under-voltage Protection

Pins FB are monitored during converter operation by under-voltage (UV) comparators. If the FB voltage drops below 0.5V, a fault signal is generated. The internal fault logic shut down regulator simultaneously when the fault signal triggers a restart. At time  $t_0$ ,  $V_{OUT}$  has dropped below 0.5V of the nominal output voltage. Output is quickly shut down and the internal soft-start function begins producing soft-start ramps. The delay interval,  $t_0$  to  $3 \times t_{ss}$ , seen by the output is equivalent to three soft-start cycles. After a short delay interval of 10.5ms, the fourth internal soft-start cycle initiates a normal soft-start ramp of the output, at time  $3 \times t_{ss}$ . Both outputs are brought back into regulation by time  $4 \times t_{ss}$ , as long as the UV event has cleared. When the cause of the UV still been present after the delay interval. A fault signal could then be generated and the outputs once again shutdown.

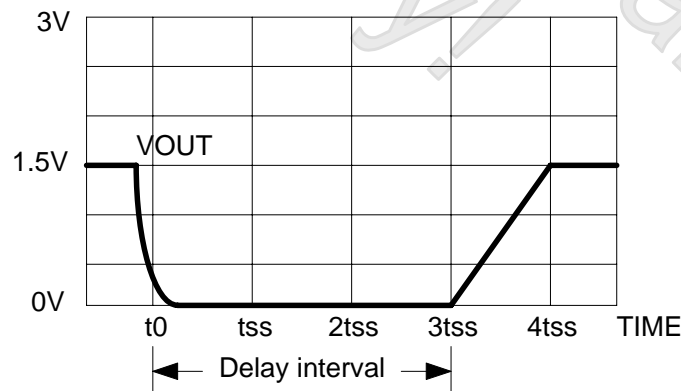


Figure 7

## 6.6 Output Voltage Selection

The output voltage of the PWM converter can be programmed to any level between VIN (i.e. 5+V) and the internal reference, 0.8V. An external resistor divider is used to scale the output voltage relative to the reference voltage and feed it back to the inverting input of the error amplifier, see Figure 8. Depending on the value chosen for R1 (the resistor connected between VOUT1 and FB), R4 (the resistor connected from FB to GND) can be calculated based on the following equation:

$$R4 = \frac{R1 \times 0.8V}{VOUT - 0.8V} \quad (EQ1)$$

If the desired output voltage is 0.8V, simply route VOUT back to FB through R1, but do not populate R4.

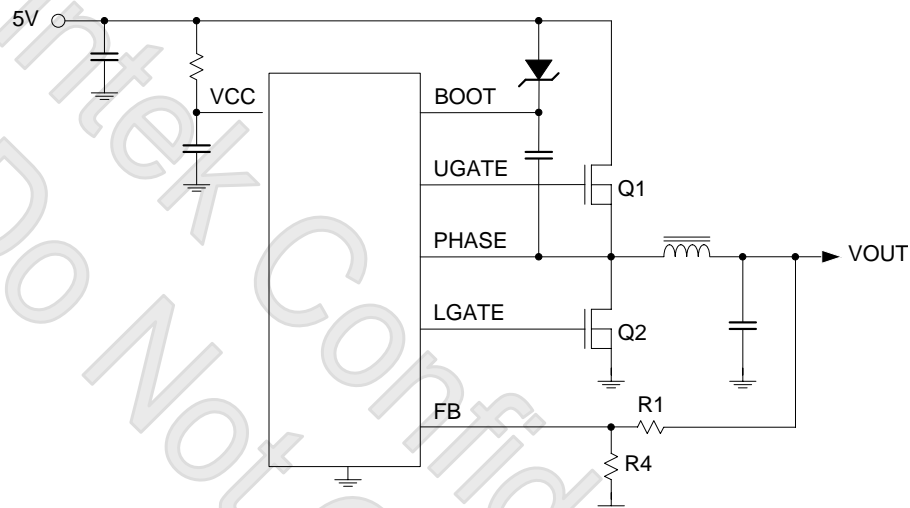


Figure 8: Output voltage selection

## 6.7 Converter Shut Down

Pulling low the OCSET pin by a small signal transistor can shutdown the F72820 PWM controller as show is typical application circuit.

## 6.8 PWM Controller Feedback Compensation

The F72820 is a voltage mode step down PWM controller. The gain of error amp is fixed at 34dB for simplified design and saving external components. The amplitude of internal Tri-wave OSC is 1.75V. The loop gain and loop Zero/Pole are calculated as follow equations.

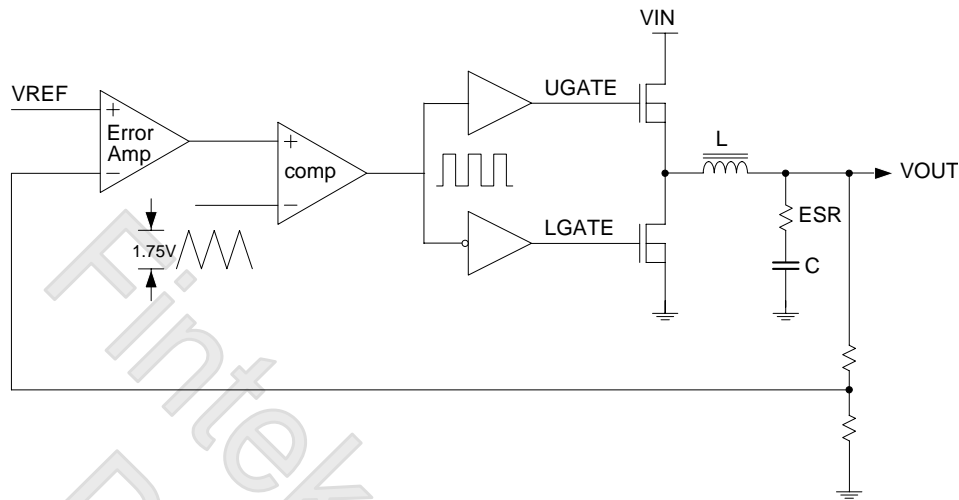
# F72820

$$\text{DC\_Loop\_Gain} = 34\text{dB} \times \frac{5}{1.8} \times \frac{0.8}{V_{\text{out}}}$$

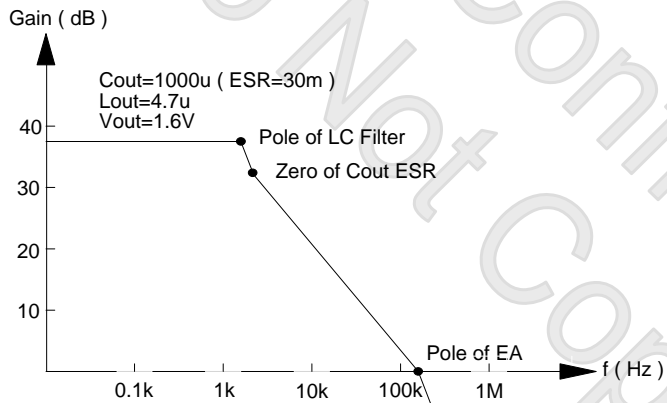
$$\text{Pole\_of\_LC\_Filter} = \frac{1}{2\pi\sqrt{LC}}$$

$$\text{Pole\_of\_EA} = 130\text{kHz}$$

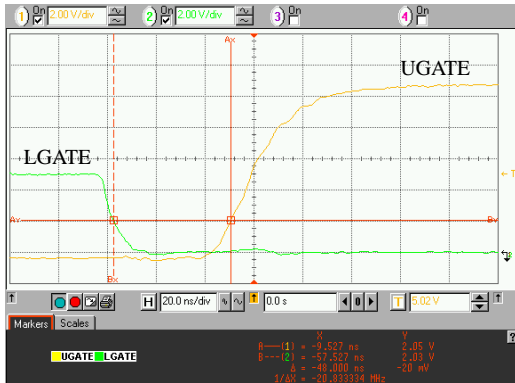
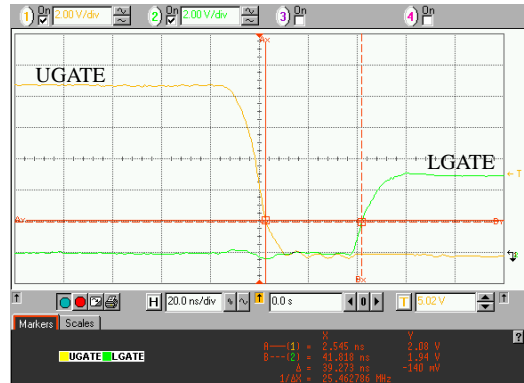
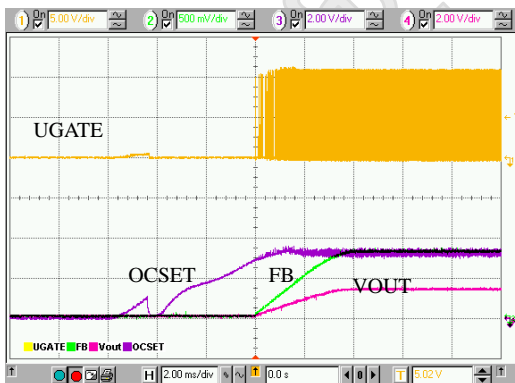
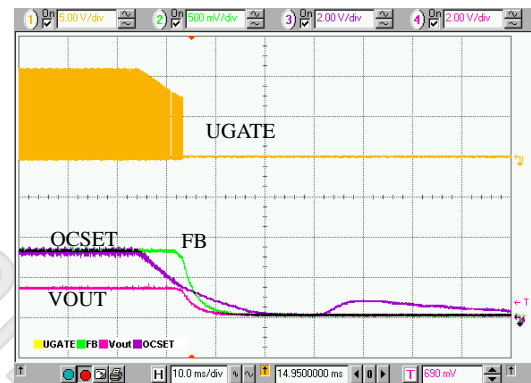
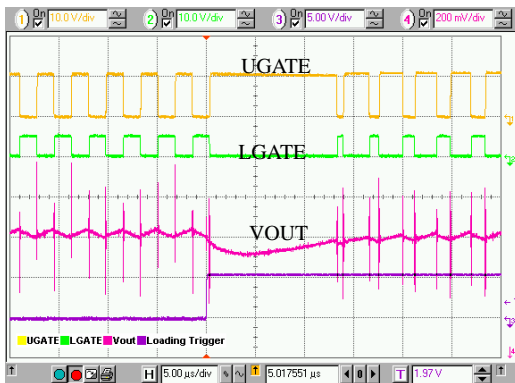
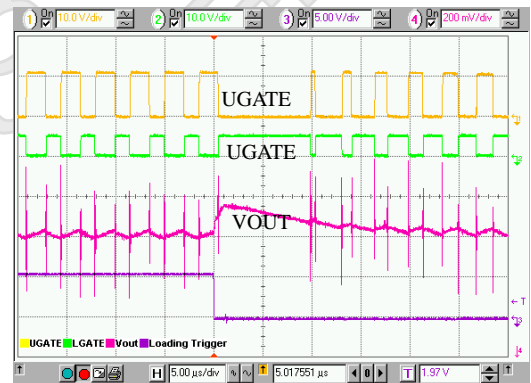
$$\text{Zero\_of\_Output\_Cap\_ESR} = \frac{1}{2\pi \times \text{ESR} \times C}$$



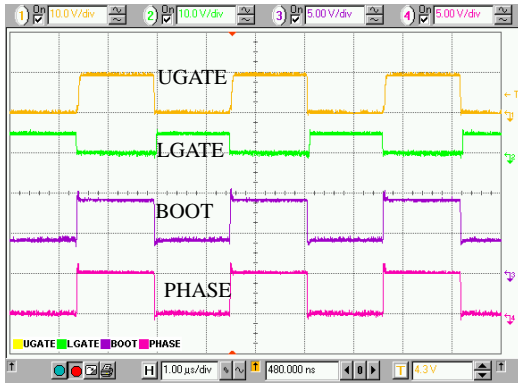
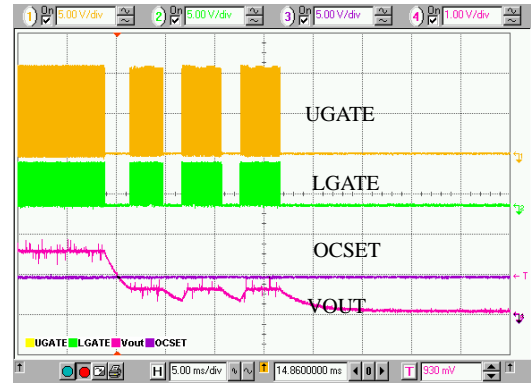
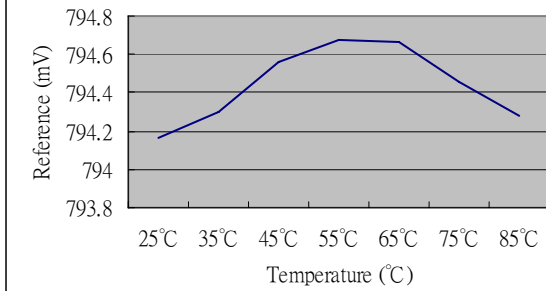
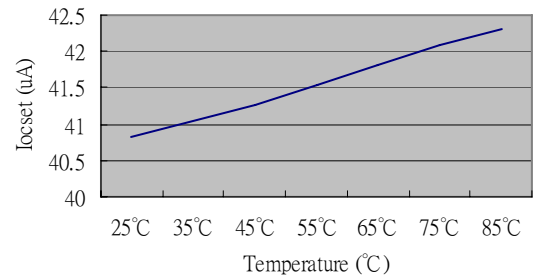
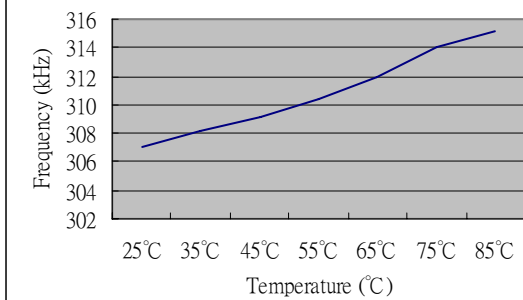
The F72820 Bode plot as shown Figure 9



## 6.9 Typical Characteristic

**Dead time**

**Dead time**

**Power up**

**Power off**

**Load transient response**

**Load transient response**


# F72820

**Bootstrap Wave Form**

**Over-Current Protect**

**Reference VS Temperature**

**Iocset VS. Temperature**

**Oscillator Frequency VS. Temperature**


## 7. Electrical Characteristic

### Absolute Maximum Ratings

| PARAMETER                                      | SYMBOL           | RATINGS      | UNIT |
|--|------------------|--------------|------|
| IC supply voltage                              | VCC              | 7            | V    |
| Gate drivers supply voltage                    | 12VCC            | 15           | V    |
| PWM controller outputs                         | UGATE, LGATE     |              | V    |
| Feedback voltages of both regulators           | FB, FB2, COMP    | GND - 0.3-17 | V    |
| ESD classification                             | HBM              | 2            | kV   |
| Maximum junction temperature (plastic package) | T <sub>j</sub>   | 150          | °C   |
| Maximum storage temperature                    | T <sub>STO</sub> | -65 ~ 150    | °C   |
| Maximum lead temperature (soldering 10s)       |                  | 260          | °C   |

Note: If ICs are stressed beyond the limits listed in the “absolute maximum ratings”, they may be permanently destroyed. These are stress ratings only and functional operation of the device at these or any other condition beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

### Package thermal information

| PARAMETER                           | SYMBOL | SOIC | UNIT |
|-------------------------------------|--------|------|------|
| Thermal resistance junction-ambient | Rth_ja | 133  | °C/W |

### DC and AC electrical characteristics

| PARAMETER                                   | SYMBOL            | TEST CONDITIONS              | MIN. | TYP.              | MAX. | UNIT             |
|---|-------------------|------------------------------|------|-------------------|------|------------------|
| <b>VCC SUPPLY CURRENT/Regulated Voltage</b> |                   |                              |      |                   |      |                  |
| Nominal supply current 5VCC                 | I <sub>CC</sub>   | UGATE, LGATE and DRIVE2 open |      | 2                 | 4    | mA               |
| Regulated Voltage from BOOT                 | V <sub>CC</sub>   | V <sub>BOOT</sub> = 12V      | 5.0  | 5.5               | 6    | V                |
| <b>POWER-ON RESET</b>                       |                   |                              |      |                   |      |                  |
| Rising VCC threshold                        |                   | VOCSET = 4.5V                |      | 3.8               | 4.0  | V                |
| Falling VCC threshold                       |                   | VOCSET1 = 4.5V               | 3.1  | 3.3               |      | V                |
| Rising V <sub>OCSSET</sub> Threshold        |                   |                              | 0.8  | 1.25              | 2.0  | V                |
| <b>OSCILLATOR AND Protection</b>            |                   |                              |      |                   |      |                  |
| Free running frequency                      | F <sub>osc</sub>  | V <sub>CC</sub> =5V          | 250  | 300               | 350  | kHz              |
| Ramp Amplitude                              | ΔV <sub>osc</sub> |                              |      | 1.75 <sup>*</sup> |      | V <sub>P-P</sub> |
| FB Over Voltage Trip                        |                   | FB Rising                    | 1.0  | 1.1               | 1.2  | V                |

# F72820

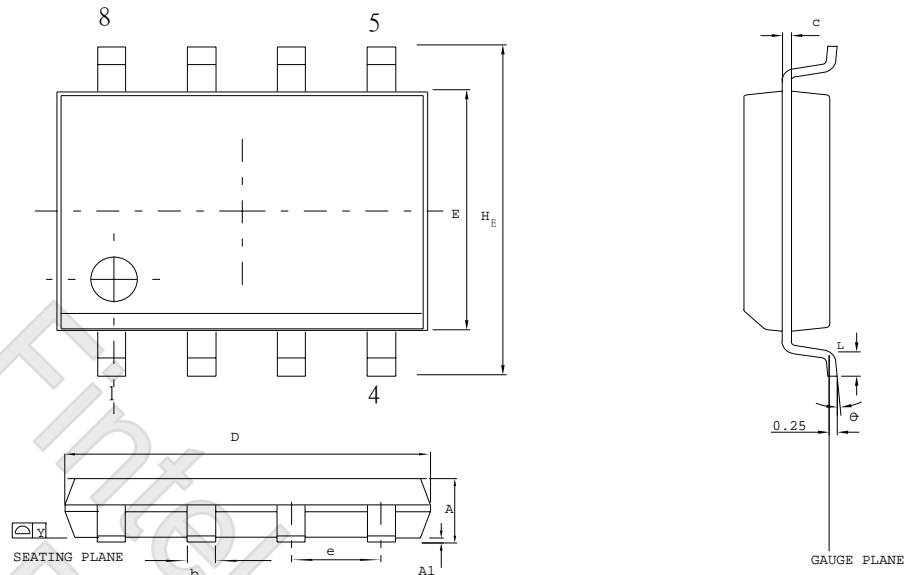
| PARAMETER                          | SYMBOL      | TEST CONDITIONS                      | MIN.  | TYP.            | MAX.  | UNIT     |
|------------------------------------|-------------|--------------------------------------|-------|-----------------|-------|----------|
| FB Under Voltage Trip              |             | FB Falling                           | 0.4   | 0.5             | 0.6   | V        |
| OCSET Current Source               | $I_{OCSET}$ | $V_{OCSET} = 4.5V$                   | 35    | 40              | 45    | uA       |
| Soft-start interval                | $T_{SS}$    |                                      | 1     | 3               | 6     | ms       |
| <b>REFERENCE VOLTAGE</b>           |             |                                      |       |                 |       |          |
| Reference voltage                  | $V_{REF}$   |                                      | 0.784 | 0.8             | 0.816 | V        |
| <b>PWM CONTROLLER GATE DRIVERS</b> |             |                                      |       |                 |       |          |
| Upper Drive Source                 | $R_{UGATE}$ | $BOOT = 12V ; BOOT - V_{UGATE} = 1V$ |       | 8               | 12    | $\Omega$ |
| Upper Drive Sink                   | $R_{UGATE}$ | $V_{UGATE} = 1V$                     |       | 4               | 6     | $\Omega$ |
| Lower Drive Source                 | $R_{LGATE}$ | $VCC - V_{LGATE} = 1V$               |       | 3               | 4.5   | $\Omega$ |
| Lower Drive Sink                   | $R_{LGATE}$ | $V_{LGATE} = 1V$                     |       | 2               | 3     | $\Omega$ |
| <b>Error Amplifier</b>             |             |                                      |       |                 |       |          |
| DC Gain                            |             |                                      |       | 34 <sup>°</sup> |       | dB       |

Note: Design Guarantee

## 8. Ordering Information

| Part Number | Package Type          | Production Flow          |
|-------------|-----------------------|--------------------------|
| F72820 SG   | 8-SOP (Green Package) | Commercial, 0°C to +70°C |

## 9. Package Dimensions (8-SOP/150 mil)



Control demensions are in milimeters .

| SYMBOL         | DIMENSION IN MM |      | DIMENSION IN INCH |       |
|----------------|-----------------|------|-------------------|-------|
|                | MIN.            | MAX. | MIN.              | MAX.  |
| A              | 1.35            | 1.75 | 0.053             | 0.069 |
| A1             | 0.10            | 0.25 | 0.004             | 0.010 |
| b              | 0.33            | 0.51 | 0.013             | 0.020 |
| c              | 0.19            | 0.25 | 0.008             | 0.010 |
| E              | 3.80            | 4.00 | 0.150             | 0.157 |
| D              | 4.80            | 5.00 | 0.188             | 0.196 |
| e              | 1.27 BSC        |      | 0.050 BSC         |       |
| H <sub>E</sub> | 5.80            | 6.20 | 0.228             | 0.244 |
| Y              | 0.10            |      | 0.004             |       |
| L              | 0.40            | 1.27 | 0.016             | 0.050 |
| θ              | 0               | 10   | 0                 | 10    |


**Feature Integration Technology Inc.**

### Headquarters

3F-7, No 36, Tai Yuan St.,  
Chupei City, Hsinchu, Taiwan 302, R.O.C.

TEL : 886-3-5600168

FAX : 886-3-5600166

www: <http://www.fintek.com.tw>

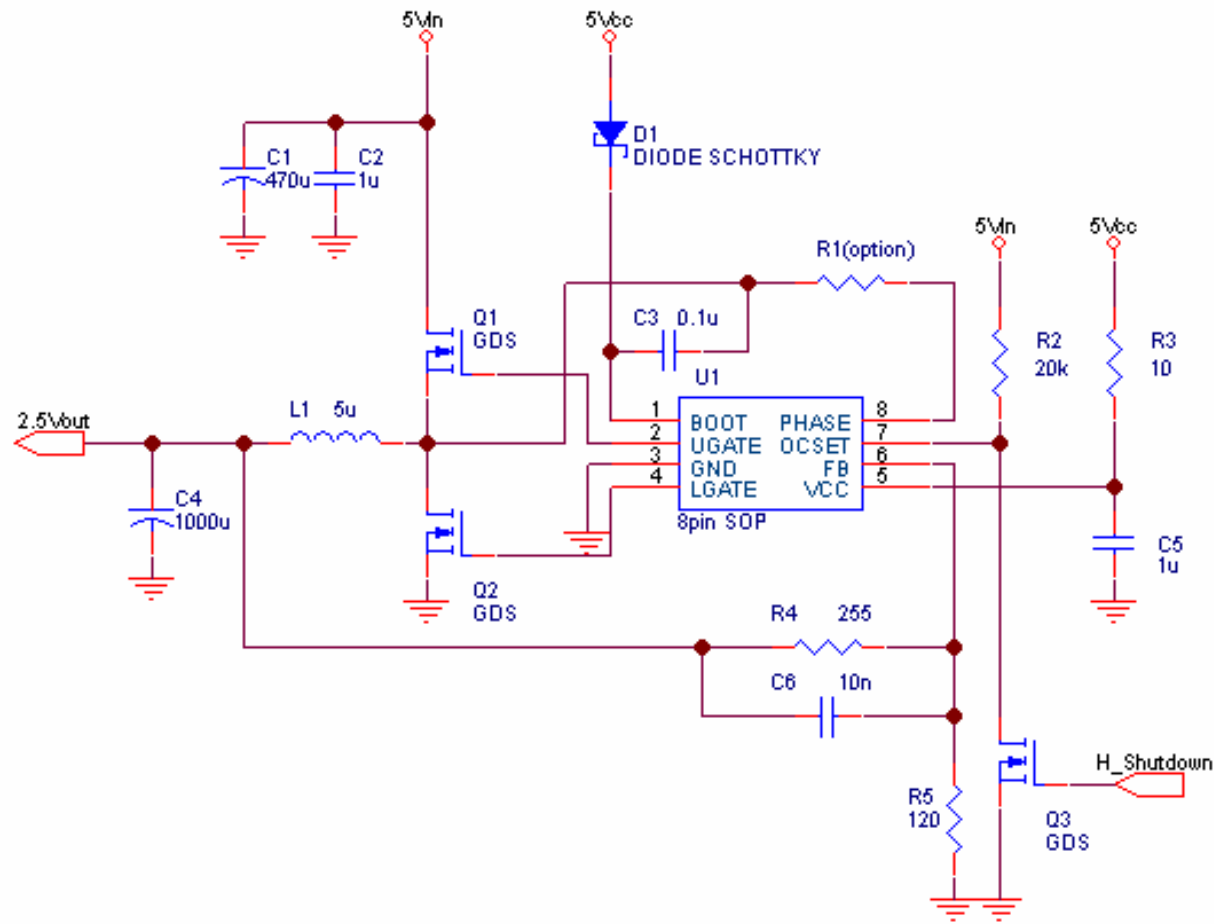
### Taipei Office

Bldg. K4, 7F, No.700, Chung Cheng Rd.,  
Chungho City, Taipei, Taiwan 235, R.O.C.

TEL : 866-2-8227-8027

FAX : 866-2-8227-8037

**Please note that all datasheet and specifications are subject to change without notice. All the trade marks of products and companies mentioned in this datasheet belong to their respective**

**F72820**
**10. Application Circuit**
**F72820S 5v single power supply application circuit**


# F72820

## F72820S 12v single power supply application circuit

