# Low-Power Off-Line CC/CV Controller

## FEATURES

- Constant-Current (CC) and Constant-Voltage (CV) with Primary Side Control
- Proprietary technology enabling high efficiency and fast dynamic response
- No audible noise over entire operating range
- Applications from 1W to more than 18W output
- Direct drive of BJT or MOS switch
- Built-in Cable Compensation
- Built-in Line Compensation
- Primary-side feedback eliminates opto-coupler and TL431
- Cycle-by-Cycle Current Limiting
- Over Temperature Protection
- VCC Over Voltage Protection
- Open Circuit Protection

## TYPICAL APPLICATION

- Adapter/Charger for Cell/Cordless Phones, PDAs, MP3 and Other Portable Apparatus
- Standby and Auxiliary Power Supplies Set Top Boxes (STB)
- AC/DC LED Driver applications

## DESCRIPTION

The FT838D/FT838R controller device is optimized for high-performance, low power switching mode power supply applications. The FT838D/FT838R facilitates CC/CV charger design by eliminating an opto-coupler and TL431. Its highly integrated functions such as Under Voltage Lockout (UVLO), Leading Edge Blanking (LEB) and built-in cable compensation offer the users a high efficiency and low cost solution for AC/DC power applications.

Power supplies built with FT838D can achieve both highest average efficiency and fast dynamic load response. FT838R is optimized for LED driver applications with slightly higher (~22uA) standby current.

Furthermore, FT838D/FT838R features fruitful protections like Open Circuit Protection and Over Temperature Protection to eliminate the external protection circuits and provide reliable operations. FT838D/FT838R is avilabel in SOT23-5 package.

## TYPICAL APPLICATION CIRCUIT

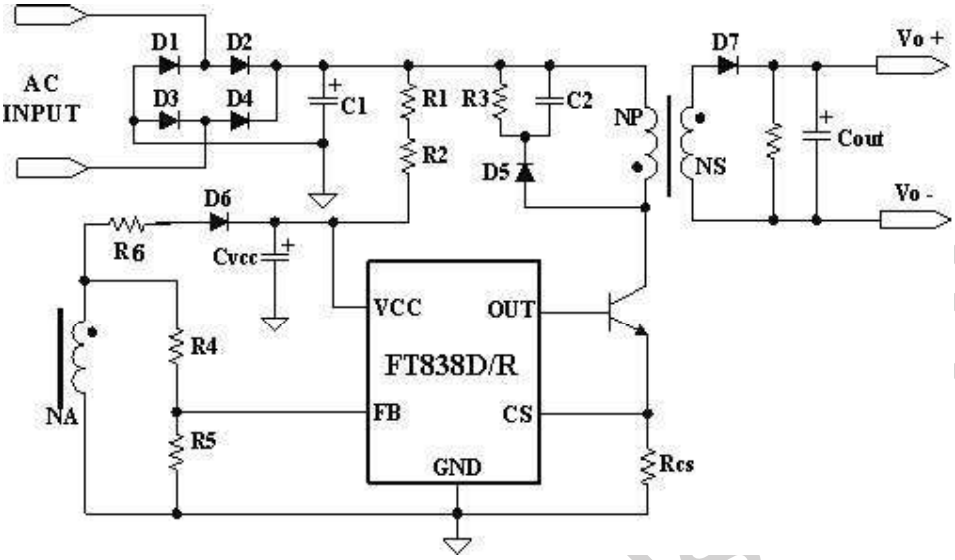



**Figure 1: Typical Application Circuit**

### ABSOLUTE MAXIMUM RATINGS

FB to GND..... -0.3V to +7V
CS to GND.....-0.3V to +7V
VCC to GND.....-0.3V to +30V
OUT to GND.....-0.3V to +7V
Operating Temperature Range.....-40℃ to +125℃
Junction Temperature..... -40℃ to +150℃
Storage Temperature Range ..... -60℃ to +150℃
ESD Protection HBM.....2000V
ESD Protection MM.....200V

**Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.**

## PIN CONFIGURATION

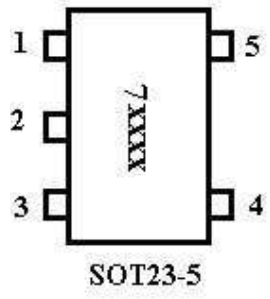


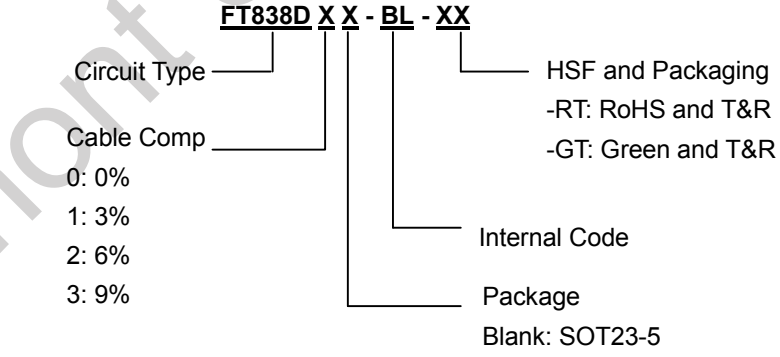

**Figure 2: Pin Assignments**

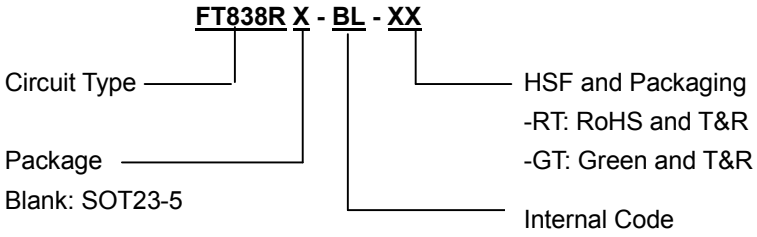
## Pin Definition

| Pin #. | Name | I/O | Pin Description |
|---|---|---|---|
| 1 | FB | I | Output voltage feedback pin |
| 2 | GND | I | Ground. |
| 3 | CS | I | Primary current sense |
| 4 | OUT | O | NPN base or MOS gate driver |
| 5 | VCC | I | Supply voltage |

**Table1: Pin Definition**

## ORDERING INFORMATION



| Device | DESIGNATOR | SYMBOL | Options |
|---|---|---|---|
| FT838D① | ① | 0 | Cable Comp = 0% |
| | | 1 | Cable Comp = 3% |
| | | 2 | Cable Comp = 6% |
| | | 3 | Cable Comp = 9% |
| FT838R | ／ | ／ | Cable Comp = 0%<br>For LED driver applications |

**Table 2**

## MARKING RULE

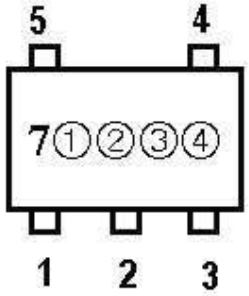



**Figure 3 marking rule**

①: Represents Version (0,1,2 or 3)
②: Represents Device (D or R)
③④: for internal reference

## BLOCK DIAGRAM

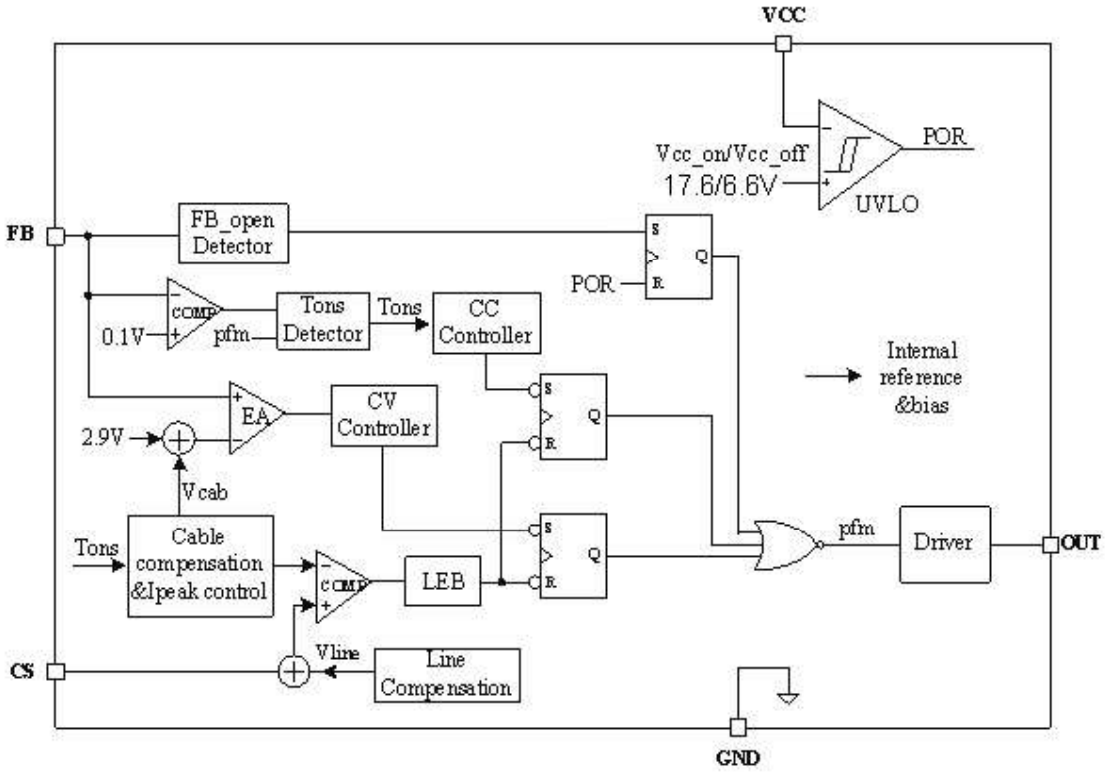



**Figure 4: FT838D/FT838R Block Diagram**

## ELECTRICAL CHARACTERISTICS

(For typical values Tj=25℃, Vcc=12V, unless otherwise noted)

| Characteristic | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| **Current Sense** | | | | | | |
| Maximum Current Threshold | | Vcs_max | 541 | 552 | 563 | mV |
| Leading Edge Blanking Duration | | Tleb | 350 | 400 | 450 | ns |
| Propagation Delay (OUT=1.0nF to GND) | | Tpd | | | 200 | ns |
| **Feedback Section** | | | | | | |
| Feedback Voltage Threshold | | Vfb | 2.856 | 2.9 | 2.944 | V |
| CCM protection Threshold Level | | Vcp | | 100 | | mV |
| **Supply Section** | | | | | | |
| Start Up Threshold Voltage | | Vcc_on | 16.5 | 17.6 | 18.5 | V |
| Under Voltage Lockout Voltage | | Vcc_off | 6 | 6.6 | 7 | V |
| VCC Start Up Current | FT838D | Istart_up | | 2 | 5 | uA |
| | FT838R | | 14 | 22 | 30 | |
| Operating Current | | Iop | 0.4 | 0.5 | 0.7 | mA |
| **Protection Section** | | | | | | |
| Feedback Loop Open Protection | | Ifb_open | 120 | 140 | 160 | uA |
| VCC Over Voltage Protection | | Vcc_OVP | 26 | 27.5 | 29 | V |
| Over Temperature Protection | | T_OTP | | 145 | | ℃ |
| **Base Driver** | | | | | | |
| Output low level ON-resistance | | Rdson | | 2 | | Ω |
| Output Maximum Source current | | Isource | 25 | 30 | 35 | mA |
| Output sourcing current after pre-off | | Is_preoff | | 1.4 | | mA |
| Output clamp voltage | | Vbase | | 9 | | V |
| **Compensation** | | | | | | |
| Line Compensation (Ifb=1mA) | | Vline | 30 | 33 | 36 | mV |
| Cable compensation | 0 | Kcab | | 0 | | % |
| | 1 | | | 3 | | |
| | 2 | | | 6 | | |
| | 3 | | | 9 | | |

**Table 3**

# FUNCTIONAL DESCRIPTION

**Operating Description**

FT838D/FT838R is a cost effective and high-performance AC-DC power supply controller for off-line low power AC-DC applications including battery chargers, adaptors and LED lighting. The constant voltage (CV) and constant current (CC) control are achieved accurately without the secondary feedback circuit,.

**Start up Control**

Start-up current of FT838D is very low so that a start-up resistor with high resistance and low-wattage is allowed to supply the start-up power for the controller. The large value startup resistor minimizes the power loss in operations and allows quick start up. FT838R increases the start-up current slightly to ensure the smooth shutting down operations in LED lighting applications with relaxed requirement on external board design.

**Operating current**

The operating current of FT838D/FT838R is as low as 500uA. Good efficiency is achieved with the low operating current. Low operating current also reduces the Vcc hold-up capacitance requirement.

**Constant voltage (CV) and constant current (CC) Operation**

The FT838D/FT838R can accurately achieve CV/CC characteristic output without secondary side voltage and current-feedback circuits. It operates in CV mode to regulate the output voltage by capturing the auxiliary winding feedback voltage at FB pin. The auxiliary winding feedback voltage is proportional to secondary winding, so it provides controller the feedback signal from secondary side and achieves constant-voltage output. In CC mode, the controller detects the secondary discharger peak current and the discharger time, which determines the off-time of the base or gate driver to make the output average current constant.

**Primary peak current modulation**

Primary peak current is constant at constant current mode. And primary peak current is modulated at constant voltage mode for the purposes of good dynamic load response and no audible noise over entire operating range. According to the output loading current the current threshold voltage is modulated from 0.55V to 0.27V. The current threshold voltage is 0.55V at rated load and 0.27V at light load.

**Leading edge blanking**

Each time the power transistor is switched on, a turn-on spike occurs at the sense resistor. To avoid premature termination of the switching pulse, a 400ns leading edge blanking time is built in. Conventional RC filtering can therefore be omitted. During this blanking period, the current limit comparator is disabled and cannot switch off the base or gate driver.

**Under voltage lockout (UVLO)**

FT838D/FT838R turn-on Vcc_on and turn-off Vcc_off are 17.6 V and 6.6 V, respectively. During start-up, the hold-up capacitor must be charged to 17.6V through the start-up resistor. The hold-up capacitor continues to supply Vcc until power can be delivered from the auxiliary winding of the transformer. Vcc must not drop below 6.6 V during this start-up process. This UVLO hysteresis window ensures that hold-up capacitor is sufficient to supply Vcc during start-up.

**Protection control**

With rich protection features of FT838D/FT838R, excellent power supply system reliability can be achieved. The protection features including cycle by cycle current limiting, Vcc over voltage protection and clamp, over temperature protection, feedback loop open circuit protection and Vcc under voltage lockout.

**Base or gate driver**

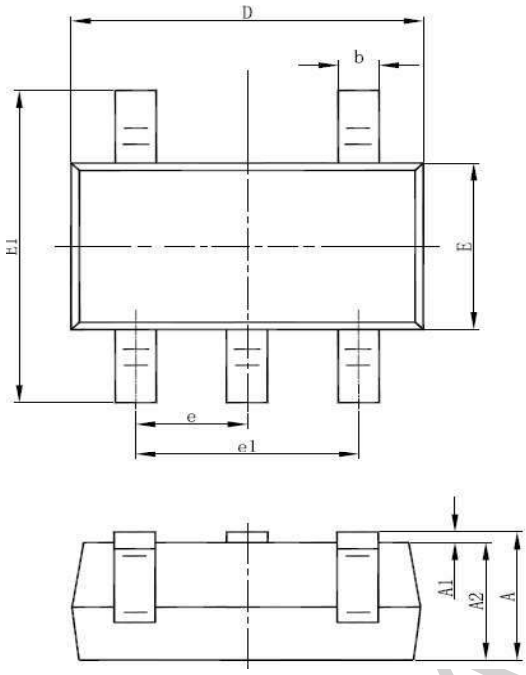
To minimize loss in the primary power NPN and to prevent it from secondary breakdown, the driving current profile is carefully controlled. The driving current is nominally 30mA.The FT838D/FT838R can also drive power MOS for high power applications.

**Output cable compensation**

The output cable compensation provides a constant output voltage at the end of the cable over the entire load rang in constant voltage mode. As the converter load increases from no-load to the peak current load, the voltage drop introduced across the output cable is compensated by increasing the feedback pin reference voltage.

## PACKAGE INFORMATION

### SOT23-5 Package




| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.95 (BSC) | | 0.037 (BSC) | |
| e1 | 1.800 | 2.000 | 0.071 | 0.079 |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 6° |

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