High Performance Low Cost Off-line PWM Power Switch

FEATURES

- **Integrated with 500V Power MOSFET and HV Startup Circuit**
- **Integrated with Freewheeling Diode**
- **Multi-Mode Control with Audio Noise Free Operation**
- **Supports Buck and Buck-Boost Topologies**
- **Support Ultra-low Input Voltage (>20V)**
- **Less than 100mW Standby Power**
- **Up to 30kHz Maximum Frequency**
- **Good Line and Load Regulation**
- **Built-in Soft Start**
- **Build in Protections:**
    - **Over Load Protection (OLP)**
    - **Cycle-by-Cycle Current Limiting (OCP)**
    - **Output OVP**
    - **On-chip OTP**
- **Available with SOP-8 Package**

APPLICATIONS

- **Smart Lighting**

GENERAL DESCRIPTION

FC35064 is a high performance Switch Mode Power Supply Switcher for low power off-line application with minimum components in typical buck solution. This IC has built-in high break down voltage MOSFET to withstand high surge input.

Unlike conventional PWM control, there's no fixed internal clock in FC35064 to trigger the GATE driver, the switching frequency is changed according to the load condition. The multi-mode PWM control is integrated to simplify circuit design and achieve good line and load regulation without audio noise generated. The peak current limit changes according to the real load condition for low standby power in no load.
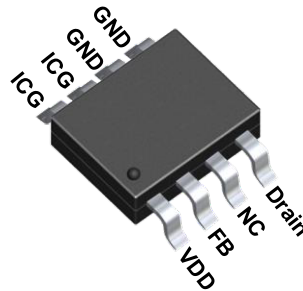
FC35064 integrates functions and protections of Under Voltage Lockout (UVLO), Cycle-by-cycle Current Limiting (OCP), Output OVP, On-chip Thermal Shutdown, Over Load Protection (OLP) with Auto Recovery Mode Protection, etc.

TYPICAL APPLICATION CIRCUIT
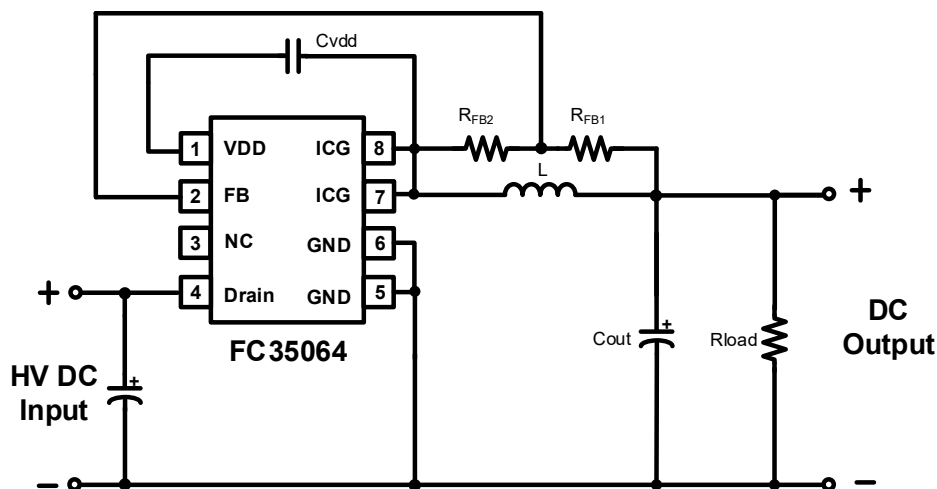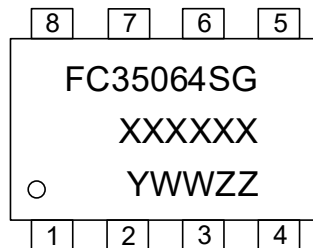
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Pin Configuration

SOP-8

Marking Information

XXXXXX: Wafer Lot Code
Y: Year Code
WW: Week Code, 01-52
ZZ: Serial Number, 01-99 or A0-ZZ

FC35064SG
XXXXXX
YWWZZ

SOP-8

Pin Description

Pin Number	Pin Name	I/O	Description
1	VDD	P	The power supply and the output voltage feedback pin. For the normal operation, a capacitor with 1µF is recommended to connect to this pin
2	FB	I	Feedback Input
3	NC	/	No Connection
4	Drain	P	The Power MOSFET Drain
5,6	GND	P	The Ground Reference for the IC
7,8	ICG	P	The Ground of the IC

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Ordering Information

Part Number	Description
FC35064SGA	SOP-8, Halogen free in T&R, 4000 Pcs/Reel

Note: Suffix "A" - Tape&Reel

Block Diagram
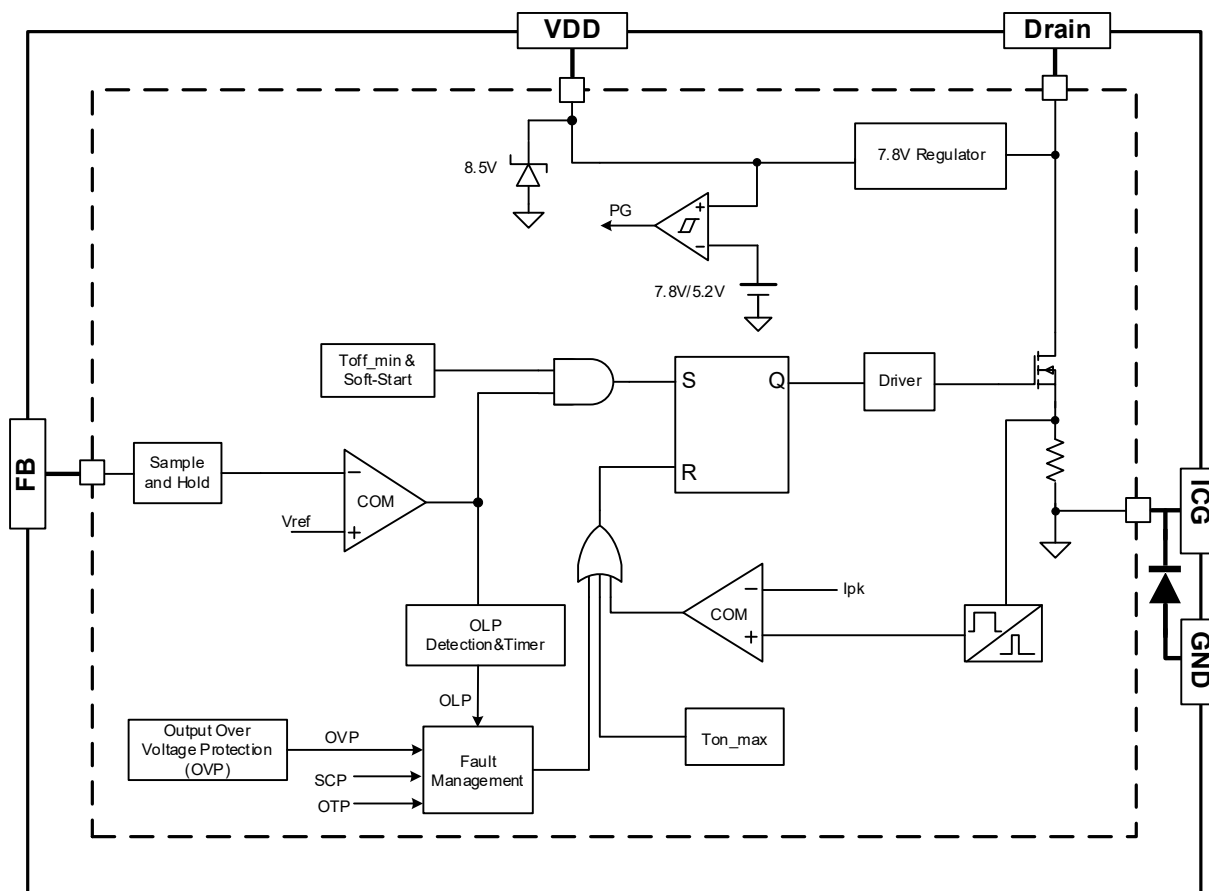
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Absolute Maximum Ratings (Note 1)

Parameter	Value	Unit
Drain - ICG Voltage Range	-0.3 to 500	V
ICG - GND Voltage Range	-0.6 to 600	V
VDD - ICG Voltage Range	-0.3 to 9	V
VDD Pin Clamp Current	10	mA
FB - ICG Voltage Range	-0.3 to 9	V
Package Thermal Resistance – Junction to Ambient (SOP-8)	165	℃/W
Maximum Junction Temperature	160	℃
Storage Temperature Range	-65 to 150	℃
Lead Temperature (Soldering, 10sec.)	260	℃
ESD Capability, HBM (Human Body Model)	2500	V

Recommended Operation Conditions

Parameter	Value	Unit
Operating Junction Temperature	-40 to 125	℃
Operation Switching Frequency	20 to 30	kHz

Electrical Characteristics (Ta = 25℃, If Not Otherwise Noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
High Voltage Startup Section (Drain Pin)						
I_{HV1}	HV Charging Current1	Drain=500V, VDD=0V		0.6		mA
I_{HV2}	HV Charging Current2	Drain=500V, VDD=4V		5		mA
$I_{HV\_leakage}$	HV Leakage Current	Drain=500V, VDD=8.5V		9	20	µA
V_{BR}	HV MOSFET Breakdown Voltage		500			V
R_{dson}	Static Drain-Source on Resistance			24		Ω
Supply Voltage Section (VDD Pin)						
V_{DD_ON}	VDD Under Voltage Lockout Exit		7.6	7.8	8	V
V_{DD_OFF}	VDD Under Voltage Lockout Enter			5.1		V
V_{CLAMP}	VDD Clamp Voltage	I_{CLAMP}=2mA		8.5		V

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I_{VDD_Op}	Operation Current	Fsw=30kHz		240	300	µA
I_{VDD_Q}	Quiescent Current	No Switching		150	190	µA
Feedback Section (FB Pin)						
V_{FB_REF}	Internal Error Amplifier (EA) Reference Input		1.75	1.78	1.81	V
V_{FB_OVP}	Output Over Voltage Protection (Output OVP) Threshold			2.6		V
N_{FB_OVP}	OVP Debounce Cycle			7		
V_{FB_OLP}	Output Over Load Protection (Output OLP) Threshold			1.66		V
T_{D_OLP}	Over Loading Debounce Time			150		ms
Current Sense Section						
T_{LEB}	Leading Edge Blanking Time			380		ns
T_{D_OCP}	Over Current Detection and Control Delay			50		ns
I_{OCP}	Over Current Detection Value			400		mA
I_{AOCP}/I_{OCP}	AOCP/OCP Ratio			1.33		
Timer Section						
$T_{OFF\_min\_norm}$	Normal Minimum OFF time	Stable state	27	30	33	µs
$T_{OFF\_max\_nom}$	Nominal Maximum OFF Time			2		ms
$T_{OFF\_max\_FDR}$	Maximum OFF Time in Fast Dynamic Response Mode			420		µs
T_{ON_max}	Maximum ON Time		26	37	48	µs
T_{ss}	Internal Soft Start Time			3		ms
$T_{Auto\_Recovery}$	Protection Auto Recovery Debounce Time			1.2		s
On-Chip Thermal Shutdown						
T_{SD}	Thermal Shutdown Trigger Point	(Note 2)		155		℃

Note 1. Stresses listed as the above "Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to maximum rating conditions for extended periods may remain possibility to affect device reliability.

Note 2. Guaranteed by design.

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Characterization Plots

V$_{DD\_ON}$ vs Temperature

V$_{DD\_OFF}$ vs Temperature

I$_{VDD\_Q}$ (μA) vs Temperature

T$_{OFF\_nom\_max}$ (ms) vs Temperature
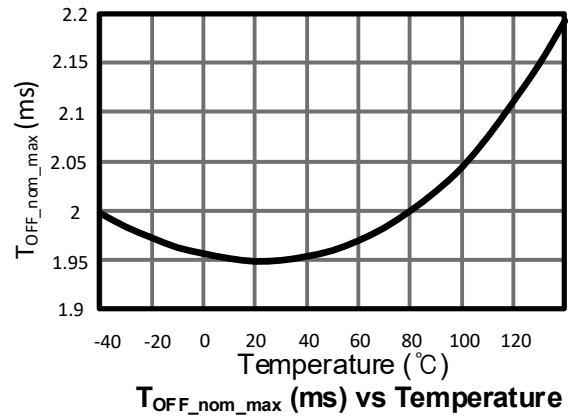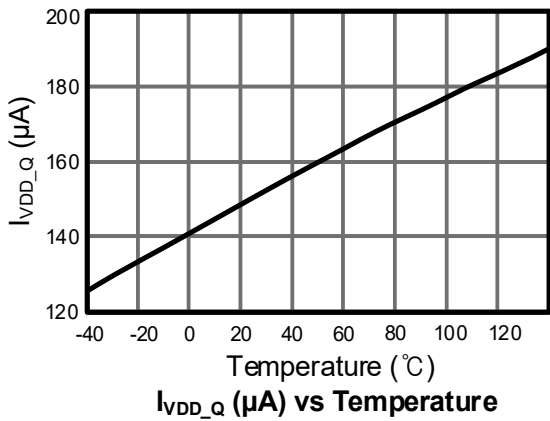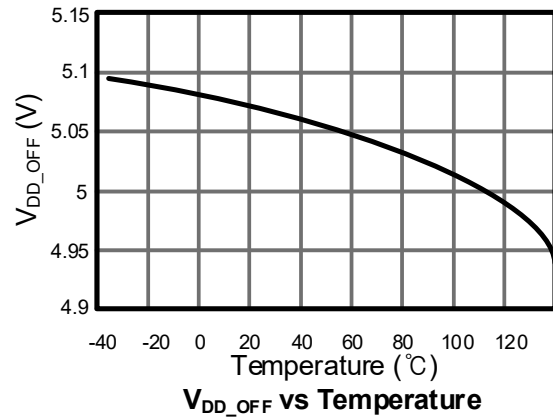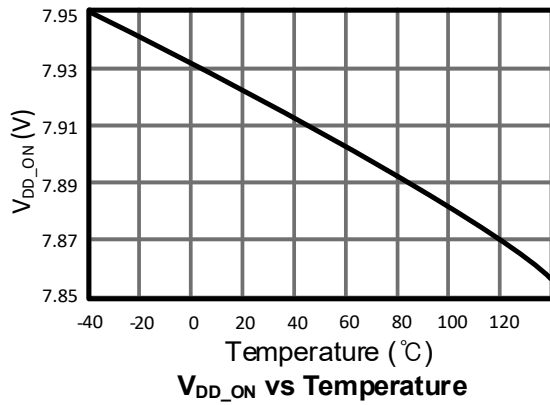
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Operation Description

FC35064 integrates a multi-mode PWM controller with high voltage power MOSFET switch on the IC. It is optimized for off-line non-isolated buck or buck-boost applications in small home appliances and linear regulator replacement. The IC utilizes the multi-mode PWM control to regulate output with high precision and lowest components count.

- ### Very Low Operation Current

The standby operating current in FC35064 is as small as 150µA (typical). The small operating current results in higher efficiency and reduces the VCC hold-up capacitance requirement.

- ### High Voltage Start-Up Operation

In FC35064, a 500V high voltage startup cell is integrated. During startup, the HV current source charges the VDD hold up capacitor Cvdd through Drain pin. When VDD reaches turn-on voltage (7.8V typical), the IC begins switching and the IC current consumed increased to 0.24mA (typical).

- ### Constant Voltage Control

During the power MOSFET off period, FC35064 samples the FB pin signal which indicates the output voltage, then using the internal Sample & Hold circuit and constant voltage control circuit to guarantee FB pin voltage meet the internal reference V_{FB_REF}. So that constant output voltage is achieved.

Below equation determines the output voltage:

$$V_O = \frac{V_{FB\_REF}}{K} - V_F$$

K---Rfb_down/(Rfb_up+Rfb_down)

VF---Freewheeling Diode Voltage

- ### Current Limit and Leading Edge Blanking

There's a programmable current limit for current sensing voltage, which is changed according to the system switching frequency. When the sampled voltage exceeds the internal threshold, the power MOSFET is turned off for the remainder of that cycle. An internal leading edge blanking circuit is built in.

- ### Multi-Mode PWM Control

To meet the tight requirement of averaged system efficiency and no load power consumption, a hybrid of frequency modulation (FM) and amplitude modulation (AM) is adopted in FC35064.

- ### Soft Start

FC35064 features an internal 3ms (typical) soft start that slowly increases the switching frequency (Toff reduce from 100µs to 30µs linearly) during startup sequence. Every restart attempt is followed by the soft start activation.

- ### Output Over Voltage Protection (OVP)

In FC35064, if the sampled FB voltage is larger than 2.6V and lasts for seven continuous PWM cycles, the IC will enter into Output Over Voltage Protection (Output OVP) mode, in which auto recovery mode will be followed.

- ### Over Load Protection (OLP) / Short Load Protection (SLP)

If over load or short load condition occurs, the output and the feedback voltage drop down to be lower than V_{FB_OLP}. If this fault is present for more than 150ms (typical), the protection will be triggered, the IC will experience an auto-restart mode (as mentioned below).

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● **Abnormal Over Current Protection (AOCP)**

When in heavy load or output short condition, the inductor current may be increased too large. To avoid system components damaged, there's a abnormal over current limit (typically 1.33*OCP). When the current sense voltage is larger than this threshold, the internal power MOSFET is turned off immediately and is to be turned on again after 60μs.

● **On Chip Thermal Shutdown**

FC35064 integrates thermal shutdown function. When the IC junction temperature is higher than 155℃, IC shuts down and enters into auto-restart mode (as mentioned below).

● **Enhanced Dynamic Response**

In FC35064, the dynamic response performance is optimized to reduce output drop in load transient.

● **Audio Noise Free Operation**

In FC35064, the optimized combination of frequency modulation and CS peak voltage modulation algorithm can provide audio noise free operation from full loading to zero loading.

● **Protections with Auto-Restart**

In the event of protections, the IC enters into auto-restart and an internal timer begins counting, wherein the power MOSFET is disabled. When 1.2s had been counted, the IC will reset and start up the system again. However, if the fault still exists, the system will experience the above mentioned process.

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Package Dimension

SOP-8
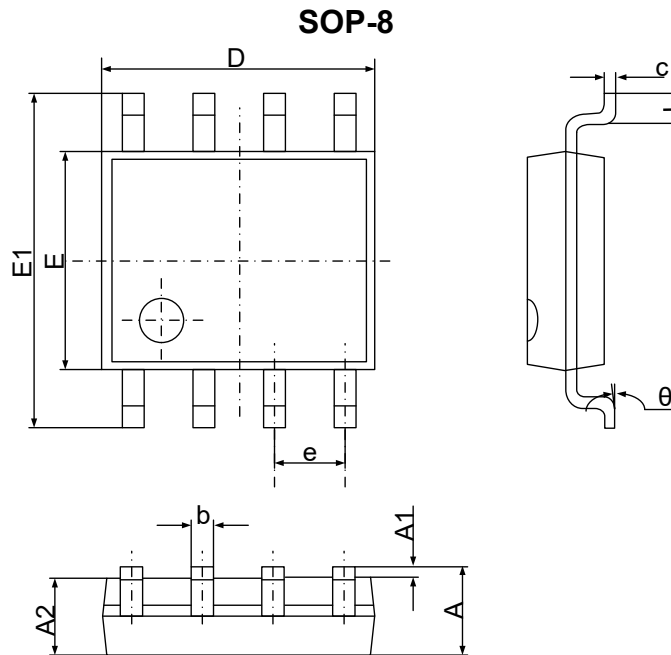
Symbol	Dimensions in Millimeters		Dimensions in Inches	
	Min	**Max**	**Min**	**Max**
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.300	1.500	0.051	0.059
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	4.700	5.100	0.185	0.201
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.050 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0º	8º	0º	8º