Current Mode PWM Controller

General Description

The FC8224 is a highly integrated current mode PWM controller optimized for high performance off-line power converters. VDD low startup current and low operating current contribute to a tiny power consumption and reliable power on startup.

FC8224A incorporates Constant voltage driving technique to facilitate the adjustment of driving speed by a external resistor; FC8224B features a auto-tuning circuit combined with a steering charge pump, ensuring stable driving speed for various Qg conditions without any external resistor.

FC8224 offers a wide VDD supply range from 9.6V to 80V. The IC operates in a maximum frequency of 70KHz @Full Load, As the load gradually decreases , the IC operates in Green Mode and Extended Burst Mode to minimize the standby power loss. EMI performance is also optimized by Frequency Jittering and Peak Current Jittering.

FC8224 offers comprehensive protection coverage including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP), VDD Under Voltage Lockout (UVLO) , Over Temperature Protection (OTP), VDD Over Voltage Protection (VDD OVP), Leading Edge Blanking (LEB) and CS open Protection (SCB)

Features

- Ultra Low start-up and quiescent current
- Wide VDD range from 9.6V to 80V
- Built-in soft start to reduce VDS stress
- Frequency Jittering and Peak Current Jittering
- Extended Burst Mode Control
- Auto -tuning soft Drive technique for various external MOS
- Internal Synchronized Slope Compensation
- Protection coverage with auto recovery
  - Cycle-by-Cycle current limiting (OCP)
  - Over Load Protection (OLP)
  - VDD Under Voltage Lockout (UVLO)
  - VDD Over Voltage Protection (VDD OVP)
  - Over Temperature Protection (OTP)
  - Leading Edge Blanking (LEB)
  - CS open Protection (SCB)

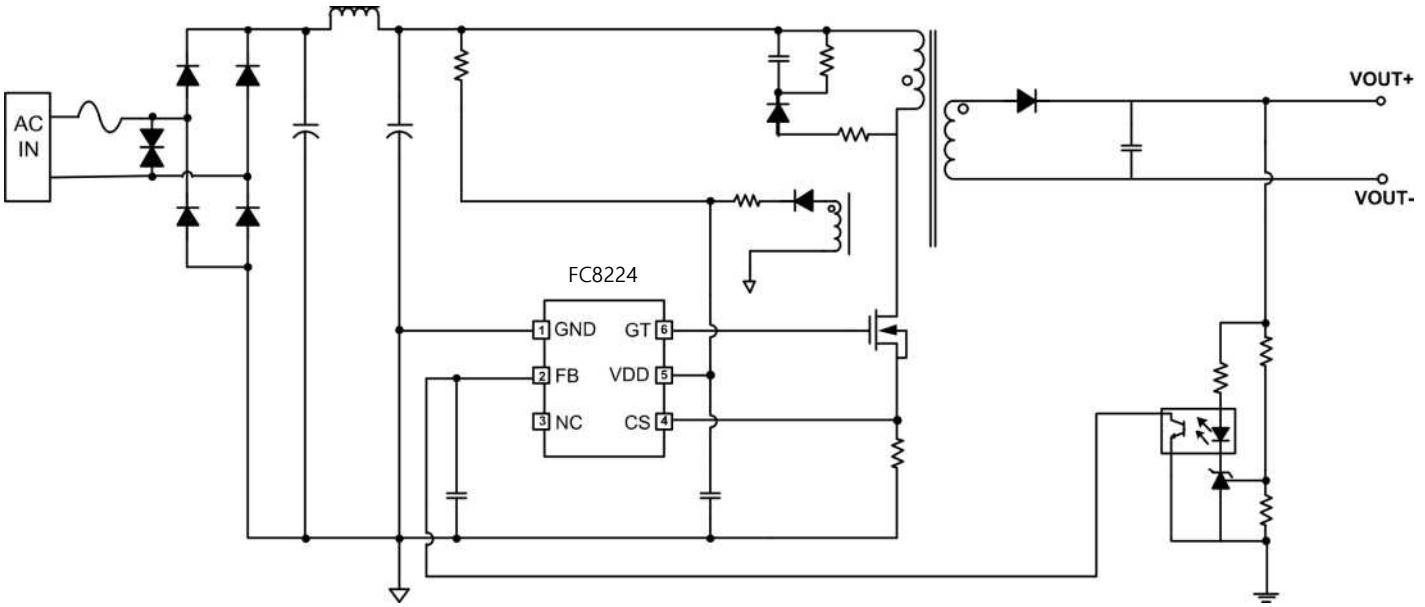
Typical Application

- General Power supply
- Adaptor

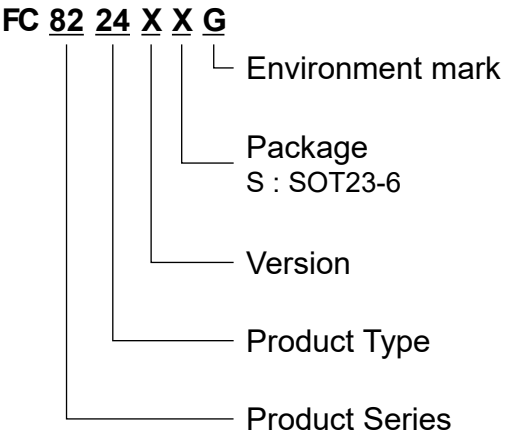
Package

- 6-pin SOT23-6

Typical Application

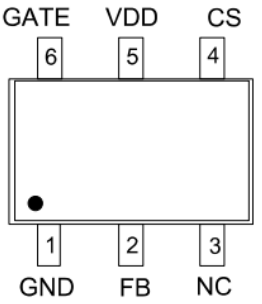


Selection Guide



product series	product description
FC8224AM6G	Package： SOT23-6
FC8224BM6G	With adaptive function； Package： SOT23-6

Pin Configuration

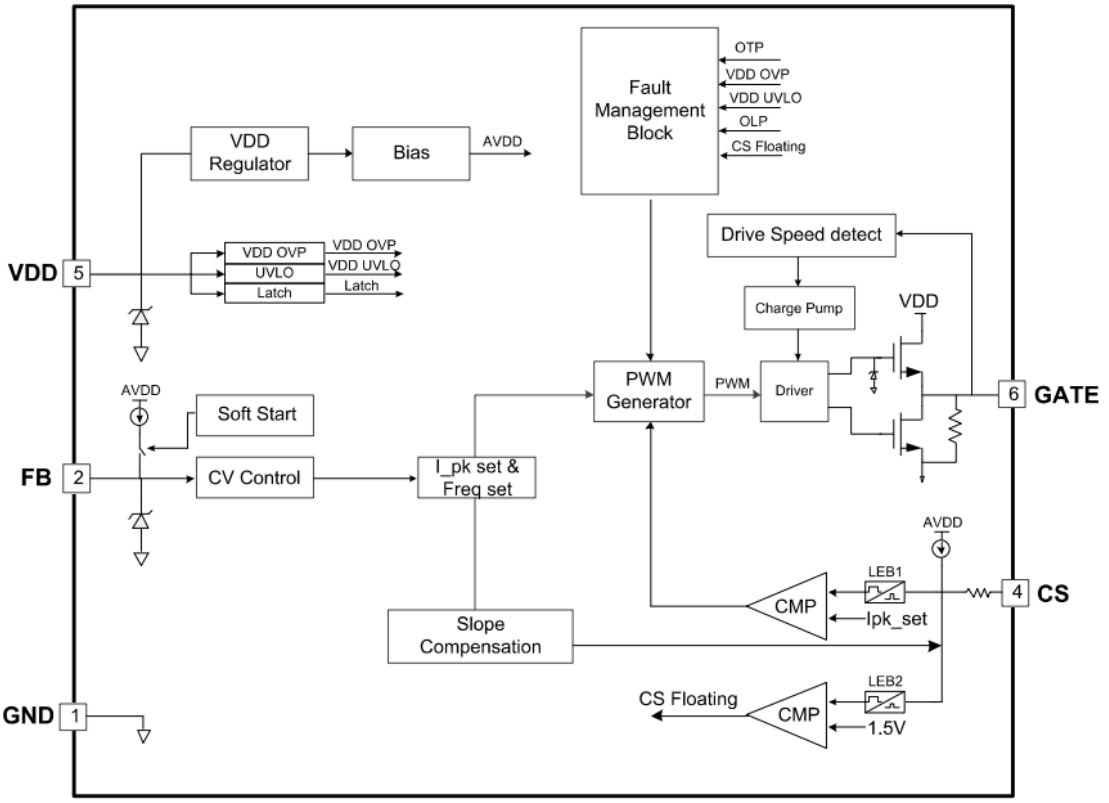


SOT23-6

PIN Assignments

PIN Num. (SOT23-6)	Symbol	Description
1	GND	Ground
2	FB	Feedback input
3	NC	No Connection
4	CS	Current Sense input
5	VDD	Power Supply
6	GATE	Gate Drive output for power MOSFET

Block Diagram



Absolute Maximum Ratings

Parameter	Range	Unit
VDD DC Supply Voltage	-0.3-80	V
VDD operating current	0-10	mA
FB、CS Input Voltage	-0.3-7	V
Operating ambient temperature :T_A	-40 ～ 85	℃
Min/Max Storage Junction Temperature	-55 ～ 150	℃
Maximum junction temperature Tj	-40 ～ 150	℃
Thermal resistance (Junction to air) θ_{JA}	200	℃/W
Continuous Total Power Dissipation P_D	0.63	W
Welding Temperature	+260 (10sec)	℃
ESD(HBM)	2500	V
ESD(MM)	300	V

Recommended Operating Condition

Parameter	Range	Unit
VDD Input Voltage	9.6-80	V
Operating Ambient Temperature	-40-85	℃

Electrical Characteristics (TA = 25℃ VDD=16V, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD)						
I_{Start}	Start-Up Current Sourced from VDD Pin	VCC=16V	-	5	-	μA
VDD	Operation Voltage		9.6	-	80	V
VDD_ON	VCC Under Voltage Lockout Enter		-	17.5	-	V
VDD_OFF	Under-Voltage Lockout Voltage of VDD Pin		-	9.5	-	V
VDD_OVP	VDD Over Voltage Protection Threshold voltage	FB=2.5V, ramp up VDD until gete clock is off	-	82	-	V
Iq	VDD Standby current	FB=0, CS=0, VDD=24V	-	240	-	uA
I_Fault	VDD Pull down current @ Fault Condition	VDD=24V@Fault condition	-	1.2	-	mA
I_oper	Operation Current	VDD=24V, FB=2.8V, CS=0	2.5	-	-	mA
Feedback Input Section (FB Pin)						
V_{FB_OPEN}	FB open Loop Voltage	FB Floating, CS=0	3.2	-	3.3	V

R_{FB}	FB Input Impedance		-	20	—	KΩ
$I_{FB\ SHORT}$	FB pin short circuit current	FB=O, CS=0	-	210	-	uA
A_{VCS}	PWM input gainA V_{FB}/△ V_{CS}		-	3	-	V/V
V_{FB_OLP}	Open loop Protection FB threshold	VDD20V, Ramp up FB until gate clock is off	-	3.1	-	V
V_{FB_ECO}	ECO Mode threshold		-	2.2	-	V
V_{FB_DPWM}	DPWM threshold		-	1.7	-	V
V_{FBL}	The threshold enter burst mode		-	0.8	-	V
V_{FBH}	The threshold exit burst mode		-	1	-	V
T_{D_OLP}	Open loop Protection De-bounce Time		-	60	-	ms
Tss	Internal Soft start time		-	6	-	ms
Current Sense Input (CS Pin)						
T_{ON_MIN}	Minimum On Time		-	450	-	ns
T_{LEB}	Leading edge Blanking Time		-	300	-	ns
Vcs min	CS minimum Voltage		-	200	-	mV
Vcs max	CS maximum Voltage		-	800	-	mV
V_{sc}	CS open Protection threshold		-	1.5	-	V
D_Max	Maximum duty cycle		70%	75%	80%	
Oscillator						
Fmax	Maximum Frequency for operation	FB=3V	66	-	75	Khz
Fmin	Burst Mode Switch Frequency	FB=1V	22	-	25	Khz
△F_jitter	Frequency jittering		-	±7%	-	
△ Ipk	Ipk jittering		-	±3%	-	
Gate Driver						
VOL	Output low level		-	-	1	V
VOH	Output high level		7	-	-	V
V_clamp	Output clamp voltage		-	11	-	V
T_adj (FC8224B)	Auto-tuning enable time duration		100	-	300	ns
Thermal Protection						
OTP IN			-	170	-	°C
OTP OUT			-	125	-	°C

Operation Description

The FC8224 is a highly integrated current mode PWM controller optimized for high performance off-line power converters. VDD low startup current and low operating current contribute to a tiny power consumption and reliable power on startup. FC8224A incorporates Constant vo ltage driving technique to facilitate the adjustment of driving speed by a external resistor; FC8224B, however, features a auto-tuning circuit combined with a steering charge pump, ensuring stable driving speed for various Qg conditions without any external resistor.

FC8224 also offers a wide VDD supply range from 9.6V to 80V and operates in a maximum frequency of

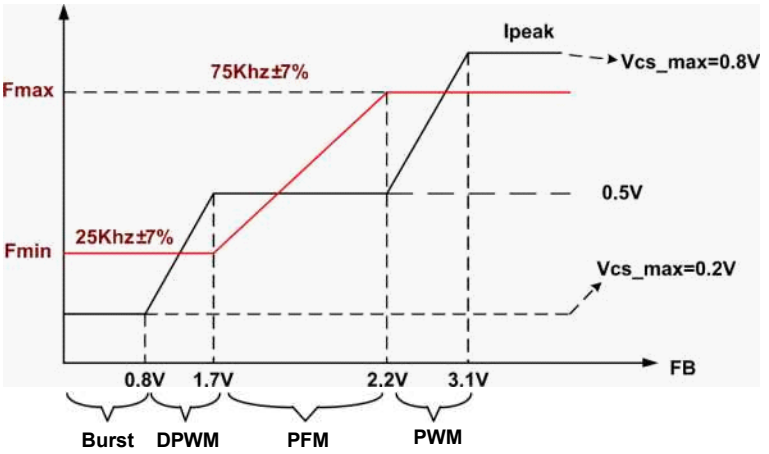
70KHz @Full Load, As the load gradually decreases , the IC operates in Green Mode and Extended Burst Mode to minimize the standby power loss. EMI performance is also optimized by Frequency Jittering and Peak Current Jittering. The good supply system reliability is also achieved with Multiple auto recovery Protection features.

Start up Control

Startup current of FC8224 is set to be extremely low so that VDD could be charged up above UVLO threshold easily by a large external resistor tied to Vbuck .

When VDD reaches VDD_ON(typical 17.5V), the controller detect fault condition, If the fault status=1, VDD then begins to fall because the controller bias current is at I_Fault(Typically 1.2mA)and the auxiliary supply voltage is not present. When VDD falls to VDD_OFF(typically 9.5V), the current source turns back on and charges VDD. This Cycle repeats indefinitely until Fault status==0.

Frequency and Ipk set



During the full load power operation, FC8224 operates at a 70KHz frequency, As the load gradually decreases , the IC operates in Green Mode and Extended Burst Mode to minimize the standby power loss. Ipk control is also achieved by DPWM & PWM control loop.

Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in FC8224 current Mode PWM control. The switch current is detected by a sense resistor into the CS pin. An internal leading edge blanking circuit chops off the sensed voltage spike at initial internal power MOSFET on state due to a snubber diode reverse recovery and surge gate current of power MOSFET during the blanking period.

Extended Burst Mode Operation

At zero load or light load condition, majority of the power dissipation in a switching mode power supply is from switching loss on the MOSFET transistor, the core loss of the transformer and the loss on the snubber circuit. The magnitude of power loss is in proportion to the switching frequency. Lower switching frequency leads to the reduction on the power loss and thus conserves the energy.

The switching frequency is internally adjusted at no load or light load condition. The switch frequency reduces at light/no load condition to improve the conversion efficiency. At light load or no load condition, the FB input drops below burst mode threshold level and device enters Burst Mode control. The Gate drive output switches only when VCC voltage drops below a preset level and FB input is active to output an on state. Otherwise the gate drive remains at off state to minimize the switching loss and reduces the standby power consumption to the greatest extend. The nature of high frequency switching also reduces the audio noise at any loading conditions.

Soft Start

Soft-start is achieved by ramping up an internal reference, VSSTART, and comparing it to the current sense signal. VSSTART ramps up from 0 V once the controller initially powers up. The peak current set point is then limited by the VSSTART ramp resulting in a gradual increase of the switch current during start-up. The soft-start duration, is typically 4 ms.

Auto-tuning soft drive

FC8224A incorporates Constant voltage driving technique to facilitate the adjustment of driving speed by a external resistor; FC8224B features a auto-tuning circuit combined with a steering charge pump, ensuring stable driving speed for various Qg conditions without any external resistor.

Protection Controls

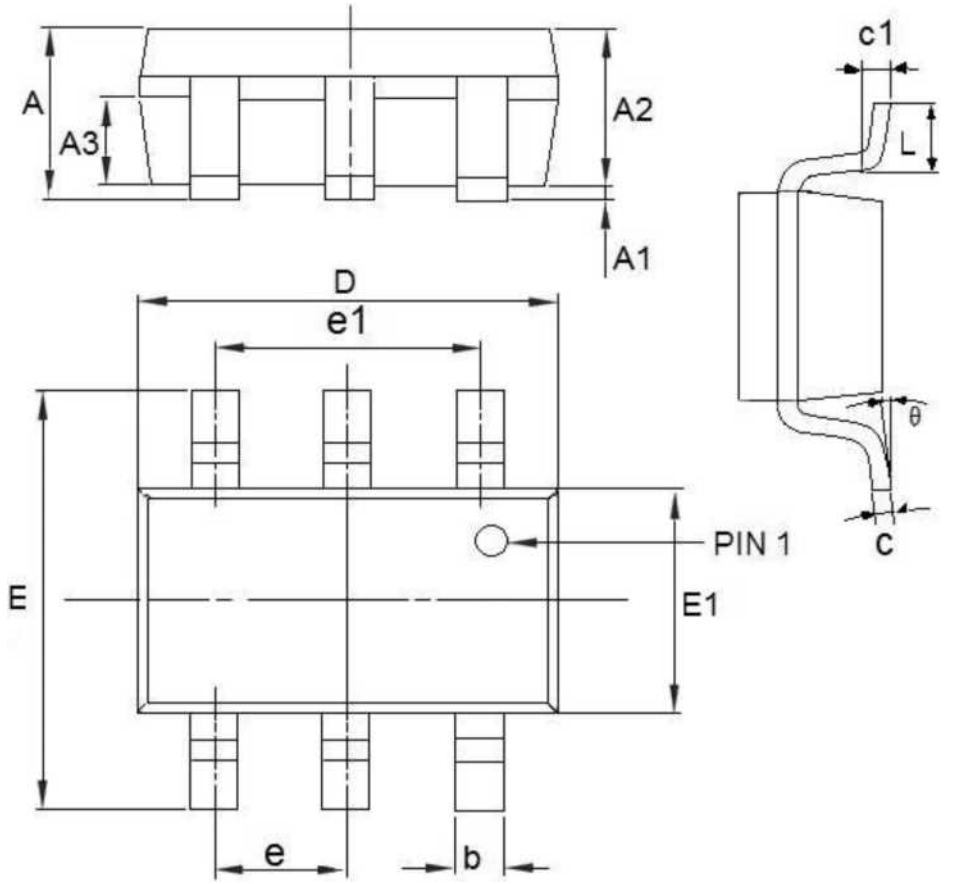
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP), CS short protection, CS floating protection, over voltage protection (OVP), and Under Voltage Lockout on VCC (UVLO).

Package Quantity

Package Type	Minimum Packing QTY	UNITS	Small Box	Large BOX
SOT23-6	3000	Tape & Reel	30K	120K

Package Information

• **Package Type: SOT23-6**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.05	1.45	0.0413	0.0571
A1	0	0.15	0.0000	0.0059
A2	0.9	1.3	0.0354	0.0512
A3	0.55	0.75	0.0217	0.0295
b	0.25	0.5	0.0098	0.0197
c	0.1	0.25	0.0039	0.0098
D	2.7	3.12	0.1063	0.1228
e1	1.9(TYP)		0.0748(TYP)	
E	2.6	3.1	0.1024	0.1220
E1	1.4	1.8	0.0551	0.0709
e	0.95(TYP)		0.0374(TYP)	
L	0.25	0.6	0.0098	0.0236
θ	0	8°	0.0000	8°
c1	0.2(TYP)		0.0079(TYP)	