Primary Side Regulation
PWM Controller for Automotive Applications

SFA0002

Data Sheet

Description

The SFA0002 is the switching power supply IC for flyback circuit and has high accuracy error amplifier.

When the load of the power supply circuit becomes light, the operation of IC becomes the burst oscillation mode in order to improve the circuit efficiency.

By employing the primary side regulation, the IC realizes low component counts and design-friendliness, leading to downsizing and standardization of the power supply circuit.

Features

- AEC-Q100 Qualified
- Current Mode Type PWM Control
  (Swithing frequency can be adjusted by external capacitor)
- Reducing External Component Count by Primary Side Regulation
- Built-in High Accuracy Error Amplifier
  (V_{FB} = 2.5 V ± 2%, −40°C to 125°C)
- Operation Mode
  Normal Operation: PWM Mode
  Light Load Operation: Burst Oscillation
- Soft Start Function
  (Startup time can be adjusted by external capacitor)
- Drive Output Stop Function
- Protections:
  Overcurrent Protection (OCP): Pulse-by-Pulse
  Overload Protection (OLP): Auto-restart
  Thermal Shutdown Protection (TSD) with hysteresis: Auto-restart

Package

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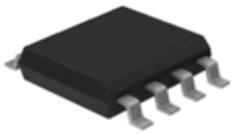


Not to scale

Specifications

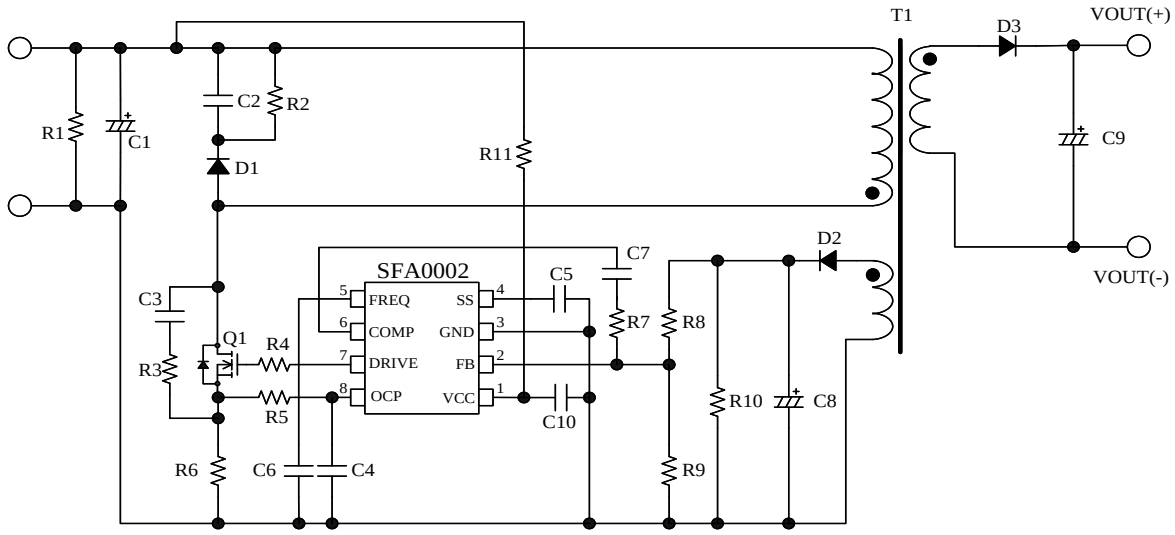
- Power Supply Voltage is V_{CC} = 36 V (max.)
- Adjustable Swithing Frequency (20 kHz to 200 kHz)

Applications

For following Isolation auxiliary power supply:

- Inverter
- On-board Charger (OBC)
- Battery Management System (BMS), etc.

Typical Application



Contents

1. Absolute Maximum Ratings

Current polarities are defined as follows: current going into the IC (sinking) is positive current (+); and current coming out of the IC (sourcing) is negative current (−).

Unless otherwise specified, T_A = 25 °C.

Parameter	Symbol	Conditions	Rating	Unit	Remarks
OCP Pin Voltage	V_{OCP}		−5 to 5	V	
SS Pin Voltage	V_{SS}		−0.3 to 9	V	
FB Pin Voltage	V_{FB}		−0.3 to 5	V	
VCC Pin Voltage	V_{CC}		0 to 36	V	
COMP Pin Voltage	V_{COMP}		−0.3 to 5	V	
FREQ Pin Voltage	V_{FREQ}		−0.3 to 5	V	
DRIVE Pin Peak Current	$I_{DRV(PEAK)}$		−270 to 540	mA	
DRIVE Pin DC Current	$I_{DRV(DC)}$		−90 to 180	mA	
Power Dissipation	P_D	* Mounting on PCB	1.2	W	
Junction Temperature	T_J		−40 to 150	°C	
Storage Temperature	T_{stg}		−40 to 150	°C	

* PCB: 42 mm × 32 mm in size, 1 mm in thickness

2. Recommended Operating Conditions

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
VCC Pin Voltage	V_{CC}		6	—	24	V	
Switching Frequency	f_{OSC}		20	—	200	kHz	

3. Electrical Characteristics

Current polarities are defined as follows: current going into the IC (sinking) is positive current (+); and current coming out of the IC (sourcing) is negative current (−).

Unless otherwise specified, T_A = −40 °C to 125 °C, VCC = 14 V, and FB = SS = OCP = 0 V.

The following electrical characteristics are design assurance value in T_A = −40 °C to 125 °C. The shipping test temperature of the products is −30 °C, 25 °C and 125 °C.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Power Supply Startup Operation							
Operation Start Voltage	$V_{CC(ON)}$		4.9	5.1	5.3	V	
Operation Stop Voltage	$V_{CC(OFF)}$		4.4	4.6	4.8	V	
Circuit Current in Operation	$I_{CC(ON)}$		1.0	2.0	3.2	mA	
Circuit Current in Non-operation	$I_{CC(OFF)}$	VCC = 4.8 V	0.3	0.5	1.0	mA	
Normal Operation							
SS Pin High Threshold Voltage of OLP Operation	V_{HSS}		1.9	2.0	2.1	V	
SS Pin Low Threshold Voltage of OLP Operation	V_{LSS}		0.9	1.0	1.1	V	
SS Pin Voltage Hysteresis of OLP Operation	ΔV_{SS}	$V_{HSS} - V_{LSS}$	0.9	1.0	1.1	V	
SS Pin Source Current	$I_{SRC(SS)}$	SS = 0.9 V	−19	−15	−11	µA	
SS Pin Sink Current	$I_{SNK(SS)}$	SS = 2.1 V	13	17	21	µA	
Switching Frequency	$f_{OSC(200\ p)}$	FREQ = 200 pF	85	100	115	kHz	
FREQ Pin Source Current	$I_{SRC(FREQ)}$	FREQ = 0.9 V	−33	−30	−27	µA	
FREQ Pin Sink Current	$I_{SNK(FREQ)}$	FREQ = 2.1 V	75	85	95	µA	
Oscillation Circuit High Threshold Voltage	V_{HF}		1.9	2.0	2.1	V	
Oscillation Circuit Low Threshold Voltage	V_{LF}		0.9	1.0	1.1	V	
Maximum Duty Cycle	D_{MAX}	FREQ = 200pF	70	74	78	%	
Slope Compensation Rate	SLP		2.1	2.5	2.9	mV/%	
Feedback Voltage	V_{FB}		2.45	2.50	2.55	V	
Burst Operation Threshold Voltage	V_{BURST}	FREQ = 200pF, COMP pin voltage increase from 0 V.	—	0.18	—	V	
Drive Voltage	V_{DRIVE}	FREQ = 3 V, one pulse	7.6	8.3	9.0	V	

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit	Remarks
Minimum Drive Voltage	$V_{DRIVE(MIN)}$	VCC ≥ 6 V, FREQ = 3 V, one pulse	4	—	—	V	
Minimum On Time	$t_{ON(MIN)}$	OCP = 1 V, DRIVE = 680 pF	—	170	—	ns	
Protection Function							
Leading Edge Blanking Time*	t_{BW}		—	100	—	ns	
OCP Threshold Voltage	V_{OCP}		0.46	0.5	0.54	V	
OLP Delay Time	t_{OLP}	SS = 10 nF	32	42	52	ms	
Drive Stop Threshold Voltage	V_{ST}		3.5	4.0	4.5	V	
Thermal Shutdown Operating Temperature*	$T_{JH(TSD)}$		150	165	—	°C	
Thermal Shutdown Release Temperature *	$T_{JL(TSD)}$		—	150	—	°C	

* Design assurance.

4. Performance Curves

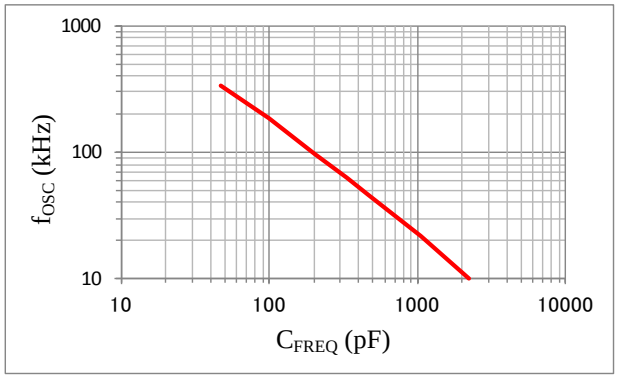


Figure 4-1. Switching Frequency, f_{OSC}, vs. FREQ Pin Capacitor, C_{FREQ}

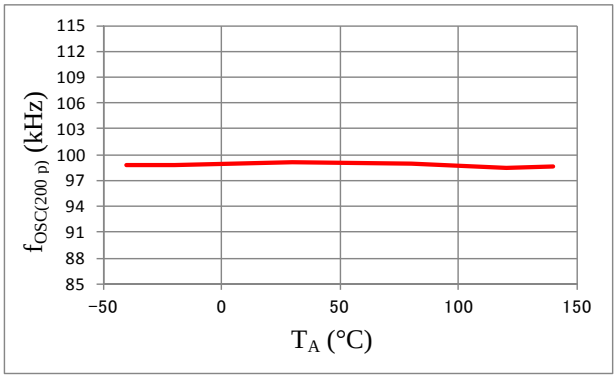


Figure 4-2. Switching Frequency (FREQ = 200 pF) Temperature Characteristics

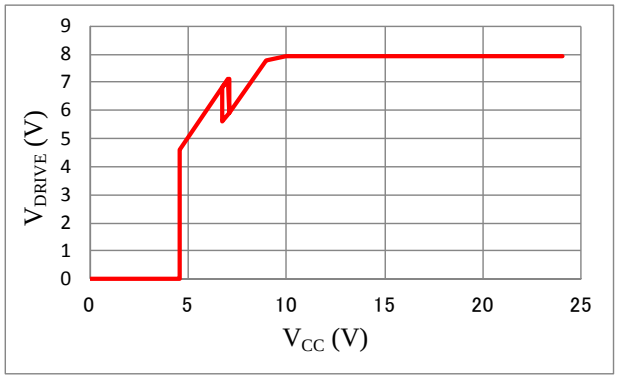


Figure 4-3. DRV Pin Voltage, V_{DRIVE}, vs. VCC Pin Voltage, V_{CC}

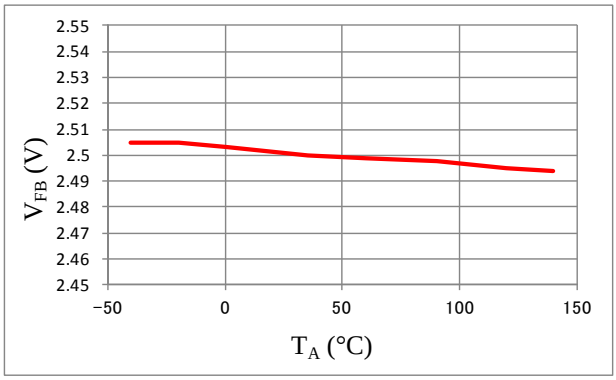


Figure 4-4. Feedback Voltage, V_{FB}, Temperature Characteristics

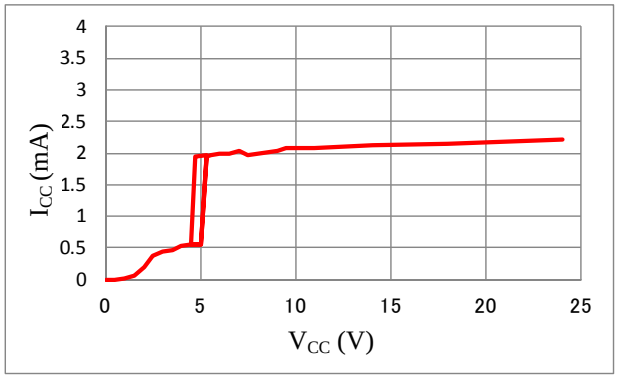
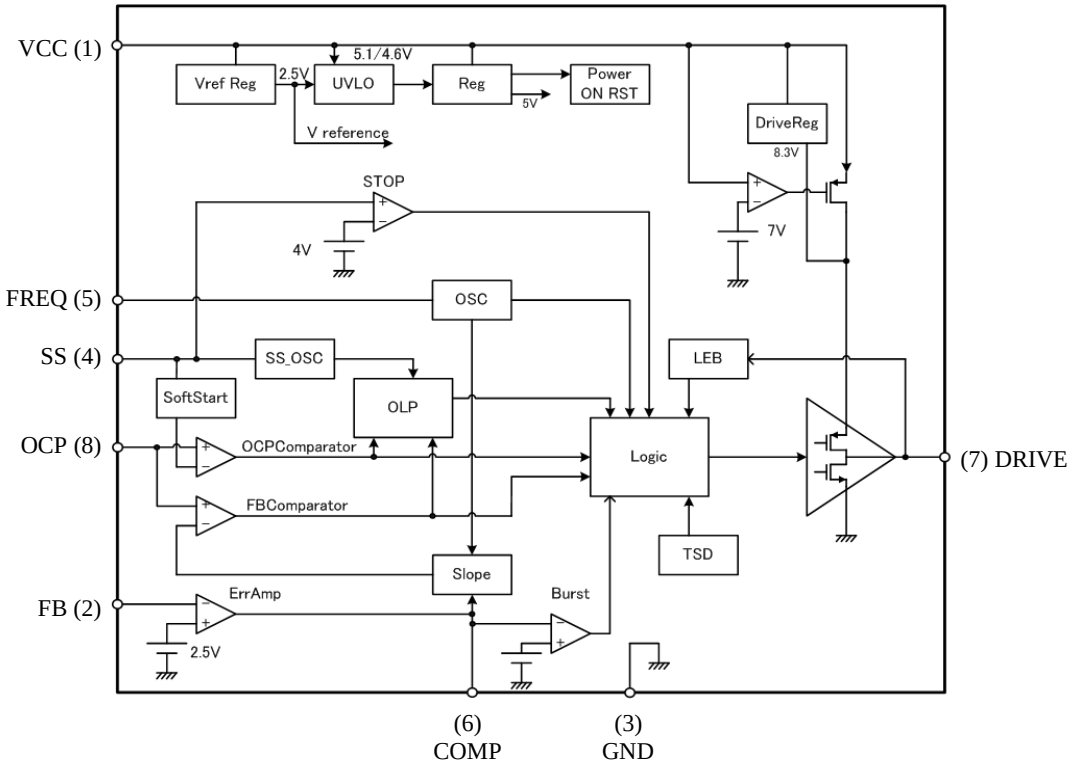
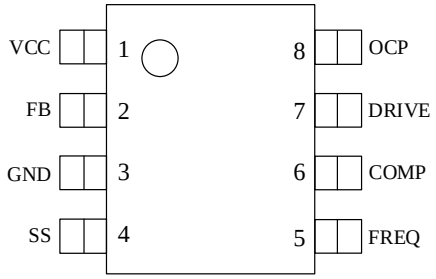


Figure 4-5. VCC Pin Current, I_{CC}, vs. VCC Pin Voltage ,V_{CC}

5. Block Diagram



6. Pin Configuration and Definitions



Pin No.	Pin Name	Function
1	VCC	Power supply voltage input
2	FB	Constant voltage control signal input
3	GND	Ground
4	SS	Connecting capacitor for soft-start time and OLP delay time setting, and the DRIVE pin stop signal input
5	FREQ	Connecting capacitor for switching frequency setting
6	COMP	Connecting capacitor for phase compensation
7	DRIVE	Gate drive output
8	OCP	Overcurrent detection signal input

7. Typical Application

In applications having a power supply specified such that the Drain pin of external power MOSFET has large transient surge voltages, a clamp snubber circuit of a capacitor-resistor-diode (C2, R2 and D1) combination should be added on the primary winding P, or a damper snubber circuit of a capacitor or a resistor-capacitor (C3 and R3) combination should be added between the Drain pin and the Source pin.

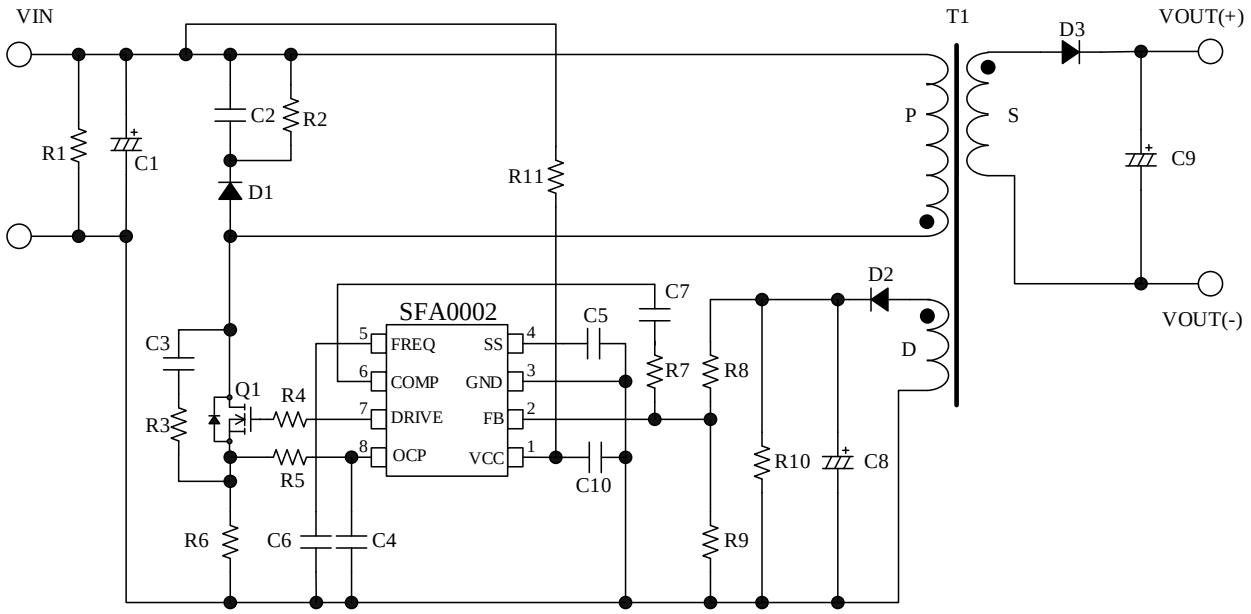


Figure 7-1. Typical Application Circuit

8. Physical Dimensions

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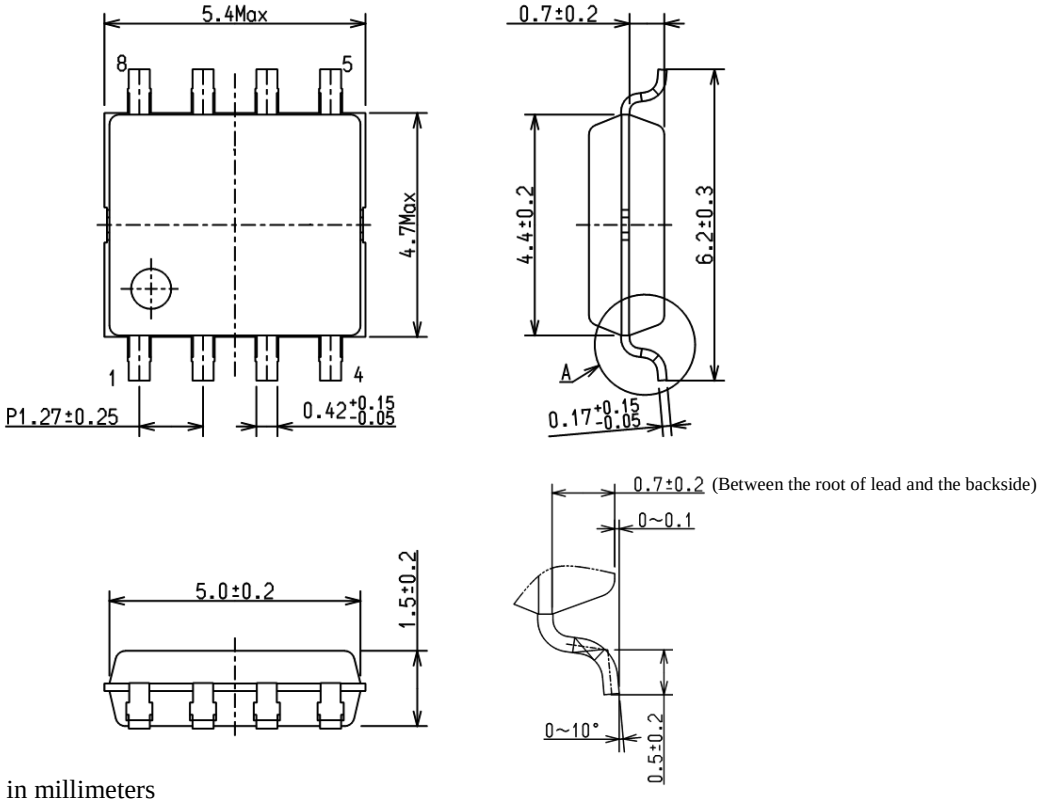
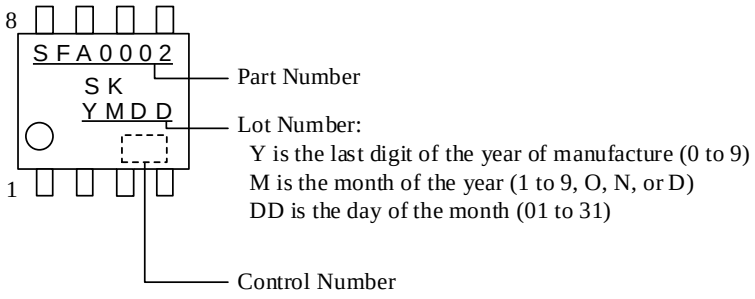


Enlarged View of A

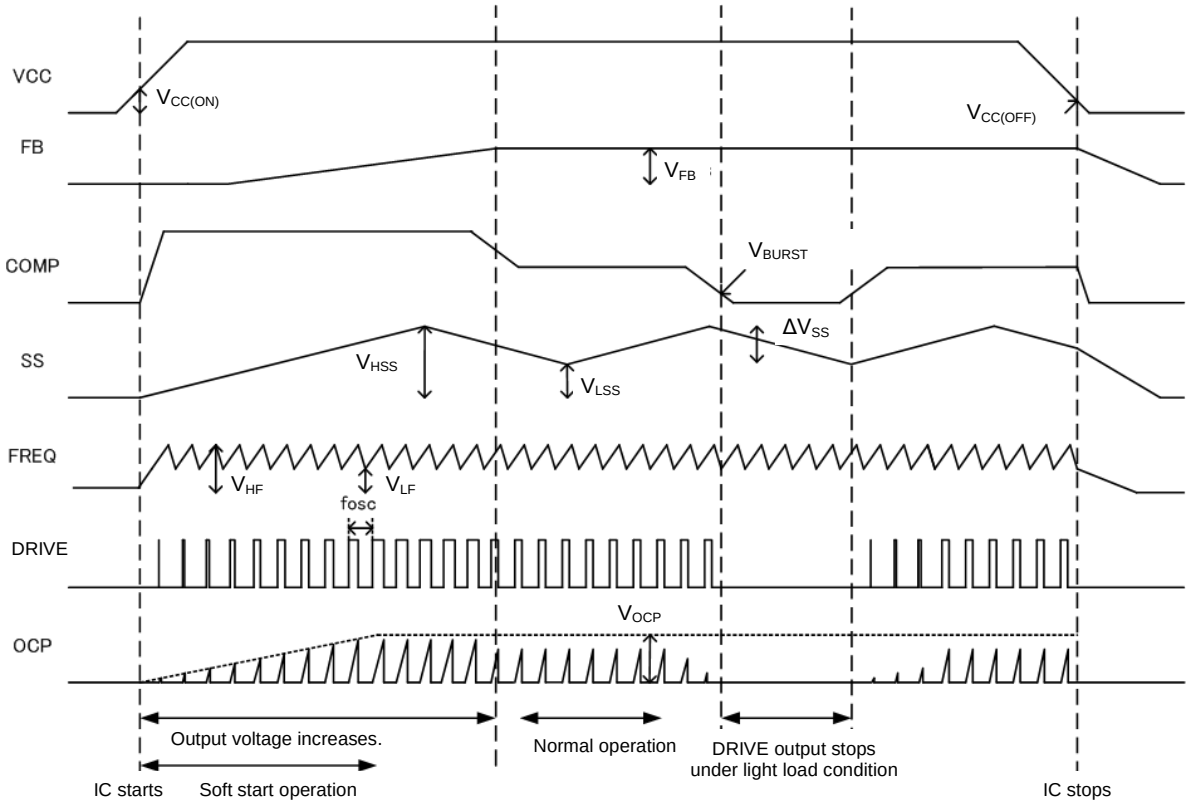
NOTES:

- Dimensions in millimeters
- Bare lead frame: Pb-free (RoHS compliant)

9. Marking Diagram



10. Timing Chart



When the COMP pin voltage decreases to V_{BURST} or less, the IC operation becomes into burst oscillation mode. The on-time and the intermittent cycle, etc. depend on the specification of typical application circuit.

Figure 10-1. Normal Operation

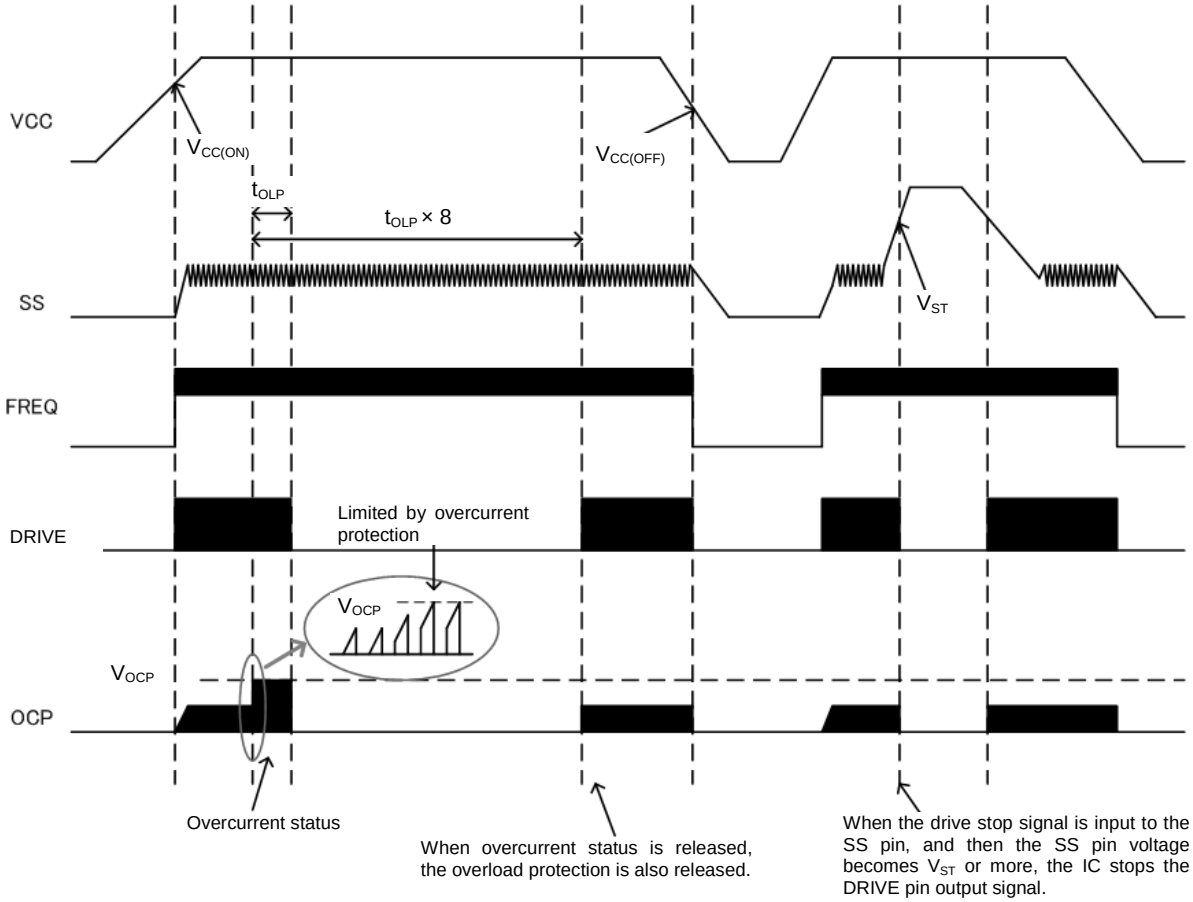


Figure 10-2. Protection Function

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