器件参数表
DataSheet

ICW8020【开关电源控制器集成电路】

艾创微
AICHUANGWEI

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Current Mode PWM Controller With Frequency Shuffling

General Description

ICW8020 is a highly integrated current mode PWM control IC optimized for high performance, low standby power and cost effective offline flyback converter applications. PWM switching frequency at normal operation is externally programmable and trimmed to tight range. At no load or light load condition, the IC operates in extended 'burst mode' to minimize switching loss. Lower standby power and higher conversion efficiency is thus achieved.VDD low startup current and low operating current contribute to a reliable power on startup design with ICW8020. A large value resistor could thus be used in the startup circuit to minimize the standby power. The internal slope compensation improves system large signal stability and reduces the possible subharmonic oscillation at high PWM duty cycle output. Leading-edge blanking on current sense input removes the signal glitch due to snubber circuit diode reverse recovery and thus greatly reduces the external component count and system cost in the design. ICW8020 offers complete protection coverage with automatic self-recovery feature including Cycle-by-Cycle current limiting (OCP), over load protection (OLP), VDD over voltage clamp and under voltage lockout (UVLO). The Gate-drive output is clamped at 16V to protect the power MOSFET. In ICW8020,OCP threshold slope is internally optimized to reach constant output power limit over universal AC input range. Excellent EMI performance is achieved with frequency shuffling technique together with soft switching control at the totem pole gate drive output. Tone energy at below 20KHZ is minimized in the design and audio noise is eliminated during operation.

Features

- Extended Burst Mode Control For Improved Efficiency and Minimum Standby Power Design
- Audio Noise Free Operation
- External Programmable PWM Switching Frequency
- Internal Synchronized Slope Compensation
- Low VDD Startup Current (3μA) and Low Operating Current (1.8mA)
- External programmable over temperature protection (OTP)
- With or without On-chip VDD OVP for system OVP
- Under Voltage Lockout with Hysteresis (UVLO)
- Gate Output Maximum Voltage Clamp (16V)
- Line Input Compensated Cycle-by-Cycle Over-current Threshold Setting For Constant Output current Limiting Over Universal Input Voltage Range(OCP).
- Over load Protection (OLP)

Typical Application

Offline AC/DC flyback converter for

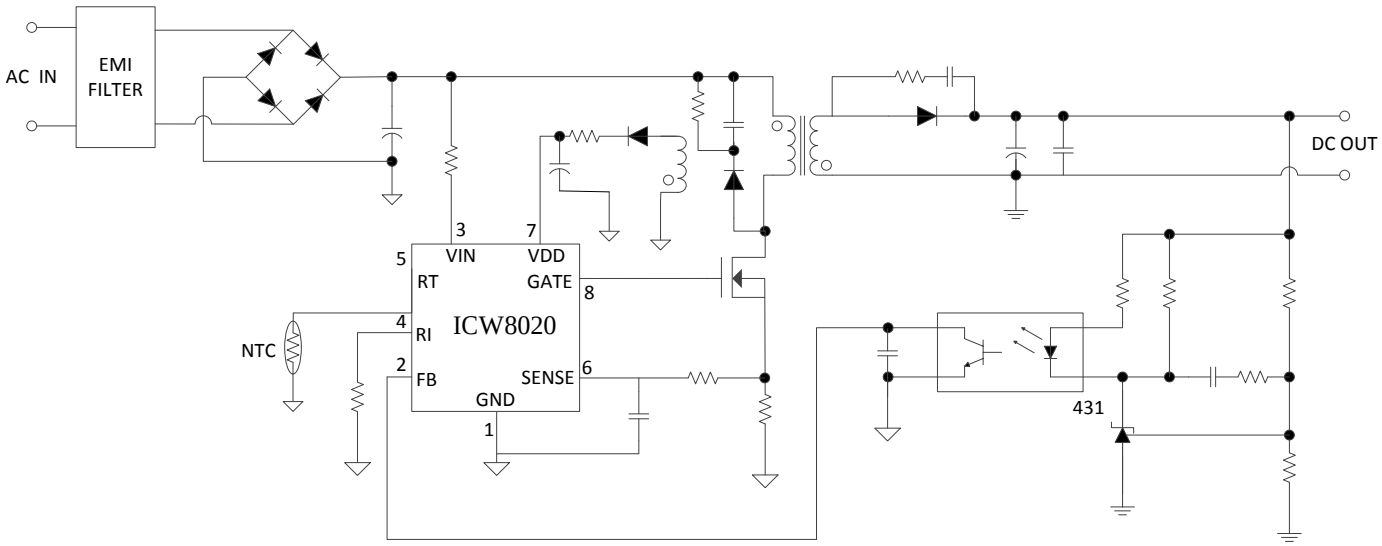
- Battery Charger
- PC/TV/Set-Top Box Power Supplies
- Laptop Power Adaptor
- Open-frame SMPS

Package

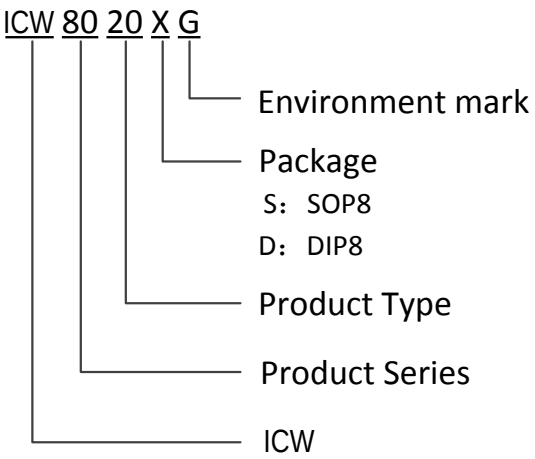
- 8-pin SOP8、DIP8

Current Mode PWM Controller With Frequency Shuffling

Typical Application Circuit



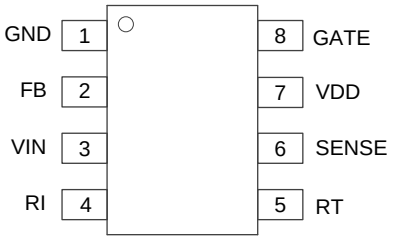
Selection Guide



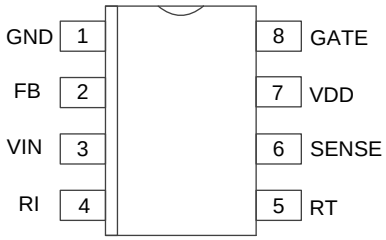
product series	product description
ICW8020SG	Package：SOP8
ICW8020DG	Package：DIP8

Current Mode PWM Controller With Frequency Shuffling

Pin Configuration& Pin Assignment



SOP8

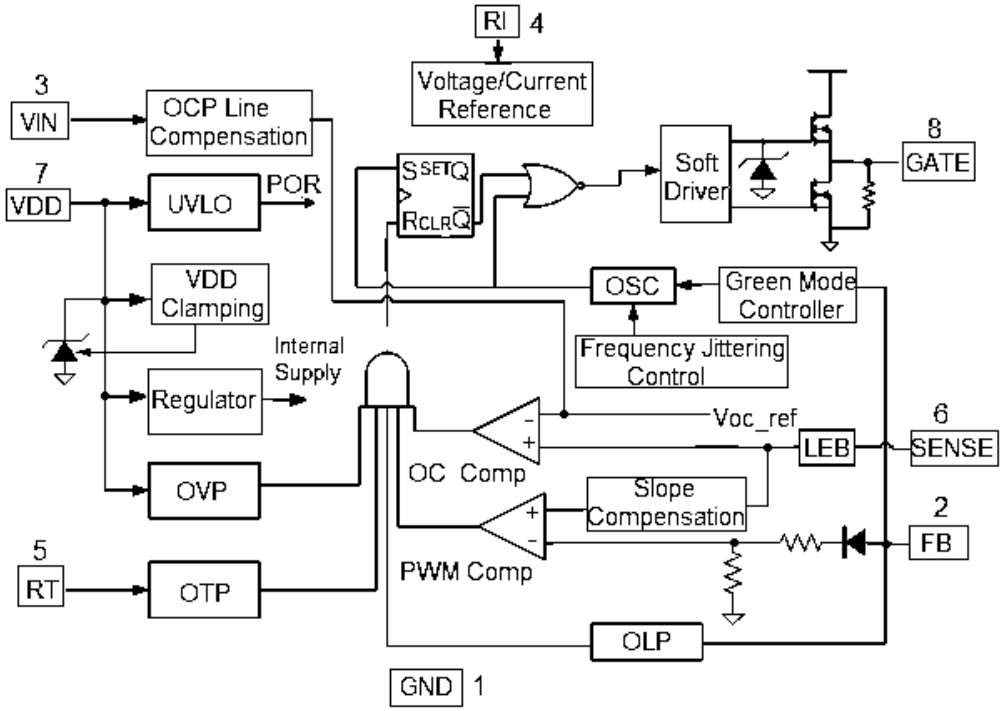


DIP8

PIN Assignments

Pin Num.	Symbol	Description
1	GND	Ground
2	FB	Feedback input pin. The PWM duty cycle is determined by voltage level into this pin and current-sense signal level at PIN6.
3	VIN	Connected through a large value resistor to rectified line input for startup IC supply and line voltage sensing.
4	RI	Internal Oscillator frequency setting pin. A resistor connected between RI and GND sets the PWM frequency.
5	RT	Temperature sensing input pin. Connected through a NTC resistor to GND.
6	SENSE	Current sense input pin. Connected to MOSFET current sensing resistor node.
7	VDD	Chip DC power supply pin.
8	GATE	Totem-pole gate drive output for the power MOSFET.

Block Diagram



Current Mode PWM Controller With Frequency Shuffling

Absolute Maximum Ratings

Parameter	Range		Unit
VDD/VIN DC Supply Voltage	30		V
VDD Zener Clamp Voltage[Note]	VDD_Clamp+0.1V		V
VDD DC Clamp Continuous Current	10		mA
V_{FB} ,V_{SENSE} ,V_{RI},V_{RT} (Voltage at FB,SENSE,RI,RT to GND)	-0.3 ~ 7		V
Min/Max Operating Junction Temperature T_J	-40 ~ 150		°C
Min/Max Storage Temperature Tstg	-55 ~ 150		°C
$R_{\theta JA}$ thermal Resistance(Junction to air)	SOP8	150	°C/W
	DIP8	90	
P_D Continuous Total Power Dissipation	SOP8	0.9	W
	DIP8	1.4	

Caution: The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

Note: VDD_Clamp has a nominal value of 35V.

Recommended Operating Condition

Parameter	Range	Unit
VDD Supply Voltage	12 ~ 23	V
RI Resistor Value	24 ~ 31	KΩ
T_A Operating Ambient Temperature	-20 ~ 85	°C

ESD Information

Symbol	parameter	Test conditon	Min.	Typ.	Max.	Unit
HBM[Note]	Human body model on all pins except VIN and VDD	MIL_STD	-	2.5	-	KV

Electrical Characteristics(T_A = 25°C,VDD=16V,RI=24KΩ, if not otherwise noted)

Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD)						
$I_{VDD\_Startup}$	VDD Start up Current	VDD=15V, Measure current into VDD	-	3	10	μA
$I_{VDD\_Operation}$	Operation Current	V_{FB}=3V	-	1.8	-	mA
$UVLO_{ON}$	VDD Under Voltage Lockout Enter		9.5	10.5	11.5	V
$UVLO_{OFF}$	VDD Under Voltage Lockout Exit (Recovery)		15	16.5	17.5	V
V_{DD_Clamp}	VDD Zener Clamp Voltage	I_{VDD} = 5 mA	-	35	-	V
OVP_{ON}	VDD Over voltage protection enter		23.5	25	26.5	V
OVP_{OFF}	VDD Over voltage protection exit(recovery)			23		V
OVP_{Hys}	OVP Hysteresis	OVP_{ON}-OVP_{OFF}	-	2	-	V
T_{D_OVP}	VDD OVP debounce time		-	80	-	μS

Current Mode PWM Controller With Frequency Shuffling

Feedback Input Section(FB Pin)						
AV_{CS}	PWM Input Gain	ΔV_{FB} /ΔV_{CS}	-	2.8	-	V/V
V_{FB_Open}	V_{FB} Open Loop Voltage		-	5.8	-	V
I_{FB_Short}	FB pin short circuit current	Short FB pin to GND,measure current	-	0.8	-	mA
V_{TH_0D}	Zero Duty Cycle FB Threshold Voltage		-		0.95	V
V_{TH_BM}	Burst mode FB threshold voltage		-	1.7	-	V
V_{TH_PL}	Power Limiting FB Threshold Voltage		-	4.4	-	V
T_{D_PL}	Power limiting Debounce Time		-	80	-	mS
Z_{FB_IN}	Input Impedance		-	7.2	-	KΩ
Current Sense Input(Sense Pin)						
T_blanking	Leading edge blanking time		-	250	-	nS
Z_{SENSE_IN}	Input Impedance		-	30	-	KΩ
T_{D_OC}	Over Current Detection and Control Delay	CL=1nF at GATE	-	120	-	nS
$V_{TH\_OC\_0}$	Current Limiting Threshold at No Compensation	I_{VIN}=0μA	0.80	0.9	0.95	V
$V_{TH\_OC\_1}$	Current Limiting Threshold at Compensation	I_{VIN}=150μA	-	0.81	-	V
Oscillator						
F_{OSC}	Normal Oscillation Frequency		60	65	70	KHz
Δf_Temp	Frequency Temperature Stability	-20°C to 100 °C		2		%
Δf_VDD	Frequency Voltage Stability	VDD = 12-25V		2		%
RI_range	Operating RI Range		12	24	60	KΩ
V_RI_open	RI open load voltage		-	2	-	V
F_BM	Burst Mode Base Frequency		-	22	-	KHz
DC_max	Maximum duty cycle			80		%
DC_min	Minimum duty cycle		-	-	0	%
Gate Drive Output						
V_{OL}	Output Low Level	I_O = -20 mA	-	-	0.3	V
V_{OH}	Output High Level	Io = 20 mA	11	-	-	V
V_{G_Clamp}	Output Clamp Voltage Level	VDD=20V	-	16	-	V
T_r	Output Rising Time	C_L = 1nF	-	120	-	nS
T_f	Output Falling Time	C_L = 1nF	-	50	-	nS
Over Temperature Protection						
I_RT	Output current of RT pin		-	70	-	μA
V_{TH_OTP}	OTP Threshold		1.015	1.065	1.115	V
$V_{TH\_OTP\_off}$	OTP Recovery threshold voltage		-	1.165	-	V
T_{D_OTP}	OTP De-bounce time		-	100	-	μS
V_RT_Open	RT Pin open voltage		-	3.5	-	V
Frequency Shuffling						
Δf_OSC	Frequency Modulation range /Base frequency	RI=100KΩ	-3	--	3	%
f_shuffling	Shuffling Frequency	RI=24KΩ	-	32		Hz

Operation Description

The ICW8020 is a highly integrated PWM controller IC optimized for offline flyback converter applications. The extended burst mode control greatly reduces the standby power consumption and helps the design easily meet the international power conservation requirements.

●Startup Current and Start up Control

Startup current of ICW8020 is designed to be very low so that VDD could be charged up above UVLO(exit) threshold level and device starts up quickly. A large value startup resistor can therefore be used to minimize the power loss yet provides reliable startup in application. For a typical AC/DC adaptor with universal input range design, a 2 MΩ, 1/8 W startup resistor could be used together with a VDD capacitor to provide a fast startup and low power dissipation solution.

●Operating Current

The Operating current of ICW8020 is low at 1.8mA. Good efficiency is achieved with ICW8020 low operating current together with extended burst mode control features.

●Frequency shuffling for EMI improvement

The frequency Shuffling/jittering (switching frequency modulation) is implemented in ICW8020. The oscillation frequency is modulated with a random source so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore reduces system design challenge.

●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 number of switching events within a fixed period of time. Reducing switching events leads to the reduction on the power loss and thus conserves the energy.

ICW8020 self adjusts the switching mode according to the loading condition. At from no load to light/medium load condition, the FB input drops below burst mode threshold level (1.8V). Device enters Burst Mode control. The Gate drive output switches only when VDD 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 thus reduce the standby power consumption to the greatest extend. The nature of high frequency switching also reduces the audio noise at any loading conditions.

●Oscillator Operation

A resistor connected between RI and GND sets the constant current source to charge/discharge the internal cap and thus the PWM oscillator frequency is determined. The relationship between RI and switching frequency follows the below equation within the specified RI in KΩ range at nominal loading operational condition.

$$F_{OSC}=\frac{1560}{RI(K\Omega)}(KHz)$$

●Current Sensing and Leading Edge Blanking

Cycle-by-Cycle current limiting is offered in ICW8020 current mode PWM control. The switch currentis detected by a sense resistor into the sense pin. An internal leading edge blanking circuit chops off the sense voltage spike at initial MOSFET on state due to Snubber diode reverse recovery so that the external RC filtering on sense input is no longer required. The current limit comparator is disabled and thus cannot turn off the external MOSFET during the blanking period. PWM duty cycle is determined by the current sense input voltage and the FB input voltage.

●Internal Synchronized Slope Compensation

Built-in slope compensation circuit adds voltage ramp onto the current sense input voltage for PWM generation. This greatly improves the close loop stability at CCM and prevents the sub-harmonic oscillation and thus reduces the output ripple voltage.

●Gate Drive

ICW8020 Gate is connected to an external MOSFET gate for power switch control. Too weak the gate drive strength results in higher conduction and switch loss of MOSFET while too strong gate drive output compromises the EMI. A good trade-off is achieved through the built-in totem pole gate design with right output strength and dead time control. The low idle loss and good EMI system design is easier to achieve with this dedicated control scheme. An internal 16V clamp is added for MOSFET gate protection at higher than expected VDD input.

●Over Temperature Protection

A NTC resistor in series with a regular resistor should connect between RT and GND for temperature sensing and protection.NTC resistor value becomes lower when the ambient temperature rises. With the fixed internal current IRT flowing through the resistors, the voltage at RT pin becomes lower at high temperature. The internal OTP circuit is triggered and shutdown the MOSFET when the sensed input voltage is lower than VTH_OTP.

●Protection Controls

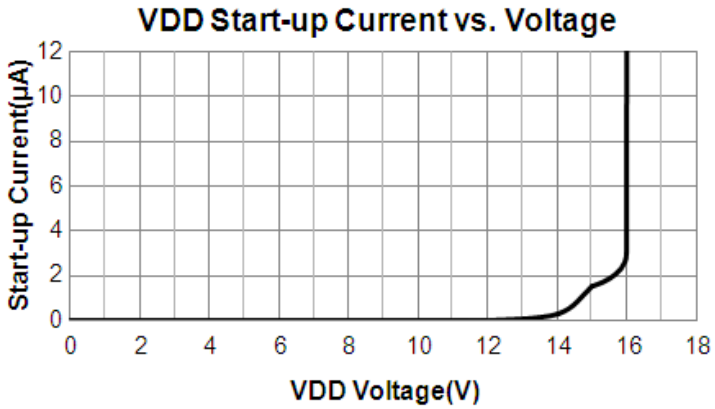
Good power supply system reliability is achieved with its rich protection features including Cycle-by-Cycle current limiting (OCP), Over Load Protection (OLP), over temperature protection(OTP), on-chip VDD over voltage protection (OVP, optional), and Under Voltage Lockout (UVLO).

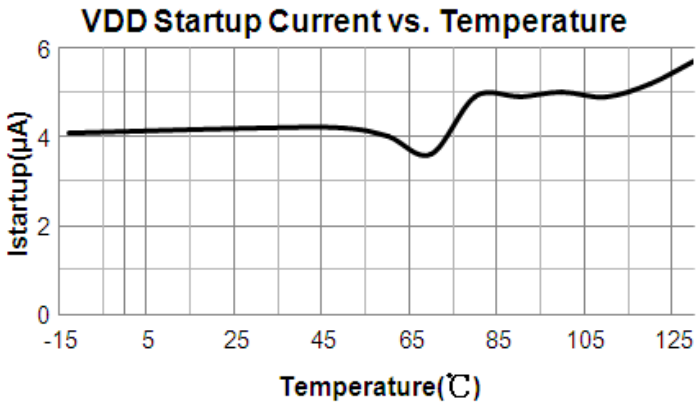
The OCP threshold value is self adjusted lower at higher current into VIN pin. This OCP threshold slope adjustment helps to compensate the increased output power limit at higher AC voltage caused by inherent Over-Current sensing and control delay. A constant output power limit is achieved with recommended OCP compensation scheme on ICW8020.

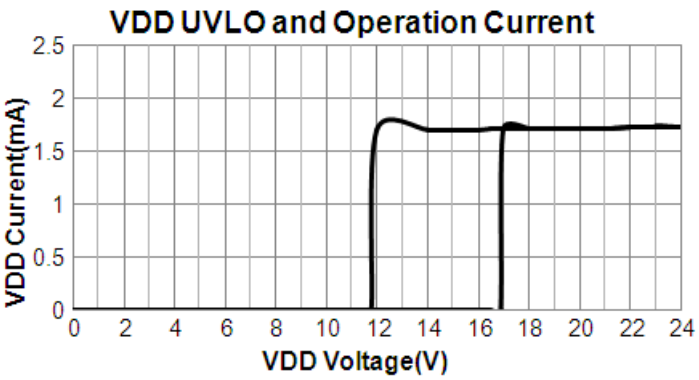
At overload condition, FB voltage is biased higher. When FB input exceeds power limit threshold value for more than TD_PL, control circuit reacts to shut down the output power MOSFET. Similarly, control circuit shutdowns the

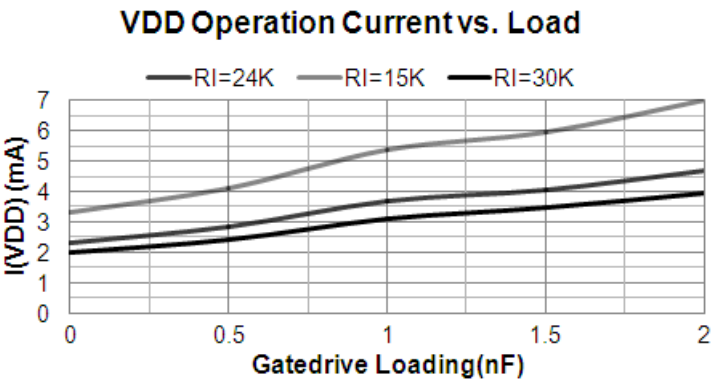
power MOSFET when an over temperature condition is detected. ICW8020 resumes the operation when temperature drops below the hysteresis value. VDD is supplied by transformer auxiliary winding output. It is clamped when VDD is higher than threshold value. The power MOSFET is shut down when VDD drops below UVLO limit and device enters power on start-up sequence thereafter.

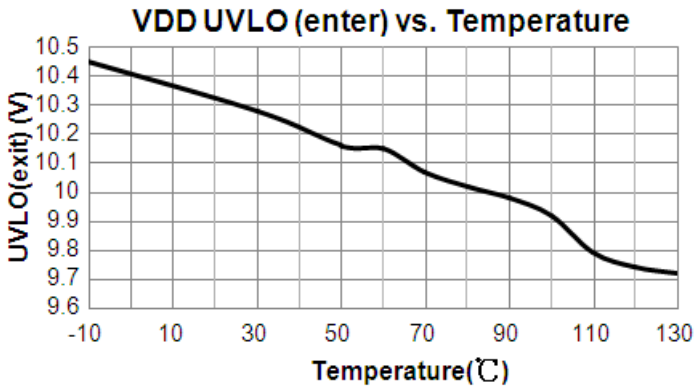
Typical Performance Characteristics

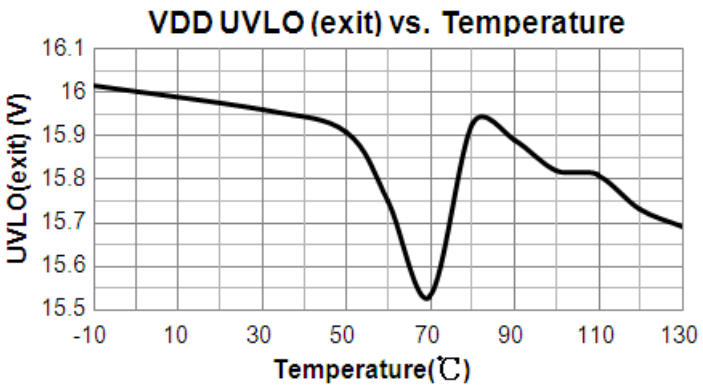


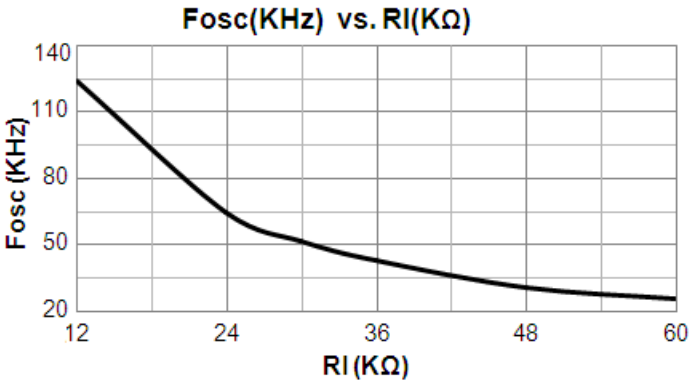


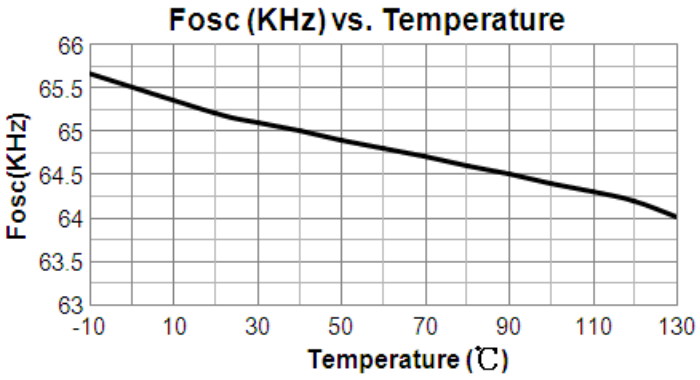


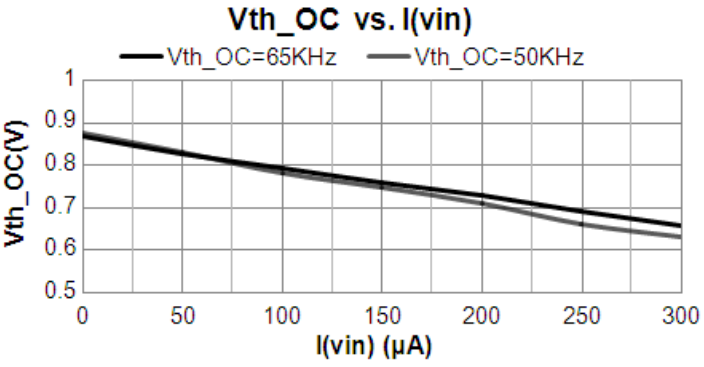


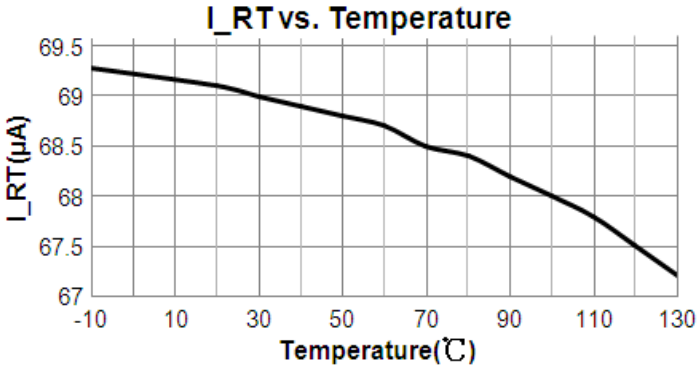





Fosc(KHz) vs. RI(KΩ)
Fosc (KHz)
140
110
80
50
20
12
24
36
48
60
RI (KΩ)

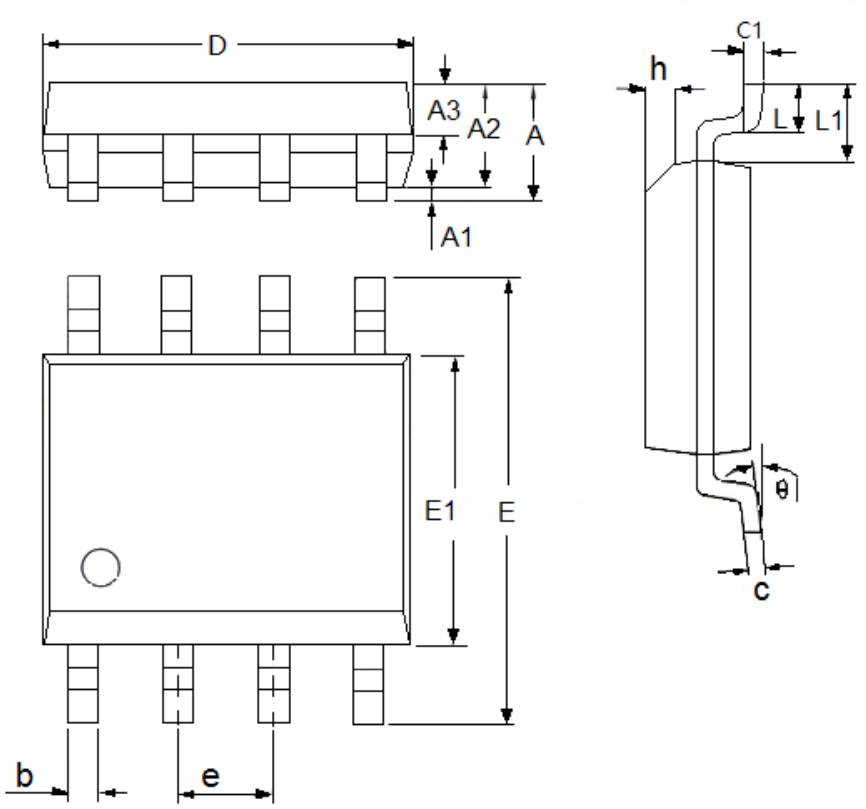

Fosc (KHz) vs. Temperature
Fosc(KHz)
66
65.5
65
64.5
64
63.5
63
-10
10
30
50
70
90
110
130
Temperature (℃)


Vth_OC vs. I(vin)
Vth_OC=65KHz
Vth_OC=50KHz
Vth_OC(V)
1
0.9
0.8
0.7
0.6
0.5
0
50
100
150
200
250
300
I(vin) (μA)


I_RT vs. Temperature
I_RT(μA)
69.5
69
68.5
68
67.5
67
-10
10
30
50
70
90
110
130
Temperature(℃)

Packaging Information

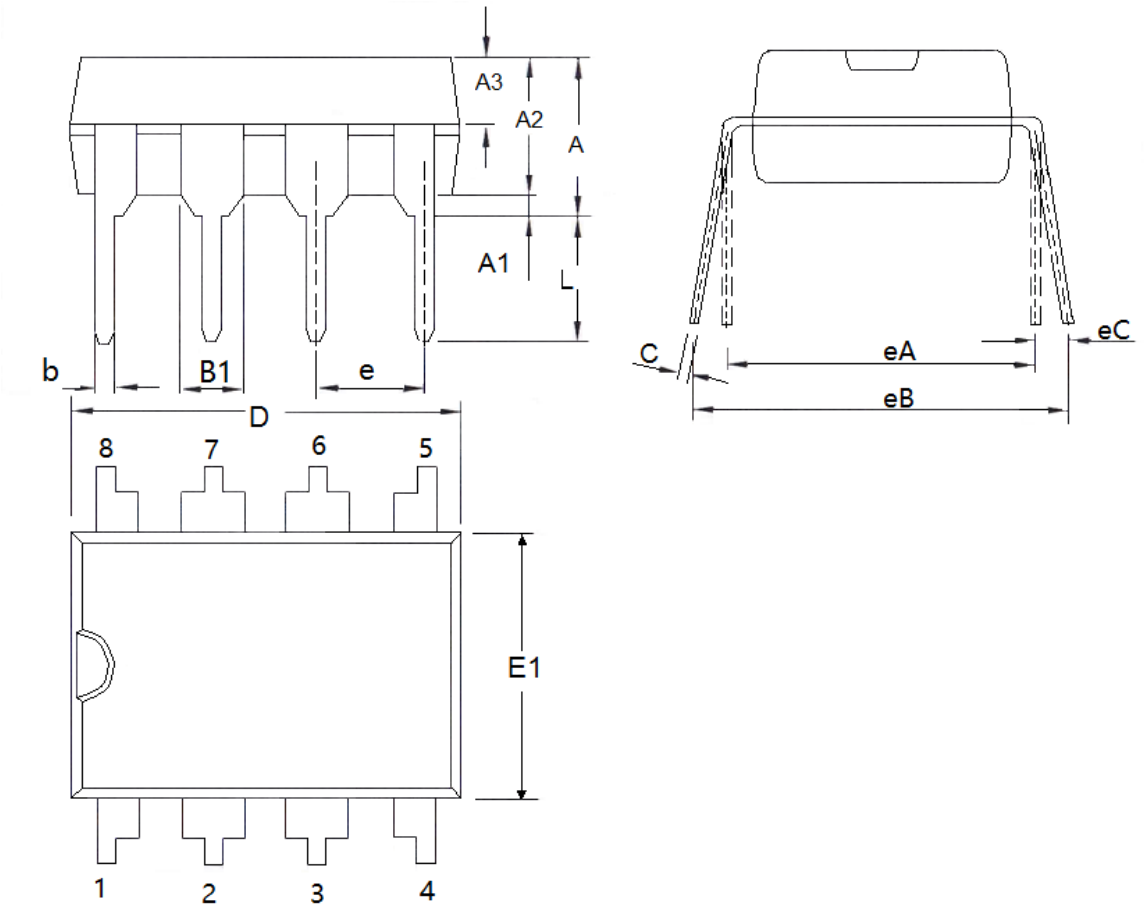
- **SOP8**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.3	1.8	0.0512	0.0709
A1	0.05	0.25	0.002	0.0098
A2	1.25	1.65	0.0492	0.065
A3	0.5	0.7	0.0197	0.0276
b	0.3	0.51	0.0118	0.0201
c	0.17	0.25	0.0067	0.0098
D	4.7	5.1	0.185	0.2008
E	5.8	6.2	0.2283	0.2441
E1	3.8	4	0.1496	0.1575
e	1.27(TYP)		0.05(TYP)	
h	0.25	0.5	0.0098	0.0197
L	0.4	1.27	0.0157	0.05
L1	1.04(TYP)		0.0409(TYP)	
θ	0	8°	0	8°
c1	0.25(TYP)		0.0098(TYP)	

Current Mode PWM Controller With Frequency Shuffling

- **DIP8**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	3.6	4.31	0.1417	0.1697
A1	0.5(TYP)		0.0197(TYP)	
A2	3.2	3.6	0.1260	0.1417
A3	1.47	1.65	0.0579	0.0650
b	0.38	0.57	0.0150	0.0224
B1	1.52(TYP)		0.0598(TYP)	
C	0.2	0.36	0.0079	0.0142
D	9	9.4	0.3543	0.3700
E1	6.1	6.6	0.2402	0.2598
e A	7.62(TYP)		0.3(TYP)	
e B	7.62	9.3	0.3000	0.3661
e	2.54(TYP)		0.1(TYP)	
e C	0	0.84	0.0000	0.0331
L	3	3.6	0.1181	0.1417