Subject

OB2222M Demo Board Manual

Board Model:AD5.0V0.2A2222M.00

Doc. No.: OB_DOC_DBM_2222M02

Key features:

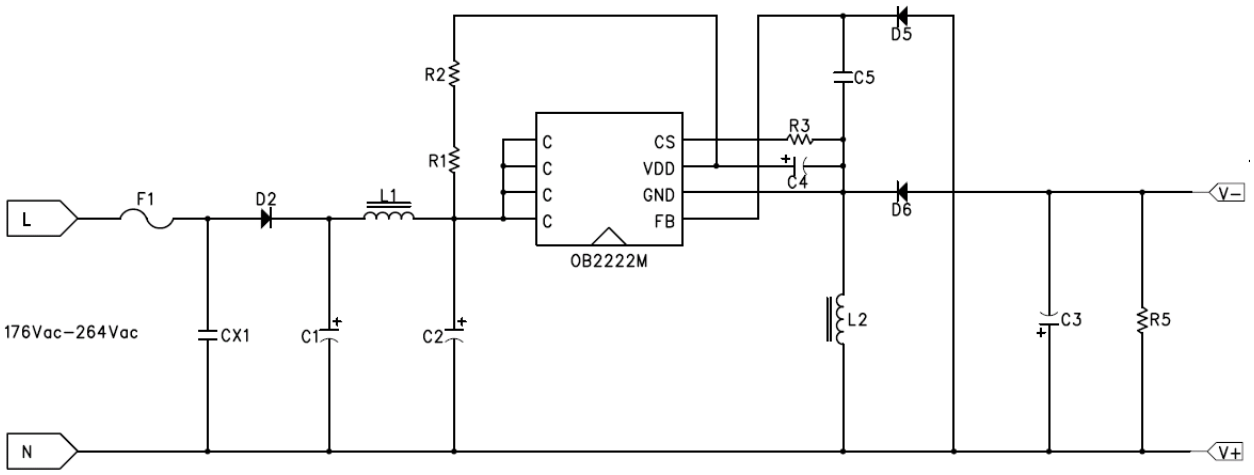
- Lowest possible component count
- Standby power <100mW @264Vac
- Efficiency measured >55% at full load
- Output voltage regulation +/-5%
- Good dynamic response
- Comprehensive protection including output short protection, OTP, etc.

Revision History

Revise Date	Version	Reason/Issue
2014-5-30	00	First issue
2014-6-25	01	Document optimization
2015-2-2	02	System optimization

1. Board Information

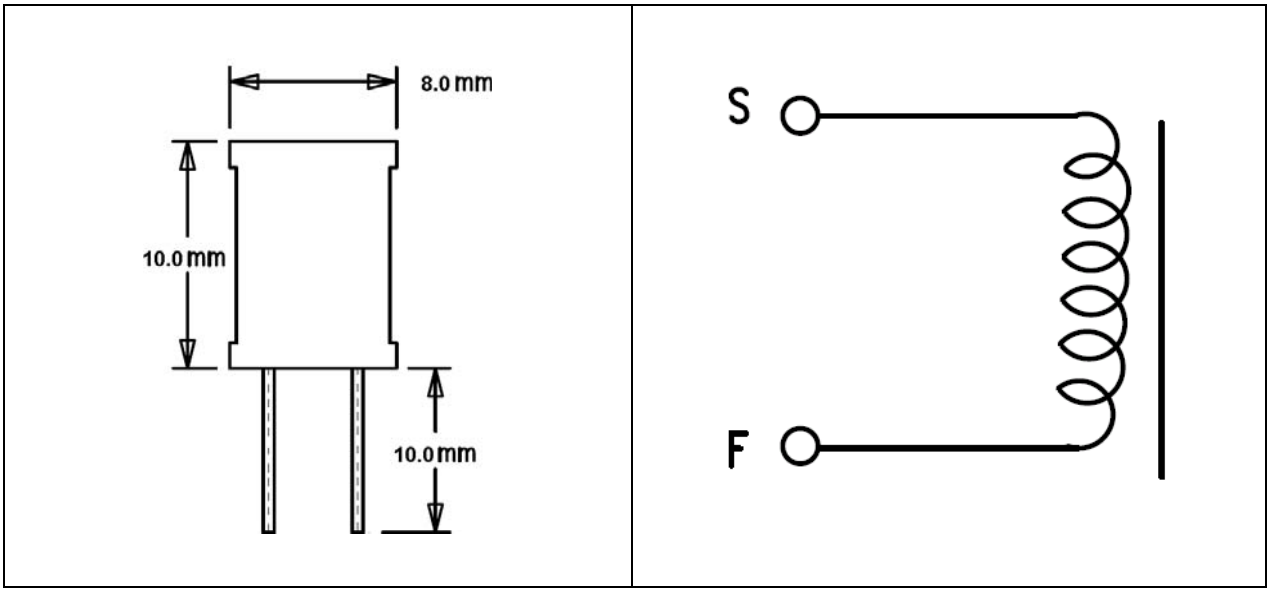
1.1. Board schematic



1.2. Component list

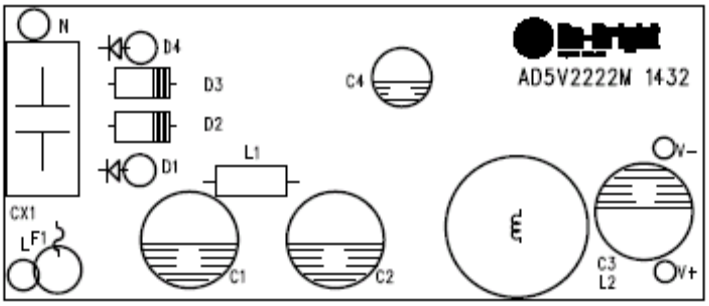
No.	Position	Description	Quantity
1	F1	Resistor fuse 10R/1W	1
2	D2	Diode 1N4007	1
3	D4	Jumper	1
4	D5	Diode M7	1
5	D6	Superfast diode ES1J	1
6	CX1	X-Cap 223P/X2	1
7	C1, C2	E.C. 2.2uF /400V	2
8	C3	E.C. 330uF /10V	1
9	C4	E.C. 4.7uF /50V	1
10	C5	SMD Cap 1uF /25V	1
11	R1,R2	SMD RES 2M /5% /1206	2
12	R3	SMD RES 1R0 /1% /1206	1
13	R5	SMD RES 1K /5% /0805	1
14	U1	OB2222M SOP8	1
15	L1	Inductor 1mH /0510	1
16	L2	Inductor 350uH /Φ8*10	1
	Total		18

1.3. Inductor design

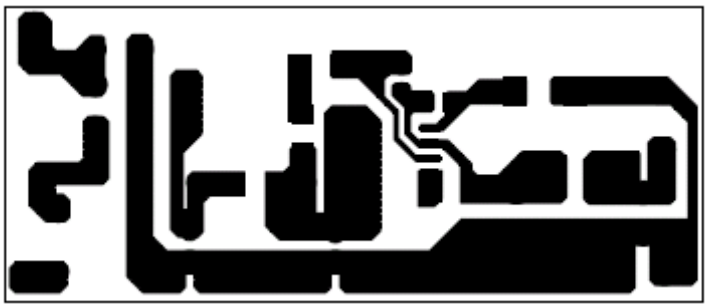


Material	Turns	Inductance & Tolerance
Φ0.25 *1　2UEW	98	350uH±10%

1.4. PCB Gerber File



Top



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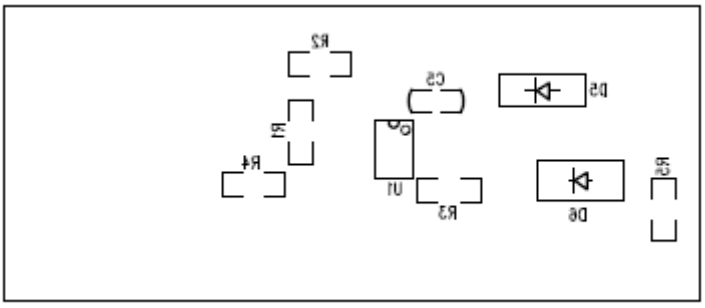


Silkscreen Bottom

1.5. Snapshot


N
D4
D3
D2
D1
C4
L1
C1
C2
C3
L2
V-
V+
AD5V2222M 1432
36660S-Y349-10


R3
D6
U1
R4
R1
R2
C5
D5
R5

2. Converter Specification

2.1. Input Characteristics

- AC input voltage range 176Vac ~ 264Vac
- AC input frequency range 50Hz

2.2. Output Characteristics

- Output voltage V_{OUT} 5.0V
- Output current I_{OUT} 200mA
- Operating frequency 40KHz
- Output power 1.0W

2.3. Performance Function

- Standby Power < 100mW @ 264Vac/50Hz, no-load, 25℃
- Efficiency >55%
- Ripple & Noise <100mV

2.4. Protection Function

- Short Circuit Protection Output shut down with auto-restart
- Over Temperature Protection Output shut down with auto-restart

3. Performance Evaluation

3.1. Standby Power

Input voltage	P_{IN} (mW)	Spec	Remark
176Vac/50Hz	60	<100mW	Pass
200Vac/50Hz	65		Pass
230Vac/50Hz	73		Pass
264Vac/50Hz	84		Pass

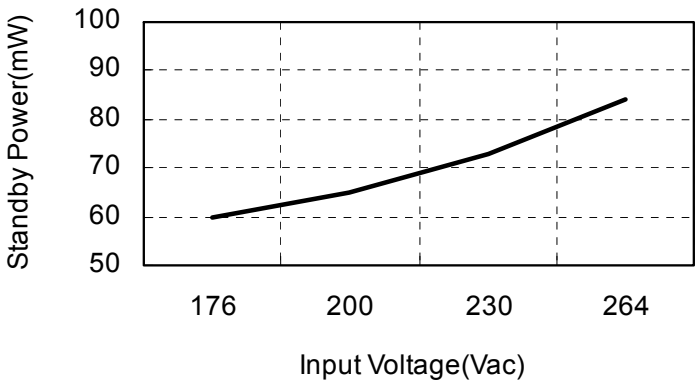


Figure 1. Standby input power

3.2. Efficiency

Input voltage	load 200mA	Spec	Remark
176Vac/50Hz	65.10	>55%	Pass
200Vac/50Hz	64.80		Pass
230Vac/50Hz	64.10		Pass
264Vac/50Hz	63.20		Pass

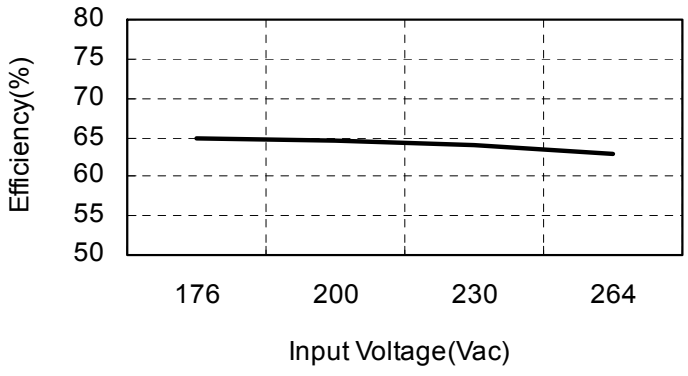


Figure 2. Efficiency @200mA load

3.3. Output Voltage

Input voltage	0mA	5mA	10mA	50mA	100mA	200mA	Spec	Remark
176Vac/50Hz	5.102	5.006	4.974	5.120	5.052	4.964	4.75~5.25V	Pass
200Vac/50Hz	5.108	5.000	4.964	5.080	5.055	4.964		Pass
230Vac/50Hz	5.114	4.999	4.952	4.993	5.053	4.960		Pass
264Vac/50Hz	5.137	5.001	4.947	4.940	5.056	4.960		Pass

3.4. Dynamic（Figure 9）

Input voltage	$V_{OUT-MAX}$ (V)	$V_{OUT-MIN}$(V)	Spec	Remark
176Vac/50Hz	5.270	4.880	4.5~5.5V	Pass
200Vac/50Hz	5.270	4.870		Pass
230Vac/50Hz	5.270	4.870		Pass
264Vac/50Hz	5.270	4.865		Pass

Note: A dynamic loading with low load set at 5mA load lasting for 5ms and high set at 200mA load lasting for 5ms is added to output. The ramp is set at 0.25A/us at transient.

3.5. Over Current Protection & Recovery

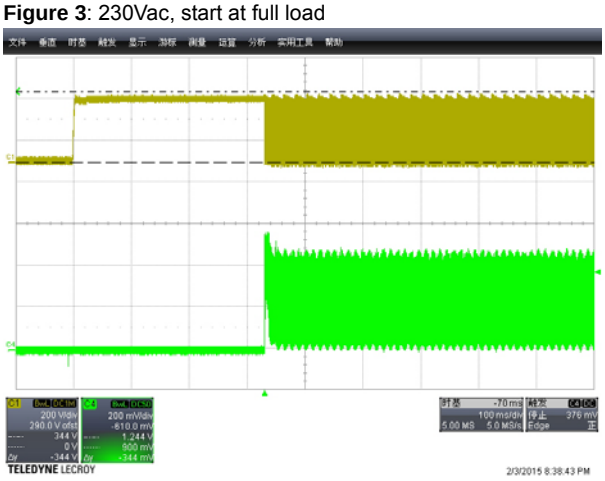
Input voltage	OCP (A)	Recovery (A)	Spec	Remark
176Vac/50Hz	0.285	0.277	≥1.1*I_{OUT}	Pass
200Vac/50Hz	0.290	0.286		Pass
230Vac/50Hz	0.293	0.290		Pass
264Vac/50Hz	0.302	0.297		Pass

3.6. Ripple & Noise（Figure 7&8）

Input voltage	No load (mV)	Full load (mV)	Spec	Remark
176Vac/50Hz	20.0	45.0	<100mV	Pass
200Vac/50Hz	19.8	46.0		Pass
230Vac/50Hz	23.8	46.0		Pass
264Vac/50Hz	25.0	45.0		Pass

3.7. Waveforms

Figure 3: 230Vac, start at full load

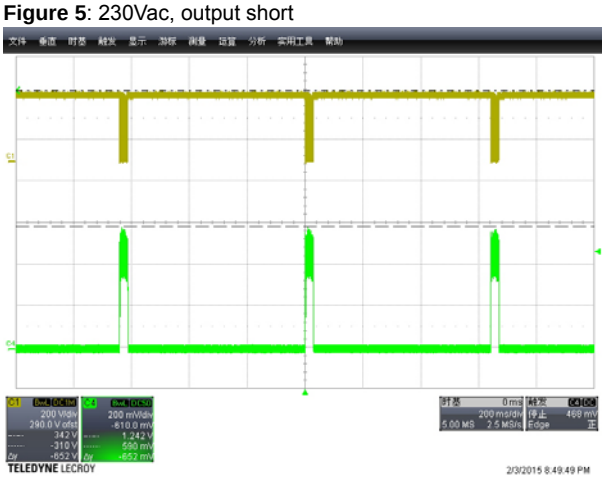


CH1: V_{ds} CH4: $I_{Inductor}$
230Vac 输入，满载启动，V_{ds}=344V

Figure 4: 230Vac, start at full load

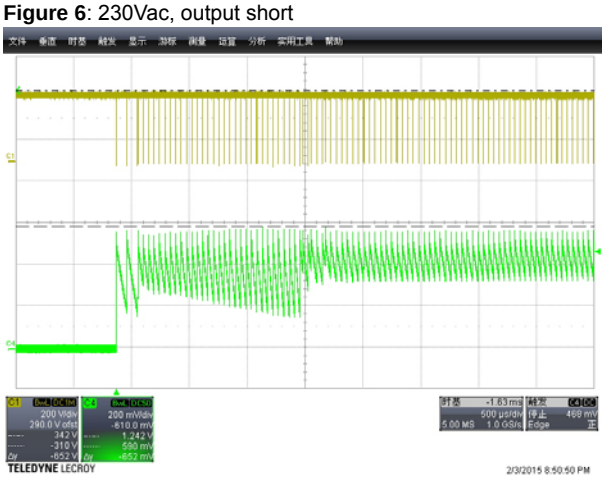
CH1: V_{ds} CH4: $I_{Inductor}$
230Vac 输入，满载启动波形展开，V_{ds}=344V

Figure 5: 230Vac, output short



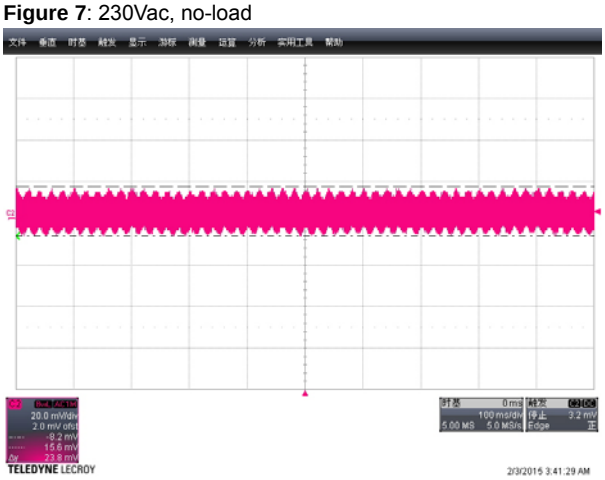
CH1: V_{ds} CH4: $I_{Inductor}$
230Vac 输入，输出短路，V_{ds}=342V

Figure 6: 230Vac, output short



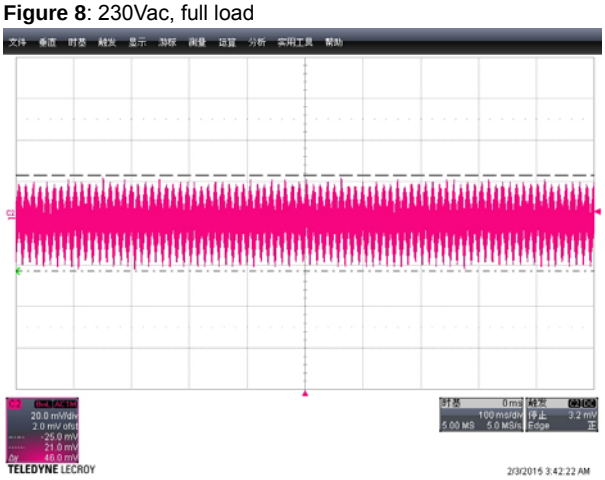
CH1: V_{ds} CH4: $I_{Inductor}$
230Vac 输入，输出短路波形展开，V_{ds}=342V

Figure 7: 230Vac, no-load



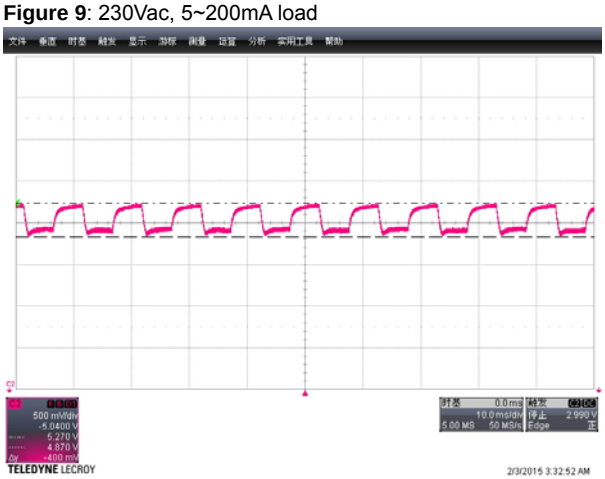
CH2: V_{ripple}
230Vac 输入，空载，V_{ripple} =23.8mV

Figure 8: 230Vac, full load



CH2: V_{ripple}
230Vac 输入，满载，V_{ripple}=46mV

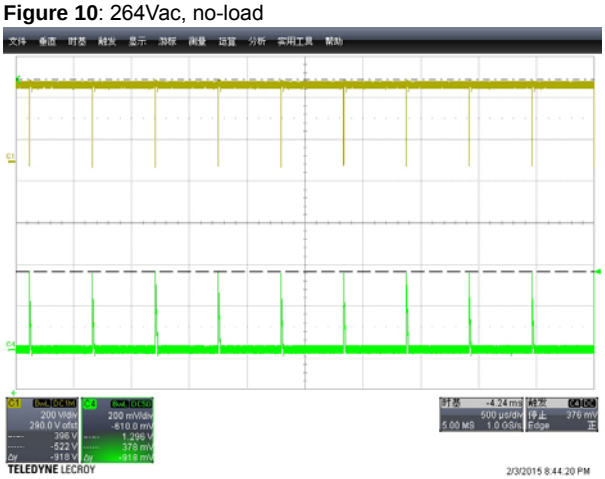
Figure 9: 230Vac, 5~200mA load



CH2: V_{out}

230Vac 输入，负载变化，V_{out} =4.87-5.27V

Figure 10: 264Vac, no-load



CH1: V_{ds} CH4: $I_{Inductor}$

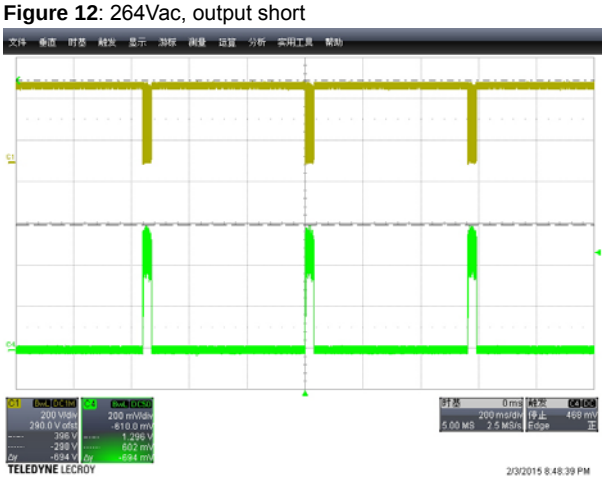
264Vac 输入，空载，V_{ds}=396V

Figure 11: 264Vac, full load

CH1: V_{ds} CH4: $I_{Inductor}$

264Vac 输入，满载，V_{ds}=400V

Figure 12: 264Vac, output short



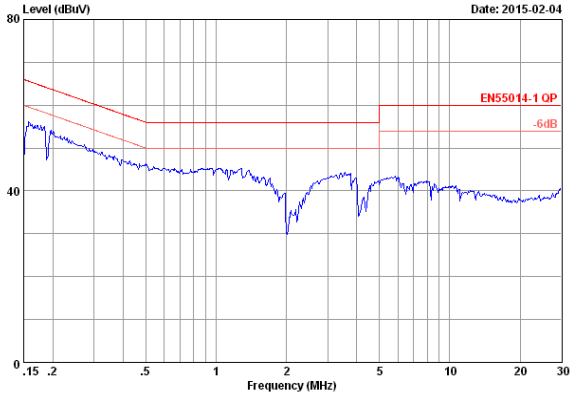
CH1: V_{ds} CH4: $I_{Inductor}$

264Vac 输入，输出短路，V_{ds}=396V

Input	V_{ds_max}(V)	Remark
264Vac @ no-load	396	Figure 10
264Vac @ full load	400	Figure 11
264Vac @ output short	396	Figure 12

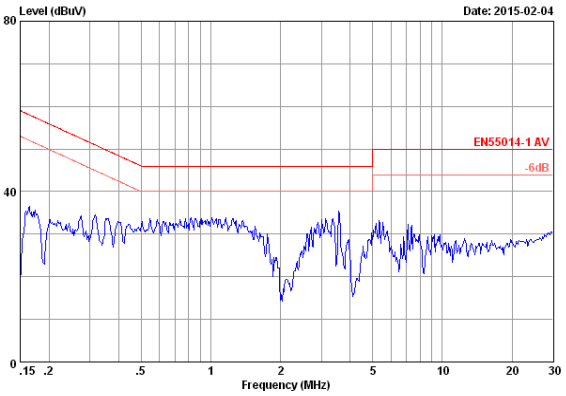
3.8. Conducted EMI Test（EN55014 Class B Standard）

Figure 13: 230Vac, Line QP



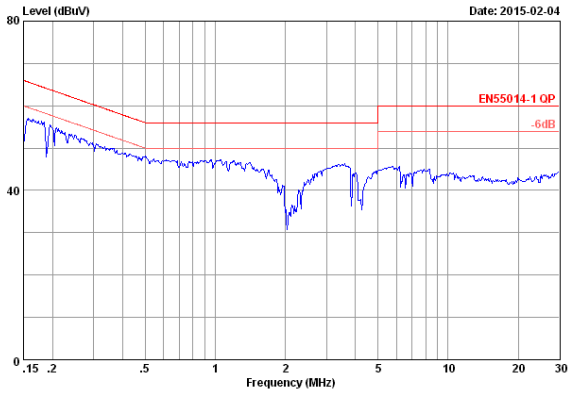

```
Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 QP ESH2-Z5-2014 LINE
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : L
Test Mode           :
Test Engineer       : Seven
Memo                :
```

Figure 14: 230Vac, Line AVG



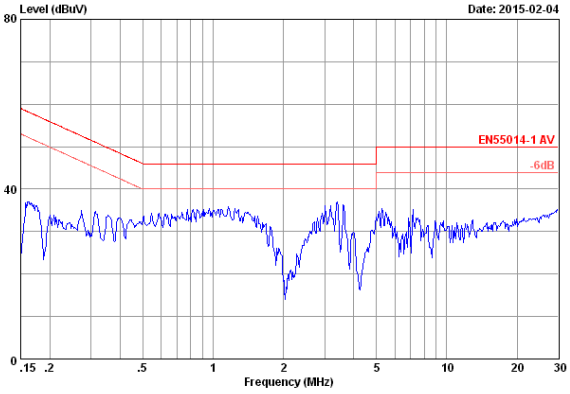

```
Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 AV ESH2-Z5-2014 LINE
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : L
Test Mode           :
Test Engineer       : Seven
Memo                :
```

Figure 15: 230Vac, Neutral QP




```
Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 QP ESH2-Z5-2014 NEUTRAL
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : N
Test Mode           :
Test Engineer       : Seven
Memo                :
```

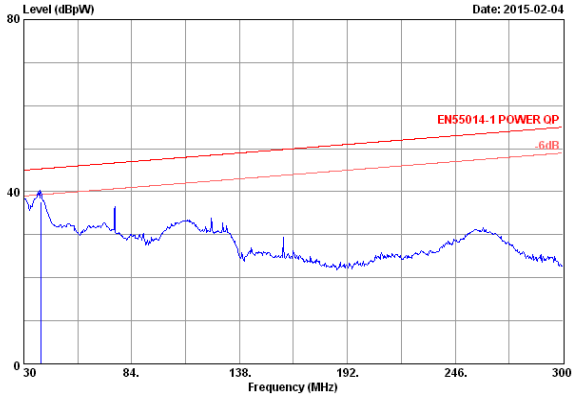
Figure 16: 230Vac, Neutral AVG




```
Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 AV ESH2-Z5-2014 NEUTRAL
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : N
Test Mode           :
Test Engineer       : Seven
Memo                :
```

3.9. Power Disturbance Test

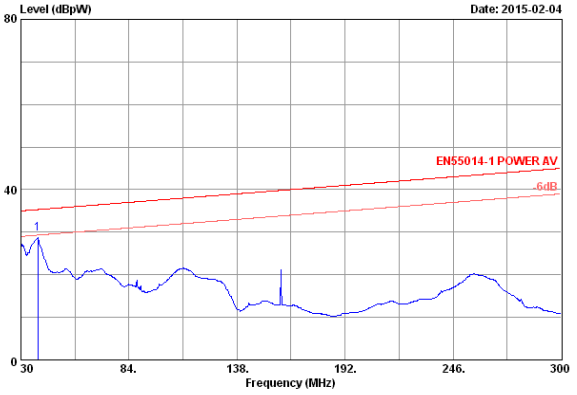
Figure 17: 230Vac, QP




```
Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 POWER QP CLAMP-MDS-21-2014-1
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : AC Line
Test Mode           :
Test Engineer       : Seven
Memo                :
```

	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remarl
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1	38.390000	37.74	16.81	0.97	19.96	20.93	45.32	-7.58	QP

Figure 18: 230Vac, AVG

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Site                : Audix(Shanghai) Shielded1
Condition           : EN55014-1 POWER AV CLAMP-MDS-21-2014-1
Project No.         :
Applicant           :
EUT                 : OB2222M
M/N                 : DEMO
S/N                 :
Power Supply        : 230V/50Hz
Ambient             : 22'C 48%RH
Test line           : AC Line
Test Mode           :
Test Engineer       : Seven
Memo                :
```

	Freq	Level	Read Level	Cable Loss	LISN Factor	Factor	Limit Line	Over Limit	Remark
	MHz	dBuV	dBuV	dB	dB	dB	dBuV	dB	
1 !	38.470000	29.63	8.71	0.97	19.95	20.92	35.32	-6.69	Averag

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GENERAL DESCRIPTION

OB2222M is a high performance, high precision and low cost PWM Power switch for non-isolated buck and buck-boost application. It combines a dedicated current mode PWM controller with a high voltage power Bipolar in SOP8 package. Its built-in error amplifier is optimized for good overshoot and dynamic response for low cost and component count. With precise inner resistor divider, precise reference of EA， constant voltage regulation of 5.0V at universal AC input can be guaranteed. Frequency reduction and burst mode control is implemented for high efficiency at light load. Good EMI performance is achieved with On-Bright proprietary frequency shuffling technique and soft base driver design. Low startup current and low operating current contribute to a reliable power on startup and low standby power consumption with OB2222M. Constant power operation is supported at over load application with OB2222M, which makes it suitable for small home appliance application where instant large power consumption is required such as start-up of a fan.

OB2222M offers power on soft start control and protection coverage with auto-recovery features including cycle-by-cycle current limiting, output short circuit protection, FB pin open loop protection, on-chip Over Temperature Protection (OTP), VDD Over Voltage Protection (OVP), and VDD Under Voltage Lockout Protection (UVLO).

The tone energy at below 20KHz is minimized in the design so that audio noise is eliminated during operation.

OB2222M is offered in SOP8 package.

FEATURES

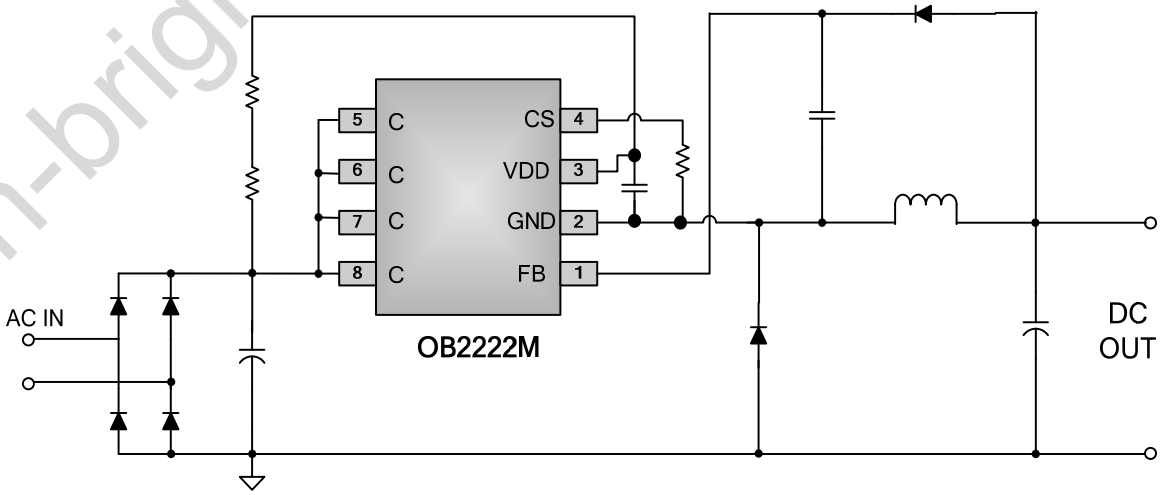
- Universal AC input range and 5.0V output voltage
- Constant power mode operation at over load application
- Low cost and less BOM for buck and buck-boost applications
- Current mode control
- 40kHz (typical) maximum switching frequency
- Frequency-reduction and burst mode control for high efficiency
- Frequency shuffling for EMI improvement
- Power on soft-start
- Built-in Leading Edge Blanking (LEB)
- Cycle-by-cycle current limiting
- FB pin open loop protection
- Output short-circuit protection
- VDD Under Voltage Lockout with Hysteresis
- VDD OVP
- On-Chip OTP

APPLICATIONS

Low power AC/DC offline SMPS for

- Small home appliance
- Linear regulator/RCC replacement

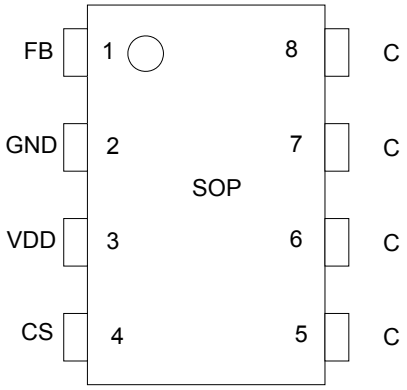
TYPICAL APPLICATION



GENERAL INFORMATION

Pin Configuration

The pin map is shown as below for SOP8



Ordering Information

Part Number	Description
OB2222MCP	SOP8, Pb-free, Tube
OB2222MCPA	SOP8, Pb-free, T&R

Package Dissipation Rating

Package	RθJA (℃/W)
SOP8	90

Note: Drain Pin Connected 100mm^2 PCB copper clad.

Output Power Table

Topology	90~264Vac Input (open frame)
Buck/Buck-Boost	300mA

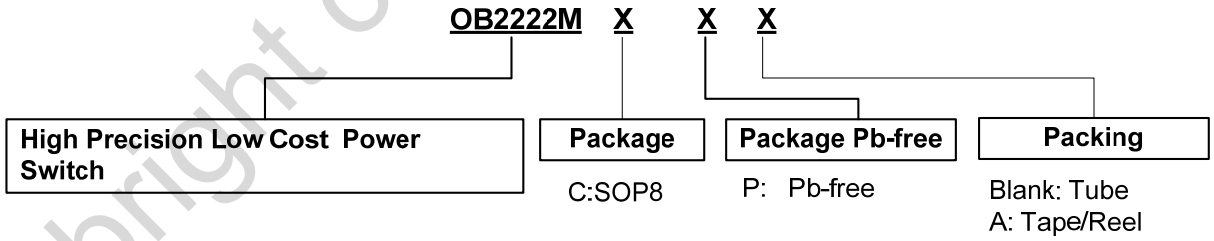
Absolute Maximum Ratings

Parameter	Value
C-B Voltage	700V
VDD Voltage	-0.3 to 20V
FB Voltage	-0.3 to 20V
CS Input Voltage	-0.3 to 7V
Min/Max Operating Junction Temperature T_J	-40 to 150 ℃
Operating Ambient Temperature T_A	-40 to 85 ℃
Min/Max Storage Temperature T_{stg}	-55 to 150 ℃
Lead Temperature (Soldering, 10secs)	260 ℃

Note: Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Condition

Symbol	Parameter	Range
VDD	VDD Supply Voltage	4.5 to 6V



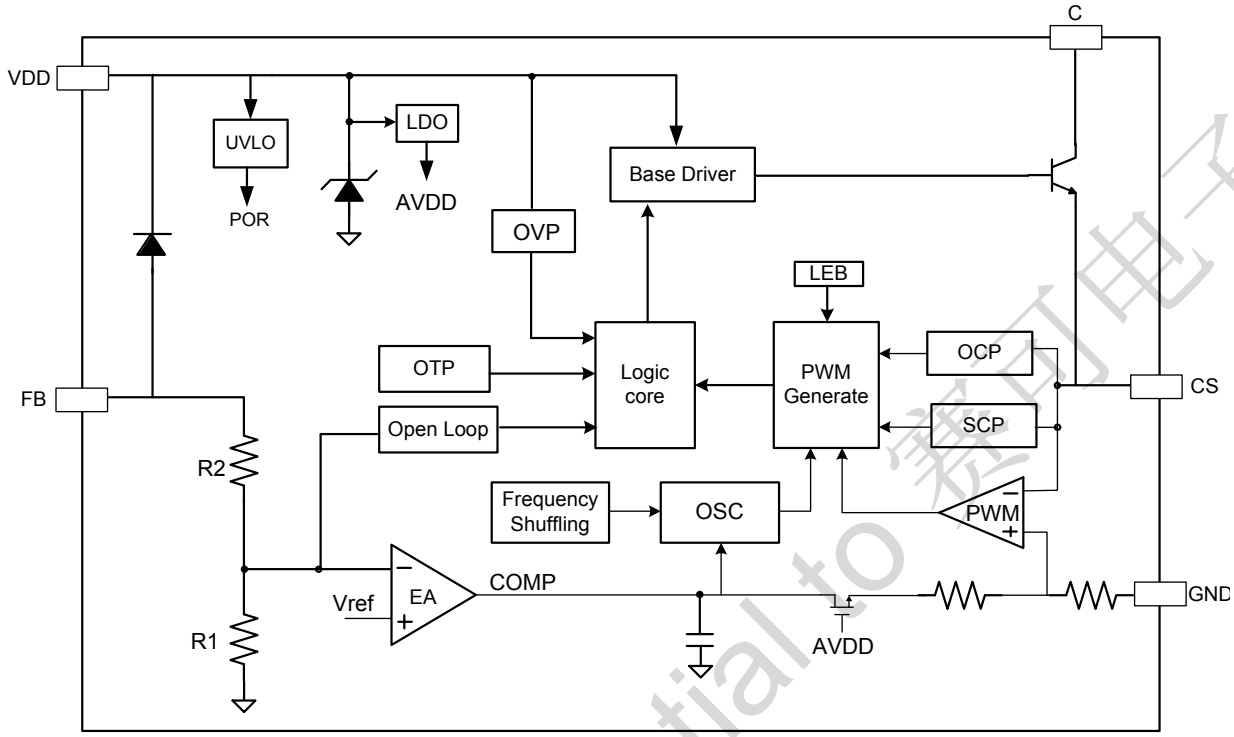
Marking Information

Y:Year Code
WW:Week Code(01-52)
ZZZ:Lot Code
C:SOP8 Package
P:Pb-free Package
S:Internal Code(Optional)

TERMINAL ASSIGNMENTS

Pin Num	Pin Name	I/O	Description
1	FB	I	Output Voltage Feedback. This pin should connect a capacitor to ground.
2	GND	P	Ground
3	VDD	P	Power Supply
4	CS	I	Current sense input
5/6/7/8	C	O	Power bipolar collector pins.

BLOCK DIAGRAM

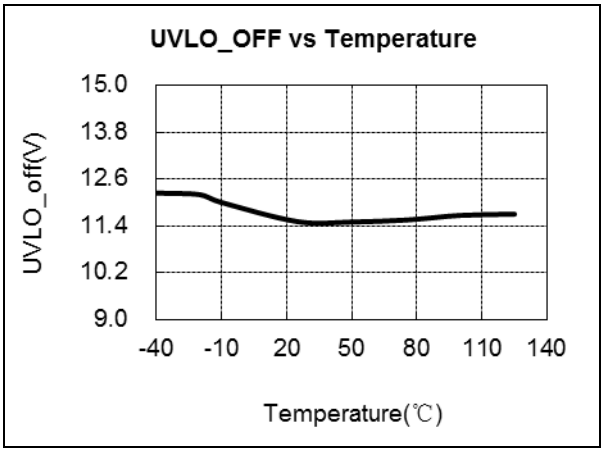


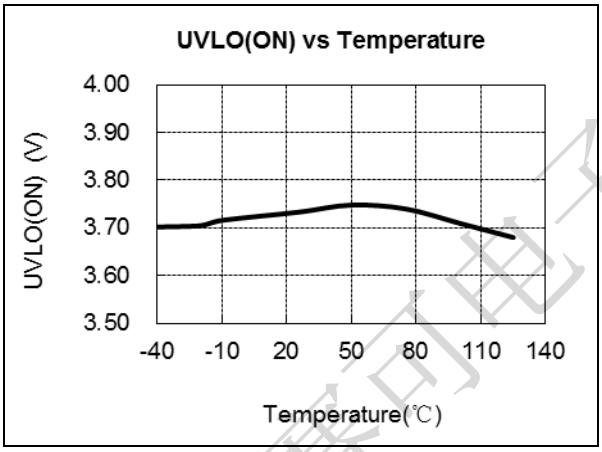
ELECTRICAL CHARACTERISTICS

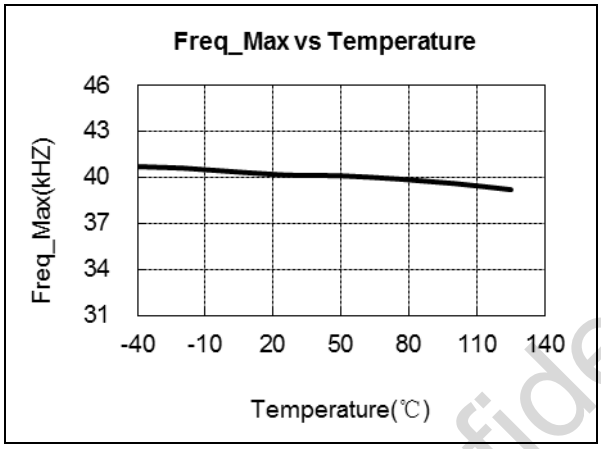
(T_A = 25℃, VDD=5.5V, if not otherwise noted)

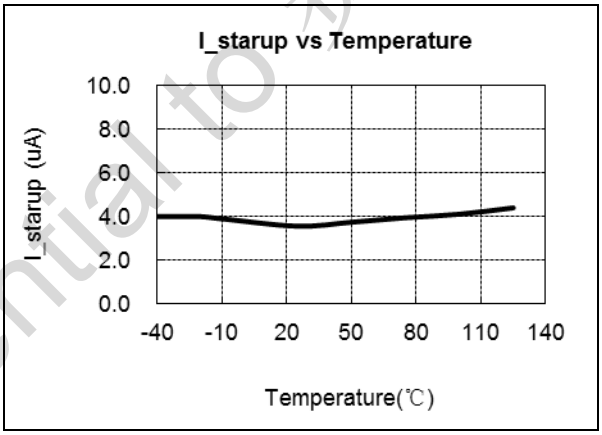
Symbol	Parameter	Test Conditions	Min	Typ.	Max	Unit
Supply Voltage (VDD) Section						
$I_{\_startup}$	Startup Current	VDD=UVLO(off) -1V			10	uA
$I_{\_VDD\_op}$	Operation Current	Operation supply current CS=0.5V		1.5	2	mA
		Operation supply current FB=6V		0.4		mA
UVLO(ON)	VDD Under Voltage Lockout Enter	VDD falling, gate disappear	3	3.7	3.9	V
UVLO(OFF)	VDD Under Voltage Lockout Exit	VDD rising	10.5	11.5	12.5	V
OVP	Over voltage protection Threshold	Ramp VDD until gate shut down	14	15	16	V
FB Regulation Voltage	In normal regulation, FB will be regulated to average of 5.15V			5.15		V
Current Sense Input Section						
TLEB	LEB time		250	300	350	ns
Vth_oc	Over current detection Threshold voltage		550	575	600	mV
Td_oc	OCP propagation delay			50	100	ns
Vth_scp	Short Current protection threshold voltage		0.6	0.7	0.8	V
Vth_flt	CS floating protection threshold voltage		0.9	1.0	1.1	V
EA Section						
Vref	EA reference		1.44	1.5	1.56	V
Kfb/vref	FB divider coefficient			3.43		
Frequency Section						
Freq_Max	IC Maximum frequency		36	40	44	KHz
Δf/Freq	Frequency shuffling range			+/-8		%
F_shuffling	Shuffling frequency			78		Hz
Dmax	Maximum Duty Cycle		7	11	15	%
F_Burst	Burst Mode Switch Frequency			20		KHz
Base Driver Section						
Is_max	Base sourcing maximum current			90		mA
Is_preoff	Base sourcing current after pre-off			3		mA
Protection Section						
Vth_OLD	FB pin open loop detection threshold voltage			0.515		V
OTP	Power switch temperature for exiting over temperature protection			125		℃
	Power switch temperature for entering over temperature protection			150		℃
Power BJT Section						
Vceo	Collector-emitter breakdown voltage	Ic=10mA, Ib=0	450			V
Vcbo	Collector-base breakdown voltage	Ic=10mA	700			V
Ic	Collect Peak Current			1.0		A

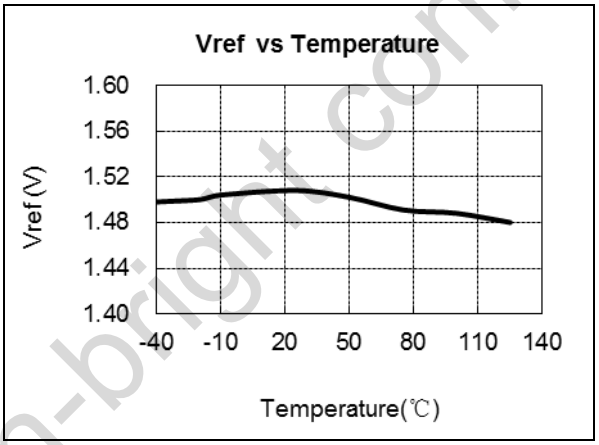
CHARACTERIZATION PLOTS

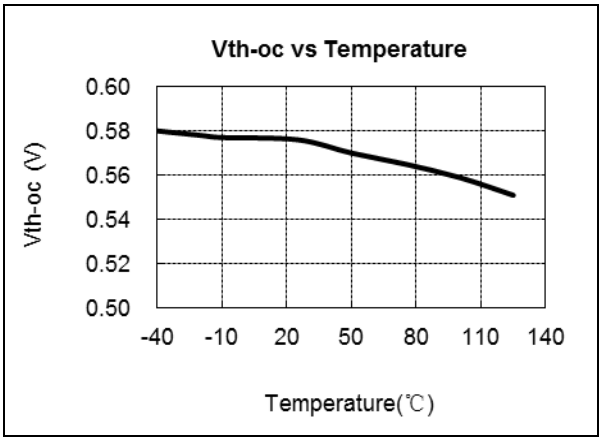












OPERATION DESCRIPTION

OB2222M is a cost effective PWM power switch optimized for off-line non-isolated buck or buck-boost applications for small home appliances and linear regulator replacement. It operates in current mode and regulates output voltage with dedicated features. High integration can afford low cost and component count solution.

Startup Current and Start up Control
Startup current of OB2222M is designed to be very low so that VDD could be charged up above UVLO threshold and starts up quickly. A large value startup resistor can therefore be used to minimize the power loss in application.

Operating Current
The Operating current of OB2222M is as low as 1.2mA (typical). Good efficiency is achieved with the low operation current together with 'Multi-mode' control features.

PWM operation
The maximum switching frequency of OB2222M is internally fixed at 40KHz (typical). No external frequency setting components are required for PCB design simplification.

At light load or zero load condition, most of the power dissipation in a switching mode power supply is from switching loss on the BJT. 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 frequency reduction and burst mode operation are implemented to achieve high efficiency at light load. The minimum switching frequency is 20KHz (typical).

Frequency shuffling for EMI improvement
The frequency shuffling (switching frequency modulation) is implemented in OB2222M. The oscillation frequency is modulated so that the tone energy is spread out. The spread spectrum minimizes the conduction band EMI and therefore eases the system design.

Soft Start
OB2222M features an internal 256 cycles (typical) soft start to soften the electrical stress occurring in the power supply during startup. It is activated during the power on sequence. After VDD reaches UVLO(OFF), the switching frequency is gradually increased from 10KHz to 40KHz. Every restart up is followed by a soft start.

Current Sensing and Leading Edge Blanking
Cycle-by-Cycle current limiting is offered in OB2222M 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 BJT on state so that the external RC filtering on sense input is no longer needed. The PWM duty cycle is determined by the current sense input voltage and the EA output voltage.

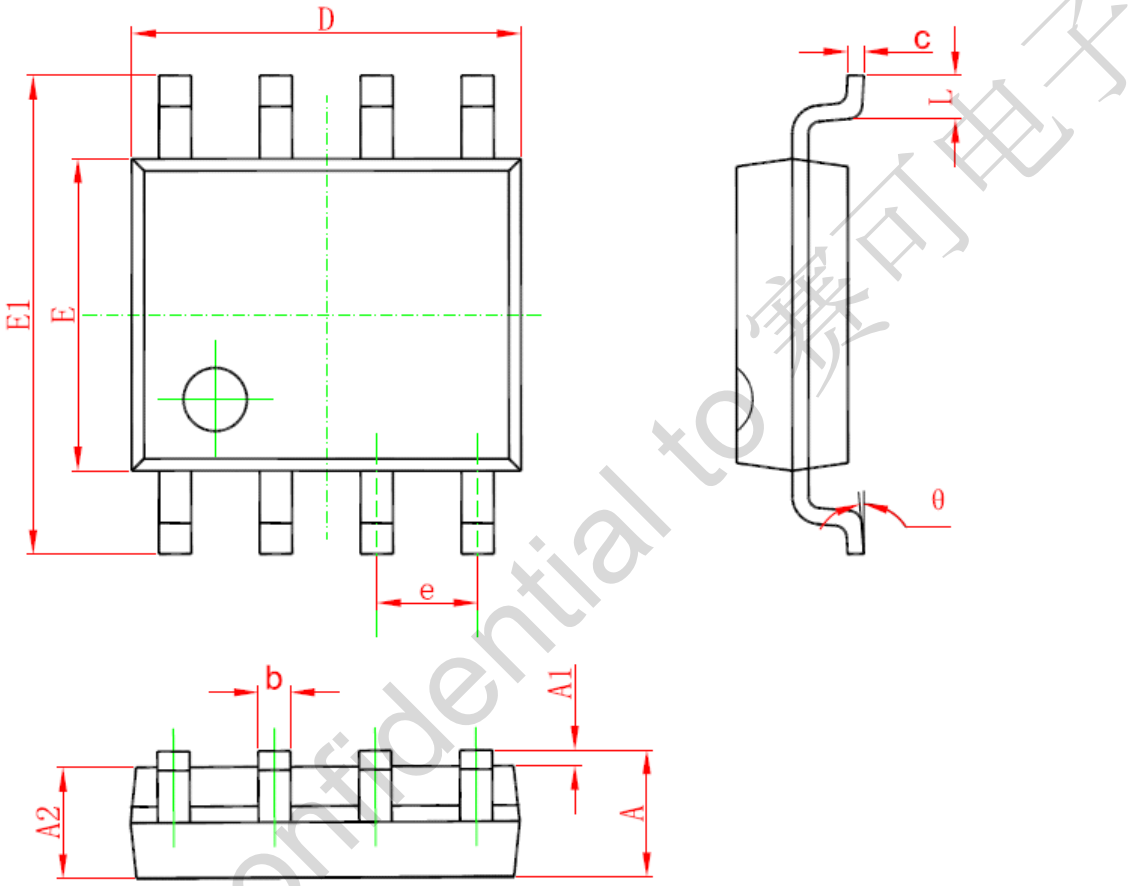
Constant Power Operation Mode
Along with the increase of output current, the inductance current is up to the Vthoc threshold. With the increase in output current, output voltage declines with output power is kept in a about constant level. This is suitable for peak current application.

Base Driver
The driver is a push pull stage with supply voltage VDD. It provides the driving current for the external power bipolar transistor. The sourcing current is limited to Is_max (typical 90mA).

Protection Control
Good power supply system reliability is achieved with its rich protection features including cycle-by-cycle current limiting, output short circuit protection, FB pin open loop protection, on-chip Over Temperature Protection (OTP), VDD Over Voltage Protection (OVP), and VDD Under Voltage Lockout Protection (UVLO).

PACKAGE MECHANICAL DATA

SOP8 PACKAGE OUTLINE DIMENSIONS



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Min
A	1.350	1.750	0.053	0.069
A1	0.050	0.250	0.002	0.010
A2	1.250	1.650	0.049	0.065
b	0.310	0.510	0.012	0.020
c	0.170	0.250	0.006	0.010
D	4.700	5.150	0.185	0.203
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270 (BSC)		0.05 (BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

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