APPROVAL SHEET

Customer Name : ___TPV_____

O2 Part Number : **ta9687GN**_____

Revision : **A**_____

Description : **LCDM Inverter Controller**_____

Package Type : **16 SOP Lead-Free**_____

Pack Type : **Tube**_____

Quantity per Type : **48**_____

Quantity per Inner Box : **4,800**_____

Quantity per Ship Box : **28,800**_____

APPROVED BY:

_____   _____

Print Name and Signature   Date

*** Please fax back a signed copy to O$_2$ Micro attn: Angela Chang at (03) 564-4273 ***
***THANK YOU ***

O₂Micro®
Breathing Life into Mobility

ta9687

LCDM Inverter Controller

FEATURES

- Constant operating frequency
- Drives positive/negative-impedance lamps during ignition
- High drive current for external MOSFETs
- User-defined ignition time and shutdown delay time
- Built-in intelligence for ignition and normal operation of CCFLs
- Built-in open-lamp protection and over-voltage protection for backlight system
- Optimized soft-start function

ORDERING INFORMATION

Part Number	Temp Range	Package
ta9687GN	-20°C to +85°C Note(3), page 3	16-pin SOP Lead-Free

GENERAL DESCRIPTION

ta9687 is a high performance, cost-effective CCFL (Cold Cathode Fluorescent Lamp) controller designed for driving large-size Liquid Crystal Display (LCD) applications requiring 2 to 6 CCFLs.

The controller converts unregulated DC voltages into a nearly sinusoidal lamp voltage and current waveforms.

The ta9687 supports full-bridge power conversion topologies while maintaining high-efficiency operation. The controller provides a soft-start operation, current and voltage regulation, over-voltage and over-current protection, high drive capability.

The control logic provides a regulated ignition voltage and appropriate protection features for over-voltage or over-current conditions.

The ta9687 offers a high level of integration, while maintaining flexibility and high-efficiency operation that reduces external component heating, resulting in higher reliability and longer CCFL life. The proprietary design technique provides a simple, low-cost system solution.

PIN DIAGRAM
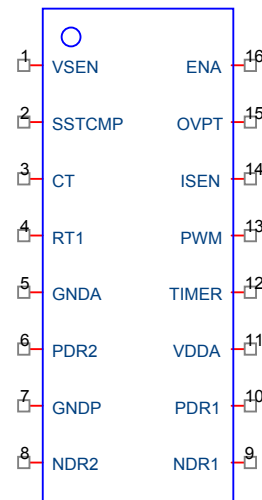
SIMPLIFIED APPLICATION CIRCUIT
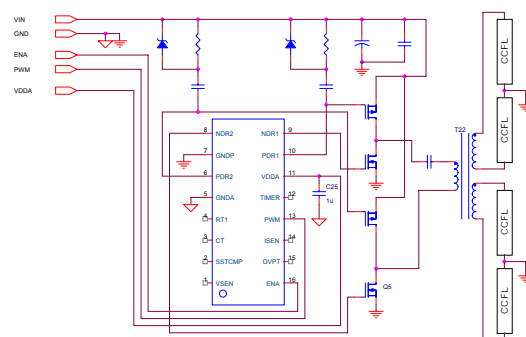
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ta9687

PIN DESCRIPTION

Pin No.	I/O[1]	Names	Description
1	I	VSEN	Voltage Sense Feedback
2	I/O	SSTCMP	Capacitor for Soft-Start and Loop Compensation
3	I/O	CT	Timing Resistor and Capacitor for Operation and Striking Frequency
4	I/O	RT1	Timing Resistor for Striking Frequency
5	---	GNDA	Signal Ground
6	O	PDR2	High Side Driver Output 2
7	---	GNDP	Power Ground
8	O	NDR2	Low Side Driver Output 2
9	O	NDR1	Low Side Driver Output 1
10	O	PDR1	High Side Driver Output 1
11	---	VDDA	Input Power Pin
12	I/O	TIMER	Timing Capacitor for Delay Timer
13	I	PWM	External PWM Dimming Input
14	I	ISEN	Current Sense Feedback
15	I	OVPT	Over-Voltage Protection Threshold Voltage
16	I	ENA	IC Enable/Disable

I/O[1]: I=input, O=output, I/O=input/output

ABSOLUTE MAXIMUM RATINGS[2]

Input Voltage VDDA	-0.3V to 7.0V
GNDA, GNDP	+/- 0.3V
All other pins	-0.3V to VDDA +0.3V

Operating Temperature[3]	ta9687
	-20°C to 85°C

Operating Junction Temp.	125°C
Storage Temperature[3]	-55°C to 150°C

RECOMMENDED OPERATING RANGE

VDDA - Input Voltage	4.5V to 5.5V	
Other pins	0V to VDDA	
f_{op} - Operating Frequency	20KHz to 150KHz	
Thermal Impedance[3,4]	θ_{J-A}	θ_{J-C}
16-pin SOP	73 °C/W	8 °C/W

Note [2]: The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The "Electrical Characteristics" table defines the conditions for actual device operation. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

Note [3]: Not to exceed the maximum junction temperature of the IC, which relates to the operating power of the IC and the thermal resistance of the IC/package as above

Note [4]: Still air, low effective thermal conductivity board per JESD51-3.

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ta9687

ELECTRICAL CHARACTERISTICS

All specifications below are at: VDDA=5V; R_{CT} = 84.5KΩ; C_{CT} = 220pF unless otherwise noted.

Parameter	Symbol	Test Conditions	Limits			Unit
			Min	Typ	Max	
Supply Current						
Stand By	I_{dds}	ENA=0V	--	2	5	μA
Operating	I_{dd}	Capacitance at NDR1/2 & PDR1/2 = 1nF	1.6	1.9	2.2	mA
Soft Start						
Current Source	ISSTCMP		1.90	2.55	3.20	μA
Under Voltage Lockout						
Lock Out Threshold	$V_{UV,TH-OFF}$	VDDA 5V→0V	3.2	3.4	3.6	V
Resume Threshold	$V_{UV,TH-ON}$	VDDA 0V→5V	3.3	3.6	4.0	V
Reference Voltage						
ISEN Reference Voltage		ISEN=SSTCMP	1.17	1.23	1.29	V
		Temperature Coefficient		330		ppm/ ^{O}C
VSEN Reference Voltage During Striking		VSEN=SSTCMP	2.75	2.9	3.05	V
		Temperature Coefficient		340		ppm/ ^{O}C
Driver Frequency						
Striking	f_{str}	R_{RT1} = 300K	61.5	63.8	66.0	KHZ
		Temperature Coefficient		200		ppm/ ^{O}C
Normal Operation	F_{op}		48.0	49.5	51.0	kHz
		Temperature Coefficient		180		ppm/ ^{O}C
Timer and Protection						
Striking Current Source		ISEN =0V	2.2	3.0	3.8	uA
Open Lamp and Over Voltage Protection Current Source		SSTCMP > 3.3V or VSEN>OVPT	8.1	10.85	13.6	uA
Drivers						
NDR1/2 Sink	$R_{ON\_SRC, NDR}$		2	6	10	Ω
NDR1/2 Source	$R_{ON\_SNK, NDR}$		10	16	22	Ω
PDR1/2 Sink	$R_{ON\_SRC, PDR}$		6	12	18	Ω
PDR1/2 Source	$R_{ON\_SNK, PDR}$		5	9	13	Ω
Maximum Overlap ratio			95	--	--	%
BBM1&4(PDR_L+NDR_L)			100	175	250	ns
				400		ppm/C
BBM2&3(PDR_H+NDR_H)			100	175	250	ns
				800		ppm/C

ELECTRICAL CHARACTERISTICS (Continued)

Parameter	Symbol	Test Conditions	Limits			Unit
			Min	Typ	Max	
PWM Dimming Control						
Logic High			2.0	----	----	V
Logic Low			----	----	1.0	V
ENABLE						
Enable Logic	V_{ON}		2.0	----	----	V
Disable Logic	V_{OFF}		----	----	1.0	V

FUNCTIONAL BLOCK DIAGRAM
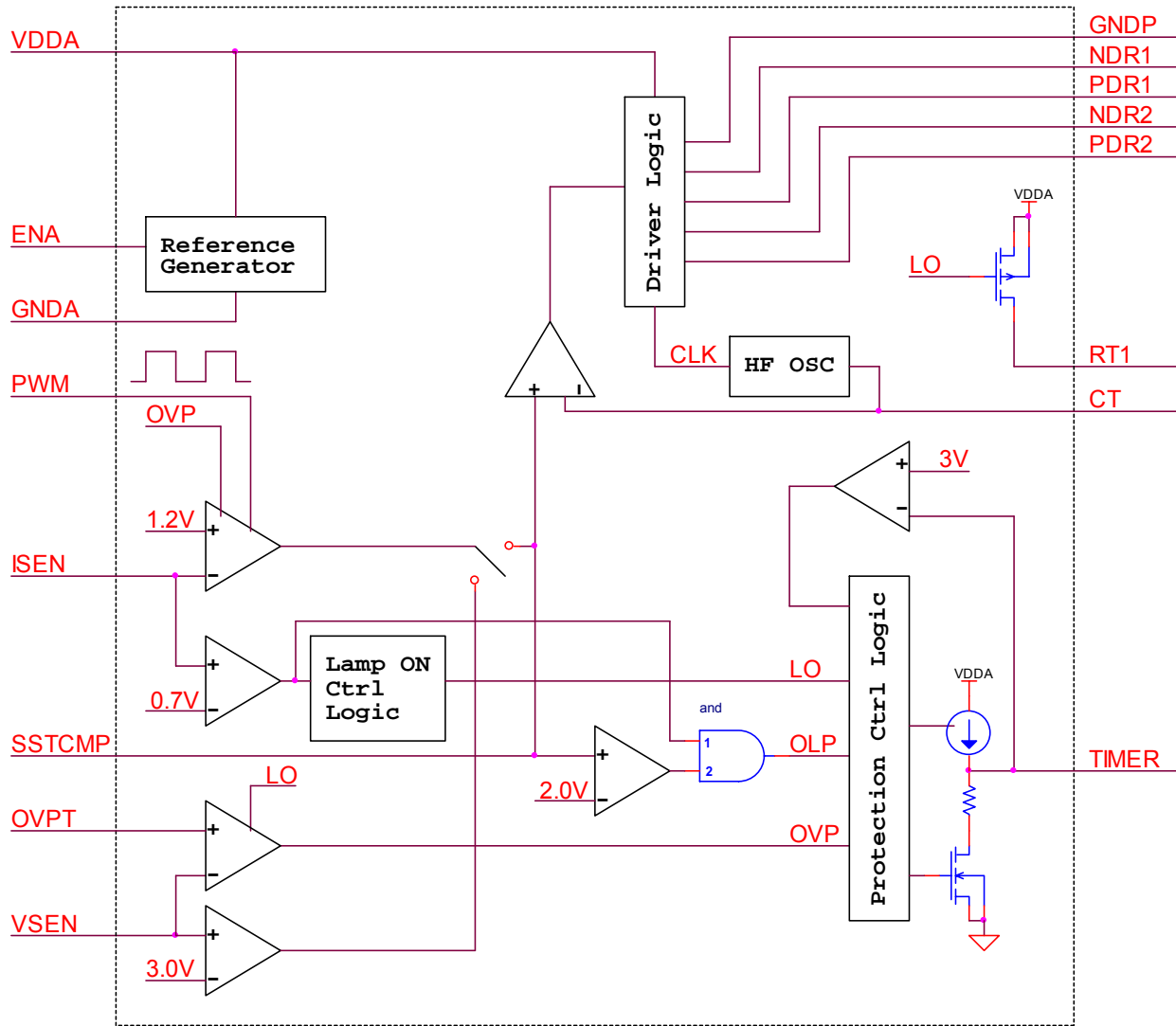
Figure 1

FUNCTIONAL DESCRIPTION

1. Power Conversion

The ta9687 controller supports full-bridge power conversion topology and provides symmetrical drive pulses to the tank circuit that includes the transformer(s), output capacitors and the CCFL/panel load that yields quasi-sinusoidal CCFL voltage and current waveforms. High efficiency operation of the ta9687 yields lower heat dissipation for the inverter system resulting in higher reliability.

To illustrate the controller functions, refer to Figures 1 and 2 on pages 5 and 8, respectively for the following sections.

2. Enable

Applying a voltage level greater than 2V to ENA (pin 16) enables the IC. A voltage less than 1V will disable the IC.

3. Soft-Start (SST)

Utilizing a patented multi-task technique, the soft-start function and the loop compensation function are combined to provide a good start-up characteristic. Connecting an external capacitor to SSTCMP (pin 2) provides the functions. In the start-up mode, current charges capacitor C21 connected to SSTCMP. The voltage at the capacitor controls the gradual increase in power to the transformer and subsequently to the output load. This reduces in-rush current and provides reliable operation to the CCFL.

4. Ignition

When the VDDA voltage exceeds the under-voltage lockout threshold, the IC is enabled and internal striking timer is activated.

During ignition, the striking frequency for the CCFL(s) can be chosen by the user to optimize the inverter operation.

The approximate striking frequency is calculated by the following equation.

$$F_{STRK}[KHz] = \frac{9.53 \times 10^5}{\left(RRT1[K\Omega] // RCT[K\Omega]\right) \times C_{CT}[pF]}$$

5. Aged CCFL Ignition

ta9687 provides a striking timer function to ensure that any aged, slow-turn-on CCFL is provided with sufficient voltage and time to ignite.

The transformer output voltage is sensed at VSEN (Pin 1). When the voltage at VSEN reaches a threshold of approximately 3.0V, the IC regulates the output voltage at the transformer secondary. If the lamps are not ignited when the voltage at TIMER (pin 12) reaches a threshold of approximately 3V, the IC will shutdown and latch

The approximate striking time is calculated by the following equation.

$$T_{STRK}[s] = C_{TIMER}[uF]$$

To resume normal operation, toggle the ENA signal or reset VDDA.

6. Normal Operation

Once the lamps are ignited and the voltage at ISEN (pin 14) is > 0.7V, the IC enters the normal operation mode and the PWM dimming control is activated.

The operating frequency is determined by resistor (R15) and capacitor (C22) connected to CT (pin 3). The control loop regulates the average current through the lamps by adjusting the overlap of the output drives. Constant frequency operation eliminates interference with the inverter and LCD panel that often occurs in a variable frequency inverter system. The peak and valley of the CT waveform are 2V and 0V respectively.

The approximate operating frequency is calculated by the following equation.

$$F_{OP}[KHz] = \frac{9.53 \times 10^5}{R_{CT}[K\Omega] \times C_{CT}[pF]}$$

7. Open Lamp Protection

If a CCFL is removed or damaged during normal operation, the voltage at SSTCMP (pin 2) rises rapidly because there is no current feedback at ISEN (pin 14). When the voltage at SSTCMP reaches a threshold of approximately 2V and ISEN is less than 0.7V, a current source charges the capacitor (C23) connected to TIMER (pin 12). Once the voltage level at the TIMER pin reaches a threshold of approximately 3V, the drive outputs shut down and latch.

The shutdown delay feature avoids inverter shutdown due to a VIN transient or if a lamp has a positive impedance characteristic.

The approximate shutdown delay time is calculated by the following equation.

$$T_{DELAY}[s] = 0.33 \times C_{TIMER}[uF]$$

To resume operation, toggle the ENA signal or restart VDDA.

8. Over-Voltage and Over-Current Protection

Over-voltage and over-current protection are monitored by the voltage on VSEN (pin 1). During normal operation, if a CCFL is damaged or removed, the voltage at VSEN increases. Once the voltage at VSEN exceeds the user-defined, preset voltage set by OVPT (pin 15), the driver output duty cycle is regulated and the shutdown delay timer is activated. OVPT sets the overall protection threshold voltage that is lower than ~3V (VSEN threshold). Once the voltage at TIMR pin reaches ~3V, the IC will shut down and latch. OVPT voltage setting is determined by a resistor divider (R17 and R18) connected to the OVPT.

The approximate shutdown delay time is calculated by the following equation.

$$T_{DELAY}[s] = 0.33 \times C_{TIMER}[uF]$$

To resume operation, toggle the ENA signal or restart VDDA.

9. Dimming Control

External PWM dimming is implemented by applying external PWM pulse to PWM (pin 13). When PWM is higher than 2V, dimming is ON and vice versa.
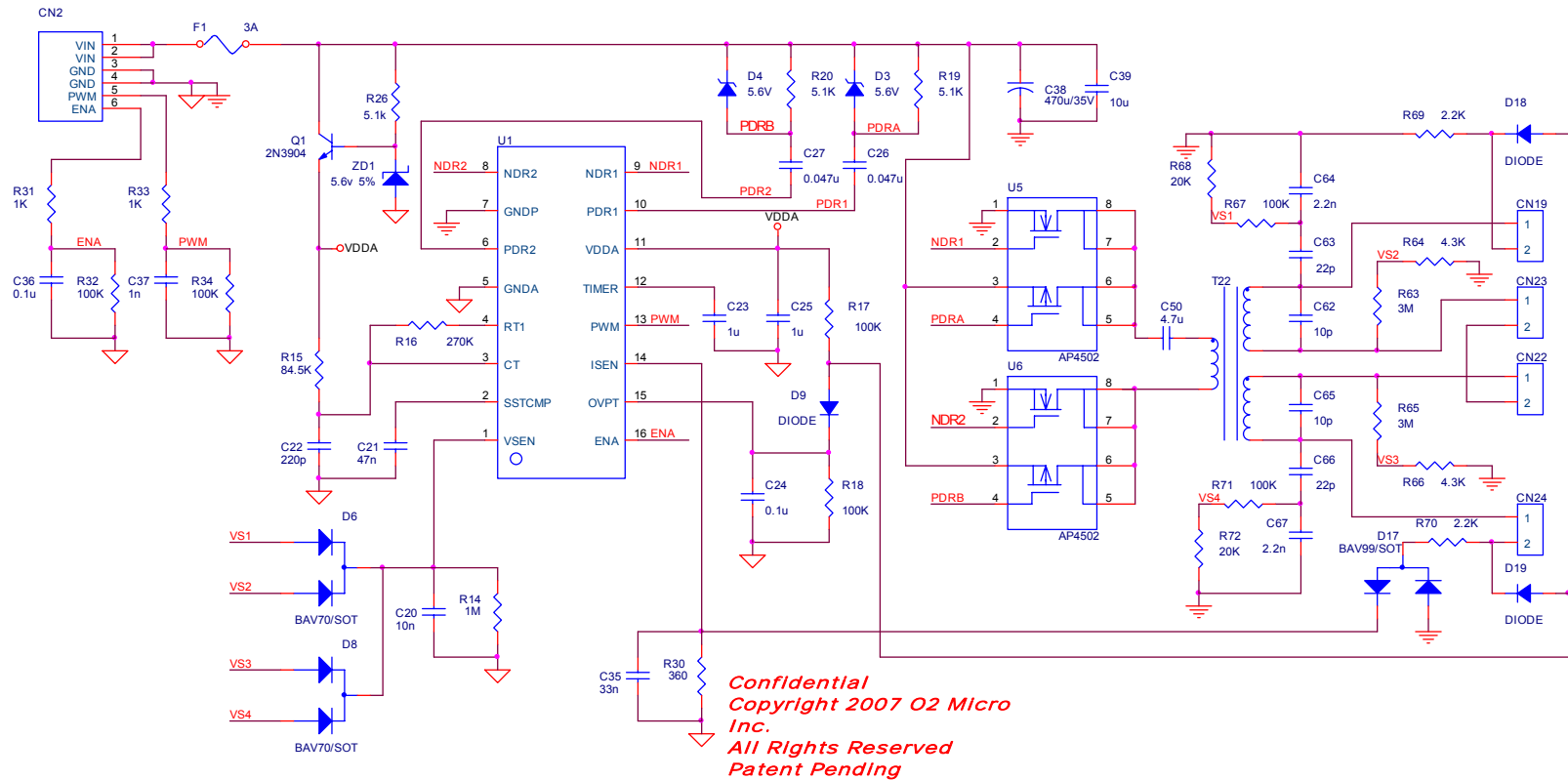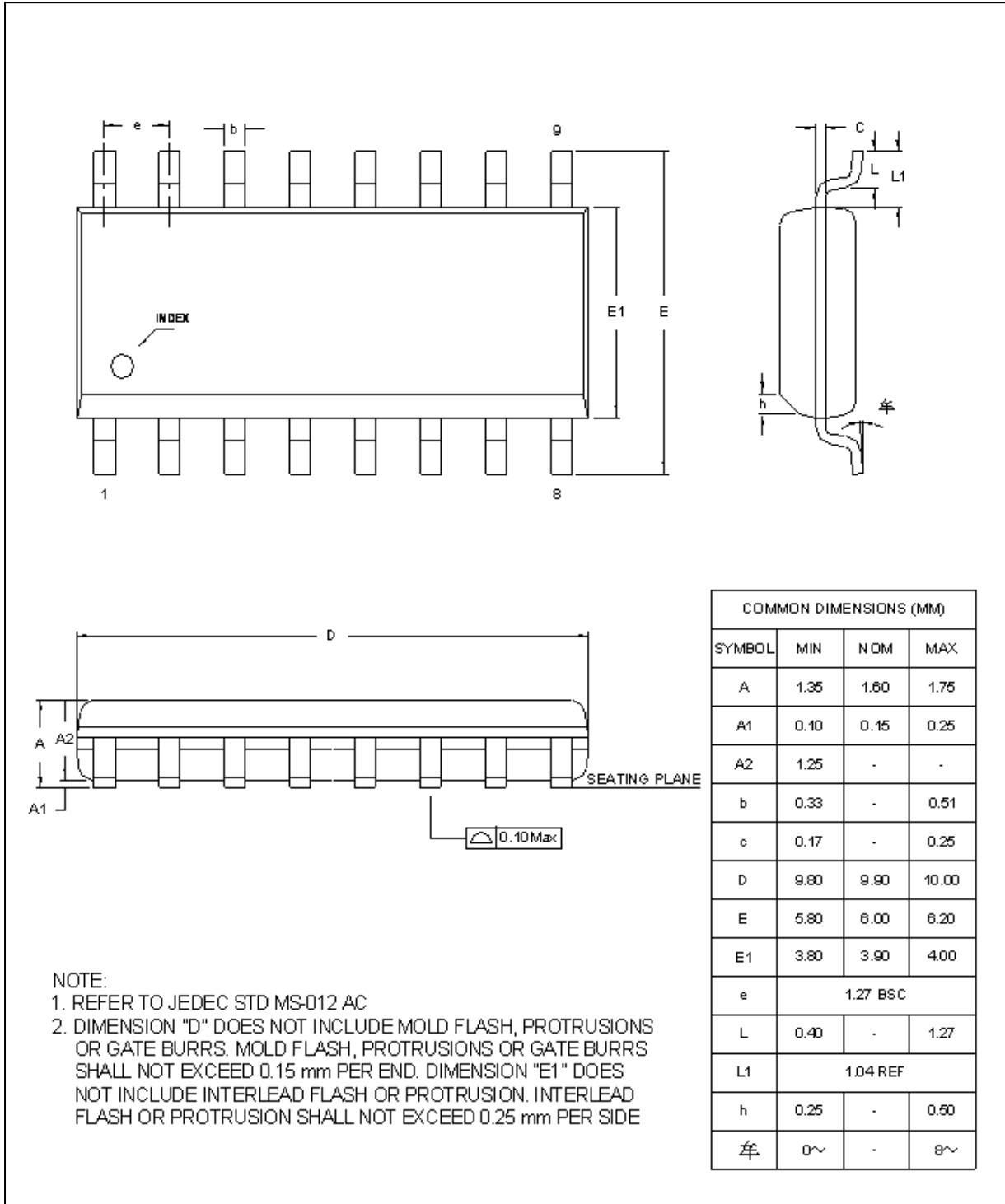
REFERENCE APPLICATION CIRCUIT

Figure 2: Typical Application

VIN: 12V ~ 18V
ENA: 0V—1V Disable; 2V—5V Enable
VDDA: 4.75V – 5.25V
PWM: 3.3Vpp, 200Hz, 10% Min Brightness, 100% Max Brightness

PACKAGE INFORMATION – 16-PIN SOP (150 mil)

COMMON DIMENSIONS (MM)			
SYMBOL	MIN	NOM	MAX
A	1.35	1.60	1.75
A1	0.10	0.15	0.25
A2	1.25	-	-
b	0.33	-	0.51
c	0.17	-	0.25
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
L	0.40	-	1.27
L1	1.04 REF		
h	0.25	-	0.50
车	0~	-	8~

NOTE:
1. REFER TO JEDEC STD MS-012 AC
2. DIMENSION "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS
   OR GATE BURRS. MOLD FLASH, PROTRUSIONS OR GATE BURRS
   SHALL NOT EXCEED 0.15 mm PER END. DIMENSION "E1" DOES
   NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD
   FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 mm PER SIDE

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To: Top Victory Electronics (Fujian) Co.,Ltd   Date:

Company: O2Micro Electronics, Inc
Address: 3118, Patrick Henry Drive,
Santa Clara, CA 95054, USA
Product name: Inverter IC

Guarantee of compliance regarding six Hazardous Substances

Top Victory Electronics (Fujian) Co.,Ltd

We (includes our subsidiary, affiliated company) here guarantee that all the components and parts shipped to you (includes directly shipping or via third parties) are in accordance with below limitation.

Hazardous substance	limitation
1. Cadmium and cadmium compounds	5ppm
2. Lead and lead compounds	100ppm
	(For solder bar:1000ppm)
3. Mercury and mercury compounds	1000ppm
4. Hexavalent chromium compounds	1000ppm
5. Polybrominated biphenyls (PBB)	1000ppm
6. Polubrominated diphenylethers (PBDE)	1000ppm
7. $Cd+Pb+Hg+Cr^{+6}$	100ppm
	(Only for packing material together with TPV production to market.)

Note:
1. Please refer to file named "specification and explanation relating with hazardous substance of TPV.PPT" for exemption items from the requirements of applications of lead, mercury, cadmium and hexavalent chromium.
2. In witness where of the above Guarantee has been duly exercised by the company's fully authorized representative signed below.

Signature: _Wayne Anderson_
Name: _Wayne Anderson_
Position: _Quality Director_

*Need to affix the official seal, afford by the post or fax.

3

ATTN: Sophia   C.C. Akila Tsai   From: HS-Shawn

RoHS 零件 可焊性 / 耐焊接熱 標準

一 DIP 零件 ，Wave Solder 要求
　　可焊性規格 ：　　條件: 溫度 255 –5/+0 ℃　　時間 2.5±0.5 sec
　　　　　　　　　　判定: 引腳沾錫面積 90% 以上
　　　　　　　　　　詳細參數見附件 [RoHS 零件可焊性標準]
　　耐焊接熱規格 ：　條件: 溫度 270 –0/+2 ℃　　時間 10±0.5 sec [端子]
　　　　　　　　　　條件: 溫度 270 –0/+2 ℃　　時間 20±0.5 sec [本體]
　　　　　　　　　　判定: 機械特性 電器特性符合規格定義要求
　　　　　　　　　　詳細參數見附件 [RoHS 零件耐焊接熱標準]

二 SMD 零件 ，Solder Reflow 要求
　　可焊性規格 ：　　條件: 溫度 255 –5/+0 ℃　　時間 2.5±0.5 sec
　　　　　　　　　　判定: 引腳沾錫面積 90% 以上
　　　　　　　　　　詳細參數見附件 [RoHS 零件可焊性標準]
　　耐焊接熱規格 ：　條件: 溫度 265 –0/+5 ℃　　時間 10 –0/+5 sec　← 此部分為 x50°C only.
　　　　　　　　　　判定: 機械特性 電器特性符合規格定義要求
　　　　　　　　　　詳細參數見附件 [RoHS 零件耐焊接熱標準]

參考附件
一 RoHS 零件可焊性標準
二 RoHS 零件耐焊接熱標準

此份規格 納入各 RoHS 零件承認書內

供應商名稱　O2Micro Electronics Inc.

負責人　QA Director / Wayne Anderson.

蓋章　Wayne Anderson

2-02

To: TPV Electronics (Fujian) Co.,Ltd

Date:

Company: O2Micro Electronics, Inc.

Address: 3118, Patrick Henry Drive,

Santa Clara, CA 95054, USA

Guarantee of non-use of The Controlled Substances

TPV Electronics (Fujian) Co.,Ltd

We (includes our subsidiary, affiliated company) here guarantee that all the components and parts (includes parts itself and all the packages) shipped to you (includes directly shipping or via third parties) are contained free of those prohibited materials which listed on SONY standard (SS-00259) or its latest version.

1. Cadmium and cadmium compounds
2. Lead and lead compounds
3. Mercury and mercury compounds
4. Hexavalent chromium compounds
5. Polychlorinated biphenyls (PCB)
6. Polychlorinated naphthalenes (PCN)
7. Chlorinated paraffins (CP)
8. Polyvinyl chloride (PVC) and PVC compounds
9. Other chlorinated organic compounds
10. Polybrominated biphenyls (PBB)
11. Polubrominated diphenylethers (PBDE)
12. Other brominated organic compounds
13. Organic tin compounds (Tributyl tin compounds, Triphenyl tin compounds)
14. Asbestos
15. Azo compounds
16 Formaldehyde

Note. In witness where of the above Guarantee has been duly exercised by the company's fully authorized representative signed below.

Signature _Wayne Anderson_

Name: Wayne Anderson

Position: Quality Director