



# FAN7535

## PFC & Ballast Control IC

### Features

- PFC, Ballast Control, and Half-Bridge Driver in One IC
- PFC Driver Current Capability: +500mA/-800mA
- Critical Conduction Mode Control Type PFC
- Internal Clamping Zener Diode (PFC): 23V
- Under-Voltage Lockout with 3.5V of Hysteresis (PFC)
- Internal Clamping Zener Diode (Ballast): 15V
- Lower di/dt Gate Driver for Better Noise Immunity
- Under-Voltage Lockout with 1.8V Hysteresis (Ballast)
- Ballast Driver Current Capability: +350mA/-650mA
- Programmable Preheat Time & Frequency
- Programmable Run Frequency
- Programmable Ignition Sweep Time
- Internal Active ZVS Control
- Internal Protection Function (Latch Mode)

### Applications

- Fluorescent Lamp Ballast

### Description

FAN7535 provides simple, high-performance, active power factor correction (PFC), and ballast control. The FAN7535 is optimized for all kinds of fluorescent lamps, which require minimum board area and reduced external components. The FAN7535 PFC control block to reduce the input current THD lower than conventional CRM boost PFC methods. An innovative Active Zero Voltage Switching (AZVS) block reduces the switching power loss. A dedicated timing section in the FAN7535 allows the user set the necessary parameters for proper lamp preheat and ignition.

24-SOP



### Ordering Information

Part Number	Package	Operating Temperature Range	Packing Method
FAN7535M	24-SOP	-25°C ~ 125°C	Tube
FAN7535MX			Tape & Reel



All packages are lead free per JEDEC: J-STD-020B standard.

## Typical Application Diagrams

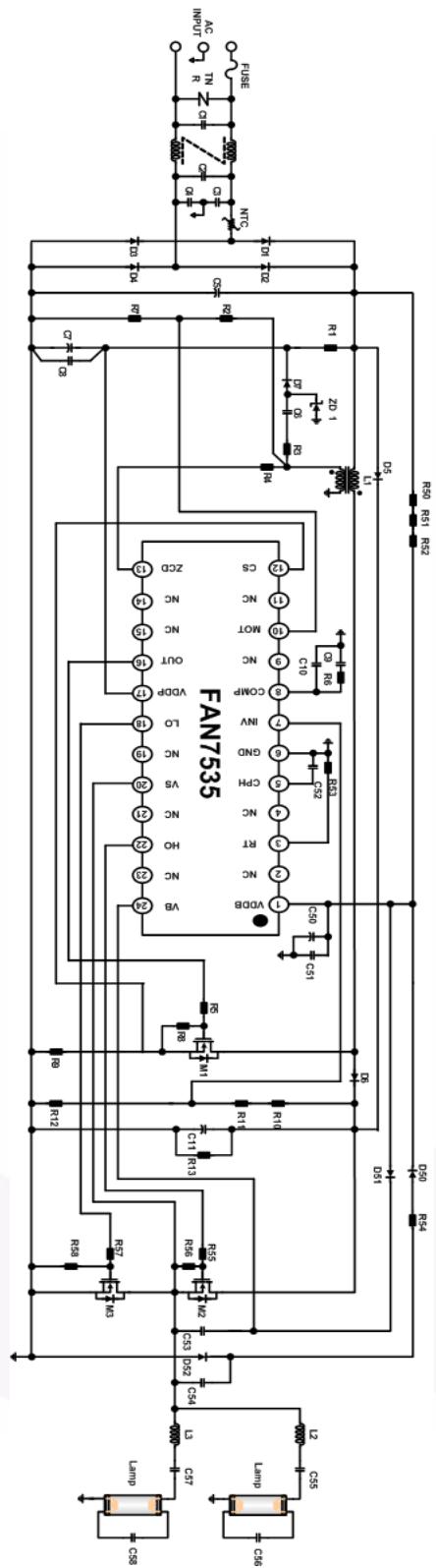


Figure 1. Typical Application Circuit for Fluorescent Lamp

## Internal Block Diagram

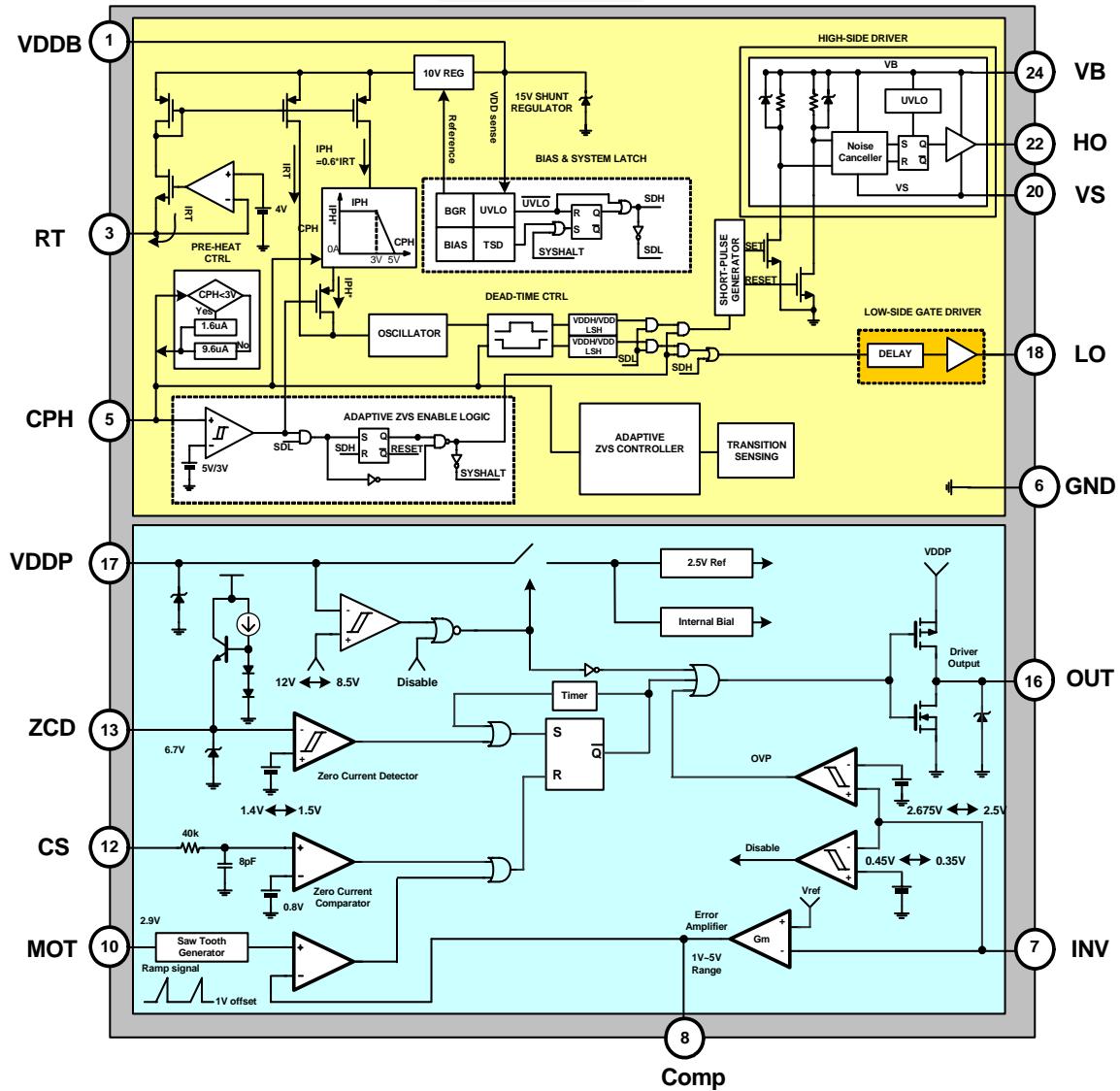


Figure 2. Functional Block Diagram (2chips-1PKG)

## Pin Configuration

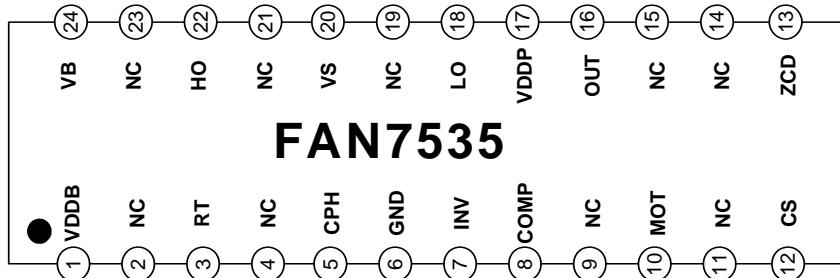


Figure 3. Pin Configuration (Top View)

## Pin Definitions

Pin #	Name	Description
1	VDDB	Supply voltage for ballast part
2	NC	No connection
3	RT	Oscillator frequency set resistor
4	NC	No connection
5	CPH	Preheating time set capacitor
6	GND	Ground for ballast part & PFC part
7	INV	Inverting input of the error amplifier
8	COMP	Output of the transconductance error amplifier
9	NC	No connection
10	MOT	Set the slope of the internal ramp
11	NC	No connection
12	CS	Input of the over-current protection comparator
13	ZCD	Input of the zero current detection block
14	NC	No connection
15	NC	No connection
16	OUT	Gate driver output
17	VDDP	Supply voltage for PFC block
18	LO	Low-side output
19	NC	No connection
20	VS	High-side floating supply return
21	NC	No connection
22	HO	High-side output
23	NC	No connection
24	VB	High-side floating supply

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability.

The absolute maximum ratings are stress ratings only.  $T_A=25^\circ\text{C}$ , unless otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Unit
<b>PFC PART</b>					
$V_{DDP}$	Supply Voltage		$V_z$		V
$I_{OH}, I_{OL}$	Peak Drive Output Current	-800		+500	mA
$I_{CLAMP}$	Driver Output Clamping Diodes $V_O > V_{CC}$ or $V_O < -0.3\text{V}$		$\pm 10$		
$I_{DET}$	Detector Clamping Diodes		$\pm 10$		
$V_{IN}$	Error Amplifier, MOT, CS Input Voltages	-0.3		6.0	V
<b>BALLAST PART</b>					
$V_B$	High-side Floating Supply	-0.3		625.0	V
$V_S$	High-side floating supply return	-0.3		600.0	
$V_{IN}$	RT, CPH Pins Input Voltage	-0.3		8.0	
$V_{CL}$	Clamping Voltage		$V_{CL}$		
$I_{CL}$	Clamping Current Level		25		mA
$dV_S/dt$	Allowable Offset Voltage Slew Rate			50	V/ns
<b>Common</b>					
$T_{OPR}$	Operating Temperature Range	-25		+125	°C
$T_{STG}$	Storage Temperature Range	-65		+150	
$P_D$	Total Power Dissipation		1.5		W
$\theta_{JA}$	Thermal Resistance (Junction-to-Air)			83	°C/W

### Caution:

Do not supply a low-impedance voltage source to the internal clamping Zener diode between the GND and the VDDB and VDDP pins of this device. Use a common supply between the two ICs (PFC, Ballast) only under careful attention.

## Electrical Characteristics

$V_{DDP}=14V$ ,  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit	
<b>PFC PART<sup>(1)</sup></b>							
<b>UNDER-VOLTAGE LOCKOUT SECTION</b>							
$V_{th(start)}$	Start Threshold Voltage	$V_{DDP}$ Increasing	11	12	13	V	
$V_{th(stop)}$	Stop Threshold Voltage	$V_{DDP}$ Decreasing	7.5	8.5	9.5		
$H_Y(UVLO)$	UVLO Hysteresis		3.0	3.5	4.0		
$V_z$	Zener Voltage	$I_{DDP} = 20mA$	20	22	24		
<b>SUPPLY CURRENT SECTION</b>							
$I_{st}$	Start-up Supply Current	$V_{DDP} = V_{TH(START)} - 0.2V$		40	70	mA	
$I_{DDP}$	Operating Supply Current	Output not switching		1.5	3.0	mA	
$I_{DDP(dyn)}$	Dynamic Operating Supply Current	50kHz, $C_L = 1nF$		2.5	4.0		
$I_{DD(dis)}$	Operating Current at Disable	$V_{INV} = 0V$	20	65	95	mA	
<b>ERROR AMPLIFIER SECTION</b>							
$V_{ref1}$	Voltage Feedback Input Threshold1	$T_A = 25^\circ C$	2.465	2.500	2.535	V	
$DV_{ref1}$	Line Regulation	$14V \leq V_{DDP} \leq 20V$		0.1	10.0	mV	
$DV_{ref3}^{(1)}$	Temperature Stability of $V_{REF}$			20			
$I_b(ea)$	Input Bias Current	$1V \leq V_{inv} \leq 4V$	-0.5		0.5	mA	
$I_{source}$	Output Source Current	$V_{inv} = V_{ref1} - 0.1V$		-12			
$I_{sink}$	Output Sink Current	$V_{inv} = V_{ref1} + 0.1V$		12			
$V_{ea0(H)}$	Output Upper Clamp Voltage	$V_{inv} = V_{ref1} - 0.1V$	5.4	6.0	6.6		
$V_{ea0(Z)}$	Zero Duty Cycle Output Voltage			0.9	1.0	1.1	V
$g_m^{(2)}$	Transconductance		90	115	140	$\mu mho$	
<b>MAXIMUM ON-TIME SECTION</b>							
$V_{MOT}$	Maximum On-Time Voltage	$R_{MOT} = 40.5\Omega$	2.784	2.900	3.016	V	
$T_{ON-MAX}$	Maximum On-Time Programming	$R_{MOT} = 40.5\Omega, T_A = 25^\circ C$	19	24	29	$\mu s$	
<b>CURRENT-SENSE SECTION</b>							
$V_{CS(LIMIT)}$	Current Sense Input Threshold Voltage Limit		0.7	0.8	0.9	V	
$I_b(cs)$	Input Bias Current	$0V \leq V_{CS} \leq 1V$	-1.0	-0.1	1.0	mA	
$T_{d(cs)}^{(1)}$	Current Sense Delay to Output			350	500	ns	

### Notes:

1. Please refer to the FAN7529 datasheet and AN-6026 application note for more detailed information. Available on Fairchild's website at:

[Datasheet: http://www.fairchildsemi.com/ds/FA%2FFAN7529.pdf](http://www.fairchildsemi.com/ds/FA%2FFAN7529.pdf)

[Application Note: http://www.fairchildsemi.com/an/AN-6026.pdf](http://www.fairchildsemi.com/an/AN-6026.pdf)

2. This parameter, although guaranteed, is not 100% tested in production.

## Electrical Characteristics (Continued)

$V_{DDP} = 14V$ ,  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
<b>ZERO CURRENT DETECT SECTION</b>						
$V_{th(ZCD)}^{(3)}$	Input Voltage Threshold		1.35	1.50	1.65	V
$HY_{(ZCD)}^{(3)}$	Detect Hysteresis		0.05	0.10	0.15	
$V_{clamp(h)}$	Input High Clamp Voltage	$I_{DET} = 3mA$	6.0	6.7	7.4	
$V_{clamp(l)}$	Input Low Clamp Voltage	$I_{DET} = -3mA$	0	0.65	1.00	
$I_b(ZCD)$	Input Bias Current	$1V \leq V_{ZCD} \leq 5V$	-1.0	-0.1	1.0	mA
$I_{source(ZCD)}^{(3)}$	Source Current Capability	$T_A = 25^\circ C$			-10	mA
$I_{sink(ZCD)}^{(3)}$	Sink Current Capability	$T_A = 25^\circ C$			10	
$T_{DEAD}^{(3)}$	Maximum Delay, ZCD to Output Turn-on		100		200	
<b>OUTPUT SECTION</b>						
$V_{oh}$	Output Voltage High	$I_O = -100mA, T_A = 25^\circ C$	9.2	11.0	12.8	V
$V_{ol}$	Output Voltage Low	$I_O = 100mA, T_A = 25^\circ C$		1.0	2.5	
$T_r^{(3)}$	Rising Time	$C_I = 1nF$		50	100	
$T_f^{(3)}$	Falling Time	$C_I = 1nF$		50	100	
$V_{O(MAX)}$	Maximum Output Voltage	$V_{DDP} = 20V, I_O = 100mA$	11.5	13.0	14.5	V
$V_{O(UVLO)}$	Output Voltage with UVLO Activated	$V_{DDP} = 5V, I_O = 100mA$			1	
<b>RESTART TIMER SECTION</b>						
$t_{d(rst)}$	Restart Time Delay		50	150	300	ms
<b>OVER-VOLTAGE PROTECTION SECTION</b>						
$V_{OVP}$	OVP Threshold Voltage	$T_A = 25^\circ C$	2.620	2.675	2.730	V
$HY_{(OVP)}$	OVP Hysteresis	$T_A = 25^\circ C$	0.120	0.175	0.230	
<b>ENABLE SECTION</b>						
$V_{th(en)}$	Enable Threshold Voltage		0.40	0.45	0.50	V
$HY_{(en)}$	Enable Hysteresis		0.05	0.10	0.15	

**Note:**

3. These parameters, although guaranteed, are not 100% tested in production.

**Electrical Characteristics (Continued)**

$V_{BIAS}$  ( $V_{DDB}$ ,  $V_{BS}$ ) = 14.0V,  $T_A$  = 25°C, unless otherwise specified.

Symbol	Characteristics	Condition	Min.	Typ.	Max.	Unit
<b>BALLAST PART<sup>(4)</sup></b>						
<b>Supply Voltage Section</b>						
$V_{DDTH(ST+)}$	$V_{DDB}$ UVLO Positive Going Threshold	$V_{DDB}$ Increasing	12.4	13.4	14.4	V
$V_{DDTH(ST-)}$	$V_{DDB}$ UVLO Negative Going Threshold	$V_{DDB}$ Decreasing	10.8	11.6	12.4	
$V_{DDHY(ST)}$	$V_{DDB}$ -side UVLO Hysteresis			1.8		
$V_{CL}$	Supply Clamping Voltage	$I_{DDB} = 10\text{mA}$	14.8	15.2		
$I_{ST}$	Start-up Supply Current	$V_{DDB} = 12\text{V}$		150		µA
$I_{DDB(dyn)}$	Dynamic Operating Supply Current	50kHz, $C_L = 1\text{nF}$		3.2		mA
<b>High-Side Supply Section (<math>V_B</math>-<math>V_S</math>)</b>						
$V_{HSTH(ST+)}$	High-side UVLO Positive Going Threshold	$V_{BS}$ Increasing	8.5	9.2	10.0	V
$V_{HSTH(ST-)}$	High-side UVLO Negative Going Threshold	$V_{BS}$ Decreasing	7.9	8.6	9.5	
$V_{HSHY(ST)}$	High-side UVLO Hysteresis			0.6		
$I_{HST}$	High-side Quiescent Supply Current	$V_{BS} = 14\text{V}$		50		µA
$I_{HD}$	High-side Dynamic Operating Supply Current	50kHz, $C_L = 1\text{nF}$		1		mA
$I_{LK}$	Offset Supply Leakage Current	$V_B = V_S = 600\text{V}$			45	µA
<b>Oscillator Section</b>						
$V_{MPH}$	CPH Pin Preheating Voltage Range		2.5	3.0	3.5	V
$I_{PH}$	CPH Pin Charging Current During Preheating	$V_{CPH} = 1\text{V}$	1.25	2.00	2.85	µA
$I_{IG}$	CPH Pin Charging Current During Ignition	$V_{CPH} = 4\text{V}$	8	12	16	
$V_{MO}$	CPH Pin Voltage Level at Running Mode			7.0		V
$f_{PRE}$	Preheating Frequency	$R_T = 80\text{kΩ}$ , $V_{CPH} = 2\text{V}$	72	85	98	kHz
$f_{OSC}$	Running Frequency	$R_T = 80\text{kΩ}$	48.2	53.0	57.8	kHz
$DT_{MAX}$	Maximum Dead Time	$V_{CPH} = 1\text{V}$ , $V_S = \text{GND}$ in Preheat Mode		3.1		µs
$DT_{MIN}$	Minimum Dead Time	$V_{CPH} = 6\text{V}$ , $V_S = \text{GND}$ in Run Mode		1.0		µs
<b>Output Section</b>						
$I_{OH+}$	High-side Driver Sourcing Current	$PW = 10\text{µs}$	250	350		mA
$I_{OH-}$	High-side Driver Sinking Current	$PW = 10\text{µs}$	500	650		
$I_{OL+}$	Low-side Driver Sourcing Current	$PW = 10\text{µs}$	250	350		
$I_{OL-}$	Low-side Driver Sink Current	$PW = 10\text{µs}$	500	650		
$t_{HOR}$	High-side Driver Turn-on Rising Time	$C_L = 1\text{nF}$ , $V_{BS} = 15\text{V}$		45		ns
$t_{HOL}$	High-side Driver Turn-off Rising Time	$C_L = 1\text{nF}$ , $V_{BS} = 15\text{V}$		25		
$t_{LOR}$	Low-side Driver Turn-on Rising Time	$C_L = 1\text{nF}$ , $V_{BS} = 15\text{V}$		45		
$t_{LOL}$	Low-side Driver Turn-off Rising Time	$C_L = 1\text{nF}$ , $V_{BS} = 15\text{V}$		25		
$V_S^{(5)}$	Maximum Negative $V_S$ Swing Range for Signal Propagation to High-side Output			-9.8		V

## Electrical Characteristics (Continued)

$V_{BIAS}$  ( $V_{DDB}$ ,  $V_{BS}$ ) = 14.0V,  $T_A$  = 25°C, unless otherwise specified.

Symbol	Characteristics	Condition	Min.	Typ.	Max.	Unit
<b>Protection Section</b>						
$V_{CPHSD}$	Shutdown Voltage	$V_{RT} = 0$ After Run Mode	2.6			V
$I_{SD}$	Shutdown Current			250	450	$\mu A$
TSD <sup>(5)</sup>	Thermal Shutdown			165		°C

**Notes:**

4. Please refer to the FAN7711 datasheet for more detailed information. Available on Fairchild's website at:

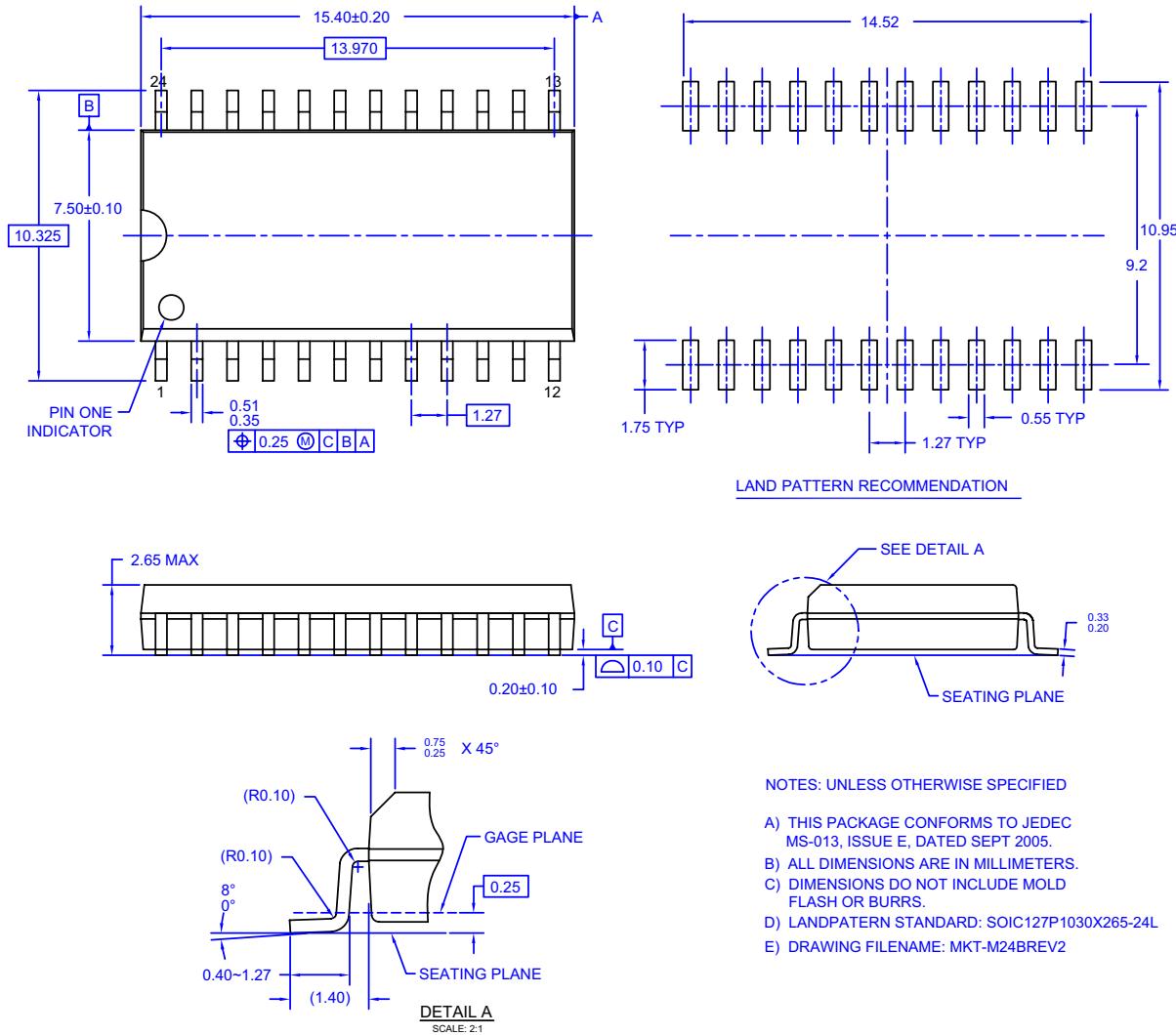
[Datasheet: http://www.fairchildsemi.com/ds/FA%2FFAN7711.pdf](http://www.fairchildsemi.com/ds/FA%2FFAN7711.pdf)

5. This parameter, although guaranteed, is not 100% tested in production.

## Component List for 32W Two Lamps

Part	Value	Note	Part	Value	Note			
<b>Resistor</b>								
R1	330kΩ	1/2W	C55	15nF/630V	Miller Capacitor			
R2	750kΩ	1/4W	C56	2.7nF/1kV	Miller Capacitor			
R3	100Ω	1/2W	C57	15nF/630V	Miller Capacitor			
R4	20kΩ	1/4W	C58	2.7nF/1kV	Miller Capacitor			
<b>Diode</b>								
D1	1N4007	1kV,1A	D2	1N4007	1kV,1A			
D3	1N4007	1kV,1A	D4	1N4007	1kV,1A			
D5	UF4007	Ultra Fast,1kV,1A	D6	UF4007	Ultra Fast,1kV,1A			
D7	1N4148	100V,1A	D8	1N4148	100V,1A			
D50	UF4007	Ultra Fast,1kV,1A	D51	UF4007	Ultra Fast,1kV,1A			
D52	UF4007	Ultra Fast,1kV,1A	ZD1	IN4746A	Zener 18V, 1W			
<b>MOSFET</b>								
M1	FQPF5N60C	500V,6A	M2	FQPF5N50C	500V,5A			
M3	FQPF5N50C	500V,5A	<b>Fuse</b>					
Fuse	3A/250V		<b>TNR</b>					
TNR	471		<b>NTC</b>					
NTC	10D-09		<b>Line Filter</b>					
LF1	40mH		<b>Transformer</b>					
L1	0.94mH (75T:10T)	EI2820	<b>Inductor</b>					
L2	3.2mH (130T)	EI2820	<b>IC</b>					
L3	3.2mH (130T)	EI2820	U1	FAN7535	Fairchild Semiconductor			
C1	47nF/275V <sub>AC</sub>	Box Capacitor						
C2	150nF/275V <sub>AC</sub>	Box Capacitor						
C3	2200pF/3kV	Ceramic Capacitor						
C4	2200pF/3kV	Ceramic Capacitor						
C5	0.22μF/630V	Miller Capacitor						
C6	12nF/50V	Ceramic Capacitor						
C7	22μF/50V	Electrolytic Capacitor						
C8	39pF/50V	Ceramic Capacitor						
C9	1μF/50V	Ceramic Capacitor						
C10	0.1μF/50V	Ceramic Capacitor						
C11	47μF/450V	Electrolytic Capacitor						
C50	10μF/50V	Electrolytic Capacitor						
C51	1μF/50V	Ceramic Capacitor						
C52	0.47μF/25V	Ceramic Capacitor, 5%						
C53	100nF/50V	Ceramic Capacitor						
C54	470pF/1kV	Ceramic Capacitor						

## Package Dimensions



M24BREV2

Figure 4. 24-Lead Small Outline Package (SOP)

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

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		SuperSOT™-6	
		SuperSOT™-8	

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2. A critical component in any component of a life support device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

## PRODUCT STATUS DEFINITIONS

### Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
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