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FAIRCHILD SEMICONDUCTOR®

December 2007

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)

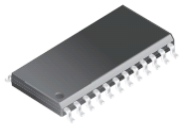
Applications

- 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 swtiching 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

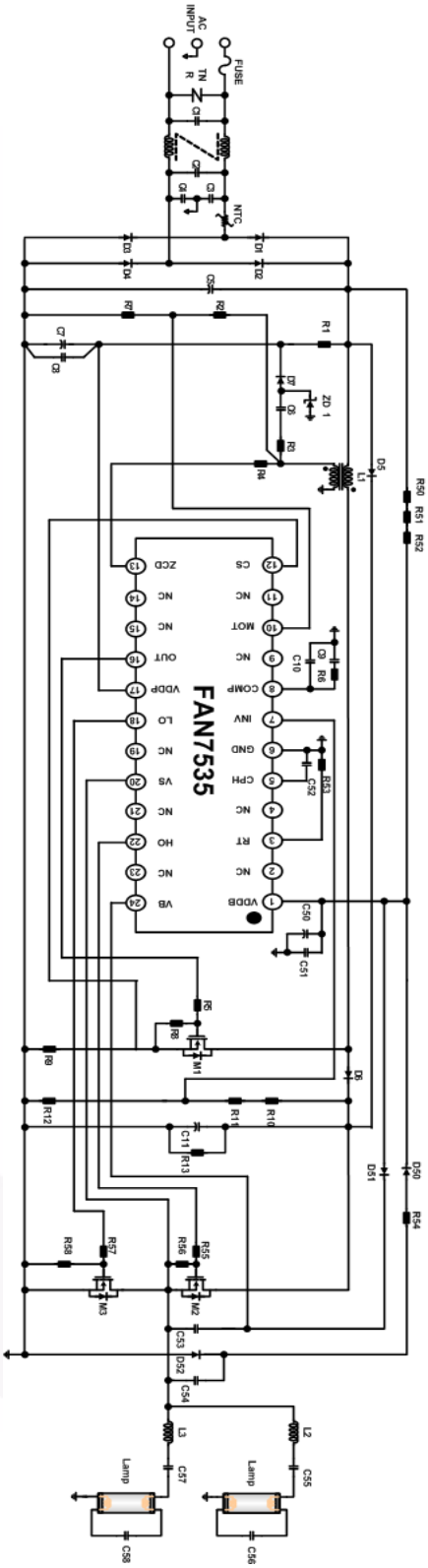


Figure 1. Typical Application Circuit for Fluorescent Lamp

Internal Block Diagram

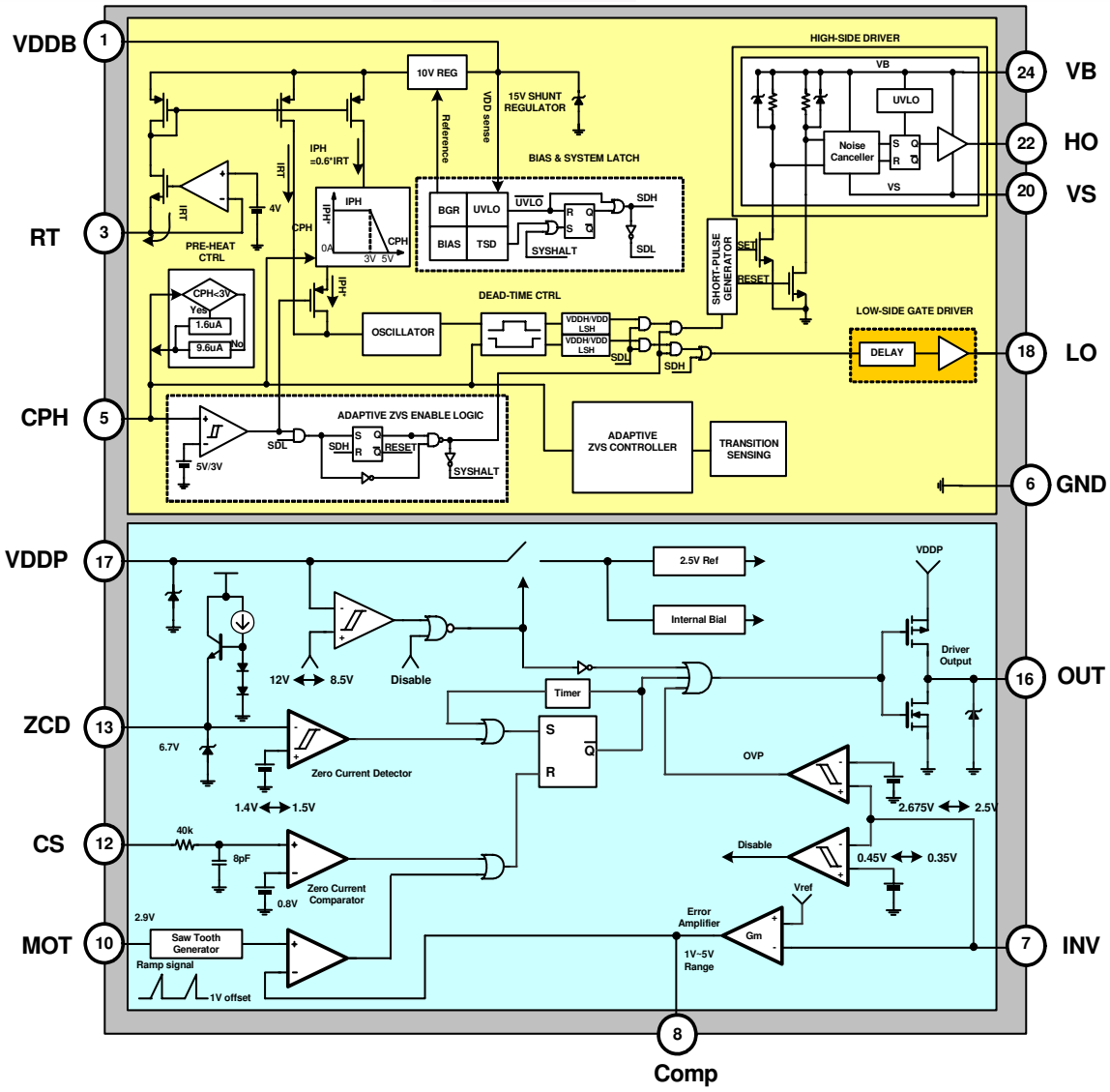


Figure 2. Functional Block Diagram (2chips-1PKG)

Pin Configuration

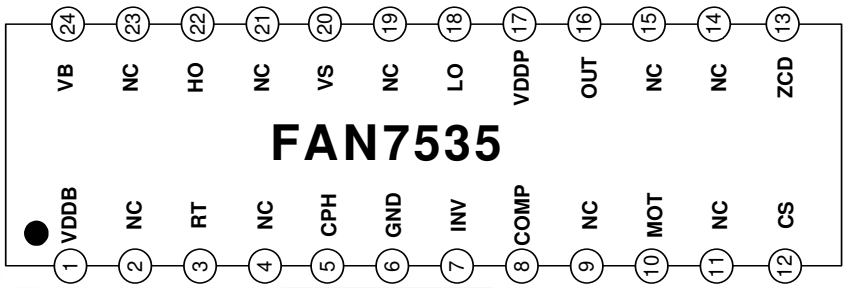


Figure 3. Pin Configuration (Top View)

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°C, unless otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Unit
PFC PART					
V_{DDP}	Supply Voltage		Vz		V
I_{OH}, I_{OL}	Peak Drive Output Current	-800		+500	mA
I_{CLAMP}	Driver Output Clamping Diodes $V_O > V_{CC}$ or $V_O < -0.3V$		±10		
I_{DET}	Detector Clamping Diodes		±10		
V_{IN}	Error Amplifier, MOT, CS Input Voltages	-0.3		6.0	V
BALLAST PART					
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
Common					
T_{OPR}	Operating Temperature Range	-25		+125	°C
T_{STG}	Storage Temperature Range	-65		+150	
P_D	Total Power Dissipation		1.5		W
θ_{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°C, unless otherwise specified.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
PFC PART(1)						
UNDER-VOLTAGE LOCKOUT SECTION						
$V_{th(start)}$	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	
Vz	Zener Voltage	I_{DDP} = 20mA	20	22	24	
SUPPLY CURRENT SECTION						
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
ERROR AMPLIFIER SECTION						
V_{ref1}	Voltage Feedback Input Threshold1	T_A = 25°C	2.465	2.500	2.535	V
DV_{ref1}	Line Regulation	14V ≤ V_{DDP} ≤ 20V		0.1	10.0	mV
DV_{ref3}(1)	Temperature Stability of V_{REF}			20		
$Ib_{(ea)}$	Input Bias Current	1V ≤ V_{inv} ≤ 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		
$V_{eao(H)}$	Output Upper Clamp Voltage	V_{inv} = V_{ref1}-0.1V	5.4	6.0	6.6	V
$V_{eao(Z)}$	Zero Duty Cycle Output Voltage		0.9	1.0	1.1	
g_m(2)	Transconductance		90	115	140	µmho
MAXIMUM ON-TIME SECTION						
V_{MOT}	Maximum On-Time Voltage	R_{MOT} = 40.5Ω	2.784	2.900	3.016	V
T_{ON-MAX}	Maximum On-Time Programming	R_{MOT} = 40.5Ω,T_A = 25°C	19	24	29	µs
CURRENT-SENSE SECTION						
$V_{CS(LIMIT)}$	Current Sense Input Threshold Voltage Limit		0.7	0.8	0.9	V
$Ib_{(cs)}$	Input Bias Current	0V ≤ V_{CS} ≤ 1V	-1.0	-0.1	1.0	mA
$Td_{(cs)}$(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

   Application Note: http://www.fairchildsemi.com/an/AN/AN-6026.pdf

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

Electrical Characteristics (Continued)

V_{DDP} = 14V, T_A = 25°C, unless otherwise specified.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
ZERO CURRENT DETECT SECTION						
$V_{th(ZCD)}$ (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	
$Ib_{(ZCD)}$	Input Bias Current	1V ≤ V_{ZCD} ≤ 5V	-1.0	-0.1	1.0	mA
$I_{source(ZCD)}$ (3)	Source Current Capability	T_A = 25°C			-10	mA
$I_{sink(ZCD)}$ (3)	Sink Current Capability	T_A = 25°C			10	
T_{DEAD} (3)	Maximum Delay, ZCD to Output Turn-on		100		200	
OUTPUT SECTION						
V_{oh}	Output Voltage High	I_O = -100mA, T_A = 25°C	9.2	11.0	12.8	V
V_{ol}	Output Voltage Low	I_O = 100mA, T_A = 25°C		1.0	2.5	
T_r (3)	Rising Time	C_l = 1nF		50	100	ns
T_f (3)	Falling Time	C_l = 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	
RESTART TIMER SECTION						
$t_{d(rst)}$	Restart Time Delay		50	150	300	ms
OVER-VOLTAGE PROTECTION SECTION						
V_{OVP}	OVP Threshold Voltage	T_A = 25°C	2.620	2.675	2.730	V
$HY_{(OVP)}$	OVP Hysteresis	T_A = 25°C	0.120	0.175	0.230	
ENABLE SECTION						
$V_{th(en)}$	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
BALLAST PART(4)						
Supply Voltage Section						
$V_{DDTH(ST+)}$	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} = 10mA	14.8	15.2		
I_{ST}	Start-up Supply Current	V_{DDB} = 12V		150		μA
$I_{DDB(dyn)}$	Dynamic Operating Supply Current	50kHz, C_L = 1nF		3.2		mA
High-Side Supply Section (V_B-V_S)						
$V_{HSTH(ST+)}$	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} = 14V		50		μA
I_{HD}	High-side Dynamic Operating Supply Current	50kHz, C_L = 1nF		1		mA
I_{LK}	Offset Supply Leakage Current	V_B = V_S = 600V			45	μA
Oscillator Section						
V_{MPH}	CPH Pin Preheating Voltage Range		2.5	3.0	3.5	V
I_{PH}	CPH Pin Charging Current During Preheating	V_{CPH} = 1V	1.25	2.00	2.85	μA
I_{IG}	CPH Pin Charging Current During Ignition	V_{CPH} = 4V	8	12	16	
V_{MO}	CPH Pin Voltage Level at Running Mode			7.0		V
f_{PRE}	Preheating Frequency	R_T = 80kΩ, V_{CPH} = 2V	72	85	98	kHz
f_{OSC}	Running Frequency	R_T = 80kΩ	48.2	53.0	57.8	kHz
DT_{MAX}	Maximum Dead Time	V_{CPH} = 1V, V_S = GND in Preheat Mode		3.1		μs
DT_{MIN}	Minimum Dead Time	V_{CPH} = 6V, V_S = GND in Run Mode		1.0		μs
Output Section						
I_{OH+}	High-side Driver Sourcing Current	PW = 10μs	250	350		mA
I_{OH-}	High-side Driver Sinking Current	PW = 10μs	500	650		
I_{OL+}	Low-side Driver Sourcing Current	PW = 10μs	250	350		
I_{OL-}	Low-side Driver Sink Current	PW = 10μs	500	650		
t_{HOR}	High-side Driver Turn-on Rising Time	C_L = 1nF, V_{BS} = 15V		45		ns
t_{HOL}	High-side Driver Turn-off Rising Time	C_L = 1nF, V_{BS} = 15V		25		
t_{LOR}	Low-side Driver Turn-on Rising Time	C_L = 1nF, V_{BS} = 15V		45		
t_{LOL}	Low-side Driver Turn-off Rising Time	C_L = 1nF, V_{BS} = 15V		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
Protection Section						
V_{CPHSD}	Shutdown Voltage	V_{RT} = 0 After Run Mode	2.6			V
I_{SD}	Shutdown Current			250	450	μA
TSD(5)	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

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

Component List for 32W Two Lamps

Part	Value	Note
Resistor		
R1	330kΩ	1/2W
R2	750kΩ	1/4W
R3	100Ω	1/2W
R4	20kΩ	1/4W
R5	47Ω	1/4W
R6	10kΩ	1/4W
R7	50kΩ	1/4W
R8	47kΩ	1/4W
R9	0.3Ω	1W
R10	1MΩ	1/4W
R11	1MΩ	1/4W
R12	12.6kΩ	1/4W,1%
R13	220kΩ	2W
R50	150kΩ	1/4W
R51	150kΩ	1/4W
R52	150kΩ	1/4W
R53	90kΩ	1/4W,1%
R54	10Ω	1/4W
R55	47Ω	1/4W
R56	47kΩ	1/4W
R57	47Ω	1/4W
R58	47kΩ	1/4W
Capacitor		
C1	47nF/275V_{AC}	Box Capacitor
C2	150nF/275V_{AC}	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
C55	15nF/630V	Miller Capacitor
C56	2.7nF/1kV	Miller Capacitor
C57	15nF/630V	Miller Capacitor
C58	2.7nF/1kV	Miller Capacitor
Diode		
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
MOSFET		
M1	FQPF5N60C	500V,6A
M2	FQPF5N50C	500V,5A
M3	FQPF5N50C	500V,5A
Fuse		
Fuse	3A/250V	
TNR		
TNR	471	
NTC		
NTC	10D-09	
Line Filter		
LF1	40mH	
Transformer		
L1	0.94mH (75T:10T)	EI2820
Inductor		
L2	3.2mH (130T)	EI2820
L3	3.2mH (130T)	EI2820
IC		
U1	FAN7535	Fairchild Semiconductor

Package Dimensions

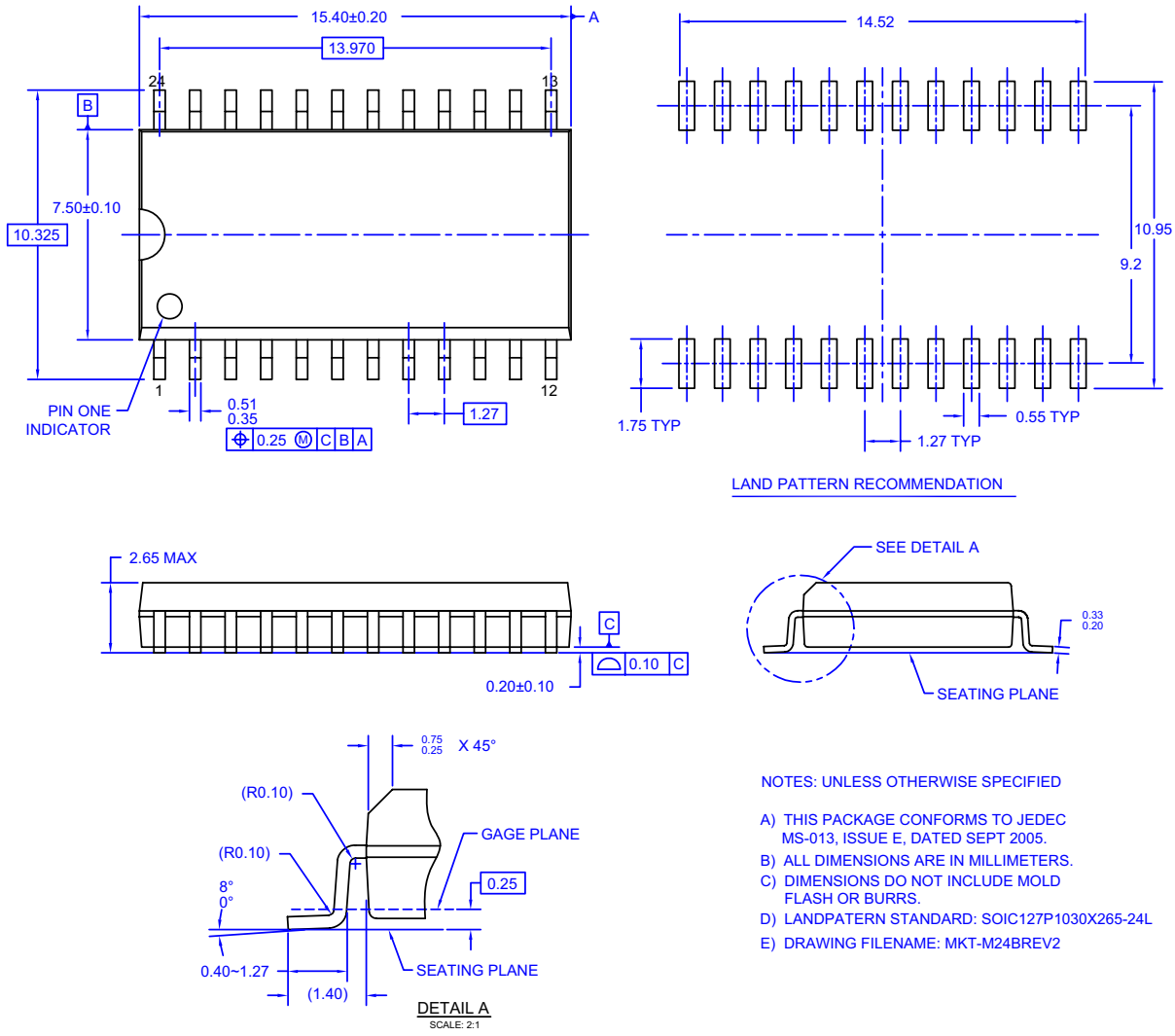


Figure 4. 24-Lead Small Outline Package (SOP)

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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Rev. I32

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