FAIRCHILD SEMICONDUCTOR®

September 2006

FAN7313
LCD Backlight Inverter Drive IC

Features

- High-Efficiency Single-Stage Power Conversion
- Wide Input Voltage Range: 4.5V to 25.5V
- Backlight Lamp Ballast and Soft Dimming
- Reduces Required External Components
- Precision Voltage Reference Trimmed to 2%
- Push-Pull Topology
- Soft-Start Capability
- PWM Control at Fixed Frequency
- Analog and Burst Dimming Functions
- Open-Lamp Protection
- Open-Lamp Regulation
- Over-Voltage Protection
- Short-Circuit Protection
- 20-Pin SOIC

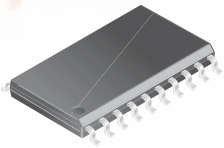
Applications

- LCD TV
- LCD Monitor

Description

FAN7313 provides all the control functions for a series parallel resonant converter as well as a pulse width modulation (PWM) controller to develop a supply voltage. Typical operating frequency range is between 30kHz and 250kHz, depending on the cold cathode fluorescent lamp (CCFL) and the transformer's characteristics.

20-SOIC



Ordering Information

Part Number	Package	Pb-Free	Operating Temperature Range	Packing Method
FAN7313M	20-SOIC	Yes	-25°C ~ 85°C	Rail
FAN7313MX	20-SOIC	Yes		Tape & Reel

Internal Block Diagram

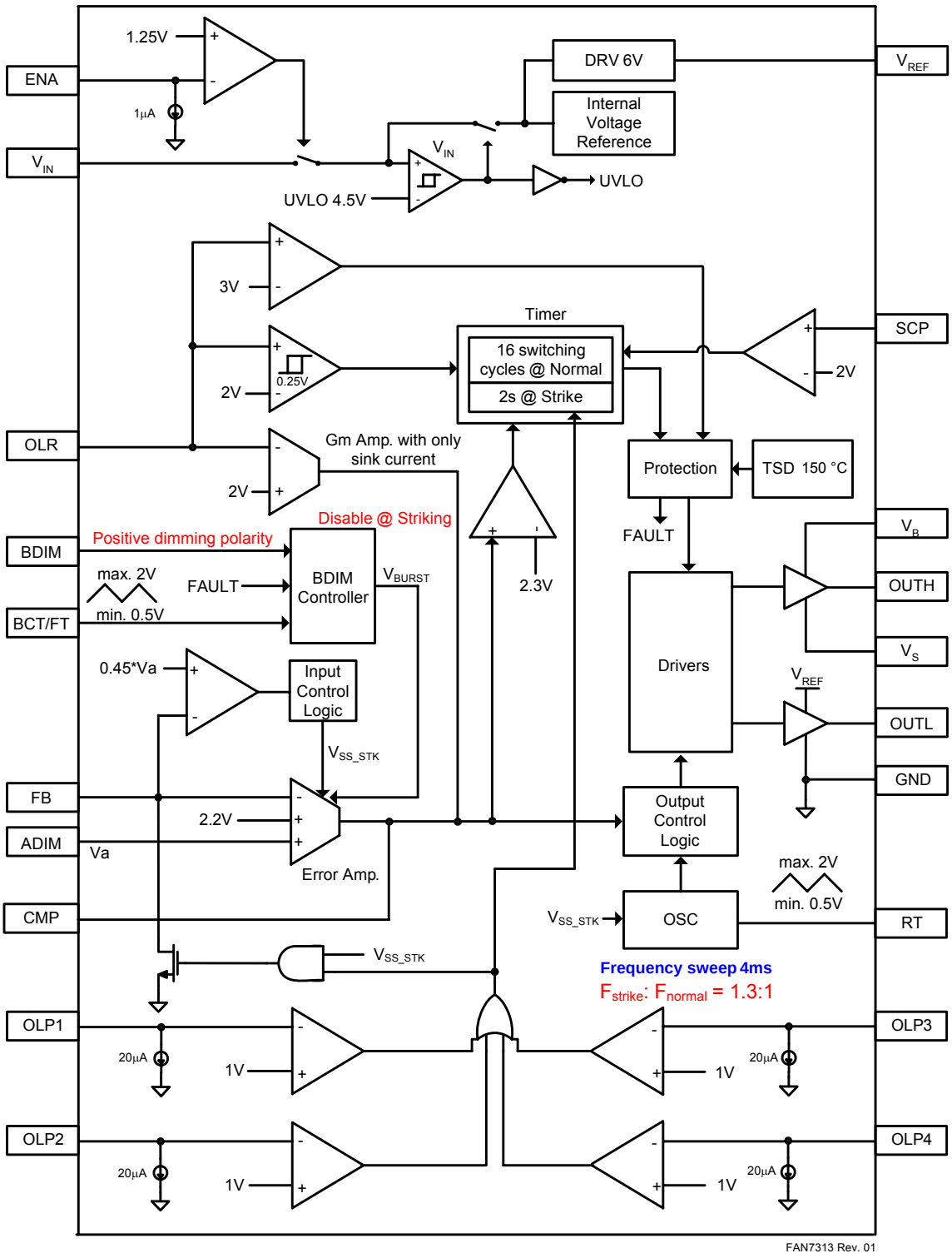


Figure 1. Functional Block Diagram of FAN7313

Pin Assignments

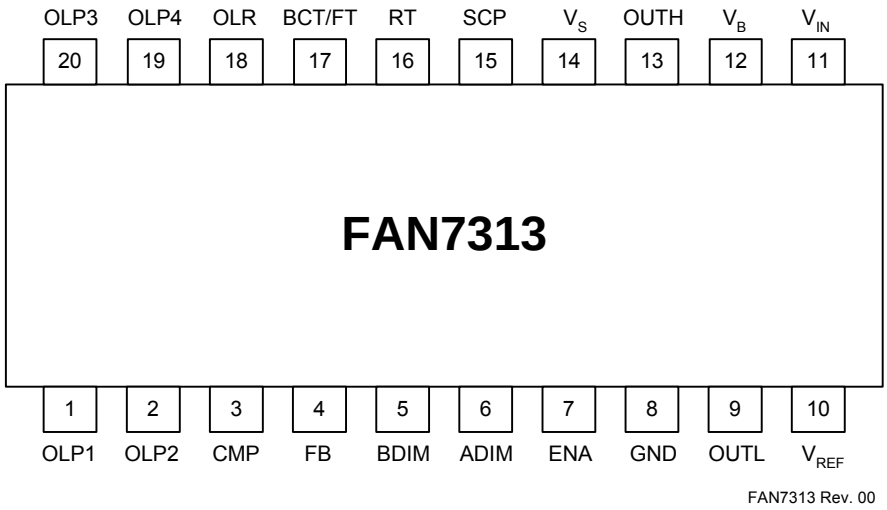


Figure 2. Pin Configuration (Top View)

Pin Definitions

Pin #	Name	Description	Pin #	Name	Description
1	OLP1	Open-Lamp Protection 1	11	V_{IN}	Supply Voltage
2	OLP2	Open-Lamp Protection 2	12	V_B	Connected to V_{REF} Internally
3	CMP	Error Amplifier Output	13	OUTH	High-Side Driver Output
4	FB	Error Amplifier Input	14	V_S	Connected to GND Internally
5	BDIM	Burst Dimming Input	15	SCP	Short-Circuit Protection
6	ADIM	Analog Dimming Input	16	RT	Timing Resistor
7	ENA	Enable Input	17	BCT/FT	Burst Dimming Timing Capacitor/ Fault Signal Output
8	GND	Ground	18	OLR	Open-Lamp Regulation
9	OUTL	Low-Side Driver Output	19	OLP4	Open-Lamp Protection 4
10	V_{REF}	Reference Voltage	20	OLP3	Open-Lamp Protection 3

Absolute Maximum Ratings

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 parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum ratings.

For typical values, T_A=25°C and V_{IN}=18V. For min./max. values, T_A is the operating ambient temperature range with -25°C ≤ T_A ≤ 85°C and 4.5V ≤ V_{IN} ≤ 25.5V, unless otherwise specified.

Symbol	Characteristics	Value	Unit
V_{IN}	Supply Voltage	25.5	V
T_A	Operating Temperature Range	-25 ~ 85	°C
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature Range	-65 ~ 150	°C
θ_{JA}	Thermal Resistance Junction-to-Ambient (1)(2)	70	°C/W
P_D	Power Dissipation	1.8	W

Notes:

1. Thermal resistance test board size: 76.2 * 114.3 * 1.6mm (1S0P). JEDEC standard: JESD51-2, JESD51-3.
2. Assume no ambient airflow.

Pin Breakdown Voltage

No	Name	Max.	Unit	No	Name	Max.	Unit
1	OLP1	10	V	11	V_{IN}	25.5	V
2	OLP2	10		12	V_B	10	
3	CMP	4		13	OUTH	6	
4	FB	10		14	V_S		
5	BDIM	10		15	SCP	10	
6	ADIM	10		16	RT		
7	ENA	10		17	BCT/FT		
8	GND			18	OLR	10	
9	OUTL	6		19	OLP4	10	
10	V_{REF}	10		20	OLP3	10	

Electrical Characteristics

For typical values, T_A=25°C and V_{IN}=18V. For min./max. values, T_A is the operating ambient temperature range with -25°C ≤ T_A ≤ 85°C and 4.5V ≤ V_{IN} ≤ 18V, unless otherwise specified. Specifications to -25°C ~ 85°C are guaranteed by design based on final characterization results.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
REFERENCE SECTION						
V_6	6V Regulation Voltage		5.76	6.00	6.24	V
V_{6line}	6V Line Regulation		0		0.1	V
V_{6load}	6V Load Regulation	0<I6<10mA	0		0.1	V
OSCILLATOR SECTION (MAIN)						
f_{osc}	Oscillation Frequency(4)	T_A=25°C, RT=27kΩ	97.5	100.0	103.7	KHz
		RT=27kΩ	96	100	104	KHz
V_{cth}	CT High-Voltage(3)			2.0		V
V_{ctl}	CT Low-Voltage(3)			0.5		V
f_{str}	Striking Frequency(4)	T_A=25°C, RT=27kΩ	125.7	130	135.6	kHz
		RT=27kΩ	124	130	136	KHz
T_{stoff}	Strike-Off Delay Time			4		ms
V_{fbth}	FB Threshold Voltage	ADIM=1	0.35	0.45	0.55	V
OSCILLATOR SECTION (BURST)						
f_{oscb}	Oscillation Frequency	T_A=25°C, BCT/FT=10nF, RT=27kΩ	301.6	318	332.5	Hz
		BCT/FT=10nF, RT=27kΩ	296	318	340	Hz
V_{bcth}	BCT/FT High-Voltage	BCT/FT=10nF, RT=27kΩ	1.9	2.0	2.1	V
V_{bctl}	BCT/FT Low-Voltage	BCT/FT=10nF, RT=27kΩ	0.4	0.5	0.6	V
V_{bctft}	BCT/FT Fault-Voltage		3.5	4.0	4.5	V
ERROR AMPLIFIER SECTION						
G_m	Error Amplifier Transconductance(3)	ADIM=1~2.2V	100	360	600	µmho
A_V	Error Amplifier Open-Loop Gain(3)			59		dB
V_{2p2}	2.2V Regulation Voltage	T_A=25°C, ADIM > 2.2V	2.119	2.150	2.195	V
		ADIM > 2.2V	2.086	2.150	2.215	V
I_{ss}	Soft-Start Current	CMP=2V, FB < 0.45*ADIM	-3.2	-1.7	-1.2	µA
I_{sin}	CMP Sink Current	CMP=1V, ADIM < FB	44	73	100	µA
I_{sur}	CMP Source Current	CMP=1V, 0.45*ADIM < FB < ADIM	-67	50	-33	µA
G_{molr}	OLR Transconductance(3)		300	719	1300	µmho
I_{olr}	Open-Lamp Regulation Current	Striking, OLR=2.5V	60	190	300	µA
		Normal, OLR=2.5V	60	260	400	µA
UNDER-VOLTAGE LOCK OUT SECTION						
V_{th}	Start Threshold Voltage		3.9	4.2	4.5	V
V_{thhys}	Start Threshold Voltage Hysterisis		0.20	0.45	0.60	V
I_{st}	Start-up Current	V_{IN}=V_{th}-0.2	20	55	120	µA
I_{op}	Operating Supply Current	Not switching	0.5	1.5	2.5	mA
I_{sb}	Stand-by Current	ENA=0	60	100	150	µA

Notes:

3. These parameters, although guranteed, are not 100% tesed in production.

4. These parameters, although guranteed, are tested in only EDS test.

Electrical Characteristics (Continued)

For typical values T_A=25°C and V_{IN}=18V. For min./max. values, T_A is the operating ambient temperature range with -25°C ≤ T_A ≤ 85°C and 4.5V ≤ V_{IN} ≤ 18V, unless otherwise specified. Specifications to -25°C ~ 85°C are guaranteed by design based on final characterization results.

Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
PROTECTION SECTION						
V_{scp}	Short-Circuit Protection Voltage	FB=OLP=2V	1.9	2.0	2.1	V
V_{cmpr}	CMP Protection Voltage		2.1	2.3	2.5	V
V_{olp}	Open-Lamp Protection Voltage		0.95	1.00	1.08	V
V_{ovp}	Over-Voltage Protection		2.85	3.00	3.15	V
V_{olr}	Open-Lamp Regulation Voltage		1.9	2.0	2.1	V
V_{olrhy}	Opem-Lamp Regulation Hystersis(5)			250		mV
T_{scp}	Short-Circuit Protection Delay	Striking, F_{oscb}=300Hz	1.7	2.0	2.3	µsec
		Normal, F_{osc}=100kHz	100	300	500	µsec
T_{cmp}	CMP Protection Delay	Striking, F_{oscb}=300Hz	1.7	2.0	2.3	sec
		Normal F_{osc}=100kHz	100	300	500	µsec
T_{olp}	Open-Lamp Protection Delay	F_{oscb}=300Hz	1.7	2.0	2.3	sec
T_{olr}	Open-Lamp Regulation Delay	Striking, OLR=2.5V	1.7	2.0	2.3	sec
		Normal, OLR=2.5V	100	300	500	µsec
TSD	Thermal Shutdown			150		°C
ENABLE SECTION						
V_{ena}	Enable State Input Voltage		2		5	V
V_{dis}	Disable State Input Voltage				0.7	V
I_{ena}	Enable Discharge Current		0.2	1.0	4.0	µA
OUTPUT SECTION						
f_{nrmo}	Output Normal Frequency(6)	V_{FB}=1V, RT=27kΩ	48	50	52	KHz
f_{stro}	Output Striking Frequency(6)	V_{FB}=0V, RT=27kΩ	62	65	68	KHz
V_{uvh}	High-Side Output Voltage Before Start-up		-0.5		0.5	V
V_{uvl}	Low-Side Output Voltage Before Start-up		-0.5		0.5	V
V_{enh}	High-Side Output Voltage at V_{ena}=0V		-0.5		0.5	V
V_{enl}	Low-Side Output Voltage at V_{ena}=0V		-0.5		0.5	V
OUTH	High-Side Output Voltage		5.5	6.0	6.5	V
OUTL	Low-Side Output Voltage		5.5	6.0	6.5	V
I_{dsurh}	High-Side Output Drive Soure Current(5)	V_{IN}=18V		530		mA
I_{dsinh}	High-Side Output Drive Sink Current(5)	V_{IN}=18V		530		mA
I_{dsurl}	Low-Side Output Drive Soure Current(5)	V_{IN}=18V		530		mA
I_{dsinl}	Low-Side Output Drive Sink Current(5)	V_{IN}=18V		530		mA
t_{rh}	High-Side Output Rising Time(5)	V_{IN}=18V, C_{load}=4.7nF		100		nsec
t_{fh}	High-Side Output Falling Time(5)	V_{IN}=18V, C_{load}=4.7nF		100		nsec
t_{rl}	Low-Side Output Rising Time(5)	V_{IN}=18V, C_{load}=4.7nF		100		nsec
t_{fl}	Low-Side Output Falling Time(5)	V_{IN}=18V, C_{load}=4.7nF		100		nsec
t_{dead}	Dead Time			430		nsec

Notes:

5. These parameters, although guaranteed, are not 100% tesed in production.

6. Output frequency is half f_{osc}.

Timing Diagram

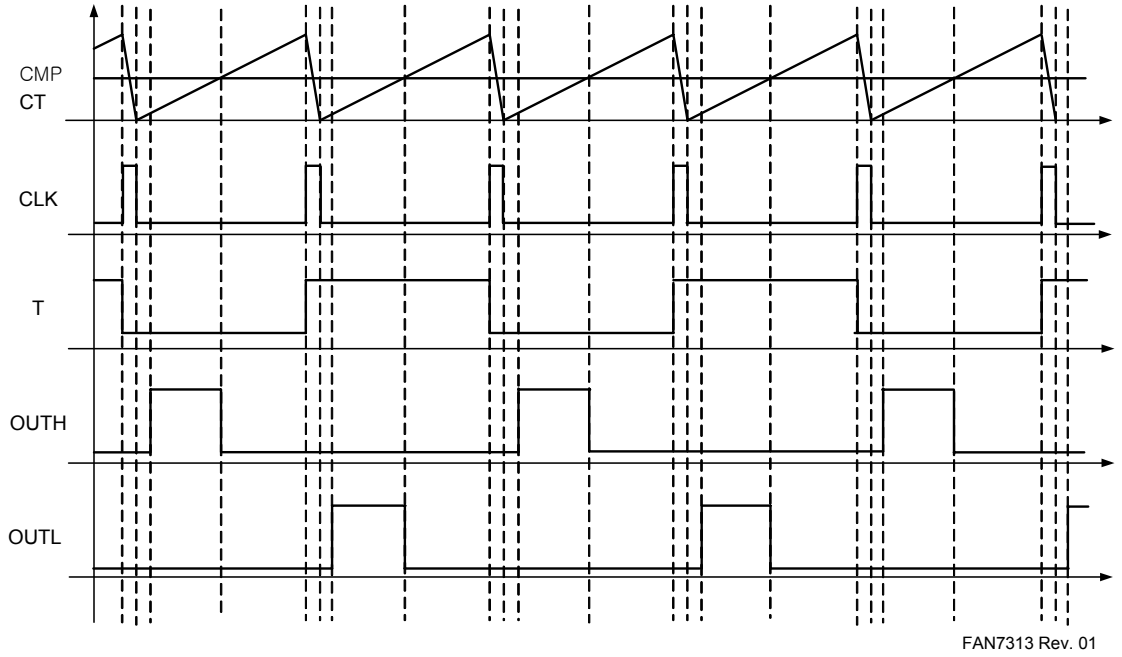


Figure 3. Push-Pull PWM Control Waveforms

Typical Application Circuits

Application	Lamps	Input Voltage
19-inch LCD Monitor	4	13V

1. Schematic

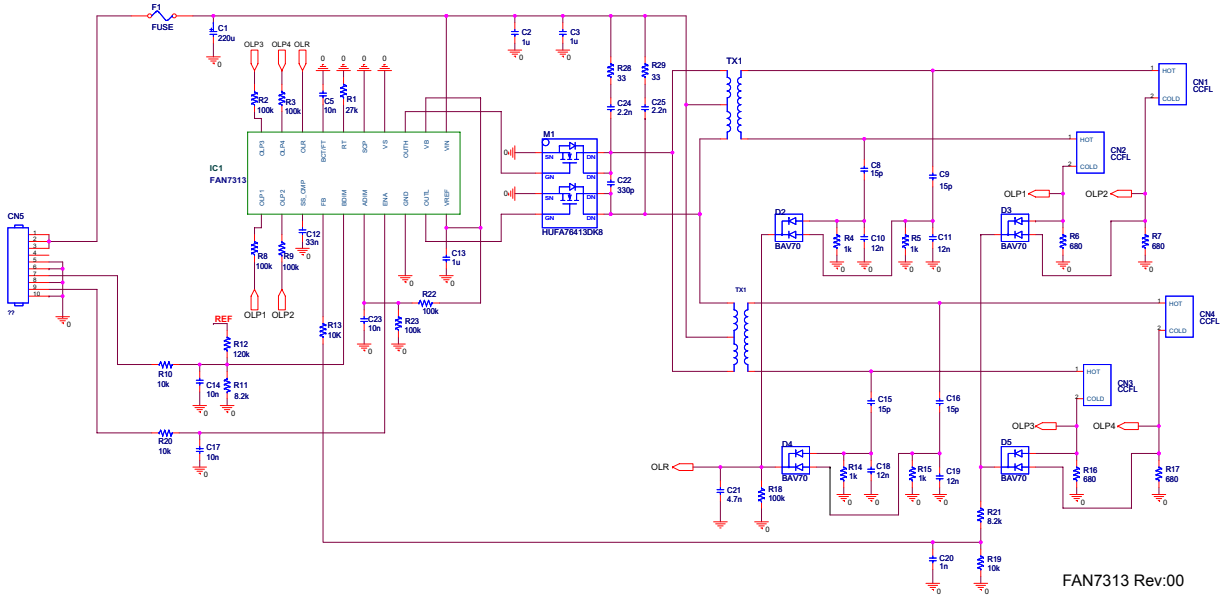


Figure 4. Typical Application Circuit

2. Transformer Schematic Diagram

Supported by Namyang electronics (http://www.namyangelec.co.kr).

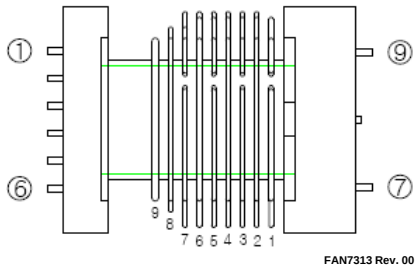


Figure 5. Transformer Schematic

3. Core & Bobbin

- Core: EFD2124
- Material: PL7
- Bobbin: EFE2124

4. Winding Specification

Pin No.	Wire	Turns	Inductance	Leakage Inductance	Remarks
6 --> 4	1 UEW 0.35 ϕ	19	50μH	1.2μH	1KHz, 1V
3 --> 5	1 UEW 0.35 ϕ	19	50μH	1.2μH	1KHz, 1V
7 --> 9	1 UEW 0.04 ϕ	2300	826mH	260mH	1KHz, 1V

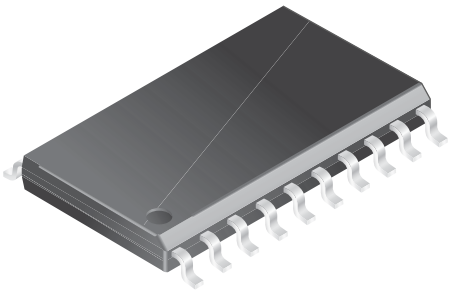
5. BOM of the Application Circuit

Part Ref.	Value	Description / Vendor
Fuse		
F1	24V 3A	Fuse
Resistor (SMD)		
R1	27kΩ	1608 J
R2	100kΩ	1608 F
R3	100kΩ	1608 F
R4	1kΩ	1608 F
R5	1kΩ	1608 F
R6	680Ω	1608 F
R7	680Ω	1608 F
R8	100kΩ	1608 F
R9	100kΩ	1608 F
R10	10kΩ	1608 F
R11	8.2kΩ	1608 F
R12	120kΩ	1608 F
R13	10kΩ	1608 F
R14	1kΩ	1608 F
R15	1kΩ	1608 F
R16	680Ω	1608 F
R17	680Ω	1608 F
R18	100kΩ	1608 J
R19	10kΩ	1608 J
R20	10kΩ	1608 J
R21	8.2kΩ	1608 J
R22	100kΩ	1608 J
R23	100kΩ	1608 J
R28	33Ω	3216 J
R29	33Ω	3216 J
Capacitor (SMD)		
C2	1μF	50V 2012 K
C3	1μF	50V 2012 K
C5	10nF	50V 1608 K
C8	15pF	3KV 3216
C9	15pF	3KV 3216
C10	12nF	50V 1608 K
C11	12nF	50V 1608 K
C12	33nF	50V 1608 K
C13	1μF	50V 2012 K
C14	10nF	50V 1608 K
C15	15pF	3KV 3216
C16	15pF	3KV 3216
C17	10nF	50V 1608 K
C18	12nF	50V 1608 K
C19	12nF	50V 1608 K
C20	1nF	50V 1608 K
C21	4.7nF	50V 1608 K
C22	330pF	50V 2012 K
C23	10nF	50V 1608 K
C24	2.2nF	50V 2012 K
C25	2.2nF	50V 2012 K
Diode / TR (SMD)		
D2	BAV70	Fairchild
D3	BAV70	Fairchild
D4	BAV70	Fairchild
D5	BAV70	Fairchild
Electrolytic Capacitor		
C1	220μF	25V
MOSFET (SMD)		
M1	HUFA 76413DK8	Fairchild
Wafer (SMD)		
CN1	35001WR-02A	
CN2	35001WR-02A	
CN3	35001WR-02A	
CN4	35001WR-02A	
CN5	12505WR-10	
Transformer (SMD)		
TX1	EFD2124	
TX2	EFD2124	

Package Dimensions

20-SOIC

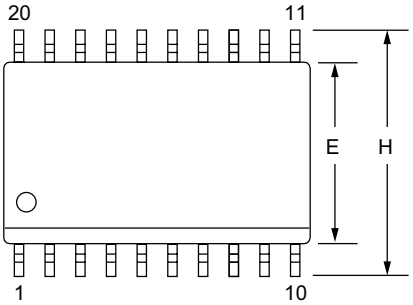
Dimensions are in millimeters unless otherwise noted.

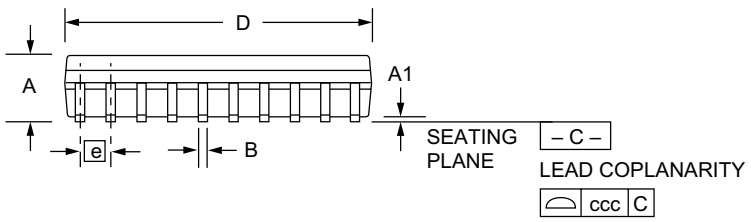


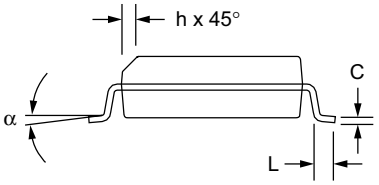
Symbol	Inches		Millimeters		Notes
	Min.	Max.	Min.	Max.	
A	.093	.104	2.35	2.65	
A1	.004	.012	0.10	0.30	
B	.013	.020	0.33	0.51	
C	.009	.013	0.23	0.32	5
D	.496	.512	12.60	13.00	2
E	.291	.299	7.40	7.60	2
e	.050 BSC		1.27 BSC		
H	.394	.419	10.00	10.65	
h	.010	.029	0.25	0.75	
L	.016	.050	0.40	1.27	3
N	20		20		6
α	0°	8°	0°	8°	
ccc		.004		0.10	

Notes:

1. Dimensioning and tolerancing per ANSI Y14.5M-1982.
2. "D" and "E" do not include mold flash. Mold flash or protrusions shall not exceed .010 inch (0.25mm).
3. "L" is the length of terminal for soldering to a substrate.
4. Terminal numbers are shown for reference only.
5. "C" dimension does not include solder finish thickness.
6. Symbol "N" is the maximum number of terminals.







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Rev. I20