



**Application Note AN026:
Reference Design Recommendation**

**High Power 60W PoE PD
Design with Dual AS1135 in
FlyBack Configuration**

October 26, 2009

Revision 0.6

Confidential and Proprietary

Preliminary Information subjected to future revision and changes

Overview

This document provides an overview of reference design using AS1135 device as a PD (Powered Devices) for a 10/100/1000 combined PoE application to deliver 50W of power to a single DC/DC converter. The intention of this document is strictly to describe how to combine two PoEs to deliver High Power PoE. The IEEE802.3 standard for Power over Ethernet (PoE) defines the maximum power supplied to PDs by a PSE (Power Sourcing Equipment) as 30Watts. However, many Ethernet network cameras and multi-channel WLAN access points require high-power solution for remote powering of current and emerging high power applications.

This application note will explain and exemplify the design of a PD (Powered Device) power front-end that relies on provision of high power over Ethernet. It is aimed at engineers who wish to equip new generations of high power IP phones, WLAN or Bluetooth access points, LAN controlled security

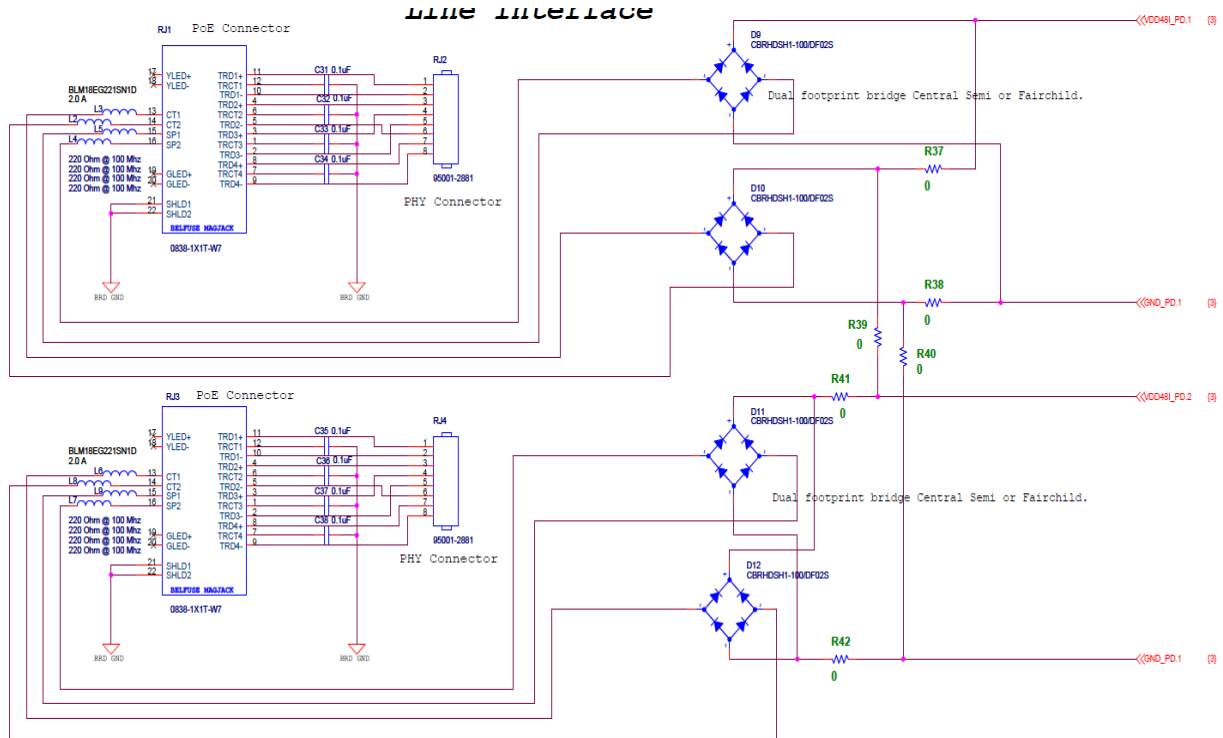
This document is to be used in conjunction with relevant parts datasheets and application notes (see list of References) that provide generic design guidelines for both AS1135 part.

Design Notes

Please refer to design schematics along with these design notes.

Magjack Interface

The approach in this design is to provide two options of connecting to PSEs. These options are: 2-pair or 4-pair connections by selecting the following resistor options. The use of these resistors are only to provide options, when designing High power PD, the designer should decide which type of PSE will be connected to high power PD connects and design the Magjacks (RJ1 and RJ2) connections accordingly.



Component Options	2-pair *PoE 50W	4-pair *PoE 50W
R37, R38, R41, R42, C35, C36, C37, C38, L6, L7, L8, L9, D11, D12, R33, R34	Install	Do Not Install
R39 & R40	Do Not Install	Install

2-pair connections

The 2-pair connection is referred to connecting two separate PSE each at 30W using either Data wires or Spare wires of Category 5 to deliver power to the HPD (High Powered Device). Each PSE will deliver power over either spare (wires 4/5 as "+" and 7/8 as "-") or data (wires 1/2 as "-" and 3/6 as "+") twisted pairs, and is extracted at the HPD data transformer center tap. In this configuration since there are two separate PSEs, the use of RJ1, RJ2, RJ3 and RJ4 is necessary, power and Data is delivered to PD over RJ1 and RJ3, RJ2 and RJ4 are used for PHY Data connection.

4-pair connections

The 4-pair connection is referred to connecting One PSE to deliver high power over Ethernet. In this configuration, the PSE utilizing both data and spare wires of Category 5 to deliver power to the HPD (High Powered Device) simultaneously. Power is delivered over both spare (wires 4/5 as "+" and 7/8 as "-") and data (wires 1/2 as "-" and 3/6 as "+") twisted pairs, and is extracted at the HPD data transformer center tap. In this configuration since there is only one PSE, the use of RJ3 and RJ4 is not necessary, power and Data is delivered to PD over RJ1 and RJ2, RJ2 is used for PHY Data connection.

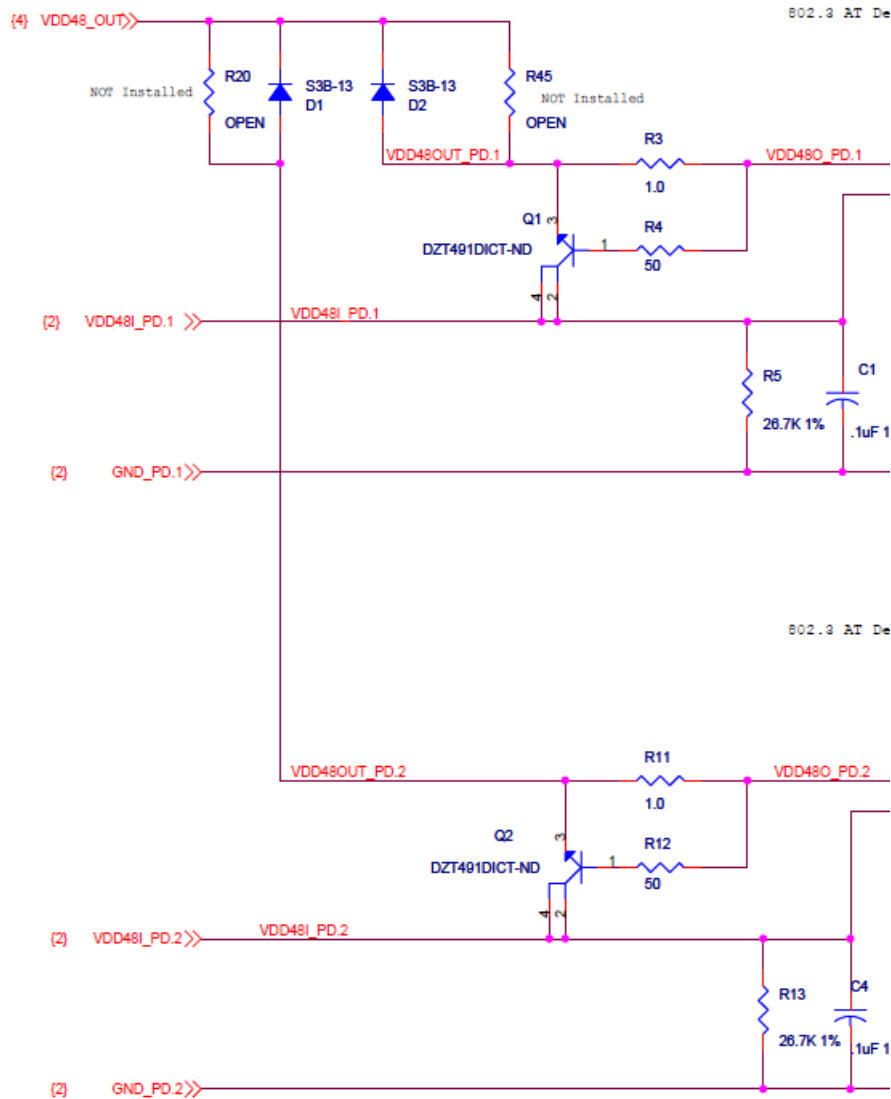
Combined PD Function Description

The AS1135 is a single chip, highly integrated CMOS solution for Power over Ethernet (PoE) Powered Devices (PD) with internal low emission DC/DC controller. In this design two AS1135 are used in order to accept 60W of power from the PSE and deliver 50W from the PD to DC/DC controller. The first AS1135 is used to provide all of the physical layer PD functionality, as required by IEEE 802.3at standards as well as DC/DC controller functions. The input (VDD48I) of the two AS1135 is connected to either two PSE in 2-pair mode or one PSE in 4-pair mode. The output (VDD48O) of the two AS1135 is added either through a Balancing current circuit for an unbalanced loops or just by simply connecting the two outputs for balanced loops.

- RClass (R7 & R15) are set to 63.4k for PoE-Class 4 operation to deliver 25W for each PoE.
- Comp pin components C25, R32, C27, C26, C24 and R34 are subjected to change based on potential board layout and component tolerances.
- Capacitors C3, C6, C22, and C23 are decoupling capacitors for various supplies and must be placed very tightly with the part. For detailed layout recommendations and recommended layout refer to AN004.
- D9, D10, D11 and D12 are external diode bridges used to provide reverse polarity protection and enable PSE in auto MDI-X mode, as it was mentioned before, the use of these diode bridges depends on the PSE connection types.

Balanced and Unbalanced wire connections

In the 4-pair connections the loop impedances are identical; therefore, the current feeding is balanced. Since the current feeding is balanced, each loop will provide half of the input current to a single DC/DC converter. In the 2-pair or 4-pair design, both current loops of two PDs feed a single DC/DC converter. When 2-pair connection is used, if both loops are identical, then the current feeding is balanced and each loop will provide half of the input current to a single DC/DC converter. However in a 2-pair connection, it is possible the loop connections between the two PSE and two PDs have different resistance, which it could then create an unbalanced current feeding to the DC/DC converter. When there is an unbalanced current feeding, one loop will carry more current than the other. The following components (R3, R11, R4, R12, Q1, Q2, D2, and D1) are optional circuit used for balancing the current feed when the loops are different in a 2-pair PSE connections, these components are not used in the 4-pair connections or 2-pair identical loop length and instead only R20 and R45 are stuffed.



DC-DC Converter

The summing of the two PD outputs will deliver 50W of power which is then passed through the first AS1135 DC/DC controller to provide 5V outputs at 10Amp. It is important to follow both the schematic and BOM associated with this design in order to have proper design circuit and component selections.

- A nonsync topology is chosen for simplicity while still maintaining high efficiency and lower BOM cost.
- Component selection and layout placement is very important for good EMI, Efficiency and Output ripple performance. Please see specific component selection recommendations on the schematic and in the BOM.
- Placement of 2kV caps C29 and C30 is critical for EMI performance. It's recommended that one be placed on each side of transformer T1 to allow flexibility during testing.
- Additional output filter inductor may be used in place of R18 based on output ripple requirements.
- Transformer TGSP-P062EFD25LF is specifically used for this design. This transformer is available through HALO. Customers can also take design specification to their own power-magnetic vendor.
- R22 is a gate drive resistor that can be used if the fast rising edges create EMI. Standard configuration is a 0 ohm resistor.
- R21 can use a very small value 5 to 10 ohm to reduce the spike and ringing on the sync FET for better EMI performance. Standard configuration is a 0 ohm resistor.
- Q5, R33 and C28 are optional components for output short circuit protection. If this protection is not needed please also remove D20 and short.
- R19 is used for bode plot measurements during testing only.
- R25, current sense resistor values is set to 0.05 ohm for this design.
- R1, R9 is a frequency adjust resistor currently set for ~350 kHz switching frequency.

References

1. Akros Silicon Datasheet: AS1135 Datasheet, Rev 0.9, Nov 2007
2. Akros Silicon Application Note: AN004 – Design Guide for the AS1113/AS1124 POE Powered Devices
3. Akros Silicon Component Spec: TGSP-P062EFD25LF

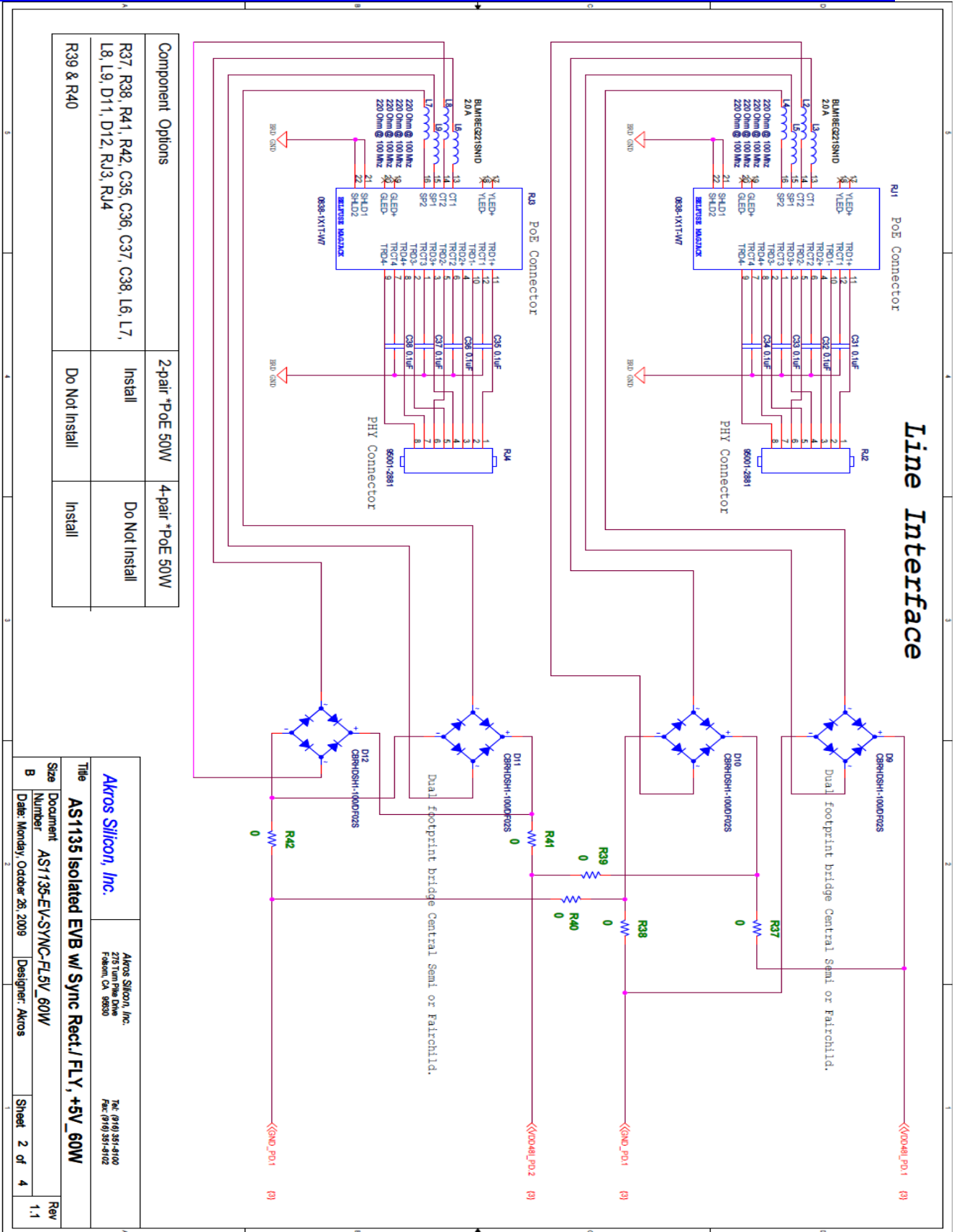


Design Schematics

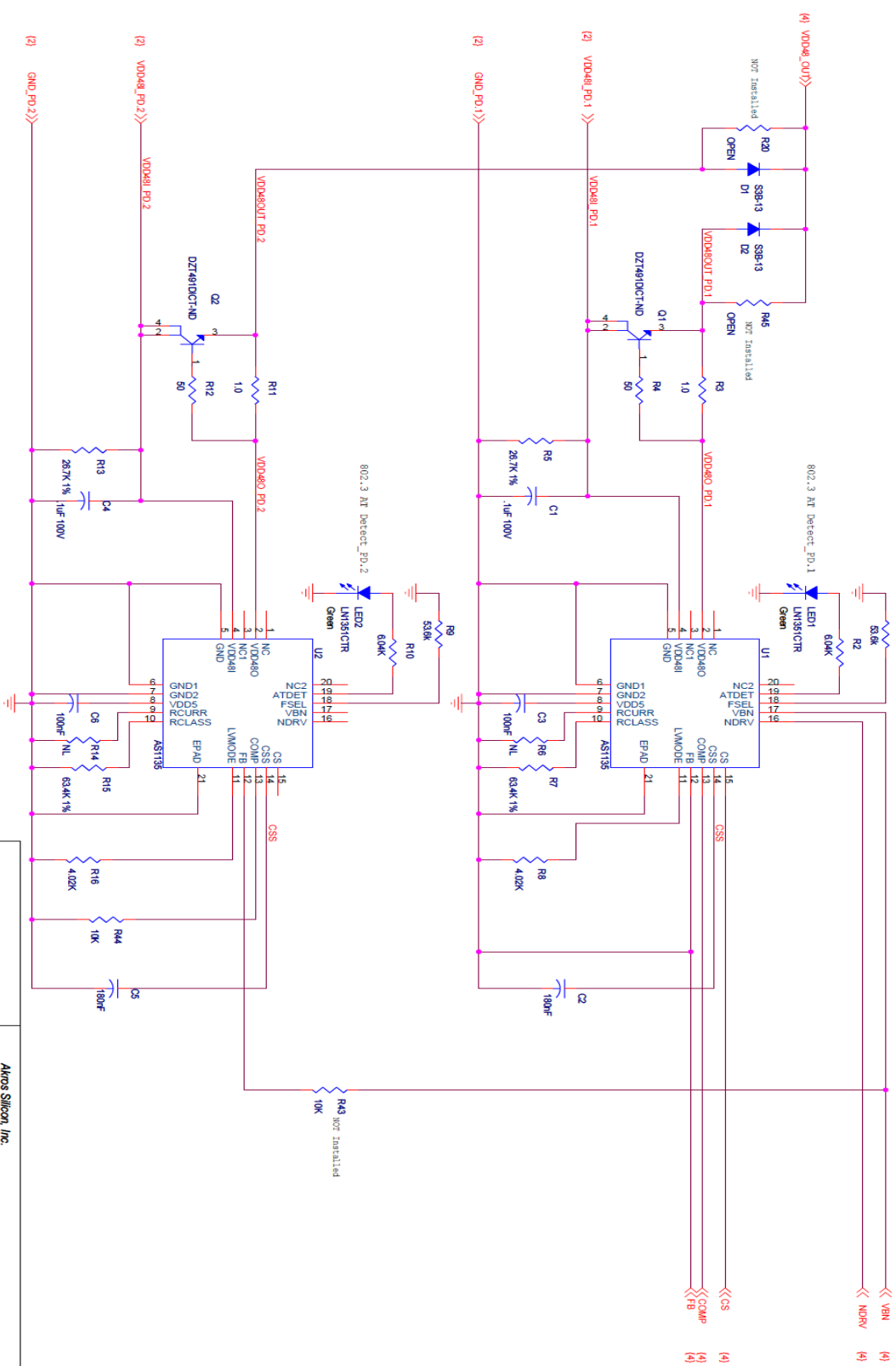
Schematics and BOM are embedded here for reference only. For high quality images, please see separate PDF and XLS files respectively.

Platform	Date	Schematic Revision	Schematic Changes and/or Updates
AS1135-ISO-SYNC-FL5-60W	10-16-09	REV 1.0	Initial Full Release
AS1135-ISO-SYNC-FL5-60W	10-19-09	REV 1.1	Removed VBN connection of U2

Akros Silicon, Inc.		Akros Silicon, Inc.	
225 Tun Park Drive Folsom, CA 95630		Tel: (916) 351-4100 Fax: (916) 351-4102	
Title AS1135 Isolated EVB w/ Sync Rect/ FLY, +5V_60W			
Size	Document Number	Designer	Sheet
B	AS1135-EV-SYNC-FL5V_60W	Akros	1 of 4
Date: Monday, October 19, 2009			Rev
			1.1



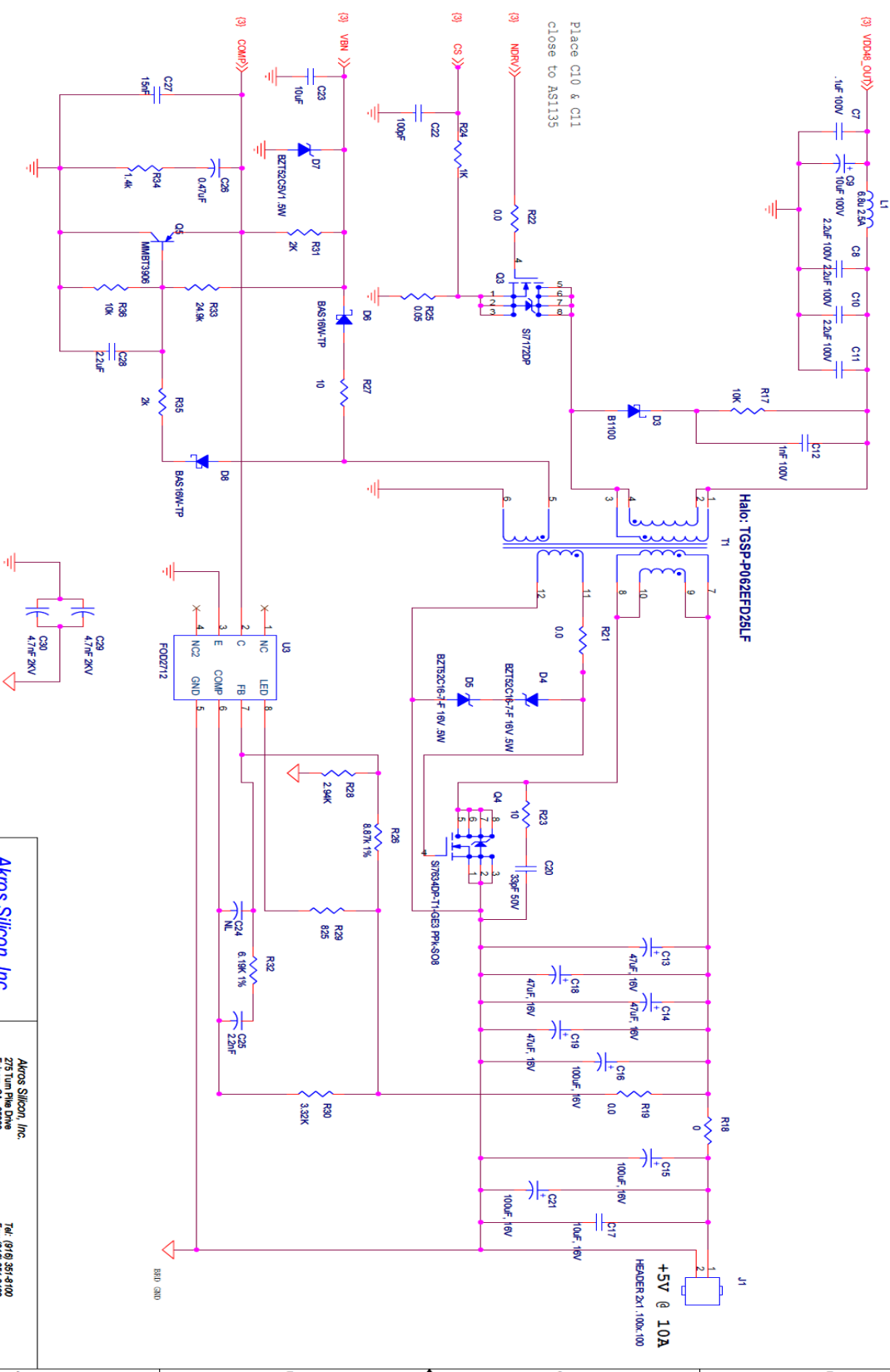
Line Interface and PD



Akros Silicon, Inc. 275 Tully Pkwy Drive Fremont, CA 94550		Title AS1135 Isolated EVB w/ Sync Rect/FLY, +5V_60W	
Size Number Date Monday, October 26, 2009		Designer: Akros	
Rev 1.1		Sheet 3 of 4	

DC-DC Converter

IPSP6225-682ML



Title		Akros Silicon, Inc.	
AS1135 Isolated EVB w/ Sync Rect./FLY, +5V_60W		Akros Silicon, Inc. 275 Tenth Street Folsom, CA 95630	
Size		794 (976) 384-8700	
Document Number		Rev 1.1	
AS1135-EV-SYNC-FLY_60W		Tel: (976) 384-8700	
Date: Monday, October 26, 2009		Fax: (976) 384-8702	
Designer: Akros		Sheet 4 of 4	

Bill of Material

AS1135 Isolated EVB w/ Sync Rect./ FLY, +5V_60W Revision: 1.1									
Item	Ref. Des.	Value	Tol%	Type	Rating	Tech.	Pkg.	Mfg. P/N	Qty
1	C3,C6	100nF	5	CERAMIC	16V	SMT	803	0603YC104JAT2A	2
2	C9	10uF	10	CERAMIC	10V	SMT	805	GRM21BR61A106KE19	1
3	C22	100pF	5	50V	50V	SMT	803	06035A101JAT2A	1
4	C2,C5	180nF	10	CERAMIC	10V	SMT	803	ECJ-1VB1A184K	2
5	C29,C30	4.7nF 2KV	10	CERAMIC	2000V	SMT	1812	1812GC472KAT1A	2
6	C13,C14,C18,C19	47uF, 16V	20	CERAMIC	16V	SMT	C1210	GRM32ER61C476ME15L	4
7	C25	2.2nF	10	CERAMIC	16V	SMT	C0805	ECJ-2VB1H882K	1
8	C28	0.47uF	10	CERAMIC	10V	SMT	C0805	LLA219R71A474MA01L	1
9	C31,C32,C33,C34,C35,C36,C37,C38	0.1uF	5	CERAMIC	25V	SMT	803	C0603C104J3RACTU	8
10	C12	1.0nF 100V	5	CERAMIC	100V	SMT	1206	06031C102KAT2A	1
11	C15,C16,C21	100uF, 100V	20	ELECTROLYTI C CAPACITOR	100V	SMT	CASEF	EEE-FK1C100P	3
12	C1,C4,C7	.1uF 100V	10	CERAMIC	100V	SMT	1206	ECJ-3YB2A104K	3
13	C17, C23	10uF, 16V	10	CERAMIC	16V	SMT	C0805	GRM21BR61C106KE15L	2
14	C20	33pF 50V	20	CERAMIC	50V	SMT	C0603	GRM188R71H330MA01D	1
15	C8,C10,C11	2.2uF 100V	20	CERAMIC	100V	SMT	1812	HMK432B7225KM-T	3
16	C28	2.2uF	10	CERAMIC	10V	SMT	C0803	GRM188R60J106M	1
17	C27	15nF	10	CERAMIC	16V	SMT	C0805	ECJ-2VB1H153K	1
18	D9,D10,D11,D12	CBRHDSH1- 100/DF02S		DIODE	1A 71V; 1A 200V	SMT	DF-S	CBRHDSH1-100, DF02S	4
19	D1,D2	DIODE SCHOTTKY 100V 3A SMB		DIODE	3A 100V	SMT	D13_SMB	S3B-13	2
20	D3	B1100		DIODE	100V 1.0A	SMT	SMA	BZT52C5V6-7-F	1
21	D6,D8	BAS16W-TP		DIODE	75V 200mA	SMT	SOD123	BAS16W-TP	2
22	D7	BZT5V1 .5W		DIODE	5.1V 500mW	SMT	SMA	BZT52C5V1-7-F	1
23	D4,D5	BZT52C16-7-F 16V .5W NL		DIODE	16V 500mW	SMT	BZT52C16-7-F	BZT52C16-7-F	2
24	LED1,LED2	LED-SMT-1206		Wire to Board, Screw	2.1V 15mA	SMT	LED-SMT-1206	ED555/2DS	2
25	J1	HEADER 2x1 .100x.100		HEADER		THT	REGULAR100x10 OHEADER2X1		1
26	L1	6.8uH 2.5A	10	INDUCTOR	2.5A	SMT	LP96225-682ML	LP96225-682ML	1
27	L2,L3,L4,L5,L6,L7,L8,L9	220 Ohm @ 100 Mhz		FERRITE CHIP	2A	SMT	803	BLM18EG221SN1D	8
28	Q1,Q2	DZT491DICT-ND							
29	Q4	Si7634DY		N-ch MOSFET	30V 40A 200V	SMT	PPK_SO8	Si7634BDP-T1-GE3	1
30	Q3	Si7172DP		N-Channel	25A 40V	SMT	PPK_SO8	Si7172DP	1
31	Q5	MMBT3906		PNP TRANSISTOR	200mA	SMT	MMBT3906	MMBT3906	1
32	R25	0.05	1	Metal Film	1W	SMT	R2512	RL3264R-R0582-F	1
33	R24	1K	1	Thick Film	1/10W	SMT	803	MCR03EZPFX1001	1
34	R26	8.87k 1%	1	Thick Film	1/10W	SMT	803	RC0603FR-078K87L	1
35	R28	2.94K 1%	1	Thick Film	1/10W	SMT	803	MCR03EZPFX2941	1
36	R29	825	1	Thick Film	1/10W	SMT	803	RC0603FR-07825RL	1
37	R4,R12	50	1	Thick Film	1/10W	SMT	803	RC0603FR-07050RL	2
38	R31,R35	2K	5	Thick Film	1/10W	SMT	803	MCR03EZPJ202	2
39	R34	1.4K	1	Thick Film	1/10W	SMT	803	MCR03EZPFX1401	1



AN026: High Power 60W PoE with Dual AS1135

40	R5,R13	26.7K 1%	1	Thick Film	1/10W	SMT	603	MCR03EZPFX2672	2
41	R32	6.19K 1%	1	Thick Film	1/10W	SMT	603	MCR03EZPFX6191	1
42	R18,R19,R21,R22,R37,R38,R39,R40, R41,R42	0	1	Thick Film	1/10W	SMT	603	RC0603FR-070RL	10
43	R2,R10	8.04K	1	Thick Film	1/4W	SMT	1206	ERJ-8ENF8041V	2
44	R3,R11	1	1	Metal Film	1W	SMT	R2512	RL3264R-R1082-F	2
45	R19,R21,R22	0	1	Thick Film	1/10W	SMT	603	RC0603FR-070RL	3
46	R30	3.32K	1	Thick Film	1/10W	SMT	603	MCR03EZPFX3321	1
47	R6,R14,R20,R45,C24	NL							5
48	R8,R16	4.02K	5	Thick Film	1/10W	SMT	603	MCR03EZPFX4021	2
49	R1,R9	53.6K 1%	1	Thick Film	1/10W	SMT	603	ERJ-3EKF5362V	2
50	R33	24.9K	1	Thick Film	1/10W	SMT	603	ERJ-3EKF2492V	1
51	R17,R36,R43,R44	10 K	1	Thick Film	1/10W	SMT	603	ERJ-3EKF102V	4
52	R7,R15	63.4K 1%	1	Thick Film	1/10W	SMT	603	ERJ-3EKF6342V	2
53	R23,R27	10	5	Metal Oxide Film	1/4W	SMT	R0805	ERJ-3EKF10R0V	2
54	RJ2,RJ4	95001-2881		JACK		THT	RJ45_8PIN	95001-2881	2
55	U3	FOD2712		IC	50mA 30V	SMT	8SOIC	FOD2712R1V	1
56	RJ1,RJ3	0838-1X1T-W7		MAGJACK			LINE_TXFR	0838-1X1T-W7	2
57	T3	EFD25 5V 60W					EFD20-12PIN- SMT	Halo:TGSP-P062EFD25LF	1
58	U1,U2	AS1135					20QFN	AS1135	2

Transformer Specification TGSP-P062EFD25LF

DIMENSIONS: Inch [mm]
 CO-PLANARITY: 0.006 [0.15]
 TOLERANCES: ±0.005 INCH IF NOT SPECIFIED

PART NO. : TGSP-P062EFD25LF

SMT 50W POWER TRANSFORMER (EFD25)
 DESIGNED FOR FLYBACK CONVERTER, 36-72V INPUT
 LEAD-FREE/RoHS COMPLIANT
 UL/EN60950 AND DEMKO RECOGNIZED
 OPERATING TEMPERATURE -40/+85°C

ELECTRICAL SPECIFICATIONS @ 25° C

TURNS RATIO
 N1:N2:N3:N4 1:0.25:0.2:0.25
 INDUCTANCE PRI 30μH ±10%
 (100KHz,0.1V,0Adc)
 LEAKAGE INDUCTANCE PRI 1μH max
 (100KHz,0.1V,short all other pins)
 DCR
 N1 65mΩ max
 N2 200mΩ max
 N3 6mΩ max
 N4 200mΩ max
 HI-POT (N1,N2 - N3,N4) 1500VAC/60s

PRI
 36-72V
 270KHz
 BIAS
 6.25V@0.02A

12 GATE DRIVE
 6.25V@0.02A
 SEC
 5V@10A

HALO/PBL	TITLE POWER TRANSFORMER		SIGNATURES		DATE	REV.	DESC.	DATE
	FOR 5V, 50W, AS1135		DRAWN PETER LU		10/15/09	A	FIRST ISSUE	10/15/09
	PART NO. TGSP-P062EFD25LF		CHECKED LEI KEONG		10/15/09			
	SCALE NONE PAGE 1 of 1		APPROVED PETER LU		10/15/09			
		FILE P062EFD25LF.DWG						



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