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EP525XHVM EVK User Guide

Power Application Controller™

Marc Sousa

Director, PAC Systems and Applications



www.active-semi.com

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1 OVERVIEW

Active-Semi's family of Power Application Controllers contains devices that can be used for high-voltage motor control applications. The PAC5250 and PAC5253 each have their own Evaluation Kit (EVK) that can be used for evaluation and characterization of AC or DC BLDC and PMSM motors.

These EVKs have been developed for 3-phase BLDC and PMSM motors, but other topologies and drive types are also possible. These EVKs can take their input from a high-voltage DC supply, or from an AC source. Each EVK has a flyback DC-DC converter that is controlled by the PAC525X device on-board to generate the power supply for the IC as well as for the gate drive for the inverter stage.

These EVKs support either one, two or three current-shunt configurations and can be used with either BEMF or FOC control algorithms just by changing firmware.

Each EVK has a programming interface for updating the PAC525X firmware, as well as a UART connector for host communication from a GUI or other host MCU.

CAUTION!!!

Dangerously high voltages exposed and may lead to injury.

This unit should only be handled by qualified individuals.

2 SYSTEM DESCRIPTION

The following diagrams show a picture of the EVKs for the PAC5250 and PAC5253 and the major connectors and sub-systems.

2.1 Solution Benefits

- Quick Prototyping of PMSM or BLDC High-Voltage Motor Control applications
- Ideal for most high-voltage motor driving applications
- Both BEMF and FOC control may be used by firmware change
- Integrated DC/DC Flyback Controller
- Integrated Differential Amplifiers
- Integrated Ultra High-Voltage Gate Drivers (up to 600V)
- SWD header for firmware programming of PAC525X
- UART header for GUI control and configuration of PAC525X
- Uplink Expansion header for connecting to other processor subsystems like a host MCU, or possibly a wireless uplink card
- Schematics, BOM and Layout drawings available
- Firmware and PAC52XX SDK available

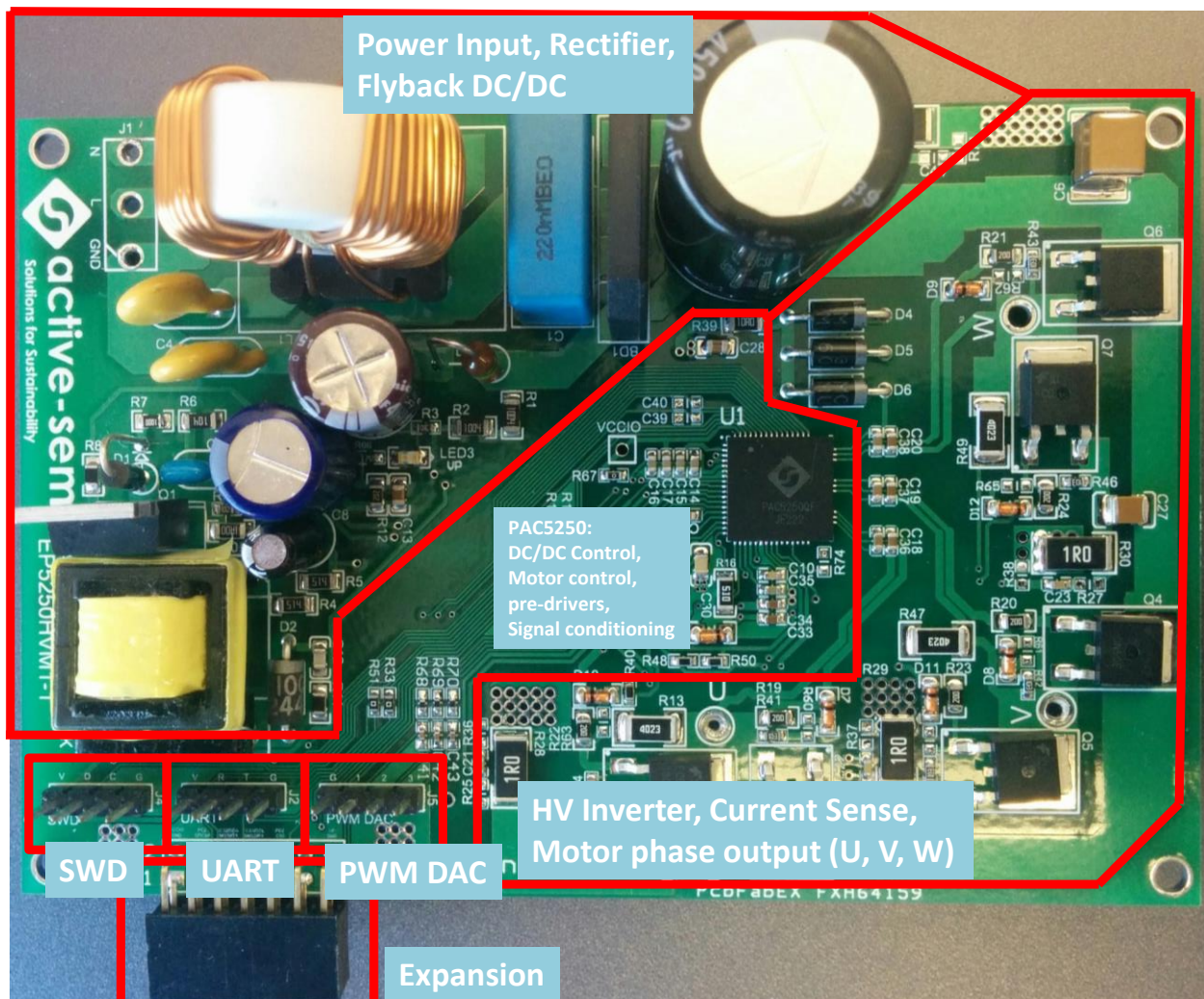
3 GETTING STARTED

The EP525XHVM EVK comes with connectors for the three phase motor, as well as DC input voltage connector.

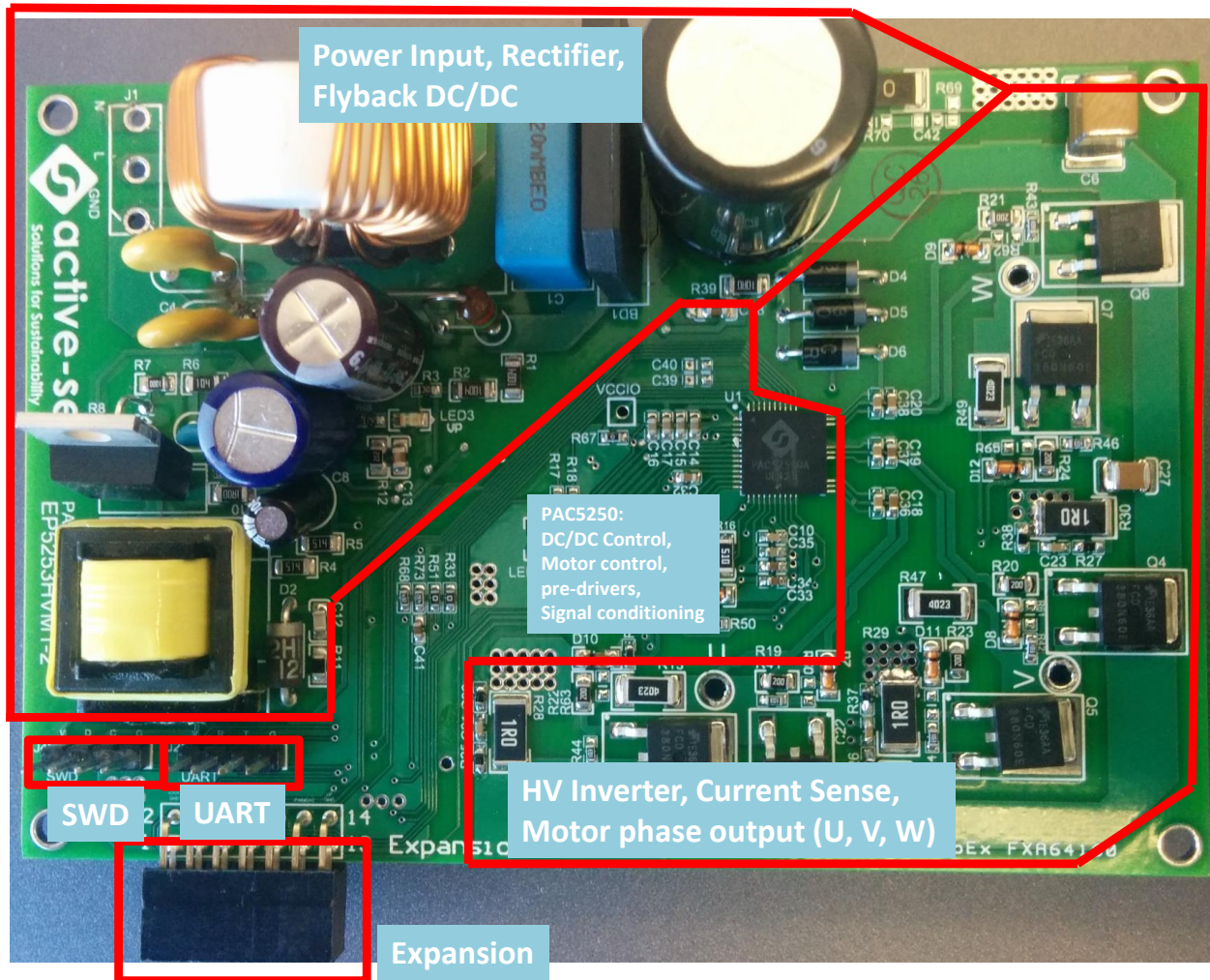
The PAC525X EVK works with the following Active-Semi EVKs:

- ET-COLINK-1: An isolated USB to SWD adapter for programming and debugging of the PAC525X IC on the EVK. This includes the USB and serial ribbon cable used to interface to the EP525XHVM EVK.
- ET-UARTISO-1: An isolated USB to UART adapter for communication between the user PC for GUI configuration and control of the EVK. This includes the USB and serial ribbon cable used to interface to the EP525XHVM EVK.

3.1 PAC5250 EVK (EP5250HVM)



3.2 PAC5253 EVK (EP5253HVM)



4 HARDWARE OVERVIEW

4.1 Motor Drive Configurations

The EP525XHVM EVK can be used to drive a wide variety of high-voltage motors. It is capable of driving a motor in either of the following configurations:

- Three-shunt FOC, for high-speed FOC applications. This is the default configuration.
- Two-shunt FOC plus one motor-current shunt FOC applications.
- Single-shunt for motor current for single-shunt FOC and BEMF applications.

To reconfigure the EVK for two-shunt plus one motor current shunt, move the current sense resistor from R30 (phase W current) to R72 (motor current) and populate R71, R73 and C44 with the correct value components for the motor current sense circuit. R30 should be populated with a 0 ohm resistor.

To reconfigure the EVK for a single-shunt, the user should populate the current sense resistor for the motor current (R72) as well as the rest of the passive components for the motor current (R71, R73 and C44). Then the user should replace the three motor phase current sense resistors (R28, R29, R30) with zero-ohm resistors. The user should also remove the three motor phase current sense circuit passive components (R25, R36, C21, R26, R37, C22, R27, R38 and C23).

4.2 Hardware Feature Overview

Some of the key features of the EP525XHVM are:

- IGBT inverter stage paired with the PAC525X integrated gate drivers reduces BOM cost by eliminating the need for an expensive IPM.
- PAC5250 integrated power controller is used to drive a flyback converter.
- Current measurement for over-current protection is done via the shunt resistor network (one, two or three current-shunt). Current measurement is used for both control in FOC and protection in FOC/BEMF applications.
- ADC is used to measure DC bus voltage to adjust the driver duty cycles
- UART capability allows users to interface with the IC via a Windows GUI. The UART module is isolated from the AC line voltage.
- SWD programming port for programming the flash memory. The SWD programming module is isolated from the AC line voltage.
- Input voltage range: 110-240VAC
- Recommend 1A max per phase. This is limited by the current sense resistor installed on the board. Sense resistor values can be changed if a higher current is desired.

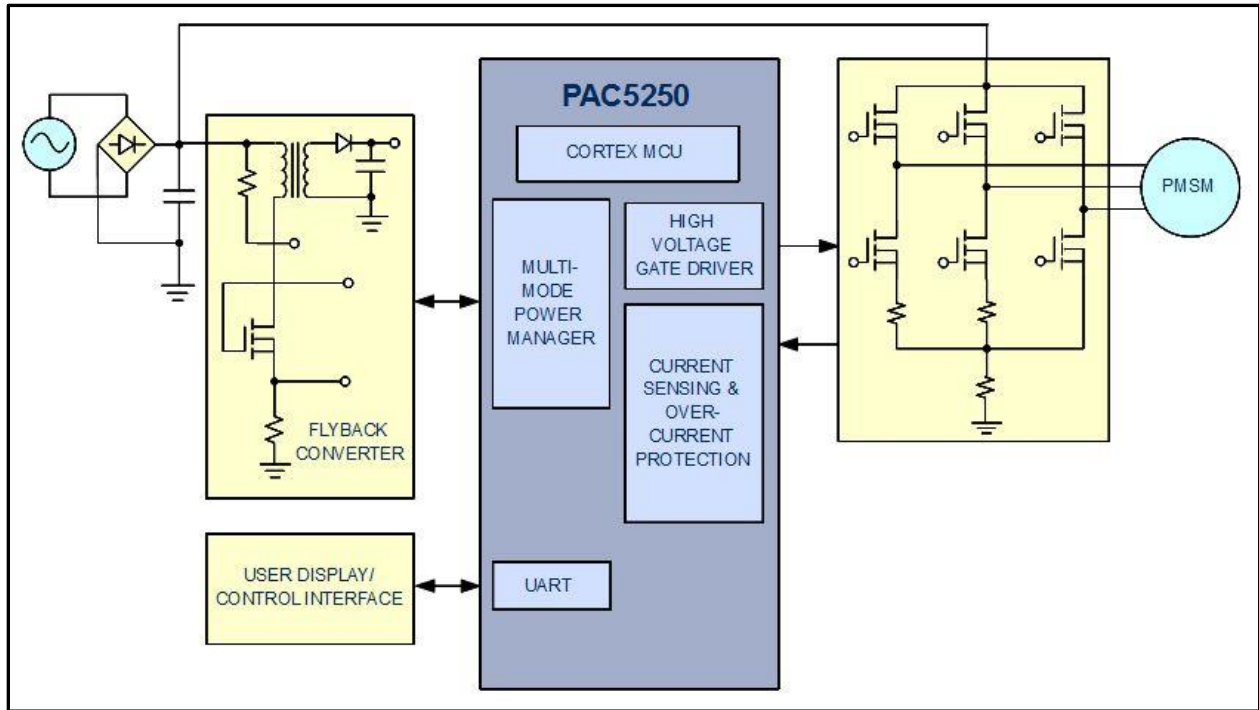


Figure 1: FOC Application Diagram

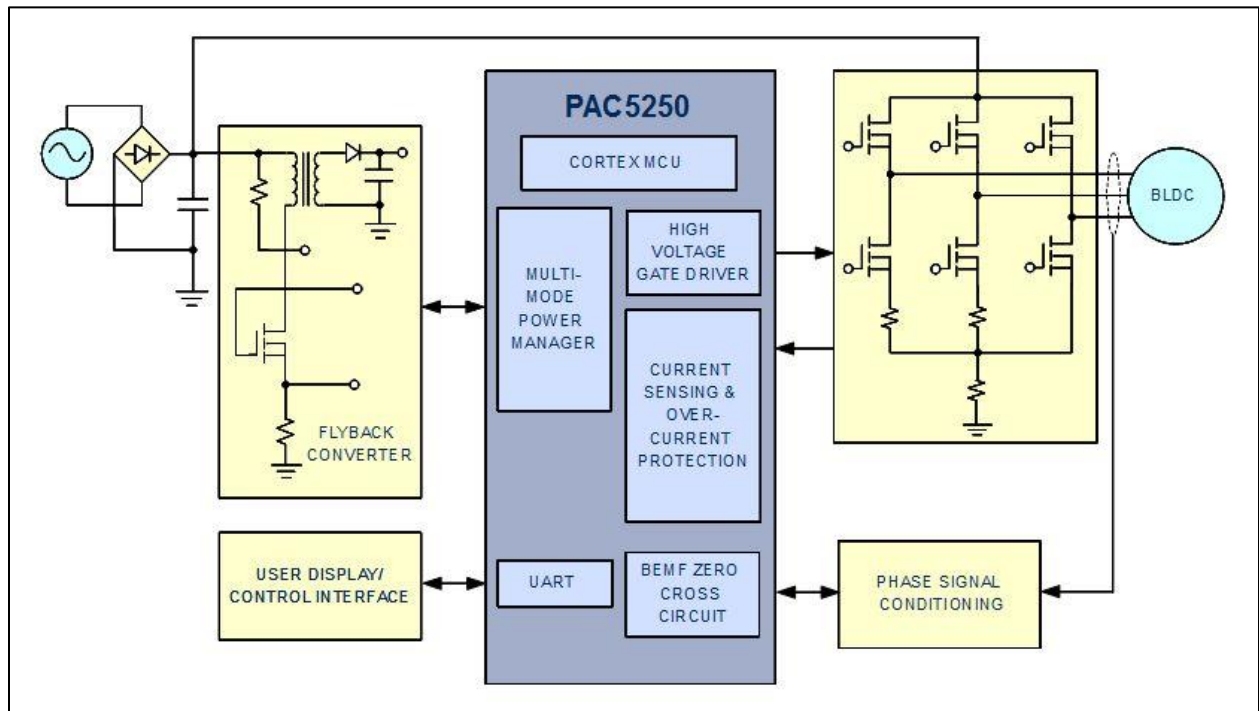


Figure 2: Sensor-less BEMF Application Diagram

4.3 Setting up the Hardware

To connect the evaluation unit, please refer to in Figure 3 and Figure 4 below while following the following steps:

- 1) Connect the UART isolation module to a USB port in the computer. Please take care to connect with the correct polarity as shown in Figure 3.
- 2) Connect the SWD programmer/debugger to a USB port in the computer. This is only necessary if it is necessary to flash a new firmware into the evaluation board. The evaluation board should already be pre-loaded with the necessary firmware. Please take care to connect with the correct polarity as shown in Figure 3.
- 3) Connect the motor to the motor output connector as shown in Figure 4.
- 4) Connect a power source to the input power port. The supply can be 110VAC-220VAC. If desired, a DC voltage ranging 150VDC-400VDC may also be supplied through this port.
- 5) Proceed to set up the GUI interface and GUI user guide that were supplied by Active-Semi.

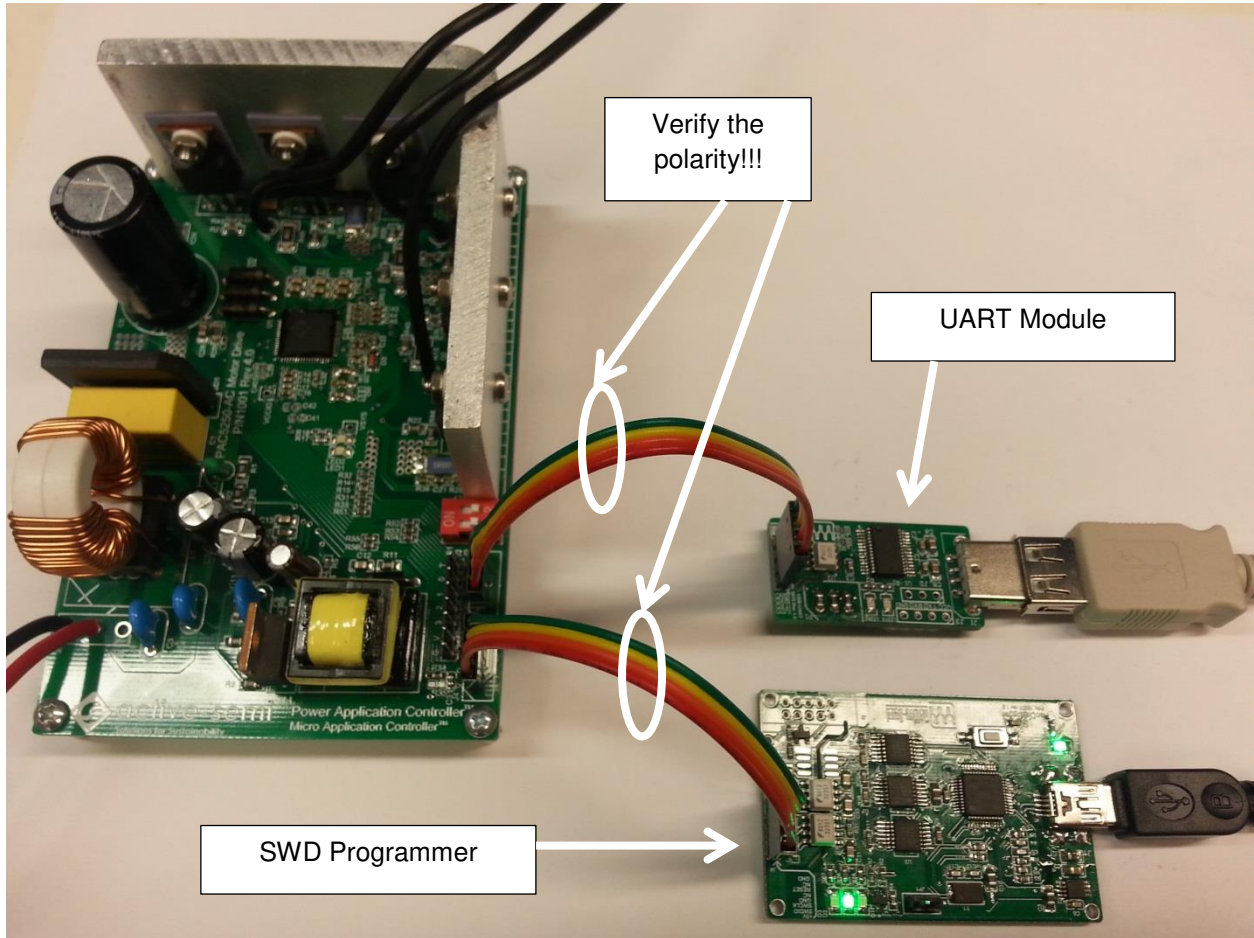


Figure 3: SWD Programmer and UART Module Connection

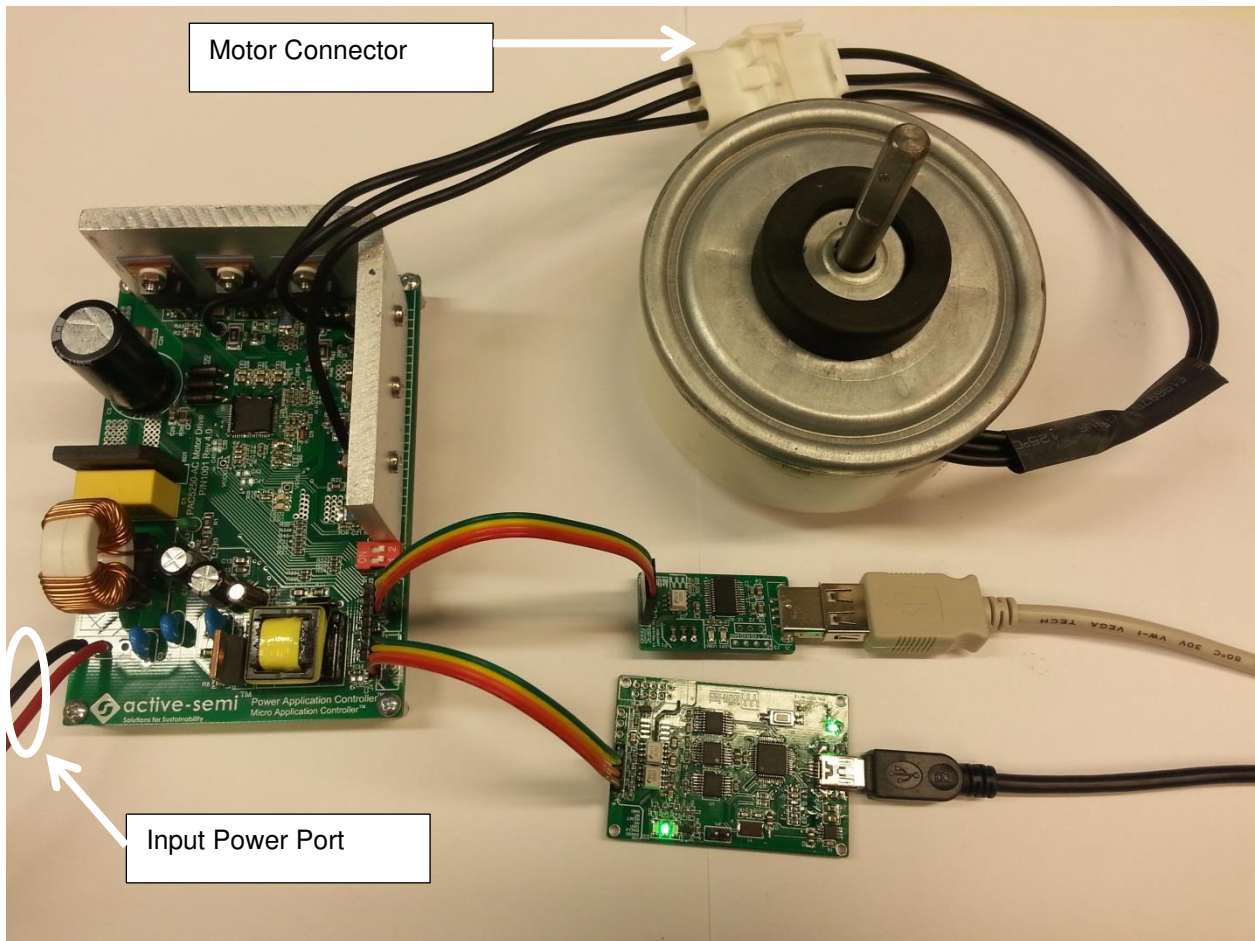


Figure 4: Motor and Input Power Connection

5 EVK RESOURCES

5.1 SWD Header (J4)

The SWD Header is used for updating the firmware in the PAC525X device. Users should connect the isolated CoLinkEx adapter to this header from the PC to update the firmware.

See the documentation for the IDE for more information on how to download code to the device.

The table below shows the pinout of this connector.

Pin	Name	Description
1	VCCIO	SWD Power Supply connected to VCCIO (+5V) generated from PAC525X
2	SWDD	SWD Bi-directional Data
3	SWDC	SWD Clock
4	GND	Ground

5.2 UART Header (J2)

The UART Header is used to connect to the USB to UART interface board, for communications with a Windows GUI. The GUI can be used to configure and monitor the operation of the motor from a Windows PC.

The table below shows the pinout of this connector.

Pin	Name	Description
1	VCCIO	SWD Power Supply connected to VCCIO (+5V) generated from PAC525X
2	UARTRX	PAC525X UART Receive
3	UARTTX	PAC525X UART Transmit
4	GND	Ground

5.3 PWM DAC (J5)

The PWM DAC Header is used to output a filtered analog output that can be used for debugging or motor tuning of the application. The PAC525X device outputs a PWM signal that is connected to a RC Filter on the EVK, and the filtered output is connected to these pins for the user to observe.

Because of the reduced pin count on the PAC5253, this header is not available on the PAC5253.

The table below shows the pinout of this connector.

Pin	Name	Description
1	GND	Ground
2	DAC1	PWM DAC output 1
3	DAC2	PWM DAC output 2
4	DAC3	PWM DAC output 3

5.4 Expansion Header (P1)

The Expansion Header may be used to connect to another processing board that may contain a host MCU or a wireless uplink.

The table below shows the pinout of this connector.

	PAC5250	PAC5253
1	Ground	
2	NC	VSYS
3	PE0/SPICLK	
4	PC2	
5	PE1/SPIMOSI/UARTRX	
6	PE5/SPICS2/I2CSDA	
7	PE2/SPIMISO/UARTRX	
8	PE4/SPICS1/I2CSCL	
9	PE3/SPICS0	
10	PD2	
11	PD3	PWMDAC
12	PC3	NC
13	Ground	
14	VP	

5.5 Power Input Connector (J1)

The EP525XHVM EVK can be supplied by a high-voltage DC supply (up to 330V) or AC input. The EVK has a rectifier as well as a Flyback converter controlled by the PAC525X controller. The High-voltage rectified DC input to the flyback converter is converted into a 12V output (VP) that is used to supply the IC as well as power the gate drive outputs from the PAC525X.

The EVK has an unpopulated connector for Neutral, Line and Ground AC inputs. For a DC supply, the power supply positive terminal can be connected to line and the return may be connected to neutral.

5.6 Inverter

The inverter stage contains 6 600V, 10A FETs for high-voltage motor drive applications. These are driven directly from the PAC525X device, which has integrated high and low-side gate drivers.

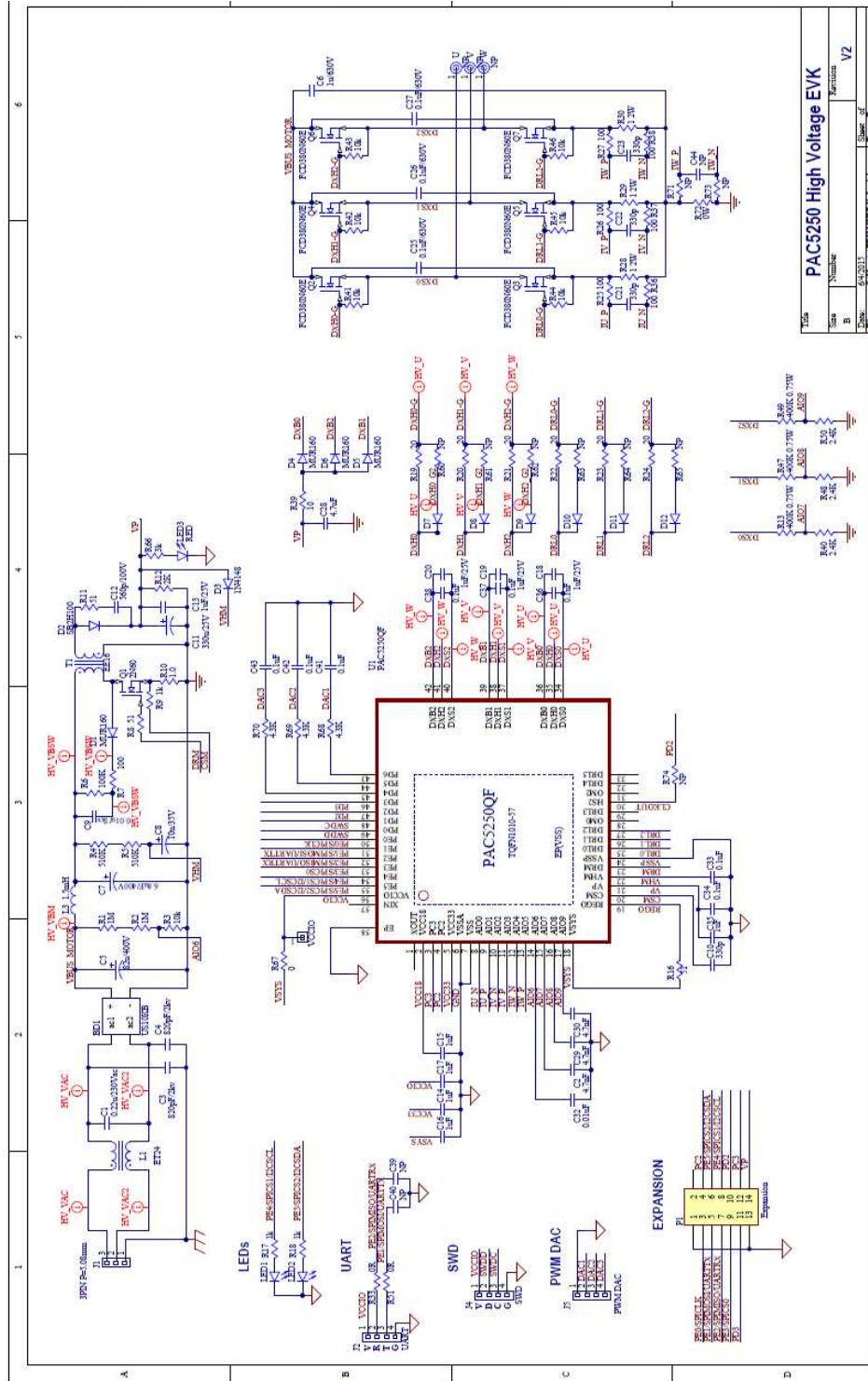
Each of the motor phases are also connected to a voltage divider so they may be sampled directly from the PAC525X device, for applications that need to measure the BEMF voltage for different control techniques.

In addition, the EVK supports one, two or three current sense resistors for the control applications. The default hardware configuration is for three current sense resistors, which are required for high-speed FOC control applications, that require accurate current readings.

For lower speed FOC applications, or for BEMF control applications that user may re-arrange the current sense resistors to remove the V-phase current sense resistor and add one for the total motor current that may be sampled instead.

6 PAC5250 DESIGN

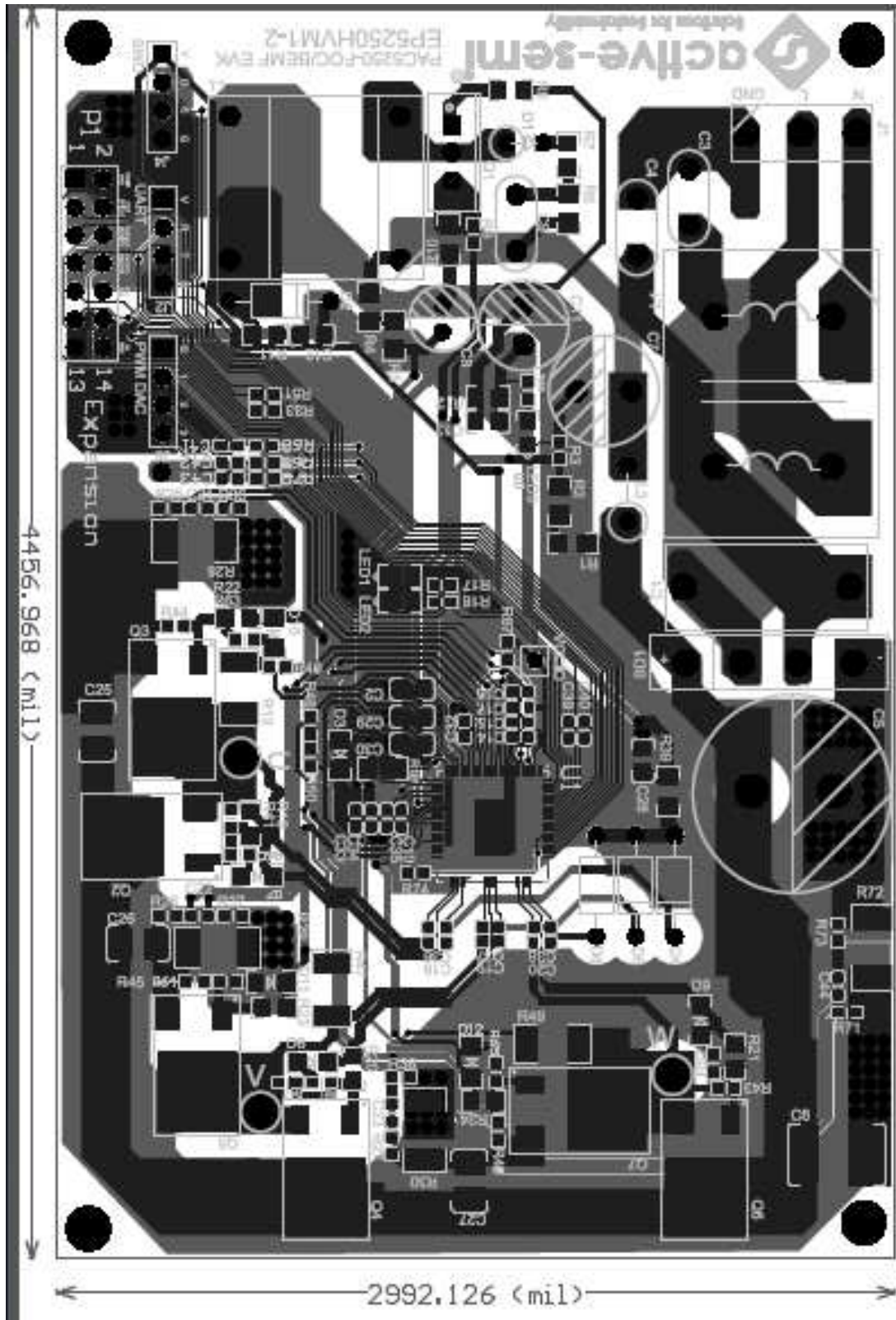
6.1 Schematic



6.2 Bill of Materials

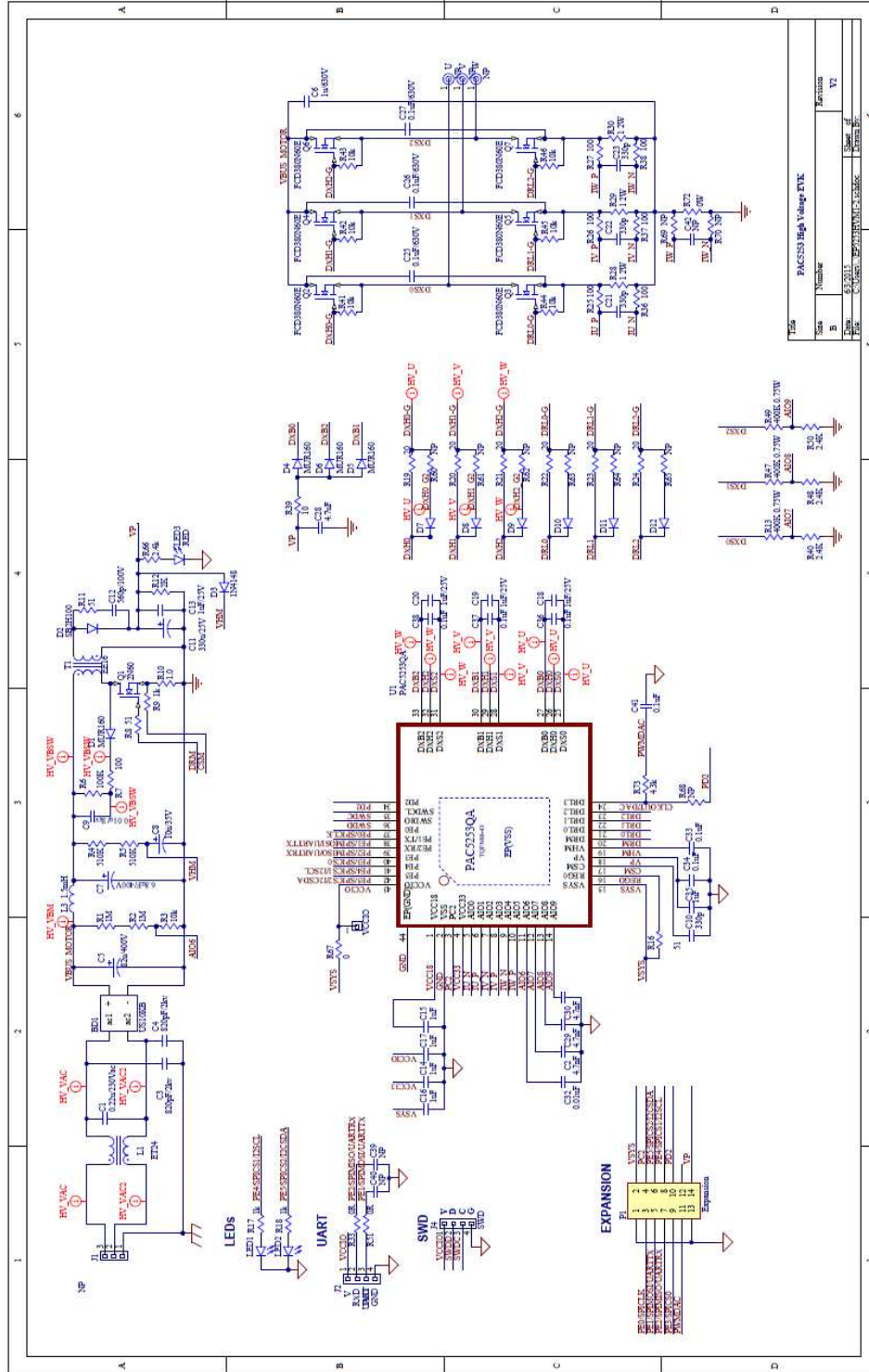
Designator	Quantity	Value	Desc	Vendor	Vendor PN	Manufacturer	Manufact PN
BD1	1	N/A	RECT BRIDGE GPP 10A 1000V GBU	Digikey	GBU1010	Didoes	GBU1010
C1	1	0.22uF	CAP FILM 0.22UF 760VDC RADIAL	Digikey	399-5427	Kemet	PHE840MX6220M806R17
C10, C21, C22, C23	4	330pF	CAP CER 330PF 50V 10% X7R 0603	Digikey	311-1186	Yageo	CC0603KRX7R98B331
C11	1	330uF	CAP ALUM 330UF 50V 20% RADIAL	Digikey	P5184-ND	Panasonic	ECA-1HM331
C12	1	560pF	CAP CER 560PF 100V 5% NP0 0805	Digikey	490-1612	Murata	GRM2165C2A561JA01D
C13	1	1uF	CAP CER 1UF 50V 10% JB 0805	Digikey	445-1149	TDK	C2012JB1H105K085AB
C14, C15, C16, C17, C35	5	1uF	CAP CER 1UF 25V 10% X5R 0603	Digikey	311-1445	Yageo	CC0603KRX5R88B105
C18, C19, C20	3	1uF	CAP CER 1UF 50V 10% X5R 0603	Digikey	445-7468	TDK	C1608X5R1H105K080AB
C2, C29, C30	3	4.7nF	CAP CER 4700PF 50V 10% X7R 0805	Digikey	311-1133	Yageo	CC0805KRX7R98B472
C25, C26, C27	3	0.1uF	CAP CER 0.1UF 630V 20% X7T 1210	Digikey	445-1494	TDK	C3225X7T2J104M160AC
C28	1	4.7uF	CAP CER 4.7UF 25V 10% X5R 0805	Digikey	445-4116	TDK	C2012X5R1E475K125AB
C3	1	820pF	CAP CER 820PF 2KV 10% RADIAL	Digikey	P4485A-N	Panasonic	ECK-D3D821KBP
C32	1	0.01uF	CAP CER 10000PF 50V 10% X7R 0603	Digikey	445-1311	TDK	C1608X7R1H103K080AA
C33, C34	2	0.1uF	CAP CER 0.1UF 50V Y5V 0603	Digikey	311-1343	Yageo	CC0603ZR5V98B104
C36, C37, C38	3	0.1uF	CAP CER 0.1UF 50V 10% X5R 0603	Digikey	445-7456	Yageo	C1608X5R1H104K080AA
C4	1	820pF	CAP CER 820PF 2KV 10% RADIAL	Digikey	CK45-B3D	TDK	CK45-B3DD821KYNR
C41, C42, C43	3	0.1uF	CAP CER 0.1UF 50V Y5V 0402	Digikey	445-5942	TDK	C1005X5R1H104K050BB
C5	1	82u	CAP ALUM 82UF 450V 20% RADIAL	Digikey	1189-139	Rubycon	450TXW82MEFC18X30
C6	1	1uF	CAP CER 1UF 630V 20% X7T SMD	Digikey	445-7110	TDK Corporation	CKG57NX7T2J105M500JH
C7	1	6.8uF	CAP ALUM 6.8UF 450V 20% RADIAL	Digikey	493-7386	Nichicon	UCS2W6R8MPD1TD
C8	1	10u	CAP ALUM 10UF 50V 20% RADIAL	Digikey	P5567-ND	Panasonic	ECA-1HHG100
C9	1	0.01uF	CAP CER 10000PF 1KV 10% RADIAL	Digi-Key	399-9793	Kemet	C322C103KDR5TA
D1, D4, D5, D6	4	N/A	DIODE SUPER FAST 600V 1A DO41	Digikey	MUR160-	Micro Commercial	MUR160-TP
D2	1	N/A	Schottky Diodes & Rectifiers Low VF ESD 2A 100V	Digikey	SB2H100-	Vishay	SB2H100-E3/73
J2, J4, J5	3	N/A	CONN HEADER 4POS .100 STR TIN	Digikey	609-3305	FCI	68002-404HLF
L1	1	N/A	Inductor 5A 30mH(Customized)	Active-Semi	Provided	N/A	ET24
L3	1	1.5mH	CHOKE RF 1500UH 100MA AXIAL	Digikey	495-5553	Epcos	B78108S1155J
LED1, LED2, LED3	3	Red	LED RED CLEAR 0805 SMD	Digikey	160-1176	Lite-On	LTST-C170CKT
P1	1	7x2 HDR F	7x2 HDR Female	Digi-Key	S5560-ND	Sullins	PPPC072LJBN-RC
Q1	1	N/A	MOSFET N-CH 600V 2A TO-220	Digikey	FQP2N60	Fairchild	FQP2N60C
Q2, Q3, Q4, Q5, Q6, Q7	6	N/A	N-CH 600V 10.2A 380mO	Digikey	FCD380N	Fairchild	FCD380N60E
R1, R2	2	1M (1%)	RES 1.00M OHM 1/4W 1% 1206 SMD	Digikey	311-1.00M	Yageo	RC1206FR-071ML
R10	1	1.0 (1%)	RES 1 OHM 1/2W 1% 1206	Digikey	A109669C	TE Connectivity	RLP73K2B1R0FTDF
R12	1	2K	RES 2K OHM 1/8W 5% 0805	Digikey	RMCF080	Stackpole	RMCF0805J2K00
R13, R47, R49	3	402K (1%)	RES 402K OHM 3/4W 1% 2010 SMD	Digikey	P402KACC	Panasonic	ERJ-12SF4023U
R16	1	51	RES 51 OHM 2/3W 5% 1206 SMD	Digikey	P51ALCT-N	Panasonic	ERJ-P08J510V
R19, R20, R21, R22, R23, R24	6	20	RES 20 OHM 1/8W 5% 0805 SMD	Digikey	311-20AR	Yageo	RC0805JR-0720RL
R25, R26, R27, R36, R37, R38	6	RES 100 O	RES 100 OHM 1/10W 5% 0603 SMD	0603R	311-100G	Yageo	RC0603JR-07100RL
R28, R29, R30	3	1	RES 1 OHM 2W 5% 2512 SMD	Digikey	CRM2512	Bourns	CRM2512-JW-1R0ELF
R3	1	10k (1%)	RES 10.0K OHM 1/10W 1% 0603 SMD	Digikey	311-10.0K	Yageo	RC0603FR-0710KL
R33, R51	2	0R	RES 0.0 OHM 1/10W JUMP 0603 SMD	Digikey	311-0.0G	Yageo	RC0603JR-070RL
R39	1	10	RES 10.0 OHM 1/4W 1% 1206 SMD	Digikey	311-10.0F	Yageo	RC1206FR-0710RL
R4, R5	2	510K	RES 510K OHM 1/4W 5% 1206 SMD	Digikey	311-510K	Yageo	RC1206JR-07510KL
R40, R48, R50	3	2.4K (1%)	RES SMD 2.4K OHM 1% 1/10W 0603	Digikey	P2.40KHC	Panasonic	ERJ-3KEF2401V
R41, R42, R43, R44, R45, R46	6	10k	RES 10K OHM 1/10W 5% 0603 SMD	Digikey	311-10KG	Yageo	RC0603JR-0710KL
R6	1	100K	RES 100K OHM 1/4W 5% 1206 SMD	Digikey	311-100K	Yageo	RC1206JR-07100KL
R66	1	3k	RES 2.4K OHM 1/10W 5% 0603 SMD	Digikey	311-2.4KG	Yageo	RC0603JR-072K4L
R67	1	0	RES SMD 0.0 OHM JUMPER 1/10W	Digikey	P0.0GCT-N	Panasonic	ERJ-3GEY0R00V
R68, R69, R70	3	4.3K	RES 4.3K OHM 1/10W 5% 0402 SMD	Digikey	P4.3KJCT-N	Panasonic	ERJ-2GEJ432X
R7	1	100	RES 100 OHM 1/8W 1% 0805 SMD	Digikey	311-100C	Yageo	RC0805FR-07100RL
R72	1	0ohm	RES 0.0 OHM 2512	Digi-key	CR2512-J	Bourns	Bourns
R8, R11	2	51	RES 51 OHM 1/8W 5% 0805 SMD	Digikey	311-51AR	Yageo	RC0805JR-0751RL
R9, R17, R18	3	1k	RES 1.0K OHM 1/10W 5% 0603 SMD	Digikey	311-1.0KG	Yageo	RC0603JR-071KL
T1	1	N/A	EE16 transformer(Customized)	Active-Semi	Provided	N/A	EE16
U1	1	PAC5250	PAC5250QF	Digikey	PAC5250C	Active-Semi	PAC5250QF
D3, D7, D8, D9, D10, D11, D12	1	N/A, NC, N	DIODE SMALL SIG 100V 0.2A SOD80	Digikey	LL4148FS	Fairchild	LL4148
C39, C40, C44, J1, R60, R61, R62, R6	4		NP				

6.3 Layout



7 PAC5253 DESIGN

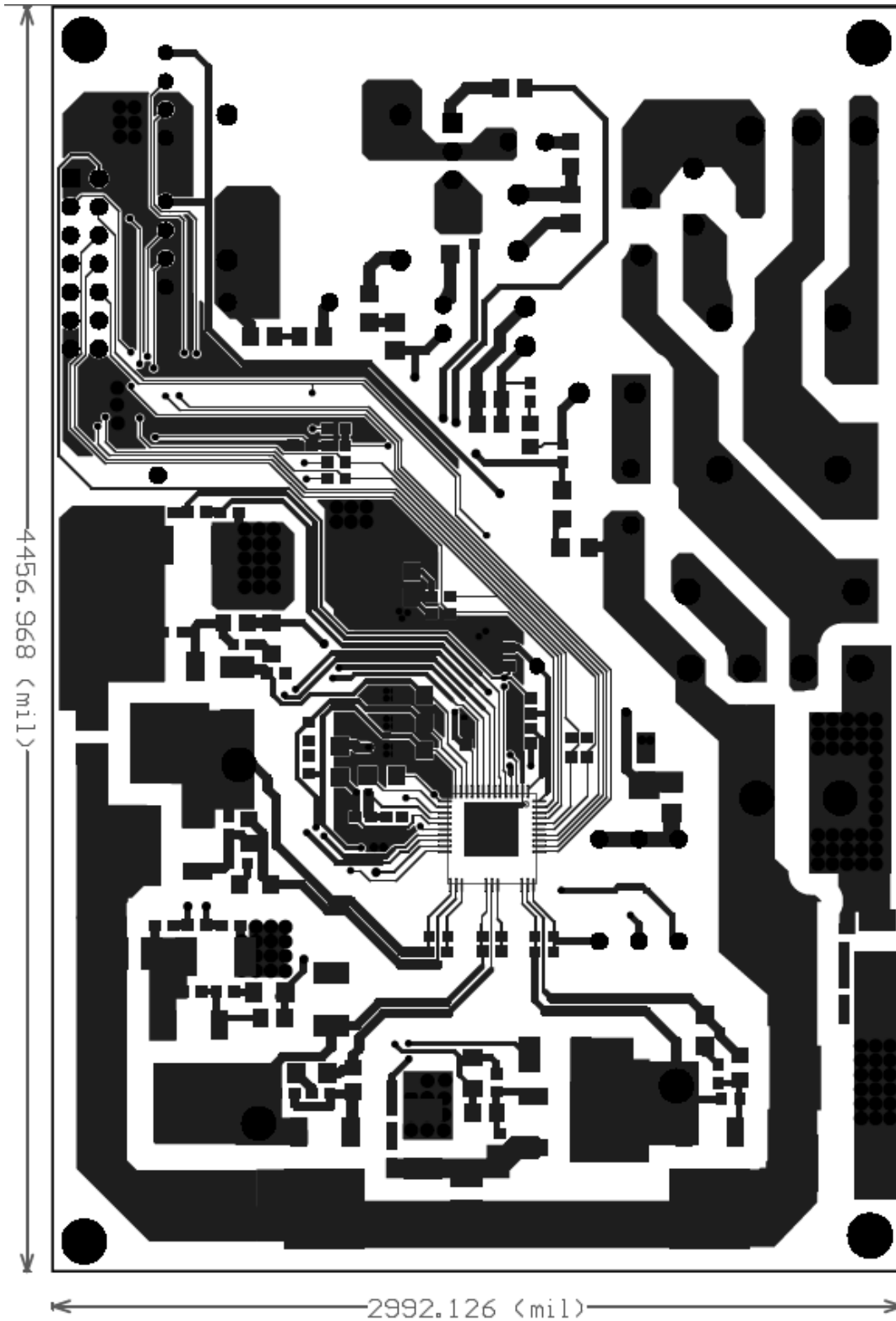
7.1 Schematic



7.2 BOM

Designator	Quantity	Value	Desc	Vendor	Vendor PN	Manufacturer	Manufact PN
BD1	1	N/A	RECT BRIDGE GPP 10A 1000V GBU	Digikey	GBU1010DI-ND	Didoes	GBU1010
C1	1	0.22uF	CAP FILM 0.22UF 760VDC RADIAL	Digikey	399-5427-ND	Kemet	PHE840MX6220MB06R17
C10, C21, C22, C23	4	330pF	CAP CER 330PF 50V 10% X7R 0603	Digikey	311-1186-1-ND	Yageo	CC0603KRX7R9BB331
C11	1	330uF	CAP ALUM 330UF 50V 20% RADIAL	Digikey	P5184-ND	Panasonic	ECA-1HM331
C12	1	560pF	CAP CER 560PF 100V 5% NPO 0805	Digikey	490-1612-1-ND	Murata	GRM2165C2A561JA01D
C13	1	1uF	CAP CER 1UF 50V 10% J8 0805	Digikey	445-11490-1-ND	TDK	C2012JB1H105K085AB
C14, C15, C16, C17, C35	5	1uF	CAP CER 1UF 25V 10% X5R 0603	Digikey	311-1445-1-ND	Yageo	CC0603KRX5R8BB105
C18, C19, C20	3	1uF	CAP CER 1UF 50V 10% X5R 0603	Digikey	445-7468-1-ND	TDK	C1608X5R1H105K080AB
C2, C29, C30	3	4.7nF	CAP CER 4700PF 50V 10% X7R 0805	Digikey	311-1133-1-ND	Yageo	CC0805KRX7R9BB472
C25, C26, C27	3	0.1uF	CAP CER 0.1UF 630V 20% X7T 1210	Digikey	445-14941-1-ND	TDK	C3225X7T2J104M160AC
C28	1	4.7uF	CAP CER 4.7UF 25V 10% X5R 0805	Digikey	445-4116-1-ND	TDK	C2012X5R1E475K125AB
C3	1	820pF	CAP CER 820PF 2KV 10% RADIAL	Digikey	P4485A-ND	Panasonic	ECK-D3D821KBP
C32	1	0.01uF	CAP CER 10000PF 50V 10% X7R 0603	Digikey	445-1311-1-ND	TDK	C1608X7R1H103K080AA
C33, C34, C41	3	0.1uF	CAP CER 0.1UF 50V Y5V 0603	Digikey	311-1343-1-ND	Yageo	CC0603ZRYSV9BB104
C36, C37, C38	3	0.1uF	CAP CER 0.1UF 50V 10% X5R 0603	Digikey	445-7456-1-ND	Yageo	C1608X5R1H104K080AA
C39, C40, C42, J1, R60, R61, R62, R63	16		NP				
C4	1	820pF	CAP CER 820PF 2KV 10% RADIAL	Digikey	CK45-B3DD821KYNR-ND	TDK	CK45-B3DD821KYNR
C5	1	82u	CAP ALUM 82UF 450V 20% RADIAL	Digikey	1189-1391-ND	Rubycon	450TXW82MEFC18X30
C6	1	1uF	CAP CER 1UF 630V 20% X7T SMD	Digikey	445-7110-1-ND	TDK Corporation	CKG57NX7T2J105M500JH
C7	1	6.8uF	CAP ALUM 6.8UF 450V 20% RADIAL	Digikey	493-7386-1-ND	Nichicon	UCS2W6R8MPD1TD
C8	1	10u	CAP ALUM 10UF 50V 20% RADIAL	Digikey	P5567-ND	Panasonic	ECA-1HHG100
C9	1	0.01uF	CAP CER 10000PF 1KV 10% RADIAL	Digikey	399-9793-ND	Kemet	C322C103KDR5TA
D1, D4, D5, D6	4	N/A	DIODE SUPER FAST 600V 1A DO41	Digikey	MUR160-TPMSTR-ND	Micro Commercial	MUR160-TP
D2	1	N/A	Schottky Diodes & Rectifiers Low VF ESC	Digikey	S82H100-E3/73GICT-ND	Comchip	S82H100-E3/73
D3, D7, D8, D9, D10, D11, D12	7		NP	Digikey	LL4148FSCT-ND	Fairchild	LL4148
J2, J4	2	N/A	CONN HEADER 4POS .100 STR TIN	Digikey	609-3305-ND	FCI	68002-404HLF
L1	1	N/A	Inductor 5A 30mH(Customized)	Active-Semi	Provided by Active	N/A	ET24
L3	1	1.5mH	CHOKERF 1500UH 100MA AXIAL	Digikey	495-5553-1-ND	Epcos	B78108S1155J
LED1, LED2, LED3	3	Red	LED RED CLEAR 0805 SMD	Digikey	160-1176-1-ND	Lite-On	LTST-C170CKT
P1	1	7x2 HDR Female	7x2 HDR Female	Digi-Key	S5560-ND	Sullins	PPPC072LJBN-RC
Q1	1	N/A	MOSFET N-CH 600V 2A TO-220	Digikey	FQP2N60CFS-ND	Fairchild	FQP2N60C
Q2, Q3, Q4, Q5, Q6, Q7	6	N/A	N-CH 600V 10.2A 380mO	Digikey	FCD380N60ECT-ND	Fairchild	FCD380N60E
R1, R2	2	1M (1%)	RES 1.00M OHM 1/4W 1% 1206 SMD	Digikey	311-1.00FRCT-ND	Yageo	RC1206FR-071ML
R10	1	1.0 (1%)	RES 1 OHM 1/2W 1% 1206	Digikey	A109669CT-ND	TE Connectivity	RLP73K2B1R0FTDF
R12	1	2K	RES 2K OHM 1/8W 5% 0805	Digikey	RMCF0805JT2K00CT-ND	Stackpole	RMCF0805JT2K00
R13, R47, R49	3	402K (1%)	RES 402K OHM 3/4W 1% 2010 SMD	Digikey	P402KACCT-ND	Panasonic	ERJ-12SF4023U
R16	1	51	RES 51 OHM 2/3W 5% 1206 SMD	Digikey	P51ALCT-ND	Panasonic	ERJ-P08J510V
R19, R20, R21, R22, R23, R24	6	20	RES 20 OHM 1/8W 5% 0805 SMD	Digikey	311-20ARCT-ND	Yageo	RC0805JR-0720RL
R25, R26, R27, R36, R37, R38	6	100	RES 100 OHM 1/10W 5% 0603 SMD	Digikey	311-100GRCT-ND	Yageo	RC0603JR-07100RL
R28, R29, R30	3	1	RES 1 OHM 2W 5% 2512 SMD	Digikey	CRM2512-JW-1R0ELFCT-ND	Bourns	CRM2512-JW-1R0ELF
R3	1	10k (1%)	RES 10.0K OHM 1/10W 1% 0603 SMD	Digikey	311-10.0KHRCT-ND	Yageo	RC0603FR-0710KL
R33, R51	2	0R	RES 0.0 OHM 1/10W JUMP 0603 SMD	Digikey	311-0.0GRCT-ND	Yageo	RC0603JR-070RL
R39	1	10	RES 10.0 OHM 1/4W 1% 1206 SMD	Digikey	311-10.0FRCT-ND	Yageo	RC1206FR-0710RL
R4, R5	2	510K	RES 510K OHM 1/4W 5% 1206 SMD	Digikey	311-510KERCT-ND	Yageo	RC1206JR-07510KL
R40, R48, R50	3	2.4K (1%)	RES SMD 2.4K OHM 1% 1/10W 0603	Digikey	P2.40KHCT-ND	Panasonic	ERJ-3EKF2401V
R41, R42, R43, R44, R45, R46	6	10k	RES 10K OHM 1/10W 5% 0603 SMD	Digikey	311-10KGRCT-ND	Yageo	RC0603JR-0710KL
R6	1	100K	RES 100K OHM 1/4W 5% 1206 SMD	Digikey	311-100KERCT-ND	Yageo	RC1206JR-07100KL
R66	1	2.4k	RES 2.4K OHM 1/10W 5% 0603 SMD	Digikey	311-2.4KGRCT-ND	Yageo	RC0603JR-072K4L
R67	1	0	RES SMD 0.0 OHM JUMPER 1/10W	Digikey	P0.0GCT-ND	Panasonic	ERJ-3GEY0R00V
R68, R73	2	4.3K	RES SMD 4.3K OHM 5% 1/10W 0603	Digikey	P4.3KGCT-ND	Panasonic	ERJ-3GEYJ432V
R7	1	100	RES 100 OHM 1/8W 1% 0805 SMD	Digikey	311-100CRCT-ND	Yageo	RC0805FR-07100RL
R72	1	0ohm	RES 0.0 OHM 2512	Digi-key	CR2512-J/-000ELFTR-ND	Bourns	Bourns
R8, R11	2	51	RES 51 OHM 1/8W 5% 0805 SMD	Digikey	311-51ARCT-ND	Yageo	RC0805JR-0751RL
R9, R17, R18	3	1k	RES 1.0K OHM 1/10W 5% 0603 SMD	Digikey	311-1.0KGRCT-ND	Yageo	RC0603JR-071KL
T1	1	N/A	EE16 transformer(Customized)	Active-Semi	Provided by Active	N/A	EE16
U1	1	PAC5253QA	PAC5253	Active-Semi	Provided by Active	Active-Semi	PAC5253QA

7.3 Layout



8 PAC HARDWARE RESOURCES

The following table shows the PAC525X hardware resources used for this EVK and application.

Pin Function	PAC5250		PAC5253		EVK Function
	IC pin	Header Pin	IC pin	Header Pin	
XOUT	1				
VCC18	2		1		1.8V supply
PC3	3	P1-12			
PC2	4	P1-4	3	P1-4	
VCC33	5		4		3.3V supply
VSSA	6				Analog Ground
VSS	7		2		Ground
AIO0	8		5		Iu, negative terminal
AIO1	9		6		Iu, positive terminal
AIO2	10		7		Iv, negative terminal
AIO3	11		8		Iv, positive terminal
AIO4	12		9		Iw/Imotor, negative terminal
AIO5	13		10		Iw/Imotor, positive terminal
AIO6	14		11		Vin
AIO7	15		12		U-phase voltage
AIO8	16		13		V-phase voltage
AIO9	17		14		W-phase voltage
VSYS	18		15		5V supply
REGO	19		16		System regulator output
CSM	20		17		Switching supply current sense input
VP	21		18		DC/DC output
VHM	22		19		Switching supply controller supply input
DRM	23		20		Switching supply driver output
VSSP	24				Power ground
DRL0	25		21		U-phase low side gate drive
DRL1	26		22		V-phase low side gate drive
DRL2	27		23		W-phase low side gate drive
OM0	28				
DRL3	29		24		
HS2	30				
OM2	31				
DRL4	32				
DRL5	33				
DXS0	34		25		U-phase ultra-high voltage high-side gate driver source
DXH0	35		26		U-phase ultra-high voltage high-side gate driver
DXB0	36		27		U-phase ultra-high voltage high-side gate driver bootstrap
DXS1	37		28		V-phase ultra-high voltage high-side gate driver source

DXH1	38		29		V-phase ultra-high voltage high-side gate driver
DXB1	39		30		V-phase ultra-high voltage high-side gate driver bootstrap
DXS2	40		31		W-phase ultra-high voltage high-side gate driver source
DXH2	41		32		W-phase ultra-high voltage high-side gate driver
DXB2	42		33		W-phase ultra-high voltage high-side gate driver bootstrap
PD6	43	J5-2			DAC1 output
PD5	44	J5-3			DAC2 output
PD4	45	J5-4			DAC3 output
PD3	46	P1-11			
PD2	47	P1-10	34	P1-10	
PD1	48	J4-3	35	J4-3	SWD Clock
PD0	49	J4-2	36	J4-2	SWD Data
PE0	50	P1-3	37	P1-3	PE0/SPICLK
PE1	51	P1-3/J2-3	38	P1-3/J2-3	PE1/SPIMOSI/UARTRX
PE2	52	P1-5/J2-2	39	P1-5/J2-2	PE2/SPIMISO/UARTRX
PE3	53	P1-7	40	P1-7	PE3/SPICS0
PE4	54	P1-8	41	P1-8	PE4/SPICS1/I2CSCL
PE5	55	P16	42	P1-6	PE5/SPICS2/I2CSDA
VCCIO	56		43		IO supply (5V)
XIN	57				

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