

EVHFC0500+MP6902+ MP5017-00A

85VAC~265VAC/50Hz/60Hz, 5.3V/10A 4 USB Ports Evaluation Board

DESCRIPTION

The EVHFC0500+MP6902+MP5017-00A Evaluation Board is mainly designed to demonstrate the capabilities of MPS flyback controller and secondary synchronous rectifier (SR) driver. The HFC0500 is a full-featured flyback controller aims at high-performance and high-integration solution while MP6902 is a secondary synchronous rectifier driver, which can promote converter efficiency observably. MP5017 is a current limiter to protect circuit.

The EVHFC0500+MP6902+MP5017-00A is typically designed for cell phone charger with 4 USB ports, each port has 2.4A source capability and input is from 85VAC to 265VAC, 50HZ/60HZ.

The EVHFC0500+MP6902+MP5017-00A has excellent efficiency, which can meet CoC V5 and DoE Level VI requirement easily. It meets IEC61000-4-5 surge immunity and EN55022 conducted EMI requirements. It has multiprotection function, e.g., Brown In/Out, over load protection, over voltage protection, short-circuit protection, cycle by cycle current limit and over-temperature protection, etc.

ELECTRICAL SPECIFICATION

Parameter	Symbol	Value	Units
Input Voltage	V _{IN}	85 to 265	VAC
Output Voltage	V _{OUT}	5.3	V
Output Current	I _{OUT}	10	А
Output Power	Pout	53	W
Efficiency (full load)	η	>87	%

FEATURES

- Fixed-frequency at Heavy Load with Cycleby-Cycle Current Limit
- High Efficiency to Meet DoE Level VI and CoC V5
- <100mW No Load Power Consumption
- Straight CC/CV Performance
- 4 USB Ports with 2.4A Output for each Port
- Good Conducted EMI Performance
- Multiple Protections: OVP, OCP, SCP, OTP, and VCC UVLO

APPLICATIONS

- Cell Phone Chargers
- Adapters for Handheld Electronics
- Stand-By and Auxiliary Power Supplies

All MPS parts are lead-free, halogen free, and adhere to the RoHS directive. For MPS green status, please visit MPS website under Quality Assurance.

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Warning: Although this board is designed to satisfy safety requirements, the engineering prototype has not been agency approved. Therefore, all testing should be performed using an isolation transformer to provide the AC input to the prototype board.



EVHFC0500+MP6902+MP5017-00A EVALUATION BOARD



TOP VIEW



BOTTOM VIEW

(L x W x H) 10.5cm x 4.6cm x 2.5cm

Board Number	MPS IC Number	
EVHFC0500+MP6902+MP5017-00A	HFC0500, MP6902, MP5017	



EVALUATION BOARD SCHEMATIC







EVHFC0500+MP6902+MP5017-00A BILL OF MATERIALS

Qty	RefDes	Value	Description	Package	Manufacturer	Manufactuer_P/N
1	C1	1nF/250V	Capacitor;250V;X7R	0805	TDK	C2012X7R2E102K
4	C2,C3,C4, C30	1500µF/16V	Electrolytic Capacitor;16V;	DIP	Nichicon	UHM1C152MPD
1	C5	100nF	Ceramic Capacitor;25V;X7R;	0805	muRata	GRM21BR71E104KA01L
1	C6	1nF/630V	Ceramic Capacitor;630V;U2J	1206	Murata	GRM31A7U2J102JW31D
1	C7	100uF/400V	Electrolytic Capacitor;400V;	DIP	SAMSUNG	
1	C8	4.7nF/1000V	High Voltage Capacitor;1000V	DIP	电子市场	
1	C9	22nF	Ceramic Capacitor;16V;X7R	0603	Murata	GRM188R71C223KA01D
1	C10	47µF/25V	Electrolytic Capacitor;25V;	DIP	江海	CD28L-25V47
1	C11	100nF	Ceramic Capacitor;50V;X7R;	0603	muRata	GRM188R71H104KA93D
2	C12, C15	1nF	Ceramic Capacitor;16V;X7R,	0603	Murata	GRM188R71C102KA01D ,
5	C13, C26, C27, C28, C29	47nF	Ceramic Capacitor;50V;X7R;	0603	muRata	GRM188R71H473KA61D
1	C14	22pF	Ceramic Capacitor;50V;C0G;	0603	muRata	GRM1885C1H220JA01D
1	C16	1µF/0805	Ceramic Capacitor;50V;X7R;	0805	muRata	GRM21BR71H105KA12L
0	C17	NC	No connected			
4	C18,C20, C21,C23	10µF/0805	Capacitor;10V	0805	TDK	C2012X7R1A106K
4	C19,C22, C24,C25	4.7µF	Ceramic Capacitor;10V;X5R;	0805	TDK	C2012X5R1A475K
2	CN1		2*2.0mm 金针			
1	CX1	0.22µF/275V	X-CAP	15mm pin distance	Carli	PX224K3ID49H200D9R
1	CY1	2.2nF/4kV	Capacitor;4000V;20%	DIP	鸿科	JN12E222MY02N
0	CY2	NC	No connected			
1	D1	P6KE51A	TVS Diode;70V,1mA	DO-15	Brightking	P6KE51A
1	D2	P6KE170CA	TVS 'Diode;145V;1mA	DO-15	Brightking	P6KE170CA
1	D3	GBU406	Diode;600V;4A	DIP	Diodes	GBU406
2	D4,D5	FR107	Diode;1000V;1A	DIP	Diodes	FR107
2	D6, D7	S1ML	Diode;1000V;1A	SMA	Taiwan Semiconductor	S1ML
1	D8	1N4148W	Diode;75V;0.15A;	SOD-123	Diodes	1N4148W
1	D9	BZT52C18	Zener Diode;18V;5mA/500mW;	SOD-123	Diodes	BZT52C18-F
1	D10	BAV21W	Diode;200V;0.2A;	SOD-123	Diodes	BAV21W-7-F
0	D11	NC	No connected			
1	F1	SS-5-3.15A	Fuse;250V;3.15A	DIP	COOPER BUSSMANN	SS-5-3.15A
1	LX1	20mH	Common Choke;20mH;2A	DIP	德科隆	T16*12*8
1	LX2	300µH	Common Choke;300uH;1A	DIP	Emei	TP4U300-00
4	MP1,MP2, MP3,MP4		USB current limiter	QFN12	MPS	MP5017GD, R7
2	Q1A, Q1B	Sir880DP	N-Channel Mosfet;80V; 5.9mOhm/10V	Powerpa k SO-8	Vishay	Sir880DP



EVHFC0500+MP6902+MP5017-00A BILL OF MATERIALS (continued)

Qty	RefDes	Value	Description	Package	Manufacturer	Manufactuer_P/N
1	Q2	IPP65R280E6	Mosfet;700V;0.28/10V;	TO220	Infineon	IPP65R280E6
4	R1, R2, R6, R7	51/1206	Film Resistor;1%	1206	Yageo	RC1206FR-0751RL
0	R3	NC	No connected			
1	R4	200k/1206	Resistor;1%	1206	Yageo	RC1206FR-07200KL
1	R5	510	Film Resistor;1%;	0603	Yageo	RC0603FR-07510RL
1	R8	11.3k/1%	Film Resistor;1%	0603	Yageo	RC0603FR-0711K3L
2	R9, R13	10k/1%	Film Resistor;1%;	0603	Yageo	RC0603FR-0710KL
2	R10,R20	0/1206	Film Resistor;5%;	1206	Yageo	RC1206JR-070RL
1	R11	49.9k/1%	Film Resistor;1%	0603	Yageo	RC0603FR-0749K9L
2	R12, R16	20k/1206	Film Resistor;5%;1/4W	1206	Yageo	RC1206JR-0720KL
1	R14	10/1206	Film Resistor;5%	1206	Yageo	RC1206JR-0710R
1	R15	1k	Film Resistor;1%	0603	Yageo	RC0603FR-071KL
1	R17	0/0805	Resistor;5%	0805	Yageo	RC0805JR-070RL
1	R18	2k	Resistor;5%;1/10W;, Resistor	0603	Yageo	RC0603JR-072KL
1	R19	2k	Resistor;1%;1/10W;, Resistor	0603	Royalohm	0603F2001T5E
2	R21, R22	1.1/1206/1%	Film Resistor;1%	1206	Yageo	RC1206FR-071R1L
1	R23	1.5/1206/1%	Resistor;1%	1206	Yageo	RC1206FR-071R5L
1	R24	200k/1%	Film Resistor;1%;1/10W	0603	Yageo	RC0603FR-07200KL
0	R25,R26, R27,R28, R29,R30, R31,R32	NC	No connected			
4	R33,R34, R35,R36	470	Film Resistor;1%	0603	Yageo	RC0603FR-07470RL
1	R37	20k	Film Resistor;1%;1/10W;	0603	Yageo	RC0603FR-0720KL
1	T1		Lm=0.4mH. Np:Np_aux:Ns:Ns_aux=40:7:3: 6	RM10	Emei	
1	U1	PC817A	Photocoupler;1-Channel	DIP	台湾亿光	PC817A
1	U2	TL431	Voltage reference, 2.5V	SOT-23	Any	
1	U3	HFC0500GS	Full features flyback controller	SOIC8-7	MPS	HFC0500GS, R4
1	U4	MP6902DS	Synchronous Rectifier	SOIC8	MPS	MP6902DS, R1
2	1# 'USB, 2# USB		Stack USB Port		Any	



TRANSFORMER SPECIFICATION

Electrical Diagram



Figure 4—Transformer Electrical Diagram

Notes:

1. Core is connected to Pin 1 with naked wire.

2. Terminal B and Terminal C are connected together.

Winding Order

Winding No.	Tape Layer Number	Start & End	Wire DiameterΦ(mm)	Turns
N1	1	5→4	0.51mm * 1	20
N2	1	3→NC	0.15mm * 1	7
N3	I	2→1	0.15mm*1	ſ
N4	1	B→A	0.81mm * 3 TIW	3
N5	1	4→3	0.51mm * 1	20
N6	3	D→C	0.15mm * 1 TIW	6

Electrical Specifications

	60 second, 60Hz, from PRI. to SEC.	3500VAC
Electrical Strength	60 second, 60Hz, from PRI. to CORE.	500VAC
	60 second, 60Hz, from SEC. to CORE.	3500VAC
Primary Inductance	Pins 3 - 5, all other windings open, measured at 60kHz, 0.1 VRMS	0.4mH±10%
Primary Leakage Inductance	Pins 3 - 5 with all other pins shorted, measured at 60kHz. 0.1 VRMS	50µH±10%

Materials

Item	Description
1	Core: RM10,
2	Bobbin: RM10, 5+0PIN 1 SECT TH, UL94V-0
3	Wire: Ф0.15mm,, 2UEW, Class B
4	Wire: Ф0.51mm,, 2UEW, Class B
5	Triple Insulation Wire: Φ0.81mm TIW
6	Triple Insulation Wire: Φ0.15mm TIW
7	Tape: 10.5mm(W)×0.06mm(TH)
8	Varnish: JOHN C. DOLPH CO, BC-346A or equivalent
9	Solder Bar: CHEN NAN: SN99.5/Cu0.5 or equivalent



CIRCUIT DESCRIPTION

The EVHFC0500+MP6902+MP5017-00A is a single-stage flyback converter with CC/CV characteristic. The input is universal and output is 5.3V/10A. There are total 4 USB ports and each port shares 2.4A source capability.

F1, LX1, LX2, CX1 and D3 compose the input stage. F1 is the fuse and is used to protect the component failure or some excessive short events. LX1, LX2 and CX1 are configured the EMI filter to suppress conducted EMI. D3 is the rectifier bridge to convert AC voltage to DC voltage.

C7 and C8 are the input capacitor. C8 is mainly used to reduce high frequency equivalent ESR, which can have better effect to filter differential mode EMI noise.

D2, D5, R4, R6, R7 and C6 are configured RCD snubber to suppress voltage spike of Mosfet.

R10, C10, C11 and D4 are used as Vcc power supply.

HFC0500 and its peripheral components are configured flyback controller circuit, which is used to control the normal operation of this circuit.

Q2 is the main switch and R21, R22 and R23 are the current sensing resistors.

T1 is the transformer to transfer the power from primary side to secondary side. It is key component for the whole circuit normal working with good performance. So it should be designed carefully.

CY1 is Y capacitor lowering common mode noise to make sure there is enough EMI margin.

Q1A and Q1B are secondary synchronous rectifier (SR) and R1, R2, C1 and D1 are their snubber to suppress SR high voltage spike.

U4 and the related external components compose SR driver. The circuit turns on/off Q1A and Q1B repeatedly and which can lead to higher efficiency and better thermal performance.

C2, C3, C4, C5 and C30 are output capacitors.

U1, U2, R5, R8, R9, R11, R13 and C9 are configured voltage feedback circuit.

MP1, MP2, MP3 and MP4 are four current limit ICs. Each IC and its peripheral components are configured one current limit circuit for every USB output.



EVB TEST RESULTS

Performance Data

Ta=25℃, unless otherwise noted.

Efficiency



No Load Consumption



		4 points Average Efficiency	10% Load Efficiency	No Load
D	oE Level VI	0.87		0.21
	Tier1	0.88	0.78	0.25
CoC V5	Tier2	0.88	0.78	0.15
Tost Data	Vin=115Vac	0.9/0.875 ⁽¹⁾	0.888/0.879 ⁽¹⁾	0.037
Test Data	Vin=230Vac	0.902/0.877 ⁽¹⁾	0.876/0.867 ⁽¹⁾	0.059

Note:

(1): The front data is tested w/o MP5017 and the latter data is tested w/i MP5017.



Conducted EMI Test

Test with 115Vac input and full load condition



Date: 11.SEP.2015 15:25:05





Date: 11.SEP.2015 15:27:59





Conducted EMI Test (continued)



Date: 11.SEP.2015 15:22:07





Date: 11.SEP.2015 15:19:10





Thermal Test

Test with 85Vac input and full load condition. PCB layout with 1Oz copper.





PCB LAYOUT (DOUBLE-SIDED)



Figure 2—Top Layer



Figure 3—Bottom Layer



QUICK START GUIDE

- 1. Preset Power Supply to 85VAC $\leq V_{IN} \leq$ 265VAC.
- 2. Turn Power Supply off.
- 3. Connect the Line and Neutral terminals of the power supply output to L and N port. For threewire input application, make OUTPUT GND connected to Earth.
- 4. Connect Load to:
 - a. Positive (+): VOUT
 - b. Negative (-): GND
- 5. Turn Power Supply on after making connections.

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