TDTTP2500B066B: 2.5kW Digital Bridge-less Totem-pole PFC Evaluation Board

Overview

The design files and source code for the TDTTP2500B066B 2.5kW digital bridge-less totem-pole PFC kit can be found at transphormusa.com/ TDTTP2500B066B and includes the complete project. The following instructions can be used to modify, build and load the project on your computer for inspection or adjustment of the code. To take maximum advantage of the existing firmware, the digital 2.5kW bridge-less totem-pole PFC code is based on an open-source design from Microchip Inc. Full documentation of the Microchip source files is available at https://www.microchip.com/design-centers/power-management.

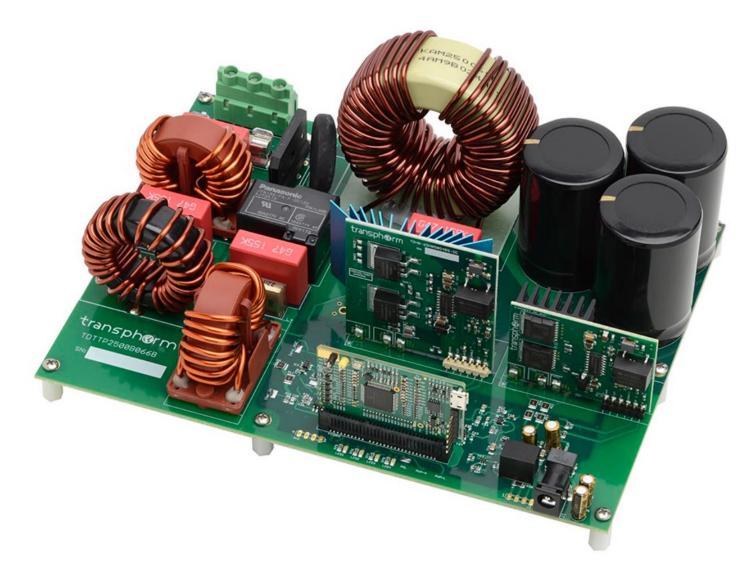


Figure 1. TDTTP2500B066B 2.5kW Digital Bridge-less Totem-Pole PFC evaluation board

TDTTP2500B066B Firmware Guide

Tools needed to modify, build and load firmware to Microchip PIM:

IDE: MPLAB® X (software) Programmer/Debugger: MPLAB REAL IDE ™ ICD4 Adaptor RJ-11 to ICSP (part number: AC164110) USB-A cable USB Isolator Microchip PIM (part number: MA330048)



Figure 2. Microchip PIM (MA330048)

Loading firmware

- 1. Download the complete TDTTP2500B066B firmware from the Transphormusa.com website or Microchip.com website. Save the downloaded zipped folder to a local folder on computer/laptop.
- 2. Open MPLAB® IDE v5.25 (or higher).



MPLAB X IDE v5.25

Арр

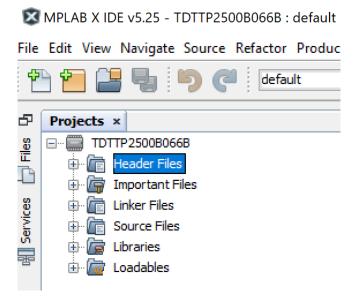
3. On the Projects window, right click and select 'Open Project'

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	Open Project Ctrl+Shift+O Open Recent Project > Project Groups		
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	Set Main Project >> Collapse All Show Selected Node(s) Project Owner		
	Notifications * Message • Date Created Calegory		
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4. Navigate to the folder where TP_TPBLPFC4kW is unzipped at and select project.

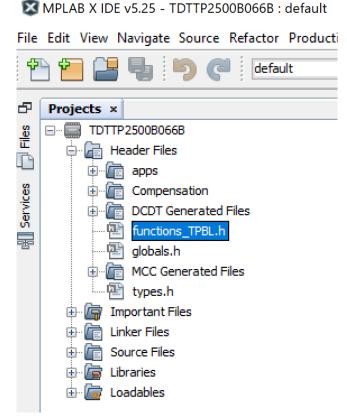
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5. The content of the firmware will now be shown on the Projects window.



Code Modification - Vin/Vout/lac

1. Locate the functions_TPBL.h file (under Headers File) to edit fundamental frequency, Vin, Vout, and Current limit conditions.



2. The default conditions are below.

Vin range is set to operate between 50 - 270Vac.

Vout is set to 390Vdc.

Current limit is set to 12.7 Arms

3. The default fundamental frequency is set to 60Hz. To run the board at 50hz, uncomment line 59.

```
51
     // setup different options
52
     #define DCFF
53
     #define DCMdetect
     #define BURSTMode
54
     //#define DCmode
55
  🛱 #ifndef DCmode
56
         #define SynchSw
57
58
     #endif
   ₿ //#define _50Hz
59
```

4. Edit Vin range by adjusting the variables circled at lines 91 and 92. See below.

#define fVOUTREF (float) ((390*7.5/2200/3.3)*4096) 86 87 #define fVOUTMIN (float) ((120*7.5/2200/3.3)*4096) #define fVOUTMAX (float) ((420*7.5/2200/3.3)*4096) 88 89 #define fVOUTSTART (float) ((200*7.5/2200/3.3)*4096) 90 #define fVACMIN (float) ((50*7.5/2200/3.3)*4096) 91 #define fVACMAX (float) (270) 7.5/2200/3.3) *4096) 92 93 #define VRampStartupDelay 5 94 95 #define VRampStartupStep 1 96 #define VRampStartupDelayVPI 1 97 #define VRampStartupStepVPI 1

5. Edit Vout by adjusting the variable circled at line 86. See below.

<pre>87 #define fVOUTMIN (float) ((120*7.5/2200/3.3)*4096) 88 #define fVOUTMAX (float) ((420*7.5/2200/3.3)*4096) 89 #define fVOUTSTART (float) ((200*7.5/2200/3.3)*4096) 90 91 #define fVACMIN (float) ((50*7.5/2200/3.3)*4096)</pre>	
<pre>89 #define fVOUTSTART (float)((200*7.5/2200/3.3)*4096 90</pre>	
90	
)
91 #define fVACMIN (float)((50*7.5/2200/3.3)*4096)	
92 #define fVACMAX (float)((270*7.5/2200/3.3)*4096)	
93	
94 #define VRampStartupDelay 5	
95 #define VRampStartupStep 1	
96 #define VRampStartupDelayVPI 1	
97 #define VRampStartupStepVPI 1	

- 6. The Current condition can be seen at line 100. The default current is set to 18A peak (12.7A rms). The default OC is set to 1.2 * flnREF.
- 7. Edit flinREF by adjusting the variable circled at line 100.

99	//Change AVG current
100	#define flinREF (float) (18)* 32.22)
101	//Change Over current limit
102	<pre>#define flinOC (float)(flinREF * 1.2)</pre>

Installing MPLAB® X IDE

MPLAB® X Integrated development Environment (IDE) is an expendable, highly configurable software program that enables powerful tools to help Engineers discover, configure, develop, debug and qualify embedded designs for most of Microchip's microcontrollers and digital signal controllers (DSP). MPLAB® X IDE is available at https://www.microchip.com/mplab/mplab-x-ide

Within MPLAB® X IDE, install plugins for MCC (MPLAB Code Configurator) and DCDT(Digital Compensator Design Tool)

MPLAB REAL ICE

We recommend using the MPLAB® REAL ICE or ICD4 In-Circuit Emulator (part number: DV164045). An overview of tools on related parts is available at https://www.microchip.com/development-tools/

The MPLAB® REAL ICE or ICD4 User's Guide is available at http://ww1.microchip.com/downloads/en/DeviceDoc/50002085E.pdf

Connect Real ICE and USB to PIM

- 1. Connect 12V Auxiliary Supply to TDTTP2500B066B (NO HIGH VOLTAGE APPLIED TO EV BOARD).
- 2. Connect Microchip RJ-11 to ICSP adapter to Microchip MA330048 and Microchip Real ICE or ICD4.

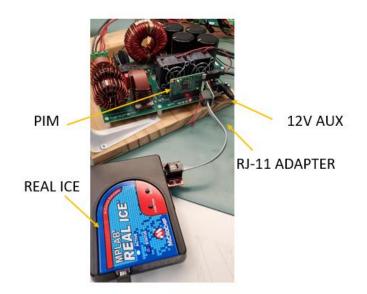


Figure 3. Cable connections to MA330048

3. Verify LD2 on PIM is illuminated after making all necessary connections.

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Figure 4. Green illuminated LD2 on MA330048

4. Verify LD1 on PIM is blinking after making all necessary connections.

Building and Loading code to MA330048.

After modifying the desired lines of code, and connecting the REAL ICE (or ICD4) to MA33008, follow the steps below to build and load the code to MA330048 Microchip PIM.

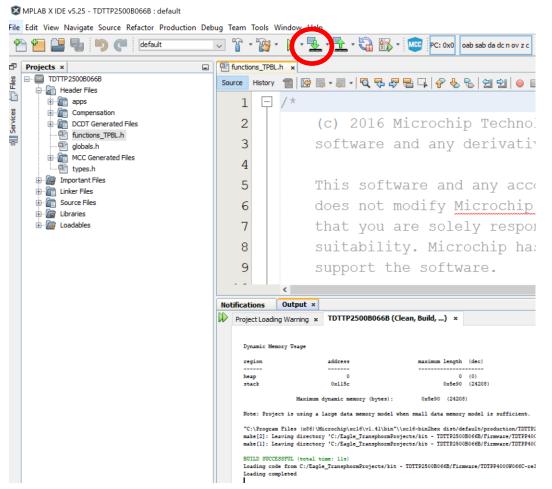
1. Under 'Production' menu, select the 'Clean and Build Project' option (or press shift + F11). See below.

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2. Verify completion of build, with no errors "BUILD SUCCESSFUL (total time: xS) and loading complete". See below.

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Not	ifications	Output ×					
	Project Loading	Warning ×	TDTTP2500	B066B (Clean, B	uild,)	×	
	Dynamic Memor	y Usage					
	region		address	22	ximum len	gth	(dec)
	heap		0			0	(0)
	stack		0x115c		0:05	e90	(24208)
		Maximum d	lynamic memory	(bytes): 0	x5e90 (2	4208)	
	Note: Project	is using a l	arge data memo:	ry model when smal	l data me	mory :	model is sufficient.
	"C:\Program F	iles (x86)\Mi	crochip\xc16\v.	1.41\bin"\\mcl6-bi	n2hex dis	t/def	ault/production/TDTTP2500B066B.X.production.elf -a -omf=elf
							066B/Firmware/TDTPP4000W066C-release-finalized updated/TDTTP2500B066B.X'
	make[1]: Leav	ving directory	'C:/Eagle_Tran	nsphormProjects/ki	t - TOTTE	2500B	066B/Firmware/TDTPP4000W066C-release-finalized updated/TDTTP2500B066B.X'
	BUILD SUCCESS	FUL (total ti	me: 11s)				
	Loading code	from C:/Eagle	TransphormPro	jects/kit - TDTTP2	500B066B/	Firm.	are/TDTPP4000W066C-release-finalised updated/TDTTP2500B066B.X/dist/default/production/TDTTP2500B066B.X.production.hex
	Loading compl	leted					

3. Once the code has be built successfully, select the 'Make and Program Device option to load the code to the MA330048 PIM. See below.



4. After code has been loaded to the MA330048, The message below will be displayed under the REAL ICE Output menu.

Currently loaded firmware on REAL ICE Firmware Suite Version01.56.00 Firmware typedsPIC33CK					
Target voltage detected					
Target device dsPIC33CK256MP506 found.					
Device ID Revision = 0x1					
Device Erased					
Programming					
The following memory area(s) will be programmed: program memory: start address = 0x0, end address = 0x15ff Programming/Verify complete					

5. Verify LD1 on MA330048 is illuminated green and LD2 on MA330048 is blinking red at 1 second pulses. Verify that LED4 on the TDTTP2500B066B board is blinking (500 msec pulses).

Remove Connections from MA330048 and restart evaluation of TDTTP2500B066B using Transphorm's SuperGaN™ and Microchip REALICE® technology.