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.
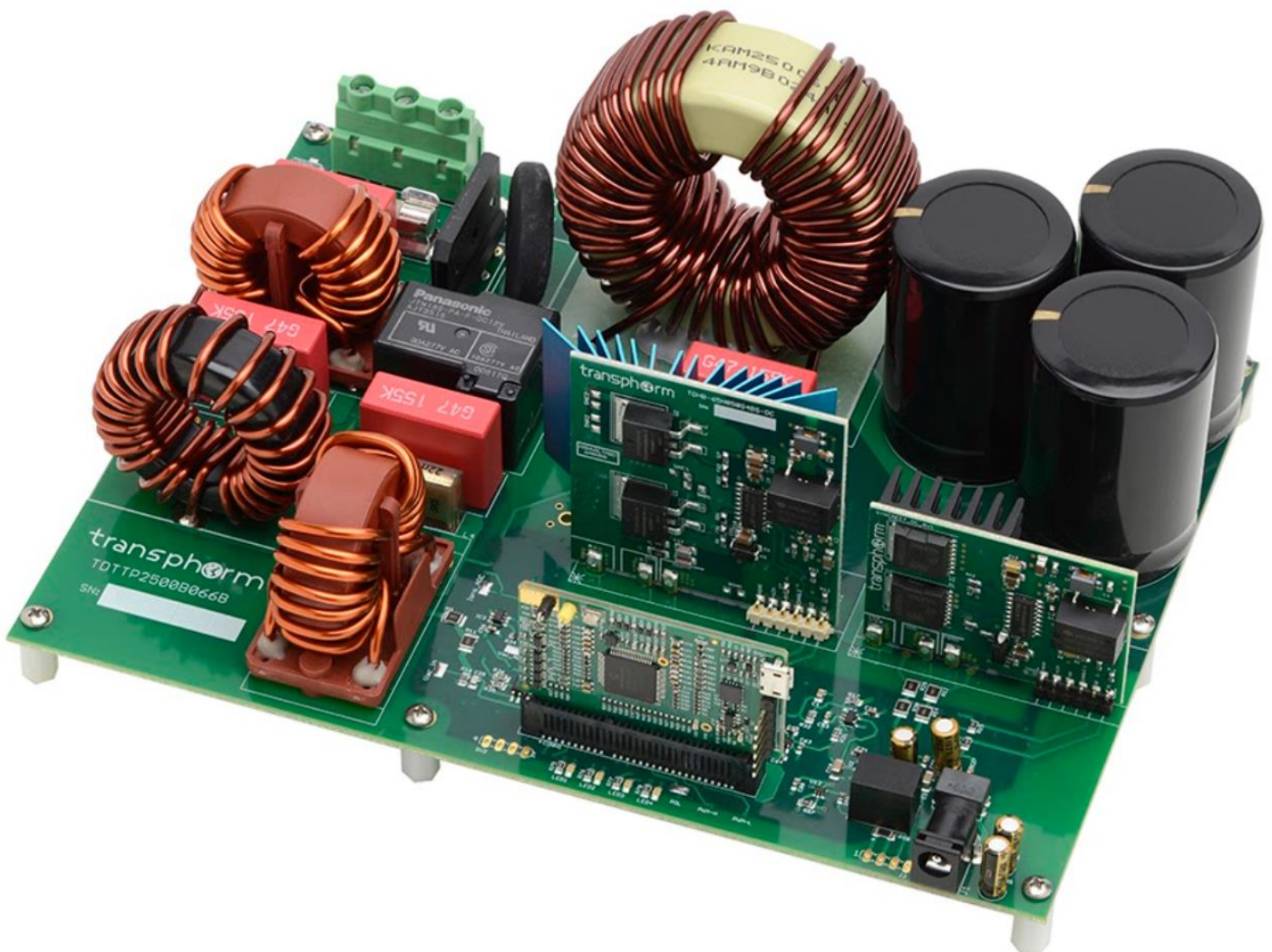

Figure 1. TDTTP2500B066B 2.5kW Digital Bridge-less Totem-Pole PFC evaluation board

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.
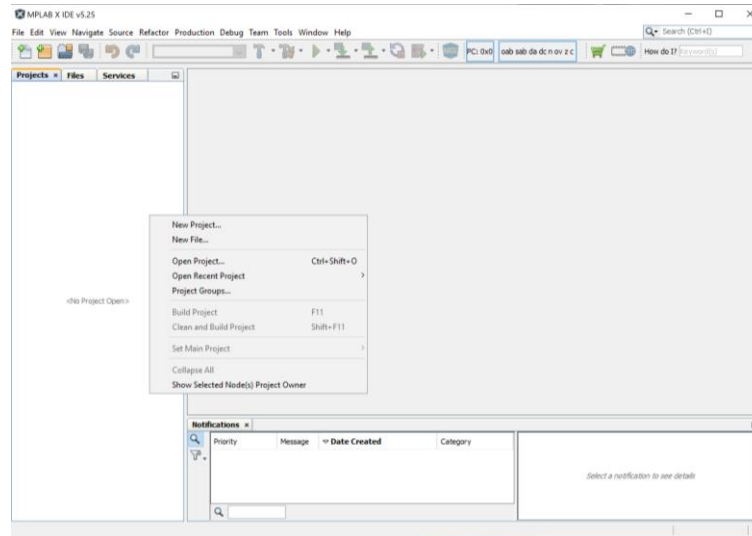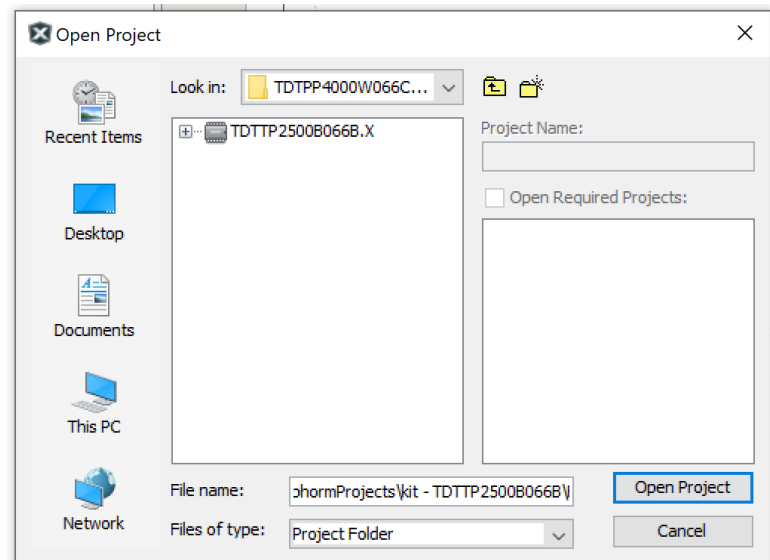2. Open MPLAB® IDE v5.25 (or higher).

MPLAB X IDE v5.25

App

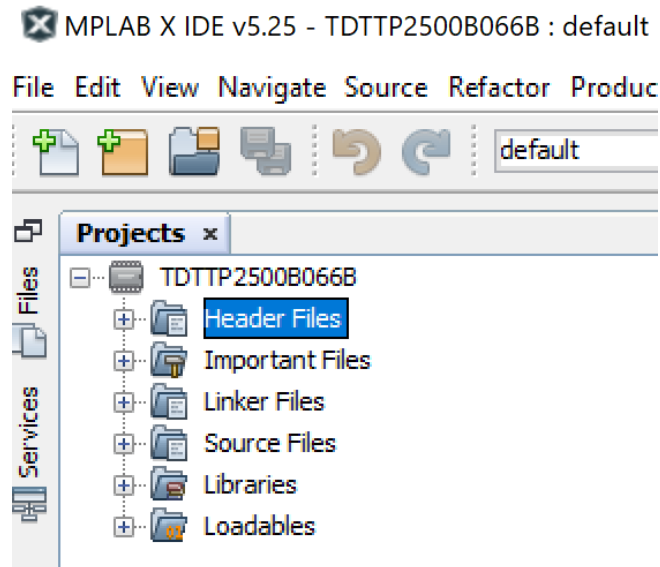3. On the Projects window, right click and select 'Open Project'

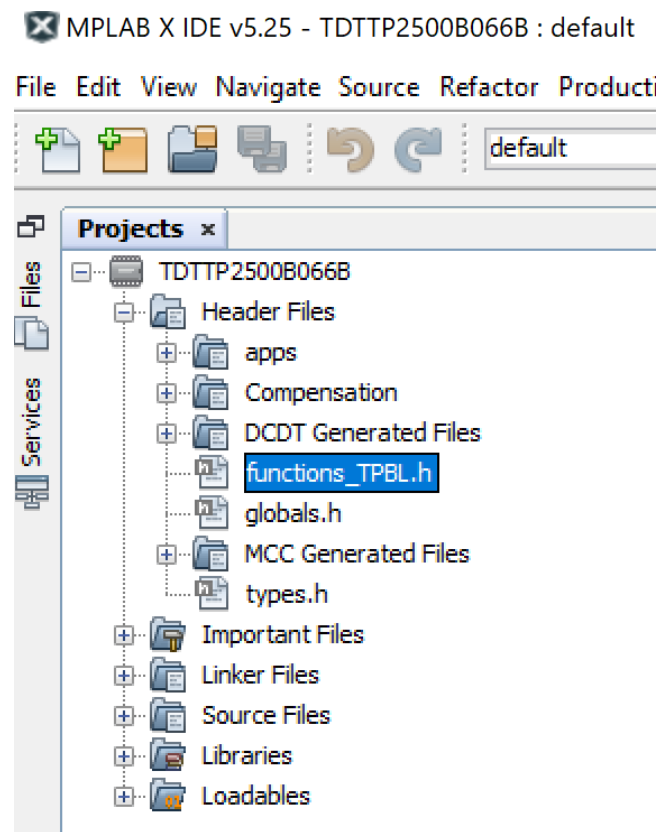4. Navigate to the folder where TP_TPBLPFC4kW is unzipped at and select project.

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

Code Modification – Vin/Vout/Iac

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
54    #define _BURSTMode
55    //#define _DCmode
56    #ifndef _DCmode
57        #define _SynchSw
58    #endif
59    //#define _50Hz
```

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

```
86    #define fVOUTREF (float)((390*7.5/2200/3.3)*4096)
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)
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
```

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

```
86    #define fVOUTREF (float)((390*7.5/2200/3.3)*4096)
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)
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 * fIinREF.

7. Edit fIinREF by adjusting the variable circled at line 100.

```
99     //Change AVG current-----------------
100    #define fIinREF (float)(18 * 32.22)
101    //Change Over current limit----------
102    #define fIinOC (float)(fIinREF * 1.2)
```

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).
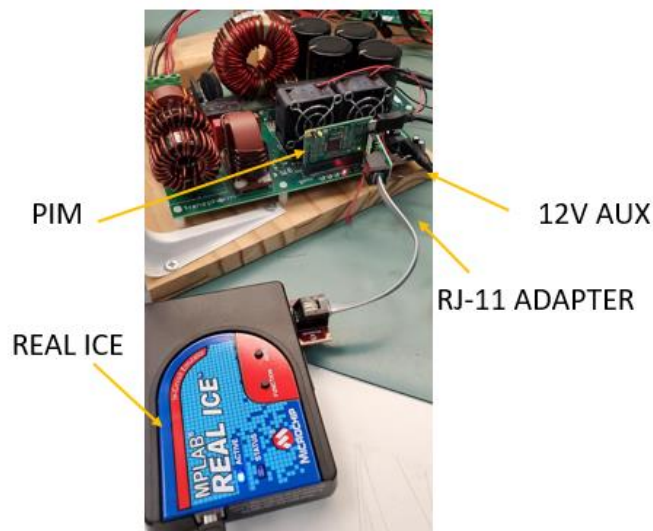2. Connect Microchip RJ-11 to ICSP adapter to Microchip MA330048 and Microchip Real ICE or ICD4.

Figure 3. Cable connections to MA330048

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

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.
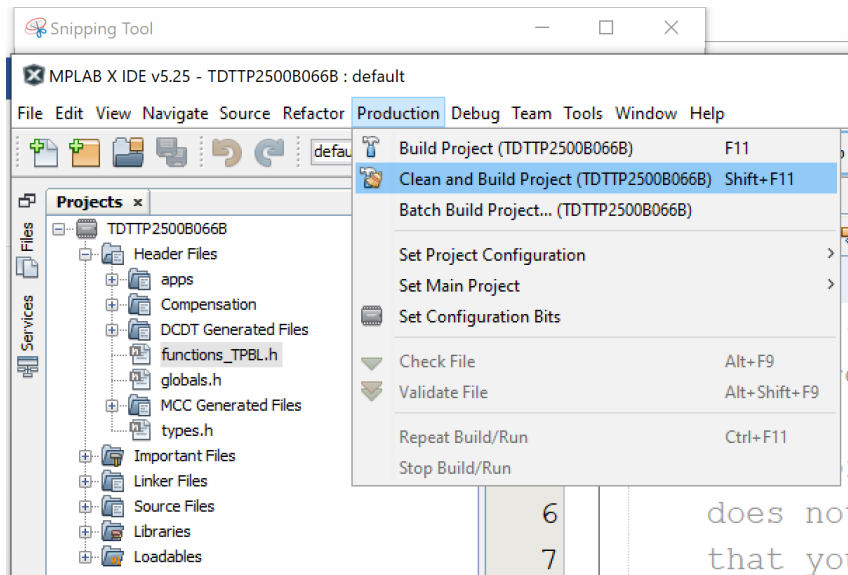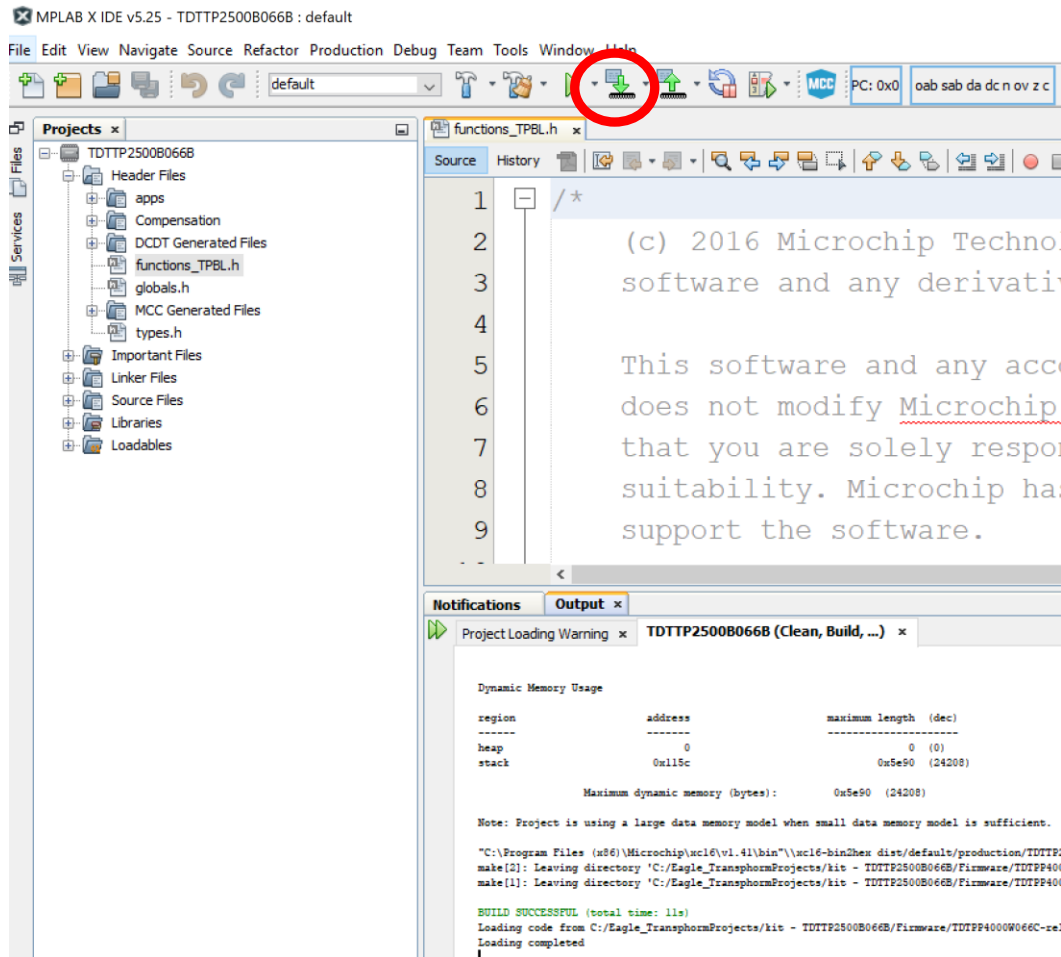

2. Verify completion of build, with no errors "BUILD SUCCESSFUL (total time: xS) and loading complete". See below.
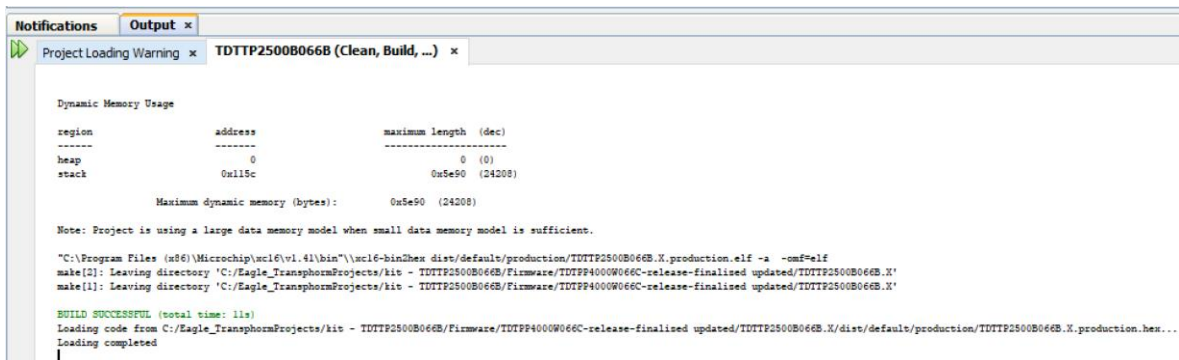
3. Once the code has be built successfully, select the 'Make and Program Device option to load the code to the MA330048 PIM. See below.

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

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.