Embedded System Design Techniques™

Building Your Own Internet Connected PLC

Class 3: PLC Software Design Part 1

April 25th , 2018
Jacob Beningo

Course Overview

Topics:

- PLC Fundamentals

- Designing a PLC

- **PLC Software Design Part 1**

- PLC Software Design Part 2

- PLC Application Design

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Session Overview

- Embedded Project Setup
- Embedded PLC Code Review

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What You will need ...

Keil MDK5

μVision® 5

Integrated Development
Environment

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arm KEIL

OR

IAR for arm

IAR SYSTEMS

FP-IND-PLCWIFI1

ST PLC App

A light snack ...

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Embedded Project Setup

- Documentation and Software Download
  - http://www.st.com/en/embedded-software/fp-ind-plcwifi1.html

GET SOFTWARE

Part Number	Software Version	Marketing Status	Supplier	Order from ST
FP-IND-PLCWIFI1	1.0.0	Active	ST	Get Software

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Embedded Project Setup

Unzip the software and copy to C:\

– There are code projects for Keil and IAR

Name	Date modified	Type	Size
📁 _htmresc	4/16/2018 9:57 PM	File folder	
📁 Documentation	4/16/2018 9:57 PM	File folder	
📁 Drivers	4/16/2018 9:57 PM	File folder	
📁 Middlewares	4/16/2018 9:57 PM	File folder	
📁 Projects	4/16/2018 9:57 PM	File folder	
📄 FP-IND-PLCWIFI1_readme.txt	8/5/2017 11:01 AM	Text Document	3 KB
🔵 Release_Notes.html	9/15/2017 4:38 AM	Chrome HTML Do...	71 KB

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Embedded Project Setup

1) Open IAR
2) From the Project menu, select import project
3) Navigate to the embedded software project and open it

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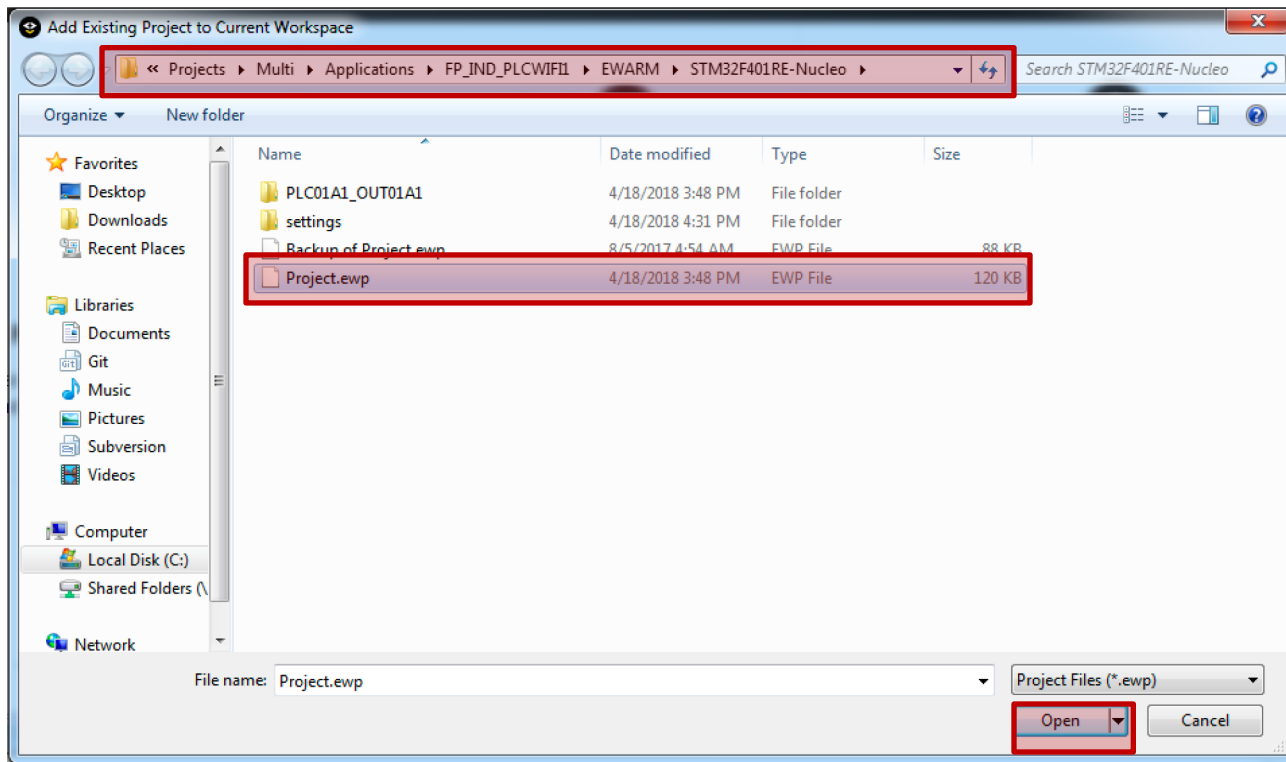
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Embedded Project Setup
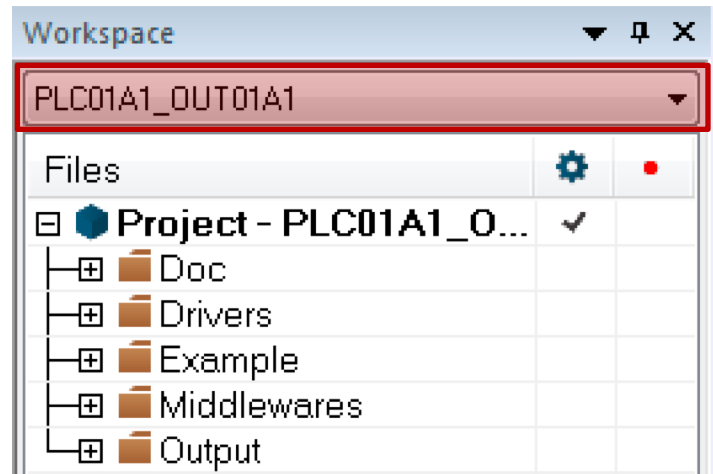
4) Select your hardware configuration
5) Under Project menu, select Rebuild All

Embedded Project Setup

When ready, the project can be executed by selecting:

- Project -> Download and Debug
- Clicking Run

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Embedded PLC Code

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Embedded PLC Application

```
┌─────────────────────────────────────┐
│            Initialization            │
└─────────────────────────────────────┘
                    │
                    ▼
┌─────────────────────────────────────┐
│               PLC_WD                 │◄───┐
└─────────────────────────────────────┘    │
                    │                       │
                    ▼                       │
┌─────────────────────────────────────┐    │
│            Wifi_Management           │    │
└─────────────────────────────────────┘    │
                    │                       │
                    ▼                       │
┌─────────────────────────────────────┐    │
│          PLC_WiFi_Interface          │────┘
└─────────────────────────────────────┘
```
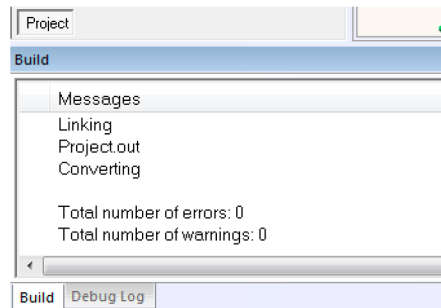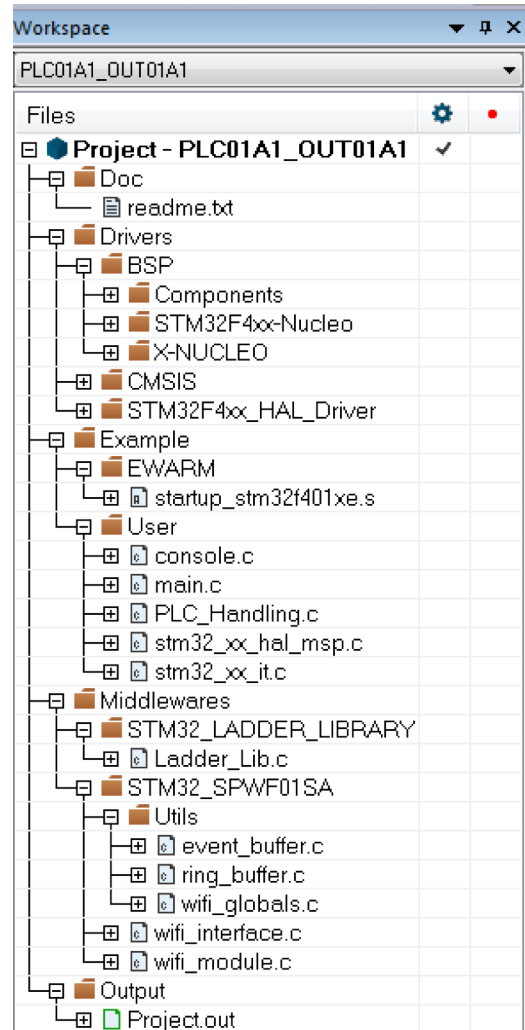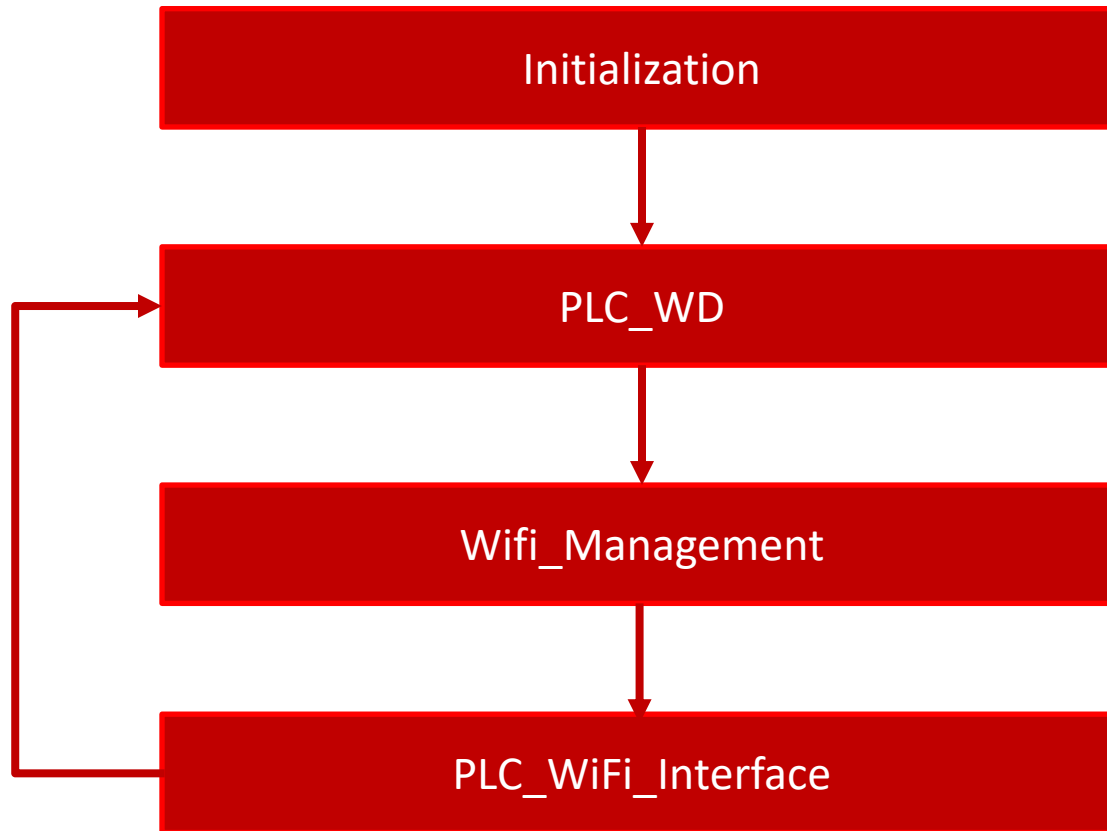
Embedded PLC Code

```
int main(void)
{
    WiFi_Status_t status = WiFi_MODULE_SUCCESS;
    char *protocol = "t";
    uint32_t portnumber = 32000;
    Board_State=BOARD_RESET;
    HAL_Init();

    /* Configure the system clock to 64 MHz */
    SystemClock_Config();

    /* configure the timers  */
    Timer_Config( );
    UART_Configuration(115200);
```

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Embedded PLC Code

```c
void initializePlc(void)
{
    /* Initialize Relay and Current Limiter */
    BSP_Relay_Init();
    BSP_CurrentLimiter_Init();

    BSP_RELAY_Reset();

    Init_Output();
    ClearFlag_ResetOUT();

#if (defined PLC01A1) || (defined PLC01A1_OUT01A1)
    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_RESET);//CS1 watchdog refresh
    /* Delfault driving pin configuration for VNI */
    HAL_GPIO_WritePin(GPIOB, GPIO_PIN_6, GPIO_PIN_SET); //CS pin
    HAL_GPIO_WritePin(GPIOB, GPIO_PIN_10, GPIO_PIN_SET);//OUTEN pin

    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_SET);//CS1 watchdog refresh
    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_RESET);//CS1 watchdog refresh
    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_SET);//CS1 watchdog refresh
    BSP_RELAY_EN_Out();
    BSP_RELAY_SetOutputs(&ToSPI);
    PLC_State=PLC_RESET;
//      CLT_State=Unchecked;
#endif
    Frame_decoding=Completed;
}
```
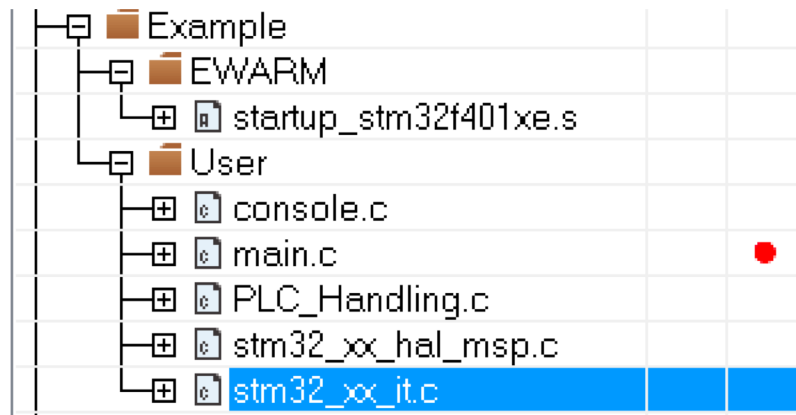
Embedded PLC

Where is the PLC code?

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Embedded PLC

```c
void SysTick_Handler(void)
{
    /******** PLC ***********/
    do{
        if((counter_up[index_c].CNT_val!=0)&&(start_delay[index_c]==1))
        {
            delay_CNT[index_c]++;
        }
        index_c++;
    }while(index_c<MAX_COMPONENT_NUMBER);
    index_c=0;

#if (defined PLC01A1_OUT01A1) ||   (defined PLC01A1)

    if(WD_Reset>100)
    {
        WD_Reset++;
        npolling=0;
    }
    else
        WD_Reset=0;
    /* end RESET SPURIOUS */

    if(WD_Refresh>=1)
    {
        WD_Refresh=0;
        HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7, GPIO_PIN_RESET); //CS pin
        HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_SET);//CS1 watchdog refresh
    }
    else
    {
        WD_Refresh++;
    }
```

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Embedded PLC

```
if(POG!=1)
{

    if(Board_State==BOARD_LOOP)
    {
        PLC_Polling ();
        POG=-1;
    }
    else
    {
        if((Board_State==BOARD_LISTENING)||(Get_FlagStatus()==1))
        {
            //          if(POG!=1)
            PLC_Polling();
            POG=-1;
        }
    }
}
else
{

    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7, GPIO_PIN_RESET); //CS pin
    HAL_GPIO_WritePin(GPIOC, GPIO_PIN_7,GPIO_PIN_SET);//CS1 watchdog refresh

}
```

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Embedded PLC

```c
void PLC_Polling (void)
{
#ifdef PLC01A1_OUT01A1
    CLT_VNI_RxTx();
    if(PLC_GetOutput(&ToISOPLC))
    {
        ToSPI=ToISOPLC;
        VNI_TxRx(ToSPI);
        VNI_TxRx(ToSPI);
        ToIPS=ToISOPLC>>8;
        BSP_ISO_Com_Settings();
        BSP_OutputEnable_Pin(GPIO_PIN_SET);
        BSP_DrivePin_GROUP(ToIPS);
        POG=-1;
    }
#elif (defined PLC01A1)
    CLT_VNI_RxTx();
    if(PLC_GetOutput(&ToISOPLC))
    {
        ToSPI=ToISOPLC;
        VNI_TxRx(ToSPI);
        VNI_TxRx(ToSPI);
        POG=-1;
    }

#elif (defined OUT01A1)
    if(PLC_GetOutput(&ToISOPLC))
    {

        BSP_ISO_Com_Settings();
        BSP_OutputEnable_Pin(GPIO_PIN_SET);
        BSP_DrivePin_GROUP(ToISOPLC);
        POG=-1;
    }
#endif
}
```

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Key Take-A-Ways

1) The Wi-Fi port is configured to 32000

2) The PLC is driven from the System Tick

3) PLC_Handling.c contains the bulk of the PLC code

4) There is a console output that developers can access to review the application execution

5) Security is limited to non-existent

Additional Resources

- Download Course Material for
  - C/C++ Doxygen Templates
  - Example source code
  - Blog
  - YouTube Videos
- Embedded Bytes Newsletter
  - http://bit.ly/1BAHYXm

From www.beningo.com under

   - Blog > CEC – Building Your own Internet Connected PLC

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