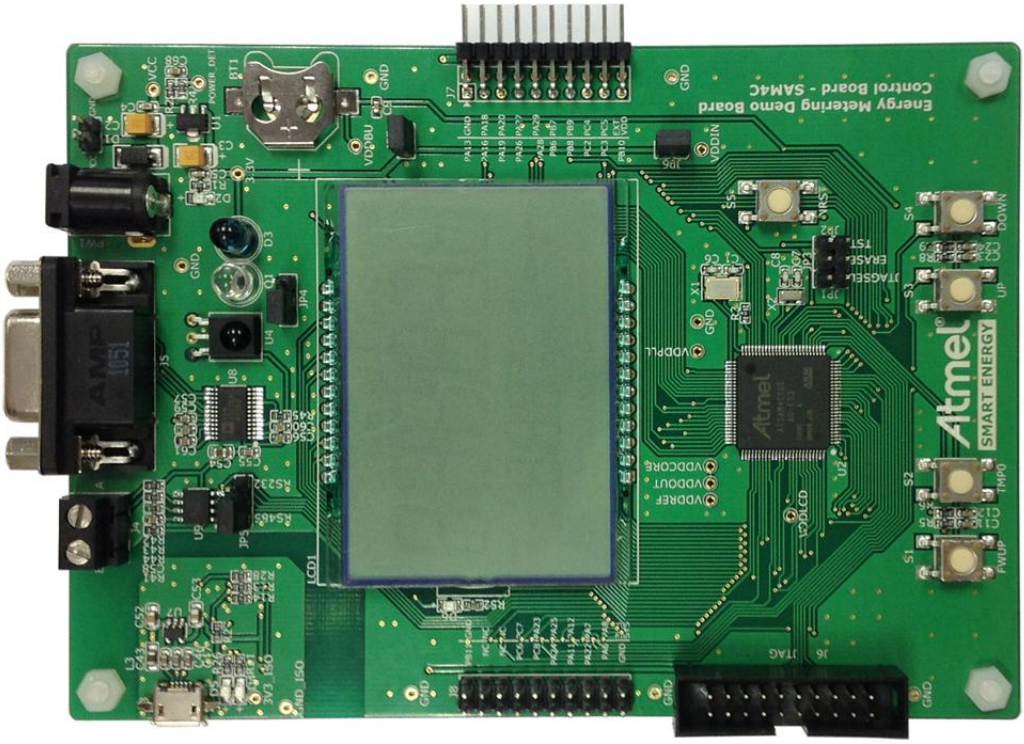
USER GUIDE

AFE Control Board - SAM4C



Preface

AFE Control Board - SAM4C is the control board in Atmel Metering Demo Kit. The kit also includes the daughter board: either ATM90E2x-DB or ATM90E3x-DB. The AFE Control Board - SAM4C communicates with and controls the daughter board, providing easy access to evaluate the energy metering chips.

Supported by the IAR integrated development platform, the AFE Control Board - SAM4C also provides easy access to the features of the Atmel ATSAM4C and explains how to integrate ATSAM4C in a customer design.

The AFE Control Board - SAM4C evaluation kits include an SAM-ICE debug tool and AC-DC adapter. It also provides the extended interface for customized applications.

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1. Introduction

1.1 Features

- Atmel® SAM4C microcontroller
- Debugger
  Programming and debugging (target) through the JTAG port
- Two possible power sources
  - External DC9V
  - External 3.3V from the daughter board
- One power indicator
- One USB communication receive LED
- One USB communication transmit LED
- Digital I/O
  - Five mechanical buttons
    - One reset button
    - Two switch buttons for display (including forward and backward button)
    - Two wake up buttons (one is FWUP, the other is TMP0)
  - One extension header
  - One communication connector
- Segment LCD display
- One LCD background light illumination
- Five types of communication interfaces
  - One USB
  - One RS485
  - One RS232
  - One Infrared Radiation (IR)
  - One Optical Infrared Radiation (OIR)
- One EEPROM
- One extension flash
- Two authentication devices
- One battery
- 8.192MHz crystal
- 32kHz crystal

1.2 Kit Overview

The whole kit contains two boards: the AFE Control Board-SAM4C and the daughter board: either ATM90E25 or ATM90E3x demo board. The AFE Control Board-SAM4C communicates with and controls the daughter board, providing easy access to evaluate the energy metering chips.

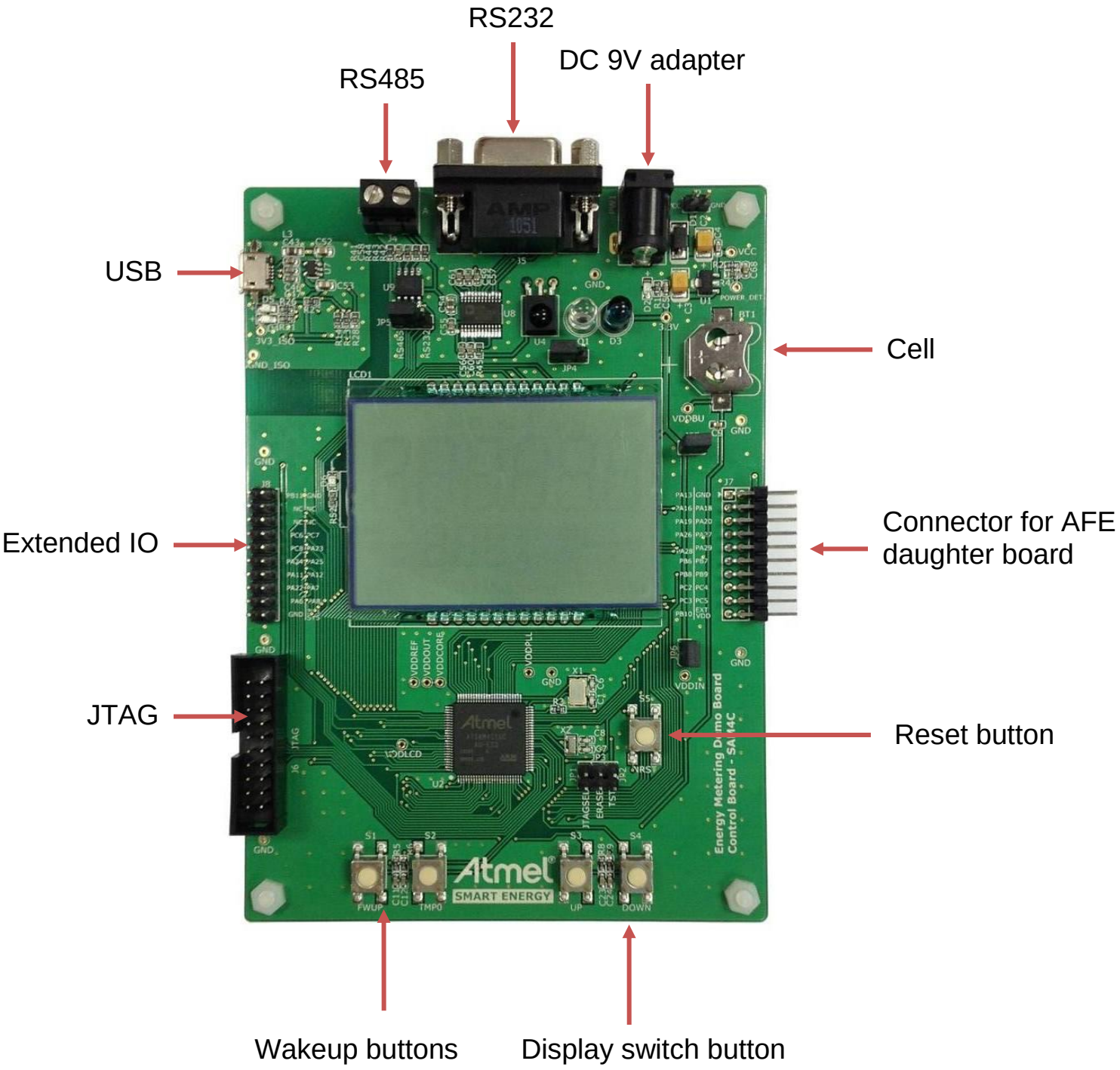


Figure 1-1 AFE Control Board-SAM4C Board Overview

2. Getting Started

There are three steps to start the AFE Control Board - SAM4C.

- Download and install IAR software
- Launch IAR software
- Connect SAM-ICE to the JTAG port

2.1 Connecting the Kit

First connect SAM-ICE to the AFE Control Board - SAM4C through the JTAG interface. Next, connect DC 9V adapter to the AFE Control Board - SAM4C, and the power indicator LED D2 will be lit. After that, launch IAR to program the software.

A program example is the project file of DemoMeter_SAM4C_90Exx/Metering_C0.eww. Customer can download the program to the AFE Control Board - SAM4C for debugging or running it.

Please refer to IAR user guide for information regarding how to compile, debug and download a program。

2.2 Design Documentation

The following list contains the related documents:

1. ATSAM4C Datasheet –Atmel ARM Cortex-M4 Flash MCU
2. Atmel Studio-Free IDE for development of C/C++ and assembler code for Atmel microcontrollers.
3. IAR Embedded Workbench for ARM. This is a commercial C/C++ compiler that is available for ARM. There is a 30 day evaluation version as well as a code size limited kick-start version available from their website. The code size limit is 16K for devices with M0, M0+ and M1 cores and 32K for devices with other cores.
4. AFE Control Board-SAM4C User Guide - PDF version of this user guide.

3. AFE Control Board-SAM4C

The AFE Control Board-SAM4C supports Atmel Software Framework (ASF) drivers and demo code. The software program is developed in environment such as IAR Embedded Workbench for ARM.

3.1 Debugger

SAM-ICE can program and debug the AFE Control Board-SAM4C. Customer can also use other instruments for programming and debugging. A JTAG debug port is designed on the AFE Control Board-SAM4C.

3.2 Power Supply

The AFE Control Board - SAM4C can be powered either by external DC 9V power source or extended connector J7. Detailed information is described in Table 3-1.

Table 3-1 Power Sources for the AFE Control Board-SAM4C

Power Input	Input Voltage Requirement	Current Requirement	Connector Name
External DC	9V	500mA ~ 2A	PW1
Extension Port	3.3V	100mA	EXT_VDD(Pin20 of J7)

The Control Board contains one backup battery. During the outage, the backup battery can provide power supply so that the Real Time Clock (RTC) can keep working.

3.3 Standard Headers and Connectors

3.3.1 Power Header

The power header (PW1) can be used to connect external power to the AFE Control Board-SAM4C.

When JP6 is connected, the control board is powered by 3.3V. User can measure power consumption by connecting to an ammeter serially.

When JP7 is connected, on-board 3.3V power route is connected to external power (EXT_VDD).

Figure 3-1 J1 Power Selection

3.3.2 JTAG Debug Connector

The AFE Control Board-SAM4C has a dual row, 20 pin, and 100mil JTAG Debug header.

For detailed information of JTAG debug header, please refer to SAM-ICE.pdf.

4. Hardware User Guide

4.1 Connectors

This chapter describes the implementation of the relevant connectors and headers on AFE Control Board-SAM4C and their connection to the ATSAM4C.

4.1.1 I/O Extension Headers

The AFE Control Board-SAM4C has a dual row, 20 pin, 100mil extension male header (J8). J8 offers access to the I/O of the microcontroller in order to expand the board, e.g. by connecting extensions to the board. Table 4-1 shows the pin assignment of J8. User can also expand the function by customized development.

Table 4-1 Pin Assignment of J8

Pin Number	Pin Name	Description
1	PB11	SAM4C GPIO PB11
2	GND	Ground
3	NC	Null
4	NC	Null
5	NC	Null
6	NC	Null
7	PC6	SAM4C GPIO PC6
8	PC7	SAM4C GPIO PC7
9	PC8	SAM4C GPIO PC8
10	PA23	SAM4C GPIO PA23
11	PA24	SAM4C GPIO PA24
12	PA25	SAM4C GPIO PA25
13	PA11	SAM4C GPIO PA11
14	PA12	SAM4C GPIO PA12
15	PA22	SAM4C GPIO PA22
16	PA7	SAM4C GPIO PA7
17	PA6	SAM4C GPIO PA6
18	PA8	SAM4C GPIO PA8
19	GND	Ground
20	VCC	Power for extension board

4.1.2 Communication Connector

The AFE Control Board-SAM4C has a dual row, 20 pin, 100mil communication male connector (J7). When connecting to the daughter board, the AFE Control Board-SAM4C can communicate with it through J7. Table 4-2 shows the definition of J7.

Table 4-2 Definition of J7

Pin Number	Pin Name	Type	Description
1	PA13	Input	SAM4C GPIO PA13, ZX0 (zero crossing signal of the daughter board)
2	GND	Power-	Ground
3	PA16	Input	SAM4C GPIO PA16, ZX2 (zero crossing signal of the daughter board)
4	PA18	Input	SAM4C GPIO PA13, ZX1 (zero crossing signal of the daughter board)
5	PA19	Input	SAM4C GPIO PA13, CF2 (energy pulse signal of the daughter board)
6	PA20	Input	SAM4C GPIO PA20, CF1 (energy pulse signal of the daughter board)
7	PA26	Input	SAM4C GPIO PA26, CF4 (energy pulse signal of the daughter board)
8	PA27	Input	SAM4C GPIO PA27, CF3 (energy pulse signal of the daughter board)
9	PA28	Input	SAM4C GPIO PA28, IRQ0 (interrupt request signal of the daughter board)
10	PA29	Input	SAM4C GPIO PA29, WarnOut (warn out signal of the daughter board)
11	PB6	Output	SAM4C GPIO PB6, PM0 (mode selection of the daughter board)
12	PB7	Input	SAM4C GPIO PB7, IRQ1 (interrupt request signal of the daughter board)
13	PB8	Input	SAM4C GPIO PB8, DMA (direct memory access signal of the daughter board)
14	PB9	Output	SAM4C GPIO PB9, PM1 (mode selection of the daughter board)
15	PC2	Output	SAM4C GPIO PC2, CS (chip select of SPI of the daughter board)
16	PC4	Input	SAM4C GPIO PC4, SDI (serial data input of SPI of the daughter board)
17	PC3	Output	SAM4C GPIO PC3, SDO (serial data output of SPI of the daughter board)
18	PC5	Output	SAM4C GPIO PC5, SCLK (serial clock output of SPI of the daughter board)
19	PB10	Output	SAM4C GPIO PB10, RST (reset signal output of SPI of the daughter board)
20	VDD_EXT	Power+	Power supply 3.3V

4.2 Peripherals

4.2.1 Crystals

The AFE Control Board-SAM4C contains two crystals that can be used as clock sources for the SAM4C device. More information about oscillator allowance and safety factor can be found in application note AVR4100.

Table 4-3 External 32.768 KHz Crystal

Pin on SAM4C	Function
XIN32	XIN32
XOUT32	XOUT32

Table 4-4 External 8.192MHz Crystal

Pin on SAM4C	Function
PA31	XIN
PA30	XOUT

4.2.2 Jumper Description

The AFE Control Board-SAM4C contains three jumpers that are used for function selection of the board. Table 4-5 shows the details.

Table 4-5 Jumper Description

Jumper Name	Function	Pin on SAM4C	Description
JP1	JTAGSEL	JTAGSEL	JTAG boundary scan select pin. It can be left unconnected for normal operation. For detailed information please refer to SAM4C_datasheet.pdf
JP2	TST	TST	TST is used for JTAG test. It can be left unconnected for normal operation. For detailed information please refer to SAM4C_datasheet.pdf
JP3	ERASE	ERASE/PC9	It can erase program in SAM4C flash when it's connected upon power up. After power up, JP3 is no longer functional. For detailed information please refer to SAM4C_datasheet.pdf

4.2.3 Segment LCD

The AFE Control Board-SAM4C has an LCD module with 6 common and 17 segment terminals. These 102 segments form several symbols and nine 7-segment characters. Figure 4-1 shows the details.

PIN	COM1	COM2	COM3	COM4	COM5	COM6
1	COM1	\	\	\	\	\
2	\	COM2	\	\	\	\
3	\	\	COM3	\	\	\
4	\	\	\	COM4	\	\
5	\	\	\	\	COM5	\
6	\	\	\	\	\	COM6
7	\	\	\	\	\	\
8	7D	7C	7B	7A	S22	S30
9	S17	8E	8G	8F	S21	S28
10	8D	8C	8B	8A	S20	S29
11	\	9E	9G	9F	S19	S26
12	9D	9C	9B	9A	S18	S25
13	S12	6A	6B	6C	6D	S33
14	S11	6F	6G	6E	P3	S32
15	S10	5A	5B	5C	5D	S31
16	S9	5F	5G	5E	COL2	P2
17	S8	4A	4B	4C	4D	S27
18	S7	4F	4G	4E	P1	S24
19	S6	3A	3B	3C	3D	S23
20	S5	3F	3G	3E	COL1	7F
21	S4	2A	2B	2C	2D	7G
22	S3	2F	2G	2E	S16	7E
23	S2	1A	1B	1C	1D	S15
24	S1	1F	1G	1E	S13	S14

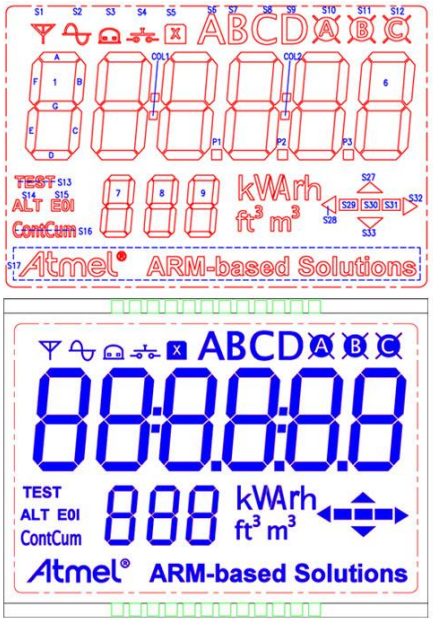


Figure 4-1 Segment LCD

4.2.4 Communication Interfaces

The AFE Control Board-SAM4C contains five communication interfaces. They are USB, RS485, RS232, modulation Infrared Radiation (IR) and Optical Infrared Radiation (OIR).

4.2.4.1 USB COM port

J3 is the USB interface for UART communication with host. LED D4 will flicker when one byte is received, and LED D5 will flicker when one byte is sent. Table 4-6 shows the details.

Table 4-6 USB COM Port

Pin on SAM4C	Function
PB5	TxD (SAM4C UART0 Tx line)
PB4	RxD (SAM4C UART0 Rx line)

4.2.4.2 RS485 and RS232 COM Port

RS485 and RS232 port is determined by JP5, as shown in Figure 4-2.

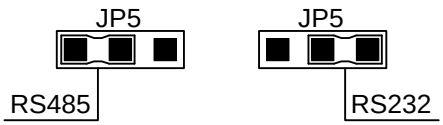


Figure 4-2 JP5 Configuration

Figure 4-4 and Table 4-7 shows RS485 and RS232 COM port schematics and connection.

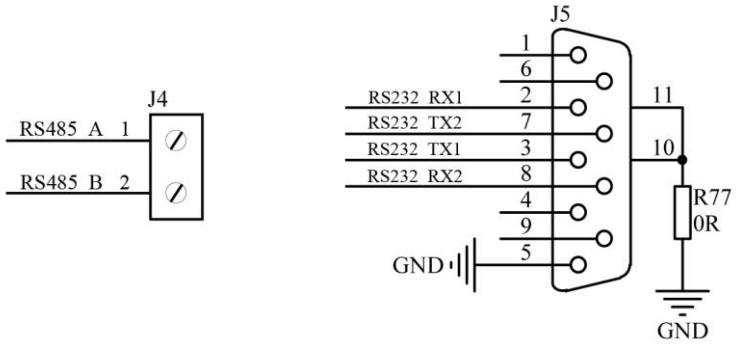


Figure 4-3 RS485 and RS232 COM Port Schematics

Table 4-7 RS485 and RS232 COM Port Connection

Pin on SAM4C	Function
PA10	TXD (SAM4C USART0 Tx line)
PA9	RXD (SAM4C USART0 Rx line)
PA15	CTS (SAM4C USART0 CTS line)
PA14	RTS (SAM4C USART0 RTS line)

4.2.4.3 IR and OIR COM port

IR and OIR COM port is determined by JP4, as shown in Figure 4-3.

Figure 4-3 JP4 Configuration

Table 4-8 shows IR and OIR COM port connection.

Table 4-8 IR and OIR COM Port Connection

Pin on SAM4C	Function
PC1	TXD (SAM4C USART1 TX line)
PC0	RXD (SAM4C USART1 RX line)

4.2.5 Electrically Erasable Programmable Read-Only Memory (EEPROM)

The AFE Control Board-SAM4C contains one EEPOM for storing data. EEPORM is U10 on the AFE Control Board-SAM4C.

Table 4-9 EEPROM Definition

Pin on SAM4C	EEPROM		Description
	Pin Number	Pin Name	
PA25	6	SCL	Serial clock
PA24	5	SDA	Serial data

4.2.6 Flash Memory (Flash)

The AFE Control Board-SAM4C contains one Flash program memory for extension programming. Flash is U12 on the AFE Control Board-SAM4C. Note that Flash memory is optional.

Table 4-10 Flash Memory Definition

Pin on SAM4C	Flash		Description
	Pin Number	Pin Name	
PA7	5	SI	Serial data input
PA6	2	SO	Serial data output
PA8	6	SCK	Serial clock
PA21	1	CS	Chip Select. Low active

4.2.7 Authentication

The AFE Control Board-SAM4C contains two authentication devices to perform data encryption and decryption. The two devices are U11 and U13 on the AFE Control Board-SAM4C. Note that the two devices are optional.

Table 4-11 Authentication Device Definition

Pin on SAM4C	Authentication Device		Description
	Pin Number	Pin Name	
PA25	6	SCL	Serial clock for I^2C
PA24	5	SDA	Serial data for I^2C

4.2.8 Mechanical Button

The AFE Control Board-SAM4C contains five mechanical buttons. Table 4-12 shows the details.

Table 4-12 Mechanical Buttons

Pin on SAM4C	Button Name	Description
RESET_N	NRST	Reset SAM4C
FWUP	FWUP	Fast wake up SAM4C from save power mode
TMP0	TMP0	Wake up SAM4C from save power mode
PB13	UP	Switch to display the previous content
PB14	DOWN	Switch to display the next content

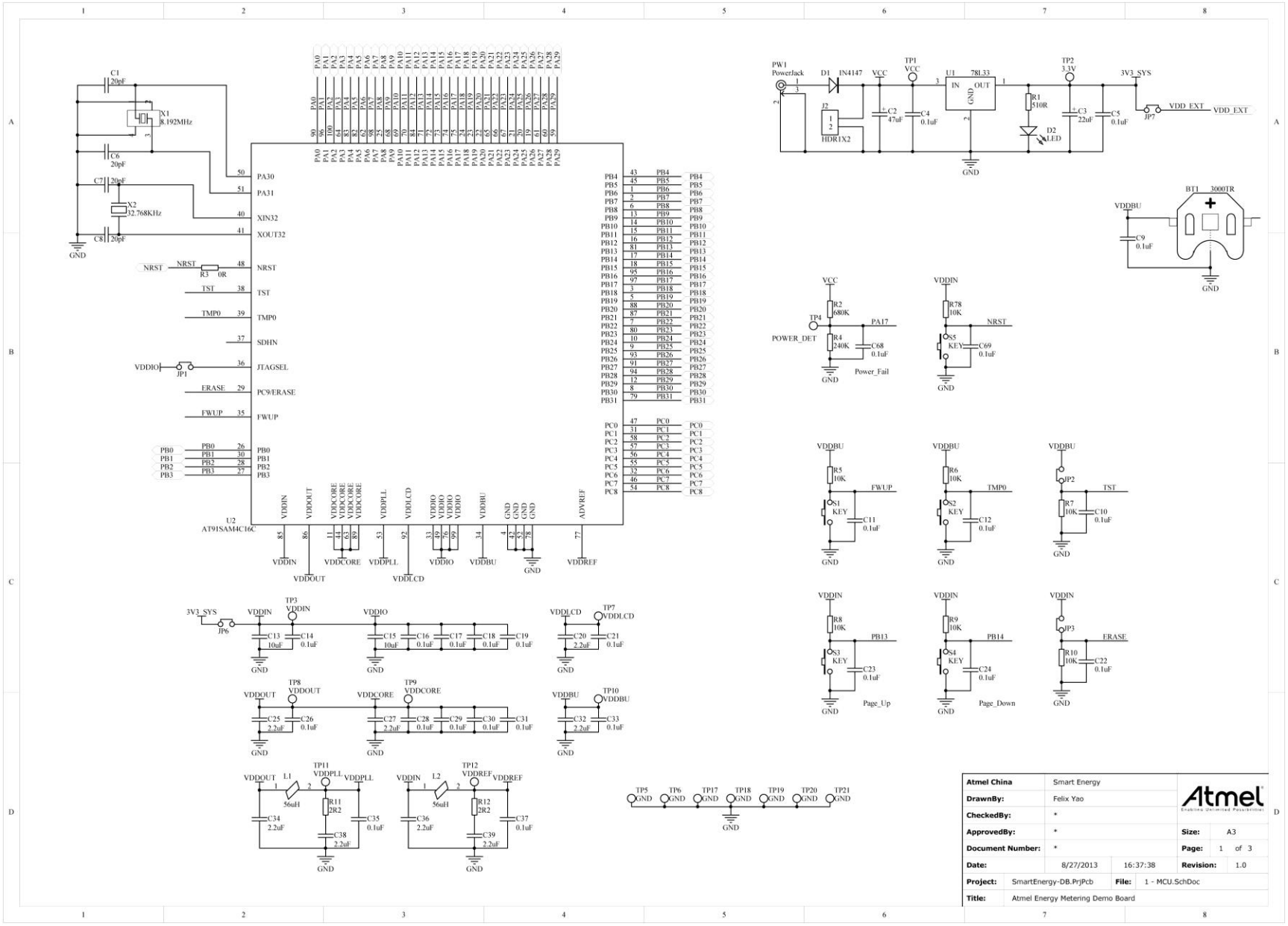
4.2.9 Button Cell Battery

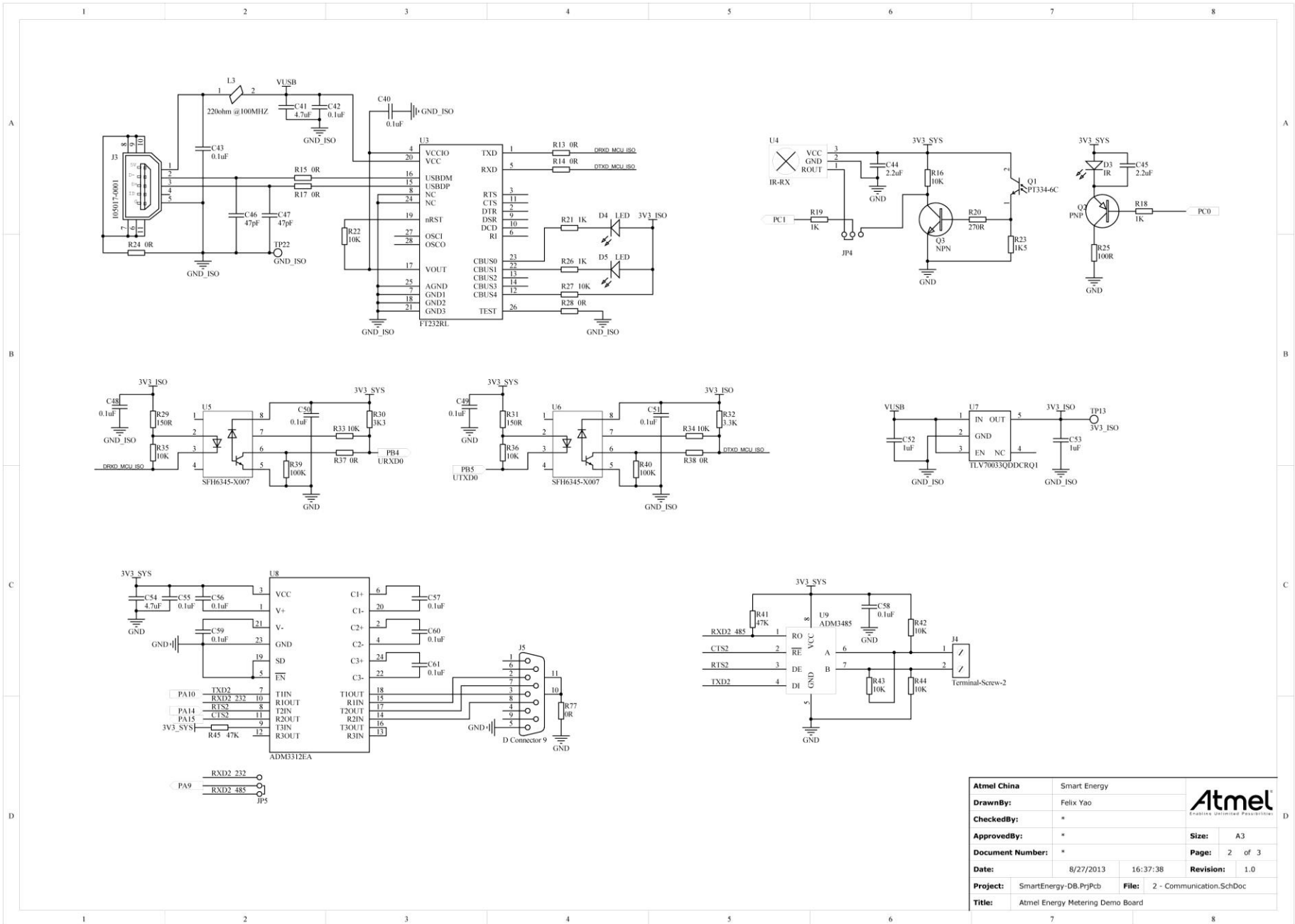
AFE Control Board-SAM4C contains one button cell battery. The button cell battery will ensure Real Time Clock (RTC) to work when outrage.

Table 4-13 Button Cell Description

Pin on SAM4C	Button Cell Name	Description
VDDBU	BT1	Keep Real Time Clock working when outrage

5. Demo Board Schematics





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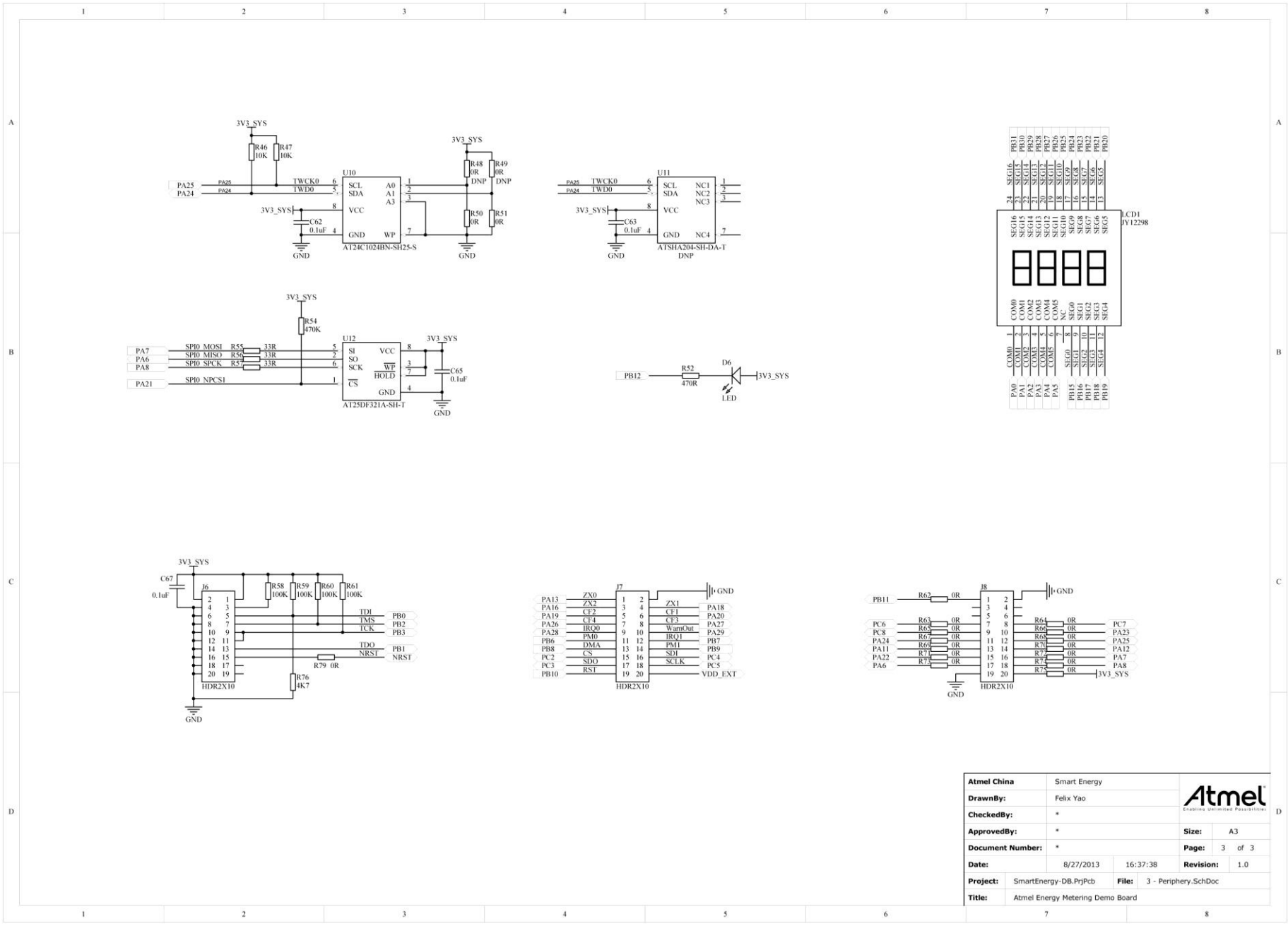
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R47 10K
U10
SCL
SDA
A0
A1
A3
VCC
GND
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R49 0R
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SPI0_NPCS1
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R61 100K
R76 4K7
R79 0R
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TCK
TDO
NRST
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PB2
PB3
PB1
HDR2X10
J7
ZX0
ZX1
CF2
CF1
CF4
CF3
IRQ0
WarmOut
PM0
IRQ1
DMA
PM1
CS
SDI
SDO
SCLK
RST
VDD_EXT
PA18
PA20
PA27
PA29
PB7
PB9
PC4
PC5
J8
PB11
R62 0R
PC6
PC8
PA24
PA11
PA22
PA6
PC7
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Atmel Energy Metering Demo Board

6. Revision History

Doc. Rev.	Date	Comments
1.0	09/09/2013	Initial release.

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