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STEVAL-IPE007V1: Single-phase energy meter  
with tamper detection based on ST7lite2x

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## Introduction

This user manual provides a description of a single chip energy meter, STEVAL-IPE007V1, with tamper detection. The meter fulfills IEC 61036:1996 + A1:2000 static meter requirements for active energy (classes 1 and 2) with  $I_b=10A$  and  $I_{max}=50A$ . It detects signals from a few mA, and continues to measure accurately even under tamper conditions.

The bill of materials and board schematics are also provided in [Appendix A](#) and [Appendix B](#).

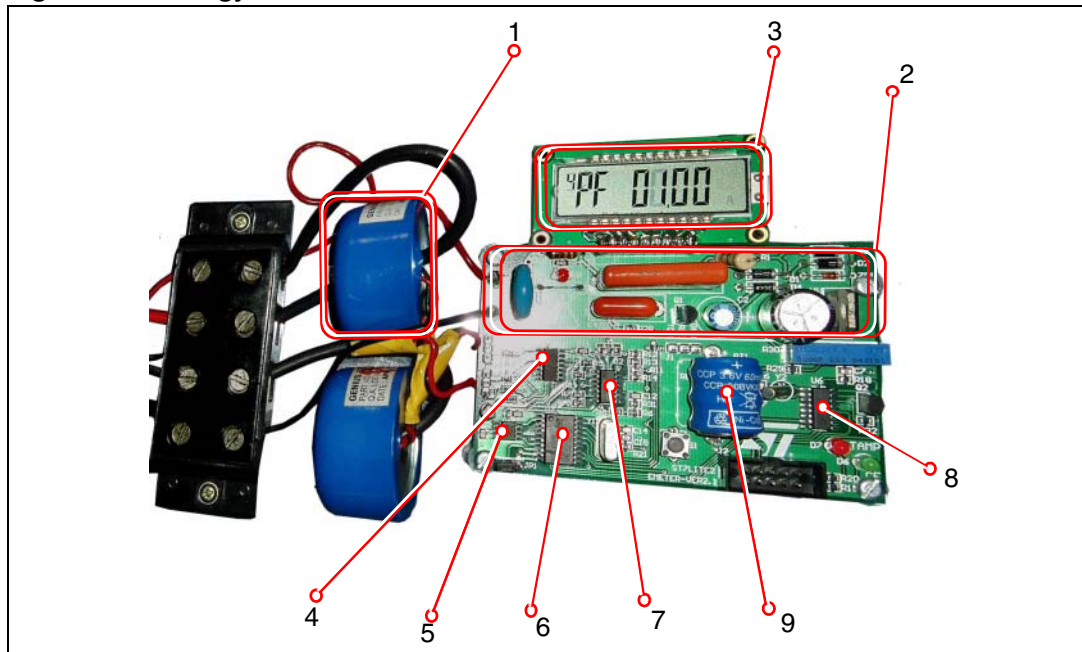
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# 1 Hardware overview

The following figure shows both the external parts and the main layout of the components across the board.

**Figure 1. Energy meter**

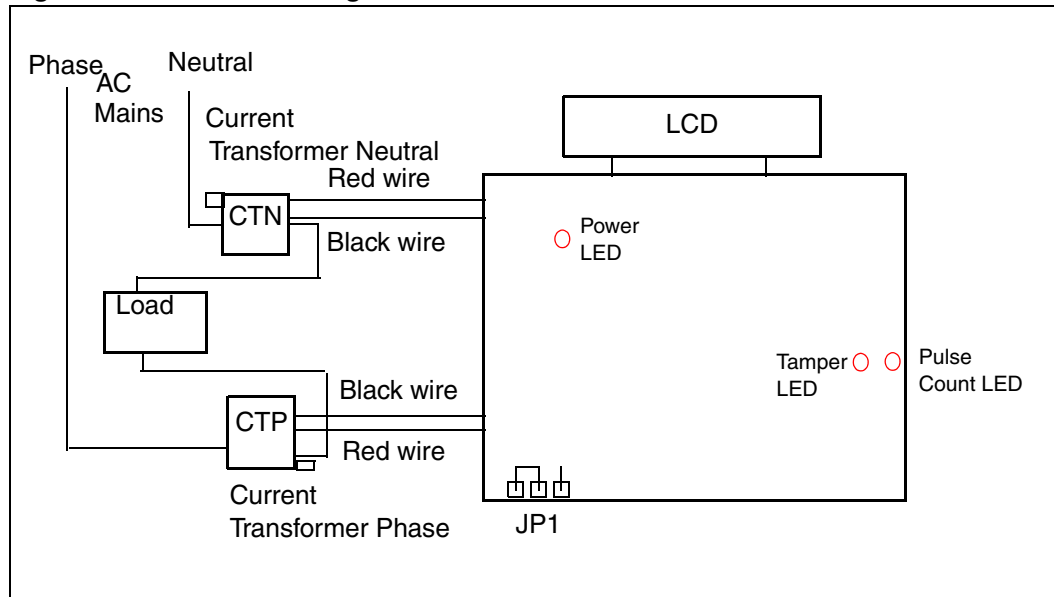


The parts are numbered as follows:

1. Current transformer
2. Power supply
3. LCD module
4. Analog switch
5. EEPROM
6. ST7Flite20 microcontroller
7. Operation Amplifier
8. Real time clock (RTC)
9. RTC Battery

The connection diagram is shown in [Figure 2](#). It shows two current transformers, the LCD display and the three LED's used.

**Figure 2. Connection diagram of meter**



The AC supply is connected to the power supply section of the energy meter. The power LED glows when the supply is on.

There are two current transformers to measure current in phase and neutral wires respectively.

The LCD module provides information about the kWh energy consumed, the input supply voltage, the input current, the power factor as well as the current date and time.

The tamper LED glows if the meter is tampered.

Finally, there is a pulse count LED which glows with a frequency proportional to the measured power. The proportionality constant can be set by the user.

## 2 Revision history

Table 1. Document revision history

Date	Revision	Changes
07-Apr-2006	1	Initial release.
25-Apr-2006	2	Document watermark removed

## Appendix A Bill of materials

**Table 2. Capacitors**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Ceramic	C5,C6,C7,C8,C9,C10,C11,C12		.1UF	50V	NA		SMD	8
2	Electrolytic	C3		1000uF	25V	NA	-55°C to +85°C	Leaded	1
3	Ceramic	C18,C19		22nF	50V	NA	NA	SMD	2
4	Ceramic	C14,C15,C16,C17		22pF	50V	NA	NA	SMD	4
5	Box	C1		1uF	400V	NA	NA	Leaded	1
6	Box	C4		10nF	400V	NA	NA	Leaded	1
7	Electrolytic	C2		100uF	25V	NA	-55°C to +85°C	Leaded	1
8	Ceramic	C13		10nF	50V	NA	NA	SMD	1
8	Ceramic	C20				NA	NA	SMD	1

**Table 3. Resistors**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1		R1		82E		2W	-55°C to +125°C	Leaded	1
2		R4		150K		1/8W	-55°C to +125°C	SMD	1
3		R2,R3		10K		1/8W	-55°C to +125°C	SMD	2
4		R5		110K		1/8W	-55°C to +125°C	SMD	2
5		R6		330K		1/8W	-55°C to +125°C	SMD	2
5		R8		470E		1/8W	-55°C to +125°C	SMD	1
6		R9		470E		1/8W	-55°C to +125°C	SMD	1
7		R7		220E		1/8W	-55°C to +125°C	SMD	1
8		R10		1.5K		1/8W	-55°C to +125°C	SMD	1

Table 3. Resistors

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
9		R11		51K		1/8W	-55°C to +125°C	SMD	1
10		R12		16K		1/8W	-55°C to +125°C	SMD	1
11		R13		0		1/8W	-55°C to +125°C	SMD	1
12		R14		390E		1/8W	-55°C to +125°C	SMD	1
13		R15		220E		1/8W	-55°C to +125°C	SMD	1
14		R16		390E		1/8W	-55°C to +125°C	SMD	1
15		R17		180E		1/8W	-55°C to +125°C	SMD	2
15		R31		220E		1/8W	-55°C to +125°C	SMD	2
16		R18		51K		1/8W	-55°C to +125°C	SMD	1
17		R21		100K		1/8W	-55°C to +125°C	SMD	1
18		R19,R20		2.2K		1/8W	-55°C to +125°C	SMD	2
19		R22,R23		36E		1/8W	-55°C to +125°C	SMD	2
20		R24,R25		1K		1/8W	-55°C to +125°C	SMD	2
21		R26		1K		1/8W	-55°C to +125°C	SMD	1
22		R28		1M		1/8W	-55°C to +125°C	SMD	1
23		R29		100E		1/8W	-55°C to +125°C	SMD	1
24		R27,R32		5.1K		1/8W	-55°C to +125°C	SMD	2

Table 4. Integrated circuits

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Positive voltage regulator	U1	L78L05A BZ	positive voltage regulators			-40°C to +125°C	TO-92	1
2	Op- Amp	U2	TS1854AID	1.8V input/output rail to rail low power operational amplifiers			-40°C to +125°C	SO14	1
3	Micro Controller	U3	ST7FLITE20F2M	8-BIT MCU with single voltage flash memory, data EEPROM, ADC, timers, SPI			-40°C to +85°C	SO20	1
4	SL EEPROM	U4	M95010-WMN6E	1kb SPI Bus	2.5V to 5.5V	NA	-40°C to +85°C	SO8	1
5	Analog Switch	U5	HCF4066M013TR	QUAD BILATERAL SWITCH	3V to 20V	NA	-55°C to +125°C	SOP14	1
6	Serial RTC	U6	M41T94MQ6E	512 Bit (64 bit x8) Serial RTC (SPI) SRAM	2.7V to 5.5V	NA	-55°C to +125°C	SOP14	1
7	LCD Module	LCD	GDM093	18x4 module					1

Table 5. Diodes

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Rectifier Diode	D1,D2,D3 ,D4	1N4007	NA	1000V (Reverse Voltage)	NA	-65°C to +175°C	Leaded, DO-41	4
2	LED	D5,D6,D7	LED 3mm	NA	NA	NA	NA	Red LED 3mm	3
3	Zener diode	ZD1			9.1V	1/2 W			1
4	Transistor	Q1,Q2	BC547B	NPN Epitaxial Silicon Transistor				TO-92	2
5	Transistor	Q3 (Very fast switching transistor)	PN2222A	NPN General Purpose Amplifier				TO-92	1



Table 6. Metal oxide varistors

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	MOV	MV1			400V				1

Table 7. Trim pot

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	TRIM POT	R30		20K		NA		Rectangular, multi-turn Trim Pot	1

Table 8. Transformers and inductors

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Current Transformer			5000 turns, 10/40 amp by Genius Electricals					2

Table 9. Crystals

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Crystal	Y1	KDS6J	16MHz	NA	NA			1
2	Crystal	Y2		32.768kHz	NA	NA			1

Table 10. Ferrite beads

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Inductor Chip Beads	L1		220uH	NA	NA	-40°C to +125°C	Leaded	1
2	Inductor Chip Beads	L2		1uH	NA	NA	-40°C to +125°C	Leaded	1

Table 11. PCB

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	PCB		92x62 mm						1

**Table 12. Switches**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Press button Switch (Size 6.1mm x 6.1 mm)	S1							1

**Table 13. ICP connector**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	ICP connector	CON10A							1

**Table 14. Rechargeable battery**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	Battery	BT1							1

**Table 15. Terminal**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	4-pin terminal			60A,500V					1

**Table 16. Bug stick, jumpers and wires**

Item #	Desc.	Ref.	Part #	Value	Voltage	Rating	Temp. Range	Pack / Type	Qnt
1	15 pin Bugstick								1
2	9 pin female bog stick								1
3	1 Jumper								1
4	Wires			60A,500V					
5	Red black wire			1A, 500V					

# Appendix B Board schematics

Figure 3. Schematic 1/6

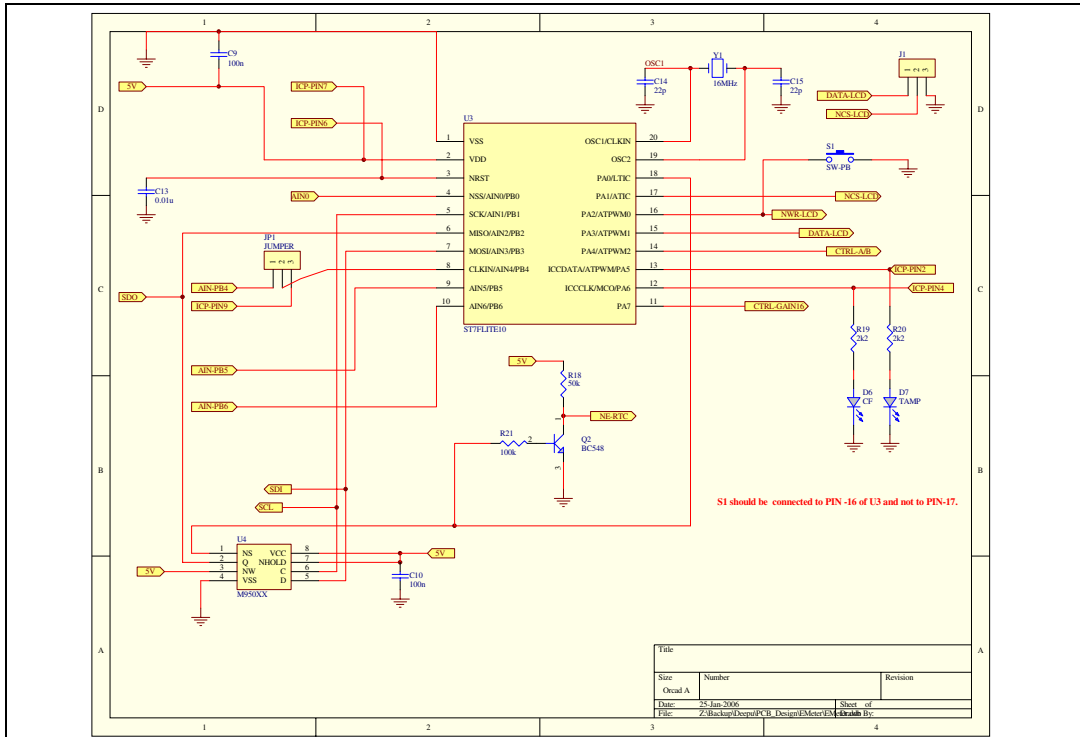


Figure 4. Schematic 2/6

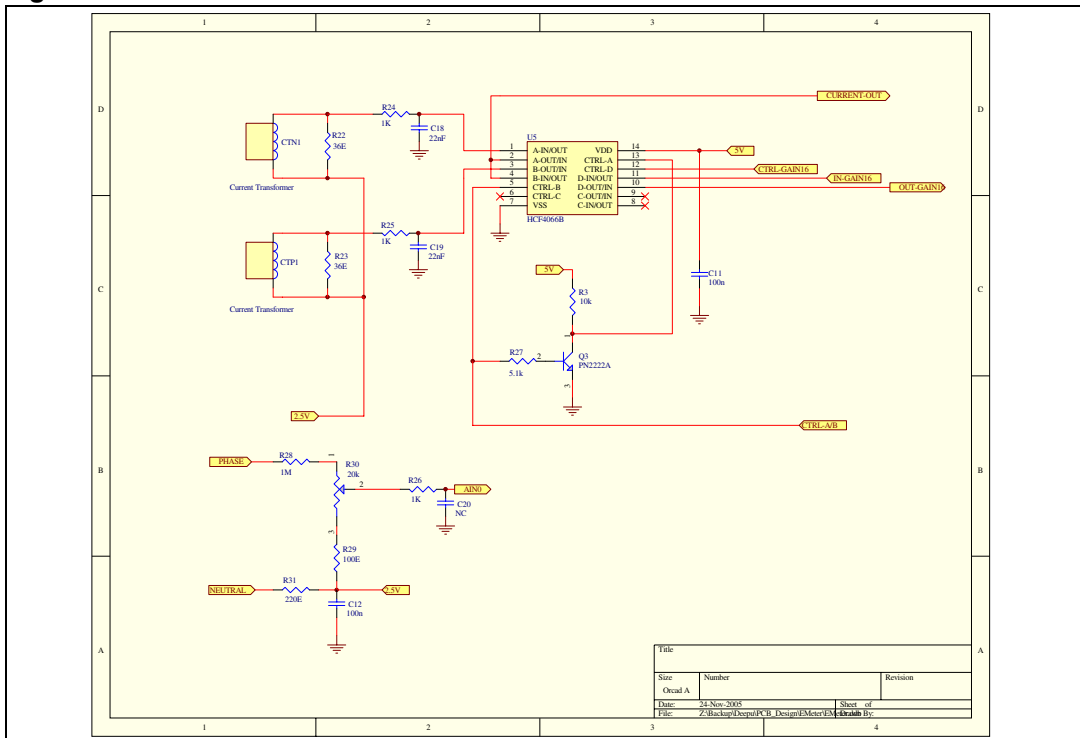


Figure 5. Schematic 3/6

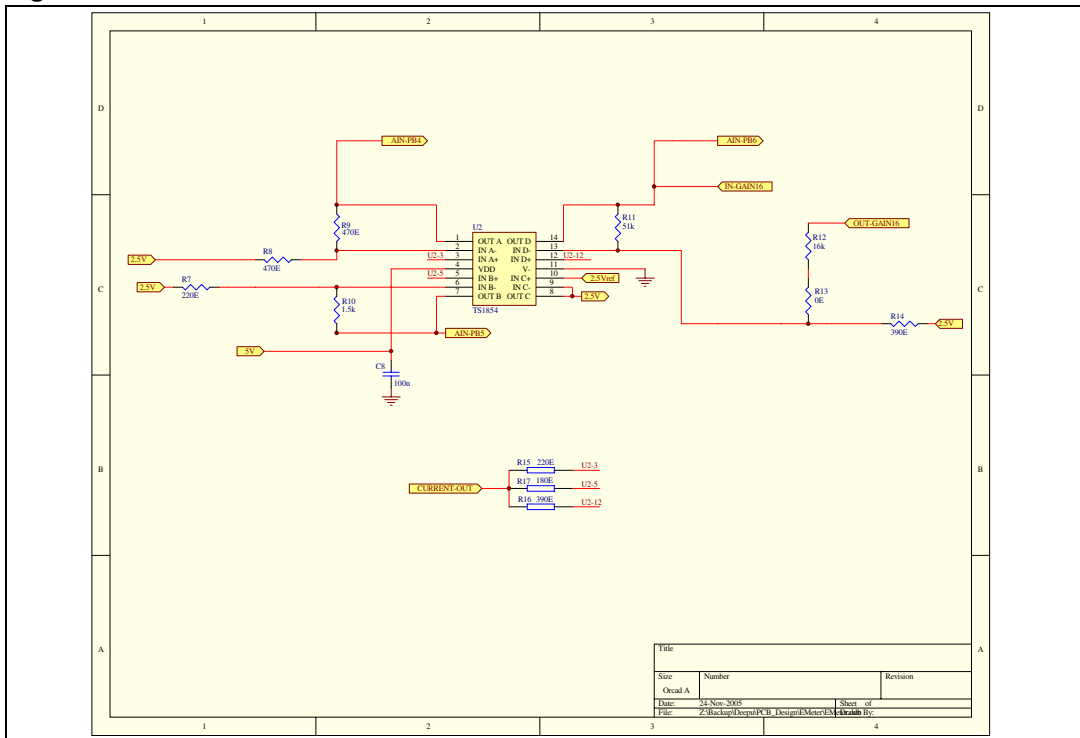


Figure 6. Schematic 4/6

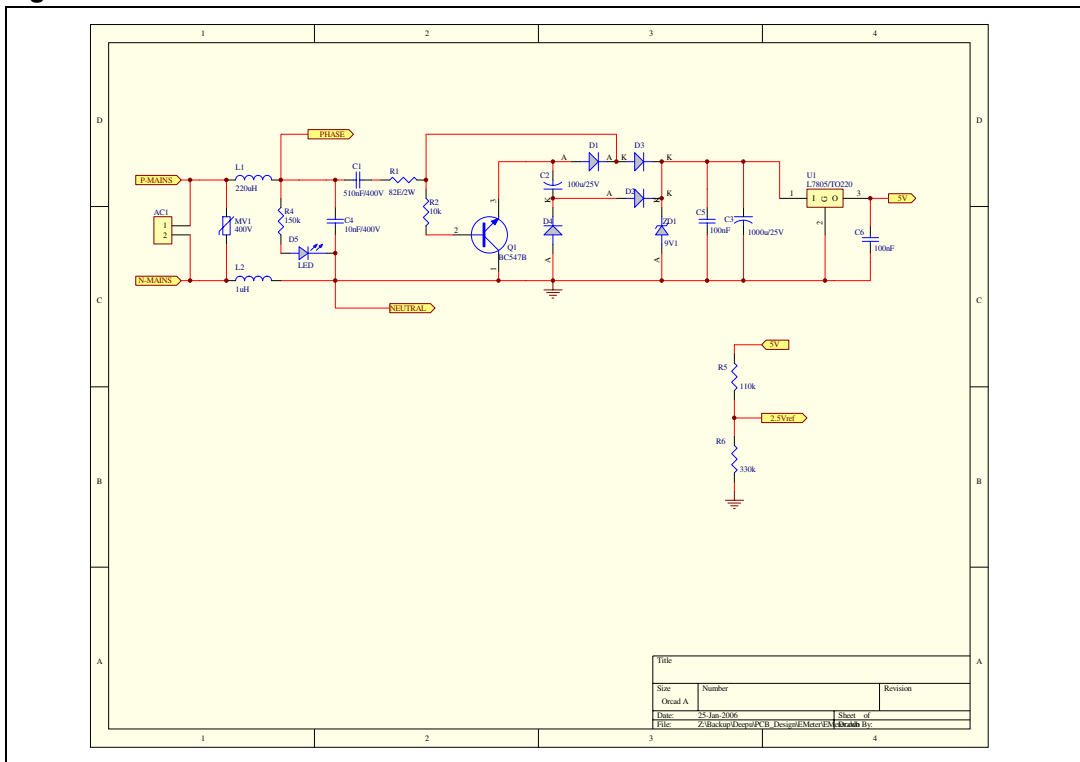


Figure 7. Schematic 5/6

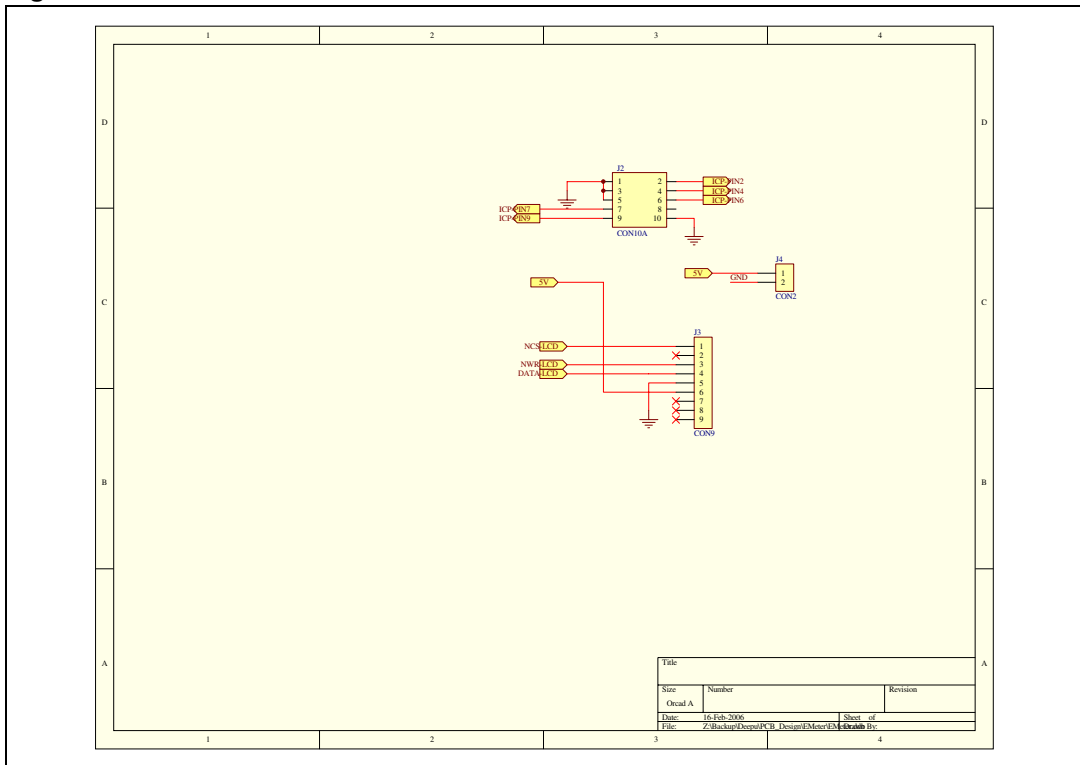
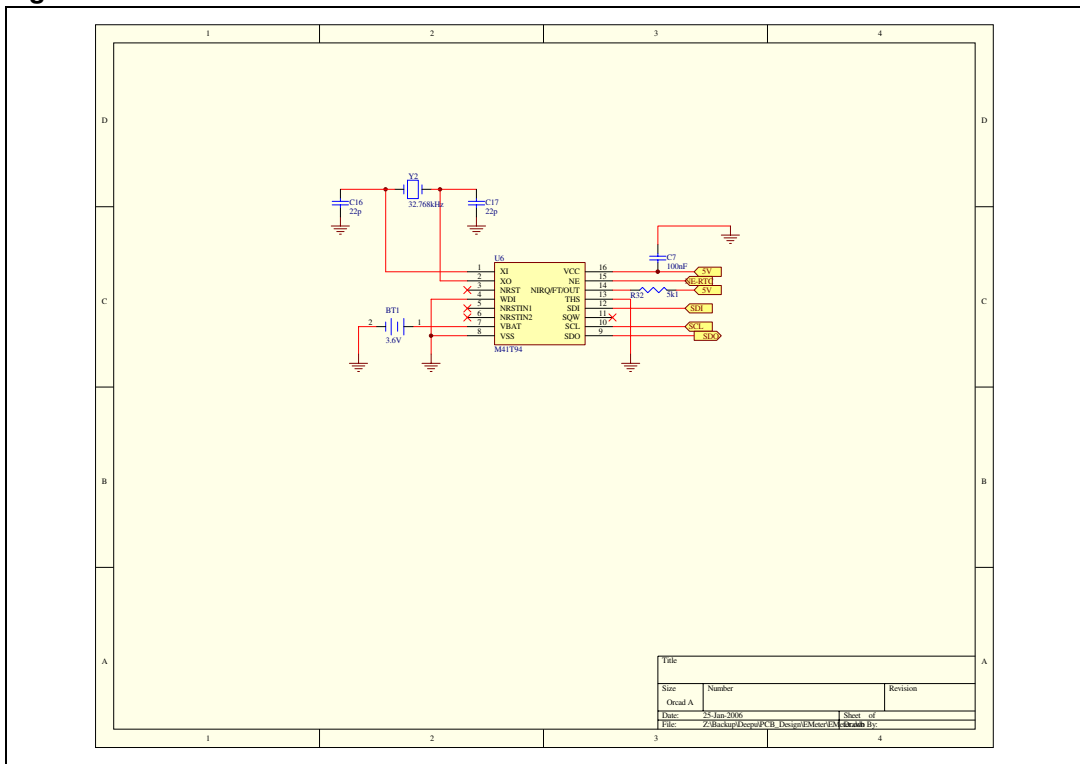


Figure 8. Schematic 6/6



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