A1/B1 Baseboard User Manual

v1.6
07/05/2017

Table of contents

Preface

This document describes the performance and other technical characteristics of the A1/B1 Baseboard. The datasheet layout is as follows:

Chapter 1. Introduction – contains the main information about the board and a description of operation.

Chapter 2. Electrical characteristics – outlines the electrical characteristics of the A1/B1 Baseboard.

Chapter 3. Installation and operation – describes how to get started using the A1/B1 Baseboard.

Chapter 4. Application notes – contains useful additional information.

Appendix A. “Schematics and Layouts” – shows the schematic and layout diagrams of the board.

Appendix B. “Bill of Materials (BOM)” – lists the parts used to build the board.

Eccel Technology provides online support via our website at www.eccel.co.uk and e-mail sales@eccel.co.uk.

1 Introduction

1.1 General description

The A1/B1 Baseboard is a demonstration board for the A1 and B1 modules. The User can test all features of both modules, check tag detection ranges, or install the Baseboard on their own systems to verify compatibility. The Baseboard is a complete reader and tag acceptance solution for passive RF transponders. The modules are designed with embedded applications in mind. These products are an ideal design choice if the user wishes to add RFID capability to their design quickly and without requiring extensive RFID and embedded software expertise and time. The on board low power ARM microcontroller handles the RFID configuration setup and provides the User with a powerful yet simple command interface to facilitate fast and easy read/write access to the memory and features of the various transponders supported by these modules. The modules simply require a single power and GND connection from the user PCB as well as two connections to an antenna. Eccel Technology Ltd (IB Technology) provide a wide range of suitable antennas designed to be used with these modules. The A1/B1 Baseboard provides these connections to the modules for the user to evaluate and develop their application on either the RFID-A1 or RFID-B1 module.

The A1/B1 baseboard is equipped with a USB 2.0 I^2C^{TM}/UART/Protocol Converter (MCP2221A) that allows the User to communicate with a PC through a USB interface if necessary, so that system features can be customised, configuration changed and tag read/write data handled by a host system. The MCP2221A has four GP pins for miscellaneous functionalities e.g. GPIO, ADC or DAC and all of them are used in the A1/B1 Baseboard to test the B1 module. More information about the MCP2221A USB Bridge: www.microchip.com/wwwproducts/en/MCP2221A/.

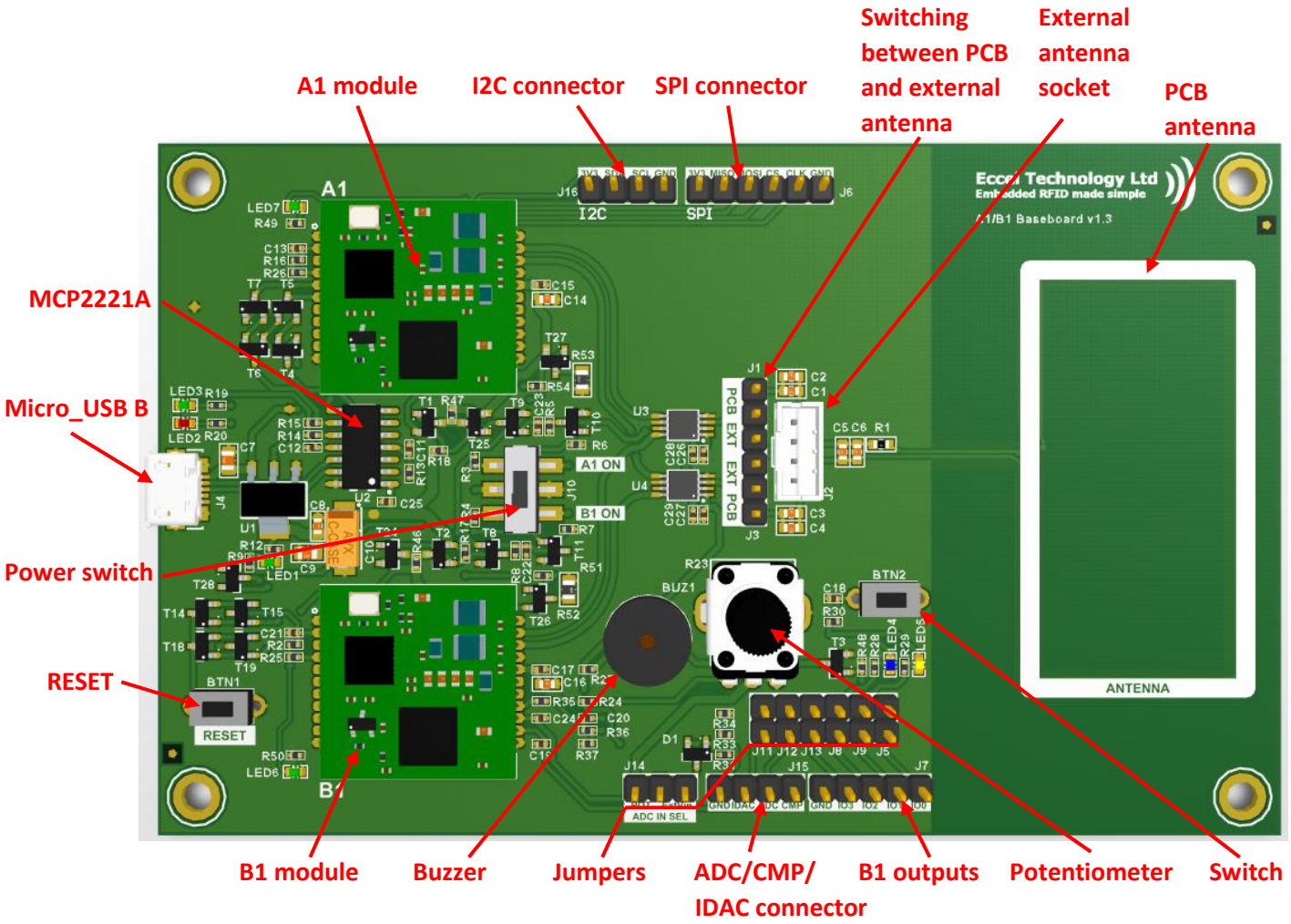
The User can install both modules on the Baseboard but only one of them will operate at a time depending the user selection of the slide switch to one of two available positions – A1_ON or B1_ON. All of the required digital lines are connected to the pin headers: SPI to pin header J6, I2C to pin header J16, B1 outputs to pin header J7, ADC/IDAC and CMP from the B1 module to pin header J15, J14.

1.2 Features

Parameter	Typical Value
Range (dependent upon antenna dimensions and tuning, tag: Mifare 1k ISO card) a) PCB antenna (on board) b) External PCB antenna 50x50mm (RFID-ANT1356-50x50-300 v1) c) External PCB antenna 25x25mm (RFID-ANT1356-25x25-300 v1)	 up to 50 mm up to 70 mm up to 40 mm
Nominal RF frequency	13.56 MHz
Supported tags	Mifare Classic, Ultralight, NTAG2
Time needed to read the whole tag memory (Classic 1k)	0.5 s
Time needed to write the whole tag memory (Classic 1k)	0.6 s
Output pin current	up to 6 mA
Switch input – pulled up (only the B1 module)	active low
SPI max speed (only the A1 module)	up to 500 kHz
I2C max speed (only the A1 module)	up to 400 kHz
Width x Length	117 x 72 mm

Table 1.

1.3 Product overview

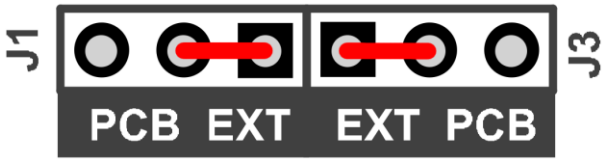


Note: Mounting holes spacing: 109 x 64 mm. Hole size is 3.2 mm.

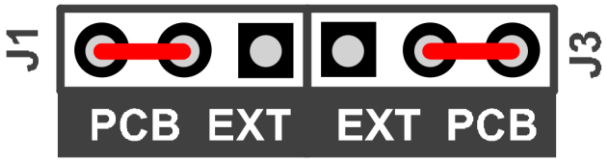
REMARK: <u>The A1/B1 Baseboard is provided without the A1 and B1 modules because they are sold separately.</u>

1.4 Outputs and headers

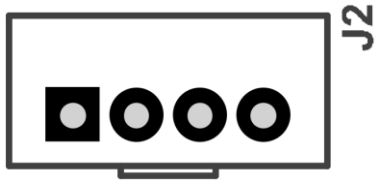
The A1/B1 Baseboard has a link option to select between either the on-board 13.56 MHz PCB antenna or an external 13.56 MHz antenna. J2 is a socket for an external antenna. To achieve better performance in ranges of the antenna Eccel Technology Ltd recommends using our external antennas from series RFID-ANT1356-50x50-xxx (where xxx means the length of cable). Antennas are available via our website: www.eccel.co.uk. The headers and jumpers used on the A1/B1 baseboard are described below.



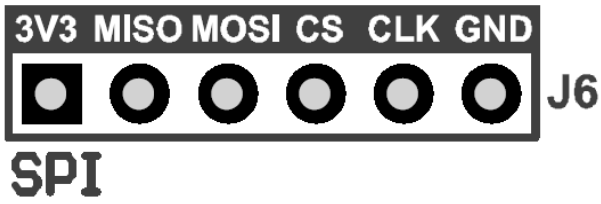
J1, J3. Antenna selection header – external antenna



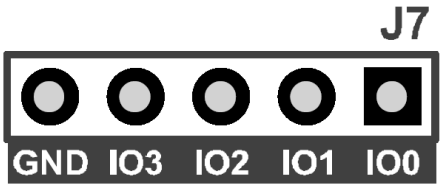
J1, J3. Antenna selection header – PCB Antenna



J2 – external antenna socket

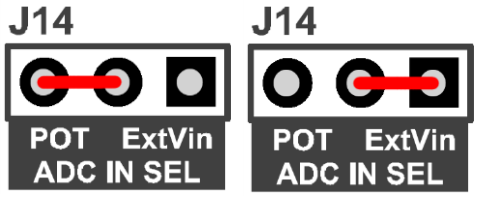


J6 – SPI connector (only the A1 module)
J6.1 – 3V3
J6.2 – MISO
J6.3 – MOSI
J6.4 – CS
J6.5 – CLK
J6.6 – GND



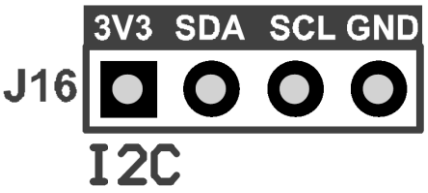
J7 – B1 inputs/outputs
J7.1 – B1 GPIO 0
J7.2 – B1 GPIO 1
J7.3 – B1 GPIO 2
J7.4 – B1 GPIO 3
J7.5 – GND

J15 – IDAC/ADC/CMP connector (only the B1 module)
J15.1 – CMP+ input
J15.2 – ADC input
J15.3 – IDAC output
J15.4 – GND

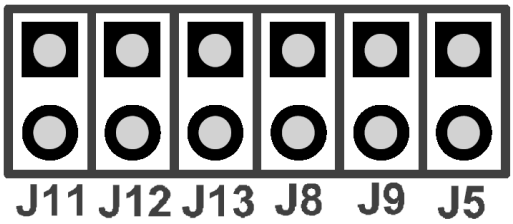


J14 – Input select for ADC (only the B1 module)

J14.1 <–> J14.2 – External input (max 3.3V)
J14.2 <–> J14.3 – Potentiometer 10k (on board – R23)



J16 – I2C connector (only the A1 module)
J16.1 – 3V3
J16.2 – SDA
J16.3 – SCL
J16.4 - GND



J11 – Jumper connecting the IDAC_OUT pin of the B1 module to the ADC input of the MCP2221A. The jumper is not connected by default.

J12 – Jumper connecting the DAC output pin of the MCP2221A to the ADC input pin of the B1 module. The jumper is not connected by default.

J13 – Jumper connecting the GPIO 3 pin of the B1 module to the button BTN2. The jumper is not connected by default.

J8 – Jumper connecting GPIO 2 pin of the B1 module to the LED4 (blue). The jumper is not connected by default.

J9 – Jumper connecting GPIO 1 pin of the B1 module to the LED5 (yellow). The jumper is not connected by default.

J5 – Jumper connecting the GPIO 0 pin of the B1 module to the buzzer. The jumper is not connected by default.

Note: The square pad is always pin number 1.

2 Electrical Characteristics

2.1 Test conditions

Typical device parameters have been measured at ambient temperature 22°C ±3°C and using a power supply of 5V ± 10%.

2.2 Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
T_S	Storage Temperature	-40	+85	°C
V_{DDMAX}	Supply Voltage	0	5.5	V
I_{IOMAX}	Output Pin Current	-	6	mA

Table 2.

2.3 Operating Conditions

Symbol	Parameter	Min	Average	Max	Unit	Notes
T_O	Operating Temperature	-25	-	+85	°C	
V_{DD}	Supply Voltage	4.5	-	5.5	V	5 V via USB bus
I_{AVE}	Current Consumption	20	60	120	mA	A1 or B1 module + LEDs + USB interface + external antenna + reading data from a tag

Table 3.

3 Installation and operation

3.1 Minimum system requirements

For USB connectivity, the minimal physical requirement of the PC is a standard USB 2.0 port. The board connects to the PC via the micro-USB connector (J4). It is recommended to connect the board to the PC via a self-powered USB hub. The following operating systems are supported: Windows XP (SP3), Vista, 7, 8, 8.1, 10, Linux® - any distribution with support for CDC and HID classes and Mac OS® – all versions – starting from 10.7.

3.2 Operation of the A1/B1 Baseboard

The board uses the Microchip MCP2221A USB bridge. Extensive support materials and driver packages can be found on the IC's webpage, on the Microchip web site. The driver will be automatically installed after connecting the A1/B1 Baseboard to a USB port on a Windows-based PC. If not, download and install the newest version of the driver from: http://www.microchip.com/wwwproducts/en/MCP2221A.

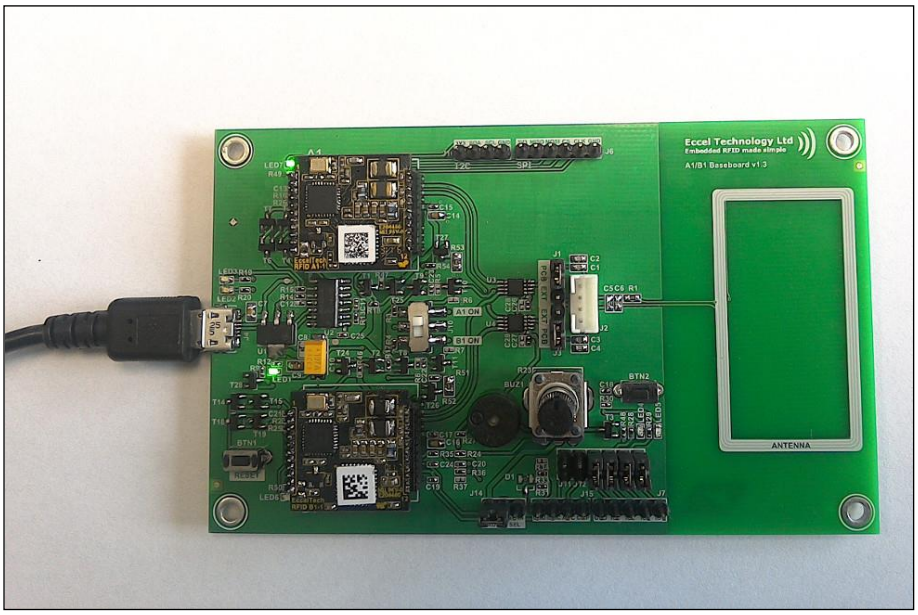
Eccel Technology provide a Windows application and debug utility named *B1-client* that allows all features of the B1 module and the card/tag type to be easily evaluated. The User can simply download the *B1-client* from the Eccel Technology website from here.

To test all features of the A1 module we recommend using a dedicated application from the Microchip website: MCP2221 I2C/SMBus Terminal: http://ww1.microchip.com/downloads/en/DeviceDoc/MCP2221Terminal.zip

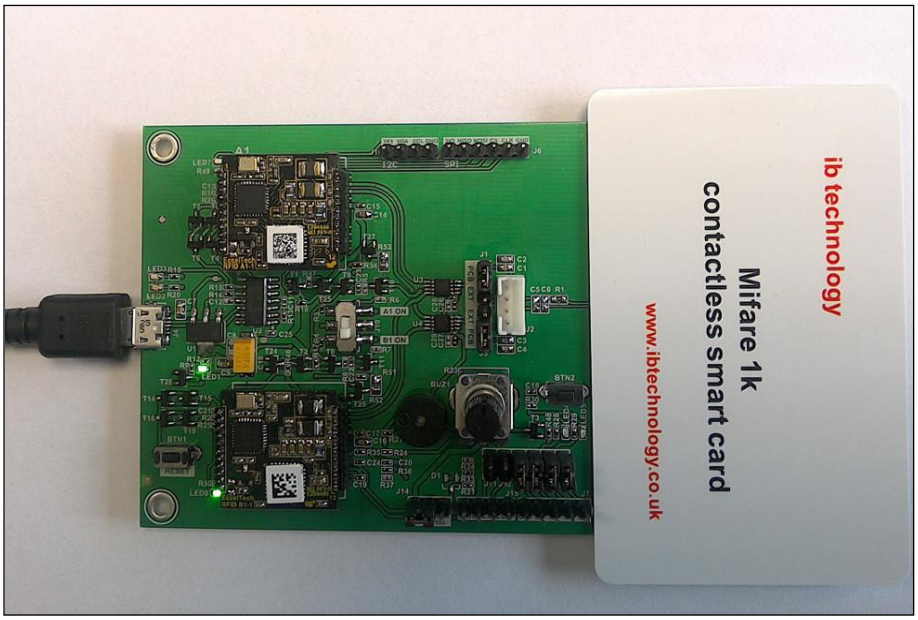
3.3 Getting started

Make sure that the A1 and/or B1 module is properly fitted (see the image in section 1.3). Check if the jumpers on the J1 and J3 connector are properly set up. It depends upon the antenna type – there is one setting for a PCB antenna and another for an external antenna (see section 1.4).

To start using the A1/B1 Baseboard simply connect it to a PC via the micro-USB cable. When power (5V DC) is first applied to the board, the green LED (LED1) lights. There are also two other green LEDs: LED7 which indicates that the A1 module is powered and LED6 which indicates that the B1 module is powered. By using the power switch J10 select the desired module for testing. The next step is to start the *B1-client* or MCP2221A I2C/SMBus Terminal and connect it with the baseboard. Before executing any commands make sure that there is a tag in the antenna field. Photos of the working baseboard and some information how to start using the baseboard are shown below.

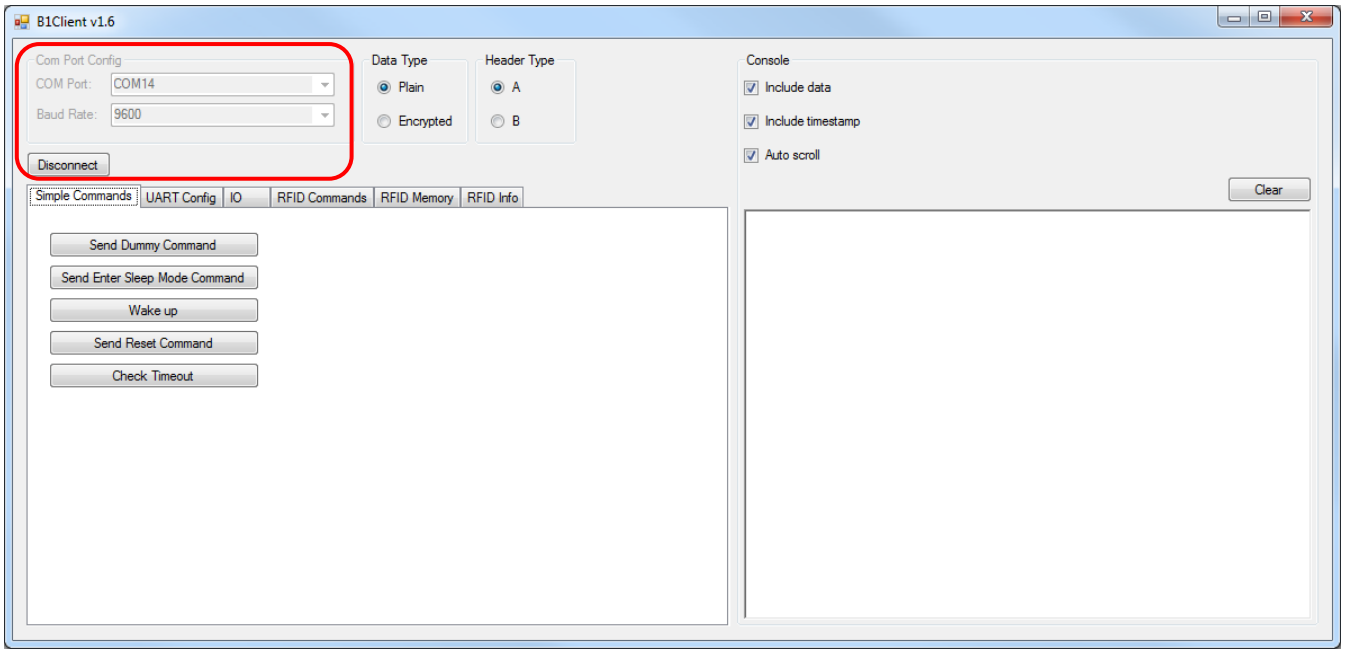


Power supply from USB,
PCB antenna mode,
A1 module powered,
no tag in RF field,
Green LED (LED7) on



Power supply from USB,
PCB antenna mode,
B1 module powered,
Mifare 1k tag in RF field
Green LED (LED6) on

The main window of the *B1-Client* software is presented below. At the beginning please select the proper COM port, set the Baud Rate to 9600 and then click *Connect* button.



To verify that everything is properly configured please send the *Dummy command* from the *Simple Commands* tab. The B1 module should answer with ACK{}. If not it is recommend to check the connection and configuration of the baseboard. The most important commands are placed in the *RFID Commands* tab. Simply select the proper command from the list and click *Execute*. Further information about the *B1-client* can be found on our website.

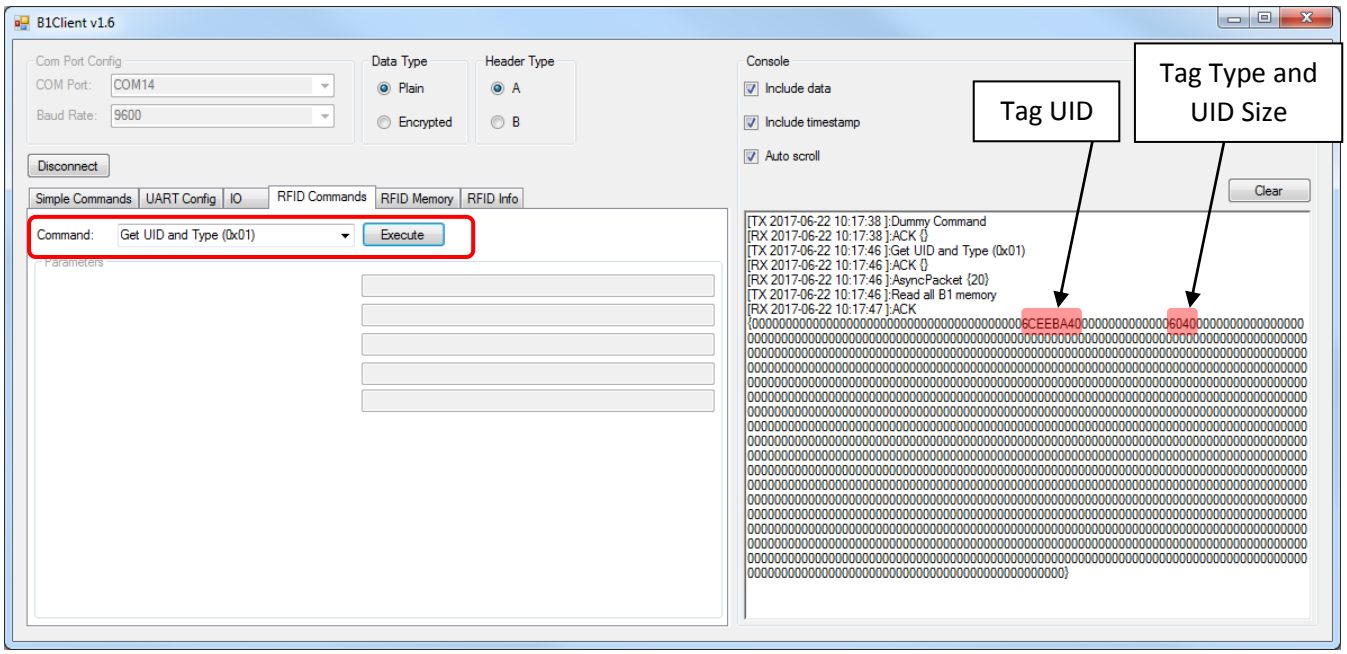
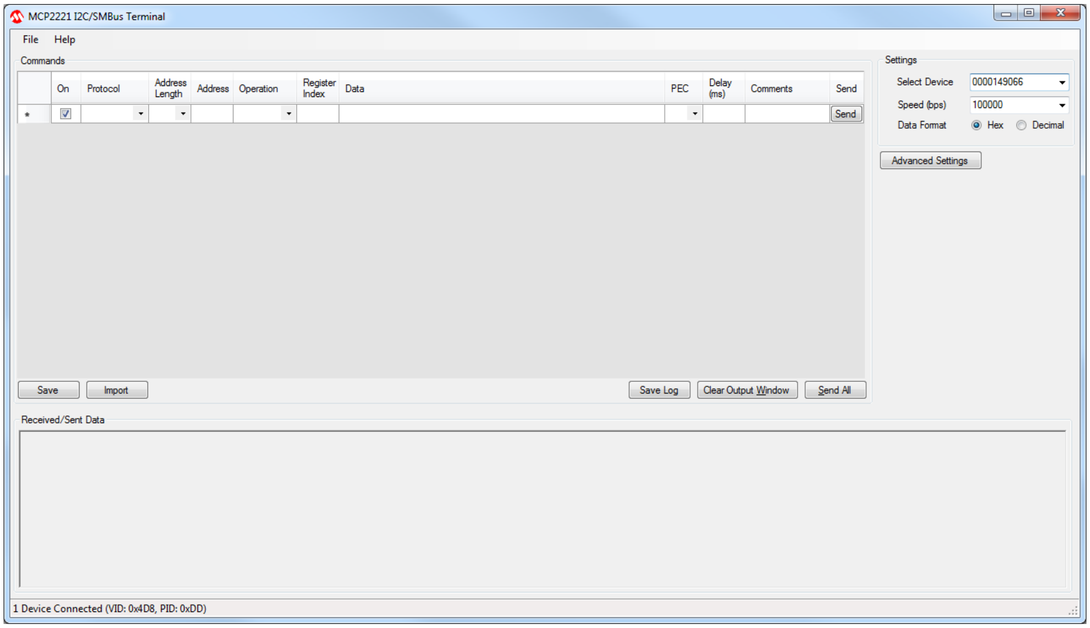


Figure 1. The Mifare Classic 1k tag in the RF field.

The main window of the MCP2221 I2C/SMBus Terminal software is presented below. If the slide switch is in the position A1_ON and the A1 module is properly fitted, then the user can start A1 module testing.



To get the Tag UID and type, the user should send 0x01 command (the Get UID and Type command has value 0x01) to the address 0x0001 (Command Register is located at address 0x0001) and then read the A1 memory, for example 255 bits (0xFF). The full A1 memory contains 728 bits (0x02D8). It is necessary to create two lines of commands: one to write the A1 command “Get UID and Type” and another to read the memory. A correctly read tag UID is shown below.

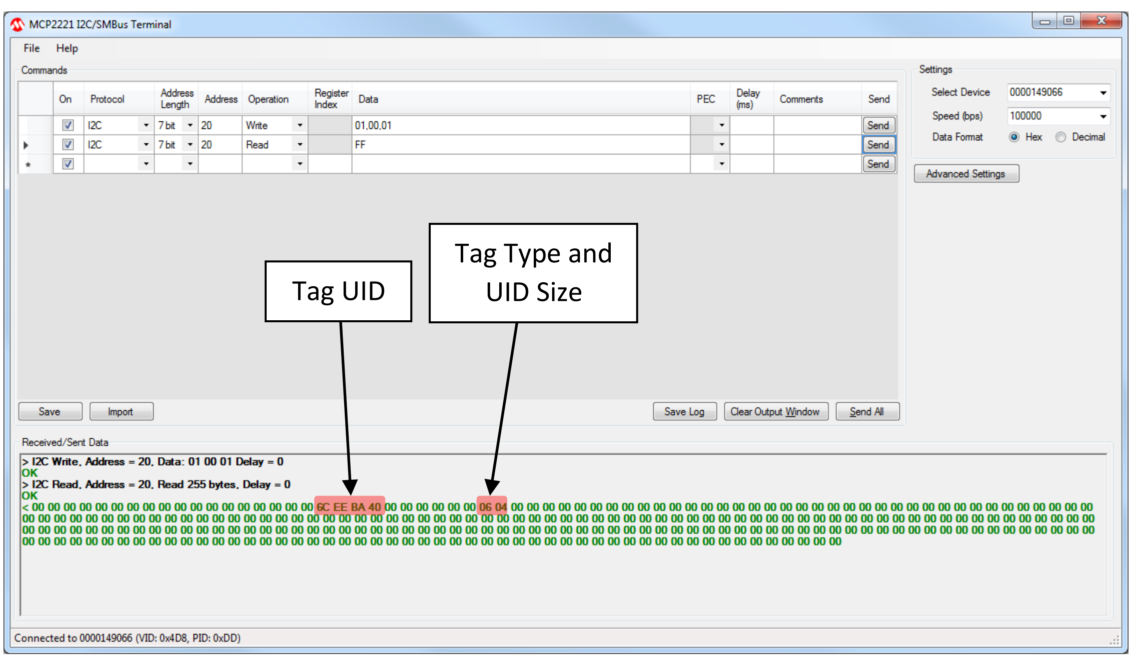
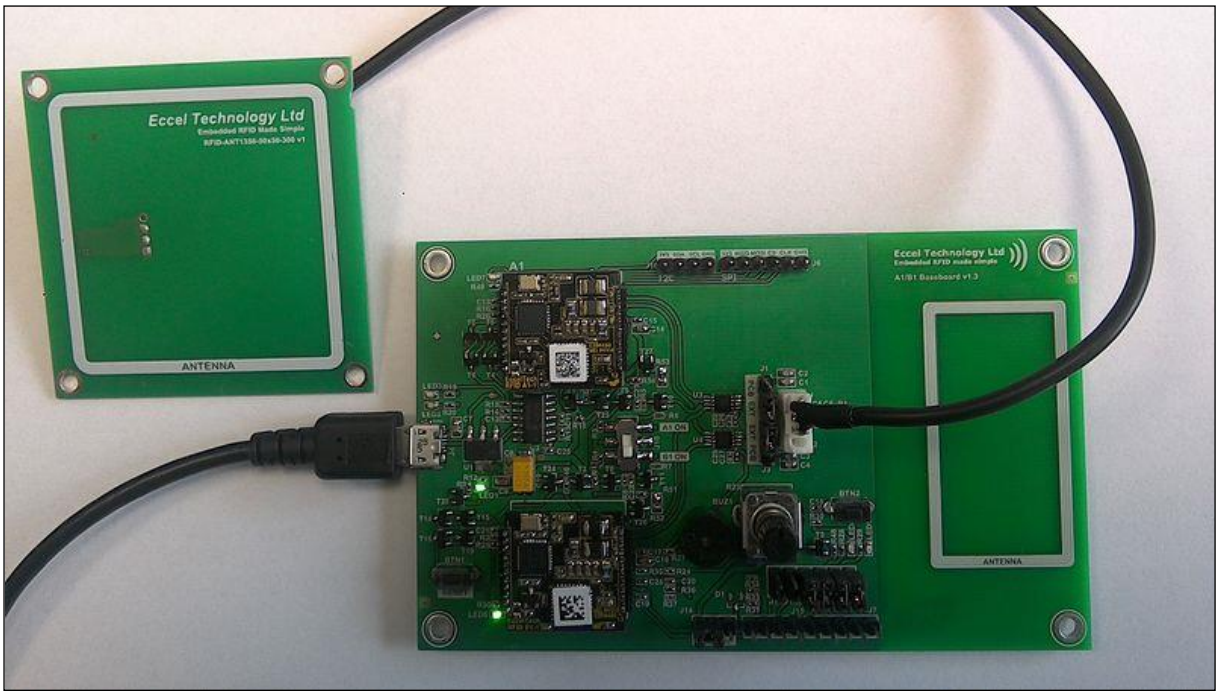


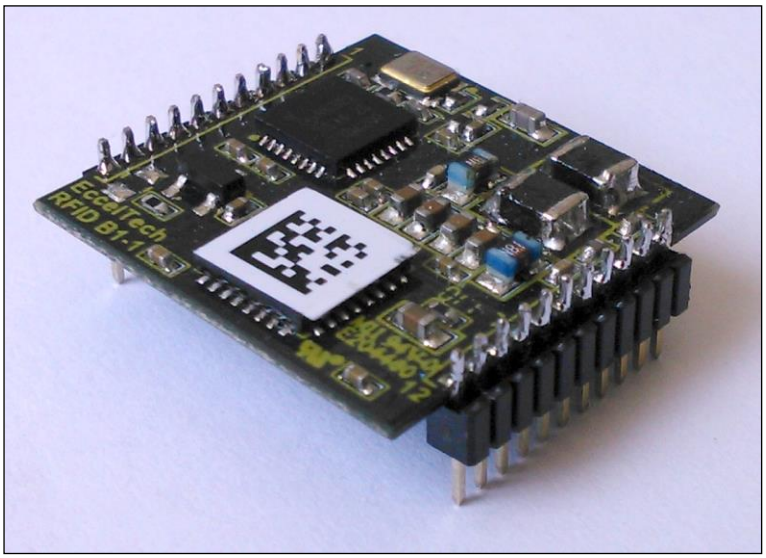
Figure 2. The Mifare Classic 1k tag in the RF field.

4 Application notes

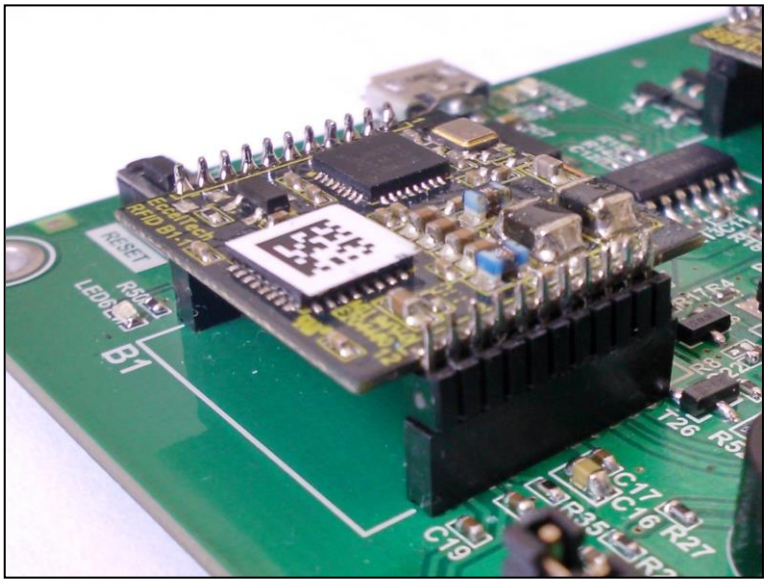
1. An external antenna can be mounted up to 1.5 meters from the A1/B1 Baseboard. The A1/B1 Baseboard with an external PCB antenna is shown below. This and other external antennas are available on our website: https://eccel.co.uk/product-category/antennas/



2. The external antenna must not be exposed to high voltage ESD sources.
3. In the application *B1-client*, the user can change GPIOs states from high to low and vice versa which allows the turning on/off LEDs: LED4 and LED5 or the buzzer and allows the reading the actual state of all of GPIOs.
4. The potentiometer is used to test the ADC operation. There are two possible inputs for the ADC, the user can choose from the potentiometer output voltage or the external voltage (the J14 header).
5. LEDS: LED2 and LED3 indicate the UART-USB interface activity. LED2 (red) indicates the UART Rx activity and LED3 (green) indicates the UART Tx activity.
6. The system will only perform well if the 5V supply is stabilised and noise free. It should be able to source the maximum current with a good safety margin.
7. There are two possibilities to mount the A1 or B1 modules. User can solder them directly on the Baseboard using castellated SMT pads or use male and female 1.27 mm headers like in the picture above.
8. Make sure that while reading the data from a tag there are no obstacles between the antenna and the tag, especially metal obstacles which can highly decrease the read range.



The RFID B1 module with male 1.27mm header

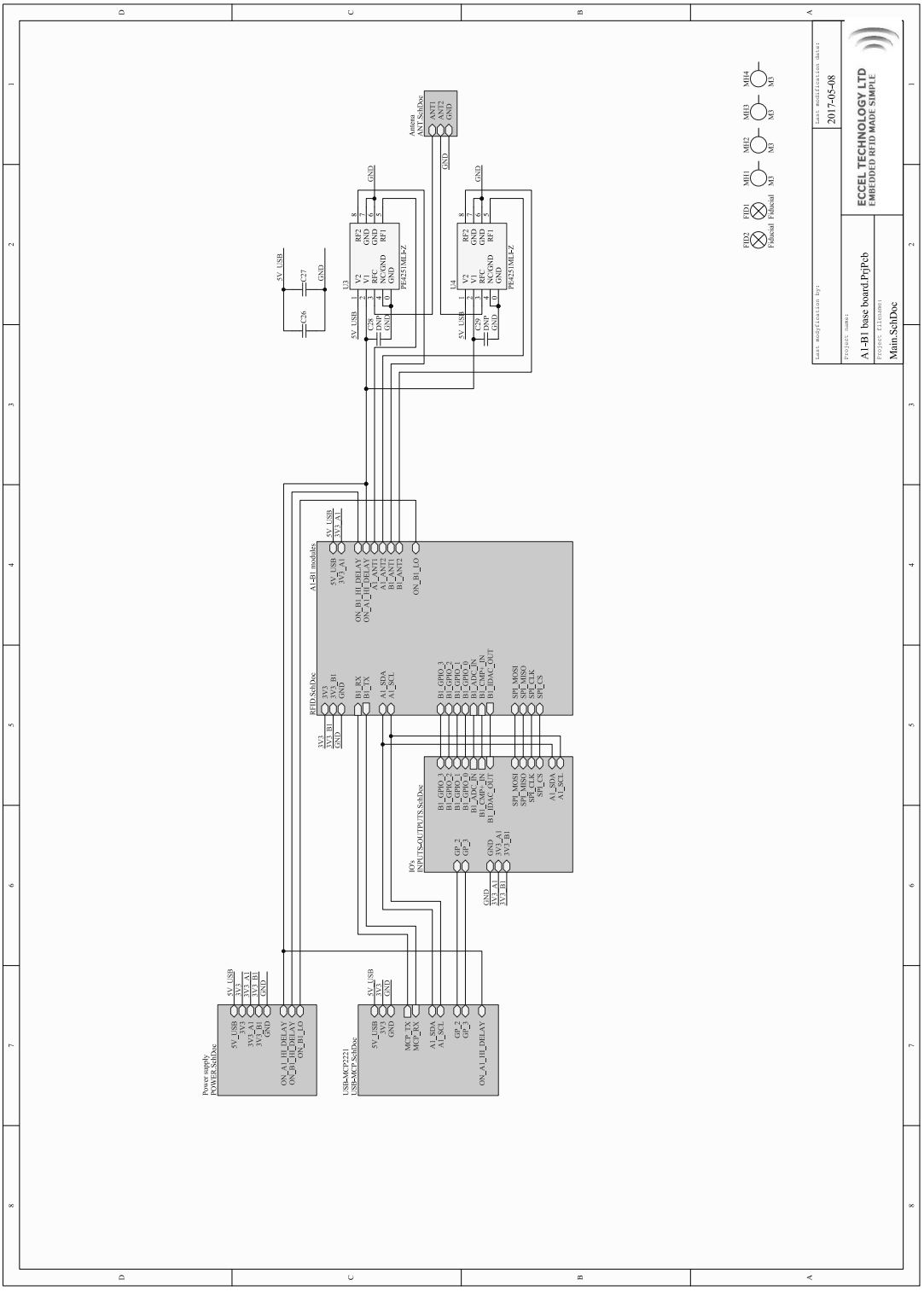


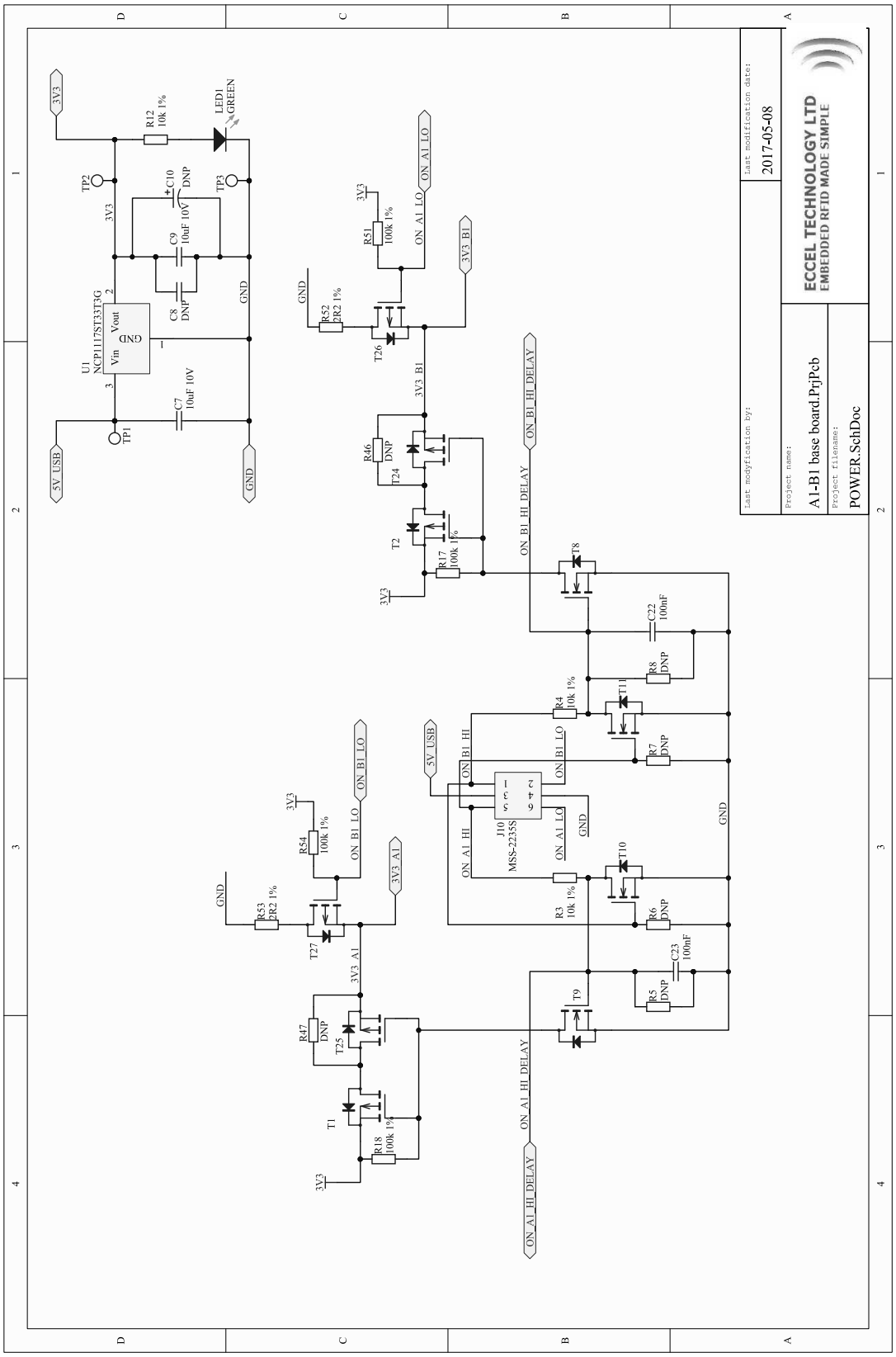
The RFID B1 module mounted on the Baseboard by using male and female 1.27 mm headers

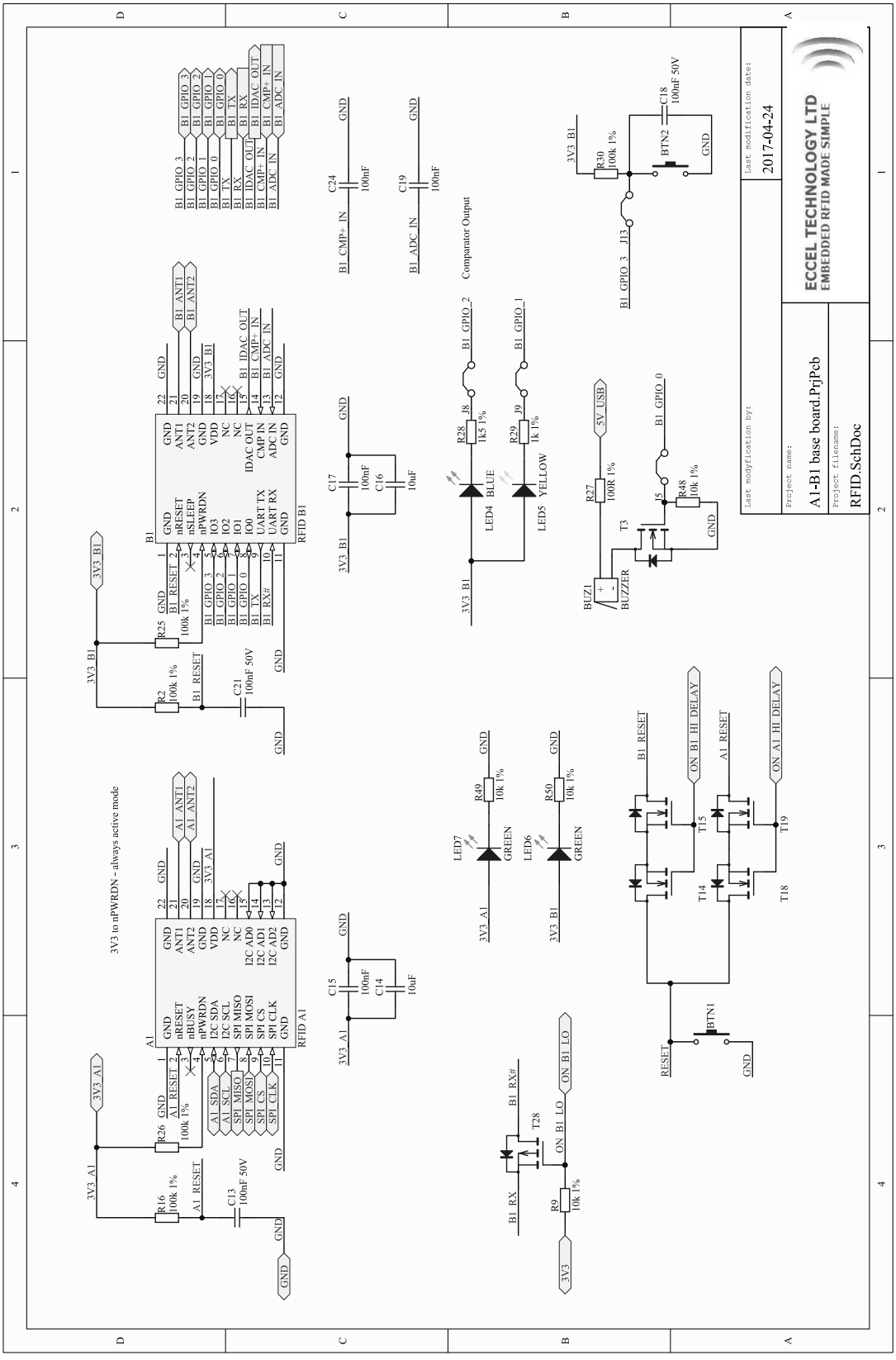
Example headers:
female: MULTICOMP 2206SA-25-46
male: MULTICOMP 2206PA-25G-739

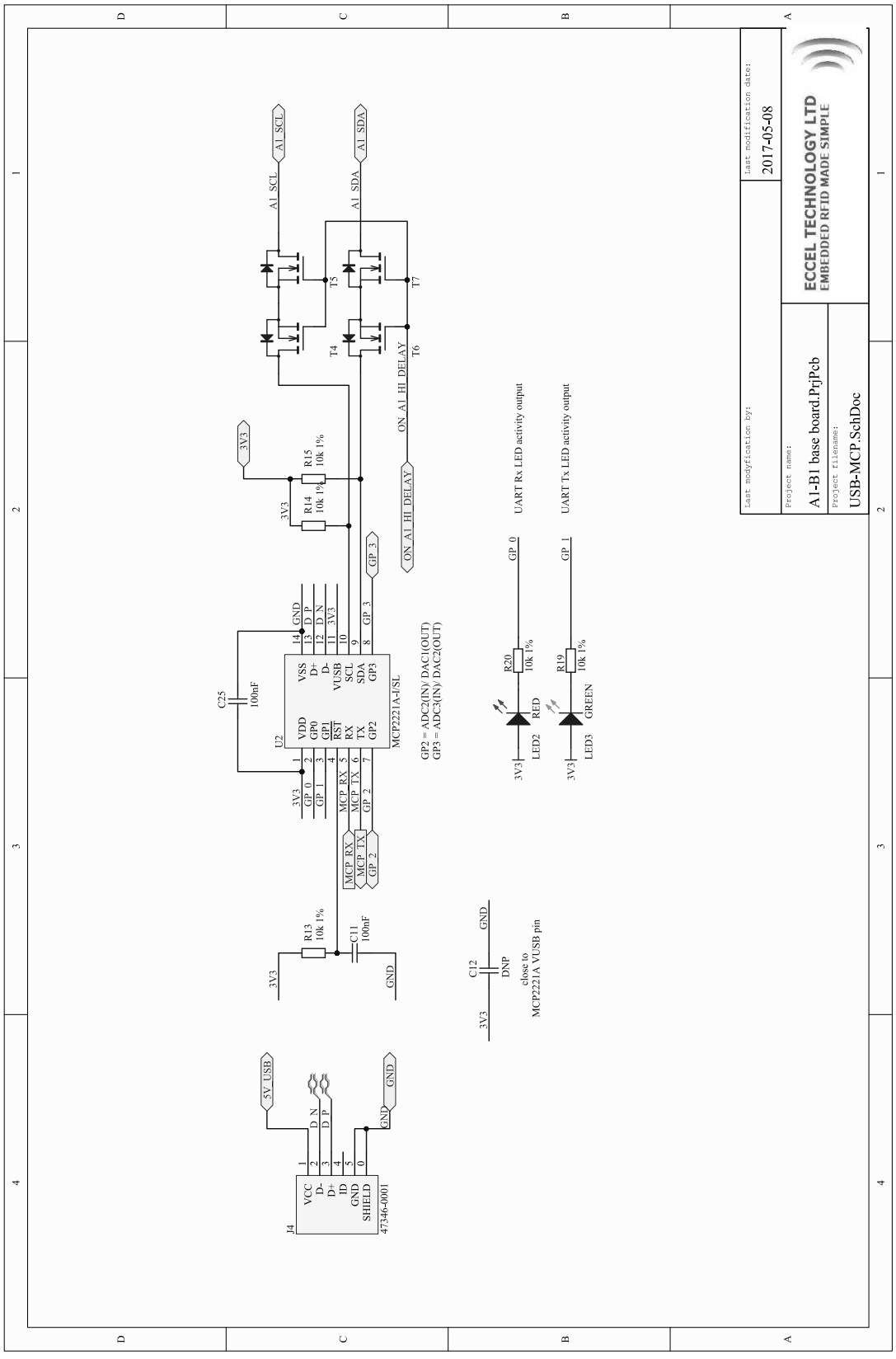
Appendix A. Schematics and Layouts

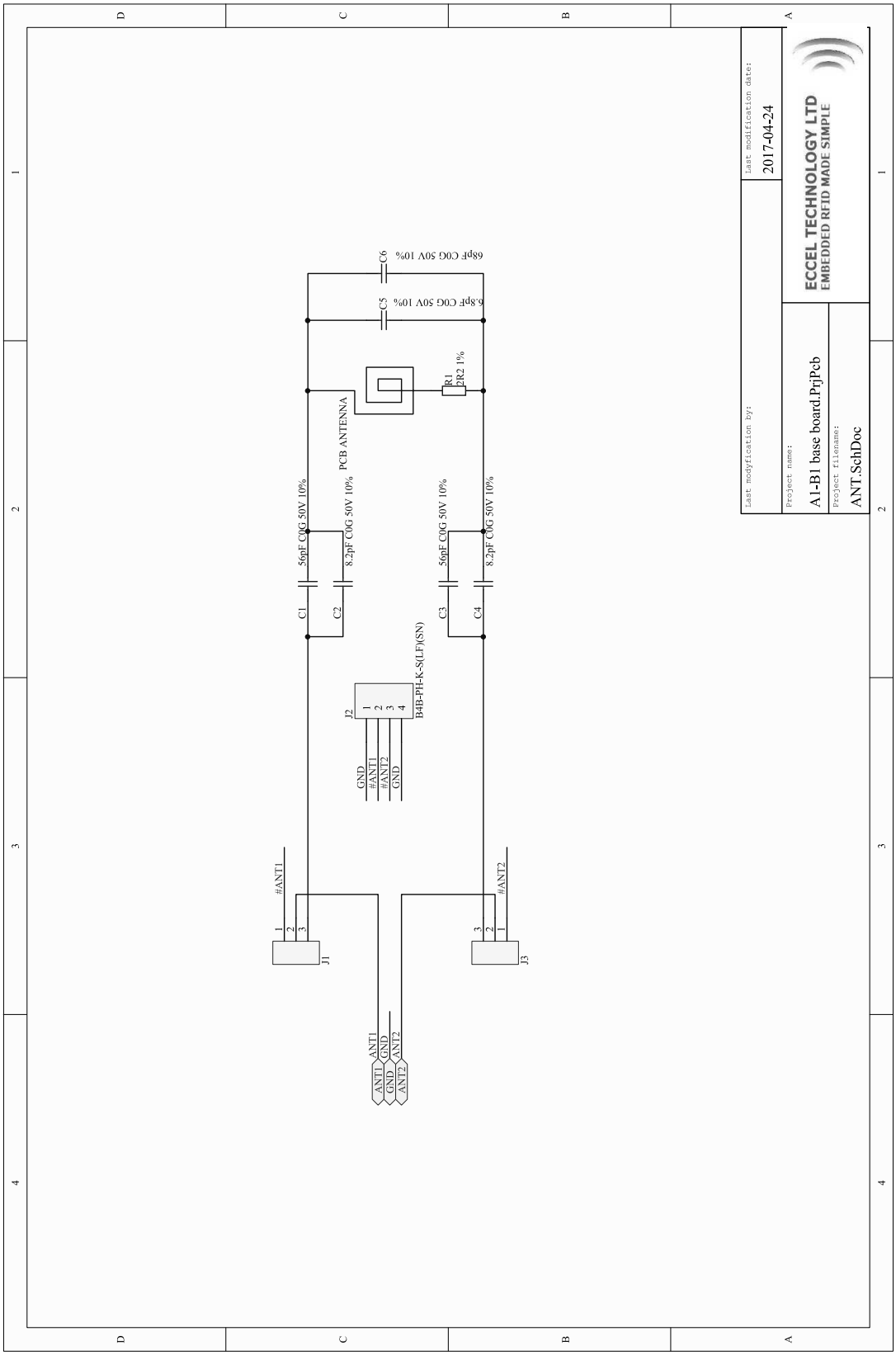
1. Schematic

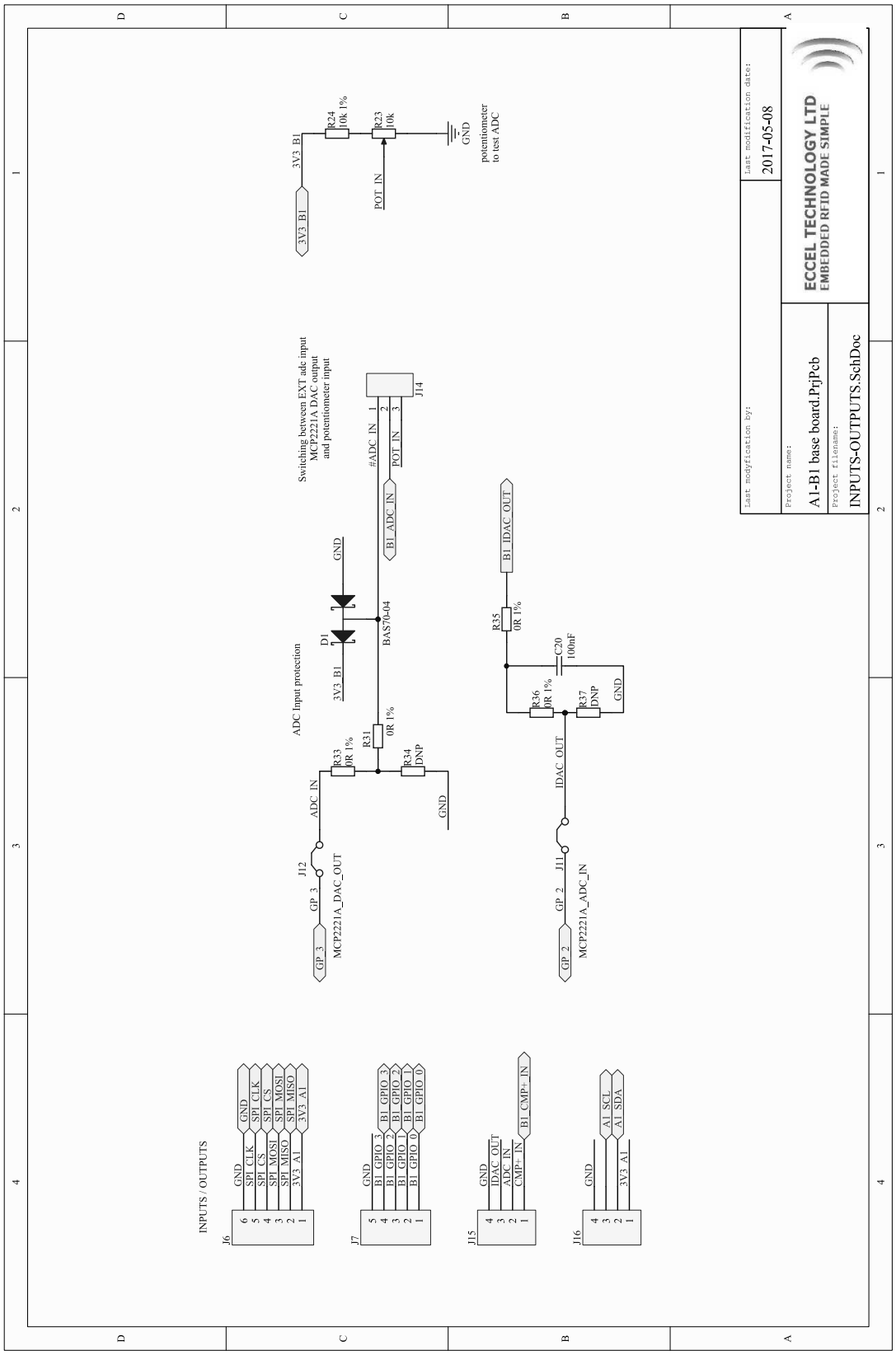



ECCEL TECHNOLOGY LTD
EMBEDDED RFID MADE SIMPLE
Last modification date:
2017-05-08
Project name:
A1-B1 base board.PrjPcb
Project filename:
POWER.SchDoc
Last modification by:
3V3
5V_USB
GND
LED1 GREEN
R12 10k 1%
TP1
TP2
TP3
C7 10uF 10V
C8 DNP
C9 10uF 10V
C10 DNP
U1 NCP1117ST33T3G
Vin
Vout
GND
R51 100k 1%
R52 2R2 1%
T26
3V3_B1
ON_A1_LO
ON_B1_HI_DELAY
R46 DNP
T24
T2
R17 100k 1%
T8
T11
T10
T9
C22 100nF
C23 100nF
R8 DNP
R7 DNP
R6 DNP
R5 DNP
R4 10k 1%
R3 10k 1%
J10 MSS-2235S
ON_B1_HI
ON_B1_LO
ON_A1_HI
ON_A1_LO
R54 100k 1%
R53 2R2 1%
T27
3V3_A1
R47 DNP
T25
T1
R18 100k 1%
ON_A1_HI_DELAY


ECCEL TECHNOLOGY LTD
EMBEDDED RFID MADE SIMPLE
A1-B1 base board.PrjPcb
RFID.SchDoc
2017-04-24
Last modification date:
Last modyfication by:
Project name:
Project filename:
3V3 to nPWRDN - always active mode
Comparator Output
RFID A1
RFID B1
BUZZER
LED4 BLUE
LED5 YELLOW
LED6 GREEN
LED7 GREEN
T3
T14
T15
T18
T19
T28
BTN1
BTN2
RESET
5V_USB
B1_GPIO_2
B1_GPIO_1
B1_GPIO_0
ON_B1_HI_DELAY
ON_A1_HI_DELAY
ON_B1_LO

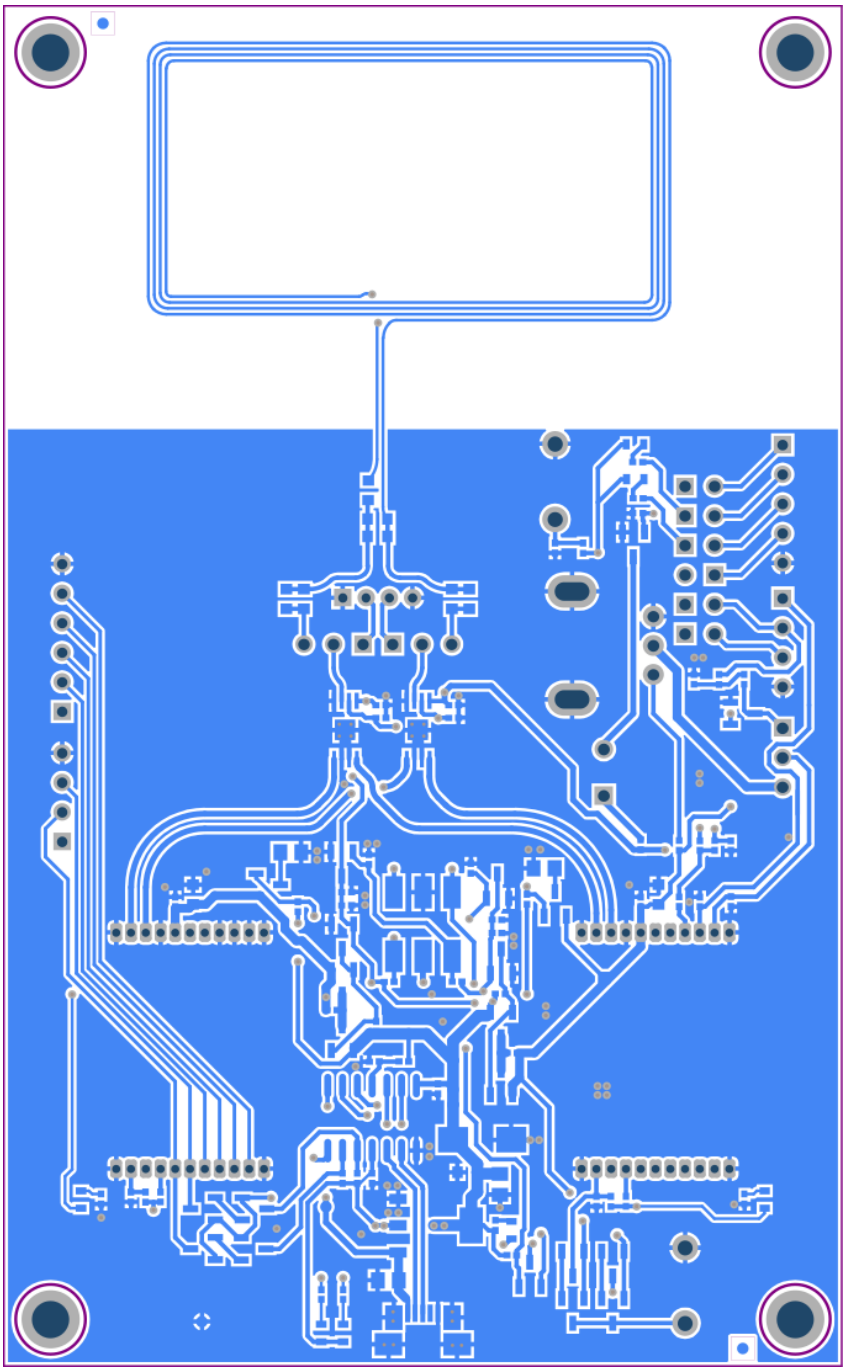

A1 SCL
A1 SDA
ON_A1_HI_DELAY
T4
T5
T6
T7
R15 10k 1%
R14 10k 1%
R13 10k 1%
C25 100nF
C11 100nF
C12 DNP
close to MCP2221A VUSB pin
U2
MCP2221A-I/SL
GP2 = ADC2(IN)/ DAC1(OUT)
GP3 = ADC3(IN)/ DAC2(OUT)
R20 10k 1%
R19 10k 1%
LED2 RED
LED3 GREEN
UART Rx LED activity output
UART Tx LED activity output
J4
47346-0001
5V_USB
GND
3V3
MCP_RX
MCP_TX
Last modification by:
Last modification date:
2017-05-08
Project name:
A1-B1 base board.PrjPcb
Project filename:
USB-MCP.SchDoc
ECCEL TECHNOLOGY LTD
EMBEDDED RFID MADE SIMPLE


C6
68pF C0G 50V 10%
C5
6.8pF C0G 50V 10%
R1
2R2 1%
PCB ANTENNA
56pF C0G 50V 10%
8.2pF C0G 50V 10%
C1
C2
C3
C4
J2
B4B-PH-K-S(LF)(SN)
GND
#ANT1
#ANT2
GND
#ANT1
#ANT2
J1
J3
ANT1
GND
ANT2
Last modification date:
2017-04-24
Last modyfication by:
Project name:
A1-B1 base board.PrjPcb
Project filename:
ANT.SchDoc
ECCEL TECHNOLOGY LTD
EMBEDDED RFID MADE SIMPLE

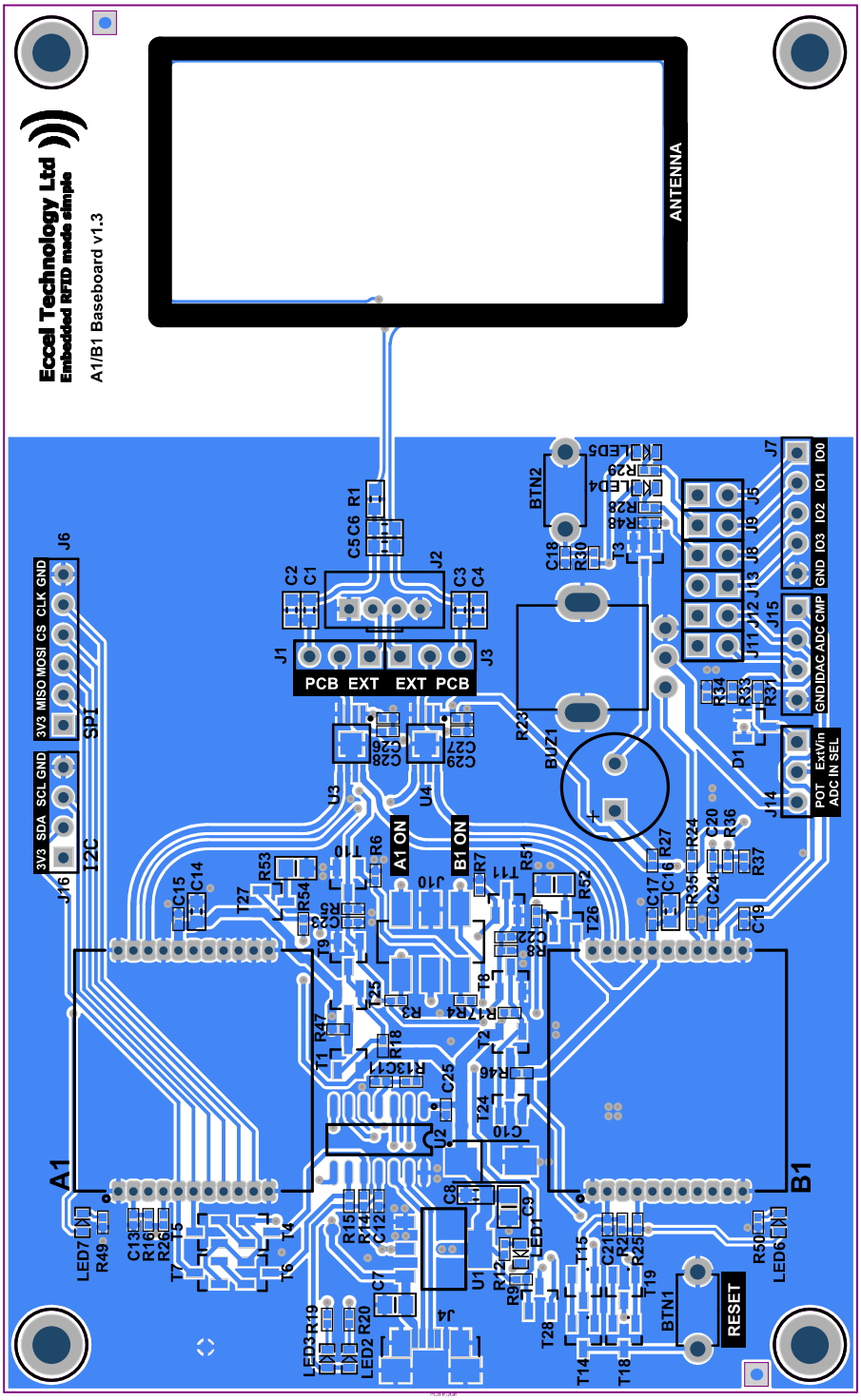

INPUTS / OUTPUTS
J6
GND
SPI_CLK
SPI_CS
SPI_MOSI
SPI_MISO
3V3_A1
J7
B1_GPIO_3
B1_GPIO_2
B1_GPIO_1
B1_GPIO_0
J15
IDAC_OUT
ADC_IN
CMP+_IN
J16
A1_SCL
A1_SDA
ADC Input protection
R33 0R 1%
R31 0R 1%
R34 DNP
D1 BAS70-04
3V3_B1
GND
B1_ADC_IN
#ADC_IN
POT_IN
J14
Switching between EXT adc input
MCP2221A DAC output
and potentiometer input
R24 10k 1%
R23 10k
potentiometer
to test ADC
R35 0R 1%
C20 100nF
R36 0R 1%
R37 DNP
B1_IDAC_OUT
IDAC_OUT
J12
J11
GP_3
GP_2
MCP2221A_DAC_OUT
MCP2221A_ADC_IN
Last modification by:
Project name:
A1-B1 base board.PrjPcb
Project filename:
INPUTS-OUTPUTS.SchDoc
Last modification date:
2017-05-08
ECCEL TECHNOLOGY LTD
EMBEDDED RFID MADE SIMPLE

2. Top Copper

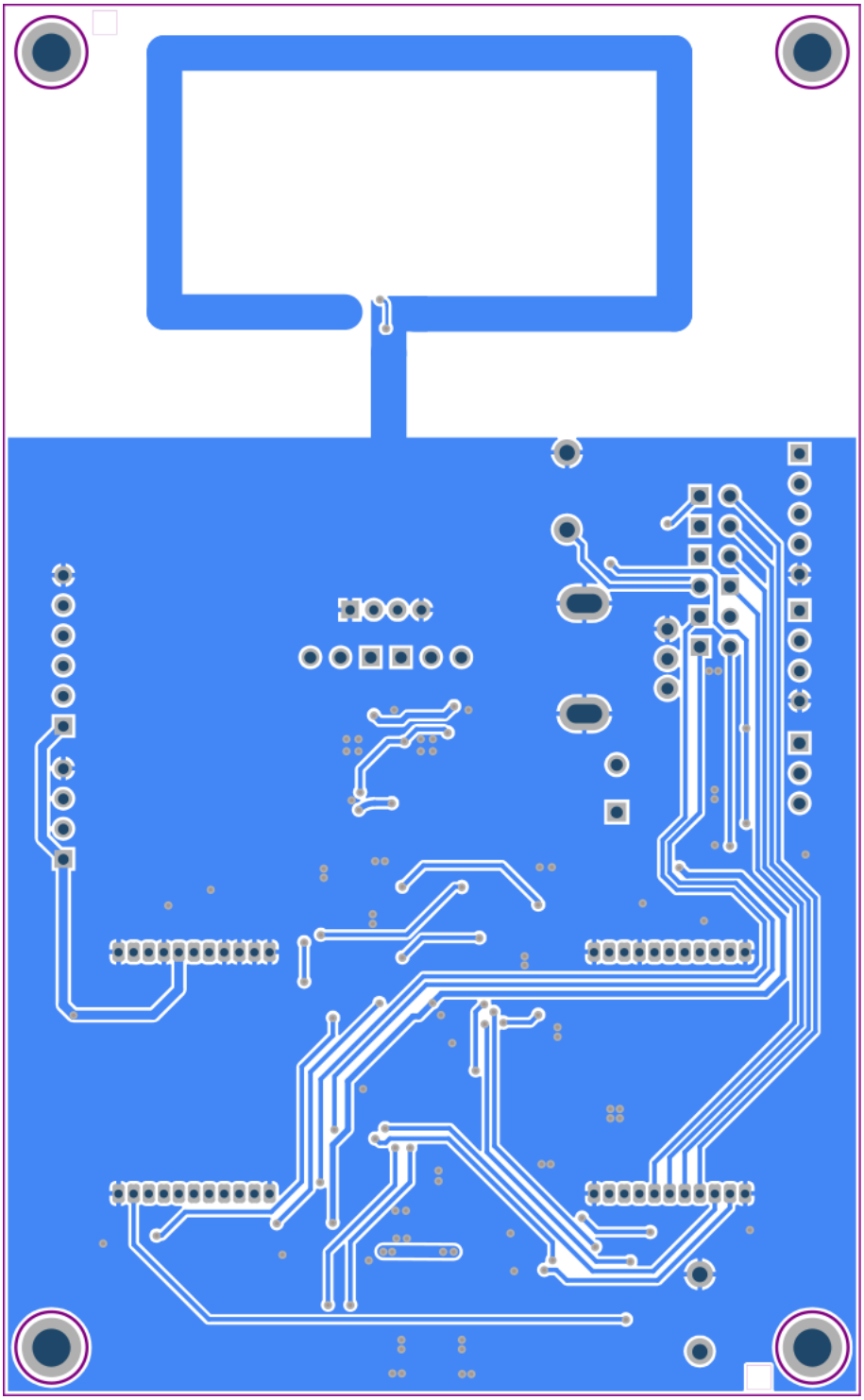
The Gerber PCB layout files for this board are available free-of-charge on request. If interested please contact us via e-mail sales@eccel.co.uk.



3. Top Copper and silk screen



4. Bottom Copper



Appendix B. Bill of materials (BOM)

Quantity	Designator	Comment	Manufacturer	Manufacturer P/N
2	BTN1, BTN2	uSWITCH	NINGI	TACT-34N-F
1	BUZ1	BUZZER	BESTAR	BMT-0903H5.5
2	C1, C3	Capacitor 56pF C0G 50V 10% SMD 0603	SAMSUNG	CL10C560JB8NNNC
2	C2, C4	Capacitor 8.2±0.25pF C0G 50V SMD 0603	SAMSUNG	CL10C8R2CB8ANNC
1	C5	Capacitor 6.8±0.25pF C0G 50V SMD 0603	SAMSUNG	CL10C6R8CB8NNNC
1	C6	Capacitor 68pF C0G 50V 10% SMD 0603	SAMSUNG	CL10C680JB8NNNC
2	C7, C9	Capacitor 10uF X5R 10V 10% SMD 0805	SAMSUNG	CL21A106KPFNNNG
14	C11, C13, C15, C17, C18, C19, C20, C21, C22, C23, C24, C25, C26, C27	Capacitor 100nF X5R 25V 10% SMD 0402	SAMSUNG	CL05A104KA5NNNC
2	C14, C16	Capacitor 10uF X5R 6V3 10% SMD 0603	SAMSUNG	CL10A106KQ8NNNC
1	D1	Schottky diode	MULTICOMP	BAS70-04
3	J1, J3, J14	Header 3x1 2.54mm	CONNFLY	DS1021-1*3SF1-1
1	J2	External antenna socket	JST	B4B-PH-K-S(LF)(SN)
1	J4	USB micro B	MOLEX	47346-0001
6	J5, J8, J9, J11, J12, J13	Header 2x1 2.54mm	CONNFLY	DS1021-1*2SF1-1
1	J6	Header 6x1 2.54mm	CONNFLY	DS1021-1*6SF1-1
1	J7	Header 5x1 2.54mm	CONNFLY	DS1021-1*5SF1-1
1	J10	Slide switch	NINIGI	MSS-2235S
2	J15, J16	Header 4x1 2.54mm	CONNFLY	DS1021-1*4SF1-1
4	LED1, LED3, LED6, LED7	Green LED SMD 0603	OPTOSUPPLY	OSG50603C1E
1	LED2	Red LED SMD 0603	OPTOSUPPLY	OSR50603C1E
1	LED4	Blue LED SMD 0603	Lucky Light	LL-S192PBC-B4-1B
1	LED5	Yellow LED SMD 0603	Lucky Light	LL-S194PUYC-Y2-2B
1	R1	Resistor 2R2 1% SMD 0603	VISHAY	CRCW06032R20FKEA
9	R2, R16, R17, R18, R25, R26, R30, R51, R54	Resistor 100k 1% SMD 0402	VISHAY	CRCW0402100KFKED
13	R3, R4, R9, R12, R13, R14, R15, R19, R20, R24, R48, R49, R50	Resistor 10k 1% SMD 0402	VISHAY	CRCW040210K0FKED
1	R23	Potentiometer 10k	ALPS	RK09K1130A8G
1	R27	Resistor 100R 1% SMD 0402	VISHAY	CRCW0402100RFKED
1	R28	Resistor 1k5 1% SMD 0402	VISHAY	CRCW04021K50FKED
1	R29	Resistor 1k 1% SMD 0402	VISHAY	CRCW04021K00FKED
4	R31, R33, R35, R36	Resistor 0R 1% SMD 0402	VISHAY	CRCW04020000Z0ED
2	R52, R53	Resistor 2R2 1% SMD 0805	VISHAY	CRCW08052R20FKEA
7	T1, T2, T24, T25, T26, T27, T28	P-Channel MOSFET SOT-23	DIODES INC	DMG2305UX-13
13	T3, T4, T5, T6, T7, T8, T9, T10, T11, T14, T15, T18, T19	N-Channel MOSFET SOT-23	NEXPERIA	2N7002P,215

1	U1	LDO 3V3 1A SOT-223	ON Semiconductor	NCP1117ST33T3G
1	U2	USB Bridge 14-SOIC	Microchip	MCP2221A-I/SL
2	U3, U4	RF Switch 8-MSOP	Peregrine Semiconductor	PE4251MLI-Z

The Baseboard has been designed with thorough attention to noise suppression and filtering of the 5-volt supply (see the circuit schematics above). In simple applications many of these precautions can be omitted. The Bill-of-Materials list above shows the typical parts-list with Manufacturer part-numbers, in most cases equivalent components can be used accordingly.

No responsibility is taken for the method of integration or final use of the A1/B1 modules

More information about the A1/B1 modules and other products can be found at the Internet site:

www.eccel.co.uk

or alternatively contact ECCEL Technology (IB Technology) by email at:

sales@eccel.co.uk