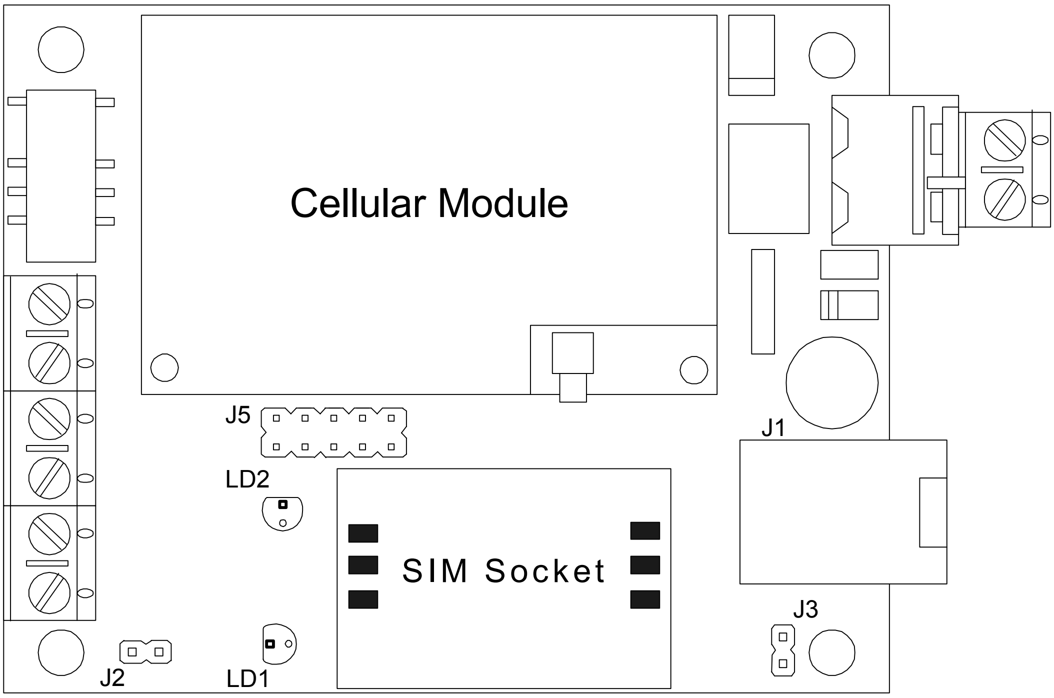

Pix-Cell

Single-Board GSM Controller

User's Manual

Pix-Cell Rev C00 User's Manual

UControl Solutions reserves the right to make changes and improvements to its products without providing notice.

Doc Revision : A.04

Date : 1.2009

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1. Introduction

The Pix-Cell is a high performance, programmable Cellular Single Board Controller, C-SBC, that offers built-in digital and analog I/O combined with GSM/GPRS connectivity in a compact form factor. A Microchip PIC 18F6722 controller operating up to 32MHz provides fast data processing. This product is specifically designed for use in embedded modem applications where space, performance, power consumption, ease of use, and fast time to market are key requirements.

2. Features

The Pix-Cell is an advanced Cellular Single-Board Controller (C-SBC), which incorporates the powerful PIC18F6722 controller from Microchip, flash memory, RAM memory, digital I/O ports, A/D converter inputs, an SPDT relay output, RS232 serial port, and a GSM/GPRS cellular module. Figure 1 shows the block diagram of the subsystems designed into the Pix-Cell C-SBC.

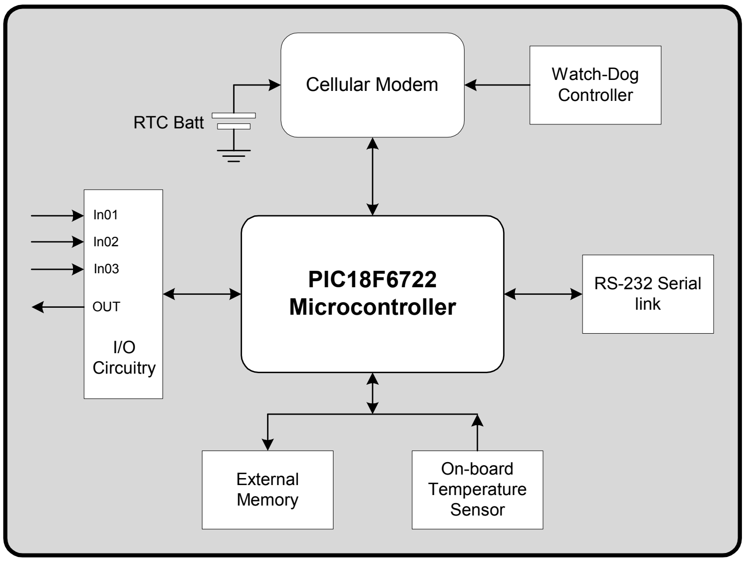


Figure 1 – Pix-Cell GSM Controller Block Diagram

- Telit GSM/GPRS cellular modem
- Microchip PIC18F6722 controller operating up to 32 MHz
- 128KB of Flash memory for user application
- 32KB of external data memory
- Watchdog controller supervisor
- 3 protected digital inputs
- 3 protected analog 10-bit A/D converter inputs
- Onboard SPDT relay output
- RS232 serial port
- Onboard temperature sensor
- Real-time clock
- Two status LEDs.

2.1. Controller Specification Table

Power requirements	
Input Voltage range	9-16 VDC
Input Current – GSM Idle, f = 32 MHz	70 mA@12 VDC
Input Current – GPRS Transmitting	500 mA@12 VDC
Input Current – GSM Module OFF, f = 32 MHz	48 mA@12 VDC
Input Current – GSM Module OFF, f = 32kHz	17 mA@12 VDC max
Digital Input specifications	
Number of input points	3 (sink)
Input impedance	6.6KΩ
Input voltage level	Low Level: 0 - 2.5 Vdc High Level: 2.5 - 40 Vdc
Surge protection voltage level	±100 V
Analog Input specifications	
Number of channels	3 single ended
Input ranges	0-5 VDC , All inputs 4-20mA @ Input number 3
Resolution	10 bit
Surge protection voltage level	±100 V
Output specifications	
Type of output	Dry contact (Relay)
Peak voltage	40 Vdc Max.
Maximum current	0.5A@40Vdc
Real-Time specifications	
Maximum RTC Voltage on J3 Header	2.05 Vdc
Minimum RTC Voltage on J3 Header	1.10 Vdc

Table 1 – Pix-Cell C-SBC Specification Table

3. Getting Started

i. Insert the GSM SIMCard to Simcard-holder SM1 in the Pix-Cell controller. Refer to "Design Guidelines" section for precautions in handling the SIMCard.

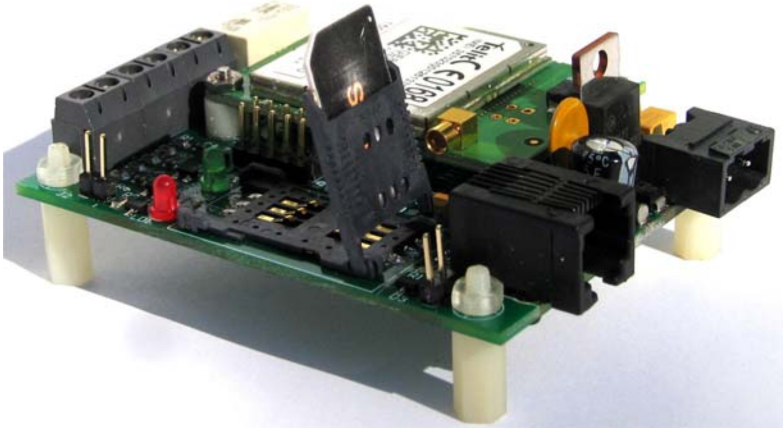


Figure 2 – SIMCard socket

CAUTION: Always insert the GSM SIMCard to the controller when no power is applied to the controller.

ii. Connect the antenna to the Cellular module.

iii. Power the Pix-Cell controller according to Figure 3. The controller is protected against reverse polarity. The input voltage range is from 8Vdc to 16Vdc.

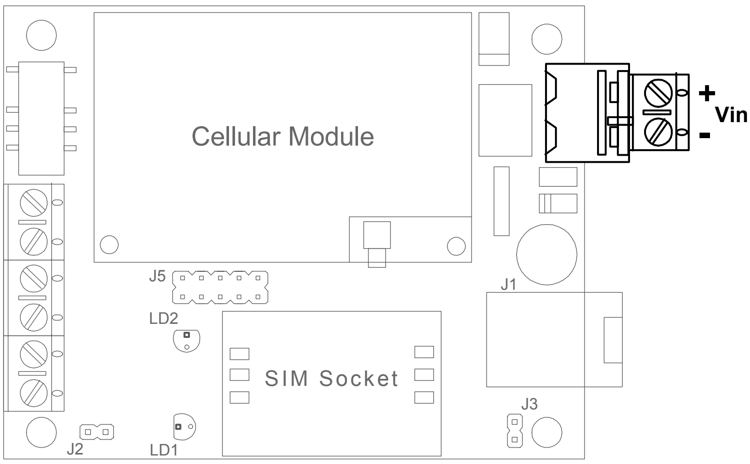


Figure 3 – Power Supply Input

iv. Install the compiler software on your PC. Instructions for installing the compiler refer to Compiler User Manual of Mikroelektronika. Be sure to install the PicFlash2 software as well.

v. Connect the 10-pins of the PicFlash2 connector cable to header J5 on the Pix-Cell controller, according to Figure 4.

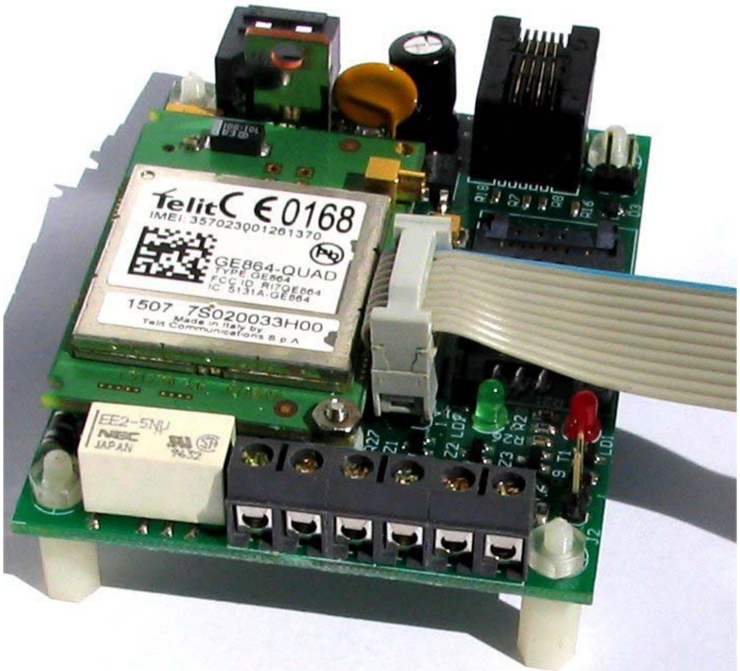


Figure 4 – Connect the 10-pins of the PicFlash2 to J5 Header

4. Compiler Setup

4.1. Installing the Compiler

Refer to the User's Manual of the Mikroelektronika compiler (www.mikroe.com).

4.2. Configuration Bits

The PIC18F6722 family of devices includes several features intended to maximize reliability through elimination of external components. These features are:

- Oscillator Selection
- Resets
- Interrupts
- Watchdog Timer (WDT)
- Fail-Safe Clock Monitor
- Two-Speed Start-up
- Code Protection
- ID Locations
- In-Circuit Serial Programming

The configuration bits can be programmed to select various device configurations (For more information refers to the PIC18F6722 datasheet at www.microchip.com).

Before you start working with the Pix-Cell controller these bits must be configure in order to work properly with the controller functions. In order to configure the "Configuration bits" click on the Compiler: **Project →Edit Project**

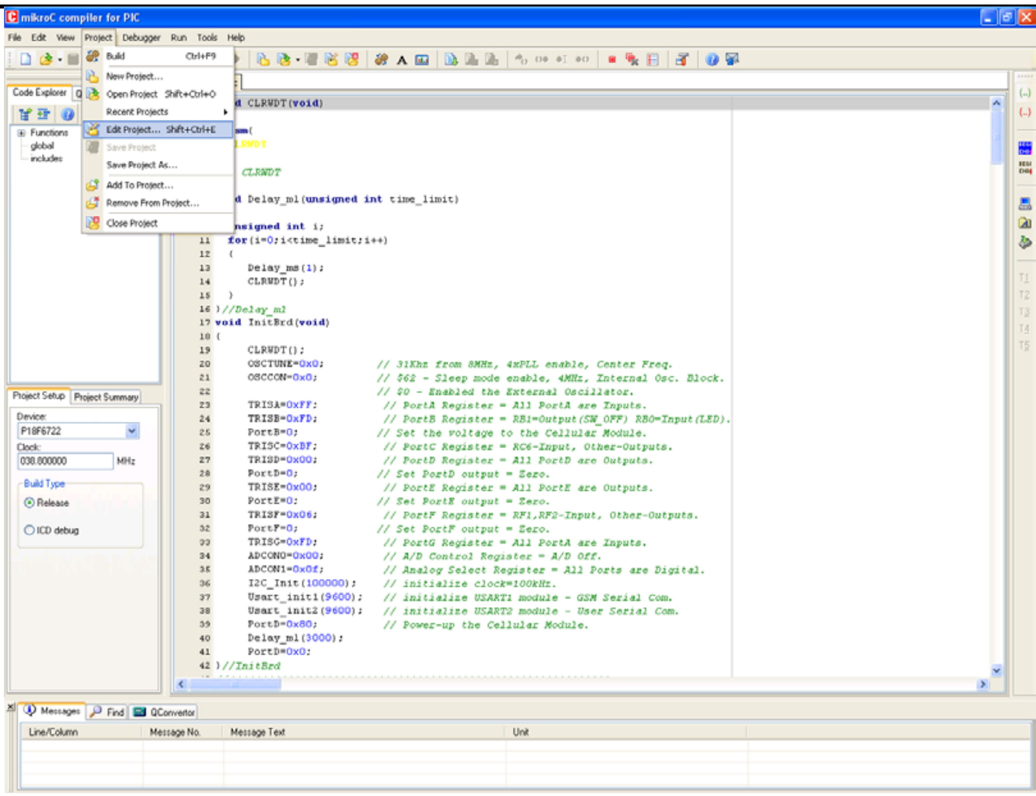


Figure 5 – MikroElektronika compiler

A new window will open with a title "**Edit Project**", as depicted in Figure 6.

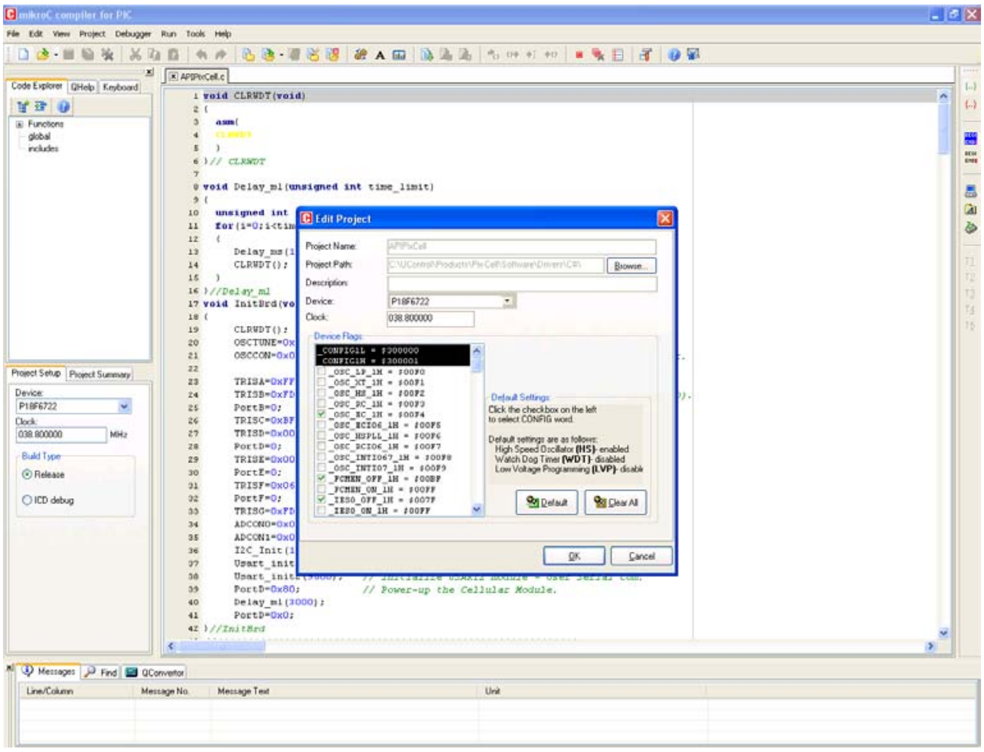


Figure 6 – Edit Project window

There are 7 Configuration words divided as "Byte High" and "Byte Low". Below we will explained the default configuration these bits must be set.

4.2.1. CONFIG1H - CONFIG1L Register:

This register defines the Oscillator bits selection. The default status:

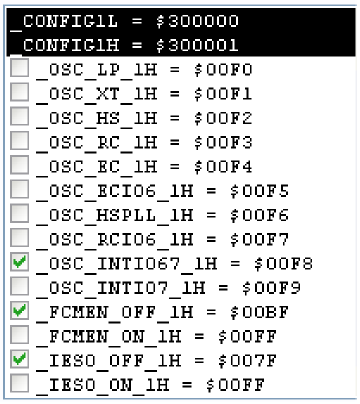


Figure 7 – CONFIG1H - CONFIG1L Register bits

4.2.2. CONFIG2L Register:

This register defines the Reset set-up sequence. The default status:

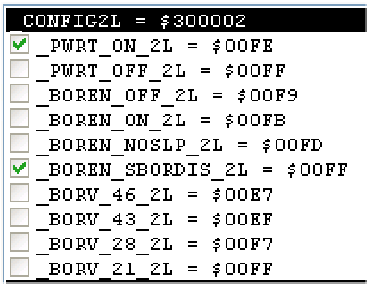


Figure 8 – CONFIG2L Register bits

4.2.3. CONFIG2H Register:

This register defines the Watchdog Timer. The default status:

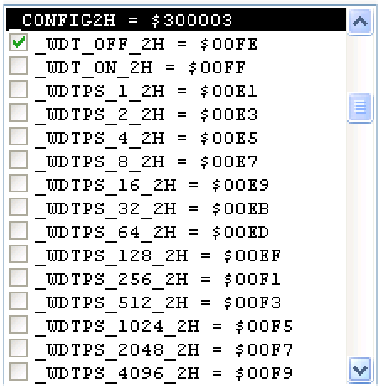


Figure 9 – CONFIG2H Register bits

UControl Solutions recommends to use the watchdog feature on any application. The recommended time sequence is 4.096 seconds.

The Watchdog Timer Postscale is defining as:

CONFIG2H Bits	Time Sequences
WDTPS_1_2H	4 ms
WDTPS_2_2H	8 ms
WDTPS_4_2H	16 ms
WDTPS_8_2H	32 ms
WDTPS_16_2H	64 ms
WDTPS_32_2H	128 ms
WDTPS_64_2H	256 ms
WDTPS_128_2H	500 ms
WDTPS_256_2H	1.024 seconds
WDTPS_512_2H	2.048 seconds
WDTPS_1024_2H	**4.096 seconds**
WDTPS_2048_2H	8.192 seconds
WDTPS_4096_2H	16.384 seconds
WDTPS_8192_2H	32.768 seconds
WDTPS_16284_2H	1.10 Minutes
WDTPS_32768_2H	2.18 Minutes

Table 2 - Watchdog Timer Postscale

4.2.4. CONFIG3L Register:

Not implemented on the PIC18F6722.

4.2.5. CONFIG3H Register:

This register defines the Master Reset and Oscillator options. The default status:

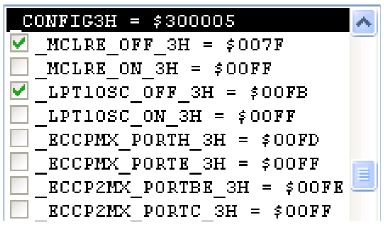


Figure 10 – CONFIG2H Register bits

4.2.6. CONFIG4L Register:

This register defines the Debugger, Extended instructions and Boot block options. The default status:

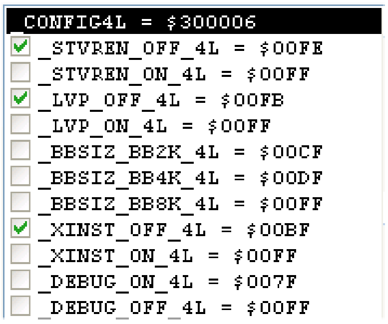


Figure 11 – CONFIG2H Register bits

4.2.7. CONFIG5L & CONFIG5H Register:

To be left unchanged.

4.2.8. CONFIG6L & CONFIG6H Register:

To be left unchanged.

4.2.9. CONFIG7L & CONFIG7H Register:

To be left unchanged.

5. Hardware Description

The heart of the Pix-Cell is the PIC18F6722 microcontroller with 128Kbytes of flash for user applications and operating frequency up to 32 MHz. This controller provides the user with a low-risk and faster time to market applications.

In this section, the user will be introduced to the hardware implementation. We will explain all the functions of the microcontroller needed in order to operate and design the user's application in minutes with the Pix-Cell SBC.

Table 3 lists the PIC18F6722 parallel ports and their use in the Pix-Cell controller.

PIC Port	Signal	I/O Configuration
RA0/AN0	Input 1	Digital or Analog input
RA1/AN1	Input 2	Digital or Analog input
RF1/AN6	Input 3	Digital or Analog input
RE2	Relay On/Off	Output
RA3/AN3	Temperature Sensor	Analog input
RA5/AN4	RTC Battery voltage	Analog input
RD7	Reset Cellular Module	Output
RF7	User's LED	Output
RB1	Turn On/Off the Module – Sleep Mode	Output
RC3/SCL1	I2C serial communication	
RC4/SDA1		
RC6/TX1	Serial communication between PIC and the GSM module	
RC7/RX1		
RG1/TX2	User RS-232 external Communication	
RG2/RX2		

Table 3 – Controller parallel ports functionality

5.1. Inputs Description

The Pix-Cell SBC has 3 independent inputs: **Input1, Input2** and **Input3**. Each input can be configured as Digital or Analog depending on the user application. The inputs relationship between the user connector J7 to the PIC port pins are shown in Table 4:

PIC Port	Signal	I/O Configuration
RA0/AN0	Input 1	Digital or Analog input
RA1/AN1	Input 2	Digital or Analog input
RF0/AN6	Input 3	Digital or Analog input

Table 4 – Relationship between Inputs to PIC controller pins

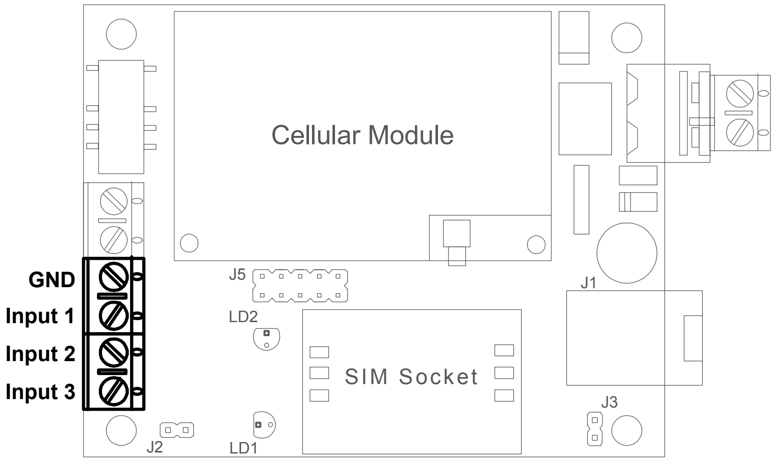


Figure 12 – User Input Connector

5.1.1. Digital Inputs

The Pix-Cell has 3 digital inputs, each of which is protected over a range of -100V to +100V, as shown in Figure 12. The actual switching threshold is approximately 2.5V for all the inputs channels, anything below this value is logic 0, and anything above is logic 1. Functions **`BitRdInput`** and **`AllRdInput`** read the status of the relevant inputs.

5.1.2. Analog inputs

The Analog-to-Digital (A/D) allows conversion of an analog input signal to a 10-bit binary representation of that signal. The Pix-Cell has 3-analog inputs with an input voltage range of 0-5Vdc on all inputs. Setting jumper J2 can also configure **Input 3** to read current sensors with input range of 4-20mA. Function **`AnaRdInput`** reads the analog value of a specific analog input.

Figure 13 shows a simplified analog input circuit on the Pix-Cell SBC. Any voltage sensor that has a 0-5Vdc output can be connected to these inputs.

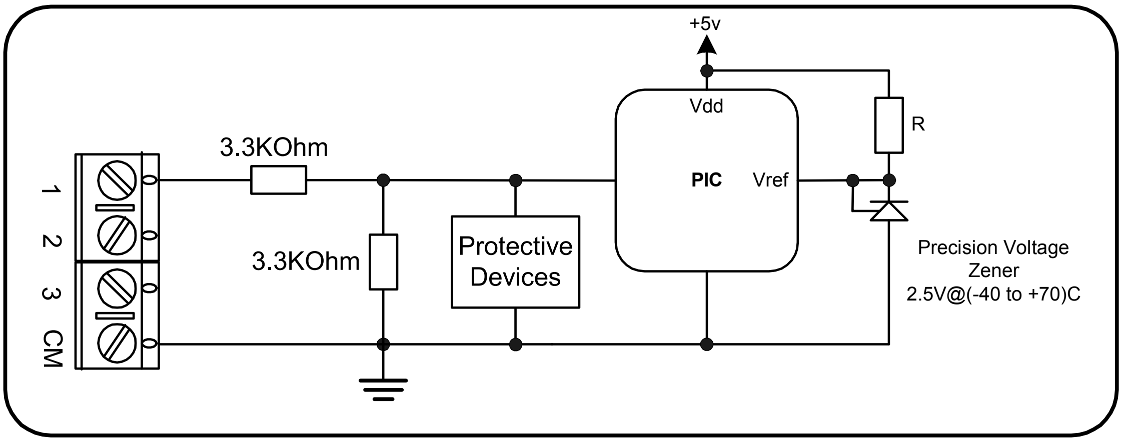


Figure 13 – Simplify Analog Input Circuit

For current sensors with 4-20mA output, Input 3 can be used individually by jumping J2, as shown in Figure 14.

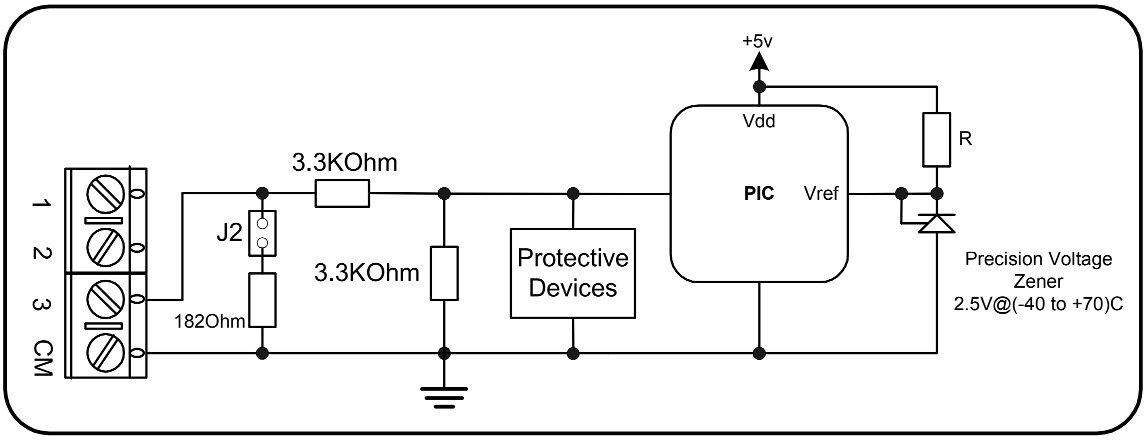


Figure 14 – Simplify Analog Input 3 Circuit

CAUTION: If the user has enabled the 4-20mA current option on input3, a precaution must be taken with any voltage source that might be connected to this input. The voltage must be less than 5V to keep the current across the resistor below the maximum allowed current.

5.2. Relay Output

The Pix-Cell has a SPDT Relay output, Figure 15 shows the controller relay contact connections. Functions **`BitWrOut`**, **`PulseWrOut`** and **`PulseWrOutNot`** change the output state according to the user application.

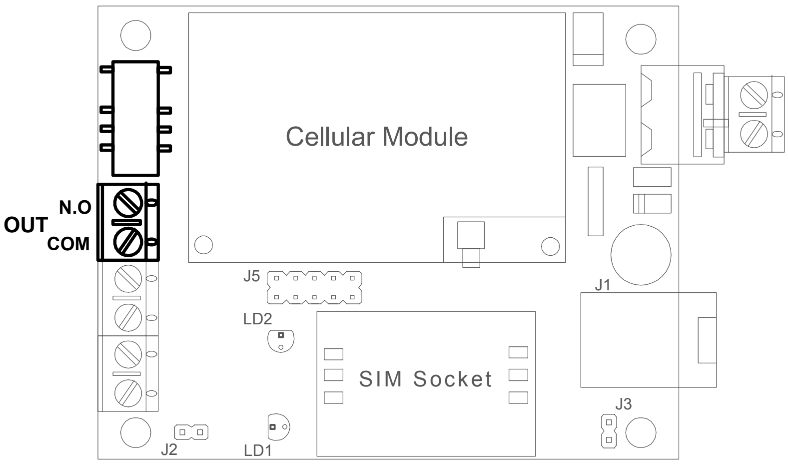


Figure 15 - Relay Output circuit

5.3. LED Output

The Pix-Cell has a green LED for user applications; Figure 16 shows the LED connection to the PIC controller. Function **`GreenLed`** changes the status of the LED according to the user application.

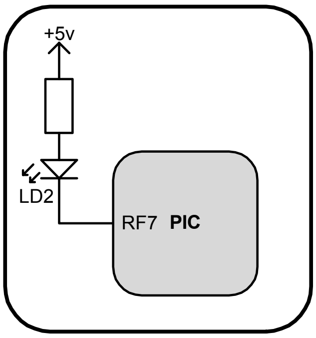


Figure 16 – User LED - LD2 connection

5.4. On-board Temperature Sensor

The on-board temperature sensor is a precision integrated-circuit sensor that can sense a -40ºC to +125ºC temperature range. Function **`TempRd`** reads the ambient-temperature value sample by the sensor.

5.5. User Serial communication

The Pix-Cell RS-232 serial communication is supported by a RS-232 transceiver. This transceiver provides the voltage output, slew rate, and input voltage immunity required to meet the RS-232 serial communication protocol. The serial port operates in an asynchronous mode (full duplex), 8 bit, no parity, even mode configuration. Functions **`UserSerialInit`**, **`UserSerialRd`** and **`UserSerialWr`** give the user simplicity when sending data to the outside world. Figure 17 shows the location of the RS232 connector - J1:

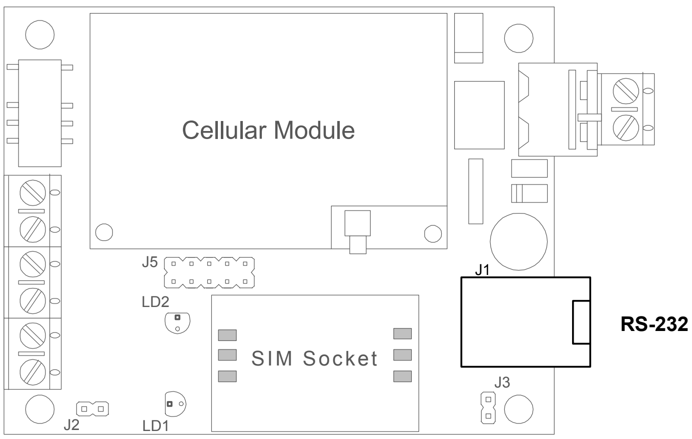
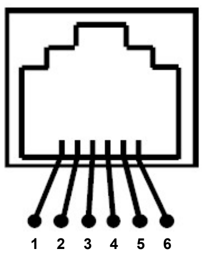


Figure 17 – User RS232 connector – J1

Figure 18 shows the User connector pinout.



1 – No Connected.
2 – RS232 Receiver – Rx
3 – RS232 Transmitter – Tx
4 – No Connected.
5 – GND
6 – GND

Figure 18 – Serial Interface Port Pinout – J1 connector

5.6. External Memory

The Pix-Cell controller has an external memory of 32KB Serial Electrically Erasable PROM for users defines. The external memory is based on an I2C 2-wire bus and data transmission protocol. Functions **`MemRd`**, **`MemWr`**, **`MemRdSeg`** give the user simplicity to store data.

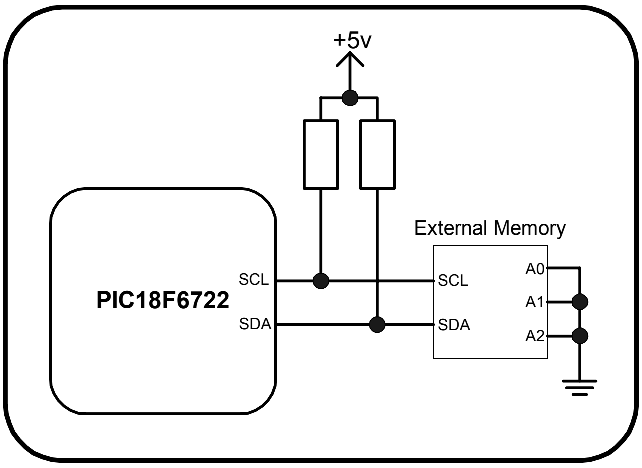


Figure 19 – Serial Interface Port Pinout – J1 connector

5.7. Real-Time Clock Battery Back-Up

The J3 Header provides an input connection to the cellular module which allows the user to power the real-time clock (RTC) within the Telit module by way of 1.5V battery.

In the backup condition the RTC block will function to as low as 1.1V on the J3 Header pins. The RTC draws 10uA typically during powered backup. Function **RtcVoltRd** reads the Analog value of the RTC backup voltage on pin J3.

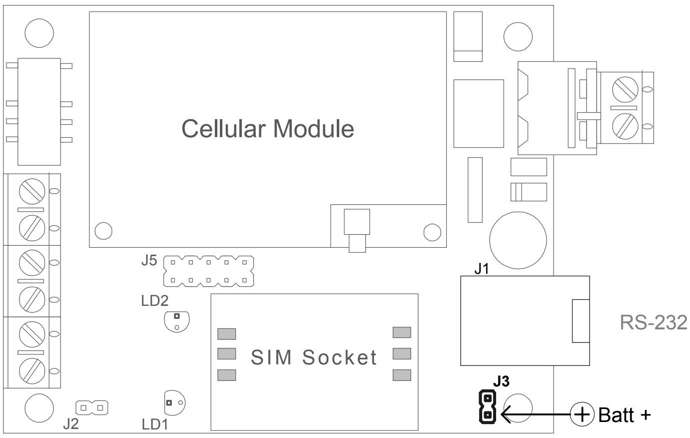


Figure 20 – RTC Battery Header – J3 connector

5.8. GPRS Connection

The General Packet Radio Services (GPRS) standard permits DATA transfers in a completely different way with respect to previous point to point communications made with Circuit Switch Data (CSD) modems.

In CSD operations the modem establishes a connection with the other party (another modem) in such a way that the entire Network in between is transparent to the data exchanged, simulating a real point-to-point connection, just as if the other party is directly connected with the controlling application of the modem.

On the other hand, in GPRS operation the connection is made directly towards internet as if the GPRS modem was a network UDP/TCP/IP socket. There is no data path reserved for the data exchange between the two peers, instead the resources are allocated dynamically on demand and the data exchanged is organized into UDP/TCP/IP packets. Furthermore, the maximum transfer speed can be theoretically up to 171,2 kbps, about ten time faster than GSM CSD.

In order to establish a GPRS connection with the Pix-Cell C-SBC controller, the user must issue the following AT commands:

- **First Step** - GPRS context setting:

AT+CGDCONT=	1,	"IP",	"internet",	"0.0.0.0",	0,	0	<cr>
command	cid	PDP	APN	PDP Add	D_comp	H_comp	

- **Command** – Define PDP Context.
- **cid** – (PDP Context Identifier) Numeric parameter which specifies a particular PDP context definitions.
- **PDP** – (Packet Data Protocol type) a string parameter which specifies the type of packet data protocol:
  - "IP" – Internet Protocol
  - "PPP" – Point to Point Protocol
- **APN** - (Access Point Name) a string parameter which is a logical name that is used to select the GGSN or the external packet data network. If the value is null or omitted, then the subscription value will be requested.
  The user must check with the local operator for the right format of this parameter, in some countries this parameter can be written as **"internetgprs"** instead of **"internet"**.
- **PDP Address** – a string parameter that identifies the terminal in the address space applicable to the PDP. The allocated address may be read using the **+CGPADDR** command.
- **D_comp** – numeric parameter that controls PDP data compression:
  - 0 – Off (Default if value is omitted)
  - 1 – On
- **H_comp** – numeric parameter that controls PDP header compression:
  - 0 – Off (Default if value is omitted)
  - 1 – On

- **Second Step** - Authentication setting #1:

AT+USERID=	"UControl Solutions"	<cr>
command	User	

- **Command** – Authentication User ID.
- **User** – String type, it's the authentication user id. The max length for this value is the output of test command, **AT#USERID=?**.

- **Third Step** - Authentication setting #2:

AT+PASSW=	"Pix-Cell C-SBC"	<cr>
command	User	

- **Command** – Authentication Password.
- **User** – String type, it's the authentication user id. The max length for this value is the output of test command, **AT#PASSW=?**.

- **Fourth Step** – Remote Host setting:

AT+SKTSET=	0,	"80",	"85.130.160.99",	0	<cr>
command	socket	Remote Port	Remote Address	Closure type	

- **Command** – Socket Definition
- **Socket type** – Socket Protocol type:
  - 0 – TCP (Factory default).
  - 1 – UDP.
- **Remote Port** – Remote Host port to be opened:
  - 0..65535 – port number (factory default is 0).
- **Remote Address** – Address of the remote host, This parameter can be either:
  - Any valid IP address in the format: xxx.xxx.xxx.xxx
  - Any host name to be solved with the DNS query in the format:<host name>
- **Closure type** – socket closure behavior for TCP:
  - 0 – local host closes immediately when remote host has closed (default).
  - 255 – local host closes after an escape sequence :+++
  - This parameter is valid only for TCP socket type.

- **Fifth Step** – For convenience, the user will store all these parameters:

AT+SKTSAV	**<cr>**
`command`	
• `Command` – Execution command saves the actual socket parameters in the NVM of the GSM device.	

- **Sixth Step** – Activation of the GPRS connection

Now it can activate the GPRS connection and let the Pix-Cell C-SBC controller contact the server:

AT+SKTOP	**<cr>**
`command`	
• `Command` – Execution command activates the context number 1, proceeds with the authentication with the user ID and password previously set by **#USERID** and **#PASSW** commands, and opens a socket connection with the host specified in the **#SKTSET** command. Eventually, before opening the socket connection, it issues automatically a DNS query to solve the IP address of the host name. • If the connection succeeds a **CONNECT** indication is sent, otherwise a **NO CARRIER** indication is sent.	

When the **CONNECT** indication is received, then data is exchanging with the HTTP server program on the remote host machine.

The GPRS AT commands connection sequence is:

- AT+CGDCONT=1,"IP","internet","0.0.0.0",0,0 <cr>
- AT+USERID="UControl Solutions" <cr>
- AT+PASSW="Pix-Cell SBC" <cr>
- AT+SKTSET=0,"80","85.130.160.99",0 <cr>
- AT+SKTSAV <cr>
- AT+SKTOP <cr>

In GPRS connection, after establishing a link, data can be transfer. Data is not available at all time and because of that we have "idle" times. Connection may be disconnected cause of this long "idle" times, it is the responsibility of the user to send every specified time a "keep alive" command in order to keep the GPRS connection link connected all of the time.

Please refer to the "AT Commands Reference Guide" at Telit website (www.telit.com), for a more details explanation on GPRS commands.

6. Functions Libraries

This section contains descriptions for all user-callable functions in UControl-API.c lib.

General Commands:	
InitBoard;	Initializes all Inputs, Outputs, Clocks frequencies, Serial Communications Etc…
ClrWdt;	Clears the post-scalar of the watchdog.
Delay_ml;	Craete a software delay in duration of milliseconds.
GreenLed;	Sets the Green Led on board according to value.
UserSerialInit;	Initializes the User Serial unit with a desired baud-rate.
UserSerialRd;	Receives data (byte) via the User RS232 communication.
UserialSerialWr;	Transmit data (byte) via the User RS232 communication.
Inputs Commands:	
BitRdInput;	Reads the Digital Status of a specific input (1,2,3).
AllRdInput;	Reads the Digital Status of all inputs.
AnaRdInput;	Reads the Analog value of a specific input (1,2,3).
TempRd;	Reads the Temperature value from the sensor on-board.
RtcVoltRd;	Reads the Analog value of the RTC backup voltage.
Outputs Commands:	
BitWrOut;	Sets the relay output according to the value.
PulseWrOut;	Sets the relay output 0-1-0 according to time duration.
PulseWrOutNot;	Sets the relay output 1-0-1 according to time duration.
Memory Commands:	
MemRd;	Reads Data from User Memory according to specific Address.
MemWr;	Writes Data to User Memory according to specific Address.
Eeprom_Read;	Reads Data from Internal EEProm according to Address.
Eeprom_Write;	Writes Data to Internal EEProm according to Address.
GSM Module Commands:	
GsmSerialInit;	Initializes GSM serial communicaton, 8 bit, No parity, Stop bit, Baud Rate…
GsmSerialRd;	Reads data from GSM Serial Com (Usart1).
GsmSerialWr;	Writes data to the GSM Serial Com.

GSM Module Commands:	
GsmOff;	Turns OFF the GSM Module.
GsmOn;	Turns ON the GSM Module.
RstGsm;	Resets the GSM module.
SendATCommand;	Send AT Commands to control the Cellular Module.
***GetGsmData;**	Receives Data from the Cellular module into an array.
SmsInit;	Initialize the Cellular modem to accept SMS data.
SendSms;	Sends SMS message.
***ReadSms**;	Reads SMS message.
DeleteSms	Delete SMS messages from module memory.

6.1. General Commands

6.1.1. Board Initialization

```
void InitBoard(void);
```

Call this function at the beginning of your program. This function initializes:

- **Board clocks** – Set internal clock to 32 MHz
- **I/O ports** - The ports are initialized according to Table 3.
- **Power-up the GSM modem.**
- **Serial ports** - Asynchronous mode, 9600 Baud Rate, 8-bit, No parity, Even mode configuration.
- **I2C Memory** - Set-up the clock to 100 kHz.

6.1.2. Clear Watch-Dog Post-Scaler.

```
void CLRWDT(void);
```

Clears the Watch-Dog and postscaler counts when executed. It must be executed at the beginning of every user procedure.

- **<u>Example:</u>** The recommended Watch-Dog time sequence is 4.096 seconds, if before this time the CLRWDT is not executed the controller will be reset.

6.1.3. Delay in milliseconds.

```
void Delay_ml(unsigned int time_limit);
```

Create a software delay in duration of milliseconds. Differ from the **Delay_ms()** of the compiler in that it has a **CLRWDT** command inside the procedure that clear the Watch-Dog postscaler. This feature gives the user the capability of using longer delay than the postscaler of the watch-dog.

- **Parameter:** `time_limit` is the value of the wanted delay time.
- **Example:** Delay_ml(1000);

6.1.4. Green LED.

```
void GreenLed(int Status);
```

LED On/Off control.

- **Parameter:** **`Status`** is the value used to control the LED:

  0 = LED OFF.
  1 = LED ON.

6.1.5. Initializes the User serial unit

```
void UserSerialInit(const int BaudRate);
```

Initializes the User serial unit with desired baud rate. The default baudrate is 9600. It is define in the **InitBrd** procedure.

6.1.6. User serial read

```
Unsigned char UserSerialRd(void);
```

This function receives a byte via the User RS232 com. If byte is not received, returns 0.

6.1.7. User serial write

```
Void UserSerialWr(unsigned char Data);
```

This function transmits a byte via the User RS232 com.

6.2. Inputs Commands

6.2.1. Read Input

```
int BitRdInput(int input_num);
```

Reads the digital state of a specific input channel. The actual switching threshold is approximately 2.5V for all inputs channels, anything below this value is Logical 0, and anything above is Logical 1.

- **Parameter**: `Input_num` is the number of the digital input 1, 2 or 3.
- **Return Value:** The state of the input (0 or 1).

6.2.2. Reads all Digital Inputs

```
unsigned char AllRdInput(void);
```

Reads the digital state of all inputs channel**.** The actual switching threshold is approximately 2.5V for all inputs channels, anything below this value is Logical 0, and anything above is Logical 1.

- **Return Value:** A value corresponding to the state of the all inputs.
- **Example:** Value return = 00000101, means inputs 1 and 3 are logical "1" and input 2 is logical "0".

6.2.3. Reads Analog Inputs

```
Unsigned int AnaRdInput(int InputNum);
```

Reads the Analog value of a specific input channel. The input voltage range is 0-5Vdc on all inputs. Input 3 can read 4-20 mA current sensors by setting jumper J2. The input reference of the A/D conversion is a precision voltage zener

- **Parameter**: `InputNum` is the number of the Analog input 1, 2 or 3.
- **Return Value:** 0 -1023 for 10-bit A/D conversions.

6.2.4. On-board Temperature Sensor

```
int TempRd(void);
```

Reads the Ambient Temperature value from the on-board temperature sensor.

- **Return Value:** The value received is the actual temperature in Celsius units.
- **Example:** Value return = 27, means that the temperature is 27 ºC.

6.2.5. RTC battery backup voltage

```
Unsigned int RtcVoltRd(void);
```

Reads the Analog value of the RTC battery backup voltage.

- **Return Value:** The value received is the actual voltage of the battery. The result must be divided by 100.

- **Example:** Value return = 247, means that the voltage is 2.47V.

6.3. Outputs Commands

6.3.1. Set Output Relay

```
void BitWrOut(int value);
```

Sets the state of relay output according to the value.

- **Parameter:** `Value` is the value used to control the Relay:

  0 = Opens the relay contacts.

  1 = Closes the relay contacts.

- **Example:** `BitWrOut(1)` means the relay is set .

6.3.2. Time Pulse Output Relay

```
void PulseWrOut(unsigned int time);
```

The relay output behaves according the sequence 0-1-0 for a time duration specify in `time` parameter.

- **Parameter:** `time` is the time duration the relay will be in the ON stage, it units is in milliseconds.

- **Example:** `PulseWrOut(2000)`; - The relay is set for 2 second and then reset.

6.3.3. Time Pulse Not Output Relay

```
void PulseWrOutNot(unsigned int time);
```

The relay output behaves according the sequence 1-0-1 according to time duration.

- **Parameter:** `time` is the time duration the relay will be in the OFF stage, units are in milliseconds.

- **Example:** `PulseWrOutNot(2000)`; - The relay is Re-set for 2 second and then Set back.

6.4. Memory Commands

6.4.1. Memory Read

```
Unsigned char MemRd(unsigned int Address);
```

Reads data from user memory according to specific address.

- **Parameter**: `Address` is the memory address location data is read.

6.4.2. Memory Write

```
void MemWrt(unsigned int Address,unsigned char Data);
```

Writes data to user memory according to specific address.

- **Parameter**: `Address` – the memory address location, `Data` – data to be written.

6.4.3. EEPROM Memory Read

```
int Eeprom_Read(unsigned int Address);
```

Reads Data from PIC Internal EEPROM according to Address.

- **Parameter**: **`Address`** is the memory address location data is read.

6.4.4. EEPROM Memory Write

```
int Eeprom_Write(unsigned int Address, unsigned char Data);
```

Writes data to user memory according to specific address.

- **Parameter**: **`Address`** – the memory address location, **`Data`** – data to be written.

6.5. GSM Commands

6.5.1. Initializes the GSM RS232 serial unit

```
void GSMSerialInit(const int BaudRate);
```

Initializes the GSM serial unit with desired baud rate. The default baud rate is 9600, as define in the **InitBrd** procedure.

6.5.2. GSM RS232 serial read

```
Unsigned char GSMSerialRd(void);
```

Returns the received byte from the GSM module. If byte is not received, returns 0.

6.5.3. GSM RS232 serial write

```
void GSMSerialWr(unsigned char Data);
```

Transmit a byte (`Data`) to the GSM module.

6.5.4. Turn OFF the GSM Cellular Module

```
void GsmOff(void);
```

Executing this procedure will turn the GSM module **OFF**. In Battery applications, the user needs to save power, one of the options is turning the Cellular module OFF.

6.5.5. Turn ON the GSM Cellular Module

```
void GsmON(void);
```

Executing this procedure will turn the GSM module **ON** (Power-Up).

6.5.6. Reset the GSM Cellular Module

```
void RstGsm(void);
```

Executing this procedure will reset the GSM module. This procedure must be executed after the Power-Up of the GSM module.

6.5.7. Send AT Command to the GSM Module

```
void SendATCommand(unsigned char p[]);
```

Executing this procedure will sends AT command to the Cellular Modem. Full description of 'AT commands' for the Pix-Cell modem refer to "Telit GE864 AT commands manual".

- **Example:** `SendATCommand("AT+CCLK="02/09/07,22:30:00+00"")` - Send the AT command to sets the Real-Time clock of the cellular module.

6.5.8. Receive GSM Data

```
Unsigned char *GetGsmData(void);
```

Executing this procedure will return a Pointer value. This Pointer refers to the location of an array, of 200 bytes, which stored the data received from the GSM modem. A "NULL" character indicates the end of the data received from the Cellular modem.

If for any reason, the GSM modem doesn't response after 5 seconds this function will terminate.

Important Note: The echo mode of the cellular modem must be set OFF, in order to work properly. The AT command to shut down the echo mode is: `SendATCommand(ATE0)`.

6.5.9. SMS Initializing

```
int SmsInit(void);
```

Executing this procedure will initialize the Cellular modem to accept SMS data. It returns a logical "1" when the initialization terminates without errors or logical "0" when errors were found. This procedure cancels the echo-mode of the cellular.

6.5.10. Send SMS Messages

```
int SendSms(unsigned char phone_num[],unsigned char msg[]);
```

Sends SMS messages to specific Phone Number. When the message is send successfully, the function will return the value "1" or "0" for a fail message.

- **Parameter:** `Phone_num[]` – Destination Cellular number of the SMS to be send.

  `Msg[]` – Message of the SMS, 160 characters long.

- **Example:** `SendSMS("+972524006068","Hello World");`

6.5.11. Read SMS Messages

```
Unsigned char *ReadSms(int index);
```

Executing this procedure will read the SMS message stored in the GSM memory location indicated by the index parameter (20 memories locations).

- **Parameter**: `index` – The memory location on the SIMCard where the message is stored.

- **Example:** `*ReadSms(2)`- Read the SMS message in memory location 2.

6.5.12. Delete SMS messages

```
int DeleteSms(int index);
```

Executing this procedure will erase a specific SMS message. This procedure receives the index memory location of the SMS message to be erased. The procedure returns:

- 0 – An error occurred.
- 1 – The message has been erased successfully.
- 2 – Indicates that the memory location `(index)` was empty.

7. CE Compliance

The system integrator has to get CE marking for the integrated solution with the PixCell GSM Controller. The system integrator only has to show compliance with the essential requirements of the controller by the integration of it into the application.

7.1. Design Guidelines

Note the following requirements for incorporating the PixCell GSM Controller into the user's application to comply with CE requirements.

7.1.1. General

- It is the customer's responsibility to provide a CE-compliant power supply for the end-product applications.
- When connecting the Pix-Cell GSM Controller to outdoor cables, the customer is responsible for providing CE-approved surge/lightning protection.
- UControl Solutions recommends placing digital I/O or analog cables that are 3m or longer in a metal conduit to assist in maintaining CE compliance and to conform to good cable design practice. Also, it is recommended using properly shielded I/O cables in noisy electromagnetic environments.

7.1.2. Safety

- For personal safety, all inputs and outputs to and from the PixCell GSM Controller must not be connected to voltages exceeding SELV levels (42.4VAC peak, or 60VDC). Damage to the PIC controller may result if voltages outside the design range of 0 to 40 Vdc are applied directly to any of its digital inputs.

Since the Pix-Cell GSM Controller is designed to be connected to other devices, good EMC practice should be followed to ensure compliance. CE compliance is ultimately the responsibility of the integrator.

8. GSM Safety Advice and Precautions

Below is advice and helpful hints on how to integrate the Pix-Cell GSM controller into your, the user's, application from the hardware perspective.

8.1. General

- Always ensure that the use of the GSM modem is permitted. The GSM modem may present a hazard if used in proximity to personal medical electronic devices. As a rule, the GSM modem must not be used in hospitals or onboard aircraft.
- The integrator is responsible for observing the country's safety standards, and where applicable the relevant wiring rules.

- Never use the GSM modem at a gas station, refueling point, blasting area or in any other environment where combustible vapors or explosives may be present.
- Operating the GSM modem close to other electronic devices, such as antennas, televisions sets, and radios may cause electromagnetic interference.
- Never try to dismantle the GSM modem yourself. There are no components inside the GSM modem that can be serviceable by the user. If you attempt to dismantle the GSM modem, you will invalidate warranty.
- Do not connect any incompatible component or product to the GSM controller.

UControl Solutions does not warrant against defects, malfunction, non-conformities or deviation caused by the connection of incompatible components or products to the Pix-Cell GSM controller.

8.2. SIM Card

- Before handling any SIM card, users should ensure that they are not charged with static electricity. Use proper precautions to avoid electrostatic discharges. The GSM modem must be switched off before the SIM card is installed or uninstalled.
- When the SIM card holder is opened, the SIM card connections lie exposed under the SIM card holder.

Do not touch these connections! Failure to heed this device may release an electrical discharged that could damage the GSM modem or the SIM card.

8.3. Antenna

- If the antenna is to be mounted outside, consider the risk of lightning.
- Always follow the instructions provided by the antenna manufacturer.
- Never connect more than one GSM modem to a single antenna.
- The GSM modem can be damaged by radio frequency energy from the transmitter of another adjacent wireless transmitter.
- Like any mobile station, the antenna of the GSM modem emits radio frequency energy. To avoid EMI (Electromagnetic Interference), users must determine whether the application itself, or equipment in the application's proximity, requires further protection against radio emissions and the disturbance it might cause. Protection is secured either by shielding the surrounding electronics or by moving the antenna away from the electronics and the external signals cable.
- The GSM modem and antenna may be damaged if either come into contact with ground potentials other than the one in the users application. Beware, ground potential are not always what they appear to be.

- In the final application, the antenna must be positioned more than 20 cm away from human bodies. When this rule cannot be applied, the application designer is responsible for providing the SAR measurements test report and declaration.
- Even is SAR measurements are not required, it is considered good practice to insert a warning in any manual produced, indicating it is a radio product and that care should be taken.

9. Installation of the Pix-Cell GSM modem

The following conditions need to be taken into consideration when designing your application as they might affect the GSM modem and its function:

9.1. Environmental Conditions

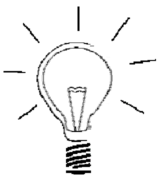
The GSM modem must be installed so that the environmental conditions stated, such as temperature, humidity and vibration are satisfied. Additionally, the electrical specifications stated must not be exceeded.

9.2. Signal Strength

The GSM modem has to be placed in a way that ensures sufficient signal strength. To improve signal strength, the antenna can be moved to another position. Signal strength may depend on how close the GSM modem is to a radio base station. You must ensure that the location, at which you intend to use the GSM modem, is within the network coverage area.

Degradation in signal strength can be the result of a disturbance from anther source, for example an electronic device in the immediate vicinity.

When an application is completed, you can verify signal strength by issuing the AT command AT+CSQ or AT*E2EMM. See the AT Commands Manual for further details.



Before installing the Pix-Cell GSM modem, use an ordinary mobile telephone to check a possible location for it. In determining the location for the GSM modem and antenna, you should consider signal strength as well as cable length.

9.3. Connection of Components to GSM modem

The integrator is responsible for the final integrated system. Incorrectly designed or installed, external components may cause radiation to be exceeded. For instance, improperly made connections or improperly installed antennas can disturb the network and lead to malfunctions in the Pix-Cell GSM modem or equipment.

9.4. Network and subscription

Before the integrator's application is used, the user must ensure that their chosen network provides the necessary telecommunication services. Integrators should contact their service provider to obtain the necessary information.

Integrators intending to use SMS in the application should ensure this is included in their (voice) subscription.
Similarly, integrators intending to use GPRS for data services should also ensure that this service is available on their network and in their account plan.

10. Antenna

10.1. General

The antenna is the component in the users system that maintains the radio link between the network and the wireless modem. Since the antenna transmits and receives electromagnetic energy, its efficient function will depend on:

- Type of antenna (for example, circular or directional)
- Placement of the antenna
- Communication disturbance in the vicinity in which the antenna operates

In the sections below, issues concerning antenna type, antenna placement, antenna cable, and possible communication disturbance are addressed.

In any case, users should contact their local antenna manufacturer for additional information concerning antenna type, cables, connector, antenna placement, and the surrounding are. Users should also determine whether the antenna needs to be grounded or not. Usually, a local antenna manufacturer should be able to design a special antenna suitable for the integrators application and environment.

10.2. Antenna Type

Users should ensure that they choose the right type of antenna for the Pix-Cell GSM modem. The antenna must be designed for the frequency bands deployed in the regions the Pix-Cell GSM modem is being used.

Other factors in choosing antenna are equally important:

- Impedance of the antenna and antenna cable must be 50 ohms at all frequencies being used
- Antenna output-power handling capability must be a minimum of 2W
- Antenna VSWR value should be less than 3:1 to avoid damage to the modem device

10.3. Antenna Placement

The antenna should be placed away from electronics devices or other antennas. The recommended minimum distance between adjacent antennas, operating in a similar radio frequency band, is at least 50 cm.

If signal strength is weak, it is useful to face a directional antenna at the closest radio base station. This can increase the strength of the signal received by the Pix-Cell GSM modem.

10.4. The Antenna Cable

Use 50 ohm impedance low-loss cable and high-quality 50 ohm impedance connectors (frequency range up to at least 2 GHz) to avoid RF losses. Ensure that the antenna cable is as short as possible.

The effectiveness of the antenna, cable and connectors is determined by their quality. All connectors, adaptor and cables should be of the highest quality, lowest loss, lowest VSWR rating that is affordable to the user.

Minimize the use of extension cables, connectors and adapters. Each additional cable, connector or adaptor will result in additional loss of signal power.

10.5. Possible Communication Disturbance

Communication disturbance can adversely affect the quality of wireless links, including the following causes:

- **Noise** can be caused by electronic devices and radio transmitters.
- **Path-loss** occurs as the strength of the received signal steadily decreases in proportion to the distance from the transmitter.
- **Shadowing** is a form of environmental attenuation of radio signals caused by hills, buildings, trees or even vehicles. This can be a particular problem inside buildings, especially if the walls are thick and reinforced.
- **Multi-path fading** is a sudden decrease or increase in the signal strength. This is the result of interference caused when direct and reflected signals reach the antenna simultaneously. Surfaces such as building, streets, vehicles, etc., can reflect signals.

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