Connecting Everything. ™

Syndesy

SynTRAC™-PL1
Series Embedded Cellular Modem
User Guide

Abstract

This Guide explains how to implement and test Cellular technologies with the SynTRAC-PL1 family of embedded cellular modem boards.

Contents

1. Starting up

1.1. SynTRAC™-PL1 Overview

The SynTRAC™-PL1 embedded boards are powerful and easy-to-use tools that simplify the evaluation of u-blox TOBY-R2 and LARA-R2 series multimode LTE Cat 1 / 3G / 2G cellular modules.

The following boards are available with u-blox TOBY-R2 cellular modules (see Figure 1):

- SynTRAC™-PL1-200 board is for evaluation of TOBY-R200
- SynTRAC™-PL1-202 board is for evaluation of TOBY-R202

The following boards are available with u-blox LARA-R2 cellular modules (see Figure 2):

- SynTRAC™-PL1-204 board is for evaluation of LARA-R204

All the SynTRAC™-PL1-200, SynTRAC™-PL1-202, SynTRAC™-PL1-204, boards are herein identified as SynTRAC™-PL1.

See the TOBY-R2 series Data Sheet [3], LARA-R2 series Data Sheet [4], TOBY-R2 series System integration Manual [5] and LARA-R2 series System Integration Manual [6] for the features supported by the Syndesy Technologies PL1 series cellular development boards.

Assumptions:

You have an active Carrier SIM that is appropriate for the connection.

You have verified that the latest firmware is loaded on the board

1.2. Board Images
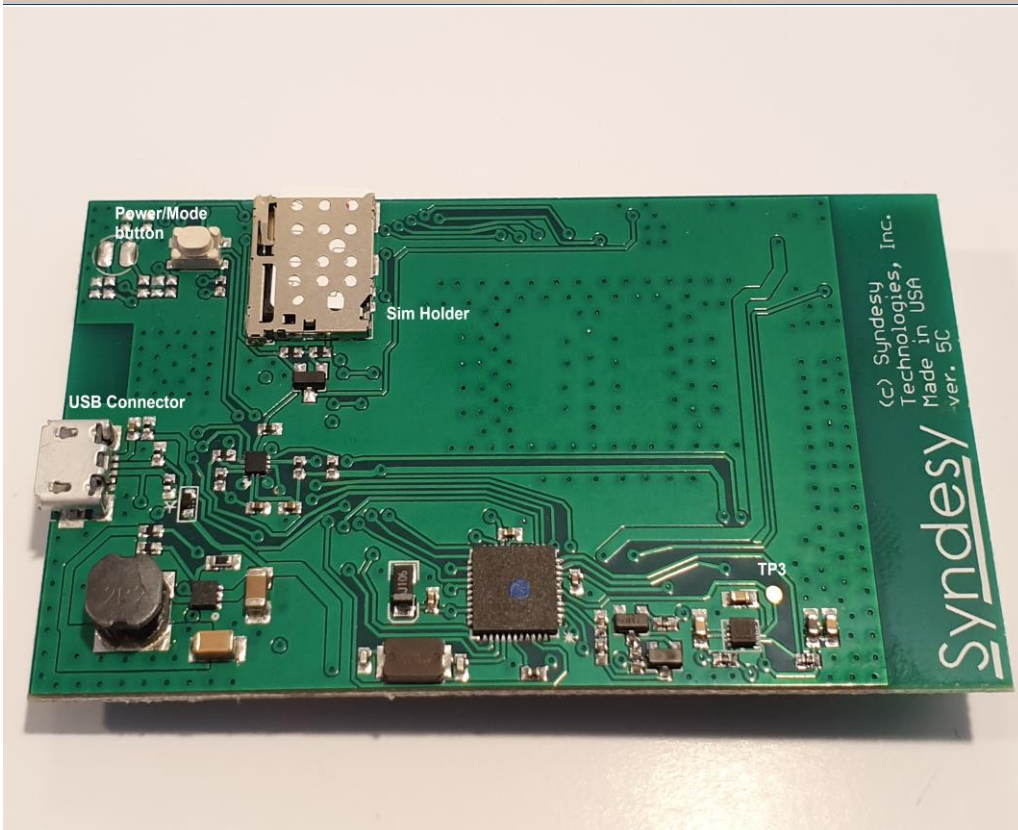
1.3. Software installation

The USB drivers are available with the SynTRAC™-PL1. Executable files can be downloaded from www.SyndesyTech.com and saved to any location on the computer hard drive. The installation can be started by running the executable file on a computer with the Windows operating system. On some versions of Windows the drivers may not be required. For Linux based Systems the device will be detected as TTYACMx, no drivers should be required. If the device is not detected please verify that your System supports this type of peripheral.

1.4. m-Center installation

We recommend you utilize the u-blox m-center application for windows if possible. It has many features available to it. Should you not have access to this program another terminal program may be used.

1.5. Board setup

1. Insert an Active SIM card into the **SIM card holder**.
2. Connect the USB for Power and Communications.
3. For communication via the cellular module's USB interface, connect a USB cable to the **Cellular native USB** connector

After the end of the module boot, the COM ports listed in Table 8 are enabled by the Windows USB driver (details as the numbering of the ports can be seen via the Windows Device Manager)[5]:

Table 8: Cellular USB interface configuration:

Parameter	Type	Remarks
U-blox Modem USB1 AT and data	Modems	AT command interface and data communication
U-blox Modem USB2 AT and data	Ports (COM & LPT)	AT command interface and data communication
U-blox Modem USB3 AT and data	Ports (COM & LPT)	AT command interface and data communication
U-blox Modem USB4 GNSS	Ports (COM & LPT)	GNSS tunneling
U-blox Modem USB5 SAP	Ports (COM & LPT)	Remote SIM Access profile
U-blox Modem USB6 Primary Log	Ports (COM & LPT)	Diagnostic purpose

[5] A message of "driver installation fail" may appear on Windows if the USB cable has been connected before the end of the module boot, but this can be ignored as the normal operating functionality of the module will be available anyway after the end of the module boot.

Run at AT terminal application (e.g. the u-blox m-center tool) selecting an AT port, with these settings:

- Data rate: 115,200 bit/s
- Data bits: 8
- Parity: N
- Stop bits: 1
- Flow control: HW

See Appendix A for how to configure the u-blox m-center AT terminal for Windows.

a. Connect a USB cable to the micro USB connector (**Cellular USB**),

When a USB cable is connected to the mini USB connector, two COM ports are enabled in Windows (the numbering of the COM ports can be seen via the Windows Device Manager). The serial port for the AT commands is available over the first numbered COM port opened by the driver.

Table 9: Serial interface configuration

Type of connections	SW401	SW403	LED
Access to cellular UART over the **Cellular USB (UART)** mini USB connector (J501)	ON BOARD	MINI USB	DL403
Access to cellular UART over the **Cellular RS232 (UART)** DB9 connector (J500)	ON BOARD	DB89	DL405
Access to cellular UART on the DIL Board-to-Board connector on the adapter board: cellular UART detached from USB (UART) J501 and RS232 (UART) J500 connectors	B2B	Do not care	DL404

Run an AT terminal application (e.g. the u-blox m-center tool) selecting an AT port, with these settings:

- Data rate: 115,200 bit/s
- Data bits: 8
- Parity: N
- Stop bits: 1
- Flow control: HW

See Appendix A for how to configure the u-blox m-center AT terminal for Windows.

1.6. Enabling error result codes

Command sent by DTE (user)	DCE response (module)	Description
AT+CMEE=2	OK	Enables the cellular module to report verbose error result codes.

1.7. PIN code insertion (when required)

Command sent by DTE (user)	DCE response (module)	Description
AT+CPIN="8180"	OK	Enter the PIN code, if needed (enter the PIN of the SIM card – 8180 is written here as an example).
AT+CLCK="SC",0,"8180"	OK	Unlock the PIN at power-on (the last parameter is the PIN of the SIM card – 8180 is written here as an example).
AT+CLCK="SC",1,"8180"	OK	Lock the PIN at power-on (the last parameter is the PIN of the SIM card – 8180 is written here as an example).

1.8. Registration on a cellular network

Command sent by DTE (user)	DCE response (module)	Description
AT+CREG?	+CREG: 0,1 OK	Verify the network registration
AT+COPS=0	OK	Register the module on the network. The cellular module automatically registers itself on the cellular network. This command is necessary only if the automatic registration failed (AT+CREG? returns 0,0).
AT+COPS?	+COPS: 0,0,"I TIM",7 OK	Read the operator name and radio access technology (RAT).

For further AT command examples regarding Mobile Network Operator, Radio Access Technology, and band selection and configuration, see the *u-blox AT Commands Examples Application Note* [2]

1.8.1. T-Mobile Sim & Profile Configuration

For T-Mobile SIMs you must use the following commands to validate the setup on their network. These commands are required to establish a proper connection.

Download the latest copy of m-center from https://www.u-blox.com/en/product/m-center or use your preferred Command Terminal.

Establish a USB connection to the Cellular modem and select one of the available AT command ports using *m-center* or another AT Terminal program.

Once connected to the modem, execute the commands in the table below in the following order:

Command sent by DTE (user)	DCE response (module)	Description
AT+COPS=2	OK	Disconnects the device from the network
AT+UMNOCONF=5	OK	Sets the modem profile to T-Mobile
AT+UIMSCFG=0,1,50,0	OK	Disables IMS (Voice Services)
AT+CEMODE=2	OK	Sets the Modem to Digital operation only.
AT+CFUN=16	OK	The modem will restart.

Upon restart your device will be configured to the T-Mobile network. Please verify your APN and other settings accordingly.

1.9. Switching off the SynTRAC™-PL1 cellular modem.

To switch off SynTRAC™-PL1 cellular modem, send the +CPWROFF AT command. Make sure to use this command before switching off the main power, otherwise settings and configuration parameters may not be saved in the internal non-volatile memory of the cellular module.

Appendix A: Setting up AT terminal applications for communication with SYNTRAC-PL1

The u-blox m-center cellular module evaluation tool is a powerful platform for evaluating, configuring and testing Syndesy Technologies products. M-center includes an AT commands terminal for communication with the device and can be downloaded free of charge from our website https://www.syndesytech.com/

1. Follow the board setup instructions in section 1.8 to provide all the required connections and switching on the cellular module.

2. Run the m-center tool: after the m-center start-up, the **Home** page appears.

3. On the **Home** page, set up the AT COM port; for the setting values see section 1.8. Check with the Windows Device Manager to find out which COM port is being used by SynTRAC™-PL1.

4. Enable the connection to Syndesy Technologies cellular module by clicking on the **Connect** button.

5. Retrieve the module and network information by clicking on the **Get Info** button.

6. The module information is retrieved and displayed on the Home page.

7. Click on the **AT Terminal** button, found at the upper right of the **Home page** a new window opens and the AT-command terminal is now ready for communication with the SynTRAC™-PL1.

8. The AT terminal is ready to use. For the complete list of AT commands supported by the modules and their syntax, see the *u-blox AT commands manual* [1].

Figure 4: "Home" page

Figure 5: AT Terminal window

For more information on using the u-blox m-center cellular module evaluation tool, press the F1 key on the keyboard to open the m-center help window on the computer.

# Appendix B: Setting up cellular packet data connection on PC

This section describes how to set up a packet data connection with the Windows 7 operating system (for PC) and SynTRAC™-PL1, using the TCP/IP stack of the PC (external TCP/IP stack). The following examples describe how to install and configure two different kinds of modem on Windows: High data rate modem, over the native USB interface of the cellular module connected to the Windows PC by the **Cellular Native USB** connector on the ADP.

## How to install and configure a high data rate modem connection

This example describes how to install and configure a high data rate packet data connection on a PC with the Windows 7 operating system, using the TCP/IP stack of the PC, over the native USB interface of the cellular module connected to the Windows PC by the **Cellular Native USB** connector to the ADP.

1. Follow the board setup instructions in section 1.8 to provide the required connections with SynTRAC™-PL1.
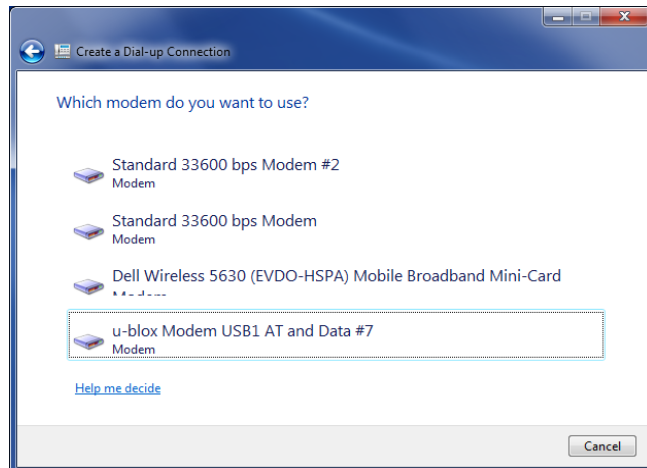
2. Select: "Control Panel > Network and Internet > Network and Sharing Center > Setup a new connection or network" This opens the "Choose a connection option" Wizard.
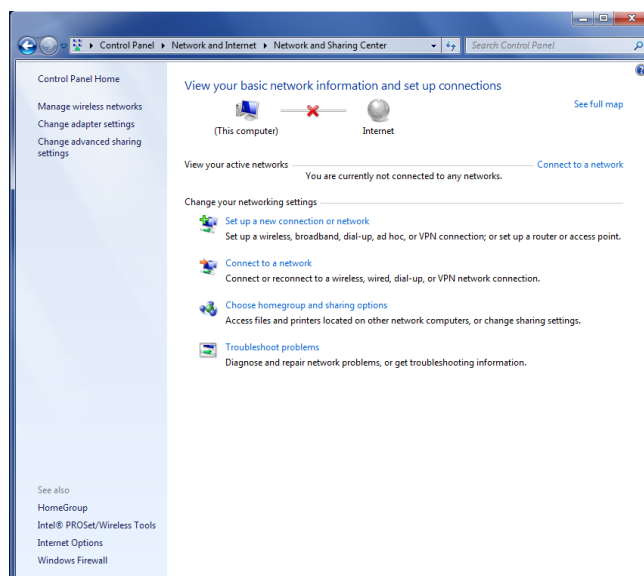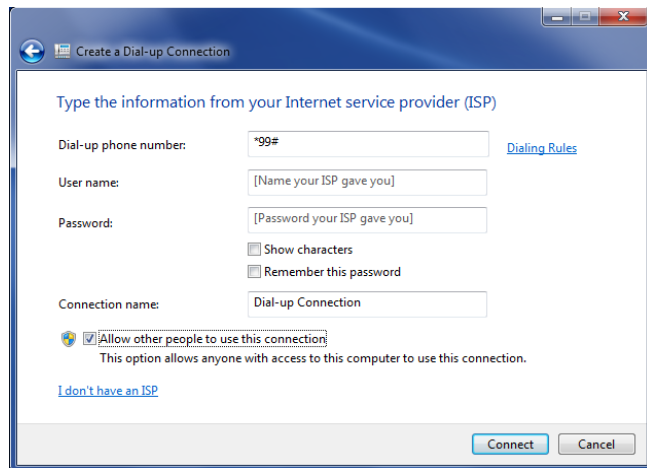

3. Select **Set up a dial-up connection**. Click on **Next**.
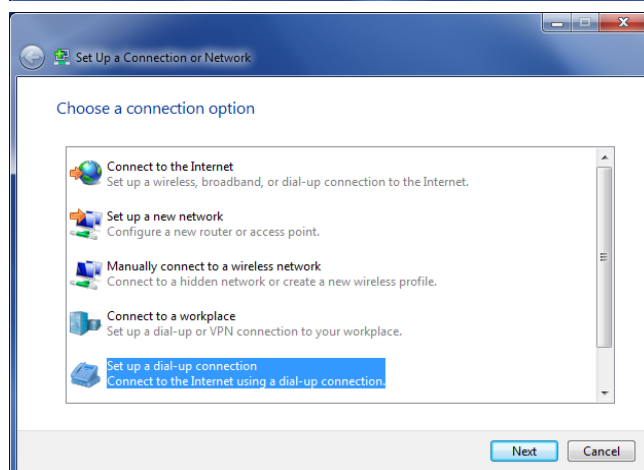
4. Select **u-blox Modem USB1 AT and Data #X** (X=7 in the picture).

5. Enter the modem telephone number (*99***1#), select **Allow other people to use this connection** and click **Connect** to finalize the procedure.

Consult the cellular network operator for the username and password. In most cases, these can be left empty.

Appendix C: Examples of AT commands

For the complete description and syntax of the AT commands supported by each TOBY-R2 and LARA-R2 series cellular module product version, see the *u-blox AT commands Manual* [1].

For detailed examples of AT commands for network r e g i s t r a t i o n a n d c o n f i g u r a t i o n , context a c t i v a t i o n , data connection management, SIM management, module interfaces configurations and other settings, see the *u-blox AT Commands Examples Application Note* [2].

Define the initial default bearer for connectivity

To change the PDN settings for the initial default EPS bearer established during LTE attach, edit the <cid>=1 PDN by means of the AT+CGDCONT AT command.

Command sent by DTE (user)	DCE response (module)	Description
AT+COPS?	+COPS: 2 OK	Module not registered
AT+CREG=2;+CGREG=2;+CEREG=2;+CGEREP=1,1;+CIREG=1	OK	Enable a set of registration URC, including PS, CS, EPS and IMS registration events.
AT+CGDCONT?	+CGDCONT: 1,"IPV4V6","","",0,0 OK	Read IP Type and APN for EPS attach bearer.
AT+CGDCONT=1,"IPV4V6","broadband"	OK	Set APN name (i.e. "broadband") and the PDP type (i.e. "IPV4V6") for EPS attach bearer.
AT+COPS=0	OK +CGEV: NW CLASS A +CREG: 1,"7CFF","00051235",6 +CGREG: 1,"7CFF","00051235",6,"FF" +CEREG: 1,"8305","04C87A0F",7 +CGEV: ME PDN ACT 1	Trigger registration and wait for LTE attach complete.
ATD*99***1#	CONNECT	Establish a PPP/dialup data session

Appendix D: Linux Based Workstations/Raspberry Pi (3/4) setup

Ubuntu, Debian, some android environments, etc., as well as Raspberry Pi would fit this category. As always, please make sure to check an update all packages to the latest versions available. This will make the installation process easier and more efficient with less chance of running into any problems. The sections in GREY are terminal commands and File contents for you to cut and paste as you like. It would be best is you login as a superuser.

Assumptions:
- Your operating system is loaded with latest updates.
- You have some command line knowledge.
- You have access to Root.

Connecting your Device:
In order to properly complete we need to verify your device in the system. From a root terminal.

#ls /dev/tty*

Make note of any changes after you have attached your SynTRAC. Raspberry Pi may require an additional USB hub, if you do not see the modem listed try to connect one first.

Typically this device will show **ttyACM0-5**, the first 3 are typically AT command ports (Table 8).

If your device is not visible at this point no need to continue. Some Operating Systems may show it as ttyUSB*

Install the pppd package with the following command:

You will need to verify that the ppp daemon is installed.
If not install with the following command depending on your OS:

#sudo apt-get install ppp
or
#sudo apt-get install pppd

Configure the Dialer:

You will need to create 3 files for the dialer to work properly. Use whatever document editor you find most comfortable.
/etc/ppp/options
/etc/ppp/net-connect
/etc/ppp/net-chat

Permissions will be set as follows:
-rw-r--r-- / root / root options
-rw------- / root / root net-chat
-rwx--x--x / root / root net-connect

The options file is a simple text file containing parameters pppd will use when it is executed—one parameter per line. The options file must be readable by whoever will execute the pppd program. In most installations this will be root, either directly or by executing pppd from a program like sudo.
If you don't have an /etc/ppp directory, as root create one using the following commands:
mkdir /etc/ppp
chown root:root /etc/ppp
chmod 755 /etc/ppp

Create an /etc/ppp/options file that looks like the following example:

```
debug
/dev/ttyACM0      *** Please verify the port on your system device addressing section above.
asyncmap 0
defaultroute
noipdefault
lock
usepeerdns
persist
holdoff 30
maxfail 0
connect /etc/ppp/net-connect
```

The pppd package includes a program called chat. The chat program is a simple program that can be used to automate the dialing procedure. Make sure to have the correct rights:

```
# chown root:root /etc/ppp/options
# chmod 644 /etc/ppp/options
```

To make use of the chat program from within pppd, we must ensure that the connect option points to a script that calls chat.

Create a script file called /etc/ppp/net-connect that looks like:

```
#!/bin/sh
/usr/sbin/chat -V -t 60 -f /etc/ppp/net-chat
```

This shell script will invoke the chat command with the -v, -t and -f arguments. The -v argument is useful when you are configuring pppd, as it sends verbose diagnostic messages to the system log to show you what is happening as the chat program runs. The -t 60 argument simply tells the chat program to wait 60 seconds for the expected text to arrive before timing out with an error. The -f argument tells chat the name of the file it should use to get the expect/send sequences it will use to login.

Make sure the script is readable and executable to invoke pppd. As root, use the following commands:

```
# chown root:root /etc/ppp/net-connect
# chmod 711 /etc/ppp/net-connect
```

Create a chat script file called /etc/ppp/net-chat.

```
ABORT 'BUSY'
ABORT 'NO CARRIER'
''AT
OK ATD*99***1#
CONNECT
```

The first two lines are special. The ABORT keyword is a special token that allows you to specify strings of characters that will cause the chat program to exit. In the example presented, if the chat program receives either the string "BUSY" or the string "NO CARRIER" then it will abort immediately. The rest of the file is a simple list of expect/send pairs, based on the information we gathered when we manually logged in. The above example reads in full:
ABORT the script if we receive "BUSY" or "NO CARRIER

Finally, we must ensure this script is readable by whoever will invoke pppd. Again assuming that whoever is be root, you can use the following commands:

```
# chown root:root /etc/ppp/net-chat
# chmod 600 /etc/ppp/net-chat
```

Starting the Link

To start the PPP link, all you need to do is execute the following command as root:

To start ppp in the foreground:
```
#sudo pppd -d -detach
```

To start it up silently in the background:
```
#sudo pppd &
```

To check the connection.

The ifconfig program is used to set or display network interface configurations. Here you are interested in displaying only.
```
#ifconfig
```

Review the response:
ppp0: flags=4305<UP,POINTOPOINT,RUNNING,NOARP,MULTICAST> mtu 1500
inet 10.xxx.xxx.xxx netmask 255.255.255.255 destination 10.xxx.xxx.xxx
ppp txqueuelen 3 (Point-to-Point Protocol)
RX packets 12 bytes 710 (710.0 B)
RX errors 0 dropped 0 overruns 0 frame 0
TX packets 14 bytes 649 (649.0 B)
TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

Your ppp0 should be established. You may need to refresh route to establish this as the default.

```
# route
```
Response should look like this:
Kernel IP routing table
Destination   Gateway   Genmask   Flags Metric Ref   Use Iface
default   0.0.0.0   0.0.0.0   U   0   0   0 ppp0
link-local   0.0.0.0   255.255.0.0   U   202   0   0 eth0

Check to make sure that the ppp0 is listed properly in the routing table as you would expect to see it. Above is the ppp0 as the default route which means all network traffic will run through that connection.

```
#route add default ppp0
```

To test the connection:

Open your browser or from the command line ping your favorite supplier website.

```
#ping www.syndesytech.com
```

You will either see the website or your ping will resolve.

2. Declaration of conformities

The equipment is intended for indoor usage. It is the user's duty to verify if further restrictions apply, such as in airplanes, hospitals or hazardous locations (petrol stations, refineries…).

Any changes or modification made to this equipment will void its compliance to the safety requirements.

Maintenance, inspections and/or repairs of the SynTRAC™-PL1 shall be performed by Syndesy Technologies, Inc.

3. Export control of classification number

ECCNs are five-character alphanumeric designations used on the Commerce Control List (CCL) to identify dual-use items for export control purposes. An ECCN categorizes items based on the nature of the product, i.e. type of commodity, software, or technology and its respective technical parameters.

All SynTRAC-PL1 devices are: ECCN 5A992.c

3. Related documents

[1] U-blox AT commands manual, Docu No UBX-13002752

[2] U-blox AT Commands Examples Application Note, Docu No UBX-13001820 [3] U-blox TOBY-R2 series Data Sheet, Docu No UBX-16005785

[4] U-blox LARA-R2 series Data Sheet, Docu No UBX-16005783

[5] U-blox TOBY-R2 series System Integration Manual, Docu No UBX-16010572 [6] u-blox LARA-R2 series System Integration Manual, Docu No UBX-16010573

All these documents are available on either website (http://www.u-blox.com) or (http://www.SyndesyTech.com)

For regular updates to Syndesy Technologies documentation and to receive product change notifications, register on our website.