

# Survey Controller

## *Using Cellular and Cellular Digital Packet Data Modems for RTK work*

### Summary

This document explains how to set up and use cell phones and Cellular Digital Packet Data (CDPD) modems for RTK work using a Trimble GPS Total Station® family system. After reading this document, you should feel comfortable talking about the technology and demonstrating the cell phone.

Note: Prices quoted in this document are in U.S. dollars and will vary from state to state and outside of the U.S.

### Advantages of Cell Phones for RTK Work

There are several important differences between cell phones and normal radio solutions:

- Because radio frequency is allocated for cell phone use, this is effectively your own private frequency. There is no interference.
- There is no distance limit to radio coverage.
- With a smaller radio at the base station, you just have to talk to the nearest cell tower.
- Most cell phones work in the bandwidth of about 9600 bps. RTCM and RTK (RTCM versions 2.1 and 2.2) work in this bandwidth.
- Cell phones are ideal for jobs where the talk time is limited to short bursts, such as photo control. Here, 5-minute calls are spread throughout a wide range over the course of a working day.

### Equipment Required for Standard Cell Phone Communication

- Phones compatible with Trimble receivers
- A base that answers the phone when the rover dials in
- A rover that dials in with a cell phone

### Equipment Required for the Base:

Any modem that supports the cellular protocols can be used. Most users select another cell modem, but it is possible to use a landline. Using a landline cuts the cell modem's cost in half. The modem must have the ability to accept multiple data calls in a row.

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## Equipment Required for the Rover:

1. A cellular modem, either in the form of a cell phone that can send and receive data, or a custom designed cell phone. The cell phone must have an RS-232 connection with a built-in Hayes-compatible modem. The cell phone can NOT require a PC card.
2. A cell phone plan that allows for streaming data.
3. An external power source or some spare phone batteries are needed. Make sure your cell phone has an adequate charge for a full day's work.
4. A cable with a NULL modem built in to connect to the receiver is required. Generally, the converter cable PN 37779 is used to connect the cell phone to PC cable. Turn off flow control if possible. If flow control is turned off, it must be turned back on for Windows to use it as a modem. If flow control cannot be turned off, a special cable is needed.

## Setting up the Base

1. Connect the cell phone to the base station using the cable.
2. Create a new Survey Style called Cell Phones.
3. For the base radio select Cellular Modem. Leave it at the default

Setting	Value	Notes
Init String	ATS0=1	This tells the phone to answer after one ring. <b>Important:</b> Depending on the phone, it may need to be set to answer in DATA mode as well. If it is needed, choose the DATA mode until power-off option.
Hang Up String	ATH0	Leave this as the default.

4. Start the base as normal.
5. The phone may or may not display something indicating it is waiting for an answer.
6. It should then make the normal modem noise.
7. Hang up.
8. Try again one minute later to make sure that the modem reset correctly. You only need to check this once with each base modem.
9. If anything goes wrong in the field, perform a manual dial to make sure the modem is working. To do this, just dial the phone number you are using. The phone should answer and sound like a modem.



## Setting up the Rover

1. Connect the cell phone to the rover station using the cable.
2. Create a new Survey Style, called Cell Phones.
3. For the Rover Radio, select Cellular Modem. Leave it at the default.

Setting	Value	Notes
Init String:		Use ATZ if any problems are encountered.
Hang Up String	ATH0	Leave this as the default.
Dial Prefix String	ATDT	Tone dialing. Leave this as the default.
Number to dial		Enter the base station number.
Dial Suffix		Generally not needed.
Post Connect		If needed, a user name and password are entered here.

4. Start the rover as normal.
5. A few screens will pass as the phone dials the base station.
6. The radio icon will display on the Trimble Survey Controller™ firmware when the cellular connection works correctly.

Note: If the phone connects and indicates it is receiving data, there is a flow control problem. When this happens, a special cable is needed or the phone's DTR setting must be changed.

## Cell Phone Issues

Depending on the plan and the carrier, your per-minute charge per cell phone will vary greatly. There are several available plans with reduced prices, including free unlimited cell-to-cell calling. Check with your local service provider for a schedule of charges.

One base can easily support one rover. To support more, a Y cable and another cell phone is required, which is not generally recommended.

## Equipment Required for CDPD Modem Communication:

1. A CDPD modem compatible with Trimble receivers. The CDPD modem requires an RS-232 connection with a built-in modem. The modem must have a Hayes-compatible interface, or not require configuration from the Trimble Survey Controller firmware. A modem with an internal battery is recommended. It can NOT require a PC card.

Trimble recommends the SAGE CDPD modem from Novatel Wireless. These units cost \$350 each (U.S. only). The internal battery lasts 6 hours, so a spare is suggested. Charging might be an issue. Because of each unit's cost, it is as cost effective to purchase a second modem as purchasing a spare and charger.

2. A CDPD plan that allows for unlimited streaming data. Some plans charge \$0.10 per Kb (US only). Trimble sends about 6Kb of data per minute, which translates to \$0.60 per minute. In this case, it may be cheaper to use a normal cell phone. Other plans do not allow streaming

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data and call it unreasonable usage. CDPD coverage is limited to major cities and is NOT available nationwide. Trimble recommends this as an additional radio solution for people working in built up areas.

3. A cable with a built-in NULL modem to connect to the receiver. The converter cable PN 37779 connects the cell phone to the PC cable. Turn off flow control if possible. If flow control is turned off, it must be turned back on to use it as a modem in Windows. If flow control cannot be turned off, a special cable is needed.

### Setting up the Base

Follow the instructions for setting up the modem, as documented in Appendix 1. You only have to do this once.

1. Connect the cable 37779 to port 3.
2. Turn the CDPD modem on, making sure that the service light turns solid. If it continues flashing, there is a problem with CDPD service.
3. Start the base as normal, with a custom radio, set at 19200,8,n,1.
4. The transmit light should flash once every second, while the receive light does not flash. If they do not perform in this way, turn the base radio off and on.
5. It is possible to use the Trimble Survey Controller's cellular modem support to allow the base to pick which rover to talk to.

### Setting up the Rover

NO setup is required for the rover unit. It works automatically when turned on assuming the base is broadcasting.

1. Connect the cable 37779 to port 3.
2. Turn the CDPD modem on, making sure that the service light turns solid. If it continues flashing, there is a problem with CDPD service.
3. Start the base as normal, with a custom radio, set at 19200,8,n,1.
4. Make sure the receiver light flashes every second.

### CDPD Modem Issues

A modem normally costs \$55 per month. Currently, two modems are required, totaling \$110 per month. TerraSat base station software has an option that allows direct TCP/IP connections to the RTCM data stream. This software should also allow multiple CDPD connections.

One base can support only one rover. To support more, a Y cable and another CDPD modem are required.



# Appendix 1

## Setting up the Rover Sage CDPD Modem

1. To set IP address of the base modem, use the command  
ATS53=xxx.xxx.xxx.xxx/1  
Where xxx.xxx.xxx.xxx is the IP address of your base modem, /1 indicates port 1. Port 1 should be selected when using a Sage CDPD modem at the base. The recommended address setting is 0.0.0.0, which allows the rover to work with any base that sends it data.
2. To set the rover to listen for the base, use the command  
ATS83=2
3. To turn off flow control and ignore DTR, use the command  
ATS211=1
4. To turn off flow control, use the command  
AT\Q0
5. To set the default power-up mode, use the command  
ATMD3
6. To store the configuration, use the command  
AT&W

## Setting up the BASE Sage Modem

1. To tell the base what rover to broadcast to, use the command  
ATS53=xxx.xxx.xxx.xxx/1  
Where xxx.xxx.xxx.xxx is the rover's IP address, /1 indicates port 1. This is required.
2. To enable RS-232 internet conversion, which reduces packet creation time, use the command  
ATS50=1
3. To set the modem to listen mode, use the command  
ATS83=2
4. To turn off flow control, which ignores DTR, use the command  
ATS211=1
5. To set the default power-up mode, use the command  
ATMD3



6. To save the changes, use the command  
AT&W
7. Configure side A or side B to the setting supplied by the CDPD provider.  
To set the unit to side A, use the command AT\N1.  
To set the unit to side B, use the command AT\N2.

**IMPORTANT: Failure to correctly set this will result in the modem roaming, even when the call is local. This will result in drastically higher monthly charges.**

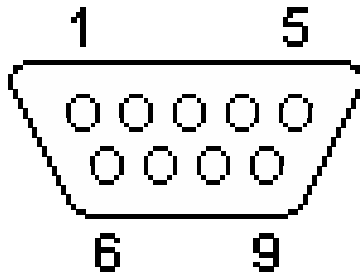
The CMR output must be enabled. When attempting to reprogram the base after it has been setup, you have 30 seconds to enter commands. If the base modem does not receive data for 30 seconds, the CONNECT message is displayed, and the unit must be powered off and restarted. Trimble recommends changing one item at a time, then using the AT&W command to save the changes. Now, when the base is turned on, it will automatically send data to the rover.



## Appendix 2

### Cable Issues

Pinouts (From [http://www.pin-outs.com/datasheet\\_11.html](http://www.pin-outs.com/datasheet_11.html))



Number	Function	Abbreviation
1	Data Carrier Detect	CD
2	Receive Data	RD or RX or RXD
3	Transmitted Data	TD or TX or TXD
4	Data Terminal Ready	DTR
5	Signal Ground	GND
6	Data Set Ready	DSR
7	Request To Send	RTS
8	Clear To Send	CTS
9	Ring Indicator	RI

Note: Some Trimble cables provide power output on pin 9. RI is not needed for cell phone operation and Trimble recommends it not be connected to the cell phone.

### Base Cables

If the base modem cannot be configured to automatically enter auto-answer mode, then the cellular modem radio type must be used. This type forces users to make a cable for the base station.

Trimble Survey Controller firmware versions 7.5 and 7.6 force hardware flow control for cellular modems, so the modem must connect to port 1 or port 3 on a 4700/4800 or port 2 on a 4000/4400. The 4000/4400/4700/4800 all allow classical use of the RS-232 hardware flow control that works best for radios.

This is how Trimble's hardware flow-control system works. When the receiver has data to send to the radio, it asserts CTS. When the radio responds by asserting RTS, the receiver sends the data. If the CTS delay option is enabled in a 4000, the receiver pauses before sending the data. Most modern modems do not require the use of CTS and RTS protocols.



ADDING VALUE TO GPS  
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If the CTS/RTS protocols are required, a cable connecting the CTS/RTS lines together is needed. This is achieved by wiring pins 7 and 8 together so they go back into the base station. Now, when the receiver asks to send data by asserting CTS, the cable responds by saying it is allowed to send data. This cable handles flow control for the GPS receiver and assumes the cellular modem does not require any special lines to be displayed. The receiver will NOT fully power up if this cable is connected, but will remain in the monitor stage. This feature allows the system to recover from corrupt firmware.

## Rover Cables

The rover cables depend on the cellular modem. For the QCP-860, as with most modems, it will not send any data to the rover receiver unless the DTR line is asserted.

- Even though the receiver does not assert this, the command must be asserted in some form.
- Wire Carrier Detect and DTR together.
- Wire DTR and DSR together.
- Wire RTS and CTS together. See Base Setup for more details.

