

PAD OPERATION



Model	Chameleon gateways
Revision	Revision 1.2

3066 Beta Avenue Burnaby, B.C. V5G 4K4
Phone: 604.294.4465
Fax: 604.294.4471
support@cypress.bc.ca

Revision Control

Description	Revision	Date
Customer Release	Revision 1.0	04-Dec-2009
Revised for Chameleon gateways	Revision 1.1	21-June-2011
Updated PAD command format Added note about multiple serial ports	Revision 1.2	20-Jan-2012

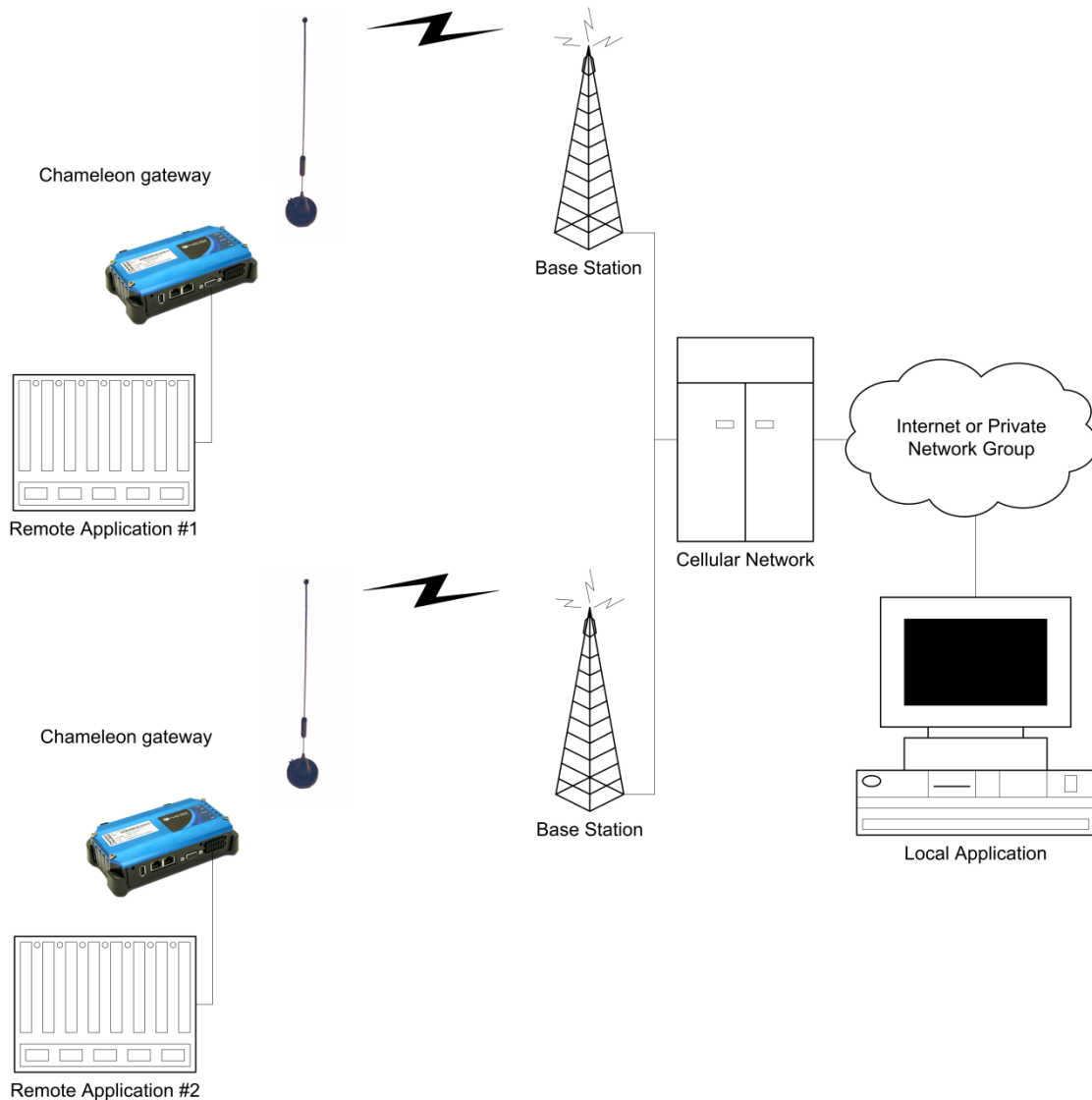
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1 PAD Operation

Packet Assembly and Disassembly (PAD) is used for sending and receiving “raw” data over IP networks. The Chameleon gateway takes care of establishing IP network connections, as well as the encapsulation of data within UDP or TCP packets. This eliminates the need for a TCP/IP stack running on the host device. This application note details how to setup a Chameleon gateway in PAD mode in order to provide a communications link between a serial port end device and a central control application.

A PAD connection uses the CDMA EVDO (Rev A) or the HSPA+ packet data network providing the advantages of higher data rates for quicker response times, and always being connected. PAD mode is typically used for supervisory control and data acquisition (SCADA) applications. PAD mode can be used with master and slave devices that use proprietary communication protocols such as the Allen Bradley DF1 or used to provide direct communications with field devices normally operated on a dial-up modem connection.



1.1 Selecting the Appropriate PAD Settings

There are two main PAD modes: UDP PAD or TCP PAD.

UDP transport protocol is connectionless and does not guarantee data delivery. However, it is much lighter than TCP in terms of data transmitted. It is considered suitable for the following applications: When total data transfer must be kept to a minimum. Losing a packet is not critical, or the application communication protocol itself provides for retransmissions.

TCP transport protocol is connection oriented and does guarantee data delivery. It will keep trying to send a packet multiple times until its delivery is acknowledged. Because of these characteristics, it has much more overhead compared to UDP. It is suitable for the following applications: When the total amount of data transfer is not critical. Losing a packet is critical and the application communication protocol itself does not perform retransmissions.

Both UDP PAD and TCP PAD can operate in either client or server mode. Client mode means that the gateway is required to establish a connection to a remote device in server mode (this may be through another gateway). Server mode means that the gateway is continually listening on a port and will accept connections from a remote server (this may be from another gateway).

2 Commands for PAD operation

On CTM devices that support multiple serial ports a second PAD session can be initiated by **cmd pad2** [command].

The **mode** command controls the function of the serial port(s). Note: 2nd or 3rd serial port is not available on all models of the CTM-200.

<i>pad</i>	<i>serial port 1</i>	<i>serial port 2</i>	<i>serial port 3</i>
pad	yes	yes	yes
pad2	no	yes	yes

The default serial port baud rate is 115,200. If you need to change the serial port settings use the following command:

cmd port n r d p s f

where *n* is the Chameleon gateway serial port to configure

n = 1 configure Primary DB9 port

n = 2 configure Secondary DB9 port

n = 3 configure RS485 port

r is the required serial port baud rate

p is the parity setting: N, E, or O

d is the number of data bits: 7 or 8

s is the number of stop bits: 1 or 2

f is the flow control setting:

0 (no flow control) OR

1 (software flow control) OR

2 (hardware flow control)

You will now need to adjust the terminal application to these new settings.

cmd mode a b c

Sets the required functionality of the serial port(s):

a = configure the function of the Primary DB9 port

b = configure the function of the Secondary DB9 port

c = configure the function of the RS485 port

Use **mode 2** (a =2, b=2, or c=2) if the host device connected to the specified serial port will initiate the PAD connection using **cmd gopad**. Use **mode 4** (a=4, b=4, or c=4) if the gateway is required to initiate the PAD connection on the specified serial port – after a power cycle the gateway will come up in PAD connected mode for the specified serial port.

cmd pad mode x

x = 0 start up UDP PAD mode. The gateway will revert to server mode once the connection is closed. (default)

x= 1 start up TCP PAD mode. The gateway will revert to server mode once the connection is closed.

x = 2 start up UDP PAD client mode - one session. The gateway will revert to command mode once the connection is closed.

x = 3 start up TCP PAD client mode - one session. The gateway will revert to command mode once the connection is closed.

x = 4 start up persistent UDP PAD client mode

x = 5 start up persistent TCP PAD client mode

cmd pad ip iii.iii.iii.iii

For server mode use 0.0.0.0 (this is the gateway's default). For client mode use the IP address of the server gateway, or if the host device will initiate the connection keep this as 0.0.0.0

cmd pad port xxxxx

For PAD mode 0 or 1 (server modes), xxxxx is equal to the gateway's PAD listening port. For all other PAD modes (client modes), xxxxx is equal to the port of the server gateway. In PAD mode 0 or 1, when used as a client the gateway will transmit to this port and then listen on this port when it reverts to server mode.

cmd pad fwdc x

This is the PAD forwarding character. It defines which Hex value or ASCII character (in decimal) will initiate the encapsulation and transmission process. The default is ASCII character 13 (carriage return). If your protocol always ends a "sentence" with the same terminating character then it can be set here. If no forwarding character is required set this to x = 0. If x = 0, **pad fwddt** or **pad fwdl** will invoke sending the packet.

cmd pad fwdl x

This is the PAD forwarding length (default x = 40). It defines how many characters will initiate the encapsulation and transmission

process. Generally this parameter is set to a value greater than the longest “sentence” in your protocol. If no forwarding length is required set this to maximum (1000). If x = 0 is specified then every character is sent immediately.

cmd pad fwdt x	This is the PAD forwarding time in 50 ms increments. It defines the time after receiving the last character in a “sentence” that the encapsulation and transmission process will be initiated. If every character is required to be sent immediately then set n = 0.
cmd pad echo x	If the connected device requires every character it sends to the gateway to be echoed back on the serial port then set n = 1. Otherwise, set n = 0 to disable the echo feature.
cmd pad svct n [c]	The n parameter sets the server connect timeout in seconds (default n = 15). The c parameter (optional) sets the maximum PAD connection timer in seconds (default c = 0, disabled). If the gateway is configured using cmd pad mode 0/1 , it starts as a client then after n seconds reverts to server mode in order to receive incoming connections from another client. If the gateway is required to be always in client mode then use cmd pad mode 4/5 while setting n = 0, c = 0 to disable the timers.
cmd save	Save the current settings to non-volatile memory. When cmd mode 4 is saved, the gateway will now always power up in auto connect, PAD mode with the settings as configured above.
cmd pwr mode 2	Power cycling the gateway will initiate the PAD connect for cmd mode 4 .
cmd pad reset	Drop the current PAD connection and perform the following: pad mode 0/1 : return to server mode pad mode 2/3 : return to serial command console pad mode 4/5 : establish new PAD connection This command allows manual triggering of the equivalent actions that occur on when one of the pad svct timers expire.

2.1 Initiating a PAD Connection from the Gateway

If the gateway has been configured in **cmd mode 4** (auto connect to network and PAD host interface) then after a power cycle no other action is required to initiate the connection.

If the gateway has been configured in **cmd mode 2** (auto connect to network) then it will be necessary to manually initiate the PAD connection(s) using a command:

cmd gopad n

where

n=1 First PAD configuration (configured via **cmd pad** [command])

n=2 Second PAD configuration (configured via **cmd pad2** [command])

If n is not specified, the PAD connection for the first PAD configuration is initiated.

Use this if **cmd pad ip** and **cmd pad port** have been previously configured. If **cmd pad ip 0.0.0.0** has been configured then the gateway will connect in server mode and listen on the port defined by **cmd pad port**. If **cmd pad ip iii.iii.iii.iii** has been configured with a non-zero IP address then the gateway will connect to that IP address in client mode and transmit to the port defined by **cmd pad port**.

Note that it is the client end that has to initiate the connection – the server is simply waiting to accept an incoming connection.

2.2 Closing a PAD Connection

Closing a PAD connection can be done in various ways:

Send the escape sequence to the serial port (the default escape sequence is **+++**) – note that no “Enter” is required as part of the escape sequence. The gateway will drop into command mode. The escape sequence may be changed using the command **cmd pad esc <string>**. Note the PAD escape guard timer is set using the **cmd pad esct n** command.

When the gateway has been previously configured for PAD client mode - one session (**cmd pad mode 2** or **cmd pad mode 3**), using the command **cmd pad reset** will cause the PAD connection to drop and the gateway will go into the serial console.

The **cmd pad svct** server connection timer will expire after a period of inactivity equal to its setting (default 15 seconds). When the gateway has been configured with **cmd pad mode 0/1** and **cmd pad ip** using a valid IP address, and is in client mode for the first time, once this timer expires the gateway will go into server mode. The **cmd pad svct** maximum connection timer will expire after a period equal to its setting, regardless of the PAD data connection condition (default 0 seconds, meaning disabled).

On TCP PAD connections if the server end drops the connection then a gateway configured with **cmd mode 4** (auto connect to network and PAD) and **cmd pad mode 5** (auto connect TCP PAD client) will attempt to reconnect the TCP session.

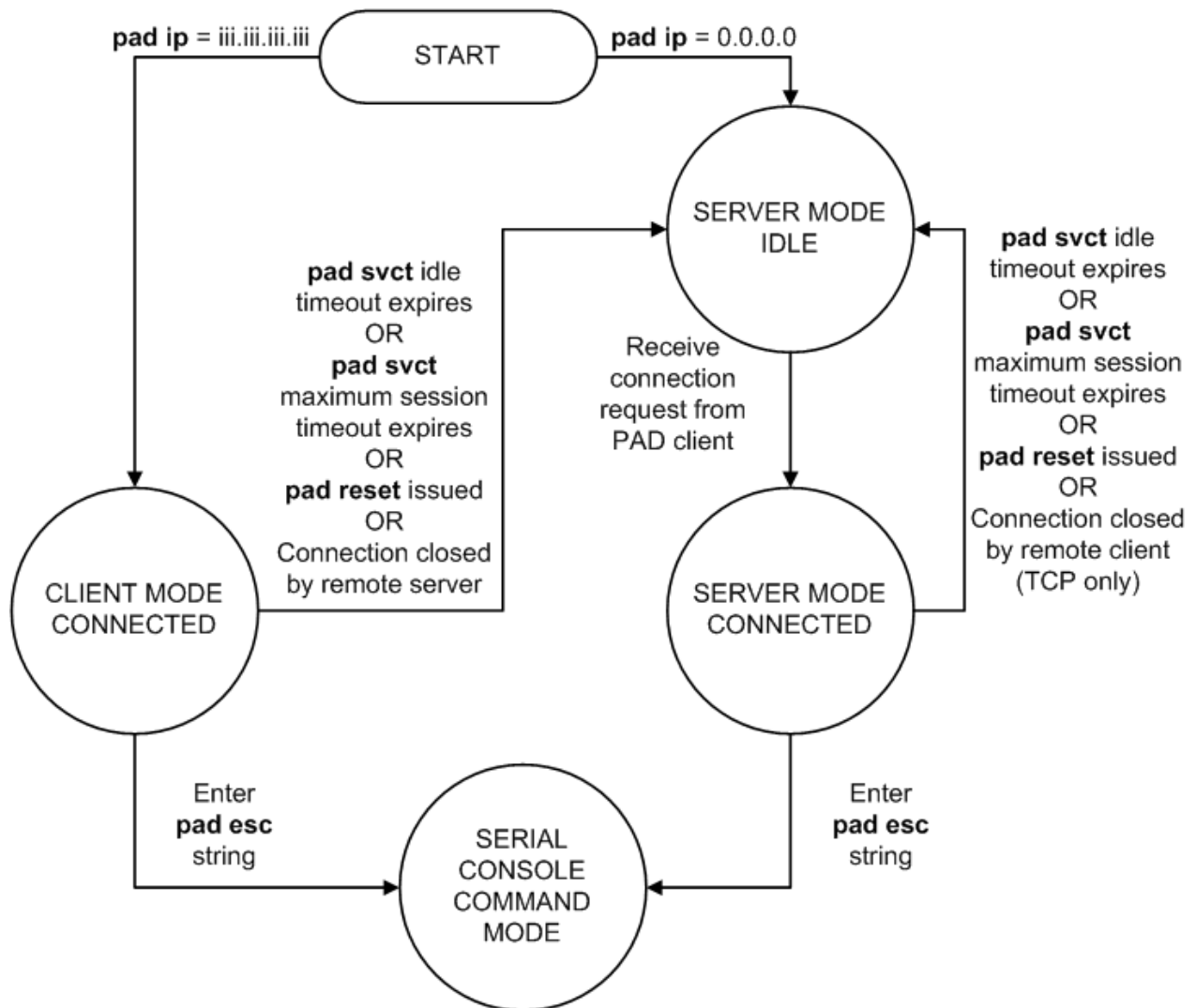
3 State Diagrams for PAD Operation Modes

The following section provides the state diagrams that describe PAD operation for each of its modes:

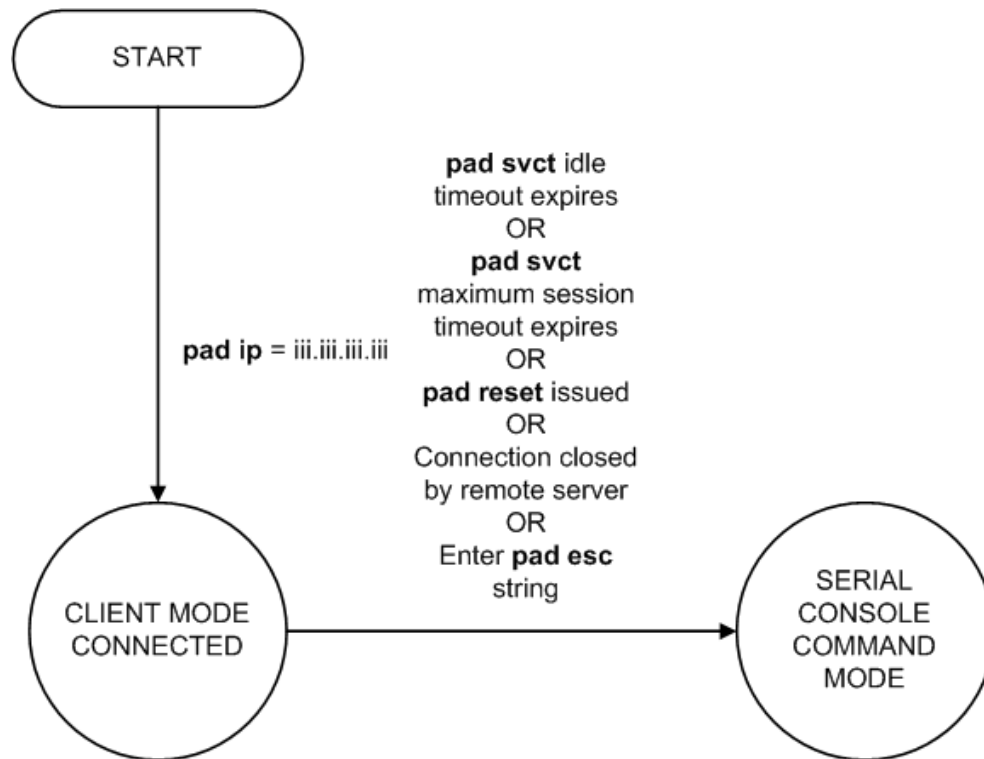
- PAD server mode: **cmd pad mode 0** (UDP), **cmd pad mode 1** (TCP)
- PAD client, single-session mode: **cmd pad mode 2** (UDP), **cmd pad mode 3** (TCP)
- PAD client, persistent mode: **cmd pad mode 4** (UDP), **cmd pad mode 5** (TCP)

In the state diagrams below, the circles indicate the current state of PAD and the arrows exiting the circles indicate events which cause PAD to change its state.

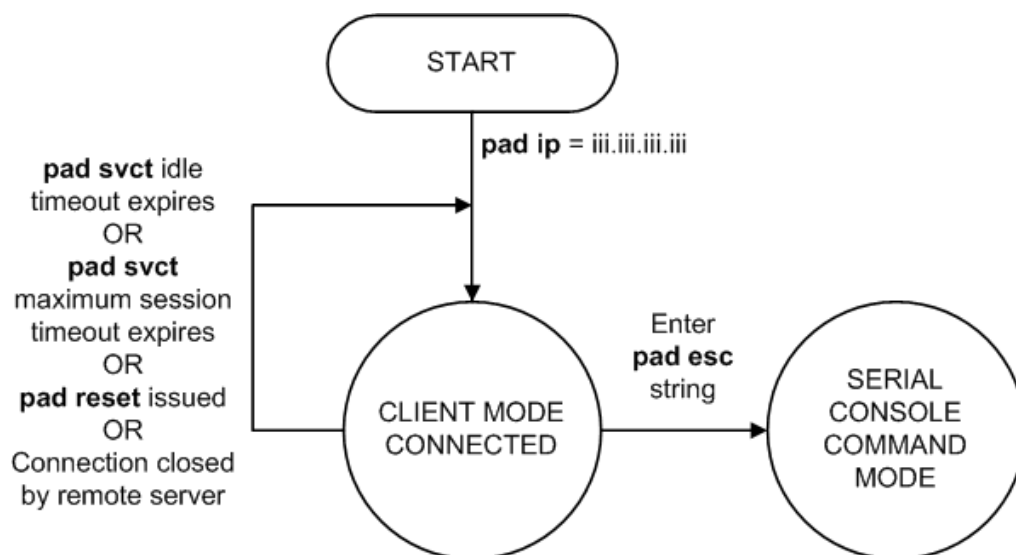
3.1 PAD Server Modes (pad mode 0/1)



3.2 PAD Client Single Session Modes (pad mode 2/3)



3.3 PAD Client Persistent Mode (pad mode 4/5)

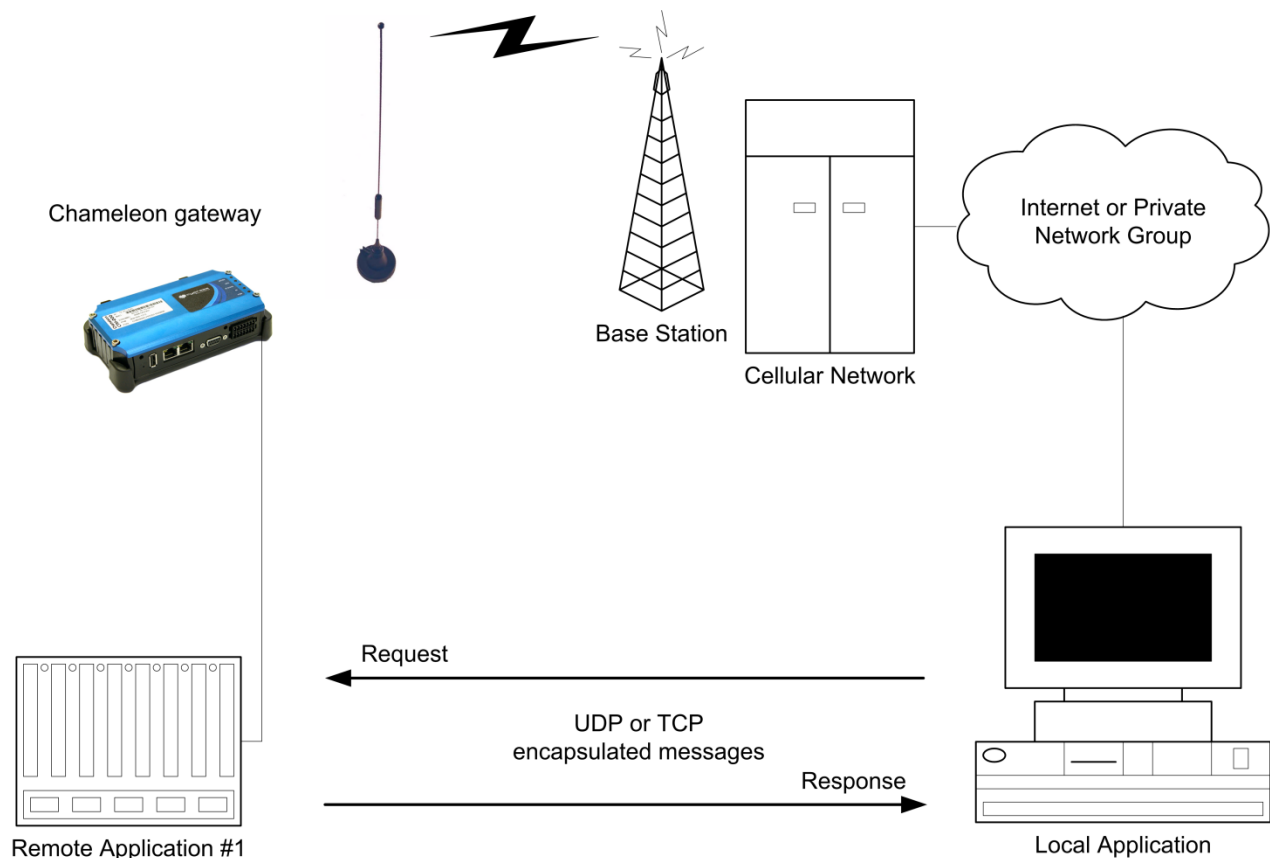


4 Example PAD Configuration

4.1 PAD Configuration for a SCADA Field Device in Slave Mode

In this example, a Chameleon gateway is connected to a SCADA field device which is polled by a remote server. The field device in slave mode is either connected to another Chameleon gateway or has built-in TCP/IP functionality. The field device communicates with a remote server or master device via a request/response protocol. The slave devices will only send responses to requests sent.

The device connected to the gateway's serial port is operating at 9600 baud with no hardware flow control (Tx, Rx, & Gnd signals only), and responds to every incoming sentence with a reply of maximum length 50 bytes of ASCII data always terminated with the character <. The serial slave device does not support echoing of data that it sends to the gateway. The chosen listening port is 5000.



Enter the following commands from the serial console of the gateway connected to the serial slave device:

```
cmd factory
cmd mode 4
cmd port 1 9600 8 n 1 0
```

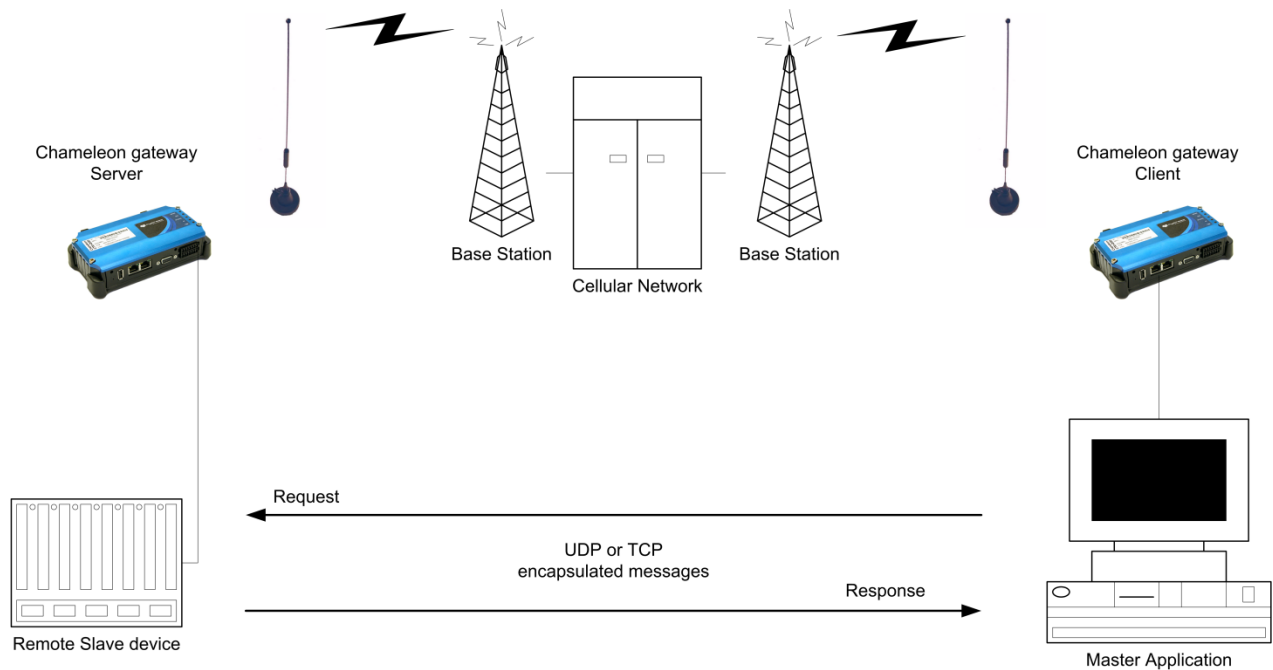
It will now be necessary to adjust the baud rate of the terminal application to 9600.

cmd pad mode 0/1	PAD server mode: 0 = UDP, 1 = TCP
cmd pad echo 0	Do not echo data sent by the slave device back on the serial port
cmd pad ip 0.0.0.0	Sets PAD to server mode only (default settings, in effect after cmd factory)
cmd pad port 5000	Sets port on which field device will be listening for requests
cmd pad fwdc 60	Decimal value of ASCII <
cmd pad fwdl 51	Greater than longest message size
cmd pad fwdt 20	Sets the forwarding time to 1 second idle period (default setting, in effect after cmd factory)
cmd pad svct 15 0	Set connection timeout to 15 seconds, maximum connection timer is disabled (default settings, in effect after cmd factory)
cmd save	Save configuration to gateway's non-volatile memory
cmd pwr mode 2	Power cycle

4.2 PAD Configuration for a SCADA Master Device Polling a Single Field Device in Slave Mode

In this example, a Chameleon gateway is connected to a master device which polls data from a single field device in slave mode. The field slave device is either connected to another Chameleon gateway or has built-in TCP/IP functionality. The master device is typically a server running a SCADA application and communicates with the field device via a request/response protocol. The slave devices will only send responses to requests sent.

The gateway connected to a master device operates at a baud rate of 19200 with full hardware flow control. The master device receives sentences on its serial port of maximum length 100 bytes (with no common end character) which are to be sent to a single slave unit at IP address 100.100.1.2, port 5000. The serial master device requires echoing of data that it sends to gateway.



For the gateway connected to the serial master device, enter the following commands from the serial console:

cmd factory

cmd mode 4

cmd port 1 19200 8 n 1 2

It will now be necessary to adjust the baud rate of the terminal application to 19200.

cmd pad mode 4/5 PAD client, persistent mode: 4 = UDP, 5 = TCP

cmd pad echo 1 Echo data sent by the master device back on the serial port
(default setting, in effect after **cmd factory**)

cmd pad ip 100.100.1.2 Sets IP address of field device being polled

cmd pad port 5000 Sets port of field device being polled

cmd pad fwdc 0 No forwarding character

cmd pad fwdl 101 Greater than longest message size

cmd pad fwdt 10 Sets the forwarding time to 0.5 seconds idle period

cmd pad svct 15 0 Set connection timeout to 15 seconds, maximum connection timer is disabled
(default settings, in effect after **cmd factory**)

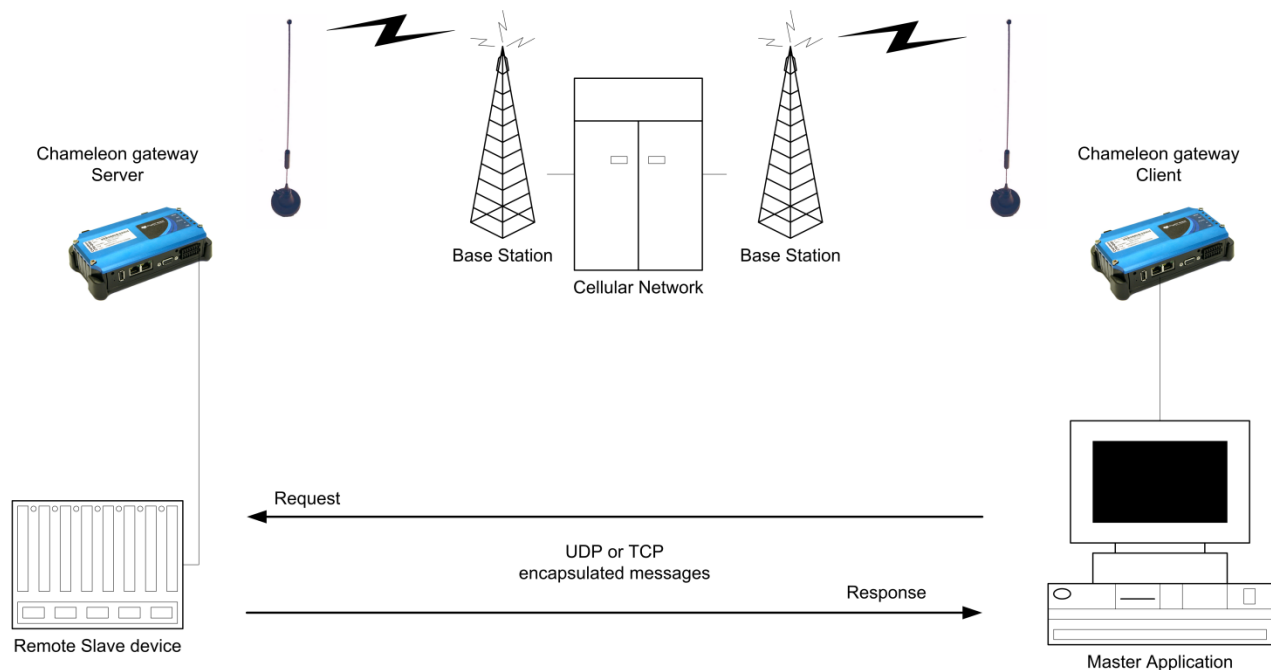
cmd save Save configuration to gateway's non-volatile memory

cmd pwr mode 2 Power cycle

4.3 PAD Configuration for a SCADA Master Device Polling Multiple Field Devices in Slave Mode

In this example, a Chameleon gateway is connected to a programmable master device intended to poll multiple field devices in slave mode. The master device is typically a server running a custom SCADA application and communicates with field devices via a request/response protocol. The slave devices will only send responses to requests sent.

The gateway is connected to a master device at baud rate of 19200 with full hardware flow control. It receives sentences on its serial port of maximum length 100 bytes (with no common end character) which are to be sent to multiple slave units at IP addresses 100.100.1.1-100.100.1.10, port 5000. The slave devices typically respond within 8 seconds. The serial master device requires echoing of data that it sends to the gateway. In this example, the master device requires built-in scripting functionality to perform predefined actions based on serial port output when in command mode.



Enter the following commands from the serial console of the gateway connected to the serial master device:

cmd factory

cmd mode 2

cmd port 1 19200 8 n 1 2

It will now be necessary to adjust the baud rate of the terminal application to 19200.

cmd pad mode 2/3 PAD client, single-session mode: 2 = UDP, 3 = TCP

cmd pad echo 1 Echo data sent by the master device back on the serial port (default setting, in effect after **cmd factory**)

cmd pad fwdc 0 No forwarding character

cmd pad fwdl 101 Greater than longest message size

cmd pad fwdt 100	Sets the forwarding time to 5 seconds idle period
cmd pad svct 10 0	Set connection timeout to 10 seconds, maximum connection timer disabled
cmd save	Save configuration to gateway's non-volatile memory
cmd pwr mode 2	Power cycle

In command mode, for each request to a specific slave device, the master device should send the following commands:

cmd pad ip 100.100.1.1	Sent by master device to set new PAD slave to which to connect
cmd gopad	Sent by master device to start new PAD connection

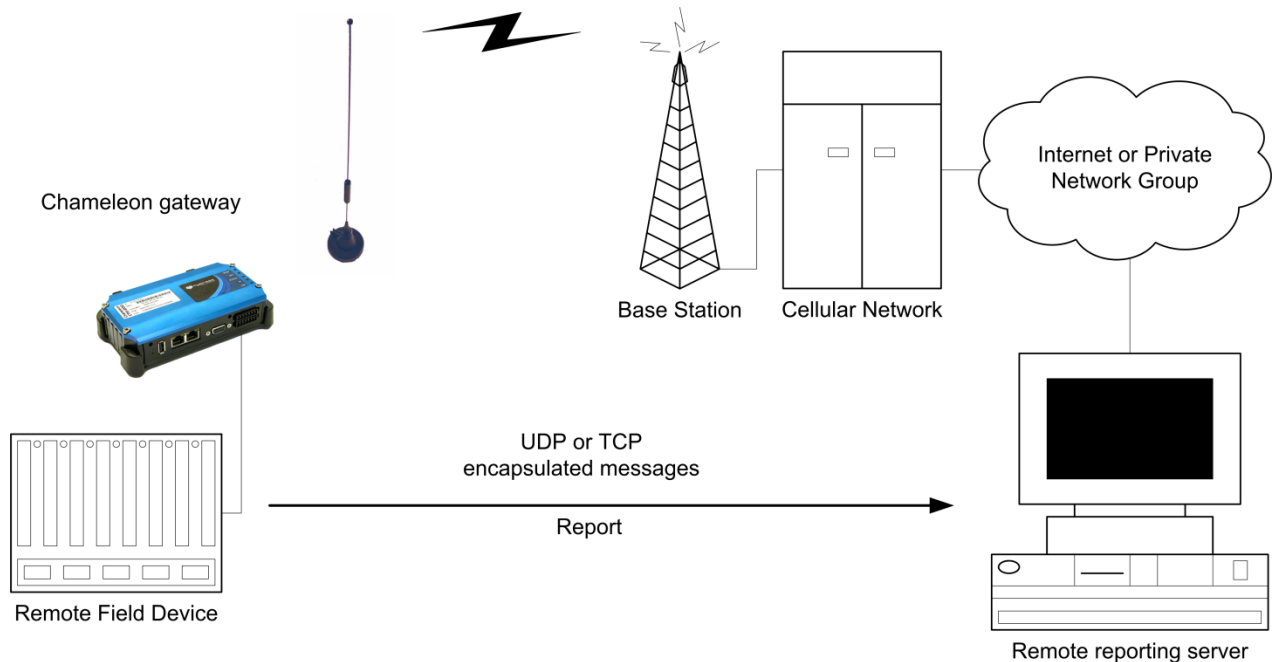
Upon executing **cmd gopad**, the gateway will connect to the PAD slave with IP address **100.100.1.1** as specified in **cmd pad ip**, transmit a request, and disconnect if the connection idle time is 10 s, or if the escape sequence is entered on the serial port (default is **+++**). Once disconnected, the gateway will drop into command mode. Repeat **cmd pad ip** and **cmd gopad** for other slave devices using IP addresses **100.100.1.2-100.100.1.10**.

In this example, the master device requires some scripting or programmable functionality to perform the following actions iteratively for polling data from slave devices:

1. Detect the gateway's command mode by checking that the pound character (#) is received on the serial port
2. Execute **cmd pad ip** using the field device's IP address
3. Execute **cmd pad port** using the field device's port
4. Execute **cmd gopad** to start PAD operation
5. Send the current field device request over the serial port
6. Wait for the response from the field device. In this example, the gateway should drop back into command mode after 10 seconds.

4.4 PAD Configuration for a Reporting Field Device

In this example, a Chameleon gateway is connected to a field device that reports to a remote server without the need to be polled. The field device generates data on the serial port whenever it is available and the gateway will send this data remotely over-the-air. The remote field device operates at a baud rate of 9600 and uses hardware flow control. The field device generates ASCII data with varying length and is always terminated with the carriage return character <CR>. The field device does not require echoing of data that it sends to the gateway.



For the gateway connected to the reporting field device, enter the following commands from the serial console:

```
cmd factory
cmd mode 4
cmd port 1 9600 8 n 1 2
```

It will now be necessary to adjust the baud rate of the terminal application to 9600.

```
cmd pad mode 4/5    PAD client, persistent mode: 4 = UDP, 5 = TCP
cmd pad ip 200.100.1.1  Sets IP address of remote server handling data reported by the field device
cmd pad port 8000    Sets port to which data is to be sent
cmd pad echo 0      Do not echo data sent by the field device back on the serial port
cmd pad fwdc 13     Decimal value of ASCII <CR> (default setting, in effect after cmd factory)
cmd pad fwdl 40     Data to be sent over the air in 40-byte packets or less if <CR> in first 40 bytes
                    (default setting, in effect after cmd factory)
cmd pad fwdt 20     Sets the forwarding time to 1 second idle period
                    (default setting, in effect after cmd factory)
cmd pad svct 15 0   Set connection timeout to 15 seconds, maximum connection timer is disabled
                    (default settings, in effect after cmd factory)
cmd save           Save configuration to gateway's non-volatile memory
cmd pwr mode 2     Power cycle
```

5 Technical Support/Warranty

**Cypress Solutions Service
Support Group**

1.877.985.2878 or 604.294.4465

9.00am to 5.00pm PST

support@cypress.bc.ca