Thank you for your selection of the 905U-D radio modem. We trust it will give you many years of valuable service.

ATTENTION!

Incorrect termination of supply wires may

cause internal damage and will void warranty.

To ensure your 905U-D enjoys a long life,

double check ALL your connections with

the user's manual

before turning the power on.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to **provide a separation distance of at least 20 cm from all persons** to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 20 cm of the antenna
- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.
- operate the equipment near electrical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

FCC Notice:

This user's manual is for the ELPRO 905U-D radio modem. This device complies with Part 15.247 of the FCC Rules.

Operation is subject to the following two conditions:

1) This device may not cause harmful interference and

2) This device must accept any interference received, including interference that may cause undesired operation.

This device must be operated as supplied by ELPRO Technologies Pty Ltd. Any changes or modifications made to the device without the written consent of ELPRO Technologies Pty. Ltd. May void the user's authority to operate the device.

End user products that have this device embedded must be supplied with non-standard antenna connectors, and antennas available from vendors specified by ELPRO Technologies. Please contact ELPRO Technologies for end user antenna and connector recommendations.

Notices:

Safety:

Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in General Docket 79-144 on March 13, 1996.

CAUTION:

To comply with FCC RF Exposure requirements in section 1.1310 of the FCC Rules, antennas used with this device must be installed to provide a separation distance of at least 20 cm from all persons to satisfy RF exposure compliance.

DO NOT:

- operate the transmitter when someone is within 20 cm of the antenna

- operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.

- operate the equipment near electical blasting caps or in an explosive atmosphere

All equipment must be properly grounded for safe operations. All equipment should be serviced only by a qualified technician.

How to Use This Manual

To receive the maximum benefit from your 905U-D product, please read the **Introduction**, **Installation** and **Operation** chapters of this manual thoroughly before putting the 905U-D to work.

Chapter Four **Configuration** details the configurations available and explains the diverse operation of the product in detail.

Chapter Five **Specifications** details the features of the product and lists the standards to which the product is approved.

Chapter Six **Troubleshooting** will help if your system has problems and Chapter Seven specifies the **Warranty and Service** conditions.

The foldout sheet 905U-D *Installation Guide* is an installation drawing appropriate for most applications.

WARNING

1. In some countries, a radio licence is not required for the 905U-D telemetry modules provided the module is installed using the aerial and equipment configuration described in the 905U-D *Installation Guide.* In other countries, refer to the relevant Regulatory Authority. Check the *Installation Guide* for your country listing.

2. Where a radio licence is not required, operation is authorised by the relevant Authority in your country on a non-protection basis. Although all care is taken in the design of these units, there is no responsibility taken for sources of external interference. Some delay in the operation of the module may occur during periods of interference. Systems should be designed to be tolerant of these delays.

3. To avoid the risk of electrocution, the aerial, and all terminals of the 905U-D module should be electrically protected. To provide maximum surge and lightning protection, the module should be connected to a suitable earth and the aerial, aerial cable, and the module should be installed as recommended in the Installation Guide.

4. To avoid accidents during maintenance or adjustment of remotely controlled equipment, all equipment should be first disconnected from the 905U-D module during these adjustments. Equipment should carry clear markings to indicate remote or automatic operation. eg. "This equipment is remotely controlled and may start without warning. Isolate at the switchboard before attempting adjustments."

5. The 905U-D module is not suitable for use in explosive environments without additional protection.

CONTENTS

Chapter One INTRODUCTION

1.1 General

The 905U-D radio modem module has been designed to provide flexible and reliable radio modem functions, at an economical price. *Radio modems* transmit serial data over a long distance via radio. The serial data is not changed - the output data is the same as the input data. Although the 905U-D is intended to be simple in its application, it also provides many sophisticated features. This manual should be read carefully to ensure that the modules are configured and installed to give reliable performance.

Each 905U-D module will connect to a host device by RS232 or RS485 serial connection. Examples of host devices are PLC's, data loggers, intelligent transducers and computers. The 905U-D unit can receive data from the host device and transmit this data by radio to another (or several) 905U-D module. The other module will recreate the serial data and output it as either a RS232 or RS485 serial signal. The 905U-D unit provides two-way communications - each module can accept serial data and also output serial data.

The 905U-D module includes power supply, microprocessor controller, serial input/output circuits and a UHF radio transceiver - no external electronics are required. The 905U-D radio frequency has been selected to meet the requirements of unlicensed operation for remote monitoring and control of equipment. That is, a radio licence is not required for the 905U-D modules in many countries. See Chapter Five **Specifications** for details. The units are configured from a terminal using Hayes commands or by using switches under the plastic cover on the front of the unit.

RS232 is an electrical standard format for a full duplex point-to-point serial connection. RS485 is an electrical standard format for a half-duplex multidrop serial connection. Up to 32 devices can communicate on a common RS485 serial bus. Each 905U-D unit can only connect to one serial signal - either RS232 or RS485. However different modules in the same system can connect to different types of serial signals.   For example, RS232 data from one host device can be transmitted to a remote 905U-D unit and output as RS485 data to another host device.
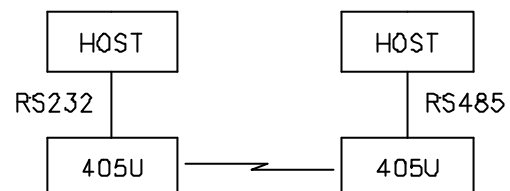
The 905U-D has been designed to be flexible enough to cover a wide range of applications. The user is able to configure many different parameters such that the 905U-D unit will connect reliably to different types of host devices. Before the radio modem can be used, these parameters must be configured. Some of these parameters are :-

- Character type - the 905U-D will accept a variety of 7 or 8 data bit characters

- Serial Data Rate - between 1200 and 115200 bits/sec

- Radio Data Rate - between 19200 and 115200 bits/sec

- Operating mode - transparent mode or controlled mode .

The operation of the 905U-D radio modem is relatively simple. As data is received at the serial port, the data is transmitted on the radio channel. Up to 520 bytes of data can be

transmitted in one transmission. The radio transmission commences when the first data byte is received, and ends when there are no more data bytes in the input buffer, or when the number of bytes transmitted equals the maximum message length (user configurable - default 520 bytes). If more than 520 bytes is input, the 905U-D unit will transmit the first 520 bytes, then the next 520 bytes, and so on until all of the data has been transmitted.

Because the radio data rate could be less than the input serial data rate, an input memory buffer of 8Kbytes is provided. The RS232 connection provides CTS control to prevent the buffer overflowing. There are no data flow control signals for RS485.

A radio channel cannot provide as secure a data channel as a wired connection. The 905U-D uses a UHF radio channel with a very low level of natural or industrial noise, however there is a chance of interference from other users of the unlicensed radio channel. We recommend that the flow of data over the radio channel is controlled by using error detection and "handshaking" - that is, returning an acknowledgment transmission if a data packet is received on the radio channel without error. This function can be performed by either the host devices or the 905U-D modules. The modules may be configured by the user to operate in one of two modes. In transparent mode, it is assumed that the host devices control the flow of data. In controlled mode, the 905U-D units control the flow of data.
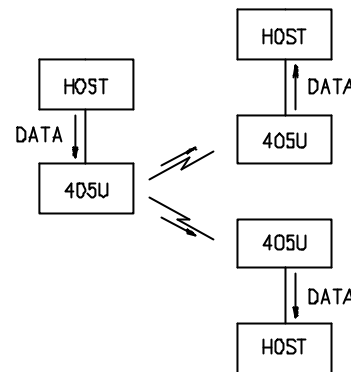
1.2   Transparent Mode

The default configuration of the 905U-D modem is transparent mode - the modules are set in this mode at the factory. In transparent mode, there is no control of the data transmissions. Input data is simply transmitted by radio and every other 905U-D unit in that system which receives the transmission will output the data. This mode relies on the host devices to perform the "handshaking" function, and re-transmitting serial data if the data is corrupted (no "handshake"). It also relies on the host devices to include any addressing necessary in the data. In this mode, modules are not configured with a unit address. Data is "broadcast" - every other 905U-D in the system will receive the data and output the data to their individual host devices. The user may configure the 905U-D modems to add error checking to each data packet transmitted - if error checking is configured, data will not be output if it is received without a correct error-check. This feature provides additional protection against corruption of the data during the radio transmission. If error-checking is not configured, then the data received by radio will be output without checking for errors.

Transparent mode is suitable for a host device which is able to communicate on a multi-drop "bus" type network. An example of an application is the use of radio modems to extend a PLC RS485 network. The serial messages from the PLC's already include PLC addressing and error detection/correction to control the flow of data.
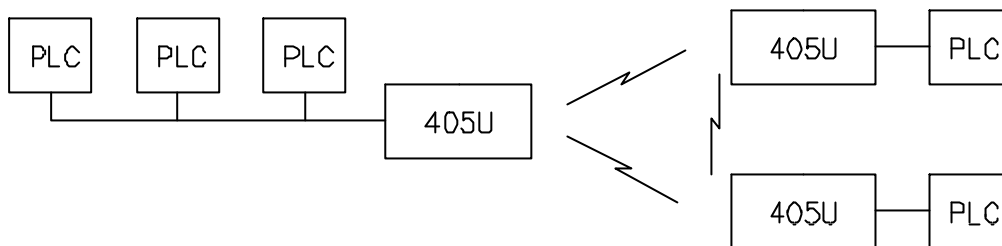
1.3   Controlled Mode

In "controlled" mode, the flow of data is controlled by the 905U-D units. Each 905U-D unit is configured with an address by the user,   and a destination address for the data to be transmitted to.   Data is transmitted addressed to the destination module,   and only this module will output the serial data. The source module will add an error-check (16 bit CRC) to the data transmitted by radio.   The destination module will process the error-check,   and if correct, it will transmit an acknowledgment message (ACK) back to the source module. If the error-check is not correct,   then the destination module will transmit a "fail" message (NACK) back to the source module. If the source module receives a NACK return,   or does not receive any return within 1 second, it will re-transmit the data. The source module will attempt to transmit the data up to five times,   until an acknowledgment (ACK) is

received. If an acknowledgment is still not received, then a "communications failure" output will be activated, and the source module will not accept any more input data from its host device.
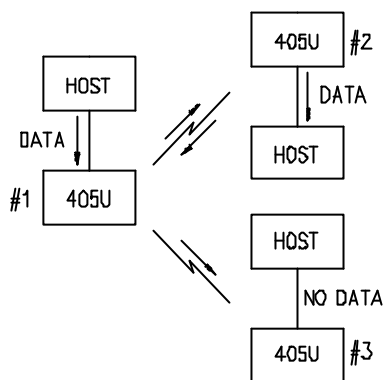
An example of an application using controlled mode would be a radio modem link between an intelligent gas analyser and a monitoring computer system.   Intelligent transducers do not normally provide addressing or error checking functions - these would be provided by the 905U-D modules.
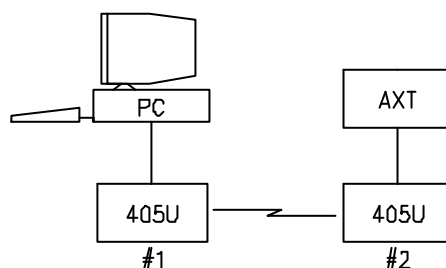
In controlled mode,   the destination address may be set by the host device by initially sending a "Hayes" command to the 905U-D module, or by on-board miniature switches. Hayes commands are a standard set of commands used with conventional telephone modems. An example of an application that would use Hayes command to set destination addresses would be a central computer polling data loggers for periodic information.

1.4   Repeater Units

A 905U-D unit may be used as a repeater to re-transmit radio messages. The purpose of a repeater unit is to extend radio range.

In transparent mode, only one module per system may be used as a repeater. If more than one module is configured as a repeater, any message transmitted in the system will be continually re-transmitted between the repeater units. The repeater in transparent mode will repeat every transmission it receives.

In controlled mode, up to five repeaters may be configured for any transmission path.
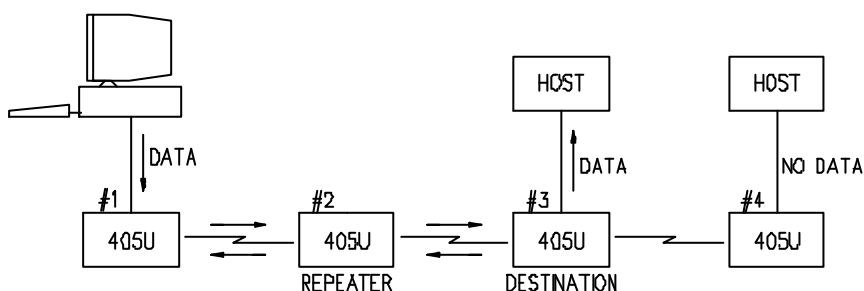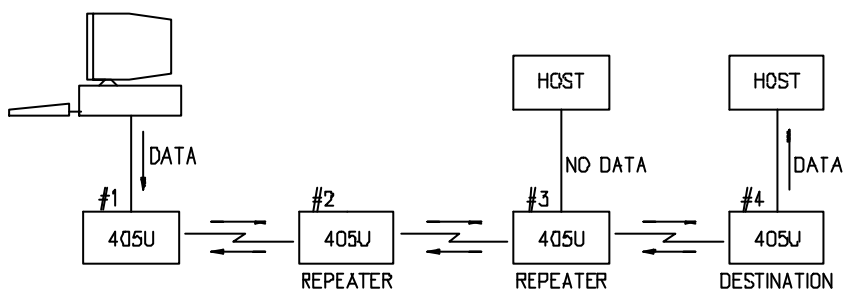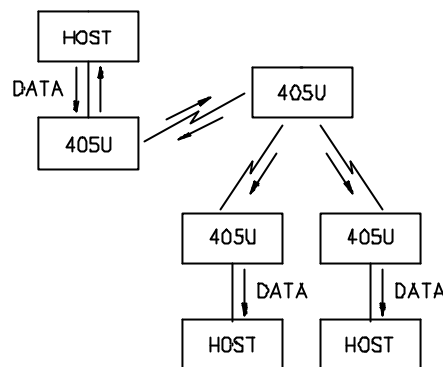
Chapter Two   INSTALLATION

2.1 **General**

The 905U-D module is housed in an rugged aluminium case, suitable for DIN-rail mounting. Terminals will accept wires up to 2.5 sqmm in size.

Normal 110-240V mains supply should not be connected to any terminal of the 905U-D module. Refer to Section 2.3 **Power Supply**.

Before installing a new system, it is preferable to bench test the complete system. Configuration problems are easier to recognise when the system units are adjacent.

The foldout sheet 905U-D *Installation Guide* provides an installation drawing appropriate to most applications. Further information is detailed below.

Each 905U-D module should be effectively earthed via the "GND" terminal on the 905U-D module - this is to ensure that the surge protection circuits inside the 905U-D module are effective.

2.2   Power Supply

The 905U-D module may be powered by either a 12VDC or a 24VDC supply.
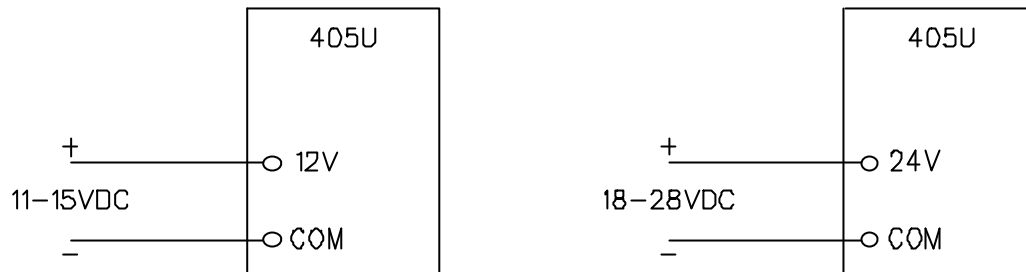
The negative side of the supply is connected to "COM" and may be connected to "ground". The supply negative is connected to the "GND" terminal internally. The positive side of the supply **must not be connected to earth.** The DC supply may be a floating supply or negatively grounded.

The 12V supply is suitable for an unregulated DC supply. Where battery backup is required, a 12V battery charger may be used to supply the 905U-D module as well as charging the battery.

The power requirements of the 905U-D units is 155mA at 12VDC or 100mA at 24VDC. The supply is protected by an internal 1A fuse, accessible at the bottom of the unit.
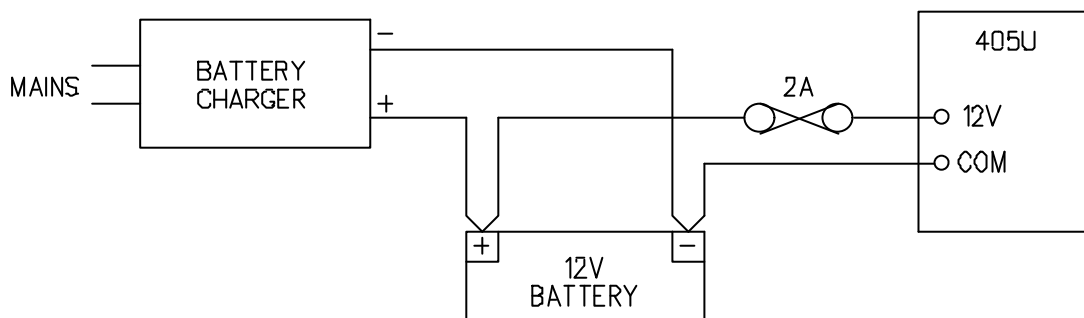
2.3   Serial Connections

2.3.1 RS232 Serial Port

The serial port is a 9 pin DB9 female and provides for connection to a host device as well as a PC terminal for configuration, field testing and for factory testing. This port is internally shared with the RS485 - ensure that the RS485 is disconnected before attempting to use the RS232 port. Communication is via standard RS232 signals. The 905U-D is configured as DCE equipment with the pinout detailed below.

DB9 Connector Pinout

Pin	Name	Direction	Function
1	DCD	Out	**Data carrier detect** - not connected Rev. 1.03 software & earlier Rev. 1.04 & later - driven when link is established in controlled mode - driven always in transparent mode
2	RD	Out	**Transmit Data** - Serial Data Output
3	TD	In	**Receive Data** - Serial Data Input
4	DTR	In	**Data Terminal Ready** - not connected Rev 1.03 & earlier, Rev. 1.04 & later: When in controlled mode, will autodial if destination address is configured In control mode, an inactive DTR will force the 905U-D to low-power mode. Rev. 1.11 & later: When in controlled mode, will autodial if destination address is configured In control mode, an inactive DTR will force the 905U-D stop communicating by radio. If low power mode is selected, an inactive DTR will also force the 905U-D to low power mode.
5	SG		**Signal Ground**
6	DSR	Out	**Data Set Ready** - always high when unit is powered on.
7	RTS	In	**Request to Send - hardware flow control**
8	CTS	Out	**Clear to send - hardware flow control**
9	RI		**Ring indicator** - not used or connected

Hardware handshaking using the CTS/RTS lines is provided. The CTS/RTS lines may be used to reflect the status of the local unit's input buffer, or may be configured to reflect the status of CTS/RTS lines at the remote site. The 905U-D does not support XON/XOFF.

Example cable drawings for connection to a DTE host (a PC) or another DCE host (or modem) are detailed below. These example are for transparent mode. Controlled mode may require the use of DTR or DCD signals.
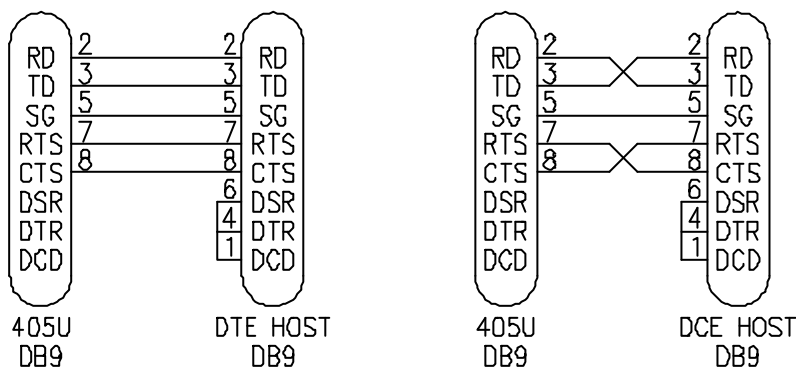
2.3.2 RS485 Serial Port

The RS485 port provides for communication between the 905U-D unit and its host device using a multi-drop cable. Up to 32 devices may be connected in each multi-drop network. Note that the RS485 port is shared internally with the RS232 port - make sure that the RS232 port is disconnected before using the RS485 port.

As the RS485 communication medium is shared, only one of the units in the system may send data at any one time.   Thus communication protocols based on the RS-485 standard require some type of arbitration.   The 905U-D "holds off" for three character times after receiving data from the RS-485 port before transmitting on the RS-485 port.

RS485 is a balanced, differential standard but it is recommended that shielded, twisted pair cable be used to interconnect modules to reduce potential RFI. An RS485 network should be wired as indicated in the diagram below and terminated at each end of the network with a 120 ohm resistor. It is important to maintain the polarity of the two RS485 wires.
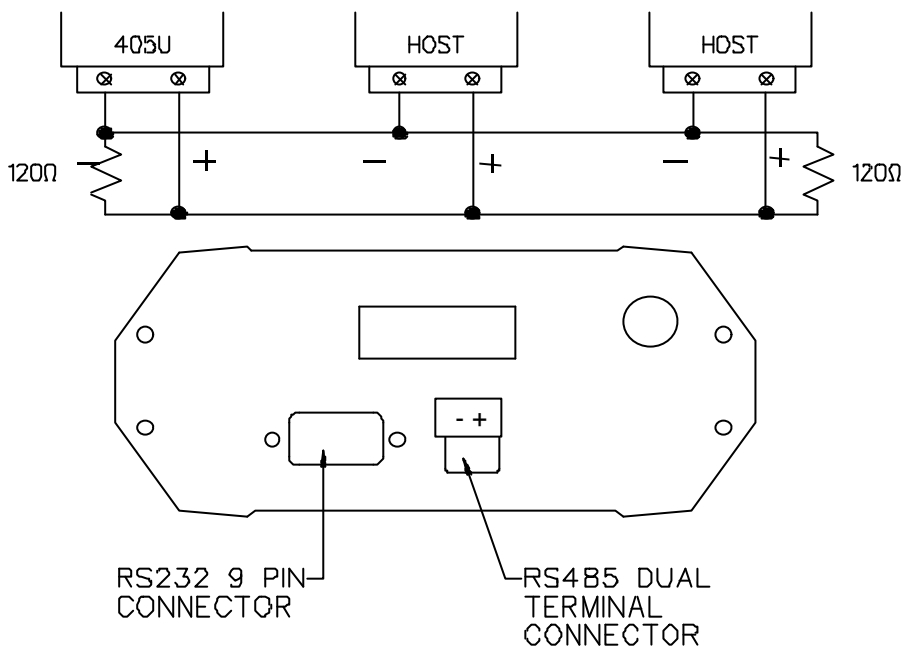
Chapter Three   OPERATION

3.1   Power-up and Normal Operation

When power is initially connected to the 905U-D module, the module will perform internal diagnostics to check its functions. The following table details the status of the indicating LEDs on the front panel under **normal** operating conditions.

LED Indicator	Condition	Meaning
OK	On	Normal Operation
Radio RX	GREEN flash	Radio receiving data
	RED flash	Weak radio signal
Radio TX	Flash	Radio Transmitting
Serial RX	GREEN flash	Serial Port Receiving
	RED flash	CTS low
	GREEN continuously	Configuration Mode
Serial TX	GREEN flash	Serial Port Transmitting
DCD	On	Transparent mode - always on
		Controlled mode - on when communications link is established
DCD	Off	Communications failure or link not established

Other conditions indicating a fault are described in Chapter Six **Troubleshooting**.

Low Power Operation

The 905U-D may be forced to a low power condition where it switches off its receiver - power consumption is reduced to approx 20% of normal. The low power condition will occur if the 905U-D is configured for controlled mode (modes 6 or 7), AND if an autodial address is configured, AND if the low power mode feature is configured in the "character type" selection, AND if the DTR signal is "low" or "off".

The use of this low power operation may be applicable in remote locations where there is a limited power supply such as solar panels. In this situation, the DTR signal from the host device is used to "wake-up" the 905U-D unit. The 905U-D unit will then operate normally until the DTR signal is reset by the host device.

3.2   Serial and Radio Data

Data input at the serial port is placed into the input buffer. This buffer will store 8Kbytes of data, and CTS control is provided on the RS232 port to prevent overflow.

When the 905U-D unit detects data in the input buffer, it initiates a radio message. The radio message will end when the number of transmitted bytes reaches the maximum message length (configurable by the user). The message will also end if the input buffer becomes empty, however the radio transmitter will remain active for a delay time in case more bytes are input at the serial port. The delay time is called the "tail time" and is configurable by the user.

3.2.1   Character Type

The 905U-D may be configured by the user to recognise the following types of characters.

Data Bits	Start Bits	Stop Bits	Parity
7	1	1	even
7	1	1	odd
7	1	2	none
7	1	2	even
7	1	2	odd
8	1	1	none
8	1	1	odd
8	1	1	even
8	1	2	none

Most applications will require the character type to be the same at each 905U-D modem in the system. Nevertheless, the character type may be configured to be different at different 905U-D modems. Data is transmitted by radio as an eight-bit byte without stop or start bits. If the input data is 7 data bits without parity, then the byte transmitted by radio comprises the 7 bits plus a zero bit. If the input data is 7 data bits with parity, then the byte transmitted comprises the same byte. Input characters with 8 bits are transmitted as just the 8 data bits, with no parity. Because the data may be transmitted without parity,   the user may configure CRC error checking to be added to each transmitted data packet. Data is output at the destination module based on the character type configured at that module - that is, the start/stop bits and parity is added to the radio data.3.2.2   Serial Data Rate

The communications baud rates supported on both the RS232 serial port and the RS485 serial port are 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 baud - the user selects one of these rates during the configuration of the modem.

3.2.3   Radio Data Rate

The data is transmitted by radio as direct modulated synchronous data at a rate between 19200 and 115200 bits per second. The user must configure the radio data rate at each 905U-D module. The configured radio data rates must be the same for each module in a system.

The radio message also includes the following :-

- A 30 msec leading sequence of alternating 1's and 0's provides the receiving unit with time to capture and lock onto the incoming signal.

- A system address is superimposed on each message to provide discrimination between different 905U-D systems on the same radio channel. Each 905U-D unit in the same system must be configured with the same system address - refer Section 4, **Configuration.** Although other 905U-D modules will hear the radio transmissions, because they have a different system address, the radio transmission is ignored and no serial data is output.

- A "frame flag" appears once at the beginning of each message, and once at the end of each message. It indicates the start and end of a message packet.

- The RTS status of the source unit is included in the message. In controlled mode only, this is used to set the CTS signal at the destination module.

- In controlled mode, unit addressing is included.

- An error-check (16 bit CRC) may be configured by the user.

Up to 520 bytes of data may be transmitted in a message - the maximum message size is configurable between 10 and 520 bytes. The data consists of a sequence of 8 bit bytes. Start, stop and parity bits are not transmitted, but they are re-generated at the receiving unit (if configured).

A "transmit delay" time and a "receive delay" time may also be configured. After each message is transmitted, a 905U-D unit will not transmit another message during the transmit delay time.   After a message is received,   a message will not be transmitted during the receive delay time.   These parameters may be used to fine tune and give priority to different 905U-D units in a system.

The default time of the transmit delay (40 msec) is selected for polling applications. If the host device sends more than one poll command, the second poll message will be delayed to allow a response to be received for the first poll message. The user can reduce this transmit delay time if it is not required.

3.3 Transparent Mode

In transparent mode, radio messages are transmitted without unit addressing. Units do not provide handshaking functions to control the flow of data. Every unit which receives the radio message, and has the correct system address, will output the data. Transparent mode operation is effectively a broadcast system.

Data received at the serial port is transmitted out of the radio port. Data received from the radio is transmitted out of the serial port. Prior to transmitting, units will listen to the radio channel to ensure that it is clear - units will hold off from transmitting until the radio channel is clear. At the RS232 port, the CTS pin is high while there is space in the input data buffer.

Host devices should provide a suitable protocol to ensure that error checking, handshaking and implementation of an appropriate re-transmission scheme is provided. This mode of operation is particularly suited to devices designed to operate over a multidrop network, such as PLC systems designed for operation over a RS-485 network.

One 905U-D unit may be configured as a repeater. This unit will not output data at its serial ports. Any message received at the radio port, with the correct system address, will be re-transmitted.

The time taken to transmit a message is :-

```
          lead-in system addr           data                    error check (if configured)

          |--------------|--------------|------------------------------------|-----------------|

          30msec         2 bytes             173us per byte          2 bytes
                         110us @ 91KB        @ 57600KB               347us @ 57600KB
```

If error checking is not configured at the receiving unit, data will start to be output approximately 1 msec after the system address has been received. If error checking is configured, data will be output approx 2msec after the end of the message. For example, a message with 20 bytes of data transmitted at 57600 bits/sec will be output approx 31msec after the data is input, if there is no error checking, or 37msec after the data is input if error checking is configured.

The time between transmissions is set by the transmit and receive hold-off times configured by the user.

3.4 Controlled Mode

In controlled mode, data is only transferred between two modules (that is, a point to point link). One of the modules is configured as a "master" unit and the other as a "slave" unit. There can also be up to five intermediate repeaters in the link. Each 905U-D unit is configured with a unit address - only the unit with an address matching the destination address of the radio message will process the message and output the serial data.

To establish a link, the master will transmit a special "connect" message. This initial message will not include any data. If the "slave" unit receives the initial message, and is not already connected to another 905U-D unit, it will return an acknowledgment message. Both units will activate their DCD LED, and also activate their DCD output signal. If the master

unit does not receive the acknowledgment, the DCD output will reset. When the connection is made (DCD set), the 905U-D units can transmit data to each other.

The destination address may be configured two ways.   The AT&Z command (see Section 4, Configuration) enters an "auto-dial" address.   The ATD command enters a "single-dial" address.   The AT&Z command only has to entered once, and the 905U-D remembers the destination address.   The ATD command has to be used each time a connection is to be made - the 905U-D will not remember the previous destination address. If an auto-dial address is configured, the master will transmit the "connect" message every ten seconds until it receives an acknowledgment. If a single-dial address , the master unit will try to connect five times   - if no acknowledgment is received, a "BUSY" or "NO ANSWER" response is sent to the host connected to the master. The host must then issue the ATD dial command to the 905U-D before it will try to connect again.

The auto-dial operation is similar to a fixed line modem, where the destination address is always the same. Once the auto-dial address is configured, it does not need to be entered again. If the communications link fails (DCD resets), the master unit will automatically send connect messages to re-establish the link.

The single-dial operation is similar to a dial-up modem. The 905U-D will make a connection to another unit only when it is told to by the host device. If the communications link fails for any reason, the master unit will not send a connect message until it receives another ATD command.

Either of the two modules at the end of the link can be the "master" unit - the "master" unit has the responsibility of establishing the radio link and periodically checking the link. Data can be transferred in both directions -   from the "master" to the "slave" and from the "slave" to the "master".

Once the communications channel has been established, the 905U-D unit will accept input data and send radio messages with data.   On the RS232 port, if CTS/RTS is enabled, the CTS signal will be active when the input data buffer is not full, AND the RTS signal at the destination module is active. The local CTS/RTS status will reflect the remote CTS/RTS status, as well as the local input buffer.   Note that CTS/RTS is disabled in the default configuration - if this feature is required, it must be enabled (refer Configuration Chapter 4). If CTS/RTS is not enabled, then data will be lost after the input buffer (8KB) is full.

When a 905U-D unit receives a radio message, it will check the system address and destination address, and also the error-check (optional). If these are correct, it will return a ACK (acknowledgment) message to the source unit. If the system address or destination address is not correct, then no return message is sent. If the addresses are correct, but the error-check incorrect, then a NACK (error) message is sent to the source unit.

If the source unit receives a NACK message, or does not receive any message within 1 second, it will re-transmit the same message. It will attempt to transmit the message up to five times, with a 5 second delay between attempts. If the unit still does not receive an ACK message after five attempts, it will reset the DCD LED, and reset the DCD output.   The unsuccessful message will be held in the input buffer until the communications link is re-established.   If the source module is the "master" unit,   then it will immediately send "connect" messages every ten seconds to the "slave" unit. If the source module was the "slave" unit, then it will wait until it receives a "connect" message from the "master" and the communications channel is re-established.

During normal operation, if there has been no radio activity for a period (called the "update" period), the "master" unit will transmit the "connect" message to check the radio path. The update period is a time configured by the user.

Establishing a Communications Link

Master Unit	Slave Unit
• Listen to ensure channel is clear • If clear, transmit "connect" ------------------> message • Radio TX LED flashes	• Receives message • Radio RX LED flashes • Check system and destination address • If OK, set DCD LED and output
  • Radio RX LED flashes <------------------	• If message OK, transmit back an ACK message. • Radio TX LED flashes
• Acknowledgment received okay communication link established • Set DCD LED and output	

Successful Communications

Source Module	Destination Module
• Serial data is received • Serial RX LED flashes	
• Listen to ensure channel is clear • If clear, transmit message • Radio TX LED flashes ------------------>	• Receive message • Radio RX LED flashes • Check system and destination address • If OK, check error-check
  • Radio RX LED flashes <------------------	• If message okay, transmit back an ACK message. • Radio TX LED flashes
• Acknowledgment received okay - communication complete	• Serial data is output • Serial TX LED flashes

Unsuccessful Communications

Source Module		Destination Module
• Listen to ensure channel is clear		
• If clear, transmit message	------------------>	• Receives message
• TX LED flashes		• RX LED flashes
		• Check system and destination address
		• If incorrect, transmit no message and no serial output.
		• If addresses are correct, check error-check.
• Radio RX LED flashes	<------------------	• If incorrect, transmit a NACK message
		• TX LED flashes
• NACK message or no message received		
• Retry up to four times	------------------>	
• If no ACK message received after five attempts		
• "Comms fail" output activated		
• DCD signal and DCD LED reset		

The time taken to transmit a message is :-

```
            |------------------HEADER-------------------|-------------------DATA-----------|
 lead-in       system    unit    repeater   dest. zero     data          error check (if configured)
 40msec        address   addr    addrs's    addr  byte
No. of bytes      2        1       0 - 5      1   1     no. of data bytes       2
```

The time for each HEADER byte is 3.8mSec @4800 bits/sec, and the time for each DATA byte is 1.9msec @ 4800 bits/sec.

If error checking is not configured at the receiving unit, data will start to be output approx 1msec after the "zero" byte has been received. If error checking is configured, data will be output approx 2msec after the end of the message. For example, a message with 20 bytes of data transmitted at 4800 bits/sec with no repeaters, will be output approx 88msec after the data is input, assuming that error checking is configured.

The time between transmissions is set by the transmit and receive hold-off times configured by the user.

Intermediate Repeaters

Where intermediate repeaters are configured, each repeater will re-transmit the message onto the next address. When the destination address is reached, the destination module will return an acknowledgment (ACK) with the reverse address structure as the received message.

If error-checking is selected, then the destination module will only return a ACK if the error check is valid. If the error check is not valid, then a NACK message is returned. If the error-checking function is not selected, then the destination module will return an ACK every time it receives a message (a NACK is never sent). Each repeater will re-transmit the ACK or NACK message until it is received by the source module.

The source module will calculate a waiting time for the acknowledgment - this time is based on the radio baud rate, the message length (number of bytes) and the number of repeaters. If the source module receives a NACK, or it does not receive an ACK within the waiting time, it will transmit the same message again. The 905U-D will transmit the message up to five times. If it does not receive an ACK after the 5th attempt, it will assume communications failure and reset its DCD status. The unsuccessful message will not be re-transmitted and will be lost.

Repeater Communications

Successful

Unit A		Unit B		Unit C		Unit D
Source		*Repeater*		*Repeater*		*Destination*
• Transmit message	--->	• Receive message				
		• Re-transmit message	--->	• Receive message		
				• Re-transmit message	--->	• Receive message
Receive ACK					<---	• Transmit ACK
		• Receive ACK		• Receive ACK		
		• Re-transmit ACK	<---	• Re-transmit ACK		• Output data
	<---					
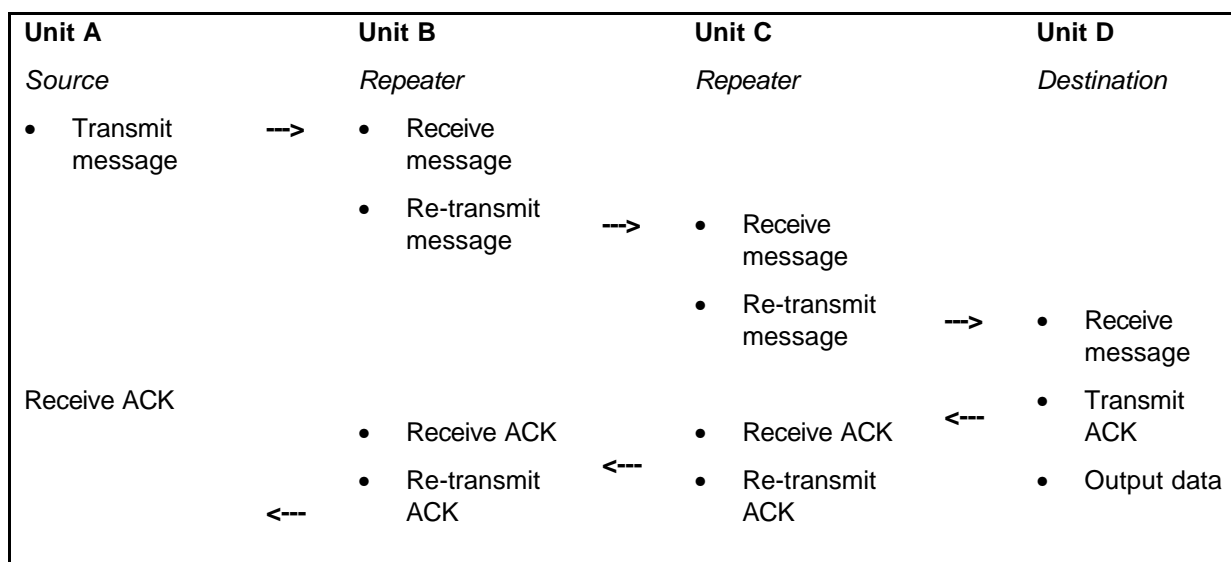
Repeater units may also act as destination addresses for some transmissions and output data to a host device.

3.5   What Operating Mode to Use ?

Transparent or Controlled Mode?

Transparent mode provides faster operation as the units do not acknowledge transmissions received. However reliable operation in transparent mode will only occur if the host devices check the messages and return acknowledgments. Generally, if a device is able to operate on a RS485 multi-drop serial link, it is suitable for transparent mode.

Controlled mode is suitable for point-to-point links, rather than multi-point networks.

If it is not known whether a device is suitable for transparent mode, then controlled mode should be used. If faster operation is desired, then transparent mode can be tried, and if the system operates reliably, then transparent mode is suitable.

It is possible to configure different units in the same system with different operating modes, however the system will not operate. A 905U-D unit configured in one mode will not process a message received from a unit in the alternate mode.

Error Check ?

Error-checking may be configured in both transparent and controlled mode. When the error-check is configured, two additional bytes are attached to the end of each message. These bytes are used to detect any corruption of the data when it is received at another 905U-D unit.

When a unit with error-check configured receives a radio message, it will not output data until it has received the whole message and ensures that the error-check is correct. If the unit does not have error-check configured, then it will output data as it is received. Hence operation of the units is faster if error-check is not configured.

We recommend that units in the same system have the same error-check configuration, however it is possible for users to configure the units differently. If a unit without error-check configured receives a message which includes an error-check, then the unit will treat the additional two bytes as data and output them to the host device. If a unit with error-check configured, receives a message without an error-check, it will treat the last two data bytes as the error check - the error-check will always be incorrect and no data will be output.

Error-check is strongly recommended for controlled mode operation. If error-check is not configured, then a 905U-D unit will transmit an acknowledgment message (ACK) whenever it receives a radio message, without checking for errors. If error-check is configured, the unit will only transmit an ACK message if the error-check is correct. If it is incorrect, an error message (NACK) is returned to the source address.

Autoconnect or Host-connect modes?

If the 905U-D is connected to a PC and the PC will automatically set-up the 905U-D on start-up, then a host-connect mode should be used (modes 0 – 3). In host-connect, the 905U-D will start up in configuration mode.

If you want the 905U-D to start up in operating mode, then use the autoconnect modes (4 – 7).

3.6   Operating Problems

Most operating problems relate to an inadequate radio path, or radio interference. Before installing a system, bench test the complete system with the 905U-D units near each other. This test eliminates the radio path or interference as a factor, and ensures that the system will operate in the way that you want.

If the bench test does not give adequate performance, then you need to adjust the configuration parameters. We recommend that you do not install the system until you are happy with the bench test performance.

If a system gives poor performance after it is installed, check the adequacy of the radio path - refer to the Diagnostics Section 6.

Interference will only cause a problem if the amplitude of the interference is comparable to the radio signal from the 905U-D units. If the interference level is relatively small, then it will not affect the performance of the system. If interference is causing a problem, try to improve

the normal radio level by mounting the aerials higher or in a better location. This not always possible.

System performance may be improved by changing the following parameters :-

- If in transparent mode, try controlled mode.

- If configured for a radio data rate of 115200 bits/sec, reduce the rate to 57600 bits/sec or 19200 bits/sec.

- If large radio messages are being transmitted, reduce the maximum message length, and transmit the data in more messages of smaller size.

Chapter Four   CONFIGURATION

4.1   Before Configuring

Configuration comprises selecting parameter values for the operation of the 905U-D unit. Before you start configuration, parameter settings must be decided.

The main parameters are :-

- Character type. You need to find out the character type of the host devices connected to the 905U-D units. The most common character type is 8 data bits, no parity, 1 start bit and 1 stop bit.

- Serial Data Rate. You need to find out the serial data rate used by the host devices. The most common serial data rate is 9600 bits/sec.

- Radio Data Rate. You need to decide what radio data rate you wish to use. It does not have to be the same as the serial data rate. Remember that the radio range for 115200 bits/sec will not be as good as that for lower data rates. Generally the data sent between process control equipment is small, and 115200 bit/sec is not required. We recommend that you use 19200 bits/sec unless your application requires the faster data rate.

- Operating mode . You need to decide which operating mode you wish to use. Modes are transparent or controlled, error-checked or no-error-check, and autoconnect or host-connect. These modes are discussed in more detail in following sections.

The other configuration parameters do not need to be selected, and are provided as a means of "fine tuning" the operation of the 905U-D units.

Configuration may be performed from a terminal using Hayes commands, or by using the miniature switches under the blue cover on the front of the unit.

The first step in configuration is to put the radio modem into Configuration Mode.

4.2   Configuration Mode

A 905U-D network comprises modules with the same "system" address. In controlled mode, each module is also configured with a unit address between 0 and 127 - there can only be 127 modules in the one system. In transparent mode, modules are not configured with a unit address, and there is no limit to the number of modules in a system (except for the capacity of the radio channel).

4.3   Hayes Commands

The 905U-D unit may be configured by a host device using Hayes AT commands. Configuration may be done by a user (with a PC terminal as the host device) or it can be done automatically by a host device such as PLC or SCADA. The AT commands are ASCII messages designed for use with conventional telephone modems.

Before a 905U-D unit will accept Hayes commands, it must be in configuration mode. A host device may force the unit to configuration mode by sending three "escape" characters - "+++". The default escape character is "+", however this may be changed as it is one of the configuration parameters Note that in the Host-connect operating modes, the 905U-D units start up in configuration mode. These modes (0, 1, 2 or 3) simulate the operation of telephone or leased-line modems, and may be used with standard host software designed with Hayes command control.

Once in configuration mode, the 905U-D unit will accept a string of Hayes commands, and the configuration changes made. The changes will not however be stored in permanent memory (EEPROM) unless the Hayes command for recording the configuration (AT&W) is sent. When the configuration changes are made, the module must be put back into its operating mode by using the "online" Hayes command,   **ATO**

The 905U-D will automatically change from configuration mode to operating mode if there has been no AT command entry within a certain time. This time is one of the configuration parameters.

The following Hayes commands are accepted by the 905U-D unit :

4.3.1   Unit Reset

The **ATZ** command resets the unit as if power had been switched off and on. After power up, the configuration will be the last saved configuration - that is, the last configuration saved by the AT&W command.

4.3.2   Storing Configuration Parameters - Write Registers

Once configuration parameters have been changed, they can be stored to non-volatile memory with the **AT&W** command. When the unit is reset from power up or via the ATZ command, the stored parameters are restored.

4.3.3   Default Values - Restore Factory Defaults

The **AT&F** command will reset the configuration parameters to the default values. To reset the values and save them to nonvolatile memory, use AT&F&W

Refer to Appendix A section 1.1.10 for using the configuration switches to reset to factory defaults.

4.3.4   S-Registers

The E405 provides 15 S-Registers to configure the operation of the unit. S-Registers may be read using the Hayes command **ATSn = xxx**, where **n** is the number of the configuration parameter, and **xxx** is the value shown below for each parameter. The entire configuration parameters may be viewed by the Hayes command **AT&V**.

The configuration parameters and values are :

Operating mode (S0)   **ATS0 = xxx**   **Default = 4**

xxx	Option	Connect Mode
0	Transparent mode without error-check	Host
1	Transparent mode with error-check	Host
2	Controlled mode without error-check	Host
3	Controlled mode with error-check	Host
4	Transparent mode without error-check	Auto
5	Transparent mode with error-check	Auto
6	Controlled mode without error-check	Auto
7	Controlled mode with error-check	Auto
8	Transparent mode repeater	Auto

NOTE The operating mode may also be changed using the mode command (AT&Mx)

Operating modes 0 to 3 try to duplicate the operation of conventional telephone modems, and can be used with software designed to operate with telephone modems. The 905U-D units will start up in configuration mode, expecting Hayes command configuration. See 3.3 Controlled Mode for a description of operation.

Tail time (S1)   **ATS1 = xxx**   **Default = 0**

where xxx is the tail time in 10 msec increments   (xxx = 20 for 200 msec)

A tail time may be configured which keeps the radio transmitter active at the end of each message. The maximum tail time is 2.55 seconds. The tail time value is the 8-bit binary equivalent of the desired time in 10 msec increments.

Escape character (S2)   **ATS2 = xxx**   **Default = 43 ("+")**

where xxx is the decimal ASCII value of the character. The default value is 43 ("+").

A host device may force the unit to configuration mode by sending three "escape" characters - "+++". The default escape character is "+", however this may be changed by the host device.

ATS2 = 255 will prevent the unit entering command mode.

Maximum message length (S3)   **ATS3 = xxx**   **Default = 265**

where the maximum message length in bytes is equal to twice xxx plus 10, or 2 * (xxx) + 10.

For example, ATS3 = 10 gives a maximum length of 30 bytes.

The message length parameter selects the maximum length (in bytes) of the data sent in each radio message. The length may be selected between 10 bytes and 520 bytes. The message length is equal to 2x(VALUE)+10, where VALUE is the decimal equivalent of the 8-bit code entered.

Serial data rate (S4)   **ATS4 = xxx**   **Default = 8**

To select or change the serial data rate, enter the following VALUE code. The serial data rate can be different at different 905U-D modules in the same system. The default value is 9600 bits/sec.

Bits/sec	xxx	Bits/sec	xxx
1200	0	57600	6
2400	1	115200	7
4800	2		
9600	3		
19200	4		
38400	5		

Radio data rate (S5)   **ATS5 = xxx**   **Default = 1**

To select or change the radio data rate, enter the following VALUE code. The radio data rate should be the same at each 905U-D module in the same system. The default value is 4800 bits/sec.

Bits/sec	xxx	Bits/sec	xxx
19200	3	115200	1
57600	2		

System address, high byte (S6)   **ATS6 = xxx**

> where xxx is the Decimal value of the first byte of the system address.

> The system address comprises two bytes. Note that the high byte cannot be more than 127.

System address, low byte (S7)   **ATS7 = xxx**

> where xxx is the Decimal value of the second byte of the system address.

Unit address (S8)   **ATS8 = xxx**

> where xxx is the decimal value of the unit address.

> Note that xxx cannot be 0 (zero) or more than 127.

In controlled mode, each module is configured with a unit address between 1 and 127 - there can only be 127 modules in the one system. In transparent mode, modules are not configured with a unit address (the value of S8 is ignored), and there is no limit to the number of modules in a system (except for the capacity of the radio channel).

Character Type (S9)   **ATS9 = x**   **Default = 4**

The Character Type parameter configures the character format, the flow control on the serial port, and the use of DTR low power mode. The character format is the data bits, start bits, and parity configuration. The serial port flow control may be configured for to enable or disable RTS/CTS control. In all RS-485 applications and some RS-232 applications, RTS/CTS control must be disabled. DTR low power mode is explained in sections 3.1 and 4.3.5 of this manual - it is only used in modes 6 or 7 with an autodial address.

The character type in the 905U-D will change as soon as the ATS9 entry is made. The character type on the configuration terminal should change at the same time such that the 905U-D understands any subsequent commands.

NOTE :   These values are valid for software version 1.11 and later. For earlier versions, refer to your distributor. To find out the software version, use the ATI command.

Data Bits	Start Bits	Stop Bits	Parity	CTS/ RTS control	VALUE DTR low power mode	VALUE DTR normal power mode
7	1	1	even	enabled	8	40
7	1	1	odd	enabled	9	41
7	1	2	even	enabled	11	43
7	1	2	odd	enabled	16	48
7	1	2	none	enabled	3	35
8	1	1	even	enabled	1	33
8	1	1	odd	enabled	2	34
8	1	1	none	enabled	0	32
8	1	2	none	enabled	10	42
7	1	1	even	disabled	12	44
7	1	1	odd	disabled	13	45
7	1	2	even	disabled	15	47
7	1	2	odd	disabled	20	52
7	1	2	none	disabled	7	39
8	1	1	even	disabled	5	37
8	1	1	odd	disabled	6	38
8	1	1	none	disabled	4	36
8	1	2	none	disabled	14	46

Display Mode (S10)   **ATS10 = x**   **Default = 3**

NOTE :   These values are valid for software version 1.11 and later. For earlier versions, refer to your distributor. To find out the software version, use the ATI command.

ECHO	VERBOSE	QUIET	VALUE "RINGING" response	VALUE no "RINGING" response
Disabled	Disabled	Disabled	0	8
Enabled	Disabled	Disabled	1	9
Disabled	Enabled	Disabled	2	10
Enabled	Enabled	Disabled	3	11

ECHO	VERBOSE	QUIET	VALUE "RINGING" response	VALUE no "RINGING" response
Disabled	Disabled	Enabled	4	12
Enabled	Disabled	Enabled	5	13
Disabled	Enabled	Enabled	6	14
Enabled	Enabled	Enabled	7	15

NOTE: This register is accessible by the "Echo" command (ATE0, or ATE1), "Quiet" command (ATQ0, or ATQ1), and "Verbose" command (ATVO, or ATV1)

Refer to section 4.3.6 for an explanation of the "Ringing" response feature.

Command Mode Timeout (S11)   **ATS11 = x**   **Default = 60**

Where x = timeout in seconds

If there has been no AT commands entered within this time, the 905U-D will automatically change from configuration mode to operating mode. If S11 is set to 0 (zero), the 905U-D will not automatically change, and will only change to operating mode when a ATO command is entered.

NOTE :   These values are valid for software version 1.09 and later. For earlier versions, refer to your distributor. To find out the software version, use the ATI command.

Transmit Hold-off Time (S12)   **ATS12 = xxx**   **Default = 70**

where xxx is the hold-off time in 1 msec increments   (xxx = 20 for 20 msec)

A delay time may be configured such that the 405U unit will not transmit during the hold-off time after transmitting a previous message. The maximum hold-off time is 255 msec. The transmit hold-off time value is the 8-bit binary equivalent of the desired time in 1 msec increments.

Receive Hold-off Time (S13)   **ATS13 = xxx**   **Default = 20**

where xxx is the hold-off time in 1 msec increments   (xxx = 20 for 20 msec)

A delay time may be configured such that the 405U unit will not transmit a message during the hold-off time after receiving a message. The maximum hold-off time is 255 msec. The receive hold-off time value is the 8-bit binary equivalent of the desired time in 1 msec increments.

Connect Update Time (S14)   **ATS14 = xxx**   **Default = 100**

where xxx is the hold-off time in 0.1 minute increments   (xxx = 20 for 2 min.)

In controlled mode, the 405U unit will transmit a "connect" message if there has been no activity on the radio channel for the update time. The connect update time value is the 8-bit binary equivalent of the desired time in 0.1 minute increments.

4.3.5   Changing Destination/Repeater Address - autodial

The destination address and repeater addresses may be changed with the AT&Z command:-
AT&Z <first repeater>,<second repeater>,. . . . . ,<destination>

The module will automatically attempt to connect to the destination address.

For example, to set the destination address to 18 with repeater addresses 2 and 8, the command would be -   AT&Z2,8,18

If the destination address was to be 105 with no repeaters, the command would be

AT&Z105 or AT&Z105&W (this command also stores the change in permanent memory).

To clear the address values, use the command **AT&Z<enter>**

In modes 6 and 7, the 405U will only connect if the DTR signal is high (active). If the DTR signal goes low (inactive), the 405U will break the connection. If low power mode is selected at S9, then the 405U will also go to low power mode.

4.3.6   Connecting to a Remote Module – single dial

If the 405U unit is already connected to a remote module, then the connection should be cancelled by using the "hang-up" command, **ATH**

To connect to a remote module, use the "dial" command

ATD <first repeater>,<second repeater>,. . . . . ,<destination>

For example, to set the destination address to 67 with repeater addresses 32 and 48, the command would be -   ATD32,48,67

The module will respond with one of the following messages :-

RINGING   the module is in the process of connecting (only if "RINGING" is selected at S10).

CONNECT   the module has successfully connected

BUSY   the destination module is already connected to another module

NO ANSWER   the module was unable to connect to the destination address

If the destination address was to be 119 with no repeaters, the command would be ATD119.

To cancel or "hang-up" a connection,   use the **ATH** command.   The ATD and ATH commands may be mixed. For example, ATHD119 (this command also clears the previous connection before trying to make the new connection).

4.3.7   Reading Configuration Parameters

Host devices are able to read the value of configuration parameters by using the **ATSn?** command, where "n" is the number of the configuration parameter.

4.3.8   Unit Test commands   - AT&Tx

Test commands are available via the command AT&Tx, where x is the test number requested. Many of these tests will be successful only during factory test. Refer to the Diagnostics section of this manual (chapter 6) for a detailed listing of the test commands available.

4.3.9   Version Information   - ATI

The command ATI will result In a response from the 405U module with the software version of the 405U. For example, "905U-D V1.09"

4.3.10 Character Type - AT&Bx

This command allows configuration of the character format and flow control used on the serial port. The x value is the same as the character type command under S-register 9.

Note: The value of this setting is also available via S-register S9

4.3.11 Character Type - AT&Mx

This command allows configuration of the operating mode. The x value is the same as the character type command under S-register 0.

Note: The value of this setting is also available via S-register S0.

4.3.12 Verbose mode control, Local Echo control, and Quiet mode

The following commands from the host control the responses of the 405U unit to the Hayes commands.

ATV0	numeric responses
ATV1	verbal responses
ATQ0	response displayed
ATQ1	No response displayed
ATE0	disable local echo
ATE1	enable local echo

Note: the values of these settings are also available via S-register S10.

4.3.13 Responses

The 405U modules provide responses to the Hayes commands. The responses will be either in verbal (ASCII) or numeric, depending on the "ATV" configuration. The following responses will be issued by the module :-

VERBAL	NUMERIC	MEANING
OK	0	Command accepted
CONNECT	1	Connected to remote unit
NO CARRIER	3	Connection lost to remote unit
ERROR	4	Invalid command
BUSY	7	Destination unit already connected
NO ANSWER	8	No response from destination address
RINGING	13	Attempting to connect to destination unit

4.4 Configuration Examples

Transparent Mode

Extending a PLC Network
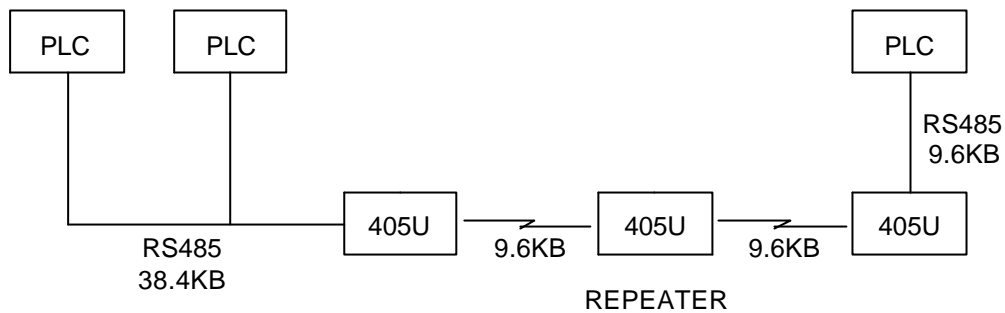
DATA = 7 DATA BITS, 1 START, 2 STOP, EVEN PARITY

Unit No. 1 Configuration

Set the module to factory default settings:	AT&F	
Set the system address to a random number:	ATS6 = 38	ATS7 = 92
Set the serial data rate to 38400	ATS4 = 10	
Set the radio data rate to 115200	ATS5 = 0	
Set the character type to 7,1,2,even	ATS9 = 15	
Exit and save the configuration	AT&W	ATO

The operating mode will already be in transparent mode from the factory default settings. The other default values for the other parameters will likely be OK.

Repeater Configuration

Set the module to factory default settings:	AT&F	
Set the system address to the same random number:	ATS6 = 38	ATS7 = 92
Set the radio data rate to 115200	ATS5 = 0	
Set the operating mode to Transparent Repeater	ATS0 = 8	
Exit and save the configuration	AT&W	ATO

Unit No. 2 Configuration

Set the module to factory default settings:	AT&F	
Set the system address to the same random number:	ATS6 = 38	ATS7 = 92
Set the radio data rate to 115200	ATS5 = 0	
Set the character type to 7,1,2,even	ATS9 = 15	

Exit and save the configuration	AT&W	ATO

Note that it was not necessary to set the serial data rate as 9600 is the default setting.

Controlled Mode

Point-to-point link with repeaters

Assume that default settings are used for data rates and character types. The only configuration required is addressing.

Module #1

```
   Source              Repeater              Repeater              Destination
     #1 ----------------> #2  -----------------> #100 --------------------> #3


                                    #101


     Apart from being a repeater in the 1 - 3 link,  100 is also in a separate link to 101
```

Set the module to factory default settings:	AT&F	
Set the system address to a random number:	ATS6 = 17	ATS7 = 50
Set the unit address to 1	ATS8 = 1	
Set the operating mode to controlled mode	ATS0 = 7	
Set the autodial address to 3 via 2, 100	AT&Z2,100,3	
Exit and save the configuration	AT&W	ATO

Note that module #1 is the "master" unit in this link.

Module #2

Set the module to factory default settings:	AT&F	
Set the system address to the same random number:	ATS6 = 17	ATS7 = 50
Set the unit address to 2	ATS8 = 2	
Set the operating mode to controlled mode	ATS0 = 7	
Exit and save the configuration	AT&W	ATO

Module #3

Set the module to factory default settings:	AT&F	
Set the system address to the same random number:	ATS6 = 17	ATS7 = 50
Set the unit address to 3	ATS8 = 3	
Set the operating mode to controlled mode	ATS0 = 7	
Exit and save the configuration	AT&W	ATO

Module #100

Note that #100 is the master unit for a link between #100 and #101, It is also acting as repeater in the #1 to #3 link.   The system address for #100 and #101 must be the same as the other modules so that #100 can act as a repeater.

Set the module to factory default settings: AT&F

Set the system address to the same random number: ATS6 = 17   ATS7 = 50

Set the unit address to 100   ATS8 = 100

Set the operating mode to controlled mode   ATS0 = 7

Set the autodial address to 101   AT&Z101

Exit and save the configuration   AT&W   ATO

The configuration for #101 is not shown as it is not part of the active link.

Chapter Five   SPECIFICATIONS

General		
Radio specification	FCC part 15.247	902-928 MHz 1W
Housing	130 x 185 x 60mm DIN rail mount	Powder-coated, extruded aluminium
Terminal blocks	Removable	Suitable for 2.5sqmm conductors
LED indication	OK operation, Serial RX and TX, Radio RX and TX, DCD active	
Operating Temperature	-20 to 60 degrees C	
Power Supply		
Nominal supply	12VDC or 24VDC	
12V supply	11.3 - 15 VDC	Overvoltage and reverse voltage protected
24V supply	18 – 28 VDC	Overvoltage and reverse voltage protected
Current Drain @ 12VDC	150 mA quiescent 30mA (low power mode)	During transmission 500mA
Current Drain @ 24VDC	80 mA quiescent 20mA (low power mode)	During transmission 300mA
Radio Transceiver		
Frequency Hopping Spread spectrum		Direct frequency modulation
Transmit power	1W	902-928 MHz
Frequency Stability	+/- 10. 0 kHz	
Signal detect / RSSI	-120 to -80 dBm	
Aerial Connector	Reverse SMA coaxial	
Serial Ports		
RS232 Port	DB9 male DCE	RTS/CTS/DCD hardware signals provided
RS485 Port	2 pin terminal block	Typical distance 1 - 2 km
Data rate (bit/sec) - configurable	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200	

Byte format	7 or 8 data bits	Stop/start/parity bits configurable
System Parameters		
Operating modes	Transparent mode Controlled mode	Broadcast system Addressed communications with acknowledged
System address	Configurable 15 bit	
User Configuration		Hayes commands from host device. Or via on-board DIP switches

Chapter Six   TROUBLESHOOTING

6.1   Diagnostics Chart

INDICATOR	CONDITION	MEANING
OK LED OFF	Continuously	• Power supply failure • CPU failure
OK LED ON	Continuously	• Normal Operation
Radio TX LED ON	Flashes briefly	• Radio transmitting
Radio RX LED ON	GREEN flash RED flash	• Radio receiving data • Weak radio signal
Serial RX LED ON	GREEN flash RED flash GREEN continuously	• Serial Port Receiving • CTS low • Configuration Mode
Radio RX and Serial RX LED ON	RED flash for 10 secs after power up	• Configuration corruption (EEPROM failure)
Serial TX LED ON	Flashes briefly	• Serial port transmitting
DCD LED ON	Continuously	• In transparent mode, always on. • In controlled mode, a radio link has been established.

The green OK LED on the front panel indicates correct operation of the unit. This LED extinguishes on failure as described above. When the OK LED extinguishes shutdown state is indicated. On processor failure, or on failure during startup diagnostics, the unit shuts down, and remains in shutdown until the fault is rectified.

6.2   Test Functions

6.2.1   Diagnostic Functions - AT&Tx

To aid in the checking and setup of the 405U unit diagnostic functions in the 405U are provided using the standard Hayes AT commands. Several of these functions are used during factory test, and will not work correctly if the unit is not connected to the factory test jig.

The table below outlines the functions of the various tests:

Test Command	Function
AT&T0	Factory test only
AT&T1	Factory test only
AT&T2	Factory test only
AT&T3	Factory test only
AT&T4	Factory test only
AT&T5	Internal RAM test
AT&T6	Nonvolatile Memory (EEPROM) test
AT&T7	Configuration Switch test
AT&T8	Received Signal Strength Display
AT&T9	Transmit Tone reversals
AT&TA	BER Test - Master
AT&TB	BER Test - Slave
AT&TC	BER Test – Two direction

The tests most useful for diagnosing system problems are "received signal strength display" and "transmit tone reversals".

AT&T9 - Transmit Tone Reversals

This provides the same function as described above (Tone Reversals). This function may be used to check VSWR of aerials, and may be used in conjunction with the Signal option (described below) to check the path between two 405U units.

AT&T8 - Received Signal Strength Display

This option provides for testing the radio path between two 405U units. Although a pair of units may communicate successfully, radio communication may be affected by a range of influences, including atmospheric conditions, changing landscape, degradation of aerials or co-axial cable, low battery voltage etc. Fade margin is an indication of how far a radio path can deteriorate before reliable communication becomes unreliable.

When using this feature, the current value of the received signal strength is displayed in dBm (decibels referenced to 1 mW). This value is updated every half second. To check the radio path between two units, select the signal option at the local unit. The remote unit may then be set up for tone reversals (refer 1 above) and the signal level read from the computer screen. We have selected a bit error rate (BER) of 1 in 300 as the point at which unreliable communications occurs. The following table lists the minimum signal required for reliable communications (BER > 1 in 300). A system with the minimum signal level will not stay reliable under all conditions, because of changing factors such as environmental conditions. A fade margin of at least 15 dB should be allowed for to take account of these factors. The table also lists our recommended minimum signal level, taking this margin into account.

Radio Baud Rate	Minimum signal for BER = 1 in 1000	Recommended minimum signal
19200	-105 dBm	-95 dBm
57600	-99 dBm	-89 dBm
115200	-95 dBm	-85 dBm

In areas experiencing radio interference or high background noise, reliable communications may not be achievable even with this signal level. To determine if interference is occurring, the signal option may be selected **without any other 405U units active**. In a normal radio environment, a reading of at most -110 dBm should be displayed. If a reading above this value is displayed (for example -100 dBm), then the received signal strength from the remote should be **at least 15 dB higher** than the background noise for reliable communication.

Example:

AT&T8   *Displayed signal level of background noise/interference*

RSSI Display - press a key to exit

-88 dBm

AT&T8   *Minimum signal level for reliable comms*

RSSI Display - press a key to exit

-73 dBm

6.2.3   Bit Error Rate Test (BER)

BER may be tested in one direction by typing AT&TA (BER master) at the sending unit and typing AT&TB (BER slave) at the receiving unit. The sending unit will repeatedly send pseudo-random frames, and the receiving unit will check these frames for errors. If a terminal is connected to the sending unit, the pseudo-random data is displayed as it is transmitted. If a terminal is connected to the receiving unit, then the test results are displayed.

An example of the receiving unit's display is here.

Test	Errors	Extra	Level	TotErr	TotTest
109	0	0	-77dBm	3	109 kbit

Test	-	the sequence number of the last received frame
Errors	-	the number of bit errors in the last received frame
Extra	-	any extra characters at the end of the frame (negative numbers indicate frame dropped out early)
Level	-	the RSSI level when the frame was received.
TotErr	-	The total errors received during this test.
TotTest	-	The total number of bits sent (in 1000's)

Occasionally during testing, the following may be displayed:

Test	Errors	Extra	Level	TotErr	TotTest
			Bad Header		

This indicated that the header information has been corrupted. Corrupted headers do not contribute to the bit errors, which are calculated only on the 1,000 bit frame.

BER testing may also be performed in both directions simultaneously. In this case, a remote module is set up to Transparent mode repeater operation, (ATS0=8) and the BER test is performed on the local module using the command AT&TC (loopback Bit Error Test). In this case, the display is identical to the display on the BER slave unit above, but the displayed bit errors are a total for the round trip, so will be the sum of the bit errors in both directions.

Chapter Seven WARRANTY & SERVICE

We are pleased that you have purchased this product. Your purchase is guaranteed against defects for a 365 day warranty period, commencing from the date of purchase.

This warranty does not extend to:

- Failures caused by the operation of the equipment outside the particular product's specification.

- use of the 405U module not in accordance with this User Manual, or

- abuse, misuse, neglect or damage by external causes, or

- repairs, alterations, or modifications undertaken other than by an authorised Service Agent.

Full product specifications and maintenance instructions are available from your Service Agent, your source of purchase, or from the master distributor in your country upon request and should be noted if you are in any doubt about the operating environment for your equipment purchase

In the unlikely event of your purchase being faulty, your warranty extends to free repair or replacement of the faulty unit, after its receipt at the master distributor in your country. Our warranty does not include transport or insurance charges relating to a warranty claim.

This warranty does not indemnify the purchaser of products for any consequential claim for damages or loss of operations or profits.

Should you wish to make a warranty claim, or obtain service, please forward the module to the nearest authorised Service Agent along with proof of purchase. For details of authorised Service Agents, contact your sales distributor.

Appendix A   Switch Configuration

1.0   Introduction

In order to configure the 405U unit, or to change the configuration, the unit must be placed into Configuration Mode. When in this mode, the unit will not operate as transparent or controlled mode.

Module configuration may be performed using the on-board miniature (DIP) switches or from the host device using Hayes AT command codes (refer to Section 4.3).

In order to avoid radio interference between adjacent 405U networks, a "**system address**" is required to be configured. Each module within the one network **must** have the same system address. The system address may be any number between 1 and 32 767.

To simplify matters, the system address may be just an arbitrary pattern of off and on switches ("0"s and "1"s) - it is not important what the actual system address value is - as long as each module in the network has the same switch pattern for the system address. A system address of zero (all 0's) is not acceptable.
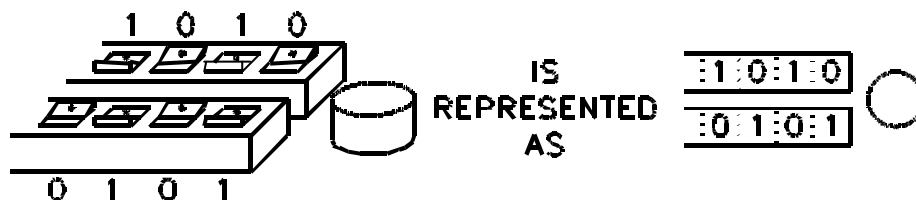
NOTE:

> The configuration used in your system should be recorded for future reference. This information will be required when the unit is initially configured, if a unit is replaced, if the system is to be expanded, or if units are tested with the internal Self Test configuration. Configuration record sheets are provided at the end of this manual. These sheets should be used to assist in planning the network for your application and to have the data readily available for entry.

Entering a system address puts the 405U in Configuration Mode:

- Carefully remove the blue plastic cover in the centre of the module to reveal the switches and red pushbutton underneath.
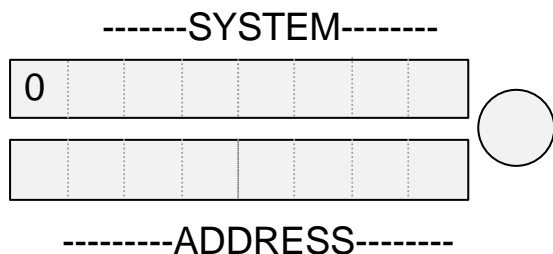
-------SYSTEM--------

---------ADDRESS--------

- Set the chosen system address on the DIP switches as shown. Make sure the switch marked '0' is set to '0'. Other switches can be in any chosen position.

- Press the red button for approx. 3 seconds - until the *Serial RX* LED indicates RED.

- The *Serial RX* LED will indicate GREEN on release of the button indicating the unit is in "Configuration Mode"

 Once the module is in configuration mode, transparent or controlled mode may be selected. This is achieved by entering in another switch pattern. If transparent mode is selected, no further configuration is required, and the module will automatically exit configuration mode. If controlled mode is selected,   further entries are required for the addressing of the communications link.

1.0.1   Default Configuration

The default configuration is the configuration set in the factory.   When you receive new modules, they will have this configuration.   The default configuration is transparent mode without error-checking, autoconnect mode, with serial data rates of 9600 bits/sec, and radio data rate of 4800 bit/sec.   The serial ports will be set up for a byte format of 8 data bits, 1 start bit, 1 stop bit and no parity. Further details of default settings are included in Appendix A – Section 1.1.10.

1.0.2   Transparent Mode

To select transparent mode the following switch pattern is entered after the system address is entered :-

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

- **First enter the system address**
- Enter the switch pattern
- Configuration mode will automatically exit and the *RX* LED will reset.

The operating mode will be set to mode 4 (Transparent mode without error check). Refer to Configuration Parameters in Appendix A – Section 1.1.
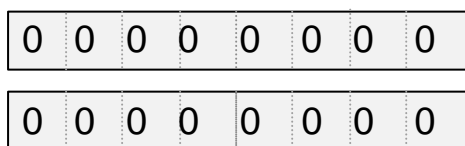
1.0.3   Controlled Mode

In controlled mode, each module within a network must be configured with an individual **unit address. Each module must have a unique unit address within the one system**. Each controlled mode system may have up to 127 modules. Addresses may be in the range 1 to 127. Note that address 0 is not accepted - if this address is entered, the module exits configuration mode and you must start configuration again. This address is coded in binary on the DIP switches. Appendix B lists the switch code for each address between 1 and 127.

To configure controlled mode, switch patterns are entered consecutively with the module unit address, any repeater addresses and the destination address. These switch patterns are entered after the system address has been entered. If more than one repeater is used in the radio link, then each repeater address is entered in order, starting with the first repeater and then the next repeater and so on. Up to five repeater addresses may be entered. If only one repeater is used, then only one repeater address is entered. If three are used, then three repeater addresses are entered - etc. The destination address is always the last address entered. If there are no repeaters used, then the destination address is entered immediately after the unit address. After the destination address is entered, a switch pattern with all "0"s (all the switches off) is entered. The module then exits configuration mode.

Note that repeater and destination addresses are only entered for the "master" unit in each link. For "slave" units, only the unit address is entered. For modules which will just act as a repeater unit, just a unit address need be entered. For these modules, enter the exit pattern of all zero's after the unit address.

To select controlled mode the following switch pattern is entered after the system address has been entered.

0	0	0	0	0	0	0	1
0							

----- ADDRESS -----

- **First enter the system address**
- Enter the unit address
- Enter the repeater addresses (if any) in order,   and then enter the destination address.

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
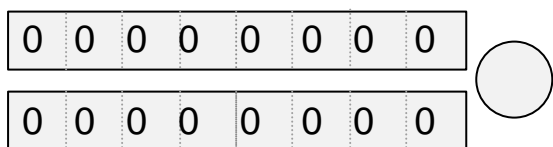
- **When all of the addresses have been entered**
- Enter all 0's
- Configuration mde will automatically exit and the *RX* LED will reset.

The operating mode will be set to Controlled Mode with Error-Checking (mode 7) - refer to Appendix A – Section 1.1, Configuration Parameters.

Example

Source   Repeater   Repeater   Destination

   #1 ----------------> #2 -----------------> #100 --------------------> #3

                                           #101

   Apart from being a repeater in the 1 - 3 link, 100 is also in a separate link to 101
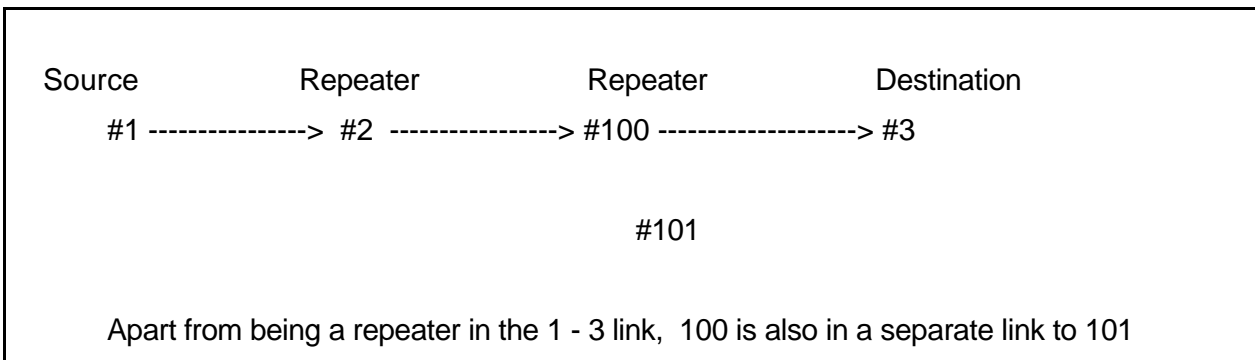
Module #1 Configuration

Module #1 is configured as the master unit .
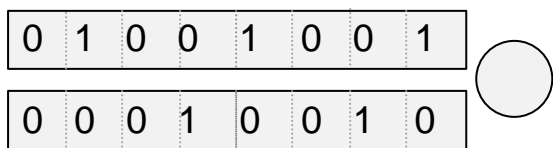
0	1	0	0	1	0	0	1
0	0	0	1	0	0	1	0

- System address 100 1001 0001 0010.

0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	1

- Unit address is 0000001 (#1)

0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0

- First repeater address is 0000010 (#2)

0	0	0	0	0	0	0	1
0	1	1	0	0	1	0	0

- Second repeater address is 1100100 (#100)

0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	1

- Destination address is 0000011 (#3)

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

- Configuration complete

Module #2 Configuration

Module #2 is the first repeater. As there is no host device connected, a destination address is not required.

0	1	0	0	1	0	0	1
0	0	0	1	0	0	1	0

- System address 100100100010010.

0	0	0	0	0	0	0	1
0	0	0	0	0	0	1	0

- Unit address is 0000010 (#2)

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

- Configuration complete
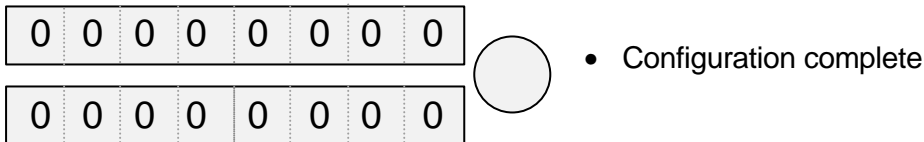
Module #100 Configuration

Module #100 is the second repeater in the link between #1 and #3. It also has a host device and transmits data to #101. It is configured as the "master" unit for the #100 - #101 link. As it has the unit address #100, it will also act as a repeater for #1 - #3. Note that the system address for #100 and #101 has to be the same as #1 and #3.

If module #100 was the "slave" unit for the #100 - #101 link, then only the unit address would be required for the #100 configuration.

| 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 |

| 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

- System address 100100100010010.

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |

- Unit address is 1100100 (#100)

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |

- Destination address is 1100101 (#101)

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

- Configuration complete
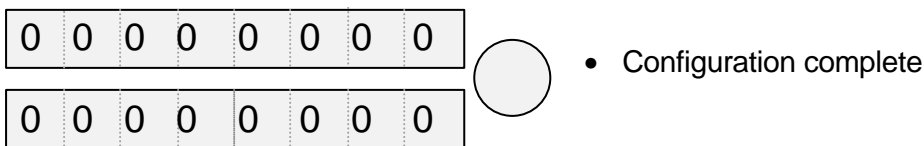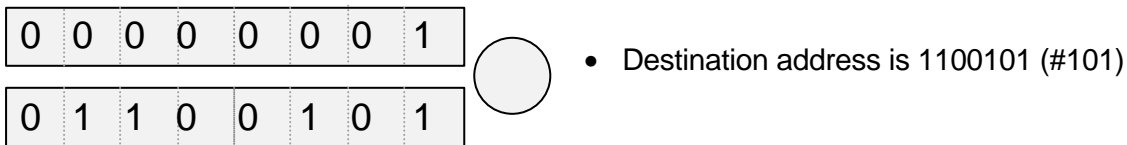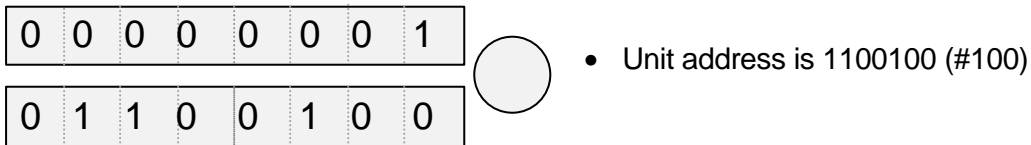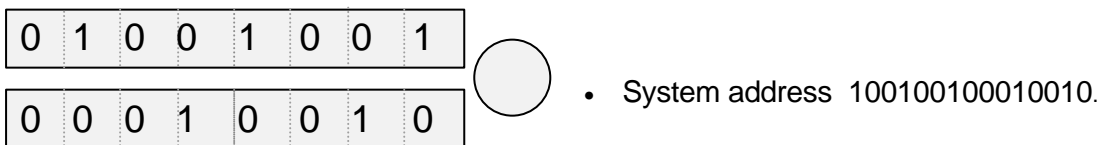
Module #3 Configuration

As module #3 is the "slave" unit for this link,   only the unit address is required for the configuration.

0	1	0	0	1	0	0	1

0	0	0	1	0	0	1	0

- System address 100100100010010.
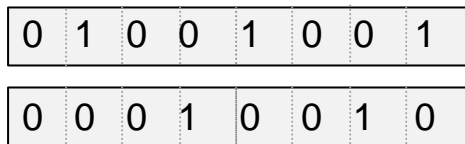
0	0	0	0	0	0	0	1

0	0	0	0	0	0	1	1
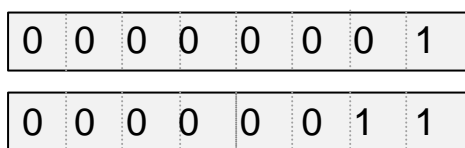
- Unit address is 0000011 (#3)

0	0	0	0	0	0	0	0

0	0	0	0	0	0	0	0
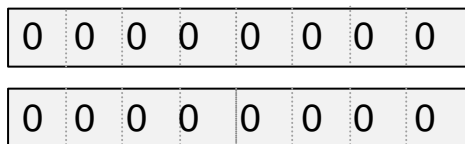
- Configuration complete

1.1 Configuration Parameters

Configuration parameters may be configured or changed at any time by entering the appropriate switch code and pressing the red button continuously until the *Serial RX* LED indicates RED. When the red button is released, the *RX* LED will return to normal. The 405U module will reset and start-up as if power had been disconnected.

Each parameter has a default value which is set in the factory. All of the parameters do not need to be set - only those which you wish to change..

Each switch entry will be of the following pattern :-

--PARAM--

1	0	0	0				
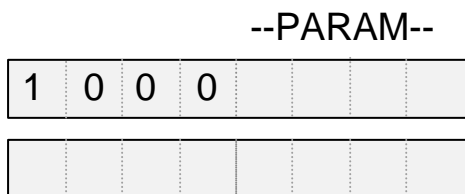
-----------VALUE----------

- Enter the code with the parameter code (PARAM) and the parameter value (VALUE) chosen and press button until *RX* LED lights.

1.1.1   Operating Mode

PARAM = 0 0 0 0   Default = 0 0 0 0 0 1 0 0

Mode	Value	Option	Connect Mode
0	0 0 0 0 0 0 0 0	Transparent mode without error-check	Host
1	0 0 0 0 0 0 0 1	Transparent mode with error-check	Host
2	0 0 0 0 0 0 1 0	Controlled mode without error-check	Host
3	0 0 0 0 0 0 1 1	Controlled mode with error-check	Host
4	0 0 0 0 0 1 0 0	Transparent mode without error-check	Auto
5	0 0 0 0 0 1 0 1	Transparent mode with error-check	Auto
6	0 0 0 0 0 1 1 0	Controlled mode without error-check	Auto
7	0 0 0 0 0 1 1 1	Controlled mode with error-check	Auto
8	0 0 0 0 1 0 0 0	Transparent mode repeater	Auto

Host connect modes are suitable for use with host devices that can drive leased-line or dial-up modems. Units in Host-connect mode power-up in Configuration Mode. They require a Hayes command to make a connection. eg. ATO for Leased-line or ATDxx - see 4.3 Hayes Commands.

Autoconnect modes will automatically establish a connection on power-up and automatically try to re-establish a connection if it is lost.

Note that the programming of a system, unit or destination address using the DIL switches will cause the unit to default to Mode 4 transparent mode or Mode 7 controlled mode. For this reason, the Operating Mode parameter must be programmed (if mode 4 or mode 7 are unsuitable) **after** entering the address information.

1.1.2   Tail Time

PARAM = 0 0 0 1   Default = 0 0 0 0 0 0 0 0

A tail time may be configured which keeps the radio channel open at the end of each message. The maximum tail time is 2.55 seconds. The tail time value is the 8-bit binary equivalent of the desired time in 10 msec increments. Hence for a desired tail time of 100 msec, a VALUE code of ten (00001010) is entered. For the maximum time of 2.55 secs, a VALUE code of 255 (11111111) is entered. The default tail time is zero seconds - that is, no tail time. Appendix A lists the 8-bit patterns for each value between 0 and 255.

1.1.3   Message Length

PARAM = 0 0 1 1   Default = 1 1 1 1 1 1 1 1

The message length parameter selects the maximum length (in bytes) of the data sent in each radio message. The length may be selected between 10 bytes and 520 bytes. The message length is equal to 2x(VALUE)+10, where VALUE is the decimal equivalent of the 8-bit code entered.

Hence for a desired message of 10 bytes, a VALUE code of zero (00000000) is entered. For the maximum length of 520 bytes, a MESSL code of 255 (11111111) is entered. The default message length is 520 bytes.

1.1.4   Serial Data Rate

<div align="center">

PARAM = 0 1 0 0   Default = 0 0 0 0 1 0 0 0

</div>

To select or change the serial data rate, enter the following VALUE code. The serial data rate can be different at different 405U modules in the same system. The default value is 9600 bits/sec.

Serial Data Rate (bits/sec)	VALUE	Serial Data Rate (bits/sec)	VALUE
1200	0 0 0 0 0 0 0 0	57600	0 0 0 0 0 1 1 0
2400	0 0 0 0 0 0 0 1	115200	0 0 0 0 0 1 1 1
4800	0 0 0 0 0 0 1 0		
9600	0 0 0 0 0 0 1 1		
19200	0 0 0 0 0 1 0 0		
38400	0 0 0 0 0 1 0 1		

1.1.5   Radio Data Rate

<div align="center">

PARAM = 0 1 0 1   Default = 0 0 0 0 0 0 0 1

</div>

To select or change the radio data rate, enter the following VALUE code. The radio data rate should be the same at each 405U module in the same system. The default value is 4800 bits/sec.

Radio Data Rate (bits/sec)	VALUE	Radio Data Rate (bits/sec)	VALUE
19200	0 0 0 0 0 0 1 1	115200	0 0 0 0 0 0 0 1
57600	0 0 0 0 0 0 1 0		

1.1.6   Transmit Hold-off Time

<div align="center">

PARAM = 1 1 0 0   Default = 0 0 1 0 1 0 0 0

</div>

A delay time may be configured such that the 405U unit will not transmit during the hold-off time after transmitting a previous message. The maximum hold-off time is 255 msec. The transmit hold-off time value is the 8-bit binary equivalent of the desired time in 1 msec increments. Hence for a desired hold-off time of 10 msec, a VALUE code of ten (00001010) is entered.   For the maximum time of 255 msec, a VALUE code of 255 (11111111) is entered. The default tail time is 40 msec. Appendix B lists the 8-bit patterns for each value between 0 and 255.

1.1.7 Receive Hold-off Time

PARAM = 1 1 0 1   Default = 0 0 0 1 0 1 0 0

A delay time may be configured such that the 405U unit will not transmit a message during the hold-off time after receiving a message. The maximum hold-off time is 255 msec. The receive hold-off time value is the 8-bit binary equivalent of the desired time in 1 msec increments. Hence for a desired hold-off time of 10 msec, a VALUE code of ten (00001010) is entered. For the maximum time of 255 msec, a VALUE code of 255 (11111111) is entered. The default tail time is 20 msec. Appendix B lists the 8-bit patterns for each value between 0 and 255.

1.1.8 Character Type

PARAM = 1 0 0 1   Default = 0 0 0 0 0 1 0 0

To select or change the data character type, enter the following VALUE code. The character type should match the type of data handled by the host device connected to that 405U module. The character type is normally the same at each 405U module in the same system.

The Character Type parameter configures both the character format and the flow control on the serial port. The character format comprises the number of data bits, start bits, and parity configuration. The serial port flow control may be configured to enable or disable RTS/CTS control. In all RS-485 applications and some RS-232 applications, RTS/CTS control must be disabled.

The default type is 8 data bits, 1 start bit, 1 stop bit, no parity, with disabled RTS/CTS.

NOTE: These values are valid for software Versions 1.11 or later, with configurations requiring DTR Low Power Mode only. Modules requiring DTR Normal Power Mode will need to be configured using Register S9 - Character Type.

Data Bits	Start Bits	Stop Bits	Parity	CTS/ RTS control	VALUE
8	1	1	none	Enabled	0 0 0 0 0 0 0 0
8	1	1	even	Enabled	0 0 0 0 0 0 0 1
8	1	1	odd	Enabled	0 0 0 0 0 0 1 0
7	1	2	none	Enabled	0 0 0 0 0 0 1 1
7	1	1	even	Enabled	0 0 0 0 1 0 0 0
7	1	1	odd	Enabled	0 0 0 0 1 0 0 1
8	1	2	none	Enabled	0 0 0 0 1 0 1 0
7	1	2	even	Enabled	0 0 0 0 1 0 1 1
7	1	2	odd	Enabled	0 0 0 1 0 0 0 0
8	1	1	none	Disabled	0 0 0 0 0 1 0 0
8	1	1	even	disabled	0 0 0 0 0 1 0 1
8	1	1	odd	disabled	0 0 0 0 0 1 1 0
7	1	2	none	disabled	0 0 0 0 0 1 1 1

Data Bits	Start Bits	Stop Bits	Parity	CTS/ RTS control	VALUE
7	1	1	even	disabled	0 0 0 0 1 1 0 0
7	1	1	odd	disabled	0 0 0 0 1 1 0 1
8	1	2	none	disabled	0 0 0 0 1 1 1 0
7	1	2	even	disabled	0 0 0 0 1 1 1 1
7	1	2	odd	disabled	0 0 0 1 0 1 0 0

1.1.9 Connect Update Time

PARAM = 1 1 1 0   Default = 0 1 1 0 0 1 0 0

In controlled mode, the 405U unit will transmit a "connect" message if there has been no activity on the radio channel for the update time. The connect update time value is the 8-bit binary equivalent of the desired time in 0.1 minute increments. Hence for a desired hold-off time of 1 minute, a VALUE code of ten (00001010) is entered. For the maximum time of 25.5 minutes, a VALUE code of 255 (11111111) is entered. The default update time is 10 minutes. Appendix B lists the 8-bit patterns for each value between 0 and 255.

1.1.10 Reset to Factory Default Settings

The following switch pattern will reset the configurations to the factory default values. Note that this also includes the original factory set system address.

1	1	0	0	0	0	0	0

0	0	0	0	0	0	0	0
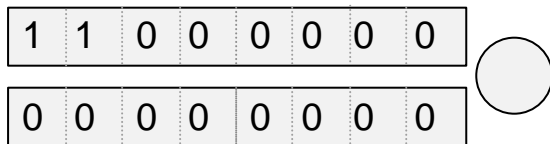
- Enter the code with and press button until *Serial RX* LED indicates RED.

1.2   Configuration Example

Transparent Mode

Extending a PLC Network

DATA = 7 DATA BITS, 1 START, 2 STOP, EVEN PARITY.
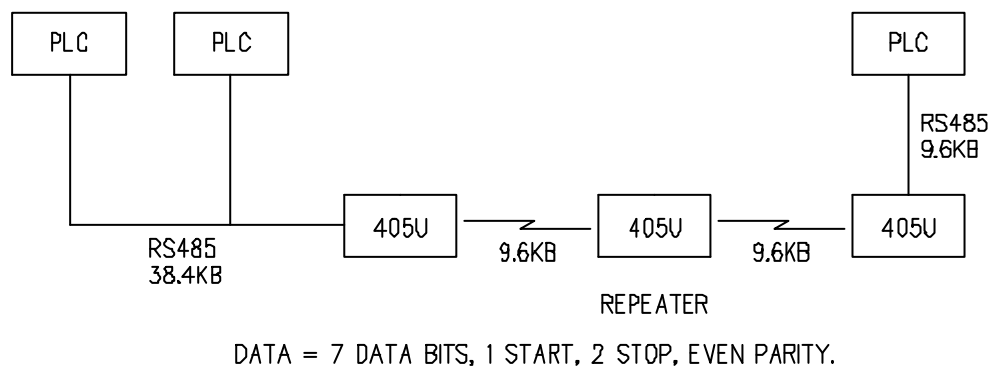
Unit No. 1 Configuration

0	0	0	1	0	1	0	1
0	0	0	1	0	1	0	1

- Set the System Address
- Press the red button for approx. 3 seconds - until the *Serial RX* LED indicates RED.

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

- Configuration mde will automatically exit as Transparent Mode

1	0	0	0	0	1	0	0
0	0	0	0	1	0	1	0

- Set serial data rate to 38400 bits/sec and press button until *RX* LED lights.

1	0	0	0	0	1	0	1
0	0	0	0	0	0	1	1

- Set radio data rate to 9600 bits/sec and press button until *RX* LED lights.

1	0	0	0	1	0	0	1
0	0	0	0	0	1	1	1

- Set the character type to 7,1,2,E, disabled control, and press button until *RX* LED lights.

  Note that as RS485 is used, the CTS/RTS control is disabled.

Repeater Configuration

0	0	0	1	0	1	0	1
0	0	0	1	0	1	0	1

- Set the System Address
- Press the red button for approx. 3 seconds - until the *RX* LED comes on.

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

- Configuration mde will automatically exit as Transparent Mode

1	0	0	0	0	0	0	0
0	0	0	0	1	0	0	0

- Set Operating Mode to Transparent Repeater and press button until *RX* LED lights.

Unit No. 2 Configuration

0	0	0	1	0	1	0	1
0	0	0	1	0	1	0	1

- Set the System Address
- Press the red button for approx. 3 seconds - until the *RX* LED comes on.

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

- Configuration mde will automatically exit as Transparent Mode

1	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0

- Set serial data rate to 9600 bits/sec and press button until *RX* LED lights.

1	0	0	0	0	1	0	1
0	0	0	0	0	0	1	1

- Set radio data rate to 9600 bits/sec and press button until *RX* LED lights.

| 1	0	0	0	1	0	0	1
0	0	0	0	0	1	1	1

- Set the character type to 7,1,2,E, disabled control, and press button until *RX* LED lights.

  Note that as RS485 is used, the CTS/RTS control is disabled.

Appendix B   DECIMAL TO BINARY TABLE

VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN
0	0 0 0 0 0 0 0 0	38	0 0 1 0 0 1 1 0	76	0 1 0 0 1 1 0 0
1	0 0 0 0 0 0 0 1	39	0 0 1 0 0 1 1 1	77	0 1 0 0 1 1 0 1
2	0 0 0 0 0 0 1 0	40	0 0 1 0 1 0 0 0	78	0 1 0 0 1 1 1 0
3	0 0 0 0 0 0 1 1	41	0 0 1 0 1 0 0 1	79	0 1 0 0 1 1 1 1
4	0 0 0 0 0 1 0 0	42	0 0 1 0 1 0 1 0	80	0 1 0 1 0 0 0 0
5	0 0 0 0 0 1 0 1	43	0 0 1 0 1 0 1 1	81	0 1 0 1 0 0 0 1
6	0 0 0 0 0 1 1 0	44	0 0 1 0 1 1 0 0	82	0 1 0 1 0 0 1 0
7	0 0 0 0 0 1 1 1	45	0 0 1 0 1 1 0 1	83	0 1 0 1 0 0 1 1
8	0 0 0 0 1 0 0 0	46	0 0 1 0 1 1 1 0	84	0 1 0 1 0 1 0 0
9	0 0 0 0 1 0 0 1	47	0 0 1 0 1 1 1 1	85	0 1 0 1 0 1 0 1
10	0 0 0 0 1 0 1 0	48	0 0 1 1 0 0 0 0	86	0 1 0 1 0 1 1 0
11	0 0 0 0 1 0 1 1	49	0 0 1 1 0 0 0 1	87	0 1 0 1 0 1 1 1
12	0 0 0 0 1 1 0 0	50	0 0 1 1 0 0 1 0	88	0 1 0 1 1 0 0 0
13	0 0 0 0 1 1 0 1	51	0 0 1 1 0 0 1 1	89	0 1 0 1 1 0 0 1
14	0 0 0 0 1 1 1 0	52	0 0 1 1 0 1 0 0	90	0 1 0 1 1 0 1 0
15	0 0 0 0 1 1 1 1	53	0 0 1 1 0 1 0 1	91	0 1 0 1 1 0 1 1
16	0 0 0 1 0 0 0 0	54	0 0 1 1 0 1 1 0	92	0 1 0 1 1 1 0 0
17	0 0 0 1 0 0 0 1	55	0 0 1 1 0 1 1 1	93	0 1 0 1 1 1 0 1
18	0 0 0 1 0 0 1 0	56	0 0 1 1 1 0 0 0	94	0 1 0 1 1 1 1 0
19	0 0 0 1 0 0 1 1	57	0 0 1 1 1 0 0 1	95	0 1 0 1 1 1 1 1
20	0 0 0 1 0 1 0 0	58	0 0 1 1 1 0 1 0	96	0 1 1 0 0 0 0 0
21	0 0 0 1 0 1 0 1	59	0 0 1 1 1 0 1 1	97	0 1 1 0 0 0 0 1
22	0 0 0 1 0 1 1 0	60	0 0 1 1 1 1 0 0	98	0 1 1 0 0 0 1 0
23	0 0 0 1 0 1 1 1	61	0 0 1 1 1 1 0 1	99	0 1 1 0 0 0 1 1
24	0 0 0 1 1 0 0 0	62	0 0 1 1 1 1 1 0	100	0 1 1 0 0 1 0 0
25	0 0 0 1 1 0 0 1	63	0 0 1 1 1 1 1 1	101	0 1 1 0 0 1 0 1
26	0 0 0 1 1 0 1 0	64	0 1 0 0 0 0 0 0	102	0 1 1 0 0 1 1 0
27	0 0 0 1 1 0 1 1	65	0 1 0 0 0 0 0 1	103	0 1 1 0 0 1 1 1
28	0 0 0 1 1 1 0 0	66	0 1 0 0 0 0 1 0	104	0 1 1 0 1 0 0 0
29	0 0 0 1 1 1 0 1	67	0 1 0 0 0 0 1 1	105	0 1 1 0 1 0 0 1
30	0 0 0 1 1 1 1 0	68	0 1 0 0 0 1 0 0	106	0 1 1 0 1 0 1 0
31	0 0 0 1 1 1 1 1	69	0 1 0 0 0 1 0 1	107	0 1 1 0 1 0 1 1
32	0 0 1 0 0 0 0 0	70	0 1 0 0 0 1 1 0	108	0 1 1 0 1 1 0 0
33	0 0 1 0 0 0 0 1	71	0 1 0 0 0 1 1 1	109	0 1 1 0 1 1 0 1
34	0 0 1 0 0 0 1 0	72	0 1 0 0 1 0 0 0	110	0 1 1 0 1 1 1 0
35	0 0 1 0 0 0 1 1	73	0 1 0 0 1 0 0 1	111	0 1 1 0 1 1 1 1
36	0 0 1 0 0 1 0 0	74	0 1 0 0 1 0 1 0	112	0 1 1 1 0 0 0 0
37	0 0 1 0 0 1 0 1	75	0 1 0 0 1 0 1 1	113	0 1 1 1 0 0 0 1

VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN
114	0 1 1 1 0 0 1 0	151	1 0 0 1 0 1 1 1	188	1 0 1 1 1 1 0 0
115	0 1 1 1 0 0 1 1	152	1 0 0 1 1 0 0 0	189	1 0 1 1 1 1 0 1
116	0 1 1 1 0 1 0 0	153	1 0 0 1 1 0 0 1	190	1 0 1 1 1 1 1 0
117	0 1 1 1 0 1 0 1	154	1 0 0 1 1 0 1 0	191	1 0 1 1 1 1 1 1
118	0 1 1 1 0 1 1 0	155	1 0 0 1 1 0 1 1	192	1 1 0 0 0 0 0 0
119	0 1 1 1 0 1 1 1	156	1 0 0 1 1 1 0 0	193	1 1 0 0 0 0 0 1
120	0 1 1 1 1 0 0 0	157	1 0 0 1 1 1 0 1	194	1 1 0 0 0 0 1 0
121	0 1 1 1 1 0 0 1	158	1 0 0 1 1 1 1 0	195	1 1 0 0 0 0 1 1
122	0 1 1 1 1 0 1 0	159	1 0 0 1 1 1 1 1	196	1 1 0 0 0 1 0 0
123	0 1 1 1 1 0 1 1	160	1 0 1 0 0 0 0 0	197	1 1 0 0 0 1 0 1
124	0 1 1 1 1 1 0 0	161	1 0 1 0 0 0 0 1	198	1 1 0 0 0 1 1 0
125	0 1 1 1 1 1 0 1	162	1 0 1 0 0 0 1 0	199	1 1 0 0 0 1 1 1
126	0 1 1 1 1 1 1 0	163	1 0 1 0 0 0 1 1	200	1 1 0 0 1 0 0 0
127	0 1 1 1 1 1 1 1	164	1 0 1 0 0 1 0 0	201	1 1 0 0 1 0 0 1
128	1 0 0 0 0 0 0 0	165	1 0 1 0 0 1 0 1	202	1 1 0 0 1 0 1 0
129	1 0 0 0 0 0 0 1	166	1 0 1 0 0 1 1 0	203	1 1 0 0 1 0 1 1
130	1 0 0 0 0 0 1 0	167	1 0 1 0 0 1 1 1	204	1 1 0 0 1 1 0 0
131	1 0 0 0 0 0 1 1	168	1 0 1 0 1 0 0 0	205	1 1 0 0 1 1 0 1
132	1 0 0 0 0 1 0 0	169	1 0 1 0 1 0 0 1	206	1 1 0 0 1 1 1 0
133	1 0 0 0 0 1 0 1	170	1 0 1 0 1 0 1 0	207	1 1 0 0 1 1 1 1
134	1 0 0 0 0 1 1 0	171	1 0 1 0 1 0 1 1	208	1 1 0 1 0 0 0 0
135	1 0 0 0 0 1 1 1	172	1 0 1 0 1 1 0 0	209	1 1 0 1 0 0 0 1
136	1 0 0 0 1 0 0 0	173	1 0 1 0 1 1 0 1	210	1 1 0 1 0 0 1 0
137	1 0 0 0 1 0 0 1	174	1 0 1 0 1 1 1 0	211	1 1 0 1 0 0 1 1
138	1 0 0 0 1 0 1 0	175	1 0 1 0 1 1 1 1	212	1 1 0 1 0 1 0 0
139	1 0 0 0 1 0 1 1	176	1 0 1 1 0 0 0 0	213	1 1 0 1 0 1 0 1
140	1 0 0 0 1 1 0 0	177	1 0 1 1 0 0 0 1	214	1 1 0 1 0 1 1 0
141	1 0 0 0 1 1 0 1	178	1 0 1 1 0 0 1 0	215	1 1 0 1 0 1 1 1
142	1 0 0 0 1 1 1 0	179	1 0 1 1 0 0 1 1	216	1 1 0 1 1 0 0 0
143	1 0 0 0 1 1 1 1	180	1 0 1 1 0 1 0 0	217	1 1 0 1 1 0 0 1
144	1 0 0 1 0 0 0 0	181	1 0 1 1 0 1 0 1	218	1 1 0 1 1 0 1 0
145	1 0 0 1 0 0 0 1	182	1 0 1 1 0 1 1 0	219	1 1 0 1 1 0 1 1
146	1 0 0 1 0 0 1 0	183	1 0 1 1 0 1 1 1	220	1 1 0 1 1 1 0 0
147	1 0 0 1 0 0 1 1	184	1 0 1 1 1 0 0 0	221	1 1 0 1 1 1 0 1
148	1 0 0 1 0 1 0 0	185	1 0 1 1 1 0 0 1	222	1 1 0 1 1 1 1 0
149	1 0 0 1 0 1 0 1	186	1 0 1 1 1 0 1 0	223	1 1 0 1 1 1 1 1
150	1 0 0 1 0 1 1 0	187	1 0 1 1 1 0 1 1	224	1 1 1 0 0 0 0 0
225	1 1 1 0 0 0 0 1	236	1 1 1 0 1 1 0 0	247	1 1 1 1 0 1 1 1
226	1 1 1 0 0 0 1 0	237	1 1 1 0 1 1 0 1	248	1 1 1 1 1 0 0 0
227	1 1 1 0 0 0 1 1	238	1 1 1 0 1 1 1 0	249	1 1 1 1 1 0 0 1
228	1 1 1 0 0 1 0 0	239	1 1 1 0 1 1 1 1	250	1 1 1 1 1 0 1 0
229	1 1 1 0 0 1 0 1	240	1 1 1 1 0 0 0 0	251	1 1 1 1 1 0 1 1

VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN	VALUE	8 BIT PATTERN
230	1 1 1 0 0 1 1 0	241	1 1 1 1 0 0 0 1	252	1 1 1 1 1 1 0 0
231	1 1 1 0 0 1 1 1	242	1 1 1 1 0 0 1 0	253	1 1 1 1 1 1 0 1
232	1 1 1 0 1 0 0 0	243	1 1 1 1 0 0 1 1	254	1 1 1 1 1 1 1 0
233	1 1 1 0 1 0 0 1	244	1 1 1 1 0 1 0 0	255	1 1 1 1 1 1 1 1
234	1 1 1 0 1 0 1 0	245	1 1 1 1 0 1 0 1		
235	1 1 1 0 1 0 1 1	246	1 1 1 1 0 1 1 0		