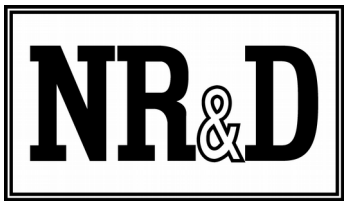
UCM2 Programming Manual

Installation and Programming Manual

This line describes the purpose of the manual. It and the "Document Tltle" can be modified by selecting File/Properties...

Effective: May 29, 2015



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1 UCM2 Programing Overview

The user programs that run in the UCM2 are known as Applications. Applications are written in the UCM2 language with a text editor, compiled with the QCOMPILE program, and downloaded into the UCM2 to run. The UCM2 allows up to two Applications to run at the same time. Each Application has its own separate memory for variables as well as shared access to the PLC Rack I/O interface via the INPUT[x] registers and the OUTPUT[x] registers. Applications may be divided into multiple THREADs which multitask within the Application. Up to sixty four THREADs may be written into an Application.

The Application has full access to the serial ports, the optional Ethernet port, LCD, Keypad, and as mentioned above the PLC I/O registers. Communication messages are sent from an Application using the TRANSMIT statement and are received with the ON RECEIVE statement. Built-in functions for calculating check-sums are provided. The general outline for a UCM2 application is shown below:

{Comments}

DECLARE global_variables

FUNCTIONS

{general startup configuration code}

THREAD 1

DECLARE local_variables

{thread 1 application code as an endless loop}

THREAD 2

DECLARE local_variables

{thread 2 application code as an endless loop}

Application code located before thread 1 is processed first as the application starts and then all threads start at the same time. Declares located before thread 1 are global and accessible in any of the threads. Declares within a thread are local only to that thread.

Warning: Applications that serve up web pages from the Quantum back-plane may be in violation of the following patents:

1. Patent no. 5,805,442
2. Patent no. 5,975,737
3. Patent no. 5,982,362
4. Patent no. 6,061,603
5. Patent no. 6,282,454

If you are writing an application that serves up web pages, you should contact Schneider Automation before proceeding.

2 UCM2 Language Definitions

The UCM2 language is its own unique structured language, although the user will probably notice similarities with BASIC, PASCAL, and C. Labels are used to control program flow. Line numbers are not required. The following definitions apply through this manual:

Constant Data Representation <const>

If numeric data is to remain the same during the entire operation of the UCM2 program then they should be treated as constants. The UCM2 supports unsigned decimal integers (16 bits), signed decimal integers, hexadecimal integers, long integers (32 bit), floating point numbers (32 bit), boolean constants, and a few reserved constants. The use of a constant is referred to as <const> in this manual.

Table 2-1: Constant Data Types

Constant Data Type	Range	Prefix Symbol
Decimal	0...65,535	NA
Signed Integer	32768...32767	NA
Hexadecimal Integer	0...FFFF	x
Long Integers	0...4294967295	NA
Floating Point	8.43 x 10E37...3.402 x 10E38	
Boolean Constants	TRUE, FALSE	NA
Reserved Constants	EVEN,ODD,NONE	NA

Decimal Integers

Decimal integers are defined as the unsigned whole numbers within the range from 0 through 65,535. The following are examples of decimal integers:

0

32114

59

65311

Signed Integers

Signed integers are defined as the whole numbers within the range from -32768 through 32767. The following are examples of signed integers.

-514

0

31

-1

Hexadecimal Integers

Hexadecimal integers are defined as the hexadecimal representation of the whole numbers within the range from 0 through FFFF. Hexadecimal numbers are defined by the prefix x. The following are examples of hexadecimal constants:

x12AB

xf34c

x15

Boolean Constants

There are two predefined boolean constants: TRUE and FALSE. The following are valid uses of the boolean constants:

SET CAPITALIZE FALSE

SET DEBUG TRUE

Floating Point Numbers

Floating point constants must end with a decimal point and at least one decimal place. The following are valid floating point examples:

-1.0

3.14159

2.5E-11

Reserved Constants

The following constants are reserved for the use in the SET PARITY statement: EVEN, ODD, and NONE. The following are valid uses of the reserved constants:

SET PARITY EVEN

SET PARITY ODD

SET PARITY NONE

Variable Data Representation

The UCM2 uses alpha-numeric names for variables and each variable must be expliciately declared using the DECLARE statement. The possible variable types supported by the UCM2 are listed below:

- BYTE (8 bits signed)
- UNSIGNED BYTE (8 bits unsigned)
- WORD (16 bits signed)
- UNSIGNED WORD (16 bits unsigned)
- LONG (32 bits signed)
- TIMER (32 bits signed)
- FLOAT (32 bits signed)
- STRING (an array of 8 bit bytes)
- SOCKET (Ethernet IP socket)

If a type is not included in the DECLARE then the type defaults to a SIGNED WORD. It is also possible to define single dimensional arrays of variables using the form variable[size], and two-dimensional arrays using the form variable[Asize, Bsize]. Valid array indices for array[N] are 0..(N-1). Multiple variables may be declared on a single statement with commas as separators. The following statements are valid DECLARE examples:

DECLARE BYTE apple

DECLARE WORD x, y, zebra

DECLARE WORD r[100], group[10]

DECLARE SOCKET s[8], mysock

DECLARE STRING in[25]

DECLARE WORD a, b, c FLOAT x, y, z {the , after the c is optional. a, b, and c are words and x, y, and z are floats.}

There are two predefined arrays of words that are fixed and reserved: INPUT[x] and OUTPUT[x]. The INPUT[x] array ranges from index 0 through 31 inclusive and refers to the 32 possible PLC input (3x) registers on the backplane. These words are PLC Read-Only and may be modified only by the UCM2 applciations. The OUTPUT[x] array ranges from index 0 through 2015. Index values 0 through 31 are reserved for the 32 possible PLC OUTPUTs (4x registers) and are Read-Only to the UCM2 applications. OUTPUT[32] through OUTPUT[2015] are Read/Write by the UCM2 Applications. The OUTPUT and INPUT variables are global to Applications and all Threads within the Application. Variables declared before the first THREAD statement are global to a given Application. Variables declared within a THREAD are local to that Thread.

Arithmetic Expressions <expr>

Numeric expressions, referred as <expr> in this manual, involve the operation of variables and constants through a precedence of operators and functions.

Numeric Operators

Table 2-2: Numeric Operators

Numeric Operators	Description	Eample
+	Addition	x+5
-	Subtraction	OUTPUT[10]-5
*	Multiplication	Apple*5
/	Divison	Z/5
%	Modulus	OUTPUT[25]%5
&	Bitwise AND	OUTPUT[25]&x100
|	Bitwise OR	OUTPUT[25]|x100
^	Bitwise Exclusive OR	INPUT[25}^x100
>>	Bitwise Shift Right	BYTE>>4
<<	Bitwise Shift Left	I<<2
-	Unary Negation	-OUTPUT[25]
~	Unary Bitwise Complement	~OUTPUT[25]
()	Parentheses	(OUTPUT[25]+5)*3

Precedence of Operators

The order of precedence of supported numeric operators are as follows:

1. Sub expressions enclosed in parentheses
2. Unary Negation or Unary Complement
3. *, /, % From left to right within the expression.
4. +, From left to right within the expression.
5. <<, >> From left to right within the expression.
6. &, ^, | From left to right within the expression.

Numeric Functions

The UCM2 supports a group of seven checksum calculating functions to be used

only within message descriptions:

Table 2-3: Checksum Functions

Function	Description
CRC(<expr>,<expr>,<expr>)	Cyclical Redundancy Check (CCITT Standard)
CRC16(<expr>,<expr>,<expr>)	Cyclical Redundancy Check
CRCAB(<expr>,<expr>,<expr>)	Special CRC16 for AB applications
CRCBOB(<expr>,<expr>,<expr>)	Special CRC16 for BinMaster SmartBob applications
CRCDNP(<expr>,<expr>,<expr>)	Special CRC16 for DNP 3.00 applications
LRC(<expr>,<expr>,<expr>)	Longitudinal Redundancy Check by byte
LRCW(<expr>,<expr>,<expr>)	Longitudinal Redundancy Check by word
SUM(<expr>,<expr>,<expr>)	Straight Sum by byte
SUMW(<expr>,<expr>,<expr>)	Straight Sum by word

The first <expr> is the starting index. The next <expr> is the ending index. The last <expr> is the initial value usually 0 or 1.

These additional functions are also provided:

Table 2-4: Additional Functions

Function	**Description**	**Example OUTPUT[45]=x1234, OUTPUT[46]=xABCD**
MIN(<expr>,<expr>)	Provides a result of the <expr> which evaluates to the smaller of the two expressions.	OUTPUT[100] = MIN(OUTPUT[45],OUTPUT[46]) results in OUTPUT[100] = x1234
MAX(<expr>,<expr>)	Provides a result of the <expr> which evaluates to the larger of the two expression.	OUTPUT[100] = MAX(R[45]*x0A,OUTPT[47]) results in OUTPUT[100] = x65E0
SWAP(<expr>)	Reversed the byte order of the register.	OUTPUT[100] = SWAP(OUTPUT[46]) results in OUTPUT[100] = xCDAB

Labels <label>

The UCM2 supports alphanumeric labels for targets of GOTO and GOSUB functions. The label consists of a series of characters ended with a colon. Labels must start with an alphabetic character, numbers are not allowed as the first character in a Label. Labels may not be the exact characters in a UCM2 language reserved word. The label TIMEOUTLoop: is valid while TIMEOUT: is not valid.

Logical Expressions <logical>

The UCM2 supports the following logical operators and relational operators. These are referred to as <logical> elsewhere in this manual.

Logical Operators

Table 2-5: Logical Operators

Logical Operators	Definition	Example
AND	Result TRUE if both TRUE	IF <expr> AND <expr> THEN
OR	Result TRUE if one or both TRUE	IF <expr> OR <expr> THEN
NOT	Inverts the expression	IF NOT(<expr>) THEN

Relational Operators

Table 2-6: Relational Operators

Relational Operators	Definition	Example
<	LESS THAN	IF <expr> < <expr> THEN
>	GREATER THAN	IF <expr> > <expr> THEN
<=	LESS THAN or EQUAL	IF <expr> <= <expr> THEN
>=	GREATER THAN or EQUAL	IF <expr> >= <expr> THEN
=	EQUAL	IF <expr> = <expr> THEN
<>	NOT EQUAL	IF <expr> <> <expr> THEN

Functions - <function>

Functions are general purpose sections of code that may be accessed from multiple threads and other functions in an application. Functions are similar to a subroutine where the parameters are passed to/from the function during the call.

Memory for variables declared within a function are allocated when the function is called, and the memory is freed when the function exits. Variable names within a function can have the same name as global or thread local variables. When a variable is referenced within a function, the compiler checks first for function local variables, then for thread local variables, then for global variables by that name.

NOTE: At the present time, only "word" variables may be passed as parameters to functions. If the function must process long, byte, string, float, or arrays then they must be declared as global.

FUNCTION <function name> <comma separated variable list>

(function body)

ENDFUNC <returned variable list>

```
FUNCTION AVERAGE ( VALUE1, VALUE2 )
        DECLARE WORD RETURNVALUE
        RETURNVALUE = ( VALUE1 + VALUE2) / 2
ENDFUNC( RETURNVALUE )
```

or

```
FUNCTION SQUARE ( VALUE)
ENDFUNC ( VALUE * VALUE)
```

Message Descriptions <message description>

The <message description> refers to the actual serial data that is transmitted from the UCM2 port or expected data that is to be received by the port. The <message description> may include literal strings, results of various message functions and the concatenation of the above.

Literal String <string>

A literal string is a string enclosed in quotes. "This is a literal string."

Literal strings may include hexadecimal characters by form \xx where xx is the two digit hex number of the character. This is useful for sending non-printable characters. "This is another literal string.\0D\0A" will print the message with a carriage return (0D) and a line feed (0A).

Embedded quotation marks may be included in literal strings by the insertion of \" in the location of the embedded quote. "This will print a \"quote\" here."

Embedded \ characters may similarly be inserted by using \\.

String Variables

String variables may be embedded directly into a message description:

```
DECLARE STRING ALPHA[ 20]
ALPHA = "ABC123"
TRANSMIT PORT 1 "=BEFORE=":ALPHA:"=AFTER="
```

would send the string =BEFORE=ABC123=AFTER= out serial port 1. Similarly, string variables may be embedded directly into ON RECEIVE statements:

```
ON RECEIVE PORT 1 ALPHA:"\0D" GOTO NEXT
```

would place all characters received before the Carriage Return (0x0D) into the string variable ALPHA. Care must be taken to ensure that the data read into the string is not longer than the string declaration. For instance, if the above ON RECEIVE were to attempt to put 21 characters into ALPHA, which was declared with a length of 20 bytes, the program would halt, with runtime stop code 7

(Value out of bounds).

Message Functions

The UCM2 can perform a variety of functions on transmitted and received data. When the UCM2 is using these functions for transmitting, register data and expressions are turned into strings according to the function's rules. When the UCM2 is using these functions for receiving, incoming strings are either matched to the strings that the UCM2 expected to receive or they are translated into data and stored in registers.

The following is a list of message functions, each function is described in more detail on pages 45 through 51.

Table 2-7: Message Functions

Functions	Description
BCD(<expr>)	Binary Coded Decimal conversion
BYTE(<expr>)	Least Significant (low) byte conversion
DEC(<expr>,<expr>)	Decimal conversion (base 10) 32768 to 32767
HEX(<expr>,<expr>)	Hexadecimal conversion (base 16)
IDEC(<expr>,<expr>)	IDEC format hexadecimal conversion
OCT(<expr>,<expr>)	Octal conversion (base 8)
RAW(<variable>,<expr>)	Sends/Receives high byte then low byte of a register(s)
RWORD(<expr>)	Sends/Receives low byte of an expression
UNS(<expr>,<expr>)	Unsigned decimal conversion (base 10) 0 to 65,535
WORD(<expr>)	Sends/Receives high byte then low byte of an expression

The message functions that take the form *FUNC*(<expr>,<expr>) use the following rules: When using these functions with TRANSMIT, the first <expr> is the data to be translated and transmitted. When using these functions with ON RECEIVE, replace the first <expr> with <variable> to have the incoming string translated and placed into the register OUTPUT[] or use (<expr>) to have the expression evaluated and matched to the incoming string. The second <expr> in the these functions is the number of characters either to transmit or to receive. An error will be generated at compile or run time if this expression evaluates to less

than zero.

RAW takes the form RAW(<variable>,<expr>). In this case the first <expr> is the starting register number and the second <expr> is the number of characters. Always uses the high byte first and then the low byte.

The message functions that take the form *FUNC*(<expr>) have fixed character lengths. BYTE transmits one character, the least significant byte, while WORD and RWORD each transmit two characters. WORD transmits the most significant byte and then the least significant byte while RWORD reverses the order, least significant then most significant. As in the previous message functions, when transmitting use <expr> and when receiving either use <variable> to receive and place in a register or (<expr>) to evaluate and match. For examples of the message functions see Chapter 5 Examples.

In all of the message functions, only characters from the valid character set for that command can be used.

Variable Fields

The width field of any transmit or receive element (that has a width) may be replaced with either of two constructions. (Transmit RAW is an exception as shown below.) The first is just the word VARIABLE, i.e. TRANSMIT DEC(OUTPUT[10],VARIABLE). The second is VARIABLE followed by a register reference, i.e. TRANSMIT HEX(OUTPUT[11],VARIABLE OUTPUT[10]) which will write the actual width to the specified register.

Transmit usage of Variable length

A variable field in a TRANSMIT statement means one encoded with only the necessary number of digits (no leading zeros).

For example, if OUTPUT[11] = 1234 then

TRANSMIT PORT 1 "$":DEC(OUTPUT[11], variable OUTPUT[10]):"#"

would send out the string $1234# and OUTPUT[10] would have the value 4. If

OUTPUT[11] = 89 then the string $89# would be transmitted and OUTPUT[10] would equal 2.

This type of transmit structure applies to the BCD, UNS, DEC, HEX, OCT, and IDEC formats. The TRANSMIT RAW variable structure requires a terminator byte of 00 hex at the end of the raw string.

The transmit raw variable sends up to but not including the null terminator. The optional count register does not include the terminator in the count.

For example, if OUTPUT[11]=x486F, OUTPUT[12]=x7764, and OUTPUT[13]=x7900 then TRANSMIT PORT 1 "$":RAW(OUTPUT[11], VARIABLE OUTPUT[10]):"#" would send the string $Howdy# and OUTPUT[10] would equal 5. If OUTPUT[12]=x0000 then the string $Ho# would be transmitted and OUTPUT[10] would equal 2.

ON RECEIVE usage of Variable length

A variable field in an ON RECEIVE statement must be followed by a literal field such as "\0d". The first character of the literal field works as a terminator.

For example, A device sends a variable length number with a fixed number of decimal points such as $125.01 or $3.99; the decimal point may be used as a terminator and it could be handled as follows:

ON RECEIVE port 1 "$":dec(OUTPUT[100],variable):".":dec(OUTPUT[101],2)

In the case of $125.01, register OUTPUT[100] = 125 and OUTPUT[101] = 1. For $3.99, register OUTPUT[100] = 3 and OUTPUT[101] = 99.

The ON Receive raw variable writes an extra zero byte to the registers following the received data. In the case of an odd number of characters, the last register contains the final character in the MSB and a zero in the LSB. In the case of an even number of characters, all 16 bits of the register following the last two characters are set to zero. This null terminator is not included in the count optionally reported.

For example: A device transmits a variable length error message terminated with a carriage return and line feed.

ON RECEIVE port 1 RAW(OUTPUT[500], variable OUTPUT[200]):"\0d\0a" will accept the message and place it in packed ASCII form starting at register 500. Register 200 would hold the number of characters (bytes) accepted in the string not including the carriage return or line feed.

Message Assignments

It is sometimes convenient to apply the message descriptions of a TRANSMIT message and store the message in a variable in the UCM2 rather than transmit the string. This is possible by simply using the assignment character = to a string variable.

STRINGVARIABLE = <message>

The message will be placed in the string variable and the LENGTH of the string will be set to the number of character is <message>. Any valid transmit message may be stored in this manner.

For example:

STRINGVAR = "Hello!\0d\0a"

would result in the string STRINGVAR containing the string "Hello!\0d\0a" (where \0d and \0a are Carriage Return, and Line Feed, respectively).Something more obviously useful might be:

STRINGVAR =
byte(Device):"\03":word(Address):word(Count):rword(crc16(1,$1,0))

which would place the reversed word of the checksum in register at the end of the

string.

3 UCM2 Language Statements

The UCM2 language statements are described in this chapter. Statements control the operation of the UCM2 by determining the flow of the program.

The format of these statements includes the definitions from Chapter 2 UCM2 Language Definitions. Whenever one of these definitions is referenced in a statement it is enclosed in brackets <>. For example, whenever a statement requires an expression it will appear as <expr>. The words statement and command are used interchangeably.

The word *newline* means a carriage return, line feed or both, whatever your text editor requires. Most commands do not require newlines but those that do use the word *newline*. Since most commands do not requires newlines, multiple statements can be placed on a single line. A whole program could be written on a single line if no statements that require a *newline* are used. For readability, newlines between statements can be used without penalty.

Also note that, except in strings, capitalization in the UCM2 program is ignored by the UCM2 and its compiler. The label Tom: is the same as the label TOM:. In literal strings, which are enclosed in quotes "", the capitalization is maintained by the UCM2. The command SET CAPITALIZE can effect the way the UCM2 handles ASCII characters on transmitting and receiving.

Program flow within a THREAD is sequential, from the first statement to the second statement to the third statement etcetera, unless a program flow control statement is reached. Program flow statements can be jumps (GOTO or GOSUB), loops or conditionals (IF...THEN ...ELSE...ENDIF). After a jump, program flow is still sequential starting with the statement immediately after the label. Loops can be accomplished with FOR...NEXT, REPEAT ...UNTIL, or WHILE...WEND.

Assignments

The UCM2 language allows for the assignment of values to variables and bits of variables. These assignments are similar to the BASIC LET statement.

variable[<expr>]=<expr>

This statement sets the variable specified by the first <expr> to the value obtained by the second <expr>. The valid range of variable numbers in the first <expr> is dependent upon the DECLARED range of the variable.

variable[<expr>].<const>=<logical>

This statement sets a single bit of a variable to be one (TRUE) or zero (FALSE). The <expr> can have the values defined by the DECLARE of the variable. The valid values for <const> depend on the type of <Expr> (see Table 3-1, below). <Logical> can have the values TRUE or FALSE.

Table 3-1: Referencing Bits in Different Variable Types

Variable Type	Range of Bits	Bit Significance
OUTPUT[N] and INPUT[N]	1...16	Modicon Bit Numbering: Most Significant Bit (MSB) = Bit 1 … LSB = Bit 16
BYTE	0...7	IEC Compliant Bit numbering: MSB = Bit 7 ... LSB = Bit 0
WORD	0...15	IEC Compliant Bit numbering: MSB = Bit 15 ... LSB = Bit 0
LONG, TIMER	0...31	IEC Compliant Bit numbering: MSB = Bit 31 ... LSB = Bit 0

<variable>.(<expr>)=<logical>

This statement sets the bit of a register to be the evaluation of the <logical> segment.

<variable>.<variable>=<logical>

This statement sets the bit of a register to be the evaluation of the <logical> segment.

<variable>=<message description>

This statement sets the string variable specified by the <expr> to the ASCII values obtained by evaluation of the <message description>. The <message description> may be any valid message used in a TRANSMIT command.

BAUD

See **SET BAUD** on page 36.

CAPITALIZE

See **SET CAPITALIZE** on page 36.

CLEAR

CLEAR variable[<expr>].<const> or CLEAR variable[<expr>].(<expr>)

The CLEAR statement sets a single bit of a variable to ZERO. The bit number <const> or <expr> must evaluate within the range of 1-16 for OUTPUT registers, 0-7 for bytes, 0-15 for words, and 0-31 for long variables. To clear a single bit of a register to be set to one use the SET statement.

CLOSE

CLOSE SOCKET <socket variable> [TIMEOUT <expr>]

Closes the open IP connection associated with <socket variable>. The optional TIMEOUT specifies how long the UCM2 TCP/IP stack will wait for the other device to acknowledge the request to close the connection before aborting (resetting) the connection. If no TIMEOUT is specified, the UCM2 will wait indefinitely for the other device to acknowledge the close request. A TIMEOUT value of zero will cause the connection to be immediately closed, without the other devices' acknowledgment.

CONNECT

CONNECT <protocol> SOCKET <socket variable> <IP Address> PORT <port number>

Connect opens an IP connection using the <protocol> to the remote <IP Address> on the <portnumber>.

NOTE: Only <protocol>= TCP is presently supported.

The <IP Addresss> must be a comma separated decimal notation:

DECLARE SOCKET S, BYTE HOST[4]

HOST = 206,223,51,161

CONNECT TCP SOCKET S HOST PORT 80

would establish a connection to port 80 of the device with IP address 206.223.51.161.

DATA

See **SET DATA** on page 36.

DEBUG

See **SET DEBUG** on page 36.

DECLARE

DECLARE [SIGNED|UNSIGNED] [<variable type>} <variable name>[[array size]]

The DECLARE statement is a compiler instruction which creates a variable named <variable name> of type <variable type>. Variables may be declared anywhere in the program, as long as they are declared before they are referenced. Variables declared before the first THREAD statement will be global in scope, thus will be accessible to all the threads. Variables declared after a THREAD statement will be accessible only within the thread in which it was declared. Variables declared within a FUNCTION will be accessible only within that function.

If the SIGNED/UNSIGNED specification is omitted, the variable created will be SIGNED. If the <variable type> is omitted, a WORD variable will be created. Thus the statement:

DECLARE FOO

will create a variable named FOO, which is a signed word variable. Multiple variable types may be declared in one DECLARE statement:

DECLARE BAR, STRING A[40], B[30], FLOAT X, Y[10]

would create five variables: BAR is a signed word, A is a string with maximum length of 40 bytes, B is a string with a maximum length of 30 bytes, X is a floating point variable, and Y is an array of ten floating point variables (Y[0] … Y[9]).

When a variable is referenced (i.e. Y[0] = 0.0), the compiler first checks whether the variable is a function local variable (if the statement is inside a function), then checks whether the variable is a thread local variable (if the statement is multi-threaded, and the statement appears after a THREAD statement), then checks whether the variable was defined as a global variable. Thus, the same variable name may be used in different threads, and each thread will access a different variable.

The available <variable types> are:

Table 3-2: Declared Variable Types

Variable Type	Description	Bytes Used	Range
UNSIGNED BYTE	Unsigned Byte (8bit) variable.	1	0...255
SIGNED BYTE	Signed Byte (8bit) variable.	1	-128…127
UNSIGNED WORD	Unsigned Word (16bit) variable.	2	0...65535
SIGNED WORD	Signed Word (16bit) variable	2	-32768...32767
UNSIGNED LONG, TIMER	Unsigned Long Word (32bit) variable.	4	0...4294967296
SIGNED LONG	Signed Long Word (32bit) variable.	4	-2147483648...2147483647
FLOAT	IEEE format 32bit Floating Point variable. Float variables are always signed.	4	
STRING	String variable. Must be declared as an array: DECLARE STRING A[40]	2 + String Length	Strings in the UCM2 are NOT zero-terminated, thus each byte may contain ANY value, including zero.
SOCKET	Socket structures are used for TCP Ethernet connections. Values in the structure are not directly accessible, except through statements (CONNECT, LISTEN, TRANSMIT, ON RECEIVE) and functions (SOCKETSTATE ()).	1538	

DEFINE

DEFINE <macro>=<replacement string> *newline*

The DEFINE statement is a compiler instruction for a global find and replace. When the UCM2 program is compiled the compiler finds every string <macro> and replaces it with the the string <replacement string>. Both <macro> and <replacement string> are type <string>. A *newline* is required to define the end of the replacement string. Use of this statement can help the readability of the user program and also make the program easier to write.

DELAY

DELAY <expr>

The DELAY statement forces the UCM2 to pause in its execution of other instructions until a period of time equal to <expr> times 1mS has expired. Valid range is 0 to xFFFFFFFF.

DUPLEX

See **SET DUPLEX** on page 36.

ERASE

ERASE <variable>

The ERASE command initializes a variable or array to zero.

EXPIRED

ON EXPIRED(<variable>) GOTO <variable>

IF EXPIRED(<variable>) THEN <expression>

The EXPIRED command is used in conjunction with a declared timer to allow the user to perform other functions based on a timeout. A timer is declared, and a value in milliseconds is assigned in one or two commands. The user can then use the EXPIRED command to check if the timer has run out.

FOR...NEXT

The FOR ... NEXT statement provides the ability to execute a set of instructions a specific number of times. The variable <variable> is incremented from the value of the first <expr> to the value of the second <expr>. Once the variable is greater than the second <expr>, control passes to the next program statement following the NEXT. If the optional STEP expression is included, the variable <variable> is incremented by the value equal to the STEP <expr>. If the STEP <expr> is not present a step of 1 is assumed.

FOR <variable>=<expr> TO <expr>

one or more statements

NEXT

FOR <variable>=<expr> TO <expr> STEP <expr>

one or more statements

NEXT

FOR ... NEXT loops may be constructed to decrement from the first <expr> to the second <expr> using the DOWNTO function. The STEP <expr> must be a negative number. If STEP <expr> is not present a step of 1 is assumed.

FOR <variable>=<expr> DOWNTO <expr>

one or more statements

NEXT

FOR <variable>=<expr> DOWNTO <expr> STEP <expr>

one or more statements

NEXT

FOR...NEXT loops may be nested any number of levels.

FLUSH

FLUSH PORT x

The FLUSH statement empties the receive buffer for the specified port.

GOSUB...RETURN

GOSUB <label>

The GOSUB statement turns control of a program to another area of code while expecting to get control back from a RETURN statement. It is useful for program flow control where one section of code may be used several times. Somewhere in the program flow following <label> needs to be a RETURN statement. The RETURN statement returns program control back to the GOSUB statement that caused the jump. After a RETURN the UCM2 will continue running using the statement immediately following the GOSUB.

GOTO

GOTO <label>

The GOTO statement turns program control over to another area of code.

IF...THEN...ELSE...ENDIF

The IF ... THEN statement is used to control the program flow based upon the logical evaluation of the expression in <logical>. When <logical> is true, the statements following the THEN are executed. If <logical> is false the statements following the ELSE are executed.

IF <logical> THEN one or more statements followed by *newline*

IF <logical> THEN one or more statements ELSE one or more statements followed by a *newline*

When more statements are required for an IF ... THEN, the statements may be placed on additional lines below the IF ... THEN. The ENDIF statement indicates the termination of the IF statement.

IF <logical> THEN *newline*

one or more statements

ENDIF

IF <logical> THEN *newline*

one or more statements

ELSE

one or more statements

ENDIF

LCD

The LCD commands allow user application to access the LCD screen.

Until a user application accesses the LCD screen, the OS "owns" the screen. After the user app accesses the LCD, it is thereafter owned by the user application. The only way for the user app to relinquish the LCD is to halt; this can be done by holding down the Up and Enter buttons simultaneously for ~3 seconds.

The process of copying a new page of data to the LCD is (relatively) slow, so all drawing functions operate on a copy of the screen in UCM2 RAM. When the page is fully completed, then the command LCD UPDATE writes the RAM buffer out to the LCD. Not only does this speed up drawing (compared to writing directly to LCD) but it also allows for smoother (instantaneous) transitions between screens.

Function Name	Parameters	Description
LCD ERASE	none	Clear buffer
LCD HLINE	X1,Y1,X2	Draw horizontal line
LCD VLINE	X1,Y1,Y2	Vertical line
LCD LINE	X1,Y1,X2,Y2	Draw any line (incl diagonal)
LCD BOX	X1,Y1,X2,Y2	Draw a rectangle
LCD INVERT	X1,Y1,X2,Y2	Invert pixels in rectangle
LCD BLANK	X1,Y1,X2,Y2	Clear (turn off) pixels in rectangle

LCD BLOCK	X1,Y1,X2,Y2	Set (turn on) pixels in rectangle
LCD SET	X,Y	Set a pixel (on)
LCD CLEAR	X,Y	Turn a pixel off
LCD WRITE	X,Y,Font,Message	Write string to buffer
LCD CWRITE	Y,Font,Message	Center string L-R
LCD UPDATE	none	Write buffer to LCD
LCD BACKLIGHT	Timeout	Force backlight ON for Timeout duration in milliseconds
LCD TIMEOUT	Interval	For trigger to repaint screen, sends char 'T' every Interval ms

Parameters in the table:

X,Y - Coordinates on the display are zero-based. X may range from 0 to 63, while Y may range from 0 to 127.

Fonts - The fonts accessible from the UCM user code are enumerated as shown in the table below. Fonts as loaded in the OS can be a subset of the font set (to save memory or avoid useless characters) but apparently all the fonts included in the OS at this time include all the characters from Space through 0x7F.

Font #	Font Name	Character Width	Character Height
1	Terminal 5	4	6
2	Terminal 6	6	8
3	Terminal 8	8	12
4	Terminal 12	12	16
5	Courier 10	8	13
6	Courier 12	9	16

Message – String to be written to the screen.

LIGHT

See SET LIGHT on page 37.

LISTEN

LISTEN <protocol> SOCKET <socket number> PORT <protocol port number>

The listen command instructs the Ethernet port to use a socket to listen for a particular protocol on a given port number. Presently only the TCP protocol is supported.

Example: LISTEN TCP SOCKET mysock PORT 502

Common TCP port numbers are shown in Table 3-3.

Table 3-3: Well Known TCP Port Numbers

Well Known Port Number	TCP Protocol	Associated RFC[1]
21	FTP	959
23	TELNET	854
25	SMTP	821
80	WEB Server (HTTP)	2616
110	POP3	1939
502	Modbus/TCP	N/A[2]

1. Internet Protocols are available as Requests For Comment (RFCs). They are available on the Internet via HTTP: http://www.rfceditor.org
2. The Modbus/TCP specification is available http://www.modicon.com/openmbus/

MOVE

Reserved instruction for a special NR&D motion control application. Must not be used in user application.

MULTIDROP

See **SET MULTIDROP** on page 38.

NICE

The nice command

NICE [0-5]

will be used to set a thread's priority:

Nice Value	Run Ratio	Mask
0 (fastest)	1:1	0
1	1:2	1
2	1:4	3
3	1:8	7
4	1:16	F
5	1:32	1F
6 (slowest)	1:64	3F

The user code thread switcher will determine whether each thread should be executed by maintaining a counter of application passes:

if((PassCount ^ Threadnum) & Mask)) == 0 then run thread

This mechanism will make it so that if 8 consecutive threads are all set NICE 3 (to run 1/8 of the time) they will each run on *consecutive* application passes, thereby spreading the CPU load.

Each thread will start with a niceness of 0, and may “renice” at any time, so that a thread might be very nice while waiting on a TCP connection, then renice itself to 1 to serve up a web page before renicing itself again to wait for next connection.

NOTE: Thread 1 will always have a niceness of zero, regardless what is chosen by the user.

ON CHANGE

ON CHANGE <variable> GOTO <label>

ON CHANGE <variable> RETURN

ON CHANGE <variable> & <expr> GOTO <label>

ON CHANGE <variable> & <expr> RETURN

The ON CHANGE statement functions within a WAIT loop (like an ON RECEIVE or ON TIMEOUT), and performs the GOTO or RETURN depending upon the result of the value of <variable>. When the value in <variable> is modified by another source, the ON CHANGE statement is performed.

ON <expression>

ON <expression> GOTO

ON <expression> RETURN

When the expression evaluates TRUE the wait loop is exited and flow proceeds to the GOTO or RETURN.

ON RECEIVE KEYPAD x

The keypad appears to the UCM code as a port named KEYPAD. To receive keypresses from the keypad, use:

ON RECEIVE KEYPAD "U" goto User_Pressed_Up

ON RECEIVE KEYPAD "D" goto User_Pressed_Down

ON RECEIVE KEYPAD "L" goto User_Pressed_Left

ON RECEIVE KEYPAD "R" goto User_Pressed_Right

ON RECEIVE KEYPAD "E" goto User_Pressed_Enter

ON RECEIVE KEYPAD "B" goto Backlight_Timed_Out

ON RECEIVE PORT x

ON RECEIVE SOCKET x

ON RECEIVE port 1 <message description> GOTO <label>

ON RECEIVE socket <socket name> <message description> GOTO <label>

ON RECEIVE port 2 <message description> RETURN

ON RECEIVE SOCKET <socket name> <message description> RETURN

The ON RECEIVE statement functions within a WAIT loop and performs the GOTO or RETURN depending upon whether the incoming string exactly matches the <message description>.

ON TIMEOUT

ON TIMEOUT <expr> GOTO <label>

ON TIMEOUT <expr> RETURN

The ON TIMEOUT statement functions within a WAIT loop (like an ON RECEIVE or ON CHANGE), and performs the GOTO or RETURN depending upon the elapsed time between incoming characters on the port. The result of the <expr> must fall within the range 0 to FFFF hex. Like the DELAY function, the ON TIMEOUT <expr> waits for a period of time equal to <expr> times 1mS.

PARITY

See **SET PARITY** on page 39.

READ FILE

READ FILE <file number> OFFSET <offset value> <variable,variable,...>

The READ FILE statement allows a UCM2 program to read memory from the 6x file areas of the UCM2 to the user memory area. The <file number> is an expression which evaluates a number in Table 3-4.

The <offset value> is an expression which evaluates to the byte location for the start of the read.

Table 3-4: UCM2 Internal File List

File Number (dec)	File Number (hex)	Memory Description	Memory Size
256	100	Application Code Space	2Mb bytes
384	180	Application Variable Space	8Mb bytes
768	300	Application Variable Space Provided for backward compatibility	1Mb bytes
1024	400	Application Variable Space Provided for backward compatibility	1Mb bytes
1281	501	PPP Configuration, Port 1	1038 bytes
1282	502	PPP Configuration, Port 2	1038 bytes
1536	600	Statistics	384 bytes
2560	A00	Flash Block 1	7*8K bytes

REPEAT...UNTIL

REPEAT

program statements

UNTIL <logical>

The REPEAT statement starts a loop based upon the evaluation of the <logical> condition located in the UNTIL statement. The loop will only be performed as long as the <logical> is FALSE. When the <logical> is TRUE, program execution jumps to the statement following the UNTIL.

Note: The program statements will execute at least once regardless of the condition of <logical>. This is different than the WHILE...WEND or FOR...NEXT loops which only execute while the <logical> is TRUE, and will not execute the program statements within their boundaries if the <logical> is FALSE.

RETURN

See **GOSUB...RETURN** on page 29.

SET

The SET statement allows the initialization of the UCM2 for the following parameters: Baud rate, Capitalization of incoming characters,

Data bits, Parity, Stop bits, and Debug mode. SET must be followed by the serial port number for the action to take place.

SET PORT x BAUD <const>

The SET BAUD statement sets the baud rate of the port for the value. Any decimal value may be chosen for the baud rate. Example: SET PORT 1 BAUD 9600

SET PORT x CAPITALIZE <const>

SET SOCKET x CAPITALIZE <const>

The SET CAPITALIZE statement performs a translation on incoming ASCII alphabet characters from the lower case to the upper case. Example: SET PORT 2 CAPITALIZE TRUE or SET PORT 1 CAPITALIZE FALSE.

SET PORT x CTS <const>

The SET CTS statement sets the operation of the CTS pin on the RS-232 port. Possible values are

CTS ON The is the normal mode of CTS where CTS must be asserted to allow the serial port to transmit.

CTS OFF Allows the use of the CTS pin to be independently monitored for its state while the serial port is allowed to transmit regardless of the state of CTS.

This operation is very useful in modem applications where CTS is wired to DCD on the modem so the UCM2 can tell if the modem has carrier.

SET PORT x DATA <const>

The SET DATA statement sets the number of data bits for the operation of the port. Valid range is 5,6,7, or 8 bits. Example: SET PORT 1 DATA 8

SET DEBUG <const>

The SET DEBUG statement determines the operation of the UCM2 port in the event of a run time error. If SET DEBUG TRUE is used, the UCM2 program will halt upon a run time error and display the error number and line number in the appropriate registers. If SET DEBUG FALSE is used, the UCM2 program will halt upon a run time error and immediately restart the program from the beginning.

SET PORT x DUPLEX <const>

The SET DUPLEX statement determines the operation of the port's receiver. With DUPLEX HALF, the receiver is only turned on when the port is not transmitting. With DUPLEX FULL, the receiver is always on. DUPLEX HALF should is used in 2-wire applications.

SET LIGHT <exp> <const>

The SET LIGHT statement is used to determine the state of the 2 indicator lights placed behind the LCD screen. SET LIGHT 1 ON turns on the light while SET LIGHT 1 OFF turns off the light. See also TOGGLE LIGHT on page 41.

SET MODE <const>

The SET MODE statement determines the operating mode of the port. Valid entries are UCM, RTU, SYMAX, RNIM, and PPP.

UCM mode allows the use of raw TRANSMIT and RECEIVE statements to communicate with the external device. Example: TRANSMIT PORT 1 "Example string"

RTU mode gives the UCM2 more automatic control of the TRANSMIT and RECEIVE statements. This mode lets the UCM2 assume that the communication will be Modbus RTU. The programmer will create a Modbus packet in a byte array, then hand the UCM2 a length and the name of the array. During TRANSMIT, the UCM2 will calculate and append the checksum to the end of the packet. During RECEIVE, the UCM2 will watch for the 3.5 character timeout, then verify the checksum. The UCM2 will then replace the data in the array with the new data from the reply.

```
DECLARE UNSIGNED BYTE CMD[100]

DECLARE WORD CMDLEN

...

TRANSMIT PORT 1 WORD(CMDLEN):RAW(CMD,CMLEN)

ON RECEIVE PORT 1 WORD(CMDLEN):RAW(CMD,CMLEN)
GOTO <variable>
```

SYMAX mode works on the same principle as RTU mode. The UCM2 will assume that the following communication is SY/MAX, and will handle checksums, ACK's, DLE escapes, etc. , involved in SY/MAX communications. During TRANSMIT, the programmer will hand the UCM2 the length of the SY/MAX packet data, the SY/MAX route escaped by xFF, and the SY/MAX packet data. During RECEIVE, the UCM2 will hand the programmer, the length of the reply, the route escaped by xFF, and the SY/MAX reply data.

```
DECLARE STRING ROUTE[16], REPLYDATA[200]

DECLARE WORD REMOTE, COUNT, REPLYLEN

...

TRANSMIT PORT 1 WORD(6):RAW(ROUTE,LENGTH(ROUTE)):
"\FF":"\00\03":WORD(REMOTE):WORD(COUNT)
```

ON RECEIVE PORT 1 WORD(REPLYLEN):"\11":RAW(ROUTE,4):
"\FF" : "\86\03":WORD((REMOTE)):RAW(REPLYDATA,REPLYLEN4)
GOTO <variable>

RNIM mode is nearly identical to SYMAX mode. The only differences are the addition of a Network

ID, transaction number, and a drop before the route.

DECLARE STRING ROUTE[16], REPLYDATA[200]

DECLARE WORD DROP, TRANSNUM, REMOTE, COUNT,
REPLYLEN

...

TRANSMIT PORT 1 WORD(6):BYTE(DROP):
BYTE(TRANSNUM) :"\00":RAW(ROUTE,LENGTH(ROUTE)):"\FF":"\
00\03":WORD(REMOTE):WORD(COUNT)

ON RECEIVE PORT 1 WORD(REPLYLEN):"\11":
BYTE(TRANSNUM): RAW(ROUTE,4):"\FF":"\86\03":
WORD((REMOTE)):RAW(REPLYDATA,REPLYLEN4) GOTO
<variable>

PPP Mode allows the UCM2 to use the serial port for TCP/IP communication using the PPP protocol.

SET SOCKET <socket> NAGLE <const>

The Set Socket Nagle statement controls how data is sent out a TCP/IP connection. In a socket with NAGLE OFF, every TRANSMIT SOCKET command will create its own Ethernet packet. In a socket with NAGLE ON (The default state), data sent out the socket is buffered as necessary by the UCM2, which results in larger packets and better throughput, especially for applications such as a Telnet server or a WWW server.

SET PORT x MULTIDROP <const>

The SET MULTIDROP statement controls the operation of the port's transmitter. With MULTIDROP TRUE, the transmitter is only on while transmitting. With MULTIDROP FALSE, the transmitter is always on.

SET PORT x RTS <const>

The SET RTS statement sets the operation of the RTS pin on the RS-232 port. Possible values are:

RTS ON - Forces RTS on continuously

RTS OFF – Forces RTS off continuously

RTS AUTO – Allows RTS to behave in normal Push-to-Talk operation

SET PORT x DATA <const>

The SET DATA statement sets the number of data bits for the operation of the port. Valid range is 5,6,7, or 8 bits. Example: SET PORT 1 DATA 8

SET PORT x PARITY <const>

The SET PARITY statement determines the parity of the port. Valid entries are EVEN, ODD, or NONE. Example: SET PORT 1 PARITY EVEN

SET PORT x PPPUSERNAME <string const|string variable>

The SET PPPUSERNAME statement determines username for the PPP connection between the UCM2 and the PPP client or server.

SET PORT x PPPPASSWORD <string const|string variable>

The SET PORT x PPPPASSWORD statement determines password for the PPP connection between the UCM2 and the PPP client or server.

SET PORT x PPPHANGUP

The SET PORT x PPPHANGUP statement causes a gracefull disconnect between the PPP connection of the UCM2 and the client/server.

SET PORT x STOP <const>

The SET STOP statement determines the number of stop bits for the port. Valid entries are 1 or 2. Example: SET PORT 2 STOP 2

SET (bit)

SET <variable>.<const> or SET <variable>.(<expr>)

The SET statement sets a single bit of a variable to ONE. The bit number <const> or <expr> must evaluate within the range off 116 for OUTPUT registers, 07 for bytes, 015 for words, and 031 for long variables. To clear a single bit of a register to be set to one use the CLEAR statement.

SOCKETSTATE

ON SOCKETSTATE (<socket>).<const> GOTO <label>

ON SOCKETSTATE (<socket>).<const> RETURN

IF SOCKETSTATE (<socket>).<const> THEN <expression>

The SOCKETSTATE statement allows the Application to make decisions based on the status of a socket that was initiated by a CONNECT statement. Status bits are set for the SOCKETSTATE of each declared socket. Bit 15 indicates when a socket is open. Bit 14 indicates that the socket is listening. These are the most useful bits.

STOP

The STOP statement causes the UCM2 program to halt upon its execution. The program may be restarted by clearing and then setting the command bit for the program.

STOP (BITS)

See **SET STOP** on page 39.

SWITCH...CASE...ENDSWITCH

SWITCH CASE<expr><statement(s)> [CASE <expr> <statement(s) ...]
ENDSWITCH

The SWITCH...CASE...ENDSWITCH construct allows many mutually exclusive conditional statements or routines to be written without nesting a lot of IF...ELSE...ENDIF statements. Only one of the CASEs contained within the SWITCH...ENDSWITCH construct will be executed. For Example:

```
SWITCH
    CASE X=2
        Y = 2 * Y {Will execute only if X = 2}
    CASE X < 5
        Y = X * 5 {Will execute only if X < 5, but not if X = 2}
    CASE Y > 10 {Logical expressions can operate on different variables}
        Y = 0
    CASE TRUE {Comparable to default: in C}
        Y = 99
        X = 0 {These will execute only if all other CASEs fail to match}
ENDSWITCH
```

Program execution will continue with the instruction immediately after the ENDSWITCH statement, whether any CASE matches or not.

TOGGLE

TOGGLE <variable>.<const> or TOGGLE <variable>.(<expr>)

The TOGGLE statement changes teh state of a single bit of a variable. The bit number <const> or <expr> must evaluate within the range off 116 for OUTPUT registers, 07 for bytes, 015 for words, and 031 for long variables.

TOGGLE LIGHT

TOGGLE LIGHT <expr>

The TOGGLE LIGHT statement is used to change the state of the 10 indicator lights for the UCM2. See also the SET LIGHT command on page 37.

TRANSMIT

TRANSMIT PORT x <message description>

TRANSMIT SOCKET s <message description>

The TRANSMIT statement allows serial (or Ethernet) communication to be emitted from the port. (socket) The exact string evaluated from the <message description> will be emitted.

WAIT

The WAIT statement follows a group of ON RECEIVE, ON CHANGE, ON <expression>, and ON TIMEOUT statements. The WAIT statement causes a loop to occur until one of the ON RECEIVE, ON CHANGE, or ON TIMEOUT conditions has occurred. Program flow will be directed by the ON RECEIVE, CHANGE, <expression>, or TIMEOUT statement.

WHILE...WEND

WHILE <logical>

program statements

WEND

The WHILE statement starts a loop based upon the evaluation of the <logical> condition. The loop will only be performed as long as the <logical> is TRUE. When the <logical> is FALSE, program execution jumps to the statement following the WEND.

WRITE FILE

WRITE FILE <file number> OFFSET <offset value> <variable,variable,...>

The WRITE FILE statement allows a UCM2 program to write memory from the user memory area to memory in the 6x file areas of the UCM2 The <file number> is an expression which evaluates a number in Table 3-5.

Table 3-5: UCM2 Internal File List

File Number (dec)	File Number (hex)	Memory Description	Memory Size
256	100	Application Code Space	2Mb bytes
384	180	Application Variable Space	8Mb bytes
768	300	Application Variable Space Provided for backward compatibility	1Mb bytes
1024	400	Application Variable Space Provided for backward compatibility	1Mb bytes
1281	501	PPP Configuration, Port 1	1038 bytes
1282	502	PPP Configuration, Port 2	1038 bytes
1536	600	Statistics	384 bytes
2560	A00	Flash Block 1	7*8K bytes

The <offset> is an expression which evaluates to the byte location for the start of the read.

4 UCM2 Language Functions

The UCM2 language includes a variety of commonly used functions to facilitate message generation and reception, and other program flow areas.

Checksum Functions

CRC

Form: CRC(<expr>,<expr>,<expr>)

The CRC function calculates the Cyclical Redundancy Check (CCITT standard) upon a message. The first <expr> is the starting index. This value is number of the character in the message where the CRC16 is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

CRC16

Form: CRC16(<expr>,<expr>,<expr>)

The CRC16 function calculates the Cyclical Redundancy Check upon a message. The first <expr> is the starting index. This value is number of the character in the message where the CRC16 is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

The CRC16 is a variation of the CCITT standard CRC and is sometimes called a CRC. The MODBUS RTU protocol uses the CRC16.

CRCAB

Form: CRCAB(<expr>,<expr>,<expr>)

The CRCAB function calculates the CRC16 Check upon a message while leaving out the $-2 character. The first <expr> is the starting index. This value is the number of the character in the message where the CRC16 is to start. The second <expr> is the ending index, usually the $ location. The final <expr> is the initial value for the checksum, usually a 0.

The CRCAB is a variation of the CRC16 customized for use with the Allen-Bradley protocols.

CRCBOB

Form: CRCBOB(<expr>,<expr>,<expr>)

The CRCBOB function calculates the CRC16 Check upon a message while leaving out the $-2 character. The first <expr> is the starting index. This value is the number of the character in the message where the CRC16 is to start. The second <expr> is the ending index, usually the $ location. The final <expr> is the initial value for the checksum, usually a-1.

The CRCAB is a variation of the CRC16 customized for use with BinMaster Smartbob II's.

CRCDNP

Form: CRCDNP(<expr>,<expr>,<expr>)

The CRCDNP function calculates the CRC16 Check upon a message while leaving out the $-1 character. The first <expr> is the starting index. This value is the number of the character in the message where the CRC16 is to start. The second <expr> is the ending index, usually the $ location. The final <expr> is the initial value for the checksum, usually a 0.

The CRCAB is a variation of the CRC16 customized for use with the DNP 3.00 protocol.

LRC

Form: LRC(<expr>,<expr>,<expr>)

The LRC function calculates the Longitudinal Redundancy Check upon a message. The first <expr> is the starting index. This value is number of the character in the message where the LRC is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

The LRC operates upon each byte of the message and the result of the function is a byte.

LRCW

Form: LRCW(<expr>,<expr>,<expr>)

The LRCW function calculates the Longitudinal Redundancy Check upon a message. The first <expr> is the starting index. This value is number of the character in the message where the LRCW is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

The LRCW operates upon each word of the message and the result of the function is a word.

SUM

Form: SUM(<expr>,<expr>,<expr>)

The SUM function calculates the straight hex sum of a message. The first <expr> is the starting index. This value is number of the character in the message where the SUM is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

The SUM function operates upon each byte of the message and returns a byte.

SUMW

Form: SUMW(<expr>,<expr>,<expr>)

The SUMW function calculates the straight hex sum of a message. The first <expr> is the starting index. This value is number of the character in the message where the SUMW is to start. The second <expr> is the ending index, usually the $ or $-1 location. The final <expr> is the initial value for the checksum, usually a 0 or -1.

The SUMW function operates upon each word of the message and returns a word.

Message Description Functions

BCD Binary - Coded Decimal conversion

Usual Format: BCD(Register location, byte count) or

BCD(Register location, VARIABLE) or

BCD(Register location, VARIABLE, Register location)

Valid characters: hexadecimal 00 through 09, 10 through 19 ... 90 through 99.

Transmitting: Converts an expression into its decimal representation, breaks the decimal number into pairs of digits and then translates each pair of digits into its BCD character.

TRANSMIT format: BCD(<expr>,<expr>)

Receiving: Converts BCD characters into pairs of decimal digits, assembles the pairs into a 16 bit decimal number and then compares the number to an expression or places the number into an UCM2 register.

ON RECEIVE formats: BCD(<variable>,<expr>) or BCD((<expr>),<expr>)

Note: The UCM2 port must be set for 8 bit for BCD to work correctly.

BYTE Single - (lower) byte conversion

Usual Format: BYTE(Register location)

Valid characters: hexadecimal 00 through FF

Transmitting: Converts an expression into its hexadecimal representation and transmits the lower 8 bits as a hexadecimal character.

TRANSMIT format: BYTE(<expr>)

Receiving: Interprets hexadecimal characters as 8bit hexadecimal numbers and then compares the numbers to an expression or places the numbers into the lower byte of UCM2 registers and zeros the upper byte of these registers.

ON RECEIVE formats: BYTE(<variable>) or BYTE((<expr>))

Note: If the UCM2 port is set to 7 bit then bit 8 will always be zero.

DEC Decimal - conversion

Usual Format: DEC(Register location, byte count) or

DEC(Register location, VARIABLE) or

DEC(Register location, VARIABLE, Register location)

Valid characters: ASCII + (plus sign), -(minus sign) and 0 through 9

Transmitting: Converts an expression into its signed decimal representation, breaks the signed decimal number into its sign and its digits and then translates each digit into its ASCII character.

TRANSMIT format: DEC(<expr>,<expr>)

After the significant digits the UCM2 pads the front of the string with ASCII zeros. Does not transmit the plus (+) sign for positive numbers but does transmit a minus sign (-) on negative numbers.

Receiving: Converts ASCII characters into decimal digits with a sign, assembles the sign and digits into a 16 bit decimal number and then compares the number to an expression or places the number into an UCM2 register.

ON RECEIVE formats: DEC(<variable>,<expr>) or DEC((<expr>),<expr>)

Total number of registers that can be affected: 1

Positive numbers can have a plus (+) sign preceding them but it is not required. Negative numbers must have a minus (-) sign preceding them.

HEX Hexadecimal - conversion

Usual Format: HEX(Register location, byte count) or

HEX(Register location, VARIABLE) or

HEX(Register location, VARIABLE, Register location)

Valid characters: ASCII 0 through 9 and A through F

Transmitting: Converts an expression into its hexadecimal representation, breaks the hexadecimal number into its digits and then translates each hex digit into its ASCII character.

TRANSMIT format: HEX(<expr>,<expr>)

Maximum number of characters that can be sent:

Receiving: Translates ASCII characters into hexadecimal digits, assembles the digits into 16 bit hex numbers and then compares the numbers to an expression or places the numbers into UCM2 registers.

ON RECEIVE formats: HEX(<variable>,<expr>) or HEX((<expr>),<expr>)

Total number of registers that can be affected: 16 (64 characters)

HEXLC Lower - Case Hexadecimal conversion

Usual Format: HEXLC(Register location, byte count) or

HEXLC(Register location, VARIABLE) or

HEXLC(Register location, VARIABLE, Register location)

Valid characters: ASCII 0 through 9 and a through f

Transmitting: Converts an expression into its hexadecimal representation, breaks the hexadecimal number into its digits and then translates each hex digit into its ASCII character. Functions the same as HEX but accepts lower case characters a through f.

TRANSMIT format: HEXLC(<expr>,<expr>)

Maximum number of characters that can be sent: 4

Receiving: Translates ASCII characters into hexadecimal digits, assembles the digits into 16 bit hex numbers and then compares the numbers to an expression or places the numbers into UCM2 registers. Transmits the hex alpha characters as lower case a through f.

ON RECEIVE formats: HEXLC(<variable>,<expr>) or

HEXLC((<expr>),<expr>)

Total number of registers that can be affected: 1 (4 characters)

IDEC conversion

Usual Format: IDEC(Register location, byte count) or

IDEC(Register location, VARIABLE) or

IDEC(Register location, VARIABLE, Register location)

Valid characters: ASCII 0 through 9 and : ; < = > ?

Transmitting: Converts an expression into its hexadecimal representation, breaks the hexadecimal number into its digits and then translates each hex digit into its pseudo-ASCII character. In pseudo-ASCII, hex digits 0 through 9 are there normal ASCII characters while hex digits A through F are replaced by the hex characters 3A through 3F which are the ASCII characters : ; < = > and ?.

TRANSMIT format: IDEC(<expr>,<expr>)

Receiving: Converts pseudo-ASCII characters into hexadecimal digits, assembles the digits into 16 bit hexadecimal numbers and then compares the numbers to an expression or places the numbers into UCM2 registers.

ON RECEIVE formats: IDEC(<variable>,<expr>) or

IDEC((<expr>),<expr>)

Note: This is the format that the IDEC processors and other devices use to pass register values. If communicating to an IDEC processor, a Square D Model 50 or Micro-1, or any other devices that use this pseudo-ASCII protocol this is a useful function.

LONG

Usual Format: LONG(Variable name)

Valid characters: hexadecimal 00 through FF

Transmitting: Converts an expression into its 32-bit hexadecimal representation, translates the 32-bit number into four 8-bit hexadecimal numbers and transmits the bytes in order of descending significance. If the variable VAR of type long contains 0x12345678, the four bytes would be transmitted: x12, x34, x56, x78.

TRANSMIT format: LONG(<expr>)

Receiving: Interprets four hexadecimal characters as four 8-bit hexadecimal numbers, assembles the four 8-bit numbers into a 32-bit number, first number the high byte, the second number in the second most significant byte, and the fourth number the low byte, and then compares the number to an expression or places the number into an UCM2 variable.

ON RECEIVE formats: LONG(<variable>) or LONG((<expr>))

OCT Octal - conversion

Usual Format: OCT(Register location, byte count)

Valid characters: ASCII 0 through 7

Transmitting: Converts an expression into its octal representation, breaks the octal number into its digits and then translates each digit into its ASCII character.

TRANSMIT format: OCT(<expr>,<expr>)

Receiving: Converts ASCII characters into octal representation.

ON RECEIVE formats: OCT(<variable>,<expr>) or

OCT((<expr>),<expr>)

RAW – Raw register conversion

Usual Format: RAW(Register location, byte count) or

RAW(Register location, VARIABLE) or

RAW(Register location, VARIABLE, Register location)

Valid characters: hexadecimal 00 through FF

Transmitting: Converts registers into their hexadecimal representation and translates each 16-bit hexadecimal number into a pair of 8-bit hexadecimal characters.

TRANSMIT format: RAW(<variable>,<expr>)

Receiving: Interprets hexadecimal characters as 8-bit hexadecimal numbers, assembles each pair of 8-bit numbers into a 16-bit hexadecimal number, high byte then low byte, and then compares the numbers to an expression or places the numbers into UCM2 registers.

ON RECEIVE formats: RAW(<variable>,<expr>) or

RAW((<expr>),<expr>)

Note: If the UCM2 port is set to 7-bit then bit 8 and bit 16 will always be 0. RAW is an expanded version of SY/MAX packed ASCII and can be used to transmit and receive packed ASCII characters as well as 8-bit characters.

RWORD

Usual Format: RWORD(Register location)

Valid characters: hexadecimal 00 through FF

Transmitting: Converts an expression into its 16-bit hexadecimal representation, translates the 16-bit number into a pair of 8-bit hexadecimal numbers and transmits the lower eight bits and then the upper eight bits as hexadecimal characters.

TRANSMIT format: RWORD(<expr>)

Receiving: Interprets two hexadecimal characters as two 8-bit hexadecimal numbers, assembles the two 8-bit numbers into a 16-bit number, first number low byte and second number high byte, and then compares the number to an expression or places the number into an UCM2 register.

ON RECEIVE formats: RWORD(<variable>) or RWORD((<expr>))

Note: Like WORD but in the reverse order, low byte then high byte.

TON – Translate on

The commands TON and TOFF work with the TRANSLATE command. The TRANSLATE command defines a string that is to be translated into another string. This is used when a character has reserved meaning but could also be used in the translation of data. Up to 8 TRANSLATE strings can be contained in an UCM2 program.

An example: the escape character (hex 1B) could be used to interrupt a transmission but hex 1B might also be valid data. When the remote process wants to interrupt transmission it sends a single hex 1B. But when the remote process wants to send data containing hex 1B it sends 1B1B and the UCM2 is responsible for interpreting two hex 1Bs as a single 1B instead of as an escape. In this case the translate command would be:

TRANSLATE 1:"\1B\1B" = "\1B"

and the command for receiving data that might contain a hex 1B:

ON RECEIVE TON(1):RAW(STRINGVAR,15):TOFF(1)

The TON command turns on translation during an ON RECEIVE or TRANSMIT. The format for turning translation on is TON(<expr>) where <expr> is the translation number and must evaluate to be between 1 and 8. The TON is usually followed by a TOFF.

TOFF – Translate off

The TOFF command turns off translation during an ON RECEIVE or TRANSMIT. The format for turning translation off is TOFF(<expr>) where <expr> is the translation number and must evaluate to be between 1 and 8.

UNS – Unsigned decimal conversion

Usual Format: UNS(Register location, byte count) or

UNS(Register location, VARIABLE) or

UNS(Register location, VARIABLE, Register location)

Valid characters: ASCII 0 through 9

Transmitting: Converts an expression into its unsigned decimal representation, breaks the unsigned decimal number into its digits and then translates each digit into its ASCII character.

TRANSMIT format: UNS(<expr>,<expr>)

Receiving: Converts ASCII characters into decimal digits, assembles the digits into a 16 bit unsigned decimal number and then compares the number to an expression or places the number into an UCM2 register.

ON RECEIVE formats: UNS(<variable>,<expr>) or UNS((<expr>),<expr>)

Total number of registers that can be affected: 1

WORD

Usual Format: WORD(Register location)

Valid characters: hexadecimal 00 through FF

Transmitting: Converts an expression into its 16-bit hexadecimal representation, translates the 16-bit number into a pair of 8-bit hexadecimal numbers and transmits the upper eight bits and then the lower eight bits as hexadecimal characters.

TRANSMIT format: WORD(<expr>)

Receiving: Interprets two hexadecimal characters as two 8-bit hexadecimal numbers, assembles the two 8-bit numbers into a 16-bit number, first number the high byte and second number the low byte, and then compares the number to an expression or places the number into an UCM2 register.

ON RECEIVE formats: WORD(<variable>) or WORD((<expr>))

Note: Like RWORD but always high byte then low byte. Also like RAW(<variable>,2).

Receive Buffer Functions

WAITCHAR(<receive_buffer_variable>)

bytevar = WaitChar(port 1)

Pulls one byte from the receive buffer of port 1 and place it in bytevar. This command will block if nothing to Rx. Returns -1 if socket closed or closing

GETCHAR(<receive_buffer_variable>)

intvar = GetChar(socket s)

Pulls one byte from the receive buffer of socket s and place it in intvar. This will return -1 if nothing to Rx.

Note: Since GetChar() can return a -1 in case of nothing to receive, you'll want to put the result into a signed word or long variable. If placed in a byte variable, you won't be able to distinguish -1 from 0xFF.

COUNTCHAR(<receive_buffer_variable>)

intvar = CountChar(port 2)

Returns number of bytes in Rx queue and place it in intvar.

Other Functions

APPLICATION

The APPLICATION internal variable returns a value of 1 or 2, indicating which application area the program is running in. A program which is loaded into application area 2 of a UCM2 will read this variable as 2.

CHANGED

Format: CHANGED(<variable>) or CHANGED(<variable> & <expr>)

The CHANGED function provides a boolean result dependent upon whether the evaluated register or mask of the register has been altered from the last operation of this function. The first occurrence of the CHANGED function will result in a FALSE regardless of the state of the evaluated register.

The CHANGED function is used in any place referred to as <logical>, such as:

IF CHANGED(OUTPUT[56]) THEN GOTO reply

The CHANGED function is similar to the ON CHANGE statement, but the CHANGED function allows program execution to continue running instead of pausing to wait for the change to occur.

MAX

Format: MAX(<expr>,<expr>)

The MAX function provides a result of the <expr> which evaluates to the larger of the two expressions.

MIN

Format: MIN(<expr>,<expr>)

The MIN function provides a result of the <expr> which evaluates to the smaller of the two expressions.

SWAP

Format: SWAP(<expr>)

The SWAP function reverses the byte order of the result of the <expr>. If OUTPUT[4] = xABCD

then SWAP(OUTPUT[4]) would bring the result xCDAB.

THREAD

The THREAD variable returns a value for the thread number where the variable is called. Valid results are 1-8 inclusive.

RTS

RTS is a variable which may be used to control the state of the Request to Send line for a UCM2 port. SET PORT 1 RTS ON will assert the RTS line. SET PORT 2 RTS OFF will negate the RTS line. SET PORT 1 RTS AUTO will force RTS to be in "push-to-talk" mode.

CTSx

CTSx is a variable which gives the current state of Clear to Send on the UCM2 port. CTS1 provides the state for port 1 while CTS2 is for port 2. IF CTSx = TRUE then CTS is asserted by the external device. If CTSx = FALSE then CTS is negated.

5 Examples

TRANSMIT message function with register references

In the following TRANSMIT examples the following initial conditions are assumed:

UCM2 Register	Decimal	Signed Decimal	Hex	Octal	Binary
OUTPUT[23]	41394	24142	A1B2	120662	1010 0001 1011 0010
OUTPUT[24]	20318	20318	4F5E	47536	0100 1111 0101 1110

TRANSMIT HEX

Command: TRANSMIT HEX(OUTPUT[23],4)

ASCII Characters transmitted: A1B2

Decimal values: 65 49 66 50

Hex values: 41 31 42 32

Command: TRANSMIT HEX(OUTPUT[23],2)

ASCII Characters transmitted: B2

Decimal values: 66 50

Hex values: 42 32

Command: TRANSMIT HEX(OUTPUT[23],8)

ASCII Characters transmitted: 0000A1B2

Decimal values: 48 48 48 48 65 49 66 50

Hex values: 30 30 30 30 41 31 42 32

Command: TRANSMIT HEX(OUTPUT[23],VARIABLE)

ASCII Characters transmitted: A1B2

Decimal values: 65 49 66 50

Hex values: 41 31 42 32

Command: TRANSMIT HEX(OUTPUT[23],VARIABLE R[600])

ASCII Characters transmitted: A1B2

Decimal values: 65 49 66 50

Hex values: 41 31 42 32

OUTPUT[600] would then equal 4.

TRANSMIT DEC

Command: TRANSMIT DEC(OUTPUT[23],6)

ASCII Characters transmitted: 24142

Decimal values: 45 50 52 49 52 50

Hex values: 2D 32 34 31 34 32

Command: TRANSMIT DEC(OUTPUT[23],5)

ASCII Characters transmitted: 24142

Decimal values: 50 52 49 52 50

Hex values: 32 34 31 34 32

Command: TRANSMIT DEC(OUTPUT[23],12)

ASCII Characters transmitted: 00000024142

Decimal values: 45 48 48 48 48 48 48 50 52 49 52 50

Hex values: 2D 30 30 30 30 30 30 32 34 31 34 32

Command: TRANSMIT DEC(OUTPUT[23],VARIABLE)

ASCII Characters transmitted: 24142

Decimal values: 45 50 52 49 52 50

Hex values: 2D 32 34 31 34 32

Command: TRANSMIT HEX(OUTPUT[23],VARIABLE LENGTHVARIABLE)

ASCII Characters transmitted: 24142

Decimal values: 45 50 52 49 52 50

Hex values: 2D 32 34 31 34 32

R[600] would then equal 6.

TRANSMIT UNS

Command: TRANSMIT UNS(OUTPUT[23],5)

ASCII Characters transmitted: 41394

Decimal values: 52 49 51 57 52

Hex values: 34 31 33 39 34

Command: TRANSMIT UNS(OUTPUT[23],3)

ASCII Characters transmitted: 394

Decimal values: 51 57 52

Hex values: 33 39 34

Command: TRANSMIT UNS(OUTPUT[23],8)

ASCII Characters transmitted: 00041394

Decimal values: 48 48 48 52 49 51 57 52

Hex values: 30 30 30 34 31 33 39 34

Command: TRANSMIT UNS(OUTPUT[23],8)

ASCII Characters transmitted: 00041394

Decimal values: 48 48 48 52 49 51 57 52

Hex values: 30 30 30 34 31 33 39 34

TRANSMIT OCT

Command: TRANSMIT OCT(OUTPUT[23],6)

ASCII Characters transmitted: 120662

Decimal values: 49 50 48 54 54 50

Hex values: 31 32 30 36 36 32

Command: TRANSMIT OCT(OUTPUT[23],3)

ASCII Characters transmitted: 662

Decimal values: 54 54 50

Hex values: 36 36 32

Command: TRANSMIT OCT(OUTPUT[23], VARIABLE)

ASCII Characters transmitted: 120662

Decimal values: 49 50 48 54 54 50

Hex values: 31 32 30 36 36 32

Command: TRANSMIT OCT(OUTPUT[23], VARIABLE R[600])

ASCII Characters transmitted: 120662

Decimal values: 49 50 48 54 54 50

Hex values: 31 32 30 36 36 32

R[600] would then equal 6.

TRANSMIT BCD

Command: TRANSMIT BCD(OUTPUT[23],3)

ASCII Characters transmitted: {not ASCII characters}

Decimal values: 4 19 148

Hex values: 04 13 94

Command: TRANSMIT BCD(OUTPUT[23],1)

ASCII Characters transmitted: {not ASCII character}

Decimal values: 148

Hex values: 94

Command: TRANSMIT BCD(OUTPUT[23],5)

ASCII Characters transmitted: {not ASCII characters}

Decimal values: 0 0 4 19 148

Hex values: 00 00 04 13 94

Command: TRANSMIT BCD(OUTPUT[23], VARIABLE)

ASCII Characters transmitted: {not ASCII characters}

Decimal values: 4 19 148

Hex values: 04 13 94

Command: TRANSMIT BCD(OUTPUT[23], VARIABLE OUTPUT[600])

ASCII Characters transmitted: {not ASCII characters}

Decimal values: 4 19 148

Hex values: 04 13 94

OUTPUT[600] would then equal 3.

ON RECEIVE message functions with register references

In the following ON RECEIVE examples it assumed that a WAIT follows immediately after the ON RECEIVE command, there are no other ON RECEIVEs set up for the WAIT and the incoming string is the following group of ASCII characters:

D876543F

Before the WAIT is executed, the following initial conditions are present:

UCM2 Register	Hex	Unsigned Decimal	Decimal	Octal	Binary
OUTPUT[23]	A1B2	41394	-24142	120662	1010 0001 1011 0010
OUTPUT[24]	03F5	1013	1013	1765	0000 0011 1111 0101

Several of the examples have remaining characters. The remaining characters will be received by the UCM2 and buffered until the next ON RECEIVE is reached by the program. This is not good programming practice unless these characters are meant to be handled elsewhere in the program. If they are not handled correctly, ON RECEIVEs later in the program may give unexpected results.

ON RECEIVE HEX

Command: ON RECEIVE HEX(OUTPUT[23],4) RETURN

Results after WAIT:

Characters used: D876

Translated to: hex D876

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	D876	55414	-10122	1101 1000 0111 0110
Register 24	03F5	1013	1013	0000 0011 1111 1001

Remaining characters: "543F"

Command: ON RECEIVE HEX(OUTPUT[23],8) RETURN

Results after WAIT:

Characters used: D876543F

Translated to: hex D876 and hex 543F

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	D876	55414	-10122	1101 1000 0111 0110
Register 24	543F	21567	21567	1001 1000 0011 1111

Note: Every character is used by this HEX function. The string was meant for a statement similar to this one, in that it handles all of the characters.

Command: ON RECEIVE HEX(R[23],2) RETURN

Results after WAIT:

Characters used: D8

Translated to: hex D8

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	00D8	216	216	0000 0000 1101 1000
Register 24	03F5	1013	1013	0000 0011 1111 1001

Remaining characters: "76543F"

ON RECEIVE DEC

Command: ON RECEIVE DEC(OUTPUT[23],4) RETURN

Results after WAIT:

Characters used: D8765

Translated to: decimal 8,765

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	223D	8765	8765	0010 0010 0011 1101
Register 24	03F5	1013	1013	0000 0011 1111 1001

Note: The first received character "D" is ignored by the DEC() function. This is all right but if a D is always the leading character then a program statement like ON RECEIVE "D":DEC(OUTPUT[23],4) may be better.

Remaining characters: "43F"

Command: ON RECEIVE DEC(OUTPUT[23],5) RETURN

Results after WAIT:

Characters used: D87654

Translated to: decimal 87,654%65,536 = 22,118

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	5666	22118	22118	0101 0110 0110 0110
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The first "D" is ignored similar to the previous ON RECEIVE.. Remaining characters: "3F"

Command: ON RECEIVE DEC(OUTPUT[23],2) RETURN

Results after WAIT:

Characters used: D87

Translated to: decimal 87

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	0057	87	87	0000 0000 0101 0111
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The "D" is ignored as above.

Remaining characters: "6543F"

ON RECEIVE UNS

Command: ON RECEIVE UNS(OUTPUT[23],4) RETURN

Results after WAIT:

Characters used: D8765

Translated to: unsigned decimal 8,765

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	223D	8765	8765	0010 0010 0011 1101
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: the first received character "D" is ignored by the UNS() function. Remaining characters: "43F"

Command: ON RECEIVE UNS(OUTPUT[23],5) RETURN

Results after WAIT:

Characters used: D87654

Translated to: unsigned decimal 87,654%65,536 = 22,118

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	5666	22118	22118	0101 0110 0110 0110
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The "D" is ignored. The next five characters "87654" do not make a valid unsigned decimal number and so the UNS() function takes the incoming number and does a modulus 65,536. In this case the result is 22,118.

Remaining characters: "3F"

Command: ON RECEIVE UNS(OUTPUT[23],2) RETURN

Results after WAIT:

Characters used: D87

Translated to: decimal 87

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	0057	87	87	0000 0000 0101 0111
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The "D" is ignored.

Remaining characters: "6543F"

ON RECEIVE OCT

Command: ON RECEIVE OCT(R[23],5) RETURN

Results after WAIT:

Characters used: D876543

Translated to: octal 76543

	Hex	Unsigned Decimal	Decimal	Binary	Octal
Register 23	7D63	32099	32099	0111 1101 0110 0011	076543
Register 24	03F5	1013	1013	0000 0011 1111 0101	001765

Note: The first two received characters "D8" are not octal digits and are ignored by the OCT() function.

Remaining characters: "F"

Command: ON RECEIVE OCT(OUTPUT[23],2) RETURN

Results after WAIT:

Characters used: D876

Translated to: octal 76

	Hex	Unsigned Decimal	Decimal	Binary	Octal
Register 23	003E	62	62	0000 0000 0011 1110	000076
Register 24	03F5	1013	1013	0000 0011 1111 0101	001765

Note: The "D" and the "8" are ignored.

Remaining characters: "543F"

Command: ON RECEIVE OCT(OUTPUT[23],6) RETURN

Results after WAIT:

Characters used: D876543F

Translated to: nothing

	Hex	Unsigned Decimal	Decimal	Binary	Octal
Register 23	A1B2	41394	-24142	1010 0001 1011 0010	120662
Register 24	03F5	1013	1013	0000 0011 1111 0101	001765

Note: Since "D", "8" and "F" are not valid octal characters they are lost by the OCT command. Between the "8" and the "F" the octal characters "76543" were received, which is only 5 characters instead of the 6 required by this ON RECEIVE. Since the next character "F" was not an octal character the previous 5 characters are ignored as not matching 6

octal characters in a row. So, not enough octal characters have been transmitted for this command. If this command is used without an ON TIMEOUT then the program will wait until 6 octal characters in a row are sent before completing this ON RECEIVE. Also note that register 23 has not yet changed.

Remaining characters: None – waiting for 6 octal characters in a row

ON RECEIVE BCD

Command: ON RECEIVE BCD(OUTPUT[23],2) RETURN

Results after WAIT:

Characters used: D8 (hexadecimal 44 and 38)

Translated to: decimal 4,438

Note: The first two received characters "D" and "8" are used by the BCD() function. The "D" is a hex character 44 and the "8" is a hex character 38 and so the unsigned decimal value is 4438.

Remaining characters: "76543F"

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	1157	4438	4438	0001 0001 1001 1010
Register 24	03F5	1013	1013	0000 0011 1111 0101

Command: ON RECEIVE BCD(OUTPUT[23],4) RETURN

Results after WAIT:

Characters used: D876 (hexadecimal 44 38 37 36)

Translated to: decimal 44,383,736 converted to 15,864

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	6AF8	15864	15864	0110 1010 1111 1000
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: Both register 23 were changed

Remaining characters: None

ON RECEIVE RAW

Command: ON RECEIVE RAW(OUTPUT[23],2) RETURN

Results after WAIT:

Characters used: D8 (hexadecimal 44 38)

Translated to: hexadecimal 4438

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	4438	17464	17464	0100 0100 0011 1000
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The "D" is a hex 44 and the "8" is a hex 38 so register 23 is now 4438

Remaining characters: "76543F"

Command: ON RECEIVE RAW(OUTPUT[23],1) RETURN

Results after WAIT:

Characters used: D (hexadecimal 44)

Translated to: hexadecimal 4400

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	4400	17408	17408	0100 0100 0000 0000
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: The RAW function places the first character into the upper bits of the register and zeros the rest of the bits.

Remaining characters: "876543F"

Command: ON RECEIVE RAW(OUTPUT[23],4) RETURN

Results after WAIT:

Characters used: D876 (hexadecimal 44 38 37 36)

Translated to: hexadecimal 4438 and 3736

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	4438	17464	17464	0100 0100 0011 1000
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: RAW changed both register 23 and 24

Characters remaining: "543F"

ON RECEIVE BYTE

Command: ON RECEIVE BYTE(OUTPUT[23]) RETURN

Results after WAIT:

Characters used: D (hexadecimal 44)

Translated to: hexadecimal 0044

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	0044	68	68	0000 0000 0100 0100
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: Only OUTPUT[23] is changed.

Characters remaining: "876543F"

ON RECEIVE WORD

Command: ON RECEIVE WORD(OUTPUT[23]) RETURN

Results after WAIT:

Characters used: D8 (hexadecimal 44, 38)

Translated to: hexadecimal 4438

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	4438	17464	17464	0100 0100 0011 1000
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: Only OUTPUT[23] is changed.

Characters remaining: "76543F"

ON RECEIVE RWORD

Command: ON RECEIVE RWORD(OUTPUT[23]) RETURN

Results after WAIT:

Characters used: D8 (hexadecimal 44, 38)

Translated to: hexadecimal 3843

	Hex	Unsigned Decimal	Decimal	Binary
Register 23	3843	14403	14403	0011 1000 0100 0011
Register 24	03F5	1013	1013	0000 0011 1111 0101

Note: Only OUTPUT[23] is changed.

Characters remaining: "76543F"

6 Compiling

QCOMPILE.EXE

QCOMPILE2.EXE is an MSDOS compatible program for compiling the UCM2 configuration text file into machine readable code. All UCM2 configurations must be compiled before they can be downloaded into the UCM2. The downloading is done by another MSDOS compatible program QLOAD.EXE described in a later section of the manual.

The QCOMPILE2 command syntax is as follows:

QCOMPILE2 filename[.*ext*] [-O*file2*][-D*macro=string*] [-L*file3*][-S][-W]

Where filename refers to the text file containing the source code for the UCM2.

The *.ext* is an optional extension to the filename. If no extension is included then .UCM2 is assumed by the compiler.

Options can appear in any order. Additional options may be displayed by using -? as an option.

-O option

The -O option is for specifying an output file other than filename.ucc. If the -O option is not used then COMPILE will create the output file filename.ucc. If the -O option is used then COMPILE will create an output file named *file2*. If an extension is desired for *file2* it needs to be added since no extension is assumed by the compiler.

-D option

The -D option is for specifying DEFINE macros at compile time. This is very useful for compiling one UCM2 configuration file for more than 1 port of the same UCM2 module. The *macro* portion of the -D option is the string inside of the UCM2 configuration file that is to be found while *string* portion is *macro*'s replacement. It is equivalent to Find what: *macro* Change to: *string* in DOS EDIT.

If, in the configuration file AMAZING.UCM2, the word Time has been used and Time needs to have a value of 50 then the DOS command to compile AMAZING with the Time replacement is:

QCOMPILE AMAZING -DTime= 50

If the compile completes with no errors then the output file AMAZING.UCC will be created. If more than one DEFINE is needed at compile time then they can be added to the end of the COMPILE command as in:

COMPILE AMAZING -DTime=50 -DPort=1 -DFlavor=strawberry

-L option

The -L option is for telling the compiler to also generate a 68000 source listing. The name of the DOS text file is *file3*. If an extension is desired for *file3* it needs to be added since no extension is assumed by the compiler.

The 68000 source listing, *file3*, is a text file that can be read by your favorite text editor. If you have any questions about the way the compiler generates code for the UCM2 then you can use the -L option. Most users will not have a use for this option.

-S option

The S option is for generating a list of the location of each declared variable. The variables are located in the 6x file areas of the UCM2.

The variable list is displayed as a table, sorted by the order that the variables were declared. The table has columns that show the variable's byte address, register address, type, number of elements (if applicable), number of bytes, and what thread they were assigned to.

-W option

The -W option disables warnings that indicate possible trouble but do not prohibit the program from successfully compiling. Mostly used for disabling the warning "Program is too large" warnings on large applications that use the optional large flash.

Compiler Errors

When the UCM2 configuration file contains code that the compiler does not recognize, variables out of range, code that is too long or any other error then the compiler generates an error listing in the proj.err file. This listing will have the compiler error number, the line number in the .UCM2 file where the error occurred, a copy of the line in question, and a description of the error. The listing will also summarize the total number of errors detected.

The programmer can use this listing to correct problems in the UCM2 configuration file. Since no object code is generated if an error occurs during the compile, all errors must be repaired before a valid object file can be made for downloading into the UCM2 module.

Debugging

For debugging purposes the user may want to store the error listing in a file in order to refer to it later. This can be accomplished with the output redirection

feature of DOS. For example:

```
COMPILE filename >error.lst
```

The text that normally would go to the screen will now appear in the text file **error.lst**.

7 Downloading Compiled Code

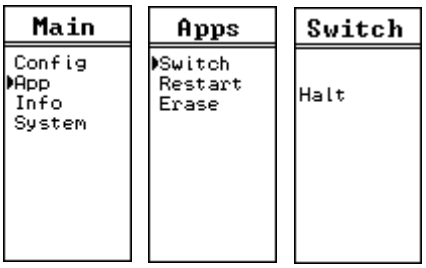
QLOAD.EXE

The program QLOAD.EXE is a Windows program that will download compiled applications into a UCM2 via Modbus serial or TCP/IP Ethernet.

QLOAD using Serial Port

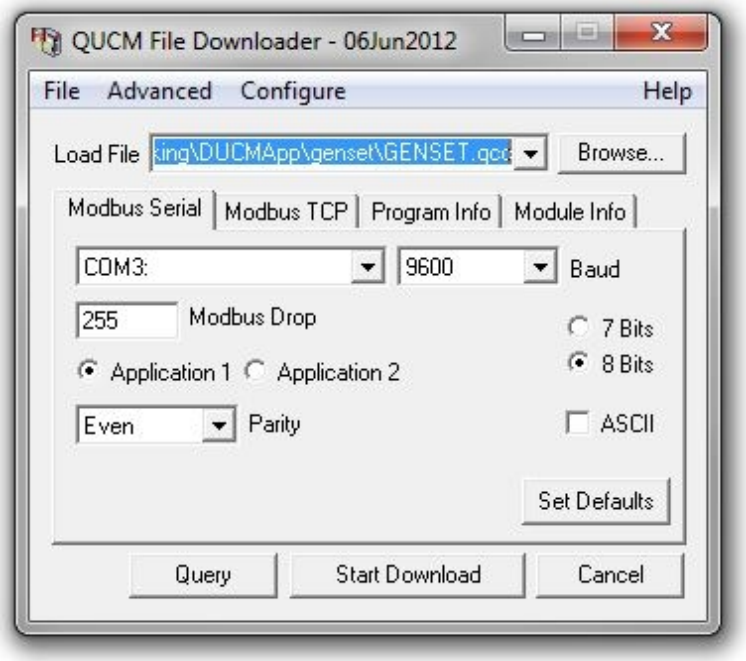
1. The module must be powered.
2. Connect the module port 1 to the PC using the appropriate cable. (MM1 cable for the QUCM and DUCM modules and MU1 cable for the MUCM)
3. Application Switch must be in HALT. To accomplish this, use the arrow keys on the module to navigate to the App option in the Main menu. Use the Enter or Right arrow button to select the option. Select the Switch option in the Apps menu. Use the Up or Down arrow to select the Halt option. Use the Enter or Left arrow to accept the choice.

Figure 7.1: Change Application Switch to Halt



4. Start QLOAD.EXE. The Windows Start Menu link is “Start, Programs, Niobrara, Apps, QLOAD.” See Error: Reference source not found

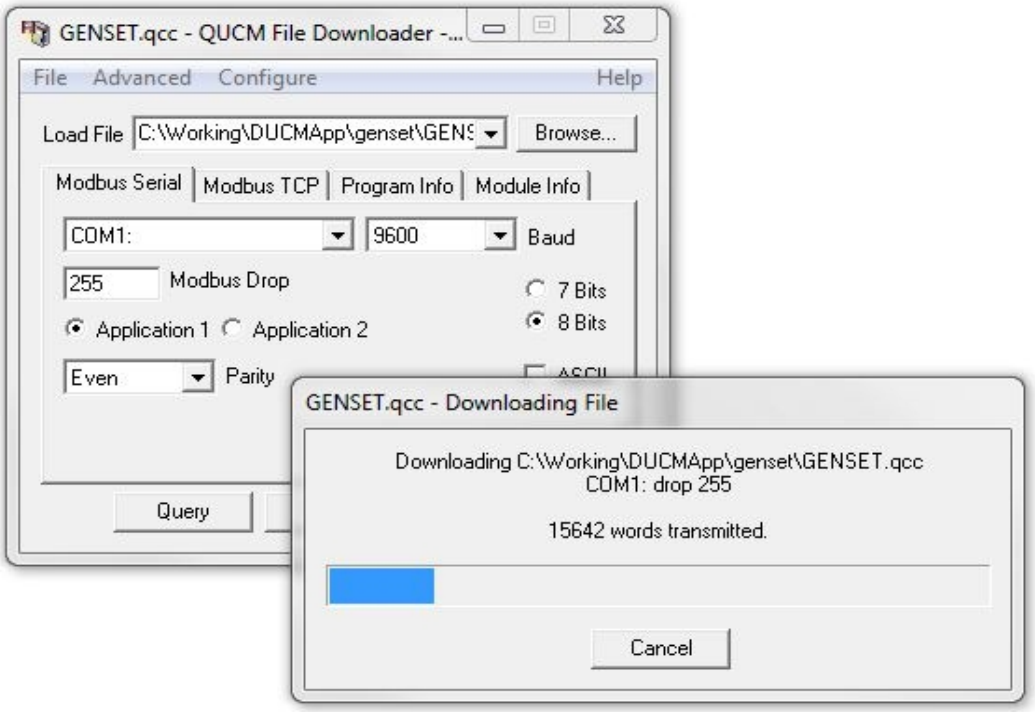
Figure 7.2: QLOAD Application



5. If necessary, Click on the Browse button and select your application.
6. Click on the "Modbus Serial" tab and verify the following:
    1. The proper PC serial port is selected (COM1, COM2,..).
    2. The baud rate matches the baud rate of the module (default is 9600).
    3. The Modbus Drop is 255.
    4. The Application 1 radio button is selected.
    5. The Parity matches the parity of the module (default is Even).
    6. The number of data bits match that of the module (default is 8 bits).
    7. ASCII is NOT checked.

7. Press the "Start Download" button. QLOAD will open a progress bar to show the status of the download see Figure 7.3.

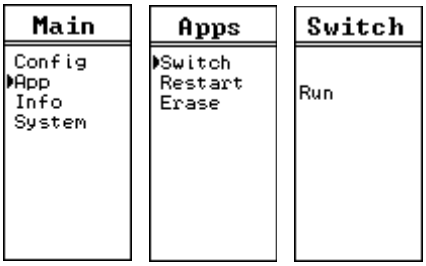
Figure 7.3: QLOAD Progress



8. The application Switch must be in Run for the application to be executed:

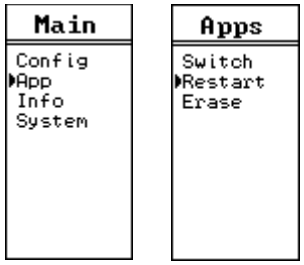
   To accomplish this, use the arrow keys on the module to navigate to the App option in the Main menu. Use the Enter or Right arrow button to select the option. Select the Switch option in the Apps menu. Use the Up or Down arrow to select the Run option. Use the Enter or Left arrow to accept the choice. See Figure 7.4

Figure 7.4: Change Application Switch to Halt



   or Restart the application. Use the arrow keys on the module to navigate to the App option in the Main menu. Select the Restart option in the Apps menu. See Figure 7.5

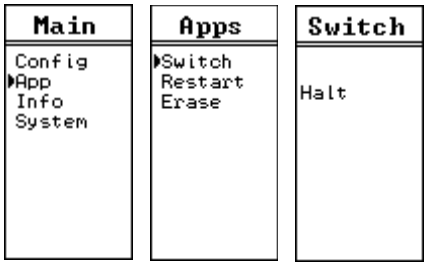
Figure 7.5: Restart the Application



QLOAD using Ethernet Port

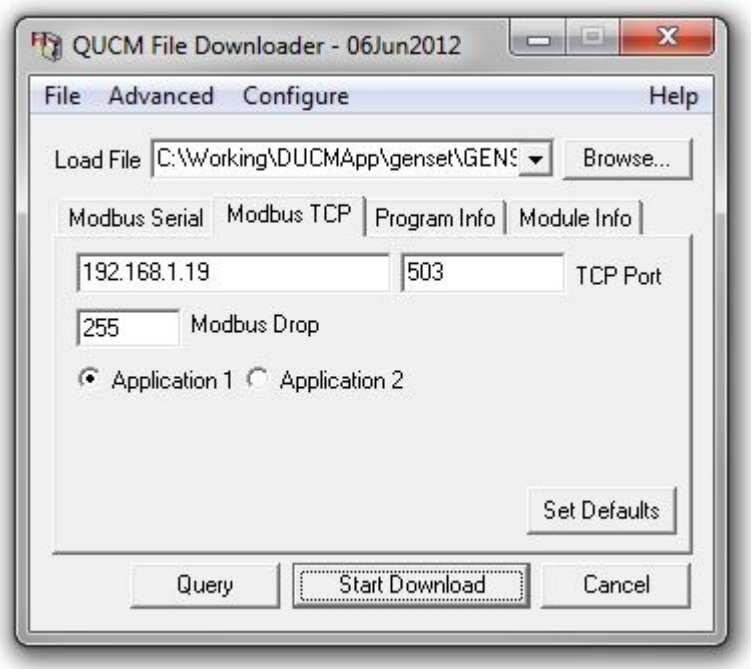
1. The module must be powered.
2. Application Switch must be in HALT. To accomplish this, use the arrow keys on the module to navigate to the App option in the Main menu. Use the Enter or Right arrow button to select the option. Select the Switch option in the Apps menu. Use the Up or Down arrow to select the Halt option. Use the Enter or Left arrow to accept the choice.

Figure 7.6: Change Application Switch to Halt



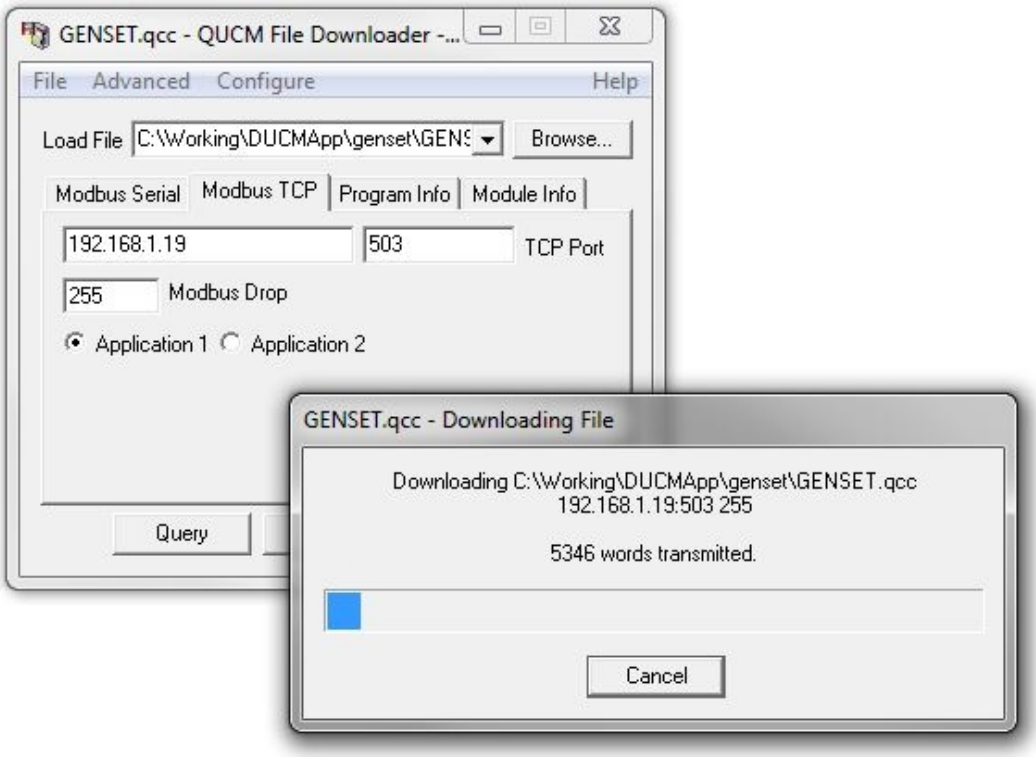
3. Start QLOAD.EXE. The Windows Start Menu link is “Start, Programs, Niobrara, Apps, QLOAD.” See Figure 7.7

Figure 7.7: QLOAD Application



4. If necessary, Click on the Browse button and select your application.
5. Click on the “Modbus TCP” tab.
6. Enter the IP address of the module(i.e. 192.168.1.19).
7. Ensure the Modbus TCP Port matches that in the module(default 502).
8. The Modbus Drop is 255.
9. The Application 1 radio button is selected.
10. Press the “Start Download” button. QLOAD will open a progress bar to show the status of the download see Figure 7.8.

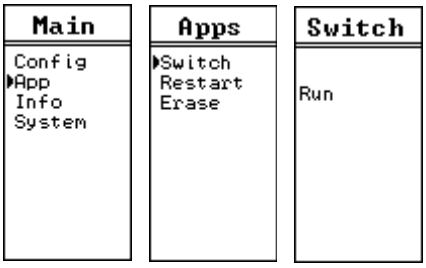
Figure 7.8: QLOAD Progress



11. The application Switch must be in Run for the application to be executed:

    To accomplish this, use the arrow keys on the module to navigate to the App option in the Main menu. Use the Enter or Right arrow button to select the option. Select the Switch option in the Apps menu. Use the Up or Down arrow to select the Run option. Use the Enter or Left arrow to accept the choice. See Figure 7.9

Figure 7.9: Change Application Switch to Halt



or Restart the application. Use the arrow keys on the module to navigate to the App option in the Main menu. Select the Restart option in the Apps menu. See Error: Reference source not found

Figure 7.10: Restart the Application