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Overview

OPTO22¹ or OPTOMUX¹ is the command set protocol used for controlling the **Control-it™** modules via the PC's serial port.

Features

- ASCII based protocol widely used in industry.
- Transmission speeds from 1200 to 115.2k baud.
- External connection to PC serial ports.

¹ OPTO22 and OPTOMUX are trademarks of OPTO 22

Quick Start

This section uses two example commands to briefly explain the construction and use of the Optomux command set.

A terminal emulator program (e.g. Telix or HyperTerminal) is used to manually construct and send the commands.

A reduced ASCII table, and a Decimal – Binary – Hexadecimal conversion table are provided on pages 69 and 70.

Set Up

- Set up the **Control-it™** module as described in the Installation manual.
- Connect your **Control-it™** module to the PC's serial port using an RS232 to RS485 converter such as the **Control-it™ 5001**.
- Set the module address to 0.

If you wish to use another address you will need to substitute it in the following examples.

- Ensure that the terminal emulator program is correctly configured as per table 5 below.

Data Parameter Set Up	
Com Port	Matched to the port where the converter is connected
Baud Rate	Matched to the setting on the module (refer to the Installation Manual)
Data Length	8 bit
Parity	No parity
Stop Bits	1

Table 5 – Data parameter set up.

First Example

The first command to try is the 'A', or Power Up Clear, command.

Not only is it a simple one to construct, it is also the first command required by all **Control-it™** remote modules.

- In your terminal emulator program type the following characters after each other:
 - > ['greater than' sign (ASCII char 63)]
 - 0 [zero (ASCII char 48)]
 - 0 [zero (ASCII char 48)]
 - A [upper case letter (ASCII char 65)]
 - ? [question mark (ASCII char 63)]
 - ? [question mark (ASCII char 63)]
- The command will now look like this:

>00A??

'>' is the first character of every command. It tells the remote module that a new command is starting and to listen.

'00' is the address, in Hexadecimal, of the remote module.

'A' is the power up clear command.

'??' replaces the checksum which will be discussed later.

- Add the **<CR>** [carriage return character (ASCII char 13)] by pressing Enter.
<CR> is the last character on all commands, telling the remote module that the command is complete.
- The module will acknowledge this command by returning an 'A' character.

If this does not happen check both your module and terminal program set ups.
- The module is now cleared and ready to receive more commands.

Second Example

The second command to try involves setting outputs. This example will turn outputs 8, 11 and 14 ON.

The 'J', or Write Outputs, command allows you to send a hexadecimal number, representing the module's I/O positions, indicating which ones you want turned on and off.

- In your terminal emulator program type the following command:

>00J490077<CR>

Remember, <CR> is added by pressing the ENTER key.

- Outputs 8, 11 and 14 will now be on and the module will return an 'A' character to acknowledge the command.

NB The remote module will always return an 'A' unless data has been requested (such as reading input states) or an error has occurred (refer to page 14 for more on error codes).

If this does not happen check both your module and terminal program set-ups.

- '>', '00' and '<CR>' are the same as for the previous example.
- 'J' is the Write Outputs command.
- '4900' is the position fields, and indicates which positions (0 – 15) are to be turned ON. The '4900' is calculated as follows:

A binary number is created by placing a '1' at each position to be turned ON, with position 15 as the MSB. This is then converted to Hexadecimal for use in the command. Table 6 demonstrates this.

Position Field calculation for Second Example																
Positions	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Binary	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Hexadecimal	4				9				0				0			

Table 6 - Position Field calculation for Second Example

For more detail on this refer to ***Position Field***, page 10.

- '77' is the checksum for this command.
This is the last two characters of the sum of the hexadecimal ASCII values of each character in the command, excluding the '>' start character. Table 7 demonstrates this.

Checksum calculation for Second Example										
Command	>	0	0	J	4	9	0	0	Sum	Checksum Used
ASCII (Hex)	N/A	30	30	4A	34	39	30	30	= 177	77

Table 7 - Position Field calculation for Second Example

For more detail on this refer to ***Checksum***, page 11.

Command Construction

The Optomux commands are made up of individual ASCII characters, each with a special purpose.

The general command from the PC takes the following general form:

>AACPPPPDDSS<CR>

Component	Description
>	The start character. (ASCII char 62)
AA	The address of the target module in Hexadecimal from 00 to FF.
C	The Command set character. Refer to specific command for further details.
PPPP	The position field used with some commands to define the target position(s).
DD	The data or modifier used with some commands. Refer to the specific command description for further details.
SS	The command Checksum.
<CR>	The end character - Carriage Return. (ASCII char 13)

Start Character [>]

The first character of every command is always the 'greater than' sign (ASCII char 62).

- This alerts the **Control-it™** module that a new command is starting and to listen.

Module Address [AA]

This is the Hex address of the target module.

- The decimal address set by the Address Jumpers on the module must be converted to its hexadecimal equivalent for

use in the command.

A hex to decimal conversion table is provided on page 69.

- As this is always 2 characters, address' 0 to 15 (decimal) are expressed as 00 to 0F (hex).

Position Field [PPPP]

The position field contains between 0 and 4 hex digits, each representing 4 positions on the module.

- 0 hex digits control all positions.
- 1 hex digit controls positions 0 to 3.
- 2 hex digits control positions 0 to 7
- 3 hex digits control positions 0 to 11
- 4 hex digits control positions 0 to 15

In its binary form each bit represents a position on the module with the least significant bit (LSB) representing Position 0. By placing a '1' at the bit or bits that represent the target position(s), the field number (in Hex) can be calculated.

If no position characters are sent, the assumed value is FFFF (all 1's).

A hex to binary conversion table is provided on page 69.

Examples:

Table 8 shows three Position Field examples.

- On the left are the example module positions to be targeted.
- The centre section lays out the module positions and constructs a binary number by placing a 1 at each target position.
- The right hand column is the Hex equivalent of this binary number for use in the Optomux command.

Position Field Examples					
Target Positions	Module Positions				Position Field (Hex)
	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0	
3				1 0 0 0	8
1 & 6			0 1 0 0	0 0 1 0	42
6, 7 & 14	0 1 0 0	0 0 0 0	1 1 0 0	0 0 0 0	40C0

Table 8 - Position Field Examples

Checksum [SS]

The Checksum is your protection against corrupted messages being received as valid messages.

The Checksum is calculated by summing the ASCII decimal values of each character, converting the result to Hex and using the last two digits. The '>' is not included in the Checksum.

- For purposes of testing, the Checksum can be replaced with "??" in all commands.
- For final use in production equipment the Checksum must be calculated and sent.

Example:

Command	>	0	2	K	1	2	3	4
ASCII value (decimal)	Not used	48	50	75	49	50	51	52

- Adding all the values gives $48 + 50 + 75 + 49 + 50 + 51 + 52 = 375$
- $375(\text{decimal}) = 177(\text{hex})$ therefore the checksum is 77

-
- The complete command with the Checksum is now

>02K123477<CR>

Carriage Return [<CR>]

<CR> is always the last character sent. It tells the **Control-it™** module that the command is completed.

- The carriage return is executed by adding ASCII char 13 immediately after the checksum in the command.
- In a manual set up, such as with Telex or Hyperlink, the <CR> is added when the ENTER key is pressed.

Returns

A successfully completed command will return an 'A' and <CR>

- If the command required data to be returned then an 'A', data, checksum, and <CR> is returned

i.e. A[data][checksum]<CR>

An unsuccessful command will return an error code indicating the problem.

- A complete list of error codes is provided in the next section.

Error Codes

Errors will occur if a command is constructed incorrectly (e.g. wrong command character or incorrect data) or there is a problem with transmission (e.g. checksum error or message time out).

The return from the module upon detecting an error is

N0x where x is the relevant error number.

This number will also be displayed by the red WD/ERR LED on the module itself, as repeated flashes.

Table 9 list the error codes and their meanings.

Opto22 Error Codes		
Return	Name	Description
N00	Power Up Clear Expected	A command other than 'A' was attempted after power-up or power failure. Once this error is received, the next command will be executed normally.
Important Receiving the N00 error means the module has undergone a power-up sequence and will have reset all characteristics to default. These will need to be re-initialised.		
N01	Undefined Command.	The Command character is not a legal character.
N02	Checksum Error.	The checksum did not match the sum of the characters.
N03	Buffer Overrun.	Command contained more than 16 characters.
N04	Non-Printable ASCII Character Received.	Command ignored
N05	Data Field Error.	[positions], [data], [modifier] or [type] numbers are out-of-range or not recognised.
N06	RS485 Watchdog Timeout Error.	No activity on RS485 line before watchdog time set by D or m command has timed-out.
N07	Specified Limits Invalid	

Table 9 – Opto22 Error Codes

Communication Parameters

Opto22 & Optomux uses the communication parameters shown in table 10.

Communication Parameters	
Baud Rate	Matched to the setting on the module (refer to <i>Jumper Configuration</i> in the Installation Manual)
Data Length	8 bit
Parity	No parity
Stop Bits	1

Table 10 – Optomux Communication Parameters

Digital Command Set Summary

General Command:

>[Address]**Char**[Additional Structure][Checksum]<**CR**>

(l/c) indicates lower case character.

Description	Char	Additional Structure	Page
Set-Up			
Power up clear	A		19
Reset	B		20
Set turn-around delay	C	[data]	21
Set watchdog delay	D	[data]	22
Set protocol	E	[data]	23
Identify module type	F		25
Enhanced Digital Watchdog	m (l/c)	[position][data]	on page 26
Set timer resolution	n (l/c)	[data]	27
Configuration			
Configure position	G	[position]	on page 28
Configure as inputs	H	[position]	on page 29
Configure as outputs	I	[position]	on page 30
Read module configuration	j (l/c)		31
Digital Read/Write			
Write outputs	J	[position]	32
Activate outputs	K	[position]	on

			page 33
Deactivate outputs	L	[position]	34
Read On/Off status	M		35
Digital Latch			
Set latch edges	N	[position]	36
Set latch OFF to ON	O	[position]	37
Set latch ON to OFF	P	[position]	38
Read latches	Q		39
Read and Clear latches	R	[position]	40
Clear latches	S	[position]	41
Digital Counter			
Start/Stop counter	T	[position]	43
Start counter	U	[position]	44
Stop counters	V	[position]	45
Read counters	W	[position]	46
Read and Clear counters	X	[position]	48
Clear counters	Y	[position]	49
Time Delay and Pulse			
Set Time Delay	Z	[position][type][data]	on page 50
Read Trigger Time Delay	h (l/c)	[position]	53
Generate n Pulses	i (l/c)	[positions][modifier] [data]	on page 54
Start ON Pulse	k (l/c)	[position][data]	on page 56
Start OFF Pulse	l (l/c)	[position][data]	on page 57

Pulse Duration Measurement			
Measure Pulse Duration	a (l/c)	[position]	on page 58
Measure ON Pulse Duration	b (l/c)	[position]	on page 60
Measure OFF Pulse Duration	c (l/c)	[position]	on page 62
Read Pulse Complete Bits	d (l/c)		on page 63
Read Duration Counter	e (l/c)	[position]	on page 65
Read & Clear Duration Counter	f (l/c)	[position]	on page 67
Clear Duration Counter	g (l/c)	[position]	on page 68

Set Up Commands

Power Up Clear

A

USE

Informs the Control-it 50x0 that a normal power up has occurred.

STRUCTURE

A

COMMENTS

When power is applied to the Control-it 50x0 modules they expect the first command to be an 'A' command. If this is not so then a N00 error is returned and the command sent will not be carried out.

If during normal operation an N00 error is received by the controlling computer then an unexpected power down and power up has occurred on a remote module.

RETURNS

A<CR>

Reset**B**

USE

Resets the Control-it 50X0 back to power up conditions.

STRUCTURE

B

COMMENTS

Power on or reset causes the following actions to be performed

- All outputs turned off
- All positions then configured as inputs
- Turn around delay = 0
- Counters / duration timers cancelled
- Latches cleared
- Timer resolution = 10ms

RETURNS

A<CR>

Set Turn-Around Delay **C[Data]**

USE

Causes the Control-it 50x0 to wait for a time before responding to commands.

STRUCTURE

C[Data] NB - Data field must be included.

COMMENTS

The (data) causes the following delays

Data	Function
0	Turn around delay = 0
1	10mSec
2	100mSec
3	500mSec

RETURNS

A<CR>

Set Digital Watchdog**D[data]**

USE

Cause the Control-it 50X0 to monitor activity on the RS485 bus and take the specified action if there is no activity for the programmed time.

This command has no affect on the Control-it 5040 as it only has inputs.

STRUCTURE

D[data] NB - Data field must be included.

COMMENTS

The (data) field contains a single ASCII digit between 0 and 7 that specifies the time interval and desired action. Times and actions are shown below.

(Data)	Time	ACTION
0		Watchdog disabled
1	10 secs	Turn all outputs OFF
2	1 minute	Turn all outputs OFF
3	10 minutes	Turn all outputs OFF
4		Watchdog disabled
5	10 secs	Turn output 0 ON, all other outputs OFF *
6	1 minute	Turn output 0 ON, all other outputs OFF *
7	10 minute	Turn output 0 ON, all other outputs OFF *

* Only the Control-it 5020 has a relay in positions 0 to 7.

RETURNS

A<CR>

Set Protocol**E[data]**

USE

Sets the Control-it 50X0 to either 2 pass or 4-pass protocol.

STRUCTURE

E[data] NB - Data field must be included.

COMMENTS

The [data] field contains a single ASCII digit, 0 or 1, that specifies the protocol.

(Data)	PROTOCOL
0	Two-Pass
1	Four-Pass

The normal operation of the Control-it 50X0 system is the 2-pass protocol. During testing it can be useful to change temporarily to 4-pass protocol. The Control-it 50X0 stays in 4-pass mode until power down or an E0 command is sent.

1. The 2-pass protocol

The host sends a command to the Control-it 50X0 (such as >04M??<CR>).

If the command was executed successfully then an A and <CR> will be returned, or if the command required data to be returned then an A, data, checksum, and <CR> is returned.

2. The 4 Pass protocol

The host sends a command to the Control-it 50X0 (such as >04M??<CR> see section 0).

If no error was detected then the command is echoed with the > replaced with an A. An error will cause a return of a normal error code such as N02.

The host must now send an E<CR> to cause the command to be executed.

The execution of the command causes the standard 2 pass response to a successful command as shown above.

EXAMPLES

A four pass example will be looked at. The board has an address of 04.

Switch to 4 pass mode >04E1DA<CR>. The response is the normal A.

Sending request for the input status in 4-pass mode.

From the host	>04MB1<CR>
From the CONTROL-IT 50X0	A04MB1<CR>
From the host	E<CR>
From the CONTROL-IT 50X0	A0011??<CR>

Identify Module Type

F

USE

The Control-it 5020, 5030 and 5040 will always report itself as a digital controller i.e. the response is 00.

STRUCTURE

F

RETURN

A0060<CR>

Enhanced Digital Watchdog

m[Positions][Data]

USE

This monitors the serial line for activity like the D command, but gives a finer resolution.

It is also possible to cause more than one output to come on if the serial line times out.

STRUCTURE

m[positions][data]

COMMENTS

(Positions) indicates the outputs that will be turned on if a serial timeout occurs. See **Position Field** (page 10) for more detail.

(data) indicates the time before timeout occurs and contains 0, 2, 3 or 4 characters in the range 14(hex) to FFFF(hex).

Timeout = (data) x 10mSecs.

A delay time of zero disables the watchdog function.

If the timeout is below the lower limit of 200mSecs then a N07 error is returned.

EXAMPLE

Set a timeout of 3 seconds. Turn on relays 8 and 9 on timeout.

[positions] = 0000 0011 0000 0000

= 0 3 0 0 (4 digits must be used)

[data] = 3000msec / 10msec

= 300 dec

= 12C hex

>04m030012C??

Set Timer Resolution

n[data]

USE

Acts as a divider for the time base of the commands listed below.

STRUCTURE

n[data]

COMMENTS

[data] contains 2 ASCII Hex digits in the range 00 to FF

- If [data] is 0, the timer resolution is 2.56 seconds.

The time base is normally 10 millisecs. By applying this command the timebase becomes:

$$\text{TSR} = [\text{data}] \times 10\text{mSecs}$$

This timebase is used on the following commands:

- Initiate Square Wave
- High Resolution Square Wave
- Generate N pulses
- Set Time Delay
- Start ON pulse
- Start OFF pulse
- Set Time delay
- Read Duration Counters
- Read and Clear Duration Counters
- Read Pulse Complete Bits

RETURN

A<CR>

I/O Configuration Commands

Configure Positions

G[positions]

USE

Specifies the positions of the relays and inputs. The Control-it 50x0 modules come pre-configured so it is not necessary to use this command.

If your software insists on using this command then because the Control-it 5020, Control-it 5030 and Control-it 5040 have fixed positions you must use the correct configuration.

STRUCTURE

G[positions]

COMMENTS

0 is used for inputs and 1 is used for outputs.

The Control-it 5020 has only outputs so use command >04GFFFF??<CR>

The Control-it 5030 has inputs in positions 0 to 7 and outputs in positions 8 to 15. Use command >04GFF00??<CR>

Control-it 5040 has only inputs so use command >04G0000??<CR>

Configure as Inputs

H[positions]

USE

Specifies the positions to act as inputs. Control-it 5000 modules come pre-configured so it is not necessary to use this command. If your software insists on using this command then because the Control-it 5020, Control-it 5030 and Control-it 5040 have fixed positions you must use the correct configuration.

STRUCTURE

H[positions]

COMMENTS

Use 1 for each input position.

The Control-it 5020 has no inputs so use command
>04H0000??<CR>

The Control-it 5030 has inputs in positions 0 to 7. Use command
>04H00FF??<CR>

The Control-it 5040 has only inputs so use command
>04HFFFF??<CR>

Configure as Outputs

I[positions]

USE

Specifies the positions to act as outputs. Control-it 50X0 modules come pre-configured so it is not necessary to use this command. If your software insists on using this command then because the Control-it 5020, Control-it 5030 and Control-it 5040 have fixed positions you must use the correct configuration.

STRUCTURE

I[positions]

COMMENTS

Use 1 for each output position.

The Control-it 5020 has only outputs so use command
>04IFFFF??<CR>

The Control-it 5030 has outputs in positions 8 to 15. Use command
>04IFF00??<CR>

The Control-it 5040 has only inputs so use command
>04H0000??<CR>

Read Module Configuration

j

USE

Returns the positions that are outputs.

STRUCTURE

j

COMMENTS

Where ever there is an output a 1 is returned.

Module	I/O	Return
5020	16 Inputs	AFFFF18<CR>
5030	8 Inputs, 8 Outputs	AFF000E<CR>
5040	18 Outputs	A000004<CR>

Digital Read & Write Commands

Write Outputs

J[positions]

USE

Turns outputs ON and OFF

STRUCTURE

J[positions]

COMMENTS

This is an unmasked command, therefore all outputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position OFF
- 1 indicates position ON

Time delays, if set, are implemented upon execution of this command.

Positions that have been configured to function as inputs are not affected by this command.

RETURN

A<CR>

Activate Outputs

K[positions]

USE

Turns indicated outputs ON and ignores the others.

STRUCTURE

K[positions]

COMMENTS

This is a masked command, therefore only indicated outputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position ignored
- 1 indicates position ON

Time delays, if set, are implemented upon execution of this command.

Positions that have been configured to function as inputs are not affected by this command.

RETURN

A<CR>

Deactivate Outputs**L[Positions]**

USE

Turns indicated outputs OFF and ignores the others.

STRUCTURE

L[positions]

COMMENTS

This is a masked command, therefore only indicated outputs are affected.

[positions] holds the module position information as described in **Position Field** (page 10).

- 0 indicates position ignored
- 1 indicates position OFF

Time delays, if set, are implemented upon execution of this command.

Positions that have been configured to function as inputs are not affected by this command.

RETURN

A<CR>

Read On/Off Status

M

USE

Read which positions are ON

STRUCTURE

M

COMMENTS

The ON/OFF state of all 16 inputs and outputs are returned.

- 0 indicates a position OFF.
- 1 indicates a position ON.

RETURN

A[data][checksum]<CR>

[data] is structured the same as [position] for other commands.
Details of it's layout are in **Position Field** (page 10).

Digital Latch Commands

Set Latch Edges

N[positions]

USE

Sets up inputs to latch ON to OFF, or OFF to ON transitions. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

N[positions]

COMMENTS

This is an unmasked command, therefore all inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates that the OFF to ON transition will be latched
- 1 indicates that the ON to OFF transition will be latched

Set Off-to-On Latches

O[positions]

USE

Sets indicated inputs to latch OFF to ON transitions and leaves the others unchanged. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

O[positions]

COMMENTS

This is a masked command, therefore only indicated inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position left unchanged
- 1 indicates OFF to ON transition latched

EXAMPLE

```
>0403??<CR>
```

Sets positions 0 and 1 to latch OFF to ON transitions. Positions 2 to 15 are unchanged.

Set On-to-Off Latches

P[positions]

USE

Sets indicated inputs to latch ON to OFF transitions and leaves the others unchanged. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

P[positions]

COMMENTS

This is a masked command, therefore only indicated inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position left unchanged
- 1 indicates ON to OFF transition latched

Read Latches

Q

USE

Reads back the inputs that have been latched. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

Q

COMMENTS

Returns (without clearing) the current state of all latches. The edge to be checked has been set up in commands N, O, and P.

RETURN

A[data][checksum]<CR>

A 1 in [data] indicates a valid transition at that position.

[data] is structured the same as [position] for other commands. Details of its layout are in **Position Field** (page 10).

EXAMPLE

If A800113<CR> is returned then inputs 0 and 15 have had valid transitions.

Read and Clear Latches

R[positions]

USE

Reads all inputs to determine if they have been latched. After reading, clears the inputs determined by [positions]. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

R[positions]

COMMENTS

Returns the latch state of all positions. Bits corresponding to Output positions should be ignored.

The edge to be checked has been set up in commands N, O, and P.

After reading, the latches selected by [position] are cleared. For more detail on [position] refer to ***Position Field*** (page 10)

RETURN

A[data][checksum]<CR>

A 1 in [data] indicates a valid transition at that position.

[data] is structured the same as [position] for other commands. Details of its layout are in ***Position Field*** (page 10).

EXAMPLE

>04RF00FA2<CR>

Reads all latches on module 4.

If A8001 is returned then inputs 0 and 15 have had valid transitions.

Latches 0 to 3, and 12 to 15, are now cleared.

Clear Latches

S[positions]

USE

Clear the specified latches to the unlatched state. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

S[positions]

COMMENTS

This is a masked command, therefore only indicated inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position left unchanged
- 1 indicates latch to be cleared

If [positions] is left clear then all latches will be cleared.

Digital Counting Commands

Counter Characteristics

- Counters start at zero and count upwards
- The maximum count is 65,535 and then the counter rolls over to zero
- The maximum frequency of count is 350Hz.
- The minimum pulse width is 150 μ Secs.
- Stopping a counter does not change its value.
- When a counter is started its current value is unchanged.

Start or Stop Counters

T[positions]

USE

Starts or stops counters in the specified positions. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

T[positions]

COMMENTS

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position stopped
- 1 indicates position started

EXAMPLE

```
>04T8020<CR>
```

Start counter at position 7. Stop counters in positions 0 to 6 on board 4. Other positions are unaffected.

For counter characteristics see Counter Characteristics (page 42).

Start Counters

U[positions]

USE

Starts in the specified positions and leaves the others unchanged.
(Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

U[positions]

COMMENTS

This is a masked command, therefore only indicated inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position left unchanged
- 1 indicates counter started

Stop Counters

V[positions]

USE

Stops in the specified positions and leaves the others unchanged.
(Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

V[positions]

COMMENTS

This is a masked command, therefore only indicated inputs are affected.

[positions] holds the module position information as described in ***Position Field*** (page 10).

- 0 indicates position left unchanged
- 1 indicates counter stopped

Read Counters

W[positions]

USE

Reads the counter values from the specified positions and leaves the others unchanged. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

W[positions]

COMMENTS

The command has no effect on the current value of the counters.

[positions] holds the module position information as described in **Position Field** (page 10).

- 0 indicates position to be ignored
- 1 indicates counter to be read

RETURN

Values are returned as 4 digit hex numbers representing 0 to 65535 (decimal).

Counter values are returned in sequence from highest to lowest position.

Attempts to read an output result in '????' being returned for that position.

EXAMPLE

```
>04W1F0??<CR>
```

Read counters from positions 4 to 8 on board 4.

The response from a Control-it 5030 module might be:

```
>A????777712345555000036
```

POSITION	COUNT (hex)	COUNT (decimal)	COMMENT
8	????	????	On a PC5030 position 8 is an output
7	7777	30583	Input 7 has had 30583 pulses
6	1234	4660	Input 6 has had 4660 pulses
5	5555	21845	Input 5 has had 21845 pulses
4	0000	0000	Input 4 has had no pulses

Read and Clear Counters***X[positions]*****USE**

This command reads the counters just as for the Read Counters (W) command, but then clears them.

STRUCTURE

X[positions]

Clear Counters**Y[positions]****USE**

Zeros the counters at the specified positions and leaves the others unchanged. (Use on Control-it 5030 and Control-it 5040 modules only).

STRUCTURE

Y[positions]

COMMENTS

[positions] holds the module position information as described in **Position Field** (page 10).

- 0 indicates position to be ignored
- 1 indicates counter to be zeroed

Digital Time Delay & Pulse Commands

Set Time Delay

Z[positions][type][data]

USE

Sets specified output positions to be used in a pulsed or delayed mode.

STRUCTURE

Z[positions][type][data]

COMMENTS

[positions] indicates the module positions to be set as described in **Position Field** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be set

[type] modifier contains a single ASCII character which specifies the type of delay to be used. Valid delay types are:

[type]	Description	
G	Normal Operation - turn off existing delay (when using this, [data] may be omitted from the command message)	
H	When instructed to go from Off to ON, turn On for desired time, then turn OFF.	
I	When instructed to go from OFF to ON, Stay OFF for desired time, then turn ON.	
J	When instructed to go from ON to OFF, turn OFF for desired time, then turn ON.	
K	When instructed to go from ON to OFF, stay ON for desired time, then turn OFF.	
L	Initiate a continuous square wave with "ON" and "OFF" times computed as follows:	"ON" time = $256 \times TRS^1 \times$ the first two digits in the data field (leftmost characters).
		"OFF" time = $256 \times TRS^1 \times$ the last two digits in the data field.

M	Initiate a continuous high resolution square wave with “ON” and “OFF” times computed as follows:	“ON” time = TRS ¹ x the first two digits in the data field (leftmost characters)
		“OFF” time = TRS ¹ x the last two digits in the data field.

¹ TRS is the Timer Resolution Setting, in mSecs, as set by the “Set Timer Resolution Command” (refer page 27). The default for TRS is 10mSec.

- With type L and M modifiers, the square wave will continue to be output until the delay type for the output is changed or turned off. The “WRITE OUTPUTS”, “ACTIVATE OUTPUTS”, and “DEACTIVATE OUTPUTS” commands will have no effect when using the type L and M modifiers.

[data] contains from 1 to 4 ASCII-hex digits representing the length of the delay. The actual delay time is equal to

$$\text{desired time} = [\text{data}] \times \text{TRS}$$

or

$$[\text{data}] = \frac{\text{desired time}}{\text{TRS}}$$

Where TRS is the Timer Resolution Setting, in mSecs, as set by the “Set Timer Resolution Command” (refer page 27). The default for TRS is 10mSec.

NB A value of 0 for [data] is equivalent to a value of FFFF (65,535).

EXAMPLES

All examples assume a TRS value of 10ms.

1. >89ZCI66C3<CR>

Set module positions 2 and 3 at the module address 89 for delay type I with a pulse length of 1.02sec.

2. >24Z1000GC8<CR>

Turn off existing delay at the module address 24, position 12.

3. >11Z66L015842<CR>

At address 11, set positions 6, 5, 2 and 1 for a square wave --ON 2.56sec, OFF 3.75min.

4. >1EZ42M041F5E<CR>

At address 1E, set positions 1 and 6 for high resolution square wave--ON 40 ms, and OFF for 310 ms.

Read Trigger Time Delay

h[positions]

USE

This command can be used to extend the time-out period of an output.

STRUCTURE

h[positions]

COMMENTS

This command overrides an existing delayed output by setting the time delay counter to the original value, then re-triggering the time delay if it was active.

- The original time delay was set by the “SET TIME DELAY” command (refer page 50).
- This command does not effect square wave generation.

[positions] indicates the module positions to be set as described in ***Position Field*** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be set

EXAMPLE

```
>2Eh2041cr
```

This command instructs the MODULE at address 2E to re-trigger a time delay on module position 5.

Generate n Pulses *i*[positions][modifier][data]

USE

Output a specified number of pulses from specified positions.

STRUCTURE

i[positions][modifier][data]

COMMENTS

[positions] indicates the module positions to be set as described in **Position Field** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be set

[modifier] must be two digits (00 - FF) and represents one half of the period for the pulses in increments of the Timer Resolution Setting (refer page 27).

i.e. Pulse Width = [modifier] x TSR

& Period = 2 x [modifier] x TSR

- All pulses have a 50% duty cycle.
- A [modifier] of 0 will cancel any time delay or pulse stream currently being generated by the specified output.
- Sending this command when a pulse train is already active, will cause the pulse train to be re-triggered with the latest values.

[data] can be from 0 to 4 ASCII-hex digits (0 to FFFF) and represents the number of pulses to be output.

- A 0 in this field will generate 65,536 pulses.

EXAMPLE

```
>CCi0040320064E2cr
```

This example instructs the module at address CC to output 100 pulses at position 6. Assuming the Timer Resolution Setting (TRS) is 10 ms, the pulses will have periods of 1 sec (500ms OFF, 500ms ON).

Start 'On' Pulse

k[positions][data]

USE

Turns on all specified outputs for a specific length of time.

STRUCTURE

k[positions][data]

COMMENTS

[positions] indicates the module positions to be set as described in ***Position Field*** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be set

[data] may be 0 to 4 ASCII-hex characters, and represents the period of the "ON" pulse in increments of the Timer Resolution Setting (refer page 27).

- If a zero is specified, the command does nothing.
- If no [data] value is given, a zero is assumed.

This function is re-triggerable, therefore it can be used as a watchdog circuit by continuously sending this command at a rate faster than the pulse length.

To cancel this pulse, set [data] to a 1, and the pulse will turn off and the outputs will be deactivated within one timer increment.

EXAMPLE

```
>BBk000514??cr
```

This command configures positions 2 and 0 of the MODULE at address BB to generate an "ON" pulse for a duration of 20 times the Timer Resolution Setting (TRS). All other positions are not effected.

Start 'Off' Pulse***l*[positions][data]****USE**

Turns off all specified outputs for a specific length of time.

STRUCTURE

l[positions][data]

NB This command letter is a lower case L

COMMENTS

This command is identical to Start 'ON' Pulse, k (refer page 56), except that the pulse is OFF

Pulse Duration Measurement Commands

Measure Pulse Duration

a[positions]

USE

Instructs the module to measure ON and OFF pulses

STRUCTURE

a[positions]

COMMENTS

[positions] indicates the module positions to be measured as described in ***Position Field*** (page 10).

- 0 indicates position to measure OFF duration
- 1 indicates position to measure ON duration

The MODULE will measure the duration of the first pulse of the appropriate level and store the result to be recalled by the host.

- As soon as the MODULE has measured a complete pulse for any position, a “pulse complete bit” is set to indicate that an entire pulse has been measured. The host computer can read the pulse complete bits to determine whether the MODULE has finished the measurement process, and can then read the values of the pulse duration counters, if any.
- Maximum pulse duration is FFFF (65,535) x TRS, where TRS is the Timer Resolution Setting (refer page 27)
- This command does not clear pre-existing duration counter values or pulse complete bits. If a positions “pulse complete bit” has been previously set, no measurements are made until that position’s “pulse complete bit” and duration counter are cleared by either the CLEAR DURATION COUNTERS command or the READ AND CLEAR DURATION COUNTERS command.

EXAMPLE

>88a506c<CR>

Instructs the MODULE at address 88 to configure positions 2 and 0 to measure "ON" pulses, positions 1 and 3 to measure "OFF" pulses and leave all other positions unchanged.

Measure 'On' Pulse Duration

b[positions]

USE

Sets the specified positions to measure the duration of 'ON' pulses.

STRUCTURE

b[positions]

COMMENTS

[positions] indicates the module positions to be set as described in **Position Field** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to measure ON pulses

The MODULE will measure the duration of the first positive pulse and store the result to be recalled by the host.

- As soon as the MODULE has measured a complete pulse for a given position, a "pulse complete bit" is set to indicate that an entire pulse has been measured. The host computer can read the pulse complete bits to determine whether the MODULE has finished the measurement process, and can then read the values of the pulse duration counters, if any.
- Maximum pulse duration is FFFF (65,535) x TRS, where TRS is the Timer Resolution Setting (refer page 27)
- This command does not clear pre-existing duration counter values or pulse complete bits. If a position's "pulse complete bit" has been previously set, no measurements are made until that position's "pulse complete bit" and duration counter are cleared by either the CLEAR DURATION COUNTERS (page 68) command or the READ AND CLEAR DURATION COUNTERS (page 67) command.

EXAMPLE

>BBb51B<CR>

This command configures positions 2 and 0 to measure “ON” pulses at the MODULE address BB. All other positions are not effected.

Measure 'Off' Pulse Duration***c[positions]*****USE**

Sets the specified positions to measure the duration of 'OFF' pulses.

STRUCTURE

c[positions]

COMMENTS

This command is identical to Measure 'ON' Pulse Duration, b (refer page 60), except that 'OFF' pulses are measured.

Read Pulse Complete Bits

d

USE

Allows PC to determine which positions have completed the pulse duration measurement period.

STRUCTURE

d

COMMENTS

Each position with a completed pulse duration measurement sets its pulse complete bit to 1.

No further measurements can be made at positions with a PCB = 1 until the pulse complete bits are reset using either the READ AND CLEAR DURATION COUNTERS (page 67) or the CLEAR DURATION COUNTERS (page 68) command.

RETURN

A[data][checksum]<CR>

[data] is structured the same as [position] for other commands. Details of its layout are in ***Position Field*** (page 10).

- 0 indicates position has not completed measurement or is not set to measure.
- 1 indicates position has completed measurement.

EXAMPLE

Inputs 0 to 7 have been configured to measure pulse duration.

>76dD1<CR>

Message sent from PC requesting the pulse complete bits from the module at address 76.

A13A5<CR>

Return message from the module indicating the proper level pulse has been measured for positions 1, 2 and 4.

Read Pulse Duration Counters

e[positions]

USE

Returns the pulse duration counter values for the specified positions.

STRUCTURE

e[positions]

COMMENTS

[positions] indicates the module positions to be read as described in ***Position Field*** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be read

If this command is used before the pulse has finished, the current duration will be returned.

- To verify that a pulse has completed, use the ***READ PULSE COMPLETE BITS*** command (page 63).

RETURN

Pulse duration values are returned as 4 ASCII-hex digits representing a single 16 bit number (0 to 65,535 decimal).

- Values are returned in sequence from highest to the lowest module position.
- Attempts to read an output will result in a string of four "????", being returned for that position.

The duration of the measured pulse can be calculated as follows:

$$\text{duration} = [\text{returned data}] \times \text{TRS}$$

Where TRS is the Timer Resolution Setting (refer page 27)

EXAMPLE

>01e2023A<CR>

Command sent from host requesting the counter value of position 1 & 9 on the module at address 01.

A6090A93CBF<CR>

Message returned from the module indicating that the duration of the pulse measured was as follows. This example assumes a TRS value of 20mSec.

6090 hex = 24720 dec $24720 \times \text{TRS} = 494.4\text{sec} = 8.24\text{min}$

A93C hex = 43324 dec $43324 \times \text{TRS} = 866.48\text{sec} = 14.44\text{min}$

Read and Clear Duration Counters ***f[positions]***

USE

Returns pulse duration counter values for the specified positions and then clears them to enable measurement of the next pulse.

STRUCTURE

f[positions]

COMMENTS

This command works in the same fashion as the ***READ PULSE DURATION COUNTERS*** command (refer page 65) with the addition of clearing the specified Pulse Counter and Pulse Complete Bit.

Resetting the Pulse Complete Bit allows measurement of the next pulse.

If this command is used before the pulse has finished, the current duration will be returned, the counting will stop and the pulse complete bit will not be set.

- To verify that a pulse has completed, use the ***READ PULSE COMPLETE BITS*** command (page 63).

Clear Duration Counters***g[positions]*****USE**

Clears the duration counters and pulse complete bits for the specified positions to enable measurement of the next pulse.

STRUCTURE

g[positions]

COMMENTS

[positions] indicates the module positions to be cleared as described in ***Position Field*** (page 10).

- 0 indicates position to be ignored
- 1 indicates position to be cleared (both duration counter and pulse complete bit).

Reference Tables

Hexadecimal – Binary – Decimal Conversion Table

Hexadecimal – Binary – Decimal Conversion Table					
Hex	Binary	Decimal			
		Most Significant Bytes		Least Significant Bytes	
		IV	III	II	I
0	0 0 0 0	0	0	0	0
1	0 0 0 1	4096	256	16	1
2	0 0 1 0	8192	512	32	2
3	0 0 1 1	12288	768	48	3
4	0 1 0 0	16384	1024	64	4
5	0 1 0 1	20480	1280	80	5
6	0 1 1 0	24576	1536	96	6
7	0 1 1 1	28672	1792	112	7
8	1 0 0 0	32768	2048	128	8
9	1 0 0 1	36864	2304	144	9
A	1 0 1 0	40960	2560	160	10
B	1 0 1 1	45056	2816	176	11
C	1 1 0 0	49152	3072	192	12
D	1 1 0 1	53248	3328	208	13
E	1 1 1 0	57344	3584	224	14
F	1 1 1 1	61440	3840	240	15

Using the table.

- Decimal value = IV+III+II+I
e.g. D42 (Hex) = 0+3328+64+2 = 3394 (Dec)
- Binary value is a group of four bits for each hexadecimal character.
e.g. D42 (Hex) = 1101,0100,0010 (Bin)

ASCII Character Table (Reduced)

Reduced ASCII Character Table								
Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
13	D	<CR>	74	4A	J	101	65	e
48	30	0	75	4B	K	102	66	f
49	31	1	76	4C	L	103	67	g
50	32	2	77	4D	M	104	68	h
51	33	3	78	4E	N	105	69	i
52	34	4	79	4F	O	106	6A	j
53	35	5	80	50	P	107	6B	k
54	36	6	81	51	Q	108	6C	l
55	37	7	82	52	R	109	6D	m
56	38	8	83	53	S	110	6E	n
57	39	9	84	54	T	111	6F	o
62	3E	>	85	55	U	112	70	p
65	41	A	86	56	V	113	71	q
66	42	B	87	57	W	114	72	r
67	43	C	88	58	X	115	73	s
68	44	D	89	59	Y	116	74	t
69	45	E	90	5A	Z	117	75	u
70	46	F	97	61	a	118	76	v
71	47	G	98	62	b	119	77	w
72	48	H	99	63	c	120	78	x
73	49	I	100	64	d	121	79	y