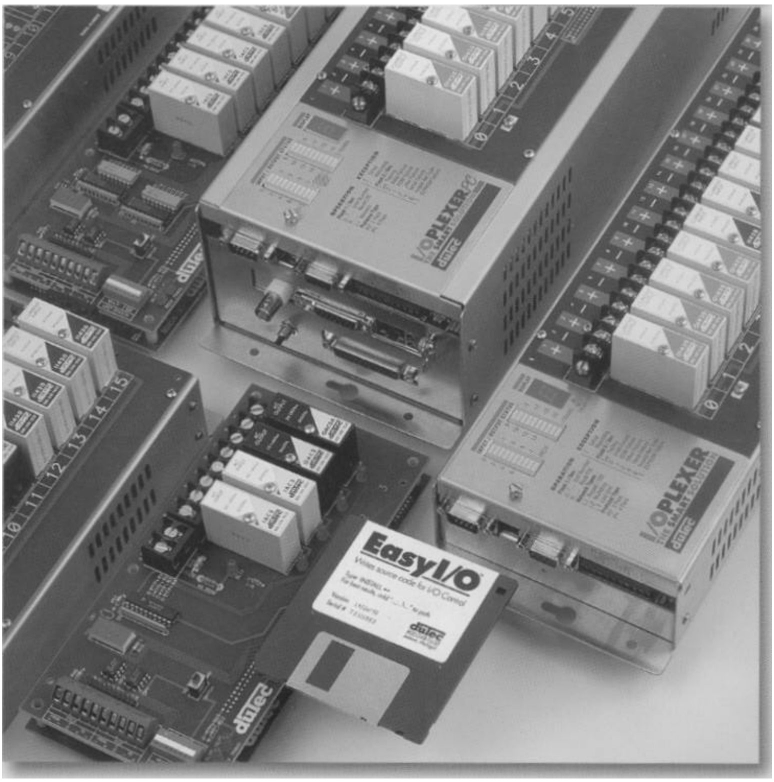
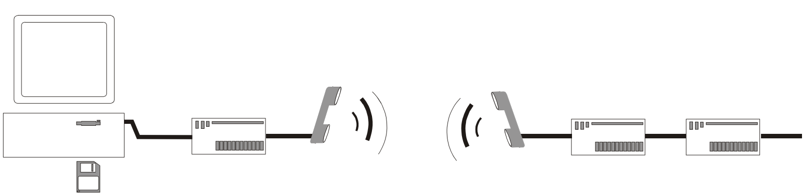
duTec

PROTOCOL MANUAL





Innovative I/O Since 1977

Appendices:

INTRODUCTION

I/O Plexers are remote I/O devices controlled by instructions sent from a Host computer over a serial communications line. The control communication protocol is that of speak-only-when-spoken-to. Only the host can initiate a response from a remotely located I/O plexer. In order to confirm communication link operation, all instructions return either an acknowledgment or an acknowledgment with data. All messages sent by the host must be made up of printable ASCII characters; they are the only characters recognized by the I/O plexer. Each I/O Plexer has a unique Master Control, Master Digital, Master Analog and Digital expander 1 address. Only the addressed I/O Plexer responds to an instruction.

ADDRESS DECODING		POSSIBLE ADDRESSES OF I/O PLEXER FUNCTIONS
Incoming Instruction	>>>>	*MC*-Master Control address
	>>>>	*MD*-Master Digital address
	>>>>	*MA*-Master Analog address
	>>>>	*DE*-Digital Expander 1 address
	>>>>	*MF*-Master Future address

This addressing scheme is used to allow the I/O Plexer to access both digital and analog modules as well as serial I/O on the same physical chassis.

When dealing with a system equipped with a digital expander 1 simply treat it as if it were a normal Master Digital address.

Refer to section 2 of this manual for communication details when making the I/O Plexer to host computer connections.

This instruction/ response interchange is handled by the host computer in a variety of ways.

Instructions could be sent using a terminal emulation package such as PROCOMM™ or HyperACCESS™. With these programs, the operator would hand-build and enter the actual instruction string directly to the I/O Plexer. This would be impractical for normal operation but is good for debugging and experimentation.

The next higher level of interaction between the Host and I/O Plexer would be the MAGIC disk included with each copy of this manual. This menu driven program guides the user through building any instruction, sends that instruction to the I/O Plexer, and then displays the corresponding response. Magic disk is an excellent tool for experimentation and debugging hardware as well as software. However this program is not designed for continuous, hands-off, operation. For details concerning the MAGIC disk, see appendix J.

The above methods provide system design/ troubleshooting help but do not offer automated operation. Since acquiring data and/ or implementing control decisions is the real purpose of the I/O Plexer, the host computer needs an algorithm to follow.

This algorithm directs the Host to poll the I/O Plexer for the required information. Once acquired, this data is manipulated inside the host. Control decisions, if any, are then made. Based upon these decisions, instructions are sent to the I/O Plexer to manipulate the correct outputs. Acquired data may be stored or dealt with graphically and control decisions may be changed based on external stimuli such as operator input or time of day.

There are two main types of programs a Host can run; third party software or user written programs.

Third party software comes pre-written to accomplish a specific set of goals. Of the dozens of different packages, each has its strong and weak points. The user need only choose the package which best suits his application needs. Many of these packages have the ability to communicate with several different types of external hardware at the same time, using specific drivers designed for each device. Once chosen, the package is installed and configured with application specific details such as: I/O Plexer addresses and parameters associated with each module. Once these packages are set up and activated, little effort is needed to operate the system. Technical support is usually available directly from the manufacturer. For a list of software that has been tested with our product please refer to appendix F. Please note: This list is always changing. Please call if the third party software the user wants to use is not listed.
(1-800-248-1632)

User written software is the most versatile of application specific Host programs. Generally developed by in-house programmers, user programs may be written in any language which supports serial communication. Typically these programs are written in BASIC, PASCAL, C or assembly language. In the case of user developed programs, support and documentation is the sole responsibility of the user. Appendix G is a simple BASIC program that demonstrates Host-I/O Plexer communications.

Local control functions (LCF) allow the I/O Plexer to control its process without Host intervention. This is an exception to the normal operation which is only under host control.

Local Control Functions (LCF)

Occasionally it is convenient to have an I/O Plexer make control decisions based on its I/O without Host intervention. This control is useful for a variety of purposes, such as; Host backup, communication load reduction, and Input/ Output reaction time. LCF's provide a means to implement these capabilities.

Local control functions allow the I/O Plexer to make decisions based upon its own inputs. These decisions can be implemented by changing outputs without action by the Host. LCF's provide several building blocks for describing the decision making. The use of this feature enhances the power of the I/O Plexer.

Having an I/O Plexer with the /L option installed (See unit part number) is a pre-requisite for using local control functions. If the I/O Plexer is to remember these functions from power cycle to power cycle without being reconfigured each time, the /M option (battery backed-up memory) is also required.

INTRODUCTION

Hosts can transmit four types of instructions:

SETUP-	Initialization used only once following a power recycle.
INPUT-	Process input module data from sensors to provide the Host with information for control decisions. These can be analog or digital.
OUTPUT-	Provide output module actuating information for carrying out control decisions. These can be analog or digital.
SERIAL I/O-	Provides the use of an additional RS-232 port for the exchange of messages or data between the Host computer and an external RS-232 device.

As instructions are introduced in this manual, the function names, which are “setup”, “analog input”, “Digital input”, “Analog output”, Digital output”, or “serial I/O” appear before the instruction.

I/O Plexer NUMBER SYSTEM:

I/O Plexer uses hexadecimal (Abbr. HEX) numbering subscript H, for example 8_H, is used to designate a hexadecimal number and subscript D is used to designate a decimal number, for example 3_D. Assume it is a decimal if not specified. For more details refer to appendices E and I.

As part of its power -up tests, the I/O Plexer determines which modules are analog and which are digital (empty positions are declared digital). All modules are initially set up as inputs. Outputs must be configured before sending any other instructions to the output modules. It is suggested that input modules be configured before using them to avoid errors.

INSTRUCTIONS:

Host initiated instructions have up to six elements. Five of which are always included. the format of all instructions is shown below.

>	Address	Function Code	Instruction Content	( )CR
Start of Instruction Character				Checksum / Carriage Return

Start of Instruction: A greater than sign (>) is always required to start an instruction.

Address: Each I/O Plexer contains 5 units, each with its own address. A two letter code is shown for each address. The addresses are always accessible by looking at the tow characters on the red flashing sequential display. Addresses can range from 00H to FFH.

ADDRESS TABLE

Address	IOP Display	2 Letter abbreviation in documentation
Master Control	U0= ??	*MC*
Master Digital	U1= ??	*MD*
Master Analog	U2= ??	*MA*
Digital Expander 1	U3= ??	*E1*
Master Future	U4= ??	*MF*

Some Addresses have counterparts in more than one unit.

Digital	U1 or U3	*DD*
Actual I/O address	U1, U2, or U3	*IO*
Any Address	U0, U1, U2, U3	*AU*

(Effects only the address it is sent to)
Applies to all addresses
Attached to IOP
simultaneously U0, U1, U2, U3 *LU*

* Master Future is reserved for future use. It defaults to the master Control address.
All address features not present in a given I/O Plexer such as Master Analog or Digital expander 1 default to the Master control address.

Function Code(s): Function codes are unique to each instruction. Instructions are explained in detail later in this section and are summarized on the *Quick Reference Guide*.

Instruction Content: Instruction contents follow the function code. They usually contain a position field that specifies which module is to be acted upon. They may also contain additional modifiers and data that tells the module what specifically should take place.

POSITION FIELD

Most I/O Plexer instructions have a position field following the function code. The contents of this field determine which modules are affected by the instruction. Some instructions affect all modules. In these, the position field determines what the effect is for each module. In either case, the construction of the position field follows the same rules.

The position field is a 4 digit hex representation of a 16 digit number. Written this way, each digit of the 16 digit number (one digit for each possible module) can only be a 1 or a 0. (These 1 or 0 are called bits)

To fill the position field, perform the following steps:

1. Make a list of the modules that the instruction is to affect, for example: 0,3,8,12,14, and 15.

2. Make a 16 digit number with a 1 in each position listed in step 1and a 0 in all the other positions. The left most digit of the number is module 15, the right most is module 0. The number for our example is:

1101000100001001

Module 15 — Module 0

Module 14 — Module 3

Module 12 — Module 8

3. Divide the number built in step 2 into 4 digit numbers. Our example appears as: 1101 0001 0000 1001.

4. Using the table below, look up each of the 4 digit numbers in step 3 and replace it with the corresponding hex number or letter. Our example becomes D109H. This is the value that should be put in the position field of the instruction. This table is on the *Quick Reference Guide* for easy access.

Module#:	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0
	-1st Char-	-2nd Char-	-3rd Char-	-4th Char-

Bit pattern	0000	0001	0010	0011	0100	0101	0110	0111
Hex Digit:	0	1	2	3	4	5	6	7
Bit Pattern:	1000	1001	1010	1011	1100	1101	1110	1111
Hex Digit:	8	9	10	11	12	13	14	15

5. It is always acceptable to use a 4-digit value in an instruction which requires a position field. Some instructions also accept an abbreviated version which has had the leading hex zeroes omitted. Some instructions consider the position field to be optional and assume a position field of FFFFH (All modules affected) if it is omitted.

Modifier/ Data Field

The Modifier/ Data field contains any additional information for the instruction. The size of this field is dependent on the instruction. The information in this field may be a letter corresponding to information presented in a table such as the *h* to select 1200 buad rate in the Serial N instruction or it may be actual variable data such as OFE for *k* in many of the analog instructions. These fields are explained in detail on each individual instruction page.

Checksum: All I/O Plexer instructions, and responses with data, require a checksum. The checksum provides a means of confirming that the communications link has not distorted or garbled the instruction message. The checksum is computed by adding the decimal values (Appendix H) of all the ASCII characters in the message excluding the start instruction character, “>” for instructions, and the “A” for responses. Subtract 256 until the number is less than 256. Convert this remaining number to two hex digits. This is the checksum. For debugging purposes a wildcard checksum can be used. “??” acts as any correct checksum. For more information, refer to appendix B.

Carriage Return**:** All instructions and responses end with a carriage return, CR.

Responses: The response depends on the instruction purpose, the communications protocol, and the correctness of their assembly. The general form of a response is listed below. For a detailed form, refer to each individual instruction. For 4 pass information, refer to section 2 of this manual.

A Response Content (if needed) ( )CR

Acknowledgment

Checksum if
Response Content

Carriage Return

Acknowledgment : A response that is an "A" or that starts with an "A" with data appended to it means the I/O Plexer received the instruction and executed it.

Response Content: These fields are similar to the ones described earlier in the instruction section. It can consist of a position field, data, modifier field, or other information.

Checksum: Checksums appear only with responses that contain data. For more information on checksums, refer to appendix B.

Carriage Return: This is the end of response character, CR, and is always present.

Special Response Messages: Special response messages are returned if unusual conditions are present. The condition can be the result of improper instruction assembly or noise in the communication link.

Message	Meaning
N00	Power has been off. An instruction other than the setup A instruction was attempted after a power cycle. This is a warning that the system needs to be reconfigured. The only exception occurs if the I/O Plexer has the /M option and setup eF is used. See N09for more information.
N01	Invalid instruction. This is returned if an invalid function code is used such as v for V
N02	Checksum error. Checksum received is not equal to the calculated checksum.
N02 *( )*	Checksum error after Setup eC instruction was sent. The correct checksum for the message received is between the asterisks.
N03	The received checksum exceeded 80 characters.
N04	Non-Printable character. Only ASCII Characters from 21H to 7FH are permitted within instructions. For an ASCII conversion table see appendix H.

N05	Invalid instruction length. Too many or too few characters were received. For example, this response is returned if a position field requires 6 data fields and only 5 are included.
N06	Communication watchdog timed out. This only occurs if Setup D and or setup M instructions are used and a watchdog failure occurs. The next instruction sent after the timeout occurs , responds with N06 and is not executed.
N07	Invalid Data. This is returned when the I/O Plexer receives data not allowed in that field.
N08	Invalid Module
N09	Battery backed restart OK. This is similar to N00 message except this unit has a battery backed memory and came up running with the configuration saved using setup eF.
N10 &N11	Reserved for local control function errors.
N12	Local RS-232 Buffer full. This occurs when the length of the serial O message would overflow the local port character buffer. The complete message is rejected.
N13 - N18	Reserved for local control function errors.

Setup A

	Instruction	Response
A Power-Up Clear	>*AU*A ( ) CR	ACR

Purpose: Prevents the N00 or N09 Response message for the first instruction received after power-up. This instruction does not affect operation or setup.

Prerequisite: None

Default: None

Battery Backed: If the Unit has the /M option installed, this instruction cancels the N09 response.

Address: Any master control, Master analog, Master Digital, or Digital expander 1 address.

Caution: This instruction *only* prevents the N00 or N09 response message. It has no effect on operation or setup or any other function of this I/O Plexer.

Remarks Any other instruction returns an N00 or N09 response message. The N00 Response tells the host that the power has been off and the I/O Plexer is now set to its default configuration. The N09 response tells the host that the power has been off and the I/O Plexer has came up in its battery backed configuration (same as before power cycle)

Example: This instruction prevents the N00or N09 response message from appearing after power is off when a message is sent to address 40.

Instruction	Response
>40AA5CR	ACR

Instruction Content:

>	=Start of Instruction
AU = 40	=Address
A	=Function Code
( ) = A5	=Checksum

Response Content:

A = Acknowledgment

Setup B

	Instruction	Response
B Reset	>*AU*B ( )CR	ACR

Purpose: Initializes analog or digital I/O configuration parameters for that I/O Plexer address to power up defaults.

Prerequisites: None

Default: None

Battery Backed This instruction DESTROYS information saved by battery backed instruction Setup eF.

Address: Any Master control, master digital, master analog, or digital expander 1 address.

Caution: The I/O Plexer only resets the address it is sent to. For example, if it is sent to the digital expander 1 address, it does not reset the master digital address
This instruction has no effect on turn around delays configured by setup C

Remarks: It affects various things depending on the address it is sent to.

Master Control Address:
• It does nothing except return an A

Master Digital or Digital expander 1 address:
• Clears Latches, pulse counters, pulse duration, and pulse complete bits.
• Stops Squarewaves
• Clears output types
• Deactivates digital watchdogs
• Resets timer resolution multiplier (TRM) to 1
• All digital modules are seen as inputs
• Turns all outputs to Off

Master Analog Address:
• Stops all analog activity (waves etc...)
• Sets all analog outputs to zero scale
• Deactivates analog Watchdogs
• Stops averaging
• Clears averaging complete bit
• Clears temperature sensor types
• Offset set to zero and Gains set to 1
• All analog modules are seen as inputs

Example: Performs the reset instruction to the I/O Plexer address 40

Instruction	Response
> 40BA6CR	ACR

Instruction Content:

>	= Start of instruction character
AU = 40	= Address
B	=Function code
( ) = A6	= Checksum

Response Content:

A = Acknowledgment

Setup C

	Instruction	Response
C Turn around Delay	>*LU*<u>C</u>*f* ( )CR	ACR

Purpose: Provides the means for delaying the transmission of an I/O Plexer response to an instruction.

Prerequisite: None

Default: No Delay (f=0)

Battery backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M Memory Option
AND
2) Setup eF instruction is issued *after* the system is configured as desired.

Address: This can be sent to any valid address, but it is a global instruction. It affects all addresses associated with the master control address such as the master digital, master analog, and the digital expander 1.

Remarks: The turn-around delays are handy for modem applications.

Example: This instruction sets up a 100mSec turn around delay for all addresses associated with this chassis, including digital expander1.

Instruction	Response
>00C2D5CR	ACR

Instruction content:

>	= Start of instruction character
LU = 00	= Address
C	= Function code
f = 2	= Turn around delay time selected from the f table below

f Table

Turn Around Delay	=No Delay	10mSec	100mSec	500mSec
Set f	=0	1	2	3

( ) = D5 =Checksum

Response Content:

A= Acknowledgment

Setup F

	Instruction	Response
F Identify station type	>*AU*F ( )CR	A0*z* ( )CR

Purpose: Identifies the function of the given address

Prerequisite: None

Default: None

Battery Backed: Not applicable

Address: Any Address

Example: This instruction is asking what station type is at address 00. The response indicates that it is a Master control address.

Instruction	Response
>00FA6CR	A0262CR

Instruction content:

>	= Start of instruction character
AU = 00	= Address
F	= Function code
( ) = A6	= Checksum

Response: All possible responses are shown below:

A0060CR = Digital Address
A0161CR =Master Analog Address
A0262CR =Master Control Address

The digital response means it is either a master digital address or a digital expander 1 address.

Setup G,H, I

	Instruction	Response
G Configure All modules	>*I0*<u>G*e*</u>( )CR	ACR
H Configure Inputs	>*I0*<u>H*e*</u>( )CR	ACR
I Configure outputs	>*I0*<u>I*e*</u>( )CR	ACR

Purpose: Designate which module positions are to be inputs or outputs.

Prerequisite: None

Defaults: All module positions are designated as inputs

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued *after* the system is configured as desired

Address: Any Master analog, master digital, or digital expander 1 address. It only configures one address at a time.

Caution: These instructions should always be issued first. If they are issued after other instructions have been sent everything in progress is stopped (Pulses, waveforms. delays etc...). It even clears all digital Z instructions from *every* module. We recommend the use of setup B and then reconfiguring if changes are needed.

Example: This instruction configures modules 15 and 7 as outputs. All other positions are inputs.

Instruction	Response
>40G80807BCR	ACR

Instruction content:

>	= Start of instruction character
I0 = 40	= Address
G	= Function code
e = 8080	=Position field

For setup G: 1's specify output modules
0's specify input modules
For setup H: 1's specify input modules
0's are disregarded
For setup I: 1's specify input modules
0's are disregarded

If this field is omitted, FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be dropped, for more information refer to appendix A

( ) = 7B = Checksum

Response Content:

A = Acknowledgment

Setup j

	Instruction	Response
j read module configuration	>*I0*j( )CR	Ac( )CR

Purpose: Returns current input/ output configuration. This is a good way to verify your configuration done with setup G, H, and I

Prerequisite: None

Default: None

Battery Backed: Not applicable

Address: Any Master digital, master analog. or digital expander 1 address.

Example: This instruction requests the configuration for all module positions, located at the I/O Plexer analog address 80. The response from I/O Plexer indicates that modules in positions 3, 4, and 5 are analog outputs.

Instruction	Response
>80jD2CR	A0038CBCR

Instruction content:

>	= Start of instruction character
I0 = 80	= Address
j	= Function code
( ) = D2	=checksum

Response Content:

A = Acknowledgment
c=0038 = Position field. 4 hex digits are returned for each module specified in the instruction's position field. 1's indicate output modules, and 0's indicate analog input modules or digital modules. Values are returned from highest module (15) to lowest module (0).

( ) = CB = Checksum

Setup E

	Instruction	Response
E Protocol -2 Pass	>*LU*E0( )CR	ACR
E Protocol -4 Pass	>*LU*E1( )CR	ACR

Purpose: Selects communication protocol to be followed. 4 pass is intended for noisy communication environments and system debugging where accidental output changes could be dangerous.

Prerequisite: None

Default: Protocol type is permanently saved in the I/O Plexer. On power up the protocol is shown on the display. It is shipped in 2 pass.

Battery Backed: No affect, always saved

Address: Any address. This is a global instruction which affects all addresses associated with the master control address including the master digital, master analog, and the digital expander 1 address.

2 Pass:

Instruction is acknowledged and executed; response message is returned if incorrect. The possible responses are shown below.

Host	I/O Plexer
Valid non-data instruction	ACR
Valid data instruction	A (DATA) ( )CR
Faulty instruction	N (Response Code)CR

4 Pass:

Host transmits the instruction; I/O Plexer echoes it but does not execute it; host returns ECR if the echo is correct.; the I/O Plexer then performs the instruction. If any character other than an E is returned to the I/O Plexer the instruction is cancelled.

Host:	I/O Plexer:
Instruction	A (Echo instruction)CR
ECR	ACR
	OR
	A(data)( )CR
	OR
	A(Response Code)CR

A list of response codes can be found on page 3-12

Example 1: Instructs the I/O Plexer units associated with master control address (Master digital, master analog, and digital expander 1) 00 to use 4 pass. This instruction is executed in 2 pass.

Instruction	Response
>00E1D6CR	ACR

Instruction content:

>	= Start of instruction character
00	= Address
E1	= Function code for 4 pass
( ) = D6	=checksum

Response content:

A = Acknowledgment

Example2: Instructs the I/O Plexer at address 00 and all associated addresses to use 2 pass. This instruction is executed in 4 pass.

	Instruction	Response
	>00E0D5CR	A00E0D5CR

Instruction content:

>	= Start of instruction character
LU = 00	= Address
E0	= Function code for 4 pass
( ) = D5	=checksum

Response content:

A	= Acknowledgment
LU = 00	= Address
E0	= Function code for 4 pass
( ) = D5	=checksum

Instruction Content:

E = Echo OK character

Response Content: A = Acknowledgment

Communication Watchdog

	Instruction	Response
D Watchdog Position delay - Digital	>*DD*D*cg*( )CR	ACR
m Watchdog Position/ delay-Digital	>*DD*m*cn*( )CR	ACR
D Watchdog Position/ delay -Analog	>*MA*D*cg*( )CR	ACR
m Watchdog Position/ delay -Analog	>*MA*m*c...l*( )CR	ACR
eD Watchdog multiplier - Enable	>*MC*eD( )CR	ACR
dD Watchdog multiplier -Disable	>*MC*dD( )CR	ACR

Purpose: The watchdog delay instructions cause the I/O Plexer to go to a specified state if no instructions are received from the host for a specified period of time. This instruction is good for switching to emergency or standby status at the I/O Plexer in the event that the host can no longer control it.

Prerequisite: For any watchdog instruction to affect an output, it must be configured as an output using setup G or I.

Defaults: Watchdog is inactive

Battery backed: The underline instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option

OR

2) Setup eF instruction is issued *afer* the system is configured as desired.

Remarks: The I/O Plexer responds to the first instruction after a serial watchdog time out with a N06 response message and the instruction not executed.

There is a separate watchdog for each digital and analog address. Digital expander 1 is separate from the master digital address. When a failure occurs, all modules at that address are set. Module positions not explicitly given other values are set to zero.

Setup eD allows the delay to be multiplied by 256 to provide longer delays

The programmable communication watchdog delay instructions should not be confused with I/P Plexer's hardware watchdog. The hardware watchdog acts automatically in the event of a hardware or firmware failure and responds within 1 second. The hardware watchdog turns all outputs off, and locks the I/O Plexer. The hardware can only be reset by recycling power. The middle horizontal bar of the display is on continuously when a hardware watchdog time out occurs.

Setup D (Digital Watchdog)

	Instruction	Response
D Watchdog Position/ Delay -Digital	>*MA*D*g*( )CR	ACR

Purpose: This instruction turns on/ off specific modules after a set time delay occurs. Setup m is a more convenient instruction.

Addressing: Any Master digital or digital expander 1 address

Remarks: When activated, watchdogs control *ALL* outputs including waveforms, delays and pulse. Analog systems are not affected by this instruction. Setting g=5,6, or 7 is useful for activating alarms or auto-shutdown outputs attached to module position 0.

Caution: This instruction affects all digital modules at the given address.

Watchdogs set up for master digital address, do *not* affect a digital expander 1 address connected to it.

Reference: For general information on communication watchdogs, refer to the watchdog introduction section.

Example: If ther is no serial communication for 1minute, this instruction activates output module 0 and deactivates all other digital outputs at address 43.

Instruction	Response
>43D6E1	ACR

Instruction content:

> = Start of instruction character

DD = 43 = Address

D = Function code

g = 6 = Time/ Action field from table below

Values for g can range from 0-7, all others return N08 response.

g	Time	Action
0		Watchdog Disable
1	10 Seconds	Turn all digital output modules off
2	1 Minute	Turn all digital output modules off
3	10 Minutes	Turn all digital output modules off
4		Watchdog Disable
5	10 Seconds	Turn module 0 on, all others off
6	1 Minute	Turn module 0 on, all others off
7	10 Minutes	Turn module 0 on, all others off

If this field is omitted, g = 0 is assumed and the watchdog is disabled.

( ) = E1 = Checksum

Response Content:

A = Acknowledgment

Setup m (Digital Watchdog)

	Instruction	Response
m Watchdog Position/ Delay -Digital	>*DD*m*cn*( )CR	ACR

Purpose: Allows the user to specify individual states for the digital modules when the serial communication watchdog times out.

Addressing: Any Master digital or digital expander 1 address

Remarks: Analog modules are not affected by this instruction. When active, watchdogs control all outputs. They will not be modified by delays, pulses, or waveforms.

Caution: If delay time is set to zero or no delay time is entered, the watchdog is disabled.

Watchdogs set up for master digital address, do *not* affect a digital expander 1 address connected to it.

Reference: For general information on communication watchdogs, refer to the watchdog introduction section.

Example: Instructs the I/O Plexer at address 41 to turn modules 15 and 0 on and disable others if there is no communication with the digital address for 2 seconds (WDM 1)

Instruction	Response
>41m8001C816CR	ACR

Instruction content:

>	= Start of instruction character
DD = 41	= Address
m	= Function code for 4 pass
C = 8001	=position field. 1's correspond to outputs on. 0's correspond to outputs off. For more information refer to Appendix A.
n = C8	= Time delay. Delay H =(desired delay seconds/ (.01 *WDM))H convert 1 to 4 hex digits. Delays of less than 200 mS or data less than 14H are not accepted and returns with a N05 response message. If no delay is given, watchdog is disabled

( ) = 16 = Checksum

Response Content:

A = Acknowledgment

Setup D (Analog Watchdog)

	Instruction	Response
D watchdog position/ Delay -Analog	>*MA*Dcg( )CR	ACR

Purpose: Setup D (Analog) sets up the time delay and can set modules to zero or full scale when a serial watchdog failure occurs. If used in conjunction with Setup m (analog), it can set up levels other than zero and full scale when a serial watchdog occurs.

Address: Any master analog address

Caution: For g = 0-7 the table presented overrides any values previously set by setup m (analog).

Reference: For general information on communication watchdogs, refer to the watchdog introduction section.

Example: Instructs the analog address 83 to output full scale to module 0 and 7 if there is no activity on the analog address line for 10 seconds.

Instruction	Response
>83D00815ADCR	ACR

Instruction content:

>	= Start of instruction character
83	= Master Analog Address
D	= Function Code
c = 0081	= Position field. 1's specify which modules are to be affected. 0's are disregarded. For more information refer to appendix A

g = 5 Time / Action from the table below or inactive communication time.

Values for g can range from 0-7 or 14_H-$FFFF_H$

g	Time	Action
0	Disable	
1	10 Seconds	Write Zero scale
2	1 Minute	Write Zero scale
3	10 Minutes	Write Zero scale
4	Disable	
5	10 Seconds	Write full scale
6	1 Minute	Write full scale
7	10 Minutes	Write full scale

If setup m is used, setup D configures the time delay and setup m specifies the output levels.

Delay = $(0.01 \text{ seconds} * \text{WDM})_H$ Convert 1 to 4 hex digits.

Delays of less than 200 mSec 14_H are not accepted and return a N07 response message.

If no delay is given, the watchdog is disabled

If WDM is in effect, all of the above times are multiplied by 256.

( ) = AD = Checksum

Response Content:

A = Acknowledgment

Setup m (Analog Watchdog)

	Instruction	Response
m Watchdog Position/ levels (Analog)	>*MA*m*c. . . l*( )CR	ACR

Purpose: Setup m must be used in conjunction with setup D (Analog). Setup D determines the delay period and setup m determines the output levels the analog outputs go to when a serial communication watchdog failure occurs.

Address: Any master analog address.

Caution: All analog modules that are not given a specific level are set to zero scale.

If in setup D (analog) g = 0 - 7, then any previous levels set by setup m are ignored.

Reference: For general information on communication watchdogs, refer to the watchdog introduction section.

Example: Instructs the I/O Plexer at address 81 to output the value 800H (1/2 scale) to analog output module 12 and the value FFFH (Full scale) to module 7, if a serial watchdog timeout occurs.

Instruction	Response
>81m1080800FFF09CR	ACR

Instruction content:

>	= Start of instruction character
MA = 81	= Address
m	= Function code
c = 1080	= Position field. 1's specify which modules are to be affected. 0's are disregarded. For more information refer to appendix A.
l = 800FFF	= Output value. 3 hex digits represent the level sent to each module chosen in the position field. The values are sent out ordered from the highest (15) to lowest (0)
( ) = 09	= Checksum

Response Content:

A = Acknowledgment

Setup eD, dD (Watchdog)

	Instruction	Response
eD Watchdog multiplier - Enable	>*MC*eD( )CR	ACR
dD Watchdog multiplier - Disable	>*MC*dD( )CR	ACR

Purpose: This instruction allows the watchdog delay time to be multiplied by 256. This extends the maximum watchdog delay time from 10.9 minutes to 46.6 hours.

Prerequisite: None

Defaults: Watchdog multiplier = 1

Battery backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option

AND

2)Setup eF instruction is issued *after* the system is configured as desired.

Address: Any master control address

Remarks: This affects all communication watchdogs both analog and digital.

When this instruction is enabled, WDM = 256

Example: This instruction enables the watchdog multiplier at all addresses connected to this master control address. This means that any time a 1 second delay is sent using setup D or m it is multiplied by 256 for an actual delay of 256 seconds.

Instruction	Response
>00eD09CR	ACR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
eD	= Function code
( ) = 09	=checksum

Response Content:

A = Acknowledgment

Setup n

	Instruction	Response
n Set Timer Resolution Multiplier	>*DD*n*y*( )CR	ACR

Purpose: Sets the resolution multiplier of the internal 10mSec clock which affects the timing of all of the digital instructions listed below.

Prerequisite: None

Default: TRM = 1. Timer resolution = 0.001 seconds.

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued *after* the system is configured as desired.

Address: Any master or digital expander 1 address.

Caution: There are separate multipliers for the master digital and the digital expander 1 address. Sending this instruction to one has no effect on the other.

Do not confuse this with watchdog multiplier, WDM

Remarks: This instruction alters the period of the digital squarewave and other instructions listed below if changed during operation.

Instructions Affected by Setup n

Digital h	Retrigger time delay
Digital K	Start ON pulse
Digital ℓ	Start Off pulse
Digital d	Read pulse complete bits
Digital e	Read duration counters
Digital f	Read and clear Duration counters
Digital Z. . H	One Shot on
Digital Z . .J	One shot off
Digital Z. . I	Delayed on
Digital Z. . K	Delayed off
Digital Z . .L	Square Wave
Digital Z . .M	Fast square Wave

Example: This instruction sets the timer resolution to 150 mSec per count.

Instruction	Response
>40n0F48	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
n	= Function code
y = 0F	=Timer Resolution. Resolution = Desired multiplier converted to 2 hex digits. It can range from 0 to 255 (FFH)
( ) = 48	= Checksum

Response Content:

A = Acknowledgment

Setup eA, dA

	Instruction	Response
eA Enable Address Tag	>*MC*eA( )CR	ACR
dA Disable Address Tag	>*MC*dA( )CR	ACR

Purpose: Provides the means for appending an address to the I/O Plexer responses.

Prerequisite: None

Defaults: Address tags disabled

Battery backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued after the system is configured as desired.

Address: Master control address only, but this is a global instruction. It affects all addresses associated with this master control address such as the master digital, master analog, and digital expander 1.

Remarks: Setup eA instruction causes the responses to add the two character address of the instruction to the end of the response. The address characters are preceded and followed by *.

Example Enables the address tag.

Instruction	Response
>00eA06CR	ACR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
eA	= Function code
( ) = 06	=checksum

Response Content:

A = Acknowledgment

Example: Disables address tag

Instruction	Response
>00dA05CR	A *00* CR

Setup eC, dC

	Instruction	Response
eC Enable Checksum tag	>*MC*eC( )CR	ACR
dC Disable Checksum tag	>*MC*dC( )CR	ACR

Purpose: Provides the means for appending correct checksum to the I/O Plexer responses.

Prerequisite: None

Defaults: Checksum tag disabled

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued *after* the system is configured as desired.

Address: Master control address only, but this is a global instruction. It affects all addresses associated with this master control address such as the master digital, master analog, and the digital expander 1.

Remarks: Setup eC instruction allows the user to specify any 2 character Hex value in the checksum position. The I/O Plexer returns an N02 response message with the correct checksum framed in " * ". When N02 is returned, the instruction is not executed. If no N02 checksum response is returned, then the checksum used was correct. "??" is processed as ignore checksum which defeats the purpose of using checksums.

Example: Enables the checksum tag

Instruction	Response
>00eC08CR	ACR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
eC	= Function code
( ) = 08	=checksum

Response Content:

A = Acknowledgment

Example: Disables Checksum tag

Instruction	Response
>00dC07CR	A * ( ) *CR

Setup eE, dE

	Instruction	Response
eE Enable Error messages	>*MC*eE( )CR	ACR
dE Disable Error messages	>*MC*dE( )CR	ACR

Purpose: Provide the means for disabling the return of error messages that the host software may not be able to handle.

Prerequisites: None

Default: Error message enabled

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued *after* the system is configured as desired.

Address: Master Control address only. but this is a global instruction. It affects all addresses associated with this master control address such as master digital, master analog, and the digital expander 1.

Caution: There is NO response when an error occurs. This condition may cause the host to wait indefinitely for a response that will never be issued.

Example: Disables error messages

Instruction	Response
>00dE009CR	ACR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
dE	= Function code
( ) = 09	=checksum

Response Content:

A = Acknowledgment

Setup eF, dF

	Instruction	Response
eF Save Setup	>*MC*eF( )CR	ACR
dF Disable Setup	>*MC*dF( )CR	ACR

Purpose: Allows the configuration information to be saved in battery backed RAM, while power is off. Must have /M option.

Prerequisite: None

Default: Disable

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) The eF instruction is issued after the system is configured as desired.

Address: Master Control address only, but this is a global instruction. It affects all addresses associated with this master control address such as the master digital, master analog, and the digital expander 1.

Remarks: When setup eF instruction is sent, the I/O Plexer calculates and stores a checksum of the configuration data. During power up a new checksum is computed. If it agrees with the stored one, the system is configured as it was before the power cycle. If they do not agree, the system is initialized to the default state as if there was no battery backup.

Caution: Changing the configuration after issuing setup eF changes the checksum. After all changes, setup eF must be re-issued to save the configuration.

Example This instruction saves the system configuration as it is at the time it was sent.

Instruction	Response
>00eF0BCR	ACR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
eF	= Function code
( ) = 0B	=checksum

Response Content:

A = Acknowledgment

Setup a, b

a set Variable Address

Instruction	Response
>*MC*a*MCMDMAEIMF*( )CR	A*MCMDMAEIMF*( )CR

b Read Variable Address

>*MC*b( )CR	A*MCMDMAEIMF*( )CR

Purpose: Provides a way to set up variable addressing in an I/O Plexer or provides a way to check the addressing of a particular I/O Plexer.

Prerequisite: None

Remarks:

MC	=Master address
MD	=Master Digital address
MA	=Master Analog address
E1	=digital Expander 1 address
MF	=Master Future address

Default: Offset addressing automatically sets the addresses based on the Master Control address. It is shown below.

Master digital address	=40H+ Master Control address
Master analog address	=80H+ Master Control Address (defaults to *MC* if not present)
Digital Expander 1 address	=C0H + Master Control address (defaults to *MC* if not present)
Master Future	= Master Control address

Offset addressing allows setting the master control address to any value from 00H to 3FH. Using setup a allows any address to be set to any value from 00H to FFH.

Caution: This instruction can also reset the Master control address. Once changed, the new Master control address is required to change it back. Powering down will not bring it back in its previous state.

Battery Backed: No effect, always saved

Address: Any master control address

Example: This requests the addresses associated with master control. 00H

Instruction	Response
>00bC2CR	A004080C000FFCR

Instruction content:

>	= Start of instruction character
MC = 00	= Master Control Address
a	= Function code
( ) = C1	=checksum

Response Content:

A = Acknowledgment
MC = 00 New master control address
MD = 40 New Master Digital address
MA = 80 New master analog address
E1 = C0 New digital expander 1 address
MF = 00 Master Future address
( ) = FF Checksum

Example 2: This instruction changes the addresses associated with master control address 00H

	Instruction	Response
	>00a0506070805C0CR	A0506070805FFCR

Instruction Content:

>	- start of instruction character
MC = 00	- Master control address
a	- function code
MC = 05	- Master control address
MD = 06	- Master digital address
MA = 07	- Master analog address
E1 = 08	- Digital expander 1 address
MF = 05	- Master future address
( ) = CO	- Checksum

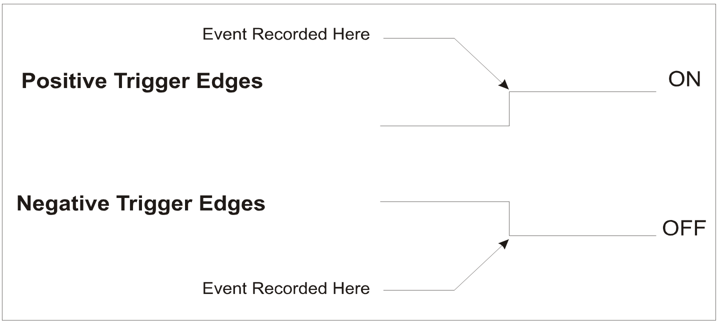
Response Content:

A	- Acknowledgment
MC = 05	- Master control address
MD = 06	- Master digital address
MA = 07	- Master analog address
E1 = 08	- Digital expander 1 address
MF = 05	- Master future address
( ) = FF	- Checksum

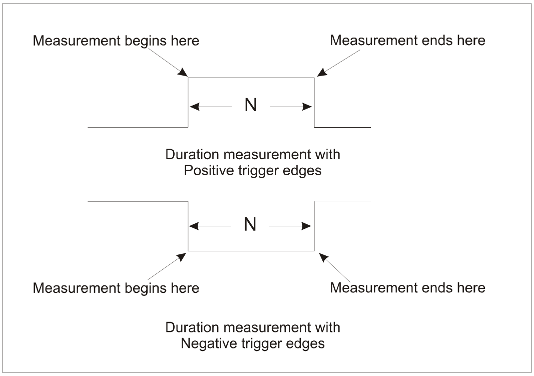
DIGITAL INPUT INTRODUCTION

PICTORIAL GLOSSARY

Digital a, b, c

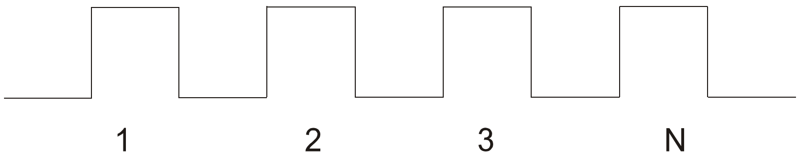


Digital e,f



Time *n* is collected. Only the first pulse is measured. It must be reset to measure another pulse.

Digital y

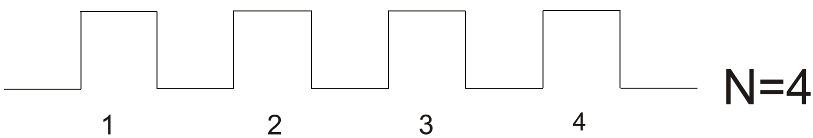


Pulse duration measurement with Accumulator option and positive edgetriggering produces the following results:

$n_T = n1 + n2 + n3$

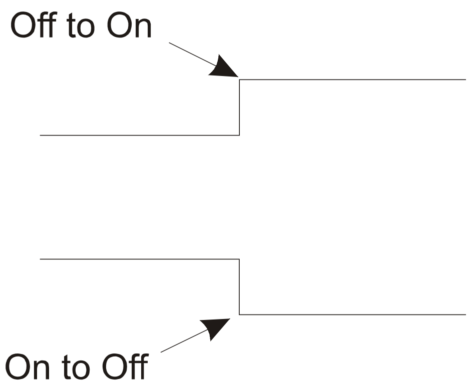
n_T = Total On time accumulated over all pulses

Digital W, X, Y, U, V, T



Pulse counter counts the number of pulses

Digital N, O, P, Q, R, S



Digital M

	Instruction	Response
M Read all modules	>*DD*M( )CR	AcCR

Purpose: Determines the on/ off state of all digital I/O positions, both input and output.

Prerequisite: Configure as inputs using step G or H

Default: None

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address.

Caution: The instruction does NOT read the physical output at the terminal strip, but the actual value last sent by the I/O Plexer.

Example: This instruction reads the status of all digital modules. The response indicates that the module 4 and 5 are on.

Instruction	Response
>40MB1CR	A0030C3CR

Instruction Content:

>	- start of instruction character
DD = 40	- Digital address
M	- function code
( ) = B1	- Checksum

Response Content:

A	- Acknowledgment
c = 0030	- Position Field, 1's mean the module is on, 0's mean they are off. The modules can be inputs or outputs. For more information refer to appendix A
( ) = C3	- Checksum

Digital a, b, c

	Instruction	Response
a Set All triggers edges	>*DD*<u>*ae*</u>( )CR	ACR
b Set Positive trigger edges	>*DD*<u>*be*</u>( )CR	ACR
c Set Negative trigger edges	>*DD*<u>*ce*</u>( )CR	ACR

Purpose: Set triggers edges for pulse duration measurements. Digital a can be used if all inputs are to have a duration measurement, otherwise Digital b and c should be used.

Prerequisites: These instructions should be used before duration counter instructions, digital d, e, and f

Default: Negative trigger edges

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction has been issued after the system is configured as desired.

Address: Any master digital or digital expander 1 address

Remarks: Positive trigger edge is for off on off pulse. Negative trigger edge is for on off on pulses.

Example: Modules 4 and 5 are set to measure positive trigger edges.

Instruction	Response
>40b003089CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
b	= Function code
e = 0030	= Position field

Digital a	1's set positive trigger edges
	0's set negative trigger edges
Digital b	1's set positive trigger edges
	0's are disregarded
Digital c	1's are negative trigger edges
	0's are disregarded

If this field is omitted, FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information , refer to appendix A.

( ) = 89 = Checksum

Response content:

A = Acknowledgment

Digital d

	Instruction	Response
d Measurement complete	>*DD*d( )CR	A*c*( )CR

Purpose: Determines which positions have completed full pulse duration measurement.

Prerequisites: Set the duration trigger edges using the digital a, b, or c instruction. Initialize duration counters to zero with the digital f or g instruction.

Default: Configure as inputs using setup G or H

Battery backed: Not applicable

Address: Any master digital or digital expander 1 address.

Remarks: A measurement complete bit is set to indicate entire pulse has been gathered. The host can read this bit to see if measurements are complete and then read the duration counters. No other durations will be measured until complete bit is cleared.

If the pulse duration is read (Digital e and f) before the pulse had finished, the partial duration is returned.

The measurement complete bit is cleared whenever digital f or g is issued, to clear pulse duration.

Caution:	These instructions are affected by the setup n instruction, which can adjust the timer resolution multiplier, TRM.
	If pulse accumulator, digital y, is used the measurement complete set bit is never set.
Example:	This instruction asks which modules have completed a pulse duration measurement. The response indicates that module 4 has completed it.

Instruction	Response
>40dC8CR	A0010C1CR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
d	= Function code
( ) = C8	= checksum

Response Content:

A	= Acknowledgment
C = 0010	= Position field. The 1's bits have completed their specified off on off, or on off on sequence. 0's have not completed transition or are not digital inputs
( ) = C1	=checksum

Digital e, f, g

	Instruction	Response
e Read Duration Counters	>*DD*e*e*( )CR	A. . . *n*( )CR
f Read and Clear Counters	>*DD*f*e*( )CR	A. . . *n*( )CR
g Clear Duration Counters	>*DD*g*e*( )CR	ACR

Purpose: Reads and /or clears pulse duration counters. When a pulse duration measurement is complete, the value is stored for the host to read. Another pulse will not be measured until this measurement is cleared. Digital f is the equivalent of the combination of Digital e and g.

Prerequisites: Duration counters must be setup using a, b, or c. Then set counters to zero with a clear instruction, digital f or g

Default: Configure as inputs using setup G or H

Battery backed: Not applicable

Address: Any master digital or digital expander 1 address.

Remarks: If the pulse duration is read before the pulse has finished, the current partial duration is returned.

The clear instruction also clears the measurement complete bits that are set.

Maximum count is 65,535 or FFFFH. If this number is reached the counter rolls over and continues counting. This occurs at 10.9 minutes to 46.6 hours depending on the value of TRM.

Caution: If pulse accumulation is being used (digital y) accumulated durations are read. Otherwise only the first pulse is measured. These instructions are affected by the setup n instruction which can adjust the timer resolution multiplier (TRM)

Example: This instruction requests the duration for modules 4 and 5. Module 5 has a duration of 3.23 seconds and module 4 has a duration of 2.4 seconds assuming TRM =1.

Instruction	Response
>40f00308DCR	A014300f09ECR

Instruction content:

>	= Start of instruction character
DD = 40	=Digital Address
f	= Function code
e = 0030	=Position field. 1's select which modules duration to read and/ or clear. 0's are disregarded. If this field is omitted, FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information refer to appendix A.
( ) = 8D	= Checksum

Response Content:

A	= Acknowledgment
n = 014300F0	= Pulse duration. 4 hex are returned for each module selected in the instruction's position field. Values are returned from the highest module (15) to lowest module (0). ???? are returned if the module is not a digital input.

Duration (Seconds)	Decimal value of n * TRM * 0.01 Seconds
Module 4	00F0H * TRM * 0.01 sec = 2.4 Sec * TRM
Module 5	0143H * TRM* 0.01sec = 3.23 * TRM
( ) = 9E	Checksum

Digital y, z

	Instruction	Response
y Pulse Accumulator -enable	>*DD*y*e*( )CR	ACR
z Pulse Accumulator - Disable	>*DD*z*e*( )CR	ACR

Purpose: This instruction is related to the instruction set of Digital a through Digital g. It allows the duration counter to accumulate the total pulse width of a train of pulses rather than just one pulse.

Prerequisite: Digital a, b, or c must be used to set up the trigger edges. Digital e, f, and/ or g may be used to read and or clear the duration.

Default: Disabled

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option

AND

2) Setup eF instruction is issued after the system is configured as desired.

Address: Any master digital or digital expander 1 address.

Caution: Pulse complete bits (Read with digital d) are never set for positions modified by Digital y.

Example: This instruction enables pulse accumulation at module 8 and 5.

Instruction	Response
>40y0120A0CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
y	= Function code
e = 0120	= Position field. 1's select which modules are effected, 0's are disregarded. If this field is omitted FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information see appendix A
( ) = A0	= Checksum

Response Content:

A = Acknowledgment

Digital U, V, T

	Instruction	Response
U Start Counters	*DD*U*e*( )CR	ACR
V Stop counters	*DD*V*e*( )CR	ACR
T Start/ stop computers	*DD*T*e*( )CR	ACR

Purpose: To stop and or start digital counters

Prerequisites: Digital Y or X should be used to clear the counters before using Digital U or T to start counting.

Default: Active

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Remarks: Pulse rates up to 400 counts / sec with minimum on and off pulse width of 1.0millisecond can be counted. Counts off to on transitions.

Caution: Digital T instruction stops all counters that are specified as zeroes in the position field.

Example: This instruction starts counters for modules 4 and 5 and stops all other counters.

Installation	Response
>40T00307BCR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
T	= Function code
e = 0030	= Position field.

Digital U : 1's start counters
0's are disregarded
Digital V : 1's stop the counters
0's are disregarded
Digital T : 1's start the counters
0's stop the counters

( ) = 7B	= Checksum

Response Content:

A = Acknowledgment

Digital W, Y, X

	Instruction	Response
W Read Counters	>*DD*W*e*( )CR	A. . . *n*( )CR
Y Clear Counters	>*DD*Y*e*( )CR	ACR
X Read & Clear Counters	>*DD*X*e*( )CR	A. . . *n*( )CR

Purpose: Reads and/ or resets the counters to zero. Digital X is equivalent to sending the digital W followed by Digital Y.

Prerequisite: Before the counters are read using digital W or X they should be started using Digital U or T and set to zero using digital Y and X.

Default: Not applicable

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Remarks: Only clear instructions, Digital Y and X, reset counters.

Pulse rates of up to 400 counts/ second with a minimum on and off pulse width of 1.0 millisecond can be counted.

If the count exceeds the maximum count of 65,535 = FFFFH it rolls over to zero and continues counting.

Example: This instruction returns the counts for module positions 4 and 5, then clears the counters. The response indicates that module 5 had 4 pulses and module 4 had 10 pulses since the last start / clear instruction.

Instruction	Response
>40X00307FCR	A0004000A95CR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
X	= Function code
e = 0030	= Position field. 1's select which modules are read, 0's are disregarded. If this field is omitted, FFFFH is assumed by the I/O Plexer. Leading Hex zeroes may be omitted. For more information see appendix A
( ) = 7F	= Checksum

Response content:

A	= Acknowledgment
n = 0004000A	= Pulse counts. Each module specified in the instruction returns a 4 digit hex count. Convert this to decimal for actual count. Counter values are returned in sequence from highest to lowest (15 -0). ???? is returned if the selected module was not a digital input. Module 4 = 004H = 4 counts Module 5 = 000AH = 10 counts
( ) = 95	= Checksum

Digital N, O, P

	Instruction	Response
N Set All Latch Edges	>*DD*N*e*( )CR	ACR
O Set Latches Off to On	>*DD*O*e*( )CR	ACR
P Set Latches On to Off	>*DD*P*e*( )CR	ACR

Purpose: Sets up latch edges for On to Off or Off to On transitions. The Digital N instruction affects all input positions.

Prerequisites: Configure as inputs using Setup G or H.

Default: Latch Off to On transitions.

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option

AND

2) Setup eF instruction is issued after the system is configured as desired.

Address: Any master digital or digital expander 1 address.

Remarks: Latches are set only when the specified transition occurs. Once a latch is set it will not change until a clear instruction Digital S or R resets the transition detecting latch.

Example: This instruction sets modules 4 and 5 to latch On to Off. The rest of the modules latch Off to On.

Instruction	Response
>40N003075CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
N	= Function code
e = 0030	= Position field. Digital N : 1's latch on to off 0's latch off to on Digital O : 1's latch off to on 0's are disregarded Digital P : 1's latch on to off 0's are disregarded If this field is omitted FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 75	= Checksum

Response content:

A = Acknowledgment

Digital Q, R, S

	Instruction	Response
Q Read Latches	>*DD*Q( )CR	A*c*CR
R Read and Clear Latches	>*DD*R*e*( )CR	A*c*CR
S Clear Latches	>*DD*S*e*( )CR	ACR

Purpose: Reads and / or Clears latches that have been set. Digital Q and R reads ALL latches, regardless of the position field. Only the latches in the specified positions are cleared.

Prerequisites: Latch direction must be set using Digital N, O, P and cleared using Digital S or R, before they can be read.

Default: Not applicable

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Remarks: Latches are set only when the specified transition occurs. Only clear type instructions Digital R or S Reset transition detecting latches.

Latches can detect pulses that are 1 mSec (0.001 seconds) or longer.

Example: Instruction reads all the latches on the I/O Plexer at address 40 and clears latches if they are set for modules 4 and 5. The response indicates module 4 and 12 have latched and that module 4 was cleared.

Instruction	Response
>40R003079CR	A1010C2CR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
R	= Function code
c = 0030	= Position field. 1's select which modules latches clear, 0's are disregarded. If this field is omitted FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 79	= Checksum

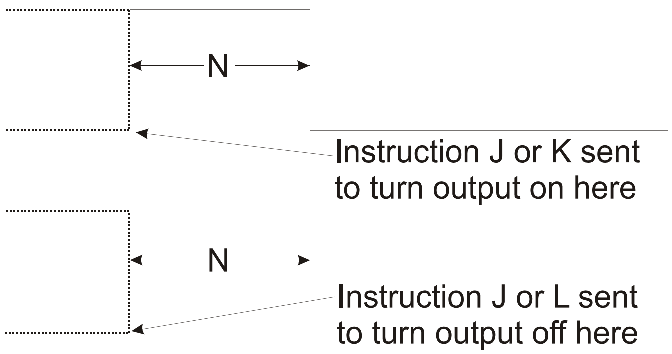
Response content:

A	= Acknowledgment
c = 1010	= Position field. 1's mean the latch has been set. 0's mean the latch hasn’t been set. For more information refer to appendix A
y	= Function code
( ) = C2	= Checksum

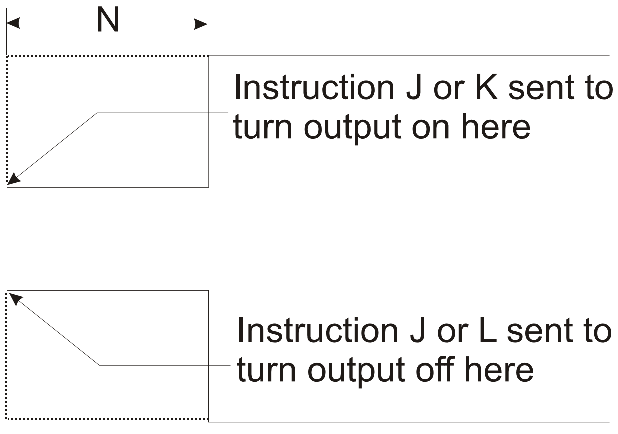
DIGITAL OUTPUT INTRODUCTION

PICTORIAL GLOSSARY

Digital Z. . .H and Z. . .J
One Shot ON/ OFF instructions

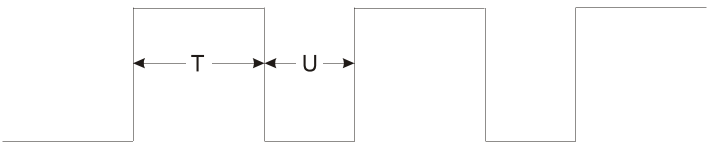


Digital Z. . I and Z. . K
Delayed ON/ OFF instructions



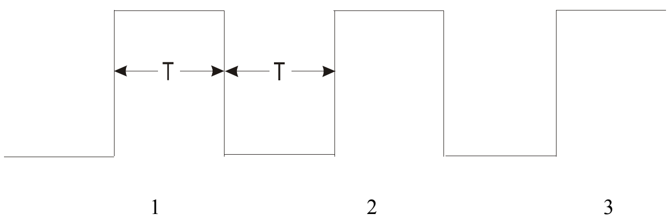
Digital Z . . L and Z . . M

Squarewave and Fast squarewave



Digital i

Generate n Pulses



Digital M

	Instruction	Response
M Read all Modules	>*DD*M ( )CR	AcCR

Purpose: Reads the On/ Off state of all digital I/O positions, inputs and outputs.

Prerequisite: None

Default: None

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Caution: This instruction does not read the physical output at the terminal strip, but actually the last value sent from the I/O Plexer.

Example: This instruction reads the current value of all digital modules. The response indicates that module 4 and 5 are On and the rest of the modules are Off OR not digital

Instruction	Response
>40MB1CR	A0030C3CR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
M	= Function code
( ) = B1	= Checksum

Response content:

A	= Acknowledgment
c = 0030	= Position Field. 1's mean the module is on, 0's mean the module is off. The module can be input or output. For more information refer to appendix A
( ) = C3	= Checksum

Digital J, K, L

	Instruction	Response
J Outputs On/ Off	>*DD*J*e*( )CR	ACR
K Outputs On	>*DD*K*e*( )CR	ACR
L Outputs Off	>*DD*L*e* ( )CR	ACR

Purpose: Turns specified outputs On or Off. Digital J should be used only if all digital modules at this address are to be set, otherwise use Digital K and L.

Prerequisite: Configure module positions as either inputs or outputs using Setup G or I

Default: Output modules Off

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Caution: If modifiers (digital Z instructions) are set up, outputs are affected accordingly when Digital J, K or L is sent.

Example: Turn On modules 0-7, and turn Off module8-15. Digital input andanalog modules are not affected.

Instruction	Response
>40J00FF9ACR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
J	= Function code
c = 00FF	= Position field. Digital J : 1's turn the module On 0's turn the module Off Digital K : 1's turn the module On 0's are disregarded Digital L : 1's turn the module Off 0's are disregarded If this field is omitted FFFFH is assumed by the I/O Plexer. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 9A	= Checksum

Response Content:

A = Acknowledgment

Digital Z

	Instruction	Response
Digital Z Modifiers		
One Shot On	>*DDZe*H*n*( )CR	ACR
One Shot Off	>*DDZe*J*n*( )CR	ACR
Terminate	>*DDZe*G( )CR	ACR

Purpose: Produces an output that when turned On/Off stays in that state for the specified time period and then returns to its initial state.
When the one shot is no longer wanted it can be terminated using digital Z. . G

Prerequisite: Configure module positions as output using Setup G or I instruction.

Defaults: Modifiers disabled

Battery Backed: The underlined instruction data is saved in memory if :

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master digital or digital expander 1 address.

Caution: These instructions are affected by setup n, which adjusts the timer resolution multiplier, TRM. If a module is set for a one shot on, it has no affect turning it off.

The time delay is restarted when Digital J, K, or L resend the data which started the delay. Digital h does the same thing. These instructions are ONLY modifiers and do not turn any modules On or Off. It performs its function only after Digital J, K, or L is sent. Terminating the instruction (Digital Z . .G) returns the output to normal behavior and turns the module Off.

Example: This instruction directs the I/O Plexer at address40 to set module 2 for one shot On (off ON off). transition. The period for the On time is 00C8H or 2 seconds if TRM = 1.

Instruction	Response
>40Z0004H00C8A5CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
Z	= Function code
e = 0004	= Position field. 1's select which modules are effected, 0's are disregarded. This field must consist of at least one digit . Leading hex zeroes may be omitted. For more information see appendix A
H	=Function Code for specifying modifier type
n = 00C8	Time the signal is On/ Off
Time H	(Desired time in seconds/ (.01 seconds *TRM)) Convert 1-4 Hex digits, Special Case: n = 0H is equivalent to 65,536 (approximately 10.9 Minutes assuming TRM = 1)
( ) = 5	= Checksum

Response Content:

A = Acknowledgment

Digital Z (Continued)

	Instruction	Response
Digital Z Modifiers		
Delayed On	>*DD*<u>*Ze*I*n*</u>( )CR	ACR
Delayed Off	>*DD*<u>*Ze*K*n*</u>( )CR	ACR
Terminate	>*DDZe*G( )CR	ACR

Purpose: Puts in a time delay before the module is turned Off or On. If the delay is no longer desired it can be terminated by Digital Z. . . G

Prerequisite: Configure as output using setup G or I instruction.

Defaults: Modifiers Disabled

Battery Backed: The underlined instruction data is saved in memory if :

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master digital or digital expander 1 address.

Caution: These instructions car affected by setup n, which adjusts the timer resolution multiplier, TRM. The time delay starts over whenever digital h is sent or Digital J, K, or L. If a module is setup for delay On, there is no delay in turning it Off.

These instructions are ONLY modifiers and do not turn any modules on/ off.
It performs its function only after digital J, K, or L is sent.
Terminating the instruction (Digital Z. . .G) return the output to normal behavior and turns the module off.

Example — This instruction sets up module 0 to have a delayed On of 2 seconds assuming TRM=1

Instruction	Response
>40Z0001I00C8A3CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
Z	= Function code
e = 0001	= Position field. 1's select which modules are effected, 0's are disregarded. This field must consist of at least one digit . Leading hex zeroes may be omitted. For more information see appendix A
I	=Function Code for specifying modifier type
n = 00C8	Time the signal is On/ Off
Time H	(Desired time in seconds/ (.01 seconds *TRM)) Convert To 4 Hex digits, Special Case: n = 0H is equivalent to 65,536 (approximately 10.9 Minutes assuming TRM = 1)
( ) = 5	= Checksum

Response Content:

A = Acknowledgment

Digital Z (Continued)

	Instruction	Response
Digital Z Modifiers		
Squarewave	>*DDZe*L*tu*( )CR	ACR
Terminate	>*DDZe*G( )CR	ACR

Purpose: Digital Z . .L generates waves with periods from 0.02 t21.8 minutes. Digital Z. . M Generates waves with periods from 5.12 to 92.8 hours.

Prerequisite: Configure module position as output using Setup G or I instruction.

Defaults: Modifiers disabled

Battery Backed: Not applicable

Address: Any master digital or digital expander 1

Remarks: Analog squarewave can be generated using analog R or V instruction.

Caution When the squarewave is terminated it goes to the off state.

Unlike other digital Z modifiers, squarewaves start immediately.

Example: This instruction outputs a squarewave to module 2. The output is Off for 4.26 minutes and on for 8.19 minutes.

Instruction	Response
>40Z0004LC064ABCR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
Z	= Function code
e = 0004	= Position field. 1's select which modules are effected, 0's are disregarded. This field must consist of at least one digit . Leading hex zeroes may be omitted. For more information see appendix A
L	=Function Code for specifying modifier type
t = C0	=Time the signal is On
u = 64	= off time Time H =(Desired time in seconds/ 2.56 Convert 2 Hex digits, Special Case: t or u = 0H is equivalent to 65,536 (approximately 10.9 Minutes assuming TRM = 1)
( ) = 5	= Checksum

Response Content:

A = Acknowledgment

Digital Z (Continued)

	Instruction	Response
Digital Z Modifiers		
Fast Squarewave	>*DDZe*M*tu*( )CR	ACR
Terminate	>*DDZe*G( )CR	ACR

Purpose: Digital Z. . L generates waves with periods from 0.02 seconds to 21.8 minutes. Digital Z. . M generates waves with periods from 5.12 seconds to 92.8hours.

Prerequisite: Configure module position as output using G or I instruction.

Defaults: Modifiers disabled

Battery Backed: Not applicable

Address: Any master digital or digital expander 1 address

Remarks: Analog squarewaves can be generated by using Analog R or V instructions.

Unlike other digital Z modifiers, squarewaves start immediately.

Caution: When the squarewave is terminated it goes to the off state

Example: This instruction inputs a squarewave to module 2. The output is turned off for 1.32 seconds and on for 1.0 second assuming TRM = 1

Instruction	Response
>40Z004M6484A5CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
Z	= Function code
e = 0004	= Position field. 1's select which modules are effected, 0's are disregarded. This field must consist of at least one digit . Leading hex zeroes may be omitted. For more information see appendix A
M	=Function Code for specifying modifier type
t = 64	=Time the signal is On
u = 84	= off time Time H =(Desired time in seconds/ 2.56 Convert 2 Hex digits, Special Case: t or u = 0H is equivalent to 65,536 (approximately 10.9 Minutes assuming TRM = 1)
( ) = A3	= Checksum

Response Content:

A = Acknowledgment

Digital h

	Instruction	Response
h Re-trigger Time Delay	>*DD*h*e*( )CR	ACR

Purpose: This instruction restarts the time delay On Digital Z instructions. This can also be accomplished by sending the module the same on/ off data as that which started the delay.

Prerequisite: Configure module positions as output using G or I instruction

Defaults: None

Battery Backed: Not applicable

Address: Master digital or digital expander 1 address

Caution: This instruction affects delays set up by:

Z. . H One shot On Digital modifier instruction
Z. . J One shot Off Digital modifier instruction
Z. . I Delay On digital modifier instruction
Z. . K Delay off digital modifier instruction

Note: this instruction does not affect squarewave generation.

Example: Instruction re-triggers the time delay on module 3 and 6.

Instruction	Response
>40h004898CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
H	= Function code
e = 0048	= Position field. 1's select which modules are effected, 0's are disregarded .If this field is omitted the I/O Plexer assumes the value FFFFH . Leading hex zeroes may be omitted. For more information see appendix A
( ) = 98	= Checksum

Response Content:

A = Acknowledgment

Digital i

	Instruction	Response
i Pulse 50% duty cycle	>*DD*i*ctn*( )CR	ACR

Purpose: Output a pulse train consisting of a specified number of pulses which are on and off for equal amounts of time.

Prerequisite: Configure module position as digital outputs using the setup G or I instruction.

Default: None

Battery Backed: Not Applicable

Address: Any master digital or digital expander 1 address

Caution: These instructions are effected by the setup n instruction, which adjusts the timer resolution multiplier, TRM.

Example: This instruction outputs a pulse train of 4 pulses whose On/ Off time is .5 seconds to module 13 and 0 assuming a TRM = 1

Instruction	Response
>40i2001320004B9CR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
i	= Function code
c = 2001	= Position field. 1's select which modules are effected, 0's are disregarded. For more information see appendix A
t = 32	=Half period, The time shown is 50% duty cycle time or the on time or the off time. On time = off time = half period. tH=((Period in seconds)/(.01 Seconds * TRM)) Convert to two hex digits
n = 004	=Number of pulses to be sent, 0-65535 or FFFFH are legal values. Special cases: n = FFFFH is treated as infinite n = 0H is treated as FFFFH
( ) = B9	= Checksum

Response Content:

A = Acknowledgment

Digital k, l

	Instruction	Response
k Start pulse On	>*DD*k*cn*( )CR	ACR
ℓ Start pulse Off	>*DD* ℓ*cn*( )CR	ACR

Purpose: Turns specified modules On or Off for a specified period of time.

Prerequisite: Configure as digital outputs using Setup G or I instruction.

Default: None

Battery Backed: Not applicable

Address: Any master digital or digital expander address

Caution These instructions are affected by the setup n, which adjusts the timer resolution TRM.

Remark: These instructions care similar to one shot waveforms Digital Z. . H and Z. . J, except this actually performs the instruction when it is sent. Furthermore, they do not modify the behavior of the normal digital J, K, and L. Digital Z is a modifier which performs its task only when the module is turned On/ Off.

Once started, a pulse may be terminated early by issuing a digital output instruction (Digital J, K, L, i, k, l) Do not use retrigger time delay, Digital h with Digital k ir l.

Example: This instruction turns module 13 and 5 On a for period equivalent to 01F4H or 5 seconds assuming TRM = M.

Instruction	Response
>40k202001F46ECR	ACR

Instruction content:

>	= Start of instruction character
DD = 40	= Digital Address
c = 2020	= Position field. 1's select which modules are effected, 0's are disregarded. For more information see appendix A
n = 01F4	=Time module is on/ off. nH = ((Time desired in seconds)/ (.01 seconds * TRM)) Convert to 1 to 4 hex digits. Special cases: n = 0 does nothing
( ) = 6E	= Checksum

Response Content:

A = Acknowledgment

ANALOG INPUT INTRODUCTION

Analog input modules range is divided into 4095 segments - 12 Bit resolution. The values are represented by 4 hex digits. The first hex digit is the “range” digit. If it is a 1, the reading is in range. The I/O Plexer handles values from 0F00H to 2BFFH. The module its self may not be able to generate values to the high and low end of this scale. There is NO guarantee of accuracy for values outside of 1000H to 1FFFH range If the module reads a value that is outside of the range it will report 000H or 3000H depending if its over or under scale. If an analog output or a digital module is interrogated, ???? are returned.

0000H	Low value default
0F00H	
	* repeatable
1000H	
	valid in-range value
1FFFH	
	* Repeatable
2BFFH	
3000H	High value default

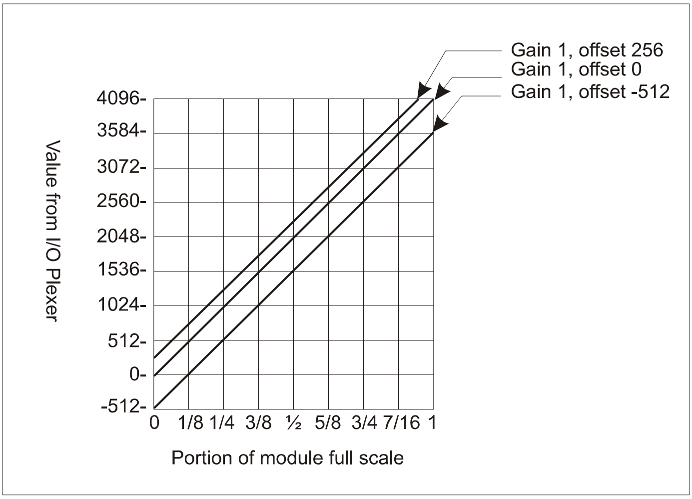
* Not all modules can generate this range

Caution 1: If an analog output module is installed but not configured as an output by the use of Setup G or I, it indicates 3000H *not*???

Caution 2: If an analog input is mistakenly configured as an analog output, it returns whatever value was last sent to the output module.

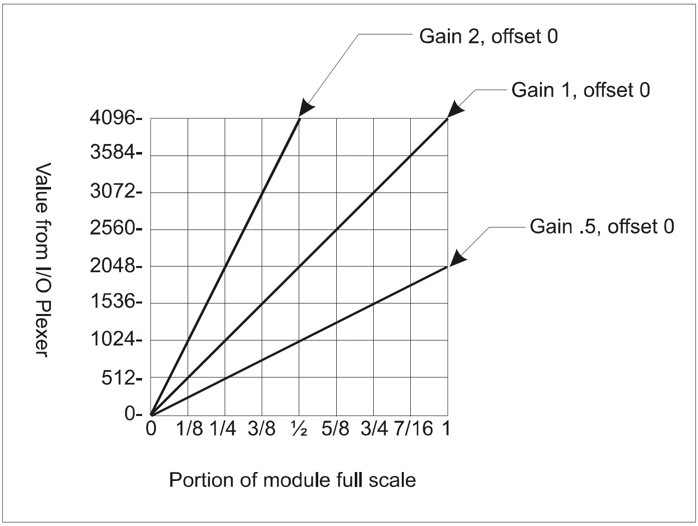
PICTORIAL GLOSSARY

analog g, h, W
Applying calculated offsets to analog inputs

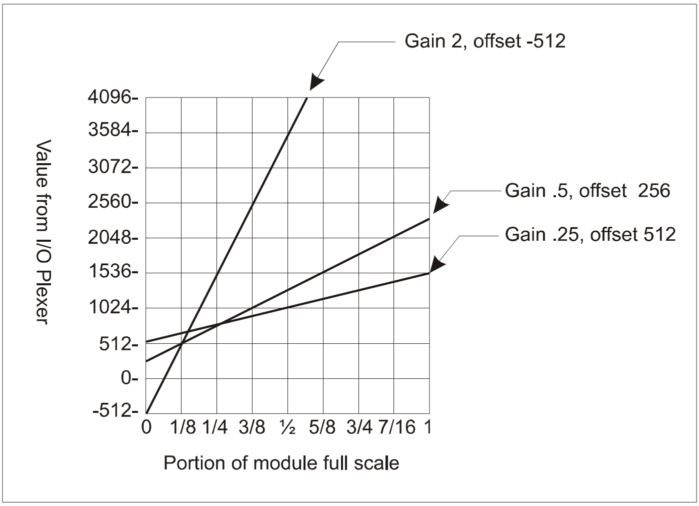


Analog X, Y, and Z

Applying calculated gains to analog input

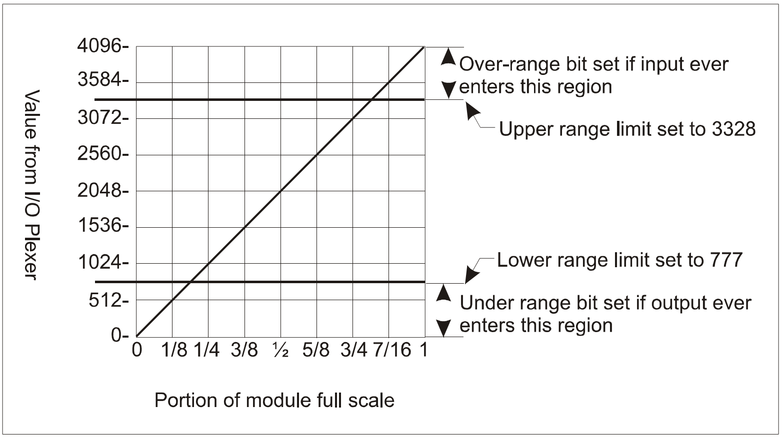


Applying both calculated gains and offsets to analog inputs simultaneously



Frequently, analog sensors and analog input modules do not exactly match where voltages and currents are concerned. The common correction for this phenomena is known as calibration. Since analog voltage and current can sometimes be difficult to adjust, the I/O Plexer contains the ability to “correct” the analog data using host defined mathematical gains and offsets. An alternate method to using host specified values is the practice of physically changing the desired sensor output to the real zero or full-scale value then issuing the calculate and set command for offset or gain respectively. Using this method, system calibration can be performed quickly and efficiently.

Analog N, O, P, Q



This instruction may be used for triggering alarms or capturing data where response needs to be faster than the host to I/O Plexer network serial link can react. Using this feature, very fast events can be recorded for the host to review after the event has occurred. The reaction speed of the I/O Plexer varies depending upon the number of analog input channels installed in the system.

Analog L

	Instruction	Response
L Read Input	>*MA*L*e*( )CR	A. . .*k*( )CR

Purpose: Determines the magnitude of analog inputs

Prerequisite: Configure as input using Setup G or H

Default: None

Battery Backed: Not Applicable

Address: Any Master analog address

Remarks Response values include the effects of offset and gain instructions

Caution: Unconnected analog input modules may result in unpredictable readings.

Example: This instruction reads the current value of model 13 and 0. The response indicates that module 13 is 1A29H and module 0 is 1089H.

Instruction	Response
>80L200177CR	A1A291089AFCR

Instruction content:

>	= Start of instruction character
DD = 80	=Master Analog Address
e = 2001	= Position field. 1's select which modules are effected, 0's are disregarded. If this value is left blank, the I/O Plexer assumes FFFFH. For more information see appendix A
( ) = 77	= Checksum

Response Content:

A	= Acknowledgment
k= 1A291089	= Response Data. 4 hex digits are returned for each module specified in the position field. Values are returned ordered from highest to lowest (15-0). If ???? is returned, an analog output or a digital module was interrogated. Module 13 response is 1A29H Module 0 response is 1089H
( ) = AF	= Checksum

Analog g, h

	Instruction	Response
g Calculate Offset	>*MA*g*e*( )CR	A . .*k*( )CR
h Calculate & Set Offset	>*MA*<u>h*e*</u>( )CR	A . .*k*( )CR

Purpose: Analog g and h calculate and/ or set a constant offset which is added to an input before sending a value to the host. This is generally used to compensate for sensor offsets - Zero adjustment.

Prerequisite: Configure as input using setup G or H

Default: Offset = 0000H

Battery Backed: The underlined instruction data is saved in memory if:

1) the I/o Plexer has the / M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master analog address

Remarks: It is recommended that the user keep the offset in the range -100% to +8% of the module range.

Use of large offsets may reduce the usable range of a nodule.

This instruction should be used wen the specified module is at the desired zero scale and the gain = 1

Caution: Do *not* use this instruction with temperature inputs

Example: This instruction calculates and sets the offset for module 13 and 0 at address analog 80. The response indicates that module 13's offset was set to F5E7H and the module 0 was offset was set to 0004H.

Instruction	Response
>80h200193CR	AF5E70003BACR

Instruction content:

>	= Start of instruction character
MA = 80	=Master analog Address
e = 2001	= Position field. 1's select which modules have an offset calculated, 0's are disregarded. If this field is omitted, the I/O Plexer assumes a value of FFFFH. Leading hex zeroes can be omitted. For more information see appendix A
( ) = 93	= Checksum

Response Content:

A	= Acknowledgment
k = F5E70003	= Response data, 4 hex digits are returned for each module position specified in the instructions position field. Values are returned from highest (15) to lowest (0). If ???? is returned, an analog output or digital module was interrogated. Negative offsets are represented as any number with a non-zero first hex digit of F F5E7H is module 13 negative offset 0003H is Module 0 positive offset For more information on analog input conversions, refer to appendix C
( ) = BA	= Checksum

Analog W

	Instruction	Response
W Set Offsets	>*MA*W*c*. . *k*( )CR	ACR

Purpose: Adds a specified constant offset to an input before transmission to host.

Prerequisite: Configure as input using setup G or H

Default: Offset = 0000H

Battery Backed: The underlined instruction data is saved in memory if:

1)The I/O Plexer has the /M memory protection option
AND
2)Setup eF is issued after the system is configured as desired

Address: Any master analog address

Remarks: We recommend the user keep the offset in a range of -100% to +8% of the module range.

Use of large offsets may reduce the usable range of a module.

Caution: Do NOT use this instruction with temperature inputs

Example: This instruction sets module 13 to an offset of 0051H and module 0 to an offset of FFAEH.

Instruction	Response
>80W20010051FFAE5ACR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
c = 2001	= Position field. 1's select which positions are to execute instructions, 0's are disregarded. For more information see appendix A
k=0051FFAE	= Offsets. 4 hex digits are sent for each specified module. Values returned are ordered from highest (15) to lowest (0). If an offset is sent to a position that is not configured as an analog input, it will be ignored.
( ) = 5A	= Checksum

Response Content:

A = Acknowledgment

Analog X, Z

	Instruction	Response
X calculate Gain	>*MA*X*e*)( )CR	A . .*k*CR
Z Calculate and set gains	>*MA*<u>Z*e*</u>( )CR	A . .*k*CR

Purpose: Multiplies an analog input's value by a constant before transmission to host. This is generally used for sensor range span adjustment.

Prerequisite: Offsets, if desired must be applied before using these instructions.

Default: Gain (slope) = 1 (k = 1000H)

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master analog address

Remarks: Gains can range from 0.25 (0400H) to 4 (4000H)
Gain (slope) instructions along with the offset instructions make it possible for an input to be adjusted to "Fill" the entire1000H to 1FFFH range

Gains larger than 1 result in lowered resolution

Special response N07 is returned if a gain is out of range

Caution: Do not use this instruction with temperature inputs

Example:	This instruction sets the gain (slope) for modules 13 and 0 based upon the current value seen by the modules. The response indicates that module 13's gain is 2500H and module 0's gain is 0750H.

Instruction	Response
>80Z200185CR	A2500075093CR

Instruction content:

MA = 80	= Master Analog Address
Z	= Function code
e = 2001	= Position field. 1's select which modules are effected, 0's are disregarded. IF this field is omitted, the I/O Plexer assumes a value of FFFFH. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 85	= Checksum

Response Content:

A	= Acknowledgment
k = 25000750	= Calculated Gain, 4 hex digits are returned for each module specified in the position field. Values are returned from highest module (15) to lowest (0). ???? is returned if the module was 2500H is the calculated gain for module 13 0750H is the calculated gain for module 0
( ) = 93	= Checksum

Analog Y

	Instruction	Response
Y Set Gain (slope)	>*MA*Y*c . . .k*( )CR	ACR

Purpose: Multiplies an analog input's value by a constant before transmission to host.

Prerequisite: Offsets, if desired must be applied before using these instructions.

Default: Gain (slope) = 1 (k = 1000H)

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master analog address

Remarks: Gains can range from 0.25 (0400H) to 4 (4000H)
Gain (slope) instructions along with the offset instructions make it possible for an input to be adjusted to "Fill" the entire1000H to 1FFFH range

Gains larger than 1 result in lowered resolution

Special response N07 is returned if a gain is out of range

Caution: Do not use this instruction with temperature inputs

Example: This instruction sets the gain (slope) for modules 13 to 111CH and module 0 to 0F33H

Instruction	Response
>80Y20010F33111C36CR	ACR

Instruction content:

MA = 80 = Master Analog Address

Y = Function code

c = 2001 = Position field. 1's select which modules are effected, 0's are disregarded. For more information see appendix A

k = 0F33111C Gain, 4 hex digits are required for each module specified in the position field. Values are returned from Highest to lowest (15-0).
Module 0 gain = 111CH
Module 13 Gain = 0F33H

( ) = 36 = Checksum

Response Content:

A = Acknowledgment

Analog N

	Instruction	Response
N Set Range Limits	>*MA*<u>N*clm*</u>( )CR	ACR

Purpose: Sets high and low range limits for specified analog inputs. If the actual analog input is above or below the specified range limit, a corresponding latch is set. This does not affect the value of the analog input.

Prerequisite: Configure as input using setup G or H

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master analog address

Default: Range limits are active. High range limit (*l*) = FFFH and the low range limit (*m*) = 000H

Remarks: Outside of range latches remain set until a clear or reset instruction.

Gain and offset instructions are applied before range limit checking occurs

Caution: Analog N range limits *l* and m consist of 3 hex digits ranging from 000H to FFFH. These correspond to input module readings of 1000H to 1FFFH.

Example: This instruction sets a high range of C00H and a low range of 400H to module 9 and module 0.

Instruction	Response
>80N0201C00400B0CR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
N	= Function Code
c = 0201	= Position field. 1's select which modules are affected. 0's are disregarded. For more information see appendix A
l = C00	=3 hex digit high range limit
m = 400	= 3 hex digit low range limit
	For more information on conversion equations and calculations, refer to appendix C
( ) = 5A	= Checksum

Response Content:

A = Acknowledgment

Analog O, P, Q

	Instruction	Response
O read all range errors	>*MA*O( )CR	A*cd*( )CR
Q Clear Range errors	>*MA*Q*e*( )CR	ACR
P Read and Clear errors	>*MA*P*e*( )CR	A*cd*( )CR

Purpose: Reads and/ or clears all range over/ under latches set when an analog input crosses a range limit specified by Analog N.

Prerequisite: Configure as input using setup G or H.

Default: Not applicable

Battery Backed: Not applicable

Address: Any master analog address

Remarks: Out of range latches remain set until a clear or reset instruction is received. Gain and offset instructions are applied before range checking is done.

Caution: Analog P reads all modules, but only clears the over/ under range latches for modules specified in the position field.

Example: Reads errors for all modules and clears the range-error bit for positions 13 and 0. The response says that module 1 is over range and module 0 is under range.

Instruction	Response
>80P20017BCR	A0002000183CR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
P	= Function code
e = 2001	= Position field. 1's select which modules range errors are to be cleared, 0's are disregarded. IF this field is omitted, the I/O Plexer assumes a value of FFFFH. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 7B	= Checksum

Response Content:

A	= Acknowledgment
c = 0002	= Position field 1's mean module is over-range 0's are disregarded
d = 0001	= Position field. 1's mean that the module is under-range 0's are disregarded. For more information on the position field refer to appendix A
( ) = 83	= Checksum

Analog a,b,c,d,e,f

	Instruction	Response
a Read Lowest Values	*MA*ae( )CR	A . . *k*( )CR
b Clear Lowest Values	*MA*be( )CR	ACR
c Read & Clear Lowest	*MA*ce( )CR	A. . .*k*( )CR
d Read Highest Values	*MA*de( )CR	A . . *k*( )CR
e Clear Highest Values	*MA*ee( )CR	ACR
f Read & Clear Highest	*MA*fe( )CR	A . . *k*( )CR

Purpose: Minimum and maximum values are the lowest or highest values an I/O Plexer has read. These values are stored until a lower or higher value is read or a clear instruction or read and clear instruction is sent.

Analog c is equivalent to sending analog a and band analog f is equivalent to analog d and e. They return the data and clear out the buffer.

Prerequisites: Configure as an input using setup G or H

Default: Always active. The minimum value is initially set to 2000H. The maximum value is 1000H

Battery Backed: Not applicable

Address: Any master analog address

Remarks: Offset and gain instructions are applied before testing for maximums and minimums.

Example: Instructs the I/O Plexer to read and clear the minimum values for modules 13 and 0.

Instruction	Response
>80c20018ECR	A19F8107CC3CR

Instruction content:

MA = 80	= Master Analog Address
c	= Function code
e = 2001	= Position field. 1's select which modules are to be acted on, 0's are disregarded. IF this field is omitted, the I/O Plexer assumes a value of FFFFH. Leading hex zeroes may be omitted. For more information see appendix A
( ) = 8E	= Checksum

Response Content:

A	= Acknowledgment
k = 19F8107C	=Minimum or maximum values. 4 hex digits are returned for each module specified in the instruction's position field. Values returned are ordered from highest (15) to lowest (0). If ??? is returned, an output or digital module was interrogated. Minimum value for module 0 = 107CH minimum value for module 13 = 19F8H
( ) = C3	= Checksum

Analog M

	Instruction	Response
M read and average	>*MA*M*bj*( )CR	A*k*( )CR

NOT RECOMMENDED!!! USE Analog T, i, U

Purpose:	Provide average value of single I/O Plexer module position over a specified number of samples
Prerequisite:	Configure as an input using Setup G or H
Default:	Averaging inactive
Battery Backed:	Not applicable
Address:	Any master analog address
Remarks:	Sample time = (10mSec * number of analog inputs installed on board)
Formula:	Average = (Sum of j readings)/ j
Caution:	The analog M instruction accumulates samples only while the user waits, and waits-and waits. The I/O Plexer can receive no more instructions until averaging is complete. Furthermore no response is sent to the host, therefore the host is tied up until the average is computed also.

Example: This instruction averages the next 240 samples for module 10. The response indicates an average of1580H

Instruction	Response
>80MAF06CCR	A1580CECR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
M	= Function code
b = A	=Module Position. This is a single character that represents a module position. The values can range from 0H (Module 0) to FH (module 15)
j = F0	= number of samples - values can range from 1-255 (1-FFH) samples. jH = Desired number of samplesH Convert to 2 hex digits.
( ) = 6C	= Checksum

Response Content:

A	= Acknowledgment
k = 1580	= Response data. 4 hex digits are returned for each module specified in the instruction's position feild. Values returned are ordered from highest (15) to lowest (0). If ???? is returned an output or digital module was interrogated. 1580H is the average for module 10. For more information on the conversion and examples, refer to appendix C
( ) = CE	= Checksum

Analog T, i

	Instruction	Response
T start averaging	>*MA*T*cj*( )CR	ACR
i averaging	>*MA*i( )CR	A*c*( )CR

Purpose: analog T initiates averaging on specified modules. Analog i Verifies that averaging is complete.

Prerequisites: Configure as input using setup G or H

Default: Averaging inactive

Battery Backed: Not applicable

Address: Any master analog address

Remarks: Sample time (10 milliseconds * number of analog inputs on board)
Several modules can be averaged at the same time.
When averaging is complete, the data can be retrieved by using analog U

Example: This instruction starts averaging the next 31 samples on module 13 and 0.

Instruction	Response
>80T2001001F56CR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
c = 2001	= Position field. 1's select which modules are to be averaged, 0's are disregarded. For more information see appendix A
j = 001F	= number of samples this number can range from 1 to 65535 or FFFFH ju = (desired samples)H Convert to 4 hex digits
( ) = 56	= Checksum

Example: This instruction is requesting which modules have completed their averaging. The response says module 13 has completed averaging.

Instruction	Response
>80iD1CR	A2000C2CR

Response Content:

A	= Acknowledgment
c = 2000	= Position field 1's mean module has completed averaging, 0's mean that module is either not involved or still averaging
( ) = C2	= Checksum

Analog U

	Instruction	Response
U Read Averaged Inputs	>*MA*U*e*( )CR	A . .*k*( )CR

Purpose: Provide the average value of a number of sequential samples of analog inputs for the specified modules as determined by the Analog T and i instruction.

Prerequisite: Averaging must be started by the use of analog T instruction.

Default: Averaging inactive

Battery Backed: Not applicable

Address: Any master analog address

Remarks: Sample time = (10 milliseconds * number of analog inputs on board)

If analog U instruction reads an average before analog i indicates the total number of samples have been accumulated, it provides the correct average for the number of samples already taken. However the number of samples used in this calculation can not be obtained.

Analog U will keep reading the last average until analog T is re-issued.

Example: This example reads the average of module 13 and module 0 at analog address 80

Instruction	Response
>80U200180CR	A19F6107ABFCR

Instruction content:

MA = 80	= Master Analog Address
U	= Function code
e = 2001	=Position field, 1's give the average for that module. 0's are disregarded. IF this field is omitted FFFFH is assumed by the I/O Plexer . Leading Hex zeroes may be omitted. For more information on the position field refer to appendix A
( ) = 80	= Checksum

Response Content:

A	= Acknowledgment
k = 19F6107A	= Response data. 4 hex digits are returned for each module specified in the instruction's position field. Values returned are ordered from highest (15) to lowest (0). If ???? is returned an output or digital module was interrogated. Average for position 0 is 107AH Average for position 13 is 19F6H For more information on the conversion and examples, refer to appendix C
( ) = BF	= Checksum

Analog K

	Instruction	Response
k Set Temperature Sensor Type	>*MA*k*cx*( )CR	ACR

Purpose: This instruction defines the type of temperature modules installed so that the I/O Plexer firmware can linearize the signal and output a temperature in °C to the host when asked.

Prerequisite: Configure as an input using setup G or H

Default: None

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory protect option
AND
2) Setup eF is issued after the system is configured as desired.

Address: Any master analog address.

Remarks: Cold reference compensation and linearization is taken care of at the module location. The user needs to convert the number to decimal and divide by 16 for a correct temperature reading.

Example: This instruction sets up modules 4, 5, 9, and 12 as type J thermocouple.

Instruction	Response
>80k123004FDCR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
k	= Function code
c = 1230	=Module Position. 1's specify which modules are to perform the instruction on, 0's are disregarded. For more information refer to appendix A
x = 04	= 2 digit hex number representing the temperature module type from table below
( ) = FD	= Checksum

duTec module type	**set x to**	**dutec module type**	**set x to**
ITCJ	04H	ITCK-1	15H
ITCJ-1	14H	100 RTD Probe	03H
ITCK	05H	590 Sensor	01H

Response Content:

A = Acknowledgment

Analog ℓ

	Instruction	Response
ℓ Read Temperature	>*MA*ℓ*e*( )CR	A. . *k*( )CR

Purpose: To read latest temperature inputs of specified modules

Prerequisite: Analog k must be issued for the appropriate temperature

Default: Configure as input using setup G or H

Battery Backed: Not applicable

Address: Any master analog address.

Remarks: Channels which read below scale return EFF0H (-273 °C)
Channels which read above scale return 7FF0H (2047 °C)

Caution: Unconnected analog input modules may result in unpredictable readings

Example: This instruction requests the temperature from module 9 and module 0.

Instruction	Response
>80ℓ020197CR	A015FFF00C8CR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
ℓ	= Function code
e = 0201	=Position field, 1's specify which modules to act on. 0's are disregarded. IF this field is omitted FFFFH is assumed by the I/O Plexer . Leading Hex zeroes may be omitted. For more information on the position field refer to appendix A
( ) = 97	= Checksum

Response Content:

A	= Acknowledgment
k = 015FFF00	= The I/O Plexer returns a k for each module selected, the first 3 characters represent degrees Celsius and the last character is a fraction of 16 015FH = Module 9 FF00H = Module 0 Temp °C = convert each k to decimal / 16 module 0 = temp °C = (351D)/ 16 = 21.9 °C If the first hex digit in a response is an F, then the temperature is negative. To take negative numbers into account, 65536 must be subtracted. Temp °C = ((Convert k to decimal) -65536/ 16) Module 0 °C = (65280 - 65536)/ 16 = -16 °C
( ) = C8	= Checksum

Other helpful formulas:

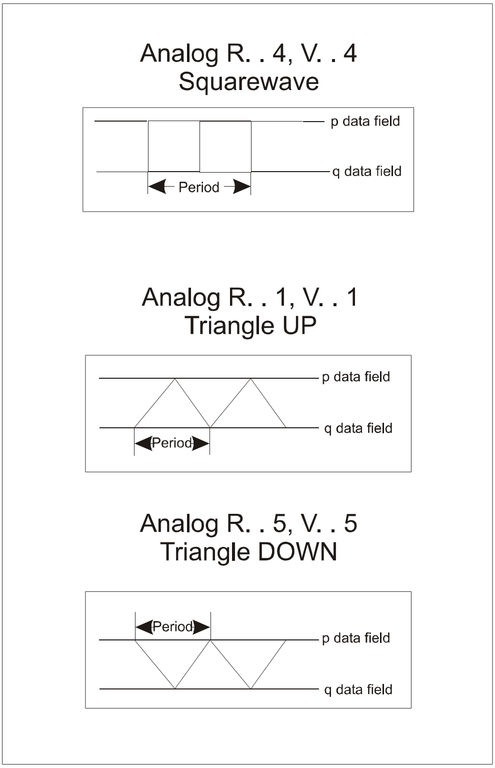
To convert to °Fahrenheit °F = (9/5 *°C) + 32)

ANALOG OUTPUT INTRODUCTION

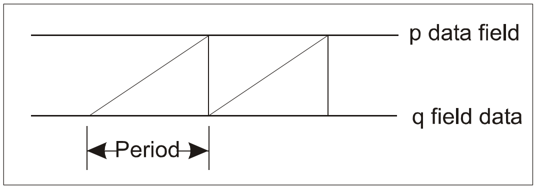
Purpose: To send specific output values or timed waveforms to the hardware.

Resolution: Analog outputs have 12 bit resolution. Their data is stored in 3 hex digits from 0 (000H) to 4095 (FFFH).

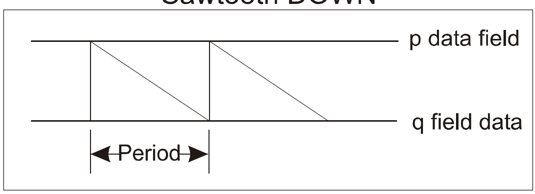
Caution: Field side circuitry may affect the actual output values of analog modules.



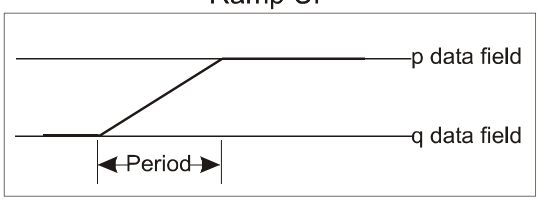
Analog R. . 3, V . .3
Sawtooth UP



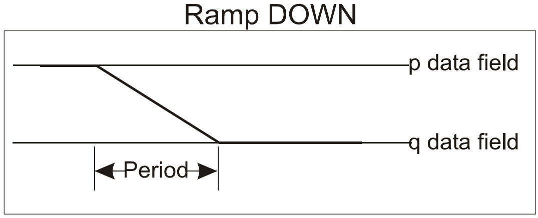
Analog R. . 7, V . .7
Sawtooth DOWN



Analog R. . 2, V . .2
Ramp UP



Analog R. . 6, V . .6
Ramp DOWN



Analog J

	Instruction	Response
J Set Levels (Same)	>*MA*J*cl*( )CR	ACR

Purpose: Outputs the same value to each specified module

Prerequisite: Configure as outputs using setup G or I

Default: None

Battery Backed: Not Applicable

Address: Any Master analog address

Example: This instruction sets modules 12 and 1 to BFFH.

Instruction	Response
>80J1002BFF43CR	>ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
J	= Function code
c = 1002	=Position field, 1's specify which modules to set to the level. 0's are disregarded. For more information on the position field refer to appendix A
l = BFF	Output level. 3 hex digits represent the level for all specified modules. For more information on the conversion refer to appendix D.
( ) = 43	= Checksum

Response Content:

A = Acknowledgment

Analog S

	Instruction	Response
S Set selected Levels	>*MA*S*c*. . . . . . *l*( )CR	ACR

Purpose: Outputs different specified values to each module chosen in the position field.

Prerequisite: Configure module positions as outputs using setup G or I.

Default: None

Battery Backed: Not applicable

Address: Any master analog address

Example: This instruction sets modules 12 to BFFH and module 1 to 01FH.

Instruction	Response
>80S1002BFF01FEACR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
S	= Function code
c = 1002	=Position field, 1's specify which modules to set to the level. 0's are disregarded. For more information on the position field refer to appendix A
l = BFF01F	Output level. 3 hex digits represent the level for all specified modules. Module levels are specified ordered from highest (15) to lowest (0) positions. BFFH = module 12 01FH = module 1 For more information on the conversion refer to appendix D.
( ) = EA	= Checksum

Response Content:

A = Acknowledgment

Analog K

	Instruction	Response
K Read Levels	>*MA*K*e*( )CR	A. . . . . lCR

Purpose: Reads the last value sent to the module

Prerequisite: Configure as outputs using the Setup G or I

Default: None

Battery Backed: Not applicable

Address: Any master analog address

Caution: The instruction does not read the physical output at the terminal strip, but the value last sent from the I/O Plexer.

Example: This instruction is requesting the last output value sent to module 13 and module 0.

Instruction	Response
>80K200176CR	A0ACBFB7ECR

Instruction content:

MA = 80	= Master Analog Address
K	= Function code
e = 2001	=Position field, 1's specify which modules to be read. 0's are disregarded. IF this field is omitted FFFFH is assumed by the I/O Plexer . Leading Hex zeroes may be omitted. For more information on the position field refer to appendix A
( ) = 76	= Checksum

Response Content:

A	= Acknowledgment
l = 0ACBFB	=Response data, 3 hex digit specifies the value of each of the modules selected by the position field. The values are returned ordered from highest to lowest (15-0) ???? is returned if an analog input or a digital module was interrogated. 0ACH = module 13 level BFBH = Module 0 level
( ) = 7E	= Checksum

WAVEFORM INTRODUCTION

Analog R, V

Purpose: Output analog signals whose amplitudes change with time.

Prerequisite: Configure as outputs using setup G or I

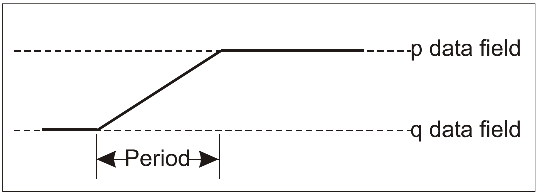
Default: Instructions inactive

Battery Backed: Not applicable

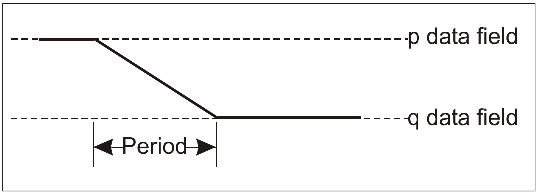
Address: Any master analog address

Remarks: The period of a waveform is the time for one complete cycle of a squarewave, triangle or sawtooth.

The duration of a ramp is the time from its minimum amplitude until it reaches its maximum amplitude.



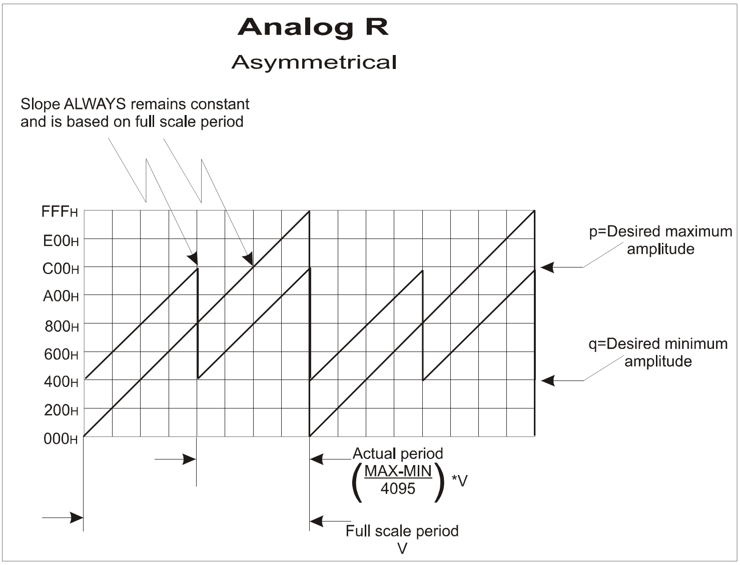
Up means starting at minimum and rising to maximum amplitude

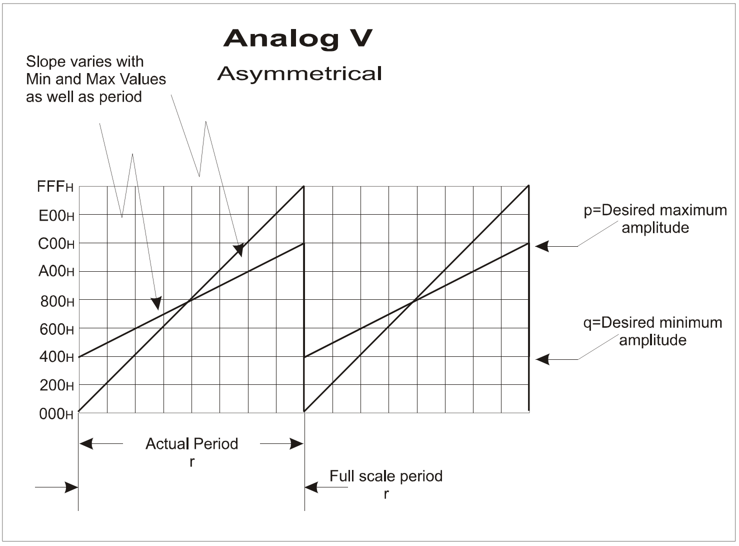


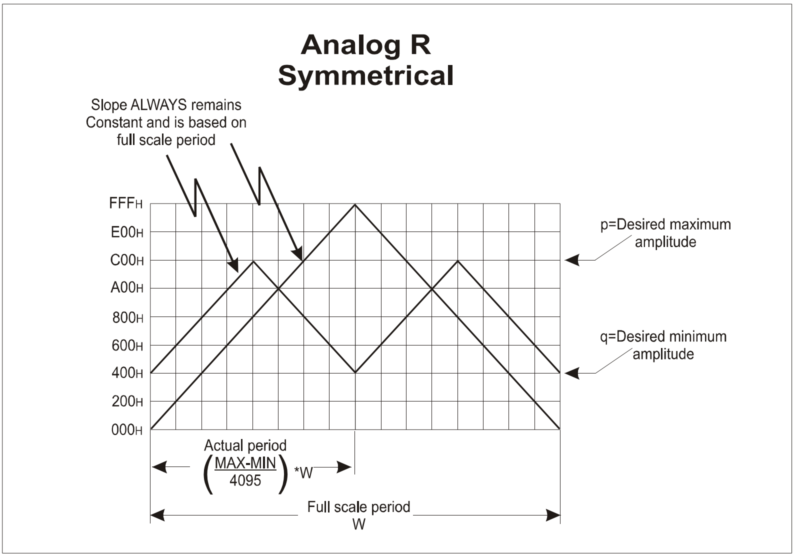
Down means starting at maximum and falling to minimum amplitude

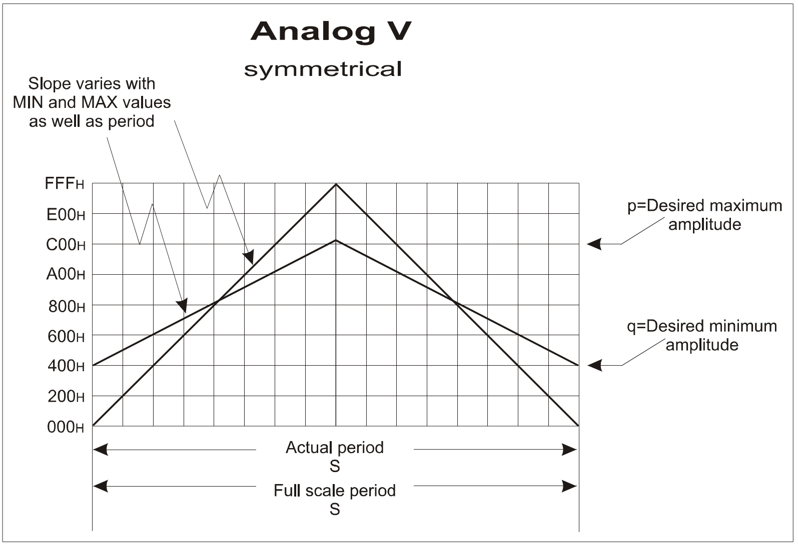
The p and q fields specify the waveforms maximum and minimum amplitude.

p = Waveform peak or maximum amplitude
q = Waveform valley or minimum amplitude


Analog R
Asymmetrical
Slope ALWAYS remains constant
and is based on full scale period
FFFH
E00H
C00H
A00H
800H
600H
400H
200H
000H
p=Desired maximum
amplitude
q=Desired minimum
amplitude
Actual period
(MAX-MIN / 4095) *V
Full scale period
V


Analog V
Asymmetrical
Slope varies with
Min and Max Values
as well as period
FFFH
E00H
C00H
A00H
800H
600H
400H
200H
000H
p=Desired maximum
amplitude
q=Desired minimum
amplitude
Actual Period
r
Full scale period
r


Analog R
Symmetrical
Slope ALWAYS remains Constant and is based on full scale period
FFFH
E00H
C00H
A00H
800H
600H
400H
200H
000H
p=Desired maximum amplitude
q=Desired minimum amplitude
Actual period
(MAX-MIN / 4095) *W
Full scale period
W


Analog V
symmetrical
Slope varies with MIN and MAX values as well as period
FFFH
E00H
C00H
A00H
800H
600H
400H
200H
000H
p=Desired maximum amplitude
q=Desired minimum amplitude
Actual period
S
Full scale period
S

Analog R

	Instruction	Response
R Waveforms (repetitive)		
Squarewave	>*MA*R*cw*0*pq*( )CR	ACR
Squarewave	>*MA*R*cw*4*pq*( )CR	ACR
Triangle up	>*MA*R*cw*1*pq*( )CR	ACR
Triangle Down	>*MA*R*cw*5*pq*( )CR	ACR
Terminate	>*MA*R*c*0( )CR	ACR

NOT RECOMMENDED!! USE ANALOG V

Remarks: The two squarewave instructions are identical.

Reference: For general information about waveforms, refer to the waveform introduction.

Example: This instruction turns on a squarewave at module 9 and module 0 with a period of 13.13 minutes, a maximum amplitude of C0H and a minimum amplitude of 40H.

Instruction	Response
>80R020154C040BDCR	ACR

Instruction content:

>	= Start of instruction character
MA = 80	= Master Analog Address
R	= Function code
c = 0201	=Position field, 1's specify which modules are affected. 0's are disregarded. For more information on the position field refer to appendix A

w = 5 = Waveform period. This must be chosen from the table on the next page. To calculate which one is needed: Desired period = (Maximum amplitude - Minimum amplitude)/ module range * full scale period from the table. The 1 hex digit from the table is what is entered in the field.

Triangle wave and squarewave zero to full scale period

w	Time	w	Time
0	Terminate Waveform	8	2.18 Minutes
1	4.37 Minutes	9	1.09 Minutes
2	6.56 Minutes	A	43.6 Seconds
3	8.74 Minutes	B	32.8 Seconds
4	10.92 Minutes	C	26.2 Seconds
5	13.13 Minutes	D	21.8 Seconds
6	15.30 Minutes	E	18.8 Seconds
7	17.48 Minutes	F	16.4 Seconds

4 = Function code modifier specifying type of waveform.
p = C0 = Maximum waveform amplitude in 2 hex digits.
PH = ((Desired amplitude/ module range) *256)H
Note This has 8 bit resolution, NOT 12 bit.
q = 40 = Minimum waveform amplitude in 2 hex digits
Follow conversion shown above
( ) = BD = Checksum

Response:

A = Acknowledgment

Analog R (continued)

	Instruction	Response
R Waveforms (Repetitive)		
Sawtooth - up	>*MA*R*cv*3*pq*( )CR	ACR
Sawtooth - Down	>*MA*R*cv*7*pq*( )CR	ACR
R Waveforms(Not repetitive)		
Ramp - up	>*MA*R*cv*2*pq*( )CR	ACR
Ramp - Down	>*MA*R*cv*6*pq*( )CR	ACR
Terminate	>*MA*R*c*0( )CR	ACR

NOT RECOMMENDED!! Use Analog V

Remark: Ramp waveforms terminate when they reach their upper or lower limit.

Reference: For general information about waveforms, refer to the waveform introduction.

Example: This instruction turns on a positive sawtooth waveform at module 9 and 0. A maximum amplitude of 80H and a minimum of 20H.

Instruction	Response
>80R0201938020B3	ACR

Instruction content:

>	= Start of instruction character
80	= Master Analog Address
R	= Function code

C = 0201 = Position field. 1's specify which module positions are to produce the desired wave. 0's are disregarded. For more information, refer to appendix A.

v = 9 = Waveform period or duration. To calculate which one is needed:
Desired Period= (Maximum amplitude - Minimum amplitude)/ Module range * full scale period or duration from the table.
The one hex digit from the table is what is entered in the field.

Sawtooth period and ramp duration (zero to zero full scale)

v	Time	v	Time
0	Terminate	8	1.09 Minutes
1	2.18 Minutes	9	32.8 Minutes
2	3.28 Minutes	A	21.8 Seconds
3	4.37 Minutes	B	16.4 Seconds
4	5.46 Minutes	C	13.1 Seconds
5	6.56 Minutes	D	10.9 Seconds
6	7.65 Minutes	E	9.4 Seconds
7	7.84 Minutes	F	8.2 Seconds

3 = Function Code specifying type of waveform

p = 80 = Maximum waveform amplitude in 2 hex digits
pH = ((Desired amplitude/ module range) * 256)H
Note: This field only has 8 bit resolution NOT 12 bit.

q = 20 =Minimum waveform amplitude, follow conversion shown above

( ) = B3 = Checksum

Response

Acknowledgment

Analog V

	Instruction	Response
V Improved waveforms (repetitive)		
Squarewave	>*MA*V*c*4*pqs*( )CR	ACR
Triangle - Up	>*MA*V*c*1*pqs*( )CR	ACR
Triangle - Down	>*MA*V*c*5*pqs*( )CR	ACR
Terminate	>*MA*V*c*0( )CR	ACR

Reference: For general information about waveforms, refer to the waveform introduction.

Example 1: This instructs the I/O Plexer at address 80 to output a triangle up wave at module 1 with a maximum amplitude of FFFH, a minimum valley of 123H and a duration of 1 second.

Instruction	Response
>80V00021FFF123000AEACR	ACR

Instruction content:

80	= Master Analog Address
0002	=Position field, 1's specify which modules to be read. 0's are disregarded. For more information on the position field refer to appendix A
1	= Function code specifying type of waveform
p = FFF	= Waveform maximum amplitude in 3 hex digits, refer to appendix D
q = 123	= Waveform minimum amplitude in 3 hex digits. For more information refer to appendix D

s = 000A	= Waveform period in 1 to 4 hex digits, For more information refer to appendix D
( ) = EA	= Checksum

Response Content:

A = Acknowledgment

Example 2: This instruction terminates the waveform at module 1.

Instruction	Response
>80V00020B0	ACR

Instruction content:

MA = 80	= Master Analog Address
V	= Function code
c = 0002	=Position field, 1's specify which modules to be read. 0's are disregarded. For more information on the position field refer to appendix A
0	= Function code specifying waveform termination
( ) = B0	= Checksum

Response Content:

A = Acknowledgment

Analog V (Continued)

	Instruction	Response
V Improved waveforms (repetitive)		
Sawtooth Up	>*MA*V*c*3*pqr*( )CR	ACR
Sawtooth Down	>*MA*V*c*7*pqr*( )CR	ACR
V Improved Waveforms (One shot)		
Ramp-Up	>*MA*V*c*2*pqr*( )CR	ACR
Ramp-Down	>*MA*V*c*6*pqr*( )CR	ACR
Terminate	>*MA*V*c*0( )CR	ACR

Reference: For general information about waveforms, refer to the waveform introduction

Example: This instructs the I/O Plexer at address 80 to output a ramp-up wave at module2. The ramp begins at 123H and rises to its final value of FFFH during a period of 1 second. The output will stay at FFFH until another output instruction is sent to this module.

Instruction	Response
>80V00022FFF123000AEBCR	ACR

Instruction content:

MA = 80	= Master Analog Address
v	= Function code
c = 0002	=Position field, 1's specify which modules to be read. 0's are disregarded. For more information on the position field refer to appendix A
2	= Function code for specifying waveform type
p = FFF	= Waveform maximum amplitude in 3 hex digits. For more information refer to appendix D

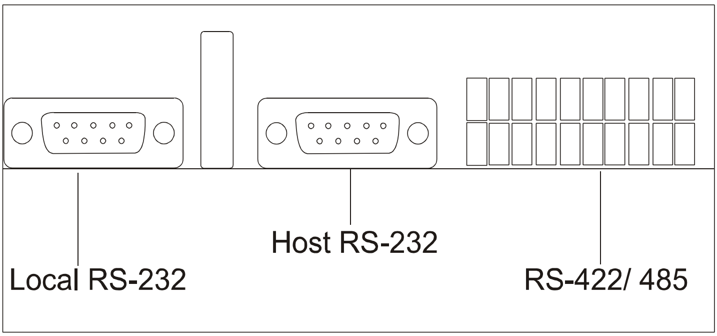
q = 123	= Minimum waveform amplitude. Follow conversion shown above.
r = 000A	= Waveform period or ramp duration Waveform period = (desired period in seconds *10) Convert to hex digits
( ) = EB	= Checksum

Response Content:

Acknowledgment

SERIAL I/O INTRODUCTION

Purpose: This series of instructions is for use with the I/O Plexer's local RS-232 port. This allows the host to exchange information with an RS-232 device.



Serial N

	Instruction	Response
N Local RS-232 Baud Rate	>*MC*Nh( )CR	ACR

Purpose: Sets the baud rate of the local RS-232 port

Prerequisite: None

Default: Baud Rate = 300

Battery Backed: The underlined instruction data is saved in memory if:

1) The I/O Plexer has the /M memory option
AND
2) Setup eF instruction is issued after the system is configured as desired.

Address: Any master control address.

Remarks: The baudrate of the local port does not have to match the baud rate of the host port. They are two separate entities.

This protocol 1 start bit, 1 stop bit, 8 data bits, no parity, baud rate selectable, and 80- character buffer

Caution: The baud rate is reset to 300 on power up if not battery backed.

Example: This instruction sets the local RS-232 port at 2400 baud.

Instruction	Response
>00Nj18CR	ACR

Instruction content:

> = Start of instruction character

MC=00 = Master Control Address

N = Function code

h = j = Baud rate from the table below.

Local RS-232 Port

Baud rate=	300	600	1200	2400	4800	9600	19200
set h =	e	f	h	j	l	m	n

( ) = 18 = Checksum

Response content:

A = Acknowledgment

Serial O

	Instruction	Response
O Host to slave message		
	>*MC*0(Message)( )CR	ACR

Purpose:	Allows the host computer to send messages to an external RS-232 device connected to the I/O Plexer local RS-232 port.
Prerequisite:	None
Default:	None
Battery backed:	Not applicable
Address:	Any master control address
Remarks:	Serial O returns a N12 response message if the remaining free space in the internal local port buffer in the I/O Plexer cannot accommodate the full message being sent by the host. This buffer is circular and can hold more than one message at a time. A message is rejected if it cannot fit in the buffer in its entirety. It should be sent again after the local device has had time to read the previous message.

The codes, >, CR, and codes 80H through FFH may not be included in network traffic from the host.

/ and \ Have special meanings as described below. Any character (0H to FFH) may be sent by embedding the "/" (forward slash) followed by the 2 digit hex code for the character. For example, if we wanted to say "and/or" we would put it in as "and /2For" Appendix H has a Hex/ Decimal/ ASCII table

Messages between the host and an I/O Plexer can contain up to 80 transmitted characters.

Caution: A \ in the message outputs a CR and a line feed. Multiple \'s can be used, each results in a CR and a line feed at the receiving device. CR cannot be sent because it is interpreted as an end of message character.

The start of message character , >, in a host-to-slave message can not be used, because it is interpreted as a new message. It can be sent using the embedding technique.

Example: This sends a message to the slave "your own message here!"

Instruction	Response
>120Your very own message here! A5CR	ACR

Message as seen at the slave:

Your own message here !

Serial P, PP

	Instruction	Response
P Message for Host?	>*MC*P( )CR	A(Message)( )CR
PP Partial	>*MC*PP( )CR	A(Message)( )CR

Purpose: Allows the Host to read the local RS-232 port device message

Default: None

Battery Backed: Not applicable

Address: Any master control address

Remarks: Messages between the I/O Plexer and host can contain up to 80 printable ASCII characters.

Mechanisms for sending ,>, and CR, characters not allowed in network traffic, depend on an agreement between the host and slave and is outside the control of the I/O Plexer.

Caution: Serial PP reads the data gathered at the local RS-232 port whether or not whether or not a carriage return was received. This could be a partial message. Partial messages read are not duplicated in the next read.

Example: This message is “Turn pump On!”

Instruction	Response
>00PP00CR	ATurn PumFBCR
Later.	
>00PP00CR	Ap On!6ECR

Doing the above sequence with Serial P

Instruction	Response
>00PB0CR	ACR
Later.	
>00PB0CR	A Turn pump On!69CR

APPENDICES

Most I/O Plexer instructions have a position field following the function code. The contents of this field determine which modules are affected by the instruction. Some functions affect all modules, in these, the position field determines what the effect is for each module. In either case, the construction of the position field follows the same rules.

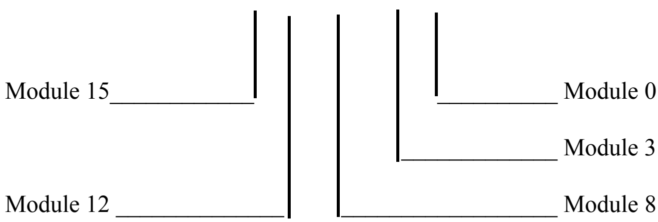
The position field is a 4 hex digit representation of a 16 digit number. The position field is a 16 digit number (one digit for each possible module) but each digit can only be a 1 or a 0. (These digits are called bits)

To fill the position field, perform the following steps:

1. Make a list of the modules that the instruction is to affect, for example: 0, 3, 8, 12, and 15.

2. Make a 16 digit number with a 1 in each position listed in step 1 and a zero in all other positions. The leftmost digit of the number is module 15, the right most is module 0. The number for our example is:

1001000100001001



3. Divide the number built in step 2 into four 4 digit numbers. Our example appears as: 1001 0001 0000 1001.

4. Using the table below, look up each of the 4 digit numbers in step 3 and replace it with the corresponding hex number or letter. Our example becomes 9109H. This is the value that should be put in the position field of the instruction. This table is on the *Quick reference guide* for easy access.

Module#:	15 14 13 12	11 10 9 8	7 6 5 4	3 2 1 0
	-1st Char-	-2nd Char-	-3rd Char-	-4thChar-

Bit pattern	0000	0001	0010	0011	0100	0101	0110	0111
Hex Digit:	0	1	2	3	4	5	6	7
Bit Pattern:	1000	1001	1010	1011	1100	1101	1110	1111
Hex Digit:	8	9	10	11	12	13	14	15

5. It is always acceptable to use a 4-digit value in a instruction which requires a position field. Some instructions also accept an abbreviated version which has had the leading hex zeroes omitted. In some instructions the position field is optional and assumes a value of FFFFH (all modules affected) if it is omitted.

Hardware method: Setup eC instruction tags correct checksum to the end of the N02 response message. Transmit instruction >00eC08CR. Now any instruction can be assembled in the usual manner, but enter 00 for checksum. The unit returns a N02 response message plus the correct checksum.

Wild card: If ?? is added to the instruction instead of a checksum, the instruction is executed. It sends a "don't care" value for checksum. This method is not recommended for programming because it does not insure proper communication error checking.

Calculation method: Checksum can also be obtained by adding all decimal values of ASCII characters that make up an instruction or response (exclude > for instructions and A for responses). Repeatedly subtract 256 from this sum until the remainder is less than 256. The checksum is the 2 digit hex equivalent of the remainder.

Example:

Instruction	Response
>80L0800( )CR	A1CAC( )CR

Instruction Character	Value	ASCII
8	56	
0	48	
L	76	
0	48	
8	56	
0	48	
0	48	
	380	

380D - 256D = 124D = 7CH

The checksum is 7CH and the complete instruction is:

>80L08007CCR

The response is:

Character	ASCII
1	49
C	67
A	65
C	67
	248D = F8H

The checksum is F8H and the complete response is: A1CACF8CR

Note: The ASCII values can be obtained from appendix H.

Analog L, a, c, d, f, M, U *k* data field

ResponseD = {(k - 4096) / 4095} * (F-Z) + Z

Where:

ResponseD is actual value in the same engineering units as F and Z.

k is the 4 digit hex response from the I/O Plexer converted to decimal.

F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
IV50M	50	0	mVolts
IV100M	100	0	mVolts
IV1	1	0	Volts
IV5	5	0	Volts
IV10	10	0	Volts
IV5B	5	-5	Volts
IV10B	10	-10	Volts
II420	20	4	mAmps

Analog L, a, c, d, f, M, U *k* data field (Continued)

Example: k = 19FCH = 6652D
II420 Module

Response valueD = [({6652 - 4096} / 4095) * (20-4) + 4]

= [(2556 / 4095) * 16 + 4]

= [(0.624) * 16 + 4]

= 9.984 + 4

= 13.984 mA

Analog g, h k Data Field

If the first hex digit is F, then the value represents a negative offset. Use the formula that applies.

Positive Offset

OffsetD = [(k / 4095) * (F-Z)] + Z

Negative Offset
(First digit is F)

OffsetD = {[(k - 65536) / 4095] * (F-Z]} + Z

Where:

Offset is the actual offset in decimal as seen by the I/O Plexer.
k is the 4 digit hex value converted to decimal that was returned by the I/O Plexer. The formula to use is chosen based on the first digit of this number

F is the full scale value of the module and Z is the zero scale value of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
IV50M	50	0	mVolts
IV100M	100	0	mVolts
IV1	1	0	Volts
IV5	5	0	Volts
IV10	10	0	Volts
IV5B	5	-5	Volts
IV10B	10	-10	Volts
II420	20	4	mAmps

Analog g, h k Data Field (Continued)

Example: $k = 01FF_H = 511_D$
IV5B Module

OffsetD = [(511 / 4095) * (5- {-5})] + {-5}

= [0.125 * 10] - 5

= 1.25 - 5

= -3.75 Volt Note: This is a -5 to 5 Volt Module!!

Example: $k = FC00_H = 64512_D$
IV10 Module

OffsetD = {[(64512 - 65536) / 4095] * [10 - 0]} + 0

= {[-1024 / 4095] * 10} + 0

= {-0.25 * 10 } + 0

= -2.5 Volt

Analog W k data field

Negative offset calculations are taken care of by subtracting the value from 65,536. Please use the appropriate formula.

Positive Offset

k = [(Desired - Z) / (F - Z)] * 4095

Negative Offset

k = 65536 + {[(Desired -Z) / (F - Z)] * 4095 }

Where:

K is the decimal number that is converted to its 4 digit hex value and plugged into the instruction.
Desired is the actual offset you want in the same engineering units as F and Z.

F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
IV50M	50	0	mVolts
IV100M	100	0	mVolts
IV1	1	0	Volts
IV5	5	0	Volts
IV10	10	0	Volts
IV5B	5	-5	Volts
IV10B	10	-10	Volts
II420	20	4	mAmps

Analog W k data field (Continued)

Example: Desired = 0.02 Volts
IV1 Module

k = [(0.02 - 0) / (1-0)] * 4095

k = [0.02 / 1] * 4095

k = 0.02 * 4095

k = 81.9D = 0051H

Example: Desired = - 11 Volts
IV10B Module

k = 65536 + {[(-11 - [-10]) / (10 -[-10])] * 4095}

k = 65536 + {[(-11 + 10) / 20] * 4095}

k = 65536 + {[-1 / 20] * 4095}

k = 65536 + {-0.05 * 4095}

k = 65536 - 204.75

k = 65331D = FF33H

Analog X, Z, k data field

GainD = k / 4096

Where:

Gain is the decimal value of the gain set by the I/O Plexer.
k is the 4 digit hex k data field converted to decimal.

Example:

k returned is 1800_H = 6144D

Gain = 6144 / 4096

= 1.5

Analog Y k data field

k = (Desired * 4096)   Convert to 4 hex digits

Where:

k is the four hex digit data entered in the instruction.

Desired is the actual decimal value required.

Example:

Desired = 1.1

k = 1.1 * 4096

k = 4505.6D = 1199H

Analog N l & m data field

These two fields set the upper and lower range limits. Any time an analog input goes above or below these limits a latch is set. These values are set using a 3-digit hex value. The 1000H offset is not used on these values.

l or m = {[(RangeD -Z) / (F - Z)] * 4095} Convert to 3 hex digits.

Where:

l or m is a value that needs to be converted to 3 hex digits and entered into the instruction.
RangeD is the actual range value that is desired in the same engineering units as F and Z.
F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
IV50M	50	0	mVolts
IV100M	100	0	mVolts
IV1	1	0	Volts
IV5	5	0	Volts
IV10	10	0	Volts
IV5B	5	-5	Volts
IV10B	10	-10	Volts
II420	20	4	mAmps

Analog N l &m data field (Continued)

Example:

IV5B Module
Upper Limit = 4 Volts
Lower limit = -4 Volts

Upper limit
l = {[(4-[-5]) / (5 - [-5])] * 40095}

l = {[(4 + 5) / (5 + 5)] * 4095}

l = {[9 / 10] * 4095}

l = 3685.5 = E65H

Lower Limit
m = {[(-4 - [-5])] / (5 - [-5])] * 4095}

m = {[(-4 + 5) / (5 + 5)] * 4095}

m = {[1/ 10] * 4095}

m = 409.5 = 199H

Analog J and S l data field:

l = {[(DesiredD -Z) / (F - Z)] * 4095} Convert to 3 hex digits.

Where:

l is the 3 digit value to be entered into the instruction.
DesiredD is the actual value desired in decimal based on the module units. For example, if you want a module to read 2.5 Volts then DesiredD = 2.5

F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
OV5	5	0	Volts
OV10	10	0	Volts
OI420	20	4	mAmps

Example: 3.6 Volts output by a OV10 Module

l = [(3.6 - 0) / (10 - 0)] * 4095

= 0.36 * 4095

= 1474.2

= 5C2H is the value entered in the l data field.

Analog k l data field:

ResponseD = [(l / 4095) * (F - Z) + Z]

Where:

Response is actual value read by the input in engineering units.
l is the 3 digit hex value converted to decimal.
F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
OV5	5	0	Volts
OV10	10	0	Volts
OI420	20	4	mAmps

Example: 78F$_H$ is returned from a OI420 Module
78F$_H$ = 1935$_D$

ResponseD = (1935 / 4095) * (20-4) +4

= 0.473 * 16 + 4

= 7.56 + 4

= 11.56 mA

Analog V p and q data field:

p or q = [DesiredD - Z) / (F - Z) * 4095 Convert to 3 hex digits

Where:

p or q is the 3 hex digit value entered in the instruction.
DesiredD is the amplitude desired in engineering units
F is the full scale value of the module and Z is the zero scale of the module. These are shown for the standard modules in the table below.

DuTec Module	F	Z	Units
OV5	5	0	Volts
OV10	10	0	Volts
OI420	20	4	mAmps

Example: 18 mA is the desired maximum amplitude and 7 is the desired minimum amplitude for a OI420 (4-20mA) Module

p = [(18-4) / (20-4)] * 4095

= [14 / 16] * 4095

= 0.875 * 4095

= 3583.125 = DFFH

q = [(7 - 4) / (20 - 4)] 4095

= [3 / 16] * 4095

= 0.1875 * 4095

= 767.81 = 2FFH

The data field of instructions and their responses are in hexadecimal.

Hexadecimal / decimal equivalents:

Decima l	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F

The two examples demonstrate the calculations that convert the base 16 hexadecimal numbers to decimal and vice versa.

Example 1: Hex to Decimal

Decimal = (1st hex digit * 4096) + (2nd hex digit * 256) + (3rd hex digit * 16) + (4 th Hex digit) Where each hex digit is the actual decimal equivalent of the hex digit.

Hex in = 0 F E D

Decimal Equivalent

13 * 1 = 13

14 * 16 = 224

15 * 256 = 2840

0 * 4096 = 0

4077$_D$

Therefore, 0FED$_H$ = 4077$_D$

Example 2: Decimal to Hex

This method works by calculating the most significant hex digit first and working down to the least significant hex digit. The formula shown only works for a maximum of 4 digits. Any whole number results are converted to hex and the remainder is carried over to determine the next hex digit.

Decimal in = 4077_D

Most significant hex digit:

4077 / 4096 < 1 therefore the most significant digit is 0.

0???

And the remainder carried over is: 4077 - (0) * 4096 = 4077

2nd Hex digit:

4077 / 256 = 15 + Therefore the 2nd hex digit is F

0F??

And the remainder carried over is 4077 - (15) * 256 = 237

3rd hex digit:

237 / 16 = 14 + therefore the 3rd hex digit is E

0FE?

and the remainder carried over is 237 - (14) * 16 = 13

4th hex digit:

Therefore the least significant digit is 13 = D.

$0FED_H$ is the hex equivalent.

The third party software vendors listed below all have drivers which will support the I/O Plexer. For further information on these companies please contact the person listed below.

86-LADDER
Wisdom Systems
1260 Iroquois Avenue
Naperville, IL 60540
(312) 505-9226

ACQUISITION ENGINE
Capital Equipment Corporation
99 South Bedford Street
Burlington, MA 01803
(617) 273-1818

* AIMAX PLUS
TA Engineering Co., Inc.
1605 School Street
P.O. Box 186
Moraga, CA 94556
(415) 376-8500

ALERT
Computer Methods Corporation
31077 Schoolcraft
Livonia, MI 48150
(313) 522-2120

CIM-PAC
Action Instruments
8601 Aero Drive
San Diego, CA 92123
(619) 279-5726

FACTORY LINK
U.S. Data
1551 Glenville Drive
Richardson, TX 75081
(241) 680-9700
Ellen Bolton

FIX
Intellution
315 Norwood Park, South
Norwood, MA 02062
(617) 769-8878

GENESIS
Iconics Inc.
132 Central, Suite 110
Foxboro, MA 02035
(508) 543-8600

HOTLINE
Industrial Control Specialists, Inc.
538 Contour Drive
Lake Charles, LA 70605
(318) 474-3163

LabTech NOTEBOOK
Laboratory Technologies Corp.
400 Research Drive
Wilmington, MA 01887
(508) 657-5400

MICRO-VIEW
Indelec
15 Boylston Place
Brookline, MA 02146
(617) 731-6234

ONSPEC
Heruistics
9845 Horn Road, MS 170
Sacramento, CA 95827
(916) 369-6606

P - CIM AFCON CONTROL AND AUTOMATION INC.
50 E. Commerce Dr.
Schaumburg, IL 60173
(708) 490-9900

PARAGON
Intec Controls
55 West Street
Walpole, MA 02081
(508) 660-1221

PROVIEW
Microvision
50 Galesi Drive
Wayne, NJ 07470
(201) 785-0325

PEGASUS
Centaurus Software Inc.
4425 Cass Street, Suite A
San Diego, CA 92109
(619) 270-4552

R/M SCADA
Ruekert & Mielke, Inc.
W329 N. 1812 Rockwood Dr.
Waukesha, 53188-1113
(414) 542-5733

RT-DAS
Talton/ Louley Engineering
9550 Ridgehaven Court
San Diego, CA 92123
(619) 565-6656

RTM 3500
Micro Specialty Systems, Inc.
5940 Keystone Drive
Northhampton, PA 18014
(215) 837-8004

REAL TIME EXPERT SYSTEMS
RTS American, Inc.
800 South Wells Street
Suite 1341
Chicago, IL 60607
(312) 431-3315

WONDERWARE
Wonderware Software Dev. Corp.
16 Technology Drive
Suite 154
Irvine, CA 92718
(714) 727-3200

Contact DuTec at 1-800-248-1632 if the software desired is not listed.

* This software package supports the use of Local Control Functions.

```
10      REM This is a demo program for the DuTec I/O Plexer
20      REM Many of the tools needed to construct GWBASIC programs to
30      REM interact with the IOP have been included. The key to the actual
40      REM IOP commands can be found in the DATA statements.
50      REM Although this may not be the most efficient algorithm, it does
60      REM serve to demonstrate each stem in communicating with the IOP.
70      REM An IV10 analog input module must be installed in position #1
80      REM of the IOP in order for the program to function properly. When the
90      REM analog input is varied the output to the screen should indicate
95      REM the change

100     CLS
110     DIM DIGIT$(15)
120     GOSUB 610 : REM Initialize HEX digit array for future use.

130     INPUT "COMMUNICATION BAUDRATE=";BAUD
140     OPEN "COM1:"+STR$(BAUD)+",N,8,1,DS,CD,CS,ASC" FOR RANDOM AS #1

150     REM  **********************************************************
155     REM  * Here to send first transmission to I/O Plexer *
157     REM  **********************************************************
160     ADDR$="80": REM hex address for analog functions in I/O Plexer as shipped from
        factory
170     CMD$="A" REM Power up clear command for first trans. To I/O Plexer
180     POSITION$="": REM No position field required for power up clear
185     GOSUB 400 : REM Build the command with the above values
190     PRINT #1,MSG$ : REM send the command to IOP.
```

```
200     GOSUB 890 : REM wait for the response from IOP.
210     IF FLAG=1 THEN GOTO 190

220     REM  *********************
222     REM  * Print the table header *
224     REM  *********************
230     CLS
240     PRINT “RAW HEX VALUE”;TAB(20);”COMPUTED INPUT VOLTS”
250     PRINT “======================”
252     REM ***************************************************
254     REM * Here to send the  request for analog data to I/O Plexer *
256     REM ***************************************************
260     ADDR$=”80": REM Hex address for analog functions in I/O Plexer as shipped from
        factory
270     CMD$=”L” : REM command letter to read analog inputs
272     POSITION$=”0002" : REM Positions field indicating module position #1
280     GOSUB 400
290     PRINT #1,MSG$
300     GOSUB 890
305     IF FLAG=1 THEN GOTO 290

340     REM ***************************************************
350     REM * Here to convert raw module HEX into decimal and print.*
360     REM ***************************************************
```

```
370    HEX.ANALOG.DATA$=MID$(RESPONSE$,2,4) : REM If in range get the actual data
375    TOTAL=0
380    FOR I=0 TO 15 : REM
382    IF MID$(HEX.ANALOG.DATA$,1,1)=DIGIT$(I) THEN TOTAL=TOTAL+(I*4096) : REM MSB
384    IF MID$(HEX.ANALOG.DATA$,2,1)=DIGIT$(I) THEN TOTAL=TOTAL+(I*256)
386    IF MID$(HEX.ANALOG.DATA$,3,1)=DIGIT$(I) THEN TOTAL=TOTAL+(I*16)
388    IF MID$(HEX.ANALOG.DATA$,4,1)=DIGIT$(I) THEN TOTAL=TOTAL+(I*1) : REM LSB
390    NEXT I
392    TOTAL=TOTAL-4096 : REM Adjust for range character “rxxx” in response
394    VOLTS=(TOTAL/4095)*10
396    PRINT HEX.ANALOG.DATA$;TAB(20);VOLTS
398    GOTO 290 : REM Continue getting data and printing it out

410    REM * here to assemble message string and calculate checksum.*
415    REM Build the message
416    REM Checksum=total ASCII value of all characters
417    REM excluding the “>” such that the subtotal after adding each
418    REM character does not exceed 255. Convert checksum into hex
419    REM value, append checksumH to the command
430    MSG$=”>”+ADDR$+CMD$+POSITION$
440    CHKSUM=0
450    FOR J=2 TO LEN(MSG$)
460    CHKSUM=CHKSUM+ASC(MID$(MSG$,J,1))
470    IF CHKSUM>255 THEN CHKSUM=CHKSUM-256
```

```
480     NEXT J
490     GOSUB 520
500     MSG$=MSG$+HEXSUM$
510     RETURN

520     REM *****************************************************
530     REM * Here to turn CHKSUM into a hex value. *
540     REM*****************************************************
550     HEXSUM$=HEX$(CHKSUM)
560     IF LEN(HEXSUM$)<2 THEN HEXSUM$-“0"+HEXSUM$
600     RETURN

610     REM *****************************************************
620     REM * Here to build hex digit array.*
630     REM *****************************************************
640     DIGIT$(0)=”0"
650     DIGIT$(1)=”1"
660     DIGIT$(2)=”2"
670     DIGIT$(3)=”3"
680     DIGIT$(4)=”4"
690     DIGIT$(5)=”5"
700     DIGIT$(6)=”6"
710     DIGIT$(7)=”7"
720     DIGIT$(8)=”8"
730     DIGIT$(9)=”9"
740     DIGIT$(10)=”A”
750     DIGIT$(11)=”B”
760     DIGIT$(12)=”C”
770     DIGIT$(13)=”D”
780     DIGIT$(14)=”E”
790     DIGIT$(F15)=”F”
```

```
830     RETURN

890     REM ****************************************************
900     REM * Here to receive a response from IOP. *
910     REM ****************************************************
920     RESPONSE$=”“:R$=”“:FLAG=0
930     DELAY=1
940     T1=TIMER
950     IF LOC(1) THEN R$ =INPUT$(LOC(1),1):GOTO 970
960     IF TIMER-T1>DELAY THEN GOTO 990 ELSE GOTO 950
970     RESPONSE$=RESPONSE$+R$
980     IF RIGHT$(RESPONSE$,1)=CHR$(13) THEN RETURN ELSE GOTO 950
990     PRINT “No response from I/O Plexer–retrying”:FLAG=1
1000    RETURN
```

DEC HEX CHAR

33 = 21 = !
34 = 22 = “
35 = 23 = #
36 = 24 = $
37 = 25 = %
38 = 26 = &
39 = 27 = ‘
40 = 28 = (
41 = 29 =)
42 = 2A = *
43 = 2B = +
44 = 2C = ,
45 = 2D = -
46 = 2E = .
47 = 2F = /
48 = 30 = 0
49 = 31 = 1
50 = 32 = 2
51 = 33 = 3
52 = 34 = 4
53 = 35 = 5
54 = 36 = 6
55 = 37 = 7
56 = 38 = 8
57 = 39 = 9
58 = 3A = :
59 = 3B = ;
60 = 3C = <
61 = 3D = =
62 = 3E = >
63 = 3F = ?
64 = 40 = @
65 = 41 = A
66 = 42 = B
67 = 43 = C
68 = 44 = D
69 = 45 = E
70 = 46 = F
71 = 47 = G
72 = 48 = H
73 = 49 = I
74 = 4A = J
75 = 4B = K
76 = 4C = L
77 = 4D = M
78 = 4E = N
79 = 4F = O
80 = 50 = P
81 = 51 = Q
82 = 52 = R
83 = 53 = S
84 = 54 = T
85 = 55 = U
86 = 56 = V
87 = 57 = W
88 = 58 = X
89 = 59 = Y
90 = 5A = Z
91 = 5B = [
92 = 5C = \
93 = 5D =]
94 = 5E = ^
95 = 5F = _
96 = 60 = ‘
97 = 61 = a
98 = 62 = b
99 = 63 = c
100 = 64 = d
101 = 65 = e
102 = 66 = f
103 = 67 = g
104 = 68 = h
105 = 69 = i
106 = 6A = j
107 = 6B = k
108 = 6C = l
109 = 6D = m
110 = 6E = n
111 = 6F = o
112 = 70 = p
113 = 71 = q
114 = 72 = r
115 = 73 = s
116 = 74 = t
117 = 75 = u
118 = 76 = v
119 = 77 = w
120 = 78 = x
121 = 79 = y
122 = 7A = z
123 = 7B = {
124 = 7C = |
125 = 7D = }
126 = 7E = ~

First
Digit Second Digit

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
2	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47
3	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
4	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
5	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
6	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
7	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127
8	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143
9	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159
A	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
C	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207
D	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223
E	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239
F	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255