



Galil Motion Control
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Hardware Command Reference

Edition 5/24/2011 8:37:49 AM (svn 395)

- Including commands that apply to:
 - All
 - DMC40x0
 - SINEAMP
- Including command details that apply to:
 - All
 - DMC40x0

Overview

This command reference is a supplement to the Galil User Manual.

Resources on www.galilmc.com
 Printable version
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What is DMC code?

DMC (Digital Motion Controller) code is the programming language used for all Galil hardware. It is a high-level, interpreted language which is simple to learn and use, yet is surprisingly powerful. Actively developed and refined since 1983, DMC code provides functionality that is particularly well suited to motion control and PLC applications.

DMC code can be used manually from a terminal, programmatically from an external device or customer application, and can be fully embedded into a Galil controller's memory to leverage powerful "embedded-only" features and for stand-alone applications.

DMC code of course provides symbolic variables, arrays, and math support. The elegance of DMC coding is particularly evident when writing code for embedded applications. When running on the controller, the DMC language supports if-then-else conditionals, code branching, subroutines, a call stack (with parameter passing and local variable scope on some models), multi-threading, and automatic subroutines (i.e. event-driven programming).

DMC code runs on the Galil Real Time Operating System (RTOS) which is specifically designed for Galil hardware and for motion control.

The learning curve on DMC code is quite fast, usually less than one hour to basic motion, so called, "spinning motors". It is the fastest to learn, the easiest, the simplest, and one of the most flexible and powerful languages in the industry. Don't forget, Galil's [Applications Support Team](#) is available to assist you; from the most basic question to the most complicated needs.

Top Down: How is a Galil system normally structured?

However you want, there are three general approaches to Galil programming.

Embedded/Galil-centric Programming

In this approach, a host computer is only used during development to program the controller. The program is then downloaded and burned to non-volatile flash using the #AUTO automatic subroutine to indicate where code execution should start on boot-up. The Galil controller will now run "standalone," not requiring any intervention from the host. Note that for serial and Ethernet controllers, the standalone controller can still actively work with other controllers in a network, without host intervention.

PCI and other PC bus-based controllers support this approach, although still require the PCI bus for power.

[GalilTools \(GT\)](#) is provided as a programming environment for developing embedded applications.

Host-centric Programming

If a GUI or other frontend is desired to be run on a host, all development can be conducted on the host PC, with the architecture, operating system, and programming language of choice. In this approach, the controller receives every command from the host PC, nothing is running embedded. Many Galil firmware features are available to facilitate host-centric programming including mode-of-motion buffers, data logging buffers, asynchronous data record updates from the controller, PCI and UDP interrupt events, and more.

[GalilTools \(GT\)](#) is bundled with a programming library (API) for programming applications from a host. Many popular operating systems and languages are supported.

Hybrid Programming

Perhaps the most versatile approach to Galil system design, the Hybrid approach allows for both embedded code and host-side code to work in tandem. Typically an application is developed for embedded use in DMC code. The code incorporates all of the detail of an application but relies on the host to provide it data. Through variables, arrays, and other commands, the host is able to define the bounds of the embedded algorithms. The host plays a supervisory role, interrogating status, receiving asynchronous updates from the controller, starting and stopping threads, and so on. The controller takes care of the motion and I/O responsibilities based on its embedded program, and the controller's real time operating system (RTOS) ensures that the application won't suffer from indeterminacy which is common on general purpose PC operating systems (e.g. Microsoft Windows). Because the controller takes care of the details, the host is able to use its resources on other tasks, such as complicated number crunching or user interface.

It is noteworthy that Galil Standalone controllers (e.g. DMC-40x0, DMC-41x3, DMC-21x3, RIO-47xxx) can leverage the Ethernet to provide powerful modularity. Using any of the above three system approaches, multiple controllers can work in concert to achieve an application's requirements. Networked controllers also provide easy scalability. Need some more digital or analog I/O? Add an RIO. Need another axis of control? Add another DMC to the network. Both the Galil firmware and the Galil software libraries provide features which allow easy use of multiple controllers on an Ethernet network. RS232/422/485 networks are also possible.

Bottom Up: Anatomy of DMC code

Classification

DMC language can be broken up into the following general classifications

Classification	Description	Examples	Example Comments
Explicit Notation Only	The command receives its arguments only by assignment with the "=" operator.	IHC=192,168,1,101<1070>2	Create a TCP connection on Ethernet handle C to a device at IP address 192.168.1.101 on port 1070
Implicit Notation Only	The command receives its arguments only by an implicit argument order.	IA 192,168,1,102	Set the local IP address to 192.168.1.102
Explicit & Implicit	The command receives its arguments either by an explicit assignment using the "=" symbol, or an implicit argument order.	KPA=64;KPB=32;KPH=128 KP 64,32,,,,,128	Assign the proportional constant (KP) of the PID filter to three different axes.
Accepts Axis Mask	The command receives its arguments as a string of valid axis names.	ST ADF	Stop (ST) axes A, D and F. Leave other axes running.

Two Letter Only	The command accepts no arguments	BN	Burn (BN) controller parameters to flash memory
Operator or Comparator	Operators take two arguments and produce a result. Comparators take two values and return a Boolean (1 or 0).	+,-,*,/ =,<,>,<=,>=,<>	Operators Comparators
@ Function	Starting with the @ character, these functions take one argument and perform a function, returning its result	@SIN,@ASIN @AN,@IN @RND,@FRAC,@COM	Trig functions Sine and ArcSine I/O functions Analog in and Digital in Numerical functions Round, Fractional Part, Bitwise compliment
Embedded Only	Not valid from the terminal, or from PC-side code, these commands are used in embedded DMC code only	IF,ELSE,ENDIF JS,JP EN, RE	IF Conditionals Jump commands End program, Return from Error
Operand	Operands hold values, and are not valid on their own. They can be used as arguments to commands, operators or comparators	_TPA _LFC _TC	Current position of axis A encoder Forward limit state on C axis Current Error code
Trippoint	Trippoints hold up a thread's execution (block) until a certain condition occurs. These are a special case of Embedded Only type commands.	WT 1000 AMA AI1	Wait 1000 ms Wait until axis A completes profiled motion Wait for input one to go high
Comment	Comments are used to document code.	"This is a comment	There are three types of comments: <i>REM</i> , <i>'</i> , and <i>NO</i>

DMC code is case sensitive. All Galil commands are uppercase. User variables and arrays can be upper-case or lower case. Galil recommends that array and variable names contain at least one lower-case character to help distinguish them from commands.

Explicit Notation

These commands specify data using an axis designator followed by an equals sign. The * symbol can be used in place of the axis designator. The * defines data for all axes to be the same. For example:

Syntax	Description
PRB=1000	Sets B axis data at 1000
PR*=1000	Sets all axes to 1000

Implicit Notation

These commands require numerical arguments to be specified following the instruction. Values may be specified for any axis separately or any combination of axes. The comma delimiter indicates argument location. For commands that affect axes, the order of arguments is axis A first, followed by a comma, axis B next, followed by a comma, and so on. Omitting an argument will result in two consecutive commas and doesn't change that axis' current value. Examples of valid syntax are listed below.

Valid Syntax	Description
AC n	Specify argument for A axis only
AC n,n	Specify argument for A and B only
AC n,,n	Specify argument for A and C only
AC n,n,n,n	Specify arguments for A,B,C,D axes
AC ,n,,,n	Specify arguments for B and E axis only
AC ,,n,n	Specify arguments for E and F

Where n is replaced by actual values.

Accepts Axis Mask

These commands require the user to identify the specific axes to be affected. These commands are followed by uppercase X,Y,Z and W or A,B,C,D,E,

F,G and H. In DMC code, X,Y,Z,W and A,B,C,D are synonyms, respectively.

No commas are used and the order of axes is not important. When an argument is not required and is not given, the command is executed for all axes.

Valid Syntax	Description
SH A	Servo Here, A only
SH ABD	Servo Here, A,B and D axes
SH ACD	Servo Here, A,C and D axes
SH ABCD	Servo Here, A,B,C and D axes
SH XYZW	Identical to SH ABCD
SH BCAD	Servo Here, A,B,C and D axes
SH ADEG	Servo Here, A,D,E and G axes
SH H	Servo Here, H axis only
SH	Servo Here, all axes

Two Letter Only

These commands have no options or arguments. Some examples follow.

Valid Syntax	Description
BN	Burn parameters
BV	Burn Variables
BP	Burn Programs
ID	Identify hardware configuration
LA	List arrays

Operator or Comparator

Operators and Comparators take two arguments and return one value. All comparison and operations occur left to right. That is, multiplication and addition have the same order-of-operation priority, and operations and comparisons are performed as encountered on a left to right search. Parenthesis should be used to indicate order of operation precedence. Some examples follow.

Valid Syntax	Description
var = 1 + 1	Variable var is assigned value 2
var = 2 + 1 * 3	Variable var is assigned value 9
var = 2 + (1 * 3)	Variable var is assigned value 5
IF ((a=b) & (a=c))	Checks if a=b=c
IF (a=b=c)	Invalid syntax to check if a=b=c
var = (a=1)	var is assigned with Boolean value (true/false) based on comparison a=1

@ Function

At functions take one value or evaluated expression and return a result. Some examples follow.

Valid Syntax	Description
var = @SIN[90]	Variable var is assigned value 1. Sine of 90 degrees.
var = @ASIN[1]	Variable var is assigned value 90. Inverse Sine of 1
var = @IN[1]	Variable var is assigned 1 or 0, based on current state of digital input 1
var = @RND[1 + 0.6]	Variable var is assigned 2, 1.6 round to the nearest integer

Embedded Only

Embedded commands make sense only in the context of an embedded application. These commands include jumps, if-then-else syntax, subroutines, etc. Some examples follow.

Valid Syntax	Description
#go	Labels can be called by name in order to jump code to specific lines
JP#go	Jump to line number indicated by #go label
#AUTO	Automatic subroutine. #AUTO is the entry point for execution on bootup. See entries starting with # for other automatic subroutines.
RI	Return from interrupt. This is the termination for certain automatic subroutines (event handlers)
IF (a=5);MG"Five";ELSE;MG"Not Five";ENDIF	If statement. ; can be replaced by carriage return for better readability

Automatic subroutines operate very similarly to event handlers in event-driven languages. When an event occurs, execution of code jumps to the automatic subroutine. Once the end of the automatic subroutine is reached, code execution continues where it left off.

Operand

Many commands have corresponding operands that can be used for interrogation or for use within mathematical or other expressions. Operands are not valid alone, and must be used inside a valid DMC code expression. For example, to print the value of the *TIME* operand the following command is issued.

```
:MG TIME
 13779546.0000
:
```

To assign *TIME* to a variable and then print it, the following is used.

```
:var=TIME
:MG var
 13909046.0000
:
```

All DMC codes starting with the underscore `_` character are operands. The servo loop counter, *TIME*, is an operand without an underscore.

Variables and array elements act similarly to operands. Whereas operands are read-only, variables and array elements are read-write. Operands, variables, and array elements can be arguments to commands, are valid in mathematical expressions, and can be used in assignments to other variables and array elements.

Trippoints

The controller provides several commands that can be used to pause execution of code until certain conditions are met. Commands of this type are called "trippoints." Such trippoints may wait for an elapsed time, wait for a particular input, or in motion controllers wait for particular motion event to occur.

When a trippoint command is executed, the program halts execution of the next line of code until the status of the trippoint is cleared. Note that the trippoint only halts execution of the thread from which it is commanded while all other independent threads are unaffected. Additionally, if the trippoint is commanded from a subroutine, execution of the subroutine, as well as its calling thread, is halted.

Trippoints are intended for use only within embedded DMC code and should not be sent from a terminal or a host application program executing from a PC.

Popular Trippoints

Trippoint	Short Description	Supported On
WT	wait for a time period (sleep)	All Galil Hardware
AI	wait for a digital input	All Galil Hardware
AM	after move	Motion Controllers
MC	motion complete, in position	Motion Controllers
AT	At time, time from reference	All Galil Hardware
AD	after distance	Motion Controllers
AS	At speed	Motion Controllers
AV	After Vector Distance	Motion Controllers
AA	After Analog	RIO-47xxx only

Comments

Comments are used to document code, and to disable lines of code while debugging. There are three ways to comment.

REM REM stands for "Remark." When a line begins with the REM command, the entire line is stripped by Galil software before downloading to the controller. REM is NOT a recognized Galil command; it is a keyword recognized by Galil software as data that is to be skipped during program download. When program speed and code length are at a premium, use REM comments.

NO NO stands for "No Operation." Lines beginning with NO are downloaded to the controller and incur a non-zero processing overhead as a result. If the developer desires the comments to stay in code so that uploaded code will still be notated, use NO or '. NO comments are not stripped when code is compressed by software.

' The single quote character is similar to NO. Lines beginning with ' are downloaded to the controller and incur a non-zero processing overhead as a result. If the developer desires the comments to stay in code so that uploaded code will still be notated, use NO or '. ' comments ARE stripped when code is compressed by software.

When commenting inline, NO and ' are valid when preceded by a ; character. REM is only valid as the start of a line. Some examples follow.

```
BG;' This is a comment. semicolon and ' precede, followed by spaces, and then the comment
ST:NO Same as above, except on compression, this data will remain, less spaces
REM This is a remark. It will not be downloaded to the controller by Galil software
NO This is an NO comment starting a line
NOTE This is also an NO comment
' This is a single quote comment starting a line
'PRX=1000;BGX;' This line of code has been disabled with a leading '
```

Special characters ; and `

;

The semicolon is used to separate individual commands on a single line of embedded code or in a single interrogation from the host. When running multi-threaded, embedded code, all commands on a single line will be executed before the program counter switches to the next thread*. Using multiple commands on a single line therefore allows for increased thread priority.

* Certain commands such as trippoints will cause the program counter to continue to the next thread before a line has completed.

`

On the RIO series of PLCs, the backtick (ascii 96) is a line continuation character. If a line of code passes the RIO's 40 character length limit, the ` character can be used to continue the line of code on the next line.

Interrogation

Most commands accept a question mark (?) as an argument. This argument causes the controller to return parameter information. Type the command followed by a ? for each axis requested. The syntax format is the same as the parameter arguments described above except '?' replaces the values.

Syntax	Description
PR ?	The controller will return the PR value for the A axis
PR ,,,?	The controller will return the PR value for the D axis

PR ?,?,?,?	The controller will return the PR value for the A,B,C and D axes
PR ,,,,,,?	The controller will return the PR value for the H axis
PR*=?	The controller will return the PR value for all axes

Data Types

Galil4.2

There is only one native data type in DMC language, the Galil4.2 format. Galil4.2 is a signed, fixed-point, decimal number with 4 bytes of integer and 2 bytes of fraction. Bit encoding of Galil4.2 is 2's compliment.

Integer values range from -2,147,483,648 to 2,147,483,647

Fractional values range from 0.999985 to .000015 in increments of .000015 (one part in 65535). When working with very small fractional values, use the \$ formatter to display the number in hex.

```
:v=1-$0.0001;'subtract the smallest fractional value
:v=?
 1.0000
:v=?{$1.4};'hex display has higher resolution
$0.FFFF
:v=v+$0.0001
:v=?
 1.0000
:v=?{$1.4}
$1.0000
:
```

Strings

Galil "strings" are still variables in 4.2 format, with each byte printed as the ASCII representation of the number. Galil strings are max 6 characters. The left most character of a string is the most significant byte in the Galil4.2 number.

Boolean

A Boolean is represented in the Galil language as a Galil4.2 value. 0.0 is false. All other values are true.

```
:a=1
:b=2
:c=(a=b);'(a=b) returns a Galil Boolean
:LV
a= 1.0000
b= 2.0000
c= 0.0000
:a=2
:c=(a=b)
:LV
a= 2.0000
b= 2.0000
c= 1.0000
:
```

Units of Distance

The units of distance in a Galil controller are either in "counts" or "steps". A count is a single unit of feedback, such as a quadrature count, an SSI or BiSS bit, or an Analog to Digital converter bit. Counts are typical with servos. Steps are used for stepper-type motors. Steps are open-loop units and refer to a single level transition sent to a stepper amplifier. In general for a unit of real distance, 1 step is NOT equal in distance to 1 count. See the "Stepper Position Maintenance Mode" in the user manual for more information.

Each axis of a Galil motion controller can be configured to control either a servo or a stepper. In this documentation, servo motors are generally assumed. Differences between functionality in stepper and servo operation are noted in each command. Where not explicitly noted otherwise, when using stepper motors, the unit "count" can be exchanged with the unit "step" (e.g. steps per second instead of counts per second).

Flash Memory

Each Galil controller has a flash memory provided for saving parameters and user data. The flash is divided into three sectors, Parameters, Variables and Arrays, and Program. Each sector has an associated burn command which burns the entire sector.

Flash Sector	Data Storage	Burn Command
Parameters	Stores the controller parameters such as PID filter coefficients, IP address, motion kinematic values, I/O configurations	BN
Variables and Array	Stores the currently allocated variable table (LV) and each of the arrays in the array table (LA)	BV
Program	Stores program currently downloaded on the controller	BP

Resetting the Controller to Factory Defaults

When a master reset occurs, the controller will reset all setup parameters to their default values and the non-volatile memory is cleared to the factory state. A master reset is executed by the command, `<ctrl R> <ctrl S> <Return>` OR by powering up or resetting the controller with the MRST jumper on.

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- [TZ - Tell I O Configuration](#)
- [UI - User Interrupt](#)
- [UL - Upload](#)
- [VA - Vector Acceleration](#)
- [VD - Vector Deceleration](#)
- [VE - Vector Sequence End](#)
- [VF - Variable Format](#)
- [VM - Vector Mode](#)
- [VP - Vector Position](#)
- [VR - Vector Speed Ratio](#)
- [VS - Vector Speed](#)
- [VV - Vector Speed Variable](#)
- [WH - Which Handle](#)
- [WT - Wait](#)
- [XQ - Execute Program](#)
- [YA - Step Drive Resolution](#)
- [YB - Step Motor Resolution](#)
- [YC - Encoder Resolution](#)
- [YR - Error Correction](#)
- [YS - Stepper Position Maintenance Mode Enable, Status](#)
- [ZA - User Data Record Variables](#)
- [ZS - Zero Subroutine Stack](#)

#	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Label (subroutine)		

Full Description

The # operator denotes the name of a program label (for example #Move). Labels can be up to seven characters long and are often used to implement subroutines or loops. Labels are divided into (a) user defined (b) automatic subroutines. User defined labels can be printed with LL and the number of labels left available can be queried with MG _DL. The automatic subroutines include #CMDERR, #LIMSWI, #POSERR, #ININT, #AUTO, #AUTOERR, and #MCTIME (no RIO).

A label can only be defined at the beginning of a new line.

There is a maximum of 510 labels available

Arguments

#nnnnnnn where

nnnnnnn is a label name up to seven characters. Uppercase or lowercase characters are valid.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (no RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

LL - List labels

_DL - Labels available

JP - Jump statement

JS - Jump subroutine

Examples:

```
'A simple example of iteration. The loop will run 10 times
i=0;'          Create a counter
#Loop;'        Label
  i=i+1;'      Increment counter
JP#Loop, i<10;' spin in #Loop until i >= 10
EN;'          End the subroutine or thread
```

#AMPERR	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Amplifier error automatic subroutine		

Full Description

#AMPERR is an automatic subroutine and is used to run code when a fault occurs on a Galil amplifier. See the TA command and individual amplifier information in the DMC-4xxx User Manual.

Other user code does not need to be running for #AMPERR to be raised.

When an external servo driver is used in an axes where the AMP-430x0 is also installed, the axis should be setup as a brushed motor (BR~a=1) otherwise the lack of hall inputs will cause an amplifier error.

Use RE to return from the AMPERR subroutine.

See the TA command for more information.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	controllers with integrated drives

Related Commands

TA - Tell amplifier status

CN - Configure I/O

OE - Off on error

RE - Return from error

Examples:

```
'this code will run in the event of an amplifier error,
'setting a digital output and notifying the operator.

#AMPERR
'Set a digital bit to signal an amplifier error to peripheral hardware
SB4

'Send a message to the user
MG"An amplifier error has occurred"

'Return from the AMPERR subroutine, restoring trippoints that were running
RE1
```

Detailed #AMPERR example. Uses LCD to display amplifier error information and remains in #AMPERR

```
routine until the error is cleared.

#AMPERR
REM mask out axes that are in brushed mode for _TA1
mask=(_BRH*128)+(_BRG*64)+(_BRF*32)+(_BRE*16)+(_BRD*8)+(_BRC*4)+(_BRB*2)+_BRA
mask=@COM[mask]
mask=((_TA1&mask)&$0000FFFF)
LU0;'turn off auto update of LCD
REM amplifier error status on LCD
MG"A-ER TA0" {L1},_TA0{L2};WT2000
MG"A-ER TA1" {L1},mask{L2};WT2000
MG"A-ER TA2" {L1},_TA2{L2};WT2000
MG"A-ER TA3" {L1},_TA3{L2};WT2000
LU1;'turn on Automatic Axis Update of LCD
WT5000
REM the sum of the amperr bits should be 0 with no amplifier error
er=_TA0+mask+_TA2+_TA3
JP#AMPERR,er0
REM Notify user amperr has cleared
LU0
MG"AMPERR" {L1}, "RESOLVED" {L2}
WT3000
LU1
RE
```


#AUTO	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Subroutine to run automatically upon power up		

Full Description

#AUTO defines code to run automatically when power is applied to the controller, or after the controller is reset. When no host software is used with the controller, #AUTO and the BP command are required to run an application program on the controller.

Upon controller startup, application code will automatically begin running in thread 0 at #AUTO.

Use EN to end the routine.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All

Related Commands

BP - Burn program

EN - End program

#AUTOERR - Automatic Subroutine for EEPROM error

Examples:

```
'On startup, this code will create a 50% duty cycle square wave on output 1 with a period of 1
second.
#AUTO;'      Start on powerup
  SB1;'      Set bit 1
  WT500;'    Wait 500msec
  CB1;'      Clear bit 1
  WT500;'    Wait 500msec
JP#AUTO;'    Jump back to #AUTO
```

#AUTOERR	Syntax:	Other
	Operands:	none
	Burn:	not burnable
EEPROM checksum error and Serial Encoder timeout error Automatic Subroutine		

Full Description

All firmware versions and controllers

#AUTOERR will run code upon power up if data in the EEPROM has been corrupted. The EEPROM is considered corrupt if the checksum calculated on the bytes in the EEPROM do not match the checksum written to the EEPROM. The type of checksum error can be queried with `_RS`

Use EN to end the routine.

-SER firmware

#AUTOERR will also run if the time to acquire serial position data exceeds 90% of the hardware sample loop. This type of error is very rare and should never occur in normal operation.

In the event of a serial position acquisition timeout, the following will occur:

- a. The controller will reset
- b. The controller servo loop will not run, TM will be set to zero
- c. TC1 will return "143 TM timed out"
- d. The automatic subroutine #AUTOERR will run, if present
- e. The Error output will be set.

When using serial encoders (SSI or BiSS), the #AUTOERR should follow these guidelines:

- a. IF `_TC=143` do not employ any trippoints in following code as the timer interrupt is suspended.
- b. Serial encoders can be disabled with the commands `SIn=0` or `SSn=0` where n is the axis indicator ABCDEFG or H
- c. In order to re-enable the timer interrupt issue "TM m" where m is the servo update period in us (usually m=1000).

See code example below.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

`_RS` - Checksum error code operand

EN - End program

Examples:

```
'Code detects a checksum error and notifies the user
#AUTOERR
  MG"EEPROM ERROR ",_RS
EN
```

```
'Distinguishing between a serial timeout
' condition and an EEPROM condition
#AUTOERR
IF _TC=143
REM BiSS or SSI timeout
REM No trippoints in this clause
REM Print message to DMC-4020 LCD
  LU0
  MG"BiSS"{L1}
  MG"Timeout"{L2}
  SSA=0
  SSB=0
ELSE
REM Checksum error
REM trippoints ok here
REM Print message to DMC-4020 LCD
  LU0
  MG"EEProm:"{L1}
  MG{Z10.0}_RS{L2}
ENDIF
EN
```

#CMDERR	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Command error automatic subroutine		

Full Description

#CMDERR is an automatic subroutine that runs code when a DMC code error occurs.

Without #CMDERR defined, if an error (see TC command) occurs in an application program running on the Galil controller, the program (and all threads) will stop.

Use EN to end the routine.

#CMDERR will only run from errors generated within embedded DMC code.

In a single threaded application (Thread 0 only), the EN command in the #CMDERR routine will restart thread 0 where it left off.

In a multi-threaded application, the thread that has an error will be halted when a command error occurs. Thread 0 will be interrupted to run the #CMDERR routine but other threads will continue to run. In order to restart the thread that encountered the error, see the example in Chapter 7 of the User Manual and the _ED operand. Thread 0 does not need to be running in order for the #CMDERR routine to execute.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All

Related Commands

TC - Tell Error Code

_ED - Last program line with an error

EN - End program

Examples:

```
'This code will put the motion controller in Position Tracking mode.
'Variable "target" is updated from the terminal or from a host program
'to specify a new target. #CMDERR is used to detect a bad target value.
#start
DPA=0;'      Define current position as zero
PTA=1;'      Turn on position tracking
target=0;'   Initialize target variable
#track;'     Start tracking
PAA=target;' Track to current value of target
WT500;'     Wait 500 ms
JP#track;'   Continue to track
'
```

```
#CMDERR;' runs if an error occurs  
JP#done,_TC<>6 ;'check that an out of range occured (See TC)  
MG"Value ",target," is out of range for Position Tracking"  
target=_PAA ;' reset target  
#done  
EN1 ;'return to tracking logic
```

#COMINT	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Communication interrupt automatic subroutine		

Full Description

#COMINT is an automatic subroutine which can be configured by the CI command to run either when any character is received, or when a carriage return is received over the com port. The auxiliary port is used if equipped.

#COMINT runs in thread 0, and an application must be running in thread 0 in order for #COMINT to be enabled. Code running in thread zero will be interrupted by the #COMINT subroutine. Use EN to end the routine

NOTE: An application program must be executing for the automatic subroutine to function, which runs in thread 0. Use EN to end the routine.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

P2CD - Serial port 2 code

P2CH - Serial port 2 character

P2NM- Serial port 2 number

P2ST - Serial port 2 string

CI - Configure #COMINT

CC - Configure serial port 2

EN - End subroutine

Examples:

```
#A;                               'Program Label
  CC9600,0,1,0
  CI2;                             'interrupt on any character
#Loop
  MG "Loop";                       'print a message every second
  WT 1000
  JP#Loop
#COMINT
  MG "COMINT:", P2CH{S1};          'print a message and the received character
EN1,1;                             ' End this subroutine, re-arming trip points that
'                                   were running and re-enabling the CI mask
```


#ININT	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Input interrupt automatic subroutine		

Full Description

#ININT is an automatic subroutine that runs upon a state transition of digital inputs 1 to 8 and is configured with II. #ININT runs in thread 0.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No

Related Commands

II- Input interrupt

@IN - Read digital input

RI - Return from interrupt

Examples:

```

II1;           'arm digital input 1
EN;           'End thread zero
'
#ININT;       'Automatic sub.  Runs on input event
  MG"Inputs:",_TI0; 'Display status of inputs 1-8
  WT100;      'Debounce input
RI;           'Return from interrupt

```


<h1>#LIMSWI</h1>	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Limit switch automatic subroutine		

Full Description

Without #LIMSWI defined, the controller will effectively issue the STn on the axis when it's limit switch is tripped. With #LIMSWI defined, the axis is still stopped, and in addition, code is executed. #LIMSWI is most commonly used to turn the motor off when a limit switch is tripped (see example below). For #LIMSWI to run, the switch corresponding to the direction of motion must be tripped (forward limit switch for positive motion and negative limit switch for negative motion). #LIMSWI interrupts thread 0 when it runs.

Use RE to terminate the #LIMSWI subroutine.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

_LFn - State of forward limit switch

_LRn - State of reverse limit switch

LD - Limit Disable

Examples:

```
#Main          ;'print a message every second
  MG "Main"
  WT1000
JP#Main
EN
'
#LIMSWI ;'runs when a limit switch is tripped
IF (_LFX = 0) | (_LRX = 0)
  MG "X"
  DCX=67107840
  STX
  AMX
  MOX
ELSE; IF (_LFY = 0) | (_LRY = 0)
  MG "Y"
  DCY=67107840
```

```
STY  
AMY  
MOY  
ENDIF ; ENDF  
RE1
```

#MCTIME	Syntax:	Other
	Operands:	none
	Burn:	not burnable
MC command timeout automatic subroutine		

Full Description

#MCTIME runs when the MC command is used to wait for motion to be complete, and the actual position TP does not reach or pass the target within the specified timeout TW.

Use RE to terminate the subroutine.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

MC - Wait for motion complete trip point

TW - MC timeout

Examples:

```
#BEGIN; '          Begin main program
  TWX=1000;'        Set the time out to 1000 ms
  PRX=10000;'       Position relative
  BGX;'            Begin motion
  MCX;'            Motion Complete trip point
EN;'              End main program
'
#MCTIME;'          Motion Complete Subroutine
  MG "X fell short";' Send out a message
EN1;'             End subroutine
```

<h1>#POSERR</h1>	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Position error automatic subroutine		

Full Description

The factory default behavior of the Galil controller upon a position error ($_TEn > _ERn$) is to do nothing more than drive the error signal low, turning on the red error LED. If OE is set to 1, the motor whose position error (TE) equals or exceeds its threshold (ER) will be turned off (MO). #POSERR can be used if the programmer wishes to run code upon a position error, for example to notify a host computer.

The #POSERR label causes the statements following to be automatically executed if error on any axis exceeds the error limit specified by ER. The error routine must be closed with the RE command. The RE command returns from the error subroutine to the main program.

Use RE to end the routine

#POSERR will also run when OE1 is set for an axes and that axis is also setup for encoder failure detection (see OA, OT, OV commands).

The automatic subroutine runs in thread 0. If thread 0 is running, it will jump to #POSERR when an error occurs. If thread 0 is not running, #POSERR will be started in thread 0.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

OE - Off on error

TE - Tell error

ER - Error limit

RE - Return from error routine

Examples:

```
#main; '      main program
'
JP #main

REM simple example of #POSERR
#POSERR
  MG "#POSERR"
RE
```

```
REM example of #POSERR that checks for position error on each axis
#POSERR
~a=0;'      axis designator
IF ((_TE~a>_ER~a)&(_OE~a))
  MG "Position Error occurred on ",~a{F1.0}," axis"
ENDIF
~a=~a+1
JP#POSERR,~a<_BV;' loop until axes have been checked
AI 1;'      wait until input 1 goes high (ex. safety switch)
SH
RE1;'      retrurn to main program
```

```
REM #POSERR example for checking to see if encoder failure occurred
REM The stop code will only update of the profilier is running at the time
REM the encoder failure is detected.
#POSERR
~a=0
#loop
IF _MO~a=1
  IF ((_TE~a<_ER~a)&(_OE~a)&(_OA~a))
    MG "possible encoder failure on ",~a{Z1.0}," axis"
  ENDIF
ENDIF
~a=~a+1
JP#loop,~a<_BV
AI1;'      wait for input 1 to go high
SH;'      enable all axes
RE
```

#SERERR	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
Serial Encoder Error Automatic Subroutine		

Full Description

When equipped with hardware featuring the -BiSS encoder upgrade, #SERERR is an automatic subroutine which runs whenever there is a fault condition on the serial encoder. The following are the fault conditions which will cause #SERERR to interrupt.

Serial Encoder Faults

BiSS
Encoder timeout (bit 0 of _SS)
CRC error (bit 1 of _SS)
Error bit* (bit 2 of _SS)
Warning bit* (bit 3 of _SS)

The active level of the Error and Warning bits for BiSS must be configured with SY.

For the encoder timeout condition, TC1 will also return "140 Serial encoder missing."

Return from this automatic sub with RE.

*Note: The encoder manufacturer may name the Error and Warning bits differently. Consult the encoder documentation for the naming convention.

Galil defines the Warning bit as the bit directly preceding the CRC. The Error bit is defined as the bit directly preceding the Warning bit. See table 1.

Arguments

N/A

Operands

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Default Value	N/A

Related Commands

SS - Configure the special Galil BiSS feature

SY - Serial encoder BiSS active level

Examples

```
#SERERR
LU0
  MG "SERERR" {L1}
  MG_SSA{L2}
```

```
REM disable axis A  
  OEA=1;ERA=0  
REM disable axis serial encoder  
  SSA=0  
RE
```

#TCPERR	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Ethernet communication error automatic subroutine		

Full Description

#TCPERR is an automatic subroutine which allows execution of code when an TCP error occurs.

The following error (see TC) occurs when a command such as MG "hello" {EA} is sent to a failed Ethernet connection:

123 TCP lost sync or timeout

This error means that the client on handle A did not respond with a TCP acknowledgement (for example because the Ethernet cable was disconnected). Handle A is closed in this case.

#TCPERR allows the application programmer to run code (for example to reestablish the connection) when error 123 occurs.

Use RE to terminate the subroutine.

Code does not need to be running in thread zero for #TCPERR to run.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All

Related Commands

TC - Tell error code

_IA4 - Last dropped handle

MG - Print message

SA - Send ASCII command via Ethernet

Examples:

```
#L
  MG {EA} "L"
  WT1000
JP#L
#TCPERR
  MG {P1} "TCPERR. Dropped handle", _IA4
RE
'NOTE: Use RE to end the routine
```


\$	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Hexadecimal		

Full Description

The \$ operator denotes that the following string is in hexadecimal notation.

Arguments

\$nnnnnnnn.mmmm

n is up to eight hexadecimal digits (denoting 32 bits of integer)

m is up to four hexadecimal digits (denoting 16 bits of fraction)

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

+ - * / % - Multiply (shift left)

+ - * / % - Divide (shift right)

MG {\$8.4} - Print in hexadecimal

Examples:

```
x = $7fffffff.0000           ;'store 2147483647 in x
y = x & $0000ffff.0000      ;'store lower 16 bits of x in y
z = x & $ffff0000.0000 / $10000 ;'store upper 16 bits of x in z
```

& ,	Syntax:	Operator or Comparator
	Operands:	none
	Burn:	not burnable
Bitwise Logical Operators AND and OR		

Full Description

The operators & and | are typically used with IF, JP, and JS to perform conditional jumps; however, they can also be used to perform bitwise logical operations.

Arguments

$n \& m$ or $n | m$ where

n and m are signed numbers in the range -2147483648 to 2147483647.

For IF, JP, and JS, n and m are typically the results of logical expressions such as $(x > 2) \& (y=8)$

"&" is also used to pass a variable by reference in a JS call. See JS.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@COM[n] - Bitwise complement

IF - If statement

JP - Jump statement

JS - Jump subroutine

Examples:

```
IF (x > 2) & (y = 4)
'x must be greater than 2 and y equal to 4
'for the message to print
  MG "true"
ENDIF
```

```
:MG 1 | 2
 3.0000
:'Bitwise operation:  01 OR 10 is 11 = 3
```

Pass By Reference Example:

```
#main
value=5;'          a value to be passed by reference
global=8;'        a global variable
```

```
JS#SUM(&value,1,2,3,4,5,6,7);' note first arg passed by reference
MG value;'          message out value after subroutine.
MG _JS;'           message out returned value
EN
'
#SUM;'             (* ^a,^b,^c,^d,^e,^f,^g)
^a=^b+^c+^d+^e+^f+^g+^h+global
EN,,^a
'notes-
'do not use spaces when working with ^
'If using global variables, they MUST be created before the subroutine is run

Executed program from program2.dmc
36.0000
36.0000
```

(,)	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Parentheses (order of operations)		

Full Description

The parentheses denote the order of math and logical operations. Note that the controller DOES NOT OBEY STANDARD MATHEMATICAL OPERATOR PRECEDENCE. For example, multiplication is NOT evaluated before addition. Instead, the controller follows left-to-right precedence. Therefore, it is required to use parentheses to ensure intended precedence.

Arguments

(n) where

n is a math (+ - * /) or logical (& |) expression

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

+ - * / - Math Operators

& | - Logical Operators

Examples:

```
:MG 1 + 2 * 3
9.0000
:MG 1 + (2 * 3)
7.0000
```

• ;	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Semicolon (Command Delimiter)		

Full Description

The semicolon operator allows multiple Galil commands to exist on a single line. It is used for the following three reasons:

- (1) To put comments on the same line as the command (STX ;'stop)
- (2) To compress DMC programs to fit within the program line limit (Note: use a compression utility to do this. Do not program this way because it is hard to read.)
- (3) To give higher priority to a thread. All commands on a line are executed before the thread scheduler switches to the next thread.

Arguments

n;n;n;n

where

n is a valid Galil command

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

NO - No Op, comment

' - comment

Examples:

```
| SB1;WT500;CB1;'multiple commands separated by semicolons with a comment
```

```
#High; '      #High priority thread executes twice as fast as
  a = a + 1; b = b + 1
JP#High

#Low; '       #Low when run in parallel
  c = c + 1
  d = d + 1
JP#Low
```

@ABS	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Absolute value		

Full Description

Takes the absolute value of the given number. Returns the value if positive, and returns -1 times the value if negative.

Arguments

@ABS[n] where

n is a signed number in the range -2147483647 to 2147483647

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

All math operators

Examples:

```
| :MG @ABS[-2147483647]
| 2147483647.0000
```

<h1>@ACOS</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Inverse cosine		

Full Description

Returns in degrees the arc cosine of the given number.

Arguments

@ACOS[n] where
n is a signed number in the range -1 to 1.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ASIN - Arc sine
@SIN - sine
@ATAN - Arc tangent
@COS - Cosine
@TAN - Tangent

Examples:

```
:MG @ACOS[-1]
180.0000
:MG @ACOS[0]
90.0000
:MG @ACOS[1]
0.0001
```

<h1>@AN</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Analog Input Query		

Full Description

Returns the value of the given analog input in volts

Arguments

@AN[n] where n is the input number assigned to a particular analog input pin (1-8)

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

While Moving Yes Default Value -
 In a Program Yes Default Format -
 Command Line Yes

@AN[] is an operand, not a command. It can only be used as an argument to other commands and operators

Related Commands

AQ Analog Range

Examples:

```
| :MG @AN[1] ;'print analog input 1
| 1.7883
| :x = @AN[1] ;'assign analog input 1 to a variable
```


<h1>@ASIN</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Inverse sine		

Full Description

Returns in degrees the arc sine of the given number.

Arguments

@ASIN[n] where
n is a signed number in the range -1 to 1.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ACOS[n] - Arc cosine
 @SIN[n] - sine
 @ATAN[n] - Arc tangent
 @COS[n] - Cosine
 @TAN[n] - Tangent

Examples:

```
:MG @ASIN[-1]
-90.0000
:MG @ASIN[0]
0.0000
:MG @ASIN[1]
90.0000
```

@ATAN

Syntax:	@ Function
Operands:	none
Burn:	not burnable

Inverse tangent

Full Description

Returns in degrees the arc tangent of the given number.

Arguments

@ATAN[n]

n is a signed number in the range -2147483647 to 2147483647

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ASIN - Arc sine

@SIN - Sine

@ACOS - Arc cosine

@COS - Cosine

@TAN - Tangent

Examples:

```
:MG @ATAN[-10]
-84.2894
:MG @ATAN[0]
0.0000
:MG @ATAN[10]
84.2894
```

@COM	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Bitwise complement		

Full Description

Performs the bitwise complement (NOT) operation to the given number

Arguments

@COM[n] where
n is a signed integer in the range -2147483647 to 2147483647.
The integer is interpreted as a 32-bit field.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

& | - Logical operators AND and OR

Examples:

```
:MG {$8.0} @COM[0]
$FFFFFFFF
:MG {$8.0} @COM[$FFFFFFFF]
$00000000
```

@COS	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Cosine		

Full Description

Returns the cosine of the given angle in degrees

Arguments

@COS[n] where

n is a signed number in degrees in the range of -32768 to 32767, with a fractional resolution of 16-bit.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ASIN[n] - Arc sine

@SIN[n] - Sine

@ATAN[n] - Arc tangent

@ACOS[n] - Arc cosine

@TAN[n] - Tangent

Examples:

```
:MG @COS[0]
1.0000
:MG @COS[90]
0.0000
:MG @COS[180]
-1.0000
:MG @COS[270]
0.0000
:MG @COS[360]
1.0000
```

@FRAC

Syntax:	@ Function
Operands:	none
Burn:	not burnable

Fractional part

Full Description

Returns the fractional part of the given number

Arguments

@FRAC[n], n is a signed number in the range -2147483648 to 2147483647.

Operand Usage

N/A

Usage

Usage and Default Detail

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@INT[n] - Integer part

Examples:

```
:MG @FRAC[1.2]
0.2000
:MG @FRAC[-2.4]
-0.4000
```

<h1>@IN</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Read digital input		

Full Description

Returns the value of the given digital input (either 0 or 1)

Arguments

@IN[n]

where

n is an unsigned integer in the range 1 to 96

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@AN[n] - Read analog input

@OUT[n] - Read digital output

SB - Set digital output bit

CB - Clear digital output bit

OF- Set analog output offset

Examples:

```

MG @IN[1]
:1.0000
x = @IN[1]
x = ?
:1.000 print digital input 1

```

<h1>@INT</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Integer part		

Full Description

Returns the integer part of the given number. Note that the modulus operator can be implemented with @INT (see example below).

Arguments

@INT[n]

n is a signed number in the range -2147483648 to 2147483647.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@FRAC - Fractional part

Examples:

```
:MG @INT[1.2]
1.0000
:MG @INT[-2.4]
-2.0000
```

```
#AUTO; '      modulus example
x = 10; '     prepare arguments
y = 3
JS#mod; '    call modulus
MG z; '      print return value
EN
```

```
'subroutine: integer remainder of x/y (10 mod 3 = 1)
'arguments are x and y. Return is in z
#mod
z = x - (y * @INT[x/y])
EN
```

@OUT

Syntax:	@ Function
Operands:	none
Burn:	not burnable

Read digital output

Full Description

Returns the value of the given digital output (either 0 or 1)

Arguments

@OUT[n] where

n is an unsigned integer in the range 1 to 80

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@AN[n] - Read analog input

@IN[n] - Read digital input

SB - Set digital output bit

CB - Clear digital output bit

OF - Set analog output offset

Examples:

```
MG @OUT[1] ;'print digital output 1
:1.0000
x = @OUT[1] ;'assign digital output 1 to a variable
```


<h1>@RND</h1>	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Round		

Full Description

Rounds the given number to the nearest integer

Arguments

@RND[n]

n is a signed number in the range -2147483648 to 2147483647.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@INT[n] - Truncates to the nearest integer

Examples:

```
:MG @RND[1.2]
1.0000
:MG @RND[5.7]
6.0000
:MG @RND[-1.2]
-1.0000
:MG @RND[-5.7]
-6.0000
:MG @RND[5.5]
6.0000
:MG @RND[-5.5]
-5.0000
```

@SIN	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Sine		

Full Description

Returns the sine of the given angle in degrees

Arguments

@SIN[n] where

n is a signed number in degrees in the range of -32768 to 32767, with a fractional resolution of 16-bit.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ASIN[n] - Arc sine

@COS[n] - Cosine

@ATAN[n] - Arc tangent

@ACOS[n] - Arc cosine

@TAN[n] - Tangent

Examples:

```
:MG @SIN[0]
0.0000
:MG @SIN[90]
1.0000
:MG @SIN[180]
0.0000
:MG @SIN[270]
-1.0000
:MG @SIN[360]
0.0000
```

@SQR	Syntax:	@ Function
	Operands:	none
	Burn:	not burnable
Square Root		

Full Description

Takes the square root of the given number. If the number is negative, the absolute value is taken first.

Arguments

@SQR[n] where
n is a signed number in the range -2147483648 to 2147483647.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

@ABS[n] - Absolute value

Examples:

```
:MG @SQR[ 2 ]
1.4142
:MG @SQR[-2 ]
1.4142
```

[,]	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Square Brackets (Array Index Operator)		

Full Description

The square brackets are used to denote the array index for an array, or to denote an array name. (They are also used to designate the argument to a function, such as @ABS[n].)

Arguments

mmmmmmmm[n] where

mmmmmmmm is the array name

n is the array index and is an integer between 0 and 15999

When used in an array, n=-1 returns the array length.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

DM - Dimension Array

QU - Print/Upload Array

Examples:

```
DM A[50]      ;'define a 50 element array
A[0] = 3      ;'set first element to 3
MG A[0]      ;'print element 0
```

```
#array
DM A[5];'      define a 5 element array
A[0] = 3;'      set first element to 3
MG "A[0]=",A[0];' print element 0
len= A[-1];'    variable len now contains the length of array A[]
QU A[,0,len-1,1;MG"' ;' print entire array
MG "A[] length=",len;' display Variable len
EN
```

```
:XQ#array
:
A[0]= 3
3, 4320, 216666, 217522, 607950
A[] length= 5
```

| :

$\wedge a, \wedge b, \wedge c, \wedge d, \wedge e, \wedge f, \wedge g, \wedge h$	Syntax:	Other
	Operands:	none
	Burn:	not burnable
JS subroutine stack variable		

Full Description

Provides local subroutine access for up to 8 variables passed on the subroutine stack when using the JS (jump to subroutine) command. Passing values on the stack is advanced DMC programming, and is recommended for experienced DMC programmers familiar with the concept of passing arguments by value and by reference. See the JS command for a full explanation of passing stack variables.

Notes:

1. Passing parameters has no type checking, so it is important to exercise good programming style when passing parameters. See examples below for recommended syntax.
2. Do not use spaces in expressions containing \wedge .
3. Global variables **MUST** be assigned prior to any use in subroutines where variables are passed by reference.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-4xxx, DMC-18x6
Default Value	N/A
Default Format	N/A

Related Commands

MG - Message - & Pass by reference

JS - Jump to subroutine

Examples:

```
#Add
JS#SUM(1,2,3,4,5,6,7,8) ;' call subroutine, pass values
MG_JS    ;' print return value
EN
'
#SUM      ;NO(^a,^b,^c,^d,^e,^f,^g,^h) Sums the values ^a to ^h and returns the result
EN,,(^a+^b+^c+^d+^e+^f+^g+^h)    ;' return sum

:Executed program from program1.dmc
36.0000
Note: For additional examples, see the "JS Subroutine Stack Variables (^a, ^b, ^c, ^d, ^e, ^f, ^g, ^h)" section in the DMC-40x0 User Manual.
```

^L^K	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Lock program		

Full Description

<control>L<control>K locks user access to the application program. When locked, the ED, UL, LS, and TR commands will give privilege error #106. The application program will still run when locked.

The locked or unlocked state can be saved with a BN command. Upon master reset, the controller is unlocked. Once the program is unlocked, it will remain accessible until a lock command or a reset (with the locked condition burned in) occurs.

Arguments

<control>L<control>K password,n where

When n is 1, this command will lock the application program.

When n is 0, the program will be unlocked.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	DMC-4xxx, DMC-18x6, RIO-47xxx
Default Value	N/A
Default Format	N/A

Related Commands

PW - Password

ED - Edit program

UL - Upload program

LS - List program

TR - Trace program

Examples:

```

:PWtest,test           Set password to "test"
:^L^K test,1          Lock the program
:LS                    Attempt to list the program
?
:TC1
106 Privilege violation
:

```

^R^S	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
Master Reset		

Full Description

The Master Reset command resets the controller to factory default settings and erases EEPROM.

A master reset can also be performed by installing a jumper at the location labeled MRST and resetting the board (power cycle or pressing the reset button). Remove the jumper after this procedure.

Note: Sending a ^R^S over an Ethernet connection will cause the IP address to be cleared from the controller and will result in a timeout.

Arguments

Operand Usage

N/A

Usage

Usage and Defalut Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Formula	N/A

Related Commands

RS - Reset

Examples:

Example burns-in a non-default value for KP, does a standard reset with the RS command, then performs a master reset with ^R^S.

```
:KP?
 6.00
:KP10
:BN
:RS

:KP?
 10.00
:^R^S

:KP?
 6.00
:
```


^R^V	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
Revision Information		

Full Description

The Revision Information command causes the controller to return the firmware revision information.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

| N/A

_GP	<u>Syntax:</u>	Operand Only
	Operands:	_GP
	Burn:	not burnable
Gearing Phase Differential Operand		

Full Description

The `_GP` operand contains the value of the "phase differential"* accumulated on the most current change in the gearing ratio between the master and the slave axes. The value does not update if the distance over which the slave will engage is set to 0 with the `GD` command.

The operand is specified as: `_GPn` where `n` is the specified slave axis

* Phase Differential is a term that is used to describe the lead or lag between the master axis and the slave axis due to gradual gear shift. $Pd = GR * C_m - C_s$ where Pd is the phase differential, GR is the gear ratio, C_m is the number of encoder counts the master axis moved, and C_s is the number of encoder counts the slave moved.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

GR - Gear Ratio

GA - Gear Axis

Examples:

```
#A
GAY;'      Sets the Y axis as the gearing master for the X axis.
'          This axis does not have to be under servo control. In
'          this example, the axis is connected to a conveyor
'          operating open loop.
GD1000;'   Set the distance that the master will travel to 1000
'          counts before the gearing is fully engaged for the X
'          axis slave.
AI-1;'     Wait for input 1 to go low. In this example, this
'          input is representing a sensor that senses an object
'          on a conveyor. This will trigger the controller to
'          begin gearing and synchronize the master and slave
'          axes together.
GR1;'      Engage gearing between the master and slave
P1=_TPY;'  Sets the current Y axis position to variable P1. This
'          variable is used in the next command, because MF
'          requires an absolute position..
```

```
MF,(P1+1000);'Wait for the Y axis (master) to move forward 1000
'|
'| encoder counts so the gearing engagement period is
'| complete. Then the phase difference can be adjusted
'| for. Note this example assumes forward motion.
IP_GPX;' Increment the difference to bring the master/slave in
'| position sync from the point that the GR1 command was
'| issued.
EN;' End Program
```

_LF	<u>Syntax:</u>	Operand Only
	<u>Operands:</u>	_LFn
	<u>Burn:</u>	not burnable
Forward Limit Switch Operand		

Full Description

The _LF operand contains the state of the forward limit for the specified axis.

The operand is specified as: _LFn where n is the specified axis.

_LFn = 1 when the limit switch state will allow motion in the positive direction.

_LFn = 0 when the limit switch state will not allow motion in the positive direction.

Note: This operand is not a direct readout of the digital input and is affected by the command CN.

Values of _LFn

Digital Input activation	_LF value for CN-1	_LF value for CN1
On. Grounded for TTL, or sufficient activation current flowing for optos.	0 (forward motion prohibited)	1 (forward motion allowed)
Off. Pullup for TTL, or insufficient activation current flowing for optos.	1 (forward motion allowed)	0 (forward motion prohibited)

Arguments

N/A

Operand Usage

_LF is an operand

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

_LR - Reverse Limit Switch Operand

Examples:

```
MG _LFA Display the status of the A axis forward limit switch
*See Connecting Hardware in User Manual for active/inactive state
```

_LR	Syntax:	Operand Only
	Operands:	_LRn
	Burn:	not burnable
Reverse Limit Switch Operand		

Full Description

The _LR operand contains the state of the forward limit for the specified axis.

The operand is specified as: _LRn where n is the specified axis.

_LRn = 1 when the limit switch state will allow motion in the reverse direction.

_LRn = 0 when the limit switch state will not allow motion in the reverse direction.

Note: This operand is not a direct readout of the digital input and is affected by the command CN.

Values of _LRn

Digital input activation	_LR value for CN-1	_LR value for CN1
On. Grounded for TTL, or sufficient activation current flowing for optos.	0 (reverse motion prohibited)	1 (reverse motion allowed)
Off. Pullup for TTL, or insufficient activation current flowing for optos.	1 (reverse motion allowed)	0 (reverse motion prohibited)

Arguments

N/A

Operand Usage

_LR is an operand

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

_LF - Forward Limit Switch Operand

Examples:

```
MG _LRA Display the status of the A axis reverse limit switch
*See Connecting Hardware in User Manual for active/inactive state
```

~	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Variable Axis Designator		

Full Description

The ~ is the variable axis designator. 8 axis variables are provided: ~a, ~b, ~c, ~d, ~e, ~f, ~g, and ~h. Each variable can be assigned an individual axis A, B,C,D,E, F,G, or H, a vector plane, or a virtual axis. Motion commands on the variable will then apply to the assigned axis.

Arguments

~n=m

n is a lowercase letter a through h

m is a positive integer or single character string, where

0 or "A" (quotes required) = X axis

1 or "B" = Y axis

2 or "C" = Z axis

3 or "D" = W axis

4 or "E" = E Axis

5 or "F" = F axis

6 or "G" = G axis

7 or "H" = H axis

8 or "S" = S coordinate system

9 or "T" = T coordinate system

10 or "N" = Virtual N axis

11 or "M" = Virtual M axis

Operand Usage

~n contains the axis number 0-11

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

Examples:

```
~a=2;~b=6;'      Sets ~a to 2(Z axis).  Sets ~b to 6 (G axis)
PR~a=1000;'      Relative position move 1000 counts on ~a variable (set as Z axis)
JG~b=9000;'      Set jog speed of ~b variable (set as G axis) to 9000 cts/sec
BG~a~b;'         Begin motion on ~a and ~b variables (Z and G)
```

+,-,*,/,%	Syntax:	Operator or Comparator
	Operands:	none
	Burn:	not burnable
Math Operators		

Full Description

The addition, subtraction, multiplication, division, and modulus (Accelera only) operators are binary operators (they take two arguments and return one value) used to perform mathematical operations on variables, constants, and operands.

Mathematical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subtraction.

Example:

$1+2*3 = 9$ (not 7)

It is recommended that parenthesis be used when more than one mathematical operation is combined in one command.

Example:

`var = ((10*30)+(60/30));` evaluates as 302

`var = 10*30+60/30;` evaluates as 12

Arguments

$(n + m)$ or $(n - m)$ or $(n * m)$ or (n / m) or $(n \% m)$ where

n and m are signed numbers in the range -2147483648 to 2147483647

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

() - Parenthesis

Examples:

```
:x = ((1+(2*3))/7)-2      ;'assign -1 to x
:MG 40 % 6                ;'integer remainder of 40 divided by 6
  4.0000
```

$\langle, \rangle, =, \langle =, \rangle =, \langle \rangle$	Syntax:	Operator or Comparator
	Operands:	none
	Burn:	not burnable
Comparison Operators		

Full Description

The comparison operators are as follows:

- < less than
- > greater than
- = equals
- <= less than or equal
- >= greater than or equal
- <> not equals

These are used in conjunction with IF, JP, JS, (), &, and | to perform conditional jumps. The result of a comparison expression can also be printed with MG or assigned to a variable.

Arguments

(n < m) or (n > m) or (n = m) or (n <= m) or (n >= m) or (n <> m) where
n and m are signed numbers in the range -2147483648 to 2147483647

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

- () - Parentheses
- IF - If statement
- JP - Jump
- JS - Jump subroutine

Examples:

```
IF(x > 2) & (y = 4)
  MG "true"
ENDIF ;'x must be greater than 2 and y equal to 4 for
;'the message to print
```


=	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Equals (Assignment Operator)		

Full Description

The assignment operator is used for three reasons:

- (1) to define and initialize a variable ($x = 0$) before it is used
- (2) to assign a new value to a variable ($x = 5$)
- (3) to print a variable or array element ($x=$ which is equivalent to $MG x$). MG is the preferred method of printing.

Arguments

mmmmmmmm = n where

mmmmmmmm is a variable name and n is a signed number in the range -2147483648 to 2147483647

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

MG - Print Message

Examples:

```

: x=5
: x=
 5.0000
: MG x
 5.0000
:           ;'define and initialize x to 5
;'print x two different ways

```

AB	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_ABn
	<u>Burn:</u>	not burnable
Abort		

Full Description

AB (Abort) stops a motion instantly without a controlled deceleration. If there is a program operating, AB also aborts the program unless a 1 argument is specified. The command, AB, will shut off the motors for any axis in which the off on error function is enabled (see command OE).

AB aborts motion on all axes in motion and cannot stop individual axes.

Arguments

AB n where

n = 0 The controller aborts motion and program

n = 1 The controller aborts motion only

No argument will cause the controller to abort the motion and program

Operand Usage

_AB gives state of Abort Input, 1 inactive and 0 active.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

SH - Re-enables motor

OE - Specifies Off On Error

Examples:

```
AB          ;'Stops motion
OE 1,1,1,1  ;'Enable off on error
AB          ;'Shuts off motor command and stops motion
```

AC	Syntax:	Explicit & Implicit
	Operands:	_ACn
	Burn:	burnable with BN
Acceleration		

Full Description

The Acceleration (AC) command sets the linear acceleration rate of the motors for independent moves, such as PR, PA and JG moves. The acceleration rate may be changed during motion. The DC command is used to specify the deceleration rate.

Arguments

AC n,n,n,n,n,n,n,n or ACA=n where

n is an unsigned number in the range 1024 to 1073740800. The parameters input will be rounded down to the nearest factor of 1024. The units of the parameters are counts per second squared.

n = ? Returns the acceleration value for the specified axes.

Operand Usage

_ACm contains the value of acceleration for the specified axis.

where m is the axis (ex MG _ACA)

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256000
Default Format	8.0

Related Commands

DC - Specifies deceleration rate.

FA - Feedforward Acceleration

IT - Smoothing constant - S-curve

Examples:

```
AC 150000,200000,300000,400000 Set A-axis acceleration to 150000, B-axis to 200000 counts/sec2,
the C axis to 300000 counts/sec2, and the D-axis to 400000 count/sec2.
```

```
AC ?,?,?,? Request the Acceleration
```

```
149504, 199680, 299008, 399360 Return Acceleration
(resolution, 1024)
```

```
V=_ACB Assigns the B acceleration to the variable V
```

Hint: Specify realistic acceleration rates based on your physical system such as motor torque rating, loads, and amplifier current rating. Specifying an excessive acceleration will cause large following error during acceleration and the motor will not follow the commanded profile. The acceleration feedforward command FA will help minimize the error.

AD	<u>Syntax:</u>	Explicit & Implicit & Trippoint
	Operands:	none
	Burn:	not burnable
After Distance		

Full Description

The After Distance (AD) command is a trippoint used to control the timing of events. This command will hold up the execution of the following command until one of the following conditions have been met:

1. The commanded motor position crosses the specified relative distance from the start of the move.
2. The motion profiling on the axis is complete.
3. If in jog (JG) mode, the commanded motion is in the direction which moves away from the specified position.

The units of the command are quadrature counts. Only one axis may be specified at a time. AD can only be used when there's command motion on the axis.

If the direction of motion is reversed when in PT mode, the starting position for AD is reinitialized to the position at which the motor is reversed.

Note: AD command will be affected when the motion smoothing time constant, IT, is not 1. See IT command for further information.

Hint: The AD command is accurate to the number of counts that occur in 2^{*TM} ?sec . Multiply your speed by 2^{*TM} ?sec to obtain the maximum position error in counts. Remember AD measures incremental distance from start of move on one axis.

Arguments

AD n,n,n,n,n,n,n,n or ADA=n where
n is an unsigned integers in the range 0 to 2147483647 decimal.

Note: The AD command cannot have more than largument.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

AV - After distance for vector moves

AP - After position trip point

AR - After relative distance trip point

MF - Motion Forward trip point

MR - Motion Reverse trip point

Examples:

```
#A;DP0,0;'          Begin Program
PR 10000,20000;'    Specify positions
BG;'               Begin motion
AD 5000;'           After A reaches 5000
MG "Halfway to A";TPA;' Send message
AD ,10000;'         After B reaches 10000
```

```
| MG "Halfway to B";TPB;'   Send message  
| EN;'                       End Program
```

AF	Syntax:	Explicit & Implicit
	Operands:	_AFn
	Burn:	burnable with BN
Analog Feedback Select		

Full Description

The Analog Feedback (AF) command is used to set an axis with analog feedback instead of digital feedback (quadrature/pulse + dir). The analog feedback is decoded by a 12-bit A/D converter. An option is available for 16-bits. The position and analog range is set using the AQ command.

Note: AQ must be set prior to setting AF

Arguments

AF n,n,n,n,n,n,n,n or AFA=n where

n = 1 Enables analog feedback

n = 0 Disables analog feedback and switches to digital feedback

n = ? Returns the state of analog feedback for the specified axes. 0 disabled, 1 enabled

For 1Vp-p Sinusoidal Encoder Input with ICM-42100 (-I100)

n = 5-12 indicates that the sinusoidal encoder input is to be used with 2^n interpolation counts per encoder cycle

n = 0 Disables Sinusoidal Interpolation and switches to digital feedback. Differential encoder inputs must be used when using digital encoders with the ICM-42100. Consult the factory for single-ended use.

n = ? Returns the state of analog feedback for the specified axes

n = -1 When not using Analog feedback, a -1 provides that the analog hardware still be sampled in the servo interrupt. This provides evenly sampled data for both the data record and the RA/RD/RC function.

Operand Usage

_AFx contains a "1" if analog feedback is enabled and "0" if not enabled for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0,0,0,0 or -1,-1
Default Format	N/A

Related Commands

AQ - Analog Configuration

CE - Configure Encoder

MT - Motor Type

Examples:

```
AF 1,0,0,1      Analog feedback on A and D axis
V1 = _AFA      Assign feedback type to variable
AF ?,?,?      Interrogate feedback type
```

AG	Syntax:	Explicit & Implicit
	Operands:	none
	Burn:	burnable with BN
Amplifier Gain		

Full Description

The AG command sets the amplifier current/voltage gain for the AMP-430x0. 0 sets the lowest ratio or value while 2 sets the highest ratio. AG is stored in EEPROM by the BN command. The MT command must be issued prior to the AG command to set the proper range. The axis must be in the motor off state (MO) before new AG settings will take effect.

Arguments

AG n,n,n,n,n,n,n,n where

AMP-43040

AG setting	Gain Value
n = 0	0.4 A/V
n = 1	0.7 A/V
n = 2	1 A/V

AMP-43240

AG Setting	Gain Value
n = 0	0.5 A/V
n = 1	1 A/V
n = 2	2 A/V

AMP-43540

AG setting	Gain Value
n = 0	0.4 A/V
n = 1	0.8 A/V
n = 2	1.6 A/V

SDM-44140

AG setting	Gain Value
n = 0	0.5 A
n = 1	1.0 A
n = 2	2.0 A
n = 3	3.0 A

SDM-44040

AG setting	Gain Value
n = 0	0.5 A
n = 1	0.75 A
n = 2	1.0 A
n = 3	1.4 A

n = ? Returns the value of the amplifier gain

Usage

Usage and Default Details

Usage	Value

While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-4xxx-D30x0; DMC-4xxx-D4140; DMC-4xxx-D4040
Default Value	1,1,1,1,1,1,1
Default Format	N/A

Operand Usage

Related Commands

TA - Tell Amplifier Error

AW - Amplifier Bandwidth

Examples:

```
MO      Set motor off
AG2,1  Sets the highest amplifier gain for A axis and medium gain for B axis on 430x0.
SH      Turn motor on
BN      Save AG setting to EEPROM
```


AI	Syntax:	Implicit Notation Only & Trippoint
	Operands:	none
	Burn:	not burnable
After Input		

Full Description

The AI command is a trippoint used in motion programs to wait until after a specified input has changed state. This command can be configured such that the controller will wait until the input goes high or the input goes low.

Hint: The AI command actually halts execution until specified input is at desired logic level. Use the conditional Jump command (JP) or input interrupt (II) if you do not want the program sequence to halt.

Arguments

AI +/-n where

n is an integer between 1 and 96 and represents the input number. If n is positive, the controller will wait for the input to go high. If n is negative, it waits for n to go low.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Operand Usage

Related Commands

@IN[n] - Read Digital Input

II - Input interrupt

#ININT - Label for input interrupt

TI - Tell Inputs

Examples:

```
#A;'      Begin Program
AI 8;'    Wait until input 8 is high
SP 10000;' Speed is 10000 counts/sec
AC 20000;' Acceleration is 20000 counts/sec2
PR 400;'  Specify position
BGA;'    Begin motion
EN;'     End Program
```

AL	<u>Syntax:</u>	Explicit & Implicit
	Operands:	_ALn
	Burn:	not burnable
Arm Latch		

Full Description

The AL command enables the latch function (high speed main or auxiliary position capture) of the controller. When the position latch is armed, the main or auxiliary encoder position will be captured upon a low going signal. Each axis has a position latch and can be activated through the general inputs:

A axis latch Input 1
 B axis latch Input 2
 C axis latch Input 3
 D axis latch Input 4
 E axis latch Input 9
 F axis latch Input 10
 G axis latch Input 11
 H axis latch Input 12

The command RL returns the captured position for the specified axes. When interrogated the AL command will return a 1 if the latch for that axis is armed or a zero after the latch has occurred. The CN command can be used to change the polarity of the latch function.

The latch function is available on incremental quadrature encoder inputs only. For other position capture methods contact Galil.

Arguments

AL nnnnnnnn or AL n,n,n,n,n,n,n,n where

n can be A,B,C,D,E,F,G or H, specifying the main encoder for the axis to be latched

n can be SA,SB,SC,SD,SE,SF,SG or SH, specifying the auxiliary encoder.

n can be TA,TB,TC,TD,TE,TF,TG or TH, specifying the main encoder is latched from the index pulse instead of a digital input.

Operand Usage

_ALn contains the state of the specified latch. 0 = not armed, 1 = armed.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	1.0

Related Commands

RL - Report Latch

Examples:

```
#A      ;'Program Label
ALB     ;'Arm B-axis latch
JG,50000      ;'Set up jog at 50000 counts/sec
BGB     ;'Begin the move
#LOOP   ;'Loop until latch has occurred
JP #LOOP, _ALB=1
RLB     ;'Transmit the latched position
```

| EN ; 'End of program

<h1>AM</h1>	Syntax:	Accepts Axis Mask & Trippoint
	Operands:	none
	Burn:	not burnable
After Move		

Full Description

The AM command is a trippoint used to control the timing of events. This command will hold up execution of the following commands until the current move on the specified axis or axes is completed. Any combination of axes or a motion sequence may be specified with the AM command. For example, AM AB waits for motion on both the A and B axis to be complete. AM with no parameter specifies that motion on all axes is complete.

Hint: AM is a very important command for controlling the timing between multiple move sequences. For example, if the A-axis is in the middle of a position relative move (PR) you cannot make a position absolute move (PAA, BGA) until the first move is complete. Use AMA to halt the program sequences until the first profiled motion is complete. AM tests for profile completion. The actual motor may still be moving. To halt program sequence until the actual physical motion has completed, use the MC command. Another method for testing motion complete is to check for the internal variable `_BGn`, being equal to zero (see BG command).

Arguments

AM nnnnnnnnnn where
n is A,B,C,D,E,F,G,H,S or T or any combination to specify the axis or sequence
No argument specifies to wait for after motion on all axes and / or sequences

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Operand Usage

`_BGn` contains a 0 if motion complete

Related Commands

BG - Begin Motion
MC - Motion Complete

Examples:

```
#MOVE;           'Program MOVE
PR 5000,5000,5000,5000;'Position relative moves
BG A;           'Start the A-axis
AM A;           'After the move is complete on A,
BG B;           'Start the B-axis
AM B;           'After the move is complete on B,
BG C;           'Start the C-axis
AM C;           'After the move is complete on C
BG D;           'Start the D-axis
AM D;           'After the move is complete on D
EN;             'End of Program
```

AO	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Analog Output		

Full Description

The AO command sets the analog output voltage of Modbus Devices connected via Ethernet.

Arguments

AO m, n

where

m is the I/O number calculated using the following equations:

$$m = (\text{HandleNum} * 1000) + ((\text{Module}-1) * 4) + (\text{Bitnum}-1)$$

HandleNum is the handle specifier from A to H.

Module is the position of the module in the rack from 1 to 16.

BitNum is the I/O point in the module from 1 to 4.

n = the voltage which ranges from 9.99 to -9.99

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Operand Usage

Related Commands

SB - Set Bit

CB - Clear Bit

MB - Modbus

Examples:

<h1>AP</h1>	Syntax:	Explicit & Implicit & Trippoint
	Operands:	none
	Burn:	not burnable
After Absolute Position		

Full Description

The After Position (AP) command is a trippoint used to control the timing of events. This command will hold up the execution of the following command until one of the following conditions have been met:

1. The actual motor position crosses the specified absolute position. When using a stepper motor, this condition is satisfied when the stepper position (as determined by the output buffer) has crossed the specified position. For further information see Chapter 6 of the User Manual "Stepper Motor Operation".
2. The motion profiling on the axis is complete.
3. The commanded motion is in the direction which moves away from the specified position.

The units of the command are quadrature counts. Only one axis may be specified at a time. AP can only be used when there's commanded motion on the axis.

Arguments

AP n,n,n,n,n,n,n,n or APA=n where

n is a signed integer in the range -2147483648 to 2147483647 decimal

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

While Moving Yes Default Value ---

In a Program Yes Default Format ---

Command Line No

Controller Usage ALL CONTROLLERS

Related Commands

AR - Trippoint for relative distances

MF - Trippoint for forward motion

Examples:

```
#TEST ;'Program B
DP0 ;'Define zero
JG 1000 ;'Jog mode (speed of 1000 counts/sec)
BG A ;'Begin move
AP 2000 ;'After passing the position 2000
V1=_TPA ;'Assign V1 A position
MG "Position is", V1 ;'Print Message
ST ;'Stop
EN ;'End of Program
```

Hint: The accuracy of the AP command is the number of counts that occur in $2 \cdot T_M$ sec. Multiply the speed by $2 \cdot T_M$ sec to obtain the maximum error. AP tests for absolute position. Use the AD command to measure incremental distances.

AQ	<u>Syntax:</u>	Implicit Notation Only
	Operands:	_AQ1, _AQ2, _AQ3, _AQ4, _AQ5, _AQ6, _AQ7, _AQ8
	Burn:	burnable with BN
Analog Input Configuration		

Full Description

The Analog Configuration (AQ) command is used to set the range of the analog inputs. There are 4 different ranges that each analog input may be assigned.

Setting a negative range for inputs 1,3,5 or 7, configures those inputs as the differential input relative to input 2,4,6 and 8 respectively.

Arguments

AQ_{n,m} where

n is an integer from 1-8 that represents the analog input channel

m is an integer from 1-4 that designates the analog range

AQ setting details

m	Analog Range	Position Range (12 bit)	Position Range (16 bit)
1	+/-5 V	-2048 to 2047	-32,768 to 32767
2	+/-10 V	-2048 to 2047	-32,768 to 32767
3	0-5 V	0 to 4095	0 to 65535
4	0-10 V	0 to 4095	0 to 65535

Usage

Usage and Default Details

Usage	Value
While Moving (no RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-4xxx, DMC-21x3, RIO-47xxx
Default Value	n,2
Default Format	1.0000

Operand Usage

_AQ_n holds the range setting for that axis where n=1-8

Related Commands

@AN[n] - Read Analog Input

AF - Analog Feedback

Examples:

```
:AQ2,3           Specify analog input 2 as 0-5V
:AQ1,-3          Specify analog input 1 as 0-5V and the differential input to analog input 2
:MG_AQ2
3.0000
```


AR	Syntax:	Explicit & Implicit & Trippoint
	Operands:	none
	Burn:	not burnable
After Relative Distance		

Full Description

The After Relative (AR) command is a trippoint used to control the timing of events. This command will hold up the execution of the following command until one of the following conditions have been met:

1. The commanded motor position crosses the specified relative distance from either the start of the move or the last AR or AD command. When using a stepper motor, this condition is satisfied when the stepper position (as determined by the output buffer) has crossed the specified Relative Position. For further information see Chapter 6 of the User Manual "Stepper Motor Operation".
2. The motion profiling on the axis is complete.
3. If in jog (JG) mode, the commanded motion is in the direction which moves away from the specified position.

If the direction of the motion is reversed when in position tracking mode (see PT command), the starting point for the trippoint is reinitialized to the point at which the motion reversed.

The units of the command are quadrature counts. Only one axis may be specified at a time. AR can only be used when there's commanded motion on the axis.

Note: AR will be affected when the motion smoothing time constant, IT, is not 1. See IT command for further information.

Arguments

AR n,n,n,n,n,n,n,n or ARA=n where
n is an unsigned integer in the range 0 to 2147483647 decimal.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

AV - Trippoint for after vector position for coordinated moves

AP - Trippoint for after absolute position

Examples:

```
#A;DP 0,0,0,0 ;'Begin Program
JG 50000,,,7000 ;'Specify speeds
BG AD ;'Begin motion
#B ;'Label
AR 25000 ;'After passing 25000 counts of relative distance on A-axis
MG "Passed _A",_TPA ;'Send message on A-axis
JP #B ;'Jump to Label #B
EN ;'End Program
```

Hint: AR is used to specify incremental distance from last AR or AD command. Use AR if multiple position trippoints are needed in a single motion sequence.

AS	Syntax:	Accepts Axis Mask & Trippoint
	Operands:	none
	Burn:	not burnable
At Speed		

Full Description

The AS command is a trippoint that occurs when the generated motion profile has reached the specified speed. This command will hold up execution of the following command until the commanded speed has been reached. The AS command will operate after either accelerating or decelerating. If the speed is not reached, the trippoint will be triggered after the speed begins diverging from the AS value.

Arguments

AS nnnnnnnnnn where
n is A,B,C,D,E,F,G,H,S or T or any combination to specify the axis or sequence

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

While Moving Yes Default Value -

In a Program Yes Default Format -

Command Line No

Controller Usage ALL CONTROLLERS

Related Commands

Examples:

```
#SPEED ;'Program A
PR 100000 ;'Specify position
SP 10000 ;'Specify speed
BGA ;'Begin A
ASA ;'After speed is reached
MG "At Speed" ;'Print Message
EN ;'End of Program
```

WARNING:

The AS command applies to a trapezoidal velocity profile only with linear acceleration. AS used with smoothing profiling will be inaccurate.

<h1>AT</h1>	<u>Syntax:</u>	Implicit Notation Only & Trippoint
	Operands:	none
	Burn:	not burnable
At Time		

Full Description

The AT command is a trippoint which is used to hold up execution of the next command until after the specified time has elapsed. The time is measured with respect to a defined reference time. AT 0 establishes the initial reference. AT n specifies n msec from the reference. AT -n specifies n msec from the reference and establishes a new reference after the elapsed time period.

AT n,1 specifies n samples from the reference. This is useful when TM is lowered and faster application loop times are required.

Arguments

AT n,m where

n is a signed, even integer in the range 0 to 2 Billion

n = 0 defines a reference time at current time

n > 0 specifies a wait time of n msec from the reference time

n < 0 specifies a wait time of n msec from the reference time and re-sets the reference time when the trippoint is satisfied.

m = 0 or omitted specifies n to be in ms

m = 1 specifies n to be in samples

(AT -n is equivalent to AT n; AT <old reference +n>)

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	0
Default Format	-

Operand Usage

Related Commands

TIME - Time Operand

TM - Update Time

WT - Wait

Examples:

```
' jog propotional to analog input example with AT in ms
'AT -n
#main0
AT0;'           set time reference for AT command
JG0;BGX;'      start Jog mode
gain=1
#atloop
  jgspd=gain*@AN[1]
  JG jgspd
  AT-100;'      wait 100 ms from last time reference (last AT-n or AT0)
```

```
REM same functionality would be:  
REM AT -100,0  
REM -or-  
REM AT 100,0;AT0  
JP#atloop
```

```
' jog propotional to analog input example with AT in samples  
' AT n,1  
#main1  
AT0;'          set time reference for AT command  
JG0;BGX;'      start Jog mode  
gain=1  
#atloop  
  jgspd=gain*@AN[1]  
  JG jgspd  
  AT -100,1;'   wait 100 samples from last time reference (AT0)  
JP#atloop
```

The following commands are sent sequentially

```
AT 0    Establishes reference time 0 as current time  
AT 50   Waits 50 msec from reference 0  
AT 100  Waits 100 msec from reference 0  
AT -150 Waits 150 msec from reference 0 and sets new reference at 150  
AT 80   Waits 80 msec from new reference (total elapsed time is 230 msec)
```

AU	Syntax:	Explicit & Implicit
	Operands:	_AUn
	Burn:	burnable with BN
Set amplifier current loop		

Full Description

AMP-43040

The AU command sets the amplifier current loop gain. The current loop is available in one of two settings (0 is default while 1 sets a higher current loop gain).

AU also sets the switching mode where available, Chopper vs. Inverter.

High current loop gain:

Use the higher current loop gain (AU 1 or 1.5) when the phase to phase inductance of the motor is > 5mH with a 24VDC supply, or if the inductance is > 10mH with a 48VDC supply.

Chopper Mode (AU 0.5 or 1.5):

The AMP-430x0 can be set to "chopper" mode. The chopper mode is in contrast to the normal inverter mode in which the amplifier sends PWM power to the motor of +/-Vs. In chopper mode, the amplifier sends a 0 to +VS PWM to the motor when moving in the forward direction, and a 0 to -VS PWM to the motor when moving in the negative direction.

Chopper mode should be used in 2 different scenarios

- 1 - The inductance of the motor is 200uH to 500uH
- 2 - The application requires a continuous operation at ≥ 4 Amps of continuous torque at a duty cycle of $\geq 50\%$.

Chopper mode is recommended for high duty-cycle and high current applications.

AMP-43540

The AU command sets the amplifier current loop gain for the AMP-43540. The optimal current loop gain setting is determined by the bus voltage supplied to the amplifier and the phase to phase inductance of the motor. The table in the Arguments section provides ideal AU settings for common bus voltages and phase to phase inductance.

Arguments

AU m,m,m,m,m,m,m,m or AU n=m

where

m = ? Returns the value of the AU setting for the specified axis.

AMP-43540

Vsupply VDC	Inductance L (mH)	m =
24	-	0
24	$L < 1$	1
24	$1 < L < 2.3$	2
24	$2.3 < L < 4.2$	3
24	$4.2 < L$	4
48	-	0
48	$L < 2.4$	1
48	$2.4 < L < 4.2$	2
48	$4.2 < L < 7$	3
48	$7 < L$	4

AMP-43040

Description	m =
-------------	-----

normal current loop gain	0
chopper mode and normal loop gain	0.5
higher current loop gain	1
1.5chopper mode and higher current loop gain	1.5

Operand Usage

_AU n Returns the AU setting for the axis specified by 'n'

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Default Value	N/A
Default Format	N/A

Related Commands

TA - Tell Amplifier

AG - Amplifier Gain

AW - Amplifier Bandwidth

BX - Sine Amp Initialization

Examples:

```
AU1,0;' Sets X-axis to higher loop gain and Y-axis to normal loop gain
```

```
AUY=?;' Query Y-axis current loop gain
```

```
:0
```

```
MG_AUA;' Query A axis current loop gain
```

```
:1
```

<h1>AV</h1>	Syntax:	Implicit Notation Only & Trippoint
	Operands:	_AVS, _AVT
	Burn:	not burnable
After Vector Distance		

Full Description

The AV command is a trippoint, which is used to hold up execution of the next command during coordinated moves such as VP,CR or LI. This trippoint occurs when the path distance of a sequence reaches the specified value. The distance is measured from the start of a coordinated move sequence or from the last AV command. The units of the command are quadrature counts.

Arguments

AV s,t where

s and t are unsigned integers in the range 0 to 2147483647 decimal. 's' represents the vector distance to be executed in the S coordinate system and 't' represents the vector distance to be executed in the T coordinate system.

Operand Usage

_AVS contains the vector distance from the start of the sequence in the S coordinate system and _AVT contains the vector distance from the start of the sequence in the T coordinate system.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	0
Default Format	N/A

Related Commands

Examples:

```
#MOVE;DP 0,0;' Label
CAT;'          Specify the T coordinate system
LMAB;'        Linear move for A,B
LI 1000,2000;' Specify distance
LI 2000,3000;' Specify distance
LE
BGT;'         Begin motion in the T coordinate system
AV ,500;'     After path distance = 500,
MG "Path>500"
TPAB;'        Print position of A and B axes
EN;'         End Program
```

Hint: Vector Distance is calculated as the square root of the sum of the squared distance for each axis in the linear or vector mode.

AW	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Amplifier Bandwidth		

Full Description

The AW command accepts the drive voltage (volts) and motor inductance (millihenries) and uses the current loop gain setting (AU) as the default and then reports the calculated bandwidth. The user can check how the amplifier bandwidth is affected by changing the n parameter. The AU command uses the transfer function for the AMP-430x0 for the calculation of the bandwidth.

Arguments

AWx = v, l, n where

x = Axis designator

v = Drive voltage in Volts

l = Motor inductance in millihenries

n = optional current loop gain setting (1 or 0)

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-40x0/DMC-21x3 with AMP-430x0, AMP-205x0 or AMP-20440
Default Value	0, 0, 0
Default Format	N/A

Related Commands

TA - Tell Amplifier

AG - Amplifier Gain

BS - Brushless Setup

Examples:

```
AWY=60,5,0      Sets a 60 volt drive, motor with 5 millihenries inductance and normal current loop
gain
: 4525.732      Is the bandwidth in hertz
```

BA	Syntax:	Accepts Axis Mask
	Operands:	_BAn
	Burn:	not burnable
Brushless Axis		

Full Description

Galil Sine Drive Use

For axes equipped with a Galil sine drive, BA is used to configure the axis for sinusoidal operation. In addition to BA, BM and BX or BZ must be used to initialize the drive commutation. When using a Galil sine drive, one axis of control is required for one axis of drive. This is in contrast to the paired behavior below.

Third-Party Sine Drives Requiring Dual Analog Inputs (Rare)

In rare cases, some third-party sinusoidal drives require two analog signals to perform commutation. In this case, the BA command configures the controller axes for sinusoidal commutation and reconfigures the controller to reflect the actual number of motors that can be controlled. In this configuration, each axis requires 2 motor command signals. The second motor command signals will always be associated with the highest axis on the controller. For example a 3 axis controller with A and C configured for sinusoidal commutation will require 5 command outputs (a 5 axis controller), where the second outputs for A and C will be the D and E axes respectively.

Arguments

BA xxxxxxxxxxx

where

n is A,B,C,D,E,F,G,H or any combination to specify the axis (axes) for this mode.

Galil Sine Drive Use

BAN removes all axes configured for use with the sine drive. Sine drives will be disabled.

Third-Party Sine Drives Requiring Dual Analog Inputs (Rare)

BA removes all axes configured for sinusoidal commutation.

Operand Usage

Galil Sine Drive Use

_BAn will contain a 1 if the BA command has been issued for that axis, or a 0 if it has not.

Third-Party Sine Drives Requiring Dual Analog Inputs (Rare)

_BAn indicates the axis number of the auxiliary DAC used for the second phase of the selected sinusoidal axis. The axis numbers start with zero for the A axis DAC. If the motor is configured as standard servo or stepper motor, _BAn contains 0.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BB - Brushless Phase Begins
BC - Brushless Commutation
BD - Brushless Degrees
BI - Brushless Inputs
BM - Brushless Modulo
BO - Brushless Offset
BS - Brushless Setup
BZ - Brushless Zero
BX - Sine Amp Initialization

Examples:

```
|BAA;' Configure axis A
```

BB	Syntax:	Explicit & Implicit
	Operands:	_BBn
	Burn:	burnable with BN
Brushless Phase Begins		

Full Description

The BB function describes the position offset between the Hall transition point and = 0, for a sinusoidally commutated motor. This command must be saved in non-volatile memory to be effective upon reset.

Arguments

BB n,n,n,n,n,n,n,n or BBA=n

where

n is a signed integer which represent the phase offset of the selected axes in degrees of the magnetic cycle. The range is +/-359.98. The resolution is 1/32 of a degree.

n = ? returns the hall offset for the specified axis.

Operand Usage

_BBn contains the position offset between the Hall transition and = 0 for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BA - Brushless Axis

BC - Brushless Commutation

BD - Brushless Degrees

BI - Brushless Inputs

BM - Brushless Modulo

BO - Brushless Offset

BS - Brushless Setup

BZ - Brushless Zero

Note: BB is only effective as part of the BC command or upon reset.

BC

Examples:

| BB,30,,60 The offsets for the Y and W axes are 30 and 60 respectively

BC	Syntax:	Accepts Axis Mask
	Operands:	_BCn
	Burn:	not burnable
Brushless Calibration		

Full Description

The function BC monitors the status of the Hall sensors of a sinusoidally commutated motor, and resets the commutation phase upon detecting the first hall sensor. This procedure replaces the estimated commutation phase value with a more precise value determined by the hall sensors.

Arguments

BC nnnnnnn where
n is A,B,C,D,E,F,G or any combination to specify the axis

Operand Usage

_BCn contains the state of the Hall sensor inputs. This value should be between 1 and 6. 0 and 7 are invalid hall states.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BA - Brushless Axis
BB - Brushless Phase Begins
BD - Brushless Degrees
BI - Brushless Inputs
BM - Brushless Modulo
BO - Brushless Offset
BS - Brushless Setup
BZ - Brushless Zero

Examples:

```
REM Example for use with AMP-43650 or AMP-43540
#EX
BAA
BMA=2000
BIA=-1;'use hall sensor inputs on the Galil
BCA;'enable brushless calibration
bi=_BIA;'store hall state
JGA=500
BGA;'begin jog
#hall;JP#hall,_BIA<>bi;'wait for a hall transition
STA
MG"Commutation Complete"
EN
```

BD	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_BDn
	<u>Burn:</u>	burnable with BN
Brushless Degrees		

Full Description

This command sets the commutation phase of a sinusoidally commutated motor. When using hall effect sensors, a more accurate value for this parameter can be set by using the command, BC. This command should not be used except when the user is creating a specialized phase initialization procedure.

Arguments

BD n,n,n,n,n,n,n,n or BDA=n where
n is an integer between 0 - 360 .
n = ? Returns the current brushless motor angle (between 0-360)

Operand Usage

_BDn contains the commutation phase of the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"BA" - Brushless Axis
"BB" - Brushless Phase Begins
"BC" - Brushless Commutation
"BI" - Brushless Inputs
"BM" - Brushless Modulo
"BO" - Brushless Offset
"BS" - Brushless Setup
"BZ" - Brushless Zero
BG

Examples:

BG	Syntax:	Accepts Axis Mask
	Operands:	_BGn
	Burn:	not burnable
Begin		

Full Description

The BG command starts a motion on the specified axis or sequence.

Arguments

BG nnnnnnnnnn where
n is A,B,C,D,E,F,G,H,S,T, M or N, or any combination to specify the axis or sequence

Operand Usage

_BGn contains a '0' if motion complete on the specified axis or coordinate system, otherwise contains a '1'.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

While Moving Yes Default Value 0
In a Program Yes Default Format -
Command Line Yes
Controller Usage ALL CONTROLLERS

Related Commands

"AM " - After motion complete

"ST" - Stop Motion

Examples:

```
PR 2000,3000,,5000      Set up for a relative move
BG ABD  Start the A,B and D motors moving
HM      Set up for the homing
BGA     Start only the A-axis moving
JG 1000,4000  Set up for jog
BGY     Start only the B-axis moving
BSTATE=_BGB  Assign a 1 to BSTATE if the B-axis is performing a move
VP 1000,2000  Specify vector position
VS 20000     Specify vector velocity
BGS     Begin coordinated sequen0ce
VMAB    Vector Mode
VP 4000,-1000 Specify vector position
VE      Vector End
PR ,,8000,5000  Specify C and D position
BGSCD   Begin sequence and C,D motion
MG _BGS Displays a 1 if motion occurring on coordinated system "S"
Hint: A BG command cannot be executed for any axis in which motion has not completed. Use the AM trippoint to wait for motion complete between moves. Determining when motion is complete can also
```

| be accomplished by testing for the value of the operand _BGn.

BI	Syntax:	Explicit & Implicit
	Operands:	_BIn
	Burn:	burnable with BN
Brushless Inputs		

Full Description

The command BI is used to define the inputs which are used when Hall sensors have been wired for sinusoidally commutated motors. These inputs can be the general use inputs (bits 1-8), the auxiliary encoder inputs (bits 81-96), or the extended I/O inputs (bits 17-48). The Hall sensors of each axis must be connected to consecutive input lines, for example: BI 3 indicates that inputs 3,4 and 5 are used for halls sensors.

With the AMP-43540 or AMP-43650 the Hall A, Hall B and Hall C inputs on the Encoder connector may be specified by setting the BI command to -1.

Arguments

BI n,n,n,n,n,n,n,n or BIA=n where

n is an unsigned integer which represent the first digital input to be used for hall sensor input

n = 0 Clear the hall sensor configuration for the axis.

n = -1 Specifies the controller to use the Hall inputs available on the AMP-43540 or AMP-43640.

n = ? Returns the starting input used for Hall sensors for the specified axis.

Operand Usage

_BIn contains the starting input used for Hall sensors for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BA - Brushless Axis

BB - Brushless Phase Begins

BC - Brushless Commutation

BD - Brushless Degrees

BM - Brushless Modulo

BO - Brushless Offset

BS - Brushless Setup

BZ - Brushless Zero

BK

Examples:

```
BI, 5;' The Hall sensor of the Y axis are on inputs 5, 6 and 7.
```

```
REM Example for use with AMP-43650 or AMP-43540
```

```
#EX
```

```
BAA
```

```
BMA=2000
```

```
BIA=-1;' use hall sensor inputs on the Galil
BCA;' enable brushless calibration
bi=_BIA;' store hall state
JGA=500
BGA;' begin jog
#hall;JP#hall,_BIA<>bi;'wait for a hall transition
STA
MG"Commutation Complete"
EN
```

BK	<u>Syntax:</u>	Implicit Notation Only & Trippoint
	Operands:	<u>_BK</u>
	Burn:	not burnable
Breakpoint		

Full Description

For debugging. Causes the controller to pause execution of the given thread at the given program line number (which is not executed). All other threads continue running. Only one breakpoint may be armed at any time. After a breakpoint is encountered, a new breakpoint can be armed (to continue execution to the new breakpoint) or BK will resume program execution. The SL command can be used to single step from the breakpoint. The breakpoint can be armed before or during thread execution.

Arguments

BK n,m where

n is an integer in the range 0 to 1999 which is the line number to stop at. n must be a valid line number in the chosen thread.

m is an integer in the range 0 to 7. The thread.

Operand Usage

_BK will tell whether a breakpoint has been armed, whether it has been encountered, and the program line number of the breakpoint:

= -LineNumber: breakpoint armed

= LineNumber: breakpoint encountered

= -2147483648: breakpoint not armed

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	of m 0
Default Format	N/A

Related Commands

Examples:

```
BK 3    Pause at line 3 (the 4th line) in thread 0
BK 5    Continue to line 5
SL      Execute the next line
SL 3    Execute the next 3 lines
BK      Resume normal execution
```

BL	Syntax:	Explicit & Implicit
	Operands:	_BLn
	Burn:	burnable with BN
Reverse Software Limit		

Full Description

The BL command sets the reverse software limit. If this limit is exceeded during motion, motion on that axis will decelerate to a stop. Reverse motion beyond this limit is not permitted.

When the reverse software limit is activated, the automatic subroutine #LIMSWI will be executed if it is included in the program.

Arguments

BL n,n,n,n,n,n,n,n or BLA=n

where

n is a signed integer in the range -2147483648 to 2147483647. The reverse limit is activated at the position n-1. The units are in quadrature counts.

n = -2147483648 Turns off the reverse limit.

n = ? Returns the reverse software limit for the specified axes.

Operand Usage

_BLn contains the value of the reverse software limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	-214783648
Default Format	Position format

Related Commands

Examples:

```
#TEST Test Program
AC 1000000 Acceleration Rate
DC 1000000 Deceleration Rate
BL -15000 Set Reverse Limit
JG -5000 Jog Reverse
BGA Begin Motion
AMA After Motion (limit occurred)
TPA Tell Position
EN End Program
```

'Hint: Galil Controllers also provide hardware limits.

BM	<u>Syntax:</u>	Explicit & Implicit
	Operands:	_BMn
	Burn:	burnable with BN
Brushless Modulo		

Full Description

The BM command defines the length of the magnetic cycle in encoder counts.

For rotary motors, it is recommended that the BM value be specified as the counts per revolution divided by the # of pole pairs.

```
cts=4096; '      Counts per rev
pp=3; '          Pole pairs
BMA=cts/pp
```

Arguments

BM n,n,n,n,n,n,n,n or BMA=n where

n is a decimal value between 1 and 1000000 with a resolution of 1/10. This value can also be specified as a fraction with a resolution of 1/16.

n = ? Returns the brushless module for the specified axis.

Operand Usage

_BMn indicates the cycle length in counts for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	2000
Default Format	4.2

Related Commands

Examples:

```
BM ,60000; '      Set brushless modulo for B axis to be 60000
BMC=100000/3; '   Set brushless modulo for C axis to be 100000/3 (33333.333)
BM , , , ? ; '    Interrogate the Brushless Modulo for the D axis
```

Note: Changing the BM parameter causes an instant change in the commutation phase.

BN	Syntax:	Two Letter Only
	Operands:	_BN
	Burn:	not burnable
Burn		

Full Description

The BN command saves controller parameters shown below in Flash EEPROM memory. This command typically takes 1 second to execute and must not be interrupted. The controller returns a : when the Burn is complete.

PARAMETERS SAVED DURING BURN:

AC CE GR MT SM
 AF CN HV NB SP
 AG CO IA NF TK
 AQ CW IK NZ TL
 AU DC IL OA TM
 BA DH IT OE TR
 BB DV KD OF VA
 BI EO KI OP VD
 BL ER KP OT VF
 BM FA KS OV VS
 BO FL LC PF YA
 BR FV LD PL YB
 BW GA LZ PW YC
 CB GM MO SB

Arguments

N/A

Operand Usage

_BN contains the serial number of the processor board.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

```
SB1;'   Set bit 1
CB2;'   Clear bit 2
CW1;'   Set data adjustment bit
BN;'    Burn all parameter states
```

BO	<u>Syntax:</u>	Explicit & Implicit
	Operands:	_BOn
	Burn:	burnable with BN
Brushless Offset		

Full Description

The BO command sets a fixed offset on command signal outputs for sinusoidally commutated motors. This may be used to offset any bias in the amplifier, or can be used for phase initialization.

Arguments

BO n,n,n,n,n,n,n or BOA=n where
n specifies the voltage n is a signed number in the range -9.998 to +9.998 with a resolution of 0.0003.
n = ? Return the brushless offset for the specified axis.

Operand Usage

_BOn contains the offset voltage on the DAC for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	0

Related Commands

BA
Brushless Axis
BB
Brushless Phase Begins
BC
Brushless Commutation
BD
Brushless Degrees
BI
Brushless Inputs
BM
Brushless Modulo
BS
Brushless Setup
BZ
Brushless Zero

Examples:

```
BO -2,,1      Generates the voltages -2 and 1 on the first DAC A, and the second DAC C of a
sinusoidally commutated motor.
HINT: To assure that the output voltage equals the BO parameters, set the PID and OF parameters
to zero.
```

BP	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Burn Program		

Full Description

The BP command saves the application program in non-volatile EEPROM memory. This command typically takes up to 10 seconds to execute and must not be interrupted. The controller returns a : when the Burn is complete.

Arguments

None

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BN
Burn Parameters
BV
Burn Variable

BR

Examples:

BR	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Brush Axis		

Full Description

The BR command is used with internal Galil amplifiers to enable which axes will be set as brush-type servos or to configure the firmware to use external drives instead of the internal channel. The hall error bits cannot cause #AMPERR events if an axis is configured as brush-type. With BR1, the hall inputs are available for general use via the QH command.

Trap Amps

If an axis has Off-On-Error(OE) set to 1, an amplifier error will occur on an axis if there are no halls and BR is set to 0. Set BR to 1 to avoid an amplifier error state.

Arguments

BR n,n,n,n,n,n,n,n

where

- n = 0 Brushless servo axis
- n = 1 Brush-type servo axis
- n = ? Returns the value of the axis

n = -1 External drive when equipped with an internal Galil sine drive

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	0, 0, 0, 0, 0, 0, 0, 0

Related Commands

OE - Off-On Error
TA - Tell Amplifier
QH - Hall State

Examples:

```
| BR 1,0,0;'      Sets X-axis to brush-type, Y and Z to brushless
```

BS	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Brushless Setup		

Full Description

The command BS tests the wiring of a sinusoidally commutated brushless motor. If Hall sensors are connected, this command also tests the wiring of the Hall sensors. This function can only be performed with one axis at a time.

This command returns status information regarding the setup of brushless motors. The following information will be returned by the controller:

1. Correct wiring of the brushless motor phases.
2. An approximate value of the motor's magnetic cycle.
3. The value of the BB command (If hall sensors are used).
4. The results of the hall sensor wiring test (If hall sensors are used).

This command will turn the motor off when done and may be given when the motor is off.

Once the brushless motor is properly setup and the motor configuration has been saved in non-volatile memory, the BS command does not have to be re-issued. The configuration is saved by using the burn command, BN.

Note: In order to properly conduct the brushless setup, the motor must be allowed to move a minimum of one magnetic cycle in both directions.

Arguments

BSA= v, n where

v is a real number between 0 and 10. v represents the voltage level to be applied to each phase.

n is a positive integer between 100 or 1000. n represents the duration in milliseconds that voltage should be applied to the motor phases.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	200

Related Commands

BA - Brushless Axis
 BB - Brushless Phase Begins
 BC - Brushless Commutation
 BD - Brushless Degrees
 BI - Brushless Inputs
 BM - Brushless Modulo
 BO - Brushless Offset
 BZ - Brushless Zero

Examples:

```
BSC = 2,900      Apply set up test to C axis with 2 volts for 900 millisecond on each step.
Note: When using Galil Windows software, the timeout must be set to a minimum of 10 seconds
(timeout = 10000) when executing the BS command.
This allows the software to retrieve all messages returned from the controller.
```


BT	Syntax:	Accepts Axis Mask
	Operands:	_BTn
	Burn:	not burnable
Begin PVT Motion		

Full Description

The BT command begins PVT motion on the specified axes. All axes will begin at the same time. For more details on PVT mode see the user manual.

Arguments

BTnnnnnnnn where n is A,B,C,D,E,F,G,H or any combination of axes

Operand Usage

_BTn contains the number of PV segments that have executed.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-40x0, DMC-18x6, and others via upgrade
Default Value	N/A
Default Format	N/A

Related Commands

PV - PVT Data

MF - Forward Motion to Position Trippoint

MR - Reverse Motion to Position Trippoint

Examples

```

:MG_BT_X           Query number of PVT segments executed
0.0000
:PVX=100,200,100  Command X axis to move 100 counts reaching an ending speed of 200c/s in 100
samples
:PVX=100,0,100   Command X axis to move another 100 counts reaching an ending speed of 0c/s in 100
samples
:PVX=,,0         Command X axis to exit PVT mode
:BTX             Begin PVT mode
:MG_BT_X           Query number of PVT segments executed
3.0000
:

```

BV	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	_BV
	<u>Burn:</u>	not burnable
Burn Variables and Array		

Full Description

The BV command saves the controller variables and arrays in non-volatile EEPROM memory. This command typically takes up to 2 seconds to execute and must not be interrupted. The controller returns a : when the Burn is complete.

Arguments

None

Operand Usage

_BV returns the number of controller axes.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"BP" - Burn Program

"BN" - Burn Parameters

Burn Program

Note 1: This command will store the ECAM table values in non-volatile EEPROM memory.

Note 2: This command may cause the Galil software to issue the following warning "A time-out occurred while waiting for a response from the controller". This warning is normal and is designed to warn the user when the controller does not respond to a command within the timeout period. This occurs because this command takes more time than the default timeout of 5 sec. The timeout can be changed in the Galil software but this warning does not affect the operation of the controller or software.

Examples:

BW	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_BWn
	<u>Burn:</u>	burnable with BN
Brake Wait		

Full Description

The BW command sets the delay between when the brake is turned on and when the amp is turned off. When the controller goes into a motor-off (MO) state, this is the time (in samples) between when the brake digital output changes state and when the amp enable digital output changes state. The brake is actuated immediately upon MO and the delay is to account for the time it takes for the brake to engage mechanically once it is energized electrically. The brake is released immediately upon SH.

Outputs 1-8 are used for Axes A-H, where output 1 is the brake for axis A and output 2 is the brake for axis B and so on.

Note: The Brake Wait does not apply when the motor is shut off due to OE1 (Off on Error). In this case (position error exceeded or Abort triggered) the motor off and brake output will be applied simultaneously.

Arguments

BW n,n,n,n,n,n,n,n or BWA=n where
n specifies the brake wait time in samples. n ranges from 1 to 32000
n = 0 Turns Brake Wait off
n = ? Returns the brake wait time in msec for the specified axis.

Operand Usage

_BWn contains the brake wait time in samples for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

Related Commands

MO - Motor Off

SH - Servo Here

Examples:

```
| BW100 Set brake delay to 100 ms (TM1000) for the X axis
```

BX	Syntax:	Explicit & Implicit
	Operands:	_BXn
	Burn:	not burnable
Sine Amp Initialization		

THIS COMMAND IS STILL IN BETA. ITS IMPLEMENTATION IS SUBJECT TO CHANGE.

Full Description

The BX command is only valid with the AMP-43540 or the AMP-43640

An axis with a Galil sine amp powers up in MO state and SH will generate an error for that axis until it is initialized.

While the BX command is executing, communication to and from the controller will be halted. This may result in a timeout if the BX command is sent from the host*. Embedded code execution will also pause during BX operation.

If the BX command fails to initialize an axis, it will return an error code of 160. TC1 will return "160 BX Command Failure".

The BX uses a limited motion algorithm to determine the proper location of the motor within the magnetic cycle. It is expected to move no greater than 10 degrees of the magnetic cycle.

* The long timeout (-l) for GalilTools 1.5.0 has been increased to prevent a timeout while using the BX command.

Arguments

BX m,m,m,m,m,m,m,m or BXn=m or BX<t

where

m is a real number from -4.998 to 4.999 representing the voltage used to initialize the axis.

A negative voltage will leave the amp on after the BX command, while a positive voltage will leave the amp in the MO state.

The time for the BX command to return will increase with the magnitude of m.

In most cases BX settings of larger than 3 are not required.

< t is an integer between 1 and 5000 and represents the final pulse duration of the BX command.

The last stage of the BX command will lock the motor into a 15 degree increment for 't' samples.

Operands

_BXn

contains 0 if n is not a Galil sine amp axis

contains 1 if n is an uninitialized sine amp axis

contains 3 if n is an initialized sine amp axis

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes (recommended)
Command Line	Yes
Default Value	t = 1000

Related Commands

BA - Brushless Axis

BM - Brushless Modulo

Examples

```

REM Simple Example
BAA
BMA=2000
BXA=-3
#bxa;JP#bxa,_BXA<>3
ENDIF

REM Detailed Example
#COM
~a=0;'0 = A axis, 1 = B axis . . .
BA~a;'enable brushless mode
BM~a=2000;'must be set per inividual motor specifications
bx_i=0;'number of tries for the BX command
#COM_H
tc=0;'response from TC command if an error occurs
MO~a;'start in motor off state
#tv;JP#tv,_TV~a>500;'make sure axis is not moving
BX<1000;'set pulse duration to 1000 samples
BX~a=-3;'command the BX command
REM loop until BX passes or error occurs
#LOOP;JP#LOOP,((_BX~a<>3)&(tc=0))
REM try again if an error ocured and the number of tries < 5
JP#COM_H,((tc<>0)&(bx_i<5))
REM if the number of tries is < 5 then BX passed
REM else, try BZ command
IF (bx_i<5)
  MG "Commutation complete"
ELSE
  MG "BX failed to complete"
  MG "attempting BZ command"
  tc=0;BZ~a=-3
  IF tc=0
    MG "BZ command complete"
  ELSE
    MG "BZ command failed"
    MG "check motor and encoder wiring"
    MG "try setting CE 2 or swapping 2 motor leads"
  ENDIF
ENDIF
ENDIF
EN

#CMDERR
tc=_TC
TC1
REM if 160 error, increase BX<t and try again
IF tc=160
  MG "Retry BX"
  bx_i=bx_i+1
  BX<(bx_i*1000);'increase pulse time on failure
ENDIF
RE

```


BZ	Syntax:	Explicit & Implicit
	Operands:	_BZn
	Burn:	not burnable
Brushless Zero		

Full Description

The BZ command is used for axes which are configured for sinusoidal commutation. This command drives the motor to zero magnetic phase and then sets the commutation phase to zero.

This command may be given when the motor is off.

Arguments

BZ n,n,n,n,n,n,n or BZA =n or BZ <t where

n is a real number between -4.998 and 4.998. The parameter n will set the voltage to be applied to the amplifier during the initialization. In order to be accurate, the BZ command voltage must be large enough to move the motor. If the argument is positive, when the BZ operation is complete, the motor will be left in the off state, MO. A negative value causes the motor to end up in the on state, SH.

<t is an integer between 1 and 32767 and represents the settling time of the BZ function. The controller will wait 't' sec to update sufficient samples (sampling rate = 1000 sec by default) to settle the motor at the zero magnetic phase. The t parameter should be specified prior to issuing the BZ command.

Note: The BZ command causes instantaneous movement of the motor. It is recommended to start with small voltages and increase as needed

Note: Always use the Off On Error function (OE command) to avoid motor runaway whenever testing sinusoidal commutation.

Operand Usage

_BZn contains the distance in encoder counts from the motor's current position and the position of commutation zero for the specified axis. This can be useful to command a motor to move to the commutation zero position for phase initialization.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	n = 0, t= 1000
Default Format	0

Related Commands

BA - Brushless Axis
 BB - Brushless Phase Begins
 BC - Brushless Commutation
 BD - Brushless Degrees
 BI - Brushless Inputs
 BM - Brushless Modulo
 BO - Brushless Offset
 BS - Brushless Setup

Examples:

```
| BZ, -3 Drive C axis to zero phase with 3 volt signal, and end with motor enabled.
```

CA	Syntax:	Accepts Axis Mask
	Operands:	_CA _n
	Burn:	not burnable
Coordinate Axes		

Full Description

The CA command specifies the coordinate system to apply proceeding vector commands. The following commands apply to the active coordinate system as set by the CA command:

CR ES LE LI LM
TN VE VM VP

Arguments

CAS or CAT where

CAS specifies that proceeding vector commands shall apply to the S coordinate system

CAT specifies that proceeding vector commands shall apply to the T coordinate system

CA ? returns a 0 if the S coordinate system is active and a 1 if the T coordinate system is active.

Operand Usage

_CA contains a 0 if the S coordinate system is active and a 1 if the T coordinate system is active.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	CAS
Default Format	N/A

Related Commands

VP - Vector Position

VS - Vector Speed

VD - Vector Deceleration

VA - Vector Acceleration

VM - Vector Mode

VE - End Vector

BG - BGS - Begin Sequence

Examples:

```

CAT      Specify T coordinate system
VMAB    Specify vector motion in the A and B plane
VS 10000      Specify vector speed
CR 1000,0,360  Generate circle with radius of 1000 counts, start at 0 degrees and complete one
circle in counterclockwise direction.
VE      End Sequence
BGT     Start motion of T coordinate system

```

CB	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Clear Bit		

Full Description

The CB command clears a particular digital output, setting the output to logic 0. The CB and SB (Set Bit) instructions can be used to control the state of output lines.

CB can be used to clear the outputs of extended I/O which have been configured as outputs. See the CO command.

The CB command can also be used with modbus devices to clear remote outputs.

Arguments

CB n

where

n is an integer corresponding to a specific output on the controller to be cleared (set to 0).

When using Modbus devices, the I/O points of the modbus devices are calculated using the following formula:

$$n = (\text{SlaveAddress} * 10000) + (\text{HandleNum} * 1000) + ((\text{Module}-1) * 4) + (\text{Bitnum}-1)$$

Slave Address is used when the ModBus device has slave devices connected to it and specified as Addresses 0 to 255. Please note that the use of slave devices for modbus are very rare and this number will usually be 0.

HandleNum is the handle specifier from A to H.

Module is the position of the module in the rack from 1 to 16.

BitNum is the I/O point in the module from 1 to 4.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

"SB" - Set Bit

"OB" - Output Bit

"OP" - Output Port

Examples:

```
CB 7;'      Clear output bit 7
CB 15;'     Clear ouput bit 15 (RIO and 5-8 axis controllers only)
```

CC	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Configure Communications Port 2		

Full Description

The CC command configures baud rate, handshake, mode, and echo for the AUX SERIAL PORT, referred to as Port 2. This command must be given before using the MG, or CI commands with Port 2.

Arguments

CC m,n,r,p

where

m - Baud rate 9600,19200, 38400, or 115200

n - Handshake 0 for handshake off, 1 for handshake on

r - Enabled 0 disabled, 1 enabled

p - Echo 0 for echo off, 1 for echo on

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes

Related Commands

CI - Configure Communication Interrupt

Examples:

```
| :CC 9600,0,0,0 9600 baud, no handshake, echo off.
| : Typical setting with TERM-P or TERM-H.
```

CD	Syntax:	Explicit & Implicit
	Operands:	none
	Burn:	not burnable
Contour Data		

Full Description

The CD command specifies the incremental position on contour axes. The units of the command are in encoder counts. This command is used only in the Contour Mode (CM). The incremental position will be executed over the time period specified by the command DT (ranging from 2 to 256 servo updates)

The = operator can be used to override the global DT time by transmitting the time in a CD with the position data.

Arguments

CD n,n,n,n,n,n,n,n = m or CDA=n where

n is an integer in the range of +/-32767.

m (optional) is an integer in the range 0 to 8 and overrides the global DT time for this interval

n = m = 0 terminates the Contour Mode.

m = 1 through 8 specifies the time interval (DT) of 2^m samples.

By default the sample period is 1 msec (set by the TM command); with m = 1, the time interval would be 2 msec.

Note 1: The command CD 0,0=0 would follow the last CD command in a sequence CD 0,0=0 is similar to VE & LE. Once reached in the buffer, CD 0,0=0 will terminate the contour mode.

Note 2: The command CD0=0 will assign a variable CD0 the value of 0. In this case the user must have a space after CD in order to terminate the Contour Mode correctly. Example: CD 0=0 will terminate the contour mode for the X axis.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	5.0

Related Commands

CM - Contour Mode

DT - Time Increment

CS - Clear Sequence

_CS is the Segment Counter

Examples:

```
#CONTOUR; '          Program Label
CMAB; '             Enter Contour Mode
DT 4; '             Set time interval
CD 1000,2000; '     Specify data
CD 2000,4000; '     Next data
```

CD 0,0=0;'	End of Contour Buffer
#Wait;'	Wait for all segments to process (buffer to empty)
WT 16,1;'	wait for 1 DT time segment (2^4)
JP#Wait,_CM<>511	
EN;'	End Program

CE	<u>Syntax:</u>	Explicit & Implicit
	Operands:	_CEn
	Burn:	burnable with BN
Configure Encoder		

Full Description

The CE command configures the encoder to quadrature type or pulse and direction type. It also allows inverting the polarity of the encoders which reverses the direction of the feedback. Note: When using a servo motor, changing the CE type can cause the motor to run away.

The configuration applies independently to the main axes encoders and the auxiliary encoders. When the MT command is configured for a stepper motor, the auxiliary encoder (used to count stepper pulses) will be forced to pulse and direction.

Arguments

CE n,n,n,n,n,n,n,n or CEA = n where

n is an integer in the range of 0 to 15. Each integer is the sum of two integers M and N which configure the main and the auxiliary encoders.

Configure Encoder Types

M argument	Main Encoder Type	N argument	Auxiliary Encoder Type
0	Normal quadrature	0	Normal quadrature
1	Normal pulse and direction	4	Normal pulse and direction
2	Reversed quadrature	8	Reversed quadrature
3	Reversed pulse and direction	12	Reversed pulse and direction

For example: n = 10 implies M = 2 and N = 8, thus both encoders are reversed quadrature.

n = ? Returns the value of the encoder configuration for the specified axes.

Operand Usage

_CEn contains the value of encoder type for the axis specified by 'n'.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

"MT" - Specify motor type

Examples:

```
CE 0, 3, 6, 2    Configure encoders
CE ?,?,?,,?
:0,3,6,2        Interrogate configuration
V = _CEB
V = ?
:3              Assign configuration to a variable
```

Note: When using pulse and direction encoders, the pulse signal is connected to CHA and the direction signal is connected to CHB.

CF	Syntax:	Accepts Axis Mask
	Operands:	_CFn
	Burn:	not burnable
Configure Unsolicited Messages Handle		

Full Description

Sets the port for unsolicited messages. By default, the controller will send unsolicited data to the main RS-232 or USB serial port. The CF command directs the controller to send unsolicited responses to the Main or Aux Serial Port (If equipped), or to an Ethernet handle.

An unsolicited message is data generated by the controller which is not in response to a command sent by the host. Examples of commands that will generate unsolicited messages follow. These commands are unsolicited only when in embedded code, NOT when sent from a host.

```
MG"Hello";'      A message (MG)
TC1;'           A command that returns a response
TP;'           "
RPA;'          "
var=?;'        A variable interogation
var=;'         "
thisIsAnError;' A dmc error will generate an error message
```

Arguments

CFn

where n is A through H for Ethernet handles 1 through 8, S for Main serial port, T for Aux serial port or I is to set to the port that issues the CF command.

The axis designator ~n can also be used.

Operands

_CF contains the decimal value of the ASCII letter where unsolicited messages are currently routed.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All Standalone Controllers
Default Value	S
Default Format	N/A

Related Commands

CW - Configures MSB of unsolicited messages

WH - What Handle

TH - Tell Handles

Examples

```
:CFI;' "Send to me"
'Sent from external hardware only, CFI directs
'unsolicited traffic to the port that sent the command
```

When communicating over Ethernet, two Ethernet handles should be used:

- 1.) The first handle should be used for command-and-response traffic. This is the primary handle that the host uses to communicate to the controller.
- 2.) The second handle should be used for unsolicited traffic. This is the primary handle that the controller uses to asynchronously communicate to the host. Use CF to point unsolicited traffic to this handle.

It is NOT recommended to use one Ethernet handle for both command-and-response, and unsolicited messages.

GalilTools will by default establish a two handle connection when using Ethernet.

```
Demonstrates from GalilTools terminal that the
main handle is seperate from the unsolicited handle
192.168.1.3, RIO47102 Rev 1.0c, 1480, IHA IHB
:TH
CONTROLLER IP ADDRESS 192,168,1,3 ETHERNET ADDRESS 00-50-4C-28-05-C8
IHA TCP PORT 23 TO IP ADDRESS 192,168,1,100 PORT 2420
IHB UDP PORT 60007 TO IP ADDRESS 192,168,1,100 PORT 2421
IHC AVAILABLE
IHD AVAILABLE
IHE AVAILABLE
:WH
IHA
:'Main handle is A
:MG_CF
 66.0000
:'Unsolicited handle. 66 is ASCII for "B"
:
```

CI	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Configure Communication Interrupt		

Full Description

The CI command configures a program interrupt based on characters received on communications port 2, the AUX serial port (port 1 on DMC-21x2/3 & RIO). An interrupt causes program flow to jump to the #COMINT subroutine. If multiple program threads are used, the #COMINT subroutine runs in thread 0 and the remaining threads continue to run without interruption. The characters received can be accessed via the operands P2CH, P2ST, P2NM, P2CD (P1 on DMC-21x2/3 & RIO). For more, see Operator Data Entry Mode in the user manual.

Arguments

CI n, m (m on DMC-21x2/3 and RIO only)

n = 0 Do not interrupt
n = 1 Interrupt on carriage return
n = 2 Interrupt on any character
n = -1 Clear interrupt data buffer

RIO And DMC-21x2/3

m = 0 Default, received serial port data is interpreted as Galil command, returning data to the port as a standard interpreted port.
m = 1 Enable serial port for CI execution. Data received will not be interpreted as a command.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Default Value	n = 0, m = 0

Related Commands

CC - Configure communications
IN - Communication input
MG - Message output

Examples:

```
:CI 1    Interrupt when the <enter> key is received on port 2
:CI 2    Interrupt on a single character received on Port 2
:
```

CM	Syntax:	Accepts Axis Mask
	Operands:	_CMn
	Burn:	not burnable
Contour Mode		

Full Description

The Contour Mode is initiated by the instruction CM. This mode allows the generation of an arbitrary motion trajectory with any of the axes. The CD command specified a position increment, and the DT command specifies the time interval between subsequent increments.

Issuing the CM command will clear the controur buffer when contour mode is not running.

Arguments

CM nnnnnnnnnn where
n is A,B,C,D,E,F,G,H or any combination to specify the axes for contour mode
n = ? Returns a 0 if the contour buffer is full and 511 if the contour buffer is empty.

Operand Usage

_CM contains a '0' if the contour buffer is full; otherwise it contains the number of available contour segments.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	Disabled
Default Format	N/A

Related Commands

CD - Contour Data
DT - Time Increment

Examples:

```
#Cont0;'          Define label #Cont0
CM ABCD;'        Specify Contour Mode Axes ABCD
DT 4;'          Specify time increment for contour (2^4 servo loops, 16ms at TM1000)
CD 200,350,-150,500;' Specify incremental positions on A,B,C and D axes
'              A-axis moves 200 counts B-axis moves 350 counts C-
'              axis moves -150 counts D-axis moves 500 counts
'
CD 100,200,300,400;' Next position data
CD 0,0,0,0=0;'   Special syntax to terminate Contour mode
#Wait;JP#Wait, _CM<>511;' Spin on #Wait label until buffer is empty
'              End of Contour Buffer/Sequence
EN;'           End program
'
#Cont1;'       Define label #Cont1
CM ABC;'      Specify Contour Mode
DT 8;'       Specify time increment for contour (2^8 servo loops, 256ms at TM1000)
```

```
CD 100,100,100;'      New position data
CD 100,100,100;'      New position data
CD 0,0,0 =-1;'        Pause countour buffer set DT to resume
CD 100,100,100;'      New position data
CD 100,100,100;'      New position data
CD 0,0,0,0=0;'        Special syntax to terminate Contour mode
#Wait2;JP#Wait2,_CM<>511;' Spin on #Wait2 label until buffer is empty
'End of Contour Buffer/Sequence
EN
```

CN	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_CN0,_CN1,_CN2,_CN3,_CN4
	<u>Burn:</u>	burnable with BN
Configure		

Full Description

The CN command configures the polarity of the limit switches, home switches, latch inputs, the selective abort function, and the program termination behaviour of the abort input.

Arguments

CN m,n,o,p,q

where

m

- 1 Limit switches active high
- 1 Limit switches active low

n

- 1 HM will drive motor forward when Home input is high. See HM and FE commands.
- 1 HM will drive motor backward when Home input is high. See HM and FE commands

o

- 1 Latch input is active high
- 1 Latch input is active low

p

- 1 Configures inputs 5,6,7,8,13,14,15,16 as selective abort inputs for axes A,B,C,D,E,F,G,and H respectively.
Will also trigger #POSERR automatic subroutine if program is running.
- 0 Inputs 5,6,7,8,13,14,15,16 are configured as general use inputs

q

- 1 Abort input will not terminate program execution
- 0 Abort input will terminate program execution

Operand Usage

_CN0	Contains the limit switch configuration
_CN1	Contains the home switch configuration
_CN2	Contains the latch input configuration
_CN3	Contains the state of the selective abort function (1 enabled, 0 disabled)
_CN4	Contains whether the abort input will terminate the program

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	-1,-1,-1,0,0
Default Format	2.0

Related Commands

AL - Arm latch

LD - Limit Switch Disable

Examples:

```
CN 1,1 Sets limit and home switches to active high  
CN,, -1 Sets input latch active low
```

CO	Syntax:	Implicit Notation Only
	Operands:	_CO
	Burn:	burnable with BN
Configure Extended I O		

Full Description

The CO command configures which banks are inputs and which are outputs on the extended I/O.

The CO command configures which points are inputs and which are outputs on the extended I/O. The 32 extended I/O points of the controller can be configured in banks of 8. The extended I/O is denoted as bits 17-48 and banks 2-5.

Arguments

CO n

where

n is a decimal value which represents a binary number. Each bit of the binary number represents one bank of extended I/O. When set to 1, the corresponding bank is configured as an output.

The least significant bit represents bank 2 and the most significant bit represents bank 5. The decimal value can be calculated by the following formula.

$$n = n_2 + 2*n_3 + 4*n_4 + 8*n_5$$

where n_x represents the bank. To configure a bank as outputs, substitute a one into that n_x in the formula. If the n_x value is a zero, then the bank of 8 I/O points will be configured as inputs. For example, if banks 3 and 4 are to be configured as outputs, CO 6 is issued.

Operand Usage

_CO returns the extended I/O configuration value.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

CB - Clear Output Bit

SB - Set Output Bit

OP - Set Output Port

TI - Tell Inputs

Examples:

```
CO 15   Configure all points as outputs
CO 0    Configure all points as inputs
CO 1    Configures bank 2 as outputs on extended I/O
```

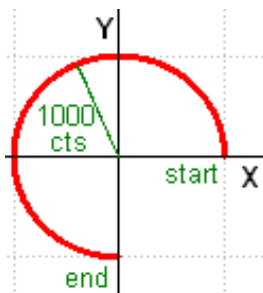

CR	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Circle		

Full Description

When using the vector mode (VM), the CR command specifies a 2-dimensional arc segment of radius r , starting at angle θ , and traversing over angle $\Delta\theta$. A positive $\Delta\theta$ denotes counterclockwise traverse, negative $\Delta\theta$ denotes clockwise. The VE command must be used to denote the end of the motion sequence after all CR and VP segments are specified. The BG (Begin Sequence) command is used to start the motion sequence. Parameters r , θ , and $\Delta\theta$ must be specified in each CR. Radius units are in quadrature counts. θ and $\Delta\theta$ have units of degrees. The parameters n and o are optional and describe the vector speeds that are attached to the motion segment.

A starting position of zero degrees denotes that the radius lies along a vector following the positive X axis, on a 2D Cartesian space:

```
VMXY
CR 1000,0,270
VE
BGS
EN
```



Arguments

CR r , θ , $\Delta\theta$ < n > o

where

r is the circle radius and is an unsigned real number in the range 10 to 6000000

θ is the circle starting angle in degrees and is a signed real number in the range 0 to +/-32000

$\Delta\theta$ is the angle to traverse and is a signed real number in the range 0.0001 to +/-32000

Note: The product $r * \Delta\theta$ must be limited to +/-4.5x10⁸

n specifies a vector speed to be taken into effect at the execution of the vector segment. n is an unsigned even integer between 0 and 22,000,000 for servo motor operation and between 0 and 6,000,000 for stepper motors.

o specifies a vector speed to be achieved at the end of the vector segment. o is an unsigned even integer between 0 and 8,000,000.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes

Command Line	Yes
Controller Usage	DMC, No RIO
Default Value	N/A
Default Format	N/A

Related Commands

VP - Vector Position

VS - Vector Speed

VD - Vector Deceleration

VA - Vector Acceleration

VM - Vector Mode

VE - End Vector

BG,BGS - Begin Sequence

Examples:

```

VMAB; '          Specify vector motion in the A and B plane
VS 1000; '       Specify vector speed
CR 1000,0,360; ' Generate circle with radius of 1000 counts, start at
'              0 degrees and complete one circle in counterclockwise
'              direction.
CR 1000,0,360 < 40000; ' Generate circle with radius of 1000 counts, start
'              at 0 degrees and complete one circle in counterclockwise
'              direction and use a vector speed of 40000.
VE; '           End Sequence
BGS; '         Start motion

```

CS	Syntax:	Accepts Axis Mask
	Operands:	_CSn
	Burn:	not burnable
Clear Sequence		

Full Description

The CS command will remove VP, CR or LI commands stored in a motion sequence for the S or T coordinate systems. After a sequence has been executed, the CS command is not necessary to put in a new sequence. This command is useful when you have incorrectly specified VP, CR or LI commands.

Arguments

CSS or CST where

S and/or T can be used to clear the sequence buffer for the "S" or "T" coordinate system.

Operand Usage

_CSn contains the segment number in the sequence specified by n, S or T. This operand is valid in the Linear mode, LM, Vector mode, VM

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"CR" - Circular Interpolation Segment

"LI" - Linear Interpolation Segment

"LM" - Linear Interpolation Mode

"VM" - Vector Mode

"VP" - Vector Position

Examples:

```
#CLEAR ;'Label
CAT ;'Specify the T coordinate system vector points
VP 1000,2000 ;'Vector position
VP 4000,8000 ;'Vector position
CST ;'Clear vectors specified in T coordinate system
CAS ;'Specify the T coordinate system vector points
VP 1000,5000 ;'New vector
VP 8000,9000 ;'New vector
CSS ;'Clear vectors specified in S coordinate system
EN ;'End program
```

CW	Syntax:	Implicit Notation Only
	Operands:	_CWn
	Burn:	not burnable
Copyright information Data Adjustment bit on off		

Full Description

The CW command will return the copyright information when the argument, n, is 0 or is omitted. Otherwise, the CW command is used as a communications enhancement for use by the Galil terminal software programs. When turned on, the most significant bit of unsolicited ASCII characters is set to 1. Unsolicited ASCII characters are characters that are returned from a program running on the controller (usually from the MG command). This command does not affect solicited characters, which are characters that are returned as a response to a command sent from a host PC (e.g. TP).

If using Galil drivers, CW will be automatically configured - the user should not change the CW settings.

Arguments

CW n,m

where

n is a number, either 0,1 or 2:

- 0 or ? Causes the controller to return the copyright information
- 1 Causes the controller to set the MSB of unsolicited returned characters.
- 2 Causes the controller to not set the MSB of unsolicited characters.

m is 0 or 1 (optional)

- 0 Causes the controller to pause program execution when hardware handshaking disables character transmissions.
- 1 Causes the controller to continue program execution when hardware handshake disables character transmissions, output characters will be lost.

Operand Usage

_CW contains the value of the data adjustment bit. 1 =on, 2 = off

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

CF - Configure Unsolicited Messages Handle

Examples:

```
CW1; '      Set CW to Galil Driver mode (MSB set on unsolicited characters)

'Note:     The CW command can cause garbled (non-ASCII) characters to be returned
'          by the controller when using third-party software. Use CW2.
CW2; '      Set CW to third-party device mode (normal ASCII on unsolicited characters)
```

DA	Syntax:	Implicit Notation Only
	Operands:	_DAn
	Burn:	not burnable
Deallocate the Variables & Arrays		

Full Description

The DA command frees the array and/or variable memory space. In this command, more than one array or variable can be specified for memory de-allocation. Different arrays and variables are separated by comma when specified in one command. The * argument deallocates all the variables, and * [0] deallocates all the arrays.

Arguments

DA c[,d,etc. where
 c[] - Defined array name
 d - Defined variable name
 * - Deallocates all the variables
 *[] - Deallocates all the arrays
 DA? Returns the number of arrays available.

Operand Usage

_DA contains the total number of arrays available.

Usage

Related Commands

"DM" - Dimension Array

Examples:

```
'Cars' and 'Salesmen' are arrays, and 'Total' is a variable.
DM Cars[40],Salesmen[50]            Dimension 2 arrays
Total=70                            Assign 70 to the variable Total
DA Cars[0],Salesmen[0],Total      Deallocate the 2 arrays & variable
DA*[0]                              Deallocate all arrays
DA *,*[0]                          Deallocate all variables and all arrays
NOTE: Since this command deallocates the spaces and compacts the array spaces in the memory, it is
possible that execution of this command may take longer time than a standard command. Variables
and arrays that are deallocated are not set to zero. A routine that writes zeros to the array and/
or variables should be created if this is desired.
```

DC	Syntax:	Explicit & Implicit
	Operands:	_DCn
	Burn:	burnable with BN
Deceleration		

Full Description

The Deceleration command (DC) sets the linear deceleration rate of the motors for independent moves such as PR, PA and JG moves. The parameters will be rounded down to the nearest factor of 1024 and have units of counts per second squared.

Arguments

DC n,n,n,n,n,n,n,n or DCA=n where
 n is an unsigned numbers in the range 1024 to 1073740800
 n = ? Returns the deceleration value for the specified axes.

Operand Usage

_DCn contains the deceleration rate for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (The DC command can only be specified while in the jog mode)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256000
Default Format	(8.0 for 21x3, 18x2), (10.0 for 40x0, 18x6)

While Moving Yes* Default Value 256000

In a Program Yes Default Format 10.0

Command Line Yes

Controller Usage ALL CONTROLLERS

* When moving, the DC command can only be specified while in the jog mode.

Related Commands

AC
 Acceleration
 PR
 Position Relative
 PA
 Position Absolute
 SP
 Speed
 JG
 Jog
 SD
 Limit Switch Deceleration

Examples:

```
PR 10000          Specify position
AC 2000000       Specify acceleration rate
DC 1000000       Specify deceleration rate
SP 5000          Specify slew speed
BG              Begin motion
```

| Note: The DC command may be changed during the move in JG move, but not in PR or PA move.

DE	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_DEn
	<u>Burn:</u>	not burnable
Dual (Auxiliary) Encoder Position		

Full Description

The DE command defines the position of the auxiliary encoders.

The DE command defines the encoder position when used with stepper motors.

Note: The auxiliary encoders are not available for the stepper axis or for any axis where output compare is active.

Arguments

DE n,n,n,n,n,n,n,n or DEA=n where

n is a signed integers in the range -2147483648 to 2147483647 decimal

n = ? Returns the position of the auxiliary encoders for the specified axes.

n = ? returns the commanded reference position of the motor (in step pulses) when used with a stepper motor. Example: DE 0 This will define the TP or encoder position to 0. This will not effect the DE ? value. (To set the DE value when in stepper mode use the DP command.)

Operand Usage

_DEn contains the current position of the specified auxiliary encoder.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0, 0, 0, 0
Default Format	Position Format

While Moving Yes Default Value 0,0,0,0

In a Program Yes Default Format Position Format

Command Line Yes

Controller Usage ALL CONTROLLERS

Related Commands

Examples:

```
DE 0,100,200,400      Set the current auxiliary encoder position to 0,100,200,400 on A,B,C and D
axes
```

```
DE?,?,?,?           Return auxiliary encoder positions
```

```
DualA=_DEA          Assign auxiliary encoder position of A-axis to the variable DualA
```

Hint: Dual encoders are useful when you need an encoder on the motor and on the load. The encoder on the load is typically the auxiliary encoder and is used to verify the true load position. Any error in load position is used to correct the motor position.

DF	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_DFn
	<u>Burn:</u>	burnable with BN
Dual Feedback (DV feedback swap)		

Full Description

This command is used only by the DMC-4xxx with SSI or BiSS upgrades.

For users wishing to operate with SSI or BiSS in Dual Loop mode (DV), the DF command can be used to configure a load-side serial encoder and a motor-side incremental encoder with DVI. Wire the motor's incremental encoder per normal to the DMC-4xxx main encoder inputs. The load SSI encoder should be wired to the axis aux encoder lines:

SSI Signals, DMC-40x0

Nominal Signal Name	Signal Reassignment with SSI	Signal Reassignment with BiSS
AA+	Clock+	MA+
AA-	Clock-	MA-
AB+	Data+	SLO+
AB-	Data-	SLO-

Issue the configuration command (SI or SS) to setup the serial decoding for the axis aux encoder (e.g. $SIn = 2, si1, si2, si3 <p >q$). Verify proper serial encoder operation by moving the motor in non-dual loop mode and checking TDn. Disable the motor with MO and issue DFn=1 and DVn=1. The axis control law will now fragment the PID loop. P and I will be closed around the serial encoder. D will be closed around the motor encoder. The serial encoder can now be interrogated with TP (not TD), and the incremental encoder with TD (not TP).

In summary, DF will cause the main encoder register (TP) and aux encoder register (TD) to be swapped. This makes the wiring configuration compatible with the standard dual loop mode (DV).

Arguments

DF n,n,n,n,n,n,n,n where

n represents a Boolean (on or off) and is either 1 or 0.

Operands

_DFn contains the value (1 or 0) of the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

DV - Dual Velocity (Dual Loop)

SI - Configure the special Galil SSI feature

SS - Configure the special Galil BiSS feature

Examples

```
MOX; '                               Disable motor on X
SIX=2,25,15,0<13>2;' Setup SSI encoder to fill the Aux encoder register
```

DF1;'	Enable Dual Feedback Swap
DV1;'	Enable Dual Loop mode
SHX;'	Enable servo with new configuration

DH	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	burnable with BN
DHCP Server Enable		

Full Description

The DH command configures the DHCP or BOOT-P functionality on the controller for Server IP addressing.

Arguments

DH n where

n = 0 disables DHCP and enables BOOT-P

n = 1 disables BOOT-P and enables DHCP

n = ? returns the current state of the setting

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	1.0
Controller Usage	DMC-4xxx / RIO-47xxx
Default Value	1.0
Default Format	N/A

Operand Usage

N/A

Related Commands

IA - IP Address

Examples:

```
DH 1    Sets the DHCP function on.  IA assignment will no longer work.  IP address cannot be
burned.  Controller will receive its IP address from the DHCP server on the network.
```

```
DH 0    Sets the DHCP function off, and the Boot-P function on.
```

DL	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	DLn
	<u>Burn:</u>	not burnable
Download		

Full Description

The DL command transfers a data file from the host computer to the controller. Instructions in the file will be accepted as a data stream without line numbers. The file is terminated using <control> Z, <control> Q, <control> D, or \. DO NOT insert spaces before each command.

If no parameter is specified, downloading a data file will clear all programs in the controllers RAM. The data is entered beginning at line 0. If there are too many lines or too many characters per line, the controller will return a ?. To download a program after a label, specify the label name following DL. The argument # may be used with DL to append a file at the end of the program in RAM.

It is recommended to use the program download functions available through the GalilTools software and drivers rather than directly using the DL command.

Arguments

DL n where

n = no argument Downloads program beginning at line 0. Erases programs in RAM.

n = #Label Begins download at line following #Label

n = # Begins download at end of program in RAM.

Operand Usage

When used as an operand, _DL gives the number of available labels (510 maximum)

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

```
DL;      Begin download
#A;PR 4000;BGA Data
AMA;MG DONE Data
EN      Data
<control> Z      End download
```

DM	Syntax:	Implicit Notation Only
	Operands:	DMn
	Burn:	not burnable
Dimension		

Full Description

The DM command defines a single-dimensional array with a name and n total elements. The first element of the defined array starts with element number 0 and the last element is at n-1.

Arguments

DM c[n] where
 c is a array name of up to eight alphanumeric characters, starting with an alphabetic character.
 n is the number of array elements.

DM? returns the number of array elements available.

Operand Usage

_DM contains the available array space.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"DA" - Deallocate Array

Examples:

```
DM Pets[5],Dogs[2],Cats[3]        Define dimension of arrays, pets with 5 elements; Dogs with 2
elements; Cats with 3 elements
DM Tests[1600]    Define dimension of array Tests with 1600 elements
```

```
:DM?
16000
:DM MyArray[1000]
:DM?
15000
'DMC-4xxx and 18x6 provide length of array with array[-1]
:MG "MyArray contains",MyArray[-1]," elements"
MyArray contains 1000.0000 elements
:
```

DP	Syntax:	Explicit & Implicit
	Operands:	_DPn
	Burn:	not burnable
Define Position		

Full Description

The DP command sets the current motor position and current command positions to a user specified value. The units are in quadrature counts. This command will set both the TP and RP values.

The DP command sets the commanded reference position for axes configured as steppers. The units are in steps. Example: DP 0 this will set the registers for TD and RP to zero, but will not effect the TP register value.

Arguments

DP n,n,n,n,n,n,n,n or DPA=n where
n is a signed integer in the range -2147483648 to 2147483647 decimal.
n = ? Returns the current position of the motor for the specified axes.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0,0,0,0,0,0,0
Default Format	Position Format (PF)

Operand Usage

_DPn contains the current position of the specified axis.

Related Commands

DE Define Aux Encoder
FI Find Index
FE Find Edge
HM Home
PF Position Format
RP Reference Position
TP Tell Encoder Position

Examples:

```
DP 0,100,200,400      Sets the current position of the A-axis to 0, the B-axis to 100, the C-axis
to 200, and the D-axis to 400
DP ,-50000           Sets the current position of B-axis to -50000. The B,C and D axes remain
unchanged.
DP ?,?,?,?          Interrogate the position of A,B,C and D axis.
:0, -0050000, 200, 400 Returns all the motor positions
DP ?                 Interrogate the position of A axis
:0                   Returns the A-axis motor position
```

Hint: The DP command is useful to redefine the absolute position. For example, you can manually position the motor by hand using the Motor Off command, MO. Turn the servo motors back on with SH and then use DP0 to redefine the new position as your absolute zero.

DR	Syntax:	Implicit Notation Only
	Operands:	_DR
	Burn:	not burnable
Configures I O Data Record Update Rate		

Full Description

The controller creates a QR record and sends it periodically to a UDP Ethernet Handle.

Arguments

DR n, m

n specifies the data update rate in samples between updates. When TM is set to the default of 1000, n specifies the data update rate in milliseconds. n=0 to turn it off, or n must be an integer in the range of 2 to 30,000.

m specifies the Ethernet handle on which to periodically send the Data Record. 0 is handle A, 1 is B, 7 is H. The handle must be UDP (not TCP).

Operand Usage

_DR contains the data record update rate.

Usage

Usage Default Details

Usage	Value
While Moving	Yes
In a Program	
Command Line	Yes
Controller Usage	
Default Value	
Default Format	

Related Commands

QZ

Sets format of data

QR

Query a single data record

Examples:

```
:DR8,0
:G•x•••••~•••P•
_•`•••••@~•••P•
_•H•••••`~•••P•
_•0•••••~•••P•
```

DR0

'Note: The data record is in a binary, non-printable format (the output above is normal when printing to the terminal)

DT	Syntax:	Implicit Notation Only
	Operands:	DTn
	Burn:	not burnable
Delta Time		

Full Description

The DT command sets the time interval for Contour Mode. Sending the DT command once will set the time interval for all contour data until a new DT command (or CDm=n) is sent.

Arguments

DT n where

n is an integer in the range 0 to 8.

n = 1 through 8 specifies the time interval of 2^n samples.

n = -1 allows a pre-load of the contour buffer or to asynchronously pause the contour buffer. DT-1 during contour mode will pause the contour buffer (and commanded movement). A positive DT will resume contour mode from paused position of buffer.

By default the sample period is 1 msec (set by the TM command); with n=1, the time interval would be 2 msec

n = ? Returns the value for the time interval for contour mode.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Operand Usage

_DT contains the value for the time interval for Contour Mode

Related Commands

CM - Contour Mode

CD - Contour Data

Examples:

```
:DT 4           Specifies time interval to be 16 msec (TM1000)
:DT 7           Specifies time interval to be 128 msec
:
```

```
REM basic contour example
#Cont0;'       Define label #Cont0
CM ABCD;'      Specify Contour Mode
DT 4;'         Specify time increment for contour
CD 200,350,-150,500;' Specify incremental positions on A,B,C and C axes
'             A-axis moves 200 counts B-axis moves 350 counts C-
'             axis moves -150 counts C-axis moves 500 counts
CD 100,200,300,400 ;' New position data
CD 0,0,0,0=0;' End of Contour Buffer/Sequence
#Wait;'       Wait for all segments to process (buffer to empty)
WT 16,1;'     wait for 1 DT time segment (2^4)
```

```
JP#Wait,_CM<>511
EN;'                               End program

REM contour example for pre-loading of contour buffer
#Cont1;'                           Define label #Cont1
CM AB;'                             Specify Contour Mode
DT -1;'                             Pause Contour Mode to allow pre-load of buffer
CD 100,200;'                         Countour Data pre-loaded in buffer
CD 400,200;'                         Countour Data pre-loaded in buffer
CD 200,100;'                         Countour Data pre-loaded in buffer
CD 300,50;'                          Countour Data pre-loaded in buffer
AI -1;'                             Wait for Analog input 1 to go low
DT 8;'                               Set positive DT to start contour mode
CD 0,0,0,0=0;'                       End of Contour Buffer/Sequence
#Wait;'                              Wait for all segments to process (buffer to empty)
WT 16,1;'                            wait for 1 DT time segment (2^4)
JP#Wait,_CM<>511
EN;'                               End program
```

DV	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_DVn
	<u>Burn:</u>	burnable with BN
Dual Velocity (Dual Loop)		

Full Description

The DV function changes the operation of the filter. It causes the KD (derivative) term to operate on the dual encoder instead of the main encoder. This results in improved stability in the cases where there is a backlash between the motor and the main encoder, and where the dual encoder is mounted on the motor.

When using Dual Loop mode with a large motor:load ratio and/or running at high velocities where low position error at speed is required, FV should be used to compensate for the derivative contribution from the higher resolution motor encoder.

The FV value is calculated by the equation:

$$FV = (KD/4) * (motor/load)$$

motor/load = effective motor to load ratio

For example:

$$KD = 200$$

motor encoder changes 5000 counts per 1000 counts of load encoder (motor/load = 5/1)

$$FV = (200/4) * (5/1) = 250$$

Arguments

DV n,n,n,n,n,n,n,n or DVX=n where

n = 0 Disables the dual loop mode.

n = 1 Enables the dual loop mode.

Operand Usage

_DVn contains the state of dual velocity mode for specified axis. 0 = disabled, 1 = enabled.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

Related Commands

KD - Damping constant

FV - Velocity feedforward

Examples:

```
DV 1,1,1,1      Enables dual loop on all axes
DV 0           Disables DV on A axis
DV , ,1,1     Enables dual loop on C axis and D axis. Other axes remain unchanged.
DV 1,0,1,0    Enables dual loop on A and C axis. Disables dual loop on B and D axis.
MG_DVA       Returns state of dual velocity mode for A axis
Hint: The DV command is useful in backlash and resonance compensation.
```


EA	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	not burnable
Choose ECAM master		

Full Description

The EA command selects the master axis for the electronic cam mode. Any axis may be chosen.

Arguments

EA n where

n is one of the axis specified as A,B,C,D,E,F,G, H, M or N

Operand Usage

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"EB " - Enable ECAM

"EC " - Set ECAM table index

"EG " - Engage ECAM

"EM " - Specify ECAM cycle

"EP" - Specify ECAM table intervals & starting point

"EQ " - Disengage ECAM

"ET " - ECAM table

Examples:

```
| EAB      Select B as a master for ECAM
```

EB	Syntax:	Implicit Notation Only
	Operands:	EBn
	Burn:	not burnable
Enable ECAM		

Full Description

The EB function enables or disables the cam mode. In this mode, the starting position of the master axis is specified within the cycle. When the EB command is given, the master axis is modularized.

Arguments

EB n where

n = 1 Starts ECAM mode

n = 0 Stops ECAM mode.

n = ? Returns 0 if ECAM is disabled and a 1 if enabled.

Operand Usage

_EB contains the state of Ecam mode. 0 = disabled, 1 = enabled

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

"EA" - Choose ECAM master

"EC " - Set ECAM table index

"EG " - Engage ECAM

"EM " - Specify ECAM cycle

"EP" - Specify ECAM table intervals & starting point

"EQ " - Disengage ECAM

"ET " - ECAM table

Examples:

```
EB1      Starts ECAM mode
EB0      Stops ECAM mode
B = _EB Return status of cam mode
```

EC	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	ECn
	<u>Burn:</u>	not burnable
ECAM Counter		

Full Description

The EC function sets the index into the ECAM table. This command is only useful when entering ECAM table values without index values and is most useful when sending commands in binary. See the command, ET.

Arguments

EC n where

n is an integer between 0 and 256.

n = ? Returns the current value of the index into the ECAM table.

Operand Usage

_EC contains the current value of the index into the ECAM table.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

"EA" - Choose ECAM master

"EB " - Enable ECAM

"EG " - Engage ECAM

"EM " - Specify ECAM cycle

"EP" - Specify ECAM table intervals & starting point

"EQ " - Disengage ECAM

"ET " - ECAM table

Examples:

```
EC0      Set ECAM index to 0
ET 200,400    Set first ECAM table entries to 200,400
ET 400,800    Set second ECAM table entries to 400,800
```

ED	Syntax:	Implicit Notation Only
	Operands:	_ED1, _ED
	Burn:	not burnable
Edit		

Full Description

Using Telnet style interface (not Galil Software). The ED command puts the controller into the Edit subsystem. In the Edit subsystem, programs can be created, changed, or destroyed. The commands in the Edit subsystem are:

- <ctrl>D Deletes a line
- <ctrl>I Inserts a line before the current one
- <ctrl>P Displays the previous line
- <ctrl>Q Exits the Edit subsystem
- <return> Saves a line

Arguments

ED n where

n specifies the line number to begin editing. The default line number is the last line of program space with commands.

Operand Usage

_ED contains the line number of the last line to have an error.

_ED1 contains the number of the thread where the error occurred (for multitasking).

_ED4 when evaluated in an embedded code thread, this operand will contain the thread id of the calling thread. This is useful for DMC code to determine which thread it is running in. See example below.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

DL - Download

UL - Upload

Examples:

```
ED
0 #START
1 PR 2000
2 BGA
3 SLKJ Bad line
4 EN
5 #CMDERR Routine which occurs upon a command error
6 V=_ED
7 MG "An error has occurred" {n}
8 MG "In line", V{F3.0}
9 ST
10 ZS0
11 EN
```


Hint: Remember to quit the Edit Mode prior to executing or listing a program.

```
'Using _ED4
XQ#id,1
XQ#id,2
XQ#id,3
XQ#id,4
XQ#id,5
XQ#id,6
XQ#id,7
#id
MG{Z10.0}"This message is from thread",_ED4
EN

' Returns...
' :XQ
' This message is from thread 1
' This message is from thread 2
' This message is from thread 3
' This message is from thread 4
' This message is from thread 5
' This message is from thread 6
' This message is from thread 7
' This message is from thread 0
```

EG	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_EGn
	<u>Burn:</u>	not burnable
ECAM go (engage)		

Full Description

The EG command engages an ECAM slave axis at a specified position of the master. If a value is specified outside of the master's range, the slave will engage immediately. Once a slave motor is engaged, its position is redefined to fit within the cycle.

Arguments

EG n,n,n,n,n,n,n,n or EGA=n where
n is the ECAM master position at which the ECAM slave axis must be engaged.
n = ? Returns 1 if specified axis is engaged and 0 if disengaged.

Operand Usage

_EGn contains ECAM status for specified axis. 0 = axis is not engaged, 1 = axis is engaged.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

"EA" - Choose ECAM master
"EB " - Enable ECAM
"EC " - Set ECAM table index
"EM " - Specify ECAM cycle
"EP" - Specify ECAM table intervals & starting point
"EQ " - Disengage ECAM
"ET " - ECAM table

Examples:

```
EG 700,1300    Engages the A and B axes at the master position 700 and 1300 respectively.
B = _EGB      Return the status of B axis, 1 if engaged
Note: This command is not a trippoint. This command will not hold the execution of the program
flow. If the execution needs to be held until master position is reached, use MF or MR command.
```

EI	Syntax:	Implicit Notation Only
	Operands:	EI
	Burn:	not burnable
Event Interrupts		

Full Description

EI enables interrupts for the predefined event conditions in the table below. When a condition (e.g. Axis A profiled motion complete) occurs after EI is armed, a particular status byte value (e.g. \$D0 or 208) is delivered to the host PC along with the interrupt.

Interrupts are issued as automatically dispatched UDP packets. GalilTools version 1.2.1.0 or newer required for software support.

The UDP packet can contain up to 16 individual status bytes and is framed as follows

Format	Header (Fixed Byte)	Status Byte (1-16 bytes)	Payload Byte Count (0x03 - 0x12) [Includes header and footer in count]
Example	0x01	0xD0F1DBE1	0x06
Example Decoded	Interrupt Packet Indicator	Axis A Profiled Motion Complete; User Interrupt 1; Application Program Stopped; Digital Input 1 is low	6 bytes in payload

Arguments

EI m,n,h

m is a 16-bit integer mask between 0 and 65535 and is used to select the interrupt condition(s) to be used. 0 (the default) means "don't interrupt" and clears the queue when issued. The * conditions must be re-enabled with EI after each occurrence.

Interrupt Bytes

bit	m=2 ^{bit} Hex (decimal)	Status Byte Hex (decimal)	Condition
0	\$0001 (1)	\$D0 (208)	Axis A profiled motion complete _BGA = 0
1	\$0002 (2)	\$D1 (209)	Axis B profiled motion complete _BGB = 0
2	\$0004 (4)	\$D2 (210)	Axis C profiled motion complete _BGC = 0
3	\$0008 (8)	\$D3 (211)	Axis D profiled motion complete _BGD = 0
4	\$0010 (16)	\$D4 (212)	Axis E profiled motion complete _BGE = 0
5	\$0020 (32)	\$D5 (213)	Axis F profiled motion complete _BGF = 0
6	\$0040 (64)	\$D6 (214)	Axis G profiled motion complete _BGG = 0
7	\$0080 (128)	\$D7 (215)	Axis H profiled motion complete _BGH = 0
8	\$0100 (256)	\$D8 (216)	All axes profiled motion complete _BGI = 0
9	\$0200 (512)	\$C8 (200)	Excess position error _TE _n >= _ER _n *
10	\$0400 (1024)	\$C0 (192)	Limit switch _LF _n = 0* Must be profiling motion in direction of activated limit switch for interrupt to occur.
11	\$0800 (2048)	\$D9 (217)	Watchdog timer (PCI only, no 40x0)
12	\$1000 (4096)		Reserved
13	\$2000 (8192)	\$DB (219)	Application program stopped _XQ _n = -1
14	\$4000 (16384)	\$DA (218)	PC command done, colon response sent (PCI only, no 40x0)
15	\$8000 (32768)	\$E1-\$E8 (225-232)	Digital input(s) 1-8 low (use n for mask)*
	UI, user interrupt command	\$F0-\$FF (240-255)	User Interrupt, See UI command

n is an 8-bit integer mask between 0 and 255 and is used to select the specific digital input(s) if bit 15 of m is set (indicating that digital inputs are to be used for interrupting). Bit 15 of m must be set for the n mask to be used.

Input Interrupts

bit	n=2^bit hex (decimal)	Status Byte hex (decimal)	Condition
0	\$01 (1)	\$E1 (225)	Digital input 1 is low @IN[1] = 0*
1	\$02 (2)	\$E2 (226)	Digital input 2 is low @IN[2] = 0*
2	\$04 (4)	\$E3 (227)	Digital input 3 is low @IN[3] = 0*
3	\$08 (8)	\$E4 (228)	Digital input 4 is low @IN[4] = 0*
4	\$10 (16)	\$E5 (229)	Digital input 5 is low @IN[5] = 0*
5	\$20 (32)	\$E6 (230)	Digital input 6 is low @IN[6] = 0*
6	\$40 (64)	\$E7 (231)	Digital input 7 is low @IN[7] = 0*
7	\$80 (128)	\$E8 (232)	Digital input 8 is low @IN[8] = 0*

h is 0-7 or -1 and indicates the preconfigured UDP handle where interrupts should be sent. 0-7 indicates handles A-H, respectively. If the handle specified by h is not UDP or not initialized, an error will occur (TC1). A -1 disables the interrupt dispatch. GalilTools software will auto configure h, allowing the user to ignore its use in most cases.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0,0 for PCI 0,0,-1 for Ethernet
Default Format	N/A

Operand Usage

_EI contains the interrupt mask m

Related Commands

UI - User interrupt

Examples:

- Interrupt when motion is complete on all axes OR if a limit switch is hit:
From the table, enable bits 8 and 10. $m = 256 + 1024 = 1280$
EI 1280
- Interrupt when digital input 3 is low. Enable bit 15 of m and bit 2 of n.
EI 32768,4

<h1>ELSE</h1>	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
Else function for use with IF conditional statement		

Full Description

The ELSE command is an optional part of an IF conditional statement. The ELSE command must occur after an IF command and it has no arguments. It allows for the execution of a command only when the argument of the IF command evaluates False. If the argument of the IF command evaluates false, the controller will skip commands until the ELSE command. If the argument for the IF command evaluates true, the controller will execute the commands between the IF and ELSE command.

Arguments

ELSE

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

ENDIF - End of IF conditional Statement

Examples:

```
#A
IF (@IN[1]=0) ;'IF conditional statement based on ;'input 1
IF (@IN[2]=0) ;'2nd IF conditional statement ;'executed if 1st IF conditional true
MG "INPUT 1 AND INPUT 2 ARE ACTIVE" ;'Message to be executed if 2nd IF ;'conditional is true
ELSE ;'ELSE command for 2nd IF conditional ;'statement
MG "ONLY INPUT 1 IS ACTIVE" ;'Message to be executed if 2nd IF ;'conditional is false
ENDIF ;'End of 2nd conditional statement
ELSE ;'ELSE command for 1st IF conditional ;'statement
MG "ONLY INPUT 2 IS ACTIVE" ;'Message to be executed if 1st IF ;'conditional statement is false
ENDIF ;'End of 1st conditional statement
EN
```

EM	Syntax:	Explicit & Implicit
	Operands:	_EMn
	Burn:	burnable with BN
Cam cycles (modulus)		

Full Description

The EM command is part of the ECAM mode. It is used to define the change in position over one complete cycle of the master. The field for the master axis is the cycle of the master position. For the slaves, the field defines the net change in one cycle. If a slave will return to its original position at the end of the cycle, the change is zero. If the change is negative, specify the absolute value.

Arguments

EM n,n,n,n,n,n,n,n or EMA=n where

n is a positive integer in the range between 1 and 8,388,607 for the master axis and between 1 and 2,147,483,647 for a slave axis.

Operand Usage

_EMn contains the cycle of the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

"EA" - Choose ECAM master

"EB " - Enable ECAM

"EC " - Set ECAM table index

"EG " - Engage ECAM

"EP" - Specify ECAM table intervals & starting point

"EQ " - Disengage ECAM

"ET " - ECAM table

Examples:

```
EAC      Select C axis as master for ECAM.
EM 0,3000,2000  Define the changes in A and B to be 0 and 3000 respectively.  Define master cycle
as 2000.
V = _EMA      Return cycle of A
```

<h1>EN</h1>	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
End		

Full Description

The EN command is used to designate the end of a program or subroutine. If a subroutine was called by the JS command, the EN command ends the subroutine and returns program flow to the point just after the JS command.

Note: Instead of EN, use the RE command to end the error subroutine and limit subroutine. Use the RI command to end the input interrupt subroutine

A return parameter can be specified to EN from a subroutine to return a value from the subroutine to the calling stack.

The EN command is used to end the automatic subroutines #MCTIME #COMINT and #CMDERR.

When the EN command is used to terminate the #COMINT communications interrupt subroutine, there are 2 arguments. The first determines whether trippoints will be restored upon completion of the subroutine, and the second determines whether the communication will be re-enabled.

Arguments

EN m, n, r where

m = 0: Return from subroutine without restoring trippoint

m = 1: Return from subroutine and restore trippoint

n = 0: Return from #COMINT without restoring CI interrupt trigger

n = 1: Return from #COMINT and restore CI interrupt trigger

r = anyvalue Return a value from a subroutine, accessible to the calling stack in _JS

Note 1: The default value for the argument is 0.

Note 2: The arguments will specify how the #COMINT routine handles trippoints. Trippoints cause a program to wait for a particular event. The AM command, for example, waits for motion on all axes to complete. If the #COMINT subroutine is executed due to a communication interrupt while the program is waiting for a trippoint, the #COMINT can end and by continue to wait for the trippoint, or clear the trippoint and continue executing the program at the command just after the trippoint.

Note 3: Use the RE command to return from the interrupt handling subroutines #LIMSWI and #POSERR. Use the RI command to return from the #ININT subroutine.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	m=0, n=0, r=0
Default Format	N/A

Operand Usage

N/A

Related Commands

RE - Return from error subroutine

RI - Return from interrupt subroutine

Examples:

```
#A;'      Program A
PR 500;'  Move A axis forward 500 counts
BGA;'     Begin motion
AMA;'     Pause the program until the A axis completes the motion
EN;'     End of Program
```


ENDIF	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
End of IF conditional statement		

Full Description

The ENDIF command is used to designate the end of an IF conditional statement. An IF conditional statement is formed by the combination of an IF and ENDIF command. An ENDIF command must always be executed for every IF command that has been executed. It is recommended that the user not include jump commands inside IF conditional statements since this causes re-direction of command execution. In this case, the command interpreter may not execute an ENDIF command.

Arguments

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Operand Usage

Related Commands

IF - Command to begin IF conditional statement

ELSE - Optional command to be used only after IF command

JP - Jump command

JS - Jump to subroutine command

Examples:

```
#A
IF (@IN[1]=0);'           IF conditional statement based on
'                          input 1
  IF (@IN[2]=0);'        2nd IF conditional statement
'                          executed if 1st IF conditional true
  MG "INPUT 1 AND INPUT 2 ARE ACTIVE";' Message to be executed if 2nd IF
'                          conditional is true
  ELSE;'                  ELSE command for 2nd IF conditional
'                          statement
  MG "ONLY INPUT 1 IS ACTIVE";' Message to be executed if 2nd IF
'                          conditional is false
  ENDIF;'                 End of 2nd conditional statement
ELSE;'                    ELSE command for 1st IF conditional
'                          statement
  MG "ONLY INPUT 2 IS ACTIVE";' Message to be executed if 1st IF
'                          conditional statement is false
ENDIF;'                  End of 1st conditional statement
EN
```

EO	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_EO
	<u>Burn:</u>	not burnable
Echo		

Full Description

The EO command turns the echo on or off. If the echo is off, characters input over the bus will not be echoed back.

Serial only, no Ethernet.

Arguments

EO n where

n = 0 0 turns echo off

n = 1 1 turns echo on.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value (PCI-based controllers)	0
Default Value (Stand Alone controllers)	1 (Galil software will set EO 0 upon connection)
Default Format	1.0

Operand Usage

_EO contains the state of the echo; 0 is off, 1 is on

Related Commands

Examples:

```
EO 0    Turns echo off
EO 1    Turns echo on
```

EP	Syntax:	Implicit Notation Only
	Operands:	_EP
	Burn:	burnable with BN
Cam table master interval and phase shift		

Full Description

The EP command defines the ECAM table intervals and offset. The offset is the master position of the first ECAM table entry. The interval is the difference of the master position between 2 consecutive table entries. This command effectively defines the size of the ECAM table. The parameter 'm' is the interval and 'n' is the starting point. Up to 257 points may be specified.

The offset parameter 'n' can also be used to instantaneously phase shift the graph of the slave position verses the master position. This can be used to make on-the-fly corrections to the slaves. See application note #2502 for more details.

<http://www.galilmc.com/support/application-notes.php>

Arguments

EP m,n where

m is the master interval and is a positive integer in the range between 1 and 32,767 master counts. m cannot be changed while ECAM is running.

m = ? Returns the value of the interval, m.

n is the phase shift and is an integer between -2,147,483,648 and 2,147,483,647 master counts. n can be changed while ECAM is running.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256,0
Default Format	N/A

Operand Usage

_EP contains the value of the interval m.

Related Commands

EA - Choose ECAM master

EB - Enable ECAM

EC - Set ECAM table index

EG - Engage ECAM

EM - Specify ECAM cycle

EQ - Disengage ECAM

ET - ECAM table

Examples:

```
EP 20           Sets the cam master points to 0,20,40 . . .
D = _EP        Set the variable D equal to the ECAM internal master interval
EP,100        Phase shift all slaves by 100 master counts
```

EQ	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	EQn
	<u>Burn:</u>	not burnable
ECAM quit (disengage)		

Full Description

The EQ command disengages an electronic cam slave axis at the specified master position. Separate points can be specified for each axis. If a value is specified outside of the master's range, the slave will disengage immediately.

Arguments

EQ n,n,n,n,n,n,n,n or EQA=n where

n is the master positions at which the axes are to be disengaged.

n = ? Returns 1 if engage command issued and axis is waiting to engage, 2 if disengage command issued and axis is waiting to disengage, and 0 if ECAM engaged or disengaged.

Operand Usage

_EQn contains 1 if engage command issued and axis is waiting to engage, 2 if disengage command issued and axis is waiting to disengage, and 0 if ECAM engaged or disengaged.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

EA - Choose ECAM master

EB - Enable ECAM

EC - Set ECAM table index

EG - Engage ECAM

EM - Specify ECAM cycle

EP - Specify ECAM table intervals & starting point

ET - ECAM table

Examples:

```
EQ 300,700 Disengages the A and B motors at master positions 300 and 700 respectively.
```

```
Note: This command is not a trippoint. This command will not hold the execution of the program flow. If the execution needs to be held until master position is reached, use MF or MR command.
```

ER	Syntax:	Explicit & Implicit
	Operands:	_ERn
	Burn:	burnable with BN
Error Limit		

Full Description

The ER command sets the magnitude of the position errors for each axis that will trigger an error condition. When the limit is exceeded, the Error output will go low (true) and the controller's red light will be turned on. If the Off On Error (OE1) command is active, the motors will be disabled. For debugging purposes, ER0 and ER-1 can be used to turn the red LED on and off.

Arguments

ER n,n,n,n,n,n,n,n or ERA=n where

n is an unsigned number in the range 1 to 2147483647 which represents the error limit in encoder counts. A value of -1 will disable the position error limit for the specified axis.

n = ? Returns the value of the Error limit for the specified axis.

Operand Usage

_ERn contains the value of the Error limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	16384
Default Format	Position Format

Related Commands

OE - Off-On Error

#POSERR - Automatic Error Subroutine

Examples:

```
ER 200,300,400,600    Set the A-axis error limit to 200, the B-axis error limit to 300, the C-
axis error limit to 400, and the D-axis error limit to 600.
ER ,1000             Sets the B-axis error limit to 1000, leave the A-axis error limit unchanged.
ER ?,?,?,?         Return A,B,C and D values
    200, 100, 400, 600
ER ?               Return A value
    200
V1=_ERA            Assigns V1 value of ERA
V1=               Returns V1
: 200
Hint: The error limit specified by ER should be high enough as not to be reached during normal
operation. Examples of exceeding the error limit would be a mechanical jam, or a fault in a system
component such as encoder or amplifier.
```

ES	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Ellipse Scale		

Full Description

The ES command divides the resolution of one of the axes in a vector mode (VM). This function allows for the generation of circular motion when encoder resolutions differ. It also allows for the generation of an ellipse instead of a circle.

The command has two parameters, m and n. The arguments, m and n apply to the axes designated by the command VM. When $m > n$, the resolution of the first axis, x, will be multiplied by the ratio m/n . When $m < n$, the resolution of the second axis, y, will be multiplied by n/m . The resolution change applies for the purpose of generating the VP and CR commands, effectively changing the axis with the lower resolution to match the higher resolution. The ES command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

ES m,n where

m and n are positive integers in the range between 1 and 65,535.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	1.1
Default Format	N/A

Related Commands

VM - Vector Mode

CR - Circle move

VP - Vector position

Examples:

```
VMAB;ES3,4      Scale B resolution by 4/3
VMCA;ES2,3      Scale A resolution by 3/2
VMAC; ES3,2     Scale A Resolution by 3/2
Note: ES must be issued after VM.
```

ET	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Electronic cam table		

Full Description

The ET command sets the ECAM table entries for the slave axes. The values of the master axes are not required. The slave entry (n) is the position of the slave axes when the master is at the point (m i) + o, where i is the interval and o is the offset as determined by the EP command.

Arguments

ET[m] = n,n,n,n,n,n,n,n where

m is an integer between 0 and 256

n is an integer in the range between -2,147,438,648, and 2,147,438,647.

n=? Returns the slave position for the specified point.

The value m can be left out of the command if the index count has been set using the command, EC. In this mode, each ET command will automatically increment the index count by 1.

Operand Usage

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

EA - Choose ECAM master

EB - Enable ECAM

EC - Set ECAM table index

EG - Engage ECAM

EM - Specify ECAM cycle

EP - Specify ECAM table intervals & starting point

EQ - Disengage ECAM

Examples:

```
ET[0]=0,,0            Specifies the position of the slave axes A and C to be synchronized with the
starting point of the master.
ET[1]=1200,,400 Specifies the position of the slave axes A and C to be synchronized with the second
point of the master
EC0            Set the table index value to 0, the first element in the table
ET 0,,0 Specifies the position of the slave axes A and C to be synchronized with the starting point
of the master.
ET 1200,,400        Specifies the position of the slave axes A and C to be synchronized with the second
point of the master
```

EW	Syntax:	Other
	Operands:	_EW0,_EW1,_EW2,_EW3,
	Burn:	not burnable
ECAM Widen Segment		

Full Description

The EW command allows widening the length of one or two ECAM segments beyond the width specified by EP. For ECAM tables with one or two long linear sections, this allows placing more points in the curved sections of the table.

There are only two widened segments, and if used they are common for all ECAM axes. Remember that the widened segment lengths must be taken into account when determining the modulus (EM) for the master. The segments chosen should not be the first or last segments, or consecutive segments.

Arguments

EW m1=n1,m2=n2 where

m1 is the index of the first widened segment. m1 is a positive integer between 1 and 255.

n1 is the length of the first widened segment in master counts. n1 is an integer between 1 and 2,147,483,647.

m2 is the index of the second widened segment. m2 is a positive integer between 3 and 255.

n2 is the length of the second widened segment in master counts. n2 is an integer between 1 and 2,147,483,647.

If m1 or m2 is set to -1, there is no widened segment. The segment number m2 must be greater than m1, and m2 may not be used unless m1 is used.

Operand Usage

_EW0 contains m1, the index of the first widened segment.

_EW1 contains n1, the length of the first widened segment.

_EW2 contains m2, the index of the second widened segment

_EW3 contains n2, the length of the second widened segment.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	-1, 0, -1, 0
Default Format	N/A

Related Commands

EP - ECAM master positions

EA - Choose ECAM master

EB - Enable ECAM

EC - Set ECAM table index

EG - Engage ECAM Slave

EM - Specify ECAM cycle

EQ - Disengage ECAM Slave

ET - ECAM table

Examples:

```
EW 41=688           :Widen segment 41 to 688 master counts
EW 41=688, 124=688 :Widen segments 41 and 124 to 688 master counts
```


EY	Syntax:	Implicit Notation Only
	Operands:	_EY
	Burn:	not burnable
ECAM Cycle Count		

Full Description

Sets or gets the ECAM cycle count. This is the number of times that the ECAM axes have exceeded their modulus as defined by the EM command. EY will increment by one each time the master exceeds its modulus in the positive direction, and EY will decrement by one each time the master exceeds its modulus in the negative direction. EY can be used to calculate the absolute position of an axis with the following equation:

$$\text{Absolute position} = \text{EY} * \text{EM} + \text{TP}$$

Arguments

EY n where

n is a signed integer in the range -2147483648 to 2147483647 decimal.

n = ? returns the current cycle count.

Operand Usage

_EY returns the current cycle count

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

EM - ECAM modulus

Examples:

```
| MG _EY * _EM + _TPY; '          print absolute position of master (Y)
```

FA	Syntax:	Explicit & Implicit
	Operands:	_FAn
	Burn:	burnable with BN
Acceleration Feedforward		

Full Description

The FA command sets the acceleration feedforward coefficient. This coefficient, when scaled by the acceleration, adds a torque bias voltage during the acceleration phase and subtracts the bias during the deceleration phase of a motion.

The Feedforward Bias product is limited to 10 Volts. FA operates when commanding motion with PA, PR and JG.

Note: If the feedforward coefficient is changed during a move, then the change will not take effect until the next move.

Acceleration Feedforward Bias = FA * AC * (1.5 10⁻⁷) * ((TM/1000)²)

Deceleration Feedforward Bias = FA * DC * (1.5 10⁻⁷) * ((TM/1000)²)

Arguments

FA n,n,n,n,n,n,n,n or FAS=n where

n is an unsigned number in the range 0 to 8191 decimal with a resolution of 0.25.

n = ? Returns the value of the feedforward acceleration coefficient for the specified axis.

Operand Usage

_FAn contains the value of the feedforward acceleration coefficient for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	4.2

Related Commands

FV - Velocity feedforward

Examples:

```
Set feedforward coefficient to 10 for the A-axis
and 15 for the B-axis. The effective bias will
be 0.75V for A and 2.25V for B.
```

```
:AC 500000,1000000
:FA 10,15
:FA ?,?           Return A and B values
10, 15
```

FE	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	not burnable
Find Edge		

Full Description

The FE command moves a motor until a transition is seen on the homing input for that axis. The direction of motion depends on the initial state of the homing input (use the CN command to configure the polarity of the home input). Once the transition is detected, the motor decelerates to a stop. This command is useful for creating your own homing sequences.

Hint: Find Edge only searches for a change in state on the Home Input. Use FI (Find Index) to search for the encoder index. Use HM (Home) to search for both the Home input and the Index. Remember to specify BG after each of these commands.

Arguments

FE nnnnnnnn where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument specifies all axes.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

FI - Find Index

HM - Home

BG - Begin

AC - Acceleration Rate

DC - Deceleration Rate

SP - Speed for search

Examples:

```
:FE      Set find edge mode
:BG      Begin all axes
:FEA     Only find edge on A
:BG      Begin all axes
:FE      Only find edge on B
:BG      Begin all axes
:FECD    Find edge on C and D
:BG      Begin all axes
```

FI	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	not burnable
Find Index		

Full Description

The FI and BG commands move the motor until an encoder index pulse is detected. The controller looks for a transition from low to high. There are 2 stages to the FI command. The first stage jogs the motor at the speed and direction of the JG command until a transition is detected on the index line. When the transition is detected, the position is latched and the motor will decelerate to a stop. In the second stage, the motor will reverse direction and move to the latched position of the index pulse at the speed set by the HV command. At the conclusion of FI, the position is defined as zero.

Arguments

FI nnnnnnnn where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or sequence

No argument specifies all axes.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

FE - Find Edge

HM - Home

BG - Begin

AC - Acceleration

DC - Deceleration

JG - Jog

HV - Homing Velocity

Examples:

```
#HOME; '           Home Routine
JG 500;'           Set speed and forward direction
FIA;'             Find index
BGA;'            Begin motion
AMA;'            After motion
MG "FOUND INDEX";' Print message
EN
```

Hint: Find Index only searches for a change in state on the Index. Use FE to search for the Home. Use HM (Home) to search for both the Home input and the Index. Remember to specify BG after each of these commands.

FL	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_FLn
	<u>Burn:</u>	burnable with BN
Forward Software Limit		

Full Description

The FL command sets the forward software position limit. If this limit is exceeded during motion, motion on that axis will decelerate to a stop. Forward motion beyond this limit is not permitted. The forward limit is activated at one count past the set value. The forward limit is disabled at 2147483647. The units are in quadrature counts.

When the forward software limit is activated, the automatic subroutine #LIMSWI will be executed if it is included in the program.

Arguments

FL n,n,n,n,n,n,n,n or FLA=n

where

n is a signed integers in the range -2147483648 to 2147483647, n represents the absolute position of axis.

n = 2147483647 turns off the forward limit

n = ? Returns the value of the forward limit switch for the specified axis.

Operand Usage

_FLn contains the value of the forward software limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	2147483647
Default Format	Position Format

Related Commands

BL - Reverse Limit

PF - Position Formatting

Examples:

```
:FL 150000      Set forward limit to 150000 counts on the A-axis
:
```

```
#TEST; '        Test Program
AC 1000000;'    Acceleration Rate
DC 1000000;'    Deceleration Rate
FL 15000;'      Forward Limit
JG 5000;'       Jog Forward
BGA;'          Begin
AMA;'          After Limit
TPA;'          Tell Position
EN;'           End
```

| 'Hint: Galil controllers also provide hardware limits.

FV	Syntax:	Explicit & Implicit
	Operands:	_FVn
	Burn:	burnable with BN
Velocity Feedforward		

Full Description

The FV command sets the velocity feedforward coefficient, or returns the previously set value. This coefficient generates an output bias signal in proportions to the commanded velocity.

$$\text{Velocity feedforward bias} = \text{FV} * (\text{Velocity [cts/s]}) * (1.22 \cdot 10^{-6}) * (\text{TM}/1000)$$

FV operates when commanding motion with PA, PR, JG, VM, LM, PVT Mode and CM.

For example, if FV=10 and the velocity is 200,000 count/s, the velocity feedforward bias equals 2.44 volts.

Arguments

FV n,n,n,n,n,n,n,n or FVA=n where

n is an unsigned numbers in the range 0 to 8191 decimal

n = ? Returns the feedforward velocity for the specified axis.

Operand Usage

_FVn contains the feedforward velocity for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	4.0

Related Commands

FA - Acceleration Feedforward

Examples:

```

:FV 10,20      Set feedforward coefficients to 10 and 20 for A and B respectively
:JG 30000,80000 This produces 0.366 volts for A and 1.95 volts for B.
:FV ?,?       Return the A and B values.
 10,20

```

GA	Syntax:	Explicit & Implicit
	Operands:	none
	Burn:	burnable with BN
Master Axis for Gearing		

Full Description

The GA command specifies the master axes for electronic gearing. Multiple masters for gearing may be specified. The masters may be the main encoder input, auxiliary encoder input, or the commanded position of any axis. The master may also be the commanded vector move in a coordinated motion of LM or VM type. When the master is a simple axis, it may move in any direction and the slave follows. When the master is a commanded vector move, the vector move is considered positive and the slave will move forward if the gear ratio is positive, and backward if the gear ratio is negative. The slave axes and ratios are specified with the GR command and gearing is turned off by the command GR0.

When the geared motors must be coupled "strongly" to the master, use the gantry mode GM.

When gearing is used in a gantry application, gearing off of the commanded position is recommended.

Arguments

GA n,n,n,n,n,n,n,n or GAA=n where

n can be A,B,C,D,E,F,G, H, M or N. The value of n is used to set the specified main encoder axis as the gearing master and M and N represents the virtual axes. The slave axis is specified by the position of the argument. The first position of the argument corresponds to the 'A' axis, the second position corresponds to the 'B' axis, etc. A comma must be used in place of an argument if the corresponding axes will not be a slave.

n can be CA,CB,CC,CD,CE,CF,CG or CH. The value of x is used to set the commanded position of the specified axis as the gearing master.

n can be S or T. S and T are used to specify the vector motion of the coordinated system, S or T, as the gearing master.

n can be DA,DB,DC,DD,DE,DF,DG or DH. The value of n is used to set the specified auxiliary encoder axis as the gearing master.

n=? returns the GA setting

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

GR - Gear Ratio

GM - Gantry Mode

Examples:

```
REM setup gearing where B axis is master for A and C axes.
#GEAR
MOB;'          Turn off servo to B motor
GAB,,B;'      Specify master axis as B
GR .25,,-5;'  Specify A and C gear ratios
SHB;'         Enable B axis
PRB=1000;BGB;' Move B axis 1000 counts
'             A axis will be commanded to move 250 counts positive
```



```
'          C axis will be commanded to move 5000 counts negative (-5000)
EN;'      End program

REM imaginary axis example
#imag
GAC=N;'   set the imaginary N axis as the master of the C axis
GRC=2.5;' set the gear ratio for the C axis as 1
PRN=1000;BGN;' Move N axis 1000 counts
'          C axis will be commanded to move 2500 counts positive
EN;'      End Program
```

<h1>GD</h1>	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_GDn
	<u>Burn:</u>	burnable with BN
Gear Distance		

Full Description

The GD command sets the distance of the master axis over which the specified slave will be engaged, disengaged or changed to a new gear setting. The distance is entered as an absolute value, the motion of the master may be in either direction. If the distance is set to 0, then the gearing will engage instantly.

Arguments

GD n,n,n,n,n,n,n,n where

N is an integer in the range 0 to 32767, the units are in encoder counts

n = 0 will result in the conventional method of instant gear change

n = ? will return the value that is set for the appropriate axis

Operand Usage

_GDn contains the distance the master axis will travel for the specified slave axis to fully engage, disengage, or change ratios.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	
Default Value	0
Default Format	(1.0 for 18x2 & 21x3) (5.0 for 18x6 & 4xxx)

Related Commands

_GP - Gearing Phase Differential

GR - Gear Ratio

GA - Gear Axis

Examples:

```
#A
GA,X      ;'Sets the X axis as the gearing master for the Y axis
GD,5000  ;'Set distance over which gearing is engaged to 5000 counts of the master axis.
JG5000   ;'Set the X axis jog speed to 5000 cts/sec
BGX      ;'Begin motion on the X axis
ASX      ;'Wait until X axis reaches the set speed of 5000 counts/sec
GR,1     ;'Engage gearing on the Y axis with a ratio of 1:1, the
'distance to fully engage gearing will be 5000 counts of the master axis
WT1000   ;'Wait 1 second
GR,3     ;'Set the gear ratio to three. The ratio will be changed
'over the distance set by the GD command
WT1000   ;'Wait 1 second
GR,0     ;'Disengage the gearing between the Y axis slave and the
'master. The gearing will be disengaged over the number of
'counts of the master specified with the GD command above
EN       ;'End program
```


GM	Syntax:	Explicit & Implicit
	Operands:	_GMn
	Burn:	not burnable
Gantry mode		

Full Description

The GM command specifies the axes in which the gearing function is performed in the Gantry mode. In this mode, the gearing will not be stopped by the ST command or by limit switches. Only GR0 will stop the gearing in this mode.

Arguments

GM n,n,n,n,n,n,n,n or GMA=n where

n = 0 Disables gantry mode function

n = 1 Enables the gantry mode

n = ? Returns the state of gantry mode for the specified axis: 0 gantry mode disabled, 1 gantry mode enabled

Operand Usage

_GMn contains the state of gantry mode for the specified axis: 0 gantry mode disabled, 1 gantry mode enabled

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

GR - Gear Ratio

GA - Gear Axes

Examples:

```
GM 1,1,1,1      Enable GM on all axes
GM 0           Disable GM on A-axis, other axes remain unchanged
GM ,,1,1       Enable GM on C-axis and D-axis, other axes remain unchanged
GM 1,0,1,0     Enable GM on A and C-axis, disable GM on B and D axis
Hint: The GM command is useful for driving heavy load on both sides (Gantry Style).
```

GR	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_GRn
	<u>Burn:</u>	burnable with BN
Gear Ratio		

Full Description

GR specifies the Gear Ratios for the geared axes in the electronic gearing mode. The master axis is defined by the GA command. The gear ratio may be different for each geared axis. The master can go in both directions. A gear ratio of 0 disables gearing for each axis. A limit switch also disables the gearing unless gantry mode has been enabled (see GM command).

When the geared motors must be coupled "strongly" to the master, use the gantry mode GM.

Arguments

GR n,n,n,n,n,n,n,n or GRA=n where
 n is a signed numbers in the range +/-127, with a fractional resolution of 1/65536.
 n = 0 Disables gearing
 n = ? Returns the value of the gear ratio for the specified axis.

Operand Usage

_GRn contains the value of the gear ratio for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	3.4

Related Commands

GA - Master Axis for Gearing

GM - Gantry Mode

Examples:

```
REM setup gearing where B axis is master for A and C axes.
#GEAR
MOB;'          Turn off servo to B motor
GAB,,B;'      Specify master axis as B
GR .25,,-5;'  Specify A and C gear ratios
SHB;'         Enable B axis
PRB=1000;BGB;' Move B axis 1000 counts
'             A axis will be commanded to move 250 counts positive
'             C axis will be commanded to move 5000 counts negative (-5000)
EN;'         End program
```

HM	Syntax:	Accepts Axis Mask
	Operands:	_HMn
	Burn:	not burnable
Home		

Full Description

The HM command performs a three-stage homing sequence for servo systems and two stage sequence for stepper motor operation.

For servo motor operation: During first stage of the homing sequence, the motor moves at the user programmed speed until detecting a transition on the homing input for that axis. The direction for this first stage is determined by the initial state of the homing input. Once the homing input changes state, the motor decelerates to a stop. The state of the homing input can be configured using the CN command.

At the second stage, the motor change directions and slowly approach the transition again at the speed set with the HV command. When the transition is detected, the motor is stopped instantaneously.

At the third stage, the motor moves forward at the speed set with the HV command until it detects an index pulse from the encoder. It latches to this point and defines it as position 0.

For stepper mode operation, the sequence consists of the first two stages. The frequency of the motion in stage 2 is set with the HV command.

Arguments

HM nnnnnnnnnn where

n is A,B,C,D,E,F,G, or H, or any combination to specify the axis. No argument homes all axes.

Operand Usage

_HMn contains the state of the home switch for the specified axis

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

CN - Configure Home

FI - Find Index Only

FE - Find Home Only

HV - Homing velocity

Examples:

```
HM      Set Homing Mode for all axes
```

```
BG      Home all axes
```

```
BGA     Home only the A-axis
```

```
BGB     Home only the B-axis
```

```
BGC     Home only the C-axis
```

```
BGD     Home only the D-axis
```

```
Hint: You can create your own custom homing sequence by using the FE (Find Home Sensor only) and FI (Find Index only) commands.
```

HS	<u>Syntax:</u>	Explicit Notation Only
	Operands:	none
	Burn:	not burnable
Handle Assignment Switch		

Full Description

The HS command is used to switch the handle assignments between two handles. Handles are opened when a connection is established by an external client (TCP or UDP), or when a handle is assigned explicitly with the IH command. Should those assignments need modifications, the HS command allows the handles to be reassigned.

A handle encapsulates the following 4 pieces of information:

1. Local IP address (same for all handles)
2. Remote IP address
3. Local Port
4. Remote Port

Handles are used as a pointer to the network socket in commands such as SAh, MBh, {Eh}, and IHh where h is the handle letter

Arguments

HSh=i where

h is the first handle of the switch (A through H, S).

i is the second handle of the switch (A through H, S)

S is used to represent the current handle executing the command.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	N/A

Operand Usage

N/A

Related Commands

IH- IP Handle

Examples:

```
HSC=D   Connection for handle C is assigned to handle D.  Connection for handle D is assigned to
handle C.
HSS=E   Executing handle connection is assigned to handle E.  Connection for handle E is assigned
to executing handle.
```

HV	Syntax:	Explicit & Implicit
	Operands:	_HVn
	Burn:	burnable with BN
Homing Velocity		

Full Description

Sets the slew speed for the FI final move to the index and all but the first stage of HM.

Arguments

HV n,n,n,n,n,n,n,n or HVA=n where

n is an unsigned even number in the range 0 to 22,000,000 for servo motors. The units are encoder counts per second.

OR

n is an unsigned number in the range 0 to 6,000,000 for stepper motors

n = ? Returns the speed for the specified axis.

Operand Usage

_HVn contains the homing speed for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256
Default Format	Position Format

Related Commands

HM - Home

FI - Find index

Examples:

```
HVX=1000 ;'set homing speed
HMX      ;'home to home switch then index
BGX      ;'begin motion
AMX      ;'wait for motion complete
EN       ;'end program
```


HX	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_HXn
	<u>Burn:</u>	not burnable
Halt Execution		

Full Description

The HX command halts the execution of any program that is running.

Arguments

HXn where

n is an integer in the range of 0 to 7 and indicates the thread number.

Operand Usage

When used as an operand, _HXn contains the running status of thread n with:

- 0 Thread not running
- 1 Thread is running
- 2 Thread has stopped at trippoint

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	n=0
Default Format	N/A

Related Commands

XQ - Execute program

HX - Stop all threads of motion

Examples:

```
XQ #A    Execute program #A, thread zero
XQ #B,3  Execute program #B, thread three
HX0     Halt thread zero
HX3     Halt thread three
```

IA	Syntax:	Implicit Notation Only
	Operands:	_IA0, _IA1, _IA2, _IA3, _IA4, _IA5
	Burn:	burnable with BN
IP Address		

Full Description

The IA command assigns the controller's IP address.*

The IA command may also be used to specify the TCP time out.

Setting the IP address over Ethernet to a new value will cause an immediate disconnect. Reconnect to the controller on the new IP address and issue a BN to save the new value to flash.

Since it assigns an IP address to the controller, communication with the controller via Ethernet cannot be accomplished until after the address has been assigned. *

* The controller defaults to DHCP and will receive an IP address from a DHCP server if present. To manually set an IP address over the serial connection, send DH0 to disable DHCP prior to setting the new IP address with IA.

Arguments

IA ip0,ip1,ip2, ip3 or IA n or IA<t

where

ip0, ip1, ip2, ip3 are 1 byte numbers separated by commas and represent the individual fields of the IP address.

n is the IP address for the controller which is specified as an integer representing the signed 32 bit number (two's complement).

<t specifies the time in update samples between TCP retries. $1 <= t <= 2,147,483,647$ up to 5 retries occur. (TCP/IP connection only)

>u specifies the multicast IP address where u is an integer between 0 and 63. (UDP/IP connection only)

IA? will return the IP address of the controller

Operand Usage

_IA0 contains the IP address representing a 32 bit signed number (Two's complement)

_IA1 contains the value for t (retry time)

_IA2 contains the number of available handles

_IA3 contains the number of the handle using this operand where the number is 0 to 7. 0 represents handle A, 1 handle B, etc.

_IA4 contains the number of the handle that lost communication last, contains A-1 on reset to indicate no handles lost

_IA5 returns autonegotiation Ethernet speed. Returns 10 for 10-Base T and returns 100 for 100-Base T, it will return -1 if there is no physical link

The IP address can be derived using _IA0:

```
a=@INT[ (_IA0&($FF000000))/ $1000000]&$FF
```

```
b=@INT[ (_IA0&($00FF0000))/ $10000]
```

```
c=@INT[ (_IA0&($0000FF00))/ $100]
```

```
d=@INT[ (_IA0&($000000FF))]
```

```
IP address = a.b.c.d
```

Usage

Usage and Default Details

Usage	Value
While Moving (no RIO)	No
In a Program	Yes
Command Line	Yes

Controller Usage	Ethernet Controllers
Default Value	n=0, t=250
Default Format	-

Related Commands

IH - Internet Handle

DH - DHCP Server Enable

Examples:

:IA 151,12,53,89	Assigns the controller with the address 151.12.53.89
:IA 2534159705	Assigns the controller with the address 151.12.53.89
:IA < 500	Sets the timeout value to 500msec
:	

<h1>ID</h1>	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Identify		

Full Description

DMC-40x0

The ID command is used to query the controller for the accessories that are attached. It will respond with the type of communications board followed by the amplifier for axes 1-4 and then axes 5-8 if any are attached. The following are example responses to the ID command and a description of each line.

Example ID

This ID response is applicable to the following part number:

DMC-4060(-16bit)-C012-I000-I100-D4040-D3020

```
:ID
DMC400016 bit adc option rev 0
Connector J3= Communications Board CMB-41012 3.3 volt i/o rev 0
Connector J1=
Connector J2= 42100 Sine rev 1
Connector P1= Stepper Amplifier Board AMP-44040 rev 0
Connector P2= Servo Amplifier Board AMP-43020 500 watt rev 1
:
```

Example ID

This ID response is applicable to the following part number:

DMC-4020-C012-I000(SSI)

```
:ID
DMC4000 rev 0
Connector J3= Communications Board CMB-41012 3.3 volt i/o rev 0
Connector J1= 42000 SSI rev 0
```

Description of response

DMC4000[bits] rev 0

where

[bits] - '16 bit adc option' if -16bit option ordered

No string returned here indicates standard 12 bit analog input

Connector J3= Communications Board CMB-41012 [IO type] rev 0

where

[IO type] - '3.3 volt i/o' for standard 3.3V extended IO

'5 volt i/o' for -5V option ordered

Connector J1/J2= [icm type] [encoder] rev 0

where

J1 = A-D axes

J2 = E-H axes. No string is output for J2 on a 1-4 axis controller

[icm type] - specifies the ICM model number used.

'42000' is the -I000 option

'42100' is the -I100 option

'42200' is the -I200 option

[encoder] - specifies the encoder option available on this ICM

'Sine' indicates sin/cos encoder support

'SSI' indicates SSI encoder support

'Biss option' indicates BiSS encoder support

An empty string after the = sign indicates that it is a standard ICM with no additional encoder option.

Connector P1/P2= [drive type] Amplifier Board [model] rev 0
where

P1 = A-D axes

P2 = E-H axes. No string is shown for P2 on a 1-4 axis controller

[drive type] - specifies the drive available on this set of 4 axes

'Servo' indicates standard servo drives

'Stepper' indicates stepper drive

'Sine' indicates sinusoidally commutated servo drives

[model] - specifies the ordered drive option for that set of 4 axes

'AMP-43040 500 watt' for -D3040 option

'AMP-43020 500 watt' for -D3020 option

'AMP-43140 1 A' for -D3140 option

'AMP-44040' for -D4040 option

'AMP-44140' for -D4140 option

'AMP-43540' for sine drive option

If no string is displayed, then that indicates that no drive is present for that set of 4 axes

Note that the rev number at the end of each line of the ID command indicates the hardware revision of that board.
Newer board revisions will have a higher revision value.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

```
:ID
Connector J3= Communications Board CMB-41012 3.3 volt i/o
Connector P1= Stepper Amplifier Board AMP-44040
Connector P2= Stepper Amplifier Board AMP-44040
```

IF	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
IF conditional statement		

Full Description

The IF command is used in conjunction with an ENDIF command to form an IF conditional statement. The arguments consist of one or more conditional statements and each condition must be enclosed with parenthesis (). If the conditional statement(s) evaluates true, the command interpreter will continue executing commands which follow the IF command. If the conditional statement evaluates false, the controller will ignore commands until the associated ENDIF command OR an ELSE command occurs in the program.

Each condition must be placed in parenthesis for proper evaluation by the controller.

Example:

```
IF((var0=1)&(var1=2));' valid IF statement
  MG "GOOD"
ENDIF

IF var0=1&var1=2;'      invalid IF statement
  MG "BAD"
ENDIF

IF (var0=1&var1=2);'    invalid IF statement
  MG "BAD"
ENDIF
```

Arguments

IF (condition) where

Conditions are tested with the following logical operators:

- < less than or equal to
- > greater than
- = equal to
- <= less than or equal to
- >= greater than or equal to
- <> not equal

Note 1: Bit wise operators | and & can be used to evaluate multiple conditions.

Note 2: A true condition = 1 and an false condition = 0.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Operand Usage

Related Commands

ELSE - Optional command to be used only after IF command

ENDIF - End of IF conditional Statement

JS - Jump to subroutine

JP - Jump to label

Examples:

```
#A
IF (_TEA<1000);' IF conditional statement based on a motor position
MG "Motor is within 1000 counts of zero";' Message to be executed for true
ENDIF;' End of IF conditional statement
EN;' End Program
```

```
#input
IF (@IN[1]=0);' IF conditional statement based on input 1
MG "Input 1 is Low";' Message to be executed if "IF" statement is true
ENDIF;' End of IF conditional statement
EN
```

```
#var
v1=@AN[1]*5;' some calculation for variable v1
IF((v1>25)&(@IN[4]=1));' Conditions based on V1 variable and input 4 status
MG "Conditions met";' Message to be executed if "IF" statement is true
ENDIF;' End of IF statement
EN
```

```
REM The conditions of an if statement can be simplified with the fact that
REM a true condition = 1 and a false condition = 0.
```

```
#true
v1=1
IF v1
MG "True v1=",v1
ENDIF
#false
v1=0
IF v1
'if statement evaluates false
ELSE
MG "False v1=",0
ENDIF
EN
```

<h1>IH</h1>	Syntax:	Explicit Notation Only
	Operands:	_IHn0, _IHn1, _IHn2, _IH3, _IH4
	Burn:	not burnable
Open IP Handle		

Full Description

The IH command is used when the controller is operated as a master (also known as a client). This command opens a handle and connects to a slave (server).

To open a handle, the user must specify:

1. The IP address of the slave
2. The type of session: TCP/IP or UDP/IP
3. The port number of the slave. This number is not necessary if the slave device does not require a specific port value. If not specified, the board will specify the port value as 1000.

Each controller (DMC) may have 8 handles open at any given time. The handles are denoted with A,B,C,D,E,F,G, or H.

Arguments

IHh= ip0,ip1,ip2,ip3 <p >q

IHh=n <p >q

IHh= >r

where

h is the handle

ip0,ip1,ip2,ip3 are integers between 0 and 255 and represent the individual fields of the IP address. These values must be separated by commas.

n is a signed integer between - 2147483648 and 2147483647. This value is the 32 bit IP address and can be used instead of specifying the 4 address fields.

<p specifies the port number of the slave where p is an integer between 0 and 65535. This value is not required for opening a handle.

>q specifies the connection type where q is 0 for no connection, 1 for UDP and 2 for TCP

IHS => r closes the handle that sent the command; where r = -1 for UDP/IP, or r = -2 for TCP/IP, or -3 for either

IHT => r closes all handles except for the one sending the command; where r = -1 UDP, or r = -2 TCP, or -3 for either

>r specifies that the connection be terminated and the handle be freed, where r is -1 for UDP, -2 for TCP/IP, or -3 for TCP/IP Reset

IHh=? returns the IP address as 4 1-byte numbers

Operand Usage

_IHh0 contains the IP address as a 32 bit number

_IHh1 contains the slave port number

_IHh2 contains a 0 if the handle is free

contains a 1 if it is for a UDP slave

contains a 2 if it is for a TCP slave

contains a -1 if it is for a UDP master

contains a -2 if it is for a TCP master

contains a -5 while attempting to establish a UDP handle

contains a -6 while attempting to establish a TCP/IP handle

_IHh3 contains a 0 if the ARP was successful

contains a 1 if it has failed or is still in progress

_IHh4 contains a 1 if the master controller is waiting for acknowledgment from the slave after issuing a command.

contains a 2 if the master controller received a colon from the slave after issuing a command.

contains a 3 if the master controller received a question mark from the slave after issuing a command.

contains a 4 if the master controller timed-out while waiting for a response from the slave after issuing a command.

Usage

Usage and Default Details

Usage	Value
-------	-------

While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0,0,0,0
Default Format	N/A

Related Commands

IA Internet Address

Examples:

```
IHA=251,29,51,1;'      Open handle A at IP address 251.29.51.1, TCP is used as default
IHA= -2095238399;'    Open handle A at IP address 251.29.51.1
'Note:  When the IH command is given, the controller initializes an ARP on the slave device before
'opening a handle.  This operation can cause a small time delay before the controller responds.
```

II	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Input Interrupt		

Full Description

The II command enables the input interrupt function for the specified inputs. By default, input interrupts are configured for activation with a logic "0" but can be configured for activation with a logic "1" signal.

If any of the specified inputs are activated during program execution, the program will jump to the subroutine with label #ININT. Any trippoints set by the program will be cleared but can be re-enabled by the proper termination of the interrupt subroutine using RI. The RI command is used to return from the #ININT routine.

Arguments

II m,n,o,p

where

m is an integer between 0 and 8 decimal. 0 disables interrupt. The value of m specifies the lowest input to be used for the input interrupt. When the 2nd argument, n, is omitted, only the input specified by m will be enabled.

n is an integer between 2 and 8. This argument is optional and is used with m to specify a range of values for input interrupts. For example, II 2,4 specifies interrupts occurring for Input 2, Input 3 and Input 4.

o is an integer between 1 and 255. Using this argument is an alternative to specifying an input range with m,n. If m and n are specified, o will be ignored. The argument o is an integer value and represents a binary number. For example, if o = 15, the binary equivalent is 00001111 where the bottom 4 bits are 1 (bit 0 through bit 3) and the top 4 bits are 0 (bit 4 through bit 7). Each bit represents an interrupt to be enabled - bit0 for interrupt 1, bit 1 for interrupt 2, etc. If o=15, the inputs 1,2,3 and 4 would be enabled.

p is an integer between 1 and 255. The argument p is used to specify inputs that will be activated with a logic "1". This argument is an integer value and represents a binary number. This binary number is used to logically "AND" with the inputs which have been specified by the parameters m and n or the parameter o. For example, if m=1 and n=4, the inputs 1,2,3 and 4 have been activated. If the value for p is 2 (the binary equivalent of 2 is 00000010), input 2 will be activated by a logic '1' and inputs 1,3, and 4 will be activated with a logic "0".

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

#ININT- Interrupt Subroutine

AI - Trippoint for input

RI - Return from Interrupt

Examples:

```
#A; '          Program A
II 1; '       Specify interrupt on input 1
JG 5000;BGA; ' Specify jog and begin motion on A axis
```

#LOOP;JP #LOOP;'	Loop to keep thread zero active, only necessary on Ecnono (21x3/18x2)
EN;'	End Program
#ININT;'	Interrupt subroutine
STA;MG "INTERRUPT";AMA;'	Stop A, print message, wait for motion to complete
AI1;'	Check for interrupt clear
BGA;'	Begin motion
RI0;'	Return to main program, don't re-enable trippoints

IK	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	burnable with BN
Block Ethernet ports		

Full Description

A Galil Ethernet controller simultaneously operates as a server (listening for Ethernet connections from a client) and a client (able to create connections to a server). The IK command blocks clients from connecting to the controller on incoming ports lower than 1000 except for ports 0, 23, 68, and 502.

Arguments

IKn where

n = 0 allows controller to receive Ethernet packets on any port

n = 1 blocks controller from receiving Ethernet packets on all ports lower than 1000 except those mentioned in the Full Description above.

n = ? queries controller for value of IK

Operand Usage

_IK can not be used as an operand.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	Ethernet Only
Default Value	0 (DMC21x3/2)
Default Value	1 (DMC4xxx/RIO)
Default Format	N/A

Related Commands

TH- Tell Handles

IH - Open new Ethernet handle

Examples

```
:IK1    Blocks undesirable port communication
:IK0    Allows all Ethernet ports to be used
:
```

IL	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_ILn
	<u>Burn:</u>	burnable with BN
Integrator Limit		

Full Description

The IL command limits the effect of the integrator function in the filter to a certain voltage. For example, IL 2 limits the output of the integrator of the A-axis to the +/-2 Volt range.

A negative parameter also freezes the effect of the integrator during the move. For example, IL -3 limits the integrator output to +/-3V. If, at the start of the motion, the integrator output is 1.6 Volts, that level will be maintained through the move. Note, however, that the KD and KP terms remain active in any case.

Arguments

IL n,n,n,n,n,n,n,n or ILA=n where
 n is a number in the range -10 to 10 Volts with a resolution of 0.0003.
 n = ? Returns the value of the integrator limit for the specified axis.

Operand Usage

_ILn contains the value of the integrator limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	9.9982
Default Format	1.4

Related Commands

KI - Integrator

Examples:

```

KI 2,3,5,8      Integrator constants
IL 3,2,7,2      Integrator limits
IL ?           Returns the A-axis limit
3.0000

```

IN	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Input Variable		

Full Description

The IN command allows a variable to be input from a keyboard. When the IN command is executed in a program, the prompt message is displayed. The operator then enters the variable value followed by a carriage return. The entered value is assigned to the specified variable name. The IN command holds up execution of following commands in a program until a carriage return or semicolon is detected. If no value is given prior to a semicolon or carriage return, the previous variable value is kept. Input Interrupts, Error Interrupts and Limit Switch Interrupts will still be active. The IN command may only be used in thread 0.

The IN command can only be used with a serial connection to the controller.

Arguments

IN "m",n where
 m is prompt message
 n is the variable name

The total number of characters for n and m must be less than 80 characters.

Note: Do not include a space between the comma at the end of the input message and the variable name.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	Position Format

Related Commands

N/A

Examples:

Operator specifies length of material to be cut in inches and speed in inches/sec (2 pitch lead screw, 2000 counts/rev encoder).

```
#A; '                               Program A
IN "Enter Speed(in/sec)",V1;'      Prompt operator for speed
IN "Enter Length(in)",V2;'         Prompt for length
V3=V1*4000;'                        Convert units to counts/sec
V4=V2*4000;'                        Convert units to counts
SP V3;'                              Speed command
PR V4;'                              Position command
BGA;'                                Begin motion
AMA;'                                Wait for motion complete
MG "MOVE DONE";'                   Print Message
EN;'                                End Program
```


IP	<u>Syntax:</u>	Explicit & Implicit
	Operands:	none
	Burn:	not burnable
Increment Position		

Full Description

The IP command allows for a change in the command position while the motor is moving. This command does not require a BG. The command has three effects depending on the motion being executed. The units of this are quadrature.

Case 1: Motor is standing still

An IP a,b,c,d command is equivalent to a PR a,b,c,d and BG command. The motor will move to the specified position at the requested slew speed and acceleration.

Case 2: Motor is moving towards a position as specified by PR, PA, or IP.

An IP command will cause the motor to move to a new position target, which is the old target plus the specified increment. The incremental position must be in the same direction as the existing motion.

Case 3: Motor is in the Jog Mode

An IP command will cause the motor to instantly try to servo to a position which is the current instantaneous position plus the specified increment position. The SP and AC parameters have no effect. This command is useful when synchronizing 2 axes in which one of the axis' speed is indeterminate due to a variable diameter pulley.

Warning: When the mode is in jog mode, an IP will create an instantaneous position error. In this mode, the IP should only be used to make small incremental position movements.

Arguments

IP n,n,n,n,n,n,n,n or IPA=n where

n is a signed numbers in the range -2147483648 to 2147483647 decimal.

n = ? Returns the current position of the specified axis.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	(7.0 on 18x2 & 21x3) (PF on 18x6 & 4xxx)

Related Commands

PF - Position Formatting

Examples:

```
| IP 50 50 counts with set acceleration and speed
```


IT	Syntax:	Explicit & Implicit
	Operands:	_ITn
	Burn:	burnable with BN
Independent Time Constant - Smoothing Function		

Full Description

The IT command filters the acceleration and deceleration functions of independent moves such as JG, PR, PA to produce a smooth velocity profile. The resulting profile, known as smoothing, has continuous acceleration and results in reduced mechanical vibrations. IT sets the bandwidth of the filter where 1 means no filtering and 0.004 means maximum filtering. Note that the filtering results in longer motion time. The use of IT will not effect the trippoints AR and AD. The trippoints AR & AD monitor the profile prior to the IT filter and therefore can be satisfied before the actual distance has been reached if IT is NOT 1.

Arguments

IT n,n,n,n,n,n,n,n or ITA=n where
 n is a positive numbers in the range between 0.004 and 1.0 with a resolution of 1/256.
 n = ? Returns the value of the independent time constant for the specified axis.

Operand Usage

_ITn contains the value of the independent time constant for the specified 'n' axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	1
Default Format	1.4

Related Commands

PR - Position relative
 PA - Position absolute
 JG - Jog
 VM - Vector mode
 LM - Linear Interpolation Mode

Examples:

```
IT 0.8, 0.6, 0.9, 0.1 Set independent time constants for a,b,c,d axes
IT ? Return independent time constant for A-axis
:0.8
```

JG	Syntax:	Explicit & Implicit
	Operands:	_JGn
	Burn:	not burnable
Jog		

Full Description

The JG command sets the jog mode and the jog slew speed of the axes.

Arguments

JG n,n,n,n,n,n,n,n or JGA=n where

n is a signed even integer in the range 0 to +/-22,000,000. The units of this are counts/second. (Use JGN = n or JGM = n for the virtual axes)

For stepper motor operation, the maximum value is 6,000,000 steps/ second

n = ? Returns the absolute value of the jog speed for the specified axis.

When ordered with the ICM-42100:

n is a signed even integer in the range of 0 to +/- 50,000,000. The units are interpolated encoder counts per second.

Operand Usage

_JGn contains the absolute value of the jog speed for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	25000

Related Commands

BG - Begin

DC - Deceleration

TV - Tell Velocity

ST - Stop

AC - Acceleration

IP - Increment Position

Examples:

JP	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
Jump to Program Location		

Full Description

The JP command causes a jump to a program location on a specified condition. The program location may be any program line number or label. The condition is a conditional statement which uses a logical operator such as equal to or less than. A jump is taken if the specified condition is true. Multiple conditions can be used in a single jump statement. The conditional statements are combined in pairs using the operands "&" and "|". The "&" operand between any two conditions, requires that both statements must be true for the combined statement to be true. The "|" operand between any two conditions, requires that only one statement be true for the combined statement to be true.

Each condition must be placed in parenthesis for proper evaluation by the controller.

Example:

```
JP#a, ((var0=1)&(var1=2)); ' valid conditional jump
JP#a, var0=1&var1=2; '      invalid conditional jump
```

Arguments

JP destination,condition

where

destination is a label, integer, or variable and is defined as the line number where code shall jump if condition is true.

condition is an optional conditional statement using a logical operator

The logical operators are:

- < less than
- > greater than
- = equal to
- <= less than or equal to
- >= greater than or equal to
- <> not equal to

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

- JS - Jump to Subroutine
- IF - If conditional statement
- ELSE - Else function for use with IF conditional statement
- ENDIF - End of IF conditional statement

Examples:

```
JP #POS1,(V1<5);'   Jump to label #POS1 if variable V1 is less than 5
JP #A,((V7*V8)=0);' Jump to #A if V7 times V8 equals 0
JP #B,(@IN[1]=9);' Jump to #B if input 1 = 1
JP #C;'            Jump to #C unconditionally
```

JS	Syntax:	Embedded Only
	Operands:	_JS
	Burn:	not burnable
Jump to Subroutine		

Full Description

Basic Usage

The JS command will change the sequential order of execution of commands in a program. If the jump is taken, program execution will continue at the line specified by the destination parameter, which can be either a line number or label. The line number of the JS command is saved and after the next EN command is encountered (End of subroutine), program execution will continue with the instruction following the JS command. There can be a JS command within a subroutine, up to 16 deep.

Multiple conditions can be used in a single jump statement. The conditional statements are combined in pairs using the operands "&" and "|". The "&" operand between any two conditions, requires that both statements must be true for the combined statement to be true. The "|" operand between any two conditions, requires that only one statement be true for the combined statement to be true. Note: Each condition must be placed in parenthesis for proper evaluation by the controller.

A jump is taken if the specified condition is true.

Each condition must be placed in parenthesis for proper evaluation by the controller.

Example:

```
JS#a,(var0=1)&(var1=2);' valid conditional jump
JS#a,var0=1&var1=2;'      invalid conditional jump
```

Passing Values on the Stack

Up to 8 parameters can be passed on the subroutine stack. One value can be returned from a subroutine. More return values are possible with pass by reference and array passing.

Using subroutine stacks and passing parameters in a subroutine has many advantages including:

1. Code flexibility/reuse. A single subroutine can be written and called many times and from various locations in code. The stack "remembers" where to return when completed. This is opposite from a "blind jump" (JP).
2. Variable Scope/ Local variables. A subroutine can run with a protected variable space. Local variables exist only in the extent of the subroutine, and no external thread or stack level can access local variables. Local variables can be used for counters, indices, and other helper variables. ^a - ^h must be used for local variables. Other variable names remain global.
3. Each thread has its own stack, therefore subroutines are reentrant. In other words, multiple threads can be running the same subroutine simultaneously at various stack depths.
4. Support for recursion. Although the subroutine stack is only 16 deep, recursion is possible. A stack depth of 16 is sufficient for many recursive tasks. E.G. recursing axes, handles, and thread status.
5. Parameter passing. A calling command can explicitly specify the inputs to a subroutine. The subroutine can pass one value back to the calling command. More returns are possible with pass by reference and array passing.

Constants, Variables, and Arrays may be passed up a subroutine stack.

Variables may be passed by value or by reference. If passed by value, a copy is made in the subroutine stack, leaving the original variable unchangeable. If passed by reference, the original variable's value will be changed when the subroutine writes to its local variable. This is similar, but not exactly analogous to a C pointer.

A variable passed by reference is automatically dereferenced; the variable pointer is not exposed to the user. Following the C syntax, a by-reference pass is accomplished with the ampersand (&) in the invoking call. When passing a variable by reference, do not allocate any new variables in the called subroutine.

Arrays can be passed in the stack, though only by reference. No "&" is used when passing arrays, by-reference is assumed. To pass an array, use its name in quotations. Arrays to be passed must have names that are 6 characters or less.

The number of elements in an array is returned by reading index -1, e.g. array[-1].

To return a value on the stack, write the value in the EN command upon ending the subroutine.

Arguments

JS destination (param1,param2,...,param8), condition

where

destination is a label, integer, or variable and is defined as the line number where code shall jump if condition is true.

param1 - param8 are optional parameters to pass to the subroutine's stack, referenced from within the subroutine as ^a-^h, respectively.

condition is an optional conditional statement using a logical operator

The logical operators are:

- < less than or equal to
- > greater than
- = equal to
- <= less than or equal to
- >= greater than or equal to
- <> not equal

Operand Usage

_JS used after JS is called, this operand contains the returned value of the subroutine called by JS

Usage*Usage and Default Details*

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All

Related Commands

& , | - Bitwise Logical Operators AND and OR

EN - End

<,> , = , <= , >= , <> - Comparison Operators

^a, ^b, ^c, ^d, ^e, ^f, ^g, ^h - JS subroutine stack variable

Examples:

```
JS #SQUARE,(V1<5);' Jump to subroutine #SQUARE if V1 is less than 5
JS #LOOP,(V1<>0);' Jump to #LOOP if V1 is not equal to 0
JS #A;' Jump to subroutine #A (unconditionally)
```

Advanced Usage Examples

```
#ADD
JS#SUM(1,2,3,4,5,6,7,8);' Call subroutine, pass values
MG_JS;' Print return value, will print 36.0000
EN

#SUM;' Sums values passed to it. Expects 8 numbers
EN,,^a+^b+^c+^d+^e+^f+^g+^h;' Return the sum
```

```
'Dimension two arrays
DM array1[10]
DM array2[100]
'Zero the contents of each array
JS#ZeroAry("array1", 0)
JS#ZeroAry("array2", 0)
```

```
EN

'Zero the contents of an array
#ZeroAry;'(^a array,^b starting index)
^a[^b]=0
^b=(^b+1)
JP#ZeroAry,(^b < ^a[-1])
EN

i=1;'          Counter
#loop
  offset=#spell+i;'  Calculate offset
  JS offset;'        Jump to offset
  i=i+1;'           Increment Counter
JP#loop,i<=3;'      Loop through 3 states
EN
'
#spell;'          Subroutine containing various words
MG"One";EN;'      Prints "One" if this line is called (i=1)
MG"Two";EN;'      Prints "Two" if this line is called (i=2)
MG"Three";EN;'    Prints "Three" if this line is called (i=3)

REM Controller responds with:
REM One
REM Two
REM Three
```

KD	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_KDn
	<u>Burn:</u>	burnable with BN
Derivative Constant		

Full Description

KD designates the derivative constant in the control filter. The filter transfer function is

$$D(z) = KP + KD(z-1)/z + KIz/2 (z-1)$$

For further details on the filter see the section Theory of Operation.

Arguments

KD n,n,n,n,n,n,n,n or KDX=n where

n is an unsigned numbers in the range 0 to 4095.875 with a resolution of 1/8.

n = ? Returns the value of the derivative constant for the specified axis.

Operand Usage

_KDn contains the value of the derivative constant for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	64
Default Format	4.2

Related Commands

KI - Integrator

KP - Proportional

Examples:

```
KD 100,200,300,400.25 Specify KD
KD ?,?,?,? Return KD
:100.00, 200.00, 300.00, 400.25
```

Note: KD now has four time more resolution as prior controllers, and thus for the same value is four times less effective.

KI	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_KIn
	<u>Burn:</u>	burnable with BN
Integrator		

Full Description

The KI command sets the integral gain of the control loop. It fits in the control equation as follows:

$$D(z) = KP + KD(z-1)/z + KI z/2(z-1)$$

The integrator term will reduce the position error at rest to zero.

Arguments

KI n,n,n,n,n,n,n,n or KIA=n where

n is an unsigned numbers in the range 0 to 255 with a resolution of 0.001.

n = ? Returns the value for the specified axis.

Operand Usage

_KIn contains the value of the integral gain for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	(4.0 for 18x2 & 21x3), (4.4 for 18x6, 4xxx & RIO)

While Moving Yes Default Value 0

In a Program Yes Default Format 4.4

Command Line Yes

Controller Usage ALL CONTROLLERS

Related Commands

KP - Proportional Constant

KD - Derivative Constant

IL - Integrator Limit

Examples:

```
KI 12,14,16,20 Specify a,b,c,d-axis integral
KI 7 Specify a-axis only
KI ,,8 Specify c-axis only
KI ?,?,?/? Return A,B,C,D
:7, 14, 8, 20 KI values
```

KP	Syntax:	Explicit & Implicit
	Operands:	_KPn
	Burn:	burnable with BN
Proportional Constant		

Full Description

KP designates the proportional constant in the controller filter. The filter transfer function is

$$D(z) = KP + KD(z-1)/z + KI z/2(z-1)$$

For further details see the section Theory of Operation in the User's Manual.

Arguments

KP n,n,n,n,n,n,n,n or KPA=n where

n is an unsigned numbers in the range 0 to 1023.875 with a resolution of 1/8.

n = ? Returns the value of the proportional constant for the specified axis.

Operand Usage

_KPn contains the value of the proportional constant for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	6
Default Format	4.2

Related Commands

KD - Derivative Constant

KI - Integrator Constant

IL - Integrator Limit

Examples:

```

| KP 12,14,16,20 Specify a,b,c,d-axis proportional
| KP 7 Specify a-axis only
| KP ,,8 Specify c-axis only
| KP ?,?,?,? Return A,B,C,D
| :7, 14, 8, 20 KP values

```

KS	Syntax:	Explicit & Implicit
	Operands:	_KS _n
	Burn:	burnable with BN
Step Motor Smoothing		

Full Description

The KS parameter sets the amount of smoothing of stepper motor pulses. This is most useful when operating in full or half step mode. Larger values of KS provide greater smoothness. This parameter will also increase the motion time by 3KS sampling periods. KS adds a single pole low pass filter onto the output of the motion profiler.

Note: KS will cause a delay in the generation of output steps.

Arguments

KS *n,n,n,n,n,n,n,n* or KSA=*n* where
n is a positive number in the range between 0.25 and 64 with a resolution of 1/32.
n = ? Returns the value of the smoothing constant for the specified axis.

Operand Usage

_KS_n contains the value of the stepper motor smoothing constant for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	
Default Format	

While Moving Yes Default Value 2.000

In a Program Yes Default Format 2.3

Command Line Yes

Controller Usage ALL CONTROLLERS

Related Commands

MT - Motor Type

Examples:

```
KS 2, 4 , 8    Specify a,b,c axes
KS 5          Specify a-axis only
KS ,,15       Specify c-axis only
Hint: KS is valid for step motor only.
```

LA	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
List Arrays		

Full Description

The LA command returns a list of all arrays in memory. The listing will be in alphabetical order. The size of each array will be included next to each array name in square brackets.

Arguments

None

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

LL - List Labels
 LS - List Program
 LV - List Variable

Examples:

```
: LA
CA [10]
LA [5]
NY [25]
VA [17]
```

LB	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	LB
	<u>Burn:</u>	burnable with BN
LCD Bias Contrast		

Full Description

Sets the Bias contrast on the LCD.

Arguments

LBn where

n is an integer between 0 and 15 where 0 is least contrast and 15 is greatest contrast. A negative value turns the optional backlight on.

Operand Usage

_LB contains setting of the LB command

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	8.0

Related Commands

MG - Message {Lx}

LU - LCD Update

Examples:

```
LB0      Set the LCD Bias Contrast to minimum
LB15     Set the LCD Bias Contrast to maximum
LB-8     Set the LCD Bias Contrast to default and turn on backlight (backlight is an optional
enhancement)
```

LC	Syntax:	Implicit Notation Only
	Operands:	_LCn
	Burn:	burnable with BN
Low Current Stepper Mode		

Full Description

The LC command causes the amp enable line for the specified axes to toggle (disabling the stepper drive) when the respective axes stops (profiler holding position). Each axis is handled individually. This will reduce current consumption, but there will be no holding torque at rest. The MT command must be issued prior to the LC command.

The user can set a time interval to wait after the profile has finished the move before the amp enable line is removed.

Using a Galil SDM drive with LC

When using an integrated Galil stepper drive LC may leverage a hardware feature providing for a fraction of the total holding torque to be used at rest. Sending LC0;MO may be necessary to shut off all current to the SDM in the "motor off" (MO) state. Consult the user manual for the SDM to be used for further details.

Arguments

LC n,n,n,n,n,n,n,n where

- n = 0 Normal (stepper drive always on)
- n = 1 Low current stepper mode
- n = ? Returns whether the axis is in low current stepper mode

n can also be an integer between 1 and 32767 specifying the number of samples to wait between the end of the move and when the amp enable line toggles

Operand Usage

_LCn contains the low current setting.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

MT - Motor Type

Examples:

```
MTZ=2 Specify stepper mode for the z axis
LCZ=1 Specify low current mode for the z axis
```

LD	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_LDn
	<u>Burn:</u>	burnable with BN
Limit Disable		

Full Description

Disables limit switches. Soft limits BL and FL are still in effect. This feature should be used to gain additional digital inputs if limit switches are not used, or if there is a noise problem which causes limit switch conditions even though no limit switches are connected.

Arguments

LD n,n,n,n,n,n,n,n or LDA=n where

- n = 0 enabled (default)
- n = 1 forward limit disabled
- n = 2 reverse limit disabled
- n = 3 both disabled
- n = ? returns the current setting

Operand Usage

_LDn contains the current value

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

_LFX - State of forward limit

_LRX - State of reverse limit

SC - Stop code

BL - Backward soft limit

FL - Forward soft limit

Examples:

```
| LDx=1   Disable the forward limit switch on the X axis
```

LE	Syntax:	Two Letter Only
	Operands:	_LEn
	Burn:	not burnable
Linear Interpolation End		

Full Description

LE

Signifies the end of a linear interpolation sequence. It follows the last LI specification in a linear sequence. After the LE specification, the controller issues commands to decelerate the motors to a stop. The VE command is interchangeable with the LE command.

The LE command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

n = ? Returns the total move length in encoder counts for the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Operand Usage

_LEn contains the total vector move length in encoder counts.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	PF

Related Commands

LI - Linear Distance

BG - BGS Begin Sequence

LM - Linear Interpolation Mode

PF - Position Formatting

VA - Vector Acceleration

VD - Vector Deceleration

VS - Vector Speed

Examples:

```
CAS    Specify S coordinated motion system
LM CD  Specify linear interpolation mode for C and D axes
LI ,,100,200  Specify linear distance
LE     End linear move
BGS    Begin motion
```


LI	Syntax:	Explicit & Implicit
	Operands:	none
	Burn:	not burnable
Linear Interpolation Distance		

Full Description

The LI command specifies the incremental distance of travel for each axis in the Linear Interpolation (LM) mode. LI parameters are relative distances given with respect to the current axis positions. Up to 511 LI segments may be given ahead of the Begin Sequence (BGS) command. Additional LI commands may be sent during motion when the controller sequence buffer frees additional space for new vector segments. The Linear End (LE) command must be given after the last LI segment in a sequence. LE tells the controller to decelerate to a stop at the last LI command. It is the responsibility of the user to keep enough LI segments in the controller's sequence buffer to ensure continuous motion.

LM ? Returns the available spaces for LI segments that can be sent to the buffer. 511 returned means the buffer is empty and 511 LI segments can be sent. A zero means the buffer is full and no additional segments can be sent. It should be noted that the controller computes the vector speed based on the axes specified in the LM mode. For example, LM ABC designates linear interpolation for the A,B and C axes. The speed of these axes will be computed from:

$$V = \sqrt{A^2 + B^2 + C^2}$$

where

V is the vector speed

A, B and C are the speed of the A,B and C axes

If the LI command specifies only A and B, the speed of C will still be used in the vector calculations. The controller always uses the axis specifications from LM, not LI, to compute the speed.

The LI command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

LI n,n,n,n,n,n,n,n <o> p or LIA=n

where

n is a signed integer in the range -8,388,607 to 8,388,607 and represents the incremental move distance (at least one n must be non-zero).

o specifies a vector speed to be taken into effect at the execution of the linear segment. o is an unsigned even integer between 0 and 22,000,000 for servo motor operation and between 0 and 6,000,000 for stepper motors.

p specifies a vector speed to be achieved at the end of the linear segment. Based on vector accel and decel rates, p is an unsigned even integer between 0 and 22,000,000 for servos, and between 0 and 6,000,000 for steppers.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

LE - Linear end

BG - BGS Begin sequence

LM - Linear Interpolation Mode

CS - Clear Sequence

VS - Vector Speed

VA - Vector Acceleration

VD - Vector Deceleration

Examples:

```
LM ABC; '          Specify linear interpolation mode
LI 1000,2000,3000;' Specify distance
LE; '             Last segment
BGS; '           Begin sequence
```

LL	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
List Labels		

Full Description

The LL command returns a listing of all of the program labels in memory and their associated line numbers. The listing will be in alphabetical order.

Arguments

None

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

LA - List Arrays

LS - List Program

LV - List Variables

Examples:

```
: LL
# FIVE=5
# FOUR=4
# ONE=1
# THREE=3
# TWO=2
```

LM	Syntax:	Accepts Axis Mask
	Operands:	LMn
	Burn:	not burnable
Linear Interpolation Mode		

Full Description

The LM command specifies the linear interpolation mode and specifies the axes for linear interpolation. Any set of 1 thru 8 axes may be used for linear interpolation. LI commands are used to specify the travel distances for linear interpolation. The LE command specifies the end of the linear interpolation sequence. Several LI commands may be given as long as the controller sequence buffer has room for additional segments. Once the LM command has been given, it does not need to be given again unless the VM command has been used.

The LM command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

LM nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

n = ? Returns the number of spaces available in the sequence buffer for additional LI commands.

Operand Usage

_LMn contains the number of spaces available in the sequence buffer for the 'n' coordinate system, S or T.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

LE - Linear Interpolation End

LI - Linear Interpolation Distance

VA - Vector Acceleration

VS - Vector Speed

VD - Vector Deceleration

AV - After Vector Distance

CS - Clear Sequence

Examples:

LM ABCD; '	Specify linear interpolation mode
VS 10000; VA 100000;VD 1000000;'	Specify vector speed, acceleration and deceleration
LI 100,200,300,400;'	Specify linear distance
LI 200,300,400,500;'	Specify linear distance
LE; BGS;'	Last vector, then begin motion

LS	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
List		

Full Description

The LS command returns a listing of the programs in memory.

Arguments

LS n,m where

n and m are valid numbers from 0 to 1999, or labels. n is the first line to be listed, m is the last.

n is an integer in the range of 0 to 1999 or a label in the program memory. n is used to specify the first line to be listed.

m is an integer in the range of 1 to 1999 or a label on the program memory. m is used to specify the last line to be listed.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	0, Last Line (for DMC)
Default Format	N/A

Related Commands

LA - List Arrays

LL - List Labels

LV - List Variables

Examples:

```
:LS #A,6           List program starting at #A through line 6
```

```
2 #A
```

```
3 PR 500
```

```
4 BGA
```

```
5 AM
```

```
6 WT 200
```

```
Hint: Remember to quit the Edit Mode <cntrl> Q prior to giving the LS command. (DOS)
```

LU	Syntax:	Implicit Notation Only
	Operands:	_LU
	Burn:	not burnable
LCD Update		

Full Description

Turns the automatic axes status update on the LCD on or off.

Arguments

LUn where

n = 0 Turns off the automatic update of the LCD with the axis status.

n = 1 Sets the LCD in an automatic update mode with the axes status shown below.

The LCD displays the following pattern:

```
A B C D E F G H
m m m m m m m m
```

where m is the axis status for axes ABCDEFGH and is

Axis Status	Description
I	Idle
i	Low power Idle
O	Motor Off
M	Motion - Axis Running in independent mode
E	Error - Positions Error exceeded TEn>ERn
S	Stop - Stopped from ST command
L	Limit - Decelerating or stopped by a limit switch
A	Abort - Stopped by abort
V	Vector - Running in Vector or Linear Interpolation Mode
C	Contour - Running in Contour Mode
P	PVT - Running in PVT mode
H	Homing - Running in a Homing Routine
e	ECAM - Running in ECAM mode
F	Fault - Amplifier Fault
T	Stall - Stepper Position Maintenance Mode Stall Detected

Operand Usage

_LU contains the setting of the LU command

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0
Default Format	1.0
Controller Usage	DMC-4000

Related Commands

MG - Message {Lx}
LB - LCD Bias Contrast
SC - Stop Code

Examples:

```
LU0      Turn the LCD update off  
MG"DMC-40x0" {L1}      Send DMC-40x0 to line 1 of the LCD screen  
MG"Galil MC" {L2}      Send Galil MC to line 2 of the LCD screen  
LU1      Set the LCD to automatically update the LCD screen with the axis status
```

LV	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
List Variables		

Full Description

The LV command returns a listing of all of the program variables in memory. The listing will be in alphabetical order.

Arguments

None

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	VF (for 18x6 & 4xxx)

Related Commands

LA - List Arrays
 LS - List Program
 LL - List Labels

Examples:

```
: LV
APPLE = 60.0000
BOY   = 25.0000
ZEBRA = 37.0000
```


LZ	Syntax:	Implicit Notation Only
	Operands:	LZ
	Burn:	burnable with BN
Inhibit leading zeros		

Full Description

The LZ command is used for formatting the values returned from interrogation commands or interrogation of variables and arrays. By enabling the LZ function, all leading zeros of returned values will be removed.

Arguments

LZ n where
n = 1 Removes leading zeros
n = 0 Does not remove leading zeros.
n = ? Returns the state of the LZ function. '0' does not remove and '1' removes zeros

Operand Usage

_LZ contains the state of the LZ function. '0' is disabled and '1' is enabled.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Details	1
Default Value	N/A

Related Commands

Examples:

```
LZ 0      Disable the LZ function
TPA      Interrogate the controller for current position of A axis
:0000021645.0000      Value returned by the controller
VAR1=    Request value of variable "VAR1" (previously set to 10)
:0000000010.0000      Value of variable returned by controller
LZ1      Enable LZ function
TPA      Interrogate the controller for current position of A axis
:21645.0000      Value returned by the controller
VAR1=    Request value of variable "VAR1" (previously set to 10)
:10.0000      Value of variable returned by controller
```

MB	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Modbus		

Full Description

The MB command is used to communicate with I/O devices using the first two levels of the Modbus protocol.

The format of the command varies depending on each function code. The function code -1 designates that the first level of Modbus is used (creates raw packets and receives raw data). The other codes are the 10 major function codes of the second level.

Modbus support is for TCP/IP.

Note: For those command formats that have "addr", this is the slave address. The slave address may be designated or defaulted to the device handle letter.

Note: All the formats contain an h parameter. This designates the connection handle letter (A thru H).

Note: Port 502 must be used in the Ethernet handle. See the IH command for more info on how to open a handle with a specific port number.

Level 2 Modbus Function Codes

Function Code	Modbus Definition	Slaved Galil Description (RIO only)
01	Read Coil Status (Read Bits)	Read Digital Outputs (RIO only)
02	Read Input Status (Read Bits)	Read Digital Inputs (RIO only)
03	Read Holding Registers (Read Words)	Read Analog Inputs (RIO only)
04	Read Input Registers (Read Words)	Read Analog Outputs (RIO only)
05	Force Single Coil (Write One Bit)	Write Digital Output (RIO only)
06	Preset Single Register (Write One Word)	Write Digital Outputs (RIO only)
07	Read Exception Status (Read Error Code)	Read Digital Outputs (RIO only)
15	Force Multiple Coils (Write Multiple Bits)	Write Digital Outputs (RIO only)
16	Preset Multiple Registers (Write Words)	Write Analog Outputs (RIO only)
17	Report Slave ID	

Arguments

MBh= addr, 1, m, n, array[] where

h is the handle letter

addr is the unit ID

1 is the function code 1, Read Coil Status

m is the address of the first coil

n is the quantity of coils

array[] is the name of the array whose first element will store the response

MBh= addr, 2, m, n, array[] where

h is the handle letter

addr is the unit ID

2 is the function code 2, Read Input Status

m is the address of the first coil

n is the quantity of coils

array[] is the name of the array whose first element will store the response

MBh= addr, 3, m, n, array[] where

h is the handle letter

addr is the unit ID

3 is the function code 3, Read Holding Registers

m is the address of the first Register

n is the quantity of registers

array[] is the name of the array that will store the resulting register data; 2-byte per element

MBh= addr, 4, m, n, array[] where

h is the handle letter

addr is the unit ID

4 is the function code 4, Read Input Registers

m is the address of the first Register

n is the quantity of registers

array[] is the name of the array that will store the resulting register data; 2-byte per element

MBh= addr, 5, m, n where

h is the handle letter

addr is the unit ID

5 is the function code 5, Force Single Coil

m is the address of the coil

n is a value of 0 or 1 to turn the coil off or on

MBh= addr, 6, m, n where

h is the handle letter

addr is the unit ID

6 is the function code 6, Preset Single Register

m is register address

n is a 16-bit value

MBh= addr, 7, m, n, array[] where

h is the handle letter

addr is the unit ID

7 is the function code 7, Read Exception Status

m is the address of the first Register

n is the quantity of registers

array[] is the name of the array where the response will be stored in the first element

MBh= addr, 15, m, n, array[] where

h is the handle letter

addr is the unit ID

15 is the function code 15, Write Multiple Coils

m is the address of the first register

n is the quantity of registers

array[] is the name of the array that will store the desired register data; 2-byte per element

MBh= addr, 16, m, n, array[] where

h is the handle letter

addr is the unit ID

16 is the function code 16, Write Multiple Registers

m is the address of the first Register

n is the quantity of registers

array[] is the name of the array that will store the desired register data; 2-byte per element

MBh = addr, 17, array[] where

h is the handle letter

addr is the unit ID

17 is the function code 17, Report Slave ID

array[] is where the returned data is stored

(not supported on RIO)

Raw Modbus Packet Send

MBh= -1,len,array[] where

h is the handle letter

len is the number of bytes in the array,

array[] is the array containing the outgoing data with a dimension of at least len

Note: each element of array[] may contain only one byte, and array[] must contain the entire modbus packet, including transaction identifiers, protocol identifiers, length field, modbus function code, and data specific to that function code.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

IA - IP Address

MW - Modbus Wait

Examples:

MC	Syntax:	Accepts Axis Mask & Trippoint
	Operands:	none
	Burn:	not burnable
Motion Complete		

Full Description

The MC command is a trippoint used to control the timing of events. This command will hold up execution of the following commands until the current move on the specified axis or axes is completed and the encoder reaches or passes the specified position. Any combination of axes may be specified with the MC command. For example, MC AB waits for motion on both the A and B axis to be complete. MC with no parameter specifies that motion on all axes should complete before code continues. The command TW sets the timeout to declare an error if the encoder is not in position within the specified time. If a timeout occurs, the trippoint will clear and the stopcode will be set to 99. An application program will jump to the special label #MCTIME, if present.

When used in stepper mode, the controller will hold up execution of the proceeding commands until the controller has generated the same number of steps as specified in the commanded position. The actual number of steps that have been generated can be monitored by using the interrogation command TD.

Note: The MC command is recommended when operating with stepper motors in lieu of AM since the generation of step pulses can be delayed due to the stepper motor smoothing function, KS. In this case, the MC command would only be satisfied after all steps are generated.

Arguments

MC nnnnnnnn where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

MC with no axis mask specifies that motion on all axes should complete before code continues

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes

Related Commands

BG - Begin

AM - After Move

TW - Timeout

Examples:

```
#MOVE; '           Program MOVE
TW 1000,1000;'     Set motion complete timeout to one second per axis
PR2000,4000;'     Independent Move on A and B axis
BG AB;'           Start the B axis
MC AB;'           After the move is complete on T coordinate system,
MG "DONE";'       Print message
EN;'             End of Program
'
'
#MCTIME;'         Motion Complete timeout Subroutine
MG "Motion Timeout";' Print failure message
```

SC;'	Print stop codes
RE1;'	End subroutine

MF	Syntax:	Explicit & Implicit & Trippoint
	Operands:	none
	Burn:	not burnable
Forward Motion to Position		

Full Description

The MF command is a trippoint used to control the timing of events. This command will hold up the execution of the following command until the specified motor moves forward and crosses the position specified*. The units of the command are in quadrature counts. Only one axis may be specified at a time. The MF command only requires an encoder and does not require that the axis be under servo control.

* When using a stepper motor, this condition is satisfied when the stepper position (as determined by the output buffer) has crossed the specified Forward Motion Position. For further information see Chapter 6 of the User Manual "Stepper Motor Operation".

Hint: The accuracy of the MF command is the number of counts that occur in 2*TM sec. Multiply the speed by 2*TM sec to obtain the maximum error. MF tests for absolute position. The MF command can also be used when the specified motor is driven independently by an external device.

Arguments

MF n,n,n,n,n,n,n,n or MFA=n where
n is a signed integer in the range 2147483648 to 2147483647 decimal

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

AR - Trippoint for after Relative Distances

AP - Trippoint for after Absolute Position

MR - Reverse Motion to Position Trippoint

Examples:

```
#TEST; '           Program Test
DP0; '           Define zero
JG 1000; '       Jog mode (speed of 1000 counts/sec)
BG A; '         Begin move
MF 2000; '      After passing the position 2000
V1=_TPA; '     Assign V1 A position
MG "Position is", V1; ' Print Message
ST; '          Stop
EN; '          End of Program
```

<h1>MG</h1>	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Message		

Full Description

The MG command can be used in two ways:

1.) From a host PC "MG val" will return the value, where val is an operand, string, variable, or number, including mathematical expressions. This is known as a solicited command, because the host sends the command and expects a response.

```
:MG TIME
 261928200.0000
:variable = 10
:MG variable + 5
 15.0000
:MG _TI0
 255.0000
:MG "Foo"
Foo
:
```

2.) From embedded DMC code, the MG command will send an unsolicited, asynchronous message from the controller to the host. This can be used to alert an operator, send instructions or return a variable value. This is known as an unsolicited command because the host is not expecting it; the DMC code sends the data when the MG command is executed in embedded code.

The CW command controls the ASCII format of all unsolicited messages.

```
#POSERR
MG "Warning, position error exceeded"
RE
```

Messages sent from within embedded code can go to any of the Ethernet handles, or serial ports. See CF to set the routing of the message.

Arguments

MG "m", {^n}, V

where

"m" is a text string including alphanumeric characters (up to 76 characters)

{^n} is an ASCII character specified by the value n

V is a value, variable name, operand, array element, or mathematical expression

Multiple strings, variables, and ASCII characters may be used, each must be separated by a comma.

Formatters

{Fm.n} Display variable in decimal format with m digits to left of decimal, and n to the right.

{Zm.n} Same as {Fm.n} but suppresses leading zeros.

{\$m.n} Display variable in hexadecimal format with m digits to left of decimal, and n to the right.

{Sn} Display variable as a string of length n where n is 1 through 6

{N} Suppress carriage return line feed (\r\n) at the end of the message.

Formatters can be placed before or after each argument in MG.

Message Routing

Messages are routed based upon the CF setting. MG can override the global CF setting.

{Ex} Sends the message out the Ethernet handle x, where x is A,B,C,D,E,F,G or H

{Pn} Sends the message out the Serial port n, where n is 1 or 2 denoting Main or Auxilary (where equipped).

Routing options should be placed at the beginning of the message, right after MG.

Printing to the LCD

{Lx} Sends the message to the LCD, where x is 1 or 2 for the top or bottom line of the LCD. The message cannot be more than 8 characters when sent to the LCD screen; excess characters will not be shown.

The LU command must be set to 0 for user messages sent to the LCD to appear.

When outputting to the LCD using multiple variables, use {L1} and {L2} before the variable in order to direct it to a specific line number. See Example Below.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes

Related Commands

CF - Configure Unsolicited Messages Handle

Examples

```
'Message command displays ASCII string
MG "Good Morning"
```

```
'Displays the string with the content of variable 'Total' in
'format of 4 digits before and 2 digits after the decimal point.
MG "The Answer is", Total {F4.2}
```

```
Message command sends any ASCII character
MG {^13}, {^10}, {^48}, {^055}
'displays carriage return, line feed, and the characters 0 and 7.
```

```
CFA;'      Messages configured to go out Ethernet handle A
MG{EB}var;'  Override CF and send the value of variable var to B handle
```

```
'printing to the LCD screen
LU0
ct=1
rpm=1432
MG{L1}"CT SPD",{L2}{F1.0}ct," ",{F4.0}rpm
EN
```

MO	Syntax:	Accepts Axis Mask
	Operands:	_MOn
	Burn:	burnable with BN
Motor Off		

Full Description

The MO command shuts off the control algorithm. The controller will continue to monitor the motor position. To turn the motor back on use the Servo Here command (SH).

Arguments

MO nnnnnnnnnn where
n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.
No argument specifies all axes.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

While Moving No Default Value 0
In a Program Yes Default Format 1.0
Command Line Yes
Controller Usage ALL CONTROLLERS

_MOn contains the state of the motor for the specified axis.

Related Commands

SH
Servo Here

Examples:

```
MO      Turn off all motors
MOA     Turn off the A motor. Leave the other motors unchanged
MOB     Turn off the B motor. Leave the other motors unchanged
MOCA    Turn off the C and A motors. Leave the other motors unchanged
SH      Turn all motors on
Bob=_MOA    Sets Bob equal to the A-axis servo status
Bob=     Return value of Bob. If 1, in motor off mode, If 0, in servo mode
Hint:    The MO command is useful for positioning the motors by hand. Turn them back on with the SH
command.
```

MR	Syntax:	Explicit & Implicit
	Operands:	none
	Burn:	not burnable
Reverse Motion to Position		

Full Description

The MR command is a trippoint used to control the timing of events. This command will hold up the execution of the following command until the specified motor moves backward and crosses the position specified*. The units of the command are in quadrature counts. Only one axis may be specified at a time. The MR command only requires an encoder and does not require that the axis be under servo control.

* When using a stepper motor, this condition is satisfied when the stepper position (as determined by the output buffer) has crossed the specified Reverse Motion Position. For further information see Chapter 6 of the User Manual "Stepper Motor Operation".

Hint: The accuracy of the MR command is the number of counts that occur in $2 \cdot TM$ sec. Multiply the speed by $2 \cdot TM$ sec to obtain the maximum error. MR tests for absolute position. The MR command can also be used when the specified motor is driven independently by an external device.

Arguments

MR n,n,n,n,n,n,n,n or MRA=n where
n is a signed integers in the range 2147483648 to 2147483647 decimal

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

AD - Trippoint for Relative Distances

AP - Trippoint for after Absolute Position

MF - Forward Motion to Position Trippoint

Examples:

```
#TEST; '          Program Test
DP0; '          Define zero
JG -1000; '      Jog mode (speed of 1000 counts/sec)
BG A; '        Begin move
MR -3000; '     After passing the position -3000
V1=_TPA; '     Assign V1 A position
MG "Position is", V1; ' Print Message
ST; '         Stop
EN; '         End of Program
```

MT	Syntax:	Explicit & Implicit
	Operands:	_MTn
	Burn:	burnable with BN
Motor Type		

Full Description

The MT command selects the type of the motor and the polarity of the drive signal. Motor types include standard servomotors, which require a voltage in the range of +/- 10 Volts, and step motors, which require pulse and direction signals. The polarity reversal inverts the analog signals for servomotors, and inverts logic level of the pulse train, for step motors.

Arguments

MT n,n,n,n,n,n,n,n or MTA=n where

- n = 1 Specifies Servo motor
- n = -1 Specifies Servo motor with reversed polarity
- n = 1.5 Specifies PWM/Sign servo drive
- n = -1.5 Specifies PWM/Sign servo drive with reversed polarity
- n = -2 Specifies Step motor with active high step pulses
- n = 2 Specifies Step motor with active low step pulses
- n = -2.5 Specifies Step motor with reversed direction and active high step pulses
- n = 2.5 Specifies Step motor with reversed direction and active low step pulses
- n = ? Returns the value of the motor type for the specified axis.

Operand Usage

_MTn contains the value of the motor type for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	1,1,1,1
Default Format	1 (18x2 & 21x3), 1.1 (18x6 & 4xxx)

Related Commands

CE - Configure encoder type

Examples:

```
MT 1,-1,2,2    Configure a as servo, b as reverse servo, c and d as steppers
MT ?,?        Interrogate motor type
V=_MTA        Assign motor type to variable
```

MW	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_MW, _MW1
	<u>Burn:</u>	not burnable
Modbus Wait		

Full Description

Enabling the MW command causes the controller to hold up execution of the program after sending a Modbus command until a response from the Modbus device has been received. If the response is never received, then the #TCPERR subroutine will be triggered and an error code of 123 will occur on _TC.

Arguments

MWn where

n = 0 Disables the Modbus Wait function

n = 1 Enables the Modbus Wait function

Operand Usage

MW? contains the state of the Modbus Wait.

_MW contains returned function code

_MW1 contains returned error code

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	1 (0 on 21x3)
Default Format	1.0

Related Commands

MB - Modbus

Examples:

```
MW1      Enables Modbus Wait
SB1001   Set Bit 1 on Modbus Handle A
CB1001   Clear Bit 1 on Modbus Handle A
```

NB	<u>Syntax:</u>	Explicit & Implicit
	Operands:	_NBn
	Burn:	burnable with BN
Notch Bandwidth		

Full Description

The NB command sets real part of the notch poles

Arguments

NB n,n,n,n,n,n,n,n or NBA=n where
n is ranges from 0 Hz to

Operand Usage

_NBn contains the value of the notch bandwidth for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0.5
Default Format	

While Moving Yes Default Value 0.5
 In a Program Yes Default Format 3.1
 Command Line Yes
 Controller Usage ALL CONTROLLERS

Related Commands

NF - Notch Filter
 NZ - Notch Zeros

Examples:

```
_NBA = 10      Sets the real part of the notch pole to 10/2 Hz
notch = _NBA  Sets the variable "notch" equal to the notch bandwidth value for the A axis
```

NF	Syntax:	Explicit & Implicit
	Operands:	_NFn
	Burn:	burnable with BN
Notch Frequency		

Full Description

The NF command sets the frequency of the notch filter, which is placed in series with the PID compensation.

Arguments

NF n,n,n,n,n,n,n,n or NFA=n where
 n ranges from 1 Hz to $1 / (4 \cdot TM)$ Hz, where TM is the update rate (default TM is 1000).
 n = ? Returns the value of the Notch filter for the specified axis.

Operand Usage

_NFn contains the value of notch filter for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

While Moving Yes Default Value 0
 In a Program Yes Default Format 3.1
 Command Line Yes
 Controller Usage ALL CONTROLLERS

Related Commands

NB - Notch bandwidth
 NZ - Notch Zero

Examples:

|NF, 20 Sets the notch frequency of B axis to 20 Hz

NO, '	Syntax:	Other
	Operands:	_NO
	Burn:	not burnable
No Operation		

Full Description

The NO or an apostrophe (') command performs no action in a sequence, but can be used as a comment in a program. This helps to document a program.

Arguments

NO m where

m is any group of letters and numbers

up to 77 characters can follow the NO command

Operand Usage

_NO returns a bit field indicating which threads are running. For example, 0 means no threads are running, 1 means only thread 0 is running, 3 means threads 0 and 1 are running, and 255 means all 8 threads are running).

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

```
#A      ;'Program A
NO      ;'No Operation
NO This Program      ;'No Operation
NO Does Absolutely   ;'No Operation
NO Nothing           ;'No Operation
EN      ;'End of Program
```


NZ	Syntax:	Explicit & Implicit
	Operands:	_NZn
	Burn:	burnable with BN
Notch Zero		

Full Description

The NZ command sets the real part of the notch zero.

Arguments

NZ n,n,n,n,n,n,n,n or NZA=n where

n is ranges from 1 Hz to 1 / (16 * update period)

update period = TM/(10⁶)

n = ? Returns the value of the Notch filter zero for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0.5
Default Format	N/A

Operand Usage

_NZn contains the value of the Notch filter zero for the specified axis.

Related Commands

NB - Notch Bandwidth

NF - Notch Filter

Examples:

```
| NZA = 10           Sets the real part of the notch pole to 10/2 Hz
```

OA	Syntax:	Explicit & Implicit
	Operands:	_OAn
	Burn:	burnable with BN
Off on encoder failure		

Full Description

Turns on or off encoder failure detection. The controller can detect a failure on either or both channels of the encoder. This is accomplished by checking on whether motion of at least 4 counts is detected whenever the torque exceeds a preset level (OV) for a specified time (OT). Note that for this function to work properly it is necessary to have a non-zero value for KI.

The OA command works like the OE command: if OA is set to 1 and an encoder failure occurs, the axis goes into the motor off (MO) state and the stop code (SC) is set to 12. The encoder failure detection will shut the motor off regardless of profiling status, but the stop code is not updated unless the axis is executing a profiled move at the time of the detection of the encoder failure.

If included in the application program and OE is set to 1 for the particular axis, #POSERR will run when an encoder failure is detected.

Arguments

OAn,n,n,n,n,n,n,n where
n is 0 or 1 with 1 enabling this feature.
? returns the last value set

Operand Usage

_OAn contains the OA value for the specified axis.

Usage

Usage and Default Detail

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-4xxx, DMC-18x6
Default Value	0
Default Format	1.0

Related Commands

OT - Off on encoder failure time
OV - Off on encoder failure voltage

Examples:

```
#setup
OTX=10;' Set time to 10 milliseconds
OVX=5;' Set voltage to 5
OAX=1;' Enable encoder detection feature
EN

REM #POSERR example for checking to see if encoder failure occurred
REM The stop code will only update of the profiler is running at the time
REM the encoder failure is detected.
#POSERR
~a=0
#loop
IF _MO~a=1
```

```
IF ((_TE~a<_ER~a)&(_OE~a)&(_OA~a))
  MG "possible encoder failure on ",~a{Z1.0}," axis"
ENDIF
ENDIF
~a=~a+1
JP#loop,~a<_BV
AI1;'          wait for input 1 to go high
SH;'          enable all axes
RE
```

<h1>OB</h1>	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Output Bit		

Full Description

The OB n, logical expression command defines output bit n as either 0 or 1 depending on the result from the logical expression. Any non-zero value of the expression results in a one on the output.

Arguments

OB n, expression where
n denotes the output bit
expression is any valid logical expression, variable or array element.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

Examples:

```
OB 1, POS=1      If POS 1 is non-zero, Bit 1 is high.
                 If POS 1 is zero, Bit 1 is low
OB 2, @IN[1]&@IN[2]  If Input 1 and Input 2 are both high, then
                 Output 2 is set high
OB 3, COUNT[1]   If the element 1 in the array is zero, clear bit 3
OB N, COUNT[1]  If element 1 in the array is zero, clear bit N
```

OC	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	_OC
	<u>Burn:</u>	not burnable
Output Compare		

Full Description

The OC command sets up the Output Compare feature, also known as Pulse on Position. Each set of 4 axes, ABCD and EFGH, has one digital output which can be configured to pulse on a specified axis absolute encoder position, and optionally on a delta encoder change after that. These operations are known as one-shot and circular compare, respectively.

One-Shot Compare: The output compare signal will go low, and stay low at a specified absolute encoder position.

Circular Compare: After the one-shot, the circular compare can be configured to pulse low at a relative delta thereafter.

This function cannot be used with any axis configured for a step motor and the auxiliary encoder of the corresponding axis can not be used while using this function. The OC function requires that the main encoder and auxiliary encoders be configured exactly the same (see the command, CE). For example: CE 0, CE 5, CE 10, CE 15.

OC only requires an encoder, and is independent of axis tuning, and motion profiling.

For circular compare, the output is a low-going pulse with a duration of approximately 250 nanoseconds.

Arguments

OCx = m, n

where

x = A,B,C,D,E,F,G H specifies which main encoder input to be used. For 5-8 axis controllers, two OC functions can work simultaneously, one on axes A,B,C or D and the other on E,F,G or H.

m = Absolute position for first pulse. Integer between -2,147,483,648 and 2,147,483,647. The beginning pulse position must be within 65535 counts of the current axis positions when the OC command is executed.

n = Incremental distance between pulses. Integer between -65535 and 65535

0 one shot when moving in the forward direction

-65536 one shot when moving in the reverse direction

OCA = 0 will disable the Circular Compare function on axes A-D.

OCE = 0 will disable the Circular Compare function on axes E-H.

The sign of the second parameter, n, will designate the expected direction of motion for the output compare function. When moving in the opposite direction, output compare pulses will occur at the incremental distance of 65536-|n| where |n| is the absolute value of n.

Operand Usage

_OC contains the state of the OC function

_OC = 0 : OC function has been enabled but not generated any pulses.

_OC = 1: OC function not enabled or has generated the first output pulse.

(on a 5-8 axis controller, _OC is a logical AND of axes A-D and E-H)

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes

Related Commands

AL - Arm Latch
 RL - Report Latched Position
 CE - Configure Encoder

Examples:

```
OCA=300,100;'   Select A encoder as position sensor.  First pulse at 300.
'              Following pulses at 400, 500, 600 ...
```

Output compare can be used to create raster scans. By using circular compare on one axis, followed by an index move on a perpendicular axis, raster patterns are easily made. The following image shows a rastered "dot matrix" type image easily created with output compare and a laser on a two dimensional stage.



OE	Syntax:	Explicit & Implicit
	Operands:	_OEn
	Burn:	burnable with BN
Off-on-Error		

Full Description

The OE command causes the controller to shut off the motor command if a position error exceeds the limit specified by the ER command, an abort occurs from either the abort input or on AB command, or an amplifier error occurs based on the description of the TA command. See the TA command for conditions of an amplifier fault.

If an error or axis-specific abort is detected on an axis, and the motion was executing an independent move, only that axis will be shut off. If the motion is a part of coordinated mode of the types VM, LM or CM, all participating axes will be stopped.

When internal servo amplifiers are installed that can drive brushless motors, such as the AMP-43040 (-D3040), or the AMP-20540, and an axis is driven with an external amplifier, the axis should be setup as a brushed motor (BR1). Otherwise the controller will detect the amplifier as having a hall error and shut down the motor if OE is set to nonzero.

Arguments

OE n,n,n,n,n,n,n,n or OEA=n

OE n,n,n,n,n,n,n,n or OEA=n where

- n = 0 Disables the Off On Error function.
- n = 1 Motor shut off (MO) by position error (TE > ER) or abort input
- n = 2 Motor shut off (MO) by hardware limit switch
- n = 3 Motor shut off (MO) either by position error (TE > ER), hardware limit switch, or abort input
- n <>0 Motor is shut off (MO) by an amplifier error (TA)

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes

Default Value	0
---------------	---

Operand Usage

_OEn contains the status of the off on error function for the specified axis.

Related Commands

AB- Abort

ER - Error limit

SH - Servo Here

#POSERR - Error Subroutine

TA - Tell Amplifier Error

#LIMSWI - Limit switch automatic subroutine

Examples:

```
:OE 1,1,1,1      Enable OE on all axes  
:OE 0            Disable OE on A-axis; other axes remain unchanged  
:OE , ,1,1      Enable OE on C-axis and D-axis; other axes remain unchanged  
:OE 1,0,1,0     Enable OE on A and C-axis; Disable OE on B and D axis  
:
```

OF	Syntax:	Explicit & Implicit
	Operands:	_OFn
	Burn:	burnable with BN
Offset		

Full Description

The OF command sets a bias voltage in the motor command output or returns a previously set value. This can be used to counteract gravity or an offset in an amplifier.

Arguments

OF n,n,n,n,n,n,n,n or OFA=n where
n is a signed number in the range -9.998 to 9.998 volts with resolution of 0.0003.
n = ? Returns the offset for the specified axis.

Operand Usage

_OFn contains the offset for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.4 (1.0 for 18x2)

Related Commands

Examples:

```
OF 1,-2,3,5      Set A-axis offset to 1, the B-axis offset to -2, the C-axis to 3, and the D-axis to
5
OF -3           Set A-axis offset to -3 Leave other axes unchanged
OF ,0          Set B-axis offset to 0 Leave other axes unchanged
OF ?,?,?,?     Return offsets
:-3.0000,0.0000,3.0000,5.0000
OF ?           Return A offset
:-3.0000
OF ,?          Return B offset
:0.0000
```


OP	Syntax:	Implicit Notation Only
	Operands:	_OP0, _OP1, _OP2, _OP3, _OP4
	Burn:	burnable with BN
Output Port		

Full Description

The OP command sends data to the output ports of the controller. Arguments to the OP command are bit patterns (decimal or hex) to set entire banks (bytes) of digital outputs. Use SB, CB or OB to set bits individually.

Arguments

OP m,a,b,c,d

where

m is an integer in the range 0 to 65535 decimal, or \$0000 to \$FFFF hexadecimal. (0 to 255 for 4 axes or less). m is the decimal representation of the general output bits. Output 1 through output 8 for controllers with 4 axes or less. Outputs 1 through output 16 for controller with 5 or more axes.

a,b,c,d represent the extended I/O (where available) in consecutive groups of 16 bits, (values from 0 to 65535). Bit patterns for I/O banks which are configured as inputs have no affect on the bank.

m,a,b,c or d = ? returns the current value of the applicable argument.

The following table describes the arguments used to set the state of outputs.

OP output bank mapping

Argument	Examples	Banks	Bits	Description
m	Set all: OP255;OP\$FF	0	1-8	General Outputs (1-4 axes controllers)
m	Set all: OP65535;OP\$FFFF	0,1	1-16	General Outputs (5-8 axes controllers)
a	Clear all: OP0;OP\$0000	2,3	17-32	Extended I/O
b	Alternating on/off:OP43690;OP\$AAAA	4,5	33-48	Extended I/O
c	Set High Byte:OP65280;OP\$FF00	6,7	49-64	Extended I/O
d	Set Low Byte: OP255;OP\$00FF	8,9	65-80	Extended I/O

The DMC-40x0 comes equipped with 32 bits of extended I/O standard (banks 2-5).

Operand Usage

_OP0 contains the value of the first argument, m

_OP1 contains the value of the first argument, a

_OP2 contains the value of the first argument, b

_OP3 contains the value of the first argument, c

_OP4 contains the value of the first argument, d

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0

Related Commands

SB - Set output bit
CB - Clear output bit
OB - Output Byte

Examples:

```
OP 0      Clear Output Port -- all bits  
OP $85   Set outputs 1,3,8; clear the others  
MG _OP0  Returns the first parameter "m"
```

OT	Syntax:	Explicit & Implicit
	Operands:	_OTn
	Burn:	burnable with BN
Off on encoder failure time		

Full Description

Sets the time in samples (milliseconds for TM1000) that the controller will wait for motion after the OV threshold has been exceeded. The controller can detect a failure on either or both channels of the encoder. This is accomplished by checking on whether motion of at least 4 counts is detected whenever the torque exceeds a preset level (OV) for a specified time (OT). Note that for this function to work properly it is necessary to have a non-zero value for KI.

Arguments

OT n,n,n,n,n,n,n,n where
n is the number of samples between 2 and 32000
? returns the last value set

Operand Usage

_OTn contains the OT value for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-40x0, DMC-18x6
Default Value	30
Default Format	5.0

Related Commands

OA - Off on encoder failure
OV - Off on encoder failure voltage

Examples:

```
#setup
OTX=10;' Set time to 10 milliseconds
OVX=5;' Set voltage to 5
OAX=1;' Enable encoder detection feature
EN
```

OV	Syntax:	Explicit & Implicit
	Operands:	_OVn
	Burn:	burnable with BN
Off on encoder failure voltage		

Full Description

Sets the threshold voltage for detecting an encoder failure. The controller can detect a failure on either or both channels of the encoder. This is accomplished by checking on whether motion of at least 4 counts is detected whenever the torque exceeds a preset level (OV) for a specified time (OT). Note that for this function to work properly it is necessary to have a non-zero value for KI.

The default value for OV is approximately .95 volts. The value should be high enough to guarantee that the motor would overcome any static friction. If it is too low, there will be false triggering of the error condition. The OV value may not be higher than the TL value.

Arguments

OV n,n,n,n,n,n,n,n where
 where n is a positive voltage between 0.001 and 9.9 volts.
 ? returns the last value set

Operand Usage

_OVn contains the OV value for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0.9438
Default Format	1.4

Related Commands

OA - Off on encoder failure
 OT - Off on encoder failure time

Examples:

```
#setup
OTX=10;' Set time to 10 milliseconds
OVX=5;' Set voltage to 5
OAX=1;' Enable encoder detection feature
EN
```

<h1>P2CD</h1>	Syntax:	Operand Only
	Operands:	P2CD
	Burn:	not burnable
Serial port 2 code		

Full Description

P2CD returns the status of the auxiliary serial port (port 2)

Arguments

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

P2CH - Serial port 2 character

P2NM - Serial port 2 number

P2ST - Serial port 2 string

CI - Configure #COMINT

CC - Configure serial port 2

#COMINT - Communication interrupt automatic subroutine

Examples:

```

: ^R ^V
DMC2240 Rev 1.0o
: ^R ^S
: CC 9600,0,0,0
: MG "TEST" {P2};'      send a message to the hand terminal
: MG P2CD;'            no characters entered on hand terminal
0.0000
: MG P2CD;'            the number 6 was pushed on the hand terminal
1.0000
: MG P2CD;'            enter key pushed on hand terminal
3.0000
: MG P2CD;'            the character B was pushed (shift f2) then enter
2.0000

```

<h1>P2CH</h1>	Syntax:	Operand Only
	Operands:	P2CH
	Burn:	not burnable
Serial port 2 character		

Full Description

P2CH returns the last character sent to the auxiliary serial port (port 2)

Arguments

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

P2CD - Serial port 2 code

P2NM - Serial port 2 number

P2ST - Serial port 2 string

CI - Configure #COMINT

CC - Configure serial port 2

#COMINT - Communication interrupt automatic subroutine

Examples:

```

: ^R ^V
DMC2240 Rev 1.0o
: ^R ^S
: CC 9600,0,0,0
: MG "TEST" {P2} ;'send a message to the hand terminal
: MG P2CH {S1} ;'the 6 button was pushed on the hand terminal
6
:

```

<h1>P2NM</h1>	Syntax:	Operand Only
	Operands:	P2NM
	Burn:	not burnable
Serial port 2 number		

Full Description

P2NM returns the last number (followed by carriage return) sent to auxiliary serial port (port 2).

Converts from ASCII (e.g. "1234") to binary so that a number can be stored into a variable and math can be performed on it. Numbers from -2147483648 to 2147483647 can be processed.

Arguments

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

P2CD - Serial port 2 code

P2CH - Serial port 2 character

P2ST - Serial port 2 string

CI - Configure #COMINT

CC - Configure serial port 2

#COMINT - Communication interrupt automatic subroutine

Examples:

```

: ^R^V
DMC2240 Rev 1.0o
: ^R^S
: CC 9600,0,0,0
: MG "TEST" {P2} ;'send a message to the hand terminal
: x = P2NM ;'the 1, 2, 3, <enter> buttons were pushed
: MG x
123.0000
:

```

<h1>P2ST</h1>	Syntax:	Operand Only
	Operands:	P2ST
	Burn:	not burnable
Serial port 2 string		

Full Description

P2ST returns the last string (followed by carriage return) sent to auxiliary serial port (port 2)
NO MORE THAN SIX CHARACTERS CAN BE ACCESSED.

Arguments

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

P2CD - Serial port 2 code
P2CH - Serial port 2 character
P2NM - Serial port 2 number
CI - Configure #COMINT
CC - Configure serial port 2
#COMINT - Communication interrupt automatic subroutine

Examples:

```
:CC 9600,0,1,0
:MG "TEST" {P2} ;'send a message to the hand terminal
:MG P2ST {S3} ;'the characters ABC were entered
ABC
```


PA	Syntax:	Explicit & Implicit
	Operands:	_PAn
	Burn:	burnable with BN
Position Absolute		

Full Description

The PA command sets the end target of the Position Absolute Mode of Motion. The position is referenced to the absolute zero.

Arguments

PA n,n,n,n,n,n,n or PAA=n

where

n is a signed integers in the range -2147483647 to 2147483648 decimal. Units are in encoder counts.

n = ? Returns the commanded position at which motion stopped.

Operand Usage

_PAn contains the last commanded position at which motion stopped.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	N/A

Related Commands

PR - Position relative

SP - Speed

AC - Acceleration

DC - Deceleration

BG - Begin

Examples:

```

:PA 400,-600,500,200      A-axis will go to 400 counts B-axis will go to -600 counts
                          C-axis will go to 500 counts D-axis will go to 200 counts
:BG                      Execute Motion
:PA ?,?,?,?             Returns the current commanded position after motion has completed
400, -600, 500, 200
:PA 700                  A-axis will go to 700 on the next move while the
:BG                      B,C and D-axis will travel the previously set relative distance
                          if the preceding move was a PR move, or will not move if the
                          preceding move was a PA move.

```

PF	Syntax:	Implicit Notation Only
	Operands:	_PF
	Burn:	burnable with BN
Position Format		

Full Description

The PF command allows the user to format the position numbers such as those returned by TP. The number of digits of integers and the number of digits of fractions can be selected with this command. An extra digit for sign and a digit for decimal point will be added to the total number of digits. If PF is negative, the format will be hexadecimal and a dollar sign will precede the characters. Hex numbers are displayed as 2's complement with the first bit used to signify the sign.

If a number exceeds the format, the number will be displayed as the maximum possible positive or negative number (i.e. 999.99, -999, \$8000 or \$7FF). The PF command can be used to format values returned from the following commands:

BL ? LE ?
 DE ? PA ?
 DP ? PR ?
 EM ? TN ?
 FL ? VE ?
 IP ? TE
 TP

Arguments

PF m.n where

m is an integer between -8 and 10 which represents the number of places preceding the decimal point. A negative sign for m specifies hexadecimal representation.

n is an integer between 0 and 4 which represent the number of places after the decimal point.

n = ? Returns the value of m.

Operand Usage

_PF contains the value of the position format parameter.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	10.0
Default Format	2.1 (10.0 for 18x2)

Related Commands

Examples:

```
TPX      Tell position of X
:0       Default format
PF 5.2   Change format to 5 digits of integers and 2 of fractions
TPX      Tell Position
:21.00
PF-5.2   New format. Change format to hexadecimal
TPX      Tell Position
: $00015.00      Report in hex
```

PL	Syntax:	Explicit & Implicit
	Operands:	_PLn
	Burn:	burnable with BN
Pole		

Full Description

The PL command adds a low-pass filter in series with the PID compensation.

The crossover frequency can be entered directly as an argument to PL. The minimum frequency for pole placement is 1 Hz. and the maximum is 1/(4*TM).

To maintain compatibility with earlier versions, a value less than 1 may be specified using the following formula.

The digital transfer function of the filter is $(1 - n) / (Z - n)$ and the equivalent continuous filter is $A/(S+A)$ where A is the filter cutoff frequency: $A=(1/T) \ln(1/n)$ rad/sec and T is the sample time.

To convert from the desired crossover (-3 dB) frequency in Hertz to the value given to PL, use the following formula

$$n = e^{-T \cdot f_c \cdot 2\pi}$$

where:

n is the argument given to PL

T is the controller's servo loop sample time in seconds (TM divided by 1,000,000)

Fc is the crossover frequency in Hertz

Example: Fc=36Hz TM=1000 $n=e^{-(0.001*36*2*\pi)}=0.8$

n	Fc (Hz)
0	Infinite (off)
0.2	256
0.4	145
0.6	81
0.8	36
0.999	0

Arguments

PL n,n,n,n,n,n,n,n or PLA=n

Frequency Argument

n is a positive integer in the range of 1 to Fmax and corresponds to the crossover frequency that the poll will create.

Fmax is given by $1/(4*TM)$

Calculated Pole Argument (deprecated)

n is a positive number in the range 0 to 0.9999.

n = ? Returns the value of the pole filter for the specified axis.

Operand Usage

_PLn contains the value of the pole filter for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0.0
Default Format	

Related Commands

KD - Derivative

KP - Proportional

KI - Integral Gain

Examples:

```
Set A-axis Pole to 0.95, B-axis to 0.9, C-axis to 0.8, D-axis pole to 0.822
```

```
PL .95,.9,.8,.822
```

```
:
```

```
Query all Pole values
```

```
PL ?,?,?,?
```

```
:0.9527,0.8997,0.7994,0.8244
```

```
Return A Pole only
```

```
PL?
```

```
:0.9527
```

PR	Syntax:	Explicit & Implicit
	Operands:	_PRn
	Burn:	burnable with BN
Position Relative		

Full Description

The PR command sets the incremental distance and direction of the next move. The move is referenced with respect to the current position. .

Arguments

PR n,n,n,n,n,n,n,n or PRA=n where

n is a signed integer in the range -2147483648 to 2147483647 decimal. Units are in encoder counts

n = ? Returns the current incremental distance for the specified axis.

Operand Usage

_PRn contains the current incremental distance for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

AC - Acceleration

BG - Begin

DC - Deceleration

IP - Increment Position

PA - Position Absolute

PF - Position Formatting

SP - Speed

Examples:

```
PR 100,200,300,400      On the next move the A-axis will go 100 counts,
BG                      the B-axis will go to 200 counts forward, C-axis will go 300 counts and the D-axis will go
400 counts.
PR ?,?,?,?            Return relative distances
:100, 200, 300
PR 500                Set the relative distance for the A axis to 500
BG                      The A-axis will go 500 counts on the next move while the B-axis will go its previously set
relative distance.
```

PT	Syntax:	Explicit & Implicit
	Operands:	_PTn
	Burn:	not burnable
Position Tracking		

Full Description

The PT command will place the controller in the position tracking mode. In this mode, the controller will allow the user to issue absolute position commands on the fly. The motion profile is trapezoidal with the parameters controlled by acceleration, deceleration, and speed (AD, DC, SP). The absolute position may be specified such that the axes will begin motion, continue in the same direction, reverse directions, or decelerate to a stop. When an axis is in the PT mode the ST command will exit the mode. The PA command is used to give the controller an absolute position target. Motion commands other than PA are not supported in this mode.

The BG command is not used to start the PT mode. The AM and MC trip points are not valid in this mode. It is recommended to use MF and MR as trip points with this command, as they allow the user to specify both the absolute position, and the direction. The AP trip point may also be used.

Arguments

PT n,n,n,n,n,n,n,n

where

n=0 or 1 where 1 designates the controller is in the special mode.

n=? returns the current setting

Operand Usage

_PTn contains the set state of position tracking, 1 or 0

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.0

Related Commands

AC - Acceleration

DC - Deceleration

PA - Position Absolute

SP - Speed

Examples:

```
#A
PT1,1,1,1,1;'      Enable the position tracking mode for axes X, Y, Z, and W
'                  NOTE: The BG command is not used to start the PT mode.
#LOOP;'           Create label #LOOP in a program. This small program will
'                  update the absolute position at 100 Hz. Note that the
'                  user must update the variables V1, V2, V3 and V4 from the
'                  host PC, or another thread operating on the controller.
'
PA V1,V2,V3,V4;'  Command XYZW axes to move to absolute positions. Motion
'                  begins when the command is processed. BG is not used
```

```
'           to begin motion in this mode.  In this example, it is
'           assumed that the user is updating the variables at a
'           specified rate.  The controller will update the new
'           target position every 10 milliseconds (WT10).
WT10;'      Wait 10 milliseconds
JP#LOOP;'   Repeat by jumping back to label LOOP
```

PV	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	_PVn
	<u>Burn:</u>	not burnable
PVT Data		

Full Description

The PV command is used to enter PVT data into the PVT buffer by specifying the target position, velocity, and delta time. For more details on PVT mode of motion see the user manual.

Arguments

PVa=p,v,t where

a specifies the axis

p is the relative target position specified in counts. $-44,000,000 \leq p \leq 44,000,000$.

v is the target velocity specified in counts per second. $-22,000,000 \leq v \leq 22,000,000$. Integer values only for p and v

t is the time to achieve target position and velocity. t is in even samples $2 \leq t \leq 2048$. If t=0 then the PVT mode is exited. If t = -1 the PVT buffer is cleared. t is in samples and sample time is defined by TM (With a default TM of 1000, 1024 samples is 1 second). If t is omitted then the previous value is used.

Operand Usage

_PVa contains the number of spaces available in the PV buffer for the specified axis. Each axis has a 255 segment PV buffer

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-4xxx, DMC-18x6, others via upgrade
Default Value	N/A
Default Format	N/A

Related Commands

BT - Begin PVT Motion

MF - Forward Motion to Position Trippoint

MR - Reverse Motion to Position Trippoint

Examples

Desired X/Y Trajectory

X Position (relative/absolute)	X Speed at end of time period (c/s)	Time (ms at TM1000) (relative/time from start)	Y Position (relative/absolute)	Y Speed at end of time period (c/s)	Time (ms at TM1000) (relative/time from start)
0/0	0	0/0	0/0	0	0/0
100/100	200	256/256	-50/-50	500	100/100
200/300	200	50/306	-100/-150	-100	510/610
300/600	0	50/356	300/150	0	50/660

```
DP0,0;'          Define zero position
PVX=100,200,256;' Command X axis to move 100 counts reaching an ending speed of 200c/s in 256
samples
```



```
PVY=-50,500,100;'      Command Y axis to move -50 counts reaching an ending speed of 500c/s in 100
samples
PVY=-100,-100,510;'   Command Y axis to move -100 counts reaching an ending speed of -100c/s in 510
samples
PVX=200,200,50;'      Command X axis to move 200 counts reaching an ending speed of 200c/s in 50
samples
PVX=300,0,50;'        Command X axis to move 300 counts reaching an ending speed of 0c/s in 50
samples
PVY=300,0,50;'        Command Y axis to move 300 counts reaching an ending speed of 0c/s in 50
samples
PVY=,,0;'             Exit PVT mode on Y axis
PVX=,,0;'             Exit PVT mode on X axis
'                     When the PVT mode is exited, the axis will be in the "SH" state
'                     (assuming position error is not exceeded, etc)
BTXY;'               Begin PVT on X and Y axis
AMXY;'               Trip point will block until PVT motion on X AND Y is complete
EN;'                 End program
```

PW	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Password		

Full Description

The password can be set with the command `PW password,password` where the password can be up to 8 alphanumeric characters. The default value after master reset is a null string. The password can only be changed when the controller is in the unlocked state (^L^K). The password is burnable but cannot be interrogated. If you forget the password you must master reset the controller to gain access.

Arguments

`PW n,n` where
 n is a string from 0 to 8 characters in length

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes (No for 40x0)
Command Line	Yes
Controller Usage	All
Default Value	"" (null string)
Default Format	N/A

Related Commands

<control>L<control>K - Lock/Unlock
 ED - Edit program
 UL - Upload program
 LS - List program
 TR - Trace program

Examples:

```
:PWtest,test    Set password to "test"
:^L^K test,1    Lock the program
:ED            Attempt to edit program
```

QD	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Download Array		

Full Description

The QD command transfers array data from the host computer to the controller. QD array[], start, end requires that the array name be specified along with the index of the first element of the array and the index of the last element of the array. The array elements can be separated by a comma (,) or by <CR> <LF>. The downloaded array is terminated by a \.

It is recommended to use the array download functions available through the GalilTools software and drivers rather than directly using the QD command.

Arguments

QD array[],start,end where

array[] is valid array name

start is index of first element of array (default=0)

end is index of last element of array (default = size-1)

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	start=0, end=size-1
Default Format	N/A (Position Format for 18x2)

Related Commands

QU - Upload array

Examples

```
:DM array[5]           Dimension array
:QD array[]           Download values to array
1,2,3,4,5\
:QU array[],0,4,1     Upload the array
:1.0000, 2.0000, 3.0000, 4.0000, 5.0000
:QD array[],2,4       Download a subset
9,8,7\
:QU array[],0,4,1
:1.0000, 2.0000, 9.0000, 8.0000, 7.0000
```

Hint: This log is from Hyperterm, a non-Galil software.

QH	Syntax:	Accepts Axis Mask
	Operands:	_QHn
	Burn:	not burnable
Hall State		

Full Description

The QH command transmits the state of the Hall sensor inputs. The value is decimal and represents an 8 bit value.

Bit Status

07	Undefined (set to 0)
06	Undefined (set to 0)
05	Undefined (set to 0)
04	Undefined (set to 0)
03	Undefined (set to 0)
02	Hall C State
01	Hall B State
00	Hall A State

When using the AMP-43540 and AMP-43640, the BA command must be issued before QH will report the hall state status.

Arguments

QHn returns the Hall sensor input byte where
n=A, B, C, D, E, F, G, H

Usage

While Moving Yes Default Value 0
In a Program Yes Default Format 1.0
Command Line Yes
Controller Usage DMC-40x0-D430x0

Operand Usage

_QHn Contains the state of the Hall sensor inputs

Related Commands

PA
Position Absolute
BS
Brushless Setup

EXAMPLE:

QHY

:6 Hall inputs B and C active on Y axis

QR

Examples:

QR	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	not burnable
I O Data Record		

Full Description

The QR command causes the controller to return a record of information regarding controller status. This status information includes 4 bytes of header information and specific blocks of information as specified by the command arguments. The details of the status information is described in Chapter 4 of the user's manual.

Arguments

QR nnnnnnnnnn where

n is A,B,C,D,E,F,G,H,S,T, or I or any combination to specify the axis, axes, sequence, or I/O status

S and T represent the S and T coordinated motion planes

I represents the status of the I/O

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	
Default Value	N/A
Default Format	N/A

Related Commands

QZ - Return DMA / Data Record information

Note: The Galil windows terminal will not display the results of the QR command since the results are in binary format.

Examples:

QS	Syntax:	Accepts Axis Mask
	Operands:	_QSn
	Burn:	not burnable
Error Magnitude		

Full Description

The QS command reports the magnitude of error, in step counts, for axes in Stepper Position Maintenance mode. A step count is directly proportional to the resolution of the step drive.

The result of QS is modularized so that result is never greater than 1/2 the revolution of the stepper motor.

Largest possible QS result = $0.5 * YA * YB$

Arguments

QS nnnnnnnn or QSn = ? where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

Operand Usage

_QSn contains the error magnitude in drive step counts for the given axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.4

Related Commands

YA - Step Drive Resolution

YB - Step Motor Resolution

YC - Encoder Resolution

YR - Error Correction

YS - Stepper Position Maintenance Mode Enable, Status

Examples:

- For an SDM-44140 microstepping drive, query the error of B axis:


```
:QSB=?
:253
```

 This shows 253 step counts of error. The SDM-44140 resolution is 64 microsteps per full motor step, nearly four full motor steps of error.
- Query the value of all axes:


```
:QS
:0,253,0,0,0,0,0,0
```

 Response shows all axes error values

QU	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Upload Array		

Full Description

The QU command transfers array data from the controller to a host computer. The QU requires that the array name be specified along with the first element of the array and last element of the array. The uploaded array will be followed by a <control>Z as an end of text marker.

The GalilTools array upload functions can be used to upload array data in .csv format.

Arguments

QU array[,start,end,delim where

"array[]" is a valid array name

"start" is the first element of the array (default=0)

"end" is the last element of the array (default = last element)

"delim" specifies the character used to delimit the array elements. If delim is 1, then the array elements will be separated by a comma. Otherwise, the elements will be separated by a carriage return.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

QD - Download array

Examples

```

:DM array[5]           Dimension Array
:QU array[,0,4,1      Upload Array
:0.0000, 0.0000, 0.0000, 0.0000, 0.0000
:array[0]=9           Set value
:array[1]=1
:QU array[,0,4,1
:9.0000, 1.0000, 0.0000, 0.0000, 0.0000
:array[0]=?          Alternative method to return just one array value
 9.0000
:

```

QZ	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Return Data Record information		

Full Description

The QZ command is an interrogation command that returns information regarding data record transfers. The controller's response to this command will be the return of 4 integers separated by commas. The four fields represent the following:

First field returns the number of axes.

Second field returns the number of bytes to be transferred for general status

Third field returns the number bytes to be transferred for coordinated move status

Fourth field returns the number of bytes to be transferred for axis specific information

Arguments

QZ

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

DR

Ethernet data record update rate

RA

Examples:

RA	<u>Syntax:</u>	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
Record Array		

Full Description

The RA command selects one through eight arrays for automatic data capture. The selected arrays must be dimensioned by the DM command. The data to be captured is specified by the RD command and time interval by the RC command.

Arguments

RA n[],m[],o[],p[],q[],r[],s[],t[]

where

n,m,o,p,q,r,s, and t are dimensioned arrays as defined by DM command. The square brackets are empty, [].

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

DM - Dimension Array

RD - Record Data

RC - Record Interval

Examples:

```
#Record; '      Label
DM POS[100]; '  Define array
RA POS[]; '     Specify Record Mode
RD _TPA; '      Specify data type for record
RC 1; '         Begin recording at 2 msec intervals
PR 1000;BG; '   Start motion
EN; '           End
```

Hint: The record array mode is useful for recording the real-time motor position during motion. The data is automatically captured in the background and does not interrupt the program sequencer. The record mode can also be used for a teach or learn of a motion path.

GalilTools: The GalilTools Realtime scope can often be used as an alternative to record array.

RC	Syntax:	Implicit Notation Only
	Operands:	_RC
	Burn:	not burnable
Record		

Full Description

The RC command begins recording for the Automatic Record Array Mode (RA). RC 0 stops recording.

Firmware Note: Do not allocate or deallocate arrays (DM,DA) while the Automatic Record Array Mode is running.

GalilTools Note: Do not download arrays from GalilTools, or call the arrayDownload() or arrayDownloadFile() functions while automatic record array mode is running.

Arguments

RC n,m

where

n is an integer 1 thru 8 and specifies 2^n samples between records. RC 0 stops recording.

m is optional and specifies the number of records to be recorded. If m is not specified, the array bounds will be used. A negative number for m causes circular recording over array addresses 0 to m-1.

n = ? Returns status of recording. '1' if recording, '0' if not recording.

Note: The address for the array element for the next recording can be interrogated with _RD.

Operand Usage

_RC contains status of recording. '1' if recording, '0' if not recording.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0

Related Commands

DM - Dimension Array

RD - Record Data

RA - Record Array Mode

Examples:

```
#RECORD; '          Record label
DM Torque[1000]; '  Define Array
RA Torque[]; '     Specify Array to record data
RD _TTA; '         Specify Data Type
RC 2; '           Begin recording and set 4 msec between records
JG 1000;BG; '     Begin motion
#A;JP #A,_RC=1; '  Loop until done
MG "DONE RECORDING"; ' Print message
EN; '            End program
```


RD	Syntax:	Other
	Operands:	_RD
	Burn:	not burnable
Record Data		

Full Description

The RD command specifies the data type to be captured for the Record Array (RA) mode. The command type includes:

Data sources for automatic record mode

Source name (where 'n' is the axis specifier, A-H)	Description
TIME	Time in servo sample as read by the TIME command
_AFn	Analog Input Value (+32767 to -32768). The analog inputs are limited to those which correspond to an axis on the controller.
_DEn	2nd encoder
_TPn	Position
_TEn	Position error
_RPn	Commanded Position (_SHn also valid)
_RLn	Latched Position
_TI	Input States
_OP	Output State
_TSn	Switches, only 0-4 bits valid
_SCn	Stop code
_TTn	Tell torque (Note: the values recorded for torque are in the range of +/- 32767 where 0 is 0 torque, -32767 is -10 volt command output, and +32767 is +10 volt.
_TVn	Filtered velocity. (Note: will be 65 times greater than TV command)
_TDn	Stepper Position

Arguments

RD m1, m2, m3, m4, m5, m6, m7, m8

where

the arguments are the data sources to be captured using the record array feature. The order is important. Each data type corresponds with the array specified in the RA command.

Operand Usage

_RD contains the address for the next array element for recording.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

RA - Record Array
RC - Record Interval
DM - Dimension Array

Examples

```
DM ERRORA[50],ERRORB[50];'      Define arrays
RA ERRORA[],ERRORB[];'         Specify arrays to be recorded
RD _TEA,_TEB;'                 Specify data source
RC1;'                           Begin recording, period is once every other servo sample
JG 1000;BG;'                   Begin motion
```

GalilTools: The GalilTools Realtime scope can often be used as an alternative to record array.

RE	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
Return from Error Routine		

Full Description

The RE command is used to end the following error automatic subroutines.

#POSERR

#LIMSWI

#TCPERR

#AMPERR (if equipped with internal amplifiers)

#SERERR (if equipped with -SER firmware)

An RE at the end of these routines causes a return to the main program. Care should be taken to ensure the error conditions no longer are present to avoid re-entering the subroutines.

Trippoint states can be preserved or cleared with RE1 or RE0, respectively.

A motion trippoint like MF or MR requires the axis to be actively profiling in order to be restored with the RE1 command.

To avoid returning to the main program on an interrupt, use the ZS command to zero the subroutine stack.

Arguments

RE n

where

n = 1 Restores state of trippoint

n = 0 Clears the interrupted trippoint

no argument clears the interrupted trippoint

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All

Related Commands

#AMPERR - Amplifier error automatic subroutine

#SERERR - Serial Encoder Error Automatic Subroutine

#TCPERR - Ethernet communication error automatic subroutine

#POSERR - Position error automatic subroutine

#LIMSWI - Limit switch automatic subroutine

Examples:

```
REM dummy loop
#A
JP #A
EN

#POSERR;'      Begin Error Handling Subroutine
MG "ERROR";'   Print message
SB1;'         Set output bit 1
RE;'          Return to main program and clear trippoint
```

<h1>REM</h1>	Syntax:	Other
	Operands:	none
	Burn:	not burnable
Remark		

Full Description

REM is used for comments. The REM statement is NOT a controller command. Rather, it is recognized by Galil PC software, which strips away the REM lines before downloading the DMC file to the controller. REM differs from NO (or ') in the following ways:

- (1) NO (or ') comments are downloaded to the controller and REM comments aren't
- (2) NO (or ') comments take up execution time and REM comments don't; therefore, REM should be used for code that needs to run fast.
- (3) REM comments cannot be recovered when uploading a program but NO (or ') comments are recovered. Thus the uploaded program is less readable with REM.
- (4) NO (or ') comments take up program line space and REM lines don't.
- (5) REM comments must be the first and only thing on a line, whereas NO (or ') can be used to place comments to the right of code (after a semicolon) on the same line

NO (or ') should be used instead of REM unless speed or program space is an issue.

Arguments

REM n

where

n is a text string comment

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

NO (' apostrophe also accepted) - No operation (comment)

Examples:

RI	Syntax:	Embedded Only
	Operands:	none
	Burn:	not burnable
Return from Interrupt Routine		

Full Description

The RI command is used to end the interrupt subroutine beginning with the label #ININT. An RI at the end of this routine causes a return to the main program. The RI command also re-enables input interrupts. If the program sequencer was interrupted while waiting for a trippoint, such as WT, RI1 restores the trippoint on the return to the program. A motion trippoint such as MF or MR requires the axis to be actively profiling in order to be restored with RI1. RI0 clears the trippoint. To avoid returning to the main program on an interrupt, use the command ZS to zero the subroutine stack. This turns the jump subroutine into a jump only.

Arguments

RI n

where

- n = 0 Clears the interrupted trippoint
- n = 1 Restores state of trippoint
- no argument clears the interrupted trippoint

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

#ININT - Input interrupt subroutine

II - Enable input interrupts

Examples:

```
#A;II1;JP #A;EN ;'Program label
#ININT ;'Begin interrupt subroutine
MG "INPUT INTERRUPT" ;'Print Message
SB 1 ;'Set output line 1
RI 1 ;'Return to the main program and restore trippoint
```

RL	Syntax:	Accepts Axis Mask
	Operands:	_RLn
	Burn:	not burnable
Report Latched Position		

Full Description

The RL command will return the last position captured by the latch. The latch must first be armed by the AL command and then a 0 must occur on the appropriate input. Each axis uses a specific general input for the latch input:

X (A) axis latch Input 1
 Y (B) axis latch Input 2
 Z (C) axis latch Input 3
 W (D) axis latch Input 4
 E axis latch Input 9
 F axis latch Input 10
 G axis latch Input 11
 H axis latch Input 12

The armed state of the latch can be configured using the CN command.

Note: The Latch Function works with the main encoder. When working with a stepper motor without an encoder, the latch can be used to capture the stepper position. To do this, place a wire from the controller Step (PWM) output into the main encoder input, channel A+. Connect the Direction (sign) output into the channel B+ input. Configure the main encoder for Step/Direction using the CE command. The latch will now capture the stepper position based on the pulses generated by the controller.

Arguments

RL nnnnnnnnnn

where

n is X,Y,Z,W,A,B,C,D,E,F,G or H or any combination to specify the axis or axes

Operand Usage

_RLn contains the latched position of the specified axis.

RELATED COMMAND:

AL - Arm Latch

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

Examples:

```
JG ,5000      Set up to jog the B-axis
BGB          Begin jog
ALB          Arm the B latch; assume that after about 2 seconds, input goes low
RLB          Report the latch
:10000
```


RP	Syntax:	Accepts Axis Mask
	Operands:	RPn
	Burn:	not burnable
Reference Position		

Full Description

The RP command returns the commanded reference position of the motor(s).

Arguments

RP nnnnnnnnnn

where

n is A,B,C,D,E,F,G,H or N, or any combination to specify the axis or axes`

Operand Usage

_RPn contains the commanded reference position for the specified axis.

RELATED COMMAND:

TP

Tell Position

Note: The relationship between RP, TP and TE: TEA equals the difference between the reference position, RPA, and the actual position, TPA.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

Examples:

Assume that ABC and D axes are commanded to be at the positions 200, -10, 0, -110 respectively. The returned units are in quadrature counts.

RS	Syntax:	Two Letter Only
	Operands:	_RS
	Burn:	not burnable
Reset		

Full Description

The RS command resets the state of the processor to its power-on condition. The previously saved state of the hardware, along with parameter values and saved program, are restored.

RS-1 Soft master reset. Restores factory defaults without erasing EEPROM. To restore saved EEPROM settings use RS with no arguments.

Arguments

N/A

Operand Usage

_RS returns the state of the processor on its last power-up condition. The value returned is the decimal equivalent of the 4 bit binary value shown below.

- Bit 3 For master reset error
- Bit 2 For program checksum error
- Bit 1 For parameter checksum error
- Bit 0 For variable checksum error

At startup the controller operating system verifies the firmware sector. If there is a checksum error in firmware, it is not loaded and the controller will boot to monitor mode.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	
Command Line	Yes
Controller Usage	
Default Value	
Default Format	

In a Program No

Command Line Yes

Can be Interrogated Yes

Used as an Operand Yes

Related Commands

^R^S - Master Reset

Examples:

```
| RS      Reset the hardware
```

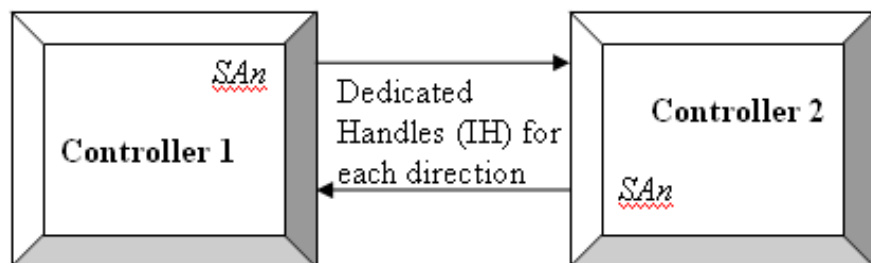
SA	Syntax:	Explicit Notation Only
	Operands:	_SA _{n0} ,_SA _{n1} ,_SA _{n2} ,_SA _{n3} , _SA _{n4} ,_SA _{n5} ,_SA _{n6} ,_SA _{n7}
	Burn:	not burnable
Send Command		

Full Description

SA sends a command, and optionally receives a response, from one controller to another via Ethernet.

Important Notes

1. SA is non-blocking. A wait (e.g. WT10) must occur between successive calls to SA.
2. SA is not valid over a handle configured for Modbus (port 502).
3. When writing multi-threaded DMC code, send all traffic from only one thread or use individual handles (IH) for each individual thread.
4. The Galil that establishes the connection and issues the SA command is called the master. The Galil that receives the connection and answers the SA is the slave. For both controllers in a connection to be both masters and slaves, open two Ethernet handles. Each of the controllers is a master over one of the handles, and a slave on the other.



Arguments

SAh=arg

SAh=arg, arg, arg, arg, arg, arg, arg, arg,

where

h is the handle being used to send commands to the slave controller.

arg is a number, controller operand, variable, mathematical function, or string. The range for numeric values is 4 bytes of integer followed by two bytes of fraction.

Strings are encapsulated by quotations.

Typical usage would have the first argument as a string such as "KI" and the subsequent arguments as the arguments to the command: Example SAF="KI", 1, 2 would send the command: KI1,2

There is a 78 character maximum payload length for the SA command.

Operand Usage

SA{hn} gives the value of the response to the command sent with an SA command. The h value represents the handle A thru H and the n value represents the specific field returned from the controller (0-7). If the specific field is not used, the operand will be -2³¹.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes

In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

IH - Open IP Handle

Examples:

```
#A
IHA=10,0,0,12;'      Configures handle A to be connected to a controller with IP 10.0.0.12
#B;JP#B,_IHA2<>-2;' Wait for connection
SAA="KI", 1, 2  ;'   Sends the command to handle A (slave controller):  KI 1,2
WT10
SAA="TE";'         Sends the command to handle A (slave controller):  TE
WT10
MG_SAA0;'          Display the content of the operand_SAA (first response to ;'TE command)
MG_SAA1;'          Display the content of the operand_SAA (2nd response to TE ;'command)
SAA="TEMP=",16;'   Sets variable temp equal to 16 on handle A controller
EN;'              End Program
```

SB	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	none
	<u>Burn:</u>	not burnable
Set Bit		

Full Description

The SB command sets a particular digital output, setting the output to logic 1. The SB and CB (Clear Bit) instructions can be used to control the state of output lines.

SB can be used to set the outputs of extended I/O which have been configured as outputs. See the CO command.

The SB command can also be used with modbus devices to toggle remote outputs.

Arguments

SB n

where

n is an integer which represents a specific controller output bit to be set high.

When using Modbus devices, the I/O points of the modbus devices are calculated using the following formula:

$$n = (\text{SlaveAddress} * 10000) + (\text{HandleNum} * 1000) + ((\text{Module} - 1) * 4) + (\text{Bitnum} - 1)$$

Slave Address is used when the ModBus device has slave devices connected to it and specified as Addresses 0 to 255. Please note that the use of slave devices for modbus are very rare and this number will usually be 0.

HandleNum is the handle specifier from A to H.

Module is the position of the module in the rack from 1 to 16.

BitNum is the I/O point in the module from 1 to 4.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All

Related Commands

CB - Clear Bit

OB - Output Bit

OP - Output Port

Examples:

```
SB 5; '      Set digital output 5
SB 1; '      Set digital output 1
CB 5; '      Clear digital output 5
```


| CB 1; ' Clear digital output 1

SC	Syntax:	Accepts Axis Mask
	Operands:	_SCn
	Burn:	not burnable
Stop Code		

Full Description

The Stop Code command returns a number indicating why a motor has stopped. The controller reponds with a number interpreted as follows:

Stop Code Table

Stop Code Number	Meaning
0	Motors are running, independent mode
1	Motors decelerating or stopped at commanded independent position
2	Decelerating or stopped by FWD limit switch or soft limit FL
3	Decelerating or stopped by REV limit switch or soft limit BL
4	Decelerating or stopped by Stop Command (ST)
6	Stopped by Abort input
7	Stopped by Abort command (AB)
8	Decelerating or stopped by Off on Error (OE1)
9	Stopped after finding edge (FE)
10	Stopped after homing (HM) or Find Index (FI)
11	Stopped by selective abort input
12	Decelerating or stopped by encoder failure (OA1) (DMC-40x0/18x6)
15	Amplifier Fault (DMC-40x0)
16	Stepper position maintainance error
30	Running in PVT mode
31	PVT mode completed normally
32	PVT mode exited because buffer is empty
50	Contour Running
51	Contour Stop
99	MC timeout
100	Motors are running, Vector Sequence
101	Motors stopped at commanded vector

Arguments

SC nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

Operand Usage

_SCn contains the value of the stop code for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (no RIO)	Yes

In a Program	Yes
Command Line	Yes
Default Value	N/A
Default Format	3.0

Related Commands

LU LCD Update

Examples:

```
| Tom =_SCD Assign the Stop Code of D to variable Tom
```

SD	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_SDn
	<u>Burn:</u>	burnable with BN
Switch Deceleration		

Full Description

The Limit Switch Deceleration command (SD) sets the linear deceleration rate of the motors when a limit switch has been reached. The parameters will be rounded down to the nearest factor of 1024 and have units of counts per second squared.

Arguments

SD n,n,n,n,n,n,n,n

SDA=n

where

n is an unsigned numbers in the range 1024 to 1073740800

n = ? Returns the deceleration value for the specified axes.

Operand Usage

_SDn contains the deceleration rate for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256000

Related Commands

AC - Acceleration

DC - Deceleration

PR - Position Relative

PA - Position Absolute

SP - Speed

Examples:

```
PR 10000          Specify position
AC 2000000        Specify acceleration rate
DC 1000000        Specify deceleration rate
SD 5000000        Specify Limit Switch Deceleration Rate
SP 5000           Specify slew speed
```

Note: The SD command may be changed during the move in JG move, but not in PR or PA move.

SH	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	burnable with BN
Servo Here		

Full Description

The SH commands tells the controller to use the current motor position as the command position and to enable servo control here. This command can be useful when the position of a motor has been manually adjusted following a motor off (MO) command.

Arguments

SH nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

MO - Motor-off

Examples:

SH Servo A,B,C,D motors

SHA Only servo the A motor, the B,C and D motors remain in its previous state.

SHB Servo the B motor; leave the A,C and D motors unchanged

SHC Servo the C motor; leave the A,B and D motors unchanged

SHD Servo the D motor; leave the A,B and C motors unchanged

Note: The SH command changes the coordinate system. Therefore, all position commands given prior to SH, must be repeated. Otherwise, the controller produces incorrect motion.

SI	<u>Syntax:</u>	Explicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Configure the special Galil SSI feature		

Full Description

Synchronous Serial Interface (SSI) allows for serial transmission of absolute position data (either binary or Gray code) from the encoder based on a timed clock pulse train from the controller. Connection between the controller and encoder is based on two signal lines, clock and data, which are usually differential for increased noise immunity. For each sequential clock pulse of the controller, the encoder transmits one data bit from shift registers on the encoder.

There are two items required when connecting an SSI encoder to a DMC-40x0: special SSI firmware and the controller -SSI option.

Clocking in SSI data has a timing overhead which may be non-negligible. In the event that clocking in data may have a negative effect on servo performance (e.g. using multiple encoders with a lowered TM sample rate) the controller will respond with an error mode. See #AUTOERR for more information. This error mode is very rare, and is expected to occur only in development.

Arguments

SIn = si0, si1, si2, si3 <p >q

where

n = The axis designator (XYZW or ABCDEFGH). Each axis must be set individually

si0 = 0 is for NO SSI, 1 is for SSI to replace MAIN encoder data. 2 is for SSI to replace AUX encoder data

si1 = Total # of Bits of SSI. A positive number designates No Rollover. A negative number will cause the controller to act as an incremental encoder, allowing the encoder to count past the max value of the encoder. (Note: when the controller is powered down, the rollover values are lost)

si2 = # of Single Turn Bits

si3 = # of Status Bits (ie: Error Bits)

Positive # designates status bits as trailing the SSI data

Negative # designates status bits as leading the SSI data

p is an integer in the range of 4-26 and indicates the clock frequency given the following formula

SSI Clock Freq = CLK/ 2*(p+1)

CLK = 20Mhz

q = 1 For Binary encoding, 2 for Gray Code

SIn=? Returns the configuration parameters (where n is the axis)

See Application Note 2438 for more information, and a Clock frequency table.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	SIn=0

SSI Hardware Upgrade Required

Related Commands

TP - Tell Position

TD - Tell Dual Encoder

SS - Configure the special Galil BiSS feature

#AUTOERR - EEPROM checksum error and Serial Encoder timeout error Automatic Subroutine

DF - Dual Feedback (DV feedback swap)

Examples

```
| SIA=1,25,25,0<10>1;' Encoder on axis A replaces main encoder (TP), 25 bits total, all single turn,  
| no status
```

```
| SIA=0;' Disable SSI on axis A
```

SL	<u>Syntax:</u>	Implicit Notation Only & Trippoint
	Operands:	none
	Burn:	not burnable
Single Step		

Full Description

The SL command is for debugging purposes. Single Step through the program after execution has paused at a breakpoint (BK). Optional argument allows user to specify the number of lines to execute before pausing again. The BK command resumes normal program execution.

Arguments

SL n

where

n is an integer representing the number of lines to execute before pausing again

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	1
Default Format	

Related Commands

BK - Breakpoint

TR - Trace

Examples:

```
BK 3    Pause at line 3 (the 4th line) in thread 0
BK 5    Continue to line 5
SL      Execute the next line
SL 3    Execute the next 3 lines
BK      Resume normal execution
```


SM	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_SM0
	<u>Burn:</u>	burnable with BN
Subnet Mask		

Full Description

The SM command assigns a subnet mask to the controller. All packets sent to the controller whose source IP address is not on the subnet will be ignored by the controller. For example, for SM 255, 255, 0, 0 and IA 10, 0, 51, 1, only packets from IP addresses of the form 10.0.xxx.xxx will be accepted.

Arguments

SM sm0, sm1, sm2, sm3 or SM n

where

sm0, sm1, sm2, sm3 are 1 byte numbers (0 to 255) separated by commas and represent the individual fields of the subnet mask.

n is the subnet mask for the controller, which is specified as an integer representing the signed 32 bit number (two's complement).

SM? will return the subnet mask of the controller

Operand Usage

_SM0 contains the subnet mask representing a 32 bit signed number (Two's complement)

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	
Default Value	SM 0, 0, 0, 0
Default Format	N/A

Related Commands

IH - Internet Handle

IA - IP address

Examples:

```
SM 255, 255, 255, 255  Ignore all incoming Ethernet packets
SM 0, 0, 0, 0  Process all incoming Ethernet packets
```

SP	Syntax:	Explicit & Implicit
	Operands:	_SPn
	Burn:	burnable with BN
Speed		

Full Description

The SP command sets the slew speed of any or all axes for independent moves.

Note: Negative values will be interpreted as the absolute value.

Arguments

SP n,n,n,n,n,n,n,n or SPA=n

where

n is an unsigned even number in the range 0 to 22,000,000 for servo motors. The units are encoder counts per second.

OR

n is an unsigned number in the range 0 to 6,000,000 for stepper motors

n = ? Returns the speed for the specified axis.

When ordered with the ICM-42100:

n is an unsigned even number in the range of 0 to 50,000,000. The units are interpolated encoder counts per second.

Operand Usage

_SPn contains the speed for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	25000

Related Commands

AC - Acceleration
DC - Deceleration
PA - Position Absolute
PR - Position Relative
BG - Begin

Examples:

```
:PR 2000,3000,4000,5000      Specify a,b,c,d parameter
:SP 5000,6000,7000,8000     Specify a,b,c,d speeds
:BG                          Begin motion of all axes
:AM C                        After C motion is complete
:
```

Note: For vector moves, use the vector speed command (VS) to change the speed.
SP is not a "mode" of motion like JOG (JG).

Note: 2 is the minimum non-zero speed.

SS	Syntax:	Explicit Notation Only
	Operands:	_SSn
	Burn:	burnable with BN
Configure the special Galil BiSS feature		

Full Description

BiSS is an open source digital interface for sensors and actuators. BiSS is hardware compatible to the industrial standard SSI (Serial Synchronous Interface). It allows serial transmission of absolute position data from BiSS encoders based on a master clock signal from the controller.

Communication between the controller and encoder is based on two signal lines, clock (MA) and data (SLO), which are differential for increased noise immunity and transmission length.

The standard Galil BiSS implementation is C-mode (unidirectional). Contact Galil for other modes.

There are two items required when connecting a BiSS encoder to a DMC-40x0: special BiSS firmware and a hardware upgrade on the controller's internal ICM board. When ordering a new controller with the -BISS option, both requirements will be loaded at the factory.

Clocking in BiSS data has a timing overhead which may be non-negligible. In the event that clocking in data may have a negative effect on servo performance (e.g. using multiple encoders with a lowered TM sample rate) the controller will respond with an error mode. See #AUTOERR for more information. This error mode is very rare, and is expected to occur only in development.

Arguments

SSn = ss0, ss1, ss2, ss3 < p

where

n = The axis designator (XYZ or W or ABCDEFG or H). Each axis must be set individually.

ss0 = 0 is for NO BiSS, 1 is for BiSS to replace MAIN encoder data (TP). 2 is for BiSS to replace AUX encoder data (TD).

ss1 = number of single-turn bits. A positive number designates true, absolute, single-turn decoding. A negative number will cause the controller to internally simulate a multi-turn encoder by counting past the single-turn max/min. This is typically used for a rotary, single-turn encoder to prevent an instantaneous change in position error when the single-turn bits roll over. When the controller loses power, the internal multi-turn state is lost.

ss2 = number of bits before E (error bit). This includes multi-turn bits + single-turn bits + zero padding bits. See Table 1.

ss3 = number of zero padding bits after single turn data and before error bit. See Table 1.

p = clock frequency argument. See Table 2.

SSn=? Returns the configuration parameters

Table 1. SS Example for Hengstler 12 bit MT 10 bit ST

Bit sequence:	T-2	T-1 (Delay)	T0	T1... T12	T13... T22	T23... T26	T27	T28	T29... T34	T35
Data (Data/SLO line):	1	0	1	M11... M0	S9... S0	0	E	W	C5... C0	MCD
Data Description:	Idle	Encoder acquiring	Start Bit	Multi-turn data	Single-turn data	Zero padding	Error Bit	Warning Bit	CRC	Multi-Cycle Data
SS command details:	-	-	-	-	ss1=10	ss3=4	ss2=26, E bit read in _SSn	W read in _SSn	CRC valid bit read in _SSn	Ignored by default

```
'BiSS setup command for the Hengstler 12 bit MT 10 bit ST
'Data will be available in TP and for servo feedback
SSA=1,10,26,4<13
```

BiSS clock (MA) frequency is set with the p argument and has the following form:

$$\text{MA freq} = 20 \text{ MHz} / (2 * (p+1))$$

20 MHz frequency is hardware dependent with a range of 18Mhz to 26Mhz. Contact Galil if tolerances must be tighter for a particular application (this is rare).

Table 2. Popular Master Clock Frequencies (MA)

p argument	Clock Frequency (kHz)
4	2000
8	1111
10	909
12	769
13	714
24	400
26	370

Operands

`_SSn` Returns 4 bits of axis status data where n is the axis ABCDEFG or H. #SERERR is an automatic sub which will run in the event of an encoder problem. See SY for setting up the active high/low status of bits 2 and 3.

_SSN Bit Map

Bit Position	Bit Meaning	Description
0	No timeout = 0, timeout occurred = 1	The BiSS decoding hardware will timeout if the encoder doesn't set the start bit within 30uS
1	CRC valid = 0, invalid = 1	BiSS employs a Cyclic Redundancy Check to verify data after transmission
2	Error bit* (active state set with SY)	When SY is set correctly, this bit should be low when there is no active warning. Consult the encoder documentation for the Warning bit definition
3	Warning bit* (active state set with SY)	When SY is set correctly, this bit should be low when there is no active alarm/error. Consult the encoder documentation for the Alarm bit definition

*Note: The encoder manufacturer may name the Error and Warning bits differently. Consult the encoder documentation for the naming convention.

Galil defines the Warning bit as the bit directly preceding the CRC. The Error bit is defined as the bit directly preceding the Warning bit. See table 1.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	SSn=0

Related Commands

TP - Tell Position

TD - Tell Dual Encoder

SI - Configure the special Galil SSI feature

SY - Serial encoder BiSS active level

#SERERR - Serial Encoder Error Automatic Subroutine

DF - Dual Feedback (DV feedback swap)

#AUTOERR - EEPROM checksum error and Serial Encoder timeout error Automatic Subroutine

DF - Dual Feedback (DV feedback swap)

Examples

```
'Configuration for 26 bit Renishaw Resolute single-turn encoder  
SYA=0;'Warning and Alarm bits are active low  
SSA=1,26,27,0<14  
'The 27 includes the Resolute single leading zero bit
```

```
'Configuration for 36 bit Hengstler multi-turn encoder  
SYA=3;'Warning and Alarm bits are active high  
SSB=1,19,36,5<14  
'19 bits single turn, 12 bits multi turn, 5 zero padding bits
```

ST	Syntax:	Accepts Axis Mask
	Operands:	none
	Burn:	not burnable
Stop		

Full Description

The ST command stops motion on the specified axis. Motors will come to a decelerated stop. If ST is sent from the host without an axis specification, program execution will stop in addition to motion.

Arguments

ST nnnnnnnnnn

where

n is A,B,C,D,E,F,G,H,M,N,S or T or any combination to specify the axis or sequence. If the specific axis or sequence is specified, program execution will not stop.

No argument will stop motion on all axes.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

BG - Begin Motion

AB - Abort Motion

DC - Deceleration rate

Examples:

```
ST A      Stop A-axis motion
ST S      Stop coordinated sequence
ST ABCD   Stop A,B,C,D motion
ST        Stop ABCD motion
ST SCD    Stop coordinated AB sequence, and C and D motion
Hint:     Use the after motion complete command, AM, to wait for motion to be stopped.
```

SY	Syntax:	Explicit & Implicit
	Operands:	_SYn
	Burn:	burnable with BN
Serial encoder BiSS active level		

Full Description

This command is used to designate the active level of the Error and Warning bits when using the Galil BiSS upgrade. The BiSS protocol defines two bits which can be used by the encoder to signal various events. The encoder manufacturer dictates the high/low active state of both of these bits. Consult your encoder documentation for details.

The SY mask should be set appropriately to ensure that the #SERERR automatic subroutine will run when the bits are active, and that the _SSn operand reports the fault state of the encoder correctly.

Example of Warning and Alarm/Error bit use

Quoted from Renishaw Data Sheet L-9709-9005-03-A

Error (1 bit)

The error bit is active low: "1" indicates that the transmitted position information has been verified by the readhead's internal safety checking algorithm and is correct; "0" indicates that the internal check has failed and the position information should not be trusted. The error bit is also set to "0" if the temperature exceeds the maximum specification for the product.

Warning (1 bit)

The warning bit is active low: "0" indicates that the encoder scale (and/or reading window) should be cleaned. Note that the warning bit is not an indication of the trustworthiness of the position data. Only the error bit should be used for this purpose.

Arguments

SY m,m,m,m,m,m,m,m or SYn=m

where

m specifies the axis Error and Warning active high/low configuration according to the following table.

SY argument

SY "m" argument	Warning Bit	Error Bit
0	Active Low	Active Low
1	Active Low	Active High
2	Active High	Active Low
3 (default)	Active High	Active High

Operands

_SYn contains the current state of the SY setting

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes

Default Value	3
---------------	---

Related Commands

SS - Configure the special Galil BiSS feature

#SERERR - Serial Encoder Error Automatic Subroutine

Examples

```
'configure SY for Renishaw Resolute encoder  
SYA=0
```


TA	Syntax:	Implicit Notation Only
	Operands:	_TA0, _TA1, _TA2, _TA3
	Burn:	not burnable
Tell Amplifier error status		

Full Description

The command returns the amplifier error status. The value is decimal and represents an 8 bit value. Bit 7 is most significant bit, 0 is least.

Tell Amplifier Error Bit Definition

	TA0	TA1	TA2	TA3	
BIT #:	STATUS:	STATUS:	STATUS:	STATUS:	BIT #
7	Under Voltage (E-H Axes) **	Hall Error H Axis *	Peak Current H Axis	0	7
6	Over Temperature (E-H Axes) **	Hall Error G Axis *	Peak Current G Axis	0	6
5	Over Voltage (E-H Axes) *	Hall Error F Axis *	Peak Current F Axis	0	5
4	Over Current (E-H Axes) ***	Hall Error E Axis *	Peak Current EAxis	0	4
3	Under Voltage (A-D Axes) **	Hall Error D Axis *	Peak Current DAxis	0	3
2	Over Temperature (A-D Axes) *	Hall Error C Axis *	Peak Current CAxis	0	2
1	Over Voltage (A-D Axes) *	Hall Error B Axis *	Peak Current B Axis	ELO Active (E-H Axes) ****	1
0	Over Current (A-D Axes) ***	Hall Error A Axis *	Peak Current A Axis	ELO Active (A-D Axes) ****	0

* Valid for AMP-43040 (-D3040)

** Valid for AMP-43040 (-D3040) & SDM-44140 (-D4140)

*** Valid for AMP-43040 (-D3040) & Valid for SDM-44140 (-D4140) & Valid for SDM-44040 (-D4040)

**** Valid for AMP-43040 (-D3040) & Valid for AMP-43140 (-D3140) & Valid for SDM-44140 (-D4140) & Valid for SDM-44040 (-D4040)

Hint: If your Brushed-type servo motor is disabling and TA1 shows a hall error, try using the BR command to set that axis as a Brushed axis, causing the controller to ignore invalid Hall states.

Arguments

TA n

returns the amplifier error status where n is 0,1,2, or 3

Operand Usage

_TA_m Contains the Amplifier error status. m = 0,1,2, or 3

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	DMC-40x0 with -D30x0, -D4040, -D4140; DMC-21x3 with AMP-204x0, AMP-205x0, or SDM 206x0
Default Value	N/A
Default Format	1.0

Related Commands

#AMPERR - Amplifier Error Automatic Subroutine

BR - Brush Axis Configuration

QH - Hall State

Examples:

```
| TA1  
| :5      Hall Error for Axis A and C
```

TB	Syntax:	Two Letter Only
	Operands:	_TB
	Burn:	not burnable
Tell Status Byte		

Full Description

The TB command returns status information from the controller as a decimal number. Each bit of the status byte denotes the following condition when the bit is set (high):

BIT	STATUS
Bit 7	Executing application program
Bit 6	N/A
Bit 5	Contouring
Bit 4	Executing error or limit switch routine
Bit 3	Input interrupt enabled
Bit 2	Executing input interrupt routine
Bit 1	N/A
Bit 0	Echo on

Arguments

TB ?

returns the status byte

Operand Usage

_TB Contains the status byte

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	3.0

Related Commands

Examples:

```
TB?
:65      Data Record Active and Echo is on (26 + 20 = 64 + 1 = 65)
```

TC	Syntax:	Implicit Notation Only
	Operands:	_TC
	Burn:	not burnable
Tell Error Code		

Full Description

The TC command returns a number between 1 and 255. This number is a code that reflects why a command was not accepted by the controller. This command is useful when the controller halts execution of a program or when the response to a command is a question mark. After TC has been read, the error code is set to zero.

TC1 will return the error code, along with a human-readable description of the code.

Tell Code List

Tell Code Number	Description	Notes
1	Unrecognized command	
2	Command only valid from program	
3	Command not valid in program	
4	Operand error	
5	Input buffer full	
6	Number out of range	
7	Command not valid while running	not valid for RIO
8	Command not valid while not running	not valid for RIO
9	Variable error	
10	Empty program line or undefined label	
11	Invalid label or line number	
12	Subroutine more than 16 deep	
13	JG only valid when running in jog mode	not valid for RIO
14	EEPROM check sum error	
15	EEPROM write error	
16	IP incorrect sign during position move or IP given during forced deceleration	not valid for RIO
17	ED, BN and DL not valid while program running	
18	Command not valid when contouring	not valid for RIO
19	Application strand already executing	
20	Begin not valid with motor off	not valid for RIO
21	Begin not valid while running	not valid for RIO
22	Begin not possible due to Limit Switch	not valid for RIO
24	Begin not valid because no sequence defined (no RIO)	
25	Variable not given in IN command	
28	S operand not valid	not valid for RIO
29	Not valid during coordinated move	not valid for RIO
30	Sequencet Segment Too Short	not valid for RIO
31	Total move distance in a sequence > 2 billion	not valid for RIO
32	Segment buffer full	not valid for RIO
33	VP or CR commands cannot be mixed with LI commands	not valid for RIO
39	No time specified	not valid for RIO
41	Contouring record range error	not valid for RIO

42	Contour data being sent too slowly	not valid for RIO
46	Gear axis both master and follower	not valid for RIO
50	Not enough fields	
51	Question mark not valid	
52	Missing " or string too long	
53	Error in { }	
54	Question mark part of string	
55	Missing [or []	
56	Array index invalid or out of range	
57	Bad function or array	
58	Bad command response (i.e. _GNX)	
59	Mismatched parentheses	
60	Download error - line too long or too many lines	
61	Duplicate or bad label	
62	Too many labels	
63	IF statement without ENDIF	
65	IN command must have a comma	
66	Array space full	
67	Too many arrays or variables	
71	IN only valid in thread #0	
80	Record mode already running	
81	No array or source specified	
82	Undefined Array	
83	Not a valid number	
84	Too many elements	
90	Only A B C D valid operand	not valid for RIO
96	SM jumper needs to be installed for stepper motor operation (no Accelera, no RIO)	
97	Bad Binary Command Format	
98	Binary Commands not valid in application program	
99	Bad binary command number	
100	Not valid when running ECAM	not valid for RIO
101	Improper index into ET	not valid for RIO
102	No master axis defined for ECAM	not valid for RIO
103	Master axis modulus greater than 256 EP value	not valid for RIO
104	Not valid when axis performing ECAM	not valid for RIO
105	EB1 command must be given first	not valid for RIO
106	Privilege Violation	not valid for Econo, Optima
110	No hall effect sensors detected	not valid for RIO
111	Must be made brushless by BA command	not valid for RIO
112	BZ command timeout	not valid for RIO
113	No movement in BZ command	not valid for RIO
114	BZ command runaway	not valid for RIO
118	Controller has GL1600 not GL1800	not valid for RIO
119	Not valid for axis configured as stepper	
120	Bad Ethernet transmit	not valid for PCI

121	Bad Ethernet packet received	not valid for PCI
122	Ethernet input buffer overrun	DMC-21x3 only
123	TCP lost sync	not valid for PCI
124	Ethernet handle already in use	not valid for PCI
125	No ARP response from IP address	not valid for PCI
126	Closed Ethernet handle	not valid for PCI
127	Illegal Modbus function code	not valid for PCI
128	IP address not valid	not valid for PCI
130	Remote IO command error	not valid for PCI
131	Serial Port Timeout	not valid for PCI
132	Analog inputs not present	
133	Command not valid when locked / Handle must be UDP	not valid for PCI
134	All motors must be in MO for this command	not valid for RIO
135	Motor must be in MO	not valid for RIO
136	Invalid Password	not valid for Econo, Optima
137	Invalid lock setting	not valid for Econo, Optima
138	Passwords not identical	not valid for Econo, Optima
140	serial encoder missing	Valid for BiSS support
141	Incorrect ICM Configuration	
143	TM timed out	Valid on SER firmware (SSI and BiSS)
160	BX failure	Valid on SINE firmware
161	Sine amp axis not initialized	Valid on SINE firmware

Arguments

TC n

where

n = 0 Returns numerical code only

n = 1 Returns numerical code and human-readable message

n = ? Returns the error code

Operand Usage

_TC contains the value of the error code.

Usage

Usage Details

Usage	Value
While Moving	Yes (No RIO)
In a Program	Yes
Not in a program	Yes
Default Value	N/A
Default Format	3.0

Related Commands

Examples:

|

:GF32	Bad command
?TC1	Tell error code
1	Unrecognized command

TD	Syntax:	Accepts Axis Mask
	Operands:	_TDn
	Burn:	not burnable
Tell Dual Encoder		

Full Description

The TD command returns the current position of the dual (auxiliary) encoder(s). Auxiliary encoders are not available for stepper axes or for the axis where output compare is used.

When operating with stepper motors, the TD command returns the number of counts that have been output by the controller.

Arguments

TD nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument will provide the dual encoder position for all axes

Operand Usage

_TDn contains value of dual encoder register.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

DE - Dual Encoder

Examples:

```
:TD      Return A,B,C,D Dual encoders
200, -10, 0, -110
TDA      Return the A motor Dual encoder
200
DUAL=_TDA      Assign the variable, DUAL, the value of TDA
```


TE	Syntax:	Accepts Axis Mask
	Operands:	_TE _n
	Burn:	not burnable
Tell Error		

Full Description

:

The TE command returns the current position error of the motor(s). The range of possible error is 2147483647. The Tell Error command is not valid for step motors since they operate open-loop.

Arguments

TE nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument will provide the position error for all axes

Operand Usage

_TE_n contains the current position error value for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	Position Format

Related Commands

OE - Off On Error

ER - Error Limit

#POSERR - Error Subroutine

PF - Position Formatting

Examples:

```
TE      Return all position errors
:5, -2, 0, 6
TEA    Return the A motor position error
:5
TEB    Return the B motor position error
:-2
Error =_TEA    Sets the variable, Error, with the A-axis position error
Hint: Under normal operating conditions with servo control, the position error should be small.
The position error is typically largest during acceleration.
```

TH	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
Tell Ethernet Handle		

Full Description

The TH command returns a list of data pertaining to the Galil's Ethernet connection. This list begins with the IP address and Ethernet address (physical address), followed by the status of each handle indicating connection type and IP address.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (no RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	Ethernet Only
Default Value	-
Default Format	-

Related Commands

HS - Handle Swap
 IA - IP address
 IH - Internet Handle
 WH - Which Handle

Examples:

```
:TH
CONTROLLER IP ADDRESS 10,51,0,87 ETHERNET ADDRESS 00-50-4C-08-01-1F
IHA TCP PORT 1050 TO IP ADDRESS 10,51,0,89 PORT 1000
IHB TCP PORT 1061 TO IP ADDRESS 10,51,0,89 PORT 1001
IHC TCP PORT 1012 TO IP ADDRESS 10,51,0,93 PORT 1002
IHD TCP PORT 1023 TO IP ADDRESS 10,51,0,93 PORT 1003
IHE TCP PORT 1034 TO IP ADDRESS 10,51,0,101 PORT 1004
IHF TCP PORT 1045 TO IP ADDRESS 10,51,0,101 PORT 1005
IHG AVAILABLE
IHH AVAILABLE
```

TI	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_TI0,_TI1,_TI2,_TI3,_TI4,_TI5
	<u>Burn:</u>	not burnable
Tell Inputs		

Full Description

The TI command returns the state of the inputs including the extended I/O configured as inputs. The value returned by this command is decimal and represents an 8 bit value (decimal value ranges from 0 to 255). Each bit represents one input where the LSB is the lowest input number and the MSB is the highest input bit.

Arguments

TIn

where

n = 0 Return Input Status for Inputs 1 through 8

n = 1 Return Input Status for Inputs 9 through 16 (Applies only to controllers with more than 4 axes)

n = 10 Return Input Status for Inputs 81 through 88 (auxiliary encoder inputs)

n = 11 Return Input Status for Inputs 89 through 96 (auxiliary encoder inputs)

no argument will return the Input Status for Inputs 1 through 8

n = ? returns the Input Status for Inputs 1 through 8

n = 2 through 5 see note 2 (These arguments only apply when using extended I/O configured as inputs)

where n represents the extended inputs ranging from $(8*n)+1$ through $(8*(n+1))$

Operand Usage

_TIn contains the status byte of the input block specified by 'n'. Note that the operand can be masked to return only specified bit information - see section on Bit-wise operations.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Default Value	N/A

Related Commands

@IN - Read digital input

CO - Configure Extended I O

Examples:

```
:TI1          Tell input state on bank 1
:8           Bit 3 is high, others low
:TI0
:0          All inputs on bank 0 low
:Input =_TI1  Sets the variable, Input, with the TI1 value
:Input=?
:8.0000
```


TIME	<u>Syntax:</u>	Operand Only
	Operands:	TIME
	Burn:	not burnable
Time Operand		

Full Description

The TIME operand returns the value of the internal free running, real time clock. The returned value represents the number of servo loop updates and is based on the TM command. The default value for the TM command is 1000. With this update rate, the operand TIME will increase by 1 count every update of approximately 1000usec. Note that a value of 1000 for the update rate (TM command) will actually set an update rate of 976 microseconds.

Thus the value returned by the TIME operand will be off by 2.4% of the actual time.

The clock is reset to 0 with a standard reset or a master reset.

The keyword, TIME, does not require an underscore "_" as does the other operands.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	
In a Program	Yes
Command Line	Yes
Controller Usage	
Default Value	
Default Format	

Related Commands

Examples:

```
|MG TIME Display the value of the internal clock
```

TK	Syntax:	Explicit & Implicit
	Operands:	_TKn
	Burn:	burnable with BN
Peak Torque Limit		

Full Description

The TK command sets the peak torque limit on the motor command output and TL sets the continuous torque limit. When the average torque is below TL, the motor command signal can go up to the TK (Peak Torque) for a short amount of time (appx 1000 samples from 0V to TK value). If TK is set lower than TL, then TL is the maximum command output under all circumstances.

Arguments

TK n,n,n,n,n,n,n

TKA=n

where

n is an unsigned number in the range of 0 to 9.99 volts

n=0 disables the peak torque limit

n=? returns the value of the peak torque limit for the specified axis.

Operand Usage

_TKn contains the value of the peak torque limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	1.4

Related Commands

TL - Torque Limit

Examples:

TLA=7	Limit A-axis to a 7 volt average torque output
TKA=9.99	Limit A-axis to a 9.99 volt peak torque output

TL	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_TLn
	<u>Burn:</u>	burnable with BN
Torque Limit		

Full Description

The TL command sets the limit on the motor command output. For example, TL of 5 limits the motor command output to 5 volts. Maximum output of the motor command is 9.998 volts.

Arguments

TL n,n,n,n,n,n,n

TLA=n

where

n is an unsigned numbers in the range 0 to 9.998 volts with resolution of 0.0003 volts

n = ? Returns the value of the torque limit for the specified axis.

Operand Usage

_TLn contains the value of the torque limit for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	9.998
Default Format	1.4

Related Commands

Examples:

```
TL 1,5,9,7.5    Limit A-axis to 1 volt. Limit B-axis to 5 volts. Limit C-axis to 9 volts. Limit D-
axis to 7.5 volts.
TL ?,?,?,?     Return limits
:1.0000,5.0000,9.0000, 7.5000
TL ?           Return A-axis limit
:1.0000
```

<h1>TM</h1>	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_TM
	<u>Burn:</u>	burnable with BN
Update Time		

Full Description

The TM command sets the sampling period of the control loop. A zero or negative number turns off the servo loop. The units of this command are microseconds.

Arguments

TM n

where

Default Firmware. Using the normal firmware the minimum sample times (n) are the following:

Accelera Controllers with 1-2 axes	62.5 usec
Accelera Controllers with 3-4 axes	125 usec
Accelera Controllers with 5-6 axes	156.25 usec
Accelera Controllers with 7-8 axes	187.5 usec

Fast Firmware. Using the fast firmware the minimum sample times (n) are the following:

Accelera Controllers with 1-2 axes	31.25 usec
Accelera Controllers with 3-4 axes	62.5 usec
Accelera Controllers with 5-6 axes	93.75 usec
Accelera Controllers with 7-8 axes	125 usec

Limitations: In the Fast firmware mode the following functions are disabled:

TD, DV, TK, NB, NZ, NF, second field of EI, Gearing, CAM, PL, Analog Feedback, Steppers, Trippoints in all but threads 0 and 1, Data Record and TV.

Maximum value for n is 10000 usec.

Resolution of n is 31.25 usec.

n = ? returns the value of the sample time.

Operand Usage

_TM contains the value of the sample time.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	1000

Related Commands

Examples:

```
TM -1000      Turn off internal clock
TM 2000 Set sample rate to 2000 msec
TM 1000 Return to default sample rate
```


See <http://www.galilmc.com/support/firmware-downloads.php> to download fast firmware.

TN	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_TN
	<u>Burn:</u>	burnable with BN
Tangent		

Full Description

The TN m,n command describes the tangent axis to the coordinated motion path. m is the scale factor in counts/degree of the tangent axis. n is the absolute position of the tangent axis where the tangent axis is aligned with zero degrees in the coordinated motion plane. The tangent axis is specified with the VMnmp command where p is the tangent axis. The tangent function is useful for cutting applications where a cutting tool must remain tangent to the part.

Arguments

TN m,n

where

m is the scale factor in counts/degree, in the range between -127 and 127 with a fractional resolution of 0.004

m = ? Returns the first position value for the tangent axis (same as _TN).

When operating with stepper motors, m is the scale factor in steps / degree

n is the absolute position at which the tangent angle is zero, in the range between -8388608 to 8388607.

Operands

_TNn (where n = S or T) contains the first position value for the tangent axis in the specified vector plane. This allows the user to correctly position the tangent axis before the motion begins. Note, _TNn will change based upon the vector path described in the VM declaration. See the example below.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	N/A

Related Commands

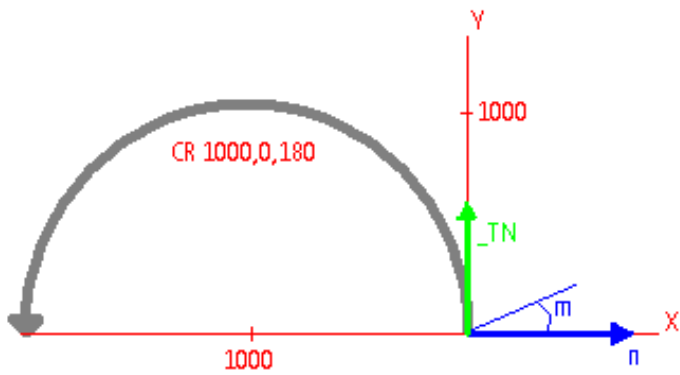
VM - Vector mode

CR - Circle Command

VP - Vector Position

Examples

Use a 2D table with a tangent cutting blade to cut a half circle. Ensure that the blade is oriented before turning on the saw. The saw is activated with output 1.



```

#EXAMPLE
VM XYZ;'           Z axis is tangent
VSS=500;'          Set vector speed
m=1000/360;'       Z axis encoder is 1000 counts per full revolution
n=0;'              When TPZ=0, blade is oriented to cut along X axis
TN m,n;'           Set these tangent characteristics
CR 1000,0,180;'    Profile a circle with radius 1000 counts,
'                  starting at 0 degrees
'                  and spanning 180 degrees
VE;'              End the vector path
MG_TN;'           Print the calculated initial tangent entry point (250)
PAZ=_TN;'         Profile a move to orient the Z axis to begin
BGZ;'             Move the blade into place
AMZ;'             Wait until the blade motion is done
SB1;'             Turn on the saw
WT1000;'          Wait for saw to spin up
BGS;'             Begin vector motion, saw will stay tangent
AMS;'            Wait for the cut to complete
CB0;'            Turn off the saw
MG "ALL DONE";'   Print a message
EN

```

<h1>TP</h1>	Syntax:	Accepts Axis Mask
	Operands:	_TPn
	Burn:	not burnable
Tell Position		

Full Description

The TP command returns the current position of the motor(s).

Arguments

TP nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

Operand Usage

_TPx contains the current position value for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	Position Format

Related Commands

PF - Position Formatting

Examples:

Assume the A-axis is at the position 200 (decimal), the B-axis is at the position -10 (decimal), the C-axis is at position 0, and the D-axis is at -110 (decimal). The returned parameter units are in quadrature counts.

```
TP      Return A,B,C,D positions
```

```
:200,-10,0,-110
```

```
TPA    Return the A motor position
```

```
:200
```

```
TPB    Return the B motor position
```

```
:-10
```

```
PF-6.0 Change to hex format
```

```
TP      Return A,B,C,D in hex
```

```
:$0000C8,$FFFFFF6,$000000,$FFFF93
```

```
Position =_TPA Assign the variable, Position, the value of TPA
```

TR	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	burnable with BN
Trace		

Full Description

The TR command causes each instruction in a program to be sent out the communications port prior to execution. TR1 enables this function and TR0 disables it. The trace command is useful in debugging programs.

Arguments

TR n, m

where

n = 0 Disables the trace function

n = 1 Enables the trace function

m is an integer between 0 and 255 and designates which threads to trace. A bit is set per thread. Thread 0=1, Thread 1=2, Thread 2=4 ... Thread 7 =128. The default is 255 (all threads)

The least significant bit represents thread 0 and the most significant bit represents thread 7. The decimal value can be calculated by the following formula.

$$n = n_0 + 2*n_1 + 4*n_2 + 8*n_3 + 16*n_4 + 32*n_5 + 64*n_6 + 128*n_7$$

where n_x represents the thread. To turn tracing on for a thread, substitute a one into that n_x in the formula. If the n_x value is a zero, then tracing will be off for that thread.

For example, if threads 3 and 4 are to be traced, TR24 is issued.

Omitting m traces all threads.

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

CF - Configure port for unsolicited messages

Examples:

```
:'Turn on trace during a program execution
:LS
0 MGTIME
1 WT1000
2 JPO
3
:XQ
:
18003461.0000
18004461.0000
```

18005461.0000

:TR1

:

2 JPO

0 MGTIME

18006461.0000

1 WT1000

2 JPO

0 MGTIME

18007461.0000

1 WT1000

:TR0

:

18008461.0000

18009461.0000

:ST

:

TS	<u>Syntax:</u>	Accepts Axis Mask
	<u>Operands:</u>	_TSn
	<u>Burn:</u>	not burnable
Tell Switches		

Full Description

TS returns status information of the Home switch, Forward Limit switch Reverse Limit switch, error conditions, motion condition and motor state. The value returned by this command is decimal and represents an 8 bit value (decimal value ranges from 0 to 255). Each bit represents the following status information:

Bit Status

Bit 7 Axis in motion if high

Bit 6 Axis error exceeds error limit if high

Bit 5 A motor off if high

Bit 4 Undefined

Bit 3 Forward Limit Switch Status inactive if high

Bit 2 Reverse Limit Switch Status inactive if high

Bit 1 Home A Switch Status

Bit 0 Latched

Note: For active high or active low configuration (CN command), the limit switch bits are '1' when the switch is inactive and '0' when active.

Arguments

TS nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument will provide the status for all axes

Operand Usage

_TSn contains the current status of the switches.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	3.0

Related Commands

Examples:

```
V1=_TSB Assigns value of TSB to the variable V1
V1=      Interrogate value of variable V1
:15      Decimal value corresponding to bit pattern 00001111
Y axis not in motion (bit 7 - has a value of 0)
Y axis error limit not exceeded (bit 6 has a value of 0)
Y axis motor is on (bit 5 has a value of 0)
Y axis forward limit is inactive (bit 3 has a value of 1)
Y axis reverse limit is inactive (bit 2 has a value of 1)
Y axis home switch is high (bit 1 has a value of 1)
```

| Y axis latch is not armed (bit 0 has a value of 1)

<h1>TT</h1>	Syntax:	Accepts Axis Mask
	Operands:	_TTn
	Burn:	not burnable
Tell Torque		

Full Description

The TT command reports the value of the analog output signal, which is a number between -9.998 and 9.998 volts.

Arguments

TT nnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument will provide the torque for all axes

Operand Usage

_TTn contains the value of the torque for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	1.4

Related Commands

TL - Torque Limit

Examples:

```
V1=_TTA Assigns value of TTA to variable, V1
TTA      Report torque on A
:-0.2843      Torque is -.2843 volts
```

TV	Syntax:	Accepts Axis Mask
	Operands:	_TVn
	Burn:	not burnable
Tell Velocity		

Full Description

The TV command returns the actual velocity of the axes in units of encoder count/s. The value returned includes the sign.

The TV command is computed using a special averaging filter (over approximately 0.25 sec for TM1000). Therefore, TV will return average velocity, not instantaneous velocity.

Arguments

TV nnnnnnnnnn

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes

No argument will provide the velocity for all axes.

Operand Usage

_TVn contains the value of the velocity for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	8.0

Related Commands

SP - Speed

AC - Acceleration

DC - Deceleration

TM - Update Time

Examples:

```
:vela=_TVA      Assigns value of A-axis velocity to the variable VELA
:TVA            Returns the A-axis velocity
0003420
```

TW	Syntax:	Explicit & Implicit
	Operands:	_TWn
	Burn:	burnable with BN
Timeout for IN Position (MC)		

Full Description

Arguments

TW n,n,n,n,n,n,n

TWA=n

n specifies the timeout in msec. n ranges from 0 to 32767 msec

n = -1 Disables the timeout.

n = ? Returns the timeout in msec for the MC command for the specified axis.

Operand Usage

_TWn contains the timeout for the MC command for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	32766
Default Format	5.0

Related Commands

MC - Motion Complete trippoint

#MCTIME - Motion Complete Timeout Automatic Subroutine

Examples:

TZ	Syntax:	Two Letter Only
	Operands:	none
	Burn:	not burnable
Tell I O Configuration		

Full Description

The TZ command is used to request the I/O status. This is returned to the user as a text string.

Arguments

N/A

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes

Related Commands

TI - Tell Inputs

SB/CB - Set/Clear output bits

OP - Output port

CO - Configure I/O

Examples:

```
:TZ
BLOCK 0 (8-1) dedicated as input - value 255 (1111_1111)
BLOCK 0 (8-1) dedicated as output- value 0 (0000_0000)
BLOCK 2 (24-17) configured as input - value 255 (1111_1111)
BLOCK 3 (32-25) configured as input - value 255 (1111_1111)
BLOCK 4 (40-33) configured as input - value 255 (1111_1111)
BLOCK 5 (48-41) configured as input - value 255 (1111_1111)
BLOCK 6 (56-49) configured as input - value 255 (1111_1111)
BLOCK 10 (88-81) dedicated as input - value 255 (1111_1111)
```

UI	Syntax:	Implicit Notation Only
	Operands:	none
	Burn:	not burnable
User Interrupt		

Full Description

UI pushes a user-defined status byte into the EI queue. UI can generate 16 different status bytes, \$F0 to \$FF (240-255), corresponding to UI0 to UI15. When the UI command (e.g. UI5) is executed, the status byte value (e.g. \$F5 or 245) is queued up for transmission to the host, along with any other interrupts.

The UDP interrupt packet dispatch may be delayed. If immediate packet dispatch is required, use the message command (MG) to send a unique message to the host software.

EI,,h must be set to a valid UDP port (set by the host, not the DMC code, is recommended) before any interrupt packet will be dispatched.

Arguments

UI n

where

n is an integer between 0 and 15 corresponding to status bytes \$F0 to \$FF (240-255).

STATUS BYTE	CONDITION
\$F0 (240)	UI or UI0 was executed
\$F1 (241)	UI1 was executed
\$F2 (242)	UI2 was executed
\$F3 (243)	UI3 was executed
\$F4 (244)	UI4 was executed
\$F5 (245)	UI5 was executed
\$F6 (246)	UI6 was executed
\$F7 (247)	UI7 was executed
\$F8 (248)	UI8 was executed
\$F9 (249)	UI9 was executed
\$FA (250)	UI10 was executed
\$FB(251)	UI11 was executed
\$FC (252)	UI12 was executed
\$FD (253)	UI13 was executed
\$FE (254)	UI14 was executed
\$FF (255)	UI15 was executed

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	3.0

Related Commands

EI - Event interrupts

MG - Message

Examples:

```
JG 5000 Jog at 5000 counts/s  
BGA      Begin motion  
ASA      Wait for at speed  
UI 1     Cause an interrupt with status byte $F1 (241)
```

UL	Syntax:	Two Letter Only
	Operands:	_UL
	Burn:	not burnable
Upload		

Full Description

The UL command transfers data from the controller to a host computer. Programs are sent without line numbers. The Uploaded program will be followed by a <control>Z as an end of text marker.

Arguments

None

Operand Usage

When used as an operand, _UL gives the number of available variables. The number of available variables is 510.

RELATED COMMAND:

DL

Download

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

Related Commands

Examples:

```
UL;      Begin upload
#A      Line 0
NO This is an Example   Line 1
NO Program           Line 2
EN      Line 3
<cntrl>Z      Terminator
```

VA	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_VA _n
	<u>Burn:</u>	burnable with BN
Vector Acceleration		

Full Description

The VA command sets the acceleration rate of the vector in a coordinated motion sequence.

Arguments

VA s,t

where

s and t are unsigned integers in the range 1024 to 1073740800. s represents the vector acceleration for the S coordinate system and t represents the vector acceleration for the T coordinate system. The parameter input will be rounded down to the nearest factor of 1024. The units of the parameter is counts per second squared.

s = ? Returns the value of the vector acceleration for the S coordinate plane.

t = ? Returns the value of the vector acceleration for the T coordinate plane.

Operand Usage

_VA_x contains the value of the vector acceleration for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256000 (10.0 for 18x6 & 40x0)
Default Format	Position Format

Related Commands

VS - Vector Speed

VP - Vector Position

VE - End Vector

CR - Circle

VM - Vector Mode

BG - Begin Sequence

VD - Vector Deceleration

IT - Smoothing constant - S-curve

Examples:

```
VA 1024 Set vector acceleration to 1024 counts/sec2
VA ? Return vector acceleration
:1024
VA 20000 Set vector acceleration
VA ?
:19456 Return vector acceleration
ACCEL=_VA Assign variable, ACCEL, the value of VA
```


VD	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_VDn
	<u>Burn:</u>	burnable with BN
Vector Deceleration		

Full Description

The VD command sets the deceleration rate of the vector in a coordinated motion sequence.

Arguments

VD s,t

where

s and t are unsigned integers in the range 1024 to 1073740800. s represents the vector deceleration for the S coordinate system and t represents the vector acceleration for the T coordinate system. The parameter input will be rounded down to the nearest factor of 1024. The units of the parameter is counts per second squared.

s = ? Returns the value of the vector deceleration for the S coordinate plane.

t = ? Returns the value of the vector deceleration for the T coordinate plane.

Operand Usage

_VDn contains the value of the vector deceleration for the specified coordinate system, S or T.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	256000
Default Format	Position Format (10.0 for 18x6 & 40x0)

Related Commands

VA - Vector Acceleration

VS - Vector Speed

VP - Vector Position

CR - Circle

VE - Vector End

VM - Vector Mode

BG - Begin Sequence

IT - Smoothing constant - S-curve

Examples:

```
#VECTOR ;'Vector Program Label
VMAB    ;'Specify plane of motion
VA1000000    ;'Vector Acceleration
VD 5000000    ;'Vector Deceleration
VS 2000 ;'Vector Speed
VP 10000, 20000 ;'Vector Position
VE      ;'End Vector
BGS     ;'Begin Sequence
AMS     ;'Wait for Vector sequence to complete
```

| EN ; 'End Program

VE	Syntax:	Implicit Notation Only
	Operands:	_VEn
	Burn:	not burnable
Vector Sequence End		

Full Description

VE is required to specify the end segment of a coordinated move sequence. VE would follow the final VP or CR command in a sequence. VE is equivalent to the LE command.

The VE command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

VE n

No argument specifies the end of a vector sequence

n = ? Returns the length of the vector in counts.

Operand Usage

_VEn contains the length of the vector in counts for the specified coordinate system, S or T.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	N/A
Default Format	N/A

Related Commands

VM - Vector Mode

VS - Vector Speed

VA - Vector Acceleration

VD - Vector Deceleration

CR - Circle

VP - Vector Position

BG - Begin Sequence

CS - Clear Sequence

Examples:

```
#A      ;'Program Label
VM AB   ;'Vector move in AB
VP 1000,2000 ;'Linear segment
CR 0,90,180 ;'Arc segment
VP 0,0 ;'Linear segment
VE      ;'End sequence
BGS     ;'Begin motion
AMS     ;'Wait for VE to execute in buffer
EN      ;'End program
```

VF	<u>Syntax:</u>	Implicit Notation Only
	Operands:	_VF
	Burn:	burnable with BN
Variable Format		

Full Description

The VF command formats the number of digits to be displayed when interrogating the controller or RIO board.

If a number exceeds the format, the number will be displayed as the maximum possible positive or negative number (i.e. 999.99, -999, \$8000 or \$7FF).

Arguments

VF m.n

where

m and n are unsigned numbers in the range $0 < m < 10$ and $0 < n < 4$.

m represents the number of digits before the decimal point. A negative m specifies hexadecimal format. When in hexadecimal, the string will be preceded by a \$ and Hex numbers are displayed as 2's complement with the first bit used to signify the sign.

n represents the number of digits after the decimal point.

m = ? Returns the value of the format for variables and arrays.

Operand Usage

_VF contains the value of the format for variables and arrays.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	10.4
Default Format	2.1

Related Commands

PF - Position Format

Examples:

```
VF 5.3 Sets 5 digits of integers and 3 digits after the decimal point
VF 8.0 Sets 8 digits of integers and no fractions
VF -4.0 Specify hexadecimal format with 4 bytes to the left of the decimal
```

<h1>VM</h1>	Syntax:	Accepts Axis Mask
	Operands:	_VMS,_VMT
	Burn:	not burnable
Vector Mode		

Full Description

The VM command specifies the coordinated motion mode and the plane of motion. This mode may be specified for motion on any set of two axes. The motion is specified by the instructions VP and CR, which specify linear and circular segments. Up to 511 segments may be given before the Begin Sequence (BGS or BGT) command. Additional segments may be given during the motion when the buffer frees additional spaces for new segments. It is the responsibility of the user to keep enough motion segments in the buffer to ensure continuous motion.

The Vector End (VE) command must be given after the last segment. This allows the controller to properly decelerate.

The VM command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

VM nmp

where

n and m specify plane of vector motion and can be any two axes. Vector Motion can be specified for one axis by specifying 2nd parameter, m, as N. Specifying one axis is useful for obtaining sinusoidal motion on 1 axis.

p is the tangent axis and can be specified as any axis except the imaginary M and N axes. A value of N for the parameter, p, turns off tangent function.

Operand Usage

_VMn contains instantaneous commanded vector velocity for the specified coordinate system, S or T.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Default Value	AB

Related Commands

CR - Circle

VP - Vector Mode

VE - Vector End

BG - Begin Sequence

Examples:

```
#A      ;'Program Label
VM AB   ;'Specify motion plane
VP 1000,2000 ;'Specify vector position 1000,2000
VP 2000,4000 ;'Specify vector position 2000,4000
CR 1000,0,360 ;'Specify arc
VE      ;'Vector end
BGS     ;'Begin motion sequence
AMS     ;'Wait for vector motion to complete
EN      ;'End Program
```

Hint: The first vector in a coordinated motion sequence defines the origin for that sequence. All other vectors in the sequence are defined by their endpoints with respect to the start of the move sequence.

<h1>VP</h1>	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_VPn
	<u>Burn:</u>	not burnable
Vector Position		

Full Description

The VP command defines the target coordinates of a straight line segment in a 2 axis motion sequence which have been selected by the VM command. The units are in quadrature counts, and are a function of the elliptical scale factor set using the command ES. For three or more axes linear interpolation, use the LI command. The VP command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Arguments

VP n,m < o > p

where

n and m are signed integers in the range -2147483648 to 2147483647. The length of each segment must be limited to 8388607. The values for n and m will specify a coordinate system from the beginning of the sequence.

o specifies a vector speed to be taken into effect at the execution of the vector segment. o is an unsigned even integer between 2 and 22,000,000 for servo motor operation and between 2 and 6,000,000 for stepper motors (o is in units of counts per sample).

p specifies a vector speed to be achieved at the end of the vector segment. p is an unsigned even integer between 2 and 22,000,000 (p is in units of counts per sample).

Operand Usage

_VPa where a=ABCDEFGH for the axis and contains the absolute coordinate of the axes at the last intersection along the sequence. For example, during the first motion segment, this instruction returns the coordinate at the start of the sequence. The use as an operand is valid in the linear mode, LM, and in the Vector mode, VM.

example: _VPA for the the A axis

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	-
Default Format	-

Related Commands

VM - Vector Mode

VE - Vector End

BG - Begin Sequence

IT - Vector smoothing

Examples

```
#A; '          Program Label
VM AB; '      Specify motion plane
VP 1000,2000 ; 'Specify vector position 1000,2000
VP 2000,4000; ' Specify vector position 2000,4000
CR 1000,0,360; 'Specify arc
```

```
VE;'          Vector end
BGS;'          Begin motion sequence
AMS;'          Wait for vector motion to complete
EN;'          End Program
```

```
REM VP n,m <o> p
REM 'o' and 'p' are in counts/sample rather than counts/second as the VS command.
REM this means that when TM <> 1000, commanded speed for VS will be different than
REM values for 'o' and 'p'
REM To get counts/second for 'o' and 'p', divide them by a ratio of 1000/_TM
REM
REM #vs and #vsop result in the same profile
#vs
TM 250
VMXY
VS 100000
VA 2560000
VD 2560000
VP 20000,20000
VE
BGS
AMS
EN
'
#vsop
TM 250
VMXY
n=1000/_TM
'VS 100000
VA 2560000
VD 2560000
VP 20000,20000<(100000/n)
VE
BGS
AMS
EN
```

Hint: The first vector in a coordinated motion sequence defines the origin for that sequence. All other vectors in the sequence are defined by their endpoints with respect to the start of the move sequence.

VR	Syntax:	Implicit Notation Only
	Operands:	_VRn
	Burn:	not burnable
Vector Speed Ratio		

Full Description

The VR sets a ratio to be used as a multiplier of the current vector speed. The vector speed can be set by the command VS or the operators < and > used with CR, VP and LI commands. VR takes effect immediately and will ratio all the following vector speed commands. VR doesn't ratio acceleration or deceleration, but the change in speed is accomplished by accelerating or decelerating at the rate specified by VA and VD.

Arguments

VR s,t

where

s and t are between 0 and 10 with a resolution of .0001. The value specified by s is the vector ratio to apply to the S coordinate system and t is the value to apply to the T coordinate system.

s = ? Returns the value of the vector speed ratio for the S coordinate plane.

t = ? Returns the value of the vector speed ratio for the T coordinate plane.

Operand Usage

_VRn contains the vector speed ratio of the specified coordinate system, S or T.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	1
Default Format	

While Moving Yes Default Value 1

In a Program Yes Default Format 2.4

Command Line Yes

Controller Usage ALL CONTROLLERS

Related Commands

VS - Vector Speed

Examples:

```
#A      ;'Vector Program
VMAB   ;'Vector Mode
VP 1000,2000 ;'Vector Position
CR 1000,0,360 ;'Specify Arc
VE     ;'End Sequence
VS 2000 ;'Vector Speed
BGS    ;'Begin Sequence
AMS    ;'After Motion
JP#A   ;'Repeat Move
```

VS	<u>Syntax:</u>	Implicit Notation Only
	<u>Operands:</u>	_VS _n
	<u>Burn:</u>	burnable with BN
Vector Speed		

Full Description

The VS command specifies the speed of the vector in a coordinated motion sequence in either the LM or VM modes. VS may be changed during motion.

Vector Speed can be calculated by taking the square root of the sum of the squared values of speed for each axis specified for vector or linear interpolated motion.

Arguments

VS s,t

where

s and t are unsigned even numbers in the range 2 to 22,000,000 for servo motors and 2 to 6,000,000 for stepper motors. s is the speed to apply to the S coordinate system and t is the speed to apply to the T coordinate system. The units are counts per second.

s = ? Returns the value of the vector speed for the S coordinate plane.

t = ? Returns the value of the vector speed for the T coordinate plane.

Operand Usage

_VS_n contains the vector speed of the specified coordinate system, S or T

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	25000

Related Commands

VA - Vector Acceleration

VP - Vector Position

CR - Circle

LM - Linear Interpolation

VM - Vector Mode

BG - Begin Sequence

VE - Vector End

Examples:

<h1>VV</h1>	<u>Syntax:</u>	Explicit Notation Only
	<u>Operands:</u>	_VVn
	<u>Burn:</u>	not burnable
Vector Speed Variable		

Full Description

The VV command sets the speed of the vector variable in a coordinated motion sequence in either the LM or VM modes. VV may be changed during motion.

The VV command is used to set the "<" vector speed variable argument for segments that exist in the vector buffer. By defining a vector segment begin speed as a negative 1 (i.e. "<-1"), the controller will utilize the current vector variable speed as the segment is profiled from the buffer.

This is useful when vector segments exist in the buffer that use the "<" and ">" speed indicators for specific segment and corner speed control and the host needs to be able to dynamically change the nominal return operating speed.

The vector variable is supported for VP, CR and LI segments.

Arguments

VVS=n or VVT=n

where,

n specifies the speed as an unsigned even number in the range 2 to 22,000,000 for servo motors and 2 to 6,000,000 for stepper motors. VVS is the speed to apply to the S coordinate system and VVT is the speed to apply to the T coordinate system. The units are in counts per second.

VVS=? Returns the value of the vector speed variable for the S coordinate plane.

VVT=? Returns the value of the vector speed variable for the T coordinate plane.

Operand Usage

_VVn contains the vector speed variable of the specified coordinate system (n= S or T)

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Value	0

Related Commands

VA - Vector Acceleration

VD - Vector Deceleration

VP - Vector Position Segment

CR - Circular Interpolation Segment

LI - Linear Interpolation Segment

VM - Vector Mode

LM - Linear Interpolation Mode

Examples:

```

:VVS= 20000           Define vector speed variable to 20000 for the S coordinate system
:VP1000,2000<-1>100  Define vector speed variable for specific segment.
:VVS=?
:20000
:

```

WH	<u>Syntax:</u>	Two Letter Only
	<u>Operands:</u>	_WH
	<u>Burn:</u>	not burnable
Which Handle		

Full Description

The WH command is used to identify the handle from which the command was received. The command returns IHA through IHH to indicate on which handle the command was executed.

The command returns RS232 if using serial communication.

Arguments

None

Operand Usage

_WH contains the numeric representation of the handle from which the command was received.

Handles A through H are indicated by the value 0-7, while a-1 indicates the serial port.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	No
Command Line	Yes

Related Commands

HS - Handle Swap
 IA - IP address
 IH - Internet Handle
 TH -Tell Handles

Examples:

```

:WH      Request incoming handle identification
IHC      Command received from handle C
:

```

<h1>WT</h1>	<u>Syntax:</u>	Implicit Notation Only & Trippoint
	Operands:	none
	Burn:	not burnable
Wait		

Full Description

The WT command is a trippoint used to time events. When this command is executed, the controller will wait for the number of miliseconds specified before executing the next command.

If $m=1$ for WTn,m then the controller will wait for the number of samples specified before executing the next command.

Arguments

WT n,m

where

n is an unsigned integer in the range 0 to 2000000000 (2 Billion)

where

n is a unsigned, even integer in the range 0 to 2 Billion

m = 0 or omitted specifies n to be in ms

m = 1 specifies n to be in samples

Operand Usage

N/A

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In A Program	Yes
Command Line	No
Controller Usage	ALL
Default Value	-
Default Format	-

Related Commands

AT - At Time

TIME - Time Operand

TM - Update Time

Examples:

```
REM 10 seconds after a move is complete, turn on a relay for 2 seconds
#A;          'Program A
PR 50000;    'Position relative move
BGA;        'Begin the move
AMA;        'After the move is over
WT 10000;    'Wait 10 seconds
SB 1;       'Turn on relay (set output 1)
WT 2000;    'Wait 2 seconds
CB1;       'Turn off relay (clear output 1)
```

| EN; 'End Program

XQ	<u>Syntax:</u>	Implicit Notation Only
	Operands:	_XQ0, _XQ1, _XQ2, _XQ3, _XQ4, _XQ5, _XQ6, _XQ7
	Burn:	not burnable
Execute Program		

Full Description

The XQ command begins execution of a program residing in the program memory of the controller. Execution will start at the label or line number specified. Up to 8 programs may be executed with the controller.

Arguments

XQ #A,n

XQm,n

where

A is a program name of up to seven characters.

m is a line number

n is an integer representing the thread number for multitasking

n is an integer in the range of 0 to 7.

NOTE: The arguments for the command, XQ, are optional. If no arguments are given, the first program in memory will be executed as thread 0.

Operand Usage

_XQn contains the current line number of execution for thread n, and -1 if thread n is not running.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	N/A

Related Commands

HX - Halt execution

Examples:

```
XQ #APPLE,0      Start execution at label APPLE, thread zero
XQ #DATA,2      Start execution at label DATA, thread two
XQ 0           Start execution at line 0
Hint: For DOS users, don't forget to quit the edit mode first before executing a program!
```

YA	Syntax:	Explicit & Implicit
	Operands:	_YAn
	Burn:	burnable with BN
Step Drive Resolution		

Full Description

The YA command specifies the resolution of the step drive, in step counts per full motor step, for Stepper Position Maintenance mode.

Arguments

YA m,m,m,m,m,m,m,m

YAn = m

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.

m is 0 to 9999 which represents the drive resolution in step counts per full motor step.

For the SDM-44040, m is 1, 2, 4, or 16 for full, half, 1/4 and 1/16 step drive resolution, respectively. YA actually sets the configurable hardware step drive resolution for the SDM-44040.

For the SDM-44140, set m to 64 when using stepper position maintenance mode. The 44140 step drive is fixed at 64 step counts per full motor step and is not modifiable with the YA command.

Operand Usage

_YAn contains the resolution for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	2
Default Format	1.4

Related Commands

QS - Error Magnitude

YS - Stepper Position Maintenance Mode Enable, Status

YB - Step Motor Resolution

YC - Encoder Resolution

YR - Error Correction

Examples:

1. Set the step drive resolution for the SDM-44140 Microstepping Drive:
YA 64,64,64,64
2. Query the D axis value:
MG_YAD
:64.0000 Response shows D axis step drive resolution

YB	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_YBn
	<u>Burn:</u>	burnable with BN
Step Motor Resolution		

Full Description

The YB command specifies the resolution of the step motor, in full steps per full revolution, for Stepper Position Maintenance mode.

Arguments

YB m,m,m,m,m,m,m,m

YBn = m

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.

m is 0 to 9999 which represents the motor resolution in full steps per revolution.

Operand Usage

_YBn contains the stepmotor resolution for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	200
Default Format	1.4

Related Commands

QS - Error Magnitude

YS - Stepper Position Maintenance Mode Enable, Status

YA - Step Drive Resolution

YC - Encoder Resolution

YR - Error Correction

Examples:

- Set the step motor resolution of the A axis for a 1.8? step motor:
YBA=200
- Query the A axis value:
YBA=?
:200 Response shows A axis step motor resolution

YC	Syntax:	Explicit & Implicit
	Operands:	_Yc _n
	Burn:	burnable with BN
Encoder Resolution		

Full Description

The YC command specifies the resolution of the encoder, in counts per revolution, for Stepper Position Maintenance mode.

Arguments

YC m,m,m,m,m,m,m,m

YC_n = m

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.

m is 0 to 32766 which represents the encoder resolution in counts per revolution.

Operand Usage

_Yc_n contains the encoder resolution for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	4000
Default Format	1.4

Related Commands

QS - Error Magnitude

YS - Stepper Position Maintenance Mode Enable, Status

YA - Step Drive Resolution

YB - Step Motor Resolution

YR - Error Correction

Examples:

- Set the encoder resolution of the D axis for a 4000 count/rev encoder:
YC,,,4000
- Query the D axis value:
YCD=?
:4000 Response shows D axis encoder resolution

YR	<u>Syntax:</u>	Explicit & Implicit
	Operands:	none
	Burn:	not burnable
Error Correction		

Full Description

The YR command allows the user to correct for position error in Stepper Position Maintenance mode. This correction acts like an IP command, moving the axis or axes the specified quantity of step counts. YR will typically be used in conjunction with QS.

Arguments

YR m,m,m,m,m,m,m,m

YRn = m

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.

m is a magnitude in step counts.

Operand Usage

None

Usage

Usage and Default Details

Usage	Value
While Moving	No
In a Program	Yes
Default Format	1.4
Command Line	Yes
Default Value	0

Related Commands

QS - Error Magnitude

YA - Step Drive Resolution

YB - Step Motor Resolution

YR - Error Correction

YS - Stepper Position Maintenance Mode Enable, Status

Examples:

- Query the error of the B axis:


```
:QSB=?
:253          This shows 253 step counts of error
Correct for the error:
:YRB=_QSB    The motor moves _QS step counts to correct for the error, and YS is set back to 1
```

YS	Syntax:	Explicit & Implicit
	Operands:	_YSn
	Burn:	burnable with BN
Stepper Position Maintenance Mode Enable, Status		

Full Description

The YS command enables and disables the Stepper Position Maintenance Mode function. YS also reacts to excessive position error condition as defined by the QS command.

Arguments

YS m,m,m,m,m,m,m,m

YSn = m

where

n is A,B,C,D,E,F,G or H or any combination to specify the axis or axes.

m = 0 SPM Mode Disable

m = 1 Enable SPM Mode, Clear trippoint and QS error

m = 2 Error condition occurred

Operand Usage

_YSn contains the status of the mode for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Default Format	1.4
Default Value	0

Related Commands

QS - Error Magnitude

YA - Step Drive Resolution

YB - Step Motor Resolution

YC - Encoder Resolution

YR - Error Correction

Examples:

1. Enable the mode:
YSH=1
2. Query the value:
YS*=?
:0,0,0,0,0,0,0,1 Response shows H axis is enabled

ZA	Syntax:	Explicit & Implicit
	Operands:	_ZAn
	Burn:	not burnable
User Data Record Variables		

Full Description

ZA sets the user variables in the data record. The eight user variables (one per axis) are automatically sent as part of the status record from the controller to the host computer. These variables provide a method for specific controller information to be passed to the host automatically.

Arguments

ZA n,n,n,n,n,n,n,n

ZAA=n

where

n is an integer and can be a number, controller operand, variable, mathematical function, or string. The range for numeric values is 4 bytes of integer (-2,147,483,648 to +2,147,483,647). The maximum number of characters for a string is 4 characters. Strings are identified by quotations.

n = ? returns the current value

Operand Usage

_ZAn contains the current value for the specified axis.

Usage

Usage and Default Details

Usage	Value
While Moving	Yes
In a Program	Yes
Command Line	Yes
Controller Usage	All
Default Value	0
Default Format	10.0

Related Commands

DR - Data Record update rate

QR - Query Data Record

QZ - Data Record format

Examples:

```
#Thread
ZAX=MyVar; 'constantly update ZA
JP#Thread
```

ZS	<u>Syntax:</u>	Explicit & Implicit
	<u>Operands:</u>	_ZSn
	<u>Burn:</u>	not burnable
Zero Subroutine Stack		

Full Description

The ZS command is only valid in an application program and is used to avoid returning from an interrupt (either input or error). ZS alone returns the stack to its original condition. ZS1 adjusts the stack to eliminate one return. This turns the jump to subroutine into a jump. Do not use RI (Return from Interrupt) when using ZS. To re-enable interrupts, you must use II command again.

The status of the stack can be interrogated with the operand _ZSn - see operand usage below.

Arguments

ZS n

where

- n = 0 Returns stack to original condition
- n = 1 Eliminates one return on stack

Operand Usage

_ZSn contains the stack level for the specified thread where n = 0 to 7.

The response, an integer between zero and sixteen, indicates zero for beginning condition and sixteen for the deepest value.

Usage

Usage and Default Details

Usage	Value
While Moving (No RIO)	Yes
In a Program	Yes
Command Line	No
Controller Usage	All
Default Value	0
Default Format	3.0

Related Commands

Examples:

```
#A; '           Main Program
II1; '         Input Interrupt on 1
#B;JP #B;EN ;' Loop
#ININT;'       Input Interrupt
MG"INTERRUPT";'Print message
S=_ZS;'        Interrogate stack
S=?;'         Print stack
ZS;'          Zero stack
S=_ZS;'        Interrogate stack
S=?;'         Print stack
EN;'          End
```