DMC-4000 Firmware Command Reference
Revision: 1806

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Legend

Burnable Not Burnable

Description

Commands with the "burnable" icon can be saved into memory with the BN command. If a reset is issued, the value of the command with this icon will persist if it has been burned into memory.

Scaled By TM

Description

Any command with the "scaled by TM" icon will be automatically adjusted whenever a change is made to the TM setting. Commands with this icon are dependEnt on the sample rate.

Trippoint

Description

A command with the "trippoint" icon will halt further program execution until the trippoint's condition is satisfied. Most trippoints cannot be issued as discrete commands, and are only valid in programs.

Valid In Program Not Valid In Program

Description

Commands with the "valid in program" icon can be used inside of a DMC program that is run locally on the controller. Certain commands may not be used in the program space, and can only be issued as discrete command from an external source such as a terminal.

Valid In Terminal Not Valid In Terminal

Description

When communicating with a controller externally, only commands which are "valid in terminal" may be sent to the controller as discrete commands. Some commands are only valid when executed in a DMC program and cannot be issued independently.

Valid In Motion Not Valid In Motion

Description

If a command is "valid in motion" then it may be executed while an axis is in motion. Some commands may not be executed while certain axes are in motion, and can only be executed when the associated axis is stopped.

~a Variable Axis Supported

Description

Commands with the "variable axis supported" icon support the use of variable axes when using the '~'. See '~' for more details.

'

Comment

' str

Description

The ' allows for a user to insert in a comment on a blank line or after a command following a semicolon ";". See examples for valid uses of '.

Arguments

Argument	Value	Description	Notes
str	String	Comments added into program	Comment strings are restricted to the maximum row size for a program. This will vary per controller.

Remarks

- Comments will be downloaded to controller, thus taking up program space and execution time.
  - See `REM` for comments that will not download to controller.

Examples

```
'Galil DMC Code Example
REM This comment is not downloaded to controller and does not take up program
REM   space or execution time
'This comment is downloaded to controller and takes up program space
SH AB;'Comments following a command MUST be preceeded by a semi-colon.
KP 10'This is NOT valid use of the '
```

' applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

- *Subtraction Operator*

n_0 - n_1

Usage	variable = (value1 - value2)	Performs an operation between two values or evaluated statements

Description

The subtraction operator takes any two values and returns a value equal to the difference of the arguments.

Arguments

Argument	Min	Max	Default	Resolution	Description
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to subtract from
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to subtract

Remarks

- An operator is not a command and is not valid individually.
- Evaluation occurs left to right. Use parenthesis for operator precedence.
- n_0 and n_1 may also be variables, array elements, operands, or `@` functions (e.g. `@SIN[]`).

Examples

```
'Galil DMC Code Example
'Terminal Example
:apple = 10-4
:banana = apple - 3
:MG banana - 1
 2.0000
:
```

```
'Galil DMC Code Example
REM It is recommended that parenthesis be used when more than one mathmatical
REM   operation is combined in one command.
cherry = ((10*30)-(60/30));' evaluates as 298
date = 10*30-60/30;' evalutes as 8
EN
```

- applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

Label Designator

#str

Description

The # denotes the name of a program label, for example, `#move`. Labels are often used to implement subroutines or loops. Labels are either user-defined or are reserved names, called "automatic subroutines", that automatically execute when a particular event occurs.

Arguments

Argument	Min	Max	Default	Resolution	Description
str	1 char	7 chars	N/A	String	Name of label

Remarks

- Labels can include the characters A-Z, a-z, 1-9. Numbers can not be the first character. All other characters are invalid.
- A label can only be defined at the beginning of a new line.
- The number of labels available can be queried with `MG _DL`.
- `LL` returns the current label table in the controller.
- Galil recommends that at least the first character be lowercase for user labels to differentiate from automatic subroutines.
- Automatic subroutines are listed in the command reference starting with a # character.

- There is a maximum of 510 labels available.

Examples

```
'Galil DMC Code Example
REM A sample FOR loop
REM Routine will run 10 times and sum all integers 1 through 10
sum=0;' Variable to hold sum of integers
i=1;' Create a counter
#for
sum=sum+i;' Add counter to sum
i=i+1;' Increment counter
JP#for,(i<=10)
EN
```

```
'Galil DMC Code Example
REM A sample Do-While loop
REM Routine will run while A axis main encoder position is under 100 counts
#while
WT10;' Wait 10 mseconds
JP#while,(_TPA<100);' Loop back if position is under 100 counts
MG"Position is equal or greater than 100"
EN
```

 # applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

#AMPERR *Amplifier error automatic subroutine*

#AMPERR

Description

Automatic subroutine used to run code when a fault occurs on a Galil amplifier. See the TA command and individual amplifier information in the controller user manual.

Arguments

Label must be the first element on a line of code.

Remarks

Use RE to return from the AMPERR subroutine.
See the TA command for more information.
See the AZ command for more information on clearing latched amplifier errors.
Thread 0 does not need to be running for #AMPERR to be executed. This was a requirement on earlier products.
When an external servo driver is used on an axes where the AMP-43000 is also installed, the axis should be setup as a brushed motor (BRm=1), otherwise the lack of hall inputs will cause an amplifier error.

Related Commands

- AG - Amplifier Gain
- AU - Set Amplifier Current Loop
- AZ - Clear Amplifier Errors
- MT - Motor Type
- TA - Tell Amplifier Error
- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
'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*
```

```
'Galil DMC Code Example
REM Detailed #AMPERR example.  Uses LCD to display amplifier error information
REM  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
```

```
'Galil DMC Code Example
## Author: Galil Motion Control
## Date: 3.3.2020
## Controller Firmware: 4103 r1.3e
// This is an example of a #AMPERR automatic subroutine.
// The best method to demonstrate the behavior of this example is to assert the ELO input.
#AUTO
// Setup the amplifier for the A axis.
```

```
MO          // disable all motors to configure axes
AZ2         // enable enhanced error clearing mode
MTA=1       // set motor type for servo motor
AGA=1       // set amplifier gain
AUA=9       // set current loop gain
TLA=3       // set continuous torque limit to 3V
TKA=6       // set peak torque limit to 6V

// Set motion parameters
SPA=4000    // set speed of the A axis to 4000 counts/sec
ACA=16000   // set acceleration of the A axis to 16000 counts/sec/sec
DCA=16000   // set deceleration of the A axis to 16000 counts/sec/sec

// Set tuning parameters
KPA=6       // set proportional term for the A axis to 6
KDA=64      // set derivative term for the A axis to 64
KIA=0       // set integrator term for the A axis to 0

// Put the program into debug mode.
debug=1     // send message for amplifier errors when debug=1

// Initialize sinusoidal commutation for the A axis.
BAA         // specify A axis for sine commutation
BMA=2000    // define brushless modulus for A axis
BIA=-1      // initialize commutation with hall sensors
BCA         // refine sinusoidal commutation from hall transition
SB1;CB2     // set indicator lights tied to outputs 1 and 2 to operating
DP0         // define position to 0

// Main routine that commands motion forward and backward for the A axis.
#main;      // label for main application program
SHA         // enable A axis

// Command motion forward and backward.
#loop       // label to jump back to for loop
PAA=4000    // command motion forward
BGA         // begin motion
AMA         // wait for motion to finish before continuing program
PAA=0       // command motion backward
BGA         // begin motion
AMA         // wait for motion to finish before continuing program
JP#loop     // jump up to line with #loop label
EN

// #AMPERR automatic routine
// This routine stops motion, sets the indicator lights to error.
#AMPERR      // Amplifier Error Automatic Subroutine
ST;AM       // stop motion and wait until motion is finished on all axes
CB1;SB2     // set indicator lights tied to outputs 1 and 2 to error
MO;WT2      // disable all axes

JS#report,(debug=1) // print messages if in debug mode

// Clear any latched amplifier errors and message to the terminal if in debug mode
IF((_TA3&64)|(_TA3&128))  // if there are any latched amplifier errors
    AZ1;WT4               // clear latched amplifier errors
    IF(debug=1)           // print message if in debug mode
        MG"Latched amplifier error cleared"
    ENDIF
ENDIF

// Create variables to track amplifier error states
ta0=0       // variable to keep track of _TA0
ta3=0       // variable to keep track of _TA3

// Loop to check if there is still an amplifier error reported.
// While in debug mode, this will send a message to the terminal when any amplifier error state changes.
#check
IF((ta0<>_TA0)|(ta3<>_TA3))       // if the state of the amplifier errors has changed
    ta0=_TA0;ta3=_TA3             // set variables to new reported amplifier error state
    JS#report,(debug=1)           // print messages if in debug mode
ENDIF
WT2
JP#check,((_TA0<>0)|(_TA3<>0))    // jump back to #check if there is still an error
IF(debug=1)                       // print message if in debug mode
  MG"No amplifier errors"
ENDIF

// When there are no reported errors, set the indicator lights to operating and return to the main program
ZS0       // zero the stack
SB1;CB2   // set indicator lights tied to outputs 1 and 2 to operating
JP#main   // jump back to main program
EN

// Debug routine for sending messages when an amplifier error is reported
#report;
IF(_TA0&1)                // message for Over-Current error on axis bank A-D
MG "Over-Current amplifier error on axis bank A-D"
ENDIF
IF(_TA0&16)               // message for Over-Current error on axis bank E-H
MG "Over-Current amplifier error on axis bank E-H"
```

```
ENDIF
IF(_TA0&2)                // message for Over-Voltage error on axis bank A-D
MG "Over-Voltage amplifier error on axis bank A-D"
ENDIF
IF(_TA0&32)               // message for Over-Voltage error on axis bank E-H
MG "Over-Voltage amplifier error on axis bank E-H"
ENDIF
IF(_TA0&4)                // message for Over-Temperature error on axis bank A-D
MG "Over-Temperature amplifier error on axis bank A-D"
ENDIF
IF(_TA0&64)               // message for Over-Temperature error on axis bank E-H
MG "Over-Temperature amplifier error on axis bank E-H"
ENDIF
IF(_TA0&8)                // message for Under-Voltage error on axis bank A-D
MG "Under-Voltage amplifier error on axis bank A-D"
ENDIF
IF(_TA0&128)              // message for Under-Voltage error on axis bank E-H
MG "Under-Voltage amplifier error on axis bank E-H"
ENDIF
IF((_TA3&1)|((_TA3&2))    // message for ELO
MG "ELO input asserted"
ENDIF
EN
```

#AMPERR applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103

#AUTO *Subroutine to run automatically upon power up*

#AUTO

Description

Defines the automatic entry point of embedded DMC code. When power is applied to the controller, or after the controller is reset, the program will automatically begin executing at this label. When no host software is used with the controller, #AUTO is required to run an application program on the controller stand-alone.

Arguments

Label must be the first element on a line of code.

Remarks

- Use EN to end the routine
- Thread 0 is used to execute #AUTO on startup
- The BP command must be used to burn a program into EEPROM for the #AUTO to function.

Examples

```
'Galil DMC Code Example
'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
 SB 1;'     Set bit 1
 WT 500;'   Wait 500msec
 CB 1;'     Clear bit 1
 WT 500;'   Wait 500msec
JP #AUTO;'  Jump back to #AUTO
```

#AUTO applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

#AUTOERR *Bootup Error Automatic Subroutine*

#AUTOERR

Description

Automatic subroutine that runs code upon power up if the firmware detects errors. If the EEPROM is corrupted, #AUTOERR will run. The EEPROM is considered corrupt if the checksum calculated on the bytes in the EEPROM do not match the checksum written to the EEPROM.

For SSI and BiSS operation, #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.

Arguments

Label must be the first element on a line of code.

Remarks

- Use EN to end the routine
- The type of checksum error can be queried with MG_RS

- For SSI and BiSS operation
  - In the event of a serial position acquisition timeout, the following will occur:
    - The controller will reset
    - The controller servo loop will not run, TM will be set to zero
    - TC1 will return "143 TM timed out"
    - The automatic subroutine #AUTOERR will run, if present
    - The Error output will be set
  - When using serial encoders (SSI or BiSS), the #AUTOERR should follow these guidlines
    - IF _TC=143 do not employ any trippoints in following code because the timer interrupt is suspended
    - Serial encoders can be disabled with the commands SIn=0 or SSn=0 where n is the axis indicator ABCDEFG or H
    - In order to re-enable the timer interrupt issue "TM n" where n is the servo update period in us (usually n=1000). See TM for more details

Examples

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

```
'Galil DMC Code Example
'Use for BiSS and SSI only (-SER firmware)
'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
```

#AUTOERR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

#CMDERR *Command error automatic subroutine*

#CMDERR

Description

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.

Arguments

Label must be the first element on a line of code.

Remarks

- Use EN to end the routine
- #CMDERR will only run from errors generated within embedded DMC code, not from the terminal or host
- 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.

Examples

```
'Galil DMC Code Example
'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
```

#CMDERR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

#COMINT *Communication interrupt automatic subroutine*

#COMINT

Description

Automatic subroutine to provide interrupt driven communications from the serial port. #COMINT 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.

Arguments

Label must be the first element on a line of code.

Remarks

- Use EN to end the routine
- #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.
- It is important to handle the interrupt condition and return without delay. The controller will continue to receive data and update the data operands (P1CH,P2CH, etc) while in #COMINT. This can lead to missed characters, numbers, and strings if #COMINT is unnecessarily delayed.
- It is the user's responsiblity to ensure the communication buffer is not filled when in this mode, otherwise the controller will report error code 5 "Input Buffer Full". The buffer on the controller is cleared when either of the two following conditions are met:
    - A carriage return is recieved on the communication port.
    - CI -1 is called.

Examples

```
'Galil DMC Code Example
#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
 CI -1;                       'Clear the buffer of the received character
EN1,1;                        ' End this subroutine, re-arming trip points that
'                             were running and re-enabling the CI mask
```

#COMINT applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

#FWERR *Firmware Error Automatic Subroutine*

#FWERR

Description

Automatic subroutine to run when the servo sample overflows. Many features require that the controller perform an action every sample. Running many of these features simultaneously can lead to there not being enough time to complete every action. See remarks for a list of these features. For the majority of applications, this will never occur. This behavior should only occur when running a low sample time (TM) and using absolute encoders with a high number of bits at a low clock frequency.

Arguments

Label must be the first element on a line of code.

Remarks

- The following are features, and their associated DMC comands, which add a non-negligible amount of time to the servo sample calculations.
  - Serial Encoders (SI/SS)
  - Analog Encoders (AF)
  - Notch Filter (NF,NZ,NB)
  - Low Sample Time setting (TM)

- Use EN to end the routine.
- #FWERR runs on thread 0. Code does not need to be running in thread 0 for #FWERR to be enabled.
- _QQ reports a value based on whether the interrupt overflow event has occured. See QQ for more details.

When the servo interrupt overlows, the following will occur:

- _QQ is set to 1.
- #FWERR, if present, will run.
- The notch filter is turned off.
- Serial and Analog feedback is disabled.
- All axes are aborted (See AB command).
- SC will report 41 for all that were profiling.

Examples

```
'Galil DMC Code Example
'Code detects a checksum error and notifies the user
#FWERR
MG "Interrupt overflow event occurred:" ,_QQ; 'printing the _QQ operand showing that the interrupt has overflown
QQ; 'returns the _QQ operand to 0
MG "Shutdown for diagnostics"
EN
```

#FWERR applies to DMC4000,DMC4103,DMC30010

#ININT *Input interrupt automatic subroutine*

#ININT

Description

The #ININT subroutine is used to execute specific code when inputs specified by the II command are in the desired state.

Arguments

Label must be the first element on a line of code.

Remarks

- Use the II command to enable the routine.
- Use RI to exit the routine.
- To make an unconditional jump from #ININT, there are two methods for re-enabling the interrupt capability
  - Issue a ZS and then re-issue the command II before the JP
  - or, use a "null" routine. The "null" routine allows for the execution of the RI command before the unconditional jump. For more information see Application Note #2418, http://www.galil.com/download/application-note/note2418.pdf

Examples

```
'Galil DMC Code Example
II 1,1,,0;'                 Specify interrupt on input 1 only, and triggers when input 1 = 0.
EN;'                        End Program
#ININT;'                    Interrupt subroutine
'                           The code the user wants to run when II triggers goes here.
WT100;'                     Debounce the input.
RI 1;'                      Return to main program, re-enabling trip point.
'                           Specify RI 0 if it is not desired to re-enable trip points.
```

#ININT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

#LIMSWI *Limit switch automatic subroutine*

#LIMSWI

Description

Automatic sub for running user-defined code on a limit switch event. A limit switch event requires the following conditions.

1. Motion profiling in the direction of the given limit. I.E. RPm increasing for forward switch, RPm decreasing for reverse switch.
2. Limit switch toggles active, either a hardware or software limit. See CN for inverting the active sense of the limit swithes.

Without #LIMSWI defined, the controller will issue ST on the axis when its limit switch is tripped during motion in the direction of the switch. With #LIMSWI defined, code is executed in addition to the stop.
In lieu of a controlled stop, the motor can turn off and coast stop in the event of a limit switch event. See OE for this feature.

Arguments

Label must be the first element on a line of code.

Remarks

- Use RE to terminate the subroutine
- See _LF and _LR for switch state operands

- #LIMSWI runs on thread 0. Code does not need to be running in thread 0 for #LIMSWI to be enabled.
- LD can be used to disable the limit operation
- SD can be used to set the deceleration speed on the limit.

Examples

```
'Galil DMC Code Example
#Main        ;'print a message every second
  MG "Main"
  WT1000
JP#Main
EN
'
#LIMSWI ;'runs when a limit switch is tripped
MG "Limit switch:"{N}
IF ((_LFA = 0) | (_LRA = 0))
 MG "Axis A"
ENDIF
IF ((_LFB = 0) | (_LRB = 0))
 MG "Axis B"
ENDIF
RE1;' RE used to exit the #LIMSWI sub
```

#LIMSWI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

#MCTIME *MC command timeout automatic subroutine*

#MCTIME

Description

Automatic sub used to run user-code if a Motion Complete (MC) trippoint times out. If the motor position does not reach or pass the target within the specified timeout (TW), #MCTIME wil run if present.

MC uses position from TP for servos, or TD for steppers.

Arguments

Label must be the first element on a line of code.

Remarks

- Use EN to terminate the subroutine

Examples

```
'Galil DMC Code Example
#BEGIN;'                  Begin main program
 TWA= 1000;'               Set the time out to 1000 ms
 PRA= 10000;'              Position relative
 BG A;'                    Begin motion
 MC A;'                    Motion Complete trip point
EN;'                      End main program
'
#MCTIME;'                  Motion Complete Subroutine
 MG "A fell short";'      Send out a message
EN 1;'                    End subroutine
```

#MCTIME applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

#POSERR *Position error automatic subroutine*

#POSERR

Description

Automatic subroutine that runs user code when a position error event occurs. The factory default behavior of the Galil controller upon a position error (_TEn > _ERn) is to drive the error signal low only, 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 is used to run code upon a position error, for example to notify a host computer.

Arguments

Label must be the first element on a line of code.

Remarks

- Use RE to end the routine.

- #POSERR runs on thread 0. Code does not need to be running in thread 0 for #POSERR to be enabled.
- #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).

Examples

```
'Galil DMC Code Example
## Author: Galil Motion Control
## Date 6.3.2020
//how to recover from position error on the A axis
#POSERR
ST; // stop commanding motion to all axes
AM; // wait until motion is halted
MO; // disable all axes
MG "Position error occurred"; // send message indicating position error occured
SHA;//reenable A axis, position error is cleared
EN
```

#POSERR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

#SERERR *Serial Encoder Error Automatic Subroutine*

#SERERR

Description

During operation, the #SERERR automatic subroutine allows user code to run when there is a serial encoder fault. Encoder faults are reported in the _SSm0 operand, see the SS command for more details.

Arguments

Label must be the first element on a line of code.

Remarks

- Use the RE command to end this routine.
- #SERERR runs on thread 0
- The following are the fault conditions which will cause #SERERR to interrupt.

Serial Encoder Faults

BiSS
Encoder timeout (bit 0 of _SSm0)
CRC error (bit 1 of _SSm0)
Warning bit* (bit 2 of _SSm0)
Error bit* (bit 3 of _SSm0)

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

Examples

```
'Galil DMC Code Example
#SERERR
'Serial Error routine messages out to the host the type of error.
sercode=_SSA0
IF (sercode & 1)
 MG "BiSS Timeout"
ENDIF
IF (sercode & 2)
 MG "Invalid CRC"
ENDIF
IF (sercode & 4)
 MG "Warning Bit Set"
ENDIF
IF (sercode & 8)
 MG "Error Bit Set"
ENDIF
RE
```

#SERERR applies to SER

#TCPERR *Ethernet communication error automatic subroutine*

#TCPERR

Description

Automatic subroutine which allows execution of user code when an TCP error event occurs. #TCPERR allows the application programmer to run code (for example to reestablish the connection) when error code 123 occurs.

Arguments

Label must be the first element on a line of code.

Remarks

- Use RE to exit this subroutine.
- Error code 123 (TCP lost sync or timeout) occurs when a message is sent out a handle, and no acknowledgement is received.
  - When this occurs, the handle the message was sent out is closed.
  - #TCPERR can be used to reestablish the handle
- Code does not need to be running in thread 0 for #TCPERR to run.

Examples

```
'Galil DMC Code Example
#loop
 MG {EA} "L"
 WT1000
JP#loop

#TCPERR
 MG {P1} "TCPERR.  Dropped handle", _IA4
RE
```

```
'Galil DMC Code Example
'example of reestablishing connection after TCPERR
'
#main
IHE=192,168,1,30;'   connect to 192,168,1,30
WT100;'             wait for handle to be established
ipe=_IHE0;'          save IP for reconnection use
n=0;'                connection counter
#loop;'             endless message loop
MG"hello"
WT1000
JP#loop
EN

#TCPERR
IHE=>-3;'            make sure handle E is clear
JP#TCPERR,_IHE2<>0;' wait for clear handle
IHE=ihe;'            set handle with saved IP var
WT100
n=n+1;'              increment counter
JP#END,n>5;'        try at least 5 times
JP#TCPERR,_IHE2<>-2;'repeat if handle failed
#END
IF(n>5)
 MG"failed connection"
 HX0;'              stop code if connection lost
ELSE
 MG"Reconnected"
 n = 0;'             reset connection counter
ENDIF
RE
```

#TCPERR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

$ *Hexadecimal*

$n

Description

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

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	$80000000.0000	$7FFFFFFF.FFFF	N/A	$0.0001	Value of hexadecimal number	32 bits of integer and 16 bits of fraction in total

Remarks

- None

Examples

```
'Galil DMC Code Example
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
```

$ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,EDD37010

% *Modulo Operator*

n % n

Usage	variable = (value1 % value2)	Performs an operation between two values or evaluated statements

Description

The % symbol is the modulo operator. It takes as arguments any two values, variables, array elements, operands, or At functions (@SIN[]) and returns a value equal to the modulo of the arguments.

Mathmatical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subraction.
Example:
1+2*3 = 9, not 7

It is recommended that parenthesis be used when more than one mathmatical operation is combined in one command.
Example:
var = ((10*30)+(60/30));' evaluates as 302
var = 10*30+60/30;' evalutes as 12

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	-2,147,483,647.9999	N/A	1/65,536	Value to use in modulo operation	

Remarks

- This is a binary operator (takes two arguments and returns one value). The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.
- Mathmatical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subraction.
  - Example: 1+2*3 = 9, not 7
- It is recommended that parenthesis be used when more than one mathmatical operation is combined in one command.
  - Example: var = ((10*30)+(60/30));' evaluates as 302
  - var = 10*30+60/30;' evalutes as 12

Examples

```
'Galil DMC Code Example
'Determine the day of week in n days
DM name[7];'Strings for day of week
name[0]="SUN"
name[1]="MON"
name[2]="TUE"
name[3]="WED"
name[4]="THU"
name[5]="FRI"
name[6]="SAT"
today=2;'Tuesday
days=123;'Days from now
dow=((days + today)%7);'calculate future day of week
MG"The day of week in ",days{Z10.0}," days will be ", name[dow]{S3.0}
EN

REM Code Returns: The day of week in  123 days will be SAT
```

% applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000,DMC1806

& *JS subroutine pass variable by reference*

JS#str0(&str1,&str1,&str1,&str1,&str1,&str1,&str1,&str1)

Description

The & symbol is used to pass a variable by reference on the subroutine stack. When passed by reference, a change to the local-scope variable changes the global value.

Arguments

Argument	Min	Max	Default	Resolution	Description
str0	1 char	7 chars	N/A	String	Name of label to use for subroutine call
str1	1 char	8 chars	N/A	String	Name of variable to pass by reference to the subroutine

Remarks

- Variables sent to a subroutine must be global variables that are already dimensioned.
- **Do not dimension any variables in a subroutine when passing variables by reference. This can break the variable pointer.**

Examples

```
'Galil DMC Code Example
REM 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

'From Terminal
:
Executed program from program2.dmc
36.0000
36.0000
```

& applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

& *Bitwise AND Operator*

n & n

Usage	variable = (value1 & value2)	Performs an operation between two values or evaluated statements

Description

The & symbol is the bitwise AND operator used with IF, JP, and JS decisions, and also to perform bitwise ANDING of values.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use with AND operator	

Remarks

- The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.
- For IF, JP, and JS, the values used for n are typically the results of logical expressions such as (x > 2) & (y=8)

Examples

```
'Galil DMC Code Example
'Bitwise use
:var1=$F;'00001111
:var2=$F0;'1111000
:MG (var1 & var2)
0.0000
:MG var1
15.0000
:MG var2
240.0000
:
```

```
'Galil DMC Code Example
'Conditional Use
var1=$F;'00001111
var2=$F0;'1111000
IF (var1 = $F) & (var2 = $F1)
 MG"True"
ELSE
 MG"False"
ENDIF
EN

REM Returned: False
```

& applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

(,) *Parentheses (order of operations)*

(n)

Description

The parentheses denote the order of math and logical operations.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647.9999	N/A	1/65,536	Math or logical expression for evaluation	

Remarks

- Note that the controller evaluates expressions from left to right, and does **not** follow academic algebraic standards (e.g. multiplication and division first, followed by addition or subtraction)
- It is required to use parentheticals to ensure intended mathematical precedence

Examples

```
'Galil DMC Code Example
:MG 1+2*3
 9.0000
:MG 1+(2*3)
 7.0000
```

```
'Galil DMC Code Example
:var1=$1F
:var2=$F
:MG var1&var2/$10
0.9375      ($0.F000)
:MG var1&(var2/$10)
0.0000      ($0.0000)
```

(,) applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

* *Multiplication Operator*

n * n

Usage	variable = (value1 * value2)	Performs an operation between two values or evaluated statements

Description

The * symbol is the multiplication operator. It takes as arguments any two values, variables, array elements, operands, or At functions (@SIN[]) and returns a value equal to the product of the arguments.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	-2,147,483,647	N/A	1/65,536	Value to use in multiplication operation	

Remarks

- This is a binary operator (takes two arguments and returns one value). The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.
- Mathmatical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subraction.
  - Example: 1+2*3 = 9;' not 7
- It is recommended that parenthesis be used when more than one mathmatical operation is combined in one command.
  - Example: var = ((10*30)+(60/30));' evaluates as 302
  - var = 10*30+60/30;' evalutes as 12

Examples

```
'Galil DMC Code Example
:var1 = (2 + 3) * 2
:var2 = var1 * 10
:MG var2 * 0.5
 50.0000
:
```

*** applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802**

/ *Division Operator*

n_0 / n_1

Usage	variable = (value1 / value2)	Performs an operation between two values or evaluated statements

Description

The / symbol is the division operator. It takes as arguments any two values, variables, array elements, operands, or At functions (@SIN[]) and returns a value equal to the quotient of the arguments.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Numerator of divide operation	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Denominator of divide operation	

Remarks

- This is a binary operator (takes two arguments and returns one value). The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.
- Mathmatical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subraction.
  - Example: 1+2*3 = 9;' not 7
- It is recommended that parenthesis be used when more than one mathmatical operation is combined in one command.
  - Example: var = ((10*30)+(60/30));' evaluates as 302
  - var = 10*30+60/30;' evalutes as 12

Examples

```
'Galil DMC Code Example
:var1 = 100/10
:var2 = var1/2
:MG var2 + 1
 6.0000
:
```

/ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

; *Semicolon (Command Delimiter)*

arg;arg;arg;arg

Description

The semicolon operator allows multiple Galil commands to exist on a single line.

Arguments

arg represents any valid Galil command

Remarks

- The semicolon operator is used for the following 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.

Examples

```
'Galil DMC Code Example
SB1;WT500;CB1;' multiple commands separated by semicolons with a comment
```

```
'Galil DMC Code Example
#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
```

; applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

@ABS *Absolute value*

@ABS[n]

Usage	variable = @ABS[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @ABS[] operation takes the absolute value of the given number. Returns the value if positive, and returns -1 times the value if negative.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,535	Number to display as absolute value	

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @ABS[-2147483647]
 2147483647.0000
```

@ABS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@ACOS *Inverse cosine*

@ACOS[n]

Usage	variable = @ACOS[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @ACOS operator returns in degrees the arc cosine of the given number.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-1	1	N/A	1/65,536	Value used for arc cosine operation	

Remarks

- @ACOS[] is an operand, not a command. It can only be used as an argument to other commands and operators
- @ACOS[] is also referred to as the inverse cosine function

Examples

```
'Galil DMC Code Example
:MG @ACOS[-1]
 180.0000
:MG @ACOS[0]
 90.0000
:MG @ACOS[1]
 0.0001
```

@ACOS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@AN *Analog Input Query*

@AN[n]

Usage	variable = @AN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @AN[] operator returns the value of the given analog input in volts.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	8	N/A	1	Analog input to query	
n	1,000	8,999	N/A	1	Read Modbus slave analog input	See Remarks

Remarks

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

Using @AN with a Modbus Slave

- RIO as Modbus Slave
- 3rd Party Modbus Slave Device

- n is the I/O number calculated using the following equations:
- n = (HandleNum*1000) + (Bitnum-1)
  - HandleNum is the handle specifier from A to H.
    - Handle must be assigned to port 502 for Modbus comms (See IH)
  - BitNum is the I/O point in the module from 1 to 8

Examples

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

@AN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,RIO57400,DMC1806

@ASIN *Inverse sine*

@ASIN[n]

Usage	variable = @ASIN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @ASIN operator returns in degrees the arc sine of the given number.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-1	1	N/A	1/65,536	Value used for arc sine operation	

Remarks

- @ASIN[] is an operand, not a command. It can only be used as an argument to other commands and operators
- @ASIN[] is also referred to as the inverse sine function

Examples

```
'Galil DMC Code Example
:MG @ASIN[-1]
 -90.0000
:MG @ASIN[0]
 0.0000
:MG @ASIN[1]
 90.0000
```

@ASIN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@ATAN *Inverse tangent*

@ATAN[n]

Usage	variable = @ATAN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @ATAN operator returns in degrees the arc tangent of the given number.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,638	2,147,483,647	N/A	1/65,536	Value used for arc tangent operation	

Remarks

- @ATAN[] is an operand, not a command. It can only be used as an argument to other commands and operators
- @ATAN[] is also referred to as the inverse tangent function

Examples

```
'Galil DMC Code Example
:MG @ATAN[-10]
 -84.2894
:MG @ATAN[0]
 0.0000
:MG @ATAN[10]
 84.2894
```

@ATAN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@COM *Bitwise complement*

@COM[n]

Usage	variable = @COM[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @COM[] operation performs the bitwise complement (NOT) operation to the given number.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1	Value to perform bitwise complement operation.	Integer interpreted as a 32-bit field

Remarks

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

Examples

```
'Galil DMC Code Example
:MG {$8.0} @COM[0]
$FFFFFFFF
:MG {$8.0} @COM[$FFFFFFFF]
$00000000
```

```
'Galil DMC Code Example
'toggle output 1
OB 1,@COM[@OUT[1]] & 1;' read current state of output 1, take the bitwise complement, mask out bits.
```

@COM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@COS *Cosine*

@COS[n]

Usage	variable = @COS[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @COS[] operation returns the cosine of the given angle in degrees

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-32,768	32,767	N/A	1/65,536	Value in degrees to use for cosine operation	

Remarks

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

Examples

```
'Galil DMC Code Example
: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
```

@COS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@FLOT *Convert Galil 4.2 to Floating Point*

@FLOT[n]

Usage	variable = @FLOT[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @FLOT operation returns the 32bit floating representation of a number

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use for floating point conversion	

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @FLOT[2.5] {$8.0}
$40200000
:MG @REAL[$40200000]
 2.5000
:
```

@FLOT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

@FRAC *Fractional part*

@FRAC[n]

Usage	variable = @FRAC[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @FRAC operation returns the fractional part of the given number

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use in fractional operation	

Remarks

- The sign of the number input to the operation will be maintained in the fractional output.
- @FRAC[] is an operand, not a command. It can only be used as an argument to other commands and operators

Examples

```
'Galil DMC Code Example
:MG @FRAC[1.2]
 0.2000
:MG @FRAC[-2.4]
 -0.4000
```

@FRAC applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@IN *Read digital input*

@IN[n]

Usage	variable = @IN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @IN operand returns the value of the given digital input (either 0 or 1).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	16	N/A	1	General input to query	Inputs 9-16 only valid for 5-8 axis controller
	17	48	N/A	1	Extended input to query	See Remarks
	81	96	N/A	1	Aux encoder input to query	Used when repurposing aux encoder inputs as digital inputs
n	1,000	8,999	N/A	1	Read Modbus slave bit	See Remarks

Remarks

- @IN[] is an operand, not a command. It can only be used as an argument to other commands and operators
- Extended IO must be configured as inputs by the CO command for valid results.
- Extended I/O points are updated once per sample.

Using @IN with a Modbus Slave

- n = (SlaveAddress*10000) + (HandleNum*1000) + ((Module-1)*4) + (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 where A is 1, B is 2 and so on.
  - 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

Examples

```
'Galil DMC Code Example
:MG @IN[1]
1.0000
:x = @IN[1]
:x = ?;'  print digital input 1
1.000
```

@IN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,RIO57400,DMC1806,DMC1802

@INT *Integer part*

@INT[n]

Usage	variable = @INT[value]	Performs a function on a value or evaluated statement and returns a value

Description

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

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use in integer operation	

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @INT[1.2]
 1.0000
:MG @INT[-2.4]
 -2.0000
```

```
'Galil DMC Code Example
#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
```

@INT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@OUT *Read digital output*

@OUT[n]

Usage	variable = @OUT[value]	Performs a function on a value or evaluated statement and returns a value

Description

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

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	16	N/A	1	General output to query	Outputs 9-16 only valid for 5-8 axis controller
	17	48	N/A	1	Extended output to query	See Remarks
n	1,000	8,999	N/A	1	Query Modbus slave bit	See Remarks

Remarks

- Extended IO must be configured as outputs with the CO command for valid response
- Extended I/O points are updated once per sample.
- @OUT[] is an operand, not a command. It can only be used as an argument to other commands and operators

Using @OUT with a Modbus Slave

- n = (SlaveAddress*10000) + (HandleNum*1000) + ((Module-1)*4) + (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 where A is 1, B is 2 and so on.
  - 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

Examples

```
'Galil DMC Code Example
:MG @OUT[1];'     print state of digital output 1
1.0000
:x = @OUT[1];'    assign state of digital output 1 to a variable
```

@OUT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,RIO57400,DMC1806,DMC1802

@REAL *Convert Floating Point to Galil 4.2*

@REAL[n]

Usage	variable = @REAL[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @REAL operation returns the Galil 4.2 equivalent of a 32 bit floating point number

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1	32 bit floating point number to convert to Galil 4.2 integer	

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @FLOT[2.5] {$8.0}
$40200000
:MG @REAL[$40200000]
 2.5000
:
```

@REAL applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

@RND *Round*

@RND[n]

Usage	variable = @RND[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @RND operation rounds the given number to the nearest integer.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use in rounding operation	

Remarks

- @FRAC[] is an operand, not a command. It can only be used as an argument to other commands and operators
- The sign of the number input to the operation will be maintained in the rounded output.

Examples

```
'Galil DMC Code Example
:MG @RND[1.2]
 1.0000
:MG @RND[1.6]
 2.0000
:MG @RND[-1.2]
 -1.0000
:MG @RND[5.7]
 6.0000
:MG @RND[-5.7]
 -6.0000
:MG @RND[5.5]
 6.0000
:MG @RND[-5.5]
 -5.0000
```

@RND applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@SIN *Sine*

@SIN[n]

Usage	variable = @SIN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @SIN[] operation returns the sine of the given angle in degrees

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-32,768	32,767	N/A	1/65,536	Value in degrees to use for sine operation	

Remarks

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

Examples

```
'Galil DMC Code Example
: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
```

@SIN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@SQR *Square Root*

@SQR[n]

Usage	variable = @SQR[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @SQR operation takes the square root of the given number.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use in square root operation	If n < 0, the absolute value is taken first.

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @SQR[2]
 1.4142
:MG @SQR[-2]
 1.4142
```

@SQR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

@TAN *Tangent*

@TAN[n]

Usage	variable = @TAN[value]	Performs a function on a value or evaluated statement and returns a value

Description

The @TAN[] operation returns the tangent of the given angle in degrees.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-32,768	32,767	N/A	1/65,536	Value in degrees to use for tangent operation	

Remarks

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

Examples

```
'Galil DMC Code Example
:MG @TAN[23]
 0.4245
:
```

@TAN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

[,] *Square Brackets (Array Index Operator)*

str[n]

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

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	8 chars	N/A	String	Name of array to access	Must be a valid dimensioned array name.
n	-1	15,999	N/A	1	Element of array to query	n = -1 returns the array length

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	8 chars	N/A	String	Name of array to access	Must be a valid dimensioned array name.
n	0	399	N/A	1	Element of array to query	For RIO-47x00
	0	999	N/A	1	Element of array to query	For RIO-47xx2 and RIO-473xx

Remarks

- If the array will be passed by reference on the subroutine stack (JS), the array name MUST be 6 characters or less.

Examples

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

```
'Galil DMC Code Example
#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];'               len now contains the length of A[]
 QU A[],0,len-1,1;MG"";'    print entire array
 MG "A[] length=",len;'     display Variable len
EN


'Example Output from terminal
:XQ#array
:
A[0]= 3
3, 4320, 216666, 217522, 607950
A[] length= 5

:
```

[,] applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

^ *JS subroutine stack variable*

^s

Description

The ^ character provides local subroutine access for variables passed on the subroutine stack. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
s	a	h	N/A	N/A	Stack variable name	a,b,c,d,e,f,g,h supported

Remarks

- See the JS command for a full explanation of passing stack variables.
- Passing parameters has no type checking, so it is important to exercise good programming style when passing parameters. See examples below for recommended syntax.
- Do not use spaces in expressions containing ^.
- Global variables MUST be assigned prior to any use in subroutines where variables are passed by reference.
- Arrays passed on the stack must have names no longer than 6 chars.
- Stack zero has no local-scope variables. Accessing these variables from stack zero writes to stack 1's variable table.

Examples

```
'Galil DMC Code Example
#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

'Output from the previous program
:XQ#Add
36.0000
```

^ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

^L^K *Lock program*

^L^K str,n

Usage	^L^K n ...	Arguments specified with an implicit, comma-separated order

Description

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. Once the program is unlocked, it will remain accessible until a lock command or a reset (with the locked condition burned in) occurs.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	0 char	8 chars	""	String	Controller password string	Password assigned with the PW command.
n	0	1	0	1	Set lock/unlock state for controller	n = 1 locks the application program. n = 0 unlocks the application program.

Remarks

- The PW command can only be set while the application program is unlocked.
- `^L^K ?` will return a 0 if the controller is not locked, and a 1 if it is locked.

ASCII Values

Char	Dec	Hex
^L	12	0C
^K	11	0B

Examples

```
'Galil DMC Code Example
:PW test,test;'          Set password to "test"
:^L^K test,1;'           Lock the program
:LS;'                    Attempt to list the program
?
:TC 1
106 Privilege violation
:
```

^L^K applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000,DMC1806

^R^S *Master Reset*

^R^S

Usage	^R^S	Command takes no arguments

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.

Arguments

^R^S has no parameters

Remarks

- 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.

ASCII Values

Char	Dec	Hex
^R	18	12
^S	19	13

Examples

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

:KP?
 6.00
:KP10
:KP?
 10.00
:BN
:RS

:KP?
 10.00
:^R^S

:KP?
 6.00
:
```

^R^S applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

^R^V *Revision Information*

^R^V

Usage	^R^V	Command takes no arguments

Description

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

Arguments

^R^V has no arguments

Remarks

- Do not use ^ symbols to send ^R^V command. ^ symbols denote using the control (Ctrl) key when pressing the characters.

ASCII Values

Char	Dec	Hex
^R	18	12
^V	22	16

Examples

```
'Galil DMC Code Example
:^R^V
DMC4040 Rev 1.1e
:
```

^R^V applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

_ *Operand Overview*

Operand Usage

Operands allow motion or status parameters of the controller to be incorporated into programmable variables and expressions. Most DMC commands have an equivalent operand - which are designated by adding an underscore (_) prior to the DMC command. An operand typically contains the value of the command associated with it, for instance _TPA contains the current position of axis A. Below is an example of proper and improper usage for an operand.

Example Usage

```
'Galil DMC Code Example
'Correct usage
MG _TPA;' Message the A Axis' current position.
err = _TC;' Save the current error code to a variable, err.

'Incorrect usage
_TPA;' Sending this to the controller will result in an error, as operands are not valid commands on their own.
```

Special Operands

The majority of DMC operands return information directly related to their command. However, there are a few operands which provide access to internal variables that are not accessible by standard DMC commands. Below is a list of special operands which contain information not stored in a typical DMC command.

For more details on the content of these operands, see their associated command page.

Special Operand	Description
_BN	Contains the controller's serial number.
_BV	Contains the number of axes on the controller.
_DA	Contains the number of array space left in the controller's memory.
_DL	Contains the number of label space left in the controller's memory.
_DM	Contains the number of array space left in the controller's memory.
_ED0	Contains the line number where an error last occured.
_ED1	Contains the thread where an error last occured.
_ED4	Contains the thread ID of the thread evaluating the operand.
_HXn	Contains the running status of thread 'n'.
_NO	Contains a bitmask of the running threads.
_RS	Contains a bitmask of checksum errors.
_UL	Contains the number of variables left in the controller's memory.
_XQn	Contains the current line number of thread 'n'.
TIME	Contains the current value of the controller's free running clock.

_GP *Gearing Phase Differential Operand*

_GPm

Usage	variable= _GP	Holds a value
Operands	_GPm	Operand has special meaning, see Remarks

Description

The _GP operand contains the value of the specified slave's "phase differential" accumulated on the most recent change in the gear 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis of interest	

Remarks

- An operand is not valid individually. Instead, _GP would be used in an expression. See example below.
- Phase Differential is a term that is used to describe the lead or lag between a master axis and the specified slave axis due to gradual gear shift.
- See application note 2440 for more information on _GP and GD.

Examples

```
'Galil DMC Code Example
GA DA;'   Sets the A axis aux encoder as the gearing master for the A axis.
GD1000;'  Set the distance that the master will travel to 1000
'         counts before the gearing is fully engaged for the A
'         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=_TDA;' Sets the current A axis position to variable P1.  This
'         variable is used in the next command
#wait
'         Wait for the aux encoder 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.
JP#wait,  (_TDA < (p1+1000))
IP _GPA;' Increment the difference to bring the master/slave in
'         position sync from the point that the GR1 command was
'         issued.
EN;'      End Program
```

_GP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

_LF *Forward Limit Switch Operand*

_LFm

Usage	variable= _LF	Holds a value
Operands	_LFm	Operand has special meaning, see Remarks

Description

The _LF operand contains the state of the forward limit.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis of forward limit switch	

Remarks

- _LF is an operand only with the following output:
  - _LFm = 1 when the limit switch state will allow motion in the positive direction.
  - _LFm = 0 when the limit switch state will not allow motion in the positive direction.
- This operand is not a direct readout of the digital input and is affected by the command CN.
- See Connecting Hardware in User Manual for active/inactive state

Values of _LF

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)

Examples

```
'Galil DMC Code Example
MG _LFA;' Display the status of the A axis forward limit switch
```

_LF applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

_LR *Reverse Limit Switch Operand*

_LRm

Usage	variable= _LR	Holds a value
Operands	_LRm	Operand has special meaning, see Remarks

Description

The _LR operand contains the state of the reverse limit.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis of reverse limit switch	

Remarks

- _LR is an operand with the following output
  - _LRm= 1 when the limit switch state will allow motion in the reverse direction.
  - _LRm= 0 when the limit switch state will not allow motion in the reverse direction.
- This operand is not a direct readout of the digital input and is affected by the command CN.
- See Connecting Hardware in User Manual for active/inactive state

Values of _LR

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)

Examples

```
'Galil DMC Code Example
MG _LRA;' Display the status of the A axis reverse limit switch
```

_LR applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

Bitwise OR Operator

n | n

Usage	variable = (value1 | value2)	Performs an operation between two values or evaluated statements

Description

The | symbol is the bitwise OR operator used with IF, JP, and JS decisions, and also to perform bitwise ORING of values.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use with OR operator	

Remarks

- For IF, JP, and JS, the values used for m are typically the results of logical expressions such as (x > 2) | (y=8)
- The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.

Examples

```
'Galil DMC Code Example
'Bitwise use
var1=$F;'00001111
var2=$F0;'1111000
MG (var1 | var2)
EN

REM Returned: 255.0000 (same as 11111111)
```

```
'Galil DMC Code Example
'Conditional Use
var1=$F;'00001111
var2=$F0;'1111000
IF (var1 = $F) | (var2 = $F1)
 MG"True"
ELSE
 MG"False"
ENDIF
EN

REM Returned: True
```

| applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

~ *Variable Axis Designator*

```
~s= "str"
~s= n
```

Description

Variable axis designator. Each variable can be assigned an individual axis, a vector plane, or a virtual axis. Motion commands on the variable will then apply to the assigned axis.

Commands supporting variable axes are denoted in this command reference with the following icon.

Variable axis supported icon

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
s	a	h	N/A	N/A	Variable axis name	a,b,c,d,e,f,g,h supported
str	"A"	"H"	N/A	String	Name of axis	"A", "B", "C", "D", "E", "F", "G", "H" supported
	"M"	"N"	N/A	String	Virtual axis	"M", "N" supported
	"S"	"T"	N/A	String	Coordinate System	"S","T" supported
n	0	7	N/A	1	Index of the axis	A= 0, B= 1, C= 2, etc.
	8	9	N/A	1	Coordinate System	S=8, T=9
	10	11	N/A	1	Virtual Axis	M= 11, N=10

Remarks

- ~s contains the axis number as defined by n and can be used in expressions (see example)

Examples

```
'Galil DMC Code Example
~a=2;~b=6;'     Sets ~a to 2 (Z axis).  Sets ~b to 6 (G axis)
MG"~a=",~a;'    Print axis number
MG"~b=",~b;'    Print axis number
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)
```

~ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

+ *Addition Operator*

n + n

Usage	variable = (value1 + value2)	Performs an operation between two values or evaluated statements

Description

The + symbol is the addition operator. It takes as arguments any two values, variables, array elements, operands, or At functions (@SIN[]) and returns a value equal to the sum of the arguments.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to use in addition operation	

Remarks

- This is a binary operator (takes two arguments and returns one value). The result of this operation is a value, which is not valid on its own. It must be coupled with a command. See examples below.
- Mathmatical operations are calculated left to right rather than multiplication and division calculations performed prior to addition and subraction.
  - Example: 1+2*3 = 9;' not 7
- It is recommended that parenthesis be used when more than one mathmatical operation is combined in one command.
  - Example: var = ((10*30)+(60/30));' evaluates as 302
  - var = 10*30+60/30;' evalutes as 12

Examples

```
'Galil DMC Code Example
:var1 = 1+2
:var2 = var1 + 1
:MG var2 + 2
 6.0000
:
```

+ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

< *Less than comparator*

$n_0 < n_1$

Usage	variable = (value1 < value2)	Performs an operation between two values or evaluated statements

Description

"Less than" comparator for testing if one value is less than another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If $n_0 < n_1$, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

Examples

```
'Galil DMC Code Example
:bool= (1<2)
:MG bool
 1.0000
:bool= (1<0)
:MG bool
 0.0000
:
```

```
'Galil DMC Code Example
REM Example to find the largest
REM value in an array
REM
REM ***************************
REM Create an array and fill it
len= 5
DM array[len]
array[0]= 5
array[1]= 100.0001
array[2]= 42
array[3]= 3.14
array[4]= 100
JS #max;' call max subroutine
MG "Max value is ", max
EN
REM
REM ****************************
REM Find max element in array
#max
i= 0
max = -2147483648;' start at min
#max_h
IF (array[i] > max)
 max = array[i]
ENDIF
i= i+1
JP #max_h, (i < len)
EN
REM
REM ****************************
REM Program output
REM :XQ
REM :
REM Max value is 100.0001
```

< applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

<= *Less than or Equal to comparator*

n_0 <= n_1

Usage	variable = (value1 <= value2)	Performs an operation between two values or evaluated statements

Description

"Less than or Equal to" comparator for testing if one value is less than or equal to another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If n_0 <= n_1, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

Examples

```
'Galil DMC Code Example
:bool= (1 <= 2)
:MG bool
 1.0000
:bool= (2 <= 2)
:MG bool
 1.0000
:bool= (3 <= 2)
:MG bool
 0.0000
:
```

```
'Galil DMC Code Example
max= 2.05
min= 1.47
value = 0.025
JS #check
value = 1.471
JS #check
EN
REM
REM *******************************
REM Determine if in range
#check
inrange=0
IF ((value >= min) & (value <= max))
 inrange= 1
ENDIF
IF (inrange)
 MG "Value ",value," in range"
ELSE
  MG "Value ",value," NOT in range"
ENDIF
EN
REM
REM *******************************
REM Program output
REM :XQ
REM :
REM  Value 0.0250 NOT in range
REM  Value 1.4710 in range
```

<= applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

<> *Not Equal to comparator*

n0 <> n1

Usage	variable = (value1 <> value2)	Performs an operation between two values or evaluated statements

Description

"Not Equal to" comparator for testing if one value is not equal to another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If n_0 <> n_1, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

Examples

```
'Galil DMC Code Example
:bool= (1 <> 2)
:MG bool
 1.0000
:bool= (2 <> 2)
:MG bool
 0.0000
```

```
'Galil DMC Code Example
REM Lock out code until
REM a particular digital
REM input pattern is detected
#AUTO
JS#lock;'block until pattern
REM
REM
REM Rest of code here
REM
REM
EN
REM
REM *************************
#lock
JP #lock, (_TI0 <> 170)
EN
```

<> applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

= *Equal to comparator*

$n_0 = n_1$

Usage	variable = (value1 = value2)	Performs an operation between two values or evaluated statements

Description

"Equal to" comparator for testing if one value is equal to another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If $n_0 = n_1$, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

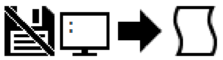
Examples

```
'Galil DMC Code Example
:bool= (1=0)
:MG bool
 0.0000
:bool= (3.14=3.14)
:MG bool
 1.0000
:
```

```
'Galil DMC Code Example
REM Checks for a digital
REM input pattern and
REM sets a bit if matched
#loop
IF (_TI0 = 170)
 SB 1
ELSE
 CB 1
ENDIF
JP#loop
```

= applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

= *Assignment Operator*



str = n

Description

The = operator is the assignment operator for the controller. The assignment operator is used for two 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)

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	8 chars	N/A	String	Variable name to access	
n	-2,147,483,648	2,147,483,647	see Notes	1/65,536	Value to assign to specified variable	Default n, or n = null results in a query of the value of variable

Remarks

- None

Examples

```
'Galil DMC Code Example
:x=5
:x=?
 5.0000
:MG x
 5.0000
'define and initialize x to 5
'print x two different ways
```

= applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

> *Greater than comparator*

$n_0 > n_1$

Usage	variable = (value1 > value2)	Performs an operation between two values or evaluated statements

Description

"Greater than" comparator for testing if one value is greater than another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If $n_0 > n_1$, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

Examples

```
'Galil DMC Code Example
:bool= (1>2)
:MG bool
 0.0000
:bool= (1>0)
:MG bool
 1.0000
:
```

```
'Galil DMC Code Example
REM Example to find the largest
REM value in an array
REM
REM ***************************
REM Create an array and fill it
len= 5
DM array[len]
array[0]= 5
array[1]= 100.0001
array[2]= 42
array[3]= 3.14
array[4]= 100
JS #max;' call max subroutine
MG "Max value is ", max
EN
REM
REM ****************************
REM Find max element in array
#max
i= 0
max = -2147483648;' start at min
#max_h
IF (array[i] > max)
 max = array[i]
ENDIF
i= i+1
JP #max_h, (i < len)
EN
REM
REM ****************************
REM Program output
REM :XQ
REM :
REM Max value is 100.0001
```

> applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

>= *Greater than or Equal to comparator*

n_0 >= n_1

Usage	variable = (value1 >= value2)	Performs an operation between two values or evaluated statements

Description

"Greater than or Equal to" comparator for testing if one value is greater than or equal to another. Comparators are used in mathematical expressions, IFs, and in conditional jumps. The result is a boolean.

Comparators in DMC Code

Symbol	Comparator
<	Less than
>	Greater than
=	Equal to
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	
n_1	-2,147,483,648	2,147,483,647	N/A	1/65,536	Value to test	

Remarks

- A comparator is not a command and is not valid individually. Instead, the above expression would be used as part of a jump (JP,JS), IF expression, or assignment. See examples below.
- If n_0 >= n_1, the expression will evaluate to 1.0000. If the comparision is false, it will evaluate to 0.0000.
- Evaluation occurs left to right. Use parenthesis for operator precedence.

Examples

```
'Galil DMC Code Example
:bool= (1 >= 2)
:MG bool
 0.0000
:bool= (2 >= 2)
:MG bool
 1.0000
:bool= (3 >= 2)
:MG bool
 1.0000
:
```

```
'Galil DMC Code Example
max= 2.05
min= 1.47
value = 0.025
JS #check
value = 1.471
JS #check
EN
REM
REM ********************************
REM Determine if in range
#check
inrange=0
IF ((value >= min) & (value <= max))
 inrange= 1
ENDIF
IF (inrange)
 MG "Value ",value," in range"
ELSE
  MG "Value ",value," NOT in range"
ENDIF
EN
REM
REM ********************************
REM Program output
REM :XQ
REM :
REM  Value 0.0250 NOT in range
REM  Value 1.4710 in range
```

>= applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

AB *Abort*

AB
AB n

Usage	AB n ...	Arguments specified with an implicit, comma-separated order
Operands	_AB	Operand has special meaning, see Remarks

Description

The AB command is a command to issue an abort to controller operation.

AB (Abort) stops motion instantly without a controlled deceleration. If there is a program operating, AB can also be specified to abort the program and all running threads. The command, AB, will shut off the motors for any axis in which the off on error function is enabled (see command "OE").

Arguments

Argument	Value	Description	Notes
n	0	Abort motion and the program operation	Default if omitted
	1	Abort motion only	

Remarks

- _AB gives state of Abort Input, 1 inactive and 0 active.
- AB aborts motion on all axes in motion and cannot stop individual axes.

Examples

```
'Galil DMC Code Example
:AB;'     Stops motion
:OE*= 1;' Enable off on error on axes
:AB;'     Shuts off motor command and stops motion
```

```
'Galil DMC Code Example
#A;'         Label - Start of program
JG 20000;'   Specify jog speed on A-axis
BG A;'       Begin jog on A-axis
WT 5000;'    Wait 5000 msec
AB 1;'       Stop motion without aborting program
WT 5000;'    Wait 5000 milliseconds
SH;'         Servo Here
JP #A;'      Jump to Label A
EN;'         End of the routine
'Remember to use the parameter 1 following AB if you only want the motion to be aborted
'Otherwise, your application program will also be aborted.
```

AB applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

AC *Acceleration*

ACm= n
AC n,n,n,n,n,n,n,n

Usage	ACm= n	Arguments specified with a single axis mask and an assignment (=)
	AC n ...	Arguments specified with an implicit, comma-separated order
Operands	_ACm	Operand holds the value last set by the command

Description

The Acceleration command (AC) sets the linear acceleration 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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	1,024	1,073,740,800	256,000	1,024	Acceleration rate	At TM 1000. Resolution and Min depend on TM, see remarks.

Remarks

- The AC command is used to designate acceleration
- Specify realistic acceleration rates based on physical system parameters such as:
  - motor torque rating
  - loads
  - amplifier current rating
- Specifying an excessive acceleration will cause a large following error during acceleration and the motor will not follow the commanded profile
- The acceleration feedforward command (FA) will help minimize the error for aggressive accelerations

Resolution

- The Min and Resolution depend on the sampling period of the control loop (TM). The equation to calculate these values is:
  - Resolution = Min = 1024*(1000/TM)^2
  - example:
    - With TM 500 the minimum AC setting and resolution is 4096 counts/second^2
    - resolution = 1024*(1000/500)^2 = 4096

Examples

```
'Galil DMC Code Example
SHAB;' Enable axes A and B
REM Set a different acceleration for each axis
AC 10000,400000;
REM Axis A acceleration is  10000 cts/sec
REM Axis B acceleration is 400000 cts/sec
SP 40000,40000;' Set the speed for each axis to 40000 cts/sec
a= _ACB;' Assigns the B acceleration to the variable a
PR 100000, 100000;' Set the move distance to 100000 cts
BG AB;' Begin motion on both axes
t=TIME;' Assign the time started to a variable
AMB;' Halt code execution until motion is completed on axis B
MG{Z5.0} "B axis finished in",TIME - t," samples"
AMA;' Halt code execution until motion is completed on axis A
MG{Z5.0} "A axis finished in",TIME - t," samples"
MO;' Disable all axes after moves are completed
EN
```

AC applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

AD *After Distance*

ADm= n
AD n,n,n,n,n,n,n,n

Usage	ADm= n	Arguments specified with a single axis mask and an assignment (=)
	AD n ...	Arguments specified with an implicit, comma-separated order

Description

Trippoint to block command execution until a given distance is traversed. This is a profiled trippoint which means it depends on the motion profiler and not the actual motor encoder. AD can only be used when there is commanded motion on the axis.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	2,147,483,647	N/A	1	Distance of motion	Cannot specify more than 1 argument at a time

Remarks

- AD will hold up the execution of the following command until one of the following conditions have been met
  - The commanded motor position crosses the specified relative distance from the start of the move
  - The motion profiling on the axis is complete
  - If in jog (JG) mode, the commanded motion is in the direction which moves away from the specified position
- Not valid for a slave during ECAM or Gearing, use MF and MR
- 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
- The AD command is accurate to the number of counts that occur in 2*TM msec
- AD command will be affected when the motion smoothing time constant, IT, is not 1. See IT command for further information
- AD measures incremental distance from start of move on one axis

Examples

```
'Galil DMC Code Example
#A
DP 0,0;'                    Zero position
PR 10000,20000;'            Specify position relative moves
BG ;'                       Begin motion
AD 5000;'                   After A reaches 5000
MG "Halfway to A";TP A;'    Send message
AD ,10000;'                 After B reaches 10000
MG "Halfway to B";TP B;'    Send message
EN;'                        End Program
```

AD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AF *Analog Feedback Select*

AFm= n

AF n,n,n,n,n,n,n,n

Usage	AFm= n	Arguments specified with a single axis mask and an assignment (=)
	AF n ...	Arguments specified with an implicit, comma-separated order
Operands	_AFm	Operand holds the value last set by the command

Description

The AF command configures analog feedback mode for the PID filter.

The controller ADC can be used as position feedback for the axis control law. The analog input used for feedback is fixed and uses the input that corresponds with the axis letter. For example, Analog input 1 is used for the A axis.

The AF command is also used to configure sin/cos encoders when using SIN firmware.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	Use the controller ADC as servo feedback	1= analog, 0= digital feedback
	5	12	0	1	Sin/cos encoder input used with 2^n interpolation counts per encoder cycle	ICM-42100 required to use sin/cos encoders

Remarks

- Below is the feedback in counts decoded by the controller hardware when reading in analog feedback for certain analog input ranges.

	12 Bit ADC	16 Bit ADC
-5V to +5V, -10V to +10V	-2048 to 2047 counts	-32768 to 32767 counts
0V to +5V, 0V to +10V	0 to 4095 counts	0 to 65535 counts

- The analog voltage range is set using the AQ command. AQ must be set prior to setting AF
- The analog feedback is decoded by a 12-bit A/D converter. An upgrade option is available for 16-bits.

- ICM-42100 required to use sin/cos encoders

- When using sin/cos encoders (AF5-12)
  - SIN firmware is required.
  - The encoder must be connected to the controller prior to issuing the AF command.
  - TP will provide position resolution of $2^{(\_AFm)}$ counts per cycle. One cycle is four quadrature counts.
    - For example, if an encoder shows a change in TP of 8000 counts with AF0. The same distance at AF 5 would be give by 8000/4 * 2^5 = 64000

Examples

```
'Galil DMC Code Example
AF 1;'          Analog feedback on A axis
v1= _AFA;'       Assign feedback type to variable
KP 1;'          Assigns PID's for motor using analog feedback on A-axis
KD 10;'
KI 0.5;'
```

```
'Galil DMC Code Example
AF 12;'         Sets sin/cos encoder to 2^12 = 4096 counts/period
AF 8;'          Sets sin/cos encoder to 2^8 = 256 counts/period
```

AF applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

AG *Amplifier Gain*

AG n,n,n,n,n,n,n,n
AGm=n

Usage	AGm= n	Arguments specified with a single axis mask and an assignment (=)
	AG n ...	Arguments specified with an implicit, comma-separated order
Operands	_AGm	Operand holds the value last set by the command

Description

The AG command sets the amplifier current/voltage gain for the internal amplifier. Note: some Galil internal amplifiers have fixed gains. Please reference the manual or data-sheet for more details.

For Servo motors, to convert motor command output (V) to actual motor current (A), use the following equation.

$$motor\ current\ (A) = \ motor\ command\ (V) * amplifier\ gain\ (A/V)$$

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	3	1	1	Gain setting	See table in Remarks for gain settings

Remarks

Current Gain Settings by Servo Amplifier Configuration

Gain settings by Amplifier (Amps/Volt)

Gain Setting, n=	0	1	2	Notes
D3040	0.4	0.7	1	
D3140	N/A	N/A	N/A	Fixed at 0.1 A/V
D3240	0.5	1	2	
D3540	0.4	0.8	1.6	
D3547	0.4	0.8	1.6	
D3640	N/A	N/A	N/A	Fixed at 0.2 A/V
D3740	0.8	1.6	3.2	

Current Gain Settings by Stepper Amplifier Configuration

Gain settings by Amplifier (Amps per phase)

Gain Setting, n=	0	1	2	3
D3547	0.75	1.5	3	6
D4040	0.5	0.75	1	1.4
D4140	0.5	1	2	3

- The axis must be in the motor off state (MO) before setting AG
- The MT command must be issued prior to the AG command to set the proper range

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AU - Set amplifier current loop
- AZ - Clear Amplifier Errors
- MT - Motor Type
- TA - Tell Amplifier Error
- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
ST ;'      Stop any motion
AM ;'      Wait for motion to decel and stop
MO ;'      Turn motor off
MT 1;'     Set the A axis as a servo
AG 2;'     Sets the highest amplifier gain for A axis on servo amplifier
BN;'      Save AG setting to EEPROM
```

AG applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,EDD37010

AI *After Input*

AI n

Usage	AI n ...	Arguments specified with an implicit, comma-separated order

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	16	N/A	1	General input to use for trippoint	+n = High trigger. -n = low trigger. 9-16 only valid for 5-8 axis controller
	17	48	N/A	1	Extended input to use for trippoint	
	81	96	N/A	1	Aux encoder input to use for trippoint	

Remarks

- 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.
- AI functions only on local input points. See Example below for network based digital inputs.

Examples

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
REM When using a remote I/O device (e.g. the RIO), the following provides
REM a similar function as AI. Assume that the remote device is already
REM configured on handle C (see IH)
'code before
JS #remote;' this call blocks and waits for the remote logic to return
'code after
EN
'***** The example subroutine *****
#remote
WT10;' wait a reasonable interval so we don't flood the network
JP#remote,(@IN[3001] = 1);'loop while input 1 on the remote device is high
EN;' return to calling code.
```

AI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

AL *Arm Latch*

AL mm

Usage	AL mm	Argument is an axis mask
Operands	_ALm	Operand has special meaning, see Remarks

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 rising or falling edge on the specified digital input. Use the CN command to configure the edge that the latch input will trigger on.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Encoder to latch	Latch main encoder
mm	SA	SASBSCSDSESFSGSH	N/A	Multi-Axis Mask	Encoder to latch	Latch aux encoder
mm	TA	TATBTCTDTETFTGTH	N/A	Multi-Axis Mask	Index input to trigger latch	Main encoder is latched from the index pulse instead of a digital input

Remarks

Latch input by Axis

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

- The command RL returns the latched position
- _ALm contains the state of the specified latch. 0 = not armed, 1 = armed
- The CN command can be used to change the edge which causes the latch to trigger.
- The latch function is available on incremental quadrature encoder inputs only. For other position capture methods contact Galil.

Examples

```
'Galil DMC Code Example
#start
AL A;'               Arm A-axis latch
JG 50000;'           Set up jog at 50000 counts/sec
BG A;'               Begin the move
#loop;'              Loop until latch has occurred
JP #loop,(_ALA=1)
RL A;'               Transmit the latched position
EN;'                 End of program
```

```
'Galil DMC Code Example
REM Homing routine using the AL command to detect the Motor's index position
#start
AL TA;'               Arm A-axis latch. Latch will trigger off the index pulse
JG 50000;'            Set up jog at 50000 counts/sec
BG A;'                Begin the move
#loop;'               Loop until latch has occurred
JP #loop,(_ALA=1)
STA;'                 Stop the jog
AMA
PAA=_RLA;'            Set up a move to return to the latched position
BGA
AMA
WT100;'               Allow for settling.
REM Checking that KI has eliminated error (TE) would be more thorough
DP0;'                 Zero position
MG "A Homed";'        Report status
EN;'                  End of program
```

```
'Galil DMC Code Example
REM manual find index using latch off of index pulse using variable axes
#index
'settings
~a=0;'axis number
s1spd=10000;'stage 1 speed
```

```
s2spd=1000;'stage 2 speed
'jog until index is latched
JG~a=s1spd;BG~a
WT1000
ALT~a
#A;JP#A,_AL~a=1
ST~a;AM~a
'Return to latched position
SP~a=s2spd
PA_RL~a;BG~a;MC~a
JS#STL;DP~a=0
EN

'wait for axis to settle
#STL
WT2;JP#STL,@ABS[_TE~a]>2
WT2;JP#STL,@ABS[_TE~a]>0
WT2;JP#STL,@ABS[_TE~a]>0
EN
```

AL applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

AM *After Move*

AM mm

Usage	AM mm	Argument is an axis mask

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 to be complete.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to wait for profiled motion to complete	
	S	T	N/A	Multi-Axis Mask	Vector plane to wait for profiled motion to complete	
	M	N	N/A	Multi-Axis Mask	Firmware Rev 1.2a and later. Virtual axis to wait for profiled motion to complete	Any combination of axes is acceptable

Remarks

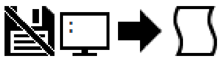
- AM is a very important command for controlling the timing between multiple move sequences.
  - For example, if the A-axis is in the middle of a position relative move (PR) you cannot make a position absolute move (PAA, BGA) until the first move is complete. Use AMA to halt the program sequence until the first profiled motion is complete.
  - AM tests for profile completion only. The actual motor may still be moving. To halt the program sequence until the actual physical motion has completed, use the MC command.
  - To test motion complete without halting the program sequence, use the operand _BGn, which will be zero when profiled motion is complete (see BG command).

Examples

```
'Galil DMC Code Example
#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
```

AM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AO *Analog Output*



AO n_0,n_1

Usage	AO n ...	Arguments specified with an implicit, comma-separated order

Description

The AO command sets the analog outputs on the Galil or for a Modbus Slave.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	1,000	8,999	N/A	1	Set Analog Output on Modbus Slave	See "Using AO with a Modbus Slave" in Remarks
n_1	-9.9998	9.9998	N/A	20/65,536	Analog Output Voltage	

Remarks

Using AO with a Modbus Slave

- RIO as Modbus Slave
- 3rd Party Modbus Slave Device

- n_0 is the I/O number calculated using the following equations:
- n_0 = (HandleNum*1000) + ((Module-1)*4) + (Bitnum-1)
  - HandleNum is the handle specifier from A to H.
    - Handle must be assigned to port 502 for Modbus comms (See IH)
  - 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

Examples

```
'Galil DMC Code Example
:AO 3005,3.2;'          Outputs 3.2 Volts on Channel 5 of the Device connected to Handle C
```

AO applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,RIO57400,EDD37010

AP *After Absolute Position*

Usage	APm= n	Arguments specified with a single axis mask and an assignment (=)
	AP n ...	Arguments specified with an implicit, comma-separated order

Description

The AP command will hold up the execution of the following command until the actual motor position crosses the specified position. This trippoint does not rely on the profiler, but on actual encoder position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Position trippoint value	Only one axis may be specified at a time

Remarks

- For AP command to clear, one of the following conditions have been met:
  - The actual motor position crosses the specified absolute position.
  - The motion profiling on the axis is complete.
  - The commanded motion is in the direction which moves away from the specified position.

- The units of the command are quadrature counts.
- When using a stepper motor, the AP trippoint condition is satisfied when the stepper position (TD) has crossed the specified position.
  - For further information see Chapter 6 of the User Manual "Stepper Motor Operation".
- Not valid for a slave during ECAM or Gearing - use MF and MR.
- The motion profiler must be active before the AP command is used.
- AP is accurate to the number of counts that occur in 2*TM msec
- AP tests for absolute position. Use the AD command to measure incremental distances.

Examples

```
'Galil DMC Code Example
#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
```

AP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AQ *Analog Input Configuration*

AQ n_0, n_1

Usage	AQ n ...	Arguments specified with an implicit, comma-separated order
Operands	_AQ1 _AQ2 _AQ3 _AQ4 _AQ5 _AQ6 _AQ7 _AQ8	Operand has special meaning, see Remarks

Description

The AQ command is used to set the behavior of the analog inputs. This command will set the analog range and operation for the specified input.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	1	8	N/A	1	Analog input channel	
n_1	1	4	2	1	Analog range setting	See Table Below
	-4	-1	N/A	1	Specify analog input is differential	See Remarks

Remarks

- AQ is a configuration command which must be set at the beginning of application code.
- The usage of this command depends on the type of analog inputs present on the particular controller model, check the ID command to determine the hardware configuration.

Configurable Analog Input Settings

Argument	Value	Description	Notes
n_1	1	-5V to +5V	
	2	-10V to +10V	Default
	3	0V to +5V	
	4	0V to+10V	

- Default resolution for analog inputs is 12bits. 16 bit is optional.
- Operands _AQ1 through _AQ8 return the setting for the specified input
- Setting a negative n_1 for inputs 1,3,5 or 7, configures those inputs as the differential input relative to input 2,4,6 and 8 respectively.

Differential Input Mapping (-n_1)

Differential Input Mapping (negative n_1)

Input (n_0)	Compliment (n_0 + 1)
1	2
3	4
5	6
7	8

Position Range when in Analog Feedback by AQ

Argument	Value	Analog Range	Position Range (12 bit)	Position Range (16 bit)
n_1	1	-5V to +5V	-2048 to 2047	-32,768 to 32767
	2	-10V to +10V	-2048 to 2047	-32,768 to 32767
	3	0V to 5V	0 to 4095	0 to 65535
	4	0V to10V	0 to 4095	0 to 65535

Examples

```
'Galil DMC Code Example
: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
```

AQ applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC52000,RIO57400,EDD37010

AR *After Relative Distance*

ARm= n
AR n,n,n,n,n,n,n,n

Usage	ARm= n	Arguments specified with a single axis mask and an assignment (=)
	AR n ...	Arguments specified with an implicit, comma-separated order

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.
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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Relative position for trippoint	Only one axis may be specified at a time.

Remarks

- The units of the command are quadrature counts.
- 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".
- If the direction of the motion is reversed when in position trackig mode (see PT command), the starting point for the trippoint is reinitialized to the point at which the motion reversed.
- The motion profiler must be active before the AR command is issued.
- Not valid for a slave during ECAM or Gearing - use MF and MR.
- Note: AR will be affected when the motion smoothing time constant, IT, is not 1. See IT command for further information.
  - AP is accurate to the number of counts that occur in 2*TM msec
- 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.

Examples

```
'Galil DMC Code Example
#A;'             Begin Program
DP 0
JG 50000;'       Specify speed
BG A;'           Begin motion
#B;'             Label
AR 25000;'       After passing 25000 counts of relative distance on A-axis
MG "Passed";TPA;' Send message on A-axis
JP #B;'          Jump to Label #B
EN;'             End Program
```

AR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AS *At Speed*

AS mm

Usage	AS mm	Argument is an axis mask

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGHST	ABCDEFGH	Multi-Axis Mask	Axes to use for AS trippoint	

Remarks

- If the speed is not reached, the trippoint will be triggered after the speed begins diverging from the AS value.
- 'The AS command applies to a trapezoidal velocity profile only with linear acceleration. AS used with Smoothing profiling will be inaccurate.

Examples

```
'Galil DMC Code Example
#SPEED;'          Program
PR 100000;'       Specify position
SP 10000;'        Specify speed
BG A;'            Begin A
AS A;'            After speed is reached
MG "At Speed";'   Print Message
EN;'              End programm
```

AS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AT *At Time*

AT n_0,n_1

Usage	AT n ...	Arguments specified with an implicit, comma-separated order

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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	0	2	Specify a wait time for AT trippoint	See Remarks
n_1	0	1	0	1	Specify time in samples or msecs	n_1=0 for msecs. n_1=1 for samples

Remarks

- n_0 = 0 sets the reference time for AT to the current time.
- n_0 > 0 specifies the wait time as the absolute value of n_0 from the reference time
- n_0 < 0 specified the wait time as the absolute value of n_0 from the reference time, and resets the reference time when the trippoint is complete to the current time.
  - AT -n_0 is equivalent to AT n_0; AT (old reference +n_0)

Examples

```
'Galil DMC Code Example
'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)
```

```
'Galil DMC Code Example
' 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
```

```
'Galil DMC Code Example
' 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
```

AT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

AU *Set amplifier current loop*

AUm= n

AU n,n,n,n,n,n,n,n

Usage	AUm= n	Arguments specified with a single axis mask and an assignment (=)
	AU n ...	Arguments specified with an implicit, comma-separated order
Operands	_AUm	Operand holds the value last set by the command

Description

The AU command sets the amplifier current loop gain for internal amplifiers.

For Galil trapezoidal amplifiers, the current loop is available in one of two settings. AU also sets the switching mode where available, Chopper vs. Inverter.

For Galil sinusoidal amplifiers, AU sets the current loop gain as well as enables or disables the current loop integrator.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	Amplifier Specific	Amplifier Specific	Amplifier Specific	Amplifier Specific	Current Loop Gain Setting	See tables below for setting the n parameter by amplifier.

D3040

Argument	Value	Description	(24VDC Bus) Current loop setting	(48VDC Bus) Current loop setting	Notes
n	0	Inverter mode, Normal current loop gain	0.5mH < L <5mH	0.5mH < L <10mH	Default.
	0.5	Chopper mode, Normal current loop gain	0.2mH < L < 0.5mH	0.2mH < L < 0.5mH	
	1	Inverter mode, Higher current loop gain	5mH < L	10mH < L	
	1.5	Chopper mode, Higher current loop gain	5mH < L	10mH < L	

D3240

Argument	Value	Description	(24VDC Bus) Current loop setting	(48VDC Bus) Current loop setting	Notes
n	0	Chopper mode, Normal current loop gain	0.5mH < L <5mH	0.5mH < L <10mH	Default.
	1	Chopper mode, Higher current loop gain	5mH < L	10mH < L	

D3540

Argument	Value	(24VDC Bus) Current loop setting	(48VDC Bus) Current loop setting	Notes
n	1	L < 1mH	L < 2.4mH	Default[1]
	9	L < 1mH	L < 2.4mH	
	10	1mH < L < 2.3mH	2.4mH < L < 4.2mH	
	11	2.3mH < L < 4.2mH	4.2mH< L < 7mH	
	12	4.2mH < L	7mH < L	

1. AU1 is default for backwards compatibility. AU 9 through 12 should be used for new applications.

D3540(160V)

Argument	Value	(160VDC Bus) Current loop setting	Notes
n	1	L < 16.4 mH	Default[1]
	9	L < 16.4 mH	
	10	16.4 mH < L < 25.2 mH	
	11	25.2 mH < L < 42 mH	
	12	42 mH < L	

1. AU1 is default for backwards compatibility. AU 9 through 12 should be used for new applications.

D3547

Argument	Value	(24VDC Bus) Current loop setting	(48VDC Bus) Current loop setting	Notes
n	9	L < 1mH	L < 2.4mH	Default
	10	1mH < L < 2.3mH	2.4mH < L < 4.2mH	
	11	2.3mH < L < 4.2mH	4.2mH < L < 7mH	
	12	4.2mH < L	7mH < L	

D3740

Argument	Value	(24VDC Bus) Current loop setting	(48VDC Bus) Current loop setting	Notes
n	1	L < 1mH	L < 2.4mH	Default[1]
	9	L < 1mH	L < 2.4mH	
	10	1mH < L < 2.3mH	2.4mH < L < 4.2mH	
	11	2.3mH < L < 4.2mH	4.2mH < L < 7mH	
	12	4.2mH < L	7mH < L	

1. AU1 is default for backwards compatibility. AU 9 through 12 should be used for new applications.

Remarks

- The axis must be in the motor off state (MO) before setting AU
- The AU settings for Galil sinusoidal amplifiers are only recommended values for the given bus voltages. For other bus voltages and their recommended settings, contact Galil.

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AZ - Clear Amplifier Errors
- MT - Motor Type
- TA - Tell Amplifier Error
- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
'Example setting for Galil trapezoidal amplifier
:AU1,0;' Sets A-axis to higher loop gain and B-axis to normal loop gain
:AUB=?;' Query B-axis current loop gain
 0
:MG_AUA;' Query A axis current loop gain
 1
```

```
'Galil DMC Code Example
'Example setting for Galil sinusoidal amplifier
'inductance = 2.6mH
:AU11;' Sets A-axis for motor inductance 2.6mH at 24V, current loop enabled
:MG_AUA;' Query A axis current loop gain
 11
```

AU applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,EDD37010

AV *After Vector Distance*

AV n_0,n_1

Usage	AV n ...	Arguments specified with an implicit, comma-separated order
Operands	_AVS _AVT	Operand has special meaning, see Remarks

Description

The AV command 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	2,147,483,647	0	1	Vector distance to be executed in the S coordinate system	
n_1	0	2,147,483,647	0	1	Vector distance to be executed in the T coordinate system	

Remarks

- The units of the command are quadrature counts.
- _AVS contains the vector distance from the start of the sequence in the S coordinate system
- _AVT contains the vector distance from the start of the sequence in the T coordinate system.

Examples

```
'Galil DMC Code Example
#MOVE;'        Label to desginate start of program
DP 0,0;'       Define the A and B axis positions as 0
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,
TPAB;'         Print position of A and B axes
EN;'           End Program
'Vector Distance is calculated as the square root of the sum of the
'squared distance for each axis in the linear or vector mode.
```

AV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

AZ *Clear Latched Amplifier Errors*

```
AZ n
```

Operands	_AZ2	Operand has special meaning, see Remarks

Description

The AZ command is used to enable enhanced error reporting and clear any latched amplifier errors.

Arguments

Argument	Value	Details
n	1	Clear latched amplifier errors.
	2	Enable Enhanced Error Clearing.

Issue AZ2 to enable enhanced error reporting.

When all axes are in a motor off state (MO) and there are no latched errors, amplifier errors will be reported live by the TA command.

While an axis is in a servo here state (SH), the following amplifier errors will latch:

- Over-Current
- Over-Temperature
- Under-Voltage
- ELO

NOTE: The Over-Voltage amplifier error does not latch. While the amplifier is in an Over-Voltage condition, the amplifier will short the motor phases resulting in a drag being felt on the motor.

To clear latched amplifier errors, issue MO followed by AZ1.

Remarks

- _AZ2 contains a 0 if the amplifier is in normal error reporting.
- _AZ2 contains a 1 if the amplifier is in enhanced error reporting
- Refer to the controller User Manual for more information on clearing amplifier errors.

Amplifier	Enhanced Error Clearing Mode
D3540	Disabled by default
D3547	Always enabled

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AU - Set amplifier current loop
- MT - Motor Type
- TA - Tell Amplifier Error
- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
#AMPERR
ST;' stop motion on all axes
AM;' wait until motion is halted
MO;WT2;' disable all axes

IF((_TA0&1)|(_TA0&16));' check if an Over-Current error occurred
MG "Over-Current amplifier error"
ENDIF

IF((_TA0&2)|(_TA0&32));' check if an Over-Voltage error occurred
MG "Over-Voltage amplifier error"
ENDIF

IF((_TA0&4)|(_TA0&64));' check if an Over-Temperature error occurred
MG "Over-Temperature amplifier error"
ENDIF

IF((_TA0&8)|(_TA0&128));' check if an Under-Voltage error occurred
MG "Under-Voltage amplifier error"
ENDIF

IF((_TA3&1)|(_TA3&2));' check if the ELO input was asserted
MG "ELO input asserted"
ENDIF

IF((_TA3&64)|(_TA3&128));' check if an amplifier error has latched
MG "Amplifier error has latched"
AZ1;WT2;' clear latched amplifier errors
```

```
ENDIF
RE
```

AZ applies to DMC4000,DMC4103

BA *Brushless Axis*

BA mm

Usage	BA mm	Argument is an axis mask
Operands	_BAm	Operand has special meaning, see Remarks

Description

For axes equipped with a Galil sinusoidal amplifier, BA is used to configure the axis for sinusoidal commutation. In addition to BA, the BM command as well as either BX, BZ or BI/BC, must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axes to configure for sinusoidal commutation.	
	N	N	N/A	Multi-Axis Mask	Disable sine commutation for all axes.	

Remarks

- _BAm will contain a 1 if the BA command has been issued for the specifed axis, or a 0 if it has not.
- There are several methods to initialize Galil's internal amplifiers for sinusoidal commutation. They are listed below:

Initialization of a Galil Sinusoidal Amplifier

Command	Description	Notes
BI/BC	Uses hall sensors to estimate the commutation angle until a hall transition can be used to set the commutation angle precisely.	This is the recommended method if hall sensors are present.
BZ	Commands the axis to a specific commutation angle.	This is the recommended method if hall sensors are not present.
BX	Uses an algorithm to determine the commutation angle with minimal motion.	Should only be used if minimal motion is required during intialization and no hall sensors are present.

Examples

```
'Galil DMC Code Example
REM Example BZ initialization procedure
BA A;'        Designate sinusoidal commutation
BM 2000;'      Length of electrical cycle in counts--required setting for commutation
BZ <1000>1500;' Set the first BZ time to 1500 msec, and second B time to 1000 msec.
BZ 3;'        Commutate motor using 3 V and timeout after 1000 msec
SH A;'        Enable motor, ready for commands
EN
```

```
'Galil DMC Code Example
REM Example BI/BC initialization procedure
BAA;' Configure the A Axis for sinusoidal commutation.
BMA=2000
BIA=-1;' Set estimated commutation based on current hall state
BCA;'     enable brushless calibration
hall=_QHA;' store hall state
SHA;'     enable amplifier
JGA=500;' slow jog so that the commutation angle is set precisely at
' the next hall transition.
BGA;' begin jog
#hall;WT2;JP#hall,_QHA=hall;' wait for a hall transition
' At this point, a precise commutation angle is set
' and the axis is fully configured for sinusoidal commutation
STA
AMA
EN
```

BA applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BB *Brushless Phase Begins*

BBm= n
BB n,n,n,n,n,n,n,n

Usage	BBm= n	Arguments specified with a single axis mask and an assignment (=)
	BB n ...	Arguments specified with an implicit, comma-separated order
Operands	_BBm	Operand holds the value last set by the command

Description

The BB command is used along with the BI/BC initialization method to correct for misalignment of the hall sensors with respect to the motor's magnetic cycle. In the majority of applications, this command is not necessary. The value specified by BB will be added to the commutation angle determined by the first hall transition point following the BI and BC commands.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value.	
n	-359.98	359.98	0	1/32	Commutation angle offset in degrees.	

Remarks

- None

Examples

```
'Galil DMC Code Example
REM Example BI/BC initialization procedure
BAA;' Configure the A Axis for sinusoidal commutation.
BMA=2000
BIA=-1;' Set estimated commutation based on current hall state
BB=7;' Account for a 7 degree offset between the halls and motor phases.
BCA;'     enable brushless calibration
hall=_QHA;' store hall state
SHA;'     enable amplifier
JGA=500;' slow jog so that the commutation angle is set precisely at
' the next hall transition.
BGA;' begin jog
#hall;WT2;JP#hall,_QHA=hall;' wait for a hall transition
' At this point, a precise commutation angle is set
' and the axis is fully configured for sinusoidal commutation
STA
AMA
EN
EN
```

BB applies to DMC50000,DMC4000,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BC *Brushless Calibration*

BC mm

Usage	BC mm	Argument is an axis mask
Operands	_BCm	Operand has special meaning, see Remarks

Description

The BC command is used along with the BI command to initialize an axis for sinusoidal commutation using hall sensors. BC monitors the status of the hall sensors, and precisely sets the commutation angle upon detecting a hall sensor transition. In addition to BI and BC, the BA and BM commands must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to initialize using hall sensors.	

Remarks

- GDK's Step-By-Step tool can be utilized for automatic setup and configuration of brushless motor with Galil internal sinusoidal amplifiers.
- When performing the BI/BC initialization method, the axis should be moved at a low speed until the first hall transition occurs. This ensures the commutation angle is accurately set.
- BI/BC initialization is valid with Galil internal sinusoidal amplifiers.
- There are several methods to initialize Galil's internal amplifiers for sinusoidal commutation. They are listed below:

Initialization of a Galil Sinusoidal Amplifier

Command	Description	Notes
BI/BC	Uses hall sensors to estimate the commutation angle until a hall transition can be used to set the commutation angle precisely.	This is the recommended method if hall sensors are present.
BZ	Commands the axis to a specific commutation angle.	This is the recommended method if hall sensors are not present.
BX	Uses an algorithm to determine the commutation angle with minimal motion.	Should only be used if minimal motion is required during intialization and no hall sensors are present.

Steps for BI/BC sinusoidal initialization

1. Specify the axis/axes for sinusoidal initialization with the BA command.
2. Specify the number of encoder counts per magnetic cycle of the motor with the BM command.
3. Issue BI to set an approximate commutation angle based on the current hall state.
4. Issue the BC command.
5. Enable the axis and issue a low speed jog until a hall transition occurs.
6. The motor is now fully initialized for sinusoidal commutation.

Operand Usage

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

Examples

```
'Galil DMC Code Example
REM Example BI/BC initialization procedure
BAA;' Configure the A Axis for sinusoidal commutation.
BMA=2000
BIA=-1;' Set estimated commutation based on current hall state
BCA;'     enable brushless calibration
hall=_QHA;' store hall state
SHA;'     enable amplifier
JGA=500;' slow jog so that the commutation angle is set precisely at
' the next hall transition.
BGA;' begin jog
#hall;WT2;JP#hall,_QHA=hall;' wait for a hall transition
' At this point, a precise commutation angle is set
' and the axis is fully configured for sinusoidal commutation
STA
AMA
EN
EN
```

BC applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BD *Brushless Degrees*

BDm= n
BD n,n,n,n,n,n,n,n

Usage	BDm= n	Arguments specified with a single axis mask and an assignment (=)
	BD n ...	Arguments specified with an implicit, comma-separated order
Operands	_BDm	Operand has special meaning, see Remarks

Description

The BD command sets the commutation angle of a sinusoidally commutated axis. This command should not be used except when the user is creating a specialized sinusoidal initialization procedure. The commutation angle is set automatically when using Galil's built-in sinusoidal initialization methods - BX, BZ and BI/BC.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	360	6	1/32	Commutation angle in degrees	

Remarks

- Using BD to set a commutation angle overrides the current value set by the BX, BZ, or BI/BC initialization methods.
- Once initialized, BD is updated by the controller automatically based on the encoder position and the value of the brushless modulus, BM.
- n = ? queries the current commutation angle
- _BDm contains the commutation angle of the specified axis.

Examples

```
'Galil DMC Code Example
BDA=100;'     Set the commutation angle for A axis to 100
MG_BDA;'      Report the commutation angle for A axis
```

BD applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BG *Begin*

BG mm

Usage	BG mm	Argument is an axis mask
Operands	_BGm	Operand has special meaning, see Remarks

Description

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

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to begin motion	Any combination of axes is acceptable. BG with no arguments begins motion on all axes
	S	T	N/A	Multi-Axis Mask	Vector plane axes to begin motion	Any combination of axes is acceptable
	M	N	N/A	Multi-Axis Mask	Virtual axis to begin motion	Any combination of axes is acceptable

Remarks

- Any combination of Axes, Vector Planes, and Virtual Axes may be mixed to begin motion.
- A BG command cannot be executed for any axis in which motion has not completed.
  - Slaving to a master in gearing mode is an exception. Gearing does not require the axis to profile a motion and therefore Independent moves may be superimposed on top of gearing.
- Use the AM trippoint to wait for motion complete between moves from embedded code.
- From host code, use one of the following methods to determine if motion is complete:
  - Poll MG_BGm.
  - Use the data record (DR/QR).
  - Use interrupts (EI), if available.

Operands

- _BGm contains a '0' if motion complete on the specified axis or coordinate system, otherwise contains a '1'
  - _BGm can be used from host programs to determine if motion is complete by polling the axes of interest

Examples

```
'Galil DMC Code Example
PR 2000,3000,,5000;'  Set up for a relative move
BG ;'                 Start the A,B and D motors moving
```

```
'Galil DMC Code Example
HM ;'   Set up for the homing
BG A;'  Start only the A-axis moving
```

```
'Galil DMC Code Example
JG 1000,4000;'   Set up for jog
BG B;'           Start only the B-axis moving
```

```
'Galil DMC Code Example
bstate= _BGB;'   Assign a 1 to bstate if the B-axis is performing a move
```

```
'Galil DMC Code Example
VM AB;'         Vector Mode
VP 1000,2000;'  Specify vector position
VS 20000;'      Specify vector velocity
BG S;'          Begin coordinated sequence
VP 4000,-1000;' Specify vector position
VE;'            Vector End
```

BG applies to DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,DMC4200,DMC50000,DMC52000,EDD37010

BI *Brushless Inputs*

BIm= n
BI n,n,n,n,n,n,n,n

Usage	BIm= n	Arguments specified with a single axis mask and an assignment (=)
	BI n ...	Arguments specified with an implicit, comma-separated order
Operands	_BIm	Operand holds the value last set by the command

Description

The BI command is used along with the BC command to initialize an axis for sinusoidal commutation using hall sensors. When this command is issued, BI sets an approximate commutation angle based on the current hall state. In addition to BI and BC, the BA and BM commands must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to initialize using hall sensors.	
n	-1	0	0	1		n = -1 uses dedicated hall inputs. n = 0 clears configuration.

Remarks

- GDK's Step-By-Step tool can be utilized for automatic setup and configuration of brushless motor with Galil internal sinusoidal amplifiers.
- There are several methods to initialize Galil's internal amplifiers for sinusoidal commutation. They are listed below:

Initialization of a Galil Sinusoidal Amplifier

Command	Description	Notes
BI/BC	Uses hall sensors to estimate the commutation angle until a hall transition can be used to set the commutation angle precisely.	This is the recommended method if hall sensors are present.
BX	Uses an algorithm to determine the commutation angle with minimal motion.	Should only be used if minimal motion is required during intialization and no hall sensors are present.
BZ	Commands the axis to a specific commutation angle.	This is the recommended method if hall sensors are not present.

Steps for BI/BC sinusoidal initialization

1. Specify the axis/axes for sinusoidal initialization with the BA command.
2. Specify the number of encoder counts per magnetic cycle of the motor with the BM command.
3. Issue BI to set an approximate commutation angle based on the current hall state.
4. Issue the BC command.
5. Enable the axis and issue a low speed jog until a hall transition occurs.
6. The motor is now fully initialized for sinusoidal commutation.

Examples

```
'Galil DMC Code Example
REM Example BI/BC initialization procedure
REM Example BI/BC initialization procedure
BAA;' Configure the A Axis for sinusoidal commutation.
BMA=2000
BIA=-1;' Set estimated commutation based on current hall state
BCA;'    enable brushless calibration
hall=_QHA;' store hall state
SHA;'    enable amplifier
JGA=500;' slow jog so that the commutation angle is set precisely at
' the next hall transition.
BGA;' begin jog
#hall;WT2;JP#hall,_QHA=hall;' wait for a hall transition
' At this point, a precise commutation angle is set
' and the axis is fully configured for sinusoidal commutation
STA
AMA
EN
```

BI applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BK *Breakpoint*

BK n_0,n_1

Usage	BK n ...	Arguments specified with an implicit, comma-separated order
Operands	_BK	Operand has special meaning, see Remarks

Description

The BK command causes the controller to pause execution of the given thread at the given program line number. When that line is reached, program execution halts before the line is executed, while all other threads continue running. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	3,999	N/A	1	Line number to set breakpoint	Firmware Rev 1.2a and later. n = null resumes execution
n_0	0	1,999	N/A	1	Line number to set breakpoint	n = null resumes execution
n_1	0	7	0	1	Thread number to set breakpoint	If n omitted, default value used.

Remarks

- Only one breakpoint may be armed at any time.
- BK can be armed before or during thread execution.

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

Examples

```
'Galil DMC Code Example
: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
```

BK applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

BL *Reverse Software Limit*

BLm= n

BL n,n,n,n,n,n,n,n

Usage	BLm= n	Arguments specified with a single axis mask and an assignment (=)
	BL n ...	Arguments specified with an implicit, comma-separated order
Operands	_BLm	Operand holds the value last set by the command

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	-2,147,483,648	1	Position for reverse soft limit	

Remarks

- The reverse limit is activated at the position n-1. n = -2147483648 effectively disables the reverse soft limit
- The software limit is specified in counts for a servo system or in microsteps for a stepper system.
- When the reverse software limit is activated, the automatic subroutine #LIMSWI will be executed if it is included in the program.
- If motion is commanded when the axis is already passed the BL value, the controller will return error code 22. See TC for details.

Examples

```
'Galil DMC Code Example
#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
'
'Galil Controllers also provide hardware limits.
```

BL applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

BM *Brushless Modulo*

BMm= n
BM n,n,n,n,n,n,n,n

Usage	BMm= n	Arguments specified with a single axis mask and an assignment (=)
	BM n ...	Arguments specified with an implicit, comma-separated order
Operands	_BMm	Operand holds the value last set by the command

Description

The BM command defines the length of the motors magnetic cycle in encoder counts. This value must be specified correctly for sinusidal commutation. In addition to BM, the BA command as well as either BX, BZ or BI/BC, must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value.	
n	1	10,000,000	2,000	1/65,536	Encoder counts per magnetic cycle.	

Remarks

- For rotary motors, the magnectic cycle (BM value) is calculated by:
  - BM = encoder counts per revolution / # of pole pairs

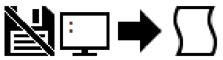
Examples

```
'Galil DMC Code Example
REM Example BZ initialization procedure
BA A;'        Designate sinusoidal commutation
BM 2000;'      Length of electrical cycle in counts--required setting for commutation
BZ <1000>1500;' Set the first BZ time to 1500 msec, and second B time to 1000 msec.
BZ 3;'        Commutate motor using 3 V and timeout after 1000 msec
SH A;'        Enable motor, ready for commands
EN
```

```
'Galil DMC Code Example
REM Example BI/BC initialization procedure
BAA;' Configure the A Axis for sinusoidal commutation.
BMA=2000
BIA=-1;' Set estimated commutation based on current hall state
BCA;'     enable brushless calibration
hall=_QHA;' store hall state
SHA;'     enable amplifier
JGA=500;' slow jog so that the commutation angle is set precisely at
' the next hall transition.
BGA;' begin jog
#hall;WT2;JP#hall,_QHA=hall;' wait for a hall transition
' At this point, a precise commutation angle is set
' and the axis is fully configured for sinusoidal commutation
STA
AMA
EN
```

BM applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

BN *Burn*



BN

Usage	BN	Command takes no arguments
Operands	_BN	Operand has special meaning, see Remarks

Description

The BN command saves certain board parameters in non-volatile EEPROM memory. Once written to the memory, all parameters which can be burned will persist through a software reset (RS command), hardware reset (reset button) or power cycle. This command typically takes 1 second to execute and must not be interrupted. The controller returns a colon (:) when the Burn is complete. All parameters which have been burned into memory can be restored to their factory defaults through a master reset.

This command reference will denote comands that can and cannot be burned with BN with the following usage icons.

Burnable with BN icon

Not burnable with BN icon

Arguments

The BN command has no arguments

Remarks

- Issuing this command will pause the output of the Data Record until the command is completed.
- The following table shows the commands that have their parameters saved with the BN command:

Parameters saved during burn

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

Operand Usage

- _BN contains the serial number of the processor board.

Examples

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

BN applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

BP *Burn Program*

BP

Usage	BP	Command takes no arguments

Description

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

Arguments

The BP command has no arguments

Remarks

- Issuing this command will pause the output of the Data Record until the command is completed.
- Legacy Software Note: 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.
- The timeout can be changed in the Galil software but this warning does not affect the operation of the controller or software.

Examples

```
'Galil DMC Code Example
:BP;'    Burn in program to controller
:'       Get colon response when done
```

BP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

BR *Brush Axis*

```
BRm= n
BR n,n,n,n,n,n,n,n,n
```

Usage	BRm= n	Arguments specified with a single axis mask and an assignment (=)
	BR n ...	Arguments specified with an implicit, comma-separated order
Operands	_BRm	Operand holds the value last set by the command

Description

The BR command configures the motor configuration and type for an axis.

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	

Argument	Value	Description	Notes
n	-1	Configured for external drive	Use for external drives with internal sine amps -D3640, -D3540 and -D3520
	0	Configured for Brushless servo	Default
	1	Configured for Brush-type servo	Use for axes with external drives on -D3040 and -D3020 to avoid hall errors

Remarks

- 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.
  - The hall error bits cannot cause #AMPERR events if an axis is configured as brush-type.
- On axes with an internal amplifier present, when BR1 is set the hall inputs are available for general use via the QH command. For example, a 2 axis amplifier such as the D3020 would allows axes A and B's hall inputs to be used for general use if BR 1 is set.
- Note: If the controller has been previously configured with the BA command for sinusoidal commutation with a Galil internal amplifier, the command "BA N" must be issued prior to setting the axis to brushed mode.

Examples

```
'Galil DMC Code Example
BR 1,0,0;'     Sets X-axis to brush-type, Y and Z to brushless
```

```
'Galil DMC Code Example
BR 1;'       Set to brush type, ignore hall errors
BR -1;'      Set to external amp
```

BR applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,EDD37010

BT *Begin PVT Motion*

BT mm

Usage	BT mm	Argument is an axis mask
Operands	_BTm	Operand has special meaning, see Remarks

Description

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

Arguments

Min	Max	Default	Resolution	Description	Notes
A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to begin PVT motion	

Remarks

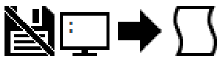
- For more details on PVT mode see the user manual.
- _BTm contains the number of PV segments that have executed.

Examples

```
'Galil DMC Code Example
:MG _BTA;'           Query number of PVT segments executed
0.0000
:PVA= 100,200,100;'  Command X axis to move 100 counts reaching an ending speed of 200c/s in 100 samples
:PVA= 100,0,100;'    Command X axis to move another 100 counts reaching an ending speed of 0c/s in 100 samples
:PVA= ,,0;'          Command X axis to exit PVT mode
:BT A;'              Begin PVT mode
:MG _BTA;'           Query number of PVT segments executed
3.0000
:
```

BT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010

BV *Burn Variables and Array*



BV

Usage	BV	Command takes no arguments
Operands	_BV	Operand has special meaning, see Remarks

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

The BV command has no arguments

Remarks

- _BV returns the number of controller axes.
- This command will store the ECAM table values in non-volatile EEPROM memory.
- This command may cause the Galil software to timeout. 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 period. The timeout can be changed in the Galil software. This warning does not affect the operation of the board or software.
- Issuing this command will pause the output of the Data Record until the command is completed.

Examples

```
'Galil DMC Code Example
:BV;'  burn in variables
:'     colon response returned
```

BV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

BW *Brake Wait*

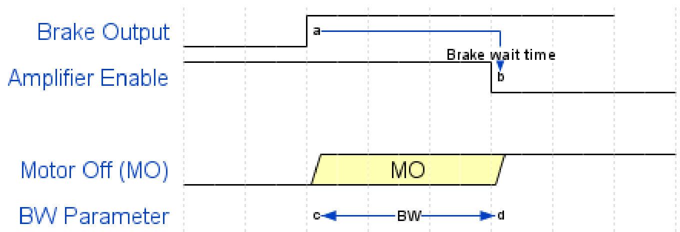
BWm= n
BW n,n,n,n,n,n,n,n

Usage	BWm= n	Arguments specified with a single axis mask and an assignment (=)
	BW n ...	Arguments specified with an implicit, comma-separated order
Operands	_BWm	Operand holds the value last set by the command

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.

Brake Wait Timing



Brake Wait Timing Diagram

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	4,096	0	1	Specify brake wait time, in samples.	0 = Turn brake function off

Remarks

- 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.
- SB,CB and OP have no effect on outputs mapped to BW. In order to toggle brake outputs without engaging the servo (e.g. for maintenance), set BWm=0 and then use SB and CB as necessary.
- The state of the output configured as a brake cannot be querried with the @OUT[] command.
- 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.

Examples

```
'Galil DMC Code Example
BW 100;' Set brake delay to 100 ms (TM1000) for the A axis
```

BW applies to DMC4000,DMC4200,DMC4103,DMC30010,DMC50000,DMC52000,EDD37010

BX *Sine Amp Initialization*

BXm= n

BX< o

Usage	BXm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_BXm	Operand has special meaning, see Remarks

Description

The BX command uses a method to initialize an axis with limited movement of the motor. It is expected to move no more than 10 degrees of the magnetic cycle. The last stage of the BX command will lock the motor into the nearest 15 degree increment. In addition to BX , the BA and BM commands must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to initialize	
n	-4.998	4.998	0	20/65,536	Torque command voltage to be applied during initialization	-n = end BX with SH. +n = end BX with MO
o	100	5,000	1,000	1	Number of samples for BX to hold final torque pulse.	See Remarks

Calculating the 'n' parameter

- Use equation below to determine the maximum n parameter where I_m (in Amps) is the continuous current rating of the motor and G is the current gain of the amplifier (in Amps/Volt).
  - A conservative starting point for the BX command is 0.5* n_{max} but may be increased up to n_{max} as needed.

$$n_{max} = I_m/G$$

Equation for maximum 'n' value

Remarks

- GDK's Step-By-Step tool can be utilized for automatic setup and configuration of brushless motor with Galil internal sinusoidal amplifiers.
- _BXm contains 0 if axis m is not a sinusoidal axis, contains 1 if axis m is an uninitialized sinusoidal axis, and contains 3 if axis m is an initialized sinusoidal axis
- The BX command may be given while the motor is off.
- While the BX command is executing, DMC code, data records, and communication from the controller will pause until completion.
- BX initialization is only valid with Galil internal sinusoidal amplifiers.
- There are several methods to initialize Galil's internal amplifiers for sinusoidal commutation. They are listed below:

Initialization of a Galil Sinusoidal Amplifier

Command	Description	Notes
BI/BC	Uses hall sensors to estimate the commutation angle until a hall transition can be used to set the commutation angle precisely.	This is the recommended method if hall sensors are present.
BZ	Commands the axis to a specific commutation angle.	This is the recommended method if hall sensors are not present.
BX	Uses an algorithm to determine the commutation angle with minimal motion.	Should only be used if minimal motion is required during intialization and no hall sensors are present.

BX Initialization Steps

1. Specify the axis/axes for sinusoidal initialization with the BA command.
2. Specify the number of encoder counts per magnetic cycle of the motor with the BM command.
3. Set the desired hold time BX<o.
4. Initialize using BX command with $n <= n_{max}$.
5. The motor is now fully initialized for sinusoidal commutation.

Examples

```
'Galil DMC Code Example
REM Initialize A axis for internal sine commutation.
BA A;'          Configure axis A for sine amp
BMA = 2000;'    Length of electrical cycle in counts
BX <1000;'      Set hold time to 1000 ms
BXA = 3;'       Initialize the motor with 3V torque command.
SH A;'          Enable motor, ready for commands
EN
```

BX applies to DMC50000,DMC4000,DMC4103,DMC30010,EDD37010

BZ *Brushless Zero*

BZm= n
BZ <o>p

Usage	BZm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_BZm	Operand has special meaning, see Remarks

Description

The BZ command is used to initialize axes which are configured for sinusoidal commutation. To do this, BZ drives the motor to two different magnetic positions and then sets an appropriate commutation angle. In addition to BZ , the BA and BM commands must be used to initialize the axis for sinusoidal commutation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to initialize.	
n	-4.998	4.998	0	20/65,536	Torque command voltage to be applied during initialization.	-n = end BZ with SH. +n = end BZ with MO.
o	100	32,767	200	1	Time in milliseconds for BZ to hold at second magnetic position.	See Remarks.
p	100	32,767	100	1	Time in milliseconds for BZ to hold at first magnetic position.	See Remarks.

Remarks

- GDK's Step-By-Step tool can be utilized for automatic setup and configuration of brushless motor with Galil internal sinusoidal amplifiers.
- The BZ hold times should be lengthened to ensure that any oscillations introduced by the BZ command fully settle in order to accurately set the commutation angle.
  - The *o* and *p* parameters can be interrogated with BZ <? and BZ >? respectively.
- The BZ command may be given when the motor is off.
- _BZm contains the un-signed distance in encoder counts from the motor's current position to the position of magnetic zero for the specified axis.
  - The value is only vaild after succesfully initializing with BZ.
- While the BZ command is executing, DMC code, data records, and communication from the controller will pause until completion.
- Use equation below to determine the maximum *n* paramete where I_m (in Amps) is the continuous current rating of the motor and G is the current gain of the amplifier (in Amps/Volt).
  - A conservative starting point for the BX command is 0.5* n_{max} but may be increased up to n_{max} as needed.

$$n_{max} = I_m/G$$

Equation for maximum 'n' value

- BZ initialization is only valid with Galil internal sinusoidal amplifiers.
- There are several methods to initialize Galil's internal amplifiers for sinusoidal commutation. They are listed below:

Initialization of a Galil Sinusoidal Amplifier

Command	Description	Notes
BI/BC	Uses hall sensors to estimate the commutation angle until a hall transition can be used to set the commutation angle precisely.	This is the recommended method if hall sensors are present.
BZ	Commands the axis to a specific commutation angle.	This is the recommended method if hall sensors are not present.
BX	Uses an algorithm to determine the commutation angle with minimal motion.	Should only be used if minimal motion is required during intialization and no hall sensors are present.

BZ Initialization Steps

1. Specify the axis/axes for sinusoidal initialization with the BA command.
2. Specify the number of encoder counts per magnetic cycle of the motor with the BM command.
3. Set the desired hold times BZ<o>p.
4. Initialize using BZ command with $n <= n_{max}$.
5. The motor is now fully initialized for sinusoidal commutation.

Examples

```
'Galil DMC Code Example
REM Initialize A axis for internal sine commutation.
BA A;'        Configure axis A for sine amp
BMA = 2000;'   Length of electrical cycle in counts
BZ <1000>1500;' Set the first BZ time to 1500 msec, and second B time to 1000 msec.
BZA = 3;'       Initialize the motor with 3V motor command.
SH A;'          Enable motor, ready for commands
EN
```

CA *Coordinate Axes*

CA m

Usage	CA mm	Argument is an axis mask
Operands	_CAm	Operand has special meaning, see Remarks

Description

The CA command specifies the coordinate system (S or T) which will be used by 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

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	S	Axis	Coordinate plane to specify	

Remarks

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

Examples

```
'Galil DMC Code Example
CAT;' Specify T coordinate system
VMAB;' Specify vector motion in the A and B plane
VST= 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
```

CA applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC50000,DMC52000

CB *Clear Bit*

CB n

Usage	CB n ...	Arguments specified with an implicit, comma-separated order

Description

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

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	16	N/A	1	General output bit to be cleared	Max value is 8 for 1-4 axis controllers
n	17	48	N/A	1	Extended I/O output bit to be cleared	I/O must be configured for outputs, see CO command
n	1,000	8,999	N/A	1	Clear Modbus slave bit	See "CB via Modbus Slave" in Remarks

Remarks

- The state of the output can be read with the @OUT[] command
- Extended I/O points are updated once per sample. After issuing this command, one sample must pass before the output is updated.

Using CB with a Modbus Slave

- n = (SlaveAddress*10000) + (HandleNum*1000) + ((Module-1)*4) + (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 where A is 1, B is 2 and so on.
  - 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

Examples

```
'Galil DMC Code Example
#main
SB 5;'     Set digital output 5
SB 1;'     Set digital output 1
CB 5;'     Clear digital output 5
CB 1;'     Clear digital output 1
EN
```

```
'Galil DMC Code Example
#modbus
REM connect to modbus slave at IP address 192.168.42.50
IHH=192,168,42,50<502>2
WT100
SB 8001;'set bit 1 on modbus slave
WT 10
CB 8003;'clear bit 3 on modbus slave
EN
```

```
'Galil DMC Code Example
:SB 18;'     Set digital output 18
:SB 21;'     Set digital output 21
:CB 18;'     Clear digital output 18
:CB 21;'     Clear digital output 21
```

For detailed information on connecting to a Modbus slave, see:
http://www.galil.com/news/dmc-programming-io-control/setting-rio-pocket-plc-or-generic-modbus-slave-extended-io

CB applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

CC *Configure Communications Port 2*

CC n_0,n_1,n_2,n_3

Usage	CC n ...	Arguments specified with an implicit, comma-separated order

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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	9,600	115,200	N/A	see Notes	Baud rate	9600, 19200, 38400 and 115200 are valid baud rates
n_1	0	1	N/A	1	Handshake setting	n_1=0 turns off handshaking. n_1=1 turns handshaking on
n_2	0	1	N/A	1	Enable aux serial port	n_2=0 disables port. n_2=1 enables port
n_3	0	1	N/A	1	Echo setting	n_3=0 for echo off. n_3=1 for echo on

Remarks

- The Aux port is not an interpreted port. It cannot receive Galil commands directly. Instead, use CI, #COMINT, and the P2 operands to handle received data.

Examples

```
'Galil DMC Code Example
:CC 9600,0,1,0;' 9600 baud, no handshake, enable, echo off.
:'         Typical setting with TERM-P or TERM-H.
```

CC applies to DMC50000,DMC4000,DMC4200,DMC4103

CD *Contour Distance*

CDm= n
CD n,n,n,n,n,n,n,n=t

Usage	CDm= n	Arguments specified with a single axis mask and an assignment (=)
	CD n ...	Arguments specified with an implicit, comma-separated order

Description

The CD command specifies the incremental position on contour axes. 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)

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-32,768	32,767	0	1	Contour position segment	Incremental position move
t	1	8	0	1	Time override option	t = 1-8 specifies 2^n samples for the given interval.
	0	0	0	0	Time override option	t=0 with n=0 disables Contour mode. See Remarks
	-1	-1	0	0	Time override option	Pauses contour buffer at the segment with t=-1. Reissue DT to re-engage contour mode.

Remarks

- The units of the command are in encoder counts.
- The = operator can be used to override the global DT time by transmitting the time in a CD with the position data.
- n=t=0 terminates Contour mode similar to VE or LE for vector mode and linear interpolation mode.
    - Example. CMBC is terminated with CD 0,0=0.
    - The user must have a space after CD in order to terminate the Contour Mode correctly.
        - The command CD0=0 (no space) will assign a variable CD0 the value of 0 rather than terminate Contour mode.

Examples

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
#contour;'                   Program Label
CMA;'                       Enter Contour Mode
DT 4;'                       Set time interval
CD 1000;'                   Specify data
CD 2000;'                  Next data
CD 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<>31)
EN;'                         End Program
```

CD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

CE *Configure Encoder*

CEm= n
CE n,n,n,n,n,n,n,n

Usage	CEm= n	Arguments specified with a single axis mask and an assignment (=)
	CE n ...	Arguments specified with an implicit, comma-separated order
Operands	_CEm	Operand holds the value last set by the command

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. The configuration applies independently to the main axes encoders and the auxiliary encoders.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	15	0	1	Encoder configuration setting	n is the sum of 2 integers M and N which configure main and auxiliary encoders. See table below for configuration description.

Configure Encoder Types. Add value from Column 1 and Column 2 to make n

Column 1	Main Encoder Type	Column 2	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 2 + 8, thus both encoders are reversed quadrature.

Remarks

- When using a servo motor, changing the CE type can cause the motor to run away.
- 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.
- When using pulse and direction encoders, the pulse signal is connected to CHA and the direction signal is connected to CHB.

Examples

```
'Galil DMC Code Example
:CE 0, 3, 6, 2;' Configure encoders
:CE ?,?,?,?;'     Interrogate configuration
0,3,6,2
:V = _CEB;'       Assign configuration to a variable
:V = ?
 3
:
```

CE applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

CF *Configure Unsolicited Messages Handle*

CF m

Usage	CF mm	Argument is an axis mask
Operands	_CF	Operand has special meaning, see Remarks

Description

The CF command sets the port for unsolicited messages. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	S	Handle	Ethernet Handle to assign as unsolicited message port	See Remarks
	I	I	S	Handle	Set the port that sent the command as the unsolicited message port	Not valid in program
	S	T	S	Handle	Set serial port as unsolicited message port	m=S is Main serial port. m=T is Aux Serial port

Remarks

- Examples of application code commands that will generate unsolicited messages follow.

```
'Galil DMC Code Example
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
```

Ethernet Handle as Unsolicited Message Port

- 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.

Operand Usage

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

Examples

```
'Galil DMC Code Example
:CFI;' send unsolicited traffic to the terminal that sent the command
```

```
'Galil DMC Code Example
'main handle is seperate from the unsolicited handle
'Note the connection indicators IHA and IHB in the following:
'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"
:
```

CF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

CI *Configure Communication Interrupt*

CI n

Usage	CI n ...	Arguments specified with an implicit, comma-separated order

Description

The CI command configures program interrupts based on input of characters over the communication port.

The command configures a program interrupt based on characters received on communications port 2, the AUX serial port. 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.

Arguments

Argument	Value	Description	Notes
n	-1	Clear interrupt data buffer	
	0	Do not interrupt	Default
	1	Interrupt on carriage return	
	2	Interrupt on any character	

Remarks

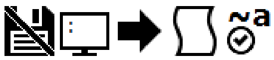
- For more, see Operator Data Entry Mode in the user manual.
- It is the user's responsiblity to ensure the communication buffer is not filled when in this mode, otherwise the controller will report error code 5 "Input Buffer Full". The buffer on the controller is cleared when either of the two following conditions are met:
  - A carriage return is recieved on the communication port.
  - CI -1 is called.

Examples

```
'Galil DMC Code Example
:CI 1;'     Interrupt when the  key is received on port 2
:CI 2;'     Interrupt on a single character received on Port 2
:
```

CI applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

CM *Contour Mode*



CM mm

Usage	CM mm	Argument is an axis mask
Operands	_CM	Operand has special meaning, see Remarks

Description

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 specifies the position interval between subsequent contour segments. The DT command specifies the time interval between subsequent contour segments.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axes to initialize to Contour mode	Disabled by default

Remarks

- CM? Returns the number of available contour seqments (0 means the buffer is full).
- _CM contains the number of available contour segments (0 means the buffer is full).
- Issuing the CM command will clear the contour buffer when contour mode is not running.

Examples

```
'Galil DMC Code Example
#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 contour 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
```

CM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

CN *Configure*

CN n_0,n_1,n_2,n_3,n_4

Usage	CN n ...	Arguments specified with an implicit, comma-separated order
Operands	_CN0 _CN1 _CN2 _CN3 _CN4	Operand holds the value last set by the command

Description

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

Arguments

Argument	Value	Description	Notes
n_0	1	Limit switches active high	
	-1	Limit switches active low	Default
n_1	1	_HM is 1 when grounded (or active-opto), and 0 when pull-up (non-active opto). Affects direction of travel for HM and FE.	See HM and FE commands
	-1	_HM is 0 when grounded (or active-opto), and 1 when pull-up (non-active opto). Affects direction of travel for HM and FE.	Default
n_2	1	Latch input triggers on rising edge	
	-1	Latch input triggers on falling edge	Default
n_3	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	Default
n_4	1	Abort input will not terminate program execution	
	0	Abort input will terminate program execution	Default

Remarks

- n_0 is useful for testing the operation of the #LIMSWI automatic subroutine. See example below.

Examples

```
'Galil DMC Code Example
CN 1,1;'   Sets limit and home switches to active high
CN ,, -1;' Sets input latch active low
```

```
'Galil DMC Code Example
REM n0 is useful for testing the operation of the #LIMSWI automatic subroutine
#test
CN -1;'     Switches are active low
JGA= 100
BG A;'      Start a slow jog move
WT1000
CN 1;'      Cause a limit fault by inverting the limit polarity
EN
'
#LIMSWI;'   Automatic sub will automatically launch on limit detection
MG "Limit Switch Routine"
WT100
CN -1;'     Return to correct polarity
RE
```

CN applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

CO *Configure Extended I/O*

CO n

Usage	CO n ...	Arguments specified with an implicit, comma-separated order
Operands	_CO	Operand holds the value last set by the command

Description

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

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	15	0	1	Bitmask to configure extended IO as inputs or outputs	Bit=1 is outputs. Bit=0 is inputs. See Table below

CO Bitmask Description

Bit #	IO Bank	IO points
7	N/A	N/A
6	N/A	N/A
5	N/A	N/A
4	N/A	N/A
3	Bank 5	41-48
2	Bank 4	33-40
1	Bank 3	25-32
0	Bank 2	17-24

Remarks

- CO is a configuration command which should be at the begining of application code.

Examples

```
'Galil DMC Code Example
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
```

CO applies to DMC50000,DMC4000,DMC4200,DMC2103,DMC1806,DMC1802

CP *Dead band within which the motor is shut off (MO)*

CPm= n
CP n,n,n,n,n,n,n,n

Usage	CPm= n	Arguments specified with a single axis mask and an assignment (=)
	CP n ...	Arguments specified with an implicit, comma-separated order
Operands	_CPm	Operand holds the value last set by the command

Description

The CP command sets the deadband within which the motor is shut off. After a move is complete (_BGn = 0) and the absolute value of the position error TE becomes less than the dead band CP, the motor is turned off. SH must be issued before further motion can be commanded. CT can be used to increment the integrator limit to ensure that the motor reaches the dead band.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-1	32,767	-1	1	Set the position deadband for motor off.	n=-1 disables the feature

Remarks

- Valid for -NAN or -CER firmware

Examples

```
'Galil DMC Code Example
:^R^V
DMC1842 Rev 1.0n-CM-F
:^R^S
:ED
0 #L
1 MG _RPX, _TEX, _ILX, _MOX
2 WT100
3 JP#L
4
:IL0
:CP100
:KI0.01
:PR1000
:BG
:XQ
:
0.0000 19.0000 0.0000 0.0000
934.0000 669.0000 0.0000 0.0000
1000.0000 684.0000 2.0406 0.0000
1000.0000 656.0000 4.6783 0.0000
1000.0000 429.0000 7.2166 0.0000
1000.0000 340.0000 9.8544 0.0000
1000.0000 83.0000 9.9982 1.0000
1000.0000 82.0000 9.9982 1.0000
```

CP applies to CER,NANO

CR *Circle*

$CR\ n_0,\ n_1,\ n_2 < o > p$

Usage	CR n ...	Arguments specified with an implicit, comma-separated order

Description

When using the vector mode (VM), the CR command specifies a 2-dimensional arc segment. 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 for radius, starting angle and traverse angle must all be entered for each CR command.

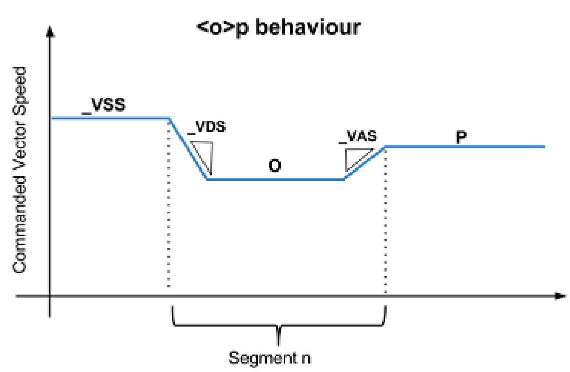
Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	10	6,000,000	N/A	1	Radius of circle segment	
n_1	-32,000	32,000	N/A	1/65,536	Starting angle of circle segment	
n_2	-32,000	32,000	N/A	1/65,536	Degrees to traverse for circle segment	
o	2	22,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 1,-1
	2	6,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 2,-2,2.5,-2.5.
p	2	22,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 1,-1,1.5,-1.5.
	2	6,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 2,-2,2.5,-2.5.

Argument	Value	Description	Notes
o	-1	Specifies vector speed to be set by Vector Speed Variable (VV command)	See VV command

Remarks

- The product of n_0 * n_2 must be less than 450,000,000
- A positive n_2 denotes counterclockwise traverse, -n_2 denotes clockwise.
- n_0 units are in quadrature counts.
- n_1 and n_2 have units of degrees.

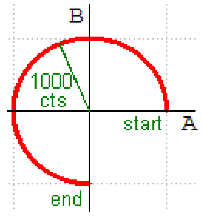


Examples

```
'Galil DMC Code Example
'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

'The 2-d map out the position output can be seen below
```




```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
'Generate a sine wave output on the A axis
VMAN;'               Specify vector motion in the A and N plane
VS 1000;'            Specify vector speed
CR 1000,0,360;'      Generate sine wave with amplitude of 1000 counts
'                    start at 0 degrees and complete one cycle
CR 1000,0,360<40000;' Generate same sine wave with same amplitude
'                    but run at faster speed (higher frequency)
'
VE;'                 End Sequence
BGS;'                Start motion
```

CR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

CS *Clear Sequence*

CS mm

Usage	CS mm	Argument is an axis mask
Operands	_CSm	Operand has special meaning, see Remarks

Description

The CS command will remove VP, CR or LI commands stored in a motion sequence for a coordinated axis. 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

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	N/A	Axis	Coordinate plane specified to clear buffer	

Remarks

- _CSm contains the segment number in the sequence specified by m= S or T.
- This operand is valid in the Linear mode, LM, and Vector mode, VM.

Examples

```
'Galil DMC Code Example
#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
```

CS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

CW *Copyright information and Data Adjustment bit on/off*

CW n_0,n_1

Usage	CW n ...	Arguments specified with an implicit, comma-separated order

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).

Arguments

Argument	Value	Description	Notes
n_0	0	Causes controller to return a copyright information string	Equivalent to n_0 = ?
	1	Controller will set the MSB of unsolicited message characters	
	2	Controller will not set the MSB of unsolicited message characters	Default. Must be set when viewing unsolicited messages from non-Galil software
n_1	0	Controller will pause program execution when hardware handshaking disables character transmissions	
	1	Controller will continue program execution when hardware handshaking disables character transmissions	Default. Output characters will be lost if serial buffer is full.

Remarks

- Galil software packages automatically sends CW 1 during connection to a controller.
  - If reading unsolicited data through a non-Galil software (eg. Hyperterminal), issue CW 2

Operand Usage

- _CW contains the value set for n_0
- _CW4 contains the value set for n_1

Examples

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

CW applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

DA *Deallocate Variables and Arrays*

DA str,str,...

Usage	DA n ...	Arguments specified with an implicit, comma-separated order
Operands	_DAm	Operand has special meaning, see Remarks

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	8 chars	N/A	String	Array name to deallocate	If str = *, deallocate all arrays
	1 char	8 chars	N/A	String	Variable name to deallocate	If str = *, deallocate all variables

where
str[] - Defined array name
str - Defined variable name
str = * deallocates all the variables
str = *[] - Deallocates all the arrays

Remarks

- _DA contains the total number of arrays available.
- DA ? returns the total number of arrays available.
- 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.

Examples

```
'Galil DMC Code Example
'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
```

DA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

DB *Range in which PID and antifriction bias are turned on (on band)*

DBm= n
DB n,n,n,n,n,n,n,n

Usage	DBm= n	Arguments specified with a single axis mask and an assignment (=)
	DB n ...	Arguments specified with an implicit, comma-separated order
Operands	_DBm	Operand holds the value last set by the command

Description

When the controller is holding position, and the absolute value of the error TE is greater than DB, the PID control loop, as well as anti-friction biases ZP and ZN, will be enabled. This is used in combination with the DS command to avoid oscillation when holding position. DS and DB are disabled during motion, and only apply when holding position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	32,767	0	1	Position setpoint for PID deadband	

Remarks

- DB should be set greater than or equal to DS.

Examples

```
'Galil DMC Code Example
DSA=100;'   set off band on A axis to +/-100 counts
DBA=200;'   set on band on A axis to +/-200 counts
```

DB applies to CER,CLS,NANO

DC *Deceleration*

DC m= n
DC n,n,n,n,n,n,n,n

Usage	DC m= n	Arguments specified with a single axis mask and an assignment (=)
	DC n ...	Arguments specified with an implicit, comma-separated order
Operands	_DC m	Operand holds the value last set by the command

Description

The Deceleration command (DC) sets the linear deceleration 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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	1,024	1,073,740,800	256,000	1,024	Deceleration rate	At TM 1000. See Remarks for resolution details.

Remarks

- The AC command is used to designate acceleration
- Specify realistic deceleration rates based on physical system parameters such as:
  - motor torque rating
  - loads
  - amplifier current rating
- Specifying an excessive deceleration will cause a large following error during deceleration and the motor will not follow the commanded profile
- DC may be changed during a move in Jog mode, but not in a PA or PR move
  - However, directly following an axis stop (i.e. ST m or a limit switch), the DC value of a PA or PR move may be changed while the axis is still decelerating

Resolution

- The resolution of the DC command is dependent on the sampling period of the control loop (TM). With the default rate of TM 1000 the resolution is 1024 counts/second^2. The equation to calculate the resolution of the DC command is:
  - resolution = min = 1024*(1000/TM)^2
  - Example:
    - With TM 500 the minimum DC setting and resolution is 4096 counts/second^2.
    - resolution = 1024*(1000/500)^2 = 4096

Examples

```
'Galil DMC Code Example
PR 10000;' Specify position
AC 2000000;' Specify acceleration rate
DC 1000000;' Specify deceleration rate
SP 5000;' Specify slew speed
BG;'     Begin motion
```

DC applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

DE *Dual (Auxiliary) Encoder Position*

DEm= n
DE n,n,n,n,n,n,n,n

Usage	DEm= n	Arguments specified with a single axis mask and an assignment (=)
	DE n ...	Arguments specified with an implicit, comma-separated order
Operands	_DEm	Operand has special meaning, see Remarks

Description

The DE command defines the position of the auxiliary (dual) encoders.

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Position set for auxiliary encoders	For MT 1,-1,1.5,-1.5
	-2,147,483,648	2,147,483,647	0	1	Position set for main encoders	For MT 2,-2,2.5,-2.5

Remarks

- When using stepper motors, the DE command defines the main encoder position.
- The auxiliary encoders are not available for the stepper axis or for any axis where output compare is active.
- The operand _DEm, as well as _TDm, holds the current aux encoder position.
- n=? will return the encoder position, as returned by TD.

Examples

```
'Galil DMC Code Example
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
```

DE applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

DF *Dual Feedback (DV feedback swap)*

DFm= n
DF n,n,n,n,n,n,n,n

Usage	DFm= n	Arguments specified with a single axis mask and an assignment (=)
	DF n ...	Arguments specified with an implicit, comma-separated order
Operands	_DFm	Operand holds the value last set by the command

Description

The DF command allows configuration of BiSS or SSI feedback in Dual Loop mode as the load encoder. Issuing the DF command will swap the main and auxiliary position registers, such that the encoder wired into the main encoder terminals will report its position in TD and the encoder wired into the auxiliary encoder terminals will report in TP.

Arguments

Argument	Value	Description	Notes
n	0	Disable feedback swap	Default
	1	Enable feedback swap	

Remarks

- When using this command, wire the motor's incremental encoder into the main encoder terminals. The load encoder should be wired to the auxiliary encoder terminals.
- Once wired, configure the serial encoder as an auxiliary encoder.
    - See SI or SS for configuration information.

Examples

```
'Galil DMC Code Example
MOA;'                Disable motor on X
SIA= 2,25,0,0<9>1;'  Setup SSI encoder to fill the Aux encoder register
DF1;'                Enable Dual Feedback Swap
DV1;'                Enable Dual Loop mode
SHA;'                Enable servo with new configuration
```

DF applies to DMC50000,SER

DH *DHCP Client Enable*

DH n

Usage	DH n ...	Arguments specified with an implicit, comma-separated order

Description

The DH command configures the DHCP or BOOT-P functionality on the controller for Server IP addressing.

Arguments

Argument	Value	Description	Notes
n	0	Enable BOOT-P and disable DHCP	Allows IP assignment through IA command.
	1	Disable BOOT-P and enable DHCP	Default. Allows IP assignment through DHCP server.

Remarks

- DH 0 must be set to manually assign and burn in an IP address. With DH 1 set, the IA command will return an error if used to set the IP address.

Examples

```
'Galil DMC Code Example
DH 1;' Sets the DHCP function on.  IA assignment will no longer work.
DH 0;' Sets the DHCP function off, and the Boot-P function on.
```

DH applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000

DL *Download*

DL n
DL #str
DL s

Usage	DL n ...	Arguments specified with an implicit, comma-separated order

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 \.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	3,999	0	1	Line number to begin program download	Firmware Rev 1.2a and later
n	0	1,999	0	1	Line number to begin program download	
str	1 char	8 chars	""	String	Name of label in RAM to begin download from.	If str = "", download begins at the end of the current program in RAM
s	#	#	N/A	Symbol	Begins download at end of program in RAM	

Remarks

- Do not insert spaces before label declarations.
- _DL gives the number of available labels.
- Issuing this command will pause the output of the Data Record until the command is completed.
- This command will be rejected by Galil software if sent via the terminal. In order to download a program using a Galil software package, use that package's prescribed programming interface (I.E. GDK's Editor Tool).

Examples

```
'Galil DMC Code Example
:DL;'      Begin Download
#A;PR 4000;BGA
AMA;MG DONE
EN
\
:'End download
```

DL applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,DMC2105

DM *Dimension Array*

DM str[n],str[n],...

Usage	DM n ...	Arguments specified with an implicit, comma-separated order

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

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	8 chars	N/A	String	Name of array to dimension	
n	1	24,000	N/A	1	Number of array elements to assign to dimensioned array	Firmware Rev 1.2a and later
n	1	16,000	N/A	1	Number of array elements to assign to dimensioned array	

Remarks

- Typing in array name with [-1] element marked reports the number of elements for that array.

- The first character of str must be alphabetic. The rest can be any alphanumeric characters.
- When assigning array elements, the number specified must be less than the current available array space
- _DM contains the available array space.
- DM ? returns the available array space.
- The DM command can allocate any number of array in a single command up to the maximum command line length of the controller being used.

Examples

```
'Galil DMC Code Example
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[100];' Define dimension of array Tests with 100 elements
```

```
'Galil DMC Code Example
:DM?;' firmware revisions prior to Rev 1.2a only have 16000 elements
24000
:DM MyArray[1000]
:DM?
23000
:'DMC-4000 provides length of array with array[-1]
:MG "MyArray contains",MyArray[-1]," elements"
MyArray contains 1000.0000 elements
:
```

DM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

DP *Define Position*

DPm= n
DP n,n,n,n,n,n,n,n

Usage	DPm= n	Arguments specified with a single axis mask and an assignment (=)
	DP n ...	Arguments specified with an implicit, comma-separated order
Operands	_DPm	Operand has special meaning, see Remarks

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Value assigned to motor/commanded position (RP and TP registers)	For MT 1,-1,1.5,-1.5
	-2,147,483,648	2,147,483,647	0	1	Value assigned to step/commanded position (RP and TD registers)	For MT 2,-2,2.5,-2.5

Remarks

- 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. When equipped with an encoder, use the DE command to set the encoder position for stepper mode.
- 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.
- The operand _DPm, as well as _TPm, holds the current main encoder position.
- n=? will return the encoder position, as returned by TP.

Examples

```
'Galil DMC Code Example
: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 A, C and D axes remain unchanged.
:DP ?,?,?,?;'          Interrogate the position of A, B, C and D axis.
0, -50000, 200, 400
:DP ?;'                 Interrogate the position of A axis
0
:
```

```
'Galil DMC Code Example
:DP 0;'       Sets the current position of the A-axis to 0
:DP -50000;'  Sets the current position of A-axis to -50000.
:DP ?;'       Interrogate the position of A
-50000
```

DP applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

DR *Configures I O Data Record Update Rate*

DR n_0, n_1

Usage	DR n ...	Arguments specified with an implicit, comma-separated order
Operands	_DR0 _DR1	Operand has special meaning, see Remarks

Description

DR specifies and enables the rate for the controller to output its data record.

For ethernet-based controllers, the controller creates a QR record and sends it to the unsolicited UDP Ethernet Handle at the specified rate. See the User Manual for the data record map.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	2	30,000	0	2	Data update rate specified in samples between packets.	n = 0 turns off data record output.
	0	0	0	0	Turn off data record output	
n_1	0	7	see Notes	1	Ethernet handle to output data record packet	0=A,1=B,2=C,3=D,4=E,5=F,6=G,7=H.

Remarks

- If a small sample period and a small update rate is used, the controller may become noticeably slower as a result of maintaining a high update rate.
- If n_1 is omitted, then the CF unsolicited message port is used by default.
- The DR port specified with n_1 must be a UDP handle.
- _DR0 contains the data record update rate (n_0).
- _DR1 contains the specified handle (n_1). Will return an integer 0-7 for handles A-H.
- Issuing any of the following commands will pause the output of the data record until the command is complete: BN, BP, BV, BX, BZ, DL, LS, LV, QD, QU, UL

Examples

```
'Galil DMC Code Example
:WH
 IHA
:DR1000,0
Gx~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)
```

DR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806

DS *Range in which PID and antifriction bias are turned off (off band)*

```
DSm= n
DS n,n,n,n,n,n,n,n
```

Usage	DSm= n	Arguments specified with a single axis mask and an assignment (=)
	DS n ...	Arguments specified with an implicit, comma-separated order
Operands	_DSm	Operand holds the value last set by the command

Description

When the controller is holding position, and the absolute value of the error TE is less than DS, the PID control loop, as well as anti-friction biases ZP and ZN, will be disabled. This is used in combination with DB to avoid oscillation when holding position. DS and DB are disabled during motion, and only apply when holding position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	32,767	0	1	Position setpoint for PID deadband	

Remarks

- DB should be set greater than or equal to DS.

Examples

```
'Galil DMC Code Example
DSA=100;'   set off band on the A axis to +/-100 counts
DBA=200;'   set on band on the A axis to +/-200 counts
```

DS applies to CER,CLS,NANO

DT *Delta Time*

DT n

Usage	DT n ...	Arguments specified with an implicit, comma-separated order

Description

The DT command sets the time interval for Contour Mode. The time interval is 2^N samples. With TM 1000, there are 1024 samples per second. 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

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	8	0	1	Set time interval for contour mode in 2^n samples.	
	-1	-1	N/A	0	n=-1 to pause the contour mode	See Remarks.

Remarks

- By default the sample period is 1 msec (set by the TM command); with n=1, the time interval would be 2 msec
- 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.
- DT can be overridden with the =t parameter within a CD segment.

Examples

```
'Galil DMC Code Example
:DT 4;'              Specifies time interval to be 16 msec (TM1000)
:DT 7;'              Specifies time interval to be 128 msec
:
```

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
REM contour example for pre-loading of contour buffer
#Cont1;'                    Define label #Cont1
CM A;'                       Specify Contour Mode
DT -1;'                     Pause Contour Mode to allow pre-load of buffer
CD 100;'                    Countour Data pre-loaded in buffer
CD 400;'                    Countour Data pre-loaded in buffer
CD 200;'                    Countour Data pre-loaded in buffer
CD 300;'                    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;'                    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<>31)
EN;'                        End program
```

DT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

DV *Dual Velocity (Dual Loop)*

```
DVm= n
DV n,n,n,n,n,n,n,n
```

Usage	DVm= n	Arguments specified with a single axis mask and an assignment (=)
	DV n ...	Arguments specified with an implicit, comma-separated order
Operands	_DVm	Operand holds the value last set by the command

Description

The DV function changes the operation of the PID filter. When DV is enabled the KD (derivative) term operates on the auxiliary encoder instead of the main encoder.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	State of dual loop mode	n = 0 disables Dual loop. n = 1 enables Dual loop

Remarks

- The DV command is useful in backlash and resonance compensation.

- DV must be set properly for commutation to be successful with internal sine drives.
  - When DVm=0, the controller will use the main encoder for sine drive commutation.
  - When DVm=1, the controller will use the aux encoder for sine drive commutation.

Correcting for Positive Feedback

- With motor off (MO) check the motor encoder with TD and load encoder with TP. Manually move the motor/load and reissue the TD and TP commands to confirm both encoders count in the same direction.
- If the encoders count in opposing directions, change the polarity of one encoder using the CE command or by changing the wiring. Consult user manual.
- If positive feedback still persists, switch the motor polarity or reverse the direction of both encoders.
  - Off on error (OE) and error limits (ER) can be used to shut down the motor in the event of a runaway.

Using DV with Large motor/load encoder ratio

- 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 estimated FV setting required to compensate for the derivative contribution can be 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

Examples

```
'Galil DMC Code Example
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
```

DV applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,EDD37010

EA *Choose ECAM master*

EA m

Usage	EA mm	Argument is an axis mask

Description

The EA command selects the master axis for the electronic cam mode. Any axis may be chosen.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign as ECAM master	
	M	N	N/A	Axis	Virtual axis to assign as ECAM master	N is default

Remarks

- The ECAM mode runs off of the master's main encoder (TP) even when the axis is running in stepper mode.
- When using the M or N imaginary axes, the commanded position is used.

Examples

```
'Galil DMC Code Example
REM example using A axis as ECAM master and B axis as ECAM slave
#CAMONE
master=400
slave=8192
EB0; 'Disable ECAM Mode
EA A; 'Set Master Axis as A
EM master,slave
EP master/4,0
ET[0]=,0
ET[1]=,2048
ET[2]=,4096
ET[3]=,6144
ET[4]=,8192
DP0,0
SHAB
'NOTE - (EP Value)*(# of Cam Points) must be >= to Master Modulus
JG100;BGA
EB1
EG,0; 'Start ECAM profile
EN
```

EA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EB *Enable ECAM*

EB n

Usage	EB n ...	Arguments specified with an implicit, comma-separated order
Operands	_EB	Operand has special meaning, see Remarks

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.

Arguments

Argument	Value	Description	Notes
n	0	Stop ECAM mode	Default
	1	Start ECAM mode	

Remarks

- When the EB command is given, the master axis position is modularized.
- _EB holds the enabled state, 1 or 0

Examples

```
'Galil DMC Code Example
EB1;'  Starts ECAM mode
EB0;' Stops ECAM mode
var = _EB;' Return status of cam mode
```

EB applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EC *ECAM Counter*

EC n

Usage	EC n ...	Arguments specified with an implicit, comma-separated order
Operands	_EC	Operand has special meaning, see Remarks

Description

The EC function sets the index into the ECAM table. This command is only useful when entering ECAM table values without index values. See the command, ET.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	256	0	1	Set the ECAM table index	

Remarks

- _EC contains the current value of the index into the ECAM table.

Examples

```
'Galil DMC Code Example
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
var=_EC;'    Set the ECAM index value to a variable
```

EC applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

ED *Edit*

ED n

Usage	ED n ...	Arguments specified with an implicit, comma-separated order
Operands	_ED _ED1 _ED4	Operand has special meaning, see Remarks

Description

The ED command puts the controller into the Edit subsystem. The ED command is used when using Telnet style interface (not Galil Software). In the Edit subsystem, programs can be created, changed, or destroyed.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	3,999	see Notes	1	Line number to begin editing	Firmware Rev 1.2a and later. Default n is the last line of program space with commands.
n	0	1,999	see Notes	1	Line number to begin editing	Default n is the last line of program space with commands.

Remarks

- This command will be rejected by Galil software if sent to via the terminal. In order to edit a program using a Galil software package, use that package's prescribed programming interface (I.E. GDK's Editor Tool).
- The commands in the Edit subsystem are the following.

ED Commands

Key Combination	Function
<ctrl>D	Deletes a Line
<ctrl>I	Inserts a line before the current
<ctrl>P	Displays the previous line
<ctrl>Q	Exits the ED subsystem
Enter	Saves a line and moves cursor to next

Operand Usage

- _ED0 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).
- _ED0 returns 0 if no error has occurred.
- _ED1 returns -1 if no error has occurred.

- _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.

Examples

```
'Galil DMC Code Example
:ED
#START
PR 2000
BGA
xx;' bad command line
EN
#CMDERR Routine which occurs upon a command error
V=_ED0
MG "An error has occurred" {n}
MG "In line", V{F3.0}
ST
ZS0
EN
ctrl-Q
:'Hint:  Remember to quit the Edit Mode prior to executing or listing a program.
```

```
'Galil DMC Code Example
'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
```

ED applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

EG *ECAM go (engage)*

EGm= n
EG n,n,n,n,n,n,n,n

Usage	EGm= n	Arguments specified with a single axis mask and an assignment (=)
	EG n ...	Arguments specified with an implicit, comma-separated order
Operands	_EGm	Operand has special meaning, see Remarks

Description

The EG command engages an ECAM slave axis at a specified position of the master. Once a slave motor is engaged, its position is redefined to fit within the cycle.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Master position to engage ECAM slave	n = outside of master axis position range causes slave to engage immediately.

Remarks

- _EGm contains ECAM status for specified slave axis. 0 = axis is not engaged, 1 = axis is engaged.
- n = ? Returns 1 if specified axis is engaged and 0 if disengaged.
- 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.

Examples

```
'Galil DMC Code Example
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
```

EG applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EI *Event Interrupts*

EI n_1,n_2,n_3

Usage	EI n ...	Arguments specified with an implicit, comma-separated order
Operands	_EI	Operand has special meaning, see Remarks

Description

The EI command is used to enable interrupts on events. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_1	0	65,535	0	1	16-bit interrupt mask	0 turns off interrupts. See Remarks for bit mask
n_2	0	255	0	1	8-bit input mask	Used to select the specific digital input trigger. Bit 15 of n_1 must be set for the n_2 mask to be used.
n_3	-1	7	-1	1	Preconfigured UDP handle for interrupt transmission	-1 disabled, 0-7 indicate Handles A-H, respectively

Remarks

- _EI contains the interrupt mask n_1
- n_1 = 0 means "don't interrupt" and clears the queue when issued
- The interrupts marked with * in the table below must be re-enabled with EI after each occurrence
- Bit 15 of n_1 must be set for the n_2 input mask to be used
- If the handle specified by n_3 is not UDP or is not initialized, an error will occur

n_1 Bit Mask

Interrupt Bits

bit	n_1=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
9	$0200 (512)	$C8 (200)	* Excess position error _TEm >= _ERm
10	$0400 (1024)	$C0 (192)	* Limit switch _LFm=0 /_LRm=0 Must be profiling motion in direction of activated limit switch for interrupt to occur.
11	$0800 (2048)	$D9 (217)	Reserved
12	$1000 (4096)		Reserved
13	$2000 (8192)	$DB (219)	Application program stopped _XQn = -1
14	$4000 (16384)	$DA (218)	Reserved
15	$8000 (32768)	$E1-$E8 (225-232)	* Digital input(s) 1-8 low (use n_2 for mask)
	UI, user interrupt command	$F0-$FF (240-255)	User Interrupt, See UI command

n_2 Bit Mask

Input Interrupts

bit	n_2 = 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

UDP Interrupts Framing

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 (0003 - 0x12) [Includes header and footer in count]
Example	0001	0xD0F1DBE1	0006
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

Examples

```
'Galil DMC Code Example
'Interrupt when motion is complete on all axes OR if a limit switch is hit:
'From the table, enable bits 8 and 10.  n1 = 256 + 1024 = 1280
EI  1280
'
'Interrupt when digital input 3 is low.
'Enable bit 15 of n1 and bit 2 of n2.
EI 32768,4
```

EI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806,DMC1802

ELSE *Else function for use with IF conditional statement*

ELSE

Usage	ELSE n ...	Arguments specified with an implicit, comma-separated order

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 is a command with no parameters

Remarks

- None

Examples

```
'Galil DMC Code Example
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 "IN1 AND IN2 ARE ACTIVE";' Message to be executed if 2nd IF conditional is true
 ELSE;'                         ELSE command for 2nd IF conditional statement
  MG "ONLY IN1 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
 IF (@IN[2]=0);'             3rd IF conditional statement executed if 1st IF conditional false
  MG "ONLY IN2 IS ACTIVE";'  Message to be executed if 3rd IF conditional statement is true
 ELSE;'                      ELSE command for 3rd conditional statement
  MG "IN1 AND IN2 INACTIVE";'Message to be executed if 3rd IF conditional statement is false
 ENDIF;'                     End of 3rd conditional statement
ENDIF;'                      End of 1st conditional statement
```

ELSE applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

EM *Ecam modulus*

EMm= n
EM n,n,n,n,n,n,n,n

Usage	EMm= n	Arguments specified with a single axis mask and an assignment (=)
	EM n ...	Arguments specified with an implicit, comma-separated order
Operands	_EMm	Operand holds the value last set by the command

Description

The EM command defines 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	Virtual axes are only valid as ECAM masters
n	2	8,388,607	N/A	1	Position change over one full ECAM cycle	For defining master axis
	0	2,147,483,647	N/A	1	Position change over one full ECAM cycle	For defining slave axis

Remarks

- If a slave will return to its original position at the end of the cycle, then n=0.
- If the change is negative, specify the absolute value for n.

Examples

```
'Galil DMC Code Example
REM example using A axis main encoder as master B axis main encoder as the slave
#cam
REM define A axis encoder as master for ECAM
EA A
REM
REM EM command options
REM ----
REM define slave modulus as 0 (returns to original position)
REM and define master modulus as 4000
EM 4000,0
REM
REM another valid EM settings for this configuration
REM ----
'EMA= 4000;' define A axis master modulus as 0
'EMB= 0;'    define B axis slave modulus as 0
REM
REM ----
REM define master increment as 1000 counts/table entry
EP 1000
ET[0]= , 0
ET[1]= , 1000
ET[2]= , 2000
ET[3]= , 1000
ET[4]= , 0
REM enable ECAM mode
EB 1
REM engage when master is at 0 position
EG 0,0
EN
```

```
'Galil DMC Code Example
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
```

EM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EN *End*

EN n_0,n_1,n_2

Usage	EN n ...	Arguments specified with an implicit, comma-separated order

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.

A return parameter can be specified to EN from a subroutine to return a value from the subroutine to the calling stack.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	1	0	1	Specify trippoint status when returning from subroutine	n_0=1 restores trippoints. n_0=0 does not restore trippoints
n_1	0	1	0	1	Set status of CI interrupt when returning from #COMINT	n_1=1 restores CI interrupt. n_1=0 does not restore CI interrupt
n_2	-2,147,483,648	2,147,483,647	0	1	Return a value from a subroutine.	Accesible from the calling program with _JS. See JS for more information

Remarks

- The EN command is used to end the automatic subroutines #MCTIME #COMINT and #CMDERR.
  - Use the RE command to end the #POSERR and #LIMSWI subroutines.
  - Use the RI command to end the #ININT subroutine

Examples

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
#example
'test program showing restoring trippoints with EN
XQ#err,1;'   Execute thread to generate error
AI1;'        Wait for input 1 to trigger
MG"hello";'  After input, message out
EN

#err
'dummy thread that runs to cause an error
XX123;'      Invalid command
'causes CMDERR to be called, interrupting thread 0
EN

#CMDERR
'error subroutine running on thread 0
tc=_TC;'     Save error code
EN1;'        End routine, restore AI trippoint.
```

EN applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

ENDIF *End of IF conditional statement*

ENDIF

Usage	ENDIF n ...	Arguments specified with an implicit, comma-separated order

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

ENDIF is a command with no parameters

Remarks

- None

Examples

```
'Galil DMC Code Example
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 "IN1 AND IN2 ARE ACTIVE";' Message to be executed if 2nd IF conditional is true
 ELSE;'                        ELSE command for 2nd IF conditional statement
  MG "ONLY IN1 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
 IF (@IN[2]=0);'            3rd IF conditional statement executed if 1st IF conditional false
  MG "ONLY IN2 IS ACTIVE";'  Message to be executed if 3rd IF conditional statement is true
 ELSE;'                      ELSE command for 3rd conditional statement
  MG "IN1 AND IN2 INACTIVE";'Message to be executed if 3rd IF conditional statement is false
 ENDIF;'                     End of 3rd conditional statement
ENDIF;'                      End of 1st conditional statement
```

ENDIF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

EO *Echo*

EO n

Usage	EO n ...	Arguments specified with an implicit, comma-separated order
Operands	_EO	Operand holds the value last set by the command

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.

Arguments

Argument	Value	Description	Notes
n	0	Echo Off	
	1	Echo On	Default

Remarks

- This command is defaulted to EO1. Galil software upon connection will set EO0
- The EO command is accepted over the serial port only.
  - The ethernet port will not echo commands

Examples

```
'Galil DMC Code Example
EO 0;' Turns echo off
EO 1;' Turns echo on
```

EO applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

EP *Cam table master interval and phase shift*

EP n_0,n_1

Usage	EP n ...	Arguments specified with an implicit, comma-separated order
Operands	_EP	Operand holds the value last set by the command

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. Up to 257 points may be specified.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	1	32,767	256	1	Master position interval	Cannot be changed while ECAM is running
n_1	-2,147,483,648	2,147,483,647	0	1	ECAM table phase shift	Can be modified during ECAM

Remarks

- _EP contains the value of the interval n_0.
- The offset parameter 'n_1' 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.galil.com/download/application-note/note2502.pdf

Examples

```
'Galil DMC Code Example
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
```

EP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EQ *ECAM quit (disengage)*

EQm= n

EQ n,n,n,n,n,n,n,n

Usage	EQm= n	Arguments specified with a single axis mask and an assignment (=)
	EQ n ...	Arguments specified with an implicit, comma-separated order
Operands	_EQm	Operand has special meaning, see Remarks

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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Master position to disengage the slave axis specified.	If n = outside of master position range, disengage slave axis immediately.

Remarks

- _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.
- 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.
- 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.

Examples

```
'Galil DMC Code Example
EQ 300,700;' Disengages the A and B motors at master positions 300 and 700 respectively.
```

```
'Galil DMC Code Example
EQ 300;' Disengages the A motor at master position 300.
```

EQ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

ER *Error Limit*

ERm= n

ER n,n,n,n,n,n,n,n

Usage	ERm= n	Arguments specified with a single axis mask and an assignment (=)
	ER n ...	Arguments specified with an implicit, comma-separated order
Operands	_ERm	Operand holds the value last set by the command

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-1	2,147,483,647	16,384	1	Set the position error limit in counts	n=0 enables Error output. n=-1 disables Error output.

Remarks

- 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
- For debugging purposes, ER0 and ER-1 can be used to turn the red LED on and off.

Examples

```
'Galil DMC Code Example
: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
200,1000,400,600
:ER ?;' Return A value
200
:V1=_ERA;' Assigns V1 value of ERA
:MG V1;' Returns V1
200
```

ER applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

ES *Ellipse Scale*

ES n_0, n_1

Usage	ES n ...	Arguments specified with an implicit, comma-separated order

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 resolution change applies for the purpose of generating the VP and CR commands, effectively changing the axis with the higher resolution to match the coarser resolution.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	1	65,535	1	1	First value used for resolution scaling	See Remarks for usage
n_1	1	65,535	1	1	Second value used for resolution scaling	See Remarks for usage

Remarks

- For VM xy
  - When $n_0 > n_1$, the resolution of x will be multiplied by n_0/n_1
  - When $n_0 < n_1$, the resolution of y will be multiplied by n_1/n_0
- The ES command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.

Examples

```
'Galil DMC Code Example
VMAB;ES 3,4;' Divide B resolution by 4/3
VMCA;ES 2,3;' Divide A resolution by 3/2
VMAC;ES 3,2;' Divide A Resolution by 3/2
'Note:  ES must be issued after VM.
```

```
'Galil DMC Code Example
VMAN;ES 3,2;' Divide A Resolution by 3/2
'Note:  ES must be issued after VM.
```

ES applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

ET *Electronic cam table*

ET n,n,n,n,n,n,n,n
ET[n_0] = n,n,n,n,n,n,n,n

Usage	ET n ...	Arguments specified with an implicit, comma-separated order

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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	256	N/A	1	Index of the ECAM table entry	
n	-2,147,483,648	2,147,483,647	0	1	Position of the slave axis at the specified table point.	

Remarks

- [n_0] can be omitted only if EC has initialized the index count. In this case, each ET command will increment the index counter by 1.
- n=? Returns the slave position for the specified point.

Examples

```
'Galil DMC Code Example
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
EC 0;'               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
```

ET applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EW *ECAM Widen Segment*

EW n_0,n_1,n_2,n_3

Usage	EW n ...	Arguments specified with an implicit, comma-separated order
Operands	_EW0 _EW1 _EW2 _EW3	Operand has special meaning, see Remarks

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	1	255	-1	1	Index of first widened segment	If n_0 = -1, no segment is widened
n_1	1	2,147,483,647	0	1	Length of first widened segment	In master counts
n_2	3	255	-1	1	Index of second widened segment	If n_2 = -1, no segment is widened. n_2 must be > n_0
n_3	1	2,147,483,647	0	1	Length of second widened segment	In master counts

Remarks

- Remember that the widened segment lengths must be taken into account when determining the modulus (EM) for the master.
- The second widened segment cannot be used unless the first widened segment is also being used.
- The segments chosen should not be the first or last segments, or consecutive segments.

Operand Usage

- _EW0 contains n_0, the index of the first widened segment.
- _EW1 contains n_1, the length of the first widened segment.
- _EW2 contains n_2, the index of the second widened segment
- _EW3 contains n_3, the length of the second widened segment.

Examples

```
'Galil DMC Code Example
EW 41, 688;'            Widen segment 41 to 688 master counts
EW 41, 688, 124, 688;'   Widen segments 41 and 124 to 688 master counts
```

EW applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

EY *ECAM Cycle Count*

EY n

Usage	EY n ...	Arguments specified with an implicit, comma-separated order
Operands	_EY	Operand holds the value last set by the command

Description

The EY command 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-2,147,483,648	2,147,483,647	0	1	Current ECAM cycle count	

Remarks

- _EY returns the current cycle count
- EY can be used to calculate the absolute position of an axis with the following equation:
    - Absolute position = EY * EM + TP

Examples

```
'Galil DMC Code Example
MG _EY * _EMY + _TPY;'        print absolute position of master (Y)
```

EY applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

FA *Acceleration Feedforward*

FAm= n
FA n,n,n,n,n,n,n,n

Usage	FAm= n	Arguments specified with a single axis mask and an assignment (=)
	FA n ...	Arguments specified with an implicit, comma-separated order
Operands	_FAm	Operand holds the value last set by the command

Description

The FA command sets the acceleration feedforward coefficient. This coefficient is scaled by the set acceleration and adds a torque bias voltage during the acceleration phase and subtracts the bias during the deceleration phase of a motion.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	8,191	0	1/4	Value of proportional term	

Remarks

- The Feedforward Bias product is limited to 10 Volts.
- If the feedforward coefficient is changed during a move, then the change will not take effect until the next move.
- FA operates on PA, PR, IP, JG and PVT mode.
- FA does not operate in:
  - Contour Mode (CM)
  - Axis is Gearing or ECAM slave
  - Coordinated motion (LM, VM)

- Acceleration Feedforward Bias = FA * AC * (1.5 10-7) * ((TM/1000)^2)
- Deceleration Feedforward Bias = FA * DC * (1.5 10-7) * ((TM/1000)^2)

Examples

```
'Galil DMC Code Example
'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
:MG _FAA,_FAB
 10 15
```

FA applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,EDD37010,DMC1802,DMC1806,DMC2103

FC *Distance-selectable feedforward gain*

FCm= n
FC n,n,n,n,n,n,n,n

Usage	FCm= n	Arguments specified with a single axis mask and an assignment (=)
	FC n ...	Arguments specified with an implicit, comma-separated order
Operands	_FCm	Operand holds the value last set by the command

Description

Adds a bias to the torque output TT proportional to the commanded velocity if the distance from the end of the move is less than FN. FC is the same as FV but activated FN counts from the end of the move and both positive and negative values are allowed.

Arguments

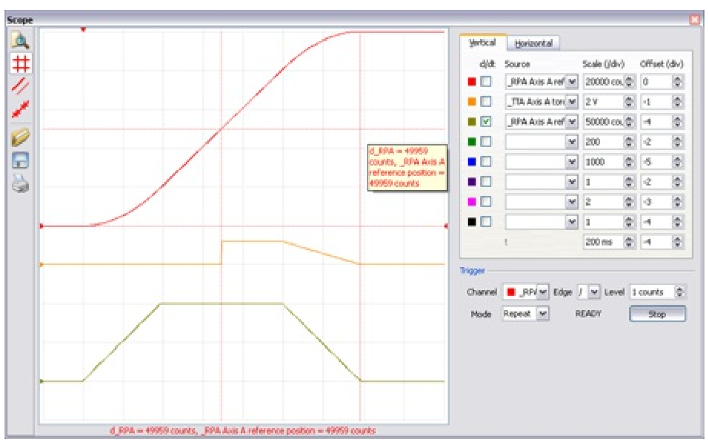
Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-8,191	8,191	0	1	Value of distance selectable feedforward gain	

Remarks

- Valid only in -NAN and -CER firmware
- Bias in volts = 1.22 E-6 * FC . (commanded Velocity in counts/s)

Examples

```
'Galil DMC Code Example
SPA=100000;'set speed to 100,000 cnts/second
FCA=10;'    set distance-selectable velocity feedforward gain to 10
FNA=50000;'  set distance from end of move when FC is engaged to 5000 counts
PRA=100000;' command move of 10,000 counts
BGA;'       begin move
EN
' Move shown below with KP 0,KD 0,KI 0,K1 0,K2 0,K3 0
```



FC applies to CER,NANO

FE *Find Edge*

FE mm

Usage	FE mm	Argument is an axis mask

Description

The FE command moves a motor until a transition is seen on the home 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 custom homing sequences.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axes to Find Edge	

Remarks

- 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
- Speed of Find Edge is set with the SP command and should be low enough to allow for a minimum of a 2 sample period pulse width on the home signal. With TM 1000, the pulse width must be at least 2ms.

Direction of Travel

_CN1 value	Home input digital state	_HMn state	Direction of travel if FE begun in this state
-1	pull-up or non-active opto	1	Backward
-1	grounded or active opto	0	Forward
1	pull-up or non-active opto	0	Forward
1	grounded or active opto	1	Backward

Examples

```
'Galil DMC Code Example
:FEB;' Only find edge on B
:BGB;
:FECD;' Find edge on C and D
:BGCD;
```

FE applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,DMC1802,DMC1806,DMC2103

FI *Find Index*

FI mm

Usage	FI mm	Argument is an axis mask

Description

The FI and BG commands move the motor until an encoder index pulse is detected.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axes to Find Index	

Remarks

- 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.
- 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.

Examples

```
'Galil DMC Code Example
#HOME;'            Home Routine
JG 1000,-2000;'    Set the speed and direction for the first phase of the FI move
HV 500,500;'       Set the speed for the second phase of the FI move
FI AB;'            Queue up a find edge move on the A and B axes
'                  Direction of phase 2 is opposite of phase 1.
BG B;'             Begin FI move on B axis
AM B;'             After the move has finished on axis B,
BG A;'             Begin FI move on the A axis
AM A;'             After the move has finished on axis A,
MG "FI done";'     Output a message indicating the FI move is complete.
EN
```

FI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

FL *Forward Software Limit*

FLm= n
FL n,n,n,n,n,n,n,n

Usage	FLm= n	Arguments specified with a single axis mask and an assignment (=)
	FL n ...	Arguments specified with an implicit, comma-separated order
Operands	_FLm	Operand has special meaning, see Remarks

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	2,147,483,647	1	Value of software forward limit	2147483647 turns off forward limit

Remarks

- The forward limit is activated at n+1. n = 2147483647 effectively disables the forward soft limit.
- The software limit is specified in counts for a servo system or in microsteps for a stepper system.
- When the forward software limit is activated, the automatic subroutine #LIMSWI will be executed if it is included in the program.
- If motion is commanded when the axis is already passed the FL value, the controller will return error code 22. See TC for details.

Examples

```
'Galil DMC Code Example
#TEST;'  Test Program
AC 1000000;' Acceleration Rate
DC 1000000;' Deceleration Rate
FL 15000;' Forward Limit
JG  5000;' Jog Forward
BGA;'    Begin
AMA;'    After Limit
RPA;'    Tell Position
EN;'     End

'Hint:  Galil controllers also provide hardware limits.
```

FL applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

FN *Distance from end of move when FC is engaged*

FNm= n
FN n,n,n,n,n,n,n,n

Usage	FNm= n	Arguments specified with a single axis mask and an assignment (=)
	FN n ...	Arguments specified with an implicit, comma-separated order
Operands	_FNm	Operand holds the value last set by the command

Description

Adds a bias to the torque output TT proportional to the commanded velocity if the distance from the end of the move is less than FN. FC is the same as FV but activated FN counts from the end of the move and both positive and negative values are allowed.

Arguments

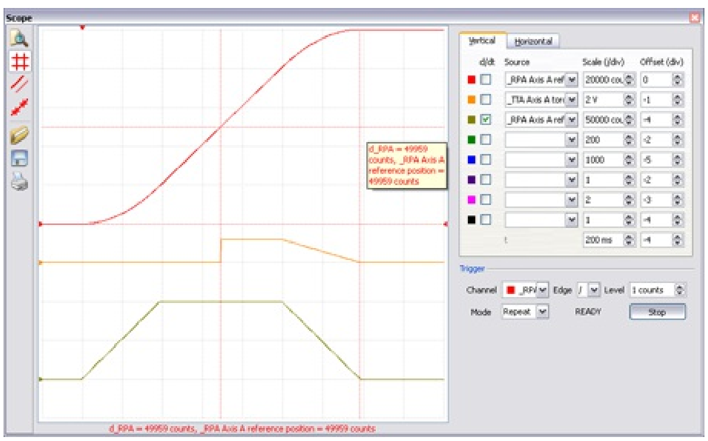
Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	2,147,483,647	0	1	Distance from end of move for FC to engage	

Remarks

- Valid only in -NAN and -CER firmware
- Bias in volts = 1.22 . E-6 . FC . (commanded Velocity in counts/s)

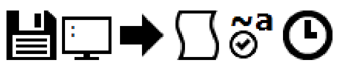
Examples

```
'Galil DMC Code Example
SPA=100000;'set speed to 100,000 cnts/second
FCA=10;'    set distance-selectable velocity feedforward gain to 10
FNA=50000;'  set distance from end of move when FC is engaged to 5000 counts
PRA=100000;' command move of 10,000 counts
BGA;'       begin move
EN
'Move shown below with KP 0,KD 0,KI 0,K1 0,K2 0,K3 0
```



FN applies to CER,NANO

FV *Velocity Feedforward*



FVm= n

FV n,n,n,n,n,n,n,n

Usage	FVm= n	Arguments specified with a single axis mask and an assignment (=)
	FV n ...	Arguments specified with an implicit, comma-separated order
Operands	_FVm	Operand has special meaning, see Remarks

Description

The FV command sets the velocity feedforward coefficient. This coefficient generates an output bias signal in proportions to the sample to sample change in reference position (RP).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	8,191.75	0	0.25	Value of proportional term	
	0	8,191	0	1	Value of proportional term	-CER firmware only.

Remarks

- FV also applies to Contour Mode (CM) and in gearing when an axis is a slave
- Velocity feedforward bias = FV * (Velocity [cts/s]) * (1.20 10-6) * (TM/1000)
  - With FVA=10, TM 1000 and the velocity is 200,000 count/s, the velocity feedforward bias equals 2.40 volts

Examples

```
'Galil DMC Code Example
'Set feedforward coefficients to 10 and 20 for A and B respectively.
'This effective bias will be 0.360 volts for A and 1.92 volts for B.

:FV 10,20
:JG 30000,80000
:MG _FVA,_FVB
 10 20
```

FV applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,EDD37010,DMC1802,DMC1806,DMC2103

GA *Master Axis for Gearing*

GAm0= m
GA m,m,m,m,m,m,m,m

Usage	GAm0= m	Arguments are single axis masks and are specified with a single axis mask and an assignment (=)
	GA m ...	Arguments are single axis masks specified with an implicit, comma-separated order

Description

The GA command specifies the master axes for electronic gearing. Multiple masters for gearing may be specified. A slave axis may have only one master. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m0	A	H	N/A	Axis	Slave axis to assign master	m0<>m
m	A	H	N/A	Axis	Master axis main encoder as the slave's master	
	CA	CH	N/A	Axis	Master axis commanded position as the slave's master	Valid arguments: CA,CB,CC,CD,CE,CF,CG,CH
	DA	DH	N/A	Axis	Master axis aux encoder as the slave's master	Valid arguments: DA,DB,DC,DD,DE,DF,DG,DH
	S	T	N/A	Axis	Vector plane as the slave's master	
	M	N	N/A	Axis	Virtual axis as the slave's master	

Remarks

- m=? returns the GA setting
- When gearing is used in a gantry application, gearing off of the commanded position is recommended
- When an axis is geared to a master axis, the slave's geared profile will be superimposed to the slave's commanded profile
- Gearing is disabled in the following conditions:
  - The gear ratio is set to 0
  - A limit switch is reached
  - The axis is commanded to stop with the ST command
- If it is desired that gearing is not disabled when a limit switch is reached or an ST command is issued, enable Gantry Mode (GM command).

Examples

```
'Galil DMC Code Example
REM setup gearing where B axis is master for A and C axes.
#gear
MO B;'           Turn off servo to B motor
GA B,,B;'        Specify master axis as B on A and C
GR .25,,-5;'     Specify A and C gear ratios
SH B;'           Enable B axis
PRB= 1000;BG B;' Move B axis 1000 counts
'                A axis will be commanded to move 250 counts positive
'                C axis will be commanded to move -5000 counts
EN;'             End program
```

```
'Galil DMC Code Example
REM imaginary axis example
#imag
GAA= N;'          set the imaginary N axis as the master of the A axis
GRA= 2.5;'        set the gear ratio for the A axis as 2.5
PRN= 1000;'       Move N axis 1000 counts
PRA= 1000;'       Move A axis 1000 counts (will be superimposed to the profiled position due to gearing)
BG AN
'                  (A axis will be commanded to move 3500 counts positive >> 2500 due to gearing + 1000 due to commanded move)
EN;'              End Program
```

GA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

GD *Gear Distance*

GD n,n,n,n,n,n,n,n
GDm= n

Usage	GD n ...	Arguments specified with an implicit, comma-separated order
Operands	_GDm	Operand holds the value last set by the command

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. Using this command will cause the master axis and the slave axis positions to differ due to the gradual gear shift. To correct for this, see the _GP operand

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Slave axis to assign value	
n	0	32,767	0	1	Absolute Value of Gearing Distance	0 engages gearing instantly

Remarks

- 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.

Examples

```
'Galil DMC Code Example
#A
GA ,A;'   Sets the A axis as the gearing master for the B axis
GD,5000;' Set distance over which gearing is engaged to 5000 counts of the master axis.
JG 5000;' Set the A axis jog speed to 5000 cts/sec
BG A;'    Begin motion on the A axis
AS A;'    Wait until A axis reaches the set speed of 5000 counts/sec
GR ,1;'   Engage gearing on the B axis with a ratio of 1:1, the
'distance to fully engage gearing will be 5000 counts of the master axis
WT 1000;' Wait 1 second
GR ,3;'   Set the gear ratio to three.  The ratio will be changed
'over the distance set by the GD command
WT 1000;' Wait 1 second
GR ,0;'   Disengage the gearing between the B 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
```

```
'Galil DMC Code Example
#A
GA DA;'   Set the aux encoder input as the gearing master
GD 5000;' Set distance over which gearing is engaged to 5000 counts of the master axis.
GR 1;'    Set a gear ratio of 1:1, the distance to fully
'engage gearing will be 5000 counts of the master axis
WT 1000;' Wait 1 second
GR 3;'    Set the gear ratio to three.  The ratio will be changed
'over the distance set by the GD command
WT 1000;' Wait 1 second
GR 0;'    Disengage the gearing between the axis aux encoder
'The gearing will be disengaged over the number of
'counts of the master specified with the GD command above
EN;'      End program
```

GD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

GM *Gantry mode*

GMm= n

GM n,n,n,n,n,n,n,n

Usage	GMm= n	Arguments specified with a single axis mask and an assignment (=)
	GM n ...	Arguments specified with an implicit, comma-separated order
Operands	_GMm	Operand holds the value last set by the command

Description

The GM command specifies the axes in which the gearing function is performed in the Gantry mode. In this mode, the geared slaves will not be stopped by the ST command or by limit switches.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	Value of GM command	1 Enables Gantry Mode, 0 disables Gantry Mode

Remarks

- Only setting Gantry Mode of the slave to 0 (GMm= 0) will disable Gantry Mode

Examples

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
GA DA;' Set master for A axis to the A axis Aux encoder input
GM 1;'  Enable Gantry Mode on A axis
GR 1;'  Set Gear Ratio to 1
WT 1000
ST;'    Axis will still be in gearing Mode
WT 1000
GM 0;'  Disable Gantry Mode (Axis still gearing)
WT 1000
ST;'    Will clear gearing mode
EN
```

GM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

GR *Gear Ratio*

GRm= n
GR n,n,n,n,n,n,n,n

Usage	GRm= n	Arguments specified with a single axis mask and an assignment (=)
	GR n ...	Arguments specified with an implicit, comma-separated order
Operands	_GRm	Operand holds the value last set by the command

Description

GR specifies the Gear Ratios for the geared axes in the electronic gearing mode. The master axis is defined by the GA command.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Slave axis to assign gear ratio	
n	-127	127	0	1/65,536	Value of Gear Ratio of Slave	n = 0 disables gearing

Remarks

- The gear ratio may be different for each geared axis.
- The master can go in both directions.
- Gearing is disabled in the following conditions:
  - The gear ratio is set to 0
  - A limit switch is reached
  - The axis is commanded to stop with the ST command
- If it it is desired that gearing is not disabled when a limit switch is reached or an ST command is issued, enable Gantry Mode (GM command).

Examples

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
REM setup gearing where virtual axis, N, is master for axis A.
#gear
GA N;'   Specify master axis as N (imaginary Axis)
GR -2;'  Specify gear ratio or -2
PRN=1000;BGN;' Move N axis 1000 counts
WT 1000
MG _RPA,_RPN;' will indicate -2000 on A and 1000 on N
EN;'           End program


:'execution of gearing example
:XQ
:
-2000.0000 1000.0000

:
```

GR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

HM *Home*

HM mm

Usage	HM mm	Argument is an axis mask
Operands	_HMm	Operand has special meaning, see Remarks

Description

The HM command performs a three stage homing sequence for servo systems and a two stage sequence for stepper motors.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axis to perform Homing Routine	No argument homes all axes

Remarks

- The HM command is derived of FE and FI commands. Custom homing sequences can be created by using the FE (Find Edge) and FI (Find Index) commands.

- The sequence of FE and FI commands varies depending upon if the axis is configured for a stepper or servo

Step One. Servos and Steppers

- During the 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 speed for step one is set with the SP command.
- The direction for this first stage is determined by the initial state of the homing input. The state of the homing input can be configured using the second field of the CN command.
- Once the homing input changes state, the motor decelerates to a stop.

Step Two. Servos and Steppers

- At the second stage, the motor changes directions and approaches the transition again at the speed set with the HV command. When the transition is detected, the motor is stopped instantaneously.

Step Three. Servos only

- At the third stage, the motor moves in the positive direction at the speed set with the HV command until it detects an index pulse via latch from the encoder. It returns to the latched position and defines it as position 0.

Operand

_HMm state as a function of CN,n and Home digital input

_CN1 value	Home input digital state	_HMn state	Direction of travel if HM begun in this state
-1	pull-up or non-active opto	1	Backward
-1	grounded or active opto	0	Forward
1	pull-up or non-active opto	0	Forward
1	grounded or active opto	1	Backward

Examples

```
'Galil DMC Code Example
:HM;'     Set Homing Mode for all axes
:BG;'     Home all axes
:HMA;'     Set Homing Mode for axis A
:BGA;'     Home only the A-axis
```

HM applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,DMC1802,DMC1806,DMC2103

HS *Handle Assignment Switch*

HSm0= m

Usage		
	HSm0= m	Arguments are single axis masks and are specified with a single axis mask and an assignment (=)
	HS m ...	Arguments are single axis masks specified with an implicit, comma-separated order

Description

The HS command is used to switch the ethernet 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m0	A	H	N/A	Handle	First handle to switch	
	S	S	N/A	Handle	First handle to switch	S = current handle sending command. Not valid in program
m	A	H	N/A	Handle	Second handle to switch	
	S	S	N/A	Handle	Second handle to switch	S = current handle sending command. Not valid in program

Remarks

- 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

Examples

```
'Galil DMC Code Example
: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.
```

HS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

HV *Homing Velocity*

HVm= n

HV n,n,n,n,n,n,n,n

Usage	HVm= n	Arguments specified with a single axis mask and an assignment (=)
	HV n ...	Arguments specified with an implicit, comma-separated order
Operands	_HVm	Operand holds the value last set by the command

Description

Sets the slew speed for the FI final move to the index and all but the first stage of HM.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	22,000,000	256	2	Value of Homing Velocity in cnts/second	For MT settings of 1,-1,1.5 and -1.5 (Servos)
	0	6,000,000	256	2	Value of Homing Velocity in cnts/second	For MT settings of 2,-2,2.5 and -2.5 (Steppers)

Remarks

- None

Examples

```
'Galil DMC Code Example
HVA=1000;'  set homing speed
HMA;'       home to home switch then index
BGA;'       begin motion
AMA;'       wait for motion complete
EN;'        end program
```

HV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

HX *Halt Execution*

HX n

Usage	HX n ...	Arguments specified with an implicit, comma-separated order
Operands	_HX0 _HX1 _HX2 _HX3 _HX4 _HX5 _HX6 _HX7	Operand has special meaning, see Remarks

Description

The HX command halts the execution of any program that is running.The parameter n specifies the thread to be halted.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	7	N/A	1	Thread number to halt	If n omitted, all threads are halted.

Remarks

- 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

Examples

```
'Galil DMC Code Example
XQ #A;'    Execute program #A, thread zero
XQ #B,3;' Execute program #B, thread three
HX0;'     Halt thread zero
HX3;'    Halt thread three
```

HX applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

IA *IP Address*

IA n_0, n_1, n_2, n_3
IA n_4
IA < o

Usage	IA n ...	Arguments specified with an implicit, comma-separated order
Operands	_IA0 _IA1 _IA2 _IA3 _IA4 _IA5 _IA6	Operand has special meaning, see Remarks

Description

The IA command assigns the controller IP address and the TCP time out. The IP address can also be assigned via Galil software or from an external server. 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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	255	0	1	Byte 3 of the IP address	
n_1	0	255	0	1	Byte 2 of the IP address	
n_2	0	255	0	1	Byte 1 of the IP address	
n_3	0	255	0	1	Byte 0 of the IP address	
n_4	-2,147,483,648	2,147,483,647	0	1	The full IP address specified as a signed 32 bit two's complement integer	
o	1	2,147,483,647	250	1	The time in update samples between TCP retries	Up to 5 retries occur

Remarks

- When specifying the IP address with IA, remember to use commas as delimeters instead of periods.
- n_4 = ? will return the IP address of the controller in comma seperated format.
- Setting the IP address over Ethernet to a new value will cause an immediate disconnect/timeout. Reconnect to the controller on the new IP address and issue a BN to save the new value to flash.
- To change the IP address manually over Ethernet on a controller which was initially assigned via DHCP, send "DH 0;IA n_0,n_1,n_2,n_3" as one command line. Reconect on the new IP and issue BN to save.

Operands

- _IA0 contains the IP address representing a 32 bit signed number (Two's complement). See the example below.
- _IA1 contains the value for o (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. This is used by a remote device to detect its outgoing handle (see WH).
- _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.
- _IA6 returns autonegotiation Ethernet speed for Ethernet port 2. Returns 10 for 10-Base T and returns 100 for 100-Base T, it will return -1 if there is no physical link.
  - This only applies to DMC-4000's with the C022 Communication Board.

Examples

```
'Galil DMC Code Example
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 500 msec
```

```
'Galil DMC Code Example
REM The individual IP address bytes can be derived within embedded code using _IA0
a=@INT[(_IA0&($FF000000))/$1000000]&$FF
b=@INT[(_IA0&($00FF0000))/$10000]
c=@INT[(_IA0&($0000FF00))/$100]
d=@INT[(_IA0&($000000FF))]
REM IP address = a.b.c.d
```

IA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

ID *Identify*

ID

Usage	ID	Command takes no arguments

Description

The ID command is used to query the controller for the hardware configuration and factory programming.

Arguments

ID is a command with no arguments

Remarks

- Refer to the Examples section for actual controller responses
- The following are descriptions of the ID response

The ID command follows this pattern:

```
:ID
FW, firmware revision
DMC, 4000, options, Rev #, nre #
CMB, communication board model #, options, Rev #
ICM1, Interconnect model # for axes A-D, options, Rev #
ICM2, Interconnect model # for axes E-H, options, Rev #
AMP1, Amplifier model # for axes A-D, options, Rev #
AMP2, Amplifier model # for axes E-H, options, Rev #
:
```

Where the firmware revision is the string returned by the ^R^V command,
options are any ordered options associated with that hardware component,
model # refers to the Galil part number for that product,
Rev # is the hardware revision for that component,
nre # is the NRE number for that component. This field will not be present if there is no NRE number, and can appear on any component after the Rev field.

- If a particular component is not present - i.e. the second amplifier on a one axis controller, it will not be listed in ID.
  - If the ICM is a standard I000 or I200 with no options, it will not be listed in ID.

Examples

```
'Galil DMC Code Example
'Part Number: DMC-4080(16BIT)-C012-I000-I000-D3540-D3040
:ID
FW, DMC4080 Rev 1.3a
DMC, 4000, 16 bit, Rev 6
CMB, 41012, 3.3v, Rev 0
AMP1, 43540, Rev 3
AMP2, 43040, Rev 6
:
```

ID applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000,DMC52000,RIO57400,EDD37010

IF *IF conditional statement*

IF (ex)

Usage	IF n ...	Arguments specified with an implicit, comma-separated order

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
ex	N/A	N/A	N/A	Expression	Conditional statement for IF statement	See Remarks

Remarks

- 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
- Bit wise operators | and & can be used to evaluate multiple conditions.
- A true condition = 1 and a false condition = 0.
- Each condition must be placed in parenthesis for proper evaluation by the controller.

```
'Galil DMC Code Example
IF((var0=1)&(var1=2));' valid IF statement

IF var0=1&var1=2;'      invalid IF statement

IF (var0=1&var1=2);'    invalid IF statement
```

Examples

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
REM The conditions of an if statement can be simplied 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
```

IF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

IH *Open IP Handle*

IHm= n_0,n_1,n_2,n_3 <o >p
IHm= n <o >p
IHm= >p

Usage	IHm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_IHm0 _IHm1 _IHm2 _IHm3 _IHm4	Operand has special meaning, see Remarks

Description

The IH command is used when the controller is operated as a master (client) to open a handle and connect to a slave (server).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to assign connection	
	S	T	N/A	Handle	Special handle designator used when closing handles	See Remarks
n_0	0	255	0	1	Byte 3 of the slave IP address	
n_1	0	255	0	1	Byte 2 of the slave IP address	
n_2	0	255	0	1	Byte 1 of the slave IP address	
n_3	0	255	0	1	Byte 0 of the slave IP address	
n	-2,147,483,648	2,147,483,647	0	1	Slave IP address as a 32 bit value	
o	0	65,535	see Notes	1	Specify the slave port to connect over	If o is omitted, the controller selects the port starting at 1000
p	1	2	2	1	Specify the connection type to open	n = 2 is TCP. n = 1 is UDP.
	-3	-1	N/A	1	Specify the connection type to close when closing a handle	See Remarks

Remarks

- All 4 bytes must be assigned for an IP address to be valid.
- IHm=? returns the IP address as 4, 1-byte numbers.
- Use the following equation to change the 4 byte IP (n_0,n_1,n_2,n_3) to a single 32 bit number, n.
  - $n = (n_0*2^{24}) + (n_1*2^{16}) + (n_2*2^8) + n_3$.
- When using Modbus, port 502, note that Galil Modbus supports one master per slave.

Opening a Handle

- To open a handle, the user must specify:
  - The IP address of the slave.
  - (optional) The port number of the slave. If not specified, the firmware will choose a port.
  - (optional)The connection type as TCP/IP or UDP/IP. If not specified, the controller will make a TCP connection.
- Issue the IH command on an available handle with the correct settings for IP (n_0-n_3), port (o) and connection type (p).
  - See TH to list handle status.
- Modbus connections must always be specified as port 502.

Closing a Handle

- Closing multiple handles is done with the T handle identifier along with a connection type p selector.
  - IHT => p closes all handles matching the p type selector, where p = -1 closes UDP handles, p = -2 closes TCP handles and p = -3 closes all handle types.
- Closing individual handles, other than the handle being used to send the IH command, is done with IHN => -1 where n is the handle to close (A-H).
- Closing the handle that sent the command is done with the S handle identifier, along with connection type p selector.
  - IHS => p closes the handle that sent the command if its type matches the p selector,where p = -1 closes UDP handles, p = -2 closes TCP handles and p = -3 closes all handle types.

Operand Usage

Operand	Reported Value	Description of Value	Notes
_IHm0	-2147483648 to 2147483648	IP address of handle m as a 32 bit number (n)	
_IHm1	0 to 65535	Slave port number for handle m	
_IHm2	0	Handle is free	Handle 'Available' in TH

	1	Handle connected as UDP slave	
	2	Handle connected as TCP slave	
	-1	Handle connected as UDP master	
	-2	Handle connected as TCP master	
	-5	Attempting to establish UDP handle	
	-6	Attempting to establish TCP handle	
_IHm3	0	ARP was successful	
	1	ARP failed or still in progress	
_IHm4	1	Waiting for ACK from slave controller after issuing a command	
	2	Received ":" as response to a command	
	3	Received "?" as response to a command	
	4	Connection timed-out waiting for a response to a command	

Examples

```
'Galil DMC Code Example
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
'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
```

```
'Galil DMC Code Example
'setting up a modbus handle
MW1;'                         setup modbus wait
IHE= 192,168,100,200<502>2;' setup a modbus handle to slave
#wt;'                         wait for handle to be connected
WT2;'                         before issuing a command
JP#wt,_IHE2<>-2;'
SB5003;'                      Set output 3 on slave
WT1000;'                      1 second wait
MBE= ,5,3,0;'                 Clear output 3 using MB command
EN
```

IH applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

II *Input Interrupt*

II n_0,n_1,n_2,n_3

Usage	II n ...	Arguments specified with an implicit, comma-separated order

Description

The II command enables the input interrupt function for the specified inputs.
The II command is used along with the #ININT subroutine to execute specific code when inputs specified by II are in the desired state.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	8	0	1	Lowest input to use for interrupt trigger	n_0=0 disables input interrupt
n_1	1	8	N/A	1	Highest input to use for interrupt trigger	n_1 must be >= n_0, If omitted n_1=n_0
n_2	1	255	N/A	1	Use bitmask as alternative selection of input interrupt triggers	If n_0 and n_1 are used, n_2 is ignored, see Remarks
n_3	0	255	0	1	Bitmask specifying required input state for interrupt trigger	Default=interrupt triggers on low inputs, see Remarks

Remarks

- The argument n_2 is a bitmask for the inputs selected for the input interrupt function. This field is ignored if n_0 and n_1 are used.
  - For example, if n_2 = 15, the binary equivalent is 00001111. This means that inputs 1-4 would be selectd by the II function, and 5-8 would not be.
- This argument n_3 is bistmask showing which state the input must be in for the II function to trigger.
  - For example, if n_0=1 and n_1=4, the inputs 1,2,3 and 4 have been activated. If the value for n_3 is 2 (the binary equivalent of 2 is 00000010), then input 2 must be a '1' and inputs 1,3, and 4 must be a "0", for II to trigger the #ININT subroutine.
- The RI command is used to return from the #ININT routine.

Examples

```
'Galil DMC Code Example
II 1,1,,0;'            Specify interrupt on input 1 only, and triggers when input 1 = 0.
EN;'                   End Program
#ININT;'               Interrupt subroutine
'                      The code the user wants to run when II triggers goes here.
WT100;'                Debounce the input.
RI 1;'                 Return to main program, re-enabling trip point.
'                      Specify RI 0 if it is not desired to re-enable trip points.
```

II applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

IK *Block Ethernet ports*

IK n

Usage	IK n ...	Arguments specified with an implicit, comma-separated order

Description

The IK command blocks client connections to the controller on most ports below port number 1000. Specific port numbers and ports above 1000 are unaffected.

Arguments

Argument	Value	Description	Notes
n	0	Allow controller to receive Ethernet packets on any port	
	1	Blocks Ethernet packets on ports lower than 1000.	Default. Ports 0,23,68, and 502 are unaffected.

Remarks

- A Galil Ethernet controller simultaneusly operates as a server (listening for Ethernet connections from a client) and a client (able to create connections to a server).
- Ports 0, 23, 68 and 502 are used for standard client connections to the controller.

Examples

```
'Galil DMC Code Example
:IK1;' Blocks undesirable port communication
:IK0;' Allows all Ethernet ports to be used
:
```

IK applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

IL *Integrator Limit*

ILm= n
IL n,n,n,n,n,n,n,n

Usage	ILm= n	Arguments specified with a single axis mask and an assignment (=)
	IL n ...	Arguments specified with an implicit, comma-separated order
Operands	_ILm	Operand holds the value last set by the command

Description

The IL command limits the effect of the integrator gain in the filter to a certain voltage.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-9.9982	9.9982	9.9982	20/65,536	Value of Integrator limit in volts	n< 0 (negative value) freezes the effect of the integrator during the move

Remarks

- IL is the absolute value of the integrator limit. For example:
  - ILA= 2 limits the output of the integrator of the A-axis to the +/-2 Volt range.
  - KD and KP terms remain active in any case. The output from the KD and KP terms is not affected.

- A negative parameter will freeze the effect of the integrator during the move. For Example:
  - ILA= -3 limits the integrator output of the A axis to +/-3V but freezes the contribution of the Integrator loop during motion.
- If, at the start of the motion, the integrator output is 1.6 Volts, that level will be maintained through the move and the integrator will not accumulate during the move.
- Once the profiled move has completed (RP has reached final commanded position), the integrator loop will be enabled.

- When using the -CER firmware, the default value of IL is -9.9982.

Examples

```
'Galil DMC Code Example
KI 2,3,5,8;' Integrator constants
IL 3,2,7,2;' Integrator limits
IL ?;'   Returns the A-axis limit
```

IL applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,EDD37010

IP *Increment Position*

IPm= n
IP n,n,n,n,n,n,n,n

Usage	IPm= n	Arguments specified with a single axis mask and an assignment (=)
	IP n ...	Arguments specified with an implicit, comma-separated order

Description

The IP command allows for a change in the command position while the motor is moving. This command does not require a BG.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Value of incremental move	

Remarks

- _IPm contains the current position of the motor
- The IP command has four effects depending on the mode of motion being executed.

IP operation based upon modes of motion

Case	Equivalent Commands	Description
Motor is standing still	IPm=n Equivalent to PRm=n;BGm	Motor will move to specified position with the predefined AC,DC,SP values.
Motor is moving toward position n	PRm=n_0; BGm;IPm=n_1 Equivalent to PRm= (n_0+n_1); BGm	Motor will move a relative move of (n_0+n_1).
Motor is in Jog Mode	JGm=n_0;BGm;IPm=n_1 Equivalent to Continuing jog from (current position + n_1)	The motor will instantly try to servo to a position which is the current instantaneous position plus the specified IP position. 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.
Motor is a slave in gearing mode	GAm= m0; GRm=n_0; IPm=n_1 Equivalent to GAm= m0; GRm=n_0; PRm=n_1; BGm	The motor will move with the predefined AC,DC,SP values superimposed on top of the existing gearing motion.

Examples

```
'Galil DMC Code Example
IP 50;'  50 counts with set acceleration and speed
#CORRECT;' Label
AC 100000;' Set acceleration
JG 10000;BGA;' Jog at 10000 counts/sec rate
WT 1000;' Wait 1000 msec
IP 10;'   Move the motor 10 counts instantaneously
STA;'    Stop Motion
EN
```

IP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

IT *Independent Time Constant - Smoothing Function*

ITm= n

IT n,n,n,n,n,n,n,n

Usage	ITm= n	Arguments specified with a single axis mask and an assignment (=)
	IT n ...	Arguments specified with an implicit, comma-separated order
Operands	_ITm	Operand holds the value last set by the command

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.

The IT command also filters the individual axes during Vector Mode (VM) and Linear Interpolation Mode (LM).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0.004	1	1	1/256	Value of independent smoothing function	1 = no filtering, 0.004 = maximum filtering

Remarks

- The IT 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.
- Details on the IT filtering can be found in Application Note #3412
  - http://www.galil.com/download/application-note/note3412.pdf

Examples

```
'Galil DMC Code Example
: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
0.8000
```

```
'Galil DMC Code Example
REM example showing increased time due to IT filtering
#move
IT 1
t=TIME;'store time reference
PR 1000
BGA;AMA
MG TIME-t;'display move time
IT 0.01
t=TIME;'store time reference
PR 1000
BGA;AMA
MG TIME-t;'display move time
EN

:'program execution output
:XQ
:
508.0000
1112.0000

:
```

IT applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

JG *Jog*

JGm= n
JG n,n,n,n,n,n,n,n

Usage	JGm= n	Arguments specified with a single axis mask and an assignment (=)
	JG n ...	Arguments specified with an implicit, comma-separated order
Operands	_JGm	Operand has special meaning, see Remarks

Description

The JG command sets the jog mode and the jog slew speed of the axes.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	N	M	N/A	Axis	Virtual axis to assign value	
n	-22,000,000	22,000,000	25,000	2	Value of jog speed in cnts/second	For MT settings of 1,-1,1.5 and -1.5 (Servos)
	-6,000,000	6,000,000	25,000	2	Value of jog speed in cnts/second	For MT settings of 2,-2,2.5 and -2.5 (Steppers)
	-50,000,000	50,000,000	25,000	2	Vale of jog speed in cnts/second	ICM-42100 with AF>=5

Remarks

- When jogging, the motion controller profiles a continuous move at the commanded speed.
- To stop the motion, use the ST command.
- JG 2 is the minimum non-zero speed
- _JGm contains the absolute value of the jog speed for the specified axis.
- The JG command will set the SP register with the absolute value of the 'n' value.

Resolution

- The resolution of the JG command is dependent upon the update rate setting (TM).
  - With the default rate of TM 1000 the resolution is 2 cnts/second.
  - The equation to calculate the resolution of the JG command is:
    - resolution = 2*(1000/TM)
  - example:
    - With TM 250 the resolution of the JG command is 8 cnts/second
    - resolution = 2*(1000/250) = 8

Examples

```
'Galil DMC Code Example
#jg
JG 100,500,2000,5000
'                        Sets for jog mode with a slew speed of 100 counts/sec for the A-axis,
'                        500 counts/sec for the B-axis,
'                        2000 counts/sec for the C-axis,
'                        and 5000 counts/sec for D-axis.
BG;'                     Begin Motion
WT 1000;'                Wait one second
JG ,,-2000;'          Change the C-axis to slew in the negative direction at -2000 counts/sec.
EN
```

JG applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

JP *Jump to Program Location*

JP #str,(ex)
JP n,(ex)

Usage	JP n ...	Arguments specified with an implicit, comma-separated order

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. A jump is taken if the specified condition is true. Multiple conditions can be used in a single jump statement.

JP can be used for relative jumps and for jump tables, see Examples.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	N/A	String	Label name for jump destination	Must be a valid label in application code
n	0	see Notes	N/A	1	Line number for jump destination	Maximum is number of lines of controller program memory - 1
ex	N/A	N/A	N/A	Expression	Conditional statement/s that must evaluate true for jump to occur	If omitted, JP automatically evaluates as true

Remarks

- The logical operators that can be used in the conditional statement are:
  - < less than
  - > greater than
  - = equal to
  - <= less than or equal to
  - >= greater than or equal to
  - <> not equal to
- 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 parentheses for proper evaluation by the controller.

```
'Galil DMC Code Example
REM Use of parentheses
JP#a,((var0=1)&(var1=2));' valid conditional jump
JP#a,var0=1&var1=2;'       invalid conditional jump
```

Examples

```
'Galil DMC Code Example
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]=1);'  Jump to #B if input 1 = 1
JP #C;'             Jump to #C unconditionally
```

Jump Table

```
'Galil DMC Code Example
REM Example of jumping to a label plus an offset
REM #error is a subroutine that prints an error
REM  message based on the value of an error
REM  variable, ecode
#a
REM Set error code and then JS to sub
ecode = 1
JS #error
ecode = 3
JS #error
ecode = 56;' bad error code
JS #error
EN
'
'****************
'Example of a Jump table
#error
REM First check that ecode is valid
IF (ecode < 0)
 ecode = 4
ENDIF
IF (ecode > 4)
 ecode = 4
ENDIF
REM Call the helper label with an offset
JP#error_h + ecode
```

```
'CRITICAL! Do not change line
' spacing in following text
#error_h;MG "No error, zero";EN
MG "Error code 1, foo";EN
MG "Error code 2, bar";EN
MG "Error code 3, baz";EN
MG "Invalid error code";EN
REM ecode indexes the line to execute
REM  above, relative to #error_h
REM
REM Returned messages:
REM Error code 1, foo
REM Error code 3, baz
REM Invalid error code
```

Relative Jump

```
'Galil DMC Code Example
REM A loop for delaying 1000 samples (~ 1 sec)
REM sample time
MG "Relative jump"
t=TIME
REM print sampled time
MG t
REM loop until TIME increments 1000 samples
REM _XQ0-1 points back to the beginning of the line
JP _XQ0-1,(TIME < (t+1000))
REM print current time
MG TIME
REM This is NOT thread safe as
REM _XQ0 refers to thread 0 only
REM For easier readability and stability, use labels
REM wherever possible
MG "Label-based jump"
t=TIME
MG t
#wait
JP#wait, (TIME < (t+1000))
MG TIME
REM Also, where possible use trippoints
MG "Trippoint"
t=TIME
MG t
WT 1000;' see WT for units
MG TIME
EN

REM Relative jump
REM  3459.0000
REM  4459.0000
REM Label-based jump
REM  4461.0000
REM  5461.0000
REM Trippoint
REM  5463.0000
REM  6464.0000
```

JP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

JS *Jump to Subroutine*

JS #str(arg,arg,arg,arg,arg,arg,arg,arg), (ex)
JS n(arg,arg,arg,arg,arg,arg,arg,arg), (ex)

Usage	JS n ...	Arguments specified with an implicit, comma-separated order
Operands	_JS	Operand has special meaning, see Remarks

Description

Allows the program to jump to a subroutine and return back after completion. This command is often used to call reusable code.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	N/A	String	Label Name for jump destination	Must be a valid label in application code
n	0	3,999	N/A	1	Line number for jump destination	Firmware Rev 1.2a and later. May be a value or a variable, but not an evaluated statement with parenthesis
n	0	1,999	N/A	1	Line number for jump destination	May be a value or a variable, but not an evaluated statement with parenthesis
ex	N/A	N/A	N/A	N/A	Conditional statement/s that must evaluate true for jump to occur	If omitted, the jump is taken
arg	N/A	N/A	N/A	N/A	A value, variable, or array to pass to the subroutine being called	referenced from within the subroutine as ^a-^h, respectively. See Remarks for a table of valid args

Remarks

- JS can be nested, called up to 16 deep
- When used after JS is called, the _JS operand contains the returned value of the subroutine called by JS

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. A variable holding a line number or an expression resulting in the calculation of a line number can also be used
- The line number of the calling JS command is saved and after an EN command is encountered (End of subroutine), program execution will continue with the instruction following the calling JS command.
- A jump is taken if the specified condition is true. Each condition must be placed in parenthesis for proper evaluation by the controller.
- 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).

Conditional Syntax

Condition	Validity
JS#A,(var1=0)&(var2=1)	This conditional statement is valid
JS#A,var1=0&var2=1	This conditional statement is not valid

Passing Values on the Stack

- Parameters can be passed on the subroutine stack
- Passing parameters in a subroutine has many advantages including the following
  - 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
  - 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.
  - 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.
  - 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 immutable. 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.
  - IMPORTANT NOTE: 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.
  - IMPORTANT NOTE: 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. The parent stack can access this value via _JS.

Examples of valid args (see examples for demo of each concept)

What to pass	arg	Example
Value	the value	JS #square(7)
Variable's value	variable name	JS #sub(var)
Variable by reference	ampersand + variable name	JS #sub(&var)
Array by reference	array name in quotes	JS#sub("array")

Examples

```
'Galil DMC Code Example
REM Example of pulsing an output
pulse=0
JS#pulse,(pulse > 0);'JS not taken
WT 2000
pulse=3
JS#pulse,(pulse > 0);'JS taken
WT 2000
pulse=5
JS#pulse;'unconditionally take jump
EN
'
'
REM Subroutine called after
REM  setting pulse variable
#pulse
SB 1;' set bit 1
WT 500;' delay 500 ms
CB 1;' clear bit 1
WT 500;' delay 500 ms
pulse=pulse-1;' decrement pulse
JP#pulse,pulse>0;' continue till zero
EN;' return to calling JS
```

Advanced Usage Examples

```
'Galil DMC Code Example
REM Run all examples
#all
JS#val
JS#var
JS#varref
JS#array
EN
REM Example for each way to pass to a subroutine
REM **********************************************
REM Pass a Value
#val
JS #square(3)
MG _JS
EN
#square
REM Return the passed value squared
EN ,,(^a*^a)
REM **********************************************
REM Pass a variable's value
#var
val= 7
REM call the same sub above
JS #square(val)
MG _JS
EN
REM **********************************************
REM Pass a variable by reference
#varref
val= 9
JS #square2(&val)
MG val
EN
#square2
REM  change the value of the variable
^a= ^a*^a
REM don't return anything
EN
REM **********************************************
REM Pass an array by reference
#array
DM array[100]
array[42]= 11
JS #square3("array")
MG array[42]
EN
#square3
REM change the array element
^a[42]= ^a[42]*^a[42]
REM don't return anything
EN
```

```
REM ********************************************
REM Controller Response
REM :XQ#all
REM :
REM 9.0000
REM 49.0000
REM 81.0000
REM 121.0000
```

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
'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
```

```
'Galil DMC Code Example
REM Using dynamic destinations in a jump table
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
```

JS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

K1 *Proportional gain during motion*

K1m= n
K1 n,n,n,n,n,n,n,n

Usage	K1m= n	Arguments specified with a single axis mask and an assignment (=)
	K1 n ...	Arguments specified with an implicit, comma-separated order
Operands	_K1m	Operand holds the value last set by the command

Description

K1 is the proportional gain in effect when the profiler is commanding motion (RP is changing). When no motion is commanded (RP constant), KP is in effect. Some systems will oscillate when holding position unless the gains are lowered.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1,023.875	6	1/8	Value of proportional term	

Remarks

- Valid only in -NANO and -CER firmware

Examples

```
'Galil DMC Code Example
K1X=10;' set X axis P gain in effect during motion
K2X=1;'  set X axis I gain in effect during motion
K3X=100;'set X axis D gain in effect during motion
KPX=6;'  set X axis P gain in effect when holding position
KIX=0;'  set X axis I gain in effect when holding position
KDX=64;' set X axis D gain in effect when holding position
```

K1 applies to CER,NANO

K2 *Integrator gain during motion*

K2m= n
K2 n,n,n,n,n,n,n,n

Usage	K2m= n	Arguments specified with a single axis mask and an assignment (=)
	K2 n ...	Arguments specified with an implicit, comma-separated order
Operands	_K2m	Operand holds the value last set by the command

Description

K2 is the integral gain in effect when the profiler is commanding motion (RP is changing). When no motion is commanded (RP constant), KI is in effect. Some systems will oscillate when holding position unless the gains are lowered.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	255.999	0	1/1,024	Value of integrator term	

Remarks

- Valid only in -NANO and -CER firmware

Examples

```
'Galil DMC Code Example
K1X=10;' set X axis P gain in effect during motion
K2X=1;'  set X axis I gain in effect during motion
K3X=100;'set X axis D gain in effect during motion
KPX=6;'  set X axis P gain in effect when holding position
KIX=0;'  set X axis I gain in effect when holding position
KDX=64;' set X axis D gain in effect when holding position
```

K2 applies to CER,NANO

K3 *Derivative gain during motion*

K3m= n
K3 n,n,n,n,n,n,n,n

Usage	K3m= n	Arguments specified with a single axis mask and an assignment (=)
	K3 n ...	Arguments specified with an implicit, comma-separated order
Operands	_K3m	Operand holds the value last set by the command

Description

K3 is the derivative gain in effect when the profiler is commanding motion (RP is changing). When no motion is commanded (RP constant), KD is in effect. Some systems will oscillate when holding position unless the gains are lowered.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	4,095.875	64	1/8	Value of derivative term	

Remarks

- Valid only in -NAN and -CER firmware

Examples

```
'Galil DMC Code Example
K1X=10;' set X axis P gain in effect during motion
K2X=1;'  set X axis I gain in effect during motion
K3X=100;'set X axis D gain in effect during motion
KPX=6;'  set X axis P gain in effect when holding position
KIX=0;'  set X axis I gain in effect when holding position
KDX=64;' set X axis D gain in effect when holding position
```

K3 applies to CER,NANO

KD *Derivative Constant*

KDm= n
KD n,n,n,n,n,n,n,n

Usage	KDm= n	Arguments specified with a single axis mask and an assignment (=)
	KD n ...	Arguments specified with an implicit, comma-separated order
Operands	_KDm	Operand holds the value last set by the command

Description

KD designates the derivative constant in the control filter. The derivative gain outputs a voltage based on the rate of change of the error. The filter transfer function follows:

$$D(z) = KP + KD\frac{z-1}{z} + KI\frac{z}{z-1}$$

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	4,095.875	64	1/8	Value of derivative term	

Remarks

- n=? will return the currently set value of KD
- m=* will set the KD value for all axes/channels

- For further details see the section "Theory of Operation" in the controller user manual.

Examples

```
'Galil DMC Code Example
:KD 12,14,16,20;' Implicit notation to set A,B,C,D axis derivative term
:KDC= 8;'         Explicit notation to set C
:KD ,,8;'         Implicit notation to set C
:KD ?,?,?,?; '     Return A,B,C,D values
 12, 14, 8, 20
:KDC= ?;'          Return C value
 8
:MG _KDA;'        Message the operand for the A axis
 12
:
```

```
'Galil DMC Code Example
REM Zeroing the PID filter allows the
REM motor command signal to be
REM used as a programmable DAC
KI*= 0;'                 Zero KI
KP*= 0;'                 Zero KP
KD*= 0;'                 Zero KD
ER -1,-1;'               Rurn off position error limit
OF 1,2;'                 Set one volt on A and two volts on B
EN
```

KD applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,EDD37010

KI *Integrator*

KIm= n
KI n,n,n,n,n,n,n,n

Usage	KIm= n	Arguments specified with a single axis mask and an assignment (=)
	KI n ...	Arguments specified with an implicit, comma-separated order
Operands	_KIm	Operand holds the value last set by the command

Description

The KI command sets the integral gain of the control loop. The integrator term will reduce the position error at rest to zero. It fits in the control equation as follows:

$$D(z) = KP + KD\frac{z-1}{z} + KI\frac{z}{z-1}$$

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	255.999	0	1/1,024	Value of Integral term	

Remarks

- n=? will return the currently set value of KI
- m=* will set the KI value for all axes/channels

- For further details see the section "Theory of Operation" in the controller user manual.

Examples

```
'Galil DMC Code Example
:KIC= 8;'         Explicit notation to set C
:KI ,,8;'         Implicit notation to set C
:KI ?,?,?,?; '    Return A,B,C,D values
 7, 14, 8, 20
:KIC= ?;'         Return C value
 8
:MG _KIA;'        Message the operand for the A axis
 7
:
```

```
'Galil DMC Code Example
REM Zeroing the PID filter allows the
REM motor command signal to be
REM used as a programmable DAC
KI*= 0;'                Zero KI
KP*= 0;'                Zero KP
KD*= 0;'                Zero KD
OF 1,2;'                Set one volt on A and two volts on B
EN
```

KI applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,EDD37010,RIO47000,DMC1802,DMC1806,DMC2103

KP *Proportional Constant*

KPm= n
KP n,n,n,n,n,n,n,n

Usage	KPm= n	Arguments specified with a single axis mask and an assignment (=)
	KP n ...	Arguments specified with an implicit, comma-separated order
Operands	_KPm	Operand holds the value last set by the command

Description

KP designates the proportional constant in the controller filter. The proportional gain outputs a control signal proportional to the amount of error. The filter transfer function follows.

$$D(z) = KP + KD\frac{z-1}{z} + KI\frac{z}{z-1}$$

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	4,095.875	6	1/8	Value of proportional term	

Remarks

- n=? will return the currently set value of KP
- For further details see the section "Theory of Operation" in the controller user manual.

Examples

```
'Galil DMC Code Example
:KP 12,14,16,20;' Implicit notation to set a,b,c,d axis proportional term
:KPC= 8;'         Explicit notation to set C
:KP ,,8;'         Implicit notation to set C
:KP ?,?,?,?; '    Return A,B,C,D values
 7, 14, 8, 20
:KPC= ?;'         Return C value
 8
:MG _KPA;'        Message the operand for the A axis
 12
:
```

```
'Galil DMC Code Example
REM Zeroing the PID filter allows the
REM motor command signal to be
REM used as a programmable DAC
KI*= 0;' Zero KI
KP*= 0;' Zero KP
KD*= 0;' Zero KD
OF 1,2;' Set one volt on A and two volts on B
EN
```

KP applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,EDD37010,RIO47000,DMC1802,DMC1806,DMC2103

KS *Step Motor Smoothing*

KSm= n

KS n,n,n,n,n,n,n,n

Usage	KSm= n	Arguments specified with a single axis mask and an assignment (=)
	KS n ...	Arguments specified with an implicit, comma-separated order
Operands	_KSm	Operand holds the value last set by the command

Description

The KS parameter sets the amount of smoothing of stepper motor pulses. Larger values of KS provide greater smoothness. KS adds a single pole low pass filter onto the output of the motion profiler.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0.25	64	2	1/32	Value of smoothing constant	

Remarks

- This is most useful when operating in full or half step mode.
- KS effect on timing:
  - This parameter will increase the time to complete a motion time by 3KS sampling periods.
  - KS will cause an overall delay in the generation of output steps.

Examples

```
'Galil DMC Code Example
:KSC= 8;'         Explicit notation to set C
:KS ,,8;'         Implicit notation to set C
:KS ?,?,?,?; '    Return A,B,C,D values
 7, 14, 8, 20
:KSC= ?;'         Return C value
 8
:MG _KSA;'        Message the operand for the A axis
 7
:
```

KS applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

LA *List Arrays*

LA

Usage	LA	Command takes no arguments

Description

The LA command returns a list of all arrays in memory. The size of each array will be included next to each array name in square brackets.

Arguments

LA is an interrogation command with no parameters

Remarks

- The listing will be in alphabetical order.

Examples

```
'Galil DMC Code Example
:DM gold[100],silver[50],plat[200];'     Dimensions arrays with given name and the number of array elements in square brackets
:LA;'                                   Commands the controller to list arrays in alphabetical order
gold[100]
plat[200]
silver[50]
:DA *[];'                               Dialocates all arrays
:LA;'                                   List arrays now returns with no arrays
:
```

LA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

LB *LCD Bias Contrast*

LB n

Usage	LB n ...	Arguments specified with an implicit, comma-separated order
Operands	_LB	Operand holds the value last set by the command

Description

The LB command sets the Bias contrast on the LCD.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-15	15	15	1	Sets LCD Contrast	A -n will turn on the optional backlight

Remarks

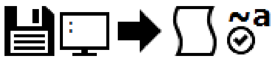
- A higher absolute value of n increases the bias contrast

Examples

```
'Galil DMC Code Example
:LB 8;'       Sets the LCD bias contrast to 8
:MG _LB;'     Returns set LDC bias contast
 8.0000
:LB -5;'      Sets the LDC bias contrast to 5 and turns on optional backlight
```

LB applies to DMC50000,DMC4000

LC *Low Current Stepper Mode*



`LCm= n`

`LC n,n,n,n,n,n,n,n`

Usage	LCm= n	Arguments specified with a single axis mask and an assignment (=)
	LC n ...	Arguments specified with an implicit, comma-separated order
Operands	_LCm	Operand holds the value last set by the command

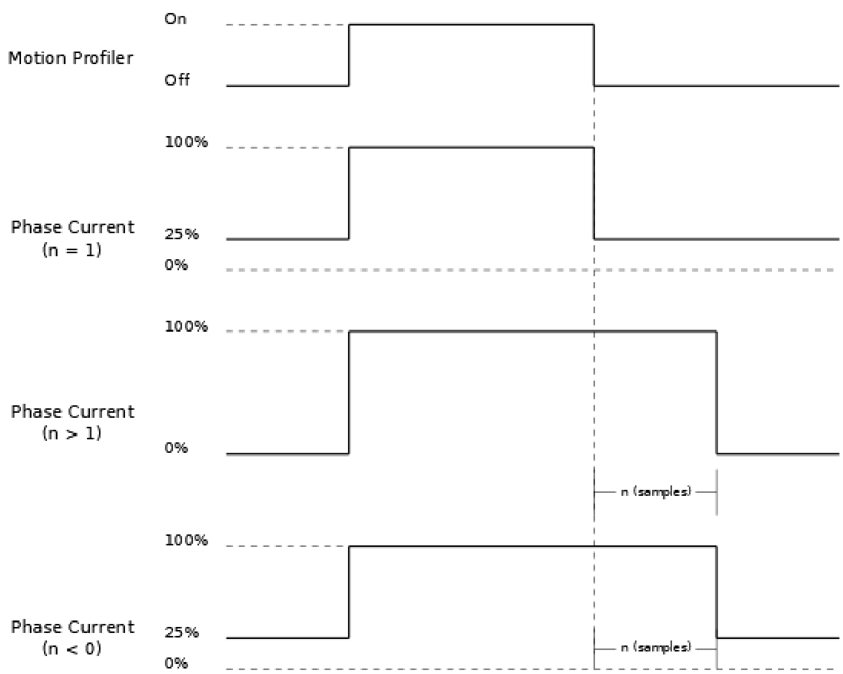
Description

The LC command enables low current mode for stepper motors. Low current mode reduces the holding current of the stepper motors while at rest.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	See Timing Diagram Below for behavior based on value of n
n	2	32,767	0	1	Waits for n samples after a move is completed, then provides 0% current	
	1	1	0	0	Provides 25% current immediately after a move is completed	
	0	0	0	0	Always provides 100% current	
	-1	-32,767	0	1	Waits for n samples after a move is completed, then provides 25% current	

Low Current Mode Timing



Low Current Mode Timing Diagram

Remarks

- The MT command must be issued prior to the LC command.
- Using LC with an internal Galil Stepper drive (SDM).
  - A setting of LC 0 is required to to shut off all current to the motor in the "motor off" (MO) state.
- Using LC will reduce current consumption, but there will be a reduction of holding torque at rest.
  - Consult the user manual for more details regarding your specific amplifier.
- Using LC with external amplifiers.
  - When using external amplifiers low current mode will simply disable the motors by toggling the amplifier enable line during rest.

Related Commands

- AG - Amplifier Gain
- BG - Begin
- MT - Motor Type

- SH - Servo Here

Examples

```
'Galil DMC Code Example
#ex
MTA=-2;'specify stepper mode for A axis
LCA=15;'specify motor to go to low current
' 15 samples after motion has completed
EN
```

LC applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

LD *Limit Disable*

LDm= n
LD n,n,n,n,n,n,n,n

Usage	LDm= n	Arguments specified with a single axis mask and an assignment (=)
	LD n ...	Arguments specified with an implicit, comma-separated order
Operands	_LDm	Operand holds the value last set by the command

Description

Allows user to disables forward and/or reverse limit switches.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	3	0	1	Sets limit disable state	See table below for details

Argument	Value	Description	Notes
n	0	Both limit switches are enabled	Default
	1	Forward limit switch disabled	
	2	Reverse limit switch disabled	
	3	Both limit switches disabled	

Remarks

- n = ? will return the current setting of LD
- When this feature should be used:
    - To gain additional digital inputs if limit switches are not being utilized.
    - To prevent noise from causing the limit switchs conditions even though no limit switches are connected.
- LD does not disable software limits set by BL and FL.

Examples

```
'Galil DMC Code Example
:LD 3,1,2;              'Implicit notation to set channel A, B, and C
:MG _LDA;'              'Message the operand for the A channel
 3.0000
:LDC= 3;'               'Explicit notation to set channel C-only
:LD*= ?;'               'Queries the value of LD for all channels
 3, 1, 3, 0
:
```

```
'Galil DMC Code Example
REM use forward limit switch as an extra I/O point
#io
LDA=1;'disable forward limit switch
io=_LFA;'set state of limit switch to variable "io"
'Use "io" in an IF statement
IF io=1
 MG "Input On"
ELSE
 MG "Input Off"
ENDIF
EN
```

LD applies to DMC4000,DMC4200,DMC4103,DMC1806,DMC30010,DMC50000,DMC52000,EDD37010

LE *Linear Interpolation End*

LE
LE?

Usage	LE	Command takes no arguments
Operands	_LEm	Operand has special meaning, see Remarks

Description

The LE command indicates to the controller that the end of the sequence is coming up. This allows the controller to slow down through multiple segments, if required. LE is required to exit the linear interpolation mode gracefully (stop code, SC, 101).

Arguments

The LE command has no arguments. See the ? Remark below.

Remarks

- _LEm will return the total move length in encoder counts for the selected coordinate system, where m is S or T.
- If not spcified, the LE command will apply to the last selected coordinate system, S or T.
- To select the coordinate system, use the command CA S or CA T.
- The VE command is interchangeable with the LE command.
- LE ? Returns the total vector move length in encoder counts for the current coordinate system

Examples

```
'Galil DMC Code Example
CA S;          'Specify S coordinated motion system
LM CD;         'Specify linear interpolation mode for C and D axes
LI ,,100,200;  'Specify linear distance
LE;            'Ends linear interpolation distance
BG S;          'Begin motion of the S-coodrinate system
```

LE applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

LI *Linear Interpolation Distance*

LIm= n <o >p
LI n,n,n,n,n,n,n,n <o >p

Usage	LIm= n	Arguments specified with a single axis mask and an assignment (=)
	LI n ...	Arguments specified with an implicit, comma-separated order

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-8,388,607	8,388,607	0	1	Assigns linear interpolation point for that axis.	
o	2	22,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the linear segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 1,-1,1.5 and -1.5.
	2	6,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the linear segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 2,-2,2.5 and -2.5.
p	2	22,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the linear segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 1,-1,1.5 and -1.5.
	2	6,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the linear segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 2,-2,2.5 and -2.5.

Argument	Value	Description	Notes
o	-1	Specifies vector speed to be set by Vector Speed Variable (VV command)	See VV command

Remarks

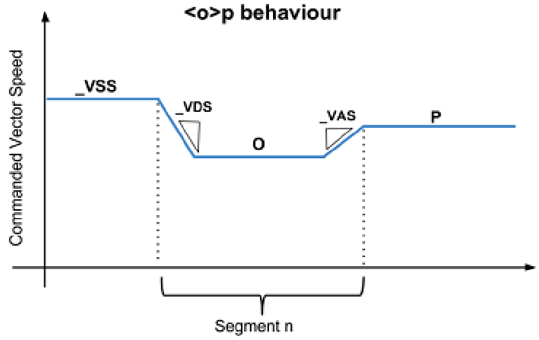
- The CA command is used to set the coordinated system (S or T) for which an LI segment is executed. The default is the S coordinate system (CAS).
- The controller always uses the axis specifications from LM, not LI, to compute the speed.
  - For example: if LM specfies that A-, B-, and C-axis are to be used in linear interpolation mode, but LI only specifies positions for B- and C-, the A-axis will still be used in calculating the overall vector speed.
  - The maximum independent speed of any axis configured as a stepper must not exceed the maximum value allowable via the SP setting.
- The slew speed, set by VS, 'o' or 'p' for linear interpolation mode, is the vector speed based on the axes specified in the LM mode. For example, if LM ABC designates linear interpolation for the A,B and C axes the speed of these axes (Va, Vb, and Vc respectively) will be computed from:

$$VS = \sqrt{V_A^2 + V_B^2 + V_C^2}$$

- 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.
- The BG S or BG T command should be issued before the total LI distance reaches 1,073,741,824 (2^30) encoder counts.

Linear Interpolation Mode Buffer

1. Up to 511 LI segments may be given ahead of the begin sequence (BG S or BG T) command.
2. Additional LI commands may be sent during motion when the controller sequence buffer frees additional space for new vector segments.
3. It is the responsibility of the user to keep enough LI segments in the controller's sequence buffer to ensure continuous motion.
4. _LMm (_LMS and _LMT) contains the available spaces for LI segments that can be sent to the buffer.
   1. 511 returned means the buffer is empty and 511 LI segments can be sent.
   2. A 0 returned means the buffer is full and no additional segments can be sent.
   3. See the LM command for full details.



Examples

```
'Galil DMC Code Example
LM ABC;                 'Specify linear interpolation mode between A-, B-, and C- axis
LI 500,,400;            'Specifies linear interpolation point, B-axis remains stationary but is still part of the interpolation.
LI 1000,2000,3000;      'Specify  linear interpolation point
LE;                     'Last segment of sequence
BG S;                   'Begin sequence
```

LI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

LL *List Labels*

LL

Usage	LL	Command takes no arguments

Description

The LL command returns a listing of all of the program labels in memory.

Arguments

LL is an interrogation command with no arguments

Remarks

- The LL command label listing will be in alphabetical order.
- The LL command returns all of the program labels in memory and their associated line numbers

Examples

```
'Galil DMC Code Example
:LL
#FIVE=5
#FOUR=4
#ONE=1
#THREE=3
#TWO=2
```

LL applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

LM *Linear Interpolation Mode*

LM mm

Usage	LM mm	Argument is an axis mask
Operands	_LMm	Operand has special meaning, see Remarks

Description

The LM command specifies the linear interpolation mode and specifies the axes for linear interpolation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axes to use for linear interpolation mode	

Remarks

- Any set of axis may be used for linear interpolation.
- LI commands are used to specify the travel distances between various linear interpolation moves.
- Several LI commands may be given as long as the controller sequence buffer has room for additional segments
  - See the LI command for more information regarding the Linear Inerpolation Buffer
- The LE command specifies the end of the linear interpolation sequence.
- Once the LM command has been given, it does not need to be given again unless the VM command has been used

Operand/Queries

- _LMm contains the number of spaces available in the sequence buffer for the 'm' coordinate system, S or T.
- The LM command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CA S or CA T.

Examples

```
'Galil DMC Code Example
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; BG S;                         'Last vector, then begin motion
```

LM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

LS *List*

LS n_0,n_1

Usage	LS n ...	Arguments specified with an implicit, comma-separated order

Description

The LS command returns a listing of the programs in memory.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	3,998	0	1	Firmware Rev 1.2a and later. Specifies the line in the program for which the listing will start	
n_0	0	1,998	0	1	Specifies the line in the program for which the listing will start	
n_1	1	1,999	1,999	1	Specifies the line at which the listing will end	

Remarks

- $n_0 < n_1$ must always be true
- If n_0 or n_1 is omitted, default values are used
- n_0 and n_1 can also specify a label, for example:
  - "LS #label,20" would print out program lines from #label to line 20.
- Issuing this command will pause the output of the Data Record until the command is completed.

Examples

```
'Galil DMC Code Example
:LS #a,6;         ' List program starting at #A through line 6
2 #a
3 PR 500
4 BG A
5 AM
6 WT 200
'Hint:  Remember to quit the Edit Mode  Q prior to giving the LS command. (DOS)
```

LS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

LU *LCD Update*

LU n

Usage	LU n ...	Arguments specified with an implicit, comma-separated order
Operands	_LU	Operand has special meaning, see Remarks

Description

The LU command turns the automatic axes status update on the LCD on or off.

Arguments

Argument	Value	Description	Notes
n	0	Turns off the automatic LCD axis updates	This allows users to print their own messages to the LCD.
	1	Turns on the automatic LCD axis updates	Default

Remarks

- _LU contains the current setting of the LU command, either 1 or 0.

Automatic LCD Axis Status Updates

- 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	Related Commands/ Example Causes
I	Idle	ST
i	Low power Idle	LCm=1, MTm=-2, ST
O	Motor Off	MO
M	Motion - Axis Running in independent mode	PA/PR/JG etc, BG
E	Error - Positions Error exceeded TEn>ERn	ER, TE
S	Stop - Stopped from ST command	ST
L	Limit - Decelerating or stopped by a limit switch	Profiled motion into hardware limit switch
A	Abort - Stopped by abort	AB
V	Vector - Running in Vector or Linear Interpolation Mode	LM, LI, VM, VP, CR
C	Contour - Running in Contour Mode	CM
P	PVT - Runnning in PVT mode	PV, BT
H	Homing - Running in a Homing Routine	HM, BG
e	ECAM - Running in ECAM mode	EG
F	Fault - Amplifier Fault	Internal amp fault, e.g. over current

Examples

```
'Galil DMC Code Example
LU 0;               'Turns off the automatic LCD axis status updates
MG {L1}"DMC-4000";  'Messages the string DMC-4000 to line 1 of the LCD screen
MG {L2}"Galil MC";  'Messages Galil MC to line 2 of the LCD screen
LU 1;               'Turns on the automatic LCD status updates
```

LU applies to DMC50000,DMC4000

LV *List Variables*

LV

Usage	LV	Command takes no arguments

Description

The LV command returns a listing of all of the program variables in memory. The listing will be in alphabetical order.

Arguments

LV is an interrogation command with no parameters

Remarks

- Use the _UL operand for total number of variables available for your controller.
    - See the UL command for more details.
- Issuing this command will pause the output of the Data Record until the command is completed.

Examples

```
'Galil DMC Code Example
:LV
apple = 60.0000
banana = 25.0000
zebra = 37.0000
:
```

LV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

LZ *Omit leading zeros*

LZ n

Usage	LZ n ...	Arguments specified with an implicit, comma-separated order
Operands	_LZ	Operand has special meaning, see Remarks

Description

The LZ command is used for formatting the values returned from interrogation commands, variables, and arrays. By enabling the LZ function, all leading zeros of returned values will be removed.

Arguments

Argument	Value	Description	Notes
n	0	Does not remove leading zeros from interrogated values	
	1	Removes leading zeros from interrogated values	Default

Remarks

- _LZ contains the state of the LZ function. '0' is disabled and '1' is enabled.

Examples

```
'Galil DMC Code Example
:LZ 0;                  'Disable the LZ function
:var1= 10;              'Sets variable var1 to the value of 10.
:TP A;                  'Interrogate the controller for current position of A-axis
 0000021645.0000
:var1=?;                'Request value of variable var1
 0000000010.0000
:LZ 1;                  'Enable LZ function
:TP A;                  'Interrogate the controller for current position of A-axis
 21645.0000
:var1= ?;               'Request value of variable var1
 10.0000
```

```
'Galil DMC Code Example
:LZ 0;      'Disable the LZ function
:TB;        'Tell status bits
001
:LZ 1;      'Inhibit leading zeros
:TB;        'Tell status
1
```

LZ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

MB *Modbus*

MBm= n_0, n_1, n_2, n_3, str[]

Usage	MBm= n	Arguments specified with a single axis mask and an assignment (=)

Description

The MB command is used to communicate with I/O devices using the Modbus TCP/IP protocol. The MB command supports the first two levels of Modbus commands. 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. The format of the command varies depending on each function code.

Galil Modbus supports one master per slave.

Arguments

Level 2 Modbus Function Codes

Function Code, n_1	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	

01: MBm= n_0, 1, n_2, n_3, str[]

Read Coil Status (Read Bits)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	1	see Notes	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first coil	
n_3	0	99	N/A	1	Quantity of coils	Or, number of IO points to read
str	1 char	8 chars	N/A	String	Name of array to store values	str[0] holds the first value.

```
'Galil DMC Code Example
MBC=,1,2,8,example[];'  Read inputs 2-9 from handle C, save to example[]
'equivalent to reading Digital Outputs or registers mapped to 100000
```

02: MBm= n_0, 2, n_2, n_3, str[]

Read Input Status (Read Bits)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	1	see Notes	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first input	
n_3	0	99	N/A	1	Quantity of inputs	Or, number of IO points to read
str	1 char	8 chars	N/A	String	Name of array to store values	str[0] holds the first value.

```
'Galil DMC Code Example
MBC=,2,4,3,example[];'  Read inputs 4,5 and 6 from handle C, save to example[]
'equivalent to reading Digital Inputs or registers mapped to 000000
```

03: MBm= n_0, 3, n_2, n_3, str[]

Read Holding Registers (Read Words)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first register	
n_3	0	99	N/A	1	Quantity of registers to read	
str	1 char	8 chars	N/A	String	Name of array to store values	str[0] holds the first value. 2 bytes per element. Array must be as large as the value for n_3

```
'Galil DMC Code Example
MBB=,3,1,4,example[];'  Read registers 1 through 4 from handle B, save to example[]
'equivalent to reading Analog Outputs, or registers mapped to 400000
```

04: MBm= n_0, 4, n_2, n_3, str[]

Read Input Registers (Read Words)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first register	
n_3	1	99	N/A	1	Quantity of registers to read	
str	1 char	8 chars	N/A	String	Name of array to store values	str[0] holds the first value. 2 bytes per element. Array must be as large as the value for n_3

```
'Galil DMC Code Example
MBB=,4,1,2,example[];'  Read registers 1 through 2 from handle B, save to example[]
'equivalent to reading Analog Inputs, or registers mapped to 300000
```

05: MBm= n_0, 5, n_2, n_3

Force Single Coil (Write One Bit)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of coil	
n_3	0	1	0	1	Set coil status	0 = turn off coil. 1 = turn on coil

```
'Galil DMC Code Example
MBB=,5,11,1;'  Set coil 11 high
'equivalent to setting a Digital Output (SB/CB)
```

06: MBm= n_0, 6, n_2, n_3

Preset Single Register (Write One Word)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of holding register	
n_3	0	65,535	0	1	Set register value	

```
'Galil DMC Code Example
MBC=,6,10,128;'      Write 128 to holding register 10 on handle C
'equivalent to setting digital outputs on the RIO, or setting registers addressed 400000
```

07: MBm= n_0, 7, str[]

Read Exception Status (Read Error Code)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
str	1 char	8 chars	N/A	String	Name of array to store value	str[0] holds the received value, one byte only.

- When using function code 7 with a Galil slave, array element zero will be set to the byte value of the combined first 8 digital outputs.
- Only one byte in the array will be populated, element zero of array str[].

```
'Galil DMC Code Example
MBE=,7,example[];'   Read register and store in example[0]
```

15: MBm= n_0, 15, n_2, n_3, str[]

Force Multiple Coils (Write Multiple Bits)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first coil	
n_3	1	16	N/A	1	Quantity of coils	
str	1 char	8 chars	N/A	String	Array to set values for coils	str[0] holds the first value. 16 bits per element

```
'Galil DMC Code Example
example[0]=255;'
MBC=,15,0,16,example[];'   Set 1st byte of coils high and 2nd byte of coils low
'equivalent to setting digital outputs on RIO, or setting coils addressed 000000
```

16: MBm= n_0, 16, n_2, n_3, str[]

Preset Multiple Registers (Write Words)

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	9,999	N/A	1	Address of first register	
n_3	0	99	N/A	1	Quantity of registers	
str	1 char	8 chars	N/A	String	Array containing modbus data	str[0] holds the first value. 2 bytes per element. Array size must be > n_3

```
'Galil DMC Code Example
example[0]=$AEAE
MBD=,16,2,1,example[];'     Set $AEAE to holding register 2 on handle D
'equivalent to setting analog outputs, or writing to holding registers addressed 400000
```

17: MBm= n_0,17,str[]

Report Slave ID

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	see Notes	1	Unit ID	Default to Handle number (A=1, B=2, etc.)
str	1 char	8 chars	N/A	String	Name of array to receive data	str[0] holds the value.

```
'Galil DMC Code Example
MBB=,17,example[];'   store slave ID of device on handle B to example[]
```

Raw Modbus Packet Send

MBm= n_0,-1,n_2,str[]

Raw Modbus Send

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to send Modbus command	
n_0	0	255	1	see Notes	Unit ID	Default to Handle number (A=1, B=2, etc.)
n_2	0	999	N/A	1	Number of array bytes to send	
str	1 char	8 chars	N/A	String	Name of array containing outgoing data	Array size >= n_2. See Remarks

MB applies to DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

MC *Motion Complete*

MC mm

Usage	MC mm	Argument is an axis mask

Description

The MC command is a trippoint command that holds up execution until motion is complete on the specified axes. The MC command, unlike the AM (after motion command) requires that both the motion profiler has completed motion AND that the motor encoder has reached the specified position before continuing execution.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axis to assign value	Any combination of the axis is valid. If no axis is specified, command applies to all axis.

Remarks

- Motion must be actively profiling on an axis for the MC command to take affect. If the MC command is issued for an axis which is not profiling motion, the trippoint will immediately clear.

Using MC with Stepper Motors

- In the case of stepper motors, MC will monitor the number of step pulses are generated to complete the move.
- The MC command is recommended when operating with stepper motors in leiu 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.

Using MC as part of the #MCTIME error routine

1. The command TW can be used to set an acceptable amount of time between when the motion profiler has completed and the encoder is in position; if this condition is not satisfied, a timeout error occurs.
    1. When a timeout occurs, the trippoint will clear and the stop code will be set to 99.
    2. Thread 0 of the DMC program will also jump to the special label #MCTIME, if present.
        1. See the #MCTIME automatic subroutine, TW and SC commands for more information

Examples

```
'Galil DMC Code Example
#move;                      'Label #move
TW 1000,1000;               'Set motion complete timeout to 1000 milliseconds per axis
PR 2000,4000;               'Position relative Move on A- and B-axis
BG AB;                      'Start the motion on A- and B-axis
MC AB;                      'After the move is complete on A and B axes
MG "DONE";                  'Print message
EN;                         'End of Program
'
'
#MCTIME;                     'Motion Complete timeout Subroutine
 MG "Motion Timeout";       'Print failure message
 SC;                        'Print stop codes
EN;                         'End subroutine
```

MC applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

ME *Modbus array write enable*

ME n

Usage	ME n ...	Arguments specified with an implicit, comma-separated order

Description

The ME command enables the ability for Modbus masters to write to array locations in the hardware's array table. When enabled, array locations can be written to as 16 bit integers or as 32 bit floating point by a modbus master by specifying different address ranges. ME is not required to read array locations, reads are always supported.

Arguments

Argument	Value	Description	Notes
n	0	Disables the ability for Modbus masters to write to the array table	Default
	1	Enables ability for Modbus masters to write to the array table	

Remarks

- Array writes when enabled by ME are done using function code 16
- Galil Modbus supports one master per slave.

- DMC-4000 requires firmware revision 1.2d or newer for use as Modbus slave.

Modbus Register Map

- Each element is accessible as a 16 bit unsigned integer (Modbus registers 10xx) -OR- as a 32 bit floating point number (Modbus registers 2000).
- The table below shows the mapping for a Modbus master writing to the controller with ME 1 set.

- 1000 (0-999) elements are available for read/write on the DMC-4000. Other array elements are not exposed to Modbus.

Modbus Register Map to Galil Array A[]

Modbus Registers:	1000-1999	2000-2999
Available Modbus function codes	3 (read) and 16 (write)	3 (read) and 16 (write)
Number Type	16 bit unsigned integer	32 bit floating point
References in A[] array	A[0]-A[999]	A[0]-A[999]
Number written to A[]	Integer only, fraction not changed	Galil 4.2 format (internal from float conversion)
Number read from A[]	Integer only, fraction not read	32 bit float (internal to float conversion)
Example Modbus Master Write	MBH=0,16,1000,1,write[]	MBH=0,16,2001,2,write[]
Example Modbus Master Read	MBH=0,3,1000,1,read[]	MBH=0,3,2001,2,read[]

Embedded Array Mapping

- Once enabled, the entire array table can be written remotely. These writes can span across dimensioned user arrays. It is the user's responsibility to partition the array table and to read/write remotely to the correct location.
- When using multiple array names, the array table is partitioned alphabetically (all captital letters first).
  - For example, a partioned array of Grape[600] and Orange[200] would place the first 600 registers in Grape[], and the next 200 registers in Orange[]. The last 200 elements would be inaccesible from embedded code. If the user then dimensioned the array Apple[200], the register mapping would change. The first 200 registers would read/write from Apple[], the next 600 from Grape[], and finally the last 200 from Orange[].
  - Additionally, all captial letters come before lowercase letters. For example, a partioned array of Banana[100] and apple[200] would place the first 100 registers in Banana[] and the next 200 registers in apple[].
- For simplicity, Galil recommends that a single array be dimensioned with the array name "A".

Examples

```
'Galil DMC Code Example
:DA *[];'       Deallocates all arrays
:DM A[400];'    Allocates array for Modbus Read/Write
:ME0;'          Disables write access
:ME1;'          Enables write access
:ME?;'          Interrogate current value
 1
:
```

```
'Galil DMC Code Example
'This example is written for a Galil modbus master to a DMC-4000, DMC-4103, DMC-4200, DMC-30010, or RIO-47000 (with expanded memory)
'Master is E.G. DMC-2103, RIO, DMC-4000
'This code runs on the master.
'Assumes a Modbus handle is available at H,
' and that ME1 has been set on the remote device

MW1;'                          Turn on modbus wait
DM write[2];'                  Dimension an array for holding data to transmit

write[0]=1234;'                Assign an integer to element 0
MBH=0,16,1000,1,write[];'      Send the integer to register 1000 on the remote

write[0]=$42F6;'               Set the 32 bit float in two steps, the value is 123.456
write[1]=$E978
MBH=0,16,2001,2,write[];'      Send the float to register 2001 on the remote
'note that register 2000 would have stepped on the integer memory written at 1000

DM read[2];'                   Dimension an array for holding read data

MBH=0,3,1000,1,read[];'        Read the integer at register 1000
MG"Integer=",read[0];'         Print the read integer

MBH=0,3,2001,2,read[];'        Read the float at register 1000
```

```
float=(read[0]*$10000) + read[1];'    Construct the float. Shifting necesary for high bytes
MG"Float=", float{$8.0};'            Print the float in hex
```

ME applies to DMC4000,DMC4200,DMC4103,DMC30010,RIO47000

MF *Forward Motion to Position*

MFm= n
MF n,n,n,n,n,n,n,n

Usage	MFm= n	Arguments specified with a single axis mask and an assignment (=)
	MF n ...	Arguments specified with an implicit, comma-separated order

Description

This command will hold up the execution of the following command until the specified motor moves forward and crosses the position specified.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Position required to be crossed before subsequent commands will be executed.	

Remarks

- Although multiple positions can be specified, only one of the MF conditions must be satisfied for subsequent code execution.
- MF command references absolute position.
- The MF command only requires an encoder and does not require that the axis be under servo control.
- 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.
    - Example with speed of 20,000 counts/second and TM of 1000 (1000 us).
        - Maximum error = 2 * 1000 E-6 seconds * 20,000 counts/second = 40 counts
- When using a stepper motor:
    - This condition is satisfied when the stepper position (as determined by the output buffer - TD) has crossed the specified Forward Motion Position.

Examples

```
'Galil DMC Code Example
#test;                    'Program Test
DP 0;                     '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 A;                     'Stop
EN;                       'End of Program
```

MF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

MG *Message*

MG "str", {^n_0}, n_1

Usage	MG n ...	Arguments specified with an implicit, comma-separated order

Description

The MG command is used to send strings, operands, variables, and array values to a specified destination.

Arguments

Argument	Value	Description	Notes
str	String	A string including alphanumeric characters to be displayed	Limited to 76 characters
n_0	ASCII character in decimal	Allows users to print ASCII characters	Range of 0-255
n_1	Numeric value	Prints the numeric value specified	See Examples for valid uses of n_1.
	Variable name	Prints the numeric value stored by the variable	
	Operand	Prints the numeric value stored by the operand	
	Array element	Prints the numeric value stored by the array element	
	Mathematical expression	Prints the numeric value of the solved equation	

Argument	Value	Description	Notes
n	Operand	Prints the numeric value stored by the operand	

Remarks

- Multiple strings, variables, and ASCII characters may be used; each must be separated by a comma.
- Solicited Messages
  - From a host terminal, application code, or device, sending the MG command will return with the requested information. This is known as a solicited command, because the host sends the command and expects a response.
- Unsolicited Messages
  - 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 explicitly requesting it.
  - The CW command controls the ASCII format of all unsolicited messages.
  - Unsolicited messages can go to any of the Ethernet handles or serial ports.
  - The CF command sets the default communication port for routing unsolicited messages.

Formatting

- Formatters can be placed after each argument in to modify how it is printed.
  - {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. If n is greater than the length of the string stored in the variable, null chars (0000) will be inserted at the end of the string.
  - {N} Suppress carriage return at the end of the message.

Message Routing

MG can override the default CF setting by using the following modifiers at the beginning of the message, right after MG.

- {Pn} Sends the message out the Serial port n, where n is 1 or 2 denoting Main or Auxilary (where equipped).
- {Ex} Sends the message out the Ethernet handle x, where x is A,B,C,D,E,F,G, or H

Printing to the LCD

- Like with other message routing modifiers, the following should be placed at the beginning of the message, right after MG.
  - {Lx} Sends the message to the LCD, where x is 1 or 2 for the top or bottom line of the LCD, respectivly.
  - 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.

Examples

Valid uses of n_1 argument

```
'Galil DMC Code Example
:'Values
:MG 1234.5678
 1234.5678
:'
:'Variables
:var= 12345678.9101
:MG var
 12345678.9101
:'
:'Operands
:MG @AN[1]
 0.0121
:'
:'Array Elements
:DM arr[3]
:arr[0]=0
:arr[1]=1
:arr[2]=2
:MG arr[0],arr[1],arr[2]
 0.0000 1.0000 2.0000
:'
:'Mathematical Expressions
:MG 1+2
 3.0000
:MG arr[2]+var
 12345680.9101
:
```

General Use

```
'Galil DMC Code Example
:MG "Good Morning";                 'Message command displays ASCII string
Good Morning
:total= 1234.5322;                  'Assigns variable total with the value 1234.5322
:MG "The answer is...",total{F4.2};  'Will print the message and the value of variable total formatted with 4 integer digits and 2 fractional digits
```

```
The answer is... 1234.53
:MG {^13}, {^10}, {^48}, {^055};      'Specifies carriage return, line feed, and the characters 0 and 7 in ASCII decimal values

07
:MG TIME;                             'Messages the operand TIME
 261928200.0000
:variable= 10;                        'Sets the variable equal to 10
:MG variable+5;                       'Messages out variable + 5
 15.0000
:MG _TI0;                             'Messages the value stored in the operand _TI0
 255.0000
```

```
'Galil DMC Code Example
CF A;         'Messages configured to go out Ethernet handle A
MG {EB}var;   'Override CF and send the value of variable var to B handle
```

```
'Galil DMC Code Example
LU 0;                                        'Turns off automatic axis status updates on the LCD
ct= 1;                                       'Sets variable ct to 1
rpm= 1432;                                   'Sets variable rmp to 1432
MG {L1}"CT SPD",{L2}{F1.0}ct," ",{F4.0}rpm; 'Prints "CT  SPD" on line one of the LCD and " 1  1432" on the second line.
EN
```

MG applies to
DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,EDD37010

MO *Motor Off*

MO mm

Usage	MO mm	Argument is an axis mask
Operands	_MOm	Operand has special meaning, see Remarks

Description

The MO command turns off the motor command line and toggles the amplifier enable signal.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Specifies axis to turn off	

Remarks

- The controller will continue to monitor the motor position
  - See the TP command for more details
- To turn the motor back on use the SH (Servo Here) command.
- The MO command is useful for positioning the motors by hand.
- _MOm contains 1.000 if the axis is in the motor off state or 0.000 if the axes is in the servo here state.

Examples

```
'Galil DMC Code Example
MO;         'Turns off all motors
MO A;       'Turns off the A motor.
MO B;       'Turns off the B motor.
MO CA;      'Turns off the C and A motors.
SH;         'Turns all motors on
axis= _MOA; 'Sets variable axis equal to the A-axis servo status
```

MO applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

MR *Reverse Motion to Position*

MRm= n

MR n,n,n,n,n,n,n,n

Usage	MRm= n	Arguments specified with a single axis mask and an assignment (=)
	MR n ...	Arguments specified with an implicit, comma-separated order

Description

This command will hold up the execution of subsequent DMC code until the specified axis moves backwards and crosses the position specified.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Value of position that must be crossed in the reverse direction	

Remarks

- MR command references absolute position.
- Although multiple positions can be specified, only one of the MR conditions must be satisfied for subsequent code execution.
- The MR command only requires an encoder and does not require that the axis be under servo control.
- The accuracy of the MR command is the number of counts that occur in 2*TM usec. Multiply the speed by 2*TM usec to obtain the maximum error.
  - Example with speed of 20,000 counts/second and TM of 1000 (1000 us).
    - Maximum error = 2 * 1000 E-6 seconds * 20,000 counts/second = 40 counts
- When using a stepper motor, this condition is satisfied when the stepper position (as determined by the output buffer - TD) has crossed the specified reverse motion position.

Examples

```
'Galil DMC Code Example
#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
```

MR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

MT *Motor Type*

MTm= n

MT n,n,n,n,n,n,n,n

Usage	MTm= n	Arguments specified with a single axis mask and an assignment (=)
	MT n ...	Arguments specified with an implicit, comma-separated order
Operands	_MTm	Operand holds the value last set by the command

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 stepper motors, which require step and direction signals. The polarity reversal inverts the analog signals for servomotors, or inverts logic level of the pulse train for step motors.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	

Argument	Value	Description	Notes
n	1	Servo motor (3-phased brushless)	Default
	-1	Servo motor (3-phased brushless), reversed direction	
	2	Stepper motor with active low step pulses	
	2.5	Stepper motor with active low step pulses, reversed direction	
	-2	Stepper motor with active high step pulses	
	-2.5	Stepper motor with active high step pulses, reversed direction	
	4	Servo motor (2-phased brushless)	Only valid for D3547
	-4	Servo motor (2-phased brushless), reversed direction	Only valid for D3547

Remarks

- The axis must be in the motor off state (MO) before setting MT
- n = ? will return the value of the motor type for the specified axis.
- For stepper motor configuration (n=2,-2,2.5,-2.5), the auxiliary encoder input for the axis is no longer available.
- For stepper motor configuration (n=2,-2,2.5,-2.5), TM 500 is required. Contact Galil for TM greater than 500.

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AU - Set amplifier current loop
- AZ - Clear Amplifier Errors
- TA - Tell Amplifier Error
- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
MO
MT 1,-1,2,2;    'Configure A as servo, B as reverse servo, C and D as steppers
MT ?,?;         'Interrogate motor type for A- and B-axis
```

MT applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

MU *Multicast Address*

MU n_0, n_1, n_2, n_3

Usage	MU n ...	Arguments specified with an implicit, comma-separated order
Operands	_MU	Operand has special meaning, see Remarks

Description

MU sets the controller's multicast address. This address is used by Galil software to detect an available Ethernet controller on the network.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	255	239	1	First field of the multicast address	
n_1	0	255	255	1	Second field of the multicast address	
n_2	0	255	19	1	Third field of the multicast address	
n_3	0	255	56	1	Last field of the multicast address	

Remarks

- Supported on DMC-4000 firmware rev 1.1e and above.

- MU ? returns the current multicast address setting in 4 byte format
- _MU contains the 32-bit multicast address number in two's complement.

Examples

```
'Galil DMC Code Example
:MU 239,255,19,57
:MU?
 239, 255, 019, 057
:MG_MU
 -268496071.0000
:MG_MU{$8.0}
$EFFF1339
:
```

MU applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010

MW *Modbus Wait*

MW n

Usage	MW n ...	Arguments specified with an implicit, comma-separated order
Operands	_MW0 _MW1	Operand has special meaning, see Remarks

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. The MW command ensures that the command that was sent to the Modbus device was successfully received before continuing program execution.

Arguments

Argument	Value	Description	Notes
n	0	Disables Modbus wait	
	1	Enables Modbus wait	Default

Remarks

- n = ? returns the state of the Modbus wait, either 1 or 0
- If a Modbus response is never received, then thread 0 will jump to the #TCPERR subroutine, if it exists, and TC will report an error code of 123.
- MW prevents the controller from sending multiple commands to the same Modbus device before it has a chance to execute them.
- Operands
  - _MW0 returns last function code received
  - _MW1 returns Modbus error code

_MWn operands

```
'Galil DMC Code Example
:MG_MW0{$8.0};' $ is the hex formatter
$00000001
:'above is an expected response to function code 1
:MG_MW1{$8.0}
$00000000
:'no error
```

_MW0 Responses

Function Code Sent	Normal _MW0 Response	_MW0 Exception Response
1	$01	$81
2	$02	$82
3	$03	$83
4	$04	$84
5	$05	$85
6	$06	$86
7	$07	$87
15	$0F	$8F
16	$10	$90

_MW1 Responses

_MW1 returns	Exception description
$00	Normal response
$01	The request referenced an illegal function code
$02	The request referenced an illegal data address

Examples

```
'Galil DMC Code Example
MW1;       'Enables Modbus Wait
SB1001;    'Set Bit 1 on Modbus Handle A
CB1001;    'Clear Bit 1 on Modbus Handle A
```

```
'Galil DMC Code Example
REM Example on Modbus master, DMC-4000
REM Using _MW operands
:IHH=192,168,42,43<502>2;' connect to RIO
:MW1
:SB 8001;' set bit one on RIO
::MBH=,5,1,0;' clear it with MB
::'CB 8001 would also work
:MG_MW0
 5.0000
:'funct code 5 confirmed
:MG_MW1
```

```
 0.0000
:'no errors
:MBH=,5,100,1;' invalid output point
::TC1
 0
:MG_MW0{$8.0}
$00000085
:'Exception on funct code 5
:MG_MW1{$8.0}
$00000002
:'illegal data address
```

MW applies to DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

NB *Notch Bandwidth*

NBm= n
NB n,n,n,n,n,n,n,n

Usage	NBm= n	Arguments specified with a single axis mask and an assignment (=)
	NB n ...	Arguments specified with an implicit, comma-separated order
Operands	_NBm	Operand holds the value last set by the command

Description

The NB command sets real part of the notch poles. In other words, the NB controls the range of frequencies that will be attenuated.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	62.5	0.5	1/2	Value of the notch bandwidth in Hz	Max value dependent upon TM setting, see Remarks

Remarks

- _NBm contains the value of the notch bandwidth for the specified axis.
- NB also determines the ratio of NB/NZ which controls the attenuation, or depth, of the notch. See NZ for more details.
- See the NF command for recommendations on choosing NZ, NB, and NF values.

- See Application note #2431 for additional information on setting the NF, NB and NZ commands
  - http://www.galil.com/download/application-note/note2431.pdf

Maximum Range

- The maximum n argument is specified in Hz and is calculated by the equation below:

$$\frac{1}{(16 \times TM \times 10^{-6})}$$

  - where TM is specified in microseconds.
  - The default TM is 1000, therefore default maximum NB value = 1/(16x1000E-6) = 62.5 Hz

Examples

```
'Galil DMC Code Example
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
```

NB applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

NF *Notch Frequency*

NFm= n
NF n,n,n,n,n,n,n,n

Usage	NFm= n	Arguments specified with a single axis mask and an assignment (=)
	NF n ...	Arguments specified with an implicit, comma-separated order
Operands	_NFm	Operand holds the value last set by the command

Description

The NF command sets the frequency of the notch filter, which is placed either in series with the PID compensation, or applied to the profiled position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-250	250	0	1	Sets the frequency of the notch filter	See Remarks

Remarks

- n = 0 disables the notch.
- n > 0 applies the notch filter in series with the PID compensation. The value of n is the frequency of the notch filter.
- n < 0 applies the notch filter to the profiler. The absolute value of n is the frequency of the notch filter.
    - n < 0 only applies to firmware rev 1.2f and later.

- _NFm contains the value of notch filter for the specified axis.
- n = ? Returns the value of the Notch filter for the specified axis.

- See Application note #2431 for additonal information on setting the NF, NB and NZ commands
    - http://www.galil.com/download/application-note/note2431.pdf

Chosing NF, NB, and NZ

1. A simple way for attaining NF, NB, and NZ parameters is to follow these simple rules:
    1. Estimate the resonance frequency
    2. Set NF equal to the resonance frequency
    3. Set NB = 1/2NF
    4. Set NZ between 0 and 5
2. The ratio of NB/NF is extremly important. See the NB command for more details.

Maximum Range

- The maximum n argument is specified in Hz and is calculated by the equation below:

$$\frac{1\times10^{6}}{(4\times TM)}$$

- Where TM is in microseconds.
    - Default TM is 1000, therefore default maximum value = 1E6/(4*1000) = 250 Hz

Examples

```
'Galil DMC Code Example
NF, 20;' Sets the notch frequency of B axis to 20 Hz
```

NF applies to EDD37010,DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

NO *No Operation*

NO str

Operands	_NO	Operand has special meaning, see Remarks

Description

The NO command performs no action in a sequence and can be used as a comment in a program.

Arguments

Argument	Value	Description	Notes
str	String	A no action sequence used to document a program	Comments are limited to the maximum row size in a program. This will vary by controller.

Remarks

- _NO returns a bit mask 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

Examples

```
'Galil DMC Code Example
#a;                       'Program A
NO;                       'No Operation
NO This Program ;         'No Operation
NO Does Absolutely;       'No Operation
NO Nothing;               'No Operation
EN;                       'End of Program
```

NO applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

NZ *Notch Zero*

NZm= n
NZ n,n,n,n,n,n,n,n

Usage	NZm= n	Arguments specified with a single axis mask and an assignment (=)
	NZ n ...	Arguments specified with an implicit, comma-separated order
Operands	_NZm	Operand holds the value last set by the command

Description

The NZ command sets the real part of the notch zero. In other words, the NB/NZ ratio controls the amount of attenuation, or depth, of the notch filter.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0.5	62.5	0	0.5	Value of Notch Frequency in Hz	Max value dependent upon TM setting, see Remarks

Remarks

- See the NF command for recommendations on chosing NZ, NB, and NF values.
- The maximum n argument is determiend by the following equation

$$\frac{1}{(16 \times TM \times 10^{-6})}$$

- Where TM is in microseconds, the default TM is 1000.

- See Application note #2431 for additonal information on setting the NF, NB and NZ commands
    - http://www.galil.com/download/application-note/note2431.pdf

The NB/NZ Ratio

- The ratio, NB/NZ controls the amount of attenuation, or depth of the notch.
    - The larger the ratio of NB/NZ, the larger the attenuation, and vice versa.
- If NB/NZ > 1 the signal will amplifiy the output signal causing a resonance.
- NB = NZ essentially eliminates the notch

Examples

```
'Galil DMC Code Example
NZA = 10;' Sets the real part of the notch pole to 10/2 Hz
```

NZ applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

OA *Off on encoder failure*

OAm= n
OA n,n,n,n,n,n,n,n

Usage	OAm= n	Arguments specified with a single axis mask and an assignment (=)
	OA n ...	Arguments specified with an implicit, comma-separated order
Operands	_OAm	Operand holds the value last set by the command

Description

The OA command 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 less than 4 counts is detected whenever the torque exceeds a preset level (OV) for a specified time (OT).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	Status of encoder failure detection	1 = enabled, 0 = disabled

Remarks

- 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 if detected during motion.
- 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 OA is set to 1, #POSERR will run when an encoder failure is detected for the axis.
    - Note that for this function to work properly it is recommended to have a non-zero value for KI.

Examples

```
'Galil DMC Code Example
OAA= 1;' enable A axis encoder error detection
MG_OAA;'query OA value for A axis
```

```
'Galil DMC Code Example
OA ,1;'  enable B axis encoder error detection
```

```
'Galil DMC Code Example
#setup
'setup the encoder error detection
OTA=10;'   Set time to 10 milliseconds
OVA=5;'    Set voltage to 5
OAA=1;'    Enable encoder detection feature
EN
```

```
'Galil DMC Code Example
REM #POSERR example for checking to see if encoder failure occured
REM This procedure is needed because the stop code will only update if
REM the profilier is running at the time 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
```

OA applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806,EDD37010

OB *Output Bit*

OB n, (ex)

Usage	OB n ...	Arguments specified with an implicit, comma-separated order

Description

The OB command allows variable control of an output bit based on logical expressions. The OB command defines output bit n as either 0 or 1 depending on the result from the logical expression.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	48	0	1	Output bit specified	Outputs 9-16 only valid on 5-8 axis controller. See Remarks.
n	1,000	8,999	N/A	1	Modbus output bit specified	See Remarks
ex	N/A	N/A	N/A	Expression	Expression that defines status of output	If ex is true/non-zero, set output to 1. If ex is false/zero, set output to 0

Remarks

- An expression is any valid logical expression, variable or array element.
- Any non-zero value of the expression results in a one set to the output bit.
- Extended IO must be configured as outputs by the CO command for proper operation with the OB command.

Using OB with a Modbus Slave

- n = (SlaveAddress*10000) + (HandleNum*1000) + ((Module-1)*4) + (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 where A is 1, B is 2 and so on.
  - 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

Examples

```
'Galil DMC Code Example
OB 1, pos;'          If pos<>0, Bit 1 is high.
'                    If pos=0, 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
```

OB applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

OC *Output Compare*

OCm = n_0, n_1

Usage	OCm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_OC	Operand has special meaning, see Remarks

Description

The OC command sets up the Output Compare feature, also known as Pulse on Position. The controller has a special digital output which can be configured to pulse on a specified absolute encoder position, and optionally on a delta encoder change after that. These operations are known as one-shot and circular compare, respectively.

Each set of 4 axes, ABCD and EFGH, has one digital output which can be configured to this mode of operation

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to enable output compare	Axes A-D share one output compare, axes E-H share a second output compare output
n_0	-2,147,483,648	2,147,483,647	N/A	1	Absolute encoder position of first pulse	n_0 must be within 65535 counts of current position
n_1	-65,536	65,535	N/A	1	Incremental encoder distance between pulses	0 indicates single-shot pulse in positive direction, -65536 indicates single shot when moving in the negative direction

Remarks

- For controllers with 5-8 axes, two output compares are available. One for the A-D axes, the other for the E-H axes
- This command is only valid when both n_0 and n_1 are specified.

One shot Compare Mode:

- The output compare signal will go low, and stay low at a specified absolute encoder position.
- This is done by specifying n_1 as 0 for positive motion, and -65536 for negative motion

Circular Compare Mode:

- After the absolute position of the first pulse (n_0), the circular compare can be configured to pulse low at a relative distance thereafter (n_1).
- This is done by specifying n_1 to a non-zero delta position (range of -65535 to 65535)
  - 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 circular compare output is a low-going pulse with a duration of approximately 250 nanoseconds.

Limitations

- The Output Compare function is only valid with incremental encoders.
  - The Output Compare function is not valid with SIN/COS (AF settings of 5-12), standard analog (AF setting of 1), BiSS or SSI feedback (SS or SI commands).
- The OC function cannot work for an axis configured as a stepper.
- The auxiliary encoder of the corresponding axis cannot be used when in this mode.
  - Dual loop mode (which uses the aux encoder input) will not operate when the OC command is enabled.
- 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.

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.

Examples

```
'Galil DMC Code Example
OCA=300,100;' Select A encoder as position sensor.
REM First pulse at 300. Following pulses at 400, 500, 600 ...
```

```
'Galil DMC Code Example
REM Output compare can be used to create raster scans.
REM By using circular compare on one axis, followed by an index move on a perpindicular axis
REM raster patterns are easily made.
REM The following image shows a rastered "dot matrix" type image easily created
REM with output compare and a laser on a two dimensional stage.
```

OC applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

OE *Off-on-Error*

OEm= n
OE n,n,n,n,n,n,n,n

Usage	OEm= n	Arguments specified with a single axis mask and an assignment (=)
	OE n ...	Arguments specified with an implicit, comma-separated order
Operands	_OEm	Operand holds the value last set by the command

Description

The OE command sets the Off On Error function for the controller. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	0	0	0	Disables the Off On Error Function	Default
	1	1	0	0	Motor shut off by position error, amplifier error or abort input	
	2	2	0	0	Motor shut off by hardware limit switch	
	3	3	0	0	Motor shut off by position error, amplifier error, abort input or by hardware limit switch	

Remarks

- For any value of OE <> 0, the axis will be shut off due to amplifier faults on any amplifier axis. See the TA command for conditions of an amplifier fault.
- BR1 must be enabled when internal brushless servo amplifiers are installed but the axis is driven with an external amplifier. BR1 disables hall error checking when OE <> 0
  - Examples of brushless servo amps that require this consideration include the AMP-43040 (-D3040) or the AMP-20540
- Motion Behavior:
  - If an error or axis-specific abort is detected, 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 GM, VM, LM or CM, all participating axes will be stopped.

Examples

```
'Galil DMC Code Example
: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
:MG _OEA;' Query A axis OE setting
 1.0000
```

```
'Galil DMC Code Example
#main
'code to enable the OE command for all error conditions
'and setup the corresponding automatic subroutines
'to display relevent data
'no loop for abort input, as that stops code operation
OE 3,3,3,3
SHABCD
JG*=1000;' all jog at 1000
BGABCD
#loop
'endless loop
WT1000
JP#loop
EN

#AMPERR
MG "amplifier fault"
MG _TA0,_TA1,_TA2,_TA3
EN

#POSERR
MG "position error fault"
MG _TEA,_TEB,_TEC,_TED
EN

#LIMSWI
MG "limit switch fault"
MG _TSA,_TSB,_TSC,_TSD
EN
```

OE applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

OF *Offset*

OFm= n
OF n,n,n,n,n,n,n,n

Usage	OFm= n	Arguments specified with a single axis mask and an assignment (=)
	OF n ...	Arguments specified with an implicit, comma-separated order
Operands	_OFm	Operand holds the value last set by the command

Description

The OF command sets a bias voltage in the command output or returns a previously set value.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-9.9982	9.9982	0	20/65,536	Offset voltage applied to MCMD	

Remarks

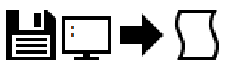
- This can be used to counteract gravity or an offset in an amplifier.

Examples

```
'Galil DMC Code Example
: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
```

OF applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,EDD37010

OP *Output Port*



OP n_0,n_1,n_2

Usage	OP n ...	Arguments specified with an implicit, comma-separated order
Operands	_OP0 _OP1 _OP2	Operand holds the value last set by the command

Description

The OP command sets the output ports of the controller in a bank using bitmasks. 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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	65,535	0	1	Decimal representation: General Outputs 1-16	On a 1-4 axis controller, max is 255 ($FF) for outputs 1-8 only.
n_1	0	65,535	0	1	Decimal representation: Extended Output (Bank 2,3)	
n_2	0	65,535	0	1	Decimal representation: Extended Output (Bank 4,5)	

Remarks

- Bit patterns for extended I/O banks (where available) configured as inputs have no affect on the IO status.

Output Mapping Examples

Example	Command Issued (Hex version)	Bits Set	Bits Cleared
1-4 axis Set all outputs	OP255 (OP$FF)	1-8	-
5-8 axis Set all outputs	OP65535 (OP$FFFF)	1-16	-
Clear all outputs	OP0 (OP$0000)	-	1-16
Alternating on/off	OP43690 (OP$AAAA)	2,4,6,8,10,12,14,16	1,3,5,7,9,11,13,15
Set High Byte	OP65280 (OP$FF00)	9-16	1-8
Set Low Byte	OP255 (OP$00FF)	1-8	9-16

- Extended I/O points are updated once per sample. After issuing this command, one sample must pass before the output is updated.

Examples

```
'Galil DMC Code Example
OP 0;'   Clear Output Port -- all bits
OP $85;' Set outputs 1,3,8 and clear the others
MG _OP0;' Returns the parameter "n0"
```

Remarks

- Bit patterns for extended I/O banks (where available) configured as inputs have no affect on the IO status.

Output Mapping Examples

Example	Command Issued (Hex version)	Bits Set	Bits Cleared
1-4 axis Set all outputs	OP255 (OP$FF)	1-8	-
5-8 axis Set all outputs	OP65535 (OP$FFFF)	1-16	-
Clear all outputs	OP0 (OP$0000)	-	1-16
Alternating on/off	OP43690 (OP$AAAA)	2,4,6,8,10,12,14,16	1,3,5,7,9,11,13,15
Set High Byte	OP65280 (OP$FF00)	9-16	1-8
Set Low Byte	OP255 (OP$00FF)	1-8	9-16

- Extended I/O points are updated once per sample. After issuing this command, one sample must pass before the output is updated.

Examples

```
'Galil DMC Code Example
OP 0;'   Clear Output Port -- all bits
OP $85;' Set outputs 1,3,8 and clear the others
MG _OP0;' Returns the parameter "n0"
```


OP applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

OT *Off on encoder failure time*

OTm= n
OT n,n,n,n,n,n,n,n

Usage	OTm= n	Arguments specified with a single axis mask and an assignment (=)
	OT n ...	Arguments specified with an implicit, comma-separated order
Operands	_OTm	Operand holds the value last set by the command

Description

The OT command sets the timeout time for the encoder failure routine. The command sets the time in samples that the encoder failure 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	1	32,000	30	1	Number of samples for error detection	

Remarks

- Encoder error detection is based 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.
- See the OA command for more details on this error detection mode

Examples

```
'Galil DMC Code Example
OTD= 400;'   Set D axis encoder error timeout to 400 samples
OT 100,200;' Set A axis to 100 and B axis to 200 sample timeouts
```

```
'Galil DMC Code Example
#setup
OTA= 10;'  Set time to 10 milliseconds
OVA= 5;'   Set voltage to 5
OAA= 1;'   Enable encoder detection feature
EN
```

```
'Galil DMC Code Example
REM #POSERR example for checking to see if encoder failure occured
REM This procedure is needed because the stop code will only update if
REM the profilier is running at the time 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
```

OT applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806,EDD37010

OV *Off on encoder failure voltage*

OVm= n
OV n,n,n,n,n,n,n,n

Usage	OVm= n	Arguments specified with a single axis mask and an assignment (=)
	OV n ...	Arguments specified with an implicit, comma-separated order
Operands	_OVm	Operand holds the value last set by the command

Description

The OV command sets the threshold voltage for detecting an encoder failure. The controller can detect a failure on either or both channels of the encoder.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9.9982	0.9438	20/65,536	Torque voltage to trigger encoder error detection	

Remarks

- Encoder error detection 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 recommended to have a non-zero value for KI.
- The value of OV should be high enough to guarantee that the motor would overcome any static friction in the system. 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.
- See the OA command for more details on this error detection mode

Examples

```
'Galil DMC Code Example
OVB= 1.2;' Set B axis encoder detection torque value to 1.2V
OV 0.54;'  Set A axis encoder detection torque value to 0.54V
```

```
'Galil DMC Code Example
#setup
'setup the encoder error detection
OTA= 10;'  Set time to 10 milliseconds
OVA= 5;'   Set voltage to 5
OAA= 1;'   Enable encoder detection feature
EN
```

```
'Galil DMC Code Example
REM #POSERR example for checking to see if encoder failure occured
REM This procedure is needed because the stop code will only update if
REM the profilier is running at the time 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
```

OV applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806,EDD37010

P2CD *Serial port 2 code*

P2CD

Usage	variable= P2CD	Holds a value
Operands	P2CD	Operand has special meaning, see Remarks

Description

P2CD returns the status of the auxiliary serial port (port 2). The value of P2CD returns zero after the corresponding string or number is read.

Arguments

P2CD is an operand that holds a value cooresponding to status. See Examples for use in code.

Remarks

- P2CD contains the following status codes

P2CD Status Codes

Status Code	Meaning
-1	Mode disabled
0	Nothing received
1	Received character, but not carriage return
2	received a string, not a number
3	received a number

Examples

```
'Galil DMC Code Example
:^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
```

P2CD applies to DMC50000,DMC4000,DMC4200,DMC4103

P2CH *Serial port 2 character*

P2CH

Usage	variable= P2CH	Holds a value
Operands	P2CH	Operand has special meaning, see Remarks

Description

P2CH returns the last character received by the controller's auxiliary serial port (port 2)

Arguments

P2CH is an operand that holds a value cooresponding to ASCII characters received by the serial port. See Examples for use in code.

Remarks

- None

Examples

```
'Galil DMC Code Example
:^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
:
```

P2CH applies to DMC50000,DMC4000,DMC4200,DMC4103

P2NM *Serial port 2 number*

P2NM

Usage	variable= P2NM	Holds a value
Operands	P2NM	Operand has special meaning, see Remarks

Description

P2NM returns the last number (followed by carriage return) sent to auxiliary serial port (port 2).

Arguments

P2NM is an operand that holds a numerical value received by the controller's serial port. See Examples for use in code.

Remarks

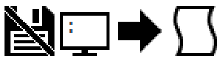
- Converts from ASCII (e.g. "1234") to binary so that a number can be stored into a variable and math can be performed on it.
    - Numbers from -2147483648 to 2147483647 can be processed.

Examples

```
'Galil DMC Code Example
:^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,  buttons were pushed
:MG x
123.0000
:
```

P2NM applies to DMC50000,DMC4000,DMC4200,DMC4103

P2ST *Serial port 2 string*



P2ST

Usage	variable= P2ST	Holds a value
Operands	P2ST	Operand has special meaning, see Remarks

Description

P2ST returns the last string (followed by carriage return) sent to auxiliary serial port (port 2)

Arguments

P2ST is an operand that contains a string. See Examples for usage.

Remarks

- No more than 6 characters can be assessed by this operand

Examples

```
'Galil DMC Code Example
:CC 9600,0,1,0
:MG "TEST" {P2} ;'send a message to the hand terminal
:MG P2ST {S3} ;'the characters ABC were entered
ABC
```

P2ST applies to DMC50000,DMC4000,DMC4200,DMC4103

PA *Position Absolute*

PAm= n
PA n,n,n,n,n,n,n,n

Usage	PAm= n	Arguments specified with a single axis mask and an assignment (=)
	PA n ...	Arguments specified with an implicit, comma-separated order
Operands	_PAm	Operand has special meaning, see Remarks

Description

The PA command sets the end target of the Position Absolute Mode of Motion.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Absolute position target for independant move	n=? returns the commanded position at which motion last stopped

Remarks

- The position is referenced to the absolute zero position, defined as position 0.
- By default a new PA command may not be issued before the previous PA command has finished executing. This operation may be changed by running in Position Tracking Mode - See the PT command for more information.

Operand Usage

- _PAm contains the last commanded position at which motion stopped.

Examples

```
'Galil DMC Code Example
: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.
```

```
'Galil DMC Code Example
DP10000;'   set current position to 10000
PA3000;'    move to absolute position 3000, which is a -7000 count move
BGA;'       begin -7000 count move
EN
```

PA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

PF *Position Format*

PF $n_0.n_1$

Usage	PF n ...	Arguments specified with an implicit, comma-separated order
Operands	_PF	Operand holds the value last set by the command

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 decimal 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-8	10	10	1	Number of places displayed preceding the decimal point	Negative numbers force data to display in hexadecimal format
n_1	0	4	0	1	Number of places displayed after the decimal point	

Remarks

- If PF is minus, 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 formats the values returned from the following commands:

BL?	IP ?	TD
DE ?	LE ?	TE
DP ?	PA ?	TN
EM ?	PR ?	TP
FL ?	RL	VE
GP	RP	

Examples

```
'Galil DMC Code Example
:DP 21;'  Set position of A axis for example
:TP A;'   Tell position of A in default format
 21
:PF 5.2;' Change format to 5 digits of integers and 2 of decimal
:TP A
 21.00
:PF-5.2;' Change format to hexadecimal
:TP A
$00015.00
```

PF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

PL *Pole*

PLm= n
PL n,n,n,n,n,n,n,n

Usage	PLm= n	Arguments specified with a single axis mask and an assignment (=)
	PL n ...	Arguments specified with an implicit, comma-separated order
Operands	_PLm	Operand holds the value last set by the command

Description

The PL command adds a low-pass filter in series with the PID compensation.

The crossover frequency is entered directly as an argument to PL. To maintain compatibility with earlier versions, a value less than 1 may also be specified.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	250	0	1	Crossover frequency created by the PL command	'Max' is a function of TM. See Remarks. n = 0 disables the Pole filter.
	0	0.9999	0	2/65,536	Value used to generate pole filter crossover frequency	See Remarks for the equation used. n = 0 disables the Pole filter

Remarks

- At lower TM settings, the maximum pole frequency is increased. The maximum value of the PL command is determined by the value of TM according to the following equation
  - Max = (1/4 * 10^6) * (1/TM)
- 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.

Calculated Pole

- To convert from the desired crossover (-3 dB) frequency in Hertz to the value given to PL, use the following formula

$$n = e^{-T \bullet f_c \bullet 2\pi}$$

- where
  - n is the argument given to PL (less than 1)
  - 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
- The following shows several example crossover frequencies achieved with various values of PL

n	Fc (Hz)
0	Infinite (off)
0.2	256
0.4	145
0.6	81
0.8	36
0.999	0

Examples

```
'Galil DMC Code Example
'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
```

PL applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

PR *Position Relative*

PRm= n
PR n,n,n,n,n,n,n,n

Usage	PRm= n	Arguments specified with a single axis mask and an assignment (=)
	PR n ...	Arguments specified with an implicit, comma-separated order
Operands	_PRm	Operand holds the value last set by the command

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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	-2,147,483,648	2,147,483,647	N/A	1	Incremental distance for independent move	n = ? returns the current incremental distance specified

Remarks

- _PRm contains the current incremental distance for the specified axis.

Examples

```
'Galil DMC Code Example
: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.
```

```
'Galil DMC Code Example
'using PA/PR, you can query PR for the incremental distance
:DP 10000
:PA 8000
:PR ?
-2000
```

PR applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

PT *Position Tracking*

PTm= n
PT n,n,n,n,n,n,n,n

Usage	PTm= n	Arguments specified with a single axis mask and an assignment (=)
	PT n ...	Arguments specified with an implicit, comma-separated order
Operands	_PTm	Operand holds the value last set by the command

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 that begin motion immediately without requiring a BG command. The absolute position may be specified such that the axis will begin motion, continue in the same direction, reverse directions, or decelerate to a stop

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	Setting for position tracking mode of motion	n = 1 enables PT mode, n = 0 disables PT mode

Remarks

- 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 motion profile is trapezoidal with the parameters controlled by acceleration, deceleration, and speed (AD, DC, SP).
- When in the PT mode the ST command will exit the mode.
- The AM and MC trip points are not valid in this mode.
  - MF and MR are recommended with this mode as they allow the user to specify both the absolute position, and the direction. The AP trip point may also be used.
- Position Tracking is not valid on virtual axes

Examples

```
'Galil DMC Code Example
DPA= 0;'   Start position at absolute zero
PTA= 1;'   Start PT mode on A axis
PA 1000;'  Move to position 1000, motion starts right away
MF 500;'   Wait till position 500 reached
PA -1000;' Reverse direction to move to position -1000
EN
```

```
'Galil DMC Code Example
#A
 PT 1,1,1,1;'         Enable the position tracking mode for axes A, B, C, and D
'                     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 ABCD 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 variable 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
```

PT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

PV *PVT Data*

PVm= n0,n1,n2

Usage	PVm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_PVm	Operand has special meaning, see Remarks

Description

The PV command is used to enter PVT data into the PVT buffer. Data is entered by specifying the target delta position, target velocity, and delta time for the segment duration.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n_0	-44,000,000	44,000,000	0	1	Position target for PVT segment	
n_1	-22,000,000	22,000,000	0	2	Velocity target for PVT segment	
n_2	0	2,048	0	2	Number of samples for PVT segment	n_2 = -1 clears the PVT buffer, n_2 = 0 exits PVT mode. See Remarks

Remarks

- n_2 is in samples and sample time is defined by TM
  - With TM 1000 set, n_2 = 1024 is equal to 1 second
- If t is omitted from the PVT command, the previous n_2 value is used
- For more details on PVT mode of motion see the user manual.

Operand Usage

- _PVm contains the number of spaces available in the PV buffer for the specified axis. Each axis has a 255 segment PVT buffer

Examples

```
'Galil DMC Code Example
PVA= 100,2000,256;'   Move 100 counts over 256 samples, end at 2000 cnts per sec
PVA= 500,1000,128;'   Move 500 counts over 128 samples, end at 1000 cnts per sec
PVA= 1000,2500;'      Move 1000 counts over 128 samples, end at 2500 cnts per sec
PVA= 0,0,0;'          End PVT mode
```

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

```
'Galil DMC Code Example
DP0,0;'              Define zero position
PVA=100,200,256;'     Command X axis to move 100 counts reaching an ending speed of 200c/s in 256 samples
PVB=-50,500,100;'     Command Y axis to move -50 counts reaching an ending speed of 500c/s in 100 samples
PVB=-100,-100,510;'   Command Y axis to move -100 counts reaching an ending speed of -100c/s in 510 samples
PVA=200,200,50;'      Command X axis to move 200 counts reaching an ending speed of 200c/s in 50 samples
PVA=300,0,50;'        Command X axis to move 300 counts reaching an ending speed of 0c/s in 50 samples
PVB=300,0,50;'        Command Y axis to move 300 counts reaching an ending speed of 0c/s in 50 samples
PVB=,,0;'             Exit PVT mode on Y axis
PVA=,,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)
BTAB;'                Begin PVT on X and Y axis
AMAB;'                Trip point will block until PVT motion on X AND Y is complete
EN;'                 End program
```

PV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010

PW *Password*

PW str,str

Usage	PW n ...	Arguments specified with an implicit, comma-separated order

Description

The PW command sets the password used to lock the controller. Locking the controller prevents interrogation of the controller program space.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	0 chars	8 chars	""	String	String to be used for password	Both parameters must match for the PW command to succeed.

Remarks

- The password can only be changed when the controller is in the unlocked state. See the ^L^K for more details.
- The password is burnable but cannot be interrogated. If you forget the password and the controller is locked you must master reset the controller to gain access.
- Quotes are not used to frame the password string. If quotes are used, they are part of the password.

Examples

```
'Galil DMC Code Example
:PWapple,orange
?
:TC1
138 Passwords not identical
:PWapple,apple
:^L^K apple,1
```

```
'Galil DMC Code Example
:PWtest,test;'          Set password to "test"
:^L^K test,1;'          Lock the program
:ED;'                   Attempt to edit program
?
:TC1
106 Privilege violation
```

PW applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000,DMC1806

QD *Download Array*

`QD str[],n0,n1`

Usage	QD n ...	Arguments specified with an implicit, comma-separated order

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	N/A	String	Name of array to receive data via download.	
n_0	0	see Notes	0	1	Index of the first array element.	Value cannot exceed size of array - 2
n_1	1	see Notes	see Notes	1	Index of the last array element.	Value cannot exceed size of array - 1. Defaults to size of array - 1.

Remarks

- Array name must be a valid, dimensioned array name followed by empty [] brackets.
- The array elements may be separated by a comma (,), a carriage return (\r), or a carriage return and line feed (\r\n). Do not use spaces.
- The downloaded array is terminated by a \ character.
- QD is not supported in the terminal of Galil software packages.
  - It is recommended to use the array download functions available through the Galil software and drivers rather than directly using the QD command.
- Issuing this command will pause the output of the Data Record until the command is completed.

Examples

```
'Galil DMC Code Example
:'From a character-buffered terminal such as Telnet or Hyperterm
:DM array[3]
:QD array[]
1,2,3\:LA
array[3]
:array[0]=?
 1.0000
:array[1]=?
 2.0000
:array[2]=?
 3.0000
:
```

QD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

QH *Query Hall State*

QH mm

Usage	QH mm	Argument is an axis mask
Operands	_QHm	Operand has special meaning, see Remarks

Description

The QH command transmits the state of the Hall sensor inputs. The value is decimal and represented by a 3 bit value (see Remarks).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to return Hall status	

Remarks

- The 3 bit value returned by QH is defined in the table below:

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

- QH should return a value from 1 through 6 as valid Hall combinations. A value of 0 or 7 is invalid when using Hall sensors and will generate a Hall error with OE set.
  - The valid sequence for Hall inputs is a greycode output (only one bit changes at a time):
    - 1,3,2,6,4,5 (or 5,4,6,2,3,1)
  - To disable Hall error checking, set the axis to brushed with a BR 1 command.
- When using an internal sine amplifier, the BA command must be issued before QH will report the Hall state status.

Operand Usage

- _QHm Contains the state of the Hall sensor inputs for the specified axis

Examples

```
'Galil DMC Code Example
QHA;'       Query the A axis Hall state
var=_QHB;'  Set a variable var equal to the B axis Hall state
```

```
'Galil DMC Code Example
:QHA;'   Query A axis Hall status
7
:TA1;'   Check for Hall errors in the amp
1
:'A 1 indicates Hall error on axis A
```

QH applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,EDD37010

QQ *Clear Sample Time Overflow*

QQ

Usage	QQ	Command takes no arguments
Operands	_QQ	Operand has special meaning, see Remarks

Description

QQ is used along with #FWERR to detect a sample overflow. Many features require that the controller perform an action every sample. Running many of these features simultaneously can lead to there not being enough time to complete every action. See remarks for a list of these features. In the event that a sample overflow occurs, the QQ command is used to report and clear this error. For the majority of applications, this will never occur. This behavior should only occur when running a low sample time (TM) and using absolute encoders with a high number of bits at a low clock frequency.

Arguments

The QQ command has no arguments.

Remarks

- If the servo sample has not yet overflowed, the value of _QQ will be 0.
- If the servo sample has overflowed and not yet been cleared, _QQ will be 1.
- The following are features, and their associated DMC comands, which add a non-negligible amount of time to the servo sample calculations.
    - Serial Encoders (SI/SS)
    - Analog Encoders (AF)
    - Notch Filter (NF,NZ,NB)
    - Low Sample Time setting (TM)

Examples

```
'Galil DMC Code Example
'Code detects a checksum error and notifies the user
#FWERR
MG "Interrupt overflow event occurred:" ,_QQ; 'printing the _QQ operand showing that the interrupt has overflown
QQ; 'returns the _QQ operand to 0
MG "Shutdown for diagnostics"
EN
```

QQ applies to DMC4000,DMC4103,DMC30010

QR *I O Data Record*

QR mm
QR

Usage	QR mm	Argument is an axis mask

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

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGHSTI	ABCDEFGHSTI	Multi-Axis Mask	Axes/Coordinated/IO data specified to display in the data record	If no argument entered, mm = "ABCDEFGHSTI"

Argument	Value	Description	Notes
mm	A-H	Output axes A-H data record block	
	S	Output coordinated axis S data block	
	T	Output coordinated axis T data block	
	I	Output General IO data block	

Remarks

- The data returned by the QR command is in binary format
  - Galil API has specialized commands to parse the data record packet. See the API documentation for more details.

Examples

```
'Galil DMC Code Example
QR A;'   Return the data record with A axis block only
QR BI;'  Return the data record with B axis block and IO block
QR ST;'  Return the data record with S and T coordinated axis blocks
QR;'    Return the data record for all axes, including IO and S and T axis blocks
```

QR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

QS *Error Magnitude*

QS mm

Usage	QS mm	Argument is an axis mask
Operands	_QSm	Operand has special meaning, see Remarks

Description

The QS command reports the magnitude of error, in drive step counts, for axes in Stepper Position Maintenance mode. A step count is directly proportional to the micro-stepping resolution of the stepper drive.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to query for step motor error magnitude	Default value used if mm is undefined.
m	A	H	N/A	Axis	Single Axis to query for error magnitude	

Remarks

- 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
- If present in embedded code, command execution will jump to #POSERR when QS is equal to 3 full motor steps (_YAm * 3)
- QSm=? will return the current error for axis m

Operand Usage

- _QSm contains the error magnitude in drive step counts for the specified axis.

Examples

```
'Galil DMC Code Example
'For an SDM-20620 microstepping drive, query the error of B axis:
:QSB
 253
:' Above shows 253 step counts of error.
:' The SDM-20620 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
```

QS applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

QU *Upload Array*

QU str[],n_0,n_1,n_2

Usage	QU n ...	Arguments specified with an implicit, comma-separated order

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	N/A	String	Name of array to be uploaded	
n_0	0	see Notes	0	1	Index of first array element	Value cannot exceed size of array - 2
n_1	1	see Notes	see Notes	1	Index of last array element	Defaults to last element of array. Value cannot exceed size of array - 1
n_2	0	1	0	1	Selects character delimiter between array elements	n_2 = 0 selects CR delimiting. n_2 = 1 select comma delimiting.

Remarks

- Array name must be a valid, dimensioned array name followed by empty [] brackets.
- The uploaded array will be followed by a <control>Z as an end of text marker.
- Issuing this command will pause the output of the Data Record until the command is completed.

Examples

```
'Galil DMC Code Example
DM test[10];'     Dimension a 10 element sized array
QU test[],0,1,1;' Upload first 2 elements
QU test[],8,9,1;' Upload last 2 elements (size-2 and size-1 used for n1,n2)
EN
```

```
'Galil DMC Code Example
: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
```

QU applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

QZ *Return Data Record information*

QZ

Usage	QZ	Command takes no arguments

Description

The QZ command is an interrogation command that returns information regarding the data record. The controller's response to this command will be the return of 4 integers separated by commas.

Arguments

QZ is an interrogation command with no parameters.

Remarks

- The four fields returned by QZ represent the following:
    1. First field returns the number of axes.
    2. Second field returns the number of bytes to be transferred for general status
    3. Third field returns the number of bytes to be transferred for coordinated move status
    4. Fourth field returns the number of bytes to be transferred for axis specific information

Examples

```
'Galil DMC Code Example
:QZ;'            standard DMC-4143 example response
 4, 52, 26, 36
```

QZ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RA *Record Array*

RA str[ ],str[ ],str[ ],str[ ],str[ ],str[ ],str[ ],str[ ]

Usage	RA n ...	Arguments specified with an implicit, comma-separated order

Description

The RA command selects the user arrays to be populated by the Record Array function. The data to be captured is specified by the RD command and time interval by the RC command.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	N/A	String	Valid array name to use in record array function	The arrays listed correspond to the source list defined by the RD command. See Remarks

Remarks

- The array name str must be followed by the [] brackets. Those brackets must be empty.
- The array name str must be a valid array defined by the DM command and reported by LA.

Examples

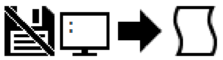
```
'Galil DMC Code Example
'  try to start record array without defining array[]
:RA array[]
?
:TC1
82 Undefined array
:DM array[100]
:RA array[]
```

```
'Galil DMC Code Example
#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

'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.
```

RA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RC *Record*



RC n_0, n_1

Usage	RC n ...	Arguments specified with an implicit, comma-separated order
Operands	_RC	Operand has special meaning, see Remarks

Description

The RC command begins recording for the Automatic Record Array Mode. RC 0 stops recording. The record array mode loads source data specified by the RD command into the arrays defined by the RA command. The address for the array element for the next recording can be interrogated with _RD.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	8	0	1	Specify the record array time interval as 2^n samples.	n_0 = 0 stops recording.
n_1	see Notes	see Notes	0	1	Specify the number of records to perform	n_1 has special rules for the maximum setting. See Remarks.

Remarks

- Do not allocate or deallocate arrays (DM,DA) while the Automatic Record Array Mode is running.
- Do not attempt to download arrays from a host application while automatic record array mode is running.

- n_0 = non zero number automatically starts record mode.
- n_0 = ? returns status of recording. '1' if recording, '0' if not recording.

Second Parameter Rules

- n_1 specifies the last array element to use for record mode.
- If arrays specified by RA have different sizes, the smallest array size is the maximum value for n_1
- If n_1 = 0 or not specified, the maximum value is used.
- A negative value for n_1 specifies circular (continuous) record over array addresses 0 to (n_1-1).
  - The absolute value of the minimum n_1 allowed = maximum n_1 allowed

Operand Usage

- _RC contains status of recording. '1' if recording, '0' if not recording.

Setting up the record array mode

1. Dimension an array/arrays for storing data. Make sure you dimension the array with the number of elements required to capture data for your application.
2. Set the RA command with the arrays to be used for recording.
3. Set the RD command with the data sources to be applied to the arrays. The order of your arrays entered into RA will match the order of data sources set by RD.
4. Set the RC command to get the desired time between records and enable the recording.
5. Monitor the _RC operand for a 0 to indicate recording is done.

Examples

```
'Galil DMC Code Example
#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
```

RC applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RD *Record Data*

RD arg, arg, arg, arg, arg, arg, arg, arg

Usage	variable= RD	Holds a value
Operands	_RD	Operand has special meaning, see Remarks

Description

The RD command specifies the data type to be captured for the Record Array (RA) mode. The data defined in this command is stored in arrays defined by the RA command at the time interval specified with the RC command.

Arguments

Valid arguments for RD command

Argument	Value	Description	Notes
arg	TIME	Time in servo samples	Value as read by the TIME command
	_AFm	Analog input digital value	Data range is -32768 to 32767. The analog inputs are limited to those which correspond to an axis on the controller. **Syntax Note:** Unlike the operand _AFm, the symbol _AFm in the context of RD records the ADC value, not the AF setting.
	_DEm	Auxiliary encoder position	_DEm and _TDm capture the same data
	_OP	Output status	
	_RLm	Latched position	
	_RPm	Commanded position	_RPm and _SHm capture the same data
	_SCm	Stop code	
	_SHm	Commanded position	_RPm and _SHm capture the same data
	_TDm	Auxiliary encoder position	_DEm and _TDm capture the same data
	_TEm	Position error	
	_TI	Input status	
	_TPm	Encoder position	
	_TSm	Switches	Only bits 0-4 valid
	_TTm	Torque command	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.
	_TVm	Filtered velocity	This value will be 64 times greater than TV command

Remarks

- Arguments listed as _XXm are valid when m is a valid axis mask
- The order of args specified in RD corresponds with the array order specified in the RA command.
- the operand _RD contains the address for the next array element for recording.
- When recording _AFm, the returned value is signed. This means that when AQ is used to set unipolar inputs, values on the upper half of the voltage range are sign extended. Anding the value with $0000FFFF will return the expected unsigned value.

Examples

```
'Galil DMC Code Example
DM errora[50],errorb[50];'      Define arrays
RA errora[],errorb[];'          Specify arrays to be recorded
RD _TEA,_TEB;'                  Specify data source
RC 1;'                          Begin recording, period is once every other servo sample
JG 1000;BG;'                    Begin motion
```

RD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RE *Return from Error Routine*

RE n

Usage	RE n ...	Arguments specified with an implicit, comma-separated order

Description

The RE command is used to end subroutines in application code. An RE at the end of these routines causes a return to the main program. Specific automatic error subroutines require the use of the RE command to end the code correctly.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	1	0	1	Determines state of interrupted trippoint when returning from an automatic subroutine.	n = 1 restores the interrupted trippoint. n = 0 clears the trippoint

Remarks

- The RE command is used to end the following error automatic subroutines.

Automatic Subroutines Used	Notes
#AMPERR	Only when using internal amps
#LIMSWI	
#POSERR	
#SERERR	Only when equipped with serial encoder firmware support
#TCPERR	

- Care should be taken to ensure the error conditions are cleared when finishing the subroutine to avoid immediate re-entering of the error routine.
- To avoid returning to the main program on an interrupt, use the ZS command to zero the subroutine stack, then use JP to return to the desired location in code.
- RE 1 restores the trippoint that was interrupted by an automatic subroutine (like WT)
    - A motion trippoint like MF or MR requires the axis to be actively profiling in order to be restored with the RE 1 command.

Examples

```
'Galil DMC Code Example
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
```

RE applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

REM *Remark*

REM str

Description

REM is used for comment lines. 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.

Arguments

Argument	Value	Description	Notes
str	String	Comment to be removed from code prior to download	This comment is not limited by the character limit of the controller, as it is never downloaded

Remarks

- REM differs from NO (or ') in the following ways:
  - NO (or ') comments are downloaded to the controller and REM comments are not.
  - NO (or ') comments take up execution time and REM comments don't; therefore, REM should be used for code that needs to run fast.
  - REM comments cannot be recovered when uploading a program but NO (or ') comments are recovered. Thus the uploaded program is less readable with REM.
  - NO (or ') comments take up program line space and REM lines do not.
  - 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.

Examples

```
'Galil DMC Code Example
REM This comment will be stripped when downloaded to the controller
'This comment will be downloaded and takes some execution time
PRX=1000 ;'this comment is to the right of the code
```

REM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RI *Return from Interrupt Routine*

RI n

Usage	RI n ...	Arguments specified with an implicit, comma-separated order

Description

The RI command is used to end the input interrupt subroutine.

The input interrupt subroutine begins with the label #ININT. An RI at the end of this routine causes a return to the main program.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	1	0	1	Determines state of interrupted trippoint when returning from an automatic subroutine.	n = 0 clears the trippoint. n = 1 restores the interrupted trippoint.

Remarks

- 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. Refer to Application Note 2418.
  - http://www.galil.com/download/application-note/note2418.pdf
- If the program sequencer was interrupted while waiting for a trippoint, such as WT, RI 1 restores the trippoint on the return to the program. RI 0 clears the trippoint.

- A motion trippoint like MF or MR requires the axis to be actively profiling in order to be restored with the RI1 command.
- The RI command re-enables input interrupts.

Examples

```
'Galil DMC Code Example
#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
```

RI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

RL *Report Latched Position*

RL mm

Usage	RL mm	Argument is an axis mask
Operands	_RLm	Operand has special meaning, see Remarks

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 the appropriate input must be activated. Each axis uses a specific general input for the latch input; see the AL command for information on latch inputs.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to query for latched position	

Remarks

- The armed state of the latch can be configured using the CN command.
- The Latch Function works with the main or auxiliary encoder.

- See the DMC-4000 user manual for a description of RL with sinusoidal encoders (-SIN firmware).

Capturing Stepper Position using the Latch

- When working with a stepper motor without an encoder, the latch can be used to capture the stepper position. Follow the steps below to achieve this.

1. Place a wire from the controller Step (PWM) output into the main encoder input, channel A+.
2. Connect the Direction (sign) output into the channel B+ input.
3. Configure the main encoder for Step/Direction using the CE command.
4. The latch will now capture the stepper position based on the pulses generated by the controller.

Operand Usage

- _RLm contains the latched position of the specified axis.

Examples

```
'Galil DMC Code Example
:JG ,5000;' Set up to jog the B-axis
:BG B;'    Begin jog
:AL B;'    Arm the B latch, assume that after about 2 seconds, input goes low
:RL B;'    Report the latch
10000
```

RL applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

RP *Reference Position*

RP mm

Usage	RP mm	Argument is an axis mask
Operands	_RPm	Operand has special meaning, see Remarks

Description

The RP command returns the commanded reference position of the motor(s). RP command is useful when operating step motors since it provides the commanded position in steps when operating in stepper mode.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report commanded position	
	M	N	N/A	Multi-Axis Mask	Virtual axes to report commanded position	

Remarks

- The relationship between RP, TP and TE: TE equals the difference between the reference position, RP, and the actual position, TP.
  - TE = RP - TP
- _RPm contains the commanded reference position for the specified axis.

Examples

```
'Galil DMC Code Example
'Assume that A axis is commanded to be at the position 200
'The returned units are in quadrature counts.
:PF 7;' Position format of 7
:RP
200
:RPA
200 Return the A motor reference position
:PF-6.0;' Change to hex format
:RP
$0000C8
:position =_RPA;' Assign the variable, position, the value of RPA
```

```
'Galil DMC Code Example
'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.
:PF 7;' Position format of 7
:RP;'   Return A,B,C,D reference positions
200,-10,0,-110
:RPA
200 'Return the A motor reference position
:RPB
-10 'Return the B motor reference position
:PF-6.0;' Change to hex format
:RP
$0000C8,$FFFFF6,$000000,$FFFF93 'Return A,B,C,D in hex
:Position =_RPA;' Assign the variable, position, the value of RPA
```

```
'Galil DMC Code Example
:GAN;'     make A axis slave to N imaginary axis
:GR-1;'    1:-1 gearing
:SPN=10000
:PRN=10000
:BGN;'     Begin motion
:RPN;'     Get master position
 10000
:RPA;'     Get slave commanded position
-10000
```

RP applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

RS *Reset*

RS n

Usage	RS n ...	Arguments specified with an implicit, comma-separated order
Operands	_RS	Operand has special meaning, see Remarks

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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	-1	0	0	1	Set behavior of RS command	n = 0 peforms normal reset. n = -1 performs soft master reset. See Remarks.

RS has no arguments.

Remarks

- A soft master reset performed by issuing RS -1 restores factory default settings without erasing the EEPROM. To restore saved EEPROM settings use RS with no arguments, or RS 0.

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 shown by _RS in firmware, it is not loaded and the controller will boot to monitor mode.
  - The #AUTOERR automatic subroutine will run if this error occurs and the subroutine is located in the program space.

Examples

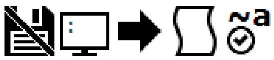
```
'Galil DMC Code Example
:RS;'     Reset the hardware

:RS-1;'   Perform a soft master reset

:
```

RS applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

SA *Send Command*



SAm= str
SAm= str,n,n,n,n,n,n,n,n

Usage	SAm= n	Arguments specified with a single axis mask and an assignment (=)

Description

SA sends a command, and optionally receives a response, from one controller to another via Ethernet.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Handle	Handle to specify for message output	
str	1 char	74 chars	""	String	String to send over handle	
n	-2,147,483,648	2,147,483,647	0	1	Value to send for the specified parameter	

Remarks

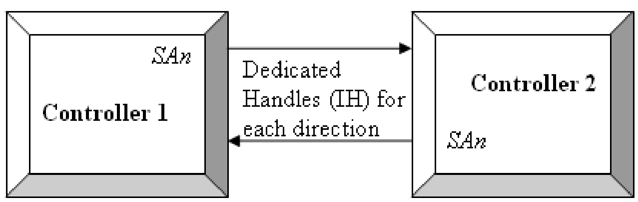
- Strings are encapsulated by quotations. This will typically begin an SA command.
- n is a number, controller operand, variable, mathematical function, or string. The range for numeric values is 4 bytes of integer followed by two bytes of fraction.
- Typical usage would have the first argument as a 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
  - SA automatically adds commas between two number values being sent.

- There is a 78 character maximum payload length for the SA command.

Operational Notes

1. SA is non-blocking. A wait (e.g. WT10) must occur between successive calls to SA.
2. When writing multi-threaded DMC code, send all traffic from only one thread.
3. SA command functionality is provided to assist with controller to controller communications under error handling conditions. Recommended commands for use with SA include, but are not limited to: HX, XQ, ST, and AB. Please contact a Galil Applications Engineer for additional details.

1. SA is not valid over a handle configured for Modbus (port 502).



Operand Usage

- _SAmn gives the value of the response to the command sent with an SA command.
  - The m 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 -2^31.

Examples

```
'Galil DMC Code Example
#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
EN;'                End Program
```

SA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

SB *Set Bit*

SB n

Usage	SB n ...	Arguments specified with an implicit, comma-separated order

Description

The SB command sets a particular digital output. The SB and CB (Clear Bit) instructions can be used to control the state of output lines.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	16	N/A	1	General output bit to be set	Max value is 8 for 1-4 axis controllers
n	17	48	N/A	1	Extended I/O output bit to be set	I/O must be configured for outputs, see CO command
n	1,000	8,999	N/A	1	Set Modbus slave bit	See "SB via Modbus Slave" in Remarks

Remarks

- The state of the output can be read with the @OUT[] command.
- Extended I/O points are updated once per sample. After issuing this command, one sample must pass before the output is updated.

Using SB with a Modbus Slave

- n = (SlaveAddress*10000) + (HandleNum*1000) + ((Module-1)*4) + (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 where A is 1, B is 2 and so on.
  - 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

Examples

```
'Galil DMC Code Example
SB 5;'     Set digital output 5
SB 1;'     Set digital output 1
CB 5;'     Clear digital output 5
CB 1;'     Clear digital output 1
EN
```

```
'Galil DMC Code Example
#modbus
REM connect to modbus slave at IP address 192.168.42.50
IHH=192,168,42,50<502>2
WT100
SB 8001;'set bit 1 on modbus slave
WT 10
CB 8003;'set bit 3 on modbus slave
EN
```

For detailed information on connecting to a Modbus slave, see:
http://www.galil.com/news/dmc-programming-io-control/setting-rio-pocket-plc-or-generic-modbus-slave-extended-io

SB applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

SC *Stop Code*

SC mm

Usage	SC mm	Argument is an axis mask
Operands	_SCm	Operand has special meaning, see Remarks

Description

The Stop Code command returns a number indicating why a motor has stopped.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	N/A	Multi-Axis Mask	Axis to query stop code	Omitting argument shows stop code for all axes

Remarks

- When SC is issued, the controller reponds with a number for the axis queried. The number is 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) (For controllers supporting OA/OV/OT)
15	Amplifier Fault (For controllers with internal drives)
16	Stepper position maintenance error
30	Running in PVT mode
31	PVT mode completed normally
32	PVT mode exited because buffer is empty
50	Contour Running
51	Contour Stopped
60	ECAM Running
61	ECAM Stopped
70	Stopped due to EtherCAT communication failure
71	Stopped due to EtherCAT drive fault
99	MC timeout
100	Vector Sequence running
101	Vector Sequence stopped

- _SCm contains the value of the stop code for the specified axis.

Examples

```
'Galil DMC Code Example
tom =_SCA;'      Assign the Stop Code of A axis to variable tom
```

```
'Galil DMC Code Example
:JG10000
:BGA
:SCA
 0             //Axis is running in independent mode
:STA
:SCA
 4             //Axis is stopped by ST command
:
```

SC applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

SD *Limit Switch Deceleration*

SDm= n
SD n,n,n,n,n,n,n,n

Usage	SDm= n	Arguments specified with a single axis mask and an assignment (=)
	SD n ...	Arguments specified with an implicit, comma-separated order
Operands	_SDm	Operand holds the value last set by the command

Description

The Limit Switch Deceleration command (SD) sets the linear deceleration rate of the motors when a limit switch has been reached.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	1,024	1,073,740,800	256,000	1,024	Value of switch deceleration	Resolution changes with TM, see Remarks

Remarks

- The resolution of the SD command is dependent upon the update rate setting (TM). With the default rate of TM 1000 the resolution is 1024 cnts/second^2. The equation to calculate the resolution of the AC command is:
    - Resolution = 1024*(1000/TM)^2
    - Example:
        - With TM 500 the minimum AC setting and resolution is 4096 cnts/second^2
        - resolution = 1024*(1000/500)^2 = 4096
- The SD command may be changed during the move in JG move, but not in PR or PA move.

Examples

```
'Galil DMC Code Example
#main
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
EN
```

SD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

SH *Servo Here*

SH mm

Usage	SH mm	Argument is an axis mask

Description

The SH commands tells the controller to use the current motor position as the command position and to enable servo control at the current position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to enable	

Remarks

Examples

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
'show how issuing SH clears position error
'by resetting the coordinate system
:MOA;'  disable the A axis
:TEA;'  check error on A axis
-12435
:TPA;'  Check position
 12435
:SHA;'  enable A axis, doing so clears the error
:TEA;'  check error again
 0
:TPA;'  confirm position hasn't changed
 12435
```

SH applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

SI *Configure the special Galil SSI feature*

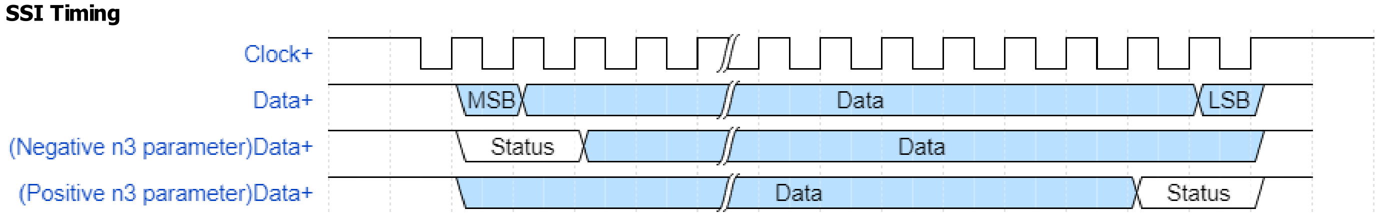
SIm = n0, n1, n2, n3 <o >p

Usage	SIm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_SIm	Operand has special meaning, see Remarks

Description

The SI command enables and configures the controller to read SSI encoder data. 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.

SSI Timing



Arguments

Argument	Min	Max	Resolution	Description	Notes
m	A	H	Axis	Axis to configure for SSI	Each axis has a dedicated SSI port *(1)*
n_0	0	2	1	Position register to use	1 = TPA, 2 = TDA, 0 = Off
n_1	12	31	1	Number of Data and Status Bits	Sign of n_1 parameter sets the position mode *(2)*
n_2	0	0	N/A	Reserved	
n_3	0	8	1	Number of status bits	Sign of n_3 parameter sets location of status bits (see timing diagram above)
o	4	26	1	Clock divider	Defines SSI Clock Frequency *(3)*
p	1	2	1	Data Encoding	1 = Binary, 2 = Gray Code

(1) SSI encoder support requires the SSI Option on either the ICM-42000 or ICM-42200 and -SER Firmware

(2) The firmware will use the position data in one of two modes:

- **Absolute Mode**, $n_1 > 0$. The controller will use the absolute position transmitted by the encoder. If the encoder exceeds its position limits, the encoder data will roll over from the maximum value to the minimum value. This discontinuity will be perceived by the controller as a large change in servo error. Absolute mode is typically used with linear encoders that have a limited range of travel.
- **Continuous Mode**, $n_1 < 0$. In this mode if the absolute position rolls over, the firmware will compensate by accounting for the roll over and counting past it. This allows for a smooth transition, avoiding the large error that occurs in Absolute Mode. Continuous mode is typically used with rotary absolute encoders. When the SS command is issued, the data first loaded into firmware will the same as in Absolute mode.

(3) Galil recommends using the lowest clock divider (highest clock frequency) possible. This will mainly be dictated by the encoder specifications and the length of the clock and data transmission lines. ** Clock frequencies *(f)* in MHz can be calculated from the clock divider (*o*) as follows: f=10/(o+1)

- *o* = 9 is a good starting value for most applications.

Remarks

- Axis must be in MO state prior to issuing the SI command.
- SIm=? will return the configuration parameters for the specified axis.
- Clocking in SSI data has a timing overhead which may be non-negligible. In the event that clocking in data will result in the controller being unable to complete all required operations, (e.g. using multiple encoders with a lowered TM sample rate) the controller will respond by turning of all serial encoders. See #FWERR and QQ for more information. This error mode is very rare, and is expected to occur only during development.

Operand Usage

- _SIm returns the value of the SSI encoder's status bits as an 8 bit bitmask. SSI status bit placement and interpretation is manufacturer specific, consult the encoder documentation for further information.

Related Commands

- DF - Dual Feedback
- DV - Dual Velocity (Dual Loop)
- TD - Tell Dual Encoder
- TP - Tell Position

Examples

```
'Galil DMC Code Example
'SSI encoder data on the A axis sent to the _TPA register
'25 total bits, 22 position data, 3 status, prepended
'1 MHz clock frequency, binary encoding
SIA= 1,25,0,-3<9>1
'message status bits to the host
MG _SIA
EN
```

SI applies to SER

SL *Single Step*

SL n

Usage	SL n ...	Arguments specified with an implicit, comma-separated order

Description

The SL command is used to single-step through a program for debugging purposes. SL can be used after execution has paused at a breakpoint (BK). The argument n allows user to specify the number of lines to execute before pausing again.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	1	255	1	1	Number of lines to execute before pausing	If n is omitted, default value used.

Remarks

- The BK command resumes normal program execution.

Examples

```
'Galil DMC Code Example
: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
```

SL applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

SM *Subnet Mask*

SM n_0,n_1,n_2,n_3
SM n

Usage	SM n ...	Arguments specified with an implicit, comma-separated order
Operands	_SM0	Operand has special meaning, see Remarks

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 10.0.000.000 will be accepted.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	255	0	1	Byte 3 of the Subnet mask	
n_1	0	255	0	1	Byte 2 of the Subnet mask	
n_2	0	255	0	1	Byte 1 of the Subnet mask	
n_3	0	255	0	1	Byte 0 of the Subnet mask	
n	-2,147,483,648	2,147,483,647	0	1	The full subnet mask specified as a signed 32 bit two's complement integer	

Remarks

- n = ? will return the subnet mask of the controller as n_0,n_1,n_2,n_3
- _SM0 contains the subnet mask representing a 32 bit signed number (Two's complement)
- Use the following equation to change the 4 byte subnet (n_0,n_1,n_2,n_3) to a single 32 bit number, n
  - n = (n_0*2^24) + (n_1*2^16) + (n_2*2^8) + n_3
- For more information, see http://www.galil.com/news/dmc-programming-software/blocking-unwanted-ethernet-devices-connecting

Examples

```
'Galil DMC Code Example
SM 255,255,255,255;' Ignore all incoming Ethernet packets
SM 0,0,0,0;' Process all incoming Ethernet packets
```

SM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,RIO47000

SP *Speed*

SPm= n

SP n,n,n,n,n,n,n,n

Usage	SPm= n	Arguments specified with a single axis mask and an assignment (=)
	SP n ...	Arguments specified with an implicit, comma-separated order
Operands	_SPm	Operand holds the value last set by the command

Description

The SP command sets the slew speed of any or all axes for independent moves.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
	M	N	N/A	Axis	Virtual axis to assign value	
n	0	22,000,000	25,000	2	Value of jog speed in cnts/second	For MT settings of 1,-1,1.5 and -1.5 (Servos) - See Remarks for Resolution details
	0	6,000,000	25,000	2	Value of jog speed in cnts/second	For MT settings of 2,-2,2.5 and -2.5 (Steppers) - See Remarks for Resolution details
	0	50,000,000	25,000	2	Vale of jog speed in cnts/second	ICM-42100 with AF>=5 - See Remarks for Resolution details

Remarks

- Negative values will be interpreted as the absolute value

Resolution

- The resolution of the SP command is dependent upon the update rate setting (TM).
  - With the default rate of TM 1000 the resolution is 2 cnts/second.
  - The equation to calculate the resolution of the SP command is:
    - resolution = 2*(1000/TM)
  - example:
    - With TM 250 the resolution of the SP command is 8 cnts/second
    - resolution = 2*(1000/250) = 8

Examples

```
'Galil DMC Code Example
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
'
'
'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.
```

SP applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

SS *Configure the special Galil BiSS feature*

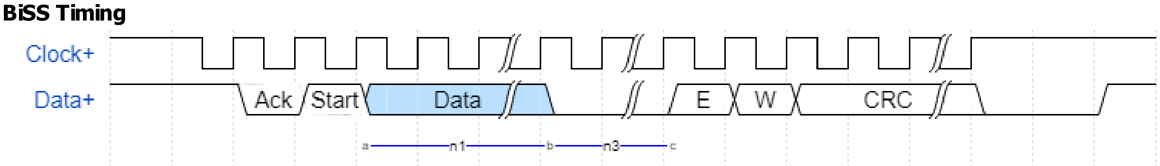
SSm = n_0,n_1,n_2,n_3 < o

Usage	SSm= n	Arguments specified with a single axis mask and an assignment (=)
Operands	_SSm	Operand has special meaning, see Remarks

Description

The SS command enables and configures the controller to read BiSS encoder data. BiSS is an open-source, digital interface for encoders. BiSS is hardware compatible to the industrial standard SSI (Serial Synchronous Interface) but offers additional features and options.

BiSS Timing



During the controller's servo interrupt, a clock will be transmitted for encoders configured for BiSS. The BiSS encoder responds by transmitting a serial data stream synchronized to the controllers's clock. The data stream has four important features as described below.

1. **Data**. Encoder position data and zero padding bits, set via n_1 and n_3
2. **Error Bit**. Shown above as E, BiSS defines an Error bit that is set by the encoder. Depending on the manufacturer, this bit can be active high or low. Use the SY command to set the correct polarity for this bit. Once BiSS is enabled, the current state of the Error Bit can be checked via the _SSm0 operand.
3. **Warning Bit**. Shown above as W, BiSS also defines a Warning bit that is set by the encoder. Depending on the manufacturer, this bit can be active high or low. Use the SY command to set the correct polarity for this bit. Once BiSS is enabled, the current state of the Error Bit can be checked via the _SSm0 operand.
4. **CRC**. The Data, Error and Warning bits are all included in the 6 bit CRC calculation. This CRC allows end to end transmission validity. In the event that the CRC is not valid, the Galil will not update the encoder position information, and _SSm0 will show an invalid CRC. See the table in the Remarks section for more details.

Arguments

Argument	Min	Max	Resolution	Description	Notes
m	A	H	Axis	Axis to configure for BiSS	Each axis has a dedicated BiSS port *(1)*
n_0	0	2	1	Position register to use	1 = TPA, 2 = TDA, 0 = Off
n_1	12	38	1	Number of Data bits, including zero padding bits	Sign of n_1 parameter sets the position mode *(2)*
n_2	0	0	0	Reserved	
n_3	0	7	1	Number of zero padding bits	Manufacturer specific
o	4	26	1	Clock divider	Defines BiSS Clock Frequency *(3)*

(1) BiSS encoder support requires the BiSS option on either the ICM-42000 or ICM-42200 and -SER Firmware

(2) The firmware will interpret the encoder position data in one of two ways:

- **Absolute Mode**, $n_1 > 0$. The controller will use the absolute position transmitted by the encoder. If the encoder exceeds its position limits, the encoder data will roll over from the maximum value to the minimum value. This discontinuity will be perceived by the controller as a large change in servo error. Absolute mode is typically used with linear encoders that have a limited range of travel.
- **Continuous Mode**, $n_1 < 0$. In this mode if the absolute position rolls over, the firmware will compensate by accounting for the roll over and counting past it. This allows for a smooth transition, avoiding the large error that occurs in Absolute Mode. Continuous mode is typically used with rotary absolute encoders. When the SS command is issued, the data first loaded into firmware will be the same as in Absolute mode.

(3) Galil recommends using the lowest clock divider (highest clock frequency) possible. This will mainly be dictated by the encoder specifications and the length of the clock and data transmission lines.

- Clock frequencies *(f)* in MHz can be calculated from the clock divider (*o*) as follows: f=10/(o+1)
- *o* = 9 is a good starting value for most applications.

Remarks

- Axis must be in MO state prior to issuing the SS command.
- SSm=? Returns the configuration parameters.
- Clocking in BiSS data has a timing overhead which may be non-negligible. In the event that clocking in data will result in the controller being unable to complete all required operations, (e.g. using multiple encoders with a lowered TM sample rate) the controller will respond by turning of all serial encoders. See #FWERR and QQ for more information. This error mode is very rare, and is expected to occur only during development.
- Axis must be in MO state prior to issuing the SS command.

Operand Usage

_SSm0: _SSm0 returns a 4 bit bitmask containing the status of the following

_SSm Bit Map

Bit	Bit Meaning	0	1	Description
0	Timeout Status	No timeout	Timeout occurred	Timeout bit will be set if the encoder doesn't set the start bit within 30us of receiving the first clock pulse.
1	CRC Status	CRC valid	CRC invalid	CRC is calculated in hardware, only the validity of the CRC is sent to firmware.
2	Warning bit	No Warning	Warning	Set active level using the SY command.
3	Error bit	No Error	Error	Set active level using the SY command.

- An _SSm0 value of 0 means that the encoder is functioning properly.
- _SSm1 saves the initial position data returned from the encoder upon issuing the SS command.
  - Used for initial configuration steps, helpful when configuring the encoder if getting an error

Error Handling

SERERR is an automatic subroutine which runs when any of the bits in _SSm0 are active i.e.

- Encoder Timeout
- Invalid CRC
- Error Bit Active
- Warning Bit Active

Related Commands

- #SERERR - Serial Encoder Error Automatic Subroutine
- DF - Dual Feedback
- DV - Dual Velocity (Dual Loop)
- SY - Serial Encoder BiSS Active Level
- TD - Tell Dual Encoder
- TP - Tell Position

Examples

```
'Galil DMC Code Example
'BiSS encoder data on the A axis sent to the TPA register
'24 total bits, 22 position data, 2 zero padding bits
'1 MHz clock frequency
SSA= 1,24,0,2<9
EN

#SERERR
'Serial Error routine messages out to the host the type of error.
sercode=_SSA0
IF (sercode & 1)
 MG "BiSS Timeout"
ENDIF
IF (sercode & 2)
 MG "Invalid CRC"
ENDIF
IF (sercode & 4)
 MG "Warning Bit Set"
ENDIF
IF (sercode & 8)
 MG "Error Bit Set"
ENDIF
RE
```

SS applies to SER

ST *Stop*

ST mm

Usage	ST mm	Argument is an axis mask

Description

The ST command stops motion on the specified axis. Motors will come to a decelerated stop.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGHMNST	ABCDEFGH	Multi-Axis Mask	Axes to command to stop motion	

Remarks

- If ST is sent from the host without an axis specification, program execution will stop in addition to motion.

Examples

```
'Galil DMC Code Example
ST A;' Stop A-axis motion
ST S;' Stop coordinate plane S
ST ABCD;' Stop A,B,C,D motion
ST SCD;' Stop coordinate plane S, as well as axes C and D
ST;' Stop motion on all axes including any virtual axes and coordinate planes
'Use the after motion complete command, AM, to wait for motion to be stopped.
```

```
'Galil DMC Code Example
:ST A;'       Stop motion on the A axis
:SC A;'       Query A axis status
 4            Indicates stopped by ST command
:MG _NO;'     Check if code is running
 1            Thread 0 running
:ST ;'        General stop
:MG _NO;'     check code again
 0            Thread 0 stopped
```

ST applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

SY *Serial encoder BiSS active level*

SYm= n
SY n,n,n,n,n,n,n,n

Usage	SYm= n	Arguments specified with a single axis mask and an assignment (=)
	SY n ...	Arguments specified with an implicit, comma-separated order
Operands	_SYm	Operand holds the value last set by the command

Description

This command is used to designate the active level of the Error and Warning bits when using the Galil BiSS feature. The BiSS protocol defines two bits, Error and Warning, which can be used by the encoder to signal various events. For more information, see the SS command.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	

Argument	Value	Description	Notes
n	0	Warning bit = Active Low; Error bit = Active Low	
	1	Warning bit = Active High; Error bit = Active Low	
	2	Warning bit = Active Low; Error bit = Active High	
	3	Warning bit = Active High; Error bit = Active High	Default

Remarks

- The SY command should be appropriately configured to ensure that the #SERERR automatic subroutine will run when the error or warning bits are active, and that the _SSm0 operand reports the fault state of the encoder correctly. Refer to the encoder's data sheet for information regarding the active level of these bits.

Examples

```
'Galil DMC Code Example
SYA=1;' Waring bit is active low, Error is active high
SSA=1,32,0,0<9;' Set up a BiSS encoder on axis A, 32 bits of data, 0 padding, 1 MHz clock frequency.
EN
#SERERR
'Serial Error routine messages out to the host the type of error.
sercode=_SSA0
IF (sercode & 1)
 MG "BiSS Timeout"
ENDIF
IF (sercode & 2)
 MG "Invalid CRC"
ENDIF
IF (sercode & 4)
 MG "Warning Bit Set"
ENDIF
IF (sercode & 8)
 MG "Error Bit Set"
ENDIF
RE
```

SY applies to SER

TA *Tell amplifier error status*

TA n

Usage	TA n ...	Arguments specified with an implicit, comma-separated order
Operands	_TA0 _TA1 _TA2 _TA3	Operand has special meaning, see Remarks

Description

The command returns the amplifier error status. The value is decimal and represents an 8 bit value. Bit 7 is the most significant bit. Bit 0 is the least significant bit.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	3	N/A	1	Selects amp status byte to return	

D3040, D3240

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128	Under-Voltage (E-H Axes)	Hall Error H Axis	Peak Current H Axis	
6	64	Over-Temperature (E-H Axes)	Hall Error G Axis	Peak Current G Axis	
5	32	Over-Voltage (E-H Axes)	Hall Error F Axis	Peak Current F Axis	
4	16	Over-Current (E-H Axes)	Hall Error E Axis	Peak Current E Axis	
3	8	Under-Voltage (A-D Axes)	Hall Error D Axis	Peak Current D Axis	
2	4	Over-Temperature (A-D Axes)	Hall Error C Axis	Peak Current C Axis	
1	2	Over-Voltage (A-D Axes)	Hall Error B Axis	Peak Current B Axis	ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)	Hall Error A Axis	Peak Current A Axis	ELO Active (A-D Axes)

D3140

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128			Peak Current H Axis	
6	64			Peak Current G Axis	
5	32			Peak Current F Axis	
4	16			Peak Current E Axis	
3	8			Peak Current D Axis	
2	4			Peak Current C Axis	
1	2			Peak Current B Axis	ELO Active (E-H Axes)
0	1			Peak Current A Axis	ELO Active (A-D Axes)

D3540

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128	Under-Voltage (E-H Axes)	Hall Error H Axis	Peak Current H Axis	Error latched (E-H Axes)[1]
6	64	Over-Temperature (E-H Axes)	Hall Error G Axis	Peak Current G Axis	Error latched (A-D Axes)[1]
5	32	Over-Voltage (E-H Axes)	Hall Error F Axis	Peak Current F Axis	
4	16	Over-Current (E-H Axes)	Hall Error E Axis	Peak Current E Axis	
3	8	Under-Voltage (A-D Axes)	Hall Error D Axis	Peak Current D Axis	
2	4	Over-Temperature (A-D Axes)	Hall Error C Axis	Peak Current C Axis	
1	2	Over-Voltage (A-D Axes)	Hall Error B Axis	Peak Current B Axis	ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)	Hall Error A Axis	Peak Current A Axis	ELO Active (A-D Axes)

1. Only available after AZ2 is issued to the controller.
2. Amplifier errors for a bank of axes will begin reporting after the BA command is issued for an axis.

D3547

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128	Under-Voltage (E-H Axes)	Hall Error H Axis	Peak Current H Axis	Error latched (E-H Axes)
6	64	Over-Temperature (E-H Axes)	Hall Error G Axis	Peak Current G Axis	Error latched (A-D Axes)
5	32	Over-Voltage (E-H Axes)	Hall Error F Axis	Peak Current F Axis	
4	16	Over-Current (E-H Axes)	Hall Error E Axis	Peak Current E Axis	
3	8	Under-Voltage (A-D Axes)	Hall Error D Axis	Peak Current D Axis	

2	4	Over-Temperature (A-D Axes)	Hall Error C Axis	Peak Current C Axis	
1	2	Over-Voltage (A-D Axes)	Hall Error B Axis	Peak Current B Axis	ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)	Hall Error A Axis	Peak Current A Axis	ELO Active (A-D Axes)

D3640

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128		Hall Error H Axis	Peak Current H Axis	
6	64	Over-Temperature (E-H Axes)	Hall Error G Axis	Peak Current G Axis	
5	32		Hall Error F Axis	Peak Current F Axis	
4	16		Hall Error E Axis	Peak Current E Axis	
3	8		Hall Error D Axis	Peak Current D Axis	
2	4	Over-Temperature (A-D Axes)	Hall Error C Axis	Peak Current C Axis	
1	2		Hall Error B Axis	Peak Current B Axis	ELO Active (E-H Axes)
0	1		Hall Error A Axis	Peak Current A Axis	ELO Active (A-D Axes)

D3740

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128	Under-Voltage (E-H Axes)	Hall Error H Axis	Peak Current H Axis	
6	64	Over-Temperature (E-H Axes)	Hall Error G Axis	Peak Current G Axis	
5	32	Over-Voltage (E-H Axes)	Hall Error F Axis	Peak Current F Axis	
4	16	Over-Current (E-H Axes)	Hall Error E Axis	Peak Current E Axis	
3	8	Under-Voltage (A-D Axes)	Hall Error D Axis	Peak Current D Axis	
2	4	Over-Temperature (A-D Axes)	Hall Error C Axis	Peak Current C Axis	
1	2	Over-Voltage (A-D Axes)	Hall Error B Axis	Peak Current B Axis	ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)	Hall Error A Axis	Peak Current A Axis	ELO Active (A-D Axes)

1. Amplifier errors for a bank of axes will begin reporting after the BA command is issued for an axis.

D4040

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128				
6	64				
5	32				
4	16	Over-Current (E-H Axes)[1]			
3	8				
2	4				
1	2				ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)[1]			ELO Active (A-D Axes)

1. An Over-Current error will report if the D4040 is not powered

D4140

Tell Amplifier Error Status Bit Definition

Bit #	Decimal	TA0	TA1	TA2	TA3
7	128	Under-Voltage (E-H Axes)			
6	64				
5	32				
4	16	Over-Current (E-H Axes)			
3	8	Under-Voltage (A-D Axes)			
2	4				
1	2				ELO Active (E-H Axes)
0	1	Over-Current (A-D Axes)			ELO Active (A-D Axes)

Remarks

- Refer to the controller User Manual for more details on clearing amplifier errors.
- _TAn Contains the amplifier error status. n = 0,1,2, or 3.
- If a brushed-type servo motor is disabling and TA1 shows a Hall error, use the BR command to set the axis as a brushed axis. This causes the controller to ignore invalid Hall states.

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AU - Set amplifier current loop
- AZ - Clear Amplifier Errors
- MT - Motor Type

- TK - Peak Torque Limit
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
#AMPERR
ST;' stop motion on all axes
AM;' wait until motion is halted
MO;WT2;' disable all axes

IF((_TA0&1)|(_TA0&16));' check if an Over-Current error occured
MG "Over-Current amplifier error"
ENDIF

IF((_TA0&2)|(_TA0&32));' check if an Over-Voltage error occured
MG "Over-Voltage amplifier error"
ENDIF

IF((_TA0&4)|(_TA0&64));' check if an Over-Temperature error occured
MG "Over-Temperature amplifier error"
ENDIF

IF((_TA0&8)|(_TA0&128));' check if an Under-Voltage error occured
MG "Under-Voltage amplifier error"
ENDIF

IF((_TA3&1)|(_TA3&2));' check if the ELO input was asserted
MG "ELO input asserted"
ENDIF

IF((_TA3&64)|(_TA3&128));' check if an amplifier error has latched
MG "Amplifier error has latched"
AZ1;' clear latched amplifier errors
ENDIF

RE
```

```
'Galil DMC Code Example
:TA1
1   'bit 0 means Hall error for A axis
:TA0
8   'bit 3 means under voltage error for amp
```

TA applies to DMC50000,DMC4000,DMC4103,DMC30010,DMC2103,EDD37010

TB *Tell Status Byte*

TB

Usage	TB	Command takes no arguments
Operands	_TB	Operand has special meaning, see Remarks

Description

The TB command returns status information from the controller as a decimal number. Each bit of the status byte denotes an active condition when the bit is set (high):

Arguments

The following table describes the specific conditions reported with each bit of the TB report.

Tell Status Byte Response Bit Description

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

Remarks

- _TB Contains the status byte reported by the TB command

Examples

```
'Galil DMC Code Example
:TB
33'      Contouring on and Echo is on (2^5 + 2^0 = 32 + 1 = 33)
```

```
'Galil DMC Code Example
:TB;'      Tell status information
129'     Executing program and echo on (2^7 + 2^0 = 128 + 1 = 129)
```

TB applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

TC *Tell Error Code*

TC n

Usage	TC n ...	Arguments specified with an implicit, comma-separated order
Operands	_TC	Operand has special meaning, see Remarks

Description

The TC command reports programming or command errors detected by the controller. 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.

Arguments

Argument	Value	Description	Notes
n	0	Return the numerical code only	Default
	1	Return the numerical code and human-readable message	

TC Error 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	
8	Command not valid while not running	
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	
14	EEPROM check sum error	
15	EEPROM write error	
16	IP incorrect sign during position move or IP given during forced deceleration	
17	ED, BN and DL not valid while program running	
18	Command not valid when contouring	
19	Application strand already executing	
20	Begin not valid with motor off	
21	Begin not valid while running	
22	Begin not possible due to Limit Switch	
24	Begin not valid because no sequence defined	
28	S operand not valid	
29	Not valid during coordinated move	
30	Sequence Segment Too Short	
31	Total move distance in a sequence > 2 billion	
32	Segment buffer full	
33	VP or CR commands cannot be mixed with LI commands	
39	No time specified	
41	Contouring record range error	
42	Contour data being sent too slowly	
46	Gear axis both master and follower	
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	
66	Array space full	
67	Too many arrays or variables	
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	
97	Bad Binary Command Format	
98	Binary Commands not valid in application program	
99	Bad binary command number	
100	Not valid when running ECAM	
101	Improper index into ET	
102	No master axis defined for ECAM	
103	Master axis modulus greater than 256 EP value	
104	Not valid when axis performing ECAM	
105	EB1 command must be given first	
106	Privilege Violation	
110	No hall effect sensors detected	
111	Must be made brushless by BA command	
112	BZ command timeout	
113	No movement in BZ command	
114	BZ command runaway	
118	Controller has GL1600 not GL1800	
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
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, See Remarks
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	
135	Motor must be in MO	
136	Invalid Password	
137	Invalid lock setting	
138	Passwords not identical	
140	Serial encoder error	Valid for BiSS support
141	Feature not supported	
143	TM timed out	Valid on SER firmware (SSI and BiSS)
144	Incompatible with encoder type	
160	BX failure	
161	Sine amp axis not initialized	
163	IA command not valid when DHCP mode enabled	
164	Exceeded maximum sequence length, BGS or BGT is required	
165	Cannot have both SINE and SSI feedback enabled at once	DMC-30000 only
166	Unable to set analog output	30000 Hardware, see AO

Remarks

- TC command accepts ? as a query. This is equivalent to TC or TC 0
- After TC has been read, the error code is set to zero.
- _TC contains the value of the error code. Use of the operand does not clear the error code.

Examples

```
'Galil DMC Code Example
:GF32;'   Bad command
?
:TC1;'    Tell error code
```

1 :	Unrecognized command

TC applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,DMC52000,RIO57400,EDD37010

TD *Tell Dual Encoder*

TD mm

Usage	TD mm	Argument is an axis mask
Operands	_TDm	Operand has special meaning, see Remarks

Description

The TD command returns the current position of the dual (auxiliary) encoder input. When operating with stepper motors, the TD command returns the number of counts that have been output by the controller.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report dual (auxiliary) encoder position.	

Remarks

- Auxiliary encoders are not available for a stepper axis or for the axis where output compare is used.

Operand Usage

- _TDm reports the dual encoder position for the specified axis.

Examples

```
'Galil DMC Code Example
: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
```

TD applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

TE *Tell Error*

TE mm

Usage	TE mm	Argument is an axis mask
Operands	_TEm	Operand has special meaning, see Remarks

Description

The TE command returns the current error in the control loop.
The command returns the position error of the motor(s), which is the difference between commanded (RP) and actual (TP) position.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report position error	

Remarks

- Under normal operating conditions with servo control, the position error should be small. The position error is typically largest during acceleration and deceleration.
- The Tell Error command is not valid for step motors since they operate open-loop.

Operand Usage

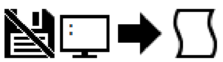
- _TEm contains the current position error value for the specified axis.

Examples

```
'Galil DMC Code Example
: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
```

TE applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,RIO47000,DMC1802,DMC1806,DMC2103

TH *Tell Ethernet Handle*



TH

Usage	TH	Command takes no arguments

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

TH is an interrogation command with no parameters

Remarks

- If no handles are shown as *AVAILABLE*, the controller will be unable to create or accept more Ethernet connections with TCP or UDP. Ping will still function when all handles are taken.

Examples

```
'Galil DMC Code Example
: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
```

TH applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

TI *Tell Inputs*

TI n

Usage	TI n ...	Arguments specified with an implicit, comma-separated order
Operands	_TI0 _TI1 _TI2 _TI3 _TI4 _TI5 _TI10 _TI11	Operand has special meaning, see Remarks

Description

The TI command returns the state of the inputs in banks of 8 bits, or 1 byte. 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

Argument	Value	Description	Notes
n	0	Report status of Inputs 1-8	Default
	1	Report status of Inputs 9-16	Only valid for 5-8 axis controllers
	2	Report status of Inputs 17-24	Must have extended IO configured as inputs for valid values. See Remarks
	3	Report status of Inputs 25-32	Must have extended IO configured as inputs for valid values. See Remarks
	4	Report status of Inputs 31-40	Must have extended IO configured as inputs for valid values. See Remarks
	5	Report status of Inputs 41-48	Must have extended IO configured as inputs for valid values. See Remarks
	10	Report status of Inputs 81-88	Auxiliary encoder inputs. See Remarks
	11	Report status of Inputs 89-96	Auxiliary encoder inputs. Only valid for 5-8 axis controllers. See Remarks

Remarks

- For n = 2 to n = 5, no additional hardware is required for extended IO support
- Extended IO blocks must be configured as inputs with the CO command before using TI
- For n = 10 and n = 11, the auxiliary encoder channels A and B can be used as additional IO. Only 2 * the number of axes worth of inputs are available.
  - See the User manual for more details.

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.

Examples

```
'Galil DMC Code Example
: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
```

TI applies to
DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802,RIO57400,DMC52000,EDD37010

TIME *Time Operand*

TIME

Usage	variable= TIME	Holds a value
Operands	TIME	Operand has special meaning, see Remarks

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. The clock is reset to 0 with a standard reset or a master reset.

Arguments

TIME is an operand and has no parameters

Remarks

- The keyword, TIME, does not require an underscore (_) as with the other operands.
- TIME will increment up to +2,147,483,647 before rolling over to -2,147,483,648 and continuing to count up.
  - TIME rollover occurs after ~24-25 days of on-time at TM 1000 with no reset.
- TM 1000 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.

Examples

```
'Galil DMC Code Example
MG TIME;'  Display the value of the internal clock
t1=TIME;'  Sets the variable t1 to the TIME value
```

TIME applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,RIO47000,EDD37010

TK *Peak Torque Limit*

TKm= n
TK n,n,n,n,n,n,n,n

Usage	TKm= n	Arguments specified with a single axis mask and an assignment (=)
	TK n ...	Arguments specified with an implicit, comma-separated order
Operands	_TKm	Operand holds the value last set by the command

Description

The TK command sets the peak torque limit on the motor command output. This command works with the TL command which sets the continuous torque limit. When the average torque is below TL, the motor command signal can go up to the TK (Peak Torque) limit for a short amount of time.

To convert motor command output (V) to actual motor current (A), use the following equation.

$$motor\ current\ (A) = \ motor\ command\ (V) * amplifier\ gain\ (A/V)$$

For Galil controllers with internal drives, refer to AG command for amplifier gain setting. For external drive control, consult drive documentation.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9.9982	0	20/65,536	Value of peak torque limit	n = 0 disables the peak torque limit

Remarks

- TK provides the absolute value of the peak torque limit for -/+ torque outputs
- Peak torque can be achieved for approximately 1000 samples upon initial command from 0V torque
- If TK is set lower than TL, then TL is the maximum command output under all circumstances
- TK should be set after the amplifier gain is selected

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AU - Set amplifier current loop
- AZ - Clear Amplifier Errors
- MT - Motor Type
- TA - Tell Amplifier Error
- TL - Torque Limit

Examples

```
'Galil DMC Code Example
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
```

TK applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

TL *Torque Limit*

TLm= n
TL n,n,n,n,n,n,n,n

Usage	TLm= n	Arguments specified with a single axis mask and an assignment (=)
	TL n ...	Arguments specified with an implicit, comma-separated order
Operands	_TLm	Operand holds the value last set by the command

Description

The TL command sets the limit on the motor command output. This limit is designed to prevent over current to motors with lower current rating than the drive.

To convert motor command output (V) to actual motor current (A), use the following equation.

$$motor\ current\ (A) = \ motor\ command\ (V) * amplifier\ gain\ (A/V)$$

For Galil controllers with internal drives, refer to AG command for amplifier gain setting.
TL works along with the TK (Peak torque) command to control output current to the motor.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9.9982	9.9982	20/65,536	Value of torque limit	

TL With Internal Drives

- When using the maximum AG setting, the maximum torque limit will automatically be lowered to ensure the amplifier is limited to its rated continuous current.
- The maximum torque limit is different for certain amplifiers when configured for its maximum AG setting.

Amplifier	AG setting	TL limit
D3040	2	7
D3140	N/A	9.9982
D3240	2	5
D3540	2	5
D3547	2	5
D3640	N/A	5
D3740	2	5

Remarks

- TL sets the absolute torque maximum for negative and positive torque.
  - For example, TL of 5 limits the motor command output to 5 volts maximum and -5 volts minimum.
- TL should be set after the amplifier gain is selected.

Related Commands

- #AMPERR - Amplifier error automatic subroutine
- AG - Amplifier Gain
- AU - Set amplifier current loop
- AZ - Clear Amplifier Errors
- MT - Motor Type
- TA - Tell Amplifier Error
- TK - Peak Torque Limit

Examples

```
'Galil DMC Code Example
: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
```

TL applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

TM *Update Time*

TM n

Usage	TM n ...	Arguments specified with an implicit, comma-separated order
Operands	_TM	Operand holds the value last set by the command

Description

The TM command sets the sampling period of the control loop. The units of this command are microseconds. A negative number turns off the servo loop.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	62.5	5,000	1,000	31.25	Set the sample time in usecs	The minimum value varies based on axis count and firmware usage. See Remarks

Remarks

- TM 1000 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.
- If a higher sampling frequency is required, please contact Galil.
- The minimum allowed TM setting for the controller is listed in the tables below.

- The following commands are automatically scaled to adjust for changes in sample time.
  - AC
  - AS
  - AT
  - DC
  - FA
  - FV
  - HV
  - JG
  - KP
  - NB
  - NF
  - NZ
  - PL
  - SD
  - SP
  - VA
  - VD
  - VS
  - WT
- The following commands are NOT automatically scaled to adjust for changes in sample time
  - BW
  - DR
  - DT
  - IT
  - KD
  - KI
  - TIME
  - TK
  - TV
  - TW
- For more infomation see:
  - [http://www.galil.com/news/dmc-programming-motion-controllers/time-based-commands-accelera-motion-controllers]

Axis Count	Minimum TM
1-2	62.5
3-4	125
5-6	156.25
7-8	187.5

Examples

```
'Galil DMC Code Example
:TM 2000;' Set sample rate to 2000 usec
:TM 1000;' Return to default sample rate
:
```

TM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

TN *Vector Tangent*

TN n_0,n_1

Usage	TN n ...	Arguments specified with an implicit, comma-separated order
Operands	_TNm	Operand has special meaning, see Remarks

Description

The TN command describes the tangent axis to the coordinated motion path. n_0 is the scale factor in counts/degree of the tangent axis. n_1 is the absolute position of the tangent axis where the tangent axis is aligned with zero degrees in the coordinated motion plane. The tangent function is useful for cutting applications where a cutting tool must remain tangent to the part.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-127	127	0	0.004	Scale factor in counts/degree of the tangent axis	
n_1	-8,388,608	8,388,607	0	1	Absolute position of tangent axis where the tangent angle is 0	

Remarks

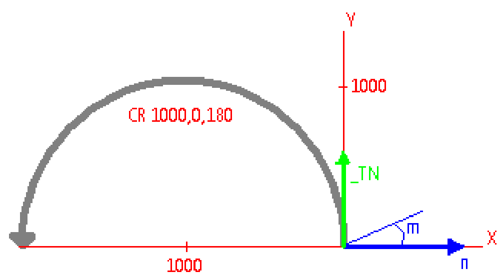
- When operating with stepper motors, n_0 is the scale factor in steps / degree
- The tangent axis is specified with the VMm0m1m2 command where m2 is the tangent axis.
  - For example, VMABD specifies the D axis as the tangent axis

Operand Usage

- _TNm (where m = 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.
  - _TNm will change based upon the vector path described in the VM declaration. See the example below.
  - n_0 = ? also reports this value

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.




```
'Galil DMC Code Example
#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_TNS;'          Print the calculated initial tangent entry point (250)
PAZ=_TNS;'        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
```

TN applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC50000,DMC52000

TP *Tell Position*

TP mm

Usage	TP mm	Argument is an axis mask
Operands	_TPm	Operand has special meaning, see Remarks

Description

The TP command returns the current position of the motor.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report motor position	

Remarks

- _TPm contains the current position value for the specified axis.
- Omitting mm returns the position of all axes.

Examples

```
'Galil DMC Code Example
'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.
:PF 7;' Position format of 7
: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
$0000C8,$FFFFF6,$000000,$FFFF93
:Position =_TPA;' Assign the variable, Position, the value of TPA
```

TP applies to DMC4000,DMC4103,DMC4200,DMC30010,DMC50000,DMC52000,EDD37010,DMC1802,DMC1806,DMC2103

TR *Trace*

TR n_0, n_1

Usage	TR n ...	Arguments specified with an implicit, comma-separated order

Description

The TR command causes each instruction in a program to be sent out the communications port prior to execution. The trace command is useful in debugging programs.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	1	0	1	Set status of trace function	n_0 = 0 or null disables Trace. n_0 = 1 enables trace.
n_1	0	255	255	1	Set threads to trace by bitmask	See Remarks

Remarks

- n_1 sets a 1-byte bitmask which determines which threads will run. Bit n set corresponds to thread n traced.
  - For example, setting bit 2 and 3 sets TR to trace threads 2 and 3. (2^2 + 2^3 = 4 + 8 = 12. TR 1,12 is issued)
- Omitting n_1 sets it to the default maximum value to enable trace on all threads.

Examples

```
'Galil DMC Code Example
:'Turn on trace during a program execution
:LS
0 MGTIME
1 WT1000
2 JP0
3
:XQ
:
18003461.0000
18004461.0000
18005461.0000

:TR1
:
2 JP0
0 MGTIME
18006461.0000
1 WT1000
2 JP0
0 MGTIME
18007461.0000
1 WT1000

:TR0
:
18008461.0000
18009461.0000

:ST
:
```

TR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

TS *Tell Switches*

TS mm

Usage	TS mm	Argument is an axis mask
Operands	_TSm	Operand has special meaning, see Remarks

Description

The TS command returns information including axis-specific IO status, error conditions, motor condition and state. The value returned by this command is decimal and represents an 8 bit value (decimal value ranges from 0 to 255).

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report axis switches	

Remarks

- Each bit of the TS response represents the following status information when the bit is set (1).

Bit #	Status
Bit 7	Axis in motion
Bit 6	Position error exceeds error limit
Bit 5	Motor off
Bit 4	Reserved (0)
Bit 3	Forward Limit switch inactive
Bit 2	Reverse Limit switch inactive
Bit 1	Home switch status
Bit 0	Position Latch has occurred

- For active high or active low configuration (CN command), the limit switch bits are '1' when the switch is inactive and '0' when active.

Operand Usage

- _TSm contains the current status of the switches for the specified axis.

Examples

```
'Galil DMC Code Example
:V1=_TSB;' Assigns value of TSB to the variable V1
:V1=?;' Interrogate value of variable V1
15 (returned value) 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)
```

TS applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

TT *Tell Torque*

TT mm

Usage	TT mm	Argument is an axis mask
Operands	_TTm	Operand has special meaning, see Remarks

Description

The TT command reports the value of the analog output signal, which is a number between -9.9982 and 9.9982 volts.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report output torque command	

Remarks

- Torque output is limited by the value set for the TL command.
- _TTm contains the value of the torque for the specified axis.

Examples

```
'Galil DMC Code Example
:v1=_TTA;' Assigns value of TTA to variable, v1
:TTA;'   Report torque on A
-0.2843
```

TT applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

TV *Tell Velocity*

TV mm

Usage	TV mm	Argument is an axis mask
Operands	_TVm	Operand has special meaning, see Remarks

Description

The TV command returns the actual velocity of the axes in units of encoder count/s. The value returned includes the sign bit for direction.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
mm	A	ABCDEFGH	ABCDEFGH	Multi-Axis Mask	Axes to report velocity	

Remarks

- 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.
- _TVm contains the value of the velocity for the specified axis.

Examples

```
'Galil DMC Code Example
:vela=_TVA;'       Assigns value of A-axis velocity to the variable VELA
:TVA;'             Returns the A-axis velocity
 3420
```

TV applies to DMC4000,DMC4200,DMC4103,DMC2103,DMC1806,DMC1802,DMC30010,DMC50000,DMC52000,EDD37010

TW *Timeout for MC trippoint*

TWm= n
TW n,n,n,n,n,n,n,n

Usage	TWm= n	Arguments specified with a single axis mask and an assignment (=)
	TW n ...	Arguments specified with an implicit, comma-separated order
Operands	_TWm	Operand holds the value last set by the command

Description

The TW command sets the timeout time for the MC trippoint. The TW command sets the timeout in msec to declare an error if the MC command is active and the motor is not at or beyond the actual position within n msec after the completion of the motion profile. If a timeout occurs, then the MC trippoint will clear and the stopcode will be set to 99. A running program will jump to the special label #MCTIME, if located in the application code.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-1	32,767	32,766	1	Set the timeout in msec for the MC command	n = -1 disables the timeout

Remarks

- The EN command should be used to return from the #MCTIME subroutine.

Examples

```
'Galil DMC Code Example
TWA= 1000;' set timeout time for MC to 1000 for A axis
var= _TWA;' set value of TW for A axis to variable, var
```

```
'Galil DMC Code Example
TWA= 5000;'     set MC timeout to 5 seconds
PRA= 10000;'    set move length
BGA
MCA
MG"Move done";' message when move completes
EN
'
#MCTIME
'code when motor doesn't reach final pos in time
MG"Move didn't finish"
MG"Longer than ",_TWA," msecs"
STA
AMA
MOA;'            shut off axis
EN
```

TW applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

TZ *Tell I O Configuration*

TZ

Usage	TZ	Command takes no arguments

Description

The TZ command is used to request the I/O status of the controller. This is returned to the user as a human-readable text string.

Arguments

TZ is an interrogation command with no parameters

Remarks

- The data reported by TZ is also accessible through the TI (inputs) and OP (outputs) command

Examples

```
'Galil DMC Code Example
:TZ;'           issued for DMC-4040
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 10 (88-81) dedicated as input - value 255 (1111_1111)
```

TZ applies to DMC4000,DMC4200,DMC4103,DMC2103,RIO47000,DMC50000,DMC52000

UI *User Interrupt*

UI n

Usage	UI n ...	Arguments specified with an implicit, comma-separated order

Description

The UI command allows user-defined interrupts to be created. UI can generate 16 different status bytes, $F0 to $FF (240-255), corresponding to UI0 to UI15.

UI pushes a user-defined status byte into the EI queue. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	15	0	1	Set the status byte for the interrupt	

Status Byte (dec)	Condition		Status Byte (dec)	Condition
$F0 (240)	UI0 was executed		$F8 (248)	UI8 was executed
$F1 (241)	UI1 was executed		$F9 (249)	UI9 was executed
$F2 (242)	UI2 was executed		$FA (250)	UI10 was executed
$F3 (243)	UI3 was executed		$FB (251)	UI11 was executed
$F4 (244)	UI4 was executed		$FC (252)	UI12 was executed
$F5 (245)	UI5 was executed		$FD (253)	UI13 was executed
$F6 (246)	UI6 was executed		$FE (254)	UI14 was executed
$F7 (247)	UI7 was executed		$FF (255)	UI15 was executed

Remarks

- The UDP interrupt packet dispatch may be delayed depending on the number of interrupts in the queue
  - 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.

Examples

```
'Galil DMC Code Example
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)
'The program above interrupts the host PC with status byte $F1 (241)
'when the motor has reach its target speed of 5000 counts/s
```

UI applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806,DMC1802

UL *Upload*

UL

Usage	UL	Command takes no arguments
Operands	_UL	Operand has special meaning, see Remarks

Description

The UL command transfers the program from the controller to a host computer. Programs are sent without line numbers. The uploaded program will be followed by a <control>Z or a '\' as an end of text marker.

Arguments

UL is a command with no parameters

Remarks

- In a Galil software, the UL command is not necessary because the UL command is handled by the graphical interface (Upload Program).
- In a terminal utility such as HyperTerminal or Telnet, the UL command will bring the uploaded program to screen.
- From there, the user can copy it and save it to a file.
- Issuing this command will pause the output of the Data Record until the command is completed.

Operand Usage

- When used as an operand, _UL gives the number of available variables.

Examples

```
'Galil DMC Code Example
:UL;' Begin upload
#A Line 0
NO This is an Example Line 1
NO Program Line 2
EN Line 3
{cntrl}Z Terminator
:
```

UL applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

VA *Vector Acceleration*

VAm= n
VA n,n

Usage	VAm= n	Arguments specified with a single axis mask and an assignment (=)
	VA n ...	Arguments specified with an implicit, comma-separated order
Operands	_VAm	Operand holds the value last set by the command

Description

The VA command sets the acceleration of the vector in a coordinated motion sequence.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	S	Axis	Coordinate plane to be specified	
n	1,024	1,073,740,800	256,000	1,024	Vector acceleration for the coordinate system	

Remarks

- _VAm contains the value of the vector acceleration for the specified coordinate system
- When issuing VA implicitly, the first argument refers to the "S" plane and the second refers to the "T" plane.

Examples

```
'Galil DMC Code Example
:VA 1024;' Set vector acceleration to 1024 counts/sec2
:VA ?;'   Return vector acceleration
1024
:VA 20000;' Set vector acceleration
:VA ?;'         Return vector acceleration
19456
:accel=_VAS;' Assign variable, accel, the value of VA
```

VA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VD *Vector Deceleration*

VDm= n
VD n,n

Usage	VDm= n	Arguments specified with a single axis mask and an assignment (=)
	VD n ...	Arguments specified with an implicit, comma-separated order
Operands	_VDm	Operand has special meaning, see Remarks

Description

The VD command sets the deceleration of the vector in a coordinated motion sequence.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	S	Axis	Coordinate plane to be specified	
n	1,024	1,073,740,800	256,000	1,024	Vector deceleration for the coordinate system	

Remarks

- _VDm contains the value of the vector deceleration for the specified coordinate system.
- When issuing VD implicitly, the first argument refers to the "S" plane and the second refers to the "T" plane.

Examples

```
'Galil DMC Code Example
#vector;'       Vector Program Label
VMAB;'          Specify plane of motion
VA 1000000;'    Vector Acceleration
VD 5000000;'    Vector Deceleration
VS 2000;'       Vector Speed
VP 1000,2000;'  Vector Position
VE;'            End Vector
BG S;'          Begin Sequence
AM S;'          Wait for Vector sequence to complete
EN;'            End Program
```

VD applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VE *Vector Sequence End*

VE n

Usage	VE n ...	Arguments specified with an implicit, comma-separated order
Operands	_VEm	Operand has special meaning, see Remarks

Description

The VE command indicates to the controller that the end of the vector is coming up. This allows the controller to slow down through multiple segments, if required. VE is required to exit the vector mode gracefully (stop code, SC, 101).

Arguments

Argument	Value	Description	Notes
n	0	Specify the end of a vector segment	Also occurs when n = 'null'
	?	Returns the length of the vector in counts	

Remarks

- The VE command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.
- _VEm contains the length of the vector in counts for the specified coordinate system, S or T

Examples

```
'Galil DMC Code Example
#vector;'       Vector Program Label
VM AB;'         Specify plane of motion
VA 1000000;'    Vector Acceleration
VD 5000000;'    Vector Deceleration
VS 2000;'       Vector Speed
VP 1000,2000;'  Vector Position
VE;'            End Vector
BG S;'          Begin Sequence
AM S;'          Wait for Vector sequence to complete
EN;'            End Program
```

VE applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VF *Variable Format*

VF $n_0.n_1$

Usage	VF n ...	Arguments specified with an implicit, comma-separated order
Operands	_VF	Operand has special meaning, see Remarks

Description

The VF command formats the number of digits to be displayed when interrogating the controller. 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

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-8	10	10	1	Specify the number of digits displayed before the decimal point	A negative value specifies hexadecimal format, see Remarks
n_1	0	4	4	1	Specify the number of digits displayed after the decimal point	

Remarks

- A negative n_0 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.
- A positive n_0 specifies standard decimal format.
- A ? is only valid for querying n_0. When queried, the value reported will be the value of the format for variables and arrrays specified by n_0 and n_1
  - eg. VF 10,4 would respond to VF ? with 10.4
- _VF contains the value of the format for variables and arrays
- If the number of digits set by n_0 is insufficient for representing the integer portion of a variable, the returned value will be the greatest number representable by $n_0.n_1$. For example, if *var=123*, and `VF` is 2.4, `var=?` will return `99.9999`.

Examples

```
'Galil DMC Code Example
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
```

```
'Galil DMC Code Example
:VF8,4;'  set vf to 8 digits of integers and 4 digits of fraction
:VF?;'    query the value of VF
8.4
:MG_VF;'  query again
8.4
```

VF applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

VM *Vector Mode*

VM m0m1m2

Usage	VM mm	Argument is an axis mask
Operands	_VMm	Operand has special meaning, see Remarks

Description

The VM command enables the coordinated motion mode and specifies the plane of motion. This mode may be specified for motion on any set of two axes, including a combination of real and virtual axes for single-axis operation. 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. The number of available segments is queriable via the _LMm operand.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m0	A	H	A	Axis	First axis specified for vector motion	
m1	A	H	N/A	Axis	Second axis specified for vector motion	
	M	N	N/A	Axis	Virtual axis specified for vector mode	Used when performing vector mode for a single real axis
m2	A	H	N/A	Axis	Tangent axis specified for vector mode.	m2 = null if tangent mode is not desired.
	M	N	N/A	Axis	Virtual axis specified for vector mode.	Used to disable the tangent function if already enabled. Otherwise, use m2 = null.

Remarks

- Specifying one axis for vector mode is useful for obtaining sinusoidal motion on 1 axis using the CR command.
- The Vector End (VE) command must be given after the last segment. This allows the controller to properly decelerate.
- 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 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.

- The VM command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.
- _VMm contains instantaneous commanded vector velocity for the specified coordinate system, S or T.

Enabling Vector Mode

1. Specify the desired coordinate system to use with the CA command. S is default.
2. Specify the vector plane to be used with the VMm0m1 command. If using tangent axis include that as the m2 parameter
   1. EG. for a AB vector plane with the D axis used as a tangent axis, issue VM ABD
   2. If only the vector plane is desired for the above example, then issue VM AB
3. Specify vector speed with VS, vector acceleration with VA, and vector deceleration with VD
4. Specify vector segments with the VP command, or circular segments with the CR command
5. When finished with the sequence of moves, issue VE
6. Issue BGS to begin motion for the S coordinate system
7. You can now wait for motion to complete, issue additional segments as buffer space is cleared, or start a new move on the T coordinate plane by specifying CAT and starting from step 2.

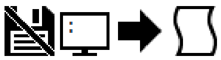
Examples

```
'Galil DMC Code Example
#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
BG S;'          Begin motion sequence
AM S;'          Wait for vector motion to complete
EN;'            End Program
```

```
'Galil DMC Code Example
#A;'            Program Label
VM AN;'         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
BG S;'          Begin motion sequence
AM S;'          Wait for vector motion to complete
EN;'            End Program
```

VM applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VP *Vector Position*



VP n_0,n_1 < o > p

Usage	VP n ...	Arguments specified with an implicit, comma-separated order
Operands	_VPm	Operand has special meaning, see Remarks

Description

The VP command defines a vector move segment for the VM mode of motion. The VP command defines the target coordinates of a straight line segment in a 2 axis motion sequence. 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 in linear interpolation mode, use the LI command.

Arguments

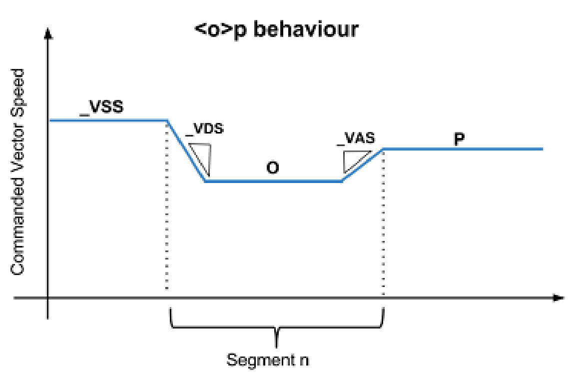
Argument	Min	Max	Default	Resolution	Description	Notes
n_0	-2,147,483,648	2,147,483,647	0	1	Specify the target position for the first vector axis	See Remarks
n_1	-2,147,483,648	2,147,483,647	0	1	Specify the target postion for the second vector axis	See Remarks
o	2	22,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the linear segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 1, -1
	2	6,000,000	N/A	2	Specifies the vector speed to be commanded at the beginning of the linear segment. The controller will start accelerating or decelerating at the start of the sequence to this speed.	For MT 2,-2,2.5, and -2.5.
p	2	22,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the linear segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 1,-1,
	2	6,000,000	N/A	2	Specifies the vector speed to be achieved at the end of the linear segment. The controller will decelerate or accelerate during the segment and will reach the specified speed at the end of the segment.	For MT 2,-2,2.5, and -2.5.

Argument	Value	Description	Notes
o	-1	Specifies vector speed to be set by Vector Speed Variable (VV command)	See VV command

Remarks

- 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.
- Vector moves are defined as absolute positions from the origin of the sequence.
- The length of each vector segment must be limited to 8,388,607.

- The VM command will apply to the selected coordinate system, S or T. To select the coordinate system, use the command CAS or CAT.
- _VPm where m = axis designator A,B,C,D,E,F,G or H 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 of _VPm as an operand is valid in the linear mode, LM, and in the Vector mode, VM.



Examples

```
'Galil DMC Code Example
#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
```

```
'Galil DMC Code Example
REM VP n,m  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
VMAN
VS 100000
VA 2560000
VD 2560000
VP 20000,20000
VE
BGS
AMS
EN
'
#vsop
TM 250
VMAN
n=1000/_TM
'VS 100000
VA 2560000
VD 2560000
VP 20000,20000<(100000/n)
VE
BGS
AMS
EN
```

VP applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VR *Vector Speed Ratio*

VR n_0, n_1

Usage	VR n ...	Arguments specified with an implicit, comma-separated order
Operands	_VRm	Operand holds the value last set by the command

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 previous vector speed commands.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	0	10	1	1/65,536	Vector ratio specified for the S coordinate plane	
n_1	0	10	1	1/65,536	Vector ratio specified for the T coordinate plane	

Remarks

- 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.
- VR is useful for feedrate override, particularly when specifying the speed of individual segments using the operator '<' and '>'.
- _VRm contains the vector speed ratio of the specified coordinate system - where m = S or T.
- _VRS contains the vector speed ratio of the specified coordinate system

Examples

```
'Galil DMC Code Example
#A;'             Vector Program
VM AB;'          Vector Mode
VP 1000,2000;'   Vector Position
CR 1000,0,360;'  Specify Arc
VE;'             End Sequence
VS 2000;'        Vector Speed
BG S;'           Begin Sequence
AM S;'           After Motion
JP#A;'           Repeat Move
#SPEED;'         Speed Override
VR(@AN[1]*.1);'  Read analog input compute ratio
vr=_VRS;'        Store vector ratio in variable 'vr'
JP#SPEED;'       Loop
XQ#A,0
XQ#SPEED,1;'     Execute task 0 and 1 simultaneously
```

VR applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VS *Vector Speed*

VSm= n
VS n,n

Usage	VSm= n	Arguments specified with a single axis mask and an assignment (=)
	VS n ...	Arguments specified with an implicit, comma-separated order

Description

The VS command specifies the speed of the vector in a coordinated motion sequence in either the LM or VM modes. This speed is in place when individual segment speeds for VP, LI and CR are not specified.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	S	Axis	Coordinate plane to be specified	
n	2	22,000,000	25,000	2	Vector speed applied to the coordinate system	

Remarks

- Vector speed can be attached to individual vector segments using the operators '<' and '>'. For more information, see description of VP, CR, and LI commands. The VV command allows for variables to be specified during vector segments.
- 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.
- _VSm contains the vector speed of the specified coordinate system
- When issuing VS implicitly, the first argument refers to the "S" plane and the second refers to the "T" plane.

Examples

```
'Galil DMC Code Example
:VS 2000;'    Define vector speed of S coordinate system
:VS ?;'       Return vector speed of S coordinate system
2000
:
```

VS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802

VV *Vector Speed Variable*

VVm= n
VV n,n

Usage	VVm= n	Arguments specified with a single axis mask and an assignment (=)
	VV n ...	Arguments specified with an implicit, comma-separated order
Operands	_VVm	Operand has special meaning, see Remarks

Description

The VV command sets the speed of the vector variable in a coordinated motion sequence in either the LM or VM modes. The VV command is used to set the "o" vector speed argument for segments that exist in the vector buffer for LI, CR and VP commands. 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.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	S	T	S	Axis	Coordinate plane to assign value	
n	0	22,000,000	0	2	Variable vector speed	For MT 1,-1,1.5 and -1.5
	0	3,000,000	0	2	Variable vector speed	For MT 2,-2,2.5 and -2.5

Remarks

- VV command 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.
- _VVm contains the vector speed variable of the specified coordinate system

Examples

```
'Galil DMC Code Example
: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
:
```

VV applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

WH *Which Handle*

WH

Usage	WH	Command takes no arguments
Operands	_WH	Operand has special meaning, see Remarks

Description

The WH command is used to identify the handle from which the command was received. This is useful for determining what interface or handle you are connected to.

Arguments

WH is an interrogation command with no parameters

Remarks

- _WH contains the numeric representation of the handle from which the command was received.
- The following table lists the possible string returned by WH, and the numerical value returned by _WH

Communication Channel	WH	_WH
Main Serial Port	RS232	-1
Ethernet Handle A	IHA	0
Ethernet Handle B	IHB	1
Ethernet Handle C	IHC	2
Ethernet Handle D	IHD	3
Ethernet Handle E	IHE	4
Ethernet Handle F	IHF	5
Ethernet Handle G	IHG	6
Ethernet Handle H	IHH	7

Examples

```
'Galil DMC Code Example
:WH;' Request incoming handle identification
IHC
:MG_WH
2
```

WH applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000

WT *Wait*

WT n0,n1

Usage	WT n ...	Arguments specified with an implicit, comma-separated order

Description

The WT command is a trippoint used to time events.When this command is executed, the controller will wait for the amout of time specified before executing the next command.

The amount of time in the WT command is specified to be either samples or milliseconds, depending on the second argument of WT

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n_0	2	2,147,483,646	N/A	2	Specify amount of time to hold execution of code	
n_1	0	1	0	1	Specify the type of WT	n = 0 or null specifies WT in msecs. n = 1 specifies WT in samples

Remarks

- If n_1=1 for WTn_0,n_1 then the controller will wait for the number of samples specified before executing the next command.
- By default, WT is specified in milliseconds. If n_1 is omitted, then n_1 = 0 is used and WT is timed in milliseconds

Examples

```
'Galil DMC Code Example
'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
```

WT applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

XQ *Execute Program*

XQ #str,n_1

XQ n_0,n_1

Usage	XQ n ...	Arguments specified with an implicit, comma-separated order
Operands	_XQ0 _XQ1 _XQ2 _XQ3 _XQ4 _XQ5 _XQ6 _XQ7	Operand has special meaning, see Remarks

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 simultaneously to perform multitasking.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
str	1 char	7 chars	See Notes	String	Label to begin code execution	If omitted, start from line 0 (n_0=0)
n_0	0	3,999	0	1	Line number to begin code execution	Firmware Rev 1.2a and later
n_0	0	1,999	0	1	Line number to begin code execution	
n_1	0	7	0	1	Thread number to execute code	

Remarks

- _XQn contains the current line number of execution for thread n, and -1 if thread t is not running.
- If using ED to add code, you must exit ED mode before executing code.

Examples

```
'Galil DMC Code Example
XQ #apple,0;'  Start execution at label apple, thread zero
XQ #data,2;'   Start execution at label data, thread two
XQ ;'          Start execution at line 0
```

XQ applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802

YA *Step Drive Resolution*

YAm= n
YA n,n,n,n,n,n,n,n

Usage	YAm= n	Arguments specified with a single axis mask and an assignment (=)
	YA n ...	Arguments specified with an implicit, comma-separated order
Operands	_YAm	Operand holds the value last set by the command

Description

Specifies the microstepping resolution of the step drive in microsteps per full motor step. Consult your drive documentation to determine its microstepping setting. See the table below for internal Galil stepper drives.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9,999	2	1	Drive resolution in step counts/motor step for SPM mode	YA has special functionality for certain hardware configurations. See the rest of the notes in this table.
	1	16	2	see Notes	Valid settings for SDM-44040 (-D4040)	1,2,4 and 16 set the step resolution of the SDM-44040 to full, half, 1/4th and 1/16th microstepping respectively. When full stepping (n=1) on the SDM-44040, the max gain will be 70% of value set with AG. Max current is available for any microstepping mode.
	64	64	2	0	Valid setting for SDM-44140 (-D4140)	The SDM-44140 is always configured for 64th microstepping, YA must be set to 64 for SPM mode

Remarks

YA Settings for Galil Stepper Drives

Stepper Drive Hardware	YA Setting	Notes
AMP-43547	256	Drive fixed at 1/256 step
SDM-44040	1	Drive set to single step (70% current max)
SDM-44040	2	Drive set to 1/2 step
SDM-44040	4	Drive set to 1/4 step
SDM-44040	16	Drive set to 1/16 step
SDM-44140	64	Drive fixed at 1/64 step

Examples

```
'Galil DMC Code Example
'Set the step drive resolution for a 1/64 Microstepping Drive:
:YA 64,64,64,64
:'Query the D axis value
:MG_YAD;'Response shows D axis step drive resolution
 64.0000
::
```

```
'Galil DMC Code Example
'Set the step drive resolution for a 1/256 Microstepping Drive:
:YA 256
:'Query the A axis value
:MG_YAA;' Response shows A axis step drive resolution
 256.0000
::
```

YA applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

YB *Step Motor Resolution*

YBm= n
YB n,n,n,n,n,n,n,n

Usage	YBm= n	Arguments specified with a single axis mask and an assignment (=)
	YB n ...	Arguments specified with an implicit, comma-separated order
Operands	_YBm	Operand holds the value last set by the command

Description

The YB command specifies the resolution of the step motor, in full steps per full revolution, for Stepper Position Maintenance (SPM) mode.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9,999	200	1	Motor resolution in full steps/revolution	

Remarks

- This command is only required if using SPM mode with stepper motors with an attached encoder.
- A 1.8 degree step motor is 200 steps/revolution.

Examples

```
'Galil DMC Code Example
'Set the step motor resolution of the A axis for a 1.8 degree step motor:
:YBA=200
:'Query the A axis value
:YBA=?
 200 Response shows A axis step motor resolution
```

YB applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

YC *Encoder Resolution*

YCm= n
YC n,n,n,n,n,n,n,n

Usage	YCm= n	Arguments specified with a single axis mask and an assignment (=)
	YC n ...	Arguments specified with an implicit, comma-separated order
Operands	_YCm	Operand holds the value last set by the command

Description

The YC command specifies the resolution of the encoder, in counts per revolution, for Stepper Position Maintenance (SPM) mode.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	32,766	4,000	1	Encoder resolution in counts/revolution	

Remarks

- This command is only required if using SPM mode with stepper motors with an attached encoder.

Examples

```
'Galil DMC Code Example
'Set the encoder resolution of the A axis
:YCA=2000
:'Query the A axis value
:YCA=?
 2000
:'Response shows A axis encoder resolution
```

YC applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

YR *Error Correction*

YRm= n
YR n,n,n,n,n,n,n,n

Usage	YRm= n	Arguments specified with a single axis mask and an assignment (=)
	YR n ...	Arguments specified with an implicit, comma-separated order

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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Number of step pulses to increment position by	

Remarks

- Users will typically use the value of QS to increment motor by the number of step pulses of error.
  - EG. YRm = _QSm increments the specified axis by the error magnitude.
- The sign of YR depends on the polarity of the position encoder
  - If the encoder increments when the stepper moves forward (increasing TD), the correction is YRm=_QSm. This is typical.
  - If the encoder decrements when the stepper moves forward, the correction is YRm= -_QSm. See CE to invert the polarity of the position encoder, if desired.

Examples

```
'Galil DMC Code Example
'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
```

```
'Galil DMC Code Example
'Query the error of the A axis:
:QSA
 253
:' This shows 253 step counts of error
:'Correct for the error:
:YRA=_QSA;' The motor moves _QS step counts to correct for the error
'and YS is set back to 1
```

YR applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

YS *Stepper Position Maintenance Mode Enable, Status*

YSm= n
YS n,n,n,n,n,n,n,n

Usage	YSm= n	Arguments specified with a single axis mask and an assignment (=)
	YS n ...	Arguments specified with an implicit, comma-separated order
Operands	_YSm	Operand has special meaning, see Remarks

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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	1	0	1	Setting of the SPM mode	n = 0 disables SPM mode, n = 1 Enables SPM mode. See Remarks

Remarks

- Both YSm = ? and _YSm contain the value of n. n is 1 when SPM mode is enabled and no error has occurred. If a position error has occured, n becomes 2.
    - If n = 2, this indicates a position error condition defined as more than 3 full motor steps of position error.
    - Issuing an n = 1 will clear the error

Position Error Limit

Microstep Setting (YA)	Error (QS) Limit
1	3
2	6
16	48
64	192
256	768

Examples

```
'Galil DMC Code Example
'Enable the mode:
:YSH=1
:'Query the value:
:YS*=?
 0,0,0,0,0,0,0,1 Response shows H axis is enabled
```

```
'Galil DMC Code Example
'Enable the mode:
:YSA=1
:'Query the value:
:YSA=?
 1 Response shows A axis is enabled
```

YS applies to DMC50000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,DMC1806,DMC1802,EDD37010

ZA *User Data Record Variables*

ZAm= n
ZA n,n,n,n,n,n,n,n

Usage	ZAm= n	Arguments specified with a single axis mask and an assignment (=)
	ZA n ...	Arguments specified with an implicit, comma-separated order
Operands	_ZAm	Operand holds the value last set by the command

Description

ZA sets the user variables in the data record. The 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

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-2,147,483,648	2,147,483,647	0	1	Value of user variable for data record	

Remarks

- n is an integer and can be a number, controller operand, variable, mathematical function, or string.
- Only 4 bytes are available for n. Fractional values are not stored or sent via the data record

Examples

```
'Galil DMC Code Example
#thread
ZAA= myVar;'   constantly update ZA with variable myVar
WT 10
JP#thread;'    run in an infinite loop
```

ZA applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC1806

ZN *Negative Antifriction Bias*

ZNm= n
ZN n,n,n,n,n,n,n,n

Usage	ZNm= n	Arguments specified with a single axis mask and an assignment (=)
	ZN n ...	Arguments specified with an implicit, comma-separated order

Description

ZN adds a negative open loop voltage to the controller?s command signal when the position error is negative.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	-9.9998	0	0	0.0003	Open loop voltage (Volts)	

Remarks

- Valid only for -NAN and -CER firmware

Examples

```
'Galil DMC Code Example
ZNA=-1;'set negative antifriction bias on A axis to -1 volt
ZPC=1;'set positive antifriction bias on C axis to 1 volt
```

ZN applies to CER,NANO

ZP *Positive Antifriction Bias*

ZPm= n
ZP n,n,n,n,n,n,n,n

Usage	ZPm= n	Arguments specified with a single axis mask and an assignment (=)
	ZP n ...	Arguments specified with an implicit, comma-separated order

Description

ZP adds a positive open loop voltage to the controller?s command signal when the position error is positive.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
m	A	H	N/A	Axis	Axis to assign value	
n	0	9.9998	0	0.0003	Open loop voltage (Volts)	

Remarks

- Valid only for -NAN and -CER firmware

Examples

```
'Galil DMC Code Example
ZNA=-1;'set negative antifriction bias on A axis to -1 volt
ZPC=1;'set positive antifriction bias on C axis to 1 volt
```

ZP applies to CER,NANO

ZS *Zero Subroutine Stack*

ZS n

Usage	ZS n ...	Arguments specified with an implicit, comma-separated order
Operands	_ZS0 _ZS1 _ZS2 _ZS3 _ZS4 _ZS5 _ZS6 _ZS7	Operand has special meaning, see Remarks

Description

The ZS command is used to clear the stack when finishing or leaving a subroutine. This command is used to avoid returning from an interrupt (either input or error). This turns the jump to subroutine into a jump. The status of the stack can be interrogated with the operand _ZS, see Remarks.

Arguments

Argument	Min	Max	Default	Resolution	Description	Notes
n	0	1	0	1	Sets zero stack operation	n = 0 clears the entire stack. n = 1 clears one level of the stack.

Remarks

- Do not use RI (Return from Interrupt) when using ZS.
  - To re-enable interrupts, you must use II command again.

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.

Examples

```
'Galil DMC Code Example
#A;'            Main Program
II1;'           Input Interrupt on 1
#B;JP #B;EN ;'  Loop
#ININT;'         Input Interrupt
MG"INTERRUPT";'Print message
S=_ZS0;'         Interrogate stack
S=?;'           Print stack
ZS;'            Zero stack
S=_ZS0;'         Interrogate stack
S=?;'           Print stack
EN;'            End
```

ZS applies to DMC50000,DMC52000,DMC4000,DMC4200,DMC4103,DMC30010,DMC2103,RIO47000,DMC1806,DMC1802