ASCII Programmer's Guide

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CHAPTER
1: INTRODUCTION

1.1: The ASCII Interface

The ASCII Interface is a set of commands that can be used to control and monitor drives over an RS-232 serial connection.

The ASCII Interface can be used to:

• Read and write the drive's parameters
• Control the trajectory generator
• Read and write CVM registers.

1.2: Communication Protocol

Drives use the "speak when spoken to" protocol. This means that the drive will never initiate communications, but it will respond to commands with a data packet, an error code, or acknowledgement (except for a reset command).

The baud rate of the drive will always be set to 9600 on power up or after a reset. Drives are designed to identify a break condition on the serial line and synchronize its communication interface based on it. A serial break command is normally an illegal condition in which the system initiating the break command holds its transmit line low for longer than a single byte of serial data. If such a condition is detected by the drive, it will flush any pending input data, reset its baud rate to 9600, and wait for a new command to be received on its serial port. The drive will never initiate a break command itself.

Use the following settings for the serial port communications:

Baud Rate	9,600 to 115,200 (Defaults to 9,600 on power up or reset.)
Data Format	N, 8, 1
Flow Control	None

CHAPTER
2: COMMAND SET

2.1: Command Format

The general syntax of a ASCII message is:

   [node ID][<.>axis letter] [command code] [command parameters] <CR>

The specific syntax for each command is described in the remaining sections of this chapter.

[node ID]

(Optional), the CANopen node ID of a drive on a multi-drop network (See Multi-Drop Network Connections). The node ID is followed by a space, unless an axis letter is specified. The valid range is 1-127.

[<.>axis letter]

Optional, the axis letter for multi-axis drives (BE2, SP4, etc.). Axes are specified by a single letter and must be preceded by a period. Valid axis letters start at "A" and continue sequentially. For example, the SP4 is a four axis drive with valid axis letters of A, B, C, D.

[command code]

The command code is a single-letter code for the command.

Code	Command	Description
s	Set	Set a value of a parameter in ram or flash.
g	Get	Read the value of a parameter in ram or flash.
c	Copy	Copy the value of a parameter from ram to flash or flash to ram.
r	Reset	Reset the drive.
t	Trajectory	Trajectory generator command.
i	Register	Read or write the value of a CVM program register.

[command specific parameters]

Command specific parameters are used to provide additional data for a command. If more than one parameter is required, they should be separated by spaces. The remaining sections of this chapter describe the parameters for each command code.

<CR>

A carriage return is used to indicate the end of the command to the drive.

2.2: Set Command (s)

The **s** command is used to set the value of a drive parameter in RAM or flash.

Syntax

> **[node ID][<.>axis letter] s [memory bank][parameter ID] [value]<CR>**

Command Specific Parameters

[memory bank]	Identifies which memory bank to set the parameter in.
	    f = flash memory
	    r = RAM memory

[parameter ID]	Identifies the parameter to set. This value can be decimal or hexadecimal.
[value]	The new value(s) to be set in the parameter. Value can be sent in integer hexadecimal format. If multiple values are required, they are separated by spaces.

The drive responds to the **s** command with:

> **ok<CR>** if the command is accepted.

> **e <error #><CR>** if the command was not accepted. See Error Codes.

Examples

Command	Response	Comment
s r0x30 1200	ok	Set parameter 0x30 (position loop proportional gain) to 1200 in RAM. The "ok" response indicates that the command executed successfully.
s f0x30 1200	ok	Set parameter 0x30 (position loop proportional gain) to 1200 in flash. The "ok" response indicates that the command executed successfully.
3 s f0x30 1200	ok	Set parameter 0x30 (position loop proportional gain) to 1200 in flash for the drive with CAN node ID of 3. The "ok" response indicates that the command executed successfully.
. b s f0x30 1200	ok	Set parameter 0x30 (position loop proportional gain) to 1200 in flash on axis B. The "ok" response indicates that the command executed successfully.
s r 0x30 1000	e 33	Attempted to set 0x30 to 1200 in RAM. Error 33 (ASCII command parsing error) was returned. Note the extra space between the bank and the parameter ID.

2.3: Get Command (g)

The **g** command is used to read the value of a drive parameter from RAM or flash.

Syntax

> **[node ID][<.>axis letter] g [memory bank][parameter ID][optional <x>]<CR>**

Command Specific Parameters

[memory bank]	Identifies which memory bank to read the parameter from.
	    f = flash memory
	    r = RAM memory

[parameter ID]	Identifies the parameter to read. This value can be decimal or hexadecimal.
<x>	(Optional), instructs the drive to return the value in hexadecimal format. This option is not available on Feature set A or Feature Set B drives.

The drive responds to the Get command with:

> **v [value]<CR>** where value equals the contents of the parameter. If the parameter contains multiple values, they will separated by spaces.

> **e <error #><CR>** if the command was not accepted. See Error Codes.

Examples

Command	Response	Comment
g r0x30	v 1200	Read the value of parameter 0x30 (position loop proportional gain) from RAM. Example shows a value of 1200 returned.
3 g r0x30	v 1200	Read the value of parameter 0x30 (position loop proportional gain) from RAM for the drive with CAN node ID of 3. Example shows a value of 1200 returned.
. b g r0x30	v 1200	Read the value of parameter 0x30 (position loop proportional gain) from RAM on axis B. Example shows a value of 1200 returned.
g r0xa0x	v 0x4000f800	Read the value of parameter 0xa0 (amplifier event status) and return the value in hexadecimal format.
g f0x17	e 15	Attempted to read parameter 0x17 (actual motor position) from flash. Error 15 (Parameter doesn't exist on requested page) was returned. Note that actual motor position is stored in RAM only.

2.4: Copy Command (c)

The **c** command is used to copy the value of a parameter from one memory bank to another (RAM to flash or flash to RAM).

Syntax

[node ID][<.>axis letter] c [memory bank][parameter ID]<CR>

Command Specific Parameters

[memory bank]	Identifies which memory bank to set the parameter in. f = copy from flash to RAM r = copy from RAM to flash
[parameter ID]	Identifies the parameter to read. This value can be decimal or hexadecimal.

The drive responds to the **c** command with:

ok<CR> if the command is accepted.

e <error #><CR> if the command was not accepted. See Error Codes.

Examples

Command	Response	Comment
c r0x30	ok	Copy the value of 0x30 from RAM to flash. The "ok" response indicates that the command executed successfully.
.b c r0x30	ok	Copy the value of 0x30 from RAM to flash for axis B. The "ok" response indicates that the command executed successfully.
3 c r0x30	ok	Copy the value of 0x30 from RAM to flash for the drive with CAN node ID of 3. The "ok" response indicates that the command executed successfully.
c f0x30	ok	Copy the value of 0x30 from flash to RAM. The "ok" response indicates that the command executed successfully.

2.5: Reset Drive Command (r)

The **r** command is used to reset the drive. The command requires no additional parameters. The drive baud rate is set to 9600 when the drive restarts. The drive does not respond to this message.

NOTE: if a reset command is issued to a drive on a multi-drop network, error code 32, "CAN Network communications failure," will be received. This is because the drive reset before responding to the gateway drive. In this case, the error can be ignored.

Syntax

[optional node ID] r<CR>

Notes

The axis letter has no effect with this command because the reset command applies to all axes of a multi-axis drive.

Example

Command	Response	Comment
r	none	Drive is reset.
3 r	none	The drive with CAN node ID of 3 is reset.

2.6: Trajectory Generator Command (t)

The **t** command controls the trajectory generator.

Syntax

1   The original syntax for the t command is:

> **[node ID][<.>axis letter] t [command code]<CR>**

2   For Feature Set C and D with a firmware version of at least 3.26 and Feature Set E drives with a firmware version of at least 1.44, the axis letter is not needed because the axis can be specified in the command code. If the axis is supplied in addition to setting the axis bits in the command code, the axis letter will be OR'd with the bits set in the command code. This is allowed for backward compatibility reasons.

> **[node ID] t [command code]<CR>**

Command Specific Parameters

[command code]	Trajectory command information, bit-mapped as follows:	
	Bit(s)	**Description**
	0-3	Sub-command
		Value **Meaning**
		0 Abort the move in progress.
		1 Initiate or update a move.
		2 Initiate home sequence
	4-11	Reserved and should be set to zero
	12*	If set apply command to axis A
	13*	If set apply command to axis B
	14*	If set apply command to axis C
	15*	If set apply command to axis D
* NOTE: The axis bits are only available on Feature Set C and D with a firmware version of at least 3.26 and Feature Set E drives with a firmware version of at least 1.44		

The drive responds to the **t** command with:

ok<CR> if the command is accepted. An "ok" response only indicates the command was accepted by the drive. Monitor the trajectory status register to verify that motion has actually been initiated.

e <error #><CR> if the command was not accepted. See Error Codes

Examples

Command	Response	Comment
t 1	ok	Initiate a move.
t 0x5002	ok	Initiate a home sequence on axis A and C
t2	e 33	Attempted to initiate a homing sequence. Error 33 (ASCII command parsing error) was returned. Note there is no space between the command and sub-command.

2.7: Register Read and Write Command (i)

The i command is used to read and write one of the CVM program's 32 registers.

Write Syntax

[node ID] i <r#> [value]<CR>

Command Specific Parameters

<r#>	Identifies which register to access. The valid range is 0-31.
[value]	If included, the new value to be written to the register. The value can be in decimal or hexadecimal format.

Read Syntax

[node ID][<.>axis letter] i <r#><CR>

Command Specific Parameters

<r#>	Identifies which register to access. The valid range is 0-31.

The drive responds to the **i** command with:

• **ok<CR>** if the command is accepted and the value is written to the register.
• **r [value]<CR>** where value equals the contents of the register that was read.
• **e <error #><CR>** if the command was not accepted. See Error Codes

Notes

All axes on a multi-axis drive share a single set of CVM registers. Therefore, the axis letter is not used for this command.

Examples

Command	Response	
i r0 15	ok	Write the value "15" to register 0.
i r0	r 15	Read the value of register 0. Example displays a returned value equal to 15.
8 i r0	r 35	Read the value of register 0 on drive with CAN node ID of 8. Example displays a returned value equal to 35.

2.8: Clear Encoder Faults Command

This command will clear the faults being reported by the encoder. When received by the drive, the drive will attept to send the clear faults command to the encoder.

Syntax

For motor encoders:

enc clear

For load encoders:

ldenc clear

Notes

The encoder must be connected to the drive for this command to work.

Examples

Command	Response	
enc clear	ok	Drive attempts to clear the faults on the motor encoder
ldenc clear	ok	Drive attempts to clear the faults on the load encoder

CHAPTER
3: OPERATING MODES

3.1: Desired State Parameter

The desired state parameter (0x24) defines the drive's operating mode and input source control. Mode-specific values are mentioned in the remaining sections of this chapter.

Value	State
0	Disabled. **NOTE:** If the desired sate is saved to flash as 0, then CME 2 assumes the drive has not been programmed, and when CME connects to the drive, the Basic Setup screen will be displayed.
1	The current loop is driven by the programmed current value.
2	The current loop is driven by the analog command input.
3	The current loop is driven by the PWM & direction input pins.
4	The current loop is driven by the internal function generator.
5	The current loop is driven by UV command.
11	The velocity loop is driven by the programmed velocity value.
12	The velocity loop is driven by the analog command input.
13	The velocity loop is driven by the PWM & direction input pins.
14	The velocity loop is driven by the internal function generator.
21	Servo mode, the position loop is driven by the trajectory generator.
22	Servo mode, the position loop is driven by the analog command input.
23	Servo mode, the position loop is driven by the digital inputs (pulse & direction, master encoder, etc.).
24	Servo mode, the position loop is driven by the internal function generator.
25	Servo mode, the position loop is driven by the cam tables.
30	Servo mode, the drive is controlled by the CANopen or EtherCAT interface.
31	Microstepping mode, the position loop is driven by the trajectory generator.
32	Microstepping mode, the position loop is driven by the analog command input.
33	Microstepping mode, the position loop is driven by the digital inputs (pulse & direction, master encoder, etc.).
34	Microstepping mode, the position loop is driven by the internal function generator.
35	Microstepping mode, the position loop is driven by the cam tables.
36	Microstepping mode, the velocity loop is driven by the analog command input.
40	Microstepping mode, the drive is controlled by the CANopen or EtherCAT interface.
42	Diagnostic use only. The current loop is driven by the programmed current value, and the phase angle is micro-stepped.

3.2: Current Mode

Programmed Current Mode

The Programmed Current mode sets the output of the drive at a programmed current level. When the drive is enabled in this mode, or when the programmed current level is changed, the output current ramps to the new level at the programmed rate.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: Programmed Current mode (1)
0x02	R F	Programmed current value. Units: 0.01 A.
0x6a	R F	Current ramp limit. Units: mA/second.
		A value of zero in this register disables slope limiting and results in a step change.

NOTE: When changing both the level and the ramp parameters while the drive is enabled, change the ramp rate first.

Example

Enable the drive in Programmed Current Mode. Ramp the output current up to 2 A in 0.5 seconds. The controller monitors the output current, and after it reaches 2 A the current is ramped down to 1 A in 2 seconds.

Command	Response	Comment
s r0x6a 4000	ok	Set ramp rate to 4 A/second.
s r0x02 200	ok	Set the output level to 2 A.
s r0x24 1	ok	Enable the drive in Programmed Current Mode. Output current will start increasing at a rate of 4 A/second.

The controller uses the following command to monitor the output current.

g r0x0c	v 150	Reads actual current output from the drive. Example displays a returned value equal to 1.50 A.

After the output current reaches 2 A, the controller sends the new ramp and level parameters.

s r0x6a 500	ok	Set new ramp rate of 0.5 A/second.
s r0x02 100	ok	Change the output level to 1 A. Output current will start decreasing at a rate of 0.5 A/second.

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

Analog Current Mode

In Analog Current Mode, the current output of the drive is proportional to the analog reference input command signal.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state. Analog Current Mode (2).
0x19	R F	Analog input scaling factor. Amount of current to be commanded when 10 volts is applied to the analog input. Units: 0.01 A.
0x26	R F	Analog input dead band. Units: mV.
0x1a	R F	Analog input offset. Units: mV.

NOTE: Parameters 0x19, 0x26 and 0x1a are used in Analog Current, Velocity and Position modes. Verify that these parameters are set correctly before switching between these modes of operation.

Example

The controller sets the scaling, enables the drive in Analog Current Mode, monitors the current output, and changes the scaling to a new value.

Command	Response	Comment
s r0x19 1000	ok	Set scaling factor to 10V = 10A.
s r0x24 2	ok	Set drive to Analog Current Mode.

The controller uses the following command to monitor the output current.

Command	Response	Comment
g r0x0c	v 525	Reads actual current output from the drive. Example displays a returned value equal to 5.25 A.

The controller changes the scaling factor

Command	Response	Comment
s r0x19 100	ok	Set scaling factor to 10V = 1A.

The controller disables the drive.

Command	Response	Comment
s r0x24 0	ok	Disable the drive.

PWM Current Mode

In the PWM Current Mode, the current output of the drive is proportional to the duty cycle of the input command signal. In most applications the command signal configuration is set using CME 2 and not changed during operation.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: PWM Current Mode (3).
0xa9	R F	Digital input scaling factor. Amount of current commanded at 100 percent duty cycle. Units: 0.01 A.
0xa8	R F	Digital input command configuration normally set using the CME 2 PWM Command screen. See table below for definition of the values.

NOTE: Parameters 0xa9 and 0xa8 are used in PWM Current and Velocity modes. Verify that these parameters are set correctly before switching between these modes of operation.

Example

The controller sets the scaling, enables the drive in PWM Current Mode, and monitors commanded and actual current.

Command	Response	Comment
s r0xa9 1000	ok	Set scaling factor to 10A.
s r0x24 3	ok	Enable the drive in PWM Current Mode.

The controller uses the following commands to monitor the commanded and output current .

g r0x15	v 500	Reads commanded current from the drive. Example displays a returned value equal to 5 A.
g r0x0c	v 495	Reads actual current output from the drive. Example displays a returned value equal to 4.95 A.

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

PWM Current Mode Command Signal Configuration

If required during operation, the PWM command signal configuration can be changed by setting the value of parameter 0xa8 as shown below.

PWM Input Type	Invert PWM Input	Invert Sign Input	Allow 100% Output	Value
50%	No	--	No	0x00
50%	No	--	Yes	0x08
50%	Yes	--	No	0x02
50%	Yes	--	Yes	0x0a
100%	No	No	No	0x01
100%	No	No	Yes	0x09
100%	No	Yes	No	0x05
100%	No	Yes	Yes	0x0d
100%	Yes	No	No	0x03
100%	Yes	No	Yes	0x0b
100%	Yes	Yes	No	0x07

3.3: Velocity Mode

Programmed Velocity Mode

The Programmed Velocity Mode sets the output of the drive to a programmed motor velocity. When the drive is enabled in this mode, or when the programmed velocity is changed, the motor velocity will ramp to the new level at the programmed rate.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: Programmed Velocity Mode (11).
0x2f	R F	Programmed velocity command. Units: 0.1 counts/second.
0x36	R F	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	R F	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	R F	Fast stop ramp. Units: 1000 counts/second^2

Example

The controller sets the velocity parameters, enables the drive in Programmed Velocity Mode, monitors the actual motor velocity, and then changes the velocity.

Command	Response	Comment
s r0x36 2	ok	Set acceleration limit to 2000 counts/second^2.
s r0x37 4	ok	Set deceleration limit to 4000 counts/second^2.
s r0x2f 10000	ok	Set the programmed velocity to 1000 counts/second.
s r0x24 11	ok	Enable the drive in Programmed Velocity Mode.

The controller uses the following commands to monitor the motor velocity.

g r0x18	v 10010	Reads actual velocity from the drive. Example displays a returned value equal to 1001 counts/second.

The controller sets a new velocity to 500 counts/second.

s r0x2f 5000	ok	Set the programmed velocity to 500 counts/second. Motor will decelerate at 4000 counts/second^2 to 500 counts/second.

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

Analog Velocity Mode

In the Analog Velocity Mode, the motor velocity is proportional to the analog reference input command signal.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: Analog Velocity Mode (12).
0x19	R F	Analog input scaling factor. Velocity commanded per 10 volts of input. Units: 0.1 counts/second
0x26	R F	Analog input dead band. Units: mV.
0x1a	R F	Analog input offset. Units: mV.
0x36	R F	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	R F	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	R F	Fast stop ramp. Units: 1000 counts/second^2

NOTE: Parameters 0x19, 0x26 and 0x1a are used in Analog Current, Velocity and Position modes. Verify that these parameters are set correctly before switching between these modes of operation.

Example

The controller sets the scaling, enables the drive in Analog Velocity Mode, monitors the actual motor velocity, and changes the scaling.

Command	Response	Comment
s r0x19 10000	ok	Set scaling factor to 1000 counts/second.
s r0x24 12	ok	Enable the drive in Analog Velocity Mode.

The controller uses the following command to monitor the actual motor velocity.

Command	Response	Comment
g r0x18	v 5000	Reads actual velocity from the drive. Example displays a returned value equal to 500 counts/second.

The controller changes the scaling factor.

Command	Response	Comment
s r0x19 7000	ok	Set scaling factor to 700 counts/second.

The controller disables the drive.

Command	Response	Comment
s r0x24 0	ok	Disable the drive.

PWM Velocity Mode

In the PWM Velocity Mode, the motor velocity is proportional to the duty cycle of the input command signal. In most applications the command signal configuration is set using CME 2 and not changed during operation.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: PWM Velocity Mode (13).
0xa9	R F	Scaling Factor. Velocity command at 100 percent duty cycle. Units: 0.1 counts/second.
0x36	R F	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	R F	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	R F	Fast stop ramp. Units: 1000 counts/second^2
0xa8	R F	Digital input command configuration. This is normally set using the CME 2 PWM Command screen. See table below for the definition of the values.

NOTE: Parameters 0xa9 and 0xa8 are used in PWM Current and Velocity modes. Verify that these parameters are set correctly before switching between these modes of operation.

Example

The controller sets the PWM scaling, enables the drive in PWM Velocity Mode, and monitors the commanded and actual velocity.

Command	Response	Comment
s r0xa9 800000	ok	Set scaling factor to 80000 counts/second at 100%.
s r0x24 13	ok	Enable the drive in PWM Velocity Mode.
g r0x2c	v 49995	Reads commanded velocity from the drive. Example displays a returned value equal to 4999.5 counts/second.
g r0x18	v 49991	Reads actual velocity from the drive. Example displays a returned value equal to 4999.1 counts/second.
s r0x24 0	ok	Disable the drive.

PWM Velocity Mode Command Signal Configuration

If required during operation, the PWM command signal configuration can be changed by setting the value of parameter 0xa8 as shown below.

PWM Input Type	Invert PWM Input	Invert Sign Input	Allow 100% Output	Value
50%	No	--	No	0x00
50%	No	--	Yes	0x08
50%	Yes	--	No	0x02
50%	Yes	--	Yes	0x0a
100%	No	No	No	0x01
100%	No	No	Yes	0x09
100%	No	Yes	No	0x05
100%	No	Yes	Yes	0x0d
100%	Yes	No	No	0x03
100%	Yes	No	Yes	0x0b
100%	Yes	Yes	No	0x07

3.4: Position Mode

Updating Trajectory Parameters in Position Modes

When the drive enters a position mode, the trajectory parameters (velocity, acceleration and deceleration) are copied into the trajectory generator. To change any of them after the drive is in a position mode, send the new value to the appropriate parameter and then send a *t 1* command to initiate a trajectory update.

Programmed Position Mode

In the Programmed Position Mode, the axis moves to target positions sent to the drive over the serial interface. The target positions can be absolute or relative from the current position. The motion profile used can be set to trapezoidal or S-curve.

To initiate a move, first set the appropriate parameters and then send the trajectory command *t 1* to start the move. When using the trapezoidal profile, the move parameters can be changed during the move. Again, first set the appropriate parameters and then send another *t 1* command. When the *t 1* command is received, the target position, absolute / relative, velocity, acceleration and deceleration rates will be updated. In this manner, the move in progress can be changed. The S-curve profile cannot be updated in this manner.

To abort a move in progress, send a *t 0* command. This will stop the move in progress using the abort deceleration rate. The drive will remain enabled.

A special velocity mode can be used to move the axis using the velocity, acceleration and deceleration of the trapezoidal profile but with no specific target position. Direction of motion is set by entering a "1" or "-1" into the position command parameter. Once started, the move will continue until the velocity parameter is set to zero and a *t 1* command is sent or a *t 0* abort command is sent.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: 21 = Programmed Position Mode, Servo 31 = Programmed Position Mode, Stepper
0xc8	R F	Profile type: 0 = Absolute move, trapezoidal profile. 1 = Absolute move, S-curve profile. 256 = Relative move, trapezoidal profile. 257 = Relative move, S-curve profile. 2 = Velocity move.
0xca	R F	Position command. Units: counts. Relative move = the distance of the move. Absolute move = the target position of the move. Velocity move = 1 for positive direction, -1 for negative direction.

0xcb	R F	Maximum velocity. Units: 0.1 counts/second.
0xcc	R F	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	R F	Maximum deceleration rate. Units: 10 counts/second^2.
0xce	R F	Maximum jerk rate. Units: 100 counts/ second^3.
0xcf	R F	Abort deceleration rate. Units: 10 counts/second^2.

NOTES: 1) Maximum jerk rate is not used in the trapezoidal profile. 2) In the S-curve profile, the maximum deceleration rate is note used. The maximum acceleration rate is used for both acceleration and deceleration.

Example

The controller sets profile parameters, executes an absolute trapezoidal move to position 40,000 counts, monitors for move completion, and then executes a relative move of 10,000 counts using the same profile parameters.

Command	Response	Comment
s r0xc8 0	ok	Set the trajectory generator to absolute move, trapezoidal profile.
s r0xca 40000	ok	Set the position command to 40000 counts.
s r0xcb 70000	ok	Set maximum velocity to 7000 counts/second.
s r0xcc 200000	ok	Set maximum acceleration to 2000000 counts/second^2.
s r0xcd 200000	ok	Set maximum deceleration to 2000000 counts/second^2.
s r0x24 21	ok	Enable the drive in Programmed Position (Trajectory Generator) Mode.

The controller verifies actual axis position before starting move.

g r0x32	v 0	Read actual position. Example displays an actual position of 0.
t 1	ok	Execute the move.

The controller monitors the event status register to determine when the move has been completed.

g r0xa0	v 134217728	The controller monitors bit 27 of the event status register to determine when the move is complete. Example displays a status register value of 134217728. When this is decoded, it shows that bit 27 is set meaning the axis is in motion.

After the controller determines that motion has stopped, it checks the trajectory status register to see if the move was aborted for any reason.

g r0xc9	v 4096	The controller checks bit 14 of the trajectory status register to determine if the move was aborted. Example displays a status register value of 4096. When this is decoded, it shows that bit 14 is not set meaning the move was not aborted.

The controller sets the trajectory configuration and commanded position parameters to their new values and executes the new move.

s r0xc8 256	ok	Set the trajectory generator to relative move, trapezoidal profile.
s r0xca 10000	ok	Set the position command to 10000 counts.
t 1	ok	Execute the move.

The controller aborts the move.

t 0	ok	Motion stops and the drive is left enabled

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

Analog Position Mode

In the Analog Position Mode, the axis position is commanded by the analog reference input command signal.

The analog position command operates as a relative motion command. When the drive is enabled the voltage on the analog input is read. Then any change in the command voltage will move the axis a relative distance, equal to the change in voltage, from its position when enabled. To use the analog position command as an absolute position command, the drive should be homed every time it is enabled.

Parameters

Parameter ID	Bank	Description
0x24	R F	Desired state: Analog Position Mode (22).
0x19	R F	Analog input scaling factor. Commanded position per 10 volts of input. Units: counts.
0x26	R F	Dead band. Units: mV.
0x1a	R F	Analog input offset. Set to 0 when in this mode of operation.
0xcb	R F	Maximum velocity. Units: 0.1 counts/second.
0xcc	R F	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	R F	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	R F	Abort deceleration rate. Units: 10 counts/second^2.

NOTES: 1) Parameters 0x19, 0x26 and 0x1a are used in Analog Current, Velocity and Position modes. Verify that these parameters are set correctly before switching between these modes of operation. 2) To invert the direction of motion with respect to the polarity of the command voltage, set the scaling factor as a negative value.

Example

The controller sets the move parameters, homes the axis and then places the amp in the Analog Position Mode. The controller monitors actual position. The controller then changes the maximum velocity and scaling factor.

Command	Response	Comment
s r0x19 4000	ok	Set analog scaling to 4000 counts per 10V.
s r0xcb 70000	ok	Set velocity to 7000 counts/second
s r0xcc 20000	ok	Set acceleration to 200000 counts/second^2
s r0xcd 20000	ok	Set deceleration to 200000 counts/second^2
s r0x24 21	ok	Drive set in Programmed Position Mode required for homing.
t 2	ok	Execute homing. Assumes all homing parameters have been previously set.

The controller monitors the trajectory status register to determine when the axis has been homed.

g r0xc9	v 8192	Controller checks bit 12 of the trajectory status register to determine if the axis was homed successfully. Example displays a status register value of 8192. Decoded, this value shows that bit 12 is not set, meaning the axis has not finished homing.

After a successful homing, the controller changes the drive's operating mode.

s r0x24 22	ok	Drive set in Analog Position Mode
t 1	ok	This command will guarantee all new move parameters are in effect.

The controller monitors actual motor position.

g r0x32	v 2012	Reads actual motor position from the drive. Example displays a returned value equal to 2012 counts.

The controller changes velocity and scaling parameters

s r0xcb 20000	ok	Set velocity to 2000 counts/second
s r0x19 1000	ok	Set analog scaling to 1000 counts / 10V input.
t 1	ok	This command required for new velocity to take effect.

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

Pulse and Direction Mode

In the Pulse and Direction Position Mode, the axis position is commanded by pulses applied to one of the drives digital inputs. The direction of the commanded move is determined by the logic level of a second digital input.

The scaling factor sets the ratio of position command, in counts, for each input pulse. This ratio is stored in parameter 0xa9 as two 16 bit words. The first word stores the numerator or number of position counts. The second stores the denominator or the number of input pulses.
Example: To set a ratio of 10 counts of position change for every input pulse.
The ration would be 10/1. To make sending the data easier, it should be converted to hex word format so the ratio would now be 0x000a / 0x0001. The two words can now simply be combined and sent to the drive by sending the command *s r0xa9 0x000a0001*.

To invert the direction, the numerator should be set to a negative value.
Example: Changing direction of the previous example would require a ratio of -10/1. Using the 2's complement method, -10 is represented as 0xfff6 hex. The ratio in hex would now be 0xfff6 / 0x001. Combining these words, the command to be sent would be *s r0xa9 0xfff60001*.

Parameters

Parameter ID	Bank	Description

0x24	R F	Desired state:
		      23 = Digital Input Position Mode, Servo
		      33 = Digital Input Position Mode, Stepper

0xa8	R F	Digital Command Configuration (Pulse and Direction)
		      0 = Increment position on rising edge
		      4096 = Increment position on falling edge

0xa9	R F	Scaling factor, Output counts/Input pulses.
0xcb	R F	Maximum velocity. Units: 0.1 counts/second.
0xcc	R F	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	R F	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	R F	Abort deceleration rate. Units: 10 counts/second^2.

Example

The controller sets the move parameters, places the amp in the Pulse and Direction Position Mode, monitors commanded and actual position, and then changes the scaling factor.

Command	Response	Comment
s r0xa8 0	ok	Configure the digital inputs to pulse and direction with the position incrementing on the rising edge of the input pulse.
s r0xa9 0x00020001	ok	Set scaling factor to 2 output counts per input pulse.
s r0xcb 70000	ok	Set velocity to 7000 counts/second.
s r0xcc 20000	ok	Set acceleration to 200000 counts/second^2.
s r0xcd 20000	ok	Set deceleration to 200000 counts/second^2.
s r0x24 23	ok	Enable the drive in Digital Input Position Mode.

The controller monitors commanded and actual motor position.

Command	Response	Comment
g r0x3d	v 4000	Reads commanded position from the drive. Example displays a returned value equal to 4000 counts.
g r0x32	v 2012	Reads actual motor position from the drive. Example displays a returned value equal to 2012 counts.

The controller changes the scaling parameter.

Command	Response	Comment
s r0xa9 0x00010001	ok	Set scaling factor to 1 output count per input pulse.

The controller disables the drive.

Command	Response	Comment
s r0x24 0	ok	Disable the drive.

Pulse Up/Down Mode

In the Pulse Up/Down Position Mode, the axis position is commanded by pulses applied to the drives digital inputs. The direction of the commanded move is determined by which of the digital inputs the pulses are applied to.

The scaling factor sets the ratio of position command, in counts, for each input pulse. It is stored in parameter 0xa9 as two 16 bit words. The first word stores the numerator or number of position counts. The second stores the denominator or the number of input pulses.
Example: To set a ratio of 10 counts of position change for every input pulse.
The ratio would be 10/1. To make sending the data easier, it should be converted to hex word format so the ratio would now be 0x000a / 0x0001. The two words can now simply be combined and sent to the drive by sending the command s r0xa9 0x000a0001.

To invert the direction, the numerator should be set to a negative value.
Example: Changing direction of the previous example would require a ratio of -10/1. Using the 2's complement method, -10 is represented as 0xfff6 in hex format. The ratio in hex format would now be 0xfff6 / 0x001. Combining these words, the command to be sent would be
s r0xa9 0xfff60001.

Parameters

Parameter ID	Bank	Description

0x24	R F	Desired state:
		    23 = Digital Input Position Mode, Servo.
		    33 = Digital Input Position Mode, Stepper.

0xa8	R F	Digital Command Configuration (Pulse Up/Down Mode):
		    256 = Increment position on rising edge.
		    4352 = Increment position on falling edge.

0xa9	R F	Scaling factor, Output counts/Input pulses.
0xcb	R F	Maximum velocity. Units: 0.1 counts/second.
0xcc	R F	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	R F	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	R F	Abort deceleration rate. Units: 10 counts/second^2.

Example

The controller sets the move parameters and then places the amp in the Pulse Up/Down Position Mode, monitors commanded and actual position, and then changes the scaling factor.

Command	Response	Comment
s r0xa8 256	ok	Configure the digital inputs to pulse up/down with the position incrementing on the rising edge of the input pulse.
s r0xa9 0x000f0001	ok	Set scaling factor to 15 output counts per input pulse.
s r0xcb 70000	ok	Set velocity to 7000 counts/second.
s r0xcc 20000	ok	Set acceleration to 200000 counts/second^2.
s r0xcd 20000	ok	Set deceleration to 200000 counts/second^2.
s r0x24 23	ok	Enable the drive in Digital Input Position Mode.

The controller monitors commanded and actual motor position.

g r0x3d	v 4000	Reads commanded position from the drive. Example displays a returned value equal to 4000 counts.
g r0x32	v 2012	Reads actual motor position from the drive. Example displays a returned value equal to 2012 counts.

The controller changes the scaling parameter.

s r0xa9 0x00010001	ok	Set scaling factor to 1 output count per input pulse.

The controller disables the drive.

s r0x24 0	ok	Disable the drive.

Quadrature Mode

In the Quadrature Position Mode, the axis position is commanded by a master encoder with its A and B channels applied to the drive's digital inputs.

The scaling factor sets the ratio of position command, in counts, for each count of the master encoder. The scaling factor is stored in parameter 0xa9 as two 16 bit words. Word 1 stores the numerator or number of position counts. Word 2 stores the denominator or the number of input counts.
Example: To set a ratio of 10 counts of position change for every input count, the ratio would be 10/1. To make sending the data easier, the ratio should be converted to its hex equivalent (0x000a/0x0001). The two words can now be combined and sent to the drive by sending the command s r0xa9 0x000a0001.

To invert the direction, the numerator should be set to a negative value.
Example: Changing direction of the previous example would require a ratio of -10/1. Using the 2's complement method, -10 is represented as 0xfff6 in hex format. The ratio in hex format would now be 0xfff6/0x001. Combining these words, the command to be sent would be
s r0xa9 0xfff60001.

Parameters

Parameter ID	Bank	Description

0x24	R F	Desired state:
		        23 = Digital Input Position Mode, Servo.
		        33 = Digital Input Position Mode, Stepper.

0xa8	R F	Digital Command Configuration: 512 = Quadrature Mode.
0xa9	R F	Scaling factor, Output counts/Input pulses.
0xcb	R F	Maximum velocity. Units: 0.1 counts/second.
0xcc	R F	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	R F	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	R F	Abort deceleration rate. Units: 10 counts/second^2.

Example

The controller sets the move parameters, enables the drive in the Quadrature Position Mode, and monitors commanded and actual position.

Command	Response	Comment
s r0xa8 512	ok	Configure the digital inputs to quadrature position mode.
s r0xa9 0x00010001	ok	Set scaling factor to 1 output counts per input pulse.
s r0xcb 70000	ok	Set velocity to 7000 counts/second
s r0xcc 20000	ok	Set acceleration to 200000 counts/second^2

```
s r0xcd  20000          ok
```
Set deceleration to 200000 counts/second^2

```
s r0x24  23             ok
```
Enable the drive in Digital Input Position Mode.

The controller monitors commanded and actual motor position.

```
g r0x3d                 v  4000
```
Reads commanded position from the drive. Example displays a returned value equal to 4000 counts.

```
g r0x32                 v  2012
```
Reads actual motor position from the drive. Example displays a returned value equal to 2012 counts.

The controller disables the drive.

```
s r0x24  0              ok
```
Disable the drive.

Homing Mode

Homing sequences can be performed using the *t* command when the drive is in Programmed Position Mode (servo or stepper). In most applications the homing sequence is configured using CME 2 and not changed during operation.

Parameters

Parameter ID	Bank	Description

0x24	R F	Desired state:
		    21 = Programmed Position Mode, Servo.
		    31 = Programmed Position Mode, Stepper.
		This is the required mode for homing.

0xc2	R F	Homing Method. See table below for values.
0xc3	R F	Fast Velocity Units: 0.1 counts/second.
0xc4	R F	Slow Velocity Units: 0.1 counts/second.
0xc5	R F	Acceleration / Deceleration Units: 10 counts/second^2.
0xc6	R F	Home Offset Units: counts.
0xc7	R F	Current Limit Units: 0.01 A.
0xbf	R F	Current Delay Time Units: milliseconds.
0xb8	R F	Positive Software Limit Units: counts.
0xb9	R F	Negative Software Limit Units: counts.

Example

The controller modifies the homing parameters, enables the drive in the Programmed Position Mode, initiates a homing sequence and then monitors homing status.

Command	Response	Comment
Command	**Response**	**Comment**

Setting the homing parameters is only required if the home sequence stored in flash memory is not satisfactory.

Command	Response	Comment
s r0xc2 544	ok	Sets the homing method to use the next index pulse as home.
s r0xc4 40000	ok	Sets the slow velocity to 4000 counts/second.
s r0xc6 1000	ok	Sets the home offset to 1000 counts.
s r0x24 21	ok	Enables the drive in programmed position mode.
t 2	ok	Starts the homing sequence.

The controller monitors the trajectory status register to determine when the homing sequence is complete.

Command	Response	Comment
g r0xc9	v 20480	Controller checks bit 12 of the trajectory status register to determine if the axis was homed successfully. Example displays a status register value of 20480. Decoded, this value shows that bit 12 is set meaning the axis is referenced.

Homing Methods

For a complete description of each homing method, refer to the Appendix on Homing Methods in the CME 2 User Guide.

Method	Start Direction	Value
Set Current Position as Home	N/A	512
Next Index	Positive	544
	Negative	560
Limit Switch	Positive	513
	Negative	529
Limit Switch Out to Index	Positive	545
	Negative	561
Home Switch	Positive	514
	Negative	530
Home Switch Out to Index	Positive	546
	Negative	562
Home Switch In to Index	Positive	610
	Negative	626
Hard Stop	Positive	516
	Negative	532
Hard Stop Out to Index	Positive	548
	Negative	564
Lower Home	Positive	771
	Negative	787
Upper Home	Positive	515
	Negative	531
Lower Home Outside Index	Positive	803
	Negative	819
Lower Home Inside Index	Positive	867
	Negative	883
Upper Home Outside Index	Positive	547
	Negative	563
Upper Home Inside Index	Positive	611
	Negative	627
Immediate Home	N/A	15

CHAPTER
4: OPERATION

4.1: Setting the Baud Rate

Parameter 0x90 (RAM only) controls the drive's serial port baud rate. To change the baud rate, write the new value to 0x90. For instance, to change the value to 19200 send: s r0x90 19200. The drive will respond with an "ok" if the command is successful but it will be sent at the new baud rate.

After the carriage return of the s command, no other characters should be sent at 9600 (by default, some programs automatically append a line feed). If more characters are sent at 9600, they may be misinterpreted as a break command and cause the drive to change back to 9600 baud. There should also be a delay of 100 mS minimum before characters at the new baud rate are sent to the drive.

When reading parameter 0x90, note that the value received may not be the exact value set. This is because the drive sets the baud rate as close to the requested baud rate as possible given the internal clock frequencies of the drive's microprocessor.

4.2: Setting Limits and Gains

This section describes the parameters used to set control loop limits and gains.

Current Loop Limits Parameters

Parameter ID	Bank	Description
0x21	R F	Peak current limit. Units: 0.01 A.
0x23	R F	I^2T time limit. Units: mS.
0x22	R F	Continuous current limit. Units: 0.01 A.
0xae	R F	Current loop offset. Units: 0.01 A.

Current Loop Gains Parameters

0x00	R F	Current loop proportional gain (Cp).
0x01	R F	Current loop integral gain (Ci).

Velocity Loop Limits Parameters

Parameter ID	Bank	Description
0x3a	R F	Velocity loop velocity limit. Units: 0.1 counts/second.
0x36	R F	Velocity loop acceleration limit. Units: 1000 counts/second^2.
0x37	R F	Velocity loop deceleration Limit. Units: 1000 counts/second^2.
0xcf	R F	Fast Stop Ramp. Units: 10 counts/second^2.

Velocity Loop Gains Parameters

Parameter ID	Bank	Description
0x27	R F	Velocity loop proportional gain (Vp).
0x28	R F	Velocity loop integral gain (Vi).

Position Loop Limits

Position loop limits are described in Position Mode.

Position Loop Gains Parameters

Parameter ID	Bank	Description
0x30	R F	Pp - Position loop proportional gain.
0x33	R F	Vff - Velocity feed forward.
0x34	R F	Aff - Acceleration feed forward.
0xe3	R F	Position loop gain multiplier. 100 equals a factor of 1.

Filter Parameters

Parameter ID	Bank	Description
0x6b	R F	Velocity loop command filter coefficients.
0x5f	R F	Velocity loop output filter coefficients.
0x150	R F	Second chained biquad filter on the output of the velocity loop (only available on Plus Products).
0x151	R F	Third chained biquad filter on the output of the velocity loop (only available on Plus Products).
0x152	R F	First chained biquad filter on the input of the current loop (only available on Plus Products).
0x153	R F	Second chained biquad filter on the input of the current loop (only available on Plus Products).

Velocity Loops Filters Usage Notes

The velocity loop command and output filters should be set up using CME 2. If it is required that the filters be changed during operation, the following procedure should be used to determine the new filter coefficients.

1 Set the filter up using CME 2.

- For Plus Products open the Filter Configuration screen, for all other products, open the Velocity Loop screen.
- Choose the filter type, and parameters, then click **Apply**, and then close.

2 Use the CME 2 ASCII command line tool (**Tools->ASCII Command Line**) to read the updated parameter. For instance, to read the command filter parameter:

Command	g r0x6B
Response	For Plus Products, the response is a combination of hex and

	floating point numbers:
	`V 0x211100c8 0x00010101 1.56119e+00 -`
	`641467e-01 2.00687e-02 4.01373e-02 2.00687e-`
	`02`

	For all other products, the response is nine decimal values: `v -7936 200 0 775 1550 775 -12774 32763 5813`

3 Write program instructions to update the appropriate parameter with those values. For instance, to write the command filter parameter:

Command	For Plus Products, use the combination of hex and floating point numbers from Step 2:
	`S r0x6B 0x211100c8 0x00010101 1.56119e+00 -`
	`641467e-01 2.00687e-02 4.01373e-02 2.00687e-`
	`02`

	For all other products, the response is nine decimal values from Step 2:
	`S r0x6B -7936 200 0 775 1550 775 -12774`
	`32763 5813`

Response	ok

4.3: Monitoring Status

Event Status Register (0xa0)

The status register parameter (0xa0) provides drive status information.
0xa0 is read-only, and available in RAM only. Bit mapped values described below:

Bits	Description
0	Short circuit detected.
1	Drive over temperature.
2	Over voltage.
3	Under voltage.
4	Motor temperature sensor active.
5	Feedback error.
6	Motor phasing error.
7	Current output limited.
8	Voltage output limited.
9	Positive limit switch active.
10	Negative limit switch active.
11	Enable input not active.
12	Drive is disabled by software.
13	Trying to stop motor.
14	Motor brake activated.
15	PWM outputs disabled.
16	Positive software limit condition.
17	Negative software limit condition.
18	Tracking error.
19	Tracking warning.
20	Drive has been reset.
21	Position has wrapped. The Position parameter cannot increase indefinitely. After reaching a certain value the parameter rolls back. This type of counting is called position wrapping or modulo count. Note that this bit is only active as the position wraps.
22	Drive fault. A drive fault that was configured as latching has occurred. For information on latching faults, see the CME 2 User Guide.
23	Velocity limit has been reached.
24	Acceleration limit has been reached.
25	Position outside of tracking window.
26	Home switch is active.
27	Set if trajectory is running or motor has not yet settled into position (within Position Tracking Error Limit) at the end of the move. Once the position has settled, the in motion

	bit won't be set until the next move starts.
28	Velocity window. Set if the absolute velocity error exceeds the velocity window value.
29	Phase not yet initialized. If the drive is phasing with no Halls, this bit is set until the drive has initialized its phase.
30	Command fault. PWM or other command signal not present.
31	Not defined.

Trajectory Status Register (0xc9)

The trajectory register parameter (0xc9) provides trajectory generator status information.
0xc9 is read-only, and available in RAM only. Bit mapped values described below:

Bit	Description
0-8	Reserved for future use.
9	Cam table underflow.
10	Reserved for future use
11	Homing error. If set, an error occurred in the last home attempt. Cleared by a home command.
12	Referenced. Set when a homing command has been successfully executed. Cleared by a home command.
13	Homing. If set, the drive is running a home command.
14	Set when a move is aborted. Cleared at the start of the next move.
15	In-Motion Bit. If set, the trajectory generator is presently generating a profile.

Latching Fault Status Register (0xa4)

The fault register parameter (0xa4) shows latching faults that have occurred.
0xa4 is available in RAM only.

Bit mapped values described below:

Bit	Fault Description
0	Data flash CRC failure. This fault is considered fatal and cannot be cleared.
1	Drive internal error. This fault is considered fatal and cannot be cleared.
2	Short circuit.
3	Drive over temperature.
4	Motor over temperature.
5	Over voltage.
6	Under voltage.
7	Feedback fault.
8	Phasing error.
9	Following error.
10	Over Current (Latched),
11	FPGA failure. This fault is considered fatal and cannot usually be cleared. If this fault occurred after a firmware download, repeating the download may clear this fault.
12	Command input lost.
13	Reserved.
14	Safety circuit consistency check failure.

15	Unable to control motor current
16	Motor wiring disconnected
17	Reserved.
18	Safe torque off active.

Note that when a latching fault has occurred, bit 22 of the status register (0xa0) is set.

To clear a fault condition, write a 1 to the associated bit of the fault register (0xa4).

4.4: Reading Run Time Parameters

This section describes the parameters used to monitor run time conditions.

NOTE: Parameters listed with * are read only.

Current Loop Parameters

Parameter ID	Bank	Description
0x15	R	Commanded current. Units: 0.01 A.
0x0c	R*	Actual current. Units: 0.01 A.
0x25	R*	Limited current. Units: 0.01 A.

Velocity Loop Parameters

Parameter ID	Bank	Description
0x2c	R	Commanded velocity. Units: 0.1 counts/second.
0x29	R*	Limited velocity. Units: 0.1 counts/second.
0x18	R*	Actual motor velocity. Units: 0.1 counts/second.
0x5e	R*	Actual load velocity. Units: 0.1 counts/second.
0x2a	R*	Velocity loop error. Units: 0.1 counts/second.

Position Loop Parameters

Parameter ID	Bank	Description
0x32	R*	Motor position. Units: counts.
0x17	R	Load position. Units: counts.
0x35	R*	Following Error. Units: counts.

Position Loop Inputs from the Trajectory Generator

Parameter ID	Bank	Description
0x3d	R*	Commanded position. Units: counts.
0x2d	R	Limited position. Units: counts.
0x3B	R*	Profile velocity. Units: 0.1 counts/second.
0x3C	R*	Profile acceleration. Units: 10 counts/second^2.

Miscellaneous System Parameters

Parameter ID	Bank	Description
0x1d	R*	Analog input voltage. Units: mV.
0x1b	R*	Sin input voltage. Units: mV.
0x1c	R*	Cos input voltage. Units: mV.
0x1e	R*	Bus voltage. Units: 100 mV.
0x20	R*	Drive temperature. Units: degrees C.
0xb0	R	Phase angle. Units: degrees.

4.5: Reading Digital Inputs

Input Pin States (0xa6)

The high/low states of the drive's programmable digital inputs can be read using parameter 0xa6. Each bit represents an input number as shown below. If an input is high, the corresponding bit is set to 1. If the input is low, the corresponding bit is set to 0.

For instance, if the value of 0xa6 is 33, the binary equivalent is 100001, showing that IN1 and IN6 are high and the other inputs are low.

0xa6 is read-only, and available in RAM only. Bit mapped values described below.

NOTE: The number of programmable digital inputs varies depending on drive model. Refer to the drive's data sheet for specific information.

Bit	Input
0	Digital Input 1
1	Digital Input 2
2	Digital Input 3
…	…
n	Digital Input n+1

Extended Input States (0x15c)

Same as parameter 0xa6 above, except it is a 32-bit version to accommodate drives with more than 16 inputs.

4.6: Reading/Setting Digital Outputs

The drives digital outputs can be programmed by CME 2 to reflect the state of any one or more of the drive's event status register bits. The outputs can also be configured so their state can be set by the controller program.

The external controller, through the Output State parameter, can set an output inactive or active. The actual level of the output pin however is determined by the Output Configuration parameter. This parameter sets the actual output pin to be high or low when active. When the drive powers up or is reset, all outputs are initially inactive. To ensure that outputs are high, or off, after power up or reset, they should be configured as active low.

Output Configuration (0x70 – 0x77, 0x1a0 – 0x1a3)

Before a controller program can set an output pin's active/inactive state, the output must be configured for program control. This is done by setting the appropriate bits in the output's configuration parameter. Output configurations require 3 or 5 words depending on the configuration. Refer to the Parameter Dictionary for details.

NOTE: The number of programmable digital inputs varies depending on drive mode. See the drive's datasheet for details.

Parameter ID	Memory Bank	Description

0x70 – 0x77	RF	Output 1 through 8 Configuration.
		        258 0 = Program Control, Active High
		         2 0 = Program Control, Active Low

0x1a0 – 0x1a3	RF	Output 9 through 12 Configuration. Same as Outputs 1through 8

Output States and Program Control (0xab)

Writing the parameter 0xab sets the active/inactive states of digital outputs that have been configured for program control. Each bit represents an output number as shown below. A bit value of 1 corresponds to an active output. A bit value of 0 corresponds to an inactive output. Writing a 1 or 0 to an output that has not been configured for program control will have no effect on the output.

Reading 0xab gets the active/inactive states of all the drive's digital outputs, including those which are not set to program control.

NOTE: The number of programmable digital outputs varies depending on drive model. See the drive documentation.

Bit	Output
0	Digital Output 1
1	Digital Output 2

…	
n	Digital Output n+1

Example

The controller configures 2 outputs for program control, reads the state of the outputs, and then sets an output low.

Command	Response	Comment
s r0x72 258 0	ok	Configures output 3 to program control, active low.
s r0x73 258 0	ok	Configures output 4 to program control, active low.
g r0xab	v 10	Reads the state of the outputs. Example returns a value of 10. Converting this value to binary equals 1010 which indicates outputs 2 and 4 are active.
s r0xab 4	ok	4 converted to binary equals 0100. This value will set Output 4 inactive and Output 3 active. Outputs 4 and 3 have been programmed active low so Output 4 will be high and 3 will be low. Since Outputs 1 and 2 are not under program control, they will not change state.

APPENDIX

5: QUICK REFERENCE TO THE PARAMETERS

5.1: Parameters by Function

Programmed Current Mode Parameters	
0x02	Programmed current value. Units: 0.01 A.
0x6a	Current ramp limit. Units: mA/second.
Analog Current Mode Parameters	
0x19	Analog input scaling factor. Units: 0.01 A.
0x26	Analog input dead band. Units: mV.
0x1a	Analog input offset. Units: mV.
PWM Current Mode Parameters	
0xa9	Digital input scaling factor. Units: 0.01 A.
0xa8	Digital input command configuration.
Programmed Velocity Mode Parameters	
0x2f	Programmed velocity command. Units: 0.1 counts/second.
0x36	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	Fast stop ramp. Units: 1000 counts/second^2
Analog Velocity Mode Parameters	
0x19	Analog input scaling factor. Units: 0.1 counts/second
0x26	Analog input dead band. Units: mV.
0x1a	Analog input offset. Units: mV.
0x36	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	Fast stop ramp. Units: 1000 counts/second^2
PWM Velocity Mode Parameters	
0xa9	Scaling Factor. Units: 0.1 counts/second.
0x36	Velocity acceleration limit. Units: 1000 counts/second^2
0x37	Velocity deceleration limit. Units: 1000 counts/second^2
0x39	Fast stop ramp. Units: 1000 counts/second^2
0xa8	Digital input command configuration.

Programmed Position Mode Parameters	
0xc8	Profile type
0xca	Position command
0xcb	Maximum velocity. Units: 0.1 counts/second.
0xcc	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	Maximum deceleration rate. Units: 10 counts/second^2.
0xce	Maximum jerk rate. Units: 100 counts/ second^3.
0xcf	Abort deceleration rate. Units: 10 counts/second^2.
Analog Position Mode Parameters	
0x19	Analog input scaling factor. Units: counts.
0x26	Dead band. Units: mV.
0xcb	Maximum velocity. Units: 0.1 counts/second.
0xcc	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	Abort deceleration rate. Units: 10 counts/second^2.
Pulse and Direction Mode Parameters	
0xa8	Digital Command Configuration
0xa9	Scaling factor. Output counts/Input pulses.
0xcb	Maximum velocity. Units: 0.1 counts/second.
0xcc	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	Abort deceleration rate. Units: 10 counts/second^2.
Pulse Up/Down Mode Parameters	
0xa8	Digital Command Configuration
0xa9	Scaling factor, Output counts/Input pulses.
0xcb	Maximum velocity. Units: 0.1 counts/second.
0xcc	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	Abort deceleration rate. Units: 10 counts/second^2.

Quadrature Mode Parameters	
0xa8	Digital Command Configuration
0xa9	Scaling factor, Output counts/Input pulses.
0xcb	Maximum velocity. Units: 0.1 counts/second.
0xcc	Maximum acceleration rate. Units: 10 counts/second^2.
0xcd	Maximum deceleration rate. Units: 10 counts/second^2.
0xcf	Abort deceleration rate. Units: 10 counts/second^2.
Homing Mode Parameters	
0xc2	Homing Method. See table below for values.
0xc3	Fast Velocity. Units: counts/second
0xc4	Slow Velocity. Units: counts/second
0xc5	Acceleration / Deceleration. Units: 10 counts/second^2.
0xc6	Home Offset. Units: counts.
0xc7	Current Limit. Units: 0.01 A.
0xbf	Current Delay Time. Units: milliseconds.
0xb8	Positive Software Limit. Units: counts.
0xb9	Negative Software Limit. Units: counts.
Current Loop Limits Parameters	
0x21	Peak current limit. Units: 0.01 A.
0x23	I^2T time limit. Units: mS.
0x22	Continuous current limit. Units: 0.01 A.
0xae	Current loop offset. Units: 0.01 A.
Current Loop Gains Parameters	
0x00	Current loop proportional gain (Cp).
0x01	Current loop integral gain (Ci).
Velocity Loop Limits Parameters	
0x3a	Velocity loop velocity limit. Units: 0.1 counts/second.
0x36	Velocity loop acceleration limit. Units: 1000 counts/second^2.
0x37	Velocity loop deceleration Limit. Units: 1000 counts/second^2.
0xcf	Fast Stop Ramp. Units: 10 counts/second^2.
Velocity Loop Gains Parameters	
0x27	Velocity loop proportional gain (Vp).
0x28	Velocity loop integral gain (Vi).
Velocity Loop Filters Parameters	
0x6b	Velocity loop command filter coefficients.
0x5f	Velocity loop output filter coefficients.
Position Loop Gains Parameters	
0x30	Pp - Position loop proportional gain.
0x33	Vff - Velocity feed forward.

0x34	Aff - Acceleration feed forward.
0xe3	Position loop gain multiplier.

Current Loop Run Time Parameters

0x15	Commanded current. Units: 0.01 A.
0x0c	Actual current. Units: 0.01 A.
0x25	Limited current. Units: 0.01 A.

Velocity Loop Run Time Parameters

0x2c	Commanded velocity. Units: 0.1 counts/second.
0xcb	Profile velocity. Units: 0.1 counts/second.
0x29	Limited velocity. Units: 0.1 counts/second.
0x18	Motor velocity. Units: 0.1 counts/second.
0x5e	Load velocity. Units: 0.1 counts/second.
0x2a	Velocity loop error.

Position Loop Run Time Parameters

0x3d	Commanded position. Units: counts.
0x2d	Limited position. Units: counts.
0x32	Motor position. Units: counts.
0x17	Load position. Units: counts.
0x35	Following Error. Units: counts.

Position Loop Inputs from the Trajectory Generator (Parameters)

0x3b	Profile velocity. Units: 0.1 counts/second.
0x3c	Profile acceleration. Units: 10 counts/second^2.
0x2d	Limited position. Units: counts.

Miscellaneous System Parameters

0x1d	Analog input voltage. Units: mV.
0x1b	Sin input voltage.
0x1c	Cos input voltage.
0x1e	Bus voltage. High voltage A/D reading. Units: 100 mV.
0x20	Drive temperature. Units: degrees C.
0xb0	Phase angle. Units: degrees.
0x90	Baud rate

Inputs and Outputs

0xa6 or 0x15c	Read input states
0xab	Read/Write output states.
0x70 thru 0x77 0x1a0 thru 0x1a3	Configure outputs.

Status and State Parameters

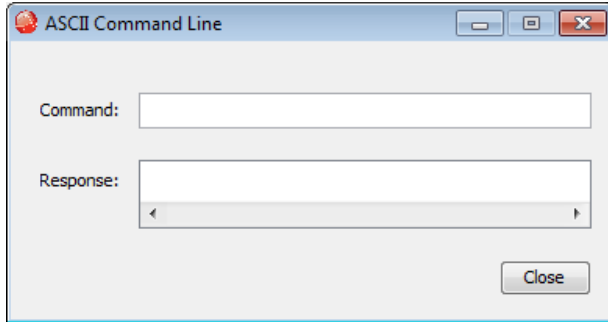|	
0xa0	Status Register.
0xc9	Trajectory Register.

| 0xa4 | Fault Register. |
| 0x24 | Drive desired state. |

CHAPTER
# 6: CME 2 ASCII COMMAND LINE TOOL

The CME 2 ASCII Command Line tool lets users send individual ASCII commands to drives.

1 From the CME 2 Main screen, select **Tools->ASCII Command Line** from the menu bar to open the ASCII Command Line screen:


2 Enter an ASCII command in the Command field.

3 Press the Enter key to send the command to the drive. Observe the response in the Response field.

If a value is returned, it is preceded by the letter "v." In the following example, the get command was used to retrieve the RAM value of parameter 0x32 (actual position).
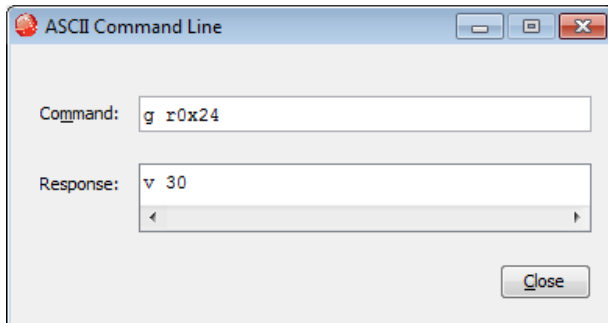
An error code is preceded by the letter "e." To view an error definition, hold the cursor over the error number. See Error Codes
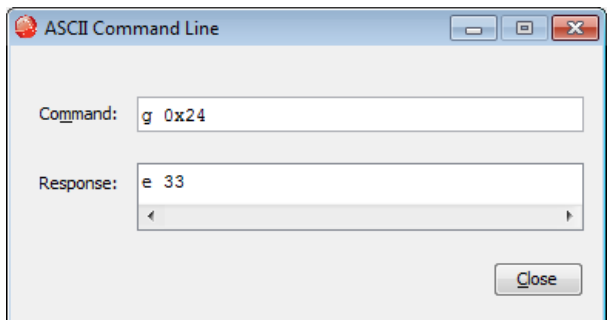
CHAPTER
7: SERIAL AND MULTI-DROP CONNECTION

7.1: Connecting

Instructions for hooking up a single-axis connection and a multi-drop network appear below.

Single-Axis Connections

For RS-232 serial bus control of a single axis, set the CAN node address of that axis to zero (0). Note that if the CAN node address is switched to zero after power-up, the drive must be reset or power cycled to make the new address setting take effect.
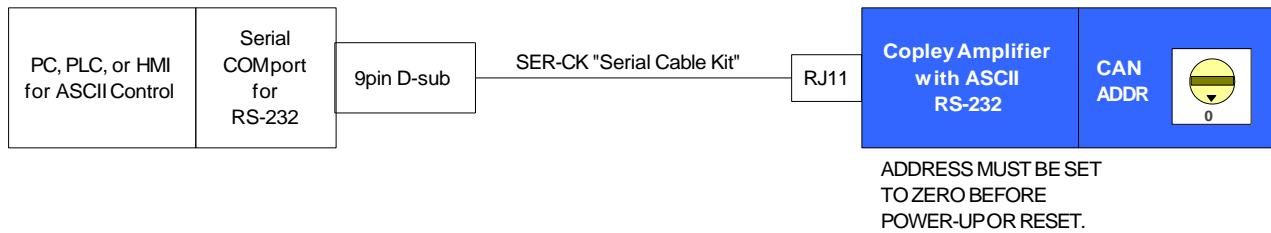
Multi-Drop Network Connections

For RS-232 serial bus control of multiple axes, set the CAN node address of the serially connected drive (gateway) to zero (0). Assign each additional drive in the chain a unique CAN node address value between 1 and 127. For information on CAN node address, see the drive user guide or data sheet. Verify that all drives are set to the same CAN bit rate. Use 120 Ω termination on the first and last drive.
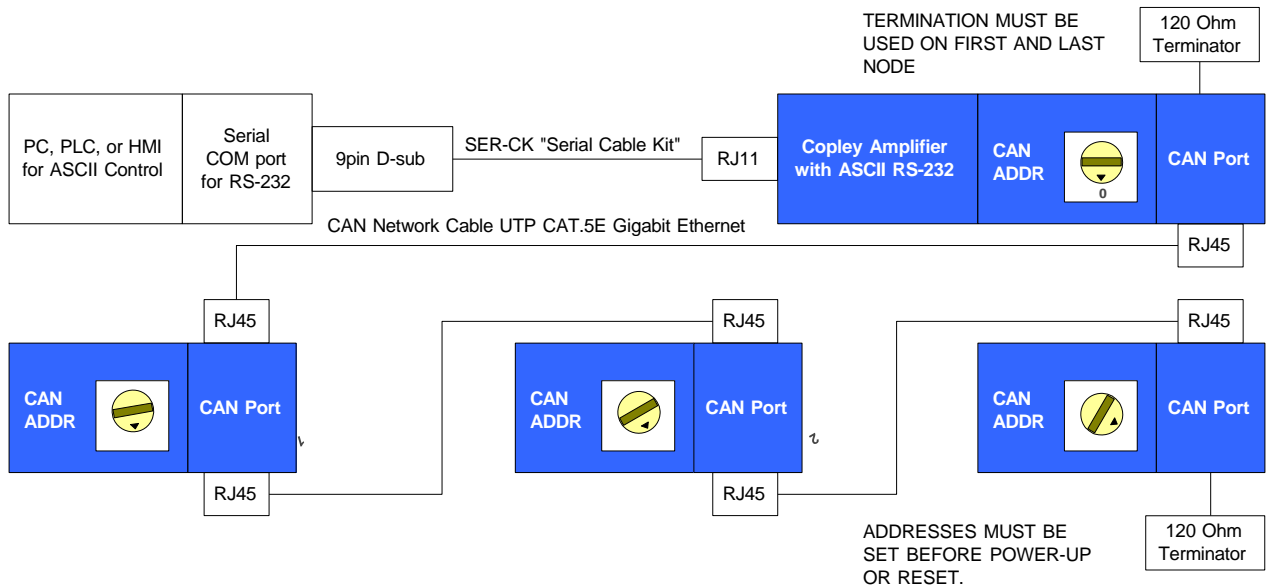
The CAN Status Light and Multi-Drop Connections

When starting drives on a multi-drop CAN loop, it is common to see a green-green-red flash sequence on the CAN Status Indicator LED of the first drive to start up.

that the drive has not found any other active nodes on the CAN loop. Under normal circumstances, this flash sequence does not indicate a problem, and it will clear after the first few commands are sent to the drive.

To avoid seeing this flash sequence, assure that the gateway drive starts up first. The CAN status indicator will always be off on node 0.

APPENDIX
A: ERROR CODES

Error Codes

Code	Meaning
1	Too much data passed with command
3	Unknown command code
4	Not enough data was supplied with the command
5	Too much data was supplied with the command
9	Unknown parameter ID
10	Data value out of range
11	Attempt to modify read-only parameter
14	Unknown axis state
15	Parameter doesn't exist on requested page
16	Illegal serial port forwarding
18	Illegal attempt to start a move while currently moving
19	Illegal velocity limit for move
20	Illegal acceleration limit for move
21	Illegal deceleration limit for move
22	Illegal jerk limit for move
25	Invalid trajectory mode
27	Command is not allowed while CVM is running
31	Invalid node ID for serial port forwarding
32	CAN Network communications failure
33	ASCII command parsing error
36	Bad axis letter specified
46	Error sending command to encoder
48	Unable to calculate filter

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