

The SD31060IX is a 310V 6.0amp stepper driver and indexer combination that communicates on a Network. The available networks, along with the corresponding AMCI part numbers, are shown in the following table.

Network	Part Number
ControlNet	SD31060IC
DeviceNet	SD31060ID
Ethernet	SD31060IE SD31060IESA

This unit uses ten 16 bit Input words (12 input words will be required in a ControlLogix ControlNet system) and ten 16 bit Output words to communicate with the network.

The SD31060IX stepper controller supports two operating modes, Configuration Mode and Command Mode.

Table of Contents

General Information	2
Configuration Mode	3
Output Data	4
Invalid Configurations	7
Input Data	8
Command Mode	9
Absolute & Relative Moves	9
Hold Move	9
Resume Move	10
Immediate Stop	10
Find Home	10
Manual Move	13
Preset Current Position	14
Reset Errors	14
Preset Encoder Position	14
Electronic Gearing	14
Velocity Mode	15
Blend Move	15
Encoder Move	17
Jerk	17
Command Mode Output Data	18
Command Mode Input Data	20
Driver LED Function	25
Breakout Box Dimensions	25
Breakout Box Pinout	26
Specifications	27
Outline Drawing & Installation Notes	31
ControlNet Setup	32
DeviceNet Setup	35
Ethernet Setup	37

General Information

Important User Information

The products and application data described in this manual are useful in a wide variety of different applications. Therefore, the user and others responsible for applying these products described herein are responsible for determining the acceptability for each application. While efforts have been made to provide accurate information within this manual, AMCI assumes no responsibility for the application or the completeness of the information contained herein. Throughout this manual the following two notices are used to highlight important points.

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Returns Policy

All equipment being returned to AMCI for repair or replacement, regardless of warranty status, must have a Return Merchandise Authorization number issued by AMCI. Call (860) 585-1254 with the model and serial numbers along with a description of the problem. A “RMA” number will be issued. Equipment must be shipped to AMCI with transportation charges prepaid. Title and risk of loss or damage remains with the customer until shipment is received by AMCI.

24 Hour Technical Support Number

Technical Support, in the form of documents, FAQs, and sample programs, is available from our website, www.amci.com. 24 Hour technical support is also available on this product. For technical support, call (860) 583-7271. Your call will be answered by the factory during regular business hours, Monday through Friday, 8AM - 5PM EST. During non-business hours, an automated system will ask you to leave a detailed message and the telephone number that you can be reached at. The system will page an engineer on call. Please have your product model number and a description of the problem ready before you call.

Configuration Mode

The Configuration Mode provides the ability to select the proper setup configuration to match the stepper application without having to set any switches.

Note: At power up, the motor will not have any holding torque until the driver has been both configured and enabled. Also, configuring the module sets the Position Invalid status bit.

The configuration file defines the following parameters.

1. If a CW Limit Switch will be used and its input active state
2. If a CCW Limit Switch will be used and its input active state
3. If an Emergency Stop will be used and its input active state
4. If an External Input will be used and its active state.
5. The function of the External Input, whether it will be used to perform a controlled stop, to capture encoder data, or to both perform a controlled stop and capture encoder data.
6. If a Home Limit Switch will be used and its input active state
7. If a Quadrature Encoder will be used with the system
8. The type of homing operation that will be performed. The three options are to a Home Limit Switch only, to a Home Limit Switch (acting like a Proximity switch) and Marker Pulse, or to a Marker Pulse Only. Either of the Marker Pulse options also requires the presence of the Quadrature Encoder.
9. The Starting Speed. The starting speed is the pulse frequency at which every move begins and ends. Some portions of the homing operations are also performed at the starting speed.
10. If Stall detection is enabled. Stall detection also requires the presence of a Quadrature Encoder.
11. The idle current reduction level.
12. If the Antiresonance function will be used and its parameter level.
13. Current Loop Tuning, either Automatic or Manual Current loop. If the manual tuning is selected, the gain value is also programmed.

Configuration Mode Output Data

While in configuration mode, the output registers have the following format.

Word	Configuration Output Data
0	Configuration Bits
1	Input Active Levels
2	Upper Start Speed
3	Lower Start Speed
4	Motor Steps/Rev (200 to 65535)
5	Third Harmonic (0 to 18)
6	Encoder Pulses/Rev (1 to 65535)
7	Idle Current (40% to 100%)
8	Antiresonance parameter
9	Current Loop Gain (1 to 100)

Word 0 (Configuration Bits):

- bit 0: set when a CW Limit Switch will be used
- bit 1: set when a CCW Limit Switch will be used
- bit 2: set when an Emergency Stop Input will be used
- bit 3: set when an External Input is used. The external input can be used to stop a Manual Move operation, to place an Absolute or Relative move in a hold state, or to capture encoder data.
- bit 4: set when a Home Limit Switch Input will be used. If both this bit and bit 12 (marker pulse homing) are set, than the Home Limit Switch will act as a proximity limit switch.
- bit 5: Reserved for future use
- bits 6 and 7: External Input Function

Bit 7	Bit 6	Function
0	0	Stop a jog or Hold an Absolute/Relative move
1	0	Stop a jog or Hold an Absolute/Relative move
0	1	Trap Quadrature Encoder Data
1	1	Stop a jog, Hold and Absolute/Relative move, and trap Quadrature Encoder Data

Note 1: Encoder Data cannot be trapped during a homing operation.

Note 2: Encoder Data is only captured on the 0 to 1 transition of the input.

- bit 8: set when quadrature encoder will be used
- bit 9: “0” to have the motor power removed if the network connection is lost.
 “1” to have the motor power retained if the network connection is lost.
Note: Motion will always stop if the network connection is lost.
- bit 10: Reserved for future use
- bit 11: Reserved for future use
- bit 12: “0” for limit switch home operations
 “1” for marker pulse home operations
- bit 13: set when Stall Detection is enabled. When enabled the driver looks at the pulses from the encoder. If they stop, then the driver stops outputting steps to the motor and the position becomes invalid. The motor retains its holding torque after stopping.
- bit 14: “0” for automatic current loops tune, “1” for manual current loops tune
- bit 15: “1” for configuration mode operations, “0” for command mode operations

Word 1 Input Active State and Enable/Disable

Defines the active level of the inputs. These bits will be set for high level active or Normally Open (NO), or reset for low level active or Normally Closed (NC). Please note that the active level of the inputs is taken into account only when the input has been defined as being present in configuration word 0.

- bit 0: determines the active level of the CW Limit Switch
- bit 1: determines the active level of the CCW Limit Switch
- bit 2: determines the active level of the Emergency Stop Input
- bit 3: determines the active level of the External Input
- bit 4: determines the active level of the Home Limit Switch Input
- bit 5 to 14: reserved for future use and are “don’t cares”
- bit 15: “0” to disable the driver, “1” to enable the driver. When the driver is disabled, power is removed from the motor. Note, to set the gain, either manually or automatically, the first enable operation after power up must take place while the drive is in configuration mode.

Words 2 & 3: Starting Speed

The starting speed is the frequency of the first and last pulse of every move. Some portions of the homing operations are also performed at the starting speed. The starting speed has a range of 1 to 3,997,696.

Word 2: Most Significant Word of the Channel 1 Starting Speed

Word 3: Least Significant Word of the Channel 1 Starting Speed

Word 4: Motor Steps per Revolution

This parameter defines how many steps are required to complete one revolution of the motor. This parameter has a range of 200 to 65535. Note, in some systems, values above 32767 will be negative.

When Electronic Gearing is being used, word 4 becomes the number of pulses/revolution of the input pulses. For example, if word 4 is equal to 4000, then 4000 input pulses will result in one turn of the motor. If word 4 is equal to 2000, then 4000 input pulses will result in two turns of the motor.

The SD31060IX uses X4 decoding when counting the pulses from an encoder and this must be taken into account when determining this value. For example, a 1000 line encoder will generate 4000 counts/turn.

Word 5: Third Harmonic

This parameter is used as a reference for the current through the motor phases. This parameter has a range of 0% to 18% and defines the percentage of the signal subtracted from the main signal. This signal has three times the frequency of the main sin signal, phase – pi,

Word 6: Encoder Pulses/Revolution

This parameter defines how many counts the encoder outputs for each revolution of the motor. This parameter has a range of 1 to 65535 (on some systems, values greater than 32767 will be negative) and must be programmed if the unit has been configured to use a Quadrature encoder. The SD31060IX uses X4 decoding when counting the pulses from an encoder and this must be taken into account when determining this value. The Encoder Pulses/Revolution parameter is used for the Stall Detection function and does not affect the encoder value reported to the PLC.

Word 7: Idle Current Reduction

This word shows how much the maximum phase current will be reduced three seconds after motion has stopped. The current level programmed in Command Word 8 is the RMS current, not the maximum current. The maximum current is defined as the value programmed in Command Word 8 * 1.414. To prevent the motor from overheating but still maintain the maximum amount of holding torque, an idle current reduction value of 71 is recommended. This will set the maximum current output to the motor to the value entered in command word 8 because $1/1.414 = 0.71$ or 71%.

Word 8: Antiresonance Parameter

This word is used if additional tuning of the Antiresonance algorithms is required. Two parameters are set with this one decimal word.

The first parameter is represented by the thousands digit and has possible values of 0, 1, 2, or 3. Use a smaller value when higher accelerations are used.

The second parameter is represented by the 1s, 10s, and 100s digits and has a range of 1 to 250. The greater this value, the higher the Antiresonance correction will be. This value can be 0 if the thousands digit is 0.

If this parameter is equal to zero, the default value of 128 will be used. A values programmed outside of the valid ranges will result in a configuration error.

In most cases the default value will work. It is recommended that this value be set to zero during the initial setup of the machine. If using the Antiresonance feature improves the performance at certain speeds but reduces the performance at others, try reducing the value entered in the hundreds digit.

Example: Use a value of 3128 for smooth motion with a normal value of the correction when relatively low accelerations are used. Use a value of 128 for smooth motion with the normal value of correction when relatively high acceleration values are being used.

Word 9: Current Loop Gain

This parameter defines the gain used in the current control loops and has a range of 1 to 100. This word is used only if manual tuning of the current loop gain is selected by setting bit 14 of word 0.

If automatic tuning is selected, the driver ignores the value written in this register and runs the procedure for auto tuning each time the drive is enabled, that is the 0 to 1 transition of word 1 bit 15.

If after being manually turned the motor makes a hissing noise, then the gain has been set to high. Setting the gain too high may also cause an Overcurrent error.

Note: The Current Loop Gain Manual Tuning is only accepted when the drive transitions from being disabled, output word 1 bit 15 reset, to enabled, output word 1 bit 15 set.

The following procedure can be used to determine the best gain value for the motor being used.

1. Program the motor current value appropriate for the motor and wiring.
2. Configure the driver using Automatic Tuning.
3. While the driver is in Configuration Mode, record the Current Loop Gain value in input register nine.
4. The next time the driver is configured, place the value from step 3 above into configuration register 9, and configure the driver using the Manual Tuning option.
5. Manual Tuning is a two step process. First, configure the driver with it disabled (output word 1 bit 15 reset). After the driver reports that it is in configuration mode and there is no configuration error, enable the driver by setting output word 1 bit 15.
6. Change the driver to command mode.

Invalid Configurations

The SD31060IX will not accept all possible configurations. The following is a list of the invalid configurations:

1. Setting any of the unused bits in the configuration words.
2. Manually changing the current loop gain without having the driver transition from disabled to enabled.

Note: The driver will not generate an invalid configuration error if it is configured with both the Manual Tuning bit set and a valid Manual Tuning value at power up. However, the motor will not have any holding torque.

3. A configuration without the ability to home the module, Home Limit Switch only, Marker Pulse Only, or Marker Pulse and Home Limit Switch (acting as a proximity limit switch).
4. A configuration without at least one End Limit Switch, either CW or CCW.

Note: The ability to home the module and at least one of the end limit switches have to be configured. They do not have to actually be used in the stepper application.

5. Selecting that a Quadrature Encoder will be used without selecting the encoder counts per turn in word 6.
6. If the Encoder Pulses/Revolution are outside of the range of 1 and 65535.
7. Setting the module for either Encoder Trapping modes without configuring the module to use the encoder.
8. Using a Marker Pulse Home without the Quadrature Encoder.
9. Setting the module for Stall Detection without configuring the module to use the encoder.
10. A starting speed outside the range of $1 \leq \text{starting speed} \leq 3,997,696$.
11. The least significant word of the starting speed is outside of the range of 0 to 999.
12. If the Third Harmonic value is outside of the range of 0 to 18.
13. If the Motor Steps/Revolution are outside of the range of 200 to 65535.
14. If the Idle Current Reduction is outside of the range of 40% to 100%.
15. Selecting Manual Tuning and a current loop gain value that is outside of the range of 1 to 100.
16. If the thousands digit of the Antiresonance parameter is outside of its range of 0 to 3, or if the lower digits are outside of the range of 1 to 250.

The SD31060IX has to be configured before starting any operations. On power up, or when the Configuration Mode flag is set in the output registers, the driver enters Configuration Mode. When in this mode, the stepper controller will set the Configuration Mode flag in the input registers. It then waits for the configuration file to be transferred over the network. If there is no current Configuration File present or if the transferred Configuration File is not valid, the Configuration Error Input bit will be set. If the transferred configuration file is accepted, then the configuration data will be mirrored in the input registers.

If the command to enter configuration mode is issued while a move operation is taking place, the move operation will run to completion before configuration mode is entered. If a Manual Move is occurring, motion will continue until Command Mode is again entered and the Manual Move command bit is reset.

Configuration Mode Input Data

While in configuration mode, a valid configuration will cause the configuration data to be mirrored in the input registers.

Note: A ControlLogix system using ControlNet will require 12 input words. The first two words will always be zero, and the Configuration Bits will be located in input word 2.

Word	Configuration Mode Input Data
0	Configuration Bits
1	Input Active Levels
2	Upper Start Speed
3	Lower Start Speed
4	Motor Steps/Rev (200 to 65535)
5	Third Harmonic (0 to 18)
6	Encoder Pulses/Rev (1 to 65535)
7	Idle Current (40 to 100)
8	Antiresonance Parameter
9	Current Loop Gain (1 to 100)

Word 0:

Valid Configuration: Mirror of bits 0 to 15 in Output Word 1

Invalid Configuration: E408h

Word 1:

bits 0 → 15: mirror of bits 0 to 15 in Output Word 1

Words 2 to 8:

Mirror of configuration output words 2 through 8

Word 9:

Current Loop Gain determined by driver during an Automatic Tuning operation or the Current Loop Gain Programmed during a Manual Tuning operation.

Command Mode Operations

The following is a description of the various commands that the module accepts and the operations that it will perform while in Command Mode.

Absolute & Relative Move

The current position must be valid in order to perform an ABSOLUTE MOVE. A HOME or PRESET operation will have to be performed before the position becomes valid. The distance moved, that is the number of steps issued by the SD31060IX, is equal to the difference between the Target Position and the Current Position. For example, if the Current Position is 5000, and the Target Position is 7500, then the unit will output 2500 steps. After the Absolute Move has been completed, the Current Position will be 7500. The direction of motion of an Absolute Move is determined by the relationship between the Current Position and Target Position. If the Target Position > Current Position, then CW motion will occur. If the Target Position < Current Position, then CCW motion will occur.

The current position does not have to be valid to perform a RELATIVE MOVE. The Target Position defines the distance, in number of steps, to travel relative to the Current Position. For example, if the Current Position is 5000 and the Target Position is 7500, then the unit will output 7500 steps. After the Relative Move has been completed, the Current Position will be 12,500. The direction of motion of a Relative Move is selected by the Most Significant Bit in the Most Significant Word of the Target Position. A "1" in the MSB will indicate a CCW move, while a "0" will indicate a CW move.

The ABSOLUTE or RELATIVE MOVE operations can produce two different velocity profiles. Normally the move operations start at the Starting Speed, accelerate to the Programmed speed at the defined acceleration rate, continue at the Programmed speed until it is time to decelerate back to the Starting Speed, and Stop. This generates a trapezoidal velocity profile.

However, if the move operation does not reach the Programmed speed by the time the deceleration is to begin, the move is decelerated to the Starting Speed and Stopped. In this way a triangular velocity profile is generated.

If the move operation runs to completion without error, the MOVE COMPLETE FLAG is set. If an error does occur, the MOVE COMPLETE FLAG will not be set, and an error flag will be set.

Hold Move

The HOLD MOVE command causes Absolute Moves, Relative Moves, Manual Moves, and Encoder Moves to decelerate to the Starting Speed and stop. When this operation is successfully performed, the Hold State Input Bit is set. While the Hold operation is in effect, the velocity and acceleration deceleration parameters can be changed, however, entering a new position will have no affect. If no error occurred during the stop operation, the RESUME MOVE command can be used to restart the move operation.

Note 1: The driver will enter a Hold State if a Hold Command is issued during the deceleration portion of a move. The Resume Command will have to be issued before the Move Complete bit will be set.

Note 2: If a Hold Move command is issued during either a Blend Move or Homing operation, the stepper controller will stop but not enter a hold state. Issuing the Resume Command will cause a Command Error to be generated.

Note 3: If a Hold Move Command is issued during if Electronic Gearing or Velocity Mode is being used, motion will stop and the unit will generate a command error.

Resume Move

The RESUME MOVE command resumes a previously held Absolute or Relative Move. If the Resume Move command is the first command issued after a Hold Move operation, and no errors have occurred, the Resume Move command will cause the stepper motor to restart from the point where it was stopped, and the Hold State Input Flag will go off. When the move operation has been successfully completed, the Move Complete Flag will be set.

It is possible to change the velocity, acceleration, and deceleration parameters while the drive is in a hold state. A move operation can be held and resumed many times until one of the following has occurred:

1. The move reaches its programmed target position
2. An error condition has occurred
3. Some other command is issued

Immediate Stop

The Immediate Stop command causes the current move operation to stop immediately. Issuing this command will cause the current position will become invalid, and the Position Invalid Input Bit will be set. The driver will have to be homed or preset again before an Absolute Move operation can be performed. However, it will be possible to perform a Relative or Manual Moves after the Immediate Interrupt command has been issued.

Find Home +/(CW), Find Home -/(CCW)

There are three homing options available, homing to the home limit switch, homing to an encoder's marker pulse, or homing to both a home limit switch (acting as a proximity switch) and an encoder's marker pulse. Encoder data cannot be trapped during a homing operation.

All three of the homing methods operate in the same way. The SD31060IX starts the homing operation at the programmed speed. When the home input is detected, the unit decelerates and stops. It then reverses direction and travels at the programmed speed until the Home Input transitions from active to inactive. It then reverses direction again and moves at the starting speed until the Home Input again turns on. The SD31060IX will then set the At Home input bit, and reset the current position and the encoder position to zero.

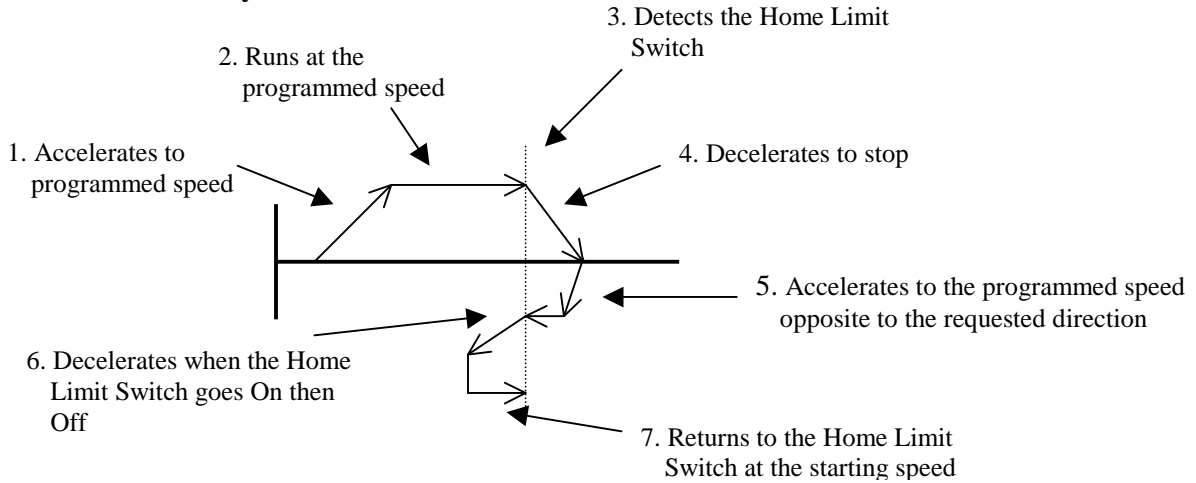
The Find Home commands require that at least one End Limit Switch, either CW or CCW, be present. The SD31060IX will not accept a Find Home +/(CW) command when there is no CW Limit Switch present. Likewise, it will not accept a Find Home -/(CCW) command when there is no CCW Limit Switch Present. If either of these operations are attempted, the COMMAND ERROR Input bit will be set.

If, during a Home operation, either of the End Limit Switch endpoints are reached, the motor will stop for two seconds, reverse direction, and start searching for the appropriate homing signal again. It is important not to have the velocity set to high during a homing operation. The sudden change in direction at high speeds may cause the motor to lock up.

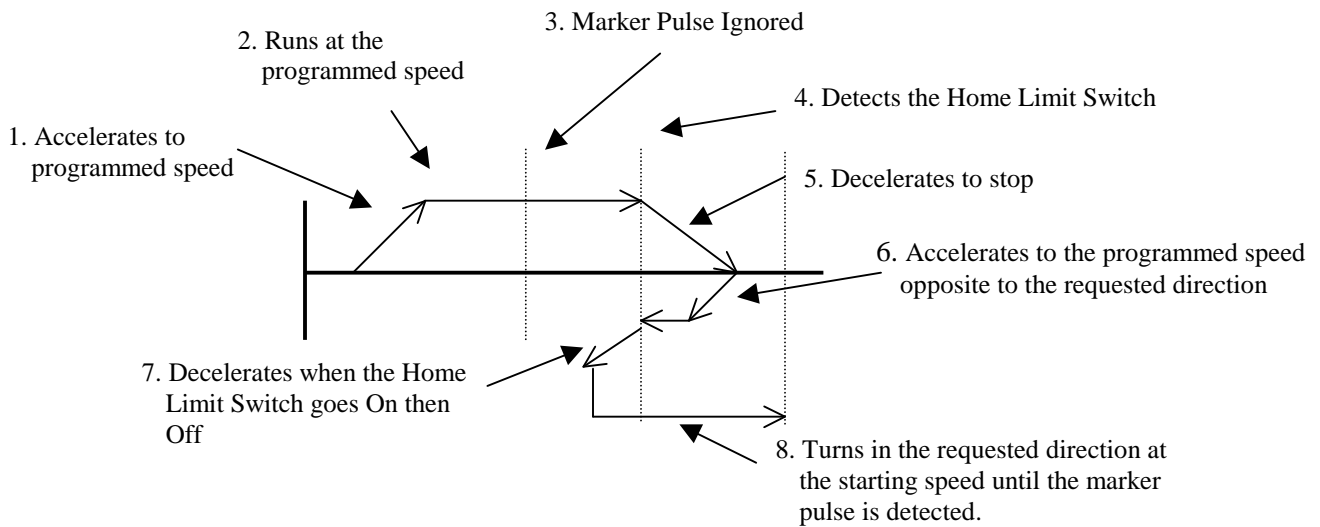
If the Limit Condition Status bit is on when a home operation is initiated, the initial direction of motion will be opposite to the requested direction.

The following diagrams illustrate the different homing options.

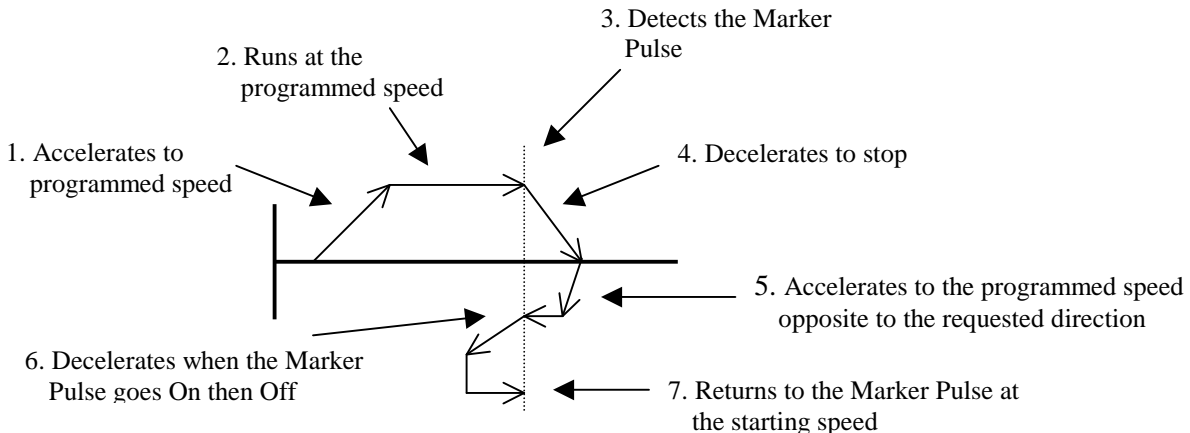
Home Limit Switch Only



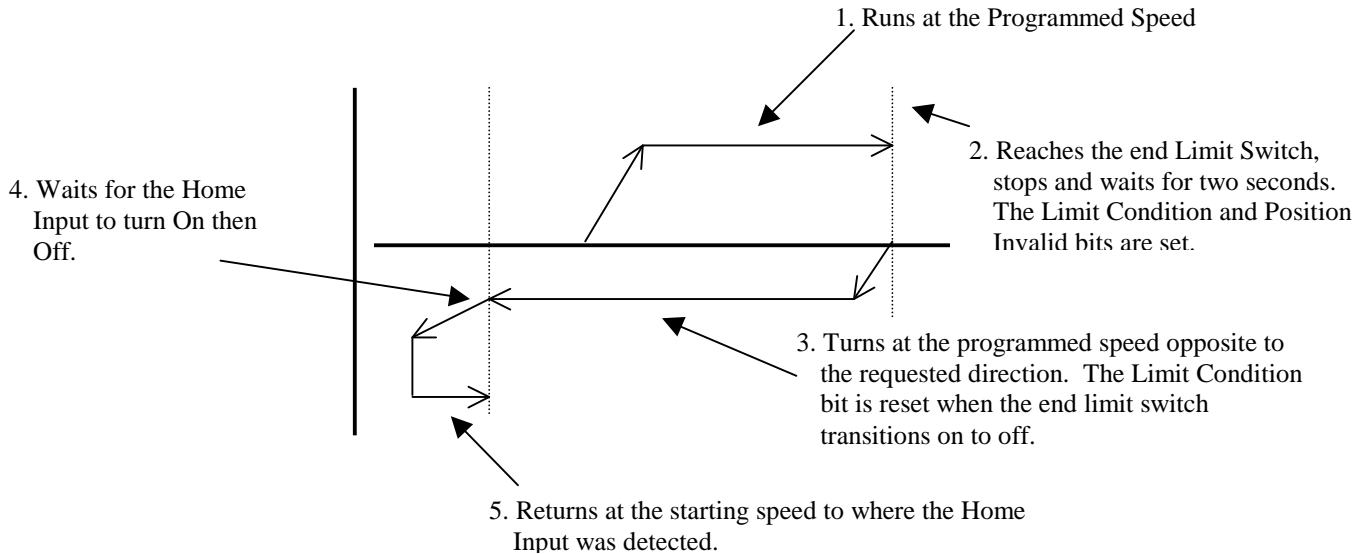
Home Limit Switch (treated as a Proximity Switch) and Marker Pulse



Marker Pulse Only



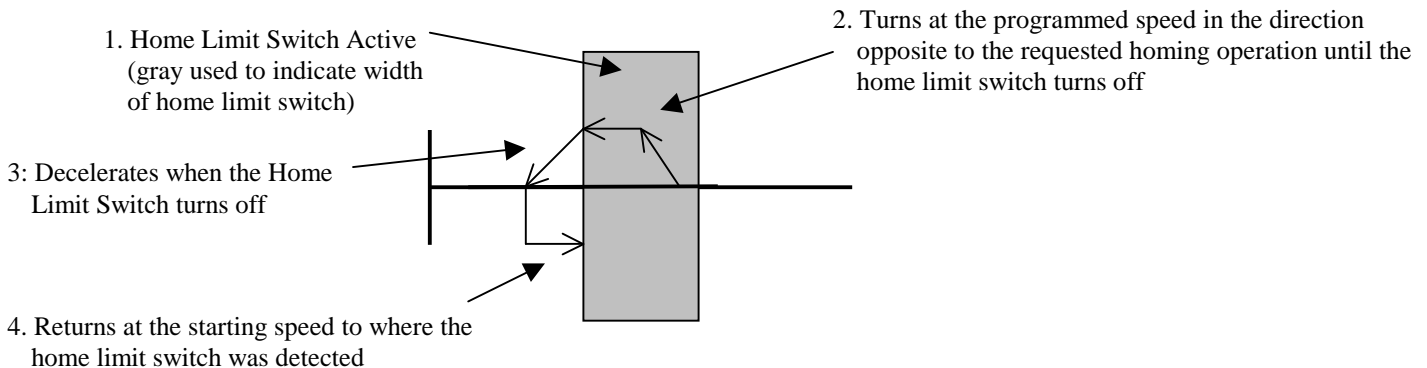
Reaching an End Limit Switch During a Homing Operation



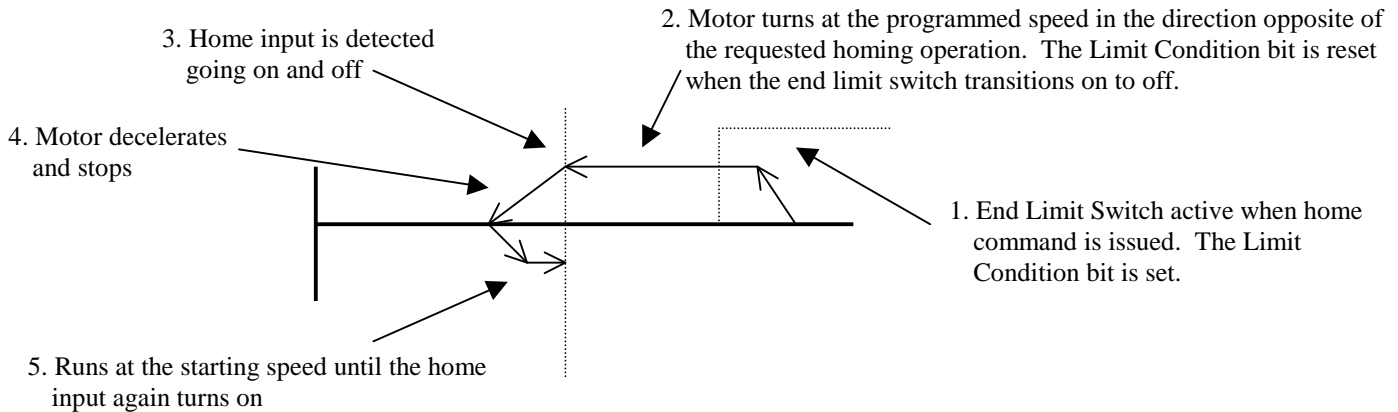
Note 1: The Home Input shown above can be either the Home Limit or the Marker Pulse.

Note 2: The above diagram will be true for all three of the homing methods, Home Limit only, Marker Pulse only, or Home Limit and Marker Pulse. In the case of the Home Limit and Marker Pulse, the SD31060IX will ignore any Marker Pulses until the Home Limit Switch is detected.

Home Limit Switch Active when the Home Command is issued



End Limit Switch Active when the Home Command is issued



Note 1: The Home Input shown above can be either the Home Limit or the Marker Pulse.

Note 2: The above diagram is only true if the active End Limit Switch is the same as the issued home command, for example if the CW Limit Switch is active and a CW home command is issued. If the CW Limit Switch is active and a CCW home command is issued, than the unit will home normally, as if the end limit switch was not active.

Note 3: The above diagram will be true for all three of the homing methods, Home Limit only, Marker Pulse only, or Home Limit and Marker Pulse.

Manual Move +/(CW), Manual Move -/(CCW)

This command performs the Manual Move operation at the programmed speed in the specified direction. Motion will occur as long as the command bit remains set. The axis begins the move at the starting speed, accelerates until the programmed speed is reached, and continues to move at the programmed speed until one of the following occurs:

- The Manual Move command bit is turned off
- The External Input, if it is configured for this function, is activated
- The Immediate Stop output bit is set
- The Emergency Stop Input is activated
- An End Limit Switch is reached
- The Programmed speed changes to an acceptable value

If the Manual Move command bit is turned off or if the External Input is active, the axis will decelerate to the starting speed and stop, retaining a valid position. If the Immediate Output bit or the Emergency Stop Input is used, the axis will stop and the position will become invalid.

It is possible to change the speed of a Manual Move operation without stopping the motion. If the velocity data is changed while the axis is moving, the module will accelerate or decelerate to the new speed. The acceleration and or the deceleration parameters can also be changed. The new speed must be equal to or greater than the starting speed. If any of the values are outside of their valid ranges, the invalid parameter bit (status word 2, bit 9) will be set and the changes will not take affect.

Manual Moves are allowed in the direction opposite to an active end limit switch. For example, a Manual Move CW will be allowed if the CCW End Limit Switch is active. A CCW Manual Move, will cause a Command Error.

Preset Current Position

This command is used to set the current position at the specified value. The Desired Position value is copied into the Current Position Input Words. If the position is currently invalid, presetting the position will cause the position to become valid. Presetting the position will also reset the Move Complete bit. The programmed speed, acceleration, and deceleration parameters do not have to be zero when this command is sent to the module.

Reset Errors

This command clears all nonfatal errors detected by the stepper controller. It is possible to recover from a nonfatal error. For example, requesting an Absolute Move when the position is not valid is a nonfatal error. When an error flag is ON, the controller will not perform any other operations until the Reset Errors command is issued. A reset error command issued while a move is occurring will be ignored.

Preset Encoder Position

This command will set the Encoder Position in input words 4 and 5 to the value present in the Target Position registers.

Electronic Gearing

This command causes the motor to follow the encoder inputs. If the encoder counts are increasing, then the motor will turn CW. If the encoder counts are decreasing, then the motor will turn CCW. If the encoder counts/rev programmed in the configuration data is the same as the number of encoder counts/turn, then the motor will make one rotation for every rotation of the encoder. The ability to apply numerator and denominator values is also available. This allows a ratio to be programmed between the input encoder counts and the motor steps to allow different relationships between the encoder and motor motion.

1. The driver uses X4 decoding when counting the encoder pulses
2. The position data does not have to be valid in order to use the electronic gearing function
3. The driver looks at the change in encoder pulses for 50 μ s before moving the motor.
4. The numerator and denominator values have a range of 1 to 255. The Invalid Parameter error bit (status word 2 bit 9) will be set if the numerator and denominator values are outside of this range.
5. The numerator and denominator values can be changed while electronic gearing motion is occurring. A 0 to 1 transition of the Manual Move command bit is not required.
6. Values located in output words 4 to 9 are ignored.
7. Caution should be used when programming the numerator value to be much larger than the denominator value.
8. An input error will be generated if an end limit switch or the emergency stop input become active.
9. Encoder values can be captured while electronic gearing motion is taking place.
10. A Command Error will be generated if a Hold Command is issued when an electronic gearing move is taking place.
11. The External Input has no affect on an Electronic gearing move.

Velocity Mode

In Velocity mode, the speed that the motor turns at is determined by an –10Vdc to +10Vdc analog input. If the input voltage is positive, the motor will turn CW. If the input voltage is negative, the motor will turn CCW. The input sensitivity parameter, which has a range of 1 to 65535, is programmed in output word 4 and defines how many steps/sec are output for each volt on the input. A change in the input sensitivity parameter will only take affect on the 0 to 1 transition of the Command bit.

While in velocity mode, the motor steps/rev is fixed at 1000.

The formula for determining the revolutions per second from the programmed sensitivity and the input voltage is $\text{Revolutions/Second} = (\text{Voltage Input} * \text{Input Sensitivity} / 1000)$

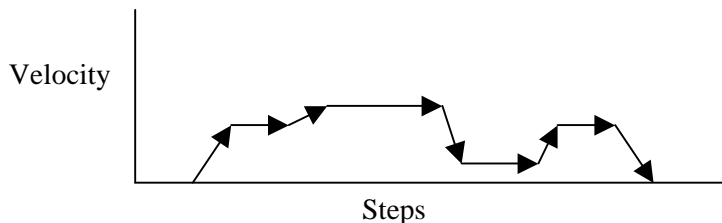
For example if the input sensitivity is set at 2000 and there is 1Vdc on the analog input, the motor will turn CW at 2 rev/sec.

The position data does not have to be valid in order to use velocity mode. Also, there are no programmed acceleration or deceleration parameters in velocity mode. The motor will simply jump from rest to the speed determined by the input sensitivity parameter and the analog input.

A Hold Command issued when a velocity move is taking place will not stop the motion and will generate a Command Error. Also, the External Input has no affect on a Velocity move.

Blend Move

This command allows the user to create more complicated move profiles consisting of two to sixteen segments, as the following diagram illustrates.



Each segment is defined by five parameters:

1. Absolute Target Position
2. Programmed speed
3. Acceleration Rate
4. Deceleration Rate
5. Jerk

The minimum amount of information necessary to define a new move segment is a change in the Absolute Target Position. The Acceleration/Deceleration rates and the velocity do not have to change during a Blend Move operation. If both a new Position and a new Programmed speed are not specified, the Command Error input bit will be set. A blend move profile cannot be setup as a series of encoder moves.

The blend move programming is done at one time, with the segments of the blend move profile stored in the internal memory of the SD31060IX. The Blend Move Profile is programmed as a series of Absolute Moves, meaning that the position has to be valid for the blend move operation to take place. The first segment starts at the Starting Speed and accelerates to the specified Programmed speed. The starting speed for the next segment is equal to the programmed speed of the current segment. The final segment will stop at the starting speed. It is not possible to program a direction reversal in the blend move profile.

Because the SD31060IX stores the data for the Blend Move Profile in its memory, the programmed profile can be run more than once. The only restriction is that the blend move must be always started from the same valid position. If the Blend Move Profile is started from a different location, the stepper controller will set the Command Error Flag. Please note that it is possible to perform other move or home operations between performing the blend move profiles.

A Configuration Operation does not clear a stored Blend Move profile.

Warning: If the programmed speed is not reached during a blend move segment, the driver will begin the next segment at what should have been the programmed speed. This jump in speed will take place without acceleration and may cause the motor to stall.

BLEND MOVE PROGRAMMING ROUTINE

The following is a description of how the Blend Move Profile will be programmed.

1. The PLC processor sets control bit 11, the PROGRAM BLEND MOVE PROFILE bit.
2. The SD31060IX responds by setting status bits 8 and 9, the BLEND MOVE MODE BIT and the SEND NEXT BLEND MOVE DATA BIT.
3. When the PLC processor detects that the Send Next Blend Move Data bit is set, it writes the first segments data and sets control bit 12, the READ BLEND DATA BIT.
4. The SD31060IX checks the data, and when finished, resets the Send Next Blend Move Data bit. If an error is detected, it also sets the Command Error bit 12, and the Error LED.
5. When the PLC processor detects that the Send Next Blend Move Data bit is reset, it resets the Read Blend Data bit
6. The SD31060IX detects that the Read Blend Data bit is reset, and sets the Send Next Blend Move Data bit.
7. Steps 3 to 6 are repeated for the remaining segments until the entire blend move profile has been entered. The maximum number of segments per profile is 16.
8. After the last segment has been transferred, the PLC processor exits Blend Move Mode by resetting control bit 11, the Program Blend Move Profile bit.
9. The SD31060IX resets the Blend Move Mode bit and the Send Next Blend Move Data bit.
10. When the blend profile is to be performed, the PLC processor sets control bit 13, the RUN BLEND MOVE PROFILE bit. Please note that the profile cannot be run until the SD31060IX has reset the Blend Move Mode bit.
11. The SD31060IX sets status bit 8, the Blend Move Mode Bit and performs the programmed profile.
12. When the profile has run to completion, the SD31060IX sets status bit 7, the MOVE COMPLETE BIT, and resets the Blend Move Mode Bit.
13. Steps 10 to 12 can be repeated as long as the profile is started from the same position every time it is run.

Encoder Move

The SD31060IX has the ability to perform an Encoder Move, where the number of counts made by an incremental encoder determines the distance of the move. If bit 2 of control word 2 is set when an absolute or relative move is initiated, the SD31060IX module will begin a move profile using the programmed velocity and acceleration parameters. The programmed position is now the number of encoder counts to move. When this encoder count is reached, the SD31060IX module will begin to decelerate at the programmed deceleration rate, and stop. After motion has stopped, the SD31060IX module will set status bit 7, the Move Complete bit.

The following must be considered when using the Encoder Move function.

- The SD31060IX module uses X4 decoding on the encoder inputs, so the number of counts per turn of the encoder will be four times the encoder's resolution. For example, if a 1000 line encoder is being used, the SD31060IX will report 4000 counts per turn. This is the number that must be used when determining the position data of your encoder move.
- It is possible to perform a negative encoder move, motion in the Counter Clockwise direction, by setting bit 15 of the Most Significant word of the position data.
- If the SD31060IX module is not configured to accept encoder inputs, attempting an encoder move will cause a command error to be generated.
- An Encoder Move can be held and the encoder data trapped.
- Setting bit 2 of the second control word during a manual move or home operation will not have any affect on the SD31060IX module's profile.
- Before performing a standard absolute or relative move, it is necessary to reset bit 2 of the second control word.

Jerk

The Jerk parameter defines the SD1798IE's acceleration profile; specifically how much of the motion profiles acceleration and deceleration time will be linear.

This parameter has a range of 0 to 5000. If this parameter is set to zero, the driver will use linear acceleration and deceleration. If this parameter is set to 1, the motion profile use the smoothest S curve acceleration possible and no part of the acceleration and deceleration will be linear. A value of 5000 is the closest to linear but still remains S curve.

1. Linear acceleration accelerates at a constant rate between starting speed and the programmed speed.
2. S curve acceleration is lower at the beginning and end of the acceleration profile than it is in the middle of the acceleration portion of the move profile.
3. A value of 0, linear acceleration, will have the shortest acceleration time.
4. A value of 1, S curve acceleration, will have the longest acceleration time.

Command Mode Output Data

All stepper motor operations are performed in command mode. This mode is entered, after a successful configuration file has been transferred to the stepper controller, by resetting the Mode Flag bit 15.

In Command Mode, the controller issues commands that activate different operations or moves. A move profile typically consists of a Target Position, Programmed Speed, Acceleration and Deceleration parameters. The following table shows the function of the output words.

Word	Acceleration and Deceleration moves	Electronic Gearing	Velocity Mode
0	Control Word 1	Control 1	Control 1
1	Control Word 2	Control 2	Control 2
2	Upper Target Position	Numerator	0
3	Lower Target Position	Denominator	0
4	Upper Programmed Speed	0	Input Sensitivity
5	Lower Programmed Speed	0	0
6	Acceleration	Acceleration	0
7	Deceleration	Deceleration	0
8	Motor Current	Motor Current	Motor Current
9	Jerk 0, 1 to 5000	0	0

Notes:

- The data format of the Output Words is 16 bit decimal.
- Only a 0 → 1 transition of any of the control bits will cause an operation to take place. Also, only one command bit in Control Word 1 should be set at any one time. If the data is being entered manually, enter the parameters before setting the control bit.
- Both the Target Position and the Programmed Speed are divided into two words. The Upper Word contains the 1000s places, the upper 4 decimal digits, and the Lower Word contains the 1s, 10s, and 100s places, the lower 3 decimal digits. For example, if the desired Target Position is 12,345, then the Upper Target Position would contain a value of 12, and the Lower Target Position would contain a value of 345.
- A negative position value will be programmed by setting bit 15 in Output Register 2.
- The Position parameter and Encoder Count values have a range of -32,768,999 to 32,767,999.
- The Programmed Speed has a range of Starting Speed ≤ Programmed Speed ≤ 3,997,696.
- The acceleration and deceleration parameters have a range of $1 \leq \text{acceleration/deceleration} \leq 32,767$ and is measured in steps/msec/sec.
- The Motor Current has a range of 1.0Arms to 9.8Arms and is programmed in units of 0.1Arms. For example, a value of 25 will set the current to 2.5Arms. Values that are outside of the range of 10 to 98 will be ignored. No errors are generated. The current is only changed when the driver is enabled and the three “key” bits in Control Word 2 transition from 0 to 1.
- In Electronic Gearing, the Numerator and Denominator values have a range of 1 to 255. These two parameters define the relationship between the number of encoder pulses and the motor rotation. Changes to these two parameters will be immediately acted on, even if the motor is running.
- In Velocity Mode, the Input Sensitivity has a range of 1 to 65535 and defines how many steps/sec are output per each volt of the input. While in Velocity Mode, the motor steps/rev is fixed at 1000. Positive voltage levels produce CW rotation and negative voltage levels produce CCW rotation. The analog input has a range of ±10Vdc. A change to the input sensitivity will only take affect on the 0 to 1 transition of the manual move bits. The input sensitivity cannot be changed on the fly.

Control Word 1

- bit 0 = set when performing an ABSOLUTE MOVE operation *
- bit 1 = set when performing a RELATIVE MOVE operation *
- bit 2 = set when performing a HOLD MOVE operation
- bit 3 = set when performing a RESUME MOVE operation *
- bit 4 = set when performing an IMMEDIATE STOP operation
- bit 5 = set when performing a FIND HOME +/(CW) operation *
- bit 6 = set when performing a FIND HOME -/(CCW) operation *
- bit 7 = set when performing a MANUAL MOVE +/(CW) operation
- bit 8 = set when performing a MANUAL MOVE -/(CCW) operation
- bit 9 = set when performing a PRESET POSITION operation *
- bit 10 = set when performing a RESET ERRORS operation
- bit 11 = set to PROGRAM BLEND MOVE PROFILE *
- bit 12 = set when the stepper controller is to READ BLEND DATA *
- bit 13 = set to RUN BLEND MOVE PROFILE *
- bit 14 = set to PRESET optical encoder or data *
- bit 15 = MODE FLAG: "1" for Configuration Mode *
"0" for Command Mode

Note: The channel must be stopped before any of the commands with the * can be initiated. If a new command is issued while a move is occurring, a Command Error will be immediately generated but the current move operation will run to completion.

Control Word 2

- bits 0,1, and 5: If these three bits are set to "1" "0" "1" (33 decimal, 21h) than they form a key that will use to set the motor current in word 8. On DeviceNet systems, the current is only changed when the drive is enabled and these three bits transition from 0 to 1.
- bit 1: Used as a key bit to set the motor current as described by bit 0 above.
- bit 2: Set to perform an Encoder Move Setting this bit during an absolute or relative move will cause the move distance to be based on the encoder input, not on the steps output to the stepper driver.
- bit 3: Set this bit together with the Reset Errors command to clear an Under Voltage fault condition. The driver must be disabled to clear an Under Voltage fault condition.
- bit 4: Set this bit together with the Reset Errors command to clear an Over Temperature fault condition. The driver must be disabled to clear an Over Temperature fault condition.
- bit 5: Used as a key bit to set the motor current as described by bit 0 above.
- bit 6: Set to enable Electronic Gearing mode. To start an electronic gearing move, use either of the manual move commands.
- bit 7: Set to enable Velocity mode. To start a velocity mode, use either of the manual move commands.
- bits 8 to 13: reserved for the future State of the Remote Outputs
- bit 14: Set to enable the Antiresonance function
- bit 15: "0" to disable the driver, "1" to enable the driver. When the driver is disabled, power is removed from the motor. Disabling the drive while a move is taking place will cause the position to become invalid.

Command Mode Input Data (Data sent from the SD31060IX to the Network)

When the SD31060IX module is in command mode, its status information is reported to the PLC in the Input Registers. This data has the following format:

Note: A ControlLogix system using ControlNet will require 12 input words. The first two words will always be zero, and the Configuration Bits will be located in input word 2.

Input Word	Status Information
0	Status Word 1
1	Status Word 2
2	Upper Current Position
3	Lower Current Position
4	Upper Encoder Position
5	Lower Encoder Position
6	Upper Word Captured Encoder Position
7	Lower Word Captured Encoder Position
8	Motor Current
9	Jerk

The Current Position, the Encoder Position, and the Captured Encoder Position are divided into two words. The Upper Word contains the 1000s places, the upper 4 decimal digits, and the Lower Word contains the 1s, 10s, and 100s places, the lower 3 decimal digits. For example, if the desired Current Position is 12,345, than the Upper Current Position would contain a value of 12 and the Lower Current Position would contain a value of 345.

Status Word 1

- bit 0 = set when the axis is moving CW
- bit 1 = set when the axis is moving CCW
- bit 2 = set when the stepper controller is in a HOLD STATE
- bit 3 = set when the axis is STOPPED, must be set before a move operation can begin
- bit 4 = set when the axis is AT HOME
- bit 5 = set when the axis is ACCELERATING
- bit 6 = set when the axis is DECELERATING
- bit 7 = set when MOVE COMPLETE
- bit 8 = set when the stepper controller is in BLEND MOVE MODE
- bit 9 = SEND NEXT BLEND MOVE DATA BIT
- bit 10 = set when POSITION INVALID
- bit 11 = set when there is an INPUT ERROR
- bit 12 = set when there is a COMMAND ERROR, must be reset before another command will be accepted
- bit 13 = set when there is a CONFIGURATION ERROR
- bit 14 = set when MODULE OK
- bit 15 = MODE FLAG "1" configuration mode
 "0" for command mode

Status Word 2

- bit 0 = set when the CW LIMIT SWITCH input is active
- bit 1 = set when the CCW LIMIT SWITCH input is active
- bit 2 = set when the EMERGENCY STOP input is active
- bit 3 = set when the EXTERNAL INPUT is active
- bit 4 = set when the HOME LIMIT SWITCH input is active
- bit 5 = reserved for future use
- bit 6 = Set when the network status has been lost and re-established. The configuration error bit will also be set.
- bit 7 = Set when there is a Drive Phase Fault. This bit will be set if one or two of the phase drivers are faulty or if an external short circuit condition has been detected.
- bit 8 = Set when there is a Motor Fault. This bit will be set if one or two of the motor's phases are not properly connected. This bit will also be set if there is a huge difference between the characteristics of the motor's two windings, indicating defective motor.
- bit 9 = Set when there is an Invalid Parameter change.
- bit 10: Limit Condition Bit. This bit will be set if an End Limit Switch is reached during a move operation. This bit will be reset during the Homing operation after the motor has reversed direction with the falling edge of the limit switch, with respect to the input active level, or when a Reset Error Command is issued.
- bit 11 = set when there is an Under Voltage error condition. This bit will also be set when the AC power is removed, but the driver retains its settings and continues to communicate with the network because it is connected to the +24Vdc Standby Power. To clear this fault, you must set the Reset Errors (bit 10 in Control Word 1), the clear Over Temperature (bit 4 in Control Word 2), and the clear Under Voltage (bit 3 in Control Word 2) simultaneously. The fault will be cleared even if the AC power has not been restored.
- bit 12 = set when there is an Over Current error condition. This fault cannot be cleared by the reset error command. Power must be cycled to clear this fault.
- bit 13 = set when there is an Over Temperature condition.
- bit 14 = set when a Stall Condition has been detected. Absolute Moves will not be allowed after a Stall condition has been detected because the position will be invalid. This bit will remain on until one of the following has occurred, a clear error command has been issued, the position has been preset, or a homing operation has taken place.
- bit 15 = set when the drive is Enable.

CURRENT POSITION

These two input words report the Current Position based on the number of steps that have been output to the stepper driver. This value may be different from the Encoder Position. If the Most Significant bit of the Most Significant word is set, then the Current Position data is negative. If the maximum value is reached, the current position data will roll over from 32,767,999 to -32,768,000.

ENCODER POSITION

These two input words report the position based on the feedback from an encoder attached to the stepper motor. This value may be different from the Current Position. If the Most Significant bit of the Most Significant word is set, then the Encoder Position data is negative. As with the Current Position data, if the maximum value is reached, the current position data will roll over from 32,767,999 to -32,768,000.

CAPTURED ENCODER POSITION

These two input words report the encoder value that was present when the external input transitions from inactive to active. This will only occur if the module has been configured to have the external input trap the encoder data. If the Most Significant bit of the Most Significant word is set, then the Captured Encoder Position data is negative. The Captured Encoder Position cannot be reset and will not be cleared by a homing operation. If the external input is not configured to trap encoder data, these two words will be zero.

MOTOR CURRENT

This word reports the programmed motor current value in 0.1Arms units. For example, a value of 1.5Arms will be displayed as 15. If the motor current is outside of the range of 1.0 to 6.0 Amps, then this register will display the last valid value. The current is only changed when the driver is enabled and the three “key” bits in Control Word 2 transition from 0 to 1. If the motor current is not programmed the driver will use a default setting of 1.0Arms.

Jerk

This register reports the value for Acceleration Profile, linear or S curve, which was programmed in the output registers.

The Stopped Bit will be set under the following conditions

The Stopped Bit will be set whenever the driver is in Command Mode and motion is not occurring. This bit will also be set when the driver is in a Hold State.

The Move Complete Bit will be set under the following conditions

After an Absolute Move, a Relative Move, or a Blend Move have been successively completed. The Move Complete bit will be reset when the next move operation is initiated or by a Preset Position Command. The Move Complete bit will not be set after a Manual Move or Home operation.

The Position Invalid will be set under the following conditions

1. After a configuration operation has occurred. This will be true even if the position was valid before the configuration operation occurred.
2. After the network connection has been lost and re-established.
3. After an Immediate Stop command has been issued.
4. If the Emergency Stop input has been activated.
5. If either of the End Limit Switches become active during any move operation.
6. If the opposite End Limit Switch is reached during a homing operation. For example, if the CCW Limit Switch is first reached during a CW homing operation. Improper wiring or placement of the limit switch would most likely cause this error.

The Input Error bit will be set under the following conditions

1. If the Emergency Stop input has been activated
2. If either of the End Limit Switches become active during any move operation except for homing.
3. Starting a manual move in the same direction as an active end limit switch.
4. If both End Limit Switches are reached during a homing operation. This error will only occur when the motor has reversed direction after encountering the first End Limit switch.
5. If the opposite End Limit Switch is reached during a homing operation. For example, if the CCW Limit Switch is first reached during a CW homing operation. Improper wiring or placement of the limit switch would most likely cause this error.

A Command Error will be generated under the following conditions

1. Initiating a move when the driver has not been enabled by setting bit 15 in Control Word 2.
2. If more than one Command bit is set in Control Word 1.
3. Issuing a move command, even if it is the same command, when a move operation is occurring. If this occurs, the move will run to completion even though the Command Error bit is set.
4. If the Target Position, Programmed Speed, Acceleration, or Deceleration parameters are outside of their valid ranges.
5. If the programmed speed is less than the starting speed.
6. Performing an Absolute Move when the Current Position is not valid.
7. Issuing a Hold Command when no motion is taking place.
8. Issuing a Hold Command when there is an Electronic Gearing or Velocity Mode move occurring. The move operation will not be stopped.
9. Issuing a Resume Command when the driver is not in a Hold State.
10. Issuing a Homing Command in a direction that does not have an End Limit Switch configured.
11. Issuing a Resume Command for a Blend Move or Homing operation that was stopped with the Hold command but not placed in a hold state.
12. Any Encoder operation, such as Encoder Move or Encoder Preset, when the module has not been configured to use an encoder.
13. Starting a Blend Move profile from a valid absolute position that is different from the position where the profile was programmed.
14. Programming a Blend Move segment without changing the Target Position.
15. Programming a Blend Move profile that contains a direction reversal.
16. Programming more than sixteen Blend Move Segments.
17. Setting the Encoder Move bit (bit 2 in Control Word 2) when running a Blend Move Profile. The Encoder Move bit will be ignored if it is set during the programming of the Blend Move Segments.
18. If the Velocity Mode Input Sensitivity is outside of the range of 1 to 65,535.
19. If the Jerk parameter is outside of the range of 0 to 5000.

The Configuration Error bit will be set under the following conditions

1. At power up.
2. If an invalid configuration has been sent to the module.
3. If the network connection was lost and restored. If the motor power was removed when the network connection was lost, than the enable bit (control word 2, bit 15) must transition from 0 to 1 to re-enable the motor.

The Limit Condition bit will be set under the following conditions

This bit will be set when an end limit switch is reached during a move operation. If the Limit Condition bit is set, only motion in the direction opposite to the previous direction of motion will be allowed. Please note that when homing, the direction of motion may be opposite from the requested direction.

The Limit Condition bit will be reset by the following conditions

1. The Clear Error command is sent to the module.
2. If the limit switch that caused the bit to be set transitions from on to off.
3. If a home operation successfully completes.

The Invalid Parameter Change bit will be set under the following conditions

1. If the velocity, acceleration, or deceleration parameters are changed to invalid values while a manual move is occurring. This will also be true if the velocity is changed to a value less than the Starting Speed.
2. If the numerator or denominator parameters are changed to invalid values during an Electronic Gearing move.

This bit will be reset when valid data has been written to the output registers. The Reset Errors command will not reset this bit.

The Module OK Flag

This bit will be set as long as the module is operating. Only a fatal error will cause this bit to be reset to zero.

External Input

This input can be configured to operate in two ways.

1. It can be used to initiate a controlled stop during a manual move operation. When this input is active, the stepper motor will decelerate to the starting speed, and stop, keeping track of the current position. During an absolute or relative move, the External Input will cause the module to make a controlled stop to a hold state.
2. Two, the inactive to active transition of this input will capture optical encoder data.

It is also possible to configure this input to perform both of the above tasks at the same time.

Emergency Stop

The Emergency Stop Input causes the current move operation to stop without any deceleration. The pulse signal is simply stopped. When this input becomes active, both the Position Invalid and Input Error status bits will be set. The channel will have to be Preset or Homed again before an Absolute Move operation can be performed. However, it will be possible to perform a Relative or a Manual Move after the Emergency Stop Input has been used.

Optical Encoder

The optical encoder has a range of -32,768,999 to 32,767,999 counts and uses X4 decoding. Only a 5V differential encoder will work with the SD31060IX. A move profile does not have to be in progress in order for the unit to count encoder pulses.

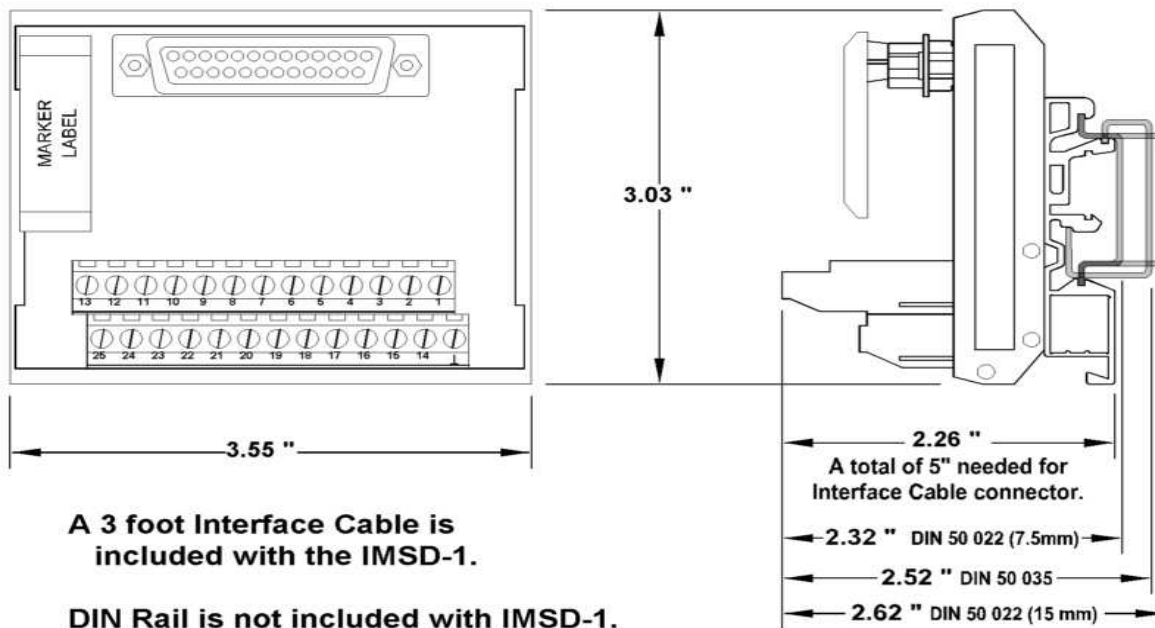
Driver LED Function

LED	Pattern	Function
Power	On Green	Drive is receiving power
	Off	Driver is not receiving power
Status	On solid green	Driver OK
	Flashing red/green	Under Voltage or Overcurrent Error detected 1Hz = Under Voltage 3Hz = Overcurrent or Interlock not attached
	Flashing Red	Overtemperature Error detected
	Solid Red	Unit initializing or initial detection of overcurrent, under voltage, or overtemperature errors.

Direction of Travel

The point of reference for determining the direction of travel is looking at the motor's shaft.

Breakout Box Dimensions



Pinout Connections of Breakout Box By Function

Pin #	Function
1	+A Motor Encoder Input
14	-A Motor Encoder Input
2	+B Motor Encoder Input
15	-B Motor Encoder Input
3	+Z Motor Encoder Input or +A for Electronic Gearing Input
16	-Z Motor Encoder Input or -A for Electronic Gearing Input
11	+B Electronic Gearing Input
24	-B Electronic Gearing Input
5	5Vdc External Input
18	7 to 24Vdc External Input
6	CW Limit Switch
19	CCW Limit Switch
7	Home Limit Switch
20	Single Ended Input Common

Pin #	Function
10	+ Emergency Stop
23	- Emergency Stop
12	Analog Input Common
25	Analog Input Negative
13	Analog Input Positive
4	No Connection
17	No Connection
8	No Connection
9	No Connection
21	No Connection
22	No Connection

Pinout Connections of Breakout Box by Pin Number

Pin #	Function
1	+A Motor Encoder Input
2	+B Motor Encoder Input
3	+Z Motor Encoder Input or +A for Electronic Gearing Input
4	No Connection
5	5Vdc External Input
6	CW Limit Switch
7	Home Limit Switch
8	No Connection
9	No Connection
10	+ Emergency Stop
11	+ B Electronic Gearing Input
12	Analog Input Common
13	Analog Input Positive

Pin #	Function
14	-A Motor Encoder Input
15	-B Motor Encoder Input
16	-Z Motor Encoder Input or -A for Electronic Gearing Input
17	No Connection
18	7 to 24Vdc External Input
19	CCW Limit Switch
20	Single Ended Input Common
21	No Connection
22	No Connection
23	- Emergency Stop
24	-B Electronic Gearing Input
25	Analog Input Negative

Note: The External Input can operate at two input voltage levels, depending on which input terminal is used. Pin 18 operates at 7 to 24Vdc and pin 5 operates at 5Vdc. These two terminals must not be used at the same time.

Specification

Environmental Specifications

Input Power	95 to 240Vac, 50/60Hz 9.5Arms max
Operating Temperature	32° to 122°F (0° to 50°C)
Storage Temperature	-40° to 185°F (-40° to 85°C)
Humidity	0 to 95% non-condensing

Power Up Delay

There is an eight second delay between power up and when the SD31060IX begins to communicate with the network.

Dimensions

Height = 9 inches
Width = 4 inches
Depth = 6 inches (9 inches with cables attached)

Mounting Requirements

In order to dissipate heat correctly, the SD31060IX must be mounted with the heat sink fins vertical. A large amount of heat can also be dissipated through the back panel if the drive is securely mounted to a metal panel.

To guarantee proper airflow around the driver, 2 inches of space must be left both above and below the unit, and 1.5 inches must be left both to the left and the right of the unit.

Relay Output

The normally open relay located on the front of the SD31060IX stepper driver will be closed when the motor is enabled, and open when the motor is disabled.

RS 232 / RS 485 Communication Terminal

This 9 pin D connector currently does not have any function.

Encoder Inputs

5V differential encoder only
A, B, and Z Maximum Input Current: 10mA per channel @5Vdc
A, B, and Z Maximum Input Frequency with X4 decoding = 1MHz
The Encoder must be powered from an external supply

The A and B signals must both be connected to the SD31060IX module to have the encoder data increment or decrement.

Standby Input Terminals

Connecting +24Vdc across these two pins will allow network communication to continue if the driver's main AC power is lost.

- This feature was added in June 2007 and is available on SD31060IX units with serial number *D06070009* and above.
- When operating on Standby Power, the SD31060I will indicate an Under Voltage Fault Condition.
- After the AC power has been restored, this Fault is cleared by setting the Clear Error Command bit, the Clear Over Temperature Command bit, the Clear Under Voltage Command bit, and resetting the Enable Driver bit. Here is the ten word data block required to recover from a loss of AC power.

Word	Value
0	1024 (400h)
1	24 (18h)
2	0
3	0
4	0
5	0
6	0
7	0
8	0
9	0

Note: This data will clear the Under Voltage fault even if the AC power has not yet been restored.

- It is possible, but not recommended, to clear Undervoltage fault before the AC power has been restored.
- Commands, especially Configuration Commands MUST NOT be sent to the driver while the AC power is removed.
- Units with serial numbers between *D06070009* and *D12070071* will indicate an Overcurrent Fault if the Standby power is applied before the AC power. This fault can be cleared using the clear error data shown in the above table.
- The Standby Input requires 185mA @24Vdc.

SD31060IESA standby power notes

The SD31060IESA's firmware was changed in December of 2007 to remove a false Overcurrent fault that was generated when the standby power was applied before the AC power. The first unit with this change had a serial number of *D12070072*. The following is a list of how the SD31060IESA with this firmware level will respond to various power up conditions.

1. An Overcurrent Fault can only be cleared by removing both the standby and AC power.
2. Both the Position Invalid (input word 0 bit 10) and the Undervoltage Fault (input word 1 bit 11) status bits will immediately be set when the AC power has been removed.
3. The Module OK status bit (input word 0 bit 14) and the At Home status bit (input word 0 bit 4) will immediately be reset when the AC power is removed.
4. If motion was occurring when the AC power is removed, the CW or CCW motion bits (input word 0 bits 0 and 1) will remain set until the Undervoltage Fault is cleared.
5. If the Hold Status (input word 0 bit 2) bit was set when the AC power is removed, it will remain set until the Undervoltage Fault has been cleared.
6. The Stopped bit (input word 0 bit 3) will be set after Undervoltage Fault has been cleared.
7. If the Move Complete (input word 0 bit 7) or Command Error (input word 0 bit 12) bits are set when the AC power is removed, they will remain in the status register after the AC power has been restored and the Undervoltage fault has been cleared.
8. The current position will remain at its current values as long as the Standby Power remains connected to the driver. However, because there is no holding torque without AC power, it is possible that the motor's shaft has moved and that the current position value no longer represents the motor's actual position.
9. Encoder data will be updated as long as the Standby Power remains connected to the driver.
10. After removing the Undervoltage Fault, the command to enable the driver must be sent in a separate command before another move operation can be initiated. That is, you cannot send the enable and move command at the same time.
11. A Command Error will not be cleared by the Clear Error command that clears the Undervoltage fault. Clearing a Command Error requires the following data.

Word 0 = 1024 (400h)

Words 1 to 9 = 0

12. If the command to clear an Undervoltage fault is already present in the output registers when the AC power is removed, the Undervoltage fault will remain until the Clear Error command (output word 0 bit 10) transitions from 0 to 1.
13. The Stalled status bit will remain on when the Undervoltage fault is present and will not be cleared by the Clear Error command that clears the Undervoltage fault. Clearing a Command Error requires the following data.

Word 0 = 1024 (400h)

Words 1 to 9 = 0

14. Assuming that the PLC remains powered, removing both the AC and Standby Power causes the unit to report an Undervoltage Fault to the PLC. This is different from the condition when only the AC power is removed because it is simply the last value that was placed in the input registers when communications were lost. The Undervoltage error will be replaced by a Configuration error when communications are restored.

CW Limit Switch, CCW Limit Switch, Home Limit Switch, and 7 to 24Vdc External Input (pin 18)

Sinking Inputs

Input Voltage Range: 7 to 24Vdc
Input Current: 5mA
Response Time: 500 μ s
Referenced to Sinking Input Common Terminal (pin 20)

5Vdc External Input (pin 5)

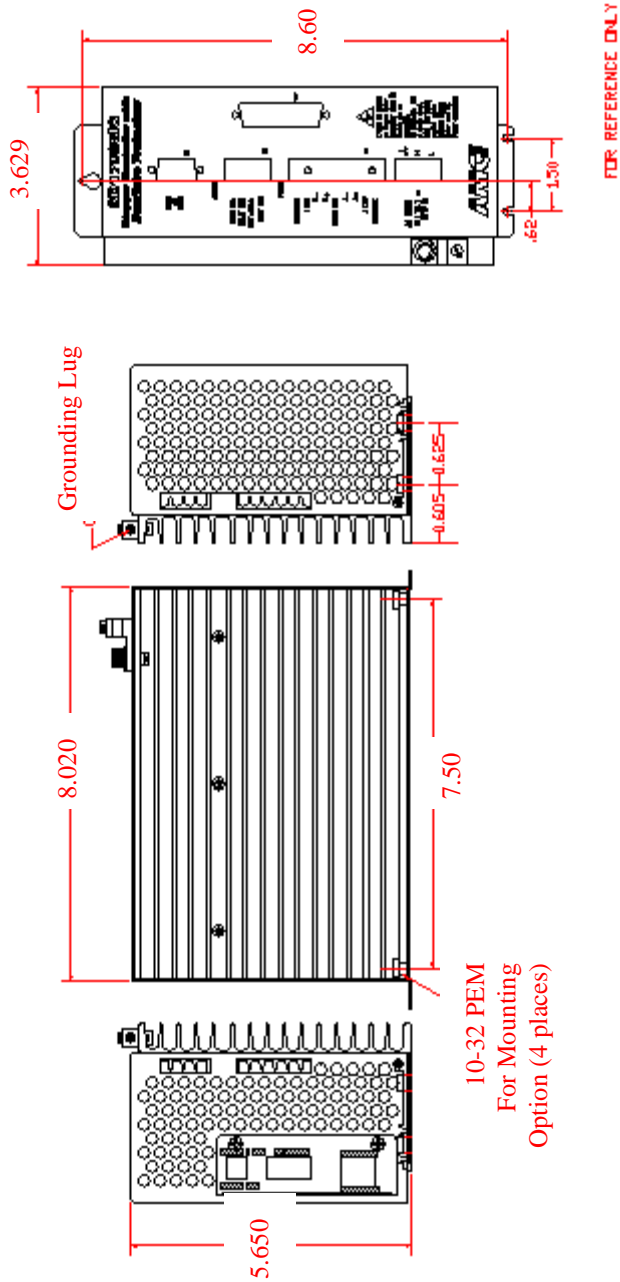
Input Voltage Level: 5Vdc
Input Current: 5mA
Response Time: 500 μ s
Referenced to Sinking Input Common Terminal (pin 20)

The External Input can operate at two input voltage level, depending on which input terminal is used. Pin 18 operates at 7 to 24Vdc and pin 5 operates at 5Vdc. These two terminals must not be used at the same time.

Emergency Stop Differential Input

Input Voltage Range: 7 to 24Vdc
Input Current: 5mA
Response Time: 500 μ s

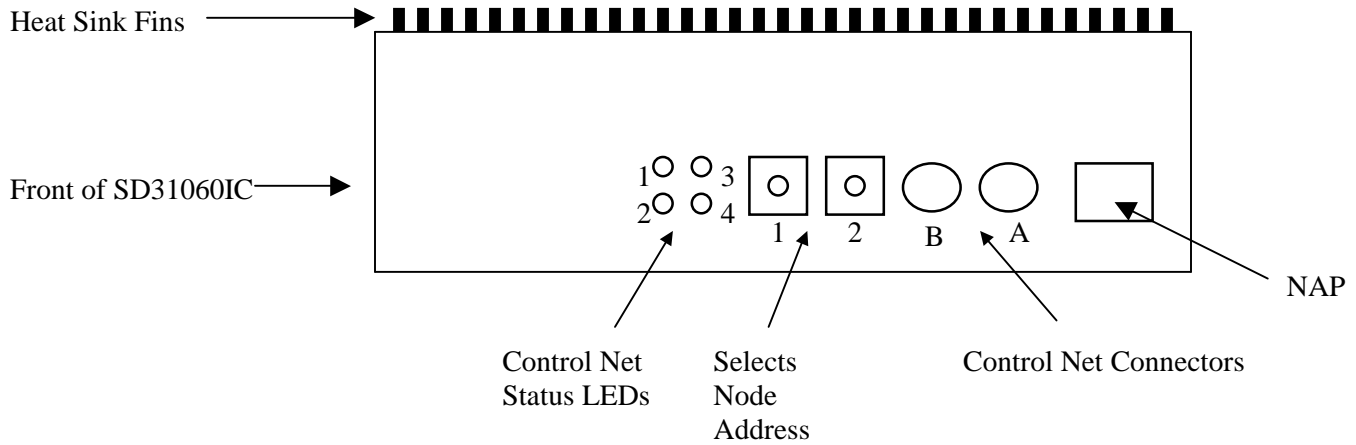
Outline Drawing



Installation Notes

- In order to dissipate heat correctly, the SD31060IX must be mounted with the heat sink fins vertical. There should be at least 2 inches of space both above and below the driver, and at least 1.5 inches of space to the left and right of the driver.
- A large amount of heat can also be dissipated if the back of the driver is securely mounted to a metal panel.
- If there is some reason that the above requirements cannot be met, it may be necessary to mount a small fan below the driver to blow air over the heat sink fins.
- The ambient temperature around the drive must not exceed 120°F (50°C).
- Never block the fins of the heat sink.
- Never expose the SD31060IX to liquids, including condensing humidity.
- Never expose the SD31060IX to metal particles. If the SD31060IX is mounted in a ventilated enclosure, the ventilation fans should have dust covers.

SD31060IC ControlNet Setup



Node Address Selection

The SD31060IC has two rotary switches used to set the module’s address on the network. Any node from 0 to 99 can be selected. Switch 1 sets the one digit and switch 2 sets the 10s digit of the address. For example, if the SD31060IC is to be installed at node 46, switch 1 would be set to 6, and switch 2 would be set to 4. Note, changing the node address only takes affect at power up. Changing the address while power is applied to the SD31060IC will generate a minor fault.

ControlNet Status LEDs

The following table describes the function of the four network status LEDs.

LED Number	Name	LED Pattern	Function
1	Channel B status	Solid Green Flashing Red/Off Solid Off	Channel Operating Correctly Channel Disconnected from Network Channel Disabled
2	Channel A status	Solid Green Flashing Red/Off Solid Off	Channel Operating Correctly Channel Disconnected from Network Channel Disabled
3	Module Owned	Solid Green Off Solid Red	Network Card is communicating with Nexus Network Card is not communicating with Nexus Incorrectly Configured Network. Possible causes are incorrect Node #, Number of I/O words, or Comm format.
4	Module Status	Flashing Green Solid Green Flashing Red Solid Red	Network Card is waiting for initialization Module is initialized and operating correctly Minor Fault (For example Node address changed) Major Fault, module must be restarted

Network Update Time

The SD31060IC has a minimum network update time of 5ms.

Quick Start Guide AMCI SD31060IC to ControlLogix PLC

1. With the power off, use the rotary switches on the SD31060IC to select the desired node address.
2. Connect the SD31060IC to the ControlNet using a ControlNet Tap to coax media. Either the A or B port can be used, depending on how your network is configured.
3. Apply power to the SD31060IC unit.
4. Start RSLogix 5000.
5. Start RSLinx and establish communications to the ControlLogix system.
6. Configure the ControlLogix hardware system, processor and discrete I/O. If it is not already present, also add the ControlNet adapter 1756-CNB(R) module to the system.
7. Right-click on the 1756-CNB(R) module and Click on **New Module...**
8. Define the NX1F4C as a generic CONTROLNET-MODULE. Click on **OK** and define the properties as follows.

Name: *Your Choice*
Description: *Your Choice*
Comm Format: Data-INT (must be set to Data-INT)
Node: Set it to the same value as the Node address on the SD31060IC

Assembly Instance – 100, **Input** – 12
Assembly Instance – 150, **Output** – 10
Assembly Instance – 110, **Config** – 0

Note: The first two input words will always be zero.

9. Click on **Next>**
10. Define the RPI. The minimum value is 5.0ms, however the value may be set higher.
11. Click **Finish**.
12. Save and Download the file to the Processor
13. Start RSNetworx for ControlNet and either open an existing project or create a new one.
14. If this is the first time using the SD31060IC, register the appropriate EDS file and icon from AMCI's website www.AMCI.com.
15. Go Online. RSNetWorx will scan the ControlNet network and should discover the SD31060IC.
16. Click on the Enable Edits checkbox and then save the project.

At this point, the 1756-CNB(R) should be communicating; steady green LED and the top right LED (ControlNet Status LED #3) for the SD31060IC communication should be on.

Go online to the ControlLogix processor. Select the **Logic** menu, followed by **Monitor Tags**. The data associated with the NX1F4C is available under the name you chose when configuring it.

Quick Start Guide

AMCI Nexus to PLC-5

1. With the power off, use the rotary switches on the Nexus to select the desired node address.
2. Connect the Nexus to the ControlNet using a ControlNet Tap to coax media. Either the A or B port can be used, depending on how your network is configured.
3. Apply power to the Nexus unit.
4. Start RSNetworkx. If this is the first time using the SD31060IC, register the appropriate EDS file and icon from AMCI's website www.AMCI.com.
5. From RSNetworkx for ControlNet, go Online. After browsing the network, the SD31060IC will appear as an "Extra Device" at the node selected by the Nexus' rotary switches.
6. Click the **Enable Edits** checkbox and choose "Use online data (upload)". Click **OK**. At this point you can right click on the SD31060IC icon and select **Properties** from the pop-up menu. In the properties window, you can change the name associated with the unit and add a description.
7. Go Offline.
8. Click the **Enable Edits** checkbox.
9. Right Click on the PLC-5 icon and click on **Scanlist Configuration** in the pop-up menu.
10. In the Device Name column, right click on the name of the Nexus unit, and click on **Insert Connection** in the pop-up menu. The Connection Properties window will appear on the screen.
11. If needed, set the Input Size and Input Address of the Data Input File. This file resides in the PLC-5 and is used by all of the ControlNet nodes. Therefore, it must be large enough to hold all of the input data on the network. The number of words that the SD31060IC transfers to the PLC-5 is shown below.

10 Input words for the SD31060IC

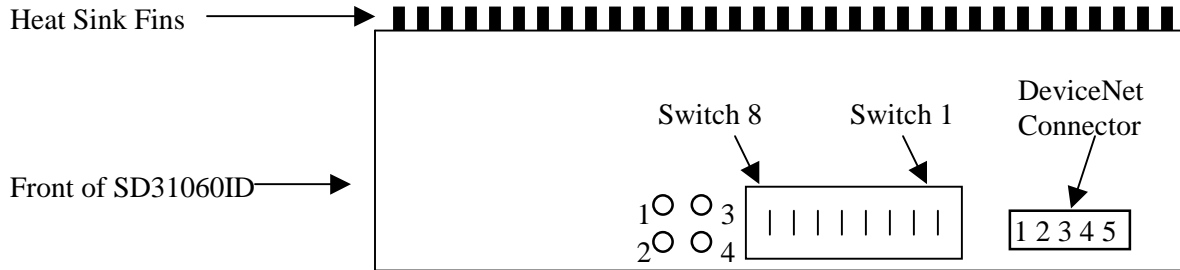
12. If needed, set the Output Size and Output Address of the Data Output File. This file resides in the PLC-5 and is used by all of the ControlNet Nodes. Therefore, it must be large enough to hold all of the output data on the network. The number of words that the SD31060IC receives from the PLC-5 is shown below.

10 Output words for the SD31060IC

13. Set the Request Packet Interval time. This has a minimum acceptable value of five milliseconds, but can be set higher.
14. Click OK to close the Connection Properties window. In the Scanlist Configuration window, save the changes and close the window.
15. Go Online.
16. Verify that the PLC is in Program Mode.
17. Click on **Network** in the toolbar and select **Download to Network** from the pull down menu that appears. After the download is complete, the Nexus unit should be communicating with the PLC.

SD31060ID DeviceNet Setup

The network connector, the DIP switches that set the node address and the Baud rate, and the network status LEDs are located on the top of the SD31060ID driver. The following diagram shows the driver, as it would appear from the top.



DeviceNet Connector

The 5 pin DeviceNet Connector has the following wiring.

Pin Number	Function	Standard Wire Color
1	+24Vdc	Red
2	Can High	White
3	Shields	Bare
4	Can Low	Blue
5	Common	Black

Node Address and Baud Rate Selection

The SD31060IX uses eight DIP switches to select the Node Address and the Baud Rate. Switches 1 and 2 set the Baud rate and switches 3 to 8 set the node, with switch 8 being the least significant bit. The following table shows the possible switch setting combinations.

On the DIP switch package, “1” is the “ON” position and “0” is the “OFF” position.

Baud Rate	Switches 1 & 2 1 2
125k	0 0
250k	0 1
500k	1 0
Reserved	1 1

Node Address	Switches 3 to 8 3 4 5 6 7 8
0	0 0 0 0 0 0
1	0 0 0 0 0 1
2	0 0 0 0 1 0
3	0 0 0 0 1 1
61	1 1 1 1 0 1
62	1 1 1 1 1 0
63	1 1 1 1 1 1

Example: For a Baud Rate = 250K and the Node Address = 5, switches 2, 6, and 8 would be ON, up towards the top of the module and switches 2, 3, 4, 5, and 7 would be OFF, down towards the bottom of the module.

Note: The state of the switch settings is only taken into account at power up.

DeviceNet Status LEDs

The following table describes the function of the four network status LEDs.

LED Number	Name	LED Pattern	Description
1	Module Network Status	Steady Off Steady Red Steady Green Flashing Red	No Power Unrecoverable Fault Device Operational Minor Fault
2	Network Status	Steady Off Steady Red Steady Green Flashing Red Flashing Green	Not Powered / Not On Line Critical link failure Link OK, On Line, Connected Connection Time Out On Line not connected
3	Reserved		
4	Reserved		

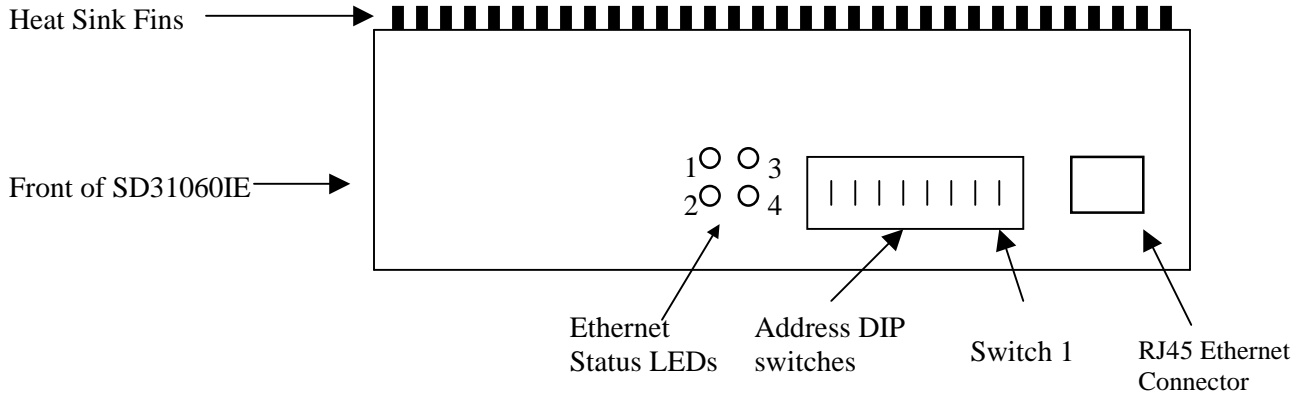
Adding the SD31060ID to your network

Before the SD31060IX can be attached to a network, it must be added to the RSNetWorx for DeviceNet software. The EDS and icon files are available in the *Tech Library* section of our website, www.amci.com. The following procedure to add the EDS file to RSNetWorx assumes that you have already downloaded and un-zipped these files.

1. With the power off, use the dip switches on the front of the SD31060ID to set the node address and the baud rate.
2. Start RSNetWorx for DeviceNet.
3. In the RSNetWorx program, click on **Tools** in the menu bar.
4. Click on **EDS Wizard...** from the pull down menu that appears.
5. Click on **Next>** in the window that appears.
6. Select **Register an EDS file(s)** and click on **Next>**.
7. Select **Register and EDS file**.
8. Click on **Choose File...** and navigate to the folder where you placed the un-zipped EDS and icon files.
9. Double click on **SD31060ID_r01.eds** file.
10. Click on **Next>**.
11. Click on **SD31060ID_r01.eds** file so that it is highlighted.
12. Click on **Next>** to assign an icon to the device.
13. Click on the SD31060IX and then click on **Change icon...** to select the icon for the Nexus unit. You can choose one of the built in icons from Rockwell Automation or click on the **Browse...** button and select the **SD31060ID_r01.ico** icon file.
14. Click on **Next>** and then click on **Finish** to complete the installation of the AMCI SD31060ID EDS file to the RSNetWorx system.

Once the EDS file is added to your system, add the SD31060ID to your network as you would any other device, including adding it to the scanlist configuration of the scanner module.

SD31060IE Ethernet Setup



Ethernet Address Selection

The SD31060IE uses an IP address of 192.168.000.XXX.

The SD31060IESA uses an IP address of 192.168.001.XXX.

In both cases “XXX” can be any number between 1 and 254. Eight dip switches on the SD31060IE are used to set the “XXX” portion of the address. Switch 8, the left most switch, is the least significant bit and switch 1, the right most switch, is the most significant bit. The address is programmed using the following procedure.

1. Determine the address of the SD31060IE. It can be any unused address between 1 and 254.
2. Convert the address to a binary number. A value of 50 will be 0011 0010.
3. Enter the address on the dip switches. Continuing the above example, switches 8, 6, 5, 2 and 1 will be off (down) and switches 7, 4, and 3 will be on (up).

Ethernet Status LEDs

The following table describes the function of the four network status LEDs.

LED Number	Name	LED Pattern	Function
1	Network Status	Steady Off Steady Green Flashing Green Flashing Red Steady Red	The module has no power or an IP address has been assigned. The module has at least one established Ethernet/IP connection. There are no Ethernet/IP connections established to the module One or more of the connections in which this module is the target has timed out
		Flashing Green/Red	The module is performing a power on self test
2	Module Status	Steady Off	No Power.
		Steady Green	The module is operating correctly.
		Flashing Green	The module has not been initialized.
		Flashing Red	A minor recoverable fault has been detected.
		Steady Red	A major internal error has been detected.
Flashing Green/Red	The module is performing a power on self test.		
3	Activity LED		This LED flashes green each time a packet is received or transmitted
4	Link		This LED indicates that the module is connected to an Ethernet network

Note: The driver removes power from the motor if the network connection is removed.

Setup Example

AMCI SD31060IE to Rockwell Automation 1756-ENET/B module

1. With power removed, use the dip switches to set the address of the SD31060IE.
2. Open an existing or create a new ControlLogix program.
3. From the project tree, right click on I/O configuration and select New Module.
4. From the Module Type list that appears, select 1756-ENET/B, the 1756 Ethernet Bridge module.
5. Type a name for the Bridge module, which must begin with a letter, in the Name field.
6. Enter the slot number where the 1756-ENET/B module is located in the ControlLogix rack.
7. In the Address/Host Name field, select the IP Address and enter the address 192.168.000.XXX where XXX can be a unique number between 1 and 254.
8. Click the Finish button.
9. From the project tree, right click on the 1756-ENET/B module and select New Module.
10. Select ETHERNET-MODULE Generic Ethernet Module from the list that appears and click on OK.

11. In the module properties that appear, enter the following parameters.

Name: **Your Choice** (must begin with a letter)
Comm Format: **Data-INT** (must be Data-INT)
IP Address: **192.168.000.XXX** where XXX is the number entered on the DIP switches

	Assembly Instance	Size
Input	100	10
Output	150	10
Configuration	110	0

12. Click on Next.
13. Select the RPI time, minimum = 3ms.
14. Click on Finish.
15. Save and download the program to the ControlLogix rack.
16. While online with the PLC, right click on the Ethernet Bridge module and select Properties.
17. Click on the Port Configuration tab and modify the following fields.

Enable Bootp: **Unselected** (This will allow the data to be manually entered in the IP address and Domain Name fields.)

IP Address: **192.168.000.XXX** (must be the same as step 7 above)
Subnet Mask: **255.255.255.0**

The Gateway Address, Domain Name, Primary DNS Server Address, and Secondary DNS Server Addresses all remain unchanged.

Note: If there is a problem with communications at power up, verify that the DNS field in the scanner module's Port Diagnostic field is not selected.

Revision History

SD31060IX_rev_0.0 was released on 10/19/06 and was the initial release of the specifications.

SD31060IX_rev_1.0 was released on 6/29/07. This revision added the standby input functionality and a breakout box outline dimension.

SD31060IX_rev_2.0 was released on 1/3/08. This revision corresponded to the V6 firmware change to the standby input functionality. Additional information was added to the specifications describing how the SD31060IESA will respond to various power up conditions.