Module Overview

The 7161 and 7162 modules are SSI interface modules that communicate with MicroLogix 1100, 1200, and 1400 rack systems. The 7161 is a one channel module that can be connected to one SSI sensor. The 7162 is a two channel module that can be connected to two independent SSI sensors. The 7161 module also has a latching input that can be used to capture the sensor's current data value.

Both the 7161 and 7162 modules use 8 input and 8 output registers to communicate with the PLC. The Position, Velocity, Actual SSI data, Latched Value, and Status information are reported to the Input Registers. All module setup parameters, including Preset Value, Count Direction, Velocity Response Time, Display Format, as well as the SSI-Logic parameters [Data Type (binary or gray code), Data Logic (positive or negative), Number of Clock Bits, Number of Data Bits, MSB Number, and Clock Frequency] are programmed through the Output registers assigned to the module.

A *Save In Flash* command bit allows the 7161 and 7162 modules to store their parameters in a non-volatile flash memory. This allows the modules to retain their setup parameters when power is removed so it will not be necessary to program the module at every power up. This flash memory is guaranteed for a minimum of 10,000 write cycles.

The 7161 and 7162 modules can be programmed an infinite number of times as long as the *Save In Flash* command bit remains reset. However, each time a programming cycle occurs with the *Save In Flash* bit set, will be counted against the 10,000 write cycle limit.

The 7161 module has an opto-coupler latching input that will capture the scaled sensor data on the rising, falling, or both transitions of the input. The input can be wired to be sinking or sourcing and will activate when it detects a voltage level between 15 and 24Vdc across the + and – latch terminals.

Sample programs showing how to program the 7161 and 7162 modules are available from the following page of our website.

http://www.amci.com/sampleprograms.asp

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.

WARNINGS tell you when people may be hurt or equipment may be damaged if the procedure is not followed properly.

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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 at 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.

Table of Contents

Chapter 1: Installing the 716X module

Disconnect power before attempting to install or remove the 716X module

1. Verify that your system's power supply has adequate reserve current capacity. The 716X module requires 150mA at +5Vdc.
2. The 716X module is not hot swap capable, power must be removed before removing or installing any module.
3. The 716X can be mounted on the following DIN Rails

   EN 05 022 – 35 X 7.5 (35 X 7.5 mm)
   EN 05 022 – 35 X 15 (35 X 15 mm)

4. Close the DIN rail latch on the module before mounting the module on the rail.
5. Press the DIN rail mounting area of the module against the rail. The latch will open as you install the module and will snap into place when the module is properly seated on the DIN rail.
6. The communication bus is carried between the modules through the ribbon cable attached to every module.
7. If necessary, remove the bus connector cover from the PLC and or from the module that the 716X will be connected to.
8. Use the pull loop on the connector to plug the ribbon cable from the 716X into either the module or the PLC directly to the left of 716X module.
9. Reinstall the bus connector cover.

10. It is very important to use the pull loop to disconnect modules. Pulling on the ribbon cable may damage the cable or the module.

Configuring a MicroLogix PLC for the 716X module

1. Open or create the RSLogix 500 project in which you want to use the 716X module.
2. Double click on I/O Configuration in the project tree.
3. Select the slot where the 716X module will be installed.
4. Double click on "Other.. Requires I/O Card Type ID" from the bottom of the list of available modules.
5. Enter the following information in the window that appears.

Vendor ID:	3
Product Type:	11
Product Code:	26 for the 7161 module 27 for the 7162 module
Series/Major Rev/Min Rev:	A
Input Words:	8
Output Words:	8
Input Bits:	0
Output Bits:	0
Extra Data Length:	0
Ignore Configuration Error:	*Your Choice, but not recommended*

6. The 716X module will now appear in the I/O Configuration with a Part Number of Other and a Description of I/O Module – ID Code = 26 or 27
7. Input Data (data from the 716X module to the PLC) will appear in Input Image Table registers I:X.0 to I:X.7, where X is the slot number.

   Output Data (data from the PLC to the 716X module) will be written to registers O:X.0 to O:X.7, where X is the slot number.

Chapter 2: Hardware Overview

Module Specifications

Current Draw
Backplane = 150mA @5Vdc typical
User Supply = 40mA @ 10 to 24Vdc (If using one supply to power both the module and the sensors, add this amount to the amount used by the sensor when sizing the power supply)

Throughput Time
7161: 500µs for clock frequencies of 125kHz and 250kHz
50µs for clock frequencies of 500kHz and 1MHz
7162 800µs

Environmental Conditions
Operating Temperature: 0 to 60° C
Relative Humidity: 5 to 95% (non-condensing)
Storage Temperature: -40 to 85° C

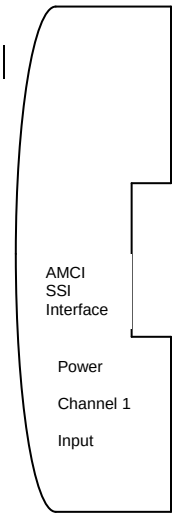
Latch Input (7161 only)
The 7161 module has an opto-coupler latching input that will capture the scaled sensor data on the rising, falling, or both transitions of the input. These inputs can be wired to be sinking or sourcing and will activate when they see a voltage level between 15 and 24Vdc across the + and – latch terminals.

Voltage Range: 0 to 24Vdc
On State: 15 to 24Vdc
Off State: 0 to 8Vdc
Current Draw: 10mA @ 24Vdc
Minimum On Time: 1µs
Noise filtering is not performed on the input

Compatible Sensors
Any sensor that outputs data in single word SSI format. This data format can either be binary or gray code. The number of bits transferred is programmable from 1 to 32. Multi-word transfers are not supported.

Front Panel & LED Function

7161 Front Panel and LED Function

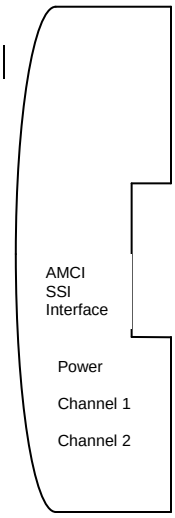


Power: Module receiving power and operating correctly

Channel 1 & Input LEDs

LED Pattern		7161
Channel 1	OFF	PLC in Program Mode
	ON	PLC in Run Mode, no motion occurring
	Blinking	PLC in Run Mode, motion occurring
Input	OFF	Latch Input Inactive
	ON	Latch Input Active
	Blinking	Not Applicable

7162 Front Panel and LED Function



Power: Module receiving power and operating correctly

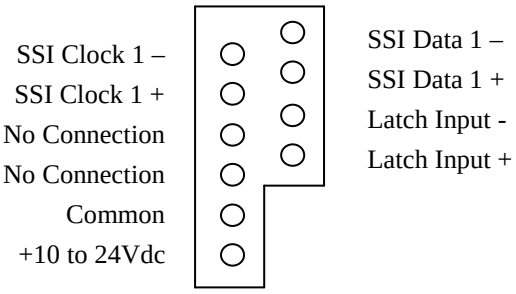
Channel 1 & Channel 2 LEDs

LED Pattern		7162
Channel 1	OFF	PLC in Program Mode
	ON	PLC in Run Mode, no motion occurring on channel 1
	Blinking	PLC in Run Mode, motion occurring on channel 1
Channel 2	OFF	PLC in Program Mode
	ON	PLC in Run Mode, no motion occurring on channel 2
	Blinking	PLC in Run Mode, motion occurring on channel 2

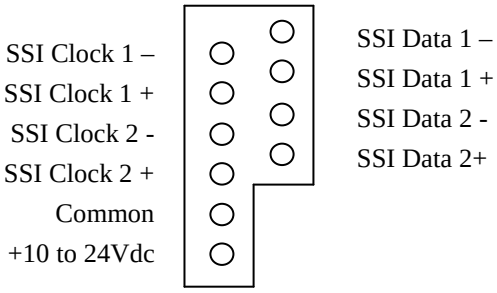
Connector Pinout

The input and sensor signals are brought into the 7161 and 7162 modules through a 10-pin connector.

7161 Connector Wiring



7162 Connector Wiring

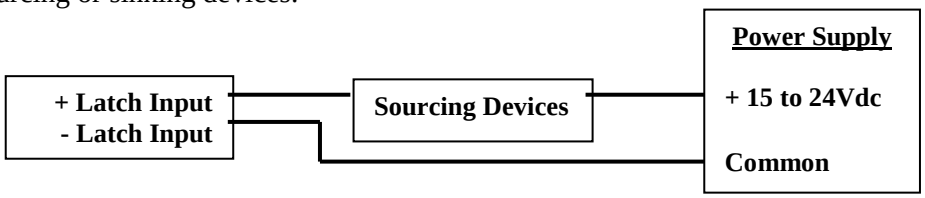


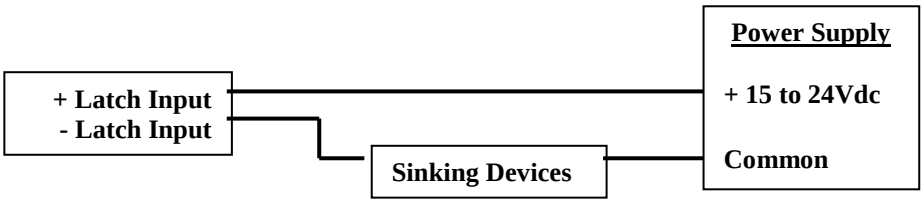
Wiring Notes

- Use the information provided by the sensor's manufacture to determine the type and maximum length of cable that should be used to connect the sensor to the 716X module.
- The +10 to 24Vdc supply is used by the module to power its isolation circuitry. If your sensor also operates on 10 to 24Vdc, the power and common conductors of the sensor's cable can also be wired to these terminals.
- SSI Clock 1, SSI Data 1 and Latched Input represent channel 1; SSI Clock 2 and SSI Data 2 represent channel 2.
- SSI Sensor signals are low voltage, low power signals. If you are using A-B guidelines for cabling installation, treat the SSI sensor cable as a Category 2 cable. It can be installed in conduit along with other low power cabling such as communication cables and low power ac/dc I/O lines. It cannot be installed in conduit with ac power lines or high power ac/dc I/O lines.
- Like all signal and communication cable, the SSI sensor cable should be shielded. These shields must be grounded only at one end of the cable. You can attach the cable shields either at the sensor end or to your earth ground bus in the controls cabinet.
- If a junction must be made in the signal cable, treat the shield as a signal-carrying conductor. Do not connect the shield to ground at any junction box.
- If the signal cable must cross power feed lines, it should do so at right angles.
- Route the cable at least five feet from high voltage enclosures, or sources of "rf" radiation.

Latch Input Wiring

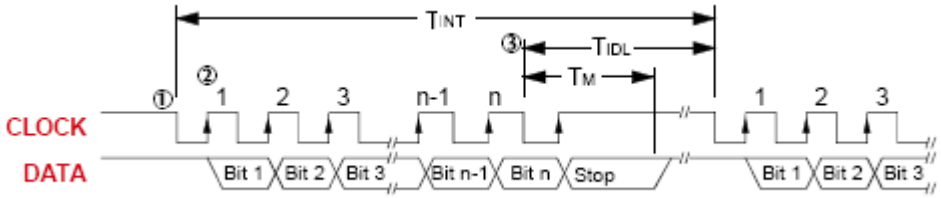
The following two diagrams show how to wire the 7161 module's opto-coupler latching input to either sourcing or sinking devices.





SSI Protocol

The following figure shows how a 716X reads data from a SSI Sensor. Note that the formal SSI definition allows for twenty-four bits of data and a twenty-fifth stop bit. However, AMCI is aware of some SSI Sensors that transmit more or less than twenty-five bits. To accommodate these SSI Sensors, the 716X can be programmed to accept up to thirty-two bits in the SSI bit stream.



"n" = Number of bits in the SSI data. Range of 1 to 32. Default of 24.

1. The first falling edge of the clock signal latches the SSI data. Note: Some SSI Sensors latch the data at the end of the previous interrogation.
2. The next "n" rising edges of the clock shift out the "n" data bits.
3. TIDL is the time between interrogations and is equal to the following.

7161: 500µs for clock frequencies of 125kHz and 250kHz
50µs for clock frequencies of 500kHz and 1MHz
7162 800µs

FLASH Memory

The 7161 and 7162 modules parameter values can be stored in a non-volatile FLASH memory. This memory type can store parameter values in the absence of power for over twenty years, but you can only write to it a limited number of times before it will be damaged. The FLASH Memory that AMCI uses is guaranteed for a minimum of 10,000 write cycles.

Chapter 3: Programmable Parameters

The 716X is configured by programming its Programmable Parameters. These parameters are broken down into three groups, Module Setup, SSI Setup, and Data Setup parameters.

Module Setup Parameters

Display Format: *Available only on the 7162 module*. The 7162 module transfers its data to eight Input Image Table words. However, the Data Value, Velocity Value, and Actual SSI value of both channels would exceed these eight words. The Display Format parameter solves this problem by allowing you to select which data is most appropriate for your application. It is possible to change the Display Format at any time. The available options for the display format are,

- Data Value and Velocity (default)
- Data Value and Actual SSI Value
- Velocity and Actual SSI Value

To ensure that the 7162 module's FLASH Memory is not depleted simply by changing what data is being displayed, the Display Parameter is typically not saved in the 7162 module's Flash memory. However, by setting the *Save in Flash Memory Bit*, (which is located in the *Control Word* along with the Display Format), it is possible to define what data the 7162 module will send to the PLC at power up

Latch Input: *Available only on the 7161 module*. The 7161 module has one Latch Input that allows you to capture and display the current Data Value whenever the input transitions. This parameter, which is composed of two bits, allows you to capture the input on the 0 to 1 transition, the 1 to 0 transition, or on both transitions.

A Latch Input Flag will indicate when a new Latch Value has been detected. A command sent from the PLC to the 7161 module will reset this flag while leaving the actual captured value in the input registers.

The latched input must be On for a minimum of 1µs to be read by the 7161 module.

The Latched Value is not saved through power down. Therefore, the Latched Value displayed in the 7161 module's input registers will be zero at power up.

Save In Flash: When this bit is set, the 716X module's current setup parameters will be stored in the module's FLASH memory. The module will not save its parameters through power down if this bit is not set at some point after the module has been programmed.

As long as this bit is reset, you can Apply the Preset, program the setup parameters, or change the Display Format (7162 module only) as many times as you want without affecting the Flash memory.

SSI Setup Parameters:

These parameters are used to extract the SSI Data Value from the bit stream. These parameters define the clock speed of the data transfer, the number of clock bits, the position and length of the SSI data within the bit stream, and the format of the data.

SSI Clock Frequency: This parameter allows you to set the SSI clock frequency to one of four values; 125kHz, 250kHz, 500kHz, or 1.0MHz. The default value of 125kHz value will work in all applications. Your sensor's user manual should contain information on what SSI Clock Frequency is appropriate for both the sensor and the type and length of cable used.

Number of SSI Data Bits: This parameter defines how many bits of the data stream make up the Data Value. This parameter has a range of 1 to 28.

Most Significant Bit (MSB) Number: This parameter defines the bit location of the first bit of the Data Value in the data bit stream. This parameter has a range of 1 to 32.

Number of SSI Clock Bits: This value sets the number of bits that the 716X will read from the SSI Sensor per interrogation. This parameter has a range of 1 to 32 and must be greater than or equal to *(Most Significant Bit Number + (Number of SSI Data Bits – 1))*. The default value of 24 bits will work in most applications.

Example: You have a 12 bit single turn SSI encoder that outputs 25 SSI Clock bits. The single turn value is located in the least significant bits of the SSI data.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0	0	0	0	0	0	0	0	0	0	0	0	0	X	X	X	X	X	X	X	X	X	X	X	X

MSB of SSI Clock Bits — MSB of Data Value — LSB of Data Value and Clock bits

In this example, the 716X module would be setup using the following data.

Number of SSI Clock Bits = 25
Most Significant Bit number = 14
Number of SSI Data Bits = 12

Data Type: This parameter tells the 716X module to interpret the SSI data either as a binary number or as a gray code number. The default value is binary.

You must read all of the data bits from a Gray Code sensor. The data value will appear to count up and down if you use the MSB Number and Number of Data Bit parameters to read only some of the data bits.

Data Logic: This parameter is included to handle situations where the SSI data is reported with negative logic. If this parameter is set, the 716X will invert the data bits before performing any scaling and decoding operations. When left in its default value of positive, the 716X module will use the SSI data as it is from the sensor.

Data Setup Parameters:

Once the 716X module has extracted the SSI data from the data stream, it uses the Data Setup Parameters to convert the raw SSI data into the Data Value it reports to the PLC.

Scalar Multiplier & Divisor: These two parameters are used to scale the SSI data. Both parameters have a default value of one and can range in value from 1 to 32,767. The Scalar Multiplier must be less than or equal to the Scalar Divisor. In other words, the ratio of Multiplier to Divisor CANNOT be greater than one.

Linear displacement transducers from Balluff and MTS have resolutions measured in µm/count. The 716X module can easily convert this data into the more familiar US Customary system of inches. The table below shows the Multiplier and Divisor values needed to convert from various metric resolutions to US Customary resolutions. For example, to convert data from a LDT sensor with 5µm/count resolution to 0.0005inch/count resolution, use a Multiplier of 50 and a Divisor of 127.

LDT Resolution	Desired Resolution						
	0.00005”	**0.0001”**	**0.0002”**	**0.0005”**	**0.001”**	**0.002”**	**0.005”**
1µm	100/127	50/127	25/127	10/127	5/127	5/254	1/127
2µm		100/127	50/127	20/127	10/127	5/127	2/127
5µm			125/127	50/127	25/127	25/254	5/127
10µm				100/127	50/127	25/127	10/127
20µm					100/127	50/127	20/127
40µm						100/127	40/127

Use the following procedure to calculate your Scalar Multiplier and Divisor values if either your LDT Resolution or Desired Resolution does not appear in the above table

Conversion Factor: $\frac{\text{Desired Resolution (counts/inch)}}{\text{LDT Resolution (counts/inch)}}$

Step 1: Convert your LDT resolution from µm to inches. For example, you are using a sensor with 1µm resolution in your application.

$$1\ \mu m * \frac{1\ mm}{1000\ \mu m} * \frac{1\ inch}{25.4\ mm} = 0.00003937\ inches/count = 25400\ counts/inch$$

Step 2: Determine the number of counts per inch for the desired resolution. For example, 0.0001”.

0.0001 inch/count = 10000 counts/inch

Step 3: Determine the Scalar Multiplier and Divisor values.

$$\frac{\text{Desired Resolution (counts/inch)}}{\text{LDT Resolution (counts/inch)}} = \frac{10000 \text{ counts/inch}}{25400 \text{ counts/inch}} = \frac{100}{254} = \frac{50}{127}$$

Therefore, to use a sensor with 1µm resolution and get 0.0001 inches per count resolution, use a Scalar Multiplier of 50 and a Scalar Divisor of 127.

Preset Value: The zero position of the SSI encoder's Data Value may not match the zero position of your machine. The Preset Value parameter gives you the ability to offset the Data Value from the actual SSI data to a value that will be more useful for your application.

Programming the Preset Value parameter does not change the Data Value. The Preset Value is stored in the 716X module's memory until the module sees a zero to one transition of the Apply Preset bit.

Apply Preset: Offsetting the Data Value to the Preset Value is a two step operation. First, the Preset Value must be saved in the module's memory. Second, setting the Apply Preset bit will change the Data Value to the Preset Value. It is possible both program the Preset Value and Apply the Preset in one programming cycle.

Setting the Apply Preset bit causes the module to generate an internal offset value that is applied to the Data Value before it is reported to the PLC. This internal offset can be saved in the 716X module's FLASH memory, so it will not necessary to home the module at every power up.

The 716X module's FLASH memory is guaranteed for 10,000 write cycles before writing to it will cause it to fault. Therefore continuously Applying the Preset and saving it in the Flash Memory should be avoided. If your application requires you to continuously Apply the Preset, do not set the Save In Flash Memory bit, or consider calculating and Applying the Preset in your PLC program.

Count Direction: This parameter is useful if your Data Value represents a linear position. It gives you the ability to reverse the direction of motion needed to increase the position count. For simplicity's sake, the two values for this parameter are called *Positive Direction* and *Negative Direction*. When this parameter is set to its default of *Positive*, the Data Value is not changed. When this parameter is set to Negative, the Data Value is multiplied by -1 before it is reported. For linear transducers, this has the effect of reversing the direction of motion needed to increase the count. When using LDT's and the Count Direction is set to *Positive*, the Data Value usually increases as the magnet moves away from the head of the LDT. When the Count Direction is set to *Negative*, the Data Value increases as the magnet moves towards the head of the LDT.

You will need to Apply the Preset after you program the Count Direction parameter.

If your Data Value represents a rotary position, you cannot change the count direction with this parameter. However, you can easily reverse the count direction with ladder logic shown in sample programs located on our website at http://www.amci.com/sampleprograms.asp

Velocity Update Time: The Velocity Update Time parameter sets the amount of time between Rate of Change information updates to the PLC. Its can be set to either 24 milliseconds or 160 milliseconds, with 160 milliseconds being the default. Decrease the time between updates for faster response to changes in this value. Increase the time between updates for better averaging of this value.

The Velocity data is measured in Counts/Second.

The Velocity Update Time parameter in no way affects how often data is read from the sensor.

Chapter 4: Backplane Programming

A 716X is programmed over the backplane through the input and output words assigned to it. Because these words are constantly updated, the unit implements a simple hand-shaking protocol to control when it accepts new programming data. This hand-shaking protocol is called a Programming Cycle.

Programming Cycle

A Programming cycle consists of six steps and is controlled by the *Transmit Bit* in the output data words and the *Acknowledge Bit* in the input data words.

1) Write the new programming data into the output data words with the Transmit Bit reset. This step insures that the correct data is in the output data words before the Programming Cycle begins.
2) Set the Transmit bit. A Programming Cycle is initiated when this bit makes a 0 to 1 transition.
3) Once the unit is done with the programming data, it will set any necessary error bits and the Acknowledge Bit in its input data words.
4) Once you see the Acknowledge Bit set, check for any errors. The error bits are only valid while the Acknowledge Bit is set.
5) Respond to any errors and reset the Transmit Bit.
6) The 716X responds by resetting the Acknowledge Bit. The Programming Cycle is complete.

FLASH Parameter Memory

Parameter values can be stored in a non-volatile Flash memory. This memory type can store parameter values in the absence of power for over twenty years, but you can only write to it a limited number of times before it will be damaged. The FLASH Memory that AMCI uses is guaranteed for a minimum of 10,000 write cycles.

Every time you have the *Save in Flash Memory* bit set during a programming cycle counts as one write cycle. If your application requires you to continuously Apply the Preset Value and save it in Flash Memory, consider offsetting the position in the PLC instead of the 716X.

The 716X sample programs show how to calculate and apply a preset value and are located at the following location on our website.

http://www.amci.com/sampleprograms.asp

7161 Output Registers:

The 716X module is configured through eight 16 bit words sent from the PLC to the module. In a MicroLogix system, these words will be defined as O:X.0 to O:X.7, where "X" indicates the slot number. The function of these words is shown below.

Output Word	Function	Range	Default
0	Control Word	See description below	
1	Number of SSI (Clock) Bits	1 to 32	24
2	Most Significant Bit Number	1 to 32	1
3	Number of SSI Data Bits	1 to 28	24
4	Scalar Multiplier	1 to Scalar Divisor	1
5	Scalar Divisor	1 to 32767	1
6	MSW Preset Value (set bit 15 for a Negative Preset Value)	0000h to 0FFFh (Upper 12 bits of preset value)	0
7	LSW Preset Value	0000h to FFFFh (Lower 16 bits of preset value)	0

Word 0: Control Word

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
Transmit	Save in FLASH	Clear Latch Value Flag	Apply Preset	Configure	0	0	Function of Latch Input		0	Velocity Update Time	Count Direction	Data Type	Data Logic	SSI Clock Frequency	

Bit 15: *Transmit Bit* (The module only acts on the data in the output registers on the 0 to 1 transition of this bit. The data in the Output Registers is ignored at all other times.)

Bit 14: *Save in FLASH* When this bit is set, the 7161 module's current setup parameters will be stored in the module's FLASH memory. The module will not save the most currently programmed parameters through power down if this bit is not set during a programming cycle.

Bit 13: *Clear Latch Value Flag*. When this bit is set during a programming cycle, the 7161 module will reset the latch input flag (input word 6, bit 14) to zero.

Bit 12: *Apply Preset*. Setting this bit during a programming cycle will cause the Data Value in the input registers to be offset to the Preset Value that is programmed in output words 6 and 7 and part of the configuration data.

Bit 11: *Configure*. Setting this bit during a programming cycle causes the module to begin using the configuration data contained in word 0 bits 0 to 8 and words 1 to 7. **NOTE, all of the parameters must be valid before any of the parameters will be accepted.** The programming error status bit, I:X.4/15, will be set to indicate that any of the parameters are outside of their valid ranges.

Bit 8 and 7: Function of Latch Input

Bit 8	Bit7	Function
0	0	Capture the Position on the Rising Edge(default)
0	1	Capture the Position on Both Edges
1	0	Capture the Position on the Falling Edge
1	1	Capture the Position on Both Edges

Bit 5: Velocity Update Time (0 = 160ms, 1 = 24ms)
Bit 4: Count Direction, (0 = Positive, 1 = Negative)
Bit 3: Data Type (0 = Binary, 1 = Gray Code)
Bit 2: Data Logic (0 = Positive, 1 = Negative)
Bits 1 & 0: SSI Clock Frequency (00=125kHz, 01=250kHz, 10=500kHz, 11=1MHz)

7162 Output Registers:

The 716X module is configured through eight 16 bit words sent from the PLC to the module. In a MicroLogix system, these words will be defined as O:X.0 to O:X.7, where "X" indicates the slot number. The function of these words is shown below.

Output Word	Function	Range	Default
0	Control Word	See description below	
1	Number of SSI (Clock) Bits	1 to 32	24
2	Most Significant Bit Number	1 to 32	1
3	Number of SSI Data Bits	1 to 28	24
4	Scalar Multiplier	1 to Scalar Divisor	1
5	Scalar Divisor	1 to 32767	1
6	MSW Preset Value (set bit 15 for a Negative Preset Value)	0000h to 0FFFh (Upper 12 bits of preset value)	0
7	LSW Preset Value	0000h to FFFFh (Lower 16 bits of preset value)	0

Word 0: Control Word

Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
Transmit	Save in FLASH	Apply Preset Ch 1	Apply Preset Ch 2	Configure Ch 1	Configure Ch 2	Display Format Channel 1		Display Format Channel 2		Velocity Update Time	Count Direction	Data Type	Data Logic	SSI Clock Frequency	

Bit 15: *Transmit Bit* (The module only acts on the data in the output registers on the 0 to 1 transition of this bit. The data in the Output Registers is ignored at all other times.)

Bit 14: *Save in FLASH* When this bit is set, the 7162 module's current setup parameters will be stored in the module's FLASH memory. The module will not save the most currently programmed parameters through power down if this bit is not set during a programming cycle.

Bit 13: *Apply Preset Channel 1*. Setting this bit during a programming cycle will cause the Channel 1 Data Value in the input registers to be offset to the Preset Value that is programmed in output words 6 and 7 as part of the channel 1 configuration data.

Bit 12: *Apply Preset Channel 2*. Setting this bit during a programming cycle will cause the Channel 2 Data Value in the input registers to be offset to the Preset Value that is programmed in output words 6 and 7 as part of the channel 2 configuration data.

Bit 11: *Configure Channel 1*. Setting this bit during a programming cycle causes the module apply the configuration data contained in word 0 bits 0 to 5 and words 1 to 7 to channel 1. **NOTE, all of the parameters must be valid before any of the parameters will be accepted.** The programming error status bit, I:X.4/15, will be set to indicate that any of the parameters are outside of their valid ranges.

Bit 10: *Configure Channel 2*. Setting this bit during a programming cycle causes the module apply the configuration data contained in word 0 bits 0 to 5 and words 1 to 7 to channel 2. **NOTE, all of the parameters must be valid before any of the parameters will be accepted.** The programming error status bit, I:X.4/15, will be set to indicate that any of the parameters are outside of their valid ranges.

Bits 9 and 8: Channel 1 Display Format

Bit 9	Bit8	Function
0	0	Data Value in words 0 & 1, and Velocity in Words 2 & 3 (default)
0	1	Data Value in words 0 & 1, and Actual SSI Value in Words 2 & 3
1	0	Velocity in words 0 & 1, and Actual SSI Value in Words 2 & 3
1	1	Data Value in words 0 & 1, and Velocity in Words 2 & 3

Bits 7 and 6: Channel 2 Display Format

Bit 7	Bit6	Function
0	0	Data Value in words 4 & 5, and Velocity in Words 6 & 7 (default)
0	1	Data Value in words 4 & 5, and Actual SSI Value in Words 6 & 7
1	0	Velocity in words 4 & 5, and Actual SSI Value in Words 6 & 7
1	1	Data Value in words 4 & 5, and Velocity in Words 6 & 7

Bit 5: Velocity Update Time (0 = 160ms, 1 = 24ms)
Bit 4: Count Direction, (0 = Positive, 1 = Negative)
Bit 3: Data Type (0 = Binary, 1 = Gray Code)
Bit 2: Data Logic (0 = Positive, 1 = Negative)
Bits 1 & 0: SSI Clock Frequency (00=125kHz, 01=250kHz, 10=500kHz, 11=1MHz)

Output Programming Notes

1. The 716X module only acts on the data in the output registers on the 0 to 1 transition of the Transmit Bit, output word 0 bit 15.
2. On 7161 modules, the data in word 0 bits 0 to 8 and words 1 to 7, the Channel Setup Parameters, is only read when Control Word bit 11 is set. The data contained in these bits and words is ignored at all other times.
3. On 7162 modules, the data in word 0 bits 0 to 5 and words 1 to 7, the Channel Setup Parameters, is only read when Control Word bit 10 or bit 11 is set. The data contained in these bits and words is ignored at all other times. Bit 10 applies the channel configuration data to channel 2 and bit 11 applied the channel configuration data to channel 1.
4. Setting bits 10 and 11 during one programming cycle will program both channels with the same setup data.
5. The Preset Value has a range of ±268,435,455 (28 bits) and is divided into two words. The lower word, the LSW, contains the lower 16 bits of the value and the upper word (the MSW, contains the upper 12 bits and the sign. For example:

   Desired Preset = 567,890
   LSW = -21934 (AA52h)
   MSW = 8 (8h)

   Desired Preset = -567,890
   LSW = -21934 (AA52h)
   MSW = -32760 (8008h)

The Internal Offset generated by an Apply Preset operation will be reset to zero when the channel's setup parameters are programmed.

6. It is possible to both program the module and change the Display Format with one programming cycle.
7. It is possible to program the 7161 module to capture the Data Value on both the Off to On and On transitions of the Latch Input.
8. It is possible to only change the Display Format by modifying the Display Format bits and setting the Transmit bit.

Sample Data

The following table shows sample setup data for the 7161 module.

Output Word	Value	Function
0	-14327 (C809h)	Bit 15 (Transmit Bit) set Bit 14 (Save Data in Flash Memory) set Bit 11 (Configure Channel 1) set Bits 8 & 7 = reset, latch input will act on the rising edge of the input Bit 3 set, Data Type = Gray Code Bit 1 reset, Bit 0 set = Clock Frequency = 250kHz
1	24	Number of SSI Clock bits = 24
2	5	Most Significant Bit = 5
3	20	Number of SSI Data bits = 20
4	1	Scalar Multiplier = 1
5	1	Scalar Divisor = 1
6	0	Preset Value = 0
7	0	

The following table shows sample setup data for channel 2 of a 7162 module.

Output Word	Value	Function
0	-15232 (C480h)	Bit 15 (Transmit Bit) set Bit 14 (Save Data in Flash Memory) set Bit 10 (Configure Channel 2) set Bits 7 set, bit 6 reset = channel 2 display format will be Data Value in words 4 and 5, and the Actual SSI Value in words 6 and 7 Bit 3 reset, Data Type = Binary Bit 1 reset, Bit 0 reset = Clock Frequency = 125kHz
1	24	Number of SSI Clock bits = 24
2	1	Most Significant Bit = 1
3	24	Number of SSI Data bits = 24
4	1	Scalar Multiplier = 1
5	1	Scalar Divisor = 1
6	0	Preset Value = 0
7	0	

Input Registers

The 716X module uses eight 16 bit words to report its data to the PLC. In a MicroLogix system, these words will be defined as I:X.0 to I:X.7. In both cases, the "X" indicates the slot number. The 7161 and 7162 modules have different word layouts. The functions of these words are shown below.

7161 Input Registers

16 bit Word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
0	Status Bits 1				MSW Data Value											
	Acknowledge	Ch 1 Velocity at Zero0	Ch 1Motion Direction	Sign Ch 1 Value 1												
1	LSW Data Value															
2	Status Bits 2				MSW Velocity (in counts / second)											
	0	Memory Error	0	0												
3	LSW Velocity (in counts / second)															
4	Status Bits 3				MSW Latched Value											
	Programming Error	Latch Flag	Latch Input Status	Sign Latch Position												
5	LSW Latched Value															
6	MSW Actual SSI Data															
7	LSW Actual SSI Data															

Status Bits 1 in Word 0

Bit 12: *Channel 1, Value 1 Sign.* Set when Channel 1 Data Value 1 is negative.

Bit 13: *Channel 1 Motion Direction.* Set when the Channel 1 Data Value is decreasing. The bit remains in the last state when there is no motion.

Bit 14: *Channel 1 Velocity at Zero.* Set when there has been no motion for a period of time equal to the Velocity Update Time.

Bit 15: *Acknowledge Bit.* Set when the *Transmit Bit* in the *Control Word* is set. Reset when the *Transmit Bit* is reset.

Status Bits 2 in Word 2

Bit 14: *Memory Error*. Set when the flash memory contains corrupt data. If this bit is set, the 7161 module must be returned to AMCI for repair.

Status Bits 3 in Word 4

Bit 12: Latch *Value Sign.* Set when the Latch Value is negative.

Bit 13: *Latch Input Status*. Set when the latching input is active.

Bit 14: *Latch Input Flag*. Set when there is a new Latch Value in the input registers 4 and 5. This Latch Input Flag can be reset by setting bit 13, the Clear Latch Value Flag bit, in the Control Word during a programming cycle.

Bit 15: *Programming Error*. Set when invalid data has been transferred to the *Output Registers*. Programming errors are cleared by programming the module with valid data

A Programming Error will be set under the following conditions.

- If any of the unused bits in the Control Word are set.
- If any of the parameters are outside of their valid ranges. A list of valid ranges is shown below.

  - If the Most Significant Bit outside of the range of 1 to 32.
  - If the Number of SSI Data bits outside of the range of 1 to 28.
  - If the Number of SSI Clock bits outside of the range of 1 to 32
  - If the Number of SSI Clock bits is less than *(Most Significant Bit Number + (Number of SSI Data Bits – 1))*.
  - If the Scalar Multiplier is outside of the range of (1 to Scalar Divisor).
  - If the Scalar Divisor is outside of the range of 1 to 32767.
  - If the Most Significant Word of the Preset Value is greater than 4095 (FFFh). Bit 15 in this word can be set to indicate a negative Preset Value.

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7162 Input Registers

16 bit Word	Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 09	Bit 08	Bit 07	Bit 06	Bit 05	Bit 04	Bit 03	Bit 02	Bit 01	Bit 00
0	Status Bits 1				MSW Channel 1Value 1											
	Acknowledge	Ch 1 Velocity at Zero0	Ch 1Motion Direction	Sign	Ch 1 Value 1											
1	LSW Channel 1 Value 1															
2	Status Bits 2				MSW Channel 1 Value 2											
	0	Memory Error	0	0												
3	LSW Channel 1 Value 2															
4	Status Bits 3															
	Programming Error	Ch 2 Velocity at Zero0	Ch 2Motion Direction	Sign	Ch 2 Value 1	MSW Channel 2Value 1										
5	LSW Channel 2 Value 1															
6	0	0	0	0	MSW Channel 2Value 2											
7	LSW Channel 2 Value 2															

Channel 1, Value 1: words 0 (MSW) and 1 (LSW)

Depending on the *Channel 1 DISPLAY FORMAT*, these values reflect the Data Value or the Velocity Value. They are limited to 268,435,455 (28 bits).

Channel 1, Value 2: words 2 (MSW) and 3 (LSW)

Depending on the *Channel 1 DISPLAY FORMAT*, these values reflect the Velocity or the Actual SSI Data for the channel. The values are limited to 268,435,455 (28 bits).

Channel 2, Value 1: words 4 (MSW) and 5 (LSW)

Depending on the *Channel 2 DISPLAY FORMAT*, these values reflect the Data Value or the Velocity Value. They are limited to 268,435,455 (28 bits).

Channel 2, Value 2: words 6 (MSW) and 7 (LSW)

Depending on the *Channel 2 DISPLAY FORMAT*, these values reflect the Velocity or the Actual SSI Data for the channel. The values are limited to 268,435,455 (28 bits).

Status Bits 1 in Word 0

Bit 12: *Channel 1, Value 1 Sign.* Set when Channel 1 Data Value 1 is negative.

Bit 13: *Channel 1 Motion Direction.* Set when the Channel 1 Data Value is decreasing. The bit remains in the last state when there is no motion.

Bit 14: *Channel 1 Velocity at Zero.* Set when there has been no motion for a period of time equal to the Velocity Update Time.

Bit 15: *Acknowledge Bit.* Set when the *Transmit Bit* in the *Control Word* is set. Reset when the *Transmit Bit* is reset.

Status Bits 2 in Word 2

Bit 14: *Memory Error*. Set when the flash memory contains corrupt data. If this bit is set, the 7162 module must be returned to AMCI for repair.

Status Bits 3 in Word 4

Bit 12: *Channel 2, Value 1 Sign.* Set when Channel 2 Value 1 is negative.

Bit 13: *Channel 2 Motion Direction.* Set when the Channel 2 Data Value is decreasing. The bit remains in the last state when there is no motion.

Bit 14: *Channel 2 Velocity at Zero.* Set when there has been no motion for the last portion of the Velocity Update Time.

Bit 15: *Programming Error*. Set when invalid data for either channel has been transferred to the *Output Registers.* Programming errors can be cleared by programming the module with valid data

A Programming Error will be set under the following conditions.

- If any of the unused bits in the Control Word are set.
- If any of the parameters are outside of their valid ranges. A list of valid ranges is shown below.
  - If the Most Significant Bit outside of the range of 1 to 32.
  - If the Number of SSI Data bits outside of the range of 1 to 28.
  - If the Number of SSI Clock bits outside of the range of 1 to 32
  - If the Number of SSI Clock bits is less than *(Most Significant Bit Number + (Number of SSI Data Bits – 1))*.
  - If the Scalar Multiplier is outside of the range of (1 to Scalar Divisor).
  - If the Scalar Divisor is outside of the range of 1 to 32767.
  - If the Most Significant Word of the Preset Value is greater than 4095 (FFFh). Bit 15 in this word can be set to indicate a negative Preset Value.

Input Data Notes (7161 and 7162)

1. If the Display Format has been programmed for velocity, than the Sign Status bit will used to indicate when the Velocity data has exceeded 268,435,455 (28 bits).
2. The velocity data is measured in units of Counts/Second.
3. Because the PLC uses bit 15 for the sign bit, it is possible that the Least Significant words of the transferred data will be shown as negative, even though the value itself is positive.
4. The Actual SSI Data is the unmodified data as it is received directly from the sensor. That is, before any offset, scalars, or data conversion operations are performed. This data is reported to allow you to detect any error or status bits that your sensor may place in the data stream.

   Additionally, the Actual SSI Data can be used to detect if your sensor or power supply are not functioning. If either are not working, this register will show a value that is equal to having all of the clock bits set. For example, if you have programmed the unit for 24 clock bits, the actual SSI Data will show a value equal to 16777215 (16#00FF FFFF).

5. The Memory Error status bit in Status Bits 2 will not be available if channel 1 of the 7162 module is programmed for 30 or more SSI Clock bits and the Actual SSI Data is selected to be displayed in input words 2 and 3.

Chapter 5: Specification Revision History

Revision 0.0 was created on 12/22/09 and was the initial release of the specifications.