FUSION

SYSTEM
OPERATION MANUAL

THIRD EDITION DECEMBER 2014

FEC
AUTOMATION SYSTEMS
Certified ISO 9001:2008
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WARNING

All applicable national and local codes must be followed when installing and operating the equipment detailed in this manual.

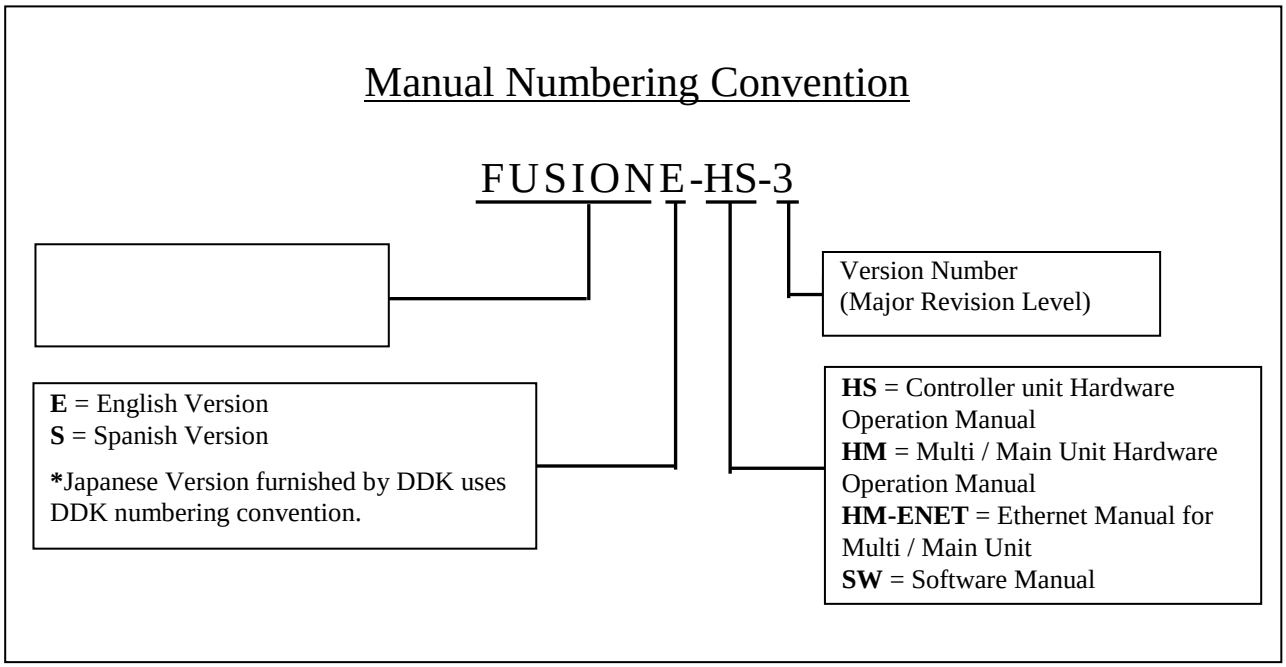
FAILURE TO ABIDE BY THESE CODES AND THE SPECIFICATIONS DESCRIBED IN THIS MANUAL CAN RESULT IN SERIOUS INJURY TO PERSONNEL AND/OR DAMAGE TO THE EQUIPMENT!

Any questions regarding the contents of this document or any related matter should be directed to FEC INC. at (586) 580-2622, faxed to (586) 580-2620 or emailed to: support@fec-usa.com.

Please contact FEC INC. if you require additional copies.

Revision History

Revision date	Manual No.	Content of Revision
2005/July	First Edition	Original Operation Manual
2007/August	FUSIONE-HS-2	Revision 2 - Updated format & added relevant information
2008 / June	FUSIONE-HS-2	MINOR Revision – Chapter 2 – Page 2-4 (Chapter Rev. 2.1 now) Updated Power Consumption (Running & Idle)
2008 / July	FUSIONE-HS-2	MINOR Revision – Chapter 4 – Page 4-48 – 4-53 (Chapter Rev.2.1 now) Added DeviceNet Interface
2014 / Dec	FUSIONE-HS-3	MAJOR Revision – Updated with all changes since 2008
2015 / Oct	FUSIONE-HS-3	Minor Rev. – Chap. 7 rev 3a -Updated Tubenut Op. Parameters (pg7-39 – 7-40)



Introduction

Thank you for purchasing our **Electric Servo Nutrunner – FUSION System**.
This instruction manual describes the procedures for installation, wiring, and handling, and actions to be taken in case of any failure.

- ◆ This instruction manual shall be delivered to the end user who operates the equipment.
- ◆ Read all instructions before use, and always keep this instruction manual with the equipment.
- ◆ Items not described in this instruction manual shall be considered “unavailable”.
- ◆ The product specification and appearance described in this instruction manual is subject to change without notice.
- ◆ All rights reserved. Any disclosure, copying, distribution, or use of the information contained herein for other than its intended purpose, is strictly prohibited.

For the safety of operator and equipment

- ◆ It is important for you to read all “Safety Precautions” before using the equipment, and understand and observe all instructions and recommendations included in this manual.
- ◆ Read all instructions and recommendations included in this manual, understand the functions and performance of this nutrunner, and correctly use this equipment.
- ◆ Wirings and parameter settings shall only be conducted by a qualified professional.
- ◆ Never conduct a withstand voltage test or insulation resistance test on this equipment.

- ◆ Indicate the following on all instruction manuals that use this equipment.
  ”This equipment is capable of high voltages hazardous to human life.”

Points to check when unpacking

Please confirm the followings when unpacking this equipment.

- ◆ Ensure that you received the correct model, as ordered.
- ◆ Ensure that there are no missing parts.
- ◆Check for any damage caused during transportation.

Warranty

Warranty Period

The standard warranty period is one year from the date of purchase or one year from delivery to the designated End User (not to exceed 18 Months). Actual terms are order specific.

Provision of warranty

If your product proves to be defective, although it has been used properly in accordance with this instruction manual, during the period of warranty, this product will be repaired free of charge.

However, in the following cases, the customer will be required to pay for repair charges, even for defects occurring within the warranty period.

1. Any defect due to improper conditions, improper circumstances, and improper handling.
2. Any defect due to modifications or repairs performed by the customer.
3. Any defect caused by other equipment.
4. Any defect caused by customer failing to meet the equipment's specification.
5. Any defect due to natural disasters and accidents.

This warranty shall be limited to repairing or replacing this product. Any liability for indirect or consequential loss or damage of any kind incurred or suffered by the customer due to a defect of the product is excluded.

Safety Precautions

Read all instructions before operating the equipment in order to use this equipment safely and correctly. Prior to use, read this instruction manual carefully and fully understand the equipments functions, safety precautions and instructions. Safety precautions in this manual are marked with two symbols [Warning] and [Caution].

To prevent danger to the user and other persons as well as property damage, instructions that must be fully observed are marked with the symbols below.

- This instruction manual uses the following two symbols according to the degree of damage that may be caused when the instruction is not observed.

This symbol indicates that failure to observe instruction marked with this symbol may result in severe personal injury or death.

This symbol indicates that failure to observe instruction marked with this symbol may result in minor personal injury or material damage.

Even instructions that are marked with 

may result in severe damage if they are not observed according to conditions.

Contents marked with the above symbols are very important instructions. For your safety, follow all instructions and especially those marked with these symbols.

- This instruction manual uses the following additional symbols for instructions that shall be observed.

Warning: Electric shock

Warning: Fire

Caution: Fire

Caution: Electric shock

Caution: High Temperature

Prohibited

Do not disassemble

Required

Ground

Safety Precautions

Warning

Do not remove the motors and gear cases of tools while power is applied..
The tool output spindle may rotate and cause injury.

Do not repair, disassemble, or modify the equipment individual components of the system..
Failure to observe this instruction may cause injury, electric shock, fire, and malfunction.

Never operate the equipment where it is exposed to water, near a corrosive atmosphere or flammable gases. Failure to observe this instruction may cause fire.

Keep fingers away from the connectors while the equipment is turned ON and for a while after the equipment is turned OFF. Failure to observe this instruction may cause electric shock.

Wiring, operation and maintenance work shall be conducted by a qualified professional.
Failure to observe this instruction may cause electric shock and injury.

Turn OFF the power when conducting wiring operation and maintenance.
Failure to observe this instruction may cause electric shock and injury.

Never damage the cables, apply excess stress to cables, or squeeze the cables.
Never use damaged cables.
Failure to observe this instruction may cause electric shock and fire.

Properly GROUND all Field Ground (FG) Connections and terminals including the ground pin on the POWER CORD. **NEVER** operate this equipment without the ground pin on the power cord grounded!
Failure to observe this instruction may cause electric shock.

In case of an abnormal odor, noise, or operation error occurrence, stop operation immediately and turn OFF the power source. Failure to observe this instruction may cause injury and fire.

Install a Power shutdown device in order to ensure the safety of equipment.
Failure to observe this instruction may cause injury.

When equipment is automatically operated, install an emergency stop circuit on the outside of equipment in order to stop operation promptly. Failure to observe this, may cause injury.

Keep away from the equipment during recovery from a temporary blackout, and ensure safety measures are conducted after restarting the equipment. The equipment may suddenly restart.
Failure to observe this instruction may cause injury.

Safety Precautions

Transportation / Storage

Caution

Transport the equipment properly according to its weight.
Failure to observe this instruction may cause injury and malfunction.

The conditions when transporting the equipment by ship is as below.
- ◆Ambient temperature: -5°C～+55°C (Avoid freezing)
- ◆Ambient humidity: 50% RH or lower (Avoid moisture)
- ◆Package: Tight seal
- ◆Rust prevention measure: Apply light oil on steel portion of tools.

Failure to observe this instruction may cause earth leakage and malfunction.

Do not transport tools by grasping cables.
Failure to observe this instruction may cause injury and malfunction.

.The equipment shall be stored under the following conditions.
- ◆Ambient temperature: -5°C～+55°C (Avoid freezing)
- ◆Ambient humidity: 90% RH or lower (Avoid moisture)
- ◆Atmosphere: Indoors (Avoid direct sunlight)
  No corrosive gases or flammable gases
  No oil mist, dust, water, salt, iron powder
- ◆Avoid direct vibration or shocks

Failure to observe this instruction may cause a ground fault and malfunction.

Safety Precautions

Installation / Wiring

Caution

Install or provide torque reaction for all tools where they can bear the maximum torque during operation. Failure to observe this instruction may cause injury and malfunction.

Make sure controller is firmly mounted and will not come lose or fall during operation.
Failure to observe this instruction may cause malfunction.

The power source shall be provided with safety measures such as breakers and circuit protectors. Failure to observe this instruction may cause fire and malfunction.

Do not use tools or controller units that are damaged or missing parts.
Failure to observe this instruction may cause fire, injury, and malfunction.

Do not subject the equipment to excess shock and impact.
Failure to observe this instruction may cause malfunction.

Route all wiring(s) properly and firmly.
Failure to observe this instruction may cause injury, false operation, and malfunction.

Operate the equipment within the specified power supply voltage.
Failure to observe this instruction may cause injury, electric shock, fire, and malfunction.

When operating the equipment in the following conditions, take sufficient measures to shield the equipment.

- ◆Location where electrical noise is generated
- ◆Location where the equipment is subjected to a strong electric field or magnetic field
- ◆Location near a high power wire.

Failure to observe this instruction may cause injury, false operation, and malfunction.

Safety Precautions

Operation / Adjustment — Caution

Never operate the equipment with wet hands or while standing in a wet location.
Failure to observe this instruction may cause electric shock.

Properly GROUND all Field Ground (FG) Connections and terminals including the ground pin on the POWER CORD. **NEVER** operate this equipment **WITHOUT** the ground pin on the power cord grounded!
Failure to observe this instruction may cause electric shock.

Use the equipment under the following conditions.

- ◆Ambient temperature: 0°C～+45°C (Avoid freezing)
- ◆Ambient humidity: 90% RH or lower (Avoid moisture)
- ◆Atmosphere: Indoors (Avoid direct sunlight)
- ◆No corrosive gases or flammable gases
- ◆No oil mist, dust, water, salt, iron powder
- ◆Avoid direct vibration or shocks

Failure to observe this instruction may cause a ground fault and malfunction.

Confirm and adjust all parameters before operation in order to prevent unexpected movement of the equipment.
Failure to observe this instruction may cause injury, false operation and malfunction.

The equipment may experience sudden torque reaction when operated by hand while engaged to a part. Grasp tool firmly with firm footing when operating. Additionally, be sure the work piece is securely clamped from any movement during torqueing operations.
Failure to observe this instruction may cause injury.

Do not turn ON and OFF the equipment repeatedly.
Failure to observe this instruction may cause malfunction.

Do not use the equipment at torque higher than the maximum torque.
Failure to observe this instruction may shorten equipment life or cause malfunction due to the high temperature caused by overload.

In case any abnormality occurs, remove the cause and ensure safety before resetting and restarting the equipment.
Failure to observe this instruction may cause injury.

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Chapter 1: Outline

1.1 About This operations manual

This manual details the configuration, components, specifications, and the operation of the FUSION Fastening System.

The following table outlines the contents of each chapter:

Chapter	Item	Contents
Chapter 1	Outline	Basic characteristics and requirements of the FUSION System.
Chapter 2	Specifications	General specifications of the FUSION System.
Chapter 3	System Description	Description of standard and optional system components.
Chapter 4	System Setup and Wiring	Equipment installation procedure, dimensions, Input and Output signal descriptions and requirements for PLC programming.
Chapter 5	Power Up and Initial Checks	Preliminary power on and operational tests.
Chapter 6	Fastening Instructions	Basic fastening operations and presetting procedures.
Chapter 7	System Operations	Instructions for the input of preset data and monitoring explanations.
Chapter 8	Maintenance and Inspection	Guide for preventive maintenance.
Chapter 9	Troubleshooting	Descriptions of fastening rejects, abnormal operation faults, and corrective actions.

1.2 Features

The FUSION Fastening System is a culmination of over twenty years of electric fastening expertise integrated with the latest electronic technology. The system is designed with modular construction in mind. The basic elements of this system are:

1) A brushless DC permanent magnet high speed motor, with resolver feedback
2) A combination Fastening Controller / Servo Amplifier
3) 32-bit RISC (Reduced Instruction Set Computing) CPU for spindle control
4) Fully digital controlled drive amplifier
5) Configurable communications interfaces

- **Compact Design**

  The controller can be set on a tabletop/shelf or back panel mounted using the mounting holes on the controller back cover. The controller maintains a maximum width of 160mm in spite of the built-in power source, controller interface and servo amplifier. Controllers operate on single-phase 100 ~ 230 VAC (Auto switching) for simplified connection to standard plant floor receptacles.

- **Front Keypad-Display.**

  A front keypad display is an integral component for programming single units and/or monitoring the fastening results and status conditions in the system. Large alphanumeric LED displays and status lights provide excellent visibility in plant operations.

- **Fastening Functions.**

  Fastening can be performed in either the Torque Control or the Angle Control method. Angle (rotational) and torque rate monitoring provide additional error proofing functions.

- **Parameter Selection**
  - Totally digitized system eliminates analog potentiometers.
  - Up to 32 sets of parameters can be stored into Flash ROM.
  - No battery-backup of memory is required.

- **"No Cost" AFC User Console Programming Software**

  Nutrunner programming and data collection can be performed via the user-friendly AFC software provided at no cost with every system. Functions such as Preset Parameter programming, fastening data monitoring and fastening data analysis can be performed. The software is primarily utilized on single spindle application in a detachable mode via a laptop computer with RS232 communications.

- **Communication and I/O Interface**

  (1) Programming and Display – Front Panel -Input/Output – Manual interface.
  (1) RS232 – Front Panel - Input/output – Programming and Data collection
  (2) RS232 – Rear Panel – Output – Printer or data collection device.
  (1) T/A MON – Front Panel – Output – Analog Torque and Angle analysis.
  (1) Discrete I/O Terminal – Rear panel - Control and PLC interface
  (1) Optional Ethernet – Programming & Data collection (Removes Front RS232 if installed)
  (1) Optional Fieldbus I/O interfaces – Input/Output – Control and PLC interface

- **Motor**

  A permanent magnet High Speed DC motor provides for improved fastening control. The sealed design of the motor provides greater protection from contamination without generating excess heat. The resolver is uniquely designed to withstand harsh environments and provide high resolution control / angular feedback signals.

- **Preamplifier**

  Quality control of the tool torque transducer is accomplished electronically (digitally) through the EEPROM (Electrically Erasable Programmable Read Only Memory) in the preamplifier. During factory setup of the torque transducer, the unit is Dead Weight and Dynamically tested against Standards that are certified and traceable to the National Institute of Standards and Technology. The resultant data is then programmed into the preamplifier where it is stored on non-volatile EEPROM. The preamplifier also contains the "Smart Tool ID" system which allows automatic tool recognition and protects against misapplication of tools onto the wrong controller or set-up.

- **Servo Amplifier (Servo Drive)**

  Reduced equipment size with improved drive circuit strength is the result of incorporating Isolated Gate Bipolar Transistor (IGBT) technology into the drive System.

- **Plug-In Firmware Update System**

  The CONTROLLER Firmware is stored in Flash ROM and can be rewritten with future Firmware updates via a plug-in connector located on each unit. There is no need to remove the unit or disassemble the unit for any Firmware upgrades.

- **Motor, Resolver and Transducer Combined Cable**

  A single high flex cable incorporates durable metal connectors to provide for extended life in harsh environments. Twist lock connectors provide easy separation of connection points for maintenance, while maintaining superior contact under operating conditions. Separate tool and extension cables (Straight and 90 Degree) are available for improved cable management.

- **ToolsNet / Network Connectivity**

  Optional Ethernet connectivity (10/100BaseT) available for export of fastening data or connection to existing Atlas Copco ToolsNet network via the Open Protocol for ToolsNet.

- **Fastening Results Data Storage**

  Fastening Data results are stored in internal FLASH memory of each controller. (Approx. 10,000 data cycles) and can be uploaded using the AFC Programming/Monitor Software.
  Past Torque Curves are stored in RAM memory and can be uploaded as long as power has not been turned off to the controller. Once power is turned off, previous Torque curves stored are erased. Torque curves are automatically stored after each cycle when power remains "On".

1.3 Functions.

- **Fastening function.**

  The following fastening control methods can be selected for either clockwise (CW) or counterclockwise (CCW) operation:

  - Torque Control / Angle Monitoring
  - Angle Control / Torque Monitoring

  The Controller unit has capability for one, two & three step fastening.
  Torque rate monitoring in up to 3 areas is available in any configuration.

- **Multi-Speed Rundown**

  The Initial, Freerun, Slowdown, Torque and Reverse speed set-ups provide capability of multi-speed fastenings for any application.

- **Reject / Abnormal Condition Display**

  When a fastening Reject has occurred the system stops, outputs the appropriate signal and displays the resultant data in the Keypad-Display. Upon a fastening reject, the unit will not require resetting prior to the next cycle.

  The System will output an abnormal signal when it detects there is a problem (Zero Check out of limits, incorrect component connection, etc.) within the system itself. The output will be displayed as a code on the Front Panel Display. Refer to Chapter 9 Troubleshooting for more details. Reset of the system is required on an abnormal before normal operation can resume.

- **Axis Bypass Function**

  When a PLC Bypass input signal is activated, the Bypass output signal is activated. In this condition, the spindle will not START, REVERSE, CAL OR RESET.

- **Auto Tool Recognition (Smart Tool ID)**

  The FUSION tools have an EEPROM in the preamplifier that contains tool data specific for each tool. The Tool type check function reads the information of the tool EEPROM and compares it to the information of the CONTROLLER unit; any mismatch is reported as a Tool Type Error Abnormal.

  The tool type check is performed during the following times:

  1) When the equipment is powered on.
  2) When preset data is downloaded from a user console to the Axis unit.

- **Torque Recovery**

  The ability to “hold” torque after fastening allows the system to overcome problems associated with joint relaxation or “slip stick” friction. After peak torque has been reach, this function allows the tool to “hold” torque for a pre-programmed number of pulses.

- **Batch Counting**

  The Batch Count function allows multiple fastening accepts to be counted for an overall “Work Accept” of the work piece.

- **Parameter Sequence**

  Up to an 8 Step Sequence can be programmed when additional sequencing or parameters are required by applications or processes

1.4 System requirements

To ensure the most effective and extended use of all equipment, adhere to the following specifications:

- **Tool Installation**

  Tools can generate a large amount of torque during operation, and the reaction force is applied to the Operator or mounting area of the tool. Therefore, tools must be installed in the proper positions and with adequate reaction devices. Tools MUST be mounted either using there supplied mounting plate or clamped only in designated areas of the tool or tool damage may result.

  Keep in mind that the fastening tool is a strain gage based instrument and, although it has been designed to withstand sudden shock, repeated shock (over time) could damage some components. Therefore, support devices must be used whenever practical to ease in handling and operation of the Fastening Tool.

- **Fastening Operation**

  Avoid fastening beyond the full scale torque. Do not use a duty cycle (the ratio of the tool "On" time to Tool "Off" time) higher than 50%, even when the torque is below the full scale value.

- **Cable Wiring**
  - Use the specified cables for all System connections.
  - Completely lock the tool cable twist lock connectors.
  - PLC I/O cables must be run separate from any high voltage power sources or cabling, and must not exceed 50 feet in length.
  - GROUNDING of the controller is REQUIRED (Perform Class 3 grounding) – Make sure the controllers power cable ground pin is connected to a proper ground.

- **Control Equipment Installation Environment**
  - Controller units must be located a minimum of 600 mm from high transient voltage sources such as transformers, motor starters, AC inverters and AC contactors. If it cannot be avoided, the units must be properly shielded.

  DO NOT use at the following locations.

  - Areas under direct sunlight.
  - Areas where the environmental temperature is out of the 32 °~122°F (0° ~ 45°C) range.
  - Areas where the relative humidity is below the 20% range.
  - Areas where the relative humidity is above the 90% range.
  - Areas where the temperature changes quickly, which may cause moisture.
  - Areas where conductive powder, oil mist, saline, or organic solvents exist.
  - Areas that have corrosive or combustible gases.
  - Areas that have strong electric or magnetic fields.
  - Areas where a strong vibration or shock could be transmitted directly to a Controller unit or tool.

- **Static Electricity**

  FUSION System construction incorporates electronic Surface Mounted Devices (SMD). It is advisable to strictly adhere to practices for safe electrostatic discharge in order to prevent damage to the System when handling the units.

- **Cleaning**

  Do not use any organic solvents, such as thinner, to clean a Controller unit or a tool. The solvent could melt the surface paint, or penetrate inside and cause damage. A cloth dampened with alcohol or warm water should be used to lightly wipe the components.

- **Handling and Shipping**

  It is critical that FUSION System components are properly handled and shipped in order to maintain the System's integrity. Adhere to the following requirements for shipping and handling:

  - Loose FUSION System components must be individually packaged in an approved anti-static container or wrap to prevent damage from electrostatic discharge.
  - Adhere to Chapter 2 Specifications for environmental requirements.

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Chapter 2: Specifications

2.1 Main Specifications

Power Supply Voltage

- Single Phase 100 ~ 240 VAC +/- 10% , 50/60 Hz Auto-Switching
  (Supplied with 100-120VAC Cable 5meter)

Installation Requirement

- No Vibration should be applied directly to the Controller. Securely mount controllers to a fixed point.

Range of Operation

- Duty cycle below 50% (reference Section 2.2 Duty Cycle Calculation)

Operating Conditions

- Temperature: 0° ~ 50°C (32° ~ 122°F)
- Humidity: 20% ~ 90%, no condensation shall be present
  (In cases where equipment may be used outside of the prescribed conditions, forced cooling / heating is required for operation)

Storage Conditions

- Temperature: -5° ~ 55°C (23° ~ 131°F) (no freezing)
- Humidity: Below 90%, no moisture

Shipping Conditions

- Temperature: -5° ~ 55°C (23° ~ 131°F) (no freezing)
- Humidity: Below 90%, no condensation shall be present
- Packing: Pack controllers in sealed (from open air) bags.
  Apply light oil to any steel portion of the tool unit to prevent rust/corrosion

2.2 Duty Cycle Calculation

Duty Cycle is rated as a percentage of the time the motor is running to the time the motor is idle. This is an important factor in determining overload protection for Servo Amplifiers and motors as it directly relates to the amount of power or heat dissipation of the motor / servo package. The rated duty cycle for the FUSION System is calculated as follows:

$$\frac{\text{Tool Rotation Time}}{\text{Total Cycle Time (Tool Rotation + Tool Idle)}} \times 100 = \text{Duty Cycle Percentage (\%)}$$

Example: Tool Rotation Time = 3 Seconds / Total Cycle Time = 12 Seconds x 100 = 25% Duty Cycle Percentage

Duty cycle ratings vary between tools. As a general rule, however, it should not exceed 50%. IF duty cycles remain above 60% for extended periods, a Servo Amplifier Error / Overload will result (See abnormal CODE 8 -10). Protection for high duty cycle is a standard feature of the Servo Amplifier to prevent servo or motor damage.

2.3 Controller Unit Specifications

Controller Model	HFC-EC-16 (Silver Unit) HFC-EC-16C (Gold Unit)
Motor Model	RM80, RM50
Controller Supply Voltage	Single Phase 100~ 240 VAC 50/60/Hz
Power Consumption (Running)	Approx. 100 watts/hour @ 99% Capacity / 50% Duty
Power Consumption (Idle)	Approx. 37 watts/hour
Inrush Current @ Power on	11A
Current During Fastening	1.3A (80% Torque, Hard Joint (<30deg rotation))

If the equipment is powered on and off repeatedly, internal circuit protection devices may trip due to high in-rush current overload, and the Controller will not function until it is cleared (powered off). (It may take up to five minutes of "off" time to clear the self-protection circuit.)

- **Controller Processor:** 32-bit RISC (Reduced Instruction Set CPU)
- **Parameter / Firmware Storage:** Flash ROM
- **Fastening Data Storage:** More than 10,000 cycles (stored in flash)
- **Fastening Method:** Torque and Angle, 1 ~ 3 step fastening
- **Torque Rate Calculation:** **3** ranges
- **Data communications:**
  - (1) RS232 – Front Panel - Input/output – Programming and Data collection
  - (1) RS232 – Rear Panel – Output – Printer or data collection device.
  - (1) T/A MON – Front Panel – Output – analog Torque and Angle analysis.
  - (1) Discrete I/O – Rear panel - Control and PLC interface
  - (1) Real Time Clock Connection
  - (1) Optional Ethernet – Programming & Data collection (Eliminates RS232 Front Panel Port)
  - (1) Optional Fieldbus – Input/Output – Control and PLC interface

2.4 Capability.

- **Fastening Accuracy (Torque):** From 1/4 to full scale torque: 3 sigma scatter less than 6%
  From 1/2 to full scale torque: 3 sigma scatter less than 5%
  Accuracy improvements available with application specific setup
- **Torque resolution:** Full Scale Torque x 1/1000.
- **Torque Display Resolution:** 4-digit display with floating decimal point.
- **Angle Resolution**: 0.1 Degree (1024 pulses / motor rev.)
- **Angle Display Resolution:** **0.**1 degree.
  Forward Max. count 9999 degree
  Reverse Max. count 1999 degree
- **Torque transducer accuracy:** (0 - Full Scale) ±1%
- **Linearity of torque transducer:** ± 0.5% of Full Scale value (Maximum).

2.4.1 Nutrunner Tool Specification Table.

Mainly, two tool models have been used to date and is designated in the model number of the tool itself. A "-01x" at the end of the tool model number indicates the original model (these models are silver in color) A "-10x" at the end of the model designates the newest models (these models are gold in color)
The two models require different tool CABLES (from the controller to the tool)
The original models use FEB-13xx-Mxx cable(s)
The newer models use C15-F7-Mxx cables

There is one controller for all size tools, however the newer model tools (gold in color) may not be recognized by older (silver) controllers due to TOOL ID information not existing in the controller firmware. In this case, request a controller firmware upgrade by contacting FEC.

TOOL TYPE		CALIBRATION TORQUE					SPEED RPM		Weight	Sq. Drive	Length
		NM	KGM	KGCM	FTLB	INLB	MAX	MIN	(Kg)	(inch)	(mm)
ANGLE	HFT-015M50-A1	14.7	1.5	150	10.8	130.2	1215	1	1.3	3/8	371
	HFT-025M80-A1	24.5	2.5	250	18.1	217.0	1070	1	1.7	3/8	391
	HFT-040M80-A1	39.2	4.0	400	28.9	347.2	648	1	1.9	3/8	416
	HFT-060M80-A	58.8	6.0	600	43.4	520.8	446	1	1.9	1/2	416
	HFT-080M80-A	78.4	8.0	800	57.9	694.4	330	1	3.8	1/2	459
	HFT-130M80-A	127.5	13.0	1300	94.0	1128.4	203	1	3.8	1/2	459
	HFT-200M80-A	196.1	20.0	2000	144.5	1734.5	132	1	4.5	5/8	492
STRAIGHT	HFT-010M50-S1	9.8	1.0	100	7.2	86.8	1800	1	1.3	3/8	332
	HFT-015M80-S1	14.7	1.5	150	10.8	130.2	1600	1	1.4	3/8	353
	HFT-025M80-S1	24.5	2.5	250	18.1	217.0	1000	1	1.4	3/8	353
	HFT-040M80-S	39.2	4.0	400	28.9	347.2	690	1	1.4	3/8	353
	HFT-055M80-S	53.9	5.5	550	39.7	476.9	508	1	3.0	1/2	393
	HFT-080M80-S	78.4	8.0	800	57.8	693.8	303	1	3.0	1/2	393
PISTOL	HFT-015M50-P1	14.7	1.5	150	10.8	130.2	1190	1	1.1	3/8	218
	HFT-035M80-P1	34.3	3.5	350	25.3	303.5	778	1	1.4	3/8	242

CONVERSION GUIDE: 1 KGM = 100 KGCM = 9.8 NM = 7.2 FTLB = 86.8 INLB

FULL SCALE TORQUE VALUES (WORK 1~32 D-NO 10) IN CONTROLLER ARE BASED UPON LIMIT SET BY Kgm VALUE.

The tool lists located throughout this manual identify the specifications for the standard tools used with the FUSION System. Additional tools are available. If additional capacity, information or special needs are required, please contact FEC INC.

2.4.2Nutrunner Decimal Point Display Table.

POSITIONS FOR DECIMAL POINT DISPLAY										
TOOL TYPE	TORQUE DECIMAL POINT DISPLAY					TORQUE RATE DECIMAL POINT DISPLAY				
	NM	KGM	KGCM	FTLB	INLB	NM	KGM	KGCM	FTLB	INLB
HFT-010M50-x	2	2	0	2	1	3	3	2	3	2
HFT-015M50-x	2	2	0	2	1	3	3	2	3	2
HFT-015M80-x	2	2	0	2	1	3	3	2	3	2
HFT-025M80-x	2	2	0	2	1	3	3	2	3	2
HFT-040M80-x	2	2	0	2	1	3	3	2	3	2
HFT-055M80-x	1	2	0	2	0	3	3	2	3	2
HFT-060M80-x	1	2	0	2	0	3	3	2	3	2
HFT-080M80-x	1	2	0	2	0	3	3	2	3	2
HFT-130M80-x	1	2	0	2	0	2	3	1	2	1
HFT-200M80-x	1	2	0	2	0	2	3	1	2	1

Example: HFT-025M80-A Torque Display = 25.**00** NM (2 positions)
Torque Rate Display = 1.**999** NM/degree (3 positions)

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Chapter 3: System Description

3.1 Controller

3.1.1 Controller Part Number Breakdown

Old (Silver) Controller

HFC-EC-16-[14]-[E]-[P]
A B C

(A) I/O INTERFACE	Blank = 24VDC Discrete I/O - NPN 2 = 24VDC Discrete I/O - PNP 3 = Modbus Plus® Interface 4 = Profinet 6 = Allen Bradley Remote I/O Interface 9 = DeviceNet® Interface 10 = Ethernet I/P 13 = Profibus® Interface 14 = CC-Link® Interface
(B) OPTIONS	Blank = Standard (with Real Time Clock) E = Ethernet (Data Output / Toolsnet Connection) B = Ethernet "Ready" – No Ethernet installed
(C) I/O OPTIONS	Blank = Standard (NPN I/O) P = Optional (PNP I/O)

New (Gold) Controller

HFC-EC-16[C]-[BU]-[EN]-[R]
A B C D

(A) MODEL	C = Standard (Gold / Black Bezel) D = STD. With Transformer (EC rated) E = STD. W/No Front RS232 (For Ethernet models)
(B) FIELDBUS INTERFACE	Blank = NPN 24VDC Discrete I/O BU = Base board only (Anybus not installed) CC = CC-LINK – (Ver2) PIO= Profinet DN = DeviceNet® Interface EIP = Ethernet I/P PB = Profibus® Interface P = PNP 24VDC Discrete I/O
(C) ETHERNET OPTIONS	EN = Ethernet Option (Baseboard + Processor) EB = Ethernet Option (Baseboard only)
(D) CASE	Blank = Standard (Hanging style) R = Shelf top (hinges opposite – cover won't fall off)

3.1.2 Controller Front Panel

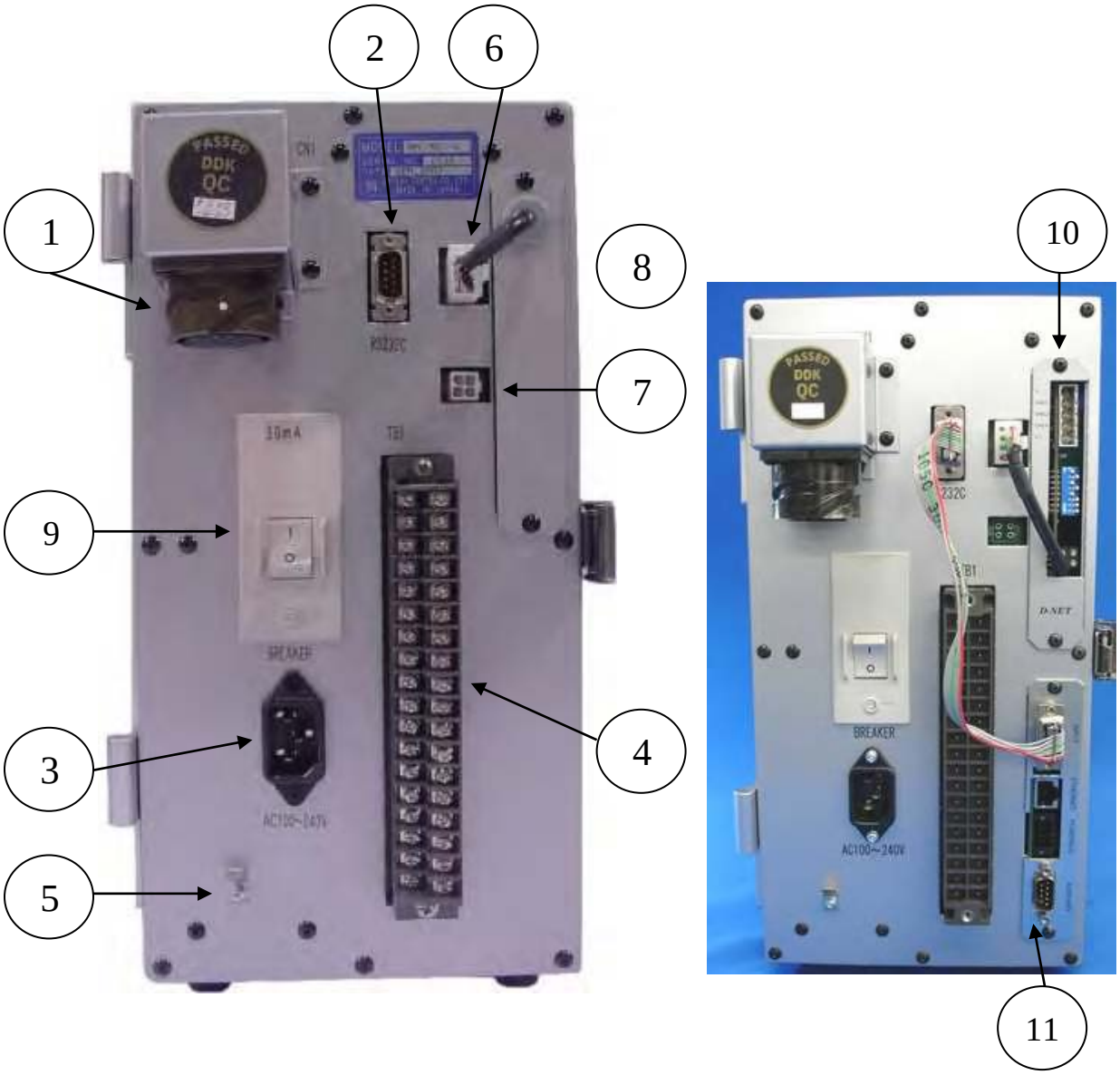
Note: Numbers correspond to item # in following table

Fig. 3.1.2 Front Panel description

FRONT PANEL DISPLAY FEATURES		
ITEM	ITEM AS MARKED ON UNIT	DESCRIPTION
1	ACCEPT	(Green) Lights to indicate that the spindle has completed an acceptable fastening cycle. Flashes for an final accept during a Batch Count.
2	WORK ACCEPT	(Green) Lights to indicate that the spindle has completed an acceptable group of fastenings. (Reached Batch Count No.)
3	REJECT	(Red). Indicates the spindle performed a rejected fastening, out of the operation limits. Flashes indicating a rate reject.
4	TORQUE	(Yellow). Indicates the “Data Display LED” is displaying Torque fastening Data.
5	ANGLE	(Yellow). Indicates the “Data Display LED” is displaying Angle fastening Data.
6	LED Display	Four digit 7 segment LED display which function is dependent upon the D-NO selected. “*ABN*” is displayed here during an “Abnormal” condition.
7	WORK	Displays two-digit parameter number and, as required, will override parameter output to display an Abnormal code.
8	COUNT/D-NO.	Display number that indicates which data in the "DATA" display field is being displayed and as required, will display an Abnormal Sub-code. Displays Fastening Count during Batch Count function.
FRONT PANEL CONTROL FEATURES		
9	CAL	Manual calibration (CAL) check pushbutton
10	RESET	Manual zero check and system reset pushbutton.
11	UP - Arrow	Data change increase pushbutton.
12	DOWN - Arrow	Data change decrease pushbutton.
13	MODE	Display mode selection pushbutton.
14	SET	Data change confirmation set pushbutton.
15	WORK RIGHT - Arrow	Parameter selection increase pushbutton.
16	WORK LEFT - Arrow	Parameter selection decrease pushbutton.
17	POWER 0 / 1	0-Off / 1-On controller power switch
FRONT PANEL CONNECTOR FEATURES		
18	T/A MON.*	Optional DB9 connector for Torque / Angle monitor. Analog outputs for use with external analysis equipment.
19	PC*	RS232 communications port for interfacing with the AFC user console software. (Removed if Ethernet option installed)

*Controllers with Ethernet option OR “HFC-EC-16B” versions do NOT include these two ports

3.1.3 Controller Back Panel



Note: Numbers correspond to item # in following table

Fig. 3.1.3 Back Panel Description

BACK PANEL CONNECTOR FEATURES		
ITEM	ITEM AS MARKED ON UNIT	DESCRIPTION
1	CN1	Twist Lock single connector for tool cable connection. Twist lock type connector can be connected and disconnected by twisting the outside ring 90 degrees Clockwise and Counter Clockwise respectively
2	RS232C	DB9 connector for fastening result data Output only. Utilized for connection to a PLC, printer, personal computer, etc.
3	AC100 ~ 240 VAC	Primary power-supply input connection. Input for 100 ~ 240 VAC single-phase 50/60Hz. AUTO SWITCHING ***DO NOT RUN WITHOUT GROUND CONNECTED!**
4	TB1	Connection point for discrete inputs and outputs (I/O). When wired in, the entire connector can be removed by loosening the upper and lower retaining screws. Refer to chapter 4 for detailed descriptions of I/O signal. .
5	Ground Lug	Ground terminal for connection to the Back Panel Cover's ground wire
6	RTC Connection	8 pin plastic connector – Real Time Clock Connection
7	SYNC Connection	4 pin plastic connector – Sync. Connector
8	Interface option Mtg.	Interface adapter port – Optional Fieldbus or Ethernet board
9	Breaker	Electrical Leakage Breaker / Ground Fault detector. I=on, 0=off
10	Fieldbus Interface slot	Optional Slot for Fieldbus Interface [Devicenet, Profibus, CCLink, Ethernet I/P, Profinet, etc]
11	Ethernet Connection	Optional Slot for Ethernet interface. Used for Ethernet connection with the AFC programming/monitoring software PC and/or Ethernet Data Server

WARNING!: DO NOT RUN THIS SYSTEM WITHOUT A PROPER GROUND CONNECTED TO THE CONTROLLER. THE CONTROLLER IS SUPPLIED WITH A 3-PRONG AC CABLE INCLUDING A GROUND CONDUCTOR. DO NOT BYPASS THE GROUND CONNECTION OR SEVERE INJURY OR SHOCK MAY RESULT!

3.2 FUSION Tool

3.2.1 FUSION Tool Part Number Breakdown

HFT-[051][M80]-[A][1][ ]-[01][A]
A B C D E F G

(A) MAXIMUM TORQUE	010 = 1.0Kgfm	(9.8Nm / 7.2ft lb)
	015 = 1.5Kgfm	(14.7Nm / 10.8ft lb)
	025 = 2.0Kgfm	(24.5Nm / 18.0ft lb)
	040 = 4.0Kgfm	(39.2Nm / 28.9ft lb)
	055 = 5.5Kgfm	(53.9Nm / 39.7ft lb)
	060 = 6.0Kgfm	(58.8Nm / 43.3ft lb)
	080 = 8.0Kgfm	(78.4Nm / 57.8ft lb)
	130 = 13.0Kgfm	(127.5Nm / 94.0ft lb)
	200 = 20.0Kgfm	(196.1Nm / 144ft lb)
(B) MOTOR	M50 = Only used on 015 Angle & Pistol Tools M80 = Used on all other tools	
(C) TOOL TYPE	A = Angle S = Straight P = Pistol T = “T” Type Pistol	
(D) MODEL REVISION	BLANK = Original Release 1 = 1st Generation	
(E) SPECIAL	BLANK = Normal Function	
(F) MINOR REVISION	Two Digit Minor Rev. Level (Factory Use Only) 01 = Silver Tool Type (Uses FEB-1309-Mxx cable) 10 = Gold Tool Type (Uses C15-F7-Mxx cable)	
(G) OPTION	BLANK = Through hole in Square Drive P = Plunger Detent in Square Drive	

3.2.2 FUSION Angle / Straight Tool Components

TOOL MAJOR COMPONENT IDENTIFICATION		
ITEM	ITEM AS MARKED ON UNIT	DESCRIPTION
1	MOTOR / RESOLVER	Provides feedback for speed regulation to the Servo Amplifier. Provides angular rotation monitoring for fastening operation. Totally enclosed DC permanent magnet motor.
2	TRANSMISSION	Durable planetary gear transmission. Refer to Chapter 2 for standard tools and gear ratios.
3	ANGLE HEAD	Durable right angle head. Refer to Chapter 2 for standard tools and gear ratios.
4	TRANSDUCER / PREAMP	Highly accurate strain gage transducer. Highly durable, compact design minimizes space requirements. Intelligent transducer design uses an “ID Chip” to verify integrity of fastening operations.
5	CABLE CONNECTOR	Twist lock single connector for tool cable connection. Twist lock type connector can be connected and disconnected by twisting the outside ring 90 degrees clockwise and counter clockwise respectively.
6	START SWITCH	Variable speed start switch. Depressing the Start switch partially initiates a manually controlled slow speed start. Depressing the Start switch fully initiate a fastening cycle as programmed into the controller. Releasing the Start switch at any time terminates the fastening operation. Used to initiate a reverse tool operation when in Reverse/Backout mode.
7	REVERSE SWITCH	Momentary Reverse selector switch or Twist Ring (“-10” models). Depressing the Reverse selector switch places the tool in the Reverse/Backout mode. The Accept/Reject LED display on the tool flashes to indicate Reverse operation selection. Depressing the Reverse selector switch again, places the tool back in the fastening mode.
8	LED DISPLAY RING	360 degree LED display ring. Green indicates an accept condition. Red indicates a Reject condition. Flashing Red and Green indicate Reverse/Backout mode. Solid Red and Green during power on for verification. Alternating Red/Green indicates RESET signal being input

3.2.3 FUSION Pistol Tool Components

TOOL MAJOR COMPONENT IDENTIFICATION		
ITEM	ITEM AS MARKED ON UNIT	DESCRIPTION
1	MOTOR / RESOLVER	Provides feedback for speed regulation to the Servo Amplifier. Provides angular rotation monitoring for fastening operation. Totally enclosed DC permanent magnet motor.
2	TRANSMISSION	Durable planetary gear transmission. Refer to Chapter 2 for standard tools and gear ratios.
3	TRANSDUCER / PREAMP	Highly durable, compact design minimizes space requirements. Intelligent transducer design uses an “ID Chip” to verify integrity of fastening operations.
4	CABLE CONNECTOR	Twist lock single connector for tool cable connection. Twist lock type connector can be connected and disconnected by twisting the outside ring 90 degrees clockwise and counter clockwise respectively.
5	START SWITCH	Variable speed start switch. Depressing the Start switch partially initiates a manually controlled slow speed start. Depressing the Start switch fully initiate a fastening cycle as programmed into the controller. Releasing the Start switch at any time terminates the fastening operation. Used to initiate a reverse tool operation when in Reverse/Backout mode.
6	REVERSE SWITCH	Momentary Reverse selector switch or Twist Ring (“-10” models). Depressing the Reverse selector switch places the tool in the Reverse/Backout mode. The Accept/Reject LED display on the tool flashes to indicate Reverse operation selection. Depressing the Reverse selector switch again, places the tool back in the fastening mode.
7	LED DISPLAY RING	LED display ring. Green indicates an accept condition. Red indicates a Reject condition. Flashing Red and Green indicate Reverse/Backout mode. Solid Red and Green during power on for verification.

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Chapter 4: System Setup and Wiring

4.1 Design and Build Procedure

Review Chapters 1 and 2 prior to designing a System. If the requirements and specifications in these two (2) Chapters are not addressed, there is a chance of degraded System performance.

WARNING:

Follow Lockout/Tagout and other safety precautions when connecting and/or disconnecting cabling, wiring, and equipment.

No.	Items	Comments	Reference Section
1	Select correct tool size.	Keep torque range between 30% and 75 % of tool capability for best performance and to capacity for future fastening specification revisions. Verify fastener location and tool clearance concerns.	2.4.1 4.4.1 4.4.2
2	Determine tool suspension /reaction requirements.	Determination of suspension and reaction requirements is dependent upon end user standard ergonomic design guidelines and preferred supplier lists.	4.4 4.4.3
3	Select correct Control Unit	Different controller options are available. Ensure the correct one is selected.	3
4	Select the circuit protectors.	Circuit protection for Controller Units should be separate from other units.	4.5 4.6
5	Select an adequate PLC.	Select a PLC which will facilitate direct connection to the FUSION System I/O (24 VDC true low).	4.7
6	Design (or review) PLC logic.	A PLC logic program can be written using signal descriptions and timing charts provided.	4.7
7	Determine Controller mounting requirements.	Keep clearances among units according to the recommended installation layout. End user specific input should be used to determine mounting requirements.	4.2 4.3
8	Set Controller Unit dip switches.	Check the setting before connecting the Unit.	4.10
9	Mount the Controller Units.	Refer to recommended installation layout.	4.2 4.3
10	Wire power connections.	Connect the power cables. **VERIFY VOLTAGE PRIOR TO APPLYING POWER.**	4.6
11	Wire I/O connections.	Connect all I/O wiring. **VERIFY VOLTAGE SOURCE PRIOR TO CONNECTION.**	4.7
12	Connect Tool / extension cables.	**VERIFY POWER IS OFF**, then connect cables for every motor, encoder and preamplifier.	Appendix A
13	Turn on the equipment.	**VERIFY WIRING AND THE VOLTAGE OF ALL POWER SUPPLIES PRIOR TO POWERING UP.**	5.1
14	Input preset data.	Set the preset data for torque, angle, speed, time, etc.	Chapter 6 Chapter 7
15	Verify normal function.	Confirm normal operation.	5.2

4.2 Component Dimensions

The specifications for all of the FUSION standard system equipment are outlined in this Chapter to aid in determining space, mounting & wiring requirements.

4.2.1 CONTROLLER Unit Dimensions

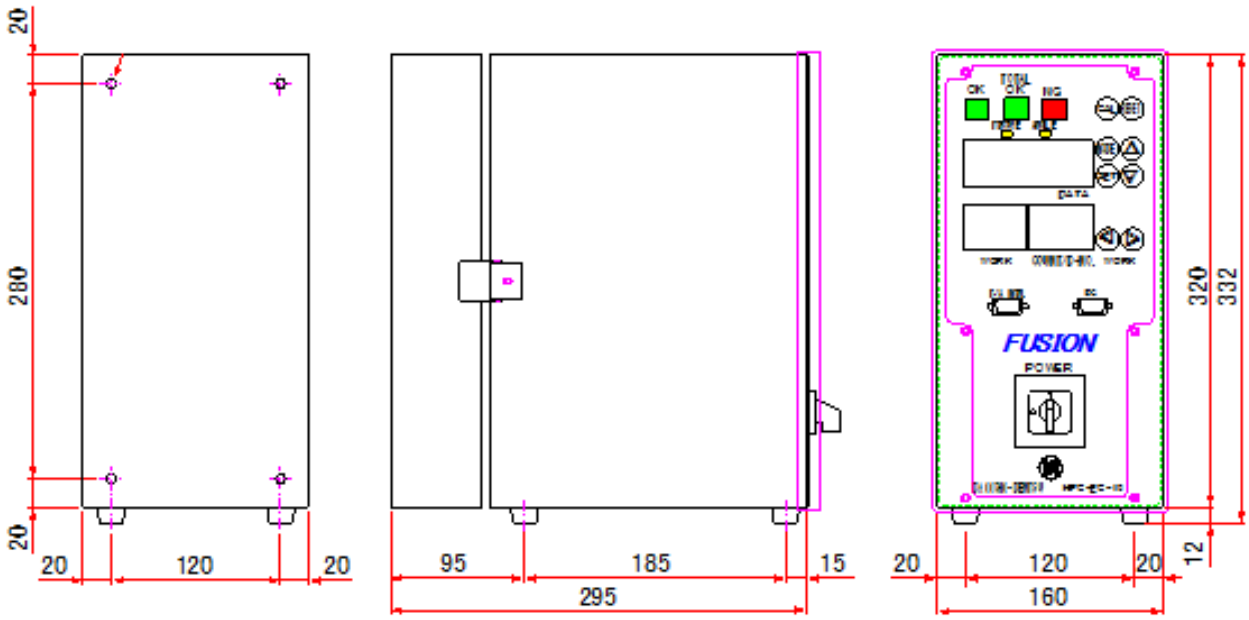
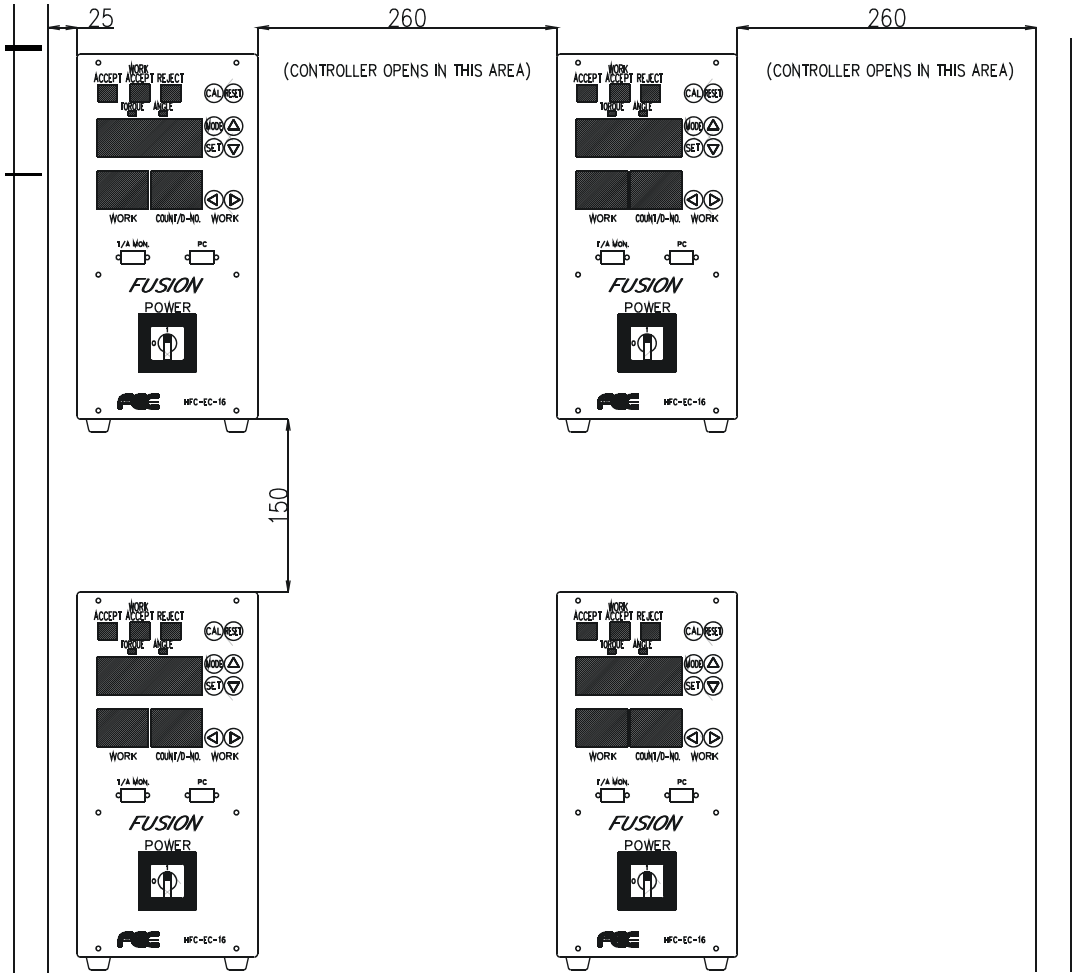


FIG. 4-2-1 Controller Unit Dimensions

Controller weight is 8.6 Kg (18.9lbs.)
Mounting: (4) points rear panel (Use M6 Screw or equivalent >9mm in length)

The Unit(s) must be mounted with a minimum clearance of 25mm on the left side and 126mm on the right side to allow for proper heat dissipation. If mounting multiple controllers side by side you must leave a minimum clearance of 260mm between the units for clearance when opening the back cover. Programming Cable connections on the front of the Unit require 100mm of clearance. Cable connections on the rear of the Units require 150mm of clearance below the unit for exiting the Rear cover other than straight down. Controller Units must be located at a minimum 300mm from any high transient voltage power source. High transient sources such as relays, AC contactors, AC motor drives, etc. may cause malfunction of the FUSION Controller unit. All motor cables and I/O cables must be run separate from all high transient voltage sources. When locating inside an enclosure, avoid mounting at or near the top where internal enclosure heat is most extreme.
Do not install in a location subject to continuous vibration

4.3 Unit Arrangement



** See preceding page for actual unit width

FIG. 4-3 Unit Arrangement

Figure 4-3 provides a reference for the layout of the FUSION System components. The Units may be mounted in any desired configuration as long as the minimum spacing requirements are not neglected. Clearance for opening the controller (260mm) and accessing the back connectors should be maintained as shown.

4.4 Nutrunner (Tool) Specifications

Tool dimensions and mounting specifications are critical in determining the design of the suspension / reaction equipment required for the tool assemblies. Provide adequate clearance to ensure that the tool assemblies do not come in contact with any object. Failure to provide adequate clearance may result in torque inaccuracies in the monitoring capability of the system, possible damage to the tool assembly, or operator injury.

Customer specific ergonomic guidelines and preferred supplier lists should be used in determining suspension / reaction equipment requirements

WARNING: Torque tools generate large amounts of torque that can cause injury when held in the hand of an operator. Be sure all precautions are taken to ensure torque reaction devices are installed to absorb or suppress reaction torque from operators! It is recommended that some type of torque reaction device is employed for torque over 10Nm to prevent repetitive operator injury.

4.4.1 Straight Tool

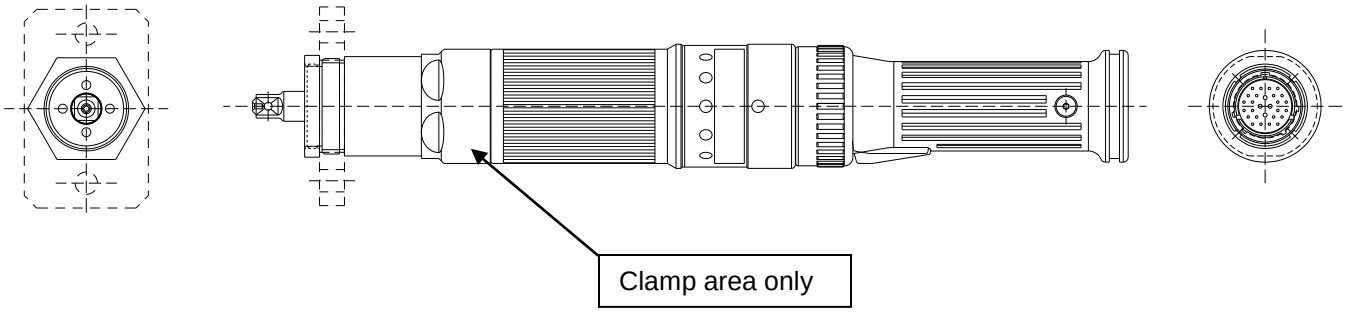


FIG. 4-4-1 Straight Tool

MODEL TYPE	TORQUE (NM / ft lb)	SPEED	Total Length (mm)	Weight (Kg / Lb)	Square Drive
HFT-010M50-S1-10	9.8 / 7.2	1800 rpm	332.5	1.3 /2.8	3/8
HFT-015M80-S1-10	14.7 / 10.8	1600 rpm	352.5	1.4 / 3.2	3/8
HFT-025M80-S1-10	24.5 / 18.1	1000 rpm	352.5	1.4 / 3.2	3/8
HFT-040M80-S-10	39.2 / 28.9	690 rpm	415.5	1.4 / 3.2	3/8
HFT-055M80-S-10	53.9 / 39.7	508 rpm	393	3.0 / 6.6	1/2
HFT-080M80-S-10	78.4 / 57.8	315 rpm	393	3.0 / 6.6	1/2

Mounting: Tool may be mounted by using a clamp collar located on the area shown in the drawing above. Tolerance for diameter of inside of clamp must be +0.1 to + +0.2mm of diameter of the "clamping area" so damage to the (tool) nut does not occur.

Note: Dimensions shown are subject to change without warning due to design improvements.

4.4.2 Right Angle Tool

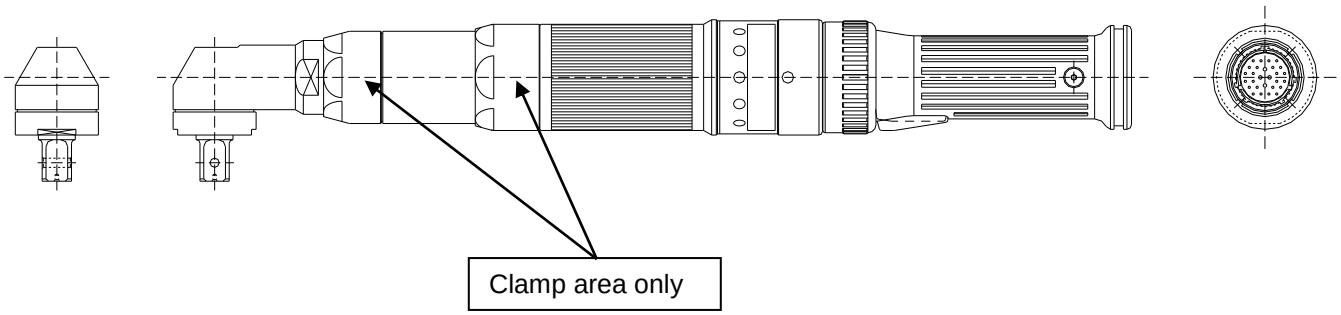


FIG. 4-4-2 Right Angle Tool

MODEL TYPE	TORQUE (NM / ft lb)	SPEED	Total Length (mm)	Weight (Kg / Lb)	Square Drive
HFT-015M50-A1-10	14.7 / 10.8	1215 rpm	365	1.6 / 3.5	3/8
HFT-025M80-A1-10	24.5 / 18.1	1070 rpm	385	1.7 / 3.8	3/8
HFT-040M80-A1-10	39.2 / 28.9	648 rpm	410	1.9 / 4.2	3/8
HFT-060M80-A-10	58.8 / 43.4	446 rpm	410	1.9 / 4.2	1/2
HFT-080M80-A-10	78.4 / 57.8	325 rpm	459	3.6 / 7.9	1/2
HFT-130M80-A-10	127.5 / 94.0	195 rpm	459	3.6 / 7.9	1/2
HFT-200M80-A-10	196.1 / 144.5	132 rpm	492	4.5 / 9.9	5/8

Mounting: Tool may be mounted by using a clamp collar located in the area shown in the drawing above.

Warning: Tolerance for diameter of inside of clamp must be +0.1 to +0.2mm of diameter of the "clamping area" so damage to the (tool) nut does not occur.

Note: Dimensions shown are subject to change without warning due to design improvements.

4.4.3 Pistol Tools

The FEC Pistol tool is available in two sizes (15Nm & 35Nm).

Note: It is recommended when using pistol type tools, that the “Ergo-Smoothing” function or other torque reaction devices are used on applications with target torques over 10Nm to reduce operator fatigue or repetitive use injury.

The FEC Pistol tool incorporates the latest “active Ergonomic smoothing” technology to reduce operator torque reaction to very low levels. This works by using an electric “pulsing” function to apply torque to the fastener. This is extremely effective in applications where the tool is supported from some type of cable of other balancer. (See Parameter data list (7.2.5) for set-up of Ergo-Smoothing function – Data No. 80 - 89)

Tools may be used in horizontal or vertical applications using supplied hanging bracket.

“P” Type Pistol Tool

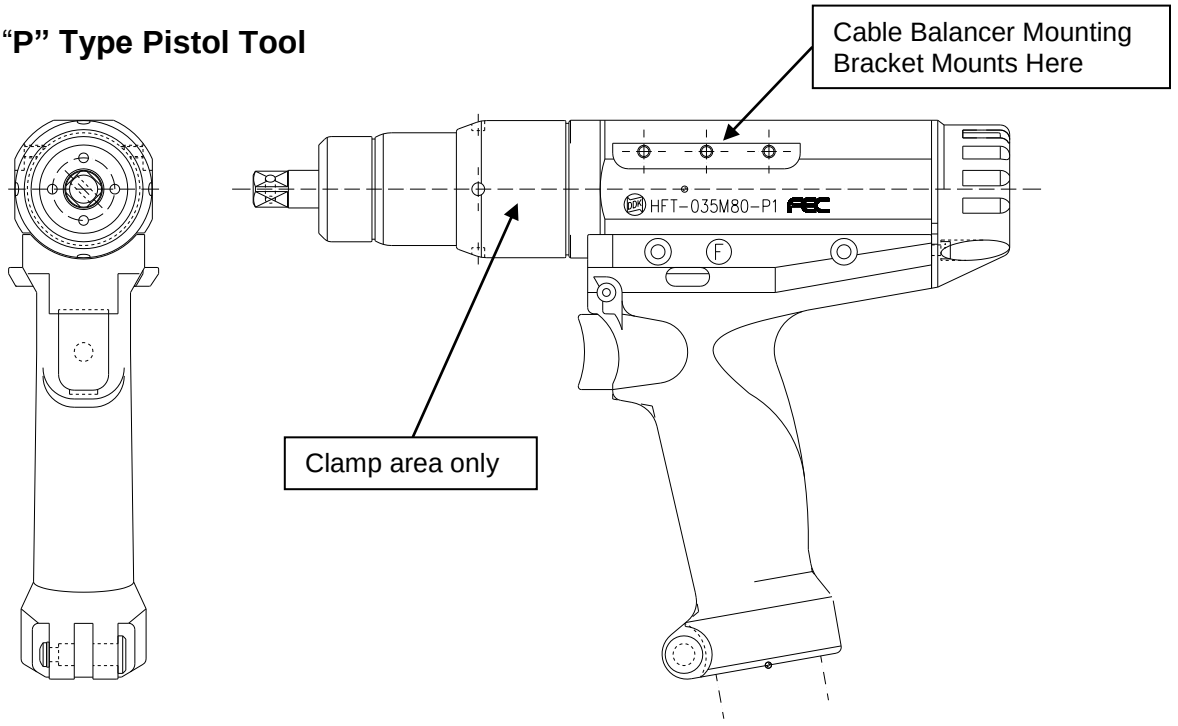


Fig. 4.4.3 “P” Type Pistol Tool

MODEL TYPE	TORQUE (NM / ft lb)	SPEED	Total Length (mm)	Weight (Kg / Lb)	Square Drive
HFT-015M50-P1	14.7 / 10.8	1190 rpm	218	1.1 / 2.2	3/8
HFT-035M80-P1	34.3 / 25.3	778 rpm	242	1.4 / 3.1	3/8

NOTE: If clamp will be used to support the tool, clamp in ONLY the area shown above or damage may occur to tool

*Cable Balancer Mounting Bracket is included (bolts area shown above)
*Optional top cable entry available (contact FEC)

4.5 Connection Diagram

A basic layout of System component interconnection is shown in Figure 4-5. Detailed reference drawings can be found throughout this Chapter, and also in Appendix A.

WARNING: Follow Lockout/Tagout and other safety precautions when connecting and/or disconnecting cabling, wiring, and equipment.

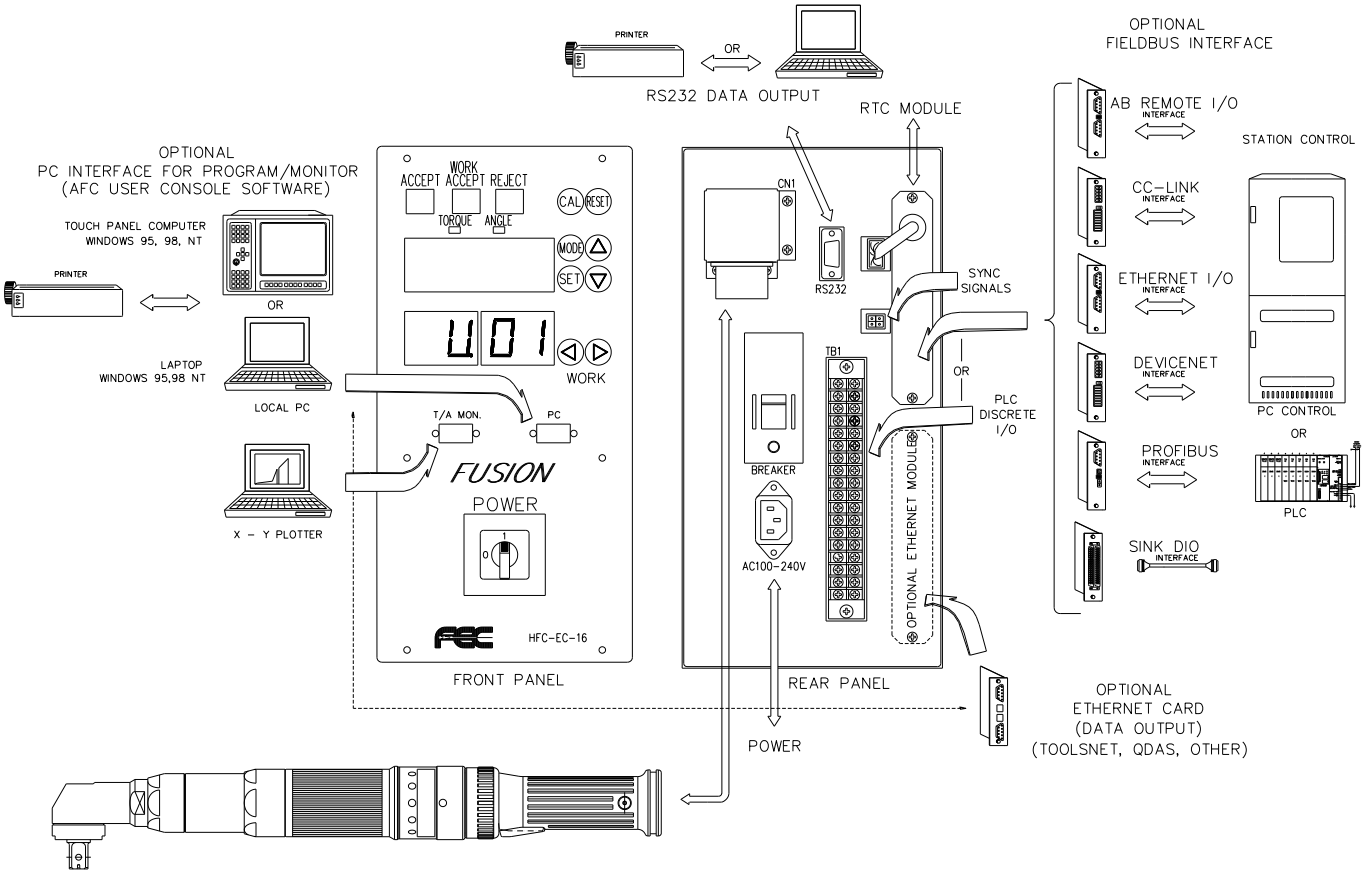


FIG. 4-5 Connection Diagram

The Fusion controller can be connected to various external devices for control and monitoring the fastening process. The system will operate with no connection to any external devices. If control I/O is required, discrete Inputs / Outputs or optional fieldbus connection is available for external controllers (PLC or PC Control). Serial RS232 or optional Ethernet is available for resultant fastening data output. Additionally, the front panel provides easy access for RS232 connection with a computer running the AFC User Console software.

4.6 Power Requirements and Connections

4.6.1 Controller Unit

The Controller uses a standard “computer” power cord which connects to the AC power connector located at the back of the unit and to a standard wall outlet. The unit operates on single phase power (100-240VAC 50/60Hz). Power consumption is 80watts while idle & 1200watts @ max. Torque. Inrush current (at power on) is 11amps.

WARNING: Do not disconnect power cable while system is in cycle.

PIN NUMBER	DESCRIPTION
1	FRAME GROUND
2	100 – 240 VAC 50/60Hz
3	100 – 240 VAC 50/60Hz

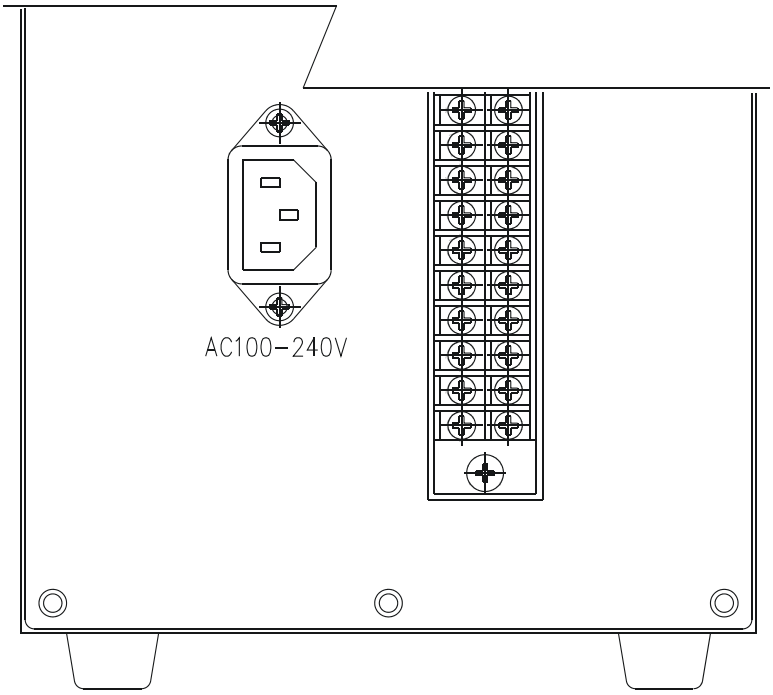


Fig. 4-6-1 Controller Unit Power Connector

NOTE:

After a Controller unit is powered down, the power must not be applied again for at least five (5) seconds. Repeated power up and power down may temporarily disable a Controller unit as a self protection feature. If a Controller unit does become disabled, turn the power off for five (5) minutes before making another attempt to power up.

4.7 Wiring PLC I/O

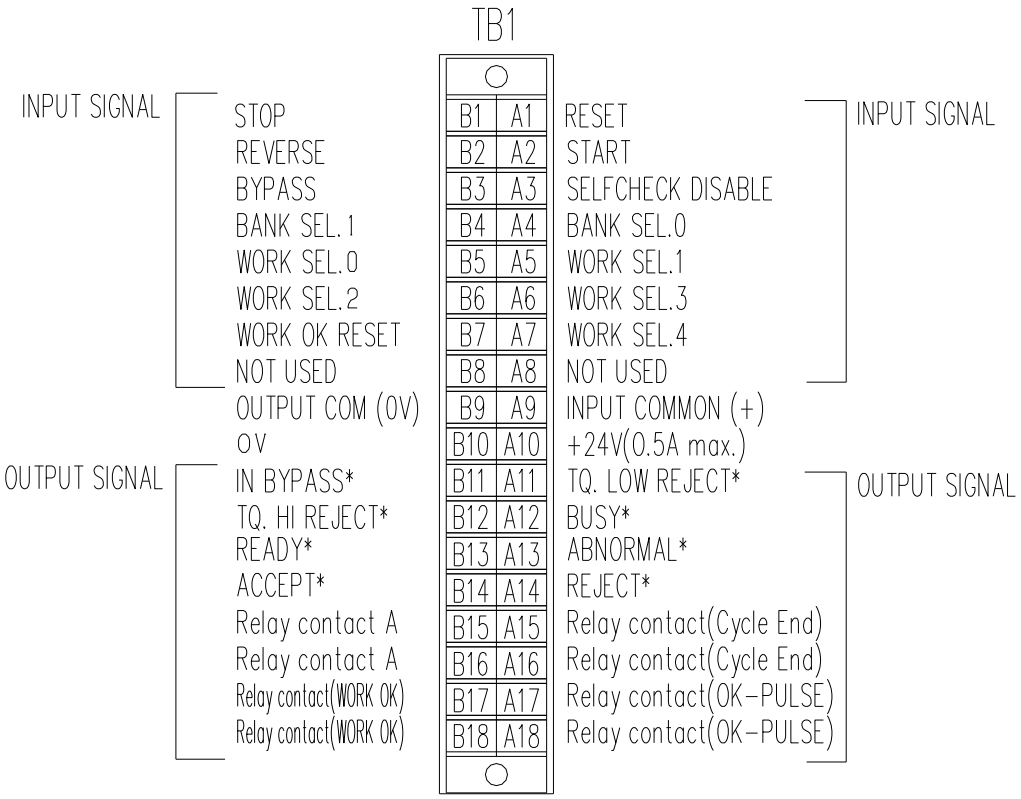
All interface devices must accommodate active true low logic for correct operation with the STANDARD FUSION CONTROLLER Unit DC inputs and outputs (I/O). (Optional PNP active true high is available) Four output relay contacts are provided for isolated connection to an external controller. Optional Fieldbus interfaces are available. Outputs are rated at 12~24 VDC, 200mA. When activated, open collector sinking outputs (normally high) pull the input device signal low (0 VDC). Inputs are (normally high) and activated when pulled low (0 VDC). (The opposite is true with the optional PNP version controller)

TB1 I/O is enabled even if a Fieldbus interface is installed. (Both I/O will be active)

Once wired, the TB1 terminal block can be quick disconnected from the Controller by loosening the captive screws located at the top and bottom of the terminal strip, for quick change-over to a new controller without disconnecting the terminal wires.

CAUTION:
The PLC I/O wiring must be routed a minimum of 300 mm away from any transient high voltage sources. Cable length must not exceed 50 feet.

*****NPN VERSION SHOWN*****



NOTE: IF Optional PNP version, A9 & B9 polarity is REVERSED. A9 is (0v) common and B10 is (+) common (see 4.7.5 for wiring example)

FIG. 4-7-1 Controller Unit PLC Connector

* Output signals shown on terminals A11 – B14 are for BANK 1 signals only. If BANK SELECT inputs are used, these outputs WILL CHANGE DEFINITION according to the Bank Select output table and the selection of BANK SELECT INPUTS.

4.7.1 Explanation of CONTROLLER Unit I/O

INPUT SIGNALS		
Pin #	SIGNAL NAME	DESCRIPTION
A1	RESET	Reset Input (Normally Open) When active (on), this signal will clear all fastening data, discrete outputs, and communication buffers. A Zero Check of the torque transducer will be completed. During the Zero Check, the Tool ACCEPT and REJECT lamp will light to indicate the performance of the Zero Check. During a RESET signal, the tool Red/Green LED's will alternately light. If the system has been disabled by an Abnormal output, the system will not return to normal operation until the Abnormal condition has been corrected, and this signal has been input for 200~500 milliseconds. Do not input this signal between cycles, due to the potential for data loss. During RESET, the connected tools RED/GREEN LED will alternate
B1	STOP	Emergency Stop Input (Normally Open) This signal must be inactive (off) for controller operation. When this signal is active (on), controller operation will stop, and input/outputs will be disabled. ***Note: This signal can inversed (Signal must be ON) configured using the AFC Software (Sequence Tab in Graphic Parameter Setup Screen)***
A2	START	Start Cycle Input (Normally Open) The Start input automatically resets the previous cycle, clears all data to zero, and initiates the next fastening cycle. The Start input must be maintained "on" for the entire cycle.
B2	REVERSE	Reverse Spindle Rotation Input (Normally Open) The spindle will rotate in an opposite direction for as long as this signal is activated (on) and maintained. (input disabled during RESET)
A3	SELF CHECK DISABLE	Input signal used to disable the performance of the automatic Self Check function at the beginning of the fastening cycle.
B3	BYPASS	Spindle Bypass Input (Normal Open) When active, all functions of this spindle are bypassed, and the Bypass output is active. Programming of the Controller is enabled
A4 B4	BANK SELECT 0 BANK SELECT 1	Bank Select Input Signals (Normally Open) These two (2) inputs form a binary code that is used to define the function/definition of outputs for Bank Data 0~7 (A11-B14). This allows up to 32 different output definitions with only 8 discrete outputs (4 Banks, 8 available outputs per Bank). See 4.7.3 Bank Select Table.
A5 B5 A6 B6 A7	WORK SELECT 1 WORK SELECT 0 WORK SELECT 3 WORK SELECT 2 WORK SELECT 4*	Work / Parameter Select Input (Normally Open) These 5 inputs form a binary code which is capable of selecting up to 32 different sets of Fastening Parameters. Refer to Section 4.7.2 Work Sequence Select Table. Note: Work 4 was added Firmware version 5.00 & higher
B7	WORK OK RESET	Reset Batch count to the initial condition/Count. D-NO display will be cleared. (If controller is setup for the work select from TB1, this input MUST be used to reset the batch count)
A8	NOT USED	
A9	INPUT COMMON	Input signal common. Connection to +12 ~ 24 VDC required.
B9	OUTPUT COMMON	Output signal common. Connection to 0 VDC required
A10	DC POWER (+24v)	Internal auxiliary 24VDC power – 0.5amp max.
B10	DC POWER (0v)	Zero volt common for Internal auxiliary power

OUTPUT SIGNALS		
A14 B14 A13 B13 A12 B12 A11 B11	BANK DATA 7 BANK DATA 6 BANK DATA 5 BANK DATA 4 BANK DATA 3 BANK DATA 2 BANK DATA 1 BANK DATA 0	Bank Data Output Signals (Normally Open) These output signals designate various fastening conditions and results as determined by Bank Select 0 & 1 (Pins A4 & B4) inputs. Refer to 4.7.3 Bank Select Table for output data descriptions.
B15 B16	Relay Contact "A"	Future Programmable Dry Contact Relay output Rating : 0.3A @125VAC or 1A @ 30VDC
A15 A16	Relay Contact "CYCLE END"	Cycle End Dry Contact Relay output Output when Reverse Mode is active and Operator activates start trigger (used as operator "Auxiliary Output")
B17 B18	Relay Contact "WORK OK"	Batch Accept Dry Contact Relay output Output after the number of accepts programmed in the Work Count parameter is met. (D-No 74) (Rating as above) Output can be programmed as either "Pulse" or "State" type using the AFC software.
A17 A18	Relay Contact "OK PULSE"	Accept Pulse (300 – 500 msec) Dry Contact Relay output – used to replace a QL click style torque wrench. (Rating as above)

4.7.2 Work / Parameter Select Table

PARAMETER NO.	WORK SELECT 3 PIN A6	WORK SELECT 2 PIN B6	WORK SELECT 1 PIN A5	WORK SELECT 0 PIN B5
1	OFF	OFF	OFF	OFF
2	OFF	OFF	OFF	ON
3	OFF	OFF	ON	OFF
4	OFF	OFF	ON	ON
5	OFF	ON	OFF	OFF
6	OFF	ON	OFF	ON
7	OFF	ON	ON	OFF
8	OFF	ON	ON	ON
9	ON	OFF	OFF	OFF
10	ON	OFF	OFF	ON
11	ON	OFF	ON	OFF
12	ON	OFF	ON	ON
13	ON	ON	OFF	OFF
14	ON	ON	OFF	ON
15	ON	ON	ON	OFF
16	ON	ON	ON	ON

OFF = Disabled ON =Enabled

Note: TB1 terminal must be enabled. (See Section 7.2.4)

4.7.3 Bank Select Table

Bank Select inputs are used to "multiplex" the output signals allowing up to 32 signals from only 8 physical outputs. By changing the input conditions of the two Bank Select inputs, up to four "Banks" may be selected, changing the definition of each output point.

	BANK SEL. INPUT		PLC / CONTROLLER UNIT BANK DATA		
BANK NO.	SEL 1 B4	SEL 0 A4	Output A11~B14	NAME OF SIGNAL	DESCRIPTION
1	OFF	OFF	DATA 7 (A14)	REJECT	Output when the fastening result is a REJECT. Indicates that the spindle has failed the fastening limits. This output remains active until the START signal or RESET signal is input.
			DATA 6 (B14)	ACCEPT	Output when the fastening result is a ACCEPT. Indicates that the spindle is within the fastening limits. This output remains active until the START signal or RESET signal is input.
			DATA 5 (A13)	ABNORMAL	Output when an Abnormal condition occurs, indicates that the System has detected an internal fault, and can no longer proceed. An Abnormal condition must be corrected before the System will resume normal operation.
			DATA 4 (B13)	READY	Output when the system is in READY condition to operate, and inputs are enabled. This signal is inactive (off) when the BUSY output is active (on).
			DATA 3 (A12)	BUSY	Output after a START signal is received, and active until the fastening cycle is complete and the READY signal is output.
			DATA 2 (B12)	TQ HIGH REJECT	Output when Fastening resulted in a Torque High Reject.
			DATA 1 (A11)	TORQUE LOW REJECT	Output when Fastening resulted in a Torque Low Reject.
			DATA 0 (B11)	BYPASS	Output when the spindle is bypass either via PLC input or the Controller Unit front panel switch.
2	OFF	ON	DATA 7 (A14)		NOT USED
			DATA 6 (B14)	1ST TIME OVER REJECT	Output when Fastening resulted in a 1st Time Reject.
			DATA 5 (B13)	FINAL TIME OVER REJECT	Output when Fastening resulted in a Final Time Reject.
			DATA 4 (B13)	WORK 0	Output confirmation of WORK SELECT 0~4 (Pins A5,B5,A6,B6 & A7) input selections.
			DATA 3 (A12)	WORK 1	
			DATA 2 (B12)	WORK 2	
			DATA 1 (A11)	WORK 3	
			DATA 0 (B11)	WORK 4	

	BANK SEL. INPUT		PLC / CONTROLLER UNIT BANK DATA		
BANK NO.	SEL 1 B4	SEL 0 A4	Output A11~B14	NAME OF SIGNAL	DESCRIPTION
3	ON	OFF	DATA 7 (A14)	ANGLE HIGH REJECT	Output when Fastening resulted in an Angle High Reject.
			DATA 6 (B14)	ANGLE LOW REJECT	Output when Fastening resulted in an Angle Low Reject.
			DATA 5 (B13)	1ST RATE HIGH REJECT	Output when Fastening resulted in a 1st Torque Rate High Reject.
			DATA 4 (B13)	1ST RATE LOW REJECT	Output when Fastening resulted in a 1st Torque Rate Low Reject.
			DATA 3 (A12)	2ND RATE HIGH REJECT	Output when Fastening resulted in a 2nd Torque Rate High Reject.
			DATA 2 (B12)	2ND RATE LOW REJECT	Output when Fastening resulted in a 2nd Torque Rate Low Reject.
			DATA 1 (A11)		NOT USED
			DATA 0 (B11)		NOT USED
4	ON	ON	DATA 7 (A14)	ZERO CAL ERR	Outputs when an abnormal condition occurs during the SELF CHECK (CAL and Zero).
			DATA 6 (B14)	PSET ERR.	Outputs when an abnormal condition occurs in the parameter setting.
			DATA 5 (B13)	RES ERR	Outputs when an abnormal condition occurs in the resolver.
			DATA 4 (B13)	TOOL ERR	Outputs when a tool related abnormality occurs.
			DATA 3 (A12)	SV AMP ERR	Outputs when a servo abnormality occurs, see SV ERR 0~2 codes below.
			DATA 2 (B12)	SV ERROR 0	Outputs a detailed code when a SV AMP ERR is output. Error code is output in three bits. (See Section 4.7.4).
			DATA 1 (A11)	SV ERROR 1	
			DATA 0 (B11)	SV ERROR 2	

4.7.4 Bank Output Servo Error Table

The Bank Servo Error Table defines the type of servo error (fault) output from Bank 4 Data bits 4-7(see above)

	SV ERR			
SV AMP ERR (Data 4)	**2 (Data 7)**	**1 (Data 6)**	**0 (Data 5)**	**DESCRIPTION**
ON	**OFF**	**OFF**	**OFF**	
ON	**OFF**	**OFF**	**ON**	Over current or Controller type mis-match.
ON	**OFF**	**ON**	**OFF**	Resolver abnormal.
ON	**OFF**	**ON**	**ON**	Controller unit overheated.
ON	**ON**	**OFF**	**OFF**	
ON	**ON**	**OFF**	**ON**	Internal voltage level abnormal.
ON	**ON**	**ON**	**OFF**	Input voltage abnormal.
ON	**ON**	**ON**	**ON**	Overload.
OFF	**-**	**-**	**-**	No error

4.7.5 PLC Wiring Sample

This diagram represents standard I/O connections to a PLC (NPN current sinking Active true low). The 24VDC power can be supplied from the FUSION controller (terminals A10,B10) if total consumption is less than 0.5A.

Standard current flow shown

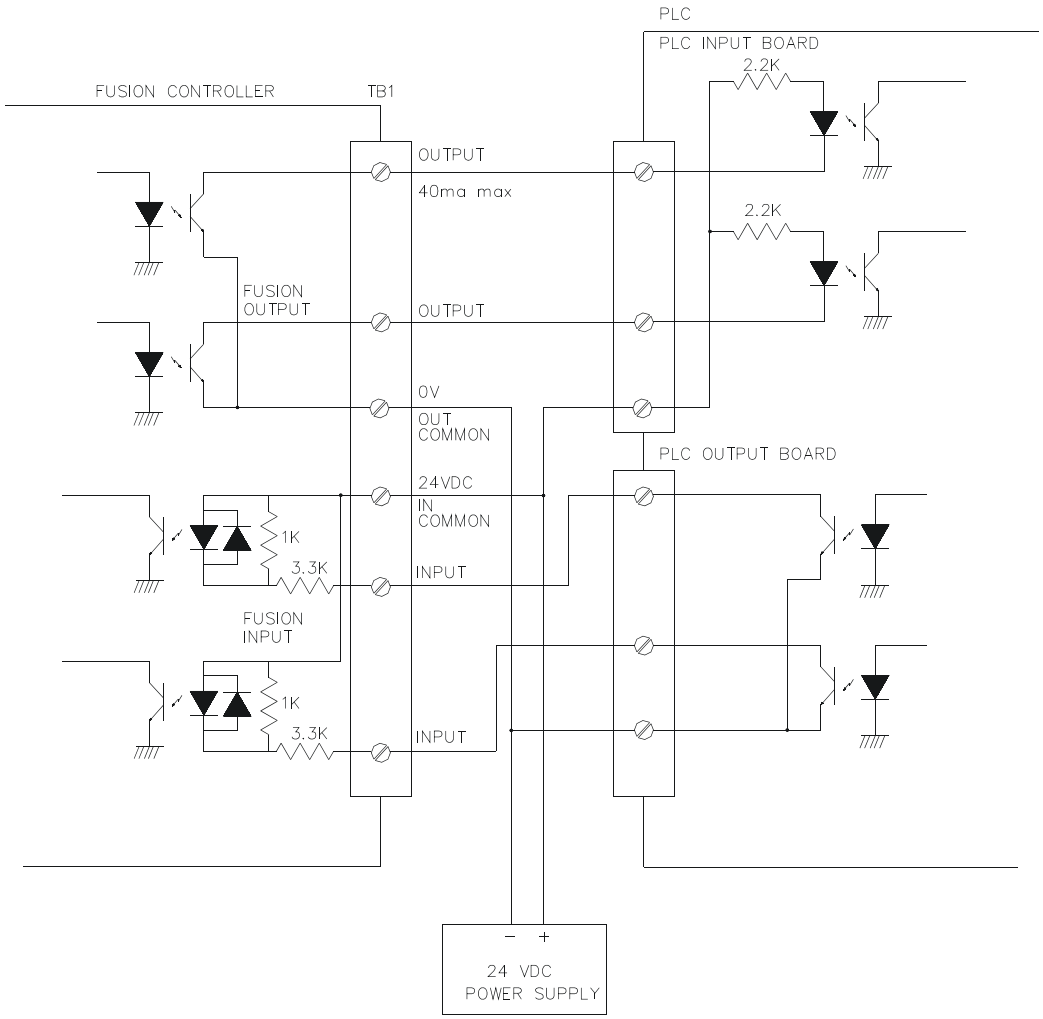


FIG. 4-7-5 PLC Wiring Sample

The standard controller inputs and outputs (I/O) are active true low. All interface devices must accommodate active true low logic for correct operation. Outputs are rated at +12~24 VDC, 40mA. When activated, open collector sinking outputs (normally high) pull the input device signal low (0 VDC). Inputs are sourced (normally high) and activated when pulled low (0 VDC).
Note: Optional PNP version I/O available – active true high, current sourcing (See next page for wiring sample diagram)

This diagram represents the OPTIONAL PNP version I/O connections to a PLC (PNP current sourcing Active true high). The 24VDC power can be supplied from the FUSION controller (terminals A10,B10) if total consumption is less than 0.5A.

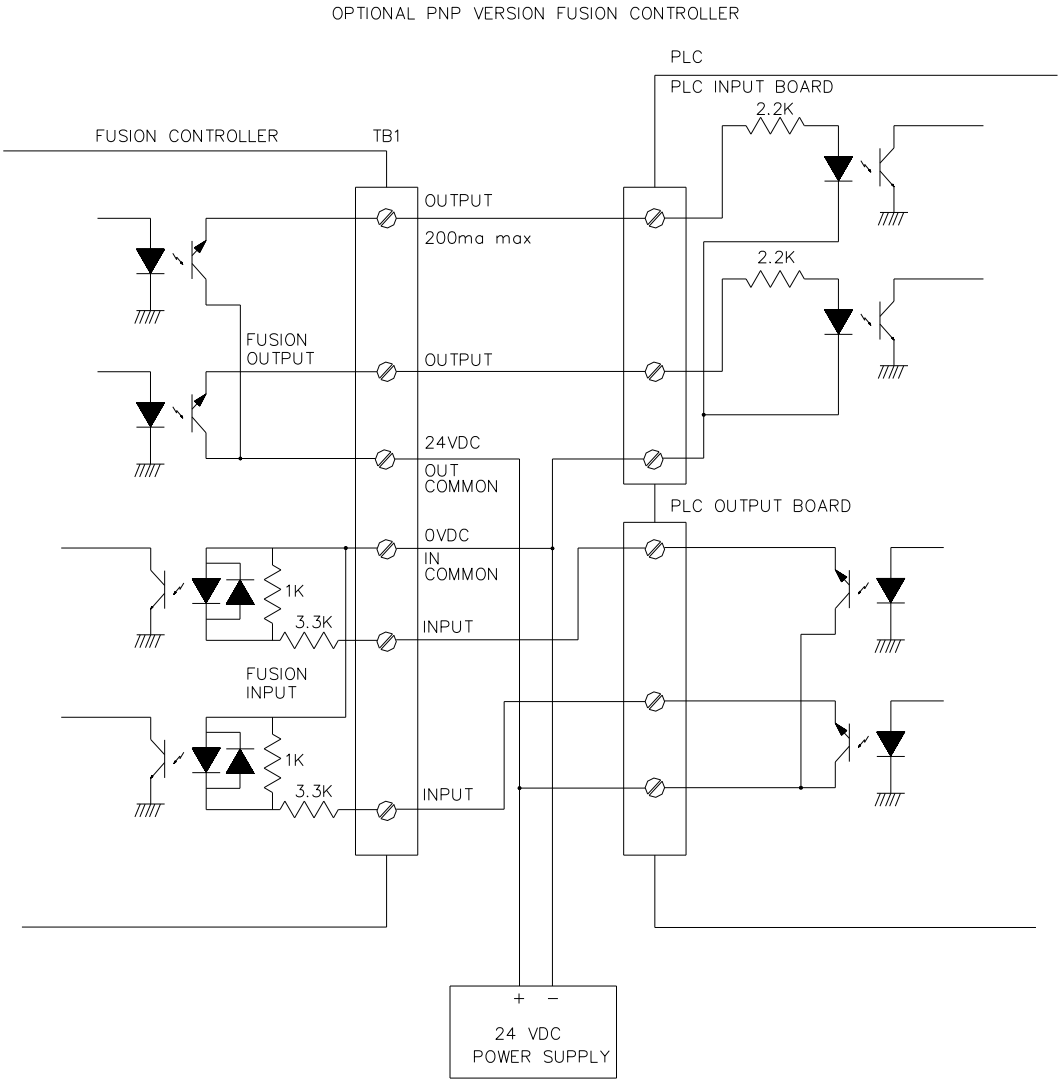


FIG. 4-7-5a Optional PNP version PLC Wiring Sample

4.8 RS-232 Data communication ports.

The FUSION system programming and monitoring can be performed utilizing a PC, Laptop or Industrial based system. Communication is performed via an RS232 port located on the front of the unit. This port provides communication to the AFC User Console Software. (No cost with a system purchase)

An additional port is available on the rear panel of the controller that can provide RS232 output data to a variety of collection devices.

4.8.1 Front Panel DB9 RS232 PC Connection for AFC User Console Software

PIN	SIGNAL	DESCRIPTION
1		NOT USED
2	RXD	RECEIVE DATA
3	TXD	TRANSMIT DATA
4	DTR	DATA TERMINAL READY (ALWAYS ON)
5	GND	SIGNAL GROUND
6	DSR	NOT USED
7	RTS	REQUEST TO SEND (ALWAYS ON)
8	CTS	CLEAR TO SEND
9		NOT USED

Note: Cabling length should be kept to a minimum (Max 50 Feet) and avoid routing near high signal noise areas such as AC Motor invertors, speed controllers or strong RF signals.

Standard DB9 Null Modem cables can be used for this connection (to a PC running the AFC User Console Software). No special cabling is required. (These are standard Null Modem cables which can be purchased at most computer stores)

See the AFC User Console Manual for more information. (Available for download on the FEC website – www.fec-usa.com)

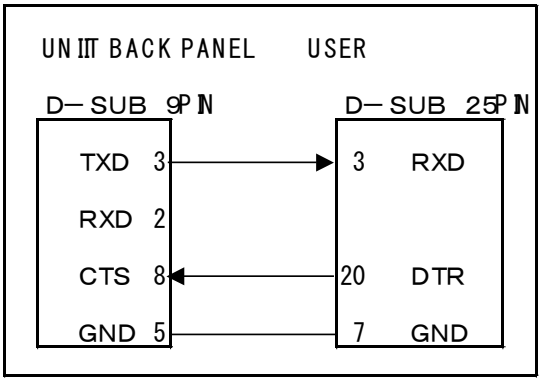
4.8.2 Rear Panel DB9 RS232 PC Connection (Fastening Data Output)

Connector: DB-9P (Male)
Mating Connector: DB-9S (Female)

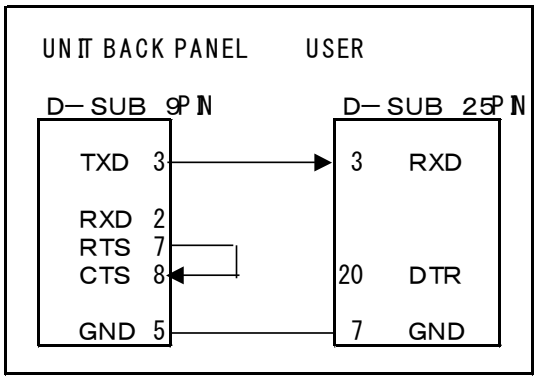
PIN	SIGNAL	DESCRIPTION
1		NOT USED
2	RXD	NOT USED
3	TXD	TRANSMIT DATA
4	DTR	DATA TERMINAL READY (ALWAYS ON)
5	GND	SIGNAL GROUND
6	DSR	NOT USED
7	RTS	REQUEST TO SEND (ALWAYS ON)
8	CTS	CLEAR TO SEND
9		NOT USED

Note: The CTS signal needs to be activated in order for the fastening data to be output. If it the data will be overwritten in a First In, First Out (FIFO) process. The CTS signal may be connected to the RTS signal if data is to be "dumped" at every fastening.

Connection with hardware handshake (with DTR signal)



Connection without handshake – data "dumped" (without DTR signal)



4.8.3 Rear Panel RS232 Standard Communication Protocol

Communication protocol from the rear panel RS232 port is as follows;

Speed: 9600bps
Parity: None
Data Bits: 8 Bit
Start Bit: 1 Bit
Stop Bit: 2 Bit
Error Control: None

The data format from the Fusion system is a formatted ASCII output. This can be connected to a serial printer, computer or other peripheral device. 214 bytes of data is output per fastening using the Standard Format. The data format is described below.

Byte	Description	Example	
		ASCII	Data
1	Start Of Text	02H	
2	Parameter No.	20H	
3	Parameter No.	31H	1
4	Clock – Year*	30H	0
5	Clock – Year*	37H	7
6	/	2FH	/
7	Clock – Month*	30H	0
8	Clock – Month*	38H	8
9	/	2FH	/
10	Clock – Day*	31H	1
11	Clock – Day*	35H	5
12	Time – Hour*	31H	1
13	Time – Hour*	32H	2
14	:	3AH	:
15	Time – Minute*	34H	4
16	Time – Minute*	35H	5
17	:	3AH	:
18	Time – Second*	33H	3
19	Time – Second*	30H	0
20	Spindle Number	30H	0
21	Spindle Number	31H	1
22	Judgment Flag[1]	4FH	O
23	Judgment Flag[1]	30H	0
24	Judgment Flag[1]	30H	0
25	Judgment Flag[1]	30H	0
26	Judgment Flag[1]	30H	0
27	Judgment Flag[1]	30H	0
28	Batch Count	30H	0
29	Batch Count	34H	4
30	Torque Unit[2]	30H	0
31	Torque Decimal[3]	32H	2
32	Rate Decimal[3]	33H	3
33	Cycle Count	31H	1
34	Cycle Count	33H	3
35	Cycle Count	35H	5
36	Cycle Count	37H	7
37	Peak Torque	31H	1
38	Peak Torque	39H	9
39	Peak Torque	39H	9
40	Peak Torque	39H	9
41	Final Torque	31H	1
42	Final Torque	39H	9
43	Final Torque	39H	9
44	Final Torque	39H	9
45	Final Angle	31H	1
46	Final Angle	39H	9
47	Final Angle	39H	9
48	Final Angle	39H	9
49	1st Rate	31H	1
50	1st Rate	39H	9
51	1st Rate	39H	9
52	1st Rate	39H	9
53	2nd Rate	31H	1
54	2nd Rate	39H	9
55	2nd Rate	39H	9
56	2nd Rate	39H	9
57	3rd Rate	31H	1
58	3rd Rate	39H	9
59	3rd Rate	39H	9
60	3rd Rate	39H	9
61	Rate Sign Flag[4]	30H	0
62	1st Rate Incr. TQ.	30H	0
63	1st Rate Incr. TQ.	30H	0
64	1st Rate Incr. TQ.	32H	2
65	1st Rate Incr. TQ.	30H	0
66	1st Rate Incr. Ang.	30H	0
67	1st Rate Incr. Ang.	31H	1
68	1st Rate Incr. Ang.	32H	2
69	1st Rate Incr. Ang.	32H	2
70	2nd Rate Incr. TQ.	30H	0
71	2nd Rate Incr. TQ.	30H	0
72	2nd Rate Incr. TQ.	32H	2
73	2nd Rate Incr. TQ.	35H	5
74	2nd Rate Incr. Ang.	30H	0
75	2nd Rate Incr. Ang.	31H	1
76	2nd Rate Incr. Ang.	30H	0
77	2nd Rate Incr. Ang.	30H	0
78	3rd Rate Incr. TQ.	30H	0
79	3rd Rate Incr. TQ.	30H	0
80	3rd Rate Incr. TQ.	31H	1
81	3rd Rate Incr. TQ.	30H	0
82	3rd Rate Incr. Ang.	30H	0
83	3rd Rate Incr. Ang.	30H	0
84	3rd Rate Incr. Ang.	32H	2
85	3rd Rate Incr. Ang.	31H	1
86	1st Time	30H	0
87	1st Time	30H	0
88	1st Time	36H	6
89	1st Time	35H	5
90	2nd Time	30H	0
91	2nd Time	30H	0
92	2nd Time	32H	2
93	2nd Time	37H	7
94	Rundown Revs	30H	0
95	Rundown Revs	31H	1
96	Rundown Revs	31H	1
97	Rundown Revs	35H	5
98	Offset Torque	30H	0
99	Offset Torque	30H	0
100	Offset Torque	30H	0
101	Offset Torque	30H	0
102	Fastening Mode[5]	30H	0

Byte	Description	Example	
		ASCII	Data
103	Cal Value	32H	2
104	Cal Value	34H	4
105	Cal Value	35H	5
106	Cal Value	32H	2
107	Peak TQ. Lo Limit	31H	1
108	Peak TQ. Lo Limit	31H	1
109	Peak TQ. Lo Limit	30H	0
110	Peak TQ. Lo Limit	30H	0
111	Peak TQ. Hi Limit	31H	1
112	Peak TQ. Hi Limit	34H	4
113	Peak TQ. Hi Limit	30H	0
114	Peak TQ. Hi Limit	30H	0
115	Final TQ. Lo Limit	30H	0
116	Final TQ. Lo Limit	30H	0
117	Final TQ. Lo Limit	30H	0
118	Final TQ. Lo Limit	30H	0
119	Final TQ. Hi Limit	32H	2
120	Final TQ. Hi Limit	34H	4
121	Final TQ. Hi Limit	39H	9
122	Final TQ. Hi Limit	38H	8
123	Standard Torque	31H	1
124	Standard Torque	32H	2
125	Standard Torque	30H	0
126	Standard Torque	30H	0
127	1st Torque	30H	0
128	1st Torque	36H	6
129	1st Torque	30H	0
130	1st Torque	30H	0
131	Snug Torque	30H	0
132	Snug Torque	35H	5
133	Snug Torque	30H	0
134	Snug Torque	30H	0
135	Threshold Torque	30H	0
136	Threshold Torque	32H	2
137	Threshold Torque	30H	0
138	Threshold Torque	30H	0
139	Crossover Torque	30H	0
140	Crossover Torque	36H	6

Byte	Description	Example	
		ASCII	Data
141	Crossover Torque	30H	0
142	Crossover Torque	30H	0
143	2nd Rate Start TQ	30H	0
144	2nd Rate Start TQ	36H	6
145	2nd Rate Start TQ	30H	0
146	2nd Rate Start TQ	30H	0
147	Angle Low Limit	30H	0
148	Angle Low Limit	30H	0
149	Angle Low Limit	30H	0
150	Angle Low Limit	35H	5
151	Angle High Limit	30H	0
152	Angle High Limit	31H	1
153	Angle High Limit	30H	0
154	Angle High Limit	30H	0
155	Standard Angle	30H	0
156	Standard Angle	30H	0
157	Standard Angle	30H	0
158	Standard Angle	30H	0
159	1st Angle	30H	0
160	1st Angle	30H	0
161	1st Angle	30H	0
162	1st Angle	30H	0
163	Crossover Angle	30H	0
164	Crossover Angle	30H	0
165	Crossover Angle	30H	0
166	Crossover Angle	30H	0
167	Correction Angle	30H	0
168	Correction Angle	30H	0
169	Correction Angle	30H	0
170	Correction Angle	30H	0
171	2nd Rate Start Ang.	30H	0
172	2nd Rate Start Ang.	30H	0
173	2nd Rate Start Ang.	30H	0
174	2nd Rate Start Ang.	30H	0
175	3rd Rate Start Ang.	30H	0
176	3rd Rate Start Ang.	30H	0
177	3rd Rate Start Ang.	30H	0
178	3rd Rate Start Ang.	30H	0

Byte	Description	Example	
		ASCII	Data
179	1st Rate Lo Limit	30H	0
180	1st Rate Lo Limit	30H	0
181	1st Rate Lo Limit	31H	1
182	1st Rate Lo Limit	30H	0
183	1st Rate Hi Limit	30H	0
184	1st Rate Hi Limit	35H	5
185	1st Rate Hi Limit	30H	0
186	1st Rate Hi Limit	30H	0
187	1st Rt. Sign Flag[4]	30H	0
188	2nd Rate Lo Limit	30H	0
189	2nd Rate Lo Limit	30H	0
190	2nd Rate Lo Limit	31H	1
191	2nd Rate Lo Limit	30H	0
192	2nd Rate Hi Limit	30H	0
193	2nd Rate Hi Limit	35H	5
194	2nd Rate Hi Limit	30H	0
195	2nd Rate Hi Limit	30H	0
196	2nd Rt. Sign Flag[4]	30H	0
197	3rd Rate Lo Limit	30H	0
198	3rd Rate Lo Limit	30H	0
199	3rd Rate Lo Limit	30H	0
200	3rd Rate Lo Limit	30H	0
201	3rd Rate Hi Limit	31H	1
202	3rd Rate Hi Limit	39H	9
203	3rd Rate Hi Limit	39H	9
204	3rd Rate Hi Limit	39H	9
205	3rd Rt. Sign Flag[4]	30H	0
206	R/D Rev Lo Limit	30H	0
207	R/D Rev Lo Limit	30H	0
208	R/D Rev Lo Limit	30H	0
209	R/D Rev Lo Limit	30H	0
210	R/D Rev Hi Limit	30H	0
211	R/D Rev Hi Limit	30H	0
212	R/D Rev Hi Limit	30H	0
213	R/D Rev Hi Limit	30H	0
214	End Of Text	03H	

Byte Numbers 2 – 106 = actual fastening data
Byte Numbers 107 – 213 = PRESET (limit) data

*Date & Time only with clock (RTC) module installed in Fusion Controller

[1-5]See next page(s) for explanation

Rear Panel RS232 Standard Communication Protocol (Continued)

[1]Judgment Flag
The Judgment Flag uses (6) ASCII bytes for detailed information to identify specific REJECT causes. Below is the definition of byte 1-6 of the Judgment Flag.

Byte 1

Status	Output Data	ASCII (Hex)
Accept	O	4F
Reject	N	4E
Stop	S	53
Bypass	B	42
Abnormal	A	41

Bytes 2-6 use flags to identify reject causes. It uses an ASCII coded hexadecimal format where the upper bits (of the byte) automatically consider an ASCII "3" or "4" for conversion purposes. (hex numbers 0-9 will automatically generate an ASCII "3x", and hex letters A-F will automatically generate an ASCII "4x")

Byte 2
Torque Reject Byte

MSB			LSB

LSB 1 : Peak Torque Low Reject
1 : Peak Torque High Reject
1 : Final Torque Low Reject
MSB 1 : Final Torque High Reject

Byte 3
Angle / Rev Reject Byte

LSB 1 : Angle Low Reject
1 : Angle High Reject
1 : Rundown Revolution Low Reject
MSB 1 : Rundown Revolution High Reject

Byte 4
Time Reject Byte

LSB 1 : 1st Time Reject
1 : 1st Time Low Reject
1 : Final Time Reject
MSB 1 : Final Time Low Reject

Byte 5
Torque Rate Reject Byte

LSB 1 : 1st Rate Low Reject
1 : 1st Rate High Reject
1 : 2nd Rate Low Reject
MSB 1 : 2nd Rate High Reject

Byte 6
Torque Rate Reject Byte

LSB 1 : 3rd Rate Low Reject
1 : 3rd Rate High
1 : Not Used
MSB 1 : Not Used

Rear Panel RS232 Standard Communication Protocol (Continued)

[2]Torque Unit

Unit	Output Data	ASCII (Hex)
Nm	0	30
Kgm	1	31
Kgcm	2	32
Ft. Lb.	3	33
In. Lb.	4	34

[3]Torque / Rate Decimal

Decimal Place	Output Data	ASCII (Hex)
0000.	0	30
000.0	1	31
00.00	2	32
0.000	3	33

[4]Rate Sign Flag

MSB			LSB

LSB 1 : 1st Rate Negative
1 : 2nd Rate Negative
1 : 3rd Rate Negative
MSB 1 : Not Used

[5]Fastening Mode

Fastening Method	Output Data	ASCII (Hex)
Torque Control	0	30
Angle Control	1	31

4.8.4 Rear Panel RS232 Abbreviated Communication Protocol

The RS232C output format can be switched between the standard format (preceding page) and the abbreviated format shown below. This function is available in firmware versions 2.22 or later. The table below describes the data set-up for enabling and configuring the abbreviated output format.

Work #	Data #	Item	Setting
00	40	Format selection	0: Standard (214 bytes) Data # 41 ~ 49 Disabled 1:Abbreviated (32bytes) Data # 41 ~ 49 Enabled
00	41	End data selection	0: 0Dh (CR) 1: 0Ah (LF) 3: 0Dh+0Ah (CR & LF)
00	42	Comm. Speed	1: 9600 BPS 2: 19200BPS 3: 38400BPS
00	43	Data bit	0: 7Bit 1: 8 Bit
00	44	Stop bit	0: 1 Bit 1: 2 Bit
00	45	Parity	0: None 1: Even 2: Odd
00	46	Torque data	0: No data 1:Enable data
00	47	Angle data	0: No data 1:Enable data
00	48	Cycle Time data	0: No data 1:Enable data
00	49	Judgment	0: No data 1:Enable data

Example of abbreviated format:

Byte	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Desc.	Spindle #		Work	Cycle Count			Peak Torque					Final Angle				
ASCII Hex	23H	31H	31H	30H	31H	32H	31H	32H	2EH	33H	34H	31H	31H	32H	2EH	33H
Data	#	1	1	0	1	2	1	2	.	3	4	1	1	2	.	3

Byte	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Desc.	Not Used									Cycle Time				Judge
ASCII Hex	30H	30H	30H	30H	30H	30H	30H	30H	30H	31H	32H	2EH	33H	40H
Data	0	0	0	0	0	0	0	0	0	1	2	.	3	@

Byte	31		31		31	32
Desc.						
ASCII Hex	0DH	OR	0AH	OR	0DH	0AH
Data	CR		LF		CR	LF

Definition of "Judge" (Byte 30):

@ = Accept G = Stop
E = Low Time Reject F = Time Reject
P = Bypass
K = Angle High Reject J = Angle Low Reject
I = Torque High Reject H = Torque Low Reject
A = Abnormal X = Other Reject

4.8.5 Rear Panel RS232 Alternate Communication Protocol

An alternate communication protocol is available upon set-up in a different “Fastening Function Mode” (See 7.2.5 Fastening Function Version [Work]-00, [D-No]-03) If the system is set-up in a “DDK” mode, this protocol becomes the Standard Communication Protocol.

This alternate protocol has 79 bytes of data per fastening.

Byte	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Desc.	Cycle Count						Spindle Number				Work Number			
ASCII Hex	30H	30H	30H	31H	20H	20H	30H	31H	20H	20H	20H	31H	20H	20H
Data	0	0	0	1			0	1				1		

Byte	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Desc.	Peak Torque					Judge			Final Angle				Judge	
ASCII Hex	31H	32H	2EH	33H	34H	4CH	20H	20H	20H	20H	35H	30H	48H	20H
Data	1	2	.	3	4	L					5	0	H	

Byte	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
Desc.	Final Torque					Judge			1st Rate					Judge		
ASCII Hex	31H	32H	2EH	33H	34H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H	20H
Data	1	2	.	3	4				0	.	1	2	3			

Byte	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Desc.	2nd Rate					Judge			3rd Rate					Judge		
ASCII Hex	30H	2EH	31H	32H	33H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H	20H
Data	0	.	1	2	3				0	.	1	2	3			

Byte	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79
Desc.	1st Time					Judge			2nd Time					Judge			Final Judge	CR	LF
ASCII Hex	20H	31H	30H	2EH	30H	20H	20H	20H	20H	20H	32H	2EH	30H	20H	20H	20H	58H	0DH	0AH
Data		1	0	.	0						2	.	0				X		

Final Judgment: “X” Reject = 58H, “O” Accept = 4FH, “A” Abnormal = 41H, “S” Stop=53H, “B” Bypass=42H
Judge: “H” High Reject= 48H, “L” Low Reject= 4CH (H = Hex)

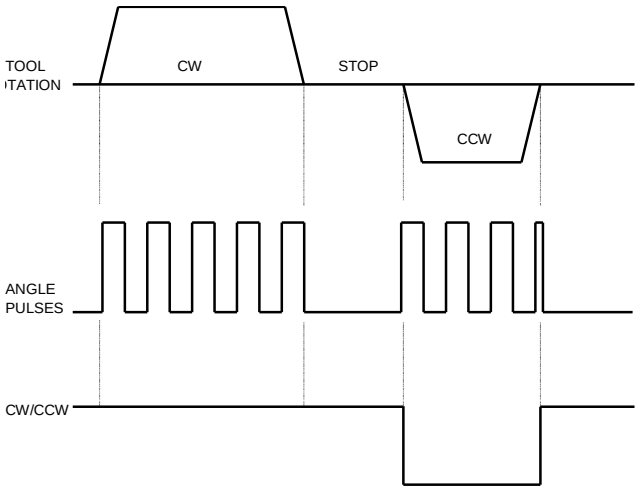
4.9 T/A MON. DB9 Connector - External Torque/Angle/Current/Speed Output

This auxiliary connector is used to output Torque, Angle, Current & Speed signals to external equipment for monitoring purposes (X-Y Plotter, etc). The signals output from this connector are the same signals that the system receives during the fastening process. This connector is not required for the system to operate.

No	Signal	In/Out	Description
1	None		
2	None		
3	Angle Pulse	Out	Angle Pulse Monitor TTL
4	Angle CW/CCW	Out	CW/CCW Monitor TTL
5	GND	Out	Ground
6	None		
7	Current Monitor	Out	-10V～+10V 10V=(HFC-EC-16 16A)
8	Speed Voltage Monitor	Out	-10V～+10V 10V=Max Speed
9	Torque Monitor	Out	Max Torque=2.5V

Torque voltage (Analog voltage)
Monitor voltage represents zero torque to full-scale torque by an electric potential difference of 2.5V.
Zero Level voltage is voltage measured with the nutrunner stopped with no load.
Angle pulse (TTL signal 0V or 5V)
Angle pulse is output at 1 pulse per degree.
It differs slightly from the actual angle of rotation displayed from the controller.
Normal/reverse revolution pulse (TTL signal 0V or 5V)
A 5v (High) signal is output during CW revolution, and 0V (Low) signal is output during CCW revolution.

Angle and direction are output as shown below;



4.10 Controller Unit DIP Switch Setting.

In a multiple controller unit system, it may be beneficial to address the controllers for organizational purposes. The number is set using the DIP switch located behind the access panel on the back panel of the unit.

DIP switch located on printed circuit board through access panel at the back of unit.

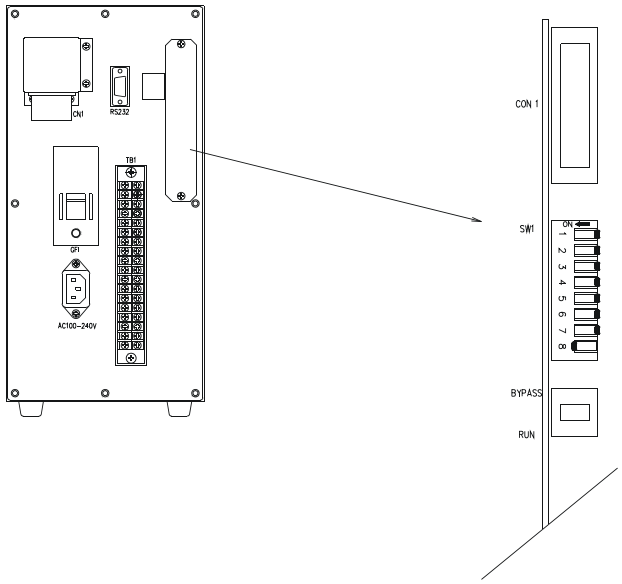


FIG. 4-10 Dip Switch settings

4.10.1 Controller Unit DIP Switch positions 1 ~ 3

- DIP switch positions 1 ~ 3 are used for setting the special configuration features as defined in the following explanation. The DEFAULT setting is switch 1 – 3 OFF.
- DIP Switch 1 - **Zero Check acceptance window selection**.
  - ON – Expanded Zero Check acceptance window
  - OFF – Normal Zero Check acceptance window
- DIP Switch 2 - **NOT USED**
  - ON – Not Used
  - OFF – Not Used
- DIP Switch 3 - **Disable Motor Ramp Down**.
  - ON - Enables dynamic brake for motor speed changes.
    - Used for applications which overshoot standard torque
    - Will reduce Motor/Tool life
  - OFF - Disables Dynamic brake during speed changes (Default)

Note: The Controller unit must be powered off and on again for the DIP switch changes to be initialized.

4.10.2 Controller Unit DIP Switch positions 4 ~ 8

DIP switch positions 4 ~ 8 are used for setting the Controller unit spindle address number as described in the following table. This can be beneficial if fastening data is being collected from multiple spindles whereas the data needs to be identified differently between each spindle. Do not set two spindles with the same address.

Note: The Controller unit must be powered off and on again for the DIP switch changes to be initialized

Unit No.	DIP SWITCH NUMBER				
	4	5	6	7	8
1	OFF	OFF	OFF	OFF	ON
2	OFF	OFF	OFF	ON	OFF
3	OFF	OFF	OFF	ON	ON
4	OFF	OFF	ON	OFF	OFF
5	OFF	OFF	ON	OFF	ON
6	OFF	OFF	ON	ON	OFF
7	OFF	OFF	ON	ON	ON
8	OFF	ON	OFF	OFF	OFF
9	OFF	ON	OFF	OFF	ON
10	OFF	ON	OFF	ON	OFF
11	OFF	ON	OFF	ON	ON
12	OFF	ON	ON	OFF	OFF
13	OFF	ON	ON	OFF	ON
14	OFF	ON	ON	ON	OFF
15	OFF	ON	ON	ON	ON

Unit No.	DIP SWITCH NUMBER				
	4	5	6	7	8
16	ON	OFF	OFF	OFF	OFF
17	ON	OFF	OFF	OFF	ON
18	ON	OFF	OFF	ON	OFF
19	ON	OFF	OFF	ON	ON
20	ON	OFF	ON	OFF	OFF
21	ON	OFF	ON	OFF	ON
22	ON	OFF	ON	ON	OFF
23	ON	OFF	ON	ON	ON
24	ON	ON	OFF	OFF	OFF
25	ON	ON	OFF	OFF	ON
26	ON	ON	OFF	ON	OFF
27	ON	ON	OFF	ON	ON
28	ON	ON	ON	OFF	OFF
29	ON	ON	ON	OFF	ON
30	ON	ON	ON	ON	OFF
31	ON	ON	ON	ON	ON

4.11 Tool Cable Connection

- Tools are connected to the controller using one cable. One cable connects to the torque transducer preamp, motor and resolver. Each cable should be labeled with a specific spindle or identification number and should be connected to the corresponding controller and tool.
- Cables should be supported to reduce fatigue points. Cable tie points should be loose enough to allow the cable to move, but yet hold it in place. Cable tie points that are too tight cause a stress point leading to premature cable failure.

WARNING: Do not make motor connections with the power on. Turn off all controller power before attempting to connect or disconnect any motor cables or tool damage may occur.

Recommended cable length: 75' or less.
Maximum cable length: 100' (must be free from Electrical Noise)

SILVER Tool Style Cables ("-01" Model designation)

FEC Part #	Cable Description	Length
FEB-1309-M5	Main Cable Straight Female Plug	5 meter
FEB-1309-M10	Main Cable Straight Female Plug	10 meter
FEB-1309-M15	Main Cable Straight Female Plug	15 meter
FEB-1311-M5	Main Cable 90 Degree Female Plug	5 meter
FEB-1311-M10	Main Cable 90 Degree Female Plug	10 meter
FEB-1311-M15	Main Cable 90 Degree Female Plug	15 meter
FEB-1310-M1	Extension Cable Straight Female Plug	1 meter
FEB-1310-M2	Extension Cable Straight Female Plug	2 meter
FEB-1310-M3	Extension Cable Straight Female Plug	3 meter
FEB-1310-M5	Extension Cable Straight Female Plug	5 meter
FEB-1310-M10	Extension Cable Straight Female Plug	10 meter
FEB-1312-M1	Extension Cable 90 Degree Female Plug	1 meter
FEB-1312-M2	Extension Cable 90 Degree Female Plug	2 meter
FEB-1312-M3	Extension Cable 90 Degree Female Plug	3 meter
FEB-1312-M5	Extension Cable 90 Degree Female Plug	5 meter
FEB-1312-M10	Extension Cable 90 Degree Female Plug	10 meter

Wave Washer (Part # WAV-25036) can be used to tighten the tool side twist lock connector. The washer must be split and inserted by threading the washer underneath the twist lock rollers.

GOLD Tool Style Cables ("-10" model designation)

FEC Part #	Cable Description	Length
C15-F7-M05	Main Cable Straight Female Plug	5 meter
C15-F7-M10	Main Cable Straight Female Plug	10 meter
C15-F7-M15	Main Cable Straight Female Plug	15 meter
C15-EF7-M05	Extension Cable Straight Female Plug	5 meter
C15-EF7-M10	Extension Cable Straight Female Plug	10 meter
C15-EF7-M15	Extension Cable Straight Female Plug	15 meter

4.11.1 Cable Installation Guidelines

Improper installation of cables can reduce cable life expectancy drastically. The following guidelines should be used when installing cables.

- The cables must be prepared for installation without twists, bends or kinks. Upon unpacking the cables, any tie wraps used in shipping should be removed.
- Before inserting the cables in the cable tray, cable track or other overhead suspension, it is important that the cables be laid out or hung prior to installation long enough to relax any stresses and remove any “memory” resulting from packaging, transit or storage. If the cables cannot be relaxed, they should be shook out by grasping the cable length at its mid point and shaking the cables as you move to each end. Then, wrap the end of each cable with masking tape and make alignment marks on the top of each end. Maintain this alignment throughout the installation to assure cable is not being twisted.
- The minimum recommended bending radius of the cable should not be exceeded. The minimum bend radius is calculated by multiplying the cable’s outer diameter by ten **(Rmin = O.D. x 10)**. When multiple cables are run together, the largest diameter cable in the bundle should be used for calculating bend radius. Minimum bend radius must be increased when repeated flexing occurs at a given point on the cables.
- Use the most direct path when routing cables.
- Do not weave cables between or wrap around one another.
- Route cables and connectors away from liquid of any type.
- Protect cable connectors from any impact or abrasion that may cause damage (IE: pulling cables through cable tray and dropping cables to the floor).
- Check cable route for possible chafing or abrasion points. Re-route or protect cable at these points with a nylon cable wrap or similar means to avoid future cable damage.
- The use of plastic cable ties (ty-wraps) should be avoided if possible. The use of Velcro straps is preferable. If the use of plastic cable ties cannot be avoided, the following practices should be followed:
    - Cables should not be tied so tight as to cause indentations in the cable jacket. Flexible cables are designed to move inside their cable jacket. If this movement is restricted, wires in the cable may become stressed and break.
    - Plastic cable ties around grouped cables should be used minimally so that cables have the ability to move individually rather than all as one.
    - An acceptable method is to include the use of a flexible tubing or sleeve between the plastic cable tie and the cable(s).
- Do not tie or hang anything, whatsoever, from tool cables.
- Avoid running cables directly next to high voltage or high frequency lines.
- Cables must be supported near connectors in panel and at tool to avoid strain on connection points.
- Certain tool operations may have foreseeable cable damaging aspects which are unavoidable. In these situations a shorter “extension” cable can be provided with the expectation of replacing this intermediate, less expensive cable as required. The use and proper placement of an “extension” cable will also make cable replacement less time consuming.

4.11.2 Considerations for Cable Trolleys

- Cables hung by festooning type systems must be secured to the individual cable trolley and positioned to avoid sharp bends and eliminate or minimize any torsion twisting.
- Restraint cords should be used in between cable trolleys to limit movement and reduce the stress on cables as they are extended. Restraint cord lengths must always be shorter than the length of cable hung between trolleys.
- Cable loops should be consistent in length,typically not exceeding 5 feet in depth between trolleys. Sufficient number of trolleys should be used in a system to support the entire length of moving cable and to allow relaxed stacking/festooning of cable loops when tool is in the retracted position.
- One trolley should be fixed to the runway rail to eliminate tugging on or stretching of cables.

4.11.3 Considerations for Flexible Cable Tracks

- Cables must **under no circumstances** have the opportunity to tangle. Therefore the clearance height of a track compartment with several similar cables next to one another **must not amount to more that one and a half times the cable diameter**.
- There should be an “all around” minimum clearance between cables of 10% of the cable’s diameter.
- Cables and hoses with very different diameters should be laid separately. Separation is achieved by using Flexible Track separators. The following rules should be followed for cable separation:
    - If (Cable 1 Diameter) + (Cable 2 Diameter) > 1.2 x Track Inner Height, then no separation is necessary.
    - If (Cable 1 Diameter) + (Cable 2 Diameter) ≤ 1.2 x Track Inner Height, then a horizontal or vertical separator must be used to reduce the inner height, thereby preventing the entanglement of the cables.
- The cable weight should be symmetrically distributed along the width of the track.
- Cables must be able to move freely along the radius.
- The cables must be secured with strain relief at both ends. In exceptional cases, the cables may be fixed with strain relief at the moving end only. Unless using a Flexible Cable Track with integrated strain relief, a gap of 10~30 x cable diameter between the end of the bending segment and the fixed point is recommended for most cables.
- **Under no circumstances should excess cable be put into a Flexible Cable Track.**

4.11.4 Considerations for Cable Trays & Ladders

- Cable drop out panels should be used where cables enter and exit a tray or ladder system. Sharp bends need to be avoided whenever possible.
- Cables should be secured at both entry and exit points of a tray or ladder.
- Avoid running high voltage or high frequency cables in the same tray or ladder as signal or control cables unless cables are designed for such environments.
- If excess cable is to be stored in a tray or ladder, do not tightly coil cable. Cable should be laid in as large of a loop as possible.

4.11.5 Tool Cable - Preamplifier Pins.

The preamplifier connection links the controller to the tool torque transducer to:
a) Read the torque voltage values from the preamplifier.
b) Test the preamplifier full scale torque via the calibration function.
c) Test the preamplifier zero level by the zero level check function.
d) Read and Write the EEPROM memory located in the preamplifier.

PIN	DESCRIPTION
T	TRx +
J	TRx -
G	GND
F	+12VDC
H	TORQUE OUT
E	-12VDC

4.11.6 Tool Cable - Motor Pins

The Motor connection provides control power to the motor.

PIN	DESCRIPTION
N	FRAME GROUND
L	W PHASE
M	V PHASE
A	U PHASE

4.11.7 Tool Cable - Resolver Pins

The resolver connection handles the signals which define the rotation of the motor.
The controller provides a signal to the winding of the rotor. As the rotor spins, two sets of stators electrically shifted 90 degrees generate a sine wave and a cosine wave signal. Both signals are processed by the controller to define position and speed of the motor.

PIN	DESCRIPTION
C	ROTOR (R1)
P	STATOR (S2)
V	STATOR (S1)
D	ROTOR R2
R	STATOR S4
S	STATOR S3
N	SHIELD

4.12 Firmware Flash Connector (CN8)

Upgrades or revisions to Firmware are handled easily with the on board Flash connector located behind the access panel on the bottom of each controller Unit. There is no need to remove or disassemble the unit. A Flash adapter (CONTROLLER-ROM) containing the new firmware can be connected to connector CN8 with the power off to the unit. The power is then cycled on until the ACCEPT LED is blinking indicating the firmware upload is complete. Turn off power and remove the flash adapter. The firmware update is now complete.
Note: This connector is for FEC use only and it is not recommended for use other than FEC.

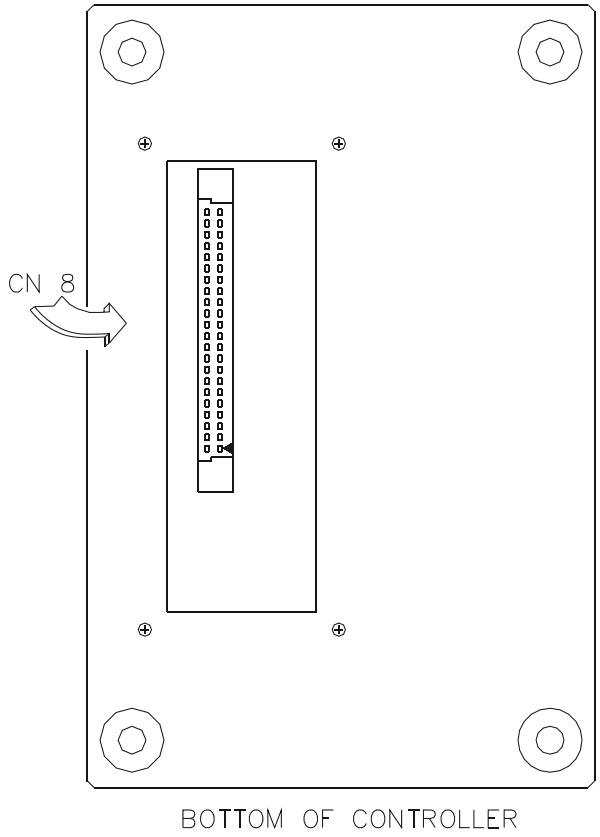


FIG 4-12: CN8 location (CONTROLLER) unit bottom view).

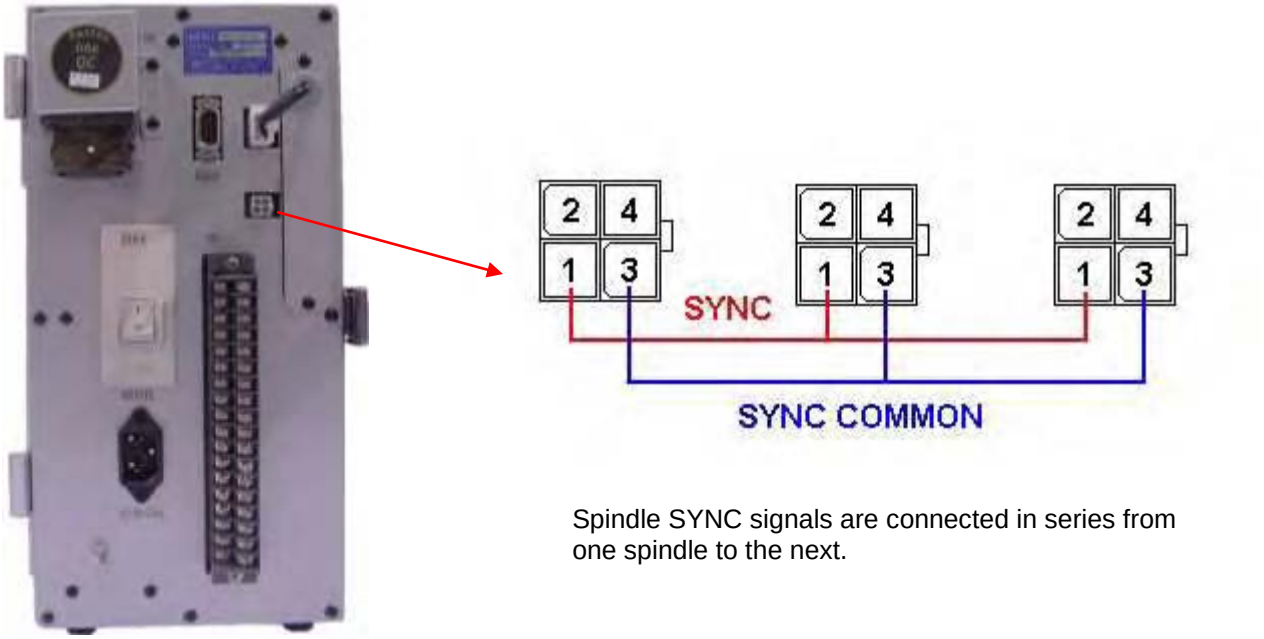
4.13 SYNC Connector

The Sync connector is provided for a means to synchronize more than one spindle during the fastening process. Synchronized fastening allows spindles to synchronize at a preset torque before attempting to reach the next target or final torque. For synchronized fastening operation using individual Fusion controllers, the SYNC terminals must be wired between all affected spindles.

The SYNC signals are Bi-directional signals for synchronized fastening (5V, TTL signal).

1. At the start of the cycle until reaching the synchronization point (1st torque), the SYNC signal is ON (LOW condition) to stop other Fusion Units from continuing to the second step (wired OR).
2. When the 1st torque is reached, the signal works as an input signal. If it reads LOW - meaning that other Fusion units have not reached 1st torque yet - the Fusion unit stays in the standby state waiting for all connected spindles to reach first torque.

When the SYNC signal is HIGH (all Fusion units have completed the first step), all units simultaneously start the second step.



Spindle SYNC signals are connected in series from one spindle to the next.

Fig. 4.13 Sync Connector

CN6 (Sync Connector)	
PIN	**DESCRIPTION**
1	Sync Signal (5V TTL)
2	Not Used
3	Sync Common (0v)
4	Frame Ground (FG)

4.14 Options – Ethernet card

An optional Ethernet card is available for “AFC Programming / Monitoring software” connection as well as fastening data communication over an Ethernet network (TCP/IP – 10 / 100BaseT). Current developed communication protocols include ToolsNet Open Protocol (Atlas Copco), Q-DAS (Qs-Stat), FECNet (proprietary protocol), Part ID / Model select via Ethernet as well as custom protocols as required by customer specifications.

The Ethernet module is installed in the back of the controller located in the top right auxiliary opening. (The Real Time Clock module (RTC) should be removed when using an Ethernet card module.) Connections are made to the RS232 port as well as the TB1 terminal strip.

The Ethernet module is set-up using an onboard browser - based configuration firmware that allows a laptop to connect to the module by an Ethernet connection and set-up the module without installing additional software. This configuration allows you to set-up the Ethernet module to communicate over various networks (described above).

For configuration, an Ethernet CROSSOVER cable (FEC Part # A3X126-07-YLW-M) must be used between the configuration computer and the Ethernet module.

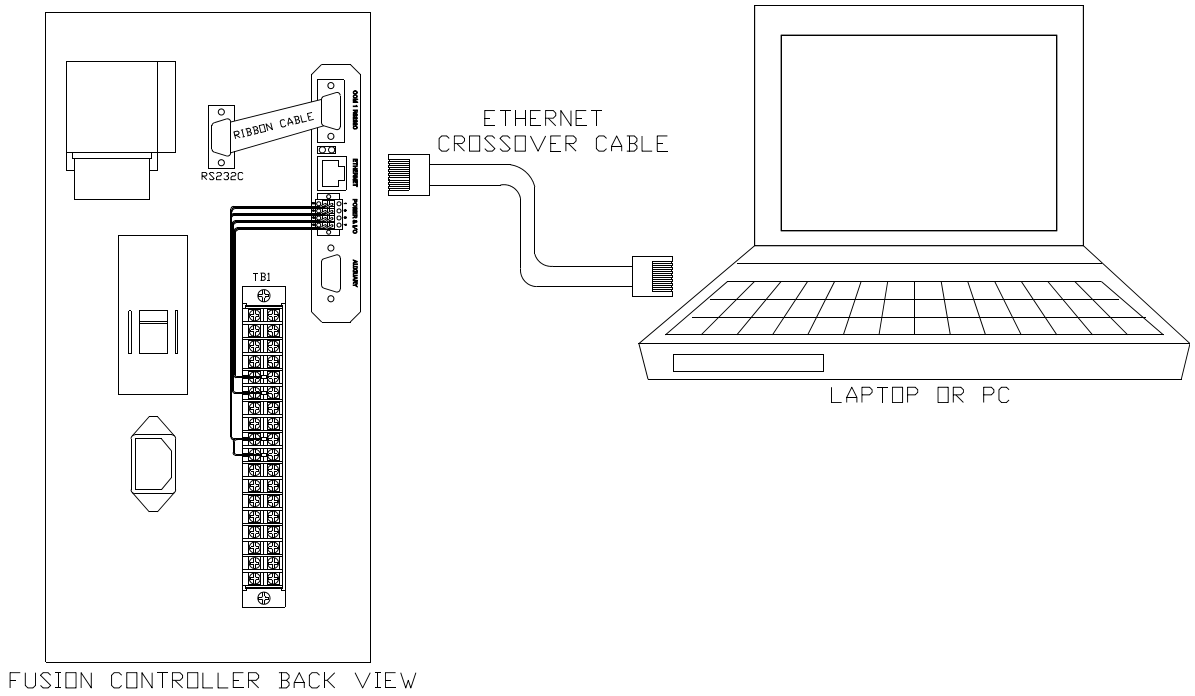


Fig. 4.14 Ethernet Configuration

4.14.1 Ethernet Set-up of PC to Communicate to Ethernet Module

The PC used to configure the Ethernet module must have the Ethernet TCP/IP settings configured for the following to communicate to the Fusion Ethernet module.
(See you network administrator or Windows® support for detailed information to set-up your Ethernet port if you are unfamiliar with Ethernet port set-up. You may also request the "Fusion Ethernet Module Set-Up Procedure" from FEC for more detail)

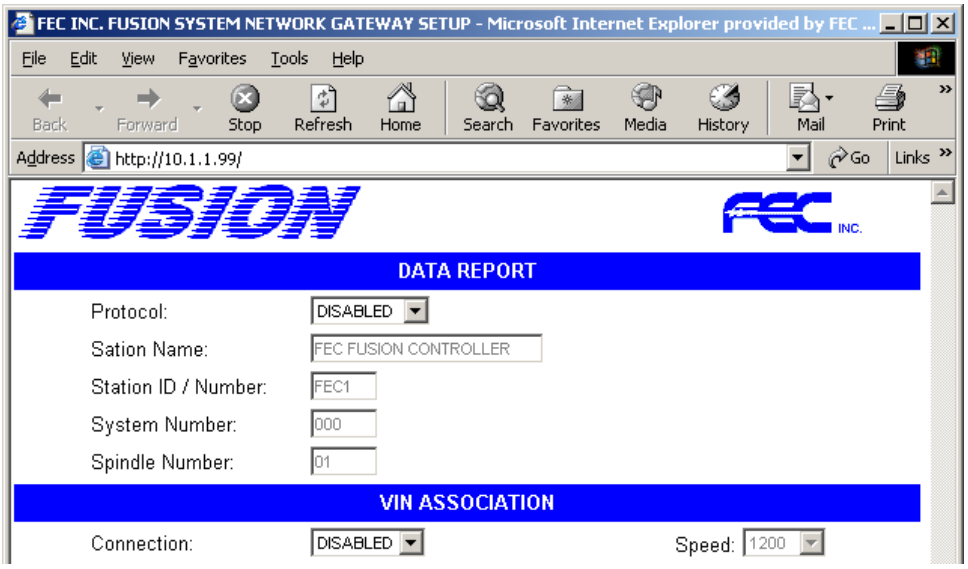
PC Ethernet Set-up

IP address: 192.168.10.40
Subnet mask: 255.255.255.0
Default Gateway:192.168.10.1

Once the PC is configured and connected to the Ethernet Module using an Ethernet cross-over cable, you can use your web browser (Ex. Internet Explorer) to configure the Ethernet module including the network IP address , Station Name, etc.

Open the web browser and put this address in the address bar ; 

This screen should appear:



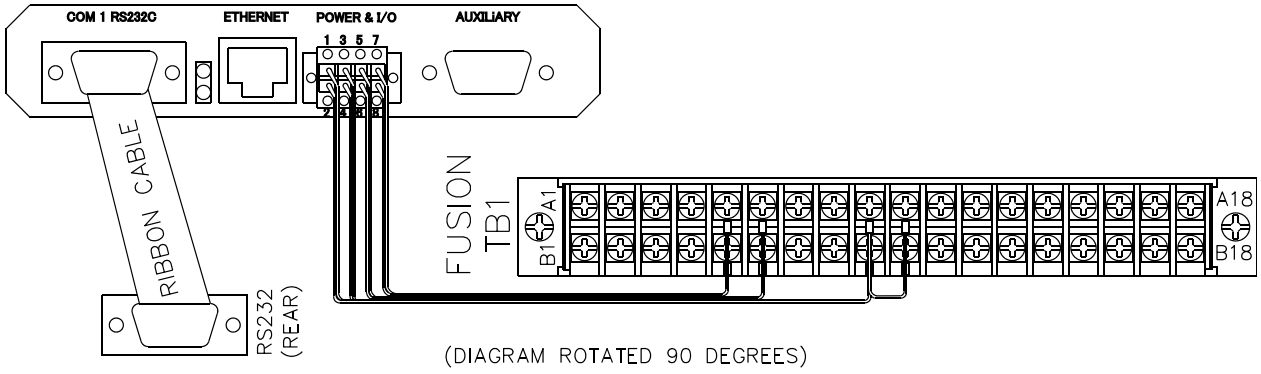
If this screen does not appear, re-check your cables and connection. (See the "Fusion Ethernet Module Set-Up Procedure" from FEC for more detail)

Note: If this screen does not show up, the IP address setup of the Fusion Ethernet module may have already been changed. The IP configuration setup of the Fusion Ethernet Module can be reset to default by putting a jumper wire between pin 3 and 5 of the Fusion Ethernet I/O "Power & I/O" connector at power up. (Power down, put jumper in and power up – jumper can be removed after resetting IP address)

Once the Ethernet module is configured for the network you are connecting to, you can disconnect the PC and cycle power. Upon the next power-up, the Ethernet module can be connected to the configured network using the IP address that was configured. (Tag the Ethernet port with the configured IP address for future easy reference)

4.14.2 Ethernet Module Connection

The Ethernet Module connections are shown below. Note that the power for the module is supplied from the Fusion controller TB1 terminal. Optional Work Select terminations only need to be made if the desired Ethernet protocol requires selection of work selects by Ethernet.



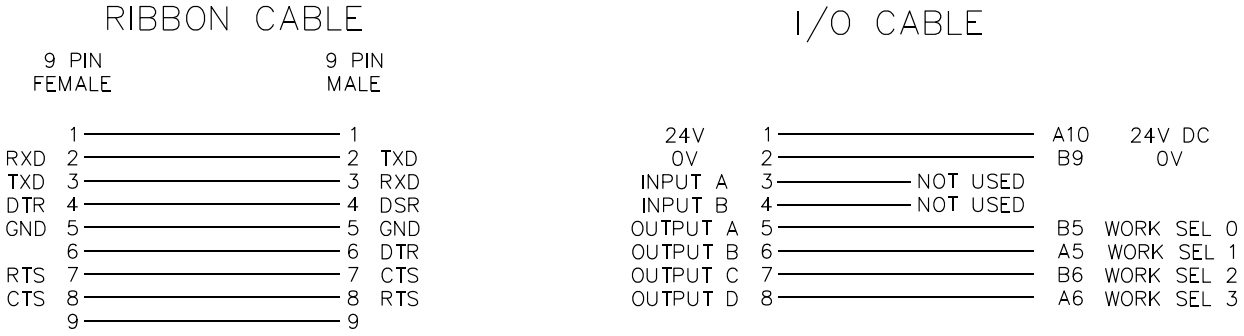
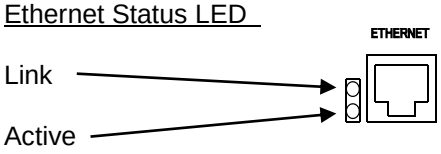


Fig. 4.14.2 Ethernet Module Connection

Connection to an Ethernet network is done by using the RJ-45 Ethernet port on the Ethernet module. (Set-up of the TCP/IP configuration must be completed in the module set-up before communication can take place) After Connection to an Ethernet network, the Ethernet status is displayed on the Ethernet Status display LED's located just above the RJ-45 Ethernet connection port (shown to the left of the Ethernet port on the drawing above)



Link: LED is "ON" (solid) when link is established
Active: LED flashes during data transmission

4.15 Options – Fieldbus Interfaces

The Fusion controller is able to operate under different Input/Output control structures through use of a modular I/O interface board installed in the rear of the unit. With the introduction of "Open" communication networks known as "Fieldbus", the direct interfacing to these networks became necessary. FEC integrated many of these Fieldbus interfaces directly into our system through use of a modular I/O board interfacing these networks directly to our I/O.

The available I/O interfaces are: Profibus, Devicenet, Ethernet I/P, CClink & Allen Bradley Remote I/O. (others available - Contact FEC for additional Fieldbus requirements) The fieldbus interface boards are integrated directly to internal I/O signals which eliminate associated I/O wiring thus reducing overall assembly labor. In fieldbus systems, the communication is typically of the Master/Slave format in which the FEC unit is a slave to the master PLC/CPU. Some of the Fieldbus interfaces are also capable of sending limited fastening data as well as I/O control.

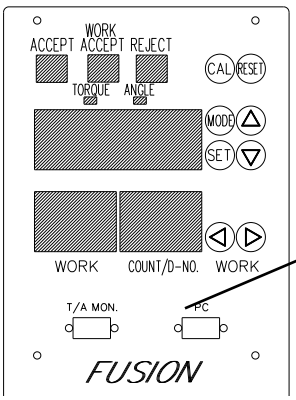
The Fieldbus interface module is factory installed in the rear auxiliary opening (where the real time clock (RTC) module normally resides). With a fieldbus interface installed, the real time clock is installed internally with the RTC cable extending through the fieldbus cover plate for connection to the rear real time clock connector.

Fieldbus interface module is factory-installed in this auxiliary slot.

Note: With the fieldbus module installed for I/O control, the I/O on Terminal TB1 is still enabled

Fieldbus Link Status

The Fusion controller display has a special function for displaying the Fieldbus link status whether the controller is connected and active on the fieldbus network or not.



Count / D

The COUNT/D-NO LED on the front of the controller indicates the fieldbus link status. The two decimal points will illuminate when the Fieldbus link is DISABLED. Check all connections and configurations for proper set-up.

4.15.1 Fieldbus Interfaces – Profibus-DP

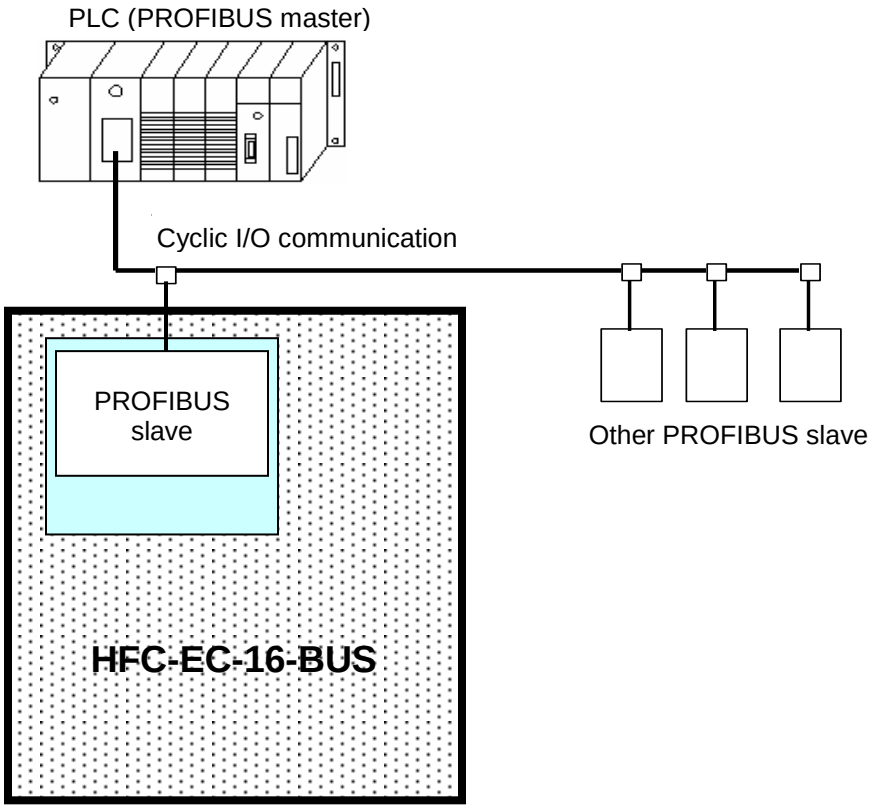
The Profibus-DP communication interface allows slave connection to an industrial Profibus-DP network. Profibus-DP allows industrial devices to be controlled over an open network architecture enabling device connection at various locations in the field. This "Fieldbus" technology reduces hardwiring/cabling & provides ease of installation. It can interface to many devices such as limit switches, sensors, directional valves, motor starters, bar code readers, process sensors, frequency drives, etc. The network can have up to 126 nodes. Its maximum communication baud rate is 12M baud and its minimum baud rate is 9.6K baud. Node addressing is selectable using the address selection switch. Baud rate is auto detected rom the master and no user setup is required. Module & Network status LED's provide network diagnostics.

The Fusion Profibus supports Cyclic I/O only. Messaging (CIP) is not supported.

Maximum configurable I/O is 32 bytes (256bits) input / 32 bytes (256 bits) output.
FEC uses 16 Bytes (128bits) for Fusion OUTPUTS (Fusion to PLC) which includes Binary Integer output of both Fastening Torque & Angle. Fusion INPUTS (PLC to Fusion) uses 4 Bytes (32 bits). The I/O signal map defines the signals/data for each address. (See below)

Note: The Profibus-DP interface is implemented according to the Profibus-DP EN 50 170 (DIN 19245 Part 1) specification.

FEC integrates the Profibus-DP board manufactured by HMS Fieldbus Systems AB into the Fusion modular I/O board. For further technical information on the Profibus-DP interface go to the HMS website. (www.hms.se)
Further Profibus information can be found on the Profibus website at www.profibus..com.



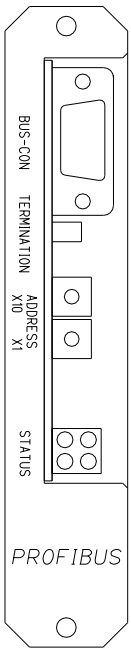
Termination

Termination of the fieldbus requires a terminating resistor at each end of the fieldbus. A termination switch is provided on the Profibus-DP interface board. Set the switch to “ON”, if termination is required. If external terminators are used, the switch must be in the off position.

GSD File

Each device on a Profibus network is associated with a GSD file containing all necessary information about the device to be connected. The network configuration program uses this file during configuration of the network.
The GSD file associated with the FEC device can be downloaded from the FEC website.
www.fec-usa.com (See Support/Download area) (File : hms_1003.gsd)
(the file can also be downloaded directly from HMS - www.hms.se)

Profibus Specifications	
Speed	9.6K - 12M baud – auto-selected
Nodes	126 Note: Node 126 is reserved for commissioning purposes only
Distance	200m max. at 1.5Mbit/s extendable with repeaters.
Cable	Shielded Copper Twisted Pair or fiber optic
Communications Type	Master/Slave - EIA RS485
Protocol Version	Ver. 1.10
Maximum Cyclic I/O Size	244bytes In, 244 bytes out max. 416 total bytes max.
Data transmission	The module only supports cyclic I/O data transmission. Note: Limited Coded Binary Integer data is sent in the cyclic I/O data



Profibus Connector

Termination Switch

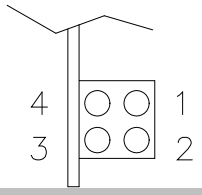
Node Address Switch

LED Status Indicator

Profibus Status LED

Profibus connector - D-Sub		
Pin 1	Not Connected	
Pin 2	Not Connected	
Pin 3	B- Line	Positive RxD/TxD according to RS485 Spec.
Pin 4	RTS	Request to send
Pin 5	GND Bus	Isolated GND from RS 485 side
Pin 6	+5V Bus	Isolated +5V from RS 485 side
Pin 7	Not connected	
Pin 8	A- Line	Negative RxD/TxD according to RS485 Spec.
Pin 9	Not Connected	
Housing	Shield	Connected to PE

Profibus Status LED



Status LEDs		
LED #4 Fieldbus Diagnostics	Red	Indicates faults on fieldbus side
	Flashing Red - 1sec	Config. Error - in/out length set at module initialization does not match length in network config.
	Flashing Red - 2sec	Error in user parameter data - parameter length/content does not match network length/content
	Flashing Red - 4sec	Error in initialization of Profibus communication ASIC
On-Line LED #2	Off	Module not online
	Green	Module online and Normal Communication - OK
Off- Line LED #3	Off	Module is not offline
	Red	Module is offline on the fieldbus

Note: LED #1- Not Used

Node Address

Before configuring the Profibus-DP module the node address has to be set. This is done with two rotary switches on the module which can set the node address 1-99 in decimal format. The Upper rotary switch (closest to the D-sub) sets the "ten" digit (X 10), and the bottom rotary switch sets the single digit. Example: To set node 37, place the "ten" switch on 3, and the single digit switch on 7.
This switch must be set before power is on, and cannot be changed during operation.

Configuration

FEC Profibus I/O is pre-configured according to the I/O Signal Map (See below). Configuration of the Profibus Master MUST match the configuration of the FEC Profibus slave. In the Profibus Master set-up, input size and output size is set as "byte" ordering. (Do not use "word" ordering. This will inverse the I/O location) When setting the Profibus Master configuration, PLC input size refers to FEC output size (ie. Accept, Reject, Busy, etc.) and PLC output size refers to FEC inputs (ie. Start, Stop, Reset, etc.). FEC will show up as 2 modules. Module 1 is inputs, module 2 is outputs.

Profibus I/O Signal Mapping

Input number: 8 bytes (64 bits) Permanently set
Output number: 16 bytes (128 bits) Permanently set

Input Signals

From PLC to Fusion: 4 Words (8 Bytes – 64bits)

Word	Byte	Bit	No.	Description	Comment
01	0	0	1		
		1	2		
		2	3		
		3	4		
		4	5		
		5	6		
		6	7	Reset/Abort Job	Resets initial condition
		7	8		
	1	0	9		
		1	10		
		2	11		
		3	12		
		4	13	Work Select 0	
		5	14	Work Select 1	
		6	15	Work Select 2	
		7	16	Work Select 3	
02	2	0	17	Stop	
		1	18	Reset	
		2	19	Reverse	
		3	20	Start	
		4	21	Bypass	
		5	22	Disable Self-check	
		6	23		
		7	24		
	3	0	25		
		1	26		
		2	27		
		3	28		
		4	29	Batch OK Reset	
		5	30	Work Select 4	
		6	31		
		7	32		

Input Word 03 ~ 04 have no signals assigned and are not shown.

Output Signals

From Fusion to PLC : 8 Words (16 Bytes – 128 Bits)

Word	Byte	Bit	No.	Signal Description	Comment
01	0	0	1	End	
		1	2	Accept	
		2	3	Reject	
		3	4		
		4	5		
		5	6	Job Cycle Accepted	Total Accept for Sequence Function
		6	7		
		7	8		
	1	0	9	Work Select 4 Selected (echo)	
		1	10		
		2	11	Time 1 Reject	
		3	12	Time 2 Reject	
		4	13	Work Select Bit 0 Selected (echo)	
		5	14	Work Select Bit 1 Selected (echo)	
		6	15	Work Select Bit 2 Selected (echo)	
		7	16	Work Select Bit 3 Selected (echo)	
02	2	0	17	Reject	
		1	18	Accept	
		2	19	Abnormal	
		3	20	Ready	
		4	21	Busy	
		5	22	Torque High Reject	
		6	23	Torque Low Reject	
		7	24	Bypass	
	3	0	25	Angle High Reject	
		1	26	Angle Low Reject	
		2	27	Rate1 High Reject	
		3	28	Rate1 Low Reject	
		4	29	Rate2 High Reject	
		5	30	Rate2 Low Reject	
		6	31	Rate3 High Reject	
		7	32	Rate3 Low Reject	
03	4	0	33	Torque Integer bit 0	Outputs Fastening Torque using binary integer 0 - 999 max. (number LEFT of decimal only) Example: Torque Integer bit 2, 4, 7 Logical "1" = 148 Total Torque including Torque decimal (word3) = 148.38
		1	34	Torque Integer bit 1	
		2	35	Torque Integer bit 2	
		3	36	Torque Integer bit 3	
		4	37	Torque Integer bit 4	
		5	38	Torque Integer bit 5	
		6	39	Torque Integer bit 6	
		7	40	Torque Integer bit 7	
	5	0	41	Torque Integer bit 8	
		1	42	Torque Integer bit 9	
		2	43		
		3	44		
		4	45		
		5	46		
		6	47		
		7	48		
04	6	0	49	Torque Decimal bit 0	Outputs Fastening Torque Decimal value using binary integer 0 - 99 max. (number RIGHT of decimal only) Example: Torque Decimal bit 1, 2, 5 Logical "1" = 38
		1	50	Torque Decimal bit 1	
		2	51	Torque Decimal bit 2	
		3	52	Torque Decimal bit 3	
		4	53	Torque Decimal bit 4	
		5	54	Torque Decimal bit 5	
		6	55	Torque Decimal bit 6	
		7	56		
	7	0	57		
		1	58		
		2	59		
		3	60		
		4	61		
		5	62		
		6	63		
		7	64		

Profibus I/O Signal Mapping

(Continued)

Word	Byte	Bit	No.	Signal Description	Comment
05	8	0	65	Angle Integer bit 0	Outputs Fastening Angle value using binary integer 0 - 9999 max. Example: Angle Integer bit 1, 2, 5, 7 Logical "1" = 166
		1	66	Angle Integer bit 1	
		2	67	Angle Integer bit 2	
		3	68	Angle Integer bit 3	
		4	69	Angle Integer bit 4	
		5	70	Angle Integer bit 5	
		6	71	Angle Integer bit 6	
		7	72	Angle Integer bit 7	
	9	0	73	Angle Integer bit 8	
		1	74	Angle Integer bit 9	
		2	75	Angle Integer bit 10	
		3	76	Angle Integer bit 11	
		4	77	Angle Integer bit 12	
		5	78	Angle Integer bit 13	
		6	79		
		7	80		
06-08	Byte 10-15		81		Not Used
			128		

Profibus AFC Software Configuration

Use the AFC User Console software to configure the Fusion controller Fieldbus Setup.

Caution

HFC-EC-16-BUS-PB is preset with the standard Fieldbus setting values. Before changing the settings inside, please make backups.

[Fieldbus Setup screen – AFC software]

BROWSE: Browse Fieldbus configuration files.
SAVE: Save Fieldbus configuration files.
UPLOAD: Upload Fieldbus set up from Fusion controller.
（BUS TYPE will automatically switch per uploaded type）
DOWNLOAD: Download Fieldbus set up to Fusion controller.
(*Cycle power after download.)
VERIFY: Verify Fusion controller set up with AFC software set up.
BUS TYPE: Choose PROFIBUS

Caution

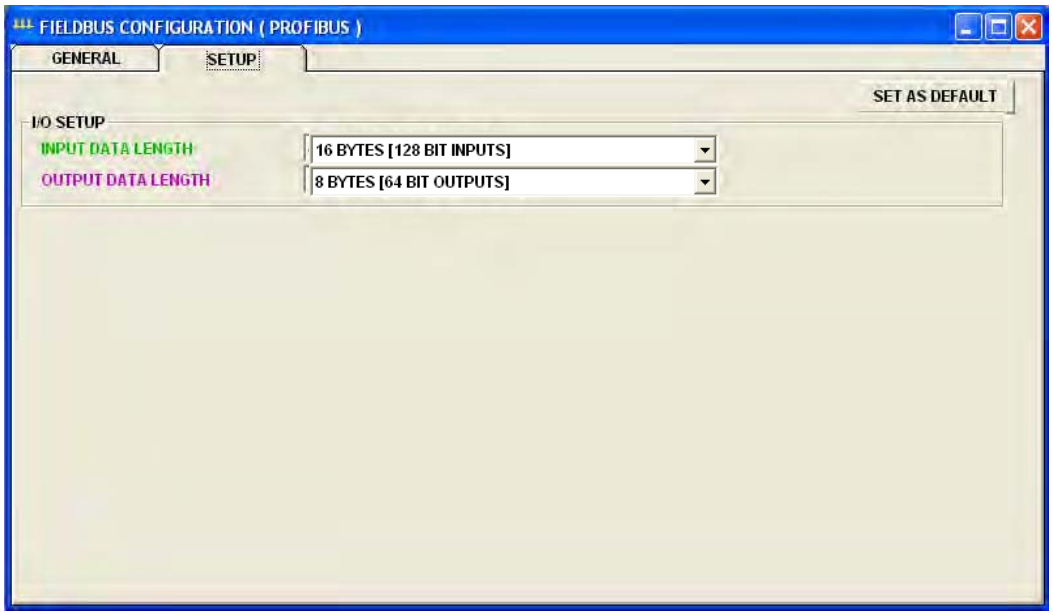
When Fieldbus setting is finished, hit the "SAVE" button to save to a file The Fieldbus setting is downloaded using the "DOWNLOAD" button and/or can be downloaded from the "PARAMETER COMMUNICATIONS" screen by selecting the "Fieldbus Configuration" checkbox (*Cycle power after download.)

・File Extension Information

Item	Extension
Parameter	.PAR
Fieldbus setting	.FCF

Profibus I/O Size Setting

The “SETUP” tab allows you to set the size of the I/O.
Once the size of I/O is set, you must DOWNLOAD the setting to the Fusion Controller. (See above)



●Default set up

Input data length : 16bytes (128bits)
Output data length : 8bytes (64bits)

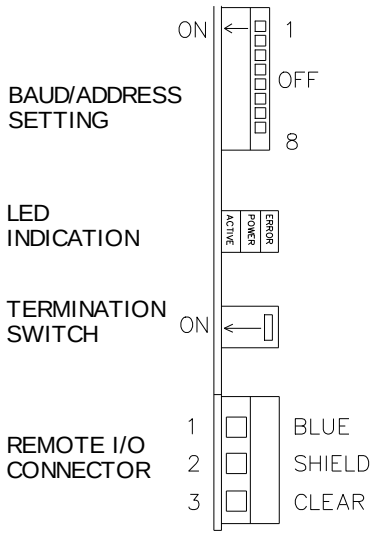
●Available I/O setup

Input data length : 1byte (8bits) ～ 32bytes (256bits)
Output data length : 1byte (8bits) ～ 32bytes (256bits)

4.15.2 Fieldbus Interfaces – Allen Bradley Remote I/O

The Allen Bradley (AB) Remote I/O communication interface allows slave connection to an AB Remote I/O network. FEC has licensed (Lic. #199906006) the use of the AB Remote I/O interface board (through HMS Fieldbus Systems). AB Remote I/O is a proprietary Fieldbus of Allen Bradley. AB - RIO allows industrial devices to be controlled over a network architecture enabling device connection at various locations in the field. The network can have up to 240 nodes with valid rack addresses of 0-59. Its maximum communication baud rate is 230K baud with two other settings of 115K & 57.6K baud.
Rack addressing & baud rate is selectable using the baud/address selection DIP switch.
Module status LED's provide network diagnostics.
Maximum FEC I/O data is 32 inputs & 32 outputs (1/4 Rack). 1/2, 3/4 & Full rack configuration are not supported by the Fusion system.

FEC integrates the AB Remote I/O board manufactured by HMS Fieldbus Systems into the Multi-Unit modular I/O board. For further technical information on the AB Remote I/O interface see the AnyBus -DT reference found at the end of this chapter or go to the HMS website. (www.hms.se)
Further AB Remote I/O information can be found through Allen Bradley's website. (www.ab.com)



Allen Bradley Remote I/O interface Board

Termination

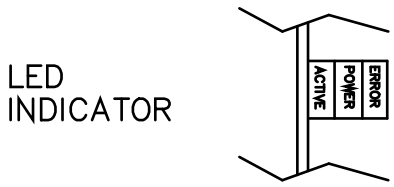
Termination of the RIO network requires a terminating resistor at each end of the network. If this is the last module on the network, turn “ON” the terminating switch located on the interface board.

Specifications

AB Remote I/O Specifications	
Speed	57.6, 115, 230K baud - Selectable
Rack Addresses	0-59
Nodes	up to 240 1/4 racks
Rack Configuration supported	1/4
Distance	57.6k - 3048 meter 115K - 1524 meter 230K - 762 meter
Cable	78 ohm Twinax Belden #9463 or equivalent
Communications Type	Master/Slave

AB Remote I/O connector		
Pin 1	COM line	Blue
Pin 2	GND	Shield
Pin 3	COM line	Clear

Status LED



Status LEDs		
Error	OFF	Normal Operation
	ON - Red	Bus off / Error
Active	OFF	No Communication
	ON - Green	Communication Active
Power	OFF	Power Off
	ON - Green	Power On

Dip Switch Setting

Address setting (DIP switch)

SW-3 (LSB)	SW-4	SW-5	SW-6	SW-7	SW-8	MAC ID
OFF	OFF	OFF	OFF	OFF	OFF	Address 0*
ON	OFF	OFF	OFF	OFF	OFF	Address 1
OFF	ON	OFF	OFF	OFF	OFF	Address 2
ON	ON	OFF	OFF	OFF	OFF	Address 3
.	.	.	.	.	.	.
ON	OFF	OFF	ON	ON	ON	Address 57
OFF	ON	OFF	ON	ON	ON	Address 58
ON	ON	OFF	ON	ON	ON	Address 59

This switch must be set before power is on, and cannot be changed during operation.
*Address should be set to “0” if this is the only device on the network.

Baud rate setting (DIP switch)

SW-1	SW-2	Baud rate
OFF	OFF	57.6K
ON	OFF	115K
OFF	ON	230K
ON	ON	Reserved

Baud rate must match the settings of the Remote I/O scanner.
This switch must be set before power is on, and cannot be changed during operation.

I/O Signal Map

From Fusion to PLC – (4 Bytes – 32 Bits)

	Octal	Bit	Signal Description	Comment
I:00	0	0	End	
	1	1	Accept	
	2	2	Reject	
	3	3		
	4	4		
	5	5	Job Cycle Accepted	Total Accept for Sequence Function
	6	6		
	7	7		
I:00	10	8	Work Select 4 Selected (echo)	
	11	9		
	12	10	Time 1 Reject	
	13	11	Time 2 Reject	
	14	12	Work Select Bit 0 Selected (echo)	
	15	13	Work Select Bit 1 Selected (echo)	
	16	14	Work Select Bit 2 Selected (echo)	
	17	15	Work Select Bit 3 Selected (echo)	
I:01	0	0	Reject	
	1	1	Accept	
	2	2	Abnormal	
	3	3	Ready	
	4	4	Busy	
	5	5	Torque High Reject	
	6	6	Torque Low Reject	
	7	7	Bypass	
I:01	10	8	Angle High Reject	
	11	9	Angle Low Reject	
	12	10	Rate1 High Reject	
	13	11	Rate1 Low Reject	
	14	12	Rate2 High Reject	
	15	13	Rate2 Low Reject	
	16	14	Rate3 High Reject	
	17	15	Rate3 Low Reject	

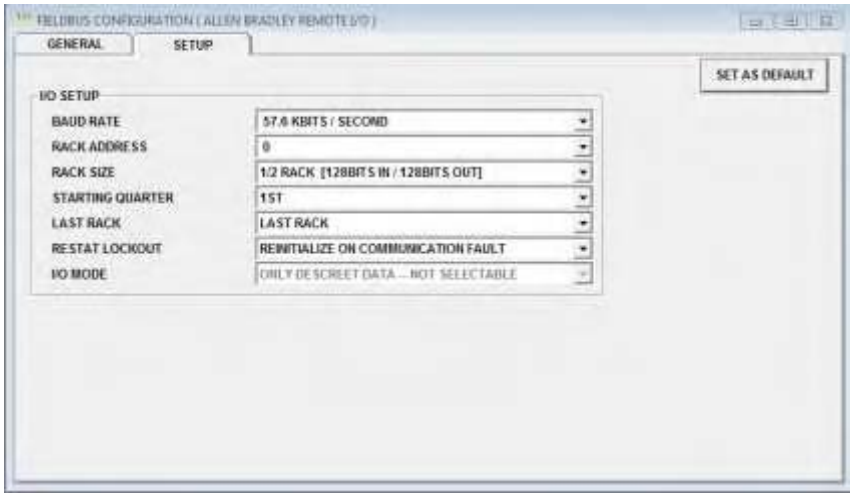
I/O Signal Map
(Continued)

From PLC to Fusion – (4 Bytes – 32 Bits)

	Octal	Bit	Description	Comment
O:00	0	0		
	1	1		
	2	2		
	3	3		
	4	4		
	5	5		
	6	6	Reset	
	7	7		
O:00	10	8		
	11	9		
	12	10		
	13	11		
	14	12	Work Select 0	
	15	13	Work Select 1	
	16	14	Work Select 2	
	17	15	Work Select 3	
O:01	0	0	Stop	
	1	1	Reset	
	2	2	Reverse	
	3	3	Start	
	4	4	Bypass	
	5	5	Disable Self-check	
	6	6		
	7	7		
O:01	10	8		
	11	9		
	12	10		
	13	11		
	14	12	Batch OK Reset	
	15	13	Work Select 4	
	16	14		
	17	15		

Software Configuration

Configuration related to Allen Bradley Remote I/O is configurable using the AFC User Console Software. Configuration should be set as required by your Remote I/O network and downloaded to the Fusion controller.



4.15.3 Fieldbus Interfaces – DeviceNet®

DeviceNet® Interface

The DeviceNet communication interface allows slave connection to an industrial DeviceNet network. DeviceNet allows industrial devices to be controlled over an open network architecture enabling device connection at various locations in the field. This "fieldbus" technology reduces hard wiring/cabling & provides ease of installation. It uses a broadcast-oriented protocol -the CAN (Controller Area Network)- that can interface to many devices such as limit switches, sensors, directional valves, motor starters, bar code readers, process sensors, frequency drives, etc. The network can have up to 64 nodes.

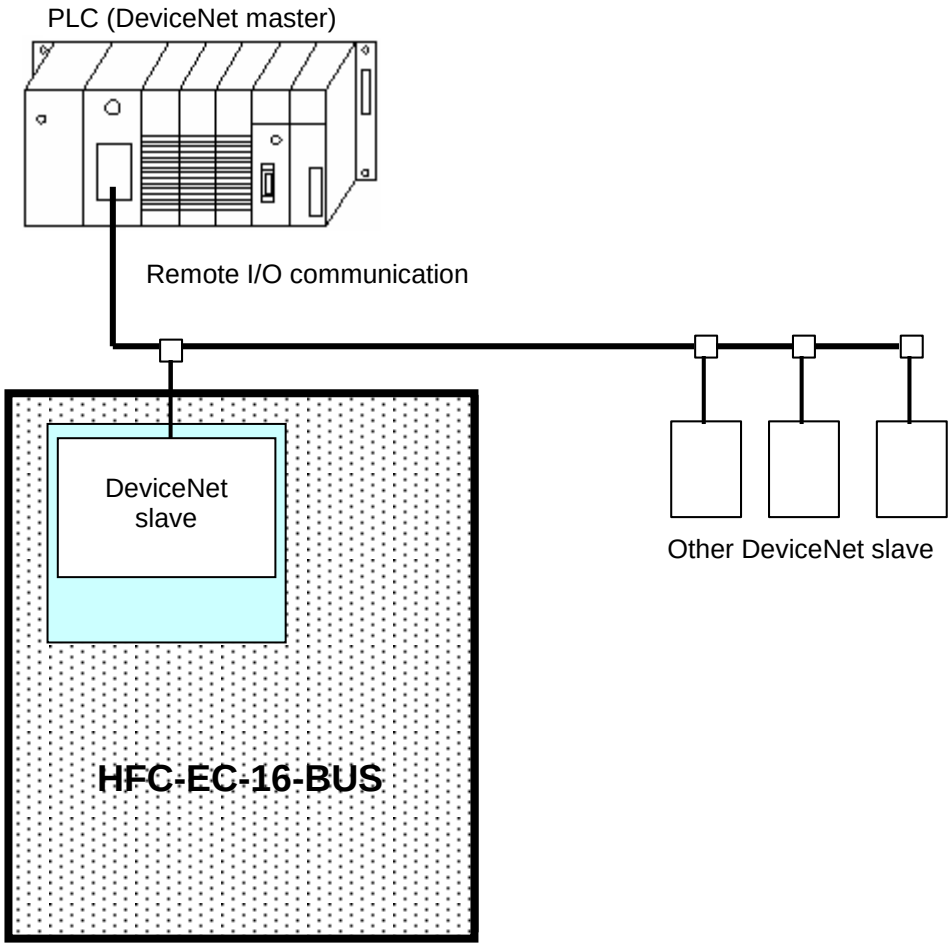
Maximum I/O data is 512 input bytes & 512 output bytes. FEC Inputs/Outputs are shown in the following I/O signal map layout.

Note: The DeviceNet interface is implemented according to the ODVA specification for a communications adapter (profile no.12). It is acting as a "group two only server" on the DeviceNet network.

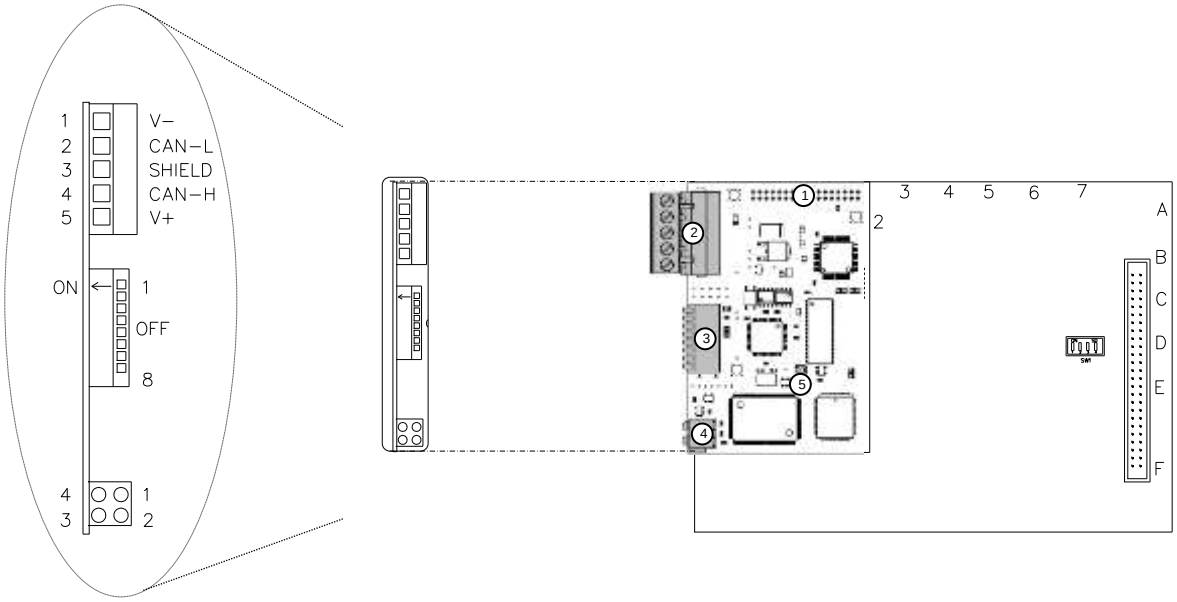
FEC integrates the DeviceNet board manufactured by HMS Fieldbus Systems into the Multi-Unit modular I/O board. For further technical information on the DeviceNet interface go to the HMS website. (www.hms.se)

Further DeviceNet information can be found through the Open DeviceNet Vendors Association (ODVA). (www.ODVA.org)

System Structure



Devicenet Hardware



Interface Board with DeviceNet Daughter Board

Item	Description	
1	Application Connector	
2	DeviceNet Connector	
3	Configuration Switches	
4	Status LEDs (4)	
5	Watchdog LED	Red - (flashing @ 2Hz) - ASIC and FLASH ROM check fault.
		Green (flashing @ 2Hz) - module not initialized.
		Green (flashing @ 1Hz) - module initialized and running OK.
		Red (flashing @ 1Hz) - RAM check fault.
		Red (flashing @ 4Hz) - DPRAM check fault.

DeviceNet Specifications

Speed	125K, 250K and 500K baud
Nodes	64
Maximum Distance	500 meters at 125K baud
	250 meters at 250K baud
	100 meters at 500K baud
Cable	Twisted pair for signal and power Allen Bradley or equivalent ; Thin Cable #1485C-P1-C Thick Cable # 1485C-P1-A
Communications Type	Master/Slave

Interface Board Specifications

Operating Voltage	+5V, 200 ma
Output data bytes	512 max.*
Input data bytes	512 max.*
Servers per group	2 Maximum
Interface type	Dual Port RAM or Serial Interface

* Actual FUSION Configuration only requires 16 Bytes of OUTPUTS (128 points) and 4 Bytes of INPUTS (32 points). Maximum settable size for the FEC board is 32 bytes (256 bits) Input / Output each (See DeviceNet Signal Reference at the end of this chapter for I/O Signal map)
NOTE: Devicenet also support the data Messaging function (CIP) for resultant data transfer. See the Ethernet I/P chapter below for more detail (Devicenet uses similar setup)

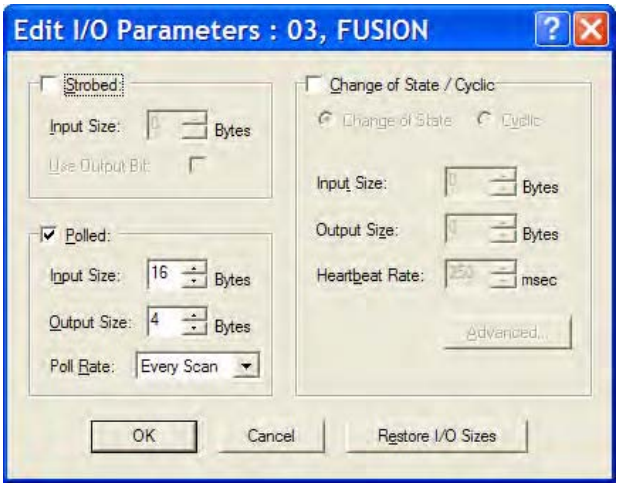
EDS File

Each device on a DeviceNet network is associated with an EDS file containing all necessary information about the device to be connected. The network configuration program uses this file during configuration of the network.
The EDS file associated with the FEC device can be downloaded from the FEC website support & downloads pages. www.fec-usa.com (file: abs.eds)
(the file can also be downloaded directly from HMS - www.hms.se)

Note: The FEC system will appear in the network Vendor list as “HMS Fieldbus Systems” and in the network as “Anybus-S DeviceNet” adapter. This is the manufacturer of the interface board which is integrated into the Multi-2 Unit.

Configuration

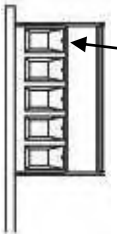
FEC DeviceNet I/O is pre-configured according to the I/O Signal Map (See below). Configuration of the DeviceNet Master MUST match the size configuration of the FEC DeviceNet slave or the network will not connect/operate properly. In the DeviceNet Master set-up using RSNetworx, set the Input/Output length using the “Polled” option. When setting the DeviceNet Master I/O configuration, Input size refers to FEC output size (ie. Accept, Reject, Busy, etc.) and Output size refers to FEC inputs (ie. Start, Stop, Reset, etc.). See the below screen shots of this configuration using RSNetworx.



Termination

Termination of the DeviceNet network requires a terminating resistor at each end of the network. These resistors should have a value of 121 ohms.

DeviceNet Interface Connections

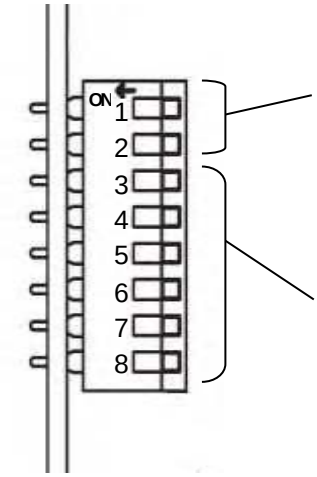


Pin No.	Signal	Wire Color
1	V-	Black
2	CAN_L	Blue
3	Drain/Shield	
4	CAN_H	White
5	V+	Red

See “Termination”

Configuration Switches

On a DeviceNet network, each node must be assigned its own unique Mac ID. The Mac ID is a value between 0 and 63 used to identify each node. The Mac ID and Baud Rate are set using the DIP switches on the front of the module.
These switches must be set before power is on and cannot be changed during operation.



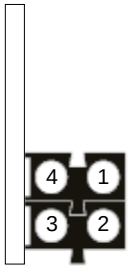
Baud Rate Settings

Baud Rate	SW-1	SW-2
125K	OFF	OFF
250K	OFF	ON
500K	ON	OFF
Reserved	ON	ON

Mac ID Settings

Mac ID	SW-3 (MSB)	SW-4	SW-5	SW-6	SW-7	SW-8 (LSB)
Address 0	OFF	OFF	OFF	OFF	OFF	OFF
Address 1	OFF	OFF	OFF	OFF	OFF	ON
Address 2	OFF	OFF	OFF	OFF	ON	OFF
Address 3	OFF	OFF	OFF	OFF	ON	ON
…	…	…	…	…	…	…
Address 61	ON	ON	ON	ON	OFF	ON
Address 62	ON	ON	ON	ON	ON	OFF
Address 63	ON	ON	ON	ON	ON	ON

Status LEDs



LED	State	Description
1 - Reserved	-	Reserved for future use.
2 - Network Status	Off	Not Powered / Not Online
	Green solid	Link OK, Online, Connected
	Green flashing	Online, Not connected
	Red solid	Critical Link Failure
	Red flashing	Connection Timeout
3 - Module Status	Off	No power to device
	Green solid	Device operational
	Green flashing	Data size bigger than configured
	Red solid	Unrecoverable fault
	Red flashing	Minor fault
4 - Reserved	-	Reserved for future use.

DeviceNet Signal I/O Map

From Fusion to PLC : 8 Words (16 Bytes – 128 Bits)

Data	Bit	No.	Signal Description	Comment
0	0	1	End	
	1	2	Accept	
	2	3	Reject	
	3	4		
	4	5		
	5	6	Job Cycle Accepted	Total Accept for Sequence Function
	6	7		
	7	8		
0	8	9	Work Select Bit 4 (echo)	
	9	10		
	10	11	Time 1 Reject	
	11	12	Time 2 Reject	
	12	13	Work Select Bit 0 (echo)	
	13	14	Work Select Bit 1 (echo)	
	14	15	Work Select Bit 2 (echo)	
	15	16	Work Select Bit 3 (echo)	
0	16	17	Reject	
	17	18	Accept	
	18	19	Abnormal	
	19	20	Ready	
	20	21	Busy	
	21	22	Torque High Reject	
	22	23	Torque Low Reject	
	23	24	Bypass	
0	24	25	Angle High Reject	
	25	26	Angle Low Reject	
	26	27	Rate1 High Reject	
	27	28	Rate1 Low Reject	
	28	29	Rate2 High Reject	
	29	30	Rate2 Low Reject	
	30	31	Rate3 High Reject	
	31	32	Rate3 Low Reject	
1	0	33	Torque Integer bit 0	Outputs Fastening Torque using binary integer 0 - 999 max. (number LEFT of decimal only) Example: Torque Integer bit 2, 4, 7 Logical "1" = 148 Total Torque including Torque decimal (word3) = 148.38
	1	34	Torque Integer bit 1	
	2	35	Torque Integer bit 2	
	3	36	Torque Integer bit 3	
	4	37	Torque Integer bit 4	
	5	38	Torque Integer bit 5	
	6	39	Torque Integer bit 6	
	7	40	Torque Integer bit 7	
1	8	41	Torque Integer bit 8	
	9	42	Torque Integer bit 9	
	10	43		
1	11	44		
	12	45		
	13	46		
	14	47		
	15	48		
1	16	49	Torque Decimal bit 0	Outputs Fastening Torque Decimal value using binary integer 0 - 99 max. (number RIGHT of decimal only) Example: Torque Decimal bit 1, 2, 5 Logical "1" = 38
	17	50	Torque Decimal bit 1	
	18	51	Torque Decimal bit 2	
	19	52	Torque Decimal bit 3	
	20	53	Torque Decimal bit 4	
	21	54	Torque Decimal bit 5	
	22	55	Torque Decimal bit 6	
	23	56		
1	24	57		
	25	58		
	26	59		
	27	60		
	28	61		
	29	62		
	30	63		
	31	64		

DeviceNet Signal I/O Map

(Continued)

Data	Bit	No.	Signal Description	Comment
2	0	65	Angle Integer bit 0	Outputs Fastening Angle value using binary integer 0 - 9999 max. Example: Angle Integer bit 1, 2, 5, 7 Logical "1" = 166
	1	66	Angle Integer bit 1	
	2	67	Angle Integer bit 2	
	3	68	Angle Integer bit 3	
	4	69	Angle Integer bit 4	
	5	70	Angle Integer bit 5	
	6	71	Angle Integer bit 6	
	7	72	Angle Integer bit 7	
2	8	73	Angle Integer bit 8	
	9	74	Angle Integer bit 9	
	10	75	Angle Integer bit 10	
	11	76	Angle Integer bit 11	
	12	77	Angle Integer bit 12	
	13	78	Angle Integer bit 13	
	14	79		
	15	80		
Data 2-3	16	81		
	31	128		

From PLC to Fusion: 2 Words (4 Bytes – 32bits)

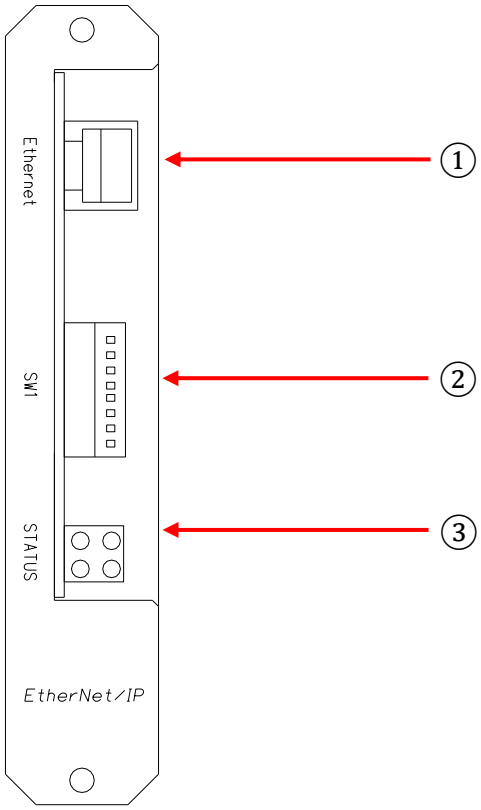
Data	Bit	No.	Description	Comment
0	0	1		
	1	2		
	2	3		
	3	4		
	4	5		
	5	6		
	6	7	Reset	
	7	8		
0	8	9		
	9	10		
	10	11		
	11	12		
	12	13	Work Select 0	
	13	14	Work Select 1	
	14	15	Work Select 2	
	15	16	Work Select 3	
0	16	17	Stop	
	17	18	Reset	
	18	19	Reverse	
	19	20	Start	
	20	21	Bypass	
	21	22	Disable Self-check	
	22	23		
	23	24		
0	24	25		
	25	26		
	26	27		
	27	28		
	28	29	Batch OK Reset	
	29	30	Work Select 4	
	30	31		
	31	32		

4.15.4 Fieldbus Interfaces – Ethernet I/P

The Ethernet-I/P communication interface allows slave connection to PLC networks that support Ethernet communication via TCP/IP.
Maximum I/O data is 256 input bits & 256 output bits. FEC Inputs match the discrete input layout. FEC Output location is programmed using the AFC User Console Software. Communication speeds of 10/100M baud (auto-selectable) are supported.

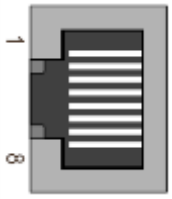
FEC integrates the Ethernet-I/P board manufactured by HMS Fieldbus Systems AB into the Multi-2 Unit's modular I/O board. For further technical information on the Ethernet-I/P interface go to the HMS website. (www.hms.se)

Ethernet I/P Hardware



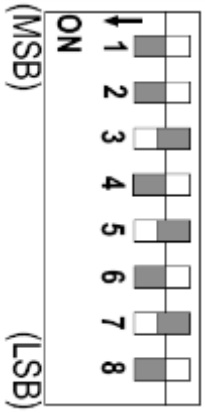
Item	Description
1	Ethernet Connector
2	Configuration Switches
3	Status LEDs (4)

Fieldbus Interface Connection



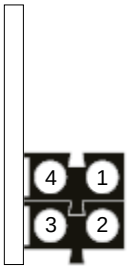
Pin	Signal	Note
1	TD+	
2	TD-	
3	RD+	
4	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in the module.
5	-	
6	RD-	
7	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in the module.
8	-	

Configuration DIP Switch



This switch is not used for FEC IP configuration and should be set to all OFF. The IP address is set-up using the AFC Software (see below) "Fieldbus Configuration" feature

Status LEDs



LED	State	Description
1 - Link	Off	No Link Established
	On	Link Established
2 - Module Status	Off	Not Powered / Not Online
	Green solid	Controlled by scanner in run state
	Green flashing	Not configured or scanner in idle state
	Red solid	A major unrecoverable fault has been detected.
	Red flashing	A minor recoverable fault has been detected.
3 - Network Status	Off	No power to device or no IP address has been set.
	Green solid	Online. One or more connections established.
	Green flashing	Data size bigger than configured.
	Red solid	Duplicate IP address. Fatal error.
	Red flashing	One or more connections timed out.
	Green / Red	Self test in progress
4 - Activity	Green	Flashes each time a packet is transmitted or received.

Input / Output Signal Mapping

Input Signals

From PLC to Fusion: 4 Words (8 Bytes – 64bits)

Word	Byte	Bit	No.	Description	Comment
01	0	0	1		
		1	2		
		2	3		
		3	4		
		4	5		
		5	6		
		6	7	Reset/Abort Job	Resets initial condition
		7	8		
	1	0	9		
		1	10		
		2	11		
		3	12		
		4	13	Work Select 0	
		5	14	Work Select 1	
		6	15	Work Select 2	
		7	16	Work Select 3	
02	2	0	17	Stop	
		1	18	Reset	
		2	19	Reverse	
		3	20	Start	
		4	21	Bypass	
		5	22	Disable Self-check	
		6	23		
		7	24		
	3	0	25		
		1	26		
		2	27		
		3	28		
		4	29	Batch OK Reset	
		5	30	Work Select 4	
		6	31		
		7	32		

Input Word 03 ~ 04 have no signals assigned and are not shown.

Output Signals

From Fusion to PLC : 8 Words (16 Bytes – 128 Bits)

Word	Byte	Bit	No.	Signal Description	Comment
01	0	0	1	End	
		1	2	Accept	
		2	3	Reject	
		3	4		
		4	5		
		5	6	Job Cycle Accepted	Total Accept for Sequence Function
		6	7		
		7	8		
	1	0	9	Work Select 4 Selected (echo)	
		1	10		
		2	11	Time 1 Reject	
		3	12	Time 2 Reject	
		4	13	Work Select Bit 0 Selected (echo)	
		5	14	Work Select Bit 1 Selected (echo)	
		6	15	Work Select Bit 2 Selected (echo)	
		7	16	Work Select Bit 3 Selected (echo)	
02	2	0	17	Reject	
		1	18	Accept	
		2	19	Abnormal	
		3	20	Ready	
		4	21	Busy	
		5	22	Torque High Reject	
		6	23	Torque Low Reject	
		7	24	Bypass	
	3	0	25	Angle High Reject	
		1	26	Angle Low Reject	
		2	27	Rate1 High Reject	
		3	28	Rate1 Low Reject	
		4	29	Rate2 High Reject	
		5	30	Rate2 Low Reject	
		6	31	Rate3 High Reject	
		7	32	Rate3 Low Reject	
03	4	0	33	Torque Integer bit 0	Outputs Fastening Torque using binary integer 0 - 999 max. (number LEFT of decimal only) Example: Torque integer bit 2, 4, 7 Logical "1" = 148 Total Torque including Torque decimal (word3) = 148.38
		1	34	Torque Integer bit 1	
		2	35	Torque Integer bit 2	
		3	36	Torque Integer bit 3	
		4	37	Torque Integer bit 4	
		5	38	Torque Integer bit 5	
		6	39	Torque Integer bit 6	
		7	40	Torque Integer bit 7	
	5	0	41	Torque Integer bit 8	
		1	42	Torque Integer bit 9	
		2	43		
		3	44		
		4	45		
		5	46		
		6	47		
		7	48		
04	6	0	49	Torque Decimal bit 0	Outputs Fastening Torque Decimal value using binary integer 0 - 99 max. (number RIGHT of decimal only) Example: Torque Decimal bit 1, 2, 5 Logical "1" = 38
		1	50	Torque Decimal bit 1	
		2	51	Torque Decimal bit 2	
		3	52	Torque Decimal bit 3	
		4	53	Torque Decimal bit 4	
		5	54	Torque Decimal bit 5	
		6	55	Torque Decimal bit 6	
		7	56		
	7	0	57		
		1	58		
		2	59		
		3	60		
		4	61		
		5	62		
		6	63		
		7	64		

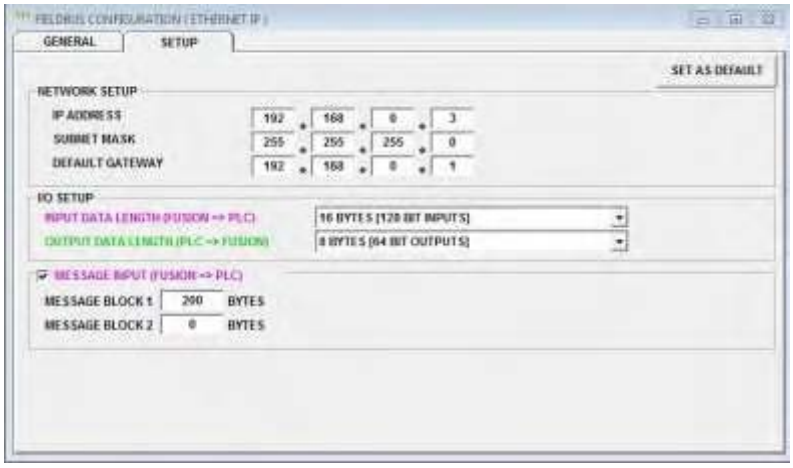
Data	Bit	No.	Signal Description	Comment
8	0	65	Angle Integer bit 0	Outputs Fastening Angle value using binary integer 0 - 9999 max. Example: Angle Integer bit 1, 2, 5, 7 Logical "1" = 166
	1	66	Angle Integer bit 1	
	2	67	Angle Integer bit 2	
	3	68	Angle Integer bit 3	
	4	69	Angle Integer bit 4	
	5	70	Angle Integer bit 5	
	6	71	Angle Integer bit 6	
	7	72	Angle Integer bit 7	
9	8	73	Angle Integer bit 8	
	9	74	Angle Integer bit 9	
	10	75	Angle Integer bit 10	
	11	76	Angle Integer bit 11	
	12	77	Angle Integer bit 12	
	13	78	Angle Integer bit 13	
	14	79		
	15	80		
Data 10-15	16	81		
	31	128		

AFC Software Configuration

The Anybus board is set up by sending a Fieldbus Configuration File (*.fcf) containing initialization messages from the Fusion Unit to the board during power up. This string of data initializes different characteristics required for the board to communicate over the Ethernet-I/P network. In this string is configuration data which sets the length of I/O data as well as length of messages (Resultant Fastening data). Since the board is only initialized during power-up, the Fusion Unit MUST have the power cycled OFF/ON after the “fcf” file is downloaded.

To download the fcf file, select “Field Bus Setup” from the “Axis” pull down menu. Select the appropriate “Bus Type” and click “Browse” to locate the correct fcf file. After the file has been selected, click “download” to send the file data to the Anybus board.

If no file exists, (or if the settings need to be changed) after the Bus Type has been selected, click on the “Setup” Tab.



In NETWORK SETUP, input all of the IP settings required by the host PLC. In I/O SETUP, select the “Input Data Length” and “Output Data Length” as required by you application. Data lengths MUST MATCH the PLC’s same I/O length setup otherwise connection will not be possible.

The Ethernet-I/P interface also has the ability to transfer resultant fastening data using the message data Transfer (CIP) function. The MESSAGE INPUT (Fusion to PLC) default setting is 200bytes. MESSAGE OUTPUT is currently not used. Refer to “Message Output Format” for message data information.

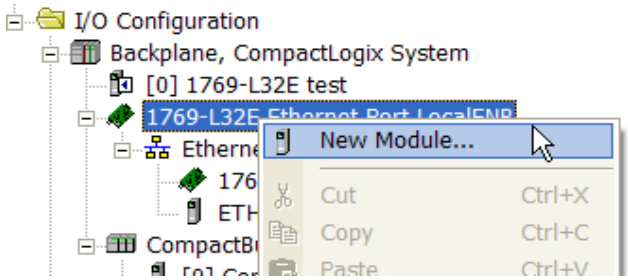
PLC Setting

The setup procedure of “Rockwell Automation RXLogix5000 V15.02.00” and “Allen Bradley CompactLogix L32E” is described.

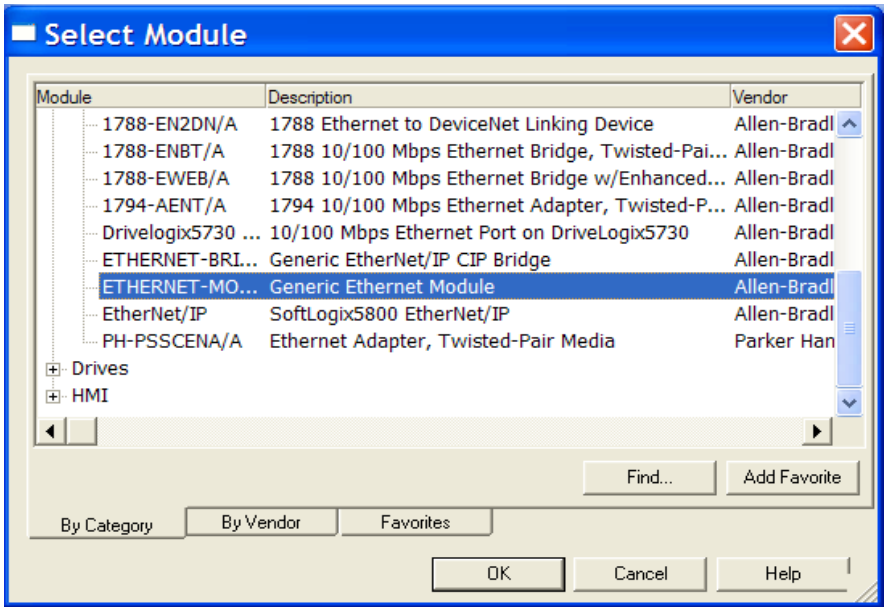
Please inquire to each manufacturer when you use other PLC (Note: Some PLC manufacturers may not support this Messaging (CIP) function)

Connection with HFC-EC-16-BUS-FEI

[I/O Configuration] right-click => [1769-L32E Ethernet Port Local ENB] => [New Module]



Please select [Generic Ethernet Module] from among the module list, and click OK.



[Module Property] General

Name:

Inputs the “Station Name”.

IP Address:

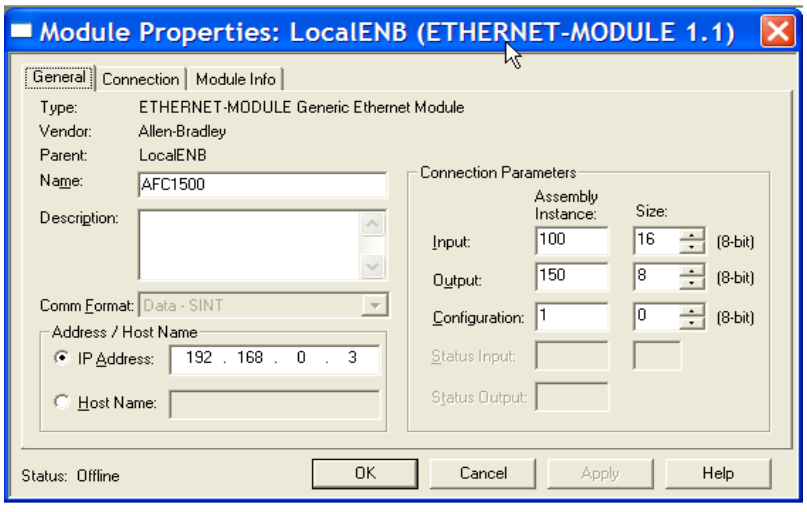
Inputs the same “IP address” as you configured the Ethernet I/P module.

Input Size, Output Size:

Inputs the same “Input Size” and “Output Size” as the Ethernet I/P is configured.

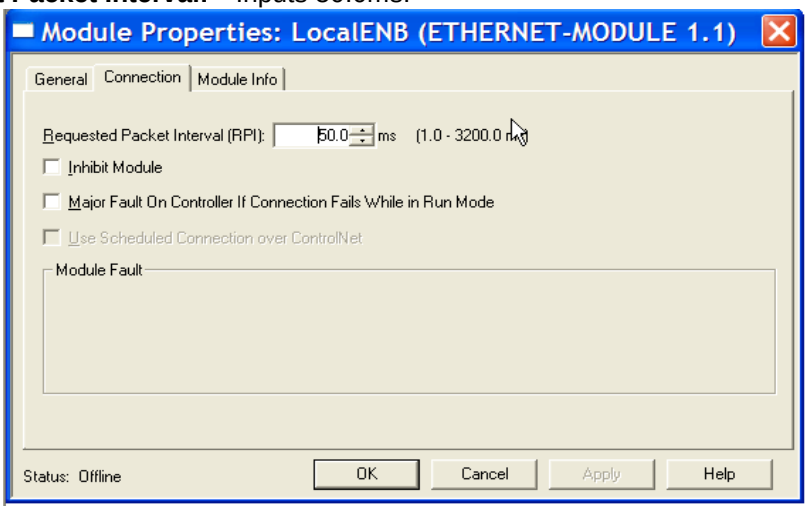
Assembly Instance:

Inputs the same value as the following setting.

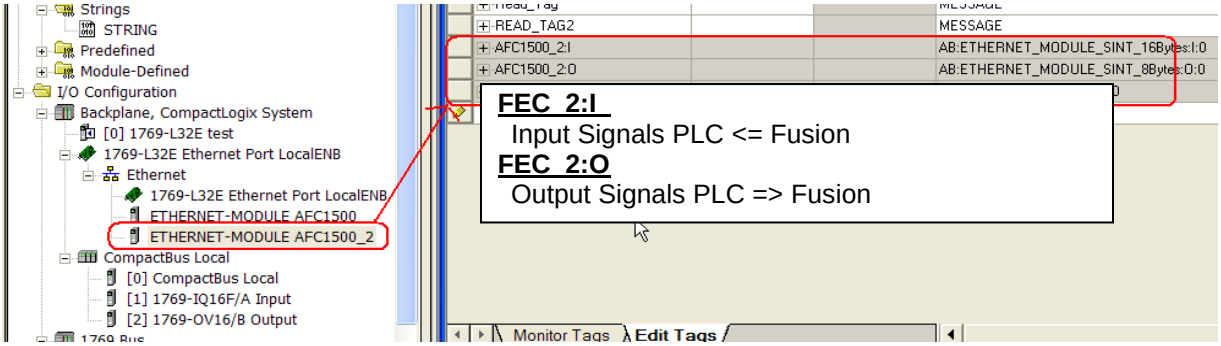


[Module Property] Connection

Request Packet Interval: Inputs 50.0ms.



The input signal and the output signal are added to Tag.



Receiving message communication (FUSION OUTPUT -> PLC INPUT)

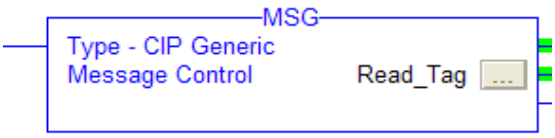
● Generation of Tag

When you perform message communication, a “Read_Tag” is necessary. Generate a “Read_Tag” using the PLC software.

Local:1:C			AB:1769_IQ16F:C:0	
Local:1:I			AB:1769_DI16:I:0	
Local:2:C			AB:1769_DO16:C:0	
Local:2:I			AB:1769_DO16:I:0	
Local:2:O			AB:1769_DO16:O:0	
Read_Data			SINT	Decimal
Read_Tag			MESSAGE	
READ_TAG2			MESSAGE	
AFC1500_2:I			AB:ETHERNET_MODULE_SINT_16Bytes:I:0	
AFC1500_2:O			AB:ETHERNET_MODULE_SINT_8Bytes:O:0	
AFC1500_2:C			AB:ETHERNET_MODULE:C:0	

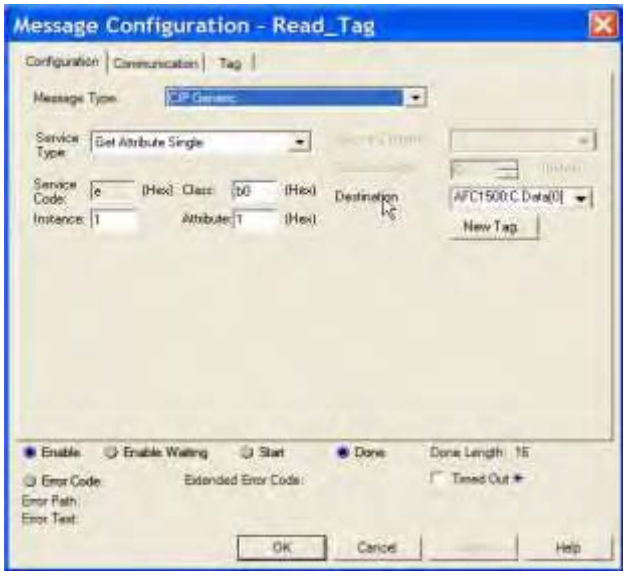
● Message Command (MSG)

With the PLC ladder editing screen, a MSG message command must be used to get transfer the Message data.



● Properties of the MSG command

MSG properties are set using Message Configuration and Communication. Please refer to the following list for Configuration. Establish Communication by pointing the message path to the (FUSION) Ethernet Module.



Message Type	CIP Generic
Service Type	Get Attribute Single
Service Code	E
Class	B0
Instance	1
Attribute	1~5
Destination	The controller tag “C” should be selected

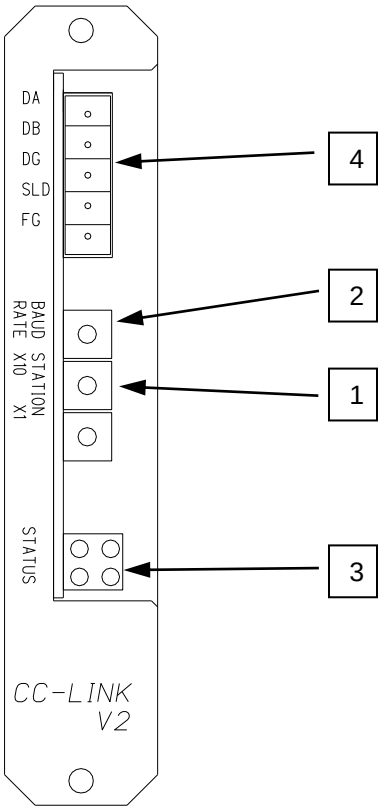
4-15-5 CC-Link® Interface (Version 2)

FEC integrates the CC-Link board (Version 2 setting) manufactured by HMS Fieldbus Systems AB into the Fusion Unit's modular I/O board when CC-link must send both I/O and Message Data. For further technical information on the CC-Link (Version 2) interface go to the HMS website. (www.hms.se)

*NOTE: The FEC CC-Link (V2) module is configured as a "**Remote Device Station**" when setting up the parameters in the PLC program.*

For detailed information on the Mitsubishi CC-Link Network, see the Mitsubishi User Manual # 13J872 Control & Communication - Link System Master / Local Module.

CCLink V2 Hardware



Item	Description
1	Station Number Setting Switch
2	Communication Speed Setting Switch
3	Status LEDs (4)
4	CC-Link Connector

CC-Link Specifications

Speed	156K - 10M baud - selectable
Stations	64 Max.
Distance	1200m max. at 156K baud / 50m max. at 10Mbit/s
Cable	Shielded Copper Twisted Pair Mitsubishi BA1SJ61-(m) m=Meters Belden 8102 or equivalent
Communications Type	Master/Slave - EIA RS485
Transmission Format	HDLC Standard
Maximum Cyclic I/O Size	896 inputs, 896 outputs max. Size set in groups of 256 I/O (Occupied Stations)
I/O Configuration*	I/O addressing set by PLC TO / FROM commands in Logic

* Actual I/O addressing must be assigned in the PLC logic. See the Mitsubishi User Manual # 13J872 Control & Communication - Link System Master / Local Module for logic reference. (Ref. Section 10)

Configuration

Configuration of the CC-Link system is done in the PLC Logic. It is essential that this configuration matches the Dip Switch settings of the FEC CC-Link slave. FEC is considered a "**Remote Device**" in the PLC configuration. The number of "Occupied Stations" set in the PLC must also match the settings in the AFC User Console set-up. **(Note: The last 16 output addresses are used by the CC-Link communication & cannot be used by the user)**

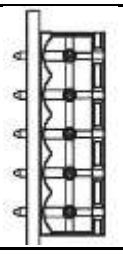
FEC CC-Link (Version 2) I/O configuration is programmable using the AFC User Console software. I/O can be set as required by the application according to parameter limits set forth by the CC-Link System Profile (CSP file). The AFC Software allows configuration of the number of Occupied Stations and Extended Cyclic Settings in the Multi Unit. Configuration of the CC-Link Master MUST match the configuration of the FEC CC-Link slave.

CSP File

To simplify network configuration, CC-Link devices may be associated with a CC-Link System Profile, also known as a CSP-file. This file contains a description of the device and can be used by some CC-Link system utilities to simplify the configuration process.
The CSP file associated with the FEC device can be downloaded directly from HMS - www.hms.se.

5.9.1 Component Descriptions

Fieldbus Interface Connection



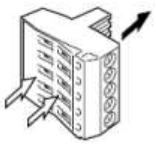
Pin 1	DA	Communication Line
Pin 2	DB	Communication Line
Pin 3	DG	Digital Ground
Pin 4	SHIELD	Connect cable shield
Pin 5	FG	Field Ground

See "Termination"

Mating Connector: Allows in-line "series" connection

Manufacturer : Phoenix Contact
Model Name : TMSTBP 2.5/5-ST-5.08

***Connector is attached.**

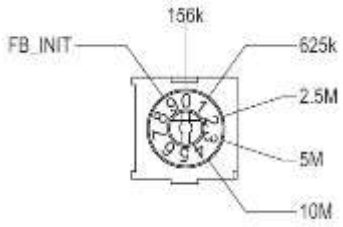


Wiring of the CC-Link network should be performed by using the cable listed above in the CC-Link Specifications. The three twisted conductors should be wired in series to each CC-Link device, using a terminating resistor at the Master end and on the last Remote/Local device between the DA & DB terminals.

Termination

Termination of the CC-Link requires a terminating resistor at each end of the fieldbus. Connect 120 ohm resistor between the DA & DB terminals if this is the last connection. (Remember that the CC-Link master also needs to be terminated)

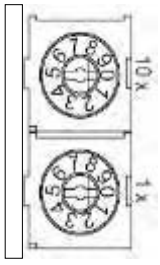
Baud Rate Switch



This rotary switch is used to specify the baud rate of the module. This can also be specified in the FB_INIT mailbox command. In this case, the switch must be set to "9".

This setting MUST match the setting of the Master module. This switch must be set before power is on and cannot be changed during operation.

Station Number Switches



These two rotary switches are used to specify the station number of the module (Two digit decimal). The Upper rotary switch (closest to the Baud Rate Switch) sets the "tens" digit (10x), and the bottom rotary switch sets the "ones" digit (1x). Valid settings range from 1 up to 64[1].

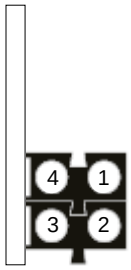
Example: To set station number 24, place the "tens" digit switch on 2 and the "ones" digit switch on 4.

This can also be specified in the FB_INIT mailbox command. In this case, the switches must be set to "99".

This switch must be set before power is on, and cannot be changed during operation.

1) If more than one station is occupied by the module, the highest possible station number is reduced by the number of occupied stations minus one.

Status LEDs



LED	Color	State	Description
1 (RUN)	Green	ON	Normal Operation
		OFF	Network non-participating or timeout status No power on module
2 (ERRL)	Red	ON	CRC error detection Illegal station number or illegal baud rate selected
		OFF	Normal Operation No power on module
3 (RDLED)	Green	ON	Data being received
		OFF	No data reception No power on module
4 (SDLED)	Green	ON	Data being transmitted
		OFF	No data transmission No power on module

○：On ●：Off ◎：Blinking

RUN	ERRL	SD	RD	Operation
○	◎	◎	○	Communication is normal. However, CRC error is occurred from time to time due to noise.
○	◎ 0.4 SEC	◎	○	Baud rate or station number setting have been changed when baud rate/ station number setting released at reset.
○	◎	●	○	Received data is CRC error and can't respond
○	●	◎	○	Normal communication.
○	●	●	○	Data can' t be received to the station.
●	◎	◎	○	Poling is responding or CRC error is occurred to refresh reception.
●	◎	●	○	CRC error occurred to the station data.
●	●	◎	○	Link does not work properly.
●	●	●	○	No station data or station data can't be received due to noise.
●	●	●	●	Data isn't received due to disconnection, etc. Power source is disconnected to H/W is in the reset process.
●	○	●	○	Illegality of communication speed and station number setting up.

CC-Link Specification

	I/O		MESSAGE	
	FUSION=>PLC	PLC=>FUSION	FUSION=>PLC	PLC=>FUSION
MAXIMUM	32BYTES(256BIT)	8BYTES(64BIT)	128WORDS(256BYTES)	
DEFAULT	32BYTES(256BIT)	8BYTES(64BIT)	128WORDS(256BYTES)	

Number of Input： 64points Fixed assignment **※Can't be changed**

Making Secure RY(n+4)0～RY(n+7)F territory not used.

Item			Specifications			
No. of link points per station	Expanded cyclic setting		Single	Double	Quadruple	Octuple
	Remote I/O (RX, RY)		32 points (30 points for local station)	32 points (30 points for local station)	64 points (62 points for local station)	128 points (126 points for local station)
	Remote register (RWw)		4 points	8 points	16 points	32 points
	Remote register (RWr)		4 points	8 points	16 points	32 points
Number of link points per number of occupied stations	Occupies 1 station	Remote I/O (RX, RY)	32 points	32 points	64 points	128 points
		Remote register (RWw)	4 points	8 points	16 points	32 points
		Remote register (RWr)	4 points	8 points	16 points	32 points
	Occupies 2 stations	Remote I/O (RX, RY)	64 points	96 points	192 points	384 points
		Remote register (RWw)	8 points	16 points	32 points	64 points
		Remote register (RWr)	8 points	16 points	32 points	64 points
	Occupies 3 stations	Remote I/O (RX, RY)	96 points	160 points	320 points	640 points
		Remote register (RWw)	12 points	24 points	48 points	96 points
		Remote register (RWr)	12 points	24 points	48 points	96 points
	Occupies 4 stations	Remote I/O (RX, RY)	128 points	224 points	448 points	896 points
		Remote register (RWw)	16 points	32 points	64 points	128 points
		Remote register (RWr)	16 points	32 points	64 points	128 points

FUSION CC-LINK V2 INPUT SIGNAL

NC：Normal Close、NO：Normal Open

Remote Output RY	Signal Name	Connection	Remote output RY	Signal Name	Connection
RY(n+0h)0h		NO	RY(n+2h)0h		NO
RY(n+0h)1h		NO	RY(n+2h)1h		NO
RY(n+0h)2h		NO	RY(n+2h)2h		NO
RY(n+0h)3h		NO	RY(n+2h)3h		NO
RY(n+0h)4h		NO	RY(n+2h)4h		NO
RY(n+0h)5h		NO	RY(n+2h)5h		NO
RY(n+0h)6h	RESET	NO	RY(n+2h)6h		NO
RY(n+0h)7h		NO	RY(n+2h)7h		NO
RY(n+0h)8h		NO	RY(n+2h)8h		NO
RY(n+0h)9h		NO	RY(n+2h)9h		NO
RY(n+0h)Ah		NO	RY(n+2h)Ah		NO
RY(n+0h)Bh		NO	RY(n+2h)Bh		NO
RY(n+0h)Ch	WORK SELECT 0	NO	RY(n+2h)Ch		NO
RY(n+0h)Dh	WORK SELECT 1	NO	RY(n+2h)Dh		NO
RY(n+0h)Eh	WORK SELECT 2	NO	RY(n+2h)Eh		NO
RY(n+0h)Fh	WORK SELECT 3	NO	RY(n+2h)Fh		NO
RY(n+1h)0h	STOP	NO	RY(n+3h)0h		NO
RY(n+1h)1h	RESET	NO	RY(n+3h)1h		NO
RY(n+1h)2h	REVERSE	NO	RY(n+3h)2h		NO
RY(n+1h)3h	START	NO	RY(n+3h)3h		NO
RY(n+1h)4h	BYPASS	NO	RY(n+3h)4h		NO
RY(n+1h)5h	SELF CHECK OFF	NO	RY(n+3h)5h		NO
RY(n+1h)6h		NO	RY(n+3h)6h		NO
RY(n+1h)7h		NO	RY(n+3h)7h		NO
RY(n+1h)8h		NO	RY(n+3h)8h		NO
RY(n+1h)9h		NO	RY(n+3h)9h		NO
RY(n+1h)Ah		NO	RY(n+3h)Ah		NO
RY(n+1h)Bh		NO	RY(n+3h)Bh		NO
RY(n+1h)Ch	BATCH OK RESET	NO	RY(n+3h)Ch		NO
RY(n+1h)Dh	WORK SELECT 4	NO	RY(n+3h)Dh		NO
RY(n+1h)Eh		NO	RY(n+3h)Eh		NO
RY(n+1h)Fh		NO	RY(n+3h)Fh		NO

Caution

Input signals are permanently set. (Cannot be changed)
Unused range in RY (n+4h) 0h to RY (n+37h) Fh is also reserved.

"WORK SELECT 4" is effective after Fusion Firmware V5.00.

FUSION CC-LINK V2 INPUT SIGNAL

Remote Input RX	Signal Name	Connection	Remote Input RX	Signal Name	Connection
RXn0	END	**NO**	**RX(n+2)0**	Torque Integer bit0	**NO**
RXn1	ACCEPT	**NO**	**RX(n+2)1**	Torque Integer bit1	**NO**
RXn2	REJECT	**NO**	**RX(n+2)2**	Torque Integer bit2	**NO**
RXn3		**NO**	**RX(n+2)3**	Torque Integer bit3	**NO**
RXn4		**NO**	**RX(n+2)4**	Torque Integer bit4	**NO**
RXn5	Job Cycle Accept	**NO**	**RX(n+2)5**	Torque Integer bit5	**NO**
RXn6		**NO**	**RX(n+2)6**	Torque Integer bit6	**NO**
RXn7		**NO**	**RX(n+2)7**	Torque Integer bit7	**NO**
RXn8	WORK SELECT 4	**NO**	**RX(n+2)8**	Torque Integer bit8	**NO**
RXn9		**NO**	**RX(n+2)9**	Torque Integer bit9	**NO**
RXnA	Time 1 Reject	**NO**	**RX(n+2)A**		**NO**
RXnB	Time 2 Reject	**NO**	**RX(n+2)B**		**NO**
RXnC	WORK SELECT 0	**NO**	**RX(n+2)C**		**NO**
RXnD	WORK SELECT 1	**NO**	**RX(n+2)D**		**NO**
RXnE	WORK SELECT 2	**NO**	**RX(n+2)E**		**NO**
RXnF	WORK SELECT 3	**NO**	**RX(n+2)F**		**NO**
RX(n+1)0	REJECT	**NO**	**RX(n+3)0**	Torque Decimal bit0	**NO**
RX(n+1)1	ACCEPT	**NO**	**RX(n+3)1**	Torque Decimal bit1	**NO**
RX(n+1)2	ABNORMAL	**NO**	**RX(n+3)2**	Torque Decimal bit2	**NO**
RX(n+1)3	READY	**NO**	**RX(n+3)3**	Torque Decimal bit3	**NO**
RX(n+1)4	BUSY	**NO**	**RX(n+3)4**	Torque Decimal bit4	**NO**
RX(n+1)5	Torque Hi Reject	**NO**	**RX(n+3)5**	Torque Decimal bit5	**NO**
RX(n+1)6	Torque Low Reject	**NO**	**RX(n+3)6**	Torque Decimal bit6	**NO**
RX(n+1)7	BYPASS	**NO**	**RX(n+3)7**		**NO**
RX(n+1)8	Angle Hi Reject	**NO**	**RX(n+3)8**		**NO**
RX(n+1)9	Angle Low Reject	**NO**	**RX(n+3)9**		**NO**
RX(n+1)A	Rate 1 Hi Reject	**NO**	**RX(n+3)A**		**NO**
RX(n+1)B	Rate 1 Low Reject	**NO**	**RX(n+3)B**		**NO**
RX(n+1)C	Rate 2 Hi Reject	**NO**	**RX(n+3)C**		**NO**
RX(n+1)D	Rate 2 Low Reject	**NO**	**RX(n+3)D**		**NO**
RX(n+1)E	Rate 3 Hi Reject	**NO**	**RX(n+3)E**		**NO**
RX(n+1)F	Rate 3 Low Reject	**NO**	**RX(n+3)F**		**NO**

Example of Torque data

Peak Torque	Integer Portion	Decimal Portion
12.34 Nm	000C	0022

Peak Torque	Integer Portion	Decimal Portion
123.4 Nm	007B	0004

* Integer portion is LEFT of decimal. Decimal Portion is Right of Decimal

Remote In-put RX	Signal Name	Connection	Remote In-put RX	Signal Name	Connection
RX(n+4)0	Angle Integer bit0	NO	RX(n+6)0		NO
RX(n+4)1	Angle Integer bit1	NO	RX(n+6)1		NO
RX(n+4)2	Angle Integer bit2	NO	RX(n+6)2		NO
RX(n+4)3	Angle Integer bit3	NO	RX(n+6)3		NO
RX(n+4)4	Angle Integer bit4	NO	RX(n+6)4		NO
RX(n+4)5	Angle Integer bit5	NO	RX(n+6)5		NO
RX(n+4)6	Angle Integer bit6	NO	RX(n+6)6		NO
RX(n+4)7	Angle Integer bit7	NO	RX(n+6)7		NO
RX(n+4)8	Angle Integer bit8	NO	RX(n+6)8		NO
RX(n+4)9	Angle Integer bit9	NO	RX(n+6)9		NO
RX(n+4)A	Angle Integer bit10	NO	RX(n+6)A		NO
RX(n+4)B	Angle Integer bit11	NO	RX(n+6)B		NO
RX(n+4)C	Angle Integer bit12	NO	RX(n+6)C		NO
RX(n+4)D	Angle Integer bit13	NO	RX(n+6)D		NO
RX(n+4)E		NO	RX(n+6)E		NO
RX(n+4)F		NO	RX(n+6)F		NO
RX(n+5)0		NO	RX(n+7)0		NO
RX(n+5)1		NO	RX(n+7)1		NO
RX(n+5)2		NO	RX(n+7)2		NO
RX(n+5)3		NO	RX(n+7)3		NO
RX(n+5)4		NO	RX(n+7)4		NO
RX(n+5)5		NO	RX(n+7)5		NO
RX(n+5)6		NO	RX(n+7)6		NO
RX(n+5)7		NO	RX(n+7)7		NO
RX(n+5)8		NO	RX(n+7)8		NO
RX(n+5)9		NO	RX(n+7)9		NO
RX(n+5)A		NO	RX(n+7)A		NO
RX(n+5)B		NO	RX(n+7)B		NO
RX(n+5)C		NO	RX(n+7)C		NO
RX(n+5)D		NO	RX(n+7)D		NO
RX(n+5)E		NO	RX(n+7)E		NO
RX(n+5)F		NO	RX(n+7)F		NO

Final Angle Integer Portion

1234 deg 04D2

Caution

Output signals are permanently set. (Cannot be changed)
Unused range in RX (n+8h) 0h to RX (n+37h) Fh is also reserved.

CCLink V2 AFC Software Configuration

Use the AFC user console software to configure the CCLink V2 in the Fusion Controller.

[Configuration file]

BROWSE: Browse Fieldbus configuration files.
SAVE: Save Fieldbus configuration files.
UPLOAD: Upload Fieldbus set up from Fusion controller.
（BUS TYPE automatically.）
DOWNLOAD: Download open net set up to Fusion controller.
(*Cycle power after download.)
VERIFY: Verify Fusion controllerset up vs AFC User Console Software set up.
BUS TYPE: Choose CC-LINK VER2

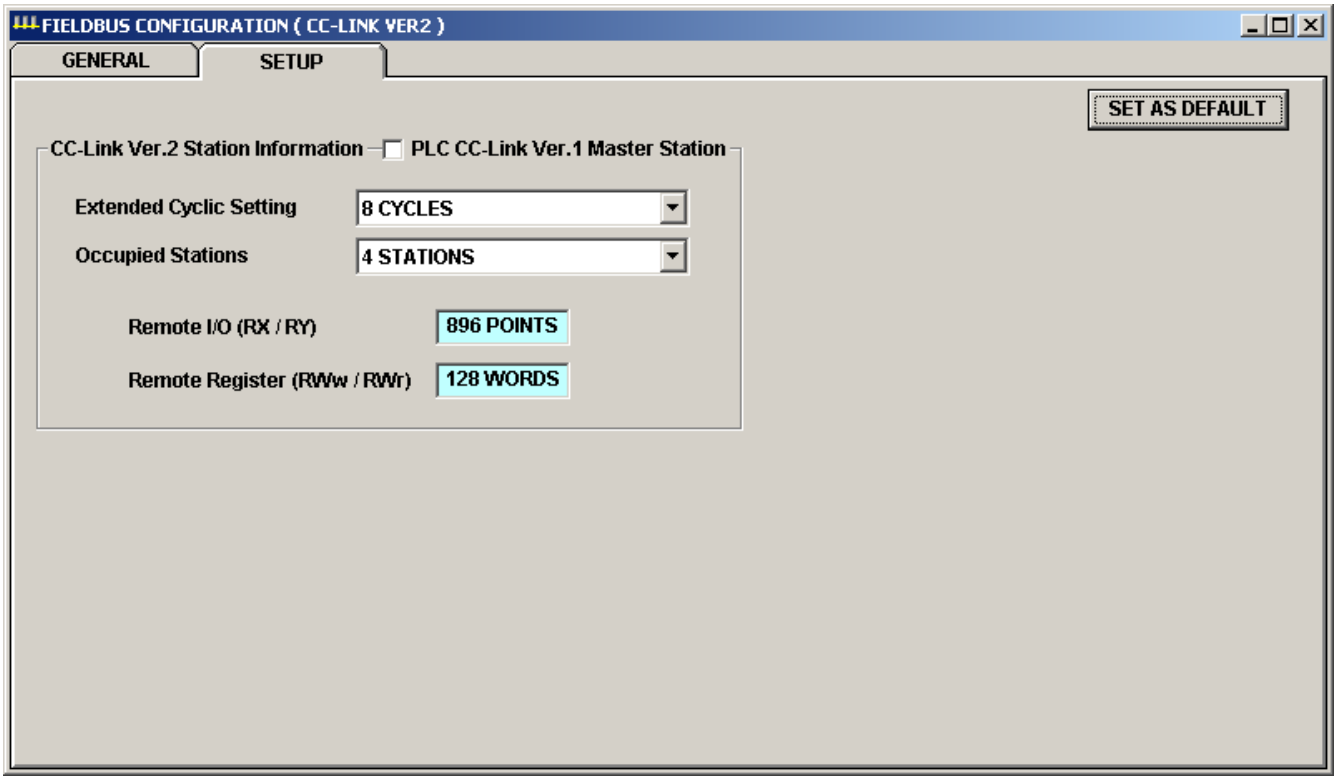
Caution

Once Fieldbus setting is configured, hit “SAVE” to SAVE the configuration to a file The Fieldbus setting is downloaded using the "PARAMETER COMMUNICATIONS" screen. (*Cycle power after download.)

・File Extension Information

Item	Extension
Parameter	.PAR
Fieldbus setting	.FCF

CCLink SETUP Tab



●Extended cyclic setting

8 cycles

●Occupied station

4 stations

●Remote I/O（RX/RY）

896 points

●Remote Register（RWw/RWr）

128 words（256 bytes）

Caution

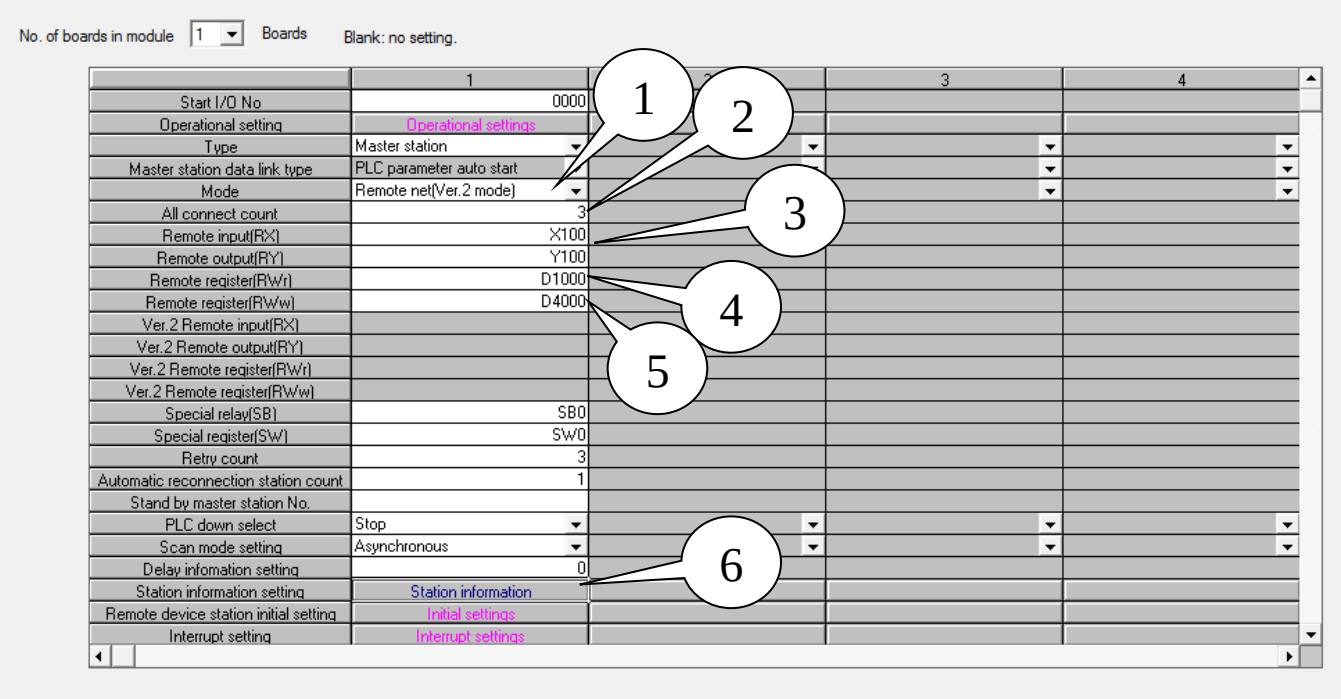
When PLC master module is CC-Link Ver1.00, check the “PLC CC-Link Ver.1 Master Station” box in the setup screen.

MELSEC-Q Series Parameter Setting (Example)

Start up GX Developer → Prepare PC Series QCPU (Q mode) Project →

Parameter → Network Parameter → Set List of CC-Link

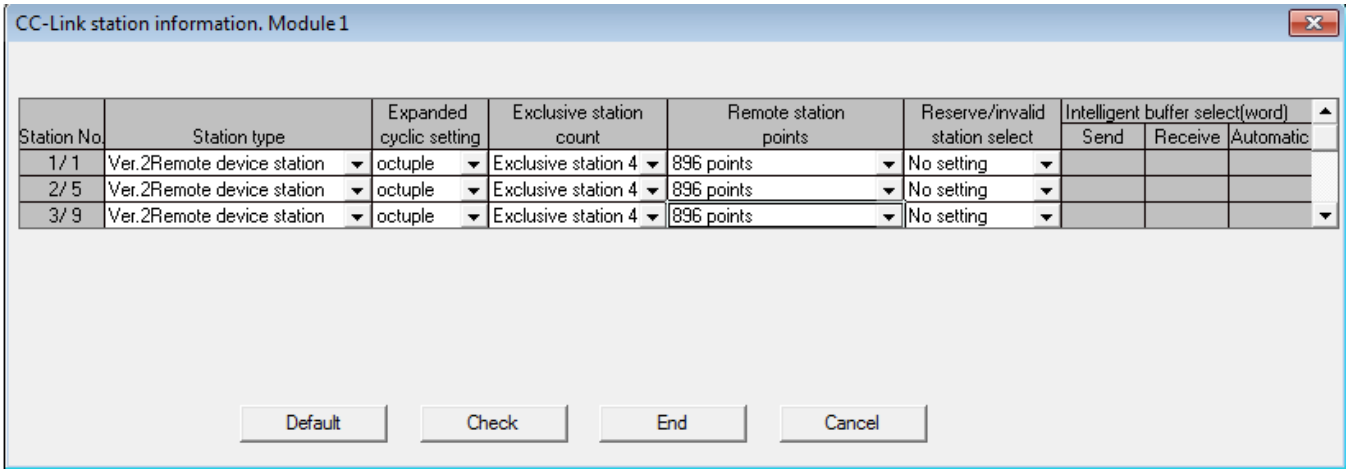
Example of PLC setting using (3) Fusion systems (3 CCLINK connections)



	1	2	3	4
Start I/O No	0000			
Operational setting	Operational settings			
Type	Master station			
Master station data link type	PLC parameter auto start			
Mode	Remote net(Ver.2 mode)			
All connect count	3			
Remote input(RX)	X100			
Remote output(RY)	Y100			
Remote register(RWr)	D1000			
Remote register(RWw)	D4000			
Ver.2 Remote input(RX)				
Ver.2 Remote output(RY)				
Ver.2 Remote register(RWr)				
Ver.2 Remote register(RWw)				
Special relay(SB)	SB0			
Special register(SW)	SW0			
Retry count	3			
Automatic reconnection station count	1			
Stand by master station No.				
PLC down select	Stop			
Scan mode setting	Asynchronous			
Delay infomation setting	0			
Station information setting	Station information			
Remote device station initial setting	Initial settings			
Interrupt setting	Interrupt settings			

1. Select “Remote Net (Ver. 2 Mode)” at Mode Select.
2. Set the All Connect Count (3) for number of connected Remote Device stations
3. Set the refresh device Remote Input (X100) / Output (Y100) at “Remote Output (RX / RY).”
4. Set the refresh device Remote Register read (D1000) at “Remote Register (RWr).”
5. Set the refresh device Remote Register write (D4000) at “Remote Register (RWw).”
   * The allocated set values differ according to the station No. of the Controller used.
6. Set the station information at Station Information Setting (the picture below shows an example for reference).

Station information Setting example (#6 above)



Enabling the CC-Link connection to the PLC

PLC Ladder logic is required to enable the CC-Link communication link. The logic must address the enable bit (Initial Data Processing Request) of which the address changes based on the size setting used. The last 16 bits of both the Inputs and outputs (no matter what size is configured) is the CCLINK system setting area and this is where the link must be enabled.

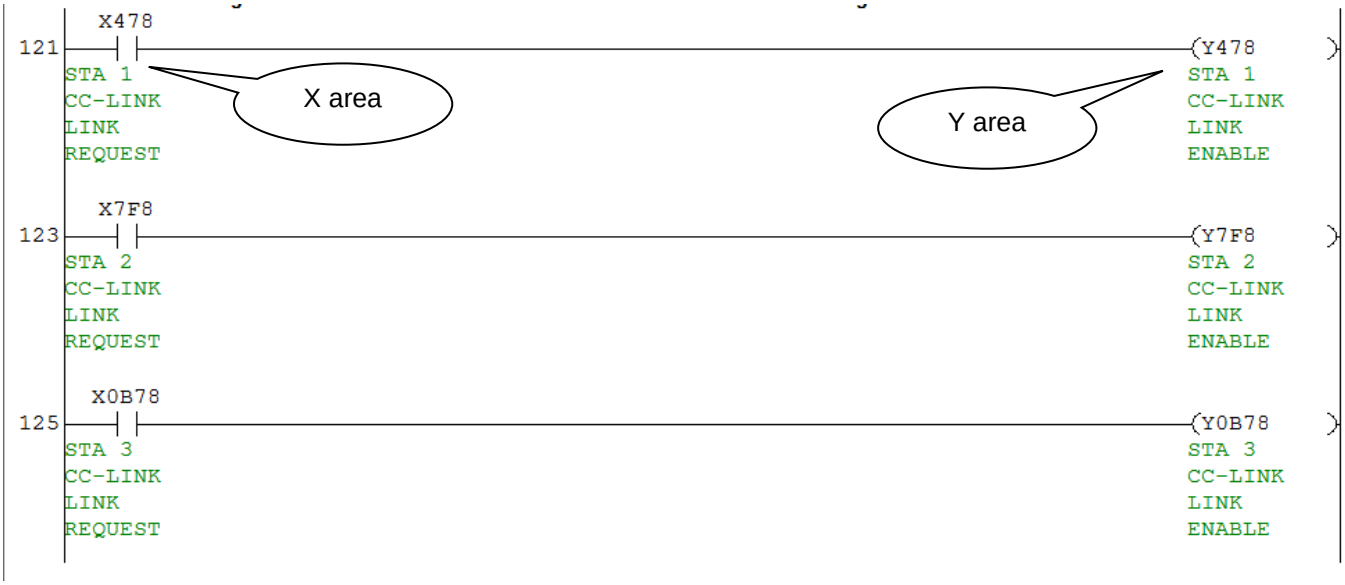
Below is an example of CC-Link configuration settings made by GX Developer software and how memory is allocated. This configuration has 3 sets of AFC3000 controllers connected with 4 occupied stations / 8 extended cyclic cycles. (I/O 896 Points, Message 72 Words)

Item	Fusion (System 1)	Fusion (System 2)	Fusion (System 3)
CC-Link Station Number	1	5	9
Configured Size (4 occupied stations/8Cyclic cycles)	896 (880 useable)	896 (880 useable)	896 (880 useable)
EM-STOP (First bit of PLC output)	Y100	Y480	Y800
Total Reject (First bit of AFC3000 Output)	X100	X480	X800
Part ID message output to AFC3000 Controllers	D4000	D4072	D4144
Fastening result message from AFC3000 controllers	D1000	D1072	D1144
CC-Link Request address	X478	X7F8	XB78
CC-Link Enable address	Y478	Y7F8	YB78

In the case of the first Fusion System (1) (shown in the table above), the PLC program is set so that when the 888th (378h) bit (“Initial Data Processing Request”) in the (CC-Link Reserved) system area (X area) is turned “ON”, the output at the 888th (378h) bit (“Initial Data Processing Complete”) of the system area (Y area) is set “ON”. (**Note: See pages 8 & 14 for CCLINK handshaking signal location**)

Since the X/Y starting address of (System 1) is configured to start at X100 and Y100, this must be added to the addresses and therefore (100h+378h) 478h is specified for the X area and the Y area as shown in the PLC Logic diagram below to enable Station 1’s link.
For Station 2’s link, the starting address (X/Y480) is added to the 888th (378h) bit for that station which is address (480h + 378h) X/Y7F8.
For Station 3’s link, the starting address (X/Y800) is added to the 888th (378h) bit for that station which is address X/YB78.

PLC Logic example that would be required to enable the CC-Link in the three systems listed above



- **Location of Handshaking Bits According to Size Configuration**

Cyclic Cycles Setting	1 Occupied Station	2 Occupied Stations	3 Occupied Stations	4 Occupied Stations
1	24th bit 18h	56th bit 38h	88th bit 58h	120th bit 78h
2	24th bit 18h	88th bit 58h	152th bit 98h	216th bit D8h
4	56th bit 38h	184th bit B8h	312th bit 138h	440th bit 1B8h
8	120th bit 78h	376th bit 178h	632th bit 278h	888th bit 378h

(Location of “Initial Data Processing Request” and “Initial Data Processing Complete” Bits)
“h” = hexadecimal

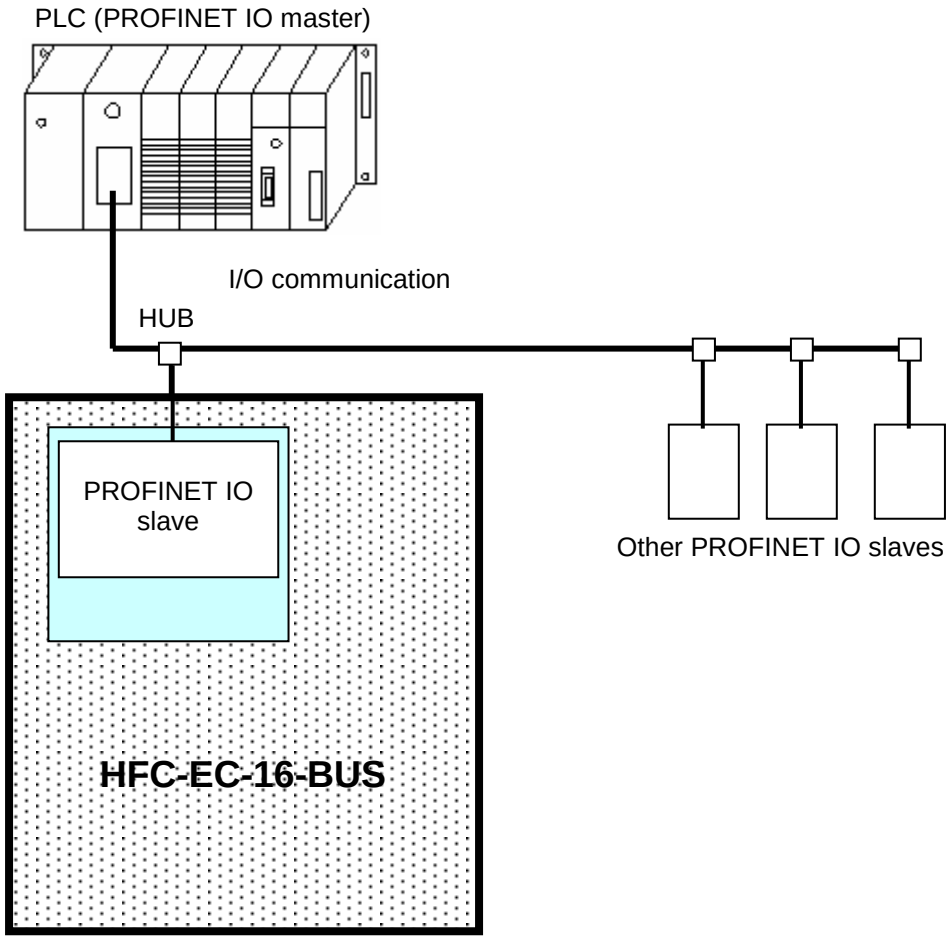
4-15-6 Profinet Interface

The Profinet communication interface allows slave connection to PLC networks that support Profinet communication via TCP/IP.

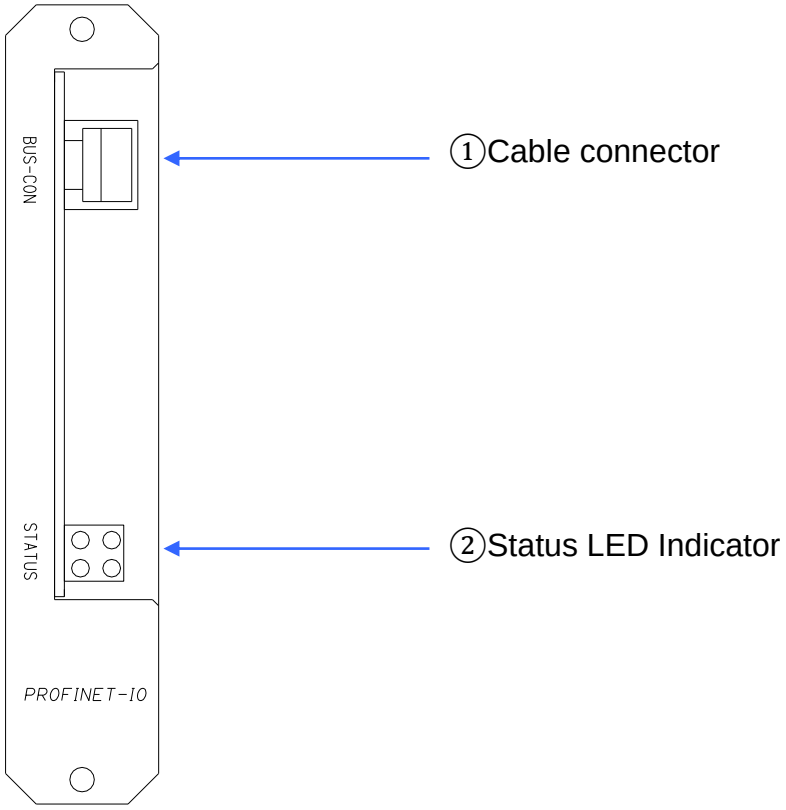
Maximum I/O data is 512 input bits & 512 output bits. FEC Inputs match the discrete input lay-out. FEC Output location is programmed using the AFC User Console Software.

FEC integrates the Profinet board manufactured by HMS Fieldbus Systems AB into the Multi-2 Unit's modular I/O board. For further technical information on the Ethernet-I/P interface go to the HMS website. (www.hms.se)

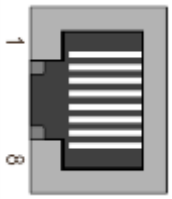
Profinet Structure



Profinet Hardware

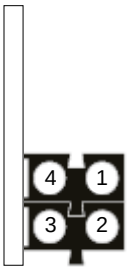


Profinet Interface Connections



Pin	Signal	Note
1	TD+	
2	TD-	
3	RD+	
4	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in the module.
5	-	
6	RD-	
7	-	Normally left unused; to ensure signal integrity, these pins are tied together and terminated to PE via a filter circuit in the module.
8	-	

Status LEDs



LED	State	Description
1 – Link/Activity	Green	Link Established
	Green, Flashing	Receiving/Transmitting data
	Off	No Link Established or power off
2 - Communication Status	Off	Offline
	Green solid	Online, Run - Connection established - IO controller in RUN
	Green, 1 flash	Online, Stop - Connection Established - IO controller in STOP
3 - Module Status	Off	No power or not initialized
	Green solid	Initialized, no error
	Green, 1 flash	Diagnostic data available
	Green, 2 flashes	Blink. Factory ID tool
	Red, 1 flash	Configuration Error - Too many modules - I/O from IO controller config. Too large - Configuration Mismatch (no module, wrong module)
	Red 3 flashes	No station name or no IP address assigned
	Red, 4 flashes	Internal error
4 – Not Used		

5.12.2 User Console Software Settings

The Anybus board is set up by sending a Fieldbus Configuration File (*.fcf) containing initialization messages from the Fusion Controller to the Profinet board during power up. This string of data initializes different characteristics required for the board to communicate over the Profinet network. In this string, is data which sets the length of I/O data as well as length of messages (Resultant Fastening data). Since the board is only initialized during power-up, the controller MUST have the power cycled OFF/ON after the “fcf” file is downloaded.

To download the fcf file, select “Field Bus Setup” from the “AXIS” pull down menu. Select the appropriate “Bus Type” and click “Browse” to locate the correct fcf file. (if one has previously been saved) After the file has been selected, click “download” to send the file data to the Anybus Profinet board.

If no file exists, (or if the settings need to be changed) after the Bus Type has been selected click on the Setup Tab.

In NETWORK SETUP, input all of the IP settings required by the host PLC. In I/O SETUP, select the “Input Data Length” and “Output Data Length” as required by you application. (INPUT & OUTPUT in this screen refer to PLC side I/O, INPUT = FEC Output size, OUTPUT = FEC Input size) Data lengths MUST MATCH the PLC’s same I/O length setup otherwise connection will not be possible.

The Ethernet-I/P interface also has the ability to transfer resultant fastening data using the message data. Set the MESSAGE INPUT (AFC1500 to PLC) settings according to the PLC settings. MESSAGE OUTPUT is currently not used. Refer to Page 5.11.5 for message setup information.

I/O Signal Specification

Input number: 32 bytes (256 bits) Input map is permanently set
Output number: 32 bytes (256 bits) Output map is permanently set

Input Map

CH. No.	Bit	Signal	Connection	Comment
Input No.01	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit	RESET	NO	
	7bit		NO	
CH. No.	Bit	Signal	Connection	Comment
Input No.02	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit	WORK SELECT 0	NO	
	5bit	WORK SELECT 1	NO	
	6bit	WORK SELECT 2	NO	
	7bit	WORK SELECT 3	NO	
CH. No.	Bit	Signal	Connection	Comment
Input No.03	0bit	STOP	NO	
	1bit	RESET	NO	
	2bit	REVERSE	NO	
	3bit	START	NO	
	4bit	BYPASS	NO	
	5bit	SELF CHECK OFF	NO	
	6bit		NO	
	7bit		NO	
CH. No.	Bit	Signal	Connection	Comment
Input No.04	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit	BATCH OK RESET	NO	
	5bit	WORK SELECT 4	NO	
	6bit		NO	
	7bit		NO	

CH. No.	Bit	Signal	Connection	Comment
Input No.05	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	

CH. No.	Bit	Signal	Connection	Comment
Input No.32	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	

Note) NC: Normal Closed, NO: Normal Open

(Example) Siemens PLC

SFC15 is used.
32 bytes are stored from M70.0.

LADDR : Output address set by H/W configuration
Hexadecimal WORD form

RET_VAL : Memory address when error occurs

RECORD : Read output signal from PLC

Output Signal Specification

Output number: 32 bytes (256 bits) Output map is permanently set

Output Map

No.	Bit	Signal	Connection	Comment
Output No.01	0bit	END	NO	
	1bit	ACCEPT	NO	
	2bit	REJECT	NO	
	3bit		NO	
	4bit		NO	
	5bit	Job Cycle Accept	NO	
	6bit		NO	
	7bit		NO	
Output No.02	0bit	WORK SELECT 4	NO	
	1bit		NO	
	2bit	Time 1 Reject	NO	
	3bit	Time 2 Reject	NO	
	4bit	WORK SELECT 0	NO	
	5bit	WORK SELECT 1	NO	
	6bit	WORK SELECT 2	NO	
	7bit	WORK SELECT 3	NO	
Output No.03	0bit	REJECT	NO	
	1bit	ACCEPT	NO	
	2bit	ABNORMAL	NO	
	3bit	READY	NO	
	4bit	BUSY	NO	
	5bit	Torque Hi Reject	NO	
	6bit	Torque Low Reject	NO	
	7bit	BYPASS	NO	
Output No.04	0bit	Angle Hi Reject	NO	
	1bit	Angle Low Reject	NO	
	2bit	Rate 1 Hi Reject	NO	
	3bit	Rate 1 Low Reject	NO	
	4bit	Rate 2 Hi Reject	NO	
	5bit	Rate 2 Low Reject	NO	
	6bit	Rate 3 Hi Reject	NO	
	7bit	Rate 3 Low Reject	NO	

No.	Bit	Signal	Connection	Comment
Output No.05	0bit	Torque Integer bit0	NO	Outputs Fastening Torque using binary integer 0 - 999 max. (number LEFT of decimal only) Example: Torque integer bit 2, 4, 7 Logical "1" = 148 Total Torque including Torque decimal (Output No. 7 below) = 148.38
	1bit	Torque Integer bit1	NO	
	2bit	Torque Integer bit2	NO	
	3bit	Torque Integer bit3	NO	
	4bit	Torque Integer bit4	NO	
	5bit	Torque Integer bit5	NO	
	6bit	Torque Integer bit6	NO	
	7bit	Torque Integer bit7	NO	
Output No.06	0bit	Torque Integer bit8	NO	
	1bit	Torque Integer bit9	NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	
Output No.07	0bit	Torque Decimal bit0	NO	Outputs Fastening Torque Decimal value using binary integer 0 - 99 max. (number RIGHT of decimal only) Example: Torque Decimal bit 1, 2, 5 Logical "1" = 38
	1bit	Torque Decimal bit1	NO	
	2bit	Torque Decimal bit2	NO	
	3bit	Torque Decimal bit3	NO	
	4bit	Torque Decimal bit4	NO	
	5bit	Torque Decimal bit5	NO	
	6bit	Torque Decimal bit6	NO	
	7bit		NO	
Output No.08	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	

No.	Bit	Signal	Connection	Comment
Output No.09	0bit	Angle Integer bit0	NO	Outputs Fastening Angle value using binary integer 0 - 9999 max. Example: Angle Integer bit 1, 2, 5, 7 Logical "1" = 166
	1bit	Angle Integer bit1	NO	
	2bit	Angle Integer bit2	NO	
	3bit	Angle Integer bit3	NO	
	4bit	Angle Integer bit4	NO	
	5bit	Angle Integer bit5	NO	
	6bit	Angle Integer bit6	NO	
	7bit	Angle Integer bit7	NO	
Output No.10	0bit	Angle Integer bit8	NO	
	1bit	Angle Integer bit9	NO	
	2bit	Angle Integer bit10	NO	
	3bit	Angle Integer bit11	NO	
	4bit	Angle Integer bit12	NO	
	5bit	Angle Integer bit13	NO	
	6bit		NO	
	7bit		NO	
Output No.11	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	
Output No.12	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	

Final Angle Integer

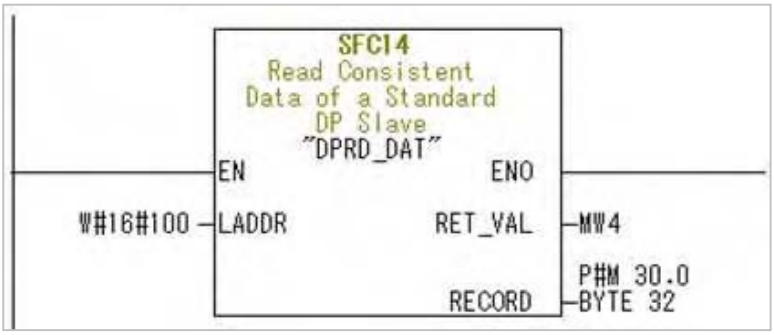
1234 deg 04D2

No.	Bit	Signal	Connection	Comment
Output No.13	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	
Output No.14	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	
Output No.15	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	
Output No.16	0bit		NO	
	1bit		NO	
	2bit		NO	
	3bit		NO	
	4bit		NO	
	5bit		NO	
	6bit		NO	
	7bit		NO	

(Example) Siemens PLC

SFC14 is used.

32 bytes are stored from M30.0.



LADDR : Input address set by HW configuration
Hexadecimal WORD form

RET_VAL : Storage place when error occurs

RECORD : Read output signal from FUSION

Receive in Fastening Data message communication

2 CPU-315-PN/DP S7 Version5.4 result data entry example made in Siemens

Reception circuit of the STL form

Message Communication PLC
Receive declaration (Fusion → PLC)

```
O     M     90.5                M30.0
O     "END"                     M30.0
S     "END"
L     W#16#800A
T     MW     6
CALL  "RDREC" , DB52            M30.0        -- Read a Process Data Record
 REQ   :="END"
 ID    :=DW#16#7FB
 INDEX :=4096
 MLEN  :=480
 VALID :=M90.4
 BUSY  :=M90.5
 ERROR :=M90.7
 STATUS:=MD12
 LEN   :=MW8
 RECORD:=P#M 300.0 BYTE 480     M30.0
R     "END"                     M30.5
```

The detailed explanation looks at programming manual or a system function block manuals of the PLC, and please refer to the PLC maker for any questions.

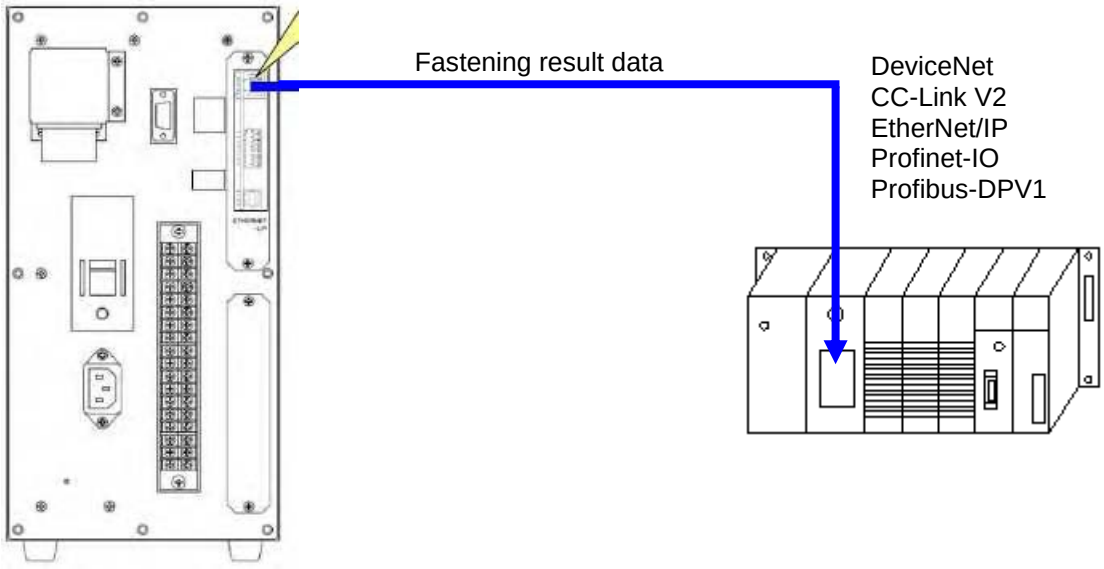
REQREQ=1: Transfer data record
(use 1 by transmission start and make it 0 by the completion of Transmission).
ID: Set the Fusion unit slave module address assigned by the hardware configuration.
INDEX: Data record number - set to 4096.
MLEN: Set message block length. A preset value is 480 at the time of factory shipment.
RECORD: Target area for the fetched data record. In the example, it is 480 bytes from M300.0.
VALID: New data record was received and valid.
BUSYBUSY=1: The read process is not yet terminated.
ERRORERROR=1: A read error has occurred.
STATUS: Call ID (bytes 2 and 3) or error code. Please read PLC manual.
LEN: Length of the fetched data record information.

4-15-7 Message Output Format

Resultant fastening data can be output to the PLC via the Fieldbus connection after the end of each fastening cycle. This is done using the Messaging function (CIP) in the PLC. (Each PLC uses a different method to acquire the data – please see the PLC manuals on how to program the PLC to receive the data)
The output message format is preset and cannot be changed. See the following for an example of the message format.

Note: The message data is available only on the Fieldbus type below.

DeviceNet
CC-Link V2
EtherNet/IP
Profinet-IO
Profibus-DPV1



Fastening Message Output Format ASCII 182bytes (Fixed Length)

"Accept" Fastening (Normal Format)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
DATE (YY/MM/DD)								TIME (HH:MM:SS)								COUNT NUMBER				ACCEPTcount	
31H	32H	2FH	30H	34H	2FH	31H	38H	31H	32H	3AH	33H	34H	3AH	35H	36H	30H	30H	30H	31H	30H	31H
1	2	/	0	4	/	1	8	1	2	:	3	4	:	5	6	0	0	0	1	0	1

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
UNIT NO		WORK NO		PEAK TORQUE					JOG	MARK		FINAL TORQUE					JOG	MARK	
30H	31H	30H	31H	31H	32H	2EH	33H	34H	20H	20H	20H	31H	32H	2EH	33H	34H	20H	20H	20H
0	1	0	1	1	2	.	3	4				1	2	.	3	4			

43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
1ST PEAK TORQUE						2ND PEAK TORQUE						FINAL ANGLE					JOG	MARK	
31H	32H	2EH	33H	34H	20H	31H	32H	2EH	33H	34H	20H	20H	20H	31H	32H	33H	20H	20H	20H
1	2	.	3	4		1	2	.	3	4				1	2	3			

63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
SIGN	DIFF ANGLE				JOG	MARK		SIGN	1ST RATE					JOG	MARK
20H	20H	20H	31H	33H	20H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H
-			1	0					0	.	1	2	3		

SIGN
" "(20H) : + VALUE
"-"(20H) : - VALUE

79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
SIGN	2ND RATE					JOG	MARK	SIGN	3RD RATE					JOG	MARK
20H	30H	2EH	31H	32H	33H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H
	0	.	1	2	3				0	.	1	2	3		

95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
1ST TIME					JOG	MARK		2ND TIME					JOG	MARK	
20H	31H	30H	2EH	30H	20H	20H	20H	20H	20H	32H	2EH	30H	20H	20H	20H
	1	0	.	0						2	.	0			

111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132
CYCLE TIME						PEAK TORQUE CURRNT				PEAK TORQUE ANGLE						1ST RATE INC TOEQUE					
20H	20H	33H	2EH	31H	20H	31H	37H	2EH	31H	20H	20H	20H	32H	30H	20H	20H	20H	31H	2EH	32H	20H
		3	.	1		1	7	.	1				2	0				1	.	2	

133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
1ST RATE INC ANGLE						2ND RATE INC TOEQUE						2ND RATE INC ANGLE					
20H	20H	20H	20H	33H	20H	20H	20H	38H	2EH	39H	20H	20H	20H	20H	31H	37H	20H
				3				8	.	9					1	7	

151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166
3RD RATE INC TOEQUE						3RD RATE INC ANGLE						RUNDOWN REVO.			
20H	20H	30H	2EH	30H	20H	20H	20H	20H	20H	30H	20H	20H	33H	2EH	35H
		0	.	0						0			3	.	5

167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182
CALIBRATION VOLT				SIGN	ZERO VOLT			SNUG DETECTION TOROUE						JOG	
32H	20H	31H	31H	20H	32H	36H	31H	20H	20H	31H	2EH	32H	20H	4FH	20H
2	5	1	1		2	6	1			1	.	2		O	

TOTAL JUDGMENT
"O"(4FH): ACCEPT

"Reject" Fastening: (Reject or Abnormal)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
DATE (YY/MM/DD)								TIME (HH:MM:SS)								COUNT NUMBER				ACCEPTcount	
31H	32H	2FH	30H	34H	2FH	31H	38H	31H	32H	3AH	33H	34H	3AH	35H	36H	30H	30H	30H	31H	30H	31H
1	2	/	0	4	/	1	8	1	2	:	3	4	:	5	6	0	0	0	1	0	1

23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
UNIT NO		WORK NO		PEAK TORQUE				JOG	MARK			FINAL TORQUE					JOG	MARK	
30H	31H	30H	31H	20H	31H	2EH	32H	33H	4CH	20H	20H	20H	31H	2EH	32H	33H	4CH	20H	20H
0	1	0	1		1	.	2	3	L				1	.	2	3	L		

43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
1ST PEAK TORQUE						2ND PEAK TORQUE						FINAL ANGLE					JOG	MARK	
20H	31H	2EH	32H	33H	20H	20H	31H	2EH	32H	33H	20H	20H	20H	20H	35H	30H	4CH	20H	20H
	1	.	2	3			1	.	2	3					5	0	L		

63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
SIGN	DIFF ANGLE				JOG	MARK		SIGN	1ST RATE					JOG	MARK
20H	20H	20H	31H	33H	20H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H
−			1	0					0	.	1	2	3		

SIGN
"_"(20H) : + VALUE
"−"(2DH) : − VALUE

79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94
SIGN	2ND RATE					JOG	MARK	SIGN	3RD RATE					JOG	MARK
20H	30H	2EH	31H	32H	33H	20H	20H	20H	30H	2EH	31H	32H	33H	20H	20H
	0	.	1	2	3				1	.	1	2	3	H	X

REJECT MARK
"X"(58H) :
REJECT cause first

95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110
1ST TIME					JOG	MARK		2ND TIME					JOG	MARK	
20H	31H	30H	2EH	30H	20H	20H	20H	20H	20H	32H	2EH	30H	20H	20H	20H
	1	0	.	0						2	.	0			

111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132
CYCLE TIME						PEAK TORQUE CURRNT				PEAK TORQUE ANGLE						1ST RATE INC TOEQUE					
20H	20H	33H	2EH	31H	20H	31H	37H	2EH	31H	20H	20H	20H	32H	30H	20H	20H	20H	31H	2EH	32H	20H
		3	.	1		1	7	.	1				2	0				1	.	2	

133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
1ST RATE INC ANGLE						2ND RATE INC TOEQUE						2ND RATE INC ANGLE					
20H	20H	20H	20H	33H	20H	20H	20H	38H	2EH	39H	20H	20H	20H	20H	31H	37H	20H
				3				8	.	9					1	7	

151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166
3RD RATE INC TOEQUE						3RD RATE INC ANGLE						RUNDOWN REVOL			
20H	20H	30H	2EH	30H	20H	20H	20H	20H	20H	30H	20H	20H	33H	2EH	35H
		0	.	0						0			3	.	5

167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182
CALIBRATION VOLT				SIGN	ZERO VOLT			SNUG DETECTION TOEQUE						JOG	
32H	35H	31H	31H	20H	32H	36H	31H	20H	20H	31H	2EH	32H	20H	58H	20H
2	5	1	1		2	6	1			1	.	2		X	

[PEAK TORQUE] JUDGMENT
"H"(48H) : HIGH REJECT "L"(4CH) : LOW REJECT
"A"(41H) : ABNORMAL "S"(53H) : STOP
"B"(42H) : BYPASS
"A", "B", "S" stand-alone generation "REJECT MARK" is not included.

[FINAL TORQUE],[ANGLE],[RATE],[TIME] JUDGMENT
"H"(48H) : HIGH REJECT "L"(4CH) : LOW REJECT

TOTAL JUDGMENT
"X"(58H) : REJECT

Chapter 5: Power Up and Initial Checks

5.1 Before Powering On

WARNING:Follow Lockout / Tag out and other safety precautions when connecting or disconnecting cabling, wiring, and equipment.

Each item below lists the manual Section(s) that will provide a reference for that specific item. Also refer to **Section 4.5** Connection Diagram.

Caution: Damage may occur if the 24 VDC and 0 VDC Commons are improperly connected.

1. **Verify CONTROLLER Unit DIP switch settings (4.10)**
   - Verify that the eight (8) DIP switches visible through the rear panel removable plate of each unit are set to indicate the appropriate spindle number and options. **Section 4.10 CONTROLLER DIP Switch setting.**

2. **Confirm Interface (PLC) connection (4.7)**
   - Verify that the CONTROLLER unit I/O Interface wiring is connected to the corresponding PLC terminals.

3. **Check connections between the tool and the CONTROLLER unit (section 3.1.2)**
   - Verify that the Single cable (resolver/ motor and transducer) connecting the tool and CONTROLLER unit is secure. If using multiple systems, ensure that the correct cable is connected to the appropriate TOOL and CONTROLLER unit.
   - If the layout contains moveable parts, visually inspect all components to ensure that there is proper clearance and that cables have sufficient length. If movement would create any excessive stress on a cable, or create any potential for damage to the system or other components in the layout, then make appropriate adjustments.

WARNING: Do not make motor connections with the power on. Turn off all controller power before attempting to connect or disconnect any motor cables or tool damage may occur.

4. **Check the input voltage (3.1.2, 4.6)**
   - Verify input power is properly connected (4.6.1).
   - Ensure input power voltage to the CONTROLLER Units is 100~230 VAC.

NOTE:After a CONTROLLER unit is powered down, the power must not be applied again for at least five (5) seconds. Repeated power up and power down, may temporarily disable the CONTROLLER unit as a safety precaution. If a CONTROLLER unit does become disabled, keep the power off for five (5) minutes, then power on again to reset the fault.

5.2 Initial Data Setting

After completion of the System verification/power on procedure in Section 5.1, the system is ready for the input of data required for the fastening operation. Chapters 6 and 7 give details on the types of information required, and the procedure for entering data into the System. The system will not run until this data is correctly set-up.

NOTE: Most FUSION systems are delivered with application-specific fastening data already setup (if provided by customer). This set-up data is considered preliminary and should be adjusted according to actual process / part runs for optimal performance.

After the system is setup with the appropriate data, perform the following procedure.

1. **Check the transducer ZERO output.**
   - Press the RESET button on front of the Keyboard-display Unit. The CONTROLLER unit will output a number (voltage) to the DATA display **WITHOUT** the “ABN” LED displayed (See NOTE 1 below.)
2. **Check the transducer CAL output.**
   - Press the CAL button on front of the Keyboard-display Unit. The CONTROLLER Unit will output a number (voltage) to the DATA display **WITHOUT** the “ABN” LED displayed (See NOTE 1 below.)

NOTE 1: If the Zero and/or Cal check results in an "ABNORMAL" LED output from the CONTROLLER unit refer to Section 9 for guidance.

WARNING: VERIFY THERE ARE NO PERSONNEL OR OBSTRUCTIONS IN THE TOOL AREA PRIOR TO ACTIVATING A SPINDLE OR OTHER MOVEABLE COMPONENT.

3. **Check manual reverse operation.**

   A. Set the Tool assembly to Reverse Mode.
      1. Momentarily depress the Reverse pushbutton switch on the Tool Assembly.
      2. The Tool Assembly light ring should be flashing to indicate Reverse Mode has been selected.

   B. Press the manual Start switch on the Tool Assembly while the tool is in Reverse Mode.
      1. Verify that the spindle is turning in the appropriate direction (opposite the preset (parameter) direction),

4. **Verify operation of manual start.**

   A. Set the Tool assembly to Fastening Mode.
      1. Momentarily depress the Reverse pushbutton switch on the Tool Assembly.
      2. The Tool Assembly light ring should **not** be flashing (flashing indicates Reverse Mode has been selected)

   B. Press the manual Start switch on the Tool Assembly while the tool is in Fastening Mode.
      1. Verify that the spindle is turning in the appropriate direction for fastening.

5. **Verify System operation by external commands (not required for normal operation).**
   - Confirm that the equipment operates correctly when PLC inputs are activated (as required). Use the PLC to perform all of the functions (Start, Work Sel, etc.) that will be utilized in system operation.
   - Confirm all PLC Output signals (Accept, Reject, Ready,etc.) that will be used in system operation.

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Chapter 6: Fastening Instructions

6.1 Fastening Control.

The Fusion system is user programmable to select from two different fastening methods, referred to as Torque Control and Angle Control methods. Each control method can be performed in 1 to 3 incremental steps, which will successively secure the fastener to the specified torque or angle values.

NOTE: All setting recommendations are based upon common fastening applications. Applications that experience high Prevailing torque, excessive joint compression or other unique characteristics must be set with these characteristics in mind.

6.1.1 Torque Control Method.

In Torque Control method, fastening is performed based upon attaining a desired torque value within one to three incremental steps, while monitoring the degrees of rotation (Angle) of the fastener and time. Additional monitor items (limits) can be set to enhance the systems ability to determine if the fastener was properly secured (Section 6.2).

- One-Step Fastening

  One-step fastening will be used primarily for joints which have no requirement to synchronize with another spindle during the final stage of the rundown. Examples: Pipe Plugs, Spark Plugs, single spindle applications.

1. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE.
2. The system will fasten to the 1ST TORQUE value during the specified 1ST TIME. 1ST TORQUE must be reached within the 1ST TIME limits or a reject will occur.
3. Upon reaching 1ST TORQUE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE is the shift point to TORQUE SPEED.
4. The system will fasten to STANDARD TORQUE using TORQUE SPEED during FINAL TIME. STANDARD TORQUE must be reached within the FINAL TIME limits or a reject will occur.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	10% of STANDARD TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE	30% of STANDARD TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation.
SNUG TORQUE	Angle Monitoring Start Point (section 6.2)
CROSSOVER TORQUE	Start point of 3RD torque rate monitoring (section 6.2)
STANDARD TORQUE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE to STANDARD TORQUE

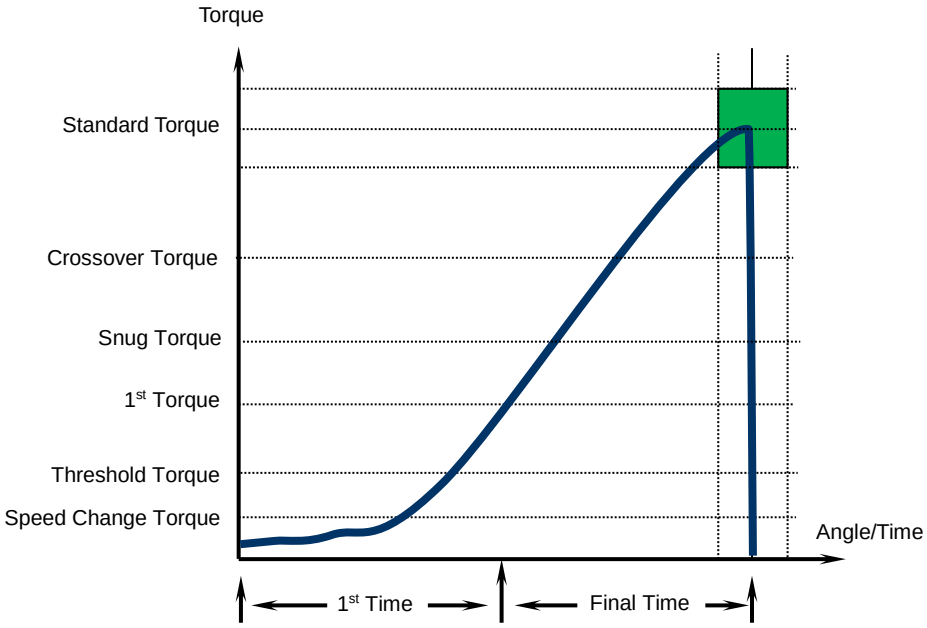

FIG. 6-1-1a Torque Control Functions for One-Step Fastening

◆ Two-Step Fastening

Two-step fastening will be used primarily for joints that have a requirement to synchronize with another spindle during the final stage of the rundown or require joint conditioning. Examples: Connecting Rod, Main Bearing Cap, any multiple-spindle application.

1. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE.
2. The system will fasten to the 1ST TORQUE value during the specified 1ST TIME. 1ST TORQUE must be reached within the 1ST TIME limits or a reject will occur.
3. Upon reaching 1ST TORQUE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE is the shift point to TORQUE SPEED and the synchronization point prior to commencing the next step. (See 4.13 for Sync. info)
4. The system will fasten to STANDARD TORQUE using TORQUE SPEED during FINAL TIME. STANDARD TORQUE must be reached within the FINAL TIME limits or a reject will occur.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	10% of STANDARD TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE	30% of STANDARD TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation. Synchronization point for 2ND STEP
SNUG TORQUE	Angle Monitoring Start Point (section 6.2)
CROSSOVER TORQUE	Start point of 3RD torque rate monitoring (section 6.2)
STANDARD TORQUE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE to STANDARD TORQUE

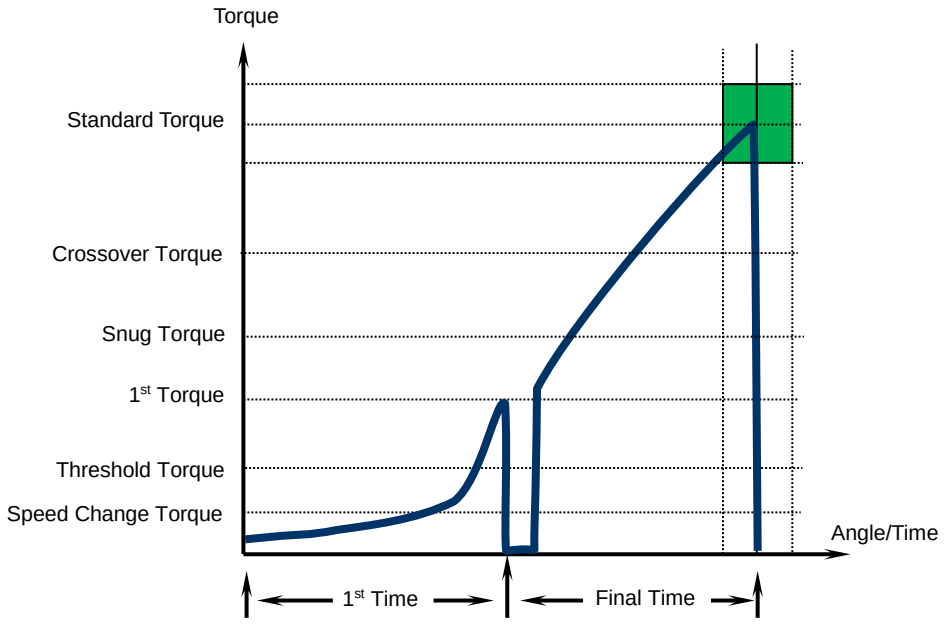

FIG. 6-1-1b Torque Control Functions for Two-Step Fastening

◆ Three-Step Fastening

Three-step fastening will be used primarily for joints that have a requirement to synchronize with another spindle during the incremental stages of the rundown to crush/compress a gasket or grommet or for special joint conditioning (valve cover, oil pan, or body assembly, for example).

1. The system will fasten to the 1ST TORQUE value during the specified 1ST TIME. 1ST TORQUE must be reached within the 1ST TIME limits or a reject will occur.
2. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE.
3. Upon reaching 1ST TORQUE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE is the shift point to TORQUE SPEED and the synchronization point prior to commencing the next step. (See 4.13 for Sync. info)
4. The system will fasten to CROSSOVER TORQUE, synchronize with other spindles and then fasten to STANDARD TORQUE using TORQUE SPEED during FINAL TIME. STANDARD TORQUE must be reached within the FINAL TIME limits or a reject will occur.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	10% of STANDARD TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE	30% of STANDARD TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation. Synchronization point for 2nd STEP
SNUG TORQUE	Angle Monitoring Start Point (section 6.2)
CROSSOVER TORQUE	Start point of 3RD torque rate monitoring (section 6.2) Synchronization point for 3rd STEP
STANDARD TORQUE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE to STANDARD TORQUE

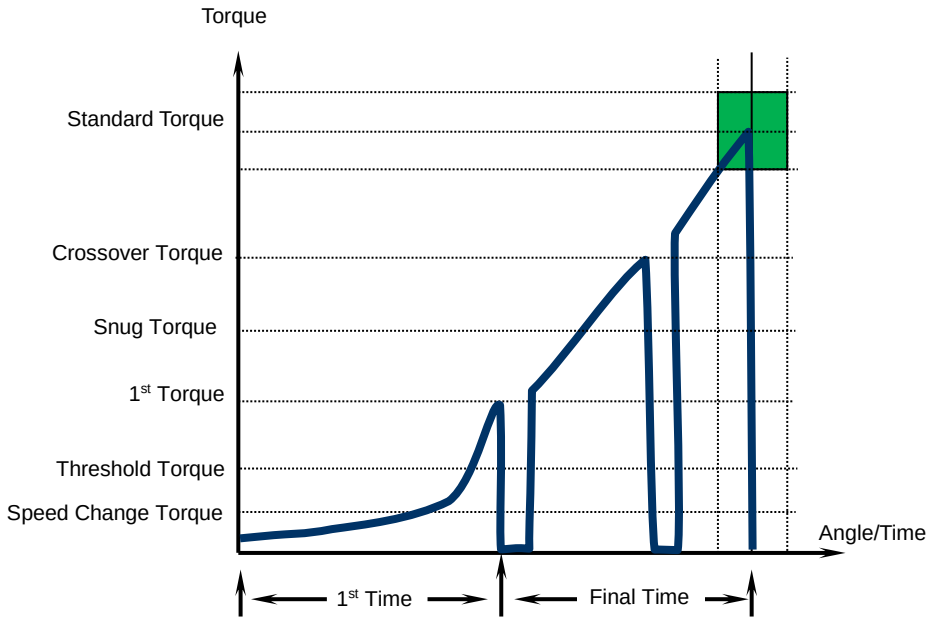

FIG. 6-1-1c Torque Control Functions for Three-Step Fastening

6.1.2 Angle Control Method.

In Angle Control method, fastening is performed based upon attaining a desired torque value and then rotating the fastener a specified number of degrees, while monitoring the Torque of the fastener and time. Additional monitor items (limits) can be set to enhance the systems ability to determine if the fastener was properly secured (Section 6.2). Fastening can be performed from 1 to 3 incremental steps that will successively secure the fastener to a specified torque or angle value before attaining the final number of degrees of rotation.

Angle Control method is primarily used when greater control of clamp load is required. (Angle Control specs. are developed through testing of the joint and fastener characteristics and therefore should not be attempted unless testing is performed)

NOTE: All setting recommendations are based upon common fastening applications. Applications that experience high Prevailing torque, excessive joint compression or other unique characteristics must be set with these characteristics in mind.

NOTE: When performing multiple step Angle control fastening, the rotation Angle should be performed as one continuous operation. There should be no intermediate stop/synchronization points once Snug Torque has been sensed and rotation angle is being controlled. Under special conditions multiple steps can be performed using intermediate Torque or Angle stop/synchronization points.

- **One-Step Fastening**

  One-Step fastening will be used primarily for joints that have no requirement to synchronize with another spindle during the final stage of the rundown.

1. Angle control commences at SNUG TORQUE. All angle values are referenced from this point.
2. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE/ANGLE.
3. The system will fasten to the 1ST TORQUE/ANGLE value during the specified 1ST TIME. 1ST TORQUE/ANGLE must be reached within the 1ST TIME limits or a reject will occur.
4. Upon reaching 1ST TORQUE/ANGLE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE/ANGLE is the shift point to TORQUE SPEED.
5. The system will fasten to STANDARD ANGLE using TORQUE SPEED during FINAL TIME. STANDARD ANGLE must be reached within the FINAL TIME limits or a reject will occur.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	30% of SNUG TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE/ANGLE	80% of SNUG TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation.
SNUG TORQUE	Angle Control Start Point
CROSSOVER TORQUE/ANGLE	Start point of 3RD torque rate monitoring (section 6.2)
STANDARD ANGLE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE/ANGLE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE/ANGLE to STANDARD ANGLE

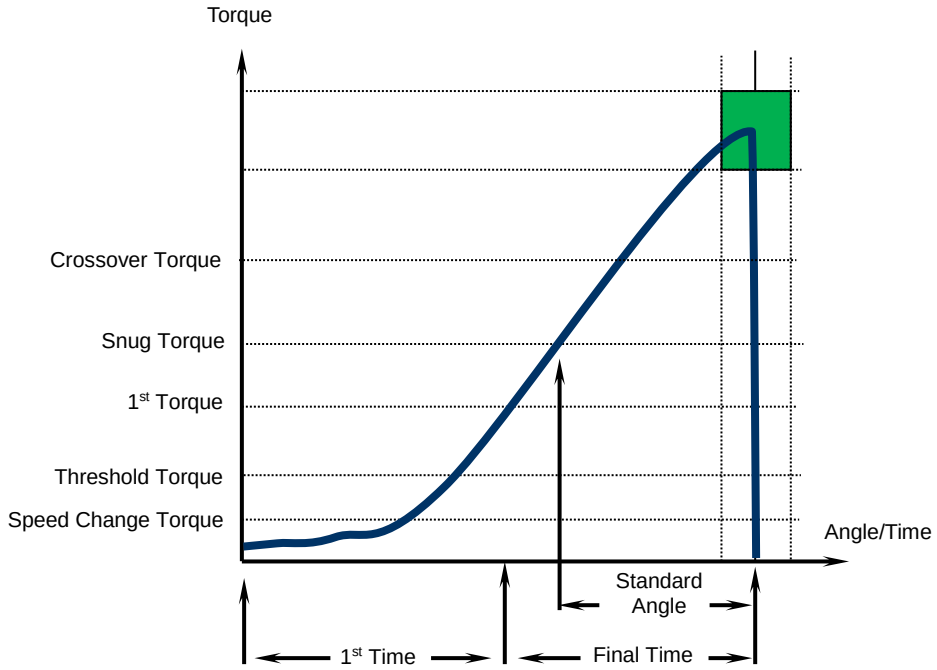

FIG. 6-1-2a Angle Control Functions for One-Step Fastening

◆ Two-Step Fastening

Two-Step fastening will be used primarily for joints that have a requirement to synchronize with another spindle during the final stage of the rundown.

1. Angle control commences at SNUG TORQUE. All angle values are referenced from this point.
2. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE/ANGLE.
3. The system will fasten to the 1ST TORQUE/ANGLE value during the specified 1ST TIME. 1ST TORQUE/ANGLE must be reached within the 1ST TIME limits or a reject will occur.
4. Upon reaching 1ST TORQUE/ANGLE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE/ANGLE is the shift point to TORQUE SPEED and the synchronization point prior to commencing the next step. (See 4.13 for Sync. info).
5. The system will fasten to STANDARD ANGLE using TORQUE SPEED during FINAL TIME. STANDARD ANGLE must be reached within the FINAL TIME limits or a reject will occur.

NOTE: When performing multiple step Angle control fastening, the rotation Angle should be performed as one continuous operation. There should be no intermediate stop / synchronization points once Snug Torque has been sensed and rotation angle is being controlled. Under special conditions multiple steps can be performed using intermediate Torque or Angle stop/synchronization points.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	30% of SNUG TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE/ANGLE	80% of SNUG TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation.
SNUG TORQUE	Angle Control Start Point
CROSSOVER TORQUE/ANGLE	Start point of 3RD torque rate monitoring (section 6.2)
STANDARD ANGLE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE/ANGLE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE/ANGLE to STANDARD ANGLE

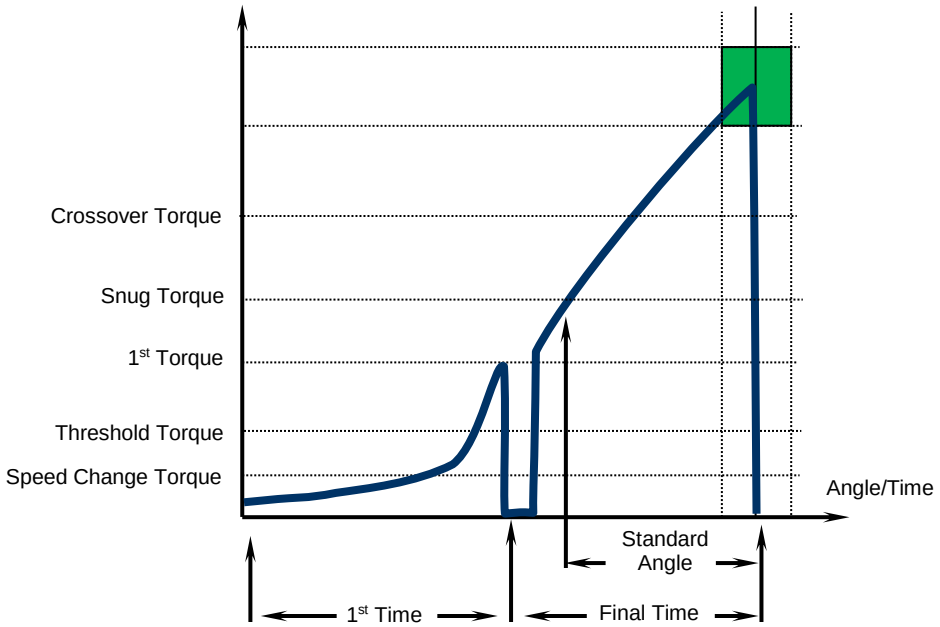

FIG. 6-1-2b Angle Control Functions for Two-Step Fastening (1st step Torque)

NOTE: When performing multiple step Angle control fastening, the rotation Angle should be performed as one continuous operation. There should be no intermediate stop / synchronization points once Snug Torque has been sensed and rotation angle is being controlled.

Under special conditions multiple steps can be performed using intermediate Torque or Angle stop/synchronization points as shown below.

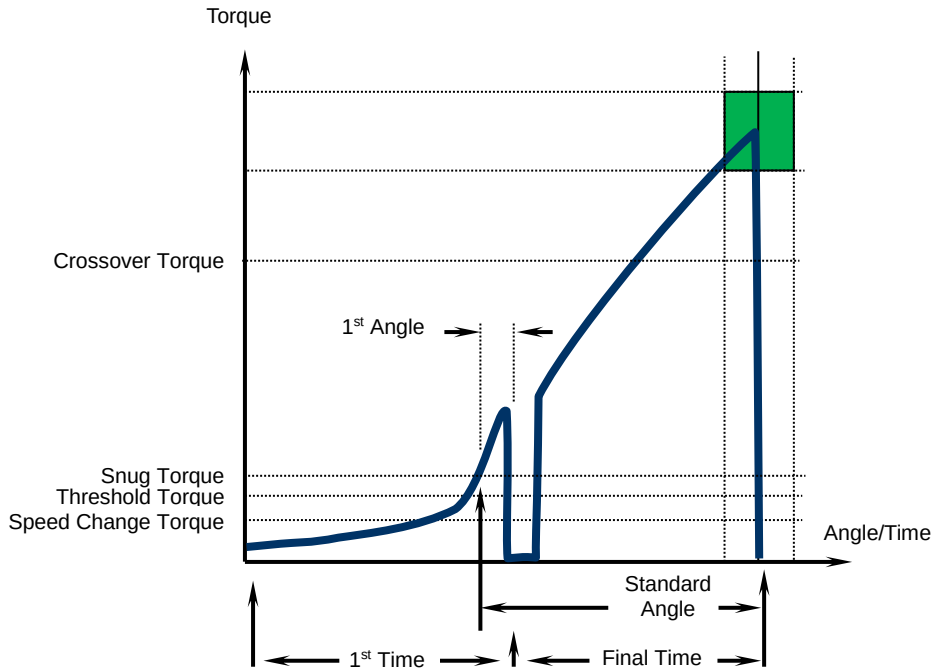

FIG. 6-1-2c Angle Control Functions for Two-Step Fastening (1st step Angle)

◆ Three-Step Fastening

Three-step fastening will be used primarily for joints that have a requirement to synchronize with another spindle during the incremental stages of the rundown to crush/compress a gasket or grommet or for special joint conditioning (valve cover, oil pan, or body assembly, for example).

1. Angle control commences at SNUG TORQUE. All angle values are referenced from this point.
2. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten to 1ST TORQUE/ANGLE.
3. The system will fasten to the 1ST TORQUE/ANGLE value during the specified 1ST TIME. 1ST TORQUE/ANGLE must be reached within the 1ST TIME limits or a reject will occur.
4. Upon reaching 1ST TORQUE/ANGLE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE/ANGLE is the shift point to TORQUE SPEED and the synchronization point prior to commencing the next step. (See 4.13 for Sync. info).
5. The system will fasten to CROSSOVER TORQUE/ANGLE, synchronize with other spindles and then fasten to STANDARD ANGLE using TORQUE SPEED during FINAL TIME. STANDARD ANGLE must be reached within the FINAL TIME limits or a reject will occur.

NOTE: When performing multiple step Angle control fastening, the rotation Angle should be performed as one continuous operation. There should be no intermediate stop / synchronization points once Snug Torque has been sensed and rotation angle is being controlled. Under special conditions multiple steps can be performed using intermediate Torque or Angle stop/synchronization points.

FUNCTION	RECOMMENDATION / COMMENT
SPEED CHANGE TORQUE	30% of SNUG TORQUE
THRESHOLD TORQUE	Start point of 1st torque rate monitoring (section 6.2)
1ST TORQUE/ANGLE	80% of SNUG TORQUE Used for RATE/TIME settings and TORQUE SPEED initiation.
SNUG TORQUE	Angle Control Start Point
CROSSOVER TORQUE/ANGLE	Start point of 3RD torque rate monitoring (section 6.2) Synchronization point for 3rd Step
STANDARD ANGLE	Engineered product fastening specification
1ST TIME HIGH/LOW LIMIT	Acceptance range to reach 1ST TORQUE/ANGLE setting
FINAL TIME HIGH/LOW LIMIT	Acceptance range to go from 1ST TORQUE/ANGLE to STANDARD ANGLE

NOTE: When performing multiple step Angle control fastening, the rotation Angle should be performed as one continuous operation. There should be no intermediate stop / synchronization points once Snug Torque has been sensed and rotation angle is being controlled.

Under special conditions multiple steps can be performed using intermediate Torque or Angle stop/synchronization points as shown below.

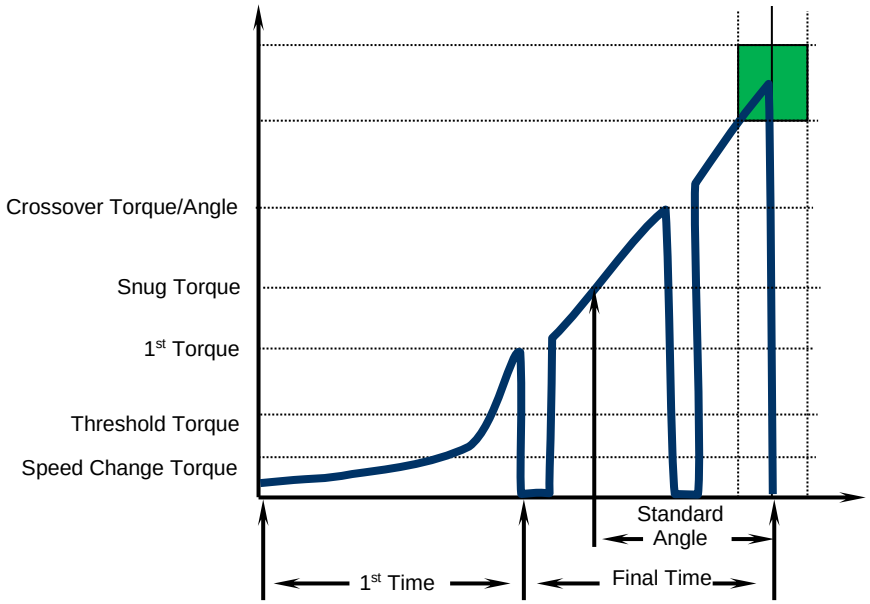

FIG. 6-1-2d Angle Control Functions for Three-Step Fastening

6.2 Monitoring Functions

The Fusion System is user programmable to select and set the monitoring limits for torque, angle, time, up to three independent torque rate areas, and special functions describe below.

6.2.1 Peak Torque Monitoring

Torque Monitoring is a continuous process whenever the System is operating. Peak Torque monitoring uses the maximum torque value detected during Fastening.

- In Torque Control method, the Peak Torque High and Low Torque limits are set based upon the engineering specification for the specific fastener.

TORQUE CONTROL	
REJECT TYPE	**CAUSES**
PEAK TORQUE HIGH LIMIT	Re-hit of pre-secured fastener. Incorrect parameter set-up.
PEAK TORQUE LOW LIMIT	Reject condition caused by another monitor item reject.

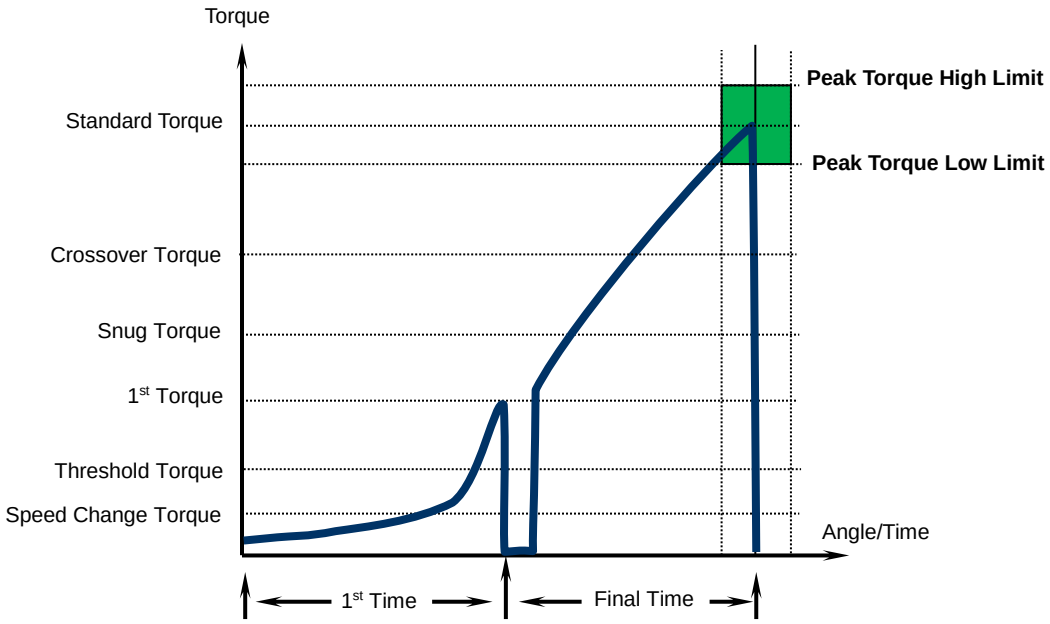

FIG. 6-2-1a Peak Torque Monitor – Torque Control

- For Angle Control operations, the High and Low Torque limits are either set by the engineering specification for that specific fastener, or by determining the acceptable limits from a study of known good and bad assemblies. The High Torque limit will stop the fastening process for Angle Control operations if it is reached before attaining the desired angle.

ANGLE CONTROL	
REJECT TYPE	**CAUSES**
PEAK TORQUE HIGH LIMIT	Reduced joint compression. Increased joint friction. Incorrect parameter set-up.
PEAK TORQUE LOW LIMIT	Increased joint compression. Reduced joint friction. High initial prevailing torque. Incorrect parameter set-up. Reject condition caused by another monitor item reject.

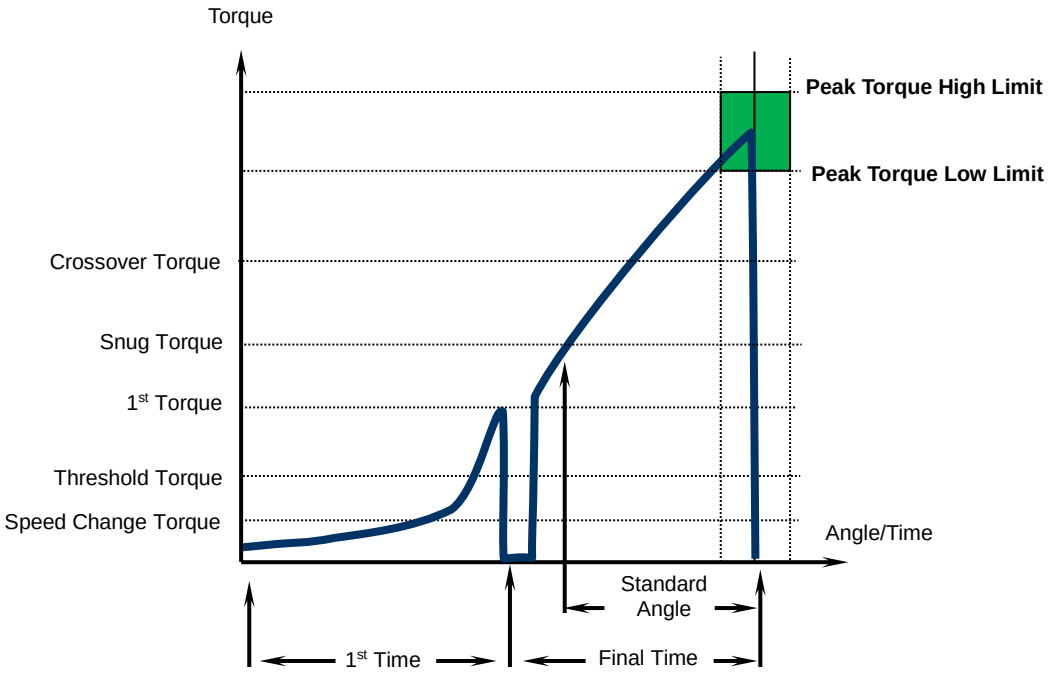

FIG. 6-2-1b Peak Torque Monitor – Angle Control

6.2.2Final Torque Monitoring

Torque Monitoring is a continuous process whenever the system is operating. Final Torque monitoring uses the torque value detected at the completion of fastening.

- In Torque Control method, the Final Torque value and Peak Torque values will be identical except in cases where Torque Recovery (Section 6.5) is enabled. In Torque Control method, the Final Torque High and Low Torque limits are only selectable when Torque Recovery is enabled, and are typically set based upon the engineering specification for that specific fastener.

TORQUE CONTROL – TORQUE RECOVERY ENABLED	
REJECT TYPE	**CAUSES**
FINAL TORQUE HIGH LIMIT	Excessive chatter of the torque signal due to slip stick friction. Incorrect parameter set-up.
FINAL TORQUE LOW LIMIT	Reject condition caused by another monitor item reject.

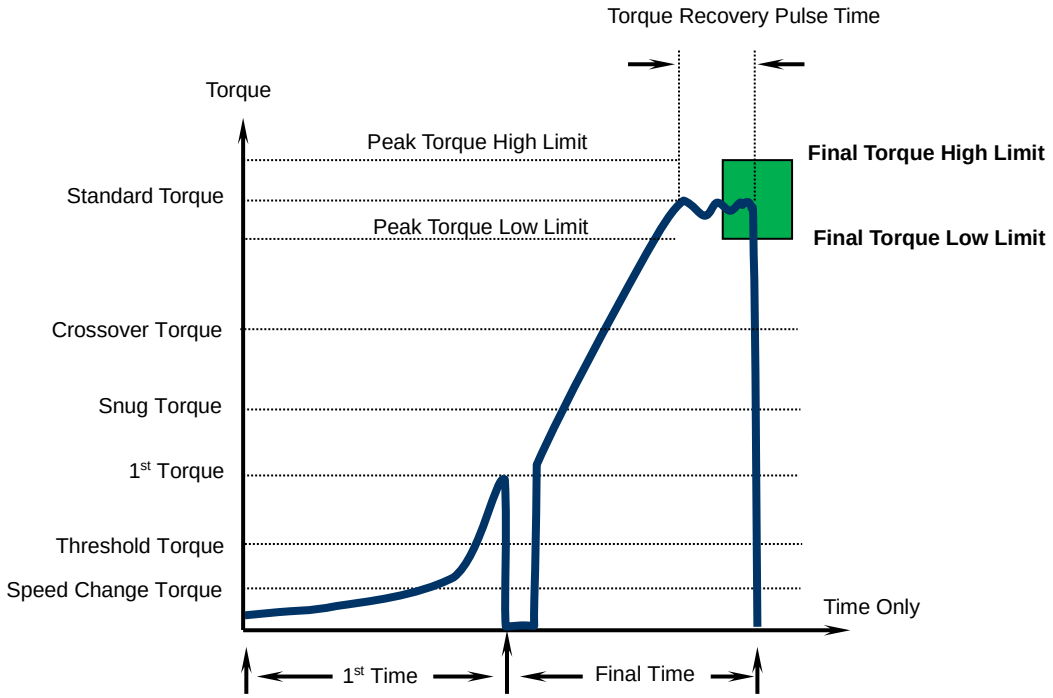

FIG. 6-2-2a Final Torque Monitor – Torque Control W/ Torque Recovery

- For Angle Control operations, the Torque value may reach a peak value and then drop to a lower value as the fastener is stretched beyond the point of yielding. Final Torque High and Low Limits are either set by the engineering specification for that specific fastener, or by determining the acceptable limits from a study of known good and bad assemblies.

ANGLE CONTROL	
REJECT TYPE	**CAUSES**
FINAL TORQUE HIGH LIMIT	Reduced joint compression. Increased joint friction. Excessive chatter of the torque signal due to slip stick friction. Incorrect parameter set-up.
FINAL TORQUE LOW LIMIT	Increased joint compression. Reduced joint friction. Excessive yield of fastener. High initial prevailing torque. Incorrect parameter set-up. Reject condition caused by another monitor item reject.

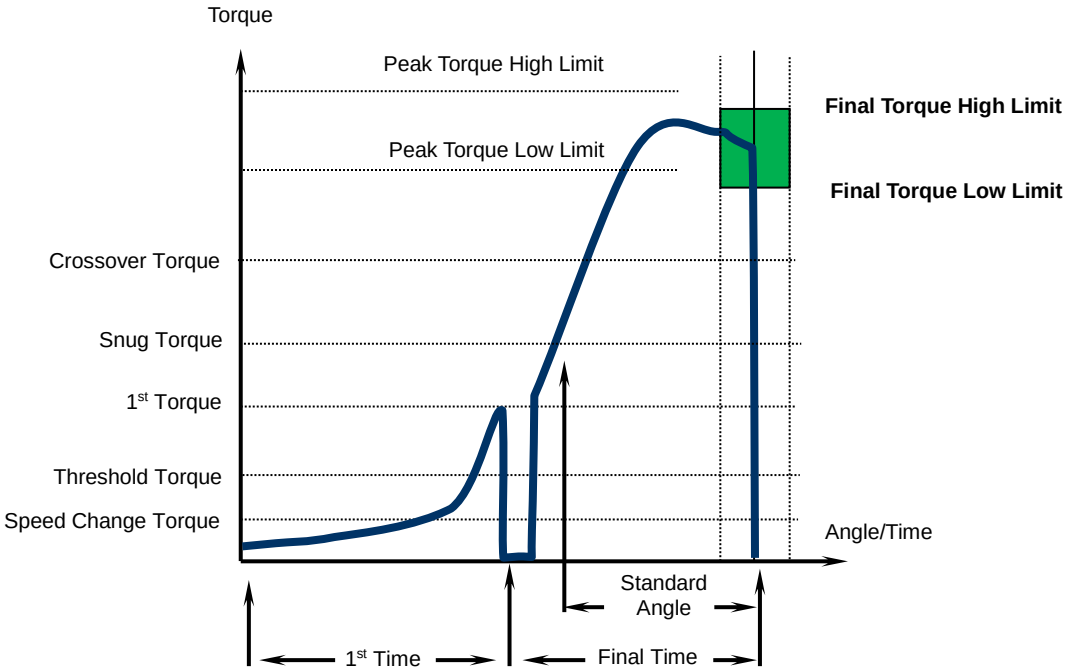

FIG. 6-2-2b Final Torque Monitor – Angle Control

6.2.3 Angle Monitoring

Angle Monitoring commences upon reaching the preset SNUG TORQUE value, and continues until completion of the fastening process.

- In Angle Control method, the Angle High and Low Limits are set based upon the engineering specification for that specific fastener.

ANGLE CONTROL	
REJECT TYPE	**CAUSES**
ANGLE HIGH LIMIT	Incorrect parameter set-up.
ANGLE LOW LIMIT	Reject condition caused by another monitor item reject.

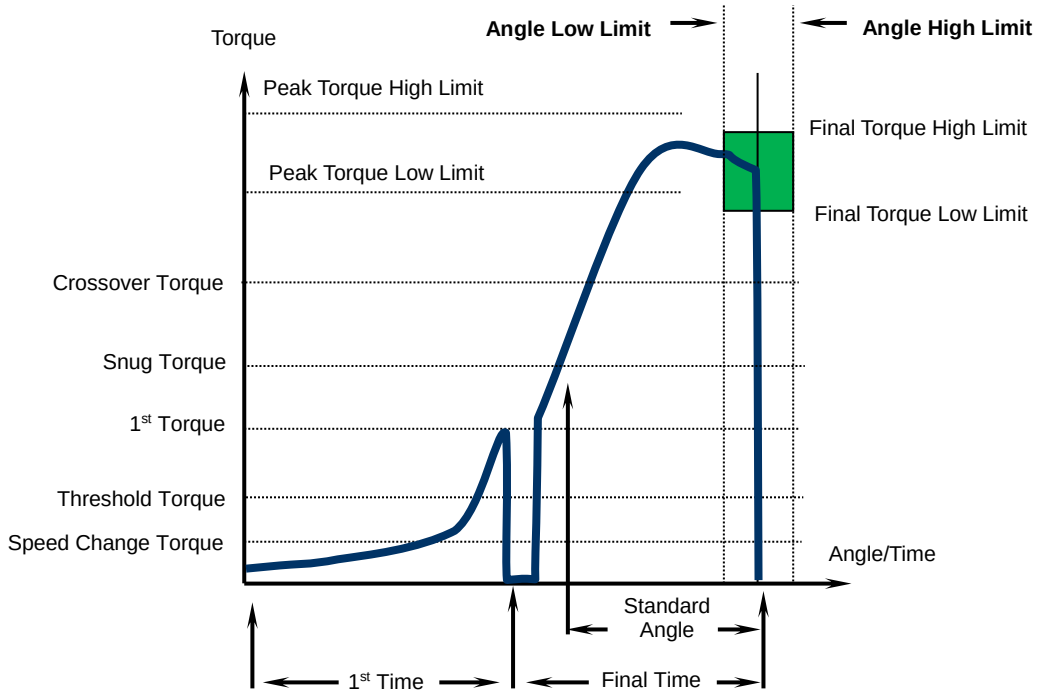

FIG. 6-2-3a Angle Monitoring – Angle Control

For Torque Control operations, the High and Low Angle limits are either set by the engineering specification for that specific fastener, or by determining the acceptable limits from a study of known good and bad assemblies. The High Angle limit will stop the fastening process for Torque Control operations if it is reached before attaining the desired torque.

TORQUE CONTROL	
REJECT TYPE	**CAUSES**
HIGH ANGLE LIMIT	Increased joint compression. Reduced joint friction. High initial prevailing torque. Incorrect parameter set-up.
LOW ANGLE LIMIT	Reduced joint compression. Increased joint friction. Reject condition caused by another monitor item reject.

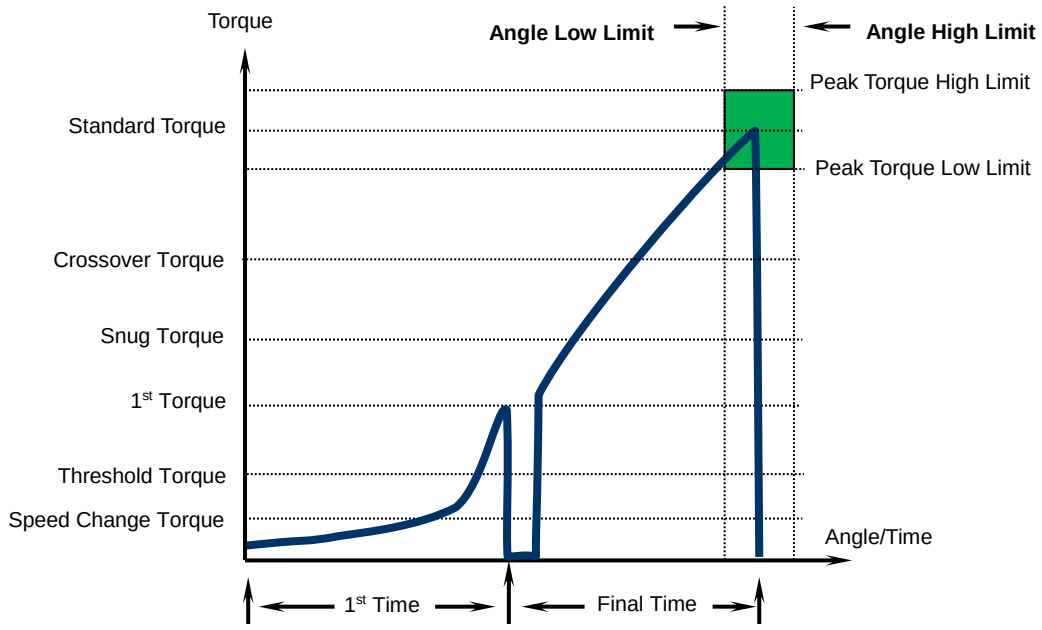

FIG. 6-2-3b Angle Monitoring – Torque Control

6.2.4 Point-to-Point Torque Rate Monitoring

The Fusion System is capable of performing 3 torque rate calculations. The Point-to-Point torque rate method performs the calculation based upon completing a step of the process, and then calculating the rate for the full duration of that step. The chart below identifies the different areas that torque rate can be calculated. Each Torque Rate is calculated by dividing the change in torque during the specific period by the change in angle.

Example: 25Nm / 100deg. = 0.25 Nm/Deg. (rate)

NOTE: Setting any of the Torque Rate START POINTS above the FASTENING END TORQUE will eliminate the torque rate calculation for that stage.

Torque Rate Calculation Areas (Typical for 1 or 2 step)
(CROSSOVER TORQUE set above FASTENING END TORQUE)
Refer to Fig. 6-2-4a

STAGE	START POINT	STOP POINT
1ST TORQUE RATE	THRESHOLD TORQUE	1ST TORQUE
2ND TORQUE RATE	2ND RATE START TORQUE	FASTENING END

Torque Rate Calculation Areas (Typical for 3 step, however can be used on 1 or 2 step)
Refer to Fig. 6-2-4b

STAGE	START POINT	STOP POINT
1ST TORQUE RATE	THRESHOLD TORQUE	1ST TORQUE
2ND TORQUE RATE	2ND RATE START TORQUE	CROSSOVER TORQUE
3RD TORQUE RATE	CROSSOVER TORQUE	FASTENING END

In the case that Torque Rate Stop Points are not set incrementally larger from THRESHOLD to 2ND RATE START TORQUE and then to CROSSOVER TORQUE, the rate calculation will be performed at the next successive available stop point prior to fastening end.

STAGE	START POINT	AVAILABLE STOP POINTS
1ST TORQUE RATE	THRESHOLD	1ST TORQUE CROSSOVER TORQUE FASTENING END
2ND TORQUE RATE	2ND RATE START	CROSSOVER TORQUE FASTENING END
3RD TORQUE RATE	CROSSOVER TORQUE	FASTENING END

For all control operations, the High and Low Torque Rate limits are set by determining the acceptable limits from a study of known good and bad assemblies.

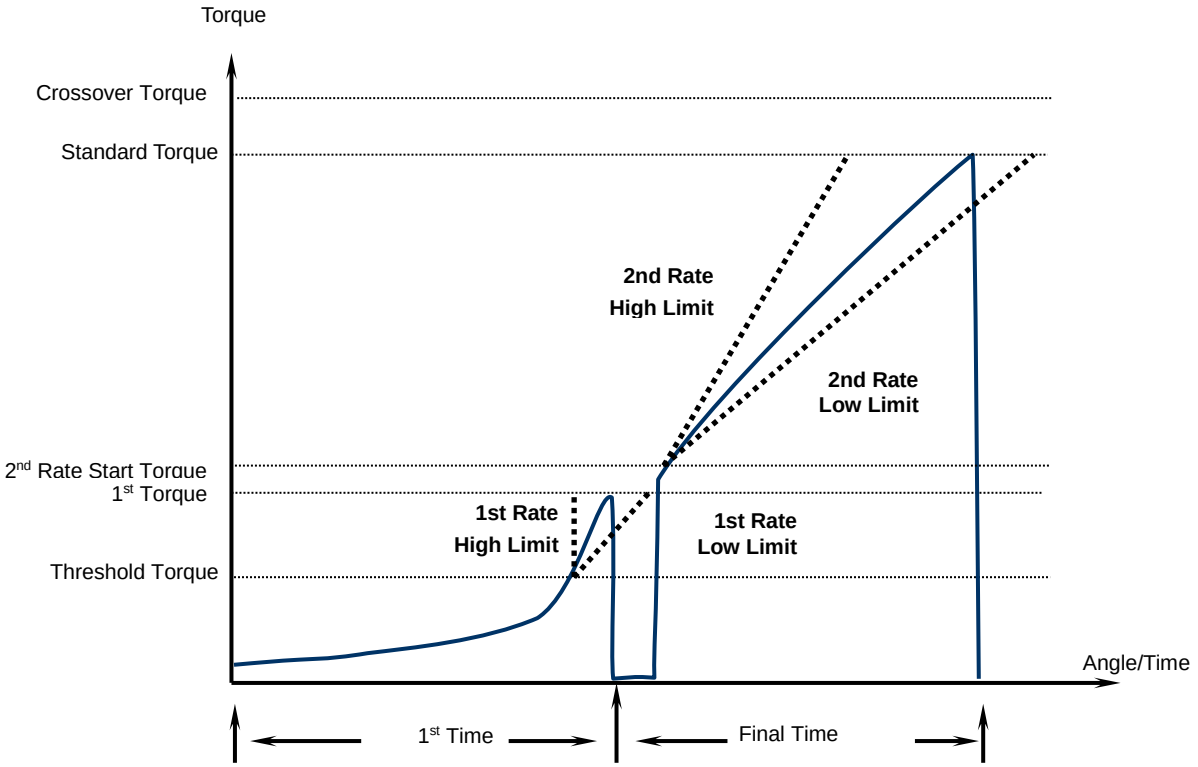

FIG. 6-2-4a Two Stage Point-to-Point Torque Rate Monitoring

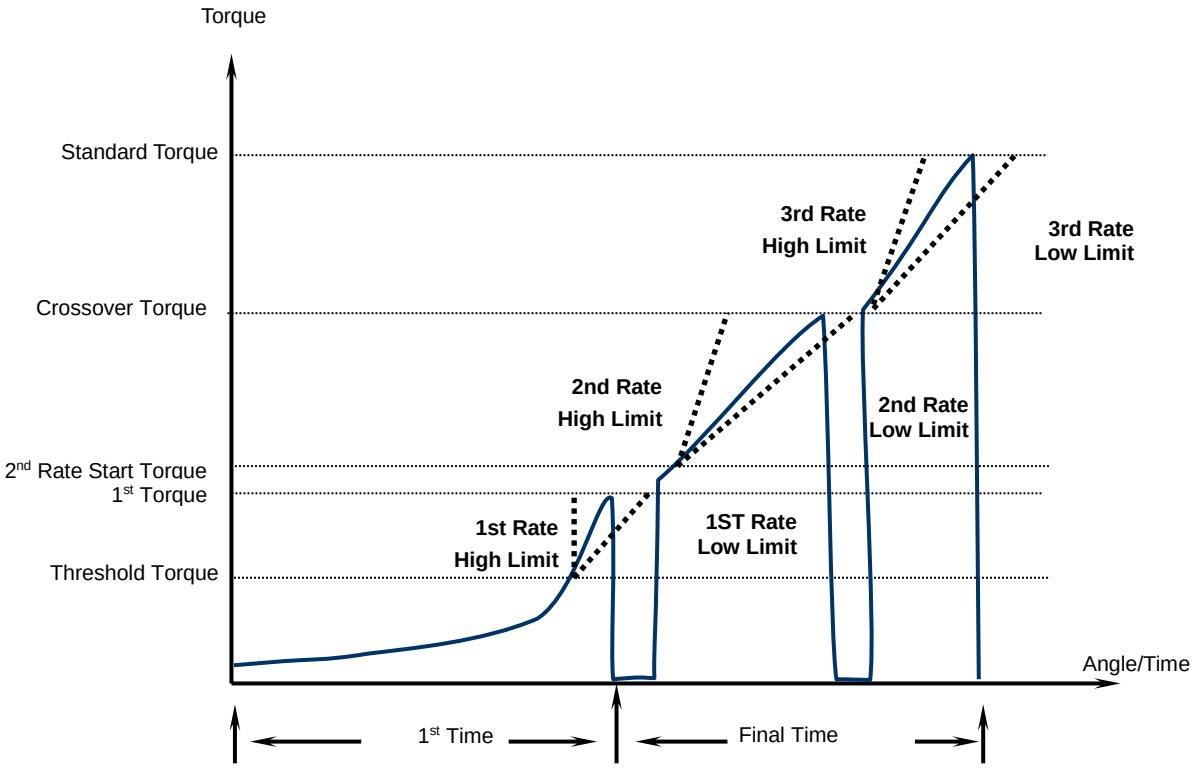

FIG. 6-2-4b Three Stage Point-to-Point Torque Rate Monitoring

6.2.5 Time Monitoring

◆ **Time High Limits**

As outlined in the Fastening Control Methods portion of this chapter, this system is capable of performing multiple-step fastening operations. The duration of each of these steps is governed by one of two independent watchdog time settings. If the step fails to attain the desired result before the completion of the specified time, a TIME HIGH reject condition will occur.

◆ **Time Low Limits**

Low time limit settings for both 1st and Final steps are available for special applications. This allows the setting of a low time limit which can be used to detect conditions in which the fastening reaches a given point before it would have under normal conditions. Short bolts, short threads, blind holes, cross threads, etc. are all conditions which may be detected with this setting. Times under the low limit will produce a reject for that fastening.

1 Step Fastening			
Function	**Start Point**	**Stop Point**	**Time Preset Limits**
1ST STEP	START	1ST TORQUE	1ST TIME HIGH/LOW LIMIT
	1ST TORQUE	FASTENING END	FINAL TIME HIGH/LOW LIMIT
1st TORQUE also serves as a shift point to TORQUE SPEED and the monitoring stop point for 1st TORQUE RATE. The system does not stop or synchronize at this point.			

2 Step Fastening			
Function	**Start Point**	**Stop Point**	**Time Preset Limits**
1ST STEP	START	1ST TORQUE	1ST TIME HIGH/LOW LIMIT
2ND STEP	1ST TORQUE	FASTENING END	FINAL TIME HIGH/LOW LIMIT
1st TORQUE also serves as a shift point to TORQUE SPEED and the monitoring stop point for 1st TORQUE RATE. The system will temporarily stop at this point and can be set to synchronize with other spindles.			

3 Step Fastening			
Function	**Start Point**	**Stop Point**	**Time Preset Limits**
1ST STEP	START	1ST TORQUE	1ST TIME HIGH/LOW LIMIT
1st TORQUE also serves as a shift point to TORQUE SPEED and the monitoring stop point for 1st TORQUE RATE. The system will temporarily stop at this point and can be set to synchronize with other spindles.			
2ND STEP	1ST TORQUE	CROSSOVER TORQUE	FINAL TIME HIGH/LOW LIMIT
3RD STEP	CROSSOVER TORQUE	FASTENING END	
For 3 Step Fastening, 2ND STEP and 3RD STEP are performed with the same preset FINAL TIME HIGH/LOW LIMITS. (both must finish within the same combined timeframe)			

6.3 Speed Functions

The Fusion system is user-programmable for operations involving multiple speed settings. The use of multiple speeds during the fastening process aids in socket engagement, achieving cycle time, operator ergonomic issues and controlling the applied torque during all stages. Speed functions work the same for Torque control and Angle control, using any of the previously stated standard monitoring function. Special conditions that affect these operations will be identified in the appropriate section.

1. The system will fasten to the 1ST TORQUE/ANGLE value during the specified 1ST TIME. During 1ST time the following steps occur:
    a. The system starts off running at INITIAL SPEED for the period specified by INITIAL TIME. This segment is intended to be used for initial fastener engagement.
    b. Upon completion of INITIAL TIME the system switches to FREERUN SPEED for the period specified by FREERUN REVOLUTIONS. The number of revolutions required to complete INITIAL TIME will be deducted from the number of revolutions run at FREERUN SPEED.
    c. Once SPEED CHANGE TORQUE is reached or FREERUN REVOLUTIONS expires, the system will switch from FREERUN SPEED to SLOWDOWN SPEED and continue to fasten until 1ST TORQUE/ANGLE is attained or the 1ST TIME HIGH LIMIT (1ST time reject) is reached. SLOW DOWN SPEED is intended to provide a slower, more controlled speed to seat the fastener.
2. Upon reaching 1ST TORQUE/ANGLE, 1ST TIME ends and FINAL TIME begins. 1ST TORQUE/ANGLE is the shift point to TORQUE SPEED and the synchronization point prior to commencing the next step. (See 4.13 for Sync. info).
3. For a 2 step fastening, the system will fasten to STANDARD TORQUE/ANGLE, using TORQUE SPEED during FINAL TIME. STANDARD TORQUE/ANGLE must be reached within the FINAL TIME limits or a reject will occur.
4. For a 3 step fastening, the system will fasten to CROSSOVER TORQUE/ANGLE, synchronize with other spindles and than fasten to STANDARD TORQUE/ANGLE using TORQUE SPEED during FINAL TIME. STANDARD TORQUE/ANGLE must be reached within the FINAL TIME limits or a reject will occur.

FUNCTION	RECOMMENDATION
INITIAL TIME	Set to a duration which will provide sufficient time for the socket to engage the fastener. Set in seconds.
INITIAL SPEED	Set to the rpm which will allow for easy socket to fastener engagement.
FREERUN REVOLUTIONS	For joints that do not react properly to high speed seating, the Freerun revolutions should be set to end prior to the fastener seating.
FREERUN SPEED	Set based upon cycle time requirements. This speed is used to run down the bolt quickly.
SLOW DOWN SPEED	First torque fastening speed. SET based upon the joint type to allow for a controlled seating. LESS THAN 200 RPM.
TORQUE SPEED	Final torque speed to which the nutrunner will shift once 1st TORQUE is reached. SET based upon the joint type to allow for a controlled final fastening. LESS THAN 50 RPM.
REVERSE SPEED	Speed used to reverse or back - out a fastener. Typically ¼ of full speed. Additional reverse functions exist when a MULTI unit is used.

The graphic below describes the ideal relationship between torque and speed. Typically for high motor durability, High speed (FREERUN speed) should slow to SLOWDOWN speed before the fastener seats. Final torque speed should not exceed 50 RPM.

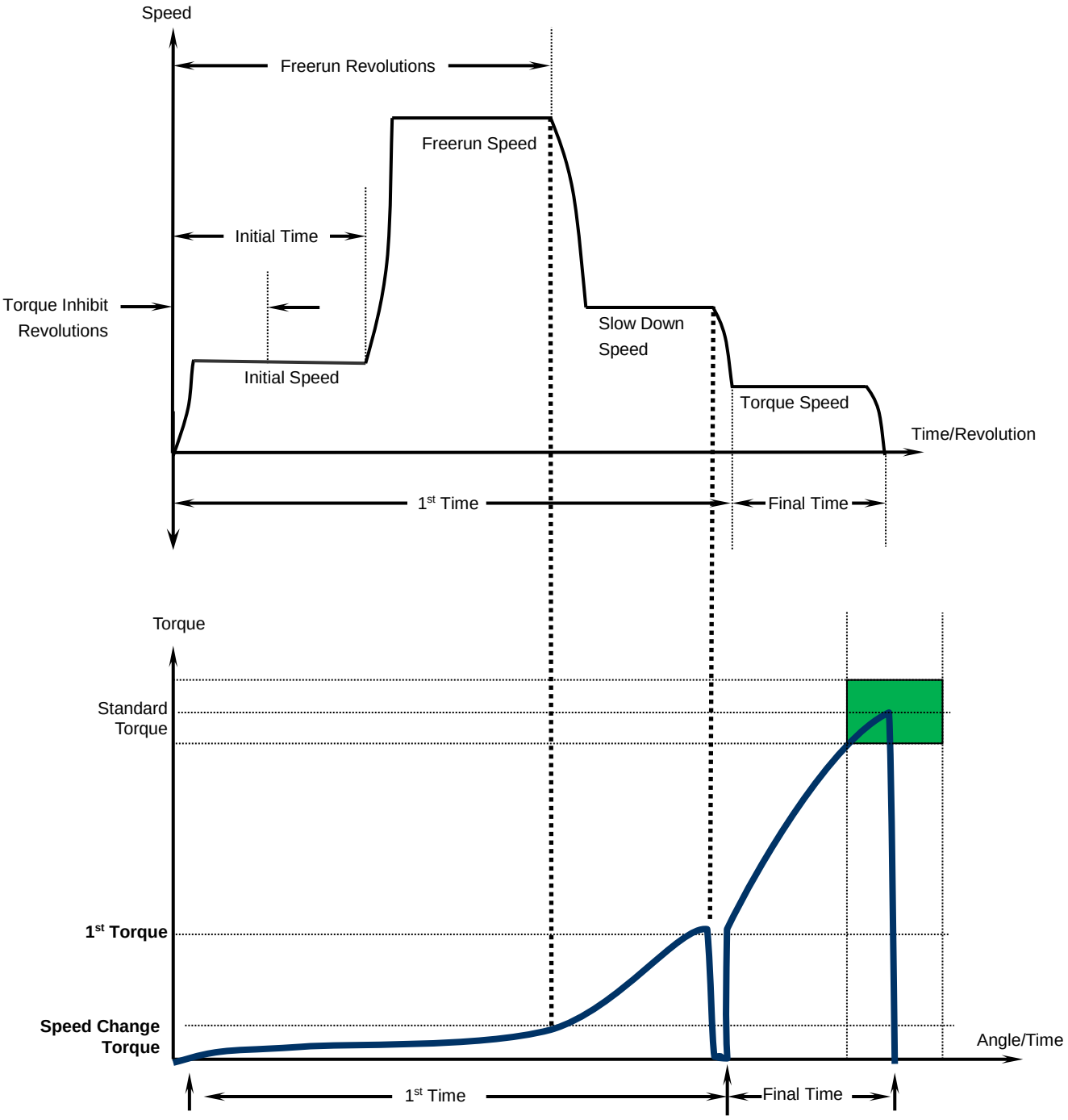

FIG. 6-3b Ideal Relationship of Speed and Torque

6.4 Reverse Functions

The Fusion system is capable of reverse operations using the reverse pushbutton on the Fusion tool or via the PLC input at TB1 Terminal. The PLC input can be used for automated reverse operations. The motor will reverse as long as the reverse signal or manual button is enabled.
One reverse speed is available per parameter (up to 16).

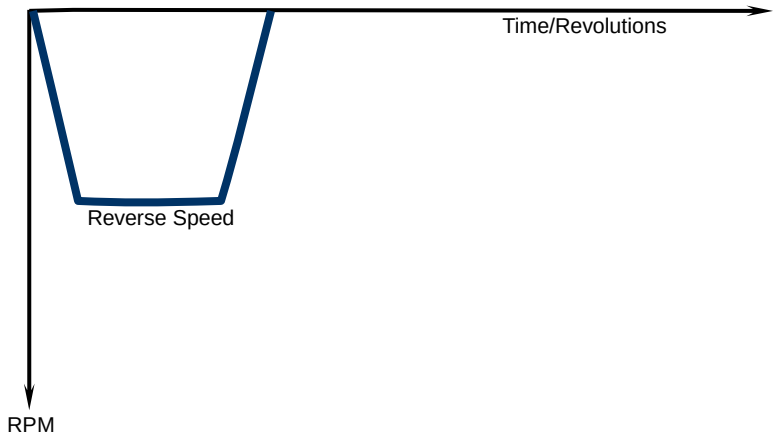

FIG. 6-4a Fusion Reverse Function

The reverse function on a stand alone SAN Unit is set with one speed setting (Reverse Speed). The duration of the reverse would be controlled from an external source (PLC) using the “Reverse” input or manual reverse pushbutton & trigger combination. (The Reverse pushbutton must first be enabled. Then depress the start trigger for the desired reverse duration. Depress the Reverse pushbutton again to disable the reverse mode)

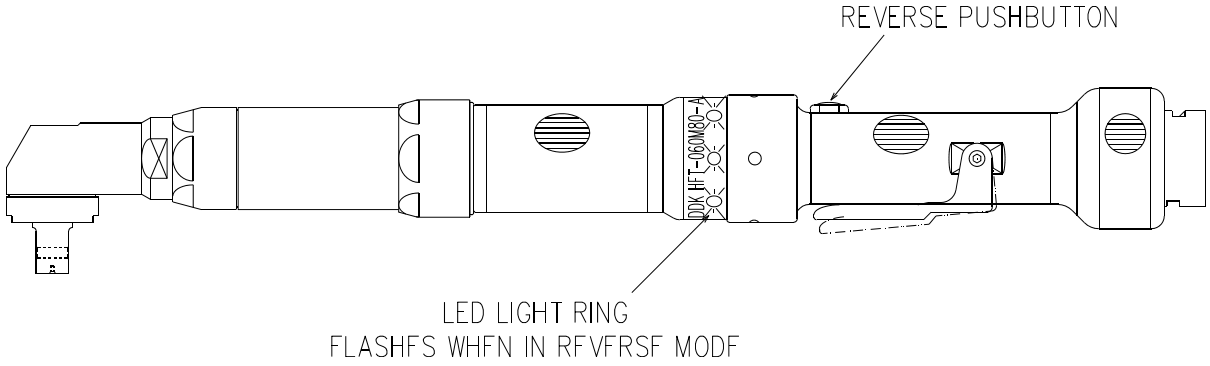

FIG. 6-4b Tool LED Function

6.5 Torque Recovery

The Torque Recovery function is used when the potential for joint relaxation and interaction exists. Under this control method, the fasteners are secured to Standard Torque, and then held at Standard Torque for a programmed duration of “pulses”. This “pulse” setting can be between 0-50 pulses. Power is applied to the motor for this duration, “holding” torque at the specified STD (Standard) Torque. During Torque Recovery the tool will use Recovery Speed as its maximum Speed, but will only rotate as a result of a drop in the Torque. Torque Recovery is only available in Torque Controlled Fastening due the fact that the use of Torque Recovery may cause addition rotation (Angle) of the fastener.

WARNING: The Torque Recovery function will cause the motor to heat up at a rate faster than normal fastening due to high amperage draw. Particular attention to minimized duty cycle is recommended if using this function or premature motor failure could result. Torque Recovery Pulses should be kept to a minimum for the application requirements.

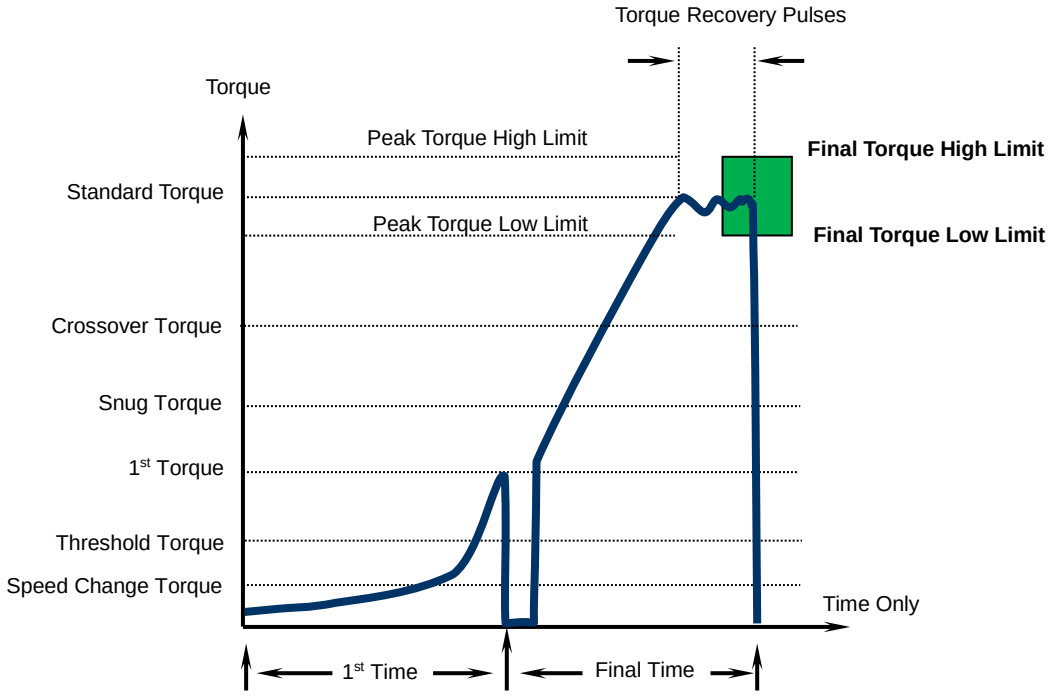

FIG. 6-5 Torque Recovery

WARNING: When a Fusion tool is held in the hand of an operator, the Torque Recovery function will cause additional or unexpected torque reaction to be applied to the operator. Be careful when using this function when held in the hand of an operator or operator harm may result.

6.6 Added Functions

Additional functions are available as standard features integrated within the Fusion controller. These functions may be helpful in special applications or for maintenance reasons. See below for additional functions.

6.6.1 Current Monitoring / Control

The current monitoring function works as a redundant protection for the torque transducer operations. By sensing the current drawn by the motor, the system can establish an alternate reference to the signals generated by the torque transducer preamplifier. It is intended to detect problems with the motor that would not be detected by the torque transducer and also as a maintenance tool to determine if there is a problem before the system will shut down.

This function allows the user to set Low Current and High Current Limits. If the current drawn by the motor overrides the High Current Limit or does not achieve the Low Current Limit, the System activates the Current Warning PLC Output Signal, without halting the System's operation. This current warning signal prompts of a potential failure in the system that requires inspection, but allows the system to continue until a suitable time is available to inspect the system.

The Fastening current limit allows a limit for maximum current draw during a fastening cycle. If this is set below Full Scale Current, then the current will not exceed this value during a fastening cycle. This function is mainly for protecting a motor during Torque recovery applications. If the Fastening Current Limit is exceeded and the motor stops turning, a Resolver Abnormal fault may occur.

The Full scale current limit is an automatically set reference value. This is generated based upon the motor/servo used and should not be changed.

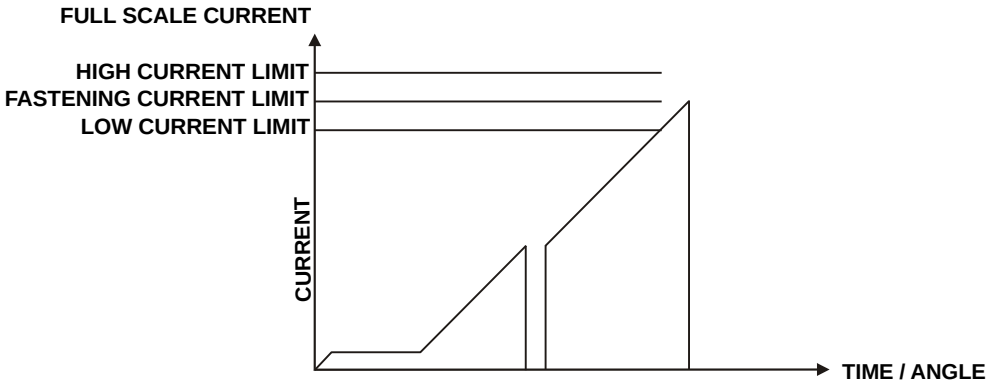

Fig. 6-6-1 Current Monitor function

6.6.2 Angle Correction

An Angle Correction preset is available for correcting angle reading disparities during calibration using a certified master transducer with Angle Monitoring capabilities. Under normal conditions this is not used. This may be necessary in applications requiring crowsfeet, right angle drives, belt or chain drives, etc.

Setting range is from -99 to +99 degrees.

See the AFC User Console software manual for additional set-up information.

6.6.3 Reduced Fastening Reaction

This function is mainly for manual or hand held applications where torque reaction during motor stopping is too extreme for an operator to handle. The motor ramp down time is extended allowing a gradual relief of the applied torque to the operator's hands, thus reducing the affect and fatigue of direct torque reaction.

See the AFC User Console software manual for additional set-up information.

6.6.4 VariSpeed

Varispeed automatically adjusts the fastening speed based on the type of joint that is being fastened. This eliminates motor overload conditions typically on very soft joints (high rotational angle) and decreases system cycle time. When the system senses a decreasing torque rate (soft joint) prior to reaching 1st Torque/Angle, the motor speed is automatically increased to an optimal speed for that particular torque rate. When the system senses an increasing torque rate (hard joint) prior to reaching 1st Torque/Angle, the motor speed is automatically decreased to an optimal speed for that particular torque rate. The speed is automatically controlled during the fastening process based on the torque rate.

See the AFC User Console software manual for additional set-up information.

6.6.5 Work Count (Batch Counting)

For applications requiring multiple "Accept" fastenings for a given part before a total "Work" (work piece) accept is output, the Work Accept count function can be used. This allows an operator to fasten multiple times, (the number of accepts is programmable) before a total WORK ACCEPT is output & displayed on the WORK ACCEPT LED.
To use the WORK count function, program the number of desired Acceptable fastenings you wish in PARM. 1-16 D-NO. 74 (0 – 99 max.). Only acceptable fastenings will be counted towards the WORK ACCEPT. If a fastening cannot be accepted during the course of the work piece fastening, the WORK ACCEPT will NOT light, and the input WORK OK RESET (input B7 on TB1 terminal) will have to be activated before starting the next work piece. Once the WORK ACCEPT has been activated, it will automatically be reset upon the next start signal.

6.6.6 Torque Inhibit

The Torque Inhibit function is used to ignore high torque spikes during initial starting of the motor or fastening process. Under normal fastening operations, peak torque will stop the fastening process (if Standard Torque is reached). This may not be desirable for applications with high starting torque and lower fastening torque. Applications such as self tapping screws, nylok nuts, crushed fasteners, and application with high starting inertia may require this function.

Torque Inhibit is set by the number of revolutions that is required to be "ignored" during the process. The Torque Inhibit Limit is a torque limit used as protection in case the amount of torque monitored during the Torque Inhibit Revolution is too high. If this torque limit is hit during the Torque Inhibit process, then the spindle will stop and an Abnormal is output.

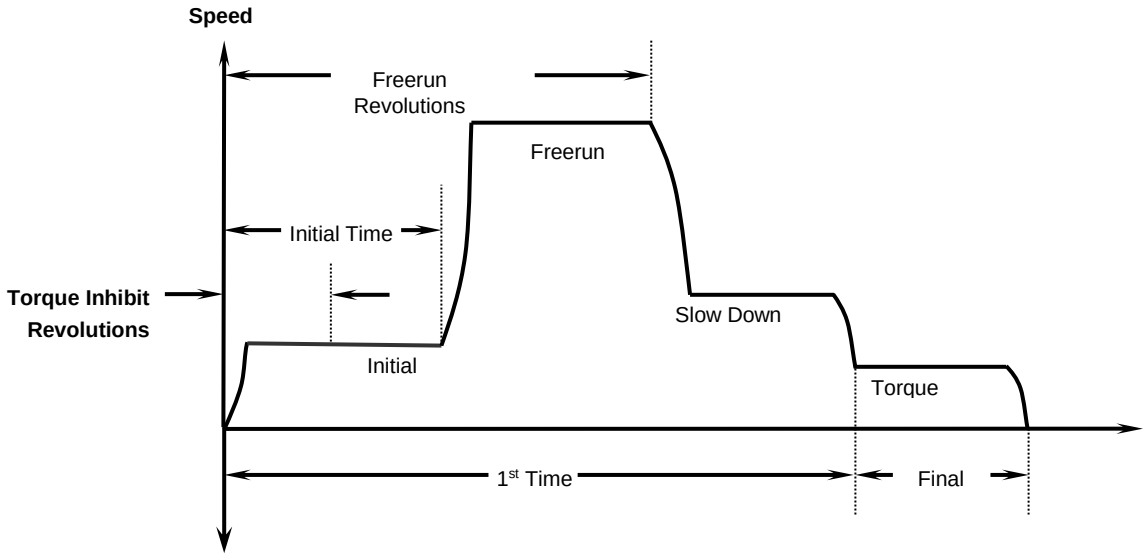

Fig. 6-6-9 Torque Inhibit Function

WARNING: The Torque Inhibit Rev setting should be set as low as possible for the intended application to avoid ignoring torque readings as the fastener approaches the seating point. If the fastener seats and the system is still in Torque Inhibit mode, possible fastener/part and/or system damage may occur.

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Chapter 7: System Operations

7.1 FUSION Display and Programming unit operation.

The FUSION system can be programmed and monitored using the AFC Software package or through use of the keypad and LED display on the front panel. While the AFC software offers an easy to use Windows based software, especially for multiples of spindles, the keypad and display offer an economical alternative.

FIG. 7-1 Operational controls and indicators

7.1.1 Manual Fastening controls.

- **START**

  The Start switch for the FUSION Controller is located on the Handheld tool. This Trigger-switch initiates the fastening cycle. When partially depressed, the tool will run in a slow start speed; until the trigger is fully depressed, until the trigger is released, or until the fastening cycle is complete. When the trigger is fully depressed the tool will operate as programmed, completing each speed change step that has not elapsed.

  (Alternative Start input available though use of PLC inputs on terminal TB1)

- **REVERSE**

  The Reverse switch for the FUSION Controller is located on the Handheld tool. This push-button switch enables Reverse/back-out operations. When depressed, the Tool LED display will flash to indicate Reverse/back-out mode selection. Depressing the Start trigger switch, while in Reverse/back-out mode, will cause the tool to run the opposite direction of the Fastening operation

  (Alternative Reverse input available though use of PLC inputs on terminal TB1)

- **CAL** (Calibration).
  Transducer calibration check push-button. Depress this push-button to obtain the CAL voltage level from the tool pre-amplifier. This level is compared to the data stored in memory. The calibration voltage level is converted to the full-scale torque, according to the parameter setting and is shown in the "DATA" display.

- **RESET**
  Used to reset the FUSION controller unit. If this key is pressed during fastening, the process will stop, and all the fastening data and output signals will be reset. At the same time, the Zero level of the torque transducer will be checked.

  (Alternative Reset input available though use of PLC inputs on terminal TB1)

7.1.2 Fastening Indicators.

- **ACCEPT LED** (Green).
  Solid Light indicates when the fastening results are within the defined limits.
  Flashing Light indicates when the fastening results, for a batch fastening step, are within the defined limits. The Batch fastening count will be displayed in the **[COUNT / D-NO]** display.

- **WORK ACCEPT LED** (Green).
  Indicates when the fastening results for a batch fastening operation are within the defined limits for all steps of the batch operation. For Batch count settings of 1 or more (99max.).

- **REJECT LED** (Red).
  Indicates when the fastening results are out the defined limits, or that an Abnormal has occurred (refer to Display for Abnormal code)

- **TORQUE** (Yellow).
  Indicates when the Data Display is set for viewing of Fastening Peak Torque. **[COUNT / D-NO]** is set to _0 while in the **Run State**.

- **ANGLE** (Yellow).
  Indicates when the Data Display is set for viewing of Final Angle. [**COUNT / D-NO]** is set to _1 while in the **Run State**.

7.1.3 Fastening Preset / Result displays.

- **[COUNT/D-NO]** Data number indicator (2 digits).
  Indicates the Display mode and data type (number)
  Indicates the Current Fastening count during a Batch count fastening operation. Count reset performed via PLC input
  Displays the Unit number during power up (U.01 ~ U.32)

- **[DATA]** Data value indicator (4 digits).

  During the **Run State**, the display mainly shows the results of fastening, abnormalities, preset values, etc.

  . During the **Bypass State,** the controller displays and allows setting of all available parameter presets.

- **[WORK]** Parameter number/Abnormal number indicator (2 digits).
  Display for the parameter number of the last fastening. Also displays an abnormal code during an abnormal condition. When the CAL switch is pressed, "E" is shown if the FULL-SCALE preset value is missing or a wrong tool is connected (Refer to Chapter 9).

Abnormal “A9” Display

Parameter No. 1

Cal “E” Fault

Calibration not set after pressing CAL switch or tool number mis-match

FIG. 7-1-3 Fastening Displays

7.1.4 Fastening Presetting / Result Display Controls

- **MODE** button

  Used to change modes while in the Run state. (Refer to 7.2)

  Used to move the cursor while in the Bypass (program) state. (Refer to 7.3)

- **SET** button

  Used to enter the data in edit mode, and to confirm data setting change.

- **MODE and SET** buttons Depressed simultaneously

  Switches unit between Run state and Bypass (program) State.

- **[↑] and [↓]** Cursor key (Vertical arrows).

  Used to scroll through available data preset items. (D-NO)

  Used to change display data values. (DATA)

  Used as YES/NO acknowledge for Tool type and Torque unit changes and for confirmation of the Parameter copy function. (Fig 7-3-6)

- **[➔] and [🡐]** Cursor key (Horizontal arrows).

  Used to scroll through available (16) parameter numbers. [WORK]

  Selection of [WORK] # is for actual Fastening Operational Selection, that the Tool will perform while in **Run State**.

  Arrows are used to select the appropriate Parameter for preset verification and changing while in the **Bypass State**.

  (Alternative WORK input while in **Run State** available though use of PLC inputs.)

  (See Section 7.2.5, item 5 for more information on set-up selection using the Terminal I/O (TB1) method for Work Selection)

7.2 Run State Modes.

The FUSION system has two operational states that are controlled by depressing the "MODE" and "SET" Buttons, on the front of the Controller, simultaneously, or by the PLC By-pass input. The operational modes available in the **Run State** are identified below. Under this condition, (after Power-up) the "MODE" and "SET" Buttons have not been pressed simultaneously, and the BYPASS external signal is not active. During the **Run State**, the display mainly shows the results of fastening, abnormalities, preset values, etc.

7.2.1 Display indication modes.

Three modes can be selected while in the **Run State** by pressing the MODE push-button. By using the [↓] and [↑] keys to change the D-NO selected, the DATA display contents may be varied up or down. The displays will remain blank, and mode selection will be disabled while the nutrunner is active. (BUSY) If an Abnormal condition occurs, the display will automatically change to the Abnormal (Abn) display mode, displaying the abnormal code and sub-code.

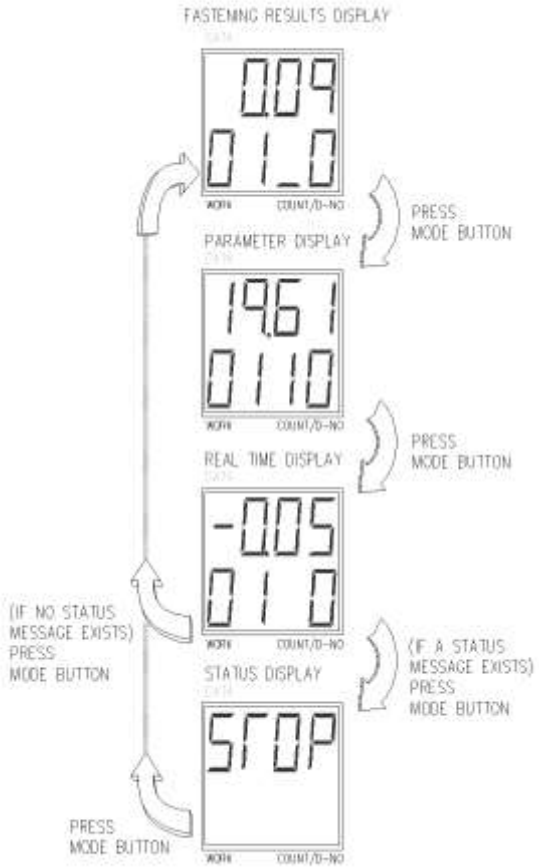


FIG. 7-2-1 Run State Display Modes

While the Controller Unit is in cycle it will display the cycle status. The display will indicate where the cycle is in its fastening sequence. The following abbreviations will be displayed in the data display;

In : Initial Speed
Fr : Freerun Speed
SL : Slowdown Speed
Tq : Torque Speed
Lo: Varispeed High Speed
UA: Varispeed Final Speed
r1: Reverse

1E : 1st Step End,2nd next
2d : 2nd Step End
2E : 2nd Step End,3rd next
3d : 3rd Step

The **Fastening results display mode** is active when the D-No displays one digit in the right hand location, and one, two or three dashes in the left hand location. The results details can be scrolled by using the [↑] and [↓] keys to change the D-No. This mode does not function while the Nutrunner is Busy. Refer to 7.2.3

The **Parameter display mode** is active when the D-No displays digits in both the right and left hand locations. The parameter data can be scrolled by using the [↑] and [↓] keys to change D-No. Refer to 7.2.4

The **Real time display mode** is active when one digit is active in the right hand display only. When the power is turned on, the default display mode is the REAL TIME display mode. The display contents can be scrolled by using the [↑] and [↓] keys to change D-NO. Refer to 7.2.2

The Controller unit is in **Status display mode** when no digits are displayed. The STATUS display indicates if an abnormal condition occurs or if an emergency stop has halted the system.

7.2.2 Real-time display indication mode.

D-NO : One digit

While the mode is in **Real time display mode**, [COUNT/D-NO] displays **0 ~8.** You can choose the desired type of data by pressing the [↓] and [↑] keys to change the [COUNT/D-NO] (data number). The indicator will display the following data in the "DATA" area for the selected D-No. The display will remain showing the parameter number.

The Controller will be in **Real time display mode** immediately after powering up the unit. Once a fastening cycle has been performed the Controller will switch to **Fastening results display mode. Real time display mode** can be selected at any time, while in the RUN state by pressing the MODE push-button. Button operation during the real-time mode is indicated in Fig. 7-2-2.

D-No	DATA
0	Torque value.
1	Torque voltage.
2	Peak Torque (maximum hold).
3	Rotated Angle.
4	Thermal Overload Value 0-100
5	Current Sensor Value
6	Start Trigger Level 127-255
7	Reverse Button Level 127-255
8	FEC specific data

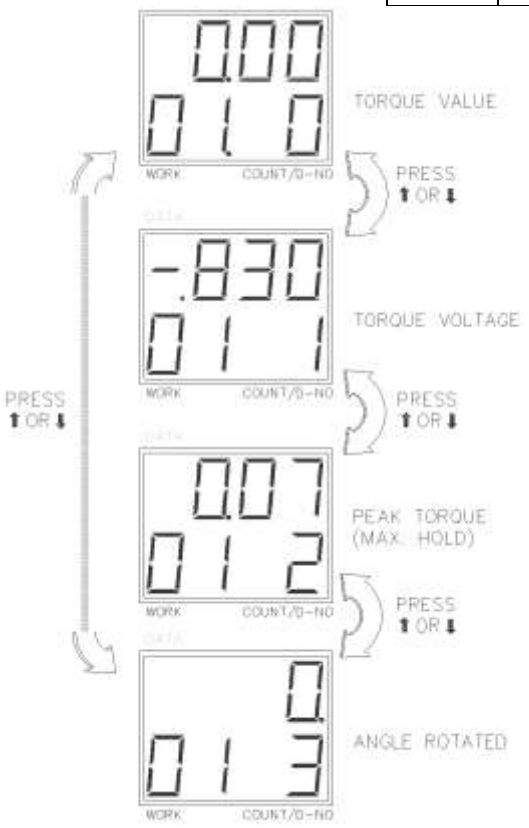


FIG. 7-2-2 Real time display selection

Torque value: The real-time torque value from the torque transducer is displayed.

Torque voltage: The real-time torque signal voltage from the torque transducer is displayed.

Peak torque: The peak torque, measured since the last time the display mode was switched to Real Time Display Mode. (This is reset when the display mode is changed from the Real Time Display Mode.)

Lock Spindle Mode : When [SET] is depressed during this display, the motor is locked for up to one minute allowing the spindle to be checked with a torque wrench while displaying the reaction torque on the data display. Press RESET to unlock the Motor before one minute has expired. **WARNING**: **Do <u>not</u> repeat this procedure repetitively or the motor will overheat.**

Angle (rotation): The real-time angle of rotation of the tool output shaft (in the fastening direction CW), measured since the last time the display mode was switched to Real Time Display Mode.

(-1999° to 9999°)

Thermal Overload Level: Between 0 -100 (100=overload)

7.2.3 Fastening Results Display Mode.

D-NO: Left digit 

In **Fastening results display mode** (when [COUNT/D-NO] shows _**0** ~ ≡**6**), data can be obtained by pressing the [↓] and [↑] keys to scroll the [COUNT/D-NO] until the desired DATA item is displayed. The following information will be displayed in the [DATA] display section for the displayed [D-NO]:

D-No	DATA
_0	PEAK TORQUE.
_1	FINAL ANGLE
_2	1ST TORQUE RATE
_3	2ND TORQUE RATE.
_4	1ST STEP TIME.
_5	FINAL STEP TIME.
_6	CYCLE TIME
_7	FASTENING MODE.
_8	3RD TORQUE RATE
_9	NOT USED
=0	FASTENING MODE.
=1	FASTENING STEPS
=2	NOT USED
=3	SELF CHECK (ON: enabled, OFF: disabled)
=4	REVERSE FLAG (ON:Reversed, OFF: Not Reversed
=5	CAUSE OF FASTENING STOP: 0: RESET / NO DATA / AFTER REVERSE. 1: ABNORMAL SIGNAL. 2: BYPASS SIGNAL. 3: STOP SIGNAL. 4: REJECT. 5: ACCEPT.
=6	TORQUE JUDGE tq H/L (FINAL) H/L (PEAK)
=7	ANGLE JUDGE AN H/L
=8	RATE JUDGE r H/L (1ST) H/L (2ND) H/L (3RD)
=9	TIME JUDGE ti H/L (1ST) H/L (FINAL)
≡0	1ST INCREMENT TORQUE.
≡1	2ND INCREMENT TORQUE.
≡2	1ST FINAL TORQUE
≡3	1ST PEAK TORQUE.
≡4	FINAL TORQUE.
≡5	ANGLE AT PEAK TORQUE
≡6	PEAK CURRENT

FIG. 7-2-3 Fastening results display selection

7.2.4 Parameter Display Mode

D-NO: Two digits

The FUSION system can store up to 16 different sets of parameters that can be selected for fastening operations via the **[➔] and [🡐]** keys (Horizontal arrows) or by PLC input signals WORK SELECT 0 ~ 3 (see section 4.7.2.) In addition to parameter 1 ~ 16 there is a PARAMETER 0 that contains configuration data common to all parameters.

Parameter display mode displays the preset values programmed in the CONTROLLER unit for fastening operation. When parameter display mode is enabled, the [COUNT/D-NO] display will show 2 digits (00-73) representing the preset data number. The [DATA] display will show the corresponding preset data value and the parameter display will indicate the parameter number (from 0 ~ 16). Use the [↓] and [↑] keys to change the preset data number [D-NO]. If the [COUNT/D-NO] display is showing the number 74 of the *parameter number 1*, pressing the [↑] key will change the [COUNT/D-NO] display to the number 00 of the *parameter number 2*.

You can verify the fastening parameters by pressing the [↓] and [↑] keys at any time. However, it is not possible to alter these settings in the **Run state**.

Note: Representation only, not actual data

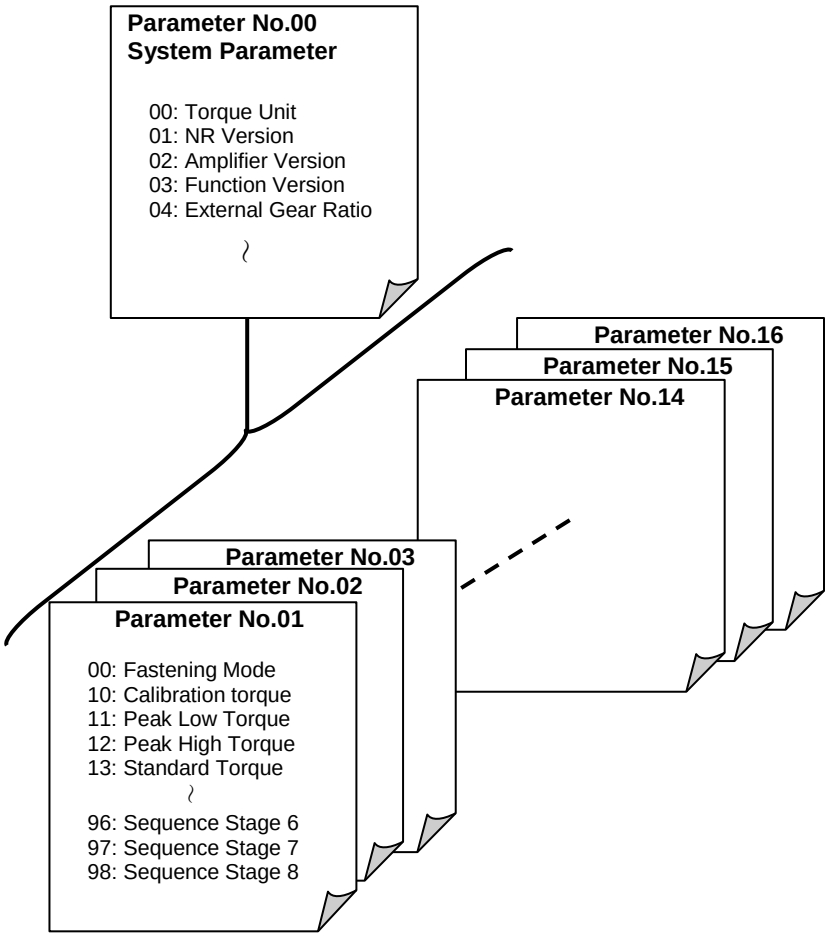


FIG. 7-2-4a Parameter number selection

7.2.5 Parameter Data List & Explanation

ITEM	DATA SETTING	WORK	D- No	DATA	
System		0	**00**	TORQUE UNIT #.	0: Nm 1: Kg.m 2: Kgcm 3: Ft lb 4: in lb
		0	**01**	ROM VERSION (Not adjustable)	
		0	**02**	AMPLIFIER VERSION (Not adjustable)	
		0	**03**	FASTENING FUNCTION VERSION (1.03 for FEC)	See Pg 7-12
		0	**04**	External gear ratio 0.3 ~ 3.00	
		0	**05**	Gear Head Type	
		0	**08**	Fastening Curve Storage (After ver. 5.17)	
Tool Data **(This section is factory set and cannot be changed)**		0	**10**	TOOL # (not adjustable)	
		0	**11**	TOOL CAL TORQUE.	
		0	**12**	CAL. VOLTAGE	
		0	**13**	ZERO TORQUE VOLTAGE	
		0	**14**	PULSES PER DEGREE	
		0	**15**	MOTOR TYPE	
		0	**16**	TRANSMISSION RATIO	
		0	**17**	ROTATE CW=0 / CCW=1	
		0	**18**	CCW TQ. CAL. VOLTAGE	
		0	**19**	TOOL SERIAL # (1ST 4 DIGITS)	
		0	**1A**	TOOL SERIAL # (2ND 4 DIGITS)	
		0	**1b**	Tool Cycle count Upper 4 digit	
		0	**1c**	Tool Cycle count Lower 4 digit	
Tool type		0	**20**	TOOL #	See List on next pages
Tool Info		0	**21**	Start switch trigger level	10 Change to 100 to disable
		0	**22**	Start switch High Speed level	40 Change to 100 to disable
		0	**23**	CW/CCW switch trigger level	20 Change to 100 to disable
		0	**24**	Switch setup (Factory setup)	67
		0	**25**	Switch setup (Factory setup)	30
		0	**26**	Switch setup (Factory setup)	1
		0	**27**	Switch setup (Factory setup)	200
		0	**28**	Switch setup (Factory setup)	5
		0	**29**	Switch setup (Factory setup)	80
Real Time Clock (After ver. 2.20)		0	**30**	Year – 'yyyy" example '2007'	See 7.5 for detail
		0	**31**	Month & Date 'mmdd example '0131' = Jan. 31	
		0	**32**	Hour & Minute 'hhmm' example '1759 = 17:59	
		0	**33**	Seconds '00ss' example '0020' = 20 seconds	
RS232 Format		0	**40 - 49**	RS232 data alternate communication format	See 4.8.4 for set-up
Torque		1~32	**00**	FASTENING MODE (METHOD + STEPS)	See List on next pages
		1~32	**05**	OPTION 1	
		1~32	**06**	OPTION 2- Torque Curve Store [0:enable, 1:disable]	
		1~32	**10**	FULL SCALE TORQUE (CAL TORQUE)	+/- 20%
		1~32	**11**	PEAK TORQUE LOW LIMIT	
		1~32	**12**	PEAK TORQUE HIGH LIMIT	Max. Full Scale x 1.1
		1~32	**13**	STANDARD (STD) TORQUE	
		1~32	**14**	SPEED CHANGE TORQUE	
		1~32	**15**	1ST TORQUE	
		1~32	**16**	SNUG TORQUE	
		1~32	**17**	THRESHOLD (THR) TORQUE	
		1~32	**18**	CROSSOVER (CROS) TORQUE	
		1~32	**19**	TORQUE INHIBIT LIMIT	Max. Full Scale x 1.1
		1~32	**1A**	Not Used	
		1~32	**1B**	BREAKAWAY TORQUE LIMIT	Max. Full Scale x 1.1
		1~32	**1C**	FINAL TORQUE LOW LIMIT	
		1~32	**1D**	FINAL TORQUE HIGH LIMIT	Max. Full Scale x 1.1
		1~32	**1E**	2ND RATE START TORQUE	Max. Full Scale x 1.1
Angle		1~32	**20**	ANGLE LOW LIMIT	
		1~32	**21**	ANGLE HIGH LIMIT	Max. 9999 deg
		1~32	**22**	STANDARD (STD) ANGLE	Max. 9999 deg
		1~32	**23**	1ST ANGLE	Max. 9999 deg
		1~32	**24**	CROSSOVER ANGLE	Max. 9999 deg
		1~32	**25**	ANGLE CORRECTION	0-99 deg.
		1~32	**26**	DIFF ANGLE (-)	
		1~32	**27**	DIFF ANGLE (+)	
Rate		1~32	**30**	1ST TORQUE RATE LOW LIMIT	For all Rate settings
		1~32	**31**	1ST TORQUE RATE HIGH LIMIT	Max. "5000"
		1~32	**32**	2ND TORQUE RATE LOW LIMIT	Setting "0000" in any of
		1~32	**33**	2ND TORQUE RATE HIGH LIMIT	The LOW rate settings
		1~32	**34**	3RD TORQUE RATE HIGH LIMIT	disables low rate judgment
		1~32	**35**	3RD TORQUE RATE HIGH LIMIT	

(Continued on next page)

Time		1~32	**40**	INITIAL TIME	Max. 999.9 sec
		1~32	**41**	1ST STEP TIME LIMIT	Max. 999.9 sec
		1~32	**42**	FINAL TIME LIMIT	Max. 300.0 sec
		1~32	**43**	FIRST TIME LOW LIMIT	Max. 999.9 sec
		1~32	**44**	FINAL TIME LOW LIMIT	Max. 300.0 sec
(Consult FEC before changing these items)		1~32	**45**	RAMP UP TIME	0.0 – 9.9 sec
		1~32	**46**	RAMP DOWN TIME	0.0 – 9.9 sec
		1~32	**47**	REVERSE RAMP UP TIME	0.0 – 9.9 sec
		1~32	**48**	TORQUE RECOVERY PULSES	0.0 – 50 pulses
Speed		1~32	**50**	INITIAL SPEED	
		1~32	**51**	FREE RUN SPEED	
		1~32	**52**	SLOW DOWN SPEED	
		1~32	**53**	TORQUE SPEED	
		1~32	**54**	REVERSE 1 SPEED	
		1~32	**55**	RECOVERY PULSE SPEED	
		1~32	**56**	Not Used	
Revolutions		1~32	**60**	FREE RUN REVOLUTIONS	Max. 99.9
		1~32	**61**	TORQUE INHIBIT REVOLUTIONS	Max. 99.9
		1~32	**62**	Not Used	
		1~32	**63**	REVERSE 2 REVOLUTIONS	
		1~32	**64**	REVERSE 3 REVOLUTIONS	
		1~32	**68**	Not used	
		1~32	**69**	Not used	
Current		1~32	**70**	FULL SCALE CURRENT VALUE	100%
		1~32	**71**	HIGH CURRENT LIMIT	100%
		1~32	**72**	LOW CURRENT LIMIT	0%
		1~32	**73**	FASTENING CURRENT LIMIT	100%
		1~32	**74**	Accept / Batch Count	0-99
Pistol Tool		1~32	**80**	CW Stop Limit Angle	30 (Set to 180 to disable)
		1~32	**81**	CW Swing Pause Angle	1
		1~32	**82**	CW Servo Lock Time	5
		1~32	**83**	CW Motor Restart Time	80
		1~32	**86**	CCW Stop Limit Angle	30 (Set to 180 to disable)
		1~32	**87**	CCW Swing Pause Angle	1
		1~32	**88**	Angle Head Torque Variation	5
		1~32	**89**	CCW Motor Restart Time	30
Sequence		1~32	**90**	Sequence Operational Mode	
		1~32	**91**	Sequence Stage 1	
		1~32	**92**	Sequence Stage 2	
		1~32	**93**	Sequence Stage 3	
		1~32	**94**	Sequence Stage 4	
		1~32	**95**	Sequence Stage 5	
		1~32	**96**	Sequence Stage 6	
		1~32	**97**	Sequence Stage 7	
		1~32	**98**	Sequence Stage 8	

1) **Display operation for Parameter selection**

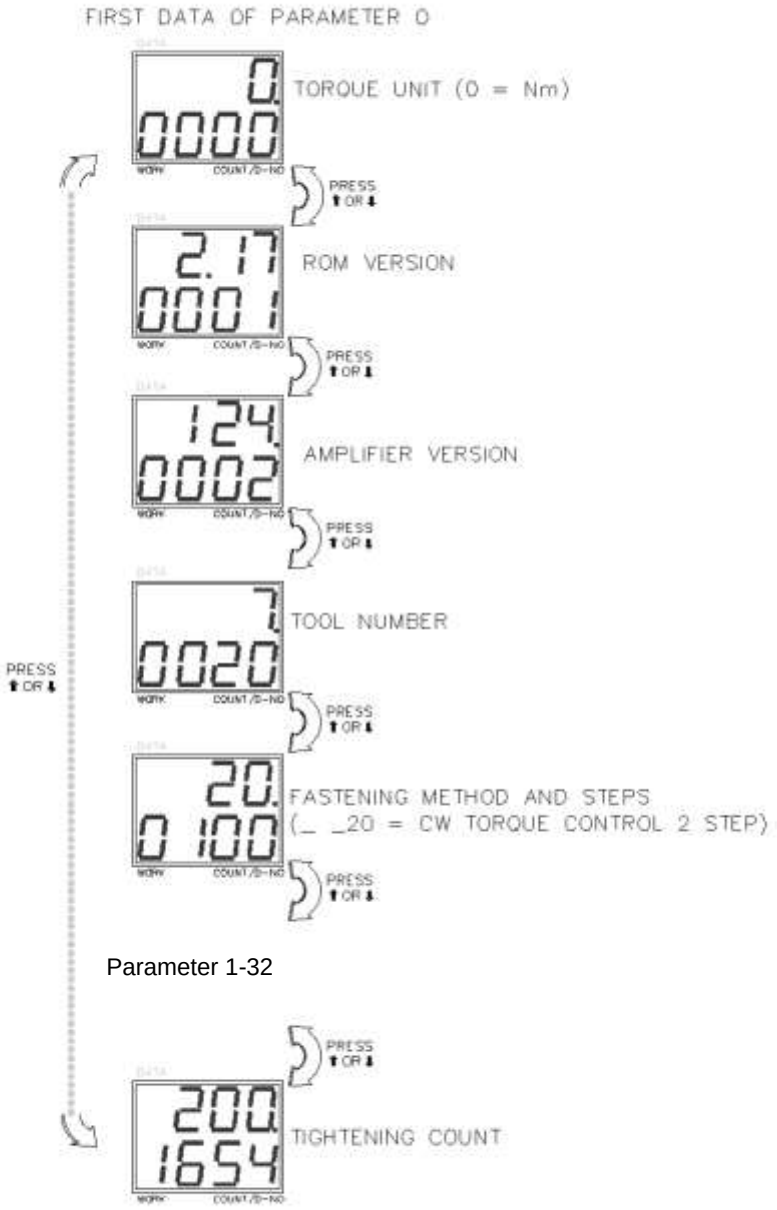


FIG. 7-2-5 Parameter display D-No selection

System "D-No" Explanation

2) **Torque Unit [WORK]-00, [D-No]-00**
00: Nm 01: Kgm 02:Kgcm 03:Ft. Lb. 04:In.Lb.

3) **ROM Version [WORK]-00, [D-No]-01**
Displays Controller ROM Version (Not adjustable)

4) **Amplifier Version [WORK]-00, [D-No]-02**
Displays Servo Version (Not adjustable)

5) **Fastening Function Version [WORK]-00, [D-No]-03.**
The Fastening Function Version is entered into [WORK]-**00**, [D-No]-**03**.
Enter the Set no. which corresponds to the Function Version desired from the table below.

Alternate Fastening Function mode selection

An alternate function mode exists which allows setting of additional functions for the fusion controller. The function version that is set in the controller will be displayed when viewing (Work 00, D-No-03). The last two digits of the function version correspond to the two digits to the right of "18" in the table below.
(Ex.- Display "1.03" corresponds to set-up of 1803)

To make a change (when the function version is being displayed D-No 03):

1. Depress [SET] and [MODE] buttons at the same time (PROGRAM mode)
2. Depress [MODE] button (Display should show Work 00 D-No – 03)
3. Depress [SET] button
4. The cursor will blink on the leftmost digit
5. Use the [↓] and [↑] buttons to enter "18xx" whereas the xx is the desired setting. (18 must always be entered as the leftmost digits)
6. Depress the [SET] button to enter the change into memory
7. "CHNG – NO" will appear in the display, use the [↓] and [↑] buttons to change NO to YES in the display
8. Depress [SET] to confirm and enter the change to memory
9. Depress [SET] and [MODE] buttons at the same time (return to RUN mode)
10. System MUST be re-booted in order to change the function mode.

Shown below are the available options for setting of this Data No.;

Set No.	AFC S/W Comm. Speed	Tool Type	Work Select Method
1800	– Comm. Speed 38400bps	: Rev Sw – Slide/twist type	: Work Select from Terminal TB1
1801	– Comm. Speed 38400bps	: Rev Sw – Slide/twist type	: Work Select from Front Panel
1802	– Comm. Speed 38400bps	: Rev Switch - PB type	: Work Select from Terminal TB1
1803 *	– Comm. Speed 38400bps	: Rev Switch - PB type	: Work Select from Front Panel
1810	– Comm. Speed 9600bps	: Rev Sw – Slide/twist type	: Work Select from Terminal TB1
1811	– Comm. Speed 9600bps	: Rev Sw – Slide/twist type	: Work Select from Front Panel
1812	– Comm. Speed 9600bps	: Rev Switch - PB type	: Work Select from Terminal TB1
1813	– Comm. Speed 9600bps	: Rev Switch - PB type	: Work Select from Front Panel

*Denotes Default setting

Note: Adding (4) to any Set No. above, sets the Fastening function in "**DDK Mode**"- Changing the RS232 data output protocol as listed in [4.8.5 Rear Panel RS232 Alternate Communication Protocol].

The effect of the Work Select Method;

*Select from Terminal TB1: (Note: This MUST be configured when using a Fieldbus interface)
- Work Select must take place from the TB1 Terminal located on the controller backpanel
- Batch OK reset input MUST be applied for clearing cycle count

**Select from Front Panel :
- Work Select can take place from the Controller front "WORK" button
- Batch OK reset input can be applied for clearing cycle count or cleared automatically at the next START (upon Accept)

NOTE: If Fieldbus is installed, changing setup to "Work Select from Front Panel" will disable the Fieldbus board and the Work Select can only be selected from Front Panel.

6) **External gear ratio [WORK]-00, [D-No]-04**

Used to enter gear ratio for EXTERNAL gearing (0.3 – 3.000)

Default : 1.000 (1:1 gear ratio)

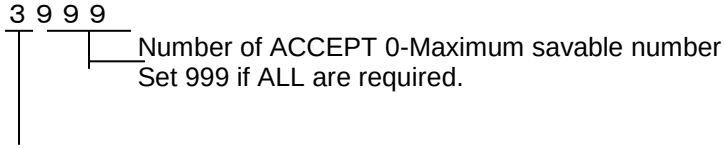
Note: If external gearing is used, be sure to set the proper gear ratio if different than 1:1 or ANGLE count could be wrong.

7) **Torque Curve Storage setup [WORK]-0 [D-No]-08**

Standard setting: 0000 Version V5.17 or later

SET UP RANGE: 0000～3999

Setup torque curve storage as below;



Number of Torque Curve data	0 : 100°	1 : 200°	2 : 400°	3 : 600°
Maximum savable number	105	70	42	30

Example: When 1: 200° is chosen, and the judgment of 35 of the 70 savable fastening's were REJECT, then only 35 Accepted torque curves will be saved.
When setting 999 as the number(savable ACCEPT), 70 Accepted torque curves will be saved.
The stored data is updated by the latest data when it reaches the upper limit.
※ Data is cleared when power is turned off and/or changing the setup.

"Curve SAVE can be set up per each parameter number.
[WORK 1-32] [D-No. 06] (Data No. 6 Enable/Disable Save)

8) **Tool Type Data number entry [WORK]-0 [D-No]-20.**

The tool number is entered into [WORK]-0 [D-No]-20 and must be set correctly to match the attached tool or an abnormal will result. (Tool Type Error) Enter the Tool Number which corresponds to the tool being connected to the CONTROLLER Unit.

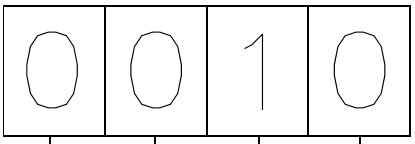
Note: When using the AFC software to program the controller, this tool number is automatically set to the tool chosen in the software set-up.

Tool No.	Tool Type	Max. Torque [Nm]	Max. RPM [rpm]	Min. RPM [rpm]	Max. Rate [Nm/deg]	Weight [kg]	Unit
4	HFT-015M50-A	15.00	1090	1	5.000	1.6	HFC-EC-16
6	HFT-015M80-S	15.00	1895	1	5.000	1.4	HFC-EC-16
5	HFT-025M80-A	25.00	1218	1	5.000	1.7	HFC-EC-16
12	HFT-040M80-A	40.00	735	1	5.000	1.7	HFC-EC-16
13	HFT-015M50-A1	15.00	1215	1	5.000	1.6	HFC-EC-16
15	HFT-025M80-A1	25.00	1070	1	5.000	1.7	HFC-EC-16
16	HFT-040M80-A1	40.00	648	1	5.000	1.9	HFC-EC-16
7	HFT-060M80-A	60.0	446	1	5.000	1.95	HFC-EC-16
19	HFT-080M80-A	80.0	330	1	50.00	3.7	HFC-EC-16
8	HFT-130M80-A	130.0	203	1	50.00	3.8	HFC-EC-16
14	HFT-015M80-S1	15.00	1600	1	5.000	1.4	HFC-EC-16
18	HFT-040M80-S	40.00	694	1	5.000	1.4	HFC-EC-16
11	HFT-040M80-T	40.00	694	1	5.000	3.1	HFC-EC-16
27	HFT-015M50-P1	15.00	1190	1	5.000	1.1	HFC-EC-16C
30	HFT-035M80-P1	35.00	778	1	5.000	1.37	HFC-EC-16C
21	HFT-010M50-S1	10.00	1800	1	5.000	1.3	HFC-EC-16
22	HFT-025M80-S1	25.00	1000	1	5.000	1.43	HFC-EC-16
29	HFT-055M80-S	55.00	508	1	5.000	3.0	HFC-EC-16
26	HFT-080M80-S	80.00	303	1	5.000	3.0	HFC-EC-16
20	HFT-015M50-P	15.00	1000	1	5.000	1.35	HFC-EC-16
3	HFT-060M80-T	60.00	420	1	5.000		HFC-EC-16
25	HFT-060M81-P	60.00	582	1	5.000		HFC-EC-16
17	HFT-015M80-A	15.00	1215	1	5.000		HFC-EC-16
10	HFT-040M80-L	40.00	805	1	5.000		HFC-EC-16
31	HFT-030M80-P1D	30.00	980	1	5.000	1.54	HFC-EC-16

Note: The list above contains the tool numbers for Standard tools. Tools in GREEN are special and no longer used.

9) **Fastening Mode and Fastening Steps [WORK]-1~32, [D-No]-00.**

The fastening mode is entered into [WORK]-1~16, [D-No]-00. Enter the Set Value number which corresponds to the fastening method desired. The figure below describes the code for the four numbers and how they relate to the type of fastening method and steps preferred. Zero's will display as blank (off) digits if there is no number (1,2 or 3) preceding them. (Example: 0020 will display as _ _ 20 or 0121 will display as _121) When entering a new fastening method, all four digits should be entered and SET.



[**Fastening Method**]
0 = Torque Control
1 = Angle Control

[**Fastening Steps**]
0 or BLANK = 1 Step w/ continuous snug Tq. angle count start*
1 = 1 Step Fastening
2 = 2 Step Fastening – Stops at 1st Tq.
3 = 3 Step Fastening – Stops at 1st and CROS Tq.

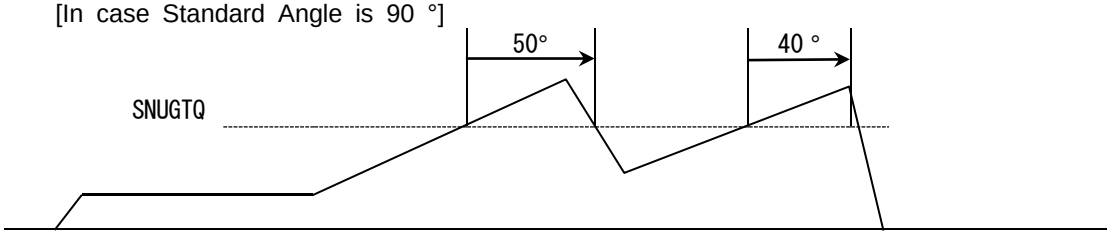
[**Fastening Direction**]
0 or BLANK = CW (clockwise) Fastening
1 = CCW (counterclockwise) Fastening

[**Reverse Operation**]
0 or BLANK = Not Used
1 = Slow Reverse Start (1.5 sec. @ 20 RPM)
2 = Varispeed
3 = Both 1 & 2

*Normal Snug angle count vs. Continuous Snug Tq. Angle Count

Angle count with normal SNUG mode (XX11)

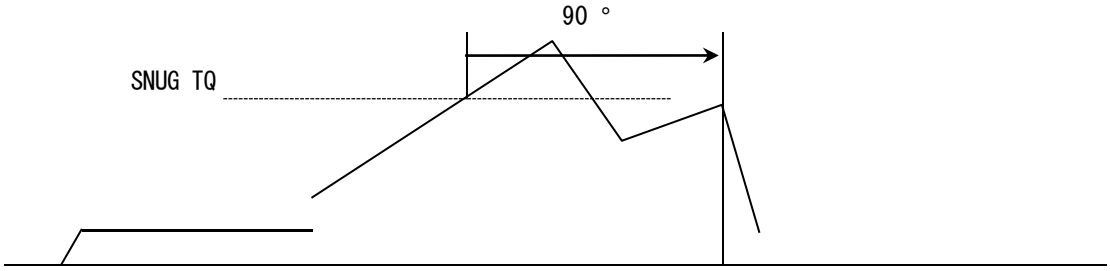
Angle value is not counted up when torque is below SNUG TORQUE.
[In case Standard Angle is 90 °]



Angle count using continuous SNUG TQ angle count Method (XX01)

Once SNUG TORQUE is reached, angle value is counted up regardless of the torque value.

[In case Standard Angle is 90 °]

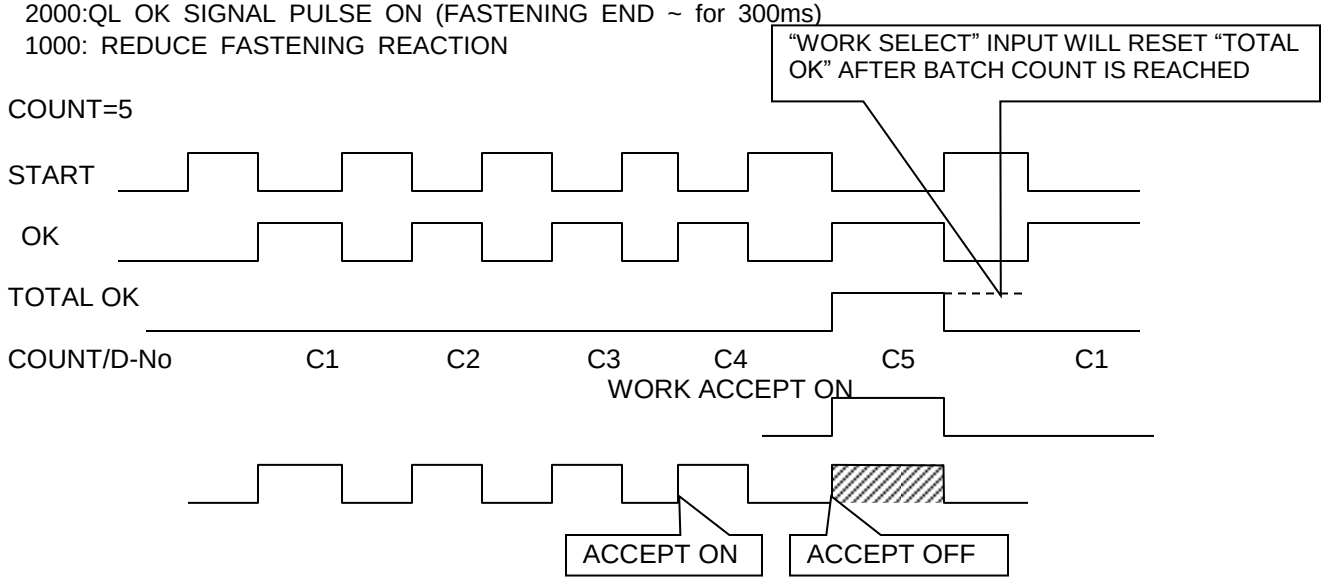


[Fastening][Torque][Angle][Rate][Time][Speed][Revolutions][Current] [Pistol] Parameter

Parameter No.01 ~32

Data No.05 Fastening Option 1

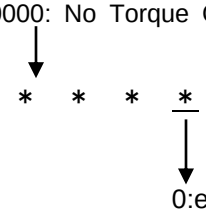
0100: Enables judgment of difference of high and low angle.
0000:QL OK SIGNAL LEVEL ON (FASTENING END ~ NEXT START)
2000:QL OK SIGNAL PULSE ON (FASTENING END ~ for 300ms)
1000: REDUCE FASTENING REACTION



* When combining multiple functions, add the data numbers in hex.
Ex.) 0400 + 0002 + 0004 = 0406

Data No.06 Fastening Option 2

0000: No Torque Curve Storage



Data No.10 Calibration torque

The calibration value is set according to the tool type (capacity). However, depending on the application characteristics or the prevailing torque generated external to the tool output shaft, the value of the applied torque and the torque display by the Fusion unit may mismatch. In this case, it is possible to adjust the FULL SCALE TORQUE (CAL) value, so the displayed torque matches the installation torque registered by an external torque transducer (Master).

The CAL value can be adjusted up to ± 20% of the FULL SCALE TORQUE value.

Example:
Consider the HFT-080M80-A tool. Nominal CAL value = 8.0 Kg.m.
Range of adjustment: from 6.2 Kg.m to 9.4 Kg.m.

Use the following formula on a collection of at least 10 fastenings when a calibration correction is necessary:

New CAL value = Master transducer mean/ FEC transducer mean x Existing CAL value

Note: The torque unit (Kgm, Nm, Ft.Lbs, etc.) must be the same for all terms. Do not mix torque units in calculation or errors will result.

If the new CAL value is out of the adjustable range, the [Err] message will be displayed.

Example.
Tool Full Scale value (EXISTING CAL) is 78.4 Nm.
STD torque is 49.0 Nm.
Master transducer mean for 10 piece run is measuring only 47.5 Nm.
FEC transducer mean for 10 piece run is measuring 49.0 Nm.

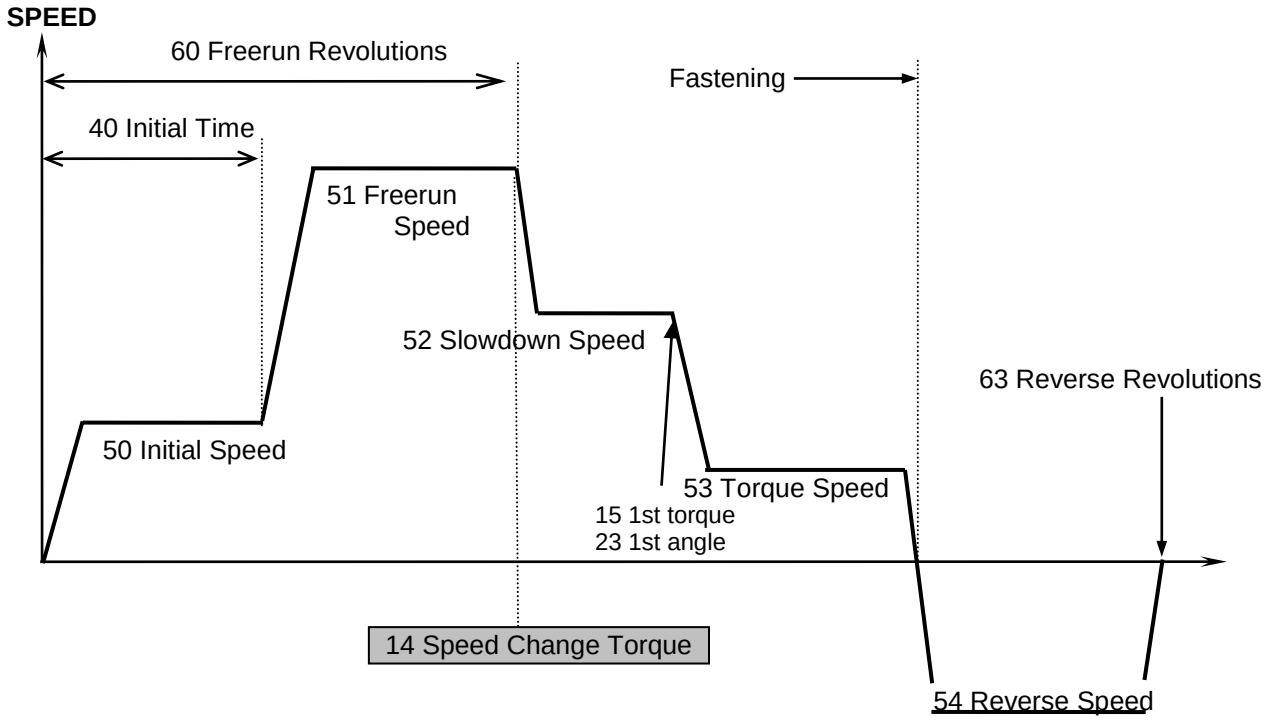
The new CAL value is obtained as follows:
(47.5/49.0 x 78.4) = 76.0

*The **FULL SCALE TORQUE (CAL) value** must be corrected to **76.0 Nm** and entered at [PARM} 1~16 [D-NO] 10.*

Data No.11 Peak Torque Low Limit [Nm, Kgm...]
Data No.12 Peak Torque High Limit Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
Setting points for the High and Low limits of the Peak Fastening Torque. If the High or Low limits are exceeded the operation is rejected.

Data No.13 Standard Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
Set point of the Fastening Standard (Target) Torque. This function is only available when Torque method is selected for [00: Fastening Mode].

Data No.14 Speed Change Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
Set the torque value that switches slow down speed to torque speed.



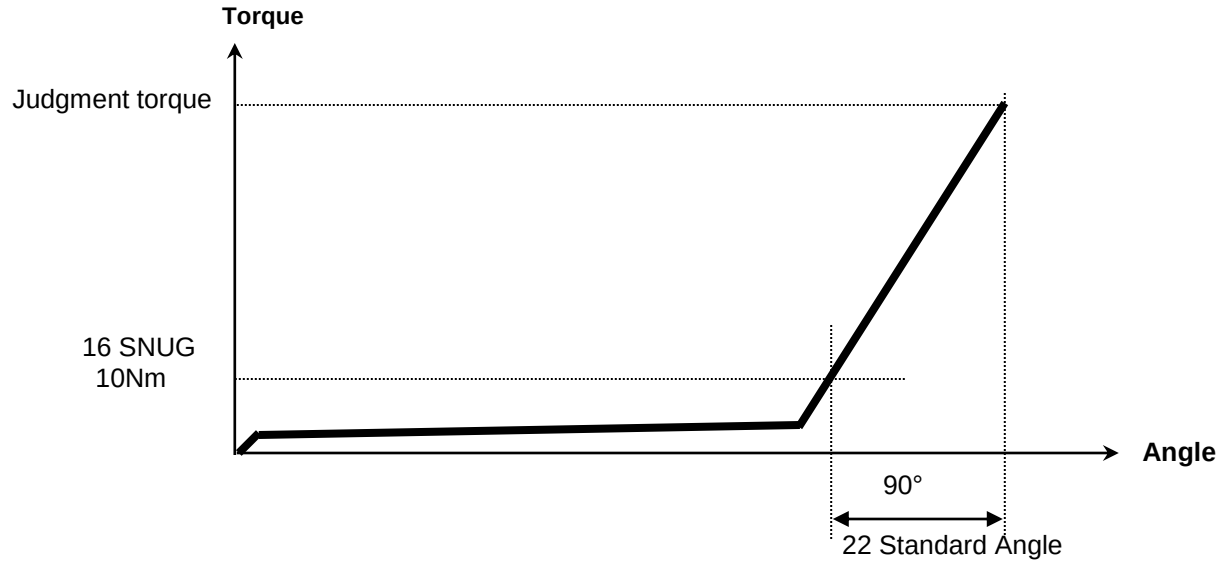
Even if Freerun Revolutions are not achieved, the speed will change to Slow Down Speed when Speed Change Torque is detected.

Data No.15 1ST Torque [Nm, Kgm...] Setting range: 0 ~ [10: Calibration torque] × 1.0
Data No.23 1ST Angle [deg] Setting range: 0 ~ 9999
1ST stop / synchronization point for multiple step fastening operations.
End point for 1st torque rate calculation. [17: Threshold Torque is beginning]
Shift point for changing to Torque Speed [53: Torque Speed]
End of 1st Time and beginning of Final Time

Data No.16 SNUG Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
Snug Torque is only available as a control start point when [00: Fastening Mode] is set for Angle Control method.

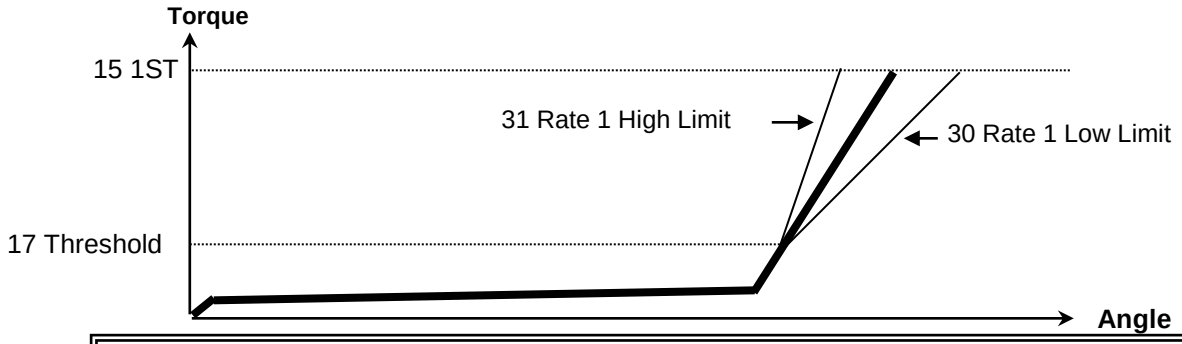
Angle (of rotation) Judgment is conducted from Snug Torque to Fastening end when this torque value is achieved, for all fastening methods. The Angle when this torque value is achieved is considered the 0° start point for judgment.

(Example.) When [16: SNUG Torque] is 10Nm, [22: Standard Angle] is 90°.



All values related to Angles are referenced from [16:SNUG Torque]

Data No.17 Threshold Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
Start point for 1st Torque Rate monitoring



If 1st Torque Rate monitoring is not required, [17:Threshold Torque] should be set the same or higher than [10: Calibration Torque]

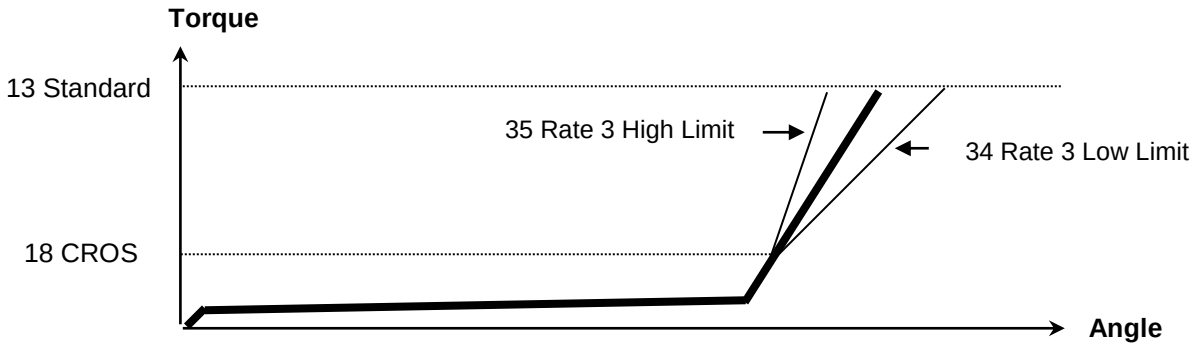
Data No.18 CROS Torque [Nm, Kgm...]

Setting range: 0 ~ [10: Calibration torque] × 1.0

2nd stop / synchronization point for multiple step fastening operations.

End point for 2nd torque rate calculation. [1E: 2nd Rate Start Torque is beginning]

Start point for 3rd Torque Rate calculation. [Fastening End is the stop point]



If 3rdt Torque Rate monitoring is not required, [18:CROS Torque] should be set the same or higher than [10: Calibration Torque]

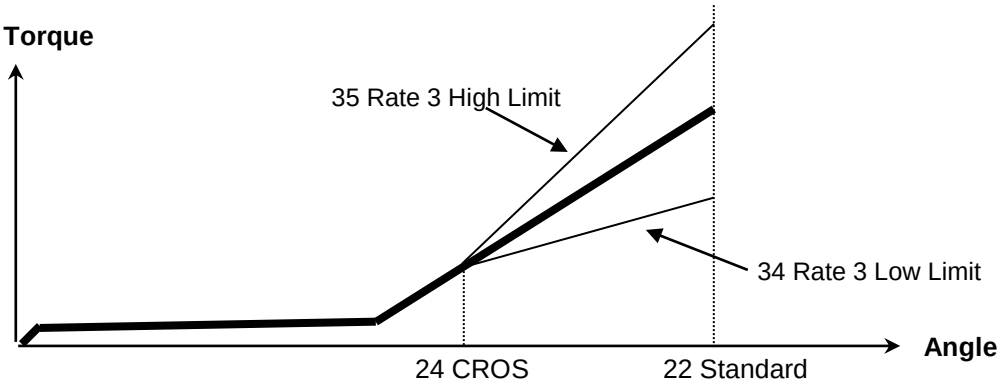
Data No.24 CROS Angle [deg] **(NOT USED as standard function)**

Setting range: 0 ~ 9999

2nd stop / synchronization point for multiple step fastening operations.

End point for 2nd torque rate calculation. [1E: 2nd Rate Start Torque or 26: 2nd Rate Start Angle is the beginning]

Start point for 3rd Torque Rate calculation. [Fastening End is the stop point]



Data No.19 Torque Inhibit Limit [Nm, Kgm...]

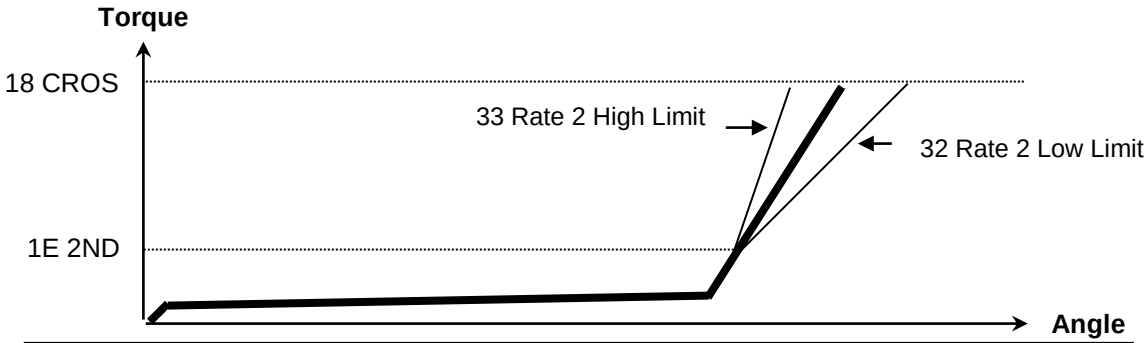
Setting range: 0 ~ [10: Calibration torque] × 1.1

Limit for ignoring the Torque value sensed during fastening start due to inertia. When the initial Torque exceeds the Torque Inhibit Limit during [61: Torque Inhibit Revolutions] an ABNORMAL will be generated and fastening will end.

Data No.1B Breakaway Torque Limit [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
When this torque is exceeded during Reverse 2 or 3 operations, an Abnormal will be generated that will stop the operation.

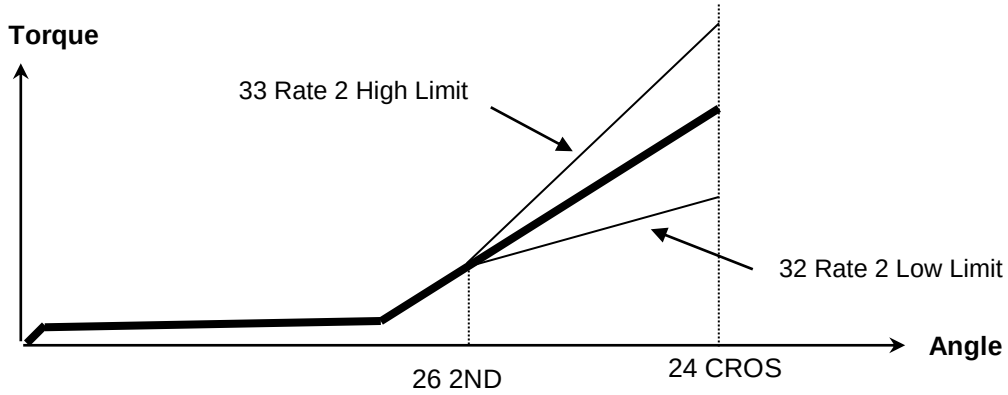
Data No.1C Final Low Torque [Nm, Kgm...]
Data No.1D Final High Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
For [Angle Method], sets the High and Low limits for Torque at the point that the final Fastening Angle is achieved.
For [Torque Method], during Torque Recovery, sets the High and Low limits for Torque at the point that the final Fastening is completed.

Data No.1E 2ND Rate Start Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Cal torque] × 1.0
Start point for 2nd Torque rate monitoring [Crossover is the end]



If 2nd Torque Rate monitoring is not required, [1E:2nd Rate Start Torque] should be set the same or higher than [10: Calibration Torque]

Data No.26 2ND Rate Start Angle [deg] **(NOT USED as standard function)**
Setting range: 0 ~ 9999 degrees
Start point for 2nd Torque rate monitoring [CROS Torque/Angle is the end]



Data No.20 Low Angle [deg]
Data No.21 High Angle [deg]
Setting range: 0~9999
Sets the High and Low limits for Fastening Judgment Angle as measured from [16:SNUG Torque] to Fastening End. If the High limit is reached the fastening operation will stop even if the operation is not complete.

Data No.22 Standard Angle [deg]
Setting range: 0~9999
Sets the target Angle value for fastening as measured from [16:SNUG Torque].
This is only available when [00: Fastening Mode] is Angle Mode.

Data No.25 Correction Angle [deg]
Setting range: 0~99
Compensation value for when the Final Angle value of the equipment does not match the value read from an external master device.
Normally, this value shall be set as 0.

Data No.30 1st Rate Low Limit [Nm/deg]
Data No.31 1st Rate High Limit [Nm/deg]
Setting range: 0~Tool type's maximum torque rate
Sets the high and low limits for the Torque rate measured between the two points [17:Threshold Torque] and [15:1ST Torque] or [23:1st Angle].
Judgment is conducted at the point when [15:1ST Torque] or [23:1st Angle] is achieved or when Fastening ends, whichever occurs first.

Data No.32 2nd Rate Low Limit [Nm/deg]
Data No.33 2nd Rate High Limit [Nm/deg]
Setting range: 0~Tool type's maximum torque rate
Sets the high and low limits for the Torque rate measured between the two points [1E:2nd Rate Start Torque] or [26:2nd Rate Start Angle] and [18:CROS Torque] or [24:CROS Angle].
Judgment is conducted at the point when the [18:CROS Torque] or [24:CROS Angle] is reached or when Fastening ends, whichever occurs first.

Data No.34 3rd Rate Low Limit [Nm/deg]
Data No.35 3rd Rate High Limit [Nm/deg]
Setting range: 0~Tool type's maximum torque rate
Sets the high and low limits for the Torque rate measured between the two points [18:CROS Torque] or [24:CROS Angle] and Fastening End.

Data No.40 Initial Time [sec]
Setting range: 0 ~ 999.9
During initial time, the start of the fastening operation will be conducted at [50: Initial Speed]
When [40 Initial Time] is set as 0, the operation will start in [51: Freerun Speed]

Data No.41 1ST Time High Limit [sec]
Setting range: 0~999.9
Set the high time limit between the start of fastening and [15: 1ST Torque] or [23: 1ST Angle].
When this time elapses before reaching the target, the process is rejected.

Data No.42 Final Time High Limit [sec]
Setting range: 0~999.9
Set the high time limit between [15:1ST Torque] or [23: 1ST Angle] and Fastening end
When this time elapses before reaching the target, the process is rejected.

Data No.43 1ST Time Low Limit [sec]
Setting range: 0~999.9
Set the low time limit between the start of fastening and [15: 1ST Torque] or [23: 1ST Angle].
When the target is reached before this time has expired the process is rejected.

Data No.44 Final Time Low Limit [sec]
Setting range: 0~999.9
Set the high time limit between [15:1ST Torque] or [23: 1ST Angle] and Fastening end
When the target is reached before this time has expired the process is rejected.

Data No.45 Ramp up Time [sec]
Setting range: 0~9.9
This is the time constant from when the fastening operation starts until when the specified speed is achieved.

Data No.46 Ramp Down Time [sec]
Setting range: 0~9.9
This is the time constant from when the fastening operation stops until when the speed becomes zero.

Data No.47 Reverse Ramp up Time [sec]
Setting range: 0~9.9
This is the time to increase rotation speed when conducting reverse operations.

Data No.48 Torque Recovery Pulses

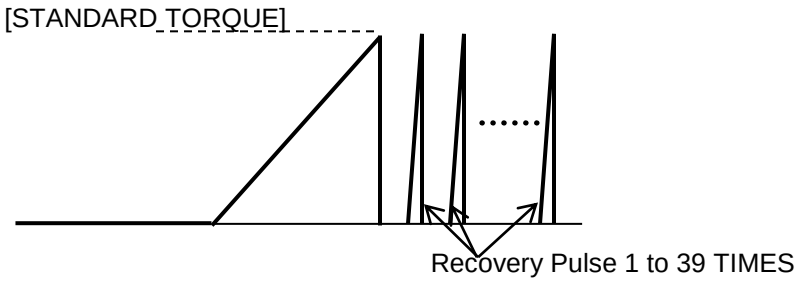
Setting range: 0~50 pulses

In Torque Method Fastening, after the fastening operation has reached the target torque, the torque will be held at Standard Torque for this duration of pulses depending on the setup below.

Unless this function is required to compensate for relaxation in the fastener, set the torque recovery value at 0.0 and do not perform the torque recovery process.

1 to 39

If set between 1-39, once STANDARD TORQUE is reached, the number set between 1-39 pulses will be performed

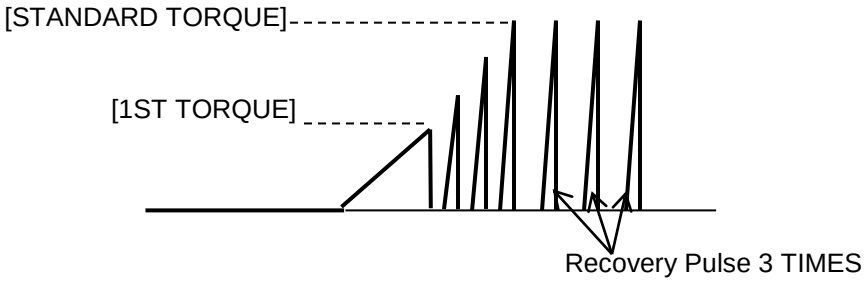


40 to 50

If set 40 – 50, pulsing will start after reaching 1st Torque until Standard Torque is achieved. The number of extra pulses once Standard Torque is reach is determined by the 1st digit of the 2 digit number.

(EXAMPLE)

When setting 43 , once first torque is reached, pulsing begins. 3 additional pulses are performed once Standard Torque is reached. (The “3” in 43)



NOTE: Setting “50” will perform the maximum recovery pulses of 10 in this mode. TORQUE SPEED should be set 60 -150rpm. Setting of 100-150rpm is optimal. The function may become unusable over 150rpm.

Caution

Please set D-No.83 and D-No.89 to “30” when using the recovery pulse function.
Set D-No. 81 to”1”, D-No. 82 to “0” and D-No. 84 to “3”.
This function may reduce fastening accuracy.

Data No.50 Initial Speed [rpm]
Setting range: Tool's minimum rpm ~ Tool's maximum rpm
Sets the speed at which the tool will begin operations. Slower speeds are used to aid in fastener engagement.

Data No.51 Freerun Speed [rpm]
Setting range: 1 ~ Tool's maximum rpm
Sets the high speed rundown value used to drive a fastener to seating. Shifts to [52: Slow Down Speed] when [14:Speed Change Torque] is sensed.

Data No.52 Slow Down Speed [rpm]
Setting range: 1 ~ Tool's maximum rpm
Sets the speed used to draw the fastener down to [15: 1st Torque] or [23:1st Angle].
When [15: 1st Torque] or [23:1st Angle] is sensed the operation will switch to [53: Torque Speed]

Data No.53 Torque Speed [rpm]
Setting range: 1 ~ Tool's maximum rpm
Sets the speed during final fastening operations.
*Slower torque speed results in better fastening accuracy.

Data No.54 Reverse Speed 1 [rpm]
Setting range: 1 ~ Tool's maximum rpm
Reverse 1 operates when the manual reverse input is selected (TB1 Terminal) or when the tool reverse switch is activated and the start trigger depressed.

Data No.55 Recovery Pulse Speed [rpm]
Setting range: Tool's minimum rpm ~ Tool's maximum rpm
Sets the speed during Recovery pulse operation.

Data No.60 Freerun Revolutions [rev]
Setting range: 0 ~ 99.9
Sets the number of revolutions the system will run from the beginning of the fastening operation until [51:Freerun Speed] is no longer needed.
Override shifts to [52: Slow Down Speed] when [14:Speed Change Torque] is sensed.

Data No.61 Torque Inhibit Revolutions [rev]
Setting range: 0 ~ 99.9
For operation that require large starting torque.
Duration for ignoring the Torque value sensed at Fastening start due to inertia. When the initial Torque exceeds the [19: Torque Inhibit Limit] during [61: Torque Inhibit Revolutions] an ABNORMAL will be generated and fastening will end.

Data No.63 2nd Reverse Revolutions [rev]
Setting range: 0 ~ 99.9
Just the value which between 1 and 2 Step, is set is reversed.

Data No.64 3rd Reverse Revolutions [rev]
Setting range: 0 ~ 99.9
Just the value which between 2 and 3 Step, is set is reversed

Data No.70 Full Scale Current [%]
Data No.71 High Current Limit [%]
Data No.72 Low Current Limit [%]
Data No.73 Fastening Current Limit [%]
Setting range: 0 ~ 120%
Used as a redundant check of the fastening process. Please contact FEC Inc. for assistance.
No.70=100%
No.71=100%
No.72=0%
No.73=100% (Will limit the amount of current allowed during fastening. Be careful when settin g too low or tool could stall during operation)

Data No.74 Accept Batch Count
Setting Range: 0 – 99
Used to set the number of accepts for WORK ACCEPT. Setting “0” disables function.

Data No.80 CW Stop Angle (Pistol Pulse Function) [Deg]
Setting Range: 0 – 200
Used to set the swing stop angle in the CW direction. This is the angle the pistol will swing up to be-fore shutting off. Setting “180” disables function.

Data No.81 CW Swing Pause Angle (Pistol Pulse Function) [Deg]
Setting Range: 0 – 200
Used to set the swing Pause angle in the CW direction.

Data No.82 CW Swing Stop Servo Lock Time (Pistol Pulse Function) [msec]
Setting Range: 0 – 500
Used to set the swing stop servo lock time in the CW direction.

Data No.83 CW/CCW Motor Resume Time (Pistol Pulse Function) [msec]
Setting Range: 0 – 500
Used to set the motor resume time in the CW direction.

Data No.86 CCW Stop Angle (Pistol Pulse Function) [Deg]
Setting Range: 0 – 200
Used to set the swing stop angle in the CW direction. This is the angle the pistol will swing up to be-fore shutting off. Setting “180” disables function.

Data No.87 CCW Swing Pause Angle (Pistol Pulse Function) [Deg]
Setting Range: 0 – 200
Used to set the swing Pause angle in the CW direction.

Data No.88 Angle Head Torque Variation [%]
Setting Range: 0 – 500% (0~4: disables function) (Default disabled)
Sets limit for torque variation caused by an angle head in an angle tool. (system internally monitors torque variation) An ABN 2_2 occurs when this is set and variations goes over this set amount.

Data No.89 CCW Motor Resume Time (Pistol Pulse Function) [msec]
Setting Range: 0 – 500
Used to set the motor resume time in the CW direction.

Data No.90 Sequence Operational mode

Data number 90 must be set in order to enable the Batch or Sequence function. Other Functions are set also with Data 90.

Data No. 90

0 0 0 0

Accept Relay Output Timing (xxx1)
(xxx0) QL-OK Pulse 300ms
(xxx1): QL-OK Pulse 800ms
Stop Input (xxx2)
(xxx0): Normally Open Stop Input
(xxx2): Normally Closed Stop Input
Total Accept Relay Output (xxx4)
(xxx0): Solid Output Signal
(xxx4): Pulse Output Signal
(Add numbers to determine setting number – ex. QL-OK Pulse 800ms (xxx**1**) + Pulse Output Signal (xxx**4**) = 000**5**)

Batch Function Enable (xx1x)
(xx0x): Batch Function Disable
(xx1x): Batch Function Enable
Auto Reverse – Between 1st & 2nd Step (fastening=2 step) (xx2x)
(xx0x): Auto Reverse OFF
(xx2x): Auto Reverse ON
Auto Reverse – Between 2nd & 3rd Step (fastening=3 step) (xx4x)
(xx0x): Auto Reverse OFF
(xx4x): Auto Reverse ON
(Note: Batch function must be Enabled for Auto Reverse to work)
(Add numbers to determine setting number – See example above)

Sequence Function Enable (x1xx)
(x0xx): Sequence Function Disable
(x1xx): Sequence Function Enable
Auto Reject Upon non-Completion (x2xx) (F/W Ver. 5.10 or later)
(x0xx): No Output until Sequence is completed
(x2xx): REJECT Output if Sequence stops before completion

(Add numbers to determine setting number – Ex. Sequence Function Enabled (x**1**xx) + Reject Output if Sequence stops before completion (x**2**xx) = 0**3**00.

Note: you can only ENABLE either the Batch or the Sequence function at one time

START signal must be maintained during sequence – if START is lost during sequence, fastening stops – Fastening will start from beginning upon next start

Data No.91 Sequence Stage 1	[Parameter / Count or Dwell]
Data No.92 Sequence Stage 2	[Parameter / Count or Dwell]
Data No.93 Sequence Stage 3	[Parameter / Count or Dwell]
Data No.94 Sequence Stage 4	[Parameter / Count or Dwell]
Data No.95 Sequence Stage 5	[Parameter / Count or Dwell]
Data No.96 Sequence Stage 6	[Parameter / Count or Dwell]
Data No.97 Sequence Stage 7	[Parameter / Count or Dwell]
Data No.98 Sequence Stage 8	[Parameter / Count or Dwell]

Setting range: Parameter 0 ~ 32 / Count or Dwell 0 ~ 99

BATCH / SEQUENCE PROGRAM EXAMPLES

Batch Function

There are 4 data digits used for each step which specifies the parameter number and number of “accepts” required in order to go to the next step. The fastening must be within the parameter limits (Accepts) to be counted. (WORK ACCEPT signal turns on after each step is complete – Both the Green ACCEPT LED on the controller and tool flash upon the step completion)

0 2 0 4

Number of accepts to complete step

Parameter Number to be used for step

Batch Step	Data Number	Data	Operation
	90	0010	Activate Batch Program
1	91	0103	Fasten 3 times using Parameter 1
2	92	0204	Fasten 4 times using Parameter 2
3	93	0701	Fasten 1 time using Parameter 7
4	94	0000	End (“0000” Ends Batch)
5	95	0000	
6	96	0000	
7	97	0000	
8	98	0000	

Sequence Function

There are 4 data digits used for each step which specifies the parameter number and dwell time after the step is complete.

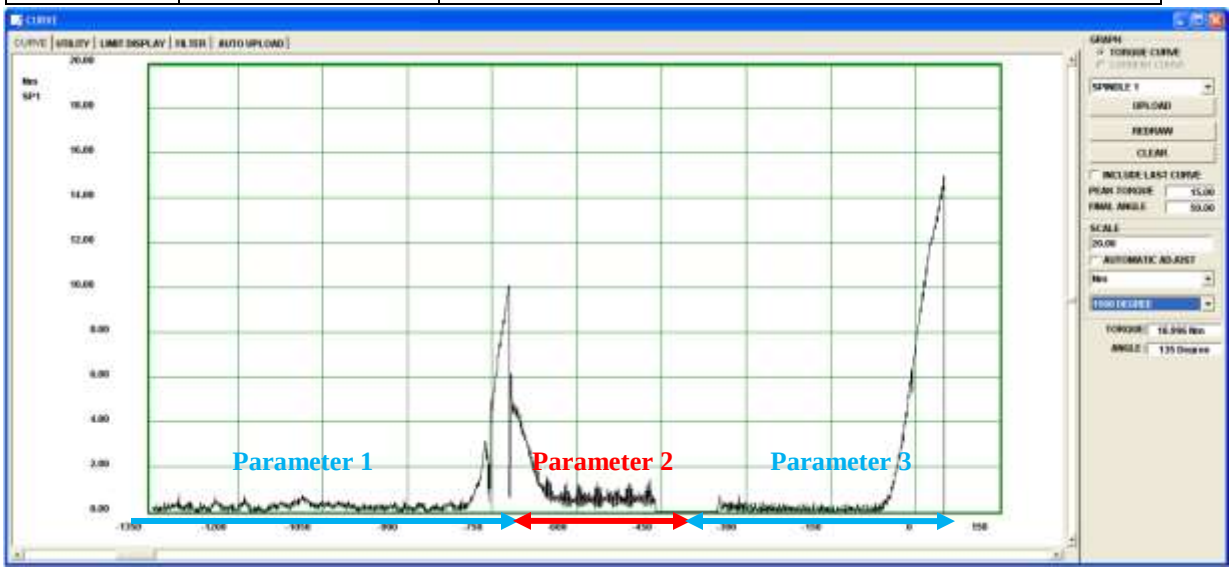
0 1 0 5

Dwell Time to be used after step

Parameter Number to be used in step

Sequence Step	Data Number	Data	Operation
	90	0300	Activate Sequence Program (with Reject if not complete)
1	91	0105	Run Parameter 1 and dwell 0.5 second after
2	92	0203	Run Parameter 2 and dwell 0.3 second after
3	93	0300	Run Parameter 3
4	94	0000	End ("0000" Ends Sequence)
5	95	0000	
6	96	0000	
7	97	0000	
8	98	0000	

	Parameter Number	Operation
	1	Fasten to 10 Nm
	2	Turn CCW for 360 degrees by angle method.
	3	Fasten to 15 Nm



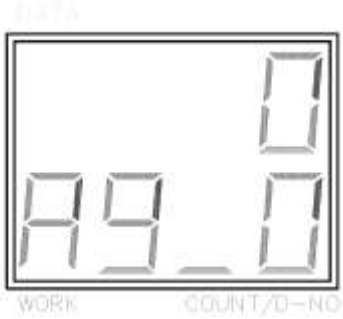
Note: PARAMETER (WORK) NUMBER must be selected from PLC prior to having the START signal input
The START signal can be input from terminal (A2) or the start trigger on the tool.
The system operates as dead man, so the START signal must be held on during operation.
The system aborts the sequence operation upon any reject during the sequence steps.
The Accept signal is only output at end of a successful sequence operation.
The fastening result and the torque curve are only available at the end of sequence.
The fastening result of each step will be stored into stored data memory.

7.2.6 STATUS display

Two types of controller STATUS can be displayed, either STOP or ABNORMAL.

1) When the STOP signal is activated:
The [DATA] display will indicate when the STOP signal has halted the FUSION as shown in the figure.

2) When an ABNORMAL condition occurs, the display will show a flashing "A" character followed by a number that represents the Abnormal number code. The [COUNT/D-NO] displays a dash and a number that represents the SERVICE CODE NUMBER or SUB Code.
The figure below shows a display reporting the Abnormal code 9 and the Sub code number 0. (Refer to chapter 9)



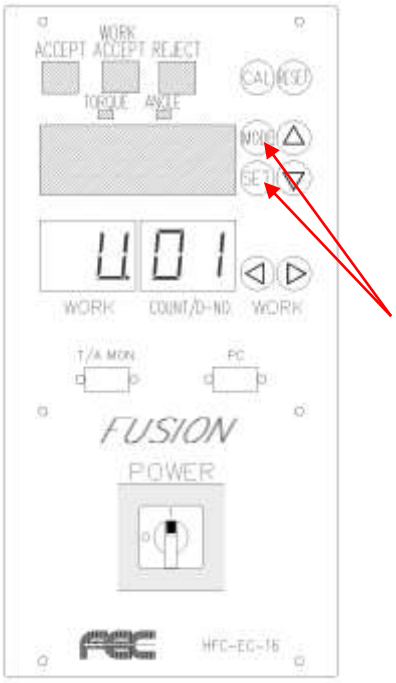
7.3 Download / Setup Mode Operation (Bypass Mode Only)

The FUSION system has two operational states that are controlled by depressing the "MODE" and "SET" Buttons, on the front of the Controller, simultaneously, or by the PLC By-pass input. The operational modes available in the **Bypass State** are identified below. Under this condition, the "MODE" and "SET" Buttons have been pressed simultaneously, or the BYPASS external signal is active. During the **Bypass State,** the controller displays and allows setting of all available parameter presets.

7.3.1 Download Mode selection

Immediately after the bypass condition has been entered, the unit is in the initial Download / Setup mode with the unit number displayed on the Count /D-No Display. The **AFC User Console** software allows the CONTROLLER Unit setup via a computer's RS232 Port. To program the CONTROLLER unit with the display programmer, press the [MODE] key to change to the primary setup mode. (If the CONTROLLER unit is performing some data communication to an external computer, the download mode will be maintained until the operation is completed.)

(Refer to the AFC Console Manual for information about the Download Mode).



Pressing both the [MODE] & [SET] keys at the same time puts the controller into BYPASS mode.

FIG. 7-3-1 CONTROLLER Unit in Download mode.

7.3.2 Setup Mode selection

Depressing the Mode button will initiate the Setup mode. Immediately after the setup mode is established, a blinking number will appear in the [COUNT/D-NO.] display. The cursor (blinking mode) will move between the 2 digit positions each time the [MODE] button is pressed. The blinking character can be increased or decreased using the [↓] and [↑] buttons. The [COUNT/D-NO] characters will display the data corresponding to the Parameter data list (7.2.5). The [DATA] characters will display the actual value of the [COUNT/D-NO] as it is currently set. You may edit the currently indicated data using the Data Edit mode. Press the [SET] button to enter into the Data Edit mode on the indicated [COUNT/D-NO.] that you want to change. (See 7.3.4 and 7.3.5 for detail)

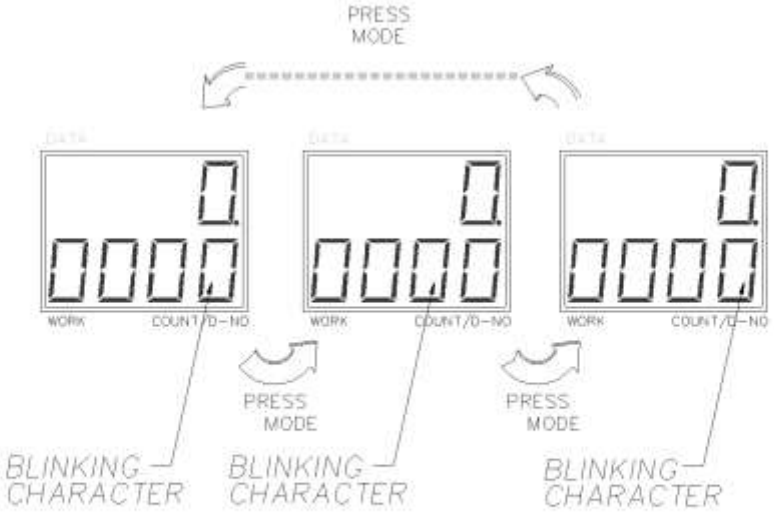


FIG. 7-3-2 Setup mode D-No selection

7.3.3 Parameter # selection

All 16 Parameter sets can be setup using the programmer. Data corresponding to the selected parameter number will be displayed in the [DATA] display. The diagram below describes the selection. Selection of the FUSION system 16 different sets of parameters for programming purposes is accomplished by depressing the **[➔] and [🡐]** Cursor key (Horizontal arrows) while in primary setup mode. In addition to parameter 1 ~ 16 there is a PARAMETER 0 that contains configuration data common to all parameters.

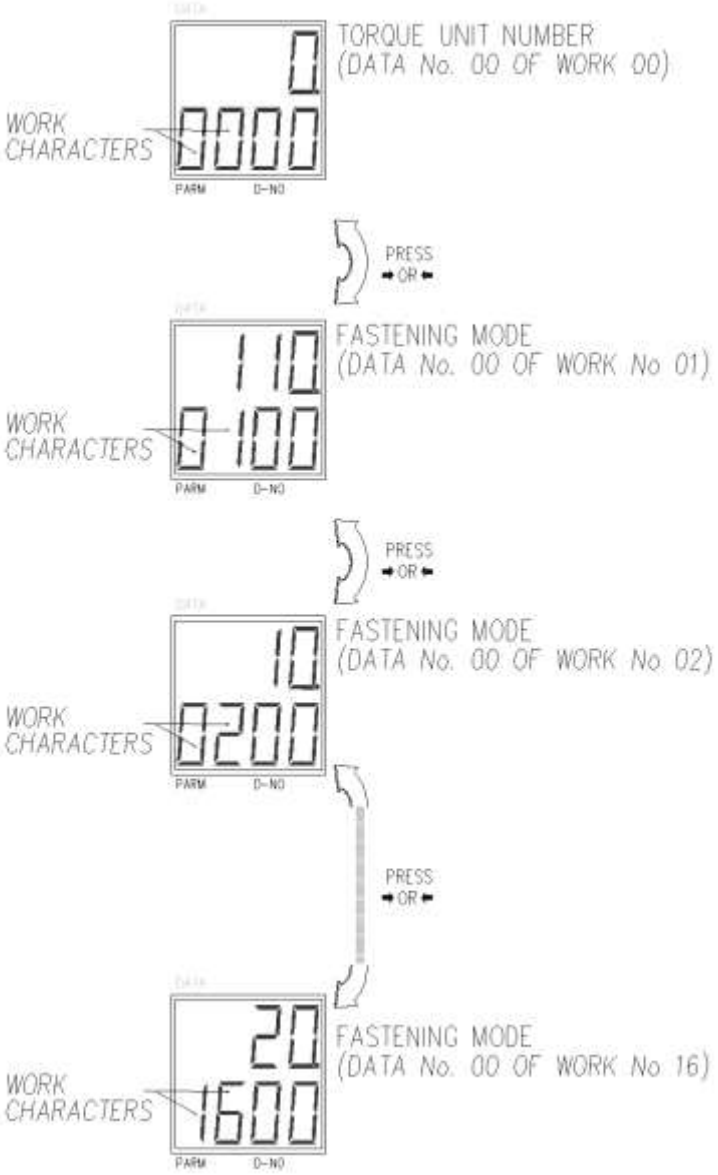


FIG. 7-3-3 Parameter display D-No selection

7.3.4 Data # selection

The value for digit 1 and 2 of the [COUNT/D-NO] display may only be changed when the (blinking) cursor is in the respected position. The [COUNT/D-NO] value is changed with the [↓] and [↑] keys. Data corresponding to the data number [COUNT/D-NO] display will appear in the [DATA] display (Refer to section 7.2.5). If the cursor is in the 1st digit position, by pressing the [↓] or [↑] keys, the DATA number will be scrolled by tens. If the cursor is in the 2nd digit position, the DATA number scrolling will be one by one. As noted in the Parameter Data List chart, the preset values are not arranged in a perfect sequence and some numbers may be skipped. When scrolling the DATA numbers, it will scroll to the next existing value in the same or the following parameter number.

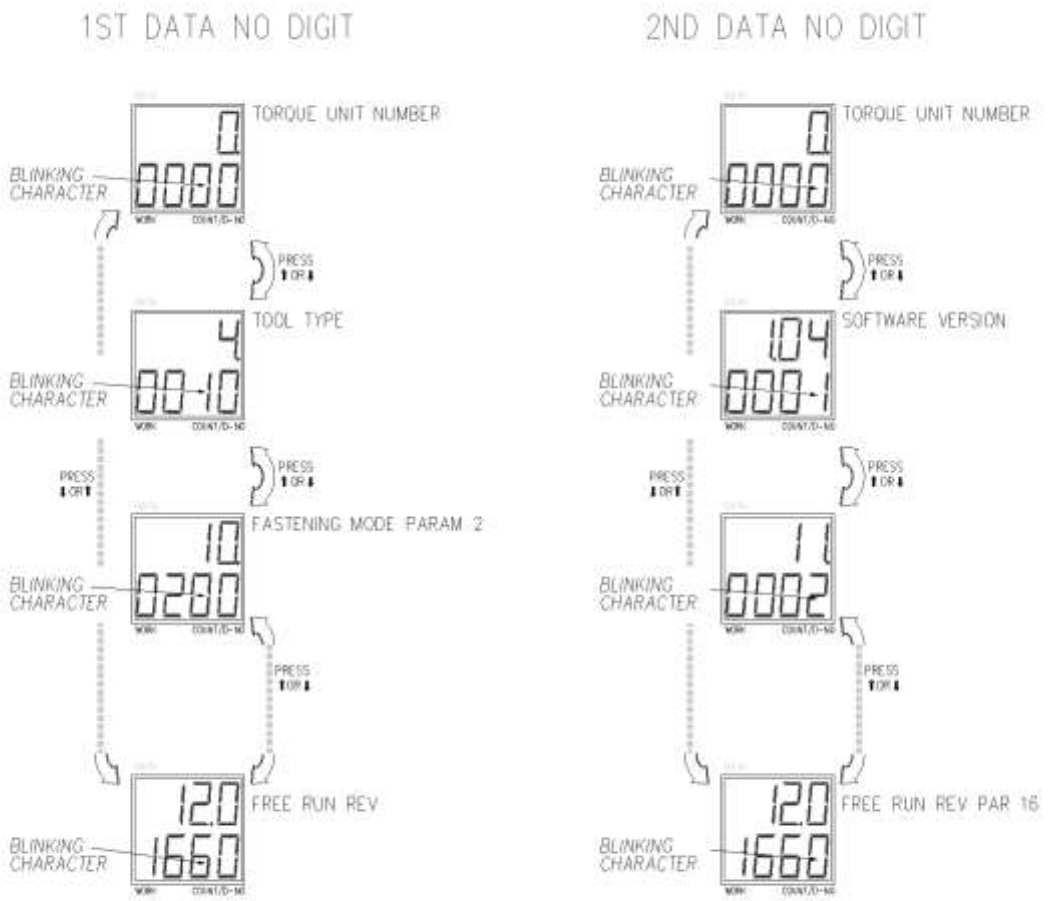


FIG. 7-3-4 Data No. changing

7.3.5 Data Edit mode operation.

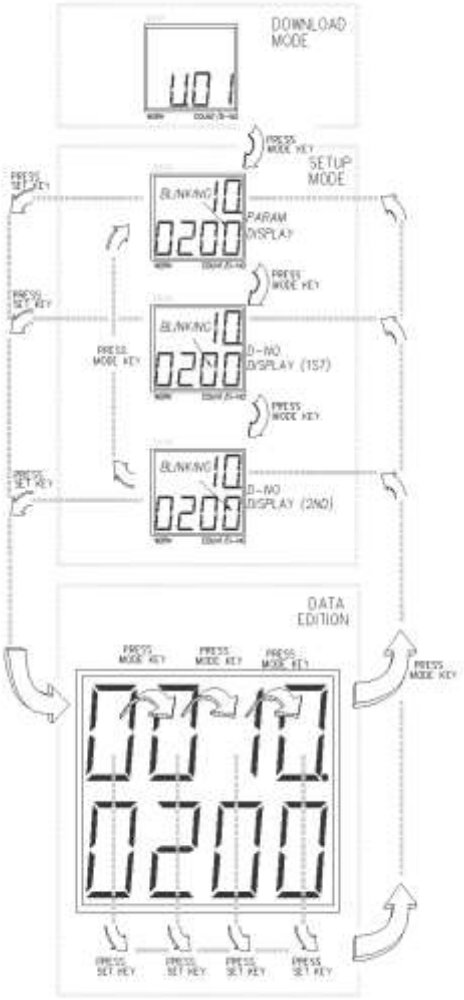


FIG. 7-3-3 Setup mode operation

Depressing the [MODE] button will bring up the primary setup mode. The blinking cursor will be positioned in the right most digit in the [COUNT/D-NO] field and depressing it again will bring it to the left digit of the field. Use the [↓] and [↑] buttons to select the desired [COUNT/D-NO] number which is to be edited.

After you have selected the Parameter number and the Data number you would like to edit, press the [SET] button to enter the Data Edit mode. The blinking digit will now appear at the left digit of the DATA field. You can move one digit to the right each time you press the [MODE] button. By pressing the button four times, you leave the Data Edit mode and return to the Setup mode (without saving any changes). Use the [↓] and [↑] buttons to increase or decrease the digit that is blinking.

After changes have been made, pressing the [SET] button will save the changes and exit to the Setup mode.

If the entered values are out of range / limits, "**Err**" will appear, and the new data will be ignored. In this case, return to the parameter number selection (using the [MODE] key) and enter data that is acceptable.

When the Torque Unit number (PARM 0 D-NO 00) or the Tool Type (PARM 0 D-NO 20) is changed, the [DATA] display will show "CHNG," and the D-NO display will show "NO." Use the vertical arrow buttons to choose YES or NO; YES means that the data will be entered if the confirmation SET button is pressed. The [SET] and [MODE] buttons will have no effect when "NO" appears. If no button is pushed within five seconds, the new data will be ignored, and the system will exit the Data Edit mode.

Note:
When the Torque Unit (PARM 0, and D-NO 00) or the Tool Type (PARM 0, and D-No 20) is changed, all torque settings (D-No 00-1E) and speed settings (D-No 50-56) will be cleared.

7.3.6 Parameter copy.

To speed parameter data entry, it may be beneficial to copy from one parameter set to another parameter set. This is especially the case if only minor changes are required. Use the procedure below for the parameter copy function using the display;

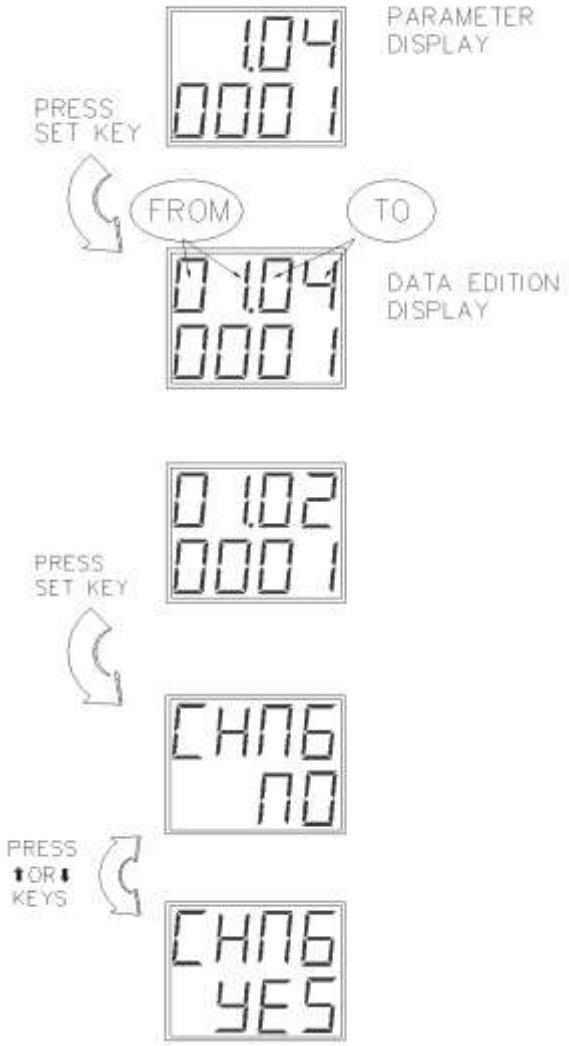


FIG. 7.3.6 Parameter copy procedure

- When the system is in Setup mode, select Data number 01 of Parameter 00. (This data corresponds to the ROM version and is non adjustable data.)

- Press the Set button and the cursor will jump to the left digit position of the 4 digit data display. (There will be a decimal point between the second and third digit) The first two digits specify which parameter number is to be copied **FROM** and the two digits after the decimal point specify which parameter number is being copied **TO**.

- Edit the numbers to change the display to get the desired source and target parameter numbers. (The example to the left shows parameter 1 being copied to parameter 2)

- Press the SET button to proceed with the copy.

- Press either arrow button to confirm the change (YES) or to cancel it (NO). (The display will return to the Setup Mode if no action is taken within 4 seconds)

- If YES is displayed, press the SET button again to copy the parameter.

7.4 Calibration Adjustment.

The calibration value is set according to the tool type (capacity). However, depending on the application characteristics or on the prevailing torque generated external to the tool output shaft, the value of the applied torque and the torque display by the CONTROLLER unit may mismatch. In this case it is possible to adjust the FULL SCALE TORQUE (CAL) value, so the displayed torque matches the installation torque registered by an external torque transducer (Master).

The CAL value can be adjusted up to ± 10% of the FULL SCALE TORQUE value.

Example:
Consider the HFT-025M80-A tool.
Nominal CAL value = 3.5 Kg.m.
Range of adjustment: from 2.8 Kg.m to 4.2 Kg.m.

The FULL SCALE TORQUE value is read from Parameter 1 ~16 D-No 10.

Use the following formula on a collection of at least 10 fastenings when a calibration correction is necessary:

New CAL value = Master transducer mean/ FEC transducer mean x Existing CAL value

Note: The torque unit (Kgm, Nm, FtLb, etc.) must be the same for all terms. Do not mix torque units in calculation or errors will result.

If the new CAL value is out of the adjustable range, the [Err] message will be displayed.

Example:
Tool Full Scale value (EXISTING CAL) is 35.00 Nm.
STD torque is 25.0 Nm.
Master transducer mean for 10 piece run is measuring only 24.00 Nm.
FEC transducer mean for 10 piece run is measuring 26.0 Nm.

The new CAL value is obtained as follows:

(24.00/26.00 x 35.00) = 32.305

*The **FULL SCALE TORQUE (CAL) value** must be corrected to **32.30 Nm** and entered at [WORK} 1~16 [COUNT/D-NO] 10.*

NOTE: WORK 1~16 can have different Calibration values entered. This provides for an improved accuracy rating over an extended torque range.

Notice: An alternative method of checking calibration using a static torque device (wrench or bench checker) can be done using the Locked Spindle Mode method. The motor can be electrically locked while the operator manually applies torque with the tool (using the tool as a torque wrench) and then comparing the readings from the FEC Controller data display vs. the torque displayed from the master. See 7-2-2 for a description of how to put the spindle into the Locked Spindle Mode.

7.5 Optional Real Time Clock Module

The Fusion system stores 10000 cycles of fastening results in its flash memory. In order to add a Date/Time stamp to this data, an optional Real Time Clock module can be added to the controller. This module is added into the back of the controller inside of the access panel at the upper right side.
When this clock module is added, the date & time will be attached to the stored data every cycle. This function is available in Firmware version 2.20 or later

The AFC software will be required for restoring stored data from controller.

Clock module model :	ANG-RTC
Backup power source :	Electric double layer capacitor
Backup memory duration :	Approx. 10000 hours
Backup power charge time	Approx. 1hour

If the controller power is turned off for more than 2 months, the clock backup power will be lost & the time settings will be lost.
The Clock can be set using the front display & keypad the same method as changing parameter data. See the table below for parameter numbers.

Work #	Data #	Item	Example
00	30	Year ‘yyyy’	‘2005’ Year 2005
00	31	Month & Date ‘mmdd’	‘0131’ January 31st
00	32	Hour & Minute ‘hhmm’	‘1759’ 17:59
00	33	Seconds ‘00ss’	‘0020’ 20 second

Seconds will be set as ‘00’ when Hour & Time (Data # 32) is changed.

Note: Clock may be off approx. 10 seconds / month. Adjust as required.
AFC Software version 5.16 or after added function to program Date/Time from software.

7.6 Tubenut Head Set-up

Tubenut heads are used for applications that require a socket to be inserted around a tube to fasten an accompanying tubenut. They require a special function to re-align the “U” shaped socket back to it’s “open” position in order to remove the nutrunner from the tube after fastening. When using an optional Tubenut head, special programming options MUST be set-up to enable the Tubenut socket automatic return function along with various other considerations.

Tubenut head applications inherently present safety concerns especially in the area of the open “U” shaped socket. The opening of the “U” shaped socket presents a PINCH POINT while rotating.

WARNING: KEEP ALL BODY PARTS AWAY FROM THE TUBENUT HEAD SOCKET OPENING DURING OPERATION OR PERSONAL INJURY MAY RESULT!

PLEASE CONSULT YOUR PLANT SAFETY PERSONNEL BEFORE USING THIS HEAD!

All safety precautions MUST be followed to ensure safe operation and operator safety!

7.6.1 Recommended Parameter Set-up for Tubenut Head

The following parameters are recommended for setting up the Tubenut head function.

1. **Fastening Function Version [WORK]-00, [D-No]-03**
   Change to version for Tubenut head tool (1.00, **1.01**, 1.10, 1.11)
   (See page 7-12 for function version change procedure)

2. **External Gear Ratio [WORK]-00, [D-No]-04**
   Default is "**1.000".** If the gear ratio is other than 1:1, then the gear ratio must be adjusted here or angle readings will not be correct when fastening. (ex. If gear ratio is 1:1.132, then "1.132" should be entered here)

3. **Gear Head Selection [WORK]-00, [D-No]-05** (Firmware Ver. 2.33 or higher)
   Select the version of Tubenut head you are using. (CW or CCW) This is determined by the direction the NUTRUNNER must rotate in order to rotate the tubenut head in the FASTENING direction and is dependant on the gearing in the tubenut head. (Without the tubenut head attached to the nutrunner, slowly rotate the tubenut socket in the CW direction and take notice of which direction the square drive is turning on the other end of the head. If it rotates in the SAME direction, use the CW setting. If it rotates in the OPPOSITE direction, use the CCW setting)

   "00" : Normal (Default) (Disables Tubenut Function)
   "01" : CW Tubenut Head (Enables CW Tubenut Function)
   "03" : CCW Tubenut Head (Enables CCW Tubenut Function)

WARNING: Setup proper CW / CCW rotation <u>PRIOR</u> to running the tool with the Tubenut head attached or Tubenut Head damage may occur! (The Tubenut head stop detail which re-aligns the "open" slot in the socket gear may be broken if too much force is applied)

4. **Full Scale Torque [WORK]-01(thru-32), [D-No]-10**
   This value will need to be adjusted to make up for torque loss through the tubenut gearing. (This should be determined by using the calibration adjustment method – Section 7-4) This value changes with tool size and capacity.

5. **Torque Inhibit Limit [WORK]-01(thru-32), [D-No]-19**
   When using the Tubenut function, the Torque Inhibit Limit parameter sets the MAX. amount of torque that can be sensed during the Torque Inhibit Revolution setting. This is used to set the max. torque to be sensed during the start of rotation of the socket or until the socket "U" opening moves to a closed position. **This will protect from damage anything being inserted into the path of the socket as it rotates in the OPEN space.** If this torque value is exceeded during the Torque Inhibit Revolution (Work – 01 (thru-16) D-No-61), a REJECT will result. This cannot be set too low or nuisance REJECTS will occur during normal motor start-up.
   Recommended setting: .75 – 1.5Nm
   NOTE: This setting will vary by tool size and Tubenut head configuration.

   <u>WARNING!</u> – Do not set this ABOVE the recommended setting or personnel injury may result!

6. **Torque Inhibit Revolutions [WORK]-01(thru-32), [D-No]-61**
   Set Torque Inhibit Revolution so that the torque can be checked during motor start-up (Just enough revolution for the socket to close the "U" opening)
   Recommended setting: .3rev

7. **Initial Time [WORK]-01(thru-32), [D-No]-40**
   Set Initial Time so that revolution time/speed is slow during motor start-up (the time that the socket is rotating in the socket "U" opening)
   Recommended setting: .3sec

8. **Initial Speed [WORK]-01(thru-32), [D-No]-50**
   Set Initial Speed for slow rotation while socket is rotating through the "U" opening.
   Recommended setting: 60rpm max.

9. **Reverse Speed [WORK]-01(thru-32), [D-No]-54**
   Reverse speed is used to re-align the socket after a fastening.
   Recommended setting: 60 – 100rpm max.

10. **Ramp Up Time [WORK]-01(thru-32), [D-No]-45**
    Sets motor ramp-up time from slow to higher speeds
    Recommended setting: 1.0 – 1.5sec.
    (Can only be set in Supervisory security mode)

11. **Ramp Down Time [WORK]-01(thru-16), [D-No]-46**
    Sets motor ramp-down time from high to slower speeds
    Recommended setting: 1.0sec.
    (Can only be set in Supervisory security mode)

12. **Socket Return Torque [WORK]-01(thru-32), [D-No]-1A**
    (Uses **Offset Torque Limit** data – since it is not used in Fusion)
    Sets the torque at which the socket returns and stops at after a fastening.
    Recommended setting: 6.0 - 10Nm
    Must be set by using Automatic Parameter Setup Function in AFC software or manually entered using the controller display keypad

Note: [D-No] 1A cannot be seen using the AFC software, however it will be transferred/copied with the parameter data file.

7.6.2 Tubenut Head Operation

When using a Tubenut head, a special function is required to re-align the socket after normal fastening operations and allow the socket to be placed onto the nut to be fastened. The start trigger must be held "ON" for the complete fastening of the part. If the trigger is released during the fastening cycle, the fastening will stop. The fastening can be re-started by simply squeezing the trigger again. Use the procedures below to re-align the Tubenut socket.

First Time Power-Up / Socket Re-alignment

If the Tubenut socket is not aligned use the following procedure to re-align the open socket.

- Press the "Reverse" pushbutton (Tool RED / GREEN LED'S will flash)
- Press the start trigger
- Hold the start trigger until the socket is re-aligned and the tool shuts off (tool automatically shuts off)

NOTE: If the socket is turning in the wrong direction to re-align the head (Re-alignment must turn CCW for proper operation), the Gear Head Selection is wrong ([WORK]-00, [D-No]-05).

(more on next page)

Return to Home Position after Fastening

After fastening a part, the tubenut socket must be re-aligned in order to remove it from the part. Use the procedure above to re-align the socket if removal is desired. Use this procedure to re-align the socket and remove the head from the part after a complete fastening.

- Hold down start trigger until fastening is complete
- While still HOLDING the start trigger after fastening is complete, lift socket off of the nut being fastened
- Release start trigger and the socket will re-align automatically.
- If the trigger is inadvertently released before the socket is re-aligned, follow the procedure above to re-align the socket.

Chapter 8: Maintenance and Inspection

8.1 Inspection Items

A scheduled inspection is recommended to keep the FUSION System in the best condition. A preventive maintenance routine should be set-up. Recommended inspection schedules are given for each item.

WARNING:Follow Lockout/Tagout and other safety precautions when connecting or disconnecting cabling, wiring, and equipment. Always verify the System is disabled prior to touching any moveable components

.

8.1.1 Nutrunner (Tool)

Recommended Schedule: Quarterly

It is important to keep the nutrunner tools clean and properly adjusted to ensure correct fastening and accurate system outputs. Inspect each tool, and ensure the following conditions exist:

- All environmental conditions are within the specified ranges.
- The duty cycle is within specifications, and the motor is producing normal heat levels.
- The tool is producing normal levels of noise and vibration (no irregular noise)
- The tool is free from excessive contamination and foreign matter.
- The tool is securely mounted, with mounting bolts properly tightened.
- The Tool cable is securely connected to the tool.

8.1.2 Tool Cable

Recommended Schedule: Quarterly

This cable connects the tool to the Controller unit. Ensure the following conditions are met:

- The cables are free from unnecessary binding, force and tension and are free to move.
- The cables are in good condition, sufficiently insulated (no cuts) with no indication of broken wires.
- The cables are free from excessive contamination and foreign matter.
- The cables are securely connected to the Controller unit and to the nutrunner (connectors are tight).
- The cables are free from heat distortion, and are not warm or hot to the touch.
- The cables and cable connectors are securely and correctly fastened.

(See 4.11.1 for Cable Installation Guidelines)

8.1.3 Controller Unit

Recommended Schedule: Quarterly

The Controller Unit requires careful use and handling. Inspect each Controller unit and ensure the following requirements are met:

- The environmental conditions are within specifications.
- There is no moisture, oil, or foreign matter on the unit.
- The unit is securely mounted, with appropriate clearance on all sides.
- All screws (for the cover of the unit and for mounting) are correctly tightened.
- The input power remains within specifications at all times.
- The unit is not producing any abnormal (excessive) heat.
- Unit cables (on the back and the underside) are securely fastened and without damage.

8.1.4 Auxiliary Tool Heads (Crowsfoot, Tubenut, Hold & Drives, etc.)

Recommended Schedule: Monthly

External auxiliary heads require special attention due to the nature of their small design withstanding high forces. These heads are typically designed for a maximum of 250,000 cycles or less and should be inspected more frequently than a standard tool. (life cycle is dependant upon the torque it is used at).
Typically, these heads should be inspected and greased every 10,000 cycles. During this inspection, the inspection time may be lengthened or shortened depending on the conditions seen during the first few inspections. (this will very by application)

Inspect each tool, and ensure the following conditions exist:

- The head is producing normal levels of noise and vibration (no irregular noise)
- The head is free from excessive contamination and foreign matter.
- The head turns freely with no binding
- The head is securely mounted to the tool, with mounting bolts properly tightened
- All covers, screws and bolts are in place and securely tightened on head
- The head is sufficiently lubricated (approx. 1/5 oz. of grease each application) Do NOT over grease!

Auxiliary Head Lubrication Information

Description	Part Number
Grease Gun	GG-K97
Lubriplate Grease (14oz)	GR-132-A
Lubriplate Grease (6 lb can)	GR-132-B

8.2 Basic Operational Tests

WARNING:Follow Lockout/Tagout and other safety precautions when connecting or disconnecting cabling, wiring, and equipment. When performing the following inspections, verify that the system is disabled prior to touching any moveable components.

8.2.1 Torque Transducer.

The system can perform a transducer check before each fastening cycle, comparing the values from the torque transducer (zero and calibration) to the data stored in the system memory. The system is maintenance free, however it can be manually checked as follows:

- 1. Be sure that the nutrunner is in the READY mode.(powered up) and not running.
- 2. Check that the torque display shows 0 when the keyboard-display unit RESET key is being pressed.
- 3. At the same time as 2 (above), check that “ABN” is not displayed on the Data display.
- 4. Check that the display is showing the full scale torque value when the Controller unit CAL key is being pressed.
- 5. At the same time as 4 (above), check that “ABN” is not displayed on the Data display.
- If any of these checks fail internal limits, an ABNORMAL will be generated and “ABN” will display. See Chapter 9 for troubleshooting.

8.2.2 Resolver.

Take the following steps to manually inspect the resolver:

- 1. Make sure that the system will not be started by an operator.
- 2. Place the Controller keyboard-display unit into the real-time display mode (Chapter 7 - Display has only one digit active in the D-NO display. This is the default mode when power is applied). The [D-NO] display must be set to [3] using the Up/Down arrow keys in order to see the angle of rotation on the DATA display.
- 3. If the socket of the tool is turned in the clockwise direction, the angle indication should increase.
- 4. Verify that the angle rotated matches the indicated angle in the data display.

8.2.3 Motor.

If doubts about the condition of the motor exist, the windings can be manually checked with a Ohm meter. To check the motor, measure the winding's resistance and the isolation resistance.

- 1. **Power down the system.**
- 2. Disconnect the motor connector from the tool assembly.
- 3. Measure the resistance between windings. (Refer to Fig 8-2-3)

- 4. Measure the isolation resistance between each pair and the frame.
  Insulation resistance: Using a megohmmeter, 500 VDC, 50 Mohms or more, test the insulation resistance between the motor windings and the motor case. The values should register in excess of 50 Mohms for each winding.

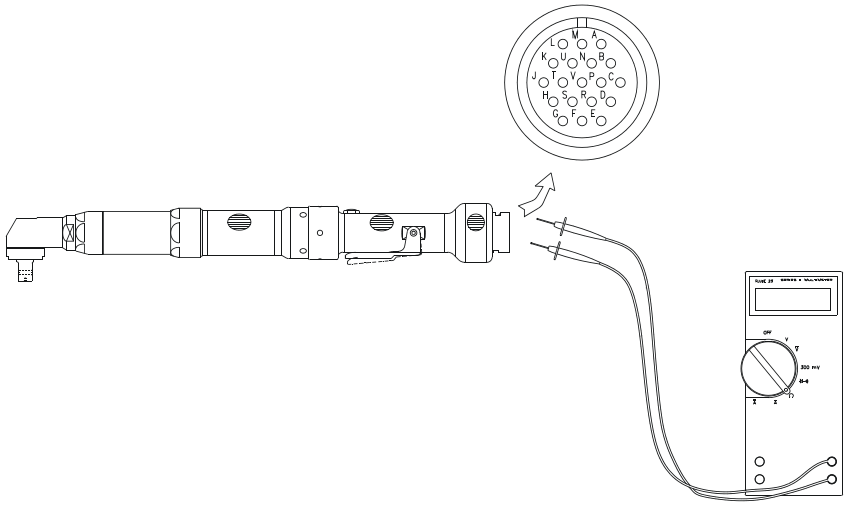


FIG. 8-2-3 Motor Inspection

Motor Winding Resistance*			
MOTOR SIZE	**Pins A - M**	**Pins M - L**	**Pins L - A**
(M80)	5.0Ω	5.0Ω	5.0Ω
(M50)	7.8Ω	7.8Ω	7.8Ω

Tolerance + / - 10%

Resolver Winding Resistance			
MOTOR SIZE	**Pins C - D**	**Pins P - R**	**Pins V - S**
(M80)	20 –30 Ω	65 – 75 Ω	65 – 75 Ω
(M50)	20 –30 Ω	65 – 75 Ω	65 – 75 Ω

Resolver windings should not be “Open” or zero ohms.

Insulation Resistance			
MOTOR SIZE	**Pins J - K**	**Pins K - L**	**Pins L - J**
(M80)	More than 50 mega ohms at 500 VDC		
(M50)			

8.2.4Transmission Disassembly and Inspection

- The planetary gear transmissions used in the FUSION System's tool assemblies are designed to withstand the forces exerted upon them by high production requirements of modern assembly plants.
- The total cycle count of the tool assembly is stored on the Tool Preamplifier and can be retrieved using the FUSION User Console Software. This count can be used for diagnostic and maintenance purposes. (Only FEC can reset this counter)
- To prolong the life of the transmission assembly, the components must be inspected and greased at regular intervals.
- FEC INC. recommends performing this procedure initially after equipment has been in use for one year or 500,000 cycles, whichever is reached first.
- When the initial maintenance is performed, the condition of the transmission assembly should be analyzed to determine future maintenance requirements. Systems operating under more severe conditions (Full scale torque in high temperatures) may require maintenance every 250,000 cycles, while other systems may only require maintenance every one million cycles.

1. REMOVE TRANSMISSION FROM TOOL ASSEMBLY. Separate the transmission from the motor by disassembling tool assembly drive end. (See Tool Assembly Manual)

Note: Care must be taken when disassembling the tool assembly. Small parts and wiring can easily be lost or damaged.

2. DISASSEMBLE TRANSMISSION. Refer to the appropriate transmission assembly drawing while disassembling the transmission for cleaning.

3. CLEAN TRANSMISSION PARTS. Clean all parts with an appropriate solvent, such as mineral spirits, to remove all excess grease and contamination. Parts should be carefully wiped dry with a lint-free cloth to remove any residue. Allow the parts to dry thoroughly in an area free from contamination.

4. INSPECT TRANSMISSION PARTS. Examine all gears, pins, bearings, etc. for signs of excessive wear. Replace any part that failed or appears it may fail.

5. LUBRICATE TRANSMISSION PARTS. Reassemble the transmission in a contaminant-free area. Re-pack all bearings and grease all gears. Do not pack the transmission housing with excessive grease; over-greasing could damage the tool and cause it to stall. Recommended grease: *Sunoco Sunaplex 992 EP* or equivalent.

6. REASSEMBLE TRANSMISSION. Refer to the appropriate transmission assembly drawing while reassembling the transmission. If needed, rotate the gears to aid in the assembly process. If the transmission does not rotate freely after re-assembly, then disassemble the transmission again to isolate and correct the cause.

7. RE-ASSEMBLE TOOL. If needed, rotate the output shaft to align the transmission planetary gears with the motor output shaft. If the transmission does not rotate freely after reassembling the tool, then disassemble the tool again to isolate and correct the cause.

8.3 Replacements

WARNING: DO NOT CONNECT OR DISCONNECT CABLES OR OTHER SYSTEM COMPONENTS WITH POWER APPLIED. FOLLOW LOCKOUT/TAGOUT AND OTHER APPLICABLE SAFETY PRECAUTIONS WHEN CONNECTING OR DISCONNECTING CABLING, WIRING, AND EQUIPMENT.

NOTE: When replacing the FUSION System Controller unit, ensure that the new unit is configured with the same Hardware and the same Firmware version as the unit being replaced. (Controller Unit displays the Firmware Version number when “WORK” 00 D-NO 01 is selected. Version will show in the Data Display. ie. 1.02)

8.3.1 Controller Unit Replacement (No Partial Replacement)

All tools operate from one model of Controller (HFC-EC-16). When one Controller unit is being replaced with another, it is important to verify that the new unit is set-up identical to the unit being removed.

1. Verify the controller power is off. Ensure all cables connected to the controller are clearly marked (for ease of reconnection).
2. Disconnect all cables from the rear (& front if applicable) of the unit. If wires are connected to the I/O terminal on the controller and to avoid removing all the I/O wires, you may simply disassemble the terminal block from the controller using the top and bottom screws holding the terminal block to the controller, and reassemble the terminal block to the new controller.
3. Turn the controller on the cover hinges 90 degrees and Lift up on the controller unit to remove.
4. Verify the new controller unit dip switches are set the same as the unit being replaced. Refer to Section 4.10.
5. Verify the SAN Units have the same configuration (hardware and software).
6. Install the new controller in reverse order of removal.
7. Apply power and confirm operation. (After approximately 5 seconds, the controller will finalize the Power On Self Test (POST)).

The new Controller will require reentry of the preset data. Refer to Chapters 6 and 7.

8.3.2 Replace Nutrunner (tool).

Do not attempt to replace a component of the tool - the tool must be replaced as a complete assembly. The tool type identification can be found on the identification tag affixed to the tool and on the System [TOOL TYPE] preset value.

WARNING: DO NOT CONNECT OR DISCONNECT CABLES OR OTHER SYSTEM COMPONENTS WITH POWER APPLIED.

1. Verify all System power is off.
2. Twist connector on the tool in the (CCW) direction and pull connector from tool.
3. Replace tool and plug in connector aligning the key in the connector to the keyway in the tool.
4. Twist connector in the (CW) direction to the fully locked position.
5. Power – up controller and confirm no ABN (abnormal) is displayed in the LED display. (Controller automatically checks that replacement tool is the same type)

8.3.3 Replace homerun cable

1. Verify all System power is off.
2. Disconnect the damaged cable(s) from the nutrunner tool and the Controller unit, and replace with the spare cable(s). (Align keyways on both ends and fully twist connectors into the locked position)

Note: Wave Washer (Part# WAV-25036) can be used to tighten the tool side twist lock connector if desired. The washer must be split and inserted by threading the washer underneath the twist lock rollers.

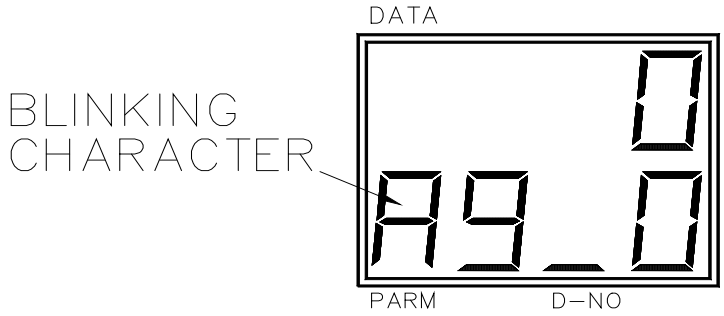
Chapter 9: Troubleshooting

9.1 Abnormal Conditions.

When an abnormal condition is detected by the system, the affected spindle stops, and lights "Abn" in the [DATA] display. For ease of troubleshooting the nature of the abnormal, the system provides an abnormal code in the [PARM] display and an abnormal sub-code in the [COUNT/D-NO] display.
Note: ABNORMALS are not to be confused with fastening REJECTS. Abnormal's signify a failure of a system process or self check during the fastening cycle.

- **Abnormal code display**.
  When an Abnormal condition occurs, the display mode will automatically change to the STATUS mode. (If the display is not in the STATUS mode, depress the MODE button until a blinking "A" appears in the [WORK] display area) A code number appears at the right side of the blinking character. This code refers to some specific type of failure detailed in the tables shown in the following sections.

- **Abnormal Sub-code display**.
  The number shown at the most right position in the [COUNT/D-NO] display area is a sub-code that can be used in conjunction with the Abnormal failure code to further narrow down the cause of the fault. See the following sections.



Example of Abnormal Code 9 Sub-Code 0

Abnormal Code Table

ABNORMAL CODE	DESCRIPTION
1	Torque Transducer Error.
2	Over Torque Error.
3	Tool EEPROM error.
4	System Memory Error.
5	Servo Amplifier Reply Error.
6	Servo Type Mismatch Error.
7	NOT USED
8	Servo Amplifier Error.
9	Parameter Error.

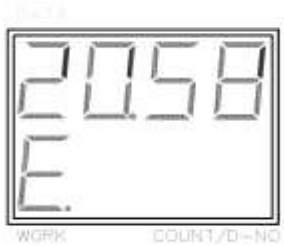
Abnormal sub-codes and specific actions for troubleshooting are detailed in the following section.

WARNING:DO NOT CONNECT OR DISCONNECT CABLES OR OTHER SYSTEM COMPONENTS WITH POWER APPLIED.

9.2 Torque Transducer Abnormals

Calibration Error

When the CAL switch is pressed on the Fusion front panel, "**E**" is shown if the FULL-SCALE preset value is missing or a wrong tool is connected.



RECOVERY:

1. Program correct Full Scale Preset value for the tool connected
2. Exchange tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
3. Replace the defective component.

9.2.1 Code 1-0 TORQUE TRANSDUCER / ZERO VOLTAGE ERROR

Zero level does not match master level read from tool EEPROM during power on initialization.
This abnormal is caused from;
1. When the tool transducer is sensing excessive torque due to pressure on the tool body.
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no signs of an external force being applied to it. (No heavy impact has occurred with the tool assembly)
2. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize.
3. Exchange tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
4. Replace the defective component.

9.2.2 Code 1-1 TORQUE TRANSDUCER / CAL VOLTAGE ERROR

Calibration voltage error during power on initialization.
This abnormal is caused from;
1. When the tool transducer is sensing excessive torque due to pressure on the tool body.
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no signs of an external force being applied to it. (No heavy impact has occurred with the tool assembly)
2. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize.
3. Exchange tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
4. Replace the defective component.

9.2.3 Code 1-2 TORQUE TRANSDUCER / ZERO CHECK ERROR

Zero level voltage loaded to memory from tool EEPROM during initialization does not match the actual zero level during a self check with the self check function DISABLED.

This abnormal is caused from;.
1. When the tool transducer is sensing excessive torque due to pressure or vibration during the fastening cycle start.
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it.
2. Verify the tool mounting bolts are tight and nothing is cause excessive vibration to the tool.
3. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and attempt again the fastening start input.
4. Exchange tool cable, tool and/or controller with known working units. Input the start signal after each exchange, and make note of any change in the location of the abnormal.
5. Replace the defective component.

9.2.4 Code 1-3 TORQUE TRANSDUCER / CAL SELF CHECK ERROR

Calibration level voltage error after a fastening start was attempted.

This abnormal is caused from;
1. When the tool transducer is sensing excessive torque due to pressure or vibration during the fastening cycle start.
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it.
2. Verify the tool mounting bolts are tight and nothing is cause excessive vibration to the tool.
3. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and attempt again a fastening start input.
4. Exchange tool cable, tool and/or controller with known working units. Input the start input after each exchange, and make note of any change in the location of the abnormal.
5. Replace the defective component.

9.2.5 Code 1-4 TORQUE TRANSDUCER /STARTED ON ZERO ERROR CONDITION

The start signal was input while a Zero voltage abnormal condition existed.
RECOVERY:
1. Interlock the PLC circuit to disable the start signal during an existing abnormal condition.
2. Follow the ZERO VOLTAGE ERROR abnormal help procedure.

9.2.6 Code 1-5 TORQUE TRANSDUCER / STARTED ON CAL ERROR CONDITION

The start signal was input while a Cal voltage abnormal condition existed.
RECOVERY:
1. Interlock the PLC circuit to disable the start signal during an existing abnormal condition.
2. Follow the CAL VOLTAGE ERROR abnormal help procedure.

9.2.7 Code 1-6 TORQUE TRANSDUCER / ZERO LEVEL SELF CHECK ERROR

Zero level voltage loaded to memory from tool EEPROM during initialization does not match the actual zero level during a self check with the self check function enabled.

This abnormal is caused from;
1. When the tool transducer is sensing excessive torque due to pressure on the tool body.
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it.
2. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize.
3. Exchange tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
4. Replace the defective component.

9.3 Torque Over Abnormals

9.3.1 Code 2-1 TORQUE OVER ABNORMAL / TORQUE INHIBIT HIGH LIMIT.

High torque was detected during the Torque Inhibit Function which was greater than the Torque Inhibit high limit parameter.

The cause of this abnormal is;
1. Torque Inhibit High Limit parameter set too low for application.
2. Initial starting torque is too high for size of tool. (If limit is set at full scale torque)
3. Excessive binding of output shaft or driver during Torque Inhibit.

RECOVERY:
1. Raise Torque Inhibit Limit.
2. Check that the tool has no external force applied to it.
3. Verify that torque required is not more than tool capability.
4. Verify that nothing is binding on the output shaft of the tool while it begins it's cycle.

9.3.2 Code 2-2 TORQUE OVER ABNORMAL / ANGLE HEAD TORQUE VARIATION.

High Torque irregularity over the set limit of (D-No. 88) was detected with the in the Angle Head of the tool.

The cause of this abnormal is;
1. Possible degradation of the Angle Head gears.
2. Initial starting torque is too high for size of tool. (If limit is set at full scale torque)
3. Excessive binding of output shaft or driver during Torque Inhibit.

RECOVERY:
1. Adjust Angle Head Variation limit (D-No.88) between 0-100
2. Replace tool with known good tool, if OK, the Angle Head of the tool removed may be experiencing wear of the internal gears.
3. Verify that torque required is not more than tool capability.
4. A highly fluctuating fastening joint may cause this limit to be reached – Adjust the limit in this case. (a joint fluctuating between hard and soft multiple times while fastening)

9.4 Tool EEPROM Errors

9.4.1 Code 3-0 PREAMPLIFIER / TOOL ID CHECKSUM ERROR

Communication data Checksum error between the Preamplifier and the CONTROLLER Unit. Data is not reliable due to data error.

This abnormal is caused from;
1. If the controller or the transducer cable is located in an electric or magnetic noise field.
2. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize the system.
2. Exchange Tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
3. Replace the defective component.

9.4.2 Code 3-1 PREAMPLIFIER / TOOL TYPE ERROR

The connected tool type does not match the tool type programmed into the controller. This error may occur in the multi- tool type application or when controllers are replaced and not reprogrammed with the correct configuration.

RECOVERY:
1. Verify the tool type name from the tool identification tag
2. Compare the tool tag name with the setup value located on Data Display (see 7.2.5)
3. Program proper tool number into CONTROLLER Unit or change tool to proper tool.

9.4.3 Code 3-2 STARTED WITHOUT TOOL CONNECTED

The start signal was applied while a TOOL IS NOT CONNECTED abnormal condition existed.
RECOVERY:
1. Interlock the PLC circuit to disable the start signal during an existing abnormal condition.
2. Follow the TOOL IS NOT CONNECTED (Code 3-3) abnormal help procedure.

9.4.4 Code 3-3 PREAMPLIFIER / TOOL IS NOT CONNECTED

Communications error between the tool preamplifier and the controller.

This abnormal is caused from;
1. The tool cable is not connected
2. If the controller or the transducer cable is located in an electric or magnetic noise field.
3. When the torque transducer, Tool cable or the controller malfunctions.

RECOVERY:
1. Verify that the tool cable is properly connected
2. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize the system.
3. Exchange Tool cable, tool and/or controller with known working units. Reinitialize the system after each exchange, and make note of any change in the location of the abnormal.
4. Replace the defective component.

9.5 System Memory Errors

9.5.1 Code 4-0 SYSTEM MEMORY ERROR / FLASH ROM WRITE ERROR

Communications error to internal CONTROLLER Flash ROM during WRITE attempt.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside CONTROLLER Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove CONTROLLER Unit and blow or shake out debris.
2. Replace and return unit to FEC for repair.

9.5.2 Code 4-1 SYSTEM MEMORY ERROR / FLASH ROM READ ERROR

Communications error to internal CONTROLLER Flash ROM during READ attempt.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside CONTROLLER Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove CONTROLLER Unit and blow or shake out debris.
2. Replace and return unit to FEC for repair.

9.5.3 Code 4-2 SYSTEM MEMORY ERROR / SERVO AMP FLASH ROM ERROR

Communications error to internal CONTROLLER Servo Amp flash ROM.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside CONTROLLER Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove CONTROLLER Unit and blow or shake out debris.
2. Replace and return unit to FEC for repair.

9.6 Servo Amplifier Response / Resolver

9.6.1 Code 5-0 SERVO AMPLIFIER REPLY ERROR / NO REPLY FROM RESOLVER

The controller is attempting to turn the motor, but is not receiving any signals back from the resolver to indicate that the tool is actually turning.

This abnormal is caused from;
1. The motor/resolver cable is damaged or not connected
2. When the resolver, motor, or the controller malfunctions.
3. If there is excessive binding in the fastener, transmission, or the spindle assembly keeping the motor from turning.

RECOVERY:
1. Verify that the motor cable is connected and not damaged.
2. Connect all spare tool cables to the existing tool.
3. Exchange tool and/or controller with known working units. Reinitialize the system after exchanges.
4. Inspect and correct any binding in the spindle assembly, transmission or fasteners.

9.7 Servo Type Error

9.7.1 Code 6-0 SERVO TYPE ERROR / SERVO TYPE MISMATCH

The CONTROLLER Unit model does not match the connected motor type.

1. Verify the servo type tag with the motor type tag.

Servo Amplifier Error

9.9.1 Code 8-1 SERVO AMPLIFIER ERROR / SERVO IS OVER HEATED

The CONTROLLER servo circuit has overheated.

This abnormal is caused from;
1. The controller servo drive circuit has failed.
2. If the environment temperature is more than 122 degrees Fahrenheit (50 degree centi-grade) without any air flow.
3. Source voltage is very close to the limit and the environment temperature is also close to the limit.

RECOVERY:
1. Replace the controller
2. Provide additional cooling to the enclosure.
3. Verify and correct the source voltage as required.

9.9.2 Code 8-4 SERVO AMPLIFIER ERROR / OVER CURRENT

The CONTROLLER servo circuit experienced a current overload.

This abnormal is caused from;
1. The controller servo drive circuit has failed.
2. If the environment temperature is more than 122 degrees Fahrenheit (50 degree centi-grade) without any air flow.
3. Source voltage is very close to the limit and the environment temperature is also close to the limit.
4. Maximum torque is being run or exceeded by the tool every cycle.
5. Speed may be too low or too high during torque speed.

RECOVERY:
1. Replace the controller
2. Verify proper cooling for the enclosure.
3. Verify and correct the source voltage as required.
4. Verify proper torque or work piece.
5. Adjust torque speed setting.

9.9.3 Code 8-5 SERVO AMPLIFIER ERROR / INTERNAL POWER SUPPLY.

The CONTROLLER servo power supply circuit is not working properly or the input voltage is above the maximum limit.

This abnormal is caused from;.
1. The controller internal power supply has failed
2. Source voltage is very close to the limit and the environment temperature is also close to the limit.
3. If the environment temperature is more than 122 degrees Fahrenheit (50 degree centi-grade) without any air flow.

RECOVERY:
1. Replace the controller
2. Provide additional cooling to the enclosure.
3. Verify and correct the source voltage as required.

9.9.4 Code 8-6 SERVO AMPLIFIER ERROR / INPUT VOLTAGE ABNORMAL

The CONTROLLER servo power supply circuit has detected improper input voltage either above or below the specified limits

This abnormal is caused from;
1. The controller internal power supply has failed
2. Source voltage is out of the limit and/or the environment temperature is also close to the limit.
3. One or more phases of input power is missing

RECOVERY:
1. Replace the controller
2. Provide additional cooling to the enclosure.
3. Verify and correct the source voltage as required.

9.9.5 Code 8-9 SERVO AMPLIFIER ERROR/ OVER SPEED.

The resolver signal received at the CONTROLLER indicates an over speed condition.

This abnormal is caused from;
1. The resolver cable or resolver has failed.

RECOVERY:
1. Check resolver using method in 8.2.2
2. Replace resolver cable to spare cable
3. Replace tool assembly.

9.9.6 Code 8-10 SERVO AMPLIFIER ERROR / OVER LOAD (I SQUARE T)

The duty cycle of the fastening application is too severe for this size of tool, or for the parameters currently setup.

RECOVERY:
1. Reduce duty cycle - Increase tool “downtime or off time” and/or increase torque speed to reduce the amount of time running at high torque/slow speed.
2. If the problem remains, a larger tool assembly may be required for this application. Please contact FEC.

9.9.7 Code 8-11 SERVO AMPLIFIER ERROR / RESOLVER SIGNAL ERROR.

The resolver signal received is not correct.

RECOVERY:
1. Check the cable; look for loose connectors for visible damages to the cable.
2. Replace with known good tool.

9.9.8 Code 8-14 SERVO AMPLIFIER ERROR / MOTOR CONTROL CIRCUIT ERROR.

An abnormality occurred in the Motor Control circuitry in the controller.

RECOVERY:
1. Check that the GROUND is connected on the controller supply power.
2. Internal tool or cable damage – Replace Cable, Replace Tool.
3. Cycle power to OFF (leave off for more than 10 seconds) and Turn on power

9.9.9 Code 8-15 SERVO AMPLIFIER ERROR / POWER ON ERROR.

The Controller power on was not completed successfully.

RECOVERY:
1. Turn off power, Wait 10 sec minimum and power back on.

9.10 Parameter Error

9.10.1 Code 9-0 PARAMETER ERROR / MISSING SPEED PRESET.

Some speed preset is not setup in the parameter number selected or the wrong parameter number has been selected by the PLC.

RECOVERY:
1. Verify that the parameter number that is being selected by the PLC is configured in the controller.
2. Check that the reverse speed preset is not <0> or out of the specified speed range of the tool.

9.10.2 Code 9-1 PARAMETER ERROR / MISSING TIME or SPEED PRESET

Some Time or Speed preset is not setup in the parameter number selected or the wrong parameter number has been selected by the PLC.

RECOVERY:
1. Verify that the parameter number that is being selected by the PLC is configured in the controller.
2. Check that the reverse speed preset is not <0> or out of the specified speed range of the tool.

9.10.3 Code 9-2 PARAMETER ERROR / PARAMETER SELECT ERROR

The parameter selected was empty.
RECOVERY:
1. Verify that the parameter number that is being selected by the PLC is configured in the controller.
2. Check that the fastening presets are not <0> or out of the specified range for the tool.

9.10.4 Code 9-3 PARAMETER ERROR / MISSING REVERSE SPEED

The Reverse speed preset is missing.
RECOVERY:
1. Verify that the parameter number that is being selected by the PLC is configured in the controller.
2. Check that the reverse presets are not <0> or out of the specified range for the tool.

9.10.5 Code 9-4 PARAMETER ERROR / TORQUE SPEED NOT SET

The Torque speed preset is missing.
RECOVERY:
1. Verify that the parameter number that is being selected by the PLC is configured in the controller.
2. Check that the Torque speed is not set as <0> or out of the specified range for the tool.

9.10.6 Code 9-5 PARAMETER ERROR / TORQUE SETUP ERROR

One of the Torque presets is out of range

RECOVERY:
1. Verify that the Torque presets are in range for the tool size.
2. Check that the torque presets are not <0> or setup as specified in 6.1.1.

9.10.7 Code 9-6 PARAMETER ERROR / ANGLE SETUP ERROR

One of the Angle presets is out of range

RECOVERY:
1. Verify that the Angle presets are in range for the tool size.
2. Check that the Angle presets are not <0> or setup as specified in 6.1.2.

9.10.8 Code 9-7 PARAMETER ERROR / REVERSE TORQUE OVER.

The Reverse torque is more than 1.5 times the Full Scale Torque.

RECOVERY:
1. Verify that the preset value is correct.
2. If the value is correct, check the application. The size of the tool is not adequate for this application or the fastener being reversed may be over-torqued.

9.11 FUSION CONTROLLER Unit Fastening Faults and Causes

9.11.1 Torque Accept Conditions

The Accept LED will light for the following reasons:

1. The previous fastening was completed within all preset limits (TORQUE, ANGLE, 1st RATE, 2nd RATE, and TIME).

9.11.2 Torque Reject Conditions

The Reject LED will light for the following reasons:

1. The final fastening torque is not between the low and high Torque limits, low and high angle limits, low and high rate 1, 2 and 3 or the time 1 or final time limits set in the parameter presets.