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ELECTRIC SERVO NUTRUNNER

AFC1500 MULTI SYSTEM

SAN UNIT OPERATION MANUAL

Stand-Alone & MULTI Type

Original Models – SAN2-12M／SAN2-24M／SAN2-40M／SAN2-80M／SAN2-120M

Updated Models – SAN3-24M／SAN3-40M／SAN3-120TM／SAN3-120WM

SAN3-24HM/SAN3-60HM



Sixth Edition **October 2009**

AUTOMATION SYSTEMS
Certified ISO 9001:2000

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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) 781-2100, faxed to (586) 781-0044 or emailed to support@fec-usa.com.

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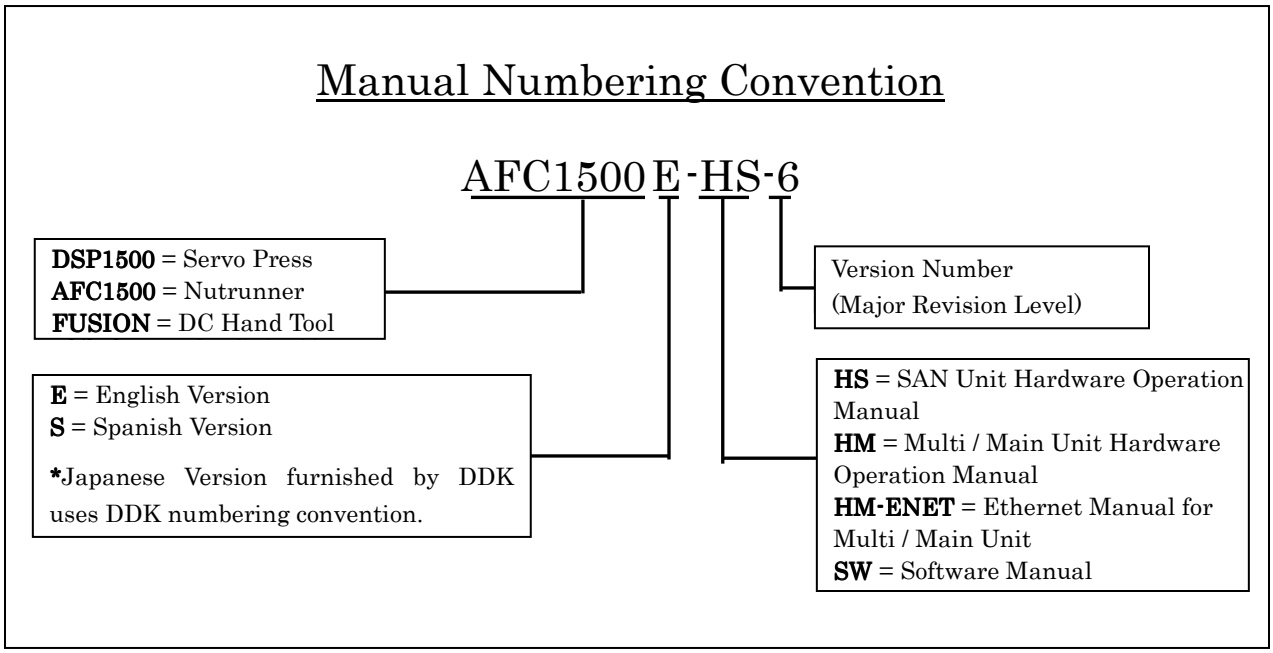
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Revision History

Revision date	Manual No.	Content of revision
1998/01/12	First Edition	Original Manual
2002/01/12	Second Edition	First update
2003/01/03	Second Edition	Corrections to First Update (internally referred to as 3rd edition)
2007/01/30	AFC1500E-HS-4	First major revision. Combination of SAN2 and SAN3 Servo Drive into a single Manual. Combination of Stand-Alone and Multi Unit operation into a single Manual.
2008/02/19	AFC1500E-HS-5	Updated for SAN3-24HM & SAN3-60HM models (High Speed motors) Updated power consumption specifications
2009/10/30	AFC1500E-HS-6	Updated for SAN3-DP1 &DP2 (including RTC setup for this) Updated for special Dual Transducer setup Various text, notes & edits



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Introduction

Thank you for purchasing our **Electric Servo Nutrunner - AFC1500 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 machine.
- 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.

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Warranty

Warranty Period

FEC Inc. warrants that the equipment manufactured by it and delivered hereunder will be free of defects in material and workmanship for a period of twelve (12) months from the date of placing the equipment in operation, or eighteen (18) months from the date of shipment, or 500,000 machine cycles - whichever shall first occur.

Provision of warranty

Should any failure to conform to this warranty be reported in writing to the company within said period, the company shall at its option, correct such nonconformity by suitable repair to such equipment or furnish a replacement part from FEC or an FEC approved facility, provided the purchaser has stored, installed, maintained and operated such equipment in accordance with good industry practices and has complied with specific requirements & recommendations of the company. Accessories or equipment furnished by the company shall not be liable for any repairs, replacements or adjustments to the equipment or any costs of labor performed by the purchaser or others without the company's prior written approval.

The effects of corrosion, erosion and normal wear and tear are specifically excluded from the company's warranty. Performance warranties are limited to those specifically stated within the company's proposal. Unless responsibility for meeting such performance warranties are limited to specified shop or field tests, the company's obligation shall be to correct in the manner and for a period of time provided above.

THE COMPANY MAKES NO OTHER WARRANTY OR REPRESENTATION OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES, INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE HEREBY DISCLAIMED.

Correction by the company of nonconformity's, whether patent or latent in the manner and for the period of time provided above, shall constitute fulfillment of all liabilities of the company for such nonconformity's, whether based on contract, warranty negligence, indemnity, strict liability or otherwise with respect to, or arising out of such equipment.

The following are defined as non-warranty situations that are outside the scope of warranty provided;

- Product is out of the warranty period as determined by FEC serial number tracking.
- Any cause external to the equipment, including but not limited to any act of God, lighting or power surges, abuse, negligence, accident or failure to maintain the proper operating environment.
- Use of equipment or adjustments or devices not approved by the manufacturer and FEC.
- Cosmetic damage to unit or any of the parts
- Consumable parts - for example; sockets, rest/wear pads, bushings, etc.
- Physical damage (example - damage caused by dropping, cut cables, etc.)
- Field Service required on a Warranty Part - FEC warranty covers the parts and labor only onsite at FEC.

Extended warranties are available as an addition to the standard warranty period outlined above - for all FEC Inc. systems. Please contact FEC if you are interested in an extended warranty.

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ety 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.

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

Caution — **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 **Caution** 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

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ety Precautions



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.



Conduct type-3 grounding of FG terminals.
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.



Install an emergency stop circuit on the outside of equipment in order to stop operation promptly. Failure to observe this instruction 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.

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ety Precautions

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℃～+55℃ (Avoid freezing)
- ◆Ambient humidity: 50% RH or lower (Avoid moisture)
- ◆Package: Tight seal
- ◆Rust prevention measure: Apply grease or oil on tools.

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

Do not hold cables and output spindles when transporting the tools.
Failure to observe this instruction may cause injury and malfunction.

Do not hold the indictor on the front panel when transporting the AXIS Unit.
The indicator may come off and drop from the front panel.
Failure to observe this instruction may cause injury and malfunction.

The equipment shall be stored under the following conditions.
- ◆Ambient temperature: -5℃～+55℃ (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 earth leakage and malfunction.

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ety Precautions



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



Install the AXIS Unit firmly inside the control panel using the specified screws.
Failure to observe this instruction may cause malfunction.



Use the specified tool for the AXIS (SAN) Unit.
Failure to observe this instruction may cause fire and malfunction.



The AXIS (SAN) Unit shall maintain the specified distance from other devices.
Failure to observe this instruction may cause fire and malfunction.



Do not block the ventilation hole of the AXIS (SAN) Unit.
Avoid any foreign body from entering inside the equipment.
Failure to observe this instruction may cause fire and 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 AXIS (SAN) Units that are damaged or missing parts.
Failure to observe this instruction may cause fire, injury, and malfunction.



Do not get on the top of equipment or do not place heavy objects on the top of equipment.
Failure to observe this instruction may cause injury, and malfunction.



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



Conduct wirings 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.

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on



Never operate the equipment with wet hands.
Failure to observe this instruction may cause electric shock.



Keep fingers away from the AXIS (SAN) Unit radiating fin and tool motors while the equipment is turned ON or for a while after the equipment is turned OFF. These parts may become very hot. Failure to observe this instruction may cause burns.



Use the equipment under the following conditions.

- ◆Ambient temperature: 0℃～+45℃ (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 earth leakage 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.



Never conduct extreme adjustments or setting changes that may cause instability of operation.
Failure to observe this instruction may cause injury, false operation and malfunction.



The equipment may restart suddenly when the equipment is reset with the start signal ON.
Always ensure that the start signal is OFF before resetting the equipment.
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

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1.1 About This operations manual

This manual details the configuration, components, specifications, and the operation of the AFC1500 Fastening System.

The following table outlines the contents of each chapter:

Chapter	Item	Contents
Chapter 1	Outline	Basic characteristics and requirements of the AFC1500 System.
Chapter 2	Specifications	General specifications of the AFC1500 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.
Appendix A	Reference Drawings	Electrical reference drawings of standard cables and connections.

Related Instruction Manuals

AFC1500 Multi Unit Manual
AFC1500 Multi-2 Manual
AFC User Console Manual

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1.2 Features

The AFC1500 Fastening System is a culmination of over thirty years of electric fastening expertise integrated with the latest electronic technology. The system is designed with modular construction in mind. Configuration can be as simple as a single spindle controlled from a PLC, or a group of up to 31 spindles controlled from one main controller, the Multi Unit. The Multi Unit can be added to any spindle(s) to perform the function of Sequencing, I/O Control, and Data Reporting for the spindles connected to it. This drastically reduces the number of I/O required and simplifies PLC logic.

The basic elements of this system are:

1) A brushless, Resolver Based permanent magnet motor
2) Durable Planetary Gear Transmission
3) Reliable intelligent torque Transducer
2) A combination Fastening Controller / Digital Servo Amplifier (SAN unit)

- **Compact Design**

As the result of miniaturization circuit technology, the compact SAN units (Controller) maintain a maximum width as little as 60 mm in spite of the built-in power source and Servo Amplifier. System components are Back Panel mounted.

- **Detachable Front Keypad-Display.**

A Hot Swap-able front keypad display is available as an optional component for programming single units and/or monitoring the fastening results and status conditions in the system. The system can operate without the display.

- **Multiple Condition Display**

The system features a set of LED's that light to indicate the status of the System.

- **Parameter Selection**

Totally digitized system eliminates analog potentiometers.

Up to 16 different sets of parameters can be stored into Flash ROM for each spindle.

No battery-backup of memory is required.

- **Available AFC User Console Programming Software**

The AFC User Console Software incorporates the user interface as an integral part of the total system configuration. Nutrunner programming and data collection can be performed via the user-friendly AFC software. Functions such as Preset Parameter programming, Fastening data monitoring and Fastening data analysis can be performed on multiple connected spindles using this software.

With the addition of a Multi Unit main controller, Fastening Sequencing and Fastening data output can be programmed and controlled from the Single (Multi Unit) connection point. Typically this software is installed in an industrial computer touch screen integrated into the system, but can also be utilized through a detachable PC.

- **Communication Interface**

For Stand-Alone operation external communication is available through an integrated RS-485 port or via an optional Keypad Display (DP2 or DP4). The DP2 and DP4 units provide individual spindle RS232 ASCII data output. Additional Communication options are available when configured with the AFC1500 Multi Unit (Refer to related instruction manuals).

- **Motor**

A permanent magnet 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.

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- **Data Storage**

Each SAN3 unit stores approximately the last 12,300 fastening results in memory as well as the last 256 Abnormal conditions. (SAN2 units DO NOT support data storage). Data is erased as a result of FIFO (First In First Out) or via the AFC user console. Date stamping of data does not take place in the Stand alone SAN units unless new SAN-DP1 display is connected (DP1 which supports the clock function) or when stored data is collected via a Multi Unit configured system. The data list that is stored in a Stand-alone SAN3 –xxx unit is as follows;

1. Cycle Count
2. Date (only with new SAN-DP1 display connected)
3. Time (only with new SAN-DP1 display connected)
4. Fastening Method
5. Fastening Steps
6. Judgment
7. Parameter Number
8. Peak Torque
9. Final Torque
10. Final Angle
11. Cycle Time
12. 1st Rate
13. 2nd Rate
14. 3rd Rate
15. Snug Torque

- **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.

- **Servo Amplifier (Servo Drive)**

Reduced equipment size with improved drive circuit strength is the result of incorporating Insulated Gate Bipolar Transistor (IGBT) technology into the drive System. SAN units are available in several models. The Servo Amplifier housed in each SAN unit determines the model type. The Servo Amplifier also dictates the nutrunner (tool) models that can be supported by the SAN unit.

- **Plug-In Firmware Update System**

The SAN 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 and Resolver Combined Cable**

A combined motor and resolver cable reduces the number of cables in the system. The torque signal cable is separate for better torque signal management.

- **Multi Unit Connectivity**

A main controller or Multi Unit can be connected to a single spindle or group of up to 31 spindles to control all spindle(s) from a single point of I/O. The Multi Unit assumes all fastening sequencing, fastening data monitoring / analysis and all data communication. Without the use of the Multi Unit, individual spindle sequencing is limited to basic multi step operations.

- **Network Connectivity**

Connection to an Ethernet network can be accomplished via the addition of the Multi Unit. For specific capabilities related to Ethernet protocols, please contact FEC Inc.

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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
- Current (Amp) Torque Control (NRT – Transducerless tools only)
- Current (Amp) Angle Control (NRT - Transducerless tools only)

The SAN unit used as a standalone unit (without the Multi Unit) has capability for one, two & three step fastening. With the addition of the Multi Unit, one - three step fastening is possible and may be repeated (using the sequence function) over multiple steps allowing for a multitude of fastening sequence possibilities.

As stand alone units, SAN Units can perform synchronized fastenings using the SYNC I/O signals, which controls the simultaneous synchronization of all spindles. Thus, each spindle stops and waits when they reach the previously defined step value. When all connected spindles have reached the same step value, they will simultaneously start again and rundown to the next step value. When configured with a Multi Unit, spindle synchronization is a standard function in the fastening sequence set-up.

Note: With the use of a Multi Unit, fastening steps may be performed repeatedly in up to 99 fastening steps in the fastening sequence.

Torque rate monitoring is available in any configuration.

- **Self-Check Disable Function**

The Self Check can be disabled by an external PLC signal. If the self check signal is "high" (inactive) before the cycle starts, the check is done automatically. The zero voltage level of the torque transducer and the CAL voltage levels are verified to within +/- 4%. When the torque transducer's automatic check is not required, this function can be disabled by activating the SELF CHECK signal before the cycle starts. The fastening cycle will then be performed without the self check.

- **Reject / Abnormal Condition Display**

When a fastening Reject has occurred, the tool stops, outputs the appropriate signal and displays the resultant data in the Detachable Keypad-Display unit if it is connected. 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 affected Axis unit. Refer to Chapter 9 Troubleshooting for more details. Correction of the abnormal cause and 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 or when the RUN/BYPASS switch on the front panel is switched to the Bypass position, the Bypass output signal is activated. In this condition, the spindle will not START, REVERSE, CAL OR RESET. The SYNC signal will be bypassed to avoid affecting synchronized operations. When the Axis unit is in the bypass mode, the "Bypass" LED on the front panel of the Axis unit will blink. When configured with a Multi Unit, the bypassed spindle is ignored as if it doesn't exist in the multiple spindle configurations.

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- **Tool Type Check Function**

The AFC1500 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 Axis (SAN) 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.
3) When a tool is changed

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1.4 System requirements

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

- **Tool Installation**

Tools generate a great amount of torque during operation, and the reaction force is applied to the mounting area of the tool. Therefore, tools must be installed in the proper positions and with adequate bolts. Use the supplied bolts to prevent the tool from loosening due to vibration. A minimum of 2mm of clearance is required between tools, with nothing touching a mounted tool that will impact free movement for torque reaction (or improper torque readings will result). The tool assembly contains precision parts and electronic components, and must not be subject to excessive shocks or stresses.

Keep in mind that the torque transducer is a strain gage based instrument and, although it has been designed to withstand sudden shock, repeated shock (over time) could damage the transducer. Therefore, cylinder cushions or shock absorbers should be used to decelerate spindle slides and prevent excessive (hard stop) vibration, particularly in short cycle time applications operating at high speeds.

- **Fastening Operation**

Avoid fastening beyond the full scale torque. Do not use a duty cycle (the ratio of the tool rotating time to the machine cycle time) higher than 60%, even when the torque is below the full scale value.

- **Cable Wiring**
  - Use the specified cables for all System connections.
  - Circuit breakers or fuses are required on branch circuit power feeds to the controllers.
  - Do not use a high voltage circuit as a frame ground (FG). Also, the frame ground should be separate from the power ground.
  - When multiple Axis units are used, ensure that each unit is connected to its matching numbered tool, and that all connectors are locked.
  - PLC I/O cables must be run separate from any high voltage power sources or cabling, and must not exceed 50 feet in length.

- **Control Equipment (Axis units) Installation Environment**
  - Controllers should be located in a NEMA 12 enclosure.
  - 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 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.

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- **Static Electricity**

AFC1500 System construction incorporates many 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 an Axis 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 AFC1500 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 AFC1500 System components must be individually packaged in an approved anti-static container or wrap to prevent damage from electrostatic discharge.
- Tighten mounting screws on all back panel mounted fastening controllers.
- Tool assemblies not vertically mounted must be removed from the powerhead during shipment to prevent damage to the transducer assembly.
- Enclosures must be protected with shrink wrap.
- Enclosures and System components should be shipped on an air ride trailer whenever possible.
- All non-painted metal parts (except for the tool motor and connectors) must be greased or oiled to prevent rust.
- Adhere to Chapter 2 Specifications for environmental requirements.

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Chapter 2: Specifications

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2.1 Main Specifications

♦ **Power Supply Voltage**

- 180~242 VAC, 3-Phase, 50/60 Hz

♦ **Operating Power Requirements**

- See section 2.3 - SAN Unit Specifications

♦ **Installation Requirement**

- NEMA 12 enclosure (minimum).

♦ **Range of Operation**

- Duty cycle below 60% (reference Section 2.2 Duty Cycle Calculation)
- Additional specifications will be provided for nutrunners greater than 50 Kgm.

♦ **Operating Conditions** (may be met by incorporating an Air Handling Unit into System)

- Temperature: 0° ~ 50°C (32° ~ 122°F) Humidity: 20% ~ 90%, no moisture

♦ **Motor Max. Operating Case Temperature**

- Temperature: 70°C (158°F)

♦ **Storage Conditions**

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

♦ **Shipping Conditions**

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

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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 AFC1500 System is calculated as follows:

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

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

Duty cycle ratings vary between tools. As a general rule, however, it should not exceed 60%. 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.

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2.3 SAN Unit Specifications

ORIGINAL SAN UNIT TYPE	SAN2 - 12	SAN2 - 24	SAN2 - 40	SAN2 - 80	SAN2 – 120
TOOL MOTOR TYPE	RM1	RM2	RM3	RM4	RM5
TOOL MAX. TORQUE	4.0 Kgfm (39Nm)	4.0 Kgfm (39Nm)	30.0 Kgfm (294Nm)	80.0 Kgfm (784Nm)	500 Kgfm (4093Nm)
MOTOR MAX. POWER	60W	80W	200W	1500W	3000W
MOTOR RATED CURRENT	1A (RMS)	2A (RMS)	3A (RMS)	11A (RMS)	21A (RMS)
SAN INPUT POWER	180-242VAC 50/60Hz				
SAN IDLE POWER CONSUMPTION (watt/hour)	18wh IDLE				
SAN AVERAGE POWER CONSUMPTION (watt/hour)*	25wh		43wh	95wh	134wh
SAN MAX. MOMENTARY CURRENT (Inrush)	9.5A	18A	38.6A	79.2A	116.2A
SAN UNIT OUTPUT POWER	270-300VAC PWM				

UPDATED SAN UNIT TYPE	SAN3 - 24		SAN3 – 24HM	SAN3 - 40	SAN3 – 60HM	SAN3 – 120TM	SAN3 – 120WM
TOOL MOTOR TYPE	RM1	RM2	RH1	RM3	RH3	RM4	RM5
TOOL MAX. TORQUE	4.0 Kgfm (39Nm)			30.0 Kgfm (294Nm)	(200Nm)	80.0 Kgfm (784Nm)	500 Kgfm (4093Nm)
MOTOR MAX. POWER	60W	80W	70W	200W		1500W	3000W
MOTOR RATED CURRENT	1A (RMS)	2A (RMS)	2A (RMS)	3A (RMS)	6A (RMS)	11A (RMS)	21A (RMS)
SAN INPUT POWER	180-242VAC 50/60Hz						
SAN IDLE POWER CONSUMPTION (watt/hour)	18wh IDLE						
SAN AVERAGE POWER CONSUMPTION (watt/hour)*	25wh			43wh	112wh	95wh	134wh
SAN MAX. MOMENTARY CURRENT (Inrush)	9.5A	18A	19A	38.6A	53.7A	79.2A	116.2A
SAN UNIT OUTPUT POWER	270-300VAC PWM						

*Watt hours measured using the SAN unit at 60% duty/95% torque capacity

CAUTION: If the equipment is powered on and off repeatedly, internal circuit protection devices may trip due to high in-rush current overload. 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 Method:** Torque, Angle and Current Control Method
- **Torque Rate Calculation:** **3** ranges
- **Data Communications:** (2) - RS485 communication ports: (1) for AFC User Console Software and (1) for Multi Unit Communications

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2.4 Capability

- **Fastening Accuracy (Torque):**
  From 1/4 to 1/2 full scale torque: 3 sigma scatter less than 4% of target torque.
  From 1/2 to full scale torque: 3 sigma scatter less than 3% of target torque.
- **Torque resolution:** Full Scale Torque x 1/1000.
- **Torque Display Resolution:** 4-digit display with floating decimal point (In detachable display unit)
- **Angle Resolution**: 1024 pulses per motor rev.
- **Angle Display Resolution:** 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).

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2.4.1 Nutrunner Tool Specification Table

TOOL TYPE	ORIGINAL SERVO TYPE	UPDATED SERVO TYPE	FULL SCALE TORQUE					GEAR RATIO	SPEED RPM	
			NM	KGM	KGCM	FTLB	INLB		MAX	MIN
NFT-051RM1(A) –S1	SAN2-12	SAN3-24	4.9	0.5	50	3.6	43	19.8 :1	500	1
NFT-051RM1(A) -S	SAN2-12	SAN3-24	4.9	0.5	50	3.6	43	9 :1	1,100	2
NFT-101RM1(A) –S/O	SAN2-12	SAN3-24	9.8	1.0	100	7.2	86	9 :1	1,100	2
NFT-201RM1(A) –S/O	SAN2-12	SAN3-24	19.6	2.0	200	14.4	173	19.8 :1	500	1
NFT-211RH1(x)-S	N/A	SAN3-24H	20.6	2.1	210	15.2	182	-	1220	1
NFT-301RM2(A) –S/O	SAN2-24	SAN3-24	29.4	3.0	300	21.7	260	19.8 :1	600	1
NFT-311RH1(x)-S	N/A	SAN3-24H	30.4	3.1	310	22.4	269	-	855	1
NFT-401RM1(A) –S/O	SAN2-12	SAN3-24	39.2	4.0	400	28.8	346	39.6 :1	250	1
NFT-411RH1(x)-S	N/A	SAN3-24H	40.2	4.1	410	29.6	356	-	635	1
NFT-401RM3(A) –S/O	SAN2-40	SAN3-40	39.2	4.0	400	28.8	346	12.6 : 1	790	1
NFT-601RM3(A) –S/O	SAN2-40	SAN3-40	59	6.0	600	43	520	12.6 : 1	790	1
NFT-801RM3(A) –S/O	SAN2-40	SAN3-40	78.4	8.0	800	57.6	693	19.8 :1	500	1
NFT-801RH3(x)-S	N/A	SAN3-60H	78.4	8.0	800	57.6	693	-	1000	1
NFT-132RM3(A) –S/O	SAN2-40	SAN3-40	127.4	13.0	1,300	94.0	1,127	25.2 :1	395	1
NFT-132RH3(x)-	N/A	SAN3-60H	127.4	13.0	1,300	94.0	1,127	-	580	1
NFT-152RM3(A) –S/O	SAN2-40	SAN3-40	147	15.0	1,500	108	1,301	31.5 : 1	317	1
NFT-202RM3(A) –S/O	SAN2-40	SAN3-40	196.0	20.0	2,000	144.0	1,734	45.0 :1	220	1
NFT-202RH3(x)-S	N/A	SAN3-60H	196.0	20.0	2,000	144.0	1,734	-	408	1
NFT-302RM3(A) –S/O	SAN2-40	SAN3-40	294	30.0	3,000	226	2,716	64.8 : 1	150	1
NFT-502RM4(A) –S/O	SAN2-80	SAN3-120TM	490	50	5,000	361	4,337	66.6 : 1	155	1
NFT-802RM4(A) –S/O	SAN2-80	SAN3-120TM	785	80	8,000	578	6,938	40:1	100	1
NFT-103RM5 –S	SAN2-120	SAN3-120WM	981	100	10,000	723	8,680	65:1	60	1
NFT-203RM5-S	SAN2-120	SAN3-120WM	1961	200	20,000	1445	17,343	65:1	60	1
NFT-303RM5-S	SAN2-120	SAN3-120WM	2942	300	30,000	2168	26,019	101:1	25	1

CONVERSION GUIDE: 1 KGM = 100 KGCM = 9.8 NM = 7.2 FTLB = 86.7 INLB

Tool Assembly Model Number Breakdown

Example: NFT-801RM3A-S

NFT: AFC1500 Series Tool

801: 8.0 Kgm tool capacity (last digit indicates decimal position from left)

RM3: Resolver Motor (Model 3) RHx = High Speed Resolver Model

A: "A" motor has bulkhead connector, " " (blank) is pigtail style connection
"A" on an RHx(A) motor - cable exits towards end of tool
"B" on an RHx(B) motor - cable exits towards Square Drive

S: S = Straight, O = Offset, SU = "U" style, S1 = Straight Special, A = Angled Head

(Straight, Offset and "U" style tools have the same operational characteristics but are physically configured to accommodate different space restrictions)
(Special and Angled Head tools have differing operational Characteristics / Capabilities than Standard tools – Please contact FEC for specifications for these types of tools)

The tool lists located throughout this manual identify the specifications for standard tools used with the AFC1500 System. Additional tools up to 5000Nm are available. If additional capacity, information or special needs are required, please contact FEC INC.

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2.4.2 Nutrunner 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
NFT-051RM1-x	2	3	1	3	1	3	3	3	3	3
NFT-101RM1-x	2	3	1	3	1	3	3	3	3	3
NFT-201RM1-x	2	2	0	2	1	3	3	2	3	2
NFT-211RH1x-S	2	2	0	2	1	3	3	2	3	2
NFT-301RM2-x	2	2	0	2	1	3	3	2	3	2
NFT-311RH1x-S	2	2	0	2	1	3	3	2	3	2
NFT-401RM1/2-x	1	2	0	2	0	3	3	2	3	2
NFT411RH1x-S	1	2	0	2	0	3	3	2	3	2
NFT-601RM3-x	1	2	0	2	0	3	3	2	3	2
NFT-801RM3-x	1	2	0	2	0	2	3	1	2	1
NFT-801RH3x-S	1	2	0	2	0	2	3	1	2	1
NFT-132RM3-x	1	2	0	1	0	2	3	1	2	1
NFT-132RH3x-S	1	2	0	1	0	2	3	1	2	1
NFT-152RM3-x	1	2	0	1	0	2	3	1	2	1
NFT-202RM3-x	1	2	0	1	0	2	3	1	2	1
NFT-202RH3x-S	1	2	0	1	0	2	3	1	2	1
NFT-302RM3-x	1	2	0	1	0	2	3	1	2	1
NFT-502RM4-x	1	2	0	1	0	2	3	1	2	1
NFT-802RM4-x	1	2	0	1	0	1	2	0	1	0
NFT-103RM5-S	0	1	0	0	0	1	2	0	1	0

Example: NFT-201RM1-S Torque Display = 19.**00** NM (2 positions)
Torque Rate Display = 1.**999** NM/degree (3 positions)

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Chapter 3: System Description

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3.1 System Block Diagram

3.1.1 Multi System Block Diagram Description

♦ Spindles can be configured as stand alone units (with independent I/O) or combined in a multiple spindle configuration controlled by one main controller (Multi Unit) using one set of I/O to control the group of spindles. This configuration is referred to as a “Multi System”.

♦ In a Multi System, communication and spindle control for up to 31 SAN Units (Spindle Controllers) is accomplished through the Multi Unit via an RS485 Daisy chain connection on the front of each Axis unit.

♦ Spindle programming / monitoring is accomplished through either a detachable Laptop PC or an embedded HMI PC, running the AFC User Console software package, for simultaneous uploading / downloading of up to 31 spindles.

♦ A “Hot -Swap” detachable keypad/display can be used on each SAN Unit to monitor the individual spindle status.

♦ The use of a Multi Unit provides one set of PLC I/O for controlling multiple spindle fastening operations. Fieldbus interfaces are available for direct connection to networks such as Profibus, DeviceNet, AB Remote I/O, CCLink, Ethernet I/P, etc.

♦ Discrete 24 VDC (Sinking) I/O on the SAN unit provides direct communications with the PLC for limited individual spindle control when the system is configured with a Multi Unit. The individual spindle I/O can provide individual spindle status when required.

♦ Dedicated communications with the system is provided via communications ports available directly on the Multi Unit. Once configured, the system is not dependent on a PC or software package to receive or transmit data from/to an external device.

♦ A detachable or embedded PC running the AFC User Console software can be connected to the Multi Unit for increased data communications or manipulation capabilities.

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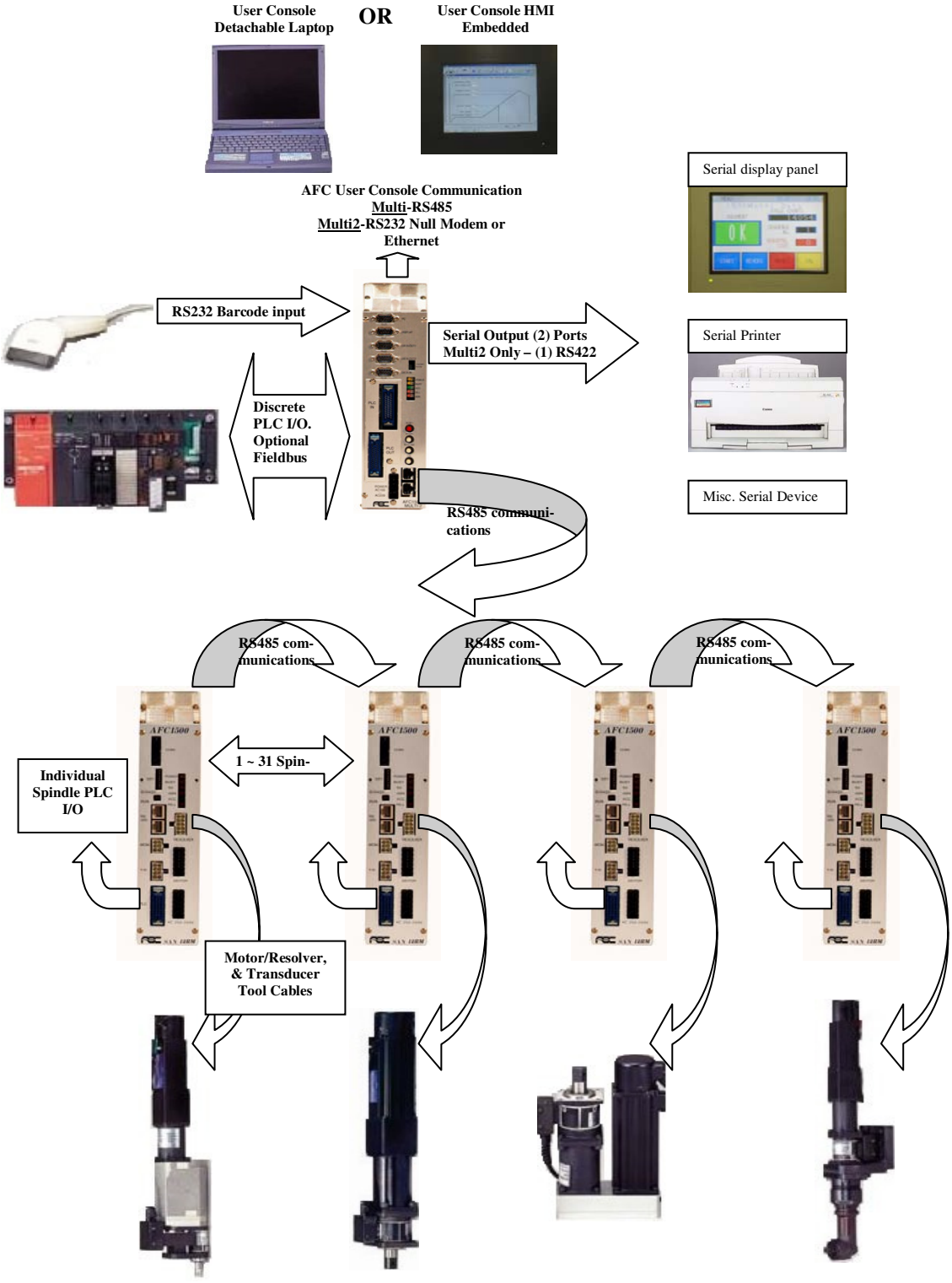


FIG. 3-1-1 AFC1500 Block Diagram with Multi Unit connection

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3.1.2 Stand Alone System Block Diagram Description

♦ Spindles can be combined in a multiple spindle configuration controlled by one main controller (Multi Unit) using one set of I/O to control the group of spindles. When communications requirements, spindle sequencing requirements or spindle quantities are limited, a simpler configuration without a Multi Unit can be set up. This configuration is referred to as a "Stand Alone" system.

♦ In a Stand Alone System, simultaneous communication for up to 31 SAN Units (Spindle Controllers) can only be accomplished via an RS485 Daisy chain connection on the front of each Axis unit. The AFC User Console software must be used in conjunction with a PC to collect and manipulate data from multiple spindles.

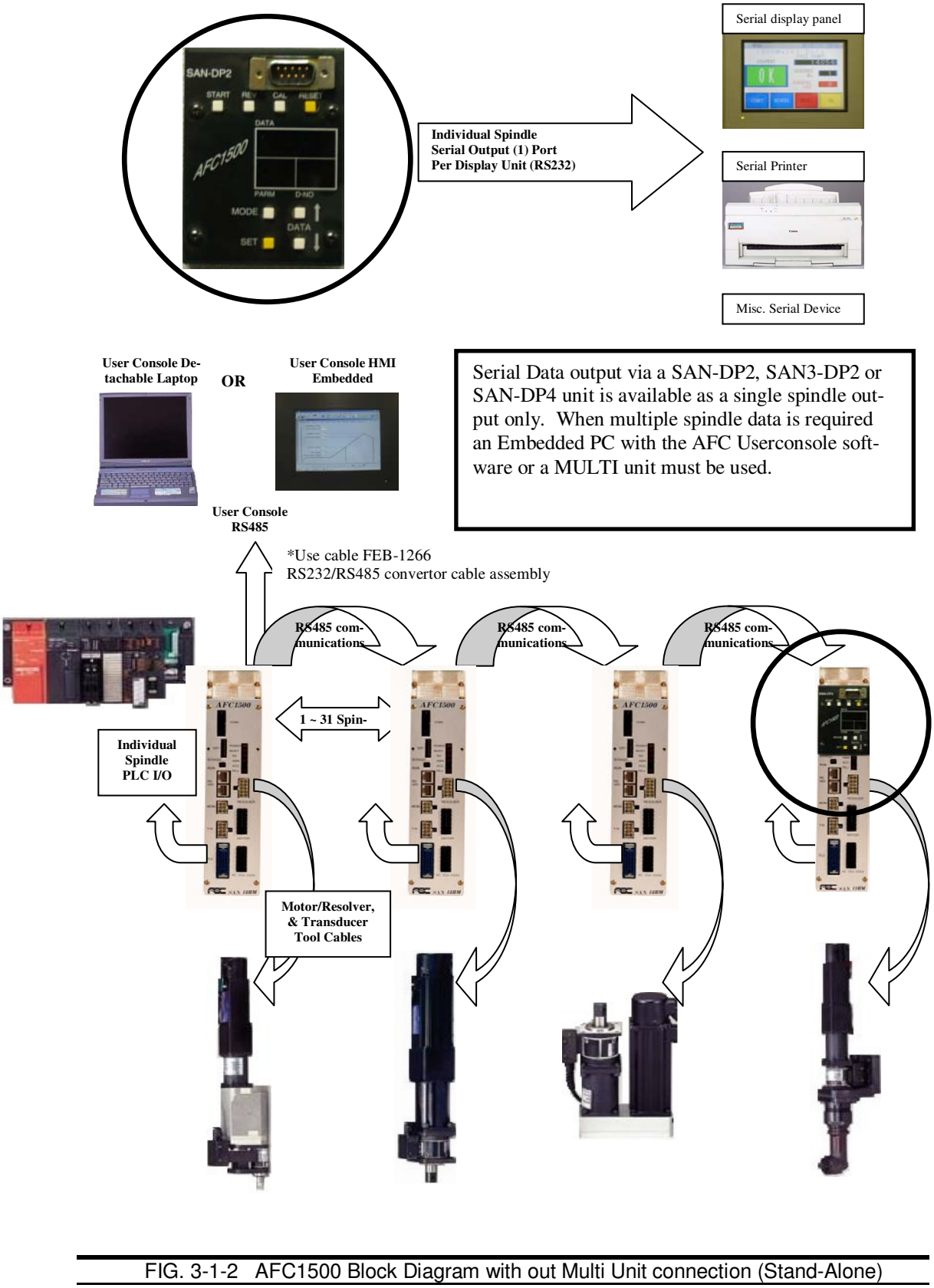
♦ Additionally, a "Hot -Swap" detachable Keypad/Display can be used on each SAN Unit to program and monitor the individual spindles.

♦ Discrete 24 VDC (Sinking) I/O on the SAN unit provides direct connection with the PLC for complete individual spindle control when the system is configured as a Stand Alone System. The spindle I/O for each SAN unit must be individually controlled and monitored

♦ Dedicated serial communications with each SAN unit can be provided via an individual communications port available directly on the optional Keypad/Display Unit (DP2, DP4) that can be connected to a single SAN unit. Once configured, the system is not dependent on a PC or software package to transmit data to an external device.

♦ A detachable or dedicated PC running the AFC User Console software can be connected to the multiple spindles in a Stand Alone system for increased data communications or manipulation capabilities.

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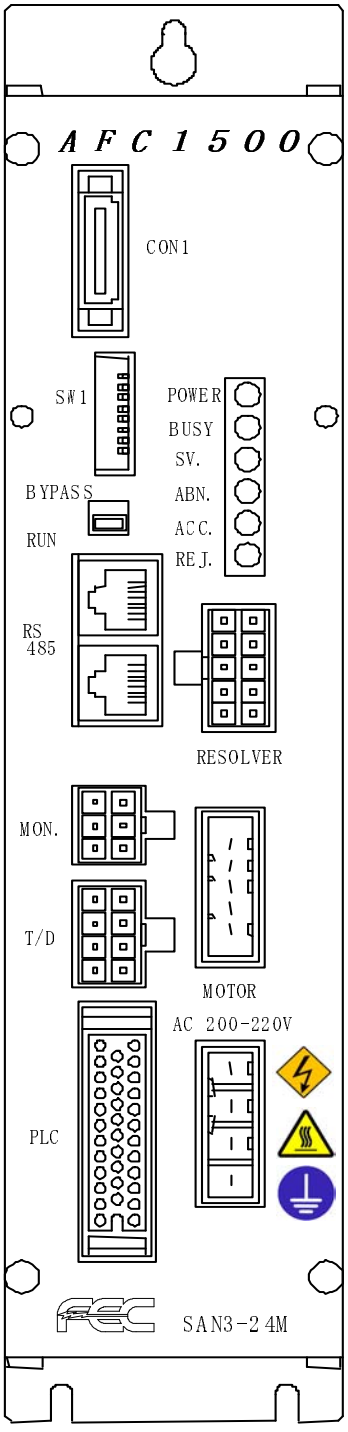
Serial Data output via a SAN-DP2, SAN3-DP2 or SAN-DP4 unit is available as a single spindle output only. When multiple spindle data is required an Embedded PC with the AFC Userconsole software or a MULTI unit must be used.

FIG. 3-1-2 AFC1500 Block Diagram with out Multi Unit connection (Stand-Alone)

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3.2 AFC1500 SAN UNIT Front panel

3.2.1 AFC1500 Front Panel Switches and Connectors



ITEM AS MARKED ON UNIT	DESCRIPTION
CON1	For Display Unit (SAN-DP*) connection. (Section 3.3 & 3.4)
SW1	Sets Spindle number for communications and special configuration features. (Section 4.10)
BYPASS/RUN	Controller Enable/Disable switch. RUN: Enable BYPASS: Bypass mode
RS485	Bi-directional Communication ports.
RESOLVER	Resolver connection for tool Motor / Resolver cable. (Angle of Rotation input)
MON.	Monitor Output Torque Analog Voltage and Angle Pulse output connection for connection to independent monitor device.
T/D	Connection for tool Transducer cable. (Torque signal input)
MOTOR	Motor Connection for tool Motor/Resolver cable. (Motor Drive)
PLC	Connection for Inputs and Output signals. Available signal vary depending on Stand alone or Multi operation.
AC 200 ~ 220	Connection for Input Power. (+/- 10%) 3 phase, 180-242VAC, 50/60Hz

FIG. 3-2-1 Axis unit Front panel controls

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3.2.2 AFC1500 Status LED and Bypass Switch Description

Located on the front of each SAN Unit are status indicators as well as a manual spindle bypass switch. The indicators provide diagnostics and overall status, while the bypass switch provides a manual method to bypass a spindle when it is part of a multiple spindle configuration. This allows other spindles to continue operation without the bypassed spindle.

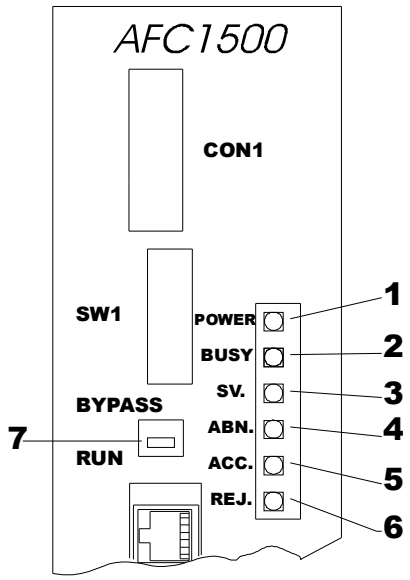


Fig. 3-2-2 Status LED and Bypass switch.

ITEM ON UNIT		DESCRIPTION
1	POWER	(Yellow). Indicates the power is on.
2	BUSY	(Orange). Lights when the unit is powering on or performing a fastening operation. Flashes when operating in reverse.
3	SV (SERVO)	(Red). Lights if an Abnormal condition is detected in the Servo section of the control circuit. See troubleshooting section for more information
4	ABNORMAL	(Red). Lights to indicate that some component of the spindle (SAN unit, Nutrunner Tool, etc.) is in an Abnormal state, and the fastening cycle has been interrupted. A failed Cal Check or Zero Check will also display as an ABNORMAL. Flashes when a Current warning has been detected. See troubleshooting section for more information.
5	ACCEPT	(Green) Lights to indicate that the spindle has completed an acceptable fastening, Zero Check, or Cal Check.
6	REJECT	(Red). Indicates the spindle performed a rejected fastening, out of the operation limits. Flashes fast indicating an Angle reject. (on 100 msec – off 300 msec) Flashes Slow indicating a Torque rate or time reject. (on 100 msec – off 700 msec)
7	BYPASS SWITCH INDICATOR	(Red) The LED mounted in the handle of the switch flashes when the unit is in Bypass mode. The system will not operate in this mode. If connected to the Multi Unit, the spindle is ignored, and the remaining spindles in the configuration will be judged as if the bypassed spindle does not exist.

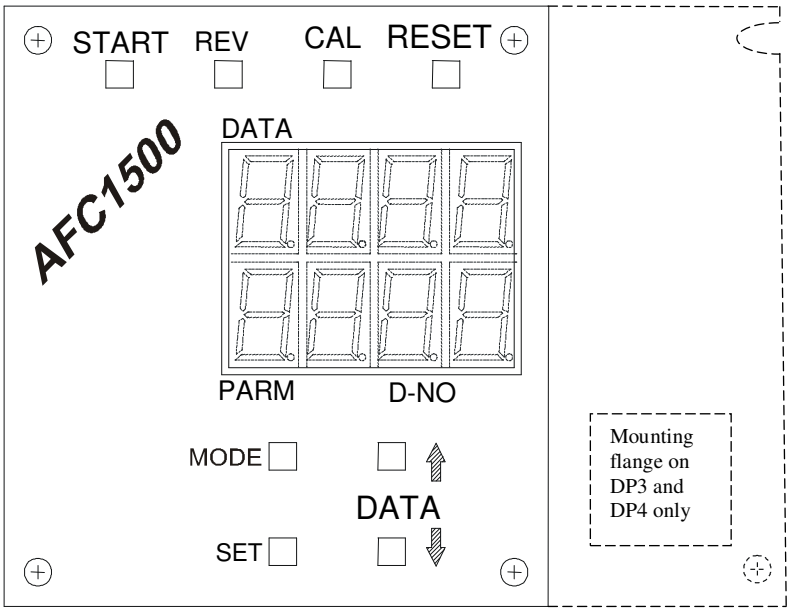
Detailed information of the System status can be obtained through the Keyboard-display unit.

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3.3 AFC1500 Keyboard-Display unit - SAN DP1/DP3 – SAN3-DP1

The SAN(3)-DP1 display unit is a "hot-swappable" detachable display also incorporating programming and monitor functions as well into this optional unit. It attaches directly to the front of the SAN unit through connector CON1 and can be removed or attached with power on. It is not required for the system to operate. Programming of parameters can be accomplished using the programming keys. For multiple spindle applications the AFC User Console Programming software is more efficient method of programming.

NOTE: Refer to Chapter 7 for detailed operation using the SAN(3)-DP units.



The SAN display units come in (2) different widths to allow mounting to the SAN Units

SAN-DP1 & DP2 can be used on the following SAN Units:

- SAN2-12, SAN2-40, SAN3-24(H), SAN3-40, SAN3-60H

SAN-DP3 & DP4 can be used on the following SAN Units;

- SAN2-80, SAN2-120, SAN3-120T, SAN3-120W

(These units have a wider mounting flange)

SAN**3**-DP1 & DP2 units were introduced in 2009 and are RoHs compatible replacements of the 1st generation SAN-DP units. These units also include the addition of a real time clock (RTC) function for stand-alone systems. (see 7.2.5 Parameter Data List for clock setup)
SAN3-DP1 & SAN3-DP2 can now be used on ALL SAN units. (DP2 has a serial port)

FIG. 3-3 SAN - DP1 Keyboard -Display unit

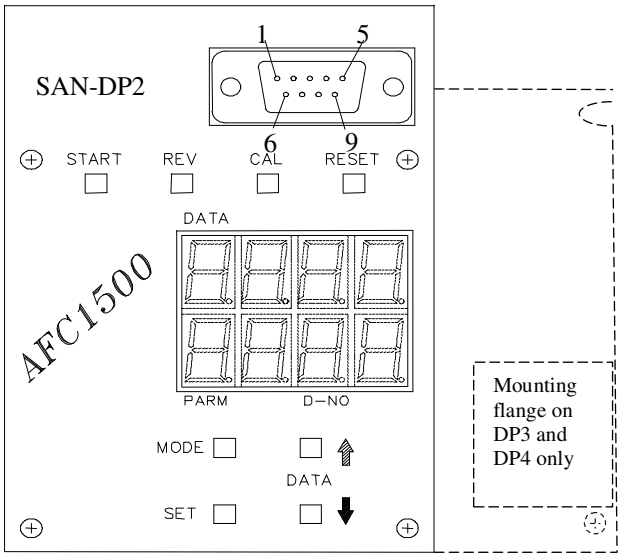
ITEM AS MARKED ON UNIT	DESCRIPTION
START	Manual fastening start pushbutton.
REV	Manual reverse pushbutton.
CAL	Manual Calibration (CAL) Check pushbutton
RESET	Manual Zero Check and System reset pushbutton.
DATA	Four digit display where function is dependent upon the D-NO selected.
PARM	Displays two-digit parameter number and, as required, will override Parameter output to display an Abnormal code.
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.
UP	Data change increase pushbutton.
DOWN	Data change decrease pushbutton.
MODE	Display mode selection pushbutton.
SET	Data change confirmation set pushbutton.

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3.4 AFC1500 Keyboard-Display Unit - SAN DP2/DP4 – SAN3-DP2

The SAN(3)-DP2 has the same function as the DP1 unit with the added function of a serial RS232 port for output of fastening data from a stand alone single SAN Unit. If the SAN unit is part of a multiple spindle configuration, then the fastening data would be output from the Multi Unit and this display would not be required for this purpose. All button functions are identical to the DP1 Unit.

NOTE: Refer to Chapter 7 for detailed operation using the SAN(3)-DP units.



The SAN display units come in (2) different widths to allow mounting to the SAN Units

SAN-DP1 & DP2 can be used on the following SAN Units:

- SAN2-12, SAN2-40, SAN3-24(H), SAN3-40, SAN3-60H

SAN-DP3 & DP4 can be used on the following SAN Units;

- SAN2-80, SAN2-120, SAN3-120T, SAN3-120W

(These units have a wider mounting flange)

SAN**3**-DP1 & DP2 units were introduced in 2009 and are RoHs compatible replacements of the 1st generation SAN-DP units. These units also include the addition of a real time clock (RTC) function for stand-alone systems. (see 7.2.5 Parameter Data List for clock setup)
SAN3-DP1 & SAN3-DP2 can now be used on ALL SAN units. (DP2 has a serial port)

Fig. 3-4 SAN - DP2 Unit

3.4.1 SAN(3)-DP2/DP4 Serial Pin out

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 is not activated, up to 16KB of data will be stored in the output buffer. Once the buffer is full, 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.

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3.4.2 SAN(3)-DP2/DP4 Communication Protocol

Communication protocol from the SAN(3)-DP2/DP4 is as follows;

Speed: 9600bps
Parity: NONE
Data Bits: 8 Bit
Stop Bit: 1 Bit

3.4.3 SAN(3)-DP2/DP4 Communication Format

The data output from the SAN(3)-DP2/DP4 is a formatted ASCII output. This can be connected to a serial printer, computer or other peripheral device. 78 bytes of data is output per fastening. The data format is described in the table below.

Byte	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Desc.	Cycle Count						Spindle Number					Parameter Number				PK TQ
ASCII Hex	30H	30H	30H	31H	20H	20H	30H	31H	20H	20H	20H	20H	31H	20H	20H	30H
Data	0	0	0	1			0	1					1			0

Byte	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Desc.	Peak Torque (PK TQ)				Judge		Final Angle				Judge		Final Torque (FN TQ)			
ASCII Hex	31H	2EH	33H	34H	4CH	20H	20H	20H	35H	30H	20H	20H	20H	31H	2EH	33H
Data	1	.	3	4	L				5	0				1	.	3

Byte	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Desc.	FN TQ	Judge		1st Rate					Judge		2nd Rate					Judge
ASCII Hex	34H	4CH	20H	30H	2EH	31H	32H	33H	20H	20H	30H	2EH	31H	32H	33H	20H
Data	4	L		0	.	1	2	3			0	.	1	2	3	

Byte	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
Desc.		3rd Rate					Judge		1st Time					Judge	
ASCII Hex	20H	30H	2EH	31H	32H	33H	20H	20H	20H	31H	30H	2EH	30H	20H	20H
Data		0	.	1	2	3				1	0	.	0		

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

Total Judgment: “X” = 58h, “O” = 4Fh

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3.4.4 SAN(3)-DP2/DP4 Data Format Description

The table below describes the data convention output from the SAN(3)-DP2/DP4 serial port. Non-data bytes will be occupied by the hex character 20H.

Data Name	Byte #	Data Format	Description
Cycle Count	1 ~ 4	0000-9999	Number is reset at Power Off
Spindle Number	7 ~ 8	01 – 31	Maximum 31 spindles
Parameter Number	12 ~ 13	1 – 16	Maximum 16 parameters
Peak Torque	16 ~20	01.34	Decimal point location may change based upon the tool type and torque unit.
Peak Torque Judgment	21	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
Final Angle	23 ~ 26	1234	4 digit number. No decimal point used
Final Angle Judgment	27	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
Final Torque	29 ~ 33	01.34	Decimal point location may change based upon the tool type and torque unit.
Final Torque Judgment	34	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
1st Rate	36 ~ 40	01.23	Decimal point location may change based upon the tool type and torque unit.
1st Rate Judgment	41	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
2nd Rate	43 ~ 47	01.23	Decimal point location may change based upon the tool type and torque unit.
2nd Rate Judgment	48	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
3rd Rate	50 ~ 54	01.23	Decimal point location may change based upon the tool type and torque unit.
3rd Rate Judgment	55	H: High Reject L: Low Reject	ASCII space (20H) will apply if judgment is accepted
1st Time	57 ~ 61	123.4	Decimal point location fixed
1st Time Judgment	62	H: High Reject	ASCII space (20H) will apply if judgment is accepted
2nd Time	64 ~ 68	123.4	Decimal point location fixed
2nd Time Judgment	69	H: High Reject	ASCII space (20H) will apply if judgment is accepted
Total Judgment	73	O: Accept X: Reject	
Carriage return	77	ODH	
Line feed	78	OAH	

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3.4.5 Cable Connection to SAN(3)-DP2/DP4

1. Connection using DTR signal

D-Sub 9-Pin Socket			Cable Drawing			D-Sub 25-Pin Pin
AFC1500	TD	3	----------	3	RD	
SAN(3)-	RD	2				Serial device
DP2/DP4	CTS	8	----------	20	DTR	
	GND	5	----------	7	GND	

2. Connection for outputting unconditionally after fastening

D-Sub 9-Pin Socket			Cable Drawing			D-Sub 25-Pin Pin
AFC1500	TD	3	----------	3	RD	
SAN(3)-	RD	2				Serial device
DP2/DP4	RTS	7	-----↓			
	CTS	8	-----↑ (Pin 7 & 8 are jumpered)			
	GND	5	----------	7	GND	

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3.5 Nutrunner (Tool) Unit

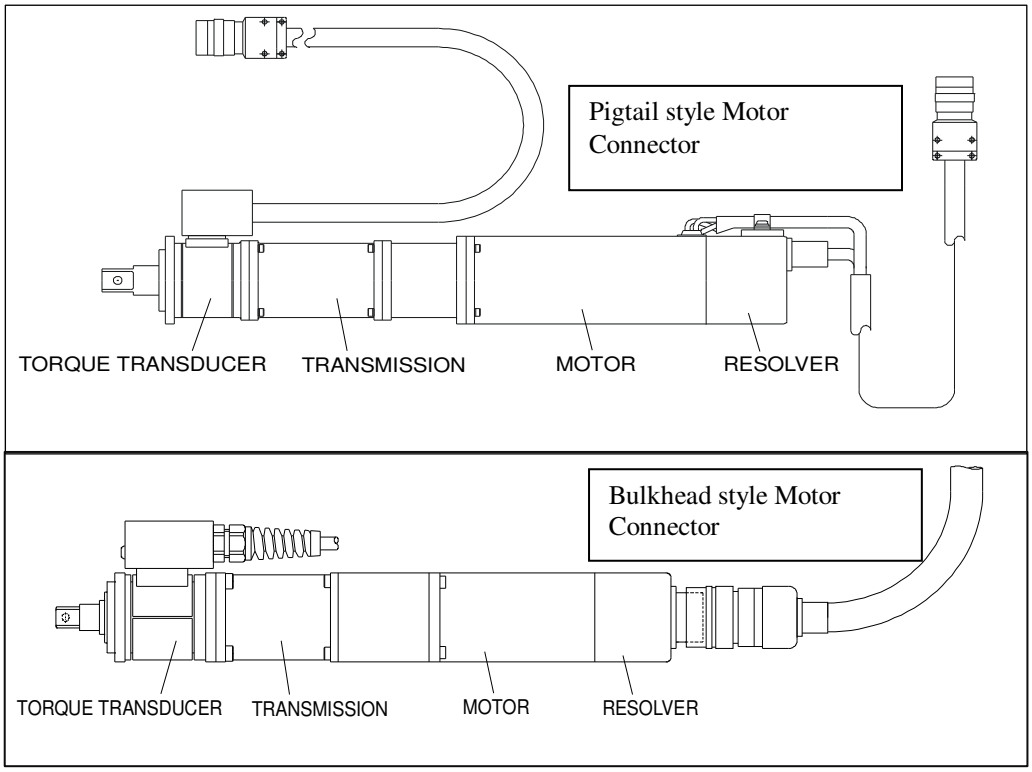


FIG. 3-5a Nutrunner (Tool) Unit components

- RESOLVER
  - Provides feedback for speed regulation to Servo Amplifier.
  - Provides angular rotation monitoring capability to fastening operation.
- MOTOR
  - Totally enclosed DC permanent magnet motor.
  - Refer to Chapter 2 for various motor sizes.
- TRANSMISSION
  - Durable Planetary gear transmission. (1,000,000 cycle before PM)
  - Refer to Chapter 2 for standard tools and gear ratios.
- TORQUE TRANSDUCER
  - Highly accurate strain gage transducer.
  - Highly Durable, compact design minimizes space requirements.
- PREAMP (Part of Torque Transducer – box on top with cable lead attached)
  - Intelligent transducer design accomplished through the use of an “ID Chip”.
  - “ID Chip” data used to verify integrity of fastening operations.

(Refer to Chapter 4 for complete tool and mounting dimensions.)

Note: High speed tools (RH1 & RH3 models) have only (1) motor cable and come in Bulkhead Style Connectors only.

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FIG. 3-5b Nutrunner (Tool) Unit examples/accessories

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Chapter 4: System Setup and Wiring

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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 50% and 75 % of tool capability for best performance. Ensure fastening bolt pattern and tool mounting patterns are compatible.	2.4.1 4.4.1 4.4.2
2	Design tool mounting plate, powerhead and spindle assemblies.	Design of mounting plate / powerhead requires adherence to several specifications.	4.4 4.4.3
3	Select correct San Unit for the tool selected.	Different tool motors require different Servo Amplifiers. Ensure the correct one is selected.	2.4.1
4	Select the circuit protectors.	Circuit protection for San Units should be separate from other units.	4.5 4.6
5	Select an air handling unit (as required).	Select an air handling unit applicable to the environmental conditions (A/C, Heat Exch., etc.)	2.1
6	Select an adequate PLC.	Select a PLC which will facilitate direct connection to the AFC1500 System I/O (24 VDC true low).	4.7
7	Design (or review) PLC logic.	A PLC logic program can be written using signal descriptions and timing charts provided.	4.7
8	Select NEMA 12 enclosure.	Keep clearances among units according to the recommended installation layout.	4.2 4.3
9	Set San Unit dip switches.	Check the setting before connecting the Unit.	4.10
10	Mount the San Units in the enclosure.	Refer to recommended installation layout.	4.2 4.3
11	Wire power connections.	Connect the power cables. **VERIFY VOLTAGE PRIOR TO APPLYING POWER.**	4.6
12	Wire I/O connections.	Connect all I/O wiring. **VERIFY VOLTAGE SOURCE PRIOR TO CONNECTION.**	4.7
13	Connect homerun cables.	**VERIFY POWER IS OFF**, then connect cables for every motor/resolver and preamplifier.	4.11 Appendix A
14	Turn on the equipment.	**VERIFY WIRING AND THE VOLTAGE OF ALL POWER SUPPLIES PRIOR TO POWERING UP.**	5.1
15	Input preset data.	Set the preset data for torque, angle, speed, time, etc.	Chapter 6 Chapter 7
16	Verify normal function.	Confirm normal operation.	5.2

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4.2 Component Dimensions

The specifications for all of the AFC1500 standard system equipment is outlined in this Chapter to aid in determining space, mounting & wiring requirements.

4.2.1 SAN Controller Unit Dimensions

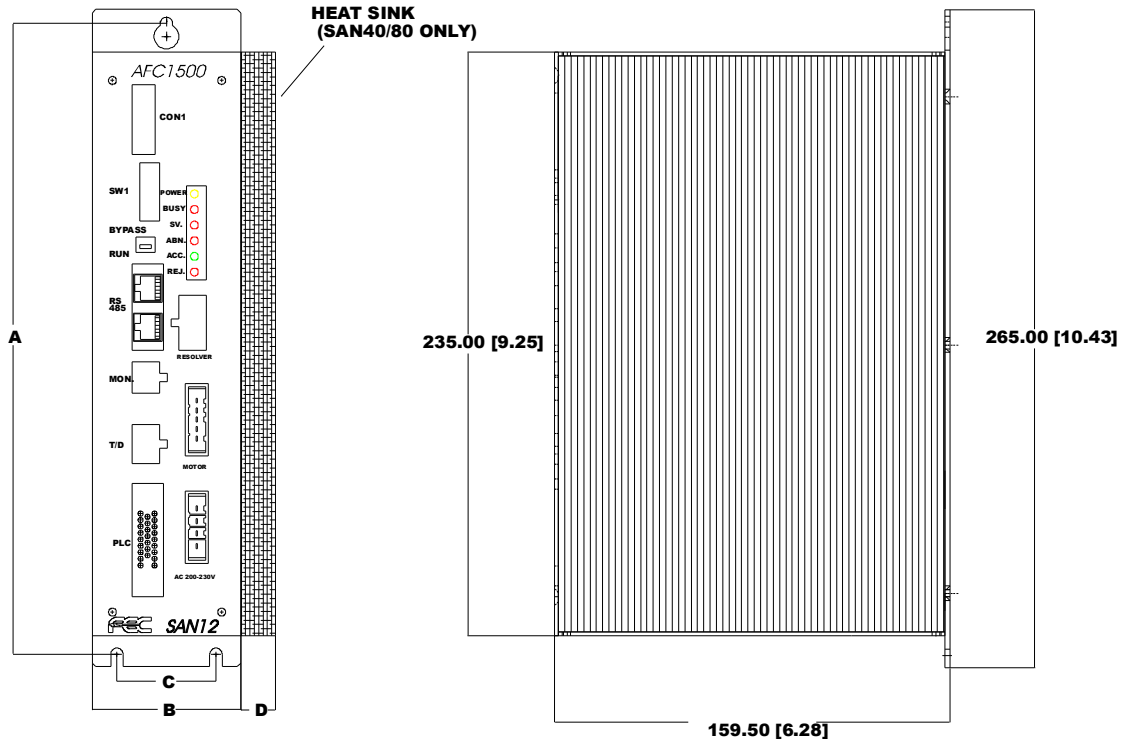


FIG. 4-2-1 SAN Controller unit Dimensions

Unit	A	B	C	D	Weight
SAN2-12	255	60	40	0	1.4 Kg
SAN2-24/40 SAN3-24/40 SAN3-24H SAN3-60H	255	60	40	14	1.8 Kg
SAN2-80 SAN3-120TW	255	90	60	14.5	3.1 Kg
SAN2-120 SAN3-120WM	255	90	60	33.5	3.6 Kg

Note: Dimensions shown in millimeters. Screw slot is 5mm width.

The Unit(s) must be mounted with a minimum clearance of 13 mm on each side to allow for proper heat dissipation. Cable connections on the front of the Units require 100 mm of clearance.

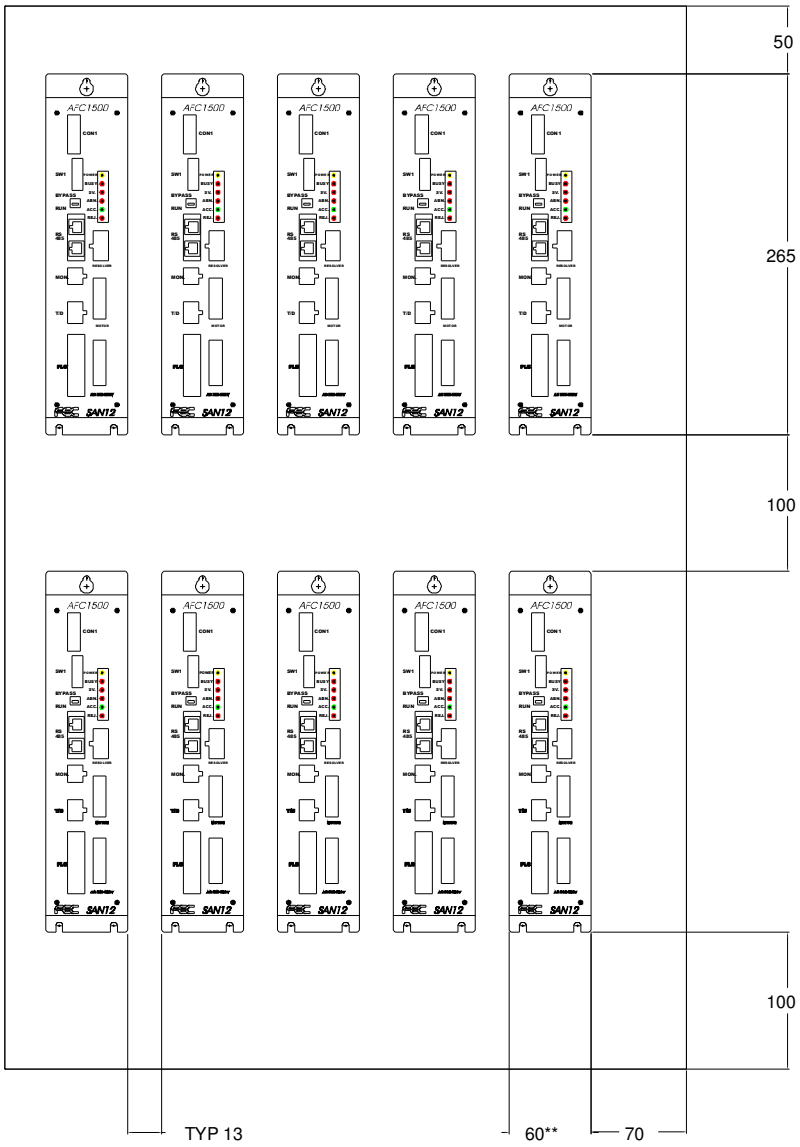
SAN Units must be located at a minimum 300 mm from any high transient voltage power source. High transient sources such as relays, AC contactors, AC motor drives, etc. may cause malfunction of the AFC1500 SAN unit.

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.

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4.3 Unit Arrangement



** See preceding page for actual unit width

FIG. 4-3 Unit Arrangement

The Units may be mounted in any desired configuration as long as the minimum spacing requirements are not neglected.

When installing duct above and below the Units, ensure that adequate space is provided to allow for removal and installation of the Units without removal of the mounting screws.

The components of the AFC1500 System are designed with slotted mounting holes for easy mounting to the back panel of the enclosure using standard 8-32 screws.

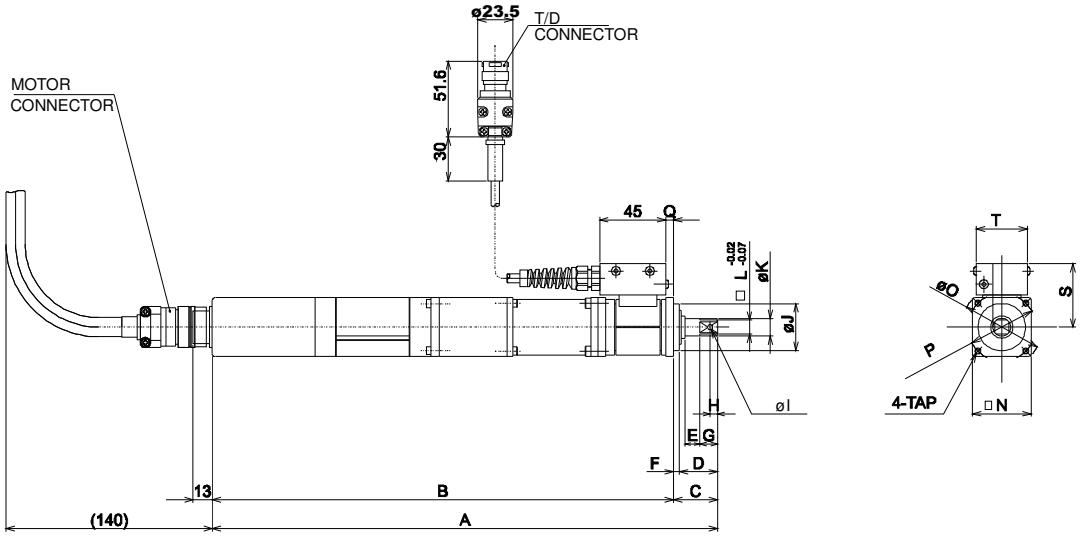
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4.4 Nutrunner (Standard Tool) Dimensions

Tool dimensions and mounting specifications are critical in determining the design of the mounting plate of 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 or possible damage to the tool assembly.

Outline drawing Files of common tool assemblies are available via FEC Inc. Website - www.fec-usa.com, or by contacting FEC Inc. directly.

4.4.1 Straight Tools

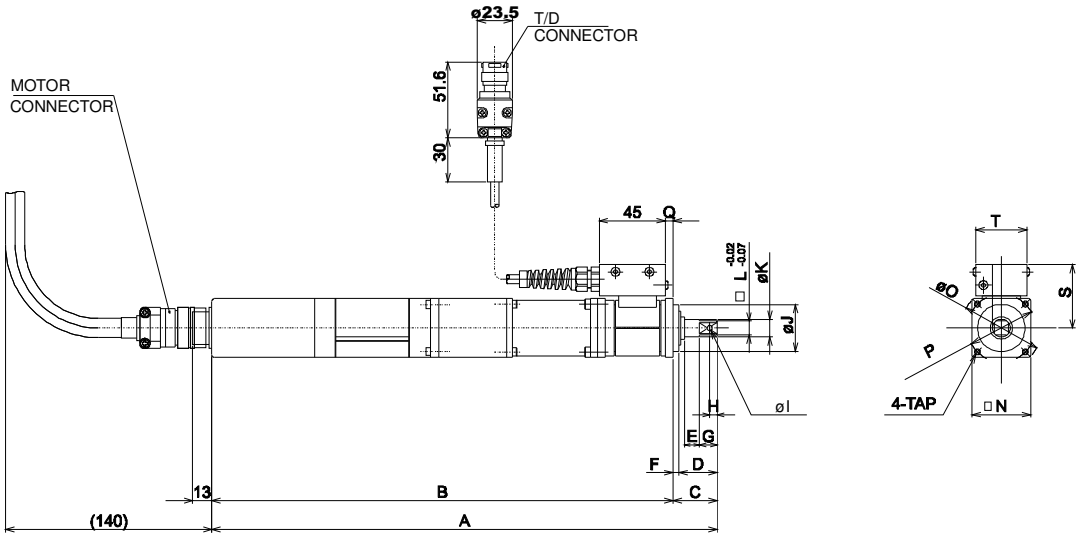


NFT-TYPE	TORQUE (Kg. M)	SPEED (rpm)	A	B	C	D	E	F	G	H	I	J
051RM1A-S	0.5	1100	311	281	30	26	10	4	12	5	3.5	32
101RM1A-S	1	1100	311	281	30	26	10	4	12	5	3.5	32
201RM1A-S	2	500	311	281	30	26	10	4	12	5	3.5	32
301RM2A-S	3	600	367	337	30	26	10	4	12	5	3.5	32
401RM1A-S	4	250	311	281	30	26	10	4	12	5	3.5	32
401RM3A-S	4	790	373	333	40	36	15	4	16	8	4.5	42
601RM3A-S	6	790	373	333	40	36	15	4	16	8	4.5	42
801RM3A-S	8	500	374	368	40	36	15	4	16	8	4.5	42
132RM3A-S	13	395	417	377	40	36	16	4	20	10	5.5	42
152RM3A-S	15	317	396	356	40	36	16	4	20	10	5.5	42
202RM3A-S	20	220	438	398	40	36	16	4	20	10	5.5	42
302RM3A-S	30	150	484	444	40	35	10	5	25	13	5.5	52
502RM4A-S	50	110	500	450	50	44	9	5	30	15	6.5	62
802RM4A-S	80	100	566	516	50	44	9	5	30	15	6.5	68

***TORQUE** CONVERSION GUIDE: 1 KGM = 100 KGCM = 9.8 NM = 7.2 FTLB = 86.7 INLB*

"A" style tools (RM1**A**, RM2**A** …) include Bulkhead style connections for the Motor/Resolver connector as shown on the reference tool drawings. Tools not designated with an "A" (RM1, RM2 …) are configured with pigtail cables for the Motor/Resolver connectors. Pigtail cables allow for tool installation in confined spaces.

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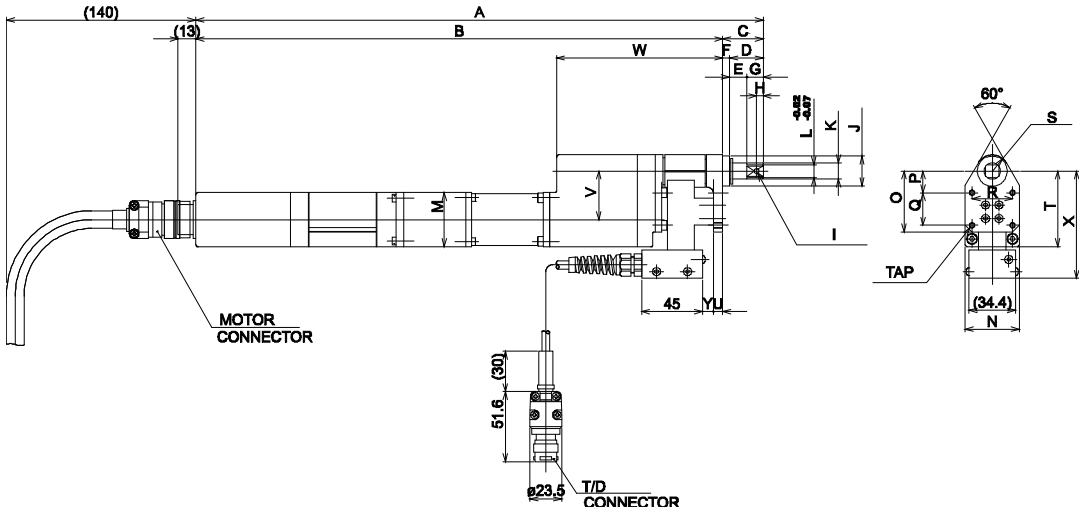
NFT-TYPE	K	L	N	O	P	TAP	Mtg. Bolt TQ.	Q	S	T	WEIGHT (Kg)
051RM1A-S	12	□9.5 (.374)	40	55	46	M4	4.5 Nm	5	43.2	34.4	1.9
101RM1A-S	12	□9.5 (.374)	40	55	46	M4	4.5 Nm	5	43.2	34.4	1.9
201RM1A-S	12	□9.5 (.374)	40	55	46	M4	4.5 Nm	5	43.2	34.4	2.1
301RM2A-S	12	□9.5 (.374)□	40	55	46	M4	4.5 Nm	5	43.2	34.4	2.5
401RM1A-S	12	□9.5 (.374)	40	55	46	M4	4.5 Nm	5	43.2	34.4	2.1
401RM3A-S	16	□12.7 (.500)	60	74	62	M6	15.5 Nm	8	50.2	34.4	4.3
601RM3A-S	16	□12.7 (.500)	60	74	62	M6	15.5 Nm	8	50.2	34.4	4.3
801RM3A-S	16	□12.7 (.500)	60	74	62	M6	15.5 Nm	8	50.2	34.4	4.5
132RM3A-S	20	□15.8 (.622)	60	80	68	M6	15.5 Nm	7	54.2	34.4	5.5
152RM3A-S	20	□15.8 (.622)	62	84	68	M8	38.5 Nm	7	54.2	34.4	5.5
202RM3A-S	20	□15.8 (.622)	62	84	68	M8	38.5 Nm	7	54.2	34.4	6
302RM3A-S	25	□19.0(0.75)	76	102	87	M8	38.5 Nm	11	61.2	34.4	9
502RM4A-S	32	□25.4(1.0)	80	110	90	M10	65 Nm	14	63.2	34.4	14
802RM4A-S	32	□25.4(1.0)	94	130	104	M12	100 Nm	14	70.2	34.4	15

WEIGHT *CONVERSION GUIDE: 1 KG = 2.2 LB*

DIMESIONAL *CONVERSION GUIDE: 1mm = 25.4 Inch. Where noted – mm (Inch)*

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4.4.2 Offset Tool

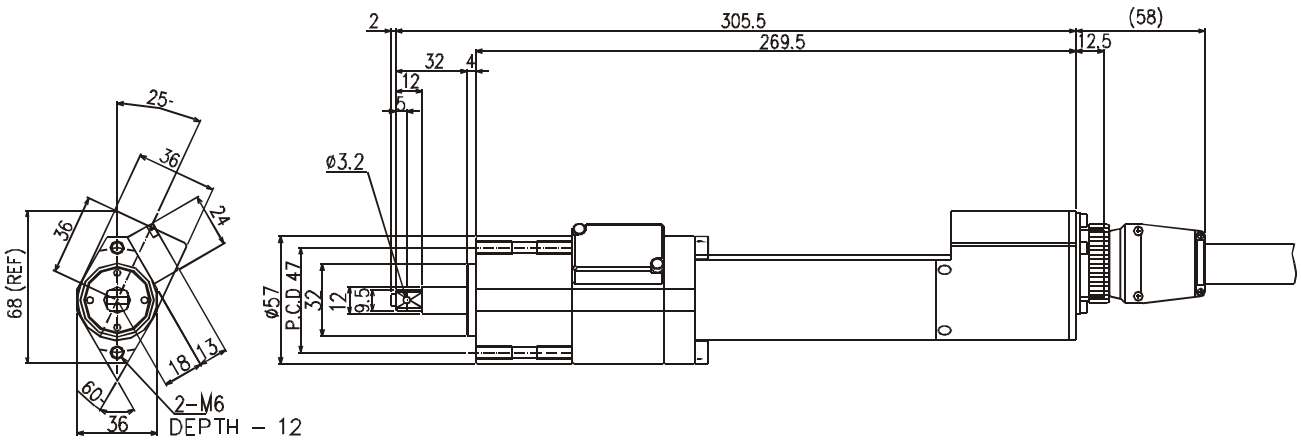


NFT-TYPE	TORQUE (Kg. M)	SPEED (rpm)	A	B	C	D	E	F	G	H	I	J	K	L	M
101RM1A-O	1	1,100	370	340	30	25	13	5	12	5	3.5	22	12	9.5 (.374)	Ø40
201RM1A-O	2	500	388	358	30	25	13	5	12	5	3.5	22	12	9.5 (.374)	Ø40
301RM2A-O	3	600	466	436	30	25	13	5	12	5	3.5	24	12	9.5 (.374)	Ø40
401RM1A-O	4	250	410	380	30	25	13	5	12	5	3.5	24	12	9.5 (.374)	Ø40
401RM3A-O	4	790	462	422	40	35	19	5	16	8	4.5	30	16	12.7 (.500)	□60
601RM3A-O	6	790	462	422	40	35	19	5	16	8	4.5	30	16	12.7 (.500)	□60
801RM3A-O	8	500	525	485	40	35	19	5	16	8	4.5	30	16	12.7 (.500)	□60
132RM3A-O	13	395	565	525	40	35	15	5	20	10	5.5	34	20	15.8 (.622)	□60
202RM3A-O	20	222	601	561	40	35	15	5	20	10	5.5	38	20	15.8 (.622)	□60
302RM3A-O	30	150	634	594	40	35	10	5	25	13	5.5	42	25	19.0(0.75)	□60
502RM4A-O	30	155	692	642	50	44	14	6	30	15	6.5	52	32	25.4 (1.0)	□80
802RM4A-O	30	100	788	738	50	45	15	5	30	15	6.5	60	32	25.4 (1.0)	□80

NFT-TYPE	N	O	P	Q	TAP	Mtg. Bolt TQ.	R	S	T	U	V	W	X	Y	WEIGHT (Kg)
101RM1A-O	40	45	16	24	M4	4.5 Nm	30	12	55.8	7	35.8	123	79.2	8	2.5
201RM1A-O	40	45	16	24	M4	4.5 Nm	30	12	55.8	7	35.8	123	79.2	8	2.7
301RM2A-O	40	50	16	24	M4	4.5 Nm	30	14	55.8	8	38.8	143	82.2	6	3.2
401RM1A-O	40	50	16	24	M4	4.5 Nm	30	14	58.8	8	38.8	143	82.2	6	3.0
401RM3A-O	60	70	18	42	M6	15.5 Nm	40	17	86.7	8	56.7	140	107.2	6	6.8
601RM3A-O	60	70	18	42	M6	15.5 Nm	40	17	86.7	8	56.7	140	107.2	6	6.8
801RM3A-O	60	70	18	42	M6	15.5 Nm	40	17	86.7	8	56.7	140	107.2	6	6.8
132RM3A-O	60	80	18	55	M6	15.5 Nm	45	19	92.6	10	62.6	174	116.2	8	8
202RM3A-O	62	85	20	55	M8	38.5 Nm	45	22	99	10	68	189	122.2	6	9.5
302RM3A-O	76	100	30	55	M10	65 Nm	58	27	121	12	82.7	204	144.2	12	13.5
502RM4A-O	87	122	35	72	M10	65 Nm	60	30	138.4	18	98.4	248	163.2	11	23
802RM4A-O	94	150	50	75	M12	100 Nm	70	34.5	163.5	20	116.5	278	186.7	18	31

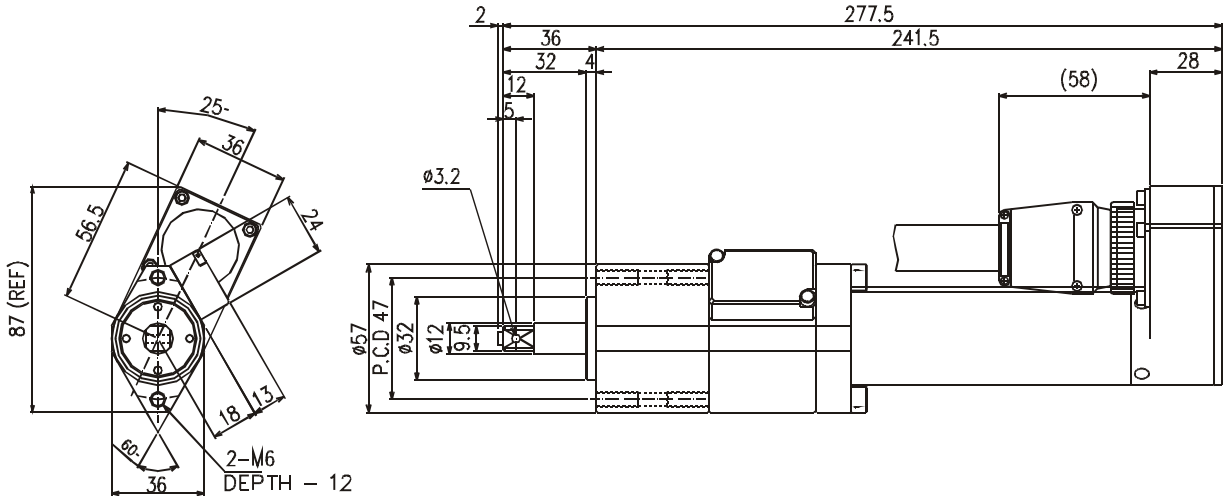
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4.4.3 High Speed Tool – (20 - 40Nm)



High Speed Tool (with "A"or "C" style connector)			
Tool Model	**Torque (Full Scale)**	**Speed (Max RPM)**	**Weight**
NFT-211RH1x-S	2.1KgM (20.6Nm)	1220	1.4Kg
NFT-311RH1x-S	3.1KgM (30.4Nm)	855	1.4Kg
NFT-411RH1x-S	4.1KgM (40.2Nm)	635	1.4Kg

Note: "x" in part number (NFT-211RH1**x**-S) represents connector type
x = "A" = Screw Type Connector (Obsolete version) - Cable exits from rear of tool assembly
x = "C" = Twist Lock Connector – Cable exits from rear of tool assembly

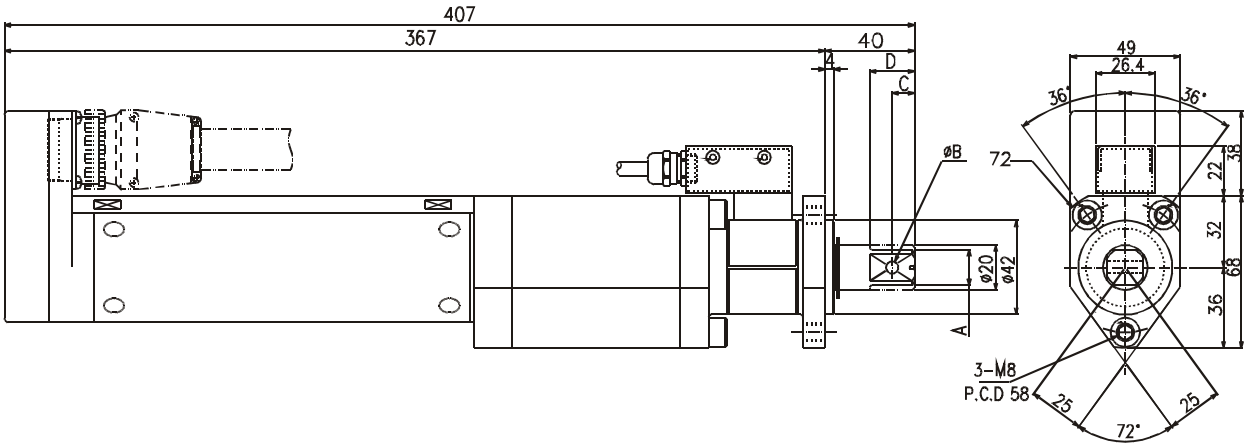


High Speed Tool (with "B" or "D" style connector)			
Tool Model	**Torque (Full Scale)**	**Speed (Max RPM)**	**Weight**
NFT-211RH1x-S	2.1KgM (20.6Nm)	1220	1.4Kg
NFT-311RH1x-S	3.1KgM (30.4Nm)	855	1.4Kg
NFT-411RH1x-S	4.1KgM (40.2Nm)	635	1.4Kg

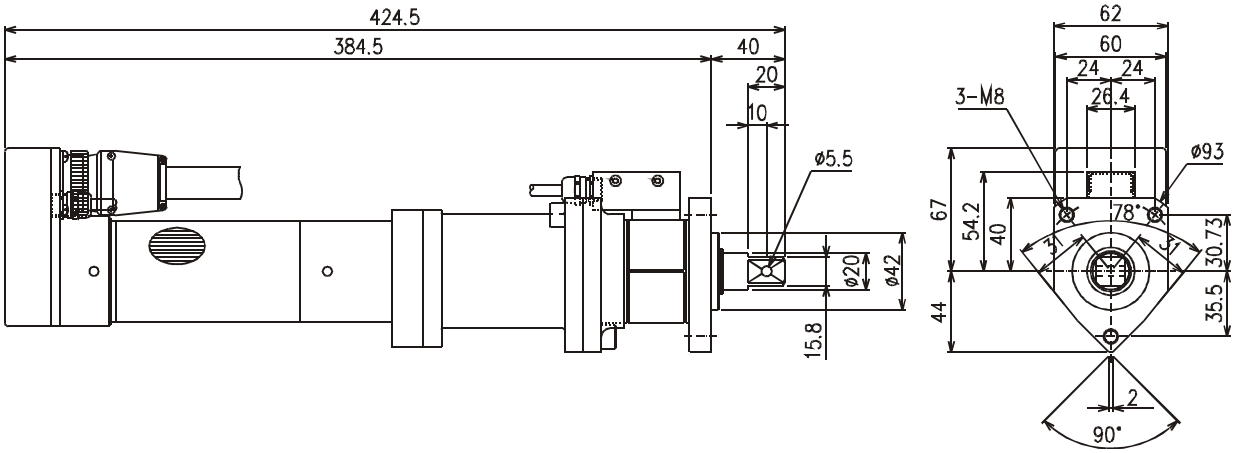
Note: "x" in part number (NFT-211RH1**x**-S) represents connector type
x = "B" = Screw Type Connector (Obsolete version) - Cable exits towards front of tool assembly
x = "D" = Twist Lock Connector – Cable exits towards front of tool assembly

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4.4.4 High Speed Tool – (78 – 128Nm)



High Speed Tool (with "B" style connector)							
Tool Model	Torque (Full Scale)	Speed (Max RPM)	Weight	DIM. (Square Drive)			
				A	B	C	D
NFT-801RH3B-S	8.0KgM (78.4Nm)	1000	4.2Kg	12.7	4.5	8	16
NFT-132RH3B-S	13.0KgM (127.5Nm)	580	4.3Kg	15.88	5.5	10	20



High Speed Tool (with "B" style connector)			
Tool Model	*Torque (Full Scale)*	*Speed (Max RPM)*	*Weight*
NFT-202RH3B-S	20.0KgM (196.1Nm)	408	5.2Kg

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4.4.5 Mounting Plate Design Requirements

The plate to which the tools are mounted must maintain the following specifications:

- Plate must be Blanchard ground (to ensure sides are adequately flat and parallel) to a minimum thickness of 15.88 mm (.625 inch) +/- .05 mm (.002 inch).
- Chamfer all bores on both sides by 1.6 mm (.063 inch) x 45 degrees.
- Tools must be mounted 1.6 mm (.063 inch) apart, at a minimum.

4.4.6 Locating Procedure for Fixtured Multi Spindle Powerhead

1. The locating of multi-spindle fastening equipment begins with a review of the floor layout and assembly drawings. They must be checked for set-up dimensions and any special instructions. Once the proper dimensions have been established, installation may proceed.

2. Verify the established dimensions of each of the following in order of precedence:

   Conveyor - Whether this is new or existing machinery, this **MUST** be done first. Adjust to print as required. **NOTE 1**

   Pallet - Verify using several pallets. Make note of any variation for further alignment.

   Machine base - Set base height and location while maintaining parallelism to the conveyor

NOTE 1: If any dimensions do not match the prints or is severely out of adjustment, evaluate the effect of the discrepancy prior to proceeding. Document any variations from print.

3. Once the conveyor, pallet and machine base are set to dimensions and level, the fastening equipment can be installed. The head, fastening tools and spindle assemblies must be assembled and secured to the slide assembly prior to locating the powerhead to the work piece. If push pull blocks are not used to locate the powerhead to the slide, dowel pins should be install at this point

4. When locating the power head to the work piece, ensure that the work piece is located as it will be during actual production. EXAMPLE: if there is a pallet locate and clamp, it must be in the clamp position). Fasteners should be rundown fully to ensure that the alignment is perform with the fasteners in their final fixed positions.

5. Next you should advance the power head slowly to check the alignment to the work piece. If there is a misalignment left to right or up and down, the base must be moved using the leveling jack screws, push pull blocks or provided spacers. The powerhead may be adjusted on the slide assembly if push pull blocks have been utilized. Do not readjust the conveyor or the pallets.

6. When adjusting the alignment by moving the machine base left to right or up and down, the base must remain parallel to the conveyor. Alignment is correct when all spindles, easily slip on and off of all the fasteners, without causing any sticking, cocking, or undue stress on the fasteners. This must be performed on several work pieces and pallets to ensure correct alignment.

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7. Once the alignment has been accomplished, adjustment of slide stops, shock absorbers and flow controls must be done. Adjust the slide advance stops for 3/8" minimum spring pre-load on the spindles when the fastener is secure (Refer to assembly drawing). Ensure that the spindle assembly does not fully compress during any phase of the powerhead advance. Setting of the flow controls is done with cycle time in mind. The speed of the slides should be set at a smooth and even movement. The cylinder cushions and shock absorbers, if provided, should be set to avoid any slamming at the end of the stroke.

8. When everything has been aligned and adjusted they should be locked down, tightened up and anchored.

NOTE: Some of the locating equipment that can be used to install a fastening system may include: a precision level, indicators with magnetic base, a conventional transit or a laser transit.

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4.5 Wiring Diagrams

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.

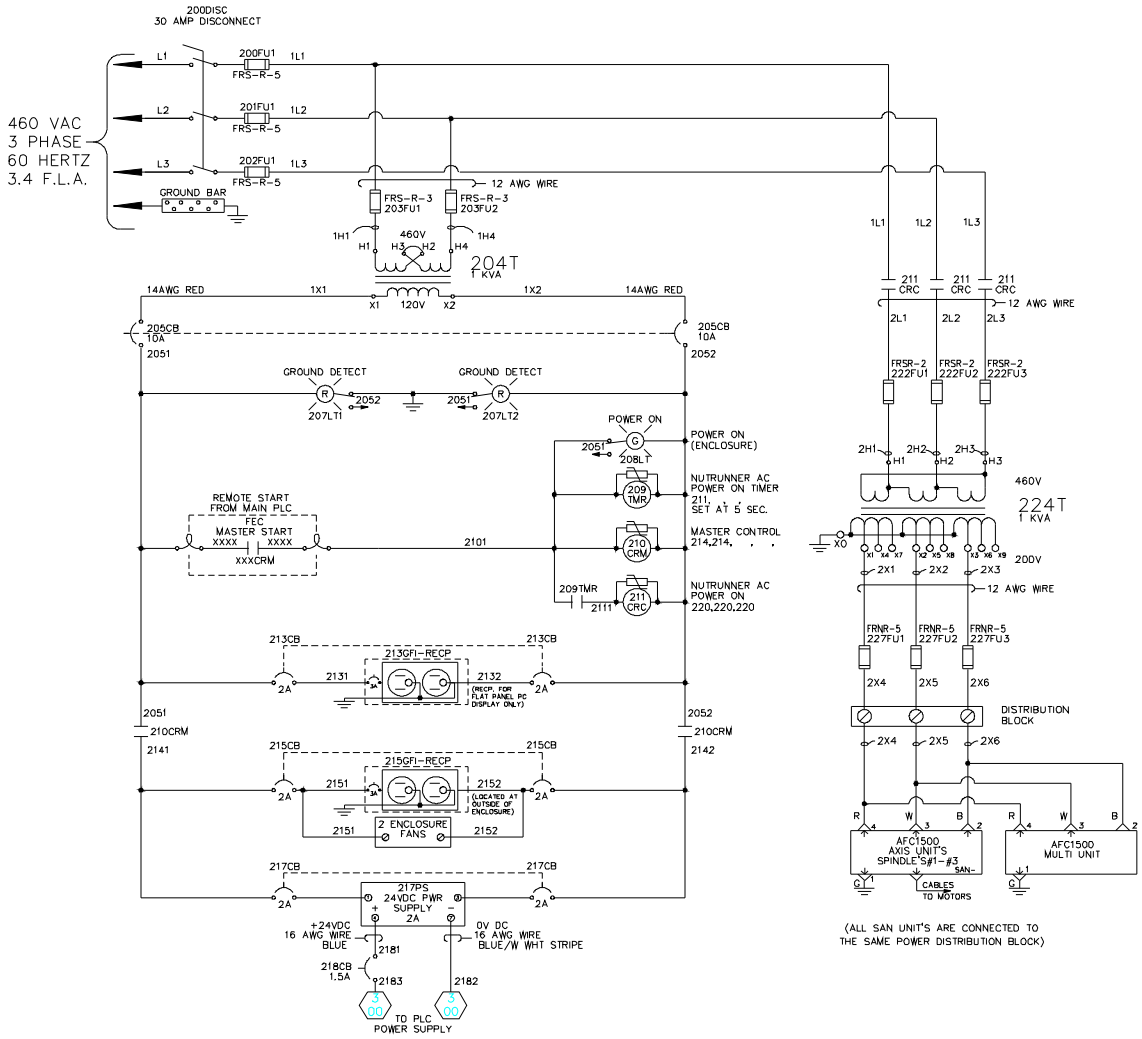


FIG. 4-5 Wiring Diagram

Note: Timer 107 is provided to prevent the system power being turned on and off in less than 5 sec. intervals.

CAUTION: If the equipment is powered on and off repeatedly, internal circuit protection devices may trip due to high in-rush current overload. It may take up to five minutes of "off" time to clear the self-protection circuit.

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4.6 Power Requirements and Connections

4.6.1 SAN Unit

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

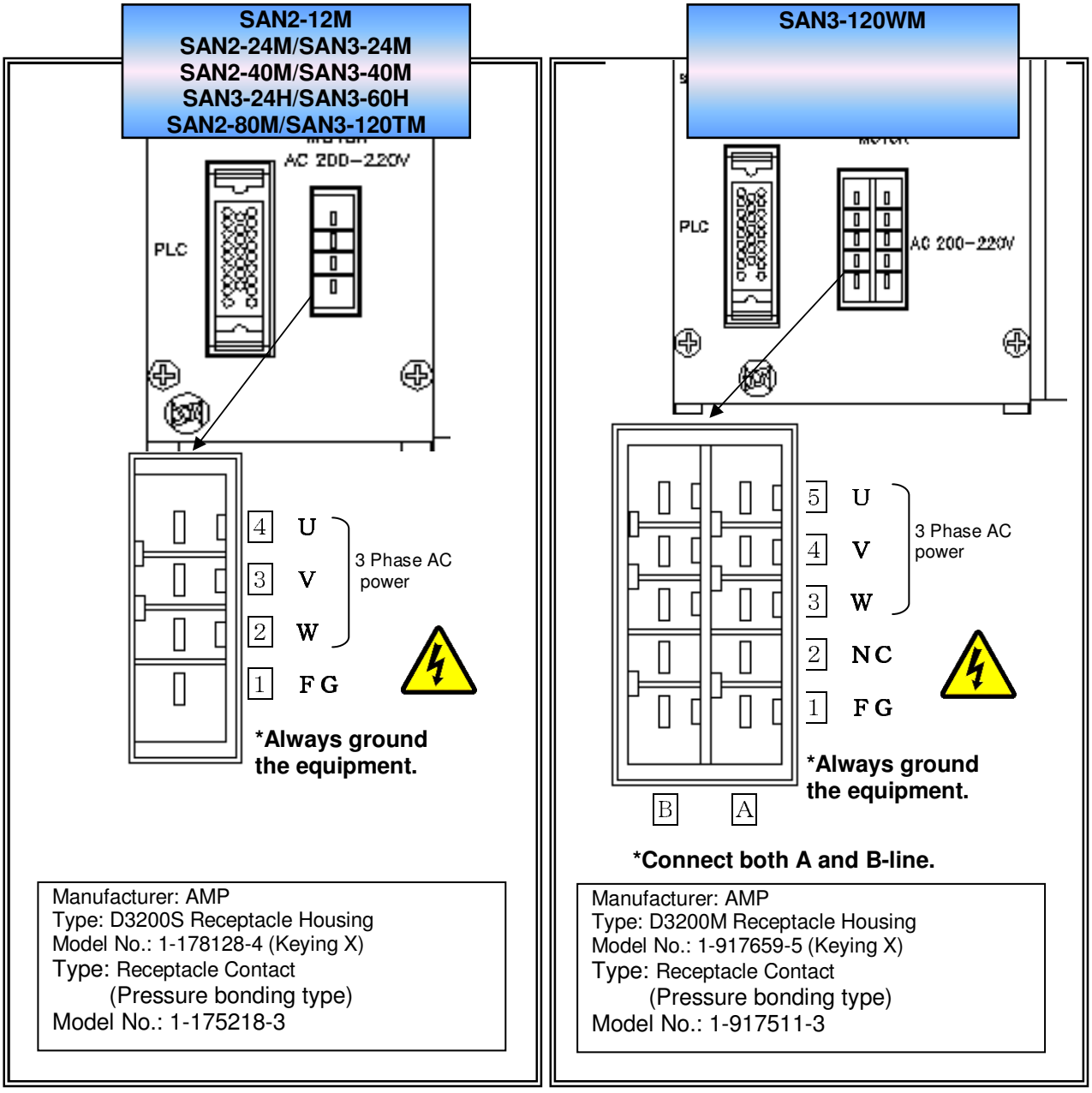


Fig. 4-6-1 SAN Unit Power Connector

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PIN NUMBER		DESCRIPTION
SAN2-12M~ SAN3-120TM	SAN3-120WM	
4	5	200~220 VAC, 50/60Hz, 3-Phase (U) Red
3	4	200~220 VAC, 50/60Hz, 3-Phase (V) White
2	3	200~220 VAC, 50/60Hz, 3-Phase (W) Black
	2	Not Connected
1	1	FRAME GROUND Green

Recommended conductor size = 16 AWG (for all units)

CAUTION: If the equipment is powered on and off repeatedly, internal circuit protection devices may trip due to high in-rush current overload. It may take up to five minutes of "off" time to clear the self-protection circuit.

4.6.2. Calculating Circuit Protection

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

RATED VALUES FOR CALCULATING CIRCUIT PROTECTION			
MOTOR TYPE	MOTOR WATTAGE	# OF SPINDLES PER 1 KVA	KVA PER SPINDLE
RM1	60	10 SPINDLES	.100 KVA
RM2 / RH1	80 / 70	8 SPINDLES	.125 KVA
RM3	200	6 SPINDLES	.166 KVA
RM4 / RH3	1500 / 200	3 SPINDLES	.333 KVA
RM5	3000	1.5 SPINDLES	.666 KVA

The chart above shows nominal motor ratings for standard motors, along with the power requirements (KVA) for each spindle. (These already have a safety factor calculated in)
Use the formula below to compute transformer secondary fuse or circuit breaker sizing:

$$1.5 \times \left(\frac{\text{TRANSFORMER (VA)}}{\text{SECONDARY VOLTAGE}} \right) \div \sqrt{3} = \text{SECONDARY FUSE SIZE}$$

Example: $1.5 \times \left(\frac{1000\ (\text{VA})}{200\ \text{VAC}} \right) \div \sqrt{3} = 4.3\ \text{AMP}$ (USE 5 AMP FUSES)*

* Use a fuse or circuit breaker with next available highest rating. Due to the high inrush current at power up, it is recommended to use SLOW BLOW type fuses or fuses rated for motor loads such as Bussman® FRS/FRN type.

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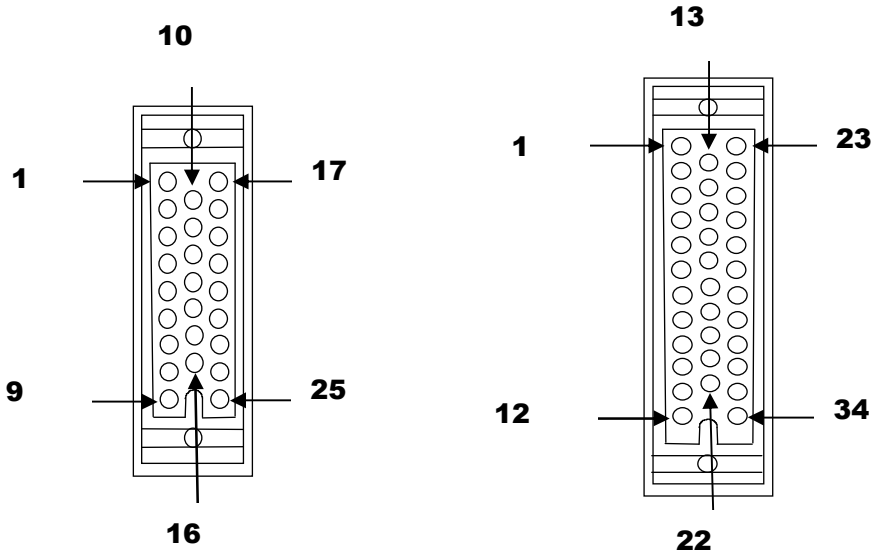
4.7 Wiring PLC I/O

All interface devices must accommodate active true low logic for correct operation with AFC1500 SAN Unit inputs and outputs (I/O).

Optional Field bus interface is available when using a Multi Unit.

Outputs are rated at 12~24 VDC, 200mA.
Open collector sink outputs pull the input device signal low (0 VDC) when activated.

Inputs are normally high and activated when pulled low (0 VDC).



SAN2 (25 pin) I/O connection
Mating connector: Honda MR-25M

SAN3 (34 pin) I/O connection
Mating connector: Honda MR-34M

As viewed from the front of the SAN Unit.

FIG. 4-7-1 San Unit PLC Connector

Note: If you are adapting from an older SAN 25pin cable connector to a new SAN3 34 pin controller, use cable adapter FEB-1522. This will allow the use of your old 25 pin I/O cable for use with a new SAN3 Controller unit.

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.

DO NOT connect a positive DC voltage source to the output common.

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4.7.1 Explanation of SAN Unit I/O

INPUT SIGNALS			
SAN2 Pin #	SAN3 Pin #	SIGNAL NAME	DESCRIPTION
1	1	STOP	Emergency Stop Input (Normally Closed) This signal must be active (on) for controller operation. When this signal is inactive (off), controller operation will stop, and input/outputs will be disabled. AVAILABLE IN STAND ALONE OPERATION ONLY,
2	2	RESET	Reset Input (Normally Open) When active (on), this signal will clear all fastening data, and discrete outputs. A Zero Check of the torque transducer will be completed. During the Zero Check, the ACCEPT or REJECT lamp will light to indicate the result of the Zero Check. 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. AVAILABLE IN STAND ALONE OPERATION ONLY,
3	3	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. The Reverse input functions the same as the reverse push-button on the front of the SAN unit. AVAILABLE IN STAND ALONE OPERATION ONLY,
4	4	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 requires a pulse of 200~500 milliseconds if the SAN Unit DIP switches are set up for AUTOMATIC Start input. If the SAN Unit DIP switches are set up for DEADMAN (hand-held operations) input, the Start input must be maintained "on" for the entire cycle. AVAILABLE IN STAND ALONE OPERATION ONLY,
5	5	BYPASS	Spindle Bypass Input (Normal Open) When active, all functions of this spindle are bypassed, and the Bypass output is active. (Available in both Stand Alone & Multi setup)
6	6	SYNC COMMON	Input common signal for input 8 "SYNC" signal. AVAILABLE IN STAND ALONE OPERATION ONLY,
7	7	SYNC COMMON	Input common signal for input 8 "SYNC" signal. AVAILABLE IN STAND ALONE OPERATION ONLY,

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SAN2 Pin #	SAN3 Pin #	SIGNAL NAME	DESCRIPTION
8	8	SYNC	Input /output signal that is directly connected to other San Units to provide for Synchronized 2nd. step fastening. AVAILABLE IN STAND ALONE OPERATION ONLY,
9	9	WORK SELECT 3	Work / Parameter Select Input (Normally Open). Works in combination with Work Select inputs 0 ~ 2 to provide selection of up to 16 different parameter sets. Refer to Section 4.7.2 Work / Parameter Select Table. AVAILABLE IN STAND ALONE OPERATION ONLY,
10	13	IN COMMON	Input signal common. Connection to +12 ~ 24 VDC required.
11	14	SELF CHECK DISABLE FASTENING END BY SELF CHECK OFF SIGNAL REF. Section 4.6.10	When activated prior to the START Input signal, the performance of the automatic Self Check (Calibration Check portion only- Zero check is still performed) function at the beginning of the fastening cycle is disabled. When this function is enabled, the system will fasten to STANDARD Torque or Angle and continue to Fasten until the High limit is reached. If activated after reaching STANDARD but prior to the High limit, the fastening operation will stop and a judgment is performed. (Enabled in AFC Software Preferences & selected in each Parameter) AVAILABLE IN BOTH STAND ALONE AND WITH MULTI.
12 13	15 16	BANK SELECT 1 BANK SELECT 0	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. 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.
14 15 16	17 18 19	WORK SELECT 0 WORK SELECT 1 WORK SELECT 2	Work / Parameter Select Input (Normally Open) These 3 inputs and input 9 form a binary code which is capable of selecting up to 16 different sets of Fastening Parameters. Refer to Section 4.7.2 Work / Parameter Select Table. AVAILABLE IN STAND ALONE OPERATION ONLY,
17	23	OUTPUT COMMON	Output signal common. Connection to 0 VDC required
OUTPUT SIGNALS			
18 19 20 21 22 23 24 25	24 25 26 27 28 29 30 31	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. (SAN2 - Pins 13 & 12, SAN3 - Pins 15 & 16) inputs. Refer to 4.7.3 Bank Select Table for output data descriptions.

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4.7.2 Work / Parameter Select Table

PARAMETER NO.	WORK SELECT 3	WORK SELECT 2	WORK SELECT 1	WORK SELECT 0
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

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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 these two inputs, up to four "Banks" may be selected, changing the definition of each output point.

BANK #	BANK SELECT INPUT		PLC / SAN UNIT BANK DATA		
	1	0	BANK DATA	SIGNAL NAME	SIGNAL DESCRIPTION
1	OFF	OFF	DATA 0 (SAN2 PIN 25) (SAN3 PIN 31)	**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 1 (SAN2 PIN 24) (SAN3 PIN 30)	**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 2 (SAN2 PIN 23) (SAN3 PIN 29)	**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 3 (SAN2 PIN 22) (SAN3 PIN 28)	**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 4 (SAN2 PIN 21) (SAN3 PIN 27)	**BUSY**	Output after a START signal is received, and active until the fastening cycle is complete and the READY signal is output.
			DATA 5 (SAN2 PIN 20) (SAN3 PIN 26)	**TORQUE HIGH REJECT**	Output when Fastening resulted in a Torque High Reject.
			DATA 6 (SAN2 PIN 19) (SAN3 PIN 25)	**TORQUE LOW REJECT**	Output when Fastening resulted in a Torque Low Reject.
			DATA 7 (SAN2 PIN 18) (SAN3 PIN 24)	**BYPASS**	Output when the spindle is bypass either via PLC input or the San Unit front panel switch.
2	OFF	ON	DATA 0 (SAN2 PIN 25) (SAN3 PIN 31)	**NOT USED**	
			DATA 1 (SAN2 PIN 24) (SAN3 PIN 30)	**1ST TIME OVER REJECT**	Output when Fastening resulted in a 1st Time Reject.
			DATA 2 (SAN2 PIN 23) (SAN3 PIN 29)	**FINAL TIME OVER REJECT**	Output when Fastening resulted in a Final Time Reject.
			DATA 3 (SAN2 PIN 22) (SAN3 PIN 28)	**WORK 0**	Output confirmation of WORK SELECT 0~3 (Pins 9 and 14~16) input selections.
			DATA 4 (SAN2 PIN 21) (SAN3 PIN 27)	**WORK 1**	
			DATA 5 (SAN2 PIN 20) (SAN3 PIN 26)	**WORK 2**	
			DATA 6 (SAN2 PIN 19) (SAN3 PIN 25)	**WORK 3**	
			DATA 7 (SAN2 PIN 18) (SAN3 PIN 24)	**NOT USED**	

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BANK #	BANK SELECT INPUT		PLC / SAN UNIT BANK DATA		
	1	0	BANK DATA	SIGNAL NAME	SIGNAL DESCRIPTION
3	ON	OFF	DATA 0 (SAN2 PIN 25) (SAN3 PIN 31)	**ANGLE HIGH REJECT**	Output when Fastening resulted in an Angle High Reject.
			DATA 1 (SAN2 PIN 24) (SAN3 PIN 30)	**ANGLE LOW REJECT**	Output when Fastening resulted in an Angle Low Reject.
			DATA 2 (SAN2 PIN 23) (SAN3 PIN 29)	**1ST RATE HIGH REJECT**	Output when Fastening resulted in a 1st Torque Rate High Reject.
			DATA 3 (SAN2 PIN 22) (SAN3 PIN 28)	**1ST RATE LOW REJECT**	Output when Fastening resulted in a 1st Torque Rate Low Reject.
			DATA 4 (SAN2 PIN 21) (SAN3 PIN 27)	**2ND RATE HIGH REJECT**	Output when Fastening resulted in a 2nd Torque Rate High Reject.
			DATA 5 (SAN2 PIN 20) (SAN3 PIN 26)	**2ND RATE LOW REJECT**	Output when Fastening resulted in a 2nd Torque Rate Low Reject.
			DATA 6 (SAN2 PIN 19) (SAN3 PIN 25)	**3RD RATE HIGH REJECT**	Output when Fastening resulted in a 3rd Torque Rate High Reject.
			DATA 7 (SAN2 PIN 18) (SAN3 PIN 24)	**3RD RATE LOW REJECT**	Output when Fastening resulted in a 3rd Torque Rate Low Reject.
4	ON	ON	DATA 0 (SAN2 PIN 25) (SAN3 PIN 31)	**ZERO CAL ERR**	Outputs when an abnormal condition occurs during the SELF CHECK (CAL and Zero).
			DATA 1 (SAN2 PIN 24) (SAN3 PIN 30)	**PSET ERR.**	Outputs when an abnormal condition occurs in the parameter set-ting.
			DATA 2 (SAN2 PIN 23) (SAN3 PIN 29)	**RES ERR**	Outputs when an abnormal condition occurs in the resolver.
			DATA 3 (SAN2 PIN 22) (SAN3 PIN 28)	**TOOL ERR**	Outputs when a tool related abnormality occurs.
			DATA 4 (SAN2 PIN 21) (SAN3 PIN 27)	**SV AMP ERR**	Outputs when a servo abnormality occurs, see SV ERR 0~2 codes below.
			DATA 5 (SAN2 PIN 20) (SAN3 PIN 26)	**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 6 (SAN2 PIN 19) (SAN3 PIN 25)	**SV ERROR 1**	
			DATA 7 (SAN2 PIN 18) (SAN3 PIN 24)	**SV ERROR 2**	

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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 SAN type mismatch.
ON	OFF	ON	OFF	Resolver abnormal.
ON	OFF	ON	ON	SAN 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

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4.7.5 PLC Wiring Sample

This diagram represents standard I/O connections. For synchronous fastening connection, Please refer to section 4.7.6: Synchronized Fastening Operation.

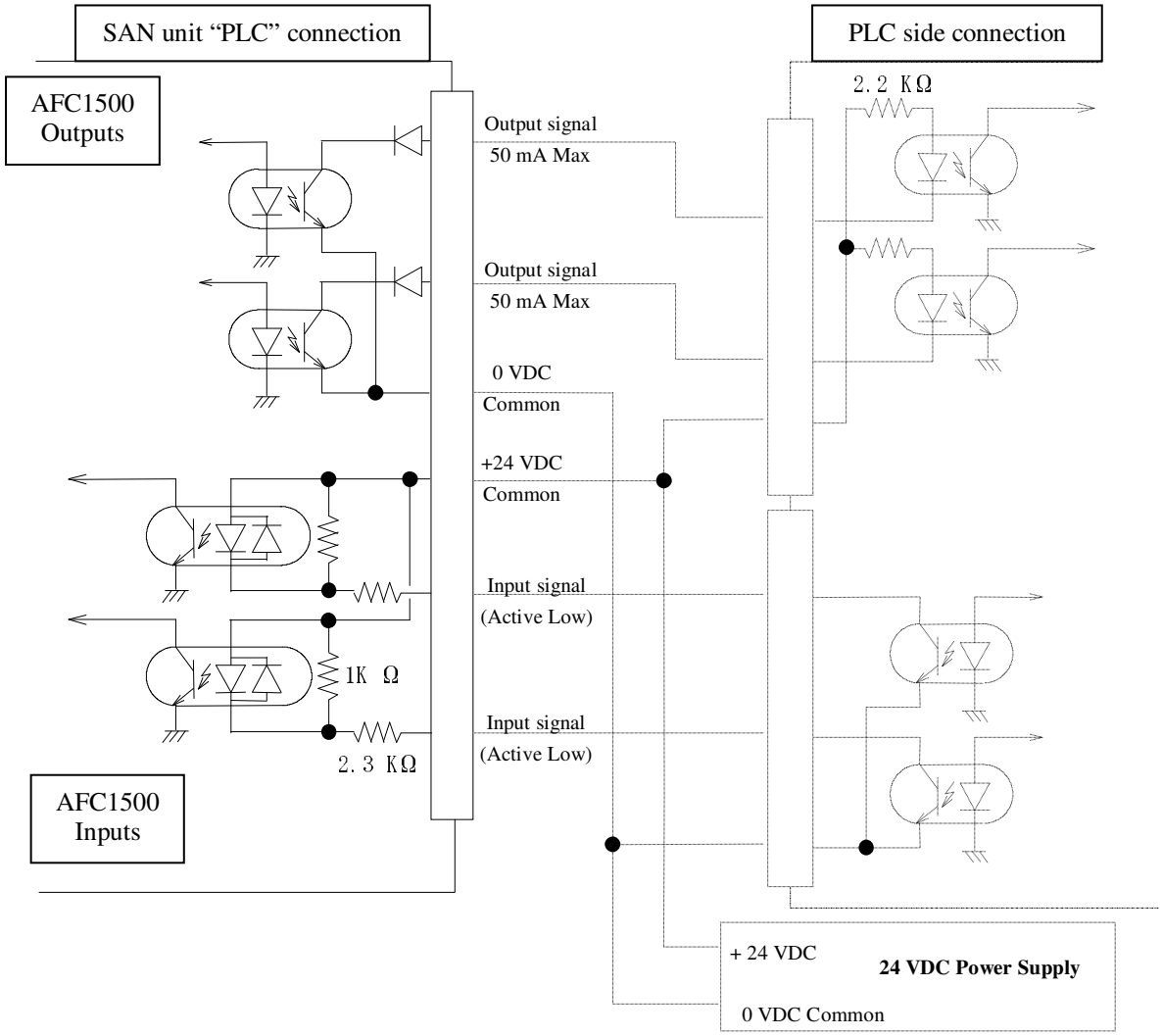


FIG. 4-7-5 PLC Wiring Sample

All AFC1500 inputs and outputs (I/O) are active true low and must be only be connected to devices that accommodate active true low logic for correct operation. Inputs are sourced (normally high) and activated when pulled low (0 VDC).

Outputs are rated at +12~24 VDC, 200mA. When activated, open collector sink outputs (normally high) pull the input device signal low. (0 VDC). To ensure correct operation of AFC1500 output circuits, do not connect to an input device with high Input resistance.

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4.7.6 Synchronized Fastening Operation (Without MULTI Unit)

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 SAN Units WITHOUT a Multi Unit, the SYNC terminals must be wired between all affected spindles.

The SYNC signals are Bi-directional signals for synchronized fastening (5V, TTL signal). with Pins 6 & 7 internally connected

1. At the start of the cycle until reaching the synchronization point (1st torque), the SAN SYNC signal is ON (LOW condition) to stop other SAN 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 SAN units have not reached 1st torque yet - the SAN unit stays in the standby state waiting for all connected spindles to reach first torque.
3. When the SYNC signal is HIGH (all SAN units have completed the first step), all units simultaneously start the second step.

The figure below shows 2 ways for wiring the SYNC in a multi-spindle configuration.

NOTE: This wiring configuration is not the same as the AFC1100.
Connecting these signals with an AFC1100 cable could damage the input circuit!

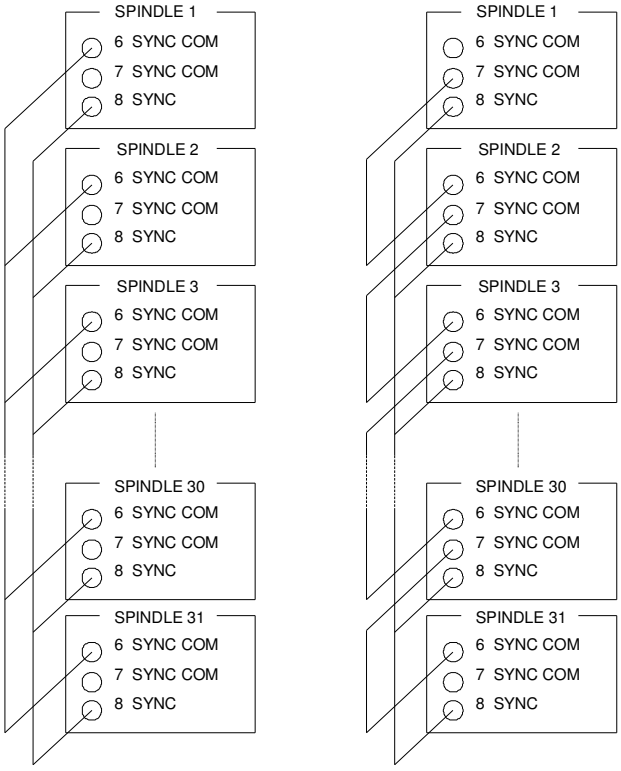


FIG. 4-7-6 Synchronizing Wiring Sample

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4.7.7 Signal Timing Chart

A. Basic Control Signals

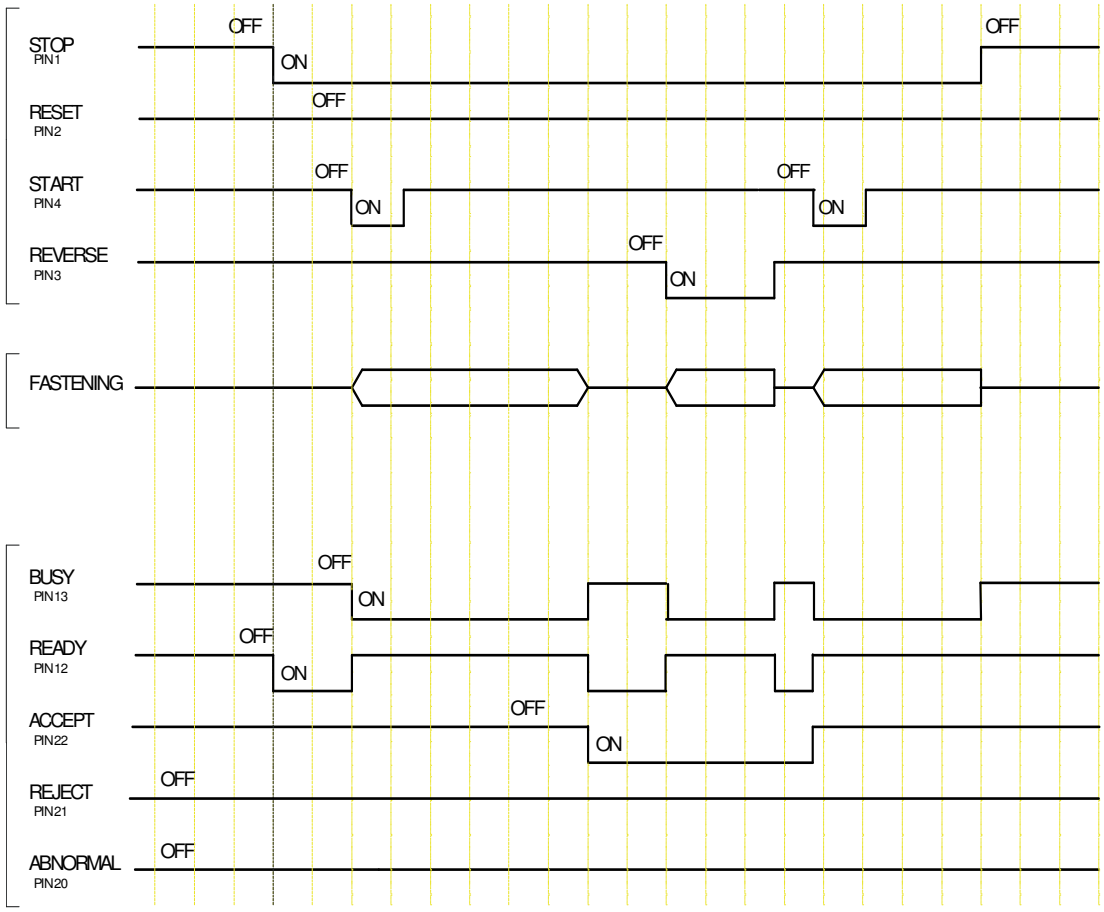


FIG. 4-7-7a Basic Control Signals

♦ Because the RESET input clears all fastening data, discrete outputs, and communication buffers, it should be activated only to clear a System Abnormal or to perform a required Zero Check. The System will automatically reset with each fastening, and a manual RESET activation between cycles could result in data loss. The RESET signal requires a pulse of 200~500 milliseconds.

♦ The STOP input is Normally Closed, and must be enabled for normal operation. When STOP is disabled, all operations cease and all inputs and outputs become inactive.

♦ Once set on, ACCEPT and REJECT signals will latch on until the start of the next cycle.

♦ The START signal will not operate during RESET, REVERSE, or ABNORMAL signal activation. The START signal requires a pulse of 200~500 milliseconds for the AUTO START mode. If the system is set-up in DEADMAN mode (Used mainly in handheld applications), this signal has to stay on during the complete fastening cycle. If the signal is prematurely disabled before the end of cycle, the spindle will immediately stop.

♦ When the ABNORMAL signal is active, normal operation will cease. The Abnormal problem must be cleared and a RESET must be input to clear the Abnormal output and begin normal operation.

♦ REJECT, ACCEPT, ABNORMAL, READY, and BUSY output signals must be interlocked with BANK 1 and activated only when BANK 1 is selected.

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B. Fastening Work Selection and START signal input

WORK SELECT Inputs provide a means to change the preset parameter sets when the system uses multiple fastening specifications. These four bits are used in a binary fashion to select up to 16 different parameter sets.

With none of the bits enabled, the system will automatically use parameter set #1. See 4.7.2 for the WORK SELECT truth table. FEC recommends the confirmation of the proper WORK SELECT prior to initiating a START input. This can be done by monitoring the Work Select output signals prior to enabling the start signal. (See 4.7.3 Bank Select Table for BANK 2)

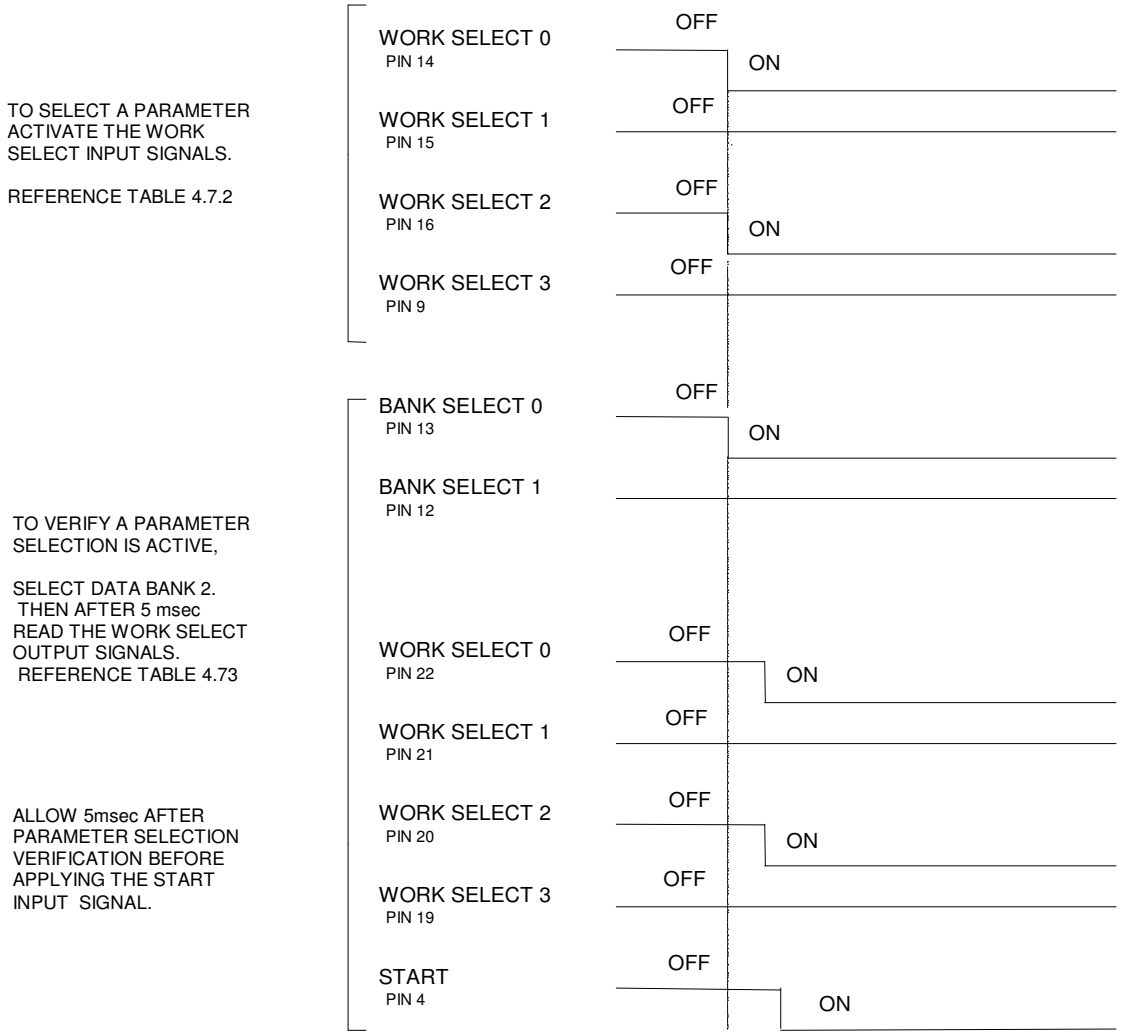


FIG. 4-7-7b Example of Parameter # 6 Selection

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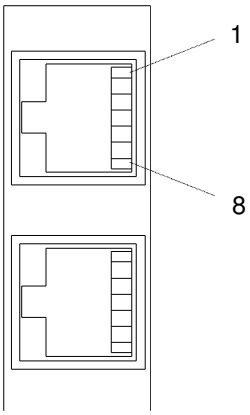
4.8 RS-485 Data communication ports.

The internal AFC1500 system communication is performed via RS-485 communications ports. These ports are linked together by means of daisy-chaining from one spindle to the next. The two connectors provided on the front of each SAN Unit are internally connected and can be connected, between units, in any order.

Each connector carries two channels of RS-485. One channel is used for external communication to the AFC 1500 User Console Computer (CH1). The other channel is used for high speed communication from spindle to spindle (CH2).

RS-485 Connection

PIN	SIGNAL NAME
1	TX+/RX+ (CH2)
2	TX-/RX- (CH2)
3	RX+ (CH1)
4	TX- (CH1)
5	TX+(CH1)
6	RX- (CH1)
7	GND
8	GND



Mating Connector: RJ45 Modular

FIG. 4.8 RS-485 port connectors diagram.

Note: Cabling length should be kept to a minimum to reduce the affect of electrical noise. Additionally, care should be taken to avoid routing cables near high signal noise areas such as AC Motor invertors, speed controllers or strong RF signals.

Standard CAT 5 or CAT 5e Ethernet cables can be used for this connection.

WARNING:
DO NOT connect the AFC1500 system RS-485 communications port to an Ethernet Network or circuit damage may occur!

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4.9 MON. 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 connection is not required for the system to operate.

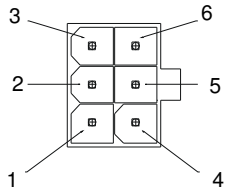


FIG. 4-9a MON connector

Mating Connector: Molex #39-01-2065 Pin # 30-00-0047

PIN	Signal	Description
1	Torque voltage	Torque voltage monitoring output. (-5V to +5V).
2	Angle pulse	Angle pulses monitoring output (TTL, IOL = 30 ma).
3	Angle CW/CCW	Forward/Reverse pulse monitoring output (TTL, IOL = 30 ma).
4	Current voltage	Current voltage monitoring output (1.2Apeak/V).
5	Speed voltage	Speed voltage monitoring output (1000rpm/V [motor speed]).
6	Signal ground	Common for all output signal.

IOL = Current Output Low

Angle and direction are output as shown below.

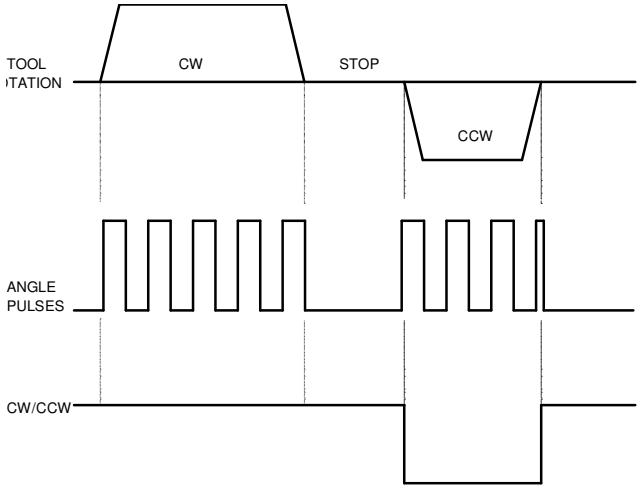


FIG. 4-9b T/A OUT signal reference

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4.9.1 Monitor Connector Output Circuit

Reference output circuitry for the Monitor Connector are shown below.

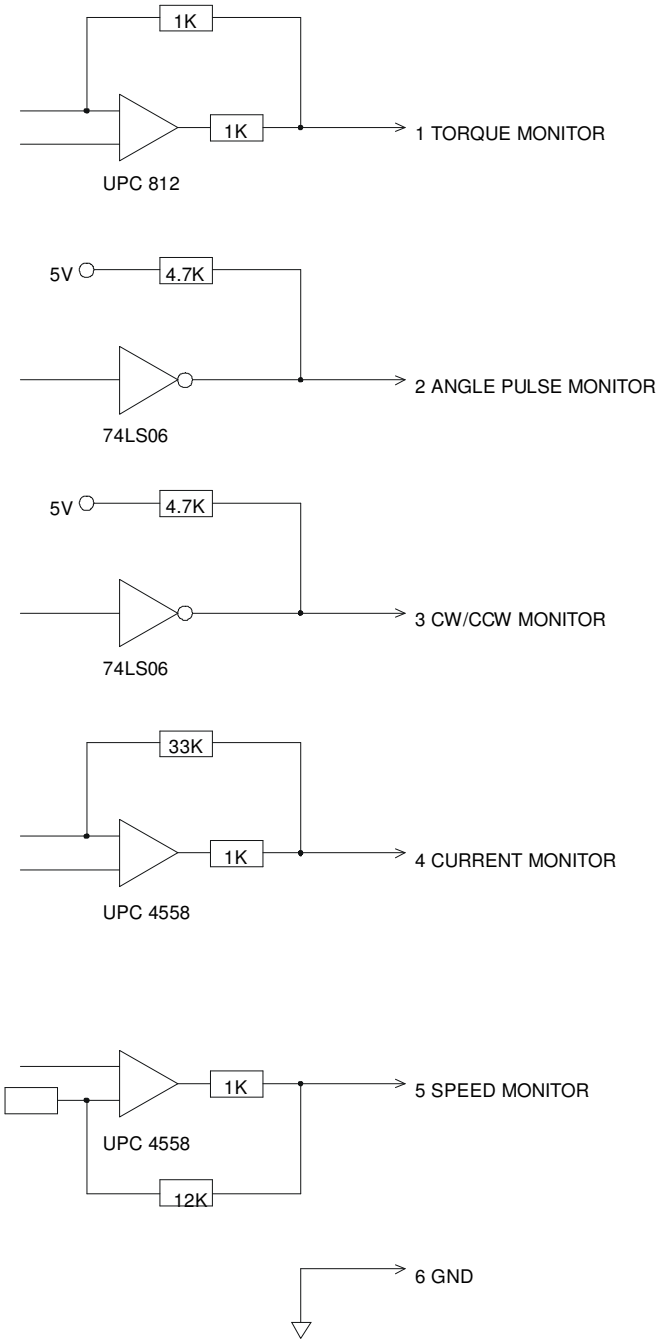


FIG. 4-9c Monitor Terminal Output Circuit.

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4.10 SAN Unit DIP Switch setting.

In a multiple SAN Unit system, it is necessary to address the SAN units for communication purposes. The number is set using the DIP switch located on the front of the SAN unit. No two units may share the same number, however units may be skipped or started from a number besides one. Typically units are numbered in sequential order. (ex. 1-31)

Note: When connected to a Multi Unit, the programmed sequence must not contain any spindle(s) which are skipped or missing from the DIP switch setting procedure.

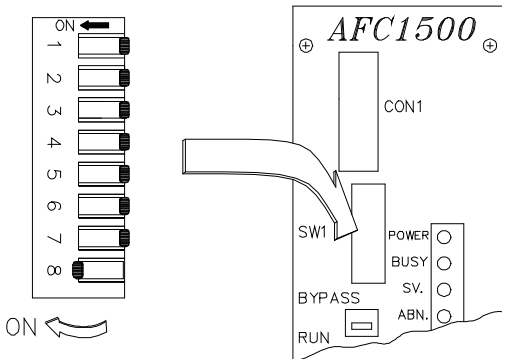


FIG. 4-10 Dip Switch settings

4.10.1 SAN 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

♦

♦ **DIP Switch 1** - **CAL/Zero acceptance window selection**.(in Firmware versions 1.03 and greater).

- ON - CAL/Zero acceptance = +/- 10 % of Full scale torque
- OFF - CAL/Zero acceptance = +/- 4 % of Full scale torque (Default)

♦ **DIP Switch 2 - Start input type selection**. (Set "OFF" with Multi Unit)

- ON - Deadman - Start input must remain on for the entire fastening cycle. (For Manual applications).
- OFF - Auto Start mode - Start input pulse initiates automatic cycle. (Default) (Cycle starts and continues from start pulse)

♦ **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)

(When set-up for "Dual Transducer" Function, DIP Switch 3 has an alternate function – ON sets the controller as MASTER & OFF sets the controller as SLAVE – see 7.3.8 for more information)

NOTE: The SAN unit must be powered off and on again after any DIP switch change.

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4.10.2 SAN Unit DIP Switch positions 4 ~ 8

♦ DIP switch positions 4 ~ 8 are used for setting the SAN unit spindle address number as described in the following table. Do not set two spindles with the same address.

NOTE: The SAN unit must be powered off and on again after any DIP switch change.

SAN UNIT	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
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

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4.11 Tool Connection

♦ Tools are connected to the SAN controller using two cables. One cable connects to the Torque Transducer preamp and the other is a combination Motor / Resolver Cable. The preamp cable is separated from the Motor / Resolver cable to reduce the possibility of high voltage noise interference.

♦ Each cable is labeled with a corresponding spindle number and should be connected to the corresponding SAN Controller and Tool.

♦ Cables should be tie wrapped to the motor as shown below. Cable ties should be loose enough to allow the cable to move, but yet hold it in place. Cable ties too tight cause a stress point leading to premature cable failure.

WARNING: Use cylinder cushions or shock absorbers to decelerate the tool head motions and prevent excessive (hard stop) vibration, especially in short cycle time applications operating at high speeds. Repeated shock (over time) could damage a tool.

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.

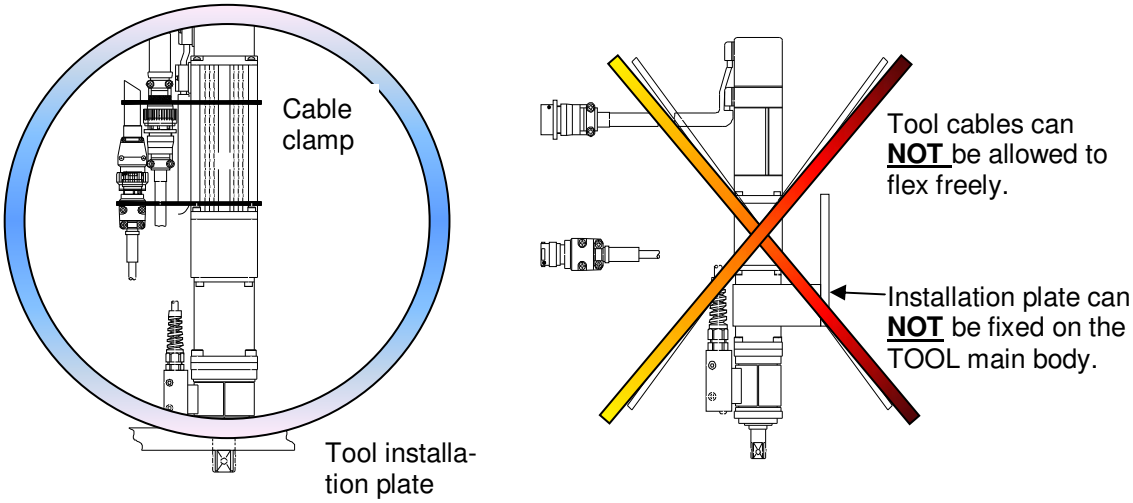


FIG. 4-11 Tool Mounting Diagram

Motor/Resolver Cable -	# FEB-1251	Nominal OD = .505”	Min. Bend Radius = 6.0“
Extension-	# FEB-1283		
Preamp Cable -	# FEB-1173	Nominal OD = .405”	Min. Bend Radius = 4.0”
Extension-	# FEB-1234		
High Speed Tool Cable	# FEB-1524	Nominal OD = .550”	Min. Bend Radius = 5.0”
Extension-	# FEB-1525		

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

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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.

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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.

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4.11.5 Preamplifier connector.

The preamplifier connector links the Controller to the tool torque transducer in order to perform the following functions:

a) Read the torque voltage values from the preamplifier.
b) Test the preamplifier condition by generating a voltage signal for full scale torque by 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. It stores the Calibration values of the tool, factory tool data and diagnostic information.

PIN	DESCRIPTION
1	SCL -SIGNAL CLOCK
2	SDA -SIGNAL DATA
3	CAL -CALIBRATION
4	TORQUE INPUT
5	FRAME GROUND
6	GROUND
7	-12VDC
8	+12VDC

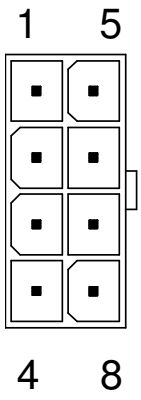


FIG. 4-11-1: Preamplifier connector.

Mating Connector: Molex #39-01-2085 Pin # 39-00-0047

4.11.6 Motor connector

The Motor connector provides control power to the motor.

PIN	DESCRIPTION
1	FRAME GROUND
2	NOT USED
3	W PHASE
4	V PHASE
5	U PHASE

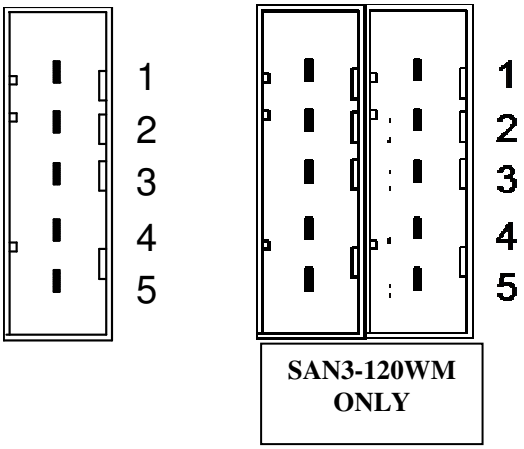


FIG. 4.11.2: Motor connector.

Standard Mating Connector: AMP #1-178288-5 Pin #1-175218-3

SAN3-120WM ONLY - Mating Connector: AMP #1-178289-5 Pin #1-175218-3

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4.11.7 Resolver Connector

The resolver connector 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
1	ROTOR (R1)
2	STATOR (S2)
3	STATOR (S1)
4	NOT USED
5	NOT USED
6	ROTOR R2
7	STATOR S4
8	STATOR S3
9	SHIELD
10	NOT USED

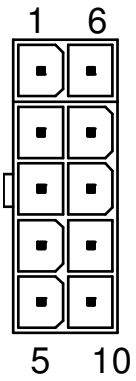


FIG.4.11.3: Resolver connector

Mating Connector: Molex #39-01-2105 Pin #39-00-0047

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4.12 Firmware Flash Connector (CN8)

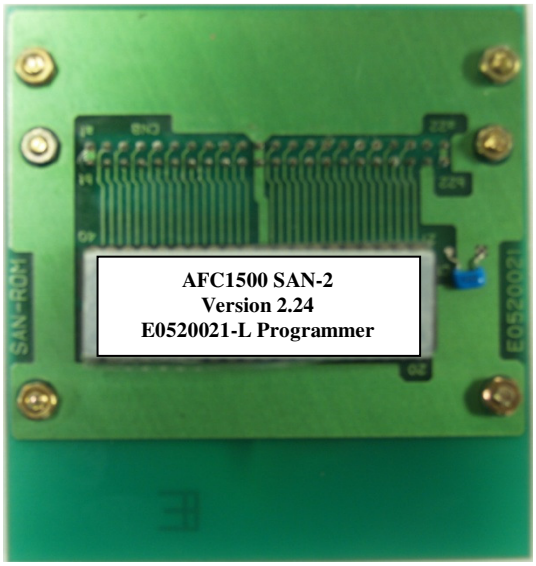
Upgrades or revisions to Firmware are handled easily with the on board Flash connector located on the bottom of each SAN Unit. There is no need to remove or disassemble the unit.

A Flash adapter (SAN-ROM) containing the new firmware can be connected to connector CN8 with the power off to the unit. The power is then cycled on and off with the adapter in place and the firmware is automatically updated.

Note: This connector is for FEC use only and it is not recommended for use other than FEC.



SAN-3 E0350061-L Flash Programmer



SAN-2 E0520021-L Flash Programmer

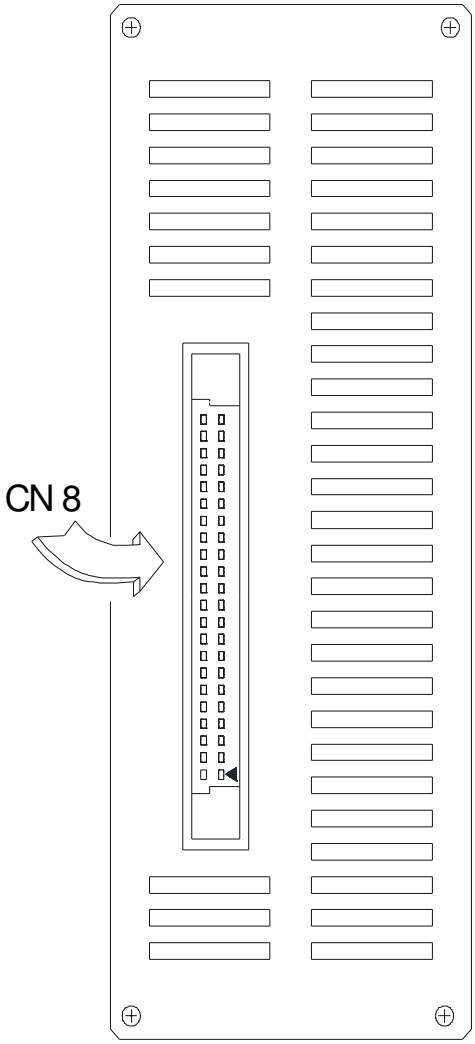


FIG 4-12: CN8 location (SAN) unit bottom view).

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Chapter 5: Power Up and Initial Checks

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5.1 Before Powering On

WARNING: Follow Lockout/Tagout 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 3.1** System Block Diagram and **Section 4.5** Wiring Diagram.

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

1. Verify San Unit DIP switch settings (4.10)

- Verify that the eight (8) DIP switches visible on the front of each unit are set to indicate the appropriate spindle number and options.

2. Confirm Interface (PLC) connection (4.7)

- Verify that the San unit I/O Interface wiring is connected to the corresponding PLC terminals.

3. Check connections between the tool and the San unit (3.2)

- Verify that the two (2) homerun cables (resolver/ motor and transducer) connecting the tool and San unit are secure. Ensure that each numbered set of two (2) cables is connected to the identically-numbered tool and San 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 (3.2, 4.6)

- Verify input power is properly connected (4.11.2).
- Ensure input power voltage to the San Units is 200~242 VAC.
- After turning on the power, verify the voltage again to ensure it has not dropped as a result of loading.

NOTE: After a SAN 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 SAN unit. If a SAN unit does become disabled, keep the power off for five (5) minutes, then power on again to reset the fault.

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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.

Programming for Multiple Spindle applications should be performed using the FEC Inc. “AFC User-console” software to simplify the programming operation and to provide a means of creating a back-up file of the Set-up.

NOTE: Most AFC1500 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, verify all San unit RUN/BYPASS switches are set to RUN. Perform the following procedure by attaching the Display and Programming Unit:

1. Check the transducer ZERO output.

- Press the RESET button on front of the Keyboard-display Unit. The San unit will output a number (voltage) to the DATA display and the "ACCEPT" LED will light. (See NOTE 1 below.)

2. Check the transducer CAL output.

- Press the RESET button on front of the Keyboard-display Unit. The San Units will output a number (voltage) to the DATA display and the "ACCEPT" LED will light. (See NOTE 1 below.)

NOTE 1: If the Zero and/or Cal check results in an "ABNORMAL" LED output from the San 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 RUN/BYPASS switch on each San unit as follows:
   1. Verify San unit #1 is set to RUN.
   2. Set all other San Units to the BYPASS position.

B. Press the manual REV button on front of the Keyboard-display Unit. Verify that spindle #1 is turning in the appropriate direction (opposite the preset direction), and that all other spindles are motionless. (See NOTE 2 below.)

C. Switch San unit #1 to the BYPASS position. Switch San unit #2 to RUN, and verify spindle #2 reverse operation (reference Step B).

D. Repeat this procedure for each San unit/spindle. **It is important to complete this step for each San unit/spindle prior to performing the next step.**

E. After all San Units are verified individually, ensure that each of the BYPASS switches are set to the RUN position. Press the REV button on the Main Operator panel to operate all spindles simultaneously and verify all spindles operate.

NOTE 2: If any SAN unit fails to activate the appropriate spindle, correct the situation before continuing to the next unit. First, check the nutrunner (tool) cables going to the SAN unit to verify correct connections to the appropriate components.

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4. Verify operation of manual start.

- Press the START button on the Main unit and verify that all tools run in the correct direction until the pre-programmed time elapses, creating a reject.
- Press the RESET button on the Main operator panel to clear the REJECT light and LED outputs from the San Units.

5. Verify System operation by external commands.

- Confirm that the equipment operates correctly when PLC inputs and outputs are activated. Use the PLC to perform all of the functions (START, CAL, etc.) that were manually activated earlier in this Section.

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Chapter 6: Fastening Instructions

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6.1 Fastening Control.

The AFC1500 is user programmable to select from two different fastening methods, referred to as Torque Control and Angle Control methods. For a stand alone SAN Unit operation, 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. With the addition of a Multi Unit, fastening can be performed in up to 3-steps and performed multiple times, making the number of steps almost limitless.

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

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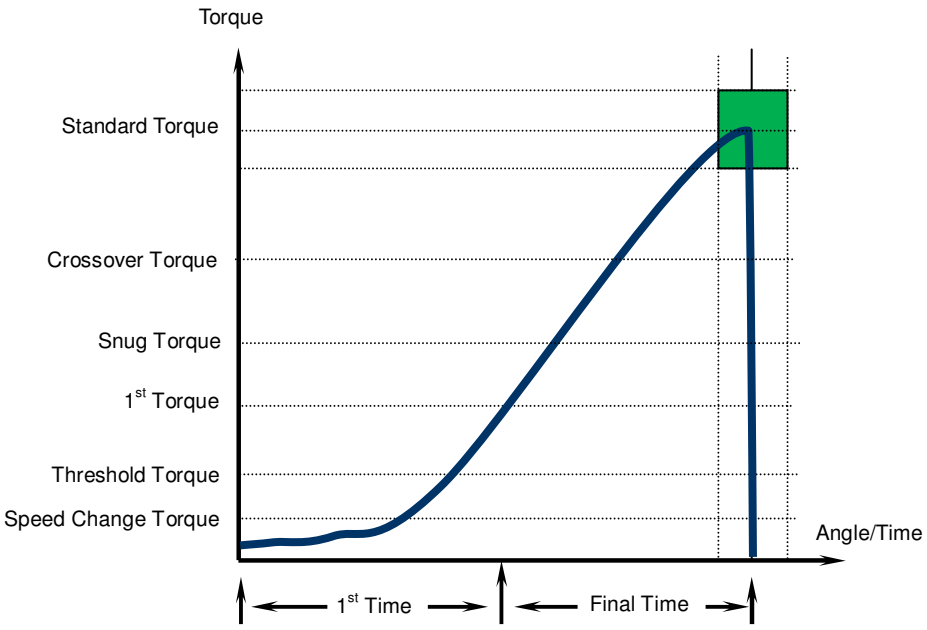


FIG. 6-1-1a Torque Control Functions for One-Step Fastening

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♦ 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 4.7.6 for Standalone 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

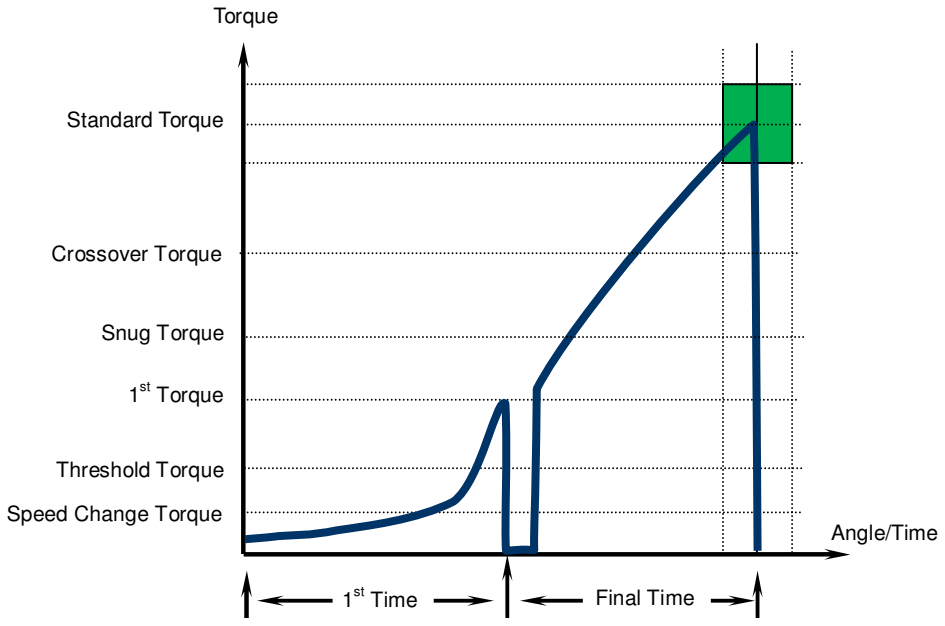


FIG. 6-1-1b Torque Control Functions for Two-Step Fastening

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♦ 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 4.7.6 for Standalone 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

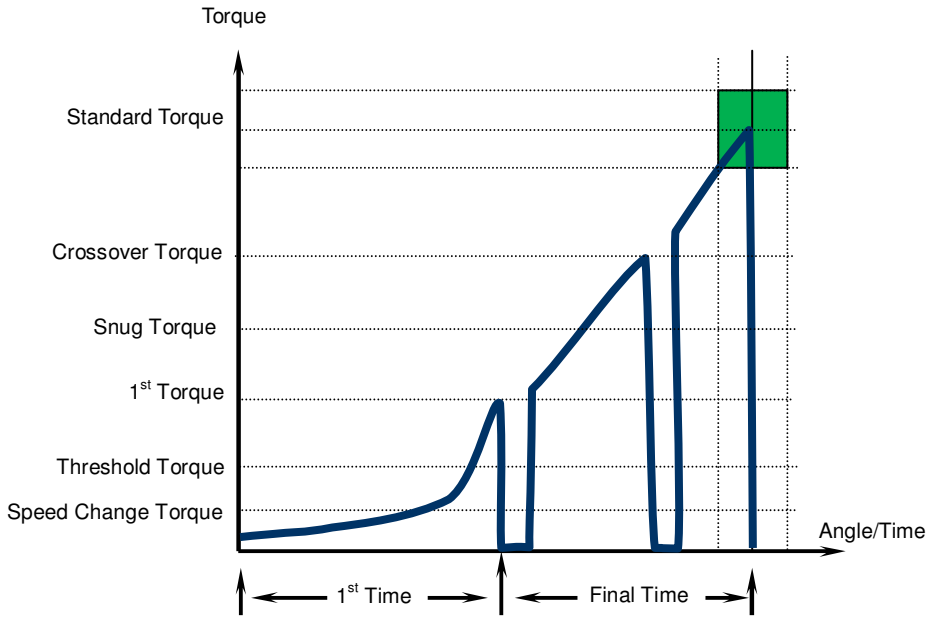


FIG. 6-1-1c Torque Control Functions for Three-Step Fastening

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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

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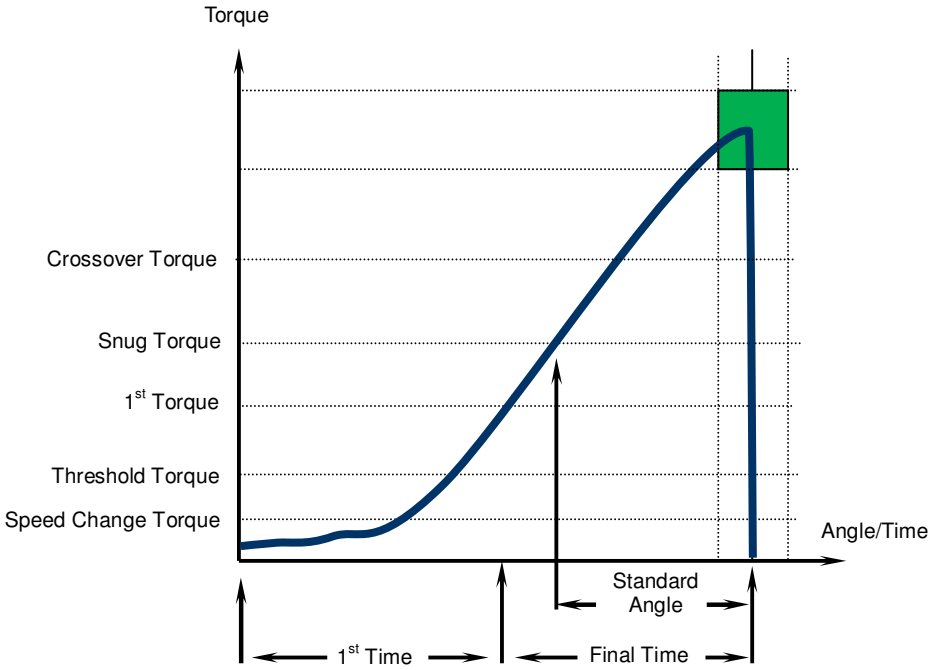


FIG. 6-1-2a Angle Control Functions for One-Step Fastening

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♦ 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 4.7.6 for Standalone 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

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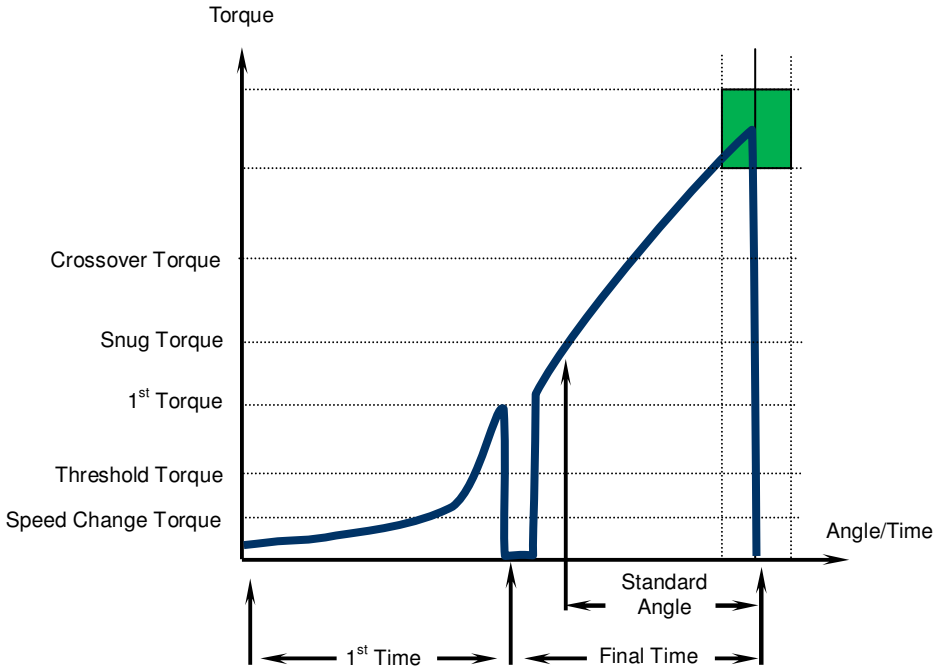


FIG. 6-1-2b Angle Control Functions for Two-Step Fastening (1st step Torque)

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.

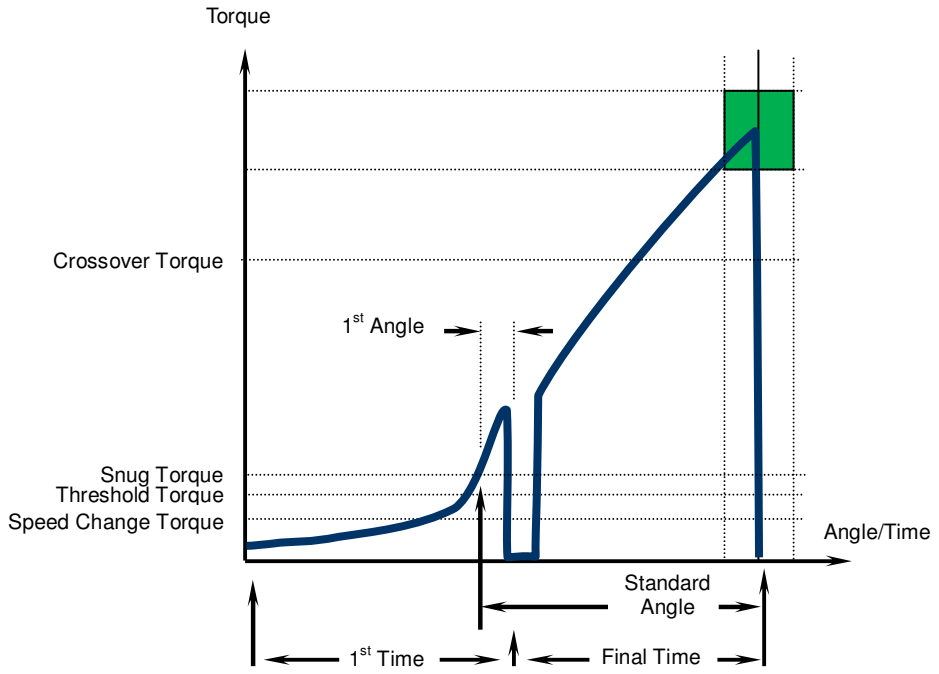


FIG. 6-1-2c Angle Control Functions for Two-Step Fastening (1st step Angle)

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♦ 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 4.7.6 for Standalone 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

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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.

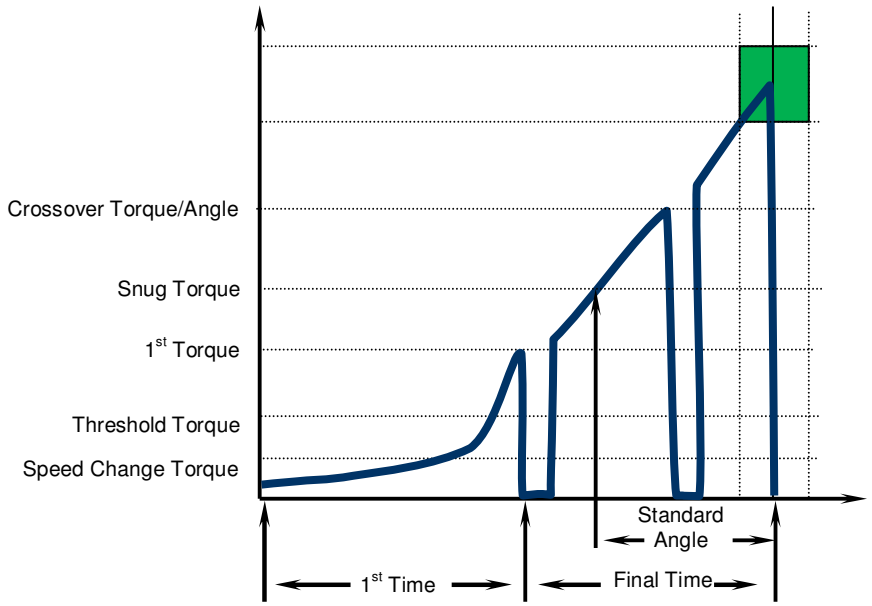


FIG. 6-1-2d Angle Control Functions for Three-Step Fastening

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6.2 Monitoring Functions

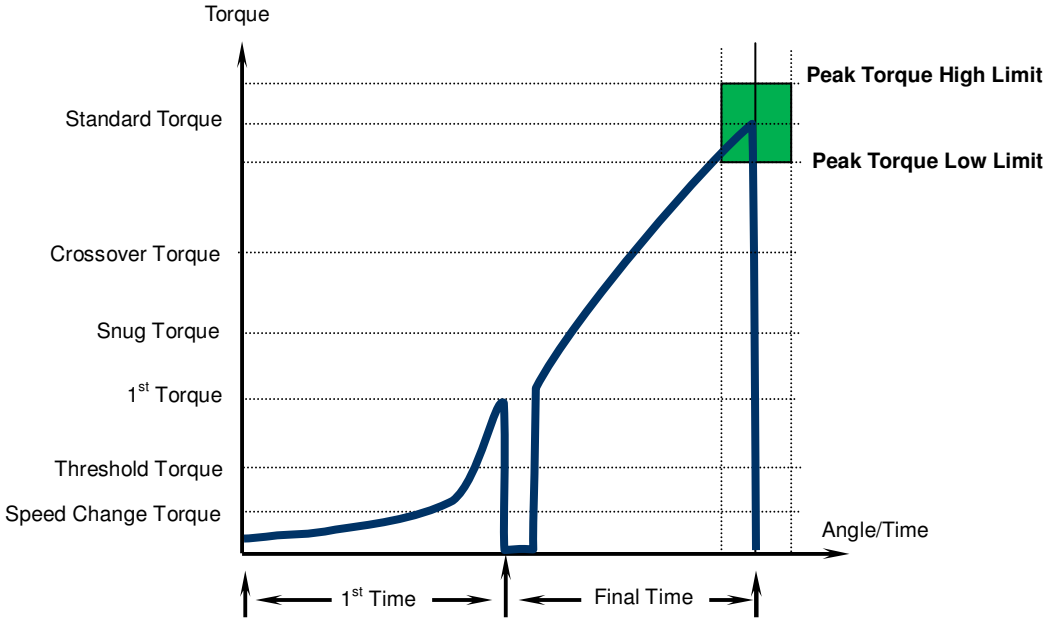
The AFC1500 System is user programmable to select and set the monitoring limits for torque, angle, time, up to three independent torque rate areas, and special functions describe below.

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.

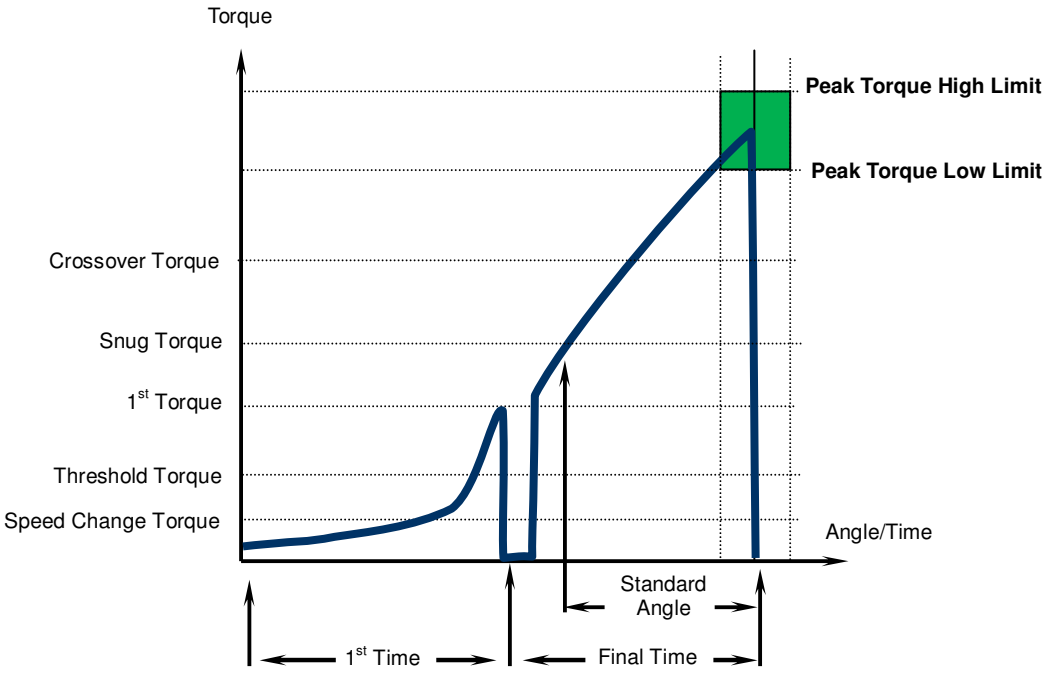
TORQUE CONTROL	
REJECT TYPE	**CAUSES**
PEAK TORQUE HIGH LIMIT	Re-hit of pre-secured fastener. Incorrect parameter set-up.
PEAK TORQUE LOW LIMIT	Reject condition caused by another monitor item reject.



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▪ 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.



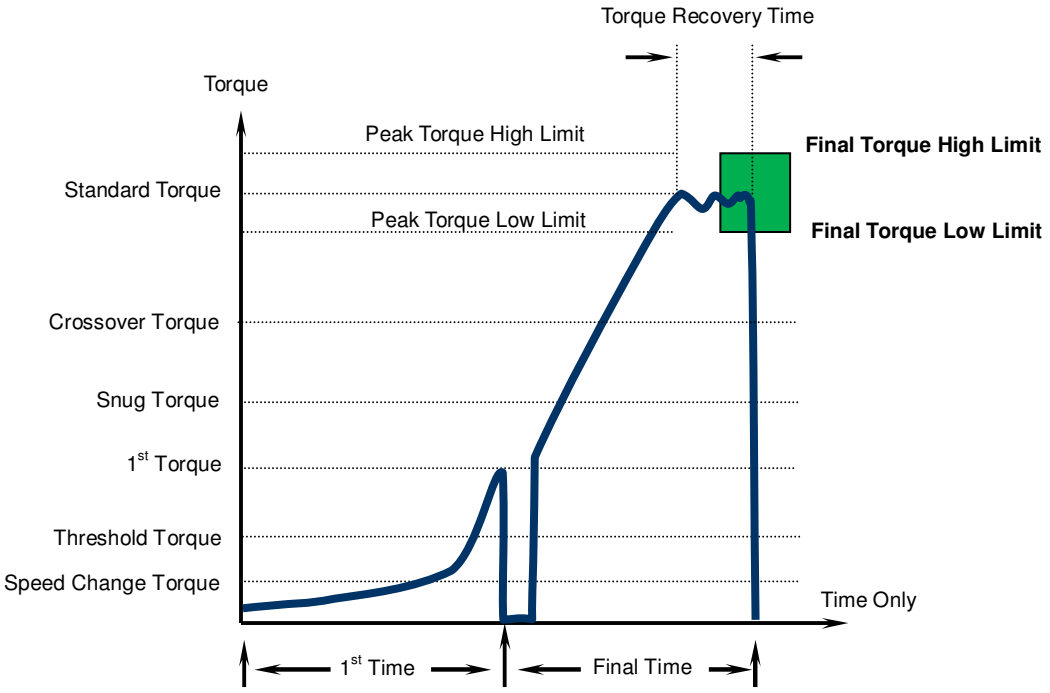
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6.2.2 Final Torque Monitoring

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.

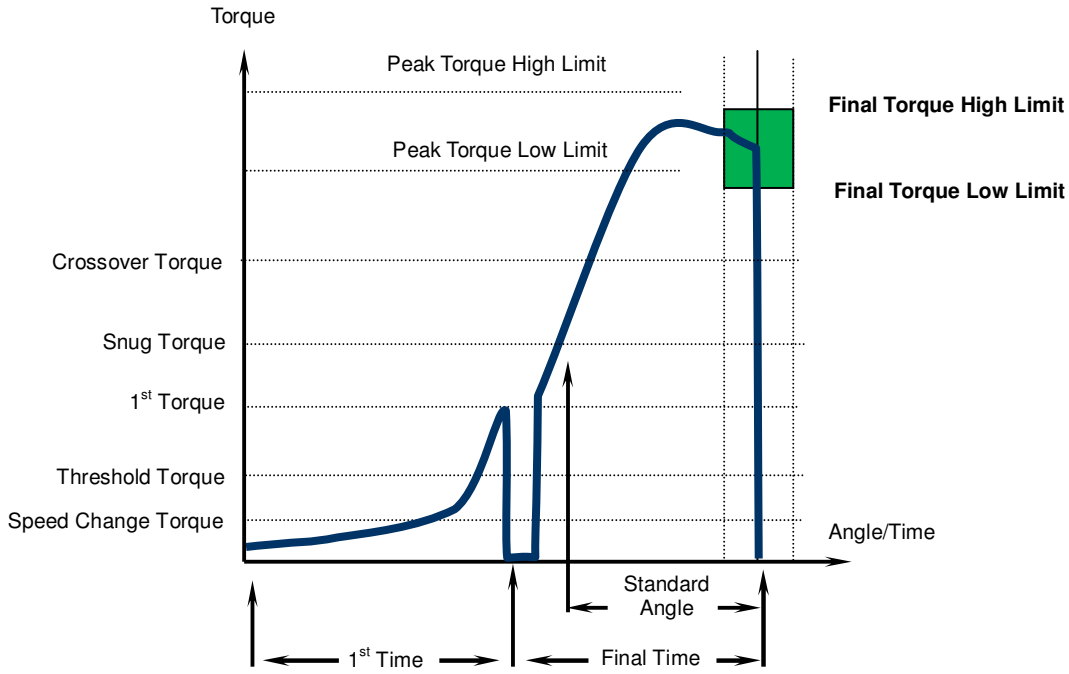
TORQUE CONTROL – TORQUE RECOVERY ENABLED	
REJECT TYPE	**CAUSES**
FINAL TORQUE HIGH LIMIT	Excessive chatter of the torque signal due to slip stick friction. Incorrect parameter set-up.
FINAL TORQUE LOW LIMIT	Reject condition caused by another monitor item reject.



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- 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.



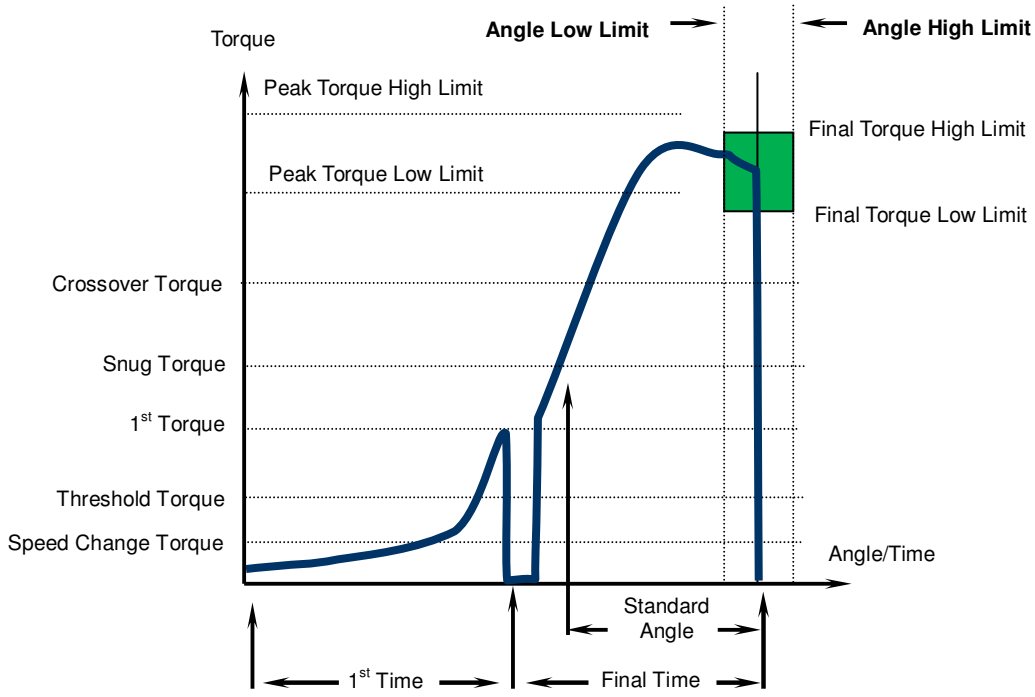
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6.2.3 Angle Monitoring

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.

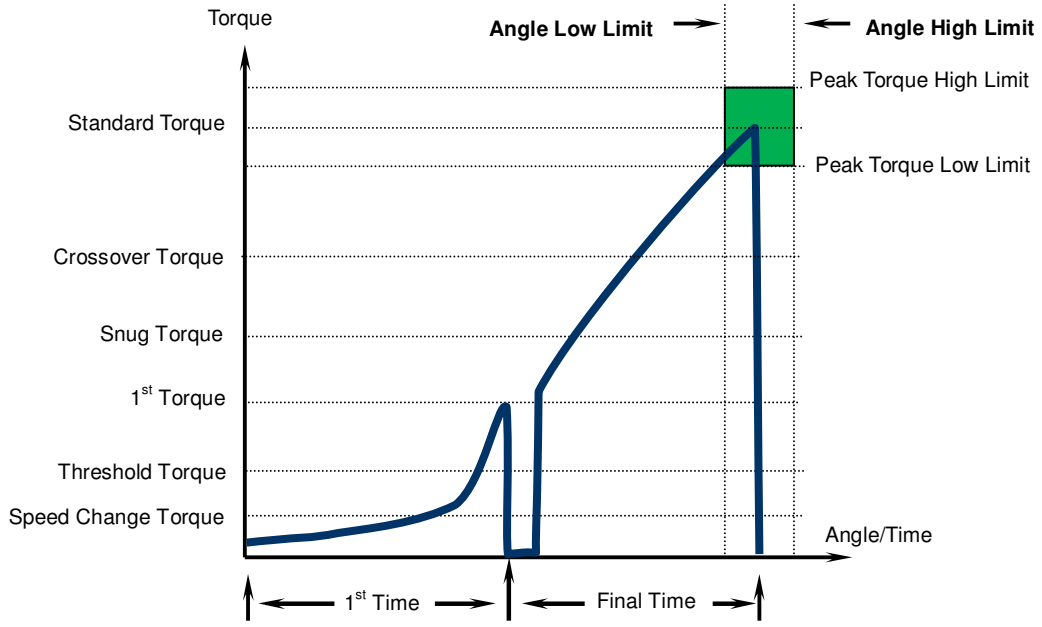
ANGLE CONTROL	
REJECT TYPE	**CAUSES**
ANGLE HIGH LIMIT	Incorrect parameter set-up.
ANGLE LOW LIMIT	Reject condition caused by another monitor item reject.



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▪ 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.



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6.2.4 Point-to-Point Torque Rate Monitoring

The AFC1500 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.

NOTE: Refer to table above for stand alone SAN Unit Start/Stop points.

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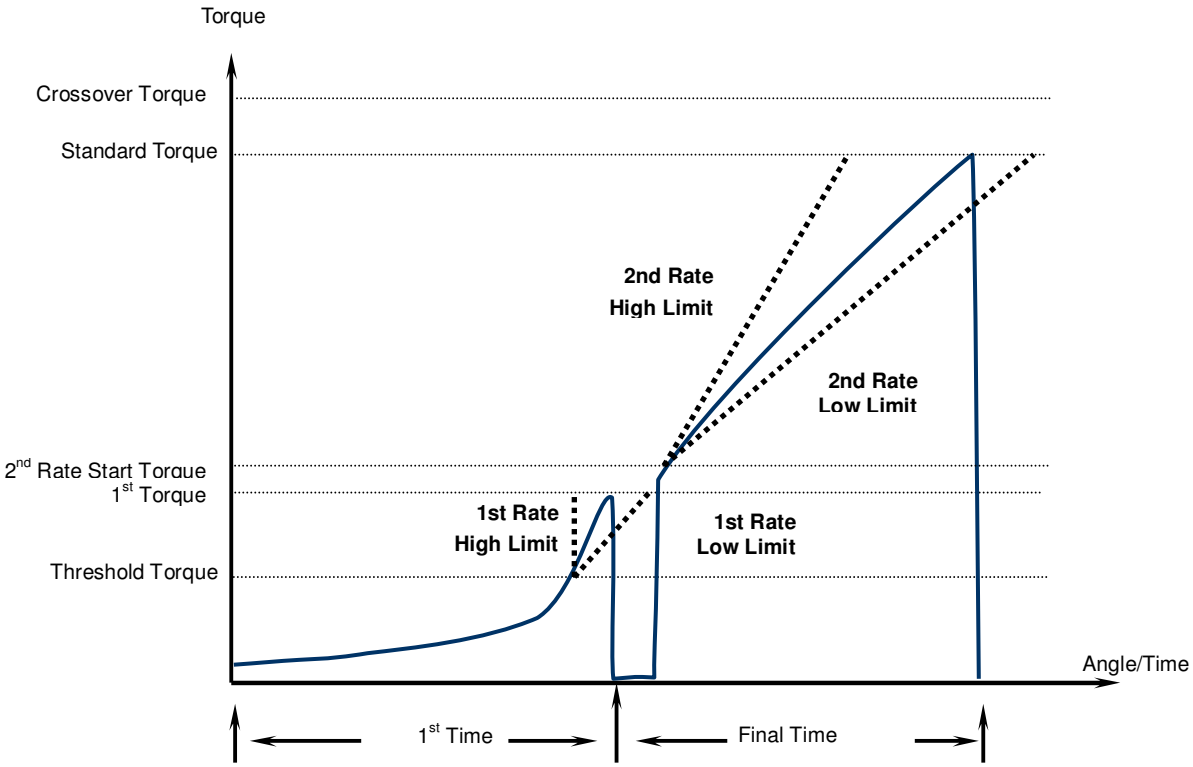


FIG. 6-2-4a Two Stage Point-to-Point Torque Rate Monitoring

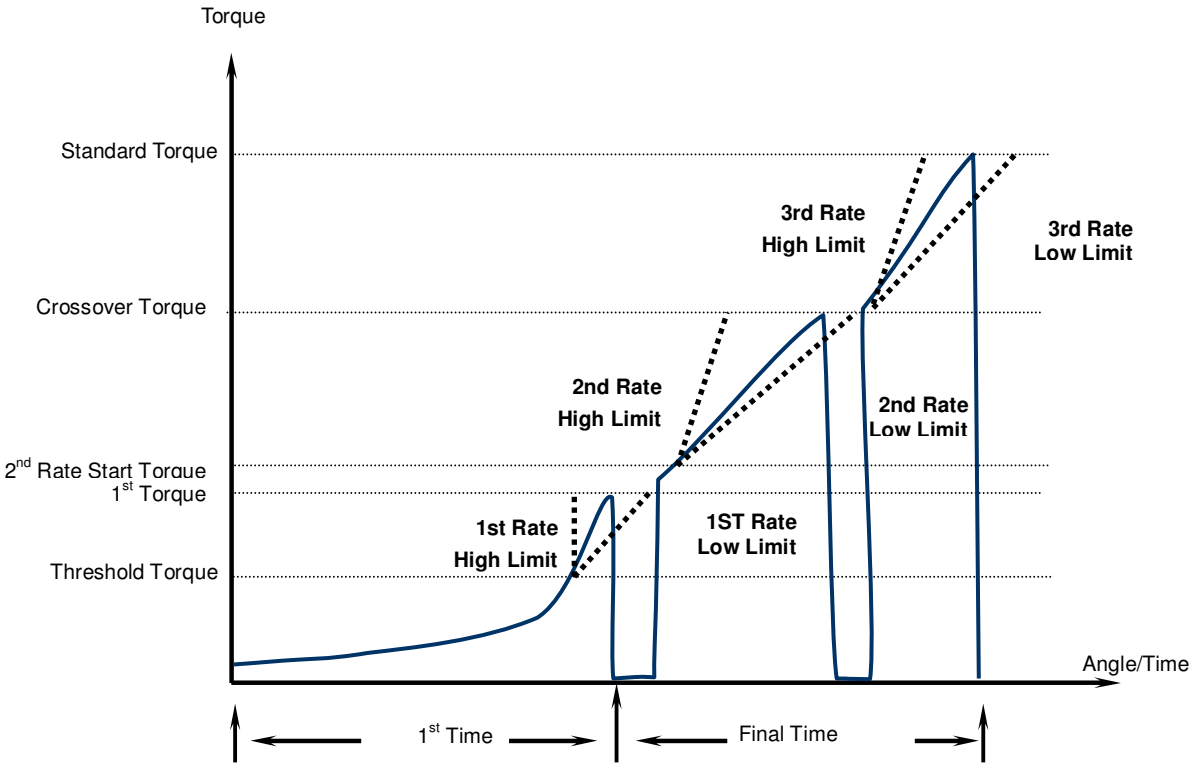


FIG. 6-2-4b Three Stage Point-to-Point Torque Rate Monitoring

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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)			

When the system is configured with a MULTI UNIT, additional operations/functions that can be performed via the Sequence Programming features are not included in the calculation of 1ST TIME and FINAL TIME. Examples of these items include: Reverse commands, Time Delays between steps, or any other items that do not happen directly as a result of initiating a 1st, 2nd, or 3rd Step command.

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6.3 Speed Functions

The AFC1500 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, 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 4.7.6 for Standalone 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.

NOTE: If CROSSOVER TORQUE is set between 95 – 100% of STANDARD TORQUE, TORQUE SPEED automatically drops to 3RPM when CROSSOVER TORQUE is reached. It is not recommended that this functions or settings be used in "soft joint" applications or overload abnormals may result.

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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.

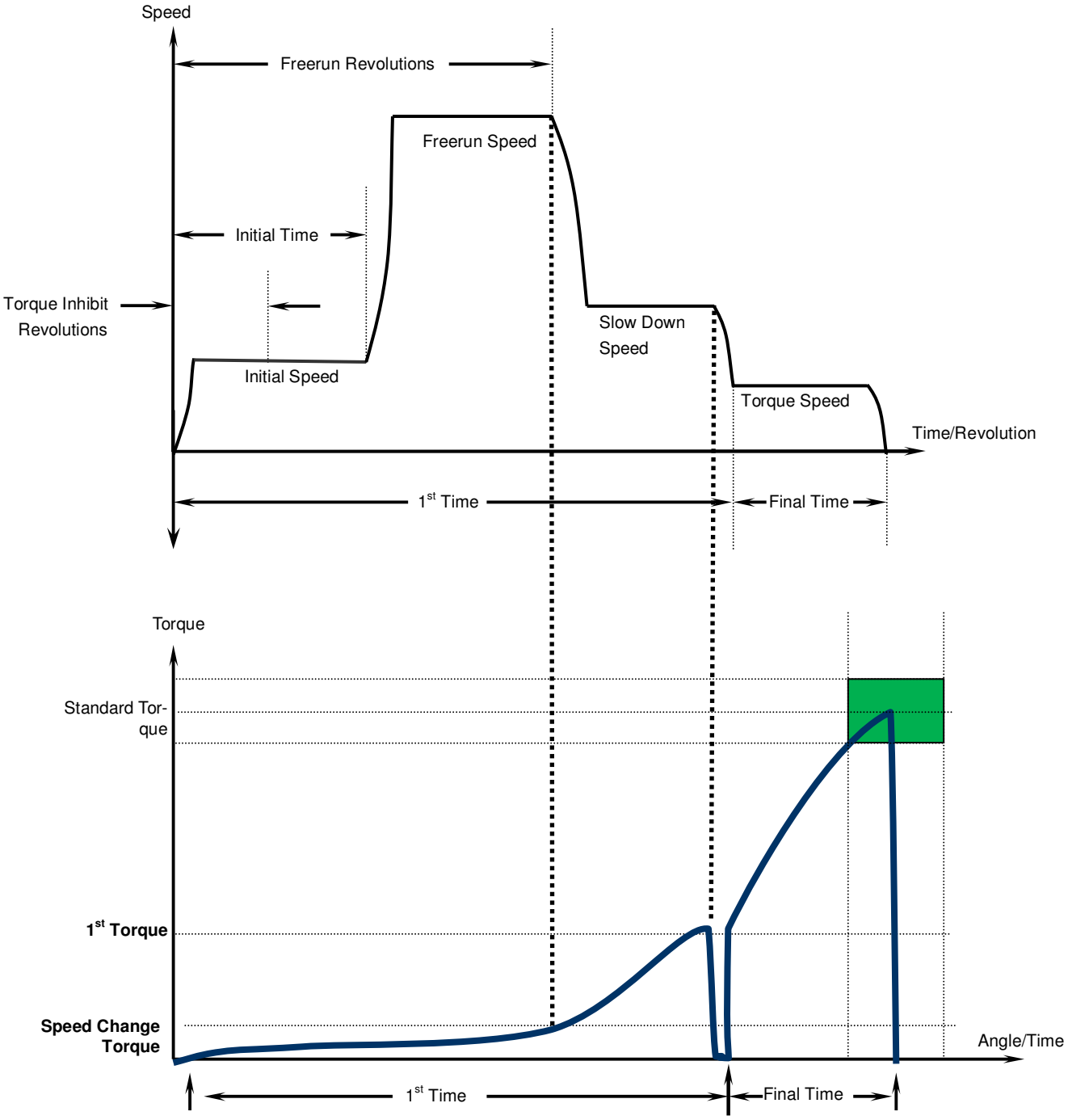


FIG. 6-3b Ideal Relationship of Speed and Torque

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6.4 Reverse Functions

The AFC1500 stand alone System is capable of reverse operations using the manual reverse input on the SAN unit front panel or via the PLC input. 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.
As a stand alone SAN Unit, only one reverse speed is available. If the spindle is controlled by a MULTI Unit, 3 reverse speeds are available.

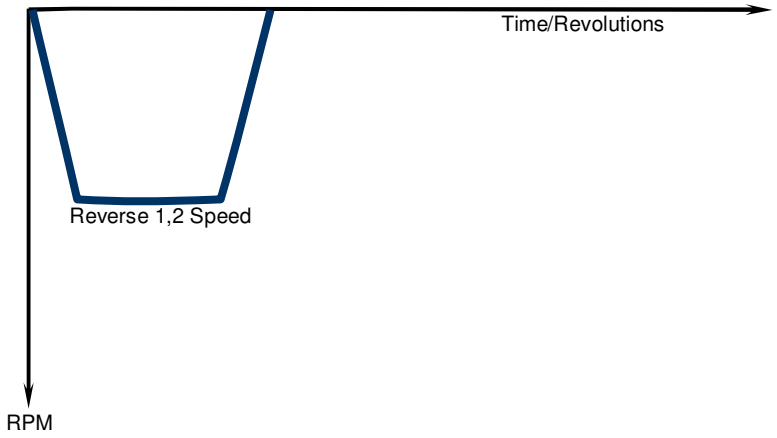


FIG. 6-4 SAN Unit Reverse (Without MULTI Unit)

The reverse function on a stand alone SAN Unit is set with one speed setting (Reverse 1,2 Speed). The duration of the reverse would be controlled from an external source (PLC) using the “Reverse” input or manual reverse pushbutton.

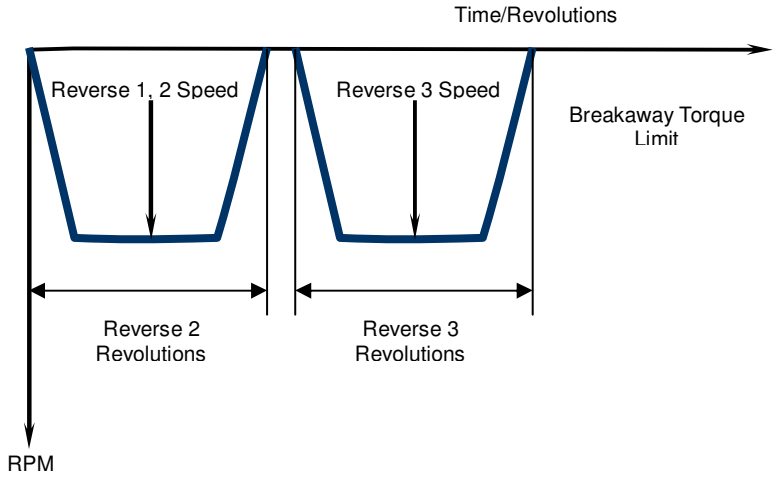


FIG. 6-4b SAN Unit Reverse (With MULTI Unit)

The reverse function controlled by the MULTI Unit has added function. Three separate reverse speeds can be set-up. REVERSE 1 can only be set-up using a time limit from the MULTI sequence. REVERSE 2 and REVERSE 3 are set-up using the number of desired revolutions (Revs.).

A Breakaway torque limit can also be set for REVERSE 2 and 3 to check breakaway torque on reversing applications. An Abnormal will be generated if the breakaway torque is over the preset limit.

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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 a programmed value for a programmed period of time. This time setting can be between 0.5 - 5.0 seconds. Power is applied to the motor for this duration "holding" torque at the specified STD (Standard) Torque. During Torque Recovery the tool will use Torque 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 time should be kept to a minimum for the application requirements.

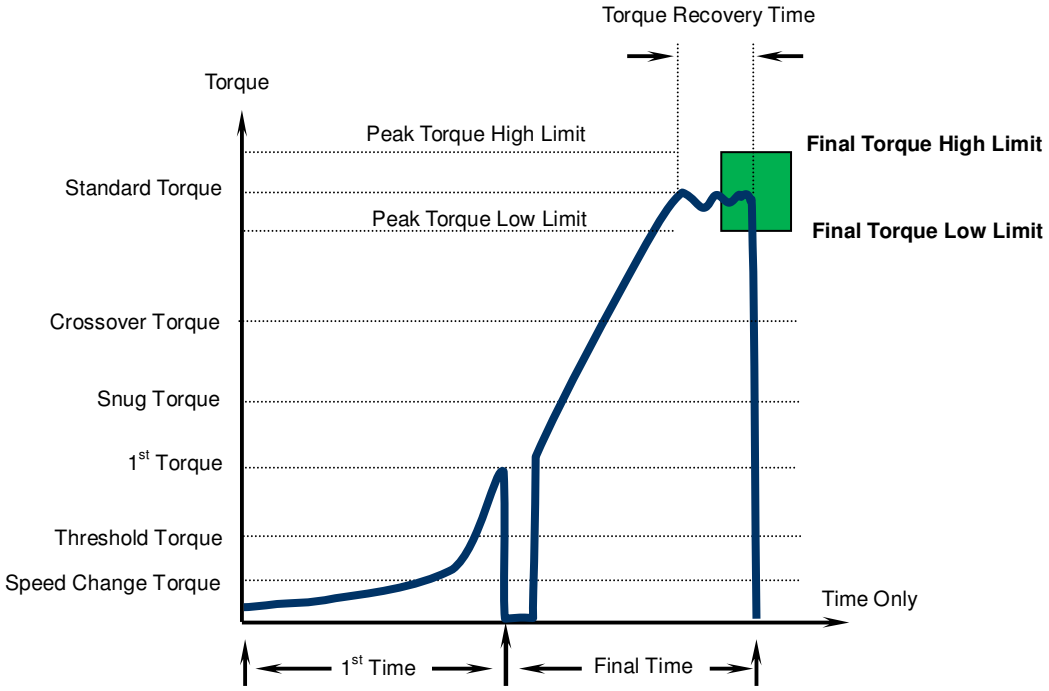


FIG. 6-5 Torque Recovery

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6.6 Added Functions

Additional functions are available in both stand alone SAN Units and Multi Unit configuration. With the addition of a MUTLI Unit as the main control for a SAN Unit or group of up to 31 SAN Units, additional fastening functions are available. The MULTI unit assumes control of the SAN Unit I/O and sequencing is controlled directly from the MUTLI Unit. An internal user programmed sequence program controls all fastening function from one set of PLC I/O, instead of connecting every spindle(s) I/O to a PLC. This drastically reduces the number of I/O and PLC programming, since the sequencing of the spindles is handled by the MULTI Unit. In addition to this function, the MULTI Unit also adds fastening data communication options that are not available directly from a SAN Unit. (See the AFC1500 MULTI Unit Hardware Manual for more information)

Some functions in this section are only available with a MULTI Unit configuration. Stand alone SAN Units DO NOT have all of these functions and have been identified for use with a MULTI Unit only.

6.6.1 Current Monitoring / Control

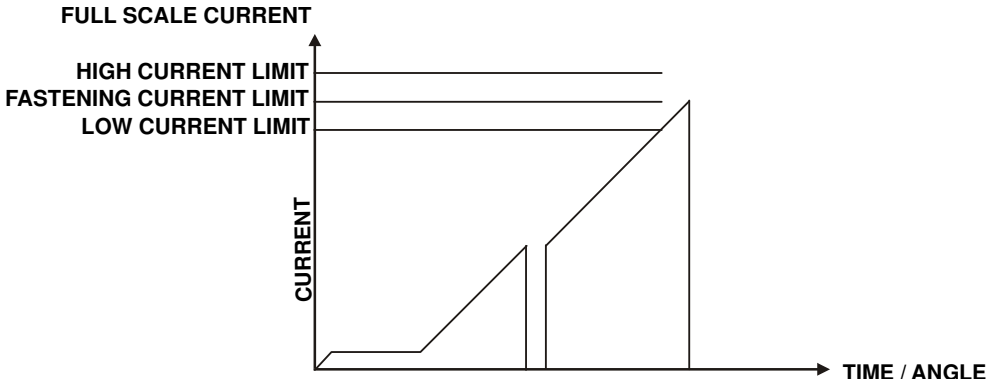
The current monitoring function works as a redundant protection for the torque transducer operations. By sensing the current drawn by the motor, the system can establish an alternate reference to the signals generated by the torque transducer preamplifier. It is intended to detect problems with the motor 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 operator 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.

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 stop 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(SAN Unit) used and should not be changed.

Fig. 6-6-1 Current Monitor function



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6.6.2 Offset Check / Offset Correction

The Offset Check is a function used for determining if there is any prevailing torque/load on the output drive of the tool assembly during a no load free spinning condition. Any external load sensed by the Tool's transducer can detract from torque applied to a fastener during a fastening operation. External loading can occur as a result of external gearing or linkage to drive that is located after the Torque transducer. The Offset Check feature checks that the average torque value sensed during Offset Check Revolutions is below the programmed Offset Torque Limit, otherwise an Abnormal will be generated upon completion of the Offset Check. Offset Check will run for the full duration of the programmed Offset Check Revolutions regardless of the amount of load sensed.

WARNING: Care must be taken to ensure that the Offset check is performed only during a free spinning conditioning. If performed while engaged on a fastener damage may occur.

The Offset Correct feature will correct for the value detected during the last Offset Check and allow the correct torque to be applied at the output shaft of the external drive system. The Offset Check must be run each time the system is powered on as the value will be lost after a power down of the system. If used, it is recommended that the Offset Check is performed at specific intervals throughout the course of a production day to verify that the value has not changed.

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

Note: In normal operation this is not required, as the FEC torque transducer is located at the output shaft of the nutrunner tool assembly. FEC spring loaded spindle assemblies have internal support bearings making external load negligible. This is mainly used when driving through external gearing.

6.6.3 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.

6.6.4 One Pulse Reverse Function

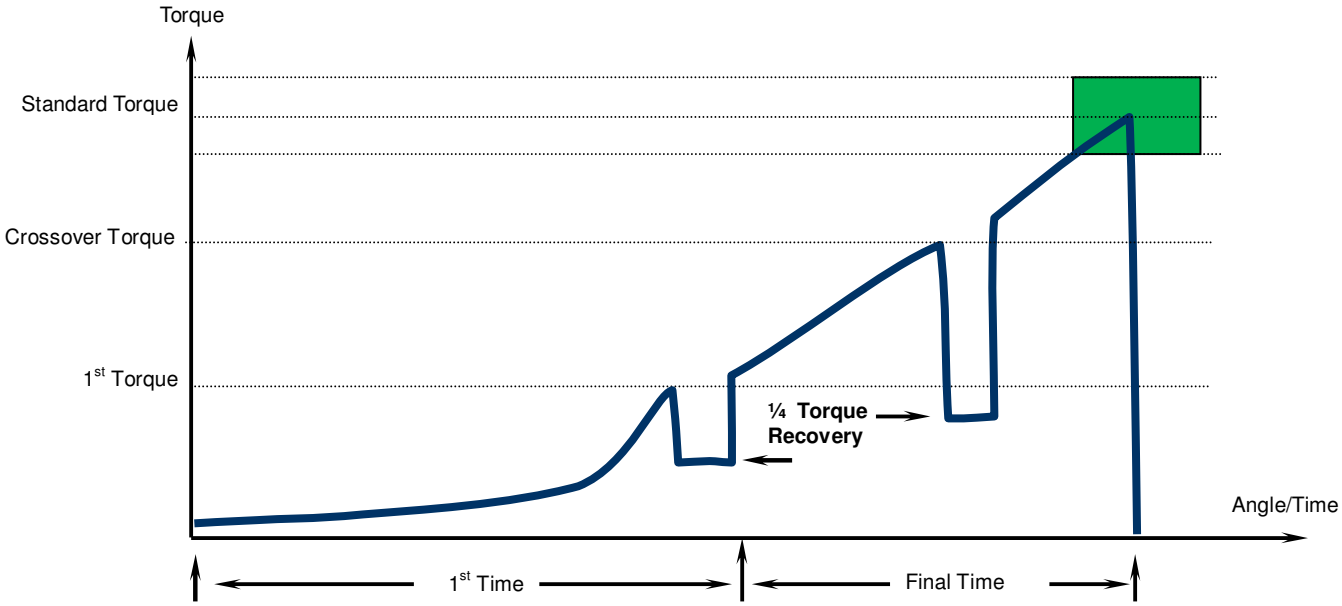
One Pulse Reverse is used in applications where socket to fastener tolerances allow the fastener to "stick" or lock into the socket during fastening operations. Upon completion of Fastening, torque is applied in the reverse direction for the full time specified by 1 Pulse Reverse Time, at the speed specified by 1 Pulse Reverse Speed, allowing the socket to free itself from the fastener. This is done without affecting the torque originally applied to the fastener by setting the 1 Pulse Reverse Torque Limit to a lower Torque value.

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

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6.6.5 Quarter Torque Recovery

When Quarter Torque recovery is enabled, torque is held at one quarter of the next Step torque value until the next step is initiated. This can occur while spindles are awaiting synchronization with other spindles, or during Sequence (MULTI unit) programmed Time Wait commands. Quarter Torque Recovery compensates for drastic torque relaxation during multiple spindle fastening and ensures that sockets remain engaged on the fastener between steps. (See 6.5 for more information on Torque Recovery)



6.6.6 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.

6.6.7 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.

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6.6.8 Rundown Revolution Limits

Rundown Revolution high and low limits can be set to identify fasteners that may be too long or too short for normal operations or for a redundant check for bolts that reach torque but are not seated. This is especially the case where different length fasteners are used and placed by hand. The number of rundown revolutions until fastening end is monitored and judged. Rundown Revolutions is measured from the start of revolution to fastening end. This can be used in conjunction with the Low 1st time limit. (6.2.5)

Note: Since fastener engagement is not always 100% guaranteed (& this is counted as revolution), bolt length differences must be enough for detection without setting limits too tight or problematic rejects may occur. Also, if bolts are hand started (with a variable starting point) this function is not recommended unless the bolts are pre-started to the same point every cycle.

6.6.9 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.

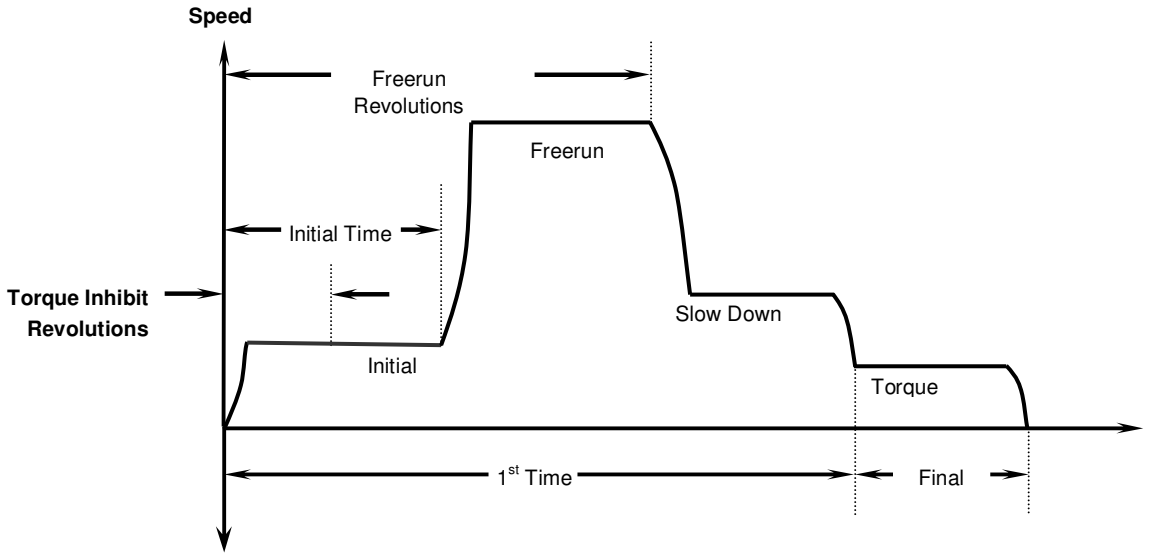


Fig. 6-6-9 Torque Inhibit Function

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.

6.6.10 Fastening End by Self Check Off Signal

The Fastening End by Self Check Off Signal function is used when a specific Torque or Angle Target must be reached prior to a final positioning operation. This function allows the system to fasten to its' Target value and than continue to fasten until either the HIGH limit is reached or the "Fastening End by Self Check Off Signal" input (section 4.7.1) is activated. This ensured that both the Target and the proper position are attained. (Function is enabled by AFC software)

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Chapter 7: System Operations

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7.1 AFC1500 Detachable Display and Programming unit operation.

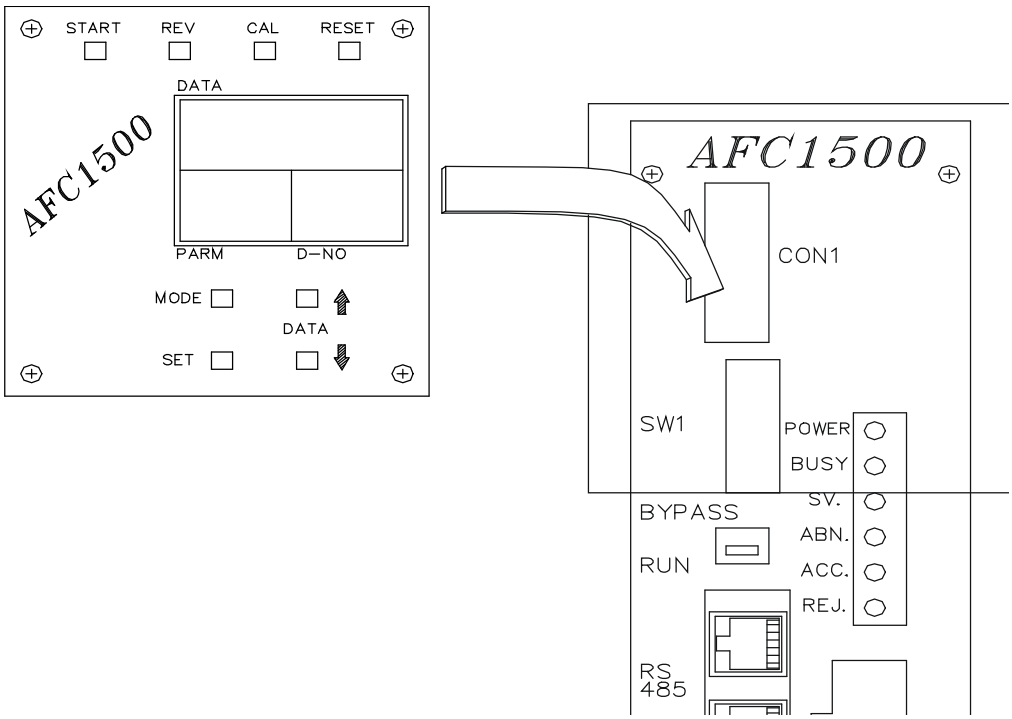


FIG. 7-1 Operational controls and indicators

7.1.1 Manual Fastening controls for Display Programming (DP) Unit.

- **START**

  This push button initiates the fastening cycle. If the unit is under AUTO start mode, a pulse of 200~500 ms activates the cycle. If the start mode is DEADMAN, the signal has to be active until the fastening ends, otherwise the cycle will be aborted. (Stand Alone mode only)

- **REV** (Reverse 1)

  Manual reverse. While this push-button is depressed, the nutrunner rotates in the opposite direction to the programmed fastening direction for the Parameter selected via the PLC "Work Select" inputs. (Stand Alone mode only)

- **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. If the difference is within the allowed range the ACCEPT LED will light, otherwise the REJECT LED will light. The calibration voltage level is converted to the full-scale torque, according to the parameter setting and is shown in the "DATA" display. (Stand Alone and Multi mode)

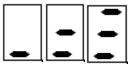
- **RESET**

  Used to reset the SAN 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. If it is within the acceptable range, the ACCEPT LED will light. If it is not within range, the torque REJECT LED will light. (Stand Alone and Multi mode)

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7.1.2 Fastening Preset / Result displays.

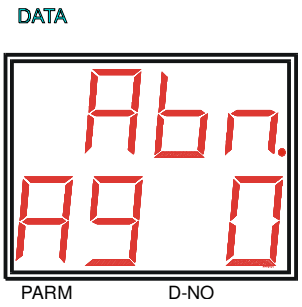
•**[D-NO]** Data number indicator (2 digits).
Indicates the Display mode and data type (number)

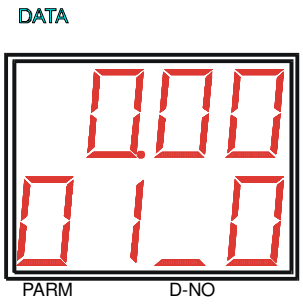
- No digit: Status Display mode
- One digit: Real Time Display mode
- Two digits: Parameter Display mode
- Digit on the left  Fastening Result Display mode

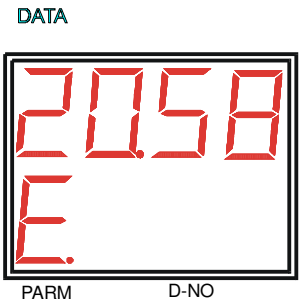
•**[DATA]** Data value indicator (4 digits).
Displays the data specified by [D-NO] while in any display mode (refer to applicable section).

•**[PARM]** Parameter number/Abnormal number indicator (2 digits).
Display for the parameter number of the last fastening parameter run when in Fastening Results Display mode, or the selected parameter when in Parameter Display or Setup mode. 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**







7.1.3 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 Data edit mode, and to confirm data setting change.

•**[↑] and [↓]** Cursor key (vertical arrows).

▪Used to scroll through available (16) parameter numbers. (PARM)

▪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. (Fig 7-3-6)

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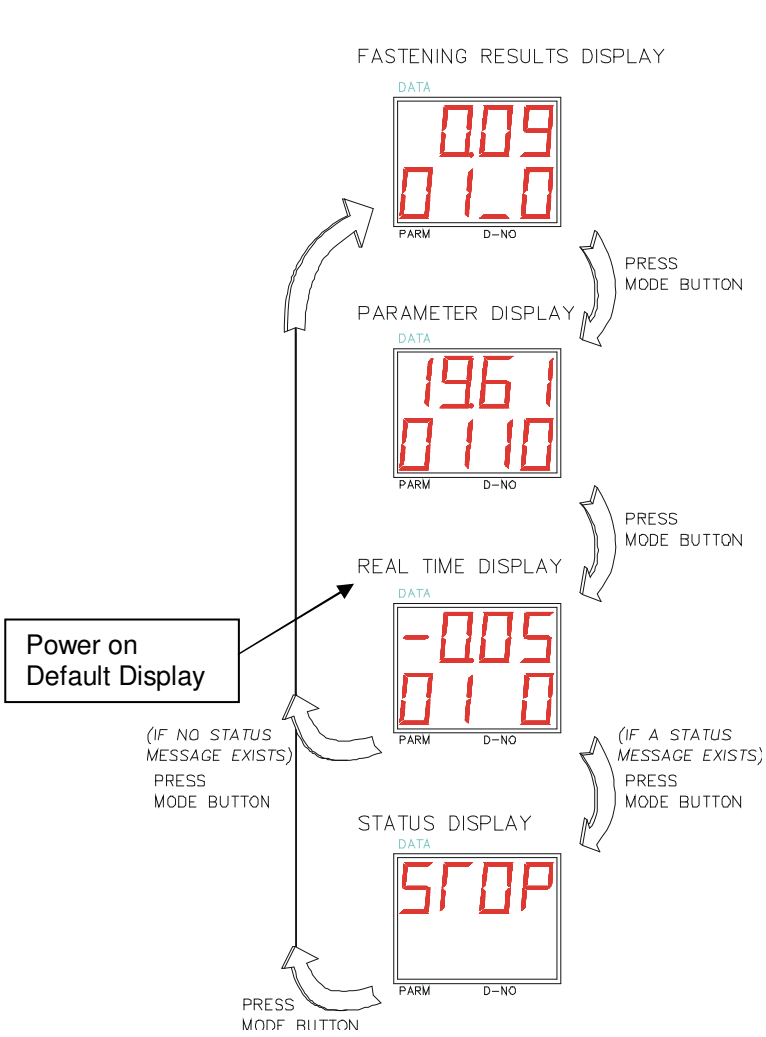
7.2 Run State Modes.

The AFC 1500 system has two operational states that are controlled by the selection of the Run/Bypass switch on the front of the SAN unit or by the PLC Bypass input. The operational modes available in the **Run State** are identified below. Under this condition, the BYPASS switch on the front panel is in the RUN position and the BYPASS external signal is not active (the BYPASS LED is off). During the RUN condition, 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 for parameters 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 subcode.

While the SAN Unit is in cycle it will display the cycle status. The display will indicate where the cycle is in its' fastening sequence. Refer to section 7.2.6 for a listing of Status display abbreviations



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.

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.

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.

The SAN 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.

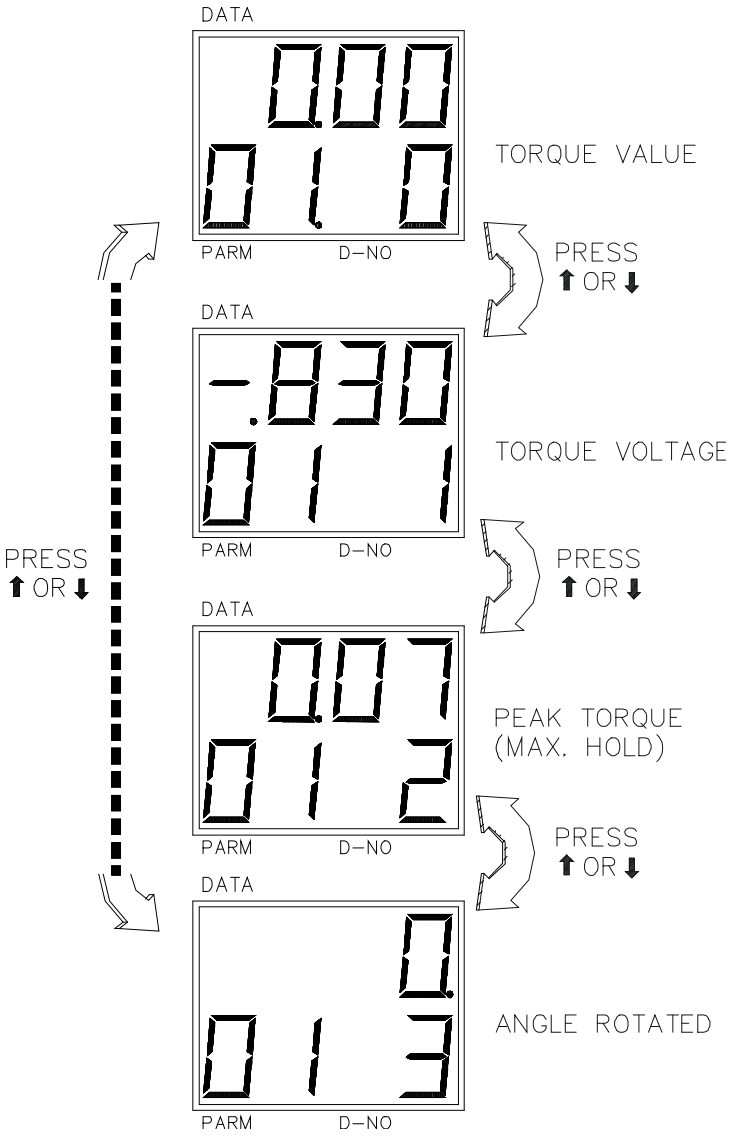
FIG. 7-2-1 Run State Display Modes

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7.2.2 Real-time display indication mode.

While the Real Time Display mode is activethe [D-NO] displays **0** ~ **5**. You can choose the desired type of data by pressing the [↓] and [↑] keys to change the [D-NO] (data number). The indicator will display the following data in the "DATA" area for the selected D-No. The PARM data will remain showing the parameter number.

D-No	DATA
0	Torque value.
1	Torque voltage.
2	Peak Torque (maximum hold).
3	Rotated Angle.
4~5	Factory settings



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.)

NOTE: Motor Lock Function
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. Press RESET to unlock the Motor before one minute has expired. **WARNING**: Do not 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°).

Button operation during the real-time mode is indicated in Fig. 7-2-2.

FIG. 7-2-2 Real time display selection

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7.2.3 Fastening Results Display Mode.

In Fastening Results Display mode (when [D-NO] shows **_0** ~ **≡**6), data can be obtained by pressing the [↓] and [↑] keys to scroll the [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	Unit *
_0	Peak Torque Value (Judgment torque value)	Nm
_1	Final Angle Value	deg
_2	1ST Torque Rate Value	Nm/deg
_3	2ND Torque Rate Value	Nm/deg
_4	1ST Area Fastening Time	Sec
_5	Final Area Fastening Time	Sec
_6	Cycle Time	Sec
_7	Fastening Mode No.	
_8	3RD Torque Rate Value	Nm/deg
_9	Not Used	
=0	Fastening Method No.	
=1	Step	
=2	Not Used	
=3	Self Check ON: Checked OFF: Unchecked	
=4	Reverse Flag ON: Reversed OFF: Not reversed	
=5	Cause of Fastening stop 0: Reset / No data / After reverse 1: Abnormal 2: BYPASS signal 3: Stop signal 4: REJECT 5: ACCEPT (Normal)	
=6	Torque Judgment tq H/L (Final) H/L (Peak)	
=7	Angle Judgment An H/L (Angle)	
=8	Torque Rate Judgment r H/L (1ST) H/L (2ND) H/L (3RD)	
=9	Time Judgment ti H/L (1ST) H/L (FNL) / r (left) = Low rundown rev – r (right) = High rundown rev	
≡0	1ST Torque Rate Area Increment Torque	Nm
≡1	2ND Torque Rate Area Increment Torque	Nm
≡2	Offset Torque	Nm
≡3	1ST Peak Torque	Nm
≡4	Final Torque Value	Nm
≡5	Angle at Peak Torque (Judgment Torque)	deg
≡6	Maximum Current Value	A
≡7	Not Used	

- Unit of measure for Torque can be Nm, Kgm, Kgcm, Ftlb or Inlb

FIG. 7-2-3 Fastening results display selection

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7.2.4 Parameter Display Mode

Parameter Display mode displays the preset values programmed in the SAN unit for fastening operation. The AFC1500 system can store up to 16 different sets of parameters that can be selected by 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.

Note: Representation only, not actual data

The data displayed in this section is the DISPLAY only for the Configured Parameters. To enable programming changes of these values the system must be switched to Download/Set-up Mode (Section 7.3)

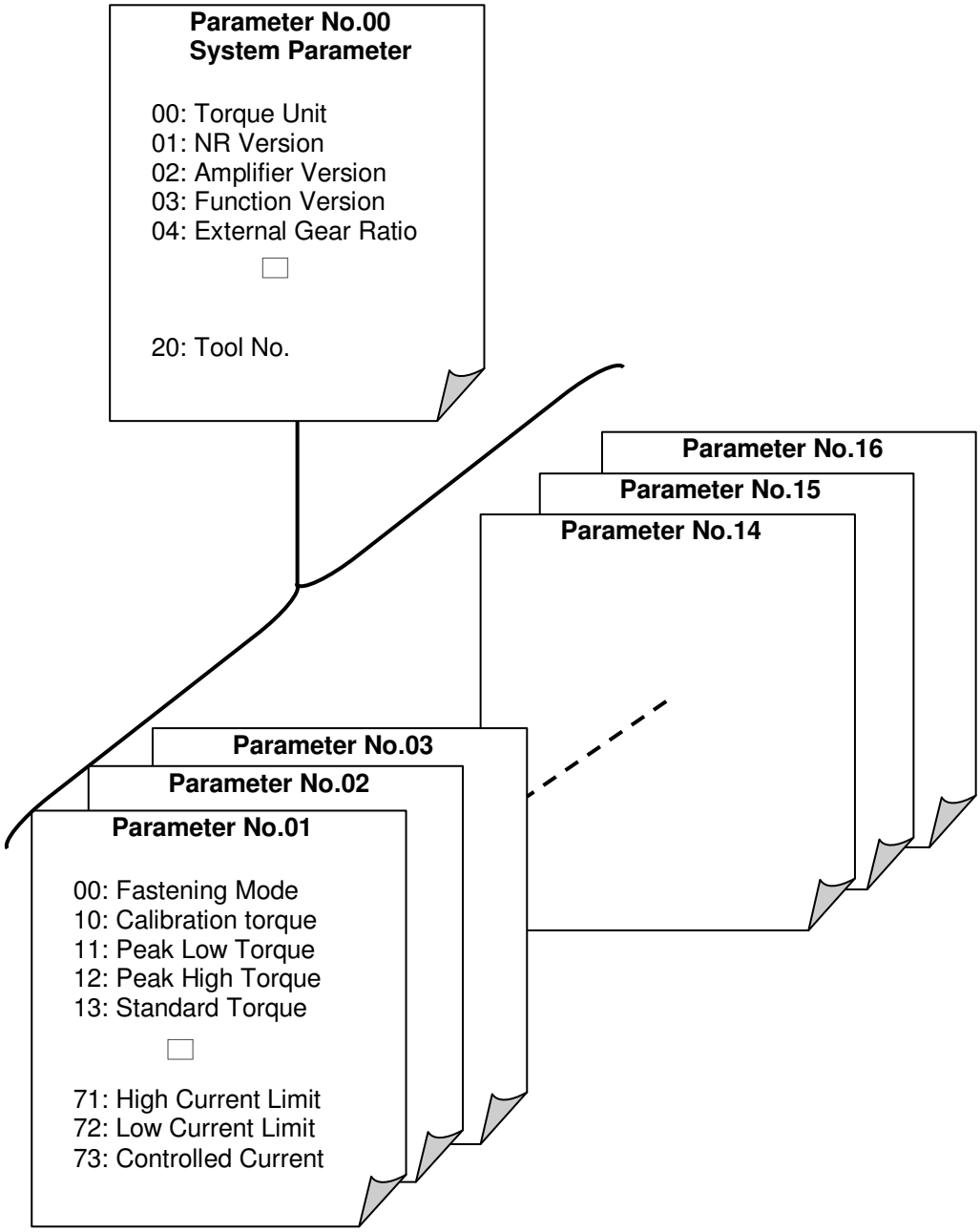


FIG. 7-2-4a Parameter number selection

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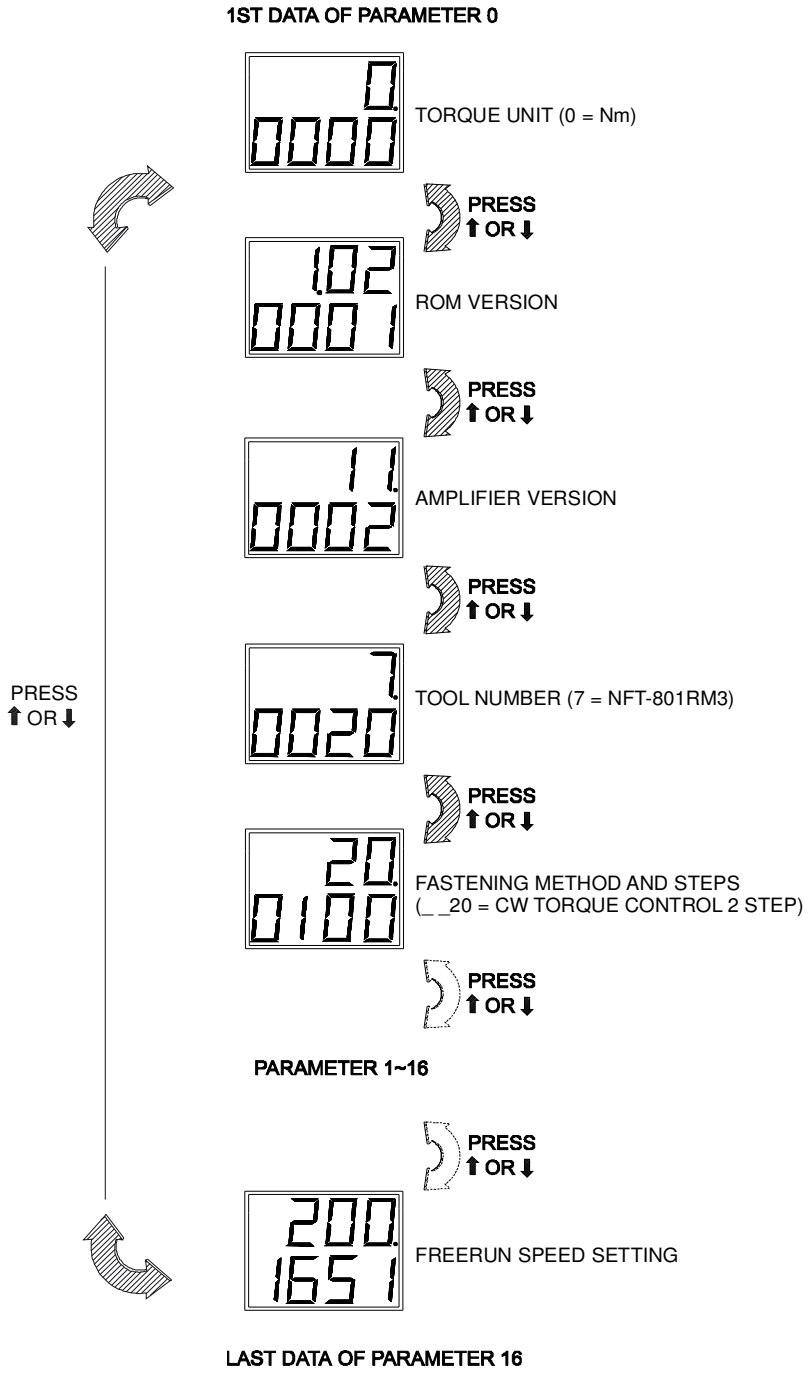


FIG. 7-2-4b Parameter display D-No selection

When Parameter Display mode is enabled, the [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 [PARM] will indicate the parameter number (from 0 ~ 16). Use the [↓] and [↑] keys to change the preset data number [D-NO]. If the [D-NO] display is showing the number 73 of the *parameter number 1*, pressing the [↑] key will change the [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).

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7.2.5 Parameter Data List

Item	Parameter No. PARM	Data No. D-NO	DATA	Unit
System	00	00	Torque Unit [0:Nm]	
	00	01	NR Version / Parameter Copy **<*Cannot be changed>**	
	00	02	Amplifier Version **<*Cannot be changed>**	
	00	03	Stand Alone or Multi Config. See 7.3.7	
	00	04	External Gear Ratio	
Tool Data **<*Cannot be changed>**	00	10	Connected Tool No.	
	00	11	Tool CAL Torque	Kgm
	00	12	Tool CAL Voltage	V
	00	13	Tool Zero Torque Voltage	V
	00	14～1A	In-house Management Data	
	00	1B/1C	Tool Fastening Count (First 4 digits/ last 4 digits)	
Tool type	00	20	Tool No.	
Time (only avail.) (w/SAN3-DPx)	00	30	Date: Year “2009” 2009	
	00	31	Date: Month / Day “705” 07 / 05	
	00	32	Time: Hours / Minutes “1510” 15:10	
	00	33	Time: Seconds “43” :43	

○ **Available** × **Cannot be changed**

Item [Unit]	Parameter No. PARM	Data No. D-NO	DATA	Torque Method	Angle Method	Offset Check
Fastening	01~16	00	Fastening Mode (Step + Method)	XXX0	XXX1	XXXX
	01~16	05	Fastening Option 1	0000	0000	0200
	01~16	06	Fastening Option 2	○	○	○
Torque [Nm]	01~16	10	Calibration torque (CAL value)	○	○	○
	01~16	11	Peak Low Torque Limit	○	○	
	01~16	12	Peak High Torque Limit	○	○	
	01~16	13	Standard Torque	○		
	01~16	14	Speed Change Torque	○	○	
	01~16	15	1ST Torque	○	○	
	01~16	16	Snug Torque	○	○	
	01~16	17	Threshold Torque (1st torque rate start torque)	○	○	
	01~16	18	Crossover Torque (3rd torque rate start torque)	○	○	
	01~16	19	Torque Inhibit Limit	○	○	○
	01~16	1A	Offset Torque Limit			○
			1 Pulse Reverse Torque Limit	○	○	
	01~16	1B	Breakaway Torque Limit	○	○	
	01~16	1C	Final Low Torque Limit	○	○	
	01~16	1D	Final High Torque Limit	○	○	
	01~16	1E	2ND Rate Start Torque	○	○	
Angle [deg]	01~16	20	Low Angle Limit	○	○	
	01~16	21	High Angle Limit	○	○	
	01~16	22	Standard Angle		○	
	01~16	23	1ST Angle		○	
	01~16	24	Crossover Angle (3rd torque rate start angle)		○	
	01~16	25	Angle Correction	○	○	
	01~16	26	2nd Rate Start Angle (Not Used)	×	○	
	01~16	27	3rd Rate Start Angle (Not Used)	×	○	

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Rate [Nm/deg]	01~16	30	1st Rate Low Limit	○	○	
	01~16	31	1st Rate High Limit	○	○	
	01~16	32	2nd Rate Low Limit	○	○	
	01~16	33	2nd Rate High Limit	○	○	
	01~16	34	3rd Rate Low Limit	○	○	
	01~16	35	3rd Rate High Limit	○	○	

Item [Unit]	Parameter No. PARM	Data No. D-NO	DATA	Torque Method	Angle Method	Offset Check
Time [sec]	01~16	40	Initial Time	○	○	
	01~16	41	1ST Time High Limit	○	○	
	01~16	42	Final Time High Limit	○	○	
	01~16	43	1ST Time Low Limit	○	○	
	01~16	44	Final Time Low Limit	○	○	
	01~16	45	Ramp up Time	○	○	
	01~16	46	Ramp Down Time	○	○	
	01~16	47	Reversed Ramp up Time	○	○	
	01~16	48	Torque Recovery Time	○	○	
Rotation Speed [rpm]	01~16	50	Initial Speed	○	○	
	01~16	51	Freerun Speed	○	○	
	01~16	52	Slowdown Speed	○	○	
	01~16	53	Torque Speed	○	○	
	01~16	54	Reverse Speed 1, 2	○	○	
	01~16	55	Reverse Speed 3 1P Reverse Speed	○	○	
	01~16	56	Offset Check Speed			○
Revolutions [rev]	01~16	60	Freerun Revolutions	○	○	
	01~16	61	Torque Inhibit Revolutions	○	○	○
	01~16	62	Offset Check Revolutions			○
	01~16	63	Reverse 2 Revolutions	○	○	
	01~16	64	Reverse 3 Revolutions 1P Reverse Time（0.1Sec）	○	○	
	01~16	68	Fastening Judgment Revolutions Low Limit	○	○	○
	01~16	69	Fastening Judgment Revolutions High Limit	○	○	○
Current [A]	01~16	70	Full Scale Current	○	○	
	01~16	71	High Current Limit	○	○	
	01~16	72	Low Current Limit	○	○	
	01~16	73	Controlled Current	○	○	

*Items that have colored cells are skipped on the indicator.

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System Parameters Parameter No. 00

Data No.00 Torque Unit

All fastening parameters inside the spindle use the same torque unit.
0= Nm, 1=Kgm, 2=Kgcm, 3=Ftlbs, 4=Inlbs

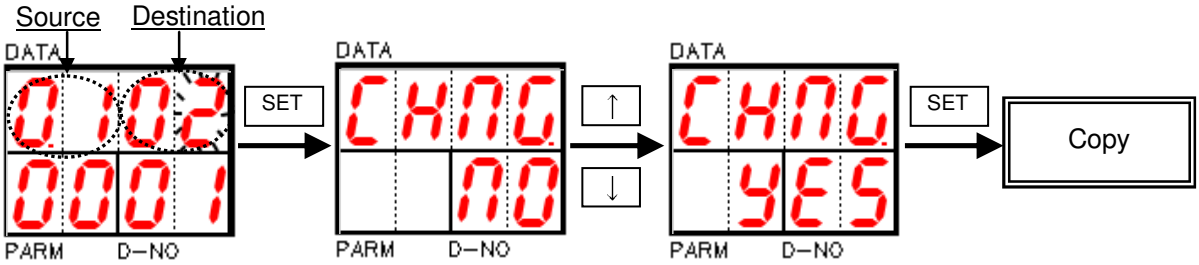
Data No.01 NR Version / Parameter Copy *** Cannot be changed**

This shows the version of AXIS Unit software version and can be used to perform the following functions.

How to copy parameters individually

Enter the parameter Number of the copy source into the first two digits of [DATA] indicator, and the parameter No. of the copy destination into the last two digits.

The parameter will be copied when normal parameter setting procedure is completed.



How to copy multiple parameters at once

Enter 99 into the first two digits of [DATA] indicator, and 16 into the last two digits. Perform normal parameter setting procedures. Parameter 1 will be copied to parameter 2~16.

How to erase fastening results record

Enter 99 into the first two digits of [DATA] indicator, and 99 into the last two digits. Perform normal parameter setting procedures. Fastening results records will be all erased.

Data No.02 Amplifier Version *** Cannot be changed**

Version of amplifier is displayed.

Data No.03 Function Version *** Cannot be changed**

This is used for special functions.
Setting: 1.03 = Multi assumes I/O 1.27= Stand-Alone PLC I/O 1.23=Dual Transducer Mode

Data No.04 External Gear Ratio

Standard setting: 1.000
Setting range: 0.300 ~ 3.000
Used to adjust the gear ratio when an external head is connected to the output of the tool assembly.

Data No.20 Tool No.

Set the connected tool number from the appendix [Tool Type List] included in the end of this instruction manual.

Data No.30 Time Setup

Sets the Date / Time when a SAN3-DP1 or DP2 is used. (Requires a SAN**3** – DPx to be installed)

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

Parameter No.01 ~16

Data No.00 Fastening Mode (Method + Steps)

[Fastening Method]
0: Torque method 2: Current (Torque) Method
1: Angle method 3: Current (Angle w/ Continuous Snug torque)

[Fastening Steps]
0: 1Step Fastening SNUG TQ Angle origin (for Backouts) (*1)
1: 1 Step Fastening
2: 2 Step Fastening - Pre-stop at 1ST Torque/Angle
3: 3 Step Fastening - Pre stops at 1ST and CROS Torque/Angle

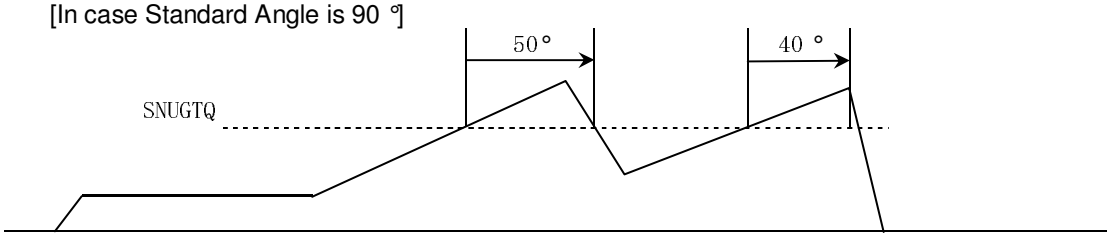
[Fastening Direction]
0: CW Direction Fastening
1: CCW Direction Fastening
(For special fastenings such as left-hand screws. Reverse direction is CW.)

[Reverse Operation]
0: Reverse operation will reach the set speed from the start.
1: Reverse operation will start rotation at the speed of 20rpm for 1.5 second, then reach the set speed.

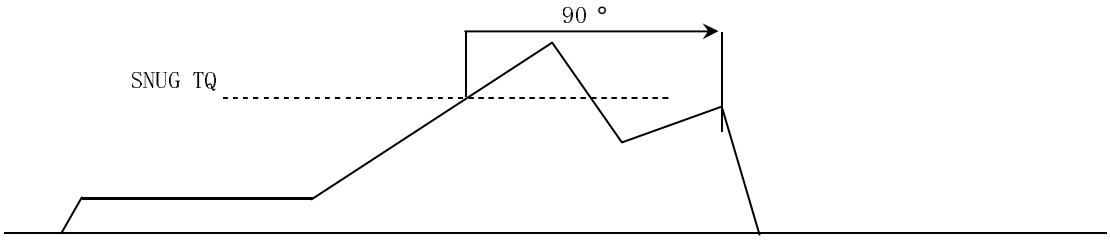
(*1) The difference between SNUG TQ Angle Origin Fastening Method and other fastening methods

The angle measurement method from SNUG TORQUE differs.
There is no difference for normal fastening applications. Therefore, select fastening mode # XX10, XX11, XX20, XX21.

◎ 1 Step Fastening Angle Method (XX11)
Angle value is not counted up when torque is below SNUG TORQUE.
[In case Standard Angle is 90 °]



◎ 1 Step Fastening SNUG TQ Angle Origin Angle Method (XX01)
Once SNUG TORQUE is reached, angle value is counted up regardless of the torque value.
[In case Standard Angle is 90 °]



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Data No.05 Fastening Option 1

0200: Offset check External gear preload torque is checked to confirm that it is less than or equal to the prescribed value. When this function is selected, fastening operation is unavailable for parameter 1.
0400: 1/4 Torque recovery operation
1000: Tool reactive force reduction operation after fastening
0001: Offset torque correction
Fastening is conducted with the torque value which passed the previous offset check. This function is unavailable when offset check is not selected.
0002: Fastening ends due to the FAS.END signal input, and judged.
0004: 1P Reverse operation is conducted after fastening to prevent sticking or locking of socket.

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

Data No.06 Fastening Option 2

Select the results to be outputted by the RS485 communication between your PC.
2000: No output at BYPASS
1000: No output at STOP
0400: No output at ABNORMAL
0200: No output at REJECT
0100: No output at ACCEPT

* When combining multiple functions, add the data numbers in hex.
Example: **0400 + 0200 + 0100 = 0700**

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 SAN 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 NFT-801RMA3-S 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

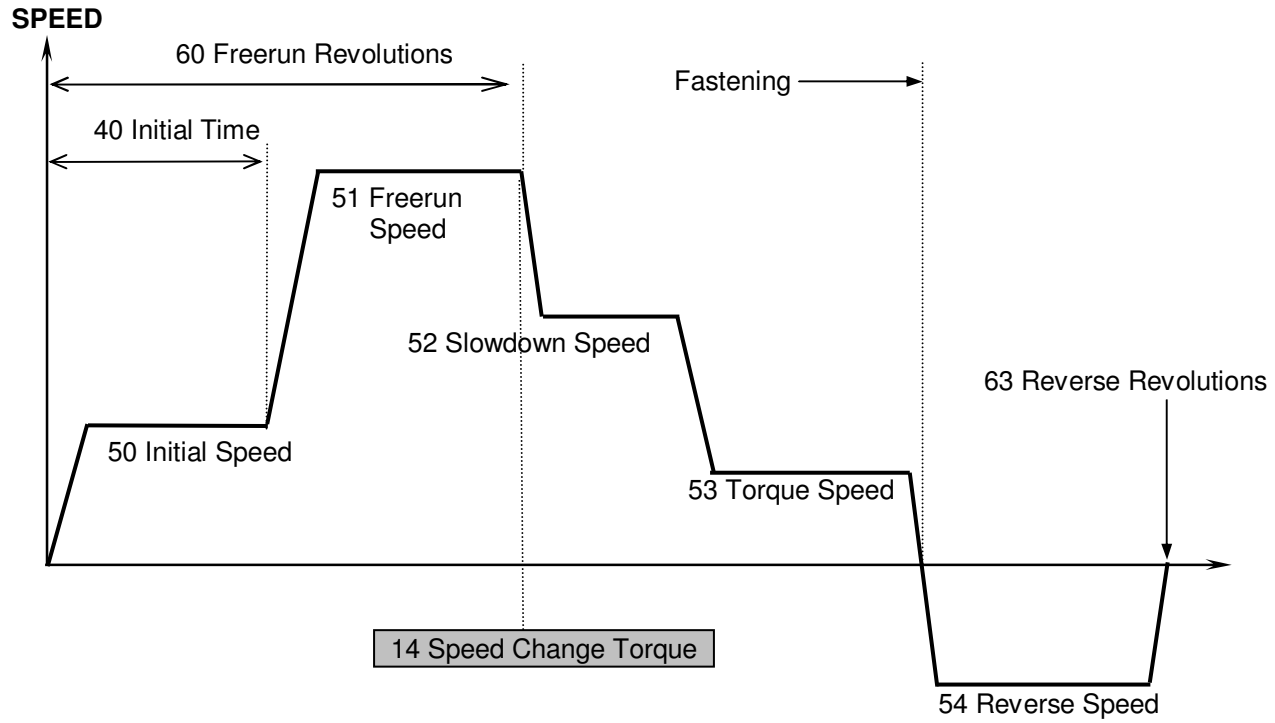
*The **FULL SCALE TORQUE (CAL) value** must be corrected to **76.0 Nm** and entered at [PARM} 1~16 [D-NO] 10.*

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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 Freerun speed to Slowdown speed.



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

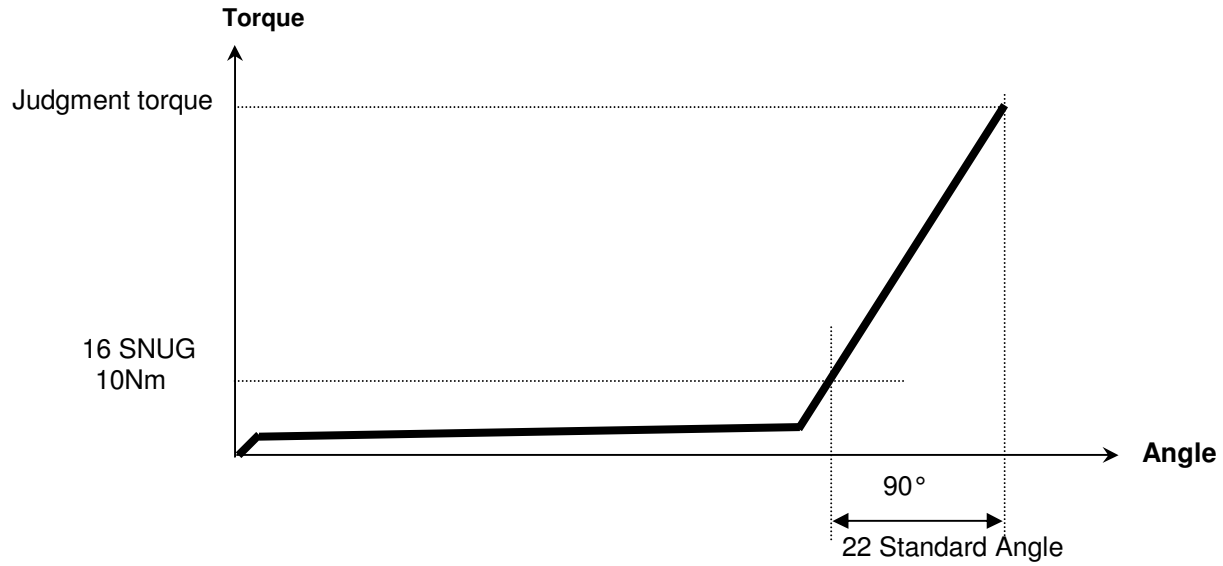
Data No.15 1ST Torque [Nm, Kgm...] Setting range: 0 ~ [10: Calibration torque] × 1.0
Data No.23 1ST Angle [deg] Setting range: 0 ~ 9999
1ST stop / synchronization point for multiple step fastening operations.
End point for 1st torque rate calculation. [17: Threshold Torque is beginning]
Shift point for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

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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.

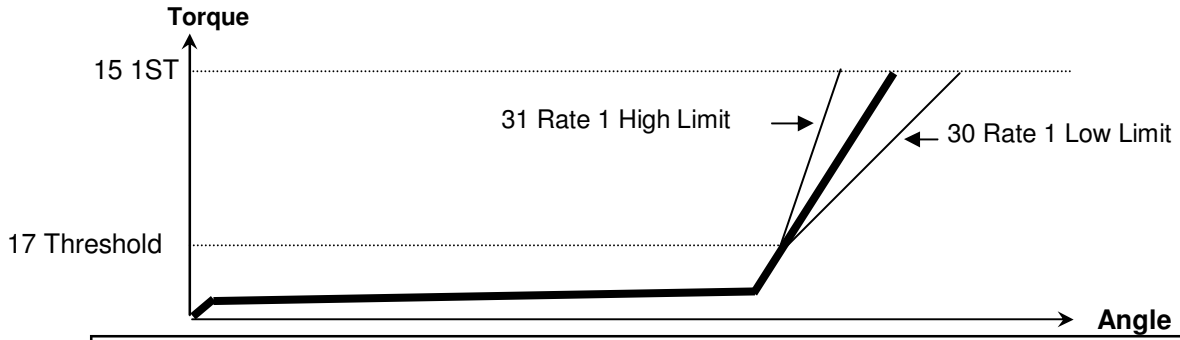
Angle (of rotation) Judgment is conducted from Snug Torque to Fastening end when this torque value is achieved, for all fastening methods. The Angle when this torque value is achieved is considered the 0° start point for judgment.

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



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

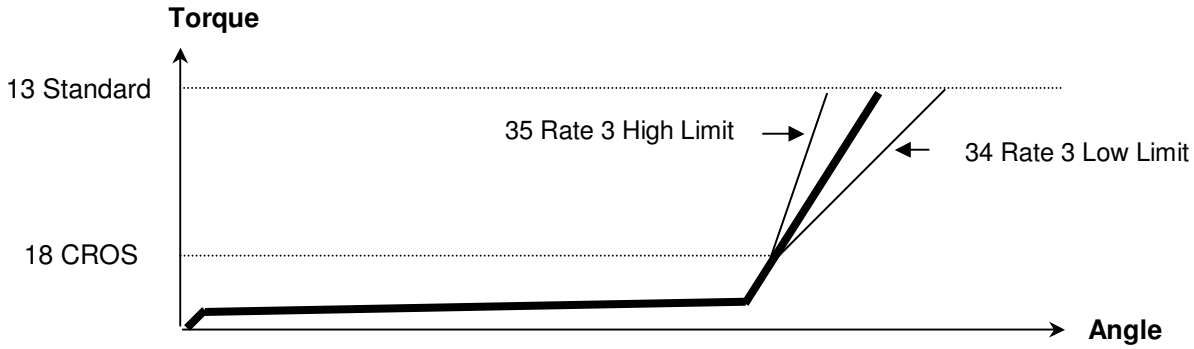
Data No.17 Threshold Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
Start point for 1st Torque Rate monitoring



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

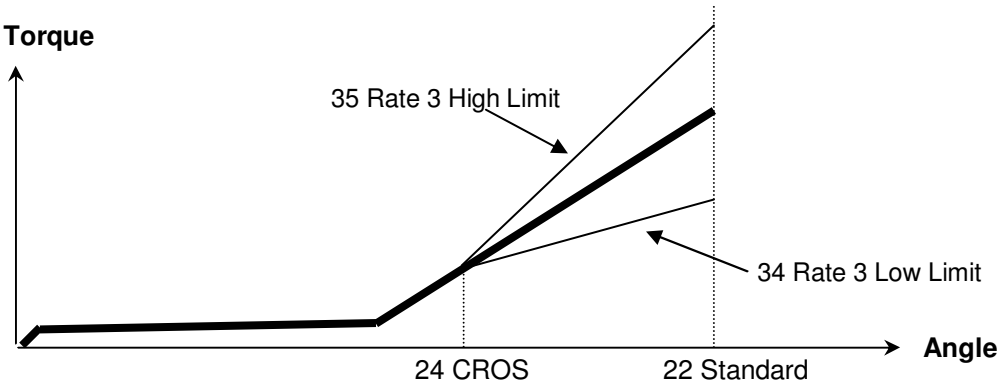
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Data No.18 CROS Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.0
2nd stop / synchronization point for multiple step fastening operations.
End point for 2nd torque rate calculation. [1E: 2nd Rate Start Torque is beginning]
Start 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.1A Offset Torque Limit [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
Maximum value that is acceptable as sensed during an offset check. Offset checking provides verification that there is not an excess load on the Spindle output drive and provides a reference value that can be used as a compensation value if Offset Correction is enabled.

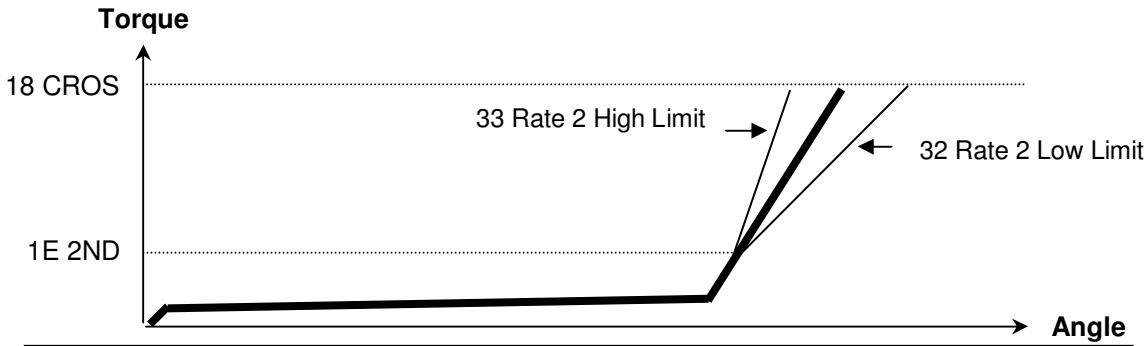
Data No.56 Offset Check Speed [rpm]
Setting range: 1 ~ Tool's maximum rpm.
Speed used to check Offset Torque value.

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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.

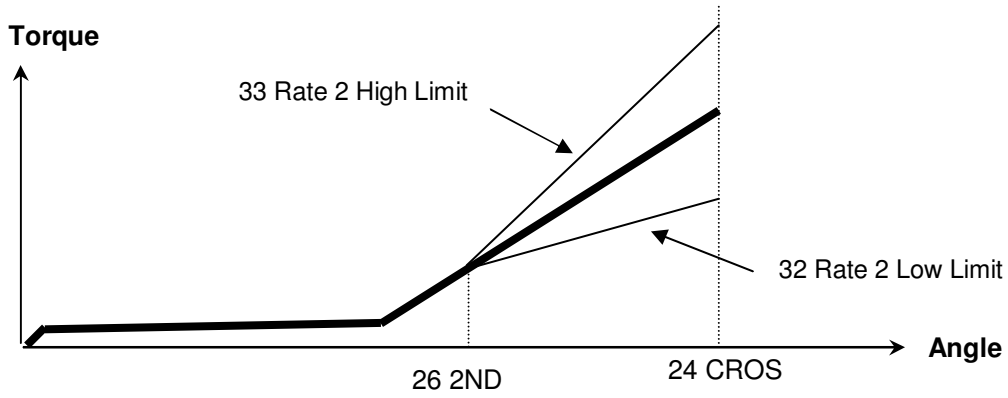
Data No.1C Final Low Torque [Nm, Kgm...]
Data No.1D Final High Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
For [Angle Method], sets the High and Low limits for Torque at the point that the final Fastening Angle is achieved.
For [Torque Method], during Torque Recovery, sets the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



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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.

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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 Time [sec]
Setting range: 0~5.0
In Torque Method Fastening, after the fastening operation has reached the target torque, the torque will be held at 0 speed for this duration.
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.

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]

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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, 2 [rpm]
Setting range: 1 ~ Tool's maximum rpm
Reverse 1 operates when the manual reverse input is selected or when programmed into a Multi system Sequence program.

Data No.55 Reverse Speed 3 [rpm]
Setting range: 1 ~ Tool's maximum rpm

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.62 Offset Check Revolutions [rev]
Setting range: 0 ~ 99.9
When [Offset Check Mode] is enabled, this is the number of revolution that will run at [56:Offset Check Speed] after [61: Torque Inhibit Revolutions] is completed. If the average torque during this period is smaller than [1A: Offset Torque Limit], the process will be accepted.
The value sensed during this period can be used to compensate for external loading by enabling the Offset Correction function.

Data No.63 Reverse 2 Revolutions [rev]
Setting range: 0 ~ 99.9
Sets the number of revolutions the fastener will back out when Reverse 2 is selected via a Multi System Sequence program.
If [1B: Breakaway Torque Limit] is achieved during reverse operation, an Abnormal will result.

Data No.64 Reverse 3 Revolutions [rev] Setting range: 0 ~ 99.9
Sets the number of revolutions the fastener will back out when Reverse 3 is selected via a Multi System Sequence program.
If [1B: Breakaway Torque Limit] is achieved during reverse operation, an Abnormal will result.

Data No.68 Rundown Revolutions Low Limit [rev]
Data No.69 Rundown Revolutions High Limit [rev]
Setting range: 0 ~ 99.9
Low and High limits used to detect if a fastener seated to early or to late during the rundown. Used to detect incorrect fastener lengths or threaded hole depths.

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Data No.70 Full Scale Current [A]
Data No.71 High Current Limit [A]
Data No.72 Low Current Limit [A]
Data No.73 Fastening Current Limit [A]
Setting range: 0 ~ Due to unit type
Set the values below according to the unit type that will be used.
Used as a redundant check of the fastening process. Please contact FEC Inc. for assistance.

Unit Type	Tool Type	**Full Scale Current [A]**	High Current Limit [A]	Low Current Limit [A]	Controlled Current [A]
SAN3-24M	NFT - □□□RM1	12.0	12.0	0.0	12.0
	NFT - □□□RM2	24.0	24.0	0.0	24.0
SAN3-40M	NFT - □□□RM3	40.0	40.0	0.0	40.0
SAN3-120TM	NFT - □□□RM4	80.0	80.0	0.0	80.0
SAN3-120WM	NFT - □□□RM5	120.0	120.0	0.0	120.0

Data No.1A 1 Pulse Reverse Torque [Nm, Kgm...]
Setting range: 0 ~ [10: Calibration torque] × 1.1
Maximum torque value that will be applied to the fastener in reverse when the 1 Pulse reverse function is enabled.

1 Pulse reverse is used to disengage the Socket from the Fastener when a locking condition can occur.

Data No.55 1 Pulse Reverse Speed [rpm]
Setting range: 1 ~ Tool's maximum rpm
Speed value that will be applied to the fastener in reverse when the 1 Pulse reverse function is enabled.

Data No.64 1 Pulse Reverse Time [sec]
Setting range: 0 ~ 99.9
Time value that will be applied to the fastener in reverse when the 1 Pulse reverse function is enabled. The Reverse operation will be maintained for as long as this time is set for.

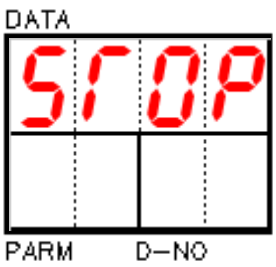
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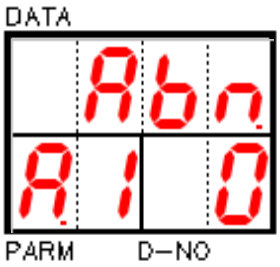
7.2.6 STATUS display

Two types of non-Fastening Results 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 SAN Unit as shown in the figure.

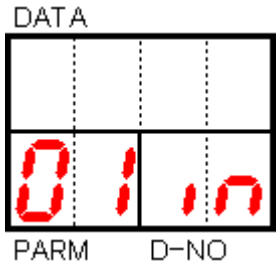
2) When an ABNORMAL condition occurs the [PARM] display will show a flashing "A" character followed by a number that represents the Abnormal number code. The [D-NO] displays a number that represents the SERVICE CODE NUMBER or SUB Code. (Refer to chapter 9)



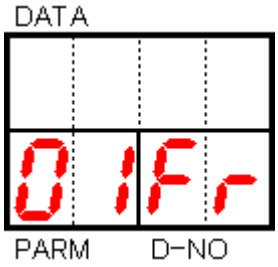


The following example values are displayed during Fastening operations using Parameter No. 1

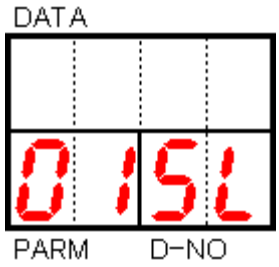
■ **During Initial Speed**



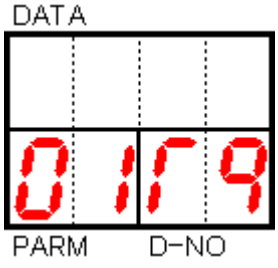
■ **During Freerun Speed**



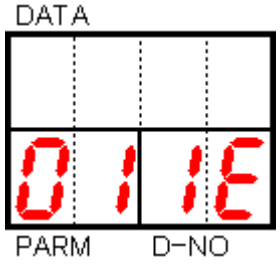
■ **During Slowdown Speed**



■ **During Torque Speed**



■ **STEP 2 Waiting**



■ **STEP 2 Fastening**



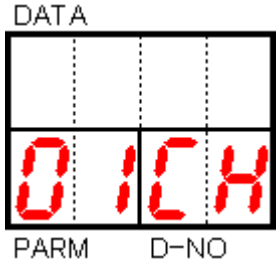
■ **STEP 3 Stand by Waiting**



■ **STEP 3 Fastening**



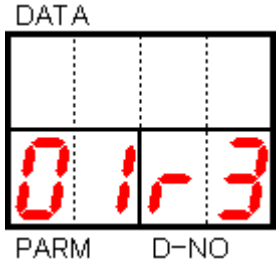
■**Offset Check**



■**Reverse 2 Revolutions**



■**Reverse 3 Revolutions**



Normal manual reverse (Reverse 1) operation is not displayed.

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7.3 Download / Setup Mode Operation (Bypass Mode Only)

The AFC 1500 system has two operational states that are controlled by the selection of the Run/Bypass switch on the front of the SAN unit or by the PLC Bypass input signal. The operational modes available in the Bypass State are identified below. The unit(s) must be in the BYPASS condition for either of these modes to be enabled. Either the BYPASS switch on the front panel is in the BYPASS position or the BYPASS external PLC signal is active (the BYPASS LED is on). During the BYPASS condition, the display shows preset values.

7.3.1 Download Mode selection

Immediately after the bypass condition has been entered, the unit is in the download mode, which allows the system to be set up by the **AFC1500 User Console** software via the RS-485 port. This software allows SAN Unit setup via a computer versus programming by the display. It is highly recommended that with any quantity of spindles that the software be used instead of the display programmer as all spindles can be downloaded at the same time.
To program the SAN unit with the display programmer, press the [MODE] key to change from the download mode to the setup mode. (If the SAN unit is performing some data communication to an external computer, the download mode will be maintained until the operation is completed.)

Downloading via the AFC Userconsole software can be accomplished without placing the unit into Bypass. This is accomplished by the software, which disables the nutrunner operation during programming.

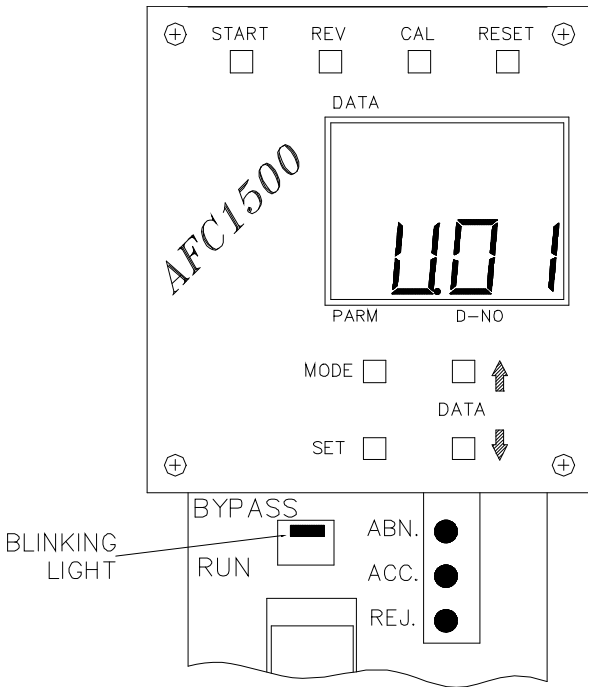


FIG. 7-3-1 SAN Unit in Download mode.

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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 [PARM] display. The cursor (blinking mode) will move each time the [MODE] button is pressed to the next character to the right.

The blinking character can be increased or decreased using the [↓] and [↑] buttons . The [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 [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 D-NO. you want to change. (see 7.3.3 for detail)

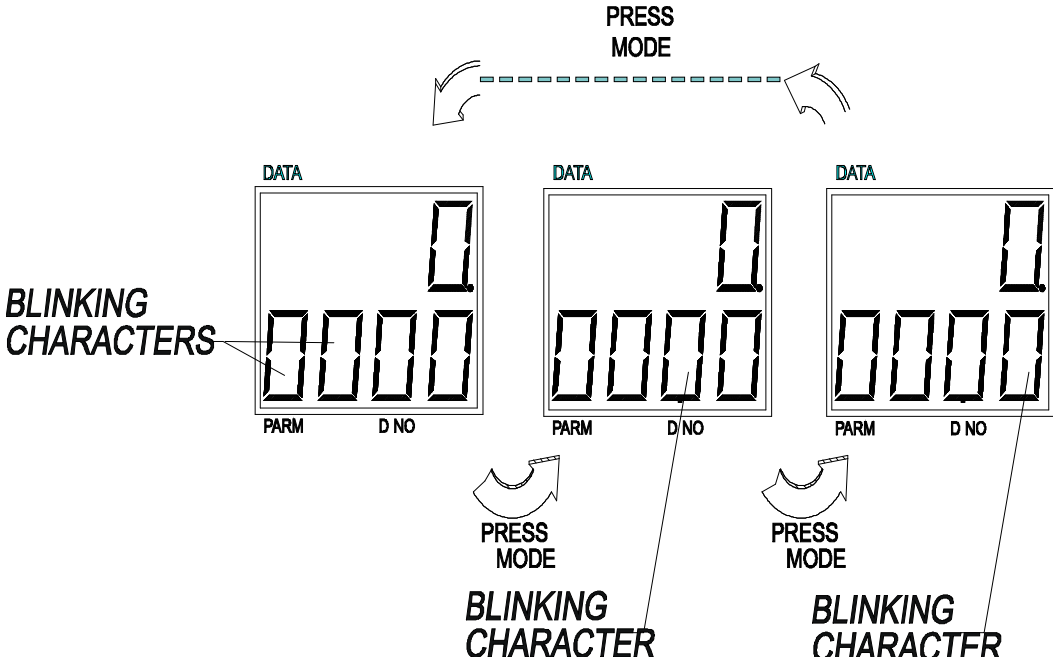


FIG. 7-3-2 Setup mode D-No selection

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7.3.3 Parameter # selection

All 16 Parameter sets can be setup using the programmer. When the cursor is in the PARM display, the settings can be changed from 0 ~ 16 with the [↓] and [↑] keys. Data corresponding to the selected parameter number will be displayed in the [DATA] display. The diagram below describes the selection.

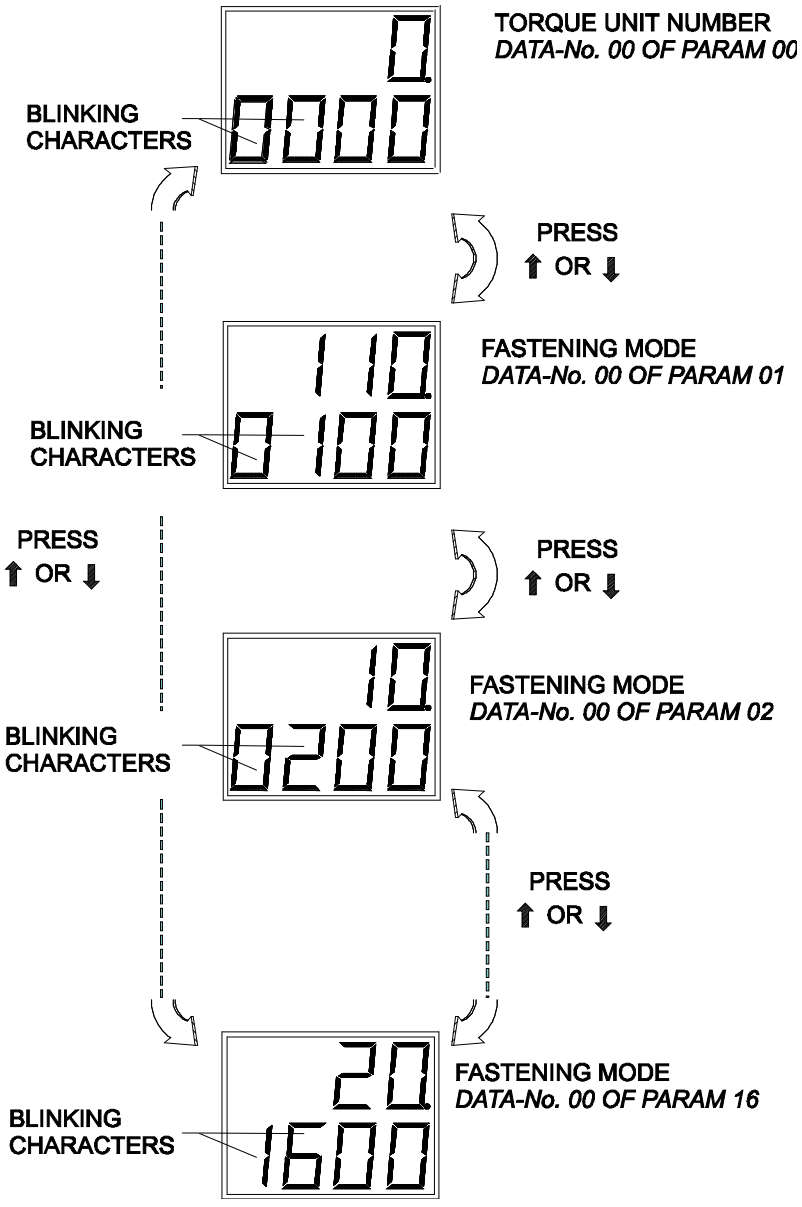


FIG. 7-3-3 Parameter display D-No selection

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7.3.4 Data # selection

The value for digit 1 and 2 of the [D-No] display may only be changed when the (blinking) cursor is in the respected position. The [D-NO] value is changed with the [↓] and [↑] keys.

Data corresponding to the data number [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.

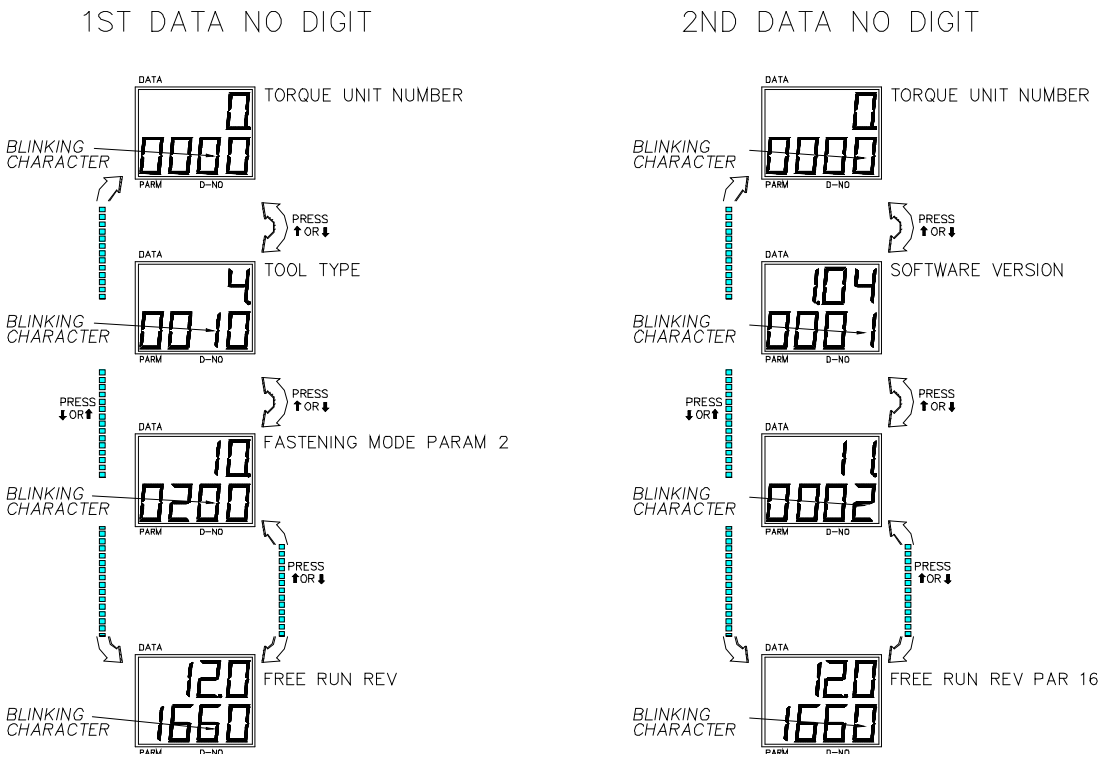


FIG. 7-3-4 Data No. changing.

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7.3.5 Data Edit mode operation.

Depressing the [MODE] button will bring up the setup mode from download mode. Both [PARM] display digits will appear blinking, specifying the cursor position. Use the [↓] and [↑] buttons to select the desired parameter number.

Depressing the [MODE] key again will bring the blinking cursor to the first digit in the [D-NO] field and depressing it again will bring it to the last digit of the field. Use the [↓] and [↑] buttons to select the desired [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.

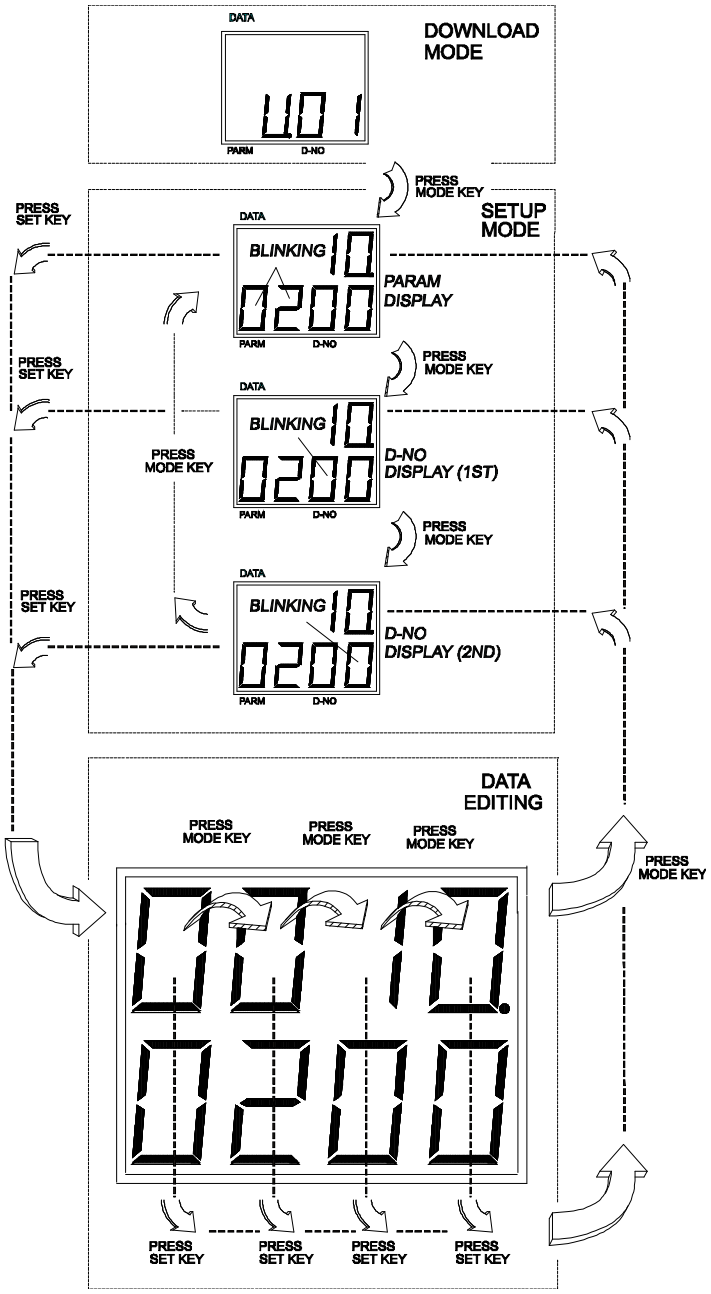


FIG. 7-3-3 Setup mode operation

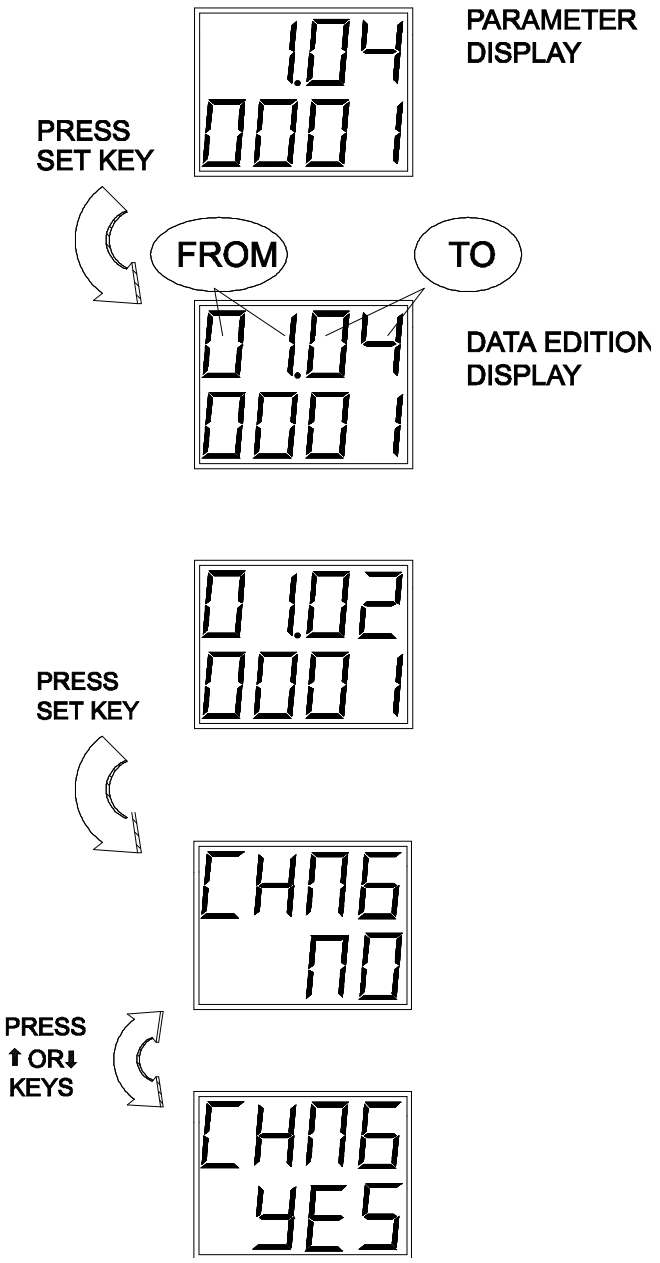
When the Torque Unit number (PARM 0 D-NO 00) or the Tool Type (PARM 0 D-NO 20) is changed, the [DATA] display will show "CHNG," and the D-NO display will show "NO." Use the vertical arrow buttons to choose YES or NO; YES means that the data will be entered if the confirmation SET button is pressed. The [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. After confirming the new data, toggle the Run/Bypass switch for data to be set.

Warning: 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.

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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;



- 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.

FIG. 7.3.6 Parameter copy procedure.

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7.3.7 I/O Enable (Stand-Alone or Multi Configuration)

Since the I/O of the SAN Unit can be controlled either as a stand alone unit or part of a multiple spindle configuration controlled by the Multi Unit, the I/O needs to be configured for the particular application. The stand alone unit is controlled from the I/O on the SAN unit using the PLC I/O connector. Using a Multi Unit, the SAN PLC I/O connector is disabled and all I/O is controlled from the Multi Unit. (Some I/O remains active in the SAN unit even with a Multi Unit. See 4.7.1)
It is important to remember that the main difference between using a stand-alone unit or a Multi Unit configuration is that with a Multi Unit, ALL spindle sequencing is controlled by the system, whereas with a stand - alone unit the sequence must be performed by the PLC. This means that for a stand alone unit any type of spindle grouping, reverse operations, timing issues or multiple fastenings must be programmed in PLC logic. Also, using a Multi Unit, Fieldbus interfaces are available for many types open architecture I/O systems.

From Power on;
1. Depress MODE Button to get to the Parameter Display Mode. (in BYPASS mode)
2. Depress MODE button two more times until blinking cursor is in the rightmost digit.
3. Depress the [↑] key until the [D-NO] is “03”, this is the Fastening Function Version.
4. Verify the data in the upper data display is the version required.
(1.27 = Stand Alone Unit PLC I/O, 1.03 = Multi Unit PLC I/O, 1.23 Dual Transducer Mode)
5. To make a change, Depress [SET]
6. The cursor will blink on the leftmost digit.
7. Using the [↓] and [↑] buttons, enter **1827** for version 1.27, **1803** for version 1.03 or **1823** for 1.23.
(use the MODE button to move to the next digit)
8. Depress the [SET] button to enter the change.
9. CHNG - NO will appear in the display, use the [↓] and [↑] buttons to change the NO to YES, then press [SET] to confirm and enter the change.
10. Cycle power OFF / ON to the unit.

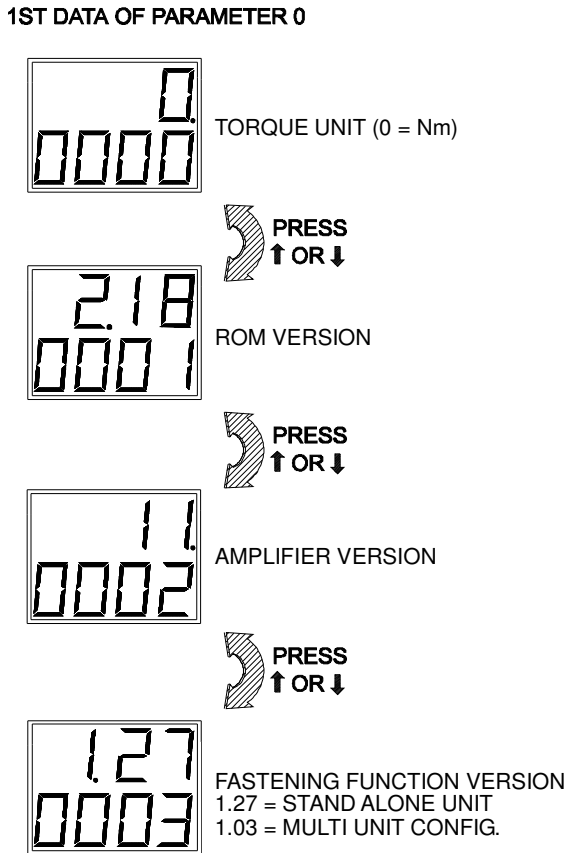
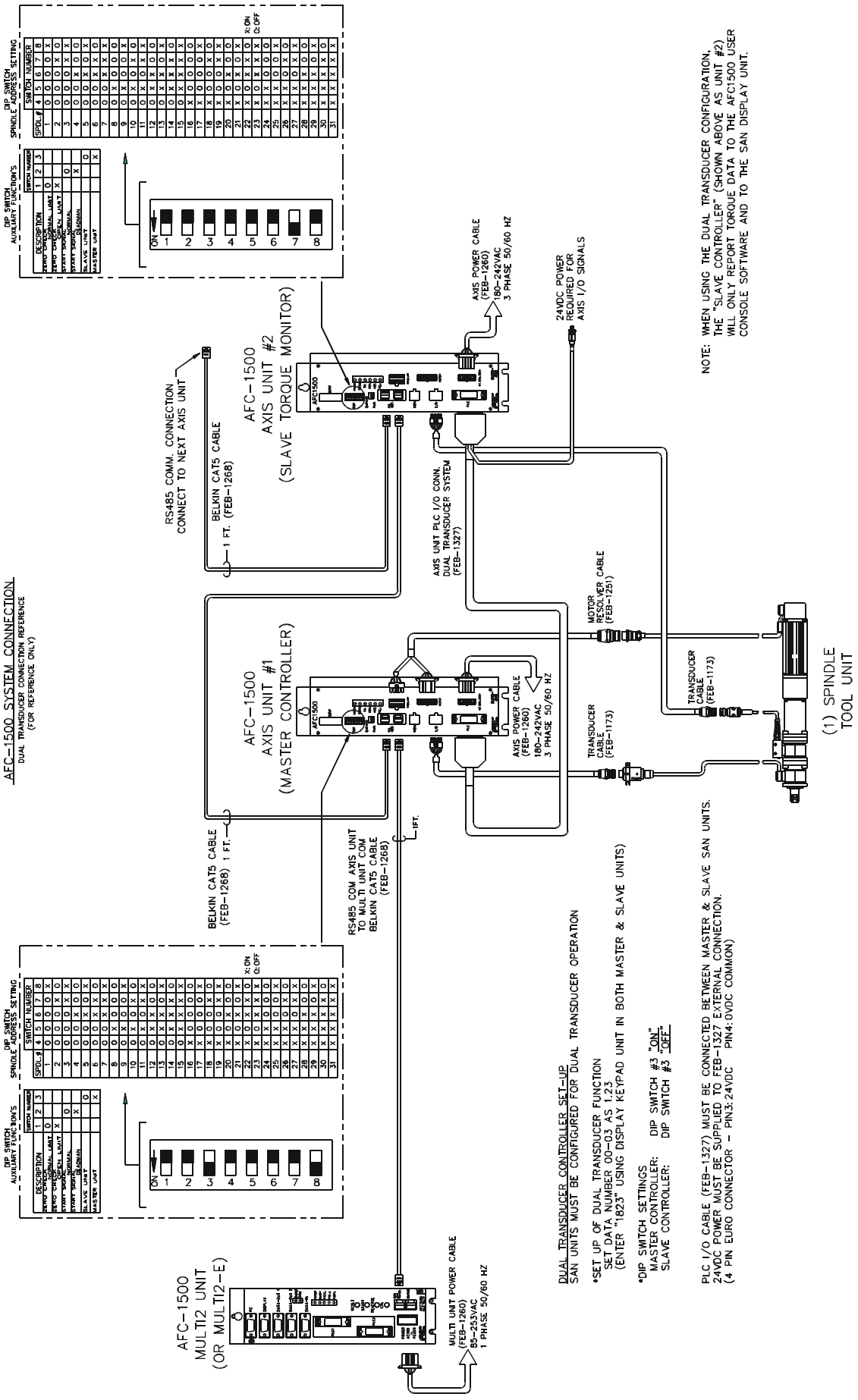


FIG. 7.3.7 I/O Enable Stand Alone / Multi Selection.

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7.3.8 Dual Transducer Set-up

Special set-up required for use of dual redundant transducers is described in the drawing below.



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Chapter 8: Maintenance and Inspection

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8.1 Inspection Items

A scheduled inspection is recommended to keep the AFC1500 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 Nutrunners 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.
- The tool is free from excessive contamination and foreign matter.
- The tool is securely mounted, with mounting bolts properly tightened.
- The homerun cables are securely connected to the tool.

8.1.2 Spindle Assembly

Recommended Schedule: Monthly

The Spindle Assembly is a spring loaded driver extension which permits travel of the driver as a fastener is fastened so that a multi-spindle head can be advanced to a single stop point without the problem of the fastener running out of the driver during the fastening process. The torque and stress generated during each fastening is applied directly to the spindle assembly. Inspect each assembly, and ensure the following specifications are met:

- The spindle assembly is producing normal levels of noise and vibration.
- The assembly is free from excessive contamination and foreign matter.
- The spindle assembly is securely mounted, with mounting bolts properly tightened.
- The square drive or socket is in good condition, and there is no excessive wear.
- The spindle assembly rotates and compresses freely, with no binding.

8.1.3 Homerun Cables

Recommended Schedule: Quarterly

These cables connect the tool to the SAN unit. Ensure the following conditions are met:

- The cables are free from unnecessary force and tension.
- The cables are secured away from any movement.
- The cables are in good condition, sufficiently insulated with no indication of broken wires.
- The cables are free from excessive contamination and foreign matter.
- The cables are securely connected to the SAN unit and to the nutrunner.
- The cables are free from heat distortion, and are not warm or hot to the touch.
- The cables, cable connectors, and connector screws are securely and correctly fastened.

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8.1.4 SAN Unit

Recommended Schedule: Quarterly

The SAN Unit requires careful use and handling. Inspect each SAN 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 front and the underside) are securely fastened and without damage.

8.1.5 Air Handling Units (Air Conditioner, Heat Exchanger, etc.)

Recommended Schedule: Every 2 months (sooner if external environment is harsh ie. machining area with coolant mist in air)

Equipment supporting the AFC1500 System's environment must be sufficiently maintained. Internal electrical enclosure (which the SAN units are housed) heat load can be calculated using the internal power consumption data in table 2.3. Verify support equipment meets the following requirements, as applicable to the unit type:

- The unit is free from dust, oil, and foreign matter.
- All filtration devices are clean, and air flow is not impeded.
- The unit is securely and correctly mounted.
- The input power remains within specifications at all times.
- All fans are functioning properly with no abnormal sound or vibration.

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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 with a STOP signal applied)

•2. Check that the torque display shows 0 when the keyboard-display unit RESET key is being pressed. (If part of a Multi Unit configuration, the Multi Unit buttons may be used to check all connected spindles)

•3. At the same time as 2 (above), check that the ACCEPT LED is lit.

•4. Check that the display is showing the full scale torque value when the SAN unit CAL key is being pressed. (If part of a Multi Unit configuration, the Multi Unit buttons may be used to check all connected spindles)

•5. At the same time as 4 (above), check that the ACCEPT LED is lit.

•If any of these checks fail internal limits, an ABNORMAL will be generated and the ABN LED will light. 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 up by the PLC (use the manual mode).

•2. Place the SAN 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 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 winds 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.

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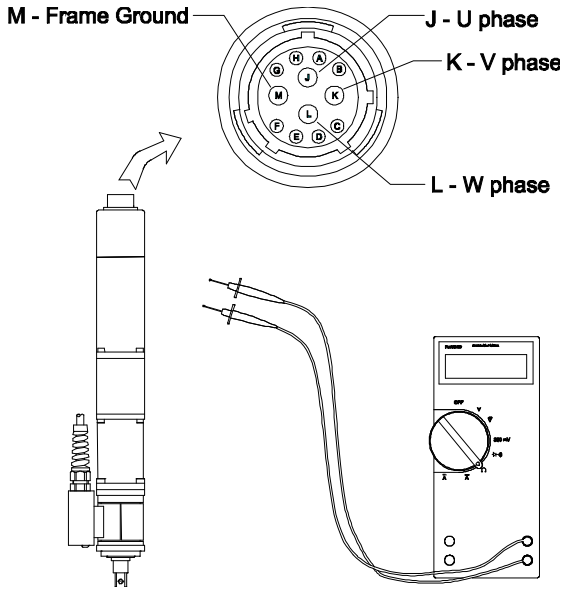


FIG. 8-2-3 Motor Inspection

Motor Winding Resistance*			
MOTOR SIZE	**Pins J - K**	**Pins K - L**	**Pins L - J**
60W (M1)	15.5Ω	15.5Ω	15.5Ω
80W (M2)	5.2Ω	5.2Ω	5.2Ω
200W (M3)	1.7Ω	1.7Ω	1.7Ω
1500W (M4)	.9Ω	.9Ω	.9Ω
3000W (M5)	.25Ω	.25Ω	.25Ω

Tolerance + / - 10%

Resolver Winding Resistance			
MOTOR SIZE	**Pins A - B**	**Pins C - D**	**Pins E - F**
60W (M1)	100 –115 Ω	90 – 100 Ω	90 – 100 Ω
80W (M2)	100 –115 Ω	90 – 100 Ω	90 – 100 Ω
200W (M3)	100 –115 Ω	90 – 100 Ω	90 – 100 Ω
1500W (M4)	30 – 40 Ω	50 – 65 Ω	50 – 65 Ω
3000W (M5)	30 – 40 Ω	50 – 65 Ω	50 – 65 Ω

Resolver windings should not be “Open” or zero ohms.

Insulation Resistance			
MOTOR SIZE	**Pins J - K**	**Pins K - L**	**Pins L - J**
ALL	More than 50 megohms at 500 VDC		

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8.2.4 Transmission Disassembly and Inspection

(This instruction is for RMx tool assemblies – RHx high speed tools are not covered by this instruction)

•The planetary gear transmissions used in the AFC1500 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 kept on the Tool Preamplifier and can be retrieved using the AFC1500 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 two years or 1,000,000 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 750,000 cycles, while other systems may only require maintenance every 2 - 3 million cycles.

1. REMOVE TRANSMISSION FROM TOOL ASSEMBLY. Separate the transmission from the motor by removing four (4) screws. Remove the snap ring from the output shaft. Separate the transducer from the transmission by removing four (4) screws.

2. DISASSEMBLE TRANSMISSION. Refer to the appropriate transmission assembly drawing while disassembling the transmission for cleaning. (See next pages)

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. Connect the transmission to the motor with four (4) screws. If needed, rotate the output shaft to align the transmission planetary gears with the motor output splined shaft. Connect the transducer to the transmission with four (4) screws. Install the snap ring onto the output shaft to hold the outer bearing in place. If the transmission does not rotate freely after reassembling the tool, then disassemble the tool again to isolate and correct the cause.

NOTE: Snap ring installation must be the last step in re-assembly.

8. INSPECT SPINDLE ASSEMBLY. Prior to installing the tool into an application, inspect the spring loaded spindle assembly that will connect to the tool. The assembly should compress evenly, without binding. Rotate the assembly in the spindle housing and verify there is no binding. Visually inspect the entire assembly for signs of wear or fatigue. Replace parts as required, and reassemble. Lubricate the inner bearings of the housing as required. Install the tool into the application and verify there is no binding.

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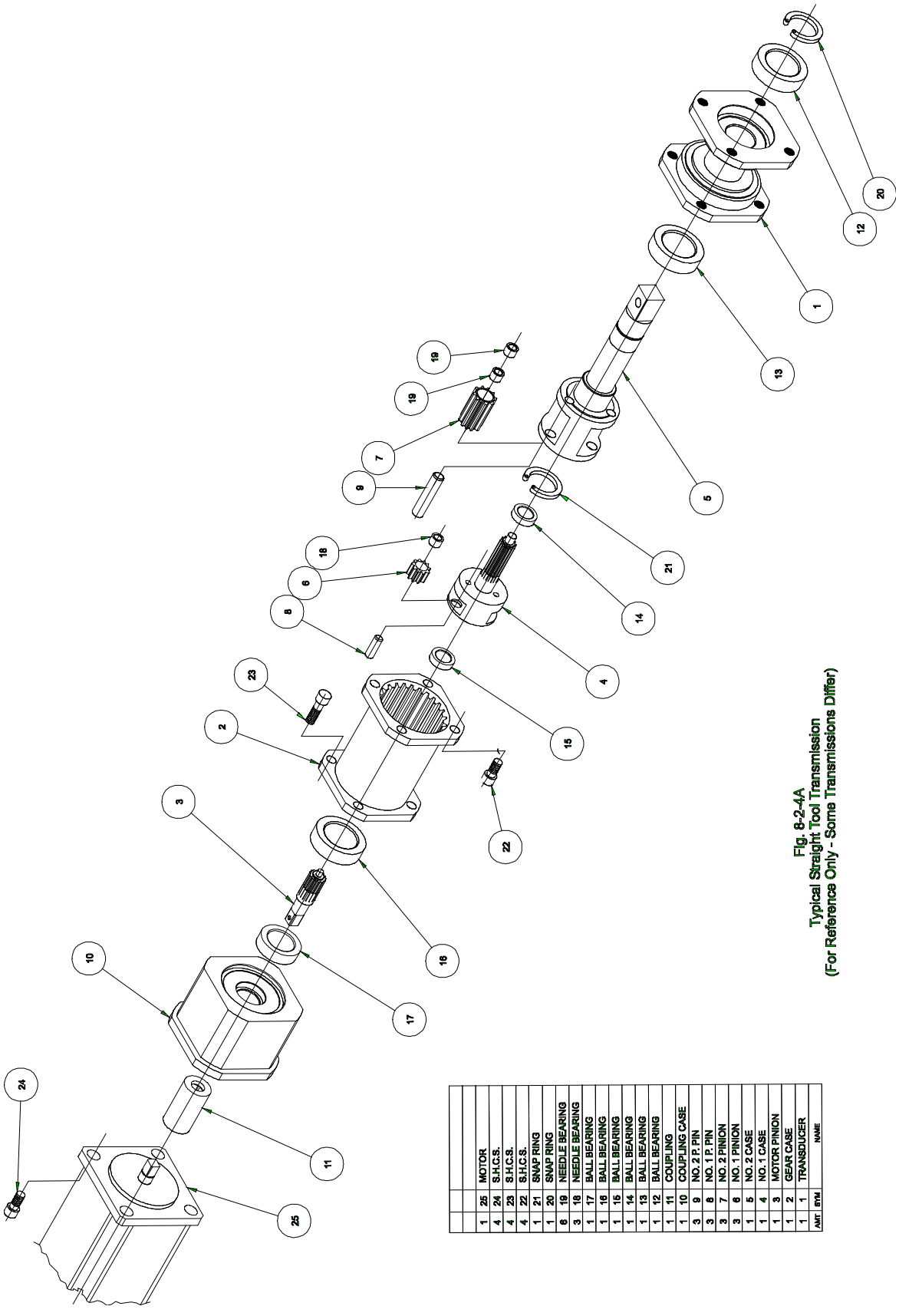
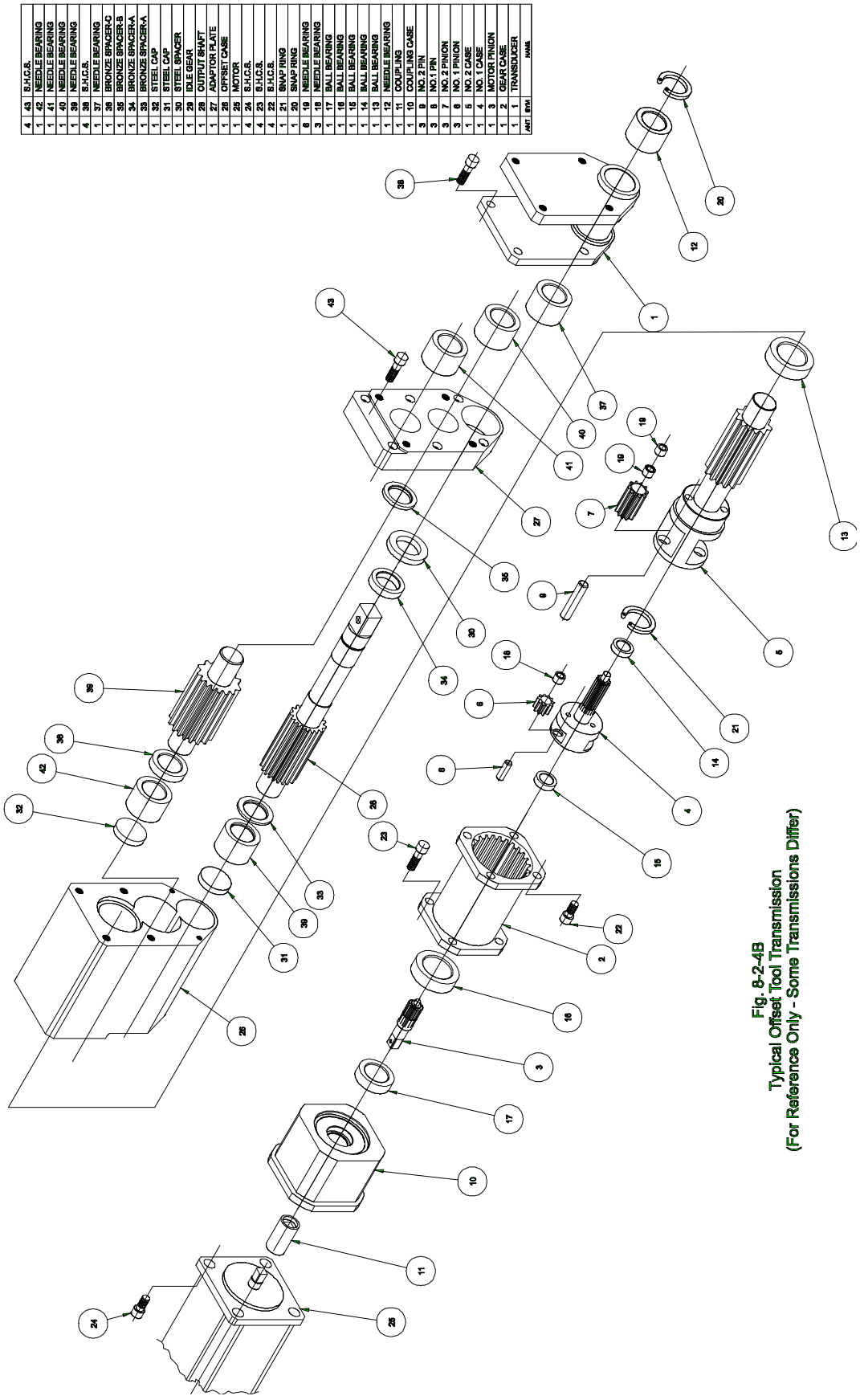


Fig. 8-2-4A
Typical Straight Tool Transmission
(For Reference Only - Some Transmissions Differ)

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ITEM	PART NUMBER	NAME
43	4	S.H.C.S.
42	1	NEEDLE BEARING
41	1	NEEDLE BEARING
40	1	NEEDLE BEARING
39	1	NEEDLE BEARING
38	4	S.H.C.S.
37	1	NEEDLE BEARING
36	1	BRONZE SPACER-C
35	1	BRONZE SPACER-B
34	1	BRONZE SPACER-A
33	1	BRONZE SPACER-A
32	1	STEEL CAP
31	1	STEEL CAP
30	1	STEEL SPACER
29	1	IDLE GEAR
28	1	OUTPUT SHAFT
27	1	ADAPTOR PLATE
26	1	OFFSET CASE
25	1	MOTOR
24	4	S.H.C.S.
23	4	S.H.C.S.
22	4	S.H.C.S.
21	1	SNAP RING
20	1	SNAP RING
19	6	NEEDLE BEARING
18	3	NEEDLE BEARING
17	1	BALL BEARING
16	1	BALL BEARING
15	1	BALL BEARING
14	1	BALL BEARING
13	1	BALL BEARING
12	1	NEEDLE BEARING
11	1	COUPLING
10	1	COUPLING CASE
9	3	NO. 2 PIN
8	3	NO.1 PIN
7	3	NO. 2 PINION
6	3	NO. 1 PINION
5	1	NO. 2 CASE
4	1	NO. 1 CASE
3	1	MOTOR PINION
2	1	GEAR CASE
1	1	TRANSDUCER

Fig. 8-2-4B
Typical Offset Tool Transmission
(For Reference Only - Some Transmissions Differ)

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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.

NOTE: When replacing the AFC1500 System SAN unit, ensure that the new unit is configured with the compatible Hardware and Firmware version as the unit being replaced.. The Firmware Version number will show in the Data Display when the Parameter number displays 00 and the D-NO displays 01.
Newer firmware versions will provide compatibility with older firmware versions under most instances. When the system requires special firmware due to customer requirements, care should be taken to ensure Spare units are ordered with the Firmware version identified.

8.3.1 SAN Unit Replacement (No Partial Replacement - Complete Unit Only)

When one SAN unit is being replaced with another, it is important to verify that both Units are compatible Types. (Refer to Section 2.4.1 SAN unit and to the chart, below.)

TOOL TYPE	ORIGINAL SERVO TYPE	UPDATED SERVO TYPE
NFT-051RM1(A) –S1	SAN2-12	SAN3-24
NFT-051RM1(A) -S	SAN2-12	SAN3-24
NFT-101RM1(A) –S/O	SAN2-12	SAN3-24
NFT-201RM1(A) –S/O	SAN2-12	SAN3-24
NFT-211RH1(A/B) -SA	N/A	SAN3-24H
NFT-301RM2(A) –S/O	SAN2-24	SAN3-24
NFT-311RH1(A/B) -SA	N/A	SAN3-24H
NFT-401RM1(A) –S/O	SAN2-12	SAN3-24
NFT-411RH1(A/B) -SA	N/A	SAN3-24H
NFT-401RM3(A) –S/O	SAN2-40	SAN3-40
NFT-601RM3(A) –S/O	SAN2-40	SAN3-40
NFT-801RM3(A) –S/O	SAN2-40	SAN3-40
NFT-801RH3(A/B) -SS	N/A	SAN3-60H
NFT-132RM3(A) –S/O	SAN2-40	SAN3-40
NFT-132RH3(A/B) -SS	N/A	SAN3-60H
NFT-152RM3(A) –S/O	SAN2-40	SAN3-40
NFT-202RM3(A) –S/O	SAN2-40	SAN3-40
NFT-202RH3(A/B) -SS	N/A	SAN3-60H
NFT-302RM3(A) –S/O	SAN2-40	SAN3-40
NFT-502RM4(A) –S/O	SAN2-80	SAN3-120TM
NFT-802RM4(A) –S/O	SAN2-80	SAN3-120TM
NFT-103RM5 –S	SAN2-120	SAN3-120WM

1. Verify the enclosure power is off. Ensure all cables connected to the front of the SAN unit are clearly marked (for reconnection).
2. Disconnect all cables from the front of the unit.
3. Loosen (do not remove) the three (3) screws that secure the SAN unit to the back panel. The upper bracket of the SAN unit has one slotted hole, and the bottom bracket has two open-ended slots.
4. Lift up and out on the SAN unit to remove.
5. Verify the new SAN unit dip switches are set to the appropriate spindle number and ramp-up time (as the unit being replaced). Refer to Section 4.10.
6. Verify the SAN Units have the same configuration (hardware and software).
7. Install the new SAN unit in reverse order of removal.
8. Apply power to the enclosure. After approximately 7 seconds, the System will finalize the Power On Self Test (POST).
9. The SAN unit **WILL** require reentry of the preset data. Refer to Chapters 6 and 7.

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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.

1. Verify all System power is off.

2. Ensure that the two (2) homerun cables are marked for reconnection, then disconnect them from the tool.

3. Ensure the spindle assembly is supported, and remove the two (2) bolts securing it to the mounting plate.

WARNING: These two (2) bolts also secure the nutrunner, with the two (2) bolts removed in the next step. Some tool models are very heavy. Use precautions when disconnecting, removing, and installing these components.

4. Ensure the nutrunner is supported, and remove the two (2) remaining bolts (two of the four were removed in Step 3).

5. Follow all safety precautions to install an identical nutrunner assembly by performing the removal procedure in reverse order.

8.3.3 Replace homerun cables

FEC INC. provides a spare set of homerun cables with each System. (Units purchased as components, may not come with spare cables sets)

1. Verify all System power is off.

2. Disconnect the damaged cable(s) from the nutrunner and the SAN unit, and replace with the spare cable(s).

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Chapter 9: Troubleshooting

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9.1 Abnormal Conditions.

When an abnormal condition is detected by the system, the affected spindle stops and lights the ABNORMAL LED. 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 [DATA-NO] display. When connected to the AFC Userconsole software, the cause of the abnormal is also reported via the Fastening Data Monitor screen.

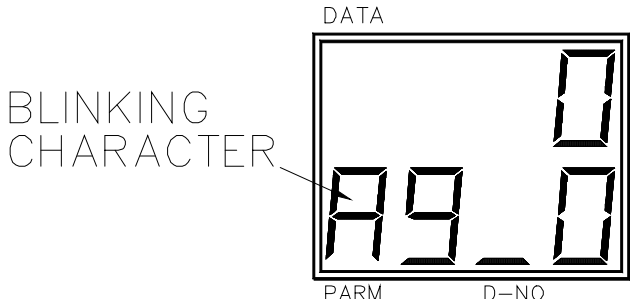
- **Abnormal code display**.

  When an Abnormal condition occurs (ABNORMAL LED is lit), 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 [PARM] 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 [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.
  The main Abnormal codes are:

Abnormal Code 9 Sub-Code 0



ABNORMAL CODE	DESCRIPTION
1	Torque Transducer Origin Error, Cal Check Error.
2	Torque Value Error.
3	Preamplifier error.
4	System Memory Error.
5	Servo Amplifier Response Error.
6	Servo Type Error.
7	Control Error with Multi.
8	Servo Amplifier Error.
9	Setting Data Error.

Abnormal sub-codes and specific actions for troubleshooting are detailed in the following section.

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9.2 Torque Transducer Origin Error, Cal Check Error.

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, transducer (T/D) cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it. (Nothing touching the tool assembly)
2. Verify that the cables or controllers are not located near any high voltage transient power sources. Relocate as required and reinitialize.
3. Exchange transducer (T/D) 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, transducer (T/D) cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it. (Nothing touching 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 transducer (T/D) 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, transducer (T/D) 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 cables or controllers are not located near any high voltage transient power sources. Relocate as required and attempt again the fastening start input.
4. Exchange transducer (T/D) cable, tool and/or controller with known working units. Apply start signal after exchange, and make note of any change in the location of the abnormal.
5. Replace the defective component.

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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, transducer (T/D) 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 cables or controllers are not located near any high voltage transient power sources. Relocate as required and attempt again a fastening start input.
4. Exchange transducer (T/D) 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, transducer (T/D) cable or the controller malfunctions.

RECOVERY:
1. Check that the tool has no external force applied to it.
2. Verify that the cables or controllers are not located near any high voltage transient power sources. Relocate as required and reinitialize.
3. Exchange transducer (T/D) 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.

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9.3 Torque Over Abnormals

9.3.1 Code 2-0 TORQUE OVER ABNORMAL / OFFSET TORQUE.

High torque was detected during an Offset Check Function which was greater than the programmed Offset Torque Limit.

The cause of this abnormal is;
1. Excessive binding in the spindle assembly or drive external to the square drive of the tool assembly.
2. The tool transducer is sensing excessive torque due to pressure or vibration during the offset check cycle.
3. The controller or the transducer cable is located in an electric or magnetic noise field.

RECOVERY:
1. Repair or replace mechanism which is binding external to the square drive output of the tool.
2. Check that the tool has no external force applied to it.
3. Verify that the cable or controller is not located near any high voltage transient power sources. Relocate as required and reinitialize.

9.3.2 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 the torque required, is not more than tool capability.
4. Verify that nothing is binding on the output shaft of the tool while it begins its cycle.

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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 SAN 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, transducer (T/D) cable or the controller malfunctions.

RECOVERY:
1. Verify that the cable or controller are not located near any high voltage transient power sources. Relocate as required and reinitialize the system.
2. Exchange transducer (T/D) 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 SAN 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 transducer 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, transducer (T/D) cable or the controller malfunctions.

RECOVERY:
1. Verify that the transducer cable is connected
2. Verify that the cable or controller are not located near any high voltage transient power sources. Relocate as required and reinitialize the system.
3. Exchange transducer (T/D) 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.

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9.5 System Memory Errors

9.5.1 Code 4-0 SYSTEM MEMORY ERROR / FLASH ROM WRITE ERROR

Communications error to internal SAN Flash ROM during WRITE attempt.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside SAN Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove SAN 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 SAN Flash ROM during READ attempt.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside SAN Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove SAN 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 SAN Servo Amp flash ROM.

This abnormal is caused from;
1. Metal chips and/or debris has migrated inside SAN Unit through vent holes.
2. Flash ROM IC chip has malfunctioned

RECOVERY:
1. Remove SAN Unit and blow or shake out debris.
2. Replace and return unit to FEC for repair.

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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.

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9.7 Servo Type Error

9.7.1 Code 6-0 SERVO TYPE ERROR / SERVO TYPE MISMATCH

The SAN Unit model does not match the connected motor type.

1. Verify the servo type tag with the motor type tag.
2. There are Multiple types of SAN Units (controllers) available & they must be connected to the correct motor size as shown in the table below.

TOOL TYPE	ORIGINAL SERVO TYPE	UPDATED SERVO TYPE
NFT-051RM1(A) –S1	SAN2-12	SAN3-24
NFT-051RM1(A) -S	SAN2-12	SAN3-24
NFT-101RM1(A) –S/O	SAN2-12	SAN3-24
NFT-201RM1(A) –S/O	SAN2-12	SAN3-24
NFT-211RH1(A/B) -SA	N/A	SAN3-24H
NFT-301RM2(A) –S/O	SAN2-24	SAN3-24
NFT-311RH1(A/B) -SA	N/A	SAN3-24H
NFT-401RM1(A) –S/O	SAN2-12	SAN3-24
NFT-411RH1(A/B) -SA	N/A	SAN3-24H
NFT-401RM3(A) –S/O	SAN2-40	SAN3-40
NFT-601RM3(A) –S/O	SAN2-40	SAN3-40
NFT-801RM3(A) –S/O	SAN2-40	SAN3-40
NFT-801RH3(A/B) -SS	N/A	SAN3-60H
NFT-132RM3(A) –S/O	SAN2-40	SAN3-40
NFT-132RH3(A/B) -SS	N/A	SAN3-60H
NFT-152RM3(A) –S/O	SAN2-40	SAN3-40
NFT-202RM3(A) –S/O	SAN2-40	SAN3-40
NFT-202RH3(A/B) -SS	N/A	SAN3-60H
NFT-302RM3(A) –S/O	SAN2-40	SAN3-40
NFT-502RM4(A) –S/O	SAN2-80	SAN3-120TM
NFT-802RM4(A) –S/O	SAN2-80	SAN3-120TM
NFT-103RM5 –S	SAN2-120	SAN3-120WM

Tool Type Part Number Breakdown

RM1 motor = SAN2-12, SAN3-24
RH1 motor = SAN3-24H
RM2 motor = SAN2-12, SAN3-24
RM3 motor = SAN2-40, SAN3-40
RH3 motor = SAN3-60H
RM4 motor = SAN2-80, SAN3-120TM
RM5 motor = SAN2-120, SAN3-120WM

Example: Tool Type NFT-601**RM3**A-S = RM3 motor size

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9.8 Multi Unit Control Error

9.8.1 Code 7-0 START SIGNAL TIMING ERROR

The controller received a start signal from the MULTI Unit or PLC while the SAN Unit was busy.

This abnormal is caused from;
1. Not enough time delay between a reverse operation and a forward operation.
2. SAN controller failure.
3. Not enough time delay between fastening Steps.

RECOVERY:
1. Add a minimum of 0.2 sec delay from a reverse operation to a forward operation.
2. Replace the SAN controller.

9.8.2 Code 7-1 REVERSE SIGNAL TIMING ERROR

The controller received a reverse signal from the MULTI Unit or PLC while the SAN Unit was busy.

This abnormal is caused from;
1. Not enough time delay between a reverse operation and a forward operation.
2. SAN controller failure.
3. Not enough time delay between fastening Steps.

RECOVERY:
1. Add a minimum of 0.3 sec delay from a reverse operation to a forward operation.
2. Replace the SAN controller.

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9.9 Servo Amplifier Error

9.9.1 Code 8-1 SERVO AMPLIFIER ERROR / SERVO IS OVER HEATED

The SAN 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 (242 volts ac) 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 SAN 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 (242 volts ac) 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. (Confirm that Crossover Torque is not set between 95% - 100% of Standard Torque – See note @ 6.3)

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 SAN 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 (242 volts ac) 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.

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9.9.4 Code 8-6 servo amplifier error / iNPUT voltage abnormal

The SAN 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 (180-242 volts AC) 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. Between 180-242 VAC 3 phase.

9.9.5 Code 8-9 SERVO AMPLIFIER ERROR/ OVER SPEED.

The resolver signal received at the SAN controller indicates an overspeed 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.
3. Confirm that Crossover Torque is not set between 95% - 100% of Standard Torque – See note @ 6.3.

9.9.7 Code 8-11 SERVO AMPLIFIER ERROR / RESOLVER SIGNAL ERROR.

The resolver signal received is not correct.

RECOVERY:
1. Check the cables and look for loose connectors or visible damages to the cable.
2. Replace with known good tool.

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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.

9.10.5 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.

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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.

WARNING: DO NOT CONNECT OR DISCONNECT CABLES OR OTHER SYSTEM COMPONENTS WITH POWER APPLIED.

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9.11 AFC1500 SAN Unit Fastening Faults and Causes

REFER TO SECTION "6.2 Monitoring Functions" for detailed descriptions of Fastening Faults and causes related to all monitoring functions.

9.11.1 Torque Accept Conditions

The Accept LED will light for the three following reasons:

1. The RESET input is active on either the display/programming unit or via a PLC input, and the reset condition (ZERO LEVEL) of the TRANSDUCER is within acceptable limits.
2. The CAL input is active on either the display/programming unit or via a PLC input, and the calibration condition (CAL LEVEL) of the transducer is within acceptable limits.
3. The previous fastening was completed within all preset limits (TORQUE, ANGLE, 1st RATE, 2nd RATE, 3rd RATE and TIME).

9.11.2 Torque Reject Conditions

The Reject LED will light for the following reasons:

1. The ZERO Level is outside acceptable limits.
2. The CAl Level is outside acceptable limits.
3. 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 1st or final time limits set in the parameter presets.

The Reject LED will blink for the following reasons:

1. Flashes fast indicating an Angle reject. (on 100 msec – off 300 msec)
2. Flashes Slow indicating a Torque rate or time reject. (on 100 msec – off 700 msec

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Telephone: (586) 781-2100 · Fax: (586) 781-0044

THIS FORM MAY BE DUPLICATED FOR FUTURE USE

RMA Number: _____

Original (purchased) FEC Job or Sales Order # _____

RMA Supplement

Company Name: _____ Contact Person: _____

Plant/Location: _____ Department: _____

Equipment Name / Model Number / Additional Description: _____

********** **CONDITIONS UNDER WHICH FAILURE OCCURRED** **********

Torque Specification: _____ Station Number: _____

Cycle Time: _____ Station Description: _____

Description of Failure (Were there indications of deteriorating performance? What application was the equipment being used in when it failed? What appears to require repair?) **Please provide as much detail as possible.**

Please help us to serve you better by providing as much information as possible regarding the returned equipment.

Complete this form & enclose it in the package with the equipment. A valid RMA number should be written clearly on the outside of the box. Ship the package to FEC INC. at:

51327 Quadrate Drive, Macomb, MI 48042 Phone: (586) 781-2100 Fax: (586) 781-0044

RMA Supplement.xls

REVISION: 2
11/17/05

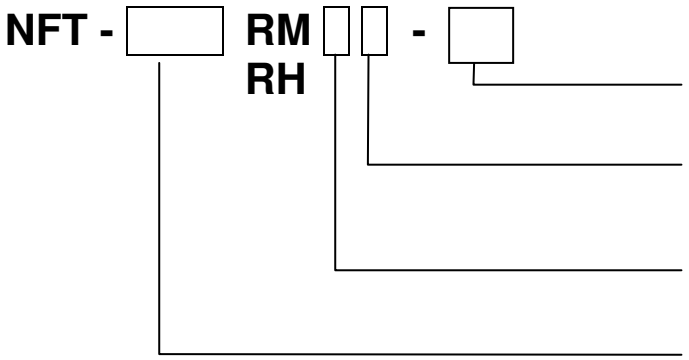
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AFC1500 Data Parameter Setting Blank Form

ITEM	DATA SETTING	PARM	D- No	DATA
System		0	**00**	TORQUE UNIT #.
		0	**01**	ROM VERSION (Not adjustable)
		0	**02**	AMPLIFIER VERSION (Not adjustable)
		0	**03**	FASTENING FUNCTION VERSION(Standalone/Multi)
		0	**04**	External Gear Ratio
Tool Data		0	**10**	TOOL # (not adjustable)
		0	**11**	TOOL CAL TORQUE.
	Factory Set	0	**12**	CAL. VOLTAGE
		0	**13**	ZERO TORQUE VOLTAGE
		0	**14~1A**	FEC In House Management Data
		0	**1B / 1C**	TOOL FASTENING COUNT (1ST 4 DIGITS / LAST 4 DIGITS)
Tool Type		0	**20**	TOOL MODEL #
Time Setup (SAN3-DPx ONLY)		0	**30**	YEAR "YYYY" EX. "2009"
		0	**31**	MONTH & DATE "mmdd" EX. "0923" (SEPT. 23)
		0	**32**	HOUR & MINUTE "hhmm" EX. "1759" 17:59
		0	**33**	SECONDS "ss" EX. "55" 55 SECONDS
Torque		1~16	**00**	FASTENING MODE (METHOD + STEPS)
		1~16	**10**	CALIBRATION TORQUE
		1~16	**11**	PEAK TORQUE LOW LIMIT
		1~16	**12**	PEAK TORQUE HIGH LIMIT
		1~16	**13**	STANDARD (STD) TORQUE
		1~16	**14**	SPEED CHANGE TORQUE
		1~16	**15**	1ST TORQUE
		1~16	**16**	SNUG TORQUE
		1~16	**17**	THRESHOLD (THR) TORQUE
		1~16	**18**	CROSSOVER (CROS) TORQUE
		1~16	**19**	TORQUE INHIBIT LIMIT
		1~16	**1A**	OFFSET TORQUE LIMIT/1 PULSE REVERSE LIMIT
		1~16	**1B**	BREAKAWAY TORQUE LIMIT
		1~16	**1C**	FINAL TORQUE LOW LIMIT
		1~16	**1D**	FINAL TORQUE HIGH LIMIT
		1~16	**1E**	2ND RATE START TORQUE
Angle		1~16	**20**	ANGLE LOW LIMIT
		1~16	**21**	ANGLE HIGH LIMIT
		1~16	**22**	STANDARD (STD) ANGLE
		1~16	**23**	1ST ANGLE
		1~16	**24**	CROSSOVER ANGLE
		1~16	**25**	ANGLE CORRECTION
		1~16	**26**	2ND RATE START ANGLE (NOT USED)
		1~16	**27**	3RD RATE START ANGLE (NOT USED)
Rate		1~16	**30**	1ST RATE LOW LIMIT
		1~16	**31**	1ST RATE HIGH LIMIT
		1~16	**32**	2ND RATE LOW LIMIT
		1~16	**33**	2ND RATE HIGH LIMIT
		1~16	**34**	3RD RATE HIGH LIMIT
		1~16	**35**	3RD RATE HIGH LIMIT
Time		1~16	**40**	INITIAL TIME
		1~16	**41**	1ST TIME HIGH LIMIT
		1~16	**42**	FINAL TIME HIGH LIMIT
		1~16	**43**	FIRST TIME LOW LIMIT
		1~16	**44**	FINAL TIME LOW LIMIT
		1~16	**45**	RAMP UP TIME
		1~16	**46**	RAMP DOWN TIME
		1~16	**47**	REVERSE RAMP UP TIME
		1~16	**48**	TORQUE RECOVERY TIME
Speed		1~16	**50**	INITIAL SPEED
		1~16	**51**	FREE RUN SPEED
		1~16	**52**	SLOW DOWN SPEED
		1~16	**53**	TORQUE SPEED
		1~16	**54**	REVERSE 1,2 SPEED
		1~16	**55**	REVERSE 3 / OR 1 PULSE REVERSE SPEED
		1~16	**56**	OFFSET CHECK SPEED
Revolutions		1~16	**60**	FREE RUN REVOLUTIONS
		1~16	**61**	TORQUE INHIBIT REVOLUTIONS
		1~16	**62**	OFFSET CHECK REVOLUTIONS
		1~16	**63**	REVERSE 2 REVOLUTIONS
		1~16	**64**	REVERSE 3 REVS. / OR 1 PULSE REV. TIME
		1~16	**68**	RUNDOWN REVOLUTIONS LOW LIMIT
		1~16	**69**	RUNDOWN REVOLUTIONS HIGH LIMIT
Current		1~16	**70**	FULL SCALE CURRENT VALUE
		1~16	**71**	HIGH CURRENT LIMIT
		1~16	**72**	LOW CURRENT LIMIT
		1~16	**73**	FASTENING CURRENT LIMIT

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Tool list (Straight, Offset, U-Tools) for Parameter set-up (refer to section 7.2.5)



Gear Type
O: Offset **S**: Straight
SU: U-Tool **A**: Angle

Motor Type
Blank: Pigtail connection
A: Bulkhead Connection

Motor Size
1: RM1/RH1 **2**: RM2 **3**: RM3/RH3
4: RM4 **5**: RM5

Maximum Torque (See List)

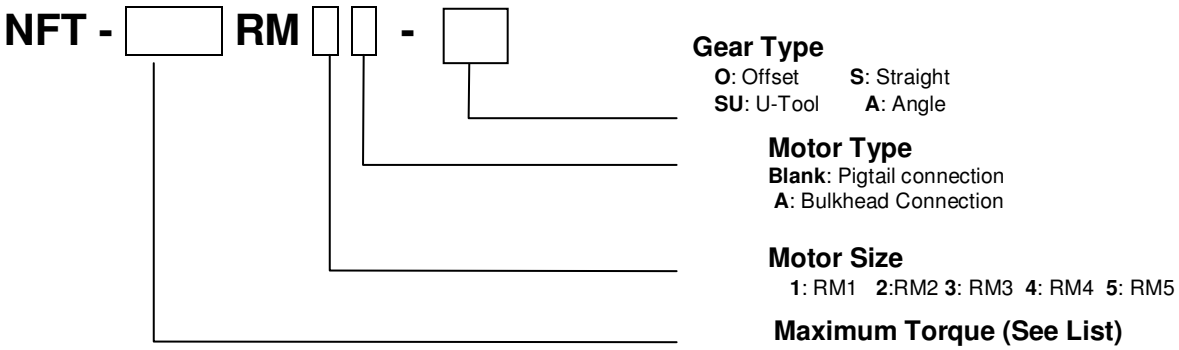
"Tool Type" is programmed based upon the tool's characteristics with regards to Speed or Torque and do not require unique "Tool No." assignments for certain characteristic changes. Example – NFT-101-RM1-S, NFT-101-RM1A-S, NFT-101-RM1-O, NFT-101-RM1-SU all use Tool No. "2" as the set-up for the connected tool type.

Tool No.	Tool Type	Max. Torque [Nm]	Max. RPM	Min. RPM	Max. TQ. Rate [Nm/deg]	Unit
47	NFT-010RM1-S	0.98	1100	2	5.000	SAN3-24M
1	NFT-051RM1-S	4.90	1100	2	5.000	SAN3-24M
25	NFT-051RM1-S1	4.90	500	1	5.000	SAN3-24M
2	NFT-101RM1-S	9.81	1100	2	5.000	SAN3-24M
3	NFT-101RM1-S1	9.81	500	1	5.000	SAN3-24M
4	NFT-201RM1-S	19.61	500	1	5.000	SAN3-24M
80	NFT-211RH1-S	20.59	1220	10	5.000	SAN3-24H
34	NFT-201RM2-S	19.61	600	1	5.000	SAN3-24M
18	NFT-201RM3-S	19.61	790	1	5.000	SAN3-40M
6	NFT-301RM2-S	29.42	600	1	5.000	SAN3-24M
81	NFT-311RH1-S	30.4	855	7	5.000	SAN3-24H
5	NFT-401RM1-S	39.2	250	1	5.000	SAN3-24M
106	NFT-401RM2-S	39.2	300	1	5.000	SAN3-24M
82	NFT-411RH1-S	40.2	635	5	5.000	SAN3-24H
19	NFT-401RM3-S	39.2	790	1	5.000	SAN3-40M
35	NFT-401RM3-S1	39.2	500	1	5.000	SAN3-40M
20	NFT-601RM3-S	58.8	790	1	5.000	SAN3-40M
7	NFT-801RM3-S	78.5	500	1	50.00	SAN3-40M
84	NFT-801RH3-S	78.5	1000	1	50.00	SAN3-60H
36	NFT-102RM3-S	98.1	395	1	50.00	SAN3-40M
8	NFT-132RM3-S	127.5	395	1	50.00	SAN3-40M
86	NFT-132RH3-S	127.5	582	1	50.00	SAN3-60H
24	NFT-152RM3-S	147.1	315	1	50.00	SAN3-40M
9	NFT-202RM3-S	196.1	220	1	50.00	SAN3-40M
87	NFT-202RH3-S	196.1	408	1	50.00	SAN3-60H
10	NFT-302RM3-S	294.2	150	1	50.00	SAN3-40M
15	NFT-502RM4-S	490.3	150	1	50.00	SAN3-120TM
12	NFT-802RM4-S	784.5	95	1	500.0	SAN3-120TM
27	NFT-163RM4-S	1569	47	1	500.0	SAN3-120TM
29	NFT-103RM5-S	981	60	1	500.0	SAN3-120WM
17	NFT-153RM5-S	1471	60	1	500.0	SAN3-120WM
26	NFT-203RM5-S	1961	60	1	500.0	SAN3-120WM
21	NFT-353RM5-S	3432	39	1	500.0	SAN3-120WM
22	NFT-403RM5-S	3923	39	1	500.0	SAN3-120WM
23	NFT-503RM5-S	4903	22	1	500.0	SAN3-120WM

※ The decimal point of torque is the decimal point of [Max. Torque].

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Tool list (Right Angle Tools) for Parameter set-up (refer to section 7.2.5)

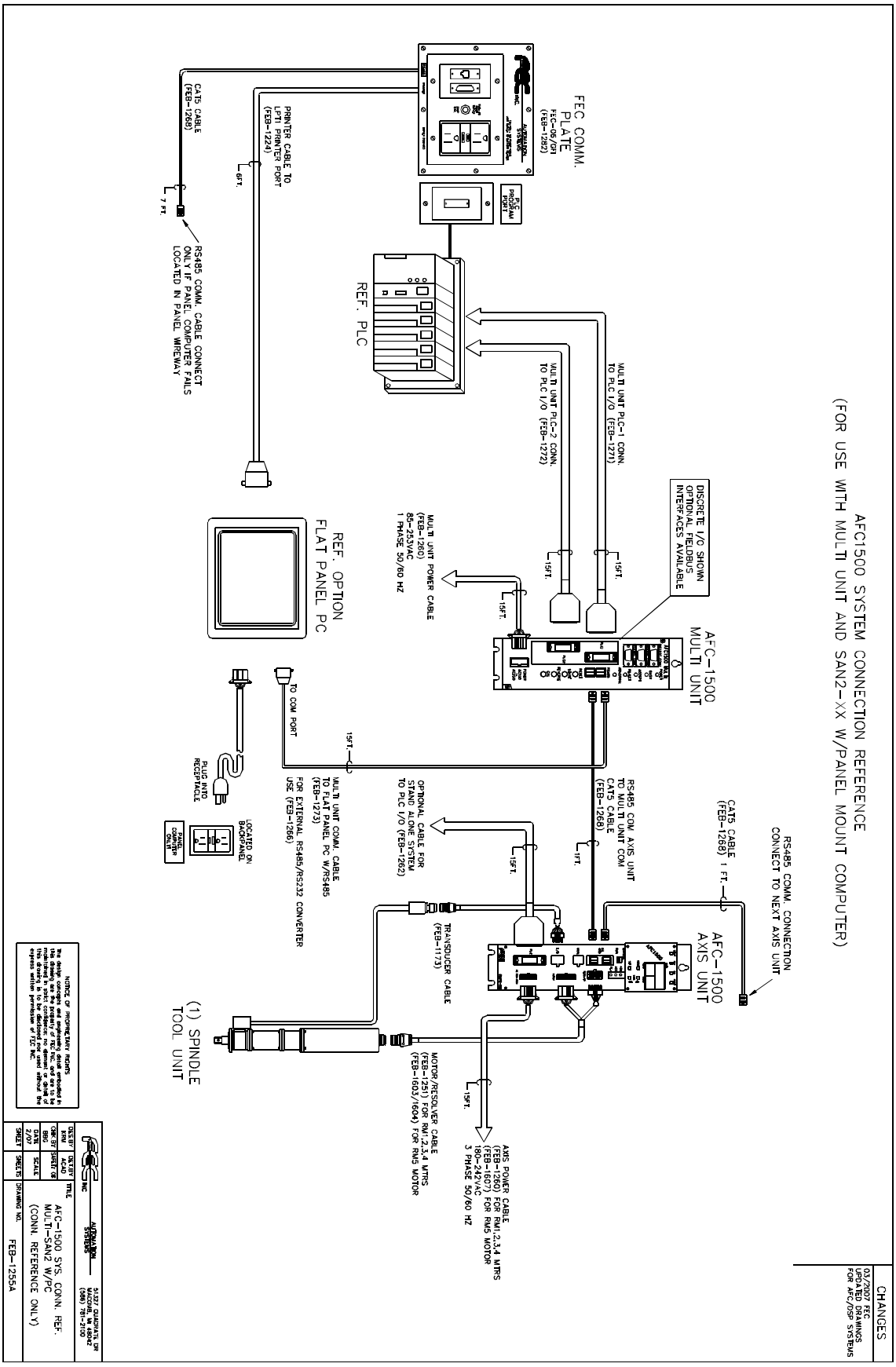


"Tool Type" is programmed based upon the tool's characteristics with regards to Speed or Torque and do not require unique "Tool No." assignments for certain characteristic changes. Example – NFT-201-RM1-A80, NFT-201-RM1A-A80 both use Tool No. "38" as the set-up for the connected tool type.

Tools with "A" Gear Types are Standard tools that have been outfitted with special Right Angle heads. The numeric value following the "A" designation for the Gear Type identifies the Maximum rated Torque value for the Right Angle head. The actual tool's "Max. Torque" value is typically less. Example – NFT-201RM1-A80 is capable of fastening to 30.40 Nm, while the Right Angle head is durable to 80 Nm.

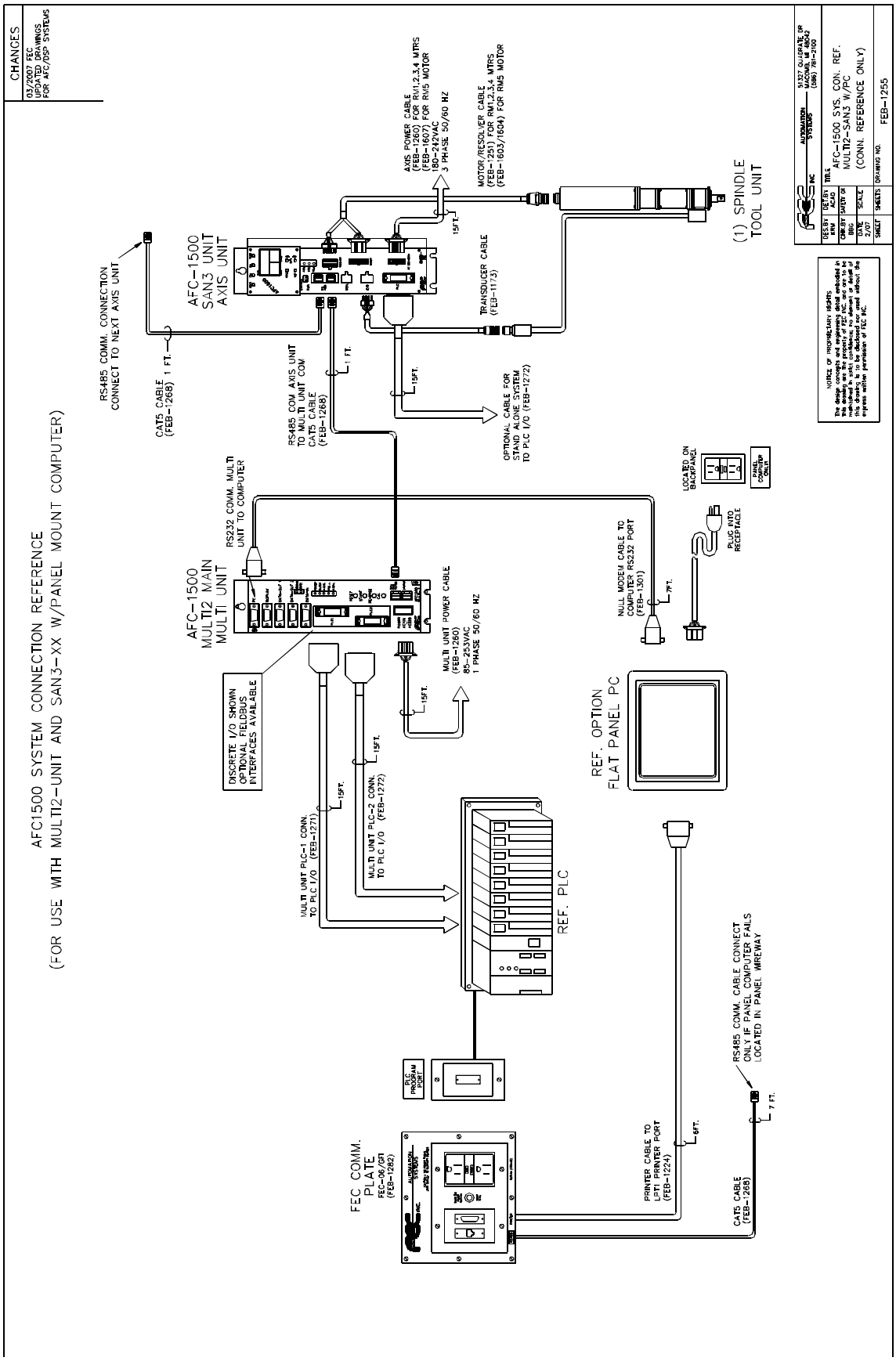
Tool No.	Tool Type	Max. Torque [Nm]	Max. RPM	Min. RPM	Max. TQ. Rate [Nm/deg]	Unit
38	NFT-201RM1-A80	30.40	320	1	5.000	SAN3-24M
88	NFT-201RM1-A55	30.40	320	1	5.000	SAN3-24M
39	NFT-401RM1-A80	60.8	160	1	5.000	SAN3-24M
89	NFT-401RM1-A55	54.9	160	1	5.000	SAN3-24M
46	NFT-301RM2-A80	45.1	385	1	5.000	SAN3-24M
96	NFT-301RM2-A55	45.1	385	1	5.000	SAN3-24M
45	NFT-601RM3-A80	79.4	510	1	50.00	SAN3-40M
90	NFT-801RM3-A130	121.6	320	1	50.00	SAN3-40M
40	NFT-801RM3-A135	135.3	270	1	50.00	SAN3-40M
41	NFT-132RM3-A250	169.7	295	1	50.00	SAN3-40M
91	NFT-132RM3-A250U	198.1	250	1	50.00	SAN3-40M
42	NFT-202RM3-A250	250.1	165	1	50.00	SAN3-40M
97	NFT-202RM3-A375	304.0	140	1	50.00	SAN3-40M
93	NFT-202RM3-A550	304.0	140	1	50.00	SAN3-40M
43	NFT-202RM3-A475	416.8	100	1	50.00	SAN3-40M
98	NFT-302RM3-A375	372.6	99	1	50.00	SAN3-40M
44	NFT-302RM3-A475	475.6	70	1	50.00	SAN3-40M
94	NFT-302RM3-A550	457.0	96	1	50.00	SAN3-40M

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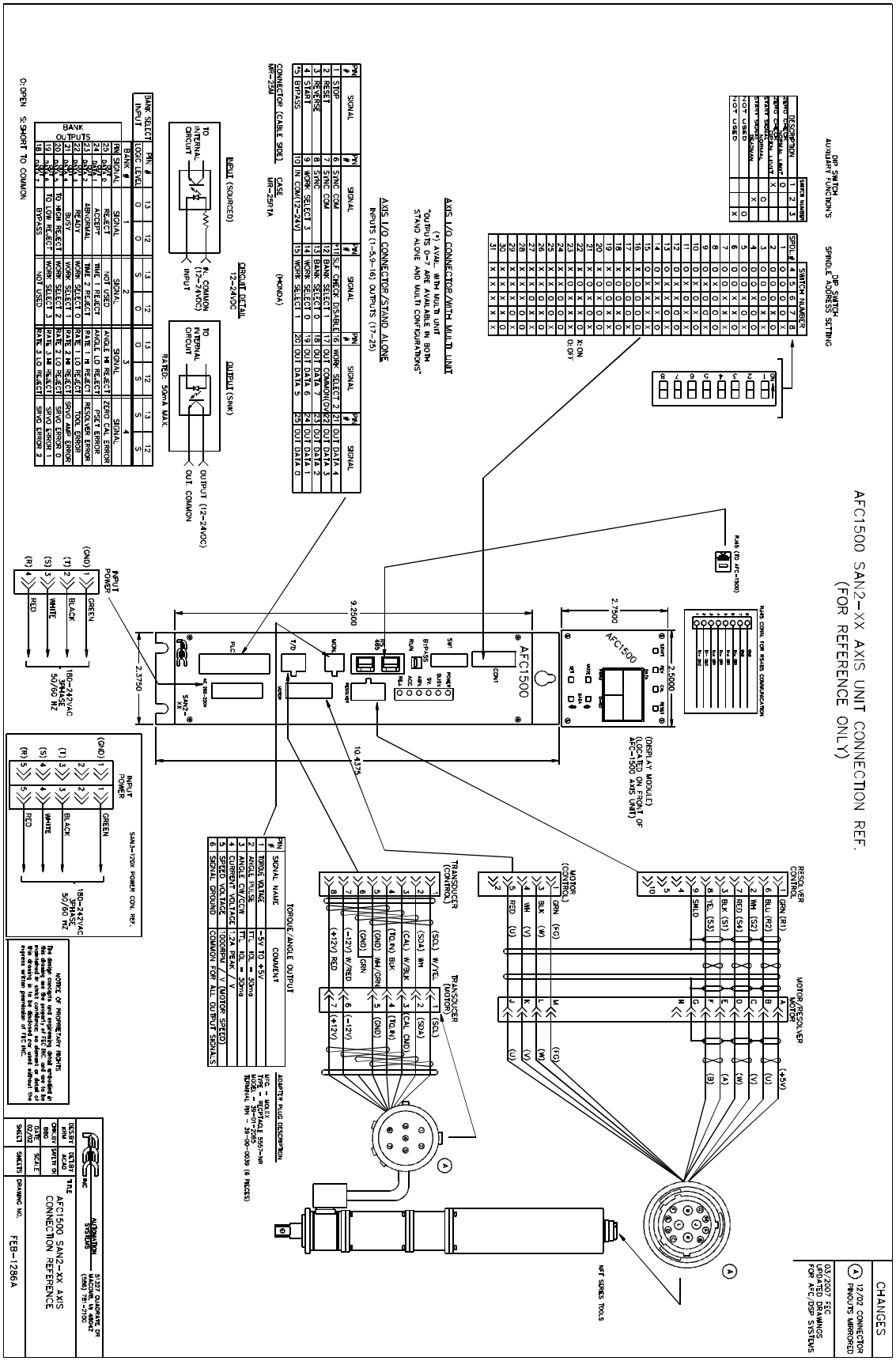
AFC1500 SAN2 with MULTI UNIT - Cable Map – FEB 1255A

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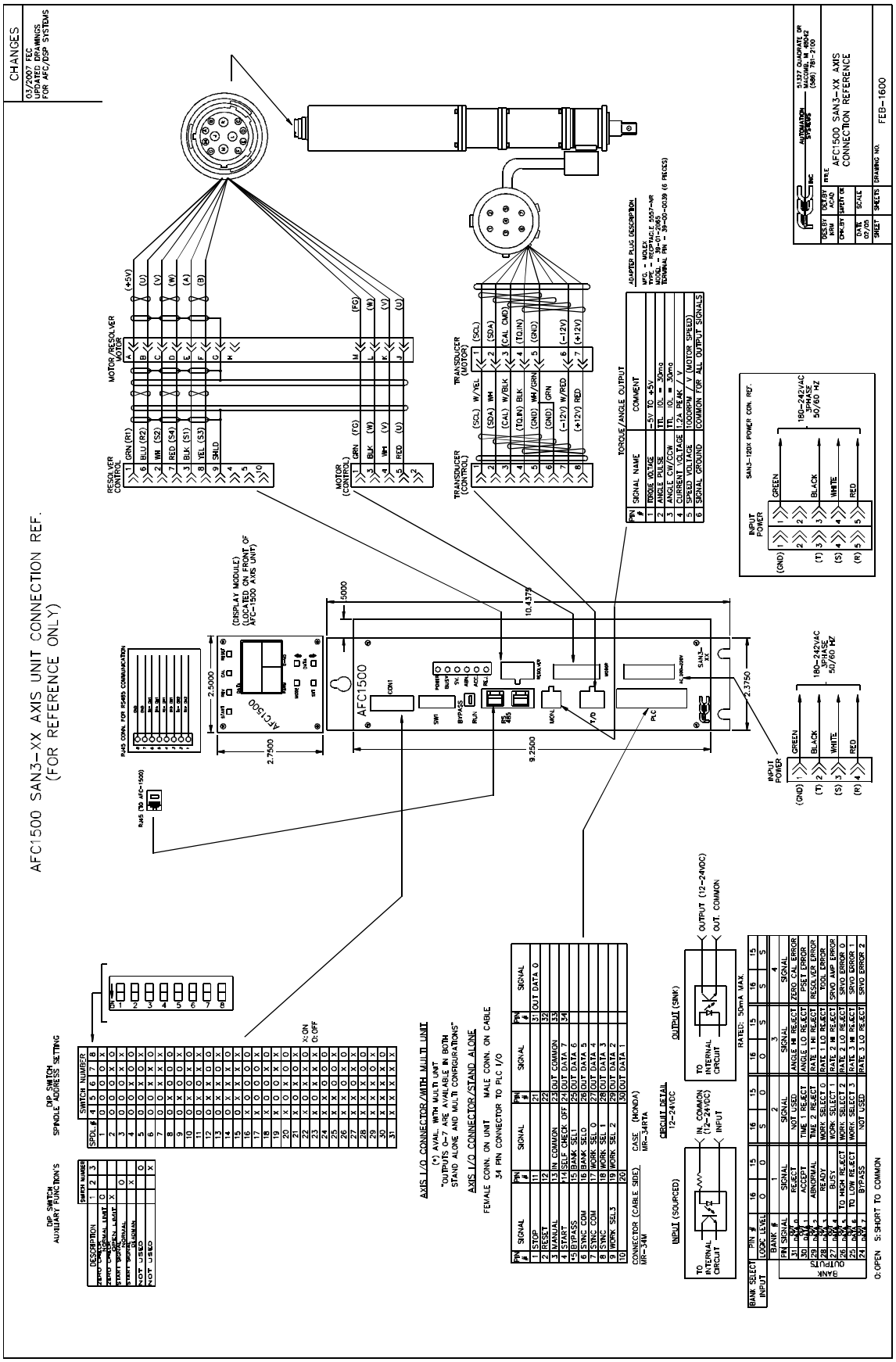
AFC1500 SAN3 with MULTI2 UNIT - Cable Map – FEB 1255

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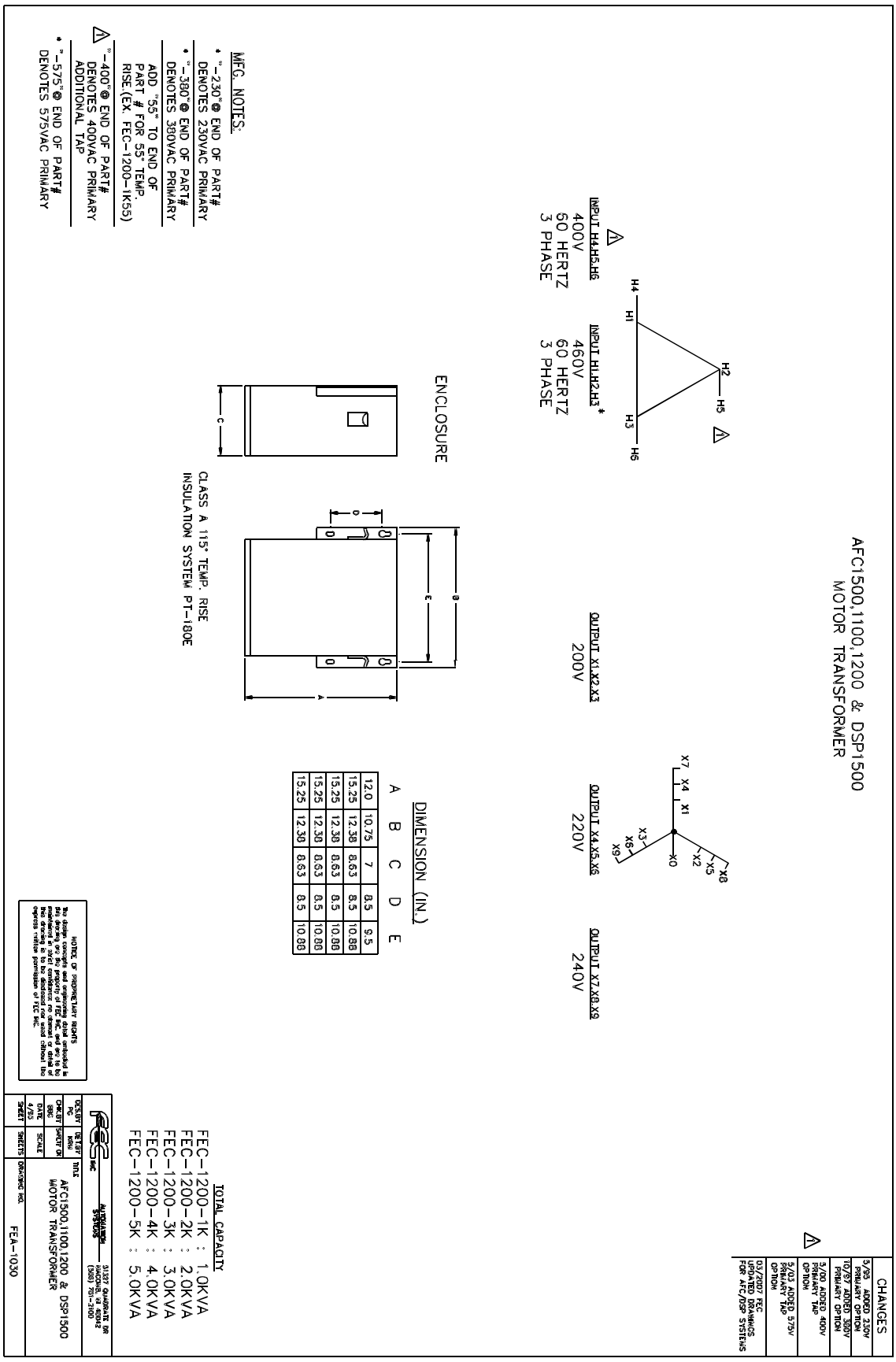
AFC1500 SAN2 Axis Unit Connection Reference – FEB 1286A

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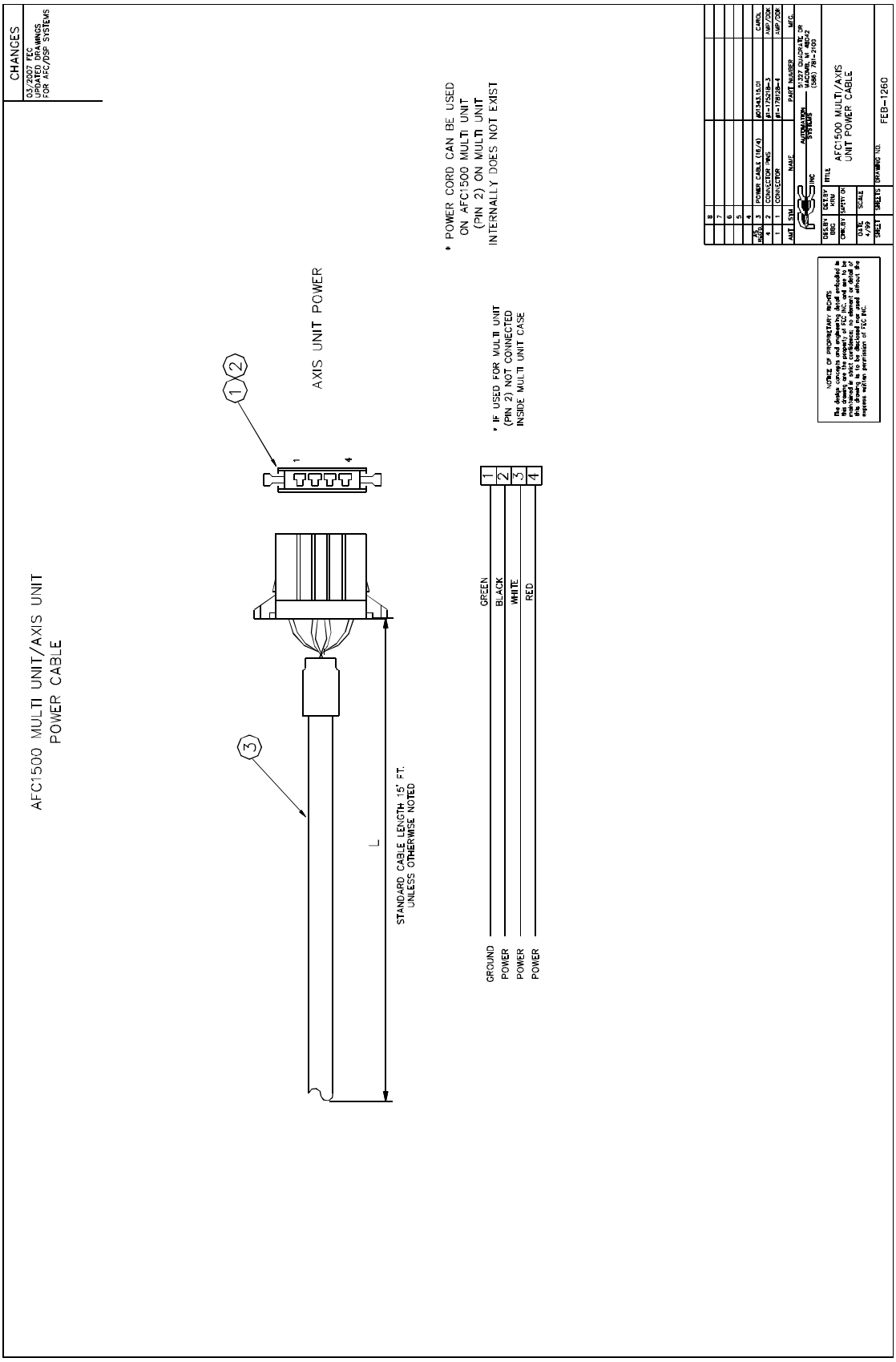
AFC1500 SAN3 Axis Unit Connection Reference - FEB 1600

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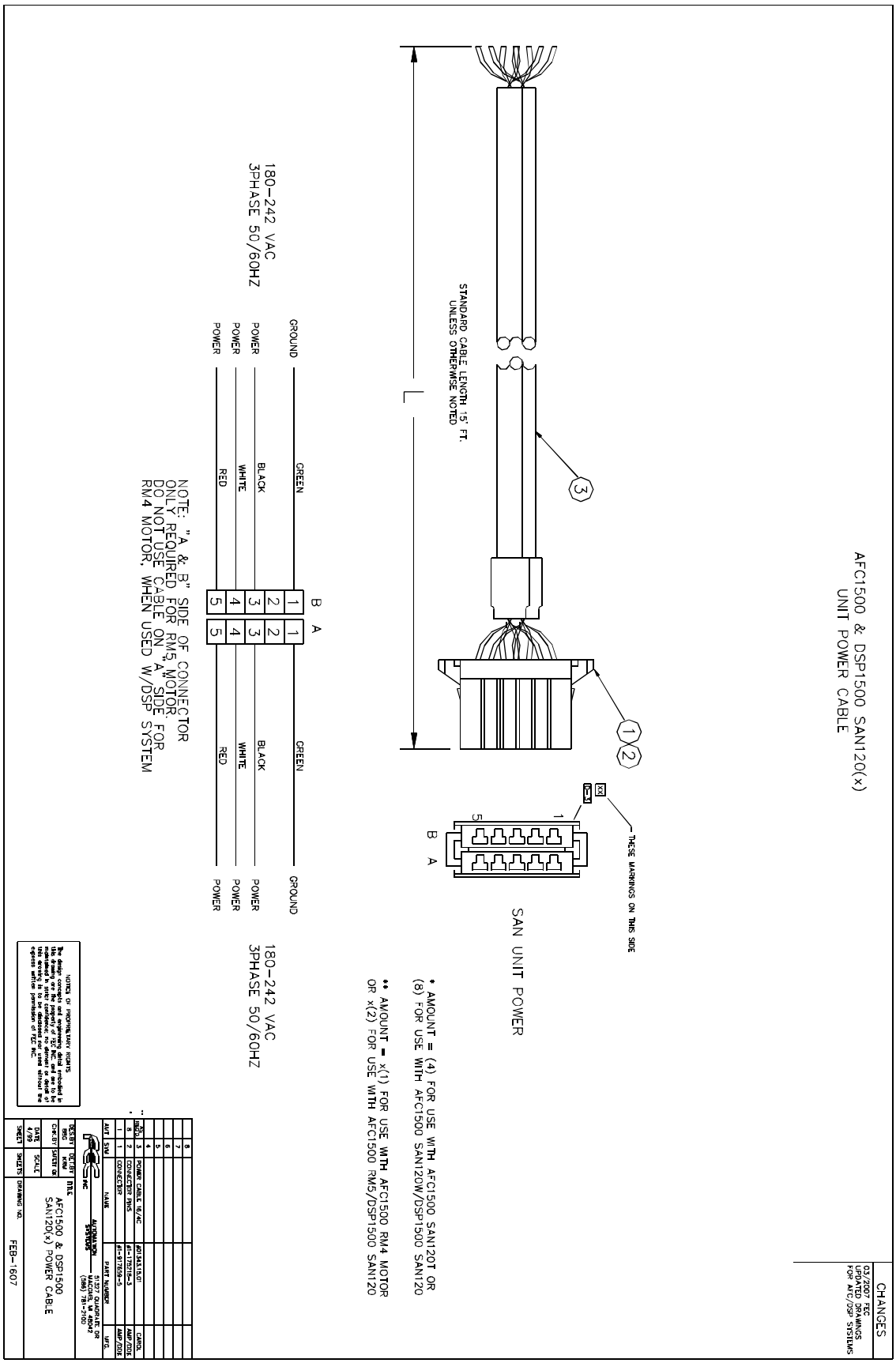
AFC1500 Transformer – FEB 1030

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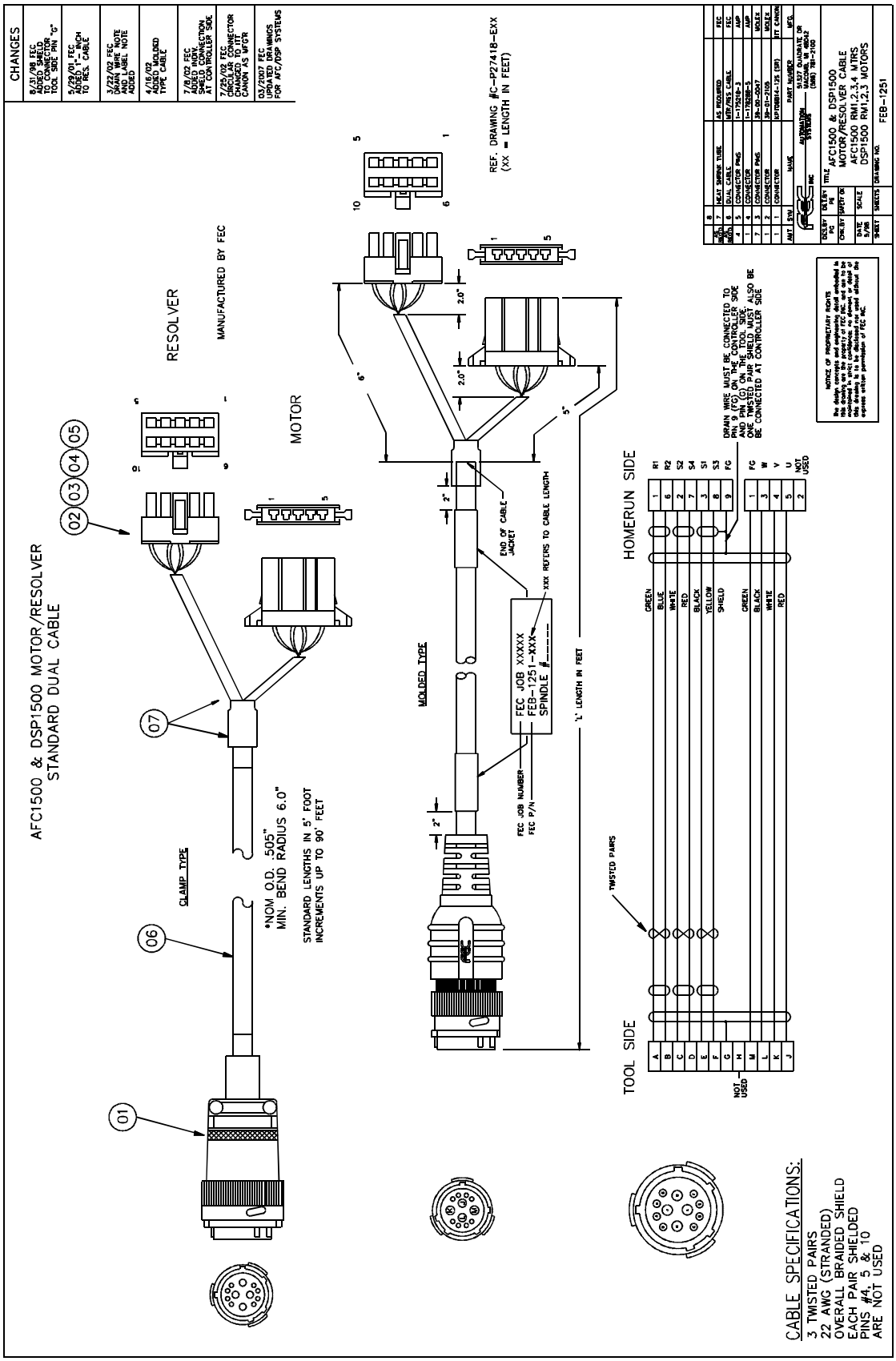
AFC1500 SAN / Multi Power Cable – FEB 1260

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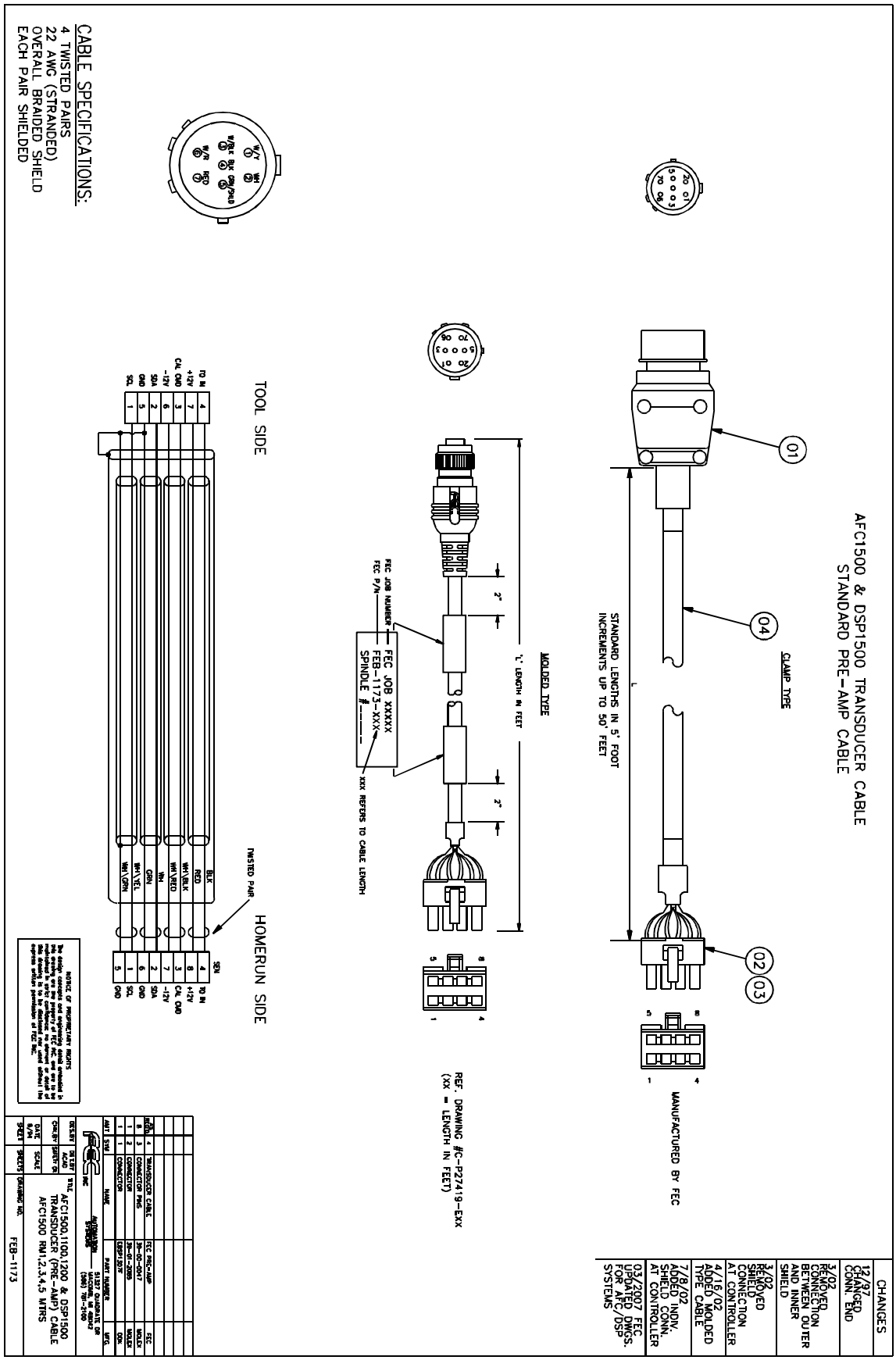
AFC1500 SAN3-120WM Power Cable (RM5) – FEB 1607

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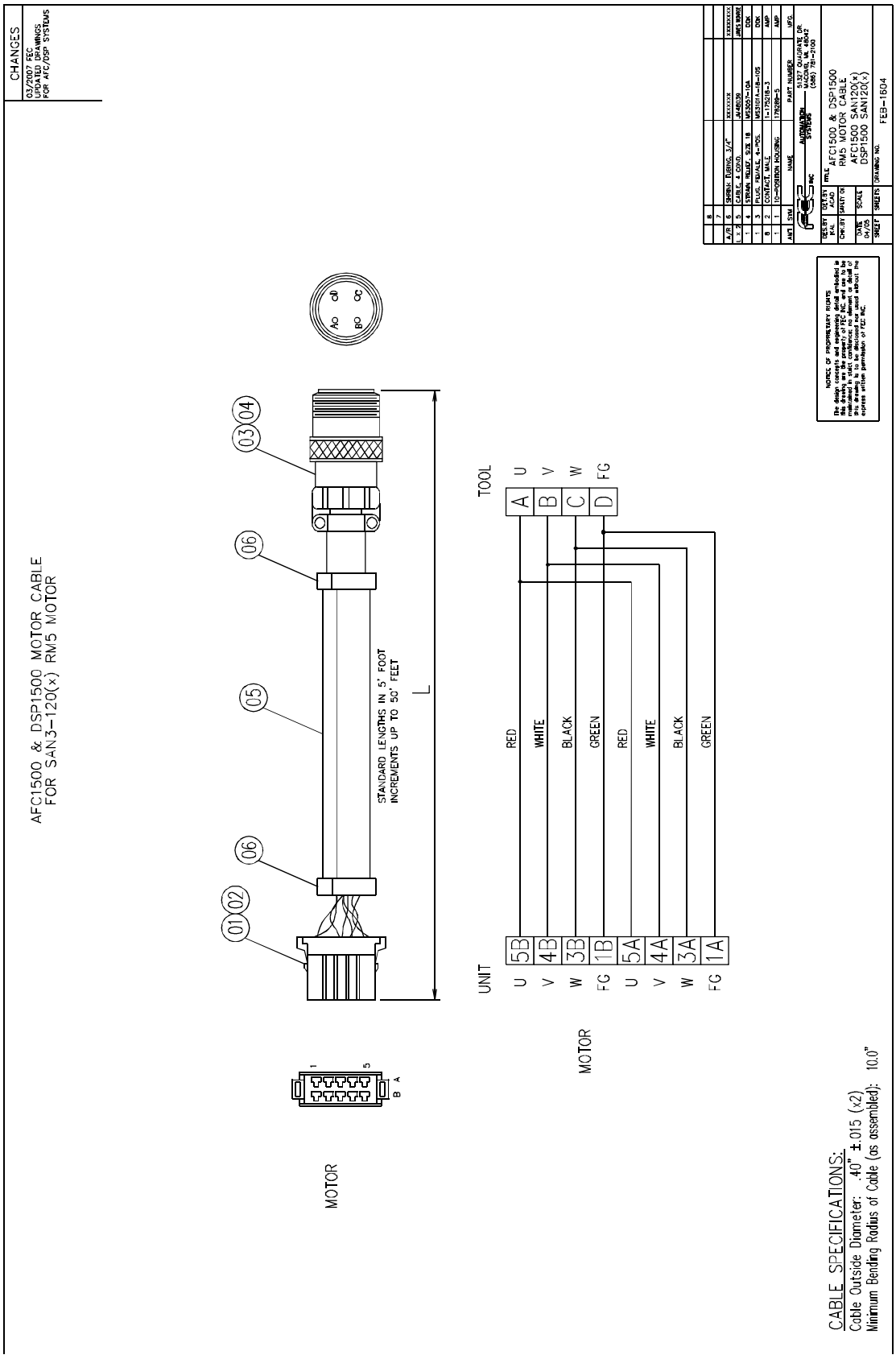
AFC1500 System Motor / Resolver Cables (RM1,2,3,4) - FEB 1251

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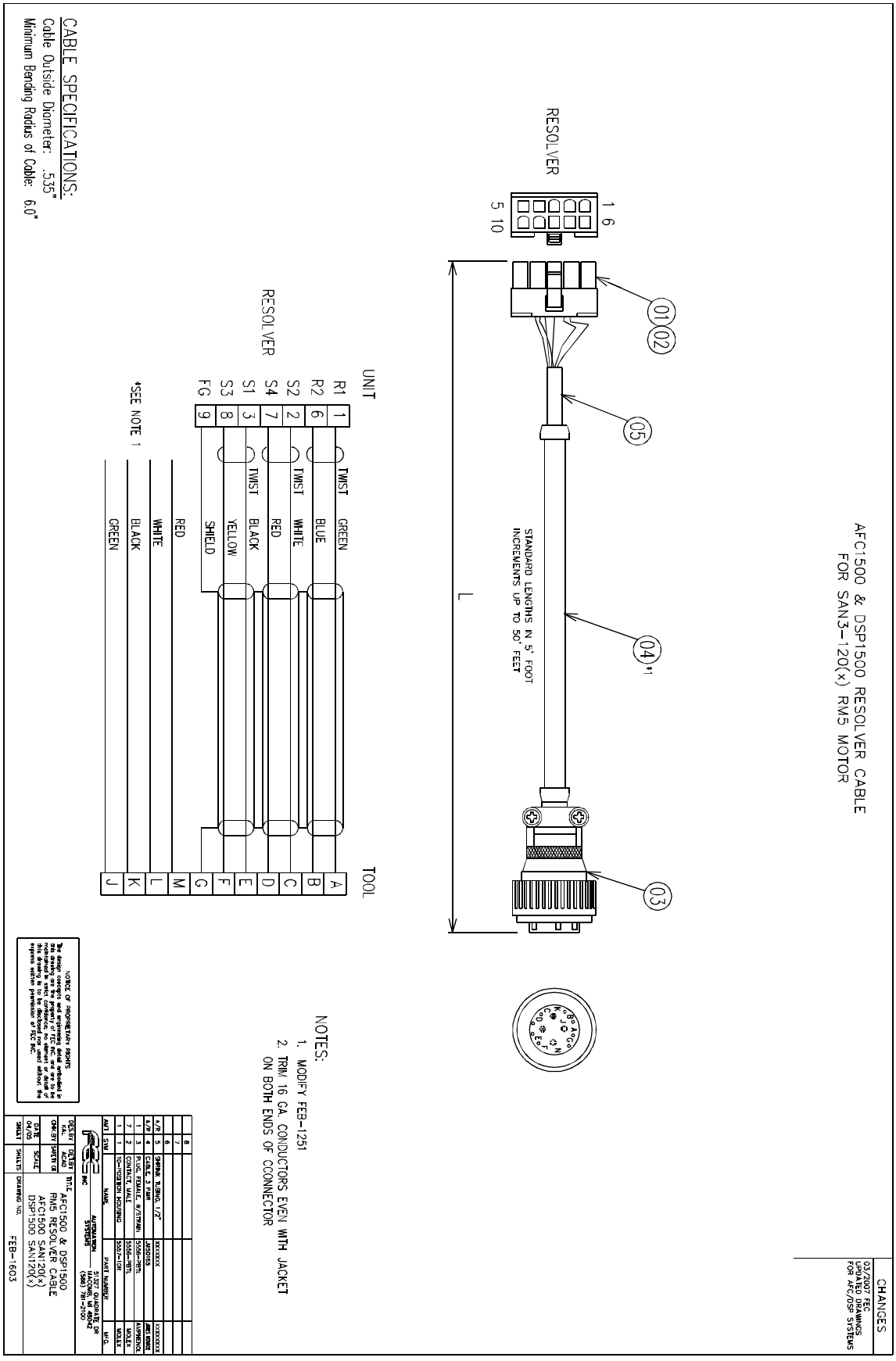
AFC1500 System Pre-Amp Cables (RM1,2,3,4,5) – FEB 1173

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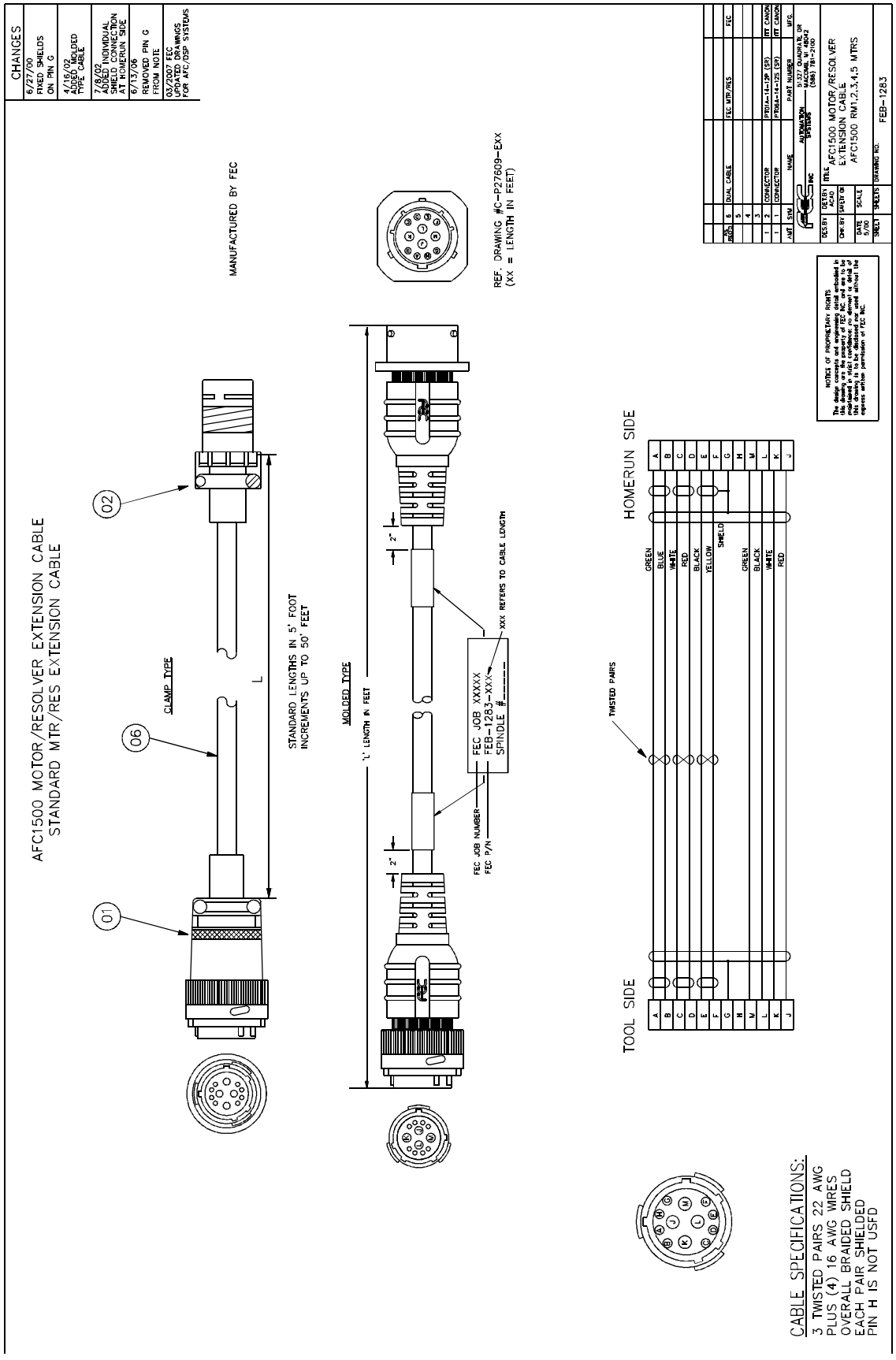
AFC1500 System Motor Cable (RM5) – FEB 1604

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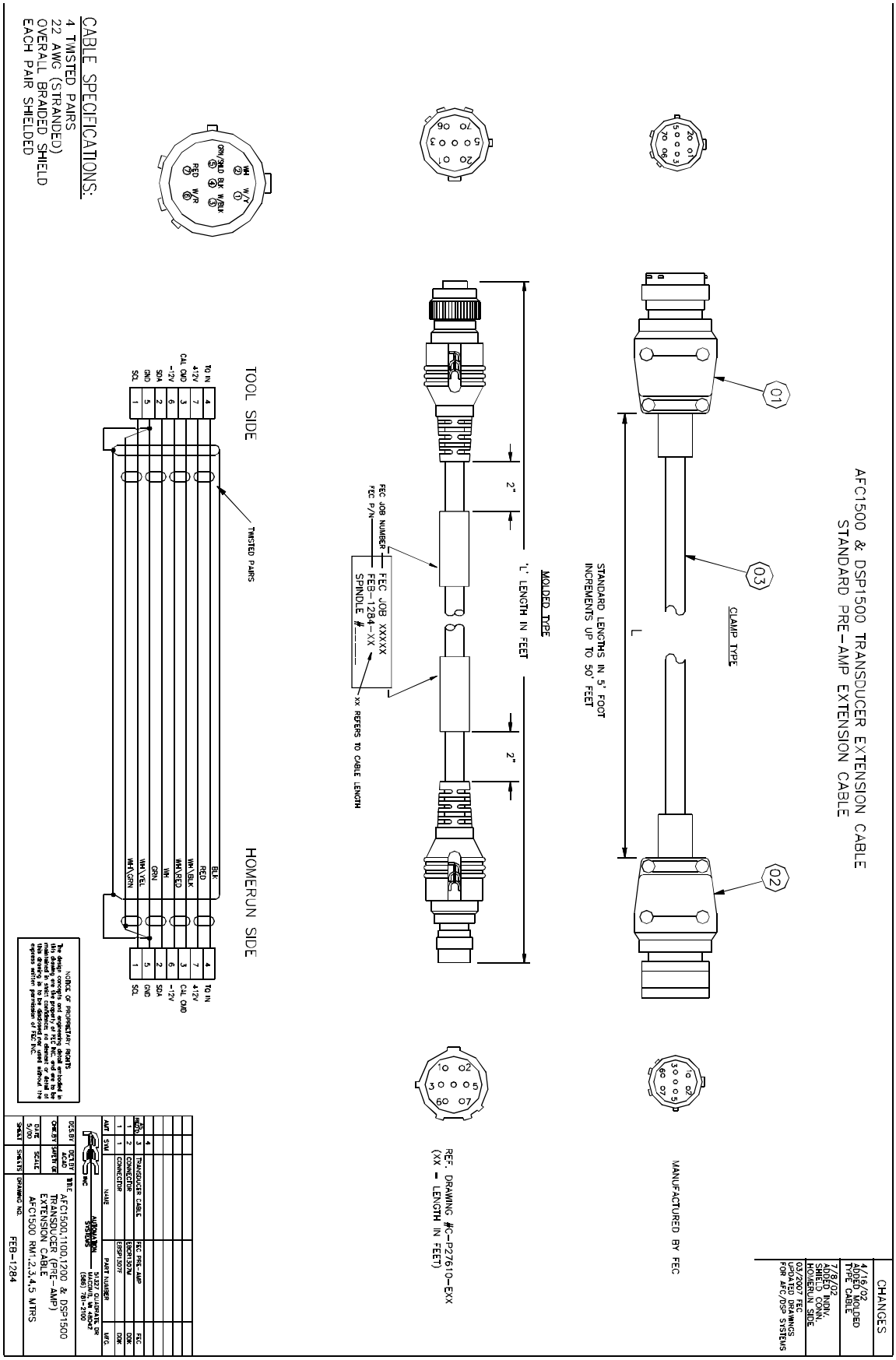
AFC1500 System Resolver Cable (RM5) – FEB 1603

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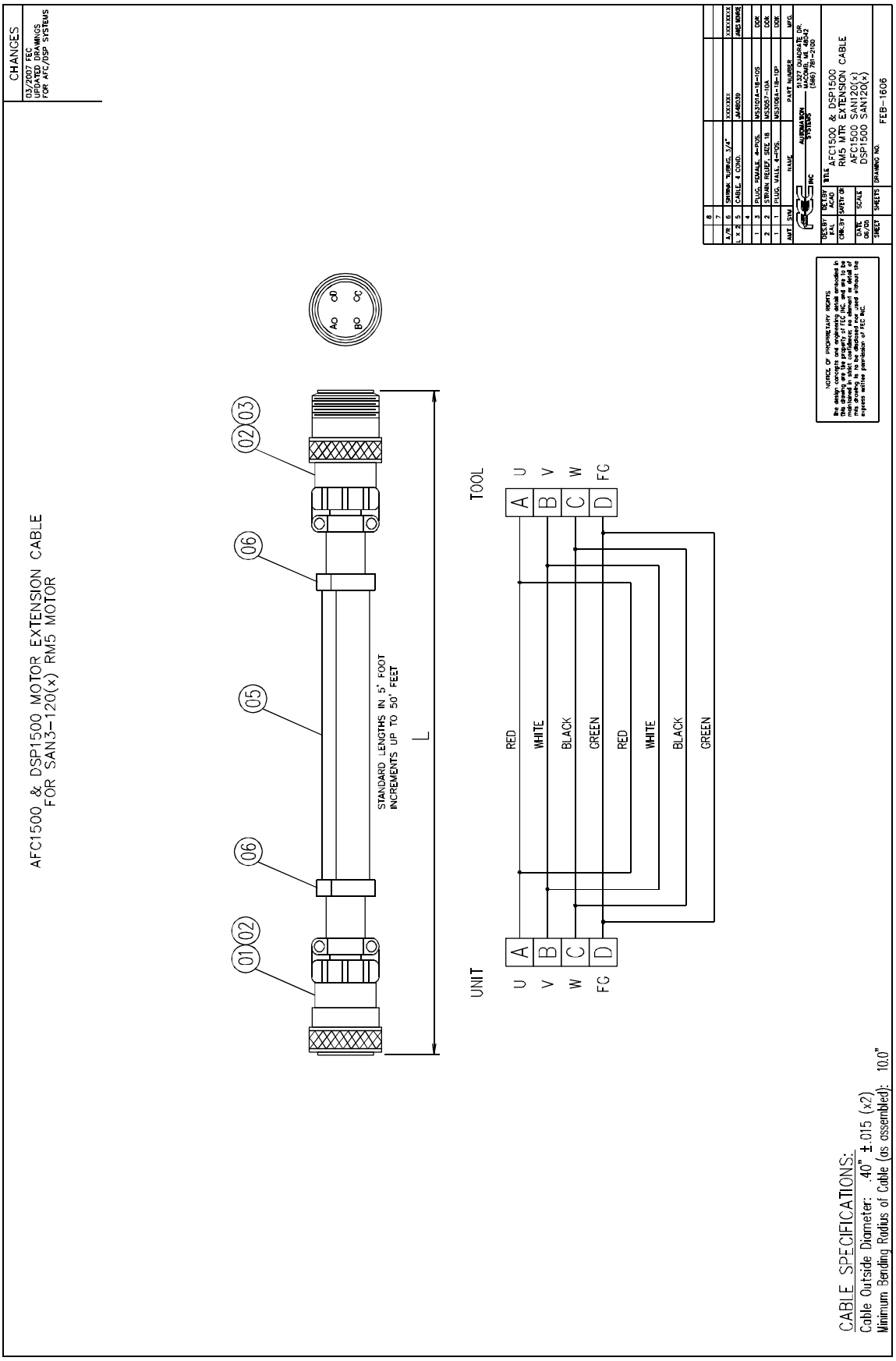
AFC1500 System Motor / Resolver Extension Cables.(RM1,2,3,4) – FEB 1283

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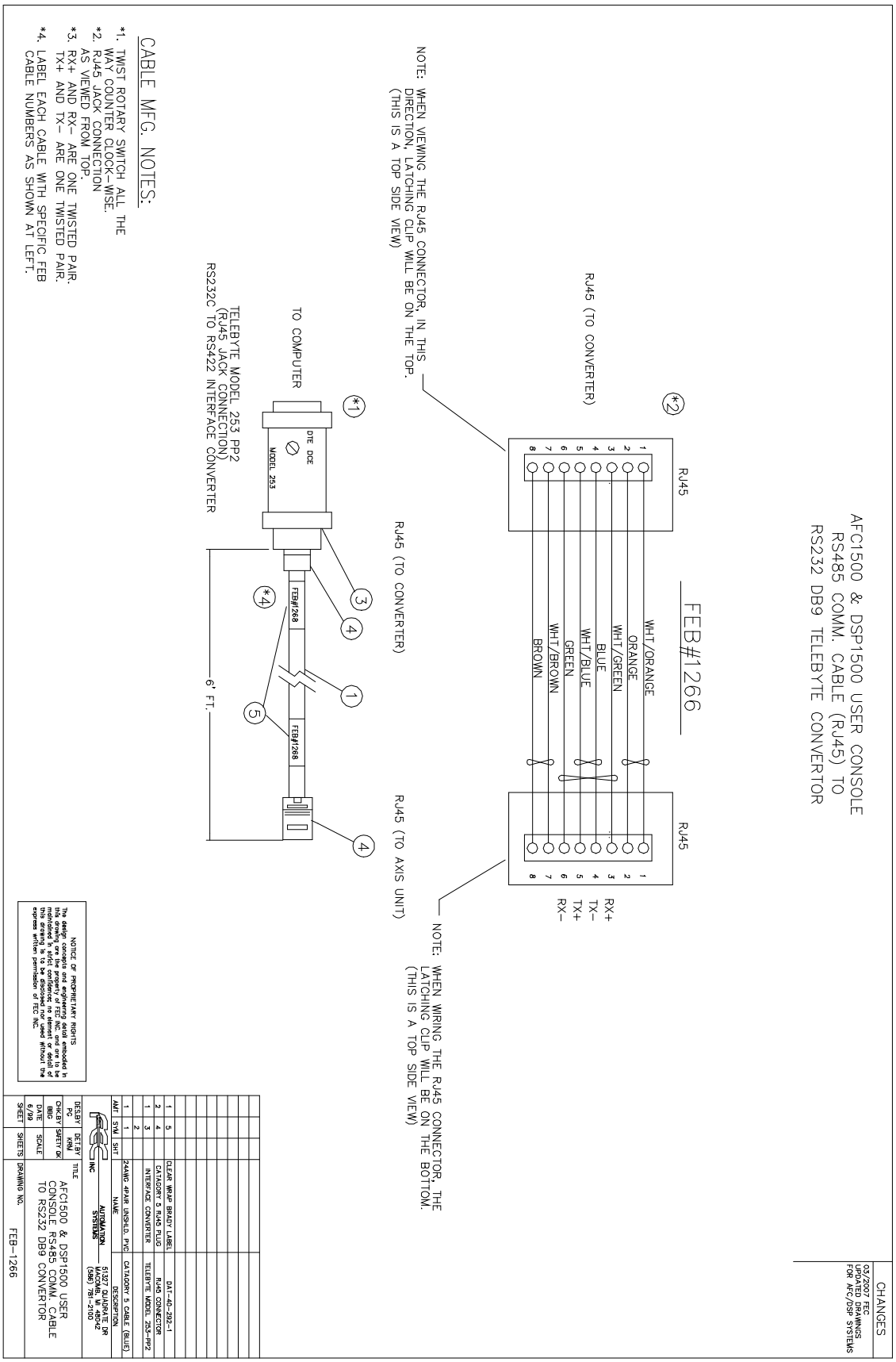
AFC1500 System Pre-Amp Extension Cable.(RM1,2,3,4,5) – FEB 1284

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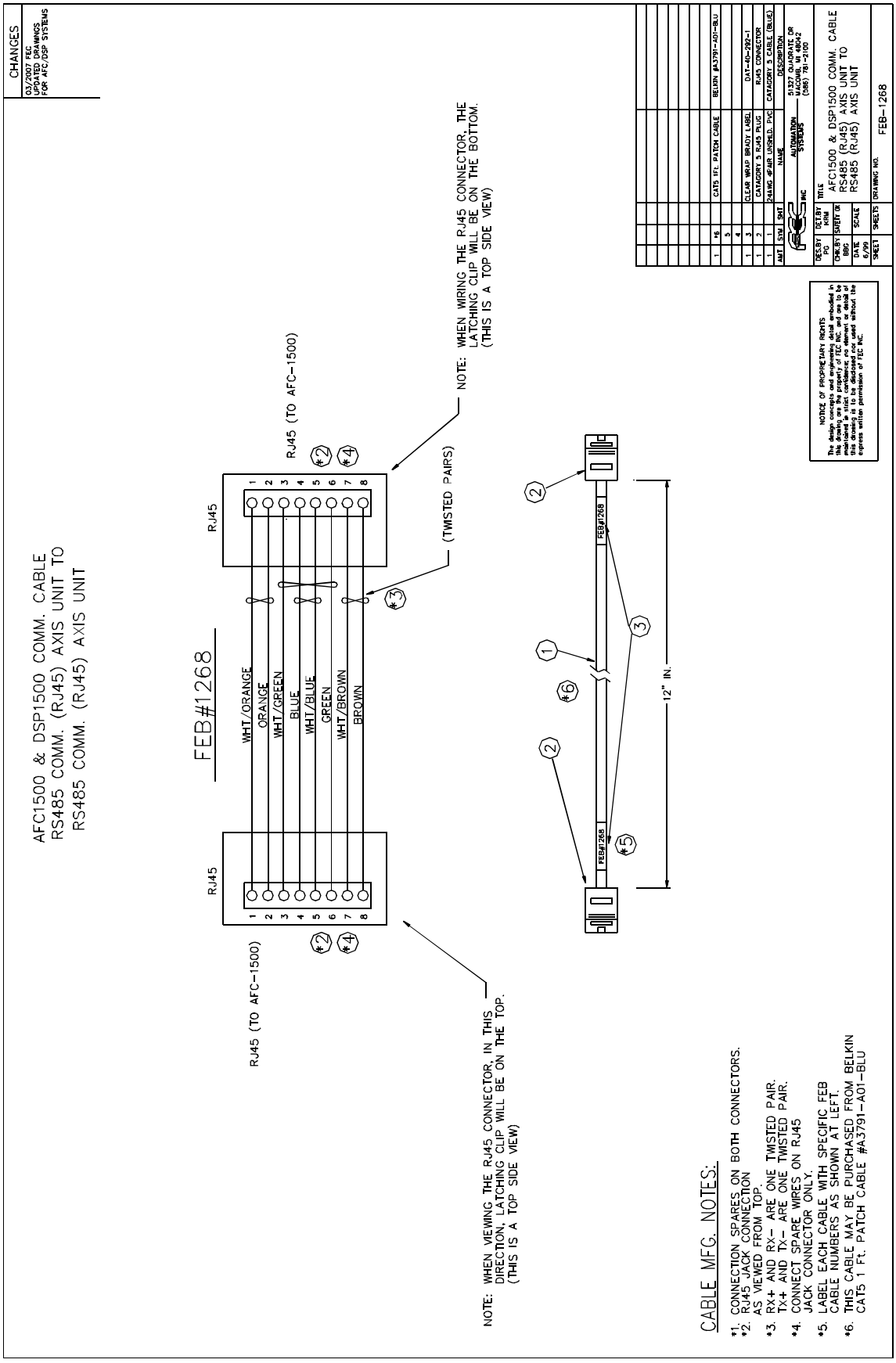
AFC1500 System Motor Extension Cable.(RM5) – FEB 1606

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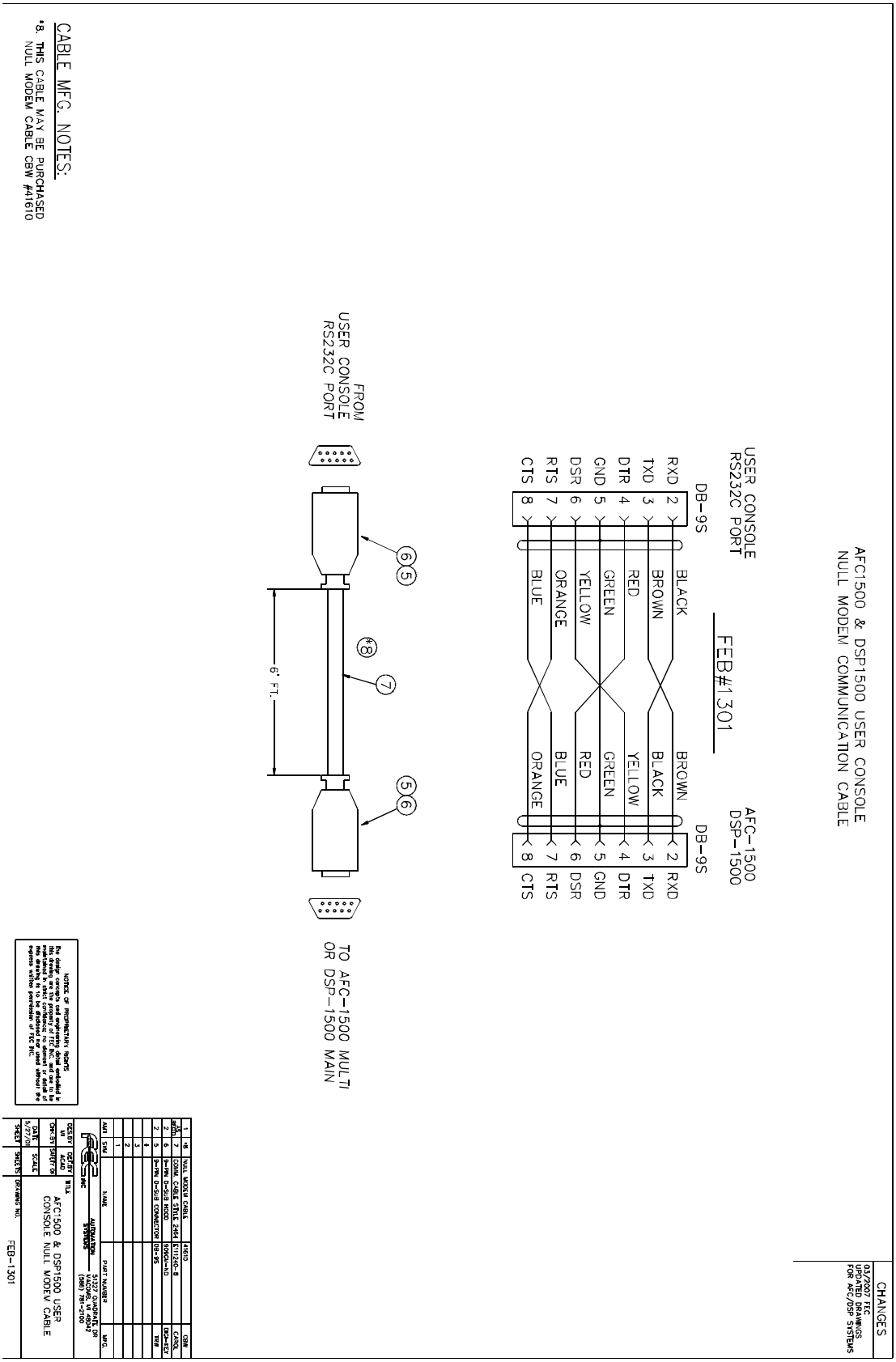
AFC1500 System Communication Cable (RS232/422 Converter) – FEB 1266

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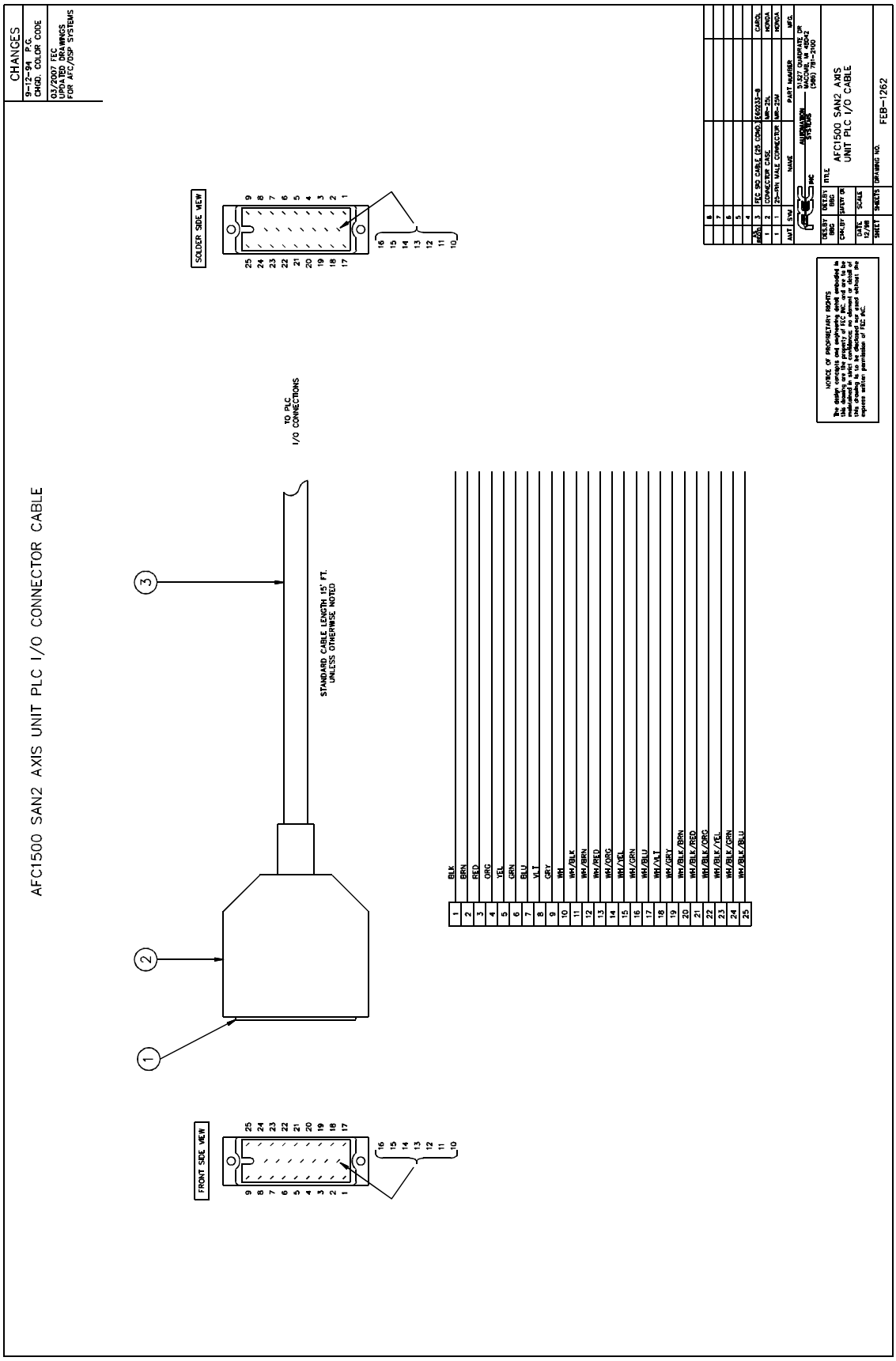
AFC1500 Communication Cable (Axis to Axis unit) – FEB 1268

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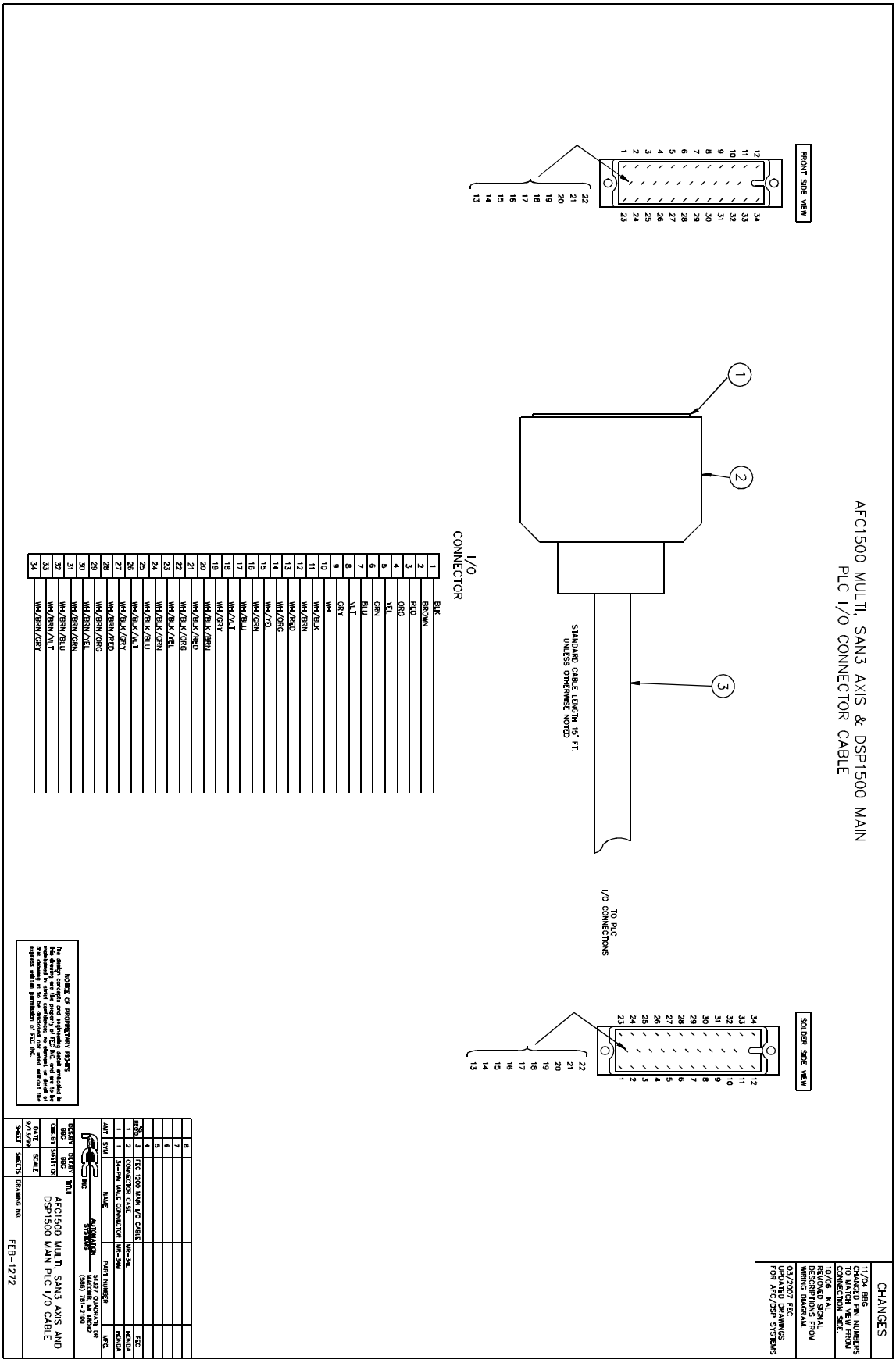
AFC1500 MULTI Unit Null Modem Cable – FEB 1301

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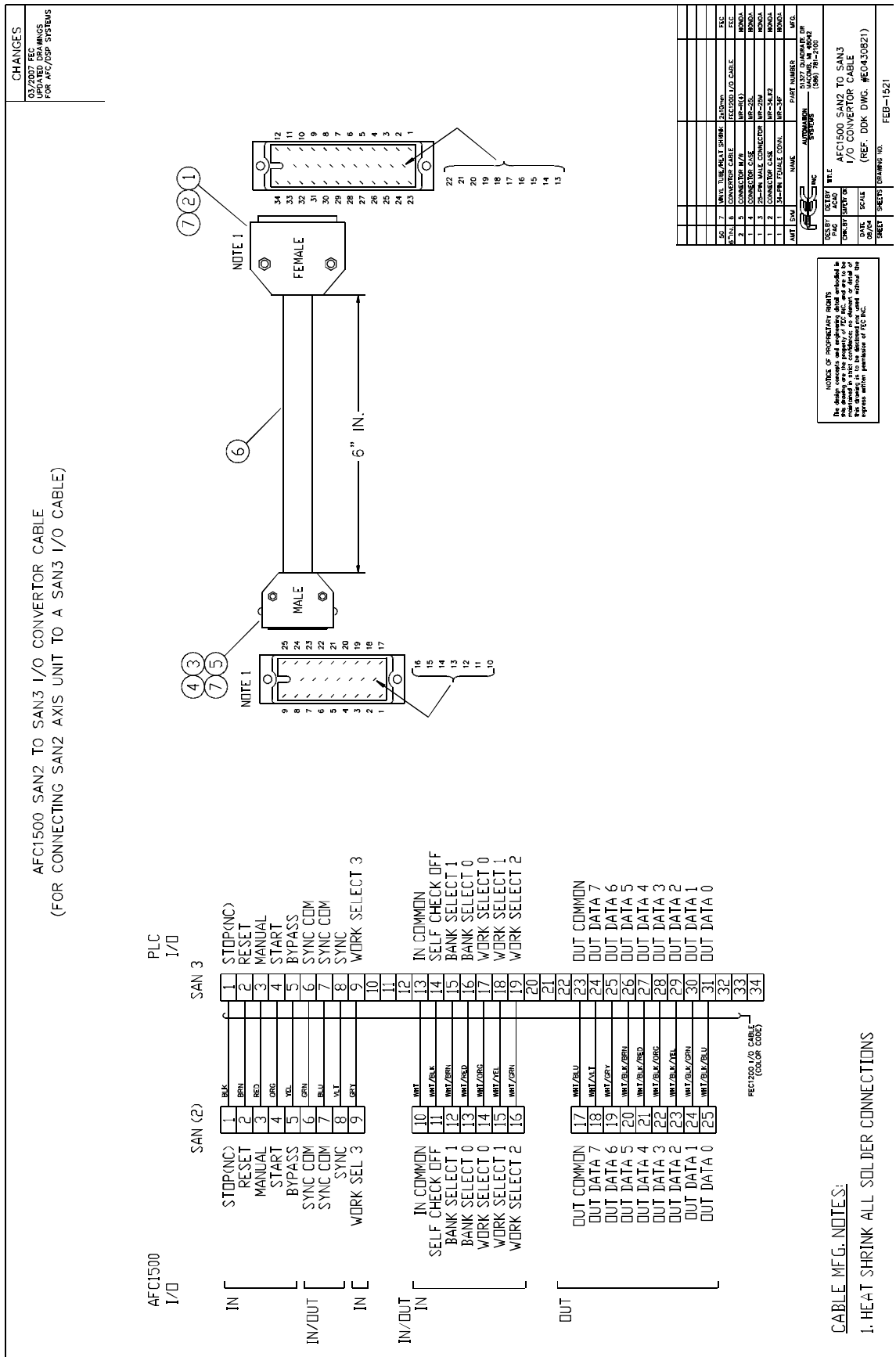
AFC1500 SAN2 Unit I/O Cable - FEB 1262

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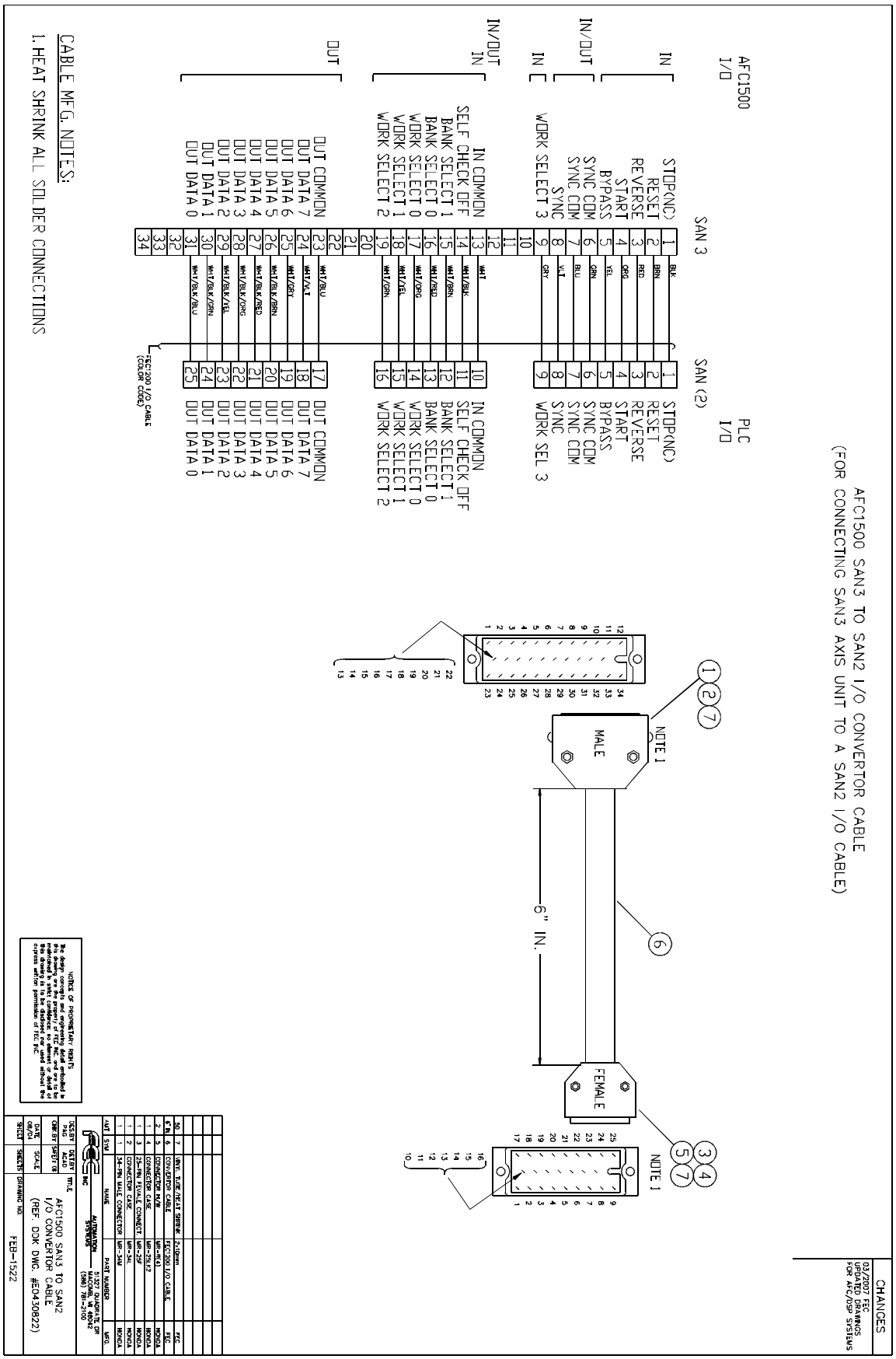
AFC1500 SAN3 Unit I/O Cable – FEB 1272

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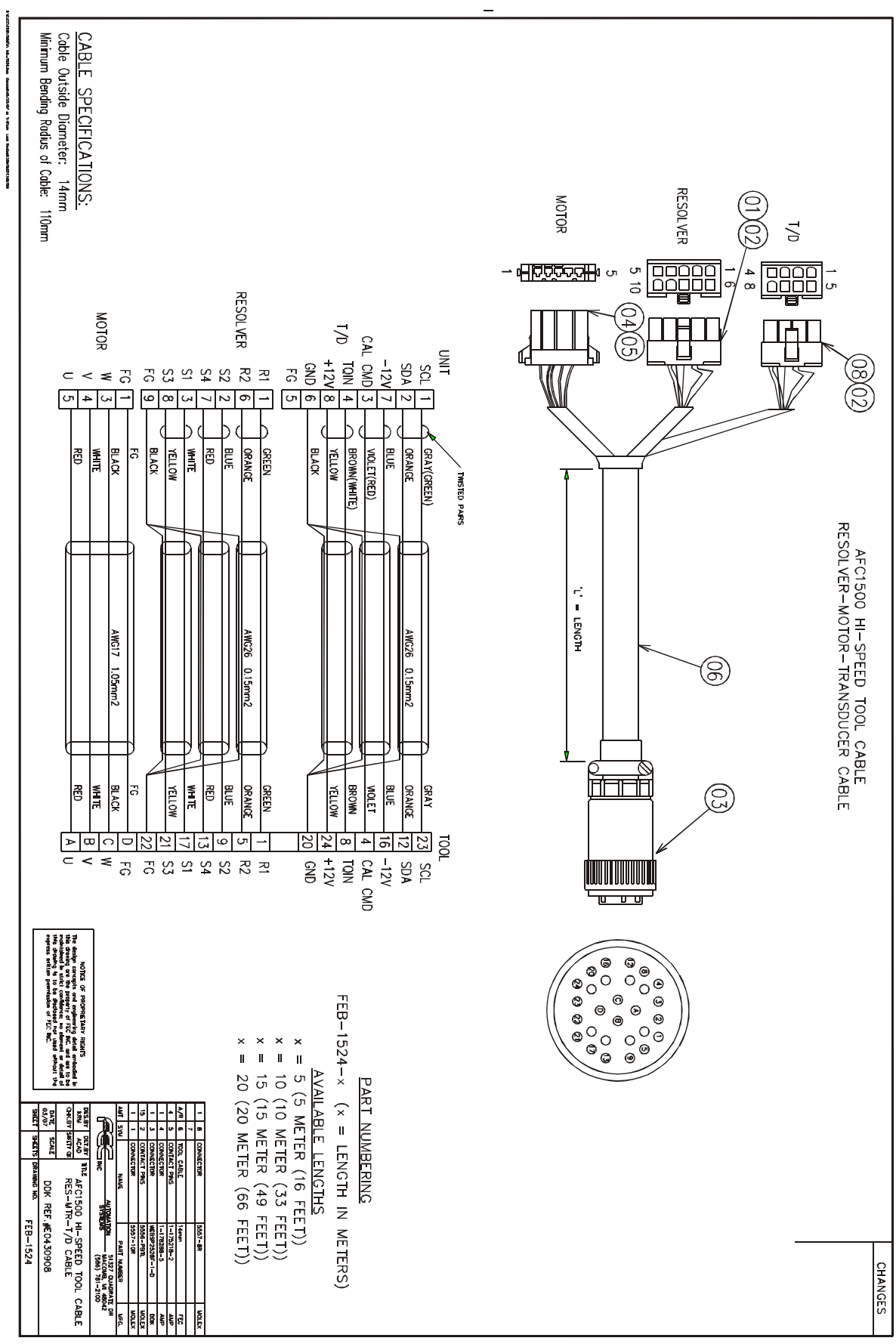
AFC1500 SAN2 ~ SAN3 Adapter Cable – FEB 1521

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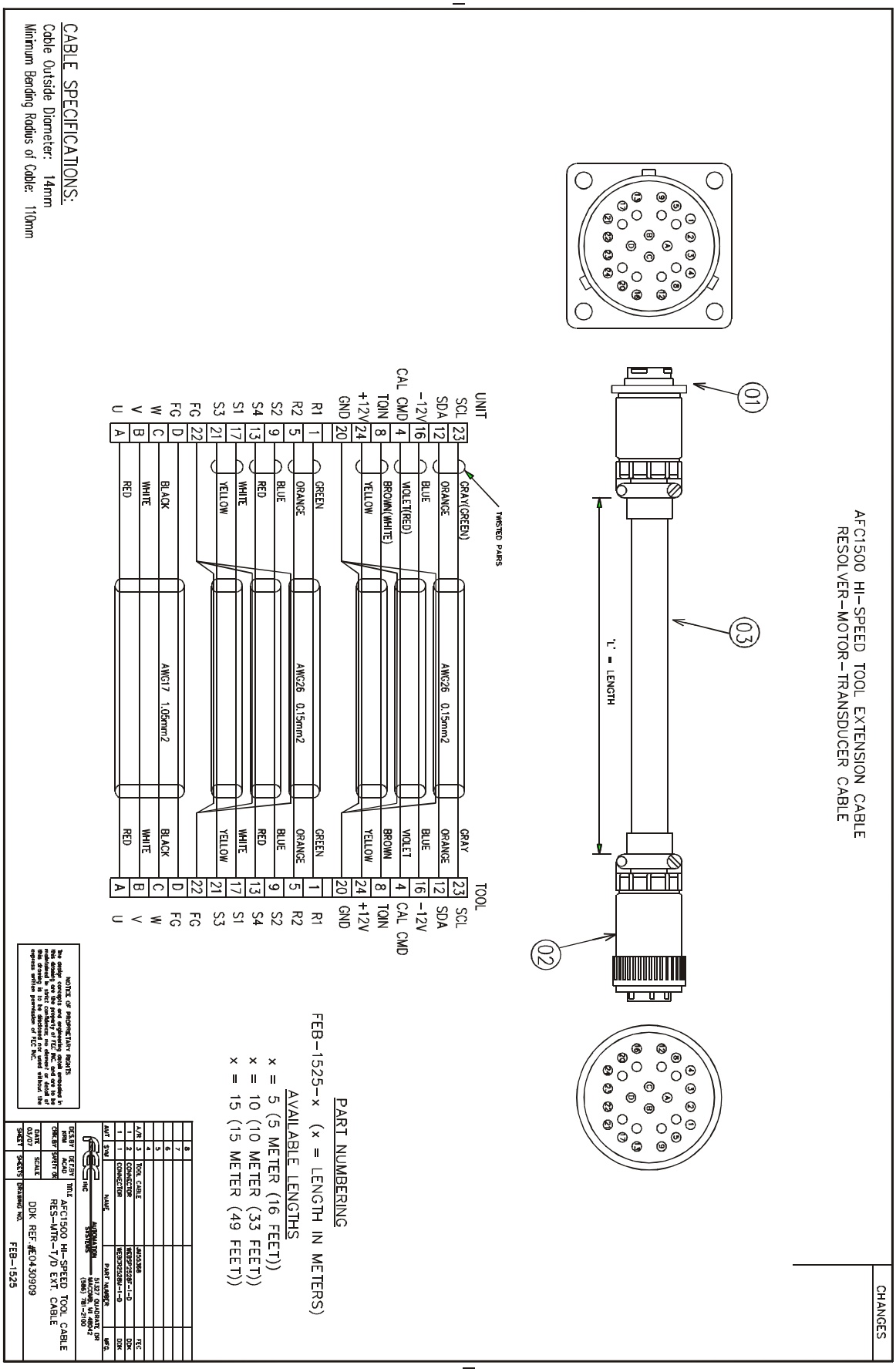
AFC1500 SAN3 ~ SAN2 Adapter Cable – FEB 1522

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AFC1500 System Motor/Resolver/Preamp Cable (RH1, RH3 Motors) FEB-1524

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AFC1500 System Motor/Resolver/Preamp Extension Cable (RH1, RH3 Motors) FEB-1525

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