Chapter 6: Fastening Instructions

6.1 Fastening Control.

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

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

6.1.1 Torque Control Method.

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

- One-Step Fastening

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

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

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

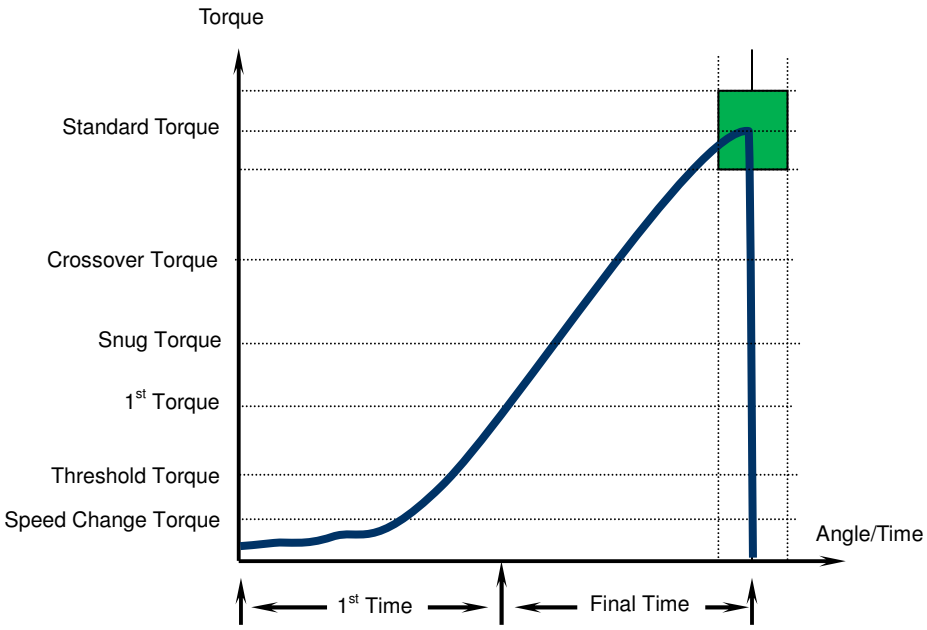

FIG. 6-1-1a Torque Control Functions for One-Step Fastening

◆ Two-Step Fastening

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

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

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

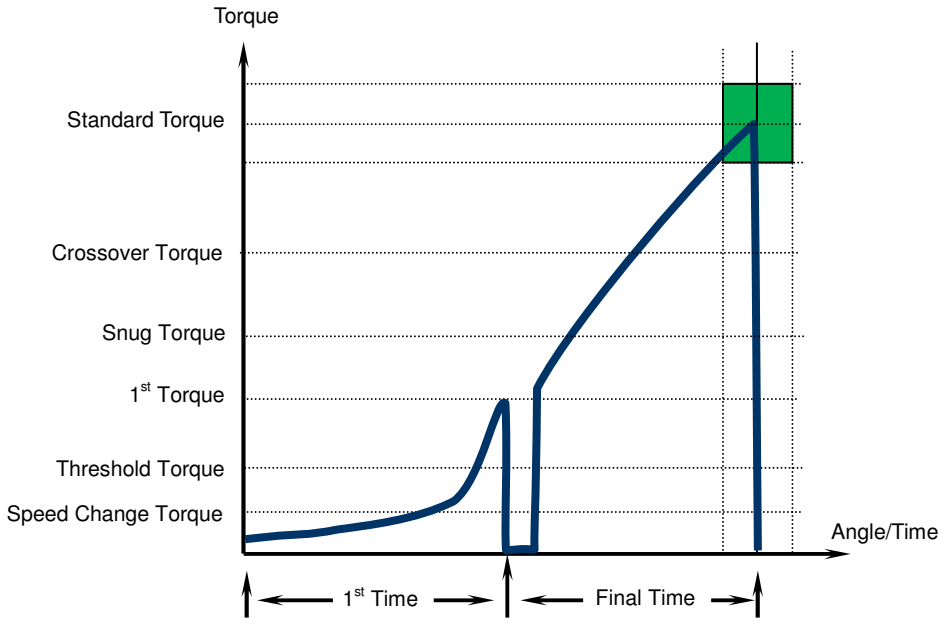

FIG. 6-1-1b Torque Control Functions for Two-Step Fastening

◆ Three-Step Fastening

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

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

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

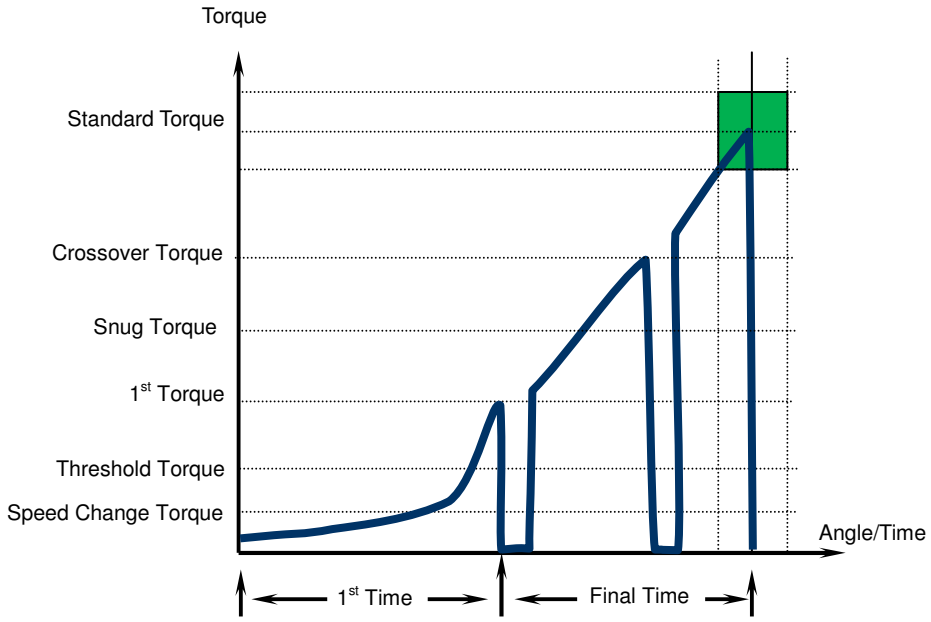

FIG. 6-1-1c Torque Control Functions for Three-Step Fastening

6.1.2 Angle Control Method.

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

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

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

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

- **One-Step Fastening**

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

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

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

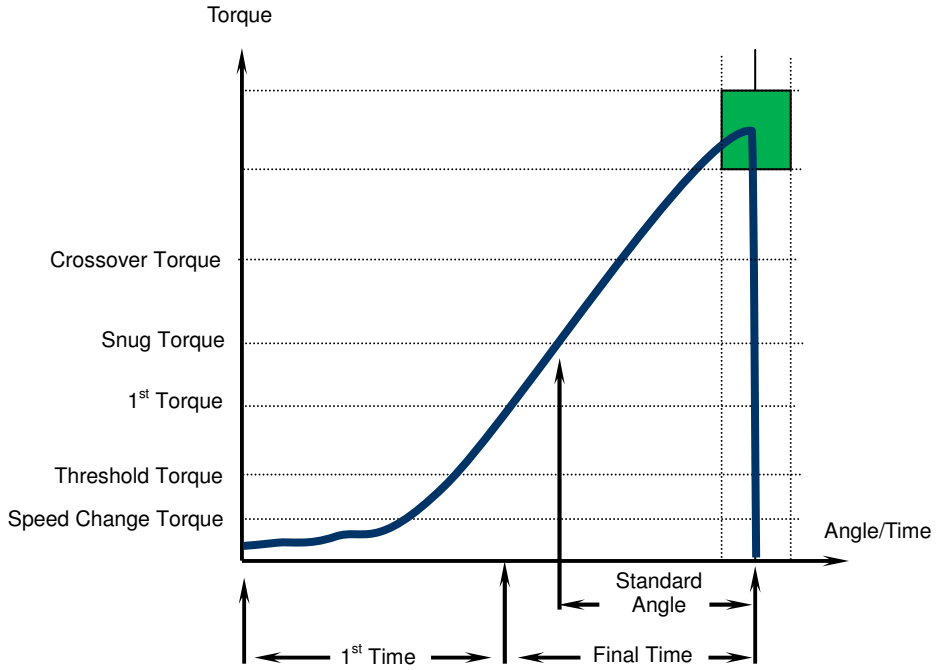

FIG. 6-1-2a Angle Control Functions for One-Step Fastening

◆ Two-Step Fastening

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

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

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

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

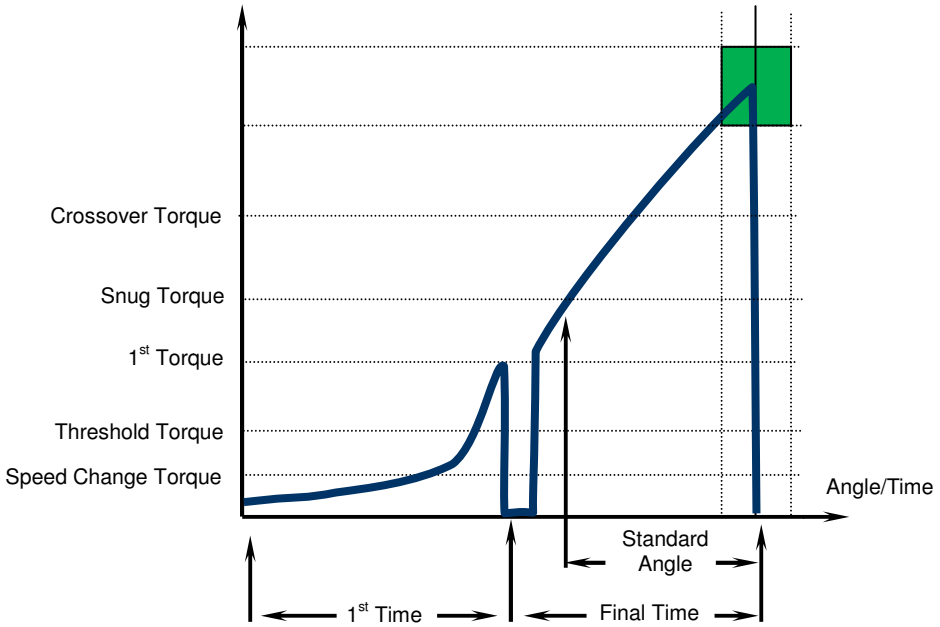

FIG. 6-1-2b Angle Control Functions for Two-Step Fastening (1st step Torque)

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

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

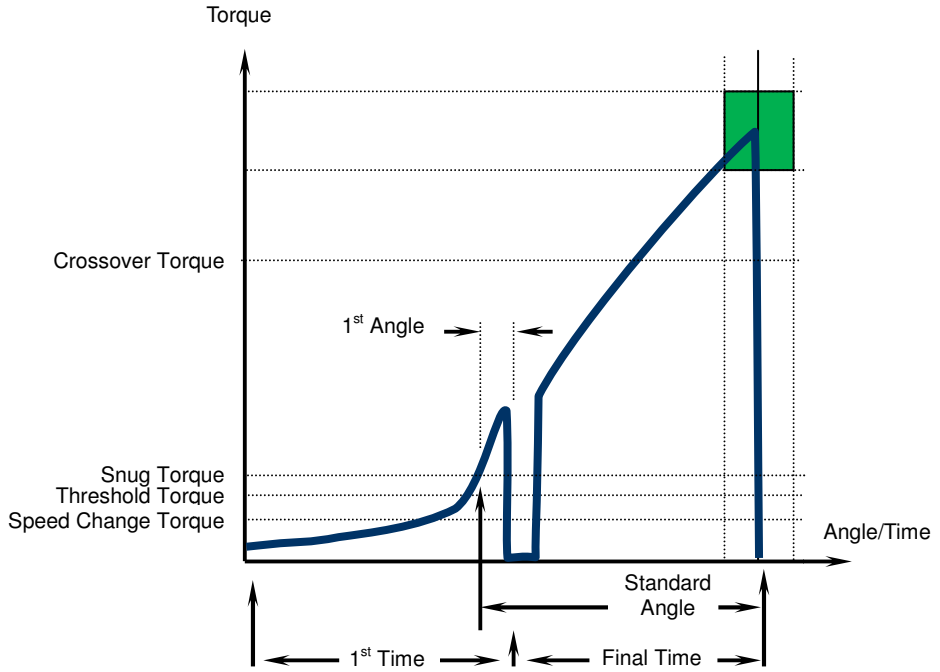

FIG. 6-1-2c Angle Control Functions for Two-Step Fastening (1st step Angle)

◆ Three-Step Fastening

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

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

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

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

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

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

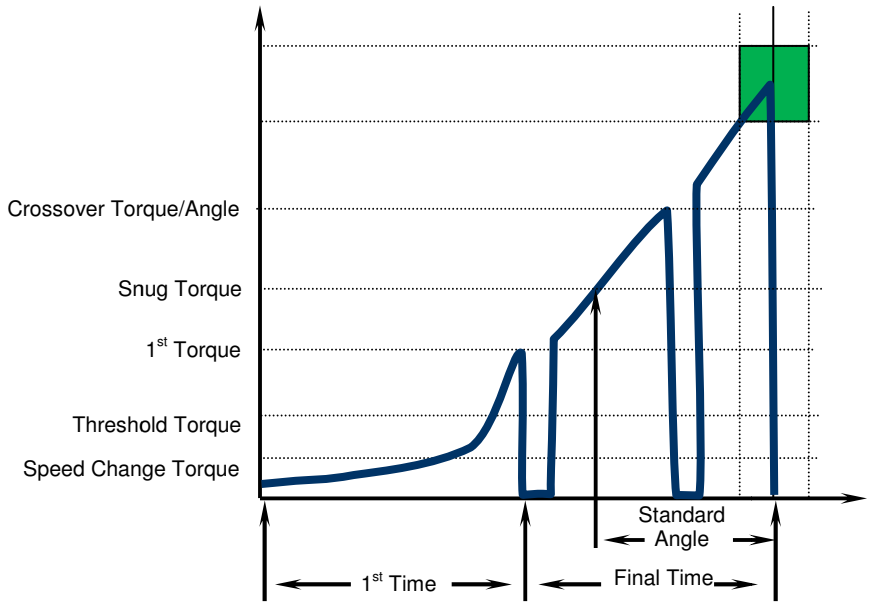

FIG. 6-1-2d Angle Control Functions for Three-Step Fastening

6.2 Monitoring Functions

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

6.2.1 Peak Torque Monitoring

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

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

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

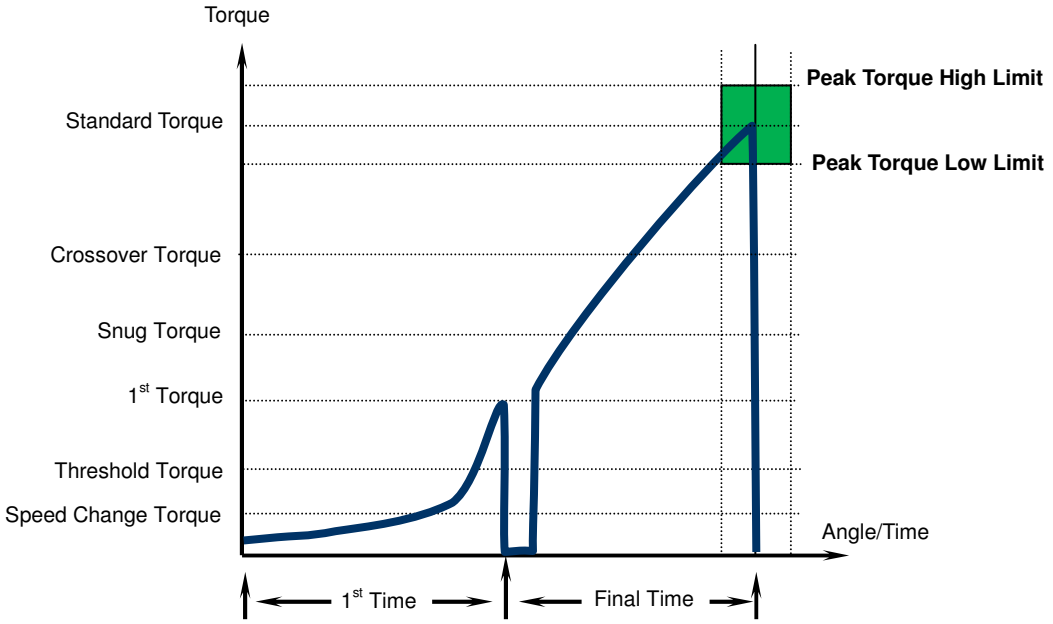

FIG. 6-2-1a Peak Torque Monitor – Torque Control

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

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

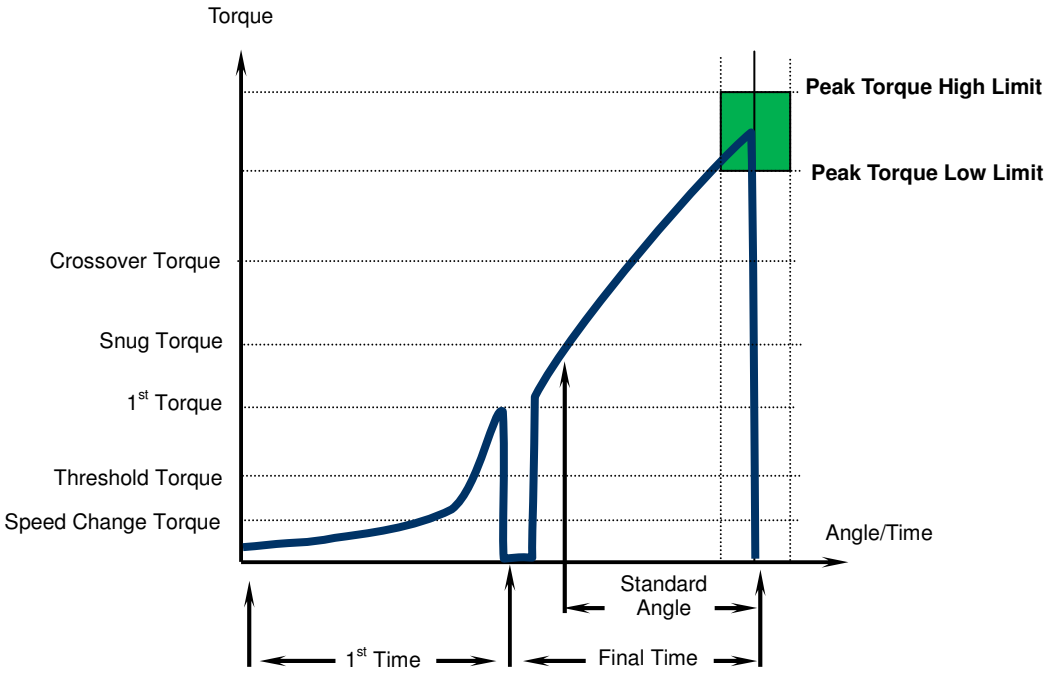

FIG. 6-2-1b Peak Torque Monitor – Angle Control

6.2.2Final Torque Monitoring

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

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

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

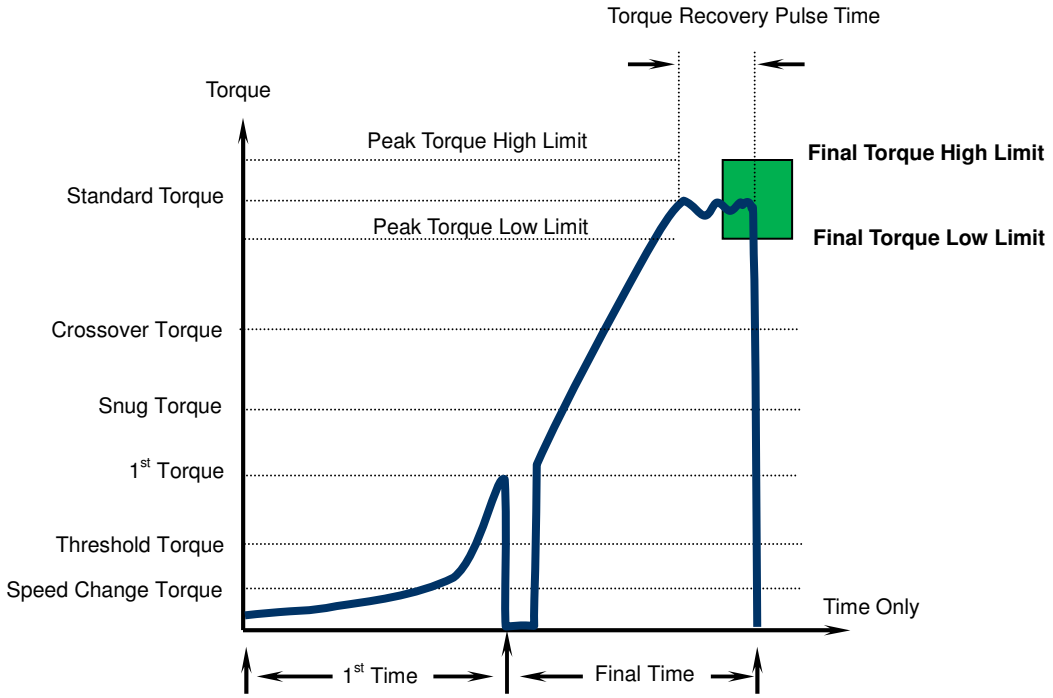

FIG. 6-2-2a Final Torque Monitor – Torque Control W/ Torque Recovery

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

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

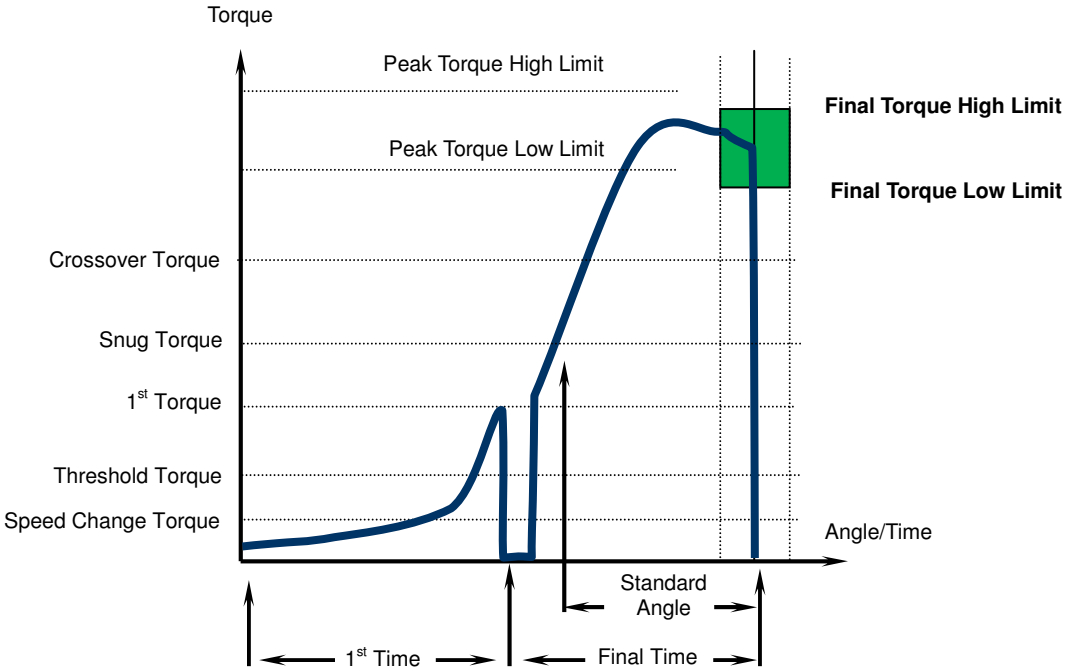

FIG. 6-2-2b Final Torque Monitor – Angle Control

6.2.3 Angle Monitoring

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

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

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

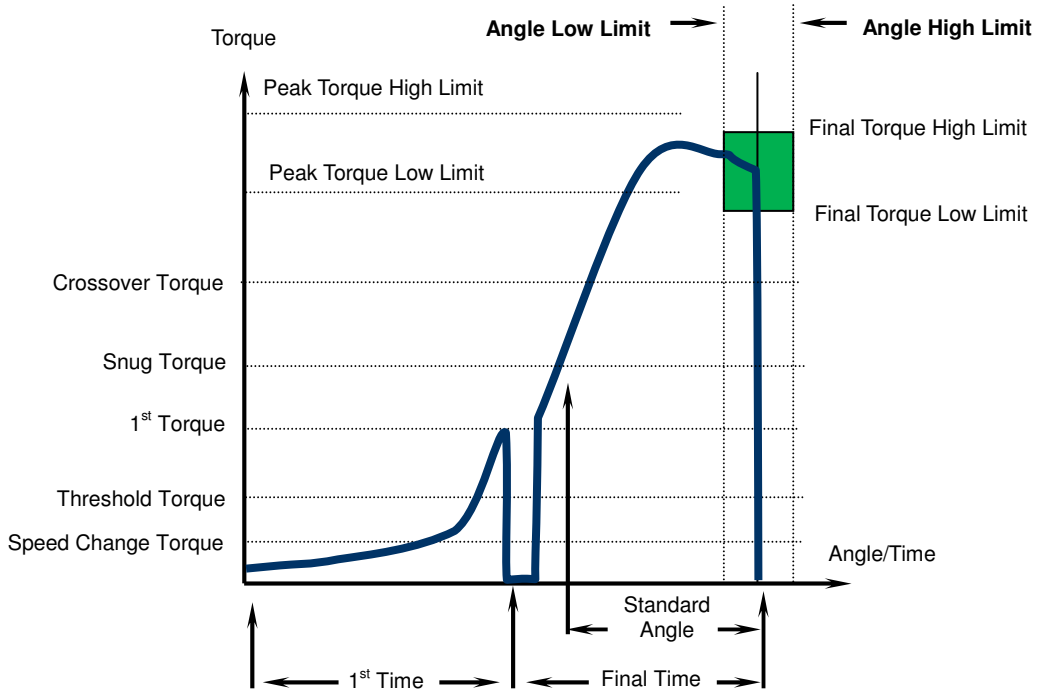

FIG. 6-2-3a Angle Monitoring – Angle Control

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

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

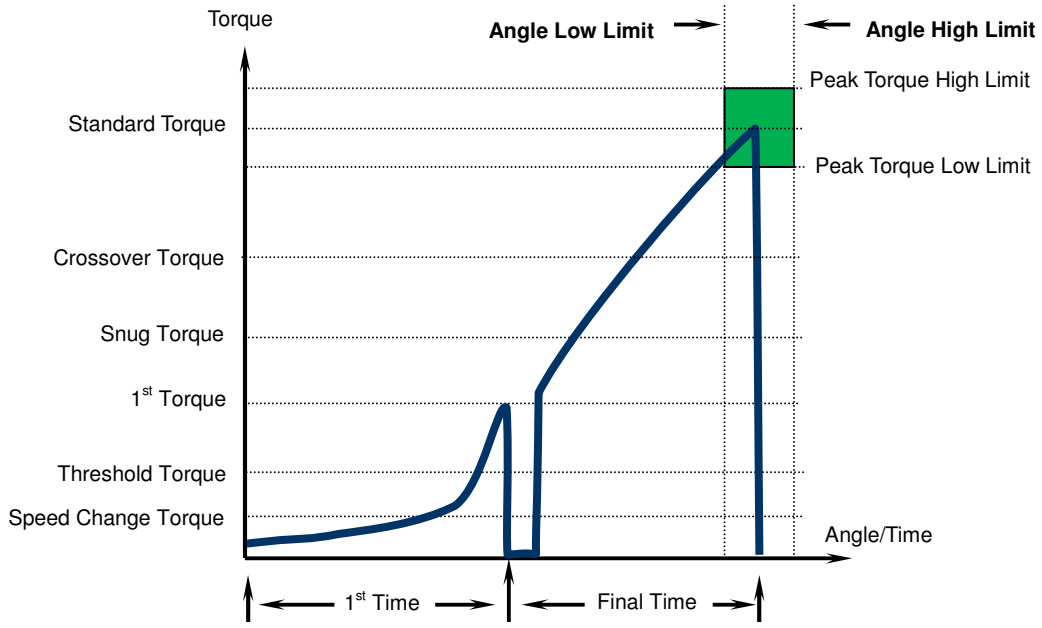

FIG. 6-2-3b Angle Monitoring – Torque Control

6.2.4 Point-to-Point Torque Rate Monitoring

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

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

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

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

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

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

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

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

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

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

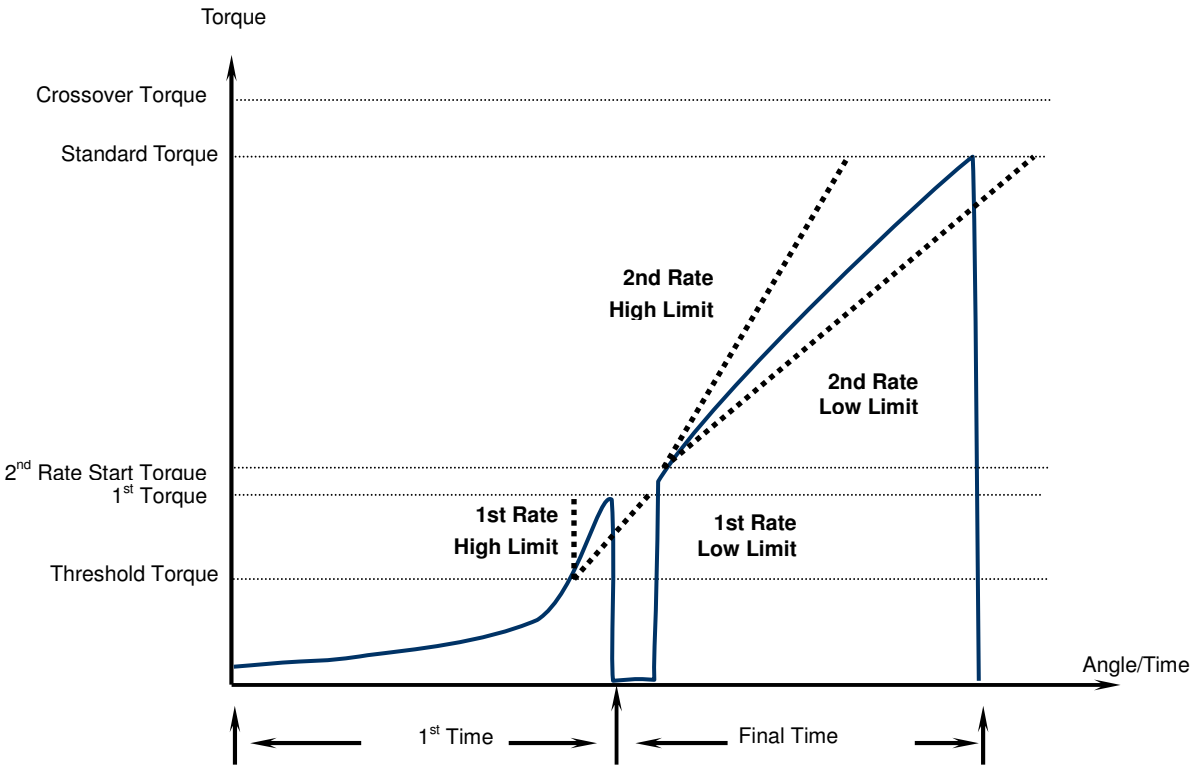

FIG. 6-2-4a Two Stage Point-to-Point Torque Rate Monitoring

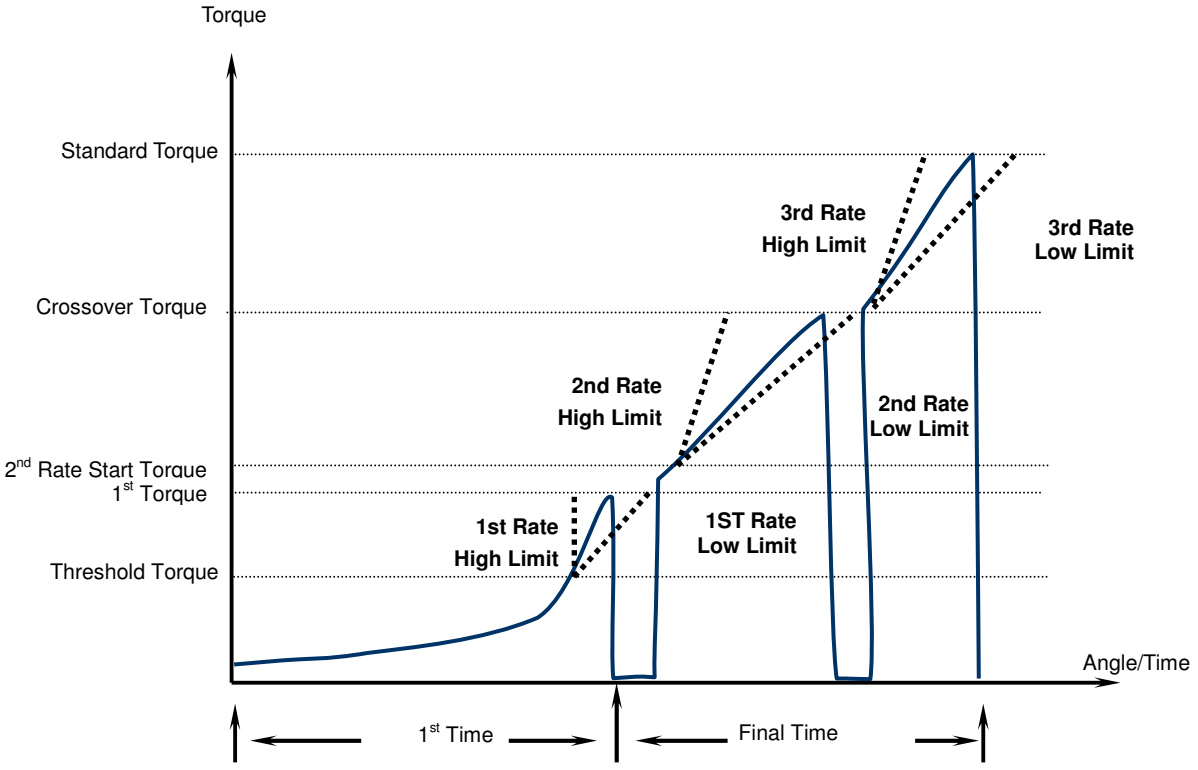

FIG. 6-2-4b Three Stage Point-to-Point Torque Rate Monitoring

6.2.5 Time Monitoring

◆ **Time High Limits**

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

◆ **Time Low Limits**

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

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

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

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

6.3 Speed Functions

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

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

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

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

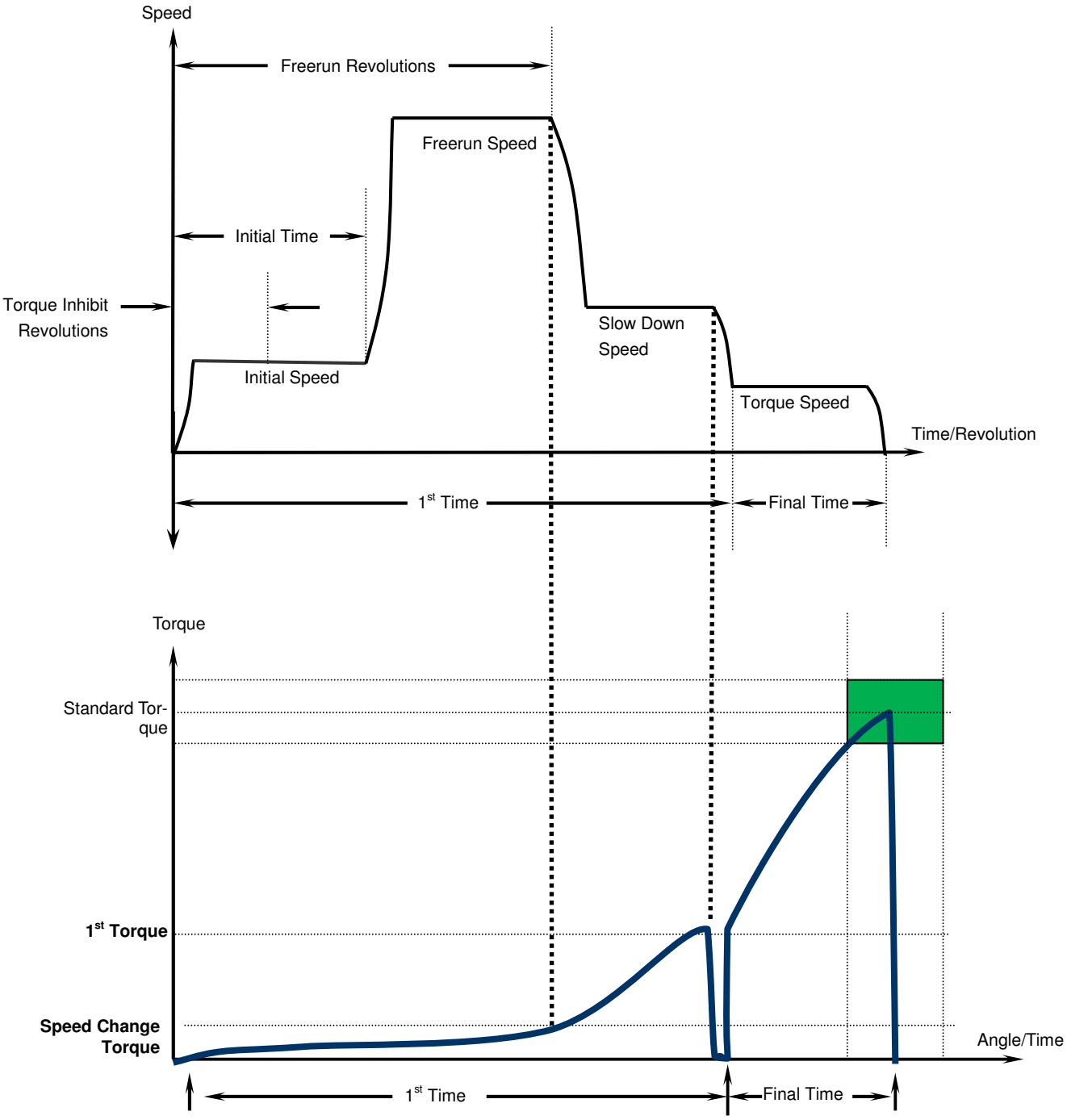

FIG. 6-3b Ideal Relationship of Speed and Torque

6.4 Reverse Functions

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

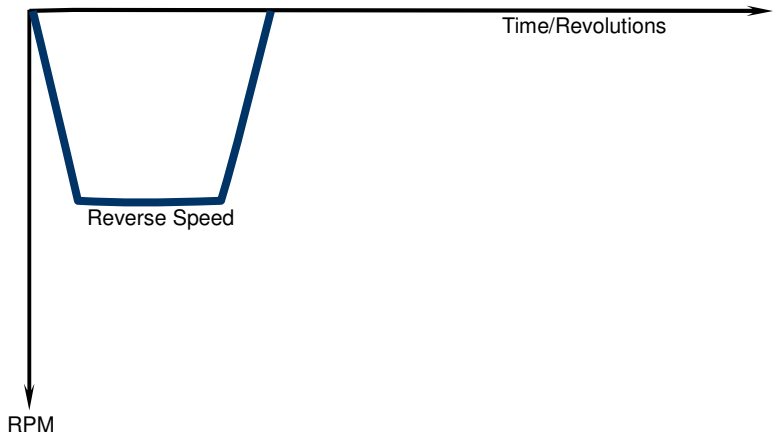

FIG. 6-4a Fusion Reverse Function

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

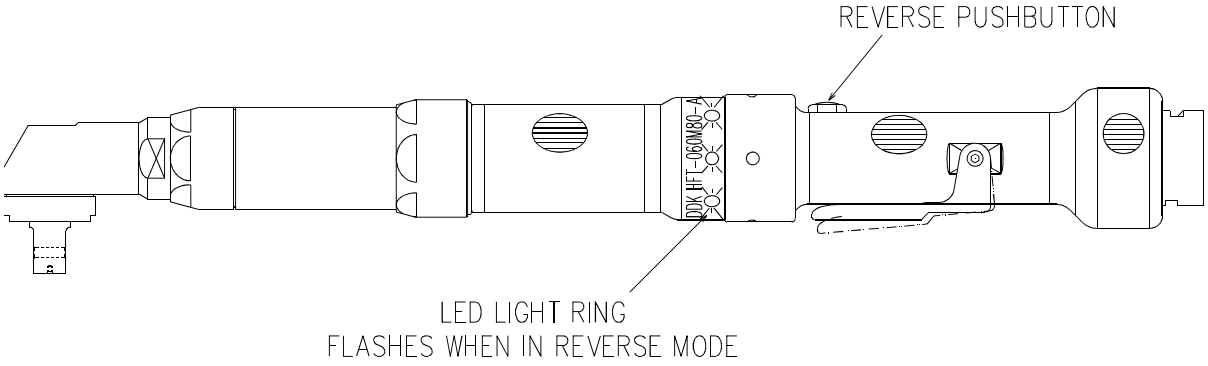

FIG. 6-4b Tool LED Function

6.5 Torque Recovery

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

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

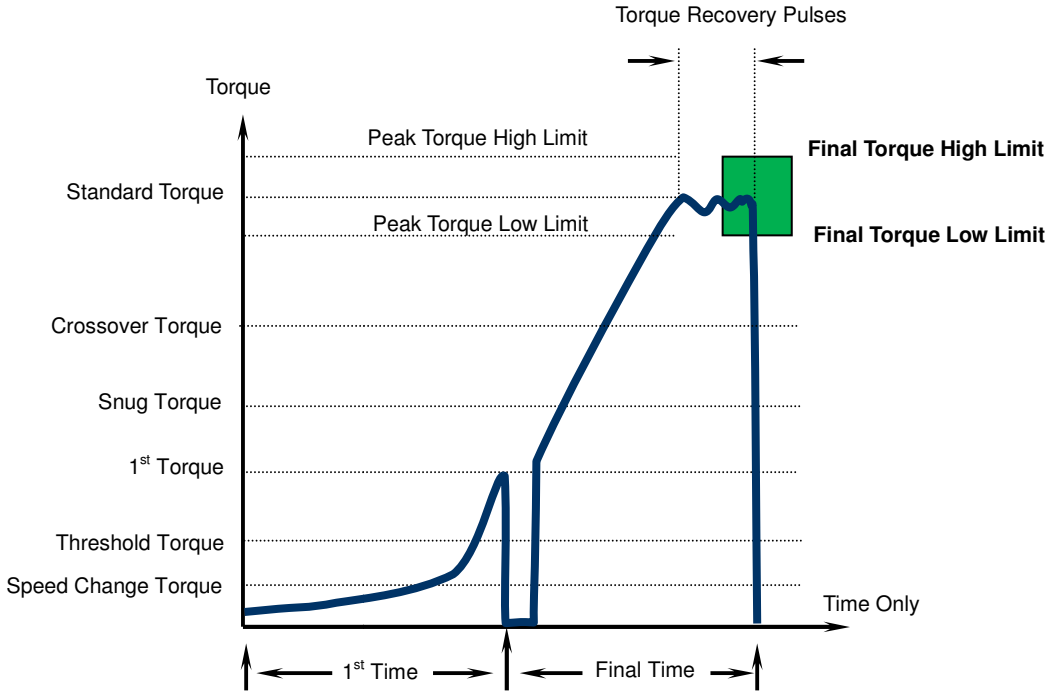

FIG. 6-5 Torque Recovery

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

6.6 Added Functions

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

6.6.1 Current Monitoring / Control

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

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

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

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

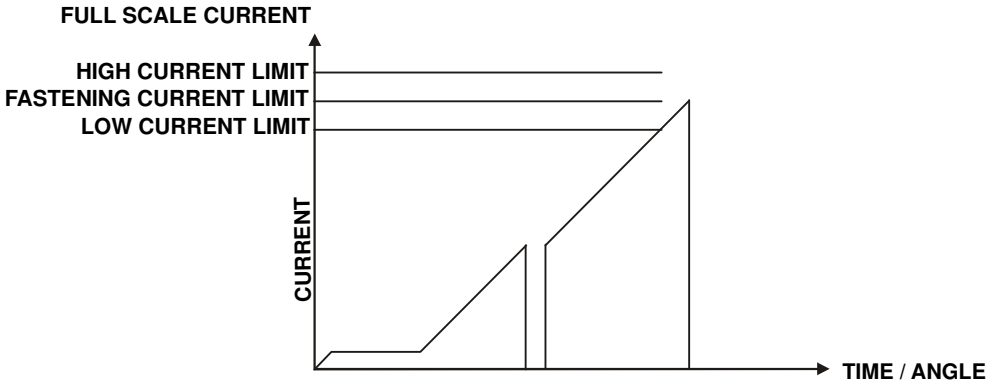

Fig. 6-6-1 Current Monitor function

6.6.2 Angle Correction

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

Setting range is from -99 to +99 degrees.

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

6.6.3 Reduced Fastening Reaction

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

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

6.6.4 VariSpeed

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

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

6.6.5 Work Count (Batch Counting)

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

6.6.6 Torque Inhibit

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

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

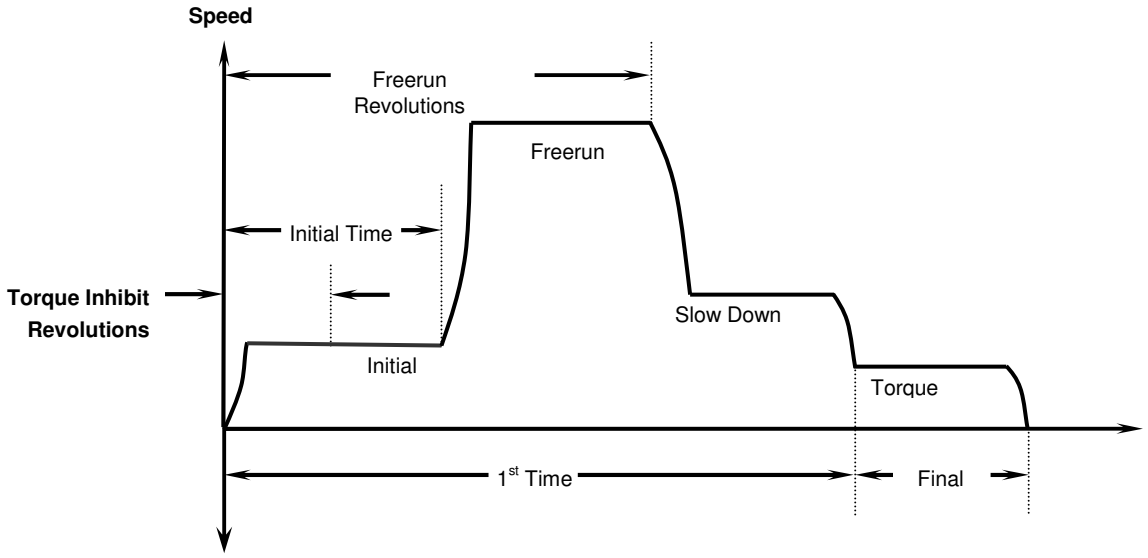

Fig. 6-6-9 Torque Inhibit Function

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

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