Torque/Force Control Configuration Attributes

These are the torque/force control configuration attributes associated with a Motion Control Axis.

Torque Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set/SSV		REAL	0	-100	+100	% Motor Rated

The Torque Offset attribute provides a torque bias when performing closed loop control. This value is summed together with the Torque Trim value that can be sent synchronously to the drive every connection update. Since the Torque Trim value is available as a templated value, real time torque corrections can be done using the Torque Trim attribute.

System Inertia

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV Optional - T	Set/SSV	T	REAL	0 FD	0	∞	% Motor Rated / (Motor Units/Sec^2)

Torque or force scaling gain value that converts commanded acceleration into equivalent rated torque/force. Properly set, this value represents the total system inertia or mass.

Backlash Reversal Offset

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - P	Set/SSV		REAL	0	0	∞	Position Units

The Backlash Reversal Offset attribute value is used to compensate for positional inaccuracy introduced by mechanical backlash. Backlash manifests itself when an axis is commanded to reverse direction. During such a reversal there is a small amount of displacement of the motor that does not translate to displacement of the load due to mechanical play in the machine, for example, through the gearing or ball-screw. As a result, there is an error in the control system's indication of the actual position for the axis versus the true position of the mechanical load, that error being equal to the lost displacement due to the mechanical backlash.

Compensation for this positioning error due to mechanical backlash can be achieved by adding a directional offset, specified by the Backlash Reversal Offset attribute, to the motion planner's command position before sending to the drive.

Whenever the commanded velocity changes sign (a reversal), the Logix controller will add, or subtract, the offset value from the current commanded position. This causes the servo to immediately move the motor to the other side of the backlash window and engage the load. It is important to note that the application of this directional offset is completely transparent to the user; the offset does not have any impact on the value of the Command Position attribute. If a value of zero is applied to the Backlash Reversal Offset, the feature is effectively disabled. Once enabled by a non-zero value, and the load is engaged by a reversal of the commanded motion, changing the Backlash Reversal Offset can cause the axis to shift as the offset correction is applied to the command position.

Acceleration to Torque/Force Scaling Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - PV Optional - T	Set		REAL	-	-	-	% Motor Rated/ (Motor Units/sec^2)

The Acceleration to Torque/Force Scaling gain attribute converts commanded acceleration into equivalent rated torque/force. This value represents the total system inertia or mass.

Backlash Compensation Window

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - P	Set		REAL	0	0	∞	Position Control Units

Defines a window around the command position. When the actual position is within this window, the effective System Inertia gain is reduced by a factor of the ratio of the Position Error and the Backlash Compensation Window. When the actual position is outside the window, the configured System Inertia gain is applied.

Friction Compensation Sliding

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	100	% Motor Rated

Value added to the current/torque command to offset the effects of coulomb friction.

Friction Compensation Static

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	100	% Motor Rated

Value added to the current/torque command to offset the effects of static friction (sometimes referred to "sticktion").

Friction Compensation Viscous

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	100	% Motor Rated / (Motor Units/Sec)

Value added to the current/torque command to offset the effects of viscous friction, for example, friction that is proportional to speed.

Friction Compensation Window

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values

Attributes
Converter Current Control Configuration Attributes
Converter Current Control Signal Attributes
Converter Current Reference Configuration Attributes
Converter Current Reference Signal Attributes
Converter Output Attributes
Converter Reactive Power Control Attributes
Converter Types
Current Control Signal Attributes
Current Control Configuration Attributes
Cyclic Read and Cyclic Write
DC Bus Condition Attributes
Device Function Codes
Device Commissioning Attributes
Drive General Purpose I/O Attributes
Drive Output Attributes
Drive Parameters
Event Capture Attributes
Exception Factory Limit Info Attributes
Exception User Limit Configuration Attributes
Exception, Fault and Alarm Attributes
Exceptions
Fault and Alarm Behavior
Feedback Interface Types
Feedback Configuration Attributes
Frequency Control Configuration Attributes
Frequency Control Signal Attribute
General Feedback Info Attributes
General Feedback Signal Attributes
General Linear Motor Attributes
General Motor Attributes
General Permanent Magnet Motor Attributes
General Rotary Motor

Optional - P	Set		REAL	0	0	∞	Position Units

Defines a window around the command position. When the actual position is within this window, the effective Friction Compensation value is reduced by a factor of the ratio of the Position Error and the Friction Compensation Window. When the actual position is outside the window, or when the axis is being commanded to move, the normal friction compensation algorithm applies.

Torque Lead Lag Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	10^4	Filter Frequency Units

Sets the pole frequency for the torque reference Lead-Lag Filter. A value of 0 disables the filter.

Torque Lead Lag Filter Gain

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	1	0	∞	

Sets the high frequency gain of the torque reference Lead-Lag Filter. A value greater than 1 results in a lead function and value less than 1 results in a lag function. A value of 0 results in a first order low pass filter function. A value of 1 disables the filter.

Torque Low Pass Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set	T	REAL	0 FD	0	10^4	Filter Frequency Units

Break frequency for the low pass filter applied to torque reference signal.

Torque Notch Filter Frequency

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	10^4	Filter Frequency Units

Center frequency of the notch filter instance applied to the torque reference signal. Up to four torque notch filter instances connect in series. A value of 0 for this attribute disables this filter.

Torque Limit - Positive

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set		REAL	100 FD	0	10^3	% Motor Rated

This positive value determines the maximum positive torque that can be applied to the motor. If the device attempts to exceed this value, the torque command is clamped to

motor. If the device attempts to exceed this value, the torque command is clamped to this value.

Torque Limit - Negative

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Required - C	Set		REAL	-100 FD	-10^3	0	% Motor Rated

This negative value determines the most negative torque value that can be applied to the motor. If the device attempts to apply a more negative torque than this limit, the torque command is clamped to this value.

Torque Rate Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	10^6	0	∞	% Motor Rated / Sec

Limits the rate of change of the torque reference signal.

Torque Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	90 FD	0	10^3	% Motor Rated

Specifies the threshold for the Filtered Torque Reference signal magnitude that when exceeded, results in the Torque Threshold status bit being set.

Overtorque Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		REAL	200	0	10^3	% Motor Rated

Maximum limit for the torque producing Iq Current Feedback signal magnitude. When the Iq Current Feedback signal is greater than this value for the duration specified by Overtorque Limit Time attribute, the result is an Overtorque Limit exception. This feature lets the device generate an exception if there is a sudden increase in load torque during operation. This condition could occur if a bearing fails, a hard stop is reached, or there is some other mechanical failure.

Overtorque Limit Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		REAL	0	0	10^3	Seconds

Specifies the amount of time allowed in an Overtorque Limit condition before generating an Overtorque Limit exception. A value of 0 for this attribute disables the Overtorque feature.

Undertorque Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values

Optional - D	Set		REAL	10	0	10^3	% Motor Rated

Minimum limit for the torque producing Iq Current Feedback signal magnitude. When the Iq Current Feedback is less than this value for the duration specified by Undertorque Limit Time attribute, the result is an Undertorque Limit exception. This feature lets the device generate an exception if there is a sudden decrease in load torque during operation. This condition could occur, for example, if a load coupling breaks or a tensioned web material breaks.

Undertorque Limit Time

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D	Set		REAL	0	0	10^3	Seconds

Specifies the amount of time allowed in an Undertorque Limit condition before generating an Undertorque Limit exception. A value of 0 for this attribute disables the Undertorque feature.

Inertia Observer Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		BYTE	0	0	10^3	Enumeration: 0 = Disabled (R) 1 = Inertia Observer (O) 2-225 = (reserved

Inertia Observer Filter Bandwidth

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	0	0	10^3	Radians/second

The Inertia Observer Filter Bandwidth attribute sets the frequency for the inertia low pass filter applied to the Total Inertia Estimate.

Cogging Compensation Table

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL [1024]	0	0	10^3	% Motor Rated

The Cogging Compensation Table attribute is an array of values that represent the cogging torque profile of the motor over one electrical cycle. The 0th element of the array corresponds to an electrical angle of 0 degrees. An motor with no cogging should have a value of 100% for all elements in the array. A value above 100% provides additional 1/Kt gain to the torque reference. A value below 100% reduces the 1/Kt gain.

Adaptive Tuning Configuration

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values

Optional - C	Set/SSV		USINT	0	-	-	Enumeration: 0 = Disabled 1 = Tracking Notch 2 = Gain Stabilization 3 = Tracking Notch and Gain Stabilization 4-255 = Reserved

Enumerated value that controls operation of the Adaptive Tuning function. This function periodically collects axis torque data and analyzes this data to identify resonances and closed loop instabilities in the system.

When Adaptive Tuning Configuration is Disabled the configured values for all servo loop attributes of the associated axis are applied directly without intervention of the Adaptive Tuning function.

When configured for Tracking Notch, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter as part of the control loop update. The configured Torque Notch Filter Frequency attribute is not overwritten as a result of this operation. All other servo loop attributes are applied directly without intervention of the Adaptive Tuning function.

When configured for Gain Stabilization, the Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attribute values are scaled by the Adaptive Tune Gain Scaling Factor as part of the control loop update. The configured values of these attributes are not overwritten as a result of this operation. The Torque Low Pass Filter Bandwidth Estimate is also applied to the Torque Low Pass Filter Bandwidth. In this configuration, the value of the Torque Notch Filter Frequency attribute is applied directly to the notch filter without intervention of the Adaptive Tuning function

When configured for Notch Filter and Gain Stabilization, the Torque Notch Filter Frequency Estimate attribute value, determined by the Adaptive Tuning function, is applied to the Torque Notch Filter as part of the control loop update. The configured Torque Notch Filter Frequency attribute is not overwritten as a result of this operation. The Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attributes are scaled by the Adaptive Tune Gain Scaling Factor as part of the control loop update. The configured values of these attributes are not overwritten as a result of this operation. The Torque Low Pass Filter Bandwidth Estimate is also applied to the Torque Low Pass Filter Bandwidth.

Even if Disabled, the Adaptive Tuning function runs periodically to collect drive data while the axis is in the Running state. When a resonance frequency is detected that meets the configured Notch Tuning criteria, the frequency of the resonance is loaded to the Torque Notch Filter Frequency Estimate attribute. The magnitude of the resonance is also loaded to the Torque Notch Filter Magnitude Estimate. The Adaptive Tuning status bits in the CIP Axis Status RA attribute are updated each time the Adaptive Tuning function is executed.

The configured Notch Tuning criteria are that the magnitude of the resonance frequency, not associated with the command, be above the configured Torque Notch Filter Tuning Threshold and that the frequency of the resonance be between the configured Torque Notch Filter Low Frequency Limit and Torque Notch Filter High Frequency Limit.

The Adaptive Tuning function sets the Torque Notch Filter Frequency Estimate to the identified resonant frequency with the largest magnitude that meets the configured Notch Tuning criteria.

A state machine, as defined in the functional requirements specification, determines the Adaptive Tune Gain Scaling Factor and the Torque Low Pass Filter Bandwidth Estimate.

- Select/Limit Instructions
- Sequential Function Chart (SFC) Instructions
- Statistical Instructions
- Safety Instructions
- Studio 5000 Logix Designer Glossary

The current state also determines which drive parameters are updated. The transition

logic for the state machine is dependent on the Adaptive Tuning status bits of the CIP Axis Status RA attribute and the Adaptive Tuning Configuration.

When the drive axis is in any other state besides the Running state, the Adaptive Tuning function is turned off and does not collect data.

When the drive transitions out of the Running state, the present values of all the Adaptive Tuning status bits and output estimates will persist. When the drive transitions into the Running state, the values of all the Adaptive Tuning status bits are set to 0 and output estimates will persist until they are updated by the Adaptive Tuning feature.

When the Adaptive Tuning Configuration is set to Disabled or Tracking Notch, the Adaptive Tune Gain Scaling Factor is reset to one. In this case the configured Torque Notch Filter Frequency, Torque Low Pass Filter Bandwidth, Load Observer Bandwidth, Load Observer Integrator Bandwidth, Velocity Loop Bandwidth, Velocity Loop Integrator Bandwidth, Position Loop Bandwidth, and Position Loop Integrator Bandwidth attribute values are not impacted by the Adaptive Tuning function.

Torque Notch Filter High Frequency Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	FD	20	2*FD	Radians/sec

This value sets the upper limit on the Torque Notch Filter Frequency Estimate value for the Adaptive Tuning function. The frequency of an identified natural resonance must be lower than this limit to be applied to the Torque Notch Filter Frequency Estimate.

Torque Notch Filter Low Frequency Limit

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set		REAL	FD	20	2000	Radians/sec

This value sets the lower limit on the Torque Notch Filter Frequency Estimate value for the Adaptive Tuning function. The frequency of an identified natural resonance must be higher than this limit to be applied to the Torque Notch Filter Frequency Estimate.

Torque Notch Filter Tuning Threshold

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Set	T	REAL	5	0	100	% Motor Rated

To be identified as a resonance frequency by the Adaptive Tuning function, the resonance magnitude must exceed the Torque Notch Filter Tuning Threshold. The magnitude of an identified natural resonance frequency must be higher than this threshold value to be applied to the Torque Notch Filter Frequency Estimate.

Torque Notch Filter Frequency Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get	T	REAL	-	-	-	Radians/sec

This value represents the resonance frequency with the highest magnitude above the Torque Notch Filter Tuning Threshold and between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit as identified by the Adaptive Tuning function.

Adaptive Tuning function.

The Torque Notch Filter Frequency Estimate value is initialized to zero when the drive is power cycled or reset.

Torque Notch Filter Magnitude Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get	T	REAL	-	-	-	% Motor Rated

This value represents the maximum magnitude for resonant peaks found above the Torque Notch Filter Tuning Threshold and between the Torque Notch Filter Low Frequency Limit and the Torque Notch Filter High Frequency Limit as identified by the Adaptive Tuning function.

The Torque Notch Filter Magnitude Estimate value is initialized to zero when the drive is power cycled or reset.

Torque Low Pass Filter Bandwidth Estimate

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Ge	T	REAL	-	-	-	Radians/sec

This value represents the Bandwidth of the Torque Low Pass Filter when the Adaptive Tuning Configuration is equal to Gain Stabilization or Tracking Notch and Gain Stabilization. The value is modified by the Adaptive Tuning function. The value is initialized to the Torque Low Pass Filter Bandwidth when the Adaptive Tuning Configuration transitions from Disabled or Tracking Notch to Gain Stabilization or Tracking Notch and Gain Stabilization. The Torque Low Pass Filter Bandwidth Estimate value is initialized to zero when the drive is power cycled or reset.

Adaptive Tuning Gain Scaling Factor

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - C	Get/GSV	T	REAL	-	-	-	Applied Gain/Configured Gain

This value proportionally scales the servo loop gain attributes of the associated axis. The value is modified by the Adaptive Tuning function. The value is reset to 1 any time the Adaptive Tuning Configuration is Disabled or set to Tracking Notch. The value is initialized to 1 when the drive is power cycled or reset.

See also

Torque Force Control Signal Attributes

Velocity Control Mode

How are we doing?