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Axis Safety Status Attributes

The following attribute tables contains axis attributes used with the integrated Safety functionality associated with a Motion Device Axis Object instance included in a CIP Motion Safety Drive. These attributes reflect the current state of an embedded Safety Core within for a CIP Motion Safety Drive device that is designed to interoperate with an external Safety Controller using a CIP Safety connection.

In the Logix Integrated Architecture, many of the safety functions can be executed either in the drive or in the associated safety controller. A unique feature of the architecture is that regardless of where the safety function is executed, the Axis Safety Status and Axis Safety Fault information reported by these safety functions is the same. This is achieved by the Safety Status Pass Thru feature where safety functions executing in the safety controller transmit their fault and status information to the drive via the Safety Output Assembly where this information is combined with the fault and status information of safety function executing in the Safety Core of the drive. The combined safety function fault and status data is then "Passed Thru" to the associated Motion Device Axis Object instance attributes.

The following table identifies the supported safety functions:

Short Name	Full Name	Control	Drive	Description
STO	Safe Torque Off	No	Yes	Disables associated drive power structure.
SBC	Safe Brake Control	Yes	No	Engages safety brake.
SS1	Safe Stop 1	Yes	Yes	Monitors Category 1 Stop followed by STO.
SS2	Safe Stop 2	Yes	No	Monitors Category 2 Stop followed by SOS.
SOS	Safe Operating Stop	Yes	No	Monitor standstill condition for movement.
SMT	Safe Motor Temperature	No	No	Monitor motor temperature for overtemperature.
SLT	Safely-limited Torque	No	Yes	Prevents the motor from exceeding the specified torque limit.
SLA	Safely-limited Acceleration	No	No	Monitor acceleration exceeding configured limit.
SLS	Safely-limited Speed	Yes	No	Prevents the motor from exceeding the specified speed limit.
SDI	Safe Direction	Yes	No	Monitor for change in direction of travel.
SSM	Safe Speed Monitor	Yes	No	Monitor speed exceeding configured limit.
SLP	Safely-limited position	Yes	No	Prevents the motor shaft from exceeding the specified position limit(s).

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SCA	Safe CAM	Yes	No	Monitors whether the motor shaft position is within a specified range.
SFX	Safe Feedback Interface	Yes	No	Scales and references safety feedback data.

The Axis Safety State, Axis Safety Status, and Axis Safety Fault attributes defined below are based on the values read from attributes resident in objects associated with the Safety Core and are used by the motion control system to monitor the behavior of the Safety Core via the CIP Motion connection.

Axis Safety State

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	UINT	-	-	-	Enumeration: 0 = Unknown (No Motion Connection) 1 = Self-Testing 2 = Configured (No Safety Connection) 3 = Self-Test Exception 4 = Running 5 = Recoverable Fault 6 = Unrecoverable Fault 7 = Configuring 8 = Not Configured 9-50 = Reserved by CIP 51 = Not Configured (Torque Permitted) 52 = Running (Torque Permitted) 53-99 = Device Specific 100-255 = Vendor Specific

The Axis Safety State attribute is an 8-bit enumerated value that indicates the state of the associated Safety Supervisor object of the device as it applies to this axis instance. There is only one Safety Supervisor object servicing the CIP Motion device so its state generally applies to all applicable Axis instances of the device. This means that all instances of this object generally have the same state for this attribute.

The two exceptions to this general state behavior are the Waiting for TUNID with Torque Permitted (state=51) and Executing with Torque Permitted (state=8) states that have axis specific qualification. When the Safety Supervisor State is Waiting for TUNID with Torque Permitted, if the Axis Safety Status bit, Safe Torque Disabled, is set, the Axis Safety State is set to Waiting for TUNID. When the Safety Supervisor State is Executing with Torque Permitted, if the Axis Safety Status bit, Safe Torque Disabled, is set, the Axis Safety State is Executing.

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Bit	Safety Supervisor State	Description
0 = Undefined/Unknown (No MotionConnection)	Undefined	No motion connection has been opened to the drive. Actual safety state is unknown.
1 = Self-Testing	Self-Testing	<p>The safety function of drive has been initialized; all attributes given appropriate defaults and safety faults have been reset.</p> <p>Device is performing tests to determine if it is qualified to execute its safety function.</p>
2 = Configured (No Safety Connection)	Idle	The safety function of drive has been initialized, successfully completed self-testing, and has a valid safety configuration. However, the device is not executing the operational components of its safety functions. Configuring and Configured are persistent states that are preserved through power cycles.
3 = Self-Test Exception	Self-Test Exception	The safety function of drive has detected an exception condition during self-testing. The details of the exception are stored in the appropriate attribute values of the Safety Supervisor object.
4 = Running	Executing	<p>The safety function of drive is fully configured with an open safety output connection and executing.</p> <p>In this state, the drive is operational and free to apply torque to the motor as long as there are no safety demands.</p>
5 = Recoverable Fault	Abort	The safety function of drive is in a faulted state that can be recovered by cycling the power or reconnecting the drive.
6 = Unrecoverable Fault	Critical Fault	The safety function of drive is in a faulted state for which there is no recovery other than replacing the module.
7 = Configuring	Configuring	<p>The safety function of drive has been initialized, successfully completed self-testing, and is in the process of receiving a valid configuration from a safety controller.</p> <p>Configuring and Idle are persistent states that are preserved through power cycles.</p>
8 = Not Configured	Waiting for TUNID	The safety function of drive has exited Self-testing and recognizes that it has the out-of-box default configuration values, for example it has not been configured by a safety controller. The drive remains in this state until a safety controller initiates the configuration process. Application of torque to the motor is NOT permitted in this state.

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9-50 = Reserved	-	-
51 = Not Configured (Torque Permitted)	Waiting for TUNID with Torque Permitted	Same behavior as Not Configured state with the exception that the drive axis is operational and the safety function will permit application of torque to the motor.
52 = Running (Torque Permitted)	Executing with Torque Permitted	Same behavior as Running state with the exception that the drive axis is operational and the safety function will permit application of torque to the motor. Entering this state from the Running state requires a successful STO Mode change service applied while the safety controller is in Program Mode.
53-99 = Device Specific	-	-
100-255 = Vendor Specific	-	-

Axis Safety Status

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = Safety Fault 1 = Safety Reset Request 2 = Safety Reset Required 3 = Safe Torque Off Active 4 = Safe Torque Disabled 5 = Safe Brake Control (SBC) Active 6 = Safe Brake Control (SBC) Engaged 7 = Safe Stop 1 (SS1) Active 8 = Safe Stop 2 (SS2) Active 9 = Safe Operating Stop (SOS) Active 10 = Safe Operating Stop (SOS) Standstill 11 = Safe Motor Temperature (SMT) Active 12 = Safe Motor (SMT) Overtemperature 13-15 = (reserved) 16 = Safe Speed

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							16 = Safe Speed Monitoring (SSM) Active
							17 = Safe Speed Monitoring (SSM) Status
							18 = Safe Limited Speed (SLS) Active
							19 = Safe Limited Speed (SLS) Limit
							20 = Safe Limited Accel (SLA) Active
							21 = Safe Limited Accel (SLA) Limit
							22 = Safe Direction (SDI) Active
							23 = Safe Direction (SDI) Limit
							24 = Safe Positive Motion
							25 = Safe Negative Motion
							26 = Safe CAM (SCA) Active
							27 = Safe CAM (SAC) Status
							28 = Safe Limited Position (SLP) Active
							29 = Safe Limited Position (SLP) Limit
							30 = Safety Output Connection Closed
							31 = Safety Output Connection Idle

The Axis Safety Status attribute is a collection of bits indicating the status of the standard safety functions for the axis as reported by the embedded Safety Core of the device. The Axis Safety Status word is a concatenation of two 16-bit safety status attributes. The lower 16-bits are the current Safety Stop Status attribute value of the Safety Stop Functions object associated with this axis instance. The upper 16-bits are the current Safety Limit Status attribute value of the Safety Limit Functions object associated with this axis instance with the exception of the two most significant bits that are masked off to accommodate two Safety Output Connection status bits. Specifically, the Safety Output Connection Closed bit, when set, indicates that the Safety Output Connection has either not been opened or has been closed. The Safety Output Connection Idle bit, when set, indicates that the Safety Output Connection's Run/Idle bit has been set to Idle.

For Rockwell Automation safety drive devices, the safety status data from the drive's Safety Core may include safety status from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Status attribute to reflect safety function status conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Status - RA

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Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = Safe Brake Integrity 1 = Safe Feedback Homed 2-31 = (reserved)
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The Axis Safety Status - RA attribute is a collection of bits indicating the status of the Rockwell Automation specific safety functions for the axis as reported by the embedded Safety Core of the device. For Rockwell Automation safety drive devices, the safety status data from the drive's Safety Core may include safety status from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Status RA attribute to reflect safety function status conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Faults

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Core Fault 2 = Safety Feedback Fault 3 = Safe Torque Off Fault 4 = Safe Stop 1 (SS1) Fault 5 = Safe Stop 2 (SS2) Fault 6 = Safe Operating Stop (SOS) Fault 7= Safe Brake (SBC) Fault 8 = Safe Motor Temperature Fault (SMT) 9-15 = (reserved) 16 = Safe Speed Monitor (SSM) Fault 17 = Safe Limited Speed (SLS) Fault 18 = Safe Limited Accel (SLA) Fault 19 = Safe Direction (SDI) Fault 20 = Safe CAM (SCA) Fault 21 = Safe Limited Protection (SLP) Fault 22-29 = (reserved) 30 = Safety Validator Fault 31 = Safety Abort Fault

The Axis Safety Faults attribute is a collection of bits indicating the safety fault status of the axis associated with standard safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and if the Safety Fault Action is set to Major Fault or Minor Fault, the corresponding bit is set in the Axis Safety Faults attribute. An active axis safety fault bit remains latched even if the underlying safety fault condition is cleared by the Safety Core. A Fault Reset Request to the associated axis clears the axis safety fault bits, but the bits immediately set again if the underlying safety fault conditions are still present. The Axis Safety Faults bitmap is a concatenation of two 16-bit safety fault attributes. The lower 16-bits is the current Safety Stop Faults attribute value of the Safety Stop Functions object associated with this axis instance. The upper 16-bits is the current Safety Limit Faults attribute value of the Safety Limit Functions object associated with this axis instance. Bits 30 and 31 are used to indicate two safety faults conditions that are not tied to the drive safety functions. Bit 30 indicates that the Safety Validator object (0x3A) has detected a safety connection fault. Bit 31 indicates that the Safety Supervisor object (0x39) has detected a recoverable fault and transitioned to the Abort state.

For Rockwell Automation safety drive devices, the safety fault status data from the drive's Safety Core may include safety faults from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Faults attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Faults - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Feedback Interface (SFX) Fault 2-31 = (reserved)

The Axis Safety Faults - RA attribute is a collection of bits indicating the safety fault status of the axis associated with Rockwell Automation specific safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and if the Safety Fault Action is set to Major Fault or Minor Fault, the corresponding bit is set in the Axis Safety Faults RA attribute. An active axis safety fault bit remains latched even if the underlying safety fault condition is cleared by the Safety Core. A Fault Reset Request to the associated axis clears the axis safety fault bits, but the bits immediately set again if the underlying safety fault conditions are still present.

For Rockwell Automation safety drive devices, the safety fault status data from the drive's Safety Core may include safety faults from the Safety Controller through the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Faults RA attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive's Safety Core.

Axis Safety Alarms

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values

Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Core Alarm 2 = Safety Feedback Alarm 3 = Safe Torque Off Alarm 4 = SS1 Alarm 5 = SS2 Alarm 6 = SOS Alarm 7 = SBC Alarm 8 = SMT Alarm 9-15 = (reserved) 16 = SSM Alarm 17 = SLS Alarm 18 = SLA Alarm 19 = SDI Alarm 20 = SCA Alarm 21 = SLP Alarm 22-29 = (reserved_ 30 = Safety Validator Alarm 31 = Safety Abort Alarm
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The Axis Safety Alarms attribute is a collection of bits indicating the safety alarm status of the axis associated with standard safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and, if the Safety Fault Action is set to Alarm, the corresponding bit is set in the Axis Safety Alarms attribute. An active axis safety alarm bit shall remain set as long as the underlying safety fault condition is present in the Safety Core.

The Axis Safety Alarm bitmap is a concatenation of two 16-bit safety fault attributes. The lower 16-bits is the current Safety Stop Faults attribute value (Attribute 41) of the Safety Stop Functions object associated with this axis instance. The upper 16-bits is the current Safety Limit Faults attribute value (Attribute 41) of the Safety Limit Functions object associated with this axis instance. Bit 30 indicates that the Safety Validator object (0x3A) has detected a safety connection fault. Bit 31 indicates that the Safety Supervisor object (0x39) has detected a recoverable fault and transitioned to the Abort state.

For Rockwell Automation safety drive devices, the safety fault status data from the drive’s Safety Core may include safety faults from the Safety Controller via the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Alarms attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive’s Safety Core.

Axis Safety Alarms - RA

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
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Optional - DE Safety only	Get/GSV	T	DWORD	-	-	-	Bitmap: 0 = (reserved) 1 = Safety Feedback Interface (SFX) Fault 2-31 = (reserved)

The Axis Safety Alarms - RA attribute is a collection of bits indicating the safety alarm status of the axis associated with RA specific safety functionality as reported by the embedded Safety Core of the device. When a safety fault condition occurs, the Safety Core forces the axis into a Safe State and, if the Safety Fault Action is set to Alarm, the corresponding bit is set in the Axis Safety Alarm RA attribute. An active safety alarm bit remains set as long as the underlying safety fault condition is present in the Safety Core.

For Rockwell Automation safety drive devices, the safety fault status data from the drive’s Safety Core may include safety faults from the Safety Controller via the Pass Thru data included in the Safety Output assembly. This allows the Axis Safety Alarms RA attribute to reflect safety function fault conditions regardless of where the safety function is executed, be it in the Safety Controller, or the drive’s Safety Core.

Safety Fault Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE Safety only	Set/SSV		USINT	4 (D) 2 (E)	-	-	Enumeration: (D) 0 = Ignore (O) 1 = Alarm (O) 2 = Minor Fault (O) 3 = Major Fault (R) 4-254 = reserved

The Safety Fault Action attribute is an enumerated value that specifies the action when the Safety Core reports a safety fault condition.

Safe Torque Off Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set		USINT	FD 1 for C 0 for F	-	-	Enumeration: 0 = Disable and Coast 1 = Current Decel and Disable 2 = Ramped Decel and Disable 3-127 = (reserved) 130-255 = (vendor specific) 128 = DC Injection Brake 129 = AC Injection Brake

Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Safe Torque Off Action attribute determines the stopping method for the motor when:

- The drive detects a Safe Torque Off (STO) Active condition that the Safe Stop 1 (SS1) Active condition does not initiate. The embedded Safety Core through the Axis Safety Status attribute reports the condition.
- The Safe Torque Off Action Source is set to Connected Drive.

Each Safe Torque Off Action enumeration initiates one of the two defined Stopping Sequences, Category 0 Stop, or Category 1 Stop. Each enumeration definition follows the same enumerations defined for the Stopping Action attribute.

Category 1 Stop enumerations of Current Decel & Disable or Ramped Decel & Disable are also used with a configured delay between the STO Active condition and Safe Torque Disabled. This allows the drive to bring the motor to a controlled stop and engage a brake before disabling the power structure. Vertical load applications use this feature.

Tip: An example of a configured delay between the STO Active condition and the Safe Torque Disabled condition is STO to Safe Brake C=Control (SBC) Delay or STO delay.

Start Inhibited or Major Fault State occurs after applying the Stopping Sequence. For either final state, the inverter power structure of the device is disabled with integrity. The is enforced by the STO safety function of the Safety Core.

Safe Torque Off Action Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/ SSV#		USINT	0	-	-	Enumeration: 0 = Connected Drive (R) 1 = Running Controller (O) 2-127 = (reserved) 128-255 = (vendor specific)

Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

The Safe Torque Off Action Source attribute determines whether the drive or the controller initiates the stopping sequence in response a STO Active condition in the Axis Safety Status attribute that was not initiated by an SS1 or Safe Stop 2 (SS2) Active condition.

When configured for Connected Drive (default), the drive will initiate the stopping sequence according to the selected Safe Torque Off Action. However, the drive must have an open connection to the controller for the configured stopping action to occur. If the drive is not connected, the drive would have already initiated the configured Connection Loss Stopping Action.

When configured for Running Controller, the stopping sequence is initiated by the connected controller as long as the controller connection's "Run/Idle" bit in the Real Time

(RT) Header is indicating Run Mode. This allows the controller to provide a programmed stopping action. If the controller is in Idle Mode, i.e. not actively running the application program, the connected drive will initiate the stopping sequence according to the configured Safe Torque Off Action. This selection is only valid if the connected controller is supplying the "Run/Idle" Real Time header.

Safe Stopping Action

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/SSV#		USINT	0	-	-	Enumeration: 0 = Current Decel 1 = Ramped Decel 2-127 = (reserved) 128-255 = (vendor specific)

Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

When an SS1 or SS2 Active condition occurs, as indicated by the Axis Safety Status attribute, and the Axis Safety Stopping Source is set to Connected Drive, this value determines the stopping method the drive is to apply to the motor. The selected stopping method is applied while in the Stopping state and the final state after the stopping method completes is the Stopped state. In this final state the device's inverter power structure will either be Disabled and free of torque, if initiated by an SS1 Active status bit, or actively held (Hold selection) in a static condition if initiated by an SS2 Active status bit.

Safe Stopping Action Bit Descriptions

Bit	Required/Optional	Name	Description
0	R/C O/F	Current Decel	Current Decel leaves the power structure and any active control loops enabled while stopping. If configured for position control mode, the drive forces the position reference to hold its current value until the axis reaches zero speed. Once at zero speed the position reference is immediately set equal to the actual position to hold the axis at standstill. If in velocity control mode, the drive forces the velocity reference to zero. In either case, forcing the position or velocity reference signals to a fixed value results in a rapid increase in control loop error of the moving axis that saturates the output current of the drive to the configured Stopping Torque that brings the motor to a stop. In torque control mode, the drive directly applies the configured Stopping Torque to the torque command signal to decelerate the motor. When the velocity feedback value reaches zero speed, the torque command is set to zero. In frequency control mode the Current Vector Limit attribute, rather than the Stopping Torque attribute, is used to regulate the stopping current. Once stopped, or the configured Stopping Time, or factory limit expires, the Current Decel stopping action is complete.

1	O/FV	Ramped Decel	Current Decel & Disable also leaves the power structure and any active control loops enabled while stopping but uses the Ramp Generator associated with the Velocity Fine Command Generator block to decelerate the motor to a stop. When initiating a Current Decel & Disable Stop, the Ramp Generator is immediately activated and the drive no longer follows command from the controller. The Ramp Generator input is initialized to zero and the output is initialized to the current speed of the motor, thus causing the Ramp Generator output to ramp the motor from its current speed down to zero according to the ramp control parameters. Once stopped, or the configured Stopping Time or factory timeout limit expires, the Ramped Decel stopping action is complete.
2-127		Reserved	
128-255		Vendor Specific	

Safe Stopping Action Source

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - D Safety Only	Set/SSV#		USINT	0	-	-	Enumeration: 0 = Connected Drive (R) 1 = Running Controller (O) 2-127 = (reserved) 128-255 = (vendor specific)

Indicates the attribute cannot be set while the tracking command (Tracking Command bit in CIP Axis Status is true).

This attribute determines whether the drive or the controller initiates the stopping sequence in response to an SS1 or SS2 Active bit transition in the Axis Safety Status attribute.

When configured for Connected Drive (default), the drive will initiate the stopping sequence according to the selected Safe Stopping Action. However, the drive must have an open connection to the controller for the configured stopping action to occur. If the drive is not connected, the drive would have already initiated the configured Connection Loss Stopping Action.

When configured for Running Controller, the stopping sequence is initiated by the connected controller as long as the controller connection's "Run/Idle" bit in the Real Time (RT) Header is indicating Run Mode. This allows the controller to provide a programmed stopping action. If the controller is in Idle Mode, i.e. not actively running the application program, the connected drive will initiate the stopping sequence according to the configured Safe Stopping Action. This selection is only valid if the connected controller is supplying the "Run/Idle" Real Time header

supplying the runtime real time header.

Axis Safety Data A

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Get/GSV		DWORD	-	-	-	General Purpose Data Container

A 32-bit container holding general purpose Safety Data passed from the Safety Controller thru the Safety Pass Thru object attribute, Safety Pass Thru Data A.

Axis Safety Data B

Usage	Access	T	Data Type	Default	Min	Max	Semantics of Values
Optional - DE	Get/GSV		DWORD	-	-	-	General Purpose Data Container

A 32-bit container holding general purpose Safety Data passed from the Safety Controller thru the Safety Pass Thru object attribute, Safety Pass Thru Data B.

See also

[Guard Safety Attributes](#)

[Guard Safety Status Attributes](#)

[Axis Exception Action](#)