INTRODUCTION TO

CONVEYSTOP®

INSIGHT AUTOMATION

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1 WHAT IS *CONVEYSTOP*?

ConveyStop is a *ConveyLinx* function that establishes a network based means to signal all *ConveyLinx* modules with a *Stop Command* in order to physically stop their motion and/or output functions and remain in a stopped state until a separate *Reset Command* network signal is received to return all connected modules back to their normal function. This is accomplished by utilizing the built-in Ethernet network that already inter-connects the *ConveyLinx* control system.

In a similar fashion to how *ConveyLinx* modules establish logical connections based upon conveyor flow; *ConveyStop*, when applied, establishes *Stop Group* connections between modules such that only modules within a given *Stop Group* are affected by stop and reset network commands. With *ConveyStop*, any given system can be segregated into as many *Stop Groups* as desired as long as all modules within a *Stop Group* are physically connected over Ethernet.

Each *Stop Group* is independent in that a *Stop Command* or *Reset Command* occurring in one *Stop Group* does not affect the modules in another *Stop Group* even if they are on the same physical Ethernet network. In fact, modules within the same subnet that have logical conveyor flow connections can be in different *Stop Groups*. This means that an *ERSC* module in a non-stopped *Stop Group* will automatically detect if it is discharging into a stopped *Stop Group* and automatically inhibit product flow accordingly.

2 WHAT ARE THE BENEFITS OF *CONVEYSTOP*?

2.1 REPLACES SEPARATE STOP CIRCUIT

One important feature of a ConveryLinx control system with *ConveyStop* enabled is that local operator buttons or switches can wire directly to a nearby *ERSC* or *CNIP* module. With these locally wired devices, anyone can initiate a controlled stop of a given *Stop Group* without requiring a separately wired stop circuit. Depending on system size and complexity, this can result in substantial savings in both installation cost and implementation time.

2.2 DETECTS NETWORK LOSS

Another important feature of a *ConveyStop* enabled system is that loss of network communication and/or loss of connection to a PLC (if originally connected) will automatically cause a *Stop Command* to be initiated. Very often in large and/or complex network based control systems; the loss of communications is not easily detected nor does adjacent unaffected devices react in predictable ways. With *ConveyStop*, not only does every device stop upon communication loss, there can be information taken from the modules to help pin-point where the communication loss occurred.

2.3 PROVIDES MORE RELIABLE RECOVERY

When any *Stop Command* is initiated in an *ERSC* module, not only is all motor commutation stopped, but the *ERSC* retains pertinent data on its status at the time the *Stop Command* was initiated. The *ERSC* will remember that it was discharging or accepting a package along with the packages tracking data. Upon getting a *Reset Command*, the *ERSC* will pick up where it left off and attempt to finish what it was doing prior to the *Stop Command*.

This same scenario applies to situations when power is disconnected to all modules within a *Stop Group*. As part of the power loss procedure in all *ERSC* modules with *ConveyStop* enabled; certain pertinent data regarding module status and package tracking is saved to flash memory such that upon power-up and subsequent *Reset Command*, each *ERSC* will attempt to complete what it was doing at the time of initial power loss.

3 HOW *CONVEYSTOP* WORKS:

3.1 INITIAL CONFIGURATION

The ability to respond to *Stop Commands* and *Reset Commands* is built in to every *ERSC* and *CNIP* module. The activation of the *ConveyStop* function requires the *ConveyStop* PC software package to first define the configuration and then enable the functionality in a group or multiple groups of *ConveyLinx* modules.

This PC software connects to a *ConveyLinx* network and shows all available *ERSC* and *CNIP* devices. From this list, the system integrator creates and populates one or more *Stop Groups*. Within each *Stop Group*, one or more *ERSC*'s can be configured to have either its Left or Right Control Port assigned to contain a hard-wired stop button or switch. Similarly, any *CNIP* module can be similarly assigned a hard-wired stop button or switch to a specific dedicated input. Also within each *Stop Group,* one or more *ERSC*'s can be configured to have either its Left or Right Control Port assigned to contain a hard-wired reset button or switch. Similarly, any *CNIP* module can be similarly assigned a hard-wired reset button or switch to a specific dedicated input.

Once configuration is complete, the integrator simply "downloads" the *ConveyStop* configuration to the network.

3.2 ONCE *CONVEYSTOP* IS ENABLED

Once any one or more of the assigned stop buttons or switches is activated, a *Stop Command* will be issued to all modules within the *Stop Group*. When all stop buttons and switches have been de-activated or reset to their normal positions; activating any one of the reset buttons will issue a *Reset Command* to all modules within the *Stop Group*.

For *ConveyLinx ERSC* modules, the *ConveyStop Stop Command* causes all motor commutation to immediately stop. For *ConveyLinx* ConveyNet I/P (*CNIP*) modules, the *Stop Command* causes the *CNIP* processor to de-energize the output bus relay, thus disconnecting control power to the affected discrete outputs.

3.3 NETWORK-BASED CONSIDERATIONS

Not only can the hard-wired buttons and switches initiate *Stop Commands* and *Reset Commands*; these commands can also be issued from a PLC or PC connected over the *ConveyLinx* network.

Also, because all modules within a given *Stop Group* are cognizant of their configuration; by connecting a PLC to any one module within the *Stop Group*, the PLC can get status data as to the state of the *Stop Group* (i.e. started, stopped, or awaiting reset) as well as diagnostic information as to where stop devices are actuated.

3.4 OTHER CONDITIONS THAT CAN INITIATE A STOP COMMAND

There are other events and scenarios other than physical actuation of a button or switch will cause a network *Stop Command* to be issued:

3.4.1 MISSING CONNECTION

If any single device (*ERSC* or ConveyNet I/P) is missing from a configured group due to for example unplugged or damaged cable or loss of power; the *Stop Command* will be issued to all modules in the *Stop Group*.

3.4.2 MISSING PLC

If any single device (*ERSC* or ConveyNet I/P) first establishes a network connection with a PLC and that connection is subsequently lost to the PLC, the *Stop Command* will be issued to all modules in the *Stop Group.*

3.4.3 POWER LOSS

For any group of *ConveyLinx* modules that has *ConveyStop* enabled; upon a power cycle, all modules will initialize in a Stopped state and a *Reset* Command must be given to the *Stop Group* in order to resume normal operation. This *Reset Command* can originate from any of the assigned hard-wired reset buttons or via the network by a PLC or PC.

4 USING *CONVEYSTOP* IN AN INTEGRATED STOP SYSTEM

The means and methods of stopping automated equipment in an integrated material handling system are governed by many factors including, but not limited to:

- Location and usage of the equipment per the application
- Operator or non-maintenance personnel access to moving equipment
- Federal, State, and/or local ordinance or code
- Accepted electrical design practice
- Customer or end user preference

With all of these variables in play; *ConveyStop* cannot claim or be advertised as a de facto "approved" stopping method for all conveyor system stopping situations including an emergency stop situation. The purpose of this section is to define a recognized standard for control system stop classifications or categories and describe how *ConveyStop* can be applied for each.

It is the responsibility of the integrator of a *ConveyLinx* equipped system utilizing *ConvetStop* to assess all of the aforementioned factors before deeming a *ConveyStop* generated *Stop Command* as being applicable and suited for an emergency stop situation.

4.1 NFPA® 79

The National Fire Protection Association (NFPA®) 79 *Electrical Standard for Industrial Machinery 2012 Edition* contains accepted definitions for stopping functionality and emergency operations that are, in general, applicable to the conveyor and material handling industry.

4.1.1 EMERGENCY OPERATIONS

NFPA® 79 section *9.2.5.4 Emergency Operations* is as follows:

(1) This section specifies the requirements for the emergency stop and the emergency switching-off functions of the emergency operations, both of which are initiated by a single human action

(2) Once active operation of an emergency stop or emergency switching off actuator has ceased following a command, the effect of this command shall be sustained until it is reset. This reset shall be possible only at the location where the command has been initiated. The reset of the command shall not restart the machinery but only permit restarting.

(3) It shall not be possible to restart the machinery until all emergency stop commands have been reset. It shall not be possible to re-energize the machinery until all emergency switching off commands have been reset.

4.1.1.1 HOW *CONVEYSTOP* APPLIES TO EMERGENCY OPERATIONS

The section 9.2.5.4 Item (1) criterion is met when physical buttons or switches are assigned and enabled with *ConveyStop*. Please note that a networked PLC or PC can generate a *Stop Command* and as such can occur programmatically and not necessarily by "single human action". In this case, the integrator would be responsible for assuring that the PLC or PC based *Stop Command* is always initiated from a "single human action" integrated with said PLC or PC controls.

The section 9.2.5.4 Item (2) criterion is met when physical buttons or switches are assigned and enabled with *ConveyStop* and these devices are proper maintained contact type. As long as the button or switch is in its "emergency" position; *ConveyStop* will not issue or respond to any *Reset Command* regardless of source (hard-wired button or networked PLC or PC). Also, resetting the physical device to its "non-emergency" state will not restart the modules to operation nor will this resetting of the device initiate any *Reset Command*.

The section 9.2.5.4 Item (3) criterion is met in *ConveyStop* by design. If multiple physical buttons or switches are assigned and enabled with *ConveyStop*; all have to be placed into their "non-emergency" state before *ConveyStop* will issue or respond to any *Reset Command* regardless of source. This is true regardless of which device first initiated the stop.

4.1.2 STOP FUNCTION

NFPA® 79 section *9.2.2 Stop Functions* defines stop functionality as:

Stop functions shall operate by de-energizing that relevant circuit and shall override related start functions. The reset of the stop functions shall not initiate any hazardous conditions.

This section further defines three (3) Categories for stop functionality:

Category 0 – An uncontrolled stop by immediately removing power to the machines actuators

Category 1 - A controlled stop with power to the machine actuators available to achieve the stop then remove power when the stop is achieved

Category 2 - A controlled stop with power left available to the machine actuators

4.1.2.1 *CONVEYSTOP* AND STOP FUNCTION DEFINITION

In general, *ConveyStop* follows the intent of the Stop Function definition for section 9.2.2. The manner in which "*de-energizing that relevant circuit"* it is accomplished differs between the *ERSC* and *CNIP* modules.

4.1.2.1.1 *CNIP* AND STOP FUNCTION

Four of the six digital output circuits on the *CNIP* modules have their control power source internally wired to a contact relay. When a *Stop Command* is active, this relay is de-energized and control power is disconnected. In this state, the digital output circuit is de-energized regardless of the state of the logical output. This is a common stop circuit design for PLC based I/O systems.

4.1.2.1.2 *ERSC* AND STOP FUNCTION

In situations where a *Stop Command* is active and control power is maintained to an *ERSC*, the de-energizing of the relevant circuit is accomplished by the on board processor. The *ERSC* utilizes a single processor and this processor directly controls (among other things) the power switching transistors that commutate the motor. When a *Stop Command* is active, the processor places all power switching transistors in their open or non-conductive state and then by-passes the task in the processor that produces motor commutation.

4.1.2.2 *CONVEYSTOP* AND STOP FUNCTION CATEGORIES

4.1.2.2.1 CATEGORY 2

Utilizing *ConveyStop* as designed and intended adheres to the criterion of Category 2. Maintaining control power to all *ConveyLinx* modules is desirable because they maintain their "pre stopped" state making for faster and more reliable recovery. Another added benefit of maintaining control power to all *ConveyLinx* modules is that the diagnostic features of both *ConveyLinx* and *ConveyStop* are available to PLC and/or PC (including the *ConveyStop* PC software monitoring capability) as an aid in troubleshooting and event logging.

4.1.2.2.2 CATEGORY 1 AND CATEGORY 0

Both of these categories involve disconnecting power to *ConveyLinx* modules and either of these can be implemented on a *ConveyLinx* system with or without *ConveyStop* being enabled.

If *ConveyStop* is implemented, the behavior would essentially be as described in section *3.4.3 Power Loss*. *ERSC* modules will retain their state to flash memory as power is being dropped. When power is restored; each *Stop Group* affected by the power disconnect will have to receive a *Reset Command* from either an assigned and enabled button or switch or from a network source (PLC or PC).

For *CNIP* modules, each is equipped with separate power terminals. One set of terminals is for module logic and input bus power and the other set powers only the output bus. In a Category 1 or Category 0 system, the motion producing control power can be disconnected from the *CNIP*'s output bus while leaving logic and input control power on. This is a typical strategy applied to PLC I/O systems and can be implemented with *CNIP* modules with or without *ConveyStop* installed and enabled. It must be noted that this strategy requires 2 separate power systems to be field wired.

4.2 WHAT HAPPENS WHEN YOU DO NOT USE CONVEYSTOP?

Operationally, *ConveyStop* is not required for any *ConveyLinx* system to function. If *ConveyStop* is not implemented, disconnecting power does cause all motor motion to stop for *ERSC*'s and all outputs to be de-energized for *CNIP*'s. However it is important to note that without *ConveyStop* enabled and when power is restored; *ERSC* modules will be enabled to run and if conveyor conditions dictate, motors will run and packages will begin to move with no other or separate reset signal or command.

Another important note is that *ConveyLinx* devices are Ethernet based, and upon cycle of power, modules will individually reinitialize at different rates making exact power up behavior unpredictable.

4.3 IN CONCLUSION

By no means is NFPA® 79 the only specification or criteria for defining the stop function of an automated system. The NFPA® 79 is a general standard for the USA and the descriptions above are based upon general experience for US installations.

The bottom line is that it is always up to the integrator to understand and adhere to the applicable specifications, codes, and standards on a per system basis. *ConveyStop* can be a valuable tool to achieve desired system stop functionality, enhanced diagnostics, and lower installed cost.