CST Controlled Start Transmission
CONTROLS SYSTEM INSTRUCTION MANUAL

These instructions must be read thoroughly before installing or operating this product.

To avoid start up delays, this checklist should be completed before scheduling the Dodge Controls Engineer commissioning trip.

CST Drive System Pre-commissioning Checklist

1. The input and output coupling alignments have been completed.
2. All bolts in the base, CST and motor have been tightened to specified torque values.
3. The CST reducers have been filled to the proper oil level.
4. The power source is connected to the primary motors and the direction of motor rotation is the same as the directional arrow on the CST input shaft.
5. The power source is connected to the CST electrical control panel.
6. All input and output connections from the CST electric control panel are properly terminated at the electrical junction boxes on each CST and other field devices.
7. The emergency stop push buttons on the CST junction boxes and the one on the electrical control panel have been tested.
8. Cooling pumps are rotating in the correct direction and have been run for at least one hour with no significant leaks.
9. The pressure gauge on CST oil inlet manifold reads 20 psi or higher.
10. Cooling fans are rotating in the correct direction with air moving over the motor and then through the radiator.
11. Oil sump heaters, if installed, have been energized.
12. The motors and all electrical equipment are ready to be tested in local control mode.
13. Spare 10 and 25 micron filters are on site.
14. The output coupling between the reducer and pulley shafts has been left uncoupled.

WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed. Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures, as may be desirable, or as may be specified in safety codes should be provided, and are neither provided by Baldor Electric Company, nor are the responsibility of Baldor Electric Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risks to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

CONTROLS OVERVIEW

Controls

A CST can be used for control of conveyor belt acceleration during starts to minimize dynamic belt tension. The acceleration ramp can be controlled to minimize peak tension and compression transients during an empty or fully loaded belt start. On long conveyors, the results can be further improved by adding an additional dwell period in the acceleration ramp (see Figure 1). The dwell period allows the initial belt slack to be removed, and all the conveyor elements to attain a running condition at a very low torque and speed before the acceleration is ramped up with higher torque values. This eliminates overstressing of the belt. The CST control system provides a communication port to establish remote data acquisition with plant central computer system.

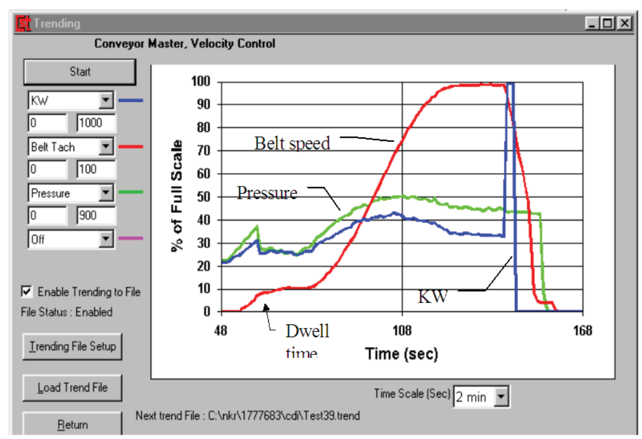


Figure 1: CST S-ramp Velocity Curve with Linear Braking

Sensors

The sensors and transducers for monitoring the CST are part of the control. On a typical CST, the following parameters are monitored: sump oil temperature, coolant pressures, hydraulic (disc pack) pressure, and output speed. The main drive motor kW signal is fed to the PLC control system from the motor control center. The kW transducer is calibrated for 0-150% of the maximum kW rating of the motor. Other parameters, as an OPTION such as belt speed (slip), belt tension, and motor winding temperature, as well as motor and CST vibrations, can also be monitored by the PLC control system. The PLC gives a controlled output signal (4-20mA) to a specially designed proportional control valve (PCV) mounted on the hydraulic manifold. The PCV is equipped with a pulse-width modulated amplifier which ensures linear and precise movement of the valve. The disc pack's stable and responsive 0-100% slip characteristics with respect to control pressure, offering a linear relationship of

torque versus clutch pressure. This key feature allows accurate overload protection and, in case of multiple drives, precise load share on long belt conveyors.

Most long conveyors employ multiple drive systems. Proper load sharing among these drives during all phases of conveyor operation is required to minimize the loads and stresses on all conveyor components. Where there is more than one CST drive in a conveyor system, the CST control system ensures that the drive motors share the load equally. The PLC controller unit of a drive station can control a maximum of four CST units. Proper load sharing among multiple drive systems is achieved by configuring one CST drive as the master and the other drives as slaves. Cascaded PID control loops allow precise torque control at very nominal (low) slip values.

The master drive is selected so that the slave drive slips to the extent needed to maintain uniform tension on the belt under varying load conditions.

Conveyor states

The conveyor motion control is explained in the following states:

State-0: Conveyor stopped.

The CST control system gives a "Ready for Start" signal when the conveyor speed is zero and the pressure on the clutch is below 5% of the system control pressure and there are no shut down signals.

State-1: Conveyor started.

When the conveyor START command is given to the CST control system, the application software in the PLC system starts the cooling pumps and the main drive motors. Drives are started at five second intervals. The clutch is pre-charged to roughly 10% of the pressure range. This is done to prime the clutch with oil prior to engaging the plates. The pre-charge setting can be changed from the operator human-machine interface (HMI) touch screen unit provided on the CST control panel.

State-2: Pre-charged

When clutch stack of each CST drive is pre-charged, the SPEED and kW PID loops are switched to "auto/feed-forward bias" mode. The set point value of the pressure PID loop for each drive is increased gradually until belt motion is detected. If the conveyor system has a brake unit, the CST control system gives a discrete and/or analog signal to customer controls to release brakes once pre-charge is complete.

State-3: Breakaway

When the belt speed is greater than 3% of full speed, the conveyor is said to be in a breakaway mode. At this state, the SPEED PID set point is gradually incremented whereas the kW PID does load share control.

State-4: Acceleration

When dwell time is over, the speed PID algorithm increments the speed set point to achieve an “S” shaped profile curve of speed versus time until full speed is reached. During acceleration, the heat exchanger cooling fan is switched on.

State-5: Full speed reached

When the conveyor belt accelerates to reach greater than 95% of speed, the system declares that full speed has been reached. Material can then be fed on the belt. Speed is held at 98% or 100%, depending upon the setpoint value selected. The master drive maintains constant speed while the slave operates under load share. At any point of time, the kW reading of both drives will be within ± 2%.

State-6 Conveyor braking

During normal operation if the CST units register a malfunction, or a STOP signal is activated, the system will engage braking mode. Pressure on the clutch is decreased gradually to achieve a linear or “s” ramp profile for a pre-set braking time. When the speed drops to less than 5%, brakes, if equipped, are applied (parking brake control).

Alarms and Shut Downs

The CST control system gives an **alarm** for the following:

- Any transducer out of calibration(pressure, temperature, speed, power)
- PID deviation high/low
- Heater starter failure, if applicable
- Oil temperature low
- Smart bearings temperature or vibration high (if applicable)

NOTE: The conveyor is not stopped nor is the main motor tripped for an alarm. For an alarm the following list potential alarms and shut downs can be provided by Baldor as the project requires. These items are subject to customer request.

- Brake faulty (if applicable)
- Smart bearing temperature or vibration high high (if applicable)
- Main motor and/or pump and/or fan and/or heater starter failure
- Cooling and/or clutch pressure(< 10 psi) low during starting
- Clutch pressure high (> 90%)
- CST slip HIHI and/or LOLO (± 20%)
- kW load share unbalanced (> ± 30%)

The CST control system will generate a **shut down** [Emergency], where the main motor and CST stop under any of the following conditions:

- Lubrication failure
- Oil temperature high high
- External emergency stop activated
- Main motor overloaded(> 110% kW) and/or kW signal faulty

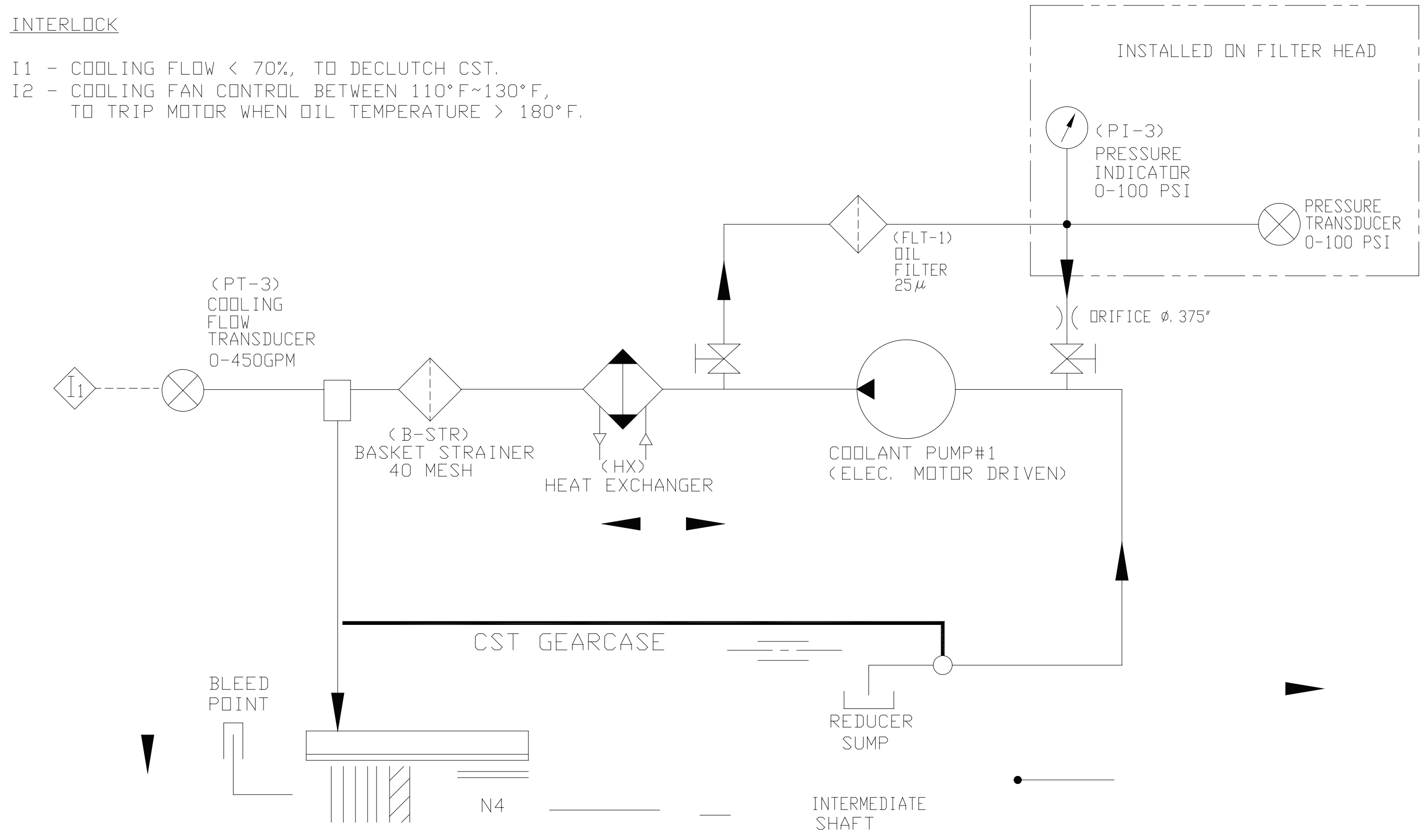


Figure 2 - Typical Cooling System Schematic

HYDRAULICS OVERVIEW

Based on specific application requirements, the actual system may have some deviations from the standard. If there are deviations that make a significant change in the operation or maintenance of the hydraulic systems they will be described in a supplement to this manual. For questions contact Dodge CST Product Support.

DESCRIPTION AND OPERATION

There are two separate hydraulic systems for each CST. The two systems are the Cooling System and the Control System. The hydraulic systems must all be functioning correctly for safe and continuous operation of the CST. The standard CST hydraulic systems take hydraulic oil from, and return oil to, the CST oil sump.

COOLING SYSTEM: Figure 2 shows the components that make up the hydraulic oil cooling system. The oil is pumped from the sump with an electric motor driven pump. The oil is pumped through an air to oil air heat exchanger that is sized to match the application requirements. The oil returns to the CST through a 40 mesh basket strainer, through the clutch stack, and back into the CST sump.

A cooling flow transducer (PT-3) is used to transmit a signal that is directly proportional to the clutch cooling oil pressure. This signal is sent to a CST Connection Box for interface with the CST Control System.

A cooling pressure indicator (PI-3) is located on the cooling oil return manifold on the CST. The flow orifice in the cooling oil return line to the CST acts to provide back pressure and limit flow through the heat exchanger.

CONTROL SYSTEM: Figure 3 shows the components contained in the control system for the CST. Hydraulic oil is drawn from the CST after the oil has been filtered by a Y strainer. There is a 10μ filter in place before the oil enters the hydraulic manifold.

The manifold is ported internally to direct pressurized flow to the System Control Pressure Relief Valve (RV). If all running conditions are satisfied, system control pressure will be established by valve RV. The system control pressure valve has been adjusted to provide a steady pressure supply to the Pressure Control Valve (PCV). System control pressure is shown on System Pressure Indicator (PI-2) which is part of the hydraulic manifold assembly. The PCV receives the control signal from the CST Control System. The output pressure from the PCV is directly proportional to the analog control signal from the control system. For the high pressure system, the control valve amplifier is adjusted to provide an output pressure range of 0 - 900 PSIG / 62 Bar for an input signal of 4-20 mA. The 4-20 mA control signal will cause a corresponding 0-100% PSIG control pressure to be sent to the clutch stack.

The pressure from the PCV is used to compress the clutch stack. For systems that require the inertia of a motor, flywheel or both in the event of an emergency stop, the blocking valve (BLV) can be installed on the hydraulic manifold assembly. The BLV is fail closed in the event of power failure.

Clutch Pressure Indicator (PI-1) is located on the hydraulic control manifold on the CST. Clutch Pressure Transducer (PT-1) is used to transmit a signal that is directly proportional to the control pressure for the clutch stack. This signal is sent to the PLC panel.

The pressurized oil from the hydraulic control manifold causes an annular piston to compress the clutch stack. As the input signal is ramped from minimum to maximum, the output shaft starts to rotate. Output shaft rotation is directly proportional to the signal from the CST Control System and to the pressure from the PCV.

CONNECTION BOX: Control interface between the hydraulic systems and the CST control system is provided through means of a connection box. The connection box has terminals for interconnection between the PLC and sensors. The following are the typical signals:

SIGNALS - CST TO CONNECTION BOX:

SIGNAL	TYPE	TAG
Clutch Pressure	Analog	PT-1
System Pressure	Analog	PT-2
Cooling Pressure	Analog	PT-3
Pressure Control valve	Analog	PCV
Output Shaft Speed	Analog	ST-1
Sump Oil Temperature	Analog	TT-1
(Optional) Blocking Valve	Discrete	BLV

HIGH PRESSURE PUMP: When the CST drive motor is started, the input and intermediate gear sections of the CST rotate. The clutch stack is not compressed, so the output shaft does not rotate. The high pressure pump is mechanically connected to the intermediate shaft and provides control pressure when the CST motor is running.

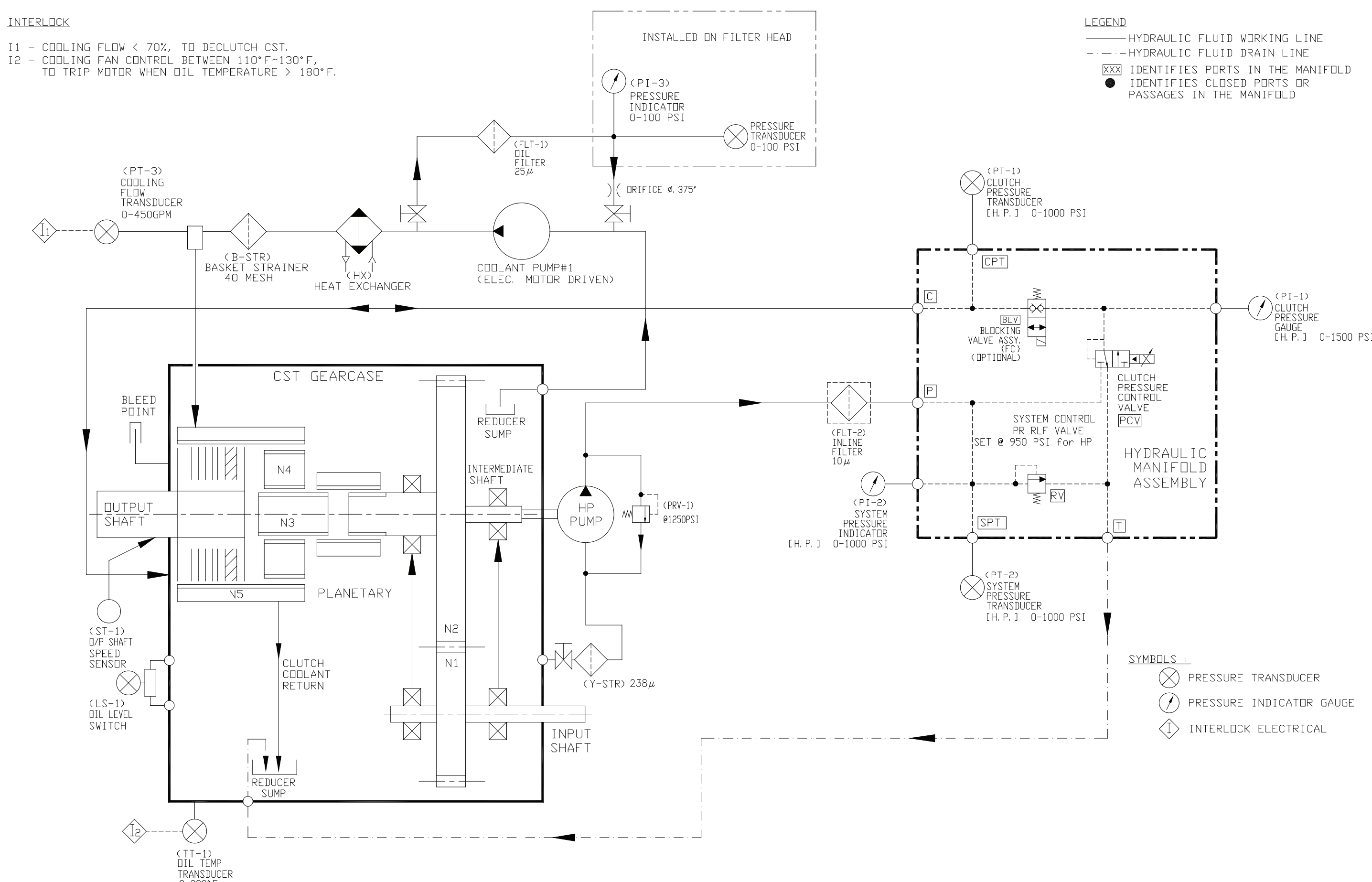


Figure 3 - Typcial Control System

HARDWARE OVERVIEW

This Section is for Baldor•Dodge supplied control systems only unless otherwise specified.

CST Control Panels supplied by Baldor•Dodge are Nema 4 enclosures, equipped with a PLC, necessary lamps, push buttons, and a touch screen-keypad monitor. The PLC executes controlled start transmission (CST) or controlled stop transmission for one or more drives on a conveyor. Both digital and analog inputs and outputs are employed to process signals such as temperature and pressure. A human machine interface (HMI) displays all information required for the CST operation. The standard HMI is PanelView.

When the conveyor start signal is given to the drive station control panel, speed in relation to time curve is achieved as an “S” curve. The acceleration time of the conveyor belt is adjustable from 40 -300 seconds to reach 100% speed. The conveyor can also be run at creep speed adjustable from 20-50%. When the conveyor stop signal is given, the control system decelerates the conveyor belt to zero speed within 30 seconds (adjustable between 10-30 seconds).
The application software in the PLC executes automatic load sharing between the drives. The PLC system is engineered to execute control of a maximum of four CST drives at one drive station. One of the drives is configured as the Master and others as Slave(s). Master/slave configuration is either made selectable from the Operator HMI unit or programmed to select automatically with the order in which the drive motor(s) is started by the end user.

The HMI is located on the control panel door. It provides the necessary human-machine interface with touch screen graphic displays for menu driven start-up and control of all CST drives. Operational features of the HMI are covered in the following sections.

It is recommended that power be fed to the CST panel from a reliable UPS (Uninterruptible Power Supply), having a minimum of 15 minute backup. (Before powering up the panel, the jumper inside the power supply module of the PLC is placed for the incoming 110VAC). All amplifiers, panel lamps, and other components are standardized for 24 VDC. A 24 VDC power pack feeds voltage to all 2-wire current loops for all CST drive health monitoring transducers.

Inputs and outputs

The PLC system is equipped with I/O hardware. Discrete inputs are 24 VDC, whereas discrete output modules are individually isolated relay contacts. This facilitates customer interface with 220 VAC or 48 VDC or 24 VDC circulating voltage towards interlocks, external relays or coils. Cable entry is from the bottom of the panel, standard cable bushing/glands are provided to ensure NEMA 4 tightness.

All health monitoring instruments on each CST (Clutch pressure, Cooling & Lubrication pressures, Oil temperature, Output-shaft speed and Proportional Control Valve + Blocking valve) are wired to a small junction box. Multipair, shielded control cable, as recommended or provided with the equipment, interconnects with the CST control panel, located within a 200 foot radius.

HMI

An HMI is user friendly with the touch screen and function key. No special knowledge is required to understand or operate the HMI terminal. The HMI is programmed with a number of graphic screens. From the MAIN MENU screen (Figure 4) by simply touching any of the keys on the screen will take you to that particular screen.

Figure 4: MAIN MENU screen [Logo Screen]

If any screen other than the MAIN MENU screen is active then F10 will activate the MAIN MENU screen. Touch screen button "NEXT"; touch screen button "PREVIOUS"

Salient features of some of the screens are discussed below.

Screens displayed below may not be exactly the same for your application. Refer to the graphics supplied with your Baldor•Dodge CST system for the application specific human-machine interface.

CONTROL SELECTION SCREEN

Before starting the main drive motors, make appropriate selections from the control selection screen. The selections are possible only when the conveyor is stopped (State-0). With reference to sample screens, the various key selections are discussed as following:

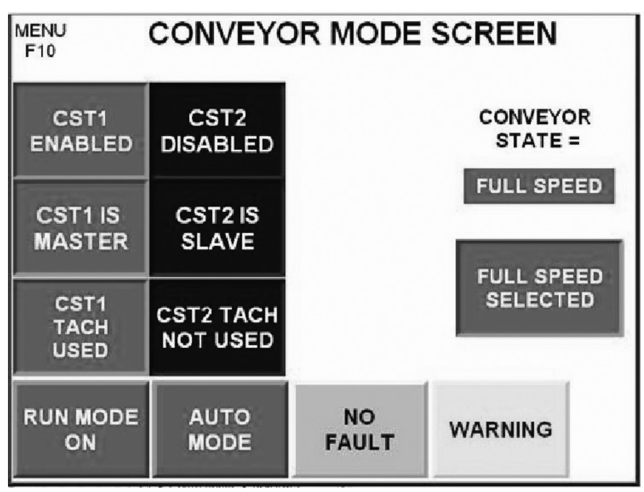
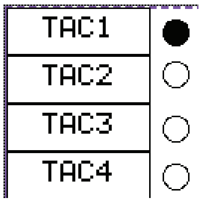
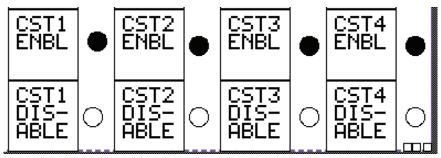


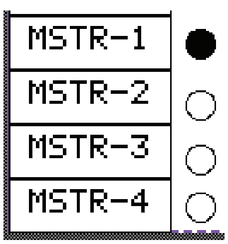
Figure 5: Conveyor Control Selection Screen



O/p TAC Speed selection: For start acceleration and full speed control, the system monitors output shaft speed of the Master CST drive. However, if the speed sensor of drive-1 (Master) develops a fault, this key offers selection to re-start the belt on the TAC speed signal of either drive-2 (Slave-1) or drive-3 (Slave-2) or drive-4 (Slave-3). This choice is to avoid production loss and attend to the speed fault problem during a major planned shutdown.



Drive Enable/ Disable: This key offers the selection of the number of drives to be started prior to issuing the RUN signal. For example, in a four drive application, if one of the slave drives is under maintenance shutdown, the conveyor can still be run by enabling the other drives and load to the conveying capacity of these drives.



Master/Slave selection: In most of the applications, the Master / Slave configuration is pre-determined and automatically handled by the PLC program. However, in some applications, typically for three or four drives at one drive station, selection of Master/Slave is provided. For example, with two drives on the same shaft, either of them can be selected as the Master.

The selection key gives user choice to either bring the cooling pump operation under automatic temperature control, as explained above, or disable it. When disabled, the cooling pump will operate only when the CST drive is operational.

NOTE: Alarm and Malfunction//Trip screens are discussed in the Troubleshooting section.

OVERVIEW SCREENS

There are two Overview screens.

- Drive System Status screen displays operational start/stop and drive selection status
- Analog Values screen displays all analog process parameters

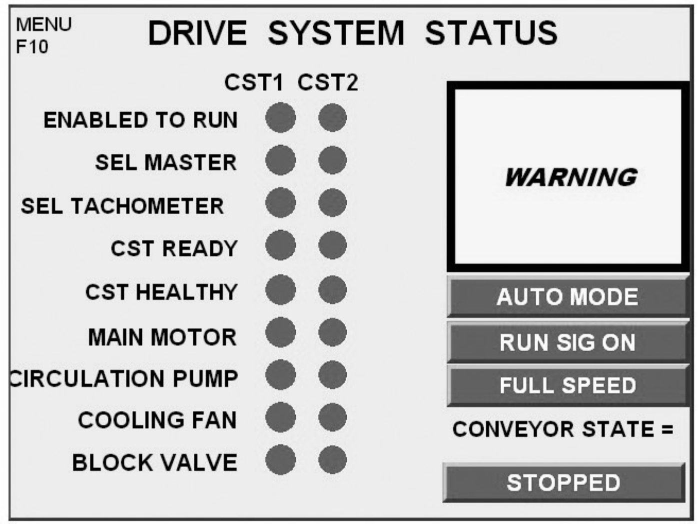


Figure 7: Drive System Status

Healthy or Run status of the conveyor belt or any equipment such as a pump or a fan is depicted by the lamp indicator turning dark when the equipment turns ON.

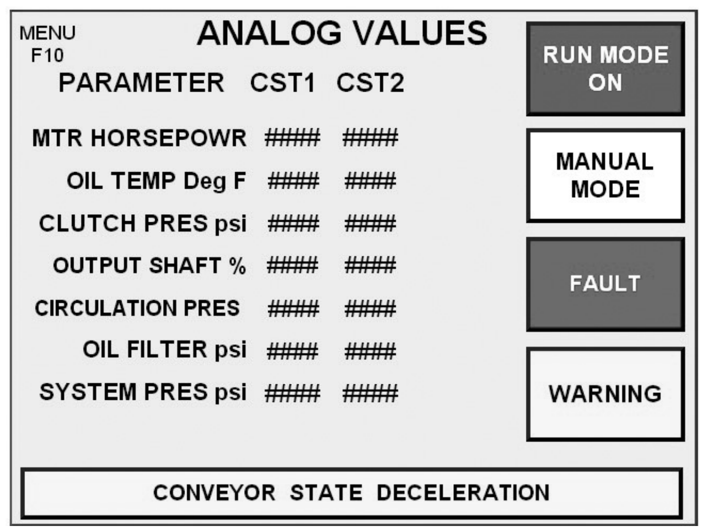


Figure 8: Analog Values

The Fault Reset button clears all faults and DRIVE HEALTHY and READY FOR START lamp turns on. The FAULT RESET HMI is available on the MAIN MENU screen [Press F10].

CONTROLS INSTALLATION

CAUTION: The following are general recommendations for wiring the CST PLC control system.

- **Locate the CST control panel within a 200 foot radius of the drive station.**
- **Route incoming power to the controller by a path separate from the device wiring. Where paths must cross, their intersection should be perpendicular.**
- **Do not run signal or communications wiring and power wiring in the same conduit. Separate paths should route wires with different signal characteristics.**
- **All shield wires should be tied to the copper ground bar provided inside the controller panel. Do not ground the shield wire in the field at the measuring side.**

- **Separate wiring by signal type. Bundle wiring with similar electrical characteristics together.**
- **Separate input wiring from output wiring.**
- **Label wiring to all devices in the system. Use tape, shrink tubing, or other dependable means for labeling purposes.**
- **Be careful when stripping wires. Wire fragments that fall into the controller panel can cause damage.**

WARNING: For recommendations concerning installation safety requirements and safety requirements and safety related work practices, refer to specific regional requirements.

- **Europe: Reference the standards found in EN60204 and your national regulations.**
- **United States: refer to NFPA 70E, Electrical Safety Requirements for Employee Workplaces.**

Customer Wiring

Refer to the drawing list supplied with the CST system for interconnect cable kit and schematics that apply to a specific application.

All 3-phase power cabling between the CST cooling pump(s), heat exchanger fan(s) and CST sump heater are to be furnished, laid and terminated by the end user.

WARNING: It is the responsibility of the customer to provide the necessary emergency stops and warning signals. E-Stop buttons provided by Baldor must be hardwired directly into the emergency stop circuitry. Check the operation of these safety devices before starting the conveyor and when making any changes to the program.

The following points should be noted while planning cable selection, laying and termination.

- All discrete control cables for input/output signals are to have stranded conductor, gauge 16-18 AWG, tinned copper, PVC insulated, twisted pairs, PVC jacket suitable for 300 V, 80°C.
- All analog signal cables are to be 18-22 AWG, stranded conductors, tinned copper, polyethylene insulated, twisted pairs. Each pair should be individually shielded with aluminum-polyester shield and 20 AWG stranded tinned copper drain wire.
- Overall chrome PVC jacket, rated 30 V 80°C.
- Entry of control/signal cables to the controller enclosure should be from the bottom plate. Detach plate before drilling holes for bushings to avoid ingress of metal powder in the controller.
- All inputs from customer control system to be individually isolated.
- Control supply to the control panel is recommended to provide power from a UPS (Uninterruptible Power Supply).
- If there is high frequency conducted noise in or around your distribution equipment, we recommend the use of an isolation transformer in the AC line to the power supply. This type of transformer provides isolation from your power distribution system and is often used as a "step down" transformer to reduce line voltage. Any transformer used with the CST controller must have a sufficient power rating for its load. Each CST controller should be regarded as 300 VA load.
- If there are excessive line voltage variations, the best solution is to correct any feeder problems in the distribution system. Where this does not solve the line variation problem, or in certain critical application, use a constant voltage transformer to power up the CST controller.
- When the CST controller is operated in a "noise polluted" industrial environment, special consideration should be given to possible electrical interference. The following reduces the effect of electrical interference:
  - proper equipment grounding
  - proper routing of wiring
  - proper suppression added to noise generating devices
- Potential noise generators include inductive loads, such as relays, solenoids, and motor starters when operated by "hard contacts" like push buttons or selector switches. Suppression may be necessary when such loads are connected as output devices or when connected to the same supply line that powers the controller. Lack of surge suppression on inductive loads may contribute to processor faults and sporadic operation.
- Use of a suppression device on outputs used to control inductive devices is recommended such as:
  - relays
  - motor starters
  - solenoids
- Switching inductive loads without surge suppression can significantly reduce the lifetime of relay contacts. Suitable surge suppression methods for inductive AC load devices include a varistor, a RC network, or a surge suppressor. These components must be appropriately rated to suppress the switching transient characteristic of the particular inductive device. The suppression device should be located as close as possible to the load device.

Grounding: Grounding helps limit the effects of electrical noise due to electromagnetic interference (EMI). The equipment grounding copper bar/lug provides the ground path for the CST enclosure. 10-1 4AWG ground conductor wire should be used and terminate on the ground lug.

Shielding: All the CST instrument analog signal cables to and from the CST should be shielded at one end only. It is recommended that the shield should be terminated on the copper bar provided inside the CST controller enclosure. The other end, towards the field transducer, should be taped/insulated and not connected to any ground.

CAUTION: The CST enclosure and other control devices must be grounded properly. All applicable codes and ordinances must be observed when wiring the control system.

CAUTION: The belt piece should be thick and bent to produce sufficient "coil spring" action. If the belt support is "rigid", then this can cause failure in the bearings of the encoder shaft and also transmit erratic signals to the controller.

CAUTION: The shielded cable must be grounded properly inside the CST controller. DO NOT GROUND THE SHIELD INSIDE THE JUNCTION BOX. All National Electric Code and applicable local codes and ordinances must be observed when wiring the system.

Output shaft speed sensor

An electromagnetic sensor, mounted on the "TAC Wheel" cover measures the output shaft speed of the CST. The speed probe is adjusted for the air-gap between the tooth wheel and the sensor tip; however, it is likely that during installation and/or during commissioning, the adjusted gap will be disturbed. If the speed signal is lost, the following corrective action may be taken:

1. Loosen the lock-nut and turn the speed probe clockwise until it touches the tach wheel.
2. Turn the probe counter clockwise by one-quarter or one-half a turn. Tighten the lock-nut. One complete turn moves the probe roughly by 0.050” axially.
3. Connect a voltmeter across the white & black wire and give +5Vdc across red & black. When the probe touches the tooth, the voltage reading will be 0. When loosened by one quarter turn, the reading will be approximately 4.9 VDC. If the probe is turned three quarters of a turn, the voltmeter reading will again drop to 0. Move the probe such that it is somewhere in between one-quarter and three-quarters of a turn and the reading remains at 4.9 VDC. Tighten the lock nut.

The air gap should range between 0.005" and 0.025". In the factory, the air gap is maintained at approximately 0.015".

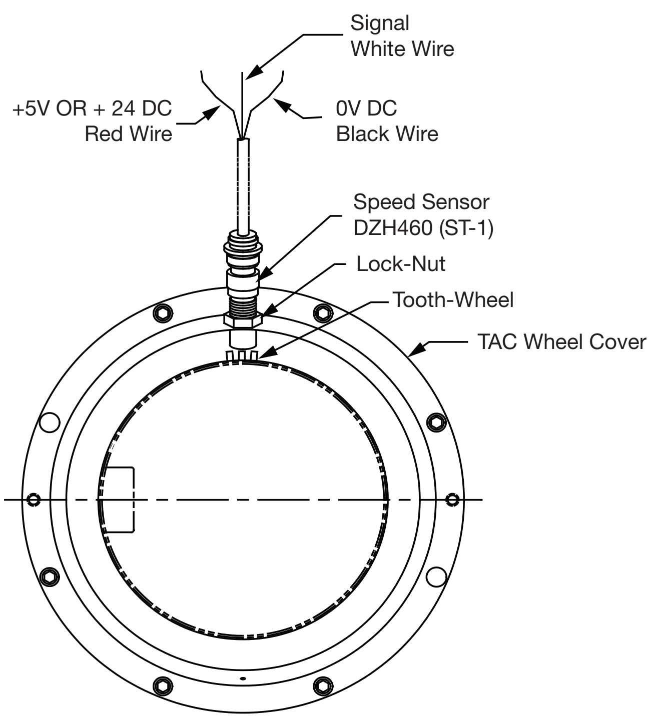


Figure 9: O/P shaft speed sensor with cover

A dead band occurs for air gap distance within 0.026”-0.035” when the signal is lost. The signal reappears within an air gap of 0.036-0.055”. In excess of 0.056”, the signal is lost completely.

NOTE: It is recommended that the air gap be maintained close to .015".

Cooling system

NOTE: Piping connections, pipe, and weld areas should be cleaned before assembly or connections with cooling system. Weld areas must also be cleaned to remove weld spatter or slag after welding is complete.

Install the cooling pump, heat exchanger, interconnecting piping and basket strainer as indicated on the supplied drawings and as explained in the mechanical system installation manual. If the Cooling Pressure Transducer PT-3 and the Cooling Pressure Indicator PI-3 are shipped separately from the CST, install the assembly of PT-3 and PI-3 as shown on the drawings. Verify that all hose, fitting, piping and flanged connections are tight to prevent hydraulic fluid leaks.
Fasten the electrical connections to the heat exchanger fan motor. Secure the electrical connections to the cooling pump motor. Fasten the electrical connections between PT-3 and the controller. The wiring in the conduit is mounted on the CST with Mini-Din connectors for PT-3 already installed on the wiring.

Place the strainer in a position where the drain plug can be easily removed. Provide over 12 inches of space above the strainer to allow for basket removal. The Lid-Ease strainer has cast arrow marks on the body to indicate the direction that the fluid must flow.

In case of a 4” flange style strainer, external support of the strainer may be required to reduce pipe strain in the system. This can be accomplished either by supporting the flanges or by providing a base for the bottom of the strainer. Ensure that the top of the strainer is not more than 3 feet off the ground to allow for lid removal and maintenance. In the event that the strainer is not at the highest point in system, the use of valves are recommended on both sides of strainer to prevent strainer from filling up while cleaning the basket.

Hydraulic control system

If the hydraulic control panel was shipped assembled to the CST, the control system hosing and fittings are already installed. Tighten all hose, fitting, piping and flanged connections to verify that they did not become loose during CST shipping and installation.

CAUTION: Do not over-tighten fittings. Over tightening fittings can cause them to break or strip. Cast Iron piping/ hose fitting connections is the most susceptible to damage due to over tightening.

START-UP INSTRUCTIONS

CAUTION: The entire installation, including all connections to and from the support equipment must be complete, and the CST system must be filled with the recommended hydraulic oil, before testing a CST or CST drive motor.

CAUTION: Do not allow dirt, shop rags, tools, or other debris to enter any of the hydraulic systems components, hosing, piping or gearbox.

All Baldor•Dodge CST units are test-run at the factory. During initial startup, after installation in the field, the following procedures will promote safe operation of a CST.

- Check the direction of rotation of all components before final connection of the driven equipment.
- Check the couplings that connect the drive motor to the CST for proper alignment. If required, check that the couplings are filled with the correct grade of grease as recommended by the coupling manufacturer. Check that the fasteners are rechecked for tightening to the correct torque values.
- Check that the drive motor bearings have been filled with the correct grade of grease as recommended by the drive motor manufacturer.
- Check all mounting bolts, nuts and screws to be sure they are tight.
- Ensure that the gear-case breather plug has been removed and the breather, access covers and coupling guards are in place and secured.

WARNING: It is the customer's responsibility to provide the necessary emergency stops and warning signals. Check the operation of these safety devices before starting the conveyor and when making any changes to the program.

WARNING: Follow lock out tag out procedures before performing any maintenance on the conveyor or CST system.

WARNING: Ensure hydraulic systems are de-energized and relieve hydraulic pressure before performing maintenance on the conveyor or CST system.

WARNING: Do not operate the unit with caps, covers or guards missing.

- If so equipped, a heater should be used to take the chill off the unit prior to start-up in extremely cold weather. A sump heater control is often integrated into the electronic control system.
- Check the clutch pressure gauge PI-1 to ensure that no pressure is on the CST clutch stack piston.
- Check all electrical connections to ensure that they are properly made and well insulated.
- If the conveyor has a backstop, check that the direction of rotation of the backstop and the CST output shaft is the same.

Lubrication

Normal operating conditions require that the CST be filled to the level indicated at the sight gauge. Use Mobil fluid 424 to fill the sump. External oil lines, a cooling pump, control lines and a heat exchanger will also require additional quantities of fluid.

The fluid capacity for the Baldor•Dodge CST is stamped on the nameplate attached to the CST. This capacity is for the CST alone and does not include the external oil lines, cooling pump, control lines and heat exchanger.

Refer to the mechanical systems installation manual for more details.

Filter (10μ)

Refer to the mechanical systems installation manual for further information.

The CST is shipped with a filter mounted on the filter head. In addition, spare filters are shipped attached to the unit. For start-up additional supplies of filters should be in place. Some units require additional filtering during start-up due to contamination or debris that entered the system during installation.

Refer to the drawings for the manufacturer and model number of the filters supplied with your CST unit.

Basket strainer

The CST is shipped with size 40-mesh basket strainer(s), either mounted or packed separately.

Before system start up, make sure that all valves are open that were shut for servicing. After starting the system, check for any leaks. If there is any leakage around the lid, remove it and refer to the Trouble Shooting section of the "Technical Service Manual on Basket-Type Line Strainers".

With the cooling pump running and with the oil circulating, loosen the cooling flow transducer PT-3 slightly to bleed a little bit of oil. This will help flush out trapped air. Tighten the transducer. Check for any leaks around the gauge and transducer fittings.

CST Control Panel

The CST control system is tested at the factory for all the health/monitoring and interlock signals related to the CST drive. The application program on the PLC and the HMI will be loaded at the installation site. At the site, customer interface cabling and wiring is to be carried out as per interconnect drawings. The following procedures should be observed to promote safe and smooth startup of the CST.

NOTE: A CST controls engineer will be onsite to perform steps 5 through 7, if this arrangement was specified in the purchase agreement. Steps 1 - 4 should be completed prior to the arrival of the controls engineer to avoid delays in the start up.

NOTE: Do not attempt system start-up until you are thoroughly familiar with the controller components and programming/editing techniques. You must also be thoroughly familiar with your plant control application.

1. Inspect installation:
   The onset of serious problems can be prevented by making a thorough physical inspection prior to installation. It is recommend that the following be completed:
   a. Make sure that the PLC control panel and all other devices in the system are securely mounted.
   b. Make certain that all wiring connections are correct and that there is no missing wires. Check the tightness of all terminals to make certain wires is secure. Make sure that all shield control cables are grounded inside the controller on the copper ground bar.
   c. Measure the incoming line voltage. Be certain that it corresponds to controller requirements and that it falls within the specified voltage range. [Within the United States of America, the control supply to the controller is generally 115 VAC, 60 Hz whereas in East- Asian countries, the control supply is 230 VAC, 50 Hz]. On the PLC controller power supply module, a jumper is provided to select for either 115 VAC or 230 VAC. Make sure the jumper is placed correctly as per your available control supply.
   d. Make certain that there are no unwanted jumpers across the terminals.
2. Disconnect belt drive pulley:
   Before powering the CST control panel, as a safety precaution, you must make certain that the conveyor output coupling is disconnected. The main motor will have to be started to build the hydraulic control pressure.
3. Test/check the CST control panel:
   a. Do not start the main motor. Simply apply control power (115 VAC 50/60 Hz, 1-phase as applicable) to the CST control panel. The HMI should display the OVERVIEW screen and all LEDs on the PLC modules should indicate healthy status.
   b. Ensure the program select key on the PLC-CPU module is in RUN state.
   c. Check following discrete input signals on Controller/HMI screen:
      1. Conveyor Start/stop input
      2. Conveyor CREEP select/de-select
      3. Emergency stop
      4. Motor ON
      5. Brake released

d. In MANUAL Mode (your Control Panel maybe either designed with selector switch or a separate screen on the HMI screen), check the operation of Cooling Pump, Cooling Fan and Sump Oil Heater (if applicable). When the cooling pump is running, observe cooling oil flow pressure and the oil temperature values on HMI screen.
e. If all analog transducers are connected correctly and functionally intact, then OVERVIEW screen will display 0 value.

4. Test/check belt encoder:
Belt encoder, an optional item if installed, should be installed as indicated on the Dodge standard installation drawing. It is recommended that prior to moving the belt, the functionality of the belt encoder should be checked. The following steps recommended:
a. De-couple the belt encoder from the stud shaft of the pulley.
b. Make note of the correct direction of rotation of the encoder shaft with respect to the pulley.
c. Rotate the encoder shaft by hand. If you don't see positive display on the Overview screen then check the cable connection, swap the A and AA or BBB signal cable. You should be equipped with a standard Frequency calibration tool set to observe the incoming pulses on the terminals. Also, check the calibration of the frequency/current converter provided in the hydraulic junction box.
d. Mount the encoder on the pulley stud-shaft. Make sure the coupling is tight; the encoder is mounted correctly as per instructions.

5. No-load spin test:
Do not couple the belt pulley; start the main motor. Observe the following:
a. As the output shaft of the CST is not coupled, when the motor is started, the shaft will spin. The HMI screen should display the following data:
1. Output rpm.
2. Motor kW (No-load)
3. Oil temperature
4. Oil lubrication flow pressure
5. Mechanical cooling pump flow pressure (applicable for certain sizes)
b. Start the cooling pump in MANUAL mode and observe the cooling oil flow pressure on the HMI screen.
c. Apply pressure on the clutch stack in MANUAL mode (this feature either made available on the HMI screen or you have to log in the PLC programmer and force the output) and observe the clutch pressure value on the HMI screen.
d. From your programming panel, force OFF the "Motor trip" output to ensure that the main motor "interlock" does trip the motor. Repeat motor trip test by simulating followings:
1. Emergency stop
2. Lubrication failure
3. Oil temperature HI HI

6. No-load belt runs test:
After satisfying that CST controller is performing well, stop the main motor and couple the belt pulley to the output shaft of the CST. Now perform no-load belt run for each CST drive individually. Following steps recommended:
a. Start the main motor of one CST only and simulate RUN signal from remote.
b. Observe the clutch pressure rise on the trend curve. Run the belt for some time. Observe the following parameters:
1. Belt encoder speed
2. Output shaft speed
3. Motor kW
4. Clutch pressure
5. Cooling and Lubrication flow pressures
6. Oil temperature rise
7. Brake control
8. Tune the Pressure PID and SPEED PID to get best trend curves.
c. Similarly, start the motor of the second CST only and observe belt performance using RSTREND. Tune Pressure PID.
d. After successfully running the belt from each CST drive and observing the parameters for a few hours, stop the motor. Start the motors in a staggered sequence interval of at least 10 seconds. When all the motors are on, give belt START signal.
e. Attend to the tuning parameters of PIDs from time to time on each control loop to allow the system to run in MASTER/SLAVE load share configuration.
f. Check operation of drives for following modes:
- Master drive clutch slip at 2%
- Master drive clutch "locked"
g. Simulate system trips for the followings:
1. Emergency stop
2. Normal stop
3. Lubrication or Cooling oil failure
4. Network communication failure
5. Temperature High
6. Motor Overload
7. Speed failure

7. Loaded belt run test:
After successfully running the belt on no load with all the drives in Master/Slave load share configuration for several hours, perform load runs with actual material. Perform load runs for 25%, 50%, 75% and 100% load. Tune the PIDs to achieve good "load share" control.

Make trend curves using RSTREND for all important parameters, as depicted in Figures 10a-c. Record the PID Gain/Integral/Derivative settings for each loop on separate trend views.

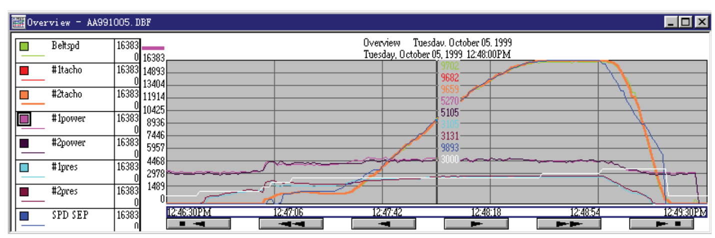


Figure 10a: Start/Stop profile of 2 x 280KRS CST drives

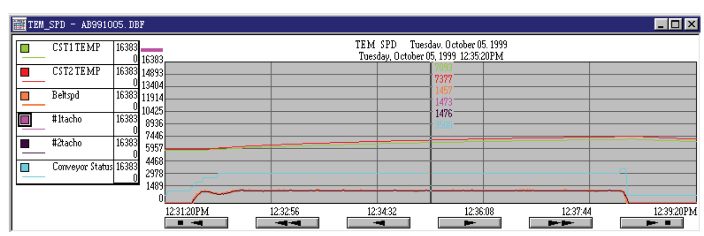


Figure 10b: Creep speed control at 10% set point

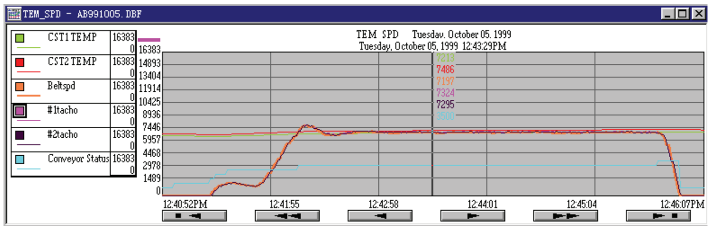


Figure 10c: Creep speed control at 50% set point

CST CONTROL PANEL MAINTENANCE

The PLC modules must be protected from dirt, oil, moisture and other airborne contaminants. To protect these boards, the enclosure should be kept clean and the door should always be kept closed. The enclosure door gasket or liner should be checked and all the clamps around the door should be fully tightened to ensure no ingress of water or dust.

Regularly inspect your terminal connections for tightness. Loose connections may cause improper functioning of the controller or damage the components of the system.

WARNING: To ensure personal safety and to guard against damaging equipment, inspect connections with power turned off.

The National Fire Protection Association (NFPA) provides recommendations for electrical equipment maintenance. Refer to article 70B of the NFPA for general requirements regarding safety related work practices.

It is recommended to keep in spare one set of the following boards:

- CPU
- I/O, one of each type
- Lamps, fuses and other similar items

NOTE: Refer to the user manuals for the PLC and HMI units for proper care and maintenance. Do not remove the CPU or any I/O module from the chassis until all power to the unit is shut down.

CAUTION: Do not expose the processor to surfaces or other areas that may typically hold an electrostatic charge. Electrostatic charges can alter or destroy memory.

TROUBLESHOOTING FAULTS

Introduction

Two levels of alarms have been defined for the drive control system:

Alarms
Shut Downs

Different actions are taken depending on the level of the alarm and the type of drive.

The red lamp provided above the HMI, on the front door of the CST control panel, turns ON to give a visual alert that an alarm is active.

CAUTION: Do not rely on the HMI terminal as a primary warning device in applications that could result in physical injury, product damage, or significant process down time. PLC discrete output assigned as CST FAULT/TRIP (See the application interconnect diagram) should be hard-wired and/or mechanical interlocked with main plant system. All other belt conveyor safety and pull cord switches should be hardwired directly to the main plant trip system.

Alarms

Alarms are non-critical faults that do not require a conveyor shutdown. When an alarm is detected, it is entered into the alarm log and the corresponding LAMP is turned on (steady) on the HMI screen. The CST ALARM output hardwired (by the user) to end user plant operating system is turned high (contact close on alarm condition).

Shut Downs

Shut downs require a manual reset to be cleared. This can be done from the HMI soft touch screen.

The RED LAMP on the front of the CST enclosure turns on and remains steady until the shut down is cleared.

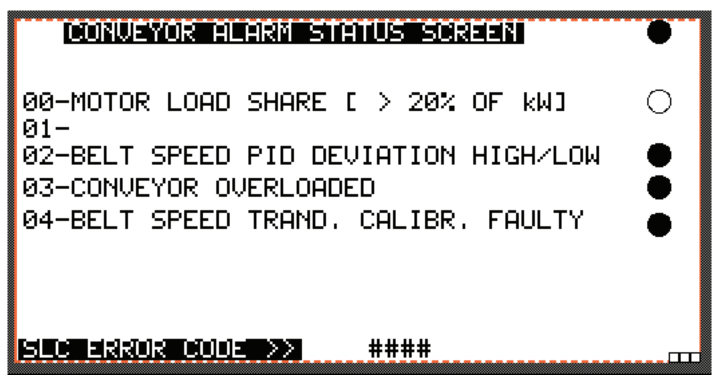
Shut downs are critical faults requiring a shutdown of the conveyor and trip the main motors using the emergency stop sequence.

Emergency malfunctions require the motor to be turned off. The Motor permissive discrete output of the PLC is turned off. Also, the Blocking Valve on/off output wired to the CST hydraulics is turned off.

The blocking valve is normally turned back on when reaching the stopped state to drain the clutch and re-enable the motor.

The valve is turned on again as soon as the motor stops.

CONVEYOR ALARM



This screen displays alarms related to the conveyor belt.

Motor Load share alarm: During ACCELERATION of the belt, the kW scaled process variable is less than kW setpoint OR during full speed operation, this value is less than the lower limit of kW PID setpoint (90% of Master kW) for 15s then an Alarm bit is set high.

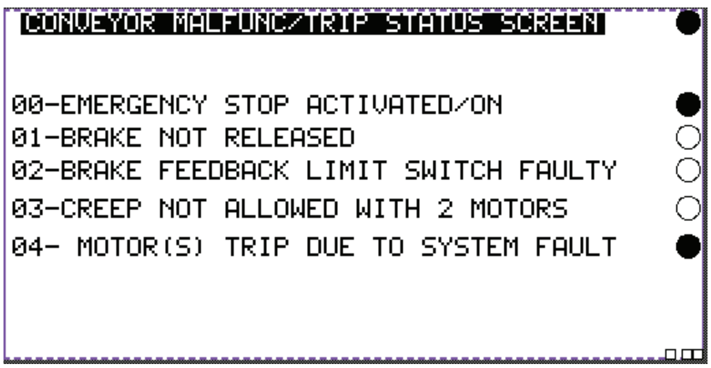
Belt speed PID loop deviation High/Low: Speed setpoint upper deviation limit is set at 110% of SP and lower deviation limit is set at 90%. During breakaway, acceleration, and full speed run of the belt, the Speed process variable value is compared with the two limits. If the PV cross any of the limits for 100ms, then an Alarm bit is set high.

Conveyor Overloaded: During ACCELERATION of the belt, when scaled process variable value (belt speed) is less than the setpoint value (Set speed) for 15s OR during full speed operation when the scaled PV (belt speed) is less than the lower limit of SPEED PID setpoint (90% of SP) for over 15s then an Alarm bit is set high.

Belt speed transducer faulty: If the PLC system is equipped with FREQUENCY input module, then ignore this alarm. When the incoming analog signal 4-20 mA from the Frequency/current converter drops below 2mA or goes above 22 mA for 100 mS, the PLC latches this as transducer faulty. Check the calibration of the F/I converter or the installation of the output shaft speed sensor.

CONVEYOR MALFUNCTION/TRIP STATUS SCREEN

This screen display malfunction and trip alarms related to conveyor.

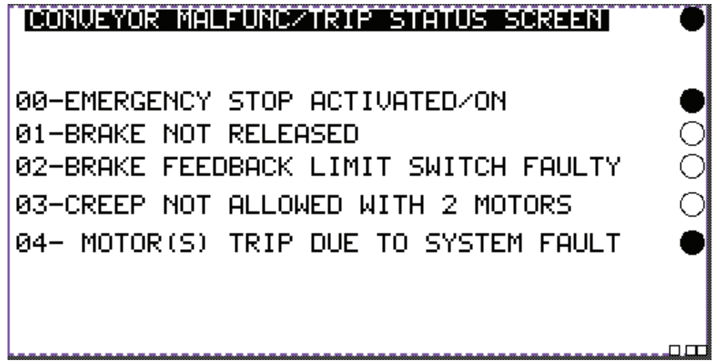


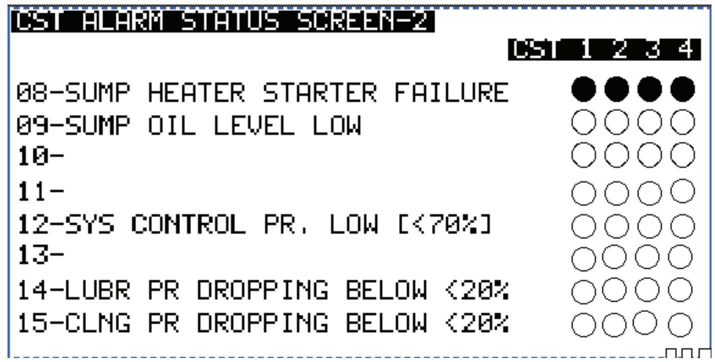
Emergency Stop activated: The E/stop button, when activated from remote or on the CST control panel, causes the main drive motor to trip. The PLC generates a trip output signal which is hardwired to the motor control main starter to trip the motor. The E/stop input is failsafe, a maintained close contact input to the PLC system when not activated. Even a momentary loose connection will cause the motor to trip. To reset, twist and pull out the red button to reset, then press fault reset to restart the conveyor.

Brake not released: If the brake (digital) control is applicable, when the CST clutch is pre-charged (state-2), the PLC gives a signal (discrete output goes high; contact close) to release the brake. It should receive a feedback (input signal, contact to close from brake limit switch) within five seconds. If the feedback is not received, the PLC will latch this bit to the malfunction and the conveyor will not move. Check for brake hydraulic system and wire continuity. The feedback time should be adjusted in the PLC program during commissioning of the system.

Brake limit switch faulty: If the brake (digital) control is applicable, when the conveyor is moving (either in breakaway state, acceleration or full speed) and the brake feedback limit switch malfunctions for one second, the PLC will latch a loss of a signal as a fault. Check the wire continuity and connections of the rocker arm of the limit switch.

CST ALARM STATUS SCREEN:





Motors tripped due to system fault: Motor interlock permissive discrete output drops low (contact opens) when any of the following faults occurs:

- Oil temperature High High
- Lubrication oil flow failure
- Emergency stop activated
- Motors overloaded for the third time

These screens display alarms related to the number of drives in application. The conveyor belt is not stopped nor any motors tripped. The alarm is generated so that corrective action can be planned in the next conveyor shutdown.

Cooling/Lubrication/Clutch/Oil Temperature transducer out of calibration: The PLC system monitors calibrated range of the transducer towards 4-20 mADC. If the incoming analog signal drops below 2 mA for 500 msec, the system latches this bit as an alarm fault. The calibration of the transducer should be checked or both ends of the wire connection should also be checked.

Motor power transducer out of calibration: The PLC system monitors the calibrated range of the transducer towards 4-20 mADC. If the incoming analog signal drops below 2 msec for 500 msec, the system will latch this bit as an alarm fault. The calibration of the transducer should be checked or both ends of the wire connection should be checked.

Pressure PID deviation low/high: Each CST has a pressure PID loop in the PLC program to control the clutch pressure. The setpoint upper deviation limit is set at 110% of SP and the lower deviation limit is set at 90%. During the normal run of the belt, the CST1 and/or CST2 process variable value is compared with the two limits. If the PV cross any of the limits for 100 msec, then an Alarm bit is set high.

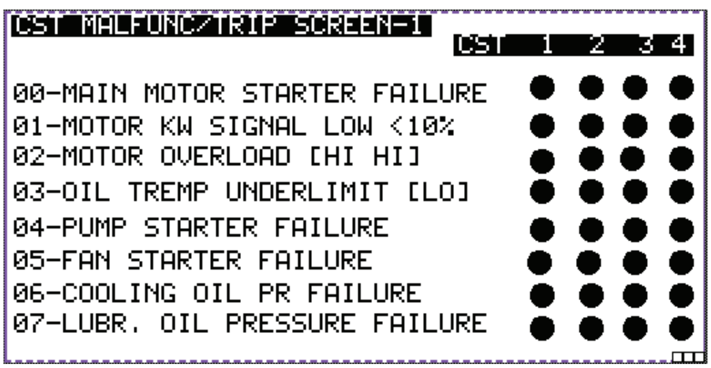
The above alarms appear and reset by themselves when the deviations clear. The belt is not tripped.

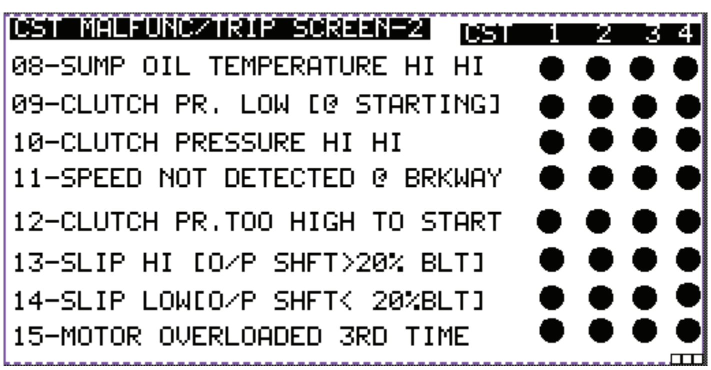
Motor overloaded: The maximum power value is set from the CST configuration screen. During BREAKWAY, ACCELERATION AND FULL SPEED run of the belt, when the actual motor kW exceeds 100% of this set limit, then alarm bit (N11:26/7 for CST1) is set high. This bit is latched. The HMI displays the message, “CST1 Motor overload ALARM” or “CST2 Motor overload alarm”. The Fault reset button must be pressed to clear this alarm. The conveyor will continue to run.

Heater starter failure: The PLC system monitors the feedback signal of the starter. The Heater cycles ON/OFF with the oil temperature. If the feedback is not received for 500 msec when the PLC indicates the Heater ON command. The starter should be checked.

NOTE: This alarm is applicable only if your system is equipped with a CST sump oil heater and on/off starter.

CST MALFUNCTION/TRIP SCREEN:





Any faults latched on this screen will cause the conveyor belt to stop. The main motor is tripped on the following conditions:

- Lubrication oil failure
- Sump oil temperature high high
- Motor overloaded for the third time.

Motor starter failure: The PLC system monitors the auxiliary contact feedback of the main motor starter. When RUN command is given, the main motor feedback should be available (input high) otherwise, this bit is latched and the conveyor will not start. During normal operation of the belt, if this feedback input is lost for 500 msec, the conveyor belt is stopped. Motor kW power signal low: The motor minimum kW limit is set from the HMI screen (generally between 5-20%). During a no-load run of the motor, the PLC system continuously monitors the incoming analog signal from the kW transducer. If this signals drops below the set limit for 100 msec, when the conveyor is enabled to run, the bit is latched to stop the belt.

Main motor overloaded: The overload upper limit is set from the panel view configuration screen. During full load operation, if any of the drive motors are overloaded for five seconds, this bit is latched to stop the conveyor. Overloading the belt should be avoided and the cause of the overload should be investigated.

Sump oil temperature underlimit: The under temperature limit is set from the panel view configuration screen. During normal operation, if the oil temperature of the CST drops below this set limit, this bit is latched to stop the conveyor. The heater should be checked. Oil should be kept warm, above 45°F, prior to the belt start.

Pump/Fan starter failure: The PLC system monitors auxiliary contact feedback of the pump and starter. Whenever the system gives discrete output to start the pump or fan, the feedback should be available (input high) within 500 msec otherwise, this bit is latched and the conveyor will not start.

The main motor is tripped when lubrication oil pressure drops below 10 psi. The oil filters should be checked. Refer to the hydraulics section to determine the probable cause of failure.

Sump Oil temperature HIHI: Oil temperature is continuously monitored by the PLC system. The high high trip limit is set from the HMI screen. If the temperature exceeds this limit for 500 msec, this bit is latched to stop the conveyor and trip the main drive motor. The system can be restarted when the oil cools down below 165°F. The oil level should be checked as well as the heat exchanger performance and RTD calibration.

Clutch pressure low: The clutch under pressure limit is set on the panel view screen. Before starting the belt, the clutch pressure should be almost zero or below the set limit, approximately 10psi. When the RUN command is chosen, the system begins building pressure on the clutch to pre-charge it. If, the pressure fails to build pressure over 10 psi within 15 seconds, this bit is latched and the conveyor start fails. The cause should be investigated. The lubrication oil filter could be clogged, the proportional valve may be sticky or the coil may be burned. There could be other probable causes of failure in the hydraulic circuit. For better understanding, refer to the section on hydraulics.

Clutch pressure high high: The clutch under pressure limit is set on the panel view screen. When the drive is enabled and if the clutch pressure exceeds the upper limit for one second duration, this bit is latched to stop the conveyor. The cause should be investigated. The proportional valve may stick or the amplifier may be out of calibration. The RV valve on the hydraulic manifold maybe malfunctioning. The system pressure should be checked with a pressure gauge. When the motor is running, the gauge should read 300 psi. Adjust the RV to maintain the system pressure at 300 psi. There may be other causes of failure in the hydraulic circuit. For better understanding, refer to the section on hydraulics.

Speed not detected during breakaway: After the clutch is pre-charged, the PLC system continues to apply pressure on the clutch to achieve breakaway. The belt is expected to start moving within 30 seconds. If the conveyor is equipped with a digital or analog brake control system, the time of 30 seconds for speed detection is adjusted, based upon the brake release time. If no speed is detected after pre-charge, within this specified time period, the bit is latched and conveyor motion is halted. The brake system should be checked as the proportional valve operation or any other obstacle which maybe holding the belt from moving. The speed loop should also be checked. The TAC- sensor may be damaged or there may be a lose wire connection. To correct this problem, from the HMI screen, select Other TAC sensor and re-start the conveyor.

Clutch pressure too high to start the conveyor: When the conveyor is stopped, all pressure on the clutch is released. The PLC system ensures that prior to the RUN signal, there should be no pressure on the clutch stack. The lower limit is set from the HMI Configuration screen. If there is pressure above the set limit, this bit is latched and conveyor will not start. The blocking valve should be checked, which should be reset by the PLC system to release locked pressure after the belt has stopped. Check to ensure that the blocking valve coil has been energized by placing a screw driver on the coil to detect the magnetic pull. If necessary, replace the burnt coil. Check the live zero calibration of the clutch pressure transducer.

CST slip high/low: The output shaft speed is continuously monitored and compared with the belt encoder speed signal. When the drive is enabled, and if the slip between the shaft the belt occurs at ± 20% of speed for five seconds, this bit is latched. The conveyor is stopped. The belt/pulley alignments and tension adjustment must be checked. Also, in wet conditions, if the belt is overloaded, it is likely to slip on the high tension pulley. Loading should be reduced to avoid slippage.

CST motor overloaded the third time: If the belt is started repeatedly under heavy load, when the overload alarm occurs for the third time, the PLC system trips the motor.

Though most of the fault alarm and trip status are monitored by the PLC and displayed on the HMI, some intermittent faults may occur. Refer to the CST Troubleshooting Tips for some of the more common faults.

CST Troubleshooting Tips

Probable fault	Corrective Action
CST alarm latched for "All transducers out of calibration". Unable to run the conveyor.	• 24Vdc supply has failed. Replace power supply. • All transducers (Clutch pressure, Lube & Cooling, temperature and speed) are 2-wire, 4-20mA dc loop, powered by the 24 VDC power unit. • Check the fuse on the dc power pack or the healthy status of the dc unit.
The kW signal fluctuates or drops to zero, causing conveyor to stop under load share alarm.	• Loose connection of power transducer due to vibration or improper shielding. • Check calibration of the kW transducer or healthy status of PT/CTs inside the MCC. • Input connector on the analog module could be loosened due to vibration and makes intermittent contact during operation. Tighten connector /terminals.
During load share, one of the slave drives begins to oscillate, causing undue stress and load imbalance on the belt.	• Controlled output on the clutch may be fluctuating due to Proportional Valve spool's sticky movement. Replace the PCV. • Blocking valve malfunction. Either coil burnt or supply wire loose. Replace coil or tighten connections. **NOTE: To check the healthy status of the BLV coil, simply bring a screwdriver close to the coil. If the coil is energized and healthy, magnetic pull will be noticeable on the screwdriver stem.**
The belt stops but no alarm registers. Or E/stop is registered but, the push button status is healthy.	• RUN (Start/Stop) signal should be steady ON. If the connection wire is loose, it may cause momentary make-break of signal. PLC scans the input signal in milliseconds to register as stop signal, causing belt to stop. Tighten the wire and check healthy status of RUN ON/OFF signal. • E/Stop wire may be loose, causing momentary make/break. Tighten wire or check push button contact status. Loose contact element, dust, or water could cause a bad contact.
During Start, CST fails to accelerate or maintain steady belt speed or there is no pressure on the clutch.	• Hydraulic circuit to be analyzed step by step. Check system pressure on pressure gauge when main motor is ON. If pressure is low, adjust the relief valve RV. Check filters. Refer to the section on hydraulics. • Check PCV. Amplifier may be out of calibration or defective. Replace or re-calibrate the amplifier. • Relief valve PRV-1 maybe leaking profusely. Replace valve. • 25-micron filter FLT-1 clogged. Replace element. • Oil could be dirty. Analyze oil sample and replace oil.

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