

GEAPS EXCHANGE '99 Educational Session

**What's New: Watchdog "Elite" from 4B Elevator Components Ltd.
Bucket Elevator Monitor for the 21st Century.**

A presentation by Johnny Wheat, Manager of Electronic Products.

INTRODUCTION:

Although one of the most efficient machines for moving grain and other bulk granular materials, the bucket elevator is also one of the most dangerous. The dust generated from the movement of grain within the elevator can be highly explosive, and mechanical failure or incorrect operation of the bucket elevator can have catastrophic consequences.

National and local regulations aimed at reducing the risk of grain dust explosions have specific requirements for monitoring potentially hazardous conditions on an inside bucket elevator (see OSHA 1910.272, NFPA 61 and specific state/local regulations). Belt speed, belt alignment, bearing temperature, plugged chute and head pulley alignment are the prime conditions to be monitored.

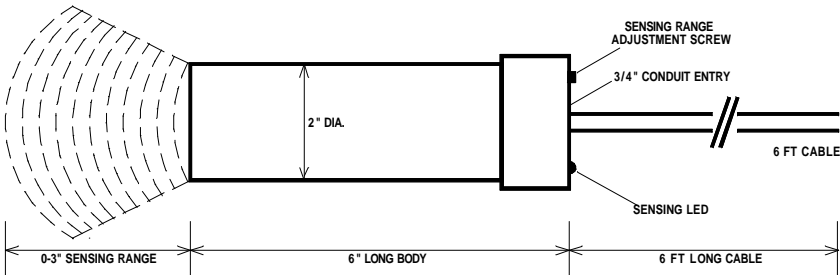
Over the years, many different system styles have been designed and implemented. All use either electronic, mechanical, or electro-mechanical transducers mounted on the bucket elevator. These transducers pass signals to a control device, which usually provides visual/audible warnings and automatic shutdown of the elevator when dangerous or improper operating conditions are identified. Designers attempt to engineer these systems to operate in fail-safe modes, which can assure correct operation of the monitoring system when a dangerous condition occurs.

The Watchdog "elite" bucket elevator monitoring system uses the latest solid state electronics and fail-safe design principles to ensure the most, accurate and reliable monitoring all the time.

DESIGN PHILOSOPHY:

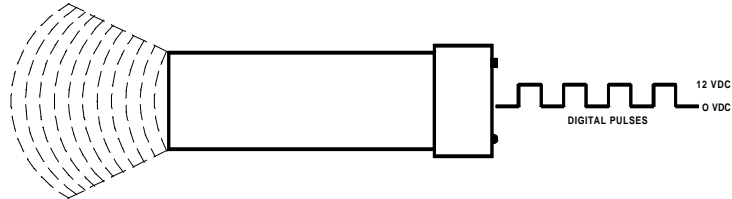
Belt speed and belt alignment monitoring utilizes extended range magnetic proximity sensors to detect either steel elevator bucket bolts or steel elevator buckets. These sensors have an adjustable sensing range of 0-3", and are not affected by any amount of dust or material build-up.

MOTION / ALIGNMENT SENSOR



BELT SPEED:

The sensors provide a single digital pulse for each target (bolt or bucket) passing through the sensing field. These digital pulse signals correspond to the speed of the elevator belt and are translated and averaged by the Watchdog control unit.

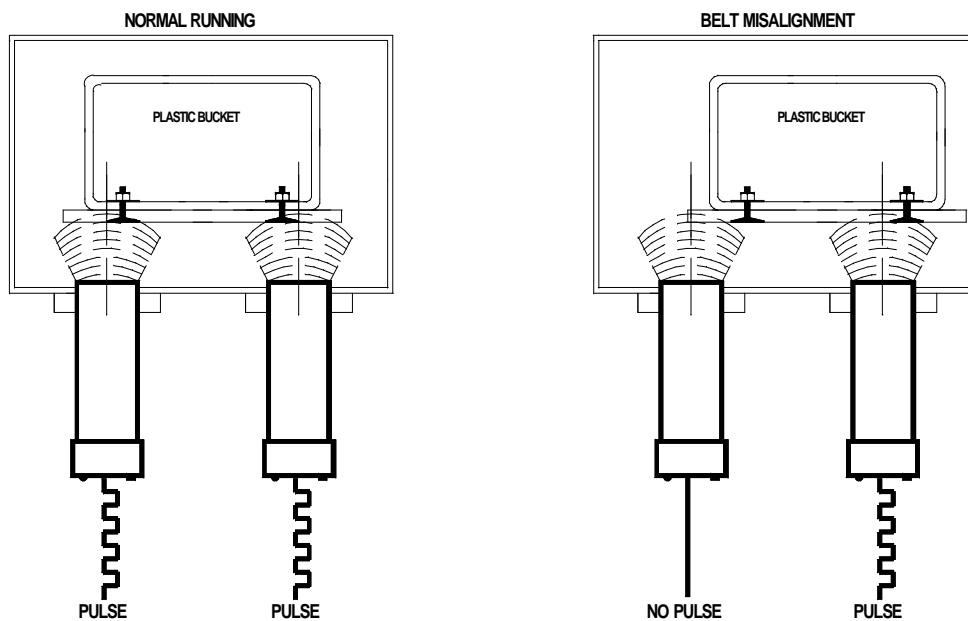


BELT ALIGNMENT:

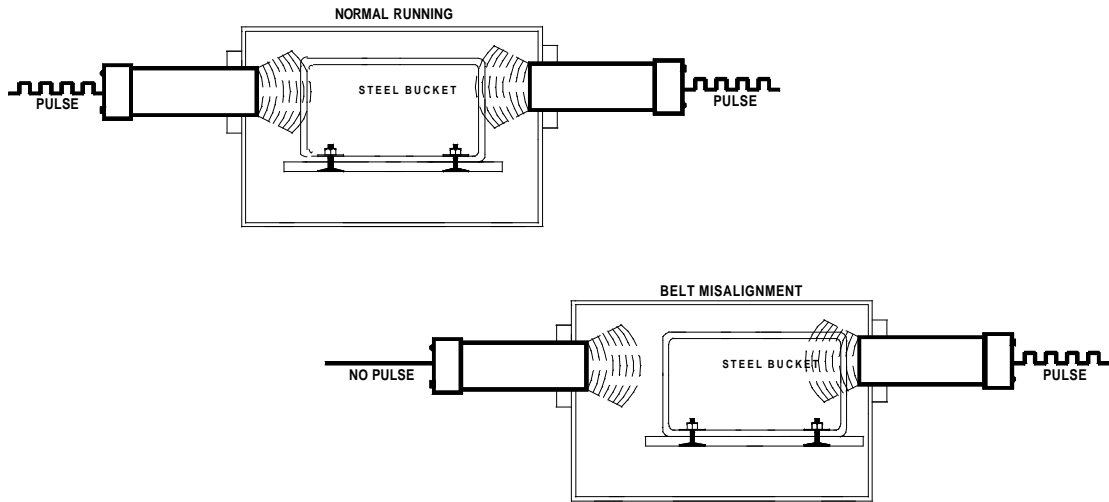
Two sensors are arranged so that during normal belt alignment both sensors detect the passing targets and during belt misalignment only one sensor detects the passing targets. This arrangement is simply achieved by installing the sensors on the outer edge of the steel bolt heads or on the sides of the steel buckets (see diagrams below). When the control unit is receiving two signals the belt is aligned correctly. When the control unit receives only one signal the belt is misaligned.

Normal belt “wander” is allowed for by adjustment of the sensing range and the position of the sensors from the targets during system installation and commissioning.

The benefits of using this type of non-contacting continual sensing system are two fold. Firstly, there is no contact with the components being monitored; therefore, no parts to wear out and no dangerous contact with the belt. Secondly, the system is actively processing signals during normal operation, ensuring fail-safe operation as no signal indicates an unsafe condition.



Typical plastic bucket arrangement

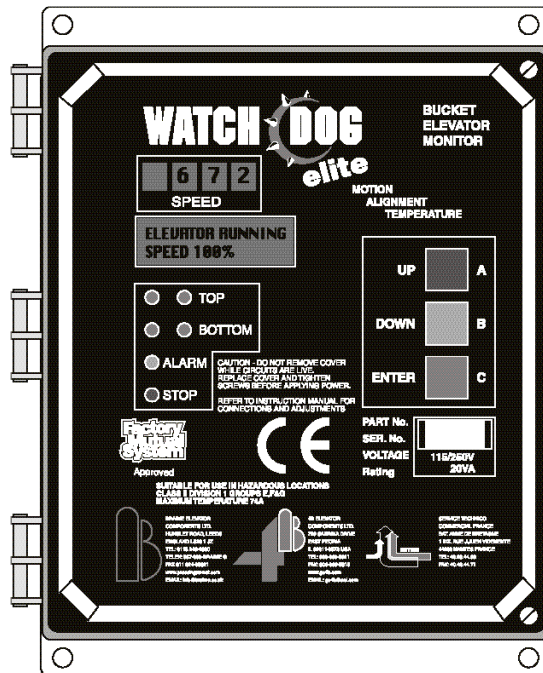


Typical steel bucket arrangement

CONTROL UNIT:

GENERAL:

Using the latest available technology, the Watchdog “elite” control unit processes the signals received from the speed and alignment sensors through dual PIC microprocessors. A menu system displayed on the Liquid Crystal Display (LCD) allows for easy parameter adjustments, which are accessed via a password and three panel mounted push buttons. Calibration and set-up parameters are retained in a non-volatile E²ROM memory chip.



DISPLAYS:

The bright light emitting diode (LED) display provides continuous indication of belt speed, and the LCD screen provides operators with clear and concise messages on the status of the monitoring system and the operation of the bucket elevator.

DISPLAY MESSAGES (examples)

000.0	437.4	650.0
ELEVATOR STOPPED READY TO RUN	START UP DELAY 15 SECONDS	ELEVATOR RUNNING SPEED 100 %
585.0	000.0	000.0
BELT SLIPPING SPEED 90 %	ELEVATOR STOPPED BELT SLIP 80 %	ELEVATOR STOPPED PLUG CONDITION
650.0	000.0	650.0
HOT BEARING ZONE 2 176 DEG. F	HEAD PULLEY MISALIGNED	CALIBRATED SPEED IS 650 FPM
000.0	000.0	000.0
TEST SET-UP CALIB. LANGUAGE	ENGLISH FRENCH SPANISH GERMAN	ENTER CALIBRATION CODE
000.0	650.0	650.0
START ELEVATOR TO CALIBRATE	TESTING ALARM RELAY	TESTING SHUTDOWN RELAY

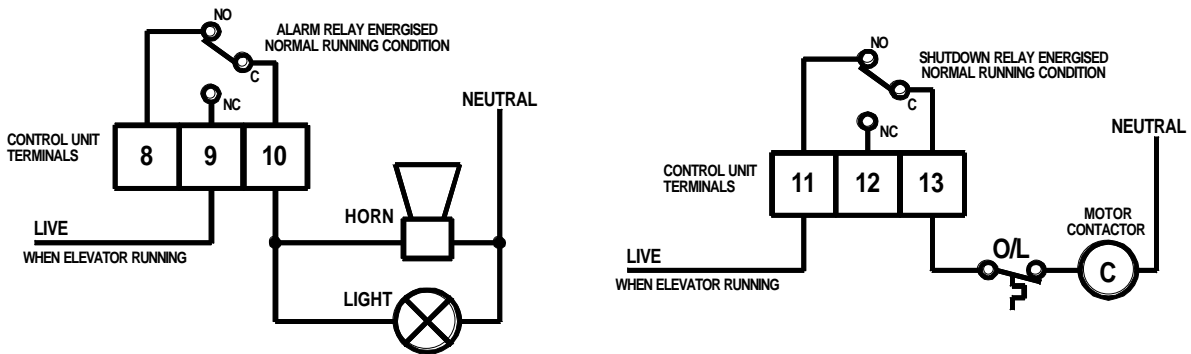
PARAMETERS & TEST:

Underspeed and misalignment alarm and shutdown trip points are adjustable within industry regulations via the password protected set-up menu. Customized parameter adjustments for special applications are available 24 hours a day from the 4B technical department.

The Watchdog system and all associated external wiring, warning and shutdown controls can be fully tested through the menu system.

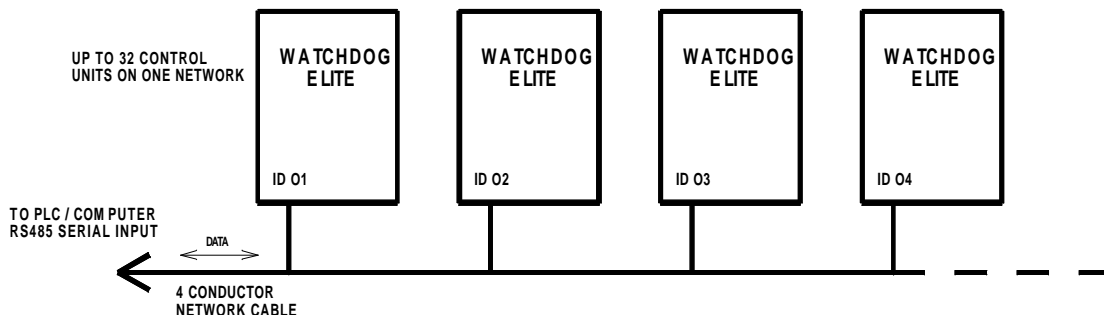
OUTPUTS:

The control unit provides three standard outputs for control of external equipment; alarm relay, shutdown relay, and RS485 serial comms. The alarm relay provides an output to warn operators when an elevator fault has been detected. The shutdown relay provides an output to automatically stop the elevator under a fault condition. Both of these outputs have user definable trip points and both operate in a fail-safe mode (relay energised during normal running conditions).



Typical relay connections

The third output is used for serial communication with a computer or PLC system. Using a 4-wire RS485 network cable, this output provides information on elevator operation and control unit status. Additional control units can be “daisy-chained” on the network as the system is expanded. (A typical RS485 “daisy-chain” system is shown below)



Typical RS485 serial communication “daisy-chain”

In addition to the three standard outputs, an optional interface board provides isolated relay contacts for belt underspeed, belt misalignment and bearing temperature. This option is useful for simple integration to PLC's or computers when the RS485 network capability is not utilized.

OPTIONAL AUXILLARY SENSORS:

BEARING TEMPERATURE:

The temperature of the bucket elevator bearings are monitored using Positive Temperature Coefficient (PTC) bearing temperature sensors. These zinc-plated steel sensors thread into the grease zerk location on the bearing housing, providing positive mounting. The sensor housing is grease-through and incorporates a standard grease zerk for bearing lubrication. The sensors wire back to the control unit, which provides a warning, followed by an automatic shutdown when an over-heated bearing is detected. The location of the failed bearing is displayed on the LCD screen to allow for rapid location and rectification. Negative Temperature Coefficient (NTC) bearing temperature sensors are available which display the temperature of the bearing.

PLUG CONDITION MONITORING:

When an elevator discharge becomes plugged, material is forced to run down the back leg of the elevator, which quickly fills up the trunking, resulting in belt slip and possible severe damage to the elevator or even explosion. A capacitance style 4B proximity sensor mounts in the discharge section or discharge spout of the bucket elevator and can provide early warning of plug conditions. A continuous signal from the sensor to the control unit indicates a normal plug-free condition, and an open signal occurs upon a plug condition. The control unit translates this signal and displays "plug condition" on the LCD screen and can automatically shut down of the elevator.

HEAD PULLEY ALIGNMENT- MONITORING:

Under certain mechanical fault conditions, the head pulley can move over and rub against the elevator trunking, while the elevator belt remains normally aligned. This can lead to severe damage or explosion, and the head pulley alignment should be monitored at all times. The Watchdog system incorporates a head pulley alignment monitoring option, which uses solid state inductive proximity sensors to monitor head pulley position. The non-contacting sensors provide a signal to the control unit when the head pulley is running within normal operating parameters and deactivates the signal under a misaligned condition. The control unit activates a warning device, displays "head pulley misalignment", and after a delay period, can automatically shut down the elevator.

APPROVALS:

The Watchdog "elite" system is FM Approved for Class 2 Division 1 Groups E, F and G hazardous locations.

CSA approval is pending.

SUMMARY:

The Watchdog “elite” system uses the latest solid state electronics and provides accurate and reliable safety monitoring for bucket elevators. Some of the key features of the system are as follows:

Non contacting fail-safe belt speed monitoring

Non contacting fail-safe belt alignment monitoring

Solid-state electronic bearing temperature sensors

Solid-state electronic sensors for plug condition monitoring

Non contacting electronic head pulley alignment sensors

Acceleration monitoring during elevator start-up

User adjustable trip points and parameter customization

Simple password protected menu system with front panel push buttons for set-up and parameter adjustment

Large bright LED speed display

LCD message / warning panel display

Display in English, French, Spanish, or German

Non volatile E²ROM memory chip

Passive and active system test which verifies Watchdog system function and correct working of all external wiring and associated equipment.

FM approved Class 2 Division 1 Groups E, F and G