Hydratect 2462 Steam / Water Detection System

The Hydratect Electronic Water Detection system is designed as an electronic alternative to conventional water level switches on steam raising plant. Hydratect gives a more reliable output than is available with conventional devices and provides local indication and configurable alarm/trip outputs.

A high temperature electrode cable is used to connect each electrode to the electronics unit. Each electrode cable contains four wires, two wires for connection to the electrode and two wires for connection to plant ground.

The electronics unit performs a resistance measurement between the insulated tip of each electrode and the cell wall (i.e wall of insertor manifold). The resistance measured in water is substantially less than that measured in steam and this is used to detect the presence or absence of water.
The Hydratect 2462 Electronics unit provides drive, signal processing and output for two electrodes. Each electrode channel is completely independent, having separate transformer, power supply, signal processing, fault detection and output circuitry. The outputs from each of the two channels are: status LEDs for water, steam and fault indication (red LED to indicate steam, a green LED to indicate water and an amber LED to indicate fault conditions); configurable fail-safe status relay for output of water or steam condition; fail-safe fault output relay.

Hydratect 2462 is a two channel unit that has been designed to operate with all existing Hydrastep and Hydratect electrodes and manifolds. Up to two electrodes may be connected to the Hydratect 2462 unit.The system consists of electrode inserts (or a manifold/watercolumn), electrodes, and an electronics unit. The electrodes are installed to detect the presence or absence of water. Typical applications are low or high level alarms and trips on steam drums, feed heaters, de-aerators etc and turbine water induction prevention systems(TWIPS) on steam lines.

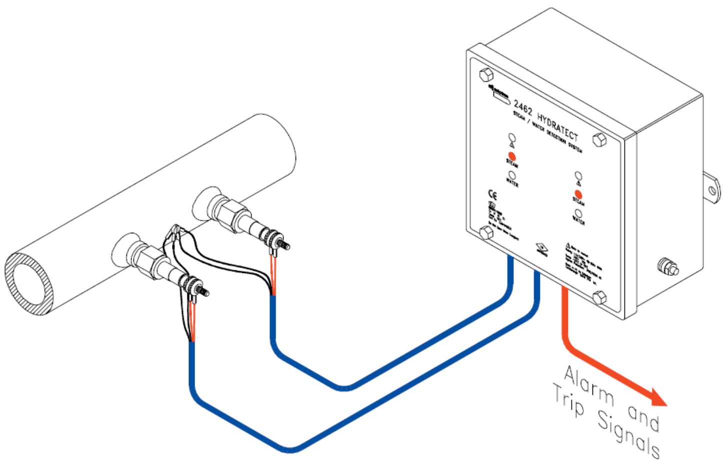


Figure 1 - Hydratect system diagram

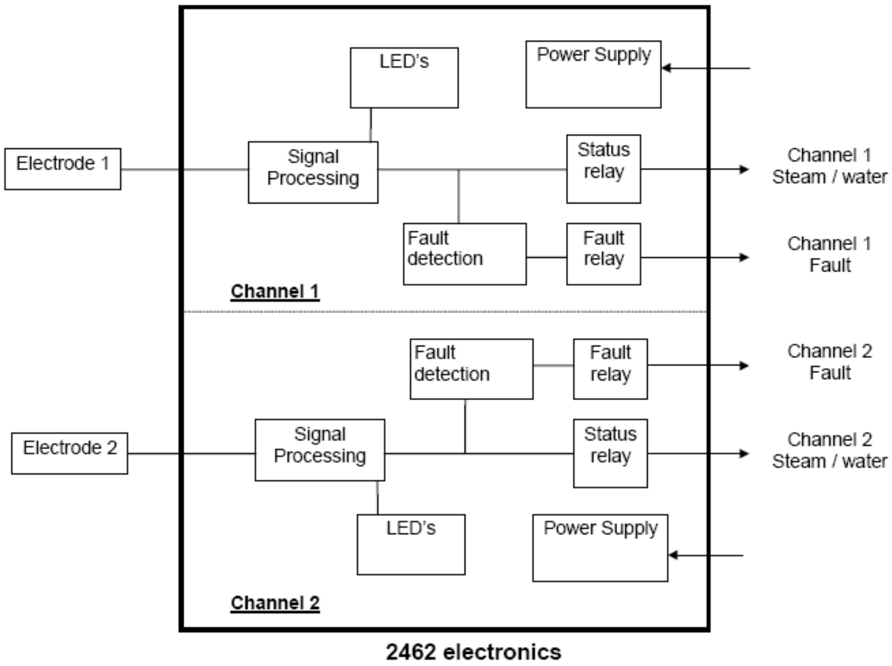
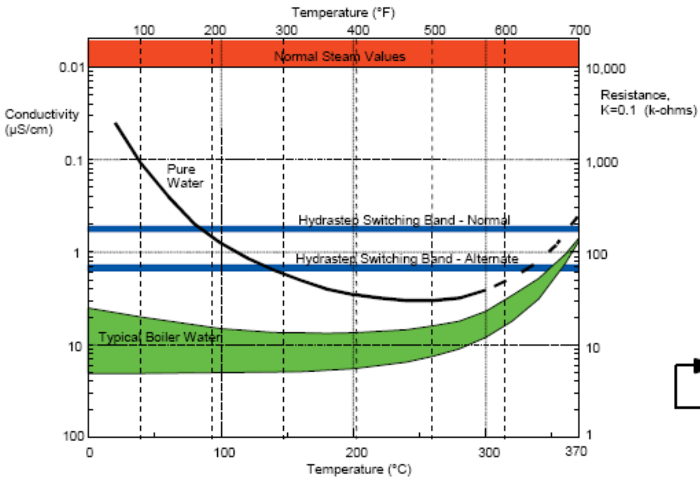
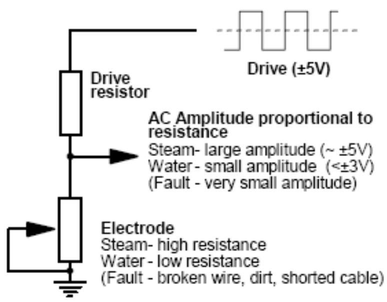


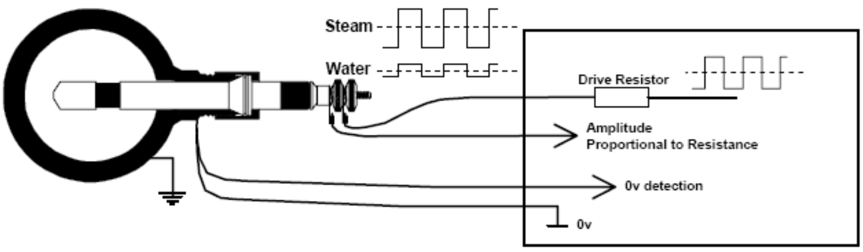
Figure 2 - 2462 block diagram

Principle of Operation

Horizontal electrodes



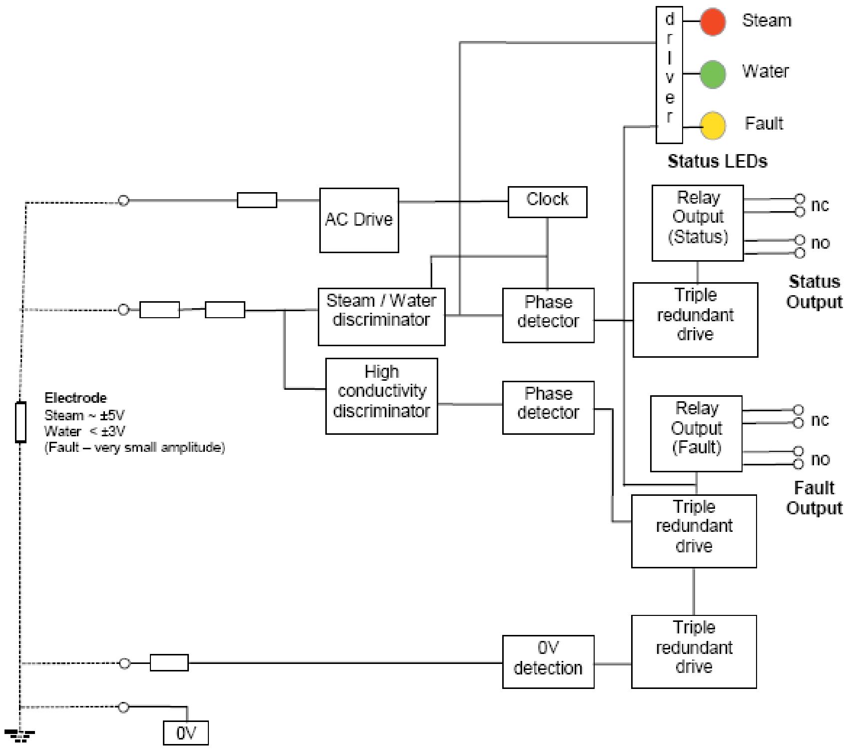




Two wires are connected to each electrode, one for the signal drive and one for the signal return. A low frequency a.c square wave is used to drive the electrodes through drive resistors. A further wire is used for the signal return from the electrode and two further wires are used for the ground connection. When the electrode is in steam, a high resistance to ground (insert wall) is presented, and therefore a large signal is returned. When the electrode is in water a low resistance to ground is presented and therefore a small signal is returned. If no signal is returned or only a very small amplitude is returned then either a short circuit to ground is present or a wire has been broken or disconnected.
If a ground connection becomes broken or disconnected then a large signal will be returned (equivalent to steam). A separate circuit is used to detect the broken or disconnected wire.The cell constant for the water column is set such that typical boiler water (conductivity between1µS/cm and 50µS/cm) has a resistance value of between 2KW and 100KW, while the typical steam value is greater than10MW. A short circuit/broken wire fault is declared if a resistance of less than 960W (conductivity greater than 104µS/cm) is measured. An alternate value of 333W (300µS/cm) is also available. The drive to the electrode is true a.c to prevent electrolytic action, and low frequency so that the electrode cable capacitance does not affect the resistance measurement.
The normal steam/water switching threshold is set at 0.6µS/cm. A second threshold of 1.6µS/cm is also available where wet steam conditions are likely (i.e at relatively low temperature, <200°C).

Design philosophy

The 2462 has been designed to comply with the requirements of prEN50156. Any failure that could adversely affect the operation of the unit will be detected and cause the 'status' or 'fault' relay to de-energise (i.e go to the safe condition). The design philosophy behind the 2462 circuitry is fail-safe, such that any component failure will cause the circuit to default to the selected safe condition.
With this design philosophy, 'validation' circuitry, whose primary purpose is to detect short circuit and internal faults, is not required.
Validation of the signals for trip purposes can be performed by connecting the status relays in the required configuration (i.e '1 out of 2' or '2 out of 2' output). The design concept relies on the circuit oscillating in a pre-determined phase for the normal operating state. Oscillation in the correct phase then energises a relay via triple redundant circuitry.The relay can be considered fail-safe if operated within 60% of its rating and capable of 3 x 106 cycles (defined by prEN50156). If the input changes to the abnormal state (i.e for low level trip, the normal condition will be water, the abnormal state will be steam) the output stops oscillating, de-energising the relay to the safe condition. Any component failure or track break will cause the circuit output to stop oscillation, which will de-energise the relay (i.e safe condition).The exception to this are the areas of circuitry that are triple redundant, where the circuit will continue to operate and provide the correct output with up to two component failures.



The circuit is configured so that the status relay is energised in the preferred (water normal or steam normal) condition. The fault relay is energised in the 'no-fault' state. The a.c drive provides a balanced square wave drive to the electrode via a drive wire. A return wire from the electrode provides a turn signal to the steam/water discriminator. The steam/water discriminator determines if the electrode is in steam or water and provides an a.c output if the electrode is in the normal condition or a d.c output if the electrode is in the abnormal condition. The normal steam/water switching threshold is set at 0.6μS/cm. A second threshold of 1.6μS/cm is also available where wet steam conditions are likely (i.e at relatively low temperature,<200°C). The high conductivity discriminator provides an a.c output if the conductivity is below the set threshold of 104μS/cm(960W) or 300μS/cm (333W). The circuitry detects contamination (low resistance or short circuit to ground) faults and broken connections to the electrode. If the return signal from the electrode is less than the fault threshold then the output from the high conductivity discriminator will be d.c. The output of each phase detector will be a.c only if its input is oscillating in the correct phase and at the correct frequency. That is, if the electrode is in the normal state and the conductivity is above the fault threshold. If the input is any else other than in phase a.c, the output will be d.c. The triple redundant drive provides energisation for its relay only if its input is a.c. Under normal operating conditions both 'status' and 'fault'relays are energised.

Circuit description

The circuit is designed using common blocks, that is, all the discriminator blocks, phase detection blocks, relay drive blocks follow the following design. The electrode is driven with a low frequency square wave (clock) via R1. The electrode forms a potential divider with R1 and the signal amplitude returned via R2 and R3 is dependent on the resistance of the electrode. IC1 is the steam/water discriminator and IC2 the phase detector. The output of the phase detector (B) then drives a triple redundant relay drive. If the signal at B is a.c the relay will be energised, if the signal at B is d.c the relay will be de-energised.

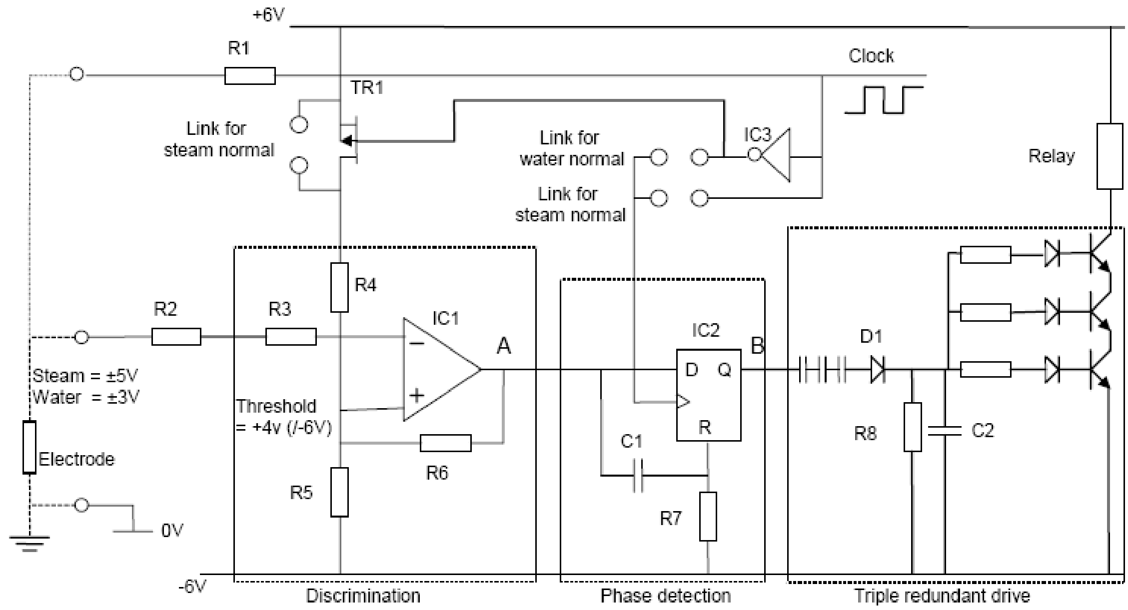


Figure 5 - Circuit block details

The output from the steam/water comparator (A) under normal conditions (e.g. water in "water normal" set-up) will be oscillation in a particular phase (in phase with clock for water normal, anti-phase with clock for steam normal). A change to the abnormal state (e.g steam in "water normal" set-up) will cause the output from the steam/water comparator (A) to cease oscillation. Any component failure or track break in the circuit path before A will cause the output from the steam/water comparator (A) to either cease oscillation or oscillate in an altered manner (incorrect frequency or phase). The phase detector output (B) will be a.c if A is oscillating at the correct frequency and the correct phase, this will energise the relay via the triple redundant relay drive circuitry.
If A is d.c or oscillating in the incorrect manner the output from the phase detector (B) will be d.c and the relay will be de-energised to the safe condition.The relay drive circuitry uses an a.c. detector circuit to drive the relay.

During the negative cycle of the signal B the drive transistors are held on by C2 being charged during the positive cycle. The size of C2 is chosen such that the relay will be de-energised within five clock cycles of B becoming d.c.

System state tables

Water normal configuration

System state	Fault LED	Status LEDs		Fault Relay	Status Relay
		Water	Steam		
No Fault, Electrode in Water	Off	On	Off	Energised	Energised
No Fault, Electrode in Steam	Off	Off	On	Energised	De-energised
Power supply loss	Off	Off	Off	De-energised	De-energised
Electrode contamination/ short circuit	On	On	Off	De-energised	Energised
Broken electrode connection (wire)	On	On	Off	De-energised	Energised
Broken ground connection (wire)	On	On**	Off**	De-energised	Energised**
Component failure (signal path)	On*	On	Off	De-energised*	De-energised*
Component failure (triple redundant section) - one or two component failures Electrode in Water	Off	On	Off	Energised	Energised
Component failure (triple redundant section) - one or two component failures Electrode in Steam	Off	Off	On	Energised	De-energised

*One or both of the output relays will be de-energised depending on where the failure has occurred
** Status LED and relay state depends on which ground wire is broken

Steam normal configuration

System state	Fault LED	Status LEDs		Fault Relay	Status Relay
		Water	Steam		
No Fault, Electrode in Steam	Off	Off	On	Energised	Energised
No Fault, Electrode in Water	Off	On	Off	Energised	De-energised
Power supply loss	Off	Off	Off	De-energised	De-energised
Electrode contamination/ short circuit	On	On	Off	De-energised	De-energised
Broken electrode connection (wire)	On	On	Off	De-energised	De-energised
Broken ground connection (wire)	On	Off**	On**	De-energised	Energised**
Component failure (signal path)	On*	On	Off	De-energised*	De-energised*
Component failure (triple redundant section) - one or two component failures Electrode in Steam	Off	Off	On	Energised	Energised
Component failure (triple redundant section) - one or two component failures Electrode in Water	Off	On	Off	Energised	De-energised

* One or both of the output relays will be de-energised depending on where the failure has occurred
** Status LED and relay state depends on which ground wire is broken

Specification

Enclosure:	190mm x 190mm x 90mm deep (7.48” x 7.48” x 3.94”) Stainless steel grade 304 Wall mounting (two point) Finish - natural IP65 - NEMA4X
Operating temperature:	-20°C to +70°C (-4°F to 158°F) Relative humidity: up to 100% Location: Indoor or outdoor Power supply (a.c): 93.5V - 130V a.c/48Hz - 65Hz 187V - 256V a.c/48Hz - 65Hz 2 x 10VA maximum Power supply (d.c): 20V - 60V dc Electrode cable length: 30m (98ft) maximum
Electrode channels:	Two
Water/steam threshold:	0.6µS/cm (normal) or 1.6µS/cm (alternate)
Fault detection:	Broken wire to electrode Short circuit to ground (100µS, 300µS, disabled) Any component failure
Indication (per channel):	One Red LED for indication of steam One Green LED for indication of water One Amber LED for indication of fault
Status relay output: (one per channel)	Energised in steam or water Separate normally open and normally closed contacts 250V a.c or 125V d.c maximum 8A maximum 240W (£ 30V d.c) 65 W (£ 60V dc) 25 W (£ 125V dc) 1500VA a.c
Fault relay output: (one per channel)	Energised during normal operation (fail safe) Separate normally open and normally closed contacts 250V a.c or 125V d.c maximum 8A maximum 240 W (£ 30V d.c) 65 W (£ 60V d.c) 25 W (£ 125V dc) 1500VA a.c

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