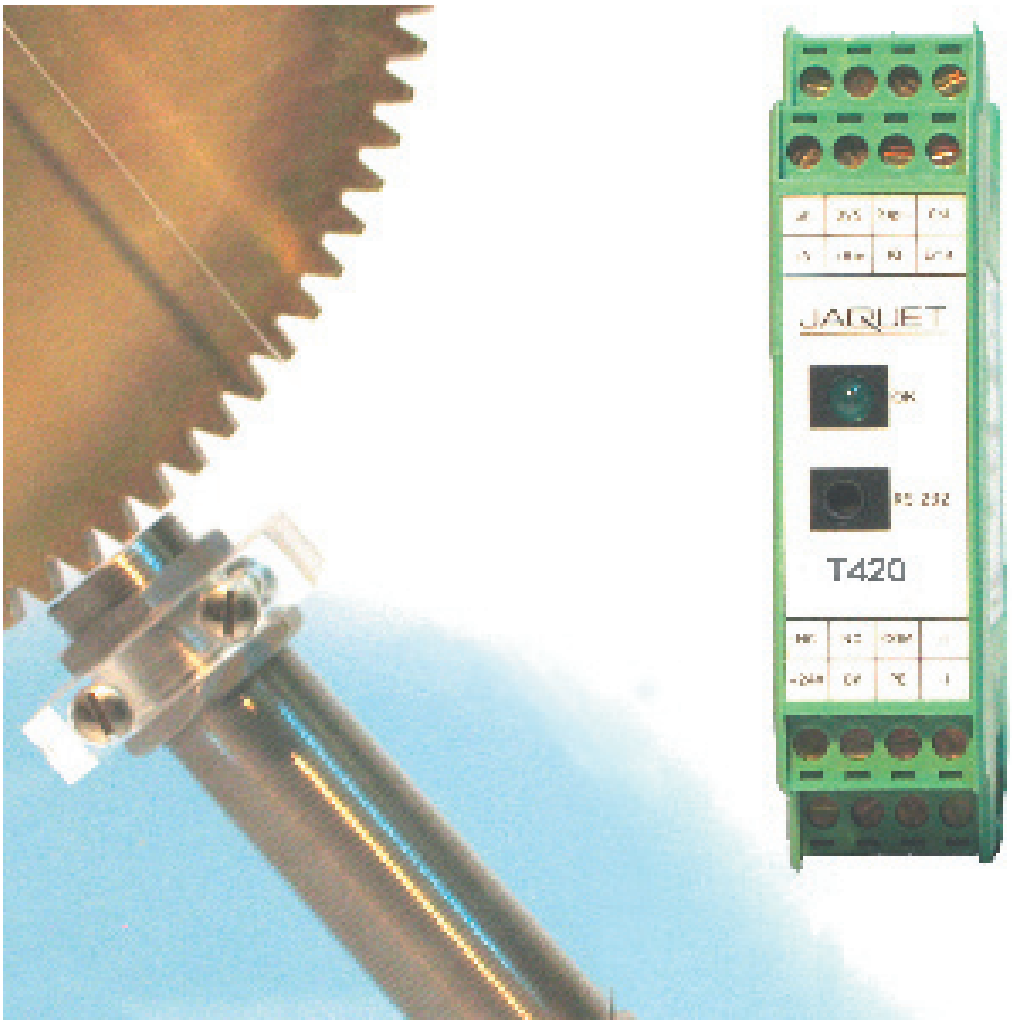
APPLICATION NOTES

JAQUET TECHNOLOGY GROUP

Protection Chain IQ-Sensor + T420



Protection Chain
IQ-Sensor + Relaiy device T420

According to IEC 61508 SAFETY Integrity Level 2

JAQUET AG Thannerstrasse 15 CH-4009 Basel (Schweiz) Tel: +41 61 306 8822 Fax +41 61 306 8818 www.jaquet.com

1 Introduction

This application note describes the functional combination of two JAQUET devices : The IQ Intelligent sensor when used together with the T420 relay creates a powerful and safe process monitoring chain.

The IQ sensor is the device that manages the monitoring process and delivers an OK/Alarm signal. The alarm or trip signal can then easily be integrated into a control system using the relay stage offered by the T420.

Safety chains are intended for monitoring critical processes. Their role is to detect dangerous process events and to deliver fail safe information to the control system. The availability of that detection capability by the IQ/T420 measurement chain is guaranteed by two integrated test sequences :

- Integrated self tests, e.g. sensor monitoring, RAM, ROM tests, Watchdog ...
- A periodic test routine which is initiated by maintenance personnel to check the integrity of the monitoring process.

Both the IQ and T420 have been developed according to the IEC 61508 standard for Safety Integrity Level 2.

2 Measurement chain description

The process monitoring can be based on any IQ-sensor function.
Examples such as over-speed / under-speed, speed regularity limits, rotation direction, temperature limits or others are covered by the IQ (see IQ data sheet).
IQ delivers a trip signal, active high in an alarm situation, and low in normal process situations (fail safe signal definitions).

The digital signal delivered by IQ is connected to the IQ input of T420. T420 is equipped with a relay stage and duplicates the processed signal to the relay output. By this means an easy integration of the monitoring chain in the control path is achieved.

A periodic test must be applied to the measurement chain to meet SIL 2 requirements. The goal of that test is to verify, at least once a year, the capability of the measurement chain to detect and transmit the monitored process event.

2.1 IQ configuration

This paragraph lists the safety prescriptions and specifications for the IQ sensor when used in a SIL 2 measurement chain. The IQ configuration is defined by this list :

A1 : Not used.
A2 : Trip signal based on the IQ monitoring function
Upper or lower limit functions applied to the following processed value :

- Speed
- Speed regularity
- Direction of rotation
- Temperature
- Custom functions available

Polarity of the signal :	No detection :	High
	Detection :	Low

A3 : Function test. For this feature, A3 is an input, driven by a potential free contact.
Test frequency = 1111 Hz.
A4 : Not used.

See also the IQ data sheet for more functional information on IQ.

2.2 Function of T420

2.2.1 Safety path of T420 :

When integrated into a SIL 2 monitoring chain, T420 duplicates the IQ alarm state to it's relay output. :

No detection : relay energised
Detection : relay de-energised (fail safe definition)

This signal is an input for the process control unit. Relay contacts are potential free.

2.2.2 T420 Alarm signal :

The open collector output of T420 is defined as system alarm . As long as the integrated self check routines confirm proper functioning of the measurement chain, the alarm output has a low impedance. If a fault is detected, the open collector output has a high impedance.

No detected internal faults :	Low impedance
Detected internal faults :	High impedance

2.2.3 Front panel LED

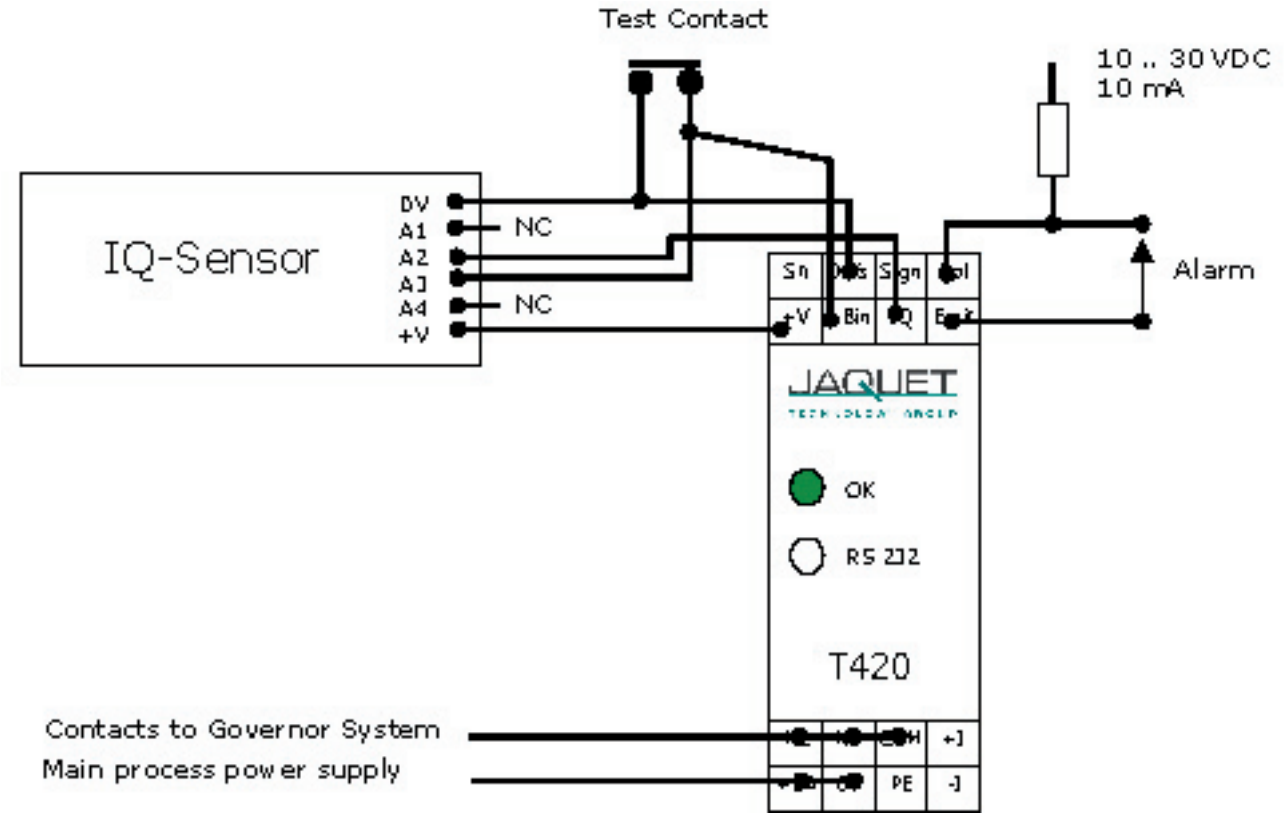
The green front panel LED of T420 indicates the system integrity.

System integrity OK :	LED green

2.3 T420 – IQ wiring

IQ and T420 are wired together according to following diagram :

Wiring diagram :



Power path : The main power supply is applied to the T420 device (0V; +24V). The T420 device has an integrated power management unit which generates an isolated power line for IQ (0Vs; +V).

Signal path : IQ delivers through it's output A2 the process information. This sensor output is wired to the 'IQ' input of T420.

Test path : This path is needed to initiate the periodic test of the measurement chain. Test functions are available on both units (IQ and T420). Both devices must be tested at the same time, so the wired test path is a common wiring between both devices.
The test of IQ or T420 is initiated through their test input (IQ/A3; T420/IQ input). Both inputs are activated when they are short circuited to the voltage reference 0VS (not 0V of main supply).
The activation of the test procedure must be realised with potential free contacts. These contacts can be contacts of a passive push button, or relay contacts.

Alarm path : The open collector output of T420 is potential free and can be supplied from 10 to 30 VDC. The same power supply as used for the main power for T420 may be used. The current Ic should be limited to a nominal value of 10mA by dimensioning the pull-up resistor accordingly.
This output is active when self test routines detect a malfunction of the measurement chain.

2.4 Integrated self tests

These self tests are running in the background. They are not initiated by the customer. These self tests are mainly driven by the T420 device. Following tests are integrated :

- Test of current drawn by the IQ sensor on the +V power line, to check the capability of the IQ to be able to detect process events.
- T420 internal self tests to avoid bad code execution, or bad parameter or variable treatments : RAM test, ROM Test, and CPU tests
- Watchdog control, to detect real-time or more general time drifts in the device.

2.5 Periodic test

This test is initiated by the customer, and is referred to as periodic test. This test has to be made at least once a year to reach the SIL 2 conformity for the whole application.

For that test, the wiring path has to be made as described in chapter ”T420 –IQ wiring/Test path».

See also chapter ”behaviour while testing the chain».

3 Measurement chain behaviour

3.1 Inputs and outputs

Measurement chain inputs :

- Inputs are the process events monitored and detected by the IQ sensor.
- The test input to generate the periodic test of the measurement chain.

Measurement chain outputs : These outputs are only T420 outputs.

- Trip signal : the relay output
- Alarm : The open collector output
- System OK : Front panel LED

Output states are defined in the following table :

Output	Output active	Output inactive
Trip signal relay	De-energised	Energised
Alarm, Open Col.	High impedance	Low impedance

3.2 Normal function

As long as the IQ sensor does not detect false process events and no internal system integrity failure is detected, the outputs are inactive. The front panel LED is on.

When a process event is detected and no internal system integrity failure is detected :

- The trip signal is active
- The alarm signal is inactive
- The front panel LED is on

When no false process events are detected and the internal self check detects a system fault :

- The trip signal is inactive
- The alarm signal is active
- The front panel LED is off

3.3 Performance / reaction time

Performance and reaction time are dependent on the selected IQ function for the A2 output.
The IQ response time is such that after the expected process event, not more than 100ms is needed to compute the information and to transmit it to the T420 via the A2 output.

Examples :

Selected function is under-speed at limit 5 Hz :
Time for the expected process event = 200 ms
IQ computing time : 100 ms
Total reaction time = 300 ms

Selected function is speed regularity at 500 Hz, 50 measurements :
Time for the expected process event = 50 periods of 2ms = 100ms
IQ computing time = 100 ms
Total reaction time = 200 ms

Throughput time from the IQ input of T420 to it's relay stage is less than 20ms. That time must be added to the IQ response time.

3.4 Behaviour during periodic testing

The periodic test procedure starts by asserting the test input of both devices.
In this mode the measurement chain does not monitor the process. For that reason, the test duration should be kept as short as possible. A minimum test duration of 2 seconds is needed to perform all the internal tests and to get the test result on the outputs.
During these tests, the IQ sensor delivers a reference signal to the T420 through the A2 line.
T420 verifies the levels and the frequency of that signal. In this test, the time-base of both devices are compared. The CPU availability of both devices is also checked. The whole internal circuitry of the sensor, the wiring between the sensor and T420, the T420 internal circuitry and the relay output are tested.

This test has to be initiated at least once a year.

Output behaviour depending on the result of the periodic test :

Output	Test ok	Test not ok
Relay output	active	inactive
Alarm output	inactive	active
LED	on	off