Pakscan P3
Hot standby master station change-over time

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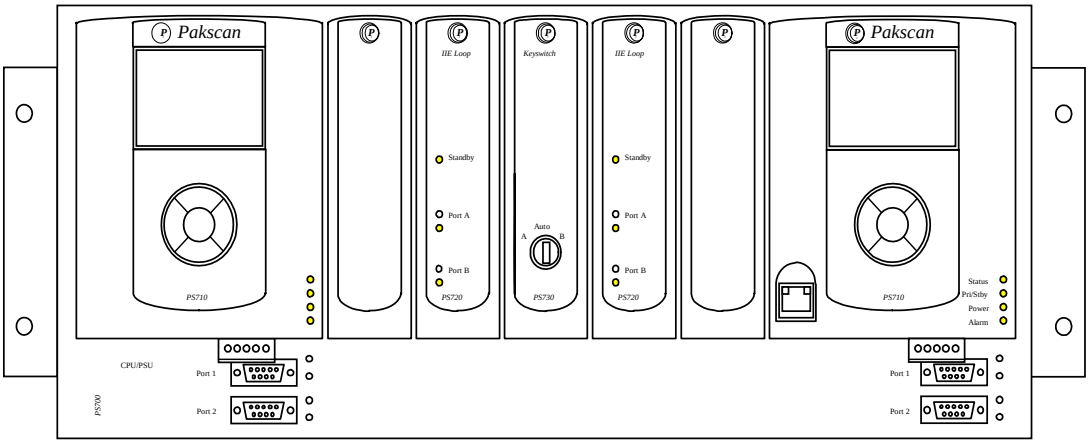
Introduction



The Pakscan P3 hot standby master station automatically releases the standby unit into main mode if the primary unit fails for any reason. This feature ensures that the system is always in control of the 2-wire loop and the connected actuators. It also ensures that the data to and from the host system is continuously available with a minimum of interruption.

The principle adopted in the hot standby version is to have the standby unit fully operational at all times, but prevented from controlling the loop. It has a data base for all the connected devices complete with their status. All system settings are ready for take over as soon as the primary unit relinquishes control. The 2-wire loop is connected through the standby station, ensuring that all the messages are read by the standby station and it is aware of all the field equipment status. In addition, the field loop protocol includes a handshake to ensure that any data transferred from the field to the master is confirmed. If a new message is in transit when the control change occurs, this mechanism ensures it is successfully transferred and is repeated, if necessary, after the disturbance to the system.

While the change over time is minimal, it does take a finite period. This report details tests carried out to determine the time taken for the master station outputs to change over control in the event of a failure of the primary unit.

Test Layout

The master station was connected to the field units and host PC, as indicated in Fig 1. The loop current was monitored using a 50 ohm resistor and the oscilloscope was connected either to the two watchdog signals or across the loop current detection resistor.

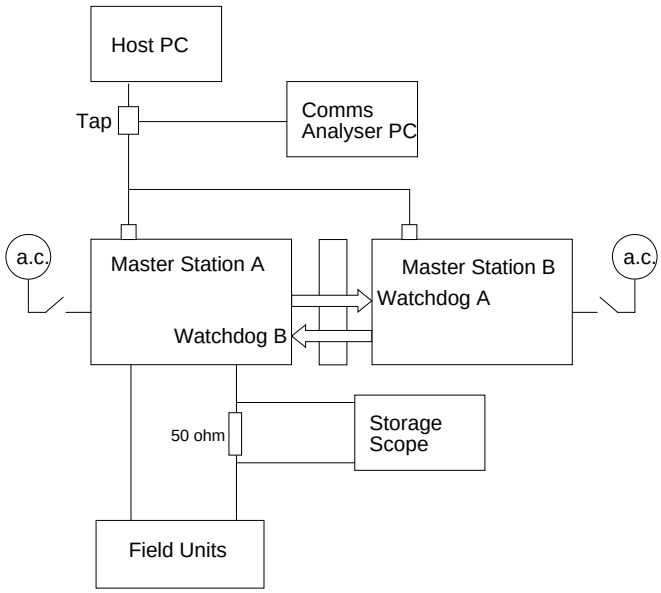


Fig 1: Test Connections

Equipment

The change over test made use of the following equipment:

Pakscan P3 Hot Standby Master Station

Loop: Set to 240 channels, loop speed 1200 baud.
Host Comms: Port 2 used, set to Generic Protocol, 9600 baud, odd parity. Standby passive setting.
Supply voltage: 240V 50 Hz.

Field devices: 4 devices including IQ and Q field units

Host System:
Dell Latitude D830, Windows 7, running Calta Mdbus software.

Comms Analyser:
Dell Latitude D830, Windows 7, running Calta Mdbus software.

Storage Oscilloscope:
Dell Latitude D830, Windows 7, running Picoscope software. (10X probe fitted).

Test Method

The master station performance was monitored at three representative points in the system and several measurements were taken at these points under each change over method.

1) The inter-unit watchdog lines were monitored.
2) The field loop communication was monitored.
3) The RS485 host communication was monitored.

Two test methods were used to cause a change of use from standby to primary in one of the two PS710 units.

a) Host generated serial command.
b) User generated change-over by a keypad command.

Measurements

Inter-unit Watchdog
The primary unit out of the pair outputs zero volts to keep the standby unit in standby mode. This will be either on the Watchdog A line when A is the primary unit, or Watchdog B line when B is the primary unit. A trace taken (Fig 2) shows the results when B was the primary unit and a Change Main to Standby serial command was sent from the host. The interval between station B stopping and station A taking over was, on average, 280 mSec. using both change-over methods.

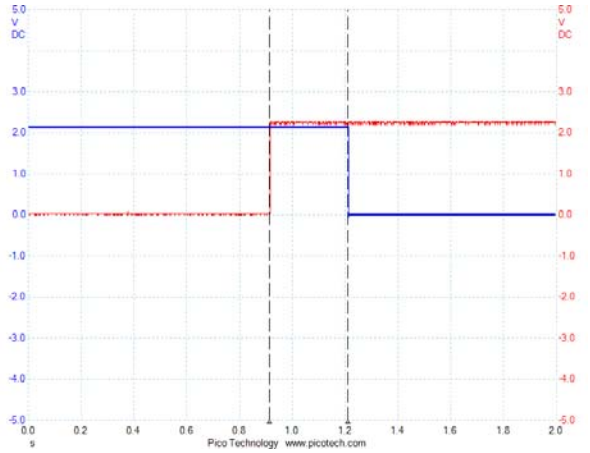


Fig 2: Watchdog Change-over Time

Once the watchdog has released station A, its main processor becomes ready for screen displays and host communication control.

Field Loop Communication
The Pakscan system relies on the ability to send and receive data from the connected field units. When the master station primary unit fails, the re-establishing of field communications falls to the back up unit and it then takes control. By monitoring the idle time on the loop while the transition takes place, a measure of the time to transfer control can be achieved.

The system was set up with a series resistor in the 2-wire loop and the signal across this was monitored on an oscilloscope.

With suitable triggering set up, a trace was recorded showing the transition time. This was generally shorter than the watchdog time because the 2-wire loop has its own current detectors in both the A station and the B station.

Fig 3 shows a typical example of the transition time.

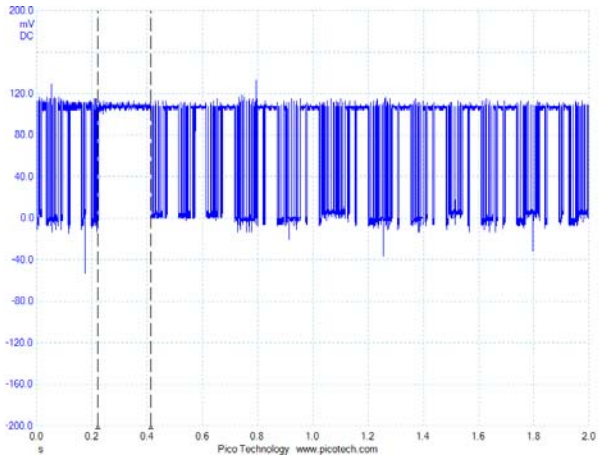


Fig 3: Loop Idle Time

There will be variations in this time at different loop communication speeds. Fig 3 shows an interval of 195 mSec.

Host Communications
The host system will become aware of the change of mode from standby to primary of one of the pair when it reads the appropriate data from the master station registers. The master station register 0 contains data indicating that both the stations are working correctly. The data in the register changes to show which has failed. When a failure occurs and the standby unit becomes primary, the host communications may experience a short disruption depending on the frequency the host uses for reading data or issuing commands. This disruption can be used as a measure for the change over time of the unit. Fig 4 shows a record taken as the control passed from the A station to the B station.

```
18 11:09:47.923 G  TX F0 03 00 00 00 01 91 2B
18 11:09:47.965 G  RX F0 03 02 E4 8C 8F 34
18 11:09:48.293 G  TX F0 03 00 00 00 01 91 2B
18 11:09:48.334 G  RX F0 03 02 E4 8C 8F 34
18 11:09:48.661 G  TX F0 03 00 00 00 01 91 2B
18 11:09:48.734 G  RX F0 03 02 E4 8C 8F 34
18 11:09:49.061 G  TX F0 05 00 04 FF 00 D8 DA
18 11:09:49.118 G  RX F0 05 00 04 FF 00 D8 DA
18 11:09:49.450 G  TX F0 03 00 00 00 01 91 2B
18 11:09:50.925 G  TX F0 03 00 00 00 01 91 2B
18 11:09:50.973 G  RX F0 03 02 E4 94 8F 3E
18 11:09:51.299 G  TX F0 03 00 00 00 01 91 2B
18 11:09:51.356 G  RX F0 03 02 E4 94 8F 3E
18 11:09:51.683 G  TX F0 03 00 00 00 01 91 2B
18 11:09:51.725 G  RX F0 03 02 E4 94 8F 3E
```

Fig 4: Comms change-over time (serial command) 1.523 Seconds.

```
18 11:10:29.914 G  TX F0 03 00 00 00 01 91 2B
18 11:10:30.053 G  RX F0 03 02 E4 8C 8F 34
18 11:10:30.378 G  TX F0 03 00 00 00 01 91 2B
18 11:10:30.404 G  RX F0 03 02 E4 8C 8F 34
18 11:10:30.730 G  TX F0 03 00 00 00 01 91 2B
18 11:10:30.773 G  RX F0 03 02 E4 8C 8F 34
18 11:10:31.099 G  TX F0 03 00 00 00 01 91 2B
18 11:10:32.573 G  TX F0 03 00 00 00 01 91 2B
18 11:10:32.628 G  RX F0 03 02 E4 8C 8F 34
18 11:10:32.954 G  TX F0 03 00 00 00 01 91 2B
18 11:10:33.044 G  RX F0 03 02 E4 8C 8F 34
18 11:10:33.370 G  TX F0 03 00 00 00 01 91 2B
18 11:10:33.395 G  RX F0 03 02 E4 8C 8F 34
```

Fig 5: Comms change-over time (key switch) 1.529 seconds.

```
18 11:10:54.693 G  TX F0 03 00 00 00 01 91 2B
18 11:10:54.735 G  RX F0 03 02 E4 8C 8F 34
18 11:10:55.061 G  TX F0 03 00 00 00 01 91 2B
18 11:10:55.151 G  RX F0 03 02 E4 8C 8F 34
18 11:10:55.476 G  TX F0 03 00 00 00 01 91 2B
18 11:10:55.568 G  RX F0 03 02 E4 8C 8F 34
18 11:10:55.893 G  TX F0 03 00 00 00 01 91 2B
18 11:10:57.366 G  TX F0 03 00 00 00 01 91 2B
18 11:10:57.488 G  RX F0 03 02 E4 94 8F 3E
18 11:10:57.813 G  TX F0 03 00 00 00 01 91 2B
18 11:10:57.854 G  RX F0 03 02 E4 94 8F 3E
18 11:10:58.181 G  TX F0 03 00 00 00 01 91 2B
18 11:10:58.221 G  RX F0 03 02 E4 94 8F 3E
```

Fig 6: Comms change-over time (HMI command) 1.595 seconds.

```
18 11:11:22.974 G  TX F0 03 00 00 00 01 91 2B
18 11:11:23.096 G  RX F0 03 02 E4 94 8F 3E
18 11:11:23.424 G  TX F0 03 00 00 00 01 91 2B
18 11:11:23.464 G  RX F0 03 02 E4 94 8F 3E
18 11:11:23.789 G  TX F0 03 00 00 00 01 91 2B
18 11:11:23.831 G  RX F0 03 02 E4 94 8F 3E
18 11:11:24.159 G  TX F0 03 00 00 00 01 91 2B
18 11:11:25.635 G  TX F0 03 00 00 00 01 91 2B
18 11:11:25.688 G  RX F0 03 02 E4 8C 8F 34
18 11:11:26.014 G  TX F0 03 00 00 00 01 91 2B
18 11:11:26.056 G  RX F0 03 02 E4 8C 8F 34
18 11:11:26.384 G  TX F0 03 00 00 00 01 91 2B
18 11:11:26.409 G  RX F0 03 02 E4 8C 8F 34
```

Fig 7: Comms change-over time (power-loss) 1.529 seconds.

A similar test is shown in Fig 5, this time with the key switch causing the change over. Again, Fig 6 shows the change over caused by the HMI and finally, caused by power-loss.

The recovery time is dependent on the host system message retry setting and its timeout setting. In general, the host should allow between 2 and 5 seconds for communications to re-establish, depending on the way it is configured.

Conclusions

The Pakscan P3 hot standby master station has two identical PS710 modules fitted. The operational settings of these two must be identical. Particular attention must be paid to the host communication port settings where the mode adopted when the module is in ‘Standby’ must be the same on both sides. (Both must be set to Standby Active when independent communication links are used and Standby Passive when a multi-drop link is used.)

Since the two units are identical, they both hold a full set of loop data and fully populated field unit status data. This allows for a rapid transfer of control in the event of the primary unit failing. Either unit may be the primary of the pair and will only relinquish its position if there is a fault or it is commanded to do so.

On average the transition time to change from standby mode to primary mode is 500 mSec for passing control of the 2-wire loop, 1 second for transferring control to the master station main processor and 2 seconds for interruption to host system communication.

There is no loss of data during the transition. Any changes in the field status are held waiting for the transition to complete. Any host commands will not be acknowledged and should be repeated by the host under its normal ‘retry’ mechanism.

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