London Underground Project

The Logical Solution for Safety

Platform Detection and Door Selection

SELLA CONTROLS HIMatrix and Tracklink III© solutions combine to afford passenger safety and reduce the amount of time trains stop at stations on the London Underground.

On-board train control systems play an essential role in safety within modern railway infrastructure; and to a large degree this safety has to be afforded irrespective of the age of the rolling stock and of the stations they serve. Such systems need to meet a variety of operator and regulatory requirements, and one in particular became important with the advent of powered doors.

These reduce the amount of time trains stop at stations and improve passenger safety. However, whether opened by or for passengers, the operating doors must be on the platform side of the train: a requirement that has given rise to the term Correct Side Door Enabling (CSDE). However, it is not simply a case of enabling all doors on one side of the train or the other. Many trains are longer than some of the platforms they serve, and accommodating this has given rise to the term Selective Door Operation (SDO).

SELLA CONTROLS

Based in Stockport and established in 1974, SELLA CONTROLS has been active in the rail sector since the early 1980s and commands an enviable reputation for its high-reliability control, safety and communications systems. The company is an appointed partner of Germany-based HIMA, a world-leading independent designer of automated safety solutions that are used in a variety of industries including rail, oil & gas and nuclear.

In addition, SELLA CONTROLS has a partnership with EKE Electronics (widely respected in the rail sector for its Trainnet® system for TCMS, train automation and onboard communications).

The company is also renowned for its ability to develop systems in response to emerging and sometimes urgent requirements.

This was most likely a key factor in the company being awarded a contract, in January 2009, by London Underground for the design and supply of a system for CSDE and SDO on trains operating on London Underground's Circle, District, Metropolitan and Hammersmith & City lines.

Scope and Solution

The above four lines are served by 104 stations, which between them have 249 platforms (of which 51 are bi-directional - or 'reverse working'). As part of a network upgrade, 191 new Bombardier 'S Stock' trains were supplied, and CSDE and SDO are required functions. However, these functions were originally to be included within a new control/signalling system but this was deferred when London Underground's former PPP contractor, Metronet, went into administration and was transferred to London Underground ownership. It is likely that CSDE and SDO may still be provided through a future signalling system, but the functions needed to be on the new trains as they entered service; during a phased roll-out which started in August 2010 and concluded in 2016. To this end, London Underground turned to SELLA CONTROLS to develop an Interim Correct Side Door Enabling and Selective Door Opening System (ICSS).

At a fundamental level, CSDE requires knowledge of which side of the train the platform is on and SDO requires knowledge of how many doors should be opened. SELLA CONTROLS solution for conveying the knowledge for both is through the wireless transfer of data, from platform to train, using its Tracklink® product; which was first launched in 1996 and is now in its third generation.

Tracklink III® comprises two key elements for the transfer of data, namely: a passive tag for storing data relevant to a platform; and a train-mounted reader for reading that data. The 'passive' aspect of the tag relates to the fact that it is a beam-powered Radio Frequency ID (RFID) device. It requires no power cable or batteries.

The Tracklink III© Tag

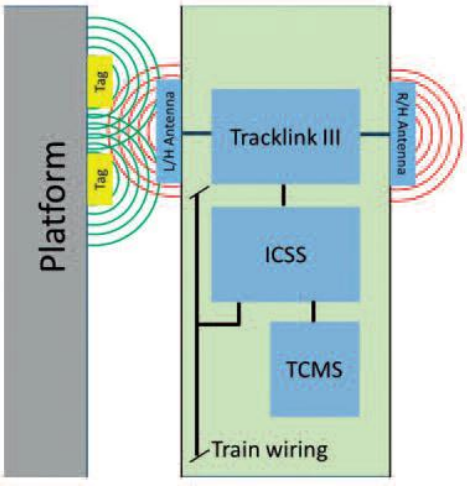
Constructed from flame-retardant, toughened polymer and with an aluminium base, the tag is factory sealed to IP 67 and suitable for use in a variety of harsh environments.

Previous systems for track-to-train data communications have typically employed large track-mounted inductive loops, wired to and powered from trackside transmitter cabinets; Which have high installation and maintenance costs. The Tracklink III© trackside beacon on the other hand contains a circuit board comprising an antenna and RFID device that is energised by the RF field transmitted by a train-mounted antenna.

In each of the stations, two or more tags are fitted at the stopping points of each platform. Each set of tags is programmed by SELLA CONTROLS at the time of manufacture and each tag within the set contains identical data; namely the door opening patterns for all possible lengths of train serving the platforms (in this case 6-, 7- or 8-Car Trains) and all possible stopping positions.

As for the train-borne Tracklink III © Reader, it is an RFID interrogation device. One is mounted to the underside of each Driving Motor Car, i.e. two per train. Each reader connects to two antennas, one on each side of the train, and knows which of the two antennas has detected a tag. They are set to energise and read tags from a distance of about 1m and they work continuously, so if a tag is in range it will be read (several times per second).
It is worthy of note that whilst for this project the tags will be read by trains that are coming to a stop they can be read at speed; and tests at speeds of up to 125mph have been successful. This means SELLA CONTROLS Tracklink III © tags and readers can be employed in a wide variety of scenarios.
For example, at-speed data transfer could be used to convey tunnel-in, tunnel-out, regenerative braking zone, traction limiting zone and other geographical triggers. In addition, instructions such as pantograph-up and pantograph-down can be conveyed.

On the London Underground application, each Tracklink III © Reader connects to an ICSS Control Unit, built around an F30, dual-processor HIMA HIMatrix programmable logic controller(PLC) that is certified up to Safety Integrity Level (SIL) 3 in terms of both its internal hardware and as a 'software programmable' platform (i.e. a fail-safe architecture).



System-level
Left, a representation of how the ICSS elements connect and how the Tracklink III antennas energise the tags - which then transmit the door opening pattern.

The illustration shows just two tags, but typically three would be employed at a designated stopping position.

For at-speed data transfer, within a tunnel for example, one tag may suffice.

In addition, each ICSS includes three dedicated PCBs, all of which were designed and built by SELLA CONTROLS for this project. The PCBs are:

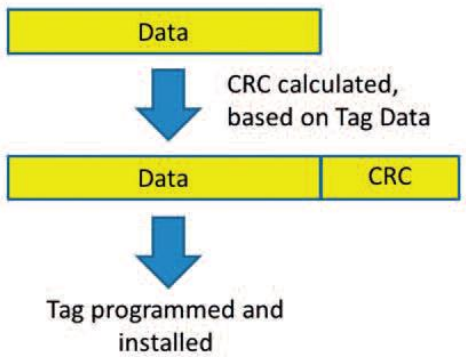
- An input PCB containing 16 (solid state) channels for converting switched train voltages (of 110V nominal) into discrete logic levels for the HIMatrix;
- An output PCB containing 16 relays for switching train control circuits; and
- A speed-monitoring PCB, which connects to a speed probe (as door opening must only be enabled when the train is stationary).

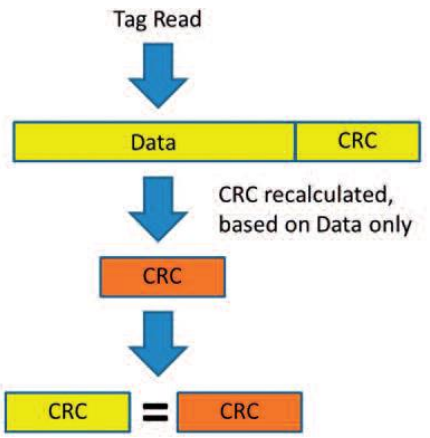
Each ICSS interfaces, via the input and output PCBs, with the train's hard-wired relay logic for CSDE and SDO. In addition, the ICSS interfaces with the train computer (or Train Control & Monitoring System - TCMS). Each ICSS is aware of how long the train is (as mentioned, either 6, 7 or 8 cars) so all it needs is the data from the Tracklink III © tags at each station to enable the opening of the correct number of doors on the platform side of the train.
Each door has a dedicated (local) control system that interfaces with sensors and motors. In terms of logic, the door will open if the driver has pressed the door opening buttons in the cab *and* if the ICSS is enabling the door to be opened (itself dependant on the tag-based door opening pattern *and* the train being stationary).

The functionality and operation of the ICSS are continuously monitored. For example, the outputs of the CSDE and SDO relays are fed back as inputs. Should there be any mismatch between the intended and actual state of the outputs a fault is communicated via RS485 to the TCMS; and if it is a 'hazardous mismatch' then the system's outputs are locked off in safe-mode.

Safely Received

As mentioned, Tracklink III © tags are used to store data (in this case door opening patterns, but space is available for lots more information). When programmed, the data undergoes a Cyclic Redundancy Check (CRC). This is essentially a calculation done on the data that results in a CRC code; which is tagged onto the end of the data.





The tag's data and CRC code are read by the Tracklink III © reader, which repeats the same calculation on (just) the data. The read and re-calculated CRC codes should of course be identical; thus validating the integrity and therefore validity of the read data.

Conclusion

Tags have been supplied for the London Underground's Circle, District, Metropolitan and Hammersmith & City lines (pre-programmed for dedicated stations and platforms).

In addition, London Underground has been provided with a number of blank tags and programmers. These additional tags are to act as replacements in the event of tags being damaged post-installation.

As for the train-borne Interim Correct Side Door Enabling and Selective Door Opening Systems, Bombardier has installed these into the new Driving Motor Cars during manufacture; taking delivery of a few systems at a time from SELLA CONTROLS.

In conclusion, the ICSS devised and supplied by SELLA CONTROLS means trains built for London Underground's Circle, District, Metropolitan and Hammersmith & City lines can (immediately) provide both the passenger safety and reduced time-at-platform benefits that powered doors offer. Also, this project represents the first use of Tracklink III © on such a large scale.

However, Tracklink III © is not just being used for ICSS. As mentioned, data transfer to a train passing at speed is possible and the system is being used to pass geographically related trigger data to the TCMS to initiate traction control and regenerative braking, plus trigger customer information announcements; functions which needed to be implemented as a result of the cancellation of the original signalling contract.

Commendable

In July 2009 Tracklink III © was commended by the Institution of Engineering and Technology (IET) as not only an innovative solution – for the contactless transfer of data at train speeds of up to 125mph – but also from a business perspective.

This latter commendation relates to how low-cost, disposable RFID tag technology has been transposed from commercial asset tracking and warehouse stock control into the rolling (rail) stock sector.

Safety improvements were also commended, as the ease of tag installation and their maintenance-free operation reduces the amount of time engineers work by rails.

The Logical Solution for Safety

With offices in Stockport, Ashby De La Zouch and Aberdeen SELLA CONTROLS has easy access to the motorway network, mainline railways and several international airports.

SELLA CONTROLS has custom built offices and workshops providing:

Consultancy	Feasibility - Risk Assessment - Reliability Studies – Lifecycle Costing
Project Management	On time delivery of project - Regular customer contact - Agreed milestones to monitor progress
Design	Detailed Design - Functional Logic - Auto CAD
Engineering	Functional Design Specification - Safety Requirements - Safety Requirements Specification
Manufacturing	Panel Build - System Build - System Integration
Testing	In-house - Factory Acceptance Testing - Site Acceptance Testing
Commissioning	System Inspection - Support during Startup
Technical Support	24 hour call out support - Upgrades/Modifications - Maintenance (IEC 615O8 life cycle)
Training	Hardware/Software Design - Maintenance and Servicing - Customised Courses

SELLA CONTROLS
Carrington Field Street, Stockport, Cheshire SK1 3JN United Kingdom
T: +44 (0)161 429 4500 • F: +44 (0)161 476 3095 • E: sales@sellacontrols.com
www.sellacontrols.com