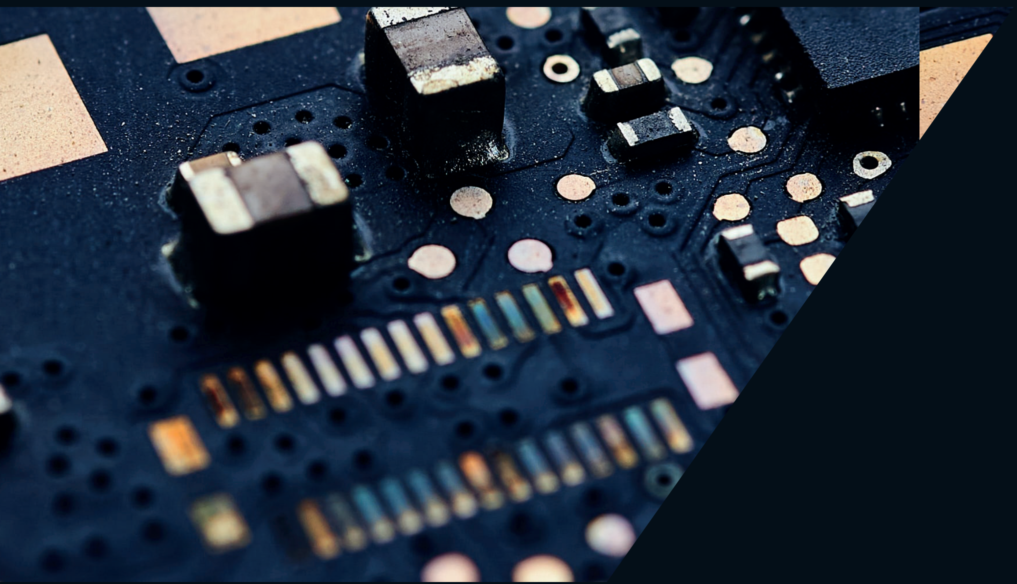
Automatic Train Protection Technology (ATP)



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Grinsty Rail

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During the 1980s, there were several high-profile instances of trains passing signals at danger, such as the Clapham Junction rail crash on 12 December 1988. This noticeable uptick in signal passed at danger (SPAD) instances led to calls for a new safety system to be adopted that would entirely prevent their occurrence; specifically, the report into the Clapham Junction crash stipulated that British Rail (BR) was to fully implement such a system on a nationwide basis within five years. From the onset, it was recognised that considerable work would be involved both to develop and deploy the envisioned system.

Accordingly, in 1988, BR launched a three-year program to develop and deploy this new system, with the aim of starting its implementation by 1992. It was assigned the name Automatic Train Protection (ATP), and was a considerably more comprehensive system than the Automatic Warning System (AWS) that was already in operation at that time. Whereas the AWS system only issued alerts to the train's driver, effectively an advisory arrangement that remained open to failure via human error, ATP would instead be able to take control of the train and override the driver to ensure it was driven in accordance with the signalling, as well as other conditions.

BR opted to perform two ATP pilot systems, of which one was London Paddington to Bristol operated by GWR, using equipment based on Belgium's Transmission balise-locomotive (TBL) system, supplied by Ateliers de Constructions Electriques de Charleroi (ACEC) which was a subsidiary within Alstom.

Part of the development was for an ATP Tester which could decode the data sent from track side control boxes, but also pick-up via a sensor box the same data, being transmitted from balise or antenna cable loops mounted within the track.

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Nearly 30 years later, much beyond the expected life of the system, Network Rail requested Alstom to supply replacement Testers due to age and reliability uses.

Alstom in Belgium declined the request. Grinsty Rail Ltd as a supplier of On-Train Monitoring Recorders (OTMR) is one of the few companies in the world that could still decode transmitted ATP messages and was contacted by Alstom UK after Network Rail reasserted their request for replacement Testers.

Imagine being asked to copy an electronic product with no circuit diagrams or software listings, this was exactly what our engineers were asked to do! The remit was to reproduce a product for use trackside on the railways but improve its operational time between battery recharges, make it more robust and design out a bulldog clip

The first step was to dismantle the equipment into its major parts then component by component develops the electronic schematic drawings and figure out how it works. Next copy the software from the unit and disassemble it back into 8032 instruction mnemonics from machine code.

This was the difficult part, having to slice up the code into the main program, subroutines, and interrupt routines then add comments back in to describe the various software functions.

Reverse engineering requires very analytical minds.

Once this was achieved the engineers could move forward to replicate the circuits. It was decided early on not to copy the power supply sections that used old inefficient technology to generate power rails from a 12V sealed lead acid battery that took 12 hours to recharge. Instead, high-efficiency DCDC modules were used to generate 3.3V and 5V power rails from a 7.2V NIMH battery pack that could be recharged in 1 hour using a mains charger but more importantly from a car or van 12V supply.

In the original design from the early 1990's, there was a large amount of glue logic including a 45-stage ripple counter, this was all replaced by a single cPLD.

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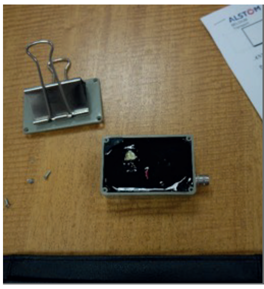
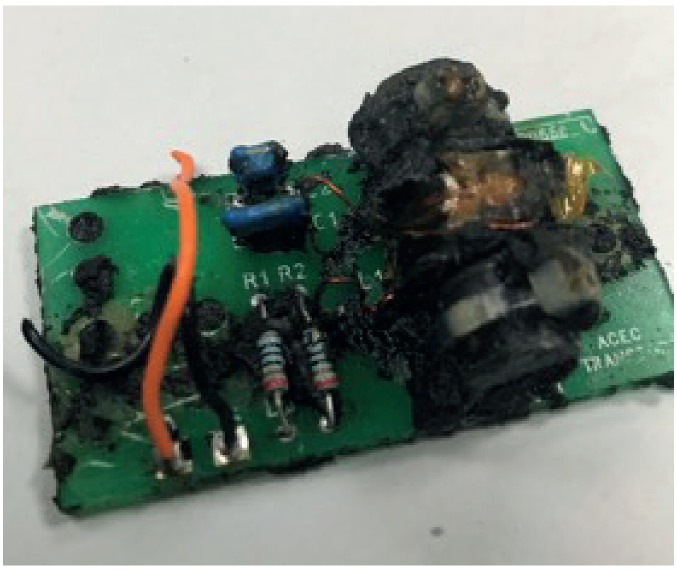
Two major sub-components were coils used to detect 90kHz and 110kHz signals from a beacon. These devices were sent to a specialist coil manufacturer who stripped the coils, identified the ferrite material and air gaps, then reproduced equivalent coils.

This one was easy in that it just needed removing from the main PCB in the Tester unit.

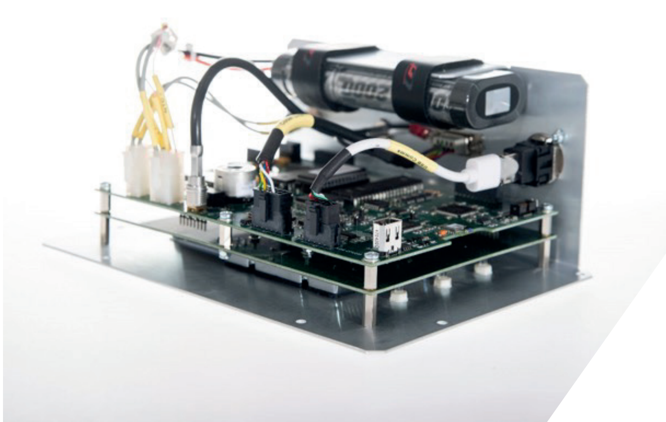


This one was more difficult as it had been sealed in epoxy!

However, with the aid of a hot air gun, the sense coil was exposed sufficiently to determine its construction.



and prove that it works in the same way? The answer, in this case, was to use the same software running on the same 8032 processor family but with a surface mount version of the same serial communications controller device. The original design used obsolete devices to read the keypad and drive the 4-line LCD, so in the new design, an NXP Cortex M3 processor was used to simulate several obsolete IO devices. The prototype was EMC tested for both emissions and immunity.



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Having a modern co-processor for the 8032 allowed other new functionalities to be added including Bluetooth connectivity to a smartphone that allowed the operator to use the test equipment from a safe distance from the railway track by simulating both the keypad and the display. From a hardware point of view, the original test equipment was supplied in a large grey vanity case whilst the new design used a smaller yellow Pelican 1400 ruggedised case

The new design weighed in at under 4Kg, a metal vandal proof IP67 keypad with the legends engraved on the faceplate, and a low energy backlit LCD that allowed over 12 hours of continuous use. The ability to be re-charged in the field from a 12V vehicle supply was included. All cables and the signal detection unit could be stored in a pocket in the case.

The original test equipment weighing 7.5Kg, had a plastic button keypad with worn-out legends and a backlit LCD that drained the battery after 6 hours of use. Re-charging required access to a mains supply.

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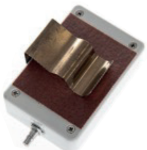
The prototype and then the production units were tested at Network Rail's training centre in Bristol and proven to perform in the same way as the original unit.

Finally, new operation manuals were written, and calibration reports were generated for the supply of production units to the customer, and the bulldog clip was retired from use!



Solving problems is what we do best.

With no documentation we had to reverse engineer the whole system, making this one of the more challenging projects I've been involved with. Our design team was able to breakdown the system and obtain a full understanding of how it functioned.

Andy Myatt
Senior Electronics Design Engineer

Our engineers are ready for a similar challenge from you, just contact us.

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