Talk to JCT Traffic Signal Symposium – September 2025

Early and Late 20th century developments in Traffic Control; Two significant periods in UK Signalling History

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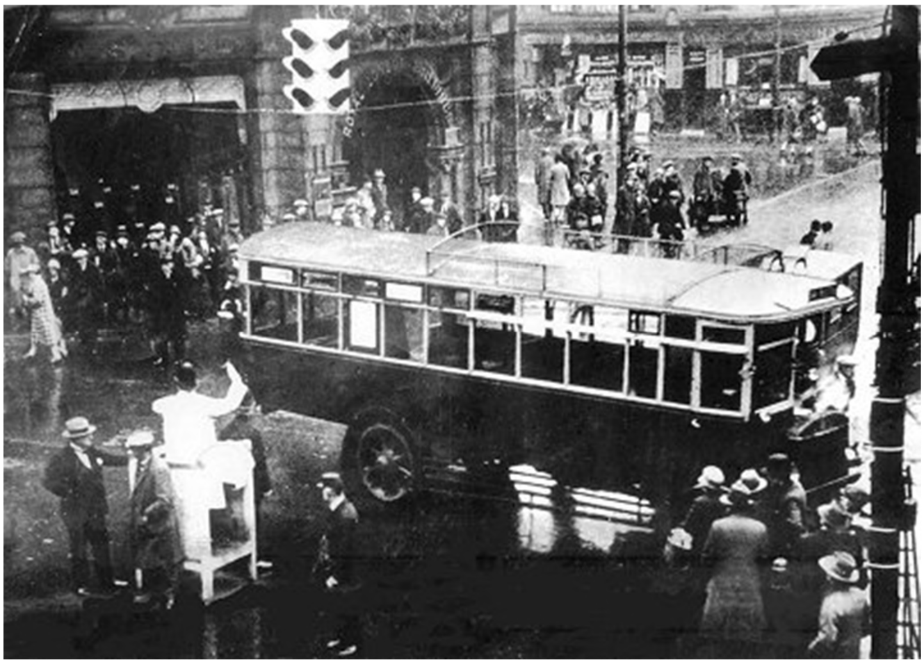
Early Developments in Traffic Signals – by Peter Bull

In the early years of the 20th Century busy road junctions were controlled by police officers manually directing traffic, sometimes more than one officer being needed at complex intersections. The earliest experiments with signalling actually began in the 19th Century with a set of gas-lit semaphore signals in Parliament Square, Westminster. These were controlled by a police officer, but the experiment ended following a gas explosion. Various experiments with electric signals occurred around the world, but the main developments came in the United States shortly after the First World War. The first three-colour light signals were installed in New York in 1918, at first they were switched by Police Officers but were soon converted to automatic operation, initially using mechanisms adapted from those used to control advertising signs.

The first UK development was a trial in 1926 where a police officer sitting in a small cabin on the corner of St James's Street operated switches controlling three-colour signals to regulate the traffic in Piccadilly. The first automatic signals were installed in 1927 at Princes Square Wolverhampton, where three colour lights were hung from wires in the centre of the junction. The experiment was successful, and the installation was upgraded to pole mounted signals in October 1928, an arrangement which continued until 1968.



Princes Square, Wolverhampton in 1927

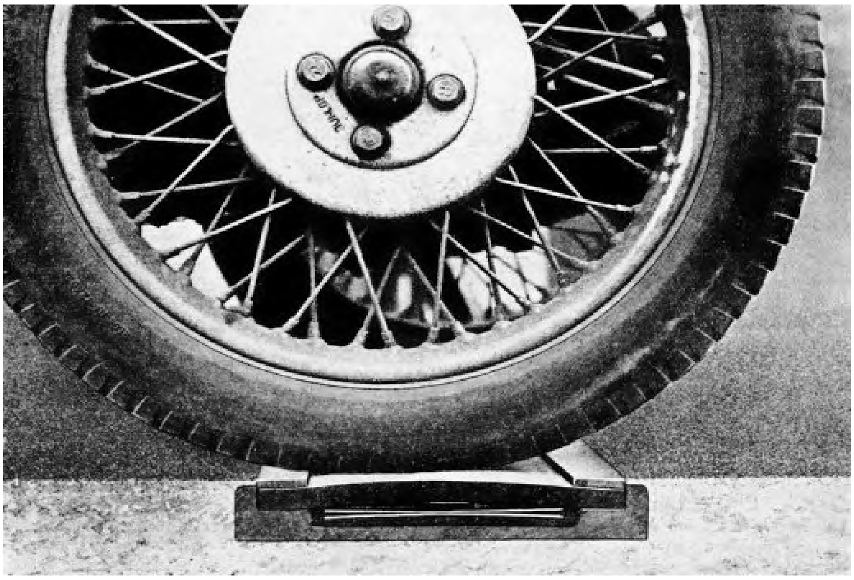
The Ministry of Transport issued Memorandum 297 (Roads) in 1929 recommending features of traffic signals that should be adopted and the installation of automatic signals proceeded rapidly. The Ministry of Transport reported that by March 1930 there were 135 sets outside London, and a considerable number in the city itself.

The junction of Cornhill, Bishopsgate, Leadenhall Street and Gracechurch Street, London, at the time of the inauguration (left) of the first "Electromatic" signals installation in Europe by the Rt. Hon. The Lord Mayor of London, Sir Maurice Jenks, 14th March, 1932.

The automatic controllers were usually based on a rotating cam shaft operating switches which controlled the lights. Many variations were tried - the shaft could slowly rotate continuously or could be advanced intermittently, and timings could be controlled by thermostatic strips, dashpot mechanisms or condenser/resistor circuits. The theory of traffic control also developed rapidly, by the early 1930s phase-based control, multiphase signalling and signal co-ordination were all being defined and operated. The disadvantages of fixed-time control were also recognised, and ways of allowing vehicle-actuation were pursued. The first successful implementation was the Electromatic system developed by the Automatic Electric Co. of Liverpool and installed at the junction of Cornhill and Gracechurch Street, in the City of London, in 1932. By 1934 Electromatic signals were controlling Trafalgar Square and a linked system of six junctions along Picadilly between Duke Street and Stratton Street. By 1937 it was reported that “few fixed-time signals are now in action in Great Britain”.

A 1934 book by Harrison and Preist states that the Electromatic system “… in effect *differentiates* the traffic streams and adjusts the time cycles in accordance with the ascertained flows from moment to moment. It constitutes a revolutionary method of handling traffic flows, not only at simple intersections, but in situations where multiphase operation is necessary. Its distinguishing feature is the automatic suppression of all unwanted “Go” periods, thus obviating unnecessary delay to vehicles which may be waiting on other phases. Hourly, daily, and weekly trends are automatically catered for, the time cycles being adjusted to give minimum delay”.

The Electromatic system has three components – the detector, the controller and the signals (which can be of any type).



Sectional view of a vehicle detector

The detector is a pressure-operated unit consisting of two steel contact plates moulded into a rubber envelope lying in a cast-iron trough mounted into a concrete base flush with the road surface. The plates are brought into contact by a vehicle wheel passing over them, effectively closing a switch which is connected to the controller for a time which is dependent on vehicle speed. The detectors are installed at a distance calculated to allow ample braking distance before the stop line – based on average traffic speed, gradient and driver reaction time. Tramcar detectors operated by the trolley wheel are also available, as are detectors with dual plates allowing uni-directional operation.

Vehicle crossing the detector

The Electromatic controller uses an intermittently rotating camshaft which makes one step per signal change. The timing circuits use condenser – resistance pairs which trigger a gas discharge tube to operate a control relay. Amber signal timings are varied by vehicle speed unless there is a gap change. The “Go” period has an initial

THE CONTROLLER comprises a solenoid-operated camshaft which changes the lights in six steps; four relays; two gas discharge tubes; two condensers; and a group of variable resistances which can be set to give any desired time intervals between the various operations of the traffic signals.

interval to allow stationary vehicles to start up and get moving followed by an extendible portion where each vehicle extension is variable depending on vehicle speed up to the preset maximum. Other features available include arterial reversion, which changes back to the main road as soon as possible after every side road operation. In some cases this allows a junction to operate with no detection installed on the main road. The system also allows a controller to send a hurry call to an adjacent controller to prepare the downstream junction. If area control is required, as in the Piccadilly situation, a master timer is used to co-ordinate the time the right of way is given to side streets in accordance with a pre-arranged plan which depends on traffic density – a flexible progressive arrangement.

Pedestrian signalling was available for both fixed time and vehicle-actuated signals using Cross Now/Don't Cross indications for the pedestrians, the Cross Now phase being called by pedestrian push-buttons. Some crossings were fitted with light beams and photo-cells across the pedestrian approach to call the signals without the need to press a button.

Transport Minister Mr Hore-Belisha inaugurates a light beam operated pedestrian crossing

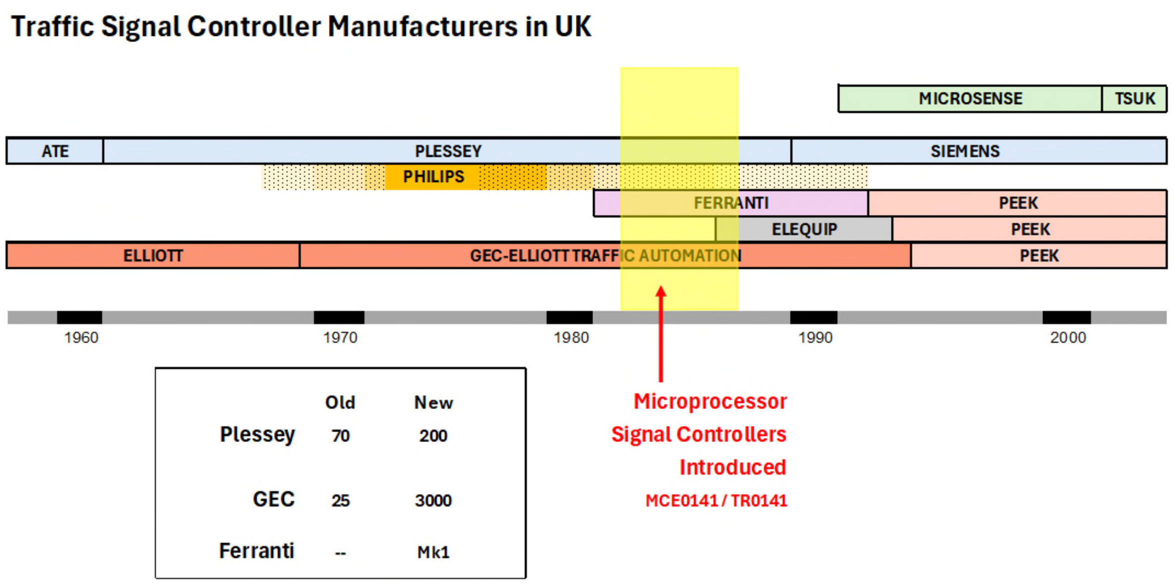
Many features of traffic signalling that we recognise today were developed before the second world war, within a decade of the first junction being automatically controlled. However, the electro-mechanical equipment was very complex, and operated in harsh on-street conditions which would impact reliability. In the 1950s and 60s developments in electronics allowed the introduction of more reliable solid-state controllers, but their capabilities did not offer many facilities that the first generation could not provide. That major advance came with the introduction of microprocessors, which Howard will describe in the next section.

Significant Changes due to the change from Solid-State to Microprocessor signal controllers in the early 1980's - by Howard Saffer

In the early 1980's significant changes in UK traffic signalling were made possible through the phasing-out of solid-state controllers and the introduction of Microprocessor-based signal controllers.

To quote my earliest signalling mentor, Terry Carter from Lancashire County Council (in a 1988 technical paper) – "Microprocessor-based control of traffic signals has removed certain difficulties and opened up a wide range of control options."

First - let's consider the signal controller market in the late 20th century.



Let's now take a brief look at some of the most significant changes that occurred.

1. Controller specification methods

Solid State signal controllers

These controllers were electric (rather than mechanical), and included electronic circuit boards, but the signal control methods were hard-wired – in the factory or on site. The control logic was normally defined and implemented by signal controller installation engineers from the supplier, based on simple staging diagrams and timings supplied by the Client. Changes of control methodology required re-wiring on site – a problematic and (we might now say) risky change method in live traffic situations. It was rarely done unless a very significant problem required addressing. Timing changes could be done by changing screw plugs on a circuit board, or by rotating dials with numbers on them.

Microprocessor Controllers

The separation of the Controller Firmware (which was tested and approved separately) from the Site Configuration was a very significant change and improvement. The configuration could be tested in a factory and modified as required before installation on site. It could also be modified later and tested on a test bench in a factory, and then the configuration Eprom installed on site (at a quiet time) with minimal risk to road users. Timing changes were done using a controller handset with an RS232 connection. Later small computers and programmable handsets became available to use for this too. Timings could be downloaded from the controller (and in some cases, new timings uploaded to the controller). Later developments provided full controller software emulation in the office or factory, so that revised configurations could be fully tested without needing to electrically test them on a test bench controller.

2. Integration of facilities into the signal controller

Solid State Controllers were very limited in their facilities. They had to be modified to allow UTC control (a 106 interface) – as well as needing an OTU. For Cableless Linking, a separate unit was required (a CLU), and other facilities were either difficult to implement or were not yet available (Hurry Calls, Bus Priority, MOVA, etc.).

On Microprocessor controllers – The range of control facilities available was extended even on the earliest controllers. These facilities started to be integrated into the signal controller – using both hardware and software. This increased flexibility and operational efficiency at junctions and reduced overall equipment costs – but led to longer MCE0141 controller specification forms and longer test periods!

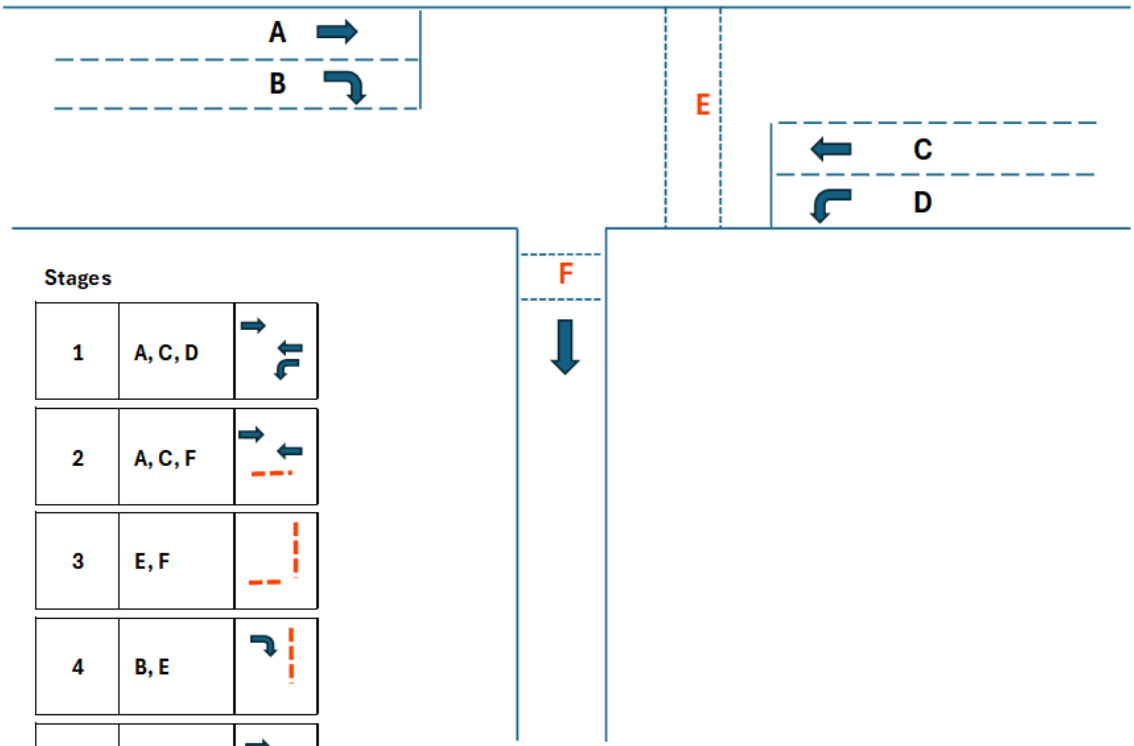
3. Stages and Phases

Solid state controllers had only stages and stage related timings – mainly minimum greens, maximum greens, stage to stage intergeens and vehicle detector extensions (although these could be separated by X, Y and Z detectors - or combined together in various ways). However, if there were two approaches on a stage, the X, Y, Z combinations were merged for the two approaches.

Microprocessor controllers still used stages, but phases were defined separately, and all timings became phase based. This allowed phase delays on starting and ending stages, and phase-based detector (and other equipment) demands and extensions. Phases could be demand-dependent in stages, or in a window at the start of a stage – and different phase starting and ending conditions became possible. Phases could also run in multiple stages. Duplicate stages could be used in longer stage sequences to avoid problematic stage sequences for the busiest phases. Dummy Phases were introduced (which weren't attached to any real traffic phase) as a way to control signal timings normally on multiple stage changes, or for complex stage changes.

4. Stage change mechanisms (including Ripple changes)

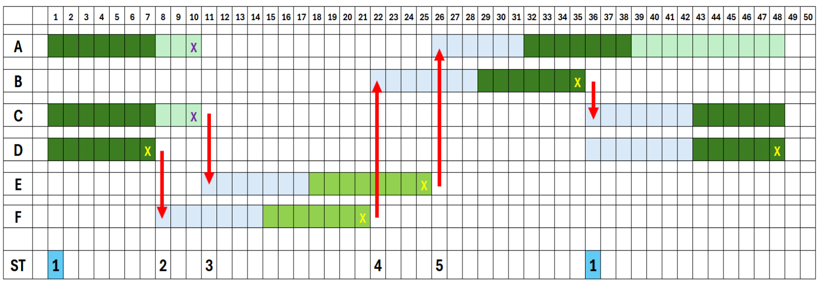
Solid state controllers had basic stage change mechanisms, for VA (Vehicle actuation) gap changing by stage. Control logic was normally determined by the



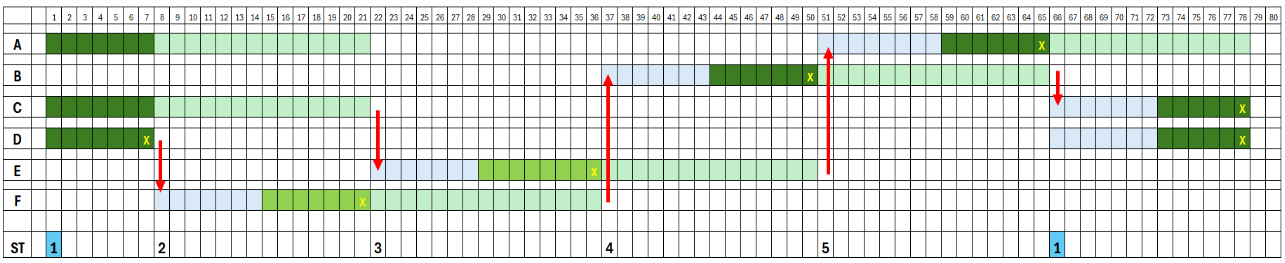
Stages

1	A, C, D	
2	A, C, F	
3	E, F	
4	B, E	
5	A, B	

Signal Timing Diagram - Ripple Stage Changes



Signal Timing Diagram - Standard Stage Changes



controller manufacturer. VA using system D loops (XYZ) was very common, although Fixed Time and Manual control was still used. UTC was added as systems were introduced, but MOVA and Bus Priority did not exist then. Speed Discrimination (SD) and Speed Assessment (SA) were available to extend stages and/or intergreens if required. Other options (e.g. Cableless Linking, VariMax, Flexible Progression) were available with equipment additions but the latter two were rarely specified.

Microprocessor controllers opened up stage change mechanisms completely by the use of Boolean logic enabling more complex stage and phase transitions. VA and UTC started to become the most common control methods, although CLF (now integrated), Fixed Time and Manual were still available. Ripple stage changes (for fast but safe multiple stage changes in some situations) became possible – making the operation of some junctions more time efficient. Other control methods were still available (SD and SA) and new options were introduced initially or over the years – e.g. Hurry Calls, Bus Priority, MOVA and LRT (tram).

5. Parallel stage streams (PSS)

Solid State controllers could only operate what we would now call a single Parallel Stage Stream – i.e. one set of stage changing conditions at a single node.

On Microprocessor controllers, one of the early manufacturers and innovators (Ferranti) introduced the concept of Parallel Stage Streams early – effectively running two or more 'controlled junctions' or 'nodes' on the same controller. This caught on slowly, and other manufacturers responded by adding this facility later. It was a very significant improvement for complex junctions and signalised roundabouts, as time synchronisation problems were eliminated. Cross-linking streams using complex Boolean conditions helped improve precise control operation. Addition of pedestrian streams within junctions also became viable.

6. Timetable, timings and modes of operation

Solid state controllers mostly had only two operational control modes (VA & FT) and one set of timings in operation. Additional control or timing sets required additional hardware (e.g. for Cableless Linking) which included time clocks. Swapping between modes therefore mostly only arose if CL or UTC was being used.

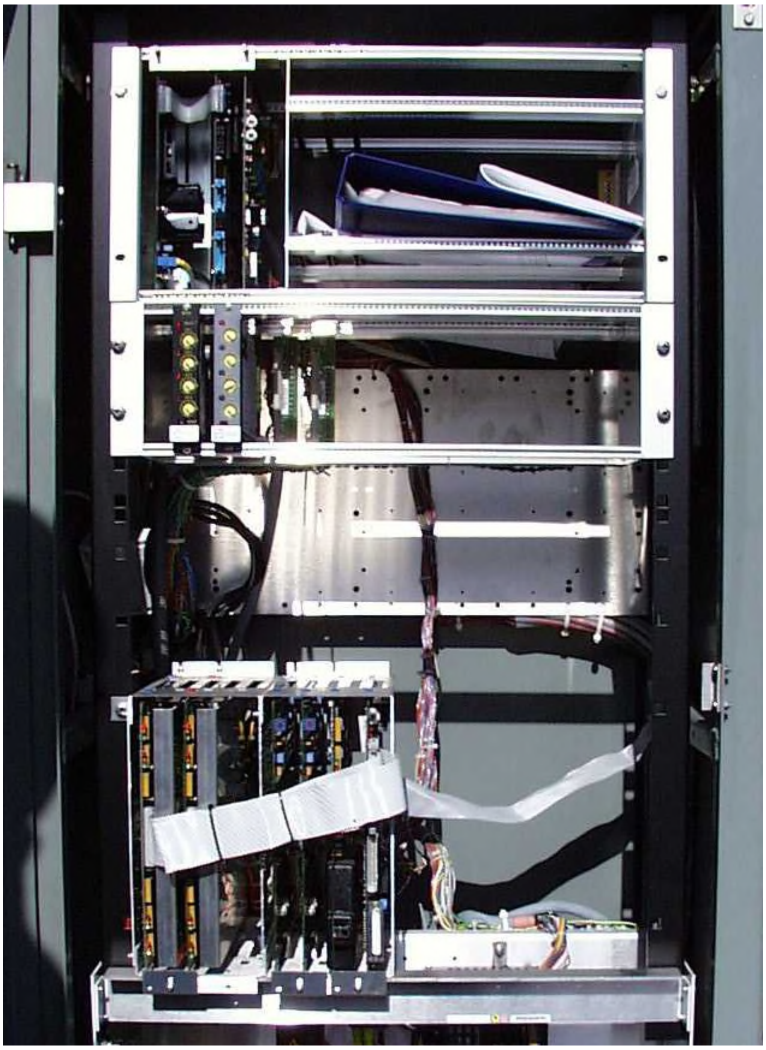
Microprocessor controllers included a time clock, and allowed multiple facilities defined as modes (such as CLF, and later Bus Priority, MOVA and LRT, etc.) and multiple timing sets for each facility - which could all be switched by time-of-day.

7. Timing accuracy

Solid State controllers' timings were adequate, but not very accurate by today's standards. Timings for cableless linking along a corridor could be problematic due to time clock drift at different controllers, and if the timings were critical, they had to be re-synchronised manually on site or through UTC.

Microprocessor controllers had more sophisticated and accurate electronic timing, and even without UTC, time synchronisation was less of an issue.

GEC 25 Solid-State controller



Siemens T400 Microprocessor Controller

8. Fault monitoring and safety

Solid State Controllers had limited monitoring of the signal displays that appeared on street. Whilst they couldn't drive conflicting greens, short circuits and other electrical faults on street equipment could result in potentially conflicting signals to drivers. Basic detection faults could be identified, however there was no possibility of automatically logging faults.

Microprocessor controllers introduced electronic lamp monitoring – relating to the condition of signal displays – both driven by the controller and as a result of any electrical faults that might arise on site. Several types of sophisticated checking were introduced to prevent green conflicting signals arising. Other fault checking also became available for detection and the operation of other facilities. The introduction of controller fault logs assisted fault finding and maintenance and gave greater confidence in the safe operation of the signals.

Concluding

There were also other important changes introduced, and these have increased and developed further over the last 45 years, to make the UK microprocessor signal controller an incredibly flexible and efficient control device – even if requiring a long learning curve for new signal engineers to understand and use well.

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