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RPC Application on 'Horton'

APR 2005

Introduction

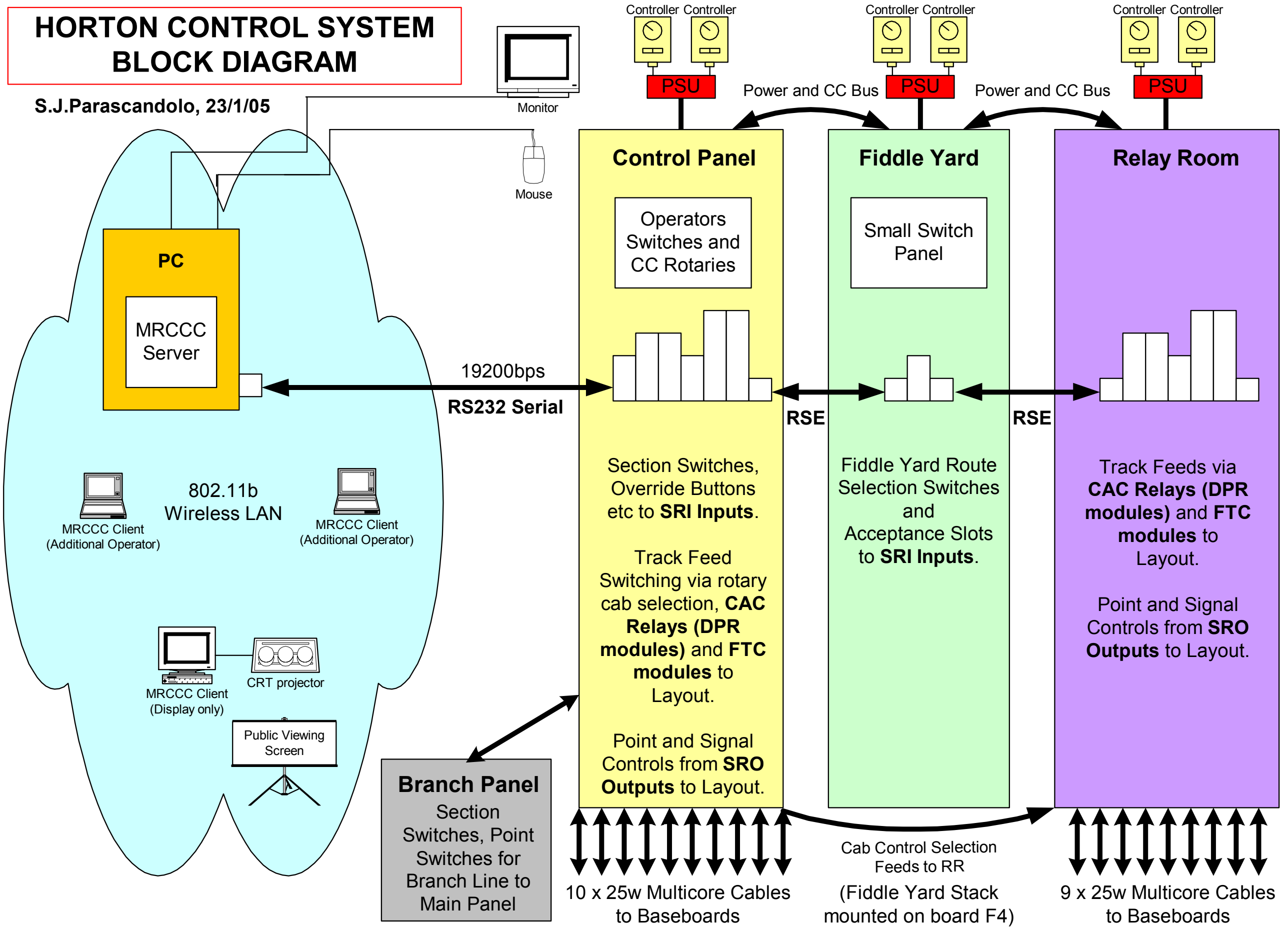
The MERG Remote Panel Control (RPC) system is a family of modules designed for interfacing model railways to a computer. The modules are well designed, cheap, fully documented and superbly supported by Gordon Hopkins [M328]. Details can be found in the G16/x series of Technical Bulletins.

The Beckenham and West Wickham Model Railway Club's 'Horton' layout is one of the largest applications of RPC equipment. The current total is:-

- RPIC [RPC Processor Module] – 1
- SRO4 [32-bit output module] – 5 (160 outputs)
- DPR [8 Double Pole Relays] – 19 (152 relays)
- SRI4 [32-bit input module] – 4 (128 inputs)
- FTC [8 Floating Track Circuits] – 11 (88 TCs)
- RSM [Remote Stack Extension Master] – 2
- RSS [Remote Stack Extension Slave] – 2
- PMR1 [Point Motor Driver] - 59
- SD4 [Signal Driver Module] - 31

This Technical Bulletin details how the system was applied to the layout. <u>This is not theory; this is a real, working application of the technology and I hope MERG members find the details useful</u>.

The block diagram below shows the high level overview of Horton's Control system, which should be referred to throughout this Bulletin. Photographs of the Panel and PC and the 'Relay Room' described are also included (see Figs. 2 and 3 on page 6).



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Horton

Horton is a 32' x 10' modern-image OO layout representing the period 1995 to the current day, and the layout plan is shown in Fig. 1.

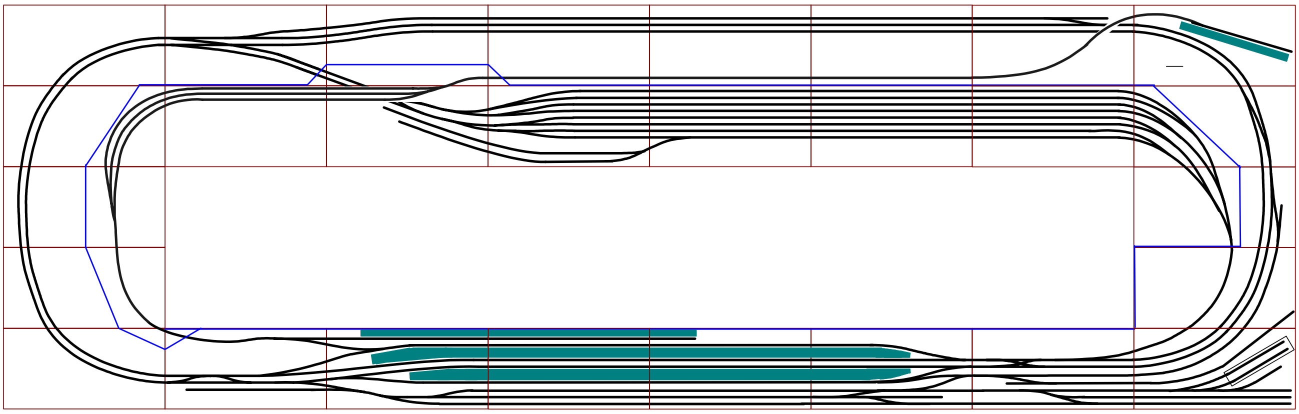

Fig. 1. Horton layout plan

Essentially a two-track oval with all round viewing, one side is a large station with five platforms; loops off the mainline and a branch bay. Three freight reception lines are provided, giving access to the small MPD (Motive Power Depot) and unit stabling sidings, and access to a future freight branch. A passenger branch line climbs from the bay, behind the backscene, running at a higher level along the other side of the layout where the mainline has a long freight loop in one direction, before crossing it to access a single-platform terminus.

A parallel fiddle yard runs inside the backscene on this side, joining via a double junction at the back, and a single lead junction into the station at the front. A bi-directional relief line runs from the station around one end of the layout.

Horton is a layout centred on 'operations'. The scenery is pleasant to look at but the focus is on realistic prototypical operation of trains and signalling. This reflects the team: we have two professional signallers, a signalling designer, two signalling maintenance engineers, an operations controller and platform staff on the team. Unlike many layouts, signalling is not only provided but provided realistically and is fully functional and prototypical. 4-aspect colour light signalling is provided; these include junction indicators, call on and ground-position light shunting signals.

Horton can be found on the Web at http://www.bwwmrc.co.uk

Power Supplies

A standard PSU (Power Supply Unit) was developed to provide the required supplies to the modules and the layout and controllers. The design of this is described in TB G16/82. Three identical units are connected using 25-way 16/0.2mm cable with some functions on more than one core to cope with the current. A Power and Controller bus is provided to link the Control Panel, Fiddle Yard Panel and 'Relay Room'. In addition a number of cab selections are fed to the 'Relay Room' via a dedicated cable. The architecture is such that a total PSU failure can be overcome with only the loss of 2 controllers by simply 'patching' supplies on tag strips on board F4.

Software

The RPC system is connected to a PC, running the Model Railway Computer Control Centre (MRCCC) application that I have developed for Horton. It is closely based on real life UK VDU (Visual Display Unit) signalling centres and looks similar to simulations such as *SimSig* or *PC Rail*. The software provides real time display of signals, points, routes and the trains' locations and gives Entry-Exit route setting to the operator.

A comprehensive signalling interlocking is built in, including aspect sequencing and user feedback. The software also uses its route setting knowledge to pick relays for the CAC system (see Traction Power), and to interlock the traction supply with the signalling, again using a relay interface.

The software is fully configurable and is available on the Web. For full details, refer to TB G16/85.

Interfacing the Layout

Signals are manufactured by Roger Murray Colour Light Signals and driven from SD4 driver modules to reduce the number of control wires. All points are motorised with SEEP motors and PMR1 point driver modules. These are located on the baseboards. Each section feed is taken back to the Relay Room or Panel. The Panel and Relay Room connect to the baseboards using 25-way 7/0.2mm cable. Boards simply connect to the nearest box to reduce cable lengths.

The RPC stack is split into three; starting with the main panel housing the RPIC processor (with RS232 link to the MRCCC Server PC), inputs from the main panel to SRI modules, outputs via SRO4 modules to points and signals, FTC track circuit modules and some traction relays, all for those boards fed from the panel. The Remote Stack Extension system of RSS and RSM modules is used to extend the stack to board F4 where inputs from the fiddle yard panel are read in, and on to the Relay Room with relays for traction power, FTC track circuits for sections fed from the Relay Room and the SRO outputs to signals and points. Standard Category 5 network cable and connectors are used to join the RSS and RSM modules to make up the RPC datalink between parts of the stack.

The RPC system has been used together with the PC to also provide a transmission system between the Panel and the Relay Room. Section Switches and Cab Control selection switches for the area of the layout fed from the Relay Room are wired to SRI inputs at the Panel. The PC monitors the states of these inputs and drives corresponding SRO4 outputs or DPR relays in the Relay Room.

Traction Power

Traction power is a 6-controller conventional cab control system with rotary switches to select the controller on the main line and the Computer Assisted Cab Control (CAC) system dealing with the station and junction areas. Refer to TB G16/87 for details. This allows complex bi-directional moves to be carried out easily with the junction's controller allocated by point position, provided by the PC. Refer also to the Traction Power example below.

Operations

The layout is operated by a signaller who uses the PC to set routes and observe the passage of trains. The signaller also has a large panel for conventional DC traction control. Up to 6 drivers have a controller and it is their job to drive the trains to the signals and listen out for instructions from the signaller, or if one is available, the layout controller who directs movements. The drivers are located outside the layout with hand-held controllers. This keeps them clear of those operating the layout and allows them to interact with the public at exhibitions. A Fiddle Yard operator calls the stock on and off the layout and uses a small Fiddle Yard Panel to set points in the yard and operate Acceptance Slots which are interlocked with the routes into the yard.

A Branch Operator has a small slave to the main panel, purely to keep him clear of the main panel and out of the way. The main panel is a demanding job at exhibitions and if the full flexibility of the system is used, the mainline may have two trains on the move in each direction and not just going round and round, but also crossing each other's paths, overtaking and slotting in special workings.

A Shunter operates the yard and depot. The section switches for the yard are 'virtual', existing only on the computer screen with relays picked as required. This allows the yard operator to do all his moves without interfering with the main panel. This is achieved through a 'client' version of the MRCCC software that enables additional operators to share control of the layout with the computers connected using a wireless or fixed LAN (Local Area Network). The MRCCC client will soon be ported to the Pocket PC platform and can then be run on a handheld PDA with a stylus used to select routes wirelessly. This is 21st-century model railway shunting!

The Client Application includes a 'supervisor' mode, which is an indication-only version, and this allows PCs to be used to display the control screen to the viewing public. A projector can be used or a PC placed somewhere else within the venue. In theory, with an Internet connection in place, the layout could be operated remotely from anywhere!

Route Setting Example

As an example of how the system works, consider the case of a route being set by the operator:-

The signaller left clicks on the entrance signal on the PC, followed by left clicking on the exit signal to the route (the next signal along the chosen path).

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The MRCCC software checks a route exists between the two signals and then if it is available. This includes:-

- Does it conflict with any other route currently set?
- Are all track circuits within the route clear?
- Are all points, including the opposite end of crossovers and any points required for flank protection free to move and not locked.
- Are any required Slots given? e.g. for moves into the fiddle yard.

If the above checks are successful, the software calls the points required. This changes the symbol on the screen, looks up the RPC output bit relating to the control to the points in question, and changes the state internally.

Another thread of the software is continuously composing RPC Type 0 messages based on this internal state, and the RPC message is transmitted to the RPIC processor which puts the data on the output line which extends via the RSE modules through to the Relay Room.

The RPC module outputs change state, which are wired to the PMR1 driver modules on the baseboards. These sense the change of state and discharge the capacitor to the SEEP motors to operate points as required.

The route lights on the PC then illuminate showing the path that is to be taken.

Another thread in the software evaluating signal aspects then realises that the entry signal can clear to better than red and checks the aspect of the signal ahead in order to establish which aspect to change to. After working out the output combination for the aspect, the RPC outputs for the signal controls are changed and transmitted to the RPIC. The SD4 module decodes the inputs it is given and the logic outputs on the module change, causing the LEDs in the signal head to change.

The software calculates if any junction indicator is required and if so, this is also sent via the RPC system to the baseboard to light the indicator. Aspects of the signals in rear will then update to a better aspect.

Finally, the software will release relays interlocked with the traction supply to allow the train to be driven past the signal which is now at a proceed aspect.

All of this happens within a fraction of a second of clicking on the exit signal. 133 routes are configured on Horton.

Traction Power Example

Having set the route, we need to connect the controller to the track to power the train. This may sound cumbersome but in practice, most of the Cab Control settings and section switches are not changed during operation as a result of the clever design of the CAC system.

The background colour to the track section identities on the panel relates to the colour under the relevant Cab Control area rotary switch. The rotaries are changed to the required controller. The controller is now connected through to the section switches (for those sections fed from the panel), or down the Panel to Relay Room cable to the section switch relay (for those sections fed from the Relay Room). The section switch relay is controlled by the PC based on the setting of the switch on the panel that is wired to an SRI input. From the section switch (or relay), the power passes through the FTC track-circuiting module to the baseboards via multicore cable and then onto the rails.

For sections in the station area, the Cab Control selection is made for the plain line area outside the station only. Two-way centre-off switches in the platforms are used to select which direction to get the power from. Relays for each point (controlled by the PC) then connect the correct Cab Control output to the sections in the platform (if the points are set that way), and also to any sections required through the junction area.

For sections approaching controlled signals, an additional relay – the ATP (Automatic Train Protection) relay – is included before the FTC module. This is controlled by the PC to release only if:-

- The signal is showing a proceed aspect, OR
- A train is passing the signal in question (the front vehicle having replaced the signal to danger), OR
- A route is set through the section in the reverse direction, OR
- The override push switch on the panel has been pushed – useful for call-on moves or ‘cheating’!

With the signal showing a proceed aspect and the traction power connected, the train may be driven from the selected controller.

Designing the system

After determining the track plan (which was driven from operational requirements), system design started with the signalling plan. This identified all points and signals. Baseboard joints were added and Cab Control areas identified. Sections requiring relay interlocking with the signalling (ATP relays) were marked. From this, cable schematics were produced for each baseboard and the most economical method of feeding each item of equipment or track feed worked out to fit into convenient connector sizes. In some cases, one board may then feed an adjacent one via a smaller connector, making up a well-loaded 25-way cable to the Panel or Relay Room. Having split the baseboards between the Panel and the Relay Room, the RPC stack was drawn up, identifying all the inputs and outputs from the RPC system.

All drawings were done in MS Excel and checked and reworked many times. Once happy with the design, RPC modules were ordered and baseboard wiring commenced. Each baseboard was wired to a tagstrip and then a 25-way socket. Each function was tested to the connector. The Panel and Relay Room layouts were drawn up to scale in MS Visio before they were constructed. Tagstrips were provided in these as well to ease fault finding and construction. Excel was used to produce this automatically from the cable schematics. Excel was also used to calculate the RPC bit numbers for each function based on the position within each module and the module's position within the stack in accordance with the RPC documentation.

The MRCCC data was painstakingly entered, mostly on a laptop computer as I travelled by train around the country for work. The layout of the screen was worked out and designed to fit the screen. Each element was referenced as required to ensure correct animation. Then all the routes were entered according to a pre-prepared Route Table that had been drawn up. Interlocking details and lists of conflicting routes were also entered. The design mode of the MRCCC software validates all the data as it is entered to ensure all cross-references are consistent and workable. All input and output bits were checked against the spreadsheet.

With this complete, the MRCCC test mode was used to check the interlocking without the layout. In parallel, the detailed design of the CAC system was developed and circuit diagrams produced. The Panel and Relay Room were wired and tested to the drawings. And in true model railway style, the wiring was completed minutes before the layout was loaded into a van for the first show! Most of it worked as intended!

Sample of RPC Functions Spreadsheet

Stack	In/Out	Code	Position (from Stack)	Bit within Module	Bit within Stack	RPC Bit	Function
Relay Room	Out	SRO4 E	21	17	81	**185**	P137
Relay Room	Out	SRO4 E	20	22	86	**190**	P138
Relay Room	Out	SRO4 E	19	18	82	**186**	P139
Relay Room	Out	SRO4 E	18	23	87	**191**	P140
Relay Room	Out	SRO4 E	17	19	83	**187**	P141
Relay Room	Out	SRO4 E	16	12	76	**180**	P142
Relay Room	Out	SRO4 E	15	8	72	**176**	P150
Relay Room	In	FTC H	5	3	27	**155**	RA
Relay Room	Out	DPR R	3	2	194	**298**	RA
Horton Panel	In	SRI4 A	10	22	22	**22**	RA SS
Relay Room	In	FTC H	6	2	26	**154**	RB
Relay Room	Out	DPR J	2	7	135	**239**	RB
Horton Panel	In	SRI4 A	9	23	23	**23**	RB SS
Relay Room	In	FTC H	7	1	25	**153**	RC
Relay Room	Out	DPR J	1	3	131	**235**	RC (ATP)
Horton Panel	In	SRI4 A	8	24	24	**24**	RC Ovr
Horton Panel	In	SRI4 A	7	25	25	**25**	RC SS
Relay Room	In	FTC H	8	0	24	**152**	RD
Relay Room	Out	DPR K	8	4	140	**244**	RD
Horton Panel	In	SRI4 A	6	26	26	**26**	RD SS
Relay Room	In	FTC I	1	7	39	**167**	RE
Relay Room	Out	DPR K	7	0	136	**240**	RE (ATP)
Horton Panel	In	SRI4 A	5	27	27	**27**	RE Ovr
Horton Panel	In	SRI4 A	4	28	28	**28**	RE SS

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Fig. 2. Control Panel and PC

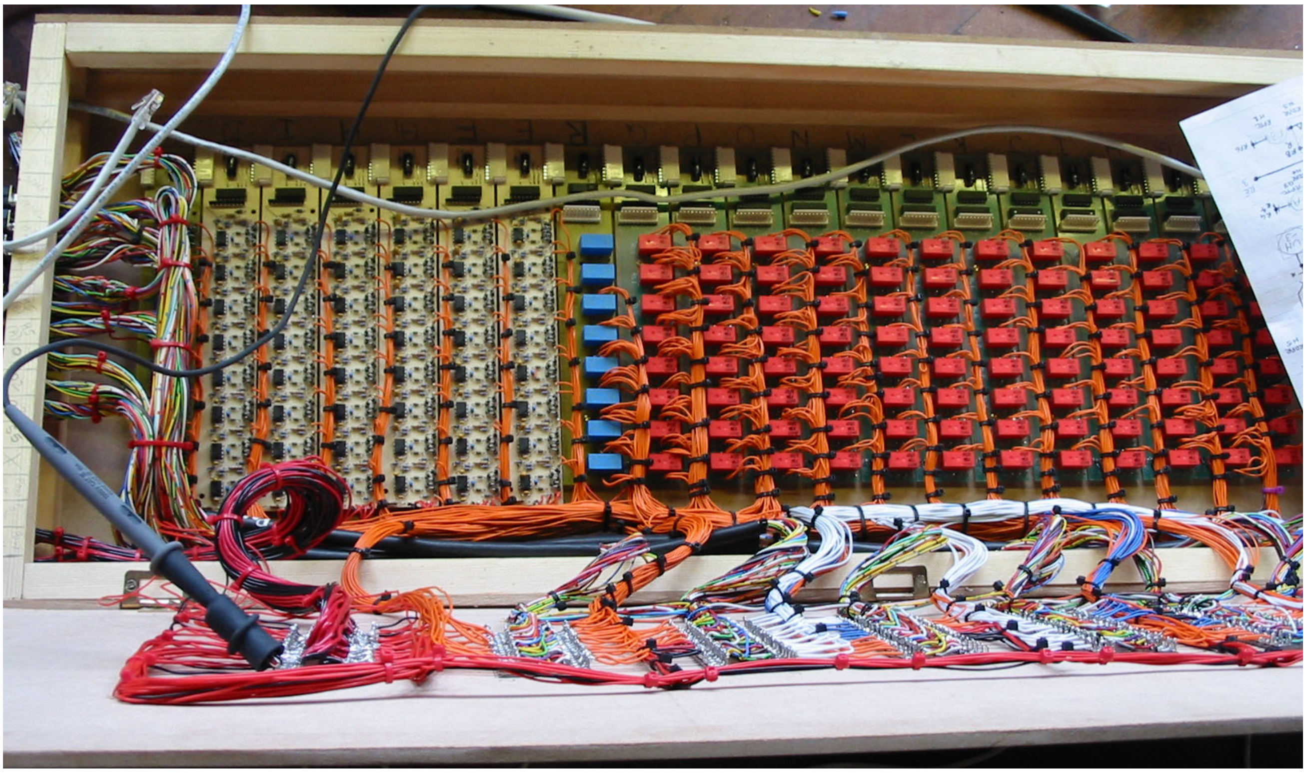

Fig. 3. The 'Relay Room'

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