

The MERG DCC System (a summary and overview), Revised 26/2/03

Although commercial DCC systems are readily available, some consider these as expensive and over-complex for the needs of the British enthusiast. Most systems (Lenz and ZTC excepted) are of US origin and all really cater for the American or Continental modeller. As a result, DCC has not really taken off in the UK in the same way. Also, as MERG is a grouping of electronics enthusiasts who may prefer to build their own systems even if they could buy what they wanted ready made, it was suggested that we might try to develop a DIY system. A trawl of members views produced the inevitable result. An easy to make, easy to use cheap system that did everything the most expensive commercial systems did! As I had a simple system up and running I made a token gesture to the 'idealists' and merely improved what I had for starters. Then it just grew and grew!

DCC systems can be broken down into a few constituent units.

1. **The Decoder.** This is the bit that goes in the loco or controls accessories.
2. **The Command Station** This generates the DCC information that is eventually sent to the track. (The clever bit). The loco controls may be on the Command Station box but more usually are on separate 'handsets'
3. **The Booster** A brute strength unit that puts the DCC signal onto the track at high power.
4. **The Programmer** Used to set up the decoders to do what you want. In most commercial systems the programming is done via the Command Station and booster. While this may be cheap it has many disadvantages. We felt a separate programmer would be useful, especially for club layouts.

Most of the operating problems (and much of the cost) of commercial systems lie in the Command Station / Handset arrangement. Some are fiendishly difficult to use.

Decoders are relatively cheap but difficult to make and boosters are really no more than power switches with several DIY designs published. It made sense to start with a Command Station system which was suitable for DIY but could be used with most commercial decoders together with a separate programmer and booster. The booster (Boost5) has an auto reverse facility and the design is very flexible in that the power supply can be separated and/or uprated for larger scales with currents over 10 amps and voltages to 50 or more if ever required. This booster can be added to other (commercial) command stations as well. However, for smaller layouts and 'home' use a simpler combined command station and booster was later developed (BC1A) which has proved very popular.

To accompany the command station / boosters is a very useful 'stand alone' programmer together with several decoder designs, an auto reverse and block cutout module, a complete accessory system and lighting unit.

All information required to build the MERG DCC system including PCB layouts and PIC source code is available for non commercial use on this [website](#).

Brief specification for the Command Station and Handsets

The handsets and operating principle are common to the separate units and to the BC1A combined unit.

The separate command station

8 handsets maximum (8 locos at once)
Produces logic level DCC to drive a booster
6 way RJ12 handset connectors
Needs a 5v supply at about 20mA (built in on BC1A)
Each handset fits a diecast box 100mm x 50mm x 25mm (nice size!)
00 to 99 address range set by thumbwheels (no extended addressing yet)
Speed control by conventional knob and potentiometer.
Analog loco control on address 00 (stretched zeros, not for ironless motors!)
Four function selection by pushbuttons. (push ON, push OFF)
Loco direction by simple on/off switch
User selectable speed modes of 14 step, 28 step and 128 step on each handset. Modes can be set while running so you can easily change between locos with different types of decoder.

There is a full lockout and alarm system to prevent two users selecting the same loco. Speed must be zero before a loco can be selected. (safety feature)

The system allows for four 'consists' of up to four locos in each. The consist roster is stored in the command station and does not use 'advanced consisting' in the decoder. Adding and removing locos from a consist is very easy.

The BC1A unit is rated at 5 amps and 16v maximum. It does not have the auto reverse capability of Boost5 and has only 4 handset sockets on the box. However, there is a multi way connector on the PCB which gives access to all 8 channels via an extender board. This also provides a low level DCC signal for additional boosters.

The boosters have automatic overload cutout and an alarm.

The BC1A PCB has facilities for a serial link to a computer. At present the microcontroller code for this is still under development but the intention is to make it LocoNet™ compatible.

Decoders.

The MERG decoders have evolved over several years from a conventional HO / OO size 2 amp version with 5 function outputs, 128 speed steps and 8 effects (Decoder 10) to the latest with high frequency PWM (silent) and fully adjustable back-emf feedback (BEMF) in Decoder 12 and 13. While electrically the same, Decoder 12a is built on a double sided PCB designed by our colleagues in South Africa and available to MERG members in kit form. Decoder 10 and the smaller Decoder 11 are also available in kits for members. Decoders 12, 12a and 13 are 'state of the art' designs which compare favourably with any commercially available. The combination of HF PWM and BEMF is particularly attractive as it gives outstanding low speed running but without the annoying buzz of LF PWM decoders. It is also ideal for coreless motors and both decoder and motors run significantly cooler.

The accessory system

The intention of this system was the control of a (large) number of point motors but with less wiring than usual. Also it had to operate like a 'normal' layout with switches on a control panel. The DCC standard allows accessory commands to be sent through the track and in commercial DCC systems, these commands are initiated by the handset. I have tried such a system (Lenz) and found it virtually impossible to control points and the loco at the same time with the same handset, especially as one handset runs two locos. The MERG system completely separates the accessory functions from loco control.

The DCC signal is generated by an encoder. This is a simple piece of electronics which uses a PIC microcontroller and a multiplexer chip to scan an array of switches. These are simple on / off switches which can be incorporated in a 'layout diagram'. The direction of the rocker indicates the set route and there can be upto 128 such switches. The encoder scans the switch array continuously and detects any changes.

The accessory command is sent when a change is recognised.

When first switched on, the encoder sends commands to all the point motors so the points are set to correspond with the switches. There is a reset button which has the same effect.

The NMRA standard only allows for four pairs of outputs in a decoder for each accessory address. (However,

a decoder can respond to more than one address).

The position of the switch in the matrix determines which address and which function within that address is activated. e.g. column 0, rows 0 to 3 send to address 1, functions 0 to 3, that is four switches controlling four points. Column 0 rows 4 to 7 send to address 2, column 1 rows 0 to 3 are address 3 etc. The arrangement gives 32 consecutive addresses.

Two different decoder designs are available. The first was designed for solenoid point motors taking pulses of DC. Experience of Peco solenoids showed a DC of more than 12v and ideally around 30v was required for reliable operation with a capacitor discharge system. (solenoid force is proportional to the square of the current and the energy in a capacitor is proportional to the square of the voltage) Consequently it was decided not to power the decoders with 'track' voltage but a separate AC supply. This also removed the need for a booster. The DCC signal is at 12v level and the decoders are opto coupled. This arrangement gives a 4 wire bus round the layout. The point motor decoder (Accdec2) has its own capacitor discharge unit with current limited rapid recharge and on board diodes for the solenoids. An additional 12v DC is available and the PCB allows outputs to be reconfigured for non-pulsed operation for lights or signals.

The decoder CVs can be set or read using a conventional programmer.

Another MERG member has adapted the decoder to work from the track or a single pair of wires.

The second accessory decoder design (Accdec3) is a flexible design suited for motorised switches (Tortoises etc.) and / or lights, signals and LEDs (series resistors on the PCB)

The accessory system can be used just to control point motors and signals etc. without having DCC for loco control. It also remains operational if the track is shorted!

The auto reverse and cutout module (ARC)

This small unit fits between the booster and a track section. The cutout action is very rapid and the main booster should be unaffected. On detecting a short, it initially reverses the track polarity. If this clears the short normal operation resumes. If the short persists it cuts the current and retries at about 1 second intervals. A light and / or alarm can be fitted.

The FLASH unit

This was developed to give realistic alternating ditch or Gyra lights when using white LEDs. It fits in a loco and is operated by the decoder function outputs.

Information on all the system components is available in the ['matrix'](#) later on this site.

Mike Bolton 26/02/03

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