Model Electronic Railway Group

TECHNICAL BULLETIN DCC11/14
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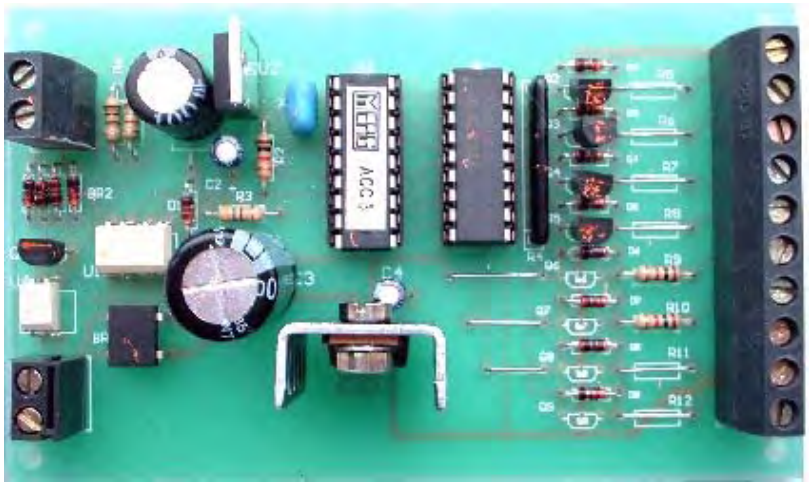
MERG DCC Steady State Output Accessory Decoder (Version 3B)

JULY 2006

DCC in
Terminal Block [J2]

AC Input
Terminal Block [J1]
12-15V AC



Output Connector [J3]

1N)	Function 1
1R)	Output
Common	+12v
2N)	Function 2
2R)	Output
3N)	Function 3
3R)	Output
Common	+12v
4N)	Function 4
4R)	Output

Fig. 1 The assembled MERG DCC Steady State Output Accessory Decoder and its connections

This Technical Bulletin (TB) is based on information provided by Mike Bolton [M786], the designer of the MERG DCC system. Modifications at issue 3 by Edwin Marks [M1876]: Dual address mode added, more information on use with Lenz systems, various clarifications.

Statements made regarding Lenz command stations are based on experience with a LH100 with software version 30 and LZV100 with version 35, both purchased April 2005. It is expected that other Lenz equipment such as the LH90 will operate similarly. However, the Lenz Compact is different in a number of ways including how CVs are set, and at least one user has needed a 1K resistor across J2 during programming so the Compact will recognise the decoder.

Introduction

The **Steady State Output Accessory Decoder** of the MERG DCC Accessory System is primarily designed for driving four motor-driven point (turnout) motors such as Tortoises that require only a low drive current, typically of the order of 25-50 milliamps (mA). However, it can be configured to power any other 'device' requiring a low current that is normally maintained for as long as the control input to the MERG DCC Encoder requires. Thus, for example, Light Emitting Diodes (LEDs), filament lamps, small motors and relays, Memory Wire etc, can all be controlled by the outputs of the Version 3B Decoder, subject to the separate and total current limits of the outputs.

While it is specifically designed for 'stand-alone' operation in conjunction with the MERG DCC Accessory Encoder, it is also designed to conform to the NMRA (National Model Railroad Association) DCC specification and so may if desired be operated by a 'conventional' DCC accessory command picked up from a DCC track feed/bus.

As the steady state decoder is intended for outputs which are not pulsed, the default settings with the ACC5 PIC are set to continuous on. If pulsed outputs are required, the timing CVs must be changed. (Note: Some earlier versions of the ACC5 PICs supplied with the MERG kits did have the timing CVs set for pulse operation. See later in this TB for checking / setting these CVs).

In many applications the decoder outputs are required to operate in inverted pairs, where one output is activated (pulsed or steady) when a function is set, and the other output activates when the function is reset. It is also possible to operate the outputs independently. This may be achieved in two ways. Certain commercial command stations (but not Lenz) allow the eight bits of a decoder address to be operated independently. For other systems (including the MERG encoder and Lenz command stations), the decoder (when fitted with the ACC5 PIC) can be configured to respond to two different decoder addresses, each of which controls four of the outputs.

<u>The decoder does not take its power from the track and needs a separate 12-15V AC, 50/60 Hz supply for programming and operation</u>.

A number of Decoders of both the Pulsed and Steady State types can run off a single low voltage transformer - how many must depend on the demands of both the Decoder outputs (some point motors draw heavier currents than others) and any other modules etc that draw current from the same source. Pulsed Output Decoders (see DCC11/13) do draw a significant recharging current for a second or so, and this could briefly pull the input volts below the level necessary to maintain the regulated 12V outputs, with a momentary dimming of any lamps or LEDs

driven from the other Decoders on the same AC supply. Should this become apparent, feeding Pulsed and Steady State Decoders from separate transformers may be preferable.

(Tip! Running two or three spare pairs of wires while cabling the railway layout, even when DCC control of the accessories is to be used, may be worth considering at the design stage.)

Technical Description

The circuit diagram of the Decoder is on page 9.

The DCC signal input drives an opto-isolator U1, which electrically isolates both the track and the AC power. The MERG DCC Accessory Encoder provides 12 to 15V for the signal. R1 sets the opto-diode current. It is suitable for any input voltage from around 10 to 25V and as stated above this input may be taken from the track. Isolated acknowledgement (ACK) is provided through opto-isolator U4 and the switched load R6.

A PIC microcontroller decodes the DCC information and drives the 8 output transistors Q2 to Q9 via U5, the ULN2803 octal driver IC. A low-power regulator U2 provides the 5V DC supply for the PIC. The PIC microcontroller is a 16F628 running at 8 MHz, and although supplied pre-programmed, the Source code *ACC5.ASM* may be downloaded from the DCC Resources page of the MERG website.

With no requirement for short-duration heavy current outputs (as in 'capacitor discharge') a 1000µF smoothing capacitor is sufficient for the 12V regulated outputs.

Output Options

The Steady State outputs have a number of uses apart from operating motor-driven points. These are illustrated in Figs. 2 and 3.

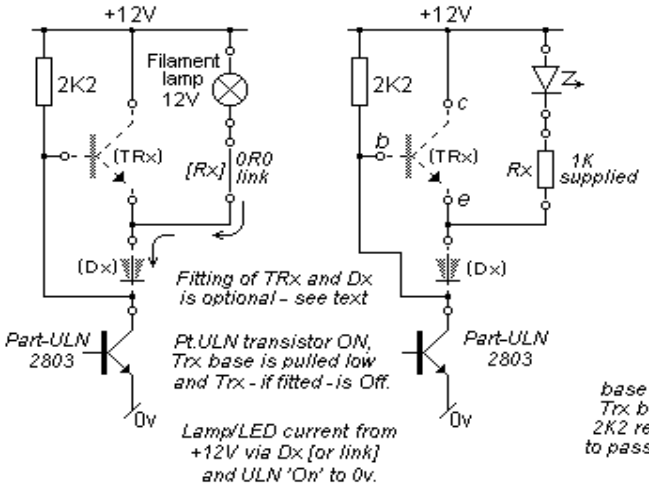


Fig. 2 Mono-polar drive **Fig. 3**

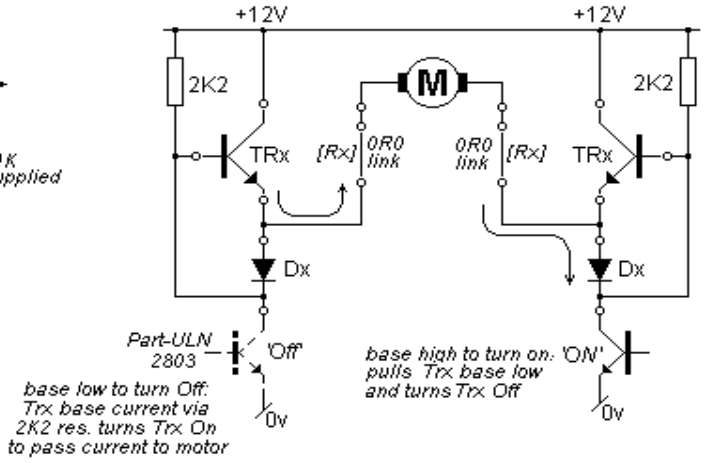


Fig.4 Bi-polar drive

Filament lamp

Fig. 2 shows the components required to drive a 12V filament lamp. The output transistor of the packaged ULN2803 (U5) is turned on when the input from the PIC (U3) goes High (H) and allows current to flow from +12V via the lamp to 0V. There will be a small voltage drop across the transistor but the lamp will be lit at near full brilliance.

Note that the transistor TRx (where 'x' refers to one of transistors Q2 - Q9) does not need to be fitted for either the Fig. 2 or Fig. 3 options, although it may be fitted in the interests of a standard Accessory Decoder. In Figs. 2 and 3, with a lamp or LED effectively bypassing the transistor, its base is pulled well below the turn-on voltage, which is effectively raised by the 0.7V drop across diode Dx (one of D2 - D9) and the transistor will remain firmly 'off'.

Should you wish to use lower voltage lamps, consider using 2 x 6V or 4 x 3V lamps in series rather than adding a dropper resistor in place of the wire link which is fitted in place of diode Dx. Should a reduced brilliance be preferred (*) and lamp(s) of the required voltage are not available then a dropper resistor will have to be used. As long as the voltage and current of the lamp(s) is known, Ohms Law is used to calculate the dropper resistance. Use the next higher preferred value (see TBs B1/1 and B2/1), and make sure that the wattage is adequate. A hot resistor isn't good for the PCB and may become an unintended smoke generator!

[* Filament lamps should if possible be run with a reduced voltage. While the brilliance will be slightly less the life will be extended considerably: a major consideration if access for replacement is difficult, and also if the lamps are in a series chain when an open-circuit failure of one will lose the rest of the chain. A 'short circuit' failure is less likely with small filament lamps, but would increase the voltage on the remaining lamps in the chain: another reason for under-running, with the resulting increase in brilliance warning that one has failed and needs to be replaced as soon as practicable.]

Light Emitting Diode

If LED(s) are to be driven (see Fig. 3), a dropper resistor is absolutely essential, even if the forward voltage of a chain of LEDs in series totals exactly 12. (Remember, the declared 'forward voltage' V_f of LEDs is a nominal figure and may vary from one LED to another even if of the same colour). TB A10/1 covers the use of LEDs in some detail, and includes the selection of suitable dropper resistors. Again, for 'scenic' functions such as station lighting, consider using LEDs in series. 'Golden white' LEDs, which more closely simulate prototype incandescent or filament lamps, are stocked by the MERG Kitmaster.

Relay

Relays may be driven subject to the current limitations: those used in most model railway applications (even from the 'one day box' stocked up with Government surplus after WW2!) are unlikely to demand anything near this current. Note that the ULN2803 outputs have built-in diodes that protect against the high voltages that are induced when the relay coil is de-energised. A dropper resistor is less likely to be needed for relays, but if, say, a 6V relay is to be driven, then a series dropper resistor will be needed, the value approximating to that of the relay coil, and of a similar wattage.

Points and other motors

Point and other **motors** requiring a reversal of the current call for a **pair of outputs** with the transistors and diodes included, as shown in Fig. 4. The '-N' and '-R' suffices refer to the 'Normal' and 'Reverse' positions of the point motor. Some commercial makes remain stalled when at full travel, and while they are designed to withstand this treatment, they will, along with point motors having limit switches which do cut off the current when the point motor is at full travel, remain as set until required to operate to the other end of travel.

Any DC motors drawing currents within the above guidelines and requiring reversal can of course be controlled. These could include turntable or traverser motors, coaling plants, rope haulage on inclined planes…

The Steady State Decoder uses the same PIC and program as the Pulse type, so each output can be set to remain on until switched off, or be programmed via the relevant CV (Configuration Variable) to remain on for up to 2.55 seconds. This should be more than enough for any known point motor to wind over the point blades; but if you have panel-mounted route indication in mind then it may be necessary to leave the output 'On' to maintain the volts needed to power the indication circuit(s).

Note that some motorised point motors do not require a change of current direction. These types have built-in changeover switching, sometimes combined with end-of-travel limit switching, which means that the motor is returned to a common supply (which may be Points Supply positive or 0V) and operation is by applying 0V or Points Supply + to one or other of the control feeds. Provided your point motors can have a return to common positive, they can be treated as for filament lamps, and fed by a pair of outputs. Reference to TB A6/1 is recommended for a full description of point motor types.

Another option could be a small relay switching the supply (or 0V) to the point motor: this would cater for point motors already installed and with a common connection to Points 0V, and also require only one output per point motor. This would also cater for point motors which have a common return to 0V, but which are driven to Normal or Reverse by applying positive or negative voltages with respect to the common 0V.

Current limits

Both the BC635 transistors and, perhaps surprisingly for a 'chip', the ULN 2803 outputs are rated at 500mA maximum. The on-board 12V regulator has a current limit of 1A above which it will shut down after a short period of overload. So while in theory two outputs could be providing 500mA each, this would be tempting fate, especially in Figs. 2 and 3, where the ULN outputs are sinking the current, and would mean that the other six outputs could not be used other than to provide a few milliamps from each.

In the Decoder circuit diagram on page 7, diodes D2 - D9 are shown as 1N4148 that are adequate for the original design for driving motors up to 50mA. 1N4001 diodes should be substituted if higher output currents are required.

A load of around 200mA should be seen as a reasonable continuous current per output, and even then, in the Figs. 2 and 3 configurations where the ULN2803 drivers are carrying the current, only drawn from 4 of the outputs. 200mA is, coincidentally, the typical current to operate memory wire as supplied in the MERG kit.

Higher currents, up to say 400mA can be tolerated provided they are maintained for only a few seconds: here, the ability to program the 'On' time for pairs of outputs for up to 2.55 seconds (see below) may prove useful if whatever requires the relatively heavy current should complete its duty within that time but could continue to draw the current if something jammed.

Should currents of around 500mA be essential, a relay driven by an output should be used, with the power for the load taken from a separate supply and carried by the relay contacts. Alternatively the 'Pulsed' decoder may be used in a steady state mode; it has the same software as the steady state decoder so can be configured in the same way to give exactly the same functions.

Remember that the 2k2 resistors comprising the ResNet will each draw 5mA when its ULN2803 output is on, or a total of 40mA with all on. This is unlikely to be significant but should be borne in mind.

Other design issues

While there is a lot of flexibility in the output options, it does mean that some decisions need to be made, preferably before assembling the Accessory Decoder, as to the uses to which it will be put. If you are looking to 'mix and match' lamps, LEDs, relays and/or point motors then it could be that a little prior planning will suggest that some Decoders are reserved for point motor driving, while others are for layout lighting etc. This means that the two types can be assembled to suit, and in the rare event that one or more needs to be changed, replacements of the appropriate assemblies could be held in reserve. Decoders could be wired as 'plug-in' modules if desired: with 10 outputs and 2 x 2 inputs a 15-way 'D' connector would probably be the most suitable.

Since the output transistors are only active when used for bi-polar driving (see Fig. 4), they can be omitted if only mono-polar outputs are required. The inclusion or omission of the dropper resistors (Rx) has been mentioned earlier. If no transistors are fitted then the 2k2 ResNet could also be left off, but if just one output pair is required for bi-polar drive then the ResNet must be fitted, and will draw 5mA for each output when 'On'.

If the Decoder has to cater for more than one type of 'load' (filament lamps and LEDs, for example) it may be preferable to fit wire links in place of all the dropper resistors, and add dropper resistors somewhere in the circuit to or from the lamps or LEDs. *This could be particularly useful if adjustment of the illumination levels after installation is required.*

The dual-address mode, described later in this bulletin, is particularly useful for driving relays and lighting circuits (with the exception of two-aspect signals), since it allows the eight outputs to be operated independently. When designing a decoder installation it is important to remember that single and dual address mode cannot be mixed in a single decoder.

Programming the Steady State Output Accessory Decoder

Configuration Variables (CVs) can be programmed (written) and read back in 'page', 'direct' or 'register' modes. The direct mode has full bit manipulation for both read and write, and this greatly speeds up reading CVs with programmers that use 'bit verify'. The MERG Stand-alone DCC Programmer (see TB DCC11/5) is of course the recommended choice, but any DCC Command Station with programming capability should be suitable (with the decoder connected to the programming track).

Configuration Variable Summary

The MERG Accessory Decoder follows the NMRA Standards & Recommended Practices (RPs) for accessory decoders with CVs starting at 513. However, many commercial DCC systems will not set CVs above 255 and so alternate (or 'low range') CVs starting at 1 can also be used. The CVs that are available on the Accessory Decoder are set out in Table 1.

CV	Alternate	Register	Description	Comments
513	1	1	Low 6 bits of Accessory Decoder address in range 0 - 63	Default as supplied = 1
514	2	-	Output enable: 1 = 'On', 0 = 'Off' for each of the 8 outputs	Default as supplied is 'all enabled' = 255 (11111111 Binary)
515	3	2	'On' time for output pair F1 (0-255)	Default as supplied = 0 (continuous)*
516	4	3	'On' time for output pair F2 (0-255)	Default as supplied = 0 (continuous)*
517	5	4	'On' time for output pair F3 (0-255)	Default as supplied = 0 (continuous)*
518	6	5	'On' time for output pair F4 (0-255)	Default as supplied = 0 (continuous)*
-	-	6	Page register	Must be 0 for register mode
519	7	7	Version number	Fixed at 5
520	8	8	Manufacturer ID	Fixed at 165 (MERG ID)
521	9	-	High 3 bits of Accessory Decoder address in range 0 - 7	Default as supplied = 0
541	29	-	Configuration	Fixed at 128
545	33	-	Selection of dual and toggle modes – see below	Default as supplied = 143 (10001111 Binary) **see note below**
* The same pre-programmed PIC may be used for both the Pulsed and Steady State Decoders, and these CV values must be changed to 5 for use with the 'pulse' decoders. Some pre-programmed ACC5 PICs may have these set to 5 by default.				

Table 1. Configuration Variables (CVs) for the MERG Steady State Output Accessory Decoder

Important Note: The current version of the software (ACC5) has dual address mode set in CV545 (CV33). Those not requiring dual address mode should unset it by writing 15 (or some other value less than 128, depending on requirement for toggle mode) into this CV. Those who wish to use dual address mode will probably have to temporarily leave this mode in any case in order to programme the two addresses. Future versions of the software may be shipped with dual address mode unset – users of later versions should read back the CV to check.

Addressing

CV 513 (CV1) and CV521 (CV9) together form a 9-bit binary address for the Decoder giving a range from 0 to 511. The terminology used can be a little confusing. It is important to realise that the range of accessory decoder addresses is separate from the range of loco decoder addresses.

Each Accessory Decoder must have a unique accessory decoder board address, which has four consecutive switch addresses for the function cells (see Table 2). The switch address of each cell is used to control the device that is connected to the output pair of the function cell.

When connected directly to the MERG Accessory Encoder, the Accessory Decoder is limited to accessory decoder board addresses 0 to 31 (corresponding to switch addresses 1 to 128).

When used with commercial Command Stations, the Decoder may have accessory decoder board addresses in the range 0 to 510 – subject to any limitations of that Command Station. [511 is defined as a broadcast address, which means that all Decoders respond to whatever commands are issued from the Command Station – unlikely to be either useful or advisable!]

Although the MERG accessory encoder starts its addressing of decoders at address 0, the NMRA recommendation is to commence the addressing at 1 and this is followed by commercial manufacturers including Lenz so accessory address 1 controls switch addresses 1 to 4, and in general accessory address *n* controls switch addresses *(4n - 3)* to *4n*. (see table 2)

Note that the accessory decoder board addresses do not have to be in a continuous numerical sequence – you can leave gaps. You may want to number decoders by geographical locations on the layout, or leave some addresses vacant for future developments.

Each output can be individually disabled if necessary by clearing (i.e. setting to 0) a bit in CV514.

Accessory Decoder Address	Switch Address Function 1	Switch Address Function 2	Switch Address Function 3	Switch Address Function 4
0	1	2	3	4
1	5	6	7	8
2	9	10	11	12
3	13	14	15	16
4	17	18	19	20
5	21	22	23	24
6	25	26	27	28
7	29	30	31	32
8	33	34	35	36
9	37	38	39	40
10	41	42	43	44
11	45	46	47	48
12	49	50	51	52
13	53	54	55	56
14	57	58	59	60
15	61	62	63	64
16	65	66	67	68
17	69	70	71	72
18	73	74	75	76
19	77	78	79	80
20	81	82	83	84
21	85	86	87	88
22	89	90	91	92
23	93	94	95	96
24	97	98	99 *	100
25	101	102	103	104
26	105	106	107	108
27	109	110	111	112
28	113	114	115	116
29	117	118	119	120
30	121	122	123	124
31	125	126	127	128 **
	and so on in groups of 4			

* Upper limit of some 'entry level' systems with 2-digit addressing

** Upper limit when used with MERG Accessory Encoder

Table 2. Decoder addresses and associated switch addresses

Note: This table is *not* applicable to Lenz command stations!

Pulse Length

The time for which an output is 'On' can also be programmed. The time unit for the MERG Accessory Decoder is 10ms so the 'On' time ranges from 10ms to 2550ms. The latter could be useful for lineside devices that can complete their operation within the maximum of 2.55 seconds.

Setting the relevant CV to a value of 0 disables the pulsed operation. One or other of the pair of outputs is then always on (except that some commercial command stations leave both off immediately after power-up).

The timing operates on each pair of outputs and it is not possible to set one of a pair to a different time to that of the other.

Note that an unattached point motor used for testing may operate satisfactorily on a shorter pulse, but require a longer pulse when having to work operating a point tiebar.

Dual Address Mode

As noted earlier, some commercial command stations (but not Lenz) allow the eight outputs to be operated independently, but Lenz and the MERG Encoder can only operate them as inverted pairs. Therefore, previous versions of the MERG Decoder (along with most or all commercial decoders) could only operate four independent circuits. The dual address mode in software version ACC5 removes this restriction and so doubles the functionality of the Decoder when used with multiple-aspect signals or other equipment requiring large numbers of independent outputs. In dual address mode, the MERG Encoder can control the 8 outputs with the matrix switches. With the MERG encoder, a switch closure turns the output off and a switch open puts it on. (see below).

Unsurprisingly, in dual address mode each decoder has two addresses. The primary address operates outputs 1 to 4 and the secondary address operates outputs 5 to 8. Any two addresses may be used, consecutive or otherwise, but setting both addresses the same is not particularly useful.

To configure dual address mode, zero is written into CV545 (CV33) to unset dual address mode and allow editing of the primary address. This address is set up in CV513 (CV1) and CV521 (CV9) as described above, then 128 (binary 10000000) is written into CV545 (CV33) to enable the secondary address. CV513 (CV21) and CV521 (CV9) are then programmed again with the secondary address.

The following should be noted:

- Lenz systems power up with all outputs deactivated. Selecting '+' for a function will activate the associated output (for the selected pulse length or indefinitely). Selecting '-' will have no effect for a pulse output, but will deactivate a steady output.
- As a consequence of the above, dual address mode *inverts* the inputs supplied to it by a MERG Encoder.
- In the pulse mode, CV515 (CV3) controls the pulse duration on outputs 1 and 2, CV516 (CV4) controls 3 and 4 and so on. Pulse mode cannot be used for single-coil point motors, since a pulse is only generated on one transition of the function state, but may find other applications.
- Toggle mode is ignored in dual address mode.
- If it is necessary to change the primary address, this may be done by unsetting bit 1 of CV545 (CV33). However the decoder then reverts to single address mode, so bit 1 must be set again once the operation is complete. The decoder will remember the secondary address in the meantime.

Toggle Mode

The default value for CV545 (CV33) on the ACC5 PICs is 143 (10001111 Binary). The top bit sets dual address mode and in this mode, the toggle action is not used. However, if the top bit is cleared, ACC5 acts exactly like ACC4 which is supplied with the pulse decoders. This 'single' mode is required for any device requiring outputs working in pairs such as Tortoise motors. As Lenz (and maybe some other systems) do not send a deactivate packet, a toggle mode may be set on all four output pairs. Each of the low four bits of this CV, when set to 1, enables toggle mode for that output pair. The decoder actually has 8 outputs but these can be paired as 1N,1R - 2N,2R - 3N,3R - 4N,4R when used for point motors or 2-aspect signals. When in toggle mode, an activate signal sent to 1N will automatically turn off 1R and vice versa.

As some Lenz systems seem to send continuous activate packets, the output will only give a single pulse (provided the time is not set to continuous) irrespective of subsequent activates. In this toggle mode, there is no need for any deactivate packets - their presence will be ignored.

In normal mode, each output is individually controlled with activate and deactivate packets. However, where an output needs to be on while a button is held down (continuous activates), you can set to normal mode with a time set to whatever is needed to avoid 'flicker' - this depends on how often the activate command is refreshed. The output will now turn off when the button is released (plus whatever the pulse time is).

As a general rule, the toggle mode should be left on for Lenz command stations, and turned off for the MERG Encoder (by setting CV545 (CV33) to zero). Leaving the toggle mode on with the Encoder appears to work normally, except that a system reset will set the points to the wrong setting.

Programming Example

The following assumes that a MERG DCC Encoder and Programmer are being used, and that dual address mode is not required.

Connect the Programmer to J2 and a separate 15-20Vac supply to J1. Polarity is not critical.

First, unset dual address mode:

Press **Read**: display shows 'CV'.

Key in '545' and press 'Enter'.

The display should show 'CV545 = 143'. (10001111 in Binary.)

Press **Prog**: display shows 'CV'.

Key in '545' and press 'Enter'.

When the '=' sign appears, key in the required value (probably 15) and then press 'Enter'.

check the existing address:-

Press **Read**: display shows 'CV'.

Key in '513' and press 'Enter'.

The display should show 'CV513 = 1'.

(In this context, the first Decoder is address 1 decimal, or 00000001 in Binary.)

Then program the new address:-

Press **Prog**: display shows 'CV'.

Key in '513' and press 'Enter'.

When the '=' sign appears, key in the required address and then press 'Enter'.

You would normally enter the next address as '2', but you can select any number between 0 and 63 decimal (0 and 31 decimal if used with the MERG DCC Accessory Encoder).

The display should show 'Program OK'.

While you are familiarising yourself with the Accessory system, its a good idea to re-program two or three more of the CVs if only to become more aware of the options available.

Setting CV514 to all zeros will disable all the outputs - there should be no response to any D-pin contact.

Programming CV514 to alternating '1's and '0's will enable or disable all the 'Set' or 'Reset' outputs. This is best achieved by using the data in Binary mode, as follows:-

Press **Prog:** display shows 'CV'.

Key in '514' and press 'Enter'.

When the '=' sign appears, press **Mode**.

'b' (for Binary) appears after the '='.

Key in '01010101' and press 'Enter'.

This will have turned alternate outputs off: check by test-leading the appropriate D-pins. Now re-program with '10101010' and you should find that the opposite outputs are disabled. You may need to manually operate the point motors to check this.

Remember to restore this CV to '11111111' to enable all four pairs of outputs.

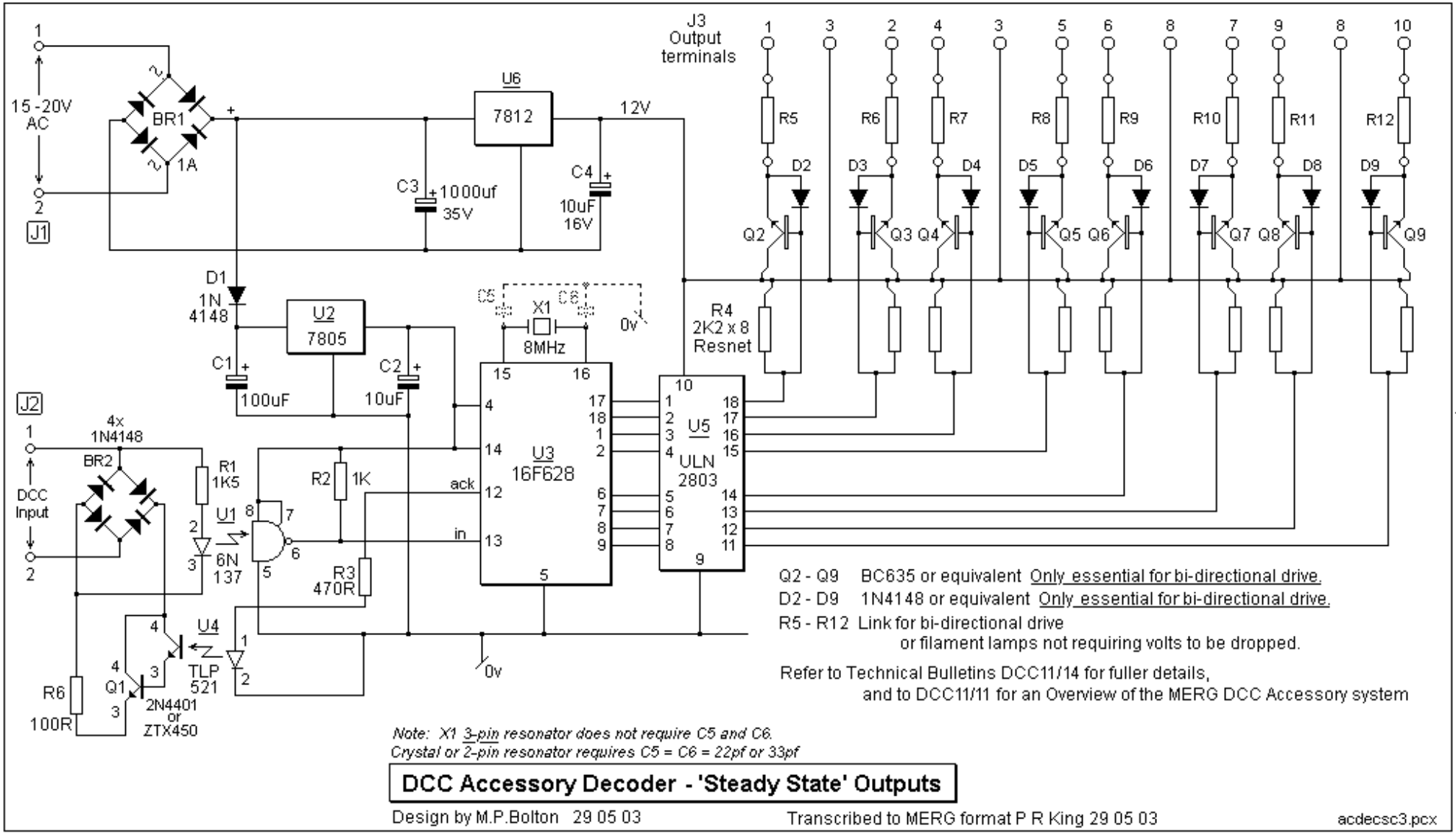
A Decimal/Hex/Binary conversion chart is included as Appendix A on page 8 for the benefit of those using other DCC systems that do not allow programming of CVs in Binary.

TB DCC11/11 is an Overview of the complete MERG Accessory System,
and includes details of the functional testing of assembled kits.

TB DCC11/12 describes the MERG DCC Accessory Encoder.

TB DCC11/13 describes the MERG DCC Pulsed Output Accessory Decoder.

Any comments or suggestions are welcome, but Mike Bolton has to advise, with regret, that he cannot guarantee to be able to provide custom solutions for individual requirements.



Appendix A. Decimal/Hex/Binary Conversion Chart

Decimal	Hex	Binary	Decimal	Hex	Binary	Decimal	Hex	Binary	Decimal	Hex	Binary
0	00	00000000	64	40	01000000	128	80	10000000	192	C0	11000000
1	01	00000001	65	41	01000001	129	81	10000001	193	C1	11000001
2	02	00000010	66	42	01000010	130	82	10000010	194	C2	11000010
3	03	00000011	67	43	01000011	131	83	10000011	195	C3	11000011
4	04	00000100	68	44	01000100	132	84	10000100	196	C4	11000100
5	05	00000101	69	45	01000101	133	85	10000101	197	C5	11000101
6	06	00000110	70	46	01000110	134	86	10000110	198	C6	11000110
7	07	00000111	71	47	01000111	135	87	10000111	199	C7	11000111
8	08	00001000	72	48	01001000	136	88	10001000	200	C8	11001000
9	09	00001001	73	49	01001001	137	89	10001001	201	C9	11001001
10	0A	00001010	74	4A	01001010	138	8A	10001010	202	CA	11001010
11	0B	00001011	75	4B	01001011	139	8B	10001011	203	CB	11001011
12	0C	00001100	76	4C	01001100	140	8C	10001100	204	CC	11001100
13	0D	00001101	77	4D	01001101	141	8D	10001101	205	CD	11001101
14	0E	00001110	78	4E	01001110	142	8E	10001110	206	CE	11001110
15	0F	00001111	79	4F	01001111	143	8F	10001111	207	CF	11001111
16	10	00010000	80	50	01010000	144	90	10010000	208	D0	11010000
17	11	00010001	81	51	01010001	145	91	10010001	209	D1	11010001
18	12	00010010	82	52	01010010	146	92	10010010	210	D2	11010010
19	13	00010011	83	53	01010011	147	93	10010011	211	D3	11010011
20	14	00010100	84	54	01010100	148	94	10010100	212	D4	11010100
21	15	00010101	85	55	01010101	149	95	10010101	213	D5	11010101
22	16	00010110	86	56	01010110	150	96	10010110	214	D6	11010110
23	17	00010111	87	57	01010111	151	97	10010111	215	D7	11010111
24	18	00011000	88	58	01011000	152	98	10011000	216	D8	11011000
25	19	00011001	89	59	01011001	153	99	10011001	217	D9	11011001
26	1A	00011010	90	5A	01011010	154	9A	10011010	218	DA	11011010
27	1B	00011011	91	5B	01011011	155	9B	10011011	219	DB	11011011
28	1C	00011100	92	5C	01011100	156	9C	10011100	220	DC	11011100
29	1D	00011101	93	5D	01011101	157	9D	10011101	221	DD	11011101
30	1E	00011110	94	5E	01011110	158	9E	10011110	222	DE	11011110
31	1F	00011111	95	5F	01011111	159	9F	10011111	223	DF	11011111
32	20	00100000	96	60	01100000	160	A0	10100000	224	E0	11100000
33	21	00100001	97	61	01100001	161	A1	10100001	225	E1	11100001
34	22	00100010	98	62	01100010	162	A2	10100010	226	E2	11100010
35	23	00100011	99	63	01100011	163	A3	10100011	227	E3	11100011
36	24	00100100	100	64	01100100	164	A4	10100100	228	E4	11100100
37	25	00100101	101	65	01100101	165	A5	10100101	229	E5	11100101
38	26	00100110	102	66	01100110	166	A6	10100110	230	E6	11100110
39	27	00100111	103	67	01100111	167	A7	10100111	231	E7	11100111
40	28	00101000	104	68	01101000	168	A8	10101000	232	E8	11101000
41	29	00101001	105	69	01101001	169	A9	10101001	233	E9	11101001
42	2A	00101010	106	6A	01101010	170	AA	10101010	234	EA	11101010
43	2B	00101011	107	6B	01101011	171	AB	10101011	235	EB	11101011
44	2C	00101100	108	6C	01101100	172	AC	10101100	236	EC	11101100
45	2D	00101101	109	6D	01101101	173	AD	10101101	237	ED	11101101
46	2E	00101110	110	6E	01101110	174	AE	10101110	238	EE	11101110
47	2F	00101111	111	6F	01101111	175	AF	10101111	239	EF	11101111
48	30	00110000	112	70	01110000	176	B0	10110000	240	F0	11110000
49	31	00110001	113	71	01110001	177	B1	10110001	241	F1	11110001
50	32	00110010	114	72	01110010	178	B2	10110010	242	F2	11110010
51	33	00110011	115	73	01110011	179	B3	10110011	243	F3	11110011
52	34	00110100	116	74	01110100	180	B4	10110100	244	F4	11110100
53	35	00110101	117	75	01110101	181	B5	10110101	245	F5	11110101
54	36	00110110	118	76	01110110	182	B6	10110110	246	F6	11110110
55	37	00110111	119	77	01110111	183	B7	10110111	247	F7	11110111
56	38	00111000	120	78	01111000	184	B8	10111000	248	F8	11111000
57	39	00111001	121	79	01111001	185	B9	10111001	249	F9	11111001
58	3A	00111010	122	7A	01111010	186	BA	10111010	250	FA	11111010
59	3B	00111011	123	7B	01111011	187	BB	10111011	251	FB	11111011
60	3C	00111100	124	7C	01111100	188	BC	10111100	252	FC	11111100
61	3D	00111101	125	7D	01111101	189	BD	10111101	253	FD	11111101
62	3E	00111110	126	7E	01111110	190	BE	10111110	254	FE	11111110
63	3F	00111111	127	7F	01111111	191	BF	10111111	255	FF	11111111

