CML Electronics Limited

User Manual

DAC10

DCC Compatible
Accessory Decoder

For 8 Point Motors

1. Introduction

The DAC10 is an advanced accessory decoder and controller for model railways operated using Digital Command Control (DCC) systems. It allows DCC command stations to control not only locomotives, but also other devices such as point motors, turntables, signals, lighting and much more. These facilities allow control of an entire layout and accessories through a single control system.

DCC control of accessories becomes invaluable when some form of automated operation of a layout is desired. Many DCC systems can be interfaced to a PC to provide a degree of automatic control and several software packages are available to provide these facilities.

The DAC10 not only allows DCC control of its attached accessories, but also allows locally connected switches to control them too. This is useful for several reasons. When controlling points, for example, a local control panel for a group of points can be connected to the DAC10 allowing switch control of the points and LED display of point position. DCC commands will also control the same points: the LEDs will display the current state of each point regardless of whether it was last operated by a switch on the local panel or by a DCC command.

User Manual Content

The remainder of this document describes what facilities the unit provides and how to use them. It is organised as follows:

- Section 2 of this document describes the features provided by the unit. This provides an introduction to the capabilities of the unit and how they might be used.
- Section 3 provides a “quick start” guide. This allows the unit to be put into operation quickly, without having to understand the full intricacies of the unit.
- Section 4 provides a definitive description of all connections to the unit.
- Section 5 provides a definitive description of the functions of all configuration variables (CVs). This allows the full range of features to be employed.
- Appendix A lists all the programmable Configuration Variables in the unit.
- Appendix B lists the address CV settings to achieve all of the possible base addresses for the unit.
- Appendix C provides a decimal to hexadecimal conversion chart if required.

The DAC10 is a LocoNet certified product.

LocoNet is a Registered Trade Mark of Digitrax, Inc., Norcross, GA, USA

2. Description of Features

The DAC10 accessory decoder provides a number of facilities for control of static, accessory units around a DCC controlled model railway layout. This section of the manual introduces these features. Further sections provide more detail about how to control and program them. The features include:

- 8 high current multi-purpose outputs may be programmed to control:
  - control momentary action point motors (e.g. Peco);
  - continuously powered motors (e.g. Tortoise);
  - relays;
  - LED and filament lighting;
  - other DC motors.
- Output type and timing is individually programmable for each output;
- An integral capacitor discharge unit is provided for momentary action motors;
- Output may be controlled by DCC commands or by local sensor / switch inputs;
- Each output may be programmed to follow another output (e.g. for crossings).

- 10 sensor / switch inputs may be individually configured for:
  - Controlling the 8 local outputs;
  - Generating LocoNet position feedback messages;
  - Generating LocoNet System control messages;
  - Multi-purpose LocoNet Sensor feedback;

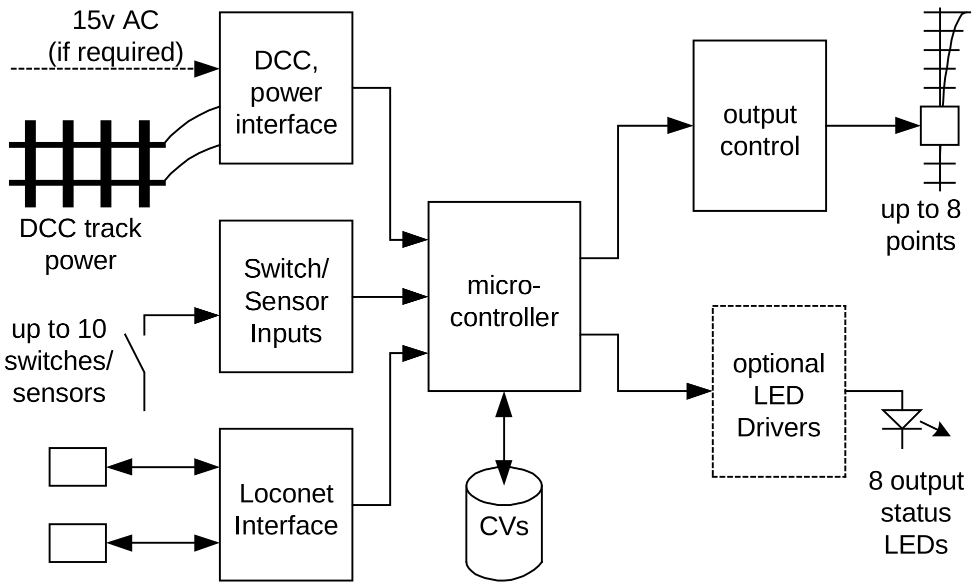
- Operating power is derived from the DCC track input;
- Auxiliary AC / DC power feed available if required;

- Full configuration available by programming Configuration Variables (CVs);
- LocoNet interface for point position feedback and/or sensor input.

- Display of the 8 output states is available via LEDs attached to an optional add-on board.

- New – pushbutton setting of board address

A block diagram of the board is shown on the next page.



2.1 Output Controllers

The principal reason to use an accessory decoder is to make use of its controlled outputs. The DAC10 offers 8 individual outputs. Each may be programmed independently to provide control for point motors or other devices.

Each accessory decoder output provides two high current controlled signals. These may be programmed to provide controls for popular point motors:

- They can be programmed to control solenoid type point motors: these require a short pulse of current to change state, but are normally left unpowered. The popular Hornby, Peco and Seep point motors are of this type. To provide sufficient current to operate these motors, a Capacitor Discharge Unit (CDU) is provided to store energy for the short current pulse required.
- Each individual output is capable of operating two Peco solenoid point motors allowing two points (for example in a crossing) to be operated together.
- The outputs can be programmed to drive stall current type motors: these consume a small current continuously and provide a “slow motion” drive to the points themselves. The Switchmaster and “Tortoise” motors are of this kind.
- The outputs can be used to drive relays or DC motors. This might be used, for example, to operate a turntable or to control gates at a level crossing. The output can be powered continuously when activated, or can be turned off by a switch when a “limit” position is reached.
- The outputs may also be used to drive lamps, Light Emitting Diodes (LEDs) and other indicators to achieve a variety of effects. The outputs may be programmed to be continuously on, or may be programmed to flash at user defined rates.

Each output may be controlled from two sources. Outputs will respond to commands over the DCC system: each has its own unique address and may be controlled either by conventional command stations or by computer based controller programs. This might allow, for example, a layout display on a computer screen to be used to control the points and other accessories by clicking on the display. Each output may also be controlled by a local input switch. This allows construction of local control panels around the layout to operate points and accessories.

An additional control facility is provided: output following. This allows an output to be “attached” to another one. When the “parent” output is changed, the attached output changes state too. This allows structures such as crossings to be controlled by a single action, rather than requiring two or more outputs to be changed manually. This feature is effective whether the “parent” control is operated through a local switch input or DCC command.

The state of each output is “remembered” after power is applied. In the case of solenoid point motors, the motor is not energised but the board records its state from a previous operating session. In the case of continuously powered point motors, the motor is driven to the same state it was left after the previous operating session. These states are reported to LocoNet as required (see section 2.3 below).

2.2 Switch & Sensor Inputs

Ten inputs to the DAC10 are provided. These may be individually programmed to provide several control functions as described in the following paragraphs.

- Each input may be connected to a manual pushbutton switch. The switch may be used to toggle the state of the associated output, to provide a control on a local layout control panel. In this way, the output changes state whenever the button is pressed.
- Each input may be connected to a toggle switch. The switch may be used to control the state of the associated output so that the output “follows” the state of the input. This can be used for local layout control panels, or could be used for some form of automation.
- Each input may be connected to a switch to control power on/off to the output. This may be used to automate operation of accessories such as turntables or level crossing gates connected to the outputs.
- Each input may be connected to a switch connected to the associated point driven by the output. The switch state is used to generate feedback of the point position.
- Each input may be connected to a switch to generate LocoNet control signals. These may be used to generate power off, power on and emergency stop signals over LocoNet.
- Each input may be connected to some kind of sensor to provide feedback over LocoNet of the state of that sensor. Common kinds of sensor are track power detectors, to detect the presence of a locomotive within a section of track; and opto-electronic sensors to detect the position of rolling stock on the layout.

2.3 LocoNet Interface

The DAC10 has an interface to LocoNet - the Local Area Network designed by Digitrax for controlling the components of a DCC system. LocoNet allows all of the “user” interface devices – for example throttles and tower cabs – to be interfaced together and to be used to control the layout. Accessory decoders such as the DAC10 and other input devices may be interfaced to LocoNet to provide feedback of point positions, and of sensor devices (for example track activity detectors or opto-detectors to detect presence of rolling stock). Personal Computers may be interfaced using Digitrax’s MS100 interface. In conjunction with an appropriate program, this allows the PC to both monitor and control the layout.

When Digitrax’s Chief system is used as the main controller for the system, it “interrogates” all sensor input devices after providing track power. This is to allow the sensor devices to announce over LocoNet the “initial” state of all attached sensors. The DAC10 unit responds to these interrogation commands by reporting the state of all outputs and all switch/sensor inputs.

2.4 Optional Display Drivers

The DAC10 can connect to an optional add-on DTX8 board to drive LEDs which indicate the state of the 8 outputs. These may be used in constructing local control panels, as suggested in section 2.1. Each LED will be lit to indicate a point in *thrown* state, and unlit if the output is in *closed* state.

For those with the ability to assembly simple electronic circuits onto prototyping board, the circuit diagram for this board is available on our web page.

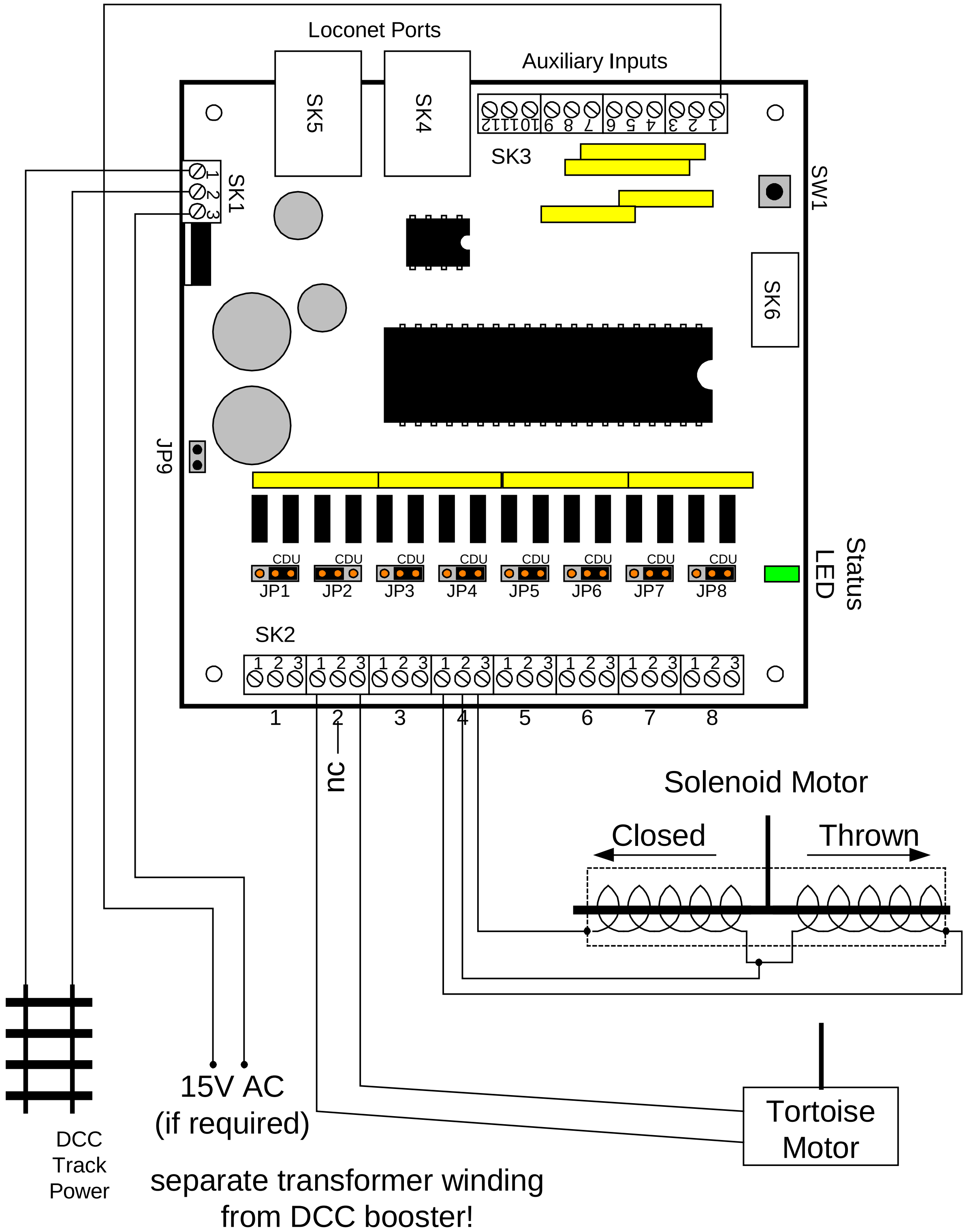
2.5 Status LED

A status LED is provided on the main board itself. This provides indications of the unit’s function, as follows:

- The LED is lit continuously while the board receives proper DCC signals. This is useful for checking that the unit is correctly connected to the DCC track signal.
- Whenever a packet is received which is addressed to an output within the unit, the LED flickers off twice momentarily. This indicates that the unit has been addressed correctly and is useful for checking that the unit’s address has been programmed correctly.
- If a serious internal error occurs, the LED will begin to blink on & off at a 1 second rate. This will continue until power is removed. In this case, the 8 user output LEDs indicate a fault code. If this happens, the states of the 8 LEDs should be written down and the manufacturer contacted.

3. Quick Start Guide

This section provides a "quick start" introduction to the DAC10. This covers connection of point motors & power, CV programming and simple operations. The diagram below shows the connections needed to provide DCC track power, and to connect output 2 to a tortoise motor and output 4 to a solenoid type motor. To connect other outputs to these motor types, see the table in section 4.2 for the relevant connections.



3.1 Safety First!

Before beginning to use the DAC10, there are a few safety points to remember:

- **Don't rest the board when operating on the black bag**: it is conductive!
- **Hold the board by its edges**. By the nature of its construction, some of the pins on the reverse side of the board are sharp and could cause skin abrasions etc if handled incorrectly.
- **Don't touch components on the board when operating**. The transistor driving the capacitor discharge unit can get quite warm. There is also a self-resetting fuse to allow for short circuits which will become very hot if tripped.
- **Allow airflow around the board**. Some of its components may run warm in use. Do not obstruct free circulation of air, or allow cloths etc to cover the board.
- **Do not exceed rated operating voltage**. The board could be damaged if an excessive input voltage is applied. **The DCC operating voltage should not exceed 20v; the auxiliary input voltage if used must not exceed 18v AC or 25v DC.**
- **Do not handle the board when in use**. The voltages present on the board (<25v DC) are not considered hazardous to health. However if they should come into contact with sensitive parts of the body (e.g. the mouth) a nasty shock might result. The same is true of the voltage on the rails of a DCC (or other model railway) system, so take care!
- **The auxiliary power feed (if used) must come from a separate winding** from that used by the DCC booster that provides the track power.

3.2 Programming

The DAC10 is factory programmed to select all outputs as solenoid types, and with an address range of 45-52. Some CVs will need to be reprogrammed for most users' purposes. Full details of the CV values and effects are described in section 5.

The board address can be set simply:

- Turn on power to the board with switch SW1 pressed. The green LED flashes.
- Release SW1
- Using a throttle, set the point address required for output 1 to "thrown"
  - The board sets its base address automatically, and resumes normal operation

The elementary CVs which need to be programmed initially are:

CV	Effect	Values to be programmed to
CV1 & CV9	board base address	Can be set automatically as above. To change the address manually, reprogram according to the settings listed in Appendix B.
CV3	Output 1	To select an output as solenoid type (e.g. Peco, Seep), program the output CV to 19 (the board is shipped with this setting). To select an output as a continuously powered stall motor type (e.g Tortoise), program the CV to 47.
CV4	Output 2	
CV5	Output 3	
CV6	Output 4	
CV10	Output 5	
CV11	Output 6	
CV12	Output 7	
CV13	Output 8	

To program CVs, the following procedure should be adopted initially.

1. Connect the programming track to SK1;
2. Remove JP9;
3. Follow the **paged mode service mode programming** instructions for your command station.

3.3 Operations

Connect the board as shown to the command station, re-insert JP9 and apply power. At this point, any stall motor type point motors (e.g. Tortoise) will be driven to one end of their travel or the other. Solenoid type point motors are only powered momentarily when commands to drive them are received so no activity will be noticed. The green LED on the front edge of the board should be lit.

Use the command station to move each point motor alternately to THROWN then to CLOSED, with about 3 seconds left in between each output change. Stall motor type point motors should slowly traverse to the new state; solenoid motors should move with a sharp “snap”. The board allows a few seconds between output changes when using solenoid motors to allow the capacitor discharge unit to recharge.

Each time a command is sent to the board, the green LED will flicker off momentarily. If this is not observed, the board is not being addressed correctly. Check the base address which has been programmed (CV1 & CV9; not base address is pre-configured to 45) and the point address being driven by the command station.

If no auxiliary supply is connected, the solenoid motors may or may not operate correctly: it is dependent on the individual solenoid type, the DCC track voltage and any point attached to the solenoid. If the solenoids do not “snap” across when a point is attached, then an auxiliary supply will be needed. 15-18V AC is recommended: this must be from a separate transformer winding.

4. Installation & Connections

The DAC 10 unit comprises a single circuit board with dimensions 100mm x 100mm as shown in Figure 4.1. It may be mounted onto spacers or pillars using four screws into the four corner holes: 6BA or M2.5mm screws will be ideal.

All connections to the DAC10 are made through the following connectors:

Power Connections	SK1
Point Motor Outputs	SK2
Auxiliary Input Connections	SK3
LocoNet Ports	SK4, SK5
Optional Add-on LED Output Connections	SK6

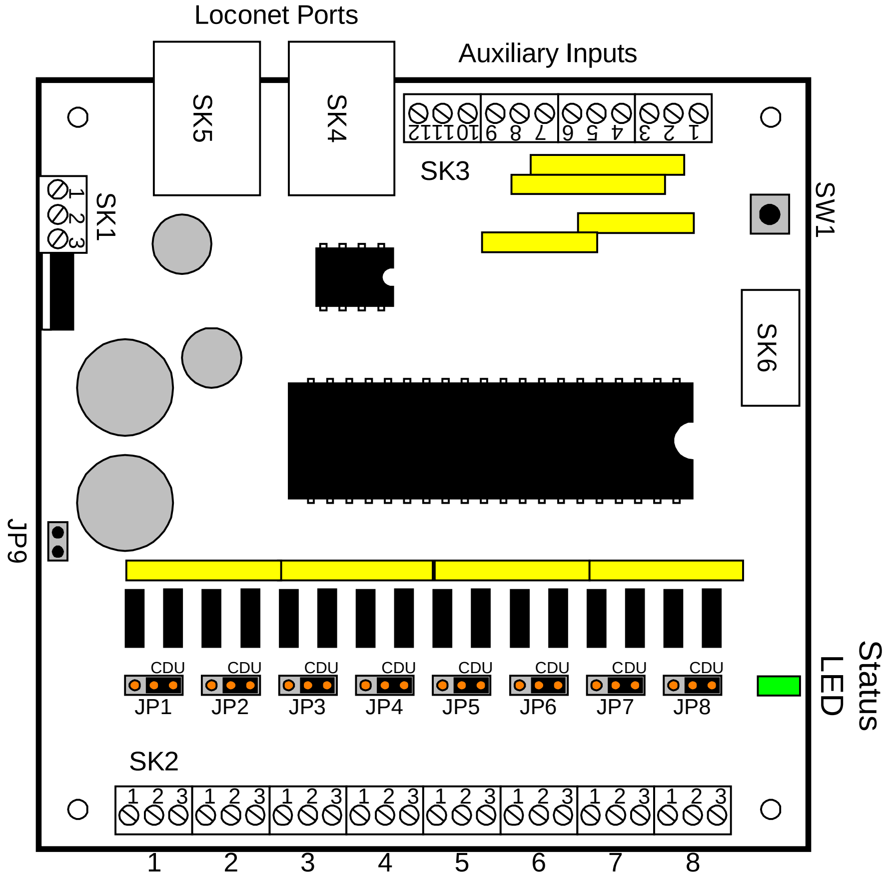
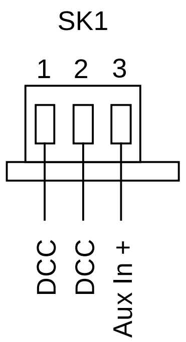


Figure 4.1: DAC10 Interconnections

4.1 SK1: Power Connections

SK1 is the power connector. This is a 3 terminal screw connector which accept wire inputs.



View looking into connector from board edge

SK1: 3 pin screw terminal		
Pin	**Function**	**Signal Level**
pin 1	DCC track power	Connects to DCC booster output. 12-20v p-p max
pin 2	DCC track power	
pin 3	Aux_in_+	Auxiliary power input to feed output stages. DC: connect +ve to pin3; -ve to SK3 pin 1 AC: connect 15-18v AC to pins 3, & pin 1 of SK3 **Do not exceed 18v AC, or 25v DC on this signal relative to ground.**

The DCC track power feed should be connected to pins 1&2 of SK1. The DCC input signal is not polarity sensitive: either rail input may be connected to either pin. Note that during programming, these pins will need to be connected to the programming track. It is suggested that a small switch be used to select between the track power feed and the programming track power feed, to avoid any problems during programming.

The DAC10 derives its operating power from the DCC track input. In normal operation it consumes up to approximately 100mA from the track feed. The DAC10 contains an in-built capacitor discharge unit to provide the high current needed to operate solenoid type point motors (eg Seep, Peco).

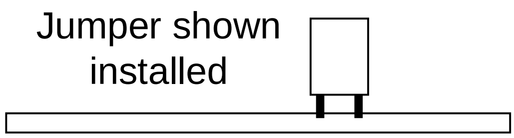
If the DAC10 is driving stall motor type point motors (e.g. Tortoise) then no auxiliary input is needed. If the DAC10 is driving solenoid type point motors, then an auxiliary power input may be needed. This depends on the point motors themselves, the DCC booster output voltage and how stiff the points themselves are. Try the unit with no auxiliary power: if it reliably operates the motors, then no auxiliary feed is needed.

An auxiliary AC or DC supply may be connected between Ground and Aux in +. Ground can be found on SK3 pin 1. This supply is recommended if the unit drives solenoid type point motors. This supply feeds the output stages & capacitor discharge unit only. **This supply must be derived from a separate transformer winding**

from the main DCC power feed to the booster. Several DAC10s can be powered from one auxiliary supply as long as they are paralleled: i.e. all grounds are connected together, and all the SK1 pin 3's connected together.

The jumper JP9 is provided to connect a power feed from the DCC track input to the output circuits and to the capacitor discharge unit. If an auxiliary supply is being used, this jumper may be removed permanently. If the DCC track feed is being used to drive the outputs, then this jumper needs to be connected in normal use and removed when programming CVs via a programming track feed.

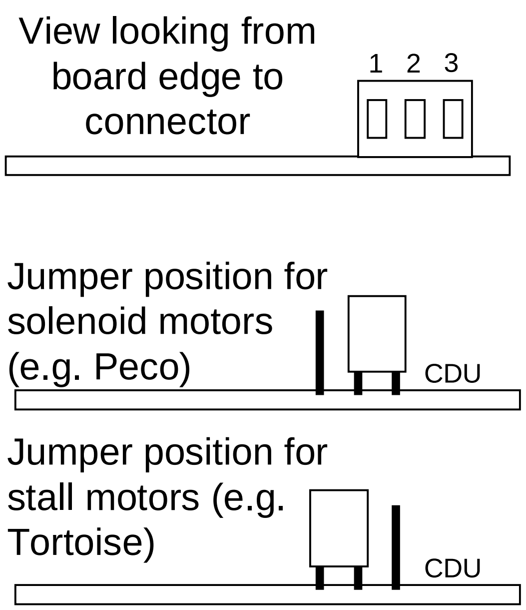
JP9	2 position jumper
Position	**Function**
installed	normal operation when DCC track power is used to drive outputs.
not installed	Must be removed when programming CVs May be left removed if an auxiliary power feed is being used.



4.2 SK2: Point Motor Connections

These connectors are provided to control the point motors themselves and may be connected to drive several different kinds of motor as indicated below. The output power feed to each output is individually selectable using jumpers which are described below. Each output has 3 screw terminals, and these are marked onto the PCB.

Output	**Relevant Jumper**
1	JP1
2	JP2
3	JP3
4	JP4
5	JP5
6	JP6
7	JP7
8	JP8



Point Motor Output Connectors SK2		
Pin number	**Function**	**Signal Level**
1	Control signal to drive point motor to THROWN state. Connect as shown below.	Clamps to Ground to energise motor.
2	Output Power Feed	See JP1-8 below
3	Control signal to drive point motor to CLOSED state. Connect as shown below.	Clamps to Ground to energise motor.

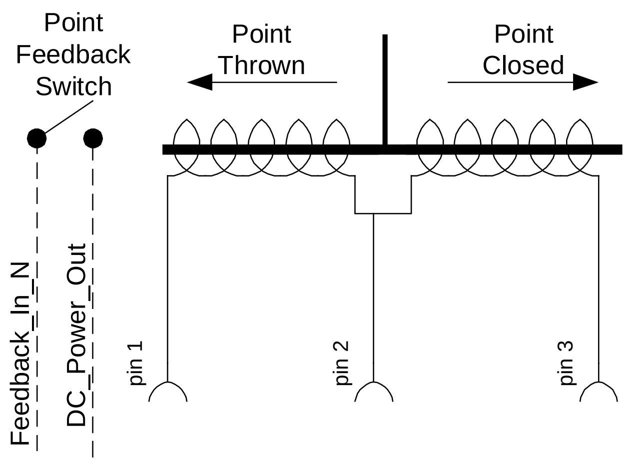
The output power feed to each output is individually selected using a jumper (JP1-8). This allows the output to have a constant +12-24v supply, or alternatively connects the output to the capacitor discharge unit.

Point Motor Output Power Select Jumpers JP1 – JP8		
Jumper Setting	**Function**	**Used For:**
1-2	Selects constant +12-24v DC power feed to output	Stall type point motors (e.g. Tortoise) Relays, LEDs
2-3 (marked “CDU” on board; nearest to green LED)	Selects Capacitor Discharge power feed to output	Solenoid type point motors (e.g. Seep, Hornby, Peco)

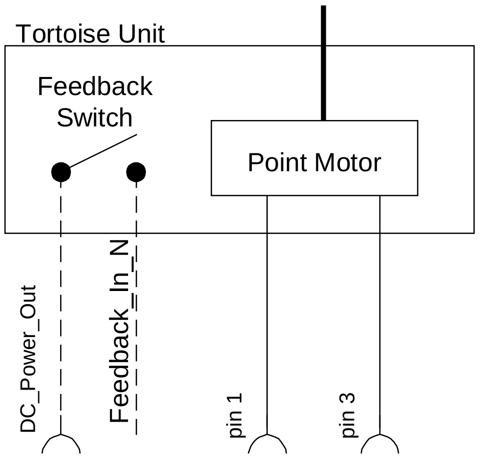
Each output is individually programmable to select the kind of point motor it controls. The common solenoid and stall motor types should be connected as follows:

<table>
<tr><th colspan="2">Connections for Solenoid type point motors</th></tr>
<tr><td>Solenoid point motors should be connected as shown (right). The Capacitor Discharge Output connects to both solenoid coils; the two other motor control signals connect to the other ends of the solenoid coils.

The appropriate jumper should be in position 2-3 (i.e. nearest to the green LED).

If feedback of actual point position is required, a switch may be connected as shown. By convention the switch contacts should be closed if the point is closed.</td><td>
</td></tr>
<tr><th colspan="2">Connections for Slow motion point motors</th></tr>
<tr><td>Slow motion point motors (e.g. Tortoise) should be connected as shown (right). The two motor control signals connect to the motor drive terminals.

The appropriate jumper should be in position 1-2 (i.e. furthest from the green LED).

If feedback of actual point position is required, a switch may be connected as shown. By convention the switch contacts should be closed if the point is closed.</td><td>
</td></tr>
</table>

The outputs are not enabled until approximately 2 seconds after power is applied. This is to ensure that the output current does not affect the service mode programming behaviour when connected to a programming track.

4.3 SK3: Switch / Sensor Feedback Inputs

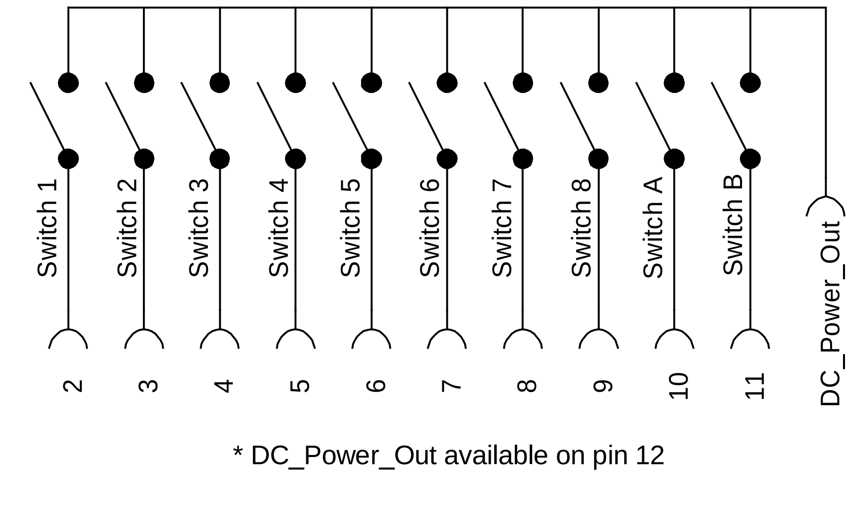
These pins are provided as external inputs to the board for at least three purposes:

- As external sensor inputs;
- As point position feedback inputs;
- As external command inputs to control the point motors directly.

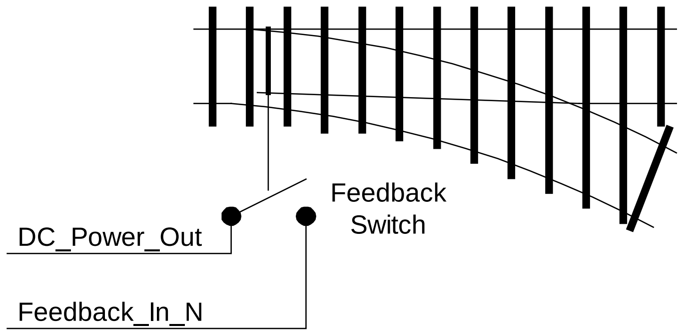
Signal	Function	Signal Level
Feedback_In_N	Feedback, switch or sensor input. Connect as shown below.	<6v in: input INACTIVE >6v in: input ACTIVE
DC_Power_Out	Common reference for feedback inputs	+12v-20v
(N=1 to 8 for input 1 to 8; N = A or B for auxiliary inputs A, B)		
Pin Number	**Function**	
1	GROUND	Board ground. If aux power supply is being used connect to this terminal
2	Feedback_In_1	Can control or feedback point 1
3	Feedback_In_2	Can control or feedback point 2
4	Feedback_In_3	Can control or feedback point 3
5	Feedback_In_4	Can control or feedback point 4
6	Feedback_In_5	Can control or feedback point 5
7	Feedback_In_6	Can control or feedback point 6
8	Feedback_In_7	Can control or feedback point 7
9	Feedback_In_8	Can control or feedback point 8
10	Feedback_In_A	Input A; can be used as sensor input
11	Feedback_In_B	Input B; can be used as sensor input
12	DC_Power_Out	Power output. May be used as a common feed for switches driving these inputs

Each input may be individually connected and programmed for a variety of functions. Three common applications are illustrated below:

Up to 10 manual switches can be connected. These may be used on local panels to control the state of the attached point motors, or may be used to generate system messages.



<table>
<tr>
<td>The inputs 1-8 may be used as point position feedback sensors. To achieve this, a switch connected to each point for which feedback is required must be connected as shown.

By convention the switch contacts should be closed if the point is closed.</td>
<td>
</td>
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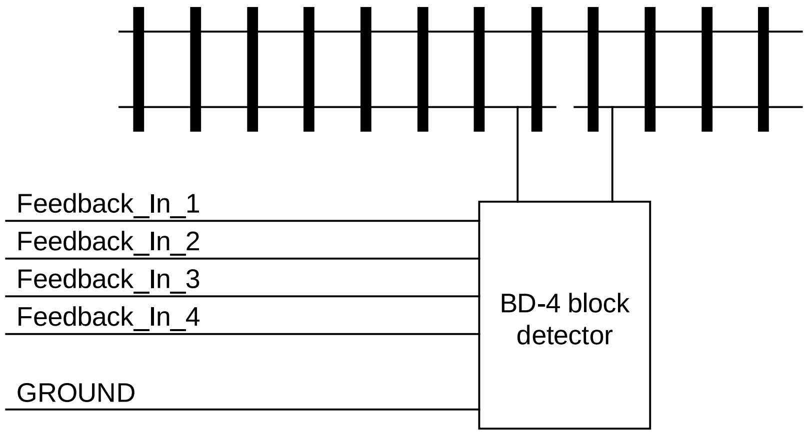
<tr>
<td>Block Detectors (such as the Digitrax BD-4) may be connected to feedback inputs as shown.</td>
<td>
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</table>

4.4 SK6: LED Drive Outputs

This connector allows an optional add-on board (DTX8) to be added to drive LEDs showing the point positions. These may (for example) be fitted into an operator panel at the side of the layout. The circuit diagram of this board is available from our web site, for those who would like to construct their own.

4.5 SK4, SK5: LocoNet Connections

These two identical connectors allow for connection to a LocoNet network using conventional 6 pin RJ12 (US style telephone) connectors. The two connectors are wired in parallel: the LocoNet wiring may be connected to either port, or may be daisy-chained through the DAC10.

SK11, SK12	6 pin RJ12
Pin	**Function**
1	RAIL_SYNC-
2	LocoNet_Ground
3	LocoNet-
4	LocoNet+
5	LocoNet_Ground
6	RAIL_SYNC+

These signals are defined in the LocoNet Specification which is available from Digitrax.

5. Configuration

In common with all DCC decoders, the function performed by the DAC10 is fully defined by the settings of a number of Configuration Variables (CVs). These parameters may be user programmed as described in this section. The settings define the following behaviour of the board:

- The addresses of the 8 outputs contained within the unit;
- The operation and timing of the point motor outputs;
- The functions performed by the Auxiliary inputs;
- Up to 8 local route definitions.

A full list of all the Configuration Variables is given in Appendix A. Figure 5.1 shows the effects of the CVs within the DAC 10 unit.

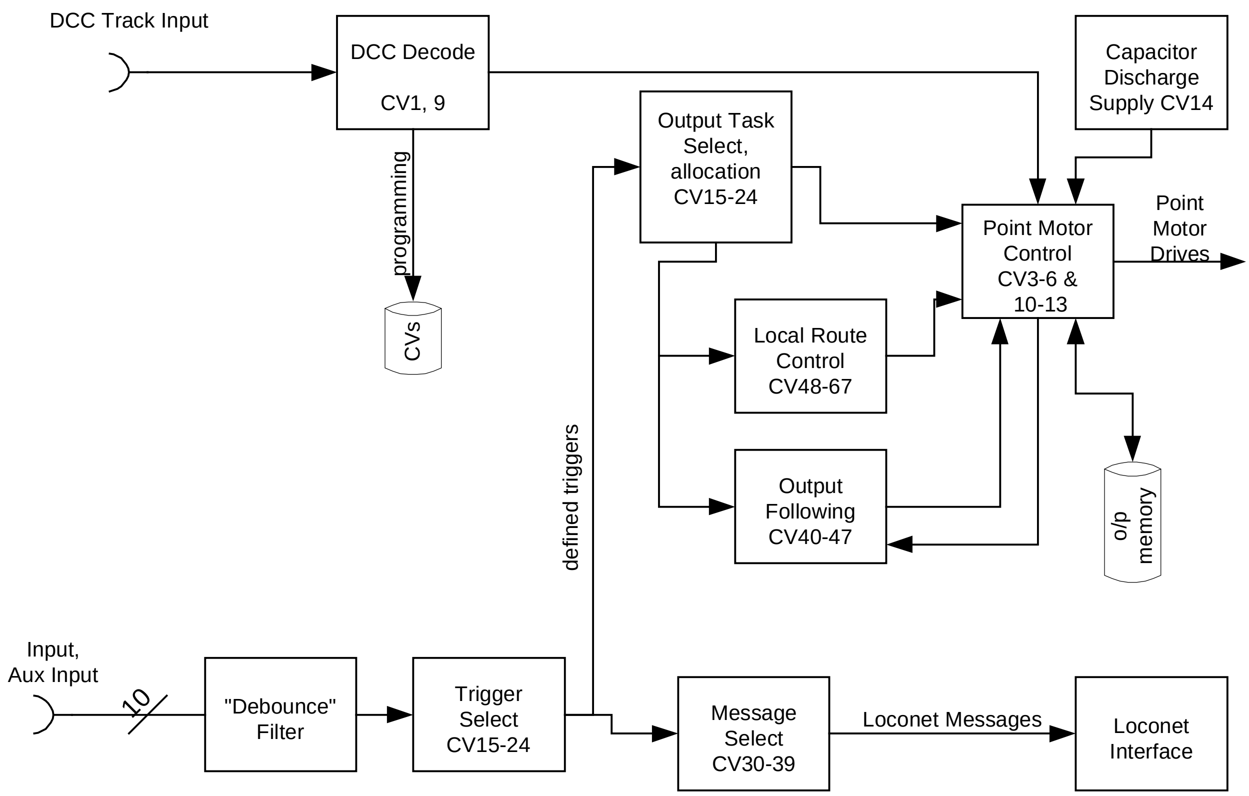

Figure 5.1: Configuration Variable (CV) Effects

5.1 Address Setting

The board address can be set without using a programming track. It enters "address set mode" if power is applied while SW1 is depressed.

- Turn on power to the board with switch SW1 pressed. The green LED flashes.
- Release SW1
- Using a throttle, set the point address required for output 1 to "thrown"

When this is done correctly, the board sets its base address automatically and resumes normal operation. It should be noted that the address can only be set in steps of 4, as listed in Appendix B.

5.2 CV Programming

Programming of the Configuration Variables is accomplished using the programming facilities offered by all DCC command stations. Each system is different: the specific use of any one command station is not covered by this manual.

The DAC10 supports **Paged Mode Programming in Service Mode** only. This means that:

- For programming, it will need to be connected to the programming track output of the command station;
- CVs cannot be updated during normal operation of the layout.

To prepare the DAC10 for programming, several steps need to be taken:

1. Remove programming jumper JP9;
2. Connect the DAC10 to the command station's programming track output;
3. Select the command station to generate Paged mode programming commands.

Most DCC command stations will use normal decimal notation to describe the values to be programmed into each register, and decimal values to describe register addresses. The DAC10 manual now follows this convention.

Some DCC systems require hexadecimal (base 16) values to be used: for example the Digitrax DT100 handheld throttle uses this system. This simply requires that the numbers be converted from decimal to hexadecimal: a decimal to hexadecimal conversion chart is provided in Appendix C for this purpose. For example, a value of 154 is equivalent to the hexadecimal number 9A.

The following sections define the values which may be programmed into each register to control the functions of the unit.

5.3 Decoder Address

DCC systems can control up to 2048 accessory devices, each of which has a unique number between 1 & 2048. The DAC10 unit control 8 accessory devices with consecutive numbers; the base address setting defines the address of the first accessory output.

The base address of the decoder is defined by two Configuration Registers, CV1 & CV9. CV1 may hold any value between 0 and 63; CV9 may hold any value between 0 & 7. A table showing the base address value corresponding to all values of CV1 & CV9 is given in Appendix B. The base address is calculated from the following formula:

Base address = ((CV9 * 64) + CV1 – 1) * 4 + 1

The board is shipped programmed to a base address of 45: it will respond to addresses 45 through to 53.

Output Number	**Address**	**Output Number**	**Address**
1	Base Address	5	Base Address + 4
2	Base Address + 1	6	Base Address + 5
3	Base Address + 2	7	Base Address + 6
4	Base Address + 3	8	Base Address + 7

5.4 Output Configuration CVs

The behaviour of each output is independently programmable by setting the corresponding Output Configuration CVs. CVs 3-6 and 10-13 provide these effects. Outputs may be programmed as:

- Steady state (i.e. power continuously applied, e.g. for Tortoise motors);
- Solenoid (i.e. power is applied for a timed period, e.g. for Peco or Seep motors).

For outputs programmed as solenoid type, the CVs define the time period for which the output is enabled. The settings needed will be dependent on the characteristics of the motor: The output needs to have a long enough duration to allow the motor to toggle to its new state. In general the duration value should be programmed to the smallest value which causes reliable operation. This is point motor dependent: start with 1 second and reduce it from there.

When the internal capacitor discharge power supply is used to the point motor (i.e. normal use), the CV value should be selected from the second column of the table. This allows a delay between operation of multiple outputs to allow the Capacitor Discharge Unit to recharge after toggling a point motor. If, for some reason, another power feed to the point motor is used, then the CVs should be selected from the first column.

For stall current type point motors, the output should be programmed as static (ie CV value = 47).

For lighting (and possibly other) functions, the outputs may be made to blink at user programmed rates. The CV value should be picked from the Continuous / Blinking output column. When a blink rate is selected, the outputs will blink on & off at the defined rate when in the “on” state. The output will be always off when in the “off” state.

The following table defines the configurations available:

Output Configuration and Timing Values (CVs 3-6 and 10-13)					
CV3: Output 1		CV10: Output 5			
CV4: Output 2		CV11: Output 6			
CV5: Output 3		CV12: Output 7			
CV6: Output 4		CV13: Output 8			
Solenoid		**Solenoid, CDU delay**		**Continuous / blinking output**	
Value	**Duration**	**Value**	**Duration**	**Value**	**blink on & off period**
0	0.125 sec	16	0.125 sec	32	0.125 sec
1	0.25 sec	17	0.25 sec	33	0.25 sec
2	0.375 sec	18	0.375 sec	34	0.375 sec
3	0.5 sec	19	0.5 sec	35	0.5 sec
4	0.625 sec	20	0.625 sec	36	0.625 sec
5	0.75 sec	21	0.75 sec	37	0.75 sec
6	0.9 sec	22	0.9 sec	38	0.9 sec
7	1 sec	23	1 sec	39	1 sec
8	2 sec	24	2 sec	40	2 sec
9	3 sec	25	3 sec	41	3 sec
10	4 sec	26	4 sec	42	4 sec
11	5 sec	27	5 sec	43	5 sec
12	6 sec	28	6 sec	44	6 sec
13	7.5 sec	29	7.5 sec	45	7.5 sec
14	10 sec	30	10 sec	46	10 sec
15	12 sec	31	12 sec	47	Continuous

Table 5.1: Output Configuration and Timing Values

Typical settings for CV3-6 & CV10-13:
For Peco type point motor: 19
For Tortoise type motor: 47

5.5 Capacitor Discharge CV

An integral Capacitor Discharge Unit is provided to drive solenoid type point motors. This unit stores energy, then dumps it in a high current pulse into the solenoid to change the point state. Using a CDU reduces the current drawn by point motors from the DCC decoder to a small level sufficient to recharge the capacitor. CV14 defines the time period needed for the capacitor discharge unit to charge following an output changing state. This will be dependent on the characteristic of the external power supply, but is normally in the range 1-2 seconds.

When outputs are selected to solenoid type with a capacitor discharge delay (ie output CV has a value between 16 and 31), then requests for several outputs to change state one after the other will be "queued". Each output will wait for the capacitor discharge unit to be fully charged before the output is toggled. This avoids the problem of multiple output change requests failing.

The delay value is established by programming a value into the Capacitor Discharge Delay CV as follows:

Capacitor Discharge Delay Values (CV 14)			
Value	**Duration**	**Value**	**Duration**
0	0.125 sec	8	2 sec
1	0.25 sec	9	3 sec
2	0.375 sec	10	4 sec
3	0.5 sec	11	5 sec
4	0.625 sec	12	6 sec
5	0.75 sec	13	7.5 sec
6	0.9 sec	14	10 sec
7	1 sec	15	12 sec

Table 5.2: Capacitor Discharge Delay CV Values

The default value is 8 (2 second delay), which will be OK for most users.

5.6 Input CVs

The 8 wired inputs (Input 1-8) to the unit and 2 auxiliary inputs (Inputs A, B) are each individually programmable, both in terms of their input conditions and of the actions initiated. Inputs 1-8 may be assigned to control points 1-8 respectively.

Inputs are filtered to remove input "glitches" defined as any transition of duration < 10ms. This, for example, is useful to "debounce" mechanical switches which open and close many times as the contacts make and break connection.

CVs 15-24 control the behaviour of the inputs. Each input is uniquely programmed according to its own CV. The required value for the CV is found fro adding two numbers: one defined the trigger condition, and the other describes the action to be taken when the trigger has happened.

5.6.1 Trigger Selection

Trigger conditions from each input are selected according to the following table. Actions are only initiated following the defined trigger events.

Each input is considered OFF if input <2v; ON if input >8v; undefined otherwise.

Input Trigger Configuration Variables		
CV15: Input 1	CV20: Input 6	
CV16: Input 2	CV21: Input 7	
CV17: Input 3	CV22: Input 8	
CV18: Input 4	CV23: Input A	
CV19: Input 5	CV24: Input B	
Trig value	Input Function	Comment
0	No event generated.	Input disabled
16	Event generated on rising edge of input (OFF to ON)	Use with momentary action switches / sensors
32	Event generated on falling edge of input (ON to OFF)	Use with momentary action sensors / switches
48	Event generated on both edges of input	E.g. For use with toggle switches, t/o feedback
64	Event depends on corresponding output state: Event on rising edge, If output CLOSED Event on falling edge, if output THROWN	Use with sensors whose behaviour depends on output direction
128	No event generated.	Input disabled
144	Event generated on rising edge of input (OFF to ON)	Use with momentary action switches / sensors; disabled when CD in use.
160	Event generated on falling edge of input (ON to OFF)	Use with momentary action sensors / switches; disabled when CD in use.
176	Event generated on both edges of input	e.g. For use with toggle switches. disabled when CD in use
192	Event depends on corresponding output state: Event on rising edge, If output CLOSED Event on falling edge, if output THROWN	Use with sensors whose behaviour depends on output direction. Disabled when CD in use.

Table 5.3: Input Trigger CV Values

Values 128-192 cause the input to be disabled (not scanned) while the capacitor discharge unit is in use. This is useful if the switch is connected to the capacitor discharge supply instead of to a fixed supply. This would typically be used if a switch is connected to the Pl1-PL8 output connectors to provide feedback of point position. In these circumstances, the CDU supply drops when an output changes state but this should not cause a change in output state to be declared.

5.6.2 Output Task Selection

The effect of each input onto its selected point motor output is separately programmed. This allows a variety of output effects to be achieved as required. The value shown in this table needs to be added to the "trigger" value from the previous value to get the required value for each CV.

Output Task Configuration Variables (adds into value for CV15 to 24)		
Task value	Output Task for Input n	Comment / Example Application
0	Input trigger has no effect on point output.	Turnout feedback (would want a LocoNet message only)
1	Output toggles on every trigger	Manual input: pushbutton switch control.
2	Output follows input (Point THROWN when input OFF; point CLOSED when input ON).	Manual input: toggle switch control
3	Point becomes CLOSED on trigger	
4	Point becomes THROWN on trigger	
5	Output becomes unpowered on trigger	Remove power from DC motor
6	Output re-enters last powered state on trigger (continuous output only)	Resume previous condition (eg DC motor powered)
7	execute local route	Executes a sequence of outputs defined by CVs 48-67

Table 5.4: Output Task CV Values

Note that Auxiliary Inputs A, B cannot cause control of a point motor directly and their task digits should be set to 0. (They may however control local routes to affect point states).

Typical settings for CV15-24:
If input is from a toggle switch to control a point: set to 17
If input is to provide turnout feedback (e.g. for Winlok etc): set to 48
If input is to provide a general sensor report: set to 48

If input is to invoke a local route: set to 23

5.7 LocoNet Message Selection

Messages may be sent over LocoNet as a response to each input trigger, according to the configuration of these CVs. This allows inputs to have effects elsewhere within the overall layout.

Input may be used as:

- General sensors, e.g. for train position reporting;
- Turnout feedback, for mechanical feedback of point position;
- Generating system level messages.
-

LocoNet Message Configuration Variables (CV30 to 39)	
CV30: Input 1 / Output 1 Message	CV35: Input 6 / Output 6 Message
CV31: Input 2 / Output 2 Message	CV36: Input 7 / Output 7 Message
CV32: Input 3 / Output 3 Message	CV37: Input 8 / Output 8 Message
CV33: Input 4 / Output 4 Message	CV38: Input A Message
CV34: Input 5 / Output 5 Message	CV39: Input B Message

CV value	**LocoNet Message for Input n**	**Comment / Example Application**
0	No message	No messages generated from this input
1	Sensor input message	General sensor input
2	Turnout feedback message	Used when connected to point motor or other positional feedback switch
3	System Power off	Sends System power OFF message
4	Emergency Stop	Sends system Emergency Stop message
8	Output State Message	"Output State" message generated on change of the driven state of the associated point motor output
9	Output State and Sensor Input Messages	Provides feedback of commanded point position of the associated output, plus independent feedback from a sensor input.
10	Output State, Turnout Feedback	Provides feedback of commanded point position of the associated output, plus generation of a turnout feedback message from a switch input at the point.

Table 5.5: LocoNet Message CV Values

Values 8, 9 and 10 may not be used for CVs 38 & 39. Note also that the "Output State" message is generated if the associated output changes state *as a consequence of a local input event only*.

5.8 Output Following Control CVs

Output following is a facility which allows one output to “follow” the state of another. This is useful where points need t be changed together. An example of this is at a crossing between two lines: the points on each line would normally be operated together. With point following, one point can be controlled by the user and the second will automatically follow its state.

Output following is controlled using CVs 40 – 47. Each CV controls the feature for one individual output.

<table>
<tr><th colspan="2">Output Following Configuration Variables (CV40-47)</th></tr>
<tr><td>CV40: Output 1 following</td><td>CV44: Output 5 following</td></tr>
<tr><td>CV41: Output 2 following</td><td>CV45: Output 6 following</td></tr>
<tr><td>CV42: Output 3 following</td><td>CV46: Output 7 following</td></tr>
<tr><td>CV43: Output 4 following</td><td>CV47: Output 8 following</td></tr>
<tr><th>Value</th><th>Effect</th></tr>
<tr><td>0</td><td>No output following (normal operation)</td></tr>
<tr><td>1-8</td><td>This output follows the output number entered</td></tr>
<tr><td>Other values</td><td>reserved (do not use)</td></tr>
</table>

Table 5.6: Output Following CV Values

Example: Output 3 is to follow the state of output 4. To achieve this CV42 is programmed with a value 4. If output 4 is activated either from a local switch input or from a DCC command, output 3 will also be driven to the same state.

5.9 Local Route CVs

Local routes provide a facility for users to control more than one point motor at a time from a single action. This is useful, for example, where a number of points need to be set to define the route to be taken by a train. This may be through a complex junction (e.g. in the throat to a large station) or a storage area (e.g. a set of “hidden” staging yards). Local Routes allow a single action to control the operation of up to 8 points connected to a single DAC10.

10 Local routes are provided, one for each input signal. Each allows up to 8 points to be set to a predefined state. Note that a local route *sets* the points to a defined state. There is no equivalent mechanism (other than using a different local route) to “*unset*” them. For operations requiring both actions, consider the “output following” mechanism.

Each local route uses two CVs to define it. The first, the Point Inclusion CV, defines which points are affected by the local route. The second, the Point State CV, defines whether the included points are set to CLOSED or THROWN by the local route action.

Each CV is determined by adding together numbers to define the function required. For each CV, start with 0 and add numbers as described below. (See example at end)

Local Route Configuration Variables (CV48 to 67)	
CV48: route 1 inclusion CV49: route 1 state	CV58: route 6 inclusion CV59: route 6 state
CV50: route 2 inclusion CV51: route 2 state	CV60: route 7 inclusion CV61: route 7 state
CV52: route 3 inclusion CV53: route 3 state	CV62: route 8 inclusion CV63: route 8 state
CV54: route 4 inclusion CV55: route 4 state	CV64: route 9 inclusion CV65: route 9 state
CV56: route 5 inclusion CV57: route 5 state	CV66: route 10 inclusion CV67: route 10 state
Point Inclusion CV	**Point State CV**
Meaning	Meaning
Add 1 if point 1 included in route; =0 otherwise	Add 1 if point 1 to be set to CLOSED by route; =0 otherwise.
Add 2 if point 2 included in route; =0 otherwise	Add 2 if point 2 to be set to CLOSED by route; =0 otherwise.
Add 4 if point 3 included in route; =0 otherwise	Add 4 if point 3 to be set to CLOSED by route; =0 otherwise.
Add 8 if point 4 included in route; =0 otherwise	Add 8 if point 4 to be set to CLOSED by route; =0 otherwise.
Add 16 if point 5 included in route; =0 otherwise	Add 16 if point 5 to be set to CLOSED by route; =0 otherwise.
Add 32 if point 6 included in route; =0 otherwise	Add 32 if point 6 to be set to CLOSED by route; =0 otherwise.
Add 64 if point 7 included in route; =0 otherwise	Add 64 if point 7 to be set to CLOSED by route; =0 otherwise.
Add 128 if point 8 included in route; =0 otherwise	Add 128 if point 8 to be set to CLOSED by route; =0 otherwise.

Table 5.7: Local Route Configuration Variables

Example: route 5 is to be programmed to set point 1 Closed, point 4 thrown, point 5 thrown, point 7 closed.

- Inclusion CV (CV56) to include points 1,4,5 & 7:
  - Required value is (1+ 8 + 16 + 64)
  - Therefore CV 56 should be set to 89

- State CV (CV 57): 1=closed, 4=thrown, 5=thrown, 7=closed
  - Numbers need to be added for points being set to CLOSED (i.e. points 1&7)
  - Required value is (1+ 64)
  - Therefore CV 57 should be set to 65

5.10 Output State Memory CV

(Access to this CV is not normally required)
The DAC10 “remembers” the state of its outputs in a non-volatile memory (EEPROM). Every time an output is changed, the new output state is recorded to this memory.

CV25 sets the address used within the non-volatile memory to record this output state information. It specifies an address in the range 0 – 127 and may be set to any value in that range.

In normal use this CV need never be touched. Because of a fundamental “lifetime” restriction with non-volatile memories, each individual address in the memory may eventually fail to store data correctly. In a DAC10 used daily this may occur once every few years. If this happens, by reprogramming this CV a different address may be selected to allow output state to be recorded.

5.11 Initial Default Configuration

When shipped, the DAC10 is configured as follows:

Function	CVs	Configuration	CV values
Decoder Address	1, 9	Base address = 45: decoder responds to accessory addresses between 45 & 52.	CV1=12 CV9=0
Output Timing	3-6, 10-13	Solenoid type output; delay between output changes to allow capacitor discharge to unit to recharge; 0.5s output timing.	CVs = 19
Capacitor Discharge	14	2 second delay between outputs changing state.	CV14=8
Input trigger/task	15-24	Trigger on rising edge; toggle output every trigger.	CVs=17
Input message	30-37	No LocoNet messages for inputs 1-8	CVs=0
Input message	38-39	LocoNet sensor messages for inputs A, B	CVs=1
Output Following	40-47	No output following.	CVs=0
Local Routes	48-60	No local routes defined.	CVs=0

Appendix A DAC10 Configuration Variables (CVs)

CV Address	Function	Meaning	Type	Default Value
1	Decoder Address LSB	6 LSBs of decoder address	R/W	0
2	Reserved	Do not change this CV!	R/W	60
3	Point output 1 timing	See Table 5.1	R/W	19
4	Point output 2 timing	See Table 5.1	R/W	19
5	Point output 3 timing	See Table 5.1	R/W	19
6	Point output 4 timing	See Table 5.1	R/W	19
7	manufacturer version no.	software version number	Read only	15
8	manufacturer id	initially set to 1	Read only	1
9	Decoder address MSB	3 MSBs of decoder address	R/W	0
10	Point output 5 timing	See Table 5.1	R/W	19
11	Point output 6 timing	See Table 5.1	R/W	19
12	Point output 7 timing	See Table 5.1	R/W	19
13	Point output 8 timing	See Table 5.1	R/W	19
14	capacitor discharge delay	See Table 5.2	R/W	8
15	Input 1 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
16	Input 2 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
17	Input 3 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
18	Input 4 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
19	Input 5 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
20	Input 6 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
21	Input 7 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
22	Input 8 trigger/event, task	See Table 5.3, Table 5.4	R/W	17
23	Input A trigger/event, task	See Table 5.3, Table 5.4	R/W	48
24	Input B trigger/event, task	See Table 5.3, Table 5.4	R/W	48
25	Output State Memory	See section 5.10	R/W	0
29	decoder configuration	set to 128	Read only	128
30	Input 1 Message	See Table 5.5	R/W	0
31	Input 2 Message	See Table 5.5	R/W	0
32	Input 3 Message	See Table 5.5	R/W	0
33	Input 4 Message	See Table 5.5	R/W	0
34	Input 5 Message	See Table 5.5	R/W	0
35	Input 6 Message	See Table 5.5	R/W	0
36	Input 7 Message	See Table 5.5	R/W	0

37	Input 8 Message	See Table 5.5	R/W	0
38	Input A Message	See Table 5.5	R/W	1
39	Input B Message	See Table 5.5	R/W	1
40	Output 1 Following	See Table 5.6	R/W	0
41	Output 2 Following	See Table 5.6	R/W	0
42	Output 3 Following	See Table 5.6	R/W	0
43	Output 4 Following	See Table 5.6	R/W	0
44	Output 5 Following	See Table 5.6	R/W	0
45	Output 6 Following	See Table 5.6	R/W	0
46	Output 7 Following	See Table 5.6	R/W	0
47	Output 8 Following	See Table 5.6	R/W	0
48	Local Route 1 Point Inclusion	See Table 5.7	R/W	0
49	Local Route 1 Point State	See Table 5.7	R/W	0
50	Local Route 2 Point Inclusion	See Table 5.7	R/W	0
51	Local Route 2 Point State	See Table 5.7	R/W	0
52	Local Route 3 Point Inclusion	See Table 5.7	R/W	0
53	Local Route 3 Point State	See Table 5.7	R/W	0
54	Local Route 4 Point Inclusion	See Table 5.7	R/W	0
55	Local Route 4 Point State	See Table 5.7	R/W	0
56	Local Route 5 Point Inclusion	See Table 5.7	R/W	0
57	Local Route 5 Point State	See Table 5.7	R/W	0
58	Local Route 6 Point Inclusion	See Table 5.7	R/W	0
59	Local Route 6 Point State	See Table 5.7	R/W	0
60	Local Route 7 Point Inclusion	See Table 5.7	R/W	0
61	Local Route 7 Point State	See Table 5.7	R/W	0
62	Local Route 8 Point Inclusion	See Table 5.7	R/W	0
63	Local Route 8 Point State	See Table 5.7	R/W	0
64	Local Route A Point Inclusion	See Table 5.7	R/W	0
65	Local Route A Point State	See Table 5.7	R/W	0
66	Local Route B Point Inclusion	See Table 5.7	R/W	0
67	Local Route B Point State	See Table 5.7	R/W	0

Appendix B Decoder Address Chart

This chart (covering both pages) tabulates the decoder base addresses obtained from all allowed settings of CV1 & CV9 **for non ZTC systems**:

CV1 value	CV9 value							
	0	1	2	3	4	5	6	7
0	n/a	253	509	765	1021	1277	1533	1789
1	1	257	513	769	1025	1281	1537	1793
2	5	261	517	773	1029	1285	1541	1797
3	9	265	521	777	1033	1289	1545	1801
4	13	269	525	781	1037	1293	1549	1805
5	17	273	529	785	1041	1297	1553	1809
6	21	277	533	789	1045	1301	1557	1813
7	25	281	537	793	1049	1305	1561	1817
8	29	285	541	797	1053	1309	1565	1821
9	33	289	545	801	1057	1313	1569	1825
10	37	293	549	805	1061	1317	1573	1829
11	41	297	553	809	1065	1321	1577	1833
12	45	301	557	813	1069	1325	1581	1837
13	49	305	561	817	1073	1329	1585	1841
14	53	309	565	821	1077	1333	1589	1845
15	57	313	569	825	1081	1337	1593	1849
16	61	317	573	829	1085	1341	1597	1853
17	65	321	577	833	1089	1345	1601	1857
18	69	325	581	837	1093	1349	1605	1861
19	73	329	585	841	1097	1353	1609	1865
20	77	333	589	845	1101	1357	1613	1869
21	81	337	593	849	1105	1361	1617	1873
22	85	341	597	853	1109	1365	1621	1877
23	89	345	601	857	1113	1369	1625	1881
24	93	349	605	861	1117	1373	1629	1885
25	97	353	609	865	1121	1377	1633	1889
26	101	357	613	869	1125	1381	1637	1893
27	105	361	617	873	1129	1385	1641	1897
28	109	365	621	877	1133	1389	1645	1901
29	113	369	625	881	1137	1393	1649	1905
30	117	373	629	885	1141	1397	1653	1909
31	121	377	633	889	1145	1401	1657	1913

Non ZTC system addressing (continued):

CV1 value	CV9 value							
	0	1	2	3	4	5	6	7
32	125	381	637	893	1149	1405	1661	1917
33	129	385	641	897	1153	1409	1665	1921
34	133	389	645	901	1157	1413	1669	1925
35	137	393	649	905	1161	1417	1673	1929
36	141	397	653	909	1165	1421	1677	1933
37	145	401	657	913	1169	1425	1681	1937
38	149	405	661	917	1173	1429	1685	1941
39	153	409	665	921	1177	1433	1689	1945
40	157	413	669	925	1181	1437	1693	1949
41	161	417	673	929	1185	1441	1697	1953
42	165	421	677	933	1189	1445	1701	1957
43	169	425	681	937	1193	1449	1705	1961
44	173	429	685	941	1197	1453	1709	1965
45	177	433	689	945	1201	1457	1713	1969
46	181	437	693	949	1205	1461	1717	1973
47	185	441	697	953	1209	1465	1721	1977
48	189	445	701	957	1213	1469	1725	1981
49	193	449	705	961	1217	1473	1729	1985
50	197	453	709	965	1221	1477	1733	1989
51	201	457	713	969	1225	1481	1737	1993
52	205	461	717	973	1229	1485	1741	1997
53	209	465	721	977	1233	1489	1745	2001
54	213	469	725	981	1237	1493	1749	2005
55	217	473	729	985	1241	1497	1753	2009
56	221	477	733	989	1245	1501	1757	2013
57	225	481	737	993	1249	1505	1761	2017
58	229	485	741	997	1253	1509	1765	2021
59	233	489	745	1001	1257	1513	1769	2025
60	237	493	749	1005	1261	1517	1773	2029
61	241	497	753	1009	1265	1521	1777	2033
62	245	501	757	(note 1)	1269	1525	1781	2037
63	249	505	761	(note 1)	1273	1529	1785	(note 2)

Note 1: Avoid this address, which is used by the LocoNet power up interrogate process

Note 2: This is a broadcast address, meaning all accessory decoders should respond

ZTC Addressing

ZTC systems use different accessory addresses. This chart (covering both pages) tabulates the decoder base addresses obtained from all allowed settings of CV1 & CV9 **for ZTC systems**:

CV1 value	CV9 value							
	0	1	2	3	4	5	6	7
0	1789	1533	1277	1021	765	509	253	n/a
1	1793	1537	1281	1025	769	513	257	1
2	1797	1541	1285	1029	773	517	261	5
3	1801	1545	1289	1033	777	521	265	9
4	1805	1549	1293	1037	781	525	269	13
5	1809	1553	1297	1041	785	529	273	17
6	1813	1557	1301	1045	789	533	277	21
7	1817	1561	1305	1049	793	537	281	25
8	1821	1565	1309	1053	797	541	285	29
9	1825	1569	1313	1057	801	545	289	33
10	1829	1573	1317	1061	805	549	293	37
11	1833	1577	1321	1065	809	553	297	41
12	1837	1581	1325	1069	813	557	301	45
13	1841	1585	1329	1073	817	561	305	49
14	1845	1589	1333	1077	821	565	309	53
15	1849	1593	1337	1081	825	569	313	57
16	1853	1597	1341	1085	829	573	317	61
17	1857	1601	1345	1089	833	577	321	65
18	1861	1605	1349	1093	837	581	325	69
19	1865	1609	1353	1097	841	585	329	73
20	1869	1613	1357	1101	845	589	333	77
21	1873	1617	1361	1105	849	593	337	81
22	1877	1621	1365	1109	853	597	341	85
23	1881	1625	1369	1113	857	601	345	89
24	1885	1629	1373	1117	861	605	349	93
25	1889	1633	1377	1121	865	609	353	97
26	1893	1637	1381	1125	869	613	357	101
27	1897	1641	1385	1129	873	617	361	105
28	1901	1645	1389	1133	877	621	365	109
29	1905	1649	1393	1137	881	625	369	113
30	1909	1653	1397	1141	885	629	373	117
31	1913	1657	1401	1145	889	633	377	121

addressing for ZTC systems (continued)

CV1 value	CV9 value							
	0	1	2	3	4	5	6	7
32	1917	1661	1405	1149	893	637	381	125
33	1921	1665	1409	1153	897	641	385	129
34	1925	1669	1413	1157	901	645	389	133
35	1929	1673	1417	1161	905	649	393	137
36	1933	1677	1421	1165	909	653	397	141
37	1937	1681	1425	1169	913	657	401	145
38	1941	1685	1429	1173	917	661	405	149
39	1945	1689	1433	1177	921	665	409	153
40	1949	1693	1437	1181	925	669	413	157
41	1953	1697	1441	1185	929	673	417	161
42	1957	1701	1445	1189	933	677	421	165
43	1961	1705	1449	1193	937	681	425	169
44	1965	1709	1453	1197	941	685	429	173
45	1969	1713	1457	1201	945	689	433	177
46	1973	1717	1461	1205	949	693	437	181
47	1977	1721	1465	1209	953	697	441	185
48	1981	1725	1469	1213	957	701	445	189
49	1985	1729	1473	1217	961	705	449	193
50	1989	1733	1477	1221	965	709	453	197
51	1993	1737	1481	1225	969	713	457	201
52	1997	1741	1485	1229	973	717	461	205
53	2001	1745	1489	1233	977	721	465	209
54	2005	1749	1493	1237	981	725	469	213
55	2009	1753	1497	1241	985	729	473	217
56	2013	1757	1501	1245	989	733	477	221
57	2017	1761	1505	1249	993	737	481	225
58	2021	1765	1509	1253	997	741	485	229
59	2025	1769	1513	1257	1001	745	489	233
60	2029	1773	1517	1261	1005	749	493	237
61	2033	1777	1521	1265	1009	753	497	241
62	2037	1781	1525	1269	1013	757	501	245
63	2041	1785	1529	1273	1017	761	505	249

Appendix C Hexadecimal Conversion Chart

dec	hex	dec	hex	dec	hex	dec	hex	dec	hex	dec	hex
0	00	44	2C	88	58	132	84	176	B0	220	DC
1	01	45	2D	89	59	133	85	177	B1	221	DD
2	02	46	2E	90	5A	134	86	178	B2	222	DE
3	03	47	2F	91	5B	135	87	179	B3	223	DF
4	04	48	30	92	5C	136	88	180	B4	224	E0
5	05	49	31	93	5D	137	89	181	B5	225	E1
6	06	50	32	94	5E	138	8A	182	B6	226	E2
7	07	51	33	95	5F	139	8B	183	B7	227	E3
8	08	52	34	96	60	140	8C	184	B8	228	E4
9	09	53	35	97	61	141	8D	185	B9	229	E5
10	0A	54	36	98	62	142	8E	186	BA	230	E6
11	0B	55	37	99	63	143	8F	187	BB	231	E7
12	0C	56	38	100	64	144	90	188	BC	232	E8
13	0D	57	39	101	65	145	91	189	BD	233	E9
14	0E	58	3A	102	66	146	92	190	BE	234	EA
15	0F	59	3B	103	67	147	93	191	BF	235	EB
16	10	60	3C	104	68	148	94	192	C0	236	EC
17	11	61	3D	105	69	149	95	193	C1	237	ED
18	12	62	3E	106	6A	150	96	194	C2	238	EE
19	13	63	3F	107	6B	151	97	195	C3	239	EF
20	14	64	40	108	6C	152	98	196	C4	240	F0
21	15	65	41	109	6D	153	99	197	C5	241	F1
22	16	66	42	110	6E	154	9A	198	C6	242	F2
23	17	67	43	111	6F	155	9B	199	C7	243	F3
24	18	68	44	112	70	156	9C	200	C8	244	F4
25	19	69	45	113	71	157	9D	201	C9	245	F5
26	1A	70	46	114	72	158	9E	202	CA	246	F6
27	1B	71	47	115	73	159	9F	203	CB	247	F7
28	1C	72	48	116	74	160	A0	204	CC	248	F8
29	1D	73	49	117	75	161	A1	205	CD	249	F9
30	1E	74	4A	118	76	162	A2	206	CE	250	FA
31	1F	75	4B	119	77	163	A3	207	CF	251	FB
32	20	76	4C	120	78	164	A4	208	D0	252	FC
33	21	77	4D	121	79	165	A5	209	D1	253	FD
34	22	78	4E	122	7A	166	A6	210	D2	254	FE
35	23	79	4F	123	7B	167	A7	211	D3	255	FF
36	24	80	50	124	7C	168	A8	212	D4		
37	25	81	51	125	7D	169	A9	213	D5		
38	26	82	52	126	7E	170	AA	214	D6		
39	27	83	53	127	7F	171	AB	215	D7		
40	28	84	54	128	80	172	AC	216	D8		
41	29	85	55	129	81	173	AD	217	D9		
42	2A	86	56	130	82	174	AE	218	DA		
43	2B	87	57	131	83	175	AF	219	DB		

Appendix D LocoNet Interrogation Sequence

The DAC10 participates in the LocoNet accessory and sensor interrogation sequence which is controlled by some command stations (e.g. DCS100). This sequence is invoked after power is applied to the layout by the command station sending accessory commands to special addresses. The DAC10 responds by generating LocoNet output state & sensor feedback messages according to the settings of each point output and the status of each input (which may be driven by a LocoNet sensor).

This behaviour allows the LocoNet system to “discover” the state of all attached points, accessory devices and input sensors after power is applied. No further messages are generated until a point output or a sensor input changes state.

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