Instruction Switch5

Note, this manual is continuously updated. Check: www.mollehem.se/doc/instruktioner/Instruction_Switch5_en.pdf **for the latest version.**

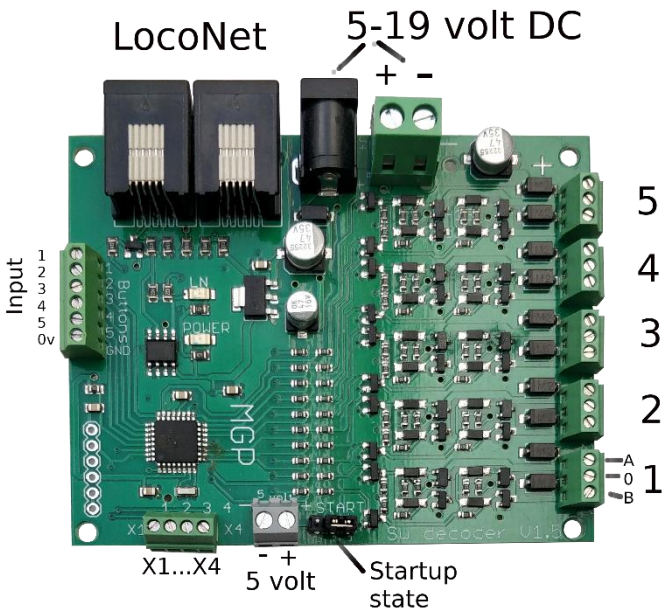
Content

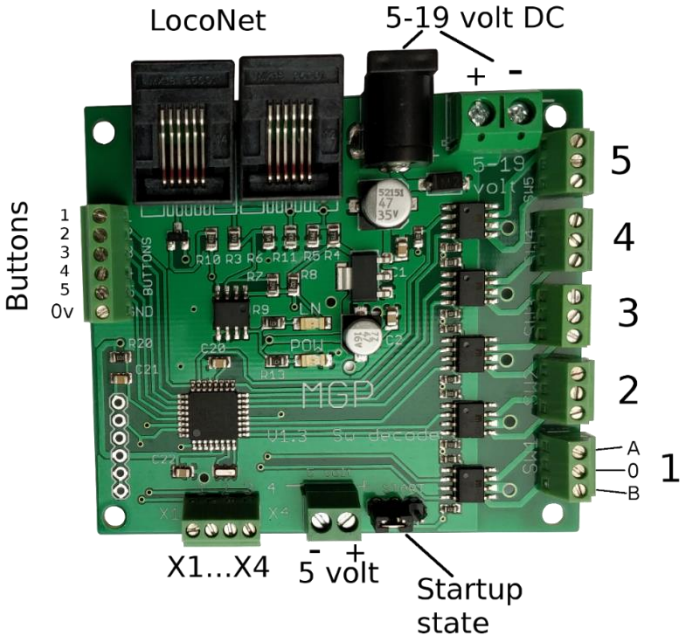
1 GENERIC SWITCH DEKODER

The Switch decoder can handle up to 5 traditional switch motors with push or switch buttons for control, see the picture for connections.
Current support with 5-19 voltage DC through a standard DC connection alternative screw terminal block. The voltage used should be selected based on the switch motor used.
Note – DC, not AC!

The decoder is exist in two versions, the new one with drivers built up with discrete components and the older one with drivers as ready-made driver circuits.

The newer version has more powerful drive stages and can handle current-hungry motors such as PECO.





New version, serial number 500+ *Old version, serial number <500*

Push buttons connects with one side to 0 Volt and the other side to the screw terminal 1 to 5. The switch will change position each time the push button is pressed.
If a switch button is used, the connection is the same, one side to 0 Volt and the other to the terminal 1 to 5.
SV 23, “Type of Buttons” should also be changed from ”Push button” to ”Switch button”, see chapter about SV programming.
Note, if push buttons are used and no LocoNet is connected to the decoder – then SV 44 ”Send LN for Buttons” must be set to ”No”!

At the bottom of the picture there are 4 connections X1 – X4. They can be used for different purposes and their function is decided by SVs.

There are also a 5 volt power connection that can be used to feed other cards. A maximum of 0.5A can be drawn from this connection.

. Important!
On the decoder there is a jumper to control the voltage of the outputs (A and B) at start-up, "Startup State" in the pictures.

Most motors should have 0 volts on these outputs during the decoder startup. Some motors (e.g. MTB) should instead have the supply voltage.

In the new version (decoders with serial numbers above 500, the jumper's normal position is between 2-3 (to the right).
In the older version, serial number below 500, the jumper's normal position is 1-2 (to the left).
"Normal mode" thus gives 0 volts on A and B during start-up.

1.1 ADDRESS TO DECODER AND SWITCHES

The decoder itself has one address stored in SV 21. The default address is **35**.
This address is used when the decoder is configured through its SV's. It is important that the address is unique on LocoNet, so it should be changed if more than one servo decoder is used.
The decoder address is changed in SV 21 through the programming app. Note that a changed address takes affect first at the next startup, so disconnect and reconnect power to the decoder after changing the address.

The connected switches are controlled through individual addresses. They are based on the main decoder address with switch 1 having the decoder address, switch 2 having "decoder address + 1" etc.

1.2 CONNECTING SWITCHES

Each of the five switches has three connections, "A", "0" and "B".

Switch motors that is controlled with to cables and reversed polarity is connected between "A" and "B".

Switch motors with two coils and a common cable are connected with the common cable to "0" and the two others to "A" and "B".

See a chapter further ahead for examples of switch motors.

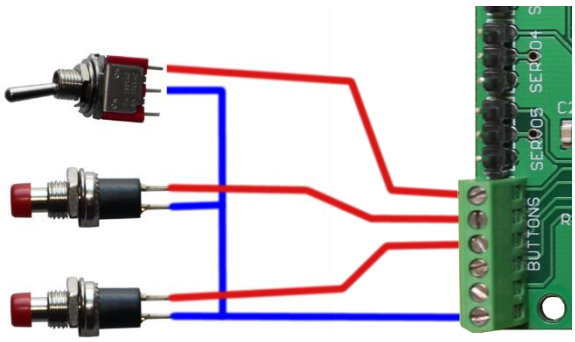
Some motors should have a continues current, and some should just have a short pulse when the position should change:
If a continues current should be used or a pulse and then the length of a pulse, is configured in SV by the help of the app.

1.3 CONNECTING BUTTONS

Buttons to control the servos are connected to the terminal for buttons.

Buttons can be push buttons or switches.

Normally simple push buttons is recommended to change the state of the turnout.
Switches with two stable directions, toggle switches, can be used in case there is a need to show the state of the turnout with the position of the switch. The drawback with this is that the position will not show the correct state if the turnout has been changed by e.g. a LocoNet order.



Buttons are connected with one common side to 0 Volt, and the other connected to the terminal at the position for the controlled turnout.

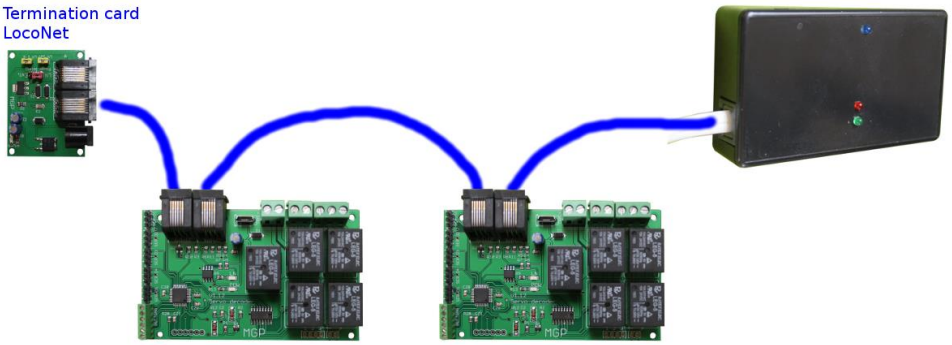
Inputs where the buttons are connected can also be used for other purposes.
In the decoder it must be stated what is applied to the inputs. This is done in Sv180, "Input use" which should have the value "Switch buttons" or "Internal routes" when buttons are connected.
In decoder version 12, two more options is available: “Track status” and “Switch status”.

The type of buttons used should also be specified. This is specified in Sv 36, "Type of buttons".
If a switch (as the top in the picture above) is used the value should be "Switch", and if push buttons (like the two lower in the picture above are used, the value should be "Toggle".

1.4 LOCONET

The switch decoder can be used without any LocoNet connection and is then controlled by connected buttons.

When the decoder is used in a larger layout or when the decoder is programmed through the programming app, LocoNet is used.
Note, when LocoNet is used there must be current support for LocoNet, which either a command station or a termination card (e.g. MGPs termination card) supplies.
In the picture to the right, a termination card, two switch decoders and one Bluetooth interface are connected to each other with LocoNet cables. LocoNet gets its power from the termination card, and that card can be replaced by a command station like Z21, Digitrax etc.



1.5 FUNCTIONS

1.5.1 ROUTES

On a station there can be several turnouts that must be set to the correct state, e.g. to take the train from the west entry to platform 1. This can be done with one command if Routes are used.

When a route is triggered the turnouts defined for this route will be set to defined states.
A route can have an address of its own and be triggered through LocoNet from a remote control panel.

The decoder can handle 5 routes with up to 6 turnouts per route. A turnout in a route can be any turnout on the layout and not just local to the decoder. A turnout in a route can also be another route so several routes can be connected if needed.

The local buttons on the decoder can be configured to control routes.

Each route has a normal turnout address. The address is specified for each route in SV, "Route X, Address"
The address of the route acts as a normal turnout address and can be used where standard addresses are used, for example. from a button in a panel, in other routes etc.
The route is set when sending "Closed" to the address, however sending "Thrown" will have no effect.
The route sends feedback about its status, "Closed" when it is set, "Thrown" if any of the turnouts are in the wrong direction. This applies regardless of whether the turnout order is sent to the route's address or if each of the individual turnouts is controlled directly.

If a panel decoder like "MGP Panel" is used to build control panels, a LED can be used to show when a route is set in its whole. A defined route will return a normal "switch feedback", with "Closed", when the route is set, and "Thrown" otherwise.

If the turnouts must not be switched at the same time, e.g. due to power consumption, a delay can be defined.
In Sv49, "Delay in routes", the delay can be defined with the number of tenth seconds. If a delay of 1s is wanted, then define the number 10 (10*0.1s).

Tip – at the entry to a yard with a few parallel tracks, it could be easier to provide one button per track instead of one button per turnout. When a train arrives and should go to e.g. track 4, then press the button for track 4 instead of a few buttons to set the turnout correct.
This can easily be accomplished with routes.

1.5.2 LOCKING OF TURNOUTS

In a small yard there could be a demand to lock some of the turnouts.
When a train should use the yard, the turnouts could be unlocked either remotely from a distant control panel, or locally at the yard with a key.

In the decoder the turnouts that should be locked is defined in SV 47 and their state in SV 48.

If turnouts should be locked for only local change, then SV47 "Lock local" should be set. This will affect all turnouts on this decoder. Note, this was introduced from version 10 of the decoder firmware.

If a local key should be used, a key can be connected to input X3 or X4. This is done with a "key switch", with one side of the switch connected to 0 volt and the other to X3 or X4.

If locking should be controlled from a distant panel, an address is defined in SV 45 and locking is done with a switch command on that address.

1.5.3 SECONDARY TRIGGING

For a turnout, another turnout can be defined to be triggered when the main turnout is triggered.
An example of usage is two turnouts connected as a crossover to enable the train to switch track on a double track. Here one button could be used to switch the first turnout, and the second turnout is switched secondary to the first.

1.5.4 OCCUPANCY DETECTION

The 5 inputs for buttons can be used for occupancy detection instead of control buttons.

To input 1 to 5, external electronic is connected that can e.g. sense the current consumed by a train a particular track. When the track becomes occupied or free, the decoder will report on LocoNet with standard status messages. This information can be used to light a LED at a control panel or set a signal by the track to Stop or Go.

Inputs where the occupancy detectors are connected, can also be used for buttons.
In the decoder it should be defined that occupancy detection is used. This is done in Sv180, "Input use" which must have the value "Track status".

Each detected track will have its own address. In Sv 181, "Status starting address", the address of the first connected track is defined. The other tracks will have consecutive addresses.

To filter disturbing signals on the input from occupancy detection or buttons there are two filter parameters to use:

”Input filter pre” sets how long a signal must be to be accepted as a new signal. The value is the time in milliseconds. With this, temporary disturbance can be removed when e.g. a loco has bad contact with the track.
If the input is used for buttons this time can be set very low or to 0, to avoid noticeable delay when a button is pressed.

”Input filter succ” is also time in milliseconds. When a new signal has been registered, other immediate signals will be discarded. The time before a new signal will be accepted is this filter time.
This is mainly used for buttons to filter away contact bounces that always appear on push buttons etc.

1.5.5 DIRECTION DEPENDANT OCCUPANCY DETECTION

In some cases it can be useful with a occupancy indication that gives information about the direction of the trains movement.
A direction dependent detection is based on two normal detections that are placed close to each other. Logic will register when a train moves between those two detections and will send occupancy messages based on the direction of travel.

The direction dependent detection will have two addresses that will indicate direction, one for direction “A to B” and the other for “B to A”.

The decoder has a total of four direction dependent detections, each with detections for both directions.
The addresses are based of one start address, defined in SV 450, “Direction dependent status”->”Start Address”.
The first of the four detections will use the start address for direction “A to B“ and the address+1 for direction “B to A”.
The second detection will use “start address”+2 etc.

For each of the direction dependent detections, the two addresses of the normal detectors, that the direction dependency is based on, are defined.
Those normal detection addresses are defined in Sv ”Direction dependent status”->”Direction dependent status X: Address A” and ”Direction dependent status”->”Direction dependent status X: Address B”.

A normal detection that is used in a direction dependent detection can still be used as a normal detection.

The direction dependent detection will signal “Occupied” when the train reaches the border between the two normal detectors, that is when both detectors signal “Occupied”.
The direction dependent detection will signal “Free” when the train leaves the border between the two normal detectors, that is when one detector signal “Free”.

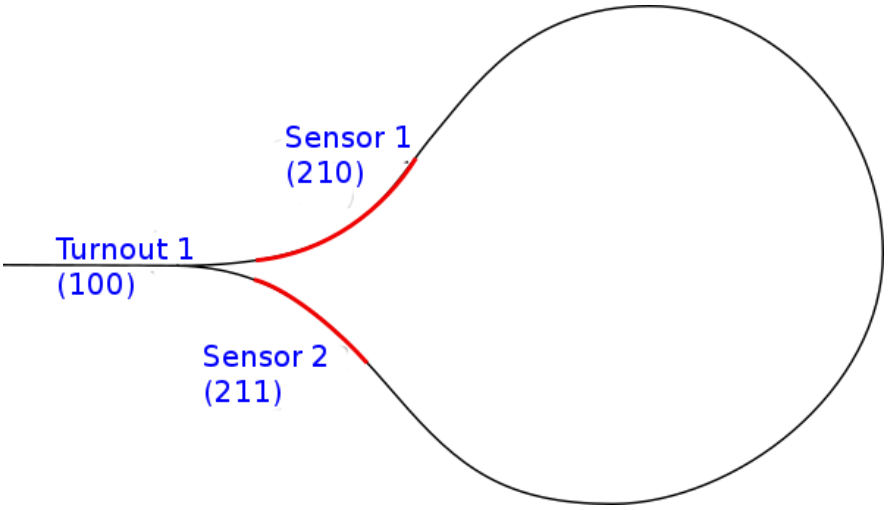
A delay for the acceptance of the normal detector going from “Occupied” to “Free” can be set. This can be used to minimize the problem for example when train has bad current collection.
The delay time is set in Sv 452, ”Direction dependent status”->”Delay free status (0.1s)”. This time is given in the number of 1/10 of a second, so e.g. the value 10 will give a delay of 1 second.

1.5.6 RULE CONTROL

Sometimes logic is needed to automate things controlled by switches.
An example could be to set a turnout when a track gets occupied, and this can be accomplished by a rule.

Example with a reverse loop:

When a train has entered the loop and is on the way out again, the turnout must be changed. This can be done with a sensor that see the train approaching the turnout. In the decoder we can have rules that tell the decoder to set the turnout correct.



We create a rule that sets the ”turnout 1” to ”closed” (i.e. up in the loop) and is triggered by an indication “occupied” from “sensor 1”.
Another rule is created that sets ”turnout 1” to ”thrown” when ”sensor 2” indicate ”occupied”.

A rule controls one of the turnout (1-5) to a set direction. To design the rule there are characteristics to decide how and when the turnout should be set:

Rule active	Controls if the rule should be used.
Switch number	The number of the turnout that should be set. The number is the internal number, 1-5, not the external address. Only turnouts local to the decoder can be controlled by rules.
Controlled state	The state of the turnout that should be controlled. The turnout is set to straight track (Closed) or diverging track (Thrown)
Triggering	Decides if the rule should actively trigger the turnout, or if it should be passive and e.g. prevent another order to set the turnout.
Mandatory	Decides if the rule must be true for the turnout to be set, or if it will be allowed to set the turnout with another order against the rule.
Scope	Controls if the rule will affect the state only when it becomes true, or also when it becomes false.

In the previous example with the loopback, the first rule could be created like this:

Turnout number is 1 (if the turnout is connected to ‘ 1),
the state to control is Closed (straight forward),
Triggering is ”Triggers switch”, we want the turnout to be triggered when the rule becomes true,
Mandatory is ”Not mandatory”, we want to be able to switch the turnout with other orders e.g. from a control panel,
”Scope” becomes ”Active only at true state”, we do not want to switch the change when the train leaves the sensor.

For each rule there are a set of logical conditions that decides if the rule is true or not – in the example that will be when the sensors are occupied.
Up to 5 conditions can be defined for each rule. Logic can be defined to require that all conditions must be true for the rule to be true, or just one, or a combination.
Each condition is defined in SVs:

Logic	The conditions dependence with previous conditions. AND defines that both this condition AND the previous condition must be true OR defines that this condition must be true OR the previous (or both).
Status	Status of the device that controls the condition, eg. a turnout is closed or an occupancy detection is occupied.
Type	The type of the device, turnout or occupancy sensor etc.
Address	The external (LocoNet) address of the controlling device.

In the loopback example the condition for the first rule will be:

”Logic” – doesn’t matter because this is the first condition,
”Status” should be ”Occupied”, we will trigger when the sensor reports occupied,
”Type” is ”Sensor”, i.e. occupancy detection,
”Address” is 210 which is the address of the sensor according to the previous picture.
(More about the loopback example can be found in appendix A.)

The relation between the statements is defined with ”AND” and ”OR”.
”AND” binds harder than ”OR”.
Example:
for ”A and B or C”, the first and is evaluated ”A and B”, and then the result of this is used with “or C”. With parentheses the expression would be: ”(A and B) or C)”.

If more complicated rules, with more than 5 conditions, is needed, then one rule could be used in another.

1.5.7 X-CONNECTION

On the decoder there are extra connection named X1, X2, X3 and X4.

The function of these is controlled with SV 183 – SV 193.

For each X-connection there is one SV defining the function and one SV that defines the address to be used.

1.5.7.1 X1 AND X2

X1 and X2 can be used for input and they must have defined potentials of 0 resp. 5 Volt.

These connections can be used to change switches or for occupancy detection.

1.5.7.2 X3 AND X4

X3 and X4 can be used both as input and output.

As input they work in the same way as the button terminals i.e. they should connect to 0 Volt when active.
As input they can be used to control switches, for occupancy control and for locking selected switches.

As output terminals their value (0/5 Volt) can be set to follow the status of the switches.
Important – when using the output linked to a switch, it is the "internal address" to be used, meaning 1-5 for switch 1-5!
As an example the output can be set to 1 when a switch is moving and then used for controlling a bell on a railroad crossing.
Output could also be used to follow an internal relay and could be used to control an external relay like the MGP relay card for changing track polarity in a loopback etc.

1.5.7.3 OPTO SENSORS ON X1/X3 OR X2/X4

Experimental support for optical sensors.

Optical sensor consists of a transmitter and a receiver (e.g. a led and a photodiode). If the light beam is broken between the transmitter and receiver, it indicates a train. It can also be used to indicate on reflections from a train.

The light is usually infrared (IR) to become independent of lighting conditions in the room. However, such as fluorescent lighting can still affect these detectors.

A transmitter can be connected to the X3 (X4) and the corresponding receiver is connected to X1 (X2).
The decoder will handle light detector in a manner that interference from, for example. fluorescent lighting is minimized.

Light emitting diode and photodiode should usually be connected to the X-connections with resistance, see instructions from sensor supplier.

The use of optical sensors is activated on the setting of the "Usage X1" or "Usage X2".

1.5.8 TRACK STATUS FROM UNITS OF OTHER BRANDS

Track sensors sends messages for busy/free tracks on the LocoNet.
For example, if a locomotive has poor connection with the track, it might send bursts of messages in vain. A track detection should have filtering capabilities to avoid these unnecessary messages but there are devices for track sense from other manufacturers that have no filter option

A rule that is based on free/busy tracks might give an unwanted behavior if unfiltered track indication is used, for example. a railroad crossing that will be opened when a track becomes available. Unnecessary message should be filtered at the source, but if that is not possible this decoder has a possibility to deal with this.

Decoders with software from version 11:
Up to 10 status addresses can be defined to be filtered. Filtering provides a delay before the change in status is accepted. If new status messages arrive during this time, the previous message is ignored, and a new delay will be started for the new message.

The delay can be set to between 0 and 3 seconds.
Suitable delay for track indication can somewhere around 0.3 - 0.5 seconds.

The delay can be activated when the status is set to busy, free or in either case.
The normal use of this function is to filter the track indication. Poor track connection will result in false free messages and for this case it is appropriate to put delay active for signals that goes to 0/off.

Use this function as a last resort.
Try to avoid unnecessarily messages before they are sent!

1.6 INSTRUCTION FOR SOME SWITCH ENGINES

There are essentially two groups of switch motors, those connected with 3 wires and those with 2 wires.
Those with 2 wires are connected between “A” and “B” and is controlled with switched polarity.
Those with 3 wires have one of the wires as the common wire and that wire should normally be connected to “0”. For a small group of motors the common wire need “+” and when that is the case, the wire can be connected to the “+”-connection for the whole decoder.

1.6.1 CONRAD

The Conrad motor has 3 wires for connection, one red and two brown. The two brown wires have diodes at the end of the wire.

With the diodes in place, the motor can be connected by connecting both brown wires to A and the red wire to B.

If the diodes are cut of, connect the motor with one brown wire to A and the other to B.
The red wire is then connected to the middle socket, 0.

Suitable operating voltage 12 volts.

Suitable pulse length about 5 (0.5 seconds).
If the diodes are included, the motor has limit switches and can handle continuous voltage.
Without diodes, pulse must be used and the time adjusted so that a stable switching is obtained.

1.6.2 FLEISCHMANN, ROCO, TRIX

Classic magnetic solenoids with three connections. The switch consists of two different coils pulling depending of the position of the gear.
Three wires whose colors may vary slightly between the fabrics.
One of the threads is common to both coils and this is connected to 0 on the decoder.
The two other threads are connected to A and B.
The motors work well at about 15 volts.
Suitable pulse length has to be tested for the individual switch but will probably end between 1 - 10. The motors have an end switch but for safety it may be good to drive in pulse mode.

1.6.3 KATO

Kato has built-in motors in their switches. These are controlled with 2 wires where polarity controls the switch.
Connect the two wires from the switch to A and B.
Suitable operating voltage is 12 volts.
Suitable pulse duration approximately 5 (0.5 seconds) but the motor has a limit switch and can then run with continuous voltage.

1.6.4 TILLIG

Tillig's motors for underlying mounting (86112) has 3 wires for connection. The common is red and the two other, yellow resp. pink, for movement in different directions.
The reason for two wire, yellow and pink, is for operation with alternating current and they have built-in diodes. For use with this switch decoder, which gives DC, connect yellow and pink together and connect in the same place.

Connect the red wire to A and both yellow and pink to B.

Different operating voltages provide different speed when switching and can be selected freely between 5 and 19 volts.

The engine is equipped with an end switch and can thus have continuous voltage or choose a pulse length slightly longer than the time the motor needs to switch.

1.6.5 TORTOISE

The Tortoise switch motor has two connections for switching. These are the two outermost on the motor, numbers 1 and 8.

Connect wire 1 and 8 to A and B.

Different operating voltages provide different switching speed and can be selected freely between 5 and 12 volts.

The engine is supposed to operate with continuous voltage.

1.6.6 MTB MP1

This switch motor has three threads where one is common, but the common wire needs “+”.

The wire of the gear motor "(+) COM" should be is connected to the plus on the terminal block for the decoder power supply, "5-19volt DC (+)".
The two other connections, "poz1" and "poz2" are connected to "A" and "B" on the usual output terminals.

"A" and "B" has default 0 volt when the output is inactive. Since this engine has "common plus", the inactive output must also be "plus".
On decoders with program version 3 or higher, this can be set with SV 29, "Neutral output state".
This is usually "LOW", but should be set to "HIGH" for this engine.

On the decoder beside the terminal for Switch 1 there is a jumper marked “Start”. This jumper should be moved to 2-3 instead of default 1-2.
This will give the correct inactive state at power-on before the decoder are initiated. If this jumper is in the wrong place the switch motors will move slightly at power up.

1.7 SYSTEM VARIABLES – SV, SWITCH DECODER

Note – some SVs is only visible if the programming app has been set to ”advanced mode”!

LocoNet decoders has their configuration stored in System Variables, SVs. These can be changed through the programming app.

The following system variables exists now.

SV number	Name	Description	Decoder version
21	Address	Identifies the decoder during programming. This address should be unique on LocoNet. It is also the address to switch 1. Switch 2 has the address +1, etc.	
23	Type of Buttons	”Toggle” is for a momentary push button, ”Switch” is for a switch with two stable positions.	
24	Turnout 1, Pulse length (*0.1s)	The number of tenth of seconds that power is applied to the switch motor. Set to 0 for continues power.	
25-28	Turnout 2-5, Pulse length (*0.1s)	The same as 24 for the other switches	
29	Neutral output state	Low (0) sets switch output to 0 when not active. High (1) sets switch output to Vcc when not active. LOW is default and should be used with most types of motors.	3
30	Time between switching (*0.1s)	The shortest time between switching of the same switch. Used with current hungry switch motors to avoid overload of the electronics. 0 – no limit 1-255 - the number of tenth of seconds between two successive switching’s.	2
39	Loconet direction	Control which way the switch should move when the loconet message is "closed". Bit 0 in the value, control switch 1, bit 1 controls switch 2 etc.	
40			
41	Button direction	When local switch buttons are used to control switches – defines the direction of the switch motor when the button is switched. Bit 0 in the value controls switch 1, bit 1 controls switch 2 etc.	
43	Switch when button is…	Defines when change order should be sent – when the button is pressed or when it is released. Default is when it is pressed.	
44, bit 0	Send LN for Buttons	Defines if a control order should be sent on LocoNet when local buttons are used.	

44, bit 1	LocoNet connected	For better performance, set to ”No” if no LocoNet is connected to the decoder	
45	Lock Address	LocoNet address that control locked state (1-Closed) or unlocked (0-thrown)	
47	Lock switches	Defines which switches that are affected by a lock order. Bit 0 in the value controls switch 1, bit 1 controls switch 2 etc.	
47, bit 7	Lock local	Defines that the all switches should be locked from local change. Remote change is still possible.	
48	Lock position	Defines the position of the switch when it is in the locked state. Bit 0 in the value controls switch 1, bit 1 controls switch 2 etc.	
49	Delay in routes	Delay between each switch order within a route.	6
50	Route 1, Address	LocoNet address for Route 1	
52	Route 1, Sw1, Address	LocoNet address to the turnout 1 in this Route	
54	Route 1, Sw1, Direction	The state of turnout 1 in this Route 0 – Closed 1 – Thrown	
55-68	Route 1, Sw2-Sw6	Turnout 2-6 in this Route in the same ways as SV 52-54. For an unused position use address 0.	
70-149	Route 2-5 in the same way as SV 50-68		
172 bit 0-3	Switch 1, Start delay, from THROWN	Delay, in seconds, between switch order and when the switch starts to move.	
172 bit 4-7	Switch 1, Start delay, from CLOSED	Delay, in seconds, between switch order and when the switch starts to move.	
173-176	Start delay switch 2-5	Same as 172 for the other switchs	
177			
178	Input sensor, value for occupied state	0 – normal, occupied at low 1 – occupied at high	
179	Input, unconnected state	0 – normal, always high 1 – undefined, floating	
180	Input use	Defines the use of input from the button terminals. They can be used for: - ”Buttons”(default), - ”Routes” - ”Occupancy detection”. In later version two more options is available: - ”Track status” - ”Switch status”	

181	Status – first address	If button terminals are used for ”Occupancy detection”, this SV contains the address of the first input. The other inputs are the address+1, +2 etc.	
183	Usage X1	Usage of X1: 0 – Not used 1 - Switch Thrown 2 - Switch Closed 3 - Switch TOGGLE 6 – Track Status 15- Track status, opto X1/X3 16- Track status, opto X1/X3, reflection	
184	X1 address	Address used for X1	
186	Usage X2	Usage of X2: 0 – Not used 1 - Switch Thrown 2 - Switch Closed 3 - Switch TOGGLE 6 – Track Status 15- Track status, opto X2/X4 16- Track status, opto X2/X4, reflection	
187	X2 address	Address used for X2	
189	Usage X3	Usage of X3: 0= Not used 1= switch CLOSED 2= switch THROWN 4=Lock local 5=Lock as lock list 3 - Switch TOGGLE 6 – Track Status 20 – Output, Switch sync CLOSED 21 – Output, Switch sync THROWN 22 – Output, Switch sync Unknown 23 – Output, Relay sync 24 – Output, Relay sync opposite	
190	X3 address	Address used for X3 - When X3 is used as input, this is a LocoNet address in the interval 1-2054 (-4095) - When X3 is used as output linked to a switch, then the number of the switch position is used, 1-5.	
191, bit 7	Active Output X3	Logic level for output that counts as active. 0 = 0 1 = 1	

192	Usage X4	Usage of X4: 0= Not used 1= switch CLOSED 2= switch THROWN 4=Lock local 5=Lock as lock list 3 - Switch TOGGLE 6 – Track Status 20 – Output, Switch sync CLOSED 21 – Output, Switch sync THROWN 22 – Output, Switch sync Unknown 23 – Output, Relay sync 24 – Output, Relay sync opposite	
193	X4 address	Address used for X4 - When X3 is used as input, this is a LocoNet address in the interval 1-2054 (-4095) - When X3 is used as output linked to a switch, then the number of the switch position is used, 1-5.	
194, bit 7	Active Output X4	Logic level for output that counts as active. 0 = 0 1 = 1	
195, bit 0-6	Auto return time, switch 1	0 if not used 1 -63 is time in seconds before the switch returns to the other direction	
195, bit 6	Auto return time factor	Can be set to 10 which means that the value for “autoreturn time” will be 10 times longer, 10 - 630 seconds	
195, bit 7	State for Auto return, switch 1	0 – Thrown 1 – Closed	
196-199	Auto return for switch 2-5	Auto return for switch 2-5, same as 195	
200, bit 0-2	Secondary trigger switch 1, type	Defines if something else should be triggered when switch 1 is changed. 0 – Not used 1 – send when switch 1 goes to ”Closed” 2 – send when switch 1 goes to “Thrown” 3 – send at each change of witch 1	
200, bit 3	Secondary trigger switch 1, when to send	Defines when the secondary command shall be sent: 0 – before the movement starts for switch 1 1 – when switch 1 has moved	
201	Secondary trigger switch 1, command	Defines what secondary order that should be sent 0 – the same order 1 – the opposite order 2 – send ”Closed” 3 – send “Thrown”	
202	Secondary trigger switch 1, Address	Address to which the secondary trigger should be sent	

204-219	Sec trigger for switch 2-5, same as 200-203		
220 - 299	Rules	Rules to control the movement of switches based on the status of other devices	
220, bit 0	Rule 1, Active	0 – inactive, 1-active	
220, bit 1-3	Rule 1, Switch number	The local number of the switch that is controlled by the rule, 1 till 5. 0 – no switch 1-5 – switch number	
220, bit 4	Rule 1, Controlled status	The state that will be set to the switch if the Rule is true. 0 – thrown 1 – closed	
220. bit 5	Rule 1, Triggering	Defines if the rule should actively trigger 0 – Rule will not trigger when active 1 – Rule will trigger switch when status change	
220, bit 6	Rule 1, Mandatory	Defines if the rule is mandatory for the switch, or if a control order can be given to the switch against the rule. 0 – not mandatory 1 – mandatory	
220, bit 7	Rule 1, Scope	Defines if the rule should trigger the switch when it becomes TRUE or when both states occur 0 – Rule active only at TRUE 1 – Rule active at both TRUE and FALSE	
221, bit 0	Rule 1, statement 1, Logic	0 – OR 1 – AND	
221, bit 1	Rule 1, Statement 1, Status	0 – Thrown/0 1 – Closed/Occupied/1	
221, bit 2-4	Rule 1, Statement 1, Type	0 – not used 2 – Switch Status 3 – Sensor 4 – Other rule	
222,223	Rule 1, Statement 1, Address	External address of switch/Occupancy sensor	
224-226	Rule 1, Statement 2	Same as 221-223	
227-229	Rule 1, Statement 3	Same as 221-223	
230-232	Rule 1, Statement 4	Same as 221-223	
233-235	Rule 1, Statement 5	Same as 221-223	
236-251	Rule 2	Same as 220-235	
252-267	Rule 3	Same as 220-235	
268-283	Rule 4	Same as 220-235	
284-299	Rule 5	Same as 220-235	
400-401	Input filter pre (ms)	Defines the minimum time that a signal must be stable on the input to be detected	

402-403	Input filter succ (ms)	Defines the time that a signal will be discarded directly after a previous signal has been detected	
410	Optosensor high diff	Experimental! Used to trim the opto sensor for different light circumstances	
411	Optosensor low diff	Experimental! Used to trim the opto sensor for different light circumstances	
412	Optosensor delay	Experimental! Used to trim the opto sensor for different light circumstances	
420 – 440	Delay of selected status messages		
420	Incoming Status Delay Type	When the message should be delayed, either when is signals 0, or 1, or both.	
421	Delay time	Delay for incoming status messages in 1/10 seconds, värde 0-30 dvs 0.0 – 3.0 sec	
422,423	Delay address 1	Address of message to be delayed, 1 - 4095	
424-440	Delay address 2-10	Same as for 422	
450 - 468	Direction Dependency Detection		5
450	Start Address	First Address of messages for Direction dependent occupancy. The rest of will be address+1, address+2 etc.	5
452	Delay Free Status	Delay of the acceptance for transision between “Occupied” and “free”. Value is number of 0.1 seconds.	5
453	Direction dependant status 1: Address A	The address of the first normal detection that this direction dependency will be based on.	5
455	Direction dependant status 1: Address B	The address of the second normal detection that this direction dependency will be based on.	5
457-467		Address A and B for direction dependen detectors 2-4, in the same way as 453 and 455.	5

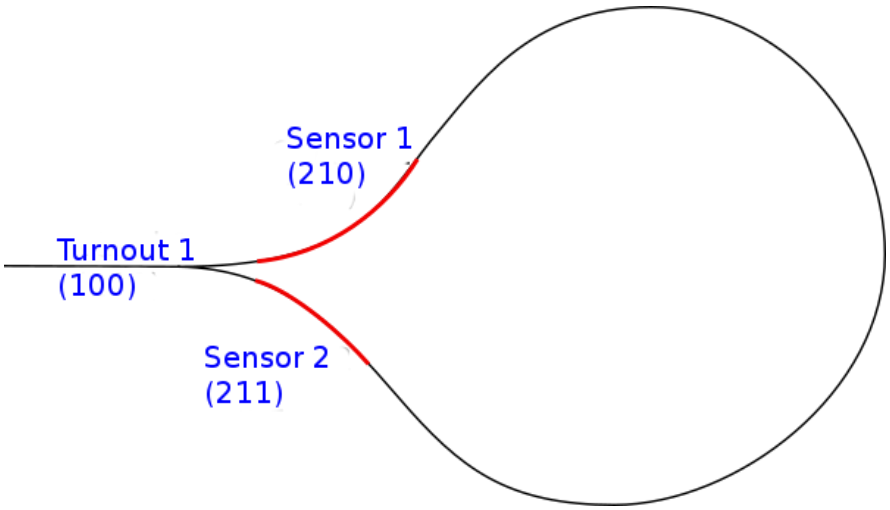
Some SV has complex values on a bit level.

Use the programming app to avoid manipulation on bit level!

2 APPENDIX A, EXAMPLE ”CONTROLLING A LOOPBACK WITH A SWITCH DECODER”

In the chapter about Rules, there is an example of building an automated loopback.
Here comes a complete description of how this application can be built.

The description result in a fully automatic loopback control where the trains themselves trigger the change of the turnout and where polarization in the loopback is controlled to avoid shortage.



Program version 5 or better is required for this example – contact MGP if an update of the decoder is required.

2.1.1.1 TURNOUT CONTROL AND OCCUPANCY DETECTION

To control the loopback, a switch decoder and occupancy detection for two tracks.
The occupancy detectors are connected to button terminal 1 and 2 of the switch decoder.

I picture we have given the turnout **address 100 (SV 21 in the decoder).**

We use sensors for occupancy detection connected to the button terminals 1 and 2. For this to work we need to set **SV 180 to ”Track status”** and the address in **SV 181 to 210**.

2.1.1.2 POLARIZATION OF THE **LOOPBACK**

A loopback the left rail with its left rail polarity will come back as the right rail and a shortage will occur.
To avoid that, the track inside the loopback is isolated from the turnout and a relay is used to switch sides of the track polarity when needed.

The relay card from MGP is well suited to be used for changing polarity and can switch sides on both rails on a track.
The external relay is connected to X3 or X4 and defined to follow the movement of the turnout switch.

If the switch decoder is used to control a double track turnout, the easiest way to accomplish polarization is to use two external relay cards.

2.1.1.3 CREATING RULES

When a train is in the loopback and approaches the turnout to exit, the turnout has to change. This should happen when the sensor at the exit indicates occupied.
Two rules is needed, one for each sensor.

”rule 1” triggers ”turnout 1” (address 100) to ”closed” (i.e. up in the loopback) when ”sensor 1” (address 210) indicates ”occupied”.
”rule 2” triggers ”turnout 1” to ”thrown” when ”sensor 2” (address 211) indicates ”occupied”.

Rule 1:

Turnout, with address 100, is set to ”closed” when Sensor 210 indicates ”occupied”.

SV 220 and the following SVs: ”Switch number” – ”Switch 1”, ”Controlled status” – ”**Switch closed**”, ”Triggering” – ”Trigger switch”, ”Mandatory” – ”Not mandatory”, ”Scope” – ”Active only at true state”	Rule 1, condition 1: ”Logic” - ”And” *(AND / OR does not matter in this case as it is the first condition)* ”Status” – ”Occupied” ”Type” – ”Sensor” ”Address” – ”**210**”

Rule 2:

Turnout, with address 100, is set to ”thrown” when Sensor 211 indicates ”occupied”.

SV 236 and the following SVs: ”Switch number” – ”Switch 1”, ”Controlled status” – **”Switch thrown**”, ”Triggering” – ”Trigger switch”, ” Mandatory” – ”Not mandatory”, ”Scope” – ”Active only at true state”	Rule 2, condition 1: ”Logic” –”And” ”Status” – ”Occupied” ”Type” – ”Sensor” ”Address” – ”**211**”

When the rules are defined they can be set active in SV 220 and 236.

APPENDIX B, HARDWARE

The MGP decoders are compatible with the Arduino computer card family.
They can be reprogrammed with the Arduino IDE and in that case be treated as “Arduino Pro mini”.

The six unpopulated connector holes that sits at the border of each decoder, is the same interface that is found on a “Pro mini”. Looking from outside of the board, “GND” is the hole to the right.

To use them with LocoNet, the LocoNet libraries from “Model Railroading with Arduino” can be used. The first versions of the decoders used them, but due to available memory, the current versions use more compact and less generic code. To use this LocoNet library, use D8 as incoming and D9 as outgoing pins.

To update the decoders with new version of the firmware, the available images can be loaded into the decoder. But - these images are not suitable to load if the decoder has been used with other code before. If a decoder needs to be reloaded with the normal firmware – please contact MGP.