# MP1/MP5 Application Note

Rev P  April 1, 2019

## Introduction

The MP1/MP5 series of switch machines are *extremely compact* switch motors measuring 1.5" wide, 1.5" high by .5" deep (MP1) or 2” x 2.25” x .75” (MP5 with connector installed), making them especially suitable for use on upper decks of multilevel layouts and for modular layouts.  While they have about the same outline as the industry-standard stall motor switch machine, the MP series are less than 1/6 as deep!

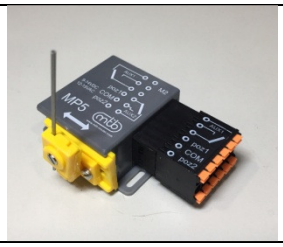
The MP series are powered by either 9-14 VDC (we recommend at least 12V when using DC) or 12-15 VAC.  The MP series are *NOT* stall motors, but have a common power supply lead and an operate lead for each direction. This makes for an extremely simple basic control installation, consisting of a SPST contact for each direction, or a single SPDT toggle switch.  The MP5 can optionally be wired for two wire control, like a stall motor but does not draw current continuously, however it draws about 100 mA while moving (about 2 seconds).  See below for a neat trick on operating the MP1 with just two wires!

Operating current (at 12V) while the motor is moving is 150mA for the MP1, 100mA for the MP5 (comparable to a servo) so an adapter such as MRCS’ ITC,  RSMC or CSNK must be used when operating the an MP series switch machine from a digital output such as a cpNode or IOX.  (Dr Chubb’s SMINI and DOUT can sink about 0.5A, so they’re OK)  The MP series is also compatible with 3rd party DCC accessory decoders such as our MPD8 and Digitrax’ DS52 and DS64.  No current is drawn once the motor reaches its limit of travel.

Features:

- The stroke can be set in one of 4 positions: 3 mm, 6 mm, 9 mm (and 12 mm - MP5 only) – see the instructions. The cam mechanism provides slow end position stop and lock.
- The MP series can use either DC or AC power supplies, with a current draw of < 150 mA during motion. The mechanism has a position end limit switch, e.g. the control voltage can be applied permanently, to be disconnected automatically once the end position is reached and the motion stops, similar to the PFM/Fulgerex switch machines of days past.
- SPDT contact for position indication or frog polarity switching.  (With resettable thermal protection fuse set to 0.5 A short–circuit protection on the point frog on MP1 Rev 1 only).  Later (V2) MP1s do not have the current limiting feature.  The MP5 has a DPDT Switch (no current limiting).
- Linear motion - the actuating rod follows a straight line and keeps a constant height through its travel.  The supplied actuator rod is 0.043" x 2" long and will fit through roadbed/subroadbed of about 1.5."  You can substitute a piece of 0.039 or 0.047" Music Wire which makes the end alignment a little less critical.

Table of features and identification:

| | MP1 | MP5 | Standard Stall Motor |
|---|---|---|---|
| |  |  | |
| 2 wire operation | With external diodes, See note below | X | X |
| 3 Wire operation | X | X | |
| Operating Current | Momentary<br>< 150mA @12V,<br>85 mA @ 9V | Momentary<br>< 100 @ 12V,<br>75 mA @ 9V | 20mA Continuous |
| Throw | 3,6,9 mm, fulcrum linkage provided with version 2 | 3,6,9,12 mm or fulcrum (linkage – included) | Move fulcrum |
| Linear or Radial Motion | Linear (Either Rev 2) | Either | Radial |
| Auxiliary Contacts | SPDT (with current limiting Rev 1) | DPDT – no current limiting | DPDT |
| Dimensions | 1.5" wide, 1.5" high by .5" deep | 2” wide x .75” high x 2.25” deep | 2” wide x .3.25” high x 2” deep |
| Connections | 6 position screw terminal | 12 position push on connector with no-solder – included. (Push in) connector – 16-28 Ga wire | PCB edge connector (user supplied) – try our Tortoise to RJ45 or screw terminal adapter |

# Manual Control

Manual control installation for the MP series is very simple. A single pole, double throw (SPDT) switch is connected with the center pole to ground and each of the normally open and normally closed contacts connected to one of the position screw terminals. They are labeled POZ1 and POZ2. A common positive, typically 12 V, is connected to the plus COM terminal. See figure 1. Typically either a toggle switch or a slide switch will be used.

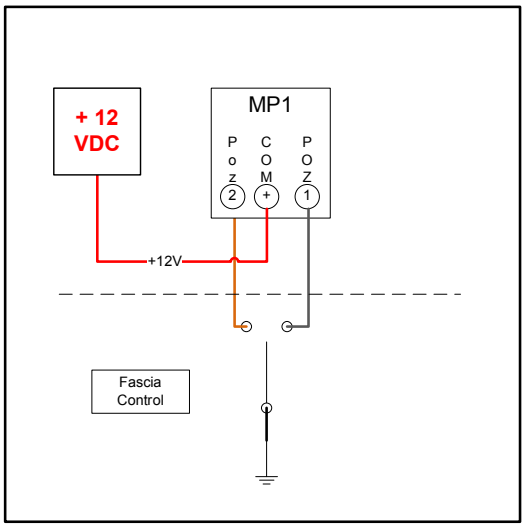



Figure 1 - Manual Control of MP1

Hint: If the turnout throws opposite of what you intend simply reverse the wires to Poz1 and Poz2.

The auxiliary contacts can either be used to power a live frog or for position reporting to a computer or simply to light LEDs on a control panel. Note that the MP1 version 1 auxiliary contact is current limited by a semiconductor device, so there is about a .5V drop across each one, therefore powering a daisy chain through the MP1's aux contact is not recommended. Version 2 MP1s and MP5s have DPDT contacts that are not current limited.

There is a 2 wire variant on this connection, submitted by George Warner who uses two switching diodes (any diode that can handle 150 mA); one each from Poz1 & 2 to the COMmon terminal to eliminate the need of a 3rd wire.

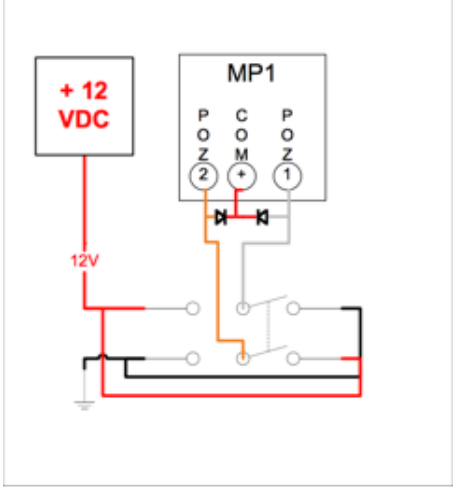



Figure 2 - George Warner's 2 wire solution

## How does a manual MP Series Installation differ From a Tortoise Installation?

For many years the Tortoise™ by Circuitron has been the standard stall motor switch machine used by serious model railroaders, at least in HO scale, although there are several stall motor options available. Stall motors feature a motor winding of fairly high resistance such that there is low torque and a low stall current. Voltage is reversed across the motor to reverse the turnout. Current continues to flow at about 20 mA as long as there's power to the motor, which is required to maintain pressure on the points. Stall motor connections typically are "two wire": one to each side of the motor. Most stall motor installations are done with a double pole, double throw (DPDT) switch such that the center poles go to the ends of the motor winding and 12 V is brought in to the outer contacts and flipped so the left side and the right side are opposite polarity and flipping the switch reverses polarity to the motor, causing the turnout to move as shown in figure 3.

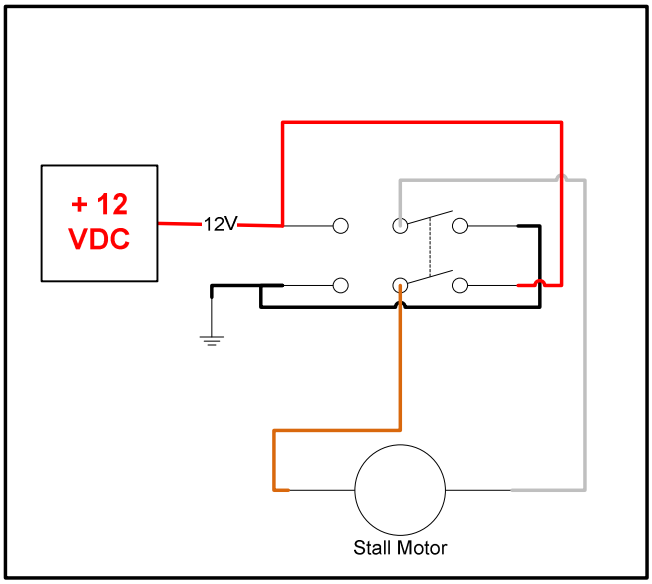



Figure 3 - Stall Motor Control with DPDT Switch

In contrast, the MP series uses a three wire connection. However it turns out that the stall motor control leads can be connected to Poz1 and Poz2 of an MP1 and 12 V from the same power supply can be connected to the common terminal of the MP one and the MP one will operate quite happily. Note that the MP Series switch machine draw as much as 150 mA while operating, so be sure your power supply is rated for at least 150 milliamps. The MP5 has an option to operate as 2-wire device, which is useful in replacing or extending existing two wire control systems. See Figure 4.

You can drive an MP Series switch machine with our ITC or RSMC, either as a standalone unit or as part of a cpNode as long as the same 12V supply is used for the ITC/RSMC and the MP series switch machine.

There are other arrangements for manually operating stall motors, so check your wiring before replacing any stall motor with an MP series switch machine.

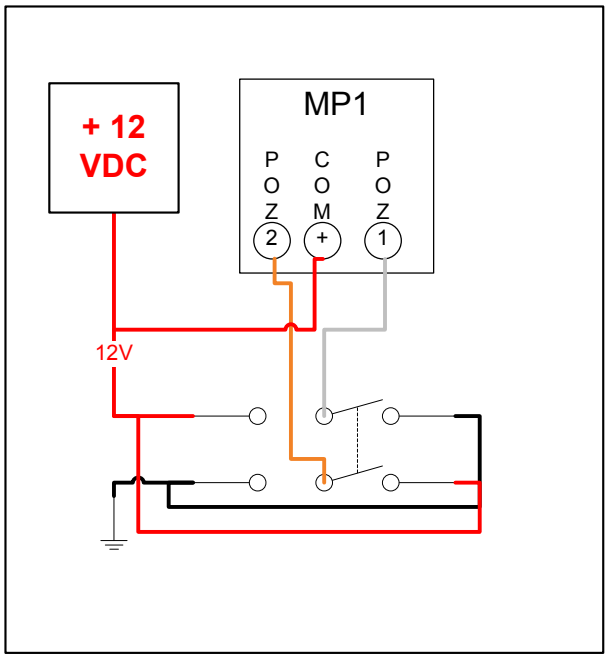



Figure 4 - DPDT Stall Motor installation Adapted for MP Series Motor

## Controlling an MP Series Switch Machine Electronically With a Digital Logic Signal

Electronic control of an MP1 is also fairly simple. All you need is a way to sink (connect to ground) 150 mA at 12 V for each of the control lines connected to POZ1 and POZ2.

### Use our RSMC or our new ITC

You can use MRCS' RSMC (Remote Stall Motor Controller) or MRCS' Integrated Turnout Controller (ITC) either via a cpNode or as a freestanding device. Just tie the MP1's COM lead to the same +12 supply as the M+ on the RSMC. The Poz1/Poz2 of the MP1 should connect to motor output pins 1 and 8 of the RSMC respectively. The "Throw" input provides single-line control of the MP1. An MP5 can either be connected the same as an MP1 or you can use it in "2_wire Mode" and connect COM to pin 1 of the RSMC and both M2 connections to the other side.

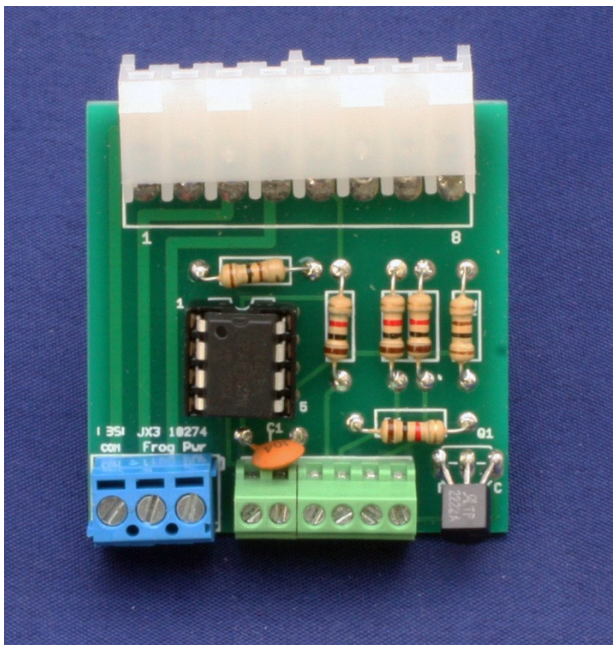


Figure 5 – RSMC

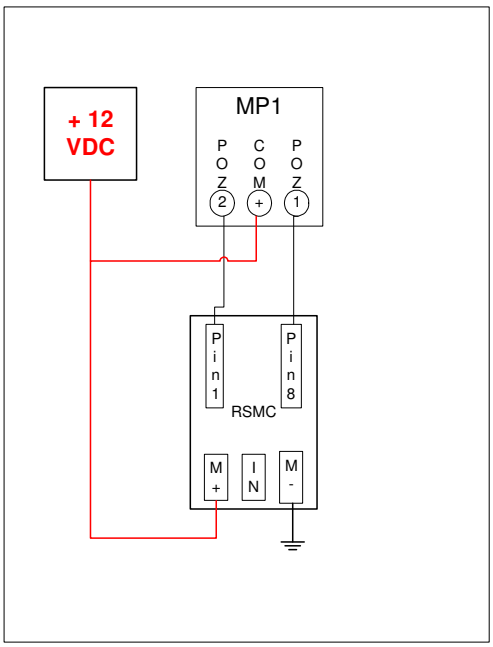



Figure 6 - RSMC Connections

See the RSMC Connection Instructions at
http://www.modelrailroadcontrolsystems.com/content/RSMC%20Instructions%201.2.pdf

See the ITC Connection Instructions at

http://www.modelrailroadcontrolsystems.com/content/ITC%20Quick%20Start%20v1.0.pdf

MP1 Instructions are at
http://www.modelrailroadcontrolsystems.com/content/MP1%20Instructions.pdf

MP5 Instructions are at

http://www.modelrailroadcontrolsystems.com/content/MP5%20instruction_EN_V1.pdf

## MRCS's Current Sink Adapter for cpNode and IOX16/32

MRCS' High Current Adapter (CSNK) may be used with a cpNode or IOX. The CSNK plugs into our cpNode (release 2 or higher), IOX16 expansion card or IOX32 expansion card (IOX32 release 2 or higher) and provides 16 high current lines. A single CSNK will support as many as eight MP1s.

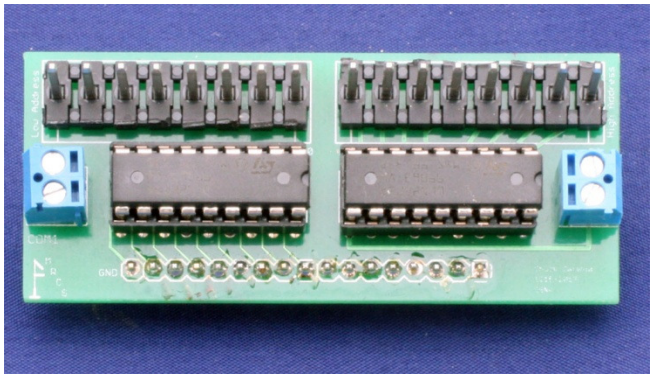


Figure 7 - CSNK - Daughterboard fits on IOX16 and can drive up to 8 MP1s

The CSNK circuit uses a pair of ULN2803 octal Darlington arrays, ($0.59 ea at Jameco) each of which provides eight drivers capable of sinking up to 500 mA at 50 V. We recommend this chip as an economical solution for controlling MP1s. A nice feature is built-in snubbing diodes which protect the Darlington outputs and suppress unwanted electrical noise sometimes caused by inductive devices such as electric motors. If using C/MRI with MRCS's cpNode you will need to define 2 lines for each MP1: one line to move it in each direction.

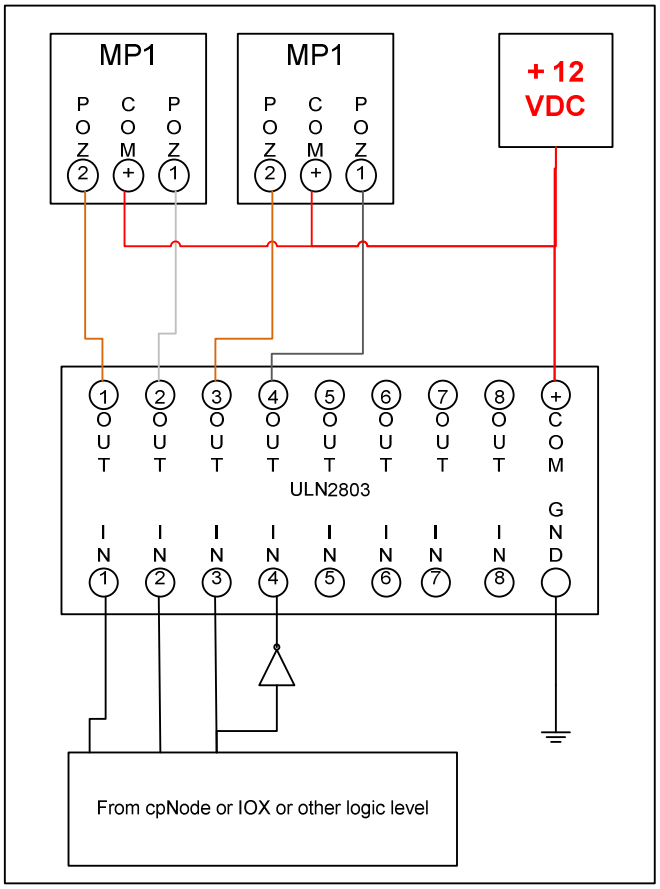


Figure 8 - ULN2803 drivers - Equivalent to one half of a CSNK

If you are short on output lines, you can use an inverter to force one line high (Poz1) and the other low (Poz2) and so on, so you can have one output line control the MP1. Note the inverter on input 4 of the ULN2803 in figure 6.

## Use an "Arduino Relay"

These are handy and inexpensive and can be found on eBay or Amazon with a search for "Arduino Relay." Connect the input of the "Arduino Relay" to an output on the cpNode/IOX. A high output will operate the relay. These are usually configured as SPDT, so just wire according to figure 1 above.

Here's an image of a typical Arduino Relay:


Figure 9 - Arduino Relay

This particular model is active low (the relay operates on a low input) and sold for $12 for quantity 10 in November of 2016.


Figure 10 - 2 Channel Arduino Relay

Arduino Relays can be purchased in 1,2,4,8, or 16 channel modules

## Driving an MP Series Switch Machine from Classic JLC CMRI Boards

If you are using C/MRI with any of the classic JLC (Chubb) devices such as a DOUT[24/32] or SMINI you will need to define 2 lines for each MP1: one line to move it in each direction. Incidentally this looks a great deal like the arrangement on page 3 – 12 of Dr. Chubb's User's Manual version 3.0. (The C/MRI User's Manual is available from JLC Enterprises and is a must for anyone implementing a model railroad signal system, regardless of the technology used. It's available from JLC at http://www.jlcenterprises.net). If you have a CMRI system with mixed cpNodes and classic JLC nodes, this is a good place to use your classic JLC nodes.

## Output with Discrete Transistors

Another approach is to use discrete transistors. All you need is a transistor capable of handling 150 mA of collector current and a maximum collector voltage greater than 12 V. Be conservative when specifying the part: the 2N4401 ($0.10 ea at Jameco) sinks up to 600mA and is a good candidate. The open collector output circuit Dr. Chubb uses in the SMINI and DOUT (which uses the 2N4401) is simple and effective and can be found in the C/MRI user's manual referenced above on page 4-15. The 2N3904 and the venerable 2N2222/2N2222A are good substitutes. Most DIY model railroaders will have these in their parts drawers.

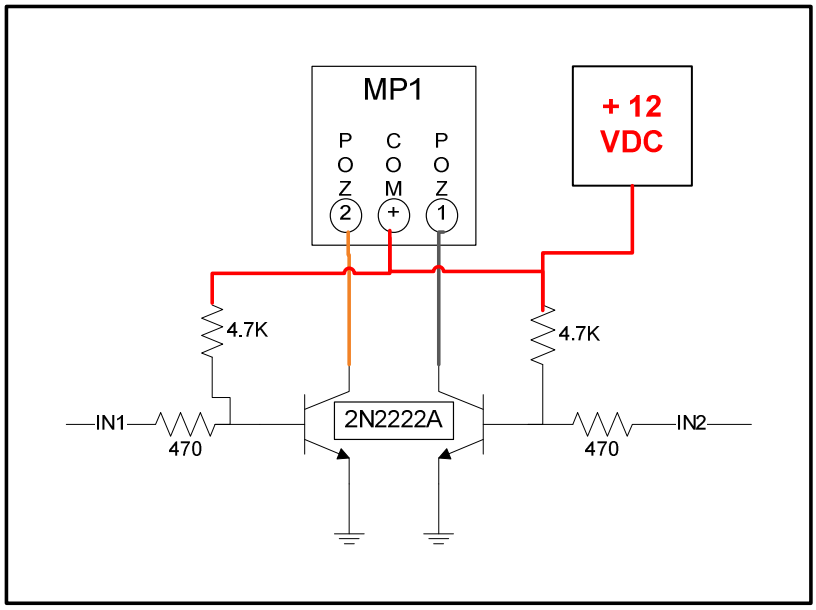



Figure 11 - Transistor Drive

## Don't use an existing SMC12

Dr Chubb's excellent SMC12 stall motor controller uses LM324 Op Amps for output which will NOT sink enough current (MP1 requires 120 mA, MP5 100mA, and SMC12 only sinks about 30) to drive an MP1.

# DCC Control for Series Switch Machines

There are lots of DCC Auxiliary decoders out there and many will work with the MP Series switch machines. This is not an exhaustive list of DCC switch machine controllers but if you want to use one that you don't see here, send us a message at sales@modelrailroadcontrolsystems.com and we will test a unit you send us.

## MRCS MPD8 8- Channel DCC Decoder

The MPD8 is a stationary DCC Decoder designed to drive up to 8 MP series switch motors, it is available Assembled and Tested only, it works with most DCC systems that support accessory decoders and controls up to 8 MP Series Switch Motors

Provides 8 inputs from:
- local turnout controls such as push buttons
- occupancy sensors
- turnout feedback sensors

Control up to 8 routes on your layout for yard throats and interlocking plants

The eight outputs of the MPD8 can individually be assigned any DCC accessory address from 1 to 2040. There are eight wired inputs available for local control. See the manual at http://www.modelrailroadcontrolsystems.com/content/mpd8_p2_doc.pdf

## CVP Products AD4

CVP's Documentation indicates that the AD4 will handle up to 600 mA which is more than enough current to operate an MP Series switch machine. Either select the "always on" mode or select a pulse duration > 2 Seconds.

## DCC Specialties Hare/Wabbit/Jack Wabbit

The Hare and Wabbit are limited to 25mA so they aren't a good choice, however the Jack Wabbit, snap coil version does sink up to 120 mA. I have not checked it myself, but the specs are promising!

## Digitrax DS52

User Jay Fuller provided a DS52 for testing. He has had success with the MP1, configuring it as 3 wire device, in "slow motion" mode, with the top jumper on.

I configured the MP5 for 2 wire operation (one side to COM and the other to the two connections called out as M2). I configured the DS52 as a "slow motion" machine and wired the COM to terminal 1 or 6 and M2 to terminal 6 or 8.

I did try to operate the MP5 as a 3 wire slow motion machine, but the results were erratic, so I don't recommend that.

## Digitrax DS64

The DS64 has been a staple in the Digitrax community for many years. It can drive as many as 4 stall motors or twin coil machines and supports local inputs and some advanced features on the LocoNet Layout Control Bus. It can be used as an auxiliary decoder on any DCC system. To use the DS64 with an MP1, program your DS64 per page 5 of the DS64 manual as a slow motion switch.

Being careful to disconnect the DS64 from power and DCC track, connect the 1R lead to Poz1 on the MP1, 1G to Poz2 and P+ to the Common on the MP1. The reconnect the DS64 to track and power.

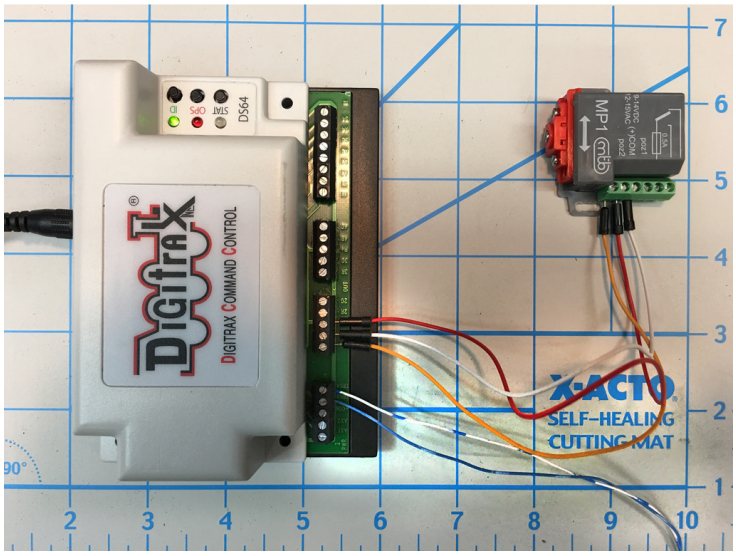



Figure 12 - MP1 with DS64 as the first device

## NCE: Don't Use a Switchit, Switch-8 or Snapit

NCE's Switchit/Swithchit 8 series are fine DCC auxiliary decoders for stall motors, however they can only handle 60mA (fine for up to 3 Tortii – as they point out) but they cannot provide the 120mA the MP Series switch machines require while it is moving. The MP Series switch machines turn off and draw no current when they reach their limit of travel so overall power consumption is far lower over time as MP Series switch machines move in about 1.5 seconds, but they won't work with the Switch-8.

NCE makes, or made, a Dual-Relay unit that operate off one channel of a Switch-8 but it's a bulky and expensive solution

The Snap-it will sink lots of current but the pulse only last for 100mS which isn't long enough for the MP1 to complete its travel

### RR-Cirkits

The only RR-Cirkits switch motor driver that will ***not*** drive the MP1/MP5 is the SignalMan. The SMD-8 and MotorMan devices should have no problem. I have not actually tried the SMD-8, but I don't see why there would be any issue with it.

## Non-DCC Electronic Controls:

### Barrett Hill Shops

Barrett Hill Shops' Direct Plus Base http://www.berretthillshop.com/store/products/direct-plus-systems/ can control up to 4 MP series motors as part of their "Touch Toggle" system.

## Mechanical Issues

The rigid actuating pins provided by the manufacturer (MTB) do not allow much play and put a premium on precise location of the motor. This can be difficult for under-table mounting, so we recommend using 0.039" or 0.047" music wire which has a little give. You can also try the swinging linkages, provided on the small plastic sprue, and a fulcrum to get a little more reach with some slack. For top side mounting I use a smaller gauge music wire, like 0.020" and a Z bend to absorb some overthrow. Richard Brennan has designed an adapter plate the motor mounts to and this has slots to help adjust the position. Look for it on our website http://www.modelrailroadcontrolsystems.com/switch-motors-drivers-mounts-etc/.

Note the slots in the "ears" are for 2.5mm screws. We will see about making those available as an option.

## Conclusion

This is not an exhaustive list of all possible control circuits but it will get you started with the MP Series Switch Machines. By the way if you have a control circuit you'd like us to test, send us an email at sales@modelrailroadcontrolsystems.com and we will test a unit you send us (we'll send it back free with your order!)