märklin

Insider

Special Edition

Märklin Digital

How Does Märklin Digital Work?

märklin Insider

The official newsletter of the Märklin Club.

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The Märklin Club is dedicated solely to serving the special interests of the Märklin enthusiast. Its goal is to help you to get the most from your Märklin trains and model railroading.

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Introduction

With the Digital system ready for the market, Märklin introduced a development in 1985 that revolutionized the model railroading hobby. From now on it was possible to operate several trains independently of each other in the same track power circuit with individually adjustable speed and direction. And if that wasn't enough: Auxiliary functions enable you to turn the headlights on and off, to turn the smoke generator on in steam locomotives at the press of a button, or to activate TELEX couplers. At first there was only one such auxiliary function but now up to five are possible in a single locomotive. The new system also made it possible to get away from the previously complicated wiring the difficulty of which frustrated many owners of medium to large sized layouts.

A little later Märklin followed with a multi-train control system by the name of DELTA that made it possible for beginners to effortlessly enter the fascinating world of digital model railroading fun.

Both systems - DELTA and Digital - will be explained simply and step by step in this magazine. We want to let readers and users know that they can get started without extensive prior technical or electronic knowledge. Just plain old fun right from the start.

This publication will make you familiar with the fundamentals of both systems. This applies to more than beginners getting started in the fascinating world of Märklin model railroading. Even model railroad neophytes who want to use Digital right from the start are in good hands here. Märklin has the 0308 (0308A for English edition in North America) digital book for people wanting to study Digital further, a true compendium of instructions for complicated circuits too.

The only thing left to do now is read this magazine. It'll be fast and enjoyable, and you'll have fun in the future with your Märklin model railroad.

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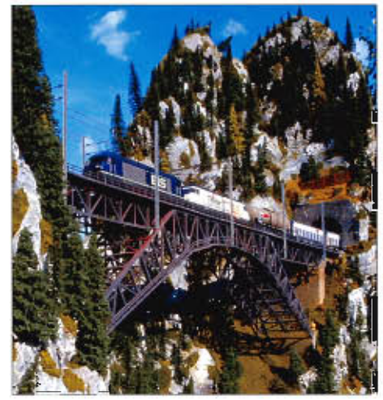


Cover page:
A group of experts examines with amazement the innards of the V 200, in the background the most important digital components. Photo: Adreas Stirl

Color double page, pages 42/43:
The old question, whether you're looking at the model or the prototype, is particularly appropriate here: Two SBB class 460 advertising locomotives labor in tandem at the point of a heavy unit ore train on the BLS Bietsch Valley bridge. A situation that can be seen daily on the south ramp of the Lötschberg Railroad in the Swiss canton of Wallis. Rainer Albrecht has skillfully built and photographed this scene.

Multi-Train Operation With DELTA

As long as only one locomotive is running on a layout, it doesn't matter much to most model railroaders how this locomotive is controlled. We can control it in the usual "conventional" way with a train control transformer or "digitally" with a digital locomotive controller.

As soon as a second locomotive or others are added, you start wishing for more possibilities than just operating the locomotives with the same speed and direction. If we want to be more or less prototypical, we have to be able to control our trains individually like real locomotive engineers. Before the digital age, this was only possible with a great deal of effort. Let's look at three examples: Operation with several track circuits in which switch yards and through routes are powered with different transformers, for example. Or you made use of track blocks where you could turn the power off, thus allowing you turn power off temporarily to individual locomotives and trains. With catenary operation, it was always possible to operate two locomotives on the same track in different directions and at different speeds. There were always limitations of some sort, such as the choice of motive power or the freedom to select a route.

Märklin Digital does away with all of these disadvantages, and anyone who has "played" with several trains on a digital layout will not want to do without the new potential of independent, multi-train control any longer.

1. DELTA shows off its advantages best on small and medium size layouts: A simple form of multi-train operation can be achieved quickly.

DELTA Is Easy To Operate

Märklin DELTA has been around since 1992. It's been a great success right from the start, because it enables flexible multi-train operation with little effort on small and medium size model railroad layouts.

DELTA allows you to control up to four locomotives independently of one another. In contrast to a conventional layout, these locomotives (or railcars) all run on the same track circuit. This alone makes the DELTA system extremely user friendly. Setup and wiring for a layout also become considerably easier.

A locomotive becomes a DELTA locomotive thanks to a small electronic component, a module, inside it. It can be used on more than must a DELTA layout, however. It will run with no problem at all on a conventionally controlled layout as well as on a digital layout.

The DELTA system is primarily designed for small to medium size model railroad layouts. As your requirements and model railroad grow with time, you can continue to use almost all of your DELTA components when moving over to the Digital system. But as long as you're not operating any more than three trains simultaneously, DELTA is the ideal program for trouble-free model railroading fun.

Because all of the locomotives run in the same track power circuit with DELTA, you only need one transformer for operating them. And yet you can control several locomotives independently of each other.

The many advantages of a DELTA layout finally lead to a fundamental consideration: If there is a DELTA version of a particular locomotive model or starter set, it hardly makes sense to buy the conventional version. This also holds true if you already have a conventional layout. Because the locomotives and powered railcars on this layout can be retrofitted with a DELTA module or digital decoder.

DELTA works both ways: On the one hand it can expand and enhance an existing conventional layout; on the other hand it is the ideal starting point for transferring later to the Digital system.

DELTA Starter Set

Model railroading fun can start very romantically: The "Prairie Pony", as railroad fans in Germany call the class 24, can huff and puff through the landscape as it once did on branch lines. It is bringing the crane car and a stake car with ties to the site of new track construction. Once this task is taken

Multi-Train Operation With DELTA

2 - 4. Above and right: In the beginning there was the starter set, often set up on the floor, that provides that first thrill of playing with trains.

care of, it goes off to switch cars on a freight siding. Then you can send it out on the main line with the freight train, perhaps into the city...

Because all of the locomotives run in the same track power circuit with DELTA, you only need one transformer for operating them. And yet the variety of ways to play with and enjoy the product begins as early as the smallest starter set. Three freight cars to load and unload and a baggage car with sliding doors open up numerous possibilities to start a freight transportation system in your own home. The little steam locomotive is strong enough to pull the cars over the C Track that is so easy to set up.

Or you can start off very modern: The German Railroad's swift, high speed Intercity Express sets standards for speed and for the look of a future model railroad layout. On the oval's straightaways we can run it fast like the prototype, while on the curves we throttle the speed back a bit with the transformer. We have a choice between the new C Track, that makes setting up a layout for just a few hours no problem at all, or the K Track with its almost unlimited possibilities for building a layout for model railroaders who like to lay their own roadbed.

As you can see, DELTA starter sets offer something for every taste. And even if it should turn out later that the second choice was really the more suitable one, that's not a problem, because we can combine everything together. All of the starter sets have a transformer with stepless speed control and an instruction book with all sorts of ideas for getting the most fun out of it. There's really nothing more standing in the way of the first steps into the world of model railroading.

DELTA Layout - Enter The Second Locomotive

That real DELTA feeling remains hidden, as long as you are operating only one locomotive on the layout. The single locomotive runs faster, when you turn the control knob to the right, and slower, when you turn it to the left. Turn the knob all the way to the stop on the left, and the train comes to a stop. Turn the knob a little more to the left past the stop, and your locomotive will reverse direction.

The real meaning of DELTA becomes clear, when the second DELTA locomotive enters the picture. Let's take Lisa who has a starter set and wants to play with Anna who also has a starter set. The only thing they need in addition to the trains, track and transformer is the DELTA Control unit. This latter controller is simply wired in between the track and the transformer. And the module address for both DELTA locomotives must be set. Now we can couple additional cars to a waiting train or uncouple cars from it. The dividing of the express train from City A to

5. All sorts of track plans can be set up with two starter sets, and each of the girls has her "own" locomotive to control.

6 - 7. The next step is the permanent small layout.

Town B, so that the two resulting trains can serve Villages C and D, is now possible with the second locomotive. This locomotive comes into Town B from behind the train and takes over the cars destined for Village D, while the rest of the train goes on to Village C with the first locomotive. During this procedure, the train control feature of the signals must be deactivated.

Or we can let the fast ICE race by on the main line. In the station area, a switch engine assembles the Regional Express that will bring passengers to the next small town on the line. In the process the switch engine may have to pick up the baggage car from the express freight section of the station, several passenger cars from the servicing area and other cars from another station platform.

The third of our countless possible variations: A class 81 or 96 freight tank locomotive is fired up in the servicing area. It's one of those mighty locomotives whose prototypes were used on the mountainous routes in the German Mittelgebirge region that are such a challenge to railroad technology. The tank locomotive comes up behind a heavy freight train that undoubtedly would not be able to make it up the steep mountainous grade. Thanks to a little push from behind, it does master the grade. When it reaches the crest of the grade, the pusher locomotive slowly falls behind, until it enters a siding at the next station. During this maneuver, the freight train does not have to stop, since we can operate both locomotives at different speeds thanks to DELTA.

Until this technique was introduced on the real life railroad, trains that were too long or heavy had to stop in the station at the base of the grade and were brought up in sections, which lengthened the travel time considerably. This method of mastering steep grades can also be reproduced easily on DELTA layouts and without a great deal of effort - even if we don't exactly have a class 96 locomotive at our disposal. Most model railroaders have the problem of steep grades, since few layouts have enough space to lay out a grade with the prescribed angle of inclination. Most are even steeper.

Basic Features Of The DELTA System

The Control Components

Apart from the DELTA module that works unseen inside the locomotive, the heart of the DELTA system is the DELTA Control unit. Several locomotives can be operated on a track power circuit with it, as we have just seen in the example. One of four addresses for the DELTA Control can be set on each locomotive with a DELTA module or with a digital decoder. You select a locomotive with the rotary control knob on the DELTA Control. The locomotive can then be controlled with the speed control knob on the transformer. If you want to control another locomotive, you use the rotary control knob on the DELTA Control to select it. The first locomotive will continue to run with the speed that has been set for it; if we now turn the speed control knob on the transformer, the last locomotive selected will react to our operating command. The same applies to other locomotives.

Up to four or five locomotives can be controlled in the same track power circuit with DELTA. The DELTA Control has capacity for four locomotives; the fifth is covered by the DELTA Pilot hand controller. The symbols on the DELTA Control are only there as a suggestion of the locomotives that can be controlled; naturally four electric locomotives or two steam locomotives and two powered railcars, for example, could be controlled with this unit.

The DELTA Control's maximum output power of about 30 VA is sufficient to have three trains running with unlighted cars. Of course, this assumes that the transformer connected to it delivers at least this output. The train control transformer from the starter sets provides 32 VA, as does the 6647/76646 transformer in the catalog program.

A circuit breaker automatically shuts the power off for a while, if the required power is greater than what the DELTA Control can deliver. This also holds true for a short circuit on the layout or if the unit becomes too warm. Approximately a minute later it turns itself back on automatically. The time until it comes back on depends on how much the DELTA Control was overloaded. A comparable overload protection is built into every Märklin transformer. For that reason the transformer can also shut off for a while, if the current demand on it becomes too great.

If you turn the rotary control knob on the DELTA Control to the "STOP" setting (left or right), the voltage to the track is automatically interrupted. With this setting, you can place new trains on the track without the risk of a short circuit. The voltage to the track is also turned off automatically, when the speed control knob is turned to the zero setting for all DELTA locomotives.

1. DELTA Control

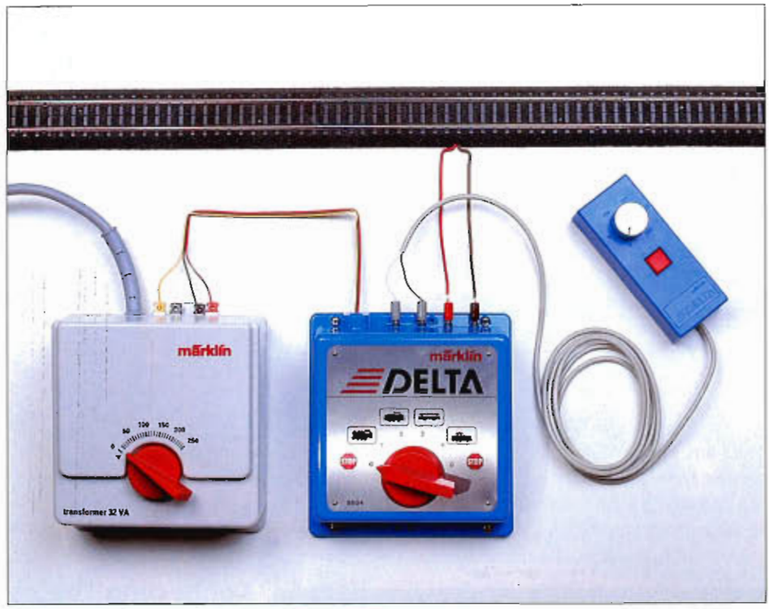
Connecting The DELTA Control

The DELTA Control is simply wired in between a conventional train control transformer and a feeder track. The power cord for the transformer must be unplugged before you connect the components.

Connect the three permanent wires on the DELTA Control to the appropriate terminal clips on the transformer - the red wire to the red terminal "B", the brown wire to the brown terminal "0", and the yellow wire to the yellow terminal "L". Make certain you have a good contact between the wires and the terminals. If your transformer has sockets instead of the terminal clips usually seen today, take the plugs included with the DELTA Control and screw them onto the wires and then plug them into the appropriate sockets on the transformer.

After that screw plugs onto the wires from the feeder track and plug them into the red and brown sockets on the DELTA Control. Now you can plug the transformer back into the wall outlet.

It is important to remember that only feeder tracks without built-in condensers for radio/television interference suppression should be used for DELTA and Digital layouts. The M Track versions of these are nos. 5111 and 5103, for K Track no. 2290 and the 74050 interference suppression unit should not be used with C



2. Connections for the DELTA Control between the transformer and the track

Track. With other tracks that are equipped with such a condenser, cut at least one connection with a wire cutter.

Turn the knob for the DELTA Control to one of the locomotive symbols to have a train operate. You control the speed and direction as you normally would at the transformer. If you want to set another locomotive into motion, then turn the DELTA Control knob to another locomotive symbol. The locomotive previously selected will continue to run at the speed and in the direction set for it. The control knob on the transformer is again used to set the speed and direction for the new locomotive. The same process is repeated for the third and fourth DELTA locomotive.

When switching to another locomotive, there is a delay of about two seconds before the DELTA Control sends the speed setting to the new locomotive. This allows you to switch, for example, from the steam locomotive (position 1 with the rotary control knob) to the electric locomotive (position 4 with the rotary control knob) without changing the speed or direction for the locomotives that are assigned to positions 2 and 3 that you have just "leapfrogged" over.

When you want all of the locomotives to stop at the same time, turn the rotary knob to the nearest "STOP" position, either to the left or right. If you now turn back to a locomotive symbol, all of the locomotives will continue to run at the speed(s) previously set for them. For that reason simply turning to the zero setting on the DELTA Control will not prevent a threatening collision. The solution: Turn the rotary knob to the left STOP position and change the direction at the transformer three times in succession. This will wipe out all data that has been transmitted to the locomotives, and you can now send out new commands with peace of mind.

3. The DELTA Station and DELTA Mobil can be used for both 1 Gauge and H0.
4. DELTA Pilot.

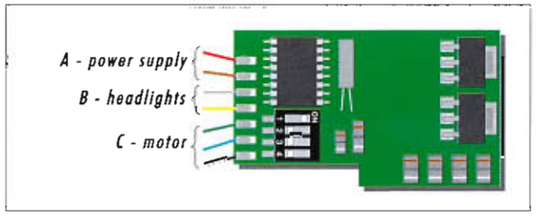
DELTA Pilot

The DELTA Pilot is an additional hand controller that you connect to the DELTA Control (6604). You can use it to control a DELTA or Digital locomotive, i.e. a fifth locomotive when all four positions on the DELTA Control are being used. The Pilot is ideal for two people to play with the trains, for example when the switch engine locomotive engineer uses it to arrange cars in the passenger, freight or switch yard. With the DELTA Pilot you can control only DELTA or Digital locomotives that are set for the address 80. Control of the locomotive cannot be transferred from the DELTA Control to the Pilot or vice versa.

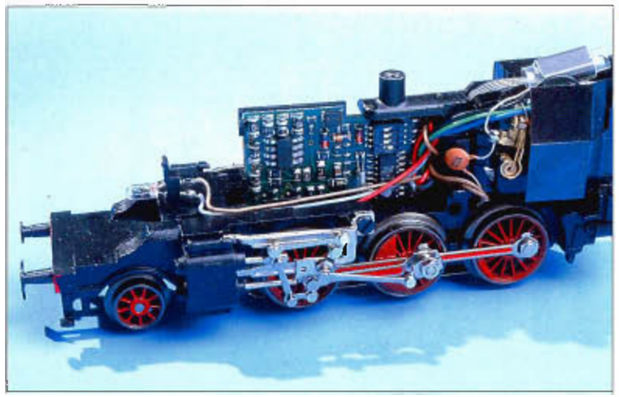
The transformer must be unplugged from the wall outlet before connecting the Pilot to the DELTA Control. After that plug the two wires from the DELTA Pilot into the gray sockets on the back of the DELTA Control. With a simple two-conductor extension cable, you can adapt the connection between the Pilot and the Control to your own personal needs. Operating the Pilot is extremely easy to do: The speed is set with the rotary knob and the direction is reversed with the red button.

DELTA Locomotives - Setting Addresses With DELTA

A particular digital address is assigned to each DELTA or Digital locomotive and to each locomotive symbol on the DELTA Control. While you will see later in the Digital system that as a rule the addresses between 01 and 80 are free to choose from, the addresses for the DELTA Control and DELTA Pilot are permanently fixed. On the DELTA Control the setting "steam locomotive" controls the digital address 78. The locomotive that is to react to operating commands from the transformer under this symbol must be set for the address on the coding switches. The symbol "diesel locomotive" controls address 72, the railcar is for address 60 and the electric locomotive is for 24. If you want to control a locomotive with the DELTA Pilot, it must be set for address 80



5. Above: The current version of the DELTA module



6. DELTA module as installed

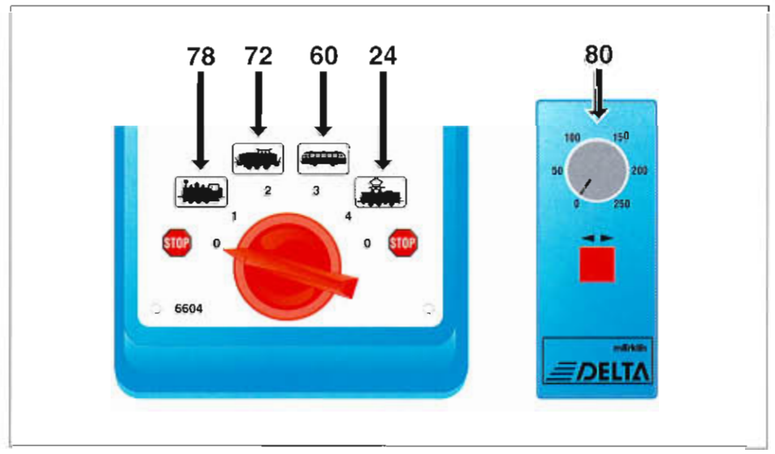
Do you remember? When you started with a single DELTA locomotive, you still didn't have a DELTA Control. Then you controlled your locomotive directly with the transformer. All four of the small coding switches on the locomotive had to be in the OFF position for this, and to make it easy for beginners, Märklin delivers all DELTA locomotives with the switches set this way. So, before you get started with multi-train operations, you have to set appropriate addresses on your locomotives.

Further Use When Switching Over To Digital

As the demands in size and flexibility for model railroad operations grow, it is time to think about switching over from DELTA to Digital.

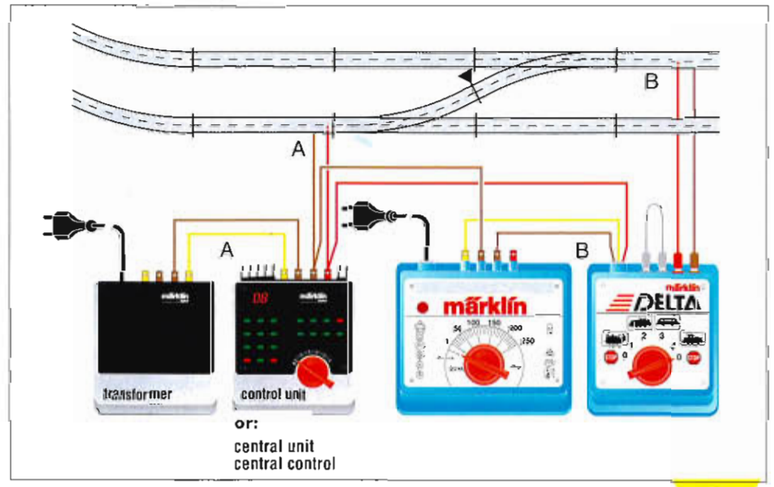
When you do this, you can continue to make use of the DELTA Control and the transformer. Both are used like the Booster as a supplemental source of power for the DELTA system. A requirement of this is that the DELTA system be controlled from the Control Unit (item no. 6021), Central Unit (item no. 6020) or Central Control (item no. 6022 or 6023) central units. The DELTA Control and the transformer supply power their own track power circuit that ideally is isolated with the rocker type insulators (M Track item no. 385550, K Track item no. 385580, C Track item no. 0204595). The digital data in all of the power circuits of the Digital system are the same, however. The transition for a locomotive in operation from one circuit to another has no significance.

As with all changes in the configuration of the components, you must first unplug all of the transformers from the house current. Then, connect the red wire from the DELTA Control with the red terminal clip for the digital central unit. The brown and yellow wires remain connected to the transformer. Also, connect the brown terminals from the train control transformer and the central unit together. The two gray sockets on the DELTA Control that are normally connected to the Pilot, should be bridged with a wire with two plugs. Now connect the wires for the feeder track from the new power circuit with the red and brown sockets on the DELTA Control. The rotary control knob on the DELTA Control must be turned to the right-hand "STOP" position so that it functions properly as a booster. Plug the transformers back into the wall outlet for house current and you're ready.



7. Digital address assignments for the five DELTA locomotives

8. The DELTA Control was used here as a supplemental digital power supply unit.Important: The DELTA Control must supply power to its own, electrically isolated power circuit on a digital layout!



Getting Started In Digital

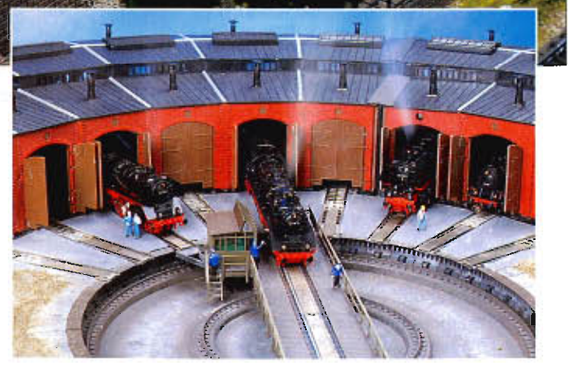
What Can Märklin Digital Do?

Multi-Train Control

Briefly stated, Märklin Digital can do three things:

- manual or programmed operation of several trains on the same track independently of each other.
- activation of a maximum of five auxiliary functions on a locomotive, operating car or solenoid accessories.
- drastic reduction in the amount of wiring for medium size or large layouts.

Almost limitless multi-train operation is possible on a digital layout. Up to 80 locomotives can be used on a layout independent of one another. When it gets to that point, you will, of course, need more transformers and Boosters to provide the necessary power, the number depending on the power requirements. To do this, you have to divide the layout up into several power circuits or power consumption areas - just as you would with a conventional layout. Unlike conventional control, several locomotives can be run with different speeds in the same power circuit.



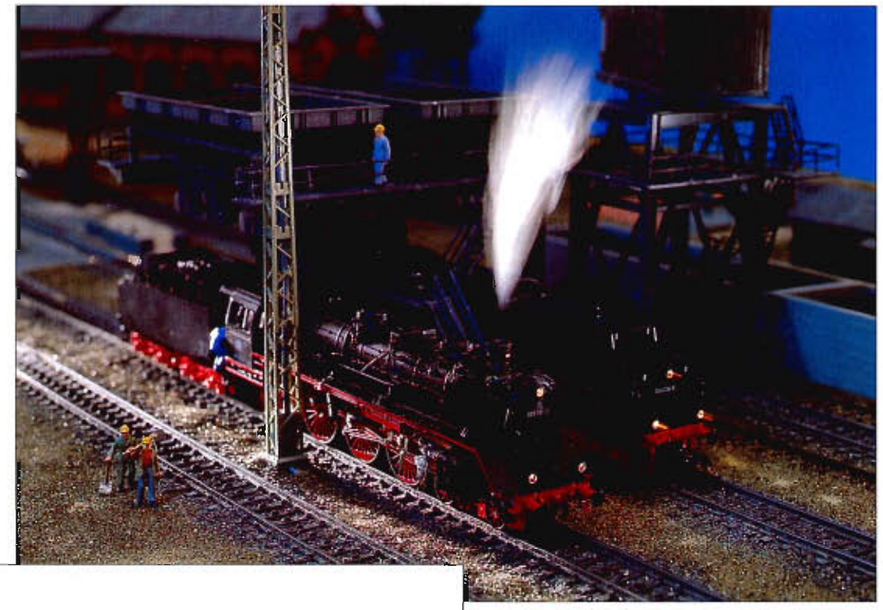
1. Doubleheading is quite easy to do on a digital layout.

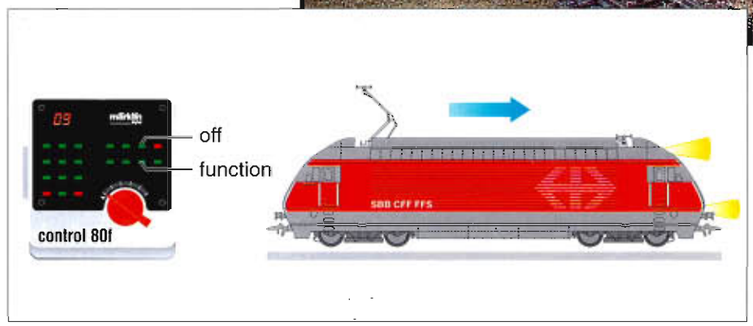
2. Since you can run a locomotive at any time, operations in a maintenance facility can be particularly interesting.

What Can Märklin Digital Do?

The basic principle of Märklin Digital is the same as that for DELTA. Each locomotive is assigned a number, the so-called address. You key in the number of the desired locomotive at a locomotive controller, then you are controlling just this locomotive, regardless of where it is located on the layout.

You can use up to 10 locomotive controllers on a digital layout; this means you can have direct access to 10 locomotives at the same time. All other locomotives that are in operation on the layout will continue to run as "road engines" with the last speed set for them. These locomotives can be controlled with signal blocks as with conventional operation. If you want to change the speed or direction of a "road engine", you can do it at any time by calling it up on any locomotive controller.



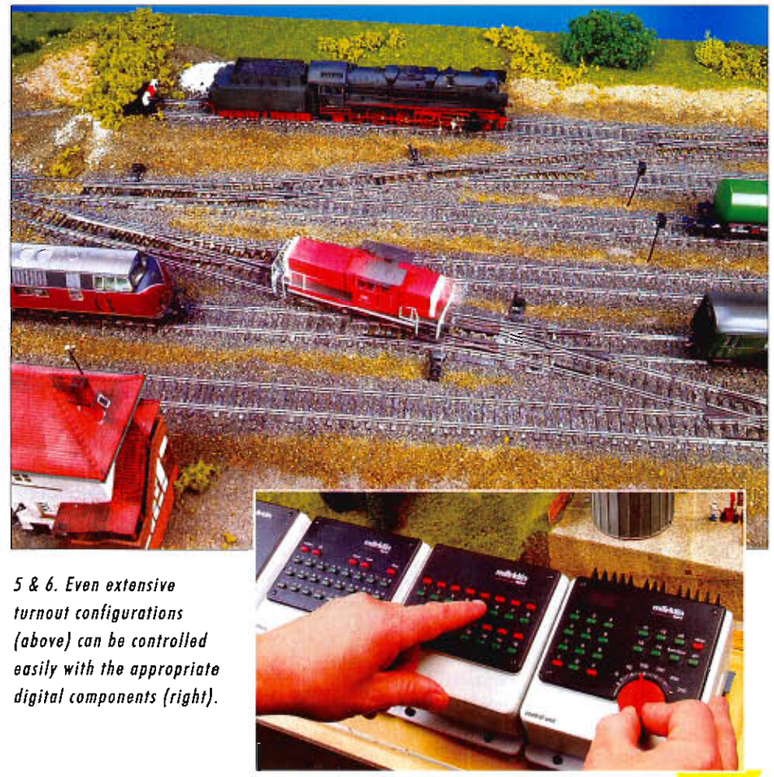


3. The activated auxiliary functions allow you to operate the smoke generator and the headlights when the locomotive is stopped.

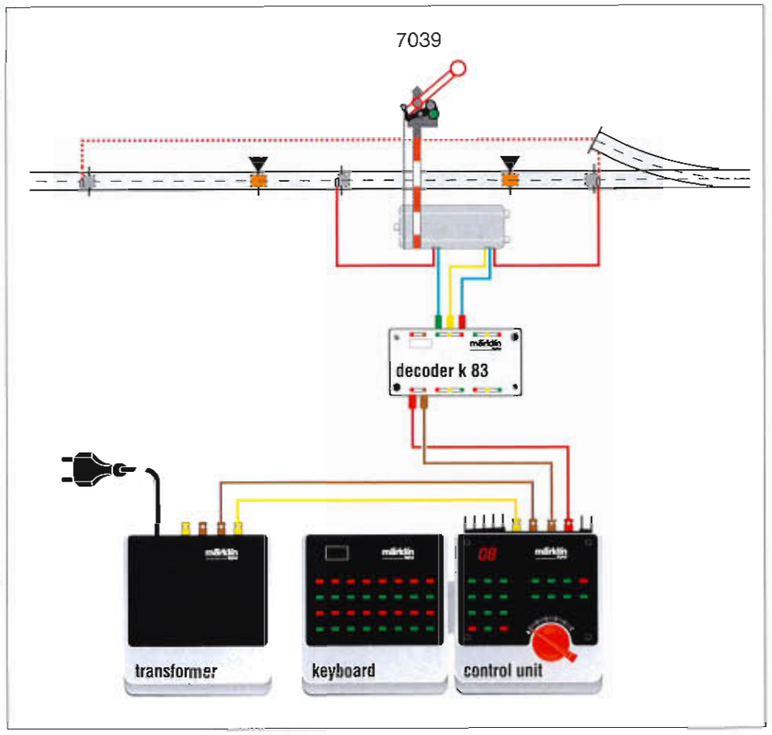
4. The headlights auxiliary function can be turned on with a simple press of a button.

In the meantime, the locomotive previously called up on this locomotive controller continues to run automatically with the speed previously set for it. Demanding operating tasks such as switching operations or doubleheading of locomotives, the addition of a through car to a train or pushing off cars on a hump track are possible when you have several digital locomotive controllers, because you are controlling practically all of the locomotives in the same power circuit. But even just one locomotive controller opens up the entire digital world to a model railroader.

Running a locomotive digitally offers still more advantages: Almost every digital locomotive has a remote controlled auxiliary function some even have several. Up to five auxiliary functions are possible. These can be the locomotive's head-



5 & 6. Even extensive turnout configurations (above) can be controlled easily with the appropriate digital components (right).

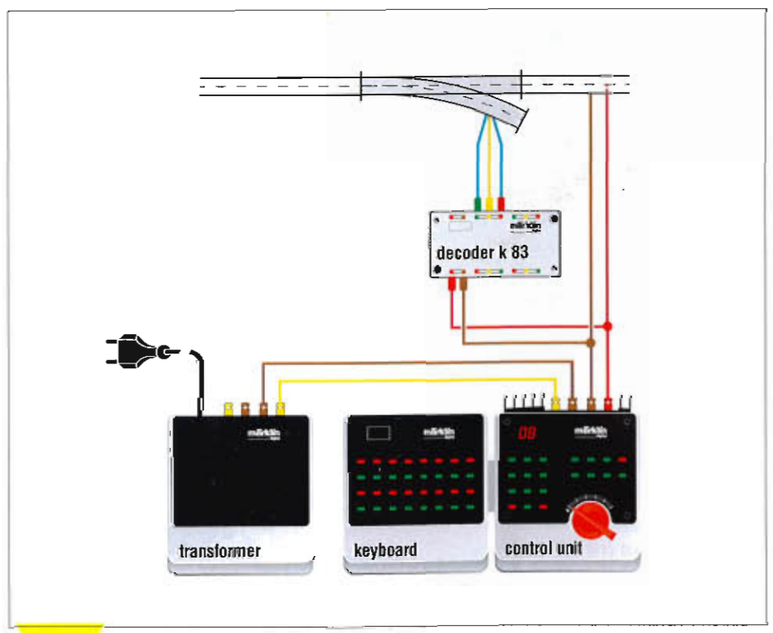


7. Basic wiring diagram for a semaphore signal

lights, remote controlled TELEX couplers or a steam locomotive's smoke generator. The newest models have, for example, long-distance headlights that can be turned on and off, such as the class 101 electric locomotive, or a sound effects circuit with a real diesel motor sound on the V 200. These auxiliary functions can be turned on and off at will with the function buttons on the digital locomotive controller.

With digital locomotives the auxiliary functions are totally independent of the unit's operating speed. The headlights for a digital locomotive can therefore be on when it is stopped.

8. Basic wiring diagram for a turnout. The yellow plug for a solenoid accessory must be plugged into the yellow socket on the k 83 decoder. Connecting it to the yellow terminal on the transformer will cause damage.



Solenoid Accessory Control

Märklin Digital is more than just a critical technological leap in the control of locomotives; it's a technical advance in the operation of solenoid accessories such as turnouts, signals, and accessories such as turntables and the rotary crane.

In a fundamental sense, the functions "operating locomotives digitally" and "operating accessories digitally" on a layout are quite independent of each other. For that reason you can leave the existing wiring of a conventional layout as it is and just operate locomotives digitally.

The reverse, operating locomotives conventionally and accessories digitally, is also possible, but it is done very seldom. Because anyone who has become familiar with the advantages of the Digital system will in all likelihood want to make use of both possibilities: "operating locomotives digitally" and "operating accessories digitally".

The expense in labor and money to convert an existing layout to "operating accessories digitally" is less than you would think, because all of the solenoid accessories and, for example, the wiring for signal blocks are used without being changed. What changes is chiefly the wiring from solenoid accessories to the control boxes - and the considerable increase in flexibility. With a digital layout there are no direct wire connections between the control panel and the solenoid accessories.

The solenoid accessories are now connected to accessory decoders with short lengths of wire. These decoders decode the digital signals from the digital central unit and process them in such a way that all conventional accessories can be controlled. The decoders themselves are connected with just two wires to the central unit or to a Booster.

This reduces the wiring for a digital layout considerably and makes it that much more easy to manage. The k 83 decoder has four outputs for up to four solenoid accessories.

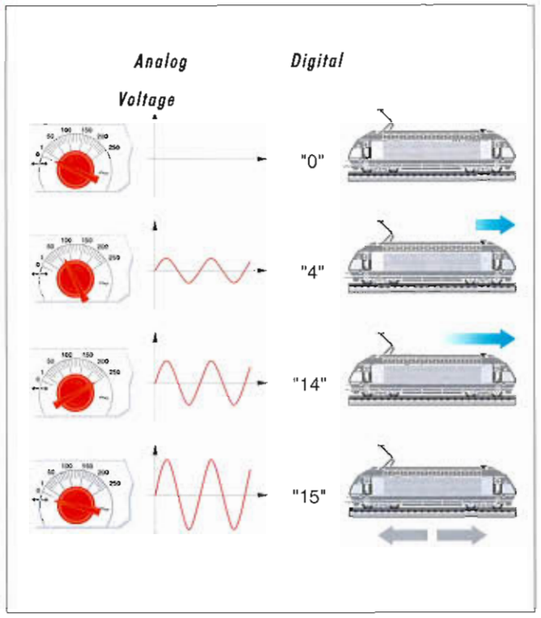
How Does Märklin Digital Work?

Locomotive Control

With the conventional method of operating a model railroad layout, the speed for a locomotive is set at the train control transformer. Inside the transformer a sliding contact taps different AC voltage, depending on the setting for the train control transformer. This voltage is fed directly to the track. The higher the voltage being fed to the track is, the faster the motor for a locomotive turns. When the speed control knob is set for zero, there is no voltage in the track. It is completely different with the Digital system. A constant voltage is always present in the track, likewise in parts of the locomotive's power circuit. For this reason, the headlights on a locomotive burn constantly, independent of the speed - provided that they are turned on. The locomotives receive their control commands as digital signals superimposed on this voltage.

The addresses for the locomotives ensure that each locomotive or powered railcar or solenoid accessory receives and processes only those signals intended for it. The 14 different speed levels are also represented as signals. The fact that they are set with a rotary control knob on the control components is proof of the ease of operation.

The number corresponding to the speed that has been set is transmitted first from the locomotive controller to the central unit, from here to the track where it is processed further by the locomo-



1. Left: On conventional locomotives, the speed for a locomotive is determined by the voltage in the track, on the Digital system by the numbers 0 - 14. The number 15 is used to reverse direction.

2. Below: Setting the digital address with the eight coding switches

tive decoder. Each digital locomotive has its own number, an address. The digital address for a locomotive can be compared with a telephone number. Each telephone has a particular number by which it can be reached. When this number is chosen, only that one telephone rings; the others remain quiet.

The same thing applies when you have several digital locomotives on the same digital layout. To change the speed for a particular locomotive, the address for that locomotive, for whom the data is intended, is transmitted to the track in addition to the code for the speed of that locomotive. And only this locomotive changes its speed. This allows you to control each locomotive individually.

As delivered from the factory, each digital locomotive is set for a particular address that you can change at any time. Each locomotive address is a number between 01 and 80. It can be set by hand on eight small rocker coding switches located on the digital locomotive decoder. Each of these switches can be set for ON or OFF. The locomotive address is determined by the combination of the eight switch settings. The code table for digital locomotive addresses on page 23 shows you which switch positions you must set. This table is also included with the instructions delivered with each locomotive.

You enter this address at the locomotive controller, when you want to control a particular locomotive. The locomotive address is already a number, so it can be transferred directly. The locomotive controller itself first checks whether the address entered is actually valid, whether it lies in the range between 01 and 80. If not, the incorrectly entered address blinks immediately in the display.

You can now select a particular speed with the locomotive controller. The setting for the control knob is analog information that must first be digitalized in the locomotive controller, i.e. it must changed into a number. In addition, the value for the auxiliary function is included with the data.

The microprocessor in the locomotive controller now transforms both numbers, locomotive address and speed, into a string of zero and one values. These values can now be sent one after the other out over a single power wire and its ground return. This string is called serial in electrical jargon. The serial data are transferred over the side connector to the central unit.

The central unit first checks whether the desired locomotive is not perhaps already called up on another locomotive controller, because it is not possible to control a locomotive simultaneously from two locomotive controllers. If the locomotive is already called up on another controller, the central unit sends an occupied message to the locomotive controller attempting to call up the locomotive in question. This causes the locomotive number selected to blink in the display, thus indicating that the locomotive is already called up on another locomotive controller. Without any further action on the part of the "locomotive engineer", the locomotive controller keeps asking the central unit, whether the locomotive can now be controlled by it. Another locomotive may possibly have been called up in the meantime on the other locomotive controller, so that "our" locomotive is now free to be controlled.

All of these processes occur in fractions of a second such that it's only a small moment between the keying in of the locomotive address and the blinking of the display.

If the desired locomotive is free, the central unit transforms the internal data signal from the locomotive controller into the Motorola data signal and sends the commands to the track. The locomotive now runs at the speed set on the locomotive controller. After that the central unit sends a confirmation message back to the locomotive controller, and it is at this point that the address entered lights up continuously on the locomotive controller. As long as the locomotive is called up at the locomotive controller, each change in speed, direction or auxiliary function is sent immediately to the central unit and from here to the locomotive.

The pure processing of data in the locomotive controller and in the central unit only requires a small amount of energy. In the central unit the digital data must be reinforced so that it can be used simultaneously for the motor and for the headlights. The reinforced digital voltage is sent by the central unit via terminal "B" to the track.

The locomotive's pickup shoe then takes up this digital voltage from the track. In the digital locomotive, this voltage does not go directly to the motor, but rather first to the decoder. The latter checks whether the address sent agrees with the address set on its coding switches. If not, it pays no attention to the data received; it keeps the previously stored values for speed and auxiliary functions. The decoder evaluates the data for direction, speed and auxiliary functions only if the address sent agrees with "its" address, checks this data for errors and stores it in memory.

Finally, it controls the motor with the help of the rectified digital voltage according to the evaluated data for "speed". It also turns the auxiliary functions on or off according to the new data.

The new speed and the auxiliary functions remain in the locomotive decoder's internal memory, until it receives new data meant for its address. The locomotive therefore continues to operate at the stored speed, regardless of whether it is called up on a locomotive controller or not.

Solenoid Accessory Control

Turnouts and signals are operated on a conventional layout by briefly connecting one of the blue wires on the unit to ground by means of the 7072, 7271, or 7272 control box. This sends current through one of the two coils on the turnout or signal, the armature magnet for the solenoid moves back or forward and also moves the signal semaphore, turnout point rails, or the relay for the color light signal.

The control boxes mentioned above offer connections for four solenoid accessories; the Keyboard in the Digital system allows you to control 16 solenoid accessories. To do this, each turnout and signal is assigned a solenoid accessory address similar to the address for locomotives. A decoder also evaluates the address for the accessories. No distinction if made between conventional and digital solenoid accessories; all turnouts and signals such as you would find on conventional layouts are wired to a decoder (k 83). So, you can continue to use solenoid accessories without any limitations.

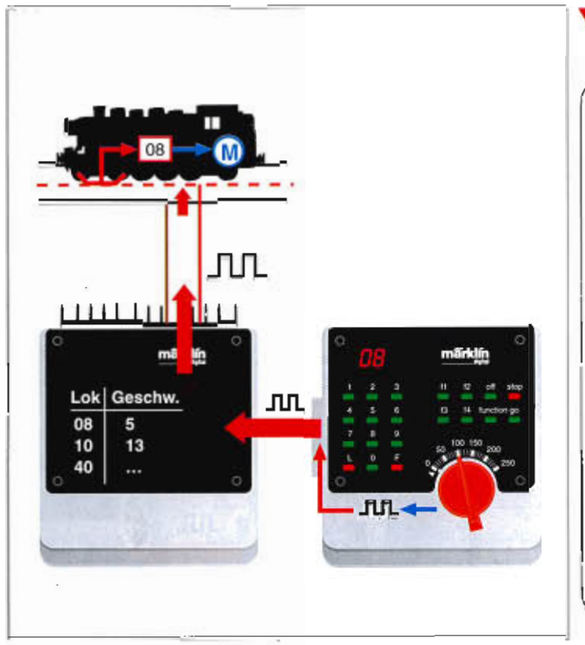
In addition to solenoid accessories that require a short impulse of current, you can also control contiuous currents with the Digital system, such as are required for lighting circuits or motors. You merely need another decoder (k 84) for this, otherwise you will not notice any difference in the operation of these units.

In the Märklin Digital system up to 256 solenoid accessories can be operated independently of each other with 16 Keyboards that are plugged together one after the other. To do this, another address is set on each Keyboard. The standard decoders for impulse and continuous currents each have four outputs. For 256 solenoid accessories then you would need 64 decoders. In each decoder there are eight coding switches on which the decoder address must first be set, because in the operation of solenoid accessories the address for an accessory is not sent directly, rather, the address for a decoder is sent. Encoded in the control data for the decoder is which output it will activate. Here are the details of how this happens: You press a particular button on a particular Keyboard. The microprocessor in each Keyboard calculates out of the address set for the Keyboard and the button number the decoder address belonging to that button. This decoder address and the data concerning which decoder output is to be turned on is converted by the Keyboard into a zero-one string of numbers and is transmitted to the central unit.

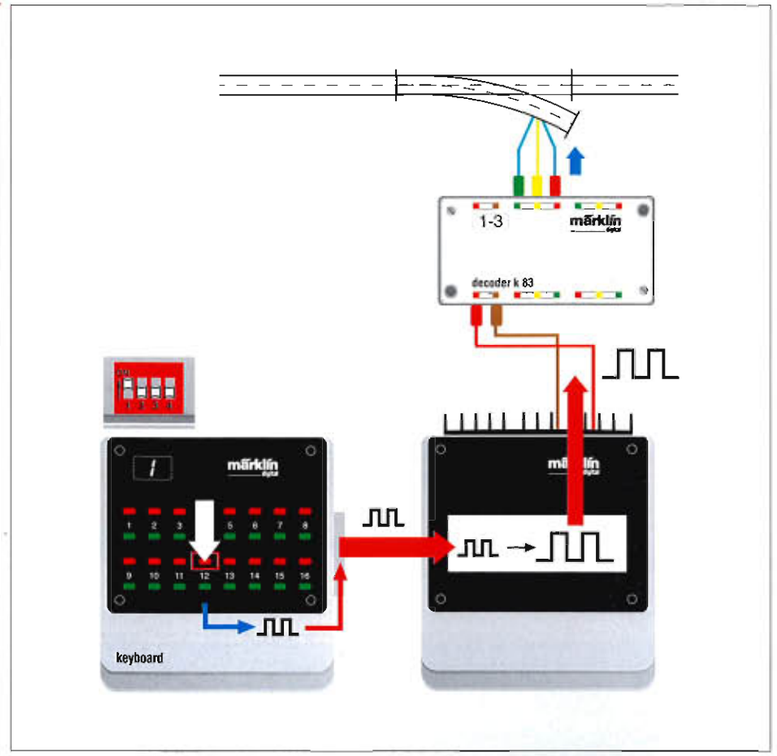
The central unit can only process one unit of solenoid accessory data at a time. It converts this data from the Keyboard into the Motorola format, arranges it in the repetition cycle for locomotive data, reinforces the digital signal, and sends it to its output terminal. From here the data goes to the track and to the solenoid accessory decoders connected by wires. The central unit does not send a confirmation report back to the Keyboards until the process described above is completed. At that point the Keyboard turns an LED on or off above the button you have pressed.

In principle, the digital data for locomotives and for solenoid accessories are built up in the

3. Schematic representation of the data transfer for controlling a locomotive. The blue arrow represents the analog current, the red is the digital data.



4. The 12X comes from the factory already set for number 12.



5. Schematic representation of the data transfer for solenoid accessories. The blue arrow represents the analog current, the red is the digital data.

6. Keyboard

same manner. They are transmitted at different frequencies so that they will not disrupt each other.

All solenoid accessories connected to the Digital system compare constantly the addresses for all data received with the addresses set for them. Only if it agrees with their own address, do they evaluate the data part that follows the address and activate the desired output. The blue wire connected to this output is switched to ground in the process and the solenoid accessory is activated - just as would happen in conventional operation.

This sounds as if complicated digital technology has been imposed on the proven electrical technology without any real progress being made, but you will notice right at the outset of using Digital that you have a marked decrease in the amount of wiring required. The solenoid accessories only have to be connected to the nearest decoder while the latter and other decoders are connected to the digital control panel with a loop circuit. When setting up the layout and the control panel, you should note that the conversion into digital signals allows more processing potential than conventional circuits: routes can be programmed easily, a computer can be used with the layout and much more.

The Digital Components - Control Unit, Central Control, Booster

The central unit is the central processor for the digital layout. It manages and arranges the data from all of the locomotive and accessory controllers connected to it, supplies this data with power and transmits them to the track or directly to the solenoid accessory decoders. Each central unit coordinates the control of up to 80 digital locomotives and up to 256 solenoid accessories. Recessed multi-pin connectors are located on both sides of a central unit, and they are used to connect digital controllers. Only digital locomotive controllers may be connected on the right side and only digital accessory controllers may be connected on the left side. The controllers are supplied with power through the multi-pin connectors, and the digital data exchanged between the central unit and the controllers over these same connectors. A multi-pin socket on the back of the central unit serves as the connection to the Booster.

The central unit receives its electrical energy from a transformer. The central unit can only produce its full output, when it is connected to a powerful enough transformer. The Märklin transformer was therefore specially developed for supplying power to digital layouts. It delivers an output of 52 VA (42 VA in North America); the central unit and the Boosters are designed to be used with it.

In principle, a conventional transformer - such as the 6631/6627 or 6647/76646 - can be used to supply power for a central unit. If you are running several trains at the same time, after a while the circuit breaker on the transformer may cut out due to an overload, and the trains will be without power for a while. Naturally, all of the transformers must be rated for the current in your house. In Germany and most of Europe that is 230 volts; in North America it is 110 volts (actually 110-120 volts). If you are in doubt, check with your local public utility company. All of the Märklin transformers sold in a particular country should be rated for the same voltage.

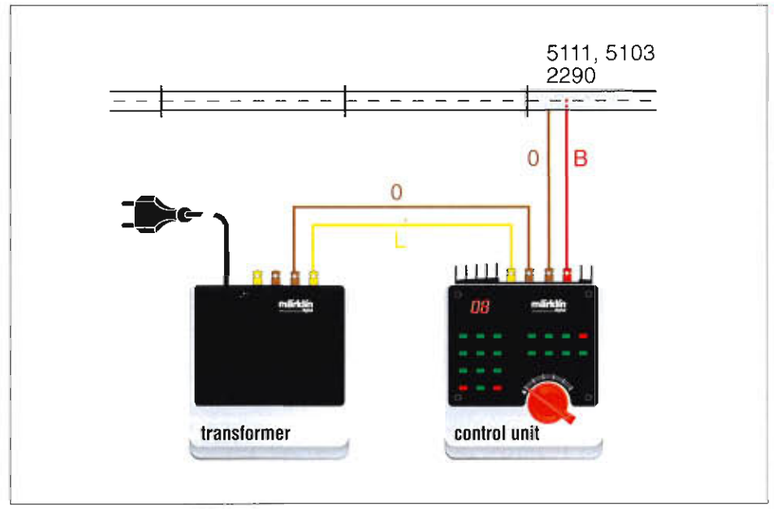
All central units are rated for a maximum current of 2.5 amps, assuming that the transformer is powerful enough. This corresponds to an output of about 45 watts. Up to five unlighted H0 trains can be run with this, if the central unit is not being called on to operate turnouts and signals. A red LED serves as a pilot light on it. In the event of an overload or short circuit, the central unit will shut off current to the track. Only one central unit is to be used on each layout. The central units are not designed to support the transmission of data between several of themselves. Additional power boosters, i.e. the Booster, must be connected to the digital layout when more power is required.

Connecting A Central Unit

All of the central units are connected to the track and the transformer in the same way. Our example here is the Control Unit. Before starting, the transformer must be unplugged from the house current. Each central unit has four terminal clips on the back for connections to the transformer and to a feeder track. Terminals of the same colors on the three units (central unit, transformer, feeder track) must be connected together:

- From the transformer (power supply): yellow terminal clips ("L" = constant current) and brown ("0" = ground).

7 & 8. Above: Transformer
Right: Connections for the transformers and Control Unit



- To the feeder track (track power and digital data): red terminal clips ("B" = track power) and brown ("0" = ground). It is important that you never connect a yellow terminal clip on the transformer with the red terminal clip on a central unit.

The Control Unit

The current central unit is the Control Unit (6021) that has been available since 1993. It replaced the Central Unit (6020) that had been used since the start of the digital era to control layouts.

Since 1994, the Control Unit has also been used for Märklin 1 Gauge. The Control Unit is thus suitable for both H0 third rail and for 1 Gauge layouts. It has its own memory for speed and auxiliary functions for each of the 80 locomotive addresses. Four coding switches on the back of the Control Unit are used to set special characteristics of the digital signal.

The Control Unit contains a full digital locomotive controller on which you can call up all addresses from 01 to 80 and control all locomotive functions. The locomotive address selected appears in a two-digit LED display. When operating Märklin 1 Gauge, the locomotive's direction is indicated with two arrow shaped LEDs.

Using the Control Unit is quite easy: If you want to call up a new locomotive address, the LED for button "L" must always be on. Usually, the LED for button "F" is also lit up. This shows that the address entered is good for both a locomotive decoder as well as for a function decoder. Always enter the locomotive address as a two-digit number, such as "08". If this number lights up constantly in the display, then you can control the locomotive. If the locomotive address blinks in the display, then either the entry was not correct or the desired locomotive is already called up on another locomotive controller. The locomotive must first be released at that controller, before you can control it at your Control Unit.

The speed is set with the speed control knob. The actual speed for different locomotives may vary despite having the same setting on the speed control knob. This depends on the motor and gear drive, the type of decoder and the setting on it as well as on the train load.

Reversing the locomotive's direction is the same with the Control Unit as with a conventional train control transformer: Turn the speed control knob to the left beyond the zero setting to the small triangle. You will hear a small click. There is nothing to see on the locomotive when you reverse it, because the reversing takes place electronically in the decoder itself. If the locomotive's headlights are turned on, with most locomotives they will change over with the change in direction - this depends on the type of locomotive, of course. On some locomotives only the front headlights will be on, on others they will be on front and back. Or in the front you will have three headlights and in the rear two red marker lights, and this will change with the change in direction. With Swiss locomotives a single white light will be on in the rear.

9. Setting the coding switches on the Control Unit., here for 1 Gauge layouts. For H0 third rail layouts all four coding switches remain in the OFF position.

10. Control Unit with locomotive address 08 called up

A second locomotive is called up by keying in its address. You can change the speed and direction for this locomotive whose address now appears constantly lit in the display. The locomotive previously called up will continue to run with the last speed set for it. In this way up to 80 digital locomotives can at least theoretically be controlled with a single locomotive controller. In practice, however, it is probably too difficult to keep more than two or three locomotives under control with a single locomotive controller.

You can take over control with your Control Unit of a locomotive in operation, if it is not currently called up on another locomotive controller and is not being controlled from that controller. You simply call it up, and you can then change the speed, direction and the settings for the auxiliary functions.

It is best if you first enter the first digit for the locomotive address. Now set the speed control knob at about the speed of the desired locomotive. Then, you should enter the second digit for that locomotive so that it continues to run at about the same speed. As soon as the second digit of the locomotive address lights up on the display, you can control the locomotive as you want.

The auxiliary function for the locomotive is controlled with the buttons "function" and "off".

11. The desired locomotive address is called up with the green buttons.

12. The speed and direction are changed with the red control knob.

13. Control Unit

With most locomotives the auxiliary function consists of turning the headlights on and off, with some it is the smoke generator or the TELEX couplers. When you want to activate the auxiliary function for long periods of time, such as for headlights or the smoke generator, the "function" button is used to turn it on and the "off" button is for turning it off. For a momentary pulse of current, such as is required for the TELEX couplers, press the "off" button and then release it right away. The red LED by the word "function" will remain on as long as the auxiliary function is activated.

Pressing the red "stop" button is an emergency halt that stops all trains on the layout. The power to the tracks (and to the decoders for turnouts and signals is interrupted; this also applies to any Boosters connected to the layout. The speeds for all of the locomotives remain in memory, however, since the locomotive controllers continue to receive power from the central unit. To resume operations, press the "go" button. All of the locomotives will resume the speed and direction previously set for them.

If you press the "stop" and "go" buttons at the same time, you reset the system to its basic setting. This stops all of the locomotives in operation and erases all data for the locomotive controllers and the central unit. You can achieve the same result by turning the layout off. However, after pressing "go", the locomotives will continue to operate at the speed still stored in each locomotive decoder.

In addition to the locomotive's auxiliary function, you can activate additional functions with the four buttons on the Control Unit lettered with "f1" to "f4". Pressing one of the buttons turns the function on, pressing it a second time turns it off. These buttons are also used to activate working models. The latter only when a function address is entered. The red LED must be lit over the "F" button when entering a function address. After a digital layout is turned on or after a reset, both of the LEDs for "F" and "L" will light up at the same time. This means that the address selected is valid for both a locomotive and a function decoder. It is possible, however, to select addresses for locomotive and function decoders independently of each other. To do this, press the "F" button and enter the address of the function decoder as a two-digit number. If you want to call up another locomotive, press the "L" button and enter the new locomotive address as a two-digit number. The earlier function address remains called up at the same time. You can activate the function buttons while the locomotive address appears in the display. The function decoder appears again when you press the "F" button.

The Central Control

The "Central Control" central unit (6602 and 6023) was part of the 2601, 2612 and 2622 digital starter sets. It is no longer produced and is therefore no longer available. It contains a full central unit. Its features are the same as those of the Central Unit, a pure central processor unit without controls that was produced until 1993 and that is also no longer available. In addition, the Central Control contains a simplified digital locomotive controller with four fixed locomotive addresses and a small digital accessory controller for four fixed solenoid accessory addresses.

The Central Control does not have a 10 button keypad with which you can select any digital address between 01 and 80; it has four buttons programmed with four permanent locomotive addresses. You have to set your locomotives for locomotive addresses 10, 20, 30 or 40 to be able to call them up with the green buttons 1, 2, 3 and 4. When the LEDs light up over the numbers that have been called up, the locomotive can be controlled with the speed control knob. A single auxiliary locomotive function is turned on and off with the "function" and "off" buttons.

You can operate four turnouts or signals directly with the four red and four green buttons with the lettering "keyboard" on the Central Control. These have to be set for the highest solenoid accessory addresses in the system: 253, 254, 255 and 256 (Note: The 6023 sold in North America has the lowest numbers for the accessory buttons: 1, 2, 3, 4). The Central Control is set for the highest solenoid accessory addresses, because the 2602 starter set contains two digital turnouts with built-in decoders that are set for addresses 253 and 254 (Note: The turnouts in the 2601 set sold in North America have the addresses 1 and 2.). Two additional turnouts were available from the dealers to supplement this set and were coded 255 and 256.

The Central Control can be expanded to the fullest extent of the Digital system. If you connect a Control 80 f on the right side of the Central Control, you can use all of the locomotive addresses between 01 and 80 as with a Central Unit and the additional functions "f1" to "f4" for any function decoder produced up to 1996. Locomotive decoders manufactured starting in 1997 and having several functions require a Control Unit to be able to address the auxiliary functions. When you connect additional accessory controllers on the left side of the Central Control, you can use all 256 solenoid accessory addresses with no limitation. The four addresses 253 to 256 are then controlled in parallel from Keyboard number 16, buttons 13-16, and also from buttons 1 to 4 on the Central Control (Addresses 1 to 4 are controlled in parallel from buttons 1 to 4 on Keyboard number 1 and also from buttons 1 to 4 on the Central Controls sold in North America).

The Booster

The Booster (6017) boosts power and the command signal for the Digital system. It is required when you want to operate more trains simultaneously on a layout or more lighted accessories than the central unit and its transformer are capable of supplying with power.

You can calculate for yourself whether the power requirement on your layout is so large that you need one or even several Boosters: A transformer provides about 52 VA (42 VA in North America), a locomotive in operation requires about 10 VA, a smoke generator 5 VA, a lighted car with two or three light bulbs consumes 2.5 to 4 VA. A "Rheingold" with a locomotive with a smoke generator needs almost half the available power. At the other extreme, four unlighted trains can be operated simultaneously on the same power. Exact tables for power requirements can be found in the digital book "Getting Started with Märklin Digital" (0308 / 0308A in North America).

The Booster can be connected to all of the central units for three-rail H0 layouts, i.e. to the Control Unit, Central Unit and the Central Control. The Booster is also used for Märklin 1 Gauge layouts in conjunction with a Control Unit.

It takes the digital signal from the central unit, reinforces it and feeds it into its (the Booster's) own power circuit. A red LED on the Booster shows that is in operation. Any number of Boosters can be used on a layout. Each one must be connected to its own, isolated power circuit.

Connecting the Booster

The transformers must be unplugged from the house current before connecting the Booster. Like a central unit, the Booster has four terminal clips on the back for connections to the transformer and to a feeder track. The Booster and its transformer must be connected to each other by means of terminal clips of the same color. From the transformer (power supply): yellow terminal clips ("L" = constant current) and brown terminal clips ("0" = ground). To the feeder track (track power and digital data): red terminal clips ("B" = track power) and brown terminal clips ("0" = ground).

The Booster can deliver its full power only with the 6002 transformer. It is designed for the latter's output of 52 VA. (Note: The 6001 transformer for North America is limited by regulation to 42 VA.) In principle, a conventional transformer, such as the 6627/6631 or 6647/6646 units, can also power the Booster. This will result in certain limitations on operations, just as with a Control Unit connected to a conventional transformer, since the circuit breaker will be activated more quickly due to the smaller power reserve.

The five-conductor ribbon cable with two plugs included with the Booster is plugged into one of the two sockets on the back of the latter. The other end is plugged into the corresponding socket on the central unit. The second socket on the Booster is for connecting another Booster.

This cable must be plugged into the different central units in different ways: on the Control Unit (6021), so that the cable points up, on the Central Unit (6020) and on the Central Control, so that the cable points down.

Before you plug the transformers back into the house current, you must be certain that the power circuits for the central unit and the Booster(s) are truly separated from one another. The red or yellow terminal clips must not on any account be connected with one another. The brown ground connections, though, may and should be connected together.

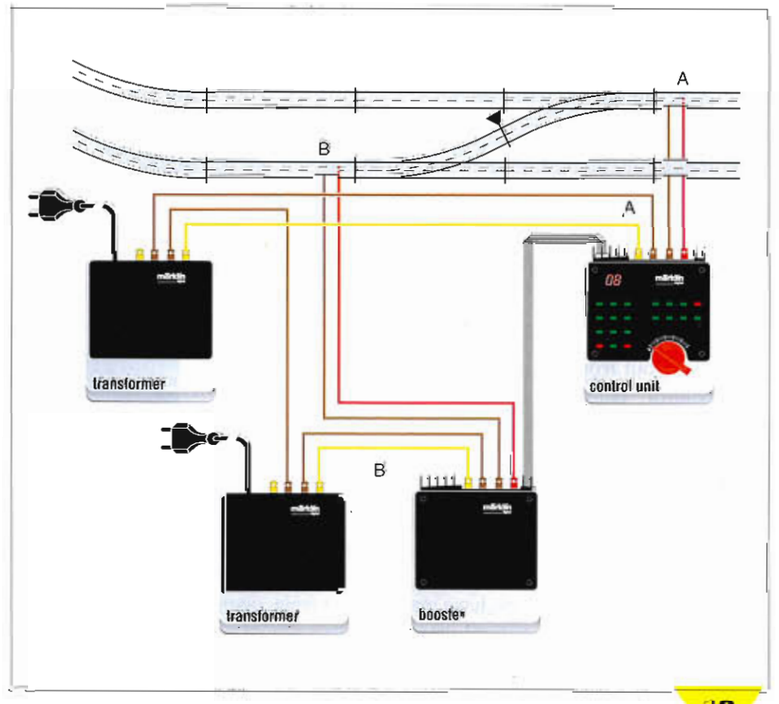
14. Booster

The third rail in the track must be isolated at all transition points between two power circuits. To do this, install insulators between the tracks:

- ❑ the 5022 insulators for M Track;
- ❑ the 7522 insulators for K Track;
- ❑ the 74030 insulators for C Track.

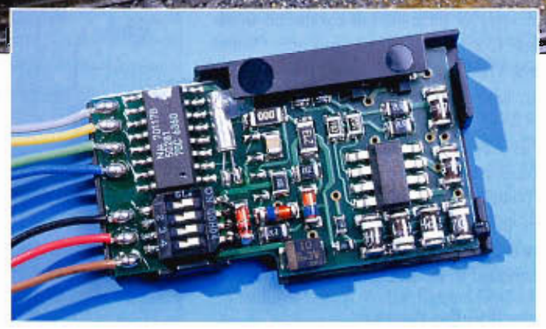
It is best if you check the insulated third rail joint right after installing the insulator. To do this, disconnect the red wire for the feeder track from the terminal clip on a Booster. Leave all other Boosters, if present, the central unit and all transformers connected. Run a locomotive over all of the separation points of this Booster power circuit. When the locomotive crosses over a separation point into the circuit, it should come to a stop. If this is not the case, then you must check and reinstall the insulator at the separation point.

15. While the central unit supplies circuit A, the Booster takes over circuit B. A center rail insulator is installed between the turnouts.



Delta and DIGITAL Locomotives

Each DELTA and digital locomotive contains a decoder that translates the coded commands sent out from the central units and control components. Märklin uses different decoders to fit the entire performance spectrum for different types of locomotives and motors.



1. DELTA module set for digital address 80

The DELTA Module

The DELTA locomotives have an electronic component to control them that is designed for the control components of this "little" digital system and that makes it possible to have multi-train operation with up to five motive power units. DELTA locomotives cannot only be used on DELTA layouts, they can also be run on conventional layouts or in digital operation. The headlights for a DELTA locomotive change with the direction of travel (assuming the rear of the locomotive also has headlights). In comparison to locomotives with digital decoders, the headlights on a DELTA locomotive cannot be turned on or off. The brightness of the headlights also depends on the speed of the locomotive.

There have been two different series of DELTA modules. The primary difference between them is the manner in which an address is set on them. With the first series the address for the locomotive was set by bridging small solder pads on the module, while on the newer series there are four coding switches mounted on the circuit board that are easy as child's play to set. Even the "non-fiddler" among model railroaders will have to reset an address now and then, and you should not have to reach for the soldering iron every time or go to your dealer.

The table shows all of the possible addresses for the DELTA module. For a DELTA layout you have to set your locomotives for one of the five combinations in bold print, on a digital layout you also have a choice of the other ten settings.

The lowest setting (all four switches set for "OFF") only applies to the new DELTA module and is used if the locomotive is to be run on conventional layouts. As mentioned above, all DELTA locomotives are being delivered from the factory with the new module set for conventional operation, so that beginners can start operating their locomotives immediately. One of the five DELTA addresses (78, 72, 60, 24, 80) must first be set for operation on a DELTA layout. With the older module, the locomotive automatically switches over to conventional operation.

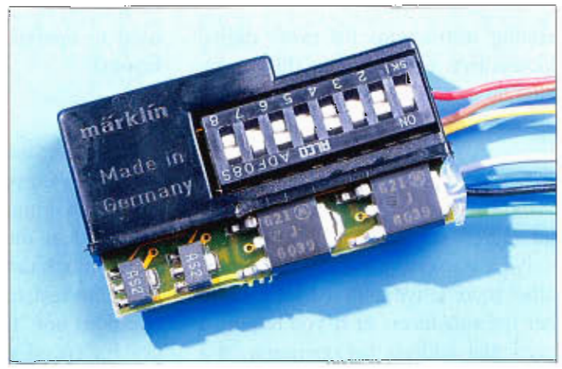
The DELTA module with the item number 6603 can be installed in almost all conventional locomotives, even older units.

The DIGITAL Decoders

Locomotive	DELTA Module Setting	Digital Address	Decoder Setting
		78	
		72	
		60	
		24	
		80	

2. Above: DELTA address settings on the DELTA module and on the digital decoder

34. Right: c 80 decoder



Only on a few units is the available space so small that considerable conversion work is required or that the installation is not even possible. As a rule even historic model railroad locomotives can be used on DELTA (and, naturally, also on digital) layouts.

Märklin covers the warranty for the operation of the module and the locomotive only if the former is installed by an authorized Märklin dealer. In addition, the dealer has a special tester to check out the function of the module before installing it. The DELTA module should be installed only on an anti-static work mat. It is also possible to turn a DELTA locomotive into a digital decoder, but that adds only a few advantages to the locomotive. The locomotive's headlights will have constant brilliance, and the locomotive can be programmed for 80 possible digital addresses instead of only 15. As a rule it isn't worth the extra expense. It's a different matter, though, to move a DELTA locomotive up to the "big" digital system with the 6090 high-efficiency propulsion. Here, however, you should seriously consider if it would be better to buy the various locomotives already available from the factory with the high-efficiency propulsion. Then you will have two fully digital locomotives for a comparatively small extra expense.

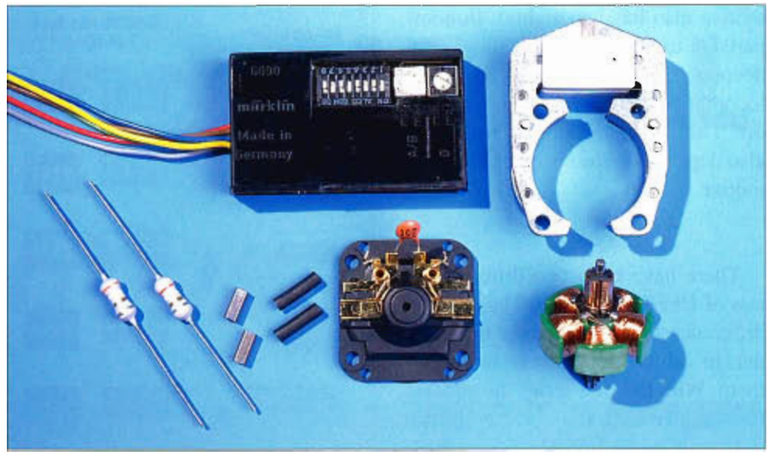
c 80 Digital Decoder

The c 80 is the standard decoder for Märklin digital locomotives with alternating current motors. Locomotives equipped with it can be used on conventional and DELTA layouts as well as on digital layouts.

A digital address from 01 to 80 is set on this decoder with eight coding switches; with this address you can call up the locomotive at a locomotive controller. The table for these possible addresses can be found in the op-

4. The 6090 digital propulsion set consists of the locomotive decoder and the high-efficiency motor. This decoder is controlled with the 6021 Control Unit.

3. Below: c 90 decoder as installed.



erating instructions for every digital locomotive as well as in this magazine on page 23.

Normally, locomotives are delivered from the factory with a particular address set on them. Actually, you only have to change it, if you have another locomotive with the same number for an address or if you require a particular address for operation on a DELTA layout.

The decoder changes the direction of travel electronically. It has an electronic memory for the last speed and direction set on it, and this memory will preserve these commands without a voltage supply for a while - between two minutes on older decoders and several hours for the latest decoders. If the locomotive loses its memory, the speed reverts back to zero and the direction goes back to "forward".

In addition, the decoder has an output that allows an auxiliary function to be controlled with the "function" and "off" buttons on the locomotive controller. The brightness of the locomotive's headlights does not depend on the speed that has been set for the unit. The headlights will also continue to shine when the locomotive is stopped, assuming that you have not turned them off (turning them off will save power that can be used to operate other things on the layout).

The electronic data storage for the direction of travel retains its "memory" much longer on the newer decoders than on the earlier ones. A signal block can be bridged by a 1.5 kilo ohm resistor so that the locomotive does not "forget" the stored values for speed and direction, even if the locomotive is stopped in the block for a long time. The resistor is not absolutely necessary when using newer locomotives and the Control Unit, because the data is constantly repeated by the central unit. However, only the resistor ensures that the locomotive retains its direction of travel if the storage time is exceeded. If there is no resistor and the storage time is exceeded, then the locomotive will run in the preferred direction, usually forwards. With steam locomotives it's easy to know where the front is. With diesel and electric locomotives where the front and rear are the same, the end with "1" on the side of the cab is the front as a rule; the "rear" is the cab with the number 2.

A digital electric locomotive should not be operated from the catenary if at all possible. It is actually not necessary technically, since with 80 possible addresses, the catenary is not required for multi-train operation. The reason for these precautions is that the digital signal is easier to disrupt if it is sent through the catenary than if it is transmitted through the third rail in the track and the locomotive's pickup shoe. Even if there is no power in the catenary, the locomotive's pantograph can still be raised up against the wire for the sake of appearance.

Most conventional locomotives can be converted to digital by installing a c 80 decoder. Here again: The conversion should be performed by an authorized Märklin dealer, since the warranty is covered by Märklin only when the decoder is installed in this way. The dealer can also check the operation of the decoder before installing it.

The c 81 Decoder

The c 81 decoder is designed for all locomotives with permanent magnet motors (DC motors). It is used to convert some Märklin H0 locomotives with DC motors or locomotives of other makes (with center rail pickup shoes) with DC motors. The c 81 decoder cannot be used in conjunction with the earlier "Central Control=" or "Central Unit=" (6027) central units for H0 two-rail layouts. The features and function of the c 81 decoder are practically identical with those of the c 80.

The High-Efficiency Propulsion

The "flag ship" of any digital layout is without a doubt the locomotives with the 6090 high efficiency propulsion. These locomotives operate almost like their real life prototypes. With this decoder, the maximum speed can be set individually over the entire speed range of the locomotive controller. Once you have set a speed on the locomotive controller, this speed will remain nearly constant on ascending or descending grades. You can reproduce the operating characteristics of heavy train compositions with the adjustable acceleration and braking delay.

Conventional locomotives with a drum-style commutator motor can be turned into digital locomotives with high-effiency propulsion by using the complete 6090 conversion kit. In the course of this conversion, a new, five-pole armature as well as the c 90 decoder are installed. In addition, the field magnet, brush plate and the pair of brushes are also replaced. The conversion work should therefore be undertaken only by an authorized Märklin dealer, as with all other decoders. He can check the operation of the decoder before installing it. Furthermore, the decoder should be installed only on an anti-static work mat.

Code Table for Digital Locomotives

All standard locomotive decoders have eight coding switches. These are used to set the digital address. This is a number between 01 and 80. This number must be entered at a digital locomotive controller, before the locomotive can be controlled. In the code table for locomotive addresses next to this text you can see which of the eight dip switches must be set in the "ON" position, in order to program the desired address. These small switches are best set with a small screwdriver or with the special stick included with the decoder. In a pinch you can also use a toothpick. The same code table can be found in the instructions for each digital locomotive. The address set at the factory is shown there in a darker colored block. A different address is set at the factory for every type of locomotive, if possible one that is related to the class designation.

Address	Switch ON	Adcress	Switch ON
01	- 2 3 - 5 - 7 -	41	- - - 4 - 6 - 8
02	- - 3 - 5 - 7 -	42	1 - - - - 6 - 8
03	1 - - 4 5 - 7 -	43	- 2 - - - 6 - 8
04	- 2 - 4 5 - 7 -	44	- - - - - 6 - 8
05	- - - 4 5 - 7 -	45	1 - 3 - - - - 8
06	1 - - - 5 - 7 -	46	- 2 3 - - - - 8
07	- 2 - - 5 - 7 -	47	- - 3 - - - - 8
08	- - - - 5 - 7 -	48	1 - - 4 - - - 8
09	1 - 3 - - 6 7 -	49	- 2 - 4 - - - 8
10	- 2 3 - - 6 7 -	50	- - - 4 - - - 8
11	- - 3 - - 6 7 -	51	1 - - - - - - 8
12	1 - - 4 - 6 7 -	52	- 2 - - - - - 8
13	- 2 - 4 - 6 7 -	53	- - - - - - - 8
14	- - - 4 - 6 7 -	54	1 - 3 - 5 - - -
15	1 - - - - 6 7 -	55	- 2 3 - 5 - - -
16	- 2 - - - 6 7 -	56	- - 3 - 5 - - -
17	- - - - - 6 7 -	57	1 - - 4 5 - - -
18	1 - 3 - - - 7 -	58	- 2 - 4 5 - - -
19	- 2 3 - - - 7 -	59	- - - 4 5 - - -
20	- - 3 - - - 7 -	60	1 - - - 5 - - -
21	1 - - 4 - - 7 -	61	- 2 - - 5 - - -
22	- 2 - 4 - - 7 -	62	- - - - 5 - - -
23	- - - 4 - - 7 -	63	1 - 3 - - 6 - -
24	1 - - - - - 7 -	64	- 2 3 - - 6 - -
25	- 2 - - - - 7 -	65	- - 3 - - 6 - -
26	- - - - - - 7 -	66	1 - - 4 - 6 - -
27	1 - 3 - 5 - - 8	67	- 2 - 4 - 6 - -
28	- 2 3 - 5 - - 8	68	- - - 4 - 6 - -
29	- - 3 - 5 - - 8	69	1 - - - - 6 - -
30	1 - - 4 5 - - 8	70	- 2 - - - 6 - -
31	- 2 - 4 5 - - 8	71	- - - - - 6 - -
32	- - - 4 5 - - 8	72	1 - 3 - - - - -
33	1 - - - 5 - - 8	73	- 2 3 - - - - -
34	- 2 - - 5 - - 8	74	- - 3 - - - - -
35	- - - - 5 - - 8	75	1 - - 4 - - - -
36	1 - 3 - - 6 - 8	76	- 2 - 4 - - - -
37	- 2 3 - - 6 - 8	77	- - - 4 - - - -
38	- - 3 - - 6 - 8	78	1 - - - - - - -
39	1 - - 4 - 6 - 8	79	- 2 - - - - - -
40	- 2 - 4 - 6 - 8	80	1 - 3 - 5 - 7 -

Extra Performance

Digital Locomotives with High-Efficiency Propulsion

You'll notice locomotives with the high-efficiency propulsion right away on any digital layout. Thanks to their special features, they run almost like real locomotives. The propulsion system includes not only the c 90 decoder, but also essential parts of the motor. The electrical characteristics of the c 90 decoder are specially designed for this motor.

These characteristics allow you to set the maximum speed, and thereby the speed over the entire range of the speed control knob on a locomotive controller, according to the type of locomotive and the wishes of the operator. A higher speed can be selected for an express locomotive than for a switch engine that you want to control with an specially fine touch in the slow speed range. All of the locomotives come from the factory with the maximum speed set at its highest level.

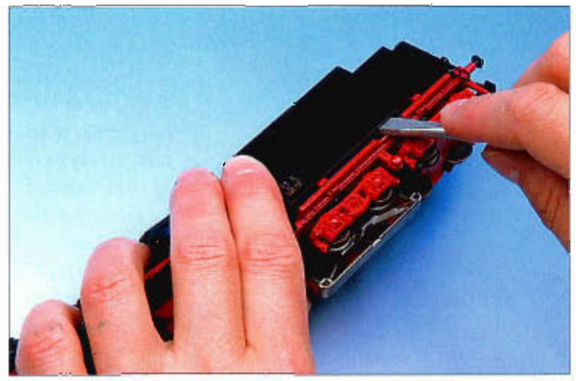
1. Above: Locomotives with the c 90 decoder installed are used on this digital layout.

2. Right: On steam locomotives with a tender, the decoder is located in the latter unit.

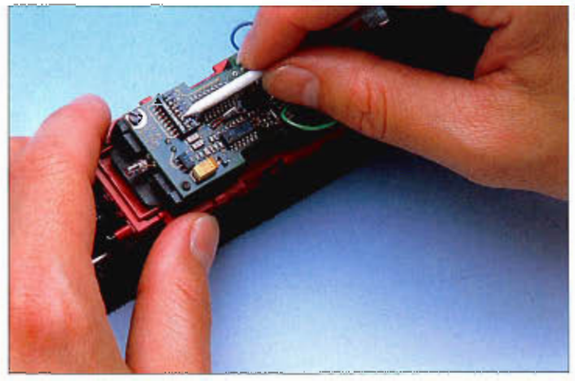
The speed can also be controlled with respect to the load. The speed set at the locomotive controller for a heavy train remains nearly constant on ascending and descending grades. With digital operation this control functions independently of the setting for the maximum speed.

Heavy trains will exhibit realistic operating characteristics on your layout, when you set the acceleration and deceleration delay. Even if the speed control knob is rapidly turned to the right or left, the trains slowly accelerate and no longer come to an abrupt stop. Jerky starts and stops are now a thing of the past.

Naturally, the braking delay works only as long the digital voltage is in the rails. The braking delay cannot function, when stopping before a signal set for stop with the train control feature hooked up to it, or when you press the "stop" button on a locomotive controller. The reason for this is that the power has been suddenly turned off on the track on which the locomotive is running. In the interest of prototypical realism you might consider doing without the train control feature for signals on a layout where you are running several trains with high-efficiency propulsion. It would be better to run the locomotives as in real life and leave it to the "locomotive engineer" to actu-

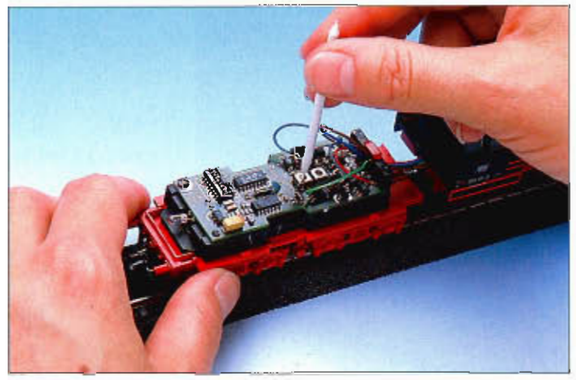


3. Removing the tender body;



4. Changing the address set at the factory to one of your own choice; and braking delays as well as the speed control on ascending and descending grades;

5. Setting the maximum speed, acceleration



6. Testing the unit

8. Above: The acceleration for specific trains can be set with the c 90 decoder. A loaded freight train (left) travels more slowly than an unloaded one (right). In addition, the maximum speed can be held nearly constant.

9. The speed remains nearly constant on ascending and descending grades.

10. Irritation in the switch yard. The switchman, accused of sleeping on the job, explains to his superior, why he is no longer required for uncoupling: the class V 60 switch engine has TELEX couplers!

11. Below: Uncoupling a freight car

ally stop the train before a signal set for stop.

The other solution would be the 72441 digital signal module which gives the locomotive a command that activates a gradual braking of the train in front of a signal set for stop. Now locomotives with high-efficiency propulsion no longer have to come to an abrupt stop at a signal with the train control feature set for stop. Furthermore, digital functions such as headlights remain on. One further note: As delivered from the factory, the acceleration and deceleration delay are set at a middle value.

When a digital locomotive with high-efficiency propulsion is run on a conventional layout, the load-dependent speed control, the adjustable maximum speed and the acceleration delay will work, but not as effectively as with digital operation. How well the load-dependent speed control works on a grade also depends in analog operation on the setting for the maximum speed. If it is set very high, there are hardly any power reserves left for the load-dependent speed control to be nearly constant on the grade.

The excellent characteristics of the 6090 high-efficiency propulsion have prompted the Märklin Company to replace the conventional five star motor in earlier locomotives whose item number began with the digits 35.

Digital Locomotives with Auxiliary Locomotive Functions

At first there was only one auxiliary locomotive function that, in addition to the independent control of several locomotives in the same track circuit, made digital operation interesting for model railroad operators. On most of the digital locomotives this was the headlights.

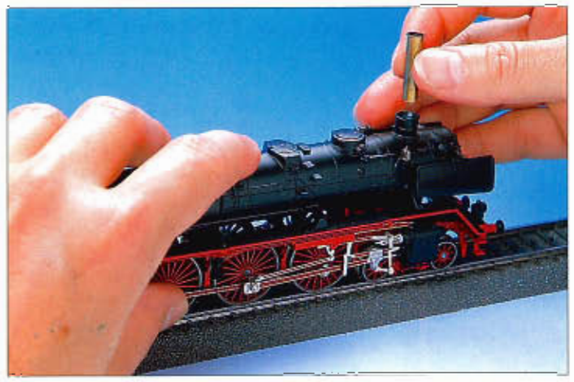
It was here that the revolutionary aspect of the new technology clearly became apparent. As with the prototype, a locomotive in the maintenance facility or in the station area could be waiting with its headlights on to be used, for example, to haul a train back out of a stub end terminal or to be used in double-heading on steep grades. The past with conventional operation was quickly forgotten in which headlights went off when the locomotive was stopped and their brightness depended on the locomotive's speed.

Some steam locomotives can be equipped with a smoke generator. If you want to use such a unit as the auxiliary function in your locomotive, see your authorized dealer or refer to the 0308 (0308A in North America) digital book.

There have been digital locomotives offered by Märklin with the Märklin TELEX coupler that allows you to uncouple cars from the locomotive anywhere on the layout. This auxiliary function is ideal for switching operations, and anyone wanting to use it on his digital layout should have a HOBBY or DELTA locomotive already equipped with TELEX couplers converted to digital for this function. An example of the wiring circuit for such a conversion can be found in the 0308 (0308A in North America) digital book.

The new 37371 and 37083 digital locomotives can show their functions only if the layout is equipped with the 6021 Control Unit, because only this central unit can work completely with the new decoder in these locomotives. Anyone still using the older 6020 Central Unit can only control the headlight changeover with the "function" button, even a 6036 Control 80 f locomotive controller is connected to the Central Unit.

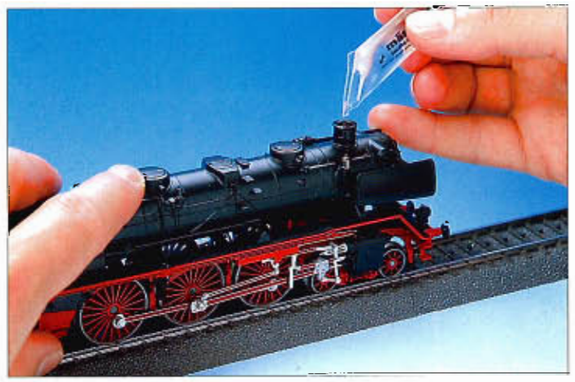
The problem of high-efficiency propulsion locomotives and powered units in track blocks with the power shut off not being able to make full use of the braking delay feature has now been solved. Locomotives with high-efficiency propulsion no longer have to come to an abrupt stop with the headlights off at a signal with the train control feature. The 72441 digital signal module gives the locomotive a command that activates a gradual braking of the train in front of a signal set for stop. Furthermore, digital functions such as headlights remain on.



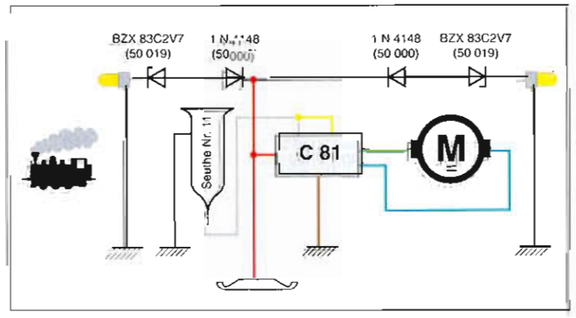
12. Installing the Seuthe smoke generator

13. Use only the special smoke fluid.

14 & 15. Steam locomotives are more realistic with the smoke generator.



16 & 17. Smoke generator as auxiliary function



DELTA - MAXI, Märklin 1 Gauge Locomotives

1. Above: Multi-train operation is also possible with the MAXI railroad. A DELTA module is built into all locomotives at the factory. Naturally, you can expand it with Märklin Digital.

2. Right: Smoke and headlights as an auxiliary function with 1 Gauge

Naturally, the large gauge can also be operated digitally, either with DELTA, or with the standard 1 Gauge Märklin locomotives. All of the standard 1 Gauge locomotives currently in the Märklin assortment come with high-efficiency propulsion and are equipped with the c 95 digital decoder. It can be set for addresses 01 to 80. You can also use it on DELTA and conventional layouts. The maximum speed as well as the acceleration/deceleration delay can likewise be set individually. This decoder controls the locomotive's speed on ascending and descending grades, and you can switch on up to five auxiliary functions. It is operated in the same manner as Märklin H0 decoders. You can expand the Digital system for 1 Gauge just as you would for H0. Actually, most of the components are identical for the two gauges. Here too, technical progress is bringing more and more functions in the new locomotives. The Swiss Am 4/4 diesel locomotive, for example, can be heard in two different ways: It has a locomotive horn that can be controlled as an auxiliary function, and a diesel motor sound effects circuit. The lights in the engineer's cabs can also be turned on and off.

MAXI and Digital

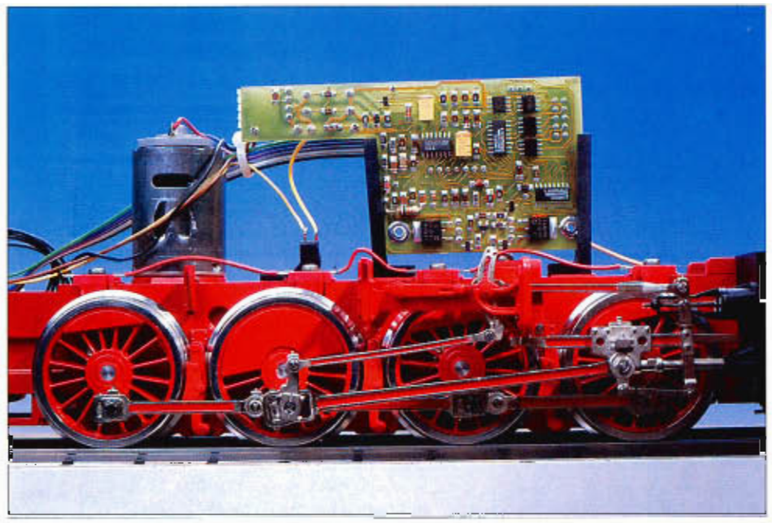
You can run your MAXI locomotives with DELTA, since they come with the factory with a DELTA module. You can also retrofit your locomotives with the 60955 digital high-efficiency decoder. This allows you to make full use of the Digital system. For example, you can set the maximum speed as well as the acceleration/deceleration delay. The build-in load-dependent speed control really becomes apparent with the heavy weight of MAXI's metal construction. On ascending or descending grades, the decoder controls the motor so that the train runs with near constant speed. In addition, you can switch on three auxiliary functions with this decoder and set all of the addresses between 01 and 80.

MAXI and DELTA

All MAXI locomotives come from the factory with a DELTA module. You only need the

4. Right: Digital decoder built into a 1 Gauge locomotive

3. Below: DELTA Station



appropriate controllers to run them. Of course, you can continue to use your transformer. The DELTA controllers for these locomotives are designed for mobility on large, extensive layouts. The 6607 DELTA Station controller is the heart of the system. Externally, it resembles the earlier 6020 Central Unit. The DELTA Station must be used with at least one and can be used with up to four DELTA Mobil hand controllers. One DELTA Mobil is included with each DELTA Station. With the DELTA Station you can operate up to four MAXI or standard 1 Gauge locomotives in a single power circuit independently of each other. A single DELTA Mobil is sufficient to do this; it's easier, however, if you have several. The DELTA Station can also be used outdoor for operation of a MAXI or a Märklin standard 1 Gauge layout. The transformer to power it must, however, remain absolutely indoors, because it must not come in contact with moisture.

These DELTA units can also be used for H0 layouts, but you are limited to the four hand controllers. If you are sure that this is all you will ever need for your layout, then these DELTA components are worth considering. They offer operators the advantage of the hand controller's mobility.

Connecting the DELTA Station to the System

The 6607 DELTA Station is connected between a transformer and a feeder track. Before making these connections, be sure that you have unplugged the transformer from the household current. A conventional train control transformer or a digital transformer can be used to supply power. Only with a digital transformer, such as item no. 6001/6002, can the full output of the DELTA Station be used.

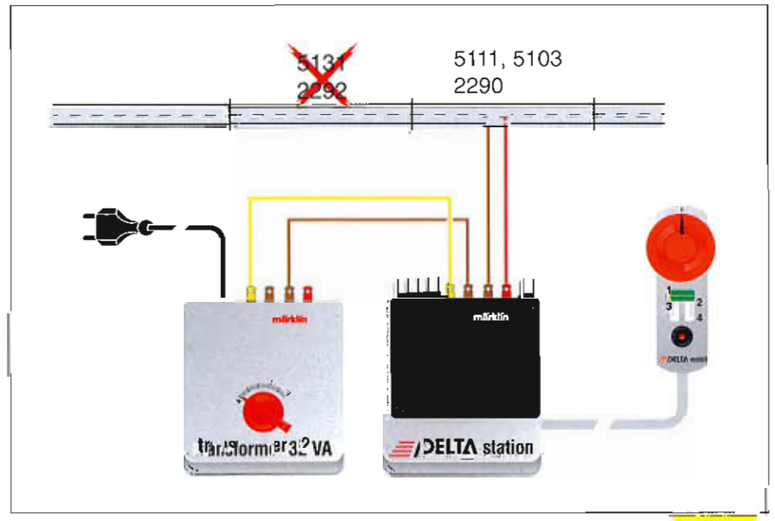
First connect the brown terminal clip on the DELTA Station with a brown terminal clip on the transformer (0 = ground return). Then make the connection between the yellow terminal clips on the DELTA Station and the transformer ("L" = constant current). Make sure that you have good contact at these connections. Connect the red and brown wires from a feeder track to the corresponding color terminal clips on the DELTA Station.

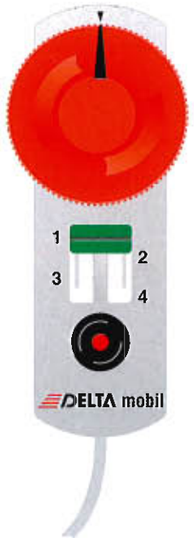
Here too, you may not use feeder tracks with built-in condensers for radio/television interference suppression. If you are going to use the DELTA Station for an H0 layout and it still has 5131 (M Track) or 2292 (K Track) feeder tracks, cut at least one of the connections on each condenser with a small wire cutter. The DELTA Station uses the same digital addresses as the the DELTA Control: 78, 72, 60, and 24 (80 does not work here). If you want to operate a digital locomotive with DELTA, it must be set for one of these four addresses. When digital locomotives are operated with a DELTA Station, their auxiliary function is on constantly. For that reason you should not use the DELTA Station to operate digital locomotives with TELEX couplers for an auxiliary function.

DELTA Mobil

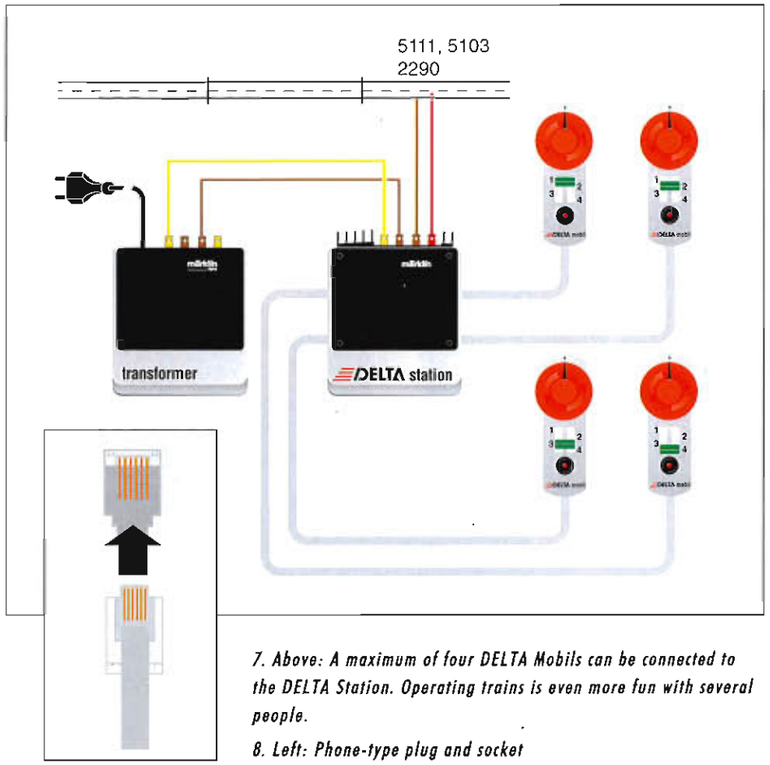
The DELTA Mobil hand controller makes you mobile in the truest sense of the word when controlling locomotives. With this controller in your hand, you can keep track of your locomotive at any time and watch it in operation on the track. You need at least one DELTA Mobil hand controller to be able to control locomotives with the DELTA Station; it is included with the Station. With two, three or four hand controllers, it's even more fun for several people to be running several locomotives. Each operator can take his hand controller along with him wherever the control job is, be it for switching, in the passenger station, or at a siding. Telecommunications fans will immediately feel at home with the DELTA Mobil: The lat-

5. Connecting the DELTA Station between the transformer and the feeder track. Please note that only feeder tracks without built-in interference suppression condensers may be used on DELTA and digital layouts.





6. DELTA Mobil



7. Above: A maximum of four DELTA Mobils can be connected to the DELTA Station. Operating trains is even more fun with several people.

8. Left: Phone-type plug and socket

ter's cable comes with an American standard RJ-11 plug, the so-called "Western plug", that is common for telephones all over the world. This plug is present at both ends of the cable. Of course, this doesn't mean you can connect a telephone to the DELTA Mobil. You should only connect the components to it that are designed for it.

You can, however, lengthen the connection between the DELTA Mobil and the DELTA Station with a telephone cable - provided it is a six conductor cable, because you need all six wires for data transmission. This connection should not be longer than 25 meters (82 feet), however, because the transmission cannot be guaranteed for distances longer than that. The hook-up is quite easy: One plug is inserted into the DELTA Mobil, the other into the DELTA Station. This plug connection will take a bit of tension, but it should not be stretched too tight.

One of four locomotives can be selected at each DELTA Mobil. If you have only one DELTA Mobil but several locomotives, the units selected previously will continue to run with the last speed set for them. If you are using several locomotives: the last one called up can now be controlled only with this controller; it cannot be called up on another controller until released from the first one. The speed and direction are set with a single control knob. In addition, an emergency button and pilot light are integrated into the DELTA Mobil.

Controlling a locomotive with a DELTA Mobil is quite easy: Set the green sliding switch to the locomotive number you want to control. The LED in the center of the black button will light up with a constant green light, the minute the controller calls up the locomotive and places it under your control. Select the speed and direction with the red control knob. The zero setting is marked in the center. Select another locomotive with the green sliding switch. The locomotive previously selected will continue to run with the speed set for it, until it is called up again and the speed or direction are changed. You can also assume control of a locomotive that was previously being controlled on another DELTA Mobil. Simply set the sliding switch to the desired locomotive number. If this locomotive is not presently called up on another controller, then you will immediately have access to controlling it - the LED will show a constant green light. If, however, this locomotive is being run from another DELTA Mobil, this latter DELTA Mobil will retain control of the locomotive and its LED will blink. Your hand controller will gain access to the locomotive only when another locomotive number is set on the first DELTA Mobil.

The black button is used to activate an emergency stop: All locomotives come to an immediate halt. At this moment the LED in the center of the button will turn red. Press the black button a second time, and all of the trains on the layout will resume operation at the speed(s) previously set for them.

9 & 10. Multi-train operation on a medium size DELTA layout. Switching cars gets really interesting with a DELTA Mobil.

Small and Medium Size Layouts

A "normal model railroader" usually starts off modestly. This is the best possibility with the Digital system, too, get to know the hobby from the ground up so to speak. Complicated concepts get explained step by step, and when the hobby is really fun to do, then nothing stands in the way of fast expansion to a medium size layout. This becomes most readily apparent when you realize that Märklin devotes a considerable amount of its development work to making sure that all of the parts fit together and that (almost) all of them can continue to be used when expanding. An example that leaps several generations: Locomotives and cars from the 1950s can be run with no problem on the new C Track with its 1990s technology.

1. A good start: Starter set with the new C Track.

Small layouts as a rule have a single power circuit and are powered by a single transformer. Yet, you can run up to five locomotives with it - depending on the type of locomotive and transformer. If children are to play with the layout, then it is recommended that you start off with DELTA, since it's easier to understand as a system, and it encourages cooperative play. In addition, this kind of start is better in price, because at present there are starter sets for DELTA, but not for the Digital system. Starter sets generally offer a clear price advantage compared to the total of the parts if purchased separately.

The starter set contains everything necessary for operation of a small layout: track, locomotive, cars, transformer, feeder wire set, instructions for setup and operation. First connect the track together in the desired pattern. Then slide the connector on the red wire from the feeder wire set on the connector on the underside of a section of C Track that supplies power to the two inner contacts. The brown, the ground connection, is slid on to the connector that supplies power to the two outer contacts. Stick the other ends of the wires into the corresponding color terminal clips on the transformer. Now, place the train on the track, plug the transformer into the wall outlet, turn the speed control knob, and you're running a train.

If you want to have two trains - and perhaps a little more of a "layout" - then we recommend a second starter set. Here you not only have a second train, but also more track and a second transformer that you can use to power all of the solenoid accessories on the layout. This allows you to use the first transformer just for powering the trains.

Of course, you can buy a locomotive with a DELTA module and several cars "à la carte", i.e. from the Märklin assortment. In any event, you'll need the DELTA Control so that you can control the two locomotives independently on the layout. The DELTA Control is wired in between the transformer and the track. Its output and that of the transformer from the starter set are sufficient to run up to three locomotives at the same time.

Before you start running trains, you have to set the decoders in the locomotives. As previously described, all of the coding switches are set at the factory in the "OFF" position, so that if necessary the locomotive can be run on a conventional layout. To turn it into a DELTA locomotive, first take the locomotive body off. The instructions packed with the starter set will show you how to do this. Usually only one screw holds the body on. Now, you can see and get to the four small coding switches. Set the locomotives for different addresses. Switch 1 must be set at "ON" and the other three at "OFF" for the "steam locomotive" symbol on the DELTA Control. Set switches 1 and 2 at "ON" and the other two at "OFF" for the "diesel locomotive" symbol, for the "powered rail car" switches 1 and 3 "ON", and for the "electric locomotive" switches 1 and 4 "ON". If you have two steam locomotives, you can use one of the other three symbols to call up the second steam locomotive. Now, put the body back on the locomotive.

Small DIGITAL Layouts

Anyone with several turnouts on his layout usually wants to operate them electrically and have signals to control blocks on one or more tracks. The turnouts in the DELTA starter sets with C or K Track can be retrofitted with electric mechanisms.

The only thing missing now is signals in the station area and uncoupler tracks in the switch yard to make your layout even more realistic and fun. Usually it's at this point in setting up a Märklin layout that you become really captured by the hobby. It's a stage at which you can sit for hours in front of the DELTA Control. You test out all sorts of train compositions and send them out on the main line, cheerfully switch cars around in the yard, try out multi-train and switching operations, etc. Maybe you even set up a regular schedule with powered commuter rail cars and the ICE.

And now is it time for a larger layout? No problem - you're now venturing into the area of medium size layouts, an area that most model railroaders end up in. This publication will deal essentially with the technical requirements for model railroading, not with scenery. There are other publications for the latter - the Märklin Insider or the Märklin Magazin for example.

You'll know that you "need" a medium size layout when your present layout is no longer sufficient to run four locomotives - or five if you're using the DELTA Pilot also. Then it's time for Digital.

The most noticeable difference between a small and a medium size layout is the fact that the larger of the two has several power circuits. With digital operation, one power circuit is supplied from the central unit, each of the others from a Booster with its own transformer.

In principle, you can use any transformer with an output of 30 VA or more for the Digital system. It could be a 6631/6627 or 6647/76646 train control transformer, an accessory transformer or a 6001/6002 digital transformer. The maximum output of a digital central unit is about 47 VA, and it can be fully utilized only with the 6002 digital transformer with its 52 VA output. (Note: The 6001 transformer for North America is limited by regulation to 42 VA.)

When you're ready to expand that small layout into a medium size one, the basic requirement is a 6001/6002 transformer and a 6021 Control Unit, the central unit and locomotive controller combined in one. During setup you must divide the layout into two power circuits. If you are only using the 6001/6002 transformer, then divide the layout into two roughly equal parts. If you are using the 6001/6002 transformer and a 32 VA train control transformer from a DELTA starter set, use the new transformer for a larger part of the layout and the less powerful train control transformer for a smaller part of the layout. The division of the layout into two or more power circuits does not affect train operations to any degree - all of the locomotives and powered rail cars can be run on the entire layout without any limitation.

To divide up the layout into power circuits, you must insulate the center rail conductors from each other at the separation points.

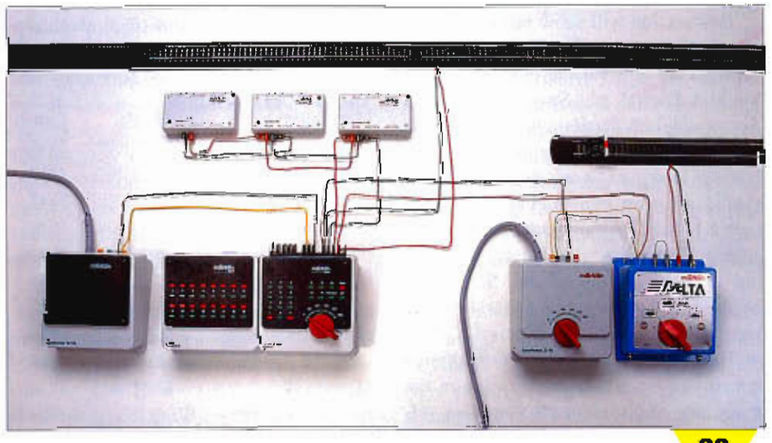
For the second power circuit you don't need to buy a transformer or a Booster, because you can use the existing transformer and DELTA Control from your DELTA period with no problem at all. In addition, you still have a third transformer from the second starter set that you can use to power solenoid accessories and lights. The newly purchased 6001/6002 transformer should be used in any event for the larger of the two power circuits due to its greater output.

The connections for the transformer, Control Unit. Booster have already been described (pages 16 - 19). The DELTA Control is connected to the layout like a Booster, with the difference being that the two sockets for the DELTA Pilot on the back of the DELTA Control must be connected together. Also, the red wire on the DELTA Control must go to the red terminal clip on the 6021 Control Unit.

You can continue to use all DELTA locomotives on the now digital layout. If you are buying new locomotives, it is best to buy digital versions so that there are no problems with different address codes. Digital locomotives also offer the advantage of controllable auxiliary functions. The locomotives with the 6090 high-efficiency propulsion offer still more ease of operation that makes running trains even more realistic.

If you want to get into Digital in steps, you can continue to operate your solenoid accessories conventionally with no problem at all. Later you can start off with a Keyboard and four k 83 decoders to handle the digital control of 16 solenoid accessories, and you can continue to control any remaining accessories conventionally. In this way you can proceed step by step to a perfect digital layout. The next goal is now the dream of a large layout...

2. Medium size layouts can be controlled with no problem with this configuration.



Setting Up A Large DIGITAL Layout

1. The Bietsch Valley bridge impressively spans the gorge on our large layout under construction.

With a large layout you must think about more than just the greater quantity of trains, signals, turnouts, etc. than what you had with a small or medium size layout. The quality and the total impression of the layout must also be in harmony, because usually such layouts do not remain for the "private enjoyment" of the builder when they are finished. Often they are shown at model railroad clubs or at shows, and the evaluation in these environments is more critical than at home in your train room.

Landscaped layouts predominate over experimental layouts with bare benchwork. The former have long, sweeping main lines interspersed with multi-track station areas or railroad maintenance facilities. Lots of turnouts and a large number of locomotives characterize a large layout as well as the space requirements that often overwhelm the resources of the average household.

And yet many large layouts develop out of "small circumstances". It's often just a short step from the medium size layouts described in the preceding section to a large layout. Also, thought must be given on the most elegant fashion in which the existing layout can be integrated into the new one to be built.

This section will show in the example of a large layout with a Swiss prototype for a theme how far the possibilities for Märklin Digital go. Space prevents us from going into detail on the construction phases and the technical solutions for this layout. However, you, as a beginner, should not start construction of a large layout without getting some professional advice. There is a wide variety of literature available on the subject. Some of it can be found in the current Märklin catalog.

The central focus of the Bietsch Valley layout is a large steel bridge high in the mountains and spanning a mountain valley above the actual layout surface. The dimensions of the layout are in themselves noteworthy: The area is "L" shaped with the legs of the "L" being 5.0 meters / 16.5 feet and 3.8 meters / 12.5feet long. Hidden in the mountains are two staging yards and two track spirals that allow the trains to climb an elevation difference of from 30 to 90 centimeters / 12 inches to 36 inches and descend an elevation difference of from 90 to 20 centimeters / 36 inches to 8 inches.

Description	Item No.	Output
Transformer	6000 (100V)	50 VA
Transformer	6001 (110V)	42 VA
Transformer	6002 (230V)	52 VA
Transformer	6003 (240V)	52 VA
Train Control Transformer	6631 (230V)	30 VA
	6627 (110V)	30 VA
	6647 (230V)	32 VA
Train Control Transformer	6671 (230V)	16 VA
(no longer available)	6667 (110V)	16 VA
Accessory Transformer	6611 (230V)	40 VA
(no longer available)		

The center of operations is the Blausee-Mitholz Station, copied from the Bern Lötschberg Simplon Railroad, that is connected via a long main line in the inner corner of the layout with one of the track spirals. As with the prototype, doubleheading of locomotives is a frequent occurrence here due to the alpine grades, and this fact alone guarantees a rich variety of digital operating enjoyment.

The Bietsch Valley layout is powered by a total of eight Boosters, each with its own transformer. The transformers provide the necessary power for the trains and accessories, while the Boosters boost or reinforce the digital data from the central unit.

When dividing the layout up into power circuits, you must keep in mind that no more than four trains can be in operation at a time in each power circuit, less if there are lighted cars. Later the operators do not have to pay attention which power circuit they are entering, because each locomotive is always controlled via its digital address, regardless of where the locomotive is located.

The builders of this large layout took care right from the start to keep the individual segments and their wiring manageable, so that problems could be systematically tracked down in the event of any interruptions of the operations. Careful work "below the baseboard" clearly cuts down on the number of interruptions.

Description	Item No.	Output
Control Unit	6021	approx. 47 VA
Booster	6015/ 6017	approx. 47 VA
Central Unit	6020	approx. 47 VA
Central Control		approx. 45 VA
DELTA-Control as Digital Booster	6604	approx. 30 VA
DELTA-Station	6607	approx. 47 VA

If you are planning a large layout, don't stop at just a simple track plan. Draw in the location of all feeder tracks and third rail separation points. Use several feeder tracks - one for about every 2 to 3 meters of track length (7 to 10 feet) - for power circuits with long track routes and many sidings or junctions.

If you are installing more than 10 locomotive controllers and accessory controllers, then the central unit should not be used for an external power circuit on the layout, so that its power output can be used only for the digital controllers and Boosters.

Up to 10 locomotive controllers can be used on a digital layout. Since the Control Unit already contains a locomotive controller, that leaves nine that can be plugged in, including any Interface that might be used and which must be counted as a locomotive controller.

Often it's handy to have two separate control panels so that parts of the layout with a great deal of operating activity can be monitored better. This also makes it easier for layout operations with several people. The 6038 or 6039 adapter cable provides the connection between the control panels. With this solution, too, there can be no more than 10 locomotive controllers connected to the central unit.

A total of up to 80 locomotive addresses can be used on a layout, i.e. 80 trains can be "addressed" and controlled independently of each other. If your layout is actually going to be this large, you should consider using a computer, since many train operating procedures can be automated with it, thus allowing you to concentrate on what is the most fun for you. The use of a track diagram control board (in the computer, for example) contributes considerably to increasing your ability to monitor and safeguard operations on the layout.

Large layouts are ideally suited for larger working models such as turntables, transfer tables, cranes, and similar accessories, since they don't dominate the layout as is often the case with smaller model railroads. On the Bietsch Valley layout there is a turntable in the staging yard; it is monitored from the control panel by a video camera.

You need 64 k 83 or k 84 decoders to fully utilize the 256 solenoid accessory addresses available for digital control of accessories. In this situation, the decoders should be powered by their own Boosters and transformers, so that they do not consume too much power that other transformers are providing for the track power circuits. A Booster and its associated transformer should be added for about every 30 lighted turnouts and signals.

You can use up to 16 Keyboards to control solenoid accessories. Each Keyboard is assigned its own address that is set with 4 coding switches on the back of that Keyboard. If you are planning several control panels, the same address can be set on Keyboards, thus allowing you to operate solenoid accessories from each control panel.

Track diagram control boards are an interesting alternative for larger layouts. Third party accessory companies offer track diagram control boards that you can "touch". Märklin is selling the "Comboard" computer track diagram control board (Note: Currently available only with German language text). This system offers a great deal of flexibility, because it can be changed again and again with no wasted or leftover parts.

Large layouts often have staging yards like the two on the Bietsch Valley layout. Here we are talking about several parallel sidings out of view on a layout, under a

2. Most of the freight trains are operated with the locomotives doubleheaded, a simple assignment for the engineers thanks to Märklin Digital.

3. The steel bridge is especially impressive from above.

mountain for example. They are entered through tunnels or from entry tracks hidden in the background. Staging yards serve to store trains that are temporarily not needed. They can also be used to simulate traffic to a distant station, whereby a train disappears into the tunnel and "releases" another train that appears from the tunnel, as if the route goes further beyond it.

Staging yards are perfectly suited for automatic operation. Their tracks should be at least as long as the longest train in operation on the layout. This ensures the greatest level of flexibility in the use of the tracks.

Automatic control is very easy to implement with the Memory route controller (see page 71). Large layouts become considerably easier to operate with the Memory. It standardizes recurring operating procedures from block control to the routes entering a station.

Up to 4 Memories can be used on large layouts. This means that you have the opportunity to store 96 different route programs, thus allowing you to safely operate layouts of a size that would be unmanageable with pure manual controls. The Memory also enables an automatic interlocking feature that recognizes intersecting routes and if desired blocks them. In this way the Memory contributes to safety on the layout in a very effective manner.

Digital Power Requirements

Add up the power requirements of your trains, locomotives, lights (don't forget turnout lanterns and signal lights!), and solenoid accessories, and provide plenty of power, because the following also applies to the wiring, track, and rail joints on your layout: There's always a bit of power loss. Even with the most carefully laid track and wiring you will experience a little voltage drop. The longer the distance to the transformer, the more important it is to have additional feeders at as many points as possible. If you've ever had a conventional layout and tried to do without additional feeder connections, and have tried to reverse a locomotive at a distant location on the layout, you know why it is penny-wise and pound-foolish to try to save on the number of feeder tracks or feeder connections.

Each motor and each light bulb requires a specific amount of electrical power. The total power from all users turned on at the same time must be provided by the transformer and processed by the central unit. The tables near this text give guidelines that you can use to figure the power requirements for your layout. This will enable you to determine whether the central unit and its transformer are sufficient for your power requirements or whether you need additional power (Boosters and their transformers). If the latter applies, then you must determine how many Boosters you need (this also depends on the power available from the transformers you are using), and how you can best divide your layout into two or more power circuits.

Power output for transformers and central units. The electrical power from transformers is given in VA (volt-amps). The equivalent unit "watt" (W) is better known: 1 VA is approximately the same as 1 W. The following listing of maximum power provided by current Märklin transformers shows that the greatest possible power requirement for a medium size layout with two powerful transformers is as high as that for two medium size household light bulbs, namely 104 watts.

Different power specifications for transformers result partially from different test regulations for different countries. This applies, for example, to the 6001 transformer. Each Märklin transformer is equipped with a safety circuit that shuts the transformer off when the latter becomes too warm. This thermal switch reacts rather slowly, however, so that as a rule the safety circuit in the central unit shuts off first.

Maximum power output for central units and Boosters

The power output indicated for the central units depends on an input voltage of about 16 volts AC. All central units and Boosters have practically the same power output. Each one has an overload safety circuit built in that limits the power output to values of about 2.5 amps. If the layout draws a greater level of current for a few seconds, then the overload protection shuts off the outputs for the central unit and all Boosters. This prevents damage to the digital components and all locomotives and cars on the layout. The power output for the transformers is somewhat higher than that for the central units, since the latter have their own power requirement.

The power specifications for conventional transformers are clearly lower than those for the digital transformers. The power capability of the central unit or a Booster cannot be utilized one hundred percent with a conventional transformer. For that reason you are more likely to experience the transformer shutting itself off due to thermal overload.

Power Requirements for Different Users

The power requirements for different users can only be estimated, because there are considerable differences in individual groups of items. To calculate the total power requirement, you must add up the total of the components and light bulbs, multiplied by each one's power requirement, that will probably be on constantly. Any lights or other users powered by their own transformer do not have to be included in the calculations.

A train with four lighted cars draws as much current as the locomotive pulling the train. When doing your calculations, only one solenoid accessory needs to be included, because only one can be activated at a time in the Digital system. Older signals and turnouts with somewhat baulky mechanisms need a maximum of up to 10 VA. If four locomotives in operation are in the same power circuit at the same time, it is possible that the output of the transformer supplying that circuit may not be sufficient for clean activation of the solenoid accessory.

Dividing the layout up into separate power circuits. If the total of your power calculations adds up to more than 40 to 45 VA, then you should set up a second power circuit with a Booster, more than 90 VA, then two additional power circuits, and so on. Each Booster must have its own transformer. Each power circuit must be isolated electrically at all transition points to other power circuits. It is not always easy to determine how to divide the layout up into several power circuits. A starting point is the maximum conceivable number of trains in a particular area of track. You should divide up the power circuits so that no more than four, at the most five, H0 locomotives are in operation at any one time in a power circuit. Standing locomotives need only one to two VA if the headlights are on.

Compared to conventional layouts, the separation points between power circuits do not have any particular technical operating significance, since the digital data are available in all power circuits. There are effectively no limitations on locomotives and powered units. If the solenoid accessories are being controlled digitally, then it's an advantage on large layouts to assign the k 83 and k 84 decoders to their own Booster with its own transformer, especially if many of these solenoid accessories are lighted. About every 30 lighted turnouts or signals should have their own Booster with its transformer. Alternatively, the lights separated beforehand from the solenoid mechanisms can also be connected to their own transformer.

If you have four digital accessory controllers connected on a large layout, then the central unit should, if at all possible, not be used for a power circuit. It should only be used for the digital control panel.

If you don't have a large layout yet, but are planning on building one, then you should plan for later expansion. Separate the power circuits when building the layout, feed power to them through their own feeder tracks, but wire the feeder tracks in parallel with each other. When the time comes to divide the layout into several power circuits, all you have to do is divide the feeder wires among the power circuits without the need to take up track to put in feeder tracks or third rail insulators for the separation points.

Effective Wiring

Only one current flows on a model railroad, if the power circuit for the layout is closed. Neat, reliable wiring is therefore an important prerequisite for the working of a model railroad layout. This is especially important for digital layouts.

The yellow wire from the "L" socket or terminal on the transformer supplies the track current to the layout. It conducts the current to the central unit which links the digital data with the current and sends it out over the red wire and the feeder track to the third rail in the track. From there the current flows through the pick-up shoe to the decoder. This electronic circuit processes the data and supplies the motor with sufficient voltage to enable the locomotive to travel at the desired speed. The decoder also interprets commands for the direction of travel and for turning the auxiliary functions on or off. When the current has powered all of the users on the layout, it flows through the locomotive frame, wheels, the running rails, and the brown wire back to the central unit and the transformer.

The question of reliable connections comes up right when you're plugging the transformer into the wall outlet. You'll probably need several outlets for your

4. The bridge is located between two tunnels. Since the layout can be disassembled into four parts, you can get an interesting view from the tunnel.

layout. It's advisable that you use a power strip with a master power on/off switch to plug all of transformers into since you usually have to disconnect the transformers from the household current for much electronic work, even for something as simple as connecting another locomotive controller to the digital control panel. Having a power strip with a master on/off switch that you can flip to turn off power to the control panel and layout is easier than having to unplug all of the transformers one by one and then plugging them all back in again.

The next place where bad connections can pop up are the multi-pin connectors between the central unit and locomotive controllers on the right and the Keyboards on the left. Of course, the first connection is usually quite reliable. For that reason, however, this contact point soon disappears out of the "internal" memory for possible weak spots, and after a period of intensive operation, the controllers may jiggle slightly out of position and come loose. For this reason you should always connect them together with the small plastic clips that come with each digital control component.

The next source for contact problems is the terminal clips on the central unit.

Component	Consumption
H0 locomotive in operation (single motor)	5 to 10 VA (depends on motor / loads)
1 Gauge locomotive	15 to 20 VA
Locomotive headlights	approx. 2 to 3 VA
Smoke generator	approx. 5 VA
Light bulbs (cars, buildings, turnouts)	each approx. 1.2 VA
Unlighted solenoid accessory at the moment of actiovation	approx. 5 to 10 VA
Turntable (unlighted)	approx. 10 VA
Rotary crane	approx. 5 VA
Digital locomotive controler	approx. 1 VA
Digital accessory controler (average)	approx. 1 to 2 VA

One of the most impressive bridges in Europe stands on the south ramp of the Lötschberg Railroad. Between Ausserberg and Hohtenn this route crosses the Bietsch Valley 90 meters / 295 feet above its floor on a 136 meter / 446 foot long, spidery looking steel truss bridge that is situated between two tunnels. This bridge was built in 1912 and was
designed from the outset for double track operation, but was initially used as a single track bridge. It was not until 1986 that the Bern Lötschberg Simplon Railroad (BLS) instituted double track operation between Ausserberg and Hohtenn. With changing the bridge very much externally, the BLS reinforced the its design to enable it to take heavier loads. Anyone wandering along the high mountain path that parallels the BLS south ramp into the Rhône Valley and crosses the Bietsch Valley bridge, can still visualize how this masterpiece originally looked.
The Faller model of the Bietsch Valley bridge is suitable for both single and double track operation. With a length of 1.10 meters / 3 feet 7-5/16 inches) it is not exactly to scale length for 1:87, but this is not serious, because you would have to make some compromises anyway in any re-creation of the scene. Even in Z scale it would be impossible to reproduce the mountains in the background to scale. When the Faller model is placed 60 centimeters / 24 inches above the valley floor in front of 1.40 meter / 5 foot mountains, you have a nice visual reproduction of the dimensions of the real thing.
You should be less ready to compromise with the locating of the route. Faller designed its model straight track. However, in the prototype the track goes over the bridge in a gentle curve. If you shorten the beams on the load bearing side each by 6 millimeters / 1/4 inches, then you can lay two lengths of K Track flex track on the bridge with a radius of 2.20 meters / 7 feet 2-5/8 inches - around 2 meters / 6 feet 6-3/4 inches. If you cut less material off, you can have a more sweeping radius; if you cut more material, then you must be content with a tighter radius. Simple trial and error will tell you what dimensions are required to fit the intermediate girders and the track supports together. The center part of the bridge, the pillars and the supports are assembled according to the plans. The kit for the bridge includes extensive instructions showing each step in detail.
Planed wood strips are best for the benchwork on the layout, since they can be assembled into a sturdy foundation. Profile boards made of plywood are fastened to the wooden strips, and openings are cut into them for the right-of-way. These profile boards give the first indication of what the scenery will look like. Since plywood has a tendency to warp, the small strips of wood should be glued or screwed to the profile boards to stiffen them.

1. View of the girder supports for this immense bridge.

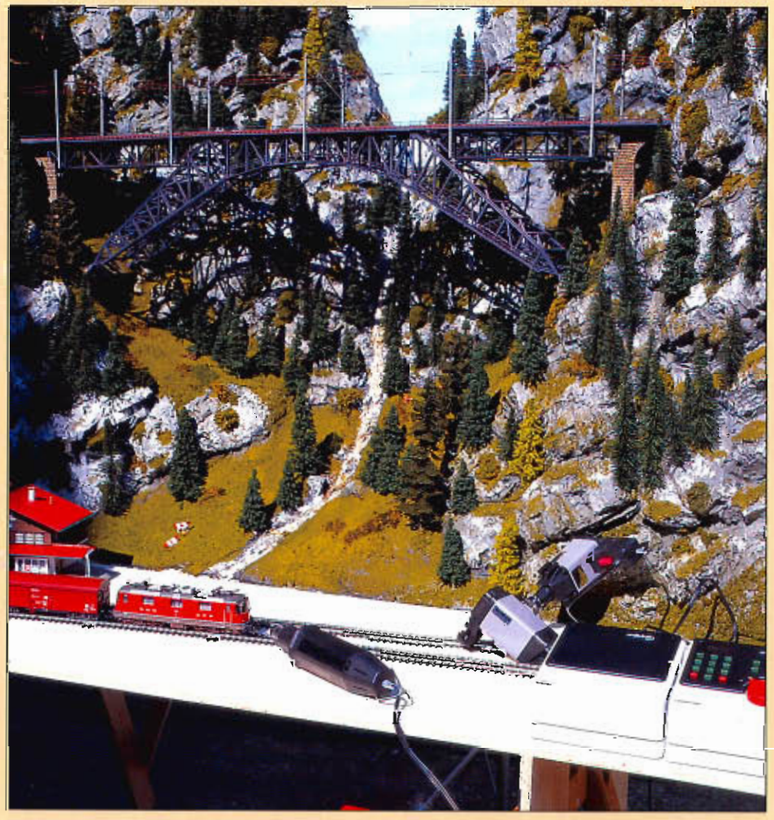
2. Lush vegetation in the shadow of the bridge.

Once the plywood boards supporting the bridge pillars and supports are mounted, the bridge can then be fitted into the benchwork. Now you should carefully look at this part of the layout from different perspectives: Do the proportions agree with each other? Does the model fit harmoniously like its prototype into the surrounding scenery that is now becoming recognizable in a rough outline? Are the pillars and supports firmly attached to the benchwork? If the answer to all of these questions is yes, then work can begin on the scenery. The first thing to do are the tunnel portals. Using an enlarged photo of the prototype, trace the outline of the portal onto a piece of plywood and cut it out. Now the tunnel entry is cut into the portal so that two tracks with catenary will fit. A board is glued on the backside to act as stop for the tunnel liner, and a thin layer of modeling compound is applied to the front. When the compound has dried, a pencil is used to lightly draw the contours for the rocks and the curve of the tunnel portal. An awl, a screwdriver with a blade that has been ground down, and a wire brush with brass bristles are used to carve the rockwork; this work goes more quickly than you would think. The tunnel portals are colored using thinned oil paint or Plaka paint (a kind of flat paint similar to latex paint) and are then fastened along with the bridge to the framework. A weight test can be done with several Märklin metal locomotives, the class 460 advertising locomotive, and several loaded freight cars. This large model bridge must be sturdy enough to take the weight of long, heavy freight trains with locomotives doubleheaded (a daily occurrence on the BLS) without the plastic parts of the reproduced steel construction sagging.
Current Swiss prototype catenary is built using double "T" mast hangers or "H" profile masts from Sommerfeldt along with this
manufacturer's hangers and wire. If you are not comfortable building your own catenary, then you can use ready made masts. You will have to make some compromises, since no one produces masts modeled from those used by the BLS and SBB and on their routes. It's worth a try building your own. After the first two or three masts are finished, you'll see how fast this kind of scratchbuilding goes.
You can give your imagination free rein in the final detailing of the scenery. You don't need to count the exact number of trees, measure the cliffs or calculate the angle of a slope. The real model railroader learns to recognize the important details and to reproduce them in such a way that the result is harmonious, flowing scenery.
There are two methods equally suited to use for forming the final layer of scenery. The easiest is to tack or staple aluminum screen wire to the profile boards and then cover it with modeling compound. After the latter has dried, you can carve the cliffs with a small chisel and a sharp modeling knife and then apply a uniform gray color to the result.
Casting cliffs in plaster gives better looking results. While the cliffs are drying, staple or tack screen wire to the profile boards. Now fit the cliffs into the scenery and use plenty of gray paint to color them. The plaster is a porous material and will absorb the wet paint. If you don't use enough paint right from the start, you will end up with very light looking cliffs when they have dried. Usually all you have to do is put on a second coat of gray, so that the rockwork looks realistic. A thin wash of black paint that will collect in the crevices is applied to the surface and

3. The rough framework already gives a clue as to the dimensions of this part of the layout.

immediately wiped from the very top surface of the scenery with a moist rag; this will add depth to the model mountains.
The small stream is modeled using casting resin. The bed for the stream must be absolutely watertight, because the casting resin is extremely thin and will flow into every crack. Noch (or other makes) grass, bushes and trees are applied to the gentler slopes, and where ever possible, the slopes are planted with forests to form a natural protection against avalanches for the right of way crossing the gorge. Pine trees from Noch as well as spruce trees from Heidi look very good here. Planted at random on the grass, the different sizes of trees look as if they had grown there naturally. Some trees stand at a slight angle, while the trunks of others are slightly bent. Basically trees try to grow as straight as possible towards the light. A forest of small, stunted groups of trees is just as unrealistic as a grove whose trees stand in neat rows resembling the pine trees of a single family housing tract planned on a drawing board. Flocking material from Noch is applied to those parts of the scenery still open. A couple of hikers out for a walk on the BLS mountain path round out the scene at the Bietsch Valley bridge.
The final layout will also include the Blausee-Mitholz station and two staging yards. The latter are reached via the track spirals from Menninghaus. The complete track plan for the "Bietsch Valley" Märklin digital layout can be obtained for a modest charge from the Modellplan Company at Tannenstrasse 8 in Göppingen, Germany (see ads in the Märklin Magazine for full address and phone number.

4. Tools from Böhler (or similar makes of small power tools such as Dremel) and digital components are already present for further construction.



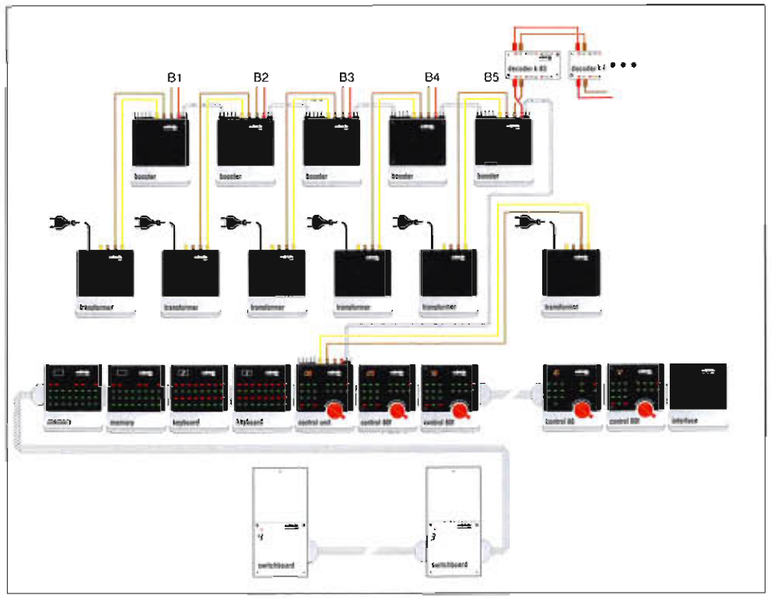
The wires connected to them should have about 8 mm / 1/4" of insulation stripped from them and the copper strands of wire should be twisted before you press them into the terminal clips; only the bare wire should be inserted into the hole on the terminal clip. How often do you look all over your layout for a problem that is interrupting operation, just to find that a wire was inserted into the terminal clip down to and including the insulation thus keeping the current from flowing to the layout?

If you are not sure about the presence of condensers beneath M or C Track feeder tracks on an existing layout (with K Track this component is clearly visible externally between the terminal clips on the feeder track), there is a way to test for them. To do this, first remove all power consumers from the track. Then disconnect the red track power wire and connect a standard model railroad light bulb between the feeder track or feeder wire set and the central unit. Enter the locomotive address 40 at the digital locomotive controller. If the light bulb does not light up, then everything is in order. If it does light up, then you must clip one lead on the condenser on the feeder track from the latter unit. If there are several power circuits on your layout, then you should test each feeder track using this method.

The Ring Circuit

With power circuits larger than a certain size you can and should use several feeder tracks or feeder wire sets, especially with digital operation. Current conduction through rail joiners is not so smooth as through a wire, because voltage resistance in the track joints must be overcome. This voltage resistance can lead to the previously mentioned condition of locomotives slowing down and becoming quite sluggish at distant locations on the layout.

A ring or loop circuit under the track (i.e. in the roadbed if you are using C Track) or under the benchword is a solution. This circuit should consist of a red and a brown wire, and should form a true ring or loop, i.e. it should not just be two long wires to the other end of the layout. The advantage of such ring circuits is that almost every spot on the layout can have a direct connection to the track power. Areas of track between two signal blocks, for example, can be supplied with power in this fashion. The following applies as a general rule of thumb: Feeder connections should be made every 2 to 3 meters (7 to 10 feet) and at every grade.



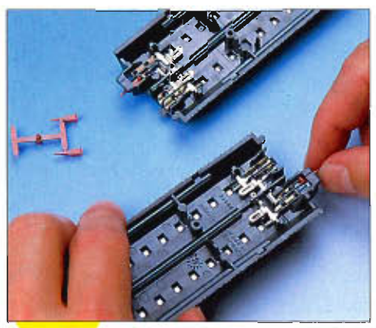
5. Example of digital controls (for locomotives and accessories) for a large layout.

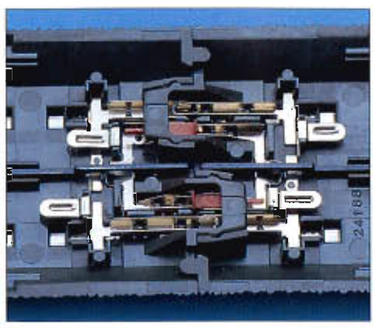
In principle, turnout and signal decoders can also be integrated into the ring circuit, and with small and medium size layouts this is also the easiest way to handle them. A better method for these decoders - and with carefully laid wiring also easier to manage - is to set up a separate ring circuit for them. When expanding the layout, you can then power the decoders quite easily with their own Booster and transformer with no other conversion work necessary.

It is best not to use catenary for digital operation. Since the digital impulses are comparatively short, very short interruptions in the current conduction in the catenary can disrupt the data. You don't have to do without catenary, which is after all a part of electric locomotive operation. Even if the electric locomotives are operating off of the track, you can still run them with the pantograph(s) raised. You can also run conventional electric locomotives from the catenary with a conventional transformer, while the digital locomotives are supplied with power through the third rail in the track. The ground return for both systems will run through the running rails of the track with no problem at all.

All Märklin H0 model railroad layouts have a special advantage with the third rail system: There is a precisely defined, common ground. All ground return connections can be connected together with no problem at all. As the example above with a digital third rail in the track and with conventional catenary, this even applies to mixed layouts with digital and conventional components. A "central" ground return should be installed on a model railroad layout in the interest of manageable wiring. The brown wires for all of the transformers, central units, and Boosters should be connected to this central ground return. The Märklin 7209 distribution strips with their sockets for 11 plugs are perfectly suited for this task.

6 & 7. Insulating the third rail on C Track.





This does not mean that you should run a single "thick" ground return wire around the layout and connect all brown wires to it. It's better and more manageable to use separate ground return wires for each power circuit. This will decrease the probability of unexpected secondary effects. If a power circuit is not correctly connected to the ground return, this can result in bad connections through the rails.

As a rule signals receive their ground connection directly from the track by means of the metal base plates. This ground connection only applies to the lighting for the signal; the solenoid mechanism for the signals is independent of this ground return. If the lights for a signal are not on, then it's quite probable that the ground connection is at fault. This ground connection can also be made with a wire, if you do not want to use the base plate or if the latter can't be used (for example, if the signal mechanism is to be installed below the baseboard). The base plates included with the semaphore signals are designed for M Track (but can also be used with C Track, while those included with the color light signals are designed for K Track. With C Track the ground connection can also be made with the 74040 wire set.

Manageable Wiring

There are a couple of rules of thumb about wiring a model railroad layout that you should definitely take to heart. A model railroader pro can lay wiring in such a way that a glance under the layout can be a real eye opener, but the amateur should also adopt certain principles of organization in this area. Otherwise, some day he will at his wits end trying to troubleshoot a problem. Always adhere to the Märklin color scheme for wire and plugs. It has been proven over decades of model railroading tradition, and all of the components are designed at the factory for it:

- red = track current
- brown = ground
- yellow = accessory or constant current
- blue wire, red plug = activation current to set a turnout to the branch, or a signal to red
- blue wire, green plug = activation current to set a turnout to the straight track, or a signal to green
- blue wire, orange plug = signal to yellow/green
- gray wire, gray plug = used for connections to the contacts on the s 88 feedback module, for example.

On small layouts with M or C Track you can get by with a minimum of wiring with only two wires (red and brown) to the track. Then, each solenoid accessory must have its own installation decoder put into it.

Always lay the wires belonging together in pairs (or in threes for turnouts and signals) next to one another; i.e. a separate red and brown wire to each feeder track and decoder.

Use separate loop circuits for each track power circuit and to supply power to decoders. These should be installed as closed circuits.

Build in additional connections in the loop circuit for the decoders. This will enable you to connect other decoders easily later on.

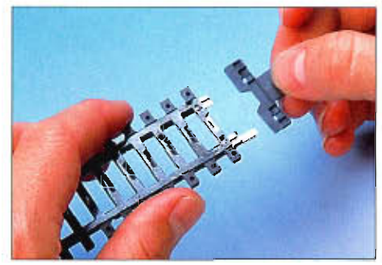
Make your wire connections and junctions carefully. For example, from an electrical and mechanical point of view it does not make sense to connect more than three plugs together through their side sockets, because too many plug connections will produce a certain amount of voltage drop or resistance. It is better to use the 7209 distribution strip when you have a large number of wires to be connected together.

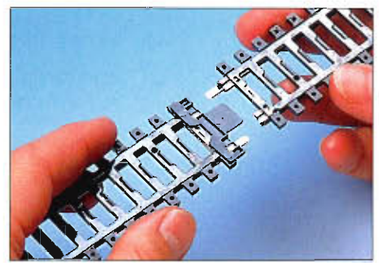
Do not let the wires hang loosely under the layout. Mount them in place with electrical wire staples or with small wire clamp style mounts. If the wires are joined together with plugs and sockets, then allow enough slack in the wire before the joint to relieve tension on the joint and to allow you to disconnect the plug from the socket by hand.

Draw up an overview plan of your layout that includes the location of all feeder tracks and all center rail isolation points, all decoders, and all feedback modules. Write the numbers of the power circuits next to them. Set up a numbering system for all of your wiring. First, number all of the power circuits consecutively. For example, designate your track power circuits with "B-1" (red), "0(B)-1" (brown), "B-2", "0(B)-2", etc. The accessory / constant current circuits would be named "L-

13. Right: An added detail for the layout: The three most frequently used colors of yellow, brown and red are being delivered appropriately by rail.

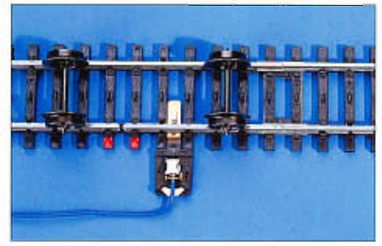
12. Below: Plugs and wires in the appropriate combinations.

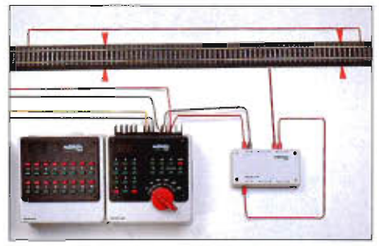




8 & 9. Insulating the third rail on K Track.

10. Bellow left: Contact track. One of the two running rails is electrically insulated. The insulated rail is connected to ground through the metal axles.
11. Right: A track block with the k 84 decoder, as would be used in a staging yard.





1" (yellow) (from the "L" above the terminal clips on the transformer, central unit, and Booster), "0(L)-1 (brown), etc. Mark the wires with small adhesive labels. If possible, set the addresses for your digital accessory controllers in consecutive order. Here too, you should affix adhesive identification labels in the depressed areas on the upper left corner of the components.

If possible designate your decoders with a number that starts with the number for the accessory controller assigned to that decoder. Decoder 2-4, for example, would be the fourth decoder for accessory controller number 2.

With the decoders especially mark the address set on that decoder on the decoder housing. To give you total manageability, you can also mark the pair of buttons on the accessory controller assigned to that decoder on each set of output sockets on the decoder, or mark the consecutive number for the solenoid accessory.

Pick a consecutive numbering system that makes sense for you and number the turnouts and signals accordingly. It's best if you use a clear combination of the controller address and the pair of buttons on that controller for an accessory as a number for each accessory. If you are controlling the solenoid accessories from a computer program through an Interface then you should also mark the consecutive solenoid accessories from 1 to 256 on the decoders.


SF
SF

Operating Locomotives Digitally

Digital locomotive controllers must always be connected on the right side of the central unit. A central unit can control up to ten locomotive controllers. A locomotive controller built into the central unit, such as on the Control Unit, or an Interface for a computer connected to the system must be counted as locomotive controllers.

In principle up to 80 locomotives can be run independently of each other on a layout. The speed and direction of the last unit called up can always be adjusted or changed at a locomotive controller. Despite this a single locomotive controller is sufficient to control several locomotives on a layout - the speeds must be set one after the other in this situation.

A digital locomotive controller does not need a direct connection to the track, since the former transmits all data to the central unit. The latter processes the data and sends it to the track and Boosters.

Connecting a digital locomotive controller to the control panel.

Before connecting a digital locomotive controller to the control panel, all of the transformers on the layout must be disconnected from the house current. Then plug the locomotive controller in on the right side of the central unit. Or connect the right (never the left!) multi-pin connector to the multi-socket connector on the left side of the locomotive controller, using a 6038 (180 mm / 70-7/8" long) or 6039 (60 cm / 23-5/8" long) adapter cable.

The various locomotive controllers can be connected to the central unit in any order desired. Only the Interface must be the last unit plugged in on the right side, because rather than a multi-pin connector on its right side, it has a socket for the connection to the computer.

Use the plastic clips included with the locomotive controllers to keep the latter from coming loose from each other. To do this, stick the clips in the slots on the underside of the controllers. The number 99 will light up

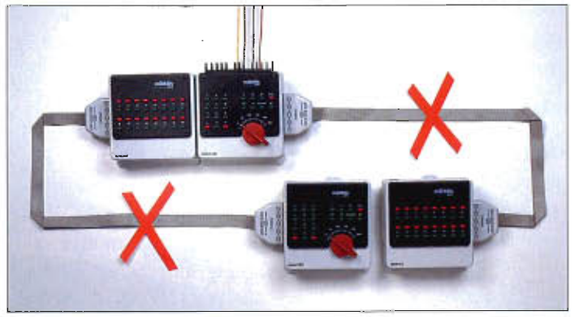
1, 2 & 3. From left to right: Pressing the button F = selecting a Function; pressing the button L = selecting a Locomotive; pressing Reset with "stop" and "go"

on every locomotive controller directly after the power is turned on. This shows that the locomotive controller has been recognized by the central unit and has been switched to the basic status ("automatic reset"). During this process the central unit assigns an internal address to the locomotive controller. This is the reason that a locomotive controller doesn't have coding switches for setting an address.

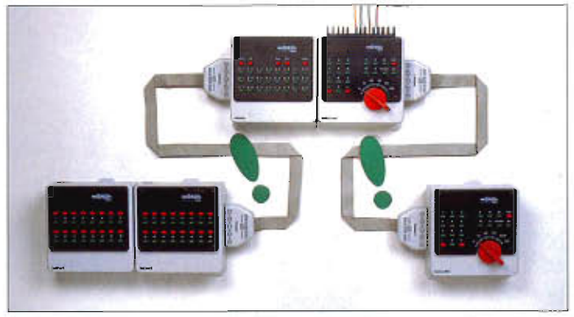
4. Calling up another locomotive with the Control Unit; a locomotive is already being run with the Control 80 f.

The Control 80 f

The standard locomotive controller in the Märklin Digital system is called the Control 80 f. It is suitable for use with all Märklin digital layouts and all central units. The Control 80 f is as easy to operate as the Control Unit: If you want to call up a new locomotive address, the LED by the "L" button must always be on. Usually the "F" button will also be lit up. This shows that the address entered is good for both locomotive and function decoders.



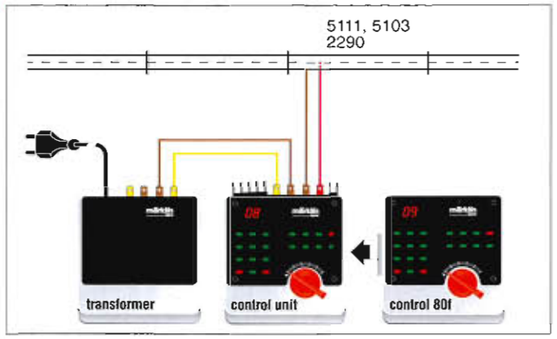
5 & 6. Left: Two control panels are connected at a distance from each other with adapter cables. Please note: At no time should the connections be done as shown! Right: The correct way to connect them; only do it this way!



Always enter the address for the desired locomotive as a two digit number, example: "08". If the number entered lights up constantly in the display, then this locomotive can be operated and controlled. If this locomotive address blinks in the display, then the entry was not correct or the desired locomotive is already called up on another locomotive controller. The control knob on the locomotive controller is used to set speed and direction. A second locomotive can be called up by entering its address on the locomotive controller. You have direct control over the speed and direction for the locomotive last called up on the locomotive controller and whose address is currently shown in the display. The locomotive called up before this one will continue to run at the last speed and with the last direction set for it. In this way up to 80 locomotives can theoretically be controlled with a single locomotive controller. In practice, however, it is too difficult maintain control of more than two or three locomotives with a single locomotive controller.

The auxiliary function for the locomotive is switched on and off with the "function" and "off" button. On most locomotives the auxiliary function consists of turning the headlights on and off, for some it is the smoke generator or TELEX couplers. If you want to activate the auxiliary function for longer periods of time, such as with the headlights or the smoke generator, the "function" button is used to turn it on and the "off". You can have momentary activation of the auxiliary function, such as TELEX couplers, by pressing the "off" button and then releasing it. The red LED by the word "function" on the locomotive controller lights up as long as the auxiliary function is activated.

Pressing the red "stop" button brings all of the trains on the layout to an emergency halt. The current to the track (and to the turnout/signal decoders) is interrupted; this also applies to any Boosters connected to the central unit. The speeds for all of the locomotives on the layout remain in memory storage while the power to the layout is shut off, since the locomotive controllers will continue to be



7. Left: The Control 80 f is plugged in on the right side of the Control Unit.

8. Right: Control 80 f

supplied with power from the central unit.

Press the "go" button within two minutes to continue operations. All of the locomotives will resume running at the last speed and in the last direction set for them.

If you press both the "stop" and "go" buttons simultaneously, this will reset the entire system back to its basic setting. All locomotives in operation will come to a stop and all data from the locomotive controllers and the central unit are erased, i.e. the direction for each locomotive reverts back to forward and the speed for each unit goes to zero. This is the same condition as when the layout is first turned on. The four buttons marked "f1" to "f4" are used to activate additional auxiliary functions for the locomotive. These buttons are required for turning on the long distance headlights on the class 101 electric locomotive or the sound effects circuit on the class V 200 diesel locomotive. Pressing one of the buttons switches the function on, pressing the button a second time turns the function off.

The functions above will work only if you are using the 6021 Control Unit as a central unit. Older central units in conjunction with the Control 80 f locomotive controller or the Interface can **only** be used to control working models such as the crane, dance car, or digital vista dome car. The buttons "f1" to "f4" or appropriate commands from a computer through the Interface are used to do this. They **cannot** be used to control the auxiliary functions on newer locomotive decoders. The functions on these newer locomotive decoders can only accept commands that have been "processed and converted" by the 6021 central unit.

As mentioned above, the buttons marked "f1" to "f4" are used to activate working models such as the dance car. A function decoder address must first be entered before operating these models. The red LED above the "F" button must be on when entering the function decoder address. The LEDs above the "F" and "L" buttons will both light up after a digital layout has been turned on or after a reset. This means that an address entered on a locomotive controller is valid for a locomotive decoder and for a function decoder. It is possible, however, to select the addresses for locomotive and function decoders independently of each other. To do this, press the "F" button and enter the address for the function decoder as a two digit number.

If you want to call up another locomotive, then press the "L" button and enter the new locomotive address as a two digit number. The function address previously called up will remain called up. You can operate the function buttons, while the locomotive address is shown in the display on the locomotive controller. The function decoder address will reappear in the display when you press the "F" button.

The Control 80

The Control 80 locomotive controller (6035) is the predecessor to the Control 80 f. Its functions are for the most part the same as those of the Control 80 f. It lacks, however, the ability to control function decoders.

The Control 80 can be used on all Märklin digital layouts and with all central units; it is also possible to use it in mixed operation with the Control 80 f or other digital locomotive controllers (example: Interface).

The Control Unit

The Control Unit has the same face as the Control 80 f; it combines the functions of a locomotive controller with that of a central unit into one unit. You operate it in the same manner as the Control 80 f; it is described in detail starting on page 45.

Tips And Ideas For Operating Trains

Almost every Märklin layout, large or small, with exceptionally realistic scenery or with just an indication of a railroad scene, has all sorts of operating potential. When the layout is being operated with Märklin Digital, the operating enjoyment is almost limitless. It becomes possible to make prototypical use of locomotives for switching work or in a maintenance facility. Extensive wiring circuits are no longer necessary, because several locomotives can be controlled independently of each other on a track while others stand still. The reliable Märklin coupler system with its preuncoupling feature on the RELEX coupler in the HOBBY program as well as the on the close coupler is very helpful for this sort of operation. In addition, some locomotives have the exclusive TELEX coupler that allows trains or cars to be uncoupled automatically from the locomotive at any location on the layout.

On The Hump Track

Many switch yards in the prototype have a hump track for directing cars into exit tracks. Trains arrive at the entry tracks and are uncoupled from the road engine that either goes to the maintenance facility or to the waiting area for trains leaving the yard. A switch engine pushes the cars slowly up the hump track. Shortly before the crest of the hump track, most of the cars are uncoupled from one another. Some remain coupled together, because they will be assembled into the same train that is leaving the yard. The switch engine now slows down more and pushes the cars over the crest of the hump track, where they roll either separately or in groups into different exit tracks. On modern switch yards in the prototype, the cars roll over computer controlled routes to the appropriate spot. Their speed is measured with radar units and the former is corrected by acceleration or braking systems in the track, before they bump into cars already waiting on the track.

When a train has been completed on an exit track, a road engine is coupled to it and pulls it out onto the mainline to the next junction point.

On a model railroad layout the hump track is not so restricted in its use as in the prototype, where, for example, most passenger cars, some special cars and freight cars with hazardous loads may not be operated over the hump track. The hump track can be used to good effect in the model, too, to assemble trains. Its slopes should be somewhat steeper than in the prototype, since the cars are obviously not as heavy and the inertia to be overcome on the hump track is therefore greater. It also helps to improve the rolling characteristics for the cars by cleaning dirt and fibers from the axles and by oiling them well but not too much.

The group of exit tracks should begin right at the bottom of the hump track. This group of tracks should be at least three tracks long. A group of entry tracks doesn't have to be installed, if the situation on the layout is plausible enough to suggest that the train to be broken down on the group of exit

1 & 2. (Above and right) The switch engine pushes the freight cars over the hump track; an uncoupler track is located on the latter.

The cars roll into the exit group of tracks where they are pushed together by a V 60 equipped with TELEX couplers.

tracks has come from a "virtual" group of entry tracks.

If an uncoupler track is installed on the crest or on the descending slope of the hump track, it won't matter which coupler the locomotive comes with. If, however, the uncoupler track is installed before the hump track or on the ascending slope of this track, then the switch engine should be equipped with a RELEX coupler.

The train of cars to be sorted on the exit tracks is now pushed slowly over the uncoupler track and up the hump track. The couplers are separated by pressing the button for the uncoupler track on the Keyboard. As soon as a car has passed over the crest of the hump track, it will begin to roll on its own, driven by gravity, until it rolls onto the track predetermined by the corresponding setting of a turnout or route circuit. If you want to be precise about this operation, you can have a signal at the crest of the hump track that is set for "stop", so that the locomotive engineer knows he is not to push any more cars over the crest. The next car isn't pushed over the crest until a new route has been switched for it. The Memory (see pages 70 to 77 etc.) is quite suitable here for large group of exit tracks.

At the end of the descending side of the hump track are the train's cars on the various exit tracks. Ideally, they are already even coupled together from rolling together - if not, the switch engine helps after pushing them over the hump, or the road engine carefully pushes them together in the act of picking up the train.

The hump track is essentially a domain of coupler technology. In the prototype a brakeman stands with a long lever just before the descending slope and separates the couplers, the brake hoses and any other lines having already been separated.

The "digital" in this account is that the switch engine can stop its work, while the road engine picks up a train on an exit track, or while another switch engine readies the next train to be pushed over the hump track. Or the road engine - in our example the V 200 - is already coupled to the train, but its yard signal is still set for "stop", because the switch engine is still picking up a car from another track to couple to the train.

If our switch engine is equipped with a TELEX coupler, it can set out the sorted cars in any way on the ladder tracks, since it doesn't need an uncoupler track to separate itself from the train. Also, in transferring a car to a train, the switch engine doesn't have to stop at an uncoupler track at every spot after finishing a switching maneuver.

Switching Games

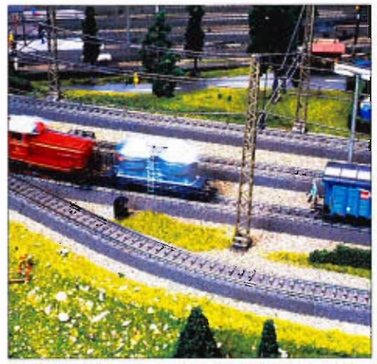
Here the locomotive equipped with TELEX couplers can do what only a few locomotives can do in the prototype - uncouple from the train by remote control at any spot on the layout. Even without TELEX couplers

3. On a neighboring track the V 200 is starting up a train that has already been assembled.

Märklin has a bit of an advantage over the prototype: The model railroader can to a large extent automate his freight train operations by strategically placing the standard uncoupler tracks around the layout. Despite decades of searching for a solution, European railroads have still not agreed on a standard system of automatic couplers, so that the classic screw type coupler will probably be a standard feature - with a few exceptions - of freight operations. Brake lines and lines for lighting must be joined by hand, and the coupler loop on one car must be placed over the hook of another car, before the train can be run on the main line. Automatic, center buffer couplers of different designs are used only on a few ore trains and on powered railcar trains such as the class 420 S-Bahn commuter train and the ICE. Technicians have installed an automatic coupler loop on some switch engines that has at least partially automated coupling in switching work. As a rule, however someone must go between the cars and perform the necessary work by hand or from the side of the car with a long lever.

In our example of switching operations, a class 260 diesel switch engine in the classic red paint scheme comes with a cement car that is to be coupled to a freight train. The engine goes past the train on a parallel track, switches to the track the train is on, pushes the cement car towards the train until the former couples with the latter, and then uncouples from the

4. Freight trains are made up on several tracks, while passenger trains can go by independent of this activity.



5, 6 & 7. Above from left to right: The freight train with a V 200 at the point has another car coupled to it. A V 60 with TELEX couplers carries out this task.

former by remote control with a press of the TELEX coupler button. The brakemen stand next to the track with nothing more to do and think perhaps about the future of their jobs.

If two cars with the standard preuncoupler feature are to be uncoupled without the help of an uncoupler track, then the best thing to use is what the prototype does: a long lever. It doesn't have to be several meters long in the model: 15 to 25 centimeters (approx. 6" to 10") will do. Push the lever under the couplers so that it works like the ramp of an uncoupler track, it raises the coupler loops and thereby uncouples the cars. Wood or plastic are the best materials for this lever, because then there is no chance of a short circuit if it should touch the third rail. If you use a screwdriver and if the coupler has a ground connection (on older cars with a metal frame this is always the case), then there will be a short circuit the moment you touch both the coupler and the third rail with the screwdriver. In the best case scenario there will be a few sparks, you will jerk the screwdriver back in surprise, and the situation takes care of itself. Most of the time you won't notice it until the circuit breaker in a transformer or central unit turns the power to the layout off. Then you'll have to wait a few minutes before resuming operations.

If you don't pull the cars apart after uncoupling them, then you can push them further down the track as a unit. The preuncoupler feature will keep the couplers from reengaging. When you arrive at the desired siding, stop the locomotive, and the uncoupled car will roll further down the track and into the siding.

In A Maintenance Facility

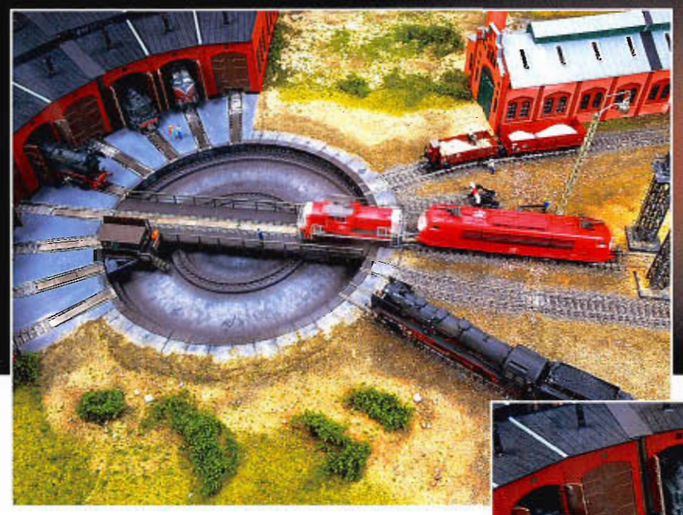
"Ladies and Gentlemen, due to a malfunction of the locomotive the "Danube Courier" Express will be delayed 20 minutes. We apologize for this interruption in our service." Announcements like this did not become a daily occurrence on the railroad just in the 1990s. When a proven piece of motive power reaches a certain age and the repairs start to mount up, but not enough replacements are coming from the builders, there will be times when this locomotive gives out on the main line.

In this switching game, this is what has happened to the passengers on the "Danube Courier", one of the German Railroad's traditional express trains that was being pulled by a V 200. The two 1,100 horsepower motors are silent - an operating condition you can also experience on a Märklin digital layout with the new model (item nos. 33803 and 37803) as well as its opposite, because this locomotive also has prototypical motor sound effects as an auxiliary function. Perhaps power to the cars in the train has also been interrupted.

To the irritation of the railroad officials, all our small town yard can offer is a steam locomotive facility; the trip will have to be continued with a steam locomotive at the head of the train. This locomotive is first fired up: headlights on, meaning the digital address for the locomotive has been called up at the locomotive controller, and the smoke generator has been turned on. In the meantime the brakeman in the yard has uncoupled the V 200 from the train, a 260 switch engine with TELEX couplers is coupled to the front of the locomotive and pulls the latter away from the train. In the prototype the locomotive would now be switched to running with no load; with Märklin Digital the locomotive must be called up and given some power, otherwise its wheels would not turn. Then the switch en-

9. Page 53. Lots of activity on the exit group of tracks in the switch yard. While several steam locomotives are still waiting for the order to depart, a freight train is already in motion.

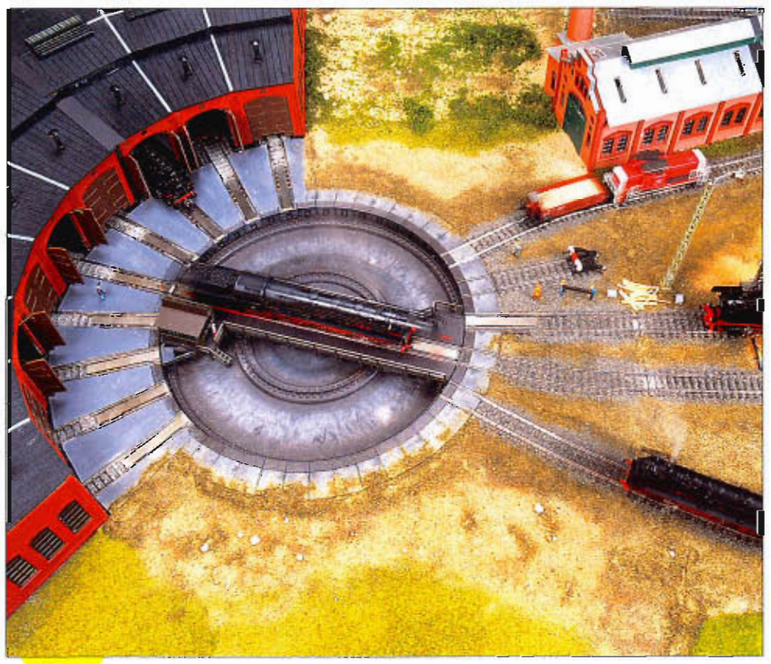
8. Below: The car is coupled to the train, and the switch engine goes onto a siding.



10. Above: There's always something going on at a railroad maintenance facility. The turntable provides a lot of operating enjoyment at the locomotive sheds.

11. Right: Now and then an electric locomotive comes here. It's a lot of fun to do the switching work, even though it becomes very precise work.

12. Below: A steam locomotive leaves the roundhouse to pull the "Danube Courier", while another locomotive is already waiting in front of the turntable.

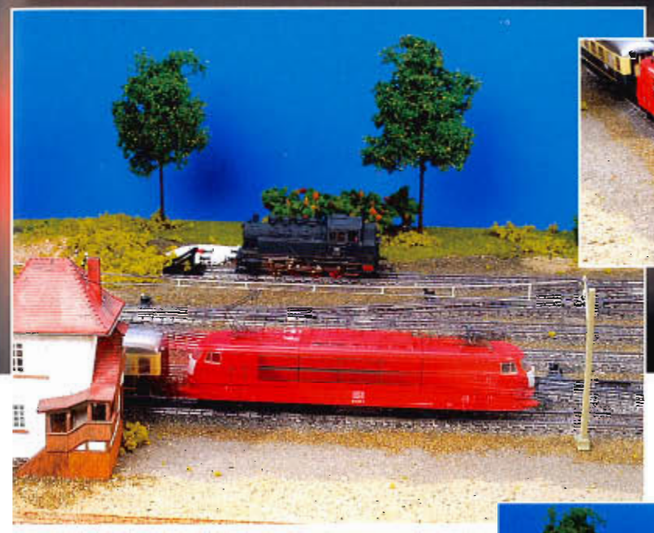


gine pushes the heavy diesel locomotive onto a siding next to the locomotive shed in the maintenance facility.

Fortunately a repairman is found who is familiar with diesel locomotives from having previously worked at a repair shop for these units, and he is able to go over the locomotive to determine its problem. In the locomotive shed the class 81 tank locomotive is waiting for its final check. The 260 can take care of other assignments until the 81 has left the shops.

Finally it's ready: The 81 slowly steams out of the shed in the direction of the freight yard, the 260 is coupled to the V 200 again. It pulls the V 200 back over the turnout and then pushes it into the locomotive shed, while the express steam locomotive moves in the direction of the station and the "Danube Courier". Here you have four locomotives that are running at different speeds simultaneously on a single power circuit.

The steam locomotive now runs past the express train on the parallel track, over the turnout, and then carefully backs toward the



13, 14 & 15. The catenary comes to an end on a section of the main line due to construction work. A V 200 is put in front of the electric locomotive to pull the express train along with the 103 (with its pantograph lowered).

train. While the brakeman is occupied coupling the locomotive to the train, the loudspeaker announces: "Caution on Track 1! The delayed "Danube Courier" is departing. Please board the train and close the doors!" The train begins to move with a powerful chuffing sound from the steam locomotive's cylinders. In the meantime, the locomotive shop repairman is tracking down the problem with the V 200.

In general railroad maintenance facilities are good examples of how to exploit the many operating possibilities of the Digital system. Initially, only locomotives operate in the maintenance facility area, and the individual locomotive handling stations are so close to one another, that in conventional operation you would need complicated isolation and feeder wire setups in order to reproduce realistically the operating movements of individual locomotives. In the Digital system, by contrast, the multi-train operation feature allows several locomotives to be handled in steps "as on an assembly line" without additional aids. One locomotive will have its ashes dumped, while the other is taking on water. With tank locomotives this happens more often, because they are not able to carry as much coal and water as their big brothers with tenders. This procedure is probably not over, as the locomotive that just dumped its ashes goes over to the coaling station. Another locomotive needs fresh sand for braking, and a fourth has to be oiled and lubricated.

Perhaps the coaling station also has to be replenished at this time. A switch engine pushes two loaded cars under the crane at the coaling station. An express locomotive for the express train in the station is driven out of the roundhouse onto the turntable - quite slowly and under the watchful eyes of the hostler. Due to its length the locomotive just fits on the turntable. The turntable deck squeals and screeches (only in the prototype?) as it turns, until the locomotive is pointed in the right direction at the appropriate exit track. Turntables are not there just to allow access to the different parts of the locomotive sheds; they also serve to turn locomotives in the right direction. As a general rule, locomotives with tenders can run faster forward than in reverse, aside from the fact that it's more comfortable for the locomotive engineer.

As in the prototype, locomotives must be moved carefully in the maintenance facility area, because unlike the main line with its signal protection, not every track in the maintenance facility area is protected from locomotives or trains entering it from other tracks. For critical situations Märklin Digital provides the "emergency brake application" in the form of the "stop" button on the locomotive controller. The "stop" button allows you to stop everything on the layout completely. After that set the speed control knob to the zero position and call up the locomotives in the affected area one after the other. After that you can press the "go" button. The locomotives may inch a little at the previously set speed before they stop, but bad accidents can be avoided in this way.

A model railroad locomotive engineer has to perform precise work in fractions of an inch or in millimeters, when he has to bring a locomotive in need of repair plus a switch engine onto the turntable. In our case we're talking about a class 103 electric locomotive requiring repair that is being pushed by a 260 switch engine with TELEX couplers into the locomotive sheds. With the switch engine in the front, both locomotives move onto the turntable deck and fill up the length of the latter down to the last millimeter or fraction of an inch. The deck is turned until the express locomotive can be pushed into the roundhouse. There the 260 is uncoupled with the TELEX coupler and leaves the steam locomotive maintenance facility. This is an operation that is actually possible only with Digital (barring some sort of conversion of the locomotives), since two locomotives must be operated on the short length of the turntable deck. Even if they are coupled together, the locomotive at the front (even if it is acting as a unit needing repair) should run a little faster than the one in back in order to prevent derailments.

16. Above: A new switching job: A mail car is being added to the express train that has just arrived.

17. Right: The road engine uncouples from the train and moves forward. At the same time the V 60 also starts moving.

In A Passenger Station

Let's suppose that your station is on the border in the western part of Germany, for example. There it's a common occurrence to change locomotives at the border, because most locomotives are not equipped for different catenary power systems. Or perhaps it's a station with catenary in only one direction of travel.

Such a situation is also conceivable on the main line: The catenary is interrupted due to a storm that has blown trees onto the wires. Although the worst damage has been cleared away and the tracks are usable again, the catenary has not been put back up everywhere. So, one area of the track must be operated with diesel locomotives. Märklin Digital can help here: The electric locomotive with the express train stops before the end of the catenary. Now its pantograph must be lowered. At the same time a diesel locomotive is coupled in front of the electric locomotive and pulls it along with the express train through the area of track without catenary. The diesel is then uncoupled from the train at the next station. All in the same power circuit.

Perhaps there are several cars for the Regional Express at this station that provide a connection to the next station on the branch line. After being uncoupled from the express train (while the electric locomotive for the latter raises its pantograph again), the diesel locomotive can be used to haul the Regional Express with its transfer and regular passengers to the small towns along the branch line. At the same time a switch engine on a parallel track can be readying the next train. If it has TELEX couplers, or if an uncoupler track has been installed in the right spot at the station, then the switch engine can spot the train on a siding automatically.

The next express train arriving in this station has a through car whose destination is also the small town. It can be uncoupled in the station, either by hand or with an uncoupler track built into the station layout. The switch engine pulls the through car from the express train and couples it to the commuter train. Later the road engine is coupled to the train and hauls the train and its passengers to their destination. It's also quite possible that in the meantime an ICE has breezed through the station.

Not so long ago the railroad regularly transported the mail with its express trains. As long as the mail car was standing on a track in the station, you could drop letters in a slot on the side of the mail car. Postal workers sorted the mail in the mail car during the train's trip. Large cities had their own yards and station buildings for the mail.

In the photos (pages 56 to 57) the express train is arriving at the switch yard, while the 260 diesel locomotive has been coupled to the mail car in the separate yard for mail cars. It has not stopped, because the brakeman has al-

18. Above: The V60 couples the mail car to the train and....

19. Right: .... then goes to the next train to switch a tank car.

20. Left: Now the express train can continue its trip.

21. Above: While the ICE accelerates again, the arriving freight train slows down.

22. Right: The class 460 locomotive waiting to be added to the train....

ready uncoupled the express train from the locomotive, and the V 200 moves forward to a waiting position. Now the switch engine can couple the mail car to the front of the train by pushing the former onto the appropriate track where the train is standing, couple it to the train, and then uncouple from the mail car with the TELEX coupler. Now the road engine backs up to its train, couples to it, and then resumes the trip.

Doubleheading And Pusher Service

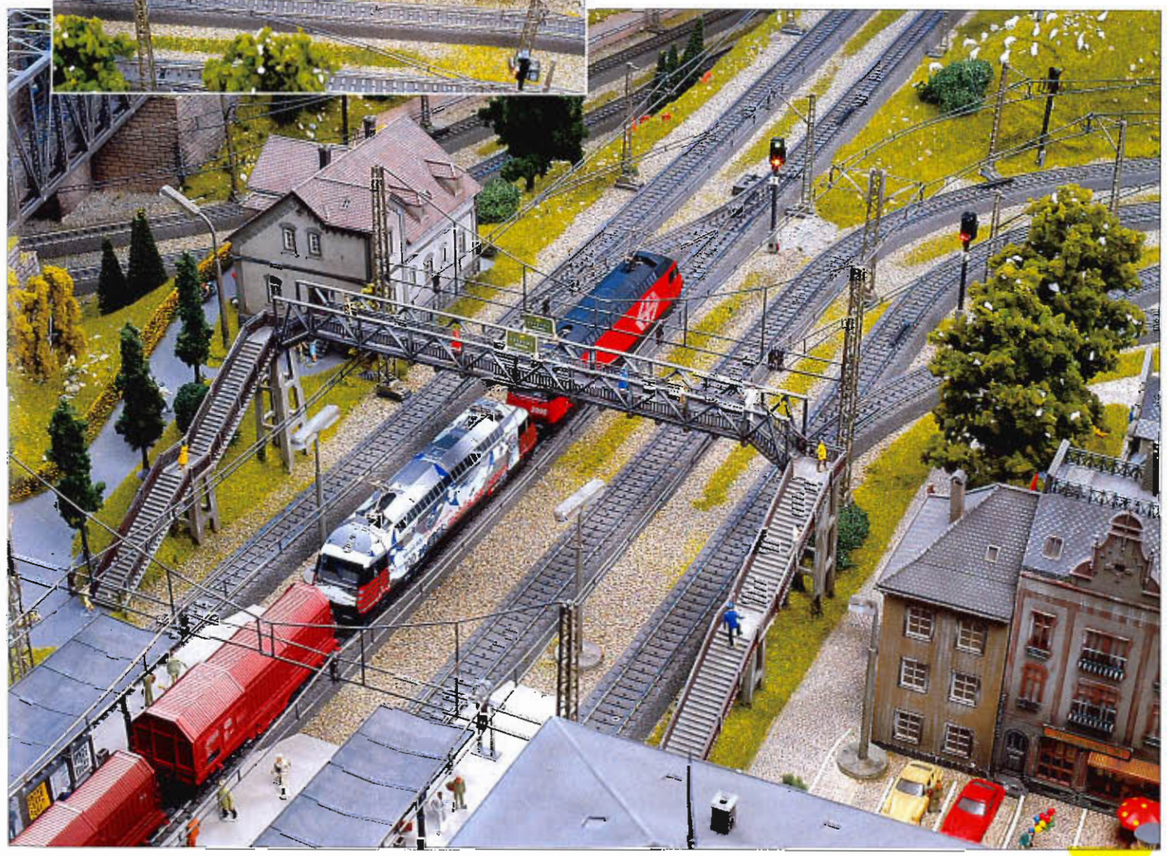
Not every train is able to climb long grades under its own power. In the early years of railroading the railroad would therefore separate the trains at the last station before the grade and run the two halves one after the other up the grade and reassemble them into one train at the top. A prominent example of this is the Orient Express going up the Geislingen Grade in the Swabian Alb mountain region. This can also be reproduced quite easily in the Digital system. The really interesting thing about such grades is actually the second phase that was practiced for decades on many steeply graded routes in the German Mittelgebirge (Middle Mountains) region: doubleheading or pusher locomotives helped the trains over the mountains. This type of service became superfluous only with the coming of the latest, powerful generations of locomotives. For example, railroad fans still remember the example of the pusher service by the class 194 up the Spessart grade on the route from Frankfurt (Main) to Würzburg. Doubleheading is required - despite the latest locomotives - on the most important alpine routes. Our example shows such a situation that can be seen daily on the Gotthard route or on the Lötschberg Railroad.

This scene can also be seen being played out in the era of the steam locomotives: A specially heavy freight train comes into a valley station and stops. The great steam locomotives, the German Federal Railroad and German State Railroad classes 44 and 50, were designed for such trains, but they were forced to take on help for some grades. Locomotives were used for this that were coupled to the back of train and provided pusher help. We recommend taking the couplers off the front of the pusher locomotive and the end of train. In this way the locomotive can simply slow down at the end of the grade - thanks to Märklin Digital - and separate from the freight train. With a fine touch you can also do this with a locomotive with TELEX couplers. The latter are activated when the end of the train reaches the crest of the grade and the pusher locomotive's speed is carefully decreased. This type of operation is, of course, best enjoyed when there are others operating the layout with you.

Passing maneuvers are practiced on upgraded routes and new routes as well as at stations designed for this type of operation on the German Railroad and are also possible in the Digital system. But, you must have a large layout for long passing tracks. The slower train goes onto a siding and slows down but does not stop. The faster train passes it without slowing down and is gone by the time the slower train reaches the end of the siding. The slower train goes back out onto the main line.

23 & 24. Above & left. ...for doubleheading starts to move to the front of the train and is coupled to it.
Now the two locomotives are ready to pull the train up the ramp.

25. Below: The second locomotive is now coupled to the train, and now the heavy freight train can start up the mountain grade, with prototypically slow acceleration, of course.



Working Models

The face of the Control Unit and the Control 80 f looks different in several respects compared to the first generation of Märklin digital components. Four buttons have been added to the controls and are located above the speed control knob. They are lettered "f1" through "f4". Under the keypad for entering addresses are two other, red buttons marked "L" and "F". In addition to controlling the main auxiliary function on locomotives and powered railcars, you can now operate other functions on locomotives and powered railcars or on cars with working functions; the latter are not self-propelled but have operating features well beyond the classic example of loading and unloading.

Several years ago Märklin gave an indication of the possibilities for such working models with two units that are described below. Locomotives presented by the factory in 1997 with several auxiliary functions show that this was not the end of this development. This is by no means the full range of possibilities, and we can only wait with anticipation to see what the designers come up with. In the beginning there were two working cars that were designed to be one-time series and are therefore no longer in the program. They have a function decoder whose principle was described earlier in this publication. The buttons "f1" to "f4" are used to activate these cars. One of the cars is simply called the "dance car" by model railroaders, although it is lettered on the outside for "Entertainment Car". To get the dance party going in this car, you need a Control 80 f and either a Control Unit or a 6020 Central Unit. The dance car is permanently coded for decoder address 20. When you call this address up, the LED over the "F" button must be lit up. The four function buttons have the following meaning:

- ❑ f1: ceiling lighting on/off;
- ❑ f2: five dance couples twirl on the dance floor or remain standing;
- ❑ f3 on, f4 off: plays the current piece of music;
- ❑ f3 off, f4 on: switches to the next piece of music;
- ❑ f3 on, f4 on: all six pieces of music are played one after the other;
- ❑ f3 off, f4 off: music is turned off.

The second working model of this type is the 4999 vista dome car. Its decoder is

3. The waiter serves the passengers in the vista dome car at the press of a button (above) ...

4. ... while the couples in the "dance car" whirl to the sound of different pieces of music.

1. Headlight changeover on the SBB Re 4/4 II: ...

2. The marker light shows up in the lower right (below).

permanently coded for decoder address 10. A waiter serves passengers in the vista dome part of the car. It may not always happen so easily in real life, but here it can be demonstrated as an example to follow: The waiter comes at the press of a button and remains standing at the table, also at the press of a button. In addition, the table and ceiling lights can be turned on and off. The function buttons for this car have the following meaning:

- ❑ f1 on, f2 off: waiter goes forward;
- ❑ f1 off, f2 on: waiter goes back;
- ❑ f1 on, f2 on: waiter remains standing;
- ❑ f1 off, f2 off: waiter remains standing;
- ❑ f3: table lights on/off;
- ❑ f4: ceiling lights on/off.

Since then a new digital decoder has opened up the possibility of additional digital functions on locomotives that go beyond controlling the locomotive's headlights. On the 37371 model of the class 101 long distance headlights can be operated as well as the standard headlights with their change over feature. For decades most locomotive engineers on the German railroads had only the three light headlight system that at night lighted up only a very small portion of the track ahead of them. This is still the case with most locomotives, and to understand why you must remember that the braking distance for an express train or heavy freight train running at its normal speed is considerably longer than the distance that headlight systems of reasonable cost can light up. In addition the railroad operated from the principle that the already high level of safety in railroad traffic could not be improved on to any great degree by long distance headlights. Since then locomotives have become quieter and much faster, so that it seemed advisable to make them more noticeable with better lighting. In addition, increasing speeds have hampered the engineer's subjective impression of the track ahead of him; with standard headlights he could hardly see anything at night. Long distance headlights could only help improve this situation. On a model railroad such long distance headlights really make an impression during "night time operations", and Märklin is now building this auxiliary function into locomotives.

You have to be a Märklin Insider to enjoy the second locomotive model with two auxiliary functions: This is the Insider model of the class 52 steam locomotive with a condensation tender. The class 52 "wartime locomotive" was built in large quantities and was used all over Europe until recently for heavy freight service. This variation of that class was designed for areas with poor water supplies where the water carried in the tender for the boiler had to last as long as possible, because supplies along the route were so uncertain. The steam was piped back to the tender instead of being allowed to escape through the smoke stack and other openings in the running gear. In the tender immense fans cooled the steam so that it condensed back into water that could be used again. The fans are very easy to see from above. This is the reason why Märklin decided to provide the fans on the Insider model of the class 52 with a special motor and to make them a digitally controlled auxiliary function.

The third new locomotive model with additional auxiliary functions is available to everyone. This is the no. 37803 model of the classic V 200 diesel locomotive. As with the "dance car", this model comes with sound. At the press of a button the two 1,100 horsepower diesel motors for the V 200 can be heard starting up: The digitally controlled sound effects circuit makes it possible. It's up to the model railroad builder to build noise barriers so that the residents of the model railroad villages can still get their nightly rest. We haven't heard of any complaints yet; on the contrary the demand for more locomotives with many auxiliary functions is greater than ever. After the success with these first three locomotives, you can be sure there will be more.

The functions on the new 37371 and 37803 digital locomotives can only be operated if your layout is equipped with the 6021 Control Unit, because only this central unit can work with the new decoder. You can also activate these functions from a Control 80 f that is connected to the Control Unit. The new functions are controlled with the four buttons marked "f1" to "f4". Pressing one of these buttons turns a function on, pressing it a second time turns it off.

Older central units such as the 6020 Central Unit or the Central Control included in earlier starter sets cannot be used to activate the auxiliary functions in newer locomotives. Although the commands can be sent from these central units, these new locomotive decoders will not understand them. The new decoders will respond only to commands that have been "translated" by the 6021 Control Unit.

Older central units can, however, can be used in conjunction with the Control 80 f locomotive controller or the Interface to control earlier working models such as the crane, dance car or vista dome car. The buttons "f1" to "f4" are used to do this.

The working models function only if a function decoder address is entered. You know that such an address is entered if the red LED over the "F" button is lit up. The LEDs for both the "F" and the "L" buttons will light up when a digital layout is turned on or after a reset procedure. This means that an address entered on the keypad is simultaneously both a locomotive and a function decoder address. It is possible to call up locomotive and function decoder addresses independently of each other. To do this for a function decoder address, first press the "F" button and then enter the address as a two-digit number. If you want to call up a locomotive, first press the "L" button and enter

5. Like the class 101 electric locomotive,...

6. ... the 128 001 has additional long distance headlights.

the locomotive address as a two-digit number. The function address previously entered will remain set. You can activate the function buttons, while the locomotive address is shown in the display field. The function decoder address will show up in the display again by pressing the "F" button again.

Operating Accessories Digitally

The Digital Accessory Controller

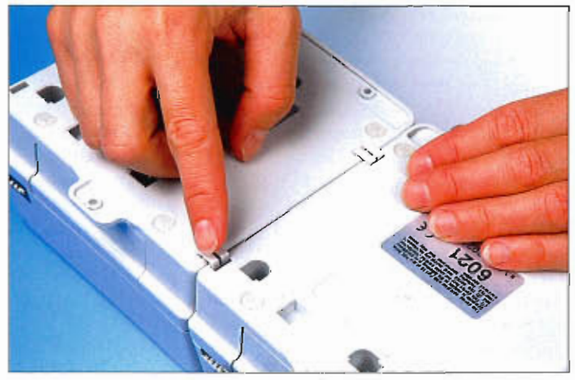
Digital accessory controllers must always be plugged in on the left side of the central unit. With the Märklin Digital system a total of 16 accessory controllers can be connected to the central unit. Four coding switches are set on each of them with one of 16 possible accessory controller addresses.

There are a total of 16 times 16 = 256 addresses for solenoid accessories or for continuous current users. In contrast to a conventional layout, on a digital layout the solenoid accessories and continuous current users are not connected directly to a controller. A decoder must be wired in between that converts digital signals into conventional switching impulses that are required by solenoid accessories, for example. All of the decoders only need to be connected through a so-called ring or loop circuit to a digital power circuit. This reduces the amount of wiring in comparison to a conventional layout. The inclusion of a decoder allows a digital accessory controller to operate solenoid accessories as well as continuous current users such as lighting circuits or motors.

Keyboard (6040)

The standard accessory controller in the Digital system is the Keyboard. It can be used with all Märklin digital layouts and central units. The Keyboard contains 16 pairs of buttons, each pair consisting of a red and a green button. One of the 256 possible addresses can be operated with each pair of buttons. A double or two single solenoid (example: uncoupler tracks) accessory or a constant current user can be switched with a decoder. A red LED is assigned to each pair of buttons. It lights up when the red button in the pair is pressed. The last setting for all solenoid accessories remains stored in the Keyboard when the layout is shut off.

1, 2 & 3. The Keyboard is plugged in on the left side of the central unit and is fixed in place with clips on the bottom of the units.



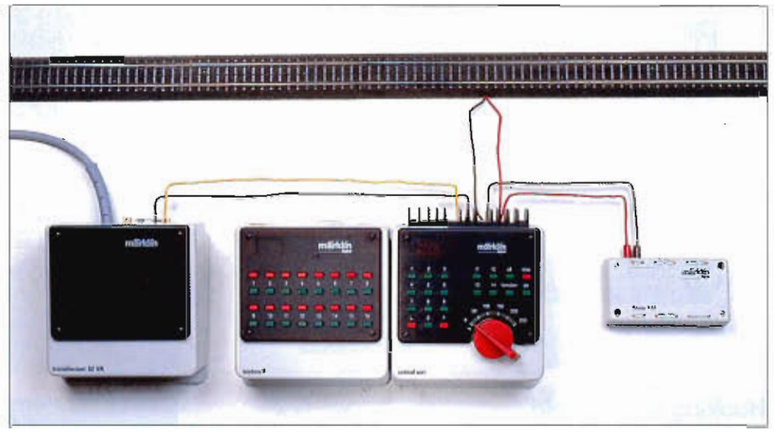
Connecting the Keyboards to the digital control panel. All transformers must be disconnected from the household current before connecting a Keyboard to the digital control panel. The Keyboard is plugged either directly into the left side of the central unit or into the left side of a Keyboard already connected to the central unit. If an accessory controller must be placed at a distance from the central unit, then it can be connected to the multi-socket connector on the left side of the latter, using a 6038 (180 mm / 70-7/8" long) or 6039 (60 cm / 23-5/8" long) adapter cable. This is a good solution if several people are going to operate a larger layout.

It doesn't matter which order the individual accessory controllers are connected to the central unit, as long as there are no more than 16 controllers. The plastic clips included with the controllers should be used to connect them together and to keep them from coming loose by accident. To do this, the clips must be inserted into the slots on the bottom of the controllers.

Setting the Keyboard address. Each of the Keyboards must be given its own address with the four coding switches on the back of the unit; this will enable the central unit to distinguish the Keyboards from one another. The table on page 63 shows which switch settings give which of the 16 addresses for the accessory controllers.

The order in which the Keyboards are connected to the central unit is independent of the addresses that have been set for the units. The addresses used do not necessarily have to follow one another in sequence. For example, four Keyboards can be

4. Connecting a k 84 decoder to the Control Unit



5. Right: Setting the Keyboard address with the four coding switches on the back of the unit

set for the addresses "2" - "1" - "3" - "4". However, such a sequence can easily become unmanageable. A label with the address set for a unit can be affixed in the rectangular depression in the upper left corner above the buttons.

If you like, more than one Keyboard can be set for the same address thus allowing you to set up two control panels at a distance from one another. They are then wired in parallel without any additional wiring, i.e. the same solenoid accessories can be operated from each of these accessory controllers. The LEDs will show the setting for the accessories on all of the Keyboards. In this way a Keyboard and a track diagram control board connected to a Switchboard (6041) can be wired in parallel. Don't forget that the total of 16 accessory controllers connected to the central unit must not be exceeded because of the power limitations.

Up to four k 83 or k 84 decoders (or a mix of four) can be addressed by each Keyboard. A decoder address must be set on each decoder that corresponds to the Keyboard address. The way to do this is shown starting on page 64.

The Keyboard is very easy to operate. To a large extent it's the same as the conventional 7271, 7272, 7273, 7274 control boxes. Pressing a red button sets a turnout for "branch", a signal for "stop", a light circuit or a motor for "off", or an uncoupler track for "uncouple". Pressing the green button of the same pair sets the turnout for the "straight", the signal for "go", a light circuit or motor for "on", or a second uncoupler track for "uncouple".

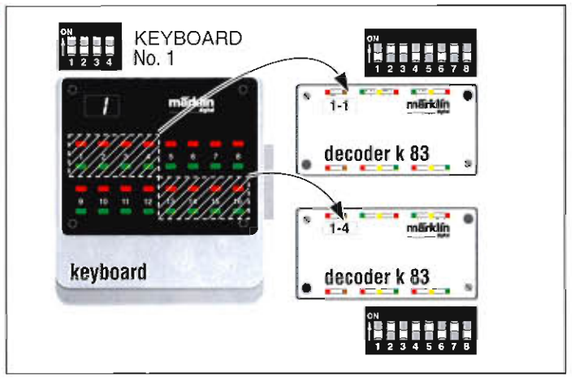
Of course, the buttons correspond to these functions only when the units mentioned above are correctly connected to the decoder. Correct connections for the k 83 decoder are described on the following page and for the k 84 decoder starting on page 68. A red LED will light up over a red button after the latter has been pressed; when the green button belonging to that pair is pressed the LED goes out. For better manageability it is best not to number the decoders consecutively. It is better to number them in such a way that the Keyboard the decoder is assigned to is also included in the number for the decoder. For example: decoder "1-4" is the fourth decoder for the Keyboard with the address 1. From this you know without any great calculations that the last four pairs of Keyboard buttons, i.e. those with the numbers 13 through 16, on the first Keyboard accessory controller are assigned to this decoder.

Controller Address	Coding Switch ON
1	– – – –
2	1 – – –
3	– 2 – –
4	1 2 – –
5	– – 3 –
6	1 – 3 –
7	– 2 3 –
8	1 2 3 –
9	– – – 4
10	1 – – 4
11	– 2 – 4
12	1 2 – 4
13	– – 3 4
14	1 – 3 4
15	– 2 3 4
16	1 2 3 4

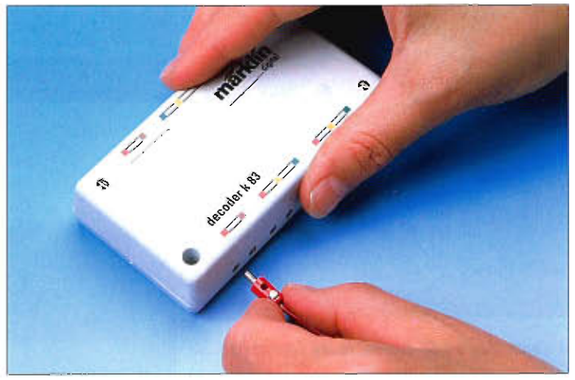
Connections To The k 83 Decoder

Each decoder is connected to the central unit or a Booster with a red and a brown wire. These two wires provide power for both the decoder itself and the solenoid accessories or other users connected to them. For that reason the decoders should have their own connections (red and brown wires) directly to the central unit or to a Booster. Of course, it's possible to take power from the track for the decoders, but we don't recommend it, because the many rail joints in the track generate a higher voltage resistance than a wire. If one or two solenoid accessories are to be activated, the voltage in the track may not be sufficient for trouble-free operation. Each decoder has two each red and brown sockets. Another decoder can be connected to the second pair of sockets.

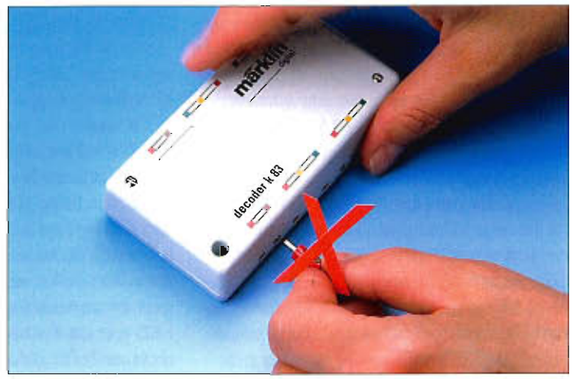
6 & 7. Pressing the green button sets the signal for "go", pressing the red one sets its for "stop".



8. Above left: Relationship between Keyboard and decoder addresses



9. Above right: Correct connection for the red plug into the socket marked in red



10. Left: Incorrect connection

Hooking Up Solenoid Accessories - M and K Track

There is an entire series of different turnouts in the Märklin program. The method of hooking up all of the solenoid accessories to the decoders is basically the same. The yellow wire with a yellow plug goes to the socket marked in yellow, the blue wire with a red plug to the socket marked in red, and the blue wire with a green plug to the socket marked in green. In the Digital system the yellow wire for a solenoid accessory must always be plugged into the yellow socket on a k 83 decoder. It must never be connected to the yellow socket on a transformer. This can result in damage to a decoder's output.

In principle it doesn't matter which of the four outputs a solenoid accessory is connected to. Before hooking anything up, you should be clear in your mind, however, about the sequence of the outputs, so that you assign the right buttons on the accessory controller to the output.

An important piece of preparation work before hooking up a solenoid accessory applies to conventional layouts as well as to digital layouts: test the turnouts and signals before hooking them up to the layout. It's quite irritating to have to track down a problem days or even weeks after installing something. Make it a general rule to test every solenoid accessory before hooking it up to the digital layout. To do this, attach the yellow plug to the yellow wire before installing the solenoid accessory on the layout. Plug the yellow wire into the socket marked with yellow on a k 83 decoder. Then alternately hold the ends of the blue wires briefly to the brown socket on the decoder or to any other ground connection. The decoder should of course be connected to the central unit which in turn should be connected to a transformer that is then plugged into the household current again. When you alternately hold the blue wires briefly to the brown socket, the solenoid accessory must alternately change its setting from one position to the other. If this doesn't happen, the problem is probably a bad contact in the wiring or an incorrect address set on the decoder or Keyboard. If you are in a hurry to connect everything up, it's quite common to forget to set the correct address on the accessory controller or on the decoder.

Double slip turnouts (5128, 5207, 2260). All of the switch rails on these Märklin double slip turnouts are set at the same time. For that reason these items have only three connecting wires. They are hooked up to the digital layout in the same manner as standard turnouts: green = straight (crossing over the intersecting track), red = branch (turning into the intersecting track).

The 2275 double slip turnout (with two 7549 electric mechanisms). The 2275 K Track double slip turnout can be equipped with two electric mechanisms. Each of these mechanisms must be connected to its own output on the k 83 decoder. This double slip turnout behaves like two standard turnouts located one behind the other that can be activated independently of each other. Knowing this will explain the wiring plan for hooking this double slip turnout to a decoder.

Three-way turnout (5214, 2270). The three-way turnouts for M and K Track also have two double solenoid mechanisms. For this reason they also occupy two outputs on a k 83 decoder. The best way to handle these units is to imagine them as a right and a left turnout superimposed over each other, with a common straight track. This makes it easier to understand the function of the two electric mechanisms. On the 5214 turnout there is only one, on the 2270 three-way turnout for K Track there are two yellow wires (due to space constraints. You can bundle them together to run them to the decoder. The two blue wires from each mechanism are connected to one of the four decoder outputs.

There is a particular sequence that must be followed when setting these three-way turnouts for either of the branch positions. Following this sequence will ensure reliable operation.

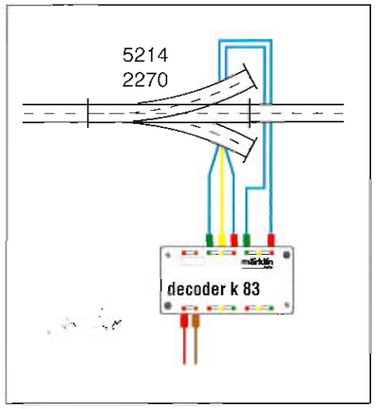
Right:
1. left branch set to straight = green
2. right branch set to branch = red

Left:
1. right branch set to straight = green
2. left branch set to branch = red

Straight:
1. left branch set to straight = green
2. right branch set to straight = green

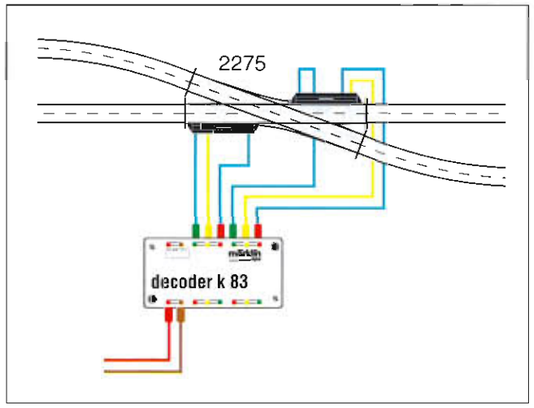
The 2604 pair of turnouts is the same as a 5137 pair of turnouts with built-in digital decoders. It was developed as a complement to the 2610/2612 and 2620/2622 digital starter sets with the Central Control central unit. This pair of turnouts is ideal for small layouts that already have digital operation installed on them, because it makes it easy to set up and change things around on the floor. The addresses for both of the turnouts are permanently coded. For that reason only one pair of the 2604 turnouts can be used on a layout. These two turnouts are set for accessory buttons 3 and 4 on the Central Control; this is the same as accessory addresses 255 and 256 or buttons 15 and 16 on the Keyboard with address 16. (Note: Buttons 3 and 4 on the Central Control units sold in the USA were the same as accessory addresses 3 and 4 or buttons 3 and 4 on the Keyboard with the address 1, and the 2604 turnouts sold there were coded accordingly.) As an alternative conventional turnouts can be converted with the k 73 installation decoder.

The 2604 digital turnouts are simply joined to other sections of track on the layout in the normal fashion. No additional wiring is necessary. The turnouts receive digital data from the third rail in the track.



11. Left: Connections for the 5214 and 2270 three-way turnouts to the k 83 decoder

12. Right: Connections for the 2275 double slip turnout to the k 83 decoder

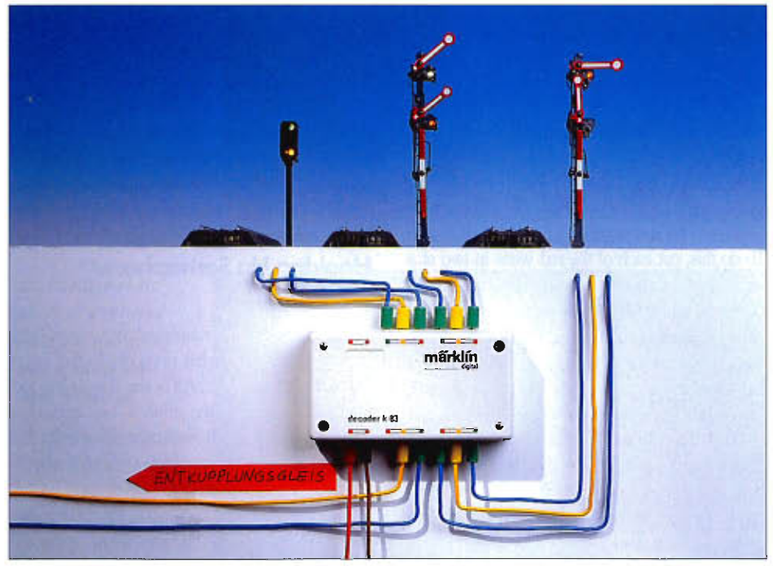


The k 73 decoder (6073) is installed directly into M Track turnouts. It has an output for a double solenoid accessory. The decoder gets its power and its digital data from the connections to the track. A turnout equipped with the installation decoder requires no other wiring. This turnout is simply joined to other sections of track on the layout in the normal fashion and can be operated immediately from a Keyboard. This makes things considerably easier when you are setting up the layout in a hurry or if you make frequent changes to the layout. However, this decoder does not fit into all solenoid accessories and specially not into the K Track turnouts. It should be installed by an authorized digital dealer. Only then does Märklin cover the warranty for the decoder and its installation. The 0308 (0308A in North America) digital book gives a detailed explanation of the installation.

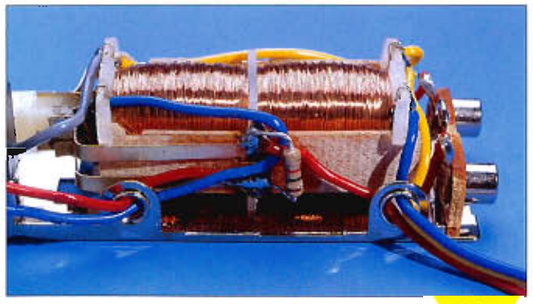
Turnouts for 1 Gauge are connected to accessory decoders in the same manner as the turnouts on an H0 layout. If you are using the Control Unit (6021) as a central unit, then use the k 83 decoder for this purpose. The k 86 decoder is not compatible with the Control Unit, and the k 83 is not compatible with the earlier Central Control 1 central unit. Anyone still using the old 6031 Central Control 1 central unit and the locomotive and turnout decoders for Märklin 1 Gauge that were used with that unit, and wanting to change over to the new technology, should contact Märklin about a special offer for this.

You can keep all of the wiring for signals and signal blocks as it is when changing from conventional to digital operation. There is one small difference between signals wired for conventional and those wired for digital operation. Märklin recommends in general that you add a 1.5 kilo ohm (1/4 watt) resistor between the two track power connections for the signals. Two of these resistors are included with each k 83 decoder. The value for a resistor is usually indicated with colored rings. A resistor rated for 1.5 kilo ohms has the following colored rings: brown - green - red - (silver or gold). The ring colors given in parentheses indicate how precisely the resistance value corresponds to the other rings printed on the resistor. The resistor works in such a way that even when the signal is set for stop a little current is flowing into the block - too little for the train to move, but enough so that the decoder in the locomotive can receive and interpret digital data in the track, even when the signal is set for stop. So, for example, the direction for a locomotive can be changed even if the latter is standing in a signal block before a signal set for red. The resistor keeps the locomotive decoder from losing its "memory" during a long stop in a "dead" signal block in a staging yard, for example.

On newer locomotive decoders the memory storage remains preserved for longer periods of time - several minutes to several hours. On newer layouts these resistors are only necessary in signal blocks if you want to be able to reverse locomotives in blocks with the signals set at stop for any length of time - up to the point the layout is shut off. The same applies to DELTA layouts: the resistor can be left off as long as it's not important to you to be able to reverse locomotives in blocks with the signals set at stop. Without the resistor the speed set for the locomotive also remains stored for a while in the locomotive decoder and, moreover, is repeated at regular intervals by the DELTA Station.



13. Above: Connections to the k 83 decoder for different signals, some of them with several settings

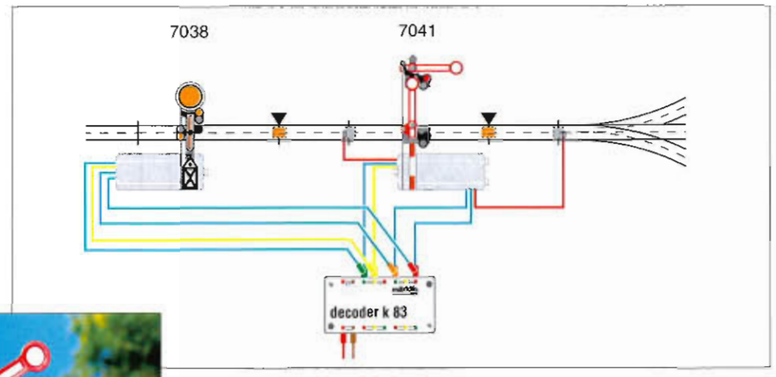


14. Right: Resistor mounted on a semaphore signal mechanism

Installing The Resistor

The most elegant way to install the resistor on semaphore signals is to solder it directly to the switching contacts inside the signal. To do this, carefully take the housing for the signal mechanism off so that the mechanism does not become damaged. Shorten the leads on the resistor and solder them in place.

If you don't feel comfortable doing this kind of soldering work on signals, the resistor can also be attached to the red wires coming out of the signals.



16. Above: Home and advance signal with k 83 decoder

17. Left: Advance and home signal combination installed on a layout

To do this, cut each of the red wires in two at a point several inches away from the signal and attach a red socket (the mating piece to the Märklin plugs) to each of the wire ends from the signal. Now solder one of the remaining ends of the cut red wires to one of the leads from the resistor (about 1/4" from the end of the resistor lead) and do the same with the other lead from the resistor. Attach a red plug to the end of each of the resistor leads and plug each lead into one of the red sockets already installed on the red wires coming out of the signal mechanism.

You can now connect the metal clips on the ends of the red wires to the track as you normally would. With color light signals clip the resistor between the two terminal clips marked in red along with the wires for the third rail connections in the track.

There is no need to clip a resistor to the two other clips. These are connected to a switch for controlling current in a catenary signal block. The two switches in the signal for third rail and catenary are completely separated from each other electrically.

Hooking Up Semaphore/ Target Signals

In principle the semaphore/target signals are hooked up to the digital decoders in the same manner as the turnouts. All home signals and the yard signal also have the ability to turn track current on or off in a signal block, according to the setting for the signal. The two blue wires and one yellow wire are connected like the turnouts to the appropriately marked sockets on a k 83 decoder. The 7039 and 7040 semaphore signals with their two different settings are connected like a simple turnout. The "three-position" 7041 home signal with the settings "stop", "go" and "slow" has three blue wires and occupies two (actually only one and a half) outputs on a k 83 decoder.

The yellow wire is used for powering the solenoid mechanism and the signal lighting. In addition, the signal lighting must have its own ground connection. This can be done in three ways.

- ❑ from the track through the metal base plate;
- ❑ by means of a separate ground wire with a plug (a socket for this is located on the front of the semaphore/target signals)
- ❑ by means of a bare metal connecting wire that is pressed against a metal part of the signal.

The two red wires with the third rail clips are for track current. If the signal is set for red, these two wires are electrically separated. When the signal is switched to green, then the two wires are electrically connected to one another and they direct track current into the signal block. The signal block is separated electrically from the rest of the layout by means of two third rail insulators. The wiring diagrams show this insulator symbolically as a black triangle. One of the red wires from the signal is connected to the third rail inside the block, the other is connected to the third rail in the normal part of the layout. When the signal is set for green, current flows through the contacts in the signal into the isolated block, and a train standing before the signal can then go.

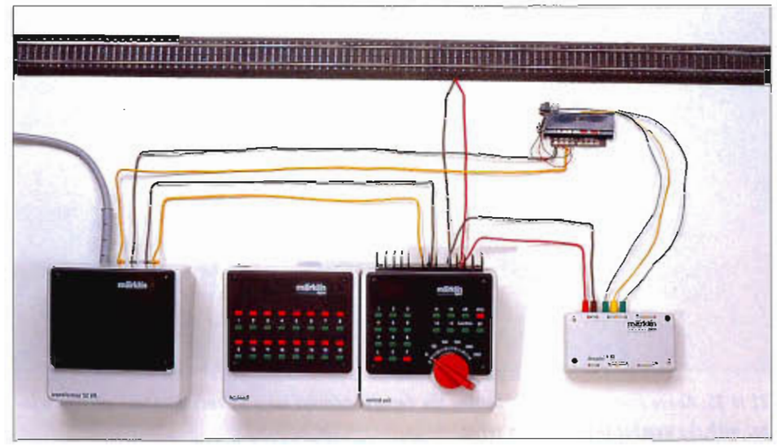
The signal block should be at least two to three standard sections of track in length, i.e. 36 to 54 centimeters (approx. 14 to 21 inches) in H0, so that faster trains come to a definite stop rather than overrunning the block. If several signal blocks are located in the same power circuit, one after the other, without a feeder track installed between the different blocks, then you must not forget to supply feeder wire connections to the track between the signal blocks. This can be done with additional feeder tracks, but you can also do it by running a feeder wire - preferably a red wire - from the area of track with the main feeder track to each of the areas of track between the signal blocks.

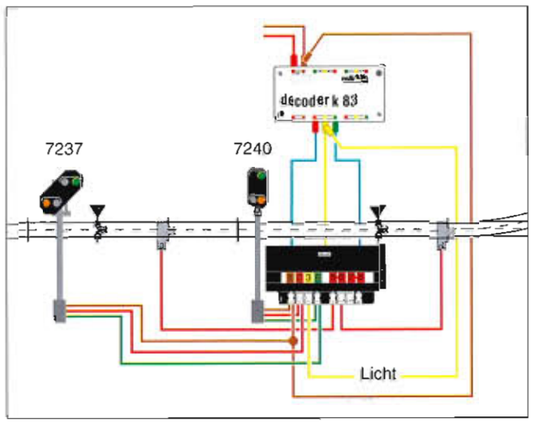
Advance signals. If you are using newer decoders, you can connect an advance signal with its home signal to the same output. On the first generation decoders an output could only handle a single double solenoid mechanism. Here you have to connect and operate advance and home signals separately. As an alternative you can set two k 83 decoders for the same address and connect the advance signal to the output on one decoder and the home signal to that same output on the second decoder. Directions on how to hook up individual semaphore and target signals are given in the instruction sheets included with these units, and special features on using these signals in a digital system are given in the digital book (0308 / 0308A in North America) "Getting Started with Märklin Digital".

Hooking Up Color Light Signals

The Märklin color light signals are frequently used with K Track. For this you need another type of insulator (7522) and feeder connection (7504) for the third rail. Two each of these parts are included with the signals as they come from the factory. Your authorized dealer can get base plates for the color light signals to allow them to be mounted with M Track.

A track current relay is built into all color light home signals. This means you can automatically stop a train in an isolated signal block with the signal set for "red" and start it up again with the "green" setting. The signal lighting can be hooked up to the layout in several different ways. The solenoid mechanism for the color light signals has special terminal clips for wires.





18. Above: Connections to the k 83 decoder for a color light signal

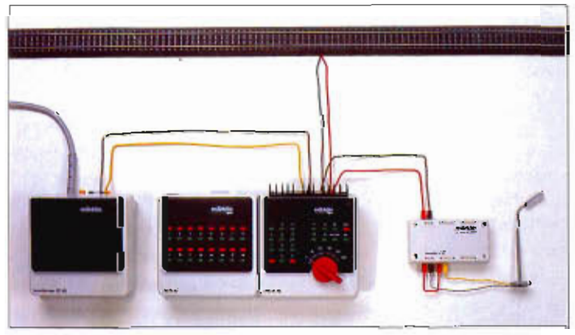
19. Left: Connections to the k 83 decoder for the 7237 and 7240 color lights

The special feature of the color light signals is that the signal mast can be separated from the mechanism and mounted by itself. If you install your signals in this manner, you must first make the connections for the signal lighting with the appropriate clips on the signal mechanism before doing the digital part of the installation.

Carefully strip a little insulation from the end of the wires included with the signal, on each wire twist the copper strands together, carefully press the terminal clip on the signal mechanism down, and insert the end of the wire into the opening. Release the clip, and the wire is fixed in place.

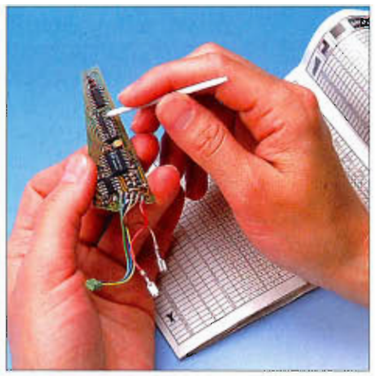
The diagram shown for the 7237 and 7240 signal is representative of the color light signals. The terminal clip to the extreme left is for the brown wire from the signals and (if you are not using a base plate) for the ground connection for the signal lighting. Next to it is the clip for the red wire from the signal, then the clip for the yellow wire for the transformer power for the signal lighting, and finally the clip for the green wire from the signal. These clips are marked accordingly in color on the housing for the signal mechanism. The fifth clip from the left is for the red track power wire from the isolated signal block, and the sixth clip is for the red wire that feeds track power from the normal part of the layout. If your 7237 and 7040 signal are later set for "green" or "green-yellow", then these two clips will be connected together by the relay inside the mechanism, and power will flow into the signal block, thus allowing the train to go.

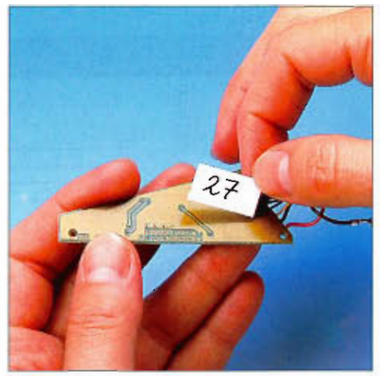
The 7241 signal has three different light settings, and you must also hook up an orange wire for it. This wire goes to the third clip from the left, marked in orange on the housing for the signal mechanism. When these connections are finished, you are now ready for the digital part of the installation. Regarding connections, it is the same in all



20. Below: Connections to the k 84 decoder for a street lamp from the Märklin assortment

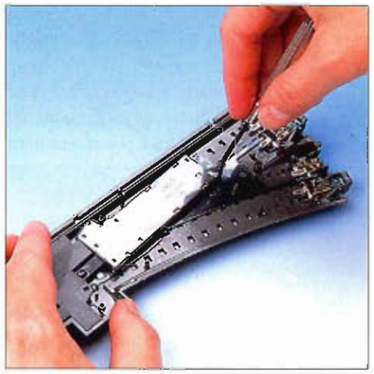
21. Effective photograph of a railroad maintenance facility with a lattice mast light turned on

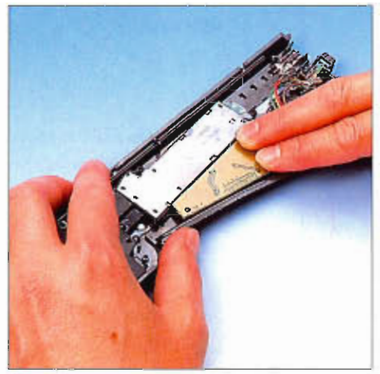




22 to 25. Above from left to right: Setting the decoder address for a C Track decoder; affixing a label with the number that has been set ...

Below: ... screwing the mechanism to the turnout and installing the decoder





details as the semaphore/target signals and the simple turnouts. Those signals with two settings - 7239, 7240, and the 7242 yard signal - are hooked up like a simple turnout. The three position 7241 signal has three blue wires and occupies two (actually only one and a half) outputs on a k 83 decoder.

The 5112 uncoupler track for M Track and the 2297 uncoupler track for K Track are used to separate couplers between cars or a car and a locomotive. These sections of track are usually installed in switch yards and on sidings. They can also be used in passenger station areas to uncouple a locomotive from a train or to facilitate a change of locomotives.

The H0 uncoupler tracks are not automatically in the uncoupling position; they are activated only as long as the corresponding accessory controller button is pressed. The 5113 light mast is mounted on the 5112 uncoupler track and tells you which uncoupler track is being activated; it also facilitates precise switching maneuvers over the ramp on the uncoupler track. The lamp on this mast lights up as long as the button for the uncoupler track is being pressed.

It is particularly important for the digital installation that the uncoupler track has only a single solenoid and therefore requires only a single blue wire. This allows two uncoupler tracks to be connected to an output on a k 83 decoder. The two yellow wires can both be connected to the yellow socket on the decoder by inserting one plug into the side socket of the other plug. One uncoupler track is then operated with the green button and the other with the red button on the Keyboard.

The uncoupler track for 1 Gauge track can be equipped with the 5625 electric mechanism (even after the uncoupler track has been installed). It is the same mechanism that is used with 1 Gauge turnouts. Unlike the H0 uncoupler tracks, the 1 Gauge uncoupler track has a lock-in position, i.e. it is switched between "uncouple" and "no uncoupling". For that reason the 5625 mechanism is connected to the k 83 decoder with two blue wires.

k 84 Decoder

The k 84 decoder is required to turn lighting circuits, motors and other continuous current users on and off on a digital layout. It has four independent double throw switches, each consisting of a relay and changeover contacts. In its function the k 84 decoder somewhat resembles the 7274 control box.

The decoder's four changeover contacts are assigned to four consecutive pairs of buttons on the Keyboard. Each of the decoder's outputs has a red and a green socket, and in the middle a socket marked with a number. The hot wire is usually connected to this center socket. The changeover contacts on the k 84 decoder can carry a high level of current. Each individual output can switch the entire output of a model railroad transformer with no problem.

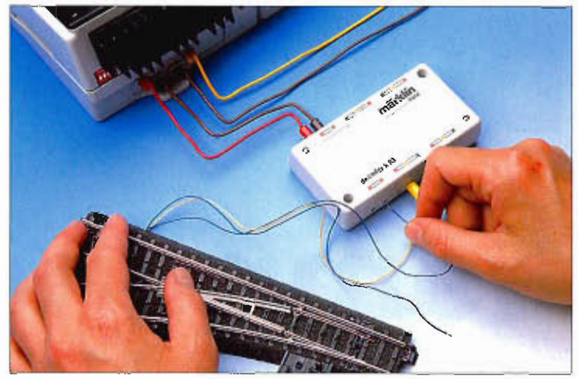
The decoder address must be set with the eight coding switches on the inside of the decoder. This procedure is the same as for the k 83 turnout and signal decoder. It is shown on page 64. The address that has been set should be marked in the rectangular depression on the top of the decoder housing.

The decoders are connected to the central unit or a Booster with a brown and a red wire. This connection provides them with digital data and power for their electronic circuit. Additional decoders can be connected to the second pair of red and brown sockets. The power for users connected to the decoder can either be taken from this pair of sockets or from an entirely separate source. In a standard circuit connect one of the wires for the constant current user, a street lamp or the distribution strip for an entire village's street lighting for example, to the green socket of the desired output on the decoder, the other wire to the brown socket of the pair of red and brown of sockets on the decoder. The center socket of the output is connected to the red socket of the pair of red and brown sockets on the decoder. Connect the opposite pair of red and brown sockets on the decoder to the central unit or to a Booster.

With this circuit the power for the user(s) is taken from the central unit or the Booster, i.e. it decreases the power otherwise available in the Digital system. If you want to avoid this, you can take the power directly from the digital transformer or, better yet, from another transformer. The circuit would look like this: The red and brown pair of sockets on the decoder are connected to the red and brown terminal clips on the central unit or the Booster. The ground wire for the constant current user(s) is connected directly to the brown terminal clip on the separate transformer, the yellow wire(s) are connected either directly (in the case of a single wire) to the green socket on the desired decoder output or through a distribution strip to the same. A wire from the center socket on this output is connected to the hot wire (yellow) terminal on the separate transformer. The 0308 (0308A in North America) book "Getting Started with Märklin Digital" gives a greater number of more detailed examples of such circuits for the k 84 decoder.

Hooking Up Solenoid Accessories - C Track

The new C Track system's reliable, continuous connections makes it a good choice for the Digital system. In addition the space under the roadbed for this track offers sufficient room for mechanisms and decoders, so that you don't need to hide them or mount them "below the baseboard". Märklin has taken this into account with special retrofit parts.



26 & 27. Connections to a k 83 decoder

The C Track turnouts come from the factory equipped for manual operation. The 74490 electric turnout mechanism can be retrofitted to them and hooked up to the layout without the need for special tools. The mechanism is mounted hidden in the turnout's roadbed. It is operated using a standard control box, the control box with a feedback feature or with a digital decoder. These turnouts can be made digital by connecting them to a k 83 decoder, just like the M and K Track turnouts. This may be the right solution, if you are converting an existing layout to C Track and you already have decoders. In this case the procedure for hooking the turnouts to the decoder is the same as already described previously for the other track systems.

A more elegant solution is the new 74460 turnout decoder. It is also installed in the turnout's roadbed - right next to the turnout's electric mechanism. The decoder is hooked up with a simple multi-plug connector and any address from 1 to 256 can be set individually for each turnout. The digital power supply can be taken directly from the track power contacts in the turnout. This does away with the need for wiring outside of the turnout.

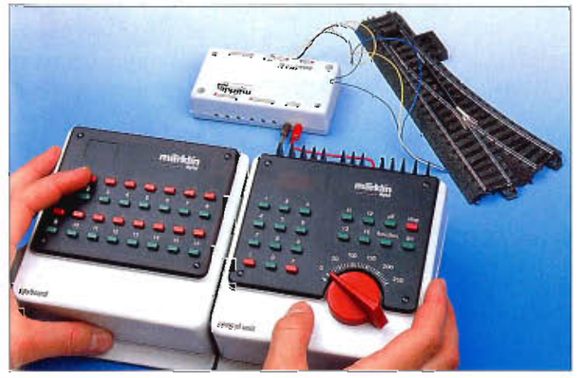
The addition of feeder sets (74040) and track insulators (74030) or the newer 74043 signal hookup kit allows the existing color light or semaphore/target signals to be used on layouts with this new track system. The 74030 third rail insulators are used to isolate the signal block for train control functions. Two of the 74030 insulator sleeves are required for on isolation point, four for two isolation points. These sleeves are slid onto the inner contacts on the track before joining two sections of track.

Power connections are made with the 74040 feeder wire sets. (Note: Both the 74040 and 74030 are included in the 74043 signal hookup kit.) These wires have spade connectors that are slid onto the connector fingers that lead to these inner contacts. The red wires - also used for supplying power to an entire track power circuit when the 74040 pair of wires is used as feeder wires - are hooked up to the fingers at the end of the track when the track is viewed upside down. These wires can be positioned under the roadbed in the guide notches provided for them and led out to the signals.

24977 Uncoupler track. This uncoupler track is made digital in the same manner as the uncoupler tracks for the M and K Track systems. The 5113 light mast can also be attached to the 24977 C Track uncoupler track. It facilitates precise switching maneuvers when uncoupling cars. The lamp on this mast lights up as long as the button for the uncoupler track is being pressed.

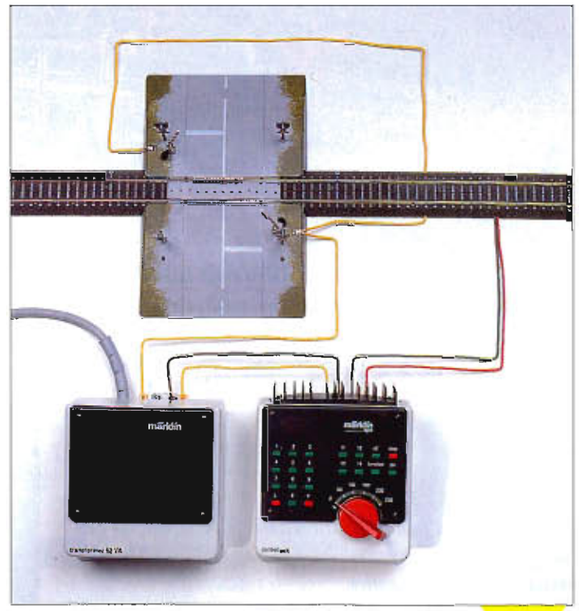
It is important for the digital installation that the uncoupler track has only a single solenoid and therefore requires only a single blue wire. This allows two uncoupler tracks to be connected to an output on a k 83 decoder. One uncoupler track is then operated with the green button and the other with the red button on the Keyboard.

74920 Railroad crossing gates. The fully automatic C Track railroad grade crossing with half gates is easy to install; only a couple of small details must be remembered. When putting the contact area together, be sure that the small, uncolored arrows on the grade crossing track section are on the same side as the small, blue arrows on the contact tracks. If the contact area must be lengthened, then the small contact bridge between the running rails must be cut with a pair of scissors or an appropriate pair of wire cutters; this contact bridge can be found at each end of the track on the right side when the track is viewed upside down.



114. Connections for the railroad grade crossing in the C Track system

113. Below: The turnout should be checked to see if it works before installing in on the layout.



Digital Components For Special Uses

1. Above: As the heart of a railroad maintenance center, a turntable is both a focus of attention and the center point of operations.

2. Right: Now and then an electric locomotive penetrates the domain of the steam locomotive. The V 60 with TELEX couplers is moving the larger locomotive.

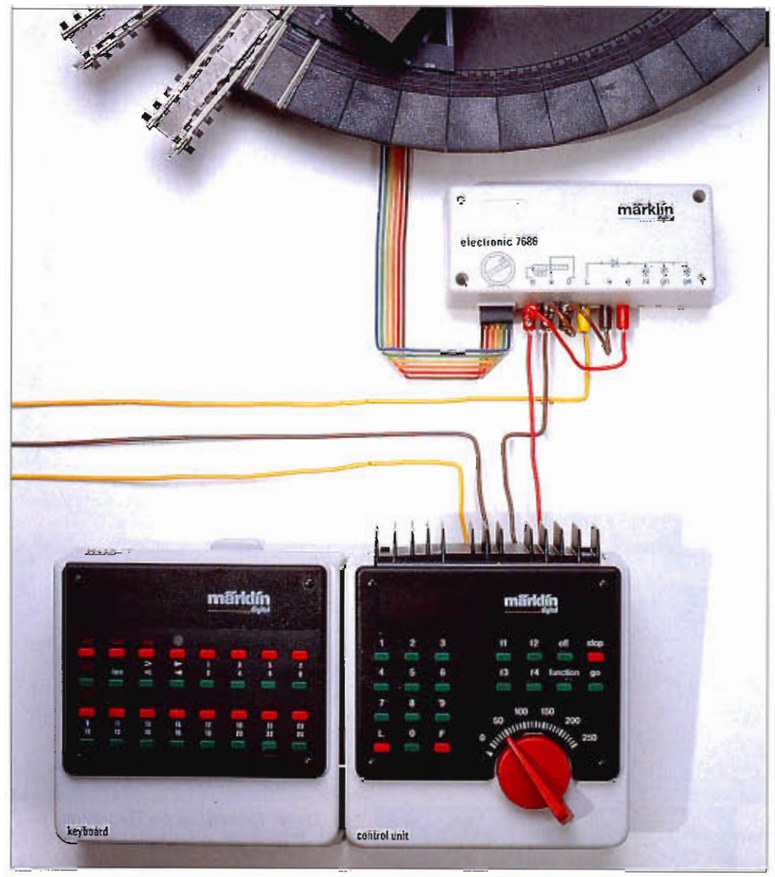
Memory, Interface, Feedback Module

6043 Memory

Operating trains like the real ones - this really becomes true with the Memory. Finally, turnouts and signals can be switched in an interdependent sequence in a real signalling center. Routes and combinations of turnout and signal settings that recur again and again in daily operation can be stored in the Memory and activated at the press of a button. It is excellently suited for automatic block controls or other automatic circuits of all kinds.

When you have installed and properly programmed a Memory, you have a continuous monitoring capability on your layout and can protect your trains to a large extent from collisions. One of the great advantages of the Memory compared to conventional circuits is that the solenoid accessories assembled into routes can still be activated independently of each other at the Keyboard without the need for further electronic circuits.

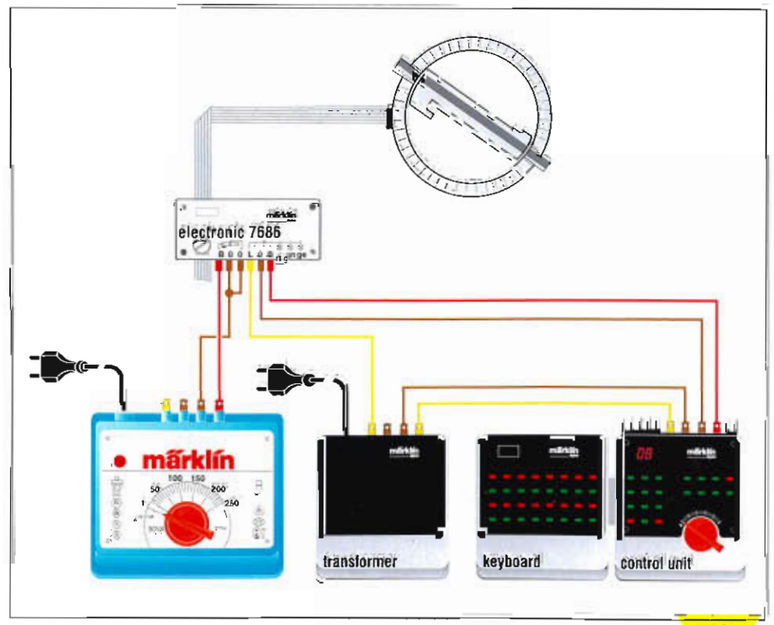
On the face of the Memory are 24 green buttons for combinations of turnout and signal settings and five red buttons for the different modes of operation.

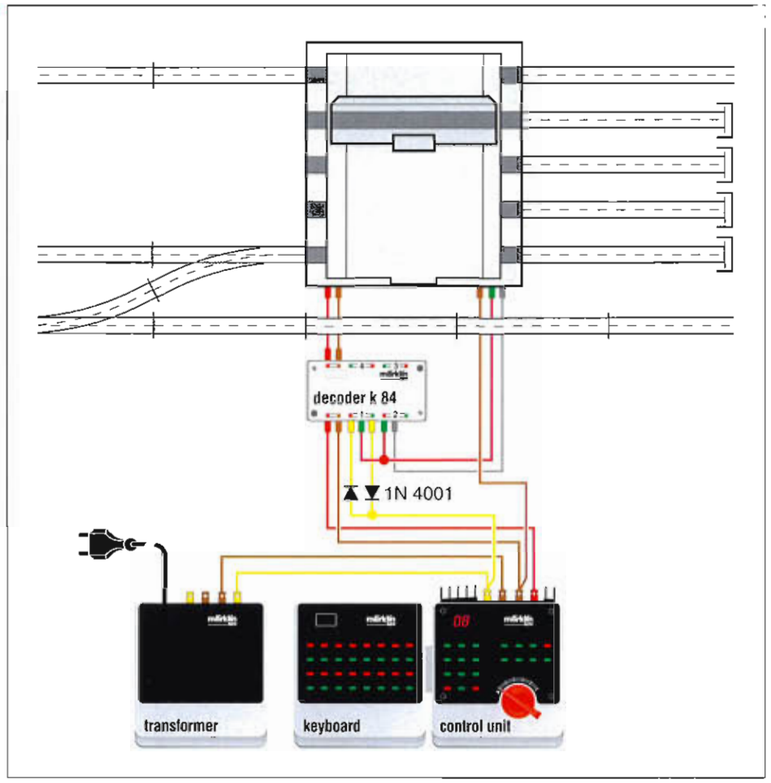


3. Above: Connections for the digital turntable with digital locomotive operation

4. Left: Installing the lettering overlay on the Keyboard for operating the 7286 turntable

5. Below: Connections for the 7286 turntable for conventional locomotive operation

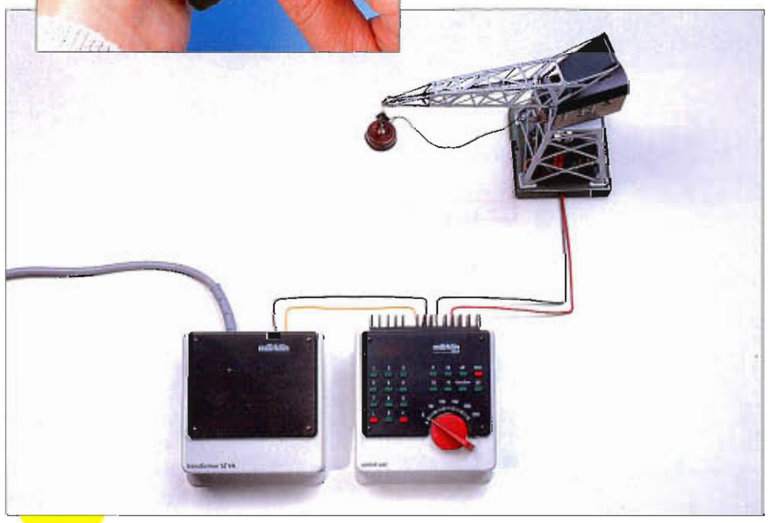




6. Above: Connections for the transfer table through a k 84 decoder

7. Left: Setting the address for the 7651 digital crane

8. Below: Connections for the 7651 digital crane



All transformers must be disconnected from the household current before connecting the Memory to the digital layout. Then simply plug the Memory in on the left side of the central unit or a Keyboard. It doesn't matter what order in which you connect Memory units and Keyboards, they just have to be to on the left side of the central unit. A maximum of four Memory units can be used on a layout.

When the layout is turned on, the Memory signifies that it is ready for operation with an LED flashing above the "off" button. On older units the LEDs above the "extern" and "end" buttons come on. Before you start programming, you should consider,

- ❑ which turnouts and signals you want to activate with a single press of a button, and
- ❑ in which sequence they are to be activated.

When a train enters a station area and is supposed to stop, the entry signal must be set for green and the exit signal set for red. In addition, the turnouts for the station area must be set so that the train is guided from the entry track to the desired station track. If it is possible and necessary, adjacent turnouts should be set so that other trains cannot intrude onto this track and cause collisions.

In setting up the sequence of signals and turnouts to be set, you should aim for safety as in the prototype. It is usually best if signals to be set for red are set first. Then come the turnouts in the route and finally the signals to be set for green. The train is then allowed to proceed only when all of the turnouts in the route have been set.

When the sequence of signal and turnout settings is clear in your mind, the programming is very

9. With the special catenary set the transfer table can also be used for electric locomotives. It requires less space than a turntable. With digital control there are all sorts of applications for the transfer table.

easy: First press the "input" button. Than press the route button under which you later want to call up this sequence of switch and turnout settings, for example A1. The red LED over this button should now light up. A systematic approach in selecting the route buttons contributes greatly to manageability of the system, for example, all entry routes in the A group, all staging yard routes in the B group, or something similar.

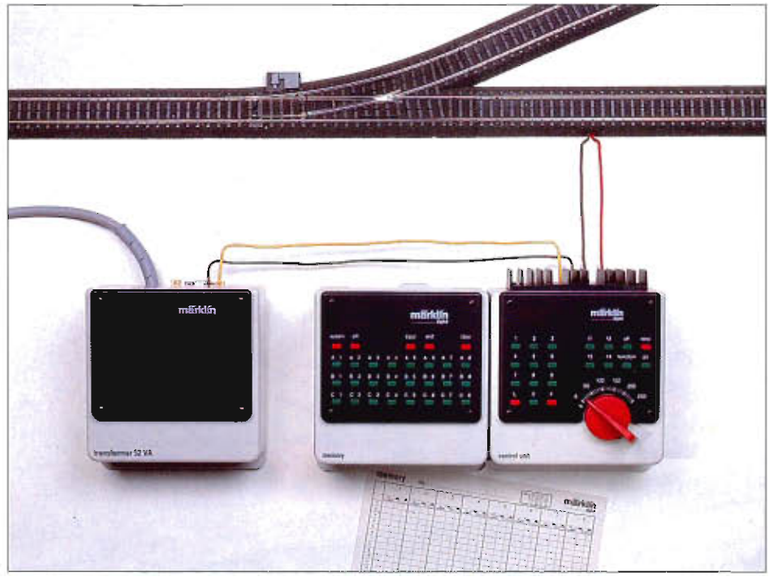
When the LED lights up above a route button, the Memory logs everything that is being switched in the Digital system and carries it out later in the same sequence. Now enter the solenoid accessories that you want to have switched in the desired sequence. When you have finished this, press the "end" button to end the programming procedure. To check the programming, manually set the affected turnouts and signals in the opposite setting at the Keyboard and then press button A1. Then you can observe how the solenoid accessories are switched one after the other to the settings just programmed.

As with the entire Digital system, the limits to this are quite broad: Each route activated can carry out up to 20 switching commands including other routes. This means you can assemble individual turnout groups into "subroutes".

s 88 Feedback Module

The s 88 feedback module is not a decoder strictly speaking, but rather an "encoder", and you can use it in conjunction with the Memory to have trains themselves activate routes. This makes even complicated block routes possible on the layout. The most elegant way to do this is with "reed contacts", small gas-filled glass tubes in which a switch is closed when a magnet is passed over it - a route switch for example. The Märklin assortment offers contacts for all of its track systems (7555) and magnets for locomotives with low ground clearance (7556) and high ground clearance (7557) as well as for freight and passenger cars (7558). These magnets and reed contacts are specially designed for the requirements of a model railroad. The 7556, 7557 and 7558 magnets have approximately ten times the power of magnets of similar size available on the market.

The s 88 feedback module has connections for eight routes and is connected with a special ribbon cable to the Memory or the Interface.

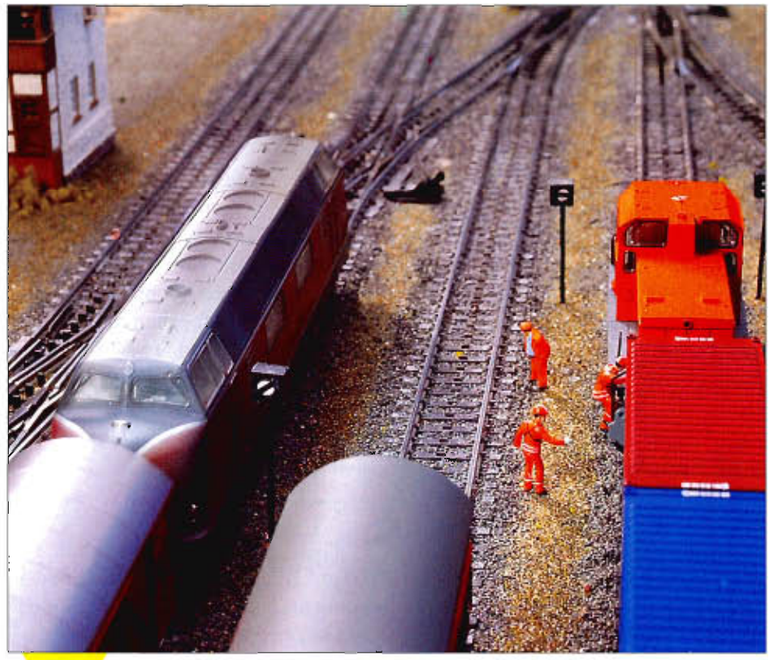


10. The Memory is connected on the left side of the central unit. When doing this make sure all of the transformers on the layout are disconnected from the household current. The photo shows the Memory without a Keyboard and after being programmed.

If you want to be able to switch all 24 routes on a Memory with the s 88, then you need three of the latter that you connect with the ribbon cable. The magnets for the reed contacts are best placed on the last car in the train. This ensures that a contact is not switched if the train separates, as would happen if the magnet were placed under the locomotive.

The traditional contact or circuit tracks are also suitable for the activation of routes by trains. And yet the following starts from the point that reed contacts are used on the layout.

11. Two freight trains wait for the go signal. The routes here were programmed with the Memory.



When a train has entered a block, it must switch the entry signal for this block to "stop" so that it is protected against collisions from the rear, and it must set the signal behind this first signal to "go" so that any train following can continue to run. This is technically the same as a route circuit, since it deals with the activation of two solenoid accessories.

On conventional layouts the pick-up shoe on the train's locomotive activates a circuit track after passing the signal; the two signals are connected to this circuit track - the one just passed with the wire that sets it for "stop" and the one before it with the wire that sets it (the second signal) for "go".

This has several serious disadvantages: Every locomotive and car with a pickup shoe activates the route, i.e. even a switch engine with a single car coupled to it headed for a siding. Trains with several pickup shoes can disrupt the entire automatic circuit. And the two signals can no longer be switched independently of each other.

With the use of a Memory and reed contacts, only a locomotive or a car with a magnet activates the circuit, and the signals can be activated independently of each other from the Keyboard. The reed contacts are connected to the s 88 feedback module and the latter is connected to the Memory with the special ribbon cable.

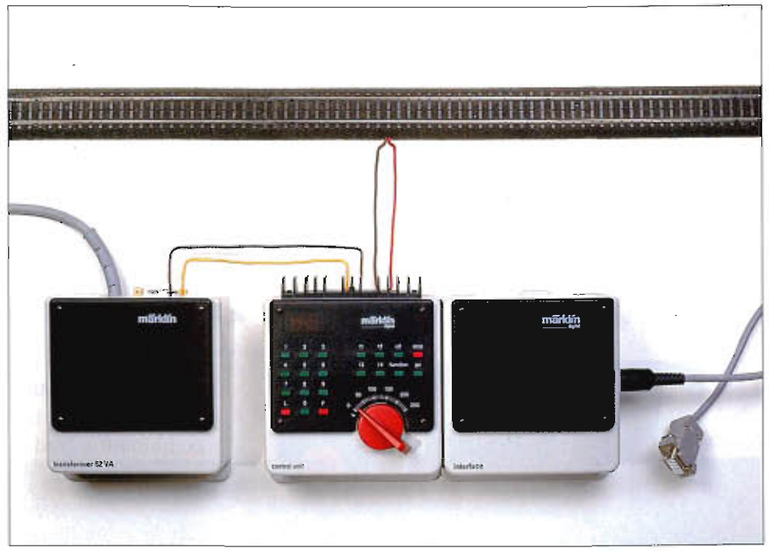
The block route

On a loop route with three blocks - the maximum required for operating two trains automatically - it can work this way:

The train that has just passed signal 1 set for "stop" passes over contact "a" in the next block. A wire from this contact to socket 1 on the s 88 feedback module activates route A1, this route in turn setting signal 1 to red and signal 3 to green. When the second train reaches signal 1, it stops - a collision with the first train is avoided. The latter now reaches signal 2 and after passing over contact "b" activates an impulse to the feedback module that in turn activates route A2 in the Memory. This impulse consists of these commands: signal 2 to red and signal 1 to green.

The second train now has the green light to proceed and can activate route A1 again when it passes over contact "a". In the meantime the first train has reached signal 3 - this signal is set for green, because train 2 has gone far enough from it - and activates route A3 in the Memory after passing over contact "c": signal 3 to red and signal 2 to green. In this way two trains can run on the same block at different speeds and never have a collision, because the faster one will always be stopped in time. The following formula applies: "x-1" trains can be run safely on a loop route with "x" number of signals on this route. Moreover, only one train is ever in motion on this "dense traffic route".

The fewer trains there are, the smoother the operation. The best situation is where there are half as many trains in operation as there are blocks: with ten blocks that would be five trains, for example. To do this you need rather long stretches of track. To do the process described above with the Memory, the latter's red "extern" button must be pressed switching the Memory to the external mode of operation. Only then will it react to commands from the feedback module. A red LED lights up over the "extern" button when the Memory is in the external mode of operation. This mode



12. The Interface is connected on the right side of the central unit. On the right side of the former is the socket for connections to a computer.

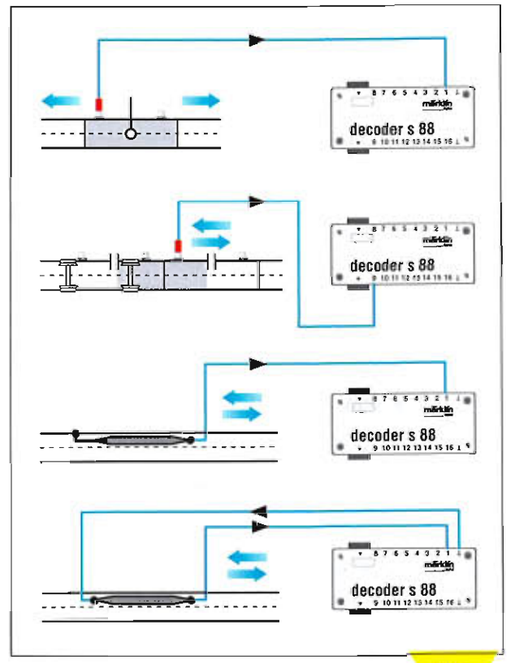
can be turned off by pressing the "off" button on the Memory. This will shut off the automatic operation.

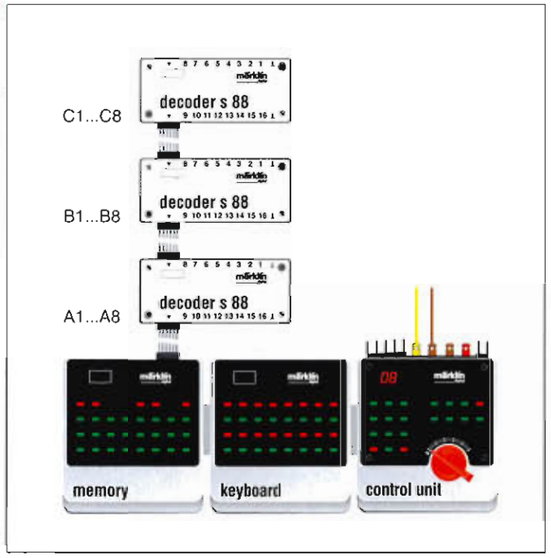
Staging yards

Staging yards can also be controlled to perfection with the Memory and without the switching of circuit tracks and reed contacts one after the other. A train entering the staging yard must, however, activate more functions than with a block route:

- the signal on its own track must be set to red;
- the signal on the adjacent track with the train that is to leave must be set to green, and the en-

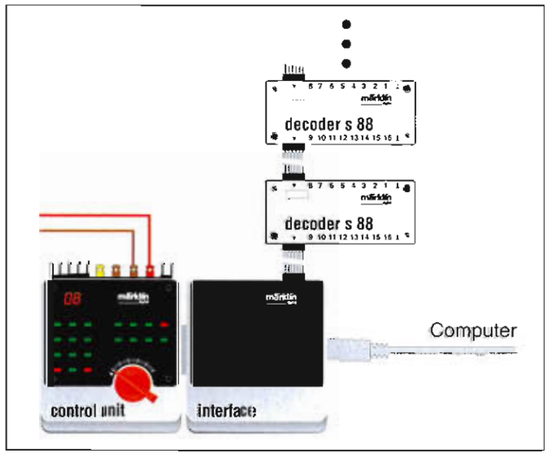
13. Connections for different types of contact generators to the s 88 feedback module: (from top to bottom) circuit track (only with Märklin H0 third rail system), contact track (only with Märklin H0 third rail system), reed contact with Märklin H0 third rail system, reed contact in general.





14. Above: Connections for s 88 feedback modules to a Memory

15. Below: Connections for s 88 feedback modules to an Interface



try turnouts must be set so that the next train can enter a free track.

All of this can be combined into a route that also includes the settings for exit turnouts, so that the train can safely leave the staging yard.

A note on the 7041 and 7241 "three-position" home signals: Basically it doesn't matter for the functioning of the turnouts and signals if the blue wire with the orange plug or the blue wire with the green plug is plugged into the second output on the k 83 decoder. If you are using a Memory then this connection will become important. The red and the green "button" for the same output cannot be activated within the same route on the Memory. For this reason the button combination "red" - "orange" should be used for the setting "slow running".

6051 Interface

Anything digital can be controlled by microchips. Microchips are contained in central units, control components and decoders from Märklin Digital, but they are also contained in computers. What could be more logical than to connect the two? This becomes possible with the Interface. It is connected on the right side of the central unit, a Control 80, or a Control 80 f. The Interface must always be the last unit on the right of the central unit, because the former does not have a multi-pin plug connector on its right side for additional digital controllers. The right side of the Interface has a socket for the connection to a computer.

The 6051 Interface includes a cable that connects it with the RS232 port on an IBM compatible computer, a brochure with installation instructions and a diskette with a demonstration program for controlling model railroads. You can make cables for other makes of computers on your own, using the instructions in the Interface brochure, or these cables can be ordered from "modellplan" Company (Tannenstrasse 8, D-73037 Göppingen, Germany. In North America you can order these cables through your authorized Märklin dealer from Märklin, Inc.

The computer must be turned off (or better yet disconnected from the household current) and all of the transformers on the layout must also be disconnected from the household current before connecting the Interface to the central unit or to the computer. If you are using a computer to control your model railroad, then with the exception of the 6020 Central Unit or the 6021 Control Unit you don't need any other control components. You can use the computer to control all of the locomotives and solenoid accessories on the layout as well as perform the functions of the Memory. You must program the computer to do all of this - for example, with a DOS Basic program - or use a finished piece of software such as is offered in the USA and in Germany. Märklin offers the Comboard program (60511) that creates an easy to use track diagram control board on your computer screen from a German Railroad prototype. (Note: The Comboard program is available at this writing only with German text.) Several ready to run programs are available on the German and American market for locomotive control; two sources are "modellplan" in Germany and in North America from Custom Software Engineering, . Details concerning different configurations and control modalities can be found in the manuals for the software.

Important Questions

Question: My digital locomotives only react partially to digital commands. Solenoid accessories can't be activated at all. What is the matter?

The causes are one or more small interference suppression condensers that are still present in feeder tracks installed on your layout. These condensers distort the data signal sent from the central unit to the accessory and locomotive decoders. Such condensers are either under the track (with M Track) or soldered between the feeder track terminal clips for the red and the brown wires (with K Track). To get rid of the problem, take a pair of wire cutters and cut the condensers from the feeder track connections.

Question: What is the difference between the 6050 and 6051 Interface?

The 6051 Interface differs from its predecessor 6050 only in the fact that the former includes a demonstration diskette (no. 66918) and a cable (61700) for connections to a computer. The electronic circuits for the two Interface units are the same. The computer cable is designed for a nine-pin serial connection to a computer.

Question: I own a combination layout with some areas powered by conventional alternating current and others with digital. With the DELTA locomotives I have the problem that when they have a DELTA/digital address set on them, they can't be controlled in the conventional area of the layout. What can I do?

The DELTA electronic circuit in the locomotives cannot automatically recognize the power system. The operating modes "conventional" or "DELTA/digital" are set on them with coding switches. If the coding switches are set for conventional operation (all four switches set at "off"), the locomotive will operate in DELTA or digital operation with a constant speed. When the coding switches are set for a DELTA or digital address, the locomotive will continue to run in the conventional area of the layout as long as the operating data remains stored in the electronic circuit. For that reason you cannot reverse the locomotive in the conventional area with the increased voltage impulse (control knob turned to the left to the stop and then released). Usually the entire layout is converted when moving from conventional to multi-train operation. Manually resetting the coding switches is a necessary but for most customers an acceptable condition, since automatic operating mode recognition involves a greater cost. For that reason it is only built into the digital decoders. On 1 Gauge layouts it is not possible to run a locomotive from a conventional area into a digital area.

Question: What must I be aware of when doubleheading locomotives?

If two locomotives are to be operated together, one coupled right behind the other, then the first one must be run a little faster than the second unit. In digital operation call up both locomotives on two locomotive controllers and coordinate the speed settings for both. Trying to give locomotives with built-in high efficiency propulsion the same address and then coordinating the speed settings for both can only be done in one direction of travel.

Question: Can I operate locomotives with DELTA, but do my accessories digitally?

This is technically not a problem. Since you will need a Control Unit anyway to operate the accessories digitally, and this unit already has a locomotive controller built into it, then why not run the locomotives digitally too? If you are using the older 6020 Central Unit or have acquired a used unit, then you would also have to buy a digital locomotive controller.

Question: Can I use digital locomotives on a DELTA layout?

Digital locomotives can be used on DELTA layouts, but you must reset their decoders for one of the four DELTA addresses, 78, 72, 60, and 24. This is done with the eight coding

switches on the locomotive decoder. If you want to control a digital locomotive with the DELTA Pilot, then the locomotive must be set for address 80. The auxiliary function on digital locomotives cannot be turned on in DELTA operation.

Question: What is the maximum load for the outputs on the k 84 decoder?

The outputs on the k 84 decoder can handle the current that is usually present on all Märklin transformers.

Question: I have just built a new digital layout, and some locomotives with c 80 decoders will not operate on the layout. The other models run flawlessly. The units with the c 80 decoder operate with no problem at all on the dealer's test layout. What's the problem?

In building the layout you have probably mistakenly swapped the brown ground connection with the red track power connection. Older generations of the c 80 decoder do not have a built-in polarity recognition feature. Since the introduction of the Motorola format for Märklin 1 Gauge, all decoders in Märklin Digital can recognize polarity and will function even with reversed connections.

Accidental swapping of these connections when installing solenoid accessories or when using Boosters can, however, cause short circuits. Even with the polarity recognition feature, you should therefore make sure that the ground connections for the individual users always go the brown terminal clip on the Control Unit and never to the red terminal clip.

Question: Should I use the k 83, k 73 or the 74460 C Track decoder for my layout?

The k 83 decoder (item no. 6083) has connections for four double solenoid accessories and is usually the most cost effective way to control accessories digitally on permanent layouts. The k 73 decoder is designed for installation in M Track turnouts, and the 74460 decoder is intended for C Track turnouts. Both have the advantage that no other wiring is necessary for the turnout after they have been installed in it. With them an H0 layout can be set up in a very short amount of time and can be connected to a Control Unit, a Keyboard, and a transformer.

Question: How do I install the new 72441 braking module for signals?

You must have three isolated track blocks in front of the signal. The first block is the transition area. It separates the digitally powered area from the braking area and on H0 layouts must be as long as a pickup shoe, i.e. about 70 to 90 mm / 2-3/4" to 3-1/2", with Märklin 1 Gauge at least as long as the longest locomotive that you have. The second block is the braking area. In this block the locomotive with built-in high efficiency propulsion comes to a gradual stop. This block should be at least as long as three standard sections of track, i.e. for H0 about 54 cm / 21" and for Märklin 1 about 90 cm / 36". The third block is the safety block. Here the track power is completely turned off. If a train overruns the braking area, it will stop in any event in this block, thus preserving the signal's safety function. The 72441 braking module for signals also has terminal clips for connections to the k 83 decoder, or to a conventional control box, or to a color light signal without its own mechanism.

Question: Is it possible to operate some locomotives digitally from the track and others conventionally from the catenary?

Thanks to Märklin's principle of a common ground, this type of mixed operation is no problem. The one thing to remember is that the red track power wire to the third rail in the track must on no account come into contact with the red track power wire from the transformer to the catenary. The brown ground wire for both systems can be connected to the running rails in the track.

This applies only to the Märklin three-rail system and the Märklin Digital H0 system. This is not possible on two-rail DC layouts with the former Märklin DC Digital system.

Question: What is the difference between the 6017 Booster and the earlier 6015 Booster?

The 6017 Booster is a somewhat advanced version of the 6015 Booster. The position of the connector for the ribbon cable to the Control Unit and to other Boosters has been adapted to that of the Control Unit. Otherwise the two units are identical technically.

Question: How do I operate the TELEX couplers on the new 33961 tank locomotive and 34641 diesel switcher with the DELTA module?

Just like conventional locomotives with TELEX couplers, the couplers on these locomotives are activated with the impulse for reversing direction in both conventional and DELTA/digital operation. Only the switching sequence differs from the mechanical version (example: item no. 3096, class 86). With the latter the first impulse turned on the TELEX couplers and kept the locomotive's direction the same, and the second impulse reversed direction and turned off the TELEX couplers.

With the 33961 and 34641 the switching sequence goes as follows: 1st impulse: locomotive direction changes, 2nd impulse: direction changes and TELEX couplers are turned on, 3rd impulse: direction changes and TELEX couplers remain on, 4th impulse: direction changes and TELEX couplers are turned off.

After four impulses for changing direction you are back to the original status. When you are controlling the locomotive with a conventional alternating current transformer by itself or in conjunction with the DELTA Control or with a digital locomotive controller, the impulse for changing direction is activated by turning the speed control knob to the left to the stop. When using the DELTA Station with a DELTA Mobil connected to it, the impulse for changing direction is activated by turning the speed control knob to the left past the center off position.

Question: The conversion of conventional locomotives and other conversion and installation work with DELTA modules and digital decoders is supposed to be done on an anti-static work mat. How can I make such an anti-static work mat for myself?

Anti-static work mats are available at any good electronics supply store.

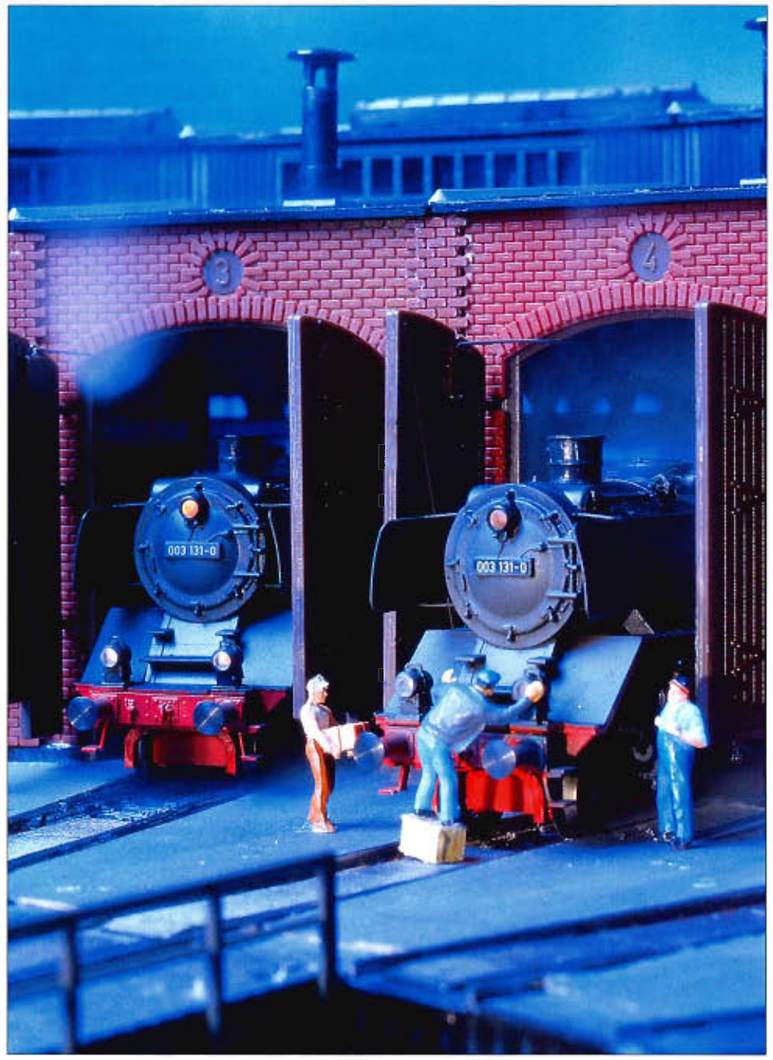
However, there are several risks associated with this conversion work. If you do it yourself, Märklin cannot guarantee either the decoder or its installation. It is therefore best that you let an authorized Märklin Digital/DELTA dealer do this work; he has been trained to work with electronic parts and the special tools used with them.

Question: Can I power the Märklin digital central unit with a DC transformer?

The Digital system will not function with a DC transformer. An AC transformer, preferably the 6001/6002 transformers, is an absolute must for all central units. If you are thinking of using another make of AC transformer, you may encounter problems. Before hooking it up to your layout, ask the manufacturer if it is suitable for use with Märklin Digital. On no account should you build your own transformer. Your digital components, but more importantly your own health and safety will be at risk.

Question: Can I use the high-efficiency propulsion with other models with permanent magnet motors and is the electronic circuit for the former available separately?

This electronic circuit is specially designed for the motor in the high-efficiency propulsion set. Using the electronic circuit with another motor may result in a reduction in the locomotive's power. However, there are locomotives in the Märklin program with the high-efficiency propulsion system controlling other types of motors. Examples of this are the class 194, the Bavarian



peat locomotive or the E 70 which all use a version of the electronic circuit adapted to their motors. If you are going to use the electronic circuit with another motor, you must make sure that the motor can handle a maximum load of 800 milliamps. Märklin cannot guarantee trouble-free operation of just any motor with this electronic circuit. If in doubt, see an authorized Märklin repair center. Their personnel have experience converting different models. The electronic circuit from the 6090 high-effiency propulsion circuit is available under item no. 648680.

Question: Can I also use the DELTA Station to control a Märklin H0 layout?

No problem. There are several features that distinguish the DELTA Station (6607) from the DELTA Control (6604). When you use the 6001/6002 transformers, the DELTA Station provides a greater power output, namely about 45 VA (somewhat less with the 6001 transformer), while the DELTA Control only supplies about 30 VA. With the DELTA Station digital locomotives will run with their auxiliary function on. The advantage in this is that as a rule the locomotive's headlights will be on, but you cannot use digital locomotives with TELEX couplers, since the latter will be on all of the time. Finally, the number of locomotives that can be controlled at the same time is limited to four, while up to five locomotives can be controlled with the DELTA Control in conjunction with the DELTA Pilot.

Question: How can I install a slow speed block on a Märklin digital layout?

There are two possibilities. In each case the slow speed block must be separated electrically from the rest of the track on the layout, i.e. isolated. The first possibility is to install a resistor (rated for 5-10 ohms, with a minimum 10 watt load) or a potentiometer (item no. T66631 from Trix, for example) in the red track power feeder wire to the isolated block. One disadvantage of this method is that these components give off a lot of heat.

The second possibility is to decrease a Booster's input voltage and assign this Booster to the slow speed block. The Booster will work with an input voltage as low as 12 volts. The output voltage for the Booster will be decreased to the same extent. With a 6001/6002 transformer this can be achieved by installing diodes in tandem (diode type 1 N 5402, for example) as described in the Märklin Magazin issue 1/88. In addition, a circuit was presented in an article in the Märklin Magazin issue 4/93 with a supplemental article in issue 5/93; this circuit allows locomotives with the 6090 high-efficiency propulsion to come to a realistic, gradual stop before a signal.

Question: I'm using a DELTA Control with my H0 layout. If I run four or five locomotives at the same time, quite often this unit shuts off. What is the problem?

Your DELTA Control is probably being overloaded. It produces a maximum of 30 VA of power. To do this you must use a 30 VA transformer with it. This power output is sufficient to operate four standard locomotives at the same time. The power capability of the DELTA Control is exceeded when additional power users are added, and the DELTA Control will shut itself off due to the overload. As an example, a smoke generator increases the power consumption of a locomotive by 50 percent. Two locomotives with smoke generators require as much power as three "non-smokers". Three lighted cars require as much power as one locomotive. Locomotives with two motors (such as the new Swiss Ae 8/14, item number 33591, or the Amtrak F7 A-B-A diesel, item number 33621, require double the amount of power for a standard locomotive. If you are also using your transformer to power turnouts, signals, and lighting circuits, then this will subtract from the power available in the track for locomotives.

There are several possible solutions for this problem:

- ❑ Power turnouts, lighting circuits, and signals with their own transformer separate from the track power;
- ❑ Use the DELTA Station (6607) with the 6001 (110 volts) or 6002 (230 volts) transformer. This will provide about 45 VA of power (somewhat less with the 6001 transformer), one and a half times so much as with the DELTA Control;
- ❑ Move over to Märklin Digital with the 6021 Control Unit and the 6001/6002 transformers. The DELTA Control can then serve as a Booster. This will provide a total of about 75 VA (somewhat less with the 6001 transformer) in two power circuits;
- ❑ Reduce the number of users consuming power at the same time.

GLOSSARY

Accessory controller. Also called Keyboard, is connected on the left side of the central unit. One each red and green button for 16 solenoid accessories with double solenoids that can be operated with each Keyboard.

Accessory power. Identified by yellow wires for the hot side of the accessory circuit and by brown wires for the ground return. In contrast to track power, is used to supply power to lighting circuits or stationary motors.

Address. Identification code for control components and users. Each locomotive and each working model has a digital address that is used to control it. Usually an address between 01 and 80 can be selected for it. Also accessory controllers can be coded for different addresses; Locomotive controllers are assigned an internal address by the central unit, and the user has no control over the latter type of address.

Auxiliary function. Feature of Märklin digital locomotives and working models. Every digital locomotive has one auxiliary function; often this is the headlights, sometimes the TELEX couplers or the smoke generator. In the last several years the Motorola format in the digital components has made it possible to have up to five auxiliary functions. Some locomotives have had controllable long-distance headlights, working cooling fans in a condensation tender, or a sound effects circuit. A digital layout must be equipped with the 6021 Control Unit to activate these auxiliary functions. Only the original auxiliary function can be operated with the older central unit.

Booster. Unit for boosting output from a central unit to its own power circuit. It is powered by a transformer and is used on medium size and large layouts.

Central unit. The heart of a digital layout, with Märklin the 6021 Control Unit. The face of the unit incorporates a locomotive controller where you can set speed, direction and auxiliary functions. Additional locomotive controllers are connected on the right of the central unit, and accessory controllers are connected on the left of the central unit. The central unit is supplied with power from a transformer; the former sends data required by the users on the layout. The first version of the Märklin digital central unit, the 6020 Central Unit, did not have any controls on it.

Control signal. Is sent from the central unit to the decoders and is processed by the latter, so that the desired users are activated and the commands are carried out.

Control Unit. See locomotive controller, see central unit.

Decoder. Electronic component that processes digital impulses sent by the central unit. It recognizes the signal sent to it with its address and causes motors, solenoids, light bulbs and other power users to carry out the appropriate commands.

DELTA. Multi-train control system from Märklin for small layouts. Up to five trains can be controlled independently of each other and three can be in operation at the same time in a power circuit.

Digital. Electronic control of model railroads (actually "with the finger or 'digit'"). Electronic components in a central unit convert command signals to a digital format and send them along with operating voltage through the track to the users, where they are decoded and transformed. Advantages are independent multi-train operation in the same power circuit.

Electronic sound effects circuit. Second auxiliary function that can be controlled in the newest model of the V 200 diesel locomotive. 6021 Control Unit required on the layout to activate this function.

Feedback module. "Encoder" for switching impulses fed into the Digital system from contact tracks, circuit tracks, or reed contacts. Used in conjunction with the Memory for automatic or partially automatic switching by trains of routes or blocks.

Ground. Common return wire from track power and accessory power. All ground wires can be connected together with no problem, even on layouts with digital and conventional components.

High-effiency propulsion system. In conjunction with a five pole motor enables individual setting of the maximum speed as well as acceleration/braking delay for locomotives and powered railcars/railcar trains. Factory-installed feature on many Märklin digital locomotives. Locomotives with this feature can be recognized by an item number beginning with 37... The high-effiency propulsion system can be retrofitted in many locomotives.

Interface. Unit to link a Märklin digital layout with a computer that can be used to control the layout. Is plugged in on the right side of the last locomotive controller on a control panel. A cable is used to connect the Interface to the RS232 port on the computer.

Keyboard. Accessory controller.

Locomotive controller. Central operating element on a digital layout. Combined with the central unit is the Märklin 6021 Control Unit. As a Control 80 f it can be plugged in on the right of the Control Unit for simultaneous control of two trains. All functions influencing locomotives / powered railcars / powered railcar trains and cars with working functions are determined and controlled at the locomotive controller: direction of travel, speed, auxiliary functions, emergency halt.

Memory. Route controller for the Märklin Digital system. Operating procedures that are used often can be stored as routines with the Memory and called up again at the press of a button.

Multi-pin connector. Connects the central unit in the Digital system with the locomotive controllers on the right side and with accessory controllers on the left side. Adapter cables are offered in different lengths to set up components at a distance from each other.

Power circuit. Part of a model railroad layout assigned to a transformer. Small layouts as a rule have only one power circuit, medium size layouts have two, larger layouts can have several. On digital layouts each additional power circuit must be assigned to its own transformer and Booster; the latter unit reinforces the command signals from the central unit and sends them to the power circuit.

Power output. Important measurement for the operation of a model railroad layout. The power output of a transformer(s) must be sufficient for the power requirements of the layout, otherwise the transformer or the central unit will overheat and shut the layout off automatically.

Route. Total of switching processes for a number of solenoid accessories that cause a train to take a particular path through a track pattern. Important for setting up staging yards. Can be programmed with the Memory.

Separation point. On model railroads electrically separates the power circuits from each other. A clean separation is absolutely necessary to ensure trouble-free operation on the layout.

Track diagram control board. A diagrammatic representation of a track layout with controls for solenoid accessories. A track diagram control board can be set up on a computer monitor screen or as an actual panel with switches and buttons to control accessories.

Track power. In the Märklin system the conductor, identified by a red wire, for digital data from the central unit to the track.

Transformer. Converts household current (110 or 230 volts) to the operating voltage for a model railroad, 16 volts AC for Märklin. On conventional layouts it is coupled with a speed controller to set the speed for locomotives by feeding a specific voltage between zero and 16 volts to the track. The locomotive will then go slow or fast accordingly. In the Digital system there is a constant alternating current in the track at all times. The speed is controlled in the locomotives by an electronic component that interprets the control signals sent from the central unit together with voltage to the track.

New dimensions on model railway layouts

Locomotive noises

The earth trembles, producing butterflies in the stomach and causing the air in your lungs to vibrate.

The hobby of model railroading has acquired a new dimension. "This way you get a far better impression of the unique qualities of the prototype", commented one model railroader about the latest developments in sound electronics in Märklin models. Märklin is steadily applying the latest technology to digital sound storage and retrieval, resulting in a level of authenticity in model railroad noises previously thought impossible. To document this, every electronic item comes with its own audio cassette, which gives the modeller a picture of the uncannily accurate reproduction quality of the chip. When played on a stereo system, you have the feeling of standing right beside the real thing and, if the volume is turned up far enough, you can just feel the power of the prototype. Model railroad noises were previously generated artificially and sounded more like a moped or a lawnmower than a locomotive. Märklin, however, sets great store by model noises that sound just like the prototype. To achieve this, recordings were made using actual railway rolling stock and produced using elaborate 8-track technology. Microphones were positioned all the way around the locomotives to pick up the entire sound spectrum. The audio material was then digitized in the lab and applied to the acoustic qualities of the model in question. Additional information about the audio qualities of the prototype is given on the cassette, together with a clear explanation, providing model railroaders with the immediacy of a prototypical experience which could never have been achieved through books alone.

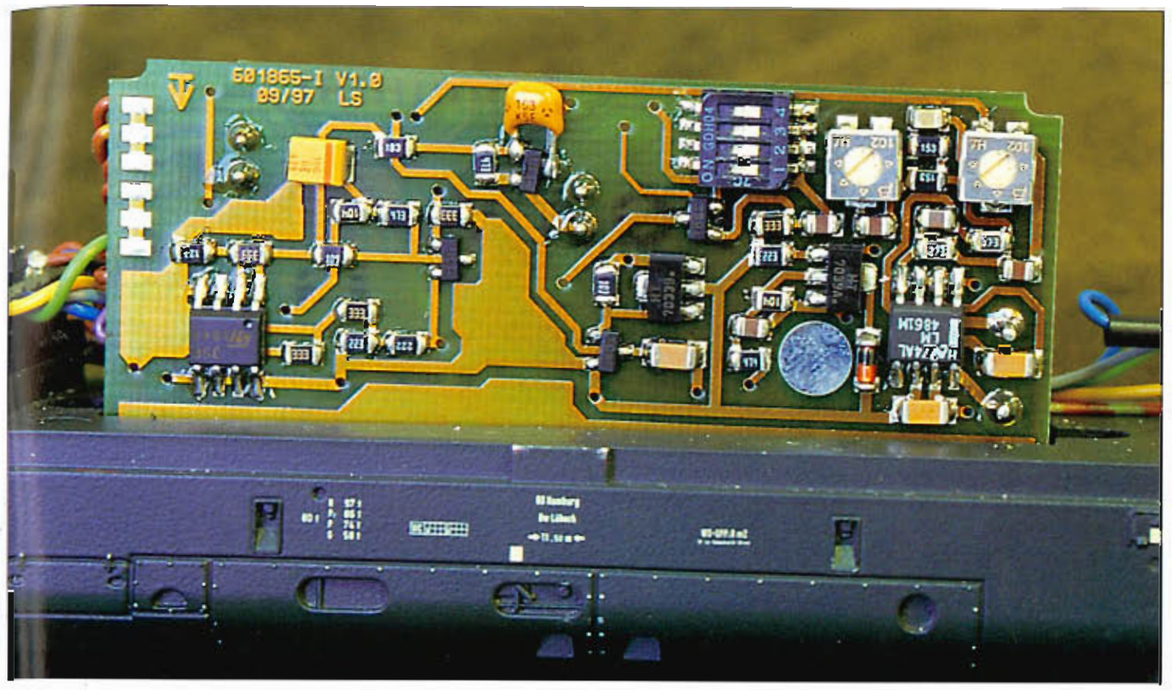
Genuine diesel sounds for the V 200

Item no. 33/37803 represents a first: an HO scale model with a built-in sound module which produces not just any sound, but the original diesel sound of the V 200. It also proved possible to introduce a number of technical achievements in the digital version of item no. 37803 which have not yet been announced. Admittedly, the sound is even better with the 1 Gauge Am 4/4 (the SBB version of the V 200). As far as HO is concerned, however, this V 200 represents a milestone in model railroad technology.

In order to make the V 200's diesel motor sound as realistic as possible, the recording was made from the prototype. To do this, Märklin technicians travelled from Göppingen to Northern Germany to record the original locomotive sound. Microphones were positioned all around the locomotive to capture the full sound spectrum. The analog recordings were then digitized in the lab and subsequently loaded onto a micro chip. The sound is replayed by a speaker built into the locomotive. The volume can be regulated via a pot adjustment on the electronic module.

If the V 200 is analog controlled, the striking sound of the motor starting begins when the speed controller on the transformer is turned slowly up at about the 50 setting. Slowly the sound of the mighty engine starting and idling is heard. At the 70-80 setting, the revs begin to climb and the locomotive starts to move. At higher speeds, the diesel sound is unfortunately somewhat overshadowed by the noise of the model. It is accordingly advisable to run the locomotive mainly at lower and mid-range speeds. When bringing the locomotive to a stop, it is also a good idea to turn the transformer down slowly to avoid removing the voltage too abruptly from the electronic module. Incidentally, the prototype V 200 achieves maximum output at 1800 rpm. Turning the motor up the way you hear them in car and truck diesel engines would thus be quite inappropriate in this case.

Märklin's technicians achieved some very interesting things with the digital version of the V 200, item no. 37803. But first we should again point out that modellers wanting to use the additional function switches via f1 to f4 will need a 6021



Central Control. This is not possible with a 6020 Central Unit, even in combination with a Control 80f, item no. 6036. When using a 6020, the diesel sound functions the same way it does in analog operation with a transformer; however, it cannot be switched off using the f1 key on the Control 80f.

When using a 6021, the second switch on the coding switch unit at the back of the controller must be flipped upward. If you have no older digital locomotives, we recommend that you also put switches 1 to 3 up - but it's best to try this out yourself. The diesel sound is activated by the f1 key. The signal horn is activated by f3. The horn volume can be adjusted using a second potentiometer on the module. A particularly fine touch is the fact that, if you switch on the diesel sound via f1 and immediately drive off, the locomotive does not immediately obey this command. First the engine is pre-lubed and started and the locomotive does not start to move until the diesel motor has caught. There is a special coding switch for fine-tuning the sound module which can regulate the following:

- whether starting and pre-lubing is a long or a short process
- whether the diesel sound starts immediately or whether the starter is first audible
- whether one or both motors are started
- whether the sound switches itself off while idling after a specified time or not.

One further special feature: the light on one side of the locomotive can be switched off using the f2 and f4 keys. For example, if the V 200 is travelling without cars (wagons), the three lamp headlight is turned on in the direction of travel, while three red marker lights are on in the rear. If the locomotive is pulling cars (wagons), the marker lights on the locomotive are not on. The marker lights can be switched off using the f4 key on item no. 37803. If the locomotive is travelling in the opposite direction, the marker lights are turned off with f2. You can of course do the same thing with the triple headlight code; this is truly the fine detail of model railroad technology.

Dieter Lorenz

Above & Right
On locomotive 37803, the volume of the signal horn is regulated using the left potentiometer while the right one regulates the volume of the diesel engine.
The sound module can be individually regulated via this coding switch.

Left
V 200, the first HO locomotive with a built-in speaker.