



From the earliest days of model railroading, hobbyists have sought methods to improve the operation and control of their trains. Much of what we take for granted today was the work of many dedicated individuals who sought to develop common methodologies which would allow reliable operation of multiple trains from a variety of manufacturers.

Decisions had to be made regarding subjects that we now consider trivial: What voltage should we use? Should the motors be AC or DC? Should we use three rails or two rails? How do you control a reverse loop? Without the early work to get agreement (eg. Standards) the ability to intermix equipment from a variety of manufacturers might never have occurred.

Today we are fortunate to have an NMRA standard for control that continues to improve and evolve. Take a moment to thank the dedicated people at the NMRA that make this happen.

The Quest For Better Train Control

- From the beginning, Train Hobbyists wanted to control their trains independently. (1893 World's Fair, first electric model train)
- Early attempts were crude but sometimes quite effective. (Traction with rectifiers)
- Toy Trains (Lionel, Marx, etc.) used AC and the "E Unit" was a breakthrough.
- Scale Trains focused on DC motors with polarity change for direction control. (12 Volts became standard)
- Elaborate methods to control the track came into use. (Huge control panels, dividing the track into blocks, automatic route selection, etc.)

In 1893 an electric train model was demonstrated at the World's Fair. This was intended to thrill and impress the attendees, with the hope that they would see the possibilities of full size electric trains. Little did they know that at the same time they were promoting electric railways they were sowing the seeds for a new hobby!

Some of the earliest attempts to independently control were surprisingly effective. Traction modelers used small Selenium rectifiers and the overhead wire (3rd rail) to control up to four trolleys independently.

Early toy trains incorporated a little lever protruding through the top of the model which could be used to switch the field winding therefore allowing direction control. Awkward at best, this manual operation was replaced with the invention of the "E Unit". This was an electromechanical sequencer that allowed the operator to change direction remotely by going through a sequence of forward-stop-reverse-stop-forward. This was a breakthrough!

The Scale train enthusiasts opted for DC control. This eliminated the need for the third rail, but added to the control complexity of the railroad., eg. most notably reverse loops.

By Kenneth Mortimer

Independent operation of four trolleys in the same block

No complex equipment needed

YES, that's what I said. No complex transmitters or other fancy equipment is needed to have control that performs very much like Astrac's carrier control—providing you are a traction man and are willing to make one small sacrifice. The idea will work with steam and diesel locomotives, too, but then you are limited to two units of motive power and the sacrifice you must make is more serious.

The sacrifice is that you must give up polarity reversing. With traction that's usually no problem, for it's very common to use the raising and lowering of the trolley poles for reversal.

The whole idea is an old one that has been in *Model Railroader* before, more recently in Moss' "Daisy," but it's too good to get buried by time. In the Detroit area quite a few traction modelers use it. It is also used in California, Wisconsin, and other states.

Actually it is a combination of two ideas. One gives you separate control of

two pieces of motive power; adding the other idea—in either order—doubles the number.

Look at fig. 1. This is as simple as A-B-C. If you adjust one rheostat it affects only one of the two motors. Turn the other rheostat and the other motor responds. Two batteries are shown (let the left) for power supplies, but any suitable source can be substituted. Since they are permanently connected at one end, and match in both voltage and polarity, you can safely substitute a single battery or power pack for both of them. This gives you fig. 2, still with independent control.

Now consider the trolley wire (or third rail if you have it instead) as the common return feeder (fig. 3), one running rail as feed wire AB, and the other rail as feed wire CD. You have the same independent motor control but on track. Note that the insulated wheels must all be on one side of one car, and all on the other side of the other car.

Note that car 101 has all of its insulated wheels on the left side and car 102 on the right. Car 101 therefore picks up current only from the right-hand rail. If it should pass through a return loop, trouble would occur, because then its hot wheels would be on the closer rail. For this reason, return loops are avoided in traction lines using this system; or else manual switches are added so the pickup can be made from either rail as desired, or both when visiting other layouts.

Well, that's the first idea. Now let's

move on to the second, which does have capacity. It is this second idea that is used, with limitations, on steam roads as well as traction, doesn't require a third rail or it does abrogate polarity reversal.

First let's look at the theory cut in fig. 4. Here the polarity can be reversed by a 2- Ω switch. Two motors, 3 and 4, are connected in leads from the egg switch in parallel fashion, but only one motor runs—but the other. Throw the switch left, and the motor runs instead. This is how

each other. Which motor runs on the polarity at the moment.

Imagine, now, that you flip the back and forth 60 times a second could do it. Now each motor runs half the time, and both will run sensibly, not too good. By alternating current for the left would get the same effect when the reversing switch. Fig. 4 is principle but it is not a practical.

In fig. 5, such an a.c. source placed to two rheostats via two diodes opposed in polarity. The output harness goes to a rail of the common return feeder (or third rail).

Now if you adjust rheostat Y, it will respond because half the a.c. can pass through diode L, and

the other car won't run as you use rheostat Z, since the other diodes are connected the other way.

While this idea with the other, and get fig. 6. The a.c. source can be of more transformers producing 110 volts. The a.c. terminals of a big power pack will also supply 16 and usually enough current for four traction cars. A heavy power pack transformer would handle heavier

loads. P, Q, R, and S must have the sort of current and voltage ratings diodes in the cars, but not necessarily the same. (If you want to

operate on a power pack, the rectifiers inside it can often be rewired to save your buying extra diodes. This will not be explained, because power packs are wired many different ways; and the cost of adding separate diodes outside the pack or transformer is not great.)

Fig. 7 shows complete wiring for a double-ended car with trolley-pole reverse. Two cars will have their diodes connected in reverse to the direction shown. Those two cars will also have to

have the wires to their motor brushes interchanged as they will still run in the same direction as the other cars.

Operation will be on pulse power, which might result in low-speed running and grinding noises in some cars. On a heavy train it also produces considerable heat. If necessary, this can be minimized by connecting a large nonpolarized electrolytic capacitor—say, 500 microfarads up to 15 working volts or more—across the motor brushes.

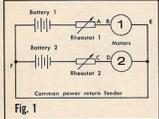


Fig. 1

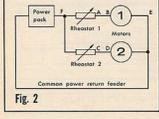


Fig. 2

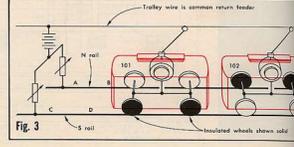


Fig. 3

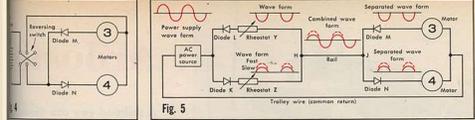


Fig. 5

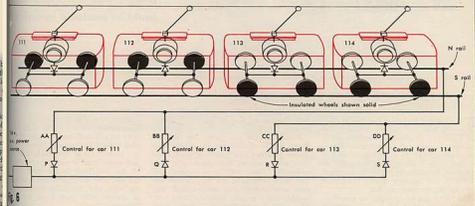


Fig. 6

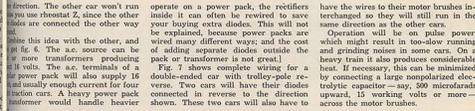


Fig. 7

Parts requirements for diodes
For the diodes in the cars, use any sort of rectifier that will fit the space, and has a current and voltage rating somewhat in excess of the current the car will draw and at least twice the voltage it runs on. A diode rated at 50 volts and 2 amperes would handle very hot the heaviest C and S scale equipment. The new silicon type is compact and now often costs under a dollar.

The following are among many that meet the requirements:

- 1N1412, by General Electric, RCA, Texas Instruments, and others.
- 1N2208, Motorola and others.
- AR1028, Motorola (low cost).
- AR1030A, as above.
- 1N251, Texas Instrument and others.
- 2F10, International Rectifier.



The HO Salem A Northern Street Ry. is run by Leonard W. Miles, Salem, Mass.

Various methods were devised to allow multiple engines or trolleys to be controlled independently on the same track, using analog signals. This article from 1966 describes such a scheme.

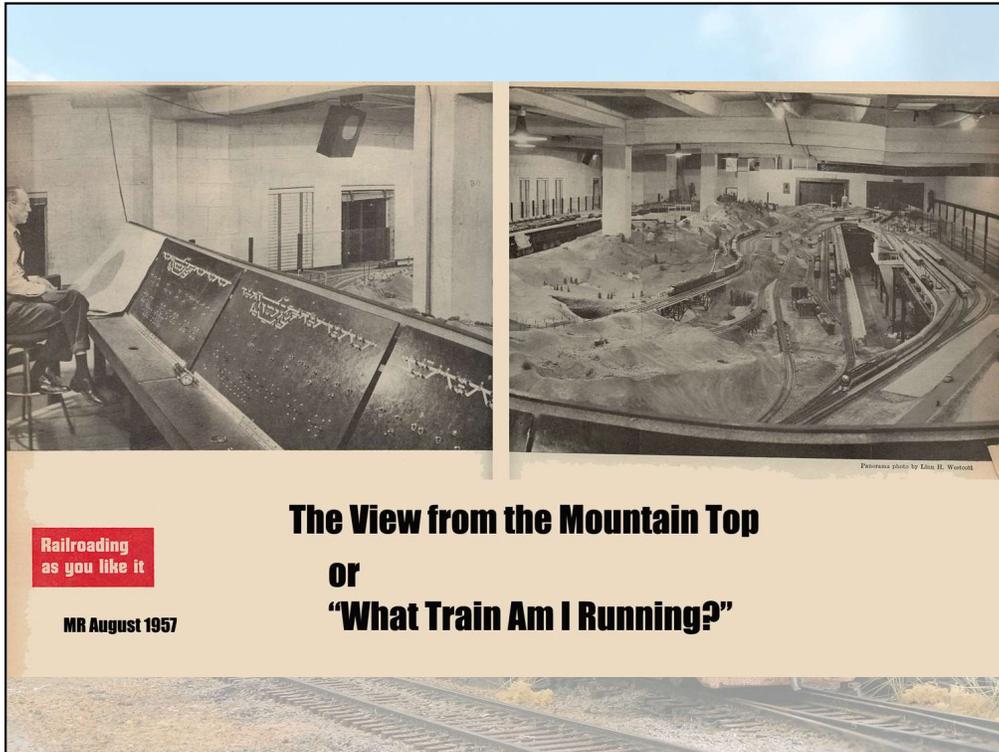
Layout Control

- Club layouts, because of their large size, gravitated toward centralized cab control with large control panels that isolated the operator from the train.
- Operations oriented hobbyists broke the layout into “divisions” or “districts” where the operator was in control of all trains in that particular area.
- Walk-around cab control came into being with the advent of “Progressive Cab Control” allowing the operator to be close to the train.
- Computerized cab control gained recognition. (CMRI-Chubb, CCC-Glaab)
- Tethered Cab controls allowed the operator to stay close to the train. Still, the methodology was to control the track.

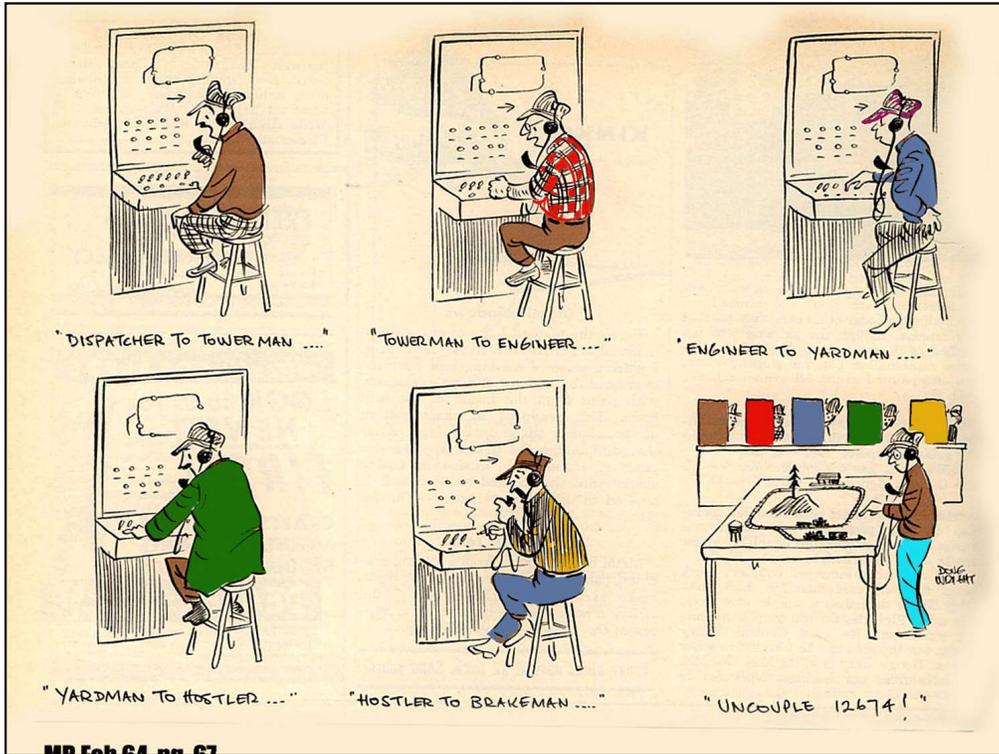
As layouts grew in size the problems with controlling multiple trains also grew. Club layouts, traditionally large, posed some of the greatest control problems and offered challenges to a larger number of hobbyists who could solve these problems working together.

The “Control Panel Era” was upon us! Several different concepts emerged. Some layouts gave control of all trains to an operator of a “district”. Other concepts duplicated the entire railroad schematically for every operator, with controls for turnouts and block power duplicated on every panel. Other concepts were hybrids of these methodologies ultimately evolving into dispatcher control which is still quite popular today.

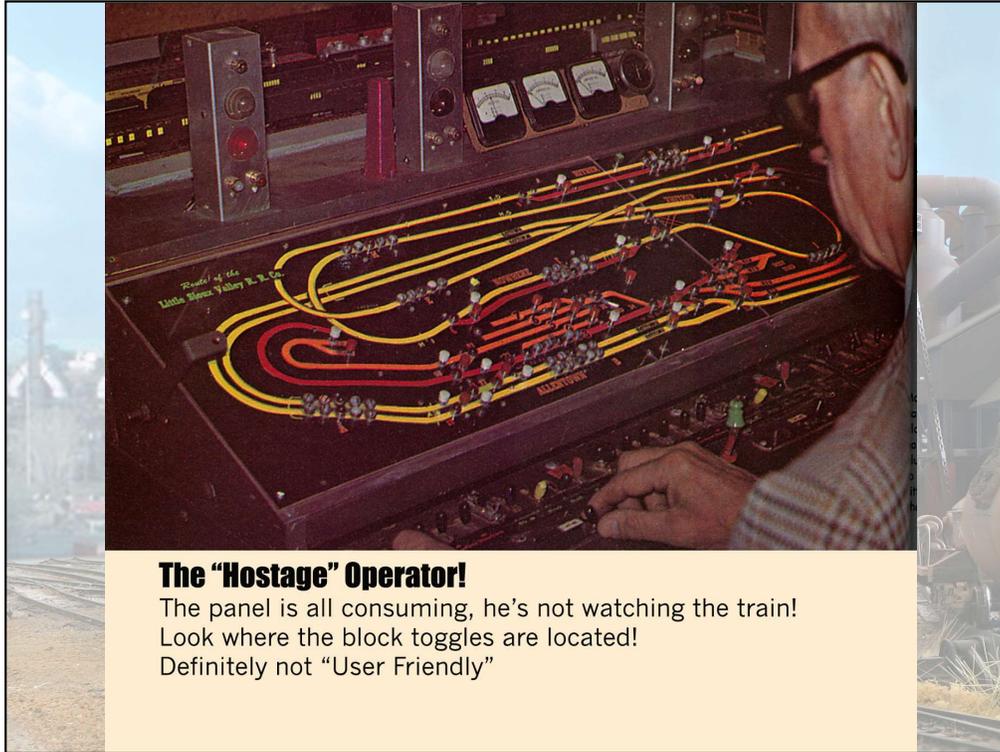
With the advent of semiconductor technology being applied, “Walk-Around” control came into popular use which allowed operators to stay close to their trains. For a short while there were forays into “Compute Cab Control” which relieved the operator from the task of throwing electrical switches to route power. Better described as “Computer Power Routing”, this concept was short lived as the technology for independent train control began to emerge.



Elaborate panels located far from the actual model train became the norm for large layouts. Although experienced operators could operate the trains smoothly and realistically, the operator was far removed from the action.



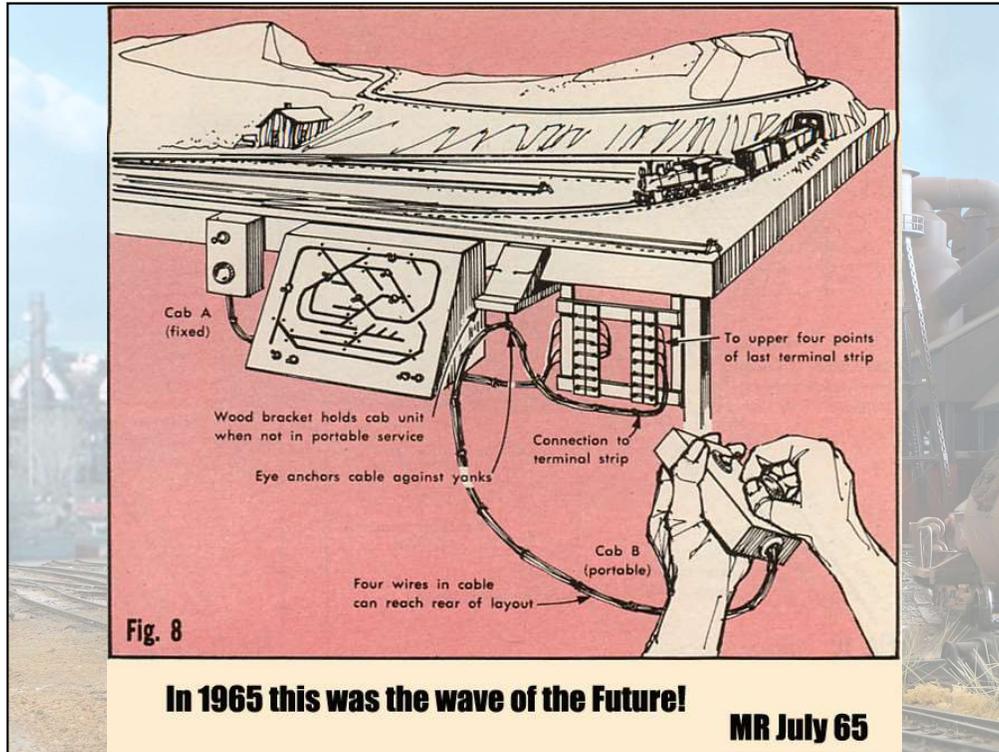
Although highly satirical, this cartoon illustrates that in some cases, the control system was more important than the train layout!



The "Hostage" Operator!

The panel is all consuming, he's not watching the train!
Look where the block toggles are located!
Definitely not "User Friendly"

The ultimate evolution of the "Control Panel Era" is achieved when the operator spends so much energy and time operating the control panel that he no longer actually sees the train!



By 1965 , train control concepts were “beginning” to change from the traditional central panel oriented control to the walkaround throttle oriented operation. Note that only one throttle is tethered, the other was still firmly fixed next to the control panel.

This introduced a fundamental conceptual change in the way trains were operated – the operator no longer was in charge of the entire layout or all the trains running in a specific district – rather he/she was assigned to a particular train. This approach became popular in the United States, while the more traditional central panel control remains popular in other parts of the world.

Controlling the Train

- Lionel developed the Electronic Train Control System in 1946 that permitted independent train control, and operation of automation in each car. A maintenance nightmare, it was phased out in 1949.
- General Electric developed Astrac in 1963 which allowed independent control of five locos. The floodgates opened!
- Dynatrol followed in 1980 and controlled up to 18 locomotives independently. Later units included sound.
- Analog control systems went into decline with the advent of DCC, due largely to their proprietary nature.

In 1946 Lionel pioneered independent train control. What in theory, appeared to be a real leap forward, was a disaster. Promoted as allowing the operator to independently control his train and uncouple each car independently proved to be impractical.

Lionel's methodology was basically a "tone-control" system which used electron tubes and frequency filters. The problem was that it was unstable.

The oscillators generating the tones shifted with heat, and crosstalk caused serious frustration.

GE's Astrac (Automatic Simultaneous Train Control) was introduced in 1963 and could independently control up to five trains simultaneously. This system demonstrated that independent control of each train was possible and affordable.

Dynatrol and other Analog systems improved and expanded the capabilities of analog control but were limited by their proprietary nature and were soon to be surpassed by a variety of digital systems which ultimately led to the open source DCC system.

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In spite of advertising and promotion some systems failed to gain acceptance. Have you ever seen or used one of these systems? It is an example of a “future product” ad that never made it to become a viable commercial product.

Summary

- Analog Systems, Astrac, Dynatrol, etc. lost popularity due to the open architecture of DCC.
- Layout design has gravitated away from large, centralized control panels toward walk-around control.
- Centralized control is still a good choice for display layouts.

Some analog systems are still supported by their manufacturers, but virtually all are out of production.

The large centralized control panel has largely given way to walk around control. No longer is the engineer removed from his train. By being close to the train switching operations are easier, and the engineer can actually see the scenery up close. (This may be good or bad.)

For some systems, primarily layouts used as commercial displays, analog still has advantages. The Pacific Fast Mail sound system is still the best sounding train control system. No DCC whistle can compare to it.

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(CAB, COMPUTER, CONTROL, BL)

The Quest for Better Train Control – Part II

Digital Train Control

Gil Fuchs & John Glaab

The second part of the clinic “The Quest for Better Train Control” discusses the history and evolution of Digital Train Control.

Digital train control evolved along with developments in the electronics industry and the adoption of digital systems, computers and microcontrollers. The ultimate goal was to improve the control experience, simplify system design, improve supportability and maintainability of the products, and make the system more robust.

Digital Train Control - Timeline

- 197x – Zero 1 developed by Hornby
- 1979 - CTC16 published in MR by Keith Gutierrez.
- 1980/2 - Selectrix developed in Europe and recognized by MOROP/NEM (European organization/ standard body)
- 1983 - CTC16e adds features to CTC16 (sound)
- 1984 - Märklin Motorola system
- 1988 - Lenz develops/introduces DCC
- 1993 - DCC accepted into NMRA Standards/RPs
- 1994 - Märklin new Motorola System
- 2002 - DCS by MTH modulates a digital signal. Rivals TMCC from Lionel.
- 2003 – RailComm developed by Lenz for Bidirectional DCC and accepted by NMRA
- 2004 - Märklin mFx has feedback and address detection

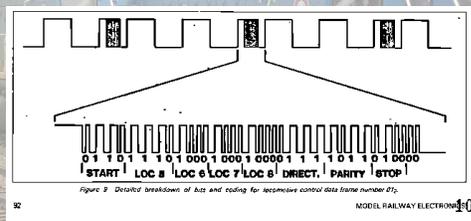
Early attempts of digital train control started appearing in the early 1970s, following the evolution of digital systems. Early systems were based on discrete components and “glue logic” rather than microprocessors, microcontrollers or computers. As a result, the design flexibility of these systems was limited by what the electronics industry had to offer.

In reviewing the progression of digital train control systems, it is noticeable that early systems were partially analog in nature. Analog elements such as pulse width and amplitude were used in those systems for lack of a better control mechanism, and due to performance limitations. As digital technology sophistication increased, with higher available transmission rates, train control systems became fully digital.

The proliferation of systems and protocols, while creating customer “forced loyalty” and binding them to a single manufacturer, created an interoperability problem. It was virtually impossible to operate one manufacturer’s equipment along with another’s on the same layout. A major milestone in the development of digital train control systems was the introduction and acceptance of NMRA DCC as a set of standards and recommended practices in 1993. While a few major manufacturers continued to develop their proprietary protocols, DCC took its place as an industry standard with the majority of manufacturers adopting it.

Hornby Zero One

- An early digital control system developed in the 1970s
- Power is provided in a square wave bipolar signal of +/- 22V
- The power is cut in short time and distributed windows to send a digital command, to either a locomotive or an accessory.
- Bits are encoded similar to DCC (long and short bits of 1 and 0 respectively).
- Limited to 16 locomotives and 100 accessories
- Receivers were “programmed” by linking pads on the PCB with conductive paint



One of the early adopters of digital technology was Hornby of the UK, with the Zero One system. This system was developed in the early 1970s and was an early attempt to combine a power signal with a digital transmission. In order to achieve that, the command station cuts power to the rails at a predefined short time window, used to transmit a short burst of data.

Power was delivered as a square 22V bipolar signal, to allow travel in both directions. As control data transmission was confined to a short window, the bandwidth was limited to controlling 16 locomotives. The limit on accessories was more lenient – 100, as they typically do not require frequent command repetitions to be sent. It is interesting to notice that the NMRA DCC bidirectional specification uses a similar technique of cutting power to the rails for a window that allows locomotives to transmit data back to the command station. Time synchronization with the locomotives is more complicated in DCC than in the Zero One protocol.

Technology limitations did not allow a sophisticated receiver programming and configuration mechanism, similar to the one offered by DCC. Receivers were configured by soldering links to pads or conductive paint links on the PCB.

CTC16 – Digital/Analog Hybrid

- CTC16 and derivatives are using a hybrid analog/digital solution in which time is sliced, and width of every pulse represents the channel speed. Limited number of channels (16).
- Developed by Keith Guttierrez starting in 1978, based on the Digitrack 1600 system but with TTL logic
- A centralized system. Decoders are simple and the “brains” is in the controller
- Later added transmission of sound over the rails by modulating the amplitudes.



Another example of an early digital control system is CTC16 which was developed by Keith Guttierrez starting in 1978. Keith is a former engineer of Texas Instruments and now owns CVP industries, a manufacturer of DCC systems. Several versions of CTC16 were introduced and gained wide popularity among modelers – especially following 2 series of articles in “Model Railroader” magazine that described the construction of the system as a DIY project.

CTC16 is based on an earlier system, “Digitrack 1600”, that was developed using discrete components. CTC16 is more compact as it was developed using digital integrated circuits (“glue logic”).

As one of the early systems, CTC16 is a good example of a hybrid analog/digital solution. It uses time slices to control up to 16 locomotives. The 16 channels are controlled by a series of 16 pulses – pulse width conveys the locomotive speed. Most of the smarts are located in the controller and receivers are simple and relatively small. In later versions of CTC16, sound transmission was added by modulating the amplitude of the pulses.

Selectrix

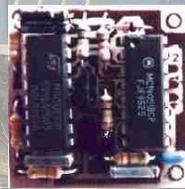
- A canned solution with dedicated hardware and chips
- Developed in 1982 by Döhler & Haas for TRIX and remained proprietary until 1999
- Partially adopted by MOROP as a NEM standard
- Very efficient in space use. Decoders are much smaller than DCC (~2mm thick).
- Transmission rate faster than DCC
- Limited to a small subset of vendors, mainly for the German bloc market (mainly Trix, Rautenhaus and Müt-Digirail).
- Full compatibility of components.

Selectrix was developed in 1982 in Europe by Döhler and Haas for TRIX (the DC branch of Märklin). In 1999 it was adopted as a NEM standard by MOROP, and became publicly known.

Although a relatively old system, it is still popular primarily in Europe. Selectrix uses proprietary hardware and this allows integration of most desired functions into a single IC, keeping decoder sizes (in general) smaller than DCC decoders. The transmission rate is higher than DCC as well. Due to the small number of implementation and dedicated hardware, compatibility and interoperability of Selectrix components is guaranteed. Despite the above, components are relatively expensive as royalties have to be paid to producers of the specialized hardware, and product selection is limited to a small subset of German manufacturers.

Märklin Motorola

- Development based on preexisting integrated circuits (MC145026/7) used in TV and other remote control units. At some point Märklin developed their proprietary chip.
- Originally supported up to 80 engines. Accessory control was a separate channel with half the transmission rate. Had to be compatible with Märklin AC and 30V+ pulses.
- Centralized system - very basic (bare bones) decoder, intelligence is centralized in the control unit.
- System designed primarily for central control operation, using Märklin's 3-rail system. Provided precise block control.

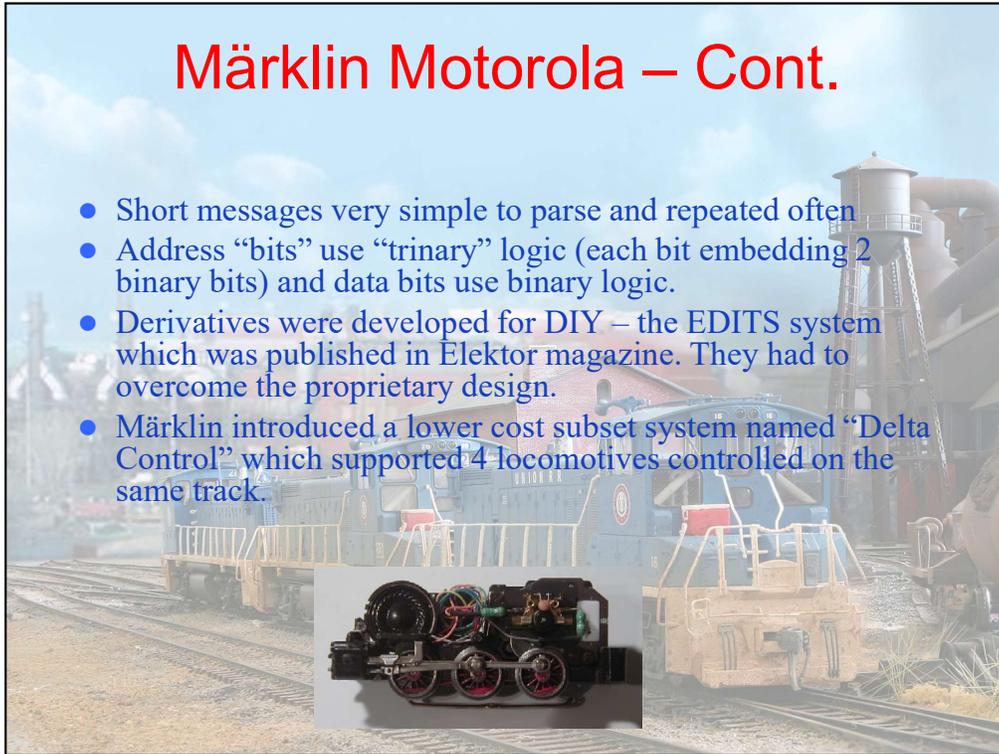


The German train manufacturer Märklin has introduced its digital track protocol in 1983. Based on a set of integrated circuits from Motorola, that were designed for remote control applications (ex. TV remote control) these gave reasonable performance for the early days of train control.

In order to support accessory control using the same IC base, the developers halved the transmission rate, thereby creating two independent channels. The Märklin – Motorola system could control up to 80 locomotives. Decoders had to be rated for high voltage to be compatible with pulses of >30V used in Märklin's AC analog system to change the direction of travel.

Märklin Motorola – Cont.

- Short messages very simple to parse and repeated often
- Address “bits” use “trinary” logic (each bit embedding 2 binary bits) and data bits use binary logic.
- Derivatives were developed for DIY – the EDITS system which was published in Elektor magazine. They had to overcome the proprietary design.
- Märklin introduced a lower cost subset system named “Delta Control” which supported 4 locomotives controlled on the same track.



The protocol used “trinary logic” in which every pair of bits represented a value of 0 (00), 1 (11) or 2 (10) and where a (01) sequence indicated an error. This trinary system was used for addressing locomotives. The command bit pairs (speed or function control) were always binary (00 or 11). For additional reliability every message was repeated twice. Effectively on the wire a message would always consist of 18 binary pulses, and polarity was significant for correct detection. This represented no problem with Märklin’s 3-rail track, but was not very suitable for 2-rail operation.

Decoder size was dictated by the space reserved for the direction control relay in analog Märklin engines, which was guaranteed to be available. Several systems spawned off of the Märklin system by the company itself (Delta for starter systems, Motorola ver. 2 and later mfx). Other compatible systems evolved as DIY projects, such as the EDITS system by “Elektor” magazine.

NMRA DCC

- Developed by Bernd Lenz in 1988
- Ratified as NMRA Standards and Recommended Practices in 1993, as part of the electrical S&RP (S9)
- **The most widely supported and globally used standard**
- A distributed design with smart decoders - less load on the central system. Decoder based on a microcontroller (single chip computer).
- Packets are 3-6 bytes long



Bernd Lenz, whose company “Lenz GMBH” formerly designed for Märklin, developed around 1988 a protocol suitable for 2-rail systems that was polarity-independent and noise immune. Initially targeted for Arnold N-scale systems, The protocol was proposed as an NMRA standard free of any patent claims, accepted and ratified in 1993. The S9 standard and RP9x include the specifications for this protocol, known as NMRA DCC.

DCC is the most widely accepted world-wide standard for train control. Apart from technical innovations that were introduced with DCC, such as the ability to program decoder configurations, it is not controlled by any specific manufacturer and is accepted as a baseline standard.

NMRA DCC – Cont.

- Supports 2 sets of addresses for locomotives and 2 sets for accessories (short & long)
- Accessory packets developed separately
- Bidirectional communication added in 1997, with limited bandwidth – but is currently handled outside of DCC
- Large number of offerings/ manufacturers, including features like sound. Interoperability is generally maintained, but due to large number of manufacturers may not be complete.
- Decoder programmed on a service track, standard and manufacturer specific CVs.



DCC is accompanied by conformance tests, providing the modeler a level of assurance that conformant products can interoperate with other DCC conformant products, regardless of the producer. As a result of its wide acceptance modelers can enjoy a large number of product offerings, from stand alone decoders and those embedded in engines, to command stations, power boosters, accessory control units and occupancy detectors. In recent years sound decoders have been proliferating, adding to the experience and enjoyment of their owners. As more and more features are introduced to the market, more problems are found – including incompatibilities and ambiguities in the standards which are continuously worked on by NMRA and participating manufacturers.

Bidirectional DCC

- European style operation mandates accurate location detection (ex. stopping in front of a red signal). Engine identification is critical as well.
- Several methods have been suggested to allow the engine to transmit back information to the command station and/or block control devices
- RailComm accepted by NMRA in 2003.
- Operates by briefly cutting power to the rails in every DCC packet.

NMRA DCC was originally designed as a one-way power and control protocol where the command station sends packets over the rails to engines and accessory controllers, and simultaneously powers the rails. In the European market, there was a demand to add the capability for an engine to transmit data back to the command station and further to other attached control systems.

The European style of operation, unlike the style mostly used in the USA, is based on central control of multiple trains – either of the entire layout or in a district. Every operator is responsible for multiple trains and passes them through the districts. Signaling systems are used with strict regulations, and it is vital that a train can be stopped directly in front of a red signal. In order to accurately locate the train, the engine can transmit some data back to the command station between every pair of regular DCC packets in a well defined time “window”. An added benefit is that engines can be immediately identified when they are set on the rails.

Bidirectional DCC – Cont.

- The engine transmits a high bit-rate message in this time slot.
- Limited bandwidth
- Requires very accurate time synchronization and difficult to implement power cut-off
- Operational issues with equipment that “chokes off” the feedback signal
- Limited use in American-style operation.

Considering DCC is a power bus as well as a data bus, in order to allow the decoder to generate a signal on the rails, power from the command station has to be cut off for a brief period. Very accurate synchronization of the cut-off window and the transmission by the decoder is required for this to work. This system was patented and named “RailCom” by Lenz and Zimo, and supported by a few manufacturers. Other methods that were investigated were modulation of high frequency signals over DCC.

Every method proposed so far has introduced some problems, and comes with its own set of restrictions. RailCom requires that no rolling stock or accessories connected to the rails load the rails with current during the BiDirectional transmission, power-off window. Frequency modulation requires that no high capacitance load is connected to the rails, since such capacitance dampens the signal and interferes with its detection. Unfortunately, old MR equipment, not designed for BiDirectional DCC operation, tends to cause more interference (examples are locomotives with open frame motors, presenting high power load and generating high electromagnetic noise). In order for Bidirectional DCC to work, such equipment should be either modified or removed from the rails.

Summary

- Digital Train Control systems evolved along with digital electronics
- The first systems were hybrid, then using discrete logic and specialized ICs, and finally a Microprocessor
- Centralized systems were faster to develop but put more strain on the controller unit, and typically have less bandwidth for growth.
- Distributed systems are more scalable but require more sophisticated receivers – decoders.
- Wider acceptance of standards like DCC inevitably creates more interoperability issues, but drives better products and innovation

The evolution of digital train control systems is closely tied to advances in microelectronics and the proliferation of microcontrollers (single chip computers).

Early systems were hybrid, a combination of analog and digital components and were constructed from dedicated ICs and “glue logic” components. Later systems utilized programmable devices, primarily microcontrollers.

Design approaches included centralized systems in which most of the “brains” and logic was concentrated in the “master” control unit. This led to high load of these units and limited bandwidth for operation – a limited number of engines could be controlled. Decentralized design mandated more sophisticated receivers (decoders) which used microcontroller technology, but performed better.

A major step in the evolution of Digital Train Control was the endorsement of DCC as an NMRA standard and its wide acceptance in the market. Modelers were finally assured to a reasonable degree that products from different manufacturers can interoperate in the same layout. While there is always room for improvement, a unified protocol brings value to the consumers and promotes innovation. Emerging enhancements to DCC include bidirectional transmission which can potentially simplify the user experience and allow for more features in operation. It requires more R&D in order to increase its reliability and viability as a widely accepted technology.

The Future of Control Systems

- Interoperability of DCC is currently only at the track. The control busses are proprietary. There are several initiatives trying to expand the standard to include a control bus, including MERG CBus and NMRA LCC.
- Cheaper, smaller and more feature rich decoders are being developed, including improved sound solutions – including WiFi based control.
- Newer generations of control units (command stations) are becoming closer to PDA technology, providing a screen and touchpad, many more features and program controls (software), leveraging PC, networking and the Internet
- Improvements in train location detection and identification
- **Call to action: Your help is needed!! Market demand is the only force that would push for more standards and better interoperability, leading to more product choices!**

The DCC developer community continues to propose enhancements and improvements to the standard. Several initiatives are attempts to standardize the control bus protocol – which is used to connect throttles, panels, sensors and signals - in a similar way to the track protocol. A major obstacle here is the competition among vendors and market presence of their proprietary solutions.

Decoders are enhanced with more features and reduced size, one key feature being improved sound capabilities. Sound decoders are becoming a de-facto standard and expected by many modelers.

Command stations are beginning to embed PC technology (PDA or single board PCs) and full operating systems such as Windows and Linux. This allows modelers a rich experience in controlling trains, including GUI displays, touchpad controls and interfaces to the network and the Internet.

Improved protocols for train location and signaling continue to be developed.

All the above initiatives are driven by market demand for improved standardization and interoperability of products – and this boils down to each and every consumer. The more demand there is for products to be conformant to the standard, the more manufacturers would be driven to follow the standards and make the extra investments necessary in testing and correction of problems. This is especially important during difficult economic times.

Links / References

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please support the DCC standard by asking for conformant DCC products!

Thank You!