Märklin Digital Model Train Control (2)

Final part: software, construction and operation

From an idea by J. Schröder

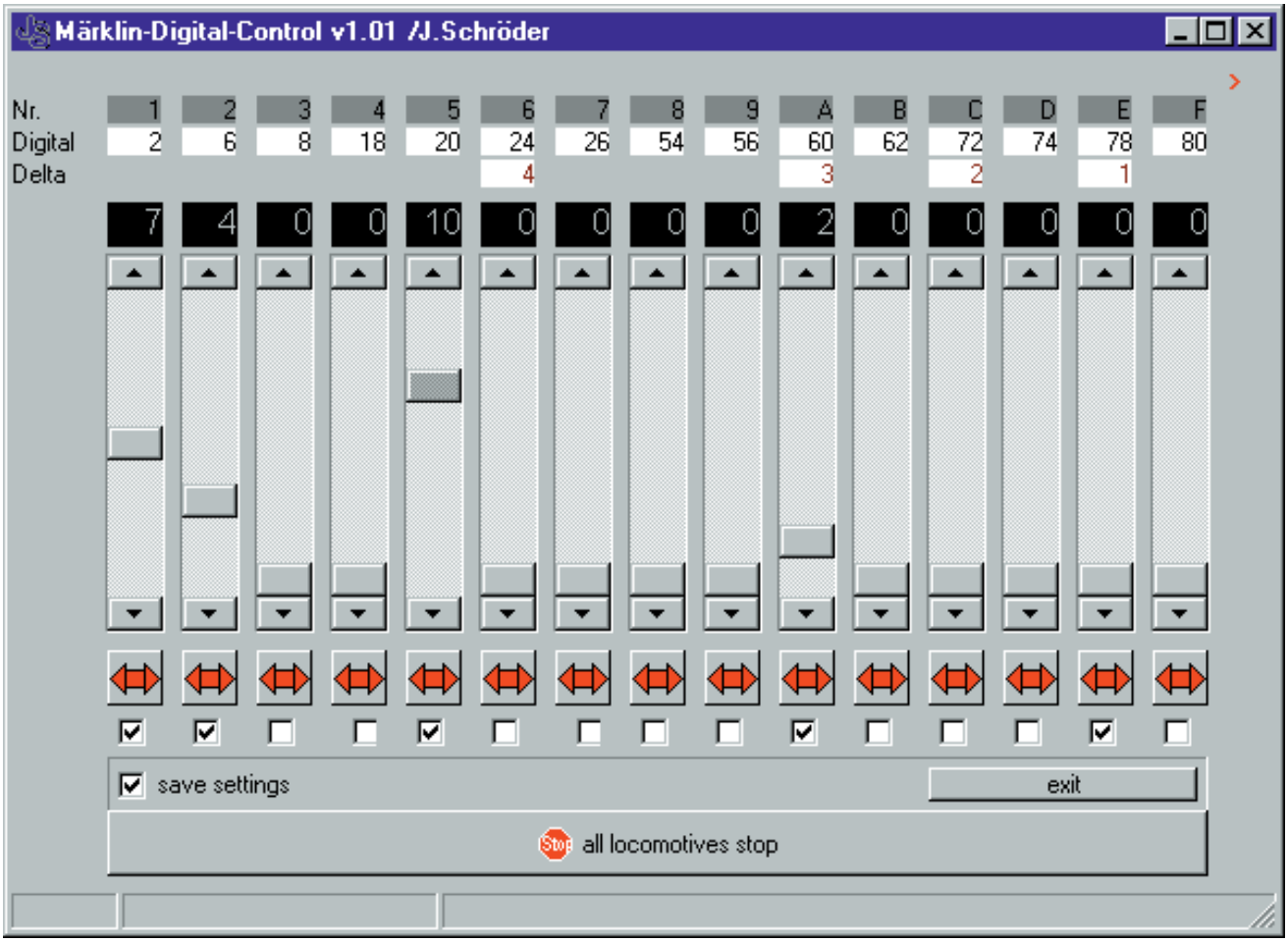

Figure 3. Screenshot of the Windows program written for the train control system.

The Software

In addition to this circuit, a PC is necessary onto which the requisite Windows program needs to be installed. Continuing in the spirit of simplicity, manual controls are not provided. The system requirements have been kept to a minimum. Practically any PC should be capable of performing the task. This applies also to the minimum required version of Windows. The time-honoured Windows 3.1x meets the needs admirably. In addition, provision has been made to make keyboard operation possible. Experience shows that, once familiar with the keystrokes, this method of operation is extraordinarily convenient and fast.

After starting the software, a screen will appear as depicted in **Figure 3**. For language purists, there

is the built in facility to customise the labels of the buttons to your heart's content.

At the top are the (fixed) loco address configurations: first the Märklin loco address, below that, the Delta loco address of the four applicable controls.

The slider (can also be operated with the arrow keys) speaks for itself, it is used to adjust the speed. The small window above the slider indicates the selected speed.

The purpose of the button below that is to select the direction of travel (toggle function). A marginal note is in order here. At certain loco speeds, this button will cause instant reversal of speed. At higher speeds (approximately speed level 7 and up) this abrupt reversal is disabled, perhaps for the wellbeing of potential model railway passengers. In this case, the speed must first be reduced to a lower value, or zero, before carrying out the reversal of direction.

The tick box at the bottom is used to enable or disable the control. The response time of the system is faster when fewer controls are active.

The button 'Save Settings' saves the configuration of the active controls in the file *mrkln01.ini*, which is in the same directory as the one from which the program was started. Note that the current position of the loco control is not stored. The stop button (also operable by hitting the space bar) immediately forces all controls to zero. In contrast with the stop button on the PCB, this stop function will maintain power to the rails.

A number of functions, including which parallel port to use (LPT1: or LPT2:) are fixed in the file *mrkln01.ini*. The details are explained in the box titled 'Software Operation'.

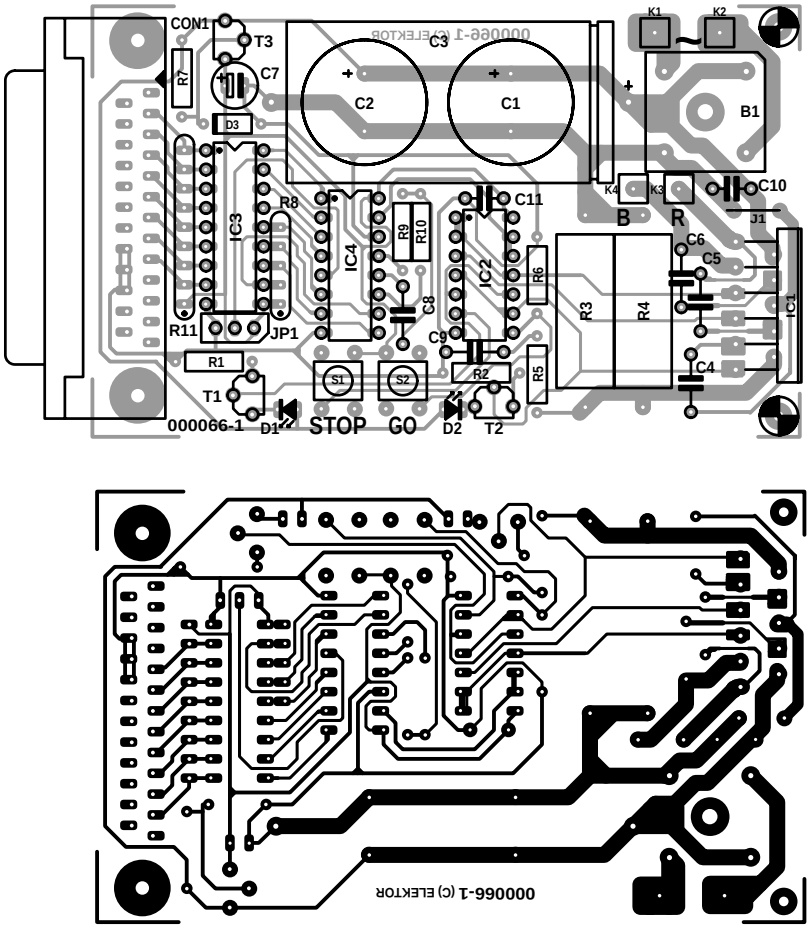

Figure 4. PCB layout and component overlay.

Construction

With the aid of the component overlay and the layout of the single sided PCB (**Figure 4**), you will not need to resort to witchcraft in order to build a functional circuit. A few construction hints, though.

There is a single wire link just above IC4. The trimmed-off part of a lead from C1, C2 or C3 may be used for this. Use this in preference to a lead from one of the resistors, since

COMPONENTS LIST

Resistors:
R1,R2 = 560Ω
R3,R4 = 1Ω5 5 watts
R5,R6 = 10kΩ
R7 = 2kΩ2
R8 = 4x10kΩ SIL9 array, 1 common
R9 = 22kΩ
R10 = 47kΩ
R11 = 8x10kΩ SIL9 array, 1 common

Capacitors:
C1,C2 = 2200µF 40V radial
or C3 = 4700µF 35V axial
C4 = 220nF MKT
C5,C6 = 15nF MKT
C7 = 10µF 16V
C8 = 1nF MKT
C9 = 10nF
C10,C11 = 100nF ceramic

Semiconductors:
B1 = KBPC601 (6A bridge, International Rectifier)
D1 = LED, red, 3 mm
D2 = LED, green, 3 mm
D3 = zener diode 5V6 400mW
T1,T2,T3 = BC547B
IC1 = L6203 (ST Microelectronics)
IC2 = 4001
IC3 = ULN2803A
IC4 = MC145026 (Motorola)

Miscellaneous:
S1,S2 = pushbutton with make contact (e.g., Diptronics DTS-6XX)
CON1 = PCB mount 25-way sub-D plug (male)
JP1 = 3-way SIL pinheader with jumper, or changeover switch
Heatsinking material for IC1 (e.g. aluminium bracket, min. thickness 2 mm)
PCB, order code **000066-1** (see Readers Services
3,5"-inch floppy disk, Windows control software, order code **996016-1**

Optional:
Power supply transformer, 15 V / 5 A, as an alternative for the Märklin transformer

this one is slightly thicker and the link carries the entire output current.

The PCB offers the option to use two radial (upright) electrolytic filter capacitors (C1 and C2) or a single axial one. C1 and C2 may both be 2200 μF. This is sufficient, but larger ones (2 $\times$ 3300 μF or 2 $\times$ 4700 μF) are permissible and will also fit. A single axial electrolytic capacitor (C3), as used in our prototype, is also a possibility. The operating voltage was deliberately selected to be on the high side (35 V minimum) to ensure that the circuit will survive if the Märklin transformer is inadvertently switched to direction-reversal.

CON1 is the connector with which the circuit is connected to the parallel port of a PC. This may be mounted directly to the PCB. Take care that the force of plugging or unplugging the connector is not transferred to the solder connections. To ensure mechanical strength, there exist connectors with holes for mounting screws or a kind of barb for soldering to the PCB. Either type fits. If you prefer not to connect the circuit directly to the PC, but position it closer to the railway, you can use a DB25 extension cable (available for a small outlay in every computer store). Alternatively, you can solder the wires of such a cable directly into the circuit board.

S1 and S2 are switches with momentary make contacts. The switches specified in the parts list fit directly in the PCB. However, other types may also be used if they are connected with a short length of wire.

A similar story applies to JP1, which switches the function on or off. Three pins in a row and a jumper are satisfactory, because the function is usually switched on. Miniature PCB mount switches with changeover contacts also exist. Of course, an external switch attached with hook-up wire is also possible.

The tolerance of C8 is critical, because it defines the timing. Use an MKT-type (Siemens or similar) capacitor.

The rectifier bridge (a very common type from International Rectifier) will, in the event that maximum output current is demanded, appreciate a small amount of heatsinking. Prior to fitting onto the board, insert an M3 bolt in the mounting hole of the bridge (the screw head is at the bottom of B1). B1 may now be soldered onto the PCB. Finally, make a thermal link, using a right-angle section of aluminium extrusion, to the right angle heatsink onto which IC4 is mounted (refer to **Figure 5**). The hole in the bottom of the circuit board allows access so that the screw can be tightened. Don't put the screw through both the rectifier bridge and the PCB or you will run the risk that, when tightening the screw, the circuit board traces get peeled off the board. Alternatively, you can mount B1

Tabel I. Loco addresses and train speed/reversing codes

control	loco address	Delta address	A1-A4
1	2		X 0 0 0
2	6		0 X 0 0
3	8		X X 0 0
4	18		0 0 X 0
5	20		X 0 X 0
6	24	4	0 X X 0
7	26		X X X 0
8	54		0 0 0 X
9	56		X 0 0 X
A	60	3	0 X 0 X
B	62		X X 0 X
C	72	2	0 0 X X
D	74		X 0 X X
E	78	1	0 X X X
F	80		X X X X

Data bit	Coding	Result
A5	0	function (lights) off
	1	function (lights) on
A6..A9	0 0 0 0	stop
	1 0 0 0	reversing command
	0 1 0 0	speed level 1
	1 1 0 0	speed level 2 (etc.) …
	1 1 1 1	… speed level 14

0 = logic zerol
X = logic open

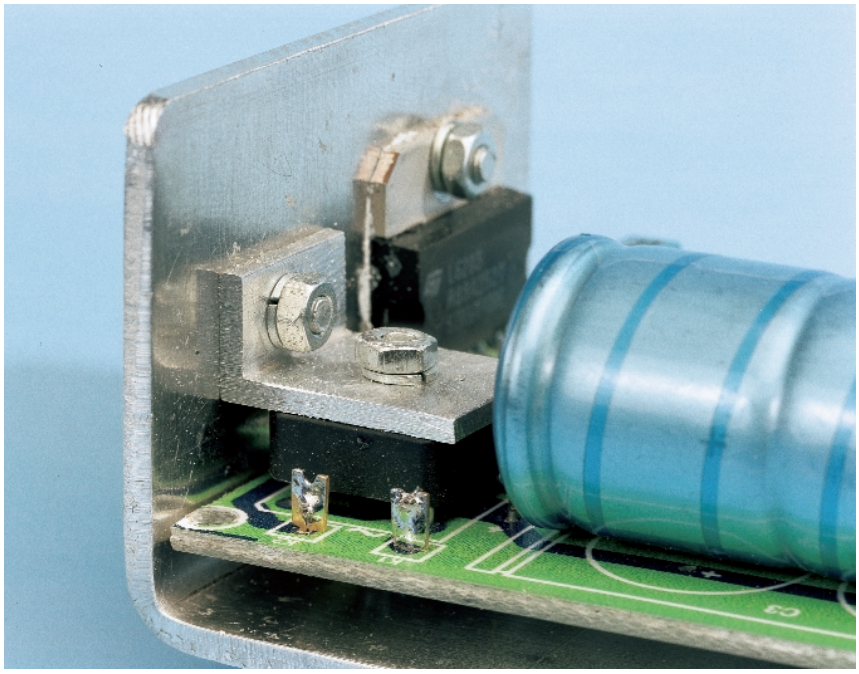

Figure 5. Construction of the thermal link for the bridge rectifier.

Software Operation

Key combinations
The program may be operated without using the mouse (applicable to mrkln01.exe V1.01)

Key (or combination)	result
<TAB>	next loco control
<SHIFT><TAB>	previous loco control
<1>-<9>,<A>-<F>	direct selection of relevant loco control
=	repeat same key, train reverse
<CTRL><1>-<9>, <A>-<F>	enable / disable relevant loco control
cursor up/down keys	increase / reduce speed
<0>	speed 0, immediately on selected control
<space>	speed 0, immediately on all controls (software emergency stop)
<ALT><F4>	quit program

Settings in file mrkln01.ini
The file mrkln01.ini (residing in the same directory as mrkln01.exe) contains information on currently used loco controllers (loco addresses), the printer port used, and the text strings inside the control buttons. Comment not included in the .ini file itself is shown to the right.

```
[PARAMETER]
CH1=0                          0 = control not in use
CH2=0
CH3=0
CH4=0
CH5=0
CH6=1                          1 = control in use
CH7=0
CH8=0
CH9=0
CH10=0
CH11=0
CH12=1
CH13=0
CH14=0
CH15=0
ADDRESS=888                    printer port; 888 = LPT1:, 632 = LPT2
USE_AD=0                       not used
SAVE_SETTING_TEXT=save settings text may be edited
EXIT_TEXT=close                to requirement
STOP_TEXT=stop all trains
```

directly to the heatsink and bend the connecting leads in a right angle; they should be long enough.

IC4 is also mounted on the heatsink. Electrical isolation is not required (the metal part is connected to the GND pin), but heat conducting paste is required. Remember that none of the AC inputs (K1 and K2) are connected to ground.

Powering up

It is always exciting the see whether or not the result of your industrious activity transforms into smoke when powering up, especially when 'power' is involved.

To be safe, it is always good practice to check the power supply voltage first. Connect the circuit terminals K1 and K2 to a Märklin transformer. By initially using the brown and red terminals (instead of the yellow) you can make a cautious start with a lower voltage.

The standard Märklin transformer is rated 30 VA. This is too small to deliver the maximum output current of 3.5 A. However, actual usage will indicate if it is sufficient for your normal use. The 50 VA 'lighting transformer', with its fixed 16 V output voltage, may be more appropriate. Naturally, any other 15 V transformer can also be utilised. From a safety point of view, we strongly discourage connecting the secondary windings of different transformers in parallel.

First check the voltage across C1 and C2 (or C3); this may be 20-25 V at the most. Then check the logic power supply, for example, between pin 8 and pin 16 of IC4. This must be between 4.8 V and 5.2 V; the exact value is not critical. If everything is in order, then the entire circuit may be connected to the PC and the tracks, using the connections B (brown, outside rails) and R (red, centre rail).

After switching on, the circuit will normally be in stop-mode. Push the appropriate button to activate the run-mode. Voltage is now applied to the tracks. In case of an overload, the circuit will automatically switch itself to stop-mode. Install the software by copying the two required files (*mrkln01.exe* and *mrkln01.ini*) to a directory of your choice (they must both be in the same directory). The file *mrkln01.ini* contains the definition specifying which printer port the circuit is connected to. This file also contains the text labels for the operating controls. After starting up the software, the screen will be as shown in **Figure 3**. Operation with a mouse is self-explanatory, for operation from the keyboard we refer you to the appropriate box. If it doesn't work, check first that the correct printer port (888 = LPT1:, 632 = LPT2:) is selected in the *mrkln01.ini* file. Another possibility is incorrect timing of the encoder. In this case you will need to tweak the values of C8 or R9. Those who hunger for more output power may connect terminals R and B directly to the input of the EEDTs-booster. If the tracks are fed only via the booster, then additional cooling for IC4 and B1 is not required. A few ground issues to keep an eye on, particularly if the EEDTs-booster is connected. Mains earth is connected through the PC to ground of the circuit (negative terminals of C1, C2, C3). Because the output is a full bridge, output B is **NOT** connected to mains earth. The R and B terminals of the EEDTs-booster must be allowed to float with respect to mains earth and this applies to the entire railway as well. When connecting (grounded) measuring equipment this has to be taken into account.

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