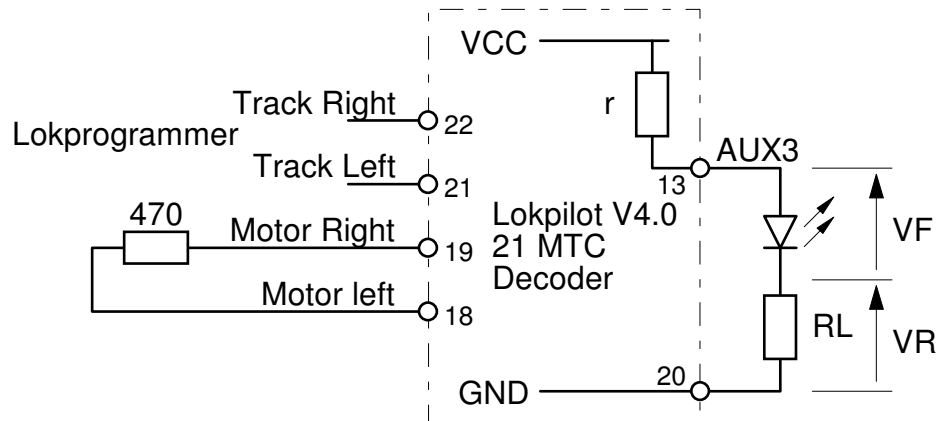


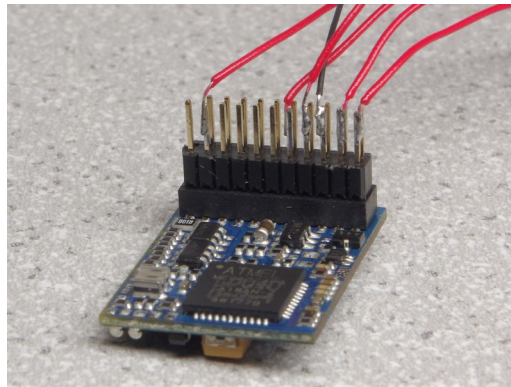
Test of the ESU Lokpilot V4.0 21 MTC decoder logic outputs

Purpose: determine the characteristics of the so-called logic outputs (i.e. non-amplified logic) of this decoder. It is assumed that AUX4 has the same characteristics as AUX3; only the latter will be tested.

Test diagram



The terminal numbers are those of the 21-pin connector. The connection was made via a 1.27 mm pitch 2 × 11-pin 2-row male connector. The pin corresponding to the terminal No. 11 (keying) has been removed.



The decoder is connected:

- To the Lokprogrammer on the Track entries
- A resistor that emulates a small motor

Decoder configuration

Before starting the tests, the decoder must be configured to match AUX3 and AUX4 with the F3 and F4 function keys (by default, these keys activate the manoeuvring mode and the elimination of the acceleration ramps). It's pretty simple with the Lokprogrammer.

Here is the listing of this decoder information:

Decoder information:

Manufacturer: ESU electronic solutions ulm GmbH & Co KG
Model: LokPilot V4.0 DCC
Flash: (Not available)

Manufacturer ID: 00000097
Product ID: 02000042
Serial: FFC68300
Firmware: 4.14.9233 (01/06/2016)
Firmware type: MultiDcc
Bootcode: 0.2.0004 (24/06/2010)
Production info: FFFFFFFF
Production date: 20/07/2015

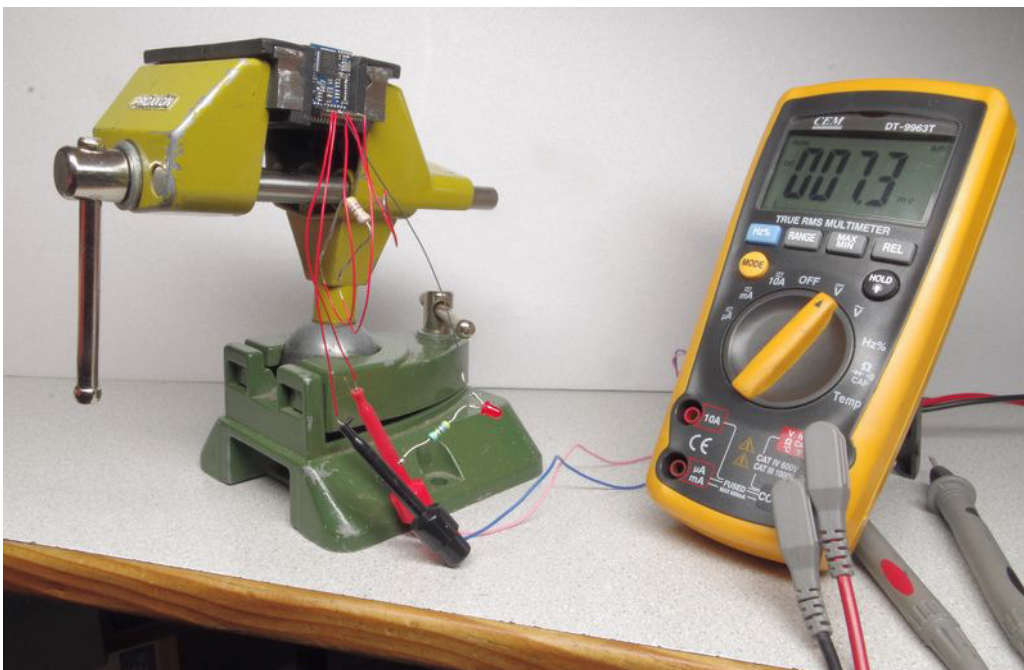
CV7: 255
CV8: 151

AUX3 output connections

The AUX3 output to be tested will be connected to different loads:

- without any connected load, the voltage between AUX3 and GND will give VCC, this is the no-load voltage;
- a load consisting of a resistance would be sufficient; but an LED makes it possible to visualize the passage of the current. By measuring the voltage V_R across the known resistor R_L , the current can be deduced therefrom, and hence the value of the output internal resistance r . Assuming that this characteristic is linear (i.e. the curve giving voltage versus current is represented by a straight line), this is sufficient to characterize the output.

In fact, the curve will be linear only up to a limit current for which the decoder will turn the output into protection mode (low voltage, low current). I did not test this threshold.



Results

Without load, $V_{CC} = 5.06 \text{ V}$.

With a load $R_L = 467 \ \Omega$, the LED lights up weakly. We measure: $V_R = 2.99 \text{ V}$. The output voltage $V_R + V_F$ is 4.93 V . We see that the voltage drop is low compared to the no-load voltage: $5.06 - 4.93 = 0,13 \text{ V}$ or 130 mV . Current in the circuit: $V_R / R_L = 2.99 \text{ V} / 467 \ \Omega = 6.4 \text{ mA}$. The value of the internal resistance r is deduced by Ohm's law: $130 \text{ mV} / 6.4 \text{ mA} = 20.3 \ \Omega$.

Another confirmation measure with another load gives $19.0 \ \Omega$.

Conclusion: the internal resistance of the so-called logic output AUX3 is about 20 ohms.

In short circuit, without protection, it would deliver $5 \text{ V} / 20 \ \Omega = 0.25 \text{ A}$ or 250 mA , which is clearly excessive. But we see that it is able to output more than 5 mA , which allows it to control, without amplification, a high brightness LED, which already visibly lights at 1 mA .

Here is a table for those allergic to calculation, assuming a 3 V direct LED voltage and also assuming that the output voltage does not vary with the load, which is about true for low currents.

Current (mA)	1	2	3	4	5
Series resistance (Ω)	2,0 k	1 k	680	470	390

I recall that these results are valid in any rigor for the Lokpilot V4.0; we can probably extend them to Loksound, but not to another type nor to another brand of decoder.

Attention: in direct connection, the diagram page 1 must necessarily be used, not the conventional diagram in which the set LED - limitation resistor is connected between the Output and the Positive Common of the decoder (terminal 16 on the 21MTC).