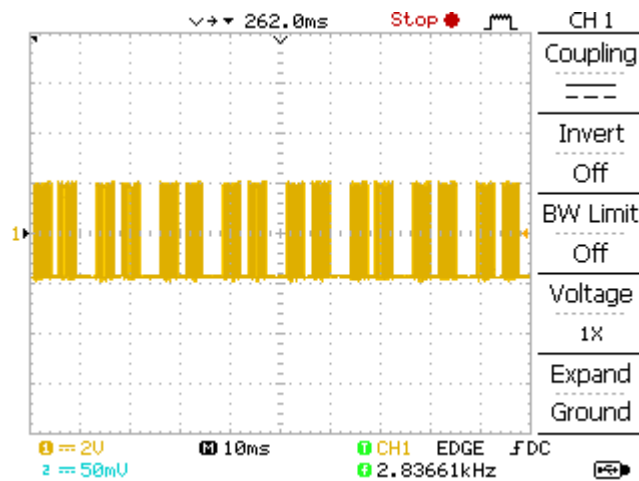# Sniffing the
Marklin Motorola protokol

(Version 1 and 2)

Vue: Based on scope screen shots , this is A short intro to the technical side of Marklin Motorola version 1 and 2, (MM1 and MM2) Protokol

Done By: Henrik Kressner
This and others can be found on: https://synkro.dk/bog

Table of Contents

1. Intro

This is what I found out about Marklin's Motorola protokol Version 1 & 2, also called MM1 & MM2, by studying the web, and doing some reverse engenering.

My messurement here is based on the controller in the Marklin 29265 trainset, and on a CS1, i believe there are some changes in other constalation.

It looks like the controller from the 29265 set runs MM1 and that the CS1 runs more protokols, and mayby MM1, but I am not shure yet.

Thanks to Andrea Scorzoni for making "THE MANUAL OF THE NEW MÄRKLIN-MOTOROLA FORMAT". It's on the web.

ToDo:

1. Info on the function mode trit

2. Info on the datapart og the package

3. Analyse programming frame/package

4. Analyse iddle state for CS1 (Checking Andrea Scorzo describtion)

No 4 Is acknowledge, more about that another day.

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2. Theory

Acording to the web, Marklin startet with a Motorola protokol, based by the MC145026 series of communication chips, the Motorola manuals are good help, but Marklin has done some changes in MM2.

2.1 This is NOT binary

Fundamentally the Motorola protokol work with 3 as base, not 2, so we have 4 states for every trits, as they are called.
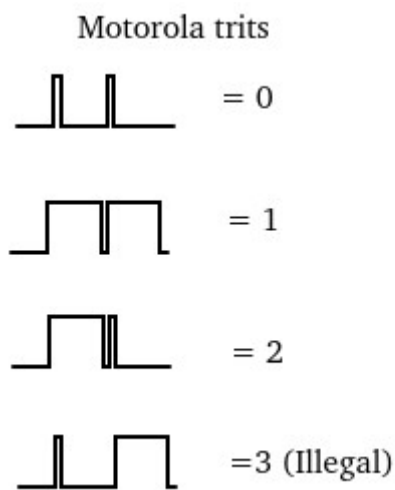
Figur 2.1

In my messurement, a short pulse is about 25 uS, a long pulse is about 175 uS, a trit is 2 pulses, and is about 400 uS.

Some sites[1] claim that this is a locomotive packege, wich gives a transmisison speed of 2405 Bit/Sek. A packege for devices shall run at dobbelt speed (4810 Bit/s), wich leads to both pulses in i device packege, is half that of the ones for locomotives.

Remark: It looks like 3 (short + long pulse) is illegal in the Marklin world.

In the original Motorola protokol, the first 10 pulses (5 trits) are the address, and the last 4 pulses, are data. In MM1 the first 4 trits are the address, trit 5 is some kind of a mode bit, and the last 4 trits is data. In MM2, the first 5 trits are the same, but the last 4 trits, is used as 8 digit.

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1   https://www.heise.de/ct/Redaktion/cm/buch/digit_1.html

3 The protokol

As shown in figur 3.1 , the protokol is a train of pulses (packages) separatet by pauses.
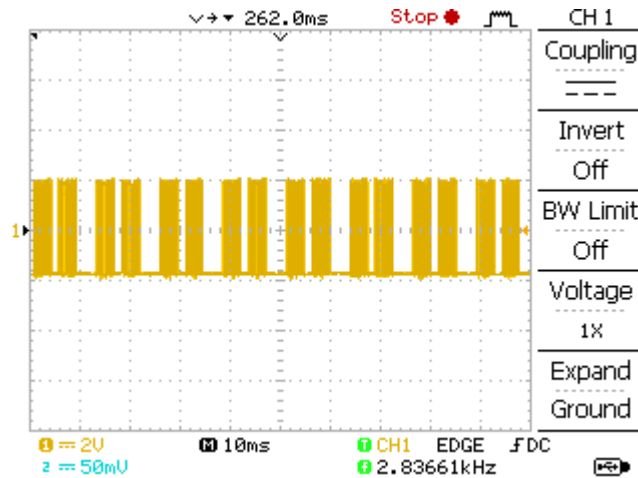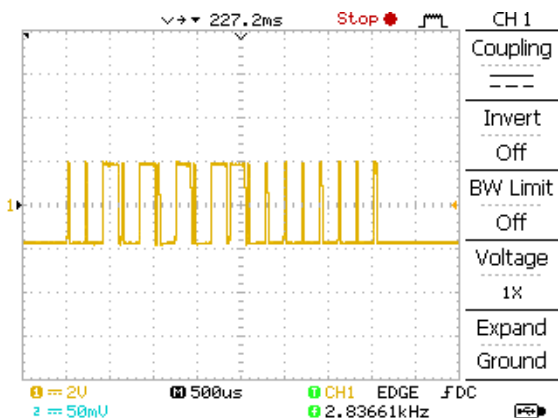

Figur 3.1

Observe the voltage goes from about -18V, to +18V, i asume the pulse train is what powers the trains.

A package is sent twice seperated by a pause about 1 mS, after the second package follow a pause of about 4 mS, and then comes the next "double" package.

Each package consist of 18 pulses, the first 8 pulses (4 trits) is the address read backwards, the next trit (the 5'th) tells us if function mode is on/off, and the last 8 bits, works differently in MM1 and MM2 protokol, but they are data.
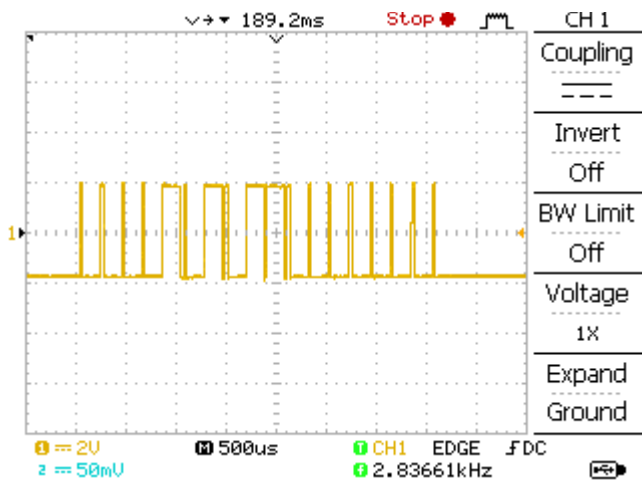

Figur 3.2

This address reads:
short short = 0
long short = 2
long short = 2
long short = 2

Marklin reads addresses backwards, so this is address 2220 in trits. Calculatet to decimal:

$$2*3^3 + 2*3^2 + 2*3^1 + 0*3^0$$
$$= 2*27 + 2*9 + 2*3 + 0*1 = 54 + 18 + 6 + 0$$
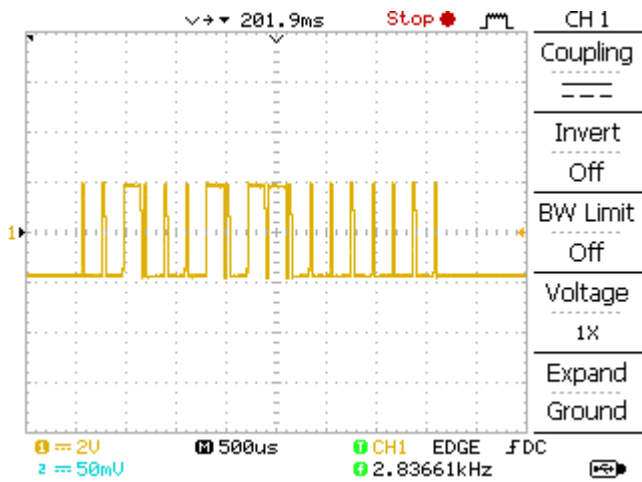
which is address 78

Figur 3.2 shows the idle package for train no 78

This address reads:
short short = 0
shot short = 0
long short = 2
long short = 2

Marklin reads addresses backwards, so this is address 2200 in trits. Calculatet to decimal:

$$2*3^3 + 2*3^2 + 0*3^1 + 0*3^0$$
$$= 2*27 + 2*9 + 0*3 + 0*1 = 54 + 18 + 0 + 0$$

which is address 72

Figur 3.3

This address reads:
short short = 0
long short = 2
short short = 0
long short = 2

Marklin reads addresses backwards, so this is address 2020 in trits. Calculatet to decimal:

$$2*3^3 + 0*3^2 + 2*3^1 + 0*3^0$$
$$= 2*27 + 0*9 + 2*3 + 0*1 = 54 + 0 + 6 + 0$$

which is address 60
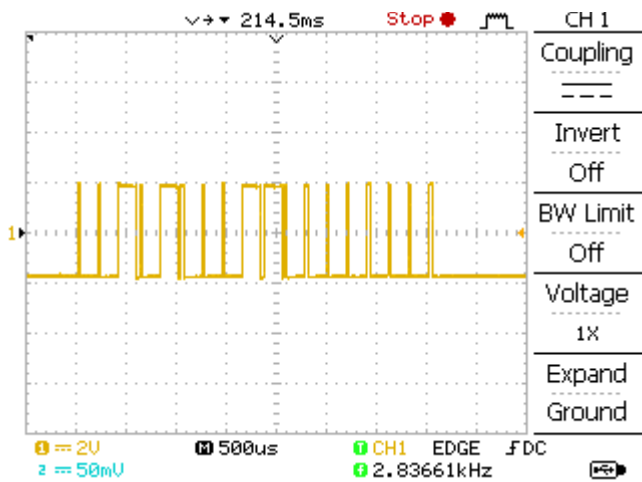
Figur 3.4

This address reads:
short short = 0
long short = 2
long short = 2
short short = 0

Marklin reads addresses backwards, so this is address 0220 in trits. Calculatet to decimal:

$$0*3^3 + 2*3^2 + 2*3^1 + 0*3^0$$
$$= 0*27 + 2*9 + 2*3 + 0*1 = 0 + 18 + 6 + 0$$

which is address 24

Figur 3.5

The pulses shown in figur 3.2 – 3.5, will continue until a state is change for one address, then this change will be repeatet for that package, until something changes, so there is a kind of round robin.

3.1 More sniffing

I build a sniffer based on a RPi with a PIC10F322 as coprocessor, to sniff continually and make statistik. Diagram and program follow later.

This is what I got for the time being.