

Analyze Märklin track signal

Get MM2 signal from track

Load files

```
Directory[]  
/home/cmaier/scad/Maerklin/analysis  
  
Dimensions[raw = Import["MM2.78.run*.csv"]]  
{2, 1048578, 3}  
  
Take[#, 4] & /@ raw  
{ {{X, CH1, }, {Second, Volt, }, {-0.231344, -17.2, }, {-0.231343, -17.2, }},  
{{X, CH1, }, {Second, Volt, }, {-0.232, -17.2, }, {-0.231999, -17.2, }}}}
```

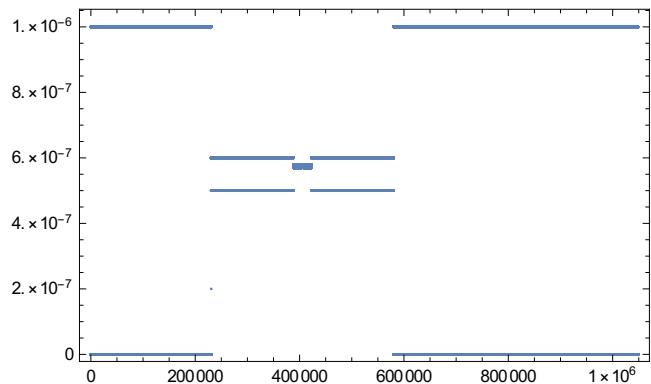
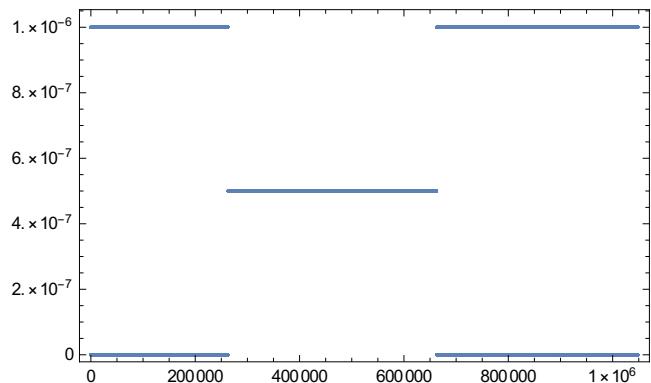
Convert into time series

```
Dimensions[timeseries = Most /@ Drop[#, 2] & /@ raw]  
{2, 1048576, 2}
```

Calculate time step

```
Dimensions[ListConvolve[{1, -1}, First /@ #] & /@ timeseries]  
{2, 1048575}
```

```
GraphicsGrid[
{ListPlot[ListConvolve[{1, -1}, First /@ #], Frame → True, PlotRange → All] } & /@
timeseries]
```



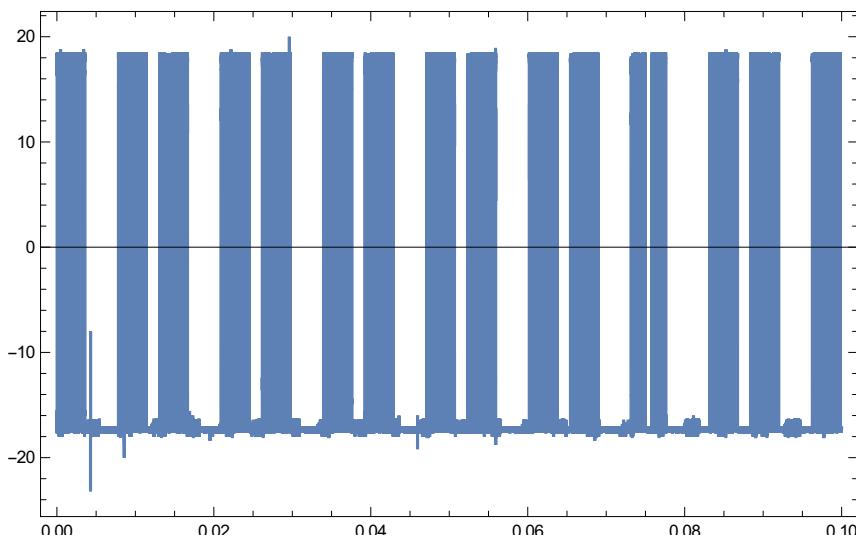
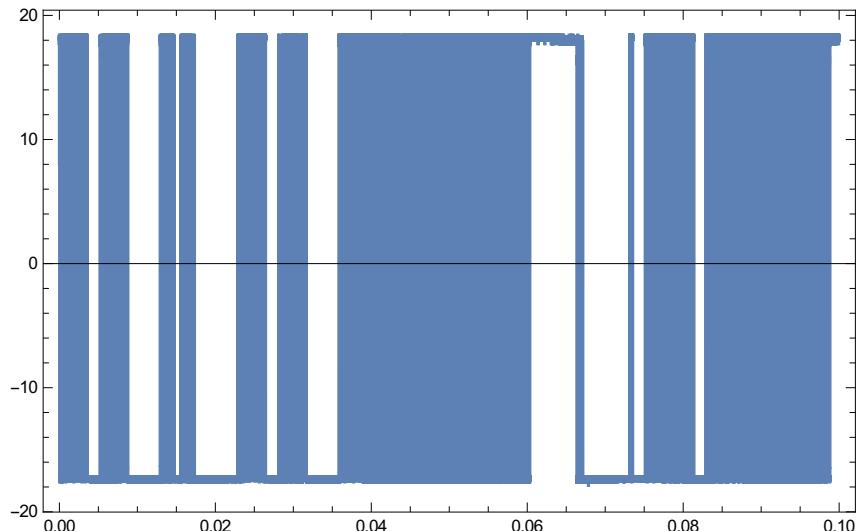
```
{Min[#, Max[#]} &[ListConvolve[{1, -1}, First /@ #]] & /@ timeseries
{{0., 1. \times 10^-6}, {0., 1. \times 10^-6}}
```

```
Median[ListConvolve[{1, -1}, First /@ #]] & /@ timeseries
timestep = Round[First[%], 10^-9]
{5. \times 10^-7, 6. \times 10^-7}
```

$$\frac{1}{2\ 000\ 000}$$

Display

```
GraphicsGrid[  
{ListPlot[Select[#, 0 <= First[#] <=.1 &], Frame -> True, Joined -> True]} &/@timeseries]
```

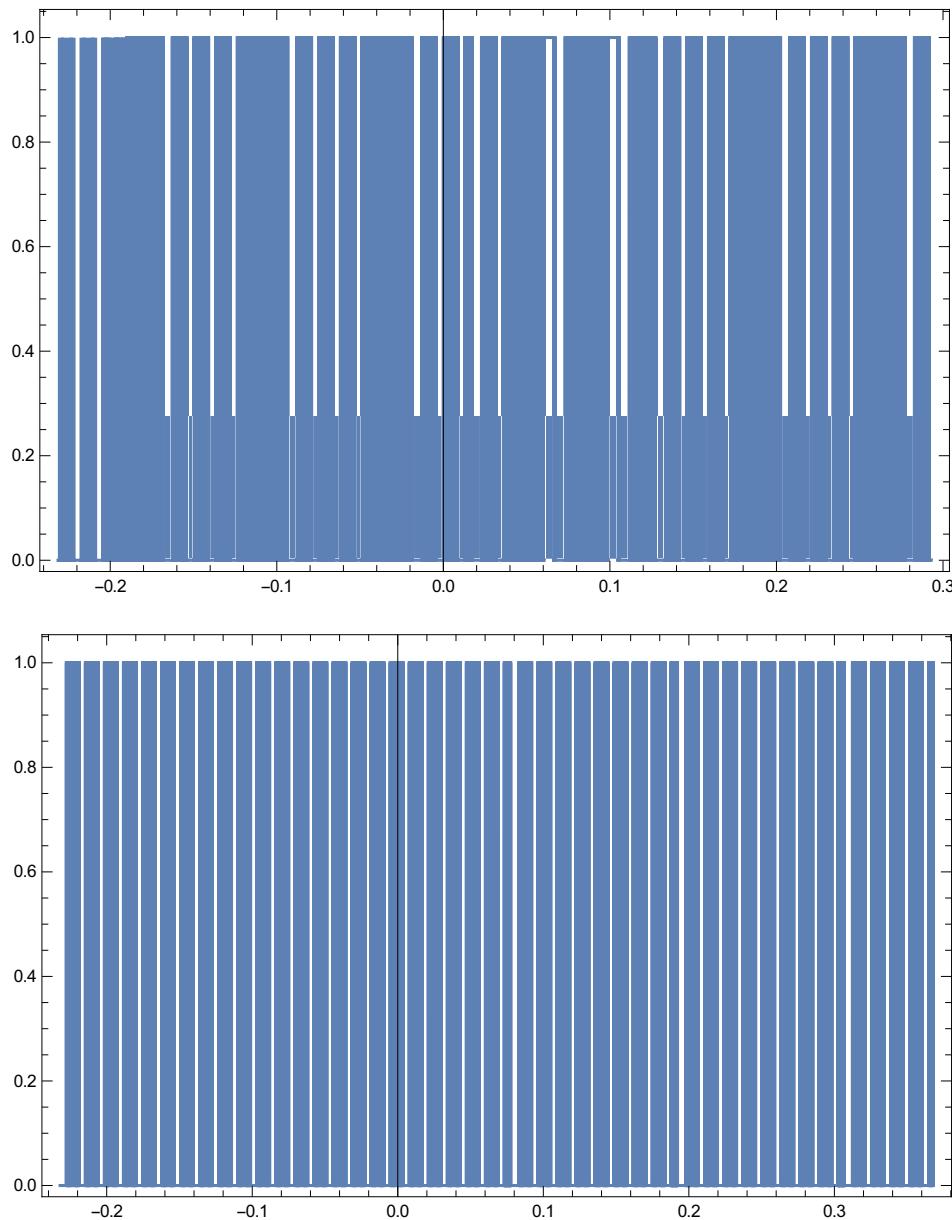


Digitize time series

```
Dimensions[digitized = Map[{#[[1]], HeavisideTheta[#[[2]] - 0.0001]} &, timeseries, {2}]]  
{2, 1 048 576, 2}
```

Display

```
GraphicsGrid[{ListPlot[#, Frame -> True, Joined -> True]} & /@ digitized]
```

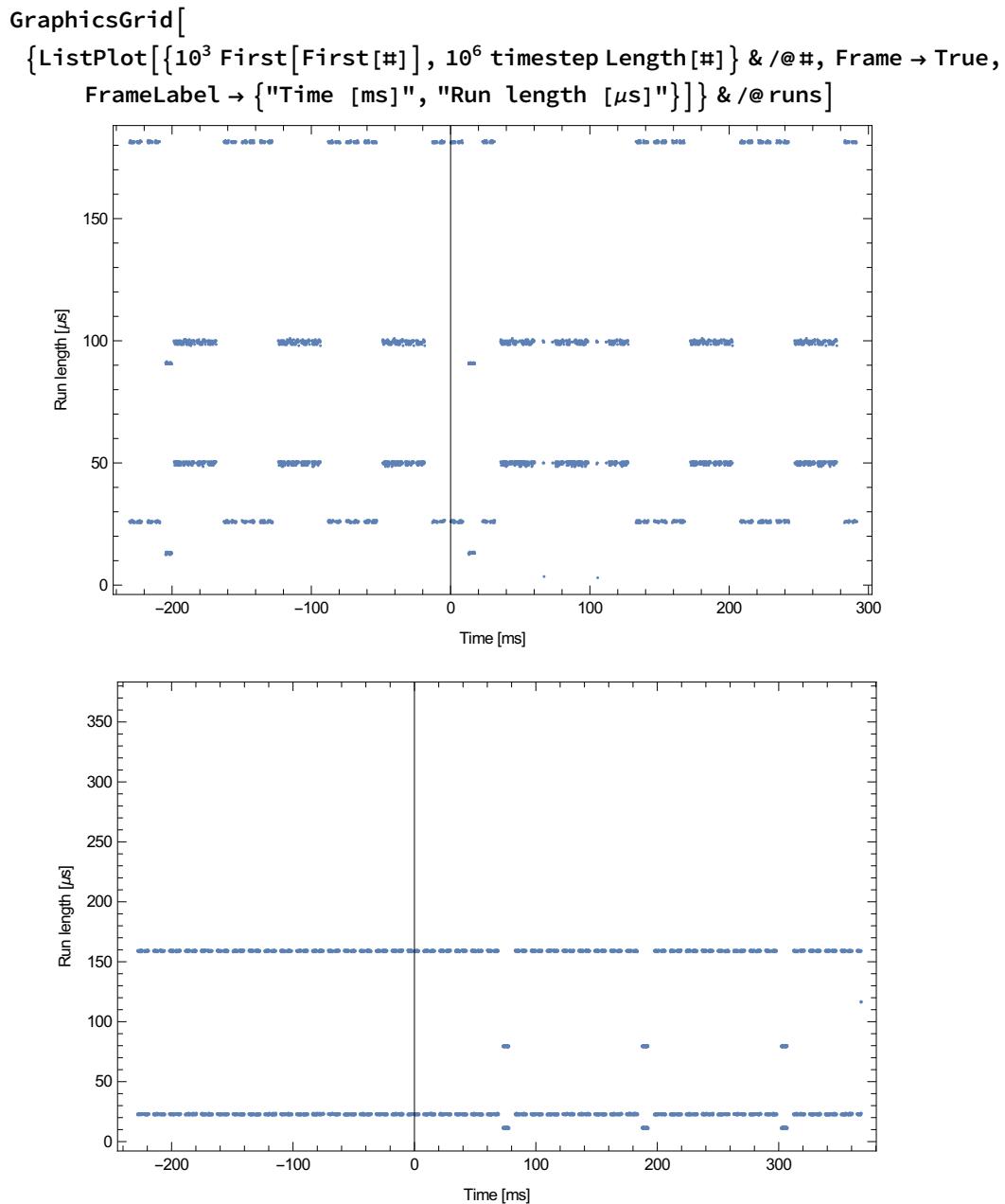


Runs of identical values for series

```
runs = SplitBy[#, Last] & /@ digitized;
```

```
Length /@ runs
```

```
{4137, 3344}
```



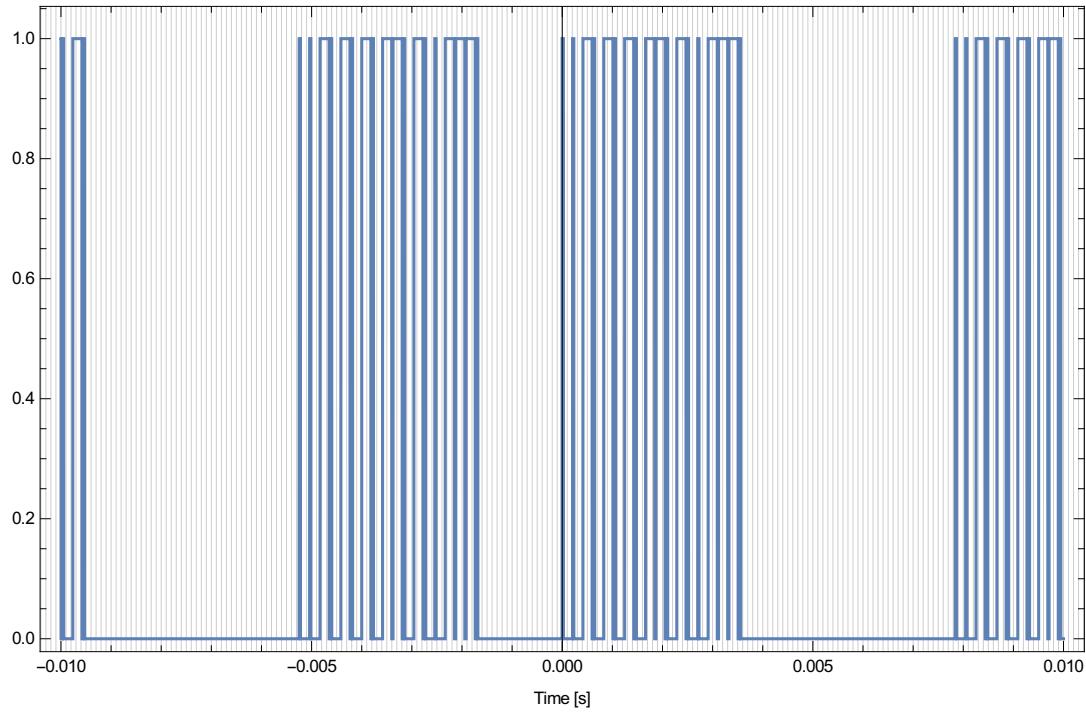
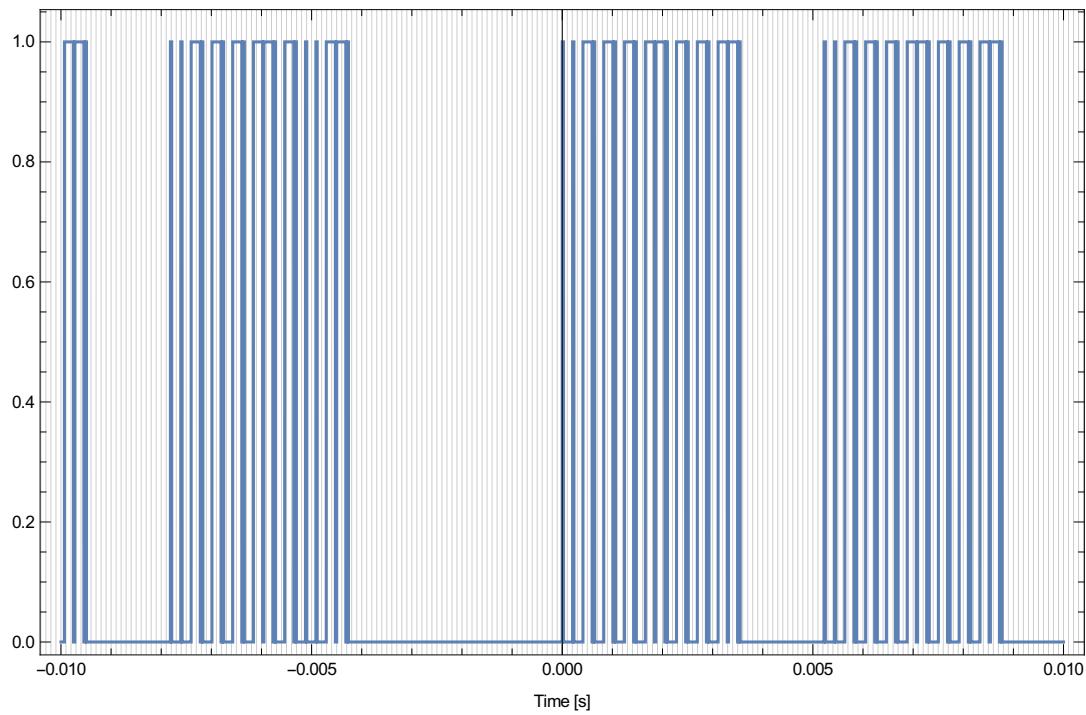
There are outliers in the MM2 packet sequence ... maybe a switch packet?

Packets within the time series

Short data packets

MM format, see 2.2.9 Einbettung von Steuerbefehlen im MM-Format

```
GraphicsGrid[{ListPlot[Select[#, -.01 < First[#] < .01 &],  
Frame → True, Joined → True, FrameLabel → {"Time [s]", ""},  
GridLines → {Range[-.15, .15, 1.*^-4], None}]]} &/@digitized]
```



Run length decoding

bit frame (100 μ s) per sampling step

timestep

10.⁻⁴

0.005

Get run lengths of full traces

```
Length /@ (fullruns = SplitBy[#, Last] & /@ digitized)
{4137, 3344}
```

Run lengths in bit frames

```
rlbits = Map[ $\frac{\text{timestep}}{10.^{-4}}$  Length[#] &, fullruns, {2}]
{{7.97, 0.26, 1.81, 0.26, 1.815, 1.815, 0.26, 0.255, 1.82, 1.815, 0.26, 0.26, 0.26, 1.81,
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Run length encoded data packets separated by run length >2 bits

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0.23, 1.59, 0.225, 1.595, 1.59, 0.23, 1.59, 0.225, 1.59, 0.235, 0.225},
{37.405}, {0.225, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23,
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0.225, 1.59, 0.235, 1.59, 0.23, 1.59, 0.23, 1.59, 0.235, 0.225},
{37.395}, {0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23,
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1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.23, 1.59,
0.225, 1.59, 0.23, 1.59, 0.23, 1.59, 0.23, 1.59, 0.235, 0.225},
{37.39}, {0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23,
0.23, 1.59, 0.225, 1.595, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.23, 1.59,
1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.23, 1.59,
0.225, 1.59, 0.23, 1.59, 0.23, 1.59, 0.23, 1.59, 0.235, 0.225},
{37.395}, {0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23,
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1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.23, 1.59,
0.225, 1.59, 0.23, 1.59, 0.23, 1.59, 0.23, 1.59, 0.235, 0.225},
{36.515}, {0.11, 0.795, 0.115, 0.795, 0.795, 0.115, 0.11, 0.795, 0.795, 0.115, 0.11, 0.8,
0.795, 0.115, 0.115, 0.79, 0.795, 0.115, 0.795, 0.115, 0.11, 0.8, 0.12, 0.795,
0.11, 0.795, 0.115, 0.795, 0.11, 0.8, 0.11, 0.8, 0.115, 0.795, 0.11}, {7.34},
{0.115, 0.795, 0.115, 0.795, 0.795, 0.115, 0.12, 0.795, 0.79, 0.115, 0.115,
0.795, 0.795, 0.115, 0.115, 0.795, 0.8, 0.11, 0.795, 0.115, 0.115, 0.8, 0.115,
0.795, 0.115, 0.795, 0.11, 0.795, 0.115, 0.795, 0.115, 0.795, 0.11, 0.8, 0.115},
{48.82}, {0.23, 1.59, 0.225, 1.595, 1.59, 0.225, 0.225, 1.59, 1.59, 0.23, 0.23,
1.59, 1.585, 0.23, 0.23, 1.59, 1.59, 0.225, 1.59, 0.235, 1.59, 0.23, 1.585, 0.23,
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1.59, 0.225, 0.23, 1.59, 1.59, 0.225, 0.23, 1.595, 1.59, 0.23, 0.225, 1.59,
0.225, 1.59, 0.225, 1.595, 0.225, 0.23, 1.59, 0.225, 0.23, 0.23}, {14.685},
{0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.59,
1.59, 0.225, 0.23, 1.59, 1.59, 0.225, 0.23, 1.595, 1.59, 0.23, 0.225, 1.59,
0.225, 1.59, 0.225, 1.595, 0.225, 0.23, 1.59, 0.225, 0.23, 0.23}, {37.39},
{0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.59,
1.59, 0.225, 0.23, 1.59, 1.59, 0.225, 0.23, 1.595, 1.59, 0.23, 0.225, 1.59,
0.225, 1.59, 0.225, 1.595, 0.225, 0.23, 1.59, 0.225, 0.23, 0.23}, {37.39},
{0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.59,
1.59, 0.225, 0.23, 1.59, 1.59, 0.225, 0.23, 1.595, 1.59, 0.23, 0.225, 1.59,
0.225, 1.59, 0.225, 1.595, 0.225, 0.23, 1.59, 0.225, 0.23, 0.23}, {37.39},
{0.23, 1.59, 0.225, 1.59, 1.59, 0.23, 0.225, 1.595, 1.59, 0.23, 0.225, 1.59,
1.59, 0.225, 0.23, 1.59, 1.59, 0.225, 0.23, 1.595, 1.59, 0.23, 0.225, 1.59,
0.225, 1.59, 0.225, 1.595, 0.225, 0.23, 1.59, 0.225, 0.23, 0.23}, {37.39}
}
```

```

{0.23, 1.59, 0.225, 1.59, 1.59, 0.225, 0.225, 1.595, 1.59, 0.23, 0.225, 1.59,
1.59, 0.225, 0.23, 1.59, 1.59, 0.23, 1.59, 0.225, 0.225, 1.59, 1.59, 0.23, 0.225,
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1.59, 0.23, 0.225, 1.59, 1.59, 0.225, 1.59, 0.235, 0.225, 1.595, 1.59, 0.23,
0.23, 1.59, 0.23, 1.595, 1.59, 0.225, 1.59, 0.225, 1.59, 0.23, 0.225}, {37.405},
{0.225, 1.595, 0.225, 1.59, 1.59, 0.23, 0.23, 1.585, 1.59, 0.23, 0.225, 1.59,
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0.23, 1.59, 0.225, 1.59, 1.595, 0.225, 1.59, 0.225, 1.59, 0.235, 0.225},
{14.68}, {0.23, 1.59, 0.225, 1.59, 1.59, 0.225, 0.23, 1.59, 1.585, 0.23, 0.225,
1.59, 1.59, 0.225, 0.235, 1.59, 1.595, 0.23, 1.59, 0.235, 0.23, 1.59, 0.23,
1.59, 0.225, 1.59, 0.225, 1.59, 1.59, 0.23, 1.59, 0.23, 1.59, 0.235, 0.23},
{37.405}, {0.23, 1.59, 0.23, 1.59, 1.595, 0.225, 0.225, 1.59, 1.59, 0.23,
0.225, 1.59, 1.59, 0.23, 0.23, 1.59, 1.59, 0.23, 1.59, 0.225, 0.23,
1.59, 1.59, 0.23, 0.225, 1.59, 0.225, 1.59, 1.59, 0.235, 1.165}}}

```

Dimensions /@ rlrnns

{ {129}, {186} }

Map[Length, rlrules, {2}]

Length of packet separators in 100 μ s bit frames

```
TableForm[Select[#, Length[#] ≤ 1 &]] & /@ rlrnrs
```

37.025
14.685
37.4
14.685
37.395
14.685
37.405
14.68
37.4
14.68
37.4
14.685
37.385
14.68
37.205

16.745 14.68
42.645 37.395
16.74 14.685
41.645 37.405
8.37 14.68
15.85 37.395
14.955 14.69
14.955 37.39
54.775 14.68
16.745 37.4
42.64 14.68
16.75 37.395
42.645 14.68
16.745 37.4
41.65 14.69
14.95 37.4
14.95 14.68
54.775 37.4
16.745 14.69
42.635 37.405
16.745 14.685
42.64 37.395
16.745 14.685
41.645 37.405
14.96 14.68
14.95 37.4
54.775 14.68
16.74 37.395
42.645 14.69
16.745 37.4
41.645 14.685
8.37 , 36.515 }
55.675 7.34
16.745 48.825
41.645 14.685
60.22 37.4
60.19 14.68
15.935 37.395
14.95 14.685
60.225 37.405
60.2 14.685
15.94 37.405
14.955 14.685
54.785 37.4
16.74 14.685
42.65 37.405
16.745 14.69
42.65 37.39
16.745 14.685
41.645 36.52
14.955 7.335
14.95 48.83
54.78 14.685
16.745 37.4
42.645 14.685
16.75 37.405
42.65 14.685
16.74 37.395
41.655 14.685
14.955 37.405
14.955 14.685
54.795 37.39
16.74 14.685
13.24 37.39
14.685

```
-----  
37.395  
14.685  
36.515  
7.34  
48.82  
14.685  
37.39  
14.685  
37.39  
14.69  
37.405  
14.68  
37.405
```

Run length encoded packets

Display number of runs per packet

```
Map[Length, packetruns = Select[#, Length[#] > 1 &] &[rlruns], {2}]  
{ {1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 197, 1, 83, 1, 83, 1, 35, 1,  
   35, 1, 35, 1, 35, 1, 35, 1, 197, 1, 83, 1, 83, 1, 35, 1, 35, 1, 35,  
   1, 35, 1, 35, 1, 35, 1, 197, 1, 83, 1, 83, 1, 35, 1, 35, 1, 35, 1, 35,  
   1, 35, 1, 35, 1, 35, 1, 346, 1, 10, 1, 5, 1, 83, 1, 232, 1, 10, 1, 5, 1, 83,  
   1, 83, 1, 35, 1, 35, 1, 35, 1, 35, 1, 197, 1, 83, 1, 83, 1, 35, 1, 35, 1, 35,  
   1, 35, 1, 35, 1, 35, 1, 35, 1, 197, 1, 83, 1, 83, 1, 35, 1, 35, 1, 35, 1, 35,  
   1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1,  
   35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35,  
   35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35,  
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   35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35, 1, 35}
```

Runs in $12.5\mu s$ time unit multiples

```
RoundRunTime = Round[8 #] &  
Round[8 #1] &  
  
mmruns = RoundRunTime[Select[#, Length[#] == 35 &] & /@ packetruns]  
{ {{2, 14, 2, 15, 15, 2, 2, 15, 15, 2, 2, 14, 14, 2, 2,  
    15, 15, 2, 14, 2, 2, 14, 14, 2, 2, 15, 2, 15, 2, 15, 14, 2, 15, 2, 2},  
   {2, 15, 2, 15, 14, 2, 2, 15, 15, 2, 2, 15, 14, 2, 2, 14, 15, 2, 14, 2, 2, 14, 15,  
    2, 2, 15, 2, 15, 2, 15, 15, 2, 2, 2}, {2, 15, 2, 15, 14, 2, 2, 14, 15, 2, 2, 15,  
    14, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 15, 14, 2, 15, 2, 2}, {2, 15, 2, 14,  
    15, 2, 2, 15, 14, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 15, 15, 2, 14, 2, 2, 14,  
    15, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 2}, {1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1,  
    1, 7, 7, 1, 1, 7, 7, 1, 1, 7, 1, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7}, {1, 7, 1, 7, 7,  
    1, 1, 7, 7, 1, 1, 7, 7, 1, 1, 7, 7, 1, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7}, {1, 7, 1, 7, 7,  
    1, 1, 7, 7, 1, 1, 7, 7, 1, 1, 7, 7, 1, 1, 7, 1, 7, 1, 7, 1, 7, 1, 7}, {2, 15, 2, 15, 14, 2, 2, 15,  
    15, 2, 2, 15, 14, 2, 2, 14, 2, 2, 15, 15, 2, 2, 15, 14, 2, 15, 2, 2}, {2, 15, 2, 15, 14,  
    2, 2, 15, 14, 2, 2, 15, 14, 2, 2, 14, 2, 2, 15, 15, 2, 2, 15, 14, 2, 15, 2, 2}, {2, 15, 2, 15,  
    14, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 15, 15, 2, 2, 15, 14, 2, 15, 2, 2, 15, 15, 2, 2, 15, 15}}
```



```
Map[Length, otherruns, {2}]
{{197, 83, 83, 197, 83, 83, 197, 83, 83, 346,
  10, 5, 83, 232, 10, 5, 83, 83, 197, 83, 83, 197, 83, 83}, {31}}
```

Parse runs

Shotgun MM parser

for locomotives

```

MMPARSER = Function[{in, out},
  If[Length[in] ≥ 2,
    Which[Take[in, 2] == {2, 13} ∨ Take[in, 2] == {2, 14} ∨ Take[in, 2] == {2, 15},
      {Drop[in, 2], Append[out, 0]},
      Take[in, 2] == {13, 2} ∨ Take[in, 2] == {14, 2} ∨ Take[in, 2] == {15, 2},
      {Drop[in, 2], Append[out, 1]},
      True, {Drop[in, 1], Append[out, △]}],
    If[Length[in] == 1,
      Which[{2} == Take[in, 1], {Drop[in, 1], Append[out, 0]}, Take[in, 1] == {13} ∨
        Take[in, 1] == {14} ∨ Take[in, 1] == {15}, {Drop[in, 1], Append[out, 1]},
        True, {Drop[in, 1], Append[out, △]}], {Drop[in, 1], Append[out, △]}]]
  ]
Function[{in, out}, If[Length[in] ≥ 2,
  Which[Take[in, 2] == {2, 13} || Take[in, 2] == {2, 14} || Take[in, 2] == {2, 15},
    {Drop[in, 2], Append[out, 0]},
    Take[in, 2] == {13, 2} || Take[in, 2] == {14, 2} || Take[in, 2] == {15, 2},
    {Drop[in, 2], Append[out, 1]}, True, {Drop[in, 1], Append[out, △]}]],
  If[Length[in] == 1, Which[{2} == Take[in, 1], {Drop[in, 1], Append[out, 0]},
    Take[in, 1] == {13} || Take[in, 1] == {14} || Take[in, 1] == {15},
    {Drop[in, 1], Append[out, 1]}, True, {Drop[in, 1], Append[out, △]}],
    {Drop[in, 1], Append[out, △]}]]]

```

for magnets

```

MMmagparser = Function[{in, out},
  If[Length[in] ≥ 2, Which[{1, 6} == Take[in, 2] ∨ {1, 7} == Take[in, 2],
    {Drop[in, 2], Append[out, 0]}, {6, 1} == Take[in, 2] ∨ {7, 1} == Take[in, 2],
    {Drop[in, 2], Append[out, 1]}, True, {Drop[in, 1], Append[out, △]}]],
  If[Length[in] == 1, Which[{1} == Take[in, 1], {Drop[in, 1], Append[out, 0]},
    {6} == Take[in, 1] ∨ {7} == Take[in, 1], {Drop[in, 1], Append[out, 1]},
    True, {Drop[in, 1], Append[out, △]}]], {Drop[in, 1], Append[out, △]}]]]

Function[{in, out},
  If[Length[in] ≥ 2, Which[{1, 6} == Take[in, 2] || {1, 7} == Take[in, 2],
    {Drop[in, 2], Append[out, 0]}, {6, 1} == Take[in, 2] || {7, 1} == Take[in, 2],
    {Drop[in, 2], Append[out, 1]}, True, {Drop[in, 1], Append[out, △]}]],
  If[Length[in] == 1, Which[{1} == Take[in, 1], {Drop[in, 1], Append[out, 0]},
    {6} == Take[in, 1] || {7} == Take[in, 1], {Drop[in, 1], Append[out, 1]},
    True, {Drop[in, 1], Append[out, △]}]], {Drop[in, 1], Append[out, △]}]]]

```

Parse by iteration over run length encoded input

```
NestWhile[MMparser@@# &, {mmruns[[1, 1]], {}}, Length[First[#]] > 0 &]
{{}, {0, 0, 1, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0}}
```

Apply parsers

Parse over MM runs

Parse over truncated runs

Eliminate duplicate sequences

It turns out in this case that there is only few packets, which are repeated

Decode MM packets

Motorola format bit

```

mmbit = Function[{in, out}, If[Length[in] < 2, {Drop[in], Append[out, ERROR]}, {Drop[in, 2], Append[out, Switch[Take[in, 2], {0, 0}, 0, {1, 1}, 1, _, △]]}]}
Function[{in, out}, If[Length[in] < 2, {Drop[in], Append[out, ERROR]}, {Drop[in, 2], Append[out, Switch[Take[in, 2], {0, 0}, 0, {1, 1}, 1, _, △]]}]]

```

Motorola format trit

```
mmtrit = Function[{in, out},
  If[Length[in] < 2, {Drop[in], Append[out, ERROR]}, {Drop[in, 2],
    Append[out, Switch[Take[in, 2], {0, 0}, 0, {1, 1}, 1, {1, 0}, 2, _,  $\Delta$ ]]}]
]
]

Function[{in, out}, If[Length[in] < 2,
  {Drop[in], Append[out, ERROR]}, {Drop[in, 2], Append[out, Switch[Take[in, 2],
  {0, 0}, 0,
  {1, 1}, 1,
  {1, 0}, 2,
  _,  $\Delta$ ]]}]]]
```

Motorola format 4-trit address (address 80, all open, is unassigned)

```
mmaddress = Function[{in, out}, If[Length[in] < 8, {Drop[in], Append[out, ERROR]}, {
  {#1[[1]], Append[out, {ADDR, FromDigits[Reverse[Last[#1]], 3]}]} &)[
  Nest[mmtrit@@#1 &, {in, out}, 4]]]]

Function[{in, out}, If[Length[in] < 8, {Drop[in], Append[out, ERROR]}, {
  {#1[[1]], Append[out, {ADDR, FromDigits[Reverse[Last[#1]], 3]}]} &)[
  Nest[mmtrit@@#1 &, {in, out}, 4]]]]

Map[mmaddress[#, {}] &, Most[mmbitseq], {1}]

{{{1, 1, 0, 0, 0, 0, 0, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 0, 0, 0, 1, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 0, 0, 1, 0, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 0, 0, 1, 1, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 0, 0, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 0, 1, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 1, 1, 0, 0, 1, 0}, {{ADDR, 78}}}, {{1, 1, 0, 1, 0, 1, 1, 1, 0, 0, 1}, {{ADDR, 78}}}, {{1, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0}, {{ADDR, 78}}}, {{1, 1, 1, 1, 1, 0, 0, 1, 1, 1, 0}, {{ADDR, 78}}}}
```

Motorola format parser

4-trit address, one function (double) bit, 4 velocity (double) bits

```

mm1parse =
Function[{in, out},
({#1, Append[Drop[#2, -4], {SPEED, FromDigits[Reverse[Take[#2, -4]], 2]}]} &) @@
Nest[mmbit @@ #1 &, ({#1[[1]], Append[Most[#1[[2]]], {FUNC, Last[#1[[2]]]}]} &) [
mmbit @@ mmaddress[in, out]], 4]]
Function[{in, out},
({#1, Append[Drop[#2, -4], {SPEED, FromDigits[Reverse[Take[#2, -4]], 2]}]} &) @@
Nest[mmbit @@ #1 &, ({#1[[1]], Append[Most[#1[[2]]], {FUNC, Last[#1[[2]]]}]} &) [
mmbit @@ mmaddress[in, out]], 4]]

mm2dataparse = Function[{in, out}, If[8 != Length[in], {in, Append[out, ERROR]}, 
Block[{speed = FromDigits[in[[7, 5, 3, 1]], 2],
data = in[[2, 4, 6, 8]], tag}, tag = Which[
data == {1, 0, 1, 0} & speed > 7, {REVERSE},
data == {1, 0, 1, 1} & speed < 8, {REVERSE},
data == {0, 1, 0, 1} & speed < 8, {FORWARD},
data == {0, 1, 0, 0} & speed > 7, {FORWARD},
True, {DATA, data}];
{Drop[in, 8], Join[out, {{SPEED, speed}, tag}}}]
]
]
]

Function[{in, out}, If[8 != Length[in], {in, Append[out, ERROR]}, 
Block[{speed = FromDigits[in[[7, 5, 3, 1]], 2], data = in[[2, 4, 6, 8]], tag},
tag = Which[data == {1, 0, 1, 0} && speed > 7, {REVERSE},
data == {1, 0, 1, 1} && speed < 8, {REVERSE}, data == {0, 1, 0, 1} && speed < 8,
{FORWARD}, data == {0, 1, 0, 0} && speed > 7, {FORWARD}, True, {DATA, data}];
{Drop[in, 8], Join[out, {{SPEED, speed}, tag}}}]]

mm2parse =
Function[{in, out},
mm2dataparse @@ (({#1[[1]], Append[Most[#1[[2]]], {FUNC, Last[#1[[2]]]}]} &) [
mmbit @@ mmaddress[in, out]])]
Function[{in, out}, mm2dataparse @@
({#1[[1]], Append[Most[#1[[2]]], {FUNC, Last[#1[[2]]]}]} &) [mmbit @@ mmaddress[in, out]]]

```

Parse Motorola packets

```

Last[mm1parse[#, {}]] & /@ Most[mmbitseq]
{{{ADDR, 78}, {FUNC, 1}, {SPEED, 12 Δ}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 4 (1 + 2 Δ)}}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 14 Δ}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 2 (Δ + 2 (1 + 2 Δ))}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 13 Δ}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, Δ + 4 (1 + 2 Δ)}}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 11 Δ}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 15 Δ}}}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 15 Δ}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, Δ + 2 (Δ + 2 (1 + 2 Δ))}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 1 + 4 (1 + 2 Δ)}}}, 
 {{{ADDR, 78}, {FUNC, 1}, {SPEED, 1 + 14 Δ}}}

mm2parse[#, {}] & /@ Most[mmbitseq]
{{{}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 8}, {DATA, {0, 0, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 12}, {DATA, {0, 0, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 8}, {DATA, {0, 1, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 12}, {DATA, {0, 1, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 8}, {REVERSE}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 12}, {REVERSE}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 8}, {DATA, {1, 1, 0, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 8}, {DATA, {1, 1, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 12}, {DATA, {1, 1, 0, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 12}, {DATA, {1, 1, 1, 0}}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 13}, {REVERSE}}}, 
 {}, {{ADDR, 78}, {FUNC, 1}, {SPEED, 11}, {REVERSE}}}

Last[mm1parse[#, {}]] & /@ Most[mmmagbitseq]
{{{ADDR, 78}, {FUNC, 1}, {SPEED, 0}}}}

```