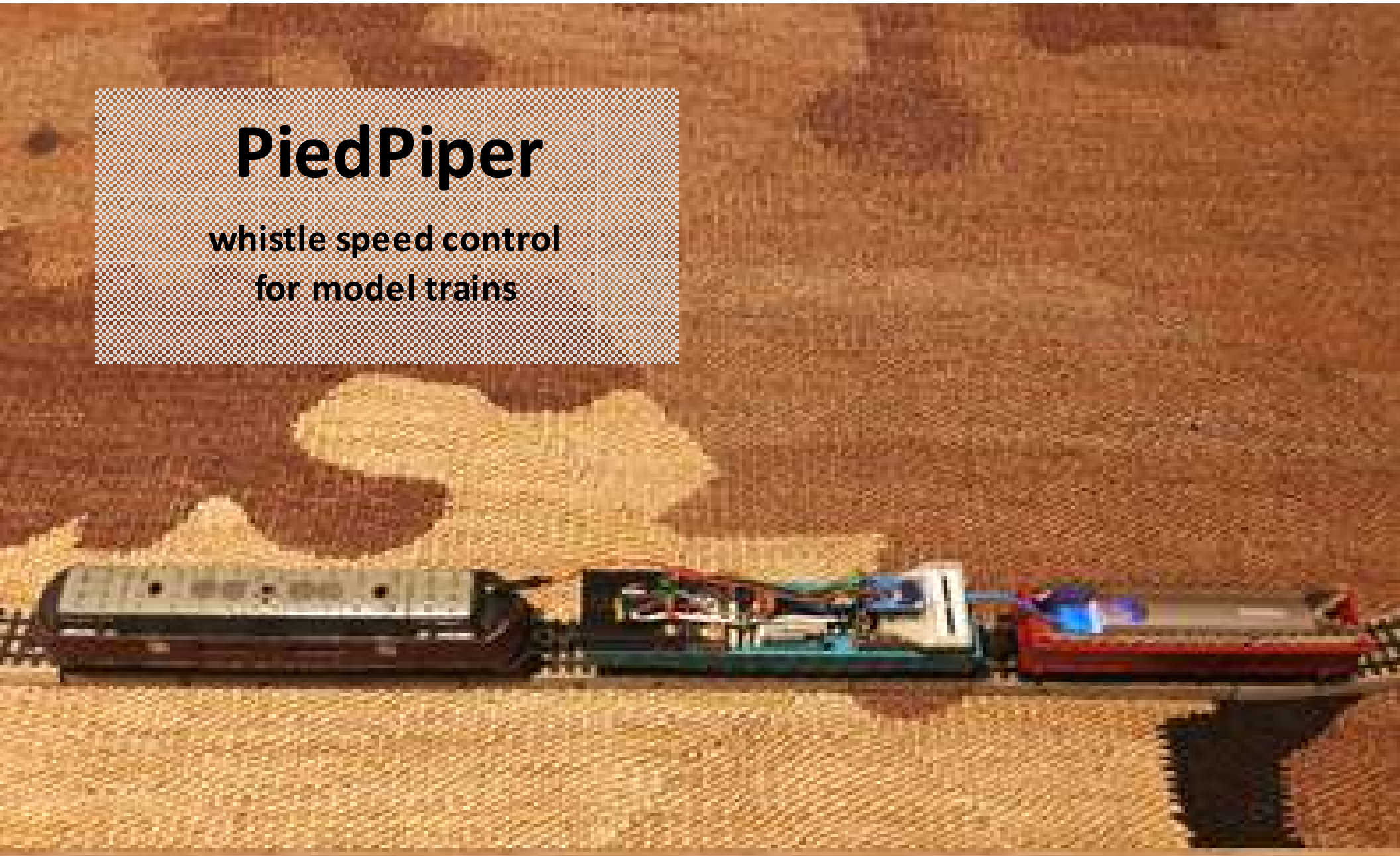
PiedPiper

whistle speed control for model trains



- **Outdoor compatible, on-board USB power supply independent of track current**
- **Electret microphone, nano size micro controller, C++ Arduino software for FFT tone analysis**
- **No proprietary elements, construction time 2-4 weekends, material cost ca. 60 €**

PiedPiper Version 056, J. Ruppert 2021-03-20, GNU GPL v3 GitHub: https://github.com/jorail/PiedPiper

Material demand

for 1 train with whistle control

Electronics

- Nano size microcontroller,
  e.g. Teensy 4.0, but similar solutions are possible with other microcontrollers like Teensy 3.2, ESP32, etc.
  - 1 analogue in for microphone output
  - 2 PWM outputs for motor control
  - 2 digital outputs for LED indicators
  - 1 digital input for option 1 switch
- Compatible electret microphone module, 3.3 V,
  e.g. MAX9814, Amplifier with Auto Gain Control
- Step-up DC/DC converter module, 5 V to 12V … 16 V
- H-Bridge DC motor control IC, e.g. TLE5206-2S
- Small size USB power bank as 5 V DC power supply
  it is good to have two, 2nd for replacement when 1st empty
- Small size breadboard, e.g. 170 contacts
- Solder IC pin contacts, single row, separable, total of ca. 50 contacts
- Shrink tube with diameter for holding two IC pin contacts
- Thin USB cable, old and used, but reliable for power connection
- LEDs: 1 green, 1 red, 2 yellow, 3 mm diameter
- 2 x 180 Ω resistors
- 1 kΩ resistor
- 2 pole cable, thin and flexible, ca. 40 cm, for connection to motor
- 3 pole isolated wire for microphone module, 10 cm
- 1 pole wires for breadboard and step up converter connections, ca. 60 cm in total

Other material

- Model train locomotive with 12V … 16 V DC motor
- Flat wagon for electronics equipment
- Eaos high board open wagon for USB power bank
- Some paper cardboard
- Single and double sided adhesive tape

Tools

- Single tone sound source: Whistle or flute, e.g. recorder
- Fine tip solder iron with equipment
- Cutter, fine pincers
- Multi-meter tool

Option 1 addition

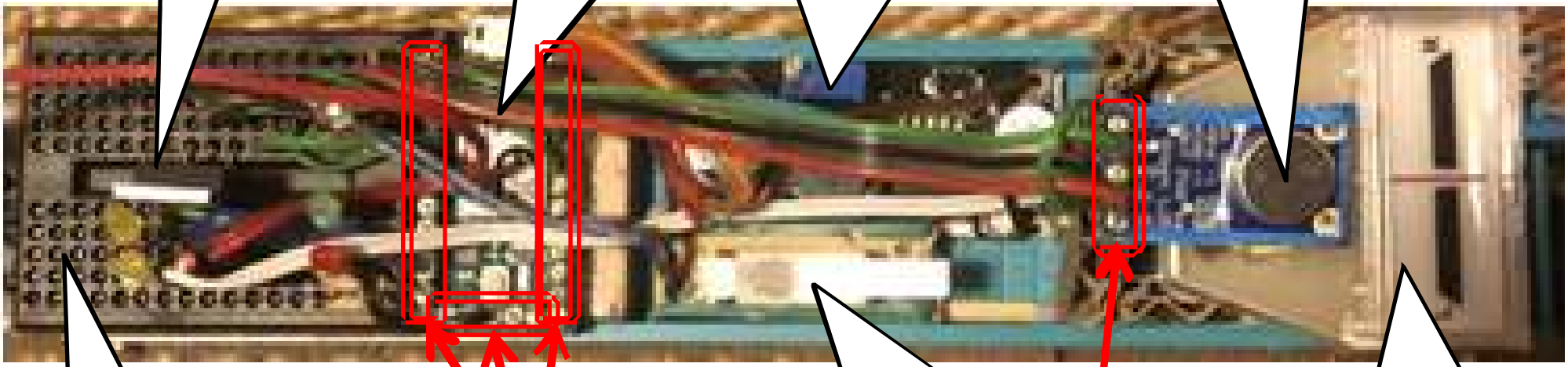
- Micro switch for testing and manual commands
- 10 kΩ resistor
- 1 pole wire, ca. 15 cm

Option 2 addition

- Small left/right sound balance meter from old equipment, e.g. 270 Ω
- Suitable set of resistors, e.g. 10 kΩ + several 1 to 5 kΩ resistors
- 2 pole cable, thin and flexible, ca. 10 cm

Estimated material cost ca. 60 € excl. other material, tools and additions

Soldered IC base contacts and small breadboard



H-bridge DC Motor control IC

Nano size micro controller, here Teensy 4.0

Adjustable step-up DC/DC converter module for 12 VDC

Electret microphone module (away from train motor noise)

Small size breadboard 170 contacts

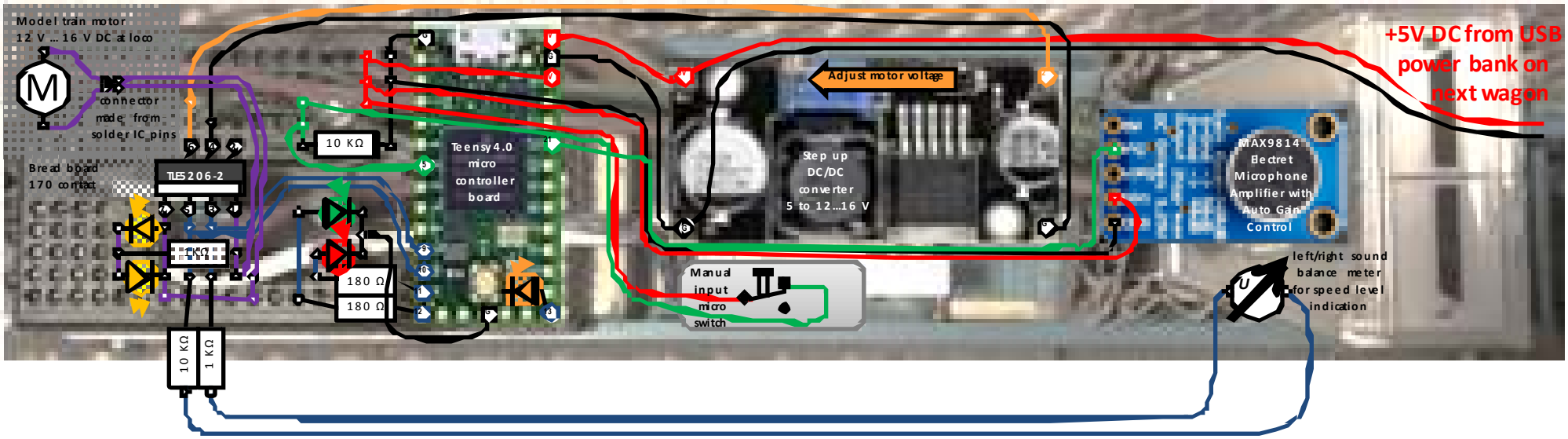
Option 1: Micro switch for testing and manual control

Option 2: Speed level meter

2x for self made motor cable connector

soldered IC pin contacts

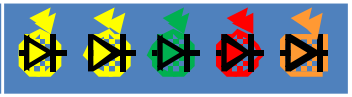
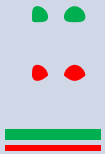
Circuit, parts and connections



PiedPiper whistle tone commands

Morse code	Command for speed level	Meaning
•	--	decrease speed
••	--------	slow down
•••	----------	break to halt
••••	0	fast brake and stop
•••••	00<	fast stop, reverse direction
• —	++	increase speed
• — —	++++++++	speed up
• — — —	++++++++++++++++	go fast
—	0	fast brake and stop
— —	00	fast brake and stop
————————	00	fast brake and stop
— — —	?	info?
?	?	info?

PiedPiper LED indicators

LEDs	
Motor speed according to pulse width, resulting voltage and polarity • forward, voltage + 12 V to + 4 V • backward, voltage - 4 V to - 12 V	
Information on motor direction and speedlevel: • forward = 1 = green LED + 0 to 32 short LED flashes • backward = 0 = red LED + 0 to 32 short LED flashes	
Adjustment of motor speed: • 2 green LED flash = speed level + 2; • 2 red LED flash = speed level - 2; • green & red LEDs long flash = fast brake, speed level = 0	
Change of motor direction: • green/red/green + green LED flash = forward = 1 • red/green/red + red LED flash = backward = 0	
Tone signal detected: • Single FFT analysis, frequency window>THRESHOLD1: red LED • Averaged FFTs, frequency windows>THRESHOLD2: green LED = tone signal active	
Program running and main loop frequency: • orange flash after 5,000,000 main loop cycles and 500,000 times monitoring for input activity	

Tone frequency table

Tone	Hertz
''A	27,50
''B	29,14
''H	30,87
'C	32,70
'Des	34,65
'D	36,71
'Es	38,89
'E	41,20
'F	43,65
'Ges	46,25
'G	49,00
'As	51,91
'A	55,00
'B	58,27
'H	61,74

Tone	Hertz
C	65,41
Des	69,30
D	73,42
Es	77,78
E	82,41
F	87,31
Ges	92,50
G	98,00
As	103,83
A	110,00
B	116,54
H	123,47
c	130,81
des	138,59
d	146,83
es	155,56
e	164,81
f	174,61
ges	185,00
g	196,00
as	207,65
a	220,00
b	233,08
h	246,94

Tone	Hertz	
c'	261,63	
des'	277,18	
d'	293,66	
es'	311,13	
e'	329,63	
f'	349,23	
ges'	369,99	
g'	392,00	
as'	415,30	
a'	440,00	
b'	466,16	
h'	493,88	
c''	523,25	
des''	554,37	
d''	587,33	
es''	622,25	
e''	659,26	
f''	698,46	
ges''	739,99	
g''	783,99	
as''	830,61	
a''	880,00	
b''	932,33	
h''	**987,77**	**=default**

Tone	Hertz
c'''	1.046,50
des'''	1.108,73
d'''	1.174,66
es'''	1.244,51
e'''	1.318,51
f'''	1.396,91
ges'''	1.479,98
g'''	1.567,98
as'''	1.661,22
a'''	1.760,00
b'''	1.864,66
h'''	1.975,53
c''''	2.093,00
des''''	2.217,46
d''''	2.349,32
es''''	2.489,02
e''''	2.637,02
f''''	2.793,83
ges''''	2.959,96
g''''	3.135,96
as''''	3.322,44
a''''	3.520,00
b''''	3.729,31
h''''	3.951,07

Tone	Hertz
c'''''	4.186,01