Electrodes

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This code was developed by Miodrag Bolic for the book PERVASIVE CARDIAC AND RESPIRATORY MONITORING DEVICES: https://github.com/Health-Devices/CARDIAC-RESPIRATORY-MONITORING

Introduction

In this notebook we will show different models of the electrodes as well as the interface between the skin and the electrodes.

Connecting 2 wet electrodes

```
load('ecg.mat')
model_name = 'ConnectingWetElectrodes';
open_system(model_name);


%blockHandle = get_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep', 'Handle')
%block = get(blockHandle);
```

Potential difference for the same electrodes and skin parameters

```
set_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R','500')
set_param('ConnectingWetElectrodes/ElectrodeSkinModel1/Rep','R','500')
set_param('ConnectingWetElectrodes/Zero','Value','0')
s=sim(model_name)
```

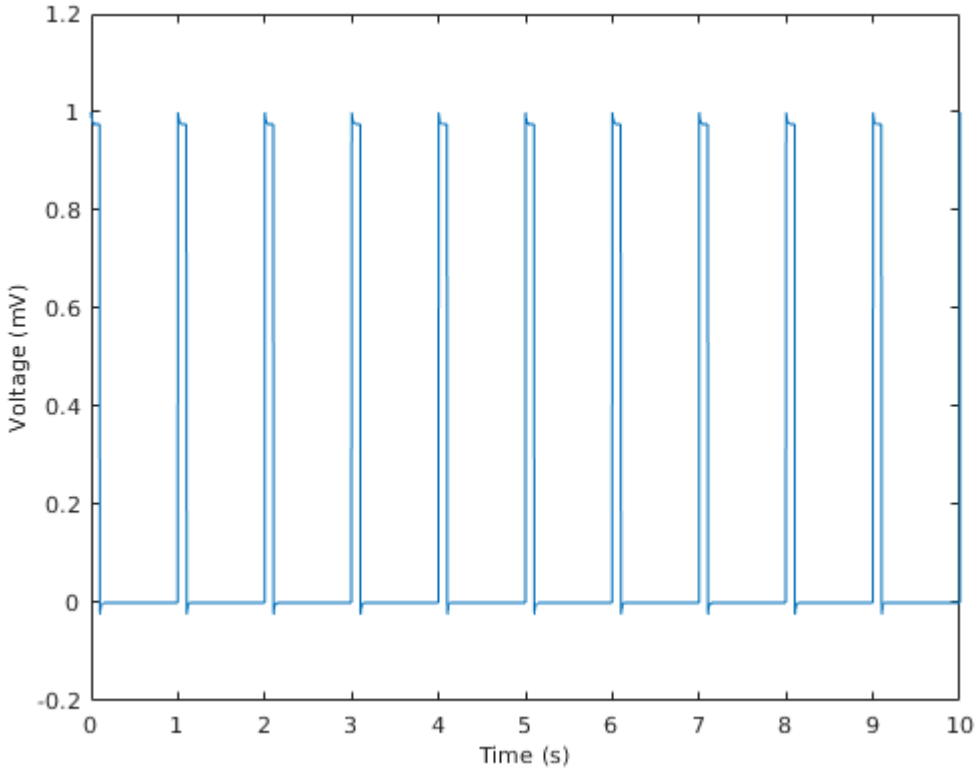
```
s =
  Simulink.SimulationOutput:

                simout: [1x1 timeseries]
                  tout: [100001x1 double]

    SimulationMetadata: [1x1 Simulink.SimulationMetadata]
```

```
        ErrorMessage: [0x0 char]
```

```
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```



Potential difference for the same electrodes and skin parameters

```
Rep=get_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R')
```

```
Rep =
'500'
```

```
set_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R','251')
s=sim(model_name)
```

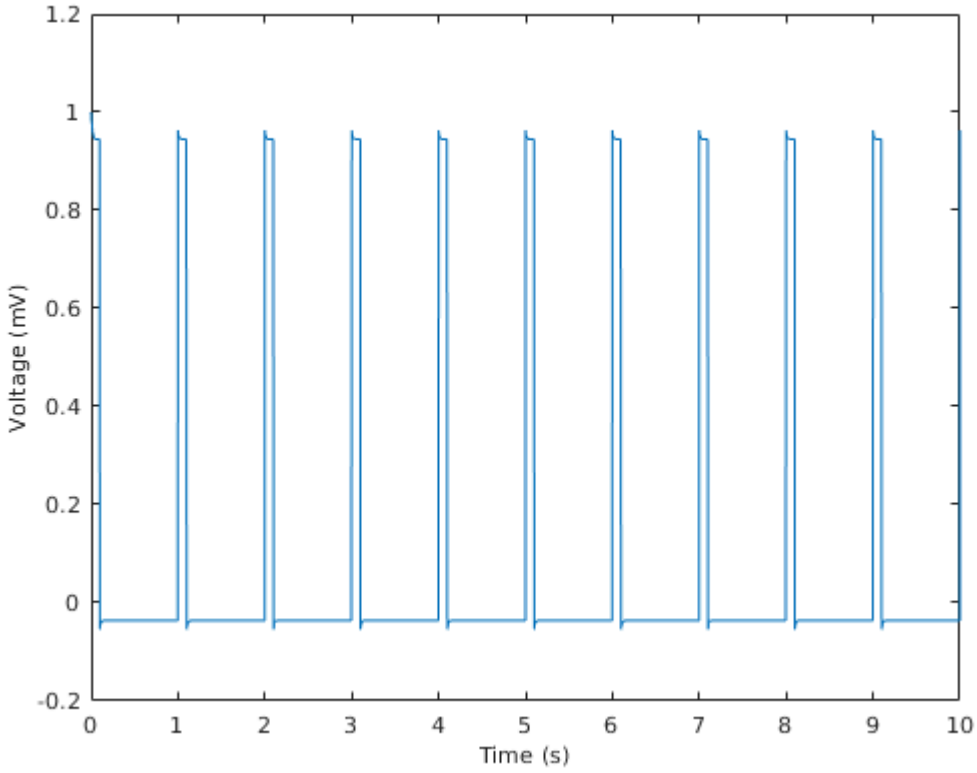
```
s =
  Simulink.SimulationOutput:

                simout: [1x1 timeseries]
                  tout: [100001x1 double]

    SimulationMetadata: [1x1 Simulink.SimulationMetadata]
          ErrorMessage: [0x0 char]
```

```
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
```

```
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```



After skin abrasion, epidermal resistances are 5kOhm and 10kOhm

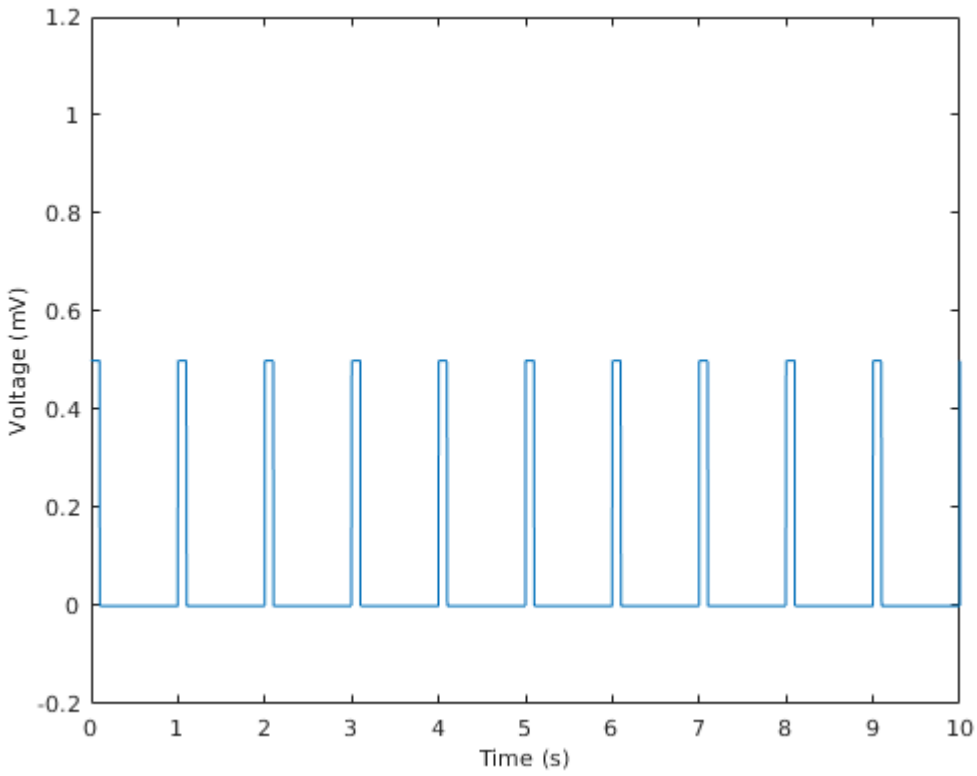
```
%Rep=get_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R')
set_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R','5')
set_param('ConnectingWetElectrodes/ElectrodeSkinModel1/Rep','R','10')
s=sim(model_name)
```

```
s =
  Simulink.SimulationOutput:

                simout: [1x1 timeseries]
                  tout: [100001x1 double]

    SimulationMetadata: [1x1 Simulink.SimulationMetadata]
          ErrorMessage: [0x0 char]
```

```
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```



After turning on sweat:

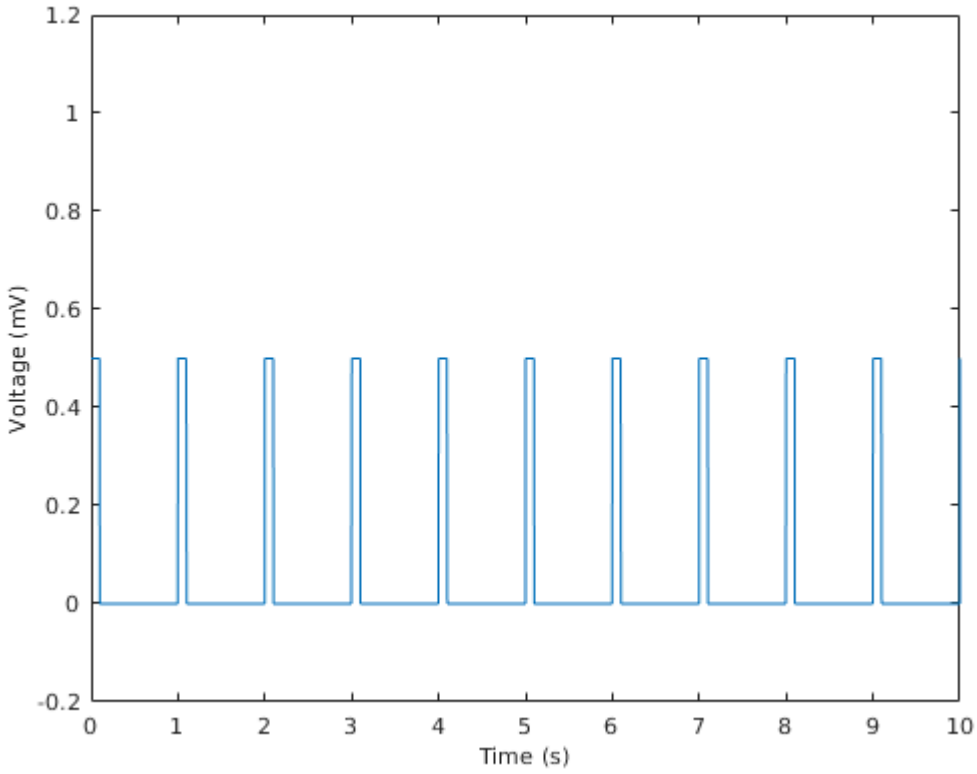
```
%Rep=get_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R')
set_param('ConnectingWetElectrodes/ElectrodeSkinModel2/Rep','R','500')
set_param('ConnectingWetElectrodes/ElectrodeSkinModel1/Rep','R','500')
set_param('ConnectingWetElectrodes/Zero','Value','1')
s=sim(model_name)
```

```
s =
  Simulink.SimulationOutput:

                simout: [1x1 timeseries]
                  tout: [100001x1 double]

    SimulationMetadata: [1x1 Simulink.SimulationMetadata]
          ErrorMessage: [0x0 char]
```

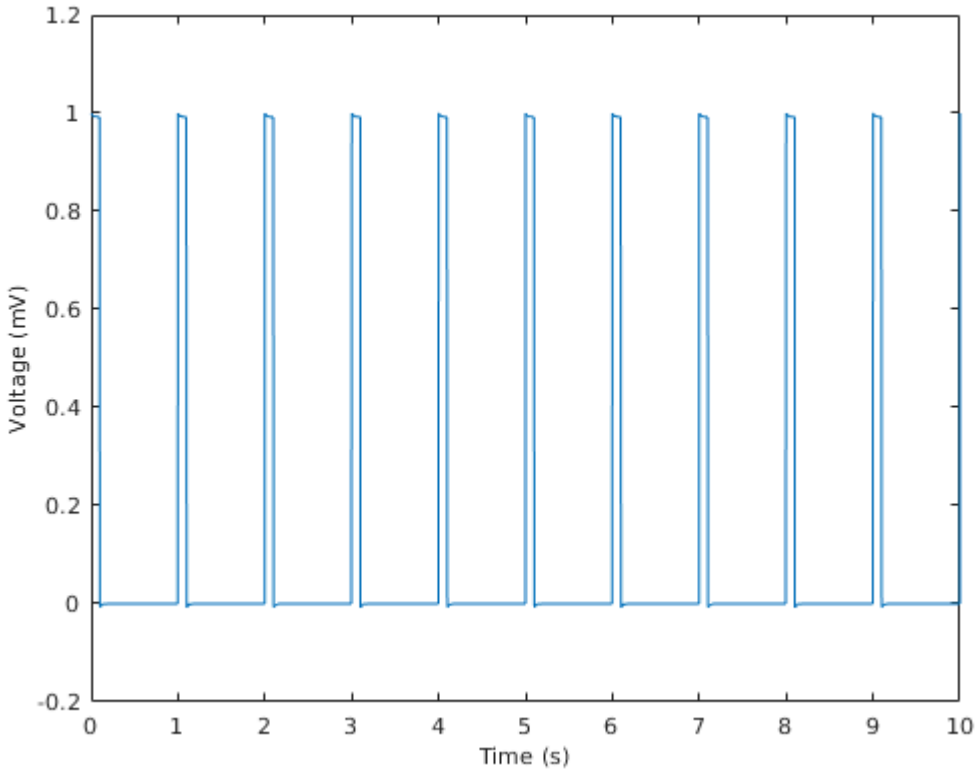
```
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```



Dry electrode

```
model_name = 'ConnectingDryElectrodes';
open_system(model_name);
```

```
s=sim(model_name);
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```

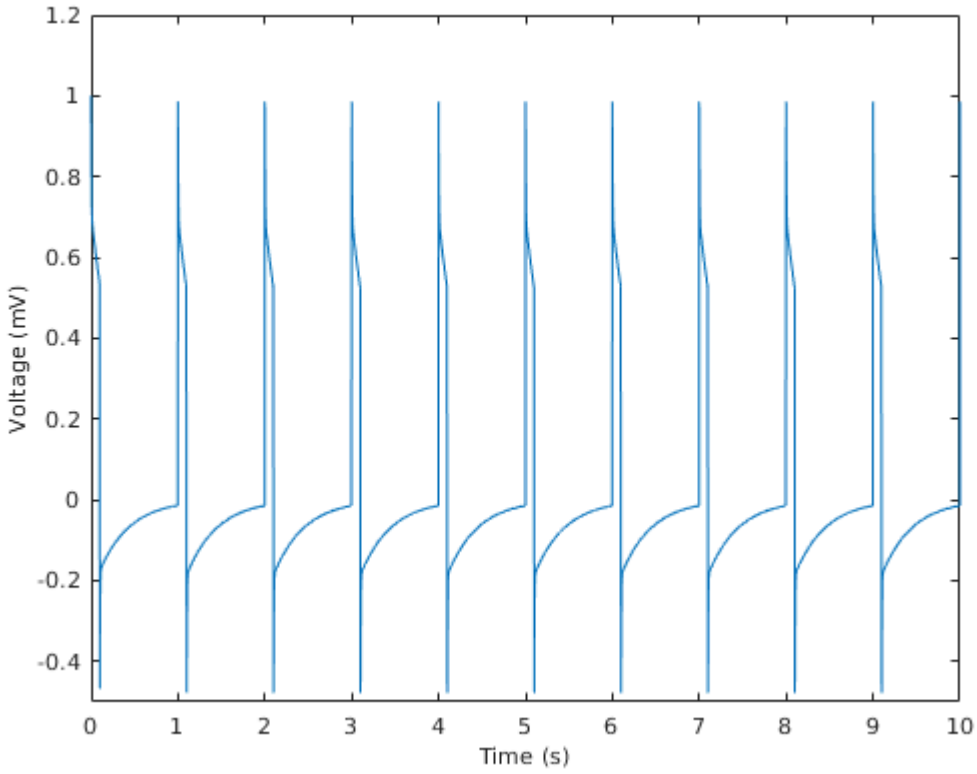


Non-contact electrode

```
model_name = 'ConnectingNoContactElectrodes';
open_system(model_name);
```

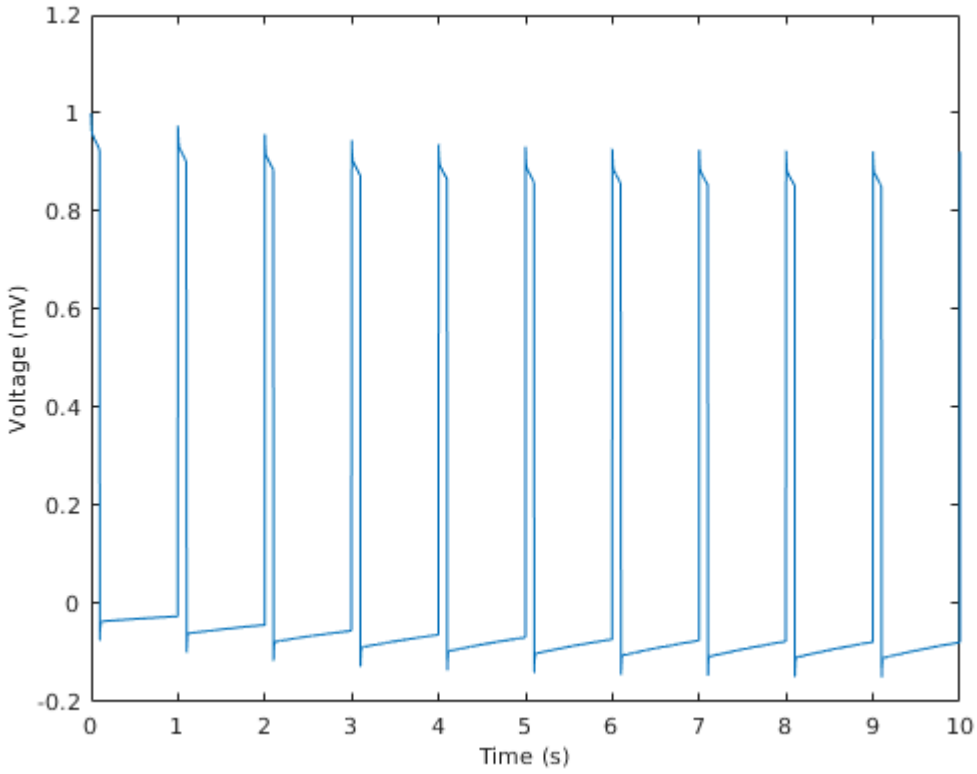
Simulation with Rin=1GOhm

```
set_param('ConnectingNoContactElectrodes/Rin','R','1')
s=sim(model_name);
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.5, 1.2])
```



Simulation with Rin=1GOhm

```
set_param('ConnectingNoContactElectrodes/Rin','R','10')
s=sim(model_name);
figure
plot(s.simout.Time, s.simout.Data*1000)
xlabel('Time (s)', 'FontSize', 10)
ylabel('Voltage (mV)', 'FontSize', 10)
ylim([-0.2, 1.2])
```


1.2
1
0.8
0.6
0.4
0.2
0
-0.2
Voltage (mV)
0
1
2
3
4
5
6
7
8
9
10
Time (s)