Versuch 242: Spannungsverstärkung

```
Needs["ErrorBarPlots`"]
```

```
dat1a48.7 = {
  {Quantity[-0.25, "Volts"], Quantity[4, "Volts"]},
  {Quantity[-0.20, "Volts"], Quantity[3.24, "Volts"]},
  {Quantity[-0.15, "Volts"], Quantity[2.44, "Volts"]},
  {Quantity[-0.10, "Volts"], Quantity[1.64, "Volts"]},
  {Quantity[+0.10, "Volts"], Quantity[-1.60, "Volts"]},
  {Quantity[+0.15, "Volts"], Quantity[-2.36, "Volts"]},
  {Quantity[+0.20, "Volts"], Quantity[-3.16, "Volts"]},
  {Quantity[+0.25, "Volts"], Quantity[-3.94, "Volts"]}
 }
```

```
{{-0.25 V, 4 V}, {-0.2 V, 3.24 V}, {-0.15 V, 2.44 V}, {-0.1 V, 1.64 V},
 {0.1 V, -1.6 V}, {0.15 V, -2.36 V}, {0.2 V, -3.16 V}, {0.25 V, -3.94 V}}
```

```
err1a48.7 = {
  {Quantity[0.005, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.003, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.003, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.08, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.06, "Volts"]}
 }
```

```
{{0.005 V, 0.08 V}, {0.005 V, 0.08 V}, {0.005 V, 0.08 V}, {0.003 V, 0.08 V},
 {0.003 V, 0.08 V}, {0.005 V, 0.08 V}, {0.005 V, 0.08 V}, {0.005 V, 0.06 V}}
```

```
plot1a48.7 = With[{d = dat1a48.7, e = err1a48.7}, ErrorListPlot[
    Table[{QuantityMagnitude /@ d[[i]], ErrorBar @@ QuantityMagnitude /@ e[[i]]},
     {i, 1, Length[d]}], ImageSize → Full, AxesLabel → {"U1 [V]", "UA [V]"},
    PlotLabel → Style["Aufgabe 1 (a): RG = 48.7 kΩ", Bold]]];
```

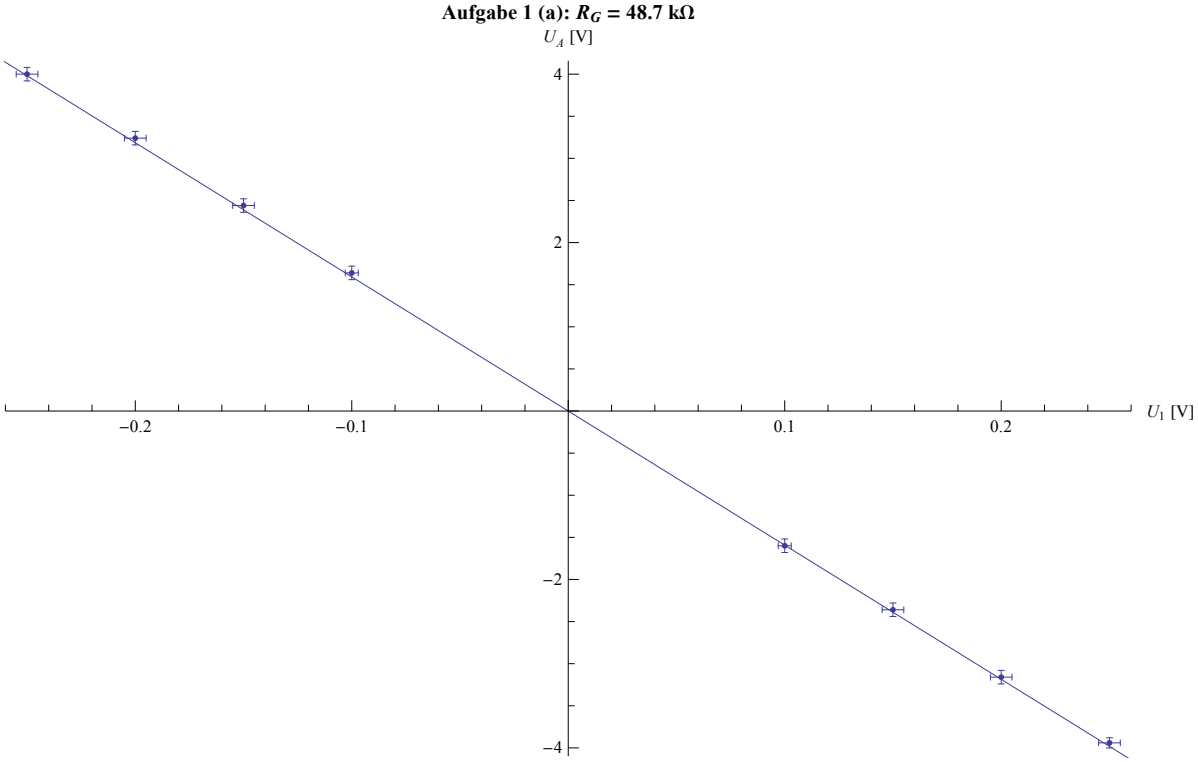
```
fit1,a,1 = With[{d = dat1a48.7, e = err1a48.7},
  LinearModelFit[QuantityMagnitude /@ d, x, x, IncludeConstantBasis → False,
   Weights → 1/(Total /@ QuantityMagnitude /@ e^2), VarianceEstimatorFunction → (1 &)]]
```

FittedModel[−15.9291 x]

```
fit1,a,1["ParameterTable"]
```

	Estimate	Standard Error	t-Statistic	P-Value
x	−15.9291	0.142069	−112.122	1.18357×10^{-12}

```
Show[plot1a48.7, Plot[fit1,a,1[x], {x, -1, 1}]]
```




```
dat1a274 = {
   {Quantity[-0.25, "Volts"], Quantity[14.4, "Volts"]},
   {Quantity[-0.20, "Volts"], Quantity[14.4, "Volts"]},
   {Quantity[-0.15, "Volts"], Quantity[13.8, "Volts"]},
   {Quantity[-0.10, "Volts"], Quantity[9.3, "Volts"]},
   {Quantity[+0.10, "Volts"], Quantity[-8.8, "Volts"]},
   {Quantity[+0.15, "Volts"], Quantity[-12.8, "Volts"]},
   {Quantity[+0.20, "Volts"], Quantity[-12.8, "Volts"]},
   {Quantity[+0.25, "Volts"], Quantity[-13.0, "Volts"]}
  }
```

```
{{-0.25 V, 14.4 V}, {-0.2 V, 14.4 V}, {-0.15 V, 13.8 V}, {-0.1 V, 9.3 V},
 {0.1 V, -8.8 V}, {0.15 V, -12.8 V}, {0.2 V, -12.8 V}, {0.25 V, -13. V}}
```

```
err1a274 = {
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.003, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.003, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.4, "Volts"]}
  }
```

```
{{0.005 V, 0.4 V}, {0.005 V, 0.4 V}, {0.005 V, 0.4 V}, {0.003 V, 0.4 V},
 {0.003 V, 0.4 V}, {0.005 V, 0.4 V}, {0.005 V, 0.4 V}, {0.005 V, 0.4 V}}
```

```
plot1a274 = With[{d = dat1a274, e = err1a274}, ErrorListPlot[
    Table[{QuantityMagnitude /@ d[[i]], ErrorBar @@ QuantityMagnitude /@ e[[i]]},
     {i, 1, Length[d]}], ImageSize → Full, AxesLabel → {"U1 [V]", "UA [V]"},
    PlotLabel → Style["Aufgabe 1 (a): RG = 274 kΩ", Bold]]];
```

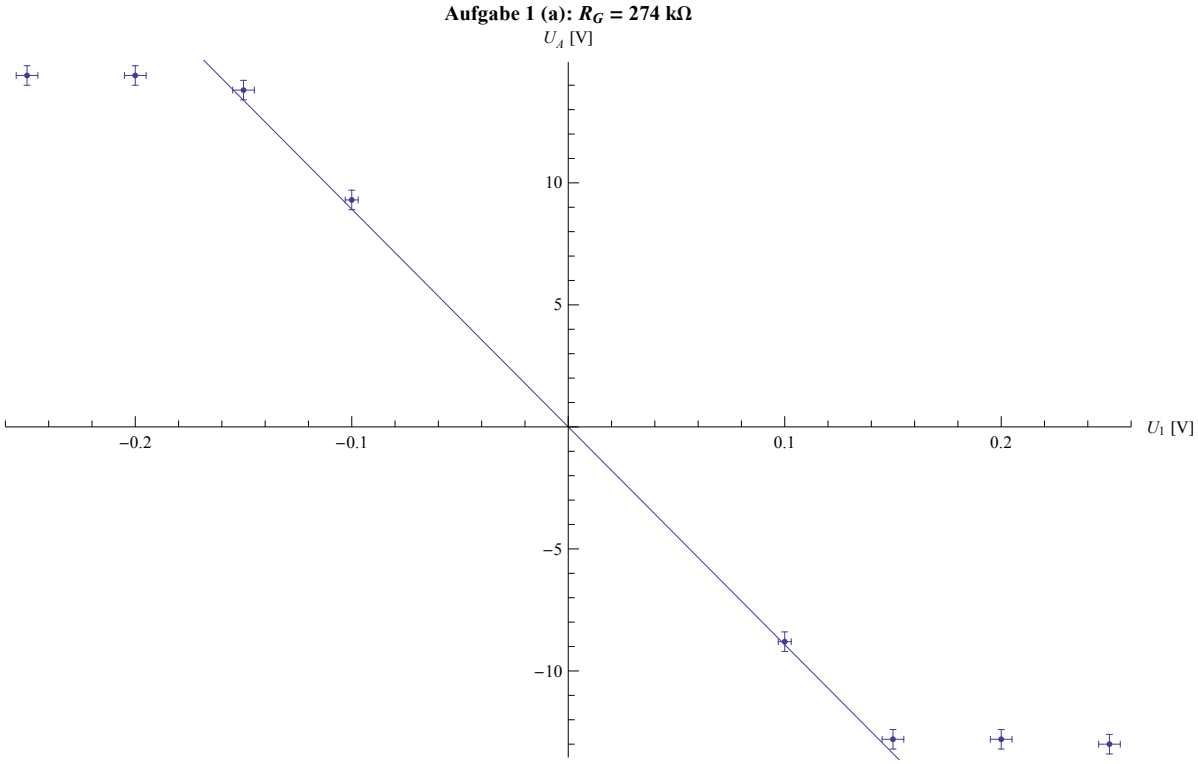
```
fit1,a,2 = With[{d = dat1a274[[3 ;; 6]], e = err1a274[[3 ;; 6]]},
  LinearModelFit[QuantityMagnitude /@ d, x, x, IncludeConstantBasis → False,
   Weights → 1 / Total /@ QuantityMagnitude /@ e^2, VarianceEstimatorFunction → (1 &)]]
```

FittedModel[−89.2308 x]

```
fit1,a,2["ParameterTable"]
```

	Estimate	Standard Error	t-Statistic	P-Value
x	−89.2308	1.56903	−56.8701	0.0000119766

```
Show[plot1a274, Plot[fit1,a,2[x], {x, -1, 1}]]
```




```
dat1b274 = {
   {Quantity[0.15, "Volts"], Quantity[1.30, "Volts"]},
   {Quantity[0.30, "Volts"], Quantity[2.63, "Volts"]},
   {Quantity[0.45, "Volts"], Quantity[3.93, "Volts"]},
   {Quantity[0.60, "Volts"], Quantity[5.28, "Volts"]},
   {Quantity[0.75, "Volts"], Quantity[6.58, "Volts"]},
   {Quantity[0.90, "Volts"], Quantity[7.84, "Volts"]}
  }
```

```
{{0.15 V, 1.3 V}, {0.3 V, 2.63 V}, {0.45 V, 3.93 V},
 {0.6 V, 5.28 V}, {0.75 V, 6.58 V}, {0.9 V, 7.84 V}}
```

```
err1b274 = {
   {Quantity[0.005, "Volts"], Quantity[0.01, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.01, "Volts"]},
   {Quantity[0.005, "Volts"], Quantity[0.01, "Volts"]},
   {Quantity[0.01, "Volts"], Quantity[0.01, "Volts"]},
   {Quantity[0.01, "Volts"], Quantity[0.02, "Volts"]},
   {Quantity[0.02, "Volts"], Quantity[0.02, "Volts"]}
  }
```

```
{{0.005 V, 0.01 V}, {0.005 V, 0.01 V}, {0.005 V, 0.01 V},
 {0.01 V, 0.01 V}, {0.01 V, 0.02 V}, {0.02 V, 0.02 V}}
```

```
plot1b274 = With[{d = dat1b274, e = err1b274}, ErrorListPlot[
     Table[{QuantityMagnitude /@ d[[i]], ErrorBar @@ QuantityMagnitude /@ e[[i]]},
      {i, 1, Length[d]}], AxesOrigin → {0, 0}, PlotRange → {{0, 1.0}, {0, 8}},
     ImageSize → Full, AxesLabel → {"UG [Vpp]", "UA [Vpp]"},
     PlotLabel → Style["Aufgabe 1 (b): RG = 274 kΩ", Bold]]];
```

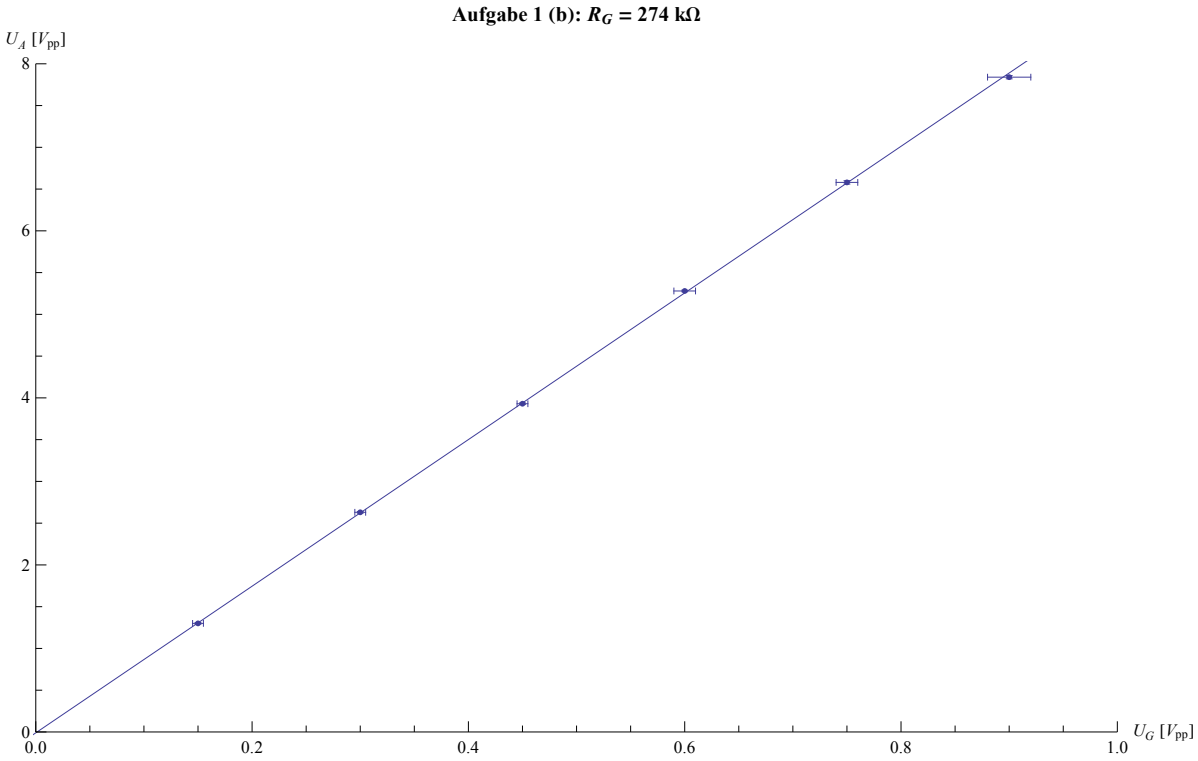
```
fit1,b,1 = With[{d = dat1b274, e = err1b274},
   LinearModelFit[QuantityMagnitude /@ d, x, x, IncludeConstantBasis → True,
    Weights → 1 / Total /@ QuantityMagnitude /@ e^2, VarianceEstimatorFunction → (1 &)]]
```

```
FittedModel[ −0.0105988 + 8.77831 x ]
```

```
fit1,b,1["ParameterTable"]
```

	Estimate	Standard Error	t-Statistic	P-Value
1	−0.0105988	0.0121458	−0.872634	0.432115
x	8.77831	0.027143	323.41	5.48418×10^{-10}

```
Show[plot1b274, Plot[fit1,b,1[x], {x, -1, 1}]]
```




```
dat1b680 = {
  {Quantity[0.15, "Volts"], Quantity[3.27, "Volts"]},
  {Quantity[0.30, "Volts"], Quantity[6.44, "Volts"]},
  {Quantity[0.45, "Volts"], Quantity[9.88, "Volts"]},
  {Quantity[0.60, "Volts"], Quantity[13.0, "Volts"]},
  {Quantity[0.75, "Volts"], Quantity[16.2, "Volts"]},
  {Quantity[0.90, "Volts"], Quantity[19.2, "Volts"]}
 }
```

```
{{0.15 V, 3.27 V}, {0.3 V, 6.44 V}, {0.45 V, 9.88 V},
 {0.6 V, 13. V}, {0.75 V, 16.2 V}, {0.9 V, 19.2 V}}
```

```
err1b680 = {
  {Quantity[0.005, "Volts"], Quantity[0.01, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.01, "Volts"]},
  {Quantity[0.005, "Volts"], Quantity[0.04, "Volts"]},
  {Quantity[0.01, "Volts"], Quantity[0.1, "Volts"]},
  {Quantity[0.01, "Volts"], Quantity[0.1, "Volts"]},
  {Quantity[0.02, "Volts"], Quantity[0.1, "Volts"]}
 }
```

```
{{0.005 V, 0.01 V}, {0.005 V, 0.01 V}, {0.005 V, 0.04 V},
 {0.01 V, 0.1 V}, {0.01 V, 0.1 V}, {0.02 V, 0.1 V}}
```

```
plot1b680 = With[{d = dat1b680, e = err1b680}, ErrorListPlot[
    Table[{QuantityMagnitude /@ d[[i]], ErrorBar @@ QuantityMagnitude /@ e[[i]]},
     {i, 1, Length[d]}], AxesOrigin → {0, 0}, PlotRange → {{0, 1.0}, {0, 20}},
    ImageSize → Full, AxesLabel → {"UG [Vpp]", "UA [Vpp]"},
    PlotLabel → Style["Aufgabe 1 (b): RG = 680 kΩ", Bold], ImageSize → Full]];
```

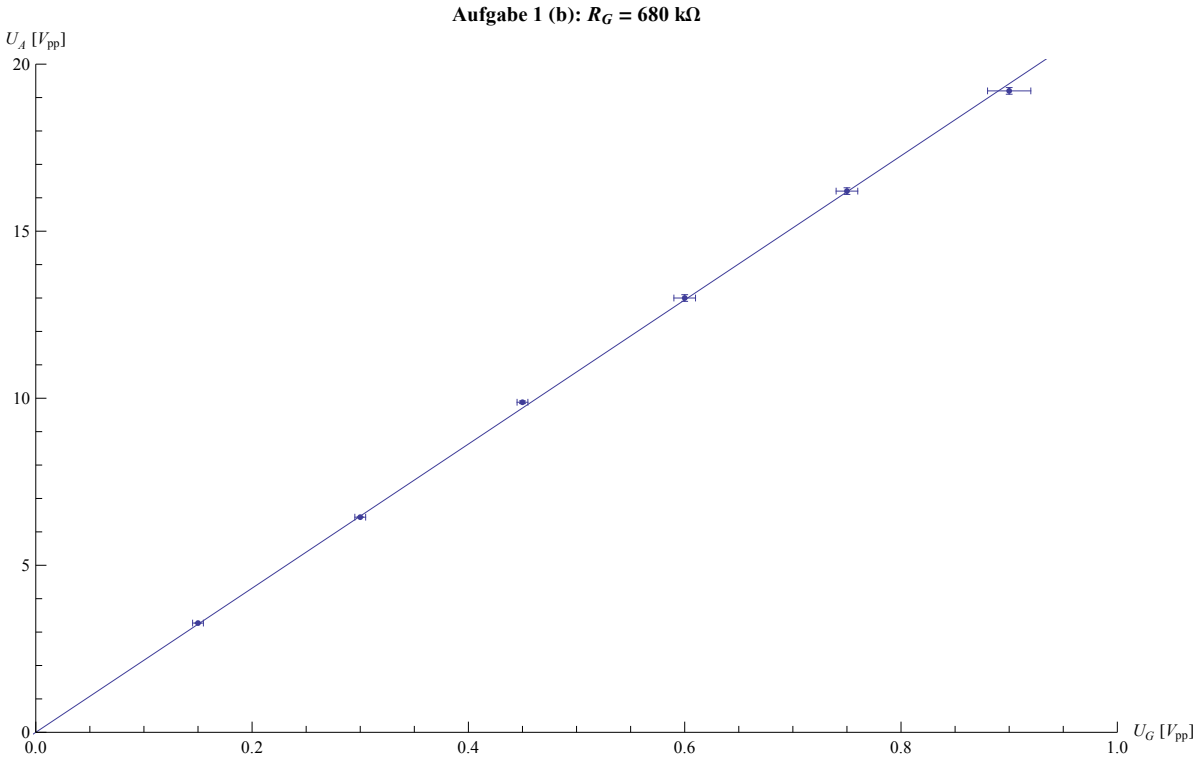
```
fit1,b,2 = With[{d = dat1b680, e = err1b680},
  LinearModelFit[QuantityMagnitude /@ d, x, x, IncludeConstantBasis → False,
   Weights → 1 / (Total /@ QuantityMagnitude /@ e^2), VarianceEstimatorFunction → (1 &)]]
```

```
FittedModel[ 21.5714 x ]
```

```
fit1,b,2["ParameterTable"]
```

	Estimate	Standard Error	t-Statistic	P-Value
x	21.5714	0.0289419	745.335	8.25157×10^{-14}

```
Show[plot1b680, Plot[fit1,b,2[x], {x, -1, 1}]]
```




```
U2,a,1 = Quantity[0.03, "Volts"]
```

```
0.03 V
```

```
dat2a48.7 = {
  {Quantity[0.1, "Kilohertz"], Quantity[0.462, "Volts"]},
  {Quantity[0.3, "Kilohertz"], Quantity[0.465, "Volts"]},
  {Quantity[0.7, "Kilohertz"], Quantity[0.465, "Volts"]},
  {Quantity[1, "Kilohertz"], Quantity[0.465, "Volts"]},
  {Quantity[3, "Kilohertz"], Quantity[0.463, "Volts"]},
  {Quantity[7, "Kilohertz"], Quantity[0.459, "Volts"]},
  {Quantity[10, "Kilohertz"], Quantity[0.456, "Volts"]},
  {Quantity[30, "Kilohertz"], Quantity[0.407, "Volts"]},
  {Quantity[70, "Kilohertz"], Quantity[0.293, "Volts"]},
  {Quantity[100, "Kilohertz"], Quantity[0.235, "Volts"]},
  {Quantity[300, "Kilohertz"], Quantity[0.0876, "Volts"]}
 }
```

```
{{0.1 kHz, 0.462 V}, {0.3 kHz, 0.465 V}, {0.7 kHz, 0.465 V},
 {1 kHz, 0.465 V}, {3 kHz, 0.463 V}, {7 kHz, 0.459 V}, {10 kHz, 0.456 V},
 {30 kHz, 0.407 V}, {70 kHz, 0.293 V}, {100 kHz, 0.235 V}, {300 kHz, 0.0876 V}}
```

```
err2a48.7 = {
  {Quantity[0.0001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.02, "Kilohertz"], Quantity[0.0004, "Volts"]}
 }
```

```
{{0.0001 kHz, 0.001 V}, {0.0001 kHz, 0.001 V},
 {0.0001 kHz, 0.001 V}, {0.0001 kHz, 0.001 V}, {0.0002 kHz, 0.002 V},
 {0.0002 kHz, 0.002 V}, {0.001 kHz, 0.002 V}, {0.001 kHz, 0.001 V},
 {0.001 kHz, 0.001 V}, {0.001 kHz, 0.001 V}, {0.02 kHz, 0.0004 V}}
```

```
{V2,a,48.7, ΔV2,a,48.7} = With[{f = # / {1, U2,a,1} &}, {f /@ dat2a48.7, f /@ err2a48.7}]
```

```
{{{0.1 kHz, 15.4}, {0.3 kHz, 15.5}, {0.7 kHz, 15.5}, {1 kHz, 15.5},
  {3 kHz, 15.4333}, {7 kHz, 15.3}, {10 kHz, 15.2}, {30 kHz, 13.5667},
  {70 kHz, 9.76667}, {100 kHz, 7.83333}, {300 kHz, 2.92}},
 {{0.0001 kHz, 0.0333333}, {0.0001 kHz, 0.0333333}, {0.0001 kHz, 0.0333333},
  {0.0001 kHz, 0.0333333}, {0.0002 kHz, 0.0666667},
  {0.0002 kHz, 0.0666667}, {0.001 kHz, 0.0666667}, {0.001 kHz, 0.0333333},
  {0.001 kHz, 0.0333333}, {0.001 kHz, 0.0333333}, {0.02 kHz, 0.0133333}}}
```

```
dat2a274 = {
  {Quantity[0.1, "Kilohertz"], Quantity[2.68, "Volts"]},
  {Quantity[0.3, "Kilohertz"], Quantity[2.68, "Volts"]},
  {Quantity[0.7, "Kilohertz"], Quantity[2.67, "Volts"]},
  {Quantity[1, "Kilohertz"], Quantity[2.67, "Volts"]},
  {Quantity[3, "Kilohertz"], Quantity[2.55, "Volts"]},
  {Quantity[7, "Kilohertz"], Quantity[2.19, "Volts"]},
  {Quantity[10, "Kilohertz"], Quantity[1.81, "Volts"]},
  {Quantity[30, "Kilohertz"], Quantity[0.826, "Volts"]},
  {Quantity[70, "Kilohertz"], Quantity[0.381, "Volts"]},
  {Quantity[100, "Kilohertz"], Quantity[0.271, "Volts"]},
  {Quantity[300, "Kilohertz"], Quantity[0.0900, "Volts"]}
 }
```

```
{{0.1 kHz, 2.68 V}, {0.3 kHz, 2.68 V}, {0.7 kHz, 2.67 V},
 {1 kHz, 2.67 V}, {3 kHz, 2.55 V}, {7 kHz, 2.19 V}, {10 kHz, 1.81 V},
 {30 kHz, 0.826 V}, {70 kHz, 0.381 V}, {100 kHz, 0.271 V}, {300 kHz, 0.09 V}}
```

```
err2a274 = {
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.01, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.02, "Kilohertz"], Quantity[0.0004, "Volts"]}
 }
```

```
{{0.0001 kHz, 0.02 V}, {0.0001 kHz, 0.02 V},
 {0.0001 kHz, 0.02 V}, {0.0001 kHz, 0.02 V}, {0.0002 kHz, 0.02 V},
 {0.0002 kHz, 0.02 V}, {0.001 kHz, 0.01 V}, {0.001 kHz, 0.002 V},
 {0.001 kHz, 0.001 V}, {0.001 kHz, 0.001 V}, {0.02 kHz, 0.0004 V}}
```

```
{V2,a,274, ΔV2,a,274} = With[{f = # / {1, U2,a,1} &}, {f /@ dat2a274, f /@ err2a274}]
```

```
{{{0.1 kHz, 89.3333}, {0.3 kHz, 89.3333}, {0.7 kHz, 89.},
   {1 kHz, 89.}, {3 kHz, 85.}, {7 kHz, 73.}, {10 kHz, 60.3333},
   {30 kHz, 27.5333}, {70 kHz, 12.7}, {100 kHz, 9.03333}, {300 kHz, 3.}},
 {{0.0001 kHz, 0.666667}, {0.0001 kHz, 0.666667}, {0.0001 kHz, 0.666667},
   {0.0001 kHz, 0.666667}, {0.0002 kHz, 0.666667},
   {0.0002 kHz, 0.666667}, {0.001 kHz, 0.333333}, {0.001 kHz, 0.0666667},
   {0.001 kHz, 0.0333333}, {0.001 kHz, 0.0333333}, {0.02 kHz, 0.0133333}}}
```

```
dat2a680 = {
  {Quantity[0.1, "Kilohertz"], Quantity[6.78, "Volts"]},
  {Quantity[0.3, "Kilohertz"], Quantity[6.78, "Volts"]},
  {Quantity[0.7, "Kilohertz"], Quantity[6.64, "Volts"]},
  {Quantity[1, "Kilohertz"], Quantity[6.52, "Volts"]},
  {Quantity[3, "Kilohertz"], Quantity[5.38, "Volts"]},
  {Quantity[7, "Kilohertz"], Quantity[3.30, "Volts"]},
  {Quantity[10, "Kilohertz"], Quantity[2.50, "Volts"]},
  {Quantity[30, "Kilohertz"], Quantity[0.870, "Volts"]},
  {Quantity[70, "Kilohertz"], Quantity[0.383, "Volts"]},
  {Quantity[100, "Kilohertz"], Quantity[0.274, "Volts"]},
  {Quantity[300, "Kilohertz"], Quantity[0.0904, "Volts"]}
 }
```

```
{{0.1 kHz, 6.78 V}, {0.3 kHz, 6.78 V}, {0.7 kHz, 6.64 V},
 {1 kHz, 6.52 V}, {3 kHz, 5.38 V}, {7 kHz, 3.3 V}, {10 kHz, 2.5 V},
 {30 kHz, 0.87 V}, {70 kHz, 0.383 V}, {100 kHz, 0.274 V}, {300 kHz, 0.0904 V}}
```

```
err2a680 = {
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0001, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.0002, "Kilohertz"], Quantity[0.02, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.01, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
  {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]},
  {Quantity[0.02, "Kilohertz"], Quantity[0.0004, "Volts"]}
 }
```

```
{{0.0001 kHz, 0.02 V}, {0.0001 kHz, 0.02 V},
 {0.0001 kHz, 0.02 V}, {0.0001 kHz, 0.02 V}, {0.0002 kHz, 0.02 V},
 {0.0002 kHz, 0.02 V}, {0.001 kHz, 0.01 V}, {0.001 kHz, 0.002 V},
 {0.001 kHz, 0.001 V}, {0.001 kHz, 0.002 V}, {0.02 kHz, 0.0004 V}}
```

```
{V2,a,680, ΔV2,a,680} = With[{f = # / {1, U2,a,1} &}, {f /@ dat2a680, f /@ err2a680}]
```

```
{{{0.1 kHz, 226.}, {0.3 kHz, 226.}, {0.7 kHz, 221.333},
  {1 kHz, 217.333}, {3 kHz, 179.333}, {7 kHz, 110.}, {10 kHz, 83.3333},
  {30 kHz, 29.}, {70 kHz, 12.7667}, {100 kHz, 9.13333}, {300 kHz, 3.01333}},
 {{0.0001 kHz, 0.666667}, {0.0001 kHz, 0.666667}, {0.0001 kHz, 0.666667},
  {0.0001 kHz, 0.666667}, {0.0002 kHz, 0.666667},
  {0.0002 kHz, 0.666667}, {0.001 kHz, 0.333333}, {0.001 kHz, 0.0666667},
  {0.001 kHz, 0.0333333}, {0.001 kHz, 0.0666667}, {0.02 kHz, 0.0133333}}}
```

```
U2,b,1 = Quantity[0.1, "Volts"]
```

```
0.1 V
```

```
dat2b = {
   {Quantity[0.1, "Kilohertz"], Quantity[1.55, "Volts"]},
   {Quantity[0.3, "Kilohertz"], Quantity[1.55, "Volts"]},
   {Quantity[0.7, "Kilohertz"], Quantity[1.54, "Volts"]},
   {Quantity[1, "Kilohertz"], Quantity[1.53, "Volts"]},
   {Quantity[3, "Kilohertz"], Quantity[1.38, "Volts"]},
   {Quantity[7, "Kilohertz"], Quantity[1.02, "Volts"]},
   {Quantity[10, "Kilohertz"], Quantity[0.800, "Volts"]},
   {Quantity[30, "Kilohertz"], Quantity[0.310, "Volts"]},
   {Quantity[70, "Kilohertz"], Quantity[0.136, "Volts"]},
   {Quantity[100, "Kilohertz"], Quantity[0.0964, "Volts"]},
   {Quantity[300, "Kilohertz"], Quantity[0.0321, "Volts"]}
  }
```

```
{{0.1 kHz, 1.55 V}, {0.3 kHz, 1.55 V}, {0.7 kHz, 1.54 V}, {1 kHz, 1.53 V},
 {3 kHz, 1.38 V}, {7 kHz, 1.02 V}, {10 kHz, 0.8 V}, {30 kHz, 0.31 V},
 {70 kHz, 0.136 V}, {100 kHz, 0.0964 V}, {300 kHz, 0.0321 V}}
```

```
err2b = {
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0002, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0002, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.004, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.001, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.0004, "Volts"]},
   {Quantity[0.02, "Kilohertz"], Quantity[0.0001, "Volts"]}
  }
```

```
{{0.0001 kHz, 0.01 V}, {0.0001 kHz, 0.01 V},
 {0.0001 kHz, 0.01 V}, {0.0001 kHz, 0.01 V}, {0.0002 kHz, 0.01 V},
 {0.0002 kHz, 0.01 V}, {0.001 kHz, 0.004 V}, {0.001 kHz, 0.002 V},
 {0.001 kHz, 0.001 V}, {0.001 kHz, 0.0004 V}, {0.02 kHz, 0.0001 V}}
```

```
{V_{2,b}, ΔV_{2,b}} = With[{f = # / {1, U_{2,b,1}} &}, {f /@ dat2b, f /@ err2b}]
```

```
{{{0.1 kHz, 15.5}, {0.3 kHz, 15.5}, {0.7 kHz, 15.4},
   {1 kHz, 15.3}, {3 kHz, 13.8}, {7 kHz, 10.2}, {10 kHz, 8.},
   {30 kHz, 3.1}, {70 kHz, 1.36}, {100 kHz, 0.964}, {300 kHz, 0.321}},
 {{0.0001 kHz, 0.1}, {0.0001 kHz, 0.1}, {0.0001 kHz, 0.1}, {0.0001 kHz, 0.1},
   {0.0002 kHz, 0.1}, {0.0002 kHz, 0.1}, {0.001 kHz, 0.04}, {0.001 kHz, 0.02},
   {0.001 kHz, 0.01}, {0.001 kHz, 0.004}, {0.02 kHz, 0.001}}}
```

```
U_{2,c,1} = Quantity[0.1, "Volts"]
```

```
0.1 V
```

```
dat2c = {
   {Quantity[0.3, "Kilohertz"], Quantity[0.414, "Volts"]},
   {Quantity[0.7, "Kilohertz"], Quantity[0.816, "Volts"]},
   {Quantity[1, "Kilohertz"], Quantity[1.00, "Volts"]},
   {Quantity[3, "Kilohertz"], Quantity[1.31, "Volts"]},
   {Quantity[7, "Kilohertz"], Quantity[1.01, "Volts"]},
   {Quantity[10, "Kilohertz"], Quantity[0.796, "Volts"]},
   {Quantity[20, "Kilohertz"], Quantity[0.446, "Volts"]}
  }
```

```
{{0.3 kHz, 0.414 V}, {0.7 kHz, 0.816 V}, {1 kHz, 1. V},
 {3 kHz, 1.31 V}, {7 kHz, 1.01 V}, {10 kHz, 0.796 V}, {20 kHz, 0.446 V}}
```

```
err2c = {
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0001, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0002, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.0002, "Kilohertz"], Quantity[0.01, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.004, "Volts"]},
   {Quantity[0.001, "Kilohertz"], Quantity[0.002, "Volts"]}
  }
```

```
{{0.0001 kHz, 0.01 V}, {0.0001 kHz, 0.01 V},
 {0.0001 kHz, 0.01 V}, {0.0002 kHz, 0.01 V},
 {0.0002 kHz, 0.01 V}, {0.001 kHz, 0.004 V}, {0.001 kHz, 0.002 V}}
```

```
{V2,c, ΔV2,c} = With[{f = # / {1, U2,c,1} &}, {f /@ dat2c, f /@ err2c}]
```

```
{{{0.3 kHz, 4.14}, {0.7 kHz, 8.16}, {1 kHz, 10.},
   {3 kHz, 13.1}, {7 kHz, 10.1}, {10 kHz, 7.96}, {20 kHz, 4.46}},
  {{0.0001 kHz, 0.1}, {0.0001 kHz, 0.1}, {0.0001 kHz, 0.1}, {0.0002 kHz, 0.1},
   {0.0002 kHz, 0.1}, {0.001 kHz, 0.04}, {0.001 kHz, 0.02}}}
```

```
u = 0.05;
```

```
pa1 = With[{r = 48.7}, With[{v = V2,a,r, Δv = ΔV2,a,r},
     Show[Table[ListLogLogPlot[QuantityMagnitude /@ (v + sgn * Δv),
        Joined → True, Mesh → If[sgn == 0, All, None], ImageSize → Full,
        PlotStyle → If[sgn == 0, ColorData[1, 1], Gray],
        AxesLabel → {"V'", "f [kHz]"}, PlotLegends → If[sgn == 0,
          Placed[{ToString[r] <> " kΩ Gegenkopplung"}, {Right, Top}], None],
        PlotLabel → Style["Frequenzgang mit " <> ToString[r] <>
           " kΩ Gegenkopplung", Bold]], {sgn, {-1, 0, 1}}]]]];
```

```
pa2 = With[{r = 274}, With[{v = V2,a,r, Δv = ΔV2,a,r},
     Show[Table[ListLogLogPlot[QuantityMagnitude /@ (v + sgn * Δv),
        Joined → True, Mesh → If[sgn == 0, All, None], ImageSize → Full,
        PlotStyle → If[sgn == 0, ColorData[1, 2], Gray],
        AxesLabel → {"V'", "f [kHz]"}, PlotLegends → If[sgn == 0,
          Placed[{ToString[r] <> " kΩ Gegenkopplung"}, {Right, Top}], None],
        PlotLabel → Style["Frequenzgang mit " <> ToString[r] <>
           " kΩ Gegenkopplung", Bold]], {sgn, {-1, 0, 1}}]]]];
```

```
pa3 = With[{r = 680}, With[{v = V2,a,r, Δv = ΔV2,a,r},
     Show[Table[ListLogLogPlot[QuantityMagnitude /@ (v + sgn * Δv),
         Joined → True, Mesh → If[sgn == 0, All, None], ImageSize → Full,
         PlotStyle → If[sgn == 0, ColorData[1, 3], Gray],
         AxesLabel → {"V'", "f [kHz]"}, PlotLegends → If[sgn == 0,
           Placed[{ToString[r] <> " kΩ Gegenkopplung"}, {Right, Top}], None],
         PlotLabel → Style["Frequenzgang mit " <> ToString[r] <>
            " kΩ Gegenkopplung", Bold]], {sgn, {-1, 0, 1}}]]]];

pb = With[{v = V2,b, Δv = ΔV2,b},
    Show[Table[ListLogLogPlot[QuantityMagnitude /@ (v + sgn * Δv),
       Joined → True, Mesh → If[sgn == 0, All, None], ImageSize → Full,
       PlotStyle → If[sgn == 0, ColorData[1, 4], Gray],
       AxesLabel → {"V'", "f [kHz]"}, PlotLegends → If[sgn == 0,
         Placed[{"48.7 kΩ Gegenkopplung, Tiefpaß"}, {Right, Top}], None],
       PlotLabel → Style["Frequenzgang mit 48.7 kΩ Gegenkopplung und Tiefpaß",
         Bold]], {sgn, {-1, 0, 1}}]]];

pc = With[{v = V2,c, Δv = ΔV2,c},
    Show[Table[ListLogLogPlot[QuantityMagnitude /@ (v + sgn * Δv),
       Joined → True, Mesh → If[sgn == 0, All, None], ImageSize → Full,
       PlotStyle → If[sgn == 0, ColorData[1, 5], Gray],
       AxesLabel → {"V'", "f [kHz]"}, PlotLegends → If[sgn == 0,
         Placed[{"48.7 kΩ Gegenkopplung, Hoch- und Tiefpaß"}, {Right, Top}],
         If[sgn == 1, Placed[{"1σ-Konfidenzintervalle"}, {Right, Top}], None],
         None], PlotLabel →
        Style["Frequenzgang mit 48.7 kΩ Gegenkopplung und Tief- und Hochpaß",
         Bold]], {sgn, {-1, 0, 1}}]]];
```

```
Show[ListLogLogPlot[{{1, 1}}, AxesLabel → {"V'", "f [kHz]"},
  PlotLabel → Style["Frequenzgang", Bold], PlotRange → {{1, 400}, {3, 250}}],
 pb, pa3, pa2, pa1, pc, ImageSize → Full]
```