# Audio 3.1 DeltaKompression

**d)**

i. Fehler bei Quantisierung von 1

```
Play/Pause  Übung3: A-Generator - Deltakompression  ▼  Quant-Faktor(1,2,4,8,16,..4096. , off: 66000): 1

Logging of:

AudioTestArray:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000,
DeltaSamplesP:      0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0
QuantSamplesP:      0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0
iQuantSamplesP:     0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000, 0.0000, 0.
iDeltaSamplesP:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000, 0.7000, 0.7000, 0.7000, 0.7000, 0.
ErrorLog:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
```

ii. Fehler bei Quantisierung von 8

```
Play/Pause  Übung3: Audio - Deltakompression  ▼  Quant-Faktor(1,2,

Logging of:

monoSamples:       0.0063, 0.0068, 0.0058, 0.0045, 0.0034, 0.0026, 0.0017, 0.00
DeltaSamplesP:      0.0063, 0.0005, -0.0010, -0.0014, -0.0010, -0.0009, -0.000
QuantSamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.
iQuantSamplesP:     0.0082, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0
iDeltaSamplesP:     0.0082, 0.0082, 0.0082, 0.0082, 0.0082, 0.0082, 0.0082, 0
ErrorLogP:      0.0019, 0.0014, 0.0023, 0.0037, 0.0047, 0.0056, 0.0065, 0.0072
Error - SAD: NaN.00, MSE: NaN.00, PSNR: NaN.00
--------------Compression Data ----------------
Orginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at AudioBuffer (16384, Ch: 1): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

# Audio 3.2 SubbandKompression

## c)

### i. Fehler bei Quantisierung von 1

```
Play/Pause | Übung3: A-Generator - Subbandkompression ▼ | Quant-Faktor(1,2,4,8,16,..4096. , off: 66000):
1                                                                                    Log

Logging of:

AudioTestArray:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000,
DeltaSamplesP:      0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000,
QuantSamplesP:      0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000,
iQuantSamplesP:     0.0000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.1000, 0.0000, 0.0000, 0.0000
iDeltaSamplesP:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000, 0.7000, 0.7000, 0.7000
ErrorLog:     0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00

Measurment Video Measurment Audio
```

### ii. Fehler bei Quantisierung von 8

```
Play/Pause | Übung3: A-Generator - Subbandkompression ▼ | Quant-Faktor(1,2,4,8,16,..4096. , off: 66000):
8                                                                                    Log

Logging of:

AudioTestArray:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000,
ALengthSamples:     0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000, 0.0000,
TPsamples:      0.0000, 0.0500, 0.1500, 0.2500, 0.3500, 0.4500, 0.5500, 0.6500, 0.3500,
HPsamples:      0.0000, 0.0500, 0.0500, 0.0500, 0.0500, 0.0500, 0.0500, 0.0500, -0.3500,
TPdownsamples:      0.0000, 0.1500, 0.3500, 0.5500, 0.3500,
HPdownsamples:      0.0000, 0.0500, 0.0500, 0.0500, -0.3500,
TPquantsamples:     0.0000, 0.0188, 0.0437, 0.0688, 0.0437,
HPquantsamples:     0.0000, 0.0500, 0.0500, 0.0500, -0.3500,
TPIquantsamples:     0.0000, 0.1500, 0.3500, 0.5500, 0.3500,
HPIquantsamples:     0.0000, 0.0500, 0.0500, 0.0500, -0.3500,
TPupsamples:      0.0000, 0.0000, 0.1500, 0.0000, 0.3500, 0.0000, 0.5500, 0.0000, 0.3500,
HPupsamples:      0.0000, 0.0000, 0.0500, 0.0000, 0.0500, 0.0000, 0.0500, 0.0000, -0.3500,
ATPOutsamples:      0.0000, 0.0000, 0.0750, 0.0750, 0.1750, 0.1750, 0.2750, 0.2750, 0.1750,
AHPOutsamples:      0.0000, 0.0000, -0.0250, 0.0250, -0.0250, 0.0250, -0.0250, 0.0250, 0.1750,
MixOutSamples:      0.0000, 0.0000, 0.0500, 0.1000, 0.1500, 0.2000, 0.2500, 0.3000, 0.3500,
DelaySamples:      0.0000, 0.0500, 0.1000, 0.1500, 0.2000, 0.2500, 0.3000, 0.3500,
ScaleSamples:      0.0000, 0.1000, 0.2000, 0.3000, 0.4000, 0.5000, 0.6000, 0.7000,
ErrorLog:     0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
```

# Audio 3.3 FFT

## c)

### i. Fehler bei Quantisierung von TP: 1 HP: 1 Grenzwert: 1

```
Play/Pause   Übung3: A-Generator - oneHz4 - FFT-Kompression   ▼  Quant-Faktor(1,2,4,8,16,.. 24 Bit. , off: 88888888):
1        HP-Quant-Faktor: 1        Grenzfreq.(1-2 Hz): 1                              Log

Logging of:

oneHzAudio:        1.0000, 0.4200, -0.4200, -1.0000, -1.0000, -0.4200, 0.4200, 1.0000,
QuantMatrix:       1.0000, 1.0000, 1.0000, 1.0000, 1.0000, 1.0000, 1.0000, 1.0000,
FFTKoef.spectrumLong:    0.0000, 5.6684, 0.0000, 0.0279, 0.0000, 0.0279, 0.0000, 5.6684,
QuantFFT.spectrumLong:   0.0000, 5.6684, 0.0000, 0.0279, 0.0000, 0.0279, 0.0000, 5.6684,
iQuantFFT.spectrumLong:   0.0000, 5.6684, 0.0000, 0.0279, 0.0000, 0.0279, 0.0000, 5.6684,
iInverseFFT:       1.0000, 0.4200, -0.4200, -1.0000, -1.0000, -0.4200, 0.4200, 1.0000,
ErrorLog:        0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
```

### ii. Fehler bei Quantisierung von TP: 16 HP: 32 Grenzwert: 1

```
Play/Pause   Übung3: A-Generator - oneHz4 - FFT-Kompression   ▼  Quant-Faktor(1,2,4,8,16,.. 24 Bit. , off: 88888888):
16       HP-Quant-Faktor: 32       Grenzfreq.(1-2 Hz): 1                              Log

Logging of:

oneHzAudio:        1.0000, 0.4200, -0.4200, -1.0000, -1.0000, -0.4200, 0.4200, 1.0000,
QuantMatrix:       16.0000, 32.0000, 32.0000, 32.0000, 32.0000, 32.0000, 32.0000, 32.0000,
FFTKoef.spectrumLong:    0.0000, 5.6684, 0.0000, 0.0279, 0.0000, 0.0279, 0.0000, 5.6684,
QuantFFT.spectrumLong:   0.0000, 0.1771, 0.0000, 0.0009, 0.0000, 0.0009, 0.0000, 0.1771,
iQuantFFT.spectrumLong:   0.0000, 5.6685, 0.0000, 0.0282, 0.0000, 0.0282, 0.0000, 5.6685,
iInverseFFT:       1.0000, 0.4201, -0.4200, -1.0000, -1.0000, -0.4201, 0.4200, 1.0000,
ErrorLog:        0.0000, 0.0001, 0.0000, 0.0000, 0.0000, -0.0001, 0.0000, 0.0000,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
```

## b) höchste Quantisierung bei bester Wahrnehmungs-Qualität

1500

```
Play/Pause  Übung3: Audio - Subbandkompression          ▼  TP-Quant-Faktor(1,2,4,8,16,..4096. , off: 66000): 1500     HP-Quant-Faktor: 1

Logging of:

monoSamples:      0.0058, 0.0080, 0.0110, 0.0140, 0.0171, 0.0206, 0.0249, 0.0302, 0.0352, 0.0379, 0.0379, 0.0369, 0.0372, 0.0390, 0.0411, 0.0
ALengthSamplesP:      0.0058, 0.0080, 0.0110, 0.0140, 0.0171, 0.0206, 0.0249, 0.0302, 0.0352, 0.0379, 0.0379, 0.0369, 0.0372, 0.0390, 0.0411,
TPsamplesP:      0.0029, 0.0069, 0.0095, 0.0125, 0.0156, 0.0189, 0.0228, 0.0275, 0.0327, 0.0365, 0.0379, 0.0374, 0.0370, 0.0381, 0.0401, 0.04
HPsamplesP:      0.0058, 0.0011, 0.0015, 0.0015, 0.0016, 0.0017, 0.0022, 0.0026, 0.0025, 0.0014, 0.0000, -0.0005, 0.0001, 0.0009, 0.0011, 0.0
TPdownsamplesP:      0.0029, 0.0095, 0.0156, 0.0228, 0.0327, 0.0379, 0.0370, 0.0401, 0.0433, 0.0472, 0.0533, 0.0547, 0.0482, 0.0403, 0.0325,
HPdownsamplesP:      0.0058, 0.0015, 0.0016, 0.0022, 0.0025, 0.0000, 0.0001, 0.0011, 0.0006, 0.0015, 0.0013, -0.0008, -0.0021, -0.0018, -0.00
TPquantsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001,
HPquantsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
TPIquantsamplesP:      0.0051, 0.0102, 0.0154, 0.0205, 0.0307, 0.0358, 0.0358, 0.0410, 0.0410, 0.0461, 0.0512, 0.0563, 0.0461, 0.0410, 0.0307
HPIquantsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000
TPupsamplesP:      0.0051, 0.0000, 0.0102, 0.0000, 0.0154, 0.0000, 0.0205, 0.0000, 0.0307, 0.0000, 0.0358, 0.0000, 0.0358, 0.0000, 0.0410, 0.
HPupsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.
ATPOutsamplesP:      0.0026, 0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205,
AHPOutsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
MixOutSamplesP:      0.0026, 0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205,
DelaySamplesP:      0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205, 0.0205, 0
ScaleSamplesP:      0.0051, 0.0102, 0.0102, 0.0154, 0.0154, 0.0205, 0.0205, 0.0307, 0.0307, 0.0358, 0.0358, 0.0358, 0.0358, 0.0410, 0.0410, 0
ErrorLogP:      -0.0006, 0.0022, -0.0007, 0.0014, -0.0018, -0.0001, -0.0044, 0.0006, -0.0045, -0.0021, -0.0020, -0.0010, -0.0013, 0.0019, -0.
Error - SAD: NaN.00, MSE: NaN.00, PSNR: NaN.00
--------------Compression Data -----------------
Orignial Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at AudioBuffer (16384, Ch: 1): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

## c) Wortbreite bei der optimalen Quantisierung

16 bit

## d) Datenrate bei 48kHz

Unkomprimierte Datenrate:

samplerate * word size * channels

48000 * 16bit * 2 = 1536000 bit/s

1536000 bit/ = 192000 byte/s = 192 kbyte/s

Komprimierte Datenrate (wort längen reduktion) bei quant. Fakt. 2:

48000 * 15bit * 2 = 1440000 bit/s

1440000 bit/s = 180000 byte/s = 180 kbyte/s

## e) Kompression

Runden mit Quantisierungsfaktor 6

Wertebereich 17Bit (Statt 16Bit)
-64.000 bis +64.000

Bestimmen der höchten Quantisierung bei bester Wahrnehmungsqualität:

Q=64 -> 6 bit weil 2^6 = 64

Berechnen der optimalen Wortbreite bei der optimalen Quantisierung:

17 bit - 6 bit = 11 bit (17 bit weil bei der Deltakomp. 1 bit hinzugefügt wird.)

# Audio 3.5 Subband

## b) höchste Quantisierung bei bester Wahrnehmungs-Qualität

1500

```
Play/Pause   Übung3: Audio - Subbandkompression      ▼ TP-Quant-Faktor(1,2,4,8,16,..4096. , off: 66000): 1500     HP-Quant-Faktor: 1

Logging of:

monoSamples:        0.0058, 0.0080, 0.0110, 0.0140, 0.0171, 0.0206, 0.0249, 0.0302, 0.0352, 0.0379, 0.0379, 0.0369, 0.0372, 0.0390, 0.0411, 0.0
ALengthSamplesP:      0.0058, 0.0080, 0.0110, 0.0140, 0.0171, 0.0206, 0.0249, 0.0302, 0.0352, 0.0379, 0.0379, 0.0369, 0.0372, 0.0390, 0.0411,
TPsamplesP:        0.0029, 0.0069, 0.0095, 0.0125, 0.0156, 0.0189, 0.0228, 0.0275, 0.0327, 0.0365, 0.0379, 0.0374, 0.0370, 0.0381, 0.0401, 0.04
HPsamplesP:        0.0058, 0.0011, 0.0015, 0.0015, 0.0016, 0.0017, 0.0022, 0.0026, 0.0025, 0.0014, 0.0000, -0.0005, 0.0001, 0.0009, 0.0011, 0.0
TPdownsamplesP:       0.0029, 0.0095, 0.0156, 0.0228, 0.0327, 0.0379, 0.0370, 0.0401, 0.0433, 0.0472, 0.0533, 0.0547, 0.0482, 0.0403, 0.0325,
HPdownsamplesP:       0.0058, 0.0015, 0.0016, 0.0022, 0.0025, 0.0000, 0.0001, 0.0011, 0.0006, 0.0015, 0.0013, -0.0008, -0.0021, -0.0018, -0.00
TPquantsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001, 0.0001,
HPquantsamplesP:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
TPIquantsamplesP:     0.0051, 0.0102, 0.0154, 0.0205, 0.0307, 0.0358, 0.0358, 0.0410, 0.0410, 0.0461, 0.0512, 0.0563, 0.0461, 0.0410, 0.0307
HPIquantsamplesP:     0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000
TPupsamplesP:       0.0051, 0.0000, 0.0102, 0.0000, 0.0154, 0.0000, 0.0205, 0.0000, 0.0307, 0.0000, 0.0358, 0.0000, 0.0358, 0.0000, 0.0410, 0.
HPupsamplesP:       0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.
ATPOutsamplesP:       0.0026, 0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205,
AHPOutsamplesP:       0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000,
MixOutSamplesP:       0.0026, 0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205,
DelaySamplesP:        0.0026, 0.0051, 0.0051, 0.0077, 0.0077, 0.0102, 0.0102, 0.0154, 0.0154, 0.0179, 0.0179, 0.0179, 0.0179, 0.0205, 0.0205, 0
ScaleSamplesP:        0.0051, 0.0102, 0.0102, 0.0154, 0.0154, 0.0205, 0.0205, 0.0307, 0.0307, 0.0358, 0.0358, 0.0358, 0.0358, 0.0410, 0.0410, 0
ErrorLogP:       -0.0006, 0.0022, -0.0007, 0.0014, -0.0018, -0.0001, -0.0044, 0.0006, -0.0045, -0.0021, -0.0020, -0.0010, -0.0013, 0.0019, -0.
Error - SAD: NaN.00, MSE: NaN.00, PSNR: NaN.00
--------------Compression Data ----------------
Orginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at AudioBuffer (16384, Ch: 1): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

## c) Wortbreite bei der optimalen Quantisierung

16 bit

## d) Datenrate bei 48kHz

48000hz * 1 channel * 11 bit

Berechnen der Compression Ratio:

## e) Kompression

16:11 weil 16 bit auf 11 bit reduziert wurden.

## f) Measurement

# Audio 3.6 FFT

## b) höchste Quantisierung bei bester Wahrnehmungs-Qualität

ca 66000

```
Play/Pause │ Übung3: Audio - Audio16384/2 - FFT-Kompression    ▼│ TP-Quant-Faktor(1,2,4,8,16,.. 24 Bit. , off: 88888888): 66000   HP-Quant-Faktor:
1888888 Grenzfreq.(1-16000/2 Hz): 1000           Log

Logging of:

monoSamples:      -0.0032, -0.0030, -0.0029, -0.0030, -0.0032, -0.0034, -0.0038, -0.0039, -0.0039, -0.0040, -0.0039, -0.0037, -0.0036, -0
QuantMatrixP:      66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000
FFTKoefP.spectrumLong:     0.0763, 0.8991, 0.1085, 0.8462, 0.5685, 0.2943, 0.7600, 0.2304, 0.5446, 0.5107, 0.7018, 0.0653, 0.6209, 0.497
QuantFFTP.spectrumLong:      0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.00
iQuantFFTP.spectrumLong:     0.0000, 0.6600, 0.0000, 1.3200, 0.6600, 0.0000, 0.6600, 0.0000, 0.0000, 0.6600, 0.6600, 0.0000, 0.6600, 0.0
iInverseFFTP:     -0.0006, -0.0007, -0.0008, -0.0009, -0.0010, -0.0011, -0.0012, -0.0012, -0.0013, -0.0014, -0.0014, -0.0015, -0.0015, -
ErrorLogP:      0.0025, 0.0023, 0.0021, 0.0021, 0.0022, 0.0024, 0.0026, 0.0026, 0.0026, 0.0026, 0.0025, 0.0022, 0.0022, 0.0024, 0.0027, 0
Error - SAD: NaN.00, MSE: NaN.00, PSNR: NaN.00
-------------Compression Data ----------------
Orginnal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at AudioBuffer (16384, Ch: 1): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

## c) Wortbreite bei der optimalen Quantisierung

TP 24-16bit = 8 Bit

HP = 0 bit

## d) Datenrate bei 48kHz

1000 Koeffizienten * 2 (real & imaginär) * 3 Blöcke * 1 * 8 Bit
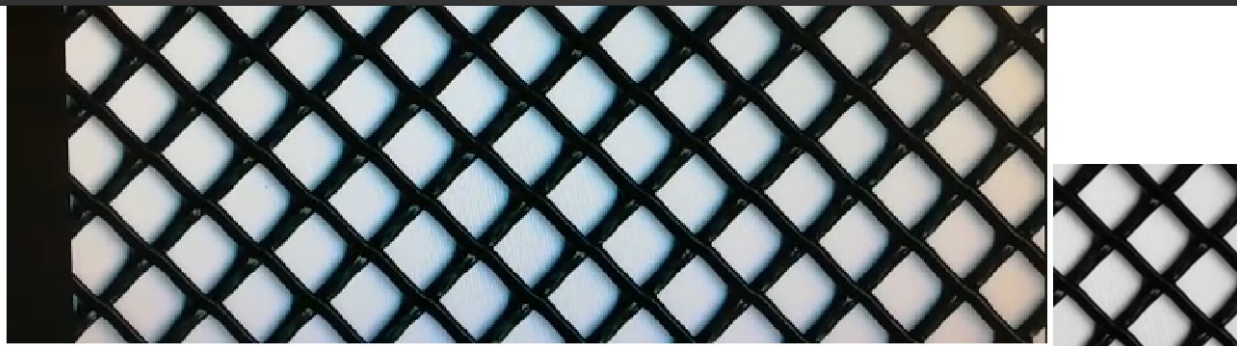
= 48.000

## e) Kompression

2000 * 8 Bit

1 : 16

## f) Measurement

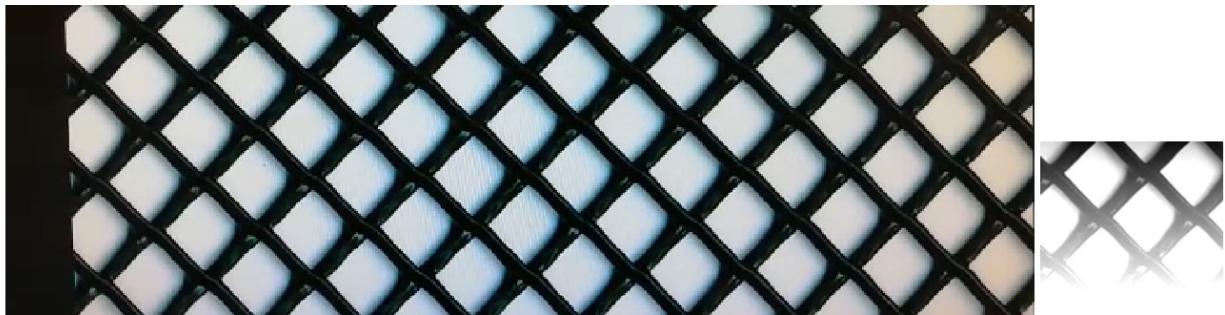# Video 3.1 DeltaKompression

**d)**

i. Fehler bei Quantisierung von 1



```
Logging of:

imgArrayIn:      216, 224, 230, 255, 214, 223, 229, 255, 213, 223, 229, 255, 212, 223, 229, 255, 209, 221, 227, 255, 205,
BridnessSamples:     223, 222, 222, 221, 219, 217, 216, 214, 214, 209, 209, 198, 185, 167, 147, 124, 104, 72, 42, 18, 8,
DeltaSamples:    223, -1, 0, -1, -2, -2, -1, -2, 0, -5, 0, -11, -13, -18, -20, -23, -20, -32, -30, -24, -10, 1, 0, 1, 1,
QuantSamples:    223, -1, 0, -1, -2, -2, -1, -2, 0, -5, 0, -11, -13, -18, -20, -23, -20, -32, -30, -24, -10, 1, 0, 1, 1,
iQuantSamples:    223, -1, 0, -1, -2, -2, -1, -2, 0, -5, 0, -11, -13, -18, -20, -23, -20, -32, -30, -24, -10, 1, 0, 1, 1
IDeltaSamples:     223, 222, 222, 221, 219, 217, 216, 214, 214, 209, 209, 198, 185, 167, 147, 124, 104, 72, 42, 18, 8, 9,
imgArrayOut:     223, 223, 223, 255, 222, 222, 222, 255, 222, 222, 222, 255, 221, 221, 221, 255, 219, 219, 219, 255, 217,
ErrorLog:      0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
-------------Compression Data ----------------
Orginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at Canvas (128, 128, p25): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

ii. Fehler bei Quantisierung von 8



```
Logging of:

imgArrayIn:      215, 223, 227, 255, 215, 223, 227, 255, 214, 223, 227, 255, 213, 223, 227, 255, 212, 223, 228, 255, 210, 22
BridnessSamples:     222, 222, 221, 221, 221, 220, 218, 215, 212, 209, 207, 198, 192, 175, 161, 138, 106, 96, 54, 29, 18, 1
DeltaSamples:    222, 0, -1, 0, 0, -1, -2, -3, -3, -3, -2, -9, -6, -17, -14, -23, -32, -10, -42, -25, -11, -4, -2, -1, 1,
QuantSamples:    28, 0, 0, 0, 0, 0, 0, 0, 0, 0, -1, -1, -2, -2, -3, -4, -1, -5, -3, -1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0
iQuantSamples:    222, 0, -1, 0, 0, -1, -2, -3, -3, -3, -2, -9, -6, -17, -14, -23, -32, -10, -42, -25, -11, -4, -2
IDeltaSamples:     222, 222, 221, 221, 221, 220, 218, 215, 212, 209, 207, 198, 192, 175, 161, 138, 106, 96, 54, 29, 18, 14,
imgArrayOut:     222, 222, 222, 255, 222, 222, 222, 255, 221, 221, 221, 255, 221, 221, 221, 255, 221, 221, 221, 255, 220, 2
ErrorLog:      0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1
Error - SAD: 2560855.68, MSE: 32614.53, PSNR: -33.10
-------------Compression Data ----------------
Orginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at Canvas (128, 128, p25): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

# Video 3.2 SubbandKompression

## c)

### i. Fehler bei Quantisierung von 1



```
Logging of:

BridnessSamples:      225, 223, 223, 223, 223, 219, 219, 222, 221, 217, 215, 213, 211, 203, 190, 177, 158, 141, 124, 90, 57, 31, 16,
ALengthSamples:       225, 223, 223, 223, 223, 219, 219, 222, 221, 217, 215, 213, 211, 203, 190, 177, 158, 141, 124, 90, 57, 31, 16, 1
TPsamples:      113, 224, 223, 223, 223, 221, 219, 221, 222, 219, 216, 214, 212, 207, 197, 184, 168, 150, 133, 107, 74, 44, 24, 15, 1
HPsamples:      225, -1, 0, 0, 0, -2, 0, 2, 0, -2, -1, -1, -1, -4, -6, -6, -9, -8, -8, -17, -16, -13, -7, -1, 0, -1, 0, 1, 1, 1, 1, 1
TPdownsamples:      113, 223, 223, 219, 222, 216, 212, 197, 168, 133, 74, 24, 13, 10, 13, 15, 15, 16, 14, 21, 104, 48, 10, 12, 11, 10
HPdownsamples:      225, 0, 0, 0, 0, -1, -1, -6, -9, -8, -16, -7, 0, 0, 1, 1, -1, 0, -4, 20, -2, -25, 4, -1, 0, 0, 4, -7, 87, -3, 1,
TPquantsamples:      113, 223, 223, 219, 222, 216, 212, 197, 168, 133, 74, 24, 13, 10, 13, 15, 15, 16, 14, 21, 104, 48, 10, 12, 11, 1
HPquantsamples:      225, 0, 0, 0, 0, -1, -1, -6, -9, -8, -16, -7, 0, 0, 1, 1, -1, 0, -4, 20, -2, -25, 4, -1, 0, 0, 4, -7, 87, -3, 1,
TPIquantsamples:      113, 223, 223, 219, 222, 216, 212, 197, 168, 133, 74, 24, 13, 10, 13, 15, 15, 16, 14, 21, 104, 48, 10, 12, 11, 1
HPIquantsamples:      225, 0, 0, 0, 0, -1, -1, -6, -9, -8, -16, -7, 0, 0, 1, 1, -1, 0, -4, 20, -2, -25, 4, -1, 0, 0, 4, -7, 87, -3, 1
TPupsamples:      113, 0, 223, 0, 223, 0, 219, 0, 222, 0, 216, 0, 212, 0, 197, 0, 168, 0, 133, 0, 74, 0, 24, 0, 13, 0, 10, 0, 13, 0,
HPupsamples:      225, 0, 0, 0, 0, 0, 0, 0, 0, -1, 0, -1, 0, -6, 0, -9, 0, -8, 0, -16, 0, -7, 0, 0, 0, 0, 1, 0, 1, 0, -1, 0, 0,
ATPOutsamples:       56, 56, 112, 112, 112, 112, 110, 110, 111, 111, 108, 108, 106, 106, 98, 98, 84, 84, 66, 66, 37, 37, 12, 12, 6, 6,
AHPOutsamples:       225, 113, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 3, -3, 5, -5, 4, -4, 8, -8, 4, -4, 0, 0, 0, 0, 0, 0, 1, 0, 0,
MixOutSamples:       281, 169, 112, 112, 112, 112, 110, 110, 111, 111, 109, 108, 107, 106, 102, 95, 89, 79, 71, 62, 45, 29, 16, 8, 7,
DelaySamples:       169, 112, 112, 112, 112, 110, 110, 111, 111, 109, 108, 107, 106, 102, 95, 89, 79, 71, 62, 45, 29, 16, 8, 7, 6, 5,
ScaleSamples:       338, 223, 223, 223, 223, 219, 219, 222, 221, 217, 215, 213, 211, 203, 190, 177, 158, 141, 124, 90, 57, 31, 16, 13,
imgArrayOut:       255, 255, 255, 255, 223, 223, 223, 255, 223, 223, 223, 255, 223, 223, 223, 255, 223, 223, 223, 255, 219, 219, 219,
ErrorLog:       113, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
Error - SAD: 112.50, MSE: 0.77, PSNR: 13.15
--------------Compression Data -----------------
Orirginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at Canvas (128, 128, p25): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

### ii. Fehler bei Quantisierung von 8



```
Logging of:

BridnessSamples:      222, 222, 222, 221, 221, 220, 219, 219, 216, 213, 209, 203, 200, 192, 179, 155, 137, 115, 87, 56, 28, 16, 14, 12, 11,
ALengthSamples:       222, 222, 222, 221, 221, 220, 219, 219, 216, 213, 209, 203, 200, 192, 179, 155, 137, 115, 87, 56, 28, 16, 14, 12, 11,
TPsamples:      111, 222, 222, 222, 221, 221, 220, 219, 218, 215, 211, 206, 202, 196, 186, 167, 146, 126, 101, 72, 42, 22, 15, 13, 12, 12,
HPsamples:      222, 0, 0, 0, 0, 0, 0, -1, -1, -2, -3, -1, -4, -6, -12, -9, -11, -14, -15, -14, -6, -1, -1, 0, 1, 1, 0, 1, 1, 0, -1, 4,
TPdownsamples:      111, 222, 221, 220, 218, 211, 202, 186, 146, 101, 42, 15, 12, 13, 14, 15, 16, 9, 5, 136, 115, 98, 45, 9, 10, 11, 14, 22
HPdownsamples:      222, 0, 0, -1, -2, -1, -6, -9, -14, -14, -1, 0, 1, 1, 0, 4, 1, -1, 24, -7, 0, -23, 1, 2, 1, 1, 4, 6, 44, 2, 1, 0, 0,
TPquantsamples:       14, 28, 28, 27, 27, 26, 25, 23, 18, 13, 5, 2, 1, 2, 2, 2, 1, 1, 17, 14, 12, 6, 1, 1, 1, 2, 3, 2, 23, 27, 27, 27, 27
HPquantsamples:       28, 0, 0, 0, 0, 0, -1, -1, -2, -2, 0, 0, 0, 0, 0, 0, 0, 0, 3, -1, 0, -3, 0, 0, 0, 0, 0, 1, 6, 0, 0, 0, 0,
TPIquantsamples:      111, 222, 221, 219, 218, 211, 202, 186, 146, 101, 42, 15, 11, 13, 14, 15, 15, 9, 5, 135, 114, 98, 45, 9, 10, 11, 14,
HPIquantsamples:      222, 0, 0, -1, -2, -2, -2, -6, -9, -14, -14, -1, -1, 1, 1, 0, 3, 1, -1, 23, -7, 0, -23, 1, 2, 1, 1, 3, 6, 44, 2, 1, -
TPupsamples:      111, 0, 222, 0, 221, 0, 219, 0, 218, 0, 211, 0, 202, 0, 186, 0, 146, 0, 101, 0, 42, 0, 15, 0, 11, 0, 13, 0, 14, 0, 15, 0,
HPupsamples:      222, 0, 0, 0, 0, -1, 0, -2, 0, -2, 0, -6, 0, -9, 0, -14, 0, -14, 0, -1, 0, 1, 0, 1, 0, 0, 0, 3, 0, 1, 0,
ATPOutsamples:       56, 56, 111, 111, 110, 110, 110, 110, 109, 109, 106, 106, 101, 101, 93, 93, 73, 73, 50, 50, 21, 21, 8, 8, 6, 6, 6, 6, 7
AHPOutsamples:       222, 111, 0, 0, 0, 0, 0, 1, -1, 1, -1, 1, -1, 3, -3, 4, -4, 7, -7, 7, -7, 0, 0, 0, 0, 0, 0, 0, -2, 2, 0, 0,
MixOutSamples:       278, 167, 111, 111, 110, 110, 110, 109, 110, 108, 106, 105, 102, 100, 96, 90, 78, 69, 57, 44, 28, 14, 8, 7, 6, 5, 6, 7, 6, 7,
DelaySamples:       167, 111, 111, 110, 110, 110, 109, 110, 108, 106, 105, 102, 100, 96, 90, 78, 69, 57, 44, 28, 14, 8, 7, 6, 5, 6, 7, 6, 7,
ScaleSamples:       334, 222, 222, 221, 221, 220, 218, 219, 216, 213, 210, 203, 200, 192, 179, 155, 138, 114, 87, 56, 29, 16, 14, 12, 10, 12
imgArrayOut:       255, 255, 255, 255, 222, 222, 222, 255, 222, 222, 222, 255, 221, 221, 221, 255, 221, 221, 221, 255, 220, 220, 220, 255, 2
ErrorLog:       112, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, -1, 0, 0, 1, 0, 0, 0, -1, 0, 1, 0, 0, 0, 0, 0, -1, 0, 1, 0, 0, 0, -1,
Error - SAD: 4331.60, MSE: 0.87, PSNR: 12.65
--------------Compression Data -----------------
Orirginal Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at Canvas (128, 128, p25): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

# Video 3.3 FFT

## c)

### i. Fehler bei Quantisierung von TP: 1 HP: 1 Grenzwert: 1



```
Play/Pause  Übung3: V-Generator - oneHz4x4 - FFT-Kompression ▾  TP-Quant-Faktor(1 bis - 24 Bit - 88888888:off): 1    HP-Quant-Faktor: 1    Grenzfreq.(Hz): 2
            Log

Logging of:

imgArrayIn2:     254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254,
oneHz:       254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254,
FFT1.spec:     8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
swepFFT.spec:    0, 0, 0, 0, 0, 0, 0, 0, 0, 7, 8, 7, 0, 0, 0, 0,
QuantMatrix:    1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
quantFFT.spec:
iquantFFT.spec:    8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
iswepFFT.spec:    8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
iFFTspec:     254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254,
imgArrayOut:     254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254,
ErrorLog:     0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
Error - SAD: 0.00, MSE: 0.00, PSNR: 0.00
```

### ii. Fehler bei Quantisierung von TP: 16 HP: 32 Grenzwert: 1



```
Play/Pause  Übung3: V-Generator - oneHz4x4 - FFT-Kompression ▾  TP-Quant-Faktor(1 bis - 24 Bit - 88888888:off): 16    HP-Quant-Faktor: 32    Grenzfreq.(Hz): 2
            Log

Logging of:

imgArrayIn2:     254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254, 255, 0, 0, 0, 255, 0, 0, 0, 255, 254, 254, 254, 255, 254, 254, 254,
oneHz:       254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254, 254, 0, 0, 254,
FFT1.spec:     8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
swepFFT.spec:    0, 0, 0, 0, 0, 0, 0, 0, 0, 7, 8, 7, 0, 0, 0, 0,
QuantMatrix:    16, 16, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32, 32,
quantFFT.spec:
iquantFFT.spec:    8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
iswepFFT.spec:    8, 7, 0, 7, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
iFFTspec:     255, 0, 0, 255, 255, 0, 0, 255, 255, 0, 0, 255, 255, 0, 0, 255,
imgArrayOut:     255, 255, 255, 255, 0, 0, 0, 255, 0, 0, 0, 255, 255, 255, 255, 255, 255, 255, 255, 255, 0, 0, 0, 255, 0, 0, 0, 255, 255, 255, 255, 255, 255, 255, 255,
ErrorLog:     1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1,
Error - SAD: 8.00, MSE: 0.50, PSNR: 15.04
```

# Video 3.4 Delta

**b) höchste Quantisierung bei bester Wahrnehmungs-Qualität**

1500

quantisierung: 8

**c) Wortbreite bei der optimalen Quantisierung**

16 bit

**d) Datenrate bei 404p25 für RGB**

Unkomprimierte Datenrate:

samplerate * word size * channels

48000 * 16bit * 2 = 1536000 bit/s

1536000 bit/ = 192000 byte/s = 192 kbyte/s

Komprimierte Datenrate (wort längen reduktion) bei quant. Fakt. 2:

48000 * 15bit * 2 = 1440000 bit/s

1440000 bit/s = 180000 byte/s = 180 kbyte/s

**e) Kompression**

Runden mit Quantisierungsfaktor 6

Wertebereich 17Bit (Statt 16Bit)
-64.000 bis +64.000

Bestimmen der höchten Quantisierung bei bester Wahrnehmungsqualität:

Q=64 -> 6 bit weil 2^6 = 64

Berechnen der optimalen Wortbreite bei der optimalen Quantisierung:

17 bit - 6 bit = 11 bit (17 bit weil bei der Deltakomp. 1 bit hinzugefügt wird.)

**f) Measurement**

# Video 3.5 Subband

**b) höchste Quantisierung bei bester Wahrnehmungs-Qualität**

1500

quantisierung: 8

**c) Wortbreite bei der optimalen Quantisierung**

16 bit

**d) Datenrate bei 404p25 für RGB**

48000hz * 1 channel * 11 bit

Berechnen der Compression Ratio:

**e) Kompression**

16:11 weil 16 bit auf 11 bit reduziert wurden.

**f) Measurement**

# Video 3.6 FFT

## b) höchste Quantisierung bei bester Wahrnehmungs-Qualität

ca 66000



```
Play/Pause | Übung3: Audio - Audio16384/2 - FFT-Kompression  ▼ | TP-Quant-Faktor(1,2,4,8,16,.. 24 Bit. , off: 88888888): 66000 | HP-Quant-Faktor:
1888888| Grenzfreq.(1-16000/2 Hz): 1000            [ Log ]

Logging of:

monoSamples:      -0.0032, -0.0030, -0.0029, -0.0030, -0.0032, -0.0034, -0.0038, -0.0039, -0.0039, -0.0040, -0.0039, -0.0037, -0.0036, -0
QuantMatrixP:      66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000, 66000.0000
FFTKoefP.spectrumLong:    0.0763, 0.8991, 0.1085, 0.8462, 0.5685, 0.2943, 0.7600, 0.2304, 0.5446, 0.5107, 0.7018, 0.0653, 0.6209, 0.497
QuantFFTP.spectrumLong:       0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.0000, 0.00
iQuantFFTP.spectrumLong:      0.0000, 0.6600, 0.0000, 1.3200, 0.6600, 0.0000, 0.6600, 0.0000, 0.0000, 0.6600, 0.6600, 0.0000, 0.6600, 0.0
iInverseFFTP:      -0.0006, -0.0007, -0.0008, -0.0009, -0.0010, -0.0011, -0.0012, -0.0012, -0.0013, -0.0014, -0.0014, -0.0015, -0.0015, -
ErrorLogP:      0.0025, 0.0023, 0.0021, 0.0021, 0.0022, 0.0024, 0.0026, 0.0026, 0.0026, 0.0026, 0.0025, 0.0022, 0.0022, 0.0024, 0.0027, 0
Error - SAD: NaN.00, MSE: NaN.00, PSNR: NaN.00
--------------Compression Data ----------------
Orignial Wortbreite: 1 Bit , Codec Wortbreite: 1 Bit
TP-Quant-Wortbreite = 2 Bit,  HP-Quant-Wortbreite = 3 Bit
TP-Codec-Wortbreite = 4 Bit,  HP-Codec-Wortbreite = 5 Bit
Datarate  at AudioBuffer (16384, Ch: 1): Orginal: 6 MBit/s, Codec: 9 MBit/s
Kompressionsrate: 1 : 10
```

## c) Wortbreite bei der optimalen Quantisierung

TP 24-16bit = 8 Bit

HP = 0 bit

## d) Datenrate bei 404p25 für RGB

1000 Koeffizienten * 2 (real & imaginär) * 3 Blöcke * 1 * 8 Bit

= 48.000

## e) Kompression

2000 * 8 Bit

1 : 16

## f) Measurement