Sidechain Dynamic Range Compression

Quinn Kast

Processing Steps

1. Level detection
    a. Square sidechain channels
    b. Leaky integrator finds mean level
    c. Root of the mean
2. Convert level to dB
3. Calculate linear gain
    a. If level below threshold, gain is 1
    b. If above threshold, $C_{dB} = (1/R - 1) * (X_{dB} - T_{dB})$
    c. Convert to linear
4. Find gain dynamics coefficient
5. Leaky integrator smooths gain
6. Apply gain to main channels

RMS Level Detector

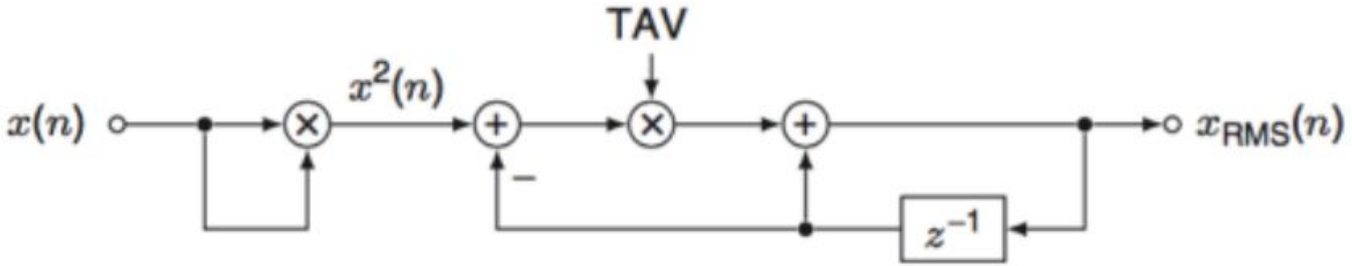
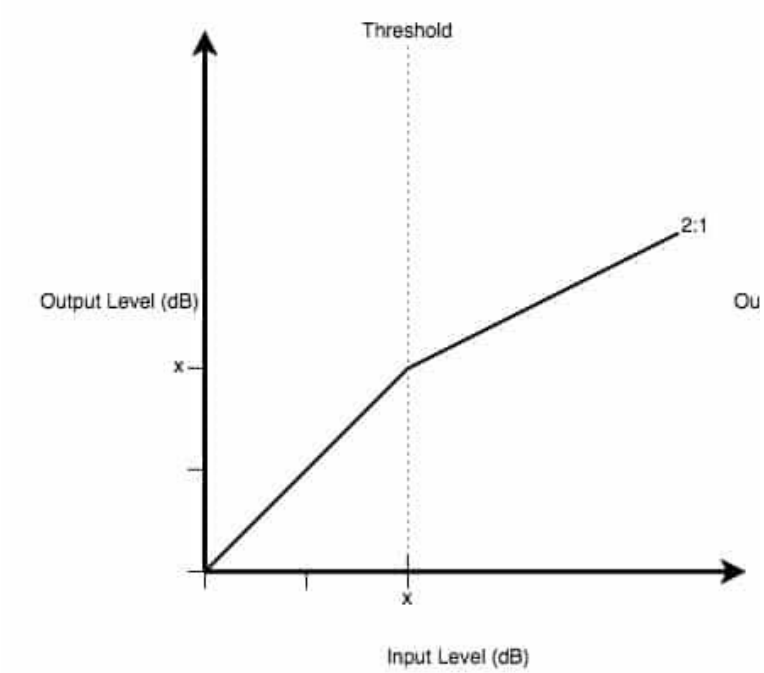


Figure 4.10 RMS measurement (envelope detector/follower) for a dynamic range controller [McN84, Zöl05].

```
// Level detector
squareL = sidechainInputLeft[samp] * sidechainInputLeft[samp];
squareR = sidechainInputRight[samp] * sidechainInputRight[samp];
mixedSquares = 0.5 * (squareL + squareR);
mEnvOut += mEnvB0 * (mixedSquares - mEnvOut);
root = sqrt(mEnvOut);
```

Gain Computation




```
// Convert to dB
levelDB = 20 * log10(root);

// Calculate gain
if (levelDB < mThresholdDB) {
    compressionGainLin = 1.0;
}
else {
    compressionGainDB = (mSlope - 1) * (levelDB - mThresholdDB);

    compressionGainLin = powf(10.0, compressionGainDB / 20.0);
}
```

Gain Dynamics

```
void QuinnKPFinalCompressionAudioProcessor::calcAlgorithmParams()
{
    mSlope = 1 / mRatioParam->get();
    mThresholdDB = mThresholdParam->get();
    float tauAttack = mAttackTimeParam->get() / 1000;
    float tauRelease = mReleaseTimeParam->get() / 1000;
    mAttackCoeff = 1.0 - exp(-1.0 / (tauAttack * mFs));
    mReleaseCoeff = 1.0 - exp(-1.0 / (tauRelease * mFs));

}
```

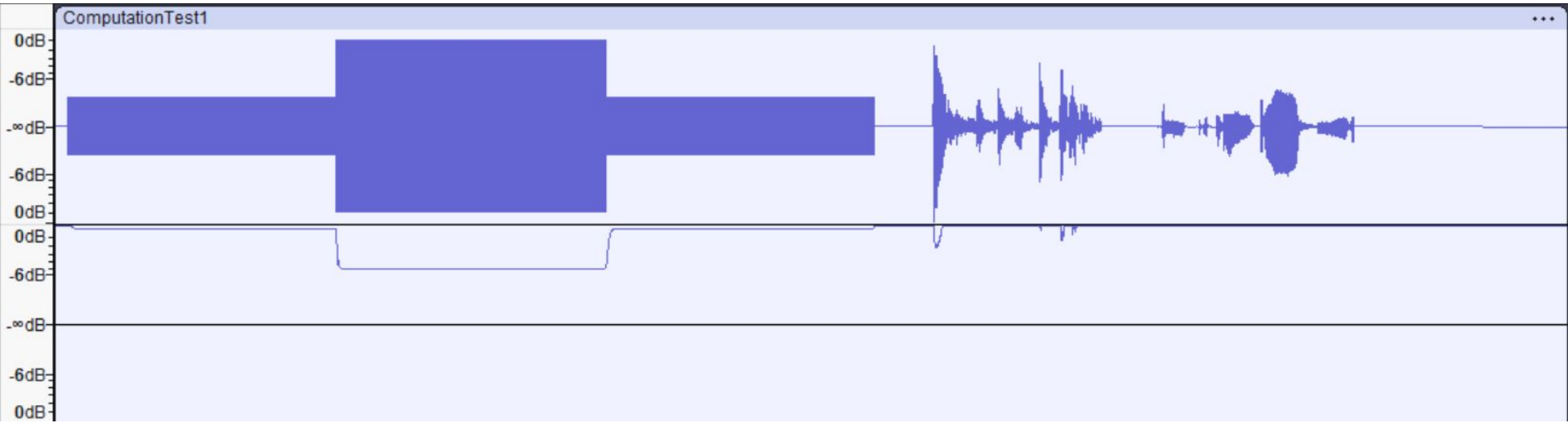
```
// Find coefficient for dynamics
if (compressionGainLin < mFinalGainLin) {
    dynamicsCoeff = mAttackCoeff;
}
else {
    dynamicsCoeff = mReleaseCoeff;
}

// Smoothe gain using coefficient
mFinalGainLin += dynamicsCoeff * (compressionGainLin - mFinalGainLin);
```

Single-track testing

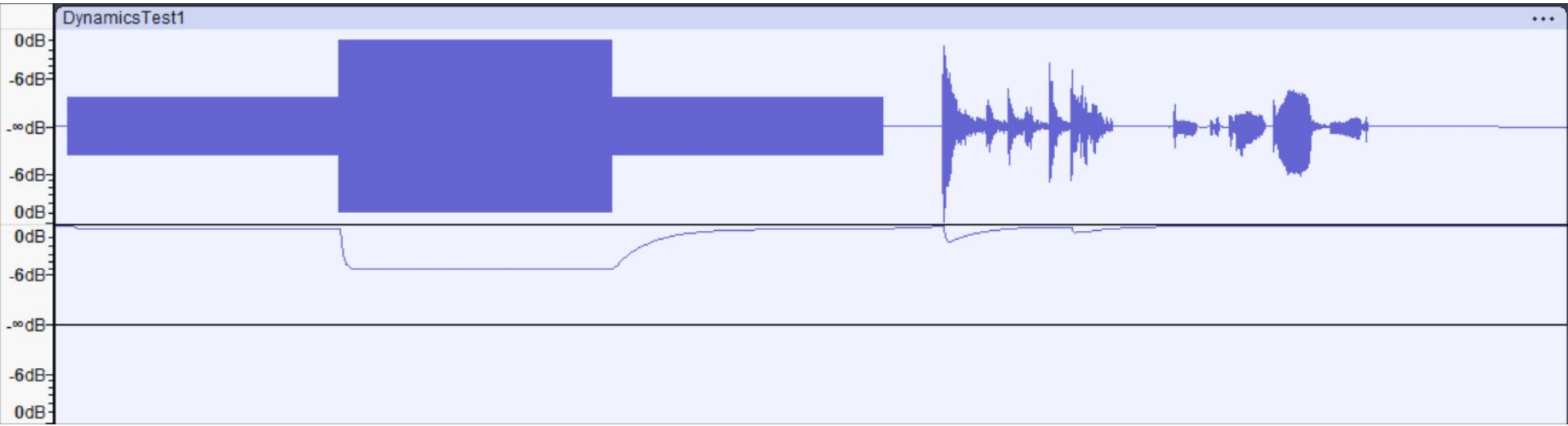
RMS Level Detection Output
(Before conversion to dB)

Threshold -14 dB
Ratio 2:1



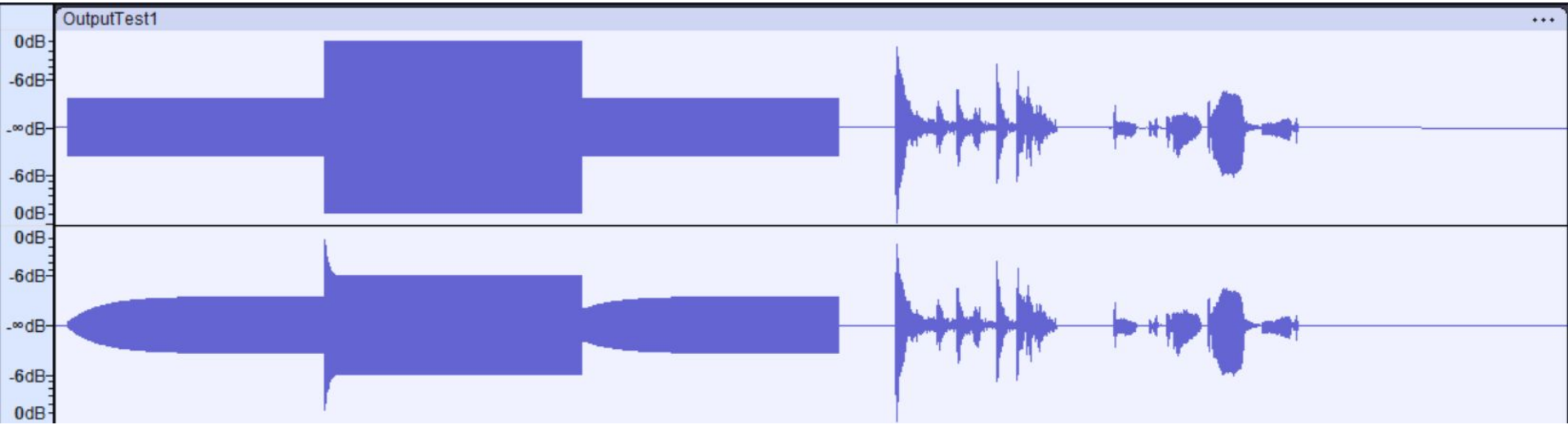
Gain Computation Output
(Linear Gain)

Threshold -14 dB
Ratio 2:1



Gain Dynamics Output
(Linear Gain)

Threshold -14 dB
Ratio 2:1
Attack 20.5 msec
Release 248 msec



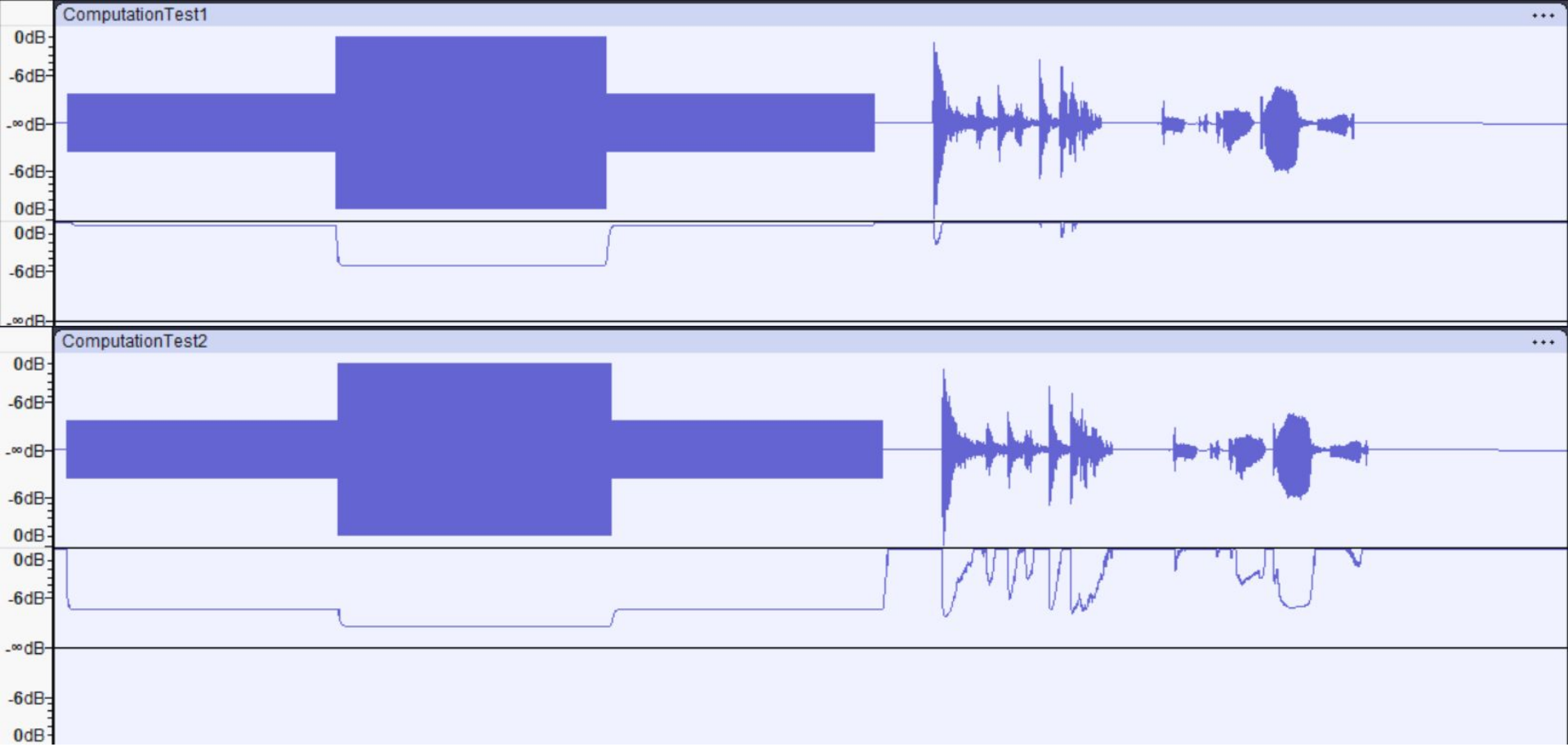
Final Audio Output

Threshold -14 dB
Ratio 2:1
Attack 20.5 msec
Release 248 msec

Lowering the threshold

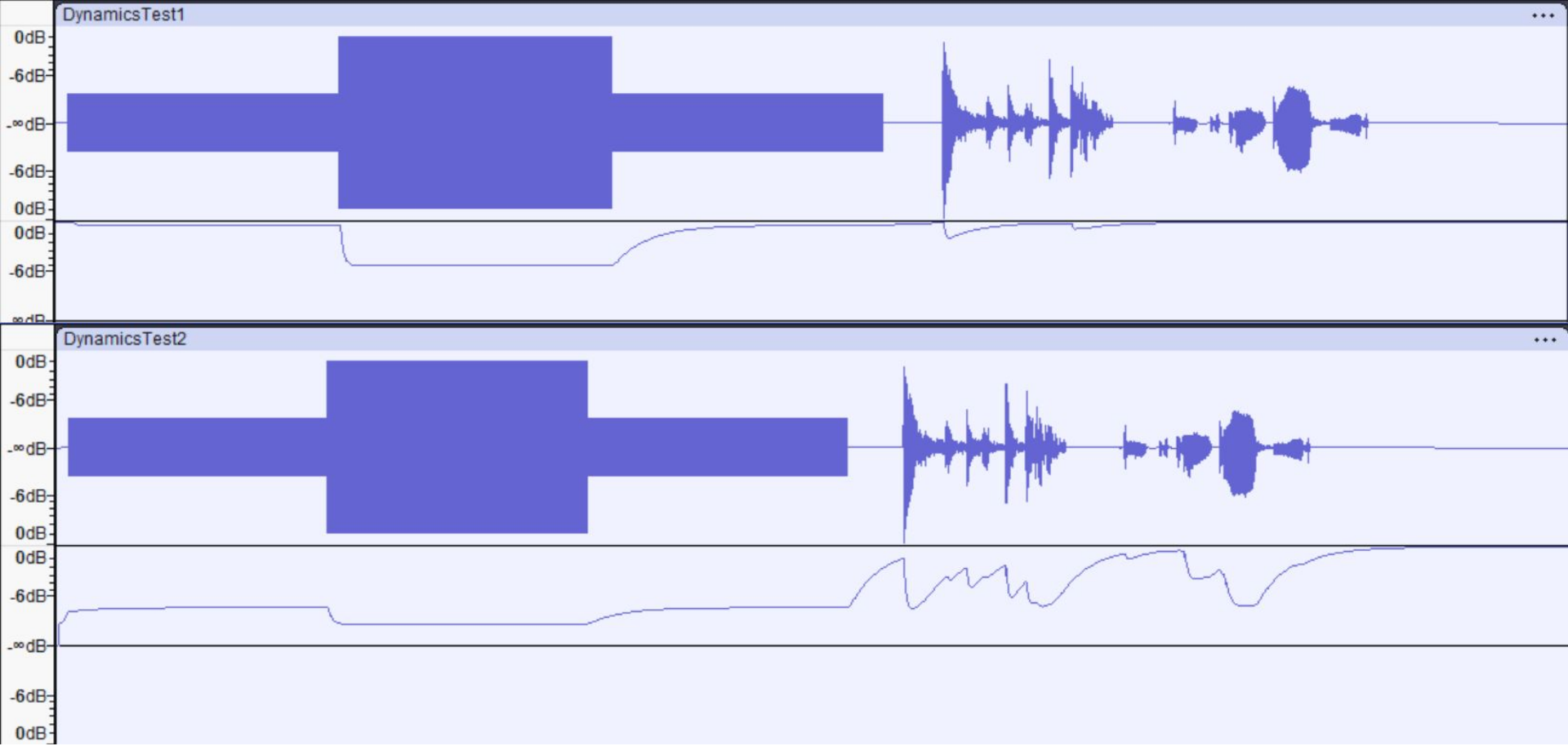
RMS Level Detection Output
(Before conversion to dB)

Threshold -30 dB
Ratio 2:1



Gain Computation Output
(Linear Gain)

Threshold -30 dB
Ratio 2:1



Gain Dynamics Output
(Linear Gain)

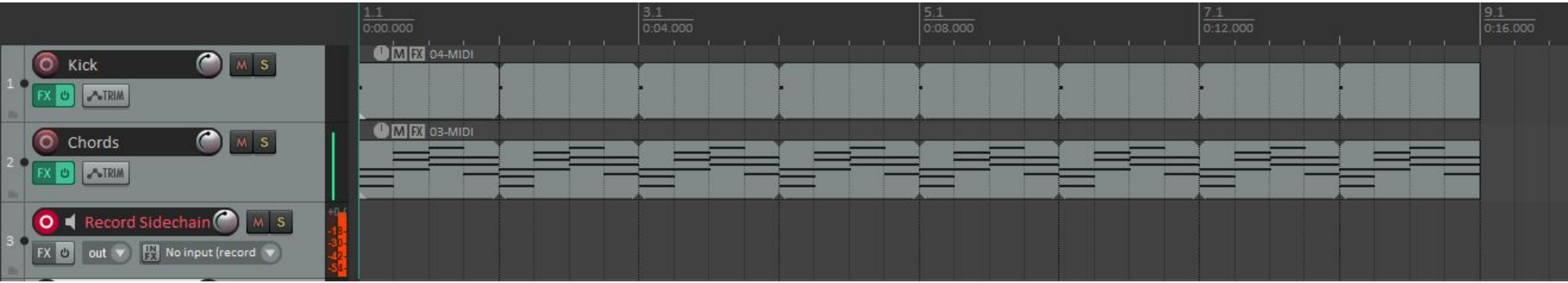
Threshold -30 dB
Ratio 2:1

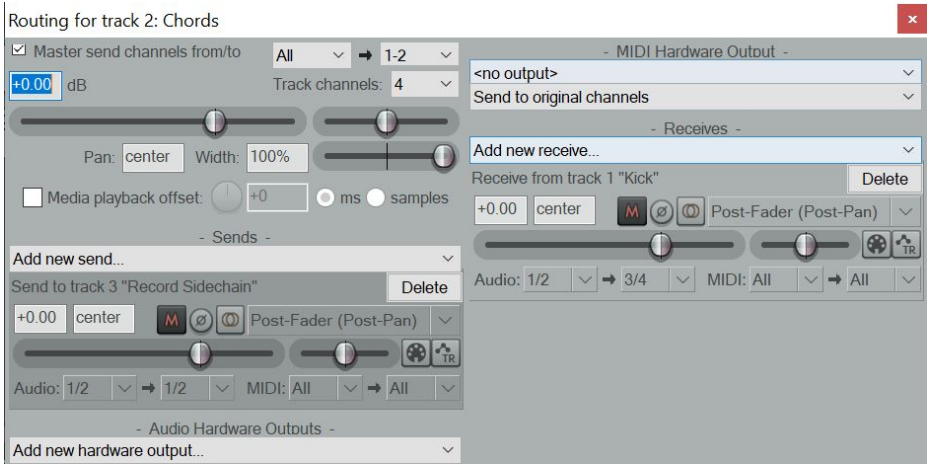
Attack 20.5 msec
Release 248 msec

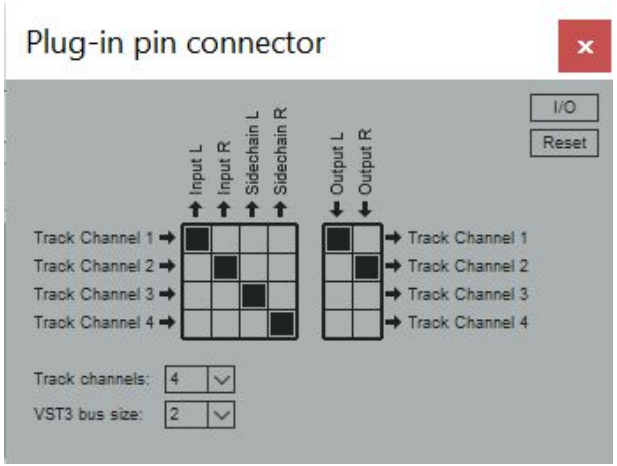
Final Audio Output

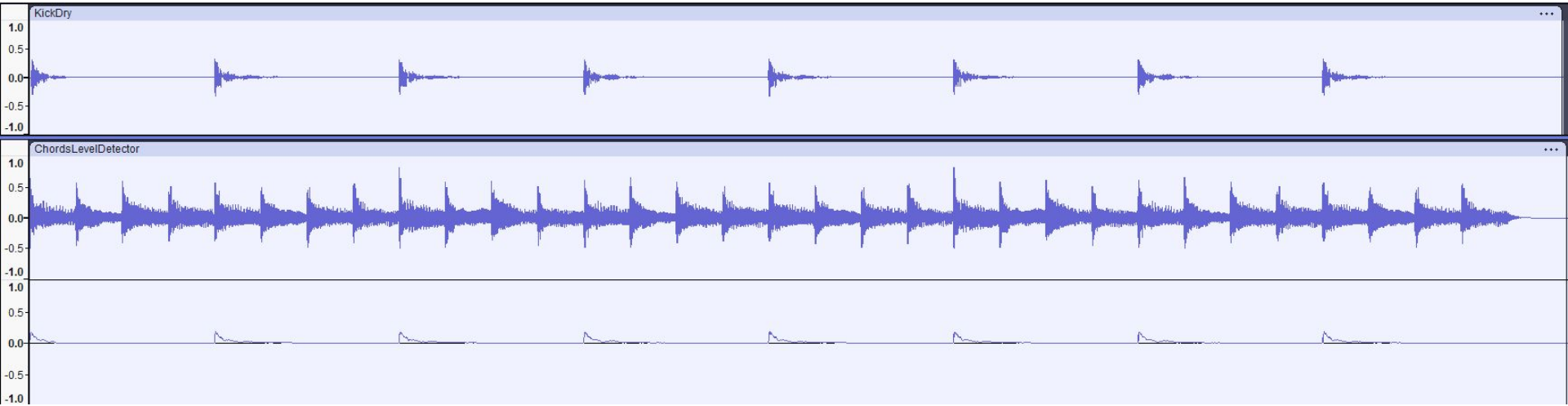
Sidechaining

Demo Project Setup



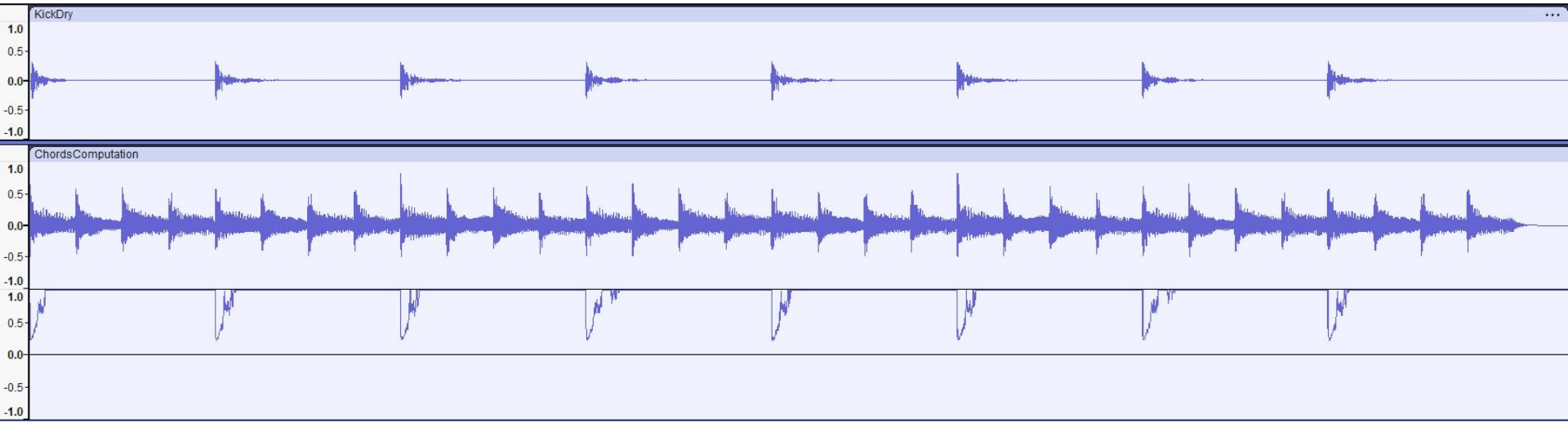






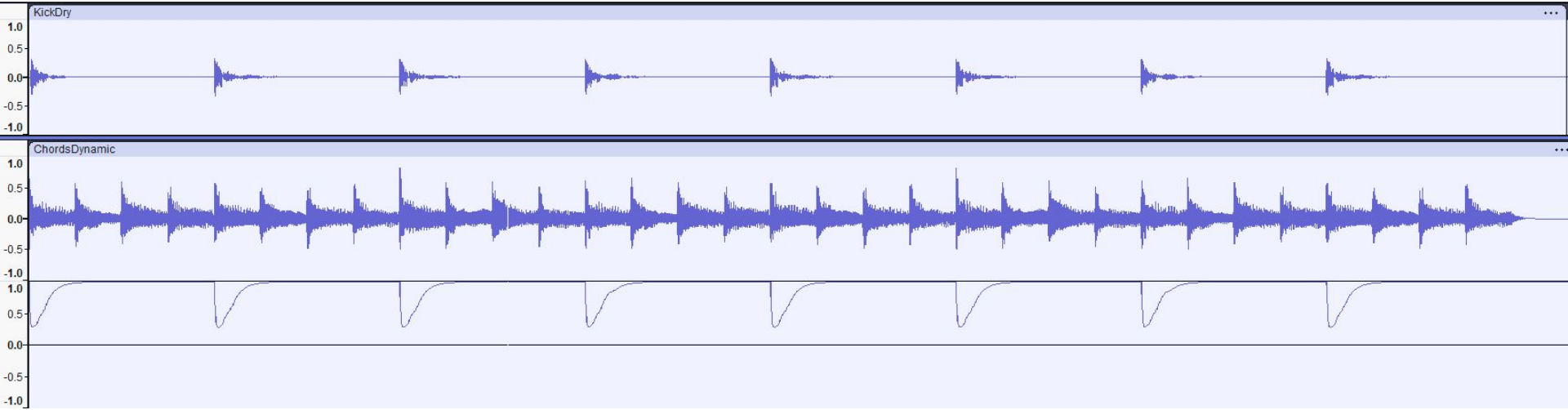
RMS Level Detection Output
(Before conversion to dB)

Threshold -30 dB
Ratio 10:1
Attack 10 msec
Release 100 msec



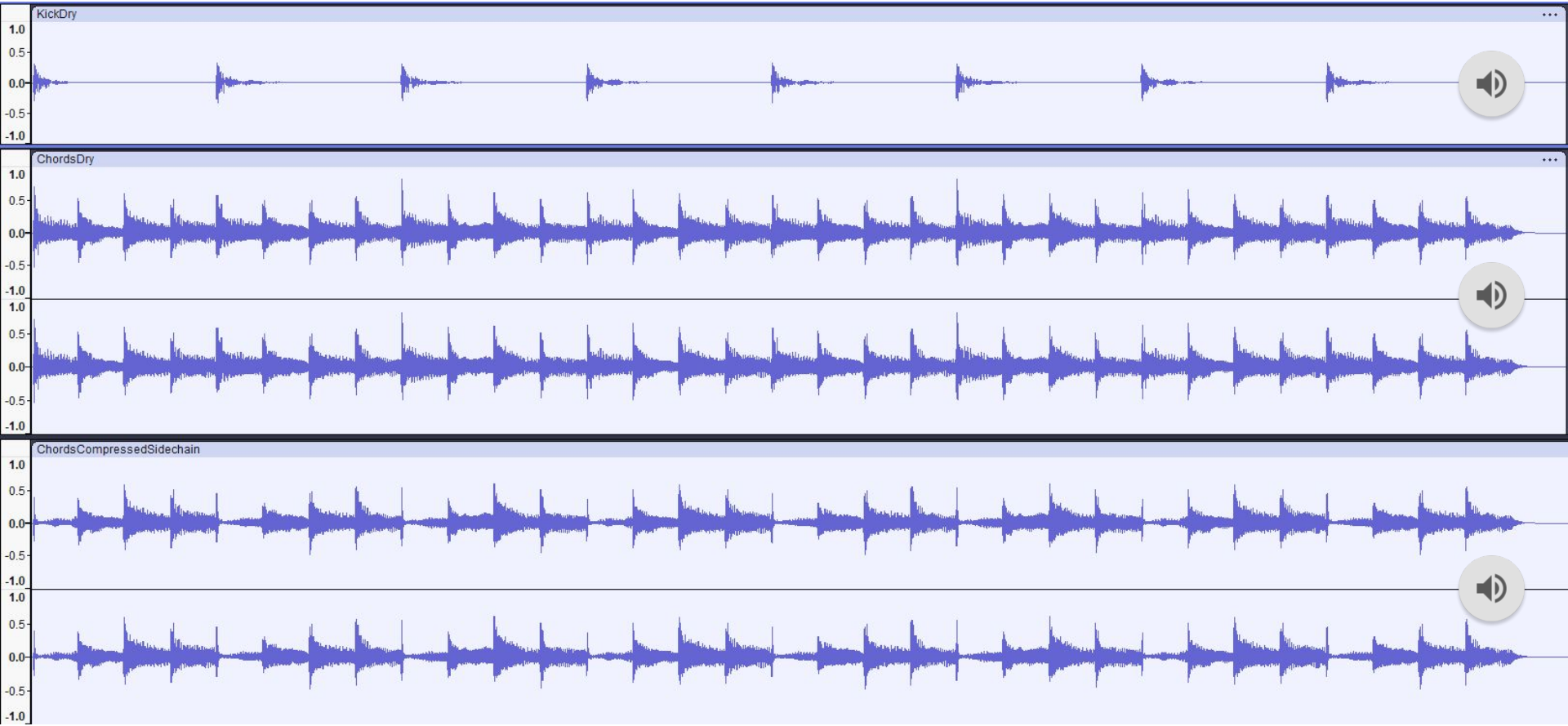
Gain Computation Output
(Linear Gain)

Threshold -30 dB
Ratio 10:1
Attack 10 msec
Release 100 msec

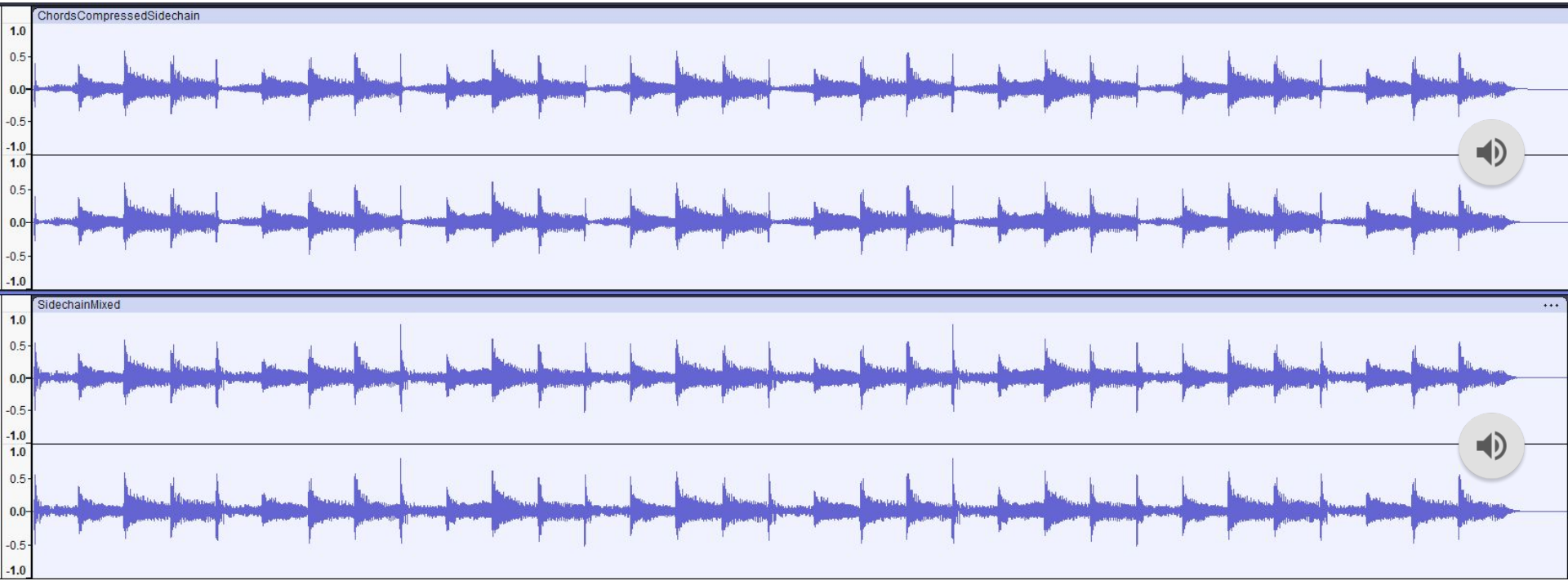


Gain Dynamics Output
(Linear Gain)

Threshold -30 dB
Ratio 10:1
Attack 10 msec
Release 100 msec



Sidechain input, original, and compressed



Compressed and mixed