MUMT-307/501 Final Project

A study in dynamic range controllers and compressor verification techniques

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Intro

Why study dynamic range controllers?

- They are complex and non-intuitive
- Most other audio effects are more straight-forward

Initial Goal

- Explore all possible types of dynamic range controllers
- Too Ambitious = Fail!
- Restrict scope to compressors

Audio Engineers/Musicians

- What do they look for?

Theory

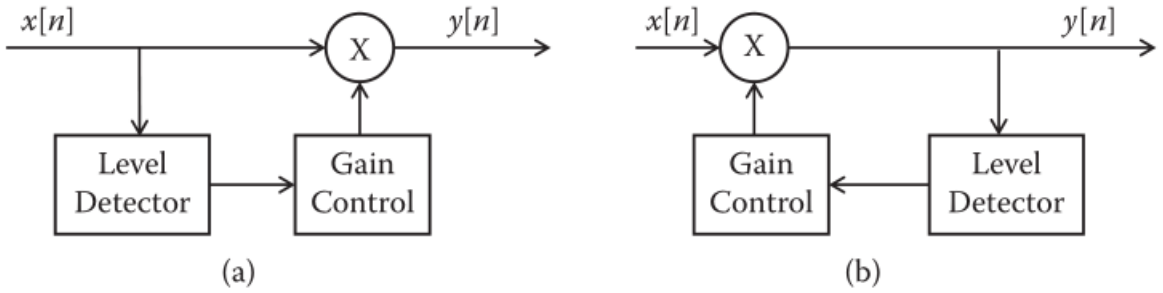
Basic theory covered in MUMT-307 earlier in semester

Different topologies:

- Feedback
- Feed-foward

More possibilities:

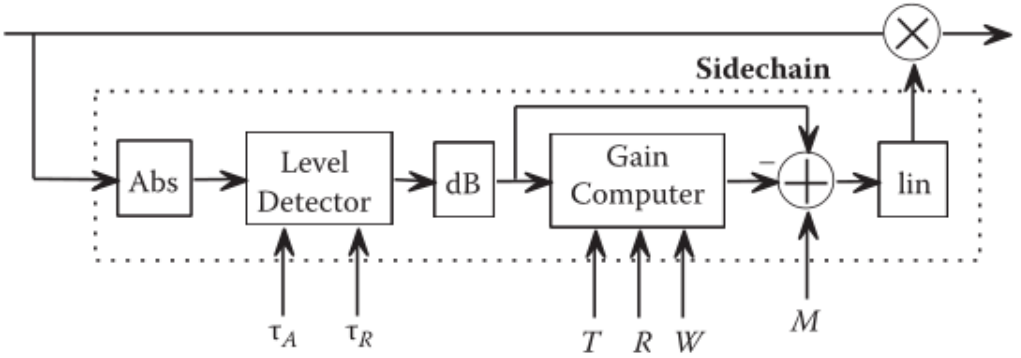
- Where to put smoothing?
- Multi-band compressors

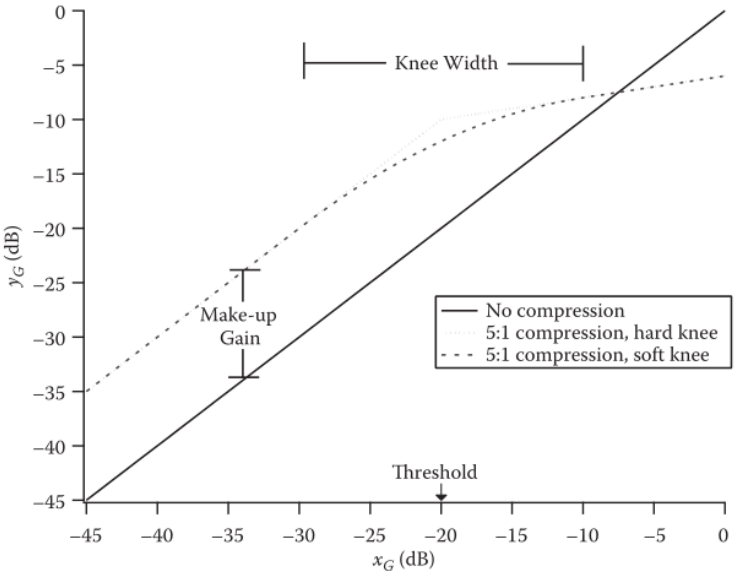


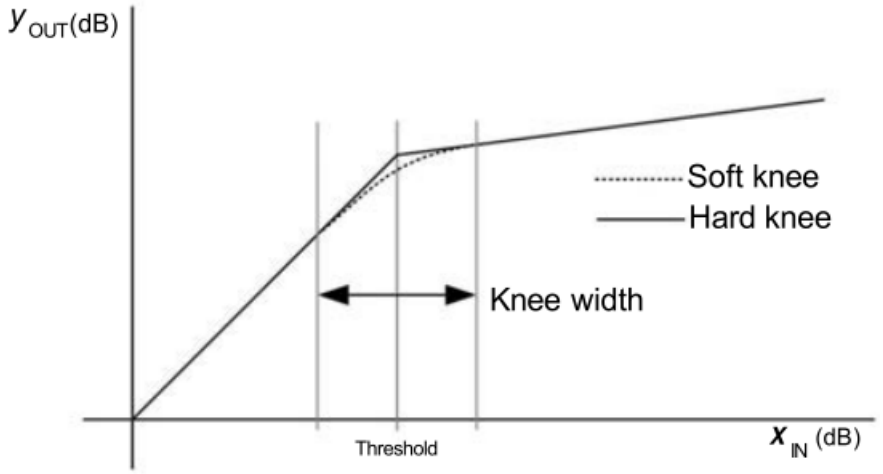
Theory

New Parameters

- Attack/Release Time
- Knee Width
- Make Up Gain







System Characteristics

Linearity

- Nope! Consider two signals right below the threshold.

Memory

- Requires memory to do smoothing w/ filters

Causality

- Causal as no future inputs required

Stability

- Yes! The gain function is memory-less and attenuation is only applied.

Time-Varying

- Yes! Consider if new signal is applied before full release time.

Design Considerations

Which level detection to use?

- Peak
- RMS
- RMS approximation

Gain Function

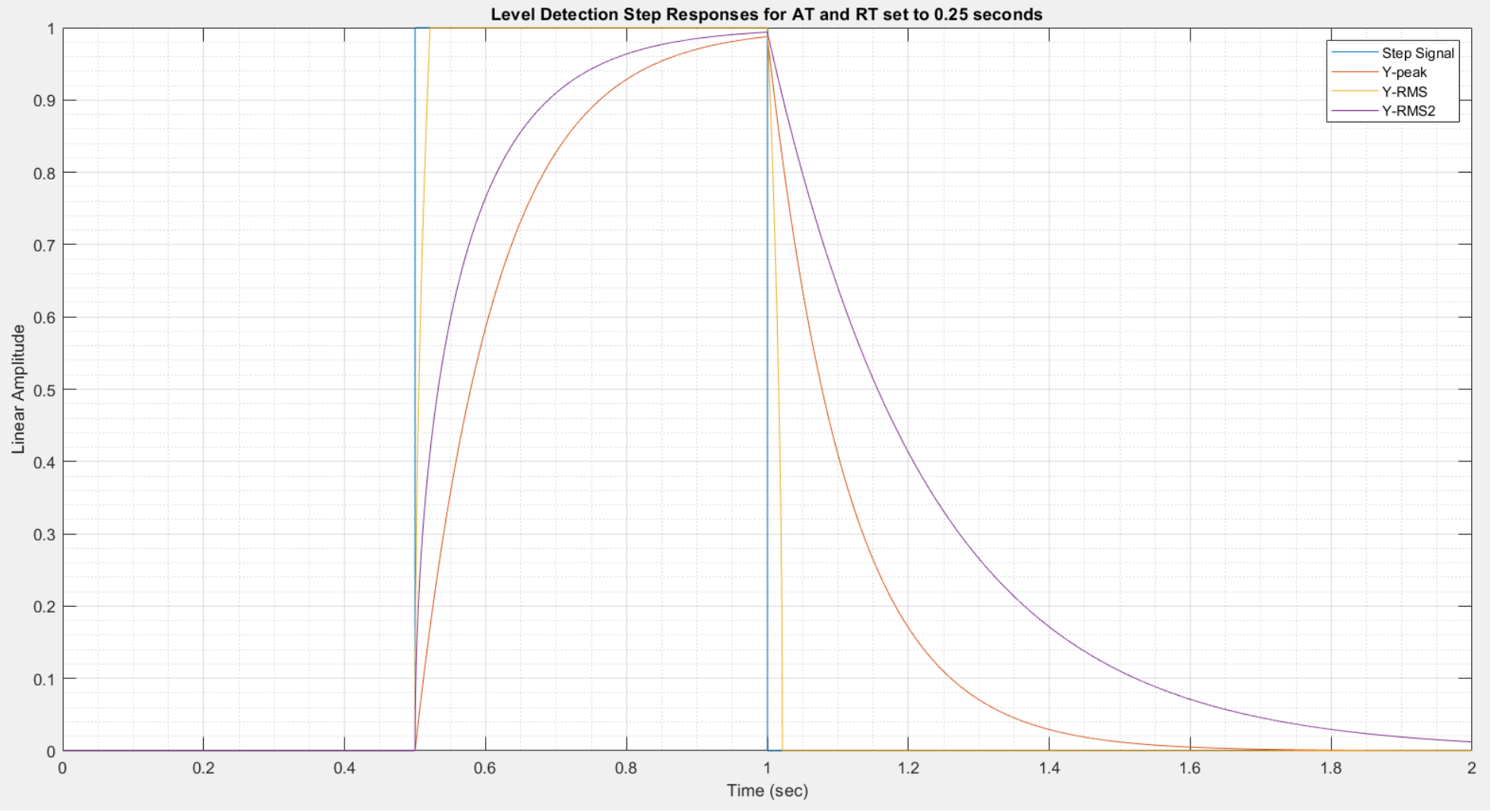
- Quantization?

  Cap input values @ -floor(20*log10(2^Q)) where Q is bit depth

- Interpolation method for knee

Focus on testability

Level Detection Comparisons



Testing Strategy - How do I know it actually does what I “told” it to do?

Strategy

- Unit test smaller components first on a larger range of parameters
- Test assembled product as a “black-box” on a smaller range of values

Motivations

- Unit testing develops through familiarity with constituent parts (a.k.a. I’ll actually know what I’m doing)
- Unit vs. Integration failure becomes easier to diagnose
- Simulates realistic scenarios: “Cloning” or being an Audio Validation Engineer
- Original plan was to develop a modular suite of functions and leverage function handles to reconfigure a general DRC model and compare different configs

Order of Parameter Testing

Parameter behaviour is coupled together

- Ratio only applies after threshold is passed
- Knee width also depends on threshold working correctly

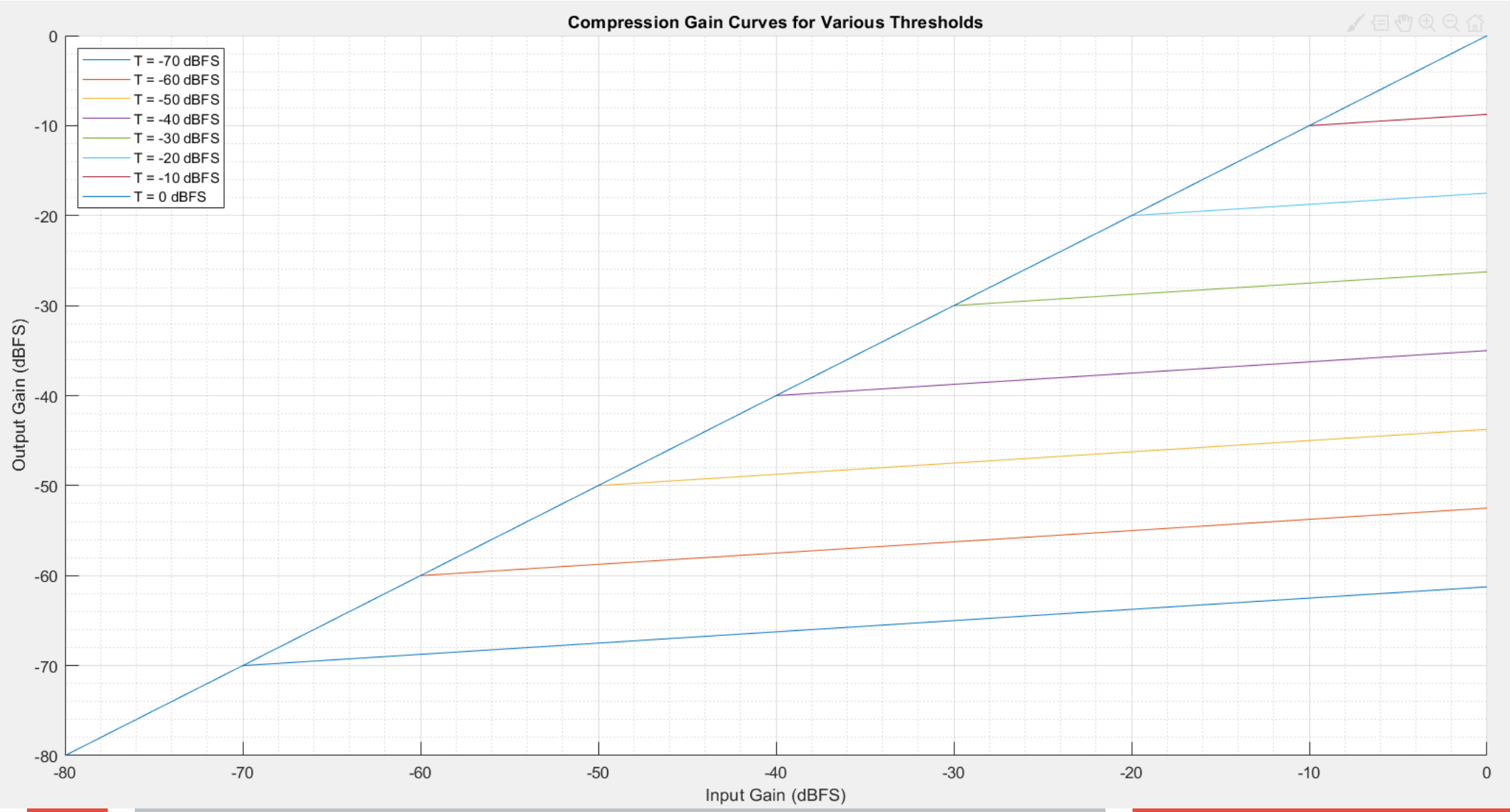
Attack and Release times

- Separate functional block
- Unit testing order doesn’t matter relative to gain functions

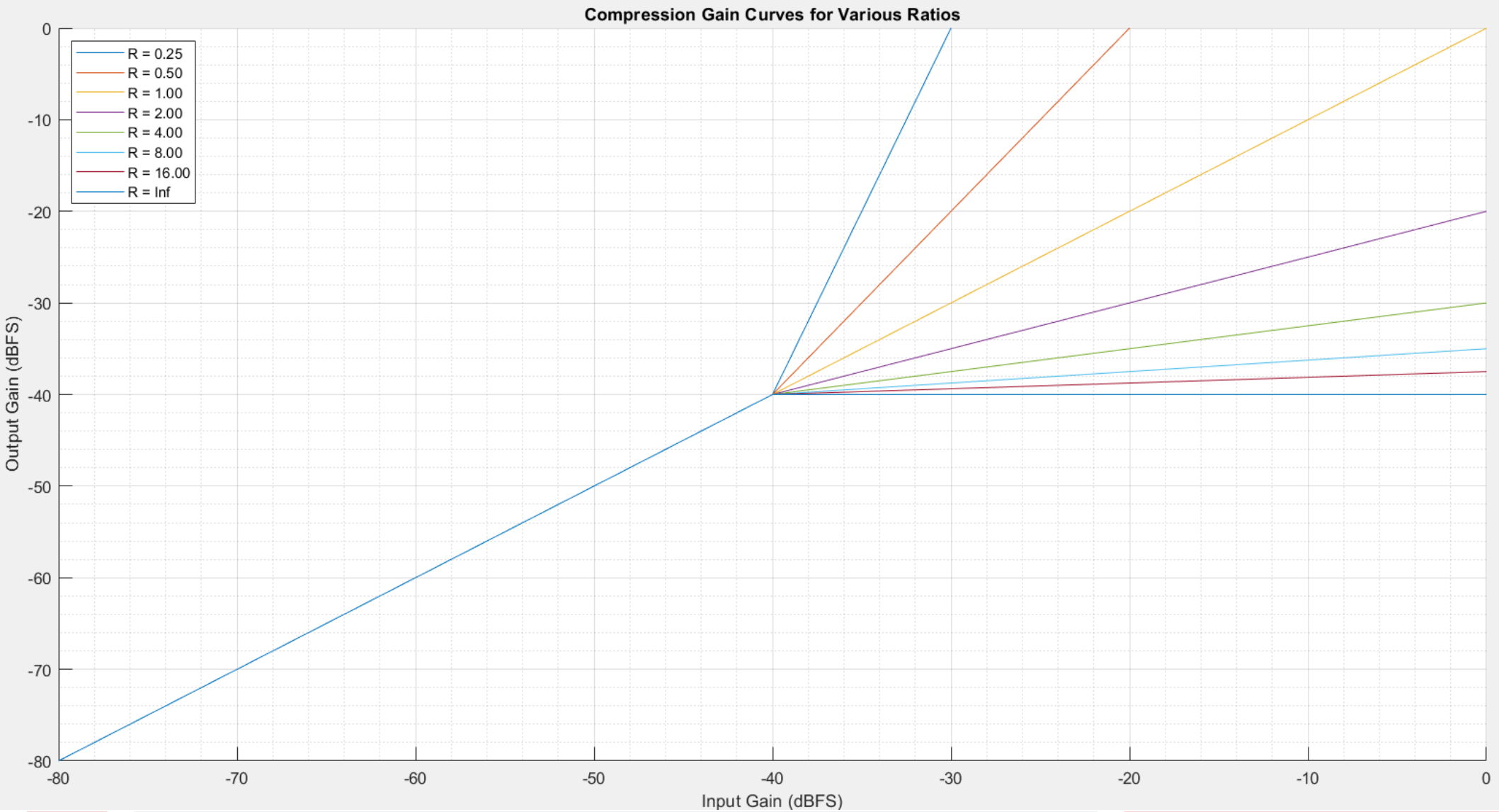
Test Signal

- Use a level sweep since everything is so gain dependent
- Use step signals for timing

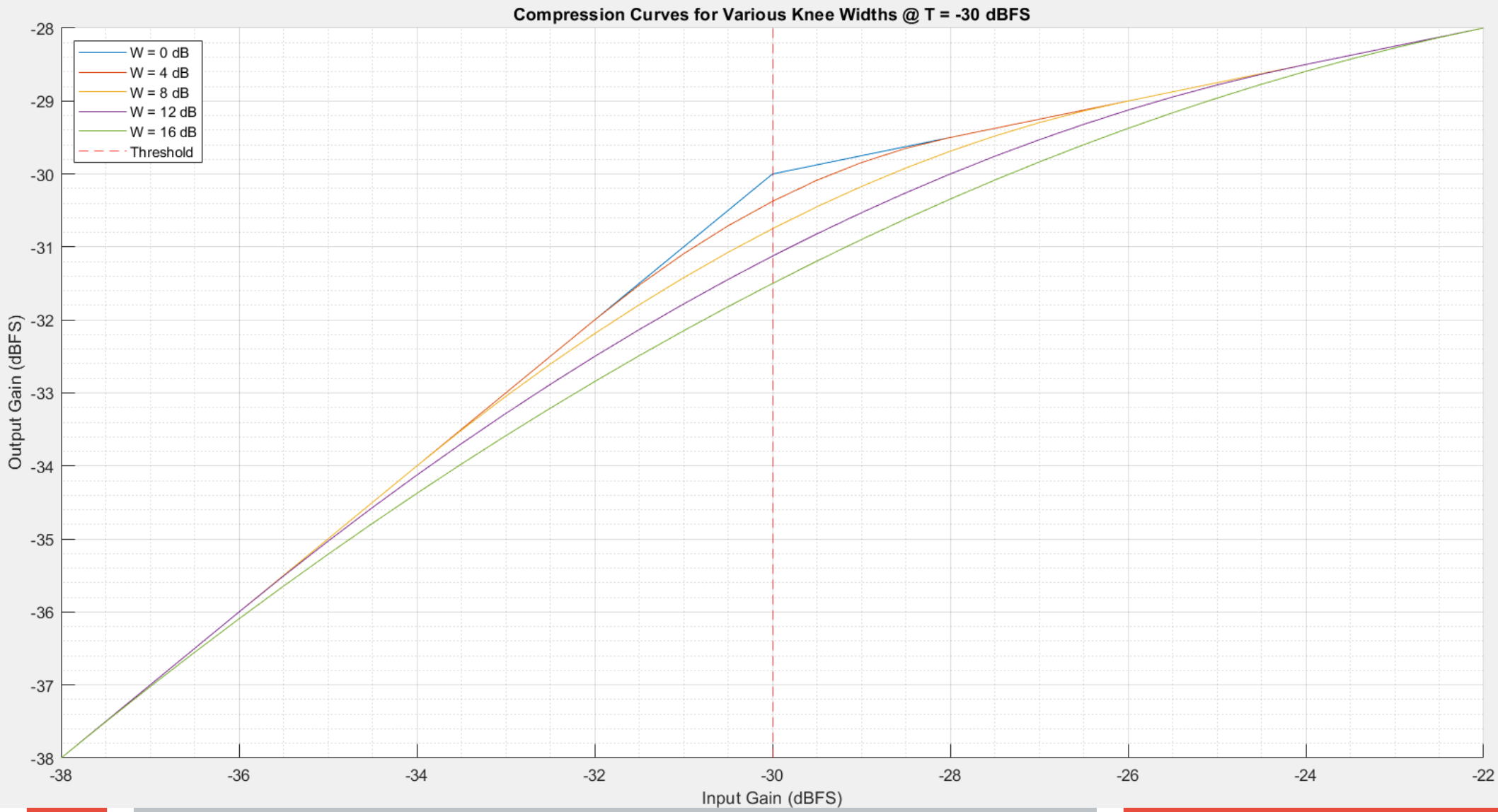
Threshold Test Results



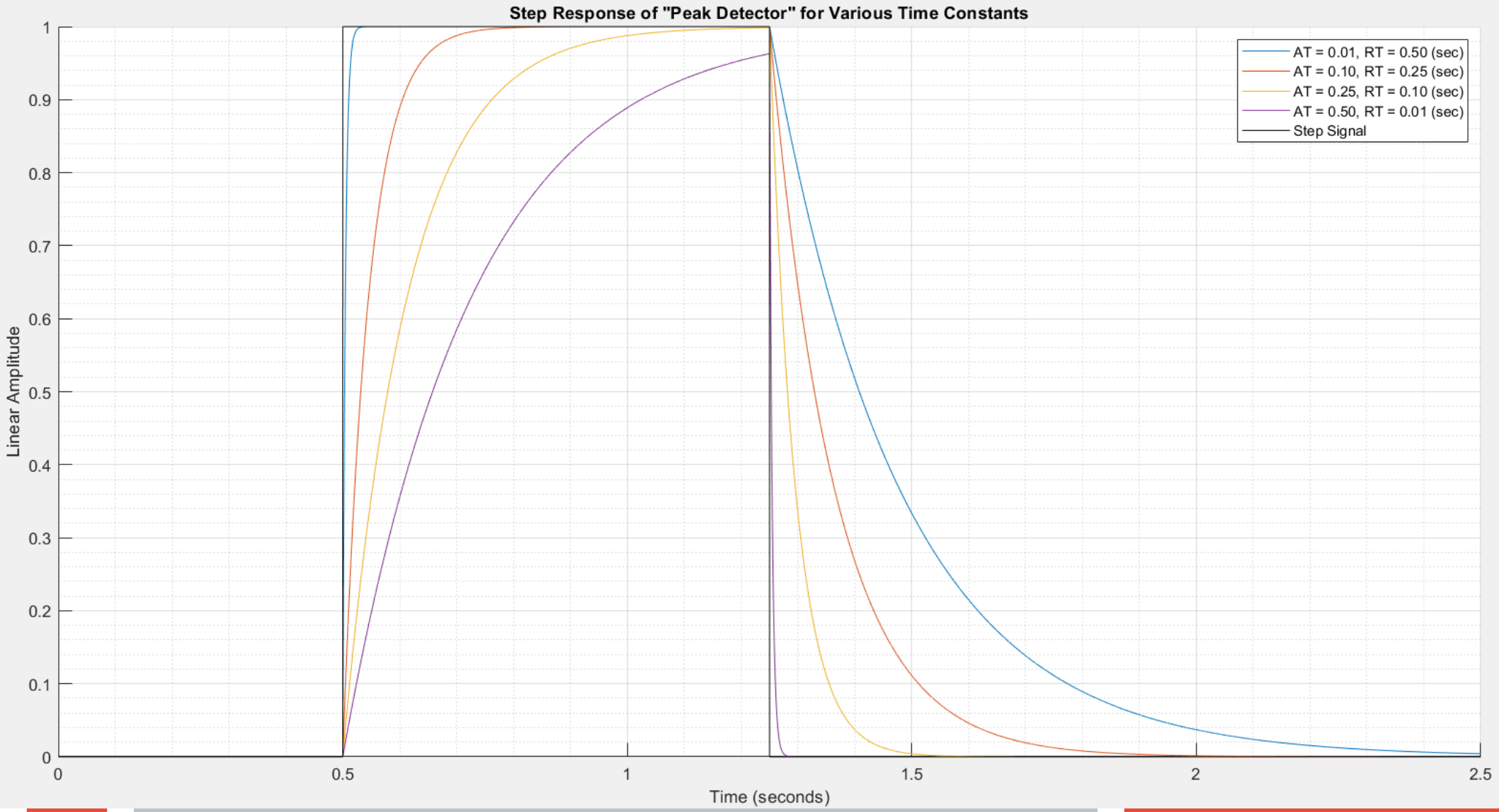
Ratio Test Results



Knee Width Results



Attack and Release Time Results



Measuring Complete System Behaviour

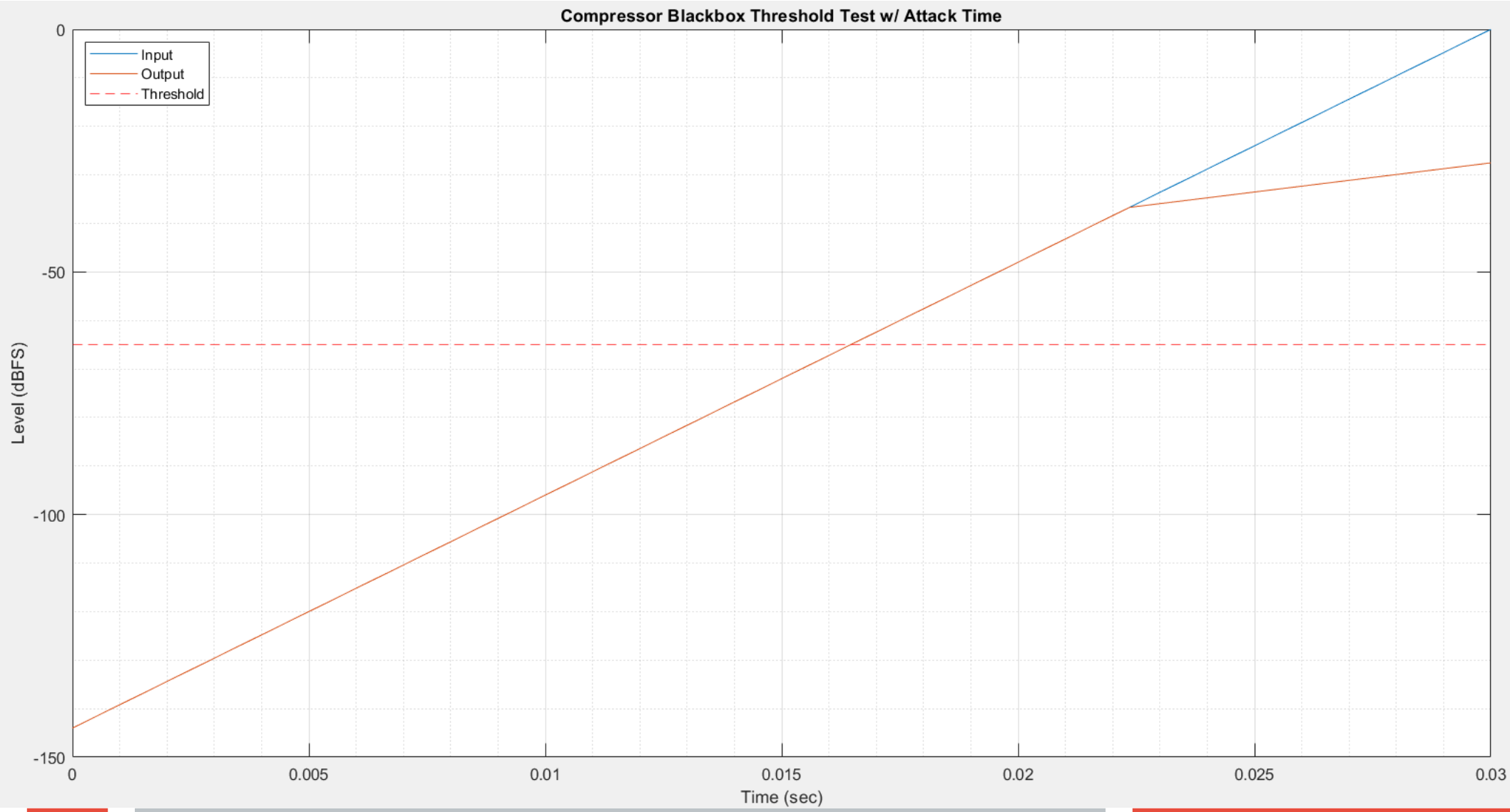
Strategy

- Similar approach as before but now timing becomes crucial
  - Same order
  - Try to isolate the effects of each parameter on the controller's behaviour

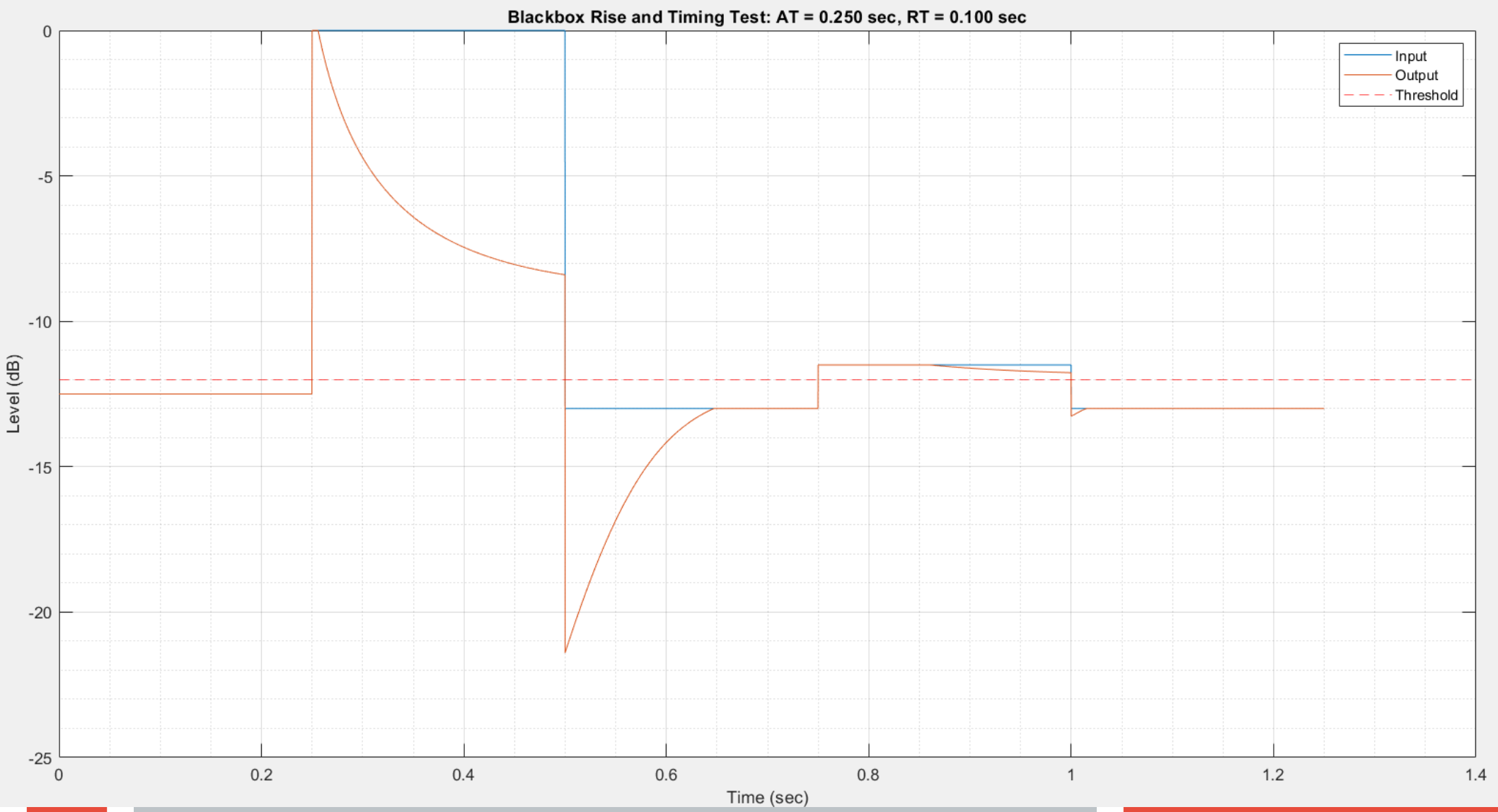
Attack and Release times

- Can be set to 0 here but that isn't always the case
- Delay from non-zero attack time causes difficulty in verifying the threshold
- Verifying the attack time is extremely difficult ("Plateauing Effect")

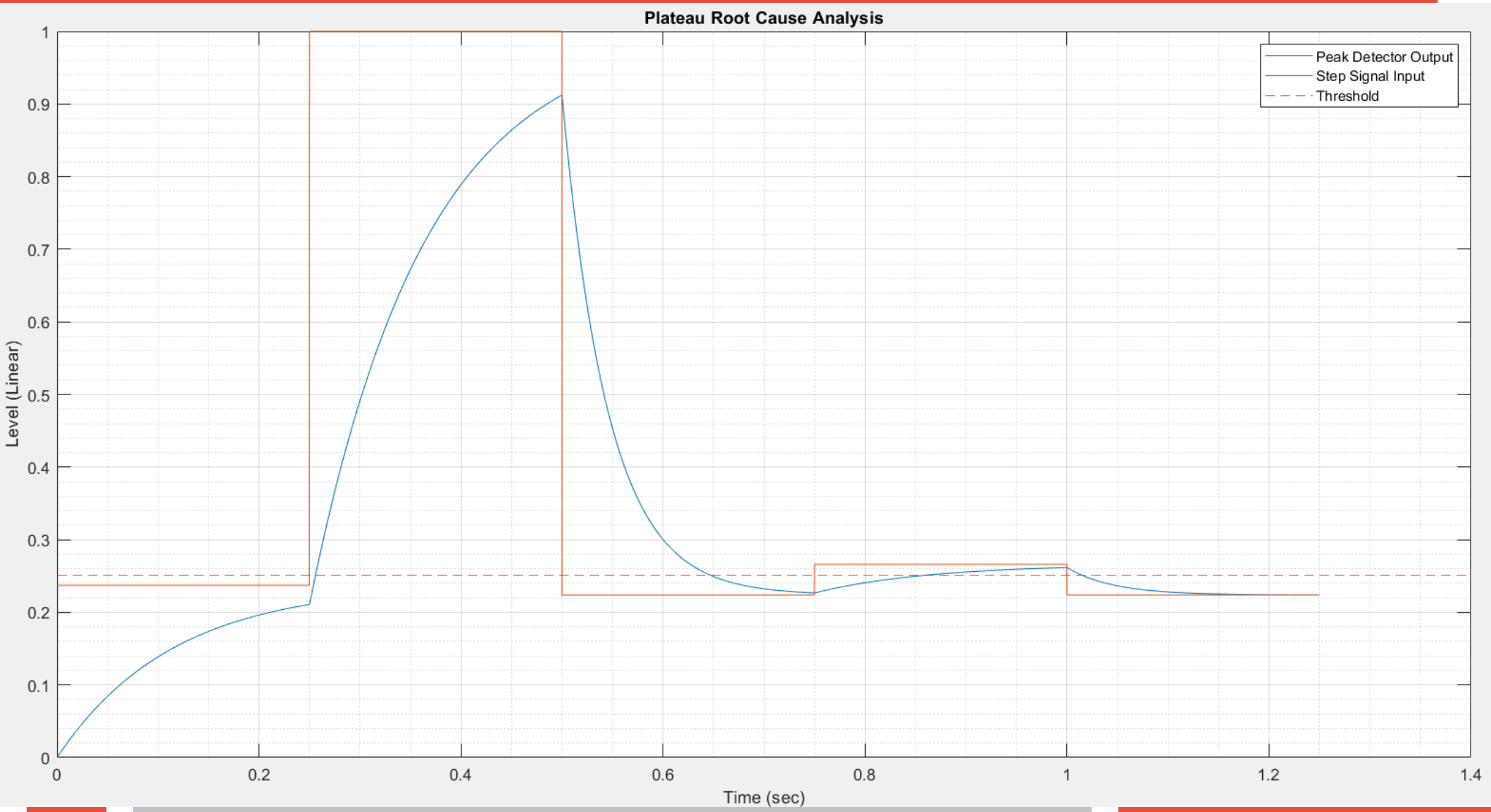
Delay from Attack Time



“Plateau”ing Issue



Plateau Root Cause



What is “correct”?

Engineer’s vs. Audio Engineers/Musicians

- All these graphs are fine and dandy for verifying behaviour
- What behaviour is “correct”?
- Ultimately if an audio engineer/musician doesn’t want to use it = FAIL!

What do audio engineers/musicians want?

- I asked a few and got conflicting results
- One wanted it to be “transparent” and “keep a signal under control”
  - Plateau bad?
- One didn’t care about the utility of DRC at all and only used it for the colouring effect
  - Plateau good?
- How to translate their wants into a design?