

Phase Noise Compensation

Theory and Practice

Trellis Demodulation Basics

- Legacy Single-Symbol Detection
 - **Basic Limiter-Discriminator operation**
 - Frequency in this bit above nominal \rightarrow data = 1
 - Frequency in this bit below nominal \rightarrow data = 0
 - Makes no use of adjacent symbols for error correction
- Trellis Detection
 - Uses the phase tree for data detection
 - Adjacent symbols are used to help decide on "iffy" bits
 - Improves BER performance by 3.5 to 5.0 dB
 - What's a "Phase Tree"?
 - Why is it useful?



Ideal PCM/FM Phase Tree (h = 0.7)



Phase Trajectory Never Forgets



Trellis Demodulation Summary

- The basic premise of trellis demodulation is that the signal from the transmitter follows a known path through the phase tree. When the demod knows this, it can use a sequence of several symbols to help make better decisions about each individual bit. This process improves BER performance by about 3.5 to 5 dB over conventional FM detection.
- However, this assumes that the transmitter is really following the "known", and "correct" phase tree, and this assumption is NOT always true.
- High phase noise can reduce the trellis detection gain.
- Why is that?



Phase Noise Corrupts the Tree





Phase Noise Impact

- Trellis demodulation is based on the assumption that the signal is following a predictable path through the trellis.
- If this is not true (due to high phase noise), then a trellis demodulator cannot provide the expected performance gain.
- Many legacy analog transmitters (a simple modulated VCO) have high phase noise.
- Vibration often further increases phase noise.
- Phase noise is generally more damaging at low bit rates.
- Phase Noise Compensation (PNC) gives back some of the trellis detection gain, by shortening the trellis observation span.
- When do I use PNC?

When to Use PNC

• There is no bullet-proof test for whether PNC is needed, but there are good indicators.

• Turn on PNC if...

- Demod is struggling to lock, even with good SNR
 - Good SNR: Quality bar is above one-quarter height



- Symptoms get worse when the transmitter is under vibration
- Symptoms get worse at low bit rates

Know Your Transmitter

 If you know the brand and type of transmitter, these are good starting points...

• Leave PNC <u>off</u>, if your TX is from

- Quasonix guaranteed
- Nova Engineering highly likely
- L3 probably, but digital transmitters only

• Turn PNC <u>on</u>, if your TX is from

- Microwave Innovations
- Emhiser
- Southern California Microwave
- L3 (analog transmitters)

Future Developments

- Quasonix has pioneered the PNC feature, and continues to refine it.
- New algorithms are under development that can differentiate between phase noise and receiver front end noise.
- A fully automatic PNC mode will be available in Quasonix receivers when these algorithms are "smart enough".
- This will be a free upgrade for most models, installed through reprogramming.



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Questions

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