What is a Tuner anyway?

“Tuners” vs. “tuners”

“Tuner”
- Consumer device
- Radio frequency in
- Multimedia out to display

“tuner”
- Component in a consumer device
- RF in
- Intermediate frequency out to demodulator
Why do we need “tuners” anyway? Isn’t everything going digital?

860 MHz

Sampling rate needed: ~2 Gsps
>12 bits
2 watts power dissipation

Processing all the input channels digitally would require a very powerful (and expensive) Analog-to-Digital converter

Analog-to-Digital Converter (?)
Demodulator
MPEG Decoder
Why do we need “tuners” anyway? Isn’t everything going digital?

860 MHz

Filtering a single RF channel would reduce bits required, but not sampling rate

Sampling rate needed: 2 Gsps
~10 bits
1.5 watts power dissipation

One channel between 54 and 860 MHz

Filter → Analog-to-Digital Converter (?) → Demodulator → MPEG Decoder
Why do we need “tuners” anyway?
RF tuners greatly simplify A/D converter requirements

Tuners greatly simplify the analog-to-digital conversion in receivers making it practical to integrate A/D converter in demodulator/decoder.

- Tuner
- Simple ADC
- Demodulator
- MPEG Decoder

Sampling rate needed: 25 Msps
~10 bits
<0.1 watts

One channel
At “Intermediate Frequency”
(typically 36-44 MHz)
Tuner IC’s are here!
Why did it take so long?

1946: First digital computer (ENIAC)
17,468 vacuum tubes

1971: First IC computer (Intel 4004)
2,300 transistors

2004:
320 million transistors

1919: Armstrong patent
Basic dual-conversion tuner architecture

1998: First practical IC tuner

Discrete component Tuner modules
Typical Technology Projections
Analog/RF technology typically defies Moore’s Law

Source: 2004 International Technology Roadmap for Semiconductors
IC Tuners offer a higher degree of integration
Example – Simplified module design

Discrete module

Tuner IC-based module
... and enable multi-tuner on-board designs
Bi-directional dual-tuner design in 10 x 10 cm footprint
Combining RF and digital blocks might not make sense.

Digital and RF IC’s don’t normally scale the same way.

**RF example:**
LNA’s are usually bigger in digital processes.

**Digital example:**
While logic components are usually bigger in RF processes.
Demodulator IC’s could end up mostly analog!

Example: A/D converter as % of die in QAM demodulator
Digital Tuner Concept

Direct digital interface to demodulator
Digital Tuner Concept
... or soft demodulator/decoding in some PC apps

Direct digital interface to CPU or co-processor
Terrestrial/Cable Receiver Convergence

Tuner solution is challenging

Off-air channels

Small number of channels

Large number of channels (up to 133)

Low signal levels

Large dynamic range

Large adjacent channel interferers

Cable channels

Flat spectrum

Large number of channels (up to 133)
Terrestrial/Cable Receiver Convergence

Also complicated by standards and specifications

- Minimal ATSC Specs
- T3/S10 ATSC Specs
- Minimal Cable Specs ("UniDir PICS")
- OpenCable or Better Cable Performance
- Minimal ATSC Specs
Minimal cable specs are not good enough
“Plug-and-Play” TV’s may not work in a real network

<table>
<thead>
<tr>
<th></th>
<th>OpenCable/SCTE 40 Specification</th>
<th>Uni-Dir PICS Specification</th>
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<tbody>
<tr>
<td>CTB</td>
<td>-63 dBC</td>
<td>Not Specified</td>
</tr>
<tr>
<td>CSO</td>
<td>-60 dBC</td>
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<td>XM</td>
<td>-57 dBC</td>
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<tr>
<td>Adjacent channel rejection</td>
<td>60 dB</td>
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<tr>
<td>Phase noise</td>
<td>-88 dBC/Hz</td>
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<td>Carrier-to-interference</td>
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<tr>
<td>Chroma-luma delay</td>
<td>&lt; 170 ns</td>
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<tr>
<td>Image rejection</td>
<td>60 dBC</td>
<td>Not Specified</td>
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</table>
Tuners will probably be with us for a long time
- Broadband A/D conversion is not yet practical

IC tuners are here!
- Simplify existing designs and enable complex on-board designs

We may see a shift of some demodulator/decoder functions into the tuner, but probably not the other way around
- Main candidate: Input A/D converter

Terrestrial/cable convergence is complicated by multiple standards/performance tiers
- Digital cable ready performance as currently defined may be underspecified