Liquid Cooled Solid State Architecture

- Allows for higher power density
- More efficient operation
- Extremely low room heat dissipation
- Highly efficient design
- Less maintenance
- Silent operation
- Much more reliable and efficient than air-cooled transmitters
- Rohde & Schwarz has shipped 10,000 liquid cooled transmitters worldwide

Liquid Cooled Solid State Architecture

- Clean, efficient design
- Two hose connections at transmitter
  - Liquid coolant in
  - Liquid coolant out
- Single power distribution
  - Transmitter
  - Pump stand
  - Heat exchanger
Liquid Cooled Solid State Architecture

- No interconnecting hoses
- No interconnecting cables
- Liquid cooled amp combiner
- Liquid cooled amplifiers and power supplies

Liquid Cooled Solid State Architecture

- Amplifier rear view
- Quick disconnect liquid connectors
- RF output connector
- Power connection
- Amplifier monitor and control
- Integrated power supplies and RF amplifiers
- Hot swappable
Liquid Cooled Solid State Architecture

- External pump stand (Internal available)
- Redundant pump design
- One assembly per cabinet
- 200 – 400W power consumption
- 60/40 mix of water/antifreeze

Liquid Cooled Solid State Architecture

- Outdoor heat exchanger (Mounting options available)
- Redundant fan design
- One assembly per cabinet
- Just 300W power consumption
Reducing costs of renting
Maximized power density

• Output power per 19 inch rack (7ft²)
  • Up to 40kW FM
  • Up to 26kW IBOC at -10dB injection
  • Less than 800W of heat dissipated into
    the room at 40kW output

Savings by maximizing the RF output power per 19 inch rack and
minimizing the impact of heat dissipation in the transmitter room

Reducing energy costs
Refined low-loss system design

• Highly efficient transistors
• Low-loss couplers
• Efficient cooling system
• Optimized power supplies
• More even and consistent cooling of components
  increases operational life and reduces maintenance
Reducing energy costs

Power bill calculation

<table>
<thead>
<tr>
<th>Liquid-cooled HD Radio™ vs. Legacy HD Radio™ air-cooled transmitter</th>
<th>Air-cooled transmitter</th>
<th>Liquid-cooled transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD Transmitter TPO</td>
<td>26.0 kW</td>
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</tr>
<tr>
<td>Power Consumption</td>
<td>65.0 kW</td>
<td>49.1 kW</td>
</tr>
<tr>
<td>Power Efficiency</td>
<td>40%</td>
<td>53%</td>
</tr>
<tr>
<td>Required energy per year (24/7)</td>
<td>570,000 kWh</td>
<td>430,000 kWh</td>
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<tr>
<td>Expected energy costs per kWh</td>
<td>$0.10</td>
<td>$0.10</td>
</tr>
<tr>
<td>Expected energy costs per year</td>
<td>$57,000</td>
<td>$43,000</td>
</tr>
<tr>
<td>Savings over 10 years</td>
<td>$140,000</td>
<td></td>
</tr>
</tbody>
</table>

Potential savings increase significantly with rising energy costs

Using less electricity is good for business, good for society and good for the environment – even if you’re not directly paying the bill!

Reducing service costs

Maximizing transmitter robustness

- Liquid-cooled amplifiers
  - Encapsulated, fanless units
  - Closed cooling circuit – All critical components protected from dust, smoke, salty air and humidity

Totally protected from external influences (no blocked air filters, no icing-up)
Reducing service costs
Fully redundant cooling system

» Fully redundant Liquid-cooling – BUILT IN
• No additional investment
• No additional service efforts
• Site HVAC can be down and there will be no operational impact on THR9

Reducing labor costs
Minimizing maintenance efforts – 1 transmitter

Liquid-cooled transmitter
Maintenance tasks and efforts over lifetime

Air-cooled transmitter
Maintenance tasks and efforts over lifetime

Liquid cooling has less required maintenance which means more up-time and lower labor costs!
Reducing labor costs
Intelligent diagnostics from remote

- Simple, easy to read, easy to operate user interface
- Status and control of transmission and complete cooling system

Instant access from anywhere – any device (HTML5, no Flash)
Rohde & Schwarz tech support can also assist
Reducing costs for off-air time
Intelligent redundancy solutions

Redundancy concepts on system and components level

Amplifier

100 % power

80 % power

OFF AIR

Minimal Cost

Power Supply Redundancy Inside

Redundancy on the system and component level

Example: R&S®THR9 20kW IBOC (-10dB injection)
Reducing costs for off-air time
Transistor Redundancy Inside

Example: R&S®THR9 20kW IBOC (-10dB injection)

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<tr>
<th>PA level</th>
<th>Transmitter level (6 PAs)</th>
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<tr>
<td>77%</td>
<td>95 %</td>
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Example: R&S®THR9 20kW IBOC (-10dB injection)

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Total cost of ownership
Influencing factors other than price

PIXEL
RENT
ENERGY
SERVICE
LABOR
OFF AIR
COSTS
Station Operator

Liquid Cooled Solid State Transmitter
Key benefits

• Output power of 3 kW-50 kW (hybrid)
  5kW-80kW (analog)
  Highest power density, smallest footprint

• Minimized energy costs
  Industry leading energy efficiency of up to 75%

• Excellent transmitter robustness
  No clogged air filters
  • Never off-air because of broken AC
  • No individual amplifier or power supply fans
Liquid Cooled Solid State Transmitter

Key benefits

- Fully redundant cooling system
- Super silent operation
- Minimized service efforts
  Significantly fewer maintenance tasks
- Liquid cooling consumes less electricity which saves money and is more environmentally sound

Summary: How R&S Lowers Your Total Cost of Ownership

- Liquid cooling reduces long term costs
- Lower energy costs
- Less required maintenance reduces costs
- Smaller footprint (lower rent costs)

- Advanced transmitter designs improve performance
  - More efficient operation means lower energy costs
  - More reliable designs and build quality reduce off air time
  - Advanced technologies like optimized crest factor reduction and HD Radio
    Generation 4 increase operational lifetime and ROI

- Our long term commitment to efficiency in broadcasting technology means we'll be here to support you decades into the future