Antenna matching and system-level RF performance validation (TRP / TIS) Design review checklist

Use this checklist during architecture review, layout freeze, enclosure freeze, and pre-certification validation.

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1. System scope and assumptions

- ☐ Wireless technologies and frequency bands are clearly defined
- ☐ Device operating modes (TX/RX duty cycle, power levels) are known
- ☐ Final product use case and orientation are understood
- ☐ Enclosure material and mechanical constraints are frozen or clearly defined

Engineering rule: TRP and TIS are system metrics and cannot be evaluated without final integration assumptions.

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2. Antenna integration readiness

- ☐ Antenna selection is complete and justified for the application
- ☐ Antenna placement on PCB is fixed
- ☐ Ground plane strategy near the antenna is reviewed
- ☐ No late mechanical or industrial design changes are pending

Red flag: TRP/TIS validation planned while antenna placement is still changing.

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3. Matching network implementation

- ☐ Matching network (π or T) is present at the antenna feed
- ☐ Component values allow sufficient tuning range
- ☐ Matching components are accessible after assembly
- ☐ Matching was tuned using measured data, not only simulation

Engineering rule: matching must be tuned in the final PCB and enclosure configuration.

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4. S11 and impedance validation

- ☐ S11 measured using a vector network analyzer
- ☐ Smith chart behavior is understood and documented
- ☐ Return loss target is met across required operating bands
- ☐ Matching re-verified after enclosure integration

Checkpoint: poor S11 will almost always degrade TRP and TIS.

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5. RF path and layout losses

- ☐ RF trace length is minimized
- ☐ Controlled impedance (typically 50 ohm) is maintained
- ☐ RF path avoids unnecessary vias
- ☐ No ground breaks under the RF feedline
- ☐ No high-speed or switching signals routed near the RF path

Engineering rule: RF losses before the antenna directly reduce TRP.

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6. Noise and interference control (TIS critical)

- ☐ DC/DC converters reviewed for RF noise coupling
- ☐ Switching regulators kept away from antenna and RF path
- ☐ MCU clocks and harmonics reviewed
- ☐ Display interfaces or cables evaluated for coupling risk
- ☐ Grounding and stitching strategy reviewed

Red flag: assuming poor TIS is an antenna problem without noise analysis.

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7. Enclosure and system effects

- ☐ Final enclosure used during RF validation
- ☐ Antenna detuning due to housing material evaluated
- ☐ Proximity to metal, batteries, or shielding reviewed
- ☐ Orientation-dependent effects understood

Engineering rule: free-space antenna behavior does not predict product behavior.

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8. OTA validation planning

- ☐ OTA validation planned before certification testing
- ☐ TRP measurement defined as transmit KPI
- ☐ TIS measurement defined as receive KPI
- ☐ Test channels and bands are representative of real operation

Checkpoint: OTA testing is an engineering validation step, not only a certification formality.

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9. TRP validation review

- ☐ Conducted TX power is known and verified
- ☐ Measured TRP is documented per band
- ☐ Loss between conducted power and TRP is understood
- ☐ Root causes of TRP loss are identified (efficiency, matching, layout, enclosure)

Engineering insight: increasing TX power rarely compensates for poor antenna integration.

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10. TIS validation review

- ☐ Conducted receiver sensitivity is known
- ☐ Measured TIS is documented per band
- ☐ Degradation relative to conducted sensitivity is quantified
- ☐ Noise-related root causes are investigated

Engineering insight: many TIS failures originate from internal noise, not antenna choice.

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11. Certification and project risk

- ☐ TRP/TIS results are aligned with certification requirements
- ☐ Margin to minimum requirements is understood
- ☐ Redesign risk is assessed before submission
- ☐ Escalation plan exists if OTA results are marginal

Red flag: first TRP/TIS measurement performed at certification lab.

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12. Final readiness decision

- ☐ Antenna matching is frozen
- ☐ PCB and enclosure are RF-validated
- ☐ TRP and TIS meet project targets
- ☐ Design is ready for certification submission

Key reminder for design reviews

TRP and TIS define real-world RF performance. They are the result of antenna integration, matching, layout, enclosure, and noise control, not of the RF module alone.