**Test Plan for 12 V to 1.2 V, 20 A Buck Converter**

**1. Objectives**

* Verify that the converter meets electrical specifications (voltage, current, ripple, efficiency).
* Validate transient response under dynamic load.
* Assess stability (control loop behavior).
* Ensure thermal performance is within limits.
* Evaluate EMI performance.

**2. Test Equipment**

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| **Equipment** | **Purpose** |
| **Oscilloscope (≥100 MHz BW)** | Ripple, switching waveform, transient tests |
| **Current probe (≥20 A)** | Measure inductor/load current |
| Differential voltage probe | Accurate Vout measurement under load |
| Power analyzer / DMM | Efficiency, Vin, Iin, Vout, Iout |
| **Programmable load (≥20 A)** | Static & dynamic load testing |
| **Electronic power supply (12 V)** | Vin source |
| **Thermal camera or IR sensor** | Thermal evaluation |
| Spectrum analyzer (up to 100 MHz or more) | EMI/FFT analysis of switch node |

**3. Test Procedures**

**3.1 Functional Tests**

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| **Test** | **Method / Acceptance Criteria** |
| **Startup Test** | Power on from 0 to 12 V. Output must rise smoothly to 1.2 V. |
| **No Load Output Voltage** | Measure Vout at 0 A: must be 1.2 V ±2%. |
| **Full Load Output Voltage** | At 20 A: Vout must remain within ±3% of 1.2 V. |
| **Switching Frequency** | Confirm ~500 kHz using scope on switch node. |
| **Duty Cycle Check** | Duty cycle should ≈ 10% at 1.2 V out. |

**3.2 Performance Tests**

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| **Test** | **Method / Target** |
| **Efficiency** | Measure Vin, Iin, Vout, Iout. Efficiency = Vout × Iout / Vin × Iin. Target: ~88%. |
| **Output Ripple (Vpp)** | Measure ripple on Vout at full load with scope, AC-coupled, at 20 MHz BW. Target: ≤25 mVpp. |
| **Inductor Current Ripple** | Scope current probe on inductor. Should match ~3.86 App. |

**3.3 Transient Tests**

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| **Test** | **Method / Acceptance Criteria** |
| **Load Step: 0 A to 10 A** | Step load, measure undershoot and recovery time. |
| **Load Step: 10 A to 20 A** | Same as above. Undershoot < 100 mV, recovery < 100 µs. |
| **Fast Transient Load Test** | 100 ns–1 µs load steps using electronic load. |

**3.4 Stability (Control Loop)**

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| **Test** | **Method** |
| **Bode Plot (optional)** | Use frequency injection (e.g. AP300) to measure phase margin. Aim for ≥45° phase margin, gain margin ≥10 dB. |
| **Step Response** | Observe Vout with fast load step. No ringing or instability. |

**3.5 Thermal Evaluation**

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| **Test** | **Method / Criteria** |
| **Steady-State Thermal** | Run at full load for 10+ minutes. Use IR camera. Max IC temperature < 125 °C (check datasheet). |
| **Hot Spot Identification** | Find and document components >85 °C at 25 °C ambient. |

**3.6 EMI / Harmonics**

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| **Test** | **Method / Target** |
| **Switch Node FFT** | Use scope FFT on switch node. Peaks should match harmonic predictions (~2.36 V, 2.24 V...). |
| **Conducted EMI** | If pre-compliance test setup is available (LISN, EMI filter), evaluate conducted emissions against CISPR 25/Class B. |

**4. Test Conditions**

* **Input Voltage:** 12 V ±10%
* **Output Current Range:** 0 A to 20 A
* **Ambient Temperature:** 25 °C ±5 °C
* **Load Type:** Resistive or programmable electronic load
* **Capacitor ESR:** 5 mΩ assumed
* **Cooling:** Natural convection unless otherwise specified

**5. Pass/Fail Criteria**

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| **Parameter** | **Criteria** |
| Vout Regulation | ±2% at no load, ±3% at full load |
| Ripple Voltage | ≤25 mVpp |
| Efficiency | ≥87% target |
| Thermal | <125 °C device max |
| EMI (optional) | Below CISPR/EN threshold |

**Optional Enhancements**

* **Line Transient Test:** Sweep Vin from 10.8 V to 13.2 V and observe Vout response.
* **Short-Circuit Test:** Test response to short-circuit at output (if IC supports protection).
* **Cold Start Test:** Test startup at -20 °C or 0 °C ambient.