FORTEC US Application Note

Medical USB Type-C 65 W AC/DC Adapter

---

1. Summary

Portable and patient-proximal medical systems increasingly standardize USB Type-C for power delivery. While 65 W USB-C adapters are widely available in commercial markets, medical applications impose significantly stricter requirements for isolation, leakage current, EMC immunity, and risk management.

This application note outlines:

- Medical regulatory requirements (IEC 60601-1, IEC 60601-1-2)
- Isolation and MOPP considerations
- USB Power Delivery (PD) implementation constraints
- EMC and thermal design strategies
- System-level integration risks
- Qualification checklist for OEM validation

A properly designed medical USB-C adapter must deliver reliable 65 W power while maintaining reinforced isolation, low leakage current, deterministic PD behavior, and verified EMC immunity in clinical environments.

---

2. Target Medical Applications

Typical use cases include:

- Clinical tablets and diagnostic handhelds
- Point-of-care computing platforms
- Bedside monitoring systems
- Portable imaging accessories
- Medical communication hubs (Wi-Fi / Cellular gateways)

These systems typically operate:

- Within patient vicinity (≤1.5 m)
- In environments containing sensitive monitoring equipment
- In multi-device configurations where leakage stacking may occur

---

3. Regulatory and Safety Framework

3.1 Medical Electrical Equipment Standard

Medical USB-C power adapters intended for patient-proximal use must comply with:

- **IEC/EN 60601-1 (Ed. 3.2)** – Medical Electrical Equipment – General Requirements for Basic Safety and Essential Performance

Key safety design elements include:

- 2 × MOPP (Means of Patient Protection) isolation where required
- Reinforced insulation between primary (mains) and secondary (SELV output)
- Proper creepage and clearance distances per pollution degree and overvoltage category
- Controlled patient leakage current limits

For Class II (double-insulated) adapters, reinforced insulation replaces protective earth.

3.2 EMC Requirements

Medical environments require enhanced electromagnetic immunity compared to commercial IT equipment.

Applicable standard:

- **IEC/EN 60601-1-2 (Ed. 4.1)** – EMC requirements for medical electrical equipment

Typical performance expectations include:

- Conducted and radiated emissions compliant with CISPR 11 Class B
- ESD immunity up to ±8 kV air discharge
- EFT immunity (e.g., ±2–4 kV)
- Surge immunity (e.g., ±1 kV differential, ±2 kV common mode)

- RF immunity up to 10 V/m (or higher for certain environments)

Adapters must maintain stable output and avoid unintended resets during immunity testing.

---

4. Electrical Performance Requirements

4.1 Input Characteristics

A 65 W medical adapter should support:

- 90–264 VAC universal input
- 47–63 Hz frequency range
- Controlled inrush current
- Brownout tolerance
- Surge withstand per IEC 61000-4-5
- Compliance with harmonic current limits (IEC 61000-3-2)

Active PFC is typically required at this power level.

4.2 Output Performance

Key electrical specifications should include:

- USB-C PD 65 W maximum output
- Tight voltage regulation (±5% or better)
- Ripple & noise typically <150 mVp-p at 20 V
- Stable load transient response
- Controlled startup rise time
- Low no-load power consumption

Output must remain stable during PD renegotiation events.

---

5. USB Power Delivery (PD) Implementation

5.1 Standard Power Profiles (SPR)

A 65 W adapter typically supports:

PDO	Voltage	Current	Power
Fixed	5 V	up to 3 A	15 W
Fixed	9 V	up to 3 A	27 W
Fixed	15 V	up to 3 A	45 W
Fixed	20 V	up to 3.25 A	65 W

Operation above 3 A requires appropriate cable capability.

5.2 Medical-Specific PD Considerations

In medical systems, PD behavior must be:

- Deterministic under brownout conditions
- Robust to cable disconnect and reconnect events
- Stable during dynamic load transitions
- Immune to unintended renegotiation

The PD controller should:

- Manage safe voltage transitions
- Detect cable faults
- Provide controlled fallback to lower PDOs
- Prevent uncontrolled voltage collapse

Unexpected power interruption can compromise essential performance in medical equipment.

---

6. Isolation Architecture

A typical architecture includes:

AC Input → EMI Filter → PFC → Isolated DC/DC Stage → Reinforced Isolation Barrier → Secondary Regulation → USB-C PD Controller → Type-C Receptacle

Key design elements:

- Reinforced transformer insulation
- Opto-feedback or isolated control
- Medical-rated Y-capacitors
- Controlled leakage current design

Creepage and clearance must satisfy 2 × MOPP requirements for patient-proximal applications.

---

7. Thermal Design

High power density USB-C adapters require careful thermal management.

Design considerations include:

- 90% efficiency at full load
- Convection-cooled enclosure
- Thermal spreading via PCB copper planes
- Component derating at maximum ambient (e.g., 40°C)
- Verification of enclosure surface temperature limits

Thermal validation should be performed at worst-case load and maximum rated ambient.

8. Protection and Control Features

A medical-grade adapter should incorporate:

- Overcurrent Protection (OCP)
- Overvoltage Protection (OVP)
- Short Circuit Protection (SCP)
- Overtemperature Protection (OTP)
- Brownout protection
- USB-C fault monitoring

Protection must operate in a controlled manner without unsafe oscillation or repeated reset cycling.

---

9. System-Level Risk Considerations

OEMs should evaluate:

- Leakage stacking when multiple supplies are connected
- PD renegotiation under EMI stress
- Ground reference shifts in multi-equipment systems
- Cable rating validation for 65 W operation
- Behavior during AC interruption and recovery

Risk analysis should align with ISO 14971 processes.

10. Integration Qualification Checklist

When validating a 65 W medical USB-C adapter:

□ Verify 2 × MOPP documentation
□ Perform Hi-Pot isolation testing
□ Measure leakage current per IEC 60601-1
□ Validate PD negotiation across all PDOs
□ Test brownout and AC dropout recovery
□ Perform full-load thermal validation
□ Conduct EMC pre-compliance testing
□ Validate cable compliance for 65 W delivery

---

11. Conclusion

Designing a 65 W USB Type-C adapter for medical applications requires significantly more than adapting a commercial USB-C power supply. Compliance with IEC 60601-1 safety requirements, IEC 60601-1-2 EMC immunity levels, reinforced isolation design, deterministic USB PD behavior, and validated thermal performance are essential for patient-proximal use.

The **Phasium 65 W USB-C PD Adapter MANGO65H-PD** addresses these challenges by combining:

- Medical-grade reinforced isolation
- IEC 60601-1 compliance
- Robust USB Power Delivery implementation
- Optimized thermal and EMI performance
- Verified protection and fault handling mechanisms

By selecting a purpose-built medical USB-C solution such as the MANGO65H-PD, OEMs can reduce certification risk, accelerate regulatory approval, and ensure reliable operation in clinical environments.

Why Partner with FORTEC US

FORTEC US provides engineered power solutions for medical, embedded, and industrial applications, including:

- Medical-grade AC/DC power supplies
- Custom and modified configurations
- System-level EMC and safety guidance
- Regulatory integration support

For technical evaluation support or design consultation, calls us at (631) 648-6400 or visit:
https://fortec.us/