

# Product Design Requirements Specification

## I. Core Product Definition & Requirements

### 1. Functional Requirements:

- **What core functions must the product implement?** Describe in as much detail as possible.
- **What is the operational flow for each function?** (e.g., How does the user enable, configure, and use the function?)
- **What are the Inputs?** (Buttons, sensors, data received via communication interfaces, etc.)
- **What are the Outputs?** (Displays, indicator lights, sounds, motor actions, data sent via communication interfaces, etc.)

### 2. Performance Specifications:

- **What are the key performance parameters?** (e.g., Measurement accuracy, response speed, processing capability, transmission rate, resolution, power range, efficiency, etc.)
- **What are the specific target values or acceptable ranges for these parameters?**

### 3. User Interface (UI) & Interaction:

- **What user interfaces are required?** (e.g., Buttons, touchscreen, knobs, LED indicators, display type & size, audio prompts, etc.)
- **How does the user interact with the product?** What is the operational logic?
- **Are there any specific ergonomic or usability requirements?**

### 4. Operating Environment:

- **In what environment will the product be used?** (e.g., Indoor/Outdoor, temperature range, humidity range, IP (Ingress Protection) rating for water/dust resistance, shock/vibration resistance requirements, presence of corrosive gases, EMI/EMC environment, etc.) *This is crucial for material selection, component grade, and protective design.*

### 5. Target Users & Market:

- **Who are the primary users of the product?** (Consumers, industrial users, medical users, etc.)
- **Where are the primary sales markets?** (Different regions have different regulatory requirements.) *This helps understand user experience needs and compliance direction.*

## II. Technical Specifications & Interfaces

### 6. Power Supply Requirements:

- **Input Power Source Type?** (AC mains, DC adapter, battery type & specifications, USB power, PoE, etc.)
- Voltage and current range? Power requirements? Are there standby power or peak power consumption requirements?
- **Is power management functionality needed?** (e.g., Low-power modes, battery charging management, etc.)

### 7. Communication Interfaces:

- **Which communication methods are required?** (e.g., USB, Ethernet, Wi-Fi, Bluetooth, Zigbee, LoRa, RS232/485, CAN, I2C, SPI, UART, etc.)
- **What are the specific interface specifications?** (e.g., USB 2.0/3.x, Wi-Fi 802.11 b/g/n/ac/ax, Bluetooth version)
- **What communication protocols are used?** (e.g., TCP/IP, Modbus, MQTT, custom protocols, etc.) Data transmission rate and distance requirements?

### 8. Sensors & Actuators:

- **Which sensors need to be integrated?** (e.g., Temperature, humidity, pressure, accelerometer, gyroscope, ambient light sensor, proximity sensor, etc.)
- **Which actuators need to be driven?** (e.g., Motor type, relays, LED strips, buzzers, etc.) What are the specific part numbers or performance requirements for these peripherals?

### 9. Processing Capability & Storage:

- **What are the requirements for the main controller's processing capability?** (e.g., Need to run complex algorithms, an operating system?)
- **How much memory and storage space is required?** (RAM, Flash/EEPROM, SD card, etc.)
- **Are there specific preferences for microcontrollers or processors?**

### 10. Mechanical Structure & Enclosure:

- What are the expected product dimensions, shape, and weight constraints?
- Enclosure material requirements? (Plastic, metal, etc.)
- Are there industrial design sketches, 3D models, or reference products available?
- Mounting method? (Wall-mount, embedded, handheld, etc.)
- Thermal management requirements? (Need for fans, heat sinks?)

#### 11. Display & Indication:

- Display type? (LED segment display, segment LCD, dot-matrix LCD, OLED, TFT color screen, etc.)
- Display size, resolution, brightness, viewing angle requirements?
- Number, color, and status meaning of indicator lights?

### III. Regulations, Certifications & Manufacturing Requirements

#### 12. Compliance & Certifications:

- **Which regulations and certifications must the product meet?** (Extremely Important)
  - **Safety Certifications:** UL, CE (LVD), CCC, PSE, KC, etc.
  - **Electromagnetic Compatibility (EMC) Certifications:** FCC, CE (EMC), CISPR, VCCI, etc.
  - **Industry-Specific Certifications:** Medical (FDA, ISO 13485), Automotive (IATF 16949), Industrial Control, Aerospace, etc.
  - **Environmental Certifications:** RoHS (Restriction of Hazardous Substances), REACH, WEEE, etc.
- *Target markets determine mandatory certifications.*

#### 13. Manufacturing & Cost Targets:

- Expected production volume? (Low-volume pilot, medium-volume, high-volume) *This directly impacts component selection, production processes, and cost.*
- **What is the target cost?** (BOM cost, ex-factory price) ***(This is a key design constraint)***
- Production process requirements? (e.g., SMT assembly, hand soldering, testing requirements)
- Country of origin requirements? (Any supply chain geographical restrictions?)

#### 14. Packaging & Shipping:

- What are the requirements for product packaging? (Eco-friendly materials, shock resistance, moisture resistance, dimensions, etc.)
- Should accessories be included? (Power adapter, cables, user manual, warranty card, etc.)

### IV. Project Execution & Deliverables

#### 15. Project Timeline:

- Expected development cycle? (Concept design, schematic, PCB, prototype, testing, certification, pilot production, mass production)
- Key milestone dates? (e.g., First prototype delivery, certification completion, mass production start)

#### 16. Deliverables:

- What specific deliverables does the client require?
  - Design Documentation? (Schematics, PCB files, BOM list, firmware source code/programming files)
  - Test Reports? (Functional testing, performance testing, environmental testing, EMC pre-compliance reports)
  - Certification Reports? (Final passed certification certificates and reports)
  - Number of prototypes?
  - Mass Production Files? (Gerber files, stencil files, assembly drawings, test fixture designs, etc.)
- **Intellectual Property (IP) Ownership?** (Very Important)

#### 17. Budget Range:

- What is the client's budget for the entire project (development fees, NRE [Non-Recurring Engineering], prototype costs, certification fees)? *(Helps assess project feasibility and provide reasonable quotations)*

### V. Other Critical Information

#### 18. Existing Solutions / Reference Products:

- Does the client have an existing prototype, reference product, or competitor product? *This is the fastest way to understand requirements.*
- What aspects of the existing solution are satisfactory and unsatisfactory?

#### 19. Intellectual Property (IP):

- How will ownership of development outputs (hardware design, software code) be defined? (*Typically belongs to the client in custom development; must be explicitly stated in the contract*)
- Is an NDA (Non-Disclosure Agreement) required?

#### **20. After-Sales Service & Support:**

- What are the client's expectations for post-launch technical support and maintenance? (e.g., Duration of support? Scope of support?)

#### **21. Decision Chain & Contacts:**

- Who is the final decision-maker for technical issues?
  - Who is the contact person for commercial/business issues?
  - Who is the primary project interface/point of contact?
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#### **How to Efficiently Collect This Information**

1. **Use a Structured Questionnaire/Checklist:** Based on the list above, create a detailed electronic questionnaire or requirements gathering form for the client to complete. This ensures systematic information collection.
2. **Conduct In-Depth Interviews:** The questionnaire is just the starting point. Schedule deep-dive meetings with the client's technical lead (or decision-maker) to discuss each item, clarify ambiguities, and uncover latent requirements (needs the client may not have explicitly stated but are important).
3. **Provide Templates/Examples:** For complex requirements (e.g., performance specs), provide templates or examples to guide the client towards providing clear, quantifiable descriptions.
4. **Emphasize the "Why":** Don't just ask "what" needs to be done; ask "why" a specific function or specification is needed. This helps understand the client's core needs and potentially find better design solutions.
5. **Manage Expectations:** Begin managing client expectations during information gathering. For example, communicate potential trade-offs early regarding conflicts between high-performance requirements and low-cost targets, or tight schedules and complex designs.
6. **Written Confirmation:** Consolidate all agreed-upon requirements into a formal Product Requirements Specification (PRD) or Technical Agreement, signed off by both parties. This serves as the baseline for subsequent design and acceptance, preventing future disputes.