

PROTIMER

Product Requirement Document

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1. Introduction

Product Overview:



Protimer is a compact, smart digital timer designed to help users focus on one task at a time with clarity and intention. Built for students, professionals, homemakers, and anyone looking to improve productivity or mindfulness, Protimer lets users configure focus sessions either manually or remotely via a browser-based interface.

Equipped with an OLED/LCD display, tactile switches, multitone buzzer, RGB LED, and built-in RTC, it provides clear audio-visual feedback and precise session tracking. Logs are saved locally on an SD card and backed up to the cloud over Wi-Fi, making it easy to analyze productivity trends or maintain records.

Whether you're studying, cooking, working, or meditating, Protimer creates a distraction-free environment and reinforces time discipline through simple, intuitive interaction.

2. Scope / Product Boundaries

What Protimer is:

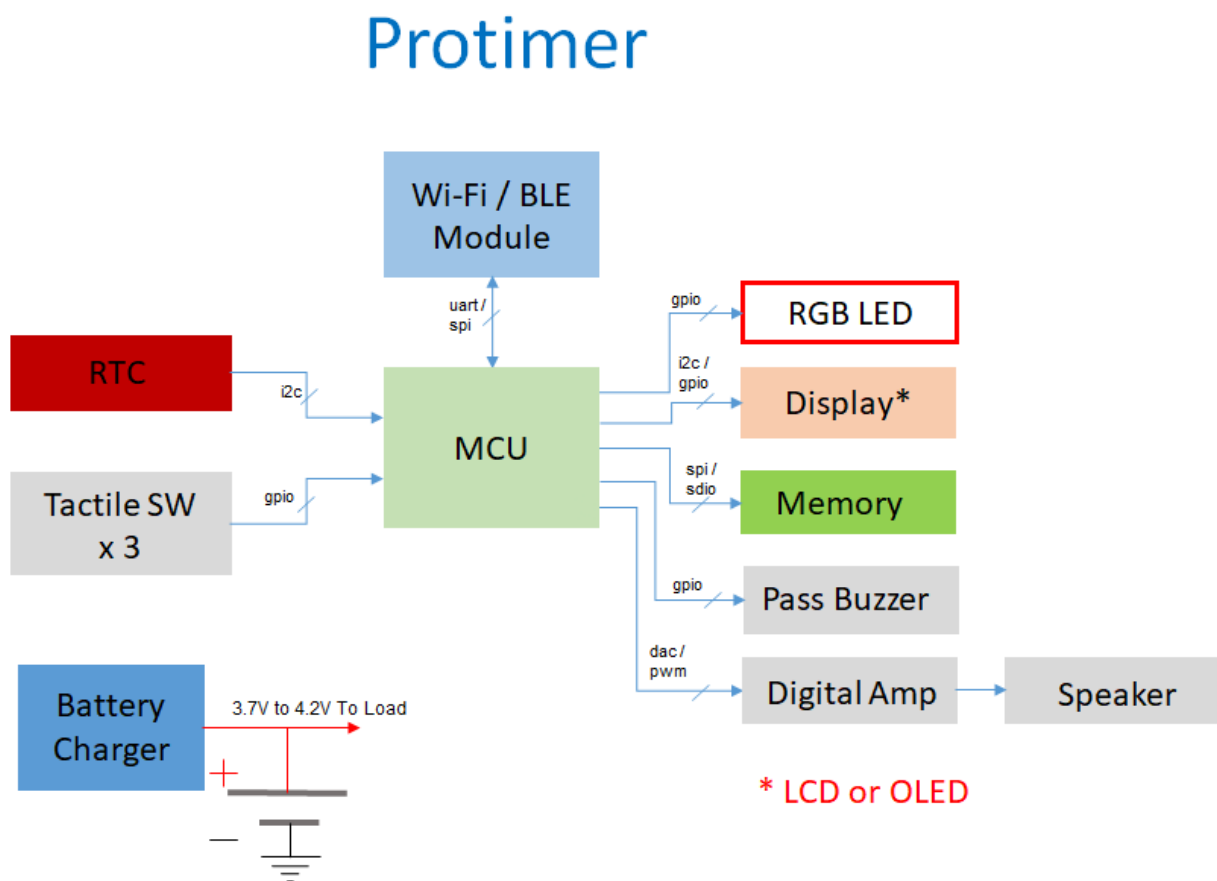
- A standalone, portable, IoT-enabled session timer designed to help users stay focused on one task at a time.
- It works independently (without a phone or PC) and can optionally be configured remotely via a browser-based app.
- It is designed to provide visual and auditory cues, maintain accurate logs, and offer real-time feedback using simple physical controls.

What Protimer is not:

- Not a mobile app or software-only solution.
- Not a voice assistant or AI-based coach.
- Not a full task management or calendar scheduler.
- Not designed for real-time collaboration or multi-user session sharing (at this stage).

3. General description

Block Diagram:



It is a device used to set short or long sessions to help focus on one task at a time. The duration of session varies from few seconds to multiple hours. The session can be set manually or remote (over web application).

4. Functional Requirements / Working:

AT POWER ON:

- The device begins with a boot sequence and proceeds to initialize all peripherals, including display, encoder, RTC, buzzer, SD card, and wireless interfaces.
- Once initialization is complete, it updates the user on the hardware status using display icons and clear status messages.
- Simultaneously, it logs the hardware readiness and status into memory for diagnostic purposes.
- The device then shows the current date and time along with a prompt encouraging the user to start a focus session.
- After this, the system enters a standby state, waiting for user input to begin interaction.

SESSION CONFIGURATION AND MODES:

Protimer supports session configuration via two methods: Manual and Remote. Manual configuration is performed directly on the device using tactile buttons and a rotary encoder with click functionality, enabling full standalone operation without the need for a PC or mobile device.

Remote configuration is facilitated through a browser-based web application accessible over Wi-Fi or Thread.

Both methods offer identical configuration options. However, a key distinction is that remote configuration allows multiple sessions to be scheduled in advance, which are stored in a session queue and executed sequentially in the defined order. This queue can be cleared at any time, either locally or remotely.

In contrast, manually configured sessions bypass the queue and execute immediately, overriding any currently running session.

Protimer supports multiple session modes, each optimized for different use cases:

1. Normal Mode: Alerts are delivered via passive buzzer tones at defined intervals.
2. Music Mode: Background MP3/WAV audio is played from internal memory during the session.
3. Silent Mode: Uses only RGB LED patterns to indicate session status, ideal for quiet environments.
4. Custom Mode: Combines all available options, allowing full customization of tones, music, LED patterns, and session behaviour.

These modes allow Protimer to adapt to a wide range of user preferences, environments, and productivity styles.

Remote vs Manual Session Handling:

If a manual session is started while a remote session is already running, the manual session will immediately **replace and override** the ongoing remote session—terminating it and starting fresh.

Conversely, if a remote session is triggered while a manual session is in progress, it will **not interrupt** the manual session by default. Instead, it will be **queued** and begin only after the manual session ends.

However, the remote session can **forcefully take over** and stop the manual session if it is issued with a **special override command**.

This hierarchy ensures manual control takes precedence unless the remote command is explicitly authorized to interrupt.

SESSION INITIALIZATION LOGIC

Upon receiving input for a new session (either manually or remotely), the system performs the following steps:

1. Determine the Source:
 - Based on the origin of the command (user interaction or remote input), identify if the session is manual or remote.
2. Conflict Handling:
 - If a session is already running, terminate it before starting a new one.
 - Manual session commands override any existing sessions.
 - Remote sessions may queue or force-stop manual ones based on control flags.
3. Prompt Mode Selection (for manual setup):
 - Display the list of available session modes and wait for the user to select one using the input interface (e.g., rotary encoder or buttons).

Parameter	Normal Mode	Music Mode	Silent Mode	Custom Mode
Session Duration	0 sec – 60 min	0 sec – 60 min	0 sec – 60 min	0 sec – 60 min
Session Pre-Time	0 sec – 60 min	0 sec – 60 min	0 sec – 60 min	0 sec – 60 min
Alert Tone	Selectable	NA	NA	Selectable
Alert Pattern	Selectable pattern	NA	NA	Selectable pattern
No. of Alert Intervals	0 – TBD	NA	Default (6)	0 – TBD
Background Music	NA	Selectable (MP3/WAV)	NA	Selectable (MP3/WAV)
RGB LED Feedback	NA	NA	VIBGYOR pattern	VIBGYOR pattern
Display Graphic	Optional (TBD)	Optional (TBD)	Optional (TBD)	Optional (TBD)

4. Remote Mode Configuration:
 - In remote mode, session configuration is performed through a web-based application and transmitted to the device over-the-air via Wi-Fi or Thread.
 - The received session details are stored in a queue and are executed sequentially in the exact order they were configured.
 - This allows users to schedule multiple sessions in advance without physical interaction with the device.

- The session queue can be managed (added, cleared, or reordered) remotely or manually.

Session Execution Logic

Once the session parameters are finalized:

1. Log session configuration to SD card and Cloud.
2. Start the session timer and begin monitoring in real-time.
3. Background Monitoring:

Continuously poll for:

- Pause / Resume
- Show Productive Time
- Stop Session
- Special override commands

Respond accordingly without interrupting the timekeeping accuracy.

Session Completion Workflow

Once the session ends:

1. Log final session details to SD card and cloud storage.
2. Logs shall include: timestamp for each session detail.
3. Display summary (e.g., session duration, productive time).
4. Return to standby mode, displaying the current time and awaiting the next user or remote input.

Productive Time

- It is a running total of all session durations completed within a single day.
- This value updates automatically at the end of each session and provides users with a clear indication of how much focused time they've accumulated.
- The productive time counter resets automatically at the end of each day if the auto-reset setting is enabled (which is the default).
- Users can manually reset this value at any point before starting or ending a session, either directly on the device or remotely via the app.
- The productive time can be viewed in three instances: when a session is paused, before a new session begins, and immediately after a session concludes.
- This feature helps users track daily productivity patterns and maintain a consistent focus routine.

CLOCK AND TIMING

As part of its session tracking and logging functionality, Protimer includes the following timekeeping mechanisms:

External Real-Time Clock (RTC):

The device is equipped with a dedicated RTC module to ensure high-precision timekeeping, even when the main MCU is in low-power or sleep mode. This ensures accurate tracking of session duration and timestamps for logs, regardless of power cycles or reboots.

Time Synchronization via NTP:

When connected to the internet over Wi-Fi, Protimer will automatically synchronize its internal time using Network Time Protocol (NTP) servers. This ensures the device's clock remains aligned with global time standards and maintains accuracy for cloud logs and multi-device coordination.

These mechanisms work together to provide reliable and consistent timing, essential for accurate session logs, productive time calculation, and time-based session triggers.

FIRMWARE UPDATES

OTA Firmware Updates:

Protimer supports Over-The-Air (OTA) firmware updates via Wi-Fi.

This allows for seamless delivery of new features, bug fixes, and performance improvements without requiring any physical connection or user intervention.

If an update attempt is made without internet connectivity, the device will log the failure and skip the update, retrying on the next available opportunity.

5. Non-Functional Requirements

Performance Requirements

1. Session Accuracy: Timer drift must not exceed ± 1 second per hour (reliable RTC required).
2. Startup Time: Device must boot and be ready within 3 seconds.
3. Log Write Latency: Session log must be written to SD card within 1 second after session ends.
4. Cloud Sync Latency: Cloud upload should complete within 5 seconds under stable Wi-Fi.
5. Button Response Time: Button input must register within 200 ms.
6. **Tone Playback:** Multitone buzzer must support at least 3 distinct sounds with <300ms response.

Power & Efficiency Requirements

7. Battery Life: Minimum of 7–10 days on a full charge or 30 days in standby.
8. Charging time: Max 1 hr to full charge.
9. Low Power Mode: Device must enter sleep mode automatically after 2 minutes of inactivity.
10. Power Consumption: Should not exceed 300 mW during session with display and buzzer active.
11. **Sleep Mode:** Auto-sleep after 2 minutes of inactivity to conserve power.

Connectivity Requirements

12. Wi-Fi Connectivity: Auto-reconnect to saved networks within 10 seconds of disconnection.

Usability Requirements

13. Ease of Use: All major actions (start session, select tone) should be possible with ≤ 3 button presses.
14. Accessibility: UI must be readable in both daylight and dim light (contrast, font size).
(Crisp and Clear Display: OLED/LCD must be readable in various lighting conditions.)
15. Multi-User Setup Simplicity: Wi-Fi and cloud sync setup should be completed in under 3 minutes. (Simple Configuration: Wi-Fi & session setup should take <3 minutes via web app.)
16. In case of disconnection Full core functionality (session start, tone playback, logging) must work offline.
17. Crisp and Clear Display: OLED/LCD must be readable in various lighting conditions.
18. Non-intrusive Sound Feedback: Tones should be clear but not jarring; optional silent mode with LED cues.
19. Accessible Feedback: Use of color + sound for inclusive feedback (e.g., visual + auditory cues for session end).
20. Offline Ready: Core functions (start, stop, tone, logging) must work even without Wi-Fi.
21. Configuration Export/Import: Settings and tone profiles should be exportable via SD card or app.

Reliability & Maintainability

22. MTBF: Mean Time Between Failures should exceed 5000 hours.
23. Fault Tolerance: Device should gracefully handle SD card removal or Wi-Fi failure.
24. Firmware Updates: Must support OTA (Over-The-Air) firmware updates via Wi-Fi.
25. Modular Design: Firmware structure should allow easy updates of tone library or UI logic.
26. Diagnostics: Include basic error logging (e.g., failed sync, SD write errors) for debugging.

- 27. Serviceability: Components like battery or SD card should be replaceable with minimal tools.

Security Requirements

- 28. Data Privacy: Cloud logs must be user-authenticated (OAuth or API token).
- 29. Network Security: Must support WPA2 at minimum or higher for Wi-Fi authentication /connections.
- 30. File Integrity: Local logs must be checksum-verified on write.
- 31. No Always-On Mic: No microphone or audio capture hardware should be present.
- 32. User Privacy: Cloud session logs should require user login/token for sync (e.g., Google Drive API).
- 33. Integrity Check: Verify local log files via hash or checksum at write.
- 34. Safe Firmware Updates: OTA updates must be authenticated and fail-safe (e.g., rollback mechanism if update fails).

Scalability & Extensibility

- 35. Log Storage: Local storage must support at least 1000 session records.
- 36. Expandable Audio: Device must allow new tone files (WAV/MP3) to be added via SD card.
- 37. Modular Firmware: Codebase should allow future integration of vibration motor or BLE beacon.

6. User Experience Requirements

Core Functional Requirements

1. Set Focus Sessions Easily
 - Users must be able to start, stop, and configure a timer session with minimal effort, using either physical buttons or a web/app interface.
2. Get Clear Session Feedback
 - Users must receive clear visual (display and LEDs) and/or auditory (buzzer tones) feedback indicating session start, progress, and completion.
3. Log Sessions Automatically
 - Every session must be automatically logged locally and synced to the cloud (e.g., Google Drive) when Wi-Fi is available.
4. Configure Remotely
 - Users must be able to configure session duration, tone, and other preferences through a web or browser-based interface.

Ease of Use

5. Minimal Interaction Required
 - Common actions like "start session" or "select tone" should be achievable with ≤ 3 button presses.
6. Use Without App if Needed
 - The device must function fully offline, without requiring a phone or internet connection to perform basic tasks.
7. Simple Visuals and Icons
 - The interface must use intuitive icons/symbols and easy-to-read text to communicate status and options.

Feedback & Alerts

8. Tactile and Audio Guidance
 - Device must provide feedback through physical buttons, buzzer tones, and LED cues—especially helpful for users with ADHD or focus difficulties.
9. Tone Customization
 - Users must be able to select from multiple alert tones for session start, nearing end, and session completion.
10. Silent Feedback Option
 - Users must have the option to mute tones and rely on visual feedback only (e.g., in libraries or meditation rooms).

Productivity Insights

11. Cloud Logs for Review
 - Users must be able to access and review their focus session logs (date, duration, frequency) via cloud storage.
12. Support for Multiple Sessions Daily
 - The device must handle 10–15 sessions per day without performance degradation or data loss.

Versatile Environments

13. Use in Various Locations

- Device must be suitable for desks, kitchens, classrooms, studios, gyms, etc., with stable placement and visibility.
14. Portable & Compact
- Device must be light and compact enough to carry in a backpack or pocket and usable without external accessories.

Special User Needs

15. Visual Feedback for Hearing Impaired
- LED indicators must be sufficient to communicate session status without sound.
16. Accessible for Children and Elderly
- Buttons should be tactile, easy to press, and clearly labelled; UI must not require advanced tech knowledge.

7. Mechanical Requirements

Enclosure & Durability

1. Drop-Resistant Design:
 - Must withstand accidental drops from a height of 2 meter on hard surfaces without functional damage.
2. Ingress Protection:
 - Minimum protection level of IP41 (protection against vertical water drops and small solid objects).
3. Material:
 - Enclosure must be made from impact-resistant ABS or polycarbonate plastic.
 - Should be UV-stable to resist yellowing or degradation over time.
4. Shock Absorption:
 - Internal components should be cushioned or isolated using rubber standoffs or foam padding to protect from vibration and shocks.

Design & Form Factor

5. Compact Size:
 - Target dimensions: $\leq 50\text{mm} \times 40\text{mm} \times 10\text{mm}$ (W x H x D) for portability and ease of desktop use.
6. Weight:
 - Total device weight (including battery) should not exceed 75 grams for handheld comfort.
7. Mounting Options:
 - Must include rubber feet for desk stability.
 - Optional mounting holes or magnetic pad for vertical mounting (e.g., on fridge or board).
8. Ventilation Slots:
 - Passive vent slots if required for speaker audio clarity or heat dissipation.

User Interaction & Ergonomics

9. Button Accessibility:
 - Minimum 3 tactile switches and a rotary encoder with click, clearly labelled or symbolized, spaced for thumb operation.
10. Display Visibility:
 - OLED/LCD screen should be tilted or flush for readable viewing angle when placed flat or upright.
11. LED Visibility:
 - RGB LED indicators must be visible from front and top.
12. Speaker and Buzzer Opening:
 - Dedicated audio grill or acoustic path for clear tone output without muffling.

Battery & Access

13. Battery Access Panel:
 - Battery should be user-replaceable through a secured panel (screwed or latched).
14. Charging Port Placement:
 - USB or charging port must be accessible from the rear or side, avoiding accidental damage when in use.

15. SD Card Slot:

- Slot must be accessible from outside or via service cover with firm click-lock.

Assembly & Maintenance

16. Tool-Free Operation:

- Daily use (e.g., buttons, SD card, charging) must not require tools.
- Service-Friendly Assembly:
- Enclosure must be easy to open using standard screwdrivers (Phillips or Torx) for repair/replacement.

17. Screw Mounts:

- PCB and display must be mounted securely using threaded brass inserts or standoffs to prevent cracking.

8. System Constraints

Hardware Constraints

1. MCU Resource Limitations
 - Limited RAM and flash memory on STM32 MCU may restrict the complexity of the user interface and tone storage.
2. Display Size and Resolution
 - Limited screen size (e.g., Nokia 5110 LCD or small OLED) constrains the amount of text/icons that can be shown at once.
3. Button Count
 - Only 2–3 tactile switches and a rotary encoder with click is available, requiring smart UI navigation logic for menu and selection.
4. Audio Output Method
 - Using a passive buzzer or small speaker limits the quality and type of tones/sounds that can be played (e.g., no full-range MP3 without amplification/DAC).
5. Battery Life vs. Features Tradeoff
 - Advanced features (Wi-Fi, display brightness, RGB LED animations) must be optimized to conserve battery, especially for 30 days of standby use.
6. Storage Constraints
 - Limited onboard memory; reliant on SD card for storing session logs and audio files.

Software Constraints

7. Real-Time Responsiveness
 - The system must respond instantly to button presses and accurately track time using RTC, requiring lightweight, efficient firmware.
8. Wi-Fi API Limitations
 - Only basic HTTP/HTTPS or MQTT communication possible, depending on Wi-Fi module (e.g., ESP8266/ESP32 if used as co-processor).
9. No Complex File Systems
 - File access from SD card must work with FAT32; advanced databases or logging methods (e.g., SQLite) not feasible.
10. Security Limits
 - Limited support for advanced security (e.g., TLS 1.3, OAuth2) due to memory and processing constraints on embedded platforms.

Integration Constraints

11. Cloud Service Compatibility
 - Integration with cloud storage (e.g., Google Drive) may require intermediate service or web hook due to API token handling complexity.
12. Firmware OTA Update Complexity
 - OTA updates must be handled carefully with fallback mechanisms; limited space for dual-partition or rollback schemes.
13. Browser-Based Configuration
 - Web interface must be minimal and designed for local access (e.g., ESP-hosted captive portal or simple web app).
14. Cross-Platform Syncing

- Integration with mobile apps or external systems (e.g., Google Fit, Notion) may require future expansion beyond MVP.

15. Real-Time Clock Sync

- RTC must support syncing with browser-based app or NTP if available, but fallback required for offline use.

9. User Interface (UI) and User Experience (UX):

Wireframes and Mockups:

Provide visual representations of the user interface.

UI/UX Guidelines:

Detail the design principles for the user interface.

Navigation:

Describe how users will navigate through the product.

10. Assumptions & Dependencies

The following assumptions and external dependencies must hold true for the Protimer to operate as intended:

1. Connectivity & Infrastructure
 - User has access to a reliable Wi-Fi network for enabling cloud sync, OTA updates, and remote configuration.
 - Basic internet access is available during initial setup or app interaction for firmware registration or cloud linking.
2. Companion Application
 - A mobile or browser-based app will be made available for session configuration, schedule syncing, and log viewing.
 - Users will have access to a smartphone, tablet, or PC with modern browsers to access the web app.
3. Storage
 - Protimer includes either a pre-inserted microSD card or has sufficient onboard memory (EEPROM/Flash) to store session logs and tones.
 - The SD card will have preloaded MP3/WAV tones, or users will upload tones through the companion app or USB.
4. Power & Charging
 - End-users will periodically charge the built-in Li-ion battery using a standard 5V USB type C charger.
 - Device includes battery protection circuitry (via TP4056 or equivalent).
5. User Behavior & Environment
 - Users will understand the basic usage of tactile buttons, Rotary Encoder and respond to visual/auditory cues (buzzer, LED, screen).
 - The device will be used in environments where short visual or audio feedback is sufficient (e.g., not in industrial high-noise zones unless modified).
6. Firmware / Software Dependencies
 - The device assumes valid firmware image has been flashed and is up-to-date.
 - OTA firmware updates depend on an available cloud backend and functional Wi-Fi.
7. Cloud Integration
 - Google Drive or equivalent cloud storage integration is supported via the app (requires user login and permission).
 - Session logs are uploaded only when Wi-Fi is available; otherwise stored locally until next sync.
8. Manufacturing & Supply Chain
 - Availability of key components like STM32, ESP8266/ESP32, OLED display, etc., is stable and not affected by global shortages.

11. Acceptance Criteria

Each criterion below defines a specific, testable condition under which the Protimer unit is considered acceptable for functional delivery and final validation.

Functional Criteria

1. Session Start/Stop
 - Device shall allow a session to be started and stopped manually using tactile buttons or remotely via the web interface.
 - *Test: Manual and remote session control triggers session timers and indicators.*
2. Countdown Display
 - OLED/LCD screen shall show the session countdown in minutes and seconds.
 - *Test: Screen shows correct remaining time within $\pm 1s$ accuracy.*
3. Audio Feedback
 - Buzzer shall produce at least 3 distinct tones (start, near-end, end).
 - *Test: Observe tone playback at designated session events.*
4. LED Indicators
 - RGB LED shall change color based on session status (e.g., blue = active, red = complete).
 - *Test: LED responds to status changes correctly.*
5. Log Creation
 - Each completed session is saved locally (SD or internal memory).
 - *Test: Review session logs for correct time, date, duration.*
6. Wi-Fi Sync
 - When connected to Wi-Fi, logs shall sync to cloud storage (e.g., Google Drive).
 - *Test: Validate appearance of log entry on remote drive within 60s.*
7. Tone Selection
 - User can select from at least 3 stored tone options using 2 tactile switches and LCD interface.
 - *Test: Navigate tone menu and confirm selection.*
8. RTC Accuracy
 - Real-Time Clock shall maintain accurate time with max drift $\leq \pm 2$ minutes/month
 - *Test: Compare RTC time to NTP server after 30 days.*
9. Battery Life
 - Device shall operate for a minimum of 7 days on a single full charge (based on 3 sessions/day).
 - *Test: Run endurance tests under realistic usage load.*
10. OTA Updates
 - Device firmware shall be updatable over Wi-Fi.
 - *Test: Perform and verify a test OTA firmware update.*

12. Appendices

Attach system diagrams, block diagrams, or reference images where applicable.

13. References

1. PROTIMER-Product_Idea_And_Planning