Naphome Phase II Manufacturing Specifications

Document Version: 1.0
Date: October 2025
Target Volume: 10,000 units
BOM Target: $40 (Base) / $55 (Premium)

Executive Summary

Product: Naphome Smart Sleep Device
Architecture: ESP32-S3 + Cloud AI + Custom Audio/Lighting
Manufacturing: Full turnkey production (PCB → Assembly → Housing → QA)
Certification: FCC/CE compliant using pre-certified ESP32-S3 module

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Product Overview

The Naphome is a premium smart sleep companion that combines: -**Voice AI** (cloud-based speech recognition and response) - **Premium Audio** (ND65/ND90 stereo speakers with passive radiators) - **Dynamic RGB Lighting** (circadian lighting with 10-16 WS2812B LEDs) - **Environmental Sensing** (6 sensors for bedroom optimization) -**IoT Control** (IR blaster for AC/TV control)

Technical Specifications

Core Hardware Requirements

Component	Specification	Notes
MCU	ESP32-S3-WROOM-1 (8MB PSRAM)	Pre-certified module (FCC/CE)
Audio Amplifier	TAS5825M (I²S, 2×20W)	TI digital amplifier
Speakers	ND65 (Base) / ND90 (Premium) + Passive Radiators	Dual acoustic chambers
Microphones	2-3× Digital I²S MEMS	Far-field, noise-canceling
RGB LEDs	10× WS2812B (Base) / 16× WS2812B (Premium) in ring configuration	Addressable, 5V
Display	256×64 OLED (SSD1322 or equivalent)	SPI interface, 3.3V
Power	USB-C PD 12V + Li-ion backup	2-3 hours battery runtime
Connectivity	Wi-Fi 2.4GHz + BLE	Dual-band support

Sensor Suite (6 Total)

Sensor	Part Number	Interface	Purpose
Temperature/Humidity	SHTC3	I²C	Environmental monitoring
VOC/CO_2	SGP30 (Base) / SCD41 (Premium)	I²C	Air quality
Ambient Light	VEML7700	I²C	Circadian lighting control
PM2.5 Air Quality	PMS5003	UART	Air quality monitoring
Sound Level	MEMS Microphone	Analog	Noise monitoring

Sensor	Part Number	Interface	Purpose
Display	256×64 OLED (SSD1322)	SPI	Status, time, visual feedback
IR Transmitter	Custom IR LED + Driver	GPIO	IoT device control

Audio Specifications

Parameter	Base SKU	Premium SKU
Drivers	ND65 + Passive Radiators	ND90 + Passive Radiators
Frequency Response	60Hz - 20kHz	50Hz - 20kHz
THD	<1% @ 1W	<0.5% @ 1W
Sensitivity	85dB @ 1W/1m	88dB @ 1W/1m
Power Handling	2×10W RMS	2×20W RMS
Acoustic Design	Dual chamber, ported	Dual chamber, tuned
LED Ring	10× WS2812B in ring configuration	16× WS2812B in ring configuration

RGB Lighting Specifications

Parameter	Base SKU	Premium SKU
LED Count	10× WS2812B	16× WS2812B
Power	5V, 0.3W per LED	5V, 0.3W per LED
Diffusion	Frosted acrylic dome	Enhanced diffuser + light pipe
Control	ESP32-S3 PWM	ESP32-S3 PWM
Configuration	Ring layout around device perimeter	Ring layout with enhanced spacing
Features	Circadian lighting, visual feedback	Enhanced diffusion, color accuracy

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Mechanical Specifications

Enclosure Requirements

Parameter	Specification
Material	PC/ABS blend (UL94 V-0)
Dimensions	~150×150×200mm (TBD)
Weight	<1.5kg
Finish	Matte white/black, soft-touch
Assembly	Snap-fit + screws (serviceable)
IP Rating	IP20 (indoor use)

Acoustic Design

Component	Specification
Speaker Enclosure	Dual acoustic chambers, ported
Mic Array	2-3 mics, 120° spacing, acoustic isolation
Vibration Isolation	Rubber feet, internal damping
Thermal Management	Passive cooling, thermal pads

Connectors & Controls

Component	Specification
Power Input	USB-C PD (12V, 3A)

Component	Specification
Touch Controls	3× capacitive touch buttons
Volume Control	Rotary encoder (360°, detented)
Display	256×64 OLED (status, time, feedback)
Status LEDs	Power, Wi-Fi, RGB feedback
Reset Button	Recessed, factory reset

PCB Specifications

Board Requirements

Parameter	Specification
Layers	4-layer PCB
Thickness	1.6mm
Material	FR4, Tg 150°C
Finish	HASL or ENIG
Size	~80×100mm (TBD)
Assembly	SMT + selective hand assembly

Component Placement

Zone	Components
MCU Zone	ESP32-S3, crystal, flash, PSRAM
Audio Zone	TAS5825M, audio connectors, filtering
Sensor Zone	I²C sensors, level shifters, pull-ups
Display Zone	OLED display, SPI interface, level shifters
Power Zone	USB-C controller, buck/boost, battery management
Interface Zone	Connectors, buttons, LEDs

Power Management

Rail	Voltage	Current	Components
VBUS	12V (USB-C PD)	3A	Input from USB-C
VCC_3V3	3.3V	1A	ESP32-S3, sensors
VCC_5V	5V	2A	RGB LEDs, audio amp
VCC_3V3_DISP	3.3V	100mA	OLED display
VBAT	3.7V	2A	Li-ion battery

Testing & Quality Assurance

Electrical Testing

Test	Specification	Method
Power Consumption	<15W @ 12V	Digital multimeter
Display Brightness	100-300 cd/m²	Luminance meter
Audio THD	<1% @ 1W	Audio analyzer
Wi-Fi Range	>30m @ 2.4GHz	RF chamber
Battery Runtime	>2 hours	Load testing

Test	Specification	Method
Sensor Accuracy	±2% (temp), ±5% (humidity)	Calibrated references

Acoustic Testing

Test	Specification	Method
Frequency Response	60Hz-20kHz (Base), 50Hz-20kHz (Premium)	Anechoic chamber
Wake Word Detection	>95% @ 3m, 60dB ambient	Controlled environment
Microphone Sensitivity	-26dBV @ 1kHz	Audio analyzer
Audio Latency	<100ms (cloud round-trip)	Network testing

Environmental Testing

Test	Condition	Duration	Pass Criteria
Temperature	-10°C to +50°C	24h	Full functionality
Humidity	10% to 90% RH	24h	No condensation
Vibration	5-500Hz, 1g	2h	No mechanical failure
Drop Test	1m onto concrete	3 drops	Cosmetic damage only

RGB Lighting Testing

Test	Specification	Method
Color Accuracy	CRI >90	Spectrophotometer
Brightness	100-1000 lux @ 1m	Lux meter
Diffusion	Uniform light distribution	Visual inspection
Power Consumption	<3W @ full brightness	Power meter

Display Testing

Test	Specification	Method
Resolution	256×64 pixels	Visual inspection
Contrast Ratio	>1000:1	Contrast meter
Viewing Angle	>160° horizontal, >120° vertical	Goniometer
Response Time	<1ms	Oscilloscope
Power Consumption	<50mW @ full brightness	Power meter

Packaging & Labeling

Packaging Requirements

Component	Specification
Box Material	Recycled cardboard, FSC certified
Box Size	~200×200×250mm
Protection	EPE foam inserts
Accessories	USB-C cable, quick start guide
Labels	FCC/CE marks, model number, serial

Documentation

Document	Language	Content
Quick Start Guide	English	Setup, Wi-Fi, basic usage
User Manual	English	Full feature documentation
Safety Information	English	Warnings, disposal, compliance
Warranty Card	English	1-year limited warranty

🇦🇱 Manufacturing Process

Production Flow

1. **PCB Assembly**
   - SMT placement (pick & place)
   - Reflow soldering
   - AOI inspection
   - ICT testing
2. **Audio Assembly**
   - Speaker mounting
   - Acoustic chamber assembly
   - Microphone array installation
   - Audio testing
3. **Sensor Integration**
   - Sensor mounting
   - Cable routing
   - Calibration
   - Functional testing
4. **Final Assembly**
   - PCB installation
   - Enclosure assembly
   - Button/control installation
   - Final testing
5. **Quality Control**
   - Electrical testing
   - Acoustic testing
   - Environmental testing
   - Packaging

Yield Targets

Stage	Target Yield	Action if Below
PCB Assembly	>98%	Rework/replace
Audio Assembly	>95%	Recalibrate
Final Assembly	>97%	Process improvement
Final Testing	>99%	Root cause analysis

🇦🇱 Cost Targets & BOM

Base SKU BOM Target: $40

Category	Cost	Components
MCU & Audio	$15	ESP32-S3, TAS5825M, ND65 speakers
Sensors	$8	SHTC3, SGP30, VEML7700, PMS5003, MEMS mic
Lighting	$5	10× WS2812B, diffuser, driver
Display	$2	256×64 OLED, driver, mounting
Mechanical	$8	Enclosure, buttons, connectors
Power	$4	USB-C, battery, power management

Category	Cost	Components
Total	**$40**	

Premium SKU BOM Target: $55

Category	Cost	Components
MCU & Audio	$20	ESP32-S3, TAS5825M, ND90 speakers
Sensors	$12	SHTC3, SGP30, SCD41, VEML7700, PMS5003, MEMS mic
Lighting	$8	16× WS2812B, enhanced diffuser, light pipe
Display	$2	256×64 OLED, driver, mounting
Mechanical	$10	Enhanced enclosure, premium buttons
Power	$5	Enhanced power management
Total	**$55**	

Compliance & Certification

Required Certifications

Standard	Scope	Method
FCC Part 15	RF emissions	Pre-certified ESP32-S3 module
CE EMC	Electromagnetic compatibility	Declaration of Conformity
CE LVD	Low voltage directive	Internal testing
RoHS	Restriction of hazardous substances	Material declaration
REACH	Chemical safety	Material declaration

Testing Requirements

Test	Standard	Pass Criteria
RF Emissions	FCC Part 15 Class B	< FCC limits
RF Immunity	IEC 61000-4-3	No degradation
ESD	IEC 61000-4-2	±8kV contact, ±15kV air
Surge	IEC 61000-4-5	±2kV differential

Timeline & Milestones

Phase II Production Timeline

Milestone	Duration	Deliverables
Tooling	8 weeks	Injection molds, test fixtures
EVT	4 weeks	Engineering validation units
DVT	6 weeks	Design validation, acoustic tuning
PVT	4 weeks	500-unit pilot run
MP	16 weeks	10,000 units production

Key Deliverables

Phase	Deliverable	Quantity
EVT	Engineering samples	50 units

Phase	Deliverable	Quantity
DVT	Design validation	200 units
PVT	Production validation	500 units
MP	Mass production	10,000 units

🆎 Contact Information

Technical Lead

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Services: Hardware design, firmware development, manufacturing liaison

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🆎 Notes & Assumptions

Key Assumptions

- ESP32-S3-WROOM-1 module is pre-certified (FCC/CE)
- 10,000 unit minimum order quantity
- 12-month production timeline
- Standard payment terms (30% deposit, 70% on delivery)
- 1-year warranty on all components

Risk Mitigation

- Multiple supplier options for critical components
- Pre-production validation at each phase
- Comprehensive testing and quality control
- Experienced manufacturing partners with IoT device experience

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Document Status: Ready for manufacturer review and quotation
Next Steps: RFQ distribution, NDA execution, technical discussions