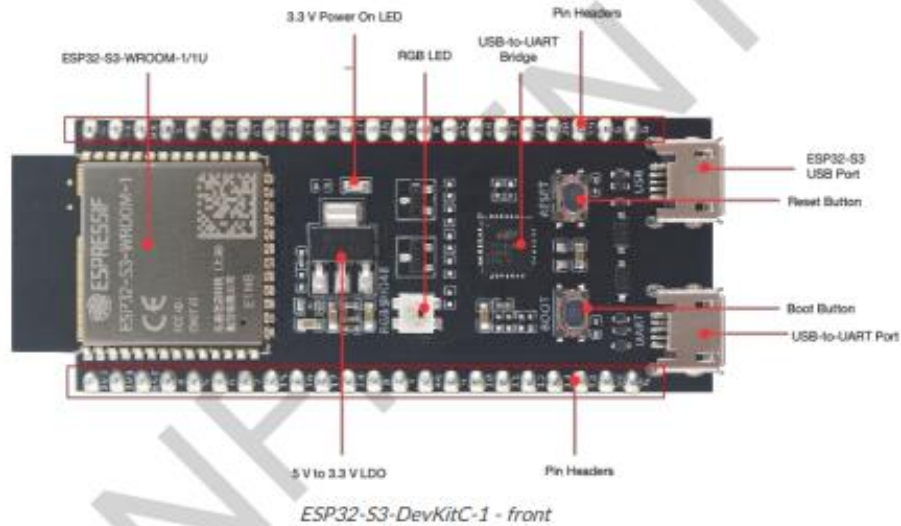


LAMPIRAN

Lampiran 1 Datasheet ESP32-S3

Description of Components



The key components of the board are described in a counter-clockwise direction.

Key Component	Description
ESP32-S3-WROOM-1/1U	ESP32-S3-WROOM-1 and ESP32-S3-WROOM-1U are two powerful, generic Wi-Fi + Bluetooth LE MCU modules that have a rich set of peripherals. They provide acceleration for neural network computing and signal processing workloads.
5 V to 3.3 V LDO	Power regulator that converts a 5 V supply into a 3.3 V output.
Pin Headers	All available GPIO pins (except for the SPI bus for flash) are broken out to the pin headers on the board for easy interfacing and programming. For details, please see Header Block .

Key Component	Description
USB-to-UART Port	A Micro-USB port used for power supply to the board, as well as the communication with the ESP32-S3 chip via the on-board USB-to-UART bridge.
Boot Button	Download button. Holding down Boot and then pressing Reset initiates Firmware Download mode for downloading firmware through the serial port.
Reset Button	Press this button to restart the system.
ESP32-S3 USB Port	ESP32-S3 full-speed USB OTG interface, compliant with the USB 1.1 specification.
USB-to-UART Bridge	Single USB-to-UART bridge chip provides transfer rates up to 3 Mbps.
RGB LED	Addressable RGB LED, driven by GPIO48.
3.3 V Power On LED	Turns on when the USB power is connected to the board.

Lampiran 2 Datasheet NX4827P043-011C

Caution:

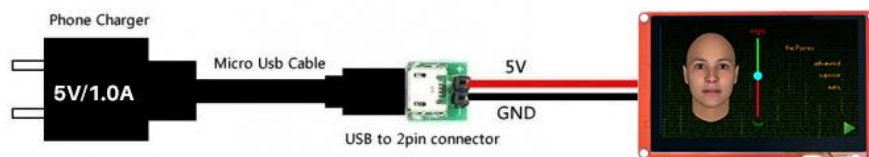
Working under insufficient power supply condition will damage the Nextion model easily.



Blurred screen? Flashing? You may be suffering from power shortages. Power off at the first possible moment. No more repeated attempts to damage your Nextion model.

A small connector is included in the package. Please try to power Nextion with your phone charger through the connector to check if Nextion works well.

A high quality usb cable is required.



Nextion Models

Nextion Type	Intelligent Series
Nextion Models	NX4827P043-011C (4.3 inch capacitive touchscreen without enclosure)

Specifications

	Data	Description
Color	65K 65536 colors	16 bit 565, 5R-6G-5B
Layout size	120mm(L)×74mm(W)×6.6mm(H)	NX4827P043-011C
Visual Area (V.A.)	105.50mm(L)×67.20mm(W)	
Active Area (A.A.)	95.04mm(L)×53.86mm(W)	
Resolution	480×272 pixel	Also can be set as 272×480
Touch type	Capacitive	
Touches	> 1 million	
Backlight	LED	
Backlight lifetime (Average)	>30,000 Hours	
Brightness	300nit	0% to 100%, the interval of adjustment is 1%
Weight	111g	

Interfaces Performance

	Test Conditions	Min	Typical	Max	Unit
Serial Port Baudrate	Standard	2400	9600	921600	bps
Output High Voltage (TXD)	I _{OH} =1mA	3.0	5.0	V _{in}	V
Output Low Voltage(TXD)	I _{OL} =1mA		0.1	0.2	V
Input High Voltage(RXD)		3.0	5.0	V _{in}	V
Input Low Voltage(RXD)		-0.7	0.0	1.3	V
Serial Port Mode	TTL (Rx:3.3V/Tx:5.0V)				
Serial Port	4Pin_2.54mm				
USB interface	NO				
SD card socket	Yes (FAT32 format), support maximum 32G Micro SD Card * presence of *.tft file on microSD: socket is exclusive to upgrade Nextion firmware/HMI design * Intelligent Series only: see Instruction Set / Editor Guide for microSD card runtime usage				
Extended IO	8 Digital extended GPIO I ₀₀ -I ₀₇ support input, output and component binding event (3.3V) * IO pin / ports are not exclusive, limit current draw to 1mA recommended I ₀₆ -I ₀₇ support PWM				
RTC	built-in RTC support (Battery type: CR1220)				

V_{in}: the input voltage of power supply

Electronic Characteristics

	Test Conditions	Min	Typical	Max	Unit
Operating Voltage		4.65	5	6.5	V
Operating Current	VCC=5V, Brightness is 100%	-	220	-	mA
	SLEEP Mode	-	170	-	mA

Power supply recommend: 5V, 1.0A, DC

Memory Features

Memory Type	Test Conditions	Min	Typical	Max	Unit
FLASH Memory	Store fonts and images			120	MB
User Storage	EEPROM			1024	BYTE
RAM Memory	Store variables			512	KB
Instruction Buffer	Instruction Buffer			4096	BYTE

Working Environment & Reliability Parameter

	Test Conditions	Min	Typical	Max	Unit
Working Temperature	5V, Humidity 60%	-20	25	70	°C
Storage Temperature		-30	25	85	°C
Working Humidity	25°C	10%	60%	90%	RH

Audio Features

Speaker	Parameter	Min	Typical	Max	Unit
Power	-	0.5	-	1.5	W

Audio Connector Type: 1.25T-2-2A (1.25mm pitch 2-pin housing)

* NX4827P043-011C do not have speaker in the package.

Lampiran 3 Hasil Pengujian RTT Start/Stop QoS 0

24/07/2026, 16:28:24 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 405, cmd: "RUNNING" }
24/07/2026, 16:28:26 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 363, cmd: "STOP" }
24/07/2026, 16:28:28 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 400, cmd: "RUNNING" }
24/07/2026, 16:28:30 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 357, cmd: "STOP" }
24/07/2026, 16:28:32 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 385, cmd: "RUNNING" }
24/07/2026, 16:28:35 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 364, cmd: "STOP" }
24/07/2026, 16:28:37 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 352, cmd: "RUNNING" }
24/07/2026, 16:28:40 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 359, cmd: "STOP" }
24/07/2026, 16:28:42 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 408, cmd: "RUNNING" }
24/07/2026, 16:28:44 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ▶ { rtt_ms: 363, cmd: "STOP" }

Lampiran 4 Hasil Pengujian RTT Start/Stop QoS 1

24/07/2026, 16:30:08 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 366, cmd: "RUNNING" }
24/07/2026, 16:30:10 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 351, cmd: "STOP" }
24/07/2026, 16:30:13 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 389, cmd: "RUNNING" }
24/07/2026, 16:30:15 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 376, cmd: "STOP" }
24/07/2026, 16:30:21 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 482, cmd: "RUNNING" }
24/07/2026, 16:30:24 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 372, cmd: "STOP" }
24/07/2026, 16:30:27 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 414, cmd: "RUNNING" }
24/07/2026, 16:30:30 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 413, cmd: "STOP" }
24/07/2026, 16:30:32 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 354, cmd: "RUNNING" }
24/07/2026, 16:30:34 node: debug 3 /esp32-mqtt/status_sistem : msg.payload : Object ‣ { rtt_ms: 328, cmd: "STOP" }

Lampiran 5 Hasil Pengujian RTT Start/Stop QoS 2

24/07/2026, 17:34:31	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 394, cmd: "RUNNING" }	
24/07/2026, 17:34:32	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 354, cmd: "STOP" }	
24/07/2026, 17:34:34	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 394, cmd: "RUNNING" }	
24/07/2026, 17:34:36	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 398, cmd: "STOP" }	
24/07/2026, 17:34:37	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 390, cmd: "RUNNING" }	
24/07/2026, 17:34:38	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 407, cmd: "STOP" }	
24/07/2026, 17:34:40	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 373, cmd: "RUNNING" }	
24/07/2026, 17:34:41	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 351, cmd: "STOP" }	
24/07/2026, 17:34:43	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 347, cmd: "RUNNING" }	
24/07/2026, 17:34:44	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
▶ { rtt_ms: 405, cmd: "STOP" }	

Lampiran 6 Hasil Pengujian RTT Slider QoS 0

24/07/2026, 16:16:16	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 305, cmd: 98 }
24/07/2026, 16:16:41	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 2836, cmd: 184 }
24/07/2026, 16:16:46	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 2293, cmd: 274 }
24/07/2026, 16:16:51	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 2157, cmd: 407 }
24/07/2026, 16:16:56	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 1812, cmd: 526 }
24/07/2026, 16:17:01	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 2108, cmd: 628 }
24/07/2026, 16:17:06	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 1797, cmd: 726 }
24/07/2026, 16:17:11	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 2561, cmd: 820 }
24/07/2026, 16:17:16	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 3262, cmd: 905 }
24/07/2026, 16:17:21	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	▶ { rtt_ms: 3579, cmd: 967 }

Lampiran 7 Hasil Pengujian RTT Slider QoS 1

24/07/2026, 16:18:36	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 2815, cmd: 93 }
24/07/2026, 16:18:41	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3354, cmd: 160 }
24/07/2026, 16:18:46	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 2902, cmd: 258 }
24/07/2026, 16:18:51	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3078, cmd: 363 }
24/07/2026, 16:18:56	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 2288, cmd: 481 }
24/07/2026, 16:19:01	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3379, cmd: 604 }
24/07/2026, 16:19:06	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 2798, cmd: 704 }
24/07/2026, 16:19:11	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3678, cmd: 807 }
24/07/2026, 16:19:16	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3482, cmd: 896 }
24/07/2026, 16:19:21	node: debug 3	/esp32-mqtt/status_sistem : msg.payload : Object	» { rtt_ms: 3370, cmd: 981 }

Lampiran 8 Hasil Pengujian RTT Slider QoS 2

24/07/2026, 16:20:32	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 1960, cmd: 104 }	
24/07/2026, 16:20:37	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 2874, cmd: 175 }	
24/07/2026, 16:20:42	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3479, cmd: 289 }	
24/07/2026, 16:20:47	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3346, cmd: 390 }	
24/07/2026, 16:20:52	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3333, cmd: 514 }	
24/07/2026, 16:20:57	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3548, cmd: 619 }	
24/07/2026, 16:21:02	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3552, cmd: 729 }	
24/07/2026, 16:21:07	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3420, cmd: 825 }	
24/07/2026, 16:21:12	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3285, cmd: 907 }	
24/07/2026, 16:21:17	node: debug 3
/esp32-mqtt/status_sistem : msg.payload : Object	
» { rtt_ms: 3580, cmd: 987 }	

Lampiran 9 Hasil Pengujian Jitter Monitoring Data Suhu QoS 0

```

16/08/2026, 18:51:59 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 114.5, cycle_interval_ms: null,
    timestamp: "2026-08-16T18:51:59.707+07:00" }

16/08/2026, 18:52:10 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 113, cycle_interval_ms: 10449,
    timestamp: "2026-08-16T18:52:10.156+07:00" }

16/08/2026, 18:52:20 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 112.75, cycle_interval_ms: 9835,
    timestamp: "2026-08-16T18:52:19.991+07:00" }

16/08/2026, 18:52:29 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 112.75, cycle_interval_ms: 9817,
    timestamp: "2026-08-16T18:52:29.808+07:00" }

16/08/2026, 18:52:40 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 113, cycle_interval_ms: 10139,
    timestamp: "2026-08-16T18:52:39.947+07:00" }

16/08/2026, 18:52:49 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 115, cycle_interval_ms: 9834,
    timestamp: "2026-08-16T18:52:49.781+07:00" }

16/08/2026, 18:52:59 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 117.5, cycle_interval_ms: 10136,
    timestamp: "2026-08-16T18:52:59.917+07:00" }

16/08/2026, 18:53:09 node: debug 1
/esp32-mqtt/temp : msg.payload : Object

```

Lampiran 10 Hasil Pengujian Jitter Monitoring Data Suhu QoS 1

```

16/08/2026, 18:56:00 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 138.5, cycle_interval_ms: null,
    timestamp: "2026-08-16T18:55:59.951+07:00" }

16/08/2026, 18:56:10 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 137.75, cycle_interval_ms: 10433,
    timestamp: "2026-08-16T18:56:10.384+07:00" }

16/08/2026, 18:56:19 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 137, cycle_interval_ms: 9330,
    timestamp: "2026-08-16T18:56:19.714+07:00" }

16/08/2026, 18:56:29 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 137, cycle_interval_ms: 10019,
    timestamp: "2026-08-16T18:56:29.733+07:00" }

16/08/2026, 18:56:39 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 137.25, cycle_interval_ms: 10024,
    timestamp: "2026-08-16T18:56:39.757+07:00" }

16/08/2026, 18:56:49 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 138, cycle_interval_ms: 9988,
    timestamp: "2026-08-16T18:56:49.745+07:00" }

16/08/2026, 18:56:59 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  ▶ { temp: 139, cycle_interval_ms: 10009,
    timestamp: "2026-08-16T18:56:59.754+07:00" }

16/08/2026, 18:57:09 node: debug 1
/esp32-mqtt/temp : msg.payload : Object

```

Lampiran 11 Hasil Pengujian Jitter Monitoring Data Suhu QoS 2

```

16/08/2026, 18:58:44 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 146.75, cycle_interval_ms: null,
    timestamp: "2026-08-16T18:58:44.892+07:00" }

16/08/2026, 18:58:55 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 146, cycle_interval_ms: 10148,
    timestamp: "2026-08-16T18:58:55.040+07:00" }

16/08/2026, 18:59:04 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 146.5, cycle_interval_ms: 9629,
    timestamp: "2026-08-16T18:59:04.669+07:00" }

16/08/2026, 18:59:14 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 146.5, cycle_interval_ms: 10022,
    timestamp: "2026-08-16T18:59:14.691+07:00" }

16/08/2026, 18:59:24 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 146.75, cycle_interval_ms: 10010,
    timestamp: "2026-08-16T18:59:24.701+07:00" }

16/08/2026, 18:59:35 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 147.5, cycle_interval_ms: 10262,
    timestamp: "2026-08-16T18:59:34.963+07:00" }

16/08/2026, 18:59:44 node: debug 1
/esp32-mqtt/temp : msg.payload : Object
  { temp: 148.25, cycle_interval_ms: 9758,
    timestamp: "2026-08-16T18:59:44.721+07:00" }

```

Lampiran 12 Standarisasi Delay TIPHON

Table 5. TYPHON Standard on Delay

Category Delay	Large Latency (ms)	Index
Very Good	<150 ms	4
Good	150 ms s/d 300 ms	3
Medium	300 ms s/d 450 ms	2
Bad	> 450 ms	1

Lampiran 13 Standarisasi Jitter TIPHON

Kategori Jitter	Jitter	Indeks
Sangat Bagus	0 ms	4
Bagus	0 - 75 ms	3
Sedang	75 - 125 ms	2
Buruk	125 - 225 ms	1