LAMPIRAN

Lampiran 1 Data Sheet Sensor MAX30100

EVALUATION KIT AVAILABLE

MAX30100

Pulse Oximeter and Heart-Rate Sensor IC for Wearable Health

General Description

The MAX30100 is an integrated pulse oximetry and heart-rate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.

The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

Applications

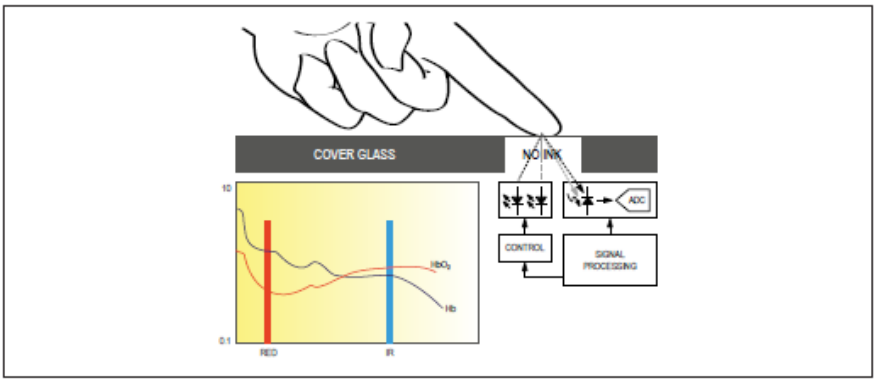
- Wearable Devices
- Fitness Assistant Devices
- Medical Monitoring Devices

Benefits and Features

- Complete Pulse Oximeter and Heart-Rate Sensor Solution Simplifies Design
  - Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
  - Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
  - Programmable Sample Rate and LED Current for Power Savings
  - Ultra-Low Shutdown Current (0.7µA, typ)
- Advanced Functionality Improves Measurement Performance
  - High SNR Provides Robust Motion Artifact Resilience
  - Integrated Ambient Light Cancellation
  - High Sample Rate Capability
  - Fast Data Output Capability

Ordering Information appears at end of data sheet.

System Block Diagram



19-7065; Rev 0; 9/14

maxim integrated™

Absolute Maximum Ratings

V_{DD} to GND .....-0.3V to +2.2V
GND to PGND .....-0.3V to +0.3V
x_DRV, x_LED+ to PGND .....-0.3V to +6.0V
All Other Pins to GND .....-0.3V to +6.0V
Output Short-Circuit Current Duration .....Continuous
Continuous Input Current into Any Terminal .....±20mA

Continuous Power Dissipation (T_A = +70°C)
OESIP (derate 5.8mW/°C above +70°C) 464mW
Operating Temperature Range ..... -40°C to +85°C
Soldering Temperature (reflow) .....+260°C
Storage Temperature Range ..... -40°C to +105°C

Package Thermal Characteristics (Note 1)

OESIP
Junction-to-Ambient Thermal Resistance (θ_{JA}) .....150°C/W
Junction-to-Case Thermal Resistance (θ_{JC}) .....170°C/W

Note 1: Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to www.maximintegrated.com/thermal-tutorial.

Electrical Characteristics

(V_{DD} = 1.8V, V_{IR_LED+} = V_{R_LED+} = 3.3V, T_A = +25°C, min/max are from T_A = -40°C to +85°C, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
POWER SUPPLY							
Power-Supply Voltage	V_{DD}	Guaranteed by RED and IR count tolerance		1.7	1.8	2.0	V
LED Supply Voltage (R_LED+ or IR_LED+ to PGND)	V_{LED+}	Guaranteed by PSRR of LED Driver		3.1	3.3	5.0	V
Supply Current	I_{DD}	SpO_2 and heart rate modes, PW = 200µs, 50sps			600	1200	µA
		Heart rate only mode, PW = 200µs, 50sps			600	1200	
Supply Current in Shutdown	I_{SHDN}	T_A = +25°C, MODE = 0x80			0.7	10	µA
SENSOR CHARACTERISTICS							
ADC Resolution					14		bits
Red ADC Count (Note 3)	RED_C	Propriety ATE setup RED_PA = 0x05, LED_PW = 0x00, SPO2_SR = 0x07, T_A = +25°C		23,000	26,000	29,000	Counts
IR ADC Count (Note 3)	IR_C	Propriety ATE setup IR_PA = 0x09, LED_PW = 0x00, SPO2_SR = 0x07, T_A = +25°C		23,000	26,000	29,000	Counts
Dark Current Count	DC_C	RED_PA = IR_PA = 0x00, LED_PW = 0x03, SPO2_SR = 0x01			0	3	Counts
DC Ambient Light Rejection (Note 4)	ALR	Number of ADC counts with finger on sensor under direct sunlight (100K lux) LED_PW = 0x03, SPO2_SR = 0x01	RED LED		0		Counts
			IR LED		0		

Electrical Characteristics (continued)

(V_{DD} = 1.8V, V_{IR_LED+} = V_{R_LED+} = 3.3V, T_A = +25°C, min/max are from T_A = -40°C to +85°C, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
IR ADC Count—PSRR (V_{DD})	$PSRR_{VDD}$	Propriety ATE setup 1.7V < V_{DD} < 2.0V, LED_PW = 0x03, SPO2_SR = 0x01, IR_PA = 0x09, IR_PA = 0x05, T_A = +25°C		0.25	2	%
		Frequency = DC to 100kHz, 100mV_{p-p}		10		LSB
RED/IR ADC Count—PSRR (X_LED+)	$PSRR_{LED}$	Propriety ATE setup 3.1V < X_LED+ < 5V, LED_PW = 0x03, SPO2_SR = 0x01, IR_PA = 0x09, IR_PA = 0x05, T_A = +25°C		0.05	2	%
		Frequency = DC to 100kHz, 100mV_{p-p}		10		LSB
ADC Integration Time	INT	LED_PW = 0x00		200		µs
		LED_PW = 0x03		1600		µs
IR LED CHARACTERISTICS (Note 4)						
LED Peak Wavelength	λ_P	I_{LED} = 20mA, T_A = +25°C	870	880	900	nm
Full Width at Half Max	$\Delta\lambda$	I_{LED} = 20mA, T_A = +25°C		30		nm
Forward Voltage	V_F	I_{LED} = 20mA, T_A = +25°C		1.4		V
Radiant Power	P_O	I_{LED} = 20mA, T_A = +25°C		6.5		mW
RED LED CHARACTERISTICS (Note 4)						
LED Peak Wavelength	λ_P	I_{LED} = 20mA, T_A = +25°C	650	660	670	nm
Full Width at Half Max	$\Delta\lambda$	I_{LED} = 20mA, T_A = +25°C		20		nm
Forward Voltage	V_F	I_{LED} = 20mA, T_A = +25°C		2.1		V
Radiant Power	P_O	I_{LED} = 20mA, T_A = +25°C		9.8		mW
TEMPERATURE SENSOR						
Temperature ADC Acquisition Time	T_T	T_A = +25°C		29		ms
Temperature Sensor Accuracy	T_A	T_A = +25°C		±1		°C
Temperature Sensor Minimum Range	T_{MIN}			-40		°C
Temperature Sensor Maximum Range	T_{MAX}			85		°C

Electrical Characteristics (continued)

(V_{DD} = 1.8V, V_{IR_LED+} = V_{R_LED+} = 3.3V, T_A = +25°C, min/max are from T_A = -40°C to +85°C, unless otherwise noted.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
DIGITAL CHARACTERISTICS (SDA, SDA, $\overline{INT}$)						
Output Low Voltage SDA, $\overline{INT}$	V_{OL}	I_{SINK} = 6mA			0.4	V
I²C Input Voltage Low	V_{IL_I2C}	SDA, SCL			0.4	V
I²C Input Voltage High	V_{IH_I2C}	SDA, SCL	1.4			V
Input Hysteresis	V_{HYS}	SDA, SCL		200		mV
Input Capacitance	C_{IN}	SDA, SCL		10		pF
Input Leakage Current	I_{IN}	V_{IN} = 0V, T_A = +25°C (SDA, SCL, INT)		0.01	1	µA
		V_{IN} = 5.5V, T_A = +25°C (SDA, SCL, INT)		0.01	1	µA
I²C TIMING CHARACTERISTICS (SDA, SDA, $\overline{INT}$)						
I²C Write Address				AE		Hex
I²C Read Address				AF		Hex
Serial Clock Frequency	f_{SCL}		0		400	kHz
Bus Free Time Between STOP and START Conditions	t_{BUF}		1.3			µs
Hold Time (Repeated) START Condition	$t_{HD,START}$		0.6			µs
SCL Pulse-Width Low	t_{LOW}		1.3			µs
SCL Pulse-Width High	t_{HIGH}		0.6			µs
Setup Time for a Repeated START Condition	$t_{SU,START}$		0.6			µs
Data Hold Time	$t_{HD,DAT}$		0		900	ns
Data Setup Time	$t_{SU,DAT}$		100			ns
Setup Time for STOP Condition	$t_{SU,STOP}$		0.6			µs
Pulse Width of Suppressed Spike	t_{SP}		0		50	ns
Bus Capacitance	C_B				400	pF
SDA and SCL Receiving Rise Time	t_R		20 + 0.1C_B		300	ns
SDA and SCL Receiving Fall Time	t_{RF}		20 + 0.1C_B		300	ns
SDA Transmitting Fall Time	t_{TF}		20 + 0.1C_B		300	ns

Note 2: All devices are 100% production tested at T_A = +25°C. Specifications over temperature limits are guaranteed by Maxim Integrated's bench or proprietary automated test equipment (ATE) characterization.

Note 3: Specifications are guaranteed by Maxim Integrated's bench characterization and by 100% production test using proprietary ATE setup and conditions.

Note 4: For design guidance only. Not production tested.

Lampiran 2 Data Sheet Sensor GY-906 (MLX90614)

MLX90614 family

Datasheet Single and Dual Zone
Infra Red Thermometer in TO-39

Melexis
INSPIRED ENGINEERING

Features and Benefits

- Small size, low cost
- Easy to integrate
- Factory calibrated in wide temperature range:
  -40°C...+125°C for sensor temperature and
  -70°C...+380°C for object temperature.
- High accuracy of 0.5°C in a wide temperature range (0°C...+50°C for both Ta and To)
- High (medical) accuracy calibration
- Measurement resolution of 0.02°C
- Single and dual zone versions
- SMBus compatible digital interface
- Customizable PWM output for continuous reading
- Available in 3V and 5V versions
- Simple adaptation for 8V...16V applications
- Sleep mode for reduced power consumption
- Different package options for applications and measurements versatility
- Automotive grade

Application Examples

- High precision non-contact temperature measurements
- Thermal Comfort sensor for Mobile Air Conditioning control system
- Temperature sensing element for residential, commercial and industrial building air conditioning
- Windshield defogging
- Automotive blind angle detection
- Industrial temperature control of moving parts
- Temperature control in printers and copiers
- Home appliances with temperature control
- Healthcare
- Livestock monitoring
- Movement detection
- Multiple zone temperature control – up to 127 sensors can be read via common 2 wires
- Thermal relay / alert
- Body temperature measurement

Ordering Information

Part No.	Temperature Code	Package Code	- Option Code	Standard part	Packing form
MLX90614	E (-40°C...85°C) K (-40°C...125°C)	SF (TO-39)	- X X X (1) (2) (3)	-000	-TU

(1) Supply Voltage/ Accuracy
A - 5V
B - 3V
C - Reserved
D - 3V medical accuracy

(2) Number of thermopiles:
A – single zone
B – dual zone
C – gradient compensated*

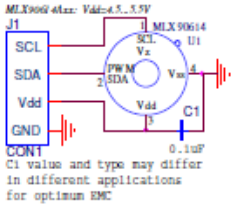
(3) Package options:
A – Standard package
B – Reserved
C – 35° FOV
D/E – Reserved
F – 10° FOV
G – Reserved
H – 12° FOV (refractive lens)
I – 5° FOV
K – 13°FOV

Example:
MLX90614ESF-BAA-000-TU *** : See page 2**

MLX90614 family
Single and Dual Zone
Infra Red Thermometer in TO-39

Melexis

1. Functional diagram



MLX90614 connection to SMBus

Figure 1: Typical application schematics

2. General Description

The MLX90614 is an Infra Red thermometer for non-contact temperature measurements. Both the IR sensitive thermopile detector chip and the signal conditioning ASSP are integrated in the same TO-39 can. Thanks to its low noise amplifier, 17-bit ADC and powerful DSP unit, a high accuracy and resolution of the thermometer is achieved.
The thermometer comes factory calibrated with a digital PWM and SMBus (System Management Bus) output.
As a standard, the 10-bit PWM is configured to continuously transmit the measured temperature in range of -20…120°C, with an output resolution of 0.14°C.
The factory default POR setting is SMBus.

The MLX90614 is built from 2 chips developed and manufactured by Melexis:

- The Infra Red thermopile detector MLX81101
- The signal conditioning ASSP MLX90302, specially designed to process the output of IR sensor.

The device is available in an industry standard TO-39 package.

Thanks to the low noise amplifier, high resolution 17-bit ADC and powerful DSP unit of MLX90302 high accuracy and resolution of the thermometer is achieved. The calculated object and ambient temperatures are available in RAM of MLX90302 with resolution of 0.01°C. They are accessible by 2 wire serial SMBus compatible protocol (0.02°C resolution) or via 10-bit PWM (Pulse Width Modulated) output of the device.

The MLX90614 is factory calibrated in wide temperature ranges: -40°C…125°C for the ambient temperature and -70°C…380°C for the object temperature.

The measured value is the average temperature of all objects in the Field Of View of the sensor. The MLX90614 offers a standard accuracy of ±0.5°C around room temperatures. A special version for medical applications exists offering an accuracy of ±0.2°C in a limited temperature range around the human body temperature.

It is very important for the application designer to understand that these accuracies are only guaranteed and achievable when the sensor is in thermal equilibrium and under isothermal conditions (there are no temperature differences across the sensor package). The accuracy of the thermometer can be influenced by temperature differences in the package induced by causes like (among others): Hot electronics behind the sensor, heaters/coolers behind or beside the sensor or by a hot/cold object very close to the sensor that not only heats the sensing element in the thermometer but also the thermometer package.

This effect is especially relevant for thermometers with a small FOV like the xxC and xxF as the energy received by the sensor from the object is reduced. Therefore, Melexis has introduced the xCx version of the MLX90614. In these MLX90614xCx, the thermal gradients are measured internally and the measured temperature is compensated for them. In this way, the xCx version of the MLX90614 is much less sensitive to thermal gradients, but the effect is not totally eliminated. It is therefore important to avoid the causes of thermal gradients as much as possible or to shield the sensor from them.

As a standard, the MLX90614 is calibrated for an object emissivity of 1. It can be easily customized by the customer for any other emissivity in the range 0.1…1.0 without the need of recalibration with a black body.

The 10-bit PWM is as a standard configured to transmit continuously the measured object temperature for an object temperature range of -20°C…120°C with an output resolution of 0.14°C. The PWM can be easily customized for virtually any range desired by the customer by changing the content of 2 EEPROM cells. This has no effect on the factory calibration of the device.

Lampiran 3 Lembar Bimbingan Pembimbing I

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN
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Judul Tugas Akhir : Sistem Monitoring Detak Jantung dan Suhu Tubuh Pada Anak *Autism Spectrum Disorder* (ASD) Menggunakan *Socially Assistive Robot*

No.	Tanggal	Keterangan	Paraf Pembimbing
1	22 Feb 2023	Pengajuan Judul TA	
2	15 Maret 2023	Pengumpulan Jurnal mengenai Autism, Socially Assistive Robot dan Sensor	
3	29 Maret 2023	Konsultasi BAB 1-3	
4	28 Maret 2023	Revisi BAB 1-3	
5	04 April 2023	Acc BAB 1-3	
6	17 Juni 2023	Acc Sempro	
7	27 Juli 2023	Konsultasi BAB 4-5	
8	04 Agustus 2023	Revisi BAB 4-5	

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LEMBAR BIMBINGAN LAPORAN TUGAS AKHIR

Lembar : 2

No.	Tanggal	Keterangan	Paraf Pembimbing
9	05 Agustus 2023	Acc BAB 4-5	
10	09 Agustus 2023	Acc Laporan TA, Rerondasi Sidang TA	
11			
12			

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Lampiran 4 Lembar Bimbingan Pembimbing II

KEMENTERIAN PENDIDIKAN, KEBUDAYAAN
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Judul Tugas Akhir : Sistem Monitoring Detak Jantung dan Suhu Tubuh Pada Anak *Autism Spectrum Disorder* (ASD) Menggunakan *Socially Assistive Robot*

No.	Tanggal	Keterangan	Paraf Pembimbing
1	10 Februari 2023	Pengajuan judul	
2	24 Februari 2023	Acc judul	
3	10 Maret 2023	Brainstorming (fungsi, tujuan, TA)	
4	6 April 2023	konsultasi Bab 1-3	
5	10 April 2023	konsultasi Bab 4-5, dan Acc Sempro	
6	4 Agustus 2023	Revisi Bab 4-5	
7	7 Agustus 2023	Rekomendasi mengikuti sidang	
8			

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LEMBAR BIMBINGAN LAPORAN TUGAS AKHIR

Lembar : 2

No.	Tanggal	Keterangan	Paraf Pembimbing
9			
10			
11			
12			

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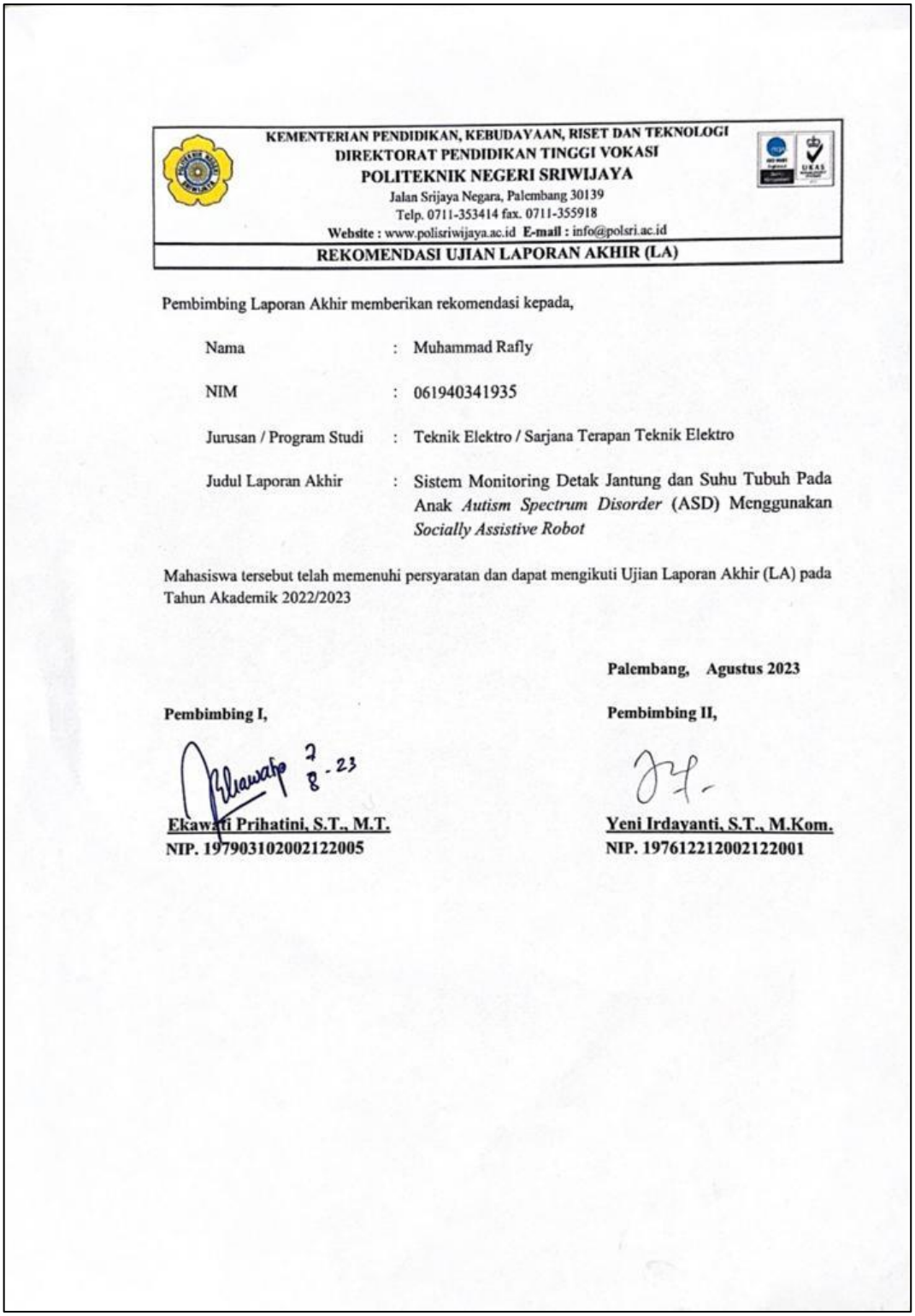
Lampiran 5 Lembar Rekomendasi Ujian Laporan Akhir



KEMENTERIAN PENDIDIKAN, KEBUDAYAAN, RISET DAN TEKNOLOGI
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REKOMENDASI UJIAN LAPORAN AKHIR (LA)

Pembimbing Laporan Akhir memberikan rekomendasi kepada,

Nama	:	Muhammad Rafly
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Judul Laporan Akhir	:	Sistem Monitoring Detak Jantung dan Suhu Tubuh Pada Anak *Autism Spectrum Disorder* (ASD) Menggunakan *Socially Assistive Robot*

Mahasiswa tersebut telah memenuhi persyaratan dan dapat mengikuti Ujian Laporan Akhir (LA) pada Tahun Akademik 2022/2023

Palembang, Agustus 2023

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Lampiran 6 Lembar Revisi Laporan Tugas Akhir

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PELAKSANAAN REVISI LAPORAN TUGAS AKHIR

Mahasiswa berikut,

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Judul Laporan Tugas Akhir	:	Sistem Monitoring Detak Jantung Dan Suhu Tubuh Pada Anak *Autism Spectrum Disorder* (ASD) Menggunakan *Socially Assitive Robot*

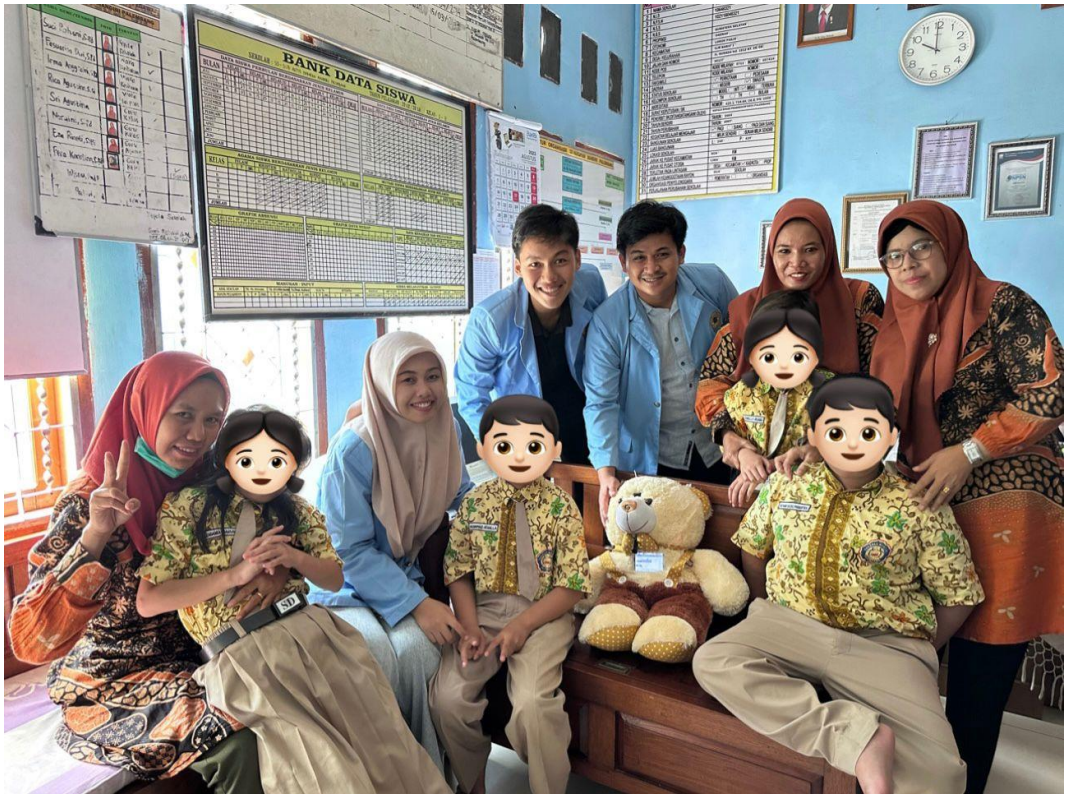
Telah melaksanakan revisi terhadap Laporan Tugas Akhir yang diujikan pada hari Kamis tanggal 10 bulan Agustus tahun 2023 Pelaksanaan revisi terhadap Laporan Tugas Akhir tersebut telah disetujui oleh Dosen Penguji yang memberikan revisi:

No.	Komentar	Nama Dosen Penguji	Tanggal	Tanda Tangan
1.	ACC	Ir. A. Rahman, M.T.	21/8-23	
2.	ACC	Evelina, S.T., M.Kom.	21/8/23	
3.	ACC	Ekawati Prihatini, S.T., M.T.	16/8/23	
4.	ACC/ACC/ACC	Abdurrahman, S.T., M.Kom.	16/8/2023	
5.	ACC	Johansyah Al Rasyid, S.T., M.Kom	21/8/2023	

Palembang, 21 Agustus 2023
Ketua Penguji,

(Ir. A. Rahman, M.T.)
NIP 196202051993031002

Lampiran 7 Foto Dokumentasi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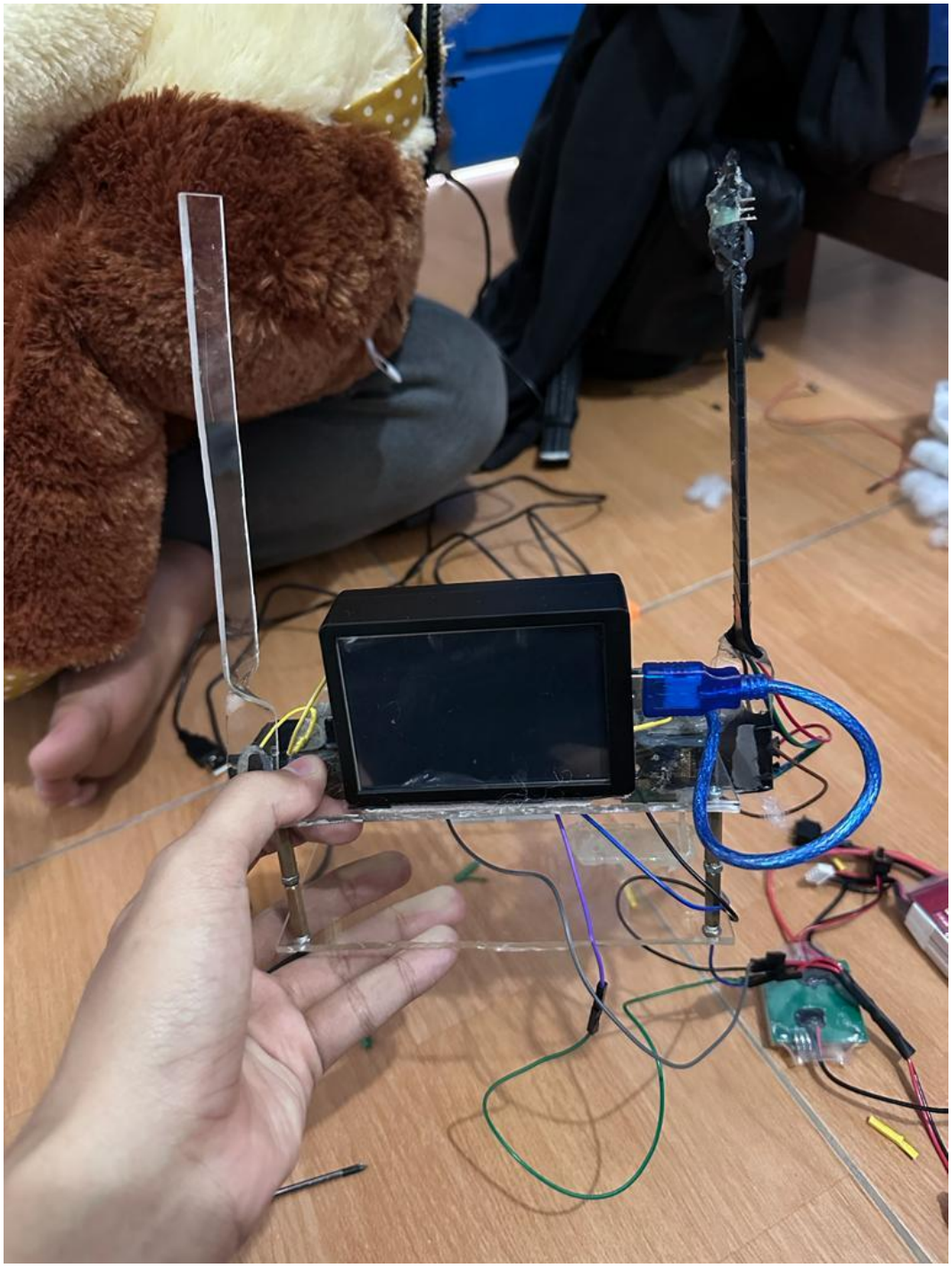

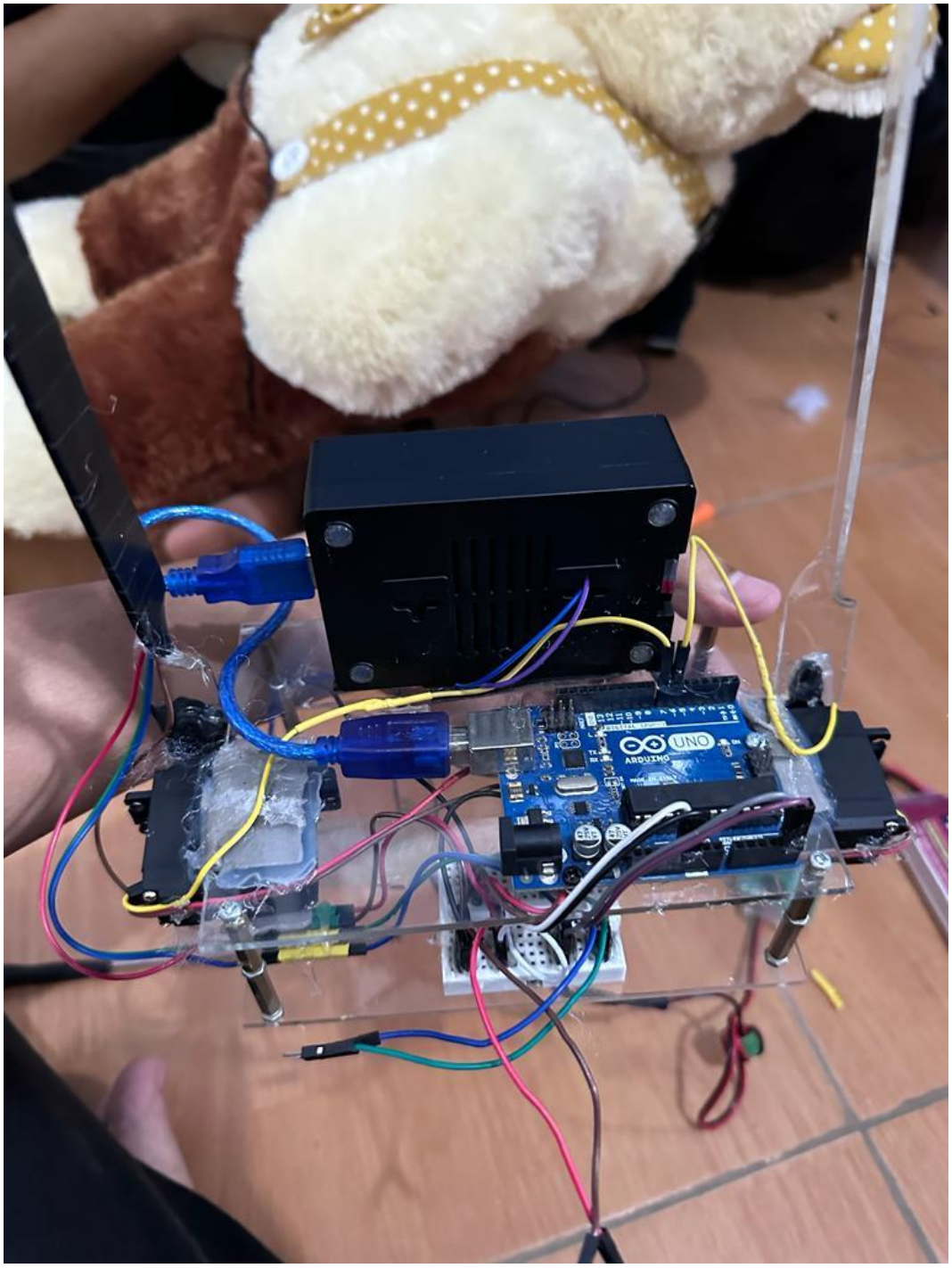
UNO
ARDUINO