BAB V
SIMPULAN DAN SARAN

A. Simpulan

Berdasarkan hasil rancang bangun, pengujian operasional, serta analisis data yang telah diuraikan pada bab-bab sebelumnya, penelitian ini telah berhasil merealisasikan *prototype* sistem kontrol otomatis dan pemantauan jarak jauh berbasis *Internet of Things* (IoT) untuk pompa *submersible* di fasilitas *Sump pit* terminal keberangkatan Bandara Internasional SMB II Palembang. Purwarupa ini mengintegrasikan mikrokontroler ESP32 sebagai unit pemroses utama yang mengakuisisi data dari sensor ultrasonik HC-SR04, *thermocouple* MAX6675, dan PZEM-004T v3.0, lalu mentransmisikannya ke antarmuka *dashboard* interaktif Node-RED melalui protokol MQTT. Diharapkan sistem ini dapat menjadi pertimbangan dalam mengganti mekanisme operasional manual yang kaku menjadi terotomatisasi, sehingga mampu menjadi solusi preventif dalam memitigasi risiko luapan limbah di area terminal melalui eksekusi *relay* yang sangat tanggap. Kelayakan dari perancangan inovasi ini juga telah diakui dan tervalidasi dengan predikat "Sangat Baik" oleh praktisi ahli materi dari pihak industri bandara yang memberikan skor 94%, serta penilaian ahli media dari pihak akademis dengan pencapaian nilai 90%.

Lebih lanjut, pengujian fungsionalitas instrumen pada purwarupa menunjukkan tingkat akurasi yang sangat presisi dalam mendukung efektivitas sistem proteksi mekanikal dan kelistrikan. Kinerja pembacaan sensor ultrasonik dalam mendeteksi elevasi air limbah mencatatkan tingkat akurasi sebesar 98,30% dengan rata-rata *error* yang sangat rendah yakni 1,70%. Pada instrumen pemantauan kondisi termal bodi motor pompa, sensor *thermocouple* mampu mendeteksi perubahan suhu dengan akurasi mencapai 98,10% (*error* 1,90%). Sementara itu, evaluasi terhadap parameter kelistrikan menggunakan sensor PZEM-004T berhasil membuktikan tingkat kestabilan pengukuran tegangan AC dengan akurasi maksimal 99,70% (*error* 0,30%) dan pendeteksian tarikan arus beban dengan akurasi 96,10% (*error* 3,90%). Secara holistik, integrasi sinkron dari berbagai pembacaan parameter tersebut efektif dalam mengaktifkan logika *emergency stop*di mana sistem mampu memutus arus daya seketika secara otomatis guna melindungi aset motor induksi dari risiko kerusakan fatal yang diakibatkan oleh fenomena panas berlebih (*overheating*) maupun operasi pemompaan tanpa cairan (*dry running*).

B. Saran

Berdasarkan kesimpulan diatas penulis memberikan saran untuk optimalisasi guna penyempurnaan sistem di masa mendatang. Adapun saran dan rekomendasi yang dapat diberikan oleh penulis adalah sebagai berikut:

1. Implementasi Skala Industri

   Replikasi sistem untuk kontrol motor 3 fasa (380V) di lapangan membutuhkan *upgrade* perangkat keras berupa: sensor ultrasonik kedap air (JSN-SR04T), pengaman arus kuat (*Magnetic Contactor* dan TOR), serta boks panel IP65 dengan PSU *DIN-Rail* untuk menjaga stabilitas daya dan mencegah interferensi elektromagnetik (EMI).

2. Peningkatan Keamanan Jaringan dan Protokol

   Untuk memenuhi standar keamanan siber bandara, protokol perlu ditingkatkan menjadi MQTTS (dengan enkripsi dan QoS tinggi). Antarmuka Node-RED juga perlu dijembatani ke Modbus TCP/IP atau OPC UA agar dapat terintegrasi dengan *Building Management System* (BMS) terpusat.

3. Penambahan Suplai Daya Darurat

   Pemasangan baterai cadangan atau Mini UPS khusus untuk mikrokontroler ESP32 dan *router* Wi-Fi. Hal ini bertujuan agar pengiriman data telemetri dan sistem *early warning* tidak terputus saat terjadi jeda perpindahan listrik dari PLN ke genset.

DAFTAR PUSTAKA

Afiah, N. I., Ramadan, D. N., & Damayanti, T. N. (2021). Prototype Otomasi Dan Monitoring Suhu Dan Kelembapan Pada Peternakan Ayam Broiler Berbasis Iot. *TELKITA (Jurnal Telekomunikasi, Elektro, Komputasi, dan Informatika)*, *7*(6).

Alkarrami, F., Iqbal, T., Pope, K., & Rideout, G. (2020). Dynamic Modelling of Submersible Pump Based Solar Water-Pumping System with Three-Phase Induction Motor Using MATLAB. *Journal of Power and Energy Engineering*, *08*(02). https://doi.org/10.4236/jpee.2020.82002

Anditasari, P., Sudjadi, S., & Darjat, D. (2020). Perancangan Sistem Akuisisi Data Multisensor (Oksigen,Hidrogen, Suhu, Aliran, Tekanan, Arus,dan Tegangan) Berbasis Human Machine Interface. *Transient: Jurnal Ilmiah Teknik Elektro*, *9*(1). https://doi.org/10.14710/transient.v9i1.107-114

Arifuddin, F., & Rafsyam, Y. (2025). Implementasi Sensor Ultrasonik HC-SR04 dengan Arduino dan LabVIEW untuk Pengukuran Level Air. *Spektral*, *6*(1). https://doi.org/10.32722/spektral.v6i1.7521

Arrahma, S. A., & Mukhaiyar, R. (2023). Pengujian Esp32-Cam Berbasis Mikrokontroler ESP32. *JTEIN: Jurnal Teknik Elektro Indonesia*, *4*(1). https://doi.org/10.24036/jtein.v4i1.347

Ashfahandika, M., Slamet, P., & Widagdo, R. S. (2025). Evaluasi Kinerja Motor Induksi 3 Fasa Menggunakan Parameter Listrik terhadap Variasi Kerusakan pada Komponen Bearing. *El Sains: Jurnal Elektro*, *7*(1). https://doi.org/10.30996/elsains.v7i1.132093

AZIZI, M. R. T. (2022). Evaluasi Koordinasi Sistem Proteksi Pompa Minyak Electric Submersible Pump (ESP) PT Pertamina Hulu Rokan (WK. Rokan). *teknik elektro*.

Barlian, T., Lestari, A. I., & Cekdin, C. (2024). Pengaruh Perubahan Harga Resistansi Rotor Terhadap Kinerja Motor Induksi Tiga Fasa. *JURNAL SURYA ENERGY*, *8*(2). https://doi.org/10.32502/jse.v8i2.8264

Begti Rizal Nugroho, N., Adji Rohman, B., Yusuf Arifin, B., Artika Rahmawati, D., Dimas Dewanto, I., & Hasanah, H. (2025). Sistem Monitoring Daya Listrik Berbasis IoT (Internet of Things). *Prosiding Seminar Nasional Teknologi Informasi dan Bisnis*. https://doi.org/10.47701/0zsg0d05

Dani Atik, Moh. U., Al - Azhari, A. H., & Djuniadi, D. (2024). Pengatur Suhu Otomatis pada Kandang Ayam selama Masa Brooding Berbasis Arduino Uno dan Sensor LM35. *AVITEC*, *6*(1). https://doi.org/10.28989/avitec.v6i1.2080

Darmanto, H., Lamsadi, L., & Asrul, H. (2025). Monitoring Ketinggian Air Tandon Berbasis IoT Dengan ESP32 Melalui Website. *JUSTER : Jurnal Sains dan Terapan*, *4*(2). https://doi.org/10.57218/juster.v4i2.1507

Dr. Sugiono. (2019). Metode Penelitian Kuantitatif Kualitatif dan R&D. Bandung Alfabeta. Procrastination And Task Avoidance Theory, Research and Treatment. Dalam *Sustainability (Switzerland)* (Vol. 11, Nomor 1).

Fahreza, M. (2021). Desain Controling Pengaman Arus Lebih Berbasis Arduino. *Jurnal MESIL (Mesin Elektro Sipil)*, *2*(1). https://doi.org/10.53695/jm.v2i1.248

Faras Dwi Putra, Salaho Dina Devy, Agus Winarno, Harjuni Hasan, & Windhu Nugroho. (2025). Studi Sistem Drainase Air Tambang Batubara di Sump Pit Bara4 PT Berkat Anugerah Sejahtera. *Globe: Publikasi Ilmu Teknik, Teknologi Kebumian, Ilmu Perkapalan*, *3*(2). https://doi.org/10.61132/globe.v3i2.816

Farid, S., Boudia, M. A., & Mwangi, G. (2023). Revolutionizing Tourism: Harnessing the Power of IoT in Smart Destinations. *Journal of Digital Marketing and Communication*, *3*(2). https://doi.org/10.53623/jdmc.v3i2.360

Fia Magfirah, & Widhiantoro, D. (2024). Sistem Monitoring Energi dan Biaya Konsumsi Listrik Rumah Tangga Berbasis IoT. *Spektral*, *5*(1). https://doi.org/10.32722/spektral.v5i1.6778

Firdaus, A. A., Sobhita, R. A., & Nugraha, A. T. (2025). Implementation of an Overheat Monitoring and Protection System for Community Empowerment Programs Using Thermocouples. *Maritime in Community …*, *xx*(xx).

Gustina, Z., Husnayayin, A., & Dewi, D. E. C. (2021). Karakteristik dan langkah-langkah metode Research and Development (R&D) dalam pendidikan (menggunakan pendekatan Borg & Gall). *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *9 Nomor 4*.

Gustina, Z., Husnayayin, A., & Dewi, D. E. C. (2024). Karakteristik dan langkah-langkah metode penelitian research and development dalam (borg&gall) pendidikan. *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *9*(4).

Hanifah, F., & Yuhendri, M. (2023). Kontrol dan Monitoring Kecepatan Motor Induksi Berbasis Internet of Thing. *JTEIN: Jurnal Teknik Elektro Indonesia*, *4*(2). https://doi.org/10.24036/jtein.v4i2.456

Hendriarianti, E., Triwahyuni, A., & Tyagita Ayudyaningtyas, A. (2022). Analisa Driving Force, Pressure, State dan Response Kualitas Air. *Prosiding SEMSINA*, *3*(2). https://doi.org/10.36040/semsina.v3i2.5190

Iman, D. F. (2024). Pompa Submersible Sebagai Sistem Penyedotan Air Limbah di PT. Krakatau Tirta Industri. *Jurnal Informatika dan Teknik Elektro Terapan*, *12*(3S1). https://doi.org/10.23960/jitet.v12i3S1.5332

Johari, H. I. (2025). Pemeriksaan Kualitas Fisik, Kimia, Biologi, pada Limbah Cair di RSUD Patuh Patju Lombok Barat. *Jurnal Ekologi, Masyarakat dan Sains*, *6*(2). https://doi.org/10.55448/r2am5906

Karti, K., & Nainggolan, G. P. (2024). Tindakan Corrective Maintenance pada Penggantian Poros Elektro Motor yang Patah Akibat Beban Berlebih di Mesin Separator PT. Hutahaean. *IRA Jurnal Teknik Mesin dan Aplikasinya (IRAJTMA)*, *3*(3). https://doi.org/10.56862/irajtma.v3i3.159

Latumeten, S. H., & Azhar, M. (2024). Analisis Pengelolaan Limbah Padat di Bandar Udara Internasional Zainuddin Abdul Majid Lombok. *Ainstech: Jurnal Penelitian Dan Pengkajian Sains Dan Teknologi*, *34*(2). https://doi.org/10.37277/stch.v34i2.2038

Martua Samosir, C., Fidayanti, N., Sukmawatie, N., & A. K. Wijaya, D. (2024). Perhitungan Volume Air Pada Sump Pit III Timur Banko Barat di PT. Bukit Asam Tbk Kabupaten Muara Enim. *Jurnal Teknik Pertambangan*, *24*(1). https://doi.org/10.36873/jtp.v24i1.12430

Novalisae, Ferdinandus, & Noveriady. (2022). Evaluasi Sistem Pemompaan Sump Pit 1. *Jurnal Teknik Pertambangan (JTP)*, *XXII*(1).

Nurcahyo, Y. B., Rizky Ramadhan, G., Supriadi, A., Tia Ardiani, G., & Hastuti LK, D. (2023). Pendekatan Non Parametik: Apakah Industri Penerbangan Indonesia Sudah Efisien? *WELFARE Jurnal Ilmu Ekonomi*, *4*(1). https://doi.org/10.37058/wlfr.v4i1.7048

Pratama, R., & Hidayat, R. (2022). Perancangan Sistem Monitoring Level Air Menggunakan Sensor Ultrasonik Berbasis IoT Dengan Aplikasi Blynk. *Jurnal Informatika dan Teknik Elektro Terapan*, *11*(2).

Rachman, I., Budiman, M. R., Muhajir, A., & Mi'raz, R. (2023). Smart Aquarium Berbasis IoT Dengan Web Server dan Intellegent OTA. *Technologia : Jurnal Ilmiah*, *14*(3). https://doi.org/10.31602/tji.v14i3.11438

Rafaai, N. H., Lee, K. E., Nazir, N. Z. M., Ab Rahim, A. R., Goh, T. L., Mokhtar, M., Wan Abdullah, W. A. R., Husain, H., & Mamat, R. B. R. (2025). Mapping sewage treatment plants for wastewater reclamation and reuse in industrial parks of Peninsular Malaysia: A path towards water security. *Water Resources and Industry*, *33*. https://doi.org/10.1016/j.wri.2025.100284

Rangan, A. Y., Amelia Yusnita, & Muhammad Awaludin. (2020). Sistem Monitoring berbasis Internet of things pada Suhu dan Kelembaban Udara di

Laboratorium Kimia XYZ. *Jurnal E-Komtek (Elektro-Komputer-Teknik)*, *4*(2). https://doi.org/10.37339/e-komtek.v4i2.404

Sartika, L., Prasetia, A. M., & Nicholas, I. E. N. (2023). Analisa Pengaruh Perubahan Beban Terhadap Kinerja Motor Induksi 3 Fasa Scrapper Conveyor di PT. Citra Sawit Lestari. *Jurnal Elektro dan Telekomunikasi Terapan*, *10*(1). https://doi.org/10.25124/jett.v10i1.5999

Senanayake, S. M. A. H., Seneviratne, I., Ranadewa, K. A. T. O., & Perera, B. A. K. S. (2024). Plumbing waste reduction through lean tools: A case for high-rise building construction. *A/Z ITU Journal of the Faculty of Architecture*, *21*(2). https://doi.org/10.58278/0.2024.45

Sitorus, H. F., Armansyah, A., & Harahap, R. (2022). Pemeliharaan Motor Induksi 3 Fasa Tegangan 380 V Pada GT 2.1 di PT. PLN (Persero) Unit Pelaksana Pengendalian Pembangkitan Belawan. *JET (Journal of Electrical Technology)*, *7*(3). https://doi.org/10.30743/jet.v7i3.6306

Solehudin, D., Priatna, T., & Zaqiyah, Q. Y. (2022). Konsep Implementasi Kurikulum Prototype. *Jurnal Basicedu*, *6*(4). https://doi.org/10.31004/basicedu.v6i4.3510

Udin, M. S., Hermawan, A. C., Aribowo, W., & Rahmadian, R. (2023). Rancang Bangun Drip Irrigation System Menggunakan Pompa Bertenaga Surya Dengan Kontrol Penyiraman Berbasis Node-Red. *JURNAL TEKNIK ELEKTRO*, *12*(2). https://doi.org/10.26740/jte.v12n2.p98-105

Utama, F. Y., & Wibowo, H. (2018). Analisis Preventive Maintenance Terhadap Submersible Pump 100 Dlc5 7,5 T Dalam Instalasi Pengolahan Air Limbah. *Indonesian Journal of Engineering and Technology (INAJET)*, *1*(1).

WIBOWO, P., & Prasetya, D. A. (2021). Rancang Bangun Data Logger Multi Kanal Terhubung IoT (Internet Of Things) Sebagai Pengukur Temperatur dengan Sensor Thermocouple. *Emitor: Jurnal Teknik Elektro*, *21*(2). https://doi.org/10.23917/emitor.v21i2.13773

Widharma, I. G. S., Wiraguna, M. A. A., Natalia, N. K. D., Bintang, R. D., Nugraha, I. G. R. A., & (085. (2020). Otomatisasi Dalam Pandemi Dengan Sensor Proximity. *Politeknik Negeri Bali*, (December).

Yurizal Bagas Permadi. (2021). Sistem Keamanan Pada Sangkar Burung Menggunakan SIM900 Dan Kamera Berbasis Mikrokontroller. *Informatika: Jurnal Teknik Informatika dan Multimedia*, *1*(1). https://doi.org/10.51903/informatika.v1i1.18

Zakaria, P., Nurwan, N., & Silalahi, F. D. (2021). Deskripsi Kemampuan Berpikir Kritis Siswa Melalui Pembelajaran Daring Pada Materi Segi Empat. *Euler :*

Jurnal Ilmiah Matematika, Sains dan Teknologi, *9*(1), 32–39. https://doi.org/10.34312/euler.v9i1.10539

Zakiyyah, F. F., & Suef, M. (2026). Pengembangan Model Predictive Maintenance Pada Main Motor Mesin Raw Mill. *Jurnal Teknologi dan Manajemen Industri Terapan (JTMIT)*, *5*(1).

LAMPIRAN

Lampiran A. Data Dukung Identifikasi Masalah

injourney AIRPORTS **STANDAR OPERASI DAN PROSEDUR FASILITAS LISTRIK, MEKANIKAL & PERALATAN BANDARA**	**PENGOPERASIAN DAN PEMELIHARAAN SEWAGE TREATMENT PLANT**	
	Dok. No. : 14.08.29/03/01/2024 / SEWAGE TREATMENT PLANT	Revisi No.: 00
	Tanggal : 15 Januari 2024	Paraf :

Pemeliharaan **pencegahan** dilaksanakan bertujuan untuk mempertahankan unjuk hasil atau perfomansi/kinerja peralatan, yang kegiatannya meliputi:

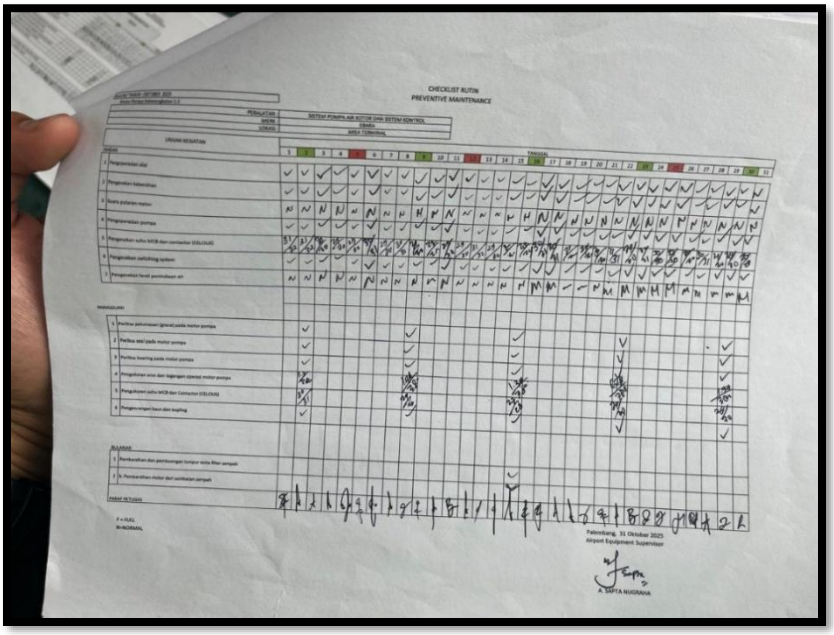
4.2.1.1 Pemeliharaan Harian

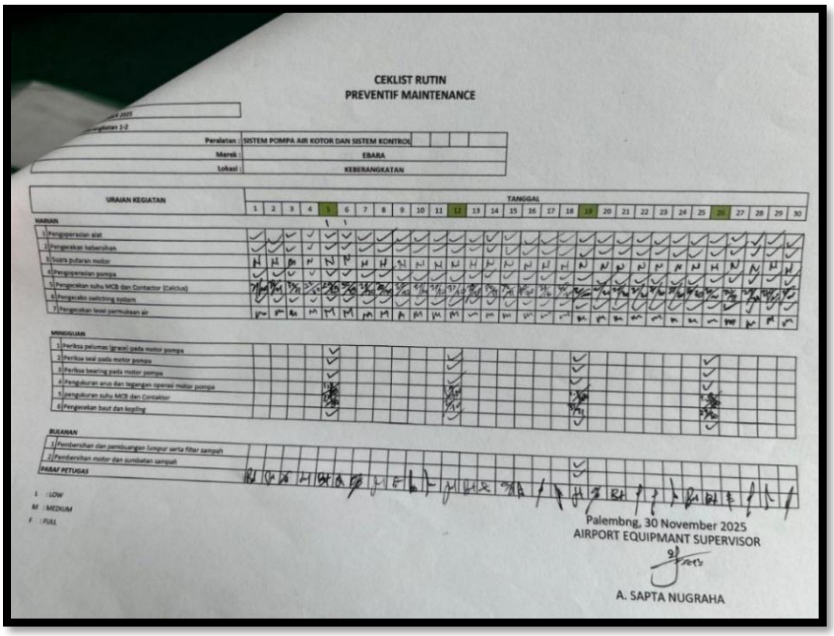
a. Mendapatkan Surat Perintah Tugas dari pimpinan unit.
b. Mendapatkan Izin/ *Clearence* dari Petugas Unit Utilitas/Lingkungan terkait.
c. Lakukan inspeksi visual pada panel kontrol utama STP, periksa indikator lampu, tegangan (Volt), dan arus (Ampere).
d. Periksa kondisi operasional pompa limbah (*submersible pump*), blower, dan sistem aerasi. Catat jika terdapat suara bising yang tidak normal, getaran, atau bau yang tidak wajar.
e. Periksa level limbah pada bak ekualisasi dan aerasi. Pastikan aliran limbah lancar tanpa adanya sumbatan.
f. Catat data hasil inspeksi harian pada *log book*.

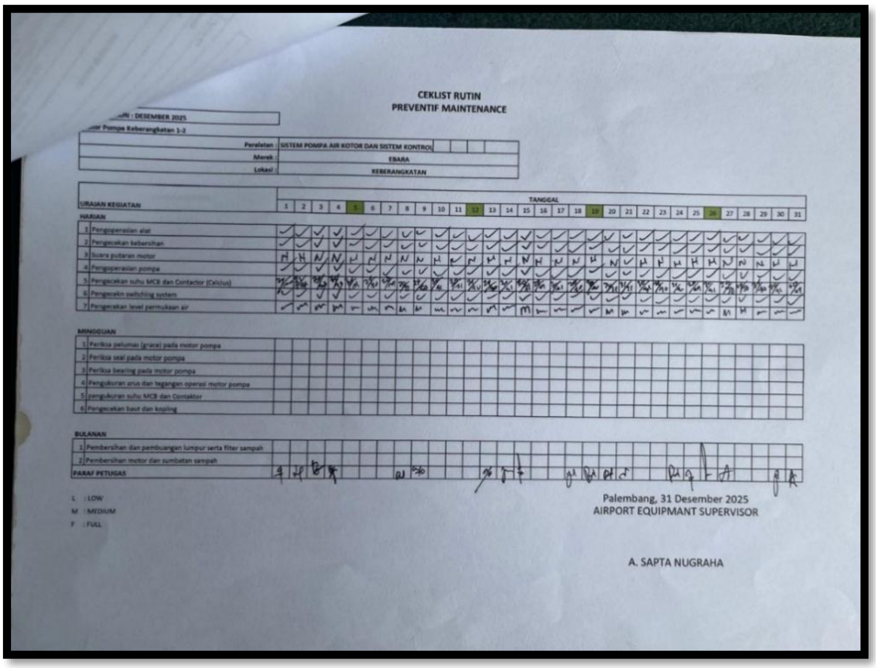
4.2.1.2 Pemeliharaan Mingguan

a. Mendapatkan Surat Perintah Tugas dari pimpinan unit.
b. Periksa dan bersihkan saringan kasar (*bar screen*) dari penumpukan sampah padat.
c. Cek kondisi mekanis dan pelumasan pada bearing pompa dan blower.
d. Periksa level tangki kimia (jika ada, e.g., untuk klorinasi).
e. Pastikan area sekitar STP bersih dan bebas dari genangan air yang tidak seharusnya.

Lampiran B. Ceklist monitoring pompa submersible Sump pit di terminal keberangkatan bandara SMB II PLM







CEKLIST RUTIN
PREVENTIF MAINTENANCE

...N : DESEMBER 2025

...or Pompa Keberangkatan 1-2

Peralatan :	SISTEM POMPA AIR KOTOR DAN SISTEM KONTROL
Merek :	EBARA
Lokasi :	KEBERANGKATAN

No	URAIAN KEGIATAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
	HARIAN																															
1	Pengoperasian alat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Pengecekan kebersihan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Suara putaran motor	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	Pengoperasian pompa	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Pengecekan suhu MCB dan Contactor (Celcius)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	Pengecekn switching system	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Pengecekan level permukaan air	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	MINGGUAN																															
1	Periksa pelumas (grace) pada motor pompa																															
2	Periksa seal pada motor pompa																															
3	Periksa bearing pada motor pompa																															
4	Pengukuran arus dan tegangan operasi motor pompa																															
5	pengukuran suhu MCB dan Contaktor																															
6	Pengecekan baut dan kopling																															
	BULANAN																															
1	Pembersihan dan pembuangan lumpur serta filter sampah																															
2	Pembersihan motor dan sumbatan sampah																															
	PARAF PETUGAS																															

L : LOW
M : MEDIUM
F : FULL

Palembang, 31 Desember 2025
AIRPORT EQUIPMANT SUPERVISOR

A. SAPTA NUGRAHA

Lampiran C. Lembar Validasi Ahli Materi

LEMBAR VALIDASI AHLI MATERI
"SISTEM KONTROL POMPA *SUBMERSIBLE* BERBASIS IoT DI SUMP PIT BANDARA INTERNASIONAL SMB II PALEMBANG"

NAMA : **Akhmad Sapta, S.T.**

TANGGAL : 15 Juni 2026

A. Pengantar

1. Lembar penilaian ini dimaksudkan untuk mendapat informasi mengenai kualitas alat Rancangan prototype pompa air baku berbasis IoT di Bandar udara Sultan Mahmud Badaruddin II Palembang.
2. Informasi mengenai kualitas media ini didasarkan pada aspek kualitas alat.

B. Petunjuk Pengisian

1. Berilah tanda check (✓) pada alternatif jawaban yang telah disediakan.
2. Berikan skor pada setiap butir pernyataan dengan penilaian sebagai berikut:
   5 = Sangat Baik
   4 = Baik
   3 = Cukup
   2 = Kurang Baik
   1 = Tidak Baik
3. Kritik dan saran perbaikan pada baris yang telah disediakan.
4. Kesimpulan akhir berupa kriteria kelayakan alat Perancangan sistem kontrol pompa *submersible* berbasis IoT di sump pit Bandara SMB II Palembang.

C. Penilaian

No	Aspek Penilaian	Skala Penilaian				
		1	2	3	4	5
A. Kegunaan *(Usability)*						
1	Tingkat kemudahan pengoperasian alat melalui antarmuka dashboard Node-RED.					✓
2	Kejelasan informasi dan visualisasi data pada sistem monitoring operasional saat digunakan.					✓
B. Fungsionalitas *(Functionality)*						
1	Efektivitas integrasi platform Node-RED dalam mengoptimalkan sistem kontrol otomatis pada pompa.					✓

2	Kemampuan sistem dalam mengelola logika kerja (otomatisasi) sesuai dengan kebutuhan level air limbah.					✓
3	Akurasi dan kinerja sensor (PZEM, Ultrasonik, dan Thermocouple MAX) dalam mendukung keandalan sistem secara keseluruhan.				✓	
C. Efisiensi *(Efficiency)*						
1	Kecepatan sistem dalam menyajikan data monitoring secara real-time tanpa hambatan (delay) yang berarti.				✓	
2	Seberapa efisien produk ini membantu pengguna mencapai tujuan mereka.					✓
D. Kepuasan *(Satisfaction)*						
1	Tingkat kenyamanan dan kepuasan pengalaman pengguna terhadap produk.					✓

D. Komentar/saran umum

Rapihkan kabelnya khususnya dalam box panel yg keluar dari mini ground tank dan diikat dengan rapih.

F. Kesimpulan

Rancangan prototype pompa air baku berbasis IoT di Bandar udara Sultan Mahmud Badaruddin II Palembang ini dinyatakan :

a. Layak digunakan
b. Layak digunakan dengan catatan
c. Tidak Layak digunakan

Palembang, 15 Juni 2026
Validator,

(A. SARTA NUGRAHA)

Lampiran D. Lembar Validasi Ahli Media

LEMBAR VALIDASI AHLI MEDIA
"SISTEM KONTROL POMPA *SUBMERSIBLE* BERBASIS IoT DI SUMP PIT BANDARA INTERNASIONAL SMB II PALEMBANG"

NAMA : **Gilang Eka Prandana, S.Kom.**

TANGGAL : 24 Juni 2026

A. Pengantar
1. Lembar penilaian ini dimaksudkan untuk mendapat informasi mengenai kualitas alat Rancangan prototype pompa air baku berbasis IoT di Bandar udara Sultan Mahmud Badaruddin II Palembang.
2. Informasi mengenai kualitas media ini didasarkan pada aspek kualitas alat.

B. Petunjuk Pengisian
1. Berilah tanda check (✓) pada alternatif jawaban yang telah disediakan.
2. Berikan skor pada setiap butir pernyataan dengan penilaian sebagai berikut:
   5 = Sangat Baik
   4 = Baik
   3 = Cukup
   2 = Kurang Baik
   1 = Tidak Baik
3. Kritik dan saran perbaikan pada baris yang telah disediakan.
4. Kesimpulan akhir berupa kriteria kelayakan alat Perancangan sistem kontrol pompa *submersible* berbasis IoT di sump pit Bandara SMB II Palembang.

C. Penilaian

No	Aspek Penilaian	Skala Penilaian				
		1	2	3	4	5
A. Kegunaan *(Usability)*						
1	Tingkat kemudahan pengoperasian alat melalui antarmuka dashboard Node-RED.					✓
2	Kejelasan informasi dan visualisasi data pada sistem monitoring operasional saat digunakan.				✓	
B. Fungsionalitas *(Functionality)*						
1	Efektivitas integrasi platform Node-RED dalam mengoptimalkan sistem kontrol otomatis pada pompa.					✓

2	Kemampuan sistem dalam mengelola logika kerja (otomatisasi) sesuai dengan kebutuhan level air limbah.				✓	
3	Akurasi dan kinerja sensor (PZEM, Ultrasonik, dan Thermocouple MAX) dalam mendukung keandalan sistem secara keseluruhan.				✓	
C. Efisiensi *(Efficiency)*						
1	Kecepatan sistem dalam menyajikan data monitoring secara real-time tanpa hambatan (delay) yang berarti.					✓
2	Seberapa efisien produk ini membantu pengguna mencapai tujuan mereka.				✓	
D. Kepuasan *(Satisfaction)*						
1	Tingkat kenyamanan dan kepuasan pengalaman pengguna terhadap produk.				✓	

D. Komentar/saran umum

Saran ditambahkan log histori data real time yang terekam oleh sistem

F. Kesimpulan

Rancangan prototype pompa air baku berbasis IoT di Bandar udara Sultan Mahmud Badaruddin II Palembang ini dinyatakan :

a. Layak digunakan
b. Layak digunakan dengan catatan
c. Tidak Layak digunakan

Palembang, 24 juni 2026
Validator,

(Gilang Eka Prandana)

Lampiran E. Transkrip Wawancara

POLITEKNIK PENERBANGAN PALEMBANG
PROGRAM STUDI TEKNOLOGI REKAYASA BANDAR UDARA
PROGRAM SARJANA TERAPAN

Hari / Tanggal : Selasa, 21 Januari 2026
Waktu : 08.30 WIB – 09.30 WIB
Tempat : Ruang Kerja Unit *Water Pump and System/Plumbing*
Identitas Narasumber :

a. Nama : Akhmad Sapta N
b. Jabatan : *Supervisor of Water Pump and System* Bandara Internasional SMB II Palembang

I. Hasil Wawancara

1. "Izin Pak Sapta, kalau dari kacamata manajemen, sebetulnya apa tantangan atau kendala terbesar yang sering dihadapi pas pengoperasian pompa submersible di sump pit ini?"	"Gini Ki, masalah utamanya itu karena debit limbah kita ini fluktuatif banget, nggak bisa ditebak. Apalagi kalau pas peak season, musim liburan, atau pas ada kloter jemaah umrah. Itu toilet di Terminal Timur kan padat sekali, nah sump pit keberangkatan kita yang kapasitasnya $16\ m^3$ itu cepat banget penuhnya. Kalau anak-anak di lapangan telat sedikit aja monitor, airnya langsung meluap lewat manhole. Di sisi lain, kita juga buta sama kondisi motor pompanya. Sering kali kita baru tahu pompa bermasalah pas kondisinya sudah mati total atau gulungannya terbakar karena dipaksa kerja terus saat ada beban berlebih."
2. "Untuk proses operasional sama pemeliharaan pompanya sendiri sekarang mekanismenya bagaimana ya, Pak?"	"Sekarang kita masih manual by schedule aja, Ki. Jadi tim yang dinas shift itu keliling ngecek visual ke boks panel lapangan, rata-rata 6 kali dalam 24 jam. Nah, untuk maintenance-nya jujur kita masih dominan corrective. Artinya, ya kalau ada keluhan bau atau pompa kedapatan macet/rusak, baru kita bongkar dan perbaiki. Belum bisa yang sifatnya bener-bener prediktif."
3. "Apakah saat ini sudah ada sistem monitoring level air yang otomatis di sump pit Keberangkatan ini, Pak?"	"Khusus untuk sump pit sewage di area Keberangkatan belum ada sistem otomatisasi ataupun monitoring jarak jauh. Semuanya murni masih manual di lapangan. Jadi kalau mau ngidupin atau matiin pompa ya teknisi harus dateng langsung ke lokasi boks panelnya."
4. "Menurut Pak Sapta, parameter apa saja yang paling krusial buat kita monitor di pompa submersible ini?"	"Kalau buat saya, yang paling penting itu ada tiga. Pertama jelas level ketinggian air biar kita bisa cegah luapan. Kedua itu parameter listriknya, terutama arus (Ampere), jadi kita tahu kalau pompa itu macet atau kelebihan beban. Dan yang ketiga itu suhu atau temperatur bodi motornya, ini penting biar pompanya nggak sampai overheating terus terbakar."
5. "Kalau prototype alat kontrol otomatis dan monitoring berbasis IoT yang sedang saya rancang ini nanti diterapkan, menurut Bapak apakah bisa membantu tim TTEQ?"	"Oh, jelas sangat membantu, Ki. Minimal bisa mengurangi beban anak-anak lapangan yang harus bolak-balik ngecek fisik secara repetitif. Terus yang paling saya suka dari konsep kamu ini, sistemnya bisa kasih peringatan dini (early warning). Jadi sebelum alatnya rusak parah, kita sudah bisa tahu duluan dari data suhu dan arusnya. Bagus ini, bisa bantu jaga keandalan fasilitas bandara kita."

POLITEKNIK PENERBANGAN PALEMBANG
PROGRAM STUDI TEKNOLOGI REKAYASA BANDAR UDARA
PROGRAM SARJANA TERAPAN

Hari / Tanggal : Selasa, 21 Januari 2026
Waktu : 09.10 WIB – 09.30 WIB
Tempat : Ruang Kerja Unit *Water Pump and System/Plumbing*
Identitas Narasumber :

b. Nama : Thobary
c. Jabatan : *Technician of Water Pump and System* Bandara Internasional SMB II Palembang

II. Hasil Wawancara

1. "Izin Pak Thobary, kalau abang-abang teknisi di lapangan biasanya sering nemuin kendala apa pas di bagian pompa sump pit?"	"Nah kalau di lapangan, musuh utama kita itu clogging alias penyumbatan di impeller (baling-baling) pompa, Ki. Namanya juga air limbah toilet terminal, kadang ada aja tisu basah atau sampah plastik yang lolos masuk ke bak. Efeknya, putaran pompa jadi seret, motornya kerja keras, arusnya langsung melonjak. Kalau telat ketahuan, ya otomatis thermal overload-nya putus atau parahnya motornya angus."
2. "Kalau alur kerja tim lapangan buat operasional sama ngerawat pompa ini biasanya gimana, Pak?"	"Kita kan bagi tim lewat sistem shift ya. Jadi tiap shift itu sudah ada jadwal checklist-nya. Anggota dinas harus jalan ke panel penampungan, buka tutup manhole buat ngintip airnya sudah seberapa tinggi. Kalau dirasa sudah penuh, sakelar di-ON-kan manual. Nah, kendalanya kita harus nungguin di sana atau dikira-kira kapan surutnya, baru di-OFF-kan lagi. Jangan sampai ditinggal lama terus airnya habis tapi pompa masih nyala, bisa dry running nanti pompanya, makin cepat rusak."
3. "Berarti untuk sistem monitoring otomatisnya emang belum masuk ke ruangan TTEQ ya, Bang?"	"Belum ada, Ki. Monitoring terpusat kita baru fokus ke fasilitas-fasilitas utama bandara yang lain. Kalau buat instalasi limbah domestik harian kayak sump pit begini, ya jalannya masih manual, musti disamperin satu-satu ke lokasi baknya."
4. "Kalau dari pengalaman Pak Thobary memimpin tim, parameter apa yang paling sering dipantau?"	"Kalau buat anak-anak lapangan sih simpel ya: status pompanya lagi HIDUP atau MATI, persentase air di dalam bak, sama nilai arus listriknya (Ampere). Nilai Ampere ini jadi patokan utama kita, kalau angkanya tiba-tiba naik tinggi, wah itu fiks pasti ada sampah yang ngeganjel di dalem pompa."
5. "Kira-kira kalau alat IoT buatan saya ini dipakai, bisa ngebantu performa tim lapangan nggak, Pak?"	"Sangat ngebantu, Ki. Masalah luapan limbah di area bawah (ground handling) itu sensitif banget, bisa bikin komplain karena bau dan ganggu operasional pesawat. Kalau alat kamu bisa bikin pompanya jalan otomatis pas air tinggi, kerjaan kita jadi lebih aman. Responsnya cepat dan anak-anak nggak perlu buang-buang waktu cuma buat mastiin pompa sudah mati atau belum."

POLITEKNIK PENERBANGAN PALEMBANG
PROGRAM STUDI TEKNOLOGI REKAYASA BANDAR UDARA
PROGRAM SARJANA TERAPAN

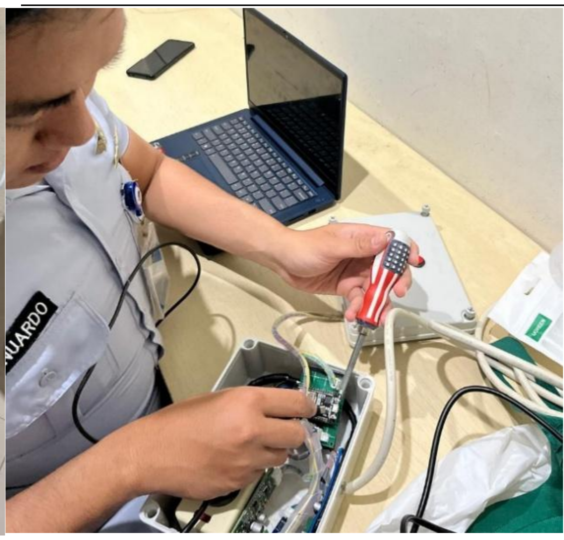
Hari / Tanggal : Selasa, 21 Januari 2026
Waktu : 10.00 WIB – 10.30 WIB
Tempat : Ruang Kerja Unit *Water Pump and System/Plumbing*
Identitas Narasumber :

d. Nama : Riza Rassanzani
e. Jabatan : *Technician of Water Pump and System* Bandara Internasional SMB II Palembang

III. Hasil Wawancara

1. "Bang Riza, izin nanya, selama ini kendala paling repot apa Bang kalau lagi nanganin pompa di sump pit?"	"Waduh Ki, paling males itu kalau dapet giliran shift terus pas jam padat bandara airnya telat dikuras sampai meluap lewat tutup got (manhole). Itu baunya ke mana-mana, mana kita musti bersihin areanya pula. Repotnya lagi, kita kan nggak tahu pompa di dalem bak itu sebenernya kepanasan atau nggak, tahu-tahu pas kita pencet tombolnya, pompanya cuma berdengung terus macet."
2. "Biasanya Abang kalau operasionalin pompa ini gimana langkah-langkahnya?"	"Ya kita jalan ke boks panel luar terminal, buka manhole, terus kita senter ke dalem buat ngira-ngira ketinggian airnya. Kalau sudah pas, kita ceklek sakelarnya ke posisi manual ON. Nah, selama pompa nguras, kita seringnya nungguin di sekitaran situ. Soalnya kalau ditinggal terus kebablasan sampai airnya tekor, pompanya muter kering, bisa kebakar."
3. "Berarti sekarang emang bener-bener murni dikontrol manual ya, Bang?"	"Iya, bener banget, Rizki. Belum ada otomatis-otomatisan. Semuanya masih bergantung sama insting sama jadwal keliling teknisi yang lagi dapet shift jaga."
4. "Mechanic Bang Riza sendiri, data apa saja yang penting tampil kalau abang lagi monitoring?"	"Kalau buat saya yang penting itu kelihatan jarak airnya sisa berapa senti lagi, suhu mesin pompanya berapa, sama tegangan listriknya (Voltase). Di bandara ini kalau pas tegangan listriknya lagi agak turun (drop), pompa itu gampang banget panas. Makanya data voltase AC 220V itu penting juga dipantau."
5. "Kalau alat prototype yang saya bikin ini kan datanya bisa dilihat di HP atau laptop lewat Node-RED nih Bang, menurut Abang gimana?"	"Wah, kalau bisa begitu ya enak banget, Ki! Meringankan tugas kita banget sebagai teknisi lapangan. Kita bisa pantau kondisi air dan pompa sambil megang perangkat digital dari ruangan, nggak perlu tiap jam bolak-balik ke lapangan terbuka apalagi pas cuaca lagi hujan. Kalau ada pompa macet atau air mau meluap kan ada alarm atau notifikasinya tuh, jadi kita bisa langsung gerak cepet sebelum jadi masalah besar."

Lampiran F. Perakitan dan uji coba *Prototype*


TARUNA

Lampiran G. Dokumentasi Observasi Lapangan

Lampiran H. Datasheet Komponen

1. Mikrokontroler ESP 32

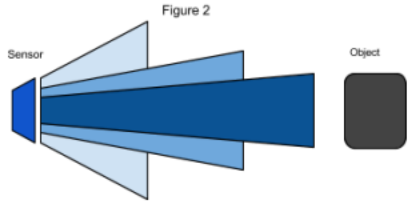
Categories	Items	Specifications
Certification	RF certification	FCC/CE-RED/IC/TELEC/KCC/SRRC/NCC
	Wi-Fi certification	Wi-Fi Alliance
	Bluetooth certification	BQB
	Green certification	RoHS/REACH
Test	Reliablity	HTOL/HTSL/uHAST/TCT/ESD
Wi-Fi	Protocols	802.11 b/g/n (802.11n up to 150 Mbps)
		A-MPDU and A-MSDU aggregation and 0.4 μs guard interval support
	Frequency range	2.4 GHz ~ 2.5 GHz
Bluetooth	Protocols	Bluetooth v4.2 BR/EDR and BLE specification
	Radio	NZIF receiver with –97 dBm sensitivity
		Class-1, class-2 and class-3 transmitter
		AFH
	Audio	CVSD and SBC
Hardware	Module interfaces	SD card, UART, SPI, SDIO, I^2C, LED PWM, Motor PWM, I^2S, IR, pulse counter, GPIO, capacitive touch sensor, ADC, DAC
	On-chip sensor	Hall sensor
	Integrated crystal	40 MHz crystal
	Integrated SPI flash	4 MB
	Operating voltage/Power supply	3.0 V ~ 3.6 V
	Operating current	Average: 80 mA
	Minimum current delivered by power supply	500 mA
	Recommended operating temperature range	–40 °C ~ +85 °C
	Package size	(18.00±0.10) mm × (25.50±0.10) mm × (3.10±0.10) mm
	Moisture sensitivity level (MSL)	Level 3

Name	No.	Type	Function
GND	1	P	Ground
3V3	2	P	Power supply
EN	3	I	Module-enable signal. Active high.
SENSOR_VP	4	I	GPIO36, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	I	GPIO39, ADC1_CH3, RTC_GPIO3
IO34	6	I	GPIO34, ADC1_CH6, RTC_GPIO4
IO35	7	I	GPIO35, ADC1_CH7, RTC_GPIO5
IO32	8	I/O	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8

IO25	10	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
IO14	13	I/O	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
IO12	14	I/O	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
GND	15	P	Ground
IO13	16	I/O	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
SHD/SD2*	17	I/O	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
SWP/SD3*	18	I/O	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
SCS/CMD*	19	I/O	GPIO11, SD_CMD, SPICS0, HS1_CMD, U1RTS
SCK/CLK*	20	I/O	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
SDO/SD0*	21	I/O	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
SDI/SD1*	22	I/O	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
IO15	23	I/O	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	24	I/O	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
IO0	25	I/O	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	26	I/O	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
IO16	27	I/O	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT
IO17	28	I/O	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
IO5	29	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
IO18	30	I/O	GPIO18, VSPICLK, HS1_DATA7
IO19	31	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
NC	32	-	-
IO21	33	I/O	GPIO21, VSPIHD, EMAC_TX_EN
RXD0	34	I/O	GPIO3, U0RXD, CLK_OUT2
TXD0	35	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO22	36	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
IO23	37	I/O	GPIO23, VSPID, HS1_STROBE
GND	38	P	Ground

2. Sensor Ultrasonik HC-SR04

Figure 2



2. HC-SR04 Specifications

The sensor chosen for the Firefighting Drone Project was the HC-SR04. This section contains the specifications and why they are important to the sensor module. The sensor modules requirements are as follows.

- Cost
- Weight
- Community of hobbyists and support
- Accuracy of object detection
- Probability of working in a smoky environment
- Ease of use

The HC-SR04 Specifications are listed below. These specifications are from the Cytron Technologies HC-SR04 User's Manual (source 1).

- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15°
- Ranging Distance: 2-400 cm
- Resolution: 0.3 cm
- Measuring Angle: 30°
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm
- Weight: approx. 10 g

The HC-SR04's best selling point is its price; it can be purchased at around $2 per unit.

3. Timing Chart and Pin Explanations

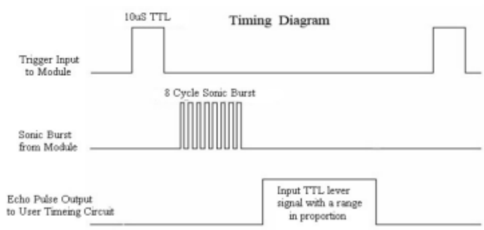
The HC-SR04 has four pins, VCC, GND, TRIG and ECHO; these pins all have different functions. The VCC and GND pins are the simplest -- they power the HC-SR04. These pins need to be attached to a +5 volt source and ground respectively. There is a single control pin: the TRIG pin. The TRIG pin is responsible for sending the ultrasonic burst. This pin should be set to HIGH for 10 μs, at which point the HC-SR04 will send out an eight cycle sonic burst at 40 kHZ. After a sonic burst has been sent the ECHO pin will go HIGH. The ECHO pin is the data pin -- it is used in taking distance measurements. After an ultrasonic burst is sent the pin will go HIGH, it will stay high until an ultrasonic burst is detected back, at which point it will go LOW.

Taking Distance Measurements

The HC-SR04 can be triggered to send out an ultrasonic burst by setting the TRIG pin to HIGH. Once the burst is sent the ECHO pin will automatically go HIGH. This pin will remain HIGH until the the burst hits the sensor again. You can calculate the distance to the object by keeping track of how long the ECHO pin stays HIGH. The time ECHO stays HIGH is the time the burst spent traveling. Using this measurement in equation 1 along with the speed of sound will yield the distance travelled. A summary of this is listed below, along with a visual representation in Figure 2.

1. Set TRIG to HIGH
2. Set a timer when ECHO goes to HIGH
3. Keep the timer running until ECHO goes to LOW
4. Save that time
5. Use equation 1 to determine the distance travelled

Figure 3
Source 2



To interpret the time reading into a distance you need to change equation 1. The clock on the device you are using will probably count in microseconds or smaller. To use equation 1 the speed of sound needs to determined,which is 343 meters per second at standard temperature and pressure. To convert this into more useful form use equation 2 to change from meters per second to microseconds per centimeter. Then equation 3 can be used to easily compute the distance in centimeters.

Equation 2. $Distance = \frac{Speed}{170.15\ m} \times \frac{Meters}{100\ cm} \times \frac{1e6\ \mu S}{170.15\ m} \times \frac{58.772\ \mu S}{cm}$

Equation 3. $Distance = \frac{time}{58} = \frac{\mu s}{\mu s/cm} = cm$

4. Wiring the HC-SR04 to a Microcontroller

This section only covers the hardware side. For information on how to integrate the software side, look at one of the links below or look into the specific microcontroller you are using.

The HC-SR04 has 4 pins: VCC, GND, TRIG and ECHO.

1. VCC is a 5v power supply. This should come from the microcontroller
2. GND is a ground pin. Attach to ground on the microcontroller.
3. TRIG should be attached to a GPIO pin that can be set to HIGH
4. ECHO is a little more difficult. The HC-SR04 outputs 5v, which could destroy many microcontroller GPIO pins (the maximum allowed voltage varies). In order to step down the voltage use a single resistor or a voltage divider circuit. Once again this depends on the specific microcontroller you are using, you will need to find out its GPIO maximum voltage and make sure you are below that.

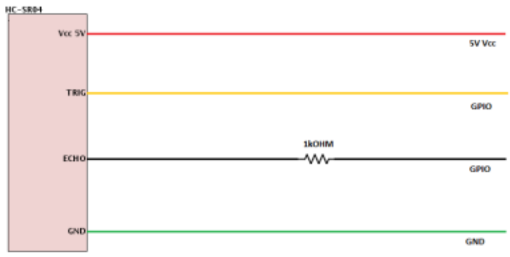
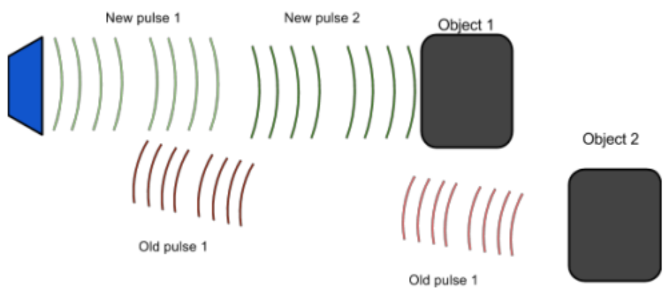


Figure 4

5. Errors and Bad Readings

Ultrasonic sensors are great sensors -- they work well for many applications where other types of sensors fall short. Unfortunately, they do have weaknesses. These weaknesses can be mitigated and worked around, but first they must be understood. The first weakness is that they use sound. There is a limit to how fast ultrasonic sensors can get distance measurements. The longer the distance, the slower they are at reporting the distance. The second weakness comes from the way sound bounces off of objects. In enclosed spaces it is possible, if not probable that there will be unintended echos. The echos can very easily cause false short readings. In Figure 2 a pulse was sent out. It bounced off of object 1 and returned to the sensor. The distance was recorded and then a new pulse was sent. There was another object farther away, so that when the new pulse reaches object 1, the first signal will reach the sensor. This will cause the sensor to think that there is an object closer than is actually true. The old pulse is smaller than the new pulse because it has grown weaker. The longer the pulse exists the weaker it grows until it is negligible. If multiple sensors are being used, the number of echos will increase along with the number of errors. There are two main ways to reduce the number of errors. The first is to provide shielding around the sensor. This prevents echos coming in from angle outside what the sensor should actually pick up. The second is to reduce the frequency at which pulses are sent out. This gives more time for the echos to dissipate.



3. Sensor Suhu *Thermocouple* Tipe K dengan Modul MAX6675

MAX6675

Cold-Junction-Compensated K-Thermocouple-to-Digital Converter (0°C to +1024°C)

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC} to GND) .... -0.3V to +6V
SO, SCK, $\overline{CS}$, T-, T+ to GND .... -0.3V to V_{CC} + 0.3V
SO Current 50mA
ESD Protection (Human Body Model) .... ±2000V
Continuous Power Dissipation (T_A = +70°C)
8-Pin SO (derate 5.88mW/°C above +70°C) 471mW
Operating Temperature Range .... -20°C to +85°C
Storage Temperature Range .... -65°C to +150°C
Junction Temperature .... +150°C
SO Package
Vapor Phase (60s) .... +215°C
Infrared (15s) .... +220°C
Lead Temperature (soldering, 10s) .... +300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +5.5V, T_A = -20°C to +85°C, unless otherwise noted. Typical values specified at +25°C.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Temperature Error		$T_{THERMOCOUPLE}$ = +700°C, T_A = +25°C (Note 2)	V_{CC} = +3.3V	-5		+5	LSB
			V_{CC} = +5V	-6		+6	
		$T_{THERMOCOUPLE}$ = 0°C to +700°C, T_A = +25°C (Note 2)	V_{CC} = +3.3V	-8		+8	
			V_{CC} = +5V	-9		+9	
		$T_{THERMOCOUPLE}$ = +700°C to +1000°C, T_A = +25°C (Note 2)	V_{CC} = +3.3V	-17		+17	
			V_{CC} = +5V	-19		+19	
Thermocouple Conversion Constant					10.25		µV/LSB
Cold-Junction Compensation Error		T_A = -20°C to +85°C (Note 2)	V_{CC} = +3.3V	-3.0		+3.0	°C
			V_{CC} = +5V	-3.0		+3.0	
Resolution					0.25		°C
Thermocouple Input Impedance					60		kΩ
Supply Voltage	V_{CC}			3.0		5.5	V
Supply Current	I_{CC}				0.7	1.5	mA
Power-On Reset Threshold		V_{CC} rising		1	2	2.5	V
Power-On Reset Hysteresis					50		mV
Conversion Time		(Note 2)			0.17	0.22	s
SERIAL INTERFACE							
Input Low Voltage	V_{IL}					0.3 x V_{CC}	V
Input High Voltage	V_{IH}			0.7 x V_{CC}			V
Input Leakage Current	I_{LEAK}	V_{IN} = GND or V_{CC}				±5	µA
Input Capacitance	C_{IN}				5		pF

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +5.5V, T_A = -20°C to +85°C, unless otherwise noted. Typical values specified at +25°C.) (Note 1)

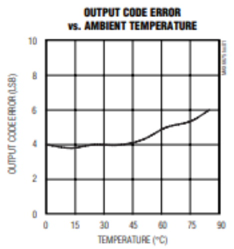
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output High Voltage	V_{OH}	I_{SOURCE} = 1.6mA	V_{CC} - 0.4			V
Output Low Voltage	V_{OL}	I_{SINK} = 1.6mA			0.4	V
TIMING						
Serial Clock Frequency	f_{SCL}				4.3	MHz
SCK Pulse High Width	t_{CH}		100			ns
SCK Pulse Low Width	t_{CL}		100			ns
CSB Fall to SCK Rise	t_{CSS}	C_L = 10pF	100			ns
CSB Fall to Output Enable	t_{DV}	C_L = 10pF			100	ns
CSB Rise to Output Disable	t_{TR}	C_L = 10pF			100	ns
SCK Fall to Output Data Valid	t_{DO}	C_L = 10pF			100	ns

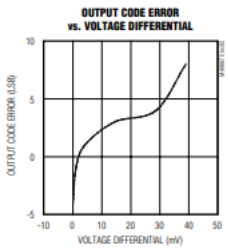
Note 1: All specifications are 100% tested at T_A = +25°C. Specification limits over temperature (T_A = T_{MIN} to T_{MAX}) are guaranteed by design and characterization, not production tested.

Note 2: Guaranteed by design. Not production tested.

Typical Operating Characteristics

(V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)





Pin Description

PIN	NAME	FUNCTION
1	GND	Ground
2	T-	Alumel Lead of Type-K Thermocouple. Should be connected to ground externally.
3	T+	Chromel Lead of Type-K Thermocouple
4	V_{CC}	Positive Supply. Bypass with a 0.1µF capacitor to GND.
5	SCK	Serial Clock Input
6	$\overline{CS}$	Chip Select. Set $\overline{CS}$ low to enable the serial interface.
7	SO	Serial Data Output
8	N.C.	No Connection

Detailed Description

The MAX6675 is a sophisticated thermocouple-to-digital converter with a built-in 12-bit analog-to-digital converter (ADC). The MAX6675 also contains cold-junction compensation sensing and correction, a digital controller, an SPI-compatible interface, and associated control logic.

The MAX6675 is designed to work in conjunction with an external microcontroller (µC) or other intelligence in thermostatic, process-control, or monitoring applications.

Temperature Conversion

The MAX6675 includes signal-conditioning hardware to convert the thermocouple's signal into a voltage compatible with the input channels of the ADC. The T+ and T- inputs connect to internal circuitry that reduces the introduction of noise errors from the thermocouple wires.

Before converting the thermoelectric voltages into equivalent temperature values, it is necessary to compensate for the difference between the thermocouple cold-junction side (MAX6675 ambient temperature) and a 0°C virtual reference. For a type-K thermocouple, the voltage changes by 41µV/°C, which approximates the thermocouple characteristic with the following linear equation:

$$V_{OUT} = (41\mu V / °C) \times (T_R - T_{AMB})$$

Where:

V_{OUT} is the thermocouple output voltage (µV).

T_R is the temperature of the remote thermocouple junction (°C).

T_{AMB} is the ambient temperature (°C).

Cold-Junction Compensation

The function of the thermocouple is to sense a difference in temperature between two ends of the thermocouple wires. The thermocouple's hot junction can be read from 0°C to +1023.75°C. The cold end (ambient temperature of the board on which the MAX6675 is mounted) can only range from -20°C to +85°C. While the temperature at the cold end fluctuates, the MAX6675 continues to accurately sense the temperature difference at the opposite end.

The MAX6675 senses and corrects for the changes in the ambient temperature with cold-junction compensation. The device converts the ambient temperature reading into a voltage using a temperature-sensing diode. To make the actual thermocouple temperature measurement, the MAX6675 measures the voltage from the thermocouple's output and from the sensing diode. The device's internal circuitry passes the diode's voltage (sensing ambient temperature) and thermocouple voltage (sensing remote temperature minus ambient temperature) to the conversion function stored in the ADC to calculate the thermocouple's hot-junction temperature.

Optimal performance from the MAX6675 is achieved when the thermocouple cold junction and the MAX6675 are at the same temperature. Avoid placing heat-generating devices or components near the MAX6675 because this may produce cold-junction-related errors.

Digitization

The ADC adds the cold-junction diode measurement with the amplified thermocouple voltage and reads out the 12-bit result onto the SO pin. A sequence of all zeros means the thermocouple reading is 0°C. A sequence of all ones means the thermocouple reading is +1023.75°C.

Cold-Junction-Compensated K-Thermocouple-to-Digital Converter (0°C to +1024°C)

MAX6675

Applications Information

Serial Interface

The *Typical Application Circuit* shows the MAX6675 interfaced with a microcontroller. In this example, the MAX6675 processes the reading from the thermocouple and transmits the data through a serial interface. Force $\overline{CS}$ low and apply a clock signal at SCK to read the results at SO. Forcing $\overline{CS}$ low immediately stops any conversion process. Initiate a new conversion process by forcing $\overline{CS}$ high.

Force $\overline{CS}$ low to output the first bit on the SO pin. A complete serial interface read requires 16 clock cycles. Read the 16 output bits on the falling edge of the clock. The first bit, D15, is a dummy sign bit and is always zero. Bits D14–D3 contain the converted temperature in the order of MSB to LSB. Bit D2 is normally low and goes high when the thermocouple input is open. D1 is low to provide a device ID for the MAX6675 and bit D0 is three-state.

Figure 1a is the serial interface protocol and Figure 1b shows the serial interface timing. Figure 2 is the SO output.

Open Thermocouple

Bit D2 is normally low and goes high if the thermocouple input is open. In order to allow the operation of the open thermocouple detector, T- must be grounded. Make the ground connection as close to the GND pin as possible.

Noise Considerations

The accuracy of the MAX6675 is susceptible to power-supply coupled noise. The effects of power-supply noise can be minimized by placing a 0.1µF ceramic bypass capacitor close to the supply pin of the device.

Thermal Considerations

Self-heating degrades the temperature measurement accuracy of the MAX6675 in some applications. The magnitude of the temperature errors depends on the thermal conductivity of the MAX6675 package, the mounting technique, and the effects of airflow. Use a large ground plane to improve the temperature measurement accuracy of the MAX6675.

The accuracy of a thermocouple system can also be improved by following these precautions:

- Use the largest wire possible that does not shunt heat away from the measurement area.
- If small wire is required, use it only in the region of the measurement and use extension wire for the region with no temperature gradient.
- Avoid mechanical stress and vibration, which could strain the wires.
- When using long thermocouple wires, use a twisted-pair extension wire.
- Avoid steep temperature gradients.
- Try to use the thermocouple wire well within its temperature rating.
- Use the proper sheathing material in hostile environments to protect the thermocouple wire.
- Use extension wire only at low temperatures and only in regions of small gradients.
- Keep an event log and a continuous record of thermocouple resistance.

Reducing Effects of Pick-Up Noise

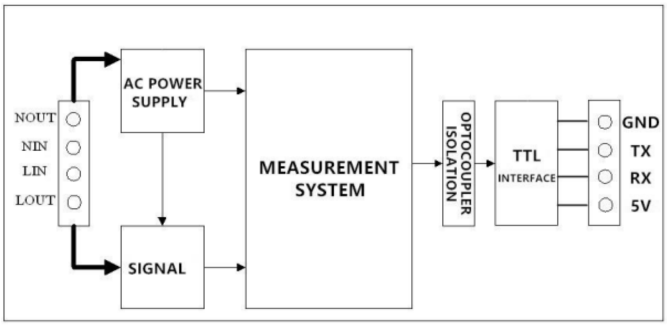
The input amplifier (A1) is a low-noise amplifier designed to enable high-precision input sensing. Keep the thermocouple and connecting wires away from electrical noise sources.

Chip Information

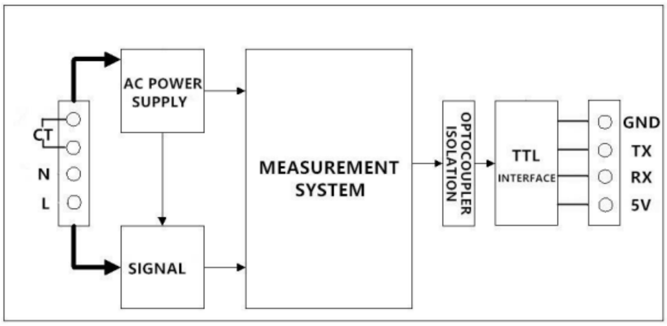
TRANSISTOR COUNT: 6720

PROCESS: BiCMOS

4. Sensor PZEM-004T



Picture 3.1 PZEM-004T-10A Functional block diagram



Picture 3.2 PZEM-004T-100A Functional block diagram

1. Function description

1.1 Voltage

1.1.1 Measuring range:80～260V

1.1.2 Resolution: 0.1V

1.1.3 Measurement accuracy: 0.5%

1.2 Current

1.2.1 Measuring range: 0～10A (PZEM-004T-10A); 0～100A (PZEM-004T-100A)

1.2.2 Starting measure current: 0.01A (PZEM-004T-10A); 0.02A (PZEM-004T-100A)

1.2.3 Resolution: 0.001A

1.2.4 Measurement accuracy: 0.5%

1.3 Active power

1.3.1 Measuring range: 0～2.3kW (PZEM-004T-10A); 0～23kW (PZEM-004T-100A)

1.3.2 Starting measure power: 0.4W

1.3.3 Resolution: 0.1W

1.3.4 Display format:

＜1000W, it display one decimal, such as: 999.9W

⩾1000W, it display only integer, such as: 1000W

1.3.5 Measurement accuracy: 0.5%

Active power threshold can be set, when the measured active power exceeds the threshold, it can alarm

1.8 Communication interface

RS485 interface。

2 Communication protocol

2.1 Physical layer protocol

Physical layer use UART to RS485 communication interface

Baud rate is 9600, 8 data bits, 1 stop bit, no parity

2.2 Application layer protocol

The application layer use the Modbus-RTU protocol to communicate. At present, it only supports function codes such as 0x03 (Read Holding Register), 0x04 (Read Input Register), 0x06 (Write Single Register), 0x41 (Calibration), 0x42 (Reset energy).etc.

0x41 function code is only for internal use (address can be only 0xF8), used for factory calibration and return to factory maintenance occasions, after the function code to increase 16-bit password, the default password is 0x3721

The address range of the slave is 0x01 ~ 0xF7. The address 0x00 is used as the broadcast address, the slave does not need to reply the master. The address 0xF8 is used as the general address, this address can be only used in single-slave environment and can be used for calibration

1.4 Power factor

1.4.1 Measuring range: 0.00～1.00

1.4.2 Resolution: 0.01

1.4.3 Measurement accuracy: 1%

1.5 Frequency

1.5.1 Measuring range: 45Hz～65Hz

1.5.2 Resolution: 0.1Hz

1.5.3 Measurement accuracy: 0.5%

1.6 Active energy

1.6.1 Measuring range: 0～9999.99kWh

1.6.2 Resolution: 1Wh

1.6.3 Measurement accuracy: 0.5%

1.6.4 Display format:

＜10kWh, the display unit is Wh(1kWh=1000Wh), such as: 9999Wh

⩾10kWh, the display unit is kWh, such as: 9999.99kWh

1.6.5 Reset energy: use software to reset.

1.7 Over power alarm

The address range of the slave is 0x01 ~ 0xF7. The address 0x00 is used as the broadcast ddress, the slave does not need to reply the master. The address 0xF8 is used as the general ddress, this address can be only used in single-slave environment and can be used for calibration tc.operation.

2.3 Read the measurement result

The command format of the master reads the measurement result is(total of 8 bytes):

Slave Address + 0x04 + Register Address High Byte + Register Address Low Byte + Number f Registers High Byte + Number of Registers Low Byte + CRC Check High Byte + CRC Check ow Byte.

The command format of the reply from the slave is divided into two kinds:

Correct Reply: Slave Address + 0x04 + Number of Bytes + Register 1 Data High Byte + egister 1 Data Low Byte + ... + CRC Check High Byte + CRC Check Low Byte

Error Reply: Slave address + 0x84 + Abnormal code + CRC check high byte + CRC check ow byte

Abnormal code analyzed as following (the same below)

- 0x01,Illegal function
- 0x02,Illegal address
- 0x03,Illegal data
- 0x04,Slave error

The register of the measurement results is arranged as the following table

Register address	Description	Resolution
0x0000	Voltage value	1LSB correspond to 0.1V
0x0001	Current value low 16 bits	1LSB correspond to 0.001A
0x0002	Current value high 16 bits	
0x0003	Power value low 16 bits	1LSB correspond to 0.1W
0x0004	Power value high 16 bits	

0x0003	Power value low 16 bits	1LSB correspond to 0.1W
0x0004	Power value high 16 bits	
0x0005	Energy value low 16 bits	1LSB correspond to 1Wh
0x0006	Energy value high 16 bits	
0x0007	Frequency value	1LSB correspond to 0.1Hz
0x0008	Power factor value	1LSB correspond to 0.01
0x0009	Alarm status	0xFFFF is alarm, 0x0000is not alarm

For example, the master sends the following command (CRC check code is replaced by 0xHH and 0xLL, the same below)

0x01 + 0x04 + 0x00 + 0x00 + 0x00 + 0x0A + 0xHH + 0xLL

Indicates that the master needs to read 10 registers with slave address 0x01 and the start address of the register is 0x0000

The correct reply from the slave is as following:

0x01 + 0x04 + 0x14 + 0x08 + 0x98 + 0x03 + 0xE8+0x00 + 0x00 +0x08 + 0x98+ 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x00 + 0x01 + 0xF4 + 0x00 + 0x64 + 0x00 + 0x00 + 0xHH + 0xLL

The above data shows

- Voltage is 0x0898, converted to decimal is 2200, display 220.0V
- Current is 0x000003E8, converted to decimal is 1000, display 1.000A
- Power is 0x00000898, converted to decimal is 2200, display 220.0W

- Power is 0x00000898, converted to decimal is 2200, display 220.0W
- Energy is 0x00000000, converted to decimal is 0, display 0Wh
- Frequency is 0x01F4, converted to decimal is 500, display 50.0Hz
- Power factor is 0x0064, converted to decimal is 100, display 1.00
- Alarm status is 0x0000, indicates that the current power is lower than the alarm power threshold

2.4 Read and modify the slave parameters

At present,it only supports reading and modifying slave address and power alarm threshold

The register is arranged as the following table

Register address	Description	Resolution
0x0001	Power alarm threshold	1LSB correspond to 1W
0x0002	Modbus-RTU address	The range is 0x0001~0x00F7

The command format of the master to read the slave parameters and read the measurement esults are same(descrybed in details in Section 2.3), only need to change the function code from ɪx04 to 0x03.

The command format of the master to modify the slave parameters is (total of 8 bytes):

Slave Address + 0x06 + Register Address High Byte + Register Address Low Byte + Register /alue High Byte + Register Value Low Byte + CRC Check High Byte + CRC Check Low Byte.

The command format of the reply from the slave is divided into two kinds:

Correct Response: Slave Address + 0x06 + Number of Bytes + Register Address Low Byte + Register Value High Byte + Register Value Low Byte + CRC Check High Byte + CRC Check Low Byte.

Error Reply: Slave address + 0x86 + Abnormal code + CRC check high byte + CRC check ow byte.

For example, the master sets the slave's power alarm threshold:

0x01 + 0x06 + 0x00 + 0x01 + 0x08 + 0xFC + 0xHH + 0xLL

Indicates that the master needs to set the 0x0001 register (power alarm threshold) to 0x08FC (2300W).

Set up correctly, the slave return to the data which is sent from the master.

For example, the master sets the address of the slave

0x01 + 0x06 + 0x00 + 0x02 + 0x00 + 0x05 + 0xHH + 0xLL

Indicates that the master needs to set the 0x0002 register (Modbus-RTU address) to 0x0005

Set up correctly, the slave return to the data which is sent from the master.

2.5 Reset energy

The command format of the master to reset the slave's **energy** is (total 4 bytes):

Slave address + 0x42 + CRC check high byte + CRC check low byte.

Correct reply: slave address + 0x42 + CRC check high byte + CRC check low byte.

Error Reply: Slave address + 0xC2 + Abnormal code + CRC check high byte + CRC check low byte

2.6 Calibration

The command format of the master to calibrate the slave is (total 6 bytes):

0xF8 + 0x41 + 0x37 + 0x21 + CRC check high byte + CRC check low byte.

Correct reply: 0xF8 + 0x41 + 0x37 + 0x21 + CRC check high byte + CRC check low byte.

Error Reply: 0xF8 + 0xC1 + Abnormal code + CRC check high byte + CRC check low byte.

It should be noted that the calibration takes 3 to 4 seconds, after the master sends the command, if the calibration is successful, it will take 3 ~ 4 seconds to receive the response from the slave.

2.7 CRC check

CRC check use 16bits format, occupy two bytes, the generator polynomial is X16 + X15 + X2 +1, the polynomial value used for calculation is 0xA001.

The value of the CRC check is a frame data divide all results of checking all the bytes except the CRC check value.

Lampiran I. Pengoprasian Alat

Lampiran J. Dokumentasi Bimbingan Tugas Akhir

Lampiran K. Lembar Bimbingan Tugas Akhir

POLITEKNIK PENERBANGAN PALEMBANG
PROGRAM STUDI TEKNOLOGI REKAYASA BANDAR UDARA
PROGRAM SARJANA TERAPAN

LEMBAR BIMBINGAN TUGAS AKHIR
TAHUN AKADEMIK 2025/2026

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NIT : 5619 22 1004
Course : TRBU 03
Judul TA : perancangan sistem kontrol pompa submersible berbasis IoT di Bandara SMB II palembang

Dosen Pembimbing : Dr. Sunardi, S.T., M.Pd., M.T.

No	Tanggal	Uraian	Paraf Pembimbing
1	30/03 26	Pembahasan latar belakang - Perlu penambahan data dukung yg memadai	[illegible]
2	09/03 26	Latar belakang oke lanjut. Bab 2 dan 3, yang harus di perhatikan teori² dan pemecahan yang akan di laksanakan -	[illegible]
3	05/04 26	Bab 2 - Tambahan teori² yang relevan. Bab 3 - pembahasan harus detail. Lanjut Sempro (perbaikan setelah Sempro). ACC Sempro	[illegible]
4	15/05 2026	Penguatan pada Bab 1 dengan data yang terjadi, aturan yang berlaku serta gap yang ada)	[illegible]
5	13/05 2026	pada Bab 2. Teori yang berkaitan dan di buat pada Bab 3 harus masuk semua.	[illegible]
6	4/06 26	Pada Bab 3. Metodologi harus dari Teori yang sudah valid dan di jelaskan sampai di mana batasan yang akan di bahas.	[illegible]
7	18/06 26	Penjelasan pada Bab 4. harus secara detail baik rangkaian, data yang digunakan, maupun prinsip kerja.	[illegible]
8	24/06 26	Bab 5. Kesimpulan dan Saran. perlu pengembangan harus di tulis - Daftar pustaka update 5 thn	[illegible]

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POLITEKNIK PENERBANGAN PALEMBANG
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PROGRAM SARJANA TERAPAN

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TAHUN AKADEMIK 2025/2026

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Dosen Pembimbing : Wildan Nugraha, S.E., M.S. ASM.

No	Tanggal	Uraian	Paraf Pembimbing
1	30/3 2026	- Pembahasan latar belakang & Bab 1	
2	1/3 2026	- Lanjut Bab 2. pembahasan. Bab 2. - Lanjut Bab 3.	
3	3/3 2026	- ACC sempro	
4	22/05 2026	pembahasan struktur Bab IV	
5	18/06 2026	Pembahasan hasil Bab IV.	
6	24/6 2026	Perkuat bagian pembahasan	
7	25/6 2026	Bagian saran diselaraskan dengan. Rumusan masalah.	
8	26/6 2026	Acc. rasa layak untuk digunakan sidang seminar Hasil.	

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