ABSTRAK

OPTIMASI STABILITAS PENGUKURAN SENSOR *ELECTRIC FIELD MILL* MELALUI REDUKSI NOISE BERBASIS RANGKAIAN AMPLIFIER, RC FILTER DAN *MOVING AVERAGE FILTER* (MAF)

(2026: 69 Halaman +19 Gambar + 19 Tabel + Daftar Pustaka + Lampiran)

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Pengukuran medan listrik atmosfer menggunakan sensor *Electric Field Mill* custom rentan terhadap gangguan noise yang berasal dari getaran mekanis rotor, interferensi elektromagnetik motor DC, dan thermal noise komponen elektronik. Penelitian ini mengembangkan sistem monitoring medan listrik atmosfer dengan mengoptimalkan stabilitas pengukuran melalui pendekatan reduksi noise berlapis yang menggabungkan rangkaian amplifier berbasis Op-Amp LM358, RC *Low Pass Filter* dengan frekuensi *cutoff* 723 Hz, dan algoritma *Moving Average Filter* (MAF) pada mikrokontroler ESP32-S3. Rangkaian amplifier menghasilkan penguatan aktual rata-rata sebesar 11,87 kali dari penguatan teoritis 10 kali, rangkaian RC *Low Pass Filter* menghasilkan gain rata-rata 0,775 dengan redaman -2,21 dB, dan rangkaian buffer menghasilkan tegangan keluaran rata-rata 1,752 V yang aman untuk input ADC ESP32-S3. Penerapan MAF dengan nilai N=20 terbukti optimal dengan peningkatan SNR sebesar +1,16 dB dari 47,52 dB menjadi 48,67 dB, serta penurunan standar deviasi sebesar 12,48% dari 0,0063 menjadi 0,0055. Sistem berhasil merekam 110.706 data valid secara kontinu selama periode pengujian 16–22 Juni 2026 dengan delay pengiriman Blynk rata-rata 302 ms, membuktikan kemampuan sistem dalam memonitor medan listrik atmosfer secara *real-time* dan andal dalam kondisi nyata.

Kata Kunci: *Electric Field Mill*, Medan Listrik Atmosfer, Reduksi Noise, *Moving Average Filter*, ESP32-S3, IoT, Blynk.

ABSTRACT

STABILITY OPTIMIZATION OF *ELECTRIC FIELD MILL* SENSOR MEASUREMENT THROUGH NOISE REDUCTION BASED ON AMPLIFIER CIRCUIT, RC FILTER AND *MOVING AVERAGE FILTER* (MAF)

(2026: 69 Pages + 19 Figures + 19 Tables + References + Appendices)

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Atmospheric electric field measurement using a custom *Electric Field Mill* sensor is susceptible to noise interference originating from rotor mechanical vibrations, DC motor electromagnetic interference, and electronic component thermal noise. This study develops an atmospheric electric field monitoring system by optimizing measurement stability through a layered noise reduction approach combining an Op-Amp LM358-based amplifier circuit, an RC *Low Pass Filter* with a cutoff frequency of 723 Hz, and a *Moving Average Filter* (MAF) algorithm on an ESP32-S3 microcontroller. The amplifier circuit produces an average actual gain of 11.87 times from a theoretical gain of 10 times, the RC *Low Pass Filter* produces an average gain of 0.775 with an attenuation of -2.21 dB, and the buffer circuit produces an average output voltage of 1.752 V which is safe for the ESP32-S3 ADC input. The application of MAF with N=20 proved optimal, achieving an SNR improvement of +1.16 dB from 47.52 dB to 48.67 dB, and a standard deviation reduction of 12.48% from 0.0063 to 0.0055. The system successfully recorded 110,706 valid data points continuously during the testing period of June 16–22, 2026, with an average Blynk transmission delay of 302 ms, demonstrating the system's capability to monitor atmospheric electric field in real-time and reliably under actual field conditions.

Keywords: *Electric Field Mill*, Atmospheric Electric Field, Noise Reduction, *Moving Average Filter*, ESP32-S3, IoT, Blynk.