

पेटेंट कार्यालय
शासकीय जर्नल

**OFFICIAL JOURNAL
OF
THE PATENT OFFICE**

निर्गमन सं. 07/2026
ISSUE NO. 07/2026

शुक्रवार
FRIDAY

दिनांक: 13/02/2026
DATE: 13/02/2026

पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application :30/01/2026

(21) Application No.202641009988 A

(43) Publication Date : 13/02/2026

(54) Title of the invention : Fault Detection and Diagnosis System for Power Electronics Using Machine Learning and Signal Processing.

(51) International classification	:G06N 20/00, G01R 31/00, H02J 3/38, G06N 3/08, G01R 31/40	(71)Name of Applicant : 1)Dr. Ranadheer Reddy Ragidi, Address of Applicant :Dr. Ranadheer Reddy Ragidi, Associate Professor, Department of Electrical and Electronics Engineering, Balaji Institute of Technology and Science, Laknepally, Narsampeta, Warangal-506331 ,ranadheer222@gmail.com , Mobile No:9705670269 Telangana India 2)V V Rajesh Babu Anumula 3)PDVSK.Kishore 4)Dr. P N V Syamala Rao M, 5)Dr. Srinivasan Nagaraj, 6)Mr. Devesh Jaiswal 7)Mr.M.Santhosh Kumar 8)Ms. Jyotsana Kaiwart 9)Ms. K. Sudha
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(32) Priority Date	:NA	
(33) Name of priority country	:NA	
(86) International Application No	:	
Filing Date	:01/01/1900	
(87) International Publication No	: NA	
(61) Patent of Addition to Application Number	:NA	
Filing Date	:NA	
(62) Divisional to Application Number	:NA	
Filing Date	:NA	

(57) Abstract :

Abstract :: The present invention discloses an intelligent fault detection and diagnosis system for power electronic systems using a combined approach of machine learning and signal processing. Power electronic converters are essential components in applications such as renewable energy systems, electric vehicles, industrial drives, and smart grids, where reliable and continuous operation is critical. Due to high switching frequencies, thermal stress, and harsh operating conditions, power electronic components are susceptible to various faults that can degrade performance, reduce efficiency, and lead to system failure if not detected at an early stage. The invention continuously monitors electrical signals such as voltage, current, and temperature obtained from the power electronic system. Advanced signal processing techniques, including time-domain, frequency-domain, and time-frequency analysis, are applied to extract meaningful features that capture fault-related characteristics and subtle deviations in system behavior. These features are then analyzed using machine learning algorithms trained to distinguish between normal and faulty operating conditions and to classify different types of faults affecting power electronic components. The proposed system operates in real time and is capable of detecting incipient faults that are difficult to identify using conventional threshold-based or rule-based methods. By learning complex patterns from data, the machine learning framework provides robust fault detection and accurate diagnosis under varying load and operating conditions. The system further supports predictive maintenance by assessing system health and providing early warnings before faults escalate into critical failures. The invention is scalable and adaptable to different power electronic topologies and applications without significant hardware modification. By integrating intelligent data-driven analysis with advanced signal processing, the proposed fault detection and diagnosis system significantly enhances reliability, safety, and operational efficiency while reducing maintenance costs and unplanned downtime. This invention offers an effective and innovative solution for condition monitoring and fault management in modern power electronic systems.

No. of Pages : 15 No. of Claims : 6