International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

# Identification Of Open Switch Faults In Three Phase Voltage Inverter Fed Permanent Magnet Brushless Dc Motor

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**ABSTRACT:**

The flawed execution of perpetual magnet (PM) brushless dc engine drives is considered less than one and concurrent two open-switches deficiencies conditions. This DC engine is provided with a three stage two level six IGBT voltage source inverter. The three stages streams mean estimations of the DC engine are utilized as indicative records. A learning calculation is constructing to get data with respect to which IGBT is in open-switch blame condition. This calculation testing demonstrates that the framework couldn't just distinguish the open-switch blame, yet in addition recognize the flawed switch. Introduced reproduction comes about affirm the viability of the proposed approach.

**Keywords: Brushless DC Motors, Fault Diagnosis, IGBT, One Open-Switch, Two Open- Switches, Mean Value, Min And Max Value, Logic Functions, Boolean Value.**

## 1. INTRODUCTION:

Programmed blame identification of electric machines and drive frameworks is a testing errand that has as of late attracted expanding consideration. A wise administration of on-line condition observing prompting issue recognizable proof, blame area, and blame seriousness assessment speaks to the far objective. Exact determination and early discovery of incipient issues help to stay away from unsafe, here and there devastative outcomes of the blame. Repair necessities and the time allotment could be preset in light of the programmed different thinkers, which reflects bring down cost. Brief therapeutic activities that enable the machine to keep running under blame are immovably in light of the online diagnostics and profoundly prescribed for blame tolerant frameworks.

Certain methodologies are to be followed keeping in mind the end goal to accomplish the programmed analysis mission. Considering framework execution under particular blame conditions and comparing it with solid execution yields at least one characteristic waveforms that could recognize the blame. Highlights extricated from the trademark waveform(s) are utilized as info information to the online analysis process.

Different systems for open-switch blame location in voltage source inverter (VSI)- nourished heartbeat width-regulation (PWM) non concurrent engine drives were exhibited in [1]. Observing voltages at key purposes of the framework and com-paring them with individual references could effectively analyze the blame. Impermanent healing activities under comparable blames on lasting magnet (PM) synchronous engine drives were endorsed for blame tolerant musical damnation [2]. Converter topology with eight switches helped the machine to create more torque under blame than the established six-switch arrangement.

Master frameworks, simulated neural systems (ANNs), fluffy and versatile

fluffy frameworks, and hereditary calculations (GAs) speak to the cutting edge AI devices, which have been utilized as a part of the territory [3], [4]. Versatile neurofluffy induction frameworks (ANFIS) are made out of fluffy derivation frameworks executed in the structure of versatile systems [5]. Example arrangement through learning, nonlinear guide ping and use of human aptitude are cases of the capable highlights of ANFIS. New and promising re-look skylines in the territory of engine blame location could be investigated utilizing fluffy derivation frameworks actualized on neural structures [6].

The present work introduces a simple demonstrative technique for one and concurrent two open-switches blames on the inverter extension of voltage-source inverter (VSI)-sustained PM brushless dc engine drives. Solid and flawed sys-tem were recreated in

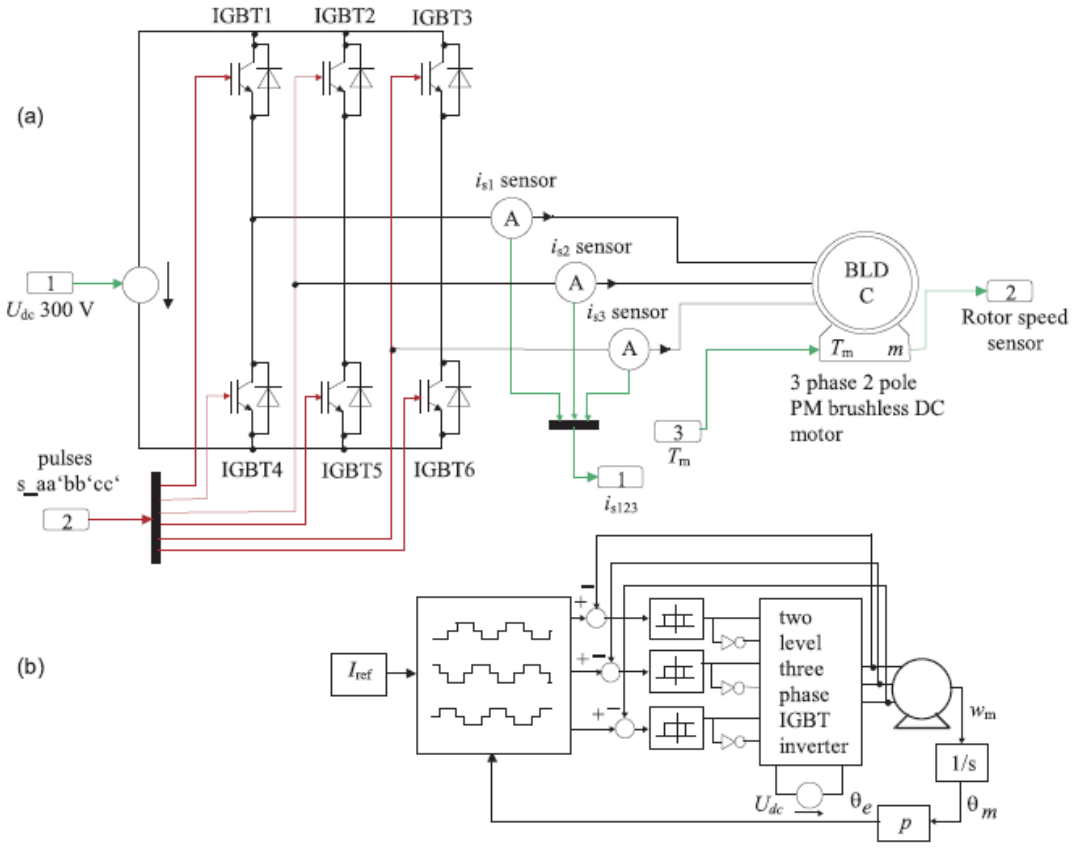


Fig. 1. Schematic diagram of the drive system:(a) - Electrical power part of the systems (Plecs/Matlab), (b) - Global of the system

PLECs/MATLAB program. Blame effect on every last one of the three stages streams mean esteems is seen to consider the fitting conclusion calculation basing on the esteem and the extremity of the mutt rents mean esteems under blame condition. This method testing demonstrates its viability in recognizing and finding the open-switch blame.

## 2. RELATED STUDY:

The VSI-fed PM brushless DC motor drive considered in this work is presented in Fig. 1, with: DC supply 300 V; IGBT-based three-stage inverter connect; Three current sensors; Three-stage engine having trapezoidal back elec-tromotive power (emf) and two shafts PM rotor with rotor speed sensor

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Re-enactment comes about under both typical and defective conditions will be utilized in the long run to consider the diagnosing calculation basing on streams zero consonant parts and their greatest and least esteems and their polarities. Ordinary working condition is portrayed by, theoretically, a nil zero consonant segment esteem and particular greatest and least estimations of each stage current. As commented in Fig. 3, in typical working condition, streams zero symphonies segments esteems are nearly nil (0 A). An adjustment in stage streams waveforms is characterized as the moment at which a sudden increment or lessening is seen in zero symphonies segments estimations of three stages ebbs and flows. A change is considered to have happened in three stages esteems when they surpass or fall underneath a given band (±0.5 A).

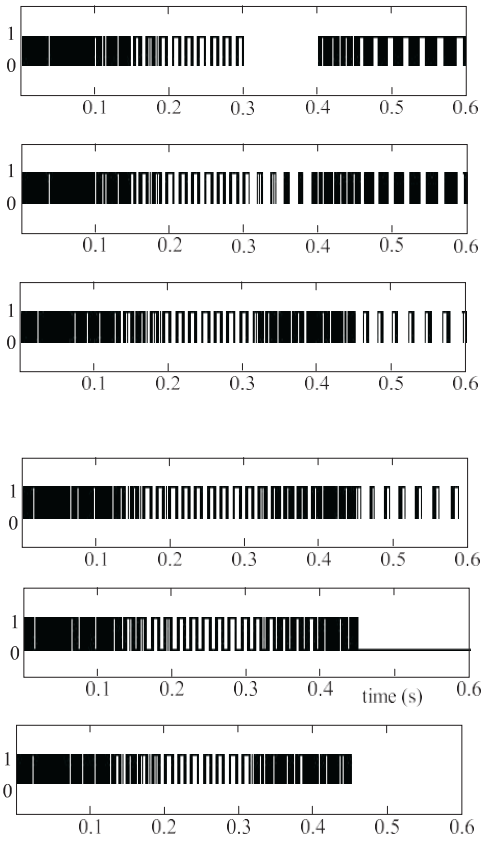


Fig. 2. Boolean firing signals in safe and open switch fault condition(IGBT1 open gate fault condition and IGBT5 and IGBT6 open gate fault condition). From the top to the bottom: IGBT1, IGBT4,IGBT2, IGBT5, IGBT3, IGBT6.

## 3. AN OVERVIEW OF PROPOSED SYSTEM:

In the two cases, one stage current zero symphonious part is of a sign that is not quite the same as the other two stages streams zero consonant segments ($i_{s1,mean}$ = 0 A to −1.6 A to 0 A to −1.6 A, $i_{s2,mean}$ = 0 A to +0.75 A to 0 A to +0.8 A, $i_{s3,mean}$ = 0 A to +0.75 A to 0 A to +0.8 A) blame of an upper IGBT of one leg and concurrent open-switch blame of lower IGBTs of different legs. In the two cases, one stage current zero symphonious part is of a sign that is not quite the same as the other two stages streams zero consonant segments ($i_{s1,mean}$ = 0 A to −1.6 A to 0 A to −1.6 A, $i_{s2,mean}$ = 0 A to +0.75 A to 0 A to +0.8 A, $i_{s3,mean}$ = 0 A to +0.75 A to 0 A to +0.8 A) (Fig. 3).

Along these lines, another parameter is acquainted with have the effect between one open-switch blame of an upper IGBT of one leg and synchronous open-switch blame of lower IGBTs of different legs. This parameter is the min-imum estimation of streams. On account of one open-switch blame of an upper IGBT of one leg, least estimations of alternate stages, connected to safe legs, streams are neg-ative. Be that as it may, on account of concurrent two open-switch blame of the lower IGBTs of the other two legs, least estimations of alternate stages, connected to these legs, streams are nil ($i_{s1,min}$ = 0 A to −5 A to −6 A, $i_{s2,min}$ = 0 A to −5 A to −6 A to −1 A, $i_{s3,min}$ = 0 A to −5 A to −6 A to −1 A) (Fig. 3).

On account of one open-switch blame of a lower IGBT of one leg and concurrent open-switch blame of upper IG-BTs of different legs, streams least esteems will be utilized

to have the effect between these two blame conditions (Fig. 3).

Streams zero consonant segments are ascertained using the discrete variable-recurrence FFT estimation hinder in Simulink/Matlab with test time of 0.0001 s and in-put flag (stage current) recurrence decided basing on the rotor speed. Stages streams waveforms with their mean esteems and least esteems are exhibited in Fig. 3 and rotor speed and electromagnetic torque waveforms are introduced in Fig. 4.The stage current fluctuates around a preset current reference that yields the coveted torque esteem.

Figure 5 demonstrates the discovery calculation Boolean out-puts when IGBT1 open circuit blame. It is noticed that the location framework is performing in open circuit IGBTs blame discovery. Notwithstanding, there is a short de-lay time of 0.02 seconds between blame event time and blame location time. This postpone time is because of the deferral presented by the mean esteem computation calculation and additionally the width of the mean esteem hysteresis tolerance band (±h1 ). This band was evaded a flawed recognition amid the beginning time of the DC brushless engine (the band might be expanded or diminished depending on the benefit of working stator

| Phase | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
|---|---|---|---|---|---|---|---|---|---|
| Faulty IGBT | $I_s$123 Mean | | | Is123 Min | | | Is123 Max | | |
| 1 | - | + | + | <-h | <-h | <-h | 0 | >h | >h |
| 2 | + | - | + | <-h | <-h | <-h | >h | 0 | >h |
| 3 | + | + | - | <-h | <-h | <-h | >h | >h | 0 |
| 4 | + | - | - | 0 | <-h | <-h | >h | >h | >h |
| 5 | - | + | - | <-h | 0 | <-h | >h | >h | >h |
| 6 | - | - | + | <-h | <-h | 0 | >h | >h | >h |
| 5,6 | - | + | + | <-h | -h | -h | H | >h | >h |
| 4,6 | + | - | + | -h | <-h | -h | >h | H | >h |
| 4,5 | + | + | - | -h | -h | <-h | >h | >h | h |
| 2,3 | + | - | - | -h | <-h | <-h | >h | H | h |
| 1,3 | - | + | - | <-h | -h | <-h | H | >h | h |
| 1,2 | - | - | + | <-h | <-h | -h | H | H | >h |
| 1,2,3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4,5,6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Table:1 Polarity of the Mean value of phase currents and limits of Min and Max values corresponding to faulty open circuit IGBT.

Streams) for this situation, current Hysteresis Band= ±0.4 A.
The band saved for Min and Max estimations of streams was picked basing one the ebbs and flows controllers hysteresis groups (h ebbs and flows = ±1 A). So the streams Min/Max esteems hysteresis band= ±h (ebbs and flows + Ψ) with (Ψ = 0.5 A).

A manufactured insightful framework, for example, a master framework is prescribed to be utilized to recognize the flawed gadget, as arranged in Table (1).Re-enactment comes about demonstrate that when the base drive open circuit blame (IGBTi, I = 1, . . . , 6 ) is presented and stator streams are inspected as a component of disappointment mode, there will be six distinctive stator ebbs and flows comparing to the individual transistor base drive open-circuit blame of IGBT1, IGBT2, IGBT3, IGBT4, IGBT5 and IGBT6. In every one of the six cases, this blame presents a non-nil zero symphonies

## 4. SIMULATION RESULTS

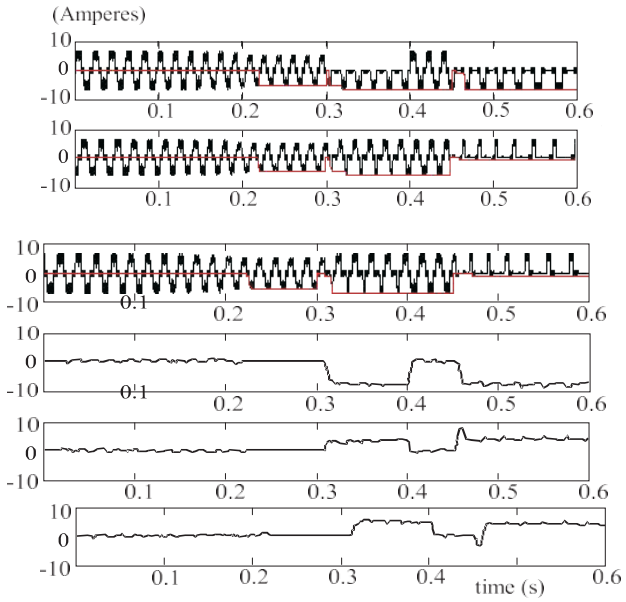


Fig. 3. Phases currents waveforms in safe and open switch fault condition (IGBT1 open gate fault condition and IGBT5 and IGBT6 open gate fault condition). From the top to the bottom: ( is1 ,is1,min ), ( is2 , is2,min ), ( is3, is3,min ), is1,mean, is2,mean, is3,mean .
Shunt APF could compensate the voltage On account of synchronous two open-switch blame IG-BTs, another parameter is acquainted with make the difference between one open-switch blame of an upper IGBT of one leg and concurrent open-switch blame of lower IGBTs of different legs and bad habit versa. If there is a blame in the three phases (in the upper leg or the lower leg) at that point it will find the blame burden.

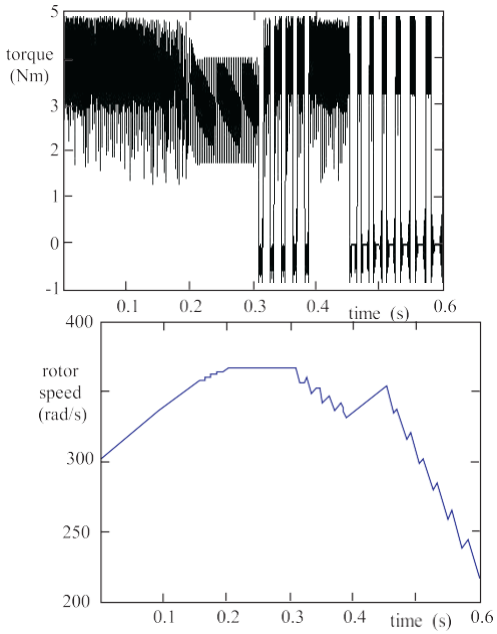


Fig. 4. Rotor speed and electromagnetic torque in safe and open switch fault condition (IGBT1 open gate fault condition and IGBT5and IGBT6 open gate fault condition) From the top to the bottom: rotor speed (rad/sec), electromagnetic torque (Nm).

## 4. CONCLUSION:

This paper exhibits efficiently a novel straightforward approach to identify the inverter shortcomings of one and simultaneous two open switches blame condition for open circle controlled PM brushless DC engine drives. The zero harmonic segment estimations of stator streams and additionally their Max/Min esteems have been utilized to

recognize the inverter deficiencies.

Usage of this procedure requires just three streams sensors, flag securing framework and estimation processor. The outcomes are critical for the screening and blame recognition of the inverter in drives framework. The work can be reached out to other converter configurations or drives.

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