THERMAL MODEL AND EXPERIMENTAL VALIDATION OF IRF 3205 MOSFET SWITCHES FOR INVERTER APPLICATION

Supported by tetfund

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Received: November 24, 2017 **Accepted:** March 05, 2018

Abstract: Power inverters operate under dynamic loads; the varying loads cause thermal expansion and contraction, which stress the internal boundaries between the material layers in the semiconductor. Eventually, the stress wears out the semiconductor module which ultimately leads to thermally induced failure. The primary goal of this article is to present thermal model for the IRF 3205 MOSFET chip switching operation for a power inverter. The solution of the models is implemented in MATLAB R2013a environment to obtain the transient temperature profile. The transient device temperatures are recorded with a K-type thermocouple and a three channel temperature logger, MTM-380SD, with real time data logger. Results show that the experimental steady state temperatures are lower than the simulated steady state temperatures by 1.10, 1.52, 1.17 and 0.73% for pulse loads of 460W, 675W, 1015W and 1500W, respectively.

Keywords: Power inverter, IRF 3205 MOSFET, stress, thermally induced failure

Introduction

Global consumption of electricity is projected to double its 2010 value by the year 2030 (World Nuclear Association, 2010). By that time it is anticipated that nearly all electrical energy will be processed through power inverters (Krein, 2010), due to the problems associated with present day conventional sources of electrical energy generation.

One of the most controversial public debates of the last decade has addressed the effects of energy related emissions on the environment. Serious and widespread recognition and alarm have centred on air quality and, in a more global context, the greenhouse effect and the destruction of the

intervening insulator (normally silicon dioxide). There is no significant current flow during either on state or off state in the circuit. The high input impedance is a primary feature of power MOSFETs, which greatly simplifies the gate drive circuitry (Baliga, 1987).

The possible advantage of operating MOSFETs at low temperature began to be explored in the 1970s when it became clear that higher current density and lower power loss at low temperatures would result in devices packaged in small, readily cooled volumes (Maddox, 1976; Gaenssslen and Rideout, 1976). Fig. 1 shows the structure of the lateral double-diffused MOSFET (LDMOS).