ACPL-339J and ACPL-C87A

Mitsubishi IGBT CM1800DY Reference Design

Reference Design

1. Introduction

Mitsubishi CM1800DY line of high power IGBT is used in high power electronic equipment such as trains and large-sized industrial machines. These applications require high voltage and current which can be supported by the CM1800DY which has rated V_{CES} of 1700V and I_C of 1800A.

The ACPL-339J is uniquely designed to support MOSFET buffer of various current ratings. The ACPL-339J makes it easier for engineers to design high power system using one hardware platform by interchanging the MOSFET buffers to drive large IGBT like the CM1800DY. This concept maximizes gate drive design scalability for power conversion applications ranging from low to high power ratings.

The ACPL-C87A voltage sensors are optical isolation amplifiers designed specifically for voltage sensing. Its 2V input range and high 1GΩ input impedance, makes it well suited for isolated voltage sensing. This is used to measure the IGBT temperature of CM1800DY via the NTC thermistor.

Figure 1. Mitsubishi IGBT CM1800DY with ACPL-339J and ACPL-C87A gate drive reference board

2. ACPL-339J and ACPL-C87A Gate Drive Reference Board Operations

Figure 2 shows the schematic of the ACPL-339J and ACPL-C87A gate drive reference board. The board consists of two ACPL-339J to drive two IGBTs in the CM1800DY in a half bridge topology. The ACPL-339J gate drive optocouplers are used to provide insulation for working voltage up to $1414V_{PEAK}$. At the same time, the dual outputs with active timing control, drive the P and NMOS mosfet pairs (Q6/Q7 for the top bridge, and Q1/Q2 for the bottom bridge) to provide more than 15A of peak current to the gate of the IGBTs.

The IGBT's collector-emitter voltage is monitored by ACPL-339J DESAT pin during IGBT normal operation. When short circuit occurs, IGBT comes out of saturation, into DESAT mode, causing the collector and emitter voltage to increase rapidly. Once it crosses the ACPL-339J's threshold of 8V, a short circuit fault is registered and soft shutdown is triggered. The ACPL-339J's V_{GMOS} pin will switch on MOSFET Q8 or Q3 to slowly discharge the gate of the IGBT to achieve the soft shut effect. The rate of the soft shutdown can be adjusted by the size of the MOSFETs (Q8/Q3) and resistors (R13/R26) to minimize the overshoot at the IGBT. Lastly, the entire DESAT operation is completed by reporting the FAULT through a built-in insulated feedback path to the controller via connecter CON1.

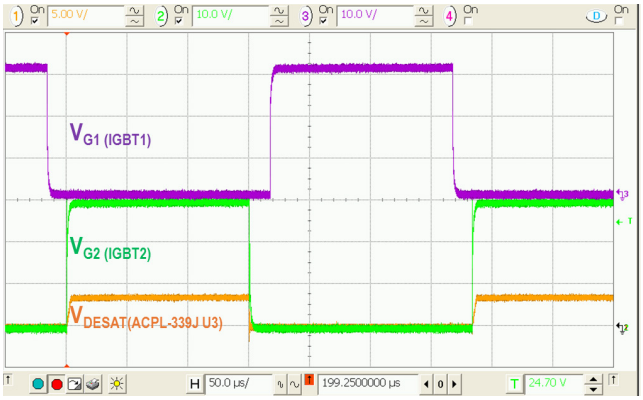

Figure 2. Switching waveforms at the gate of the IGBTs

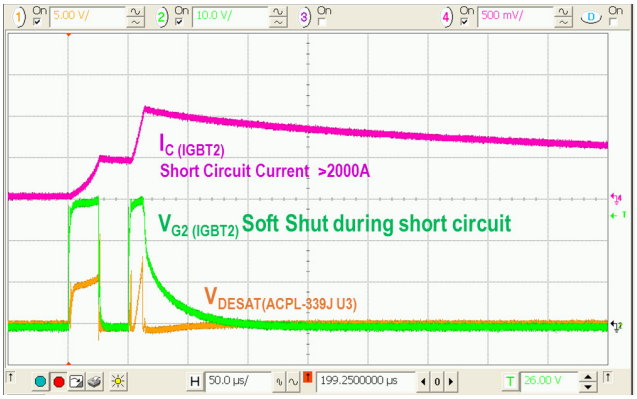

Figure 3. ACPL-339J soft shut the IGBT during short circuit

The temperature of the IGBT is measured via the IGBT's NTC thermistor terminal TH1 and TH2. The resistance of the thermistor is a linear function of the temperature as shown in figure 4.

A resistive voltage divider network, R27, is used to scale the thermistor voltage to suit the input range of the voltage sensor ACPL-C87A. The scaled input voltage is filtered by the anti-aliasing filter formed by R32 and C29 and then sensed by the ACPL-C87A. A differential output voltage that is proportional to the input voltage is created on the other side of the optical isolation barrier.

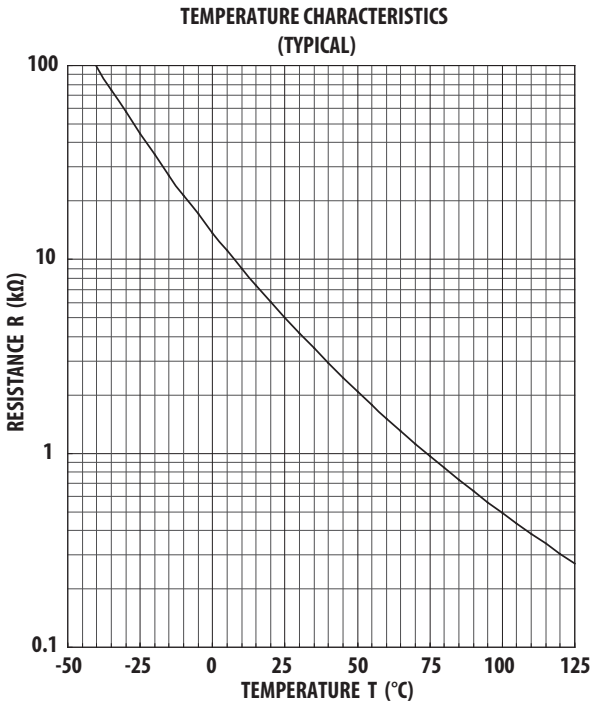

Figure 4. CM1800DY NTC thermistor resistance vs. temperature

Following the isolation amplifier, an OPA237 configured as a difference amplifier converts the differential signal to a single-ended output. This stage can be configured to further amplify the signal, if required, and form a low-pass filter to limit the bandwidth. In this circuit, the difference amplifier is designed for a gain of 1 with a low-pass filter corner frequency of 8 kHz. Resistors R28 and R31 can be selected for a different gain. The bandwidth can be reduced by increasing capacitance for C26 and C30.

The isolated power supplies are provided by DC/DC converters (U2/U4) for the top and bottom bridge. The DC/DC converter accepts an input voltage range from 9 to 18V and provides dual ±15V supply to power up the ACPL-339J and MOSFET buffers. U6 is used to regulate the 15V supply to 5V to power up the ACPL-C87A.

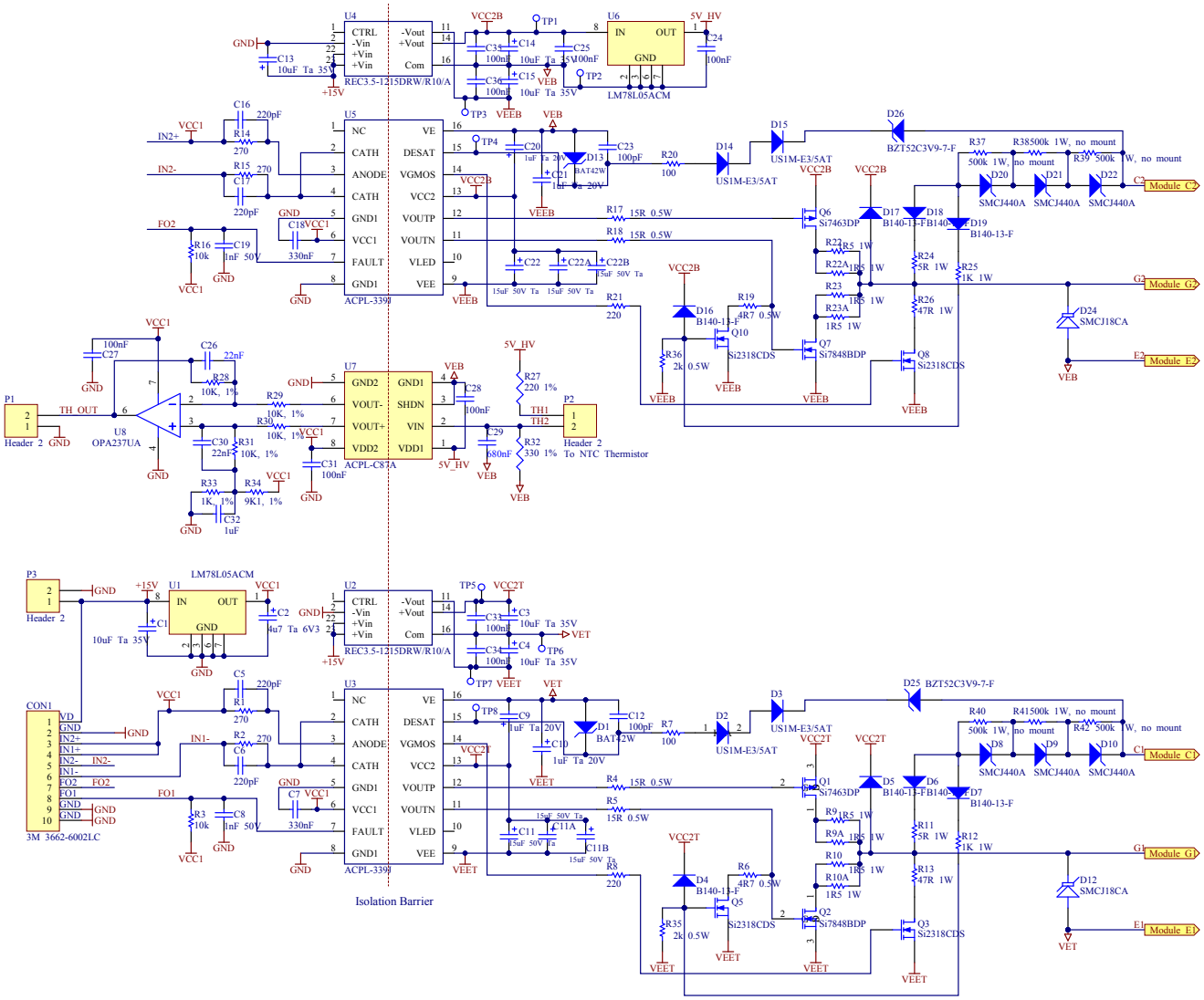

Figure 5. Schematic of ACPL-339J and ACPL-C87A gate drive reference board

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