Application Note AN-1163

IR5001 Active ORing Controller for solar panels and +48V applications

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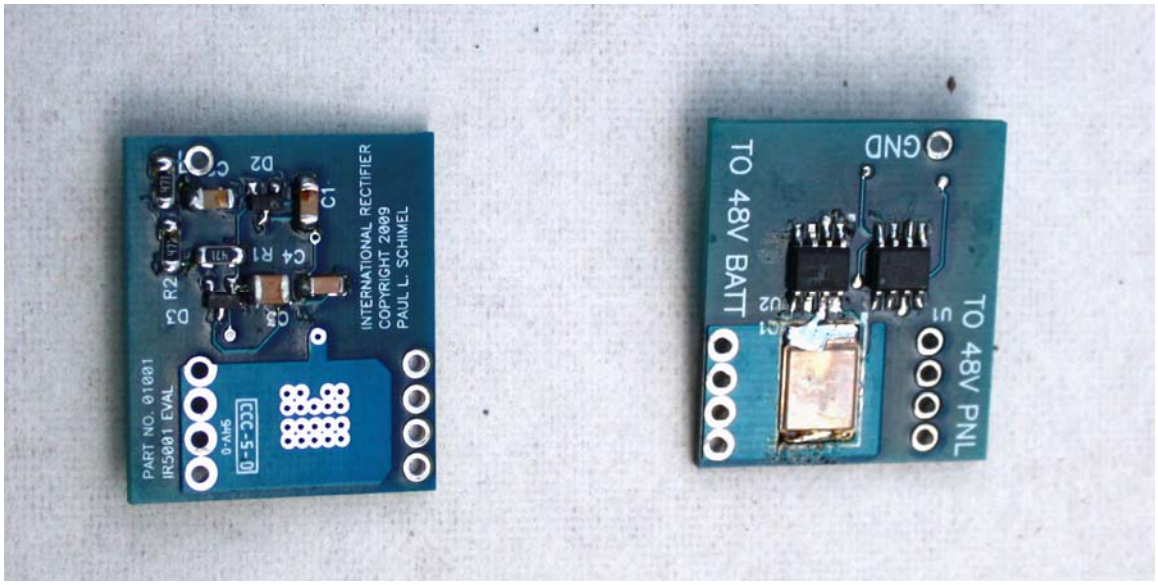
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USER GUIDE FOR IR5001 EVALUATION BOARD

The IR5001 is a universal high-speed controller and N channel MOSFET driver for Active ORing and reverse polarity protection applications. The output voltage of the IR5001S is determined based on the polarity of the voltage difference on its input terminals—if the current flow through the N-channel ORing FET is from source to drain, the output of the IR5001S will ve pulled high to Vcc thus turning the active ORing FET on. If the current reverses direction and flows from drain to source, the IC will quickly switch the Active ORing FET off.

DESCRIPTION

The IR5001 evaluation board features the IR5001 and either a medium can DirectFET or a large can DirectFET. This board was designed for Active ORing applications up to 36 to 72V telecom mains voltage. The active switch in this design is in series with the positive lead of the output, thereby allowing Active ORing in a +48V system like those in solar panels, 48V backplanes, and small wind power applications. The IR5001 evaluation board can be easily changed to operate in a +24V system. The DirectFET can also be reduced in voltage for these applications.

BOARD FEATURES

- IR5001S Active ORing Controller,
- A large or medium can DirectFET
- ISL7660 Charge pump controller IC (from Intersil™)
- Set up for active ORing on +48V applications
- Large Can DirectFET can handle 15A of throughput current with minimal airflow at 50 degrees C ambient temperature

CONNECTIONS AND OPERATING INSTRUCTIONS

Connecting the IR5001 Evaluation Board to your power supply or solar panel is very straightforward. First, open the connection on the positive output bus between the output capacitor bank of your power supply and the output connector. The output capacitor bank connects to the 4 large vias on the board labeled “TO 48V PANEL”. The Output connector then connects to the other 4 large vias on the board labeled “TO 48V BATT”. These are high current connections and the conductors, foils, or bussbars need to be sized accordingly.

The one remaining large via labeled “GND” needs to connect to ground with a small conductor. This simply gives the charge pump circuit a reference and a return. This is a low current connection.

If you are connecting a solar panel to the evaluation board, and perhaps a battery bank and you intend on using the evaluation board as an electronic means to keep current from flowing from the battery bank into the panels, you connect the positive lead from the 48V panels to the 4 vias labeled “TO 48V PANEL”. You then connect positive lead from the 48V battery to the 4 vias labeled “TO 48V BATT”. Again, these are the high current connections, and the conductors need to be sized accordingly.

The vias labeled “GND” needs to be connected to the negative bus. This is a low current connection.

Also, in any connection, the loop areas should remain as small as possible with shortest possible leads. Remember, this switch opens quickly. The stored energy in the nH of the loop inductance to the evaluation board and the square of the current flowing in the loop need to be kept much smaller than the maximum avalanche energy of the DirectFET power switch.

Operating the board is fairly simple and autonomous. It passes forward current (from the panel to the battery) via a saturated DirectFET and blocks reverse current (from the battery to the panel) by opening the DirectFET power switch and allowing the intrinsic body diode of this switch to block the current. The IR5001 evaluation board can be easily reconfigured to operate a +24V system by changing R1, R2, and R3 in the charge pump circuit to 1.47K. The power switch can also be changed to a lower Vds rating such as the IRF7749 or the IRF6648 for 24V operation.

The IR5001 datasheet states that the reverse current threshold is at (INN-INP)=4mV typical and 8mV max. There is of course hysteresis on this number to keep the part from oscillating. This number allows us to see the sensitivity of the reverse interrupt circuit. For example, with the IRF7769 DirectFet, the Rdson is stated as 0.0028 Ohm. For the interrupt circuit to trip, we would need a maximum

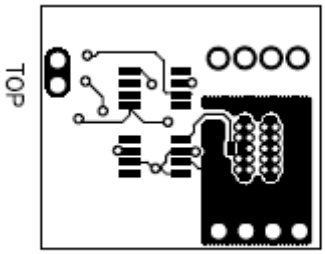
reverse current of 8mV/0.0028 Ohm or 2.86A maximum. The circuit would trip within 40 ns of detecting this as per the tf specification in the datasheet.

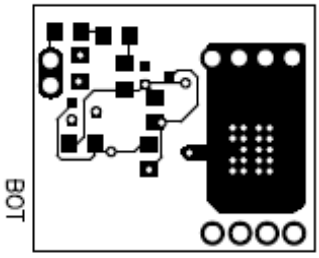
If the threshold is to be tested, I recommend placing a 48V battery on the “TO 48V Panel” side of the switch, and then either a power supply to attempt to charge the battery on the “TO 48V BATT” side of the switch or a load. You will find that the reverse current interrupt threshold is less then approximately 2A for the IR7769 Large Can DirectFET and less than 0.5A for the IRF6644 Medium Can DirectFET. The large can device has lower $R_{DS(on)}$ and will have lower forward losses for a given current. The medium can DirectFET will have slightly larger forward losses which are traded against reverse interrupt sensitivity in this circuit.

This circuit provides a means to remove the loss of the blocking diode in active Oring applications. The specific technical details on the operation of the IR5001 IC is included in the IR5001 datasheet at:

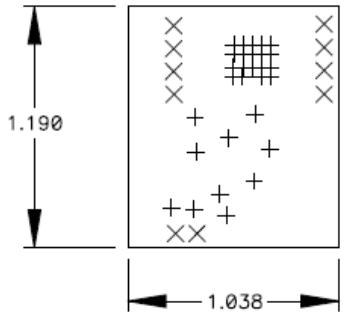
http://www.irf.com/product-info/datasheets/data/ir5001s.pdf

PCB LAYOUT



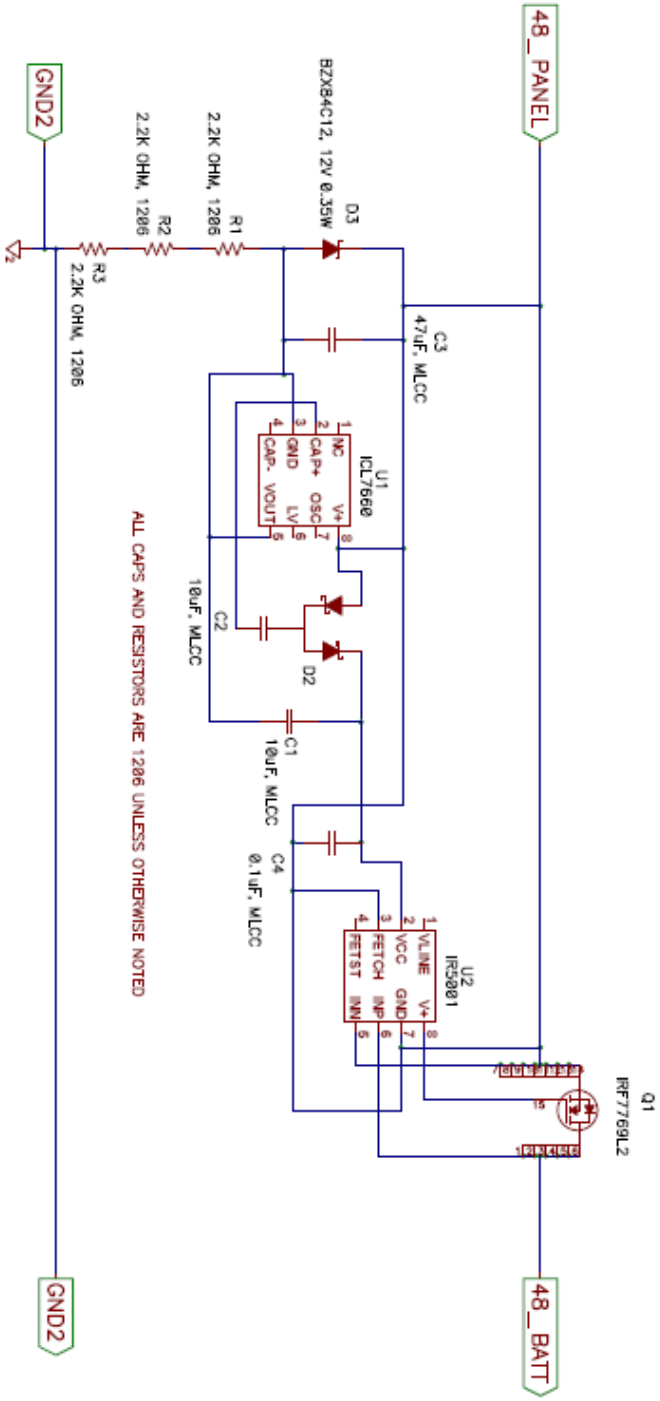


Drill Table			
Hole Dia (inch)	Symbol	Quantity	Plated
0.018	+	29	Yes
0.056	×	10	Yes



NOTES:
1.) LAMINATE MATERIAL: COPPER–CLAD FR–4
2.) COPPER WEIGHT: 1oz FINISHED
3. FINISHED THICKNESS: 0.062" +/–0.010
4.) MIN PLATING THICKNESS IN THROUGH HOLES: 0.001"
5.) LPI SOLDERMASK ON BOTH SIDES USING APROPRIATE LAYER ARTWORK: COLOR=BLUE
6.) LPI SILKSCREEN AS REQUIRED: COLOR=WHITE
7.) VENDOR INFORMATION TO BE INCORPORATED ON BACKSIDE WHENEVER POSSIBLE
8.) BOARD MATERIALS ARE TO BE UL94V–0
9.) STACKUP IS AS FOLLOWS:
TOP
BOT

SCHEMATIC


48_PANEL
GND2
BZX84C12, 12V 0.35W
D3
2.2K OHM, 1206
R1
2.2K OHM, 1206
R2
2.2K OHM, 1206
R3
C3
47uF, MLCC
U1
ICL7660
NC
CAP+
GND
CAP-
VOUT
LV
OSC
V+
C2
10uF, MLCC
D2
C1
10uF, MLCC
C4
0.1uF, MLCC
U2
IR3801
VLINE
VCC
FETCH
FETST
GND
INP
INN
V+
Q1
IRF7769L2
ALL CAPS AND RESISTORS ARE 1206 UNLESS OTHERWISE NOTED
GND2
48_BATT

BILL OF MATERIALS

BOM FOR PN01001
IR5001 48POS

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REF DES	DESCRIPTION
C1, C2	10uF, MLCC, 1206, X7R
C3	47uF, MLCC, 1206, X7R
C4	0.1uF, MLCC, 1206, X7R
D2	BAT54S, DUAL SCHOTTKY, SOT23
D3	BZX84C12, 12V, 0.35W ZENER, SOT23
R1, R2, R3	2200 OHM, 5%, 1206 RESISTOR
Q1	IR7769L2, 100V, 0.0035 OHM, DIRECTFET 2
U1	ICL7660 INTERSIL CHARGE PUMP SOIC
U2	IR5001 OR CTRL, SOIC