Applied Processor and Measurement, Inc.

Application Note AN-0001 – Using an External MOSFET to Increase PWM Controller Output Power

• Summary

The Model 205 and Model 400 PWM Controller are rated for a maximum of 50W of output power. For a 12V application, this is 4A maximum. For an automotive application where VBAT can vary from 9 to 16V, a 3A maximum is recommended. Although there are many power MOSFET's available, internal construction of the PWM Controller (connectors, PCB, and wiring ratings) prohibit APM, Inc. from simply changing the MOSFET device in order to increase the operating voltage and/or current. There are devices capable of switching much higher power ratings than 50W. This application note describes how to connect the Model 205 or the Model 400 PWM Controller with an external MOSFET device in order to increase the operating voltage and or current rating of the PWM application.

• MOSFET Device Review

The Model 205 and the Model 400 PWM Controllers use MOSFET's from International Rectifier Corporation in a low side drive output configuration (refer to the User's Manual for a block diagram of the PWM Controller output configuration). The ratings of three International Rectifier MOSFET's are given in the table below.

Parameter	IRL530N	FA38SA50LC	FB180SA10
Voltage (max)	100V	500V	100V
Current (max)	17A	38A	180A
RDSon (max)	0.12 ohms	0.13 ohms	0.0065 ohms
Power (max)	79W	500W	480W
Gate Switching Voltage (nom)	5V	10V	10V
Package	TO-220	SOT-227	SOT-227
Cost (unit, approximate)	$1.50	$35.00	$35.00

Note from the table data that the maximum power that can be achieved with some of these devices is up to 500W (for example, the FA38SA50LC). However, if the application is operating at 50V, then only 10A max may be controlled by the device. If the device is pulsed, more current may be switched. In order to determine how much current may be safely switched by the device for a particular application, consult the Safe Operating Area graph on the device datasheet. Using this data, you can then select the proper device and insure that the MOSFET is suitable for the application. Finally, these specifications are all cited considering that the device is operating at 25 ºC. Heatsinking and operating temperature must be considered, and the maximum operating power can be de-rated accordingly.

The Model 205 uses the IRL530N in the TO-220 package which is a standard 3 pin, power IC transistor package. The transistor is PCB mounted with a heatsink, however, the Model 205 is a sealed plastic box (no airflow) and not intended for very high power dissipation applications. In a 12V application, 2 to 3 A may be easily controlled by the IRL530 without having to be concerned about heat dissipation in the MOSFET. Therefore, the Model 205 maximum power dissipation is rated at 50W (= 12.5V * 4A).

The Model 400 uses a smaller surface mount device. In order to compensate to achieve the same power capability as the Model 205, a device with a higher current rating (and lower RDSon of 0.027 ohms) was chosen.

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• Applying the FA38SA50LC MOSFET Device Using an APM, Inc. PWM Controller

The output power rating of the APM, Inc, PWM Controller may be easily extended by using a MOSFET device such as the FA38SA50LC from International Rectifier. The device is stocked by electronic component distributors such as Newark InOne (www.newark.com) and Digi-Key Corporation (www.digikey.com).

The FA38SA50LC is packaged in an SOT-227 metal 'brick' style package, with 4 screw terminal leads (see illustration below). The metal base is electrically isolated from all of the terminal connections and is therefore easy to heatsink by mounting the device on an electrical panel, enclosure, or any suitable piece of metal for a benchtop / experimental application.

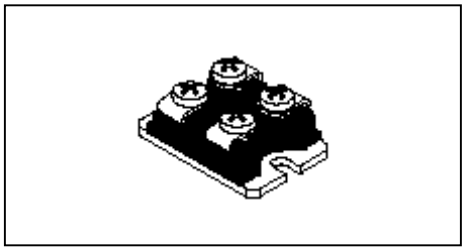

Figure 1. Illustration of a MOSFET in an SOT-227 package.

Consulting the datasheet for the FA38SA50LC and examining the Safe Operating Area curve, it can be seen that nearly 20A of DC current should be able to be switched for a 12V DC application. Note that even higher currents may be switched based on the pulse times shown on the graph.

Figure 3 shows how to connect the Model 205 PWM Controller to the FA38SA50LC MOSFET in order to switch higher voltage and/or currents in a PWM application.

Figure 2 below shows the pin out for the FA38SA50LC device. Be sure to consult the data sheet on the device for the proper pin out if a different part number is used in your application. Note that for the FA38SA50LC pins 1 and 4 are both connected to the MOSFET Source pin (S). Also note that the metal base of the device is NOT connected to any of the device pins. Therefore, when mounting the device, there is no concern with electrically shorting external power to any device pin through the metal base.

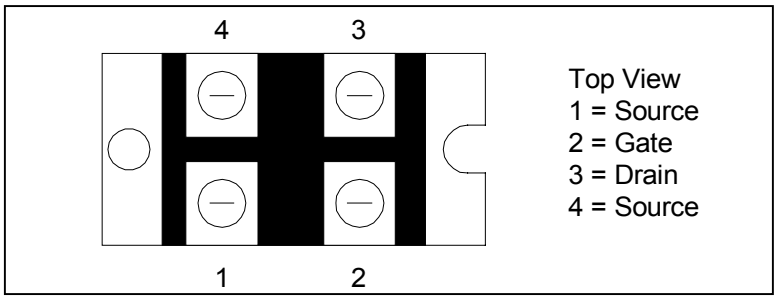

Figure 2. FA38SA50LC MOSFET device pin out.

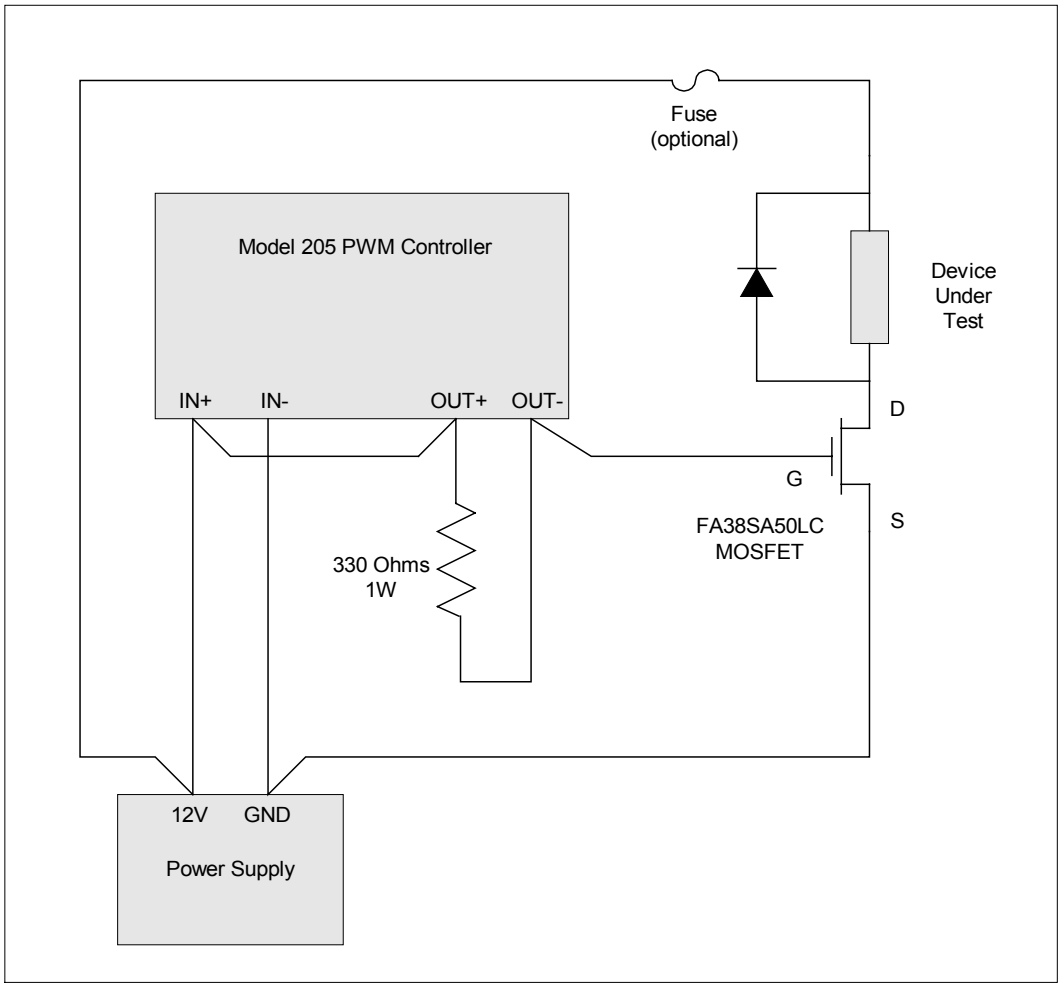

Figure 3. Switching a FA38SA50LC MOSFET device with the Model 205 PWM Controller.

In the example of figure 3, the Model 205 PWM Controller drives the gate pin (G) of the FA38SA50LC MOSFET. In this example, a single 12V power supply is used to power both the PWM Controller, and the load being switched. This configuration extends the current driving capability of the Model 205 PWM Controller. If the load must be powered by a voltage > 20V, then two power supplies will be required for the application. One higher voltage or current power source is used for the load, and a second lower power output, 12V supply, is used for the PWM Controller and the MOSFET gate drive. Note that the MOSFET gate must have at least 10V gate drive and cannot exceed 20V (even though the PWM Controller may be powered by 24V DC). The power supply ground may be commoned at the power supply. Avoid placing the common ground at the PWM Controller. Having the common ground connection there may introduce noise to the PWM Controller input circuitry.

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Since the PWM Controller output is itself an open-drain MOSFET, a load must be placed at the output in order for the gate voltage to switch, thus the 330 ohm resistor. Note that the PWM Controller output coupled with the additional external MOSFET adds a level of inversion. That is, when the PWM Controller output is engaged (100% duty cycle), the voltage at the external MOSFET gate is 0V and the external MOSFET will be off. This may be compensated at the PWM Controller by using its Output Polarity Setting feature. If the polarity is set as High, the PWM Controller will read 100% duty cycle when the external MOSFET is fully on.

The figure also shows an optional external fuse. An in-line wired, AG type glass fuse is convenient and easy to install. Set the fuse value to protect your device and/or the external MOSFET from being subjected to extreme currents or an accidental short circuit.

• Conclusion

This application note presents a configuration by which the output power of a PWM application can be extended using a PWM Controller from APM, Inc. and a high power external MOSFET device. A configuration example is shown which extends the 12V PWM output current. In order to apply an external MOSFET in your particular application, follow these steps:

1. specify the output power requirements for your application
    a. operating voltage
    b. output current
    c. on-time or potential continuous output

2. consult MOSFET device data sheets (start with the example devices presented in this App Note)
    a. verify application operating voltage vs. device maximum VDSS specification
    b. verify application operating current vs. device maximum IDD specification
    c. verify application power vs. device Safe Operating Area graph

3. connect the device to the PWM Controller output
    a. if the application operating voltage is > 9V and < 20V use the example in figure 3 above
    b. if the application operating voltage is >20V, then a second power supply is required for the output load, a power supply of 12V is recommended for the PWM Controller and external MOSFET gate switch voltage
    c. be sure to use properly rated wiring and apply circuit protection as necessary

• Questions? Product Support

If needed, contact APM, Inc. directly for product support for assistance in applying a Model 205 or Model 400 PWM Controller and an external MOSFET with your application.

• APM, Inc. High Current Module

In order to provide a pre-packaged solution for our customers requiring extended power for their applications, a high current module accessory will be available for purchase from APM, Inc. The accessory is currently in design. The pre-packaged module will contain one of the International Rectifier SOT-227 MOSFET devices (table above) as well as the following:

- properly rated connectors (terminal strip) for the extended output power connections
- cabling from the module for direct connection to the Model 205 PWM Controller binding posts
- optical isolation between the PWM Controller and the high power external load
- an internal circuit board with a MOSFET gate driver circuit (improves gate turn-on time and reduces power losses during turn-on and turn-off)
- selectable output protection timer, allows the user to set maximum pulse width of the module output for improved load protection

Contact APM, Inc. sales for more information, pricing, and expected availability.

• Contact Information

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• References

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