

# OPTICALLY ISOLATED INTERFACE

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## Ramsey Electronics Model No. OM2

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*The OM2 provides 5000 volts of electrical isolation between the input and output signals. Any input signal, AC or DC, greater than 1.5 volts can be used to provide an output signal up to 40VDC at up to 150mA. The output can follow an input signal with a frequency from 0Hz to 250KHz or it can provide a constant level when an input signal is applied.*

- **AC or DC input**
- **40VDC @ 150mA output**
- **0Hz to 250KHz operation**
- **Output can either follow AC input or “latch” with signal input**
- **Over 5000 volts optical isolation between input and output signals**
- **Full custom configuration instructions included**





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### OM2

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## INSTRUCTION MANUAL FOR

# OPTICALLY ISOLATED INTERFACE

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## Introduction

The OM2, Optically Isolated Interface, provides an optically isolated interface between two devices. It can be used to interface nearly any AC or DC signal to a logic level signal. It can also be used to operate a relay upon detection of an input signal. The really great thing about the OM2 is the input and output are totally isolated from each other. Virtually any voltage input level above 1.5 volts can be used as long as the input current is limited to a maximum of 60mA. The input can be a simple DC level or an AC signal with a frequency up to 250KHz. (That's 250,000 cycles per second for the old pre-Hertz folks.) The input and output are isolated from each other to 5000 volts AC(rms) difference between the input and output connections. The output can drive up to 150mA at up to 40VDC. It even provides active low and high outputs when the input is activated.

## Theory of Operation

The heart of the OM2 is an optical coupler. An optical coupler contains an infrared LED and a photo transistor. When the LED is turned on it causes the photo transistor to turn on. The coupler used in the OM2 actually has two LED's on the input. These LED's are connected in parallel with each other in opposite directions. This makes it able to operate using either a DC or AC input. The DC polarity of the input doesn't matter since one of the LED's will be turned on when an input signal is applied regardless of polarity. We'll take a look at the schematic now and go thru the entire circuit operation.

## The Input Circuit

On the left side of the schematic you will see J1 which is the input connection. The input signal is applied to J1's two pins. Starting at pin 2 of J1 you will see resistors R1, R2 and capacitor C2 connected in series with each other. These components act to limit the current supplied to the LED's in OC1 pins 1 and 2. The LED's in OC1 are just like any other LED in that the forward current must be limited, in this case to a maximum of 60mA. Why are there two resistors and a capacitor you ask. Well we tried to give you lots of options to configure the OM2 to meet your requirements. The values shown for R1 and R2 are such that you can use a standard 110VAC or 220VAC signal to trigger the output. Since the original concept for the OM2 was to sense presence or absence of power on an AC power line it made sense to provide a simple way to select the input voltage by either having both resistors in place for 220VAC or to remove R2, by installing JMP1, to change to 110VAC. Notice they are both the same value and 220VAC is twice 110VAC so the current is changed by a factor of 2 by adding or removing one of the resistors. The "Configuring Your OM2" section of this manual explains how to set up the input of the OM2 for your application+. But what's C2 there for?

Under most conditions C2 is not required. If you have a DC input JMP2 MUST be installed which removes C2. If you are using an AC voltage input you may want to install C2 but for most applications JMP2 may be installed which removes C2. See the “Configuring Your OM2” section of this manual for more information about how to figure out resistor and capacitor values and if you need C2 for your specific requirements.

### **The Output Circuit**

Moving on, the output circuit consists of the transistor inside optical coupler OC1, transistors Q1 and Q2, along with resistors R3, R4, R5, R6, capacitor C2 and diodes D1 and D2. When either of OC1’s LED’s is turned on it causes it’s internal transistor to turn on. An external voltage, +V, is required for the output circuitry to operate. This voltage is applied to the OM2 on J3 and J4 and may be any voltage up to 40 volts DC depending on your application. Again the “Configuring Your OM2” section of this manual provides more information about this.

A little bit of transistor theory is provided here to help with understanding the OM2 operation. The base connection of a transistor is used to control the current flow between the emitter and collector. A very small amount of current flowing in the emitter/base circuit can control a very large current flow in the emitter/collector circuit. With no emitter/base current flowing, the current in the emitter/collector circuit is essentially turned off. If current is allowed to flow between the emitter and base then a larger current is allowed to flow in the emitter/collector. The base current can control a proportional amount of collector current based on the gain of the transistor. For our purposes we’ll just say that the collector/emitter current is either on when base current flows or off when there is no base current.

With no input signal applied to the OM2 the output transistor in OC1 is off which places a high level on the base of Q1 thru R3. Transistors don’t like a lot of current flowing from emitter to base so resistor R3 limits the current. This allows current to flow in the emitter/base circuit and Q1 is turned on allowing current to flow in the emitter/collector thru R4. When a signal is applied to the OM2 input the OC1 transistor turns on. It’s collector, OC1 pin 4, is essentially connected to it’s emitter, pin 3 connecting it to ground which stops the emitter/base current in Q1 and Q1 turns off. All that to say when an input is applied to the OM2 the optical coupler transistor is turned on and transistor Q1 is turned off making it’s collector high. With no input the optical coupler transistor is turned off and Q1 is turned on placing it’s collector at a low or ground level.

Now look at the connection between Q1’s collector and Q2’s base thru R6. When Q1 is turned off current can flow in the emitter/base of Q2 thru R4 and R6. This turns on Q2 in the same way Q1 is turned on when it’s emitter/base current flows which in turn places Q2’s collector at a low level. Turning on Q1

turns off Q2 by stopping its emitter/base current placing Q2's collector at a high level.

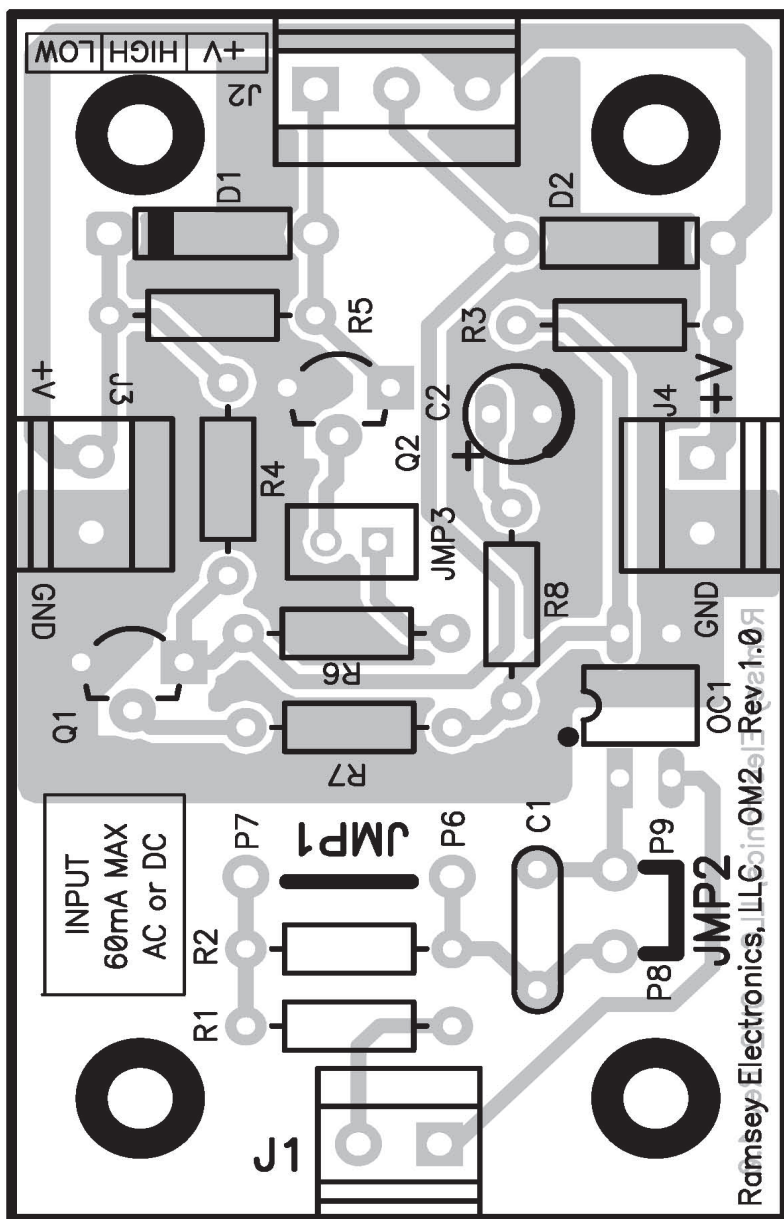
What we have is the ability to provide both a high(active high), and a low (active low), output signal when an input is applied to the OM2. The active high output is connected to J2 pin 2 from the collector of Q1. Active low output is provided on J1 pin 1 from the collector of Q2.

Now that we've explained the operation of the output transistors the only thing left is what capacitor C2 does. For simple DC input levels there is no need to have C2 in the circuit. It may even be desirable to remove it if fast acting input signals are used. But if you need to monitor an AC input signal such as an AC power line at 50/60Hz then C2 will be required. Without it the output will change at the rate of the input signal frequency. C2's value is such that a 50/60Hz input signal will produce a solid output signal from an AC input signal. For example when the input signal is power on an AC power line the output will be held at its active state until power is removed. Input signals with a frequency from 0Hz (DC) to 250KHz can be applied and will produce a corresponding pulsed output if C2 is not installed. With C2 installed the output will be a steady level according to the input signal.

Diodes D1 and D2 are placed across both the active high and active low outputs to provide protection if an inductive load such as a relay is used. This is necessary because when a current is passed through an inductor, the coil of a relay for example, a magnetic field is created around it. When the current is removed the field collapses and a voltage is induced in the coil in the reverse direction of the original applied voltage. This voltage can be many times the original and is the opposite polarity. This is called counter EMF (Counter Electromotive Force) and can damage the output transistors. The diodes are connected so they do not conduct when normal voltage is applied but conduct when the field collapses the diodes conduct and short out the counter EMF. They are optional and can be left in place for most applications but can be removed if they interfere with your application.

A load that draws up to 150mA at up to 40VDC can be connected between +V and either or both the active high and active low outputs on J2. See the "Connecting Your OM2" section for this manual for more information about connecting your OM2 to input and output devices.

# PARTS LAYOUT DIAGRAM



## RAMSEY “LEARN-AS-YOU-BUILD” ASSEMBLY STRATEGY

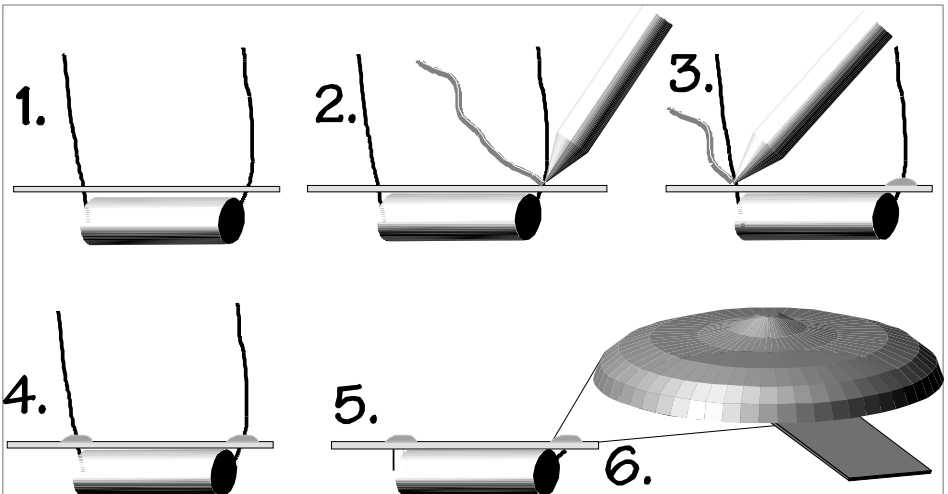
Be sure to read through all of the steps, and check the boxes as you go to be sure you didn't miss any important steps. Although you may be in a hurry to see results, before you switch on the power check all wiring and capacitors for proper orientation. Also check the board for any possible solder shorts, and/or cold solder joints. All of these mistakes could have detrimental effects on your kit - not to mention your ego!

### ***Kit building tips:***

Use a good soldering technique - let your soldering iron tip gently heat the traces to which you are soldering, heating both wires and pads simultaneously. Apply the solder on the iron and the pad when the pad is hot enough to melt the solder. The finished joint should look like a drop of water on paper, somewhat soaked in.

Mount all electrical parts on the top side of the board provided. The top side is clearly marked with the word “TOP”, you can't miss it. This is the side that has little or no traces on it, but is covered with mostly copper. When parts are installed, the part is placed flat to the board, and the leads are bent on the backside of the board to prevent the part from falling out before soldering (1). The part is then soldered securely to the board (2-4), and the remaining lead length is then clipped off (5). Notice how the solder joint looks on close up, clean and smooth with no holes or sharp points (6).

**Warning:** Use only rosin core solder or solder designed to be used with electronic equipment. Use of acid core solder will void your warranty and produce a board that will disintegrate in a short period of time.





## PARTS LIST

### Semiconductors

- 1 SFH620A optical isolator, (OC1)
- 2 2N3904 transistor, (Q1, Q2)
- 2 1N4002 diode, (D1, D2)

### Resistors

- 2 1K resistor, (R6) [brown-black-red]
- 3 10K resistor, (R3, R4, R5) [brown-black-orange]
- 1 10 ohm resistor, (R8) brown-black-black]

### Configuration Resistors

- 2 33K resistor, (R1, R2) [orange-orange-orange]
- 2 15K resistor, (R1, R2) [brown-green-orange]
- 1 39 ohm [orange-white-black]
- 1 82 ohm [gray-red-black]
- 1 220 ohm [red-red-brown]
- 1 470 ohm [yellow-violet-brown]
- 1 330 ohm [orange-orange-brown]
- 1 680 ohm [blue-gray-brown]

### Capacitors

- 1 47uF, 16V (C2 optional, application specific)
- 0 Application specific, NONE INCLUDED (C1)

### Connectors

- 3 2 pin screw terminals
- 1 3 pin screw terminals
- 1 2 pin header
- 1 Jumper block

### Miscellaneous

- 1 Circuit board

## **ASSEMBLY STEPS**

First we'll install the components that are common to all configurations of your OM2. Then the components that are configuration specific will be installed. Make sure to save at least 2 of the resistor leads trimmed off the resistors for use as jumpers later on.

- 1. Install OC1, optical isolator marked SFH620A. Make sure the small dot near one corner on the device matches the dot printed on the board outside the OC1 outline.
- 2. Install R3, 10K [brown-black-orange]
- 3. Install R4, 10K [brown-black-orange]
- 4. Install R5, 10K [brown-black-orange]
- 5. Install R6, 1K [brown-black-red]
- 6. Install R7, 1K [brown-black-red]
- 7. Install R8, 10 ohm [brown-black-black]

The white band on the component **MUST** match the white band on the circuit board for D1 and D2.

- 8. Install D1, 1N4002 [1N4002]
- 9. Install D2, 1N4002 [1N4002]

The following terminals are installed so the openings on the housing are facing the edge of the board.

- 10. Install J1, 2 position screw terminal
- 11. Install J3, 2 position screw terminal
- 12. Install J4, 2 position screw terminal
- 13. Install J2, 3 position screw terminal

Make sure the flat side on the component matches+ the printed pattern on the board for Q 1 and Q2.

- 14. Install Q1, 2N3904 [2N3904].
- 15. Install Q2, 2N3904 [2N3904]
- 16. Install 2 pin header, JMP3 and jumper block

OK... now that we have the basic components installed it's time to install the application specific parts. The values indicated in the schematic for R1 and R2 are for an input voltage of 110VAC. Unfortunately we cannot tell you exactly what parts you need. You will need to refer to the "Configuring Your OM2" section of this manual to determine the values for R1 and R2, if you need C1 or not and if jumpers JP1 and JP2 are required for your application. Also under consideration is whether or not you need to install C2, and if so what value do you need. Everything you need to determine what is required is covered in the "Configuring Your OM2" section. Once you have determined what your application requires you can then install the following components as required.

The table below lists suggested values for resistors R1 and R2 based on some common input signals and we have included resistors for these values in your OM2 kit. We've also provided some extra rows for entry of your own custom configuration. Because C1 is probably not required for most applications no values have been provided. The value for C2 is again highly dependent on your application and a value has not been suggested. For many applications C2 is probably not required. We have provided a 47uF, 16 volt value as suggested in the schematic. Make sure the voltage rating for C2 is at least equal to the maximum voltage to be used for +V on the output.

### INPUT SIGNAL LEVEL CONFIGURATION

<b>INPUT SIGNAL</b>	<b>R1 VALUE</b>	<b>R2 VALUE</b>	<b>INSTALLED JUMPERS</b>
110VAC	15K(brown-green-orange)	15K(brown-green-orange)	JMP2
220VAC	33K(orange-orange-orange)	33K(orange-orange-orange)	JMP2
3VDC	39 (orange-white-black)	N/A	JMP1, JMP2
5VDC	82(gray-red-black)	N/A	JMP1, JMP2
12VDC	220(red-red-brown)	N/A	JMP1, JMP2
24VDC	470(yellow-violet-brown)	N/A	JMP1, JMP2
12VAC	330(orange-orange-brown)	N/A	JMP1, JMP2
24VAC	680(blue-gray-brown)	N/A	JMP1, JMP2

## Final Configuration Assembly Steps

- ❑ 1. Install R1, value as determined above
- ❑ 2. Install R2 or jumper JMP1 as required.
- ❑ 3. Install C1 or JMP2 as required. Notice that there is no indication of polarity for C1. If an electrolytic capacitor is used make sure to install it so the “+” terminal is installed in the hole that is on the side **electrically** nearest the positive connection of the input signal.
- ❑ 4. Install C2 as required. If the required capacitor is an electrolytic type and has a polarity make sure it is installed with the “+” lead inserted into the hole next to the + printed on the circuit board. Notice that the printed pattern has a small fat area on one side of the pattern. This indicates the “-” side of the capacitor.
- ❑ 5. Remember to remove jumper JMP3 if an active high output is required.

# Configuring Your OM2

The OM2 is a versatile interface and can be configured to meet the requirements of many applications. This section describes how to figure out the necessary set-up and component values for your application. We'll try to give you the tools to work with and keep it simple but it is possible that we may miss something you need to know since not all applications are created equal.

## Input Configuration

### **DC Input Calculations**

The most complex set-up will involve the input circuit even though it looks like it is very simple. Hang in there and we'll get you thru it. The main thing to keep in mind is that it is essential the input current be kept less than 60ma or the input LED's may be damaged. Ohm's Law is the primary tool we'll use here. The following calculations assume C2 is bypassed (JMP2 installed) and are for DC conditions only.

$$E = I * R$$

Where:

E = voltage in volts

I = current in amps

R = resistance in ohms

To calculate the circuit current and the resistance required the formulas are:

$$I = E / R$$

$$R = E / I$$

OK, so to calculate the value for R1 and R2 combined we need to figure out the voltage that will be across R1 and R2 for the input you apply to turn on the LED. For this we need to know not only the voltage you are applying but also the voltage that will be across the LED when it is on. This is easy because the manufacturer of the optical coupler tells us that there will be 1.25 volts across the LED in the on state. That means that the voltage across R1 and R2 will be your input voltage, we'll call it  $V_{in}$ , minus 1.25 volts. The total resistance of R1 and R2 in series is  $R_1 + R_2$ , we'll call it  $R_t$ , so the formula for their total resistance is:

$$R_t = (V_{in} - 1.25) / I$$

Even though the maximum current is 60mA (0.060 amps) it is a good idea to stay a little lower than this so lets pick 50mA, (0.050 amps) and an input voltage of 5 volts and see what happens.

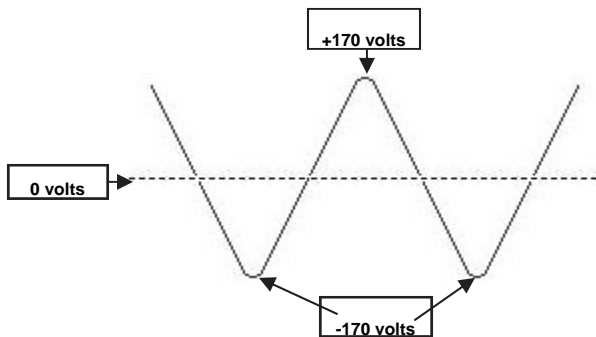
$$R_t = (5 - 1.25) / 0.05 = 3.75 / 0.05 = 75 \text{ ohms}$$

Now the problem is finding a resistor or resistors that add up to 75 ohms. In this case we're in luck because 75 ohms is a standard 5% resistor value, (that was purely by accident by-the-way). All you need to do is install a 75 ohm resistor in R1's location and place a jumper at JMP1 position. If the calculated value isn't standard, check out values around it. Pick one close and plug the value into the formula for current to see if it is less than 60mA. You can also use two resistors that will add up to the calculated resistance and install them in the R1 and R2 locations and leave JMP1 out. You can probably use less current and your circuit will work fine. It's a matter of experimenting to see what works. The important thing this is to not exceed 60mA. In the real world the formulas give a starting point and then engineers start to play.

### AC Input Signal Calculations

Now what about an AC input voltage. Well it gets a little more complicated but Ohm's Law still applies. The problem with an AC voltage is it is constantly changing voltage and possibly polarity at some frequency. To make it even more interesting the AC voltage, we'll call it a signal now, may be 'riding on a DC voltage. All of these factors come into play in the calculations. Don't panic it's not that bad.

If a circuit contains only simple resistors things are straight forward. For this discussion we'll assume C1 is not in the circuit. The only concern is how the AC voltage is specified. To keep it simple we'll talk about a voltage that swings around a zero voltage point and is a simple sine wave. The figure below shows what this voltage 'looks' like.



The AC signal shown is what standard 120 volt house AC power 'looks' like. The voltage of 120 volts is what is called RMS (Root Mean Squared) voltage. Notice that the voltage goes up to a peak voltage of about 170 volts, goes down to 0 and then goes to 170 volts in the opposite direction. The RMS value is a complicated value determined with calculus and represents the equivalent DC voltage of the peak voltage of 170 volts. In other words a DC voltage of 120 volts would produce as much power as a 170 volt peak sine wave voltage.

Now that you are totally confused all you need to know is that if 120VAC(rms) is applied to the input of the OM2 the calculations need to use 170VDC as the input voltage,  $V_{in}$ . To get the 170 volts simply multiply 120V(rms) times 1.414. So the formula is:

$$V_{peak} = V_{rms} * 1.414$$

Or

$$V_{peak} = 120 * 1.414 \approx 170 \text{ volts peak}$$

To calculate the resistance required for a 120V(rms) input use the formula for the DC signal described above as follows:

$$R_t = (V_{in} - 1.25) / I$$

$$R_t = (170 - 1.25) / 0.05 = 168.75 / .05 = 3375 \text{ ohms} = 3.375 \text{ Kohms}$$

A standard resistor value that is very close to 3.375Kohms is 3.3Kohms. If we use this value the current is calculated as:

$$I = (V_{in} - 1.25) / R_t = (170 - 1.25) / 3300 = 0.051A = 51mA$$

We are well below the maximum allowable current so this is a good choice and is how the values shown in the schematic were determined.

If you decide to include C2 in the input circuit it gets more complex and since you have determined you need C2 we are going to assume you know a good deal about electronics and physics and provide a very basic explanation of how to calculate a value for C2.



As described earlier a capacitor will block the flow of a DC current but will appear to conduct and AC current. However it is not an absolute short circuit to AC and actually changes its resistance with changes in the frequency of the signal. In an AC circuit resistance is called impedance and can be plugged into Ohm's Law in place of the resistance values. To calculate the impedance of a capacitor, we'll call it 'Zc', of a capacitor the formula is:

$$Zc = 1 / \{(2 * \pi) * f * C\}$$
$$Zc = 1 / 6.28 * f * C$$

- Zc = Impedance of capacitor in ohms
- f = frequency of the AC signal in Hertz
- C = capacitance in Farads
- pi = 3.14 (approx)

Notice that as the value of a capacitor or the signal frequency is increased the impedance of the capacitor decreases. So then if the frequency is zero Hertz the impedance of the capacitor is infinity since 1 divided by 0 is infinity. Hence a capacitor blocks DC current since the frequency of a DC current is zero Hertz.

To calculate the input resistance with an AC input signal with C2 in the circuit all you need to do is add the impedance of the capacitor to the values of R1 and R2 and calculate the current. So the total resistance, Rt, becomes:

$$Rt = R1 + R2 + Zc$$

Insert the total resistance into the formula for current and you have:

$$I = (Vin - 1.25) / Rt = ( Vin - 1.25) / (R1 + R2 + Zc)$$

### Output Configuration

The OM2 output is easily configured. The main considerations are the output current, output voltage, and if the output needs to go low(active low) or high (active high) when the input is activated by turning on an input LED. Start by determining the output voltage level required. The outputs are capable of supplying up to 150mA with a maximum voltage of 40 volts.

Now determine if you need an active high or active low output level. This will be entirely dependant on your specific circuit requirements based on the type of device you are connecting.

If an inductive load such as a relay is being used then diodes D1 and D2 **MUST** be installed. Otherwise they are optional. For most applications they should not cause any problems. They may be removed if the load is not

inductive and they cause problems with any output devices.

The only other output consideration is if C2 is required. The basic function of C2 is to fill in the gaps of an AC input signal and keep the output in it's active state during the time an AC signal is at a low level. The larger the value of C2 the bigger the gap can be and the output will not change. It does this by charging to the peak voltage of the signal and keeping a high level on the base of Q1, and therefore keeping Q1 turned on, for the short time the signal is low. After the input signal is removed for more than a few input cycles, C2 will discharge and Q1 will turn off, changing the state of the output. This delay can cause problems with very short input pulses and will delay the time it takes for the output to respond to changes in the input. Because of this it may be desirable to not install C2 unless the output is required to provide a solid output for an AC input signal. For example if you are monitoring the AC line. The value indicated in the schematic and supplied with your OM2 should work for most AC input signals with a frequency from 50Hz or more. It is possible you may need to change it's value due to your circuit requirements.

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## **CONCLUSION**

We sincerely hope that you will enjoy the use of this Ramsey product. As always, we have tried to compose our manual in the easiest, most “user friendly” format possible. As our customers, we value your opinions, comments, and additions that you would like to see in future publications. Please submit comments or ideas to:

Ramsey Electronics, LLC.  
Attn. Hobby Kit Department  
590 Fishers Station Drive  
Victor, NY 14564

or email us at: [techsupport@ramseyelectronics.com](mailto:techsupport@ramseyelectronics.com)

And once again, thanks from the folks at Ramsey

## **OM2 SPECIFICATIONS**

Input Requirements:	$\geq 1.5$ volts DC or $\geq 1.5$ volts peak AC at 1mA to 60mA depending on application
Input to Output Isolation:	5000 volts maximum
Switching Rate:	DC to 250kHz
Output Configuration:	Active High DC or Active Low DC
Maximum Load:	40 VDC max @ 150mA max
Dimensions:	
Board:	1.5in (W) X 2.5in (L) X 0.875in (H) 31.1mm (W) X 63.5mm (L) X 22.2mm (H)
Mounting:	4 holes, 4/40 screw clearance on 1" x 2" pattern 4 holes on 25.4mm x 50.8mm pattern
Weight:	0.7 Oz, 0.0198 Kg

# THE RAMSEY KIT WARRANTY

## 1. GENERAL:

Notice that this is not a "fine print" warranty. We want you to understand your rights and ours too! All Ramsey kits will work if assembled properly. The very fact that your kit includes this new manual is your assurance that prior to release of this kit, a varied group of knowledgeable people have assembled this kit from scratch using this manual. During this process, changes and additions are noted by each assembler and integrated into the final version of the manual...which you have! If you need help, please read through your manual carefully, all information required to properly build and test your kit is contained within the pages! However, customer satisfaction is our goal, so in the event that you do have a problem, please note the following:

## 2. DEFECTIVE PARTS:

It's always easy to blame a part for a problem in your kit. Before you conclude that a part may be bad, thoroughly check your work. Today's semiconductors and passive components have reached incredibly high reliability levels, and it's sad to say that our human construction skills have not! But on rare occasions a sour component can slip through. All of our kit parts carry the Ramsey Electronics Warranty that they are free from defects for a full ninety (90) days from the date of purchase. Defective parts will be replaced promptly at our expense. If you suspect any part to be defective, please mail it to our factory for testing and replacement. Please send only the defective part(s), not the entire kit. The part(s) MUST be returned to us in suitable condition for testing. Please be aware that testing can usually determine if the part was truly defective or damaged by assembly or usage. Don't be afraid of telling us that you "damaged it" or "burned it out", we're all human and in most cases, replacement parts are very reasonably priced. Remember, our goal for over three decades is to have a happy customer, and we're here to work WITH you, not AGAINST you!

## 3. MISSING PARTS:

Before assuming a part value is missing, check the parts listing carefully to see if it is a critical value such as a specific coil or IC, or whether a RANGE of values is suitable for the component (such as a "100 to 500 uF capacitor"). Often times, common sense will solve a mysterious missing part problem. If you're missing five 10K ohm resistors and received five extra 1K resistors, you can pretty much be assured that the "1K ohm" resistors are actually the "missing" 10 K parts ("Hum-m-m, I guess the orange band really does look red!") Ramsey Electronics project kits are packed with pride in the USA by our own staff personnel. While separate QC checks are made on all product kits, we too are human, and once in a great while there is a chance something can get through those checks! If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual for your Ramsey kit, please contact us with information on the part you need. Contact our Repair Department via telephone, email or writing. Please have your invoice number and date of purchase handy.

## 4. REFUNDS:

All Ramsey products, kit or factory assembled units have an unconditional 10 day (from the date of purchase) return policy to examine our products. If you are not satisfied for any reason, you may return your unassembled kit with all the parts and instructions, or your factory assembled and tested product, together with your proof of purchase to the factory for a full refund less shipping. The return package should be packed securely. Insurance and tracking is highly recommended. A reminder, this applies to unassembled kits. They must be in the same new condition as received, not partially assembled! Assembled kits cannot be returned for credit. No RMA's are required; simply return to Ramsey Electronics LLC, Attn: Product Returns, 590 Fishers Station Drive, Victor, NY, 14564. If you have any questions, please contact us at 585-924-4560.

## 5. FACTORY REPAIR OF ASSEMBLED KITS:

Most of us at Ramsey are technically oriented and we do realize that things happen! Even following the best practices, with all of the best intentions, there is that chance that your kit doesn't work when you have completed it. Each manual goes into detailed troubleshooting based on the specific kit to help you troubleshoot the problem. We have found that 95% of returned kits involved wrongly installed components (wrong part or backwards polarity). This section of the warranty assumes you have gone through all those steps, and have now reached the point that you need to send it back.

To qualify for factory repair of customer assembled kits, the following conditions apply:

1. Kits must not be assembled with acid solder flux
2. Kit boards or circuits must not be modified in any manner from the version received
3. Kits must be fully assembled, not partially assembled. Our warranty does not include "finishing" your kit!
4. Must include a full description of the problem encountered including the troubleshooting steps you have already done.
5. Must not include non-standard, non-Ramsey accessories, cases, enclosures, knobs, etc. or any batteries.
6. Must include the minimum repair fee of \$25 USD in the form of check, money order or credit card authorization.
7. Ramsey Electronics, LLC reserves the right to refuse any repair due to excessive errors in construction methods.
8. If, due to customer construction methods, the repair is estimated to exceed the minimum flat rate, Ramsey Electronics, LLC will contact the customer to discuss the repairs needed and to receive authorization and payment for repair prior to repair.
9. In the unlikely case that a defective part is found to be the cause of the problem, the repairs will be made at no-charge to the customer, and any payments received for repair will be returned or credited back to the customer.
10. Properly pack your kit, insure the package, and use a carrier that can be tracked. Ramsey Electronics, LLC is not responsible for any loss or damage in shipment. Send the package together with your repair fee to the return address below. No RMA is required.

## 6. FACTORY REPAIR FEES:

Please understand that our Tech Support Group personnel are not volunteers! They are a dedicated group of highly trained technicians each configured with a very properly equipped test bench. Upon receipt of a repair, the setup, testing, diagnosis, repair, paperwork, and repacking of your kit requires nearly an hour of their time regardless of the size or complexity of the kit! The minimum repair fee represents ½ hour Tech Support time at \$50/hour USD. We try to keep all kit repairs within the realm of the \$25 flat rate whenever possible...and trust us; we exceed that time spent on most kits received more often than not!

## 7. CONTACT INFORMATION AND RETURN ADDRESS:

### Technical Questions

**RAMSEY ELECTRONICS, LLC**  
Attn: Tech Support  
590 Fishers Station Drive  
Victor, NY 14564  
585-924-4560; 585-924-4886 Fax  
techsupport@ramseyelectronics.com

### Product Repair & Returns

**RAMSEY ELECTRONICS, LLC**  
Attn: Repairs  
590 Fishers Station Drive  
Victor, NY 14564  
585-924-4560; 585-924-4886 Fax  
repairs@ramseyelectronics.com

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### REQUIRED TOOLS

- Soldering Iron
- Thin Rosin Core Solder
- Needle Nose Pliers
- Small Diagonal Cutters

### ADDITIONAL SUGGESTED ITEMS

- Helping Hands Holder for PC Board/  
Parts
- Desoldering Braid



**RAMSEY ELECTRONICS, LLC**  
590 Fishers Station Drive  
Victor, New York 14564  
Phone (585) 924-4560  
Fax (585) 924-4555  
[www.ramseykits.com](http://www.ramseykits.com)

### TOTAL SOLDER POINTS

53

### ESTIMATED ASSEMBLY TIME

Beginner..... 1.5 hrs  
Intermediate..... 1 hrs  
Advanced ..... 0.5 hrs

Ramsey Publication No. OM2  
Assembly and Instruction manual  
for:OM2