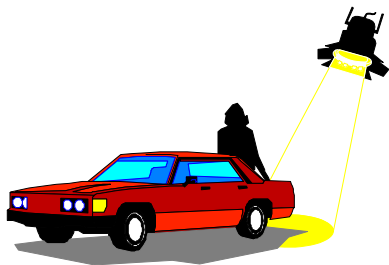


MICROWAVE MOTION DETECTOR

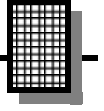


Ramsey Electronics Model No.

MD3

Solve difficult detection problems easily with the MD3. Senses any moving body - be it a person, animal, car, bicycle or extra-terrestrial! Teaches microwave and antenna theory too.

- **True microwave Doppler shift operation**
- **Unaffected by heat, light, sound, humidity or temperature**
- **A real microwave transmitter/receiver - runs at 1 GHz**
- **Runs on 9 to 15 volts DC - ideal for car burglar alarms**
- **Informative manual answers questions on theory, hook-ups and uses - enhances resale value, too!**
- **Add our case set for a finished 'Pro' look. Cases match all Ramsey products**
- **Clear, concise assembly instructions carefully guide you to a finished kit that works the FIRST time!**



RAMSEY TRANSMITTER KITS

- FM100 Professional FM Stereo Transmitter
- FM25 Synthesized Stereo Transmitter
- AM1, AM25 AM Transmitters
- TV6 Television Transmitter

RAMSEY RECEIVER KITS

- FR1 FM Broadcast Receiver
- AR1 Aircraft Band Receiver
- SR2 Shortwave Receiver
- AA7 Active Antenna
- SC1 Shortwave Converter

RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70A Speech Scrambler
- SP1 Speakerphone
- WCT20 Wizard Cable Tracer
- PH10 Peak hold Meter
- LC1 Inductance-Capacitance Meter

RAMSEY AMATEUR RADIO KITS

- FX146 VHF Transceivers
- HR Series HF All Mode Receivers
- QRP Series HF CW Transmitters
- CW7 CW Keyer
- CPO3 Code Practice Oscillator
- Packet Computer Interfaces
- QRP Power Amplifiers

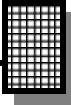
RAMSEY MINI-KITS

Many other kits are available for hobby, school, Scouts and just plain FUN. New kits are always under development. Write or call for our free Ramsey catalog.

MD3 MICROWAVE MOTION DETECTOR KIT INSTRUCTION MANUAL

Ramsey Electronics publication No. MMD3 Revision 1.4

COPYRIGHT ©1994 by Ramsey Electronics, Inc. 590 Fisher Station Drive, Victor, New York 14564. All rights reserved. No portion of this publication may be copied or duplicated without the written permission of Ramsey Electronics, Inc. Printed in the United States of America.



KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

MD3 MICROWAVE MOTION DETECTOR KIT

TABLE OF CONTENTS

Introduction to the MD3	4
Parts list.....	6
Schematic diagram.....	8
Building your kit	9
Testing, adjustments	12
Experiments and modifications.....	12
Interface circuits	13
Ramsey kit warranty	15



INTRODUCTION TO THE MD3

The Ramsey MD3 is a true microwave Doppler transmitter and receiver. From intrusion alarms to Doppler speed and motion sensing experiments, the use of the MD3 is limited only by your imagination and curiosity. Interfacing your MD3 to the "real world" is easily accomplished using one of the circuits provided on page 11 of this manual.

Doppler Theory

The operation of the Ramsey MD3 is based on a physical theory known as the "Doppler Effect". In its simplest form the Doppler theory states that as sound, light or even radio waves are reflected back by a moving object, the frequency of these waves will be different from the frequency when the object is stationary. As the object moves away the frequency will decrease and if the object moves toward you, the frequency will increase. This effect is demonstrated very visibly (or should we say audibly) by a train whistle passing you. This change in frequency is due to the waves being either stretched or compressed as they leave the moving object. Compressing the waves closer will have the effect of increasing the perceived frequency while stretching the waves will cause the frequency to appear lower.

This is obviously not the place for an in depth discussion of Doppler theory. Just be aware that it is the basis for the operation of the MD3. In fact, with an oscilloscope you can actually see this frequency change at U1:c pin 10.

The MD3 "How It Works"

All the RF "magic" is accomplished with Q3 and D1. Q3 is a free running microwave oscillator operating at a frequency of approximately 1.0 GHz. The frequency is determined by the length of the etched strip line and the lead lengths (inductance) of the associated oscillator components.

The microwave RF energy that is developed by the oscillator is radiated in an omni-directional pattern from the antenna. This radiated energy will fill the surrounding area with radio waves. These waves will be reflected back toward the antenna.

Here's where the Doppler effect comes in. If within that area there is an object that is moving, the waves that are reflected will either be higher in frequency if the object is moving closer or lower if moving away. The MD3 doesn't really care which direction, it is only looking for a frequency difference.

The radiated signal and the redefected signal are mixed at diode D1. The difference in the two frequencies provides the input to U1:C pin 10. This frequency (the difference) is in the range of 10 Hz to 40 Hz. U1:C is the amplifier that feeds the sensitivity potentiometer R8.

Transistors Q1 and Q2 function as a very precise voltage regulator providing the proper bias to the amplifiers.

U1:D functions as a bandpass filter and amplifier. Buffer amplifier U1:A provides the drive to output transistor Q8.

The output transistor Q8 can be safely operated at voltage levels as high as 50 VDC and current levels of 500 ma. PARTS SUPPLIED WITH THE MD3 KIT

Parts List

CAPACITORS AND INDUCTORS

- 4 .01 uf. disk capacitor (marked .01 or 103 or 10nf)(C3,C8,C15,C18)
- 3 0.1 uf. disk capacitor (marked .1 or 104)(C11,C12,C20)
- 2 2.0 pf. or 2.2 pf. disk capacitor (C6,C7)
- 1 22 pf. disk capacitor (C5)
- 2 1.0 uf electrolytic capacitor (C16,C17)
- 6 10.0 uf electrolytic capacitor (C1,C2,C9,C10,C13,C14)
- 1 220 uf electrolytic capacitor (C4)
- 1 1000 uf electrolytic capacitor (C19)

RESISTORS

- 1 220 ohm (red-red brown) (R2)
- 2 470 ohm (yellow-violet-brown) (R1,R15)
- 4 1K ohm (brown-black-red) (R6,R7,R11,R20)
- 1 4.7K ohm (yellow-violet-red) (R12)
- 5 10K ohm (brown-black-orange) (R4,R14,R16,R19,R21)
- 1 47K ohm (yellow-violet-orange) (R3)
- 3 100K ohm (brown-black-yellow) (R5,R17,R18)
- 1 470K ohm (yellow-violet-yellow) (R13)
- 2 1 Megohm (brown-black-green) (R9,R10)
- 1 10K potentiometer (R8)

SEMICONDUCTORS

- 1 Diode 1SS99 (clear glass body with black and blue bands) (D1)
- 1 Diode 1N4148 (glass body with single black band) (D2)
- 1 LED (D3)
- 2 2N3904 NPN transistor (Q1,Q2)
- 1 2SC2498 or 2570 NPN UHF transistor (Q3)
- 1 BS170 FET transistor (Q8)
- 1 LM-324 op-amp (U1)

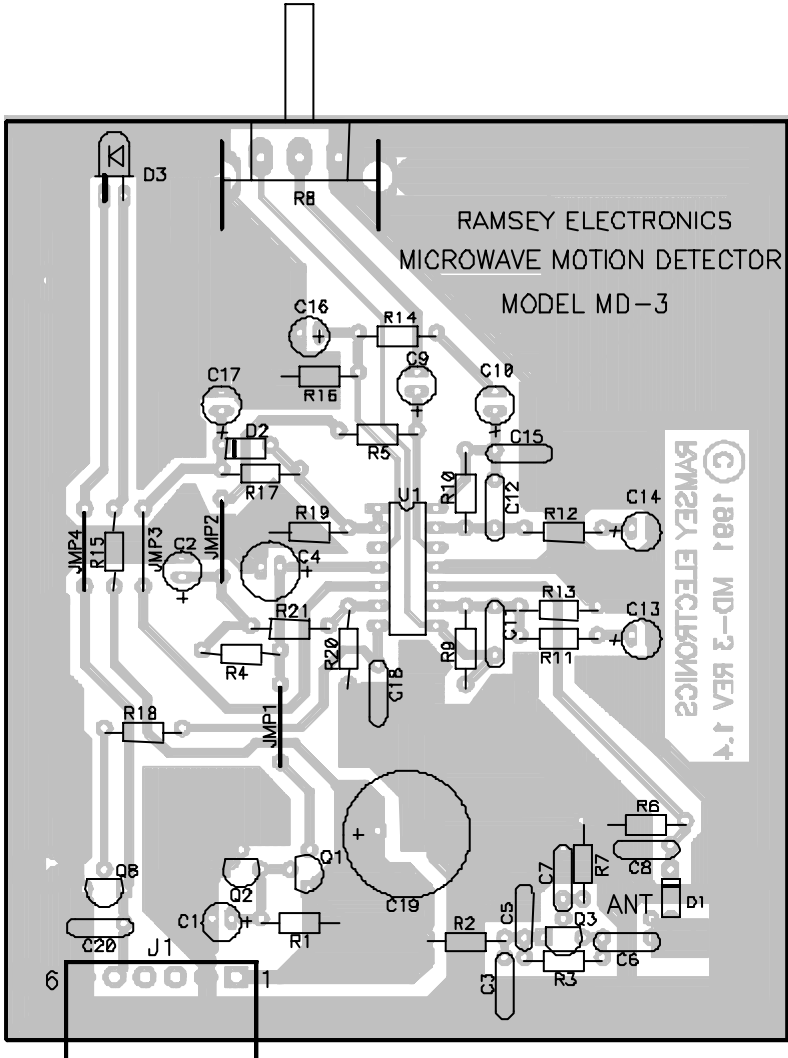
HARDWARE AND MISCELLANEOUS

- 1 Drilled Ramsey MD3 Printed Circuit Board
- 1 Connector 6 Pin (J-1)

OPTIONAL

- Ramsey CMD case and knob set for the MD3

MD3 PARTS LAYOUT DIAGRAM



CONSTRUCTION:

Check off each step as understood and completed. Examine the parts layout diagram for parts location on the PC board. In all steps, “install” means to carefully insert the part into the correct hole, solder the leads to the PC board and trim away the excess lead wire.

Use good soldering techniques - let your soldering iron tip heat each connection wire enough so that the wire itself and PC board circuit trace BOTH become hot enough to melt the applied solder. The solder should flow smoothly around the lead wire and PC board trace.

- 1. Orient the circuit board as shown in parts layout diagram.
- 2. Install the LED, with the longer lead towards potentiometer R8. Leave the leads about 3/4” long if you are using the MD3 case.
- 3. Install sensitivity control R8, 10K potentiometer. R8 acts as a “volume” control, adjusting the level of Doppler shift signal being applied to amplifier and switching portions of the MD3.
- 4. Install J1, 6 pin connector.
- 5. Install C1, 10 uf electrolytic capacitor. Electrolytic capacitors are polarized and must be installed correctly. Usually PC layouts will show where the + lead should go while the capacitor itself will usually indicate the - lead. In any case, be sure you observe correct polarity.
- 6. Install Q2, 2N3904. Orient the flat side of the transistors as shown on parts layout diagram. Q2 has an interesting function, being connected as a zener diode! The reversed biased base-emitter junction on a silicon transistor behaves as a low power zener diode with a breakdown voltage in the 6 to 8 volt range.
- 7. Install Q1, 2N3904 Orient the flat side as shown. Q1 acts as a power supply filter and regulator for the op-amp IC chip, U1.
- 8. Install R1, 470 ohm (yellow-violet-brown).
- 9. Install Q8, BS170 and orient the flat side as shown. Q8 is a power MOSFET that controls the external load you connect to your MD3. A MOSFET is used since, as the load is turned on and off, a regular bipolar transistor will cause the MD3 to “see” itself . This is due to the diode switching action in a bipolar transistor’s base-emitter junction.
- 10. Install C20, .1 uf capacitor (marked .1 or 104).

- ❑ 11. Install C19, 1000 uf electrolytic capacitor (observe polarity). Capacitor C19 “filters” the power to the MD-3, assuring a clean and smooth source of direct current.
- ❑ 12. Install R2, 220 ohm (red-red-brown).
- ❑ 13. Install C3, .01 uf. disk capacitor (marked .01 or 103 or 10nf).
- ❑ 14. Install C5, 22 pf disk capacitor.
- ❑ 15) Install Q3, 2SC2498. Observe placement of the flat side. Q3 is the microwave “transmitter” for the MD-3.
- ❑ 16. Install R3, 47K ohm (yellow-violet-orange).
- ❑ 17. Install C6 & C7, 2.0 pf or 2.2 pf.
- ❑ 18. Install R6 & R7, 1K ohm (brown-black-red).
- ❑ 19. Install D1, 1SS99. This is the glass diode with the black and the blue bands. Orient the black band as indicated on the parts layout. Diode D1 “mixes” the transmitted signal along with the received signal, producing both the sum and difference or Doppler frequency.

Don't be alarmed when looking at the PC board trace connecting D1's anode to ground. This trace is carefully designed to function as a small inductor, forming part of the resonant tank circuit of oscillator Q3!

- ❑ 20. Install C8, .01 uf disk capacitor..(marked .01 or 103 or 10nf)
- ❑ The last few steps completed the assembly of the microwave portion of the MD-3. Now we'll start building the Doppler amplification and switching portion of your kit.
- ❑ 21. Install jumpers JMP1 - JMP4. Jumpers are “bridges” carrying signals over circuit traces on the PC board below. Use a scrap component lead bent into a “staple” shape inserted into the indicated holes.
- ❑ 22. Install R15, 470 ohm (yellow-violet-brown)
- ❑ 23. Install C2, 10 uf electrolytic capacitor
- ❑ 24. Install R4 & R21, 10K ohm (brown-black-orange)
- ❑ 25. Install C4, 220 uf, observing polarity.
- ❑ 26. Install R19, 10K ohm (brown-black-orange).
- ❑ 27. Install U1, LM324. Maintain proper orientation of the marked end.
- ❑ 28. Install R20, 1K ohm (brown-black-red).
- ❑ 29. Install C18, .01 uf (marked .01 or 103 or 10nf).

- ❑ 30. Install R18, 100K ohm (brown-black-yellow).
- ❑ 31. Install R9 and R10, 1 Meg ohm (brown-black-green).
- ❑ 32. Install C11 and C12, both 0.1 uf (marked .1 or 104).
- ❑ 33. Install R11, 1K ohm (brown-black-red).
- ❑ 34. Install R13, 470K ohm (yellow-violet-yellow).
- ❑ 35. Install R12, 4.7 K ohm (yellow-violet-red).
- ❑ 36. Install C13 and C14, both 10uf (observe polarity).
- ❑ 37. Install R5 and R17, both 100K ohm (brown-black-yellow).
- ❑ 38. Install D2, 1N4148 style diode. D2 has a glass body with a single black band. Orient black band as shown.
- ❑ 39. Install C17, 1.0 uf electrolytic capacitor (observe polarity). C17 along with R17 sets how long the MD-3 output stays on after picking up motion. Larger values of either part will result in longer turn-off delays.
- ❑ 40. Install R14 and R16, both 10K ohm (brown-black-orange).
- ❑ 41. Install C9 and C10, both 10uf (observe polarity).
- ❑ 42. Install C15, .01uf disc capacitor (marked .01 or 103 or 10nf).
- ❑ 43. Install C16, 1.0uf (observe polarity).
- ❑ 44. Solder one end of the buss wire supplied into the hole near C6 and D1. Trim the wire so it is 4" long. This is the antenna for the MD-3. The 4" length makes it resonant at the transmission frequency of the MD-3. After fully wiring and testing the unit, you may "tweak" the length for maximum range.

1. Connect +9 to +12 volts DC to pin 1 of J1. A stripped and tinned wire can be pushed into J1.
2. Connect pin 2 of J1 to the common or ground of the DC supply.
3. Rotate sensitivity control R8 fully CCW; the LED should go off. Slowly rotate R8 CW until the LED lights. Back off R8 until the LED just goes out and move your hand near the antenna - you should see the LED light up.
4. Connect pin 5 of J1 to a load such as a relay, light or buzzer. Connect the other side of your load to the power source positive.
5. Perform step 3 again and verify that your connected load operates along with the LED. If you find that your load triggers the MD-3, try moving it away from the MD-3 or running the load off a different power source from the MD-3. The MD-3 is extremely sensitive and load changes on the power supply can cause it to mis-trigger.
6. Adjust R8 for desired sensitivity.

The output (pin 5) switches to ground when motion is detected. DO NOT apply an AC voltage or load to pin 5. DO NOT attempt to sink more than 0.25 amps (250ma.) from pin 5.

EXPERIMENTS AND MODIFICATIONS

The antenna may be trimmed to maximize detector range. Simply clip or add small 1/4" lengths to the antenna wire while checking for range improvement. Normal sensitivity will pick up a normally walking adult at 10 to 12 feet away in a clear room. Room characteristics can effect range.

You may wish to direct the MD-3's detection in a certain direction., This is fairly easy to do - and easy to understand if you are familiar with radios and antennas! Try adding a 12" x 12" metal plate about 4" behind the MD-3's antenna; this will direct the detection beam forward of the plate and diminish it behind the plate. You may wish to experiment with different sizes of plates and distances to antenna. This is an ideal way to experiment and understand VHF through microwave frequencies and antennas!

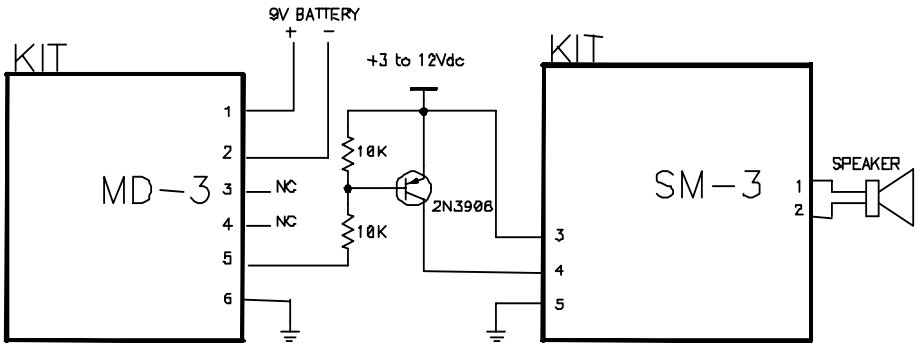
INTERFACE CIRCUITS

As you might have already noticed, the MD-3 output transistor provides a pulse when motion is sensed. You have probably asked the question, "How do I make it do something?" We provide the following circuits to give you a few ideas.

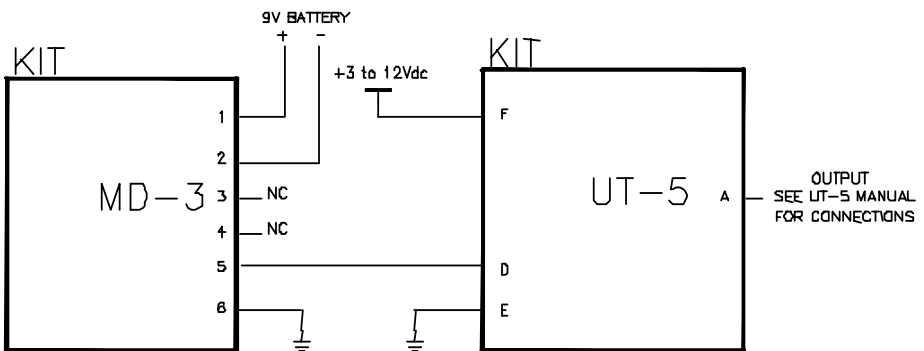
For instance, you might want an alarm to be activated for a period of time AFTER the motion is detected. Easily accomplished with our UT-5 timer kit or any solid state timer. If you just want to pull in a relay to turn on a light, use the relay output circuit. Well, I'm sure you've got the idea now. Have fun!

If you enjoyed building this Ramsey kit, call or write for our free catalog - it's full of other neat and useful kits.

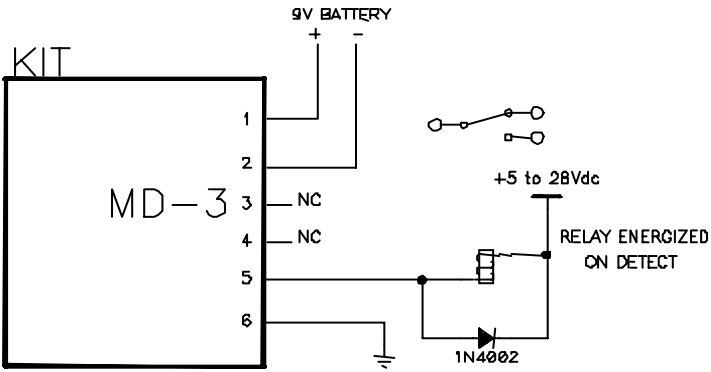
SIREN OUTPUT (SM-3)



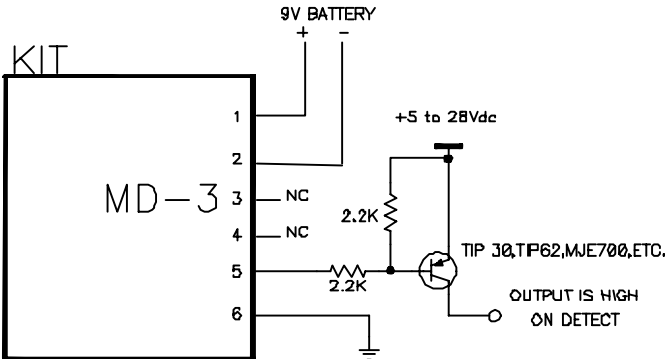
TIMER OUTPUT (UT-5)



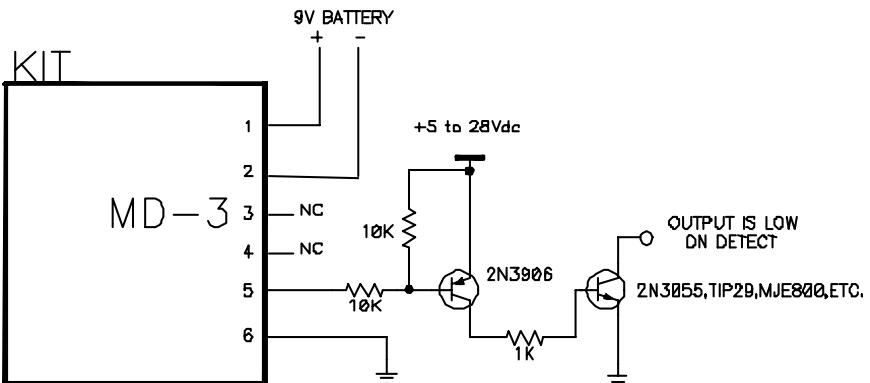
RELAY OUTPUT



TRANSISTOR OUTPUT (PNP)



TRANSISTOR OUTPUT (NPN)



The Ramsey Kit Warranty

Please read carefully BEFORE calling or writing in about your kit. Most problems can be solved without contacting the factory.

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 a team of knowledgeable people have field-tested several "copies" of this kit straight from the Ramsey Inventory. 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!

1. 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 occasion a sour component can slip through. All 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 'blew-it', we're all human and in most cases, replacement parts are very reasonably priced.

2. MISSING PARTS: Before assuming a part value is incorrect, 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 (such as "100 to 500 uF"). 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 'red' band really does look orange!") Ramsey Electronics project kits are packed with pride in the USA. If you believe we packed an incorrect part or omitted a part clearly indicated in your assembly manual as supplied with the basic kit by Ramsey, please write or call us with information on the part you need and proof of kit purchase.

3. FACTORY REPAIR OF ASSEMBLED KITS:

To qualify for Ramsey Electronics factory repair, kits MUST:

1. NOT be assembled with acid core solder or flux.
2. NOT be modified in any manner.
3. BE returned in fully-assembled form, not partially assembled.
4. BE accompanied by the proper repair fee. No repair will be undertaken until we have received the MINIMUM repair fee (1/2 hour labor) of \$25.00, or authorization to charge it to your credit card account.

5. INCLUDE a description of the problem and legible return address. DO NOT send a separate letter; include all correspondence with the unit. Please do not include your own hardware such as non-Ramsey cabinets, knobs, cables, external battery packs and the like. Ramsey Electronics, Inc., reserves the right to refuse repair on ANY item in which we find excessive problems or damage due to construction methods. To assist customers in such situations, Ramsey Electronics, Inc., reserves the right to solve their needs on a case-by-case basis.

The repair is \$50.00 per hour, regardless of the cost of the kit. Please understand that our technicians are not volunteers and that set-up, testing, diagnosis, repair and repacking and paperwork can take nearly an hour of paid employee time on even a simple kit. Of course, if we find that a part was defective in manufacture, there will be no charge to repair your kit (But please realize that our technicians know the difference between a defective part and parts burned out or damaged through improper use or assembly).

4. REFUNDS: You are given ten (10) days to examine our products. If you are not satisfied, you may return your unassembled kit with all the parts and instructions and proof of purchase to the factory for a full refund. The return package should be packed securely. Insurance is recommended. Please do not cause needless delays; read all information carefully.

MD3 MICROWAVE MOTION DETECTOR Quick Reference Page Guide

Introduction to the MD3	4
Parts list	6
Schematic diagram	8
Building your kit.....	9
Testing, adjustments.....	12
Experiments and modifications	12
Interface circuits.....	13

REQUIRED TOOLS

- Soldering Iron Ramsey WLC100
 - Thin Rosin Core Solder Ramsey RTS12
 - Needle Nose Pliers Ramsey MPP4 or RTS05
 - Small Diagonal Cutters Ramsey RTS04
- <OR> Technician's Tool Kit TK405

ADDITIONAL SUGGESTED ITEMS

- Holder for PC Board/Parts Ramsey HH3
- Desoldering Braid Ramsey RTS08
- Digital Multimeter Ramsey M133

Price: \$5.00

Ramsey Publication No. MMD3

Assembly and Instruction manual for:

***RAMSEY MODEL NO. MD3 MICROWAVE
MOTION DETECTOR KIT***



TOTAL SOLDER POINTS

137

ESTIMATED ASSEMBLY TIME

Beginner3.8 hrs
Intermediate2.2 hrs
Advanced1.7 hrs