

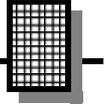
# SMD1 STEPPER MOTOR DRIVER KIT

**Ramsey Electronics Model No.**

**SMD1**

*How do computers interface with motors to drive precision machinery? You've seen stepper motors for years, but how can you control them without shelling out a fortune? With the Ramsey Super Stepper Motor kit you'll be able to drive any stepper from 5 to 15 volts. Put a stepper motor to work for you!*

- Drives most any stepper motor from 5-15 volts.
- On board CMOS clock for easy hook up and go operation.
- Front panel adjustable speed control.
- Controls direction, step size, and power to the motor.
- Isolated, regulated internal logic supply for "glitch" free operation.
- Informative manual answers questions on theory, hook-ups and uses - enhances resale value, too!
- A fun and exciting kit that is not only useful but educates too!
- Clear, concise assembly instruction carefully guide you to a finished kit that works the FIRST time!



### RAMSEY TRANSMITTER KITS

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- FM25B Synthesized Stereo Transmitter
- AM1, AM25 AM Transmitters
- TV6 Television Transmitter

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- CW7 CW Keyer
- CPO3 Code Practice Oscillator
- VLF1 Low Bander Low Frequency SWL Converter
- QRP Power Amplifiers

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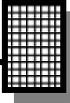
Many other kits are available for hobby, school, Scouts and just plain FUN. New kits are always under development. Write or call for our free Ramsey catalog.

#### SMD-1 STEPPER MOTOR DRIVER KIT INSTRUCTION MANUAL

Ramsey Electronics publication No. MSMD-1 Revision 1.2

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## KIT ASSEMBLY AND INSTRUCTION MANUAL FOR

# SMD1 STEPPER MOTOR DRIVER KIT

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# INTRODUCTION TO THE SMD1 STEPPER MOTOR DRIVER:

Stepper motors are highly accurate pulse driven motors commonly used in computer disc drives, printers, and robotic applications. These motors are commonly available in surplus electronics stores, at hamfests or electronic flea markets. They are very high quality machines, but they are not easy to control. Your SMD1 kit should help you not only to control these motors, but learn how they operate as well.

Not only will you find this kit very useful, you'll also find it enjoyable to build, whether you are a beginner or an experienced kit builder.

**NOTE TO NEWCOMERS:** If you are a first time kit builder you may find this manual easier to understand than you may have expected. Each part in the kit is checked off as you go, while a detailed description of each part is given. If you are to follow each step in the manual in order, and practice good soldering and kit building skills, the kit is next to fail-safe. If a problem does occur, the manual will lead you through step by step in the troubleshooting guide until you find the problem and are able to correct it.

## CIRCUIT DESCRIPTION:

Before we discuss the operation of the circuit used to control the stepper motor, the actual operation of the motor should be discussed. Remember also from your physics, that: 1) unlike magnetic poles attract each other, and, 2) when current flows through a coil of wire, a magnetic field is produced. A permanent magnet stepper motor consists of two main components, a rotor, (the spinning shaft) with permanent magnets attached, and the stator (the case or stationary part of the motor) with the control coils attached (see figure 1). As voltage is applied to the stator coils, the magnetic field produced will move the rotor to the point of lowest magnetic reluctance. Each time the successive stator is energized the rotor will continue to "step". The number of steps possible by the motor is proportional to the number of poles contained on the rotor assembly, and the number of stator coils.

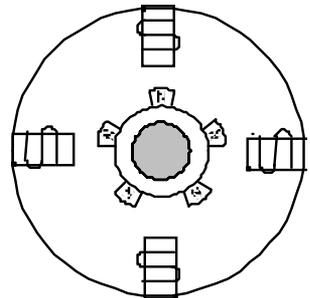


fig. 1

By pulsing the voltage to the stator coils in the proper *sequence* the rotor can be induced to spin in either direction at various speeds. This is accomplished by the MC3479 IC, which was designed specifically for this purpose. The external controls to this chip are a

clock input which is provided by U2, a 74HC00 CMOS IC configured to oscillate. There is also a clockwise / counterclockwise control line for motor direction, a run / hold control to "freeze" the motor in a specific position, and a full / half step to control the amount of rotational travel per clock cycle. The low power input limits the amount of current to the stator coils, and therefore the torque of the spinning shaft. Be aware, however, that the driver output current is rated at 500 mA max, so keep an eye on how much current your motor draws. The motor will run in low power mode, and this is the mode that is recommended for normal use. Resistors R3 and R5 determine the high / low power current, and may be adjusted in value to attain the 500 mA output current.

The phase A output is an open collector output that is active when the motor is in phase A operation. This occurs every fourth clock cycle in full step mode, or on the eighth clock cycle while in half step mode.

## **SMD1 STEPPER MOTOR PARTS LIST**

### RESISTORS

- 1 1K ohm [brown-black-red].
- 7 10K ohm [brown-black-orange].
- 1 47K ohm [yellow-violet-orange].
- 1 220K ohm [red-red-yellow].
- 1 100K ohm potentiometer [PC mount].

### CAPACITORS

- 1 .01 uF disc [marked .01 or 103 or 10nF].
- 2 1 uF electrolytic [marked 1uF].
- 2 10 uF electrolytic [marked 10uF].
- 1 220 uF electrolytic [marked 220uF].

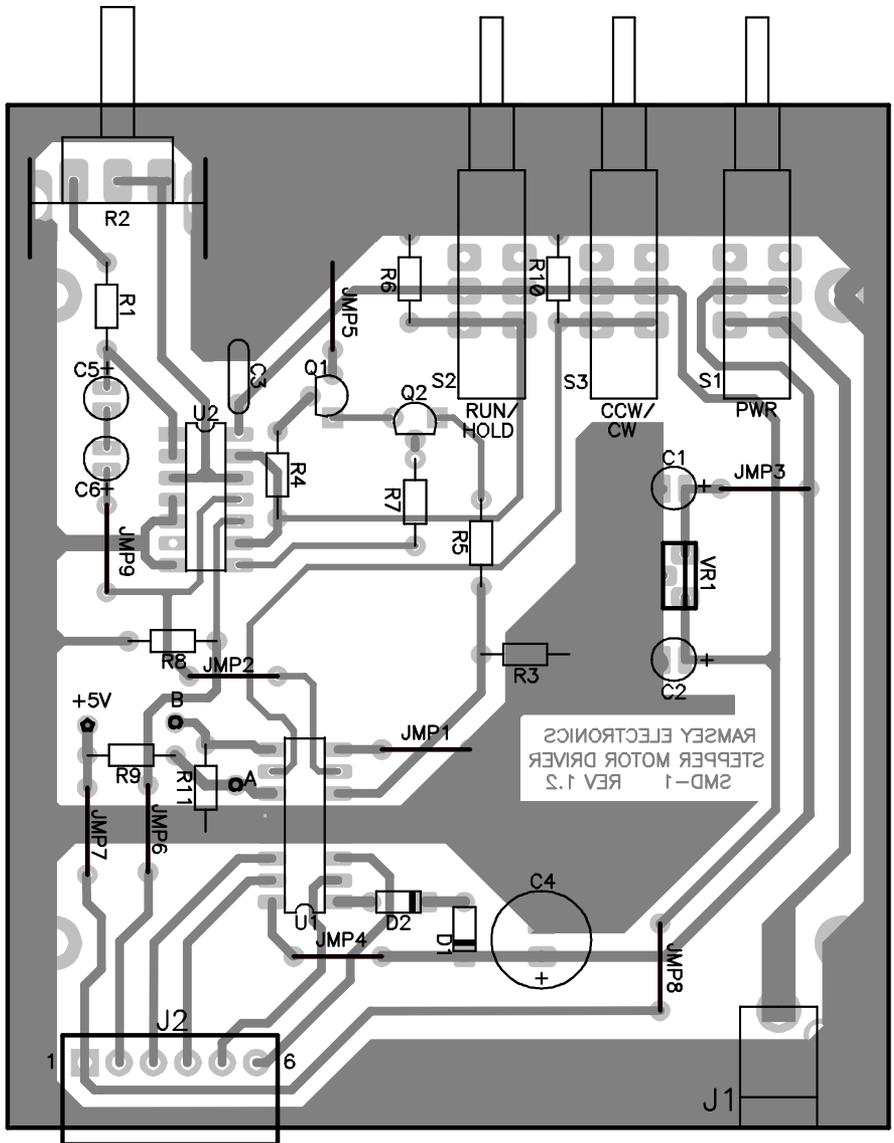
### SEMICONDUCTORS AND IC'S

- 2 1N4148 diodes [marked 1N4148].
- 2 2N3904 NPN transistors.
- 1 5 volt regulator [marked 7805].
- 1 74HC00 IC [14 pin DIP].
- 1 MC3479 IC [16 pin DIP].

### OTHER COMPONENTS

- 3 PC mount DPDT push button switches.
- 1 PC mount 6 pin MOLEX type connector.
- 1 PC mount 2.5mm DC power jack
- 1 SMD1 printed circuit board.

# SMD1 PARTS LAYOUT DIAGRAM





## **RAMSEY Learn-As-You-Build KIT ASSEMBLY:**

We have a twofold "strategy" for the order of the following kit assembly steps. First, we install parts in physical relationship to each other, so there's minimal chance of inserting wires into wrong holes. Second, whenever possible, we install in an order that fits our "Learn-As-You-Build" Kit building philosophy.

**For each part,our word 'install' means:**

1. Pick the CORRECT part value to start with.
2. Insert it into the CORRECT PC board location.
3. ORIENT it correctly, which means: PLEASE follow the PC board drawing and the written directions for ALL parts where there's a right way AND a wrong way to solder it in. (Diode bands, electrolytic capacitor polarity, transistor shapes, dotted or notched ends of IC's, and so forth.)
4. Push the component as close to the component side as is mechanically possible, this will keep the component side neat and prevent parts from "radiating" signals to undesired locations.
5. Solder ALL connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections. Don't be afraid of ANY pen-style soldering iron having enough heat to damage a component.
6. Trim or "nip" excess wire lengths after soldering.

NOTE: Save some of the longer wire scraps nipped from resistors and capacitors. These will be used to form wire jumpers (JMP1, etc.) to be soldered in just like parts during these construction steps.

## **FIRST ASSEMBLY STEPS**

Since you may appreciate some "warming up" soldering practice as well as a chance to put some "landmarks" on the SMD1 PC-board, we first will install some "hardware" components, to make the up-down, left-right orientation of the PC board as clear as possible. Initially, it can be quite confusing to find the right holes, even for an experienced builder. Just remember that the "component" side of the circuit board, the side shown in the parts layout diagram, is viewed from the TOP side. There are NO PC traces on this side of the circuit board, the component leads will pass through the board and be soldered on the "solder" side of the board.

## **NOW, LETS START BUILDING**

- ❑ 1. Install J-2, the 6 pin MOLEX type jack. Be sure that the open end of the connector faces toward the outside circuit board.
- ❑ 2. Install J-1, the 2.5 mm PC mount DC power jack.
- ❑ 3. Moving to the front of the PC board, now install R2, the 100K trimmer potentiometer. Gently guide the three legs through the PC board mounting holes.
- ❑ 4. Next install R-10, 10K ohm [brown-black-orange].
- ❑ 5. Install switches S1,S2, and S3. Make sure they are pushed flat to the PC board before soldering them.
- ❑ 6. Install R6, 10K ohm [brown-black-orange]. Be sure to save your 'scrap' resistor leads to use as jumper wires later.
- ❑ 7. Install R1, 10K ohm [brown-black-orange].
- ❑ 8. Install C5, 1 uF electrolytic capacitor. Electrolytic capacitors are polarized and *must* be installed correctly. They are usually marked with a black stripe and a (-) indicating their negative lead, while PC boards will usually indicate the (+) hole.
- ❑ 9. In the same manner, install C6, another 1 uF electrolytic. Watch that polarity! These capacitors are wired in series on the PC layout, minus to minus forming a non-polarized device which is required by the oscillator circuit.
- ❑ 10. Install U2, the 74HC00 14 pin IC. Use care when inserting the IC into the circuit board, as not to bend one of the pins so it does not pass through the circuit board. Note also that one end of the IC is marked by a dot, notch or a band; this end *must* be oriented as shown on the PC board layout diagram.
- ❑ 11. Install C3, the .01 disc capacitor [marked .01 or 103 or 10nF].

You've now finished the oscillator section of your stepper motor driver. This will control the speed of the turning shaft. Take some time now to re-check your solder connections. Be certain that there are no solder "bridges" between component leads or foil runs. Make sure all component leads are trimmed, and resolder any connection that is less than perfect.

- ❑ 12. Using a scrap component lead, form a "jumper" wire to insert in the printed circuit board. Install it in the JMP 5 position. Jumpers act as electronic "bridges" carrying signals over PC traces underneath.

- 13. Install R4, 10K ohm [brown-black-orange].
- 14. Form and install another jumper wire in the JMP 9 position.
- 15. Install R8, 10K ohm [brown-black-orange].
- 16. Install R7, 10K ohm [brown-black-orange].
- 17. Install Q1, the 2N3904 transistor. The component placement drawing clearly show how the flat side of each transistor points in relation to other parts. To install a transistor, press the three leads in place as far as they will go without forcing it, the wires may be spread as needed to hold it in place before soldering. Don't hesitate to use sufficient soldering heat to make good connections.
- 18. Install Q2, the other 2N3904 transistor.
- 19. Install R5, 47K ohm [yellow-violet-orange].
- 20. Install R3, 220K ohm [red-red-yellow].
- 21. Using a scrap component lead, form a "jumper" wire to insert in the printed circuit board. Install it in the JMP 2 position.
- 22. Form and install a jumper in the JMP 1 position.
- 23. Install U1, the MC3479 16 pin IC. Use care when inserting the IC into the circuit board, as not to bend one of the pins so it does not pass through the circuit board. Note also that one end of the IC is marked by a dot, notch or a band; this end *must* be oriented as shown on the PC board layout diagram.
- 24. Install R11, 10K [brown-black-orange].
- 25. Install R9, 1K ohm [brown-black-red].
- 26. Form and install jumper JMP6.
- 27. Form and install jumper JMP7.
- 28. Form and install jumper JMP4.
- 29. Install diode D2, the 1N4148 small signal diode. Note the band on the one end of the component. This is the cathode connection, and its orientation is shown in the parts layout diagram. The diode *must* be installed in this direction.
- 30. Install diode D1, the other 1N4148 diode.
- 31. Install the 220 uF electrolytic capacitor C4. Watch the polarity!
- 32. Form and install jumper JMP8.

You've now completed the "heart" of the controller. Now is a good time to take a step back, check component placement and soldering. Use a bright light and a magnifying lens to help.

- 33. Install C2, 10uF electrolytic capacitor. Watch the polarity.
- 34. Install C1, 10uF electrolytic capacitor. Again, watch the polarity.
- 35. Form and install jumper JMP3

In the following step, you will have to decide whether or not to install the separate 5 volt regulator IC. If the motor you have chosen to operate runs on 5 volts DC there is no reason to use the separate regulator for the logic power supply. Simply jumper the input and output connection of the 7805 voltage regulator as shown in the parts layout diagram. If the motor runs on any other voltage the regulator IC should be installed.

- 36. If needed, install VR1, the 7805 voltage regulator. Be sure to orient it correctly. Consult the parts placement diagram for correct orientation.

## **CONGRATULATIONS**

Your stepper motor driver is complete. Take one more good hard look at component placement and your soldering job. Make sure all leads have been trimmed as not to bend and "short" out against adjacent parts. Be aware that 95% of kit repairs are due to improperly placed parts and poor soldering. Also, in the following steps the circuit will be energized and component damage can result from improper assembly.

## **TESTING AND OPERATION:**

In order to test your motor driver, you must first determine the "pinout" of your particular stepper motor. Since these motors come in a variety of shapes and sizes, a general approach will be given. One must first determine which of the bundle of wires coming from the motor are the stator coils. This can be simply accomplished using an ohmmeter and trying various combinations in a logical sequence while looking for a "low" resistance measurement between controlling wires. Make a note of which combinations measure this low condition, as these are the coils internal to the stepper motor. Generally, one coil uses a red and grey wire while the other coil uses a yellow and black. Some motors are four phase with four coils. You can still use these motors by by just using two of the coils. Experiment to see *which* two coils to use.

We're sorry that we can't be more specific on how to identify the coils, but

please understand that there are many different types of stepper motors and we can't explain all of them. Also, please don't call us and ask us to tell you where to hook up the red, orange, and green wires, we simply do not have the manpower to trace out each stepper motor type in existence.

Please continue with the following steps *in the proper order* to avoid any chance of damaging the MC3479 IC.

Form and install a jumper wire in the 6-pin molex connector in the low power position. The connector should allow you to slide in the jumper and allows for easy removal. This will limit the current supplied to the motor coils and is recommended for initial setup operation.

Place the motor wire pairs in the corresponding motor coil connections, e.g. "set" one to L1 and L2 contacts and "set" two to the L3 and L4 connection. Don't be overly concerned yet with which coil set belongs with which coil connections, we're about to determine that!

Connect a suitable power source (for most applications 12 - 14 volts is recommended) to the DC input connector. Set switch S2 to the "on" or run position. Then switch the power switch momentarily to the "on" position.

Observe the motor and note:

- 1) Is it rotating?
- 2) What is the direction of rotation?

If the motor is not rotating you may reverse *one* set of coil connections, either L1 and L2 *or* L3 and L4. Re-energize the circuit and the motor should rotate. If it still does not rotate, disconnect the motor and re-check your ohmmeter measurements to be sure you have the coils identified correctly.

If the direction of rotation is incorrect, reverse the polarity of *both* coil sets.

Adjust the speed control pot on the front of the controller. This should vary the speed of the steps. The 74HC00 IC should oscillate with a range of between 20 - 80 Hz. If the motor is "pulsed" too quickly, it will begin to slip and step intermittently. If you wish to experiment with the speed of the oscillator, capacitors C5 and C6 may be changed. A larger total capacitance figure will result in a slower clock, or step speed. Both C5 and C6 must be equal in value.

Switch the clockwise / counterclockwise front panel switch. The motor should reverse direction. This reverses the stepping sequence internal to the MC3479 IC.

Switch the run / stop switch the motor should "hold" in position. This is different than the power off condition in that the motor is held in position by the stator coils. Remember that the maximum current rating for the IC is 500 mA. A DC ammeter connected in series with either stator coil will give you a true measurement of the actual current being supplied. Resistor R5 may be adjusted in value to limit the current (a larger value of resistance results in a lower current figure).

If you desire to run your motor in half step increments simply install a jumper wire between point B on the circuit board to the + 5 vdc connection, as shown in the parts layout diagram. You may also wish to install a SPST toggle switch to accomplish this connection. This will enable you to control the full / half step operation remotely.

## **TROUBLESHOOTING HINTS**

While we had hoped that it wouldn't come to this, if you are still having trouble getting your SMD1 to operate please try the following.

Most importantly, check your soldering and parts orientation. Checking your work backwards through the assembly steps is very effective in locating placement errors. Have another pair of eyes check your work, we've all looked at our own mistakes and never even seen them!

Employ logical troubleshooting techniques on the circuit operation. Do I have 5 volts at the output of the voltage regulator? Are the front panel switches truly switching the 5 volts? This kit includes many "jumper" wires, are they all connected on both ends? A volt-ohmmeter and a cool head can debug even the toughest problem.

## **INTERFACING INSTRUCTIONS**

If you wish to interface your SMD1 kit with external logic control, the printed circuit design lends itself to easy interface connections.

### **EXTERNAL CLOCK INPUT**

You may input an external clock by removing jumper JMP2 and tying the clock to the clock input PC trace of the MC3479 IC. The IC is "looking" for a 5 volt peak to peak squarewave.

### **REMOTE SWITCH CONTROL**

External control of the run / hold, CW / CCW, and power connections is also

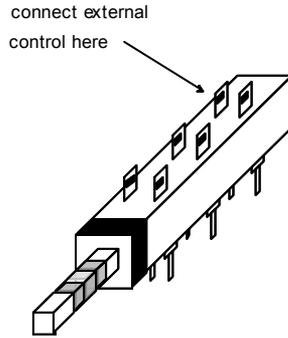
an easy task. You'll notice that each switch contains solder "lugs" on the top of the switch assembly. The external logic control can be connected directly to the appropriate terminal. The only requirement is that the control's "on" state is five volts dc when energized.

## **ENCLOSURE IDEAS**

While we believe that the Ramsey enclosure and knob option is a fine value for finishing off your Ramsey kit, we are happy to give you additional suggestions and our reasons for them. If rugged portability is your goal, you will find that the circuit board can be nicely mounted in a VHS video cassette case. The controls are easily mounted at one end of such a box. These storage boxes come in several styles, so pick the one that looks truly practical as a project enclosure.

## **REMOTE SWITCH CONTROL**

External control of the run / hold, CW / CCW, and power connections is also an easy task. You'll notice that each switch contains solder "lugs" on the top of the switch assembly. The external logic control can be connected directly to the appropriate terminal. The only requirement is that the control's state is equal to 5 vdc when energized.



## **ENCLOSURE IDEAS**

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## **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 its sad to say that our human construction skills have not! But on rare occasions 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.

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### 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

### TOTAL SOLDER POINTS

126

### ESTIMATED ASSEMBLY

#### TIME

Beginner .....3.5 hrs

Intermediate .....2 hrs

Advanced .....1.5 hrs

Price: \$5.00

Ramsey Publication No. MSMD1

Assembly and Instruction manual for:

***RAMSEY MODEL NO. SMD1***

***STEPPER MOTOR DRIVER KIT***



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