

# ***DTMF CONTROLLER INTERFACE***

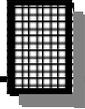


**Ramsey Electronics Model No.**

**DCI1**

*Have you ever wished you could call home and turn on the lights late at night before you pull in the driveway? Finally, an easy way to remotely control just about anything with the touch of a button! The DCI1 offers full control of four independent relay contacts for quick and easy custom applications!*

- **Remote control almost anything from any DTMF device!**
- **Call in from the road to turn on your lights... and more!**
- **User configurable security code for your protection**
- **Easy administrative security code bypass for free running DTMF control makes custom applications even easier!**
- **User feedback tones confirm remote operation success!**
- **Full microprocessor control for simple, but comprehensive features.**
- **FLASH memory holds security code data for years!**
- **Decodes all sixteen DTMF codes!**
- **Built-in RJ-11 jack for easy interfacing with your phone line!**



### RAMSEY TRANSMITTER KITS

- FM100B Professional FM Stereo Transmitter
- FM25B Synthesized Stereo FM Transmitter
- MR6 Model Rocket Tracking Transmitter
- TV6 Television Transmitter

### RAMSEY RECEIVER KITS

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

### RAMSEY HOBBY KITS

- SG7 Personal Speed Radar
- SS70A Speech Scrambler
- BS1 "Bullshooter" Digital Voice Storage Unit
- AVS10 Automatic Sequential Video Switcher
- WCT20 Cable Wizard Cable Tracer
- LABC1 Lead Acid Battery Charger
- ECG1 Electrocardiogram Heart Monitor
- LC1 Inductance-Capacitance Meter

### RAMSEY AMATEUR RADIO KITS

- DDF1 Doppler Direction Finder
- HR Series HF All Mode Receivers
- QRP Series HF CW Transmitters
- CW7 CW Keyer
- CPO3 Code Practice Oscillator
- 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.



## DCI1 INSTRUCTION MANUAL

Ramsey Electronics publication No. MDCI1 Rev 1.1

First printing: April 2002

COPYRIGHT 2002 by Ramsey Electronics, Inc. 590 Fishers 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

## ***DTMF CONTROLLER INTERFACE***

### TABLE OF CONTENTS

Introduction.....	4
Circuit Description.....	5
Schematic Diagram .....	8
Parts Layout Diagram .....	9
Parts List .....	10
Learn As You Build .....	11
DCI1 Assembly.....	12
Custom Case Assembly .....	18
Using Your DCI1.....	19
Wiring & Custom Applications.....	22
Troubleshooting Guide .....	24
DCI1 Specifications .....	26
Conclusion.....	26
Warranty.....	27



### **RAMSEY ELECTRONICS, INC.**

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

## INTRODUCTION

The DTMF Controller Interface, or DCI1 for short, was designed to meet the needs of the home automation experimenter. The easy hookup interface and simple operational control lends itself well for a variety of applications.

The DCI1 continually monitors your phone line (or just about any other DTMF audio source) and looks for the proper user programmed security code. Once it is heard, the user may select which of the 4 trigger relays to turn on or off. Feedback tones from the DCI1 are then sent back over the line to confirm your selection. No more wondering if your commands are carried out as is commonly found with other similar devices! Now you can call home and, when your answering machine picks up, control lights, security systems, or just about any number of other custom applications!

The DCI1 is a slim line unit with four 5 Amp (1250VA AC/150W DC) relay outputs, each with its own sure grip screw terminal. It requires a 12 to 15 VDC 300 mA (positive tip) power source for operation; our standard AC125 110 VAC power adapter works well. A matching case & knob set is also available to make your kit look more professional and attractive in any setting (not to mention cover up any potentially hazardous voltages you may be switching).

Note: The DCI1 does not answer or seize control of your phone line or other audio source. An answering machine or similar device is needed to retain control on a phone line. The DCI1 simply “listens” to the line.

## CIRCUIT DESCRIPTION

Take a look at the DC11's Schematic Diagram as we walk through the circuit description. We will start with the DTMF audio input and work our way through to the power supply section.

The DTMF audio input uses a standard style RJ-11 modular phone jack (J6 - Phone Line Monitor In) for easy interfacing with your phone line or other audio source (a direct audio pinout for J6 is shown in the wiring section). The input circuitry near the phone jack allows you to continually monitor the audio signal and pull off any DTMF data that comes in so it can be decoded. The audio sniffer formed by C14, C15, R8, R9, and R10 will not capture the line so it does not interfere with the normal use of your phones. All it does is quietly feed any audio tones present to the decoder IC for processing. Protection diodes D2 and D3 limit the incoming signal to +/- 0.7 V so that potentially damaging voltages like the 90 Vp-p 'Ring' signal do not blow up your decoder IC!

The DTMF decoder IC (U3) has the task of monitoring all the input audio signals from the phone line (or other audio source) and pulling off any valid audio tones. When a DTMF audio tone is detected, U3 presents a 4 bit digital code (meaning 0000 through 1111, each position is a bit) to the micro-controller (U1) that represents which one of the possible 16 different valid characters it is receiving.

Why a 4 bit code you may ask? Think back to your High School math class for a moment when you learned about different base numbering systems. Humans like to work in a base 10 system (decimal system, deci = 10) using the digits 1 through 10 (or 0 through 9 to be more precise). This is probably due to the 10 fingers and 10 toes we all learned to count on as kids. Computers on the other hand (pardon the pun) like to work with a base 2 numbering system (binary system, bi = 2) using digits 0 and 1; 0 for off / low and 1 for on / high. In order to represent the 16 different possible tones (base 10) you need to have 4 bits in a binary system  $2^4 = 1111$  (binary) = 16 (decimal). Wow... kind of got off on a tangent there!

Internally, U3 has a set of counters that latch the 4 outputs depending on the detected tones. The counters are referenced to a television color-burst crystal operating at 3.579 MHz (X1) for rock solid measurements. Notice how C1 couples a bit of the X1 crystal frequency over to U1 (the micro-controller) to set its timing as well.

U1 is the pre-programmed 68HC908JK1 micro-controller.

<u>DTMF Tone</u>	<u>4-bit Code</u>
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
0	1010
*	1011
#	1100
A	1101
C	1110
C	1111
D	0000

This IC contains the developed code required to take the DTMF tone data from U3 and process while reading and writing to FLASH memory, generating the feedback tones, monitoring the programming switch, and turning the relays on and off as needed. Quite a bit for one little part!

Since the four relay driver circuits are identical, we'll walk through the operation of one section and leave it to you to trace out the other three. Take a look at the K1 relay driver circuit on the schematic. It consist of these 5 components: R1, R14, D5, Q1 and K1. When the relay driver output from the micro-controller (RELAY\_1) switches 'High', Q1 is forward biased pulling its normally high impedance Collector down to ground potential. This completes the circuit path for relay K1 to turn on causing its internal contacts to close providing you with a 'switch closure' for your custom applications.

This all seems fairly simple, but what is the function of R1, R14, and D5? Resistor R1 acts as a current limiter so that the Base-Emitter junction of the transistor does not pull the 'High' output (+5 VDC) of the micro-controller down to 0.7 VDC. In this way, the loading on the micro-controller is well within the needed parameters for proper operation.

Resistor R14 is also used as a current limiting resistor just like R1. Since the relays used in the DCI1 are all 9 VDC models and our power supply puts out upwards of 12 VDC, R14 allows us to limit the current to the needed 50 mA or so needed to fully activate the relay and set its terminal voltage to the desired 9 VDC.

Now why is Diode D5 placed across the input terminals of the relay? It looks like it is always reverse biased (the Cathode is more positive than the Anode) so it can never turn on! If you look on a schematic for any quality product that uses a relay, you should see a diode set in the same configuration (we aren't just trying to dump off a few extra parts here!). Relays such as K1 are very inductive due to there construction. Since inductors have the property  $V = L \frac{di}{dt}$ , they resist changes in current over time ( $di/dt$ ). As the magnetic field begins to collapse when Q1 turns off, a huge 'kickback voltage' is generated with reverse polarity on the terminals of the inductor (upwards of a 1000 V is easily possible!). This generated 'kickback voltage' is more then enough to destroy Q1 and other parts on the board! To avoid this, D5 is inserted to provide a safe discharge path when the reverse 'kickback voltage' starts to rise above 0.7 VDC. Neat huh!

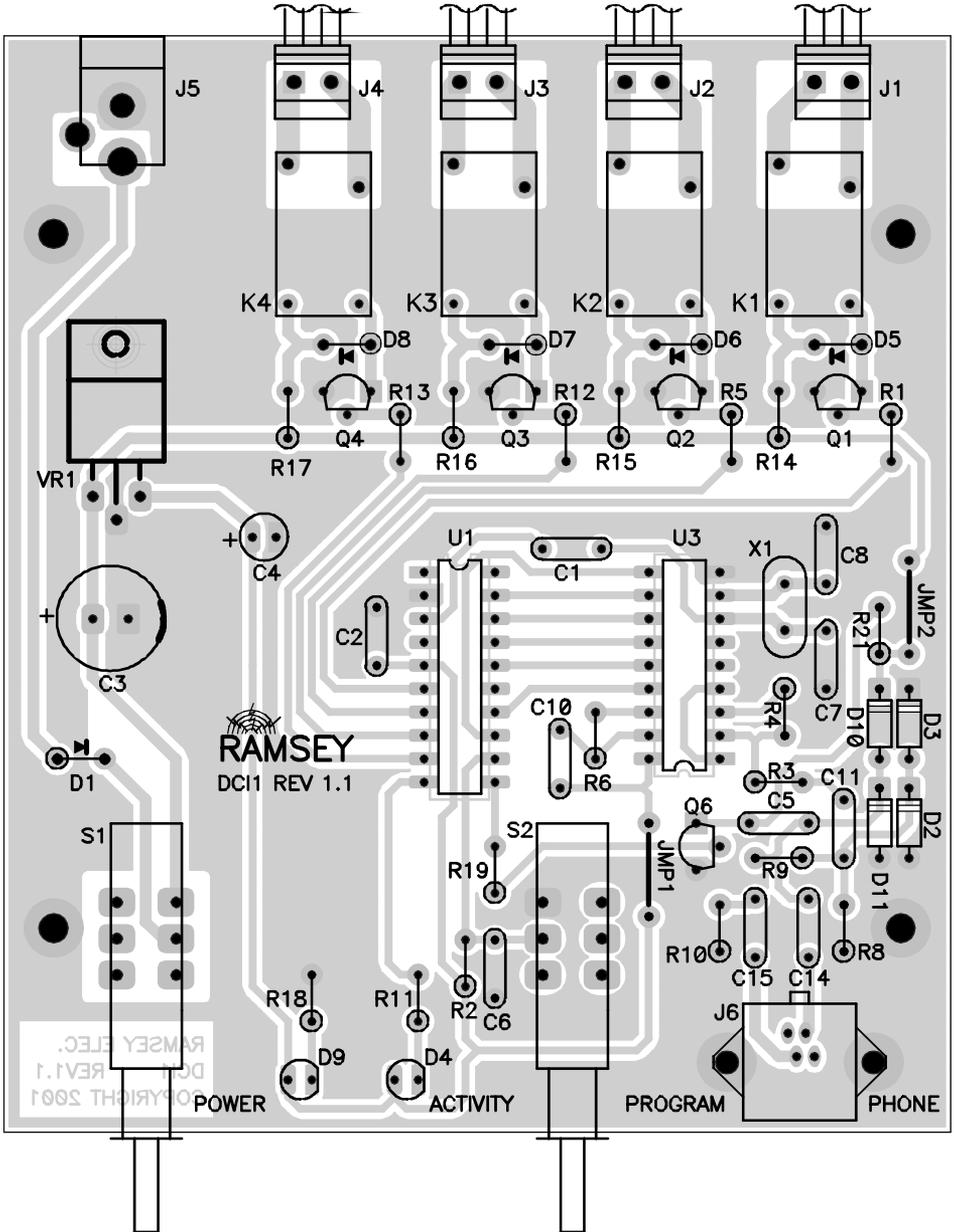
When the micro-controller receives valid data from the user, it flashes LED D4 (the activity indicator) and sends a feedback tone back over the phone line to let you know the command was received. Components R19, R21, Q6, C5, D10 and D11 work together with the micro-controller to generate the tone pulse. The pulsed tone output from U1:pin 11 is amplified from 0 to 5 VDC up to 0 to 12 VDC to ensure that enough signal will couple through to the phone

line. Protection diodes D10 and D11 limit the incoming signal on the phone line (between +12.7 and - 0.7 V) so that potentially damaging voltages like the 90 Vp-p 'Ring' signal does not blow up Q6!

So far we have covered most of the circuitry on the board with exception of the power supply. VR1 and the surrounding parts C3, C4 and the polarity protection diode D1 form a simple voltage regulator to supply a steady 5 VDC to the ICs on the board. By using this scheme, we can operate the unit with a single 12 VDC (positive tip on J5) source and have access to the multiple voltages needed for the unit to operate.



# DCI1 PARTS LAYOUT DIAGRAM



## **PARTS SUPPLIED WITH YOUR DCI1 KIT**

### **Capacitors**

- 2 22 pF disc capacitor (marked 22) [C7,8]
- 1 470 pF disc capacitor (marked 470 or 471) [C1]
- 2 .01 $\mu$ F disc capacitor (marked .01, 103 or 10 nF) [C2,6]
- 5 .1  $\mu$ F disc capacitor (marked .1 or 104) [C5,10,11,14,15]
- 1 10  $\mu$ F electrolytic capacitors [C4]
- 1 100  $\mu$ F electrolytic capacitors [C3]

### **Resistors**

- 4 100 ohm (brown-black-brown) [R14,15,16,17]
- 2 220 ohm (red-red-brown) [R11,18]
- 1 1K ohm (brown-black-red) [R3]
- 10 10K ohms (brown-black-orange) [R1,2,5,8,9,10,12,13,19,21]
- 1 100K ohms (brown-black-yellow) [R4]
- 1 330K ohms (orange-orange-yellow) [R6]

### **Semiconductors and Integrated Circuits**

- 5 1N4000 series diode (black body with white band) [D1,5,6,7,8]  
-Note that 1N4002-1N4007 diodes may be used.
- 4 1N4148 diodes (small glass diode) [D2,3,10,11]
- 5 2N3904 transistor (three leads TO-92 package marked 3904)  
[Q1,2,3,4,6]
- 1 7805 +5 volt voltage regulator [VR1]
- 2 JUMBO red LED [D4,9]
- 1 68HC908JK1 pre-programmed micro-controller (20 pin DIP) [U1]  
(marked with a sticker labeled DCI1)
- 1 HT9170B DTMF decoder IC (18 pin DIP) [U3]

### **Miscellaneous Components**

- 4 2 screw terminal jack [J1,2,3,4]
- 1 2.1 mm DC power jack [J5]
- 1 RJ11 modular phone jack (PCB mount) [J6]
- 2 DPDT PC mount pushbutton switch [S1,2]
- 4 9 Volt Relay [K1,2,3,4]
- 1 3.579 MHz crystal (Marked 3.579 or 3.579545) [X1]
- 1 #4-40 kepnut [for VR1]
- 1 #4-40x1/4" screw [for VR1]

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

There are many solder connections on the DC11 printed circuit board. PLEASE take us seriously when we say that good soldering is essential to the proper operation of your DTMF Controller Interface!

- Use a 25-watt soldering pencil with a clean, sharp tip.
- Use only rosin-core solder intended for electronics use.
- Use bright lighting; a magnifying lamp or bench-style magnifier may be helpful.

Do your work in stages, taking breaks to check your work. Carefully brush away wire cuttings so they don't lodge between solder connections.

We have a two-fold 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. This entails describing the circuit that you are building, instead of just blindly installing components. We hope that this will not only make assembly of our kits easier, but help you to understand the circuit you're constructing.

For each part, our word "Install" always means these steps:

1. Pick the correct component with the proper value to start with.
2. Insert it into the correct PC board location.
3. Orient it correctly, following the PC board drawing and the written directions for all parts - especially when 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. Solder all connections unless directed otherwise. Use enough heat and solder flow for clean, shiny, completed connections.
5. Trim or nip the excess component lead wire 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.

**Enough of that ... let's get started!**

## DC11 DTMF CONTROLLER INTERFACE KIT ASSEMBLY

Although we know that you are anxious to complete the assembly of your DTMF Controller kit it is best to follow the step-by-step instructions in this manual. Try to avoid the urge to jump ahead installing components.

Since you may appreciate some warm-up soldering practice as well as a chance to put some landmarks on the PC board, we'll first install some of the larger mounting components. This will also help us to get acquainted with the up-down, left-right orientation of the circuit board. Remember that all of the components will be mounted on the component side of the circuit board and soldered on the solder side of the circuit board (the side that contains the printed circuit traces). Have a look at the parts layout diagram to help with your assembly.

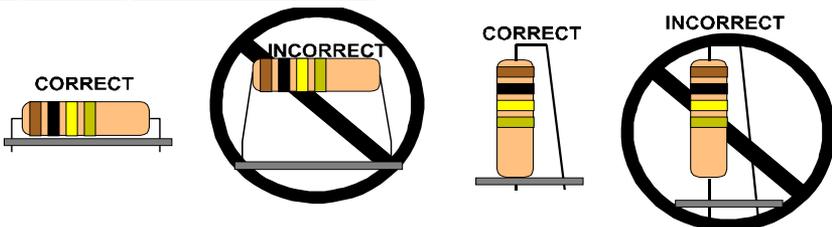
Use the boxes to check off your progress.

Check all received parts against the parts list. The parts list describes the various markings that may be found on the kit parts. Carefully sort the parts into small piles, (an empty egg tray does nicely for this purpose) to aid in finding the correct part at the required time.

Today's IC's have achieved remarkable performance levels and it is extremely unlikely that any of your chips will have problems, yet we know that some of our hobbyists insist on socketing all IC components. The addition of these will not "void" your warranty, but if a problem arises from a socketed component you will be required to pay the additional technician fee for labor in the repair of your kit, if necessary.

We will begin by installing the input and output connectors on the rear side of the circuit board. These will act as our landmark components and make the orientation of the rest of the parts a bit easier.

### Proper Component Installation:



**NOTE:** All of the diodes and resistors used in the kit will be installed in a stand up fashion. This means one lead will go straight into the board while the other is bent around to go back down into the other hole. The straight lead goes into the hole with the silk-screened circle around it on the circuit board.

- 1. Locate and install J1, one of the green 2 screw terminal jacks. The open holes should face outward from the center of the circuit board. These holes are where you will interface your external wiring to the relay contacts.
- 2. Install J2, one of the green 2 screw terminal jacks.
- 3. Install J3, one of the green 2 screw terminal jacks.
- 4. Install J4, the last green 2 screw terminal jack.
- 5. Identify and install the power connector J5, the 2.1 mm DC power jack at the edge of the PC board. Gently slide the leads through the component side of the circuit board until the connector is mounted flush. Solder all three connections using enough heat to flow the ground connection completely.
- 6. Install D5, a 1N4004 diode (black with white band). The body of the part should be placed in the hole with the silk-screened circle around it. The banded end should be away from the board and the wire lead needs to be bent over to into position for the other hole.
- 7. Install D6, another 1N4004 diode. Watch its orientation!
- 8. Install D7, another 1N4004 diode. No more reminders, you should know by now that diode orientation is critical.
- 9. Install D8, another 1N4004 diode. Again, watch its orientation (sorry, I had to do it)!
- 10. Install Q1, a three leaded transistor marked 2N3904. The flat side must be placed as shown on the PC board silkscreen. Look at the Parts Layout Diagram for further clarification. When you insert it, mount it as close to the board as possible without forcing it.
- 11. Install Q2, another 2N3904 transistor.
- 12. Install Q3, can you guess? Yup... another 2N3904.
- 13. Install Q4, the last 2N3904 transistor used in the relay control circuit.
- 14. Install R1, a 10K ohm resistor (brown-black-orange). Save a few of the clipped off wire leads from the resistors. We'll use them to construct jumper wires JMP1 and JMP2 later.
- 15. Install R14, a 100 ohm resistor (brown-black-brown).
- 16. Install R5, a 10K ohm resistor (brown-black-orange).
- 17. Install R15, a 100 ohm resistor (brown-black-brown).

- 18. Install R12, a 10K ohm resistor (brown-black-orange).
- 19. Install R16, a 100 ohm resistor (brown-black-brown).
- 20. Install R13, a 10K ohm resistor (brown-black-orange).
- 21. Install R17, a 100 ohm resistor (brown-black-brown).
- 22. Locate and install K1, one of the large white relays
- 23. Install relay K2.
- 24. Install relay K3.
- 25. Install K4, the last relay.

Great job... you just finished building the relay driver circuit! The transistors (Q1 through Q4) energize their respective relays when they are turned on and off by the micro-controller (U1). Next we'll build the power supply section.

- 26. Install VR1, the 7805 voltage regulator. Install the three leads as shown on the silkscreen and gently bend the part over to match the silkscreen layout. Affix VR1 to the circuit board using the provided #4x40 screw and kepnut; then solder all three leads. This part "smoothes" out any ripple that may still be present on the main input supply voltage and provides us with the needed 5 VDC the ICs operate on.
- 27. Install C3, the 100  $\mu$ F electrolytic capacitor. This part must be installed properly for it to function. In fact, this capacitor has the potential to explode if installed in reverse polarity! The PC board silkscreen shows the positive hole and the band on the capacitor shows the negative side. You'll also notice that the lead closest to the stripe is shorter the other lead; this also indicates the negative side.
- 28. Install C4, the 10  $\mu$ F electrolytic capacitor. Watch that polarity!
- 29. Install D1, the last 1N4004 diode. Watch your orientation like you did for D5 through D8.

With exception of the power switch, which we'll install a bit later, you just finished the power supply section! Diode D1 acts as a polarity safety net so that you don't accidentally harm the unit should a miss wired plug be used. Since diodes only conduct in one direction, the unit will only power up if a positive tip DC power plug is hooked up to J5. Capacitors C3 and C4 work with VR1 to provide you with a well regulated 5 VDC supply needed to power the ICs.

- 30. Install the 20 pin DIP socket for U1, the 68HC908JK1 micro-controller IC. It doesn't matter which way the socket is orientated, as long as the chip is place in the socket the correctly. You can bend two of the corner leads out slightly to hold the socket in place when you flip the board over to solder it in. Make sure all 20 pins are through the holes and then solder each one. Check your solder joints for even flow before moving on.

- ❑ 31. Insert U1, the micro-controller marked with a sticker labeled DCI1 into the socket. Orient the notched end as shown on the PC board silkscreen and Parts Layout Diagram (toward the relays). Before you push it down into the socket, check to be sure none of the pins are bent under or outside of the socket. When you're sure the pins are where they belong, press the chip down so that it is seated flat within the socket.
- ❑ 32. Install C2, a .01 $\mu$ F ceramic capacitor (marked .01, 103 or 10 nF). Disc capacitors are not polarized so they can be installed in either direction. The reason we call them "disc" caps can be seen by the package style. The capacitor itself is two conductive discs separated by a dielectric compound.
- ❑ 33. Install C1, a 470 pF disc capacitor (marked 470 or 471). This capacitor couples over a bit of the X1 clock signal from U3 to run the micro-controller.
- ❑ 34. Install C10, a .1 $\mu$ F ceramic capacitor (marked .1 or 104).

Have you figured out what that 104 value stands for yet? Here's the answer. Disc capacitors are typically marked with their value in picofarads, or pF (commonly pronounced "puff"), equal to a value of  $1 \times 10^{-12}$  Farad. A 104, or 100,000 pF disc cap (notice how 104 breaks up as a 1, 0, and then 4 more 0s to equal 100,000) has an equivalent value of 0.1 microfarad or 0.1  $\mu$ F. Mathematically speaking,  $100,000 \times 10^{-12} = 0.1 \times 10^{-6}$ . That's how we switch between the 104 and .1 values so easily.

- ❑ 35. Install R6, a 330K ohm resistor (orange-orange-yellow).
- ❑ 36. Install U3, the 18 pin DIP tone decoder chip marked HT9170B. Make absolutely sure it is mounted in the proper direction. The small semi-circle (or notch as commonly called) on the IC represents pin 1 and should be mounted in the same direction as in the Parts Layout Diagram. The ICs in this kit are not mounted in the same direction so look closely before soldering it in.
- ❑ 37. Install JMP1 using one of the scrap wire leads you saved from the earlier steps. Form the wire into a staple like shape and insert it from the top side of the board in the holes shown on the silkscreen and the Parts Layout Diagram. Solder it in place so that it will act like an electronic bridge connecting the circuit traces over the top side of the circuit board.
- ❑ 38. Install JMP2 in the same fashion as the last step.
- ❑ 39. Install C8, a 22 pf ceramic capacitor (marked 22).
- ❑ 40. Install C7, another 22 pf ceramic capacitor (marked 22).
- ❑ 41. Install R21, a 10K ohm resistor (brown-black-orange).
- ❑ 42. Install X1, the 3.579 MHz crystal (silver can marked 3.579). Make sure it is flush to the board before soldering.
- ❑ 43. Install R4, a 100K ohm resistor (brown-black-yellow).

- 44. Install R3, a 1K ohm resistor (brown-black-red).
- 45. Install D10, one of the 1N4148 diodes (small glass diode with black band). The lead closest to the black band is the Cathode end. Make sure it lines up with the white band shown on the PC board silkscreen and the Parts Layout Diagram. Be gentle with this fragile part and double check the orientation before soldering.
- 46. Install D3, another 1N4148 diode in the same fashion as D10.
- 47. Install D11, another 1N4148 diode.
- 47. Install D2, the last 1N4148 diode.
- 48. Install Q6, the last 2N3904 transistor. Follow the same guidelines you did for Q1 through Q4. We're getting down to the last few parts!
- 49. Install C5, a .1 $\mu$ F ceramic capacitor (marked .1 or 104). This capacitor is used to couple the feedback tone back onto the phone line.
- 50. Install C11, a .1 $\mu$ F ceramic capacitor (marked .1 or 104).
- 51. Install R9, a 10K ohm resistor (brown-black-orange).
- 52. Install R10, a 10K ohm resistor (brown-black-orange).
- 53. Install C15, a .1 $\mu$ F ceramic capacitor (marked .1 or 104).
- 54. Install C14, a .1 $\mu$ F ceramic capacitor (marked .1 or 104).
- 55. Install R8, a 10K ohm resistor (brown-black-orange).

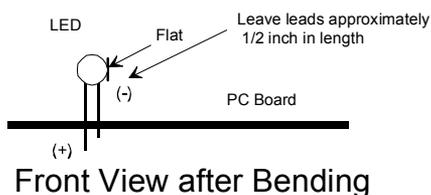
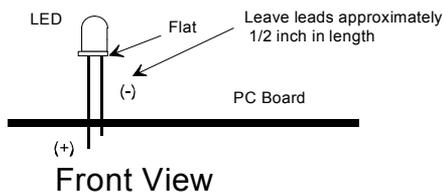
With exception of the modular phone jack (J6), you just finished building the entire DTMF detector circuit! Almost done... just a few more parts to go. Most of the final few components form the user interface section of the kit.

- 56. Install R19, a 10K ohm resistor (brown-black-orange).
- 57. Install R18, a 220 ohm resistor (red-red-brown).
- 58. Install R11, a 220 ohm resistor (red-red-brown).
- 59. Install R2, a 10K ohm resistor (brown-black-orange).
- 60. Install C6, a .01 $\mu$ F ceramic capacitor (marked .01, 103 or 10 nF).

Almost there! Even though you can hardly wait to fire up the kit, take a few minutes to recheck your assembly up to now. Touch up any solder connections, recheck all electrolytic/diode/transistor component orientations. A few minutes now can save time tenfold once you have energized the circuit. Incorrectly installed parts can be damaged once power is applied.

- 61. Install pushbutton switch S1 by inserting all six leads through the circuit board. The switch should fit flat to the circuit board before soldering.

- ❑ 62. Install S2 the same way.
- ❑ 63. Install J6, the modular RJ-11 phone jack. Pay close attention to the silkscreen and line up the four conductor wires with their respective holes before snapping the part onto the board. Solder all four wire connections being careful not to short them together (they're really close to each other). Do not solder the plastic posts. The snap fit design will hold it in place.
- ❑ Install LED D9. The flat side is oriented as shown in the diagram. Leave it standing about 1/2 of an inch off of the board when soldering. After soldering bend it over to a 90° angle at its midpoint so that it faces the outside of the board. Observe the following diagrams for proper orientation.



- ❑ 6. Install LED D4 the same way as D9.

## **CONGRATULATIONS !**

Your DCI1 DTMF Controller Interface is now complete! Have a final look over your work, paying particular attention to the orientation of all diodes, capacitors, and ICs. Remember that any problems you find now can save time and effort after the unit has been cased up.

## ASSEMBLY INSTRUCTIONS FOR CUSTOM CASE

The enclosure is a key element to the overall pride you will have upon completing your Ramsey kit. The enclosure will show how you were able to “build from scratch” a commercial piece of high-tech electronics. For some of us, the enclosure will also hide a number of “not-so-pretty” assembly mistakes. Once the kit is enclosed, your friends will never know that you were new to soldering. Finally, the enclosure case will protect your electronics from many possible causes of damage so that you can receive years worth of enjoyment using, talking about, and remembering the fun you had building your kit. In short, TAKE YOUR TIME when assembling the enclosure. This is the part that you and your friends will look at and admire for years!

- 1. Lay the front and rear plastic plates over their corresponding labels to verify which sticker goes with which panel. You'll want to work with one panel at a time to avoid possible mix-ups.
- 2. Remove the backing material from one of the stickers and line it up properly on its pre-punched panel. Make sure that they are aligned correctly before allowing them to touch the plastic plates. They stick the first time; line them up right!
- 3. Use a sharp hobby knife to cut out the holes in the labels along the pre-punched holes. A short sawing motion from the front side works well around the inner circumference of the holes.
- 4. Repeat the above steps for the other panel.
- 5. Insert the board into the case with the buttons and LEDs extending through the holes in the front panel.
- 6. Insert the rear panel into the grooves on the back of the base tray.
- 7. Secure the PC board to the bottom base tray with 4 short Phillips head screws.
- 8. Mount the top cover using the 1” screws after you have completed the testing phase and final hookup wiring.

Use of a case set with your DCI1 is highly recommended. The voltage on the exposed traces near the relay contacts (bottom side of K1 through K4 and the clamping screws themselves) may be potentially as high as 120 VAC depending on your target hookup configuration. The added security from using a plastic (non-conductive) enclosure ensures protection from any potentially lethal voltages.

Great care should be taken with any wiring arrangement to guarantee the safety of the operator and any others that may come into contact with this unit

## **USING YOUR DCI1 DTMF CONTROLLER INTERFACE**

Now we're ready for the moment of truth, the initial power up and running of your DCI1! It's best to run through the initial power up with nothing wired to the relays just incase you have any build errors. For testing and programming purposes, use a phone next to the DCI1. You will not need to call another phone to work with the system. The unit has built in dial tone and busy tone rejection filters so you can use just one phone to set it up. Pay no attention to the TELCO busy tone or recorded voice messages while in programming or normal modes.

1. Connect your 12 VDC power supply (12 to 15 VDC) to the J5 Power jack.
2. Connect your phone line to the J6 Phone jack using a standard RJ-11 patch cord. Only the two center conductors are needed.  
Note: The DCI1 does not answer or seize control of your phone line or other audio source. An answering machine or similar device is needed to retain control on a phone line. The DCI1 simply "listens" to the line.

### **User Controls:**

#### DTMF Control Codes

1. 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, \*, # - Valid DTMF data
2. \* - Reset from any state and start of a valid security code.
  - \* has no effect on the state of the relays, only command code entry.
1. # - Start of a new security code in Program Mode.
2. 1, 2, 3, 4 - Valid relay control numbers (1 = J1 output, 2 = J2 output, etc...)
3. 0 - Turn off relay X (X= relay number 1, 2, 3, or 4 ).
4. 1 - Turn on relay X (X= relay number 1, 2, 3, or 4).

#### Front Panel Buttons

1. S1 - Power Button with Power indicator LED (D9).
2. S2 - Program Button with multi-purpose 'Activity' LED (D4).

The default security code is 1, 2, 3, 4 from the factory. If you forget your security code at any time, you can override it by reprogramming the unit (you don't need to know the old security code to program a new one). This can only be done while the Program button on the front panel is pressed in so that a remote user cannot change your code without your knowledge.

## **Normal Mode Operation:**

1. Turn on the unit with power switch S1; Power LED D9 should light up.
2. Lift the phone receiver and press \* followed by the 4 digit security code. (The default code is 1, 2, 3, 4 until you change it.)
3. You should hear two quick confirmation tones and the Activity LED should flash twice.
  - If you enter the code incorrectly you will hear a low frequency error tone and the Activity LED will only flash once. Press \* to reset the system and go back to step 2 to try again.
4. Select the relay you want to control by pressing 1, 2, 3, or 4 (1 = J1 output, 2 = J2 output, etc...). You will hear X number of quick confirmation tones (X= relay number 1, 2, 3, or 4) and the Activity LED will also flash accordingly.
5. After the relay confirmation tones have stopped, press 1 to turn the relay on or 0 to turn it off.
6. Continue to select the relays followed by the on/off command as long as desired.
  - Turn each relay output on and off individually the first time through to verify that they are all working properly.
7. Press \* when you are finished to reset the system so the next command entry will require the security code to be entered.
  - The unit will time out automatically after 1 minute without valid DTMF tones in order to ensure security.
8. Hang up the receiver.

## **Programming Mode Operation (Setting A New Security Code):**

NOTE: # and \* are special characters and should not be used in your security code except for one special case (more on this below).

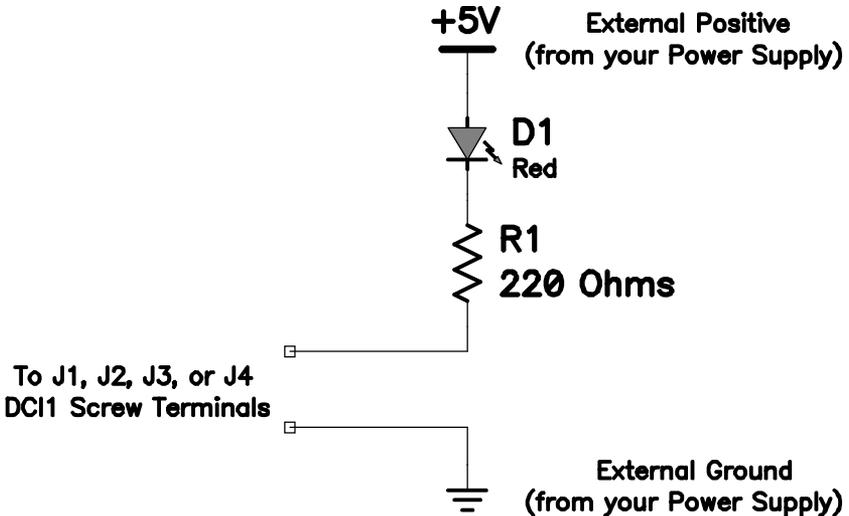
1. Turn on the unit with Power switch S1; Power LED D9 should light up.
2. Press in the Program button S2; Activity LED D4 should light up.
3. Lift the phone receiver and press # ; you should hear a confirmation tone.
4. Enter the new 4 digit security code; you should hear a confirmation tone and the Activity LED (D4) should flash on and off until you press the Program button again to go back to normal operating mode.
  - Avoid using codes that start with common TELCO feature numbers like 69XX or 72XX as your security code. You may wind up accidentally activating some feature on your phone line! Check your phone book for local feature codes to keep this from occurring.
  - Entering #, #, #, # as the new security code will disable the security check feature and allow the unit to operate in free running mode. In this mode the DCI1 will always respond to any valid DTMF tones without forcing you to enter a security code first.
  - If you have any errors during the programming phase, recycle the unit's power and start again from step 1.
5. Once back in normal mode (Program button released), the Activity LED (D4) should stop flashing and you're ready to go!

## WIRING AND CUSTOM APPLICATION SUGGESTIONS

Using your DC11 for a variety of applications is very simple. You just need to keep in mind the ratings for the relay contacts listed on the specification page to avoid any problems and use a common sense approach for personal safety. If you need to operate a simple low voltage DC circuit or switch on and off a low wattage 120 VAC lighting application, interface the your wiring directly to the J1 through J4 screw terminals and your off to the races! For heavily inductive loads such as a large motor or applications that exceed the power ratings of the relays, the following diagrams will help you get started wiring the DC11 as a trigger source for a larger relay or similar device.

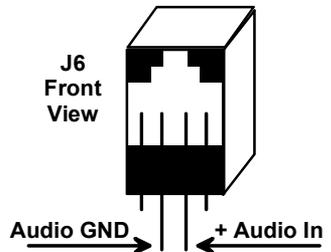
### Typical Low Power DC Wiring:

-LED switch application



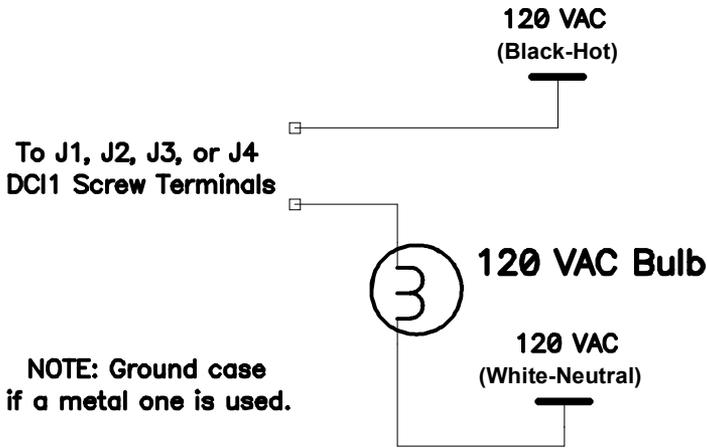
### Line Level Audio Input Wiring:

-Custom Audio feed wiring arrangement using a standard RJ-11 Patch cable.



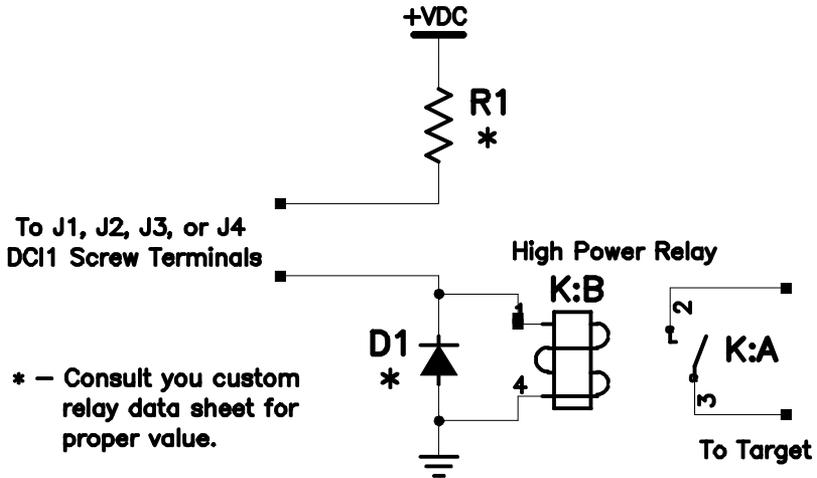
### Typical Low Power AC Wiring:

-120 VAC light being switched on Hot side.



### Typical High Power Relay:

-DC11 used to trigger another Higher Power relay.



## **TROUBLESHOOTING GUIDE**

If your DC11 does not work at all, recheck the following:

- correct orientation of U1 and U3 (see PC board Parts Layout Diagram)
- correct polarity of all electrolytic capacitors.
- correct orientation of all diodes (especially D1).
- all solder connections
- jumper wires at all JMP locations.

Still having trouble?

While we had hoped that it wouldn't come to this, if you are still having trouble with your DC11, here are a few additional suggestions.

**PROBLEM:** The Power LED (D9) doesn't light and VR1 gets very hot quickly.

**SOLUTION:** You likely have a short across the power supply or you have a component placed in the incorrect orientation. Check all of your parts to make sure they correlate with those on the Parts Layout Diagram.

**PROBLEM:** The Power LED (D9) doesn't light and VR1 remains cool.

**SOLUTION:** Using an oscilloscope or a frequency counter to verify that there is a 3.579 MHz signal on pin 7 of U3 and pin 3 of U1. It should be approximately 0.5 Vp-p or greater. If you cannot check the oscillator, verify that 5 Volts DC is present on the IC power pins (U1:5 and U3:18). If not, check VR1 for 5 VDC output with at least 12 VDC input from your power supply.

**PROBLEM:** It seems to be missing key entries when I try to enter commands.

**SOLUTION:** Wait until after the confirmation tones have stopped before entering new commands. This is most common when controlling the J4 relay output due to the amount of time it takes to provide the four feedback tones telling you which device is about to be controlled.

**PROBLEM:** My answering machine hangs up before I finish my commands.

**SOLUTION:** Some answering machines will hang up automatically if they do not sense any voice activity. Try talking into the phone at the same time to provide the needed audio for it to hold the line. Example: Say "relay #1 ON" at the same time you are typing the commands. Some answering machines may not be compatible.

**PROBLEM:** The relays seem to get warm when they are on for a while.

**SOLUTION:** This is normal. These 9 VDC relays are rated to work up to almost 12 VDC across their input windings without any problem. The series limiting resistors (R14, 15,16, and 17) keep them well within range over the normal 12 to 15 VDC input operating voltage. Their nominal operating power is about 450 mW so they will get warm to the touch.

**PROBLEM:** It keeps giving me an error tone and it does do what I want.

**SOLUTION:** Press \* to reset the system. Then repeat your security code and command string. More than likely you just wound up out of synch with the DCI1 so you are not entering the data it is looking for. When in doubt, press the \* button to reset the command entry algorithm back to a known state. Using the \* reset feature has no effect on the state of the relays, they hold their last instruction state forever unless power is removed from the system or the user commands a new state change.

**PROBLEM:** I forgot my security code!

**SOLUTION:** No problem, just follow the instructions in the Using Yout DCI1 DTMF Controller Interface section to program a new one.

**PROBLEM:** I'm trying to feed audio into the J6 input but it doesn't work.

**SOLUTION:** Depending on your audio level, you may need to replace R8, a 10K ohm resistor (brown-black-orange), with a jumper wire to connect it directly to ground. This will increase your audio levels if needed.

Have another set of eyes look over your work. Here at the shop we have often run into a "stone wall" of a problem only to have a fellow technician see our obvious error. It is sometimes very difficult to see your own mistakes.

## DC11 DTMF CONTROLLER INTERFACE SPECIFICATIONS

Here are few of the commonly requested specifications for the DC11:

### J1, 2, 3, and 4 Relay Outputs

- Contact Rating: 5 A, 120 VAC / 28 VDC (Resistive)
- Rated Contact Current: 5 A
- Max. Contact Capacity: 1250VA AC, 150W DC
- Contact Arrangement: SPST-NO
- Contact Material: AG Alloy
- Note: Not intended for heavily inductive loads such as large motors.

### J5 Power Input

- Input working voltage range: 12 - 15 VDC
- Max DC11 current draw is between 200 - 250 mA.

### J6 DTMF Audio Input

- Signal Level = -29 to 1 dBm
- Dial Tone Tolerance = 10 dB
- Noise Tolerance = -12 dB
- Third Tone Tolerance = -16 dB
- Frequency Deviation Acceptance = +/- 1.5%

### Miscellaneous Information

- PCB Dimensions: 4.7" L x 4" W (max component height: 0.9")

## CONCLUSION

We sincerely hope that you enjoy the use of this Ramsey product. As always, we have tried to compose our manual in the easiest, most user-friendly format that is 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 Inc.  
Attn. Hobby Kit Department  
590 Fishers Station Drive  
Victor, NY 14564

Please also feel free to visit our Website at [www.ramseykits.com](http://www.ramseykits.com) and offer your observations to other kit enthusiasts as well.

**And once again, thanks from the folks here at Ramsey!**

## **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 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.

# DC11 DTMF CONTROLLER INTERFACE KIT

## Quick Reference Page Guide

Introduction .....	4
Circuit Description .....	5
Schematic Diagram .....	8
Parts List .....	10
DC11 Assembly.....	12
Using Your DC11 .....	19
Wiring & Custom Applications .....	22
DC11 Specifications .....	26
Warranty.....	27

### REQUIRED TOOLS

- Soldering Iron                      Ramsey WLC100,
- Thin Rosin Core Solder          Ramsey RTS12
- Needle Nose Pliers                Ramsey RTS05
- Small Diagonal Cutters          Ramsey RTS04
- <OR> Complete Soldering Tool Set RS64-2801

### ADDITIONAL SUGGESTED ITEMS

- Optivisor Magnifier Headband      Ramsey OPMAG
- Helping Hands Holder for PC Board/Parts Ramsey HH3
- Desoldering Braid                    Ramsey RTS08

Price: \$5.00

Ramsey Publication No. MDC11  
Assembly and Instruction manual for:

**RAMSEY MODEL NO. DC11**



**RAMSEY ELECTRONICS, INC.**

590 Fishers Station Drive

Victor, New York 14564

Phone (585) 924-4560

Fax (585) 924-4555

[www.ramseykits.com](http://www.ramseykits.com)

<b>TOTAL SOLDER POINTS</b>
<b>190</b>
<b><u>ESTIMATED ASSEMBLY TIME</u></b>
Beginner .....3.5 hrs
Intermediate .....2 hrs
Advanced .....1.5 hrs

