



QUANTICS

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ASSEMBLY INSTRUCTIONS (version 6.6)

for the

W9GR DIGITAL SIGNAL PROCESSOR

As featured in the September 1992 issues of both QST and QEX Magazines

To use these instructions and build this kit, you should be capable of constructing a PC board from a parts list and schematic diagram, recognize electronic component parts, identify integrated circuit pin numbers, and solder. Potential kit builders lacking these skills are referred to **The Radio Amateur's Handbook**. This is not a kit for beginners!

The PC board is double sided with silk screen and solder mask. The "silk screen" is the set of white markings (such as "C14" and "R5") on the PC board which guides you in inserting the parts at the correct location. The components mount on the side with the silk screen.

The dark colored solder mask will help to avoid "solder bridges" between adjacent leads. It also provides insulation between the traces on the board and the exposed metal parts on the bottom of some of the IC sockets. Because of this, be careful not to scratch the solder mask; otherwise, there could be shorts or intermittent shorts between the IC sockets and the traces which run underneath the IC sockets.

The installation of parts progresses from the shortest parts, such as IC sockets and resistors, to the tallest parts such as the electrolytic capacitors and heatsink.

This double sided board has plated through holes. At various places on the board, the traces on the top side need to connect to traces on the bottom side. A plated through hole called a "via" performs this function. If you look at the board, you can see quite a few examples of "vias" under U1, the largest IC on the board. Notice that the vias have somewhat smaller tinned copper pads than the pads where the parts mount. When you install parts, do not install them in these "via" holes, which may be close to the hole where the part is supposed to go. Most of the parts have silk screened lines which will help you avoid making this error. C27 and C28 are examples of places where you should be careful to insert the capacitor into the component holes and not the nearby "via."

If you find you made a mistake and need to unsolder and remove a part, be careful so as to not remove the plating or the pads from the plated through hole. Use a minimum amount of heat, and either a vacuum solder removal device or wire braid to remove the solder from the hole.

The electrolytic capacitors are polarized, and must be installed in a particular direction.

There is a "+" mark on the PC board where the "+" or positive end of the capacitor must be installed. Sometimes capacitors have the "-" end marked instead of the "+" end. In this case, insert the unmarked end, which will be the "+" end, into the "+" hole on the PC board.

Similarly, the two diodes have a circular band at one end; this marked end should match up with the markings on the silk screen.

The integrated circuits must also be inserted in the correct direction. Each IC will have either a notch or a "dimple" at one end. This end of the chip must match the silk screen markings on the board.

The integrated circuits used in this kit are susceptible to electrostatic damage. When handling the ICs, use standard procedures to avoid static damage. In brief, ground the circuit, the ICs, and most importantly yourself before handling static sensitive parts.

When you insert the ICs into their sockets, it is very important to check that the pins are all straight and that the IC is pushed into its socket straight. Otherwise, an IC pin can easily be bent under the chip as you insert it, and visual inspection will not reveal the problem!

If you need to remove a chip from its socket, insert a small screwdriver between the socket and the chip alternately at one end then the other, and back the chip out straight so as not to bend its pins.

Review the following parts list and identify all parts *before* soldering them into the board. Notice that one of the 20 pin IC sockets resembles a wire-wrap type, with its pins bent 90 degrees to accommodate the LED bargraph display. Also be aware that there may be several different styles of capacitors of the same value; for instance 0.1 uF mylar and 0.1 uF ceramic disc. (The disc ceramic capacitors are round and thin while the mylars have a more rectangular shape.)

Some parts may be marked with a number that indicates the value indirectly. According to this convention, the first two digits are followed by a number of zeros which is indicated by the third digit. "103" on a disc ceramic capacitor would indicate 10 followed by 3 zeros: 10000 pF or equivalently, 0.01 uF. The 22 pF capacitors may be marked "220J03." The "220" part of the marking means "22 followed by no zeros." So this means 22 pF, *not* 220 pF!

Parts List

Unless otherwise specified, all resistors are 1/4 watt 5% and capacitors are 10% tolerance. Some of the capacitors may be marked with a three digit number where the last digit represents the number of zeros to follow the first two digits. For example, "103" would translate to 10000 picofarads, which would be the same as 0.01 uF (0.01 microfarad). Sometimes these numbers are combined with other digits or letters. Any of the following CPU variants will work and may be supplied as U1: TMS320C10, TMS32010, TMS320P15, TMS320E15, or TMS320C15.

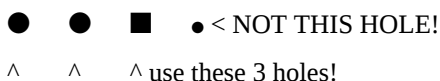
Quantity	Reference Designator(s)	Description
2	C6, C11	0.001 uF mylar (may be marked "102," "102J," "102K," or "2A102KT")
2	C2, C31	0.001 uF ceramic 20% (may be marked "102" or "102Z")
2	C13, C32	0.01 uF ceramic 20% (may be marked "103" or "103Z")
2	C9, C4	0.022 uF mylar (may be marked "223," "223J," "223K," or "2A223KT")
3	C5, C8, C10	0.1 uF mylar (may be marked "104," "104K," or "2A104KT")
11	C1, C15, C16, C18, C22, C25, C26, C27, C28, C29, C30	0.1 uF ceramic, 20% (may be marked "104," ".1Z," ".1M," or "104Z")
2	C7, C12	1 uF electrolytic 16V
3	C3, C14, C19	10 uF electrolytic 16V
2	C20, C21	22 pF silver mica or ceramic (may be marked "220J03" or "22PJ3")
3	C17, C23 C24	220 uF electrolytic 16V
2	D1, D2	1N4001 silicon diode (diodes with higher voltage ratings such as 1N4002, 1N4003, 1N4004 etc. may be supplied)
2	L1, L2	10 uH RF chokes
1	LED1	10 segment LED bargraph, Radio Shack 276-081B or equivalent
1	R1	100 k ohms (brown-black-yellow-gold)
3	R2, R3, R5	15 k ohms (brown-green-orange-gold)
1	R4	30 k ohms (orange-black-orange-gold)
2	R6, R12	4300 ohms (yellow-orange-red-gold)
2	R7, R13	4700 ohms (yellow-purple-red-gold)
3	R8, R14, R15	3900 ohms (orange-white-red-gold)
1	R9	22 k ohms (red-red-orange-gold)
2	R10, R11	10 k ohms (brown-black-orange-gold)
1	R16	100 k ohm pot, linear taper
2	R17, R22	1.8 k ohms (brown-gray-red-gold)
1	R18	39 ohms (orange-white-black-gold)
2	R19, R21	1000 ohms (brown-black-red-gold)
1	R20	2.7 ohms (red-purple-gold-gold)
1	R23	100 ohms (brown-black-brown-gold)
10	R24, R25, R26, R27, R28, R29, R30, R31, R32, R33	330 ohms (orange-orange-brown-gold)
1	S1	DPDT toggle switch
1	S2	SPST momentary pushbutton
1	S3	SPDT toggle switch (for BIO function)
1	U1	TMS320C10, or TMS32010 variant digital signal processor CPU
1	U2	AD7569 analog interface subsystem
2	U3, U4	74S472 bipolar PROMs (not supplied with multi-program kit) (programmed with desired firmware function)
1	U5	74HC139, 74LS139, or 74F139 decoder
2	U6, U7	74HC374 or 74LS374 octal flip flop
1	U8	LF347, TL074, or LM348 quad opamp
1	U9	LM380 audio power amplifier
1	U10	LM340T-5 or 7805 TO-220 5 volt regulator
1	Y1	20 MHz fundamental crystal, 20 pF load
1		TO220 heatsink
2		14 pin IC sockets
1		16 pin IC socket
1		24 pin "skinny DIP" (0.3") IC socket
1		40 pin IC socket
4		20 pin IC socket
1		20 pin right angle socket (for LED bargraph)

PC BOARD ASSEMBLY

❑ 1. First install and solder each of the fixed resistors.

❑ 2. There are three pads at jumper position W2 which are used to configure the DSP for single function or multi function operation. If you are building the single-function DSP kit (with TMS32010 or TMS320C10 processor with firmware in bipolar PROMs), take one of the clipped-off resistor leads and solder it between the center pad at jumper W2 (MC/MP-) and the "0" pad. There is a silk screened line between the two pads. If you are building the kit with the Multi-Program chip (TMS320P15), solder the wire between the center pad and the "1" pad. NOTE: the silk screened "1" is hard to see because it falls on top of a "via" hole. DO NOT solder the jumper wire to the via hole! The "1" pad is square, not round. (The "0" position tells the TMS320C10 processor to look for firmware in the external bipolar PROMs at U3 and U4. The "1" position tells the TMS320P15 processor to use its internal program.)

W2



❑ 3. Install and solder the two 1N4001 silicon diodes (D1 & D2). Be sure to match the polarity band on the diode to the one on the silk screen.

❑ 4. Install and solder the IC sockets. **Do not install an IC socket at LED1 (the LED bargraph).** Be sure to align the notch at the notched end of the socket with the notch on the PC board silk screen. Sometimes sockets will have a beveled mark, a dot, or some other distinguishing characteristic at pin 1 instead of a notch. (Pin 1 is the lower left hand corner viewed from the top with the notch on the left; pin numbers increase counterclockwise from pin 1.) (Note: if you look at the board from the "front" end, where the LED bargraph is located, all the notched ends go to the left.)

❑ 5. Install and solder the two RF chokes, L1 and L2.

❑ 6. Install and solder the ceramic disc capacitors (0.001 uF, 0.01 uF, 0.1 uF). Notice that C5, C6, C8, C11, and C10 are *mylar* capacitors, not ceramic.

❑ 7. Install and solder the (usually green colored) mylar capacitors (0.001 uF, 0.022 uF, 0.1 uF). Again, notice that mylar capacitors, not ceramic capacitors, are installed at C5, C6, C8, C11, and C10.

❑ 8. Install and solder the two 22 pF capacitors at C20 and C21.

❑ 9. Install and solder the rest of the electrolytic capacitors, being careful to observe the polarity markings on the board and on the capacitors.

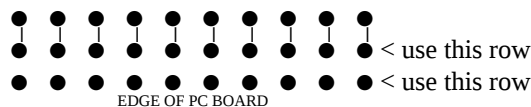
❑ 10. Install and solder the 20 MHz crystal at Y1. If you leave a little lead length on this component, it will not break off if inadvertently bent over. The crystal supplied may have a third wire soldered to the metal case. If it does, cut the wire off.

❑ 11. In this step, the voltage regulator (U10) is mounted together with a heatsink to the PC board, and then the leads are soldered to the board. Use a small

amount of thermal grease (not supplied) between U10 and the heat sink. If the heatsink has solder tabs which would interfere with the voltage regulator U10 leads, cut them off. Use the #4 hardware supplied to mount U10 and the heatsink to the board.

❑ 12. A right angle 20 pin IC socket is supplied for the LED bargraph display. In most applications the PC board will mount horizontally and the LED bargraph will poke through an opening in your front panel.

The printed circuit board is drilled to accept a LED bargraph display socket (DS1) with either 0.1" or 0.2" row spacing. So, there are three rows of holes on the board, and the back two rows are connected together. 0.1" sockets are generally supplied with this kit. Therefore, the LED bargraph socket should be installed in the *front* two rows of PC board holes. The three rows of holes for the LED bargraph socket will look like this:



❑ 13. Do not insert the integrated circuits into their sockets just yet! After the "*Installation in Your Circuit & Enclosure*" section below, a "smoke test" will be performed to make sure that the supply voltage applied to the logic integrated circuits is not excessive.

INSTALLATION IN YOUR CIRCUIT & ENCLOSURE

Next install the PC board in your enclosure. (If there is room to spare, you may want to install it in your speaker cabinet.) The switches and volume control are mounted on the front panel of your enclosure rather than on the PC board. The digital signal processor is a snug fit inside a Radio Shack 270-253A cabinet. Use long screws or spacers to raise the board up about an inch and help the fit. If you mount the board low in the box it may be necessary to either file the board (be careful not to destroy the ground bus that runs around the outside of the board) or to re-bend the rear of the box to allow a little bit more front to back clearance.

Another enclosure which works well for this project, but which may be harder to find, is the GC/Thorsen model 16-143. This is an ABS plastic box, with inside dimensions of 6" W x 6.25" L x 2.5" H. Another possible enclosure is the Radio Shack 270-272A enclosure, which has enough room for an internal power supply and/or a large extra filter capacitor.

High speed CMOS, as used in this project, produces EMI in prodigious quantities. As with most any project designed for use in a ham environment, it is highly recommended that you shield the PC board by installing it in a metal cabinet and bypass signals going into and out of the cabinet. Some of this EMI bypassing is already provided on the PC board itself. If you do not shield the digital signal processor, at least its autototcher firmware will help clean up some of its own radiated birdies which you might tune across!

Follow these steps, improvising as necessary to suit your installation:

❑ 1. Wire the volume control pot to the pads at R16. If the pot is mounted with its lugs down and if you look at the board from the LED bargraph end, then the leftmost lug should mount to the leftmost pad (square pad); the center lug connects to the center pad, etc.

❑ 2. Connect the reset switch S2 (SPST momentary contact) to the S2 pads along the front edge of the PC board.

❑ 3. Connect the in/out switch S1 (DPDT toggle switch) to the pads at S1. If the switch is held above the S1 printed circuit board pads with the toggle up and the terminals down, then the upper left pad (looking at it from the toggle end) connects to the upper left switch terminal, the lower left pad connects to the lower left switch terminal, etc. In this orientation, when the switch is flipped to the right, the DSP will be "in."

❑ 4. Connect the BIO switch S3 (SPDT toggle switch) to the W1 jumper pads. The center terminal on the switch goes to the center jumper pad, the lower terminal goes to the "1" pad, and the upper terminal goes to the "0" pad. With these connections and with the BIO switch S3 flipped "up," the BIO pin will have a logic "1" applied to it.

❑ 5. Connect the +12 pad E1 to a connector which will supply a reasonably good source of +12 volt DC. (**Do not actually apply power yet.**) Most "wall mount" transformers have too much AC ripple at the 1/2 amp load current required. If you elect to use one of these "wall mount" supplies, first be sure it has adequate ratings (at least 1/2 amp) and then install a 4700 uF or larger value capacitor of suitable voltage ratings to reduce the ripple. The power supply voltage may be as low as 8 volts and as high as 16 volts, but more audio output power will be available with a higher supply voltage.

❑ 6. Connect pad E2 to ground. This ground point should also connect to your radio's ground (or the ground of the connector which accepts the radio's audio output), the speaker's ground return (or the ground connection on the jack you use for the speaker), and the power supply ground.

❑ 7. The speaker output of your radio should connect to pad E3.

❑ 8. Connect your speaker to pad E4.

❑ 9. If you include a "headphone" output jack, you might want to put a 100 ohm resistor in series with the headphone output (but not the speaker output) to compensate for the high sensitivity of most "walkman" type headphones.

❑ 10. Now comes the "smoke test." For this test it is best to use a 12 volt power supply which is **current limited** to 1 ampere. If you do not use a current limited power supply, there is the danger of burning traces off the board if there is a short. With **none** of the integrated circuits installed in their sockets (except for U10, the soldered-in voltage regulator), apply power and turn on the switch S1. Using a voltmeter, connect its negative lead to ground. While viewing the board from the LED bargraph end, at U10 the leftmost pin should have approximately 12 volts present. (Depending on your power supply, the voltage may be as low as 8 volts or as high as 16 volts.) There should be zero volts at the middle pin. The rightmost pin must have 5 volts +/- 0.5 volts. If there is more than 5.5 volts at the rightmost pin of U10, **do not install the socketed integrated circuits**. If you do, they may be destroyed and the warranty will be voided. Check the installation of components and correct the problem before proceeding.

After this test is completed, disconnect the power.

❑ 11. After you have verified that there is not excessive voltage on the nominally 5 volt output of the voltage regulator IC U10, disconnect power and insert the integrated circuits into their sockets, being careful to insert them straight and with the proper orientation. On most ICs it is usually necessary to bend the leads *slightly* inward so that they will go into the socket straight. Bend the leads as a group against a flat surface. Your kit may be supplied with "LS" (low power Schottky) parts instead of "HC" (high speed CMOS). The LS parts are faster, avoiding a possible logic timing problem (see *Technical Correspondence*, February 1993 **QST**). Use the supplied 74LS139 in place of the 74HC139 (U5), and the two 74LS374 parts in place of the 74HC374s (U6 and U7).

❑ 12. Insert the LED bargraph into its socket. The markings, if any, are usually along the pin 1-10 edge, which goes down in this application. If the bargraph does not light up you can try reversing it; we have found a few bargraphs with the lettering along the pin 11-20 (top) edge.

❑ 13. Install the firmware IC PROMs. They come in pairs, and will be marked "high" and "low" or "U4" and "U3." Be sure that each PROM of the pair is inserted into the correct socket. This step is not necessary if you bought the "multi-program" version of the kit, in which U3 and U4 are not used.

OPERATION

To make best use of the 8 bit dynamic range and the noise filter/notcher algorithm, it is important to make sure the input signal is at the expected level. The recommended method of operation is to set the receiver audio gain so that on the strongest signals, the top LED on the bargraph display occasionally comes on. Once the receiver gain is properly adjusted, do not touch it; instead use the AF gain control on the processor to adjust speaker volume. This procedure will keep the A/D and D/A precision highest, and the quantizing noise lowest. Most modern receivers have good AGC characteristics with a flat AGC slope, the result being consistent audio level for both strong and weak signals. (You might want to add a separate audio AGC circuit to avoid having to set the receiver's AF gain.) If your receiver's audio level is inconsistent, you may experience occasional overloads of the digital signal processor. The distortion in this case will be quite obvious, because instead of simply clipping, many DSP systems including this one tend to "wrap around," which maps positive peak overloads into negative peaks and vice versa. If this happens, simply turn down the audio input a tad.

The standard autonotcher/denoiser firmware uses the Widrow-Hoff LMS adaptive filtering algorithm. The front panel "BIO" or mode switch selects either the noise reduction ("denoiser") mode or the automatic notch filter mode. The noise reducer mode is most effective against hiss and thermal noise but also reduces impulse noise and static crashes. This mode reduces listener fatigue and is recommended for long-term monitoring. The automatic notch mode eliminates multiple carriers very quickly, within a few milliseconds. Tuner-uppers, CW interference, carriers, and other forms of undesired audio tones are quickly eliminated. If a carrier comes on your frequency, all you will hear will be a subtle "click" as the automatic

notch acquires.

For those using the LMS denoiser/notcher firmware, the recommended mode of operation is to leave the BIO switch S3 in the "0" position, which is the denoiser mode. On most signals this mode gives the best sound. Then when carriers and CW interference appear, throw the switch to the "UP" (BIO=1) position, which actuates the automatic notch mode. If you expect frequent CW interference, you might want to leave the switch in the BIO=1 (automatic notch) position all the time.

For users of the CW filter firmware, the BIO switch has a different function. When the BIO switch is UP (BIO=1) then the CW filter operates normally. When BIO is set to 0, the CW filter is bypassed. Switching the BIO pin to 0 momentarily can help you find signals that are outside the CW filter passband.

Note: when BIO is switched to 0 (filter out), may be aliasing on CW signals above 1 kHz. This is normal and is due to the oversampling algorithm. When the filter is in, which is the normal operational mode, the aliasing will disappear.

An explanation of the algorithms used in this digital signal processor and a description of the hardware are in the September 1992 *QST* magazine article "Low Cost Digital Signal Processing for the Radio Amateur" by Dave Hershberger, W9GR. For those looking for a thorough mathematical treatment of the firmware noise reduction and autonotcher algorithm, refer to "Using the LMS Algorithm for QRM and QRN Reduction" by Dr. Steven E. Reyer, WA9VNJ, and David L. Hershberger, W9GR, in September 1992 *QEX* magazine.

If you are using the multi-program chip with its 10 different digital filters, you must "select" a program when the unit is first powered up. When you hit the reset button or power up the unit with the *Multi-Program* chip, a single LED segment will light and move across the display, staying lit for about one second at each segment. Each of the 10 segments corresponds to a particular LMS filter, CW filter, etc. If you toggle the BIO switch when a particular LED is lit up, then the corresponding program will begin. If you don't do anything, then after one pass across the bargraph (about 10 seconds) the "default" program will execute (#1, the LMS noise filter & automatic notch filter). As soon as the program is selected, then the BIO switch (mode switch) has a new function depending on which program is running (for most programs, the mode switch is a filter IN/OUT select).

When the DSP is in the "menu select" mode where the 10 LEDs are lighting up in succession, the DSP will pass unprocessed audio through to the output. This will allow you to hear the received signal "straight-through" while you are selecting the DSP mode. For those with vision impairments or who would rather not watch the LEDs, a short "beep" will be heard from the speaker as each menu LED comes on. The first "beep" is a little bit longer than the other nine.

If you are running one program and want to change programs, simply hit the reset button (or cycle power) and select the desired program using the LED display and BIO (mode) switch.

Program #1, the "standard" firmware, is the same combination noise reducer and automatic notch filter (noise reduction **or** automatic notching), described above.

Program #2 is a simultaneous automatic notch and denoiser filter, which while effective, is somewhat of a compromise compared with programs #1, #3, and #4. The front panel mode switch switches the filter in or out.

Program #3 is an optimized denoiser filter only. The denoising function is somewhat more effective than the combined switchable function in program #1. The front panel mode switch switches the filter in or out.

Program #4 is an optimized automatic notch filter only. This automatic notch function is optimized in the sense that it has less of an effect on some voice signals than the autonotcher function in program #1. The front panel mode switch switches the filter in or out.

Programs #5-9 are CW filters of different center frequencies and bandwidths. The front panel mode switch switches the filter in or out.

Filter 5 is a 400 Hz Linear Phase CW Filter (200 Hz bandwidth).

Filter 6 is a 600 Hz Linear Phase CW Filter (200 Hz bandwidth).

Filter 7 is a 750 Hz Linear Phase CW Filter (200 Hz bandwidth).

Filter 8 is a 1000 Hz Linear Phase CW Filter (200 Hz bandwidth).

Filter 9 is a 750 Hz Linear Phase Ultra-Narrow CW Filter (30 Hz bandwidth). This filter may be useful for very weak or very noisy CW signals (for example moonbounce), or for machine copied CW.

Program #10 is a HF packet (1600/1800 Hz) or RTTY (2125/2295 Hz) bandpass filter. The front panel mode switch selects either the packet tones (BIO=0) or the RTTY tones (BIO=1).

The packet filter in the DSP has the following specifications:

Passband: 1550-1850 Hz (at -0.3 dB)

Stopband: below 1325 Hz and above 2075 Hz (at -47 dB)

The ripple bandwidth (0.3 dB) is 300 Hz and the -3 dB bandwidth is about 400 Hz.

The RTTY filter specifications are as follows:

Passband: 2075-2345 Hz (at -0.6 dB)

Stopband: below 1850 Hz and above 2570 Hz (at -49 dB)

The ripple bandwidth (0.6 dB) is 270 Hz and the -3 dB bandwidth is about 350 Hz.

Both of these FSK filters are 120th order FIR filters with a sampling frequency of approximately 14 kHz.

An advantage of the multi-program chip is lower power consumption: by removing the power-hungry bipolar PROMs, the current requirement is reduced from 400 mA to 175 mA at normal audio levels.

MODIFICATIONS of EARLIER KIT VERSIONS

You may have heard of several modifications to the Digital Signal Processor. These modifications were devised by several amateurs (WA3RMX and W6GO) to correct a problem with the two earlier versions of the PC board (REV A and REV B). In these earlier PC boards, there were digital traces which were located close to analog traces, resulting in unwanted coupling of digital noise into U9, the audio power amplifier chip. The "REV C" board supplied with this kit has a completely different physical arrangement of parts which eliminates the need for these modifications. Although the electrical circuit is identical to the earlier versions, the physical layout is different and improved. Therefore, you will not need to make any of these

modifications.

Because the physical layout is new, you will notice that the appearance of your PC board will be somewhat different than the photographs in **QST** and the illustrations accompanying these instructions, which show the earlier versions of the PC board. Refer to the illustrations only for ideas on mounting the PC board and installation, and not for component location.

IN CASE OF DIFFICULTY

❑ 1. Check your soldering for unconnected pins, cold solder joints, and/or solder bridges. ***This is a very important troubleshooting step! Almost every kit which has been returned to us for repair has not worked because of simple soldering defects!*** The odds are that you can save yourself a lot of time and possible embarrassment if you carefully check your soldering work for unsoldered connections, "cold" joints, solder bridges, and scratched off PC board traces. Use a magnifying glass to find suspicious connections, and re-solder them. Don't rely on the solder mask to be an infallible insulator against sloppy soldering. Remove solder blobs which encroach over the solder mask or onto nearby "vias." Use a soft brush to remove metallic and conductive solder dust and debris. In several cases, the soldering problem was found *underneath* an IC socket, necessitating removal and replacement of the socket! Sometimes capillary flow can draw solder up through vias and holes to the other side of the board. If this happens underneath a socket, it could be very hard to find the problem. It's really true what Heathkit used to say in their manuals: 90% of the problems with Heathkits were due to bad soldering.

❑ 2. Check all of the integrated circuits to see if pins are bent underneath the chips. With the power off, use an ohmmeter to check for continuity from the IC pin to the pad underneath the board. Or, you can remove each chip for visual inspection and then reinstall them.

❑ 3. Use an oscilloscope if you have one available to look for "sick" looking (i. e. lack of full logic swings) digital waveforms. If you find a sick looking logic waveform, it may be shorted to a neighboring trace. Look for bad soldering somewhere on that node. Bear in mind that many of the logic signals on the board are "tri-state" meaning that the drivers go high impedance at certain times. You may see what looks like "sagging" voltages; this is normal on some nodes such as the data bus. Look for the logic swings to go all the way to a valid logic 1 and a valid logic 0 at least some of the time. With the power off, use an ohmmeter to check for shorts to nearby traces and IC pins.

❑ 4. From our statistical experience so far, there is at least a 95% probability that any given non-working kit has *soldering defects*. To search for soldering defects, begin by first going around each chip with an ohmmeter. Check to see if pin 1 is shorted to pin 2, pin 2 to 3, etc. on each chip. If you find pins shorted together, refer to the schematic to see if they are supposed to be connected; sometimes that will be the case.

❑ 5. If you do not find a short that way, then take your ohmmeter and go around each chip and check not only adjacent pins on each IC, but *every* other pad on the PC board. Each time you find continuity, check against the schematic to see if the two points which you found to be connected are in fact supposed to be connected. Although this may sound time consuming, it may be the

fastest way to get your kit working.

❑ 6. Some of the shorts we have found have been due to very small dendrites of solder which worked their way under the solder mask. You might have to look very closely, with a magnifying glass, to find them!

❑ 7. We have learned of several failures which have occurred after weeks or months of normal operation. These failures were due to residual debris and flux from soldering working through the solder mask and contacting nearby traces. These failures may not be "zero ohm" shorts but may measure in the tens, hundreds, or thousands of ohms. If you experience such a delayed failure, it may be cured by using a small brush and chemical flux remover. Alternatively, you might try *carefully* and *gently* scraping off the flux and soldering residue from around each pad with a small screwdriver or awl, being careful not to scrape off the traces.

❑ 8. Make sure that all grounds are connected together among the devices that connect to the DSP: the 12 volt power supply, the audio source (receiver), the DSP unit itself, and the speaker. Make sure that the "hot" and "ground" wires in cable connectors are not reversed.

❑ 9. Check wiring to the off-board components (the volume control and switches).

❑ 10. Check to make sure that the jumper wire at W2 is installed properly. It should NOT be soldered to the small "via" hole with a silk screened "1" on it. If the jumper wire is soldered between the square hole and the small "via" hole with the "1" on it, then the one of the data bus lines will be shorted to +5 volts, the second LED on the display will never light up, and the CPU chip may be damaged!

❑ 11. Check the two diodes at D1 and D2; the banded ends should be oriented towards the front (LED bargraph) end of the board.

❑ 12. Check the DC voltages at various points throughout the circuit. With power on but no signal applied, you should measure the following DC voltages:

U8 pin 8: 5.0	U8 pin 1: 5.0
U8 pin 7: 5.0	U8 pin 14: 5.0
U9 pin 2: 0.0	U9 pin 3: 0.0
U2 pin 23: 1.25	U2 pin 5: 5.0
U2 pin 24: 5.0	
U9 pin 8: approximately half of the +12 volt power supply (about 6 volts)	

❑ 13. Push the "reset" pushbutton. With the button held down, the voltage at U2 pin 5 should go to zero. When you release the switch, the voltage should return to 5 volts.

❑ 14. If you have an oscilloscope, you can trace the signal through the unit. U8 pin 1 is the output of the input buffer amplifier. U8 pin 7 is the output of the input antialias filter. The lowpass filtered input signal, centered around 1.25 volts, should appear at U2 pin 23 (the input to the A/D converter). The DSP D to A converter output should appear at U2 pin 2. The lowpass filtered output signal appears at U8 pin 14. Finally, the speaker output is driven from U9 pin 8.

❑ 15. As of March 1993, of the units that have been

returned for "warranty service," all but three of the problems have been *defective soldering*. The first exception was a unit which had an IC pin bent under the chip, not making contact with the socket. The second exception was a case where a ham had bought bipolar PROM firmware for both the CW filter and the LMS algorithm. He had the high byte from the CW filter installed with the low byte from the LMS algorithm (the PROMs have to be installed as a pair). The third non-soldering problem was a PC board defect. So in every case so far except one, the problems have been attributable to defects in kit building. We say this not to impugn anybody's building skills but to point out that there have been no defective components discovered as yet.

❑ 16. Although the great majority of kit builders have completed the W9GR DSP kit successfully, there have been significant numbers of "warranty" returns, the vast majority of which are anything but that. Over 95% of the kits returned for "warranty service" do not work because of *bad soldering*. The warranty covers "defects in materials and workmanship" of Quantics, and *does not* cover the workmanship of the kit builder, over which we have no control.

❑ 17. We are spending so much time correcting soldering defects that it is slowing down kit shipments. Therefore, effective immediately, any kit returned for "warranty repair" must be accompanied by a check for \$40.00 which is our "flat rate" for getting defective kits to work and returning them to you (abuse excepted). If in our judgment the failure is due to a defect in our components or workmanship, your \$40.00 payment will be returned to you with the repaired kit. On the other hand, if the failure is due to improper assembly or soldering defects, the flat rate fee will be retained.

❑ 18. In summary, the warranty covers defects in components supplied by Quantics (for example PC board manufacturing flaws). The debugging service, which is not free, covers kit building errors (for example soldering defects). This policy supersedes and clarifies any previous statements.

❑ 19. As of March 1993, the statistics regarding kit problems are as follows:

Defective soldering:	42
Chips plugged into sockets incorrectly:	2
PC board flaws:	1
Bad parts supplied by Quantics:	0

❑ 20. If you are still unable to resolve the difficulty, you may either write for assistance or return the unit for repair. Any returned kit **must be accompanied by a check for \$40.00**. If in our opinion the problem is covered by the warranty, then your check will be returned to you with the kit. The warranty is not intended to cover defective soldering, so please check your soldering before returning kits for repair. Support is handled by correspondence; at the present time we are not able to provide support via telephone. However, problem reports, suggestions, comments, and questions are welcomed and should be directed to:

QUANTICS
P. O. Box 2163
Nevada City, California 95959-2163

If you need a reply to a question, a self-addressed stamped envelope would be appreciated.

UPS shipping address for returned kits:

David L. Hershberger, W9GR
10373 Pine Flat Way
Nevada City, California 95959-9136

Parcel post shipments (U. S. mail) should be directed to the P. O. Box address above.

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LIMITED WARRANTY

This product is warranted to be free of defects in materials and workmanship for a period of thirty days from the date of purchase. In the event of notification within the warranty period of defects in materials or workmanship, the seller will, upon return of the product, repair or replace (at its option) the defective parts. The remedy for breach of this warranty shall be limited to repair or replacement and shall not encompass any other damages, including but limited to loss of profits, special, incidental, consequential or other similar claims. This warranty does not cover any damages due to accident, misuse, abuse or negligence on the part of the purchaser. This warranty does not cover other equipment or components that a customer uses in conjunction with this product.

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**Thank you for your purchase of the
W9GR Digital Signal Processor!**

73, Dave Hershberger, W 9 G R

