GEMINI ROBOT KITS

Testing and Calibration Procedures

Individual Board Test Procedures - Testing

TESTING AND CALIBRATION OF THE POWER DISTRIBUTION BOARD

1. Set up the board so it is about 1" above your work surface. Standoffs in each corner will work nicely. Make sure that the board does not lay flat on any conductive surface.

2. Connect 18-24vDC to J1. Positive lead goes on pin nearest R3. Negative lead goes on pin nearest R2.

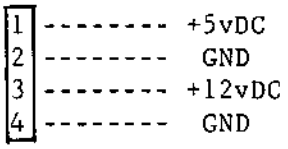
3. Set up a meter to read DC volts. Connect the positive lead to J2 pin 1, and the negative to J4 pin 2.
   Adjust R4 so the meter reads 13.5vDC.
   Move the positive lead to J2 pin 3, negative to J4 pin 4.
   Adjust R3 so the meter reads 13.5vDC.
   Move the positive lead to J2 pin 5, negative to J4 pin 6.
   Adjust R2 so the meter reads 13.5vDC.
   Move the positive lead to J4 pin 7, negative to J4 pin 8.
   Adjust R11 so the meter reads 5.2vDC.

This completes the testing and calibration of the power distribution board.

TESTING THE CPU BOARD

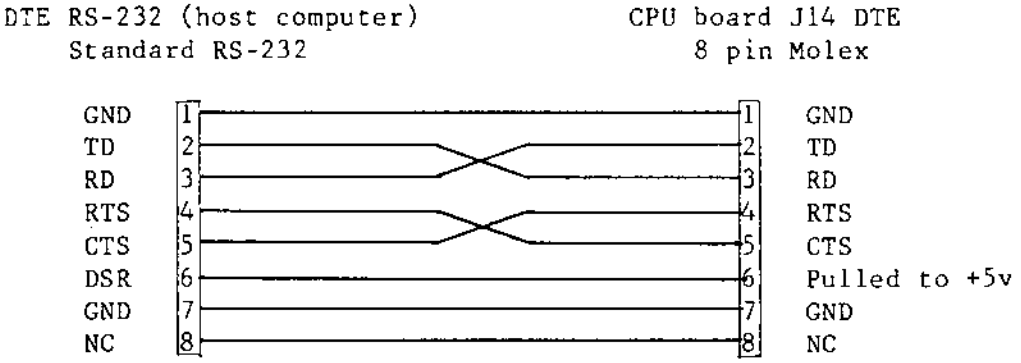
1. Set up the CPU Board so it is about 1" above your work surface, which should be as static free as possible. Standoffs in each corner of the board work nicely.

2. Locate J3 and connect the following voltages:



   It would be best if this power could be switched, but a single plug to pull on/off will work. Leave disconnected for now.

3. This next step establishes a serial communications link between the CPU board and your remote terminal (computer). Most computers are DTE configured on their RS-232 ports, which we will use. The CPU board is also DTE configured, so a cable/connector known as a "null modem" must be used. The purpose of this connector is to switch a couple of wires around so that two DTE configured machines can communicate with each other. One end of this connector must also be an 8 pin Molex type, as follows:



4. Place your computer in "Terminal" mode.

5. Turn power onto the CPU board. Ensure that the dip switch (SW1) has #1 on, and all others off. After this test, set all switches off, if you are going to use this board as a GEMINI Robot. Dip switch #1 tells the CPU board to "look" for a remote terminal, and bypass the GEMINI Robot's display screen.

6. With power on, your terminal screen should look like this:

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>
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7. The display indicates that the CPU is working and communicating with your terminal. If there is no display, check your computer to make sure that it is in the correct mode. Check the RS-232 cable. Check power to the CPU board. If there is still no display, consult the trouble shooting section.

8. Consult with the Technical Manuals for information on how to write commands to the CPU board from your terminal. You may also want to consider purchasing a listing of the monitor ROM's program, to aid in your software development.

This completes the testing and calibration of the CPU Board.

TESTING VIOS BOARD

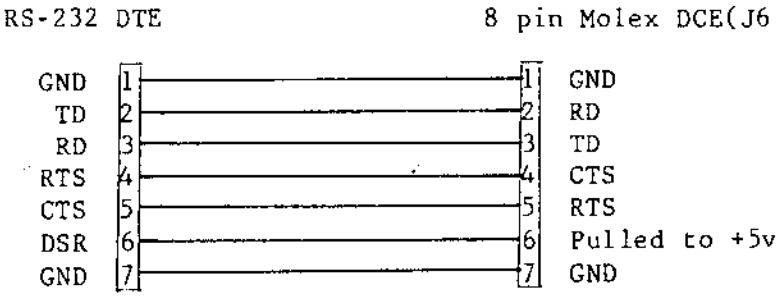
1. Position the VIOS board approximately 1" above your work surface, which should be as static free as possible. Standoffs at each corner of the board work best.

2. Locate J1 and apply the following voltages:

   pin 1 - GND
   pin 6 - +5vDC
   pin 8 - +12vDC
   pin 9 - ENABLE (on/$\overline{\text{off}}$) (jumper to pin 6 to enable)

3. Pin 9 is the signal that enables the VIOS board. It should be disabled for now, until the link with your computer terminal is established.

4. Prepare a cable to connect from the RS-232 port on your terminal to J6 on VIOS as follows:

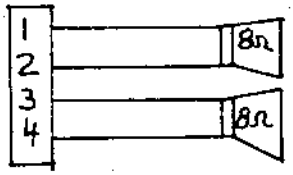


5. Set your computer up in its terminal mode, configured as DTE equipment. Connect the cable from you computer to J6 on VIOS.

6. Ensure that the dip switch on VIOS has switch #1 on, and all others off. This sets the Baud rate to 300 Baud.

7. Enable the VIOS board with J1 pin 9, jumpered to J1 pin 6. On your terminal display (computer screen), there should be an exclamation point (!). This signifies that the VIOS board and your terminal are communicating. Consult the Technical Manuals for information on how to command the VIOS board from your terminal.

8. If you wish to test the sound and speech circuit with your ears, you can connect speakers to J3 as such:



9. If you are building a GEMINI kit, you can stop at this point. Voice recognition will be tested when the boards are mounted on the robots' frame. If you are using the VIOS board as a stand-alone, all you need to do for voice recognition (hardware side) is to connect a mic level input into J9 on the board. Consult the Technical manuals for information on software development.

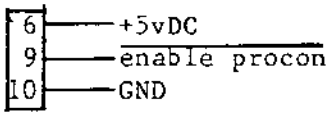
10. If you fail to get a prompt on your terminal display (computer screen), double check all of your connections. Ensure that your terminal is set up correctly, as DTE equipment. Make sure that VIOS is enabled (+5vDC on J1 pin 9). If you still have no prompt, consult the trouble shooting section.

This completes the tesing and calibration of the VIOS board.

TESTING PROCON BOARD

1. Position procon board approximately 1" above your work surface, which should be as static free as possible. Standoffs at each corner of the board work best.

2. Locate J2 on Procon. Apply +5 volts to pin 6, and logic GND to pin 10. Jumper pin 9 to pin 10 to enable the board. Keep the board

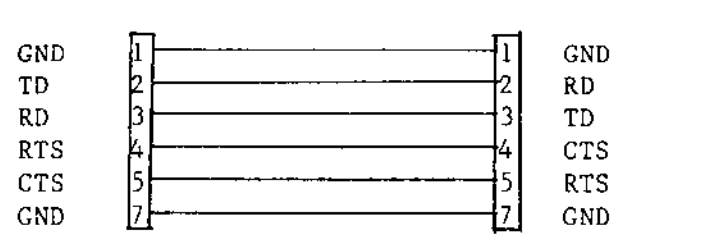


J2

disabled until ready to communicate with it from your terminal. A switch from pin 9 to pin 10 would be handy, but alligator clips will work.

3. Ensure that 1 and 2 on the dip switch (SWT 1) are on, and that 3 and 4 are off. This setting sets the Baud rate for communications on the serial link with your terminal at 300 Baud.

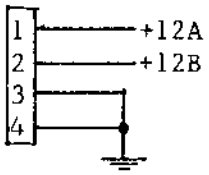
4. Connect an RS-232 standard type plug from your computer (terminal) to J3 on the Procon board (the black plug). Procon is set up as a DCE device, so ensure that your computer is set up in its terminal mode as a DTE device.



5. Enable the procon board by jumpering J2 pin 9 to pin 10. On your terminal screen there should be an exclamation point (!). This signifies that the procon board and your terminal are communicating. Consult with the Technical Manual for commands to procon.

6. If you fail to get a prompt (!), check your computer to see if it is set up properly. Check your serial connections. Check to see if you have enabled the procon board with J2 pin 9. If there is still no prompt, refer to your schematics to isolate your problem. Consult the trouble shooting charts for guidance.

7. If you are building a GEMINEX or GEMINI kit, this completes the test. If you have purchased the PROCON stand-alone, you will have to design your own drive unit and power supplies. You will need 2 separate 12vDC systems, as well as 5vDC for the logic functions. The 12vDC supplies are connected to J1 as follows:



J1

Arctec System has both the base drive unit and power supply available separately, and it is highly recommended that you consider purchasing these items.

This completes the testing and calibration of the procon board.

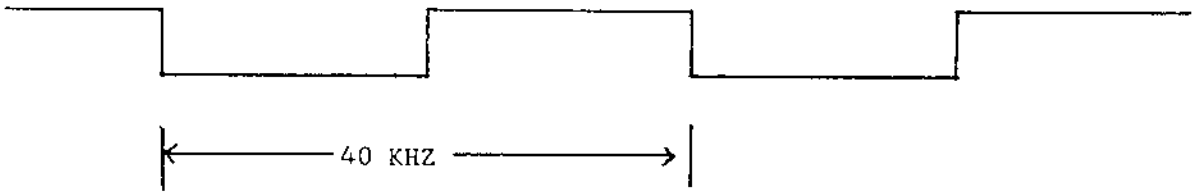
TESTING AND CALIBRATION OF ROOM BEACON

1. For this procedure you will need an oscilliscope. Set up the time base for 5 microsec.

2. Plug in the AC adapter (9vDC) to the beacon.

3. Measure the signal on V2 pin 10. It should be adjusted with R4 to be 40 KHZ. With the scopes time base set to 5 microsec, the total period of the square wave should be 5 divisions. Do not worry if the duty cycle is uneven. This will change depending on the setting of the dip switch (SW-1).

4. Measure the signal at the anode of LED 1 (collector of Q1). Ensure it is the same frequency, but reduced amplitude, as the signal on V2 pin 10 from the previous step.



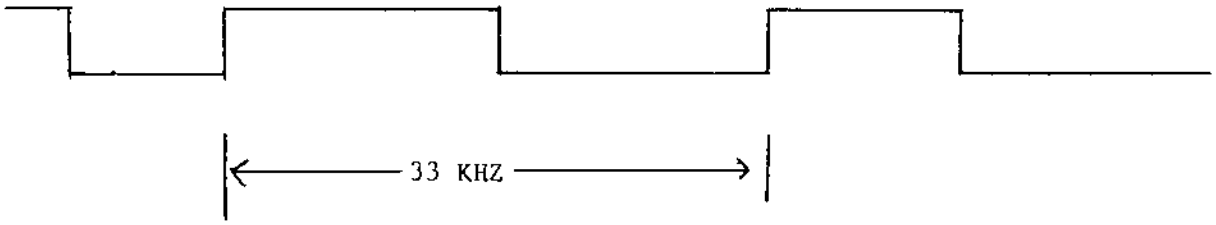
This completes the testing and calibration of the room beacon.

ADJUSTING THE KEYBOARD IR FREQUENCY

1. Ensure that the batteries to the keyboard are fully charged. (approximately 6vDC)

2. Turn keyboard on. Press any key and keep it held down.

3. Using an oscilliscope, measure the signal on IC 9 pins 3, 6, or 8. Adjust for 33 KHZ with R14. On a 5 microsec time base, 33 KHZ is 6 divisions. Do not worry if the signals (square wave) duty cycle is not even.



This completes the adjustments to the keyboard IR frequency.

TESTING CHARGER

1. Be sure that the fuse is installed.

2. Plug the charger into a 110vAC grounded wall outlet and check if the red light on the top lights. If it does not, check carefully your wiring and be certain the fuse is not blown.

3. Use a volt meter and measure the voltage across the charging plates. (Top plate is positive, bottom negative). You should read approximately 18 - 24vDC. If you receive no voltage, check your wiring carefully.

BASE, TORSO AND HEAD ASSEMBLY INSTRUCTIONS

In this step, you will attach the individual mechanical subassemblies together. You will need the completed base, torso and head subassemblies for this procedure. Also required will be the allen wrench that came with the head subassembly which fits the allen screws in the head gear.

1. Place the base section on the floor. The front of the base is identified by the brass plated bumper, known as the "charging bumper". This will be important when positioning the torso. Located on the top of the base are eight shock mount studs for attaching the torso. Remove the wingnuts from the studs.

2. Locate the torso subassembly. The front is identified by the multiple sonars and dual speakers. Position the torso for the same orientation as the base.

3. Carefully handle the torso so as not to damage it. Guide the base wire harness through the opening in the large aluminum disc. Ensure base connector J4 is not binded or pinched anywhere, and that it is laying out on the left side of the torso. Align the holes with the eight shock mount screws on the base and secure with the wingnuts.

4. Locate the head subassembly, and the brass gear. Position the head onto the torso by sliding the nylon busing through the hole and placing the gear onto the bushing from beneath. Secure the gear in place with the allen screws. Ensure that the gear is flush up against the busing and that it makes properly with the head motor gear. Spin the head around slowly by hand, adjusting the gear if necessary to obtain a smooth, non-binding motion.

Board Mounting and Final Test

BOARD MOUNTING PROCEDURE

The following assembly steps will guide you through the attachment of all the PC boards to the robot frame. Refer to pages 8 and 9 in the Technical Manual for greater ease in identifying where the boards are mounted. Here is a list of the parts you will use:

GEMINI	Part #
25 - 1/4" nylon spacers	30F1436
24 - 4-40 1/2" screws	91783A110
10 - nylon shoulder washers	90062A005
29 - 4-40 nuts	91841A005
4 - 4-40 3/8" screws	9178A108
2 - 1" threaded standoffs	67F4067
2 - 4-40 1/4" screws	91783A106
24 - 4-40 1/2" screws	9178A110
1 - 4-40 1/2" nylon screw	94611A110
1 - 4x6 insulation backing	bd - insulator

1. Mount the main CPU board - remove the motherboard mount from the bottom of the torso by removing the nuts in each of its corners, and then lifting it up and out through the back of the torso. Place the motherboard mount on an anti-static surface (charger static mat will work). Using nine 4-40 1/2" screws, nine 1/4" spacers, and nine 4-40 nuts, attach the main CPU board to the motherboard mount making sure that J14, J8, and J9 on the CPU board are located near the slots on the motherboard mount. Re-install the mount on the torso. Do not connect anything to the CPU board yet.

2. Mount the VIOS board - using four 4-40 1/2" screws, four 1/4" spacers, and four 4-40 nuts, mount the VIOS board to the lower section of the robot's right side area. Position the board so that the crystal and battery are towards the rear of the robot.

3. Mount the SSS board - using three 4-40 1/2" screws, one 4-40 1/2" nylon screw, four 1/4" spacers, four 4-40 nuts, and four shoulder washers, mount the SSS board above where the VIOS board is mounted. Position it so that the relays are on the bottom. Ensure that the nylon screw goes into the hole nearest the small polaroid sonar board which is tie-strapped onto the SSS board. This screw keeps from shorting the sonar board to the chassis. GEMINI does not like to wear shorts!

4. Mount Procon Board - using four 4-40 1/2" screws, four 1/4" spacers, and four 4-40 nuts, mount procon on the bottom left side area of the torso. Position it so that the crystal is pointing towards the rear of the robot

5. Mount Power Distribution Board - using four 4-40 1/2" screws, four 1/4" spacers, four nuts, and the insulation backing, mount the power distribution board on the upper left side area of the front of the torso. Ensure that J2, J3, and J4 are positioned to the left, and the insulation backing is between the board and the torso.

6. Mount the keyboard Infra-red receiver - locate two holes in the torso top plate, at the rear and directly above the LCD display. Using two 1/4" screws and two 1" threaded standoffs, attach standoffs to the underside of the top plate. Use two 4-40 3/8" screws and two shoulder washers, attach IR board to the standoff, making sure that the shoulder washers are between the board and the standoff, and that the components on the board are facing up. The nylon shoulder washers keep the board from shorting to the standoffs, which are chassis ground. Using the telephone coil, plug the keyboard into the robot using the connector on the back of the keyboard and the connector on the panel under the LCD.

This completes the board-mounting procedure. Make sure that you have not connected anything to any of the boards yet. That will be covered in the next section. Double check your work, looking for physical shorts or poor alignment of mechanical parts. Poor alignment can sometimes mean that the board is not mounted correctly. Ensure all screws are snug.

ASSEMBLING THE SUBASSEMBLIES

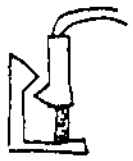
You are now ready to assembly the robot. Refer to the instructions entitled "BASE, TORSO AND HEAD ASSEMBLY INSTRUCTION" and follow the steps indicated.

MAKING THE RIGHT CONNECTIONS

Use extreme care during this next phase of GEMINI's assembly. Make very sure that the wiring harness has been wired correctly. One wire out of place could mean serious damage to GEMINI's CMOS circuitry. Look for wires hanging loose, and for obvious shorts (such as red colored wires touching any metal parts, etc.). Also a good idea is obtaining a wrist-strap and cord and grounding yourself to the robot's chassis. That will prevent any static buildup from zapping the robots circuits. This procedure requires a digital multi-meter.

1. Connect J4 torso connector (male) to J4 Base connector (female). These are big white Molex connectors located near the bottom torso plate. One comes from the base unit. Ensure a tight connection.

2. On the power distribution board, connect J2 (on/off switch). Ensure switch on front panel is in the OFF position. Make sure connector is correctly oriented.



3. Connect J3 on power distribution board (battery input). Turn the switch on the front panel to the ON position. Measure the pins on J4 of power distribution board for the following voltages + - 10%:

1	+12vDC	
2	12 return	Motor 1
3	+12vDC	
4	12 return	Motor 2
5	+12vDC	
6	12 return	Logic 12v
7	+5vDC	
8	5 return	Logic 5v

If voltages are incorrect, check wiring from J3 to Base. Turn switch off. Do not continue unless the voltages are correct.

4. Connect all remaining connectors to power distribution board. Ensure that the red wire is on the bottom of connector DS1. Turn switch on and check for blown fuses. If a fuse is blown, do not continue until you know why it blew. A little patience during this procedure will help prevent serious problems later on. Turn power off.

5. On the main CPU board, connect only J2 (display) and J3 (power). Turn robot on. Screen display should look like this:

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   ALL RIGHTS RESERVED

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   If no display is seen, refer to trouble shooting section. If there is a display, continue by turning robot off.

6. Connect remaining connectors to CPU board. Make sure they are connected properly (pin 1 on board to pin 1 on connector, etc.). Turn on robot. There will be a click (GND connect relay) and then the display should come up the same as in the previous step. If there is no display now, isolate the trouble by disconnecting one connector at a time (turning robot off each time of course) until you find the guilty one. Correct the problem and when ready for the next step, turn the robot off. KEEP CHECKING FOR BLOWN FUSES.

7. Connect all connectors to the procon board. Turn robot on and check display. Check fuses. If everything is acceptable, turn robot off.

8. On SSS board, ensure that J7 and J8 are disconnected. They are the two connectors that come from the small polaroid board tie-strapped to the bottom right on the SSS board. Remove U16, U17 and U18. Connect all other connectors, being especially careful that J1 (CPU connector) is wired correctly. Turn robot on and adjust for the following voltages:

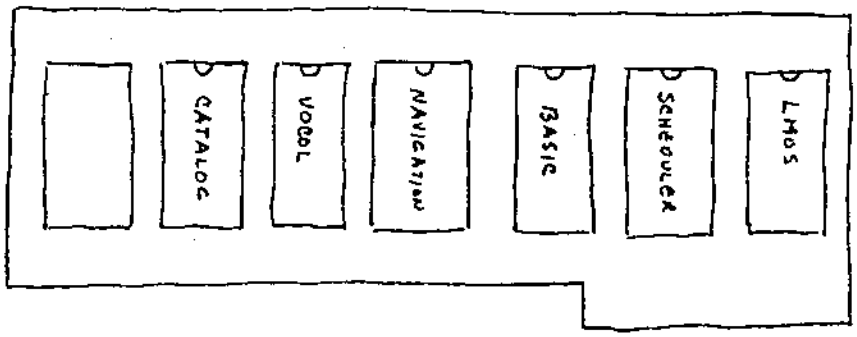
   IC 12 pin 6 to chassis = 3.0vDC - adjust with R 107
   VR1"O" to J7 pin 1 = 5.5vDC - adjust with R 91

   If everything is acceptable, turn robot off. Reconnect J7 and J8, and re-install U16, U17 and U18.

9. Connect the three-pin connector to the beacon detector board. Ensure that the red wire is closest to the adjustment pot.

10. Connect the three-pin connector to the keyboard IR board. Ensure that the grey wire is closest to the adjustment pot.

11. Locate the ROM/RAM Card and the package of operating system ROMS (LMOS, SCHEDULER, BASIC, NAVIGATION, VOCOL and CATALOG). In a static free location, carefully remove each ROM from the static foam and insert the ROMS into the sockets on the ROM/RAM Card as shown below. Make certain the ROM's are properly aligned and that all pins are in their sockets.



This completes all the connections to the robot. If there are any connectors left that are not connected, re-check all steps. The robot is now ready to come to life.

INITIAL TESTING AND CALIBRATION

In this section you will activate the robot's "cold start procedure", and perform calibrations to the circuits. Although these adjustments can be done with a multi-meter, they are easier and more accurate if done with an oscilliscope. Some adjustments on GEMINI have very close tolerances and these will be noted. They may require a bit of fiddling to get them just right, especially without the use of an oscilliscope. A little patience is heavily recommended.

Cold Starting

1. Place the robot on it's charger. Make sure power switch on robot is in off position.

2. Carefully place the plastic head shell on the robot with shell holes properly aligned.

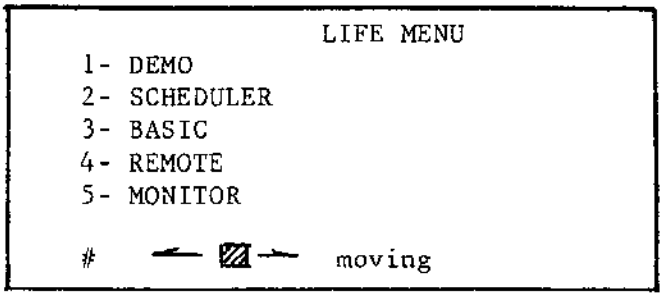
3. Install the ROM card in slot four on the main CPU board. Secure it with the ROM clip.

4. Attach the keyboard to the robot.

5. Turn power switch ON. The copyright notice should appear on the LCD for a few seconds. The robot will begin speaking and go through self-test of systems. Self-test sequence is listed on page 24 of the User's Manual. Do not be concerned at this point if the robot does not pass all self-tests. It must go through these checks before it can be calibrated. Things to note:

    1. VIOS will probably be labeled as "speech chip bad" and "sound chip bad". This will be adjusted later.
    2. All batteries should read near 12 volts.
    3. ROM and RAM should pass test, except for ROM 7 (SECURITY) which is missing.
    4. With no disk or tape, the robot should respond with "I/O error 32".
    5. Keep keyboard plugged in for now during the IR link test.
    6. Procon should pass test.
    7. Bumpers should pass test.
    8. Sonars should pass test.
    9. Head should pass test.
    10. Beacon detector will probably be a little out of adjustment.
    11. Door edge detector will probably be out of adjustment.
    12. Motion detector needs adjustment.

GEMINI should now be in LIFE MENU. Display will look like this:



Adjustments to SSS Board

1. Press function switch 5 or key 5 on the keyboard to put the robot into monitor mode.

2. On the keyboard type $E060:FF This enables the robot sensors.

3. Set up digital multi-meter for DC volts. Read voltage from U1 (SSS Board) pin 7 to chassis. Adjust with R14 for 2.98vDC.

4. Measure between U1 pin 14 and chassis. Adjust with R17 for 2.73vDC.

5. Adjust R94 fully clockwise, then back off approximately 2 turns (pot is fully clockwise when faint clicking sounds can be heard from the pot while turning it). If using a scope, adjust for maximum peak to peak signal at U10 pin 1 when waving your hand in front of the motion detectors.

6. Adjust R89 until you measure approximately 3.91vDC between U10 pin 10 and chassis. If using a scope, adjust for a signal on U10 pin 8 that goes high when you move your hand, otherwise is a low (logic).

7. Push reset button to put the robot back in Life Menu.

8. Push function 1 for Demo.

9. Enter sensual robot routine.

10. Enter sight and sound routine.

11. On SSS board, adjust R3 so that the light bar on the display is approximately 3/4 full screen with normal room light, and approximately 1.4 screen when all light is blocked from sensor. (Put finger over sensor located on top of head.)

12. Adjust R35 so that when whistling or speaking loudly, the sound bar goes to approximately half screen.

13. Press any function key to re-enter the sensual robot menu.

14. Enter temperature routine.

15. Adjust R17 to make the temperature read correct normal room temperature. Room temperature is approximately 20-21 degrees Celsius.

16. Press reset to re-enter life menu.

CALIBRATING VIOS WITH OSCILLISCOPE

1. Enter Basic (function key 3).

2. Type ENVIOS (enable VIOS).

3. Using chassis as common, look at signal on pin 37 on IC 8 on VIOS board. Adjust with R50 so that with normal room noise, the signal is a logic high, with occasional intermittent low going spikes. Now whistle or produce a steady tone. Trigger the oscilliscope so you see a clean square wave. (5 vpp 5vDC max.). This is the frequency of zero crossings, signal name ZCDET.

4. Look at signal on pin 38 of IC 8. There should be a logic high unless a spoken sound is detected, then it goes low. The signal should be adjusted with R60 so that it stays low for only the duration of the sound. Best results are obtained when multi-syllable words such as "retrain" or "negative" are used. Signal named is WRDAV (word-available).

5. Push reset key to re-enter life menu.

6. Press key "A" on the keyboard to test VIOS.

7. During the VIOS self-test, the robot emits a tone from both the sound chip and the speech chip, and checks to see if it heard itself. If the volume from the sound and speech circuits are not loud enough to cause WRDAV to go low, assuming that signal goes low when you, the robot-master are speaking, then just turn the volume pots up. For speech, the pot is R39; for sound, R42. Also try the test with the robot both on the charger and off, because sometimes a 60 Hz hum from the charger can cause problems.

CALIBRATING VIOS BOARD WITHOUT OSCILLISCOPE

1. Enter Monitor. When the robot has life menu on display, press function key 5.

2. On the keyboard type: $4000 : A9 02 0C 60 E0 20 63 E4 F0 06 20 5D E4 20 E8 E4
   Press return key.

   Type: $4010 : A9 01 20 69 E4 F0 EE 20 5D E4 80 E9
   Press return key.

   Type: $4000L (list data at 4000)
   Press return key.

   Display should look something like this:

```
                    1000          .OR $4000
4000- A9 02         1010 VIOSTK   LDA #$02      ENABLE VIOS
4002- 0C 60 E0      1020          TSB $E060
4005- 20 63 E4      1030 .1       JSR $E463     CHK FOR KEY PRESS
4008- F0 06         1040          BEQ .2        BR IF NONE
400A- 20 5D E4      1050          JSR $E45D     LCDOUT
400D- 20 E8 E4      1060          JSR $E4E8     VIOSOT
4010- A9 01         1070 .2       LDA #$01
4012- 20 69 E4      1080          JSR $E469     POLPRT
4015- F0 EE         1090          BEQ .1        BR IF NO CHAR
4017- 20 5D E4      1100          JSR $E45D     LCDOUT
401A- 80 E9         1110          BRA .1
```

   Type $4000 G Display should show a "!".

   Now the test program is ready to run. To run type the control key and key "T". The result is a WXYZ format and should be all 0's. Refer to chart for interpretation of format. Adjustments for speech and sound test are made with potentiometers R50 and R60 on the VIOS board. R60 should be very near the 12 o'clock position. R50 should be very near the 7 o'clock position. Very slight movement of those pots should be enough to bring the system back up to snuff.

WXYZ INTERPRETATION

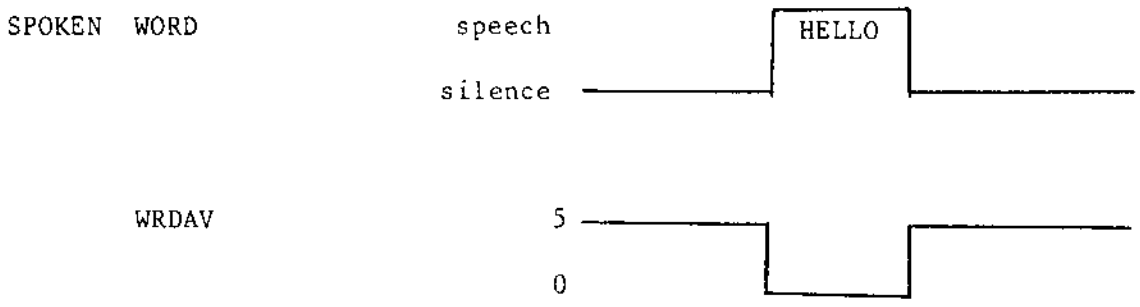
W = RAM test
- 0 - RAM ok
- 1 - RAM 1 bad
- 2 - RAM 2 bad

X = ROM test
- 0 - ROM ok
- 1 - ROM 1 bad
- 2 - ROM 2 bad
- 3 - ROM 3 bad
- 4 - ROM 4 bad

Y = Speech test
- 0 - speech loop ok
- 1 - WRDAV already is low
- 2 - WRDAV did not go low

Z = Sound test
- 0 - Sound loop ok
- 1 - WRDAV already is low
- 2 - WRDAV did not go low
- 3 - ZCDET did not change

WRDAV is a signal which goes low when sound of a predetermined amplitude is detected (amplitude set by R50 - preamp gain). When WRDAV is low, the computer starts counting zero crossings, or frequency. If WRDAV is held low too long, the computer comes back with a speech buffer overflow. R60 adjusts WRDAV sensitivity. The ideal situation is for WRDAV to be low only for the duration of the spoken words.



ADJUSTING THE DOOR EDGE DETECTOR

The door edge detector is the yellow box located in the robot's head.

1. Enter monitor by pressing key 5 when the robot is in life menu.

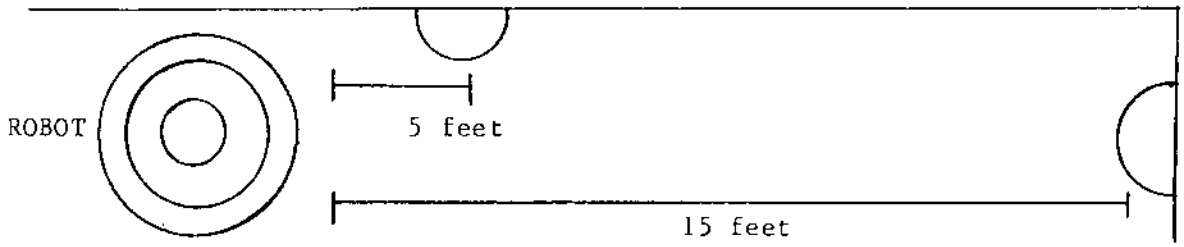
2. Type on the keyboard: $E060 : FF (enables sensors)

3. Position the robot next to a wall, preferably a light colored one, as close as possible. Set up a door edge reflector approximately 15 feet away from the robot, and another about 5 feet away.

4. Pop out one of the head side sonars, being careful not to short any of the leads to any metal. This will let you see the red LED on top of the door edge detector while the robot has his head on.

5. Turn the robot's head around, watching the red LED as you do. It should light up every time it "sees" a reflector.

6. The detector is adjusted with the trimmer pot located in the top of the detector. To get to it, you will have to loosen one of the screws that holds the light detector bracket and swing the bracket aside. Then remove the white nylon cap on top of the detector. Down about 1/4" is the adjustment pot. A jeweler's screwdriver is needed. Clockwise increases the gain. Best results are obtained if you adjust the pot so that when the detector is closest to a wall, the gain is adjusted so that the LED is off. Adjust so it lights up, then back off until it just turns off. That is maximum permissible gain.



A proper door edge reflector adjustment is crucial for the robot's navigation system. Take the time and get it right. You will be rewarded later. Replace the nylon cap that goes on top of the detector and screw the bracket back in place.

ADJUSTING BEACON DETECTOR

Make sure the robot is still in monitor and that the sensors are enabled ($E060 : FF).

Using a digital multi-meter -

1. Measure the voltage between chassis ground and the wiper of R3 on the receiver board (the wiper is the middle lead of the pot). Adjust R3 so the voltage is approximately 9.1vDC.

2. Push reset key to enter life menu routine. Test beacon detector by pressing key "1" on the keyboard. If, during the adjustment procedure, the robot's head got turned, it may be necessary to initialize the head first. This is done by pressing key "K" on the keyboard.

3. It will probably be necessary for you to "fiddle" with the adjustment until you get it right; that is, when the robot points it's head straight at the beacon when looking for it. A properly tuned beacon detector is another crucial factor in the robot's navigational system.

Using an oscilliscope -

1. Ensure robot is in monitor and sensors are activated ($E060 : FF).

2. Look at signal on J5 pin 8 on the SSS board. Chassis is common.

3. Ensure that the robots head is on. Turn the head so that it is facing a beacon dead-on. Adjust R3 on the beacon detector board until an even square wave is produced. It is important that is has an even duty cycle. R3 can be adjusted by poking your finger in the hole in the back of the head, just above the rear microphone hole. Now move the head around in circles to make sure that no interference is being picked up by the detector (no spikes, reflective beacon signal, etc.). The robot should only see the beacon when the head is pointing right at it. This is a very sensitive adjustment and a crucial one to the navigation system.

ADJUSTING KEYBOARD IR DETECTOR

1. Using a digital meter, measure the voltage between chassis ground and the wiper of R3 on the keyboard IR board. Adjust with R3 for a voltage of approximately 8.63vDC. This adjusts the center frequency for about 33 KHz.

2. If using an oscilliscope, look at the signal on J4 pin 9 on the CPU board. Take your keyboard, making sure that it is unplugged from the robot, and position it so that the LEDS in the keyboard can be seen by the IR board. Press any key on the keyboard and hold it down. Adjust R3 on the IR board until a square wave with an even duty cycle is seen.

This completes the calibration procedure for the robot. Turn the robot off for approximately 10 minutes. After this time, install the battery backing jumpers on both the VIOS board (J5) and the main CPU board (J20). See page 12 in Users Manual.

Turn the robot on and press both function key 5 and the reset button at the same time. Then release, letting go of the reset button first. This puts the robot back into cold start routine. Make sure the robot passes every test perfectly. If failure occurs, refer to either the calibration procedure or the trouble shooting section.

The robot is now ready to serve you.

GEMINEX Initial Testing and Calibration

BOARD MOUNTING PROCEDURE

The next step in the assembly of your GEMINI robot is to attach all of the PC boards to the robot frame. Refer to pages 8 and 9 of the Technical Manual for greater ease in identifying where the boards are mounted. Here is a list of the parts you will need:

21 - 1/4" nylon spacers	30F1436
20 - 4-40 1/2" screws	91783A110
1 - 4-40 1/2" nylon screw	94611A110
1 - 4x6 insulation backing	board insulator
10 - nylon shoulder washers	90062A005
25 - 4-40 nuts	91841A005
2 - 4-40 1/4" screws	91783A106
4 - 4-40 3/8" screws	91783A108
2 - 1" threaded standoffs	67F4067

1. Mount the main CPU board - remove the motherboard mount from the bottom of the torso by removing the screws in each of its corners, and then lifting it up and out through the back of the torso. Place the motherboard mount on an anti-static surface (charger static mat will work). Using nine 4-40 1/2" screws, nine 1/4" spacers, and nine 4-40 nuts, attach the main CPU board to the motherboard mount making sure that J14, J8 and J9 on the CPU board are located near the thin slots on the motherboard mount. Re-install the mount on the torso. Do not connect anything to the CPU board yet.

2. Mount the SSS board - using three 4-40 1/2" screws, one 4-40 1/2" nylon screw, four 1/4" spacers, four 4-40 nuts and four shoulder washers, mount the SSS board above where the VIOS board is normally mounted. Position it so that the relays are on the bottom. Ensure that the nylon screw goes into the hole nearest the small polaroid sonar board which is tie-strapped onto the SSS board. This screw keeps from shorting the sonar board to the chassis.

3. Mount Procon board - using four 4-40 1/2" screws, four 1/4" spacers, and four 4-40 nuts, mount procon on the bottom left side area of the torso. Position it so that the crystal is pointing towards the rear of the robot.

4. Mount Power Distribution Board - using four 4-40 1/2" screws, four 1/4" spacers, four nuts, and the insulation backing, mount the power distribution board on the upper left side area of the front of the torso. Ensure that J2, J3, and J4 are positioned to the left, and the insulation backing is between the board and the torso.

5. Mount Room Beacon Detector - using two 4-40 3/8" screws and two nuts, mount the Beacon detector Board Assembly in the head, right in front of the rear microphone. Ensure that the parabolic dish is facing straight forward.

This completes the board-mounting procedure. Make sure that you have not connected anything to any of the boards yet. That will be covered in the next section. Double check your work, looking for physical shorts or poor alignment of mechanical parts. Poor alignment can sometimes mean that the board is not mounted correctly. Ensure all screws are snug.

ASSEMBLING THE SUBASSEMBLIES

You are now ready to assemble the robot. Refer to the instructions entitled "BASE, TORSO AND HEAD ASSEMBLY INSTRUCTIONS" and follow the steps indicated.

MAKING THE RIGHT CONNECTIONS

Use extreme care during this next phase of the robot assembly. Make very sure that the wiring harness has been wired correctly. One wire out of place could mean serious damage to the robot's CMOS circuitry. Look for wires hanging loose, and for obvious shorts (such as red colored wires touching any metal parts, etc.). Also a good idea is obtaining a wrist-strap and cord to ground yourself to the robot's chassis. This will prevent any static build up from zapping the robot's circuits. This procedure requires a digital multi-meter.

1. Connect J4 torso connector (male) to J4 base connector (female). These are big white Molex connectors located near the bottom torso plate. One comes from the base unit. Ensure a tight connection.

2. On the power distribution board, connect J2 (on/off switch). Ensure switch on front panel in the OFF position. Make sure connector is correctly oriented.

3. Connect J3 on power distribution board (battery input). Turn the switch on the front panel to the ON position. Measure the pins on J4 for the following voltages + - 10%:

1	+12vDC	
2	12 return	Motor 1
3	+12vDC	
4	12 return	Motor 2
5	+12vDC	
6	12 return	Logic 12v
7	+5vDC	
8	5 return	Logic 5v

If voltages are incorrect, check wiring from J3 to Base. Turn switch OFF. Do not continue unless the voltages are correct.

4. Connect all remaining connectors to power distribution board. Ensure that the red wire is on the bottom of connector DS1. Turn switch on and check for blown fuses. If a fuse is blown, do not continue until you know why it blew. A little patience during this procedure will help prevent serious problems later on.

5. Connect your computer to the CPU board using the procedure outlined in the CPU board testing procedure. Turn the power switch on. On your screen you should view the following:

```
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If no display is seen, refer to trouble shooting section. If there is a display, continue by turning robot off.

6. Connect remaining connectors to CPU board. Make sure they are connected properly (pin 1 on board to pin 1 on connector, etc.). Turn on the robot. There will be a click (GND connect relay) and then the dispaly should come up the same as in the previous step. If no display now, isolate the trouble by diconnecting one connector at a time (turning robot off each time, of course) until you find the guilty one. Correct the problem and when ready for the next step, turn the robot off. Keep checking for blown fuses.

7. Connect all connectors to the Procon board. Turn the robot on and check display. check fuses. If everthing is acceptable, turn the robot off.

8. On SSS board, ensure that J7 and J8 are disconnected. They are the two connectors that come from the small polaroid board tie-strapped to the bottom right on the SSS board. Remove U16, U17 and U18. Connect all other connectors, being especially careful that J1 (CPU connector) is wired correctly. Turn the robot on and adjust for the following voltages:

    IC 12 pin 6 to chassis = 3.0vDC - adjust with R107
    VR1"0" to J7 pin 1 = 5.5vDC - adjust with R91

    If everything is acceptable, turn the robot off. Reconnect J7 and J8 and re-install U16, U17 and U18.

9. Connect the three-pin connector to the beacon detector board. Ensure that the red wire is closest to the adjustment pot.

This completes all the connections to GEMINEX. If there are any connectors left not connected, re-check all steps. The robot is now ready to come to life.

INITIAL TESTING AND CALIBRATION

In this section you will talk to the robot with your computer system (Apple, PC, TRS-80, etc.) Then you will need to perform certain adjustments to the robot's circuits. Although these adjustments can be done with a digital multi-meter, they are easier and more accurate if done with an oscilliscope. Some adjustments have very close tolerances; these will be noted. They may require a bit of fiddling to get them just right, especially without the use of an oscilliscope. A little patience is heavily recommended.

1. Place the robot on its charger.

2. Because the kit does not include body or head shells, it will be necessary for you to make a slight modification to the robot's head. The head on the robot has a functional purpose as well as a cosmetic one, in that it blocks any infrared signals that might be present behind the head, which would degrade the performance of the beacon detector. It will be necessary for you to fabricate "blinders" so that the beacon detector will "see" the beacon only when it is in front of the head. this is very important for the robot's navigational system. Any material can be used - cardboard, tape, plastic. Refer to the diagram on the following page for clarification.

3. Turn the robot on, making sure that the display still looks like this:

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  ALL RIGHTS RESERVED
 >
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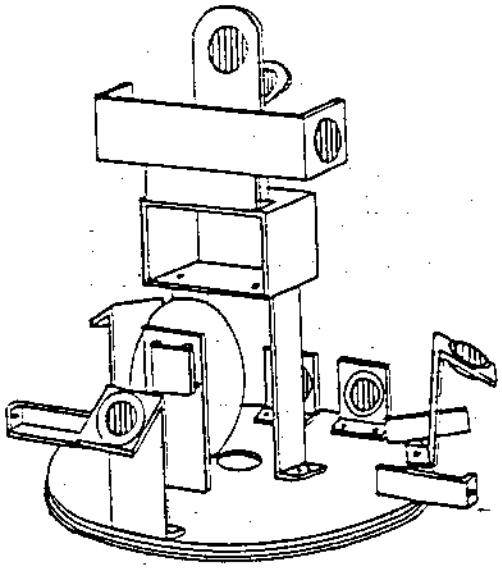
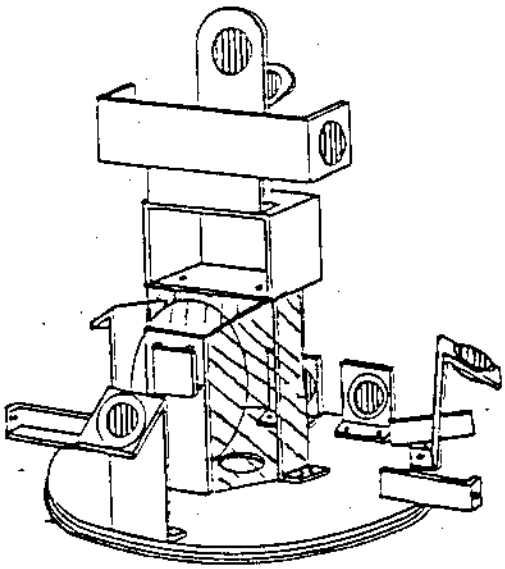
Beacon Detector Screening Modification

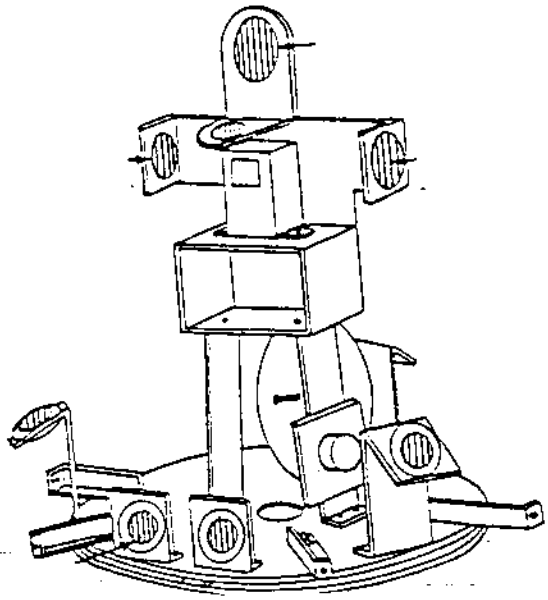
Before (rear view)



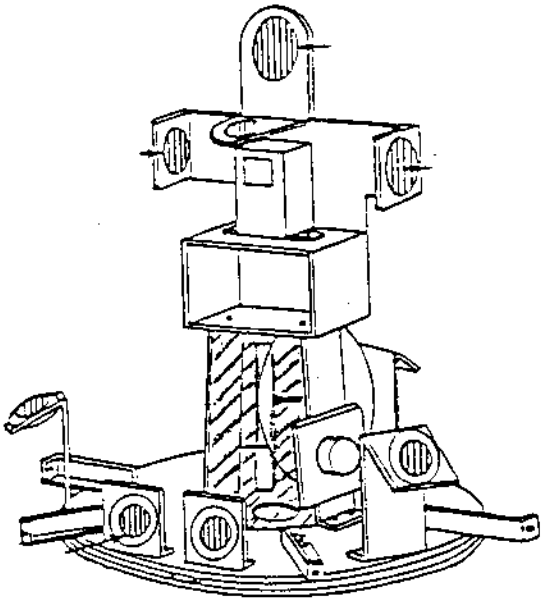
After (rear view)



Before (front view)



After (front view)



ADJUSTING THE SSS BOARD

1. On the keyboard type: $E060: FF
   Return. This enables the robot's sensors.

2. Set up a digital multi-meter for DC volts. Read voltage from U1(SSS) pin 7 to chassis. Adjust with R14 for 2.98vDC.

3. Measure between U1 pin 14 and chassis. Adjust with R17 for 2.73vDC.

4. Adjust R94 fully clockwise, then back off 2 turns. Adjust R89 until you measure approximately 3.91vDC between U10 pin 10 and chassis. This adjusts the motion detector circuit.

5. Push the reset button on the robot. Copyright display should come back.

ADJUST THE DOOR EDGE DETECTOR

The door edge detector is the yellow box located in the robot's head.

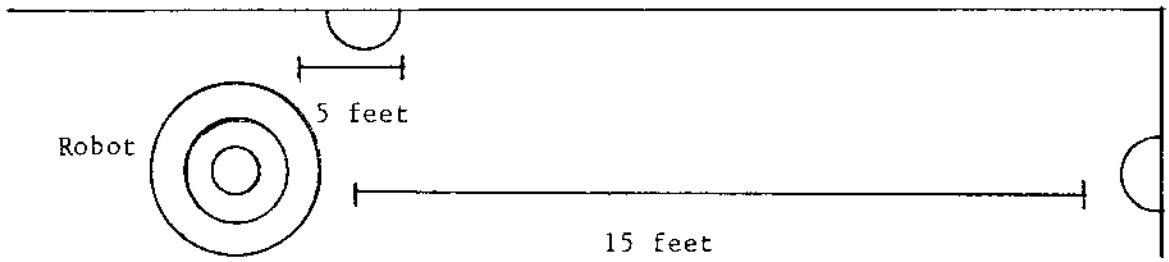
1. Type on the keyboard: $E060 :FF (enables sensors)

2. Position the robot next to a wall, preferably a light colored one, as close as possible. Set up a door edge reflector approximately 15 feet away from the robot and another about 5 feet away.

3. Pop out one of the head side sonars, being careful not to short any of the leads to any metal. This will let you see the red LED on top of the beacon detector while the robot has his head on.

4. Turn the robot's head around, watching the red LED as you do. It should light up everytime it "sees" a reflector.

5. The detector is adjusted with the trimmer pot located in the top of the detector. To get to it, you will have to loosen one of the screws that holds the light detector bracket and swing the bracket aside. Then remove the white nylon cap on top of the detector. Down about 1/4" is the adjustment pot. A jeweler's screwdriver is needed. Clockwise increases the gain. Best results are obtained if you adjust the pot so that when the detector is closest to a wall, the gain is adjusted so that the LED is off. Adjust so it lights up, then back off until it just turns off. That is maximum permissible gain.



A proper door edge reflector adjustment is crucial for the robot's navigation system. Take the time and get it right. You will be rewarded later.

ADJUSTING BEACON DETECTOR

Make sure the robot is still in monitor and that the sensors are enabled ($E060:FF).

Using a digital multi-meter -

1. Measure the voltage between chassis ground and the wiper of R3 on the receiver board (the wiper is the middle lead of the pot). Adjust R3 so the voltage is approximately 9.1vDC.

2. Push the reset button. To test beacon, type the entry point for the beacon test on your keyboard. Consult manual for entry address.

3. It will probably be necessary for you to fiddle with the adjustment until you get it correctly; that is, when the robot points his head straight at the beacon when looking for it. A properly tuned beacon detector is another crucial factor in the robot's navigational system.

Using an oscilliscope -

1. Ensure robot is in monitor and sensors are activated ($E060:FF).

2. Look at the signal on J5 pin 8 on the SSS board. Chassis is common.

3. Turn the head so that it is facing a beacon dead-on. Adjust R3 on the beacon detector board until an even square wave is produced. It is important that it has an even duty cycle. R3 can be adjusted by poking your finger in the hole in the back of the head, just above the rear microphone hole. Now move the head around in circles to make sure that no interference is being picked up by the detector (no spikes, reflective beacon signal rate). The robot should only see the beacon when the head is pointing right at it. This is very sensitive adjustment and a crucial one to the navigation system.

This completes the adjustments to the various boards on the robot. You may find it necessary to recalibrate occasionally until everything is "worked in".

Smart Mobile Base - Set-up and Test

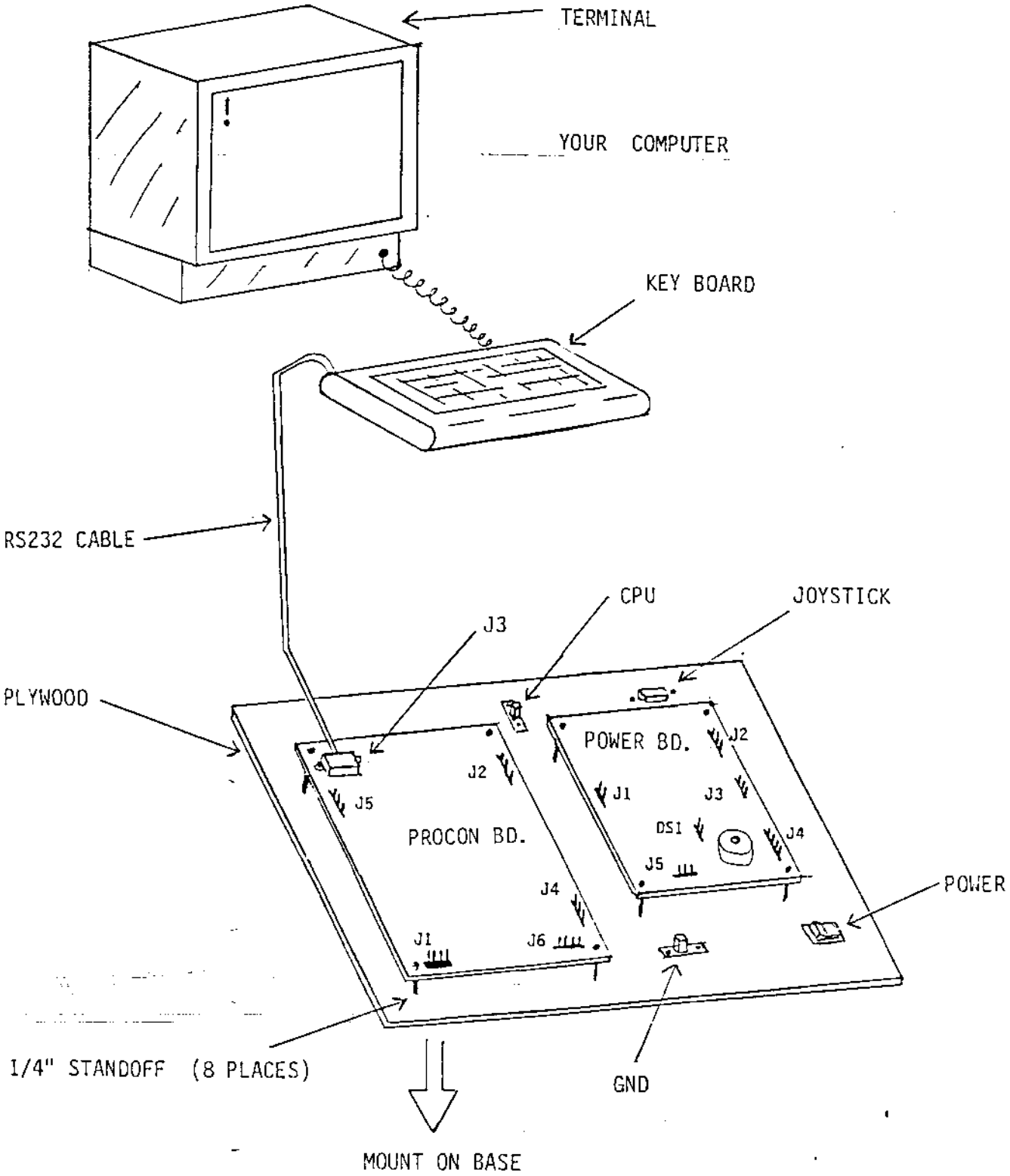
MOUNTING BOARDS

1. The next step in the assembly of your smart mobile base kit is to mount the procon and power distribution boards on the base unit. These boards are normally mounted on the robot's torso assembly, which is not included in this kit. These boards may not coordinate with your own particular design plans, therefore, it is suggested that you custom design your own mounting scheme, or refer to the "Smart Mobile Base Set Up" section, pages 16-19 of the Torso Cable - Part B Assembly Instructions. If you are thinking of possibly expanding in the future to a complete GEMINI, you may wish to purchase the torso assembly separately.

   After you have mounted the boards to your satisfaction, your next step is to make the connections from the base to the boards. Make sure that you have labeled your connectors properly and that the pins on the connectors are labeled properly.

2. Connect base connector J4 (female) to the torso connector J4 (male).

3. Attach the cable connector labeled "J2 POWER" to port J2 on the power distribution board.


TERMINAL
YOUR COMPUTER
KEY BOARD
RS232 CABLE
CPU
JOYSTICK
J3
PLYWOOD
POWER BD.
J2
J1
J3
DS1
J4
J5
PROCON BD.
J2
J5
J4
J1
J6
POWER
I/4" STANDOFF (8 PLACES)
GND
MOUNT ON BASE

4. Attach the cable connector labeled "J3 POWER" to port J3 on the power distrubution board. Turn on the power switch to the ON position. Measure the voltages on port J4 pins (power distribution board) by connecting a volt meter to pins 1 and 2, 3 and 4, etc. You should observe the following voltages:

Pin No.	Use
1	+12vDC supply, Motor #1 battery
2	Ground, Motor #1 battery
3	+12vDC supply, Motor #2 battery
4	Ground, Motor #1 battery
5	+12vDC supply, Logic battery
6	Ground, Logic battery
7	+5vDC, Logic supply from switch regulator
8	Ground, Logic

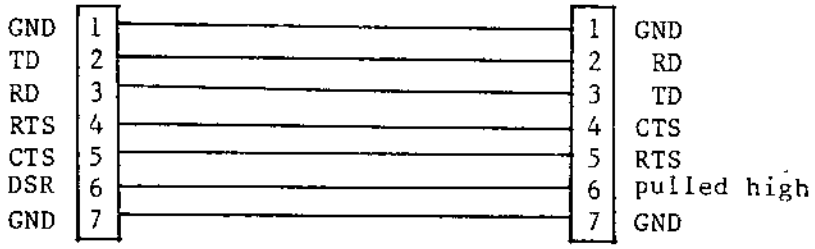
If voltages are incorrect, check the wiring from J3 to the base. DO NOT CONTINUE UNTIL VOLTAGES ARE CORRECT.

5. Turn the power switch OFF. Attach the cable connector labeled "J4 POWER" to port J4, the cable connector labeled "J5 POWER" to port J5, and the cable connector labeled "J1 POWER" to port J1 all located on the power distribution board. Place both the GND and CPU SPDT switches in their off positions.

6. Turn the power switch ON. Check for blown switches. Check all wiring if any fuses are blown.

7. Turn the power switch OFF. Attach the cable connectors labeled "J1 PROCON", "J2 PROCON","J4 PROCON", "J5 PROCON" and "J6 PROCON" to ports J1, J2, J4, J5 and J6 on the Propulsion Computer. Turn the power switch ON and check for blown fuses. If any fuses blow, check all wiring.

8. Connect a terminal with DTE RS232 type plug to port J3 on the propulsion computer. Port J3 is wired as a DCE RS232 device so ensure that your terminal is wired to the propulsion computer as follows:



DTE - Terminal DCE - Procon J3

If your terminal is a DCE device, then make up a connector that swaps pins 2 and 3 and pins 4 and 5.

9. Place the CPU SPDT switch connected to port J2 on the propulsion computer to its on position. On the screen of your terminal should appear an exclamation mark "!". This is the propulsion computer's prompt. It is now ready for commands below. This completes the testing. Put the CPU SPDT switch back to the off position.

10. Place the base on the charger and place the SPDT switch connected to port J5 on the power distribution board to its closed position. This will connect battery grounds together so all batteries can be charged. You may wnat to attach an LED to port DS1 on the power distribution board to let you know visually that the batteries are charging.

(See pages 10-22 in the Technical Reference Manual.)