W8ZR Receiver Multicontroller
Assembly Instructions
(rev 2 May 2005)

I. Preparation for Assembly

The W8ZR Receiver Multicontroller consists of four modules: the front panel assembly, the rear panel assembly, the main circuit board, and the optional AM/LF filter circuit board. These modules plug together and slide into the enclosure, so no point-to-point wiring is required.

Before starting construction, you should collect and inventory all the parts for each circuit board. Loose parts can be grouped in a muffin pan, and components with leads (resistors, capacitors, diodes, etc.) can be stuck in the edge of a piece of cardboard. The resistor color codes will be given later in the instructions, so be sure you use the correct values. If you have any doubts about reading the color bands, measure the resistors with a DVM. Be careful not to confuse diode types, since their markings are hard to see. Use a clean, brightly lighted, uncluttered worksurface and keep the cat and family members away.

II. Metal Fabrication (Skip this section, if pre-punched enclosure is used.)

Metal-Working Tools
> 12" metal scale
> metal scribe
> center punch
> tap hammer
> flat fine-tooth metal file
> nibbler (optional)
> 1/4" chassis punch or drill bit
> 3/8" chassis punch or drill bit
> 1/2" chassis punch or drill bit
> 3.5 mm or 9/64" drill bit
> 10 mm or 13/32" chassis punch or drill bit
> electric drill (drill press preferable)
> press-on letters of desired size and font
> Krylon matt-finish clear plastic spray

> **Metal Fabrication Hints**
>
> 1. Make sure your workbench surface is clean and free of clutter.
>
> 2. Take care not to scratch the panel. Experienced homebrewers often tape wrapping paper over panels as protection.
>
> 2. Measure hole locations to 1/64," because holes must line up exactly with the cutouts on the printed circuit boards.
>
> 3. Always use a sharp center punch to locate the position of holes.
>
> 4. To drill well-shaped holes in aluminum panels, start with a small drill and work up gradually to the finished size.

(1) Using the supplied templates, mark and drill (or punch) the indicated holes on the front and rear cabinet panels. It is a good idea to secure the templates to the panels with masking tape, so they don't slip. De-burr the holes and make sure the components slide freely into their holes.

(2) (rear panel only) After the holes are drilled, rough out the opening for the AC connector using a nibbling tool. If you don't have a nibbling tool, drill a series of small

holes around the edge of the cutout and then file the opening to the desired shape. Check clearances with the AC connector as you increase the opening size, so that you don't make it any larger than necessary. Note that the molded flange on the connector attaches on the *outside* of the panel (the side with the countersunk holes). *(Hint: To save yourself some metalwork, you can drill a single hole for a strain relief and install a permanently connected AC power cord.)*

(3) After degreasing each panel with alcohol, label both panels with press-on lettering, available from any art supply store. Tape a sheet of paper to the panel to use as a lettering guide and to protect already-applied labels. Take your time and make sure the lettering is even.

(4) Seal each panel with two or three coats of matt-finish clear plastic (Krylon) spray.

III. Front Panel Assembly
(estimated assembly time: 1 hr 15 min)

Circuit Board Tools
> small tip soldering iron (adjustable temperature type preferred)
> small diameter resin core solder (1/32" approximately)
> magnifying glass
> small needle-nose pliers
> small flush-cut wire cutters
> needle-tip tweezers
> isopropyl (rubbing) alcohol & Q-tips

Identify the front panel circuit board and, using the parts list, collect all the components. With the exception of the 12-pin Molex headers J100 and J101 (which mount on the back side), all of the components mount on the silk-screened side of the board, as shown in the figure. Refer to the parts list to identify the values of each circuit board component, since only the designation numbers (e.g., R100) are silkscreened on the circuit baords.

Front Panel Circuit Board

(1) Solder all nine 1000 Ω (brown-black-red) resistors R100-R109 and the diode D100 to the front panel circuit board. Be sure to align the banded side of the diode with

the silkscreened outline. Your board will look more professional if you align all the resistor color codes in the same direction.

(2) Solder the two 12-pin straight headers (J100 and J101) onto the *bottom side* of the front panel circuit board. (*Hint: solder the end pins first to secure the headers. After you're certain the headers are seated snugly against the board, with the pins perpendicular to the board, solder the remaining pins.*)

(3) Remove all hardware from the toggle switches (but not S110, the AC power switch) and then temporarily secure each toggle switch to the front panel, using only the nut, which should be finger-tight. The slots on the barrels of S100-S108 should point down, and slot on S109 should point to the left, as viewed from the front of the panel (*Hint:Check to make sure each toggle switch operates smoothly before you install it.*)

(4) Snap the LED plastic mounting bezels into their holes on the front panel.

(5) Push the toggle switch pins (but not the AC power switch) into their matching circuit board holes. Note that S100 is the only DPDT switch. After verifying that the switches are seated snugly against the circuit board, solder the pins to the circuit board.

(6) Now remove the nuts from the toggle switches and set aside the metal panel.

(7) Slide the LEDs into their respective holes on the circuit board (red for "Overload", yellow for "Preamp" and "Mute Enable", and green for "Receiver Enable"), but do not solder them. Note that the LEDs have a flattened side that must match the flat side on the silkscreened outline. This is also the side with the short lead. Double check to make sure they're installed properly.

(8) Now reattach the front panel to the toggle switches. Put the lockwasher on the back side of the panel. There should be no other hardware behind the panel. Tighten (but do not overtighten!) the nuts. Discard the flat washer and extra nut.

(9) Slide the LEDs into the rear of their bezels until they click into place. Use a small flat-bladed screwdriver to pop the LEDs into place. Once each LED is correctly mounted in its bezel, solder all the LEDs to the circuit board.

(10) Slide the AC power switch into its front panel hole and secure it with the supplied plastic nut. The pins of the AC switch should extend through the bottom two holes on the circuit board. Solder the pins to the circuit board.

(11) Clean the flux from the back side of the circuit board with isopropyl alcohol and then inspect each solder connection using a magnifying glass.

(12) Set aside the completed front panel assembly.

IV. Rear Panel Assembly
(estimated assembly time: 2 hrs)

(1) Install capacitor C200 on the *bottom (solder) side* of the circuit board, so that it can be easily removed once the rear panel assembly is completed. This capacitor is marked with an asterisk on the silkscreen.

(2) Install the 1000 Ω (brown-black-red) resistor R200 and the remaining capacitors (C201-C208) on the *silkscreen side* of the circuit board, as shown in the figure. Bend the capacitor leads to fit into the holes, if necessary.

(3) Install the three .156" straight headers (J202, J208, J217) on the *bottom side* of the circuit board, the same way as you did for the front panel. Also, install the small .100" 4 pin header (J200) on the *bottom side*.

(4) Remove all hardware from the 9 BNC jacks, and carefully straighten the two pins if they are bent. Make <u>absolutely sure</u> each jack is snug against the circuit board, and then solder its pins and the mounting pegs to the circuit board. Note that the circuit board hole marked "GND" is not used.

(5) Remove all hardware from the nine RCA phono jacks, and solder a 2" (approx) length of <u>bare</u> solid wire (# 22 or # 20 AWG) to the center pin of each jack.

(6) Secure the nine RCA jacks to the rear panel. Red jacks indicate which receivers "close on mute." (I used three red jacks for RX1-RX3.) The lockwashers go behind the panel, and flat solder lugs go under tne nuts Note that the rounded edge of the nuts goes to the outside. Tighten all nuts securely.

(7) Slide the nine bare wires from the RCA jacks through their mating circuit board pads, as identified in the following list. Each pad is directly behind its matching jack. When you have all nine wires sliding smoothly into their circuit board holes (this is a bit tricky, but can be done!), place a lockwasher on each BNC jack and slide the rear

panel down over the barrels of the BNC jacks. Tighten the nuts securely on the BNC jacks.

Hi-Z………J203	RX7...........J214
RX6...........J215	RX5...........J216
RX4...........J218	RX3...........J219
RX2...........J220	RX1...........J221
Control......J213	

(8) Now solder each wire from the RCA jacks to the circuit board. Make sure none of the wires is kinked or bent.

(9) Locate the molded AC connector, and with pliers carefully bend the "L" and "N" solder terminals back across the connector, so that they lie as flat as possible against the back side of the connector. The bent terminals should point in the same direction as the ground terminal. Bending the pins is necessary so they don't bump into the main circuit board, as shown in the photo.

(10) Using #6 hardware (screw, lockwasher, nut) mount the AC connector on the rear panel. The molded bracket mounts on the *outside* of the panel and its ground (center) terminal is toward the *center* of the panel. Use a #6 solder lug instead of a lockwasher on the lower screw.

(11) Connect two 6" lengths of well-insulated stranded hookup wire to the AC connector terminals. It is advisable to use color-coded wire: black for the "live" (bottom) terminal, and white for the "neutral" (top) terminal. Also connect a short length of hookup wire from the AC connector center (ground) terminal to the ground lug previously installed. Solder all connections.

(12) Slip a short length of sleeving (heat-shrink tubing preferred) over the exposed "live" and "neutral" terminals. Use a longer length of sleeving, or nylon Ty-Wraps to keep the two wires bundled together.

(13) Solder or crimp a Molex 0.156 female pin to the ends of the two wires coming from the AC jack and snap the pins into the 3-pin Molex connector. This connector will plug into J6 on the main circuit board. The "live" (black) wire connects to pin 1, and the "neutral" (white) wire to pin 3. Pin 2, the center pin, is not used. *(Hint: The pins on J6 are identified on the silk-screening on the main circuit board.)*

(14) Clean and inspect all solder connections. Check especially for solder bridges between the closely spaced pins of the BNC connectors. Now set aside the completed rear panel assembly.

V. AM/LF Filter Circuit Board
(estimated assembly time: 30 min.)

Note: This filter is used to block strong signals on the AM broadcast band. Since you won't need it unless you experience overload from strong local AM stations, you may want to skip this assembly step until you've completed and tested the Multicontroller.

(1) Install and solder the 4-pin 0.100" female connector J300 on the *bottom side* of the circuit board, making sure it is snug against the board. All other components mount on the component side of the board.

(2) Install and solder all the capacitors to the board.

(3) Install and solder the three inductors. Keep the body of the inductors about 1/8" above the circuit board, so that they do not interact with the board's ground plane.

(4) Clean and inspect all solder connections. Check carefully and set aside the completed circuit board.

VI. Main Circuit Board
(estimated assembly time, including checkout: 4 hrs 30 min)

A. Installation of the GALI-6 Integrated Circuit (U3):

The GALI-6 is a surface-mount component and is installed first so that the other components won't get in the way. It is important that you use a small-tipped soldering iron and fine (1/32" diameter) solder. *Please* don't try to use a larger iron, because your chances of success are near zero. If you install U3 wrong, you won't be able to remove it without destroying it. A bright light, a magnifying glass and some needle-tipped tweezers will be helpful, and it is desirable to wear a wrist grounding strap (available from Radio Shack), or at least take care to avoid static electricity.

(1) Inspect the underside of the GALI-6 with a magnifying glass and note the metal ground trace that runs down the middle of the chip. You will solder both ends of this trace to pads (one small, one large) on the circuit board.

(2) With the component side of the main circuit board up, and the right side of the board facing you, position the GALI-6 so that it is centered in its silk-screened outline. Make sure the pins on the chip are centered on their respective circuit board pads.
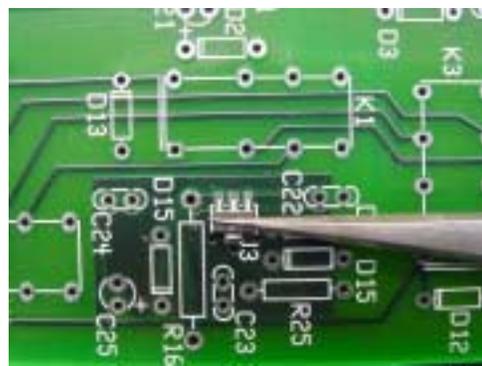
(3) With a finger, a needle, or a pair of tweezers, hold the GALI-6 in position while you tack solder the small center pin on its matching pad. (*Hint: if you have trouble holding the GALI-6 in position, try taping it to the board with a piece of cellophane tape.)* If the GALI-6 slips, then reheat the connection and start over. Important: use no more heat than necessary! Now inspect your work with a magnifying glass.

(4) Once you have the GALI-6 tack-soldered correctly on its pad, then solder the other two small pins. Touch your soldering iron tip on the exposed edge of each pad and allow a tiny bit of solder to flow under the chip. Use the smallest amount of solder you can.

(5) Now go back and resolder the small center pin, and also the large center pin.

(6) Clean off the solder flux with isopropyl alcohol and inspect your work with a magnifying glass.

B. Installation of Other Components:

Note: In general, it is good practice to install components in order of increasing height above the circuit board, which makes it easier to keep the component bodies positioned against the board. For this project, we'll make exceptions in the case of the integrated circuits and a few components that require special handling.
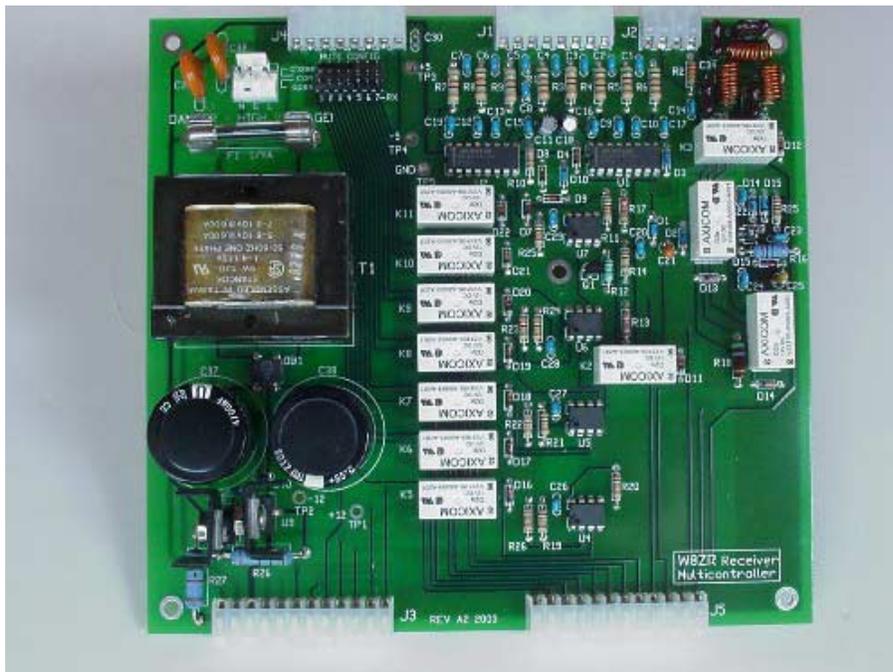
Main Circuit Board

(1) Install all the 1/4 watt and 1/2 watt resistors, as shown in the list below. Orient all color codes in the same direction.

R1, R3-R9	qty 8	51 Ω, ½ W	greeen-brown-black
R18	qty 1	56 Ω, ½ W	green-blue-black
R10	qty 1	100 Ω, 1/4W	brown-black-brown
R11, R15	qty 2	1 KΩ, 1/4W	brown-black-red
R2	qty 1	12 KΩ, 1/4W	brown-red-orange
R12	qty 1	15 KΩ, 1/4W	brown-green-orange
R13, R17	qty 2	2200 Ω, 1/4W	red-red-red
R19- R26	qty 8	10 KΩ, 1/4W	brown-black-orange
R14	qty 1	100KΩ, 1/4W	brown-black-yellow

(2) Install all the diodes, and the silver mica and ceramic disk capacitors. Make sure the diodes bands match their silkscreen outlines. Take care not to confuse the values of the small disk capacitors. A "102" marking indicates a 1000 pF value, a "103" marking indicates a .01 µF value, and a "104" marking indicates a 0.1 µF value. Note that C31 and C32 are .01 µF 250V AC line-rated capacitors that are larger than the other capacitors

(3) Install the 2N4401 transistor Q1, taking care to match the flat side with the silkscreened outline.

(4) Install the eleven relays. Begin by soldering two opposing pins on each relay so you can make sure the relay bodies are snug against the board. Then solder the remaining pins.

(5) Install the five Molex 0.156" side-entry connectors at J1-J5, and the 3-pin Molex 0.156" connector at J6. *(Hint: tack solder the first and last pins to hold the connectors in place against the circuit board. Then solder the remaining pins.)*

(6) Locate the 40-pin 0.100" header strip and clip off three lengths, each seven pins long. Solder these three lengths into the "mute config" outline on the circuit board and make sure they are all perpendicular to the board and snug against the board. *(Hint: temporarily insert jumpers across some of the header pins to hold them together as a single unit.)* After the header is soldered, install jumpers as desired. Since most receivers are "open to mute" it is recommended that you jumper receivers RX4-RX7 with this configuration. Jumpers RX1-RX3 should be configured as "close to mute."

(7) Install integrated circuits U4-U7, making sure the notches are aligned with the silk-screened outline. Do not install the other integrated circuits, yet.

(8) Install the diode bridge rectifier DB1 (looks like a small DIP integrated circuit.) Orient DB1 so that the "+" and "-" on the component are aligned with the corresponding markings on the silk-screened outline.

(9) Install the fuse clips at F1. *(Hint: insert a fuse into the clips to hold them in place while you solder them to the board.)*

(10) Install the two 150 Ohm 3W power resistors at R27 and R28. Because these resistors normally run hot, position the resistors about 1/8 inch above the circuit board.

(11) Install all the electrolytic and tantalum capacitors, including the large snap-in capacitors. Be absolutely certain the plus and minus pins on the capacitors are aligned properly with the symbols on the silkscreened legend.

(12) With a length of #22 bare or enameled wire, fabricate two coils of 8 turns each and one coil of 9 turns. Use a 1/4-20 bolt as a former, as shown in the figure. Scrape and tin the ends and solder the 8-turn coils at L1 and L3, and the 9-turn coil at L2. Keep the body of each coil about 1/16 inch above the circuit board, so it does not interact with the ground plane.

(13) Install the power transformer T1, making sure it is snug against the board. Match the pin numbers on the transformer with the numbers on the silkscreen. If your transformer has only a single primary winding (no pin 2 or pin 3) then skip the next step.

(14) If your transformer has a dual winding, it can be used either on 115 VAC or 230 VAC. For 115 VAC operation, connect wire jumpers between the dashed lines (labeled 1-2 and 3-4) on the silkscreen next to the fuse F1. For 230 VAC operation, jumper only pins 2-3.

VII. Initial Checkout and Final Assembly

(1) Install a 1/4A 3AG fuse in F1 (1/8 A for 230VAC) and temporarily plug the rear and front panel assemblies into their mating edge connectors on the main circuit board, as shown in the figure. The first time the connectors are seated, they are likely to be quite stiff. Plug the 3 pin connector from the AC socket into J6 and make sure the AC power switch on the front panel is off (down). The antenna switch should be in the 50 ohm position.

Completed Circuit Board Assembly

(2) Connect a power cord to the AC socket and flip on the front panel AC switch.

(3) Measure the d.c. voltages between tie points TP1 (+12) and TP2 (-12), and ground (TP5). The voltages should be approximately +14 V and -14 V. BE CAREFUL NOT TO TOUCH THE EXPOSED LINE VOLTAGE AT THE FUSE CLIPS!

(4) Flip up the other front panel toggle switches to verify that the LEDs light. Wait a few minutes while you look for smoke or something overheating.

(5) Turn off the unit, unplug the power cord, and wait a few seconds for the electrolytic capacitors to discharge. Then install the voltage regulators U8 (+5V, type 7805)and U9 (-5V, type 7905), bending their leads to conform to the silk-screened outline. Attach heatsinks to each regulator with 6-32 hardware. (Heatsinks are desirable but not essential.)

(6) Reattach the power cord, turn the unit on, and measure the voltage at tie points TP3 (+5) and TP4 (-5). The voltage should measure +5.0 V and -5.0 V. respectively, within about 0.1V. AGAIN, BE CAREFUL NOT TO TOUCH THE FUSE CLIPS! It is normal for U8 and U9 to run hot.
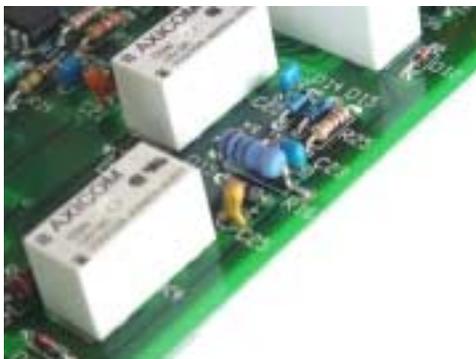
(7) Turn off unit, unplug the power cord, and after a minute install the 110 Ohm 1W resistor at R16. *Note: Because the clearance between the end of this resistor and the ridge in the center of the metal cabinet is tight, bend the lead nearest the edge of the circuit board flat against the board, as shown in the figure.* Power up the unit again and flip the preamp switch on (as indicated by the yellow LED). Make sure the

antenna switch is still in the 50 Ohm position. Then measure the voltage drop across R16. It should be in the range 6.5V-7.5V if the GALI-6 amplifier is operating normally. Unplug the unit and let the electrolytic capacitors discharge.

(8) Install the two MAX497CPE amplifiers at U1 and U2. Make sure the notches on U1 and U2 are oriented properly because these ICs are expensive!

(9) Carefully inspect the circuit board to verify that all components have been installed, and that there are no cold solder joints or solder bridges, especially between the integrated circuit pads or the pins on the "mute config" headers. Clean off the solder flux with isopropyl alcohol.

VIII. Final Checkout of Completed Unit

(1) Make sure the front and rear panel assemblies are securely mounted into their mating connectors on the main circuit board. Don't install the AM/LF filter, and for the moment leave the unit out of its enclosure.

(2) Connect a receiving antenna to the 50 ohm antenna jack on the rear panel, and connect a coax cable from your receiver's antenna connector to the rear panel AUX OUT jack. Turn the preamp switch off, and set the antenna switch to 50 Ohms.

(3) Power up the unit and verify that you hear normal signals on your receiver. Move the coax cable from the receiver to each of the output ports RX1-RX7 to verify that all are operating normally.

(4) While listening to a signal on any port, switch on the preamp. The signal should become notably stronger.

(5) Turn on the "Mute Enable" switch and all seven "Receiver Enable" switches. Ground the "Control" jack on the rear panel and verify that the seven green LEDs go out. With the "Mute Enable" switch off, grounding the control jack will have no effect.

(6) Measure the resistance from the seven mute jacks to ground. With the "Control" jack jumpered to ground, they should either be open-circuited or short-circuited, depending on the jumper selections on the "Mute Config" header.

(7) A signal generator is required to test the overload circuit. If one is available, connect it to the 50 ohm antenna BNC connector and pick a frequency in the 1-50 MHz range. Slowly advance the generator output. When it reaches approximately 900 mV rms, the red overload LED should light. At a slightly higher output, the green LEDs should turn off. With the preamplifier on, the overload threshold will be reduced by the amount of the preamplifier gain, approximately 12 dB. However, because the input to the preamplifier is limited by protective diodes, you may not be able to trip the overload circuit with the preamplifier on, no matter how strong the input signal.

LF/AM Filter Mounted on Rear Panel

(8) If you decide to use the LF/AM filter, then clip out capacitor C200 on the rear circuit board and plug the filter into its mating connector (J200). Mount the filter board on small spacers, securing it to the mounting holes with 4-40 hardware. With this board installed, you won't be able to listen to the AM broadcast band or VLF stations. Thus, don't use the filter unless it is needed to prevent overload from nearby AM broadcast stations.

IX. Mounting the Completed Unit in the Enclosure
(estimated assembly time: 30 min)

(1) The enclosure consists of identical top and bottom extrusions, and identical side extrusions. These slide together to make an interlocking unit. Slide the four pieces together and then attach the plastic bezel to the assembled unit using 4 supplied long round-head screws in each corner of the bezel.

(2) Attach four adhesive-backed feet to the underside of the enclosure.

(3) Secure the front panel assembly to the front plastic bezel with 2 supplied long round-head screws.

(4) Slide the main circuit board (component side up!) from the rear of the enclosure into the first slot below the mid-point of the enclosure. Carefully push on the circuit board until it seats into the mating connectors on the front panel assembly.

(5) Attach the Molex connector from the AC socket to J6 on the main circuit board.

(6) Taking care not to pinch the wires coming from the AC socket, slide the rear panel assembly onto its mating connectors on the main circuit board. Secure the rear panel to the enclosure with 6 supplied flat-head screws. This completes the assembly of the multicontroller. Now take a moment to admire your handiwork. Nice job!

Total Estimated Assembly Time (entire project, excluding metalwork):

gathering and organizing parts	: 1 hr	
front panel assembly	: 1 hr	15 min
rear panel assembly	: 2 hr	0 min
AM/VLF filter assembly	: 0 hr	30 min
main circuit board & checkout	: 4 hr	30 min
enclosure assembly	: 0 hr	30 min
TOTAL	9 hrs	45 min