TALRIK-IV™ ASSEMBLY MANUAL

by

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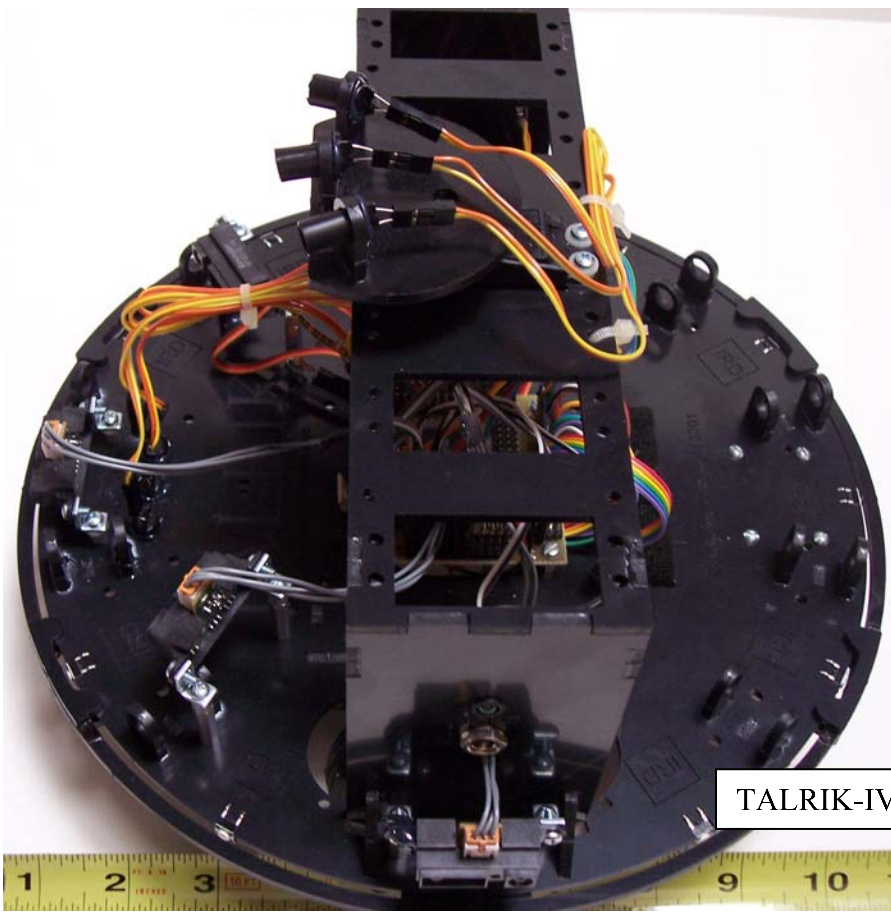
Version 01



TALRIK-IV™

AGREEMENT

NETWORK SITE: ***http://mekatronix.com/***

MANIFESTO

MEKATRONIX™ espouses the view that the personal autonomous agent will usher in a whole new industry, much like the personal computer industry before it, if modeled on the same beginning principles:

- Low cost,
- Wide availability,
- Open architecture,
- An open, enthusiastic, dynamic community of users sharing information.

Our corporate goal is to help create this new, exciting industry!

Disclaimer

While MEKATRONIX™ has placed considerable effort into making these instructions accurate, MEKATRONIX™ does not warrant the results and the user assumes the risks to equipment and person that are involved.

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1 INTRODUCTION

Welcome to the world of Mekatronix robots. This manual provides sufficient instruction for the assembly any of the variety of Talrik-IV robot kits listed in Table 1.

Table 1. TALRIK-IV Kit Forms

Part #	Brief Description
TALIVBody-ABS	Precut Talrik IV Robot body cut from black, ABS plastic (body only, no hardware). Assembly Required.
TALIV-NM	Precut ABS Plastic Body, 2 wheels, 5 IR range sensors with mounting hardware, 10 bump switches, 6 CdS photoresistors and mounting hardware, and one pan servos with pan head (no Microcontroller, no cables). Assembly Required.
TALIV-U	Talrik IV Robot Complete Kit: Cables and precut ABS body must be assembled. Soldering and gluing required. MEKAVR128™ Microcontroller preassembled and tested. Most MEKAVR128™ headers must be soldered onto the board.
TALIV-QA	Talrik IV Robot Quick Assembly Kit: Pre-made cables. MEKAVR128™ Microcontroller preassembled and tested. All headers are pre-soldered on board. Requires assembling body and connecting cables. No soldering required.
TALIV-TA	Totally Assembled & Tested Talrik II Robot ready to program and run.

To construct a TALRIK-IV robot from an expert kit you will

1. Assemble the robot body, the IR range sensors and mounts, the green and red LED mounts with the LEDs in them, and the pan head,
2. Construct the 6 Photoresistor sensors and mount three on the robot body and three on the pan head,
3. Construct the bumper switch cables and test them for electrical continuity, test the bumper switches for proper operation,
4. Construct remaining cables and test them for electrical continuity, test the toggle and push-button switches for proper operation,
5. Connect all but the bumper switch and battery power cables to the MEKAVR128™ microcontroller board,

6. Mount the MEKAVR128™ microcontroller board with all but the bumper switch and battery power cables attached to the board,
7. Mount the unattached ends of the cables to the appropriate sensors, motors, servos, LEDs, etc., connect the bumper switch socket to the MEKAVR128™ microcontroller board, and connect the battery cable last,
8. Run a diagnostic check of the robot.

2 TOOLS

Figure 1, Figure 2 and Figure 3 illustrate tools you may find useful for building your robot kits. These tools do not come with the kits. You will also require a heat source, such as a hair dryer or matches or lighter to appropriately apply heat to shrink-wrap tubing.

Figure 1. You will find these tools useful for assembling your Mekatronix robots. The jeweler's screwdriver set provides precision flat blade and Phillips head screwdrivers required for mechanical assembly of the robot. The tweezers allow you to easily manipulate small parts (washers, nuts, screws) while the needle nose pliers permit you to exert greater gripping forces while manipulating parts. The nut driver easily tightens 4/40 screws…but be careful not to over tighten nuts if you use this tool. The diagonal cutters and wire strippers cut wire. The wire stripper also allows you to strip wire for tinning and soldering. The mulitmeter is optional, but if you build electronic circuits you may want one on hand.

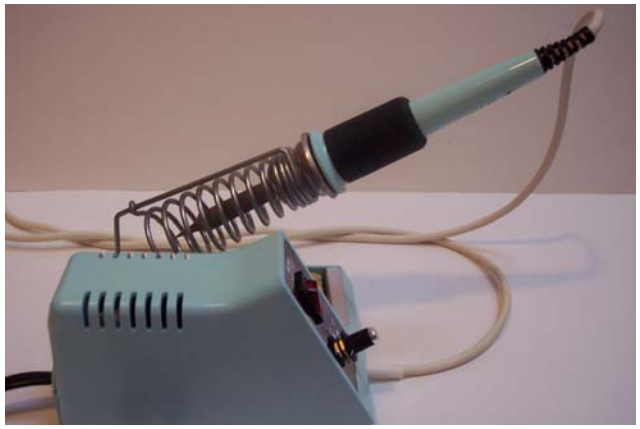


Figure 2. Use a soldering iron for cable assembly and other soldering tasks. If you do extensive solder, you may want to invest in the expensive version shown. Otherwise, you can invest in a low cost version designed for light electronic work.

Figure 3. Hot-glue gun enables you to encapsulate cable connector solder joints to increase mechanical strength of the connection. The black cylinder of low-melting-temperature plastic glue matches the black ABS body of the robot and may be used to secure light sensors and other elements to the robot body.

3 SUPPLIES

Your robot assembly may require some gluing and soldering. You will need superglue, solder, low-melting point thermoplastic (Figure 4), and a small sheet of black construction paper. Purchase these items separately.

Figure 4. Depending upon your robot kit type, you may require superglue for joining robot body parts, rosin-core solder to mechanically and electrically connect cable wires to end-connectors and solder electronic components to a printed circuit board, and black-plastic glue rods for the glue gun to encapsulate soldered, cable connections for added mechanical strength or to secure sensors and other body parts.

4 WHAT IS IN YOUR TALRIK-IV ™ EXPERT KIT?

The contents of your *TALRIK-IV*™ expert kit are described in Table 2 and Table 3. Expanded views of the TALRIK-IV parts sheet, a 36-pin socket, and a 36-pin headers appear in Figure 5, Figure 6, and Figure 7, respectively.

***Caution**: Some of TALRIK-IV™'s electronic components are static sensitive, particularly, the MEKAVR128™ microcontroller board components and the IR range sensor. Do not touch these parts without being properly grounded. Static discharge can destroy them.*

Table 2. *TALRIK-IV* Expert Kit

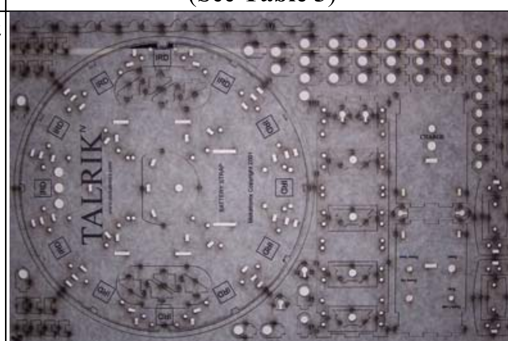
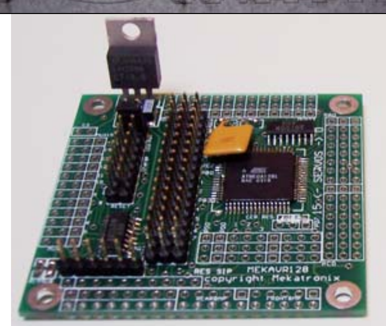
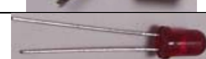
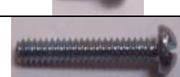
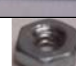
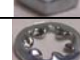
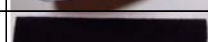
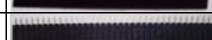
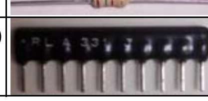
Part	Picture	Quantity
TALRIK-IV Kit Bag	(See **Table 3**)	1
TALRIK-IV ABS Plastic Body & Bumper		1
Robot Controller Board Kit (Mekavr128)		1
Rear Caster		1
Servos with Horns and Hardware	 	3
3inch Rubber Wheels		2

Table 3. *TALRIK-IV* Kit Bag

Component	Picture	Quantity
IR Range Sensors		5
IR Range Sensor Cables 		5
Photoresistors (Cadmium Sulfide, CdS Cells)		6
LED Mounts		2
Bumper Switches		10
Red LED		1
Green LED		1
Toggle Switches		2
Reset Button		1
Charge Jack		1
¼ inch 4-40 Machine Screw		18
½ inch 4-40 Machine Screw		30
# 4 Nuts		20
# 4 Lock Washers		20
¼ inch Hex Standoff		8

(Continue Table 3 *TALRIK-IV* Kit Bag)

Component	Picture	Quantity
¾ inch Hex Standoff		10
Angle bracket		10
Washer (1” O.D. ¼ “ I.D.)		2
9V Battery Cable 		1
Shrink Wrap 3M MW 1/4"		150mm (6")
60 Wire Ribbon Cable		600mm (2')
Battery Holder (6 Pack)		1
AA-Nickel-Cadmium Rechargeable Battery		Not Included (6 Required)
Velcro Strapping		250mm (10")
Single Row Socket, 1x36		4 (36 pins each)
Single Row Male Header, 1x36		6 (Expert Kit Only) (36 pins each)
40-pin Double Row Socket, 2x20[1]		1
Resistors ¼ watt		30K Ohm (6) 470 Ohm (6)
10-Pin Single-in-Line (SIP) Resistor Network: 330 Ohms		1 (Expert Kit Only)

[1] This double row socket fits over the FM1, FM2, FM3, FM4, FM5, FM6, FM7, FM8, REARBMP, FRONTBMP male headers at the bottom of the MEKAVR128 microcontroller board. The standard TALRIK-IV kit only requires cabling REARBMP and FRONTBMP, but it is advisable to cable everything and just leave unused wires tied off underneath the robot.

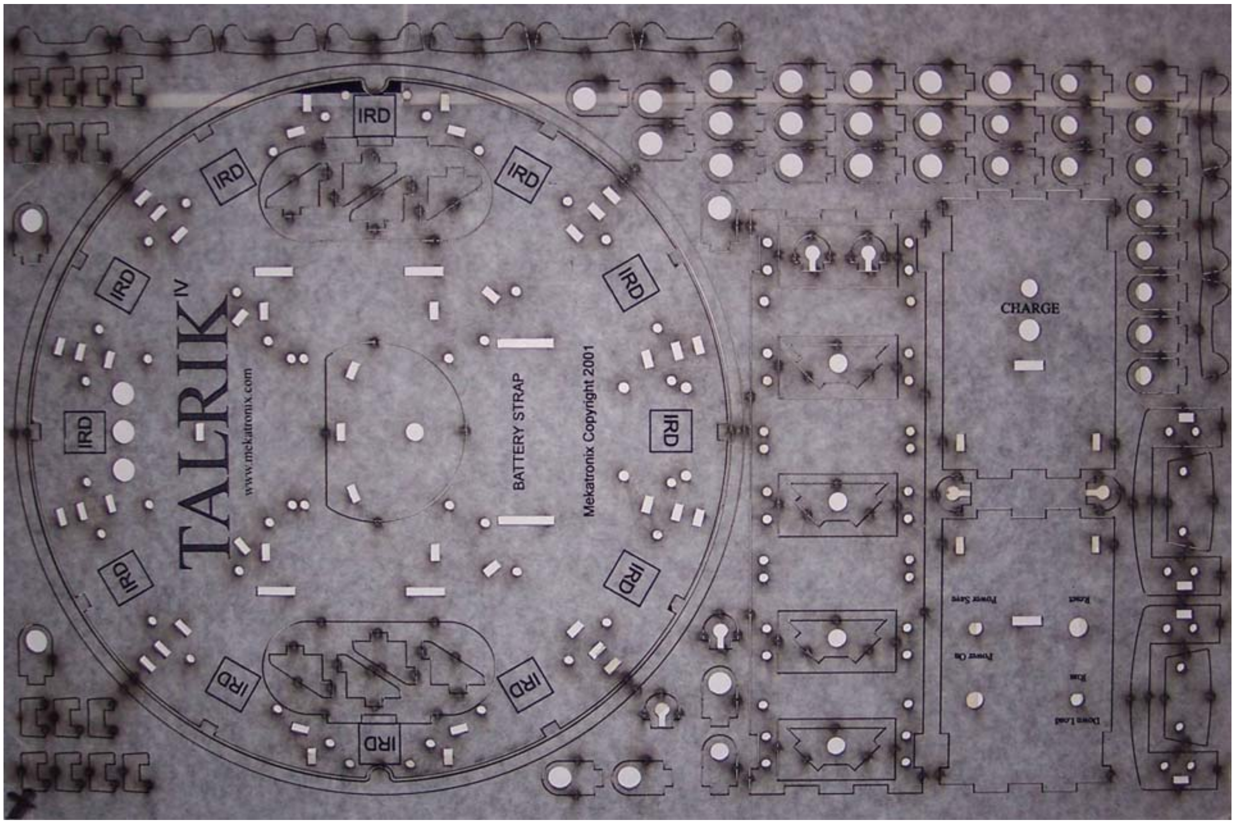


Figure 5. The TALRIK-IV laser cut parts sheet is covered on both sides with a protective cover to be removed before assembly.

Figure 6. This enlarged view of a 36-pin female socket shows the segmentation that allows you to cut various length sockets for cable construction. In constructing cables you will tin the socket pins and then solder tinned cable wires to the pins.

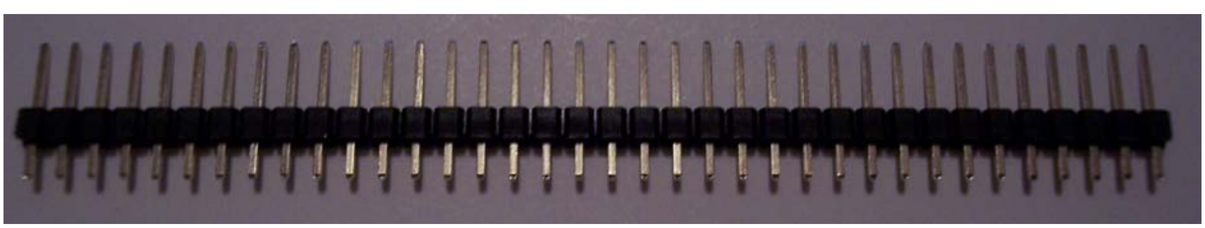


Figure 7. This enlarged view of a 36-pin male header shows the segmentation that allows you to cut various length headers for soldering into the MEKAVR128™ board. The short ends solder into the board, the long ends insert into the sockets.

5 CONVERTING SERVOS TO DC GEARHEAD MOTORS

Programs executing on the MEKAVR128™ control TALRIK-IV™'s motors using pulse-width-modulation (PWM). For the software PWM program to work, however, one must first hack the two servos used to drive the left and right wheels. Typically, the pulse width varies from 1ms to 2ms with 1.5ms being the zero setting of the servo position. The converted servos output 42 oz.-in. of torque at 100% speed. A pulse width command of approximately 1.5ms will stop the motor. Duty cycles less than 1.5ms but greater than 1ms drive the motor in one direction and a duty cycle greater than 1.5ms, but less than 2ms drives the motor in the opposite direction. The PWM period can vary from 18ms to 20ms. Although the motor function specifies a speed from 0 to 100%, the non-linear response of the motor drive electronics does not produce a prorated speed. Thus, a setting of 26% is not 26% of full speed and so on. Differential control of the motors provides complete maneuverability. The TALRIK-IV™ can literally turn 180 degrees in place.

5.1 Hacking the Servos into DC Gearhead Motors with Controllers

A standard servo can be hacked in the following manner to create a DC gearhead motor with electronic control. Refer to Figure 8.

1. Mount a servo horn on the output shaft and approximately rotate the servo to the center of its range.
2. Remove the 4 back plate screws. Carefully remove the gear box cover on top.
3. Remove the output gear and with sharp, miniature diagonal cutters, cut off the plastic tab stop.
4. a) Take the potentiometer lock-tab out of the output gear (Figure 9) so it will not turn the potentiometer shaft, or
   b) If the output gear does not have a removable potentiometer lock-tab, but, rather has a molded slot in the output gear, then you will have to ream out the slot so that the gear will not engage the potentiometer. Use a drill bit just slightly larger than the longest dimension of the slot.
5. Remount the output gear without the shaft-lock tab and reassemble the servo. Avoid rotating the potentiometer shaft from its center position during the reassembly.

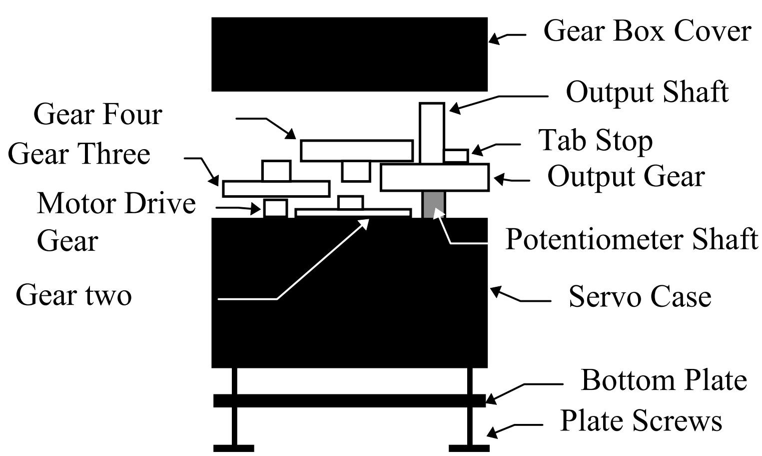


Figure 8 Servo hack: Remove tab-stop, remove potentiometer tab inside *Output Gear*, set potentiometer shaft at center setting.

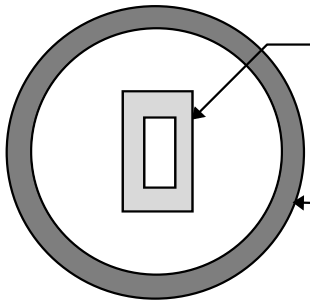


Figure 9 Illustration of the potentiometer shaft lock-tab inside the output gear.

5.1.1 Variations in Servos and the Hack

Some servos may not be constructed as described above, but usually the servo hack can still be performed with more or less difficulty. Some variations you might encounter are mentioned here.

The gear cover on top of some servos has separate screws from the bottom plate. This permits you to remove only the gear cover. Do not remove the bottom plate screws. Otherwise, the hack described above applies.

Some servos have ball bearings under the output gear and their raceways and often disassemble as you take the output gear off. Usually, the ball bearing grease keeps the bearings together or stuck to some other part of the gearbox. Nonetheless, be careful not to lose the tiny ball bearings. The outer raceway fits snugly into the underside of the output gear and must be gently removed. Be careful not to damage the raceway. Reassemble the bearing. Be sure to place all the ball bearings between the raceways. At this point in the procedure, remove the potentiometer shaft-lock tab in the output gear and center the potentiometer shaft as described above. Press the reassembled bearing inside the output gear. Reassemble the gear train and box. Close up the gear box to complete the hack.

Some servos do not have removable lock-tabs; rather, the rectangular potentiometer shaft socket is molded into the output gear. In such cases you will have to ream out the rectangular socket with a drill bit that circumscribes the rectangle. This will allow the output gear to turn without turning the potentiometer shaft.

5.1.2 Motor Runs in the Wrong Direction

If a robot's motor runs in the wrong direction when given a motor command, all you have to do is complement the bit in constant `MOTOR_DIRECTION_C` for the offending motor: bit-0 for the left motor and bit-1 for the right motor. This constant appears in the file <servo.h> in the directory <Include_Meka> :

```
#if(TKIVAVR_H != 0)
   const unsigned char  MOTOR_ENABLE_C    =   0x03;
   const unsigned char  MOTOR_DIRECTION_C =   0x02;
```

6 ASSEMBLY OF THE TALRIK-IV™ ROBOT BODY

This section contains three dimensional drawings that illustrate how to put the Talrik-IV™ robot body together. Refer to Figure 10 for the names of the robot's body parts used in the assembly and to Figure 11 for location of various mounting holes. Figure 12 and Figure 13 illustrate the standard TALRIK-IV™ assembled body with the MEKAVR128™ without cables and bumper switches. Figure 14 shows a version with the optional ARGOS pan-tilt sensor head in place of the panning photoresistor sensor head.

The next section summarizes the assembly process. Refer to the specific sections where the referenced figure is located to obtain more details.

6.1 Robot Body Assembly Summary

1. (Figure 15, Figure 16 and Figure 17) Construct the floating bumper.
2. (Figure 18) Assemble and glue *Servo Mount* under the *Top Plate*.
3. (Figure 19) (Optional) Superglue *IR LED Holders* onto the underneath side of the *Top Plate*. If you do not plan to use any IR or visible LEDs underneath the *Top Plate*, this step can be skipped. If you change your mind later, you can always glue as many as you want into position. The radial mounting of the holders allows you to point the LEDs radially.
4. (Figure 20) Mount modified (hacked) servos (wheel motors) into the *Servo Mounts*. Be sure to place the output shaft of the servo closer to the rear than the front of the robot.
5. (Figure 22 and Figure 23) (Optional) Superglue the *Photoresistor Holders* on the top side of the *Top Plate*. If you do not plan to use any photoresistor sensors around the periphery, this step can be skipped. If you change your mind later, you can always glue as many as you want into position. The radial mounting of two successive holders allows you to stably position and point the photoresistor sensor radially.
6. (Figure 24) Construct the TALRIK-IV™ *Bridge*.
7. (Figure 25) Glue the TALRIK-IV™ *Bridge* onto the *Top Plate.*
8. (Figure 26) (Figure 27) Mount the 5 IR Range sensors.
9. (Figure 28, Figure 29, and Figure 30) Insert the cadmium sulfide light cell into a light collimator made from black shrink-wrap tubing to create a TALRIK-IV™ photoresistor.
10. (Figure 31) Assemble the *Sensor Head* with the pan servo.
11. (Figure 32 and Figure 33) Insert the photoresistors into the *Sensor Head.*
12. (Figure 34) Mount the *Sensor Head* onto the *Bridge*.
13. (Figure 35) (Optional) If you have an ARGOS™ Pan-Tilt Sensor Head mount it in the same place you would normally mount the pan *Sensor Head*.
14. (Figure 36) Inset the line-following photoresistors into the *Top Plate*.
15. (Figure 37 and Figure 38) Construct the wheel mounts and mount them on the wheel motors.
16. (Figure 39) Mount the rear castor and battery pack onto the bottom of the *Top Plate.*
17. (Figure 16) Mount the floating bumper onto the *Top Plate*.

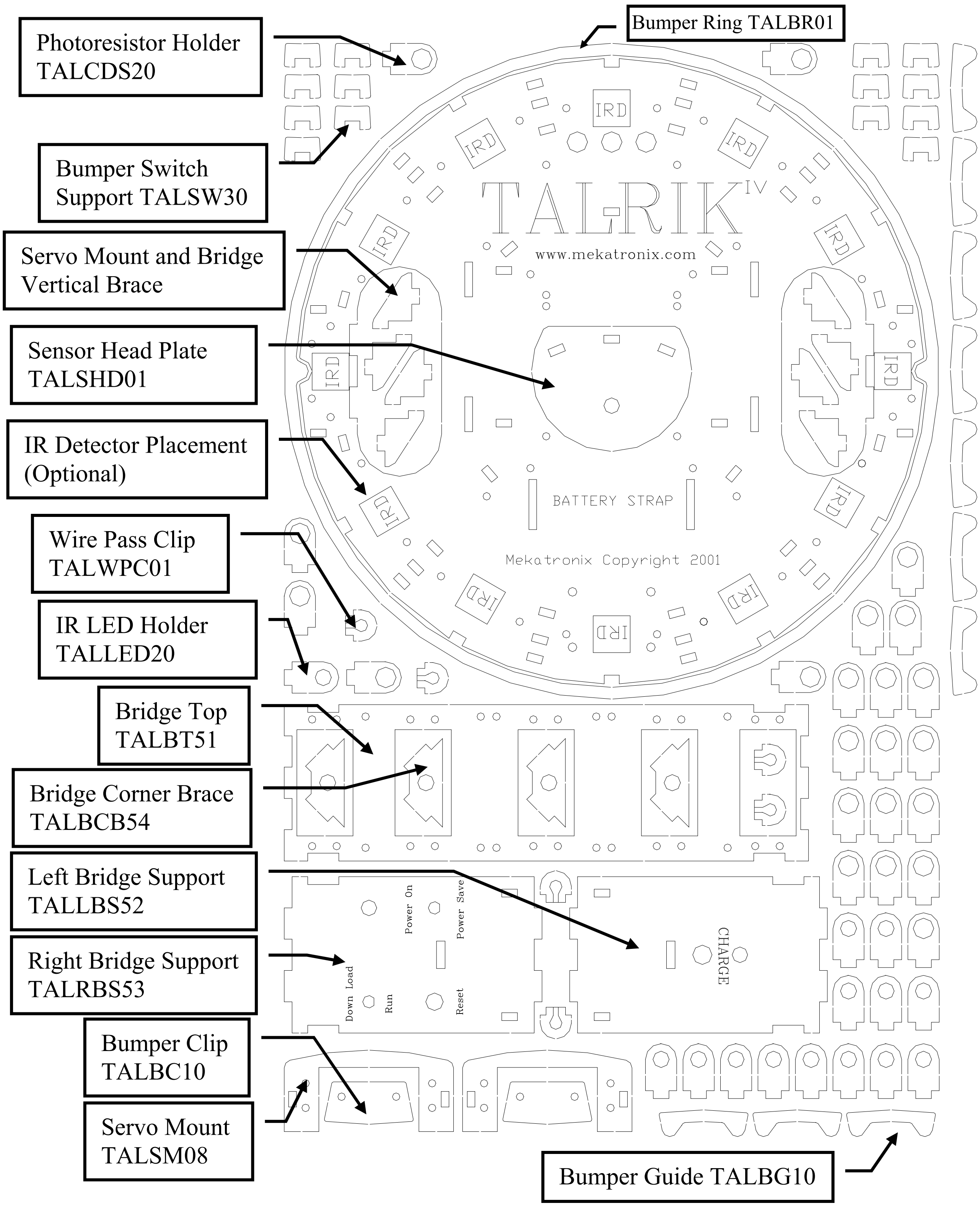


Figure 10. Drawing of TALRIK-IV body parts with part numbers.

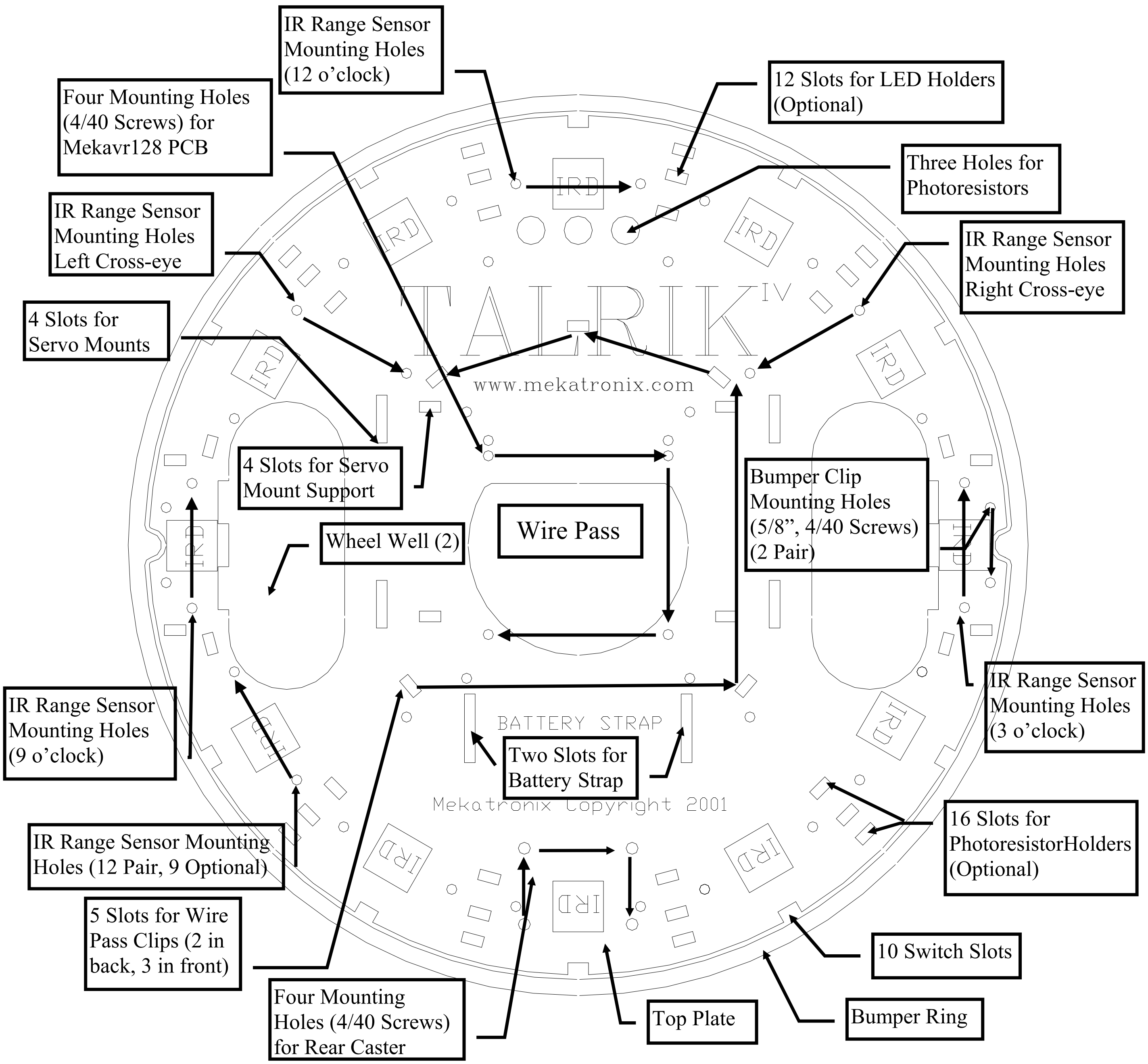


Figure 11 This figure depicts the function of the various holes on the *TALRIK-IV™ Top Plate*. The recessed bumper switch slots, along with the switch supports (TALSWS30), protect the tactile switches while providing a secure mounting. The two inch center cutout allows you to pass wires between the top and bottom layers of the plate. The center cutout itself constitutes the *Sensor Head*. Wire clips (TALWPC01) mount underneath the plate into wire pass clips slots and help tie down switch and IRE wires underneath the plate.

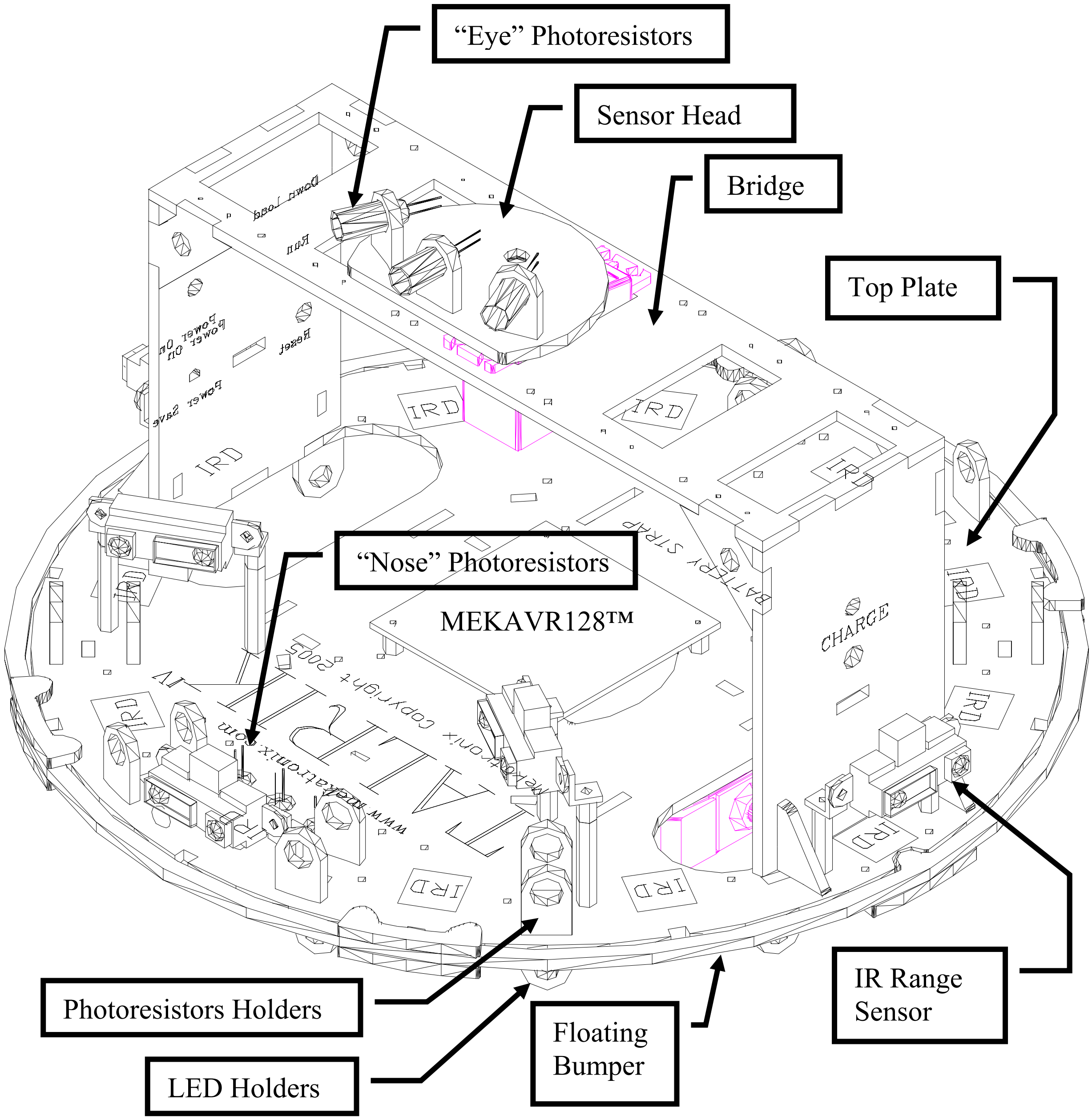


Figure 12. This wire diagram depicts an assembled TALRIK-IV™ body with mounted IR range and photoresistor light sensors. The diagram also depicts the MEKAVR128™ microcontroller board and its mounts, located in the center of the top plate.

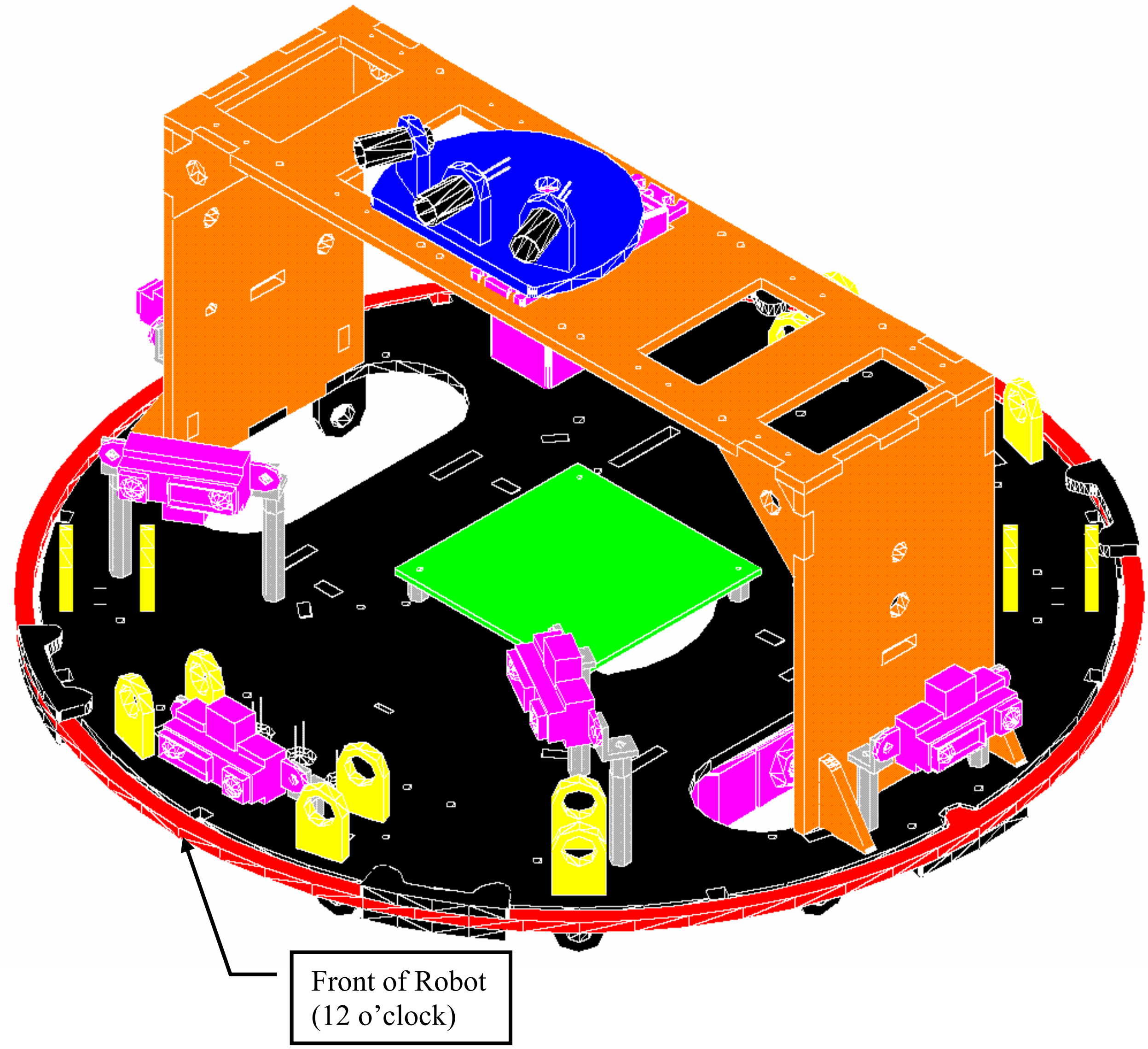


Figure 13. This color drawing makes it easier to identify the different elements of an assembled Talrik-IV™ body. The diagrams depict 1) the servos and the IR range sensors at 9, 10, 12, 2, and 3 o'clock on the top plate in magenta, 2) IR mounting hardware in gray, 3) the MEKAVR128™ microcontroller board in green, 4) the Sensor Head in blue, 5) the Floating Bumper™ in red and black, 6) the Top Plate, LED Holders, and Photoresistors in black, 7) the Photoresistor Holders in yellow, and 8) the Bridge in orange.

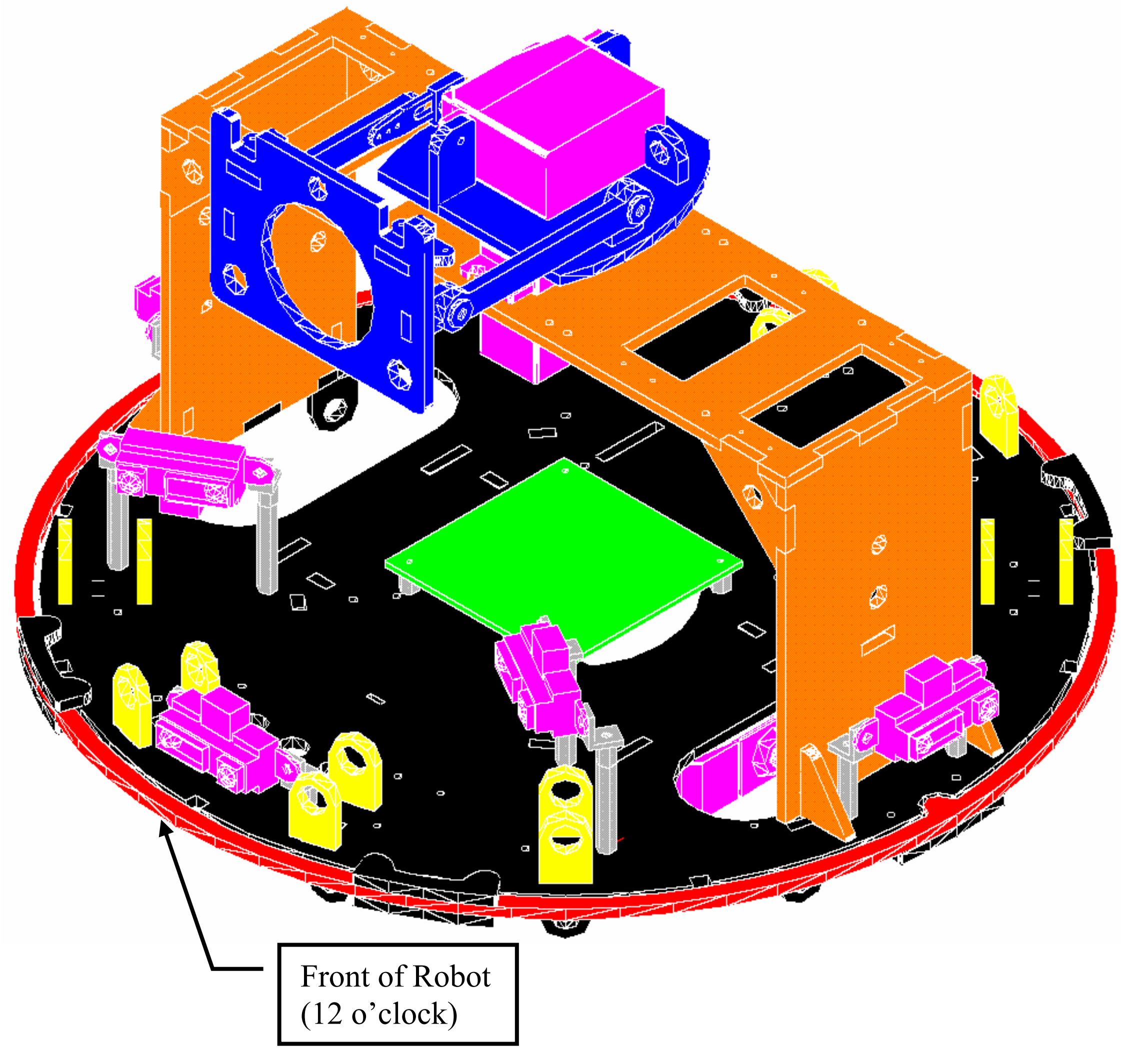


Figure 14. This diagram pictures a TALRIK-IV with an optional Argos™ Pan-tilt Sensor Head (blue) mounted on the bridge in place of the standard photoresistor sensor head. The large circular hole on the Argos™ face plate allows you to mount a Mekatronix Sonar unit.

6.2 Removing Parts from TALRIK-IV Body Sheet

In each assembly process to follow,

1. Identify the parts needed for the current assembly.
2. Break or cut away the pre-cut parts from the TALRIK-IV™ plastic sheet. Several back and forth bends of a tab will cause it to fracture and release the part.
3. Peel the protective cover from both sides of the parts taken from the sheet.
4. You can now assemble the parts.

6.3 Making the TALRIK-IV™ Floating Bumper™

Collect the *Bumper Ring*, 8 *Bumper Guides*, 2 *Bumper Clips*, four ½ inch 4/40 screws, lock washers and nuts.

1. (Figure 15) Cut four black construction paper or 1/64 inch plastic shims the width and curvature of the *Bumper Ring* and the length of a *Bumper Guide*. Shim material is not provided with the kit.
2. Glue the shims onto one side of each of four bone-shaped *Bumper Guides*. The shims should do not extend into the knobby part of the *Bumper Guide*. These will be called the upper *Bumper Guides* and must eventually glue to the top side of the *Bumper Ring*. The clearance provided by the shims permit the *Bumper Guide* to move small distances freely over the *Top Plate*.
3. (Figure 16) Bolt two *Bumper Clips* to the underneath side of the *Top Plate* with two ½ inch 4/40 screws and two lock washers and nuts each. Slip the screws through the top of the *Top Plate* and then through the *Bumper Clip*. Place the lock washer over the screw and fasten the nut securely.
4. (Figure 16) Align the two side projections of the *Bumper Ring* with the notches on the *Top Plate* and rest the *Bumper Ring* onto the *Bumper Clips*.
5. (Figure 16) Line up the centers of the small notches cut along the edge of the *Top Plate* and the lower *Bumper* Guide at 11, 1, 5, and 7 o'clock. Glue the lower *Bumper Guides* onto the *Bumper* Ring at the positions indicated, with the protrusions facing inwardly.
6. (Figure 15) Align the four upper (shimmed) *Bumper Guides* with the four lower guides and glue them on top of the *Bumper Ring*. Warning! Avoid gluing the bumper assembly to the *Top Plate*!
7. (Figure 17) This completes the bumper assembly. The flexibility of the bumper allows you to remove the bumper during the rest of the assembly process, if you desire. Be sure to wait for all the glued pieces to dry before doing so, however.

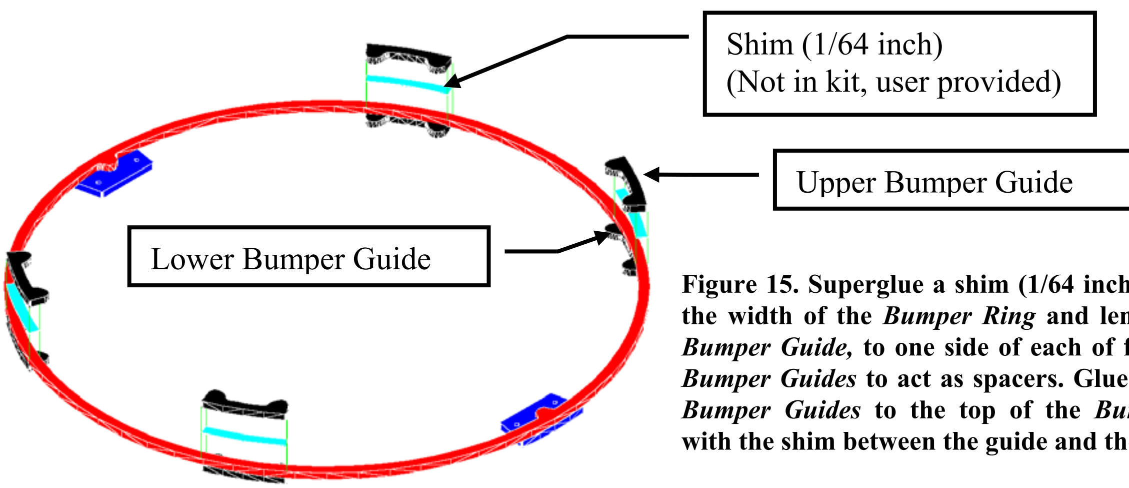
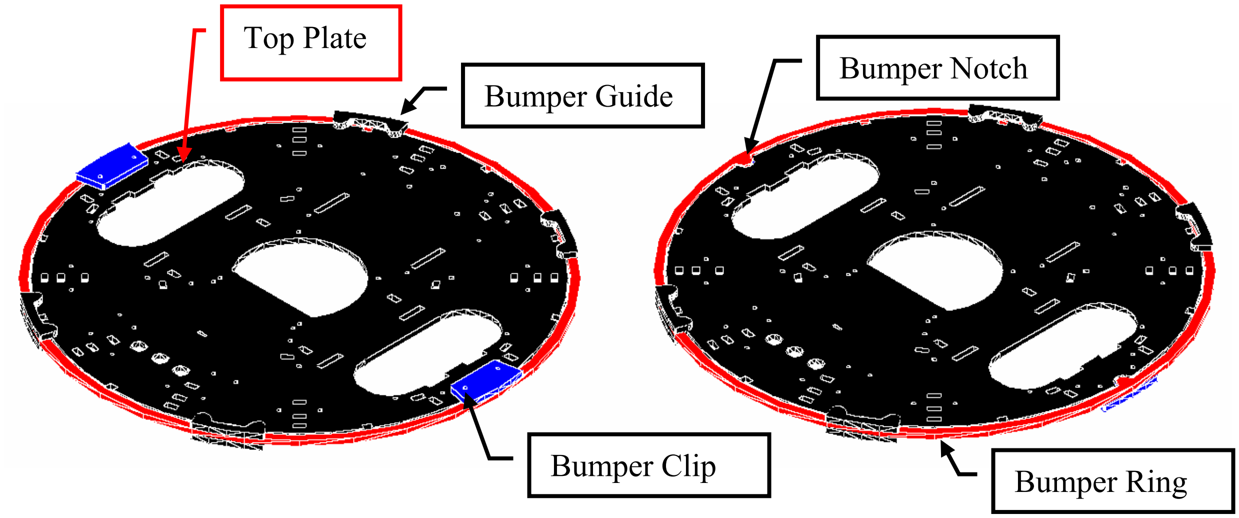


Figure 15. Superglue a shim (1/64 inch), equal to the width of the *Bumper Ring* and length of the *Bumper Guide,* to one side of each of four upper *Bumper Guides* to act as spacers. Glue the upper *Bumper Guides* to the top of the *Bumper Ring* with the shim between the guide and the ring.



a) Bottom View b) Top View

Figure 16. After aligning the notches in the *Top Plate* and the *Bumper Ring*, slip the back *Bumper Guides* over the *Top Plate* and then stretch the *Bumper Ring* slightly forward and slip the front *Bumper Guides* over the *Top Plate*. To prevent sagging, bolt two *Bumper Clips* to the underneath side of the *Top Plate* with two ½ inch 4/40 screws and two lock washers and nuts each.

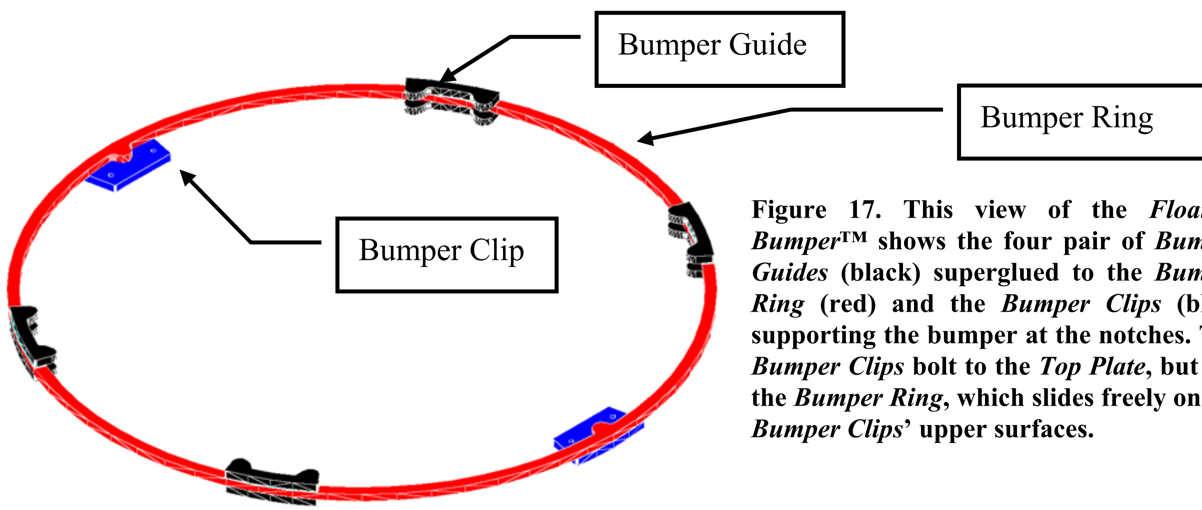


Figure 17. This view of the *Floating Bumper*™ shows the four pair of *Bumper Guides* (black) superglued to the *Bumper Ring* (red) and the *Bumper Clips* (blue) supporting the bumper at the notches. The *Bumper Clips* bolt to the *Top Plate*, but not the *Bumper Ring*, which slides freely on the *Bumper Clips*' upper surfaces.

6.4 Bumper Removal

The removal process involves grasping the bumper at one of the *Bumper Guides* with your thumb and index finger and pulling toward you. The bumper will flex enough to enable you to slip the *Bumper Guide* up and over the *Top Plate*. Repeat this for the adjacent bumper guide. Once released from two adjacent *Bumper Guides*, push back to release the other two. Lift and remove the bumper. During the rest of the assembly process, I suggest you remove the bumper and place it out of the way. As a final assembly process, put the bumper back onto the *Top Plate*, reversing the removal process just described.

6.5 Underneath Assembly of the TALRIK-IV Body

6.5.1 Installation of Standard Servos

For the standard servos provided with the kit, the underneath assembly proceeds as follows.

1. Collect 4 *Vertical Braces,* 2 *Servo Mounts,* two servos, four ½ inch 4/40 screws, lock washers, and nuts plus (optional) 12 *IR LED Holders.*
2. (Figure 18) Turn the *Top Plate* upside down (side with no engraving).
3. (Figure 18) Superglue the two *Vertical Braces* onto the *Servo Mount*.
4. Superglue the *Vertical Braces* to the underneath side of the *Top Plate*. Do this for both the left and right side. Keep the *Servo Mounts* vertical while the glue dries.
5. (Optional) (Figure 19) Superglue LED Holders to the underneath side of the *Top Plate*. You can glue all 12, none, or some of these holders, as your application dictates.
6. (Figure 19) Do not insert the 5 wire pass clips (red) at this time (recommended wires to pass through these clips is illustrated in Figure 39 and Figure 53 and discussed in Section 6.16).
7. (Figure 20) Slide the motor servos into the *Servo Mounts* with the output shafts closer to the rear than the front of the robot and bolt them to the mounts with two ½ inch 4/40 screws, lock washers, and nuts. Place the screws through the two holes of the *Servo Mount* furthest from the *Top Plate* (preferable) or through any two diagonal holes. Be sure to mount the drive shaft of the motors towards the rear of the robot.

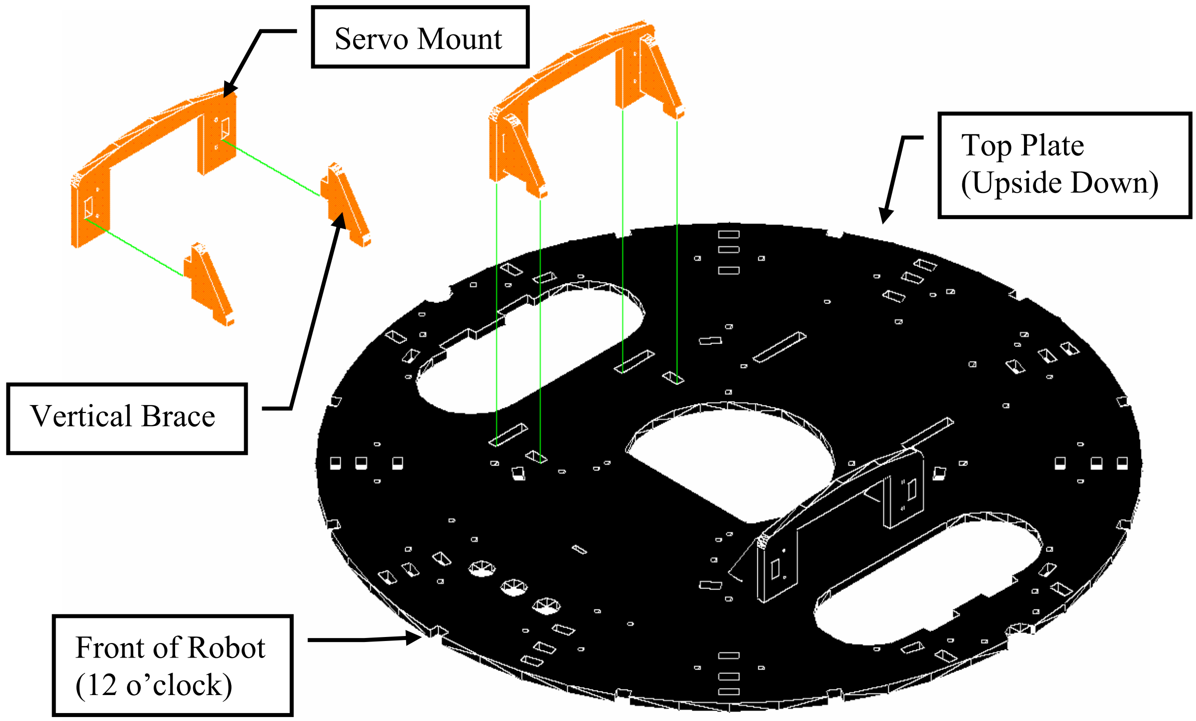


Figure 18. Mount the Servo Holders for the right and left wheel motors onto the underneath side of the Top Plate.

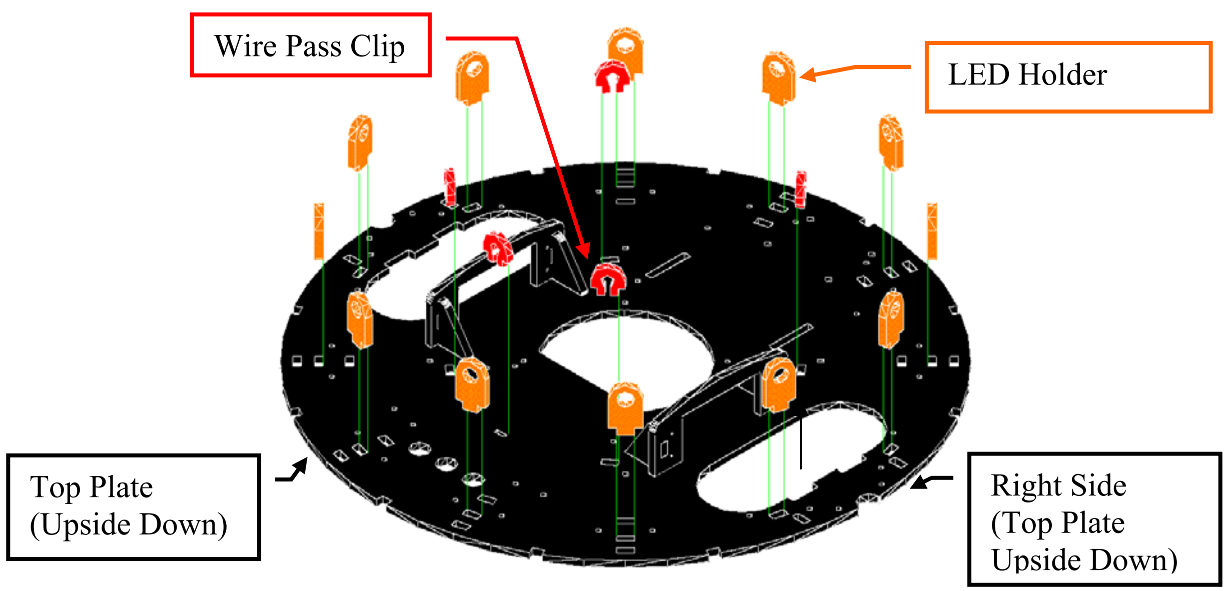


Figure 19. For further underneath assembly of the TALRIK-IV, if desired, superglue the 12 LED holders into place. These holders constitute legacy elements inherited from the TALRIK-II, but they still may serve a useful purpose for illumination applications.

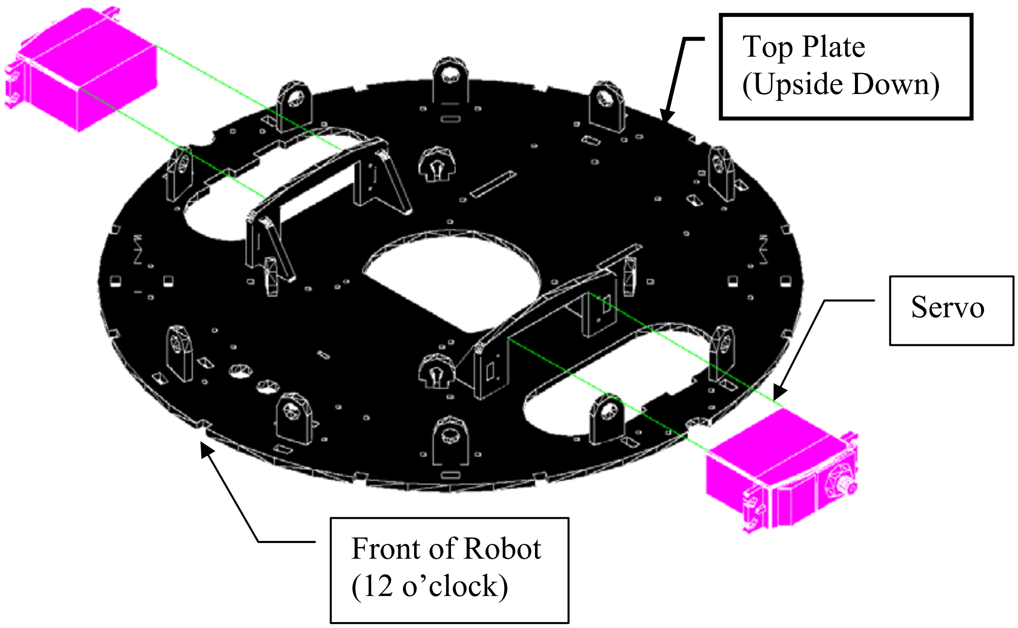


Figure 20. On the underneath side of the plate, slide the wheel motor servos (magenta) into the mounts as shown and bolt them with two screws, either diagonally or through the top two holes, as long as there is one screw on each side of the servo. The motor drive shafts should be closer to the rear than the front of the robot.

6.5.2 Oversized-Servo Installation

If you purchase heavy duty servos to install in place of the standard servo, you will have to file the *Servo Mount* openings larger lengthwise to accommodate insertion of the larger casing of the heavy duty servo. This will permit you to remove the servo after assembly, if ever needed. Before gluing servo mounts and braces, hold them firmly in place and make sure you have filed enough to slip the servos into the *Servo Mount* opening with relative ease. Alternatively, you can mount each servo with two each of ½ inch 4/40 machine screws, lock washer and nuts onto the *Servo Mounts* before gluing the *Servo Mounts* to the *Top Plate* (Figure 21). Two screws, diagonally placed, fix the servos onto the *Servo Mount*. Unfortunately, you will not be able to remove the servos after gluing the mounts and mount braces to the top plate.

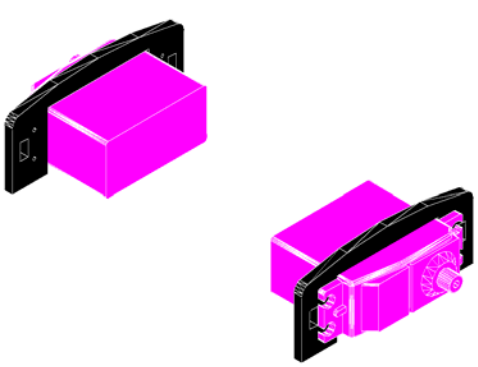


Figure 21. Oversized, high torque servos can be mounted onto the *Servo Mounts* before gluing, but this eliminates the possibility of removal in the future.

6.6 Mount Top Plate Photoresistor Holders (Optional)

1. Collect the 16 *Photoresistor Holders* .
2. Flip the *Top Plate*, engraved side up.
3. (Figure 22) Superglue the 8 pairs of *Photoresistor Holders* into the slots provided on the *Top Plate*. You can glue all, none, or some of these holders, as your application dictates.

6.6.1 Mounting Photoresistors into the Top Plate Photoresistor Holder Pairs

You can optionally mount up to eight radially-directed Photoresistor around the *TopPlate* using *Photoresistor Holder* pairs (Figure 22). The technique for mounting them in a cannon configuration is illustrated in Figure 23. A stiff grade shrink-wrap collimates the light striking the CdS cell. The photoresistor slides through the two *Photoresistor Holders* (TALCDS20), slightly projecting out the outermost holder. This arrangement makes the photoresistor extremely direction sensitive to incident light. To obtain less direction sensitivity, you will need to shorten the barrel suitable to your application. In such cases you may only need the one of Photoresistor Holders. If you want a cell sensitive to overall ambient light, just encase the edge of the cell and its leads.

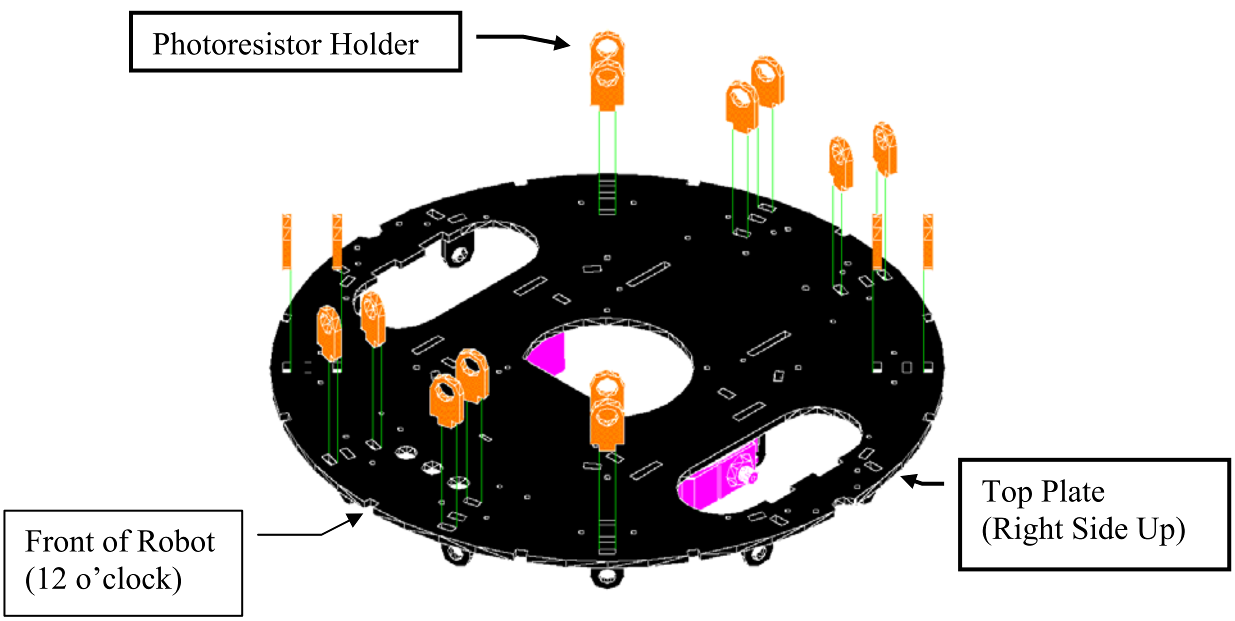


Figure 22. If desired, superglue the *Photoresistor Holders* on top of the Top Plate, in pairs. The standard configuration does not use these holders, which constitute legacy elements inherited from the TALRIK-II, but may still serve as mounts for user sensors or devices.

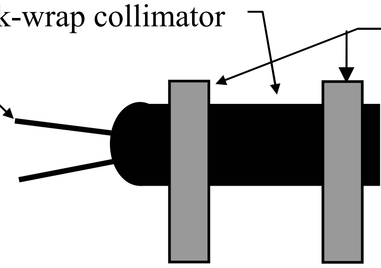


Figure 23 . This diagram illustrates the optional cannon mounting of photoresistors on the *Top Plate.*

6.7 Bridge Assembly

The bridge assembly consists of the 11 parts: *4 Vertical Braces, Left and Right Bridge Supports, 4 Corner Braces, and the Bridge Top*. The function of the holes on the *Bridge Top* (TALBT51), illustrated in Figure 24, indicate three sets of mounting holes for MEKAVR128™ boards as well as slots for up to 5 servos or various combinations of boards and servos. The holes can also be used to mount your own devices. In the standard kit, the *Sensor Head* (TALSHD01) with its pan servo mount into the center servo slot.

Later, you will mount the control switches and the red power-on LED on the *Right Bridge Support* (TALRBS53), which mounts on the *Top Plate* at 3 o'clock. The charge jack and the green charge-indicator LED mount on the *Left Bridge Support* (TALLBS52), which mounts on the *Top Plate* at 9 o'clock.

For a *lefty* configuration of the bridge, reverse the *Left* and *Right Bridge Supports* in the bridge assembly process to configure the POWER, DOWNLOAD/RUN and RESET switches on the left side of the robot and the charge plug on the right side. This reversal of the bridge supports does not cause any cable difficulties and works just fine. So, if you accidentally reversed the bridge supports during assembly, you will not need to bother breaking things apart and reassembling them. This assembly manual's descriptions assume the standard bridge configuration (*righty*).

Assemble the Bridge

1. (Figure 24) Collect the 11 Bridge pieces together.
2. Superglue the Left Bridge Support and two Corner Braces to the Bridge Top.
3. Superglue the Right Bridge Support and two Corner Braces to the Bridge Top.
4. Superglue the vertical braces to the Left and Right Bridge Supports.
5. (Figure 25) Superglue the assembled Bridge to the *Top Plate* by inserting the Vertical Braces into the slots provided and gluing the tabs of the Left and Right Bridge Supports against the *Top Plate*.

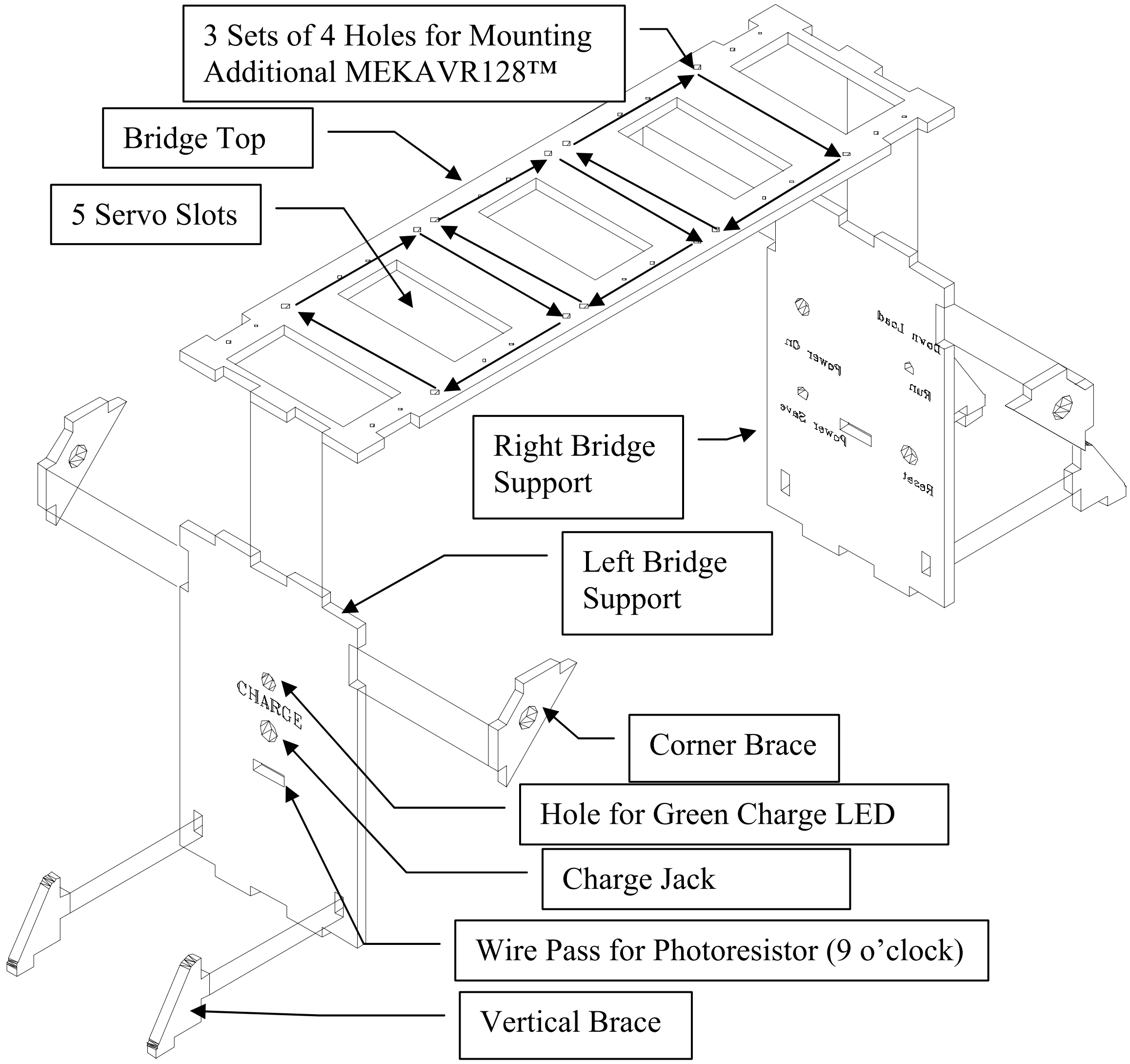


Figure 24. To assemble the bridge, simultaneously superglue the top and 4 corner braces to the side supports. Next, superglue 2 vertical braces each to the outside surfaces of the Left and Right Bridge Support.

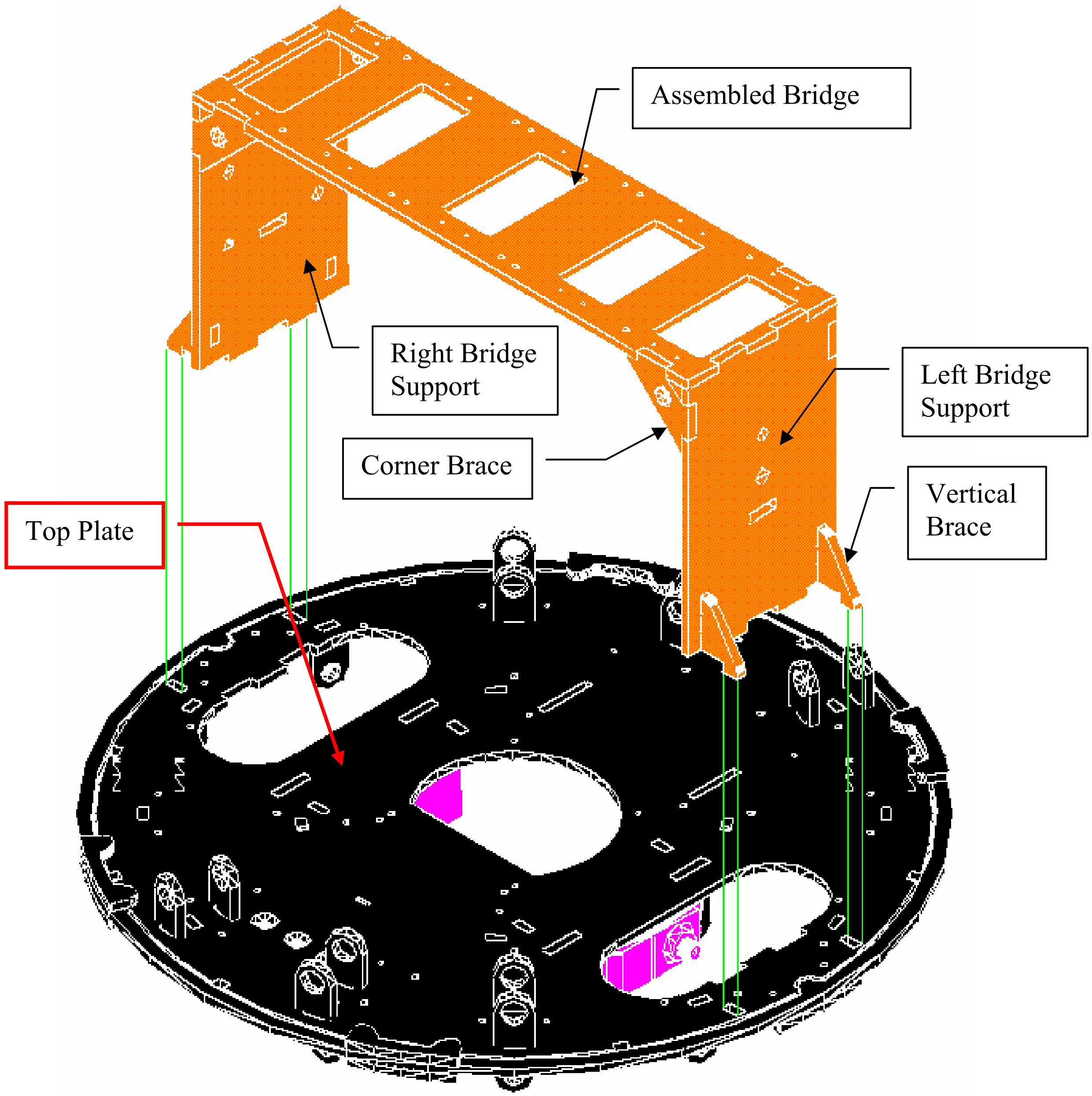
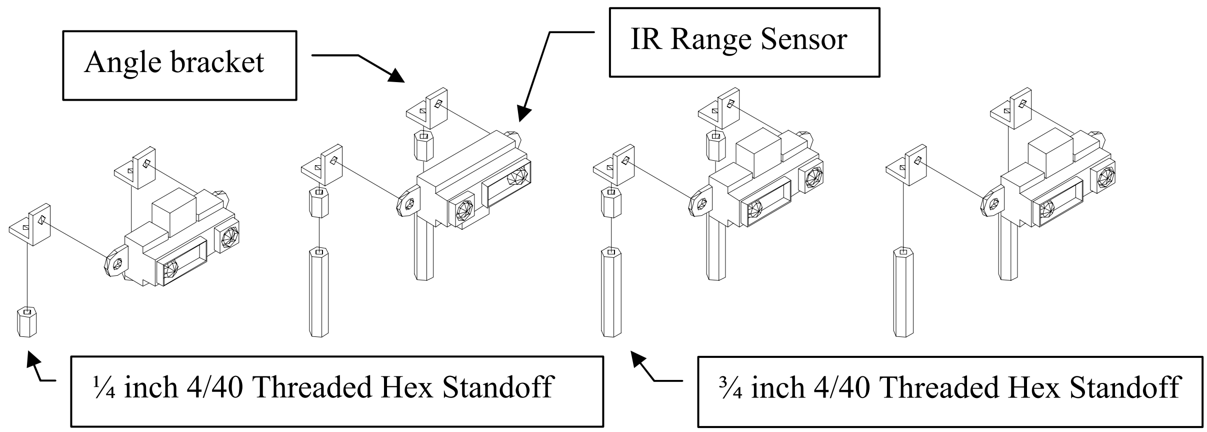


Figure 25. To mount the bridge onto the top of the base plate, superglue the four vertical braces and the Left and Right Bridge Supports to the Top Plate.

6.8 Assemble and Mount the IR Range Detectors

Figure 26 demonstrates how to assemble the five IR range sensors. Note especially that the right cross-eyed IR range sensor (Figure 26b.) mounts with its plug upside down. This configuration makes the right sensor mirror image the ranging of the left IR range sensor to yield uniform results with cross-eyed object detection.



a) Front IR b) Right Cross-Eyed IR c) Left Cross-Eyed IR d) Side Looking IR

Figure 26. The five IR sensors assemble in four ways, a) front, b) right cross-eyed, c) left cross-eyed and d) side looking. The Right Cross-Eyed IR sensor mounts upside down to provide mirror ranging of the Left Cross-Eyed IR sensor.

6.8.1 Front Looking IR Sensor Assembly

1. (Figure 26.a) Collect two angle brackets, two ¼ inch 4/40 threaded hex standoffs, two ¼ inch 4/40 machine screws, and two ½ inch 4/40 machine screws.
2. (Figure 27) From the underneath side of the *Top Plate*, near 12 0'clock, insert ½ inch screws through the holes provided and screw into the bottom of the ¼ inch hex standoffs. The screws will pass completely through the *Top Plate*, the hex standoffs and extend about an 1/8 inch beyond the top of the hex standoff.
3. Screw the short side of the angle brackets to the projections of the ½ inch screws.
4. Use two ¼ inch screws to screw the IR range sensor to the long side of the angle brackets.
5. Adjust and tighten screws as needed to secure the mounting.

6.8.2 Right Cross-Eyed IR Sensor Assembly

1. (Figure 26.b) For the right cross-eyed IR at 2 o'clock, collect two angle brackets, two ¾ inch 4/40 threaded hex standoffs, two ¼ inch 4/40 threaded hex standoffs, four ¼ inch and two ½ inch 4/40 screws (1 inch 4/40 hex standoffs can replace the combined ¾ and

¼ inch standoffs, if available, and then the two ½ inch screws can be replaced by ¼ inch screws).

2. Screw the short side of the angle brackets to the ¼ inch and ¾ inch hex standoffs with two ½ inch screws.
3. ***Turn the IR sensor upside down with its connector underneath*** and screw the IR sensor to the long side of the angle brackets with two ¼ inch screws.
4. (Figure 27) From the underneath side of the *Top Plate*, insert ¼ inch screws through the holes provided at 2 o'clock and screw into the hex standoffs.

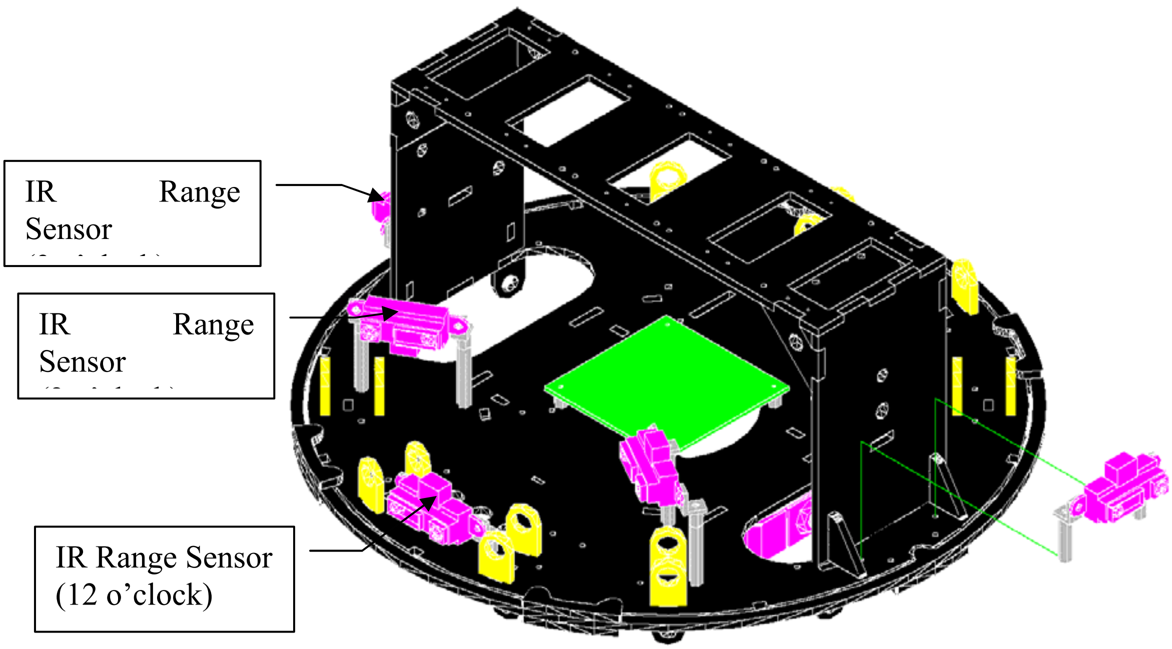


Figure 27. Mount the five IR range sensors onto the Top Plate at 9, 10, 12, 2 and 3 o'clock using ¼ inch 4/40 screws inserted from the bottom and screwed into the bottom of the ¾ inch hex standoff. The right cross-eyed sensor at 2 o'clock should be mounted upside down for mirror operation of the left cross-eyed sensor at 10 o'clock.

6.8.3 Left Cross-Eyed IR Sensor Assembly

1. (Figure 26.c) For the left cross-eyed IR at 10 o'clock, collect two angle brackets, two ¾ inch 4/40 threaded hex standoffs, two ¼ inch 4/40 threaded hex standoffs, four ¼ inch and two ½ inch 4/40 screws (1 inch 4/40 hex standoffs can replace the combined ¾ and ¼ inch standoffs, if available, and then the two ½ inch screws can be replaced by ¼ inch screws).
2. Screw the short side of the angle brackets to the ¼ inch and ¾ inch hex standoffs with two ½ inch screws.
3. Screw the IR sensor to the long side of the angle brackets with two ¼ inch screws.
4. (Figure 27) From the underneath side of the *Top Plate*, insert ¼ inch screws through the holes provided at 10 o'clock and screw into the hex standoffs.

6.8.4 Side Looking IR Sensor Assembly

1. (Figure 26.d) For each side looking IR, collect two angle brackets, two ¾ inch 4/40 threaded hex standoffs and six ¼ inch 4/40 screws.
2. Screw the short side of the angle brackets to the hex standoffs with two ¼ inch screws.
3. Use two ¼ inch to screw the IR sensor to the long side of the angle brackets.
4. (Figure 27) From the underneath side of the *Top Plate*, insert ¼ inch screws through the holes provided next to the Left and Right Bridge Supports and screw into the hex standoffs.

6.9 Collimating the CdS Cells to create a Directional Photoresistor Light Sensor

At this stage you can assemble the photoresistors (Figure 28) that mount on the Sensor Head and the *Top Plate*. Black shrink-wrap tubing will be used to collimate light onto the cadmium sulfide photoresistor cell to give the light sensor high directivity.

1. Cut ¾ inch length of shrink wrap tubing (Figure 29).
2. Insert photoresistor ¼ inch into tubing (Figure 30.a, b).
3. Use a hair-dryer to blow hot air on the shrink-tubing at the rear of the sensor. Be sure the hot air only strikes the back of the shrink wrap tubing and not the whole tube. While the end of the shrink wrap tubing is hot and soft, close up the rear opening of the sensor by pinching the hot tubing together. Use needle nose pliers. Cover working surfaces of the pliers with black electrician's tape to keep the tubing from sticking to the pliers. Be sure the seal eliminates any light leakage into the photoresistor from the back. Other heat sources can be used to shrink the tubing, but be careful with whatever source you use.

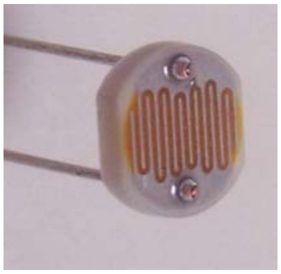


Figure 28. Cadmium Sulfide Photoresistor.

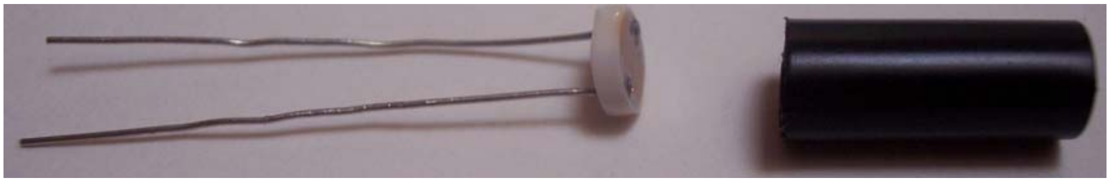
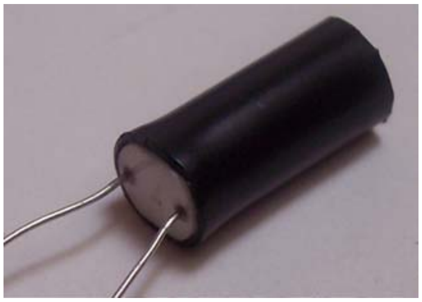


Figure 29. Insert the photoresistor on the right ¼ inch into a ¾ inch length of shrink wrap tubing.




a) b)

Figure 30. These pictures show a) a partially inserted photoresistor and b) a photoresistor recessed in its final position within the tubing.

6.10 Assembly the Photoresistor Sensor Head

The pan head that mounts on the Bridge, consists of the *Sensor Head Plate*, three *Photoresistor Holders*, a servo horn and a servo (Figure 31).

1. (Figure 31) Superglue the *Photoresistor Holders* onto the *Sensor Head Plate*
2. Superglue the servo horn underneath the *Sensor Head* with the servo horn and *Sensor Head* circular openings aligned.
3. When the glue is dry, attach the *Sensor Head* assembly to the output shaft of the servo.
4. Drop a servo horn screw through the circular opening of the *Sensor Head* and tighten.
5. (Figure 32) From the front, insert three photoresistors into the holders on the *Sensor Head Plate* about ¼ inch.
6. (Figure 33) Black hot glue the sensors to the *Photoresistor Holders* to secure them firmly. Be sure to keep the sensors level as the hot glue sets.

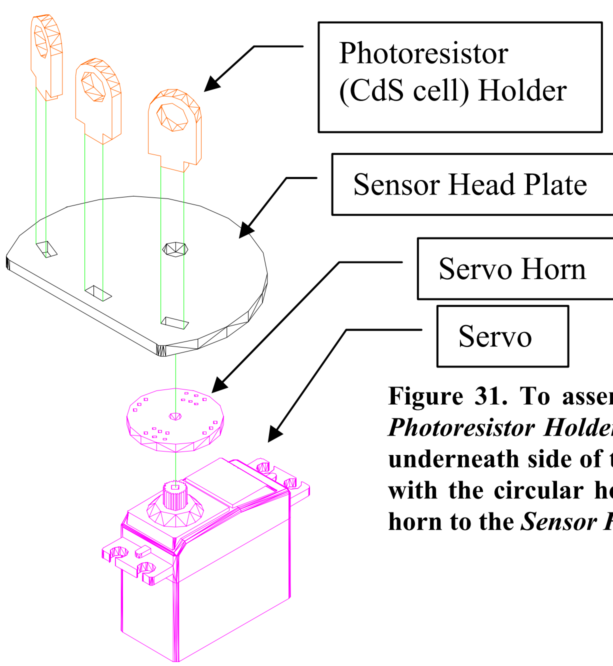


Figure 31. To assemble the pan Sensor Head, superglue the three *Photoresistor Holders* onto the top of the *Sensor Head Plate*. On the underneath side of the *Sensor Head Plate*, center the servo horn hole with the circular hole on the *Sensor Head Plate* and glue the servo horn to the *Sensor Head Plate* with superglue.

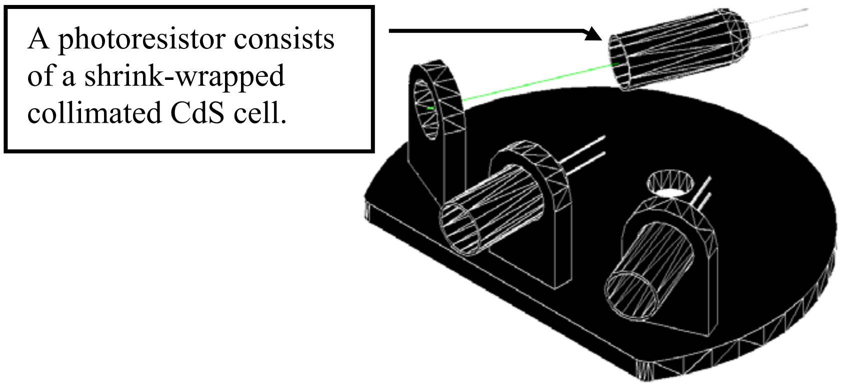


Figure 32. Insert three photoresistors into the holders on the *Sensor Head Plate* and secure with hot glue.

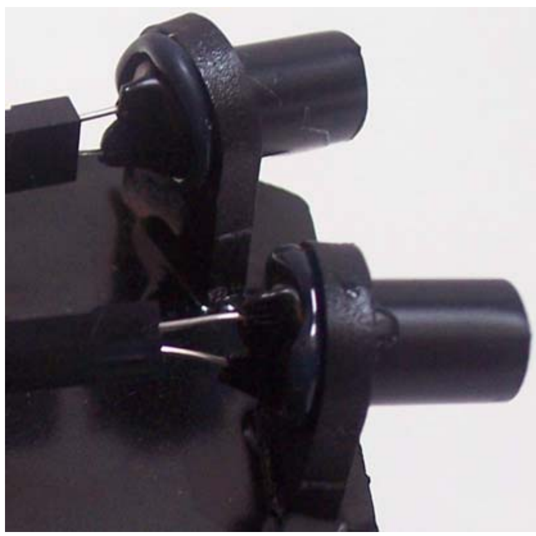


Figure 33. This picture shows the insertion of the photoresistors into the *Photoresistor Holders* of the *Sensor Head*. The shrink-wrap tubing encapsulates the wires and the back of the sensor to block out light. Black hot glue secures the sensors firmly into the holders.

6.11 Mounting the Photoresistor Sensor Head onto the TALRIK-IV™ Bridge

1. (Figure 34) The *Pan Sensor Head* assembly inserts into the center opening on the *Bridge*.
2. Use four ½ inch 4/40 screws, lock washers and nuts to secure the servo to the *Bridge*.

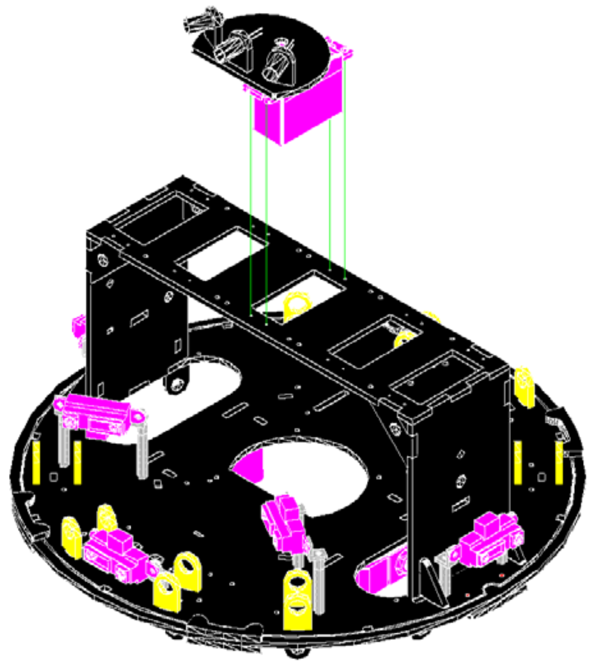


Figure 34. Slip the *Sensor Head* servo through the center servo opening on the *Bridge* and fasten with four ½ inch screws and nuts.

6.12 Mounting the ARGOS™ Sensor Head onto the TALRIK-IV™ Bridge

The optional ARGOS™ Pan-Tilt Sensor Head bolts to the TALRIK-IV™ Bridge in the same manner as the *Pan Photoresistor Sensor Head* does (Figure 35).

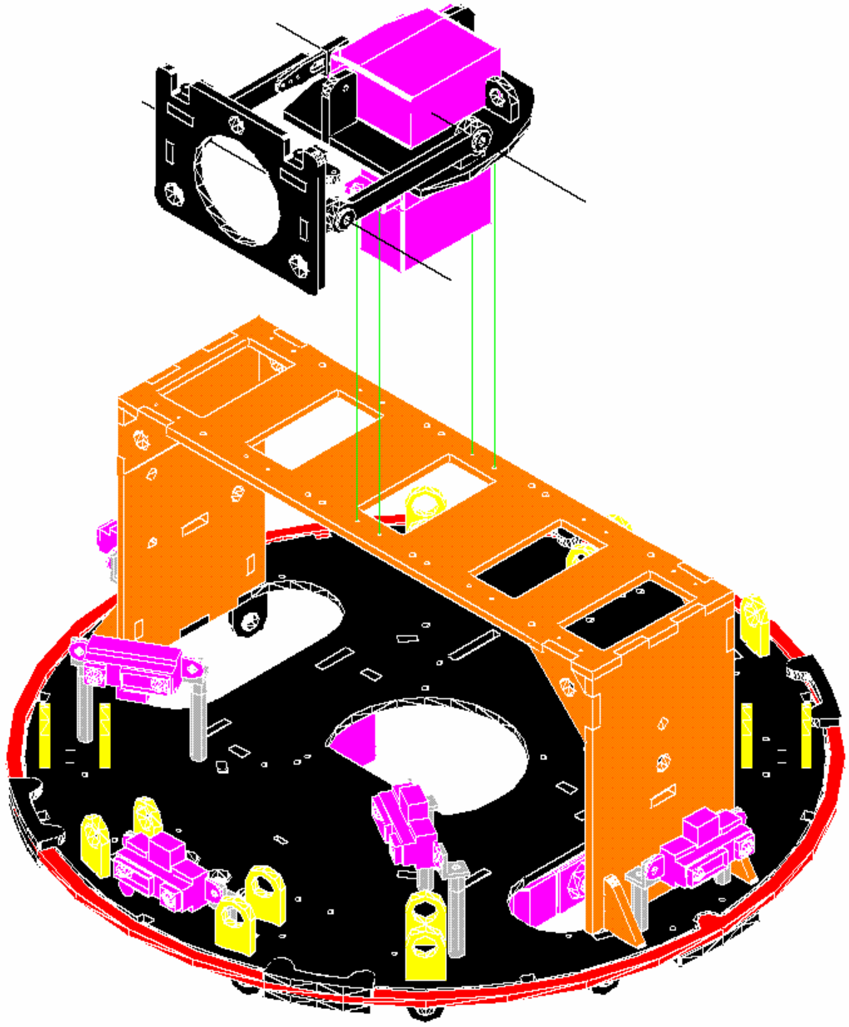


Figure 35. This diagram shows how to bolt the Argos™ Sensor Head onto the TALRIK-IV *Bridge* using four 4/40 screws and nuts.

6.13 Inserting the Line-Following Photoresistors

1. (Figure 36) From the top, insert three photoresistor ½ inch into the holes provided on the *Top Plate* with the terminal wires pointing up.
2. Hot glue the sensors to the *Top Plate* to secure them firmly. Be sure to keep the sensors vertical as the hot glue sets.

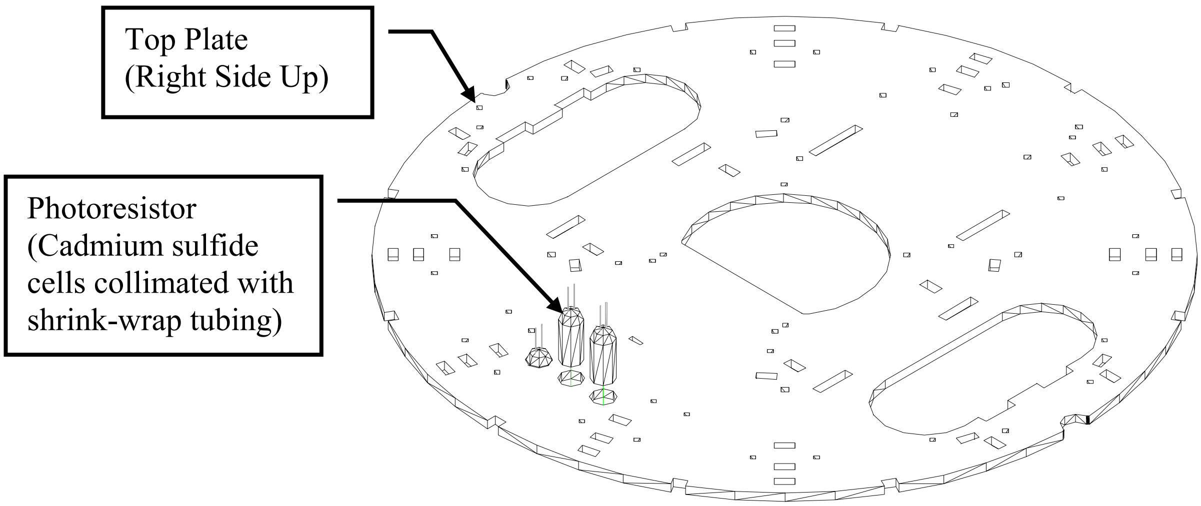


Figure 36. Insert three line-following photoresistors (collimated cadmium sulfide cells) through the top of the *Top Plate* with the leads point up. The other elements assembled onto the *Top Plate* are not shown for clarity.

6.14 Assemble Wheels and Mount on Robot

Assemble two wheels for the robot:

1. (Figure 37) Collect two each of Servo Horns, servo horn screws, 1 inch steel washers and rubber-tired wheels.
2. Center the steel washer onto the wheel hub and superglue to the hub.
3. Inset the servo horn screw into the servo horn in the normal manner. Center the servo horn and screw onto the washer and superglue the horn to the washer. The output shaft coupling of the servo horn faces away from the wheel and the end of the servo horn screw should be visible (Figure 38).
4. After the glue sets, mount the wheels by screwing the wheel servo horn onto the robot wheel motor output shafts with the servo-horn screw. A jeweler's screwdriver will fit through the center hole of the wheel. You may have to turn the wheel slightly to align the grooves on the output shaft with the horn grooves as you tighten the servo horn screw. There is little space to maneuver the wheels into position, but it does fit!

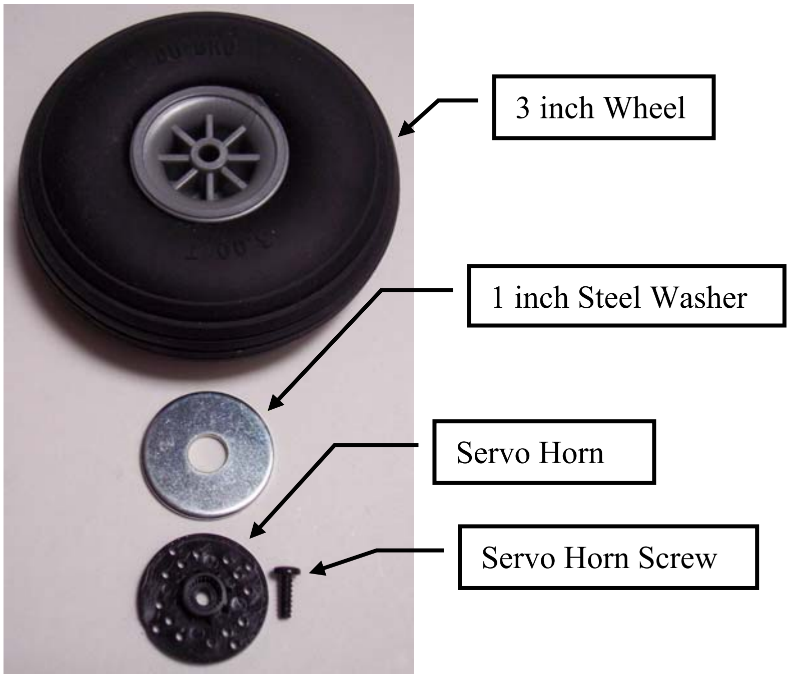


Figure 37. A Servo Horn and a 1 inch steel washer superglues to the wheel hub to allow mounting on a wheel servo.

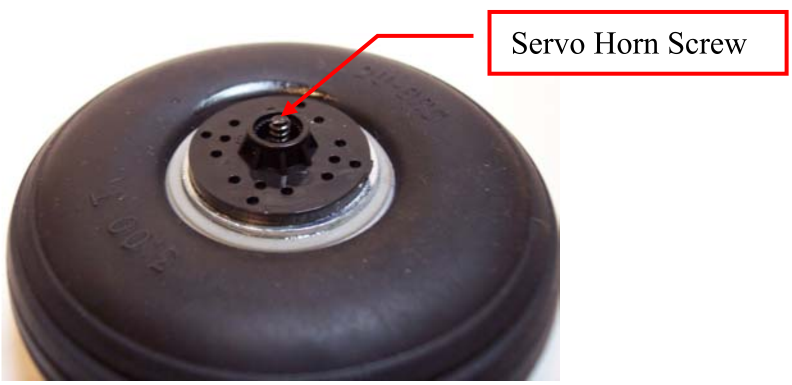


Figure 38. To enable mounting wheels on the wheel servo output shaft, center and superglue a 1 inch steel washer to the wheel hub. Center and superglue a servo horn with its mounting screw onto the steel washer, with the output shaft coupling of the servo horn facing away from the wheel. In the picture you can see the end of the servo horn screw sticking out. Since the wheel hub center hole is to small to insert the screw through it, the screw must be inserted into the servo horn before gluing. If you forget to put the screw in before gluing, you can drill the center hole larger to accommodate the servo horn screw head.

6.15 Attach Rear Caster and Battery Pack to Robot Body

(Figure 39) Bolt the rear castor underneath the robot body with four ½ inch 4/40 screws, lock washers and nuts.

Do not install the Velcro™ battery strap and battery 6-pack until after mounting the MEKAVR128™ microcontroller wiring the bumper switches and connecting all the cables as described in the following sections.

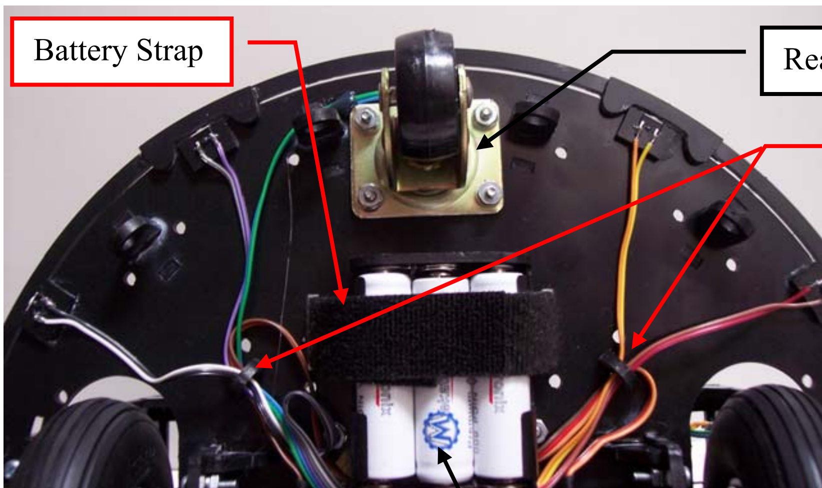


Figure 39. The rear caster fits underneath the robot body as shown. The battery pack and strap can be seen just below the caster. The cabling to the five rear bumper switches and the wheel motors pass through the wire clips as shown.

6.16 Wires Passed through the Wire Clips

When you wire up the robot later, the wire clips will come into play. Pass the left servo cable and the switch cables at 6, 7, and 8 o'clock through the left-rear wire clip and the right servo cable and switch cables at 4 and 5 o'clock through the right-rear wire clip to hold the wires in place and prevent them from dragging on the floor (Figure 39). Pass the switch cable at 12 o'clock through the center-front wire clip (Figure 19). Pass the switch cables at 1 and 2 o'clock through the right-front wire clip and the switch cables at 10 and 11 o'clock through the left-front wire clip (Figure 19).

7 TALRIK CABLES

For the expert kit, you will construct most of the cables shown in Figure 40, Figure 41 and the bumper switch cables (Figure 42) as well as soldering most of the male headers onto the MEKAVR128™ microcontroller board. Cable construction requires soldering wires and encapsulating soldered connections with hot glue for mechanical strength. In the TALIV-QA kit all cables are factory-made for quick, easy connection to the MEKAVR128™ board. In the TALIV-TA the entire robot arrives completely assembled and ready to use.

Each cable name (Table 4) begins with “C” followed by a specific name. Since the standard model employs 5 IR range sensors CIRxx expands to CIR09, CIR10, CIR12, CIR02, CIR03 corresponding to the IR range sensors at 9, 10, 12, 2, and 3 o’clock on the *Top Plate* where 12 o’clock is located at the front-center of the robot. CSERVxx expands to 16 labels, CSERV00 to CSERV15, with various aliases, depending upon the Mekatronix robot. For example, CSERV15 = CLWM (Cable_Left_Wheel_Motor) for the TALRIK-IV and the TJ-AVR. The label CxCDSx expands to CECDSL (Cable_Eye_CDS_Left), CECDSM, CECDSR for the photoresistor cables to the three photoresistors on the pan head and to CNCDSL (Cable_Nose_CDS_Left), CNCDSM, and CNCDSR for the photoresistor cables to the three photoresistors on the *Top Plate*. Details of cable fabrication are presented in Section 8.

Table 4. Cable Names and Functions

Cable Name	Cable Function
CBATT	Connects battery power to the MEKAVR128 Microcontroller (Figure 40)
CCHARGE	Transfers charge current to battery pack (Figure 41)
CCHARGELED	Connects Green charge LED to the charge circuit (Figure 41)
CIRxx	IR range sensor cables (5 total) (Figure 40)
CMODE	Mode (Download/Run) switch cable (Figure 40)
CPWRLED	Red Power LED cable: powers LED when power switch on (Figure 40)
CPWR	Power-on switch cable (Figure 40)
CRESET	Reset switch cable (Figure 40)
CSERVxx	Servo cables (integrated as part of the servo) (3 total, 13 optional) (Figure 40)
CxCDSx	Photoresistor sensor cables (6 total) (Figure 40)
CFRONTBMP	10 wires in a ribbon cable routed to the 5 front bump switches (Figure 42)
CREARBMP	10 wires in a ribbon cable routed to the 5 rear bump switches (Figure 42)
CFMx	Ribbon cable routed to FMx outputs (1 to 8 optional:16 wire max) (Figure 42)

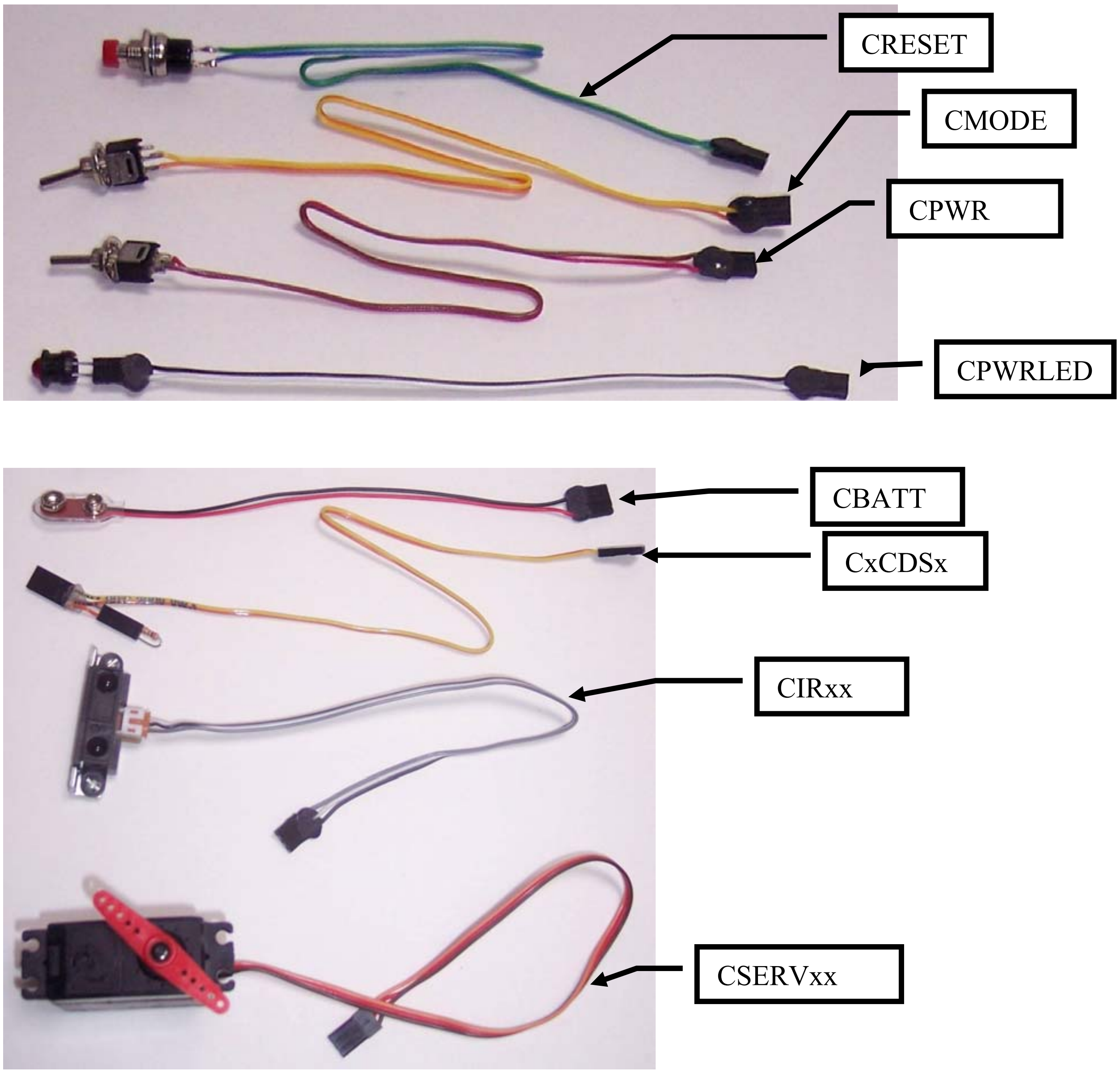


Figure 40. These photographs show the Mekatronix robot cable types with female connectors and components soldered to them. From left to right: blue-green reset cable with reset button; yellow-orange mode cable with toggle switch; red-brown power-on cable with toggle switch; black-white red LED power indicator cable; black-white-gray charge cable with charge jack and load resistors; black-white green LED charge indicator cable; red-black battery pack cable with snap connector (snap end is factory assembled); orange-yellow photoresistor cable with three pin connector and resistor divider at one end; IR position detector and cable; standard Mekatronix servo with brown-red-orange cable (factory assembled). This picture does not show the bumper switch cables.

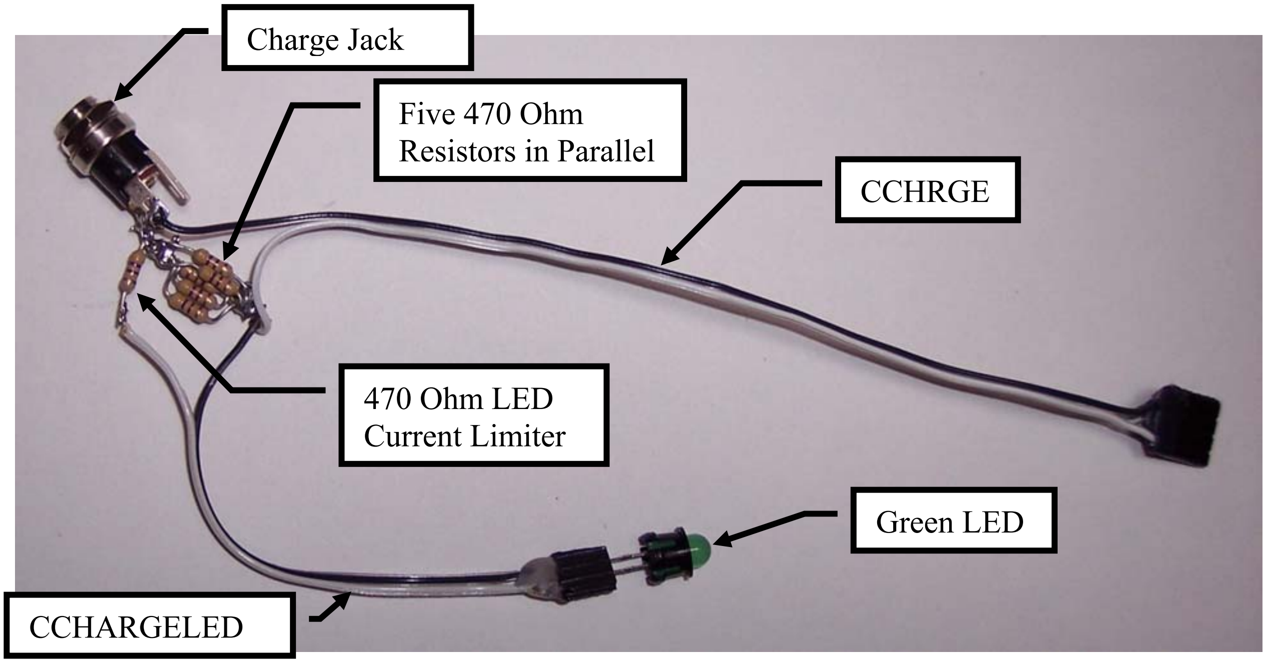


Figure 41. The CHRGE and CHARGELED cables have been combined into a single cable harness. The CCHARGELED cable does not connect to the CHARGELED header on the MEKAVR128. The CHARGELED header must be shorted with a jumper, otherwise power is blocked to the MEKAVR128.

Figure 42. Forty-wire Insulation Displacement Connector (IDC) for the front bumper (10 wires), rear bumper (10 wires), and the FM bus (16 wires) mounts onto the headers at the bottom of the MEKAVR128 board. Since the headers only use 36 wires, you can strip away four end wires.

7.1 Bumper and FM Cable Harness

You can construct the 5 front bumper switch cables, 5 rear bumper switch cables and the 8 FMx cables in Table 4 as a single cable harness consisting of a 36 wire ribbon cable attached to a 40-pin (*2x20*) IDC (Insulation Displacement Connector) (Figure 42). The other end of the harness connects to the 10 bumper switches or to the devices driven by the FMx signals (x = {1,2,3,4,5,6,7,8}. All the FMx connections to the IDC are optional on the standard kit. Of course, you can individually 2-wire cable each of the bumper inputs and FMx outputs or choose to group them. For example, you may want a FRONTBMP wiring harness with a (*2x5*) socket, a REARBMP wiring harness with a (*2x5*) socket and an FM wiring harness with a (*2x8*) socket. Details of cable fabrication are presented in Section 8.

7.2 Servo and IR Range Sensor Cables

You will not need to fabricate the IR Range sensor cables (CIRxx) or the servo cables (CSERVxx) listed in Table 4. These cables arrive factory-made.

7.3 Photoresistor Cables

The 6 photoresistor cables listed in Table 4 are the most complex cables to fabricate. They require two 3-pin female sockets, one 2-pin female socket and a voltage divider resistor inserted into one of the 3-pin female sockets. Details of cable fabrication are presented in Section 8.

8 ROBOT CABLE FABRICATION

To connect switches, LEDs, and sensors to the Mekavr128 microcontroller, you will need to construct various cables in the expert kit (TALIV-U). For the quick-assembly kit (TALIV-QA) and the totally assembled and tested kit (TALIV-TA), you will not have to fabricate cables. Factory-made servo and motor cables form an integral part of the servo or motor units and do not require you to fabricate them.

8.1 Specifying Cable Types

Most Mekatronix robot cables utilize multi-stranded (AWG 28) colored ribbon cable. The cable type *FnWkFm* designates a cable with *k* wires with sockets at each end (Figure 43). The wires connect to an *n*-pin female connector or socket at one end and to an *m*-pin socket at the other end. Typically, the number of wires does not exceed the smallest socket pin count, $k \leq \min(n, m)$, although one can imagine violations of this rule. Some cables start or end with sockets of more than one row of pins. In such cases the designator is generalized to *FrxnWkFpxm* where *Frxn* means the socket consists of *r* rows of *n* pins each at one end and a socket of *p* rows of *m* pins at the other end. The letter *x* serves as a multiplier symbol. For example an *rxn* socket possesses a total of *r times n* pins. Observe that the cable type designator does not tell you which wire is soldered to which pin. Those details must be given separately.

If a designator is missing, the corresponding socket is missing. Table 5 lists some examples and Figure 43 depicts them graphically. For example, W2F4 is a cable with two wires connected to a 4-pin female connector at one end only, as illustrated in Figure 43. The * symbol designates a "wildcard" indicating a termination of the cable into something other than a standard in-line socket. For example, **W2F2* designates a cable with a 2-pin socket at one end and a non-socket termination at the other end.

Table 5 Example Cable Types

Cable Type	Description
F2W2F2	Two stranded wires connecting two 2-pin female connectors.
F3W3F3	Three stranded wires connecting two 3-pin female connectors.
F4W2F4	Two stranded wires connecting two 4-pin female connectors. Every other pin is connected.
F6W6F6	Six stranded wires connecting two 6-pin female connectors.

Figure 43 Illustration of several cable types.

Female connectors or sockets can be cut from a multi-pin female connector (Figure 6). When making cables, be sure to tin the wire and connector ends before soldering. After soldering cable wires to the socket pins, cover the exposed wires with hot glue to provide mechanical strength. For additional strength and esthetics shrink heat-shrink tubing over the connectors and wires. The robot kit does not provided heat shrink tubing for cables, only for the photoresistor covers.

NOTICE!

Broken wires on connectors can be a source of frustration and error. Use a multi-meter or continuity checker to check all cables for electrical continuity before connecting them to circuits.

8.2 Standard TALRIK-IV™ Cable Types and Color Code

Table 6, Table 7, and Table 8 list required cables and recommended cable wire color code. Although you need not stick to the color code, systematic color-coding is recommended to help you maintain the robot and discuss technical problems about your assembly should the need arise. You do not need to build any of the cables in Table 8 for your standard TALRIK-IV™ kit, but the table is provided for your reference.

Table 6. Cable Types and Color-Code for the TALRIK-IV ™

Cable Name	Cable Type	Wire Color Code and MEKAVR128™ Header Connector
BATTERY & CHARGE (Wire Length: 6.5 inches)		
CBATT	*W2F4	(red, N.C., black, N.C.) = BATT(1,2,3,4) * = Battery Pack snap connector at other end
CCHARGE	*W2F4	(white, N.C., black, N.C.) = CHARGE(1,2,3,4) * = Charge jack at other end
SWITCHES (Wire Length: 5 inches)		
CMODE	*W2F3	(yellow, N.C., orange) = PE4(1,2,3) * = toggle switch, single-pole-double-throw (SPDT) at other end
CPWR	*W2F2	(red, brown) = PWR_SWITCH(1,2) * = toggle switch, single-pole-double-throw (SPDT) at other end
CRESET	*W2F2	(blue, green) = RESET(1,2) * = push-button reset switch at other end
CFRONTBMP (Uses 10 wires of a Ribbon Cable, Wire Length:10 inches)		
CBSW02	W2F2x18	(brown, red) = FRONTBMP(1,2)
CBSW01	W2F2x18	(orange, yellow) = FRONTBMP (3,4)
CBSW12	W2F2x18	(green, blue) = FRONTBMP (5,6)
CBSW11	W2F2x18	(violet, gray) = FRONTBMP (7,8)
CBSW10	W2F2x18	(white, black) = FRONTBMP (9,10)
CREARBMP (Uses 10 wires of a Ribbon Cable, Wire Length:10 inches)		
CBSW04	W2F2x18	(brown, red) = REARBMP(11,12)
CBSW05	W2F2x18	(orange, yellow) = REARBMP (13,14)
CBSW06	W2F2x18	(green, blue) = REARBMP (15,16)
CBSW07	W2F2x18	(violet, gray) = REARBMP (17,18)
CBSW08	W2F2x18	(white, black) = REARBMP (19,20)
CFM FREQUENCY MODULATED OUTPUTS FM1 to FM8 (Uses 10 wires of a Ribbon Cable, Wire Length:10 inches)		
CFM8	W2F2x18	(brown, red) = FM8(21,22) {Optional for user supplied devices}
CFM7	W2F2x18	(orange, yellow) = FM7(23,24){Optional for user supplied devices}
CFM6	W2F2x18	(green, blue) = FM6(25,26) {Optional for user supplied devices}
CFM5	W2F2x18	(violet, gray) = FM5(27,28) {Optional for user supplied devices}
CFM4	W2F2x18	(white, black) = FM4(29,30) {Optional for user supplied devices}
CFM3	W2F2x18	(brown, red) = FM3(31,32) {Optional for user supplied devices}
CFM2	W2F2x18	(orange, yellow) = FM2(33,34){Optional for user supplied devices}
CFM1	W2F2x18	(green, blue) = FM1(35,36) {Optional for user supplied devices}

Table 7. Cable Types and Color-Code for the TALRIK-IV ™ (Continued)

Cable Name	Cable Type	Wire Color Code and MEKAVR128™ Header Connector
		IR RANGE DETECTORS (Wire Length 8.5 inches)
CIR09	*W3F3	(gray, white, black) = MUX09(1,2,3) = (signal, 5 volts, ground) * = Special 2mm locking connector at the sensor header
CIR10	*W3F3	(gray, white, black) = MUX10(1,2,3) = (signal, 5 volts, ground) * = Special 2mm locking connector at the sensor header
CIR12	*W3F3	(gray, white, black) = MUX12(1,2,3) = (signal, 5 volts, ground) * = Special 2mm locking connector at the sensor header
CIR02	*W3F3	(gray, white, black) = MUX14(1,2,3) = (signal, 5 volts, ground) * = Special 2mm locking connector at the sensor header
CIR03	*W3F3	(gray, white, black) = MUX15(1,2,3) = (signal, 5 volts, ground) * = Special 2mm locking connector at the sensor header
		LEDs
CCHARGE LED	F2W2F2	(white, black) = (470 Ohm resistor, Node of Parallel resistors) = (anode, cathode) = 2-pin socket at LED end (WL: 3 inches)[1]
CPWRLED	F2W2F2	(white, black) =PWR_LED(3,4) = (cathode, anode) = 2-pin socket at LED end (WL: 5 inches)[1]
		PHOTORESISTORS
CECDSL	F2W2F3	(orange, N.C., yellow) = MUX17(1,2,3)= ECDSL (WL: 11 inches)[1]
CECDSM	F2W2F3	(orange, N.C., yellow) = MUX18(1,2,3)= ECDSM (WL: 11 inches)[1]
CECDSR	F2W2F3	(orange, N.C., yellow) = MUX19(1,2,3)= ECDSR (WL: 11 inches)[1]
CNCDSL	F2W2F3	(orange, N.C., yellow) = MUX21(1,2,3)= NCDSL (WL: 5 inches)[1]
CNCDSM	F2W2F3	(orange, N.C., yellow) = MUX22(1,2,3)= NCDSM (WL: 5 inches)[1]
CNCDSR	F2W2F3	(orange, N.C., yellow) = MUX23(1,2,3)= NCDSR (WL: 5 inches)[1]
		SERVOS
CSERV00	*W3F3	(orange, red, brown) = PA0(1,2,3) PAN-SERVO
CSERV01	*W3F3	(orange, red, brown) = PA1(1,2,3) Tilt-Servo {Optional}
CSERV02	*W3F3	(orange, red, brown) = PA2(1,2,3) Wrist-Servo {Optional}
CSERV03	*W3F3	(orange, red, brown) = PA3(1,2,3) Gripper-Servo {Optional}
CSERV04-CSERV13	*W3F3	(orange, red, brown) = PA4(1,2,3) to PA7(1,2,3) {Unassigned} (orange, red, brown) = PC7(1,2,3) down to PC2(1,2,3) {Unassigned}
CSERV14	*W3F3	(orange, red, brown) = PC1(1,2,3) RIGHT WHEEL MOTOR
CSERV15	*W3F3	(orange, red, brown) = PC0(1,2,3) LEFT WHEEL MOTOR

[1]WL = Wire Length

Table 8. Unassigned Cable Types and Color-Codes for the TALRIK-IV ™

Cable Name	Cable Type	Wire Color Code and MEKAVR128™ Header Connector
		UNASSIGNED MEKAVR128™ ANALGO INPUTS
CMUX4 to CMUX8	*W3F3[1]	(violet, gray, white)[2] = MUX4(1,2,3) to MUX8(1,2,3)
CMUX11	*W3F3[1]	(violet, gray, white)[2] = MUX11(1,2,3)
CMUX13	*W3F3[1]	(violet, gray, white)[2] = MUX13(1,2,3)
CADC2 to CADC6	*W3F3[1]	(white, black, brown)[2] = ADC2(1,2,3) to ADC6(1,2,3)
CMUX16	*W3F3[1]	(violet, gray, white)[2] = MUX16(1,2,3)
		UNASSIGNED MEKAVR128 PORTS
CPB0 to CPB7	*W3F3[1]	(green, blue, violet)[1] = PB0(1,2,3) to PB7(1,2,3)
CPD0 to CPD7	*W3F3[1]	(orange, yellow, green)[1] = PD0(1,2,3) to PD7(1,2,3)
CPE2	*W3F3[1]	(yellow, green, blue)[1] = PE2(1,2,3)
CPE3	*W3F3[1]	(yellow, green, blue)[1] = PE3(1,2,3)
CPE5 to CPE7	*W3F3[1]	(yellow, green, blue)[1] = PE5(1,2,3) to PE7(1,2,3)
CPG3	*W3F3[1]	(blue, violet, gray)[1] = PG3(1,2,3)
CPG4	*W3F3[1]	(blue, violet, gray)[1] = PG4(1,2,3)

[1] * = User defined component

[2] color1 > color2 > color3 in standard color code order on ribbon cable. The colors combinations recommended here are assigned by PORT and not by function.

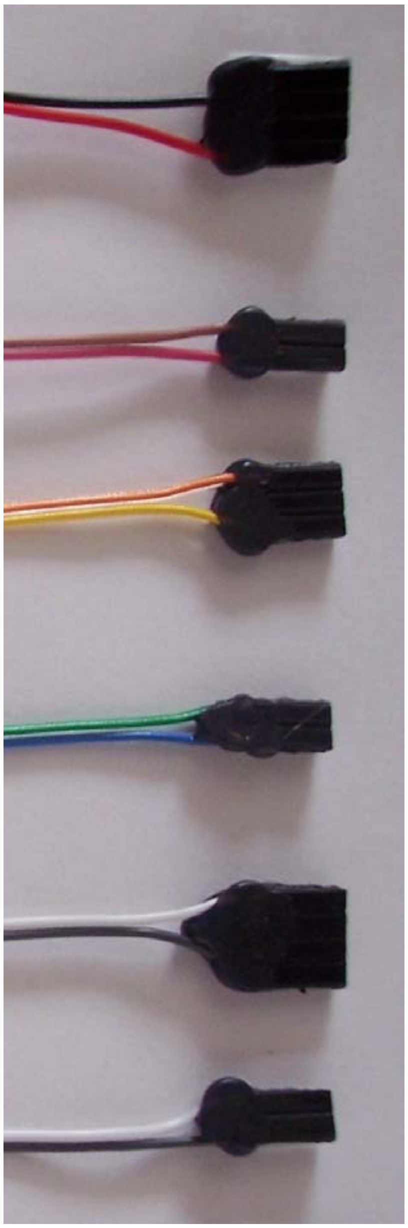
8.3 Cable Lengths for the TALRIK-IV™

Table 9. Cable Lengths for the TALRIK-IV™

Cable Name	Approximate Wire Length
BATTERY & CHARGE	
CBATT	Pre-cut
CCHARGE	6.5 inches / 160 mm
SWITCHES	
CMODE	5 inches / 125 mm
CPWR	5 inches / 125 mm
CRESET	5 inches / 125 mm
CFRONTBMP(Uses 10 wires of a Ribbon Cable)	
CBSW02	10 inches / 250 mm
CBSW01	10 inches / 250 mm
CBSW12	10 inches / 250 mm
CBSW11	10 inches / 250 mm
CBSW10	10 inches / 250 mm
CREARBMP) (Uses 10 wires of a Ribbon Cable)	
CBSW04	10 inches / 250 mm
CBSW05	10 inches / 250 mm
CBSW06	10 inches / 250 mm
CBSW07	10 inches / 250 mm
CBSW08	10 inches / 250 mm
CFM FREQUENCY MODULATED OUTPUTS (FM1 to FM8) Uses 16 wires of a Ribbon Cable	
CFM1-CFM8	(Optional) User Defined or 10 inches / 250 mm
IR RANGE DETECTORS	
CIR09	Factory-made
CIR10	Factory-made
CIR12	Factory-made
CIR02	Factory-made
CIR03	Factory-made
LEDS	
CCHARGELED	5 inches / 125mm
CPWRLED	3 inches / 125mm
PHOTORESISTORS	
CECDSL	11 inches / 280mm
CECDSM	11 inches / 280mm
CECDSR	11 inches / 280mm
CNCDSL	5 inches / 125mm
CNCDSM	5 inches / 125mm
CNCDSR	5 inches / 125mm

8.4 Robot Connector Types for the TALRIK-IV™

The following figure indicates the variety of female socket connectors for the robot. These sockets fit onto male headers of the MEKAVR128 microcontroller board.



Battery Cable: 4-Pin Socket

(red, N.C., black, N.C.) = BATT(1,2,3,4)

Power Switch Cable: 2-Pin Socket

(red, brown) = PWR_SWITCH(1,2)

Mode Switch Cable: 3-Pin Socket

(yellow, N.C., orange) = PE4(1,2,3)

Reset Cable: 2-Pin Socket

(blue, green) = RESET(1,2)

Charge Cable: 4-Pin Socket

(white, N.C., black, N.C.) = CHARGE(1,2,3,4)

LED Cable: 2-Pin Socket

(white, black) =CHARGE_LED(1,2)
= (anode, cathode) at LED end
= PWR_LED(1,2) = (cathode, anode)

Figure 44. This figure illustrates the socket connectors soldered to one end of the robot cables and encapsulated with black hot-glue. Note the color reversal on the pins of the PWR_LED with respect to the CHARGE_LED. Do not worry about this. There is no deep hidden meaning here, just an inconsistency!

8.5 Component Termination of Cables

Some cables have components attached to their ends and not connectors. Also, the number of wires in the cable may not be the same as the number of pins on the terminating socket. Figure 45 through Figure 47 illustrate the different terminations.

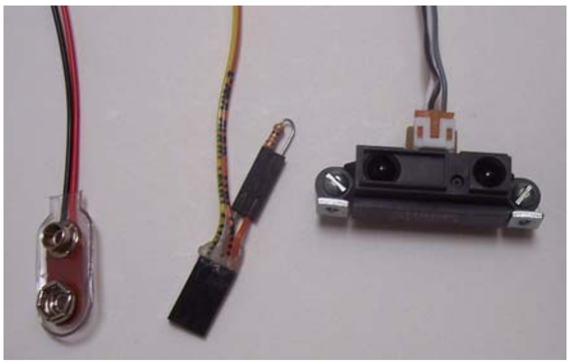


Figure 45. Cable terminations (left-to-right) on the CBATT, CxCDSxx, and CIRxx cables are battery snap, resistor-socket arrangement, and IR range detector. These components are polarized, meaning the socket must insert only one way for proper operation.

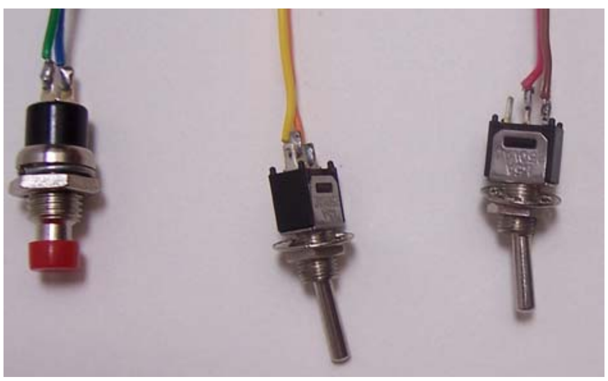


Figure 46. This picture illustrates the terminations (left-to-right) of CRESET, CMODE, and CPWR cables with the push-button reset switch, the mode (Download/Run) toggle switch, and the power-on toggle switch. These terminations are not polarized, but for consistency, wire the yellow wire to the center terminal of the SPDT MODE toggle switch and the red wire to the center terminal of the SPDT POWER toggle switch. The wire order on the RESET button switch does not matter.

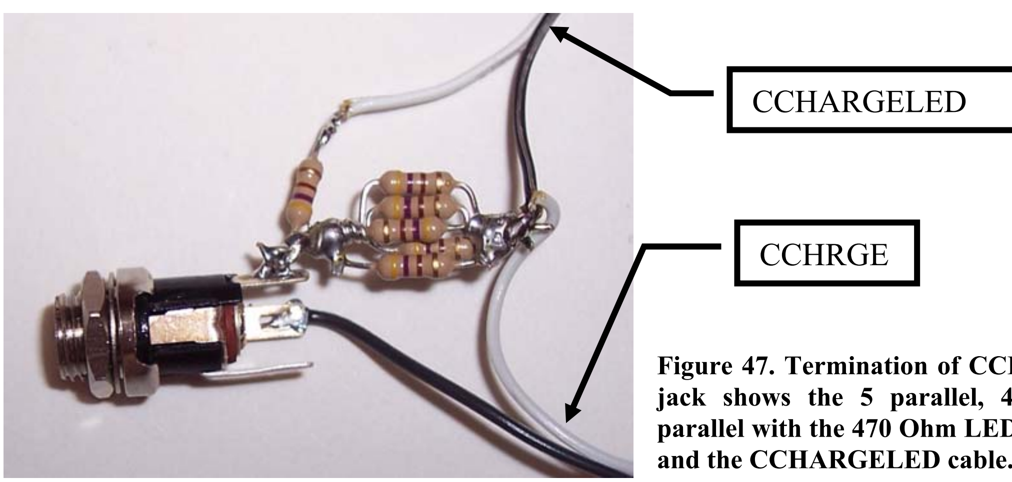


Figure 47. Termination of CCHARGE at the charge jack shows the 5 parallel, 470 Ohm resistors in parallel with the 470 Ohm LED current-limit resistor and the CCHARGELED cable.

8.6 Basics of Cable Making

To begin making cables

1. Gather materials: ribbon cable, female sockets, solder.
2. Locate tools: diagonal cutters, wire strippers, soldering iron, ruler.

Before soldering wires to female connector pins, strip about ¼ inch of insulation of the ends of the wire and tin as shown below. The figures illustrate the five-step process of fabricating cables for Mekatronix robots.

8.6.1 Cable Fabrication Technique

NEATNESS AND CAREFUL SOLDERING MAKES GOOD SENSE! You will make fewer errors and the quality of your workmanship will be better.

1. Measure the length of cable (Section 8.3, Table 9) the robot requires for each particular cable. Leave enough slack in the cable so you can plug and unplug the cables without stressing the wires or the pin connections. The suggested lengths may be longer than needed. You can, of course, cut the cable lengths to suit your requirements.
2. Cut the appropriately sized female connector from the female header (Figure 6).
3. Tin the female connector pins to which you will solder wire. Strip and tin the wire leads.
4. Solder the wires to the connector pins. Be sure to use enough heat, but not too much to melt the plastic, and not too much solder. The solder connection will have a bright shinny appearance if soldered correctly. A grainy or dull solder joint indicates a cold solder joint, which often fails electrically.
5. Cover soldered connections on the sockets with hot glue to give mechanical strength and stability. Form the hot glue coat with a clamping device covered with a surface that hot glue does not adhere to. For example, you can use a variable-crescent wrench whose jaws are covered with electrician's tape. Clamping will insure even distribution of the glue and produce a relative smooth surface. The glue in the picture is clear, so you can see the wires, but black glue may also be used for esthetic reasons. Clear glue is used in the pictures so you can see the solder connections through them.
6. *IMPORTANT! Test all fabricated cable wires for end-to-end electrical continuity. Use a multi-meter or a short-detector.*

1. Measure correct length for wire

2. Cut appropriately sized connector from the large female socket.

3.

4.

5.

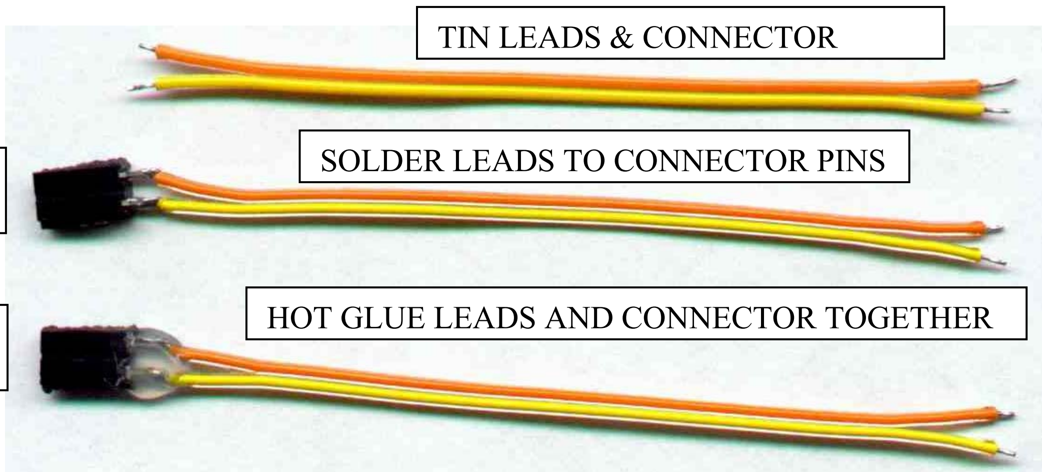


Figure 48. This figure illustrates five steps in soldering connectors to an end of a cable. The number of wires and size of the connector may vary from cable to cable, but the technique remains the same. After you make a cable, test end-to-end electrical continuity.

8.7 Wiring the Bumper Switches: CFRONTBMP and CREARBMP

CFRONTBMP consists of 5 pairs of cables CBSW10, CBSW11, CBSW12, CBSW01, CBSW02 that connect to the bumper switches at 10, 11, 12, 1 and 2 o'clock on the TALRIK-IV™ *Top Plate*. REARBMP consists of 5 pairs of cables CBSW04, CBSW05, CBSW06, CBSW07, CBSW08 that connect to the bumper switches at 4, 5, 6, 7, and 8 o'clock on the TALRIK-IV™ *Top Plate*.

The construction of the cable in Figure 49 includes the cables CFRONTBMP, CREARBMP, and, optionally, all or some of the 8 pairs FM1 to FM8.

8.7.1 Bumper and FMx Harness Construction

1. Collect the 60-wire ribbon cable and the 40-pin (*2x20*) insulation-displacement connector (IDC) (Figure 49).
2. a) If you plan to use any FMx outputs, split 20 + 2*n wires from the 60-wire ribbon cable, where $0 \leq n \leq 8$ is the number of FMx outputs you plan to use. The maximum number of wires used in this cable is 36, when $n = 8$. The minimum number of wires ($n=0$) is 20.

b) If you do not plan to use any FMx outputs, split off 20 wires for the 60-wire ribbon cable. If you change your mind later, you can (carefully!) remove the top lock clip by releasing the tabs from the notches on both sides of the IDC base and lay cable wires on the exposed IDC wire clips and proceed with Steps 4 through 10.

3. Cut off 10 inches of the separated ribbon cable, save the unused portion of the ribbon cable for other cable construction.

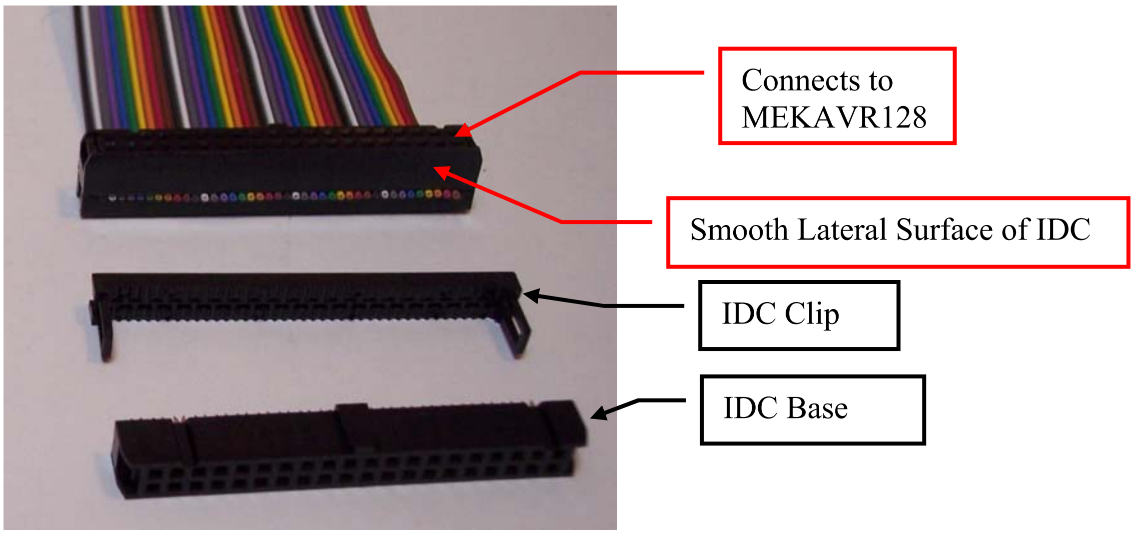


Figure 49. The 40-pin IDC (Insulation Displacement Connector) and a ribbon cable constitute the cable harness for the 10 bumper switches and the 8 FMx cables of 2 wires each (36 total wires). The picture shows all 40 wires, but 4 wires are never used and can be stripped away from the 40 wire cable. If you do not implement any of the FMx cables, the ribbon cable reduces to its minimum of 20 wires.

4. Lay the resulting cable wires (obtained in Step 3) across the connector pins with the brown wire flush at one end and mount the connector clip. Make certain that the smooth lateral surface of the IDC faces away from the cable (Figure 49) in order to enable inserting the socket without interference with the SIP or other components on the MEKAVR128™ board.
5. Use a vice or IDC tool to press the wire and clip into the cutting pins of the IDC base. Perform this operation with slow steady pressure over the entire socket.
6. Stuff pins into the never used portion of the 40-pin socket, namely, the leftmost two columns-of-two pins (total of 4 pins), and cut them so they do not protrude. These pins keep you from stepping the socket over the wrong pins when plugging it onto the header.
7. Starting at the open end of the cable, separate 10 pairs of wires about 6 inches, starting with the (brown, red) pair. Separate further, if needed to reach some of the bumper switches. Of course, you can trim wires that are too long.
8. If FMx outputs are used, separate the remaining wires by pairs.
9. Strip about 1/8 inch of insulation off of each wire and tin.
10. The bumper wires (first 20 wires) are now ready for soldering to the bumper switches.
11. The remaining pairs, from none to 8 pairs, depending upon your application, are ready for soldering connectors or other two terminal devices.

8.7.2 Wiring the Bumper Harness to the Bumper Switches

1. The bumper switches and switch supports must be glued to the bottom of the *Top Plate* (Figure 50, Figure 51, and Figure 52) before wiring (Figure 53) the 5 front (top of figure) and 5 rear bumper switches on the TALRIK-IV.
    a) If you use super glue for the bumper switches, be careful not to glue the push button so it fails to operate.
    b) The flat side of the bumper switch terminals must lie flat against the *switch-support* and *Top Plate* combination. The two bumper switch terminals lying on the *Top Plate* duplicate the function of those underneath and are not used.
    c) To test for correct layout of the bumper switches, verify that the two bottom terminals are normally open and close when the push button is depressed.
2. Tin the two bottom leads of each bumper switch.
3. Solder the color coded wire pairs to the appropriate bumper switch. This is important as the software assumes the connections dictated by Table 6. As you solder each wire-pair to bumper switch terminals, you may have to further separate the pair from the main ribbon cable. The idea is not to separate the wire pairs from the main ribbon cable more than necessary in order to keep the cable neat and orderly. You may also want to trim the length.

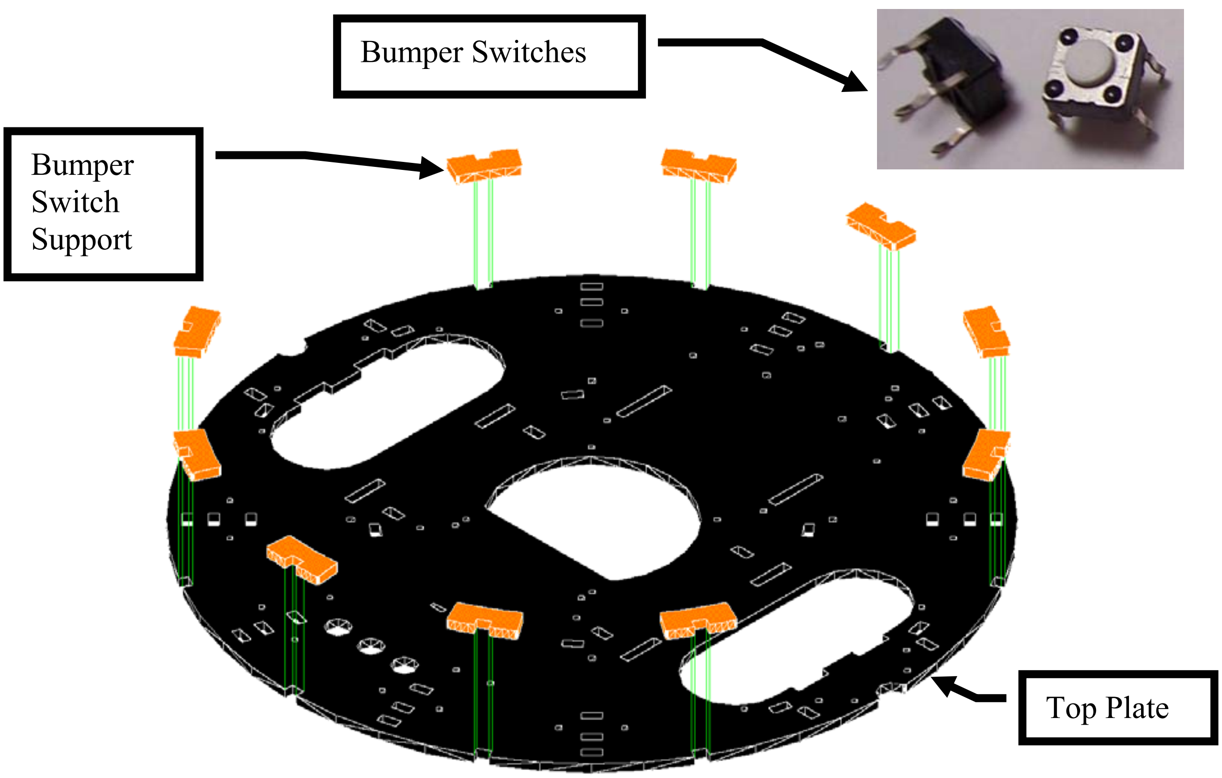


Figure 50. Superglue 10 bumper switch supports to the BOTTOM of the *Top Plate*.

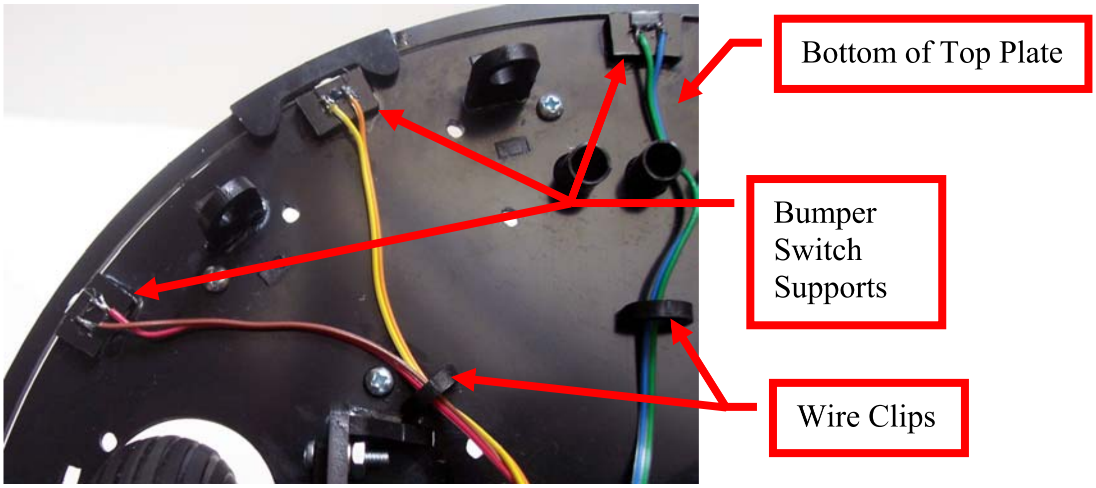


Figure 51. The *Bumper Switch Supports* glue underneath the *Top Plate*, aligned with the cutouts on the plate. The switches mount into the gaps provide for them on the *Top Plate*.

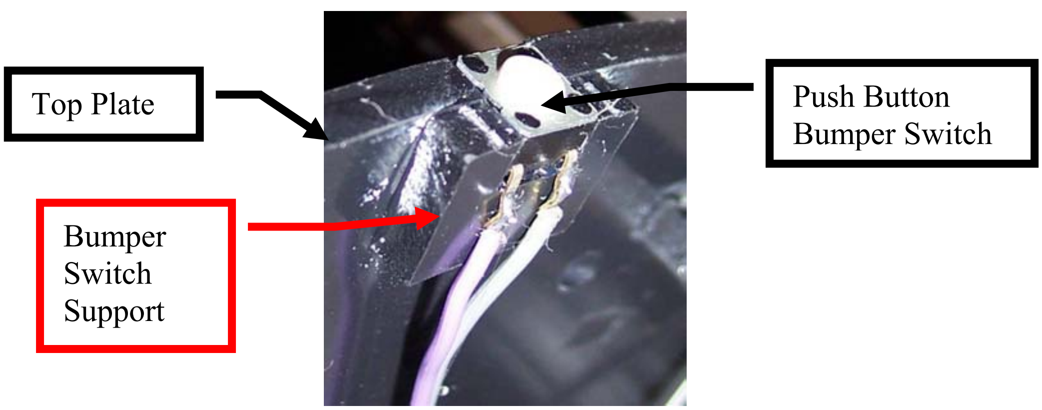


Figure 52. This picture shows the orientation of the bumper switches in the notches on the *Top Plate*. Two bumper switch terminals on one side slip over the switch support and the two others slip over the top of the *Top Plate*. The flat side of these switch terminals lie flat against the lateral surfaces. The *Bumper Switch Supports* superglued below the *Top Plate* mechanically stabilizes the switch mounting onto the *Top Plate*.

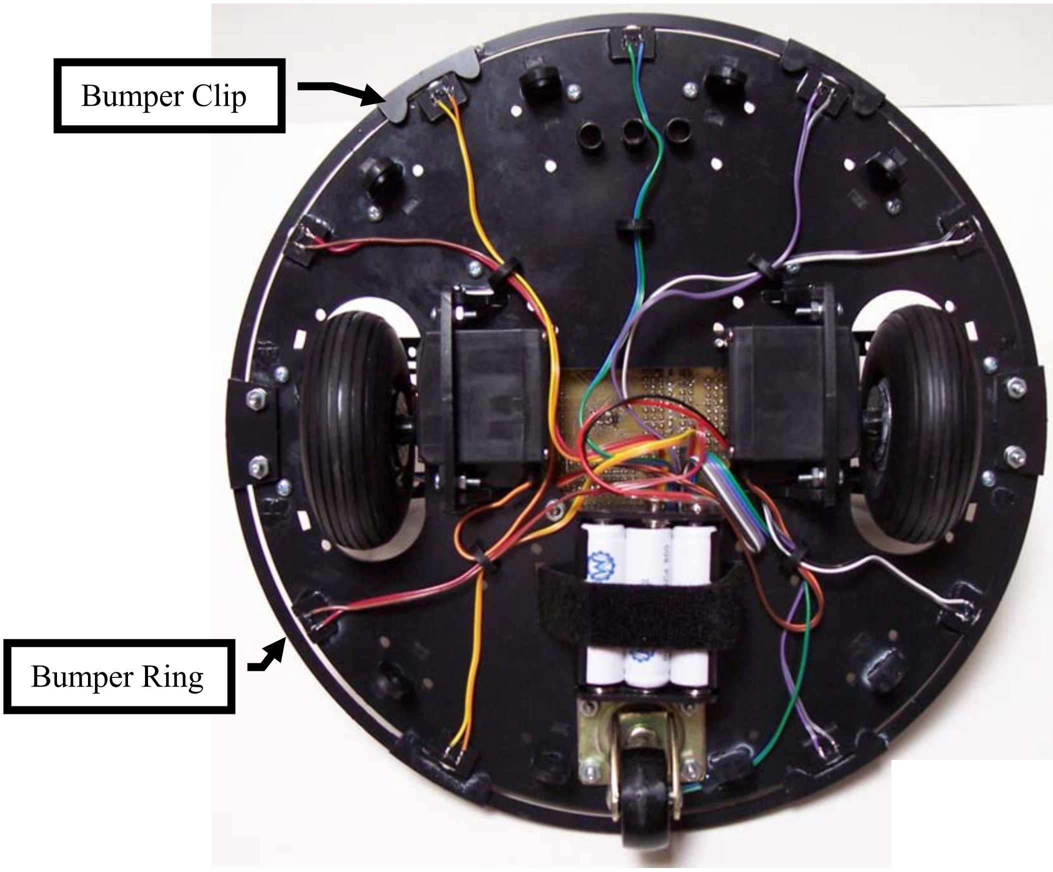


Figure 53. Wire the 10 bumper switches on the TALRIK-IV™ robot as shown. Starting at 10 o'clock, going clockwise, the color scheme for the front bumpers is (brown, red), (orange, yellow), (green, blue), (violet, green), and (white, black). Starting at 8 o'clock, going counterclockwise, the color scheme for the back bumper cables is the same: (brown, red), (orange, yellow), (green, blue), (violet, green), and (white, black).

8.7.3 Wiring the FMx Harness to Connectors

If you included wire-pairs for the FMx outputs, terminate the open ends with the appropriate terminal device for your application. In general, the terminal device soldered to the FMx cables will be a 2-pin socket to insert into LED leads.

8.8 Photoresistor Cable Assembly: CxCDSxx

Figure 54 and Figure 55 illustrate the construction of the photoresistor cable. This cable's combined 3-pin socket and 2-pin resistor socket at one end is *polarized*, meaning it must be wired and inserted in a specific orientation for the cable to serve its designated purpose. At the photoresistor-end the orientation of the 2-pin socket has no effect and may attached to the photoresistor in either orientation.

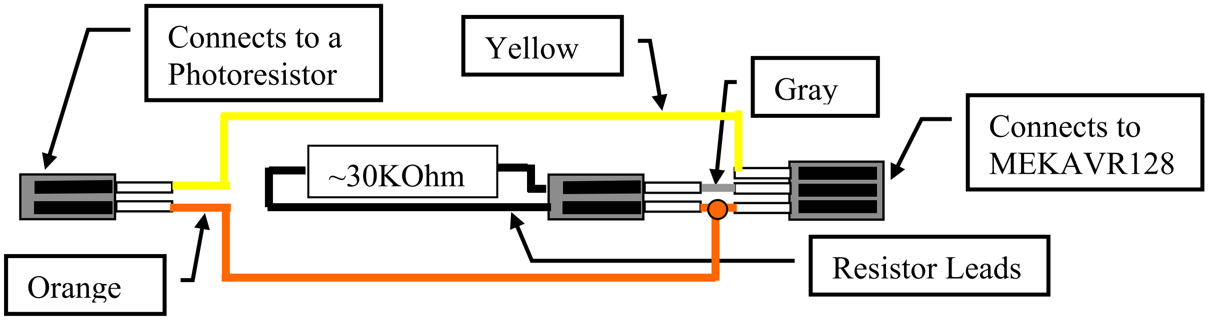


Figure 54. Construction of the Photoresistor cables (CxCDSxx) involve two 2-pin sockets and one 3-pin socket along with a voltage divider resistor which you can vary depending upon the characteristics of the photoresistor to be connected to the 2-pin socket at the left of the figure.

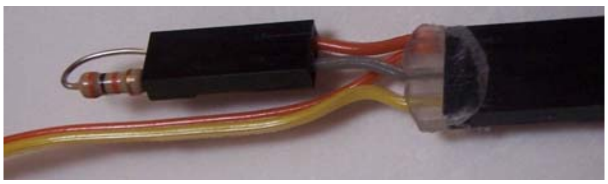


Figure 55. Details of the Photoresistor connector show the wire colors and terminations. The nominal 30K Ohm voltage divider resistor inserts into the 2-Pin Female connector, which connects to the 3-Pin Female connector. The orange wire connects to an outside pin of the 3-Pin connector and is common to the orange wire from the 2-pin connector. The yellow wire connects to the other outside pin of the 3-Pin connector while the gray wire connects its center pin to the remaining pin of the 2-Pin connector.

8.9 Charge Cable and LED Cable Assembly: CCHARGE, CPWRLED, CCHARGELED

The cables in this section are all polarized, meaning they must be wired and connected in a specific orientation for the cable to serve its designated purpose.

Figure 56 illustrates how to fabricate an LED cable. Be sure to follow the color code exactly, otherwise when you connect the LED cable to the MEKAVR128™ board according to color code, the LED will not light appropriately. If you do mess up, just reverse the connector on the LED pins to correct the situation.

Figure 57 and **Error! Reference source not found.** (also, refer to photograph Figure 47) illustrates five 470 Ohm resistors in parallel soldered to the charge jack. The charge LED circuit consists of a single 470 Ohm resistor in series with a green LED. Solder this circuit in parallel with the five resistors. The 470 Ohm resistor in the series circuit limits the current through the LED and provides a small amount of additional charge current for the batteries.

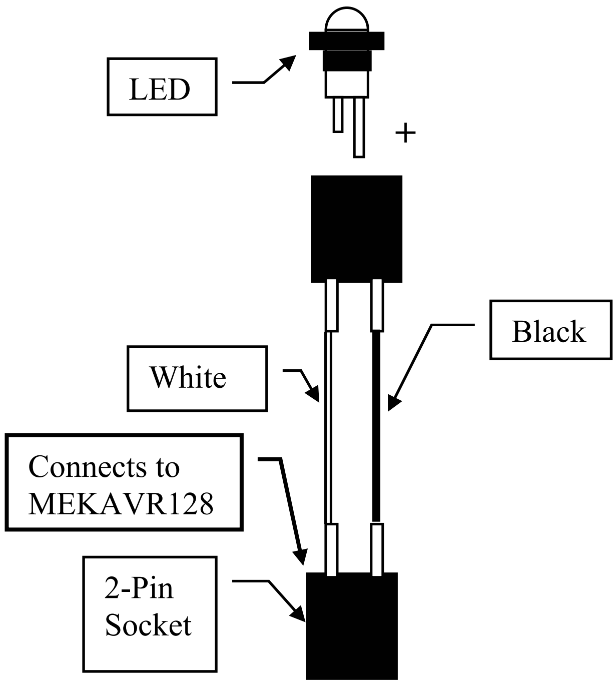


Figure 56. This diagram illustrates the red power-on LED cable (CPWRLED) wiring (Note: this connection is inconsistent, color-code-wise, with the green charge LED connection in the next figure). The longer lead on the LED is the anode and the shorter lead the cathode. When you trim the leads, be sure to preserve an obvious difference in length. This plug is polarized and must be inserted properly into the header on the MEKAVR128™..

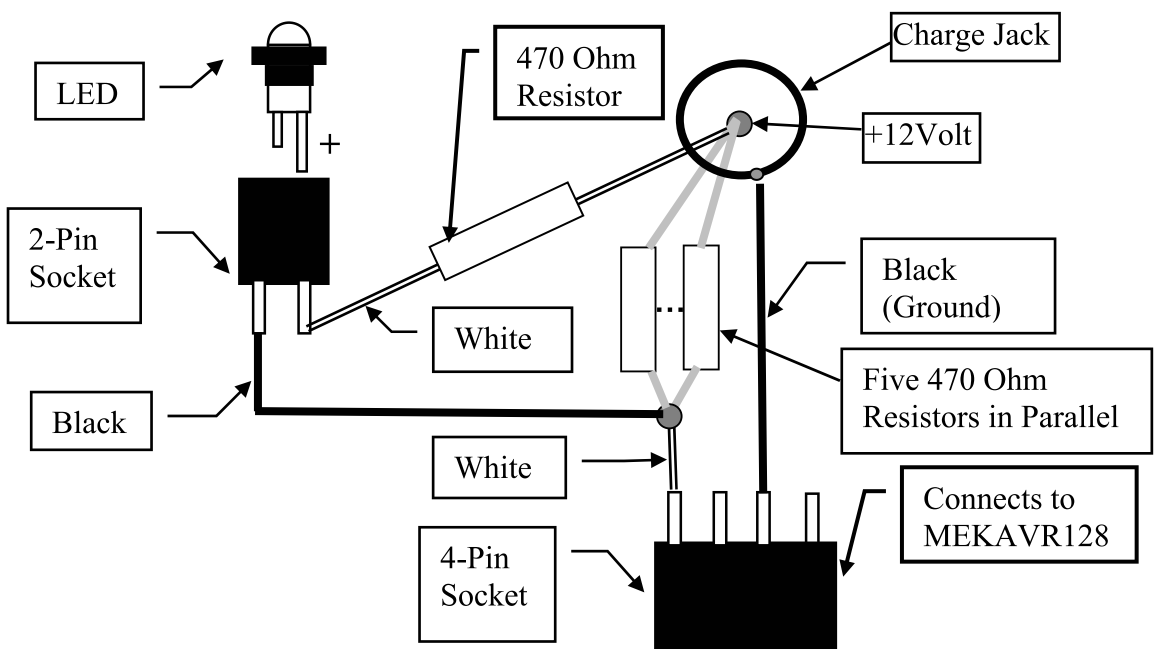


Figure 57. This diagram illustrates the green charge LED cable (CCHARGELED) and the charge jack and charge cable (CCHARGE) wiring. The longer lead on the LED is the anode and the shorter lead the cathode.

8.10 Switch Cable Terminations: CMODE, CPWR, and CRESET

Mekatronix robots incorporate a three switch operation scheme, a

1. Power-On toggle switch to switch power onto the MEKAVR128™ board (Figure 58),
2. Mode (Download/Run) toggle switch that informs the MEKAVR128™ whether to download code or execute (run) the code already in its memory (Figure 59),
3. Push-button Reset switch to reset the microcontroller.

If a) the Mode toggle switch is in the Download position, b) serial communication is established between the MEKAVR128™ and your host computer, and c) a terminal simulator is enable to send a file in Xmodem mode, then the selected ".hex" program file will be downloaded into the MEKAVR128™ flash memory when reset is pressed . If the Mode toggle switch is in the Run position when reset is pressed, the program in memory will be executed (Figure 60).

Solder the cables to the switches as shown in Figure 58, Figure 59, and Figure 60. Do not forget to tin the wires and the switch terminals before soldering. The other end of each of these cables is terminated with a 2-pin socket (Figure 44). None of these cables are polarized.

Figure 58. The red wire of the power-on toggle switch solders to the center post and the brown to one of the edge posts, which edge post does not matter.

Figure 59. The yellow wire of the download/run (mode) toggle switch solders to the center post and the orange to one of the edge posts, which edge post does not matter.

Figure 60. Solder the green wire to one terminal and the blue wire to another terminal on the reset button switch.

8.11 IR Range Sensor Cables CIRxx

The IR range detector cables usually arrive factory-made as seen in Figure 61. If your kit requires you to fabricate them, construct the cable as shown in Figure 62. This cable is polarized. The 2mm socket (white in Figure 61) fits only one way into the range sensor. The 3-pin socket at the other end physically fits two ways and must be oriented properly when inserted onto the MEKAVR128™ board. The proper insertion orientation of this connector will be shown later.

Figure 61. The three wire IR range detector cable (CIRxx) with a standard 3-Pin Female connector at one end and a locking, miniature 2mm-pin-spacing connector.

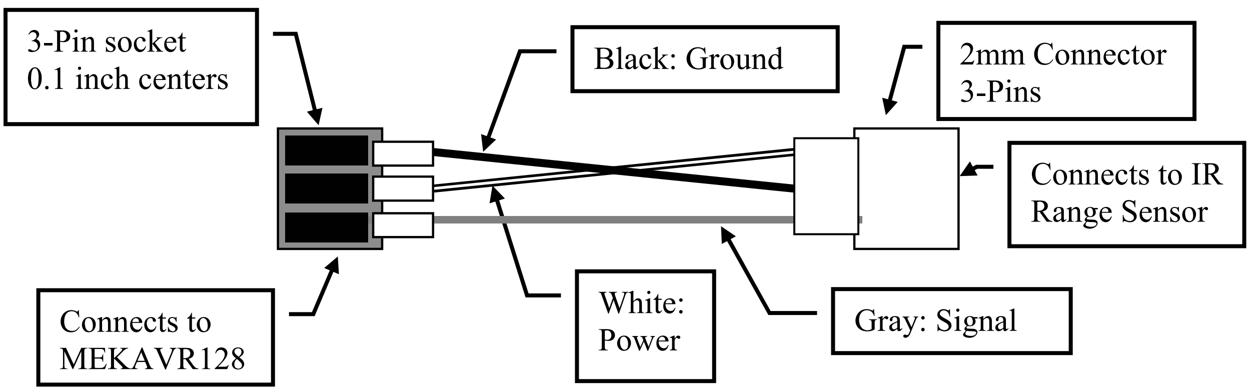


Figure 62. This diagram depicts the structure of the IR Range sensor cables CIRxx. This is a polarized cable where the socket on the left plugs into the MEKAVR128 and the 2mm connector sockets into the range sensor in only one way.

8.12 BATTERY Cable CBATT

The battery cable CBATT, already cut to length with the snap connector at one end and tinned wires at the other, solders to the 4-pin socket as shown in Figure 63. The connectors at both ends are polarized.

WARNING! WARNING! WARNING!

To prevent accidental reversal of voltages on the MEKAVR128™ board, always connect the battery pack to the snap connector before connecting the 4-pin socket to the MEKAVR128™ board.

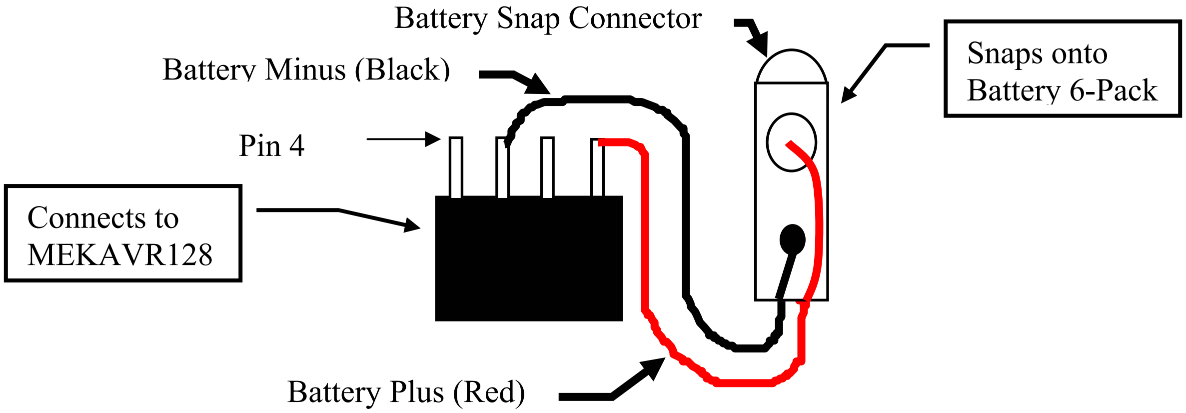


Figure 63. Battery pack snap connector cable CBATT, (red, black) = Pin(1,3) supplies battery power to the MEKAVR128™.

9 MEKAVR128™ MICROCONTROLLER

Figure 64 and Figure 65 provide views of several versions of the Mekatronix MEKAVR128™ microcontroller board. Figure 64 illustrates the MEKAVR128™ with a full complement of headers while the expert kit version in Figure 65 does not come with all the headers soldered to the board. The version of the board pictured in Figure 66 is the same as Figure 64 without the solder mask and will, for clarity, be used to illustrate cable connections to the board.

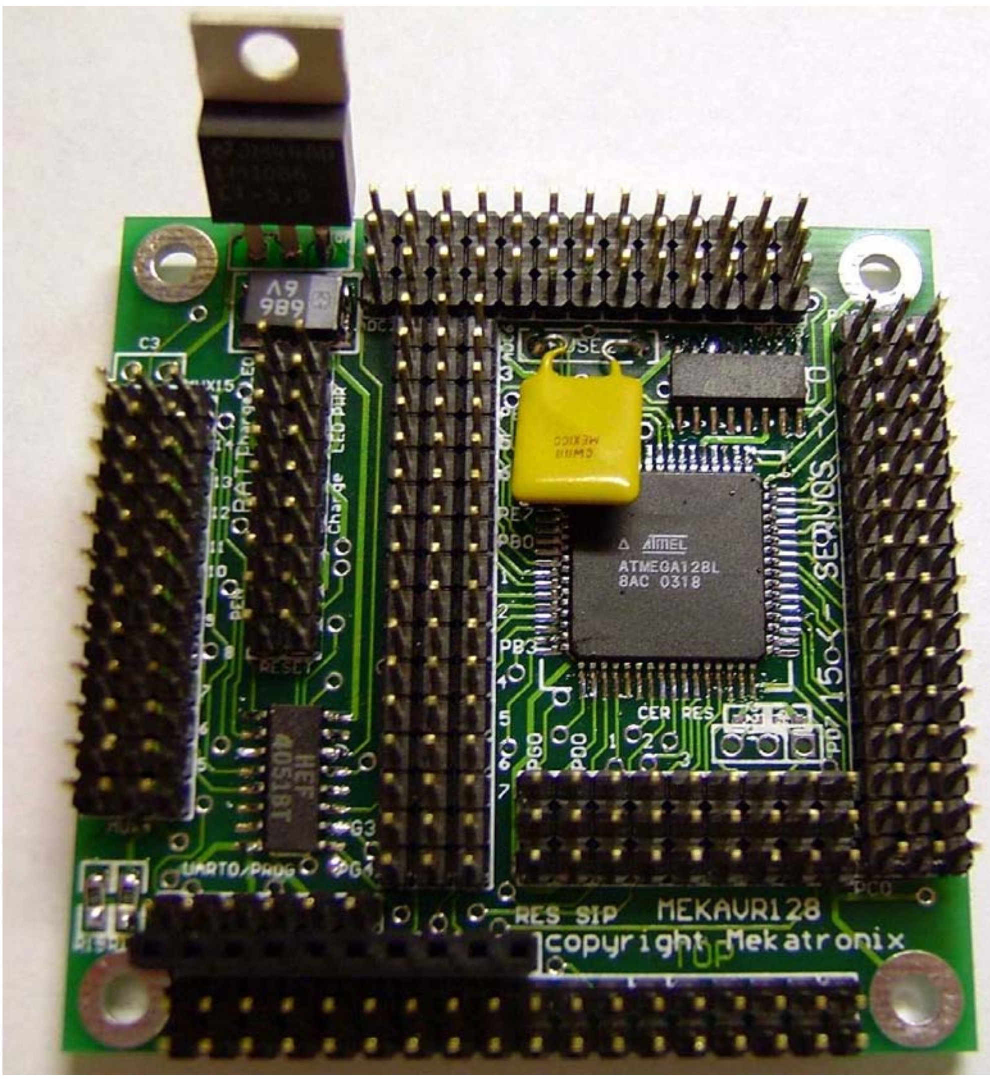


Figure 64. The MEKAVR128™ microcontroller expands the 8-channel analog port to 29 analog input channels, controls up to 16 servos and provides up to 23 digital IO ports. This photograph illustrates the board fully populated with male headers.

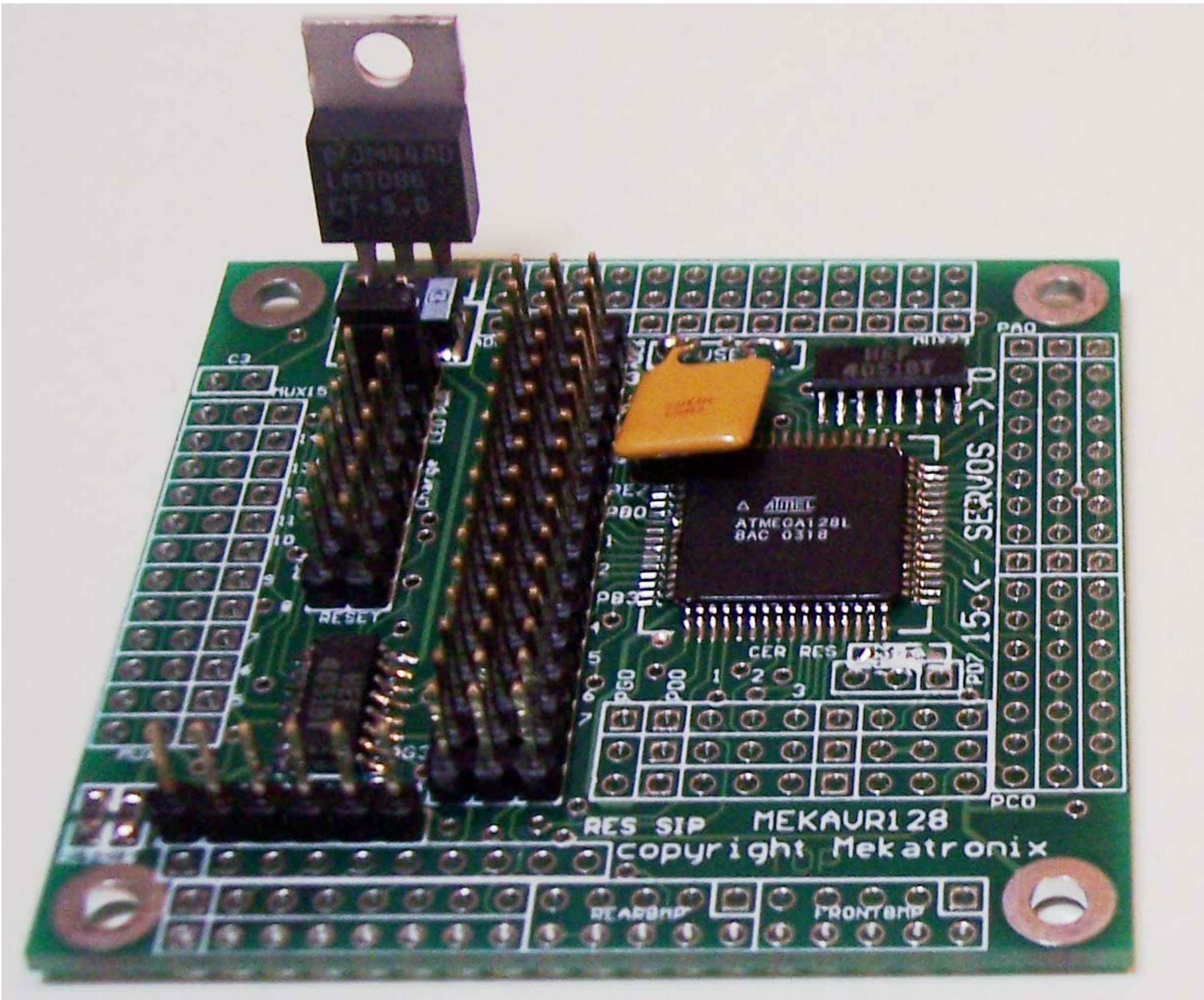


Figure 65. This is a photograph of the expert-kit (TALIV-U board. The headers on this board allow you to attach the power (CPWR), reset (CRESET), charge LED (CCHARGELED), power LED (CPWRLED), battery (CBATT), and charge cables (CCHARGE) in the upper left headers. The 6-pin serial communications connector in the lower left of the board allows you to communicate with the board through a 6-wire serial cable (C2325). The three columns of headers at center—left provide some digital IO along with the header for the mode (download/run) cable (CMODE).

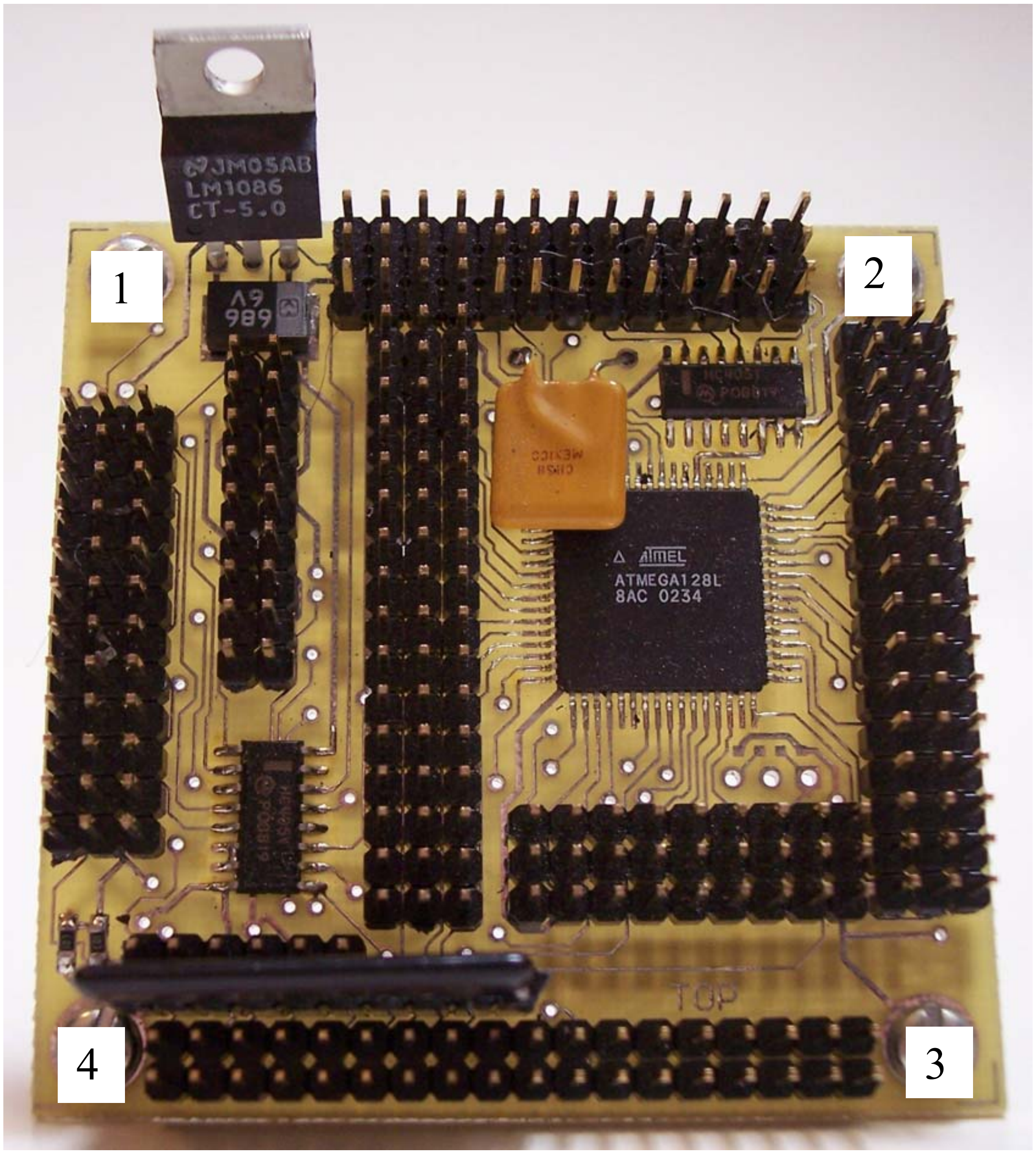


Figure 66. This fully populated version of the MEKAVR128™ board without the green solder mask enhances photographic contrast for illustrating cable connections to the board in the sections to follow. The corners of the board, starting from the top left and proceeding clockwise, are labeled 1, 2, 3, 4 to aid in orienting the subsequent figures.

10 MEKAVR128™ HEADER LOCATIONS, NAMES AND FUNCTIONS

Figure 67 describes header layout and header names for the Mekatronix MEKAVR128™. Blue lines designate ground rails and red lines the regulated Vcc power rails. The unregulated servo power rail (pink line) attaches directly to the battery pack via a fuse and does not connect to the regulated power rail.

Table 10, Table 11, Table 12, and Table 13 itemize the MEKAVR128™ headers and their TALRIK-IV™ assigned functions. The headers in bold type indicate ones with TALRIK-IV™ assignments. Gray highlighted headers indicate headers not used in the basic TALRIK-IV™ configuration. Yellow highlighted headers indicate internal use and, even if the header is available externally (some are, some are not), you should not assign it to another use.

For each of the three-pin headers, you will observe that the label next to the header, say PA7, designates the name of both the header and the port signal pin (the square pad next to the ATmega128 microcontroller chip). In those situations where the header and pin name cannot be differentiated by context, the pin designator of the header will provide the differentiation. For example, PD3 is pin 3 on PORTD, but PD3(1, 2, 3) is the three pin header whose Pin-1 (square pad) connects to PD3 on the ATMEG128, Pin-2 is the regulated power rail, and Pin-3 is ground. As another example, PA7(1, 2, 3) is the three pin header whose Pin-1(square pad) connects to PA7 of the ATMEGA128. Pin-2 connects to a battery power rail (unregulated) and Pin-3 to ground.

PORTF and multiplexed PORTF analog input channels (Table 10) provide 29 sensor input channels. The basic configuration supports eleven external sensors, 5 IR range Sensors and 6 Photoresistor light sensors, and four internal sensors, MUX0 through MUX. MUX0 and MUX1 sense the battery level and charge voltage, respectively. MUX2 and MUX3 sense the rear and front bump switch closures in a digital-to-analog conversion scheme.

PORTA and PORTC drive servos (Table 11). The important point to notice is that unregulated battery power is supplied to the servos in order to handle the motor surge currents without resetting the processor.

Table 12 lists the various support headers for communications, switch control, power, LED indicators, and bumpers. The Program Enable pin, PEN, is not used by the TALRIK-IV™. The resistor SIP header is needed for current limiting FM signals into IR or visible LEDs.

Most of PORTB, PORTD and PORTE are available for digital input/output (Table 13). Serial communication uses PE0 and PE1, but the rest of PORTE, namely, PE2 –PE7, is available for digital IO or alternate function use. PB1 has internal connections to USART0/ PROG header making it available for non-TALRIK-IV software, but normally you can use it for digital IO or for your own serial synchronous communications bus (alternate functions of PB0, PB1, PB2, PB3). PB4 drives the FM ports and must not be used as digital IO if the FM ports are enabled. You can use PG3 and PG4 as digital IO, but PG0, PG1, and PG2 must not be used as they perform internal analog multiplexer selection.

The numbers labeling the corners of the MEKAVR128™ diagram in Figure 67 indicate orientation of the chip. Starting with 1 in the upper left, the numbers sequence through 2, 3, and 4 in the clockwise direction. In subsequent diagrams, these numbers help you to identify the location of the header set under consideration.

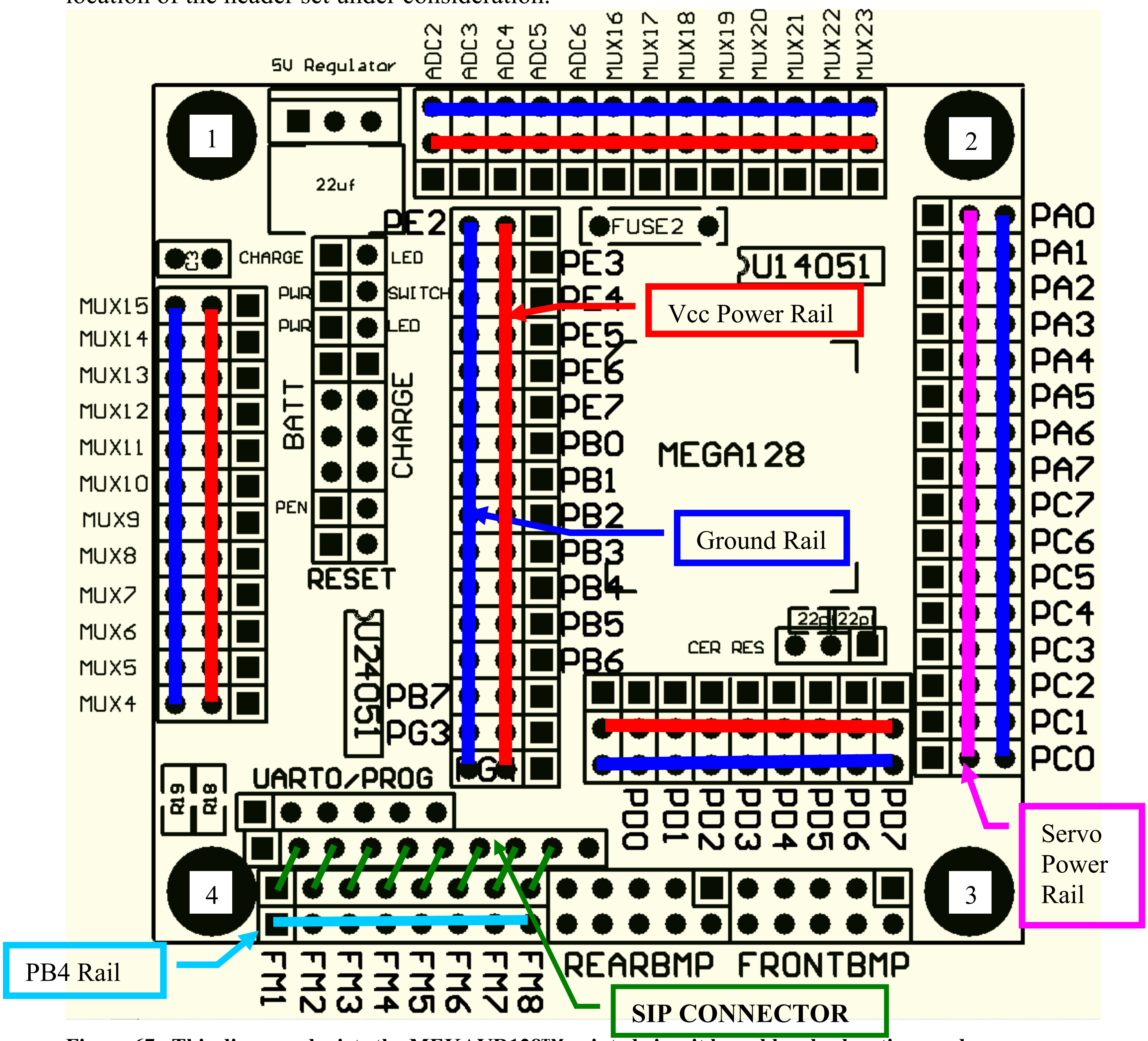


Figure 67. This diagram depicts the MEKAVR128™ printed circuit board header locations and names.

Table 10. Analog Sensor Headers for TALRIK-IV™

SENSOR NUMBER	***HEADER*** **Pin-1 = Input Pin-2 = Regulated Power Pin-3 = Ground**	***TALRIK-IV SENSOR NAME***
0	MUX16(1,2,3)	LIRA (Argos-Head left IR detector)
1	**MUX17**(1,2,3)	**ECDSL or LCDSA (Argos-Head left CDS)**
2	**MUX18**(1,2,3)	**ECDSM or SONARA (Argos Sonar)**
3	**MUX19**(1,2,3)	**ECDSR or RCDSA (Argos Head right CDS)**
4	MUX20(1,2,3)	RIRA (Argos-Head IR detector)
5	**MUX21**(1,2,3)	**CDS6 or NCDSL (Line Follow) or**
6	**MUX22**(1,2,3)	**CDS5 or NCDSM (Line Follow)**
7	**MUX23**(1,2,3)	**CDS4 or NCDSR (Line Follow)**
8	MUX8(1,2,3)	IR08 (8 o'clock)
9	**MUX9**(1,2,3)	**IR09 (IR Ranger at 9 o'clock)**
10	**MUX10**(1,2,3)	**IR10 (IR Ranger at 10 o'clock)**
11	MUX11(1,2,3)	IR11 (IR Ranger at 11 o'clock)
12	**MUX12**(1,2,3)	**IR12 (IR Ranger at 12 o'clock)**
13	MUX13(1,2,3)	IR01 (IR Ranger at 1 o'clock)
14	**MUX14**(1,2,3)	**IR02 (IR Ranger at 2 o'clock)**
15	**MUX15**(1,2,3)	**IR03 (IR Ranger at 3 o'clock)**
16	ADC2(1,2,3)	Reserved
17	ADC3(1,2,3)	Reserved
18	ADC4(1,2,3)	Reserved
19	ADC5(1,2,3)	Reserved
20	ADC6(1,2,3)	Reserved
21	**MUX0**	**BATTERY (Battery Level)**
22	**MUX1**	**CHARGE (Charge Voltage)**
23	**MUX2**	**REAR_BUMP (Rear bumper)**
24	**MUX3**	**FRONT_BUMP (Front bumper)**
25	MUX4(1,2,3)	IR04 (IR Ranger at 4 o'clock)
26	MUX5(1,2,3)	IR05 (IR Ranger at 5 o'clock)
27	MUX6(1,2,3)	IR06 (IR Ranger at 6 o'clock)
28	MUX7(1,2,3)	IR07 (IR Ranger at 7 o'clock)

Table 11. Talrik-IV™ Servo Headers

SERVO NUMBER	*HEADER* Pin-1 = Input Pin-2 =Battery Pin-3 = Ground	*PIN-1*	*Talrik-IV™ USAGE*
0	**PA0(1,2,3)**	**PA0**	**Sensor Head Pan Servo** or Argos Pan Servo
1	PA1(1,2,3)	PA1	Argos Tilt Servo or MekArm Shoulder Servo
2	PA2 (1,2,3)	PA2	MekArm Wrist Servo
3	PA3 (1,2,3)	PA3	MekArm Gripper Servo
4	PA4(1,2,3)	PA4	Unassigned
5	PA5(1,2,3)	PA5	Unassigned
6	PA6(1,2,3)	PA6	Unassigned
7	PA7(1,2,3)	PA7	Unassigned
8	PC7(1,2,3)	PC7	Unassigned
9	PC6(1,2,3)	PC6	Unassigned
10	PC5(1,2,3)	PC5	Unassigned
11	PC4(1,2,3)	PC4	Unassigned
12	PC3(1,2,3)	PC3	Unassigned
13	PC2(1,2,3)	PC2	Unassigned
14	**PC1(1,2,3)**	**PC1**	**Right Wheel Motor**
15	**PC0(1,2,3)**	**PC0**	**Left Wheel Motor**

Table 12. Switch Control, Power, LED Indicator and Communication Headers

HEADER	*FUNCTION*
CHARGE LED(1,2)	**Shorted with a jumper**
PWR SWITCH(1,2)	**Off-On Power Switch**
POWER LED(1,2)	**Red LED Indicator: Power-On**
BATT(1,2)	**Battery Power**
CHARGE(1,2)	**Charge Power**
PEN(1,2)	Program Enable (NOT USED by TALRIK-IV™)
RESET(1,2)	**Reset Processor**
FRONTBMP(1,2,3,4,5,6,7,8,9,10)	**Front Bumper**
REARBMP(1,2,3,4,5,6,7,8,9,10)	**Rear Bumper**
FM1(1,2) to FM8(1,2)	**Square Wave Output; Frequency programmable**
UART0/PROG(1,2,3,4,5,6)	**Serial Communication/Programming**
RES_SIP(1,2,3,4,5,6,7,8,9,10)	**Current Limiting Resistors for FM output driver PB4**

Table 13. Digital IO Port Headers with Alternate Function Specification.

HEADER **Pin-1 = Input/Output Pin-2 = Regulated Power Pin-3 = Ground**	***ALTERNATE FUNCTION***	***HEADER*** **Pin-1 = Input/Output Pin-2 = Regulated Power Pin-3 = Ground**	***ALTERNATE FUNCTION***
PE0	**RXD0**	PD7(1,2,3)	T2
PE1	**TXD0**	PD6(1,2,3)	T1
PE2(1,2,3)	XCK0/AIN0	PD5(1,2,3)	XCK1
PE3(1,2,3)	OC3A/AIN1	PD4(1,2,3)	IC1
PE4(1,2,3)	**MODE SWITCH**	PD3(1,2,3)	TXD1/INT3
PE5(1,2,3)	OC3C/INT5	PD2(1,2,3)	RXD1/INT2
PE6(1,2,3)	T3/INT6	PD1(1,2,3)	SDA/INT1
PE7(1,2,3)	IC3/INT7	PD0(1,2,3)	SCL/INT0
PB0(1,2,3)	(SS)’	**PG0 PG1 PG2**	**INTERNAL MUX SELECT (DO NOT USE)**
PB1(1,2,3)	**SCK**		
PB2(1,2,3)	MOSI		
PB3(1,2,3)	MISO		
PB4(1,2,3)	**Drives FM1 to FM8**		
PB5(1,2,3)	OC1A		
PB6(1,2,3)	OC1B		
PB7(1,2,3)	OC2/OC1C		
PG3(1,2,3)	TOSC2		
PG4(1,2,3)	TOSC1		

Table 13 list the alternate functions permitted with the available PORTE, PORTB, and PORTG pins of the ATMEG128(L) microcontroller chip. Refer to the ATMEL AVR ATMEGA128 Manual to be found on the atmel.com web site for detailed descriptions of these features and how to program them.

11 SOLDER RESISTOR SIP ONTO THE MEKAVR128™

For the expert kit, solder the Resistor Sip into the 10 vias provided, RES_SIP(1,2,3,4,5,6,7,8,9,10). Be sure you match pin-1 of the SIP with pin-1 of the socket, namely, the pin with the rectangular pad in Figure 67.

12 SOLDERING MALE HEADERS ONTO THE MEKAVR128™

The expert kit version in Figure 65 does not come with all the headers soldered to the board. Figure 64 illustrates the MEKAVR128™ with a full complement of headers. For the header names refer to Figure 67.

12.1 SOLDER the BUMPER and FM HEADER (FRONTBMP, REARBMP, FM1- FM8)

1. Cut two 18-pin male headers from one 36-pin header.
2. From the top side of the board (the side with the ATMEGA128), insert the short pins of the two 18-pin headers into the two rows of vias (holes) at the bottom edge (edge 3-4) of the board. Make sure the header pins are in the correct two rows of vias. From left-to-right these holes correspond to the headers for FM1- FM8, REARBMP, and FRONTBMP.
3. Holding the headers into place, turn the board upside down and place the top of the header pins onto a raised, flat level surface with the protruding voltage regulator draped over an edge of the raised surface so that the header pins all rest flat on the surface.
4. Press down on the board firmly against the headers. Keep the board level to insure the headers are vertical and snug against the board.
5. Spot solder each pin (4 in all) at the ends of the two 18-pin headers to lock the headers into place.
6. Flip the board over and check to make sure all the headers properly align and are vertical to the board.
7. Flip the board onto its back and finish soldering the remaining 32 pins.

12.2 SOLDER the ANALOG MUX HEADER (MUX4-MUX15)

1. Cut three 12-pin male headers from one 36-pin header.
2. Insert the short pins of the headers into the *MUX HEADER* vias from the top side of the board (the side with the ATMEGA128). Make sure the header pins are in the correct holes, the three columns of 12 along the left edge (edge 1-4) of the board.
3. Holding the headers into place, turn the board upside down and place the top of the header pins onto the raised, flat level surface with the protruding voltage regulator draped over an edge of the raised surface so that the header pins all rest on the flat surface.
4. Press down on the board firmly against the headers' plastic supports. Keep the board level to insure the headers are vertical and snug against the board.
5. Spot solder each pin (6 in all) at the ends of the three 12-pin headers to lock the headers into place.
6. Flip the board over and check to make sure all the headers properly align and are vertical to the board.
7. Flip the board onto its back and finish soldering the remaining 30 pins.

12.3 SOLDER the SERVO HEADER (PA0- PA7, PC7-PC0)

1. Cut three 16-pin male headers, two from one 36-pin header and one from another 36-pin header.
2. Insert the short pins of the headers into the *SERVO HEADER* vias from the top side of the board (the side with the ATMEGA128). Make sure the header pins are in the correct holes along the right edge (edge 2-3).
3. Holding the headers into place, turn the board upside down and place the top of the header pins onto the raised, flat level surface with the protruding voltage regulator draped over an edge of the raised surface so that the header pins all rest on the flat surface.
4. Press down on the board firmly against the headers' plastic supports. Keep the board level to insure the headers are vertical and snug against the board.
5. Spot solder each pin (6 in all) at the ends of the three 16-pin headers to lock the headers into place.
6. Flip the board over and check to make sure all the headers properly align and are vertical to the board.
7. Flip the board onto its back and finish soldering the remaining 42 pins.

12.4 SOLDER the ANALOG HEADER (ADC2-ADC6, MUX16-MUX23)

1. Cut two 13-pin male headers from a 36-pin male header and cut a 13-pin male header from the leftover 20-pin male header.
2. Insert the short pins of the headers into the *ANALOG HEADER* vias from the top side of the board (the side with the ATMEGA128). Make sure the header pins are in the correct holes along the top edge (edge 1-2)
3. Holding the headers into place, turn the board upside down and place the top of the header pins onto the raised, flat level surface with the protruding voltage regulator draped over an edge of the raised surface so that the header pins all rest on the flat surface.
4. Press down on the board against the headers' plastic supports. Keep the board level to insure the headers are vertical and snug against the board.
5. Spot solder each pin (6 in all) at the ends of the three 13-pin headers to lock the headers into place.
6. Flip the board over and check to make sure all the headers properly align and are vertical to the board.
7. Flip the board onto its back and finish soldering the remaining 33 pins.

12.5 SOLDER the PORTD Header

1. Cut three 8-pin male headers from a 36-pin male header.
2. Insert the short pins of the headers into the *PORTD HEADER* vias from the top side of the board (the side with the ATMEGA128). Make sure the header pins are in the correct vias, the 3 rows, right-adjusted, just below the ATMEGA128's lower edge and above the bumper headers *REARBMP* and *FRONTBMP*. DO NOT INSERT THE HEADERS IN THE LEFT-MOST via, as these are test points for PG0, PG1 and PG2 which are used internally to multiplex the analog channels and are not to be used externally.

3. Holding the headers into place, turn the board upside down and place the top of the header pins onto the raised, flat level surface with the protruding voltage regulator draped over an edge of the raised surface so that the header pins all rest on the flat surface.
4. Press down on the board against the headers' plastic supports. Keep the board level to insure the headers are vertical and snug against the board.
5. Spot solder each pin (6 in all) at the ends of the three 13-pin headers to lock the headers into place.
6. Flip the board over and check to make sure all the headers properly align and are vertical to the board.
7. Flip the board onto its back and finish soldering the remaining 33 pins.

13 MOUNT THE MEKAVR128™ ONTO THE TALRIK-IV BODY

After soldering the headers into place, you are ready to mount the MEKAVR128 onto the robot body and connect up the cables.

1. Collect four ½ inch 4/40 screws, four ¼ inch hex standoffs, two lock washers and two nuts.
2. (Figure 68) Pass the ½ inch screws through the top of the 4 corner holes of the MEKAVR128™ and screw them into the ¼ inch standoffs placed underneath the board.
3. (Figure 66 and Figure 68) Orient the MEKAVR128™, face up, with the top edge of the board (edge 1-2) toward the front of the robot and insert the screw projections into the 4 holes on the top plate provided for this purpose.
4. Underneath the robot place the lock washers and nuts on the two rear screws and tighten. There is not enough room in the front to fasten the screws down with nuts, so hot glue them to give some mechanical stability. The hot glue is easily removed should the need arise to remove the MEKAVR128™.

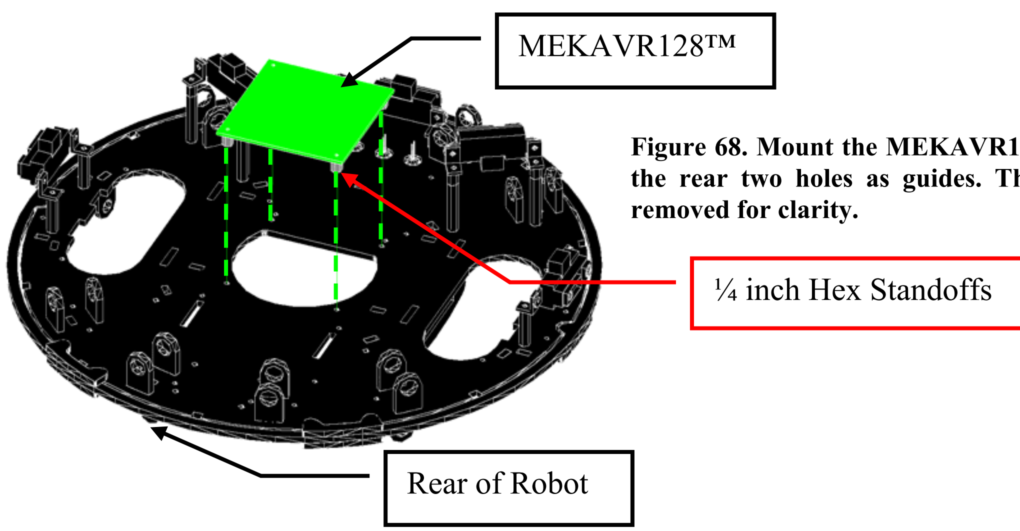


Figure 68. Mount the MEKAVR128™ as shown. Use the rear two holes as guides. The bridge has been removed for clarity.

14 CONNECTING CABLES TO THE MEKAVR128™

Table 14, Table 15, and Table 16 summarize the MEKAVR128™ cable connections, indicating whether a cable socket is polarized or not. Recall that a polarized cable requires insertion of the socket in exactly one way whereas the insertion orientation of a non-polarized socket does not matter.

Warning ! Warning! Warning!

Stepping (shifting the socket to the left or right over the header) or reversing a polarized socket may cause hardware damage, so be careful when inserting polarized connections.

The cable connections in the tables highlighted in light gray expand beyond the minimum configured kit model and are optional. The other cable connections are required.

In the tables, a cable socket that attaches to a MEKAVR128™ male header is designated **S2** in column 3 and the other end of the cable is designated **S1**, which may or may not actually be a socket. For those cables terminated in switches, for example, **S1** is not a socket, but a switch. The second column, in general, indicates the source or connector at one end of the cable specified in column 1. The last column (column 4) in each of the tables indicates the polarization of the sockets **S1**, **S2** with a pair of words. *Yes, Yes* indicates that both sockets are polarized whereas a *No, Yes* indicates that **S1** is not polarized and **S2** is, and so on. The IR Range Sensor cables CIRxx possess special 2mm connectors for **S1** that fit into the sensor socket. **S2** for these cables consists of a polarized three pin socket on 0.1inch centers. The Photoresistor Light Sensor cables C*CDS* terminate into a polarized 3-pin socket for **S2** and a non-polarized 2-Pin socket for S1, both on 0.1 inch centers, the standard TALRIK-IV™ socket pin spacing.

Column3 in the tables identifies the MEKAVR128™ headers (refer to Figure 67) and establishes the correspondence between a header pin number, the color of the wire that connects to the mating socket's receptacle pin and the signal or voltage on the pins. For example,

BATT(1,2,3,4)
= (red, N.C., black, N.C.)
= (power, N.C., N.C., ground)

indicates the BATT header has 4 pins and the 4-receptacle socket at one end of CBATT, designated by the generic symbol **S2,** connects a red wire to its number 1 pin, and a black wire to its number 3 pin. The red wire connects to power and the black wire to ground. The other two pins have no connection (N.C.). The arrangement of power and ground on the socket allows the incorrect insertion of the CBATT **S2** socket without damage to the hardware.

The CFRONTBMP, CREARBMP, and FM1 to FM8 cables, as segments of a ribbon cable, join together at a 40-pin (*2x20*) Insulation Displacement Connector (IDC), which plugs into the 36-

pins (*2x18*) male header at the bottom of the MEKAVR128™ microcontroller printed circuit board. The last two columns of the socket hang over the left end of the male headers and are not used. Pins stuffed into those sockets prevent stepping the connector. Depending on the number of FMx cables you desire at the outset, the ribbon cable varies from 20 wires to 36 wires since each FMx cable requires 2 wires and there are 8 of them. The standard kit uses only a 20 wire ribbon cable for the front and rear bumper connections. You can add the FMx cables later by

1. Carefully releasing the tabs on both sides of the IDC clip (Figure 49) to remove it. The tabs are easy to break, so be careful.
2. Place the new cable wires on the IDC, being careful to lay over the insulation-slicing wedges associated with the pins you wish the cable to connect to.
3. Replace the IDC clip and compress it uniformly with a vice to connect the new cable.

In summary, a table entry such as

Cable Name	From: Socket S1	To MEKAVR128™ Header Socket S2	Polarized S1, S2
CIR12	IR Range Sensor 2mm keyed socket	MUX12(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes

indicates that cable CIR12 plugs into an IR range sensor at one end with a 2mm, mechanically keyed connector, and to the 3-pin male header MUX12(1,2,3) on the MEKAVR128™ board with a 3-pin socket. The cable wire colors are gray, white and black with the gray wire connecting to the signal pin of the header, namely, pin-1 (rectangular pad of the MUX12(1,2,3) header layout in Figure 67). The white wire connects to the center pin and power while the black wire connects to pin-3 and ground.

Photographs in subsequent sections will detail all the cable connections of the basic TALRIK-IV™ configuration.

14.1 Neat Cable Layouts Matter

As you cable the robot, arranging wires neatly not only increases the esthetic appearance of your robot, but also makes trouble-shooting easier. For example, neat wire arrangements make it easier to visually ascertain correct insertion of a socket and avoid such things as stepping the socket over a pin or missing pins altogether. Plugging and unplugging sockets also becomes more manageable.

Table 14 Connecting the TALRIK-IV Cables to the MEKAVR128™ Microcontroller

Cable Name		From: Socket S1	To MEKAVR128™ Header Socket S2	Polarized S1, S2
BATTERY & CHARGE				
CBATT		Battery Snap Connector	BATT(1,2,3,4) = (red, N.C., black, N.C.) = (power, N.C., N.C., ground)	Yes, Yes
CCHARGE		Charge Jack Soldered	CHARGE(1,2,3,4) = (white, N.C., black, N.C.) =(power, N.C., N.C., ground)	Yes, Yes
CMODE		Download / Run Toggle Switch Soldered	PE4(1,2,3) = (yellow, N.C., orange) = (PE4, N.C., ground)	No, No
CPWR		Power Toggle Switch Soldered	PWR_SWITCH(1,2) = (red, brown) = (Battery+, 5v Regulator-Input)	No, No
CRESET		Reset Switch Soldered	RESET(1,2) = (blue, green) = (RESET', ground)	No, No
CFRONTBMP(Uses 10 wires attached to 40-pin IDC Connector)				
CBSW02 CBSW01 CBSW12 CBSW11 CBSW10	**CFRONT-BMP**	Front Bumper Switches Soldered at 2, 1, 12, 11, 10 o'clock on the *Top Plate*.	FRONTBMP(1,2,3,4,5,6,7,8,9,10) = (brown,…,white, black) 10 wires of ribbon cable	No[1], No
CREARBMP(Uses 10 wires attached to 40-pin IDC Connector)				
CBSW04 CBSW05 CBSW06 CBSW07 CBSW08	**CREAR-BMP**	Rear Bumper Switches Soldered at 4, 5, 6, 7, 8 o'clock on the *Top Plate*.	REARBMP(11,12,…,19,20) = (brown,…,white, black) 10 wires of ribbon cable	No[1], No
CFM FREQUENCY MODULATED OUTPUTS (Optional) (FM1 to FM8 attached to 40-pin IDC Connector)				
CFM1 to CFM8	**CFM**	User LEDs (anode, cathode) =(yellow, green) or User Device	PB(4) = FM1=FM2= …= FM7 = FM8 (yellow, green) = (FMk, SIPk) pairs, k=1…8; or 16 wires of ribbon cable	Yes, Yes

[1] Bumper switches are not polarized, so the wires soldered to the two switch terminals may be reversed without electrical functional effect.

Table 15 Connecting the TALRIK-IV Cables to the MEKAVR128™ Microcontroller (Continued)

Cable Name	From: Socket S1	To MEKAVR128™ Header Socket S2	Polarized S1, S2
		IR RANGE DETECTORS	
CIR09	IR Range Sensor 2mm keyed socket	MUX09(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes
CIR10	IR Range Sensor 2mm keyed socket	MUX10(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes
CIR12	IR Range Sensor 2mm keyed socket	MUX12(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes
CIR02	IR Range Sensor 2mm keyed socket	MUX14(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes
CIR03	IR Range Sensor 2mm keyed socket	MUX15(1,2,3) = (gray, white, black) =(signal, power, ground)	Yes, Yes
		LEDS	
CCHARGELED	Green LED (white, black) = (cathode, anode)	Connects to Charge Jack through a 470 Ohm resistor. The header CHARGELED is shorted with a jumper.	Yes, NA
CPWRLED	Red LED (white, black) = (cathode, anode)	PWR_LED(3,4) = (white, black)	Yes, Yes
		PHOTORESISTORS	
CECDSL	Left Photoresistor Pan Head (yellow, orange)	MUX17(1,2,3)= ECDSL (orange, gray, yellow) =(signal, power, ground)	No, Yes
CECDSM	Middle Photoresistor Pan-Head (yellow, orange)	MUX18(1,2,3)= ECDSM (orange, gray, yellow) =(signal, power, ground)	No, Yes
CECDSR	Right Photoresistor. Pan-Head (yellow, orange)	MUX19(1,2,3)= ECDSR (orange, gray, yellow) =(signal, power, ground)	No, Yes
CNCDSL	Left Photoresistor *Top Plate* (yellow, orange)	MUX21(1,2,3)= NCDSL (orange, gray, yellow) =(signal, power, ground)	No, Yes
CNCDSM	Middle Photoresistor *Top Plate* (yellow, orange)	MUX22(1,2,3)= NCDSM (orange, gray, yellow) =(signal, power, ground)	No, Yes
CNCDSR	Right Photoresistor *Top Plate* (yellow, orange)	MUX23(1,2,3)= NCDSR (orange, gray, yellow) =(signal, power, ground)	No, Yes

Table 16 Connecting the TALRIK-IV Cables to the MEKAVR128™ Microcontroller (Continued)

Cable Name	From: Socket S1	To MEKAVR128™ Header Socket S2	Polarized S1, S2
SERVO			
CSERV00 Pan-Servo	Servo	PA0(1,2,3) = (orange, red, brown)	N.A.[1], Yes
CSERV01 Tilt Servo	Servo	PA1(1,2,3) = (orange, red, brown)	N.A. [1], Yes
CSERV02 Wrist Servo	Servo	PA2(1,2,3) = (orange, red, brown)	N.A. [1], Yes
CSERV03 Gripper Servo	Servo	PA3(1,2,3) = (orange, red, brown)	N.A. [1], Yes
CSERV04-CSERV07	Servo	PA4(1,2,3) to PA07(1,2,3)	N.A. [1], Yes
CSERV08-CSERV13	Servo	PC7(1,2,3) down to PC2(1,2,3)	N.A. [1], Yes
CSERV14 Right Wheel	Servo	PC1(1,2,3) = (orange, red, brown)	N.A. [1], Yes
CSERV15 Left Wheel	Servo	PC0(1,2,3) = (orange, red, brown)	N.A. [1], Yes
UNASSIGNED MEKAVR128™ ANALGO INPUTS			
CMUX4 to CMUX8	User Device	MUX4(1,2,3) to MUX8(1,2,3) (violet, gray, white)	Yes, Yes
CMUX11	User Device	MUX11(1,2,3) = (violet, gray, white)	Yes, Yes
CMUX13	User Device	MUX13(1,2,3) = (violet, gray, white)	Yes, Yes
CADC2 to CADC6	User Device	ADC2(1,2,3) to ADC6(1,2,3) (white, black, brown)	Yes, Yes
CMUX16	User Device	MUX16(1,2,3) = (violet, gray, white)	Yes, Yes
UNASSIGNED MEKAVR128 PORTS			
CPB0 to CPB7	User Device	PB0(1,2,3) to PB7(1,2,3) (green, blue, violet)	Yes, Yes
CPD0 to CPD7	User Device	PD0(1,2,3) to PD7(1,2,3) (orange, yellow, green)	Yes, Yes
CPE2	User Device	PE2(1,2,3) = (yellow, green, blue)	Yes, Yes
CPE3	User Device	PE3(1,2,3) = (yellow, green, blue)	Yes, Yes
CPE5 to CPE7	User Device	PE5(1,2,3) to PE7(1,2,3) (yellow, green, blue)	Yes, Yes
CPG3	User Device	PG3(1,2,3) = (blue, violet, gray)	Yes, Yes
CPG4	User Device	PG4(1,2,3) = (blue, violet, gray)	Yes, Yes

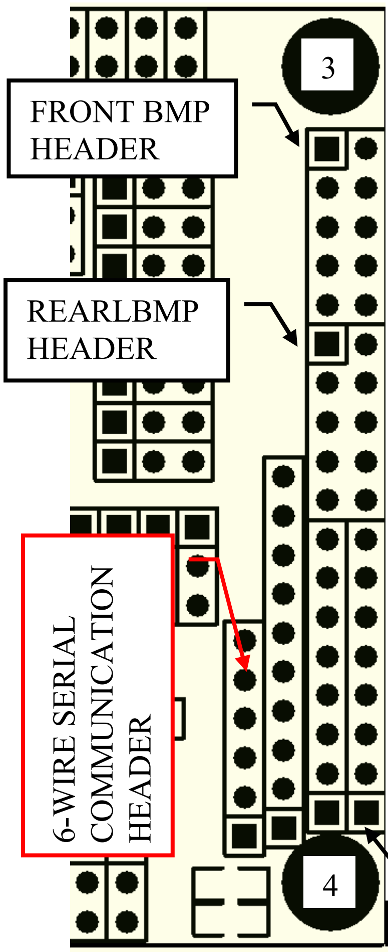
[1]N.A. = Not Applicable, there is no socket at the servo end of the servo cable.

14.2 Connect the Bumper Switches and the FM Signal Cables

After you have constructed the bumper switch and FM ribbon cable, plug the 40-pin Insulation Displacement Connector (IDC) onto the combine male headers

FRONTBMP, REARBMP, FM8, FM7, FM6, FM5, FM4, FM3, FM2, FM1

as indicated in Figure 69. For proper alignment the lead-off brown and red wires of the IDC connect to pin-1 and pin-2 of the FRONTBMP male header. The unused portion of the 40-pin IDC (pins 37 to 40) overlaps corner-4.

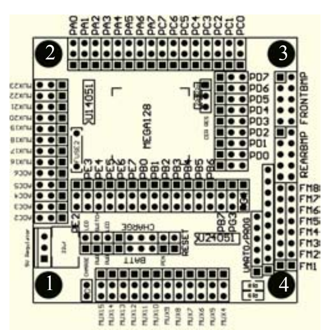


BOTTOM OF MICROCOMPUTER
BUMPER SWITCH CONNECTIONS
(CLOCK POSITIONS)

HEADER		*LEFT PIN*	*RIGHT PIN*	*CABLE*
BSW02	**FRONTBMP**	**BROWN (01)**[1]	**RED (02)**	**CFRONT-BMP**
BSW01		**ORANGE(03)**	**YELLOW(04)**	
BSW12		**GREEN (05)**	**BLUE (06)**	
BSW11		**VIOLET (07)**	**GRAY (08)**	
BSW10		**WHITE (09)**	**BLACK (10)**	
BSW04	**REARBMP**	**BROWN (11)**	**RED (12)**	**CREAR-BMP**
BSW05		**ORANGE(13)**	**YELLOW(14)**	
BSW06		**GREEN (15)**	**BLUE (16)**	
BSW07		**VIOLET (17)**	**GRAY (18)**	
BSW08		**WHITE (19)**	**BLACK (20)**	
[FM8]	**FM HEADER**	[USER] (21)	[USER] (22)	CFM8
[FM7]		[USER] (23)	[USER] (24)	CFM7
[FM6]		[USER] (25)	[USER] (26)	CFM6
[FM5]		[USER] (27)	[USER] (28)	CFM5
[FM4]		[USER] (29)	[USER] (30)	CFM4
[FM3]		[USER] (31)	[USER] (32)	CFM3
[FM2]		[USER] (33)	[USER] (34)	CFM2
[FM1]		[USER] (35)	[USER] (36)	CFM1

[1] **Numbers in parentheses are IDC pin numbers.**

Figure 69. The Bumper and FM headers are located along edge 3-4 of the board. The pin numbers of the 40-pin IDC are shown in parentheses in the table entries. The small header layout at the right orients the figure in the upper-left by the placement of the labeled corners.



14.3 Mount the Switches and LEDs onto the Bridge Supports.

Gather together the fabricated CMODE, CCHARGE, CPWRLED, CCHARGELED, and CRESET, cables. Refer to Figure 70, Figure 71, and Figure 72 during the execution of the following steps.

Right Bridge Support

1. Mount the *Download/Run* toggle switch in the upper-left hole on the *Right Bridge Support* with the lock washer and nut that comes with the switch..
2. Mount the push button *Reset* switch in the lower-left hole on the *Right Bridge Support* with the lock washer and nut that comes with the switch.
3. Mount the *Power-On* toggle switch in the lower-right hole on the *Right Bridge Support* with the lock washer and nut that comes with the switch.
4. Insert an *LED Mount* and a red power-on LED into the upper-right hole on the *Right Bridge Support*. Hot glue the *LED Mount* and LED to the hole to mechanically secure them.
5. You will use the rectangular hole to pass the CIR03 cable to the circuit board.

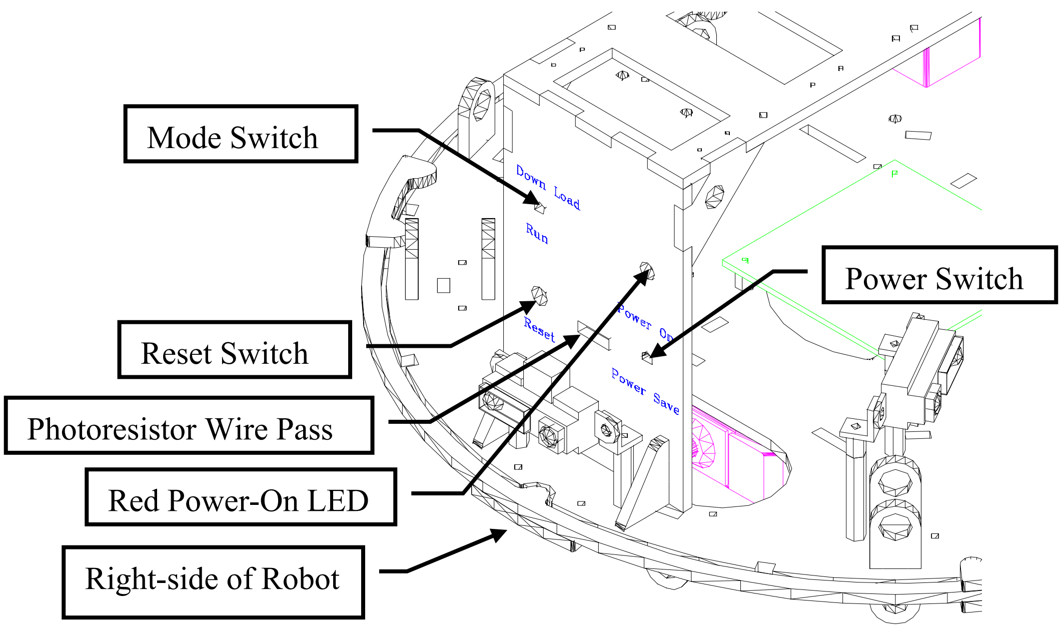


Figure 70. Mount the Mode (Download/Run), Reset and Power switches and the red power-on LED through the *Right Bridge Support*.

Left Bridge Support

1. Mount the charge jack in the large hole on the *Left Bridge Support* with the lock washer and nut that comes with the jack.
2. Insert an *LED Mount* and a green charge LED into the top hole on the *Left Bridge Support*. Hot glue the *LED Mount* and LED to the hole to mechanically secure them.
3. You will use the rectangular hole to pass the CIR09 cable to the circuit board

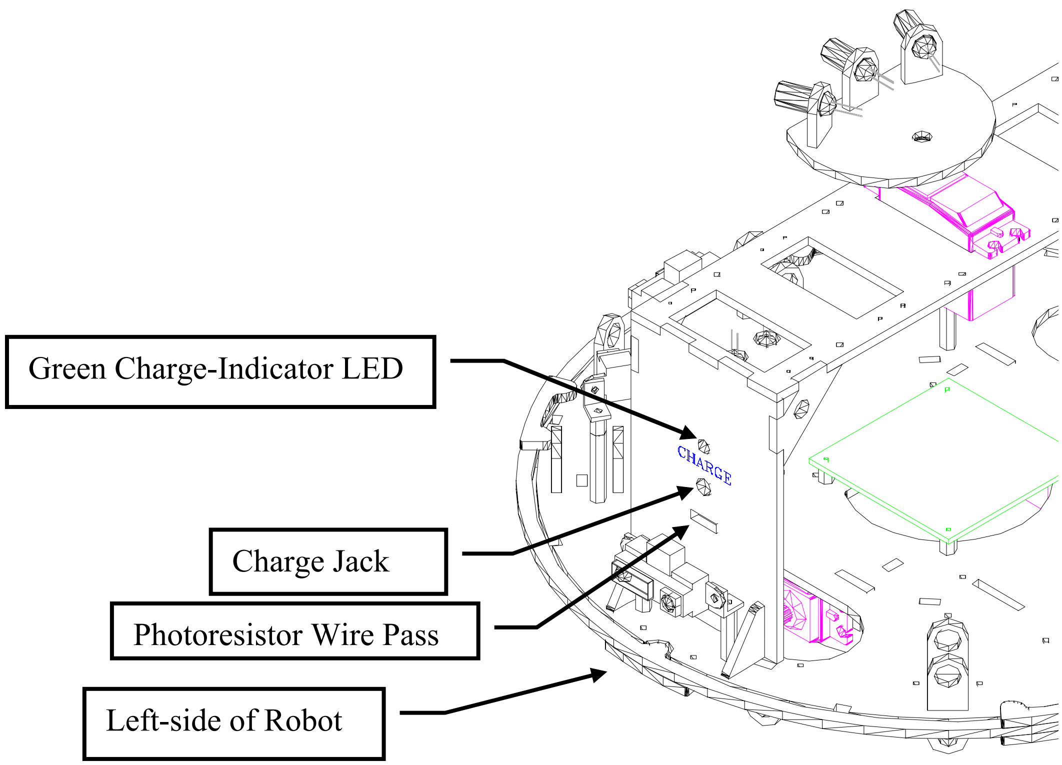


Figure 71. Mount the charge jack and the green charge-indicator LED through the *Left Bridge Support*.

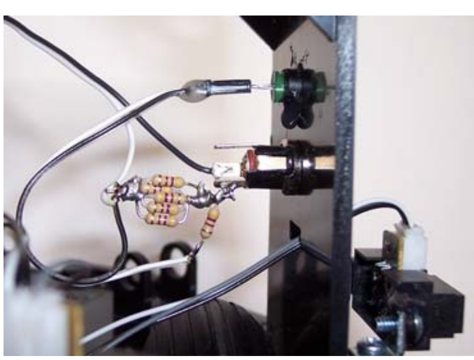
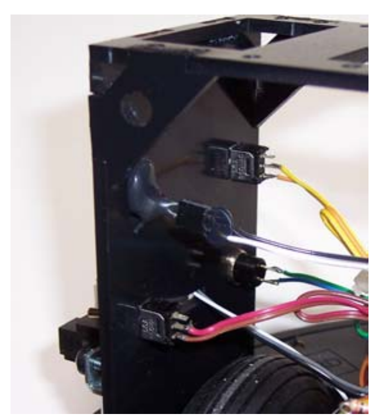


Figure 72. The photograph on the left shows the Left-Bridge Support with charge jack and green charge LED and the photograph on the right shows the *Right Bridge Support* with Mode, Reset and Power switches plus the red power-on LED. Note the IR range sensor cables threading through the slots of the bridge supports.



14.4 Connect CBATT, CCHARGE, CRESET, CPWR, CCHARGELED CPWRLED Cables To the MEKAVR128 Microcontroller

Take the socket end of the CBATT, CCHARGE, CRESET, CPWR, CPWRLED cables and plug them into the MEKAVR128 microcontroller headers as shown in Figure 73 and Figure 74.

NOTE BENE

Short the pins of the CHARGELED header with a jumper. The robot will not operate without this header shorted. The CCHARGELED cable DOES NOT CONNECT to the CHARGELED header. Rather, CCHARGELED solders to the recharge jack at one end and plugs into the green LED at the other end, as shown earlier (e.g., refer to Figure 72***).***

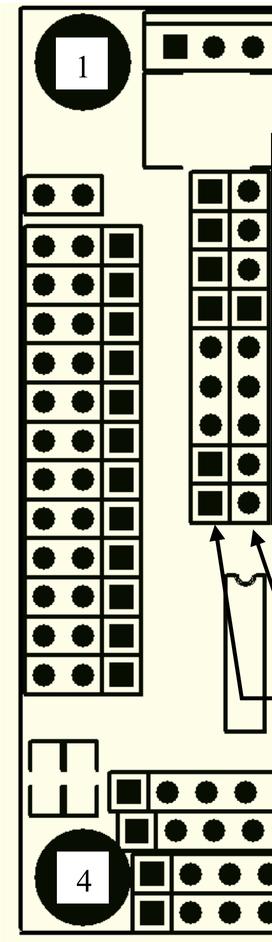
While circuit fuses should protect against damaging the MEKAVR128™, reversing the polarity of the power cable is definitely not a good practice! Polarity reversal can happen when you attempt to fasten the snap connector end of the power cable to the battery pack while the 4-pin female header of CBATT is connected to the board. Even though the snap connector will not snap over the battery pack erroneously, the damage might occur if even momentary electrical contact is made with the snap buttons reversed. As a precaution, snap or unsnap the battery pack with CBATT NOT attached to the board, or, be extra cautious when disconnecting the battery pack with CBATT connected.

WARNING! WARNING! WARNING !

PLUG CBATT's 4-PIN POWER SOCKET INTO THE MEKAVR128™ BOARD AFTER COMPLETE ASSEMBLY OF THE ROBOT AND ALL CABLE CONNECTIONS ARE VERIFIED.

FOR PROTECTION AGAINST POLARITY REVERSAL OF THE BATTERY PACK, THE SNAP END OF CBATT SHOULD ALWAYS BE CONNECTED TO THE BATTERY PACK BEFORE CONNECTING THE OTHER END OF CBATT (4-PIN FEMALE SOCKET) TO THE MEKAVR128™ BOARD.

TOP OF MICROCOMPUTER



CABLE COLORS

HEADER	*LEFT PIN*	*RIGHT PIN*	*CABLE*
CHARGE LED	NA	NA	Short
POWER SWITCH	RED	BROWN	CPWR
POWER LED	WHITE	BLACK	CPWRLED
BATT / CHARGE	RED	WHITE	CBATT / CCHARGE
BATT / CHARGE	N.C.	N.C.	
BATT / CHARGE	BLACK	BLACK	
BATT / CHARGE	N.C.	N.C.	
[PEN]	[PIN]	[GROUND]	NONE
RESET	BLUE	GREEN	CRESET

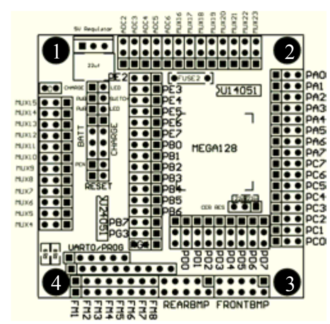


Figure 73. This figure indicates the header and color code for the associated cable connections. The CBATT (battery cable) and CCHARGE (charge jack cable) 4-pin sockets, fit vertically over four pins (BATT in red and CHARGE in magenta, respectively). The two pin connectors of CCHARGELED, CPWR, CPWRLED and CRESET span two horizontal pins. The small header layout in the lower-right orients the figure to the left by the placement of the labeled corners. The PEN (Program Enable) header must be left open in order for the Mekatronix boot loader to operate; otherwise the microcontroller expects a serial downloading protocol established by ATMEL™ for downloading programs to their microcontrollers.

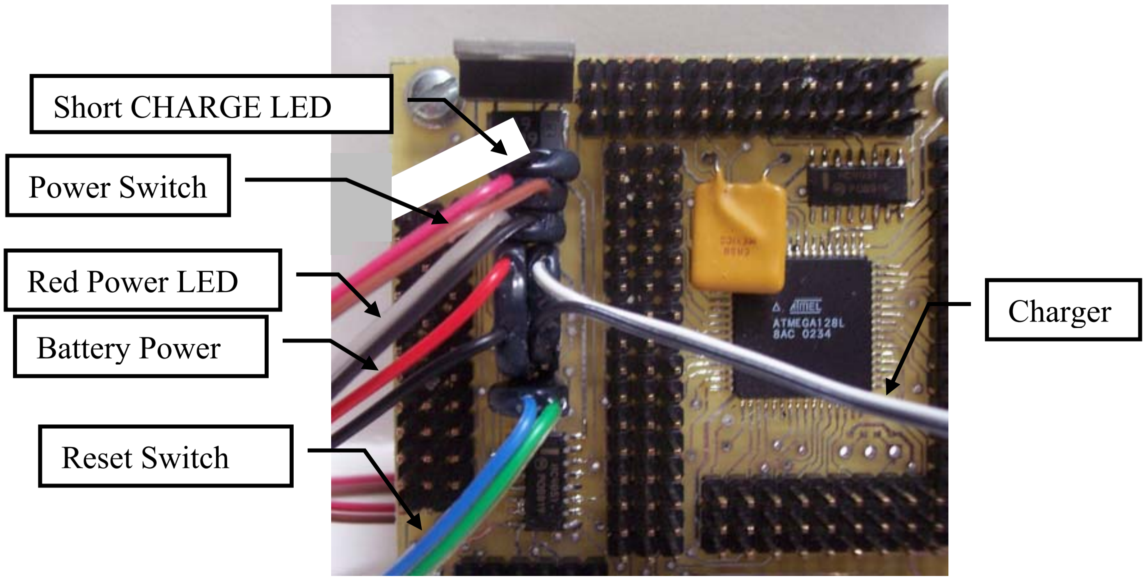


Figure 74. This figure illustrates all the connections labeled in Figure 73. The cable colors match those indicated in Figure 73.

14.5 Mode (Download/Run) Switch Connection on the MEKAVR128

The *Download/Run* switch attaches to header PE4(1,2,3) = (PE4, N.C., Ground). Placing the switch in the *Download* position forces a logical zero on PORTE pin PE4 configured as an input pin. The *Run* position forces a logic one on the PE4 input pin. A photo of the connection in Figure 75 illustrates how to connect the switch to the microcontroller. Figure 76 indicates the connection schematically.

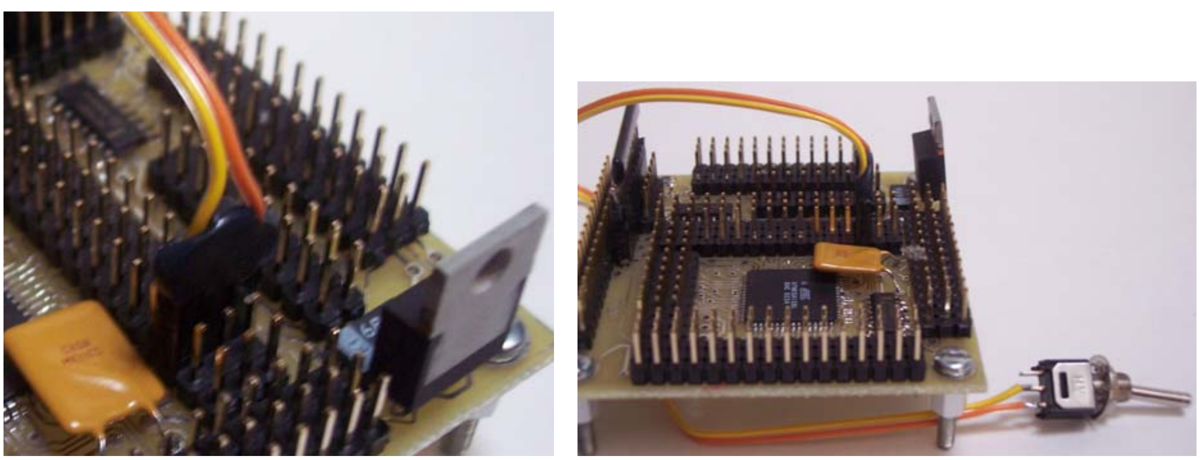
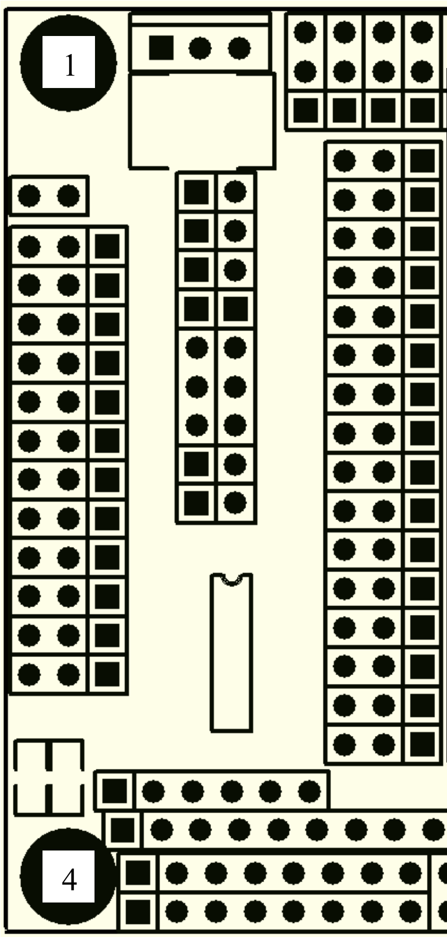


Figure 75. Download/Run mode switch connection.



DOWNLOAD/RUN & USER DEFINED DIGITAL INPUT/OUTPUT (IO) OR SPECIAL FUNCTION

HEADER	*LEFT PIN-3*	*MID PIN-2*	*RIGHT PIN-1*	*CABLE*
PE2(1,2,3)	---	---	---	---
PE3(1,2,3)	---	---	---	---
PE4(1,2,3)	Orange	*N.C.*	Yellow	**CMODE**
PE5(1,2,3)	---	---	---	---
PE6(1,2,3)	---	---	---	---
PE7(1,2,3)	---	---	---	---
PB0(1,2,3)	---	---	---	---
PB1(1,2,3)	---	---	---	---
PB2(1,2,3)	---	---	---	---
PB3(1,2,3)	---	---	---	---
PB4(1,2,3)	---	---	---	---
PB5(1,2,3)	---	---	---	---
PB6(1,2,3)	---	---	---	---
PB7(1,2,3)	---	---	---	---
PG3(1,2,3)	---	---	---	---
PG4(1,2,3)	---	---	---	---

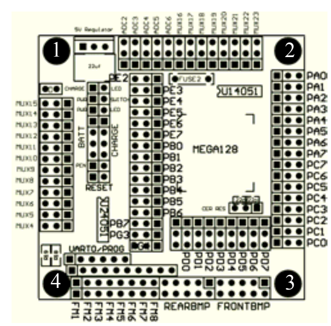
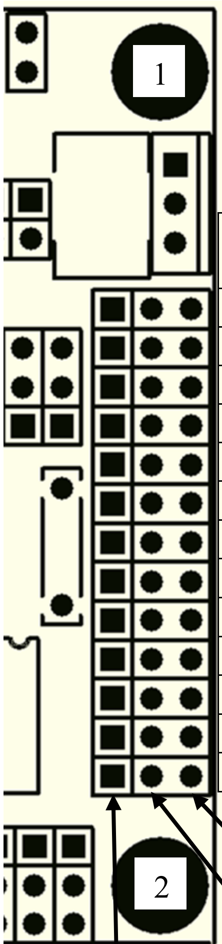


Figure 76. Connect the Download/Run Switch to header PE4(1,2,3) on the Mekavr128 Microcontroller board. The small header layout on the right orients the figure on the upper-left by the placement of the labeled corners.

14.6 Photoresistor Cable Connections to the MEKAVR128

Figure 77 and Figure 78 indicate how to plug the 6 photoresistor light sensor cable (C*CDS*) sockets into the requisite headers. The table in Figure 77 highlights the unused analog inputs in gray. Figure 79 illustrates how the photoresistor cables connect the “eye” photoresistor light sensors on the *Sensor Head* to the MEKAVR128™ board. The yellow wires connect to the pins on the edge of the board and the orange wires connect to pin 1 of each header. The other three photoresistors connect to the line-following (“nose”) sensors on the top plate (Figure 80).



PHOTORESISTOR CONNECTIONS

HEADER	*LEFT PIN-1*	*MID PIN-2*	*RIGHT PIN-3*	*CABLE*	*FUNCTION*
ADC2(1,2,3)	---	---	---	---	---
ADC3(1,2,3)	---	---	---	---	---
ADC4(1,2,3)	---	---	---	---	---
ADC5(1,2,3)	---	---	---	---	---
ADC6(1,2,3)	---	---	---	---	---
MUX16(1,2,3)	---	---	---	---	[Left IR Argos]
MUX17(1,2,3)	**Orange**	**Gray**	**Yellow**	**CECDSL**	Eye CdS Left
MUX18(1,2,3)	**Orange**	**Gray**	**Yellow**	**CECDSM**	Eye CdS Middle
MUX19(1,2,3)	**Orange**	**Gray**	**Yellow**	**CECDSR**	Eye CdS Right
MUX20(1,2,3)	---	---	---	---	[Right IR Argos]
MUX21(1,2,3)	**Orange**	**Gray**	**Yellow**	**CNCDSL**	Nose CdS Middle
MUX22(1,2,3)	**Orange**	**Gray**	**Yellow**	**CNCDSM**	Nose CdS Right
MUX23(1,2,3)	**Orange**	**Gray**	**Yellow**	**CNCDSR**	Nose CdS Left

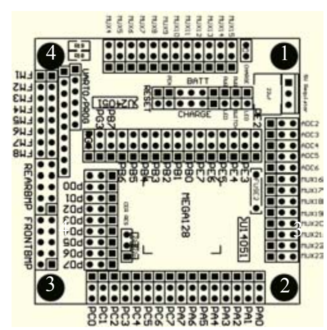


Figure 77. The row of three-pin headers along the top edge (edge 1-2) of the MEKAVR128 microcontroller board provide connections for the six standard photoresistor light sensors (cadmium sulfide cells). The top five, unused, three-pin headers (ADC2 through ADC6) serve as direct inputs to analog channels 2 through 6. The remaining unused connectors multiplex into analog channel 1. The small header layout on the right orients the figure on the upper-left by the placement of the labeled corners.

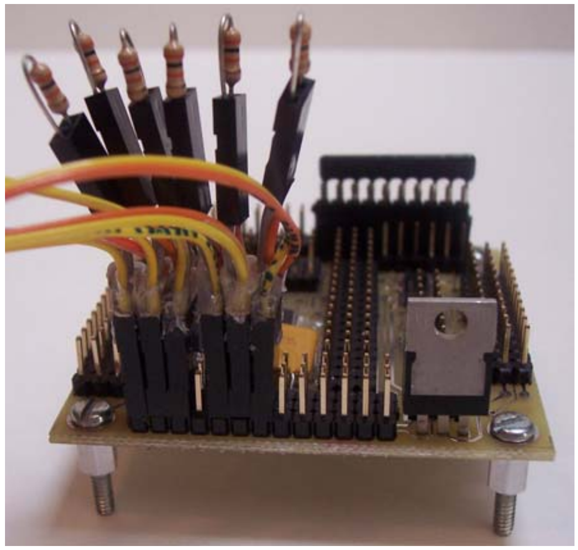


Figure 78. From this front view of the Mekavr128 microcontroller board, the six photoresistor sensors connect from left-to-right to the line-following ("nose") NCDSR, NCDSM, NCDSL and to the ambient light detectors ("eye") ECDSR, ECDSM, ECDSL, the two groups being separated by an Unused Analog Input.

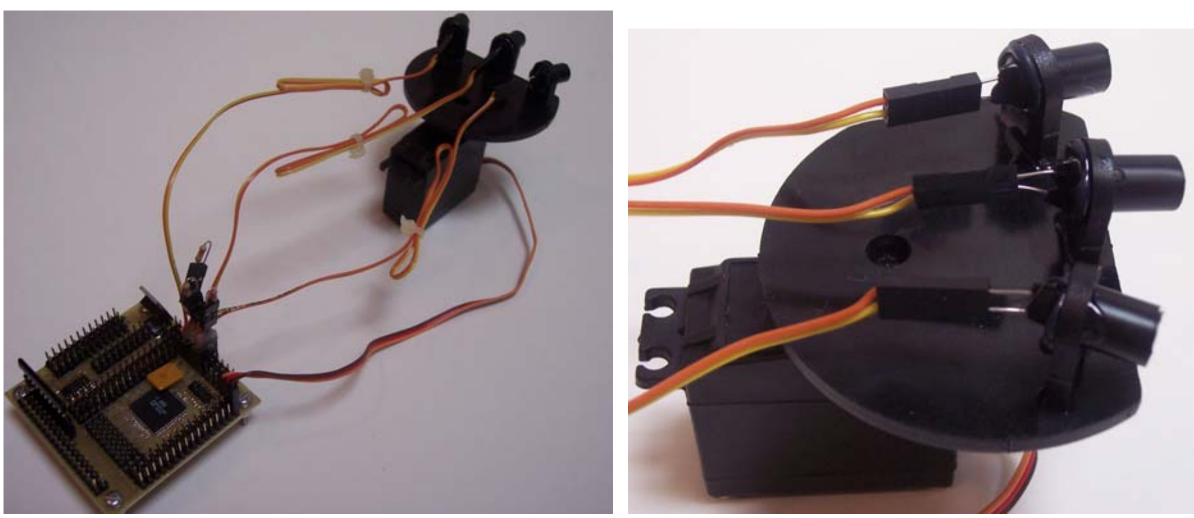


Figure 79. The photoresistors cables connect the ambient light detectors ECDSR, ECDSM, ECDSL on the pan servo to the Mekavr128 microcontroller board. The pan servo cable connects the servo to the microcontroller.

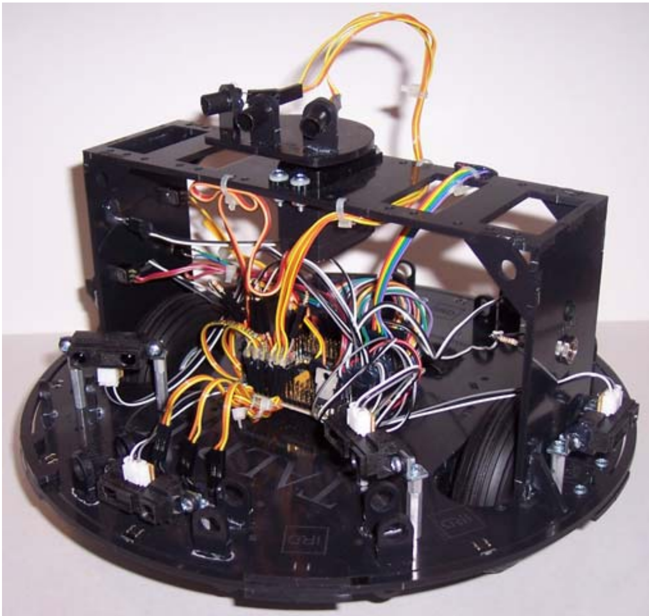
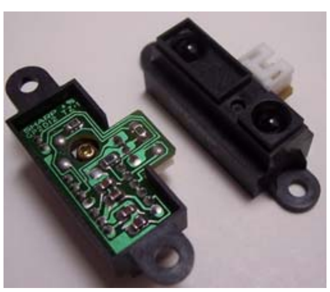


Figure 80. This view of a completed model shows the 6 photoresistor sensors connections, three on the *Sensor Head* and three on the *Top Plate*.

14.7 Connecting the IR Range Sensor Cables to the MEKAVR128™ Board

Figure 81 illustrates how to connect an IR range sensor to the MEKAVR128™ board and the sensor itself. The ground (black) wire connects to the outside pin through the 3-pin, 0.1inch between pin-centers, socket. The mechanically keyed 2mm connector at the other end of the cable fits into the socket provided by the sensor. Figure 82 and Figure 83 display how to connect the five IR range sensors to the MEKAVR128™ headers. The clock position on the *Top Plate* of each sensor is specified by the digits in its cable number, CIR03 is at 3 o'clock, CIR02 is at 2'o'clock, etc. The flat socket of cables CIR03 and CIR09 must be threaded through the right and left bridge supports, respectively, before plugging into the board (Figure 80).



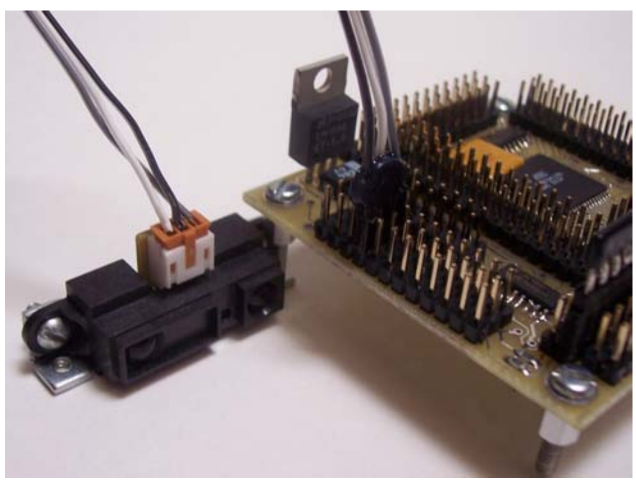
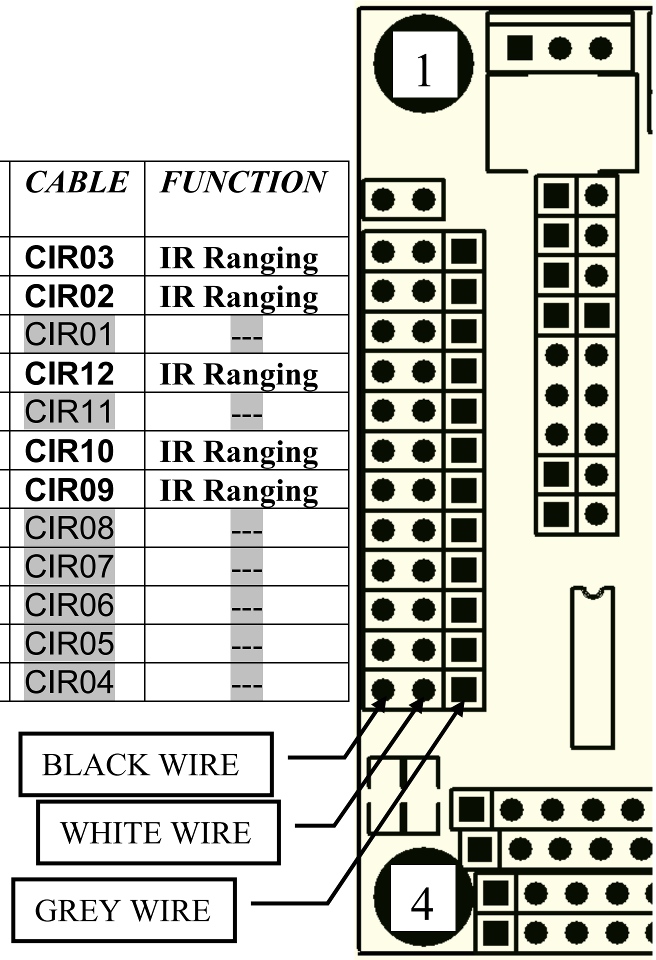


Figure 81. The 2 mm connector on a CIRxx cable inserts into the IR range sensor's mechanically keyed socket. The 3-pin, 0.1 inch between-centers, socket of the cable plugs into the appropriate header on the MEKAVR128™ board.

IR DETECTORS

HEADER	*LEFT PIN-3*	*MID PIN-2*	*RIGHT PIN-1*	*CABLE*	*FUNCTION*
MUX15(1,2,3)	**Black**	**White**	**Gray**	**CIR03**	**IR Ranging**
MUX14 (1,2,3)	**Black**	**White**	**Gray**	**CIR02**	**IR Ranging**
MUX13 (1,2,3)	Black	White	Gray	CIR01	---
MUX12 (1,2,3)	**Black**	**White**	**Gray**	**CIR12**	**IR Ranging**
MUX11 (1,2,3)	Black	White	Gray	CIR11	---
MUX10(1,2,3)	**Black**	**White**	**Gray**	**CIR10**	**IR Ranging**
MUX9 (1,2,3)	**Black**	**White**	**Gray**	**CIR09**	**IR Ranging**
MUX8 (1,2,3)	Black	White	Gray	CIR08	---
MUX7 (1,2,3)	Black	White	Gray	CIR07	---
MUX6(1,2,3)	Black	White	Gray	CIR06	---
MUX5 (1,2,3)	Black	White	Gray	CIR05	---
MUX4(1,2,3)	Black	White	Gray	CIR04	---



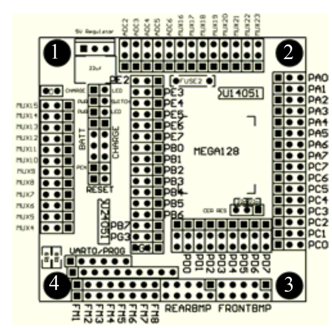


Figure 82. The row of three-pin headers along the left edge (edge 1-4) of the MEKAVR128 microcontroller board provide connections for the five standard IR range sensors. The unused analog inputs may be used to install more IR range sensors or other analog inputs. The small header layout on the right orients the figure on the upper-right by the placement of the labeled corners

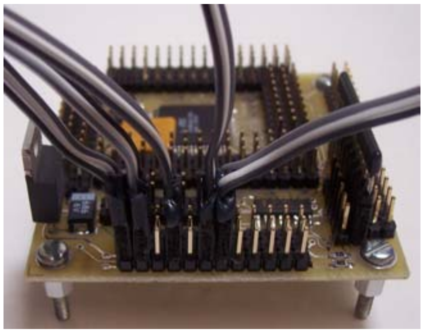


Figure 83. This picture shows all five IR range sensor cables plugged into the standard headers on the MEKAVR128™ board. From left-to-right the IR sensors are located at 3, 2, skip, 12, skip, 11, and 10 o'clock on the *Top Plate*, where 12 o'clock is at the front-center of the plate.

14.8 Connecting Servo and Motor Cables to the MEKAVR128™ Board

Figure 84 illustrates how to plug in the wheel motor (hacked servo) cables. Observe that the wheel cables thread up through the center of the robot. With the MEKAVR128™ oriented as shown Figure 85, the servos and motors connect to the right-hand column of 3-pin male headers as indicated. The left wheel motor is at the bottom of the column and the right wheel motor connects just above it. Pin PA0, at the very top of the column of servo headers, drives the pan servo for the *Sensor Head*. The 13 gray-highlighted header table entries indicate servo/motor expansion capabilities. These headers can be used to drive any combination of servos and servos hacked as D.C. motors.

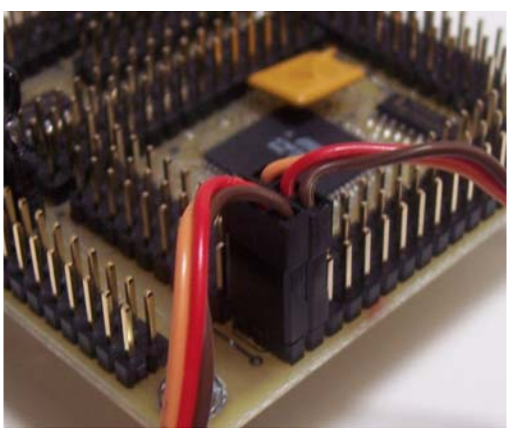
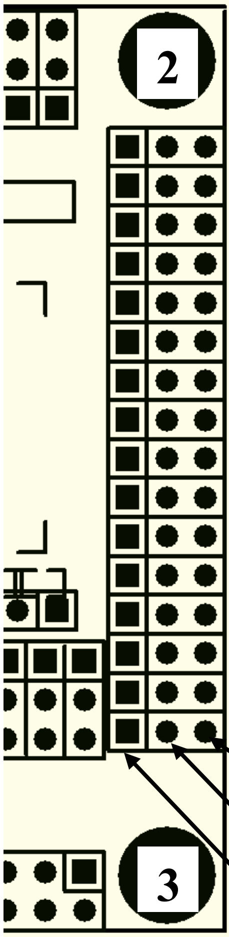
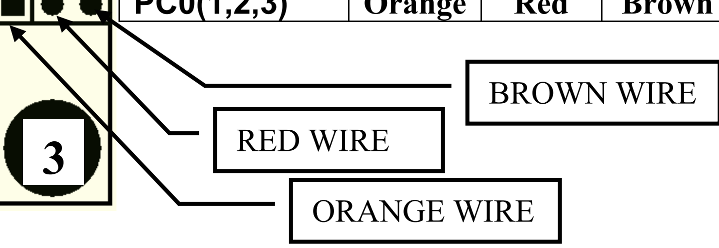


Figure 84. The left photograph shows the right and left wheel motor sockets plugged into the lower two servo/motor headers: PC1(1,2,3) and PC0(1,2,3). A wheel motor is shown mounted in the right photograph.

SERVO/MOTOR DRIVES



HEADER	*LEFT PIN-1*	*MID PIN-2*	*RIGHT PIN-3*	*FUNCTION*
PA0(1,2,3)	Orange	Red	Brown	PAN SERVO
PA1(1,2,3)	Orange	Red	Brown	TILT/SHOULDER
PA2(1,2,3)	Orange	Red	Brown	MEKARM WRIST
PA3(1,2,3)	Orange	Red	Brown	MEKARM GRIPPER
PA4(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 4]
PA5(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 5]
PA6(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 6]
PA7(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 7]
PC7(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 8]
PC6(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 9]
PC5(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 10]
PC4(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 11]
PC3(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 12]
PC2(1,2,3)	Orange	Red	Brown	[SERVO/MOTOR 13]
PC1(1,2,3)	Orange	Red	Brown	RIGHT WHEEL
PC0(1,2,3)	Orange	Red	Brown	LEFT WHEEL



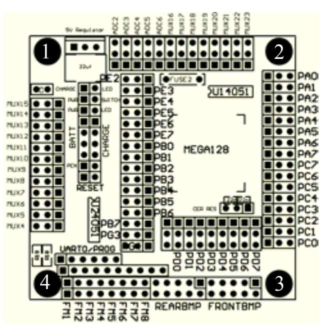


Figure 85. The column of 3-pin male connectors on the right edge (edge 2-3) of the MEKAVR128 circuit board drives any combination of 16 servos and servos hacked to operate as gearhead D.C. motors. The top connector drives the pan servo on the bridge and the bottom two servo headers drive the right and left wheel motors of the minimally configured TALRIK-IV. The MekArm shoulder, wrist and gripper servos (purchased separately) connect just below the pan servo, driven by PA1(1,2,3), PA2(1,2,3), PA3(1,2,3), respectively. [SERVO/MOTOR n], n ranges from 4 to 13, allow for user servo and motor expansion and future Mekatronix add-on products.

15 COMPLETED ASSEMBLY

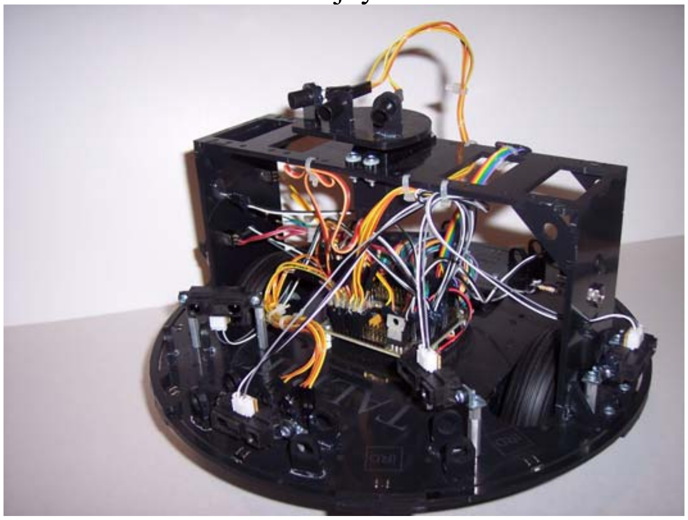
You have now completely assembled TALRIK-IV™ (Figure 86). Now it is time to run a test program to verify operation. Go to the TALRIK-IV™ Users Manual for details.

Share with other TALRIK-IV™ owners your experiences and programs via the *Web*. Check

http://www.mekatronix.com

for details.

Enjoy!



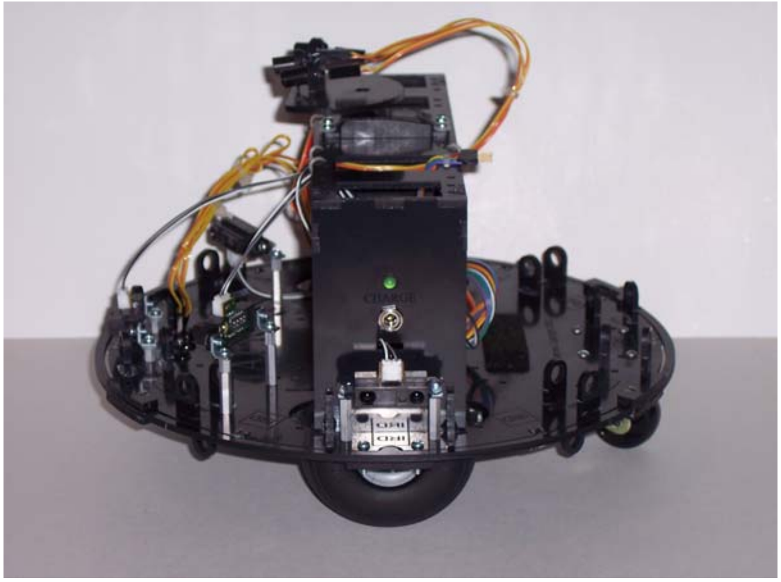


Figure 86. Pictures of a completed TALRIK-IV™ robot standard kit.