ARGOS™ ASSEMBLY AND USERS MANUAL

by
Keith L. Doty
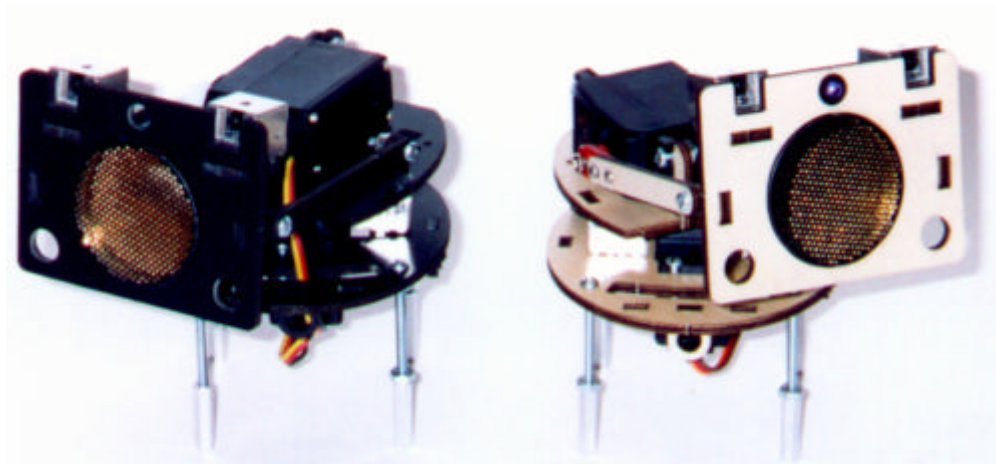
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1. INTRODUCTION TO ARGOS™ KITS

The Argos™ name applies to a number of Mekatronix kit options for the TALRIK JR.™ (TJ™), TALRIK JR. PRO™ (TJ PRO™), ROBOBUG™ and TALRIK II ™ robots. This product suite divides into three main branches, the Argos™ Pan-Tilt Mechanics Package, Argos™ Sensor Package and the Argos™ Sensor Expansion Board with line following, force sensing and multiplexed analog channels. This manual does not cover the Argos™ Sensor Expansion Board, which is described in a separate manual. The photographs in Figure 1 show how the Argos™ Head mounts on the Mekatronix autonomous mobile robot product line.
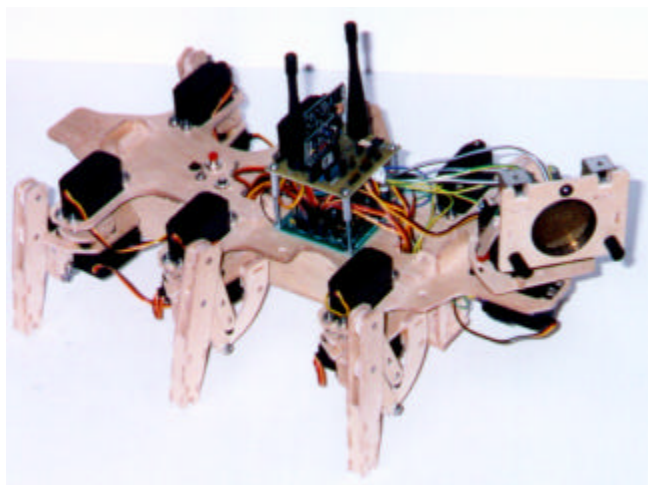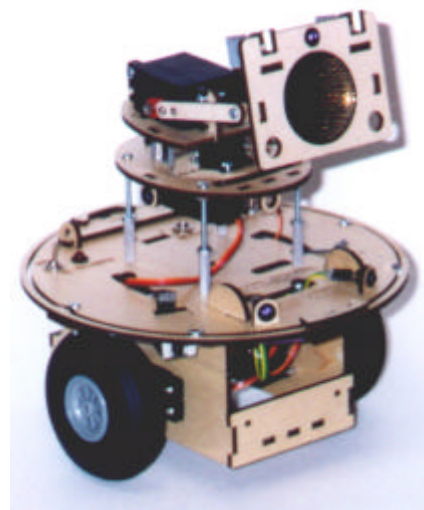
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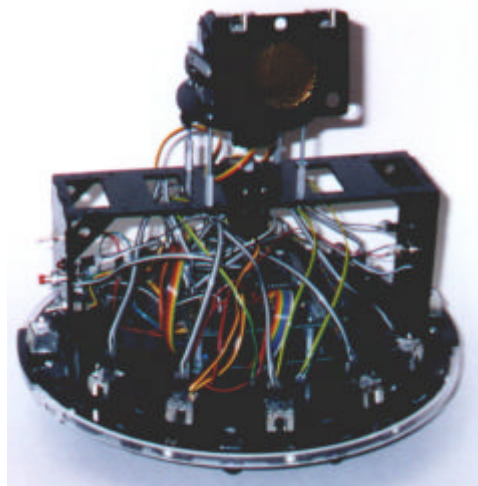
c)

Figure 1. These photographs illustrate the mounting of the Argos™ Pan-Tilt head on a) ROBOBUG™, b) TJ and TJ PRO, c) TALRIK II.

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A complete Argos™ Pan-Tilt head consists of two tiers. The lower layer, called the mezzanine (see Figure 2), supports a servo actuator that rotates a turret platform attached to it. The turret supports a second servo that generates tilt motion to any sensor or actuator head attached to the second servo. Fully assembled TJ Pro Argos™ Pan-Tilt head looks somewhat like a two-tier wedding cake (refer to Figure 1).

The turning axes of the pan servo on the mezzanine and the tilt servo on the turret intersect at right angles. For the TJ™ and TJ PRO™ robots the mezzanine axis passes through the center of the robot and the turret axis parallels the center wheel axis of the robot. These axis alignments provide a number of computational conveniences. For example, the angle of the pan servo about its own axis equals the angle of the pan servo with respect to the heading of the robot.

ROBOBUG™ does not require the use of the mezzanine platform since it already has a pan servo mount at its front. For the TALRIK II™ you have a choice, 1) use the bridge servo as the pan-servo and eliminate the mezzanine or 2) mount the entire Argos™ Pan-Tilt Head on the TALRIK II™ bridge.

Descriptions of the various Argos™ kit options appear in the sections to follow.

2. ARGOS PAN-TILT HEAD KIT

Table 1 lists the mechanical components of the Argos™ kit. The Argos™ Mechanical kit sheet (Figure 2) illustrates the name, shape and number of Argos™ parts. The six *linkmounts* insert into slots on the *turret*, *spirh* sensor head, and *camerah* sensor head, two for each. Two sets of *links* and *servlinks* permit you to attach individual linkage to each of the two sensor heads, although this is not necessary because sensor heads themselves switch out just as easy as switching out the linkage with the sensor heads.

Table 1 Argos Mechanical Kit

Qty	Part #	Description
1	argos-camerah	Argos Head for Camera(optional), 2 IR Detectors, 2 IR Emitters (only one IR emitter in basic kit)
4	argos-cdseyelet	CdS eyelets – optional use
4	argos-irdmount	IR Detector mount
4	argos-ireyelet	IR LED eyelets – optional use
2	argos-link	Connecting link from head to turret
6	argos-linkmount	Link mounting posts
1	argos-mezzanine	Mezzanine platform
2	argos-servlink	Connecting link from tilt-servo to head
2	argos-servmount	Tilt-servo Mount
1	argos-spirh	Argos Head for Sonar (optional), 2 Photoresistors, 2 IR Detectors & 1 IR LED – optional use
1	argos-turret	Turret

Table 2 lists the mounting hardware and the two servos that actuate the head, the *pan-tilt* servo and the *tilt-servo*.

Table 2 Argos Servos and Hardware Kit

2	MS492	Mekatronix standard servos
4	1 ½ inch 4/40 screws	1 ½ inch 4/40 screws for mezzanine mount
4	¾ inch hex standoffs	¾ inch hex standoffs for mezzanine mount
8	½ inch 4/40 screws	½ inch 4/40 screws for servo and linkage fastening
2	¼ inch horn wood screws	¼ inch horn wood screws for tilt linkage
4	4/40 nuts	4/40 nuts for servo and mezzanine mounting
4	4/40 lock nuts	4/40 lock nuts for mounting tilt linkages
4	4/40 lock washers	4/40 lock washers for servo mounting

Table 3 lists the basic electrical and sensor kit for the Argos package.

Table 3 Argos Basic Sensor Kit

Qty	Part #	Description
2	MCDS01	Cadmium Sulfide photoresistor
1	MIR27E	IR Emitter for MIR58Y40A Detectors
2	GP1U58Y[1]	40 kHz Digital Infrared Receiver, Y-axis leads
2 feet	GWBR03	Gray-White-Black ribbon wire for MIR58Y40A
2 feet	OYR02	Orange-Yellow ribbon wire for MCDS01
1 foot	YGR02	Yellow-Green ribbon wire for MIR27E
1	F1x36	One row, 36-pin Female connector
2	R33K	33K ohm Resistors (nominal) for CdS voltage divider
1	R220	220 ohm current limiting resistor for IR LED

[1]The digital IR receivers must be hacked to make them function as analog IR receivers. Refer to either the TJ Pro Assembly Manual or the IR Hack White Paper on www.mekatronix.com under *Manuals* or *Free Stuff* , respectively.
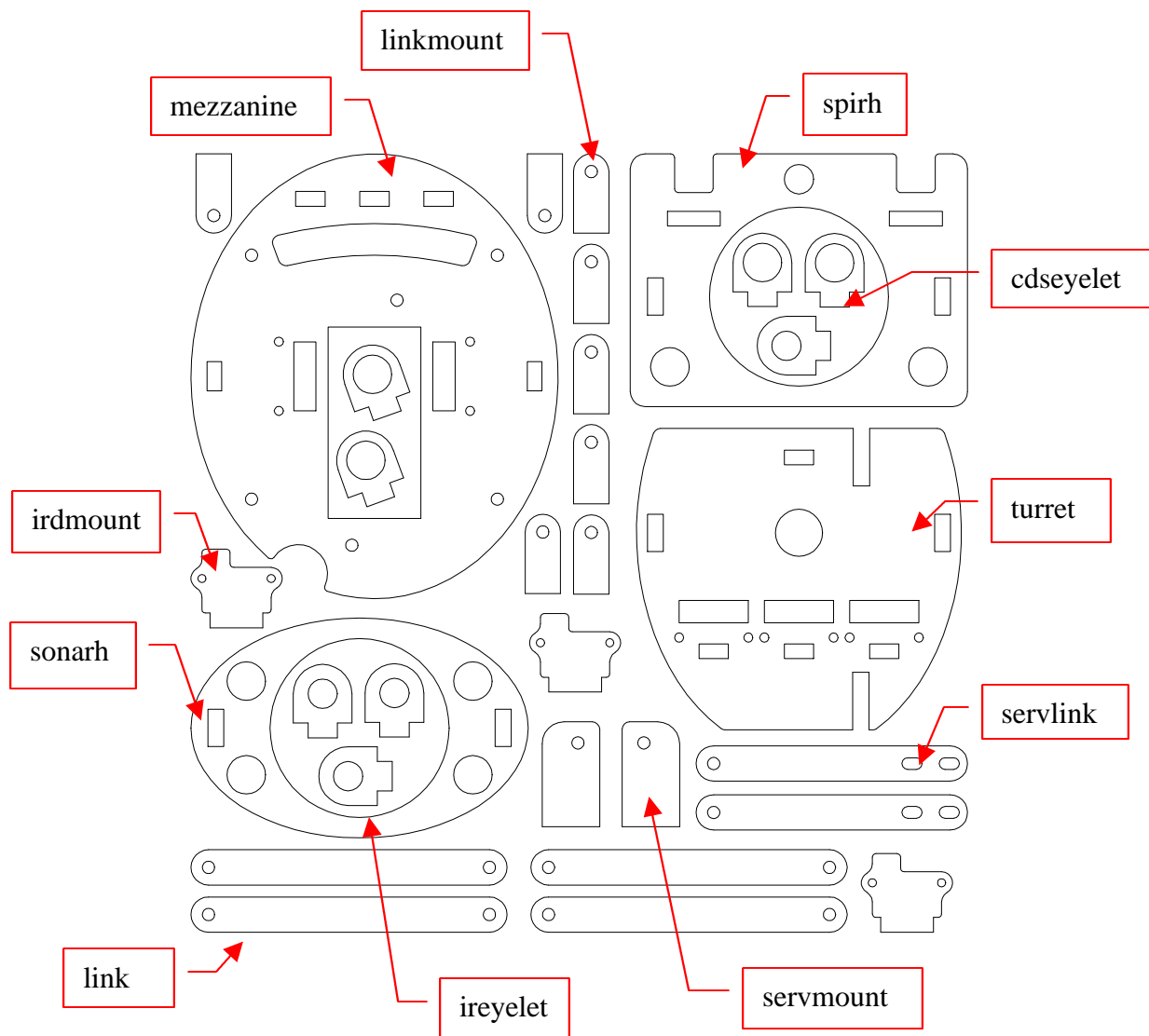
Figure 2. This drawing illustrates and names all the distinct cut parts for the Argos MECHANICAL Kit

3. ARGOS MECHANICAL ASSEMBLY

Tools and Materials

1. Screwdriver, slot-head, for 4/40 screws
2. Screwdriver, phillips-head, servo horn screws
3. Small wrench for tightening 4/40 nuts
4. Cyanoacrylate adhesive (super glue)
5. Fine grain sandpaper and (Optional) paint or clear-coat
6. Knife to cut out tabbed parts

An exploded view of the Argos mechanical assembly (Figure 3) will help you to visualize where the different parts go.
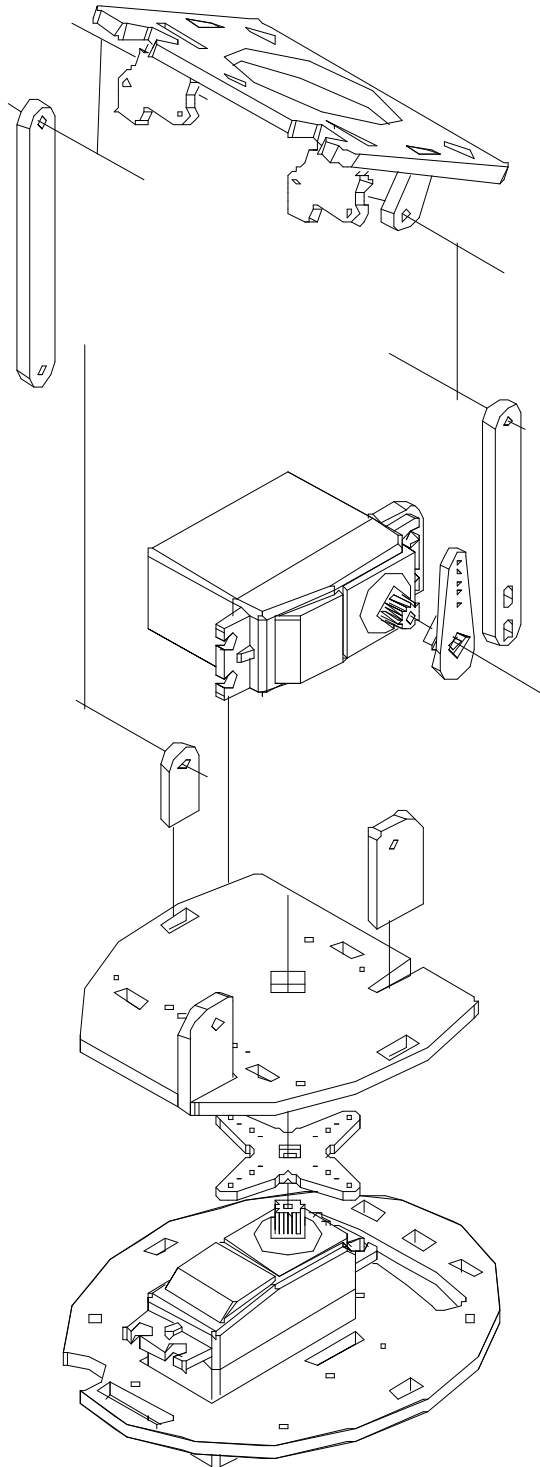
Figure 3. Argos™ Pan-Tilt Head Assembly exploded view.

Figure 4 shows a top view of the Argos™ turret. Either end of the turret may serve as the front of the turret, depending upon whether a tilt servo is mounted or not. The long straight-lined segment of the perimeter is the front of the turret when using the tilt-servo, whereas the shorter straight-lined segment is the front when no tilt-servo is used.

The Argos™ turret tilt-servo produces a turning axis perpendicular to the center axis perpendicular to the page and passing through the center of the circular cutout. Figure 3 helps to visualize the tilt-servo turning axis more easily (also refer to Figure 11). The pan-servo output shaft axis coincides with the center axis of the robot.
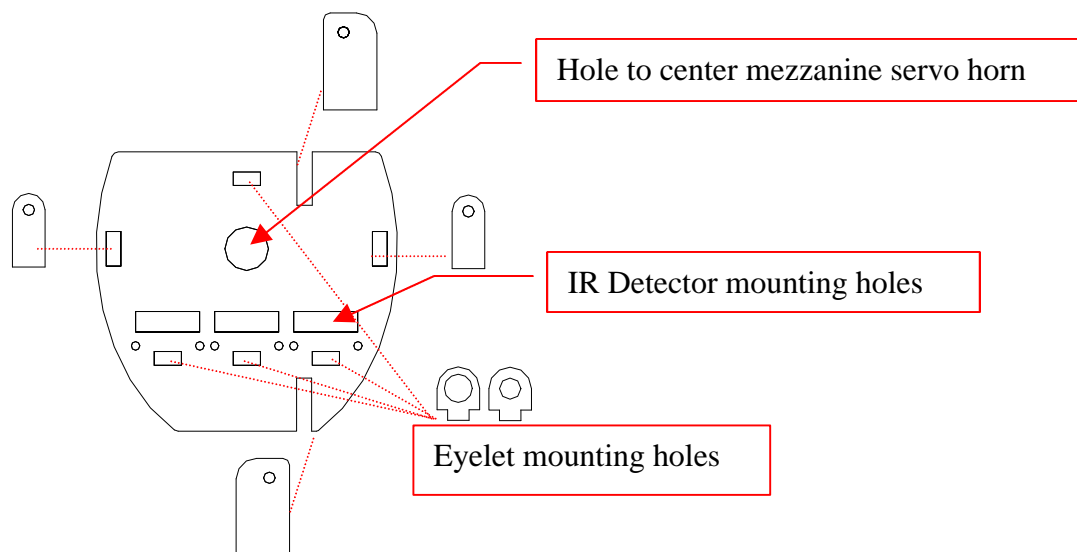
Figure 4. This diagram shows where the *servmounts*, and *linkmounts* fit in the turret. The long side is the front of the turret. The *linkmount* on the right side is not used if the tilt-servo is mounted. If you do not use the tilt-servo, you can mount *ir* or *cds eyelets* in the slots indicated or three IR detectors whose output pins thrust through the three large rectangular slots.

The cutouts at either end of the turret hold vertical tabs (*servomounts*), refer to
Figure 4 and Figure 5. The tilt-servo attaches to these tabs. The slots to the left and right hold tabs (*linkmounts)* which support rotating links to a sensor head. A tilt-servo horn replaces the left tab when a tilt servo is used. This allows the tilt-servo to raise and lower any attached sensor head. The three small rectangular slots at one end hold eyelets for IR and visible LEDs, photoresistors, or small switches. A single eyelet at the other end usually holds an *on-off* toggle switch for a sonar sensor. The larger rectangular slots behind them pass the three pins of an IR detector. The tilt-servo blocks these eyelets and the IR detector slots. These slots cannot be used with the tilt-servo mounted. Sensor heads still mount on the turret, even without a tilt servo, but then the sensor head can be adjusted manually but not actively with a servo
.

With glue, attach the underneath side of the turret to a servo horn fixed to the mezzanine pan-servo.
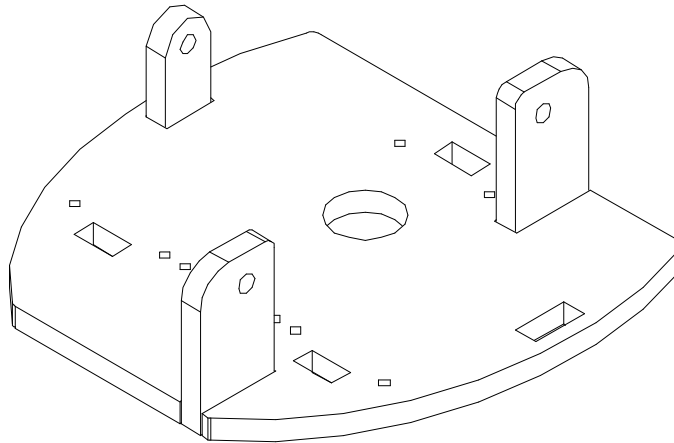
Figure 5. Turret subassembly ready for mounting tilt-servo. The *linkmount* on the right-side of the turret is not used when the tilt-servo is mounted. If the tilt-servo is not mounted (Pan-head only), then the two *servmount* parts are not required and a second *linkmount* must be inserted in the slot provided on the right side of the turret.

3.1 Pre-assembly

1. Cut out tabbed parts (Figure 2) as needed.
2. Lightly sand the wooden parts or clean off all burrs on the wood or plastic parts. DO NOT SAND THE PLASTIC finished surfaces.
3. Coat wooden parts with clear coat for a natural look, or paint wood or plastic, if desired. Be sure the paint is dry before continuing with assembly.

3.2 Argos™ Mezzanine Assembly Instructions

TJ™ and the TJ PRO™ Robots
1. Place the pan-servo into the *mezzanine* layer with the output shaft centered. Fasten with two, ½ inch, 4/40 screws, nuts and lock washers. The nuts and lock washers mount on the underside.
2. Insert 1 ½ inch 4/40 screws through the four round holes on the *mezzanine*, heads flush against the top surface. On the underside, fasten a nut on each screw and tighten against the surface of the *mezzanine* to lock the screw into place.
3. Screw the four ¾ inch standoffs onto the 1 ½ inch screws the same number of turns. When the Argos assembly is completed, these standoffs screw onto the four printed circuit board mounting screws projecting through the top plate of the robot and can be adjusted to make the platform level.
4. Mount the pan-servo into the *mezzanine* with the output shaft centered (refer to bottom of Figure 3). Use two diagonally opposite, ½ inch 4/40 screws with nuts and lock washers fixed on the underneath side of the *mezzanine* to clamp the servo onto the *mezzanine*.

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TALRIK II™ Robots
1. Mount the pan-servo directly on the TALRIK II™ Bridge and eliminate the *mezzanine*,
   > OR
2. Mount Argos *mezzanine* as described for the TJ™ or TJ PRO™. The *mezzanine* will mount on any of the three sets of four screw holes provided for mounting MSC11 boards on the TALRIK II™ Bridge.

ROBOBUG™
1. Do not use the *mezzanine*. Mount the pan-servo directly on ROBOBUG™'s head mount with two screws and lock nuts placed at diagonally opposite corners (screws are not needed for the other two holes),
   > OR
2. Mount the mezzanine in the middle segment of the BUG, just above the MSCC11 microcontroller board. The mounting instructions for the TJ™ and TJ PRO™ robots apply in this case.

3.3 Argos Turret Assembly

These instructions apply to the TJ™, TJ PRO™, ROBOBUG™, and TALRIK II™.

1. Glue the *servomounts* perpendicular to the plane of the *turret* in the slots provided (refer to
2. Figure 4 and Figure 5). The bottoms of the *servomounts* must be flush with the bottom surface of the *turret* and with the rounded edges furthest from the center.
3. a. If you plan to mount the tilt-servo, the usual case, then, on the left side of the *turret*, glue a *linkmount* perpendicular to the *turret* in the rectangular slots provided (Figure 5). Do not attach a *linkmount* on the right side of the turret.
   > OR

   b. If you plan not to use the tilt-servo, insert the right-side *linkmount*. *But do not Glue*. By not gluing it, you can remove it later if you decide to mount a tilt-servo. The *linkmounts* must project out of the turret on the same side as the *servmounts* and the other ends must be flush with the bottom surface of the *turret*. Skip to the section on Argos Head Assembly.

4. Center a servo horn with 2 or more arms on the underneath side of the *turret* center hole and glue. The top-center of the servo horn should be visible and centered in the *turret* hole.
5. Secure the horn and turret subassembly onto the pan-servo output shaft with the horn screw.
6. Mount the tilt-servo on the *servomounts* with two ½ inch 4/40 screws, nuts and lock washers.

3.4 Argos™ HEAD ASSEMBLY

Figure 6 illustrates a planar layout of the Argos™ sensor head (*spirh*) and Figure 7 offers a three-dimensional rendering of the head assembly. Insert and glue the *linkmounts* and *irdmounts* as shown. The *irdmounts* are stepped and will limit the insertion to the proper depth (*CAUTION! Before gluing be sure the* irdmounts *are mounted as shown in Figure 7 or you will not be able to mount the IR detectors properly*). The *linkmounts* are not stepped and so must be inserted until flush on the opposite surface of the head.

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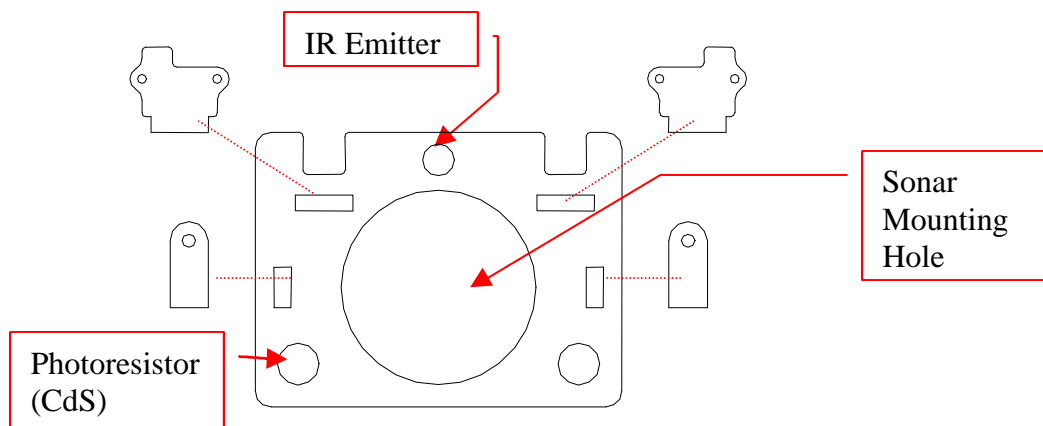
Figure 6. Argos™ head (*spirh*) for mounting sonar, two IR detectors, one I R emitter, and two CdS photoresistors. Observe that the projection of the *irdmounts* must be on the right side when inserted. This arrangement allows the three pins of the MIR58Y40A to clear the mount and project downward.
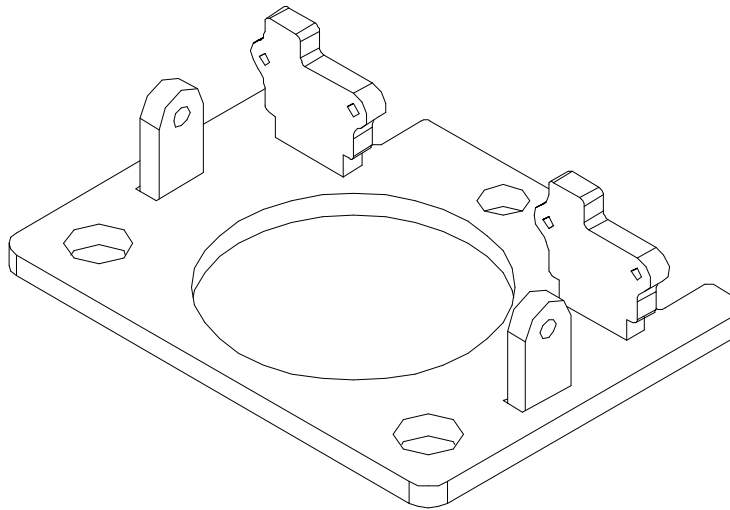
Figure 7. This three dimensional rendering of the Argos™ head (*spirh*) shows the IR detector mounting plates (*irdmount*) and the *linkmounts* glued into place.

3.5 Mount Argos™ IR Emitter

Refer to Figure 8 for mounting the MIR27E.
1. Insert the black, plastic T-1 ¾ LED panel mounts into the Argos™ head. These fit in from the front. Push the flared end, which compresses, into the hole first.
2. Insert the IR emitters into the LED panel mounts from the backside.
3. The short lead on the IR emitter is the cathode of the LED diode.

On the *camerah* (Figure 2), two IR emitters (MIR27E) mount below the sonar. These holes, while smaller than the holes for the photoresistors (CdS cells) in the *spirh*, are located in the same spots as the latter.

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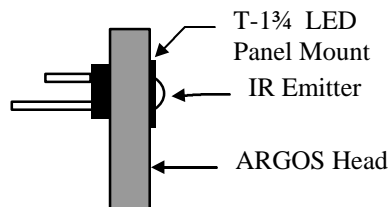
Figure 8. Mounting an IR emitter into the Argos™ Head. In the above diagram, the black plastic T-1 ¾ panel mount pushes in from right-to-left. The LED is pushed in from left-to-right until it snaps into the flared part of the panel mount.

3.6 Mount Argos™ Photoresistors (CdS Cells)

Photoresistors (MCDS01) can be mounted onto any *spirh* in the two holes just below and to each side of the sonar hole (Figure 6). Two can be mounted on the *spirh* head. Figure 9 illustrates how to mount them through the sensor head holes. Close off the back of the device by heating the back end of the shrink-wrap until soft and pinching it closed against the leads. This construction will seal off any light leakage from the backside of the sensor and will collimate the light arriving from the front. Apply just enough heat so that the shrink wrap almost starts to melt. HOT! BE CAREFUL! DO NOT PINCH OFF WITH YOUR BARE FINGERS!

After adjusting the projection depth of the shrink-wrap collimator to your satisfaction, you can lock the collimator into place with a small glob of hot glue on either side. To free the collimator for further adjustment, simply chip the hot glue away, adjust and reglue.
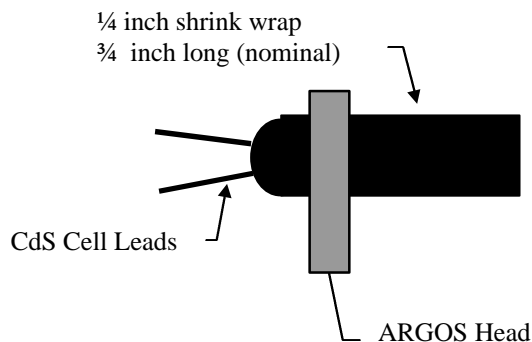
Figure 9. Mounting collimated CdS photoresistors in a cannon configuration. A stiff grade shrink-wrap collimates the light striking the CdS cell. The collimated CdS cell slides through the Argos sensor head. This arrangement makes the CdS cell extremely direction sensitive. To obtain less direction sensitivity, you will need to shorten the barrel suitable to your application.

The *camerah* does not have holes for mounting photoresistors (Figure 2).

3.7 Mount IR Detectors on Argos™ Head

The IR receivers come as digital and must be hacked to analog (Refer to a white paper *IR HACK* on www.mekatronix.com or the TJ Pro Assembly Manual for hacking IR receivers). Thrust the two MIR58Y40A mounting tabs through the small holes on the *irdmounts*. Take care that the three pins of the IR detector clear the *irdmount*. The frictional fit should hold. If not, glue them on the mounts to keep them there.

3.8 Mounting Sonar on an Argos™ Head

Both the *camerah* and *spirh* heads (Figure 2) provide an aperture for mounting the optional Mekatronix MUST01 sonar device. Simply insert the MUST01 through the backside of the opening and attach by gluing along the small annular outside edge of the sensor where it contacts the back face of the head.

3.9 Attaching the Argos Head to the Turret

Two links connect the Argos sensor head to the turret (Figure 10 and Figure 11). These links are fastened to the *linkmounts* on the head and the turret with ½ inch 4/40 screws and lock nuts.

Figure 10. Tilt-head link on the left, the longer of the two, attaches to the turret *linkmount* away from the tilt-servo output shaft. The shorter tilt-head *servolink* on the right attaches to the tilt-servo horn with two small screws. The combined length of the short *servolink* with the servo horn equals the length of the longer *servolink.* The *linkmounts* on the ends glue into the slots provided on the turret and the tilt head. Screws (4/40) join the *links* with the *linkmounts*. and are locked into place with 4/40 hex lock nuts.

If no tilt-servo is used, then two long links connect the turret with the head. These links can be manually adjusted to provide the correct elevation and orientation for the head.

3.10 Manual Adjustments to Argos™ Sensor Heads

If not clamped too securely, the screws on the sensor head *linkmounts* may be manually rotated to adjust the attitude of the sensor head. Or, you can loosen the screws somewhat, adjust the head, and then clamp securely. With zero angle defined when the head *linkmounts* line up with the *links* attached to the turret, the sensor head can tilt up to 90 degrees forward and 60 degrees back. This extra degree of freedom greatly enhances the utility of the Argos™ sensor head.
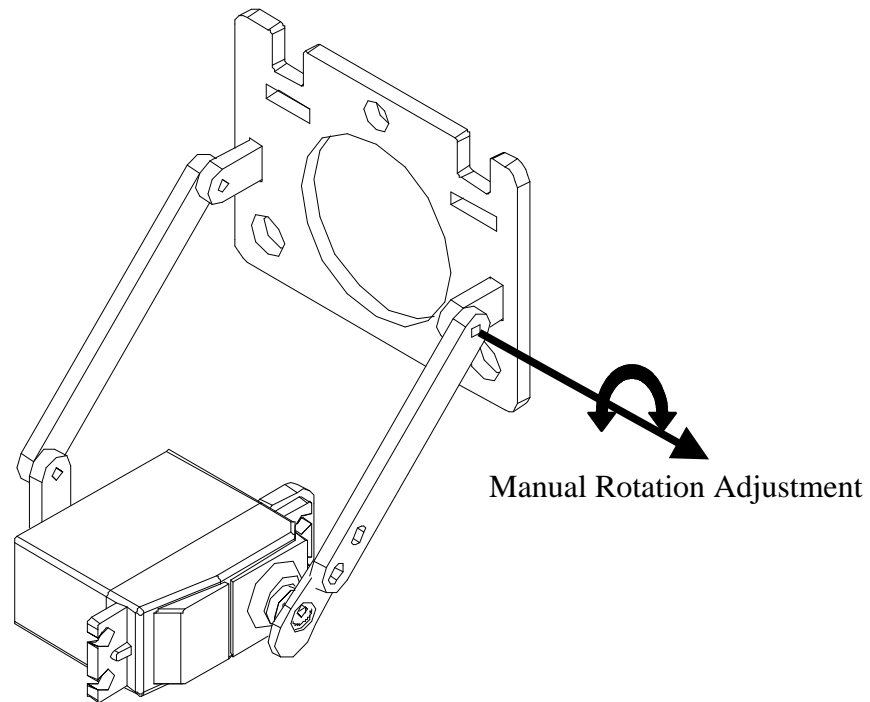
Figure 11. The assembled linkage between the tilt-servo and the Argos™ head. If the tilt servo is not used then the right side is replaced by one of the longer *servolinks* and a second *linkmount* attached to the turret.

3.11 Mounting Sonar (Optional)

Insert the sonar from the backside of the hole provided in the sensor head. Lightly glue the sonar into place. The 7-pin connector on the sonar head should be in back and at the bottom of the sensor head. The bottom of the head is the edge furthest away from the IR detector mounts on top of the head plate. The front plate of the sonar has two different circular dimensions providing a small annular ring to glue against the back side of the head piece.

3.12 Mounting a Color Camera (Optional)

The camera sensor head in your kit, *camerah*, provides a hole to insert Mekatronix miniature color camera. Two screw holes at diagonal positions permit mounting the camera securely to the head. The color camera kit sells as a separate Argos™ option. Additional parts, assembly and application details come with the Mekatronix Projection Reality Camera system.

3.13 Final Mechanical Assembly of the Argos Pan-Tilt Platform

At this point you should have mounted:
1. The *mezzanine* with pan-servo onto the robot,
2. The *turret* with tilt-servo onto the *mezzanine*, or just the *turret*,
3. The *links* and sensor-head to the *turret*,
4. All the basic sensors and optional sonar onto the sensor head.

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The mechanical assembly of the Argos Pan-Tilt (or, Pan) Head is now complete. Next the cables must be constructed and connected.

4. ARGOS ELECTRICAL ASSEMBLY

At this stage you should have completed the mechanical assembly of the Argos™ Pan-Tilt Head. The following sections instruct you in the construction and connection of the sensor cables.

Cable Nomenclature
Cable designator Mn = n-pin male connector, Fn= n-pin female connector, Wn = n-wires between the connectors. As a notational example: an F3W2M2 cable designates a 2-wire cable with a 3-pin female connector at one end and a 2-pin male connector at the other end.   For detailed cable nomenclature refer to the TJ™ Assembly Manual.

4.1 Cable Assembly

Tools: Wire cutter and stripper, soldering iron and solder, hot-glue gun and hot-glue.
Assembly: You will need to construct 5 cables, each approximately one foot in length.
Do not separate the ribbon wires, except where needed to strip the ends and solder.

MIR58Y40A
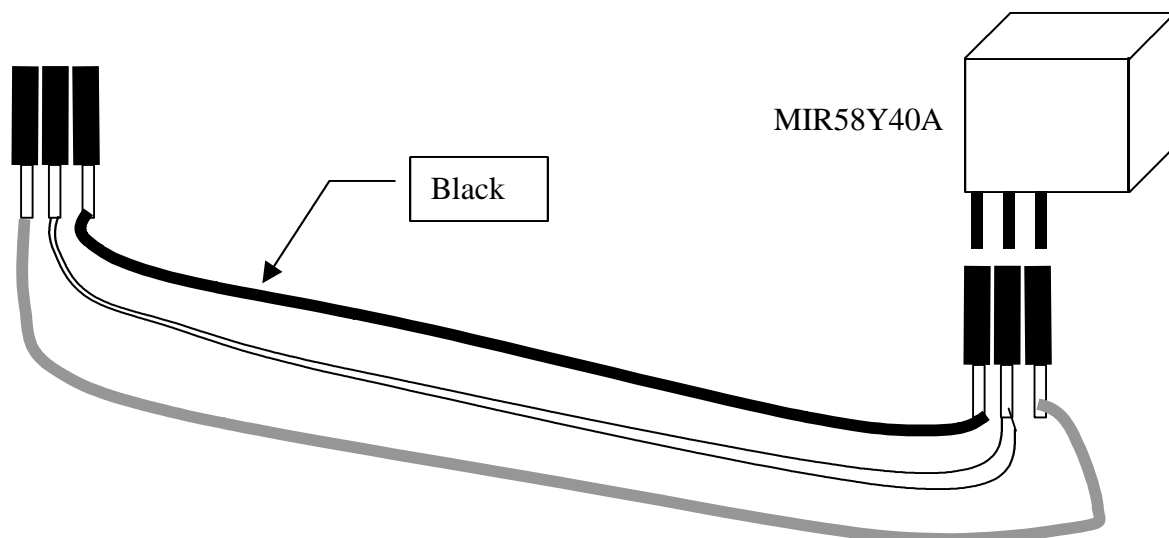
Black

Figure 12. Cable for the IR Detector. The black wire is ground, the white one power and the gray one is the analog signal coming from the detector. The black wire connects to the outside pin , closest to the side of the cube.

 1. **IR Detector Cables (Two cables for the MIR58Y40A sensors)**
    Refer to Figure 12 to see the construction of these two F3W3F3 cables.
    a.   Cut the GWBR03 ribbon cable (gray-white-black) in half.
    b.   Strip and tin the three wires at each end of both wire segments.
    c.   Cut four, 3-pin segments off of the F1x36 pin female connector and tin the leads.
    d.   Solder the 3-pin female connectors at the four ends of the two GWBR03 wires.
    e.   Cover the solder connection and wires about the connection with hot glue for mechanical
         strength. Shape for esthetics. BE CAREFUL! HOT GLUE CAN BURN!

2. Photoresistor Cables (Two cables for the MCDS01 sensors)

TJ™ , TJ PRO™ and ROBOBUG™ (Figure 13)

A series resistor has to be wired into this cable (F3W2F2). Wiring a series resistor into the cable can be done a number of ways Figure 13 shows one way.

   a. Cut the OYR02 ribbon cable (orange-yellow) in half.

   b.   Strip and tin the two wires at each end of both wire segments.

   c. Cut four, 2-pin segments and two 3-pin segments off of the F1x36 pin female connector and tin all leads.

   d. Lay a 3-pin and 2-pin connector flat with their terminals facing each other (Figure 13). Solder one pin of the 2-pin connector to an outside pin and the other to the middle pin of the 3-pin connector. Do this for both 3-pin connectors.

   e. Solder a 2-pin female connector at one end of each cable.

   f. At the other end of each cable solder the 2-pin-3-pin combined connector. Solder the orange and yellow wires to the outside pins. The yellow wire must solder to the outside pin that is also attached to a pin of the 2-pin connector (Figure 13).

   f. Cover the solder connection and wires about the connection with hot glue for mechanical strength. Shape for esthetics. BE CAREFUL! HOT GLUE CAN BURN! Do not cover the holes of the 2-pin connector of the 2-pin-3pin-connector configuration.

   g. Insert a 33K ohm resistor (any resistance between 10K and 50K will probably work) across the 2-pin connector in the 2-pin-3pin-connector configuration (Figure 13). This resistor establishes a voltage divider for a CdS photoresistor cell.
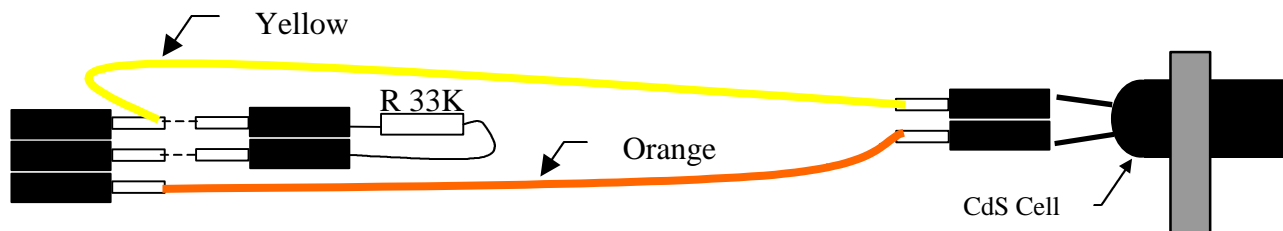
Figure 13. The Photoresistor cable requires a voltage divider circuit. This picture illustrates one way to wire it. The 3-pin female connector connects directly to an analog port on the MSCC11 (TJ™ or ROBOBUG™) or the MTJPRO11 (TJ PRO™) robot microcontroller boards.

TALRIK II™

The TALRIK II robot has 2-pin connectors available for photoresistors. No external resistor is needed.   Its construction is simple and shown in Figure 14 (F2W2F2).   Each Argos photoresistor cable plugs directly into a TALRIK II™ MRSX01 CdS 2-pin male header.

Figure 14. The photoresistor cable for the TALRIK II does not require an external resistor.

Yellow   Orange

CdS Cell
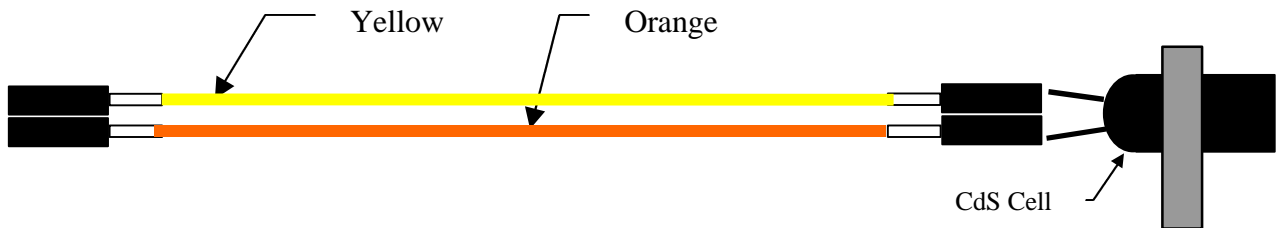
3. IR Emitter Cable (One cable for the MIR27E)

TJ™ and ROBOBUG™ Only (Figure 15)

A series resistor has to be wired into this cable. Wiring a series resistor into the cable (F3W2F2) can be done a number of ways. Figure 15 shows one way.

   a. Strip and tin the two wires at each end of the YGR02 ribbon cable (yellow-green).
   b. Cut two, 2-pin and one 3-pin segments off of the F1x36 pin female connector and tin the leads.
   c. Cut the middle pin out of the 3-pin connector. Cut it as close as you can to the plastic.
   d. Solder a 2 pin connector to the 3-pin connector as shown in Figure 15. Insert the 470ohm resistor into this 2-pin .
   e. Solder the green wire to the free pin of the 2-pin connector.
   f. Solder the yellow wire to the free pin of the 3-pin connector.
   g. Solder the other 2-pin female connectors at the other end of the YGR02 wires.
   h. Cover the solder connection and wires about the connection with hot glue for mechanical strength. Shape for esthetics. BE CAREFUL! HOT GLUE CAN BURN!

470 ohm
Resistor

Cut the middle pin out

T-1¾ LED
Panel Mount
IR Emitter

ARGOS Head
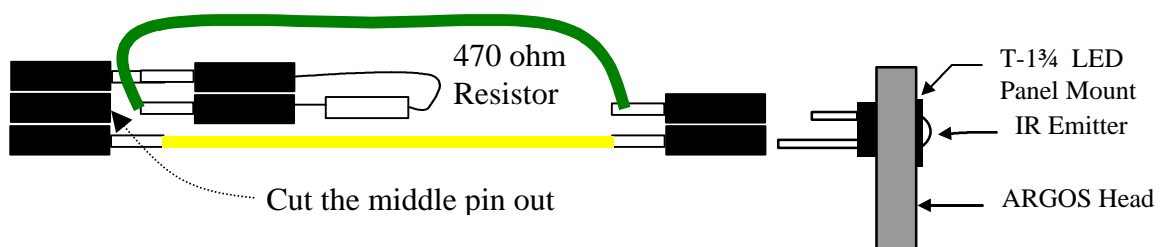
Figure 15. A completed IR emitter cable with 220 ohm current limiting resistor for the TJ™ and ROBOBUG™ robots. The TJ PRO™ and TALRIK II™ robots do not require the resistor. The female connector permits you to change the resistor to suit your applications.

TJ PRO™ and TALRKI II™

Refer to Figure 16 for constructing the F2W2F2 cables.
   a. Strip and tin the two wires at each end of the YGR02 ribbon cable (yellow-green).
   b. Cut two, 2-pin segments off of the F1x36 pin female connector and tin the leads.
   c. Solder the 2-pin female connectors at the both end of the YGR02 wires.

d. Cover the solder connection and wires about the connection with hot glue for mechanical strength. Shape for esthetics. BE CAREFUL! HOT GLUE CAN BURN!

 For the TJ PRO™ and the TALRIK II™ no external resistor is required. The TJ PRO™ has a direct connection available. The TALRIK II ™ robot requires substitution wiring. Namely, run a connector from one of the IR emitters underneath the TALRIK II™ robot to the IR emitter in the sensor head. This will require a 2-pin male connector at both ends of another cable (not supplied) which will plug into one end of this cable and the connector for the substituted IR. Since the TALRIK II™ produces considerable IR light, this substitution will not cause performance difficulties for many applications.
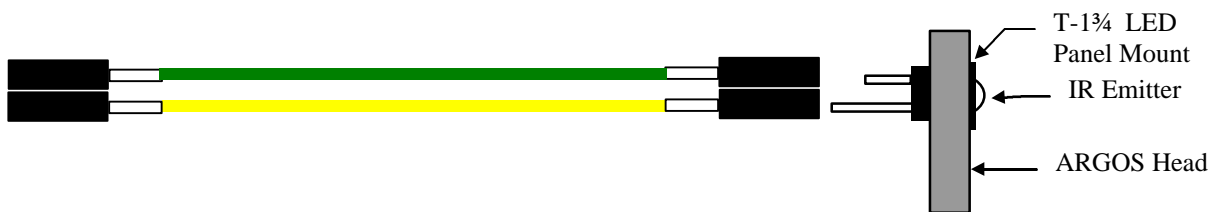
Figure 16. An IR emitter cable for the TJ PRO™ and TALRIK II™ robots do not require an external resistor.

4. Sonar Cable (Optional)

Refer to Figure 17 for this F3W3F7 cable.

a. Cut about 12 inches of GWBR03 ribbon cable (gray-white-black) .

b.   Strip and tin the three wires at each end of both wire segments.

c. Cut a 7-pin and a 3-pin segment off of an F1x36 pin female connector and tin the leads.

d. Solder the 3-pin female connectors at one end of the cable.
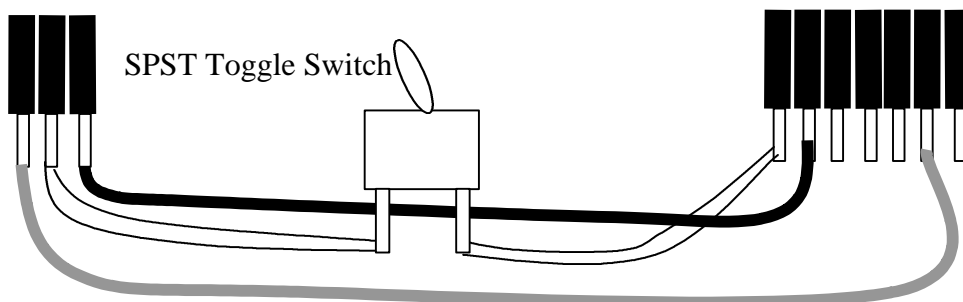
Figure 17. Wiring for the sonar cable. The toggle switch allows you to turn sonar power off when the sonar is not in use or when you are programming and do not want to listen to the sonar clicking away.

e. Solder the other end of the cable to the 7-pin connector. Solder the white wire (power) to an outside pin. Call this pin 1. Solder the black wire (ground) to pin 2, the one next to the white one. Solder the gray wire (signal) to pin 6 of the 7-pin connector.

f. About 5 inches from the 7-pin connector cut the white wire, strip and tin about 1/8 inch of the cut white wire and solder these wires across a single-pole, single-throw (SPST) toggle switch with tinned leads.

g. Cut a male header pin and jam into pin-7 of the 7-pin female connector. This prevents plugging the connector in reverse.

h. Cover all solder connections and wires about the connection with hot glue for mechanical strength. Shape for esthetics. BE CAREFUL! HOT GLUE CAN BURN!

5. CONNECTING THE ARGOS™ CABLES

Your objective here is to connect the cables you constructed to the appropriate sensors on the sensor head at one end and to the appropriate male headers on the robot's microcontroller or sensor expansion board at the other end. You also will connect the servo cables to the appropriate male headers.

IMPORTANT!
After connecting the cables at both ends, tie down all but the sonar cables on the side links to keep the wires from working loose from their connections on the sensor head. Leave enough slack between the tie points and the printed circuit board connection so the pan-tilt head can move freely without binding or chaffing wires. You may have to iterate the adjustment process to get the freedom of movement to your satisfaction.

5.1 Cable Connection at Sensor Head

IR Emitter (MIR27E)
Yellow-green cable (YGR02) with 2-pin female connector plugs into the wires of the IR emitter as shown in Figure 15. Be sure the yellow wire connects to the anode or longest wire projecting out of the IR emitter.

IR Detector (MIR58Y40A)
Refer to Figure 12. The gray-white-black cable (GWBR03) with the 3-pin connector plugs into the IR detector (MIR58Y40A), the shinny metal cube with three wires sticking out. The black wire is ground potential and connects with the pin that is closest to the side of the cube.

Photoresistors (MCDS01)
Connect the photoresistor cable to the CdS cell as shown in Figure 13.

Sonar (Optional)
The 7-pin connector slides on the MUST01 Sonar 6-pin male header. Looking at the sonar board from the rear, pin 1 is on the extreme right if mounted as described in Section 3.11. Pin-1 (white) of the 7-pin connector must match the male header pin-1. If you orient the board so you can read the silk-screen normally, then the 6-pin male header is on the left side of the board and pin one is at the bottom of the connector.

5.2 Cable Connection on TJ Pro™ Robot Computer Board

Table 4 indicates how to connect the Argos™ head sensors to the robot's microcontroller printed circuit board (MTJPRO11). The **Pin** column specifies the MC68HC11 microcontroller pin involved. Each of these pins connects to the "inside" pin of a 3-pin male header (labeled 1). The middle pin of the male header (labeled 2) is power and the "outside" pin (labeled 3) is ground. For example, the right IR detector connects to the 3-pin male header PE4-1, PE4-2, and PE4-3, associated with the analog input pin PE4 of the microcontroller.

Table 4 Argos™ Cable Connections to the TJ PRO Microcontroller

Pin	Description	Connection on MTJPRO11 PCB
PA5	Tilt Servo (turret servo)	Plug 3-pin servo connector into PA5-1 (Signal), PA5-2 (Power), PA5-3(Ground –usually Black)
PA6	Pan Servo (mezzanine servo)	Plug 3-pin servo connector into PA6-1 (Signal), PA6-2 (Power), PA6-3(Ground –usually Black)
PE1	Right Photoresistor	Plug 3-pin female connector into to PE1-1(Yellow), PE1-2, PE1-3 (Orange).
PE4	Right IR Detector	Plug 3-pin female connector into to PE4-1(Gray), PE4-2 (White), PE4-3 (Black).
PE5	Sonar	On the topside of the *turret*, insert an *ireyelet* in the right-rear slot next to the base of the tilt-servo. Pass the toggle switch lever through the hole of the *ireyelet* from front-to-back. Rotate the switch so the lever action moves along the horizontal. Lock into place from the front with a single hex-nut and lock washer provided on the switch. The second nut on the switch is not used. Plug 3-pin female connector into to PE5-1(Gray), PE5-2 (White), PE5-3 (Black).
PE6	Left IR Detector	Plug 3-pin female connector into to PE6-1(Gray), PE6-2 (White), PE6-3 (Black).
PE7	Left Photoresistor	Plug 3-pin female connector into to PE7-1(Yellow wire), PE7-2, PE7-3 (Orange wire).
Pin-6 IROH	IR Emitter	Connect to the 2-pin male header associated with Pin-6 of the IRLED OUTPUT HEADER. The female connector fits perpendicular to the edge of the board. The green wire connects to the pin at the edge of the board and the yellow wire connects to the pin away from the edge of the board.

5.3 Cable Connection on TJ™ Robot Computer Board

Table 5 lists the Argos™ connections to the MSCC11microcontroller for the TJ™ robot. Refer to Table 4 and Figure 4 in the TJ Assembly Manual (You can download this manual free from www.mekatronix.com/manuals) for the male header pin designations on the MSCC11 microcontroller board. Pin 3 of the three pin male headers on the MSCC11 board is ground and is the pin nearest the edge of the printed circuit board. Pin 1 of the header connects to an MC68HC11 pin and the center pin, Pin 2, connects to power, typically battery power, but it can be jumpered to regulated 5 volts for some applications (not here).

Table 5 Argos™ Cable Connections to the TJ™ Microcontroller (MSCC11)

Pin	Description	Connection on MTJPRO11 PCB
PB1	IR Emitter	Plug 3-pin (minus middle pin!) connector into 41-1(Yellow) 41-2, 41-3(Green). Modify `irmod40()` code to modulate PB1 in the same manner as PB0[1].
PB2	Tilt Servo (turret servo)	Plug 3-pin servo connector into 40-1 (Signal), 40-2 (Power), 40-3(Ground –usually Black)
PB3	Pan Servo (mezzanine servo)	Plug 3-pin servo connector into 39-1 (Signal), 39-2 (Power), 39-3(Ground –usually Black)
PE0	Left Photoresistor	Plug 3-pin female connector into to 43-1(Yellow), 43-2, 43-3 (Orange).
PE1	Right Photoresistor	Plug 3-pin female connector into to 45-1(Yellow), 45-2, 45-3 (Orange).
PE3	Left IR Detector	Plug 3-pin female connector into to 49-1(Gray), 49-2 (White), 49-3 (Black).
PE4	Right IR Detector	Plug 3-pin female connector into to 44-1(Gray), 44-2 (White), 44-3 (Black).
PE5	Sonar	On the topside of the *turret*, insert an *ireyelet* in the right-rear slot next to the base of the tilt-servo. Pass the toggle switch lever through the hole of the *ireyelet* from front-to-back. Rotate the switch so the lever action moves along the horizontal. Lock into place from the front with a single hex-nut and lock washer provided on the switch. The second nut on the switch is not used. Plug 3-pin female connector into to 46-1(Gray), 46-2 (White), 46-3 (Black).

[1] In the function "void irmod40(void)" in program "irtj.c" found in directory "libsrctj"
Change   "eora #1\n"   /* 2 cycles - necessary */
To   "eora #3\n"   /* 2 cycles - necessary */
This will cause both PB0 and PB1 to be modulated at 40KHz simultaneously.

5.4 Cable Connection on Robobug™ Robot Computer Board

Table 6 lists the Argos™ connections to the ROBOBUG™'s MSCC11microcontroller. . Refer to Table 4 and Figure 4 in the TJ Assembly Manual (You can download this manual free from www.mekatronix.com/manuals) for the male header pin designations on the MSCC11 microcontroller board. Pin 3 of the three pin male headers on the MSCC11 board is ground and is the pin nearest the edge of the printed circuit board. Pin 1 of the header connects to an MC68HC11 pin and the center pin, Pin 2, connects to power, typically battery power, but it can be jumpered to regulated 5 volts for some applications (not here).

Table 6 Argos™ Cable Connections to the ROBOBUG™ Microcontroller (MSCC11)

Pin	Description	Connection on MTJPRO11 PCB
PA5	IR Emitter	Cut the 3-pin female connector into two female connectors, a 2-pin connector to the yellow wire and a 1-pin connector to the green wire and series resistor. Plug the 2-Pin connector into 29(Yellow). Insert the 1-pin connector (Green) onto an available ground pin, for example, PB0-3.
PB2	Tilt Servo (turret servo)	Plug 3-pin servo connector into 40-1 (Signal), 40-2 (Power), 40-3(Ground –usually Black)
PB3	Pan Servo (mezzanine servo)	Plug 3-pin servo connector into 39-1 (Signal), 39-2 (Power), 39-3(Ground –usually Black)
PE1	Right Photoresistor	Plug 3-pin female connector into to 45-1(Yellow), 45-2, 45-3 (Orange).
PE2	Right IR Detector	Plug 3-pin female connector into to 47-1(Gray), 47-2 (White), 47-3 (Black).
PE3	Left IR Detector	Plug 3-pin female connector into to 49-1(Gray), 49-2 (White), 49-3 (Black).
PE4	Left Photoresistor	Plug 3-pin female connector into to 44-1(Yellow wire), 44-2, 44-3 (Orange wire).
PE5	Sonar	On the topside of the *turret*, insert an *ireyelet* in the right-rear slot next to the base of the tilt-servo. Pass the toggle switch lever through the hole of the *ireyelet* from front-to-back. Rotate the switch so the lever action moves along the horizontal. Lock into place from the front with a single hex-nut and lock washer provided on the switch. The second nut on the switch is not used. Plug 3-pin female connector into to 46-1(Gray), 46-2 (White), 46-3 (Black).

5.5 Cable Connection on Talrik II™ Robot Computer Board

One of the IR emitters underneath the robot must be sacrificed for the Argos IR emitter. Since there is so much IR light produced by the 12 IR emitters underneath the top plate this should not cause any operational problems in most cases. For connections on TALRIK's MRSX01 Sensor Expansion Board, refer to Figure 4 in the TALRIK II Assembly Manual, which you can download gratis from www.mekatronix.com/manuals.

Table 7 Argos™ Cable Connections to the TALRIK II™ Sensor Expansion Board (MRSX01)

Header	Description	Connection on MTJPRO11 PCB
N.A.	IR Emitter	Create a 2-wire cable (yellow & green) with two 2-pin male connectors at each end (M2W2M2). Disconnect one of the IR emitters underneath the robot and plug in one end of this cable. Plug the other end into the 2-pin female connector at the end of the IR emitter cable coming from the Argos head. Be sure yellow is positive and wire colors match at all pin connections.
SERV01	Tilt Servo (turret servo)	Plug 3-pin servo connector into SERV01 connector on the left side of the board. with the black wire closer to top of circuit board.
SERV02	Pan Servo (mezzanine servo)	Plug 3-pin servo connector into SERV02 connector on the left side of the board. with the black wire closer to top of circuit board.
CDS1	Right Photoresistor	Plug 3-pin female connector into to 45-1(Yellow), 45-2, 45-3 (Orange).
IRDT13	Right IR Detector	Plug 3-pin female connector into to 47-1(Gray), 47-2 (White), 47-3 (Black).
IRDT14	Left IR Detector	Plug 3-pin female connector into to 49-1(Gray), 49-2 (White), 49-3 (Black).
CDS2	Left Photoresistor	Plug 3-pin female connector into to 44-1(Yellow wire), 44-2, 44-3 (Orange wire).
IRDT6	Sonar	On the topside of the *turret*, insert an *ireyelet* in the right-rear slot next to the base of the tilt-servo. Pass the toggle switch lever through the hole of the *ireyelet* from front-to-back. Rotate the switch so the lever action moves along the horizontal. Lock into place from the front with a single hex-nut and lock washer provided on the switch. The second nut on the switch is not used. Plug 3-pin female connector into to 46-1(Gray), 46-2 (White), 46-3 (Black).

Two CdS connections on the MRSX01 board will also need to be sacrificed. There are six available. The natural candidates would be two of the three bridge CdS photoresistor

connections, namely, CDS1, CDS2. Consequently, these are selected for the two *spirh* Argos™ CdS cells. The Sonar is plugged into IRDT6, which usually connects to the IR detector in the back middle (six-o'clock). The right and left IR detectors connect to the IRTD13 and IRTD14 male headers on the board. IRDT13 and IRDT14 have no pre-defined use on the TALRIK II and so should be open for this purpose. All the preceding connector choices will be used here and will be compatible with the test software provided. If you make other choices, you will have to change the software code accordingly.

6. ARGOS SONAR KIT (OPTIONAL)

Table 8 briefly describes the Argos™ Sonar Kit. Construction of the Argos™ sonar cable is described in Section 4.1. Installation of this cable is described in Section 5 for each of the Mekatronix robots.

Table 8 Argos Sonar Kit

Qty	Description
1	MUST01 Sonar Transducer
12 inches	MUSTO1 cable(F7W3F3)(Gray-White-Black)-unassembled
1	1/3 of F1x36 (12 pins of 1 row female connector, 10 pins required)
1	SWSPST Single Pole Single Throw Switch

7. VISION KIT(OPTIONAL)

A miniature color camera attaches to the *camerah*. A platform to support an extra printed circuit board and radio transmitter for the color image, either in NTSC or PAL format, attaches to the mezzanine mounting screws. This kit permits you to use your robot for vision research, games, security, surveillance, and entertainment and for general telepresence operations. A separate assembly and installation manual comes with the vision kit. Check the Mekatronix web site for more details.

8. ARGOS™ TJ PRO™ DISTRIBUTION SOFTWARE

The distribution software includes files with important instructions and information. Being familiar with the contents of this package will help you find the information you need to install and use it with your Argos™.

8.1 Contents of the TJ Pro™ Argos™ Distribution Software Package

The file `argostjp_readme.txt` summarizes the contents of the distribution software package.

```
**************************************************************************
BE SURE TO REFER TO THE Argos™ USERS MANUAL FOR DETAILED INSTRUCTIONS!
**************************************************************************

ARGOS™ DISTRIBUTION SOFTWARE
==========================================================================
This disk includes the following directories:
```

```
<include_tjpargos>    Argos™ include files used specifically by Argos™ programs
<Libsrc_tjpargos>     Argos™ library files with new, required libtjp.a
<tjpargos_code>       Example source and object code for Argos™ testing and use

-----------------------------------------------------------------------------
The distribution also contains the following files:

-----------------------------------------------------------------------------

argos_install.txt

      Brief directions on installation of Argos™ Distribution Software.

argaum01.pdf

      Argos assembly and users manual.
-----------------------------------------------------------------------------


-----------------------------------------------------------------------------
<include_tjpargos> Directory

      isrdecl8.h
      servo_8.h
      tjpbase.h
-----------------------------------------------------------------------------
<Libsrc_tjpargos> Directory

      Libtjp.a
      Libtjpmake.bat
      Servo_8.o           Object file of new program to control up to eight
                            servos or motors on the TJ Pro.
-----------------------------------------------------------------------------
<tjpargos_code>   Directory

   C-Code
      avsotjp8.c          Avoid obstacles using sonar
      servdeg.c           Interactive program to move servos in degrees
      tjparg8.c           Interactive program to read sensors and move servos
                            and motors
   Code S19 files
      avsotjp8.s19
      servdeg.s19
      tjparg8.s19
-----------------------------------------------------------------------------
```

8.2 Integrating TJ Pro™ Argos™ Distribution Software with ICC11 for Windows

Integrating Argos™ software amounts to copying Argos™ files into the appropriate directories in the `icctjp` directory.

Prerequisites
1. You have already installed the TJ Pro™ Distribution Software and the ICC11 C-Compiler for WINDOWS into the directory `icctjp`.
2. You have successfully downloaded ".`s19`" files and executed them on your TJ Pro™ robot.

3. You have transferred the Argos™ Distribution Software argostjpdist??.zip (?? indicates latest version number) to `icctjp` and unzipped it with its directory structure intact.

Given the above prerequisites,

4. Copy all the files in `include_tjpargos` to `icctjp\Include` . This action replaces older versions of these files.
5. Copy `Libtjp.a` in `Libsrc_tjpargos` to `icctjp\Lib` . This action replaces older version of this file.

8.3 Testing the Argos™ Sensors on TJ Pro™

The program `tjparg8.c` permits you to read all the sensors on the *spirh*, IR, photoresistors and sonar(optional) .

```
Title   tjparg8.c
        Programmer        Keith L. Doty
        Date              Dec 14, 1999
        Version           1

Select one of the following TJ PRO ARGOS test procedures
   1. Test TJ PRO ARGOS Sensors
   2. Test TJ PRO ARGOS Servos Automatically
   3. Test TJ PRO ARGOS Servos Manually
   4. Test TJ PRO ARGOS Servos Manually & Display Sensors
```

Make selection four by typing 4 followed by *Enter*. The screen below will appear.

```
ARGOS MANUAL SERVO-MOTOR TEST WITH SENSOR DISPLAY

Left IR       Right IR      Left CDS      Right CDS      Sonar
88            89            139           138            97


Left Motor(7)  Right Motor(3)  Pan Servo(6)    Tilt Servo(5)
0              0               2550            4580

Servo No.   Servo Pulse Width




Servo No. in {0,1,2,3,4,5,6,7} and 1000 < Servo Pulse Width < 5000



Press TJ PRO Reset Switch to select another test.
```

The actual numerical value in the various fields will depend upon your sensor readings and what positions you have set the pan and tilt servos. You can also run the motors by selecting Servo No. equal to 7 (Left Motor) or 3 (Right Motor). To select a servo number, just type the number followed by a *space-bar* or an *Enter* key. Any non-numeric key will stop the integer entry, but will clutter up your screen. To enter the set-point for the servo, type another integer, usually

between 1000 and 5000. Some servos go as low as 600 and others no higher than 4000. Exercise caution initially to determine the range on your servos.

WARNING!

This program does not protect against overdriving the servos. Overdriving servos in either direction for more than a minute or so may burn out the electronic circuitry on the servo and render them useless.

Use `tjparg8.c` to experiment and find the

1. Upper limit,
2. Lower limit, and
3. Mid-range value

for each servos by entering various pulse widths. Write down the numerical values experimentally determined for each of these parameters. In the file `servo_8.h,` found in the `include` directory of `icctjp`, update the macro defines (refer to boxed listing of `servo_8.h` below)

```
#define PW5L 900
#define PW5U 4580
#define PW6L 700
#define PW6U 4450
```

with these experimental values, where

```
PW5L  Lower Limit for the tilt-servo
PW5U  Upper Limit for the tilt-servo
PW6L  Lower Limit for the pan-servo
PW6U  Upper Limit for the pan-servo
```

These values establish the range of your servos. During normal operation, the global parameter `srv_lim_default==1` forces a check on the servo limits so they cannot be overdriven in normal operation (refer to comments about this variable in the boxed listing below). The programmer can override this protection by setting `srv_lim_default==0` at any time, but this is not advised (refer to the WARNING above).

Many applications require servo mid-values, so hang onto these numbers for use in applications.

```
/***********************************************************************
 * Title          servo_8.h  (Servo Drivers for TJ PRO)              *
 * Programmer     Keith L. Doty                                      *
 * Date           June 28, 1999                                      *
 * Version        1                                                  *
 *                                                                   *
 * Description: Servo drivers*
      servo i on SERVO_PORT[i], i =0,1,2,3,4,5,6,7

      All pulse widths created in sequence, i.e., the five servos
      are phase shifted relative to one another by the pulse width
      of the servo that precedes it in the sequence.

        SERVO_PORT drives the servo signal lines and can be defined
        as any 8-bit output port.

      SERVO_ENABLE determines which servos are enable to run.
 * History:     Total revision                                       *
 ***********************************************************************/


/************************** Includes **********************************/
#include <hc11.h>
#include <mil.h>
/*********************************************************************/


/************************** Constants ********************************/
#define init_motortjp() init_servotjp() //makes old code compatible

//Servo limits. PWnL is the lower limit for servo n
//             PWnU is the lower limit for servo n
// These limits can be individualized for each servo

#define MAX_SERVO 8

#define PW0L 2000
#define PW0U 4000
#define PW1L 2000
#define PW1U 4000
#define PW2L 2000
#define PW2U 4000
#define PW3L 2200
#define PW3U 4200
#define PW4L 2000
#define PW4U 4000
#define PW5L 900
#define PW5U 4580
#define PW6L 700
#define PW6U 4450
#define PW7L 2200
#define PW7U 5100
```

```
/*
  When srv_lim_default==1, servo(servo#,pulse_width) verifies that

                 PWnL <= pulse_width <= PWnU

  Changing the #defines for PWnL and PWnU and recompiling provides a
  compile time values for the servo limits.
*/

//Change SRV_LIMIT_DEFAULT to 0 to disable servo limit checking
#define SRV_LIMIT_DEFAULT 1

/*************************************************************************/


/************************* Prototypes ******************************/
#pragma interrupt_handler TOC4_isr
void init_servotjp(void);
void servotjp(unsigned char, unsigned int); //Servo command
void servo_idle(unsigned char);
void servo_n_hand(void);       //ISR, generates PWM sequences
/*************************************************************************/


/************************* Globals ******************************/

 /*
  When srv_lim_default==1, servo(servo#,pulse_width) verifies that

      servo_limits[servo#][0]<= pulse_width fall <= servo_limits[servo#][1]

  You can dynamically change servo limits for the current execution by
  changing the appropriate contents of servo_limits[servo#][0] (lower) and
  servo_limits[servo#][1] (upper).
*/
 unsigned int servo_limits[MAX_SERVO][2]=
 {
      {PW0L,PW0U},
      {PW1L,PW1U},
      {PW2L,PW2U},
      {PW3L,PW3U},
      {PW4L,PW4U},
      {PW5L,PW5U},
      {PW6L,PW6U},
      {PW7L,PW7U}
 };
//You can dynamically change srv_lim_default to disable limit checks
//in current execution.
 unsigned char srv_lim_default= SRV_LIMIT_DEFAULT;

/**********************END GLOBALS**********************************
```

In the program `servdeg.c` the pan and tilt servo limits have the names

```
#define PAN_M90        675
#define PAN_CENTER     2525
#define PAN_P90        4450

#define TILT_UP        2700
#define TILT_FRONT     4580
#define TILT_BACK      900
```

The values apply to specific pan and tilt servos used in a particular robot.

The suffixes on the pan-servo names mean
      M90 = -90 degrees, face right, PW6L
      CENTER = 0 degrees, face forward, mid-range value
      P90 = +90 degrees, face left, PW6U

The suffixes on the tilt-servo names mean
      UP   =   0 degrees, face straight up, mid-range value
      FRONT = +90 degrees, face forward, PW5U
      BACK   = -90 degrees, face back, PW5L

8.4 Important Servo Angle Definitions

The mid-range serves as the reference points on all servos:
-90 degrees	PWnL	Lower Servo Limit
0 degrees	mid-range value	Mid-Range Value
+90 degrees	PwnU	Upper Servo Limit

8.5 Motor Control with Argos™ Software

You can also drive the motors with `tjparg8.c`. Select and type the Servo No. of the motor (7 for left and 3 for right) and enter the servo pulse width. Less than the mid-range value (approximately) should make it turn one way and greater than the mid-range value should make it turn the other.

9. ARGOS™ ROBOBUG™ DISTRIBUTION SOFTWARE

Since your Robobug™ software configuration automatically supports Argos™, no reconfiguring or additional support software is required. As a service, Mekatronix provides you with several application programs to test the Argos *sprih* sensors and to illustrate how Bug can walk while avoiding collisions with obstacles.

9.1 Contents of the Distribution Software Package

The file `argosbg.txt` summarizes the contents of the distribution software package and is listed below.

```
*************************************************************************
BE SURE TO REFER TO THE Argos™ USERS MANUAL FOR DETAILED INSTRUCTIONS!
*************************************************************************


ROBOBUG ARGOS™ DISTRIBUTION SOFTWARE
=========================================================================

<argosbg>       Example source and ASCII object code for Argos™ testing and use

   C-Code Source
      argostst.c  Outputs all eight analog inputs to terminal screen
      avbg_ir.c   Collision avoidance using IR on the Argos™ head
      avbgson.c   Collision avoidance using Sonar on the Argos™ head

   Code S19 files for immediate downloading and test
      Argostst.s19
      Avbg_ir.s19
      Avbgson.s19

argaum01.pdf        Argos assembly and users manual.
-------------------------------------------------------------------------
```

9.2 Integrating Argos™ Distribution Software with ICC11 for Windows

Integrating Robobug Argos™ software amounts to copying the directory `argosbug` into the `iccbg` directory.

Prerequisites
1. You have already installed the Robobug™ Distribution Software and the ICC11 C-Compiler for WINDOWS into the directory `iccbg`.
2. You have successfully downloaded ".`s19`" files and executed them on your Robobug™ robot.

If you have performed the prerequisites above, then simply

3. Transfer the Robobug™ Argos™ Distribution Software argosbgdist??.zip (?? indicates latest version number) to `iccbg` and unzip it with its directory structure intact.

9.3 Testing the Argos™ Sensors on Robobug™

The program `argostst.c` outputs all eight analog inputs to terminal screen as follows

```
0 71
1 218
2 86
3 85
4 223
5 254
6 65
7 60
```

This cryptic display is a consequence of Robobug's extremely small memory space forces this cryptic display. There is not enough memory to perform more esthetic and readable IO and still provide the code and data to drive the robot.

The number in the first column refers to the PortE pin on the microcontroller and also equals the analog channel number. For example, the number 5 in column one indicates PE5, analog channel 5, which is connected to the sonar. Number two designates PE2, analog channel 2 and the Right IR detector on the *spirh*. And so on. Table 6 lists the usage of the PortE pins for Robobug™. Since there are eight analog channels on the MSCC11 microcontroller, all eight are displayed.

After testing the sensors you can test the pan and tilt servos just as you would any servo on Robobug™.

After passing the above test, you can now download the other example programs to explore the capabilities of the Argos™ package.

10. ARGOS DISTRIBUTION SOFTWARE FOR TALRIK™

The software and hardware support for controlling Argos on the Talrik™ already exists. There is no separate distribution software. Consequently, programming Argos™ operations on the Talrik™ simply amounts to utilizing existing servo drivers and sensor inputs. Refer to 5.5.

11. ARGOS DISTRIBUTION SOFTWARE FOR TJ™

11.1 Contents of the TJ™ Argos™ Distribution Software

The file `argostjp_readme.txt` summarizes the contents of the distribution software package.

```
****************************************************************************
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January 2000


Address technical questions by email to tech@mekatronix.com
Mekatronix Web Site:  www.mekatronix.com


****************************************************************************
BE SURE TO REFER TO THE Argos USERS MANUAL FOR DETAILED INSTRUCTIONS!
****************************************************************************


TJ ARGOS DISTRIBUTION SOFTWARE
========================================================================

<include_tjargos>    Argos include files used specifically by Argos programs
<libsrc_tjargos>     Argos library files with new, required libtjp.a
<tjargos_code>        Example source and object code for Argos testing and use
```

```
------------------------------------------------------------------------------
The distribution also contains the following files:

------------------------------------------------------------------------------
argostj_readme.txt       This file
install_argostj.txt

     Brief directions on installation of TJ Argos Distribution Software.

argaum01.pdf

          Argos assembly and users manual.
------------------------------------------------------------------------------


------------------------------------------------------------------------------
<include_tjargos> Directory

Analog2.h    New
clocktj.h    Same
Irtja.h              New
motjadr.h    New
serialtj.h   New More efficient. write_int() no longer available.
isrtjad.h    New
Mil.h        Same
tjabase.h    New
Vectors.h    Same
------------------------------------------------------------------------------
<libsrc_tjpargos> Directory

Analog2.c    New
clocktj.c    Same
Irtja.c              New
motjadr.c    New
serialtj.c   New More efficient. write_int() no longer available.
Vectors.c    Same

     Object code of above c programs:
      Analog2.o
      clocktj.o
      Irtja.o
      motjadr.o
      serialtj.o
      Vectors.o

Libtja.a
Libtjamake.bat


------------------------------------------------------------------------------
<tjargos_code>    Directory

   C-Code
argotst.c   Displays all TJ an ARGOS sensors and motor settings.
            User can change motor and servos settings.
avoidtja.c  Avoid obstacles: Note modifications to normal TJ code

   Code S19 files
```

Gainesville, Florida   www.mekatronix.com   Tech Questions: tech@mekatronix.com

```
argotst.s19
avoidtja.s19
--------------------------------------------------------------------------
```

****

11.2 Integrating TJ™ Argos™Distribution Software with ICC11 for Windows

The main point to follow on installing the TJ™ Argos™ is to make a copy of your current directory icctj and all its contents and call the copy icctja. Install the Argos™ package into the new system icctja. The second point is to change the "Additional Libraries" from libtj to libtja on the LINKER tab. The selection sequence in IDE toolbar to do this is

OPTIONS->COMPILER->LINKER->Additional Libraries->libtja

A number of significant code improvements were required of the TJ™ library routines in order to use Argos™ on the TJ robot. These routines have some impact at the source code level that results in correct, old code not compiling. While it is not difficult to make the previous TJ™ applications code compatible with the new system, it is important that you be aware of this and not be surprised when a previously compiled program does not compile!

Warning!
Previous TJ CODE will not compile correctly without changing
#include <tjbase.h>
to
#include <tjabase.h>
and eliminating the init_ir() routine and some other minor variances which become obvious when you try to recompile in the Argos software. Converting from old TJ™ code to TJ™ Argos™code, however, is typically straightforward.

```
****************************************************************************
MEKATRONIX
Copyright by Mekatronix 2000

January 2000

Address technical questions by email to tech@mekatronix.com
Mekatronix Web Site:  www.mekatronix.com


                    CAUTION! CAUTION! CAUTION!
****************************************************************************
```

Some of your previous TJ code will not compile correctly with the Argos include and library files because of certain improvements in the code. For best results it is recommended that you keep the ARGOS version separate from the original TJ distribution version. The installation instructions below do just that. To transfer original tj code to argos compatible code, you must change the statement

#include <tjbase.h>

to

#include <tjabase.h>

Delete init_ir() from your code. There may also be other changes that will become apparent when you attempt to recompile.
Mekatronix also recommends you use the defines in tjabase.h to name all the sensors and motors of the TJ robot and to use these names exclusively in your code to maintain compatibility with future developments and user-code code sharing.
****

INSTALLATION

TJ Argos Distribution Software with ICC11 for Windows

Integrating Argos software amounts to copying Argos files into the appropriate directories in the icctja directory which you will create (see instructions below).

Prerequisites
1. You have already installed the TJ Distribution Software and the ICC11 C-Compiler for WINDOWS into the directory icctj.

2. You have successfully downloaded ".s19" files and executed them on your TJ robot.

Given the above prerequisites,

3. Create an entirely new directory icctja which is a duplicate of icctj and all that is in it.

4. Transferred the Argos Distribution Software tj_argosdist??.zip (?? indicates latest version number) to icctja and unzip it with its directory structure intact.

5. Copy all the files in include_tjargos to icctja\Include. This action replaces older versions of these files.

6. Copy Libtja.a in libsrc_tjargos to icctja\Lib. Delete icctja\Lib\Libtj.a (don't confuse this with Libtja.a that you just installed!)

7. IMPORTANT! IMPORTANT! IMPORTANT!
   When you execute Icc11ide.exe from your Bin file you must change the Linker library.
   a. On tool bar select OPTIONS.
   b. In OPTIONS select COMPILER.
   c. In COMPILER select LINKER tab.
   d. In Linker "Additional Libraries" change libtj to libtja

You are now ready to program TJ Argos. Enjoy!

11.3 Testing the Argos Sensors and Motors on the TJ™

The program `Argostst.c` permits you to read all the sensors on the *spirh*: left and right IR, left and right photoresistors and sonar(optional) plus the basic TJ™ sensors: left and right front IR, back IR(optional), front and back bumpers. In addition, you can specify a motor and a pulse width from nominal 1800 to 4200 to control the servos and wheel motors. You may cautiously explore beyond this range (usually never below 700 or above 5000) with the servos to be sure you can determine the full 180degree swing settings.

WARNING!

Do not overdrive the servos for more than several seconds to avoid burning out the drive electronics.

The program `argostst.c` outputs a screen (
Figure 18) each time you enter a motor number, {0,1,2,3}, and a Pulse Width (PW). A typical range for the pulse width is 1800< PW <4200. If you input a number between –100 and +100 for the pulse width, for example, Set PW=100, the program will interpret this as a percentage of full range backward or forward, respectively. After changing the set point of a motor or servo, the screen updates and displays the changed value in the appropriate labeled motor column. The next table indicates the meaning of the screen display names.

Table 9 Screen Labels for Argos™ Servos and TJ™ Wheel Motors

Motor Number	Motor Label	Motor
0	LM	Left wheel motor
1	RM	Right wheel motor
2	TILT	Tilt-servo
3	PAN	Pan-servo

The screen also displays the current values of all the TJ™ sensors and the Argos™ *spirh* sensors. The next table defines the meaning of each of the sensor screen names.

Table 10 Screen Labels for Argos™ and TJ™ Sensors

Label	Program Variable	Sensor
LCDSA	analog_value[0]	Left photoresistor on Argos™ *spirh* head
RCDSA	analog_value[1]	Right photoresistor on Argos™ *spirh* head
BIR	analog_value[2]	Back IR detector on TJ™ (optional)
LIRA	analog_value[3]	Left IR detector on Argos™ *spirh* head
RIRA	analog_value[4]	Right IR detector on Argos™ *spirh* head
SONAR	analog_value[5]	Sonar on Argos™ *spirh* head (optional)
LIR	analog_value[6]	Left IR detector on TJ™
RIR	analog_value[7]	Right IR detector on TJ™
FBMP	FRONT_BUMP	TJ front bumper
BBMP	BACK_BUMP	TJ back bumper

```
                TJ ARGOS


SENSORS:     LCDSA RCDSA BIR    LIRA   RIRA   SONAR LIR    RIR    FBMP   BBMP

             45    31    60     43     41     30    88     86     0      0


MOTORS:     LM    RM     TILT  PAN

            0     0      0     0


Enter Motor=0

Set PW=2000


                TJ ARGOS


SENSORS:     LCDSA RCDSA BIR    LIRA   RIRA   SONAR LIR    RIR    FBMP   BBMP

             57    40    60     43     42     38    88     86     0      0


MOTORS:     LM    RM     TILT  PAN

            2000  0      0     0


Enter Motor=
```

Figure 18. Screen output of the program `argostst.c`. The top display occurs at reset. If you enter motor number 0 and set the pulse width at 2000, the next screen appears. Note the update of LM, the left motor.

Since servo limits vary from servo to servo and manufacturer to manufacturer, you will probably want to use this program to experimentally determine the actual range of pulse widths for your servos. Write these numbers down and then use them in your programs from more accurate control of the servo positions.

11.4 Argos™ Applications on TJ™

The `avoidtja.c` program is the standard TJ™ avoid obstacles program. Compare this program with the original `avoidtja.c` program to see the difference in coding when you use the Argos™ library files.

Enjoy your Argos™ system! ☺