



LIPPERT
COMPONENTS®

Formerly  Atwood Mobile Products

LITERATURE NUMBER MPD 66166

LEVELEGS™ SYSTEM

•Installation •Operation •Maintenance

ENGLISH

Effective 11.21.07

SAFETY ALERT SYMBOLS

Safety Symbols alerting you to potential personal safety hazards. Obey all safety messages following these symbols.



WARNING

avoid possible
injury or death



CAUTION

avoid possible
injury and/or property damage

FOR YOUR SAFETY READ ALL INSTRUCTIONS BEFORE INSTALLATION AND OPERATION

Installer: Provide these instructions to the consumer.

Consumer: Keep documents for future reference.

Atwood Levelegs™ Levelers are intended for use on recreation vehicle motorhomes and trailers, any other use is strictly prohibited.



WARNING

VEHICLE CAN MOVE OR COLLAPSE

- Never exceed the rated capacity of the leveler as stated on its label.
- Levelers are not designed to be used as jacks. Do not use levelers to lift the vehicle during tire changes, axle work or other servicing. The tires must stay on the ground.

INSTALLATION

LEVELER LEG

1. Prior to installation, retract the levelers so the foot pads are within 1/2" to 1" from the end of the outer housing (FIG 1-A).
2. Position leveler vertically against frame so base of foot has 8-9" minimum ground clearance when vehicle is loaded to its maximum GVWR (FIG 1-B).
3. A. **For 7.5K Square Tube Levelegs™**, attach the frame bracket (FIG 12-C) to frame (FIG 12-D) using 4 sets of 1/2" - 13 grade 5 nuts and bolts and 1/2" flat and locking washers. Fit the Leveleg bracket (FIG 12-E) around the Leveleg, (FIG 12-F) engaging one tab in the slot of the bracket (FIG 12-G) and the other tab below the bracket (FIG 12-H). Attach the Leveleg bracket to the frame bracket with a 1/2" - 13 grade 5 bolt and 1/2" flat washer on the Leveleg bracket and a 1/2" flat washer, 1/2" locking washer and 1/2" - 13 grade 5 nut. To install on 5th wheel trailers, refer to MPD 71125.
- B. **For 10K Square Tube Levelegs™**, attach the leveler bracket (FIG 13-J) to the frame bracket (FIG 13-C) using four (4) each 1/2"-13 grade 8 bolts and 1/2" flat hardened washers.
- C. **For 15K Square Tube Levelegs™**, attach the leveler bracket (FIG 14) to the frame bracket (FIG 14-C) using six (6) each 1/2"-13 grade 8 bolts and 1/2" flat hardened washers.
4. Lubricate the bolts and torque to 65 ft-lbs.

CONTROLS

FOR 5TH WHEEL CONTROLS REFER TO MPD 87920 AND 71125.

Relay Pack Controller



WARNING

EXPLOSION

- Controller is not ignition protected. DO NOT install in areas that require ignition protected devices (such as battery or propane tank storage compartments).

1. Install Relay Pack Controller in a clean, dry interior area protected from moisture. Use corner holes of unit to fasten base horizontally to mounting surface, using appropriate hardware for surface.
2. Install the AUTO POSITION Relay Pack Controller so the forward arrow points toward the front of the motorhome. The Relay Pack must be right side up and within 10° of horizontal level (FIG 3).

Auto Position Control Pads

1. Locate the controller midway between front and rear wheels of the vehicle. Provide a 4-15/16" (FIG 2A) x 3-3/16" (FIG 2B) cutout with a 1/4" angled edge (FIG 2C) at 45° (FIG 2D) for the control pad at desired location. Note: Reference control pad when making cutout; there is tight clearance.
2. Use corner holes (FIG 2E) of unit to fasten control pad to mounting surface using appropriate hardware for surface.
Note: Fastener must pierce mylar surface of control pad.
3. Connect control pad wire harness (FIG 3H) to control pad.
4. Route the control pad wire harness to controller and connect the two (FIG 3-J).
5. Control pad wire harness is configured as follows (FIG 4).

Required Parts

ITEM	DESCRIPTION	QTY
A+B	43025-0400 Molex® Micro-fit 3.4 circuit receptacle	2
C	43030-0007 Molex® Micro-fit 3.0 female terminal	8
D	Unshielded 22 AWG multiconductor cable	1

Pin Requirements

CONNECTOR PIN	COLOR	CONNECTOR PIN	COLOR
A1	White	B1	White
A2	Green	B2	Green
A3	Red	B3	Red
A4	Black	B4	Black

6. Crimp the contacts with approved Molex® die.
7. Crimped contact must be able to withstand a minimum of nine (9) pound pull force.
8. Terminate sleeve of multiconduit cable to within 1" of connector (FIG 4-E)
9. Adjust the length of harness as required to easily connect control pad to controller (FIG 4-F).

MOTOR HOME SIGNAL WIRE HARNESS

1. Connect the motor home signal wire harness (FIG 3-I) to the controller (FIG 3-K).
2. Motor home signal wire harness to be configured as follows (FIG 8):

ITEM	DESCRIPTION	QTY
A	43025 Molex® Micro-fit 3.0,8 circuit receptacle	1
B	43030 Molex® Micro-fit 3.0 female tin terminal	4
C	Unshielded 20 AWG multiconductor cable	1

Pin Requirements - (FIG 8)

CONNECTOR PIN	DESCRIPTION (REFERENCE)	FIGURE	COLOR
P1	Park Brake	D	white
P2	Transmission	E	green
P3	N/A	F	N/A
P4	N/A	G	N/A
P5	Foot Brake	H	red
P6	N/A	I	N/A
P7	Ignition*	J	black
P8	N/A	K	N/A

* Install with a 3 AMP in-line fuse to chassis ignition wire.

3. Crimp the contacts with the approved Molex® die.
4. Crimped contacts must withstand a minimum nine (9) pound pull force.
5. Terminate the sleeve of multi-conduit cable to within 1" of connector (FIG 8-L).
6. Length of harness "as required" to easily connect control pad to controller (FIG 8-M).

POWER CONNECTIONS (FIG 3)

- | | |
|---|------------------------------------|
| A - Driver Front Leveler | G - Yellow (+) Motor Gear Box Lead |
| B - Passenger Front Leveler | H - Control Pad Wire Harness |
| C - Driver Rear Leveler | I - Motor Home Signal Wire Harness |
| D - Passenger Rear Leveler | L - Female Connector (Delphi®) |
| E - 125 Resettable Circuit Breaker for 2 AWG battery wire | M - Male Connector (Delphi®) |
| F - Red (-) Motor Gear Box Lead | O - Air Bag Dump Valve (optional) |
| | P - Air Bag Fill Valve (optional) |
| | R - Male connector (Deutsch®) |
| | S - Female connector (Deutsch®) |

Controller to Battery

1. Connect the controller to the chassis 12V DC battery through the manual reset circuit breaker or fuse (FIG 3-E).
2. Connect the controller to the battery through 2 AWG wire (FIG 3-N).
3. Terminate 2 AWG wire (FIG 5-A) power wire to controller through a 2 AWG 1/4" ID ring terminal (FIG 5-B).
4. Attach ring terminal to controller with following components:
 - #10 conductive washer FIG 5-C
 - #10 lock conductive washer FIG 5-D
 - 10-32 conductive nut FIG 5-E

Note: Torque nut (FIG 5-E) to 20-25 in/lbs.

Levelers to Controller

Controller must be connected to levelers through a wire harness using 8 or 10 AWG wire.

- Use 8 AWG wire for leveler rated above 10,000 lbs or wire runs longer than 30 feet.
- Use 10 AWG wire for levelers rated at or below 10,000 lbs or wire runs shorter than 30 feet.

Leveler End (FIG 6)

- A. Use the following Delphi® or comparable components to terminate both leads coming from the controller to lower motor connector of the 7.5K or 10K levelers.

- | | | | |
|------------|----------------|------|---------|
| • 12065863 | Connector | Male | FIG 6-A |
| • 12052172 | Terminal | Male | FIG 6-B |
| • 12034170 | Cable Seal | | FIG 6-C |
| • 12059897 | Secondary Lock | | FIG 6-D |

1. Strip wires (FIG 6-F) back about 3/8" (FIG 6-E).
2. Slide cable seal (FIG 6-C) onto wire with neck of cable seal facing stripped metal in wire.
3. Push cable seal forward to align neck of cable seal with edge of insulation of stripped back wire end.
4. Put stripped wire into crimp wings closest to mating end of terminal (FIG 6-B) and neck of cable seal (around insulation) into second set of wings furthest from mating end.

5. Crimp metal from wire to first set of wings.
6. Crimp cable seal neck (around insulation) to second set of wings. Then snap secondary lock (FIG 6-D) onto connector (FIG 6-A).
7. Minimum of strength of core crimp without insulation crimp should withstand a pull of 300 N (75 lbs).
8. Crimp dimensions:
CORE: 2.4mm (.094") high 5.05mm (.20") wide
INSULATION: 7.6mm (.30") high 7.4mm (.30") wide
NOTE: Insert the terminals into the connectors with the flat bottoms of the terminals oriented toward the connector locks.
- B. To terminate 8 gage wire leads from the controller to 15K levelers use the following components:

ITEM	PART	ATWOOD P/N	DEUTSCH P/N
S	connector, female	66627	DTHD04-1-8P FIG 15-S
S2	contact pin	66635	0460-204-08 FIG 15-S2
R	connector, male	66636	DTHD06-1-8S FIG 15-R
R2	contact socket	66634	0462-203-08 FIG 15-R2

Auto Position Controls

1. To terminate leads from the wire harness connected to the levelers use the following components:
 - 8 or 10 AWG wire FIG 5-A
 - 8 or 10 AWG, ring terminals FIG 5-B

10 AWG	8 AWG		
42816-0512	42516-0512	Connector	FIG 7-A
42815-0011	42815-0331	Terminal	FIG 7-B
2. Trim lead 5/16" FIG 7-C.
3. Pin connectors to match pins in Auto Position Control Board as shown in FIG 3.
4. Insert Molex® connector from wire harness into control board.
5. To address communication with the air suspension system, the controller must have a single signal lead provided for "Air Dump" (FIG 3-O) and a single signal lead provided for "Air Fill" (FIG 3-P).

PRE-DELIVERY PREPARATION

Wipe any excess fluid from the top of the foot before delivery.

OPERATION

BEFORE OPERATING THE LEVELERS

 CAUTION PERSONAL INJURY
• Stand clear of the vehicle.

Before operating the levelers, you must do the following:

1. Park the vehicle on a level site. Check for rocks, holes, or other obstructions. Warn all persons to stand clear of vehicle.
2. For a motorhome,
 - Put the vehicle transmission in PARK.
 - Engage the vehicle PARKING BRAKE.
 - Have the vehicle engine running.
3. Do not extend the slideouts until coach is level.

 WARNING VEHICLE CAN TIP
• Levelers must be on firm solid ground or surface prior to operation. Soft/spongy ground may allow levelers to sink.
• Area below and around leveler must be clear of obstructions.
• Do not place blocks under the leveler for additional ground clearance.

LEVELERS ARE SHIPPED IN THE ERROR MODE STATE.

To take controls out of error mode state, complete a successful **ALL RETRACT** (as defined in items 1-3) under **TO RETRACT**.

4. Put stripped yellow (+) wire end into contact pin (FIG 15-52) and crimp together. Crimp must withstand a minimum pull of 75 lbs.
5. Put stripped red (-) wire end into contact socket (FIG 15-R2) and crimp together. Crimp must withstand a minimum pull of 75 lbs.
6. Insert the contact pin (FIG 15-S2) into the female housing (FIG 15-S) until it is secured. Then slip seal into housing.
7. Insert the contact socket (FIG 15-R2) into the male housing (FIG 15-R) until it is secured. Then slip seal into housing.

CONTROL PAD LED INDICATORS

The control pad LED's indicate the following when illuminated (FIG 9):

DESCRIPTION	COLOR	ITEM
Vehicle Engine running (ignition switch is in the ON position) (MOTORHOME ONLY)	green	A
Park Brake engaged (MOTORHOME ONLY)	green	B
Park engaged (MOTORHOME ONLY)	green	C
Low Voltage (less than 13V DC present at controller)	red	D
ON/OFF (referencing power to control box)	green	E
Extend/Retract Mode	green	F
Leveler positions		
Fully Retracted	solid green	G
Extended	green blinking	G
Extending/Retracting	red blinking	G
Fully Extended	solid red	G

TO LEVEL

For 5th Wheels, refer to MPD 71125 and MPD 87920 for Operation.

AUTO POSITION CONTROLS

Your keypad may have LEDs to indicate 'EXTEND' OR 'RETRACT' mode.

If the Auto position is already set or programmed,

- Press the ON button (FIG 9-A) to activate the system.
- Press the AUTO button (FIG 9-B).
- The levelers will extend and automatically reach the pre-set position.
- The system will check each Leveler to insure its foot is in contact with ground. During this time, the control board "WAIT" LED will be on (FIG 9-C).

TO SET AUTO POSITION

1. Look at the keypad for your system. You have an automatic controller if there is a button that says "AUTO" (FIG 9-B).
2. To set the AUTO position
 - a. Manually get the RV to the position you want.
 - b. Then press the ON (FIG 9-A) button one time, to turn controls off.
 - c. Press 'EXT' button (FIG 9-D) 5 times.
 - d. Press 'RET' button (FIG 9-E) 5 times.
 - e. Unit will respond by blinking all LEDS slowly.
 - f. Press 'ALL' button (FIG 9-F) 3 times.
 - g. Press 'ON' (FIG 9-A) then 'RET' 'All' to retract all Levelers (FIG 9-E and 9-F).

TO SET AIR DUMP MODE

1. If LEDs blink left-to-right and back again, your RV has the Air Dump feature.
 - a. To enable Air Dump, press the "DRIVER" button (FIG 9-G) three (3) times. The driver side LEDs (FIG 9-H) will illuminate for 3 seconds and shut off. Press "ON" (9-A), then "RET" "All" to retract all Levelers (FIG 9-E and 9-F).
 - b. To disable Air Dump, press the "PASSENGER" button (FIG 9-I) three (3) times. The passenger side LEDs (FIG 9-J) will illuminate for 3 seconds and shut off. Press "ON" (FIG 9-A), then "RET" "All" to retract all Levelers (FIG 9-E and 9-F)
 - c. If the Air Dump feature is not set or has never been configured, the system will wait for 30 seconds. It will default to "Not Configured" and the passenger side LEDs will illuminate for 3 seconds and shut off.
2. To change Air Dump from enabled to disabled or vice versa, have the engine running, the park brake engaged and the transmission in PARK.
 - a. Press "ON" (FIG 9-A) to turn the controls off.
 - b. Press the "EXT" button (FIG 9-D) ten (10) times.
 - c. Press the "RET" button (FIG 9-E) ten (10) times.
 - d. The LEDs will blink left-to-right and back again. Go up to step 3 above and follow the directions to either enable (step 3-a) or disable (step 3-b) the Air Dump feature.
 - e. To check the status of the Air Dump, wait 30 seconds and see which LEDs illuminate. If the air dump is enabled, the driver side LEDs (FIG 9-H) will illuminate and if the air dump is disabled, the passenger side LEDs (FIG 9-J) will illuminate.

TO MANUALLY DUMP THE AIR BAGS

- a. Engine must be running.
- b. Transmission must be OUT of Park/Neutral.
- c. Parking brake must NOT be engaged.
- d. Atwood Levelers keypad is NOT on. Lights inside the ON switch are not lit.
- e. Press the FRONT + REAR + ALL buttons to dump air from air bags. (Note: Air dump feature does need to be enabled for this feature to work.)
- f. Air bags dump in approximately 20 seconds and air bags refill 60 seconds from the start of the air dump.

These controls have the following features to facilitate leveling:

- **TO MAXIMIZE AVAILABLE LEVELER STROKE** During the initial activation of a pair of levelers following the ALL extend activation, for every six (6) seconds the first pair of levelers extend, the opposite pair of levelers will retract for two (2) seconds. This process will repeat for the first 60 continuous seconds of extension of first pair of levelers.
- **FULL EXTENSION** If a leveler is fully extended, its corresponding LED will indicate this and further operation of that pair of levelers in the extend direction is prevented. If the switch is held on, the second leveler of the pair will operate with its alternate pair partner leveler. (i.e., if the front two levelers are extending and the left front leveler becomes fully extended, the right front leveler will continue to operate and the right rear leveler will start to extend.) This is to keep the frame from twisting.
- **LOAD COMPENSATION** If one leveler becomes disproportionately more loaded than its pair partner, power will shut off to the first leveler. The second leveler will continue to operate until the load is more balanced between the pair of levelers. Power to the first leveler will then resume.

TO RETRACT

1. Ensure slideout rooms are fully retracted (in their inboard position).
 2. Press the ON button (FIG 9-A).
 3. Press the ALL button (FIG 9-F) and RETRACT button (FIG 9-E) simultaneously and release. Levelers will retract automatically to their fully retracted position. The leveler indicator LEDs will blink red (FIG 9-H or 9-J) during this activity.
 4. Once levelers are fully retracted, level indicator LED (FIG 9-H) will be solid green.
- NOTE: After operating levelers, the position LEDS for all the levelers must be solid green before the vehicle is to be moved. A visual examination of all the levelers outside the motor home is recommended to insure levelers are fully retracted.



CAUTION PRODUCT DAMAGE

- Do not move vehicle until levelers and landing legs are fully retracted.
- Damage can occur to levelers, coach and surrounding property if the levelers are not fully retracted prior to vehicle being moved.

5. Press the ON button (FIG 9-A) to turn off power to the control pad.

SYSTEM PROTECTION FEATURES

Automatic Retract

- Anytime the engine is on, if the vehicle brake is depressed and transmission is taken out of park, the levelers will fully retract automatically.
- During auto retraction, an alarm will sound and all LEDs will blink on and off.

Nine Cycle Maximum

- The controls will shut off for 15 minutes any time nine (9) full retractions occur in less than 30 minutes.
- When this occurs, all four system status lights blink off and on.
- This sequence can be over ruled by turning the ignition off, then back on.

Low Voltage Protection

- If the voltage falls below 10.5V DC, leveler operation will cease and the low voltage LED will flash.
- Controls will be inoperable until battery voltage climbs above 13V DC, at which time leveling functions will resume.

Manual Override

- To Manually Extend or Retract Leveler, use a 1/2" socket on Drive Nut on the end of the motor (FIG 10-A). Rotate nut counter clockwise (looking from bottom end of nut [FIG 10-B]) to extend leveler.

NOTE: It takes 500 revolutions of nut to extend/retract leveler 1".



CAUTION

PERSONAL INJURY/PRODUCT DAMAGE

- Battery operated drills, 9.6V to 18V, are powerful. Hold drill with both hands to protect your wrist. Keep loose clothing and body parts away from drill as the reaction torque from the drill may cause it to kick back.
- Refer to your drill manufacturer's operation manual.
- Do not over extend or over retract levelers. Each leveler has built in stops. Excessive force applied against the stops will cause damage.
- When manually overriding the leveler do not use pneumatic tools to operate any leveler. They can over-extend or over-retract the leveler.
- If the motor will not extend/retract the leveler and the motor is making a ratcheting sound (clutch slipping), do not use the manual override. Immediately contact an Atwood Service Center and have leveler replaced. Do not use the leveler until replaced.

MAINTENANCE

1. Internal parts of leveler are permanently lubricated at the factory and do not require any further lubrication.
2. If it is not possible to get levelers to operate freely, replace leveler.

7.21.07



LIPPERT
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LEVELGS™ SYSTEM

TROUBLESHOOTING GUIDE

Effective: 11/21/07

Guides are only intended for use on Atwood® products by service technicians who have successfully completed Atwood® training. This guide should be used in conjunction with the appropriate Instruction Manual provided with the product and any applicable Industry Standards. This is not intended to be a complete list. Please direct questions concerning service of Atwood® products to 800-825-4328 before proceeding.



WARNING

PERSONAL INJURY AND/OR PRODUCT DAMAGE

- If any of the following conditions develop, the RV must not be used until proper corrective action is taken.

CAUSE WITH SOLUTIONS

SCROLLING LIGHTS ON KEYPAD

- Communication between keypad and control board lost.
Check wiring between keypad and control board.

JACK CONTINUES TO CLUTCH AND WILL NOT TURN OFF

- Short jack extension followed by jack retraction.
Put system in error mode by disconnecting one jack from power and pressing RET and ALL. Reconnect jack to power. Manually extend individual jacks for 10 seconds by holding down the EXT key and the two jack keys that make up the camper corner of that jack. Listen to insure all jacks move when manually activated. Press RET and ALL to retract all jacks.

RED AND GREEN LIGHTS COME ON FOR A SPECIFIC JACK LOCATION

- Loss of power to jack
 1. Manually extend individual jack by holding down the EXT key and the two jack keys that make up the camper corner of that jack. Listen to insure all jacks move when manually activated. Press RET and ALL to retract all jacks.
 2. If jacks do not move, inspect wiring at jacks and at control board to insure proper connection.

KEY PAD WILL NOT TURN ON

- No power to key pad
 1. Insure vehicle engine is running, transmission is in 'PARK' and park brake is set.
 2. Check wiring between keypad and control board.

JACKS WILL NOT MOVE

- No power to jacks
 1. Insure vehicle engine is running, transmission is in park and park brake is set.
 2. If emergency stop was activated by pressing any keypad button, press 'RET' and 'ALL' to reset legs.

AUTO POSITION DOES NOT LEVEL THE COACH

- The last position in memory was not level. Leveler System always returns to position in memory
 1. The control board must be mounted horizontally, on a solid fixed surface and can not be more than 10 degrees out of level.
 2. Manually set coach to desired position and program position into memory, following the steps in the IOM.

PANEL LIGHTS BLINK "ON" AND "OFF"

- An Auto Position is not set
Set the Auto Position, referring to the IOM.

TRANSMISSION LIGHT WILL NOT COME ON

- Chassis wiring fuse problem.
Check fuse on chassis fuse box.

The following error modes are built into your system to detect problems.

FALSE RET (FULL RETRACTION) ERROR MODE

- For extensions greater than 20 seconds, if the retraction time for any leveler is less than the extension time (indicating premature clutching prior to full retraction), the following occurs:
 1. Warning alarm will sound.
 2. Power is removed from the control box disabling normal operations. (This is done to encourage operator to do a visual inspection of levelers prior to further leveling operations.)
 3. The red and green LED's for the particular leveler will blink on and off to indicate the system is in an error mode.
- To proceed,
 1. Press "ON". This will shut the warning alarm off.
 2. Visually inspect the leveler.
 3. If it is required, activate levelers to correct problem.
Simultaneously press the EXTEND or RETRACT mode switch along with the adjacent two (2) leveler switches common to the lit LED's. In error mode, any leveler can be activated in this manner.
 4. Complete an ALL RETRACT operation and system is now out of error mode and ready for normal operations.

NO CURRENT ERROR MODE

- During any operation if no current is detected from leveler after leveler is activated, the following occurs:
 1. Warning alarm will sound.
 2. Power is removed from the control box disabling normal operations.
 3. The red and green LED's for that leveler will blink on and off to indicate the system is in an error mode.
- To proceed,
 1. Press "ON". This will shut the warning alarm off.
 2. Simultaneously hold down all four direction buttons and the "All" button. This resets the timers so controls will detect the next clutch.
 3. Press "RET" and "ALL" buttons. The system is now out of error mode and ready for normal operations.

If step 3 does not fix the problem, individual levelers can be retracted by simultaneously pressing the "RET" button and the adjacent two (2) leveler buttons common to the leveler requiring retraction.

LEVELER CONTINUES TO "CLUTCH"

- To proceed,
 1. Press "ON". This will shut the warning alarm off.
 2. Simultaneously hold down all four direction buttons and the "All" button. This resets the timers so controls will detect the next clutch.
 3. Press "RET" and "ALL" buttons. The system is now out of error mode and ready for normal operations.

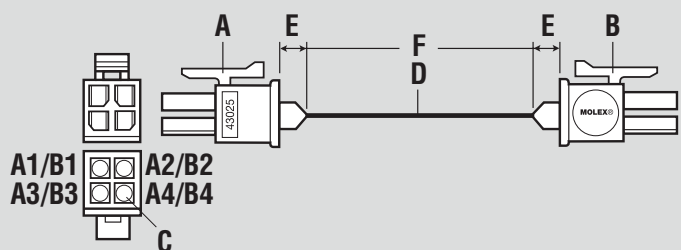


Figure 4 — Control Pad Wire Harness

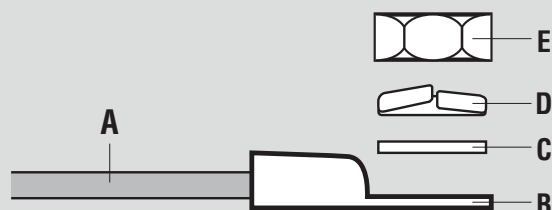


Figure 5 — Battery Connection

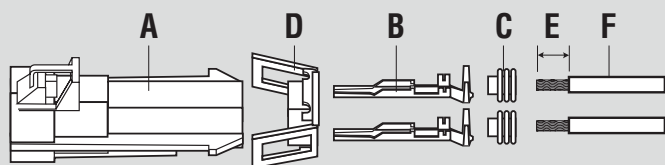


Figure 6 — Delphi Connector

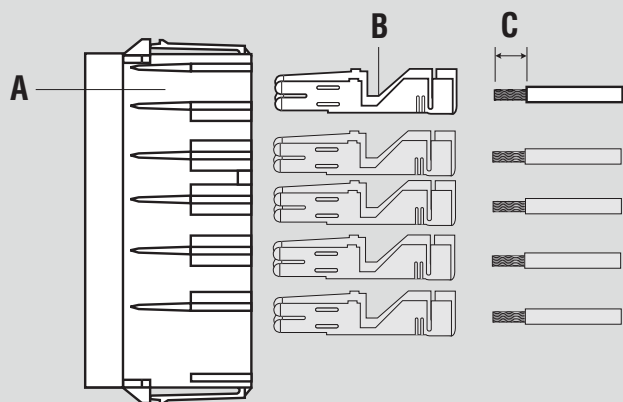


Figure 7 — Controller Molex Connector

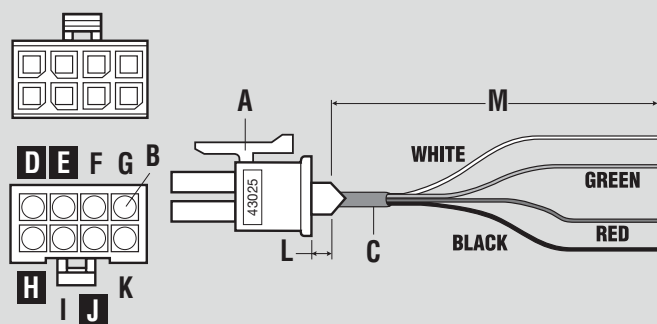


Figure 8 — Signal Wire Harness

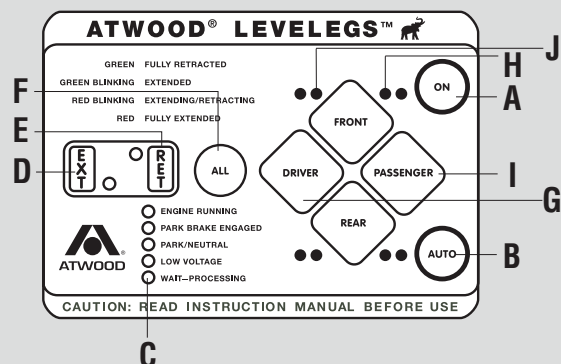


Figure 9 — Control Pad

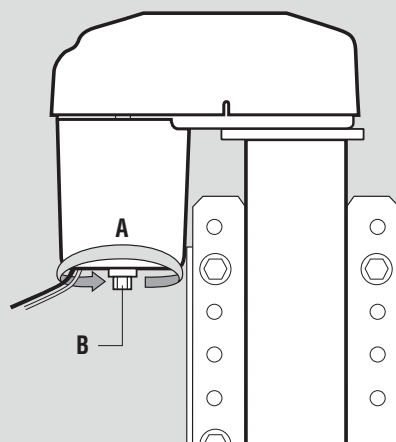


Figure 10 — Manual Override

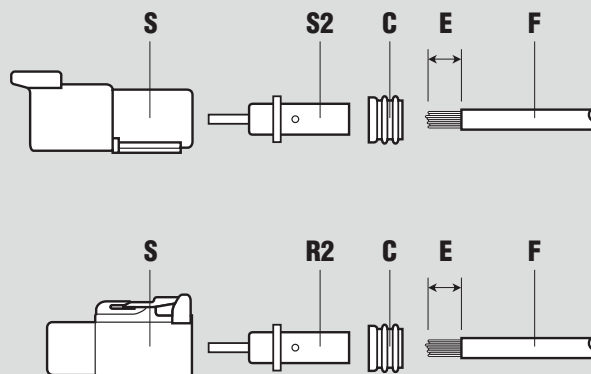


Figure 11

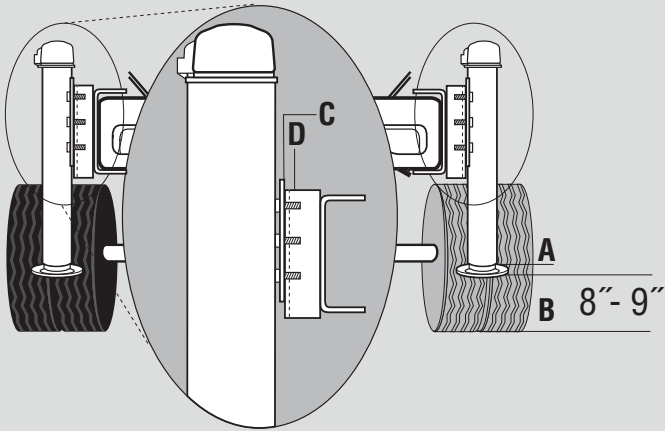


Figure 1 — Levelleg Installation

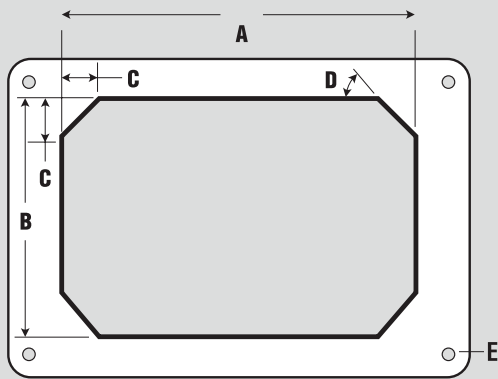


Figure 2 — Control Pad Template

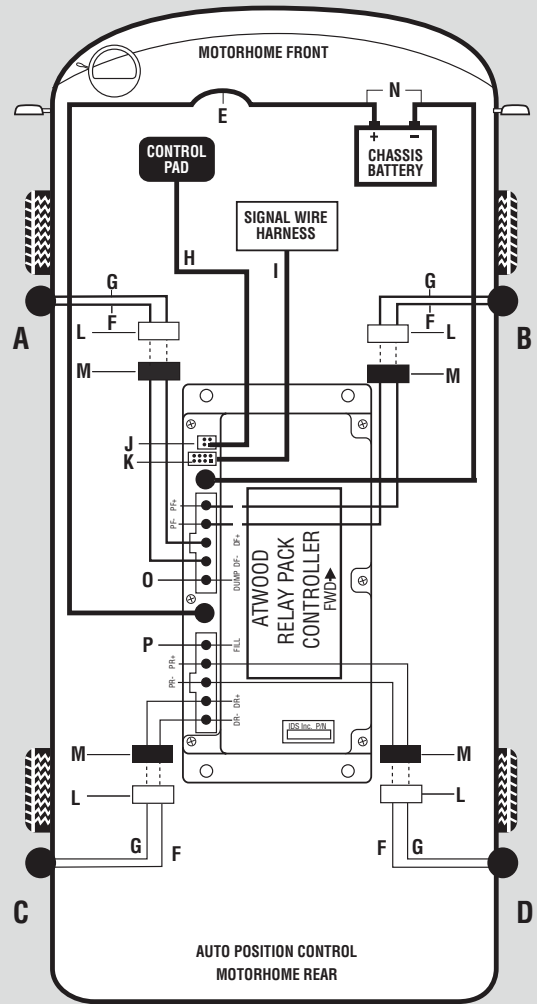


Figure 3

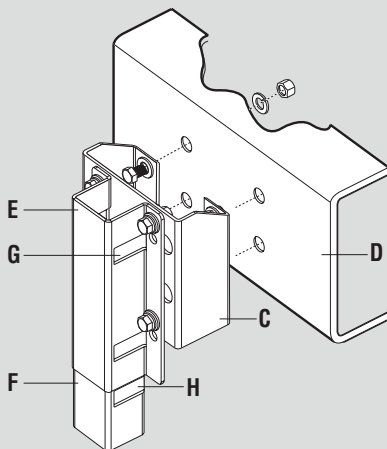


Figure 12 — 7.5K Square Tube

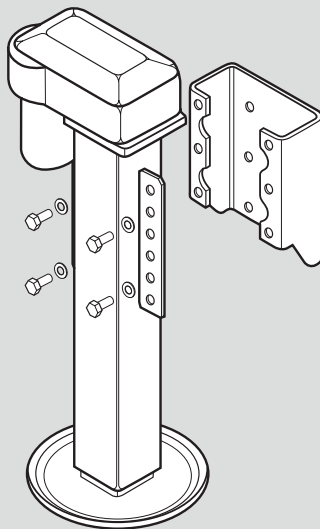


Figure 13 — 10K Square Tube

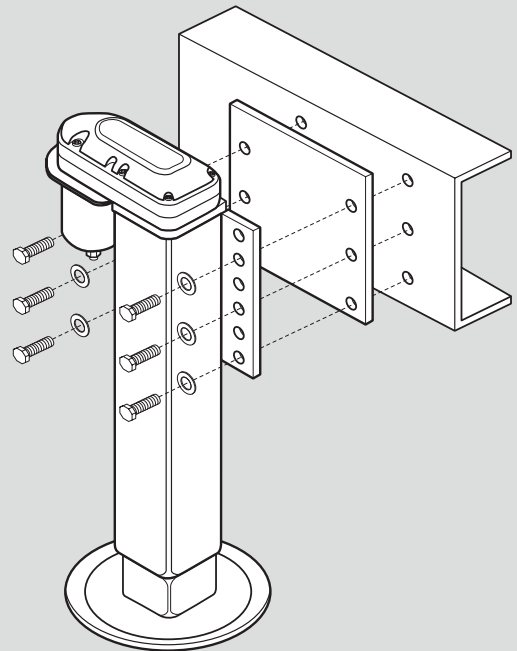


Figure 14 — 15K Square Tube



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