

WAITER's

**LANDING GEAR
CONTROLLER**

**LongEZ/Cozy
Berkut**

Tricycle/ Tail-dragger

Controller for all retractable landing gear systems

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THEORY OF OPERATION

Waiters Landing Gear Controller is designed around an industrial Programmable Logic Controller (PLC). Model # D0-05DR-D and Input Card D0-10ND3. These are available from Automation Direct.

Automation Direct does NOT APPROVE these controllers for use in aviation. Use this controller at your own risk.

The firmware is written in Ladder Logic (DirectSoft32 Ver 5.1) and allows the controller to safely and effectively manage a standard retractable landing gear. AND, more importantly, the split gear configuration found on Long EZ / Velocity / Cozy / Berkut style aircraft.

<http://www.automationdirect.com>

Standard landing gear or separate nose gear control.

The nose gear can be configured to operate in a Split mode (For LongEZ that needs to retract/Extend the nose independent of the Mains (ground Operations)).

The Nose can also be configured to either be Electric (it has its own electric actuator) or the nose can be Hydraulic (plumbed into the main system) and extends/retracts with the mains.

The controller has intelligence built in to reduce the possibility of an accidental retraction of the main gear, yet provides the ability to retract and extend the nose gear while performing routine ground operations.

PLUS - the ability to provide canopy warnings, gear alarms, and emergency operations.

The computer hardware interfaces to the following systems;

- Infinity gear that compresses the struts for retraction
- Retractable main gear, with left and right gear mechanically linked
- Retractable main gear, with separate actuators for left/right gear legs
- EZ Nose Lift - Nose gear actuator only (no need for controller or harnesses)
- Speed Brake system – Electric actuator must have built-in end stop switches.
- Other systems can be easily adapted.

There are basically five main functions of the computer controller:

- 1) Power up Self Test
- 2) Airborne Main and Nose extend/retract operation
- 3) Ground Nose extend/retract operation
- 4) Emergency Retract Operation
- 5) Alarming for gear down and canopy closed

SYSTEM REQUIREMENTS

POWER – Minimum voltage required is 10 volts. The Controller may switch itself off/on as the voltage continues to drop below this value.

SENSORS – ALL switch and sensors described in this manual and in the wiring diagrams MUST be installed and adjusted (Don't leave any switches out thinking; "Oh Yah, it will work without this switch!"). Failure to do so will most likely result in an inadvertent gear retraction or a gear up landing.

WAIVER – This software is released to the General public under the conditions of the GNU. Use and modify at your own risk.

INSTALLATION REQUIREMENTS

Although Waiters Landing Gear Controller isn't complicated, the fact that it interfaces with just about every system on the aircraft (electrical, flight controls, hydraulic, engine controls, etc) places a great demand on the knowledge and abilities of the installer.

Because this system can be installed in just about any aircraft, its simply not feasible to provide highly detailed instructions.

The Installer must be able to review the drawings and make any modifications necessary to provide a safe installation in their aircraft.

WARNING

The installer must have at minimum, a basic understanding of electrical theory and skills. If you don't know what "Ohms Law" is, or you can't trace a path through the electrical diagram with a full understanding of the path;

YOU ARE NOT QUALIFIED TO PERFORM THIS INSTALLATION.

FIRMWARE CONFIGURATION

There are Five Firmware settable control flags. These flags, C0, C1, C73, C121, and C122 define how the controller will interface with the aircraft, and what landing gear is installed on the aircraft.

These flags are SET/RESET when the PLC is programmed. These are NOT user changeable.

C0 = OFF Inputs X100/X101, Hydraulic Switches are Normally Open. When the hydraulic pressure raises to the switch pressure, the switch Closes.

C0 = ON (DEFAULT) Inputs X100/X101, Hydraulic Switches are Normally Closed. When the hydraulic pressure raises to the switch pressure, the switch Opens.

C1 = OFF Outputs Y0/Y1 are wired as UP and DOWN control relays. These relays are then wired to the Pump Control Solenoids.

C1 = ON (DEFAULT) Outputs Y0/Y1 are wired as Direction and Power relays. These relays are then wired to the Pump Control Solenoids.

C73 = OFF Output Y4 is used to control a speed brake.

C73 = ON (DEFAULT) Output Y4 is used to control the Strut Compression valve on an Infinity Gear (LongEZ / Berkut).

C121 = OFF Nose gear operates in Conjunction with main gear UP / DOWN.

C121 = ON (DEFAULT) Nose gear operates in Split Mode i.e. Ground Operations can Retract/Extend nose independent of Mains (LongEZ / Berkut).

C122 = OFF Nose gear is operated Hydraulically.

NOTE – C121 must be set to OFF

NOTE – Y2 is used for Speed Brake Retract

C122 = ON (DEFAULT) Nose gear is operated electrically, regardless of the C121 setting.

PLC CONFIGURATION

RUN – TERM – STOP switch

This switch needs to be in the TERM position when using the Monitor program or when programming the PLC.

Although the PLC will normally work ok in the TERM position, There have been situations where the PLC becomes unresponsive (locks up) after some weird power cycle/voltage spike. The lockup is attributed to the PLCs internal serial port 2 waiting for a connect sequence from the programming software. Obviously it will never receive this sequence if the programming software isn't connected.

This lockup doesn't happen if the switch is in the RUN position. So;

WARNING

The RUN-TERM-STOP switch MUST be in the RUN position for normal operations.

If the PLC seems "Locked up", move this switch to the STOP position, then to the RUN position. This will reset the PLC.

CONTROLLER CONFIGURATION

INTELLEAGENT NOSE / MAIN GEAR INTERCONNECTION

One switch, UP-OFF-DOWN, provides full functionality for both air and ground operation. Intelligence is built into the computer to reduce the likelihood of an inadvertent main gear retraction while on the ground. The main gear and nose gear now operate as one complete system, rather than two separate systems.

The nose gear can be extended, retracted, and stopped anywhere in its travel by placing the UP-OFF-DOWN switch in any of the three positions.

The main gear doesn't use the OFF position of the switch. It will always be in a full UP or DOWN mode, whatever was the last commanded.

SAFE POWER UP MODE

A key feature of this controller is its ability to analyze the current gear configuration, and make the safest possible determination on how to power up the gear computer, and what mode it should be in.

The simplest approach would be to just do what the switch says, i.e. if the switch is in UP, then retract the gear. Its EZ to see, this approach has a great deal of risk.

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The approach used in this design is more complicated, and safeguards not only against inadvertent gear retractions, but inadvertent gear extensions. i.e. power cycled during cruise, and the gear switch was accidentally placed in the DOWN position.

The Gear computer attempts to reconcile the control switches against the actual position of the gear and its sensors. If the "rules" are not met, the computer will stay in the SAFE POWER UP MODE indefinitely, until the pilot resolves the problem or makes a decision on what mode the computer should be in.

WHY IS MODE IMPORTANT

The Main gear has to remember what mode it's in. It can't use the UP OFF DOWN switch, because it may be in the OFF position. The "mode" is simply an internal software "switch", that's either in the EXTEND or RETRACT position. Normally, when power is on, the mode will follow the last position of the UP OFF DOWN switch.

A problem arises when power is first applied to the controller. If someone has tampered with any of the switches, or the gear has changed position, or there was a sensor failure, then the computer will attempt to resolve this by determining position of the UP-OFF-DOWN switch, and reconciling this with the current gear positions and status switches.

The "Power up Evaluation Mode" places the system in a mode that corresponds to the safest operating position. Once the mode is set, the computer monitors the status switches and coordinates the relays, pumps, and valves, depending on what mode it's in.

POWER UP EVALUATION

During the power up mode, the Computer provides one of five results. The power up test conditions are much more stringent than the normal test conditions.

These results can be paraphrased in the following manner;

- 1) (UP) The UP-OFF-DOWN switch is in the UP position. From the status of the landing gear switches and sensors, this is correct, so I will place the main gear in the RETRACT mode of operation.
- 2) (DOWN) The UP-OFF-DOWN switch is in the DOWN position. From the status of the landing gear switches and sensors, this is correct, so I will place the main gear in the EXTEND mode of operation. (all three must be down)
- 3) (OFF) The UP-OFF-DOWN switch is in the OFF position, From the status of the landing gear switches and sensors, I have determined the main gear is in the EXTEND mode, So I will place the main gear in its respective mode. (don't care about what position the nose gear is in)
- 4) I have determined that the gear switch is in the UP, DOWN, or OFF position, but I can't safely determine the position of the gear. I will NOT do anything further until you fix the problem
- 5) I have determined that the EMERGENCY RETRACT switch is in the RETRACT position. I will NOT do anything further until you put this switch in the OFF position.

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The following conditions are evaluated during the power up, and must be ACTIVE in order to set the corresponding mode. Note that these conditions are more stringent than their “normal” operations counterparts.

OPEN = The switch is OPEN – (The X input will read Greater than 10 volts)

SHORTED = The switch is shorted (The X input will read Less than 1 volt)

ITEM 1 - Sets RETRACT mode on power-up if. This is the most stringent test.

RIGHT DOWN	OPEN
LEFT DOWN	OPEN
RIGHT UP	SHORTED
LEFT UP	SHORTED
Nose DOWN Limit	OPEN
Nose UP Limit	SHORTED
UP Switch	SHORTED
DOWN Switch	OPEN
* Hyd UP Pres Low	OPEN (SHORTED)
* Hyd DOWN Pres Low	SHORTED (OPEN)
Airspeed Low	OPEN
Throttle Full	SHORTED
Throttle Off	OPEN
Canopy Open	OPEN
** UP Interlock – Grounded	SHORTED
** Infinity Strut Retracted	SHORTED
UP Interlock – Open	OPEN
Alarm Mute	OPEN
EMER Retract	OPEN

*** Configuration Bit C0 will determine if the Hydraulic switches are Normally Closed (NC) (Default) or, Normally Open (NO).**

**** Configuration Bit C73 will determine if X106 is the Strut or an Interlock**

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ITEM 2 - Sets the EXTEND mode on power-up if;

(If switch is in EXTEND)

RIGHT DOWN	SHORTED
LEFT DOWN	SHORTED
RIGHT UP	OPEN
LEFT UP	OPEN
Nose DOWN Limit	SHORTED
Nose UP Limit	OPEN
UP Switch	OPEN
DOWN Switch	SHORTED
Hyd UP Pres Low	SHORTED
Hyd DOWN Pres Low	OPEN
Airspeed Low	SHORTED
Throttle Full	OPEN
Throttle Off	SHORTED
Canopy Open	DON'T CARE
UP Interlock – Grounded	DON'T CARE
Infinity Strut Retracted	DON'T CARE
UP Interlock – Open	DON'T CARE
Alarm Mute	OPEN
EMER Retract	OPEN

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ITEM 3 - Sets the EXTEND mode on power-up if;

(If switch is in OFF, This is the least stringent)

RIGHT DOWN	SHORTED
LEFT DOWN	SHORTED
RIGHT UP	OPEN
LEFT UP	OPEN
Nose DOWN Limit	DON'T CARE
Nose UP Limit	DON'T CARE
UP Switch	OPEN
DOWN Switch	OPEN
Hyd UP Pres Low	SHORTED
Hyd DOWN Pres Low	OPEN
Airspeed Low	SHORTED
Throttle Full	DON'T CARE
Throttle Off	DON'T CARE
Canopy Open	SHORTED
UP Interlock – Grounded	DON'T CARE
Infinity Strut Retracted	DON'T CARE
UP Interlock – Open	DON'T CARE
Alarm Mute	OPEN
EMER Retract	OPEN

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In order for the computer to proceed to normal operation, the RETRACT or EXTEND mode must be set by ITEMS 1, 2, or 3.

WHAT TO DO

If the computer is stuck in the SAFE POWER UP MODE, The Warning horn will sound continuous, ½ second ON, ½ sec OFF, until the mode is determined by the operator.

To Force the mode to either RETRACT or EXTEND;

- 1) Verify that the EMERGENCY RETRACT is in the OFF position.

The controller will NEVER go past the SAFE POWER UP MODE if the EMERGENCY RETRACT switch is in the RETRACT position.

- 2) The UP OFF DOWN switch must be cycled. Move it to any position, then move it again to the position desired.

NOTE: If the switch is placed in the UP position, ALL conditions for a normal gear retraction must be correct, or the alarm will chirp once a second and the main gear will NOT enter the RETRACT mode

There are NO conditions to place the gear in the EXTEND mode.

An indication that the mode was accepted by the computer will be an immediate 2 chirps of the warning horn.

EMERGENCY RETRACT MODE

In the Event that the pilot decides to do a last second retract of the gear. i.e. The engine is out, and the pilot thought he could make the runway, but now realizes he can't. If the pilot decides to retract the gear by using the normal UP-OFF-DOWN switch, the system safeguards may not allow it (i.e. the airspeed is too low, The Airspeed Interlock will not allow the gear to be retracted).

The EMERGENCY RETRACT switch overrides ALL safeguards and starts the retraction process immediately.

All three gear will start retracting.

The Speed Brake will also be commanded to retract (If this option is set by C73 and the Speed brake retract is wired to the controller)

DIRECTION DELAY

This feature protects the Hydraulic pump and Nose gear motor from quick direction changes.

A ½ second delay is introduced if the direction is change to quickly

ALARMING

This controller supplies meaningful, prioritized alarms for several situations.

The Alarm Mute button will silence the alarm horn for 10 seconds. EXCEPT the Canopy warning and the stuck mute button. These alarms cannot be silenced.

- 1) INITIAL POWER UP – Initial Landing gear condition cannot be determined. (alarm horn sounds - 1 second ON/OFF)
- 2) Throttle full and Canopy NOT closed (non mutable)
- 3) Alarm Mute Button stuck (or held in) for longer than 30 seconds. (alarm horn sounds - 1 second ON/OFF)
- 4) Gear Switch in UP position, Canopy closed, BUT one of the other interlocks is preventing the gear from retracting (Airspeed LOW, or Gear Interlock switch) (Alarm horn is a "CHIRP" at one second interval)
- 5) The main gear is NOT down and the Canopy is open.
- 6) The main gear is NOT down and the throttle is at idle.
- 7) The Nose gear is NOT down, the throttle is at Idle, and the Canopy is closed.

PILOT INTERFACE – The following lights and switches perform the functions indicated

UP-OFF-DOWN switch - Performs multiple functions, depending on mode.

- 1) From the NORMAL MODE. Allows the pilot to extend and retract the gear.
- 2) From the NORMAL MODE. When parked, allows the pilot to extend/retract the nose gear only (Canopy open and airspeed < 85kts).
- 3) From the POWER UP MODE. If the computer cannot reconcile the gear position, use this switch to force the computer into EXTEND or RETRACT mode.

ALARM MUTE button – Performs multiple functions, depending on mode.

- 1) From Normal Mode. When momentarily pressed, squelches the alarm for 10 seconds. (Canopy alarm does NOT squelch)
- 2) From Normal Mode. If held in (or stuck) for longer than 30 seconds, will generate an alarm.

EMERGENCY RETRACT switch – Located at the top left of the instrument panel. Covered and safety tied with breakaway wire. Overrides all safety rules and Retracts all three gear.

When powering up the gear controller, this switch must be OFF, or the gear controller stays in the power up test mode indefinitely.

AUX GEAR - Located on the left side of the instrument panel, grouped with the landing gear circuit breakers. Covered and safety tied with breakaway wire. Supplies power to the Aux Gear control circuits. (See below)

CAUTION – The Gear Controller circuit breaker MUST be pulled before using the AUX GEAR EXTENSION switch. Failure to do so can result in serious damage to the electrical system.

STRUT / OFF / AUX GEAR EXTENSION switch – Located behind the throttle inside the armrest. This switch is spring loaded to the OFF position.

This switch gets its power from the AUX GEAR circuit breaker. In the event of a controller failure, this switch can be used to apply power directly to the solenoids.

STRUT EXTENSION position –

When held in this position, Aux Power is applied directly to the Main Gear DOWN Power Solenoid, AND, the Infinity Strut Solenoid, bypassing all computer control.

AUX GEAR EXTENSION position –

When held in this position, Aux Power is applied directly to the Main Gear DOWN Power Solenoid, bypassing all computer control.

This position also applies Aux Power directly to the Nose Down Relay.

CAUTION – The Gear Controller circuit breaker MUST be pulled before using the AUX GEAR EXTENSION switch. Failure to do so can result in serious damage to the electrical system.

INSTALLATION PLANNING

SYSTEM POWER

Use the Electrical system diagrams as a guide.

Basically, there are four power feeds , Three will come directly from the battery (they are hot all the time) and the fourth will come from the switched side of the master relay



The Main gear (50) and Nose Gear (10) breakers are wired directly to the battery.



The Aux Gear (10 amp Toggle) is also wired directly to the battery. This Covered breaker is used as an emergency supply to the circuits and is used to power the pump and motor relays directly, without the use of the controller.

The CONTROL circuit breaker is wired normally through the master relay. It supplies power to the sensors, controller, and the control relays.

EMERGENCY EXTEND SWITCH

The Emergency Extend switch is used in the event you suspect a controller failure. I.e. the voltage level has dropped below 9 volts. Still might be enough to energize a relay, but not enough to run the controller.



The Emergency Extend circuit gets its power directly from the battery, through the AUX GEAR circuit breaker (described above). This is a spring loaded switch that energizes the pump and motor relays directly.

NOTE – Pull the Controller circuit breaker before attempting to use this feature.

PLC CONNECTIONS

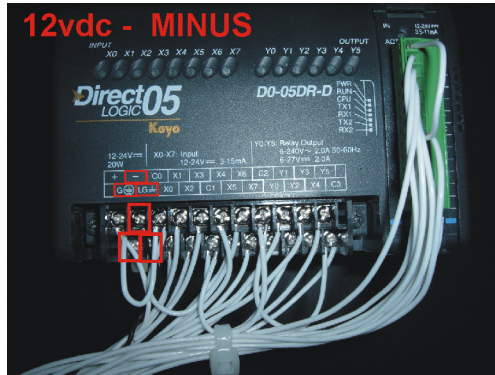
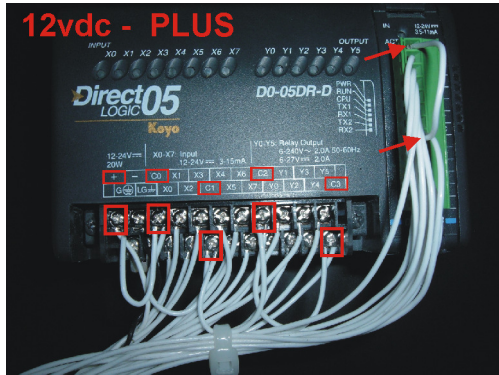
Connections to the PLC are made with screw terminals.

Strip back ¼ of insulation from the wire, Solder tin the exposed wire. Insert the wire under the correct terminal then snug the screw down.

DO NOT OVERTIGHTEN the screws, they strip very easily.

Use extreme care when determining what terminal is used to insert wires,. Because of the small size of the terminals and the close proximity of other terminal, its very easy to use the incorrect terminals.

POWER TERMINALS

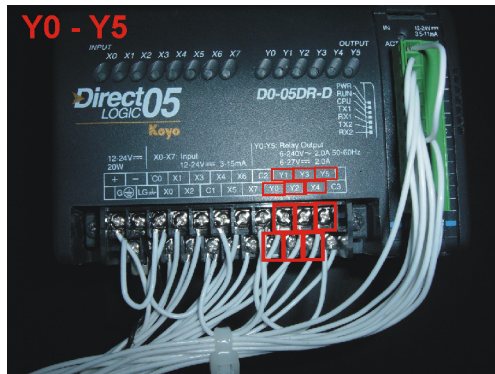
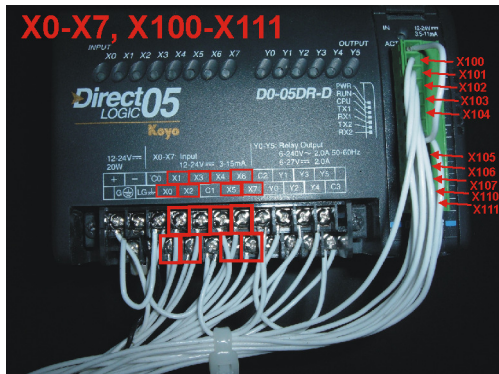


SENSORS AND SWITCHES (INPUTS)

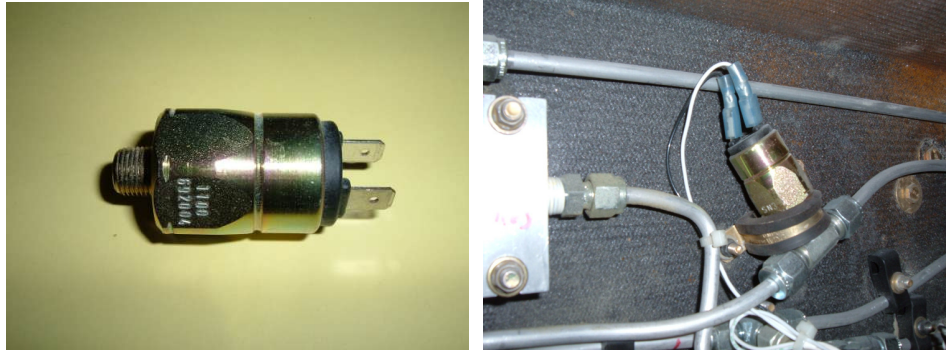
ALL switches and sensors MUST be connected properly in order to achieve the protection that is supplied by this controller.

The Installation, wiring and adjustment of the switches and associated wiring should only be performed by a qualified aviation electrician.

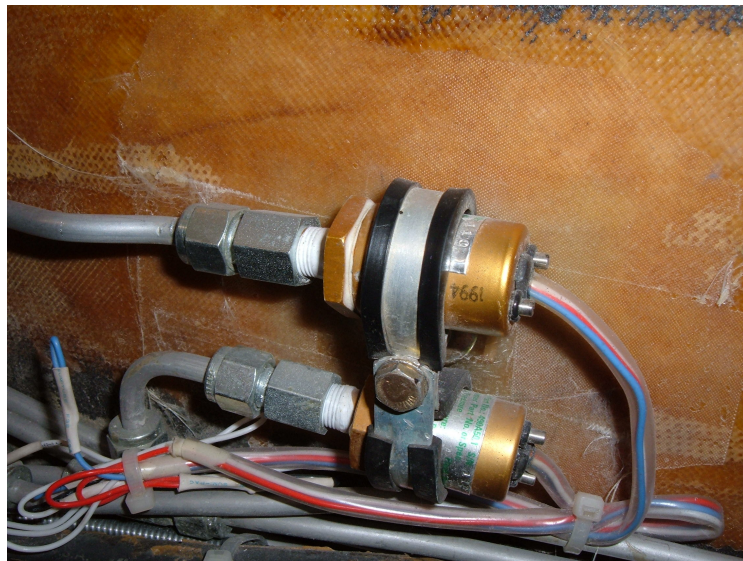
To Clarify, The way the inputs are wired, ON means that current is flowing, i.e. the X input is switched to ground. OFF means the circuit is open, there is no current flow.



HYDRAULIC PRESSURE SWITCH



Strut Pressure sensor (Infinity Gear Only)



Hydraulic UP / DOWN line pressure sensors

There are two (or three) pressure switches used in the Landing gear system.

The Strut pressure sensor (top two photos) is a normally open switch, and closes when the struts are compressed to 1100 psi. This switch is used in place of the two mechanical switches on the Infinity Gear to indicate that the struts are fully compressed and the gear can now be retracted.

The two pressure sensors (lower photo) are wired Normally Closed. These two switches sense the hydraulic pressure to determine if the gear is up or down

These switches can be purchased from Velocity Aircraft.

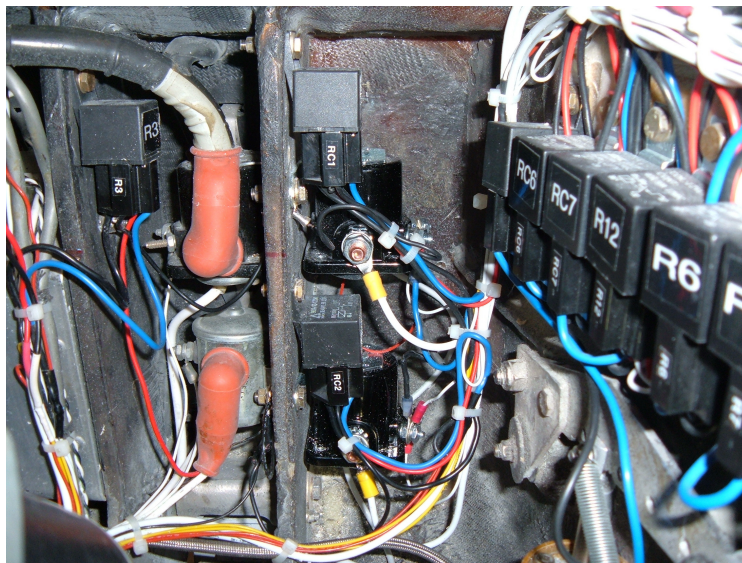
CONTROLLER OUTPUTS

The controller does NOT enough current drive capability to energize aircraft components or pump solenoids directly.

ALL outputs of the controller MUST connect through the small cube drive relays.

FAILURE TO DO THIS WILL RESULT IN FAILURE OF THE CONTROLLER.

In the following photo, you can see the small cube relays and the larger Master solenoid and the pumps control solenoids.



Power Cube relays and Pump Solenoids

NORMAL MAIN AND NOSE OPERATION

Normal operations are performed by a three position switch. Double Pole Double Throw (DPDT), UP – OFF – DOWN



Part # S7AL-R0 is a 3 position switch that locks in all three positions. This switch can be purchased from Digikey for about \$18.

DOWN (EXTEND)

Any time the UP – OFF – DOWN switch is placed in the DOWN position, the MAINS and NOSE will attempt to extend. With the exception of DIRECTION DELAY, there are no safeties associated with the DOWN mode.

If the UP – OFF – DOWN is placed in the UP position during the extend process, both, the main and nose will stop where they're at, and one second later (DIRECTION DELAY) they will start the retract process. (provided proper UP conditions are met)

NOSE GEAR SEQUENCE

The nose down contactor is energized and continues until the nose DOWN LOCK switch closes to signal the computer to remove power from the contactor.

The GREEN NOSE DOWN light will illuminate when the DOWN switch is closed.

The nose extension can be stopped by moving the selector switch to the OFF or UP positions. The OFF position will stop the nose gear where its at. (The OFF position will not stop the main gear extension)

MAIN GEAR SEQUENCE

- 1) The main gear Down pump contactor is energized.
- 2) It stays energized until the Hyd DOWN Pres Low switch deactivates. activates. The switch deactivates when the hydraulic pressure is high enough.

UP (RETRACT)

Anytime the switch is in the UP position, the status of other system components will be validated before retraction is allowed to take place (i.e airspeed, canopy, tilt, and throttle). Once the conditions are validated, the retraction begins and cannot be canceled if one of the conditions changes. The only way to stop retraction once it is started is to place the switch in the opposite (EXTEND) position (MAIN GEAR) or the OFF position (NOSE GEAR only)

NOSE GEAR SEQUENCE

Retraction of the nose gear is conditional upon the Canopy, airspeed sensor, and Throttle position.

Ground Operation - The nose gear can be extended and retracted on the ground without effecting the main gear (it must be down). These are the conditions that allow ground operation of the nose gear.

1) Main UP-OFF-DOWN Switch	Any Position
2) Airspeed Low	SHORTED (must be less than 85 knots)
3) Throttle Full	OPEN (cannot be at full)
4) Throttle Idle	SHORTED (must be at idle)
5) Canopy Open	Don't care
6) UP Interlock – Grounded	Don't care
7) UP Interlock – Open	Don't care
8) EMER RETRACT	OPEN (must be OFF)

Air Operation – The nose gear follows the same rules as the main gear;

The Nose Up contactor is energized and continues until the UP Lock switch signals the computer to remove power. The nose retract can be stopped by moving the selector switch to the OFF or DOWN positions. The OFF position will stop the nose gear at its current position. (The OFF position does not stop the main gear retraction)

MAIN GEAR SEQUENCE

Main gear retraction is ALWAYS conditional on the following;

1) Main UP Switch	SHORTED
2) Airspeed Low	OPEN (must be greater than 85 knots)
3) Throttle Full	SHORTED (Must be Full position)
4) Canopy Open	OPEN (Canopy must NOT be open)
5) UP Interlock – Grounded	SHORTED (NOT used if Infinity Strut)
6) UP Interlock – Open	OPEN
7) EMER RETRACT	OPEN

- 1) Place the main control switch in the UP position.
- 2) Airspeed Switch – The airspeed must be above 85kts (sensor switch adjusted to 85 kts)

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- 3) The throttle must be full
- 4) The Canopy must be closed
- 5) This Interlock input must be shorted to ground If we are NOT using the Infinity Strut compression solenoid
- 6) This Interlock input must be open (not shorted to ground)
- 7) The EMER RETRACT switch must be OFF

Once the sequence is started, the only way to abort it is the place the switch in the DOWN (extend) position. The OFF position does not stop main gear retraction

Once all these conditions are met, the gear will start retracting. If all conditions are not meet when the switch is moved to the UP position, the ALARM horn will chirp once a second until the conditions are meet.

The UP Pump continues to run until the Hyd UP Pres Low switch deactivates (Pressure is now OK).

OFF (center position)

This switch position performs two functions:

- 1) Disables all three gear UP LOCK red lights. This is great for flying at night when the UP lights can be very distracting. Does not effect the DOWN lights.
- 2) Stops the nose gear were its at in its travel. Disables nose gear switch monitoring

NOTE: The OFF position does NOT affect the main gear. The Main gear stays in the last mode it was in. If the mains were retracting, they will continue to retract and behave as if the switch were still in the UP position. If the mains were extending, they will continue to extend and behave as if the switch were still in the DOWN position.

DIRECTION DELAYS

The CPU provides a one half second delay between changing modes i.e. if you move the switch to DOWN, then immediately back to UP again, there will be a one half second delay before the UP command is issued to the contactor. This delay provides time for the pump or motor to come to a full stop, before changing direction. The delay is valid for both, the Main Gear Up / Down Pump, and the Nose gear Up / Down motor.

EMERGENCY RETRACT OPERATION

These procedures must be committed to memory, and occasionally practiced and reviewed.

RETRACTING NOSE ONLY

Retracting the nose would be useful in the event of total brake system failure, and you decide to collapse the nose in order to bring the aircraft to a stop.

NOTE

With the original manual retract system, once the nose gear is no longer over center, the Boston drive gear strips and the nose drops instantly. HOWEVER, With this system, the retract process will take 10 - 15 seconds. Think early.

1) Pull the 50 amp MAIN GEAR PUMP breaker. This should have been mounted close to the EMERGENCY RETRACT switch.

WARNING

If you fail to pull this circuit breaker, the mains will also retract.

2) Break the safety wire on the EMERGENCY RETRACT switch.

3) Place the EMERGENCY RETRACT switch in the RETRACT position.

NOTE: If the Speed brake is deployed, it will also retract when the EMER RETRACT switch is activated.

RETRACTING ALL GEAR

In the event of an off field landing, it is often more survivable to land with the gear retracted. Each situation must be evaluated, and have appropriate options available.

When the EMERGENCY RETRACT switch is placed in the RETRACT position, it overrides all other switches and safety items, including the UP-OFF-DOWN switch, and starts the retraction process.

The complete retract process will take XXX seconds.

1) Break the safety wire on the EMERGENCY RETRACT switch.

2) Place the EMERGENCY RETRACT switch in the RETRACT position.

NOTE: If the Speed brake is deployed, it will also retract when the EMER RETRACT switch is activated.

ABORTING THE EMERGENCY RETRACT

In order to minimize the re-extension time, its important to perform these steps in the order listed

- 1) Move the UP-OFF-DOWN switch to the DOWN position.
- 2) Move the EMERGENCY RETRACT switch back to its original OFF position.
- 3) If the 50 amp Main Gear breaker was pulled, push it back in.

ALARMING

A set of contacts (Y5) is dedicated to a Canopy / Gear / System Alarm. This contact should drive a relay, that in turn drives a loud audible alarm. I use a car horn. Its loud and will get your attention.



Alarm Buzzer

Needs to be installed in headrest so it can be heard over everything else

Canopy and stuck switch alarms cannot be muted.

Gear alarms can be muted by momentarily pressing the ALARM MUTE button. Muting disables the alarm feature (open the contacts) for a period of 10 seconds, regardless of new or old alarms.

NON-MUTE ALARMS

CANOPY NOT CLOSED - Canopy Open **AND** Full Throttle is applied (Constant alarm)

ALARM MUTE SWITCH STUCK – the Alarm Mute switch has been active for greater than 30 seconds.

MUTABLE ALARMS

GEAR NOT DOWN – There are two tiers of alarms for gear warnings, these are decided based on the canopy position.

IF CANOPY CLOSED – The alarm will sound for the following conditions:

If the Airspeed is less than 85 knots (airspeed sensor open) **AND** all three gear are NOT down (three green).

OR

Waiter's Landing Gear Controller – LongEZ / Cozy / Berkut

If the throttle is moved to idle AND all three gear are NOT down (three green).

IF CANOPY OPEN – Both Mains MUST be down (two green).

AUDIBLE CHIRP

POWER UP - 2 quick chirps if power up OK.

MUTE BUTTON PRESSED - If the MUTE button is pressed, but no alarms exist, the alarm horn will chirp once. This brief chirp verifies that the MUTE button and the Alarm system are functional.

GEAR RETRACT NOT ALLOWED - The UP-OFF-DOWN switch is in the UP position, but the conditions are not correct to allow the gear to retract. The alarm system will chirp once per second until either the UP-OFF-DOWN is repositioned, OR, the conditions for retract all become OK and the gear starts to retract.

AUDIBLE ½ sec ON - ½ sec OFF

MUTE BUTTON STUCK - If the MUTE button is stuck for longer than 30 seconds, The alarm will sound ½ second ON – ½ second OFF until the button is no longer stuck.

SERIAL DATA OUTPUT

The Gear Controller outputs a serial stream out its PORT 2 connection. The RUN-TERM-STOP switch MUST be in TERM position).

WARNING

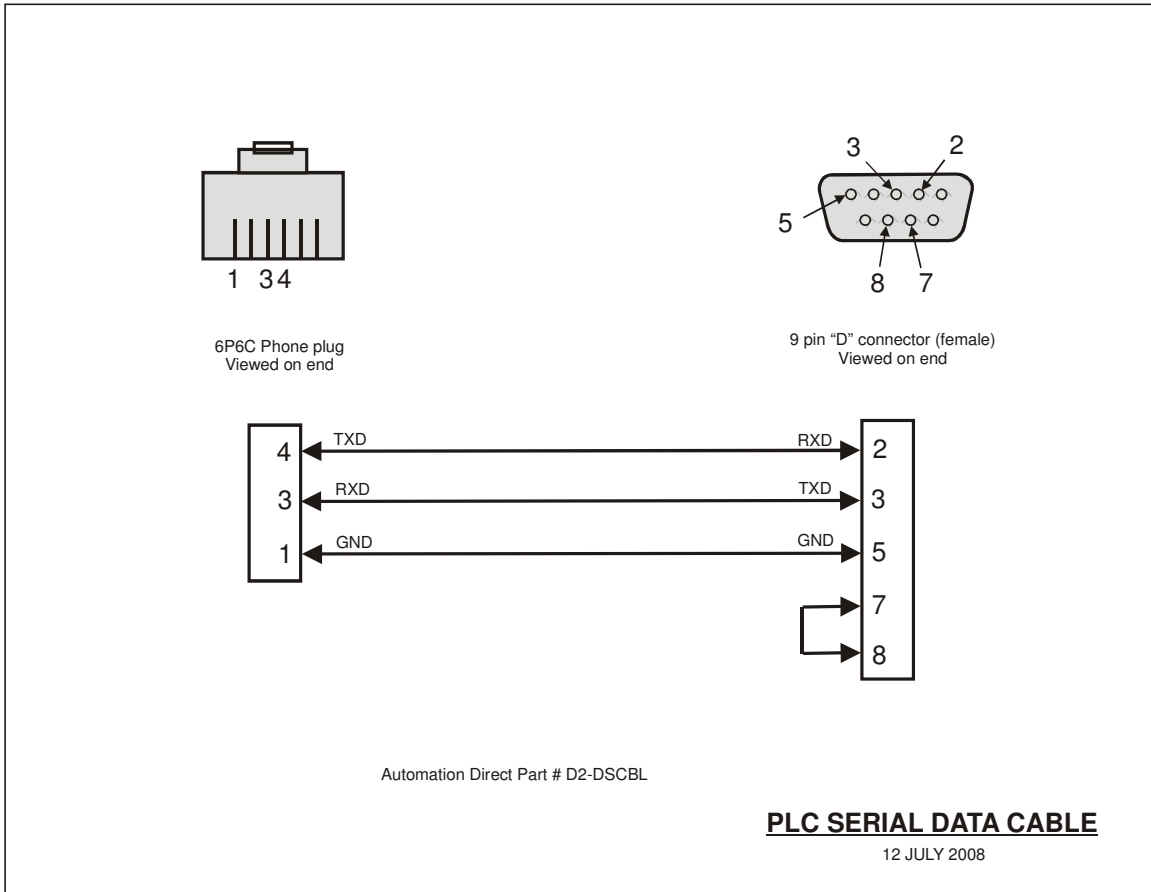
The RUN-TERM-STOP switch MUST be in the RUN position for normal operations.

Serial Data Port Settings

The port settings are:

9600 Baud
1 Stop bit
8 Data bits
No flow control

If you connect the special serial cable, you can see the serial data stream. You can build this cable, purchase from Waiter, or, purchase directly from Automation Direct.



SERIAL DATA CABLE

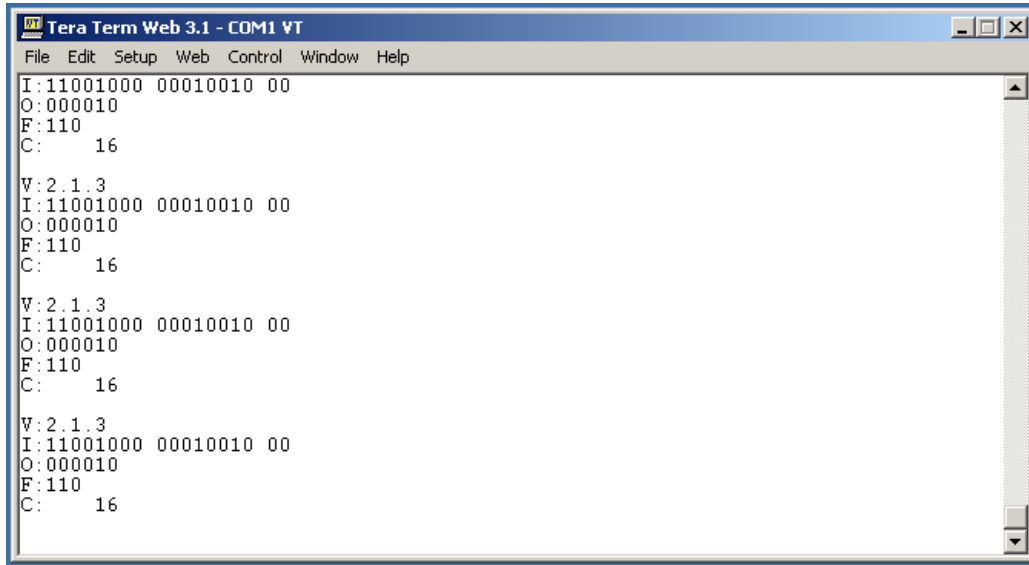
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The Serial data stream includes useful troubleshooting data.

You can view this data directly using a terminal program such as TeraTerm or Hyperterm.

OR

You can use the companion program Waiters LG Control Monitor.



The screenshot shows a terminal window titled "Tera Term Web 3.1 - COM1 VT" with a menu bar (File, Edit, Setup, Web, Control, Window, Help). The terminal displays a repeating sequence of data: "V:2.1.3", "I:11001000 00010010 00", "O:000010", "F:110", and "C: 16".

```
Tera Term Web 3.1 - COM1 VT
File Edit Setup Web Control Window Help
I:11001000 00010010 00
O:000010
F:110
C: 16

V:2.1.3
I:11001000 00010010 00
O:000010
F:110
C: 16

V:2.1.3
I:11001000 00010010 00
O:000010
F:110
C: 16

V:2.1.3
I:11001000 00010010 00
O:000010
F:110
C: 16
```

Typical Serial Stream output

Serial Stream Definitions

V: = Version Number. Current version is 2.2.0

I: = Sensor Inputs (X inputs), 1 = ON (Switch shorted), 0 = OFF (Switch open), there are a total of 18 total inputs, these are numbered X0 – X7, X100 – X107, and X110 and X111.

X0	RIGHT MAIN DOWN
X1	LEFT MAIN DOWN
X2	RIGHT MAIN UP
X3	LEFT MAIN UP
X4	NOSE GEAR DOWN
X5	NOSE GEAR UP
X6	GEAR SWITCH UP
X7	GEAR SWITCH DOWN
X100	HYDRAULIC UP PRESSURE
X101	HYDRAULIC DOWN PRESSURE
X102	AIRSPEED LOW
X103	THROTTLE POSITION FULL
X104	THROTTLE POSITION IDLE
X105	CANOPY OPEN
X106	GEAR UP INTERLOCK LOW (OFF), or Infinity Strut Compressed switches (or sensor) **
X107	GEAR UP INTERLOCK HIGH (ON)
X110	ALARM MUTE
X111	EMERGENCY RETRACT

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O: = Controlled outputs 1= ON (Power is applied to the Y terminal), 0 = OFF

Y0	Hydraulic UP relay (or Power relay)**
Y1	Hydraulic DOWN relay (or Direction relay)**
Y2	Nose UP relay
Y3	Nose Down relay
Y4	Speed Brake Retract Relay (or Infinity Strut Solenoid relay) **
Y5	Alarm Relay

** Must be configured in firmware, see description for "F:" (flags) below

F: = Firmware Configuration Flags. There are currently Five configurations. These flags signal how the firmware is configured for this controller.

F1 Control Flag C0 - sets if the hydraulic pressure switches that monitor UP and DOWN pressure are normally open (NO) or normally closed (NC) (Default = NC)

F1 = 0 The Hydraulic switch are NO.

The switches are OPEN, then close (short) when pressure is built up in the line.

F1 = 1 (Default) The Hydraulic switch are NC.

The switches are CLOSED (shorted), then open when pressure is built up in the line.

F2 Control Flag C1 - Defines how the relay outputs Y0 and Y1 are configured, and how they should control the hydraulic pump drive solenoids. Either directly, or the fail safe Direction / power method.

F2 = 0 Configured to control UP (Y0) and DOWN (Y1) directly.

When Y0 is active, it energizes the UP relay which then energizes the UP solenoid, and the pump runs UP. When Y1 is active, it energizes the Down relay, which in turn, energizes the Down solenoid and the pump runs down.

In this configuration, its possible that a failure in the controller or wiring could conceivably cause the pump to try and run UP and DOWN at the same time.

F2 = 1 (Default) Configured to control Power and Direction.

The small cube relays are wired in such a fashion that one of the relays (Y1) controls where the power will be sent.

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If Y1 is active, the Direction relay is energized. When power is applied, the UP solenoid will be energized.

If Y1 is not active, the Direction relay is de-energized. When power is applied, the DOWN solenoid will be energized.

When Y0 is active, the Power relay is energized, and voltage is routed to the Direction relay, the direction relay then steers the voltage to either the UP or DOWN solenoids.

The chief advantage of this configuration, its impossible to energize both UP and DOWN pump solenoids simultaneously.

F3 Control Flag C73 - Defines how the relay output Y4 is configured and used.

F3 = 0 Configured so Y4 is a Speed Brake Retract output.

Y4 is active whenever the throttle is at the FULL position, OR when the EMERGENCY RETRACT switch is in the ON position.

(NOTE – The Speed brake should have some type of cutoff so when it reaches its fully retracted position, power is removed from the speed brake retract circuit.

F3 = 1 (Default) Configured so Y4 controls the Hydraulic Strut Valve

If this is an Infinity Gear installation, AND, the struts must be compressed before retracting the gear, then this configuration must be selected.

At the beginning of a Retract Cycle, Y4 is energized to force the UP hydraulic pressure to compress the Infinity struts.

When the gear is extended, the Y4 is again energized to uncompress the struts.

F4 Control Flag C121 - Defines how the relay output Y4 is configured and used.

F4 = 0 Nose gear operates in conjunction with the main gear.

The Nose gear follows the switch position, just as the mains do.

This setting is to be used for tricycle aircraft

F4 = 1 (Default) Split mode Nose gear can be operated independently of the mains

This mode is used for a LongEZ where the nose can be retracted/extended on the ground.

Safeguards are in place so the mains will not retract on the ground.

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F5 Control Flag C122 – Defines if the nose is Electric or uses the same Hydraulic system as the mains

F5 = 0 The Nose gear is also Hydraulic.

C121 MUST be set to 0.

NOTE This frees up Y2 to be used as the Speed Brake Retract

F5 = 1 (Default) Nose gear is electric

Nose gear will follow the mode that is set in C121

C: = Cycle Counts. Number of times the gear has completed a full retract and extend cycle. (0 – 999,999)

The Controller looks at the UP sensors (X2, X3, and X5) After it sees all three, it then looks for all three DOWN sensors (X0, X1, and X4) to go active .

IMPORTANT NOTE – The DL05 Controller uses a “Super Capacitor” to retain counter data. This could last from several days to several weeks. Be aware that this counter could reset to zero if no power is applied for long periods.

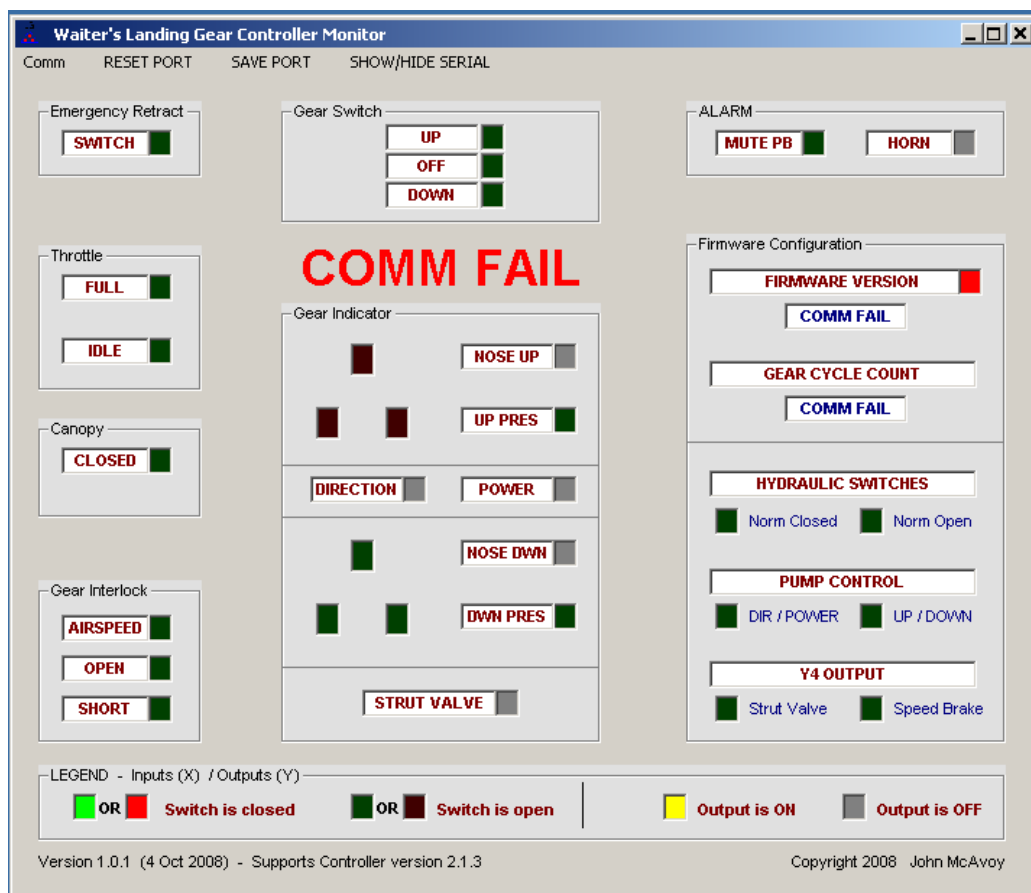
Waiters LG Controller Monitor

Waiters LG Controller Monitor runs on a PC, and is used to read and display the controllers Serial Stream in a user friendly format.

The RUN – TERM – STOP switch on the PLC must be in the TERM position for this communication to work. You must return the switch to the RUN position when your finished testing.

WARNING

The RUN-TERM-STOP be in the RUN position for normal operations.



Comm –

Select the computers Serial Comm port and port settings:

The Default settings being transmitted by the controller (Version 2.1.3) will be:

BAUD = 9600
PARITY = NONE
FLOW CONTROL = NONE

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DATA BITS = 8
STOP BITS = 1

These settings are saved in a file named : WaitersGearMonitor.XML

RESET PORT –

Reinitializes the comm. Port and restarts the program.:

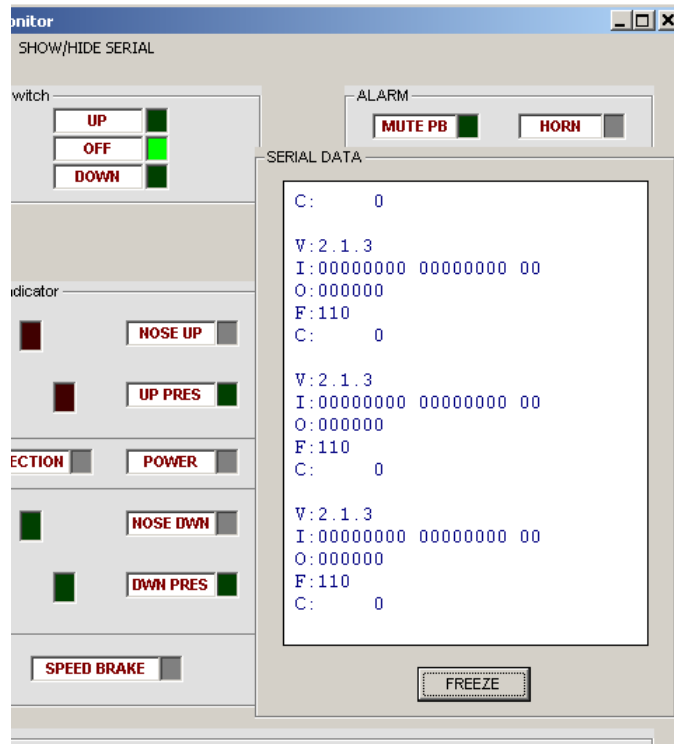
SAVE PORT –

Saves the current comport settings to the configuration file: WaitersGearMonitor.XML.:

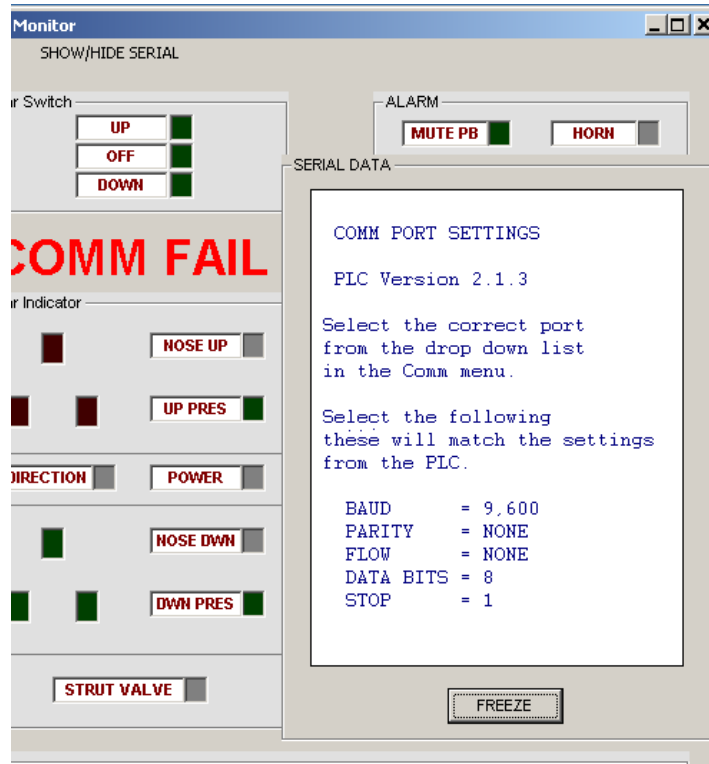
HIDE / SHOW SERIAL –

Shows and hides the raw serial in window.

If serial port connectivity is lost, this Window will display default comm. Port settings.



RECEIVED SERIAL DATA



COMM FAIL (SERIAL DATA SHOWS SETTINGS)

CHECKLIST INSERTS

CHECKLIST

Incorporate the following into the appropriate sections of your current checklist.

PRE-ELECTRICAL POWER INSPECTION CHECKLIST

Perform the following prior to applying power to the aircraft

INTERIOR INSPECTION

- 1) Verify EMER RETRACT switch is OFF and safety tied with Break-Away wire.
- 2) Verify UP-OFF-DOWN switch is in the OFF position.

EXTERIOR INSPECTION

- 3) Remove the ground safety locks, if installed.
- 4) Verify the Main Gear is down and the lock device is engaged.

APPLY MASTER POWER CHECKLIST

- 1) While turning on the MASTER, The Alarm horn will give two quick “chirps”.
- 2) Verify the status of the main and nose gear with the status lights.
- 3) Test the ALARM HORN. Momentarily press the ALARM MUTE button, the audio alarm will chirp once

GROUND OPERATION CHECKLIST

- 1) Use the UP-OFF-DOWN switch as required to raise / lower the nose for Passenger / Pilot entry or exit.

TAXI CHECKLIST

- 1) Verify UP-OFF-DOWN switch is in the DOWN position.
- 2) Verify gear status, THREE GREEN

PRE TAKEOFF CHECKLIST

- 1) Verify UP-OFF-DOWN switch is in the DOWN position.
- 2) Verify gear status, THREE GREEN gear down and locked

POST TAKEOFF CHECKLIST

Airspeed must be greater than 85 kts.

Throttle must be FULL

1) Move UP-OFF-DOWN switch is in the UP position.

Retract cycle takes approximately 12 seconds

2) Verify gear status, THREE RED gear up and locked

CRUISE CHECKLIST

1) OPTIONAL - move UP-OFF-DOWN switch is in the OFF position. This extinguishes the Three RED gear up and locked lights.

LANDING CHECKLIST

- 1) Verify airspeed is below the maximum gear speed
- 2) Move UP-OFF-DOWN switch to the DOWN position.
Extend cycle takes approximately 12 seconds
- 3) Verify gear status, Three GREEN gear down and locked

GROUND OPERATIONS CHECKLIST

Canopy - OPEN Throttle- IDLE

Nose gear can be positioned using the UP-OFF-DOWN switch.

Mains will NOT retract.

Canopy CLOSED

Full safeties apply to the mains and the nose; the nose gear will not retract.

POST SHUT-DOWN CHECKLIST

INTERIOR INSPECTION

- 1) Verify EMER RETRACT is OFF, and safety tied with Break-Away wire.
- 2) Verify UP-OFF-DOWN is OFF position.

EXTERIOR INSPECTION

- 3) Verify both Main Gear side brace are over center.
- 4) Install Ground Safety locks if available

EMERGENCY PROCEDURES

AUXILIARY ELECTRICAL GEAR EXTENSION

Located under the EMERGENCY GEAR protective panel, is a two position switch labeled GEAR-OFF. The switch is spring loaded OFF.

In the event of a landing gear computer failure, this switch can be used to directly energize the DOWN HYDRAULIC PUMP SOLENOID, and the NOSE EXTEND MOTOR.

- 1) Pull the GEAR CONTROLLER 10 AMP circuit breaker. This will prevent any extraneous signals from being issued by a faulty controller.
- 2) Gear switch in the DOWN position.
- 3) Break the safety wire on the AUX CONTROL POWER switch (under cover on power panel) and move it to the ON position.
- 4) Press and hold the auxiliary GEAR-OFF switch in the GEAR position.

The Down Hydraulic pump will start and the nose gear motor will extend.

You **MUST** monitor the systems manually, as there is no automatic shutoff features without the computer.

When Either the Mains OR the Nose DOWN indicators light, release the switch.

CAUTION – When the Nose gear reaches its full DOWN position, the clutch inside the actuator will start to slip. This can be heard and felt as a pop, pop, pop, as the clutch slips.

If the main gear is extended before the nose is completely down, then momentarily release the Auxiliary GEAR button, and pull the 50 AMP Main Landing Gear circuit breaker. This will prevent the pump from running as you continue to hold the Auxiliary GEAR button, in order to get the nose gear to completely extend.

If the nose gear reaches its down position before the mains, then pull the 10 AMP Nose Gear circuit breaker. This will prevent the nose gear motor from running as you continue to hold the Auxiliary GEAR button, in order to get the main gear completely down.

EMERGENCY MANUAL EXTENSION

Manufactures procedures normally recommend pulling their main power breaker prior to manual extension. THIS IS MANDATORY,

50 amp for Custom main

10 amp for EZNoseLift

- 1) UP OFF DOWN gear switch in DOWN position.
- 2) Pull the GEAR CONTROLLER 10 AMP circuit breaker. This will prevent any extraneous signals from being issued by a faulty controller.
- 3) Follow the emergency procedures recommended by the landing gear manufacture.
- 4) Verify all three gear are DOWN and LOCKED.

EMERGENCY RETRACT - NOSE ONLY

- 1) Pull the 50 amp MAIN GEAR PUMP breaker.

WARNING

If you fail to pull this circuit breaker, the mains will also retract.

- 2) Break the safety wire on the EMERGENCY RETRACT switch.
- 3) Place the EMERGENCY RETRACT switch in the RETRACT position.

EMERGENCY RETRACT - ALL GEAR

- 1) Break the safety wire on the EMERGENCY RETRACT switch.
- 2) Place the EMERGENCY RETRACT switch in the RETRACT position.

REVISION HISTORY

2.2.1	13 Mar 2010	Turn off Y3 if nose is in Hydraulic mode
2.2.0	28 Feb 2010	Add C121 and C122 to provide Split mode and Hydraulic nose Operation
2.1.4	06 Oct 2008	Correct X106 for Infinity Strut Sensor switch
2.1.3	12 July 2008	Add Configuration flags to allow NO or NC hydraulic switches Add the Throttle IDLE into the nose gear ground safety loop Add Serial Data Output on COM 2
2.1.2	31 MAY 2007	Correct for N.C. vs N.O. on the Hydraulic switch.
2.1.1	29 MAY 2007	Stuck MUTE button alarms ½ sec ON ½ sec OFF
2.1.0	26 MAY 2007	Change logic of Canopy Open and Airspeed Sensor
2.0.1	23 MAY 2007	INITIAL RELEASE
1.1.2		BETA NOT RELEASED