

**WAITER's**

**LANDING GEAR  
CONTROLLER**

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## **THEORY OF OPERATION**

The Gear Computer is designed to safely and effectively manage the split gear configuration found on Long EZ style aircraft. The controller has intelligence built into it 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.

Integrated into the controller, are additional features that address speed brake retraction, canopy warnings, gear alarms, emergency operations, and a built in test feature for evaluating system input / output control performance.

The computer hardware interfaces to the following systems;

Infinity Aerospace Retractable Main gear system.

EZ Nose Lift - Nose gear actuator only (no need for controller or harnesses)

Ken Miller Landing Brake system

Other systems can be easily adapted.

There are basically eight main functions of the computer controller:

- 1) Power up Self Test
- 2) Normal Main and Nose extend/retract operation
- 3) Ground Nose extend/retract operation
- 4) Ground KNEEL Mode
- 5) Emergency Retract Operation
- 6) Ancillary control
- 7) Alarming
- 8) INPUT / OUTPUT Self Testing

## **CONTROLLER DIFFERENCES / FEATURES**

There are three main differences between the original controllers, and the Waiter's Landing Gear Controller;

- 1) Integration of nose and mains into one operational unit,
- 2) Main gear sequencing method,
- 3) Individual strut switches replaced with single pressure switch that monitors the pressure applied to the struts to compress them.

**NOTE – There are advantages to using a pressure switch instead of using individual oleo strut position switches. The pressure switch is adjusted several hundred psi higher (i.e 1200psi) than required to hold the struts compressed (i.e. 1000 psi) This method allows us to**

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**recognize that the struts are losing their pressure, and re-pressurize them BEFORE they start to extend.**

**When using individual position switches on each strut, it's possible for the struts to extend inside the wheel well, and depending how much sloop is in the switches, they may not signal that the struts have extended.**

### **GROUND OPERATION –OLEO STRUT RETRACTION**

The original Infinity controller performed its "OK to retract" checks AFTER the oleo struts were compressed. Example, if the retract interlocks were tied to the canopy and airspeed switches as recommended by Infinity, and someone placed the switch in the UP position while the aircraft was parked, the gear would actually start the retraction cycle, the oleo struts would compress, and the sequence would stop because of the interlocks.

On Waiter's controller, the retraction cycle does not begin until all conditions are satisfied. The oleo struts will NOT start compressing.

This feature adds approximately 3 – 5 seconds of warning that a retraction is taking place. In the example given above, When the switch is placed in UP, The pump will not start and the oleo struts will not retract.

If the pump does start running, the oleo struts will immediately start to compress. You have about 3 seconds to flip switches or pull breakers. Because when the oleo struts are fully compressed, the gear is going to retract.

### **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 plane to see, that this approach has a great deal of risk. The approach used in this design is more complicated, and safeguards against not only 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 meet, the computer will stay in the SAFE

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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 mode. 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, and the UP OFF DOWN switch is in the OFF position. The computer then attempts to resolve this by determining the current gear positions and status switches. Once the mode is set, the computer monitors the status switches and coordinates the relays, pumps, and valves, depending on what mode its in.

### POWER UP EVALUATION

During the power up mode, the Computer provides one of six results. 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 ENTEND mode of operation.
- 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 RETRACT or EXTEND mode, So I will place the main gear is its respective mode.
- 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.
- 6) The ALARM MUTE switch was pressed when power was applied, and has been pressed for greater than 5 seconds. I will enter the SWITCH SELF TEST MODE mode.

The following conditions are evaluated during the powerup, and must be true in order to se3t the corresponding mode. Note that these conditions are more stringent then their "normal" operations counterparts.

ITEM 1 - Sets RETRACT mode if;

Canopy Closed

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Hyd UP Pressure > 450  
Hyd DOWN Pressure < 550  
Left Gear UP  
Right Gear UP  
Nose gear UP  
Struts Compressed Pressure > 1200 psi  
Airspeed > 80 kts  
Ground Proximity OPEN  
Tilt Switch OPEN  
Retract Switch NOT in DOWN position

ITEM 2 - Sets the EXTEND mode if;

Retract Switch NOT in UP position  
Left Gear DOWN and Locked  
Right Gear DOWN and Locked  
Nose gear DOWN and Locked (OR)  
Retract Switch in OFF position

ITEM 3 - If the UP OFF DOWN switch is in the OFF position,

Sets RETRACT mode if conditions of ITEM 1 met  
Sets EXTEND mode if conditions of ITEM 2 met

In order for the computer to proceed to normal operation, the RETRACT or EXTEND mode must be set by ITEMS 1, 2, or 3. PLUS, ITEM 5, the EMERGENCY RETRACT switch must be in the OFF position.

### WHAT TO DO

If the computer is stuck in the SAFE POWER UP MODE, ALL the lights (gear up/down, Canopy, airspeed) will be blinking. The Warning horn will be turning on/off at the same rate as the lights. (1/2 sec ON, 1/2 sec OFF)

#### ALL LIGHTS BLINKING SIMULTANEOUSLY

- 1) The Computer cannot reconcile the UP OFF DOWN switch against the actual gear position and sensors. Move the UP OFF DOWN switch to the OFF Position
- 2) The EMERGENCY RETRACT must be in the OFF position.

#### UP and DOWN gear LIGHTS BLINKING ALTERNATELY

The Computer cannot determine if the gear is down or up. This will require the pilot to do the following;

- 1) Move the UP OFF DOWN switch to the OFF position, if it isn't already there.
- 2) Move the switch to the UP or DOWN position, depending on needs.

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NOTE: If the switch is placed in the UP position, ALL conditions for a normal gear retraction must be correct, or 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 beeps of the warning horn, two flashes of ALL lights, then normal indications on the lights.

**HINT: Press and hold the ALARM MUTE button to display the actual gear position switches on the UP DOWN indicators. The lights will stop blinking (the horn will be squelched) and the lights will display their current status.**

### 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 aircraft is too slow and the gear is locked out from retracting).

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

All three gear will start retracting.

The Speed brake is also commanded to retract (if this circuit is connected)

Full retract takes about 10 seconds, so plan ahead.

### KNEEL MODE

The KNEEL mode allows the Main Gear Oleo Struts to be compressed while parked on the ramp. This lowers the plane by as much as 10 inches, thus making entry and exit much Ezer.

In order to get the plane to KNEEL, the following criteria MUST be met;

- The nose of the plane must be tilted down (TILT switch made)
- Main Gear DOWN and LOCKED (both mains overcenter switch made)
- Main Gear Down Pressure > 550psi (Down Pressure switch made)
- Airspeed < 60kts (Airspeed Low Light ON)
- Ground Proximity switch ON
- Throttle at IDLE
- Canopy OPEN
- Main Gear in EXTEND mode
- UP-OFF-DOWN switch in OFF position
- EMER RETRACT switch in OFF position
- ALARM MUTE button NOT pressed

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When all of these criteria are met, the KNEEL/TILT light will blink at a one second rate.

With the KNEEL light blinking, simply press and hold the KNEEL button until the desired KNEEL is completed. The KNEEL can be started and stopped at any point.

The KNEEL/TILT light will illuminate steady to indicate the system is KNEELing.

Once the KNEEL mode has been entered, the criteria to maintain the KNEEL is less stringent. The following criteria will halt the kneel mode:

- Nose tilt no longer makes the TILT switch
- UP-OFF-DOWN switch moved from the OFF position
- Either Main gear comes out of its overcenter position
- Down Hyd pressure drops below 550 psi.
- EMER RETRACT switch placed in the RETRACT position.

If the KNEEL mode is halted, the struts will extend as part of the normal Main Gear EXTEND mode of operation.

To cancel the KNEEL mode, simply move the UP-OFF-DOWN switch to the DOWN position. The switch can be returned back to the OFF position if you don't want the nose gear to extend.

### **DIRECTION DELAY**

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

**NOSE GEAR** – Provides a ½ second delay between direction changes. This allows the motor to come to a full stop before being commanded to run in the opposite direction.

**MAIN GEAR** – The main gear is a little more complicated, because the hydraulic pump motor is made up of two separate windings, one for each direction. The engineering approach was to design the electrical interface so that it's impossible to energize both windings simultaneously. This approach uses two relays, one controls the direction, and one controls the power.

Example: When changing hydraulic pump direction, the DIRECTION DELAY will de-energize the power relay, wait ¼ second, energize (or de-energize) the direction relay to change directions, Wait ¼ second, then reenergize the power relay. This delay ensures that no power is being applied to the pump when we change directions. The ½ second total delay should also ensure the pump has slowed down or come to a stop before changing directions.

### **SWITCH (input) and RELAY/SOLENOID (output) SELF TEST**

The INPUT SWITCH TEST allows the pilot / maintenance person to see and evaluate all switches connected to the computer. This mode is great during initial installation to verify if switches are ON/OFF. The computer steps through each switch and displays its ON

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OFF status on the gear UP DOWN indicators. This test continues indefinitely, until power is cycled off.

The OUTPUT TEST cycles through each relay, solenoid, etc. Each item is energized for ½ second.

### **CAUTION**

To ensure against unwanted gear movement during this test, its always wise to pull the 50 amp MAIN GEAR and the 10 amp NOSE GEAR circuit breakers.

### **SPEED BRAKE INTERACTION**

If the electric speed brake is connected, the Gear computer will issue RETRACT commands to the speed brake controller. These commands are issued anytime the Throttle is in the FULL position, or if the EMERGENCY RETRACT switch is in the RETRACT position.

### **ALARMING**

This controller supplies meaningful, prioritized alarms for several situations.

Gear not down when its supposed to be.

Canopy not down when its supposed to be

Stuck ALARM MUTE switch

Unresolved gear position when the Gear computer first starts up

**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.
- 3) From the NORMAL MODE. When placed in the OFF position, turns off the RED, GEAR UP LEDs. Nice for night flights.
- 4) 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.

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- 1) From the POWER UP MODE. If pressed and held in while applying power to the controller, the System will enter the INPUT SWITCH TEST Mode.
- 2) From the INPUT SWITCH TEST mode. The ALARM MUTE switch must be released for at least one complete switch test cycle. Then, press and hold the ALARM MUTE switch for 5 seconds, System will enter the OUTPUT RELAY TEST mode. All outputs are cycled.
- 3) From the POWER UP MODE. Restarts the powerup mode timer.
- 4) From the POWER UP MODE. When pressed, shows the individual gear positions.
- 5) From the Normal Mode. When pressed Squelches the alarm for 10 seconds. (Canopy alarm will NOT squelch)
- 6) From the Normal Mode. When pressed, performs a Light test of all system lights.
- 7) From Normal Mode. If held for longer than 10 seconds, will generate an alarm.

**KNEEL** pushbutton – Allows the main gear oleo struts to be compressed while parked on the nose. This lowers the plane by as much as 10 inches and makes boarding and unboarding much EZer. The KNEEL/TILT light indicates if its OK to perform a KNEEL.

**CANOPY UNLOCKED** indicator – The light ON indicates the Canopy is NOT down and locked.

**AIRSPEED LOW** indicator – The light ON indicates the airspeed is below the gear retract speed, The gear will not retract if below this speed.

**KNEEL/TILT** indicator –

- 1) When Blinking at a one second rate, indicates that all conditions are meet and KNEEL can be performed.
- 2) When On steady, indicates the system is KNEELing.

**GEAR INDICATORS** – Performs multiple functions, depending on mode.

- 1) From the POWER UP MODE. If a normal Powerup, these will blink twice.
- 2) From the POWER UP MODE. UP and DOWN lights blink simultaneously to indicate a Power Up problem.
- 3) From the POWER UP MODE. UP and DOWN lights blink alternately to indicate computer waiting for mode selection by pilot (move switch to UP or DOWN).

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- 4) From the POWER UP MODE. Show the current gear positions if the MUTE button is pressed.
- 5) From the NORMAL MODE. Light on indicates the corresponding gear position is locked. I.e. if the RED light is on, that gear is UP.
- 6) From the NORMAL MODE. Light blinking indicates the corresponding gear is in transit. I.e. If the RED light is blinking, the gear is retracting.
- 7) From the NORMAL MODE. If the UP-OFF-DOWN switch is placed in the OFF position, RED LEDS will be extinguished, GREEN lights operate as normal.
- 8) From the INPUT SWITCH TEST Mode. The RED LEDs blink to show a sequential count. The GREEN LEDs will blink if the switch under test is closed. (contacts made). SEE SELF TEST.
- 9) From the OUTPUT TEST mode. Outputs are energized sequentially, the LEDs will illuminate when their sequence is energized. SEE SELF TEST.

**PUMP DIRECTION** - Located on the Gear Indicator panel, shows the current status of the Main Gear Hydraulic pump. These LEDs light to indicate Hydraulic pump running UP or DOWN.

**EMERGENCY RETRACT** switch – Located at the top left of the instrument panel. Covered and safety tied with break-away wire. Overrides all safety rules and Retracts all three gear. ALSO retracts the Speed brake.

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 break-away wire. Supplies power to the Aux Gear control circuits. (see below)

**AUX OLEO STRUT EXTENSION / OFF / AUX GEAR EXTENSION** switch – Located behind the throttle inside the armrest. This switch is spring loaded to the center OFF position. NOTE, The Strut portion of the switch has a safety pin installed to prevent inadvertent actuation.

**AUX GEAR EXTENSION** portion –

The UP-OFF-DOWN switch MUST be in the DOWN position.

When held in this position, it energizes the Main Gear Power relay (RC2). The Main power relay provides a ground through the de-energized Direction Relay (RC1) to the DOWN power solenoid (R2) of the Hydraulic pump. The DOWN Solenoid energizes and the pump runs in the DOWN direction. The Hydraulic pump gets its power from the Main Gear Circuit breaker.

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ALSO, When the switch is pressed in the AUX GEAR EXTENSION position, this supplies power directly to the Nose Down Relay (RC7). The Nose gear gets its power through its normal Nose Gear Circuit breaker.

### **AUX OLEO STRUT EXTENSION** portion –

The Safety pin must be removed to move the switch to this position.

The UP-OFF-DOWN switch MUST be in the DOWN position.

The switch applies power from the AUX GEAR circuit, through the normal UP-OFF-DOWN switch (in the DOWN Position) directly to the Oleo Strut Solenoid. When the Oleo Strut Solenoid energizes, it bleeds hydraulic pressure from the strut, allowing it to extend.

**WARNING – Do NOT perform this feature if the gear is still in the wheel well.**

## **POWER UP SELF TEST**

The Power up Self test is exactly as the name implies, it happens when the controller is first turned on. Normally, the controller is powered through a circuit breaker to the aircraft's main "switched" master bus. In this configuration, the controller gets power anytime the MASTER switch is turned ON.

Power up self test performs 5 functions:

- 1) Check the computer system and memory for faults.
- 2) Check the ALARM MUTE switch for possible failure (shorted out)
- 3) Determine the existing GEAR / SWITCH settings
- 4) Determine if its OK to enter normal gear control operations.
- 5) Determine if we should enter the INPUT / OUTPUT Self test.

### **Computer System Test**

Within the first two seconds of startup, the computer tests the program memory and verifies that the computer is functioning correctly.

If no alarms are discovered, and the switches are in their correct positions, the computer will generate a short "beep – beep" from the alarm horn. Note also that the short "beep – beep" is accompanied by the indicator lights also performing a quick "blink - blink". The following indicator lights are cycled during the "blink – blink";

LEFT GEAR UP  
NOSE GEAR UP  
RIGHT GEAR UP  
LEFT GEAR DOWN  
NOSE GEAR DOWN  
RIGHT GEAR DOWN  
CANOPY WARNING

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AIRSPEED  
KNEEL/TILT

### **ALARM MUTE Stuck Switch**

If this switch is stuck, the computer will switch into the INPUT/OUTPUT test mode five seconds after power is applied. The stuck switch can then be seen during that test. The computer will NOT switch into the Normal Operations mode if this switch is stuck.

NOTE: If the **ALARM MUTE** switch becomes stuck after the computer enters the Normal Operations mode, all operations will be normal, except you will get a continuous ½ second ON/OFF of the alarm horn. (see ALARMS)

### **System Mode Test**

This test attempts to set the modes for the Mains and Nose, and reconcile this with the gear UP-OFF-DOWN switch.

This test is important as it protects against switches that may be in the wrong position. The computer is looking for known gear positions with corresponding switch positions. If it doesn't find correlated positions, the alarm horn blows and the computer will NOT move onto normal operations until the problem is resolved.

If the UP-OFF-DOWN switch is in the UP position, then all three gear must be UP AND the conditions must exist for this mode, See ALARM for the startup conditions.

If the UP-OFF-DOWN switch is in the DOWN position, then all three gear must be DOWN AND the conditions must exist for this mode, See ALARM for the startup conditions.

If the UP-OFF-DOWN switch is in the OFF position. The computer doesn't care what position the gear is in.

The EMERGENCY RETRACT switch must be in the OFF position.

### **Generate Startup alarms**

If a startup alarm is generated, the computer will not come out of the self test mode until the alarm is cleared. The alarm is a ½ second on, ½ second off from the alarm horn. The alarm continues until the problem is corrected.

To clear the alarm, verify that the UP-OFF-DOWN switch and the EMERGENCY RETRACT switch are both in the OFF position. If the alarm continues, there may be an internal computer fault that is creating the alarm.

**ALARM** - If The EMERGENCY RETRACT switch is in the RETRACT position, an Emergency Retract Alarm is generated.

**ALARM** - If the UP-OFF-DOWN switch is in the UP position, then the following conditions must exist, or an alarm is generated:

Canopy Closed  
Hyd UP Pressure OK

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Strut Pressure OK  
NO Hyd Down Pressure  
Airspeed Switch OK  
Tilt Switch is NOT made  
All three gear UP and Locked

**ALARM** - If the UP-OFF-DOWN switch is in the DOWN position, then the following conditions must exist, or an alarm is generated:

Canopy OPEN  
All three gear DOWN and Locked

**CLEAR ALARM** - If the UP-OFF-DOWN switch is in the OFF (center) position, AND the EMERGENCY RETRACT switch is in the OFF position.

### Enter Normal Control operations

If the Emergency Retract Alarm and the Gear Switch Alarm are both clear, and the ALARM MUTE button is not pressed, the computer will enter the Normal Control mode 2 seconds after power is applied.

If either Emergency Retract Alarm and the Gear Switch Alarm were set, and subsequently cleared, the computer will enter the Normal Control mode 2 seconds after the alarms have been cleared.

This is an important safeguard feature, as it reduces the possibility of an accidental gear retraction caused by someone forgetting to check switch positions before turning the Master power switch ON.

### Enter INPUT / OUTPUT Self Test

To enter this mode, you must simultaneously hold the ALARM MUTE button while applying power to the Gear computer. Continue to hold the ALARM MUTE button for 5 seconds. This also bypasses the normal "beep – beep" of the lights and horn.

# **WARNING**

**THE MAIN GEAR MAY COLLAPSE**

**AND**

**THE NOSE GEAR MAY EXTEND DURING THIS TEST.**

**Read and understand the entire INPUT / OUTPUT SELF TEST section  
before performing this test.**

**CAUTION**

To ensure against unwanted gear movement during this test, its always  
wise to pull the 50 amp MAIN GEAR and the 10 amp NOSE GEAR  
circuit breakers.

## **NORMAL MAIN AND NOSE OPERATION**

Normal operations are performed by a three position switch. UP – OFF – DOWN

There is only one requirement to allow the gear to extend, that is, the EMERGENCY RETRACT switch must be in the OFF position.

### **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.

### **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 both of the side brace switches signal they are over centered.

At this time the corresponding LEFT –and RIGHT GEAR DOWN lights will illuminate.

NOTE: If the Strut Compressed Pressure > 1200 psi, the main gear GREEN GEAR DOWN lights will be blinking ½ sec ON/OFF.

- 3) A five second timer (oleo strut timer) starts when both over center (down lock) switches are closed
- 4) The Oleo Strut Solenoid is energized for the duration of the five second timer. The main gear oleo struts continue to extend during this time.
- 5) Upon completion of the 5 second timer, the computer monitors the Down Pressure switch.
- 6) When the down pressure switch closes, the Down pump contactor opens to shut off the pump.

NOTE If the Down pressure switch opens (low pressure), or either the side brace Over Center switches opens, the sequence restarts at #1

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### **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)

### **NOSE GEAR SEQUENCE**

The Nose Up contactor is energized and continues until the UP Lock switch signals the computer to remove power. There are no safeguards for nose gear retraction. 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 conditional on the following;

- EMERGENCY RETRACT in OFF position
- UP-OFF-DOWN switch in the UP position.
- Canopy Closed
- Throttle Full
- Airspeed above 80kts
- Ground Proximity OPEN
- Tilt Switch OPEN

Once the sequence is started, the only way to abort it is to 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;

The Hydraulic pump starts in the retract mode.

The Oleo Strut Solenoid energizes.

The oleo struts start compressing.

When the oleo Struts Compressed Pressure > 1200 psi, the Struts Compressed Pressure switch closes, and the oleo Strut Solenoid de-energizes.

The Gear now swings to the retract position.

When the retract pressure reaches 450lbs. the hydraulic pump shuts off.

1) The Up pump is turned on if ANY of the following is true. The pump will continue to run for 1/3 second after ALL of the conditions are false. This prevents the pump from doing quick ON-OFF-ON cycles if the oleo strut solenoid switches in and out.

- Up Pressure to low
- Struts Compressed Pressure < 1200 psi

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- 2) The Oleo strut Solenoid is energized (compress the oleo strut) anytime the following is true  
Struts Compressed Pressure < 1200 psi

**NOTE – There are advantages to using a pressure switch instead of using individual oleo strut position switches. The pressure switch is adjusted several hundred psi higher (i.e 1200psi) than required to hold the struts compressed (i.e. 1000 psi) This method allows us to recognize that the struts are losing their pressure, and re-pressurize them BEFORE they start to extend.**

**When using individual position switches on each strut, it's possible for the struts to extend inside the wheel well, and depending how much sloop is in the switches, they may not signal that the struts have extended.**

### **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 or the CANOPY light.
- 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 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 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.

### **OLEO STRUT RETRACTION (Kneel on ground)**

Verify that the nose is retracted to its boarding position and the KNEEL / TILT light is illuminated.

When the UP OFF DOWN switch is in the OFF position, and the Main gear is extended, the KNEEL / TILT light is illuminated when the aircraft is in a safe tilt position to perform a KNEEL operation.

Press the KNEEL switch to compress the oleo struts. This lowers the plane for EZ entry / exit

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**WARNING – You must have grass cutter gear doors installed; otherwise the bottom of the gear doors will contact the pavement when the oleo struts compress. CRUNCH!**

In order for the KNEEL function to work, the following conditions must be true;

- Canopy OPEN
- Throttle IDLE
- TILT switch CLOSED (nose down)
- Both mains DOWN and LOCKED
- DOWN PRESSURE > 550
- UP-OFF-DOWN switch in the OFF position
- EMERGENCY RETRACT in OFF position
- ALARM MUTE button NOT pressed
- GROUND PROXIMITY is ON
- Airspeed sensor is OFF ( <80 kts)

The KNEEL function initiates the following sequence;

- 1) The Oleo strut Solenoid energizes
- 2) The PUMP Direction relay switches to the RETRACT position.
- 3) The Pump Power relay energizes and the struts start compressing.

All conditions above must be true for the KNEEL mode to work. If any of the conditions becomes false, then the KNEEL is stopped.

The KNEEL button may be released at any time before the full strut compression is reached. However, If the KNEEL button is held in, the Pump will continue to run until the Strut Compressed Pressure switch closes (the Strut Compressed Pressure > 1200 psi), OR the TILT switch opens, at which time the pump will turn off.

If ANY of the conditions above drop out. The controller will drop out of the KNEEL mode, and perform a complete EXTEND cycle, including re-extending the struts.

**NOTE – The TILT switch is a safe guard against retracting the struts to the point that the aircraft could be inadvertently tipped back on its tail.**

The TILT switch is adjusted so that it should remain closed with the nose gear retracted to its normal Boarding Position, and the struts are fully compressed. VERIFY that in this position, the aircraft cannot be tipped back on its tail.

The KNEEL TILT light illuminates

## **GROUND NOSE OPERATION**

The UP-OFF-DOWN switch is identical for ground operations, except the Main gear will not retract. The nose gear can be stopped at any position simple by placing the switch in the OFF position.

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## **EMERGENCY RETRACT OPERATION**

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

### **RETRACTING NOSE ONLY**

The Nose only retract 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. With this system, the retract process will take 5 to 8 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.

### **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 8 - 10 seconds.

**CAUTION: The Landing brake is also retracted with this process!**

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

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

### **ABORTING THE EMERGENCY RETRACT**

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

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- 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.

## **ANCILLERY CONTROL**

During the monitoring of switch status, the computer also has the ability to provide control over other key systems in the aircraft.

### **LANDING BRAKE**

If the aircraft is equipped with an electric landing brake, The computer can issue retract commands to it.

Anytime the computer sees that the Throttle is in the FULL position, It closes a set of contacts called "Auto Speed Brake Retraction", These contacts will stay closed as long as the throttle is in FULL.

The "Auto Speed Brake Retraction" relay is also energized if the landing gear EMERGENCY RETRACT switch is placed in the RETRACT position.

### **TAXI / LANDING LIGHTS**

With the Landing and taxi lights mounted on the landing gear oleo struts, we want to disable the lights anytime the gear is not extended.

The side brace must be over center locked to enable the lights.

This relay is wired in such a fashion, when it is de-energized, the lights are enabled. This provides fail safe operation in the event the gear must be manually extended during night time operations.

## **ALARMING**

A set of contacts is dedicated to a Gear / System Alarm. This contact should drive a loud audible alarm. Most 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**

- 1) Canopy Open **AND** Full Throttle is applied (Constant alarm)
- 2) ALARM MUTE button engaged for greater 30 seconds (pulsating ½ sec on, ½ sec off)
- 3) Computer error detected (pulsating ½ sec on, ½ sec off)

### **MUTABLE ALARMS**

- 1) MAIN GEAR not Locked **AND** Airspeed < 80 kts
- 2) MAIN GEAR not Locked **AND** Throttle at Idle
- 3) MAIN GEAR not Locked **AND** Ground Proximity
- 4) NOSE GEAR not Locked **AND** Canopy Down **AND** Throttle at Idle
- 5) Gear switch NOT in the DOWN position **AND** Canopy Down **AND** Throttle at Idle

## **INPUT / OUTPUT SELF TEST**

Input Output self test allows testing and checking of all inputs and outputs to/from the controller.

### **WARNING**

**Before performing the SELF TEST, support the aircraft in case the main gear is inadvertently retracted.**

**Inadvertent gear retraction during self test is caused by incorrect wiring, or faulty switches. SELF TEST assists you in verifying correct wiring, and identifying faulty switches.**

### **YOU HAVE BEEN WARNED!!!!**

In order to initiate the SELF TEST mode, perform the following;

Master switch OFF

Gear controller circuit breaker ON

Main Gear Pump breaker OFF

Nose Gear motor breaker OFF

While holding the ALARM MUTE button in, Turn the Master switch ON.

Continue to hold the ALARM MUTE button for 5 seconds.

When you see the three RED –UP lights start blinking, release the ALARM MUTE.

You have just entered the Switch SELF TEST mode.

NOTE: There is a safety built into the computer that looks to see if the ALARM MUTE button is stuck or shorted. If this button is stuck or shorted, the computer will enter the SWITCH SELF TEST mode on power up, but will not be allowed to enter the OUTPUT SELF TEST mode. The ALARM MUTE button will show up as item 7 on the RIGHT GREEN – GEAR DOWN light.

#### **Switch test mode**

This mode sequences through all the switches and provides visual status of each switch. The switches or sensors can be toggled, and their status monitored in this mode.

The three RED – GEAR UP lights act as a sequence count. counting from 1, 2, ... 9, 10. Each count will last 1 second. The RED – GEAR UP light lights for ½ second during each count. When the count reaches 10, there is a 4 second pause, then the count starts again at 1 and the sequence repeats.

The GREEN – GEAR DOWN lights provide feedback as to the status of switches. This version used the LEFT light for switches 1 – 10, and the RIGHT light for switches 11 – 20. The NOSE light is not used on this version.

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If the switch is closed (making contact), the light will light for ½ second. The following table shows what switch is assigned to what light.

EXAMPLE: You want to check the "Canopy Down" switch. Start counting the RED light sequence, while also watching the RIGHT GREEN GEAR DOWN light. When the count hits 6, if the RIGHT GREEN GEAR DOWN light is lit, the switch is closed (making contact). If the light does not light, the switch is open.

To exit either of the self test modes, remove power from the Gear Controller computer for at least 5 seconds.

### **SELF TEST SWITCH SEQUENCE NUMBER AND ASSIGNMENT**

<b>#</b>	<b><u>LEFT GEAR DOWN LIGHT</u></b>	<b><u>RIGHT GEAR DOWN LIGHT</u></b>
1	Left Main Up Switch (X0)	Nose Up Lock (X12)
2	Right Main Up Switch (X1)	Up Pressure Switch (X13)
3	Left Main Down (X2)	Down Pressure Switch (X14)
4	Right Main Down (X3)	Full Throttle Switch (X15)
5	Strut Compressed Pressure(X4)	Idle Throttle Switch (X16)
6	TILT Switch (X5)	Canopy Down Switch (X17)
7	Normal Down Switch (X6)	Mute Button Switch (X20)
8	Normal UP Switch (X7)	Ground Proximity Switch (X21)
9	Emergency Retract Switch (X10)	Airspeed Switch < 80 kts (X22)
10	Nose Down Lock (X11)	KNEEL Push Button (X23)

### **Output Test Mode**

This mode steps through all the outputs, relays, lights, and solenoids. Each step is 1 second long, and each output is energized for ½ second.

Do not go into this mode without completely reading and understanding the how it "Normally" operates section

Always assume that the worst is going to happen, and the Main Gear is going to retract during this test. If you prepare for this, and it DOES happen, there will be no damage.

As stated earlier, the reason for performing these tests, is to verifying correct wiring and operation of controlled components, relays, solenoids, etc. If there are wiring problems or switches are malfunctioning, this test could end with disastrous results.

**WARNING – THE MAIN GEAR MAY EXTEND or RETRACT DURING THIS TEST, if the following safeguards are not used.**

- 1) Pull the 50 amp breaker that supplies power to the Main Hydraulic pump. Without power, the pump will not run. Make this a standard policy whenever performing this test, or any other maintenance on the main gear. The “Main Gear power Contactor” will still energize, but no power will get to the pump.
- 2) If you have down lock safety bars, install them. If not, think about making or purchasing them. These bars will prevent the retract side brace from moving from the over center position.
- 3) Place jack stands under the plane, or support the plane with a hoist.

**WARNING - THE NOSE GEAR MAY EXTEND or RETRACT DURING THIS TEST, if the following safeguards are not used.**

- 1) Pull the 10 amp Nose Gear Circuit Breaker. Without power, the nose gear actuator will not run. Make this a standard policy whenever performing this test, or any other maintenance on the main gear. The “Nose Gear power Contactor” will still energize, but no power will get to the actuator.

**THE OUTPUT SELF TEST**

To get into the OUTPUT SELF TEST mode, you must first be in the SWITCH SELF TEST mode.

NOTE: There is a safety feature built into the computer that looks to see if the ALARM MUTE button is stuck or shorted. If it is, the computer will not allow the OUTPUT SELF TEST to be entered.

- 1) The computer has to be in the SWITCH SELF TEST mode for at least one complete test cycle, WITHOUT touching the ALARM MUTE button. This is how the computer decides if the ALARM MUTE button might be stuck.

- 2) Press and hold the ALARM MUTE button for 5 seconds.

The red GEAR UP lights will stop flashing, and 2 seconds later, the computer will start stepping through the controlled outputs, energizing each for ½ second.

You can watch and listen as each item is energized in sequence.

To exit either of the self test modes, remove power from the Gear Computer for at least 5 seconds.

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<b>#</b>	<b><u>OUTPUT</u></b>
1	Main Pump Power (Y0)
2	Main Pump Direction (Y1)
3	Oleo strut Solenoid (Y2)
4	Lights Enable Relay (Y3)
5	Alarm Output (Y4)
6	Left Main Up Indicator (Y5)
7	Right Main Up Indicator (Y6)
8	Left Main Down Indicator (Y7)
9	Right Main Down Indicator (Y10)
10	Canopy Warning Light (Y11)
11	Nose Gear UP Relay (Y12)
12	Nose Gear DOWN Relay (Y13)
13	Nose Up Indicator (Y14)
14	Nose Down Indicator (Y15)
15	Speed Brake Auto Retract (Y16)
16	Airspeed Light (Y17)
17	Kneel Light (Y100)

**NOTE : The Direction relay is DE-ENERGIZED in the EXTEND mode,  
and ENERGIZED in the RETRACT mode.**

## **CHECKLIST INSERTS**

### **CHECKLIST**

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

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### **PRE-ELECTRICAL POWER INSPECTION CHECKLIST**

Perform the following prior to applying power to the aircraft

#### **INTERIOR INSPECTION**

- 1) Observe the Down hydraulic pressure. If the pressure is low (below 550 psi) the Hydraulic pump will cycle after power is applied.
- 2) Verify EMERGENCY RETRACT is OFF and safety tied with Break-Away wire.
- 3) Verify UP-OFF-DOWN switch is in the OFF position.

#### **EXTERIOR INSPECTION**

- 4) Remove the ground safety locks, if installed.
- 5) Verify both Main Gear side brace are over center.

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### **APPLY MASTER POWER CHECKLIST**

- 1) While turning on the MASTER, Observe the 8 status lights for a quick "blink-blink". The Alarm horn also gives two quick blasts.
- 2) The Hydraulic Pump may cycle on for 5 seconds if the Down Hydraulic pressure was low.
- 3) Verify the status of the main and nose gear with the status lights.
- 4) Test the ALARM HORN and status lights. Momentarily press the ALARM MUTE button. The audio alarm will chirp once, and the all 8 status lights will illuminate for 1 second.

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### **GROUND OPERATION CHECKLIST**

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

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### **TAXI CHECKLIST**

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

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### **PRE TAKEOFF CHECKLIST**

- 1) Verify UP-OFF-DOWN switch is in the DOWN position.
- 2) Verify gear status, THREE GREEN gear down and locked
- 3) Verify Canopy Status, CANOPY OPEN light extinguished

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### **POST TAKEOFF CHECKLIST**

Airspeed must be greater than 80 kts.

Verify LOW AIRSPEED light extinguished

Throttle must be FULL

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

Retract cycle takes approximately 10 seconds

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

3) Verify UP Hydraulic pressure > 450 psi.

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### **CRUISE CHECKLIST**

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

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### **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 10 seconds
- 3) Verify gear status, THREE GREEN gear down and locked
- 4) Verify Down Hydraulic pressure > 550 psi.

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### **POST SHUTDOWN CHECKLIST**

#### **INTERIOR INSPECTION**

- 1) Verify EMERGENCY RETRACT is OFF, and safety tied with Break-Away wire.
- 2) Verify UP-OFF-DOWN is OFF position.
- 3) Observe the Down hydraulic pressure > 550 psi.

#### **EXTERIOR INSPECTION**

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

## **EMERGENCY PROCEDURES**

### **AUXILIARY ELECTRICAL GEAR EXTENSION**

Located under the EMERGENCY GEAR protective panel, is a three position switch labeled GEAR-OFF-STRUT. The switch is centered OFF, and momentary contacts to the other two positions, GEAR and STRUT

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

- 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-STRUT 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.

CAUTION - The MAIN gear DOWN Pressure sensor is NOT utilized to stop the pump. You MUST monitor the DOWN Pressure and release the AUX button when the DOWN PRESSURE starts building up to 550 lbs. This is an indication that the mains are down and locked.

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 (550 lbs) 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

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Auxiliary GEAR button, in order to get the main gear completely down.

After main gear is down, you can extend the Main Gear Oleo Struts by doing the following;

- 5) Remove the safety pin from the GEAR-OFF-STRUT switch guard. This pin is normally installed to prevent the inadvertent extension of the strut while the gear is still in the wheel well.
- 6) Press and hold the auxiliary GEAR-OFF-STRUT switch in the STRUT position. Pressure within the struts should now bleed and the struts will extend. When the struts are extended (visually verify) release the button, and reinstall the pin.
- 7) Re-verify that the MAIN Gear DOWN pressure is at 550 lbs.
- 8) Return the AUX CONTROL POWER switch (under cover on power panel) to the OFF position, close the cover.

### **EMERGENCY MANUAL EXTENSION**

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

50 amp for Infinity Main Gear

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.
- 5) If Equipped, Use the AUXILIARY STRUT EXTENSION switch to extend the struts.

(NOTE: The success of the emergency strut extension will depend on what failed, The aircraft can be landed safely with the struts compressed)

**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.

**CAUTION: The Landing brake is also retracted with this process!**

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### **EMERGENCY RETRACT - ALL GEAR**

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

**CAUTION: The Landing brake is also retracted with this process!**

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## **REVISION HISTORY**

- |       |             |  |
|-------|-------------|--|
| 1.07  | 1 Jan 2005  | Initial Release  |
| 1.08  | 1 Feb 2005  | Added Auto Speed brake retract capability  |
| 1.09  | 12 Feb 2005 | Added SQUAT capability to the main gear.   |
| 1.10  | 20 Mar 2005 | Change the Nose Gear power to a direction relay, and a power relay. This eliminates the possibility of both directions being energized at the same time. |
| 1.11  | 2 May 2005  | Clean up SQUAT mode and added down pressure safeguard.   |
| 1.12  | 3 May 2005  | Change Main Gear to power / direction concept.   |
| 1.13  | 5 MAY 2005  | Clean up KNEEL mode  |
| 1.14  | 4 JUNE 2005 | Changed the Strut position switches to a Strut Compressed Pressure Switch.<br><br>Added a TILT switch to safeguard against tip back when using KNEEL     |
| 1.15  | 16 OCT 2005 | Debug against real hardware.<br>Installed Aux IO board at location X/Y100  |
| 2.1.0 | 21 OCT 2005 | Rework Startup sequence, timers, and display lights<br>Fine tuned rules for EXTEND / RETRACT<br>Verify code against documentation                        |
| 2.1.1 | 22 OCT 2005 | Redefine KNEEL criteria and OP interface<br>Fixed backwards Strut Pressure switch<br>Fixed Speed brake retract for EMER RETRACT                          |
| 2.1.2 | 23 OCT 2005 | Removed the KNEEL mode checks from the Powerup cycle.  |