



Basic Landing Gear Operation Troubleshooting

Overview

While relatively basic from an electrical/mechanical system view, the varying engineering designs found in different models of aircraft, interaction of the various system components, and the great variation of base knowledge found in aircraft service organizations can make it time consuming and expensive for owners to correct landing gear actuation problems. The following decision tree is intended to assist both owners, and potentially their mechanics, in efficiently troubleshooting system problems found in 112/114/115 Commander airframes. Note that there will be some variation in procedure based upon the serial number of the subject aircraft as Commander changed the system logic and components as product system engineering evolved.

This information is primarily for new owners, those that are perhaps less mechanically inclined, or others unfamiliar with the Commander design. It is not exhaustive; rather, it should aid in eliminating system elements from further inspection and focus efforts on those elements most likely to be causing the problem. In certain situations, the tree will lead the user to inspect/eliminate those system elements most easily/quickly accessed and progress to more complicated/expensive/difficult to access elements even though the more complicated elements may be more the likely source of the problem. The focus is to minimize time and expense and not necessarily follow the most "logical" (from an engineering point of view) order of component inspection.

The decision tree is going to begin with a basic gear operation test sequence and branch into different test procedures based upon noted discrepancies. In order to effectively utilize this document, you should have access to a set of aircraft jacks and know how to safely use them. Have materials at hand to set up wheel weighting arrangement described in the Maintenance Manual to properly check for retraction/extension within specified time constraints.

Personal injury and expensive damage to your aircraft is likely if the jacks are misused. COG, nor any of the contributors to this document, accept any liability for use, or misuse, of the information contained herein. It is offered as an unaudited reference and is not endorsed by any person, nor any organization, nor legal entity. If you are slow on the uptake, USE THE INFORMATION AT YOUR OWN PERIL. ... and by all means, BE SAFE. What is D-I-Y for Bob Villa or Norb Abrams is NOT D-I-Y for Paris Hilton. If you are unsure about how to properly prepare for or conduct any sequence or test, ask someone who is a professional or competent to assist you.

Section 1

Electrical Design

Serial numbers 7-188

A few generalities that may be of use...

1. Power is provided to the hydraulic pump directly from the main buss (through the gear circuit breaker) via the Gear Up/Down Relays. (large diameter power terminal on the relays always “hot” when Main Buss is energized) The pump power circuit is continuously grounded.
2. The Gear Up/Down Selector Switch provides the Gear Up/Down Relay coils (to close relay power contacts) a continuous path to ground in both Up and Down positions. Power is sent to the Up/Down Relay coils from the main power buss through the Gear Up/Down position limit switches. Actuation (or triggering) of the coils to make the pump run depends upon the availability of a viable power path for the coil circuit.
3. Multiple coil power paths exist that will allow the pump to run.
 1. For the selector in the DOWN position:
 - Gear Down Lock switches. The Down Lock Switch on each wheel and Detent Piston Position limit switch on each actuator has a separate power path (N/C condition) to provide V+ to Gear Down relay coil. Until all switches actuate (opening N/C contacts on down lock and closing N/C contacts on Detent Piston switches) indicating wheel down/locked, the pump will continue to run.
(NOTE: each down lock switch offers both N/O and N/C contacts. N/C contacts are used BOTH in parallel and in series with the associated detent piston position switches for pump motor operation and N/O contacts [down lock] are used to illuminate gear lights in series with N/C contacts on Detent Piston switches. This is a clever design worthy of study.)
 2. For the selector in the UP position:
 - The Logic Relay N/C power terminals are continuously provided V+ via main power buss. Gear Squat Switch – Normally Open (“N/O” – “Ground” position) terminal connected to Gear Up Relay coil and will provide V+ from Logic Relay. Squat switch must be actuated (closing N/O contacts) by bolt on Right Main gear knee (“Air” position) to provide V+ to pump Gear Up Relay coil to run pump during gear up cycle. (ground for Gear Up Relay coil through Gear UP/Down Select switch) Squat switch does not affect DOWN cycle operation.
 - Gear Up Lock switches. The Up Lock Switches on each wheel linkage are connected in series. Until all three switches actuate (closing their N/O contacts) indicating all wheels up/locked, the pump will continue to run. When all switches are closed V+ is provided to Logic Relay coil opening Logic Relay N/C power contacts to shut off V+ to Gear Up Relay coil.
4. Until ALL power paths are made (Up), Open (Down) pump will continue to run. This situation underscores the value of having a “pullable” breaker for the gear pump. Extended (5 minutes or less!) operation of the pump will cause it to overheat resulting in an expensive repair bill. If a switch component fails resulting in a continuous power path, causing extended operation of the pump, aircraft w/o a pullable breaker must turn off the master switch to cut power to the pump.
5. Gear Down indicator lights are provided continuous grounds. They will not illuminate unless a power path is provided. The “Push To Test” circuit offers a local V+ path to verify proper operation of the

- lamp. Operational power path is provided through the Down Lock Switch and Actuator Detent Piston position switch associated with each wheel. Down Lock Switch contacts are N/C and lamp will not illuminate until switch is actuated closing N/O contacts and providing a path for V+ through the Detent Piston switches. If Detent Piston switches do not seat (to N/C position) Gear Unsafe light will illuminate through Detent Position N/O contacts. When Detent Piston switches seat (AND Down Lock switch is actuated to close N/O contacts), associated Gear Down Light will illuminate. **NOTE: If Detent Piston switches are set too “loose” they will always show closed and may incorrectly indicate a “safe” condition.**
6. Warning Bell and Gear Unsafe annunciators are continuously grounded. To sound/light alarm they must achieve a valid path to V+ from multiple potential sources. Available power paths:
 1. If Gear Up/Down Selector Switch in (or moved to) the UP position, and Ground Squat Switch is in the “Ground” (N/C) position, electrical power is immediately available and Gear Unsafe will illuminate. (This is not a recommended condition and should be tested w/ aircraft on jacks!)
 2. Alternate V+ path is achieved (and bell sounds) if EITHER Flap Extended Limit Switch or Throttle Retarded Position Limited Switch are closed AND any of the Gear Down Lock limit switches are not actuated (down lock switch actuation opens N/C contacts to ground) or actuator switches are not seated in their detents.
 3. If NEITHER Down Lock nor Up Lock switches are actuated for any gear wheel, V+ will be provided to Gear Unsafe lamp. Either Up or Down Lock switches must be actuated and Detent Piston not actuated (sitting in detents) for all three wheels for Gear Unsafe light to extinguish.
 7. Gear Unsafe Warning Light is provided continuous ground. It requires a path to V+ to illuminate. Operational paths for V+ run through ALL three wheel BOTH Up and Down lock switches. If UP Lock switches have not actuated (opening N/C contacts) OR Down Lock switches have not actuated (opening N/C contacts) a valid path to power will be achieved and Gear Warning light will illuminate.
 8. To reiterate Hydraulic Pump operational logic:
 1. Following Gear Up/Down Selector Switch operation, Gear Up Relay coil needs at least one Gear Up Lock switch not actuated AND Squat Switch AIR (closed) to provide V+ to Up Relay coil and operate pump. No other logic switches required or offer viable paths to power. Only conditions that will allow pump motor shut off are either Up Lock position switches all being actuated (opens N/C contacts) or failure of N/O contacts/wiring at Squat Switch (in AIR position). Note: If Gear UP is selected and pump motor does not start, after checking breaker is not popped, verify continuity across squat switch (in AIR position). Simple inspection and common fault is a broken wire or faulty lug connection. If pump stops prematurely, suspect one (or more) misadjusted Up limit switches (not actuating to open N/C contacts providing V+ to relay coil.
 2. Following Gear Up/Down Selector Switch operation, Gear Down Relay coil receives multiple viable paths to power and will continue to run until ALL paths to power are opened. (All wheel Down Lock limit switches actuated AND Detent Piston position switches NOT actuated [sitting in detents]. Down Locks open N/C contacts and Detent Piston switches open N/O contacts)

Setup

- ✓ Hydraulic Pump reservoir filled to top w/ H-5606 hydraulic fluid.
- ✓ Verify Emergency Gear Valve Knob up and fully engaged in detent.
- ✓ Gear Selector Switch – DOWN.
- ✓ Flaps – RETRACTED
- ✓ Throttle – ADVANCED to 50% or greater
- ✓ Aircraft up on appropriate jacks and safety collars and tail stand in place.
- ✓ Visual leak check complete for all external hoses and actuator shafts.
- ✓ NOTE: If any recent opening of system lines, purge air by cycling gear up and down several times. Complete purge by placing emergency drop handle in DOWN position and placing gear selector in UP position. Pump will run continuously. Turn Master Switch OFF after 45 seconds. Place Emergency Drop handle in UP position (seated in detent) and Gear Selector in DOWN position and turn master ON to pressurize gear down side lines.

1. Initial Condition Check

Note: Micro switches are known to **NOT** make continuity in their respective positions at life's end and careful checking need to be done to ensure continuity.

Master Switch - ON

Does hydraulic pump remain silent or run briefly then shut off?

YES

All three Gear Down indicator lights illuminated?

YES – Proceed to initial UP CYCLE test (if gear pump runs briefly and shuts off, indicates either down lock or detent switches may be set too tightly to down and locked position. May cause intermittent pump operation. Check gear extended gap in linkage knee for proper extension clearance.)

NO – Push-to-test to verify lamp and local V+ @ holder. Replace lamp, clean holder, trace broken/damaged V+ wire. Verify broken/missing local ground wire or lug. If all other conduits to ground are intact, N/O contacts on down lock switch or N/C contacts on Detent Switch may be faulty.

NO (hyd pump runs continuously – Note: **Do NOT allow pump to run more than 45 (???) sec w/o allowing to cool.**)

All three Gear Down indicator lights illuminated?

NO – Check unlit lamp w/ Push-to-test to verify lamp. If no P-T-T lamp light, see above lamp ground checks. Remedy wiring or holder problem and/or replace lamp if necessary before proceeding. Check unlit Gear Down Lock switch for proper adjustment and operation. N/C contacts should be OPEN w/ gear fully down thereby opening one path to V+. Also Detent Switch N/C contacts must be CLOSED (switch not actuated) to cut power to pump relay coil and provide V+ to lamp. Check associated wiring harness for good V+ continuity when N/C contacts are closed.

YES - Possible stuck gear relay (check for continuity across power terminals w/ power off)

System leak (inspect all hoses and remove rear seat & divan cover to inspect hydraulic lines found underneath.

2. Gear Up Cycle Condition Check

Master Switch – ON

Gear Selector - UP

Does hydraulic pump activate, retract gear within 12 seconds and shut off?

YES - **Turn off Master and allow system to sit w/ gear retracted for 15-20 minutes. Stay to observe retracted gear.**

Do all gear remain fully retracted?

Yes – actuator leaks, check valve, pump internal bypass, and retraction side hyd line leaks unlikely. Go to Down test.

No - *Do all gear begin to droop from fully retracted position?* (possible actuator internal leak, check valve leak, Emergency drop valve leak, retraction side hyd line leaks, pump internal bypass. Remove rear divan to visually inspect lines and switches beneath for obvious leaks.

Check actuators by fully retracting gear and capping lines to each actuator

and noting if individual gear falls on its own. If one actuator is leaky, strongly recommend rebuilding all actuators at same time.

If all actuators pass internal leak check, suspect check valve or Emergency Drop valve. Fully retract gear and cap up-pressure line upstream of Emergency Gear Down Valve and down stream of check valve. If gear falls, overhaul o-rings in Emergency Down Valve. If Emergency Down valve passes leak check, fully retract gear and cap up-pressure line upstream of check valve (between check valve and pump). If gear drops, replace check valve internal cartridge or rebuild check valve as appropriate to part in use.

Does pump fail to start?

YES -

- possible squat switch broken wiring harness or bad squat switch. Test switch N/O contacts are closed (switch in "Air" position) via continuity check.
- possible sticking or bad gear relay – test for +V @ one of coil leads. If V+ available, short other coil terminal to ground to test for relay slap. No slap, replace relay. If slap is heard, check resistance across power terminals of relay. Should be less than 0.5 Ohm. Replace relay if resistance higher value.

Does run, retract gear and then fail to stop or cycle on/off?
(possible emergency dump valve internal bypass – verify handle up and locked before ovhl'g o-rings, hydraulic retraction line leak, hyd pump internal bypass leak, stuck Logic relay power contacts, broken Logic Relay ground. Only way for system to stop pump is for pump to close ALL Up Lock switches N/O contacts (actuate switches) AND Logic Relay to open (via V+ provided to Logic Relay coil.)

3. Gear Down Cycle Check

Gear – RETRACTED

Master – ON

Gear Selector – DOWN

Does pump run, gear extend, and pump stop within 10 seconds?

YES

All three Gear Down indicator lights illuminated?

YES – Down cycle normal. Leave master ON for five minutes to test for system internal leakage (pressure bleed down and pump cycling on/off .

NO – Test as in initial condition check.

NO

Pump does not start - stuck or bad Gear Down Relay – test as in Gear UP relay check; possible bad down logic (position) switches but easier to test these w/ gear down and locked (lights good starting indicator) Test as indicated in 1.0.

Pump continues to run – stuck Gear Down relay – test continuity across power terminals w/ power off. Continuity indicates failed relay.

Intermittent down lock switches - Test as indicated in 1.0.

End Section 1-----

Section 2

Electrical Design Serial 189-380

Serial numbered aircraft 189 through 380 have a gear system that is a blend of the early design and the modern design. It is a “ground” based logic system like the modern system but still has the actuator detent position switches. This series does NOT use the “Logic Relay” like the earlier s/n’s nor does it use the Pressure Switches like the later s/n’s.

A few generalities that may be of use...

1. Power is provided to the hydraulic pump directly from the main buss (through the gear circuit breaker) via the Gear Up/Down Relays. (large diameter power terminals on the relays always “hot” when Main Buss is energized) The pump power circuit is continuously grounded.
2. Power to the Gear Up/Down Relay coils (to close relay power contacts) is sent directly to from the Gear Up/Down Selector Switch (which receives its power from the main buss). Actuation (or triggering) of the coils to make the pump run depends upon the availability of a viable ground path for the coil circuit.
3. Multiple coil ground paths exist that will allow the pump to run.
 1. For the selector in the DOWN position:
 - Gear Down Lock switches. The Down Lock Switch on each wheel has a separate ground path (N/C condition). Until all three switches actuate (opening N/C contacts) indicating wheel down/locked, the pump will continue to run. (NOTE: each down lock switch offers both N/O and N/C contacts. N/O contacts are used for gear lights and N/C contacts are used for gear pump motor operation.)
 - Actuator Detent Switches. Each wheel actuator has a Detent detection Switch that will close when the actuator reaches full throw. At positions not at full throw, the Detent Switches will close N/O contacts allowing a path to ground for hyd pump relay coil causing pump to run
 2. For the selector in the UP position:
 - NOTE: Gear Squat Switch – Normally Open (“N/O” – “Ground” position) terminal connected to ground. Switch must be actuated (closed) by bolt on Right Main gear knee (“Air” position) to allow pump to run. This switch does not affect DOWN cycle operation.
 - Actuator Detent Position Switches will provide a path to ground if actuators are not seated in full throw position
 - Gear Up Lock switches. The Up Lock Switch on each wheel linkage has a separate ground path (N/C condition). Until all three switches actuate (opening N/C contact) indicating wheel up/locked, the pump will continue to run.
4. Until ALL ground paths are broken, pump will continue to run. This situation underscores the value of having a “pullable” breaker for the gear pump. Extended (as little as 5 minutes) operation of the pump will cause it to overheat resulting in an expensive repair bill. If a switch component

- fails resulting in a continuous ground path, causing extended operation of the pump, aircraft w/o a pullable breaker must turn off the master switch to cut power to the pump.
5. Gear Down indicator lights are provided continuous power from the main buss. They will not illuminate unless a ground path is provided. The "Push To Test" circuit offers a local ground path to verify proper operation of the lamp. Operational ground path is provided through the Down Lock Switch associated with each wheel. Down Lock Switch contacts are N/O and lamp will not illuminate until both Down Lock is actuated closing N/O contacts and Actuator Detent Switch is seated providing a path to ground.
 6. Power is provided continuously to Warning Bell from the Main Power Buss. To sound alarm it must achieve a valid path to ground from multiple potential sources. Available ground paths:
 - If Gear Up/Down Selector Switch in (or moved to) the UP position, and Ground Squat Switch is in the "Ground" (N/C) position, electrical ground is immediately available and bell will sound. (This is not a recommended condition and should be tested w/ aircraft on jacks!)
 - Alternate ground path is achieved (and bell sounds) if EITHER Flap Extended Limit Switch or Throttle Retarded Position Limited Switch are closed AND any of the Gear Down Lock limit switches are not actuated (down lock switch actuation opens N/C contacts to ground).
 7. Gear Warning Light is provided continuous power from Main Power Buss. It requires a path to ground to illuminate. Operational paths to ground run through ALL three wheel BOTH Up and Down lock switches. If UP Lock switches have not actuated (opening N/C contacts) OR Down Lock switches have not actuated (opening N/C contacts) a valid path to ground will be achieved and Gear Warning light will illuminate.
 8. To reiterate Hydraulic Pump operational logic:
 1. Following Gear Up/Down Selector Switch operation, Gear Up Relay coil needs Squat Switch AIR (closed) or Up Lock limit switches to achieve ground and operate pump. Only conditions that will allow pump motor shut off are all Up Lock limit switches opening. Note: If Gear UP is selected and pump motor does not start, after checking breaker is not popped, verify squat switch ground is intact. Simple inspection and common fault is a broken wire or faulty ground lug connection.
 2. Following Gear Up/Down Selector Switch operation, Gear Down Relay coil receives multiple viable paths to ground and will continue to run until ALL paths to ground are opened. (All wheel Down Lock limit switches AND Actuator Detent Switches reaching seated condition (N/C contacts closed).

Decision Tree Setup

- ✓ Hydraulic Pump reservoir filled to top w/ H-5606 hydraulic fluid.
- ✓ Verify Emergency Gear Valve Knob up and fully engaged in detent.
- ✓ Gear Selector Switch – DOWN.
- ✓ Flaps – RETRACTED
- ✓ Throttle – ADVANCED to 50% or greater
- ✓ Aircraft up on appropriate jacks and safety collars and tail stand in place.
- ✓ Visual leak check complete for all external hoses and actuator shafts.
- ✓ NOTE: If any recent opening of system lines, purge air by cycling gear up and down several times. Complete purge by placing emergency drop handle in DOWN position and placing gear selector in UP position. Pump will run continuously. Turn Master Switch OFF after 45 seconds. Place Emergency Drop handle in UP position (seated in detent) and Gear Selector in DOWN position and turn master ON to pressurize gear down side lines.

1. Initial Condition Check

Master Switch - ON

Does hydraulic pump remain silent or run briefly then shut off?

YES

All three Gear Down indicator lights illuminated?

YES – Proceed to initial UP CYCLE test (if gear pump runs briefly and shuts off, indicates Hi Pressure switch cut out is functional).

NO – Push-to-test to verify lamp and local ground. Replace lamp, clean holder, trace broken/damaged ground wire to restore missing local ground. If all other conduits to ground are intact, N/O contacts on down lock switch may be faulty and need continuity test.

NO (hyd pump runs continuously – Note: Do NOT allow pump to run more than 45 sec w/o allowing to cool.)

All three Gear Down indicator lights illuminated?

NO – Check unlit lamp w/ Push-to-test to verify lamp. If no P-T-T lamp light, see above lamp ground checks. Remedy ground problem and/or replace lamp if necessary before proceeding. Check unlit Gear Down Lock switch for proper adjustment and operation. N/C contacts should be OPEN w/ gear fully down thereby opening path to ground. Check associated wiring harness for good ground continuity when N/C contacts are closed.

YES - Possible bad Down limit switch. N/C contacts should OPEN w/ gear fully down. Check for no continuity across N/C contacts w/ gear fully down.

Possible stuck gear relay (check for continuity across power terminals w/ power off)

Actuator leak (run gear up check to look for leaky actuator)

System leak (inspect all hoses and remove rear seat & divan cover to inspect hydraulic lines/switches/etc found underneath.

Bad pressure switch (above s/n 380 only) or hydraulic pump pressure (refer to Maint Manual Sect 3.10 for system pressure check and pressure switch operation).

2. Gear Up Cycle Condition Check

Master Switch – ON

Gear Selector - UP

Does hydraulic pump activate, retract gear within 12 seconds and shut off?

YES - Turn off Master and allow system to sit w/ gear retracted for 15-20 minutes. Stay to observe retracted gear.

Do all gear remain fully retracted?

Yes – actuator leaks, check valve, pump internal bypass, Emergency Down Valve and retraction side hyd line leaks unlikely. Go to Down test.

No - *Do all gear begin to droop from fully retracted position?* (possible actuator internal leak, check valve leak, Emergency drop valve leak, retraction side hyd line leaks, pump internal bypass. Remove rear divan to visually inspect lines and switches beneath for obvious leaks.

Check actuators by fully retracting gear and capping lines to each actuator and noting if individual gear falls on its own. If one actuator is leaky, strongly recommend rebuilding all actuators at same time.

If all actuators pass internal leak check, suspect check valve or Emergency Down valve. Fully retract gear and cap up-pressure line upstream of Emergency Gear Down Valve and down stream of check valve. If gear falls, overhaul o-rings in Emergency Down Valve. If Emergency Down valve passes leak check, fully retract gear and cap up-pressure line upstream of check valve (between check valve and pump). If gear drops, replace check valve internal cartridge or rebuild check valve as appropriate part in use.

Does pump fail to start?

YES -

- possible squat switch broken ground or bad squat switch. Inspect ground wire (rt main gear well). Test switch N/O contacts are closed (switch in

“Air” position) via continuity check.

- Possible bad pressure switch or ground. Check continuity across Pressure Switch terminals and to associated ground. Pressure switch contacts are N/C unless in “HI” condition. (contacts open)
- possible sticking or bad gear relay – test for +V @ one of coil leads. If V+ available, short other coil terminal to ground to test for relay slap. No slap, replace relay. If slap is heard, check resistance across power terminals of relay. Should be less than 0.5 Ohm. Replace relay if resistance higher value.

Does run, retract gear and then fail to stop? (possible emergency dump valve internal bypass – verify handle up and locked before ovhl'g o-rings, pressure switch failure – check pressure as shown in Maintenance Manual 3.10, hydraulic retraction line leak, hyd pump internal bypass leak. Only way for system to stop pump is for pump to achieve enough pressure to bring pressure switch to “Hi” condition. (N/C contacts open path to ground)

3. Gear Down Cycle Check

Gear – RETRACTED

Master – ON

Gear Selector – DOWN

Does pump run, gear extend, and pump stop within 10 seconds?

YES

All three Gear Down indicator lights illuminated?

YES – Down cycle normal. Leave master ON for five minutes to test for system internal leakage (pressure bleed down and pump cycling on/off .

NO – Test as in initial condition check.

NO

Pump does not start - stuck or bad Gear Down Relay – test as in Gear UP relay check; faulty Down Pressure Switch or bad ground – test continuity across pressure switch N/C terminals and continuity to ground; possible bad down logic (position) switches

but easier to test these w/ gear down and locked (lights good starting indicator) Test as indicated in 1.0.

Pump continues to run – stuck Gear Down relay – test continuity across power terminals w/ power off. Continuity indicates failed relay.

Intermittent down lock switches - Test as indicated in 1.0.

Failed pressure switch (s/n 381 and up). Run system pressure check and test switch for continuity @ high pressure. Continuity indicates failed switch.

End Section 2 =====

+++++

Section 3

Electrical Design Serial 381 and up

A few generalities that may be of use...

1. Power is provided to the hydraulic pump directly from the main buss (through the gear circuit breaker) via the Gear Up/Down Relays. (large diameter power terminals on the relays always “hot” when Main Buss is energized) The pump power circuit is continuously grounded.
2. Power to the Gear Up/Down Relay coils (to close relay power contacts) is sent directly to from the Gear Up/Down Selector Switch (which receives its power from the main buss). Actuation (or triggering) of the coils to make the pump run depends upon the availability of a viable ground path for the coil circuit.
3. Multiple coil ground paths exist that will allow the pump to run.
 1. For the selector in the DOWN position:
 - Down Pressure Switch in the LO condition (normally closed – “N/C”). Switch must reach “HI” condition (open N/C contacts) to break grounded state.
 - Gear Down Lock switches. The Down Lock Switch on each wheel has a separate ground path (N/C condition). Until all three switches actuate (opening N/C contacts) indicating wheel down/locked, the pump will continue to run. (NOTE: each down lock switch offers both N/O and N/C contacts. N/O contacts are used for gear lights and N/C contacts are used for gear pump motor operation.)
 2. For the selector in the UP position:
 - NOTE: Gear Squat Switch – Normally Open (“N/O” – “Ground” position) terminal connected to ground. Switch must be actuated (closed) by bolt on Right Main gear knee (“Air” position) to allow pump to run. This switch does not affect DOWN cycle operation.
 - Up Pressure Switch in the LO condition (N/C). Switch must reach “HI” condition to break ground path state.
 - Gear Up Lock switches. The Up Lock Switch on each wheel linkage has a separate ground path (N/C condition). Until all three switches actuate (opening N/C contact) indicating wheel up/locked, the pump will continue to run.
4. Until ALL ground paths are broken, pump will continue to run. This situation underscores the value of having a “pullable” breaker for the gear pump. Extended (as little as 5 minutes) operation of the pump will cause it to overheat resulting in an expensive repair bill. If a switch component fails resulting in a continuous ground path, causing extended operation of the pump, aircraft w/o a pullable breaker must turn off the master switch to cut power to the pump.
5. Gear Down indicator lights are provided continuous power from the main buss. They will not illuminate unless a ground path is provided. The “Push To Test” circuit offers a local ground path to verify proper operation of the lamp. Operational ground path is provided through the Down Lock Switch associated with each wheel. Down Lock Switch contacts are N/O and lamp will not illuminate until switch is actuated closing N/O contacts and providing a path to ground.

6. Power is provided continuously to Warning Bell from the Main Power Buss. To sound alarm it must achieve a valid path to ground from multiple potential sources. Available ground paths:
3. If Gear Up/Down Selector Switch in (or moved to) the UP position, and Ground Squat Switch is in the "Ground" (N/C) position, electrical ground is immediately available and bell will sound. (This is not a recommended condition and should be tested w/ aircraft on jacks!)
4. Alternate ground path is achieved (and bell sounds) if EITHER Flap Extended Limit Switch or Throttle Retarded Position Limited Switch are closed AND any of the Gear Down Lock limit switches are not actuated (down lock switch actuation opens N/C contacts to ground).
7. Gear Warning Light is provided continuous power from Main Power Buss. It requires a path to ground to illuminate. Operational paths to ground run through ALL three wheel BOTH Up and Down lock switches. If UP Lock switches have not actuated (opening N/C contacts) OR Down Lock switches have not actuated (opening N/C contacts) a valid path to ground will be achieved and Gear Warning light will illuminate.

NOTE: it is possible for gear to properly retract and hydraulic pump to shut off (HI pressure switch opens Up Relay path to ground) and still have the Gear Unsafe light illuminate if one of the Up or Down Lock switches fail and maintain their path to ground. Gear Unsafe lamp may also illuminate erroneously if a stray ground occurs through the panel.

8. To reiterate Hydraulic Pump operational logic:
 1. Following Gear Up/Down Selector Switch operation, Gear Up Relay coil needs both Up Pressure Switch LO and Squat Switch AIR (closed) to achieve ground and operate pump. No other logic switches required or offer viable paths to ground. Only conditions that will allow pump motor shut off are either UP Pressure Switch reaching HI condition (opens N/C contacts) or failure of ground at Squat Switch. Note: If Gear UP is selected and pump motor does not start, after checking breaker is not popped, verify squat switch ground is intact. Simple inspection and common fault is a broken wire or faulty ground lug connection.
 2. Following Gear Up/Down Selector Switch operation, Gear Down Relay coil receives multiple viable paths to ground and will continue to run until ALL paths to ground are opened. (All wheel Down Lock limit switches AND Down Pressure Switch reaching "HI" condition. (all switches opening N/C contacts)

Decision Tree Setup

- ✓ Hydraulic Pump reservoir filled to top w/ H-5606 hydraulic fluid.
- ✓ Verify Emergency Gear Valve Knob up and fully engaged in detent.
- ✓ Gear Selector Switch – DOWN.
- ✓ Flaps – RETRACTED
- ✓ Throttle – ADVANCED to 50% or greater
- ✓ Aircraft up on appropriate jacks and safety collars and tail stand in place.
- ✓ Visual leak check complete for all external hoses and actuator shafts.
- ✓ NOTE: If any recent opening of system lines, purge air by cycling gear up and down several times. Complete purge by placing emergency drop handle in DOWN position and placing gear selector in UP position. Pump will run continuously. Turn Master Switch OFF after 45 seconds. Place Emergency Drop handle in UP position (seated in detent) and Gear Selector in DOWN position and turn master ON to pressurize gear down side lines.

1. Initial Condition Check

Master Switch - ON

Does hydraulic pump remain silent or run briefly then shut off?

YES

All three Gear Down indicator lights illuminated?

YES – Proceed to initial UP CYCLE test (if gear pump runs briefly and shuts off, indicates Hi Pressure switch cut out is functional).

NO – Push-to-test to verify lamp and local ground. Replace lamp, clean holder, trace broken/damaged ground wire to restore missing local ground. If all other conduits to ground are intact, N/O contacts on down lock switch may be faulty and need continuity test.

NO (hyd pump runs continuously – *Note: Do NOT allow pump to run more than 45 sec w/o allowing to cool.*)

All three Gear Down indicator lights illuminated?

NO – Check unlit lamp w/ Push-to-test to verify lamp. If no P-T-T lamp light, see above lamp ground checks. Remedy ground problem and/or replace lamp if necessary before proceeding. Check unlit Gear Down Lock switch for proper adjustment and operation. N/C contacts should be OPEN w/ gear fully down thereby opening path to ground. Check associated wiring harness for good ground continuity when N/C contacts are closed.

YES - Possible bad Down limit switch. N/C contacts should OPEN w/ gear fully down. Check for no continuity across N/C contacts w/ gear fully down.

Possible stuck gear relay (check for continuity across power terminals w/ power off)

Actuator leak (run gear up check to look for leaky actuator)

System leak (inspect all hoses and remove rear seat & divan cover to inspect hydraulic lines/switches/etc found underneath.

Bad pressure switch (above s/n 380 only) or hydraulic pump pressure (refer to Maint Manual Sect 3.10 for system pressure check and pressure switch operation).

2. Gear Up Cycle Condition Check

Master Switch – ON

Gear Selector - UP

Does hydraulic pump activate, retract gear within 12 seconds and shut off?

YES - Turn off Master and allow system to sit w/ gear retracted for 15-20 minutes. Stay to observe retracted gear.

Do all gear remain fully retracted?

Yes – actuator leaks, check valve, pump internal bypass, Emergency Down Valve and retraction side hyd line leaks unlikely. Go to Down test.

No - *Do all gear begin to droop from fully retracted position?* (possible actuator internal leak, check valve leak, Emergency drop valve leak, retraction side hyd line leaks, pump internal bypass. Remove rear divan to visually inspect lines and switches beneath for obvious leaks.

Check actuators by fully retracting gear and capping lines to each actuator

and noting if individual gear falls on its own. If one actuator is leaky, strongly recommend rebuilding all actuators at same time.

If all actuators pass internal leak check, suspect check valve or Emergency Down valve. Fully retract gear and cap up-pressure line upstream of Emergency Gear Down Valve and down stream of check valve. If gear falls, overhaul o-rings in Emergency Down Valve. If Emergency Down valve passes leak check, fully retract gear and cap up-pressure line upstream of check valve (between check valve and pump). If gear drops, replace check valve internal cartridge or rebuild check valve as appropriate to part in use.

Does pump fail to start?

YES -

- possible squat switch broken ground or bad squat switch. Inspect ground wire (rt main gear well). Test switch N/O contacts are closed (switch in "Air" position) via continuity check.
- Possible bad pressure switch or ground. Check continuity across Pressure Switch terminals and to associated ground. Pressure switch contacts are N/C unless in "HI" condition. (contacts open)
- possible sticking or bad gear relay – test for +V @ one of coil leads. If V+ available, short other coil terminal to ground to test for relay slap. No slap, replace relay. If slap is heard, check resistance across power terminals of relay. Should be less than 0.5 Ohm. Replace relay if resistance higher value.

Does run, retract gear and then fail to stop? (possible emergency dump valve internal bypass – verify handle up and locked before ovhl'g o-rings, pressure switch failure – check pressure as shown in Maintenance Manual 3.10, hydraulic retraction line leak, hyd pump internal bypass leak. Only way for system to stop pump is for pump to achieve enough pressure to bring pressure switch to "Hi" condition. (N/C contacts open path to ground)

3. Gear Down Cycle Check

Gear – RETRACTED

Master – ON

Gear Selector – DOWN

Does pump run, gear extend, and pump stop within 10 seconds?

YES

All three Gear Down indicator lights illuminated?

YES – Down cycle normal. Leave master ON for five minutes to test for system internal leakage (pressure bleed down and pump cycling on/off .

NO – Test as in initial condition check.

NO

Pump does not start - stuck or bad Gear Down Relay – test as in Gear UP relay check; faulty Down Pressure Switch or bad ground – test continuity across pressure switch N/C terminals and continuity to ground; possible bad down logic (position) switches but easier to test these w/ gear down and locked (lights good starting indicator) Test as indicated in 1.0.

Pump continues to run – stuck Gear Down relay – test continuity across power terminals w/ power off. Continuity indicates failed relay.

Intermittent down lock switches - Test as indicated in 1.0.

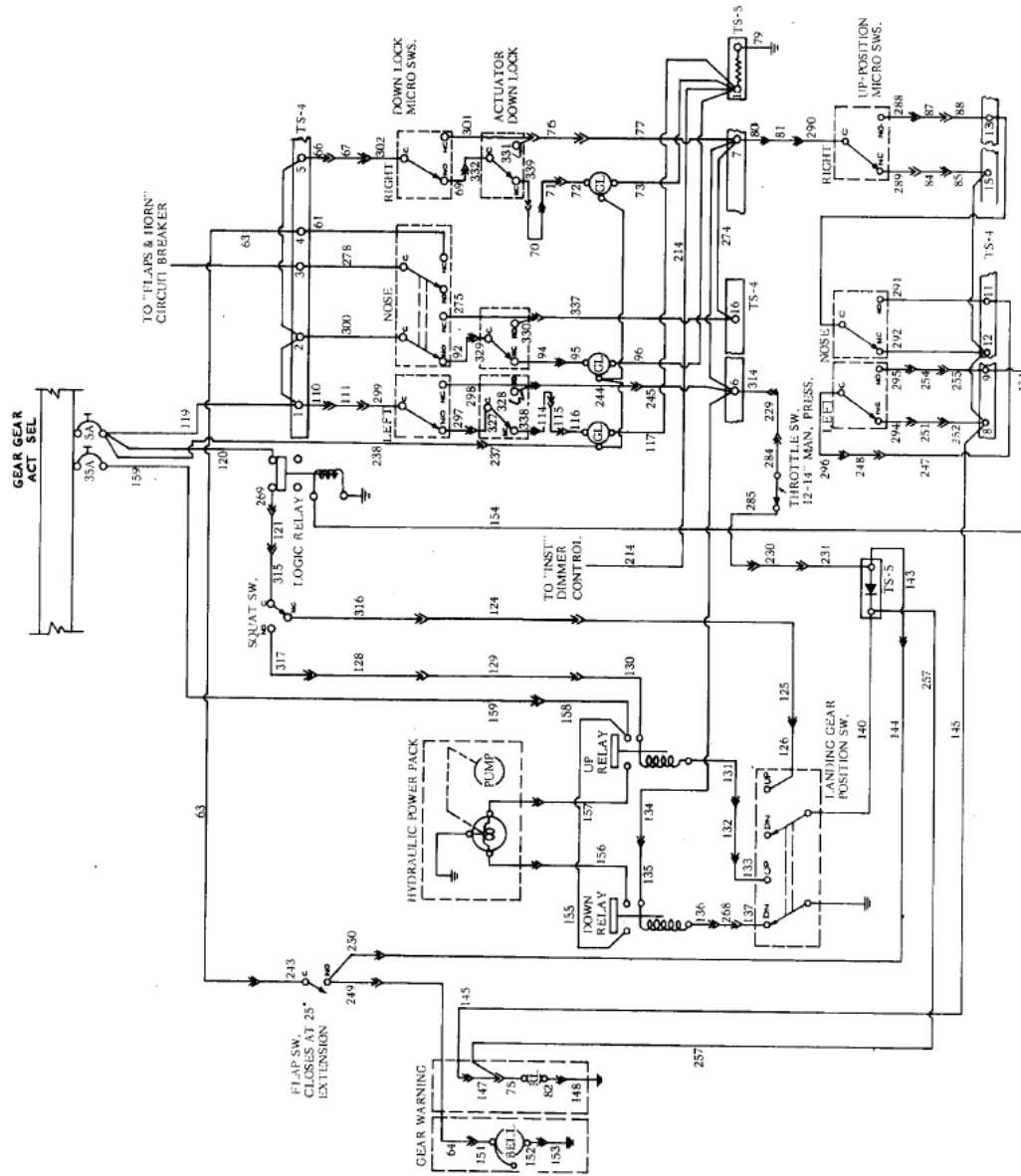
Failed pressure switch (s/n 381 and up). Run system pressure check and test switch for continuity @ high pressure. Continuity indicates failed switch.

End Section 3 ++++++

SECTION X
ELECTRICAL

MAINTENANCE MANUAL

ROCKWELL
COMMANDER
112/B/TC/TCA

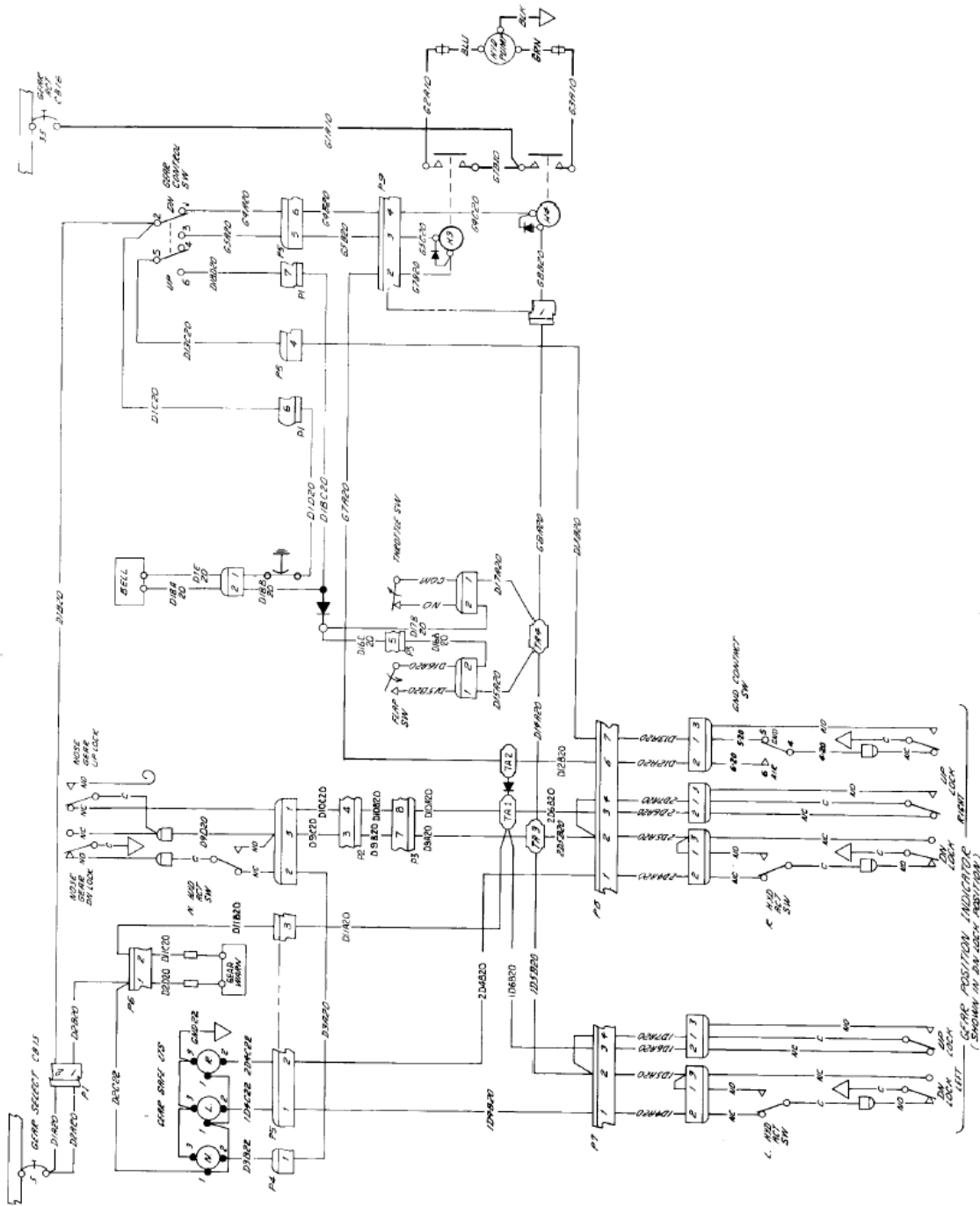


Electrical Diagram Serial 7-188

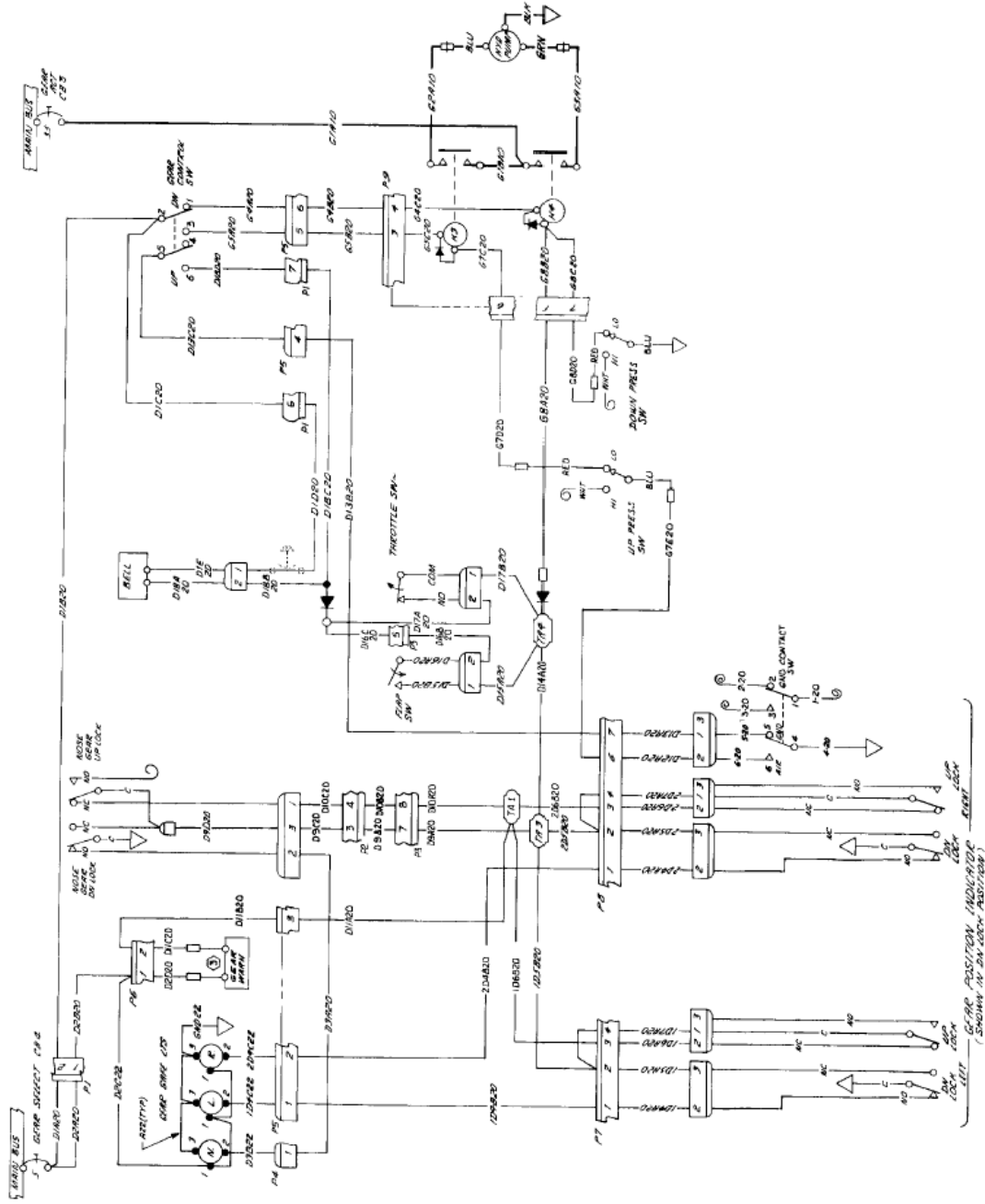
SECTION X
ELECTRICAL

MAINTENANCE MANUAL

ROCKWELL
COMMANDER
112/B/TC/TCA



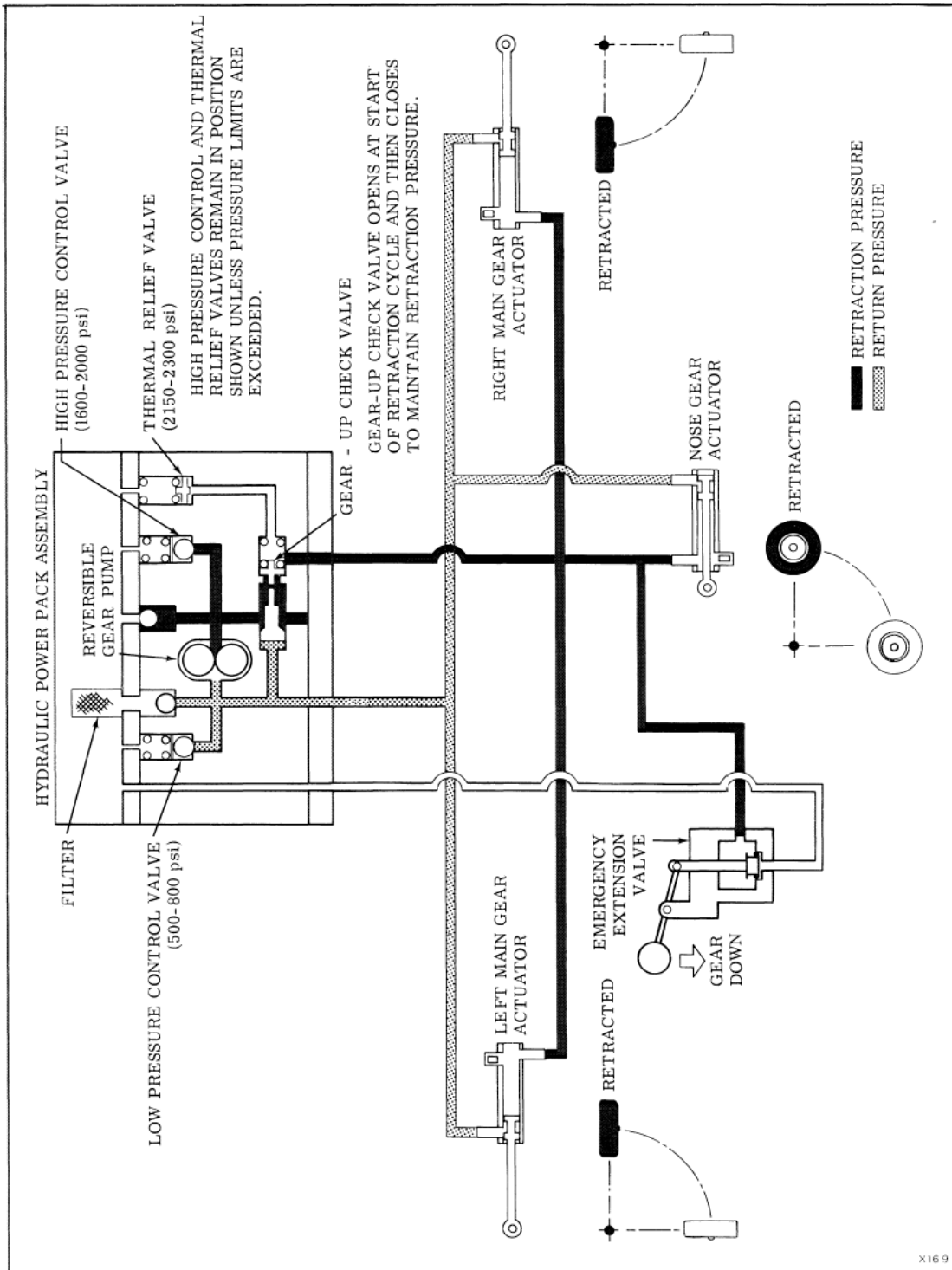
Electrical Diagram Serial 189-380



Electrical Diagram Serial 380+

MANUFACTURERS DATA

PART III
SYSTEMS



Revised 4/12/74

Figure 3-1. Hydraulic System Schematic - (Gear Retracted)
Serial 7-380

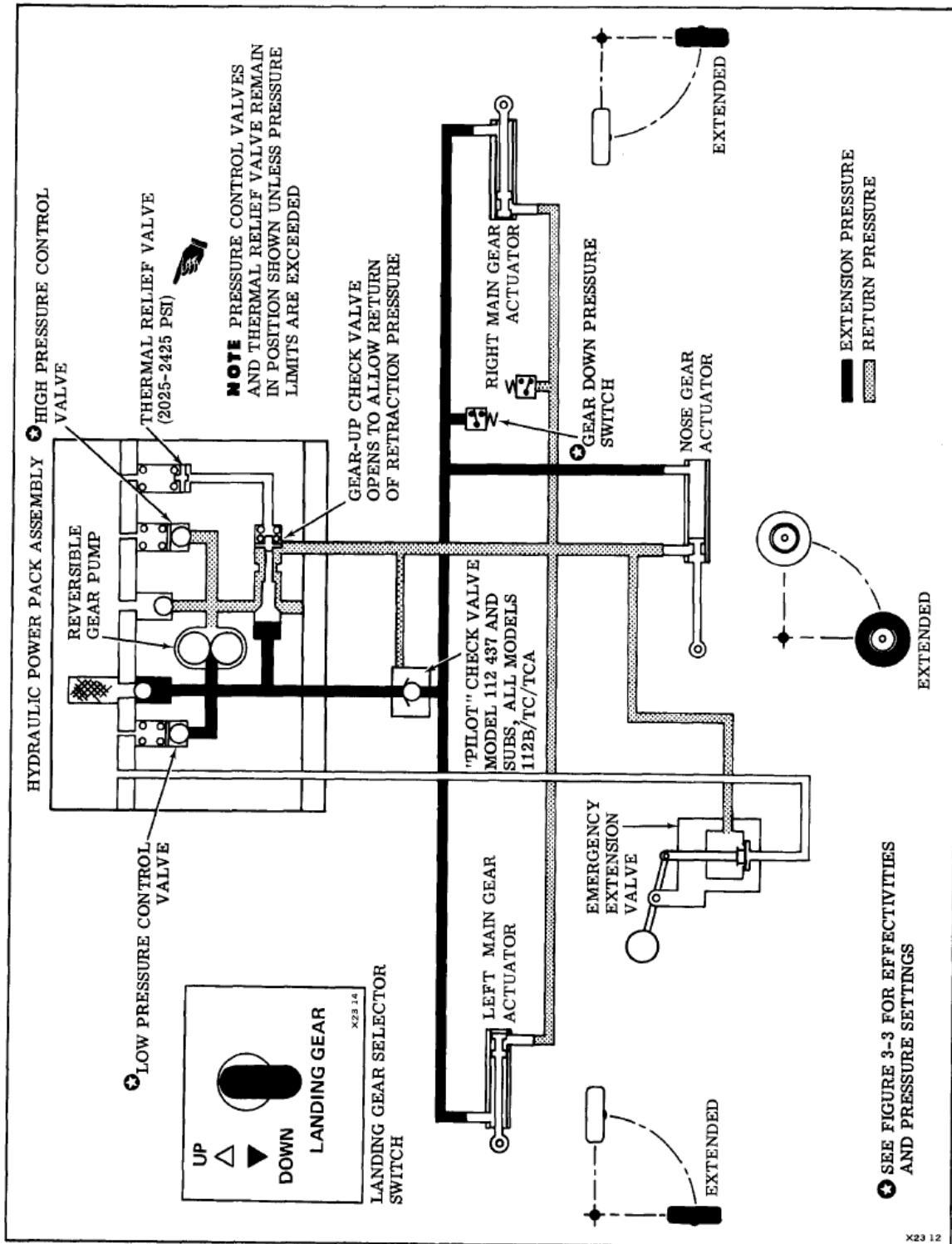


Figure 3-2. Hydraulic System Schematic - Gear Extended (Sheet 2 of 3)

Serial 381+

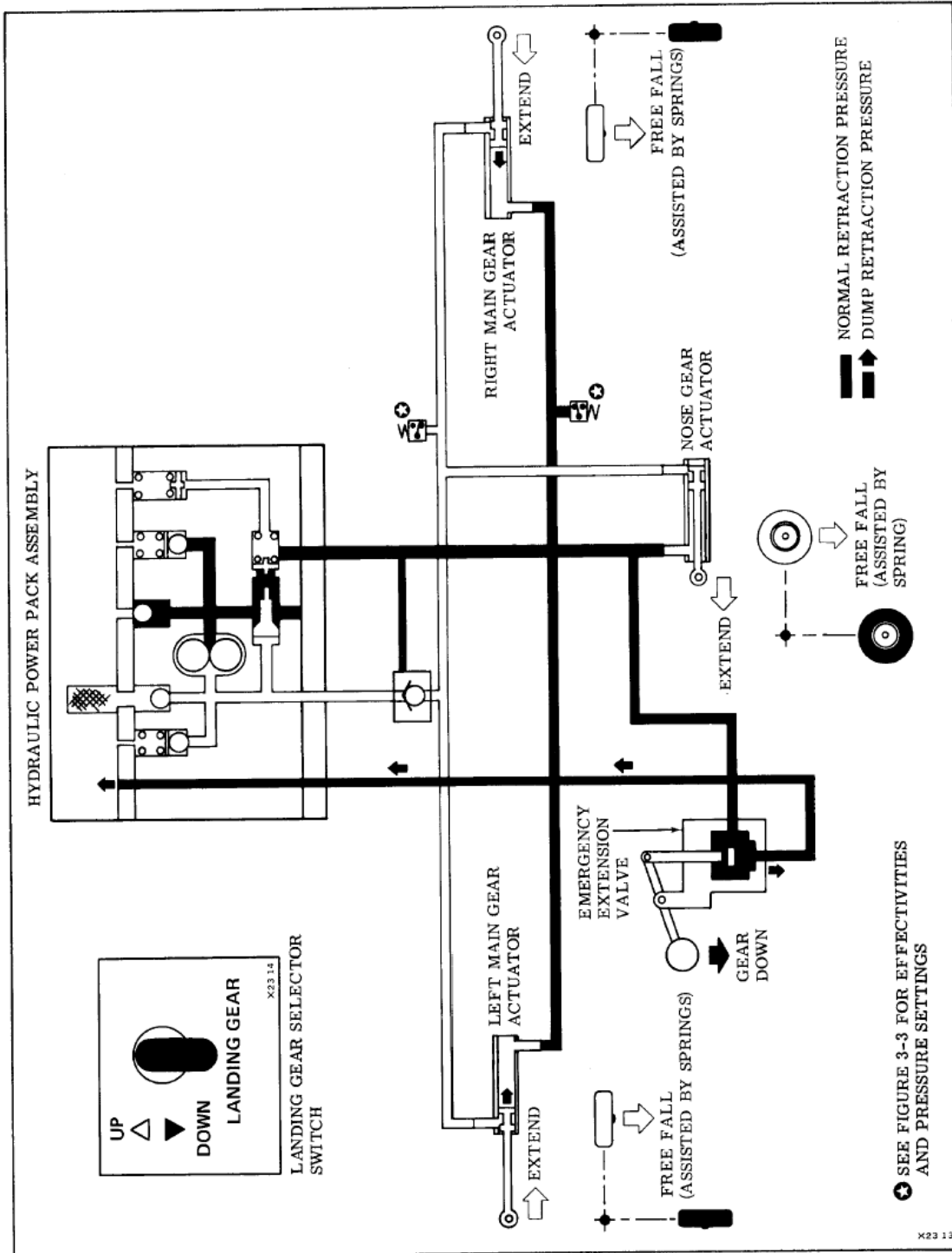


Figure 3-2. Hydraulic System Schematic - Emergency Gear Extension (Sheet 3 of 3)

Serial 381+



Serial 7-380



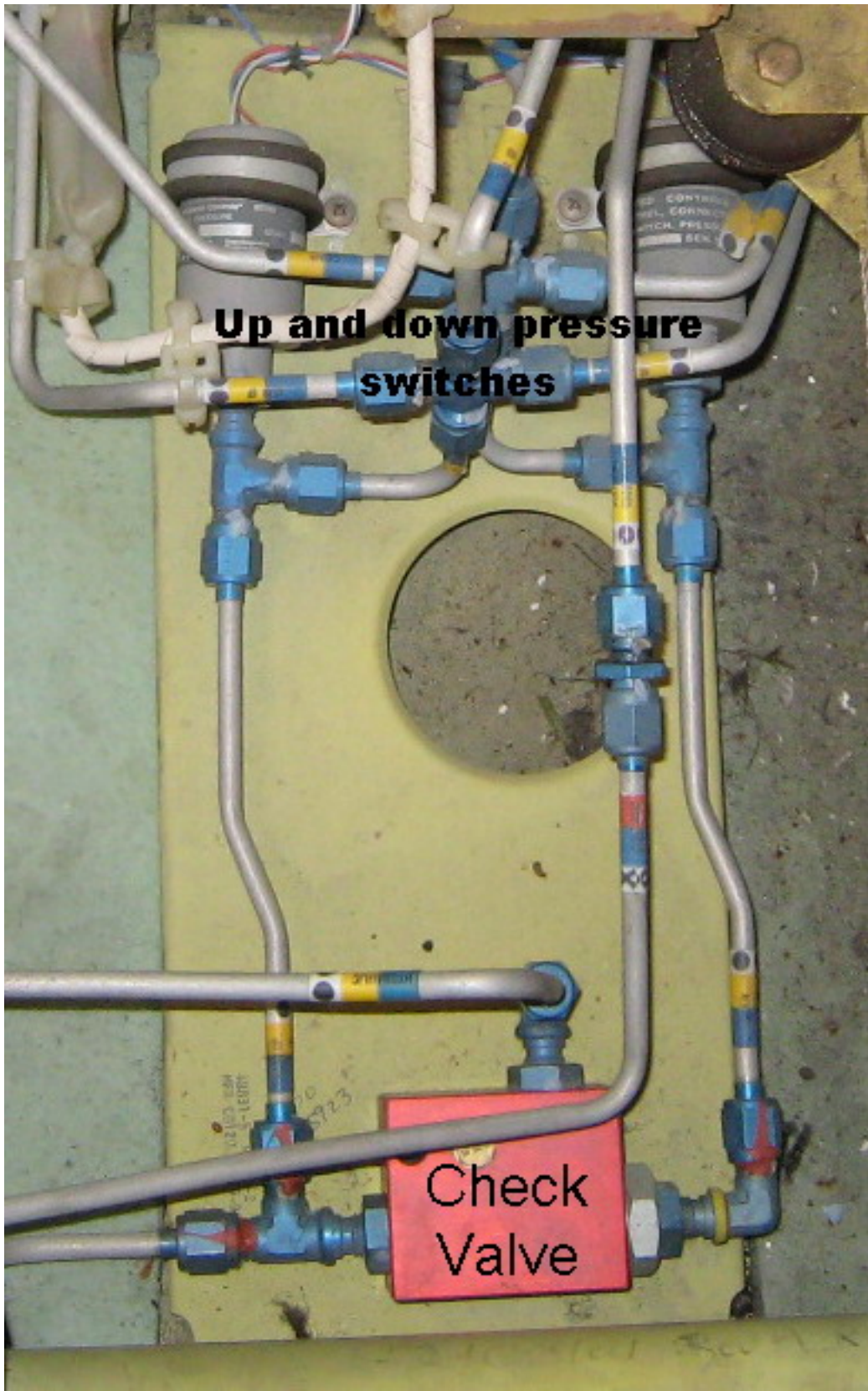
Serial 7-380



Serial 7-380



Serial 7-380



Serial 381 and up