GearMinder

Users' Manual
Version 1.1

for Lancair IV, IV-P and 360

February 9, 1997

Index

WARNING

This device is intended for use in experimental aircraft only.

This system is intended to be a supplemental warning device to assist the pilot in managing the cockpit workload. It is not intended to replace normal departure, enroute, approach and landing checklists. Consequently, this system is not designed with the redundancy of a mission critical system.

1.0 Introduction

GearMinder is a solid state microprocessor based system for monitoring a retractable gear airplane's landing gear and airspeed and generating a warning if the gear is in an abnormal condition for the given flight regime. The system also operates the gear retract lockout and depressurization mechanisms on aircrafts equipped with them.

The unit accepts 3 gear indicator inputs. When an input is driven to below 2V, the system sees it as gear down. If the input is driven high, or left disconnected, the system sees it as gear up. Only when all 3 inputs are pulled below 2V, will the system recognizes a gear down condition. Only when all 3 inputs are taken above 2V or left disconnected will the system considers the gear to be up. If some inputs are below 2V and others are above 2V or disconnected, the system considers this to be "Gear In Transition" state. For use in airplanes with less than 3 gear indicator switches, the unused gear input(s) should be connected in parallel to one of the used input(s).

The system employs three separate outputs to alert the user; a self contained buzzer, an output for a warning light and an audio output. All warning messages consist of a 1 second tone on the buzzer accompanied by the activation of the light, followed by a voice message. All advisory messages consist only of a voice message and no tone or light activation

The light output is a low side switch. It is intended to be connected to a LED or incandescent light to provide a visual warning to the pilot. The audio output is designed to drive the input of a standard aviation audio panel. It is recommended that this output be connected to one of the unswitched audio inputs of the audio panel. A single turn rotary potentiometer allows the user to set the volume during installation.

All speeds mentioned in this document are in knots indicated airspeed (KIAS). While most of the speeds are fixed for the model of the aircraft, the main landing gear warning speed is adjustable by the user by means of a rotary switch during installation. A jumper selects the model of the aircraft.

The gear retract lockout and depressurization mechanisms are controlled by the output of a relay. When the airspeed is below the retract lockout speed, the relay is "inactive" causing the *normally open* output to be disconnected and the *normally closed* output to be connected to ground. When the airspeed exceeds the threshold speed, the relay is "activated" causing the normally open output to be connected to ground and the normally closed output to disconnected. The normally closed output can be used to drive the pressure dump input in the pressurization system, while the normally open output can be used to drive a gear retract lockout solenoid.

2.0 Warning Messages

The following warnings are generated by the system:

Gear Up Landing Warning:

This warning is generated if the gear is still up when the airspeed drops below a user selectable *Gear Warning Speed*. This speed is selected by the user during installation using a rotary switch located in the unit (refer to section 6 for instruction on setting the speed). The warning consists of a buzzer tone and light activation followed by the message "Put Gear Down Now". The sequence is repeated every 10 seconds until the gear is deployed or the speed increases above the *Gear Warning Speed*. This warning is disabled for 1 minute after reaching the *Gear Lockout Speed* (see section 8).

Early Gear Warning:

This warning is generated if the gear is still up when the airspeed drops to within a specified value (see section 8) of the *Gear Warning Speed*. The warning consists of a buzzer tone and light activation followed by the message "Put Gear Down". The sequence is repeated every 15 seconds until the gear is deployed, the speed increases above the threshold for this warning, or the speed falls below the Gear Warning Speed at which case the Gear Up Landing Warning sequence is initiated. This warning is disabled for 1 minute after reaching the *Gear Lockout Speed* (see section 8). This warning is also disabled if the airspeed is within 10 KIAS of the maximum speed attained since the landing gear retraction was initiated. This allows the pilot to climb out at a speed below the *Early Gear Warning Speed* without activating this warning.

Gear Still Down Warning:

This warning is generated if the gear has still not been retracted 2 minutes after the speed increases above *Gear Lockout Speed*. The warning consists of a buzzer tone and light activation followed by the message "Put Gear Up". This is a one time warning and is not repeated until after the airplane has slowed down to below the *Gear Lockout Speed.* This allows the pilot to intentionally operate the airplane with the gear down without being constantly hounded to put the gear up. Care should be taken when performing instrument approaches, low passes and touch and go landings. In all these cases since the speed does not decay to below the *Gear Lockout Speed* the system is not re-armed and will not warn the operator if the gear is left down after an approach or touch and go landing.

V_{LE} Warning:

This warning is generated any time the airspeed exceeds the V_{LE} with the gear down. The warning consists of a buzzer tone and light activation followed by the message "Put Gear Up Now". This sequence is repeated every 10 seconds until the airplane slows down below V_{LE} or the landing gear is retracted.

Gear Fault:

This message is generated if the landing gear remains in transition for more then 10 seconds. The landing gear is considered to be in transition if all three gear inputs are not in the same state. The warning consists of a buzzer tone and light activation followed by the message “Gear Fault”. This is a one time warning and is not repeated until after the gear has returned to either the up or down condition.

3.0 Informational Messages

The following informational messages are generated by the system:

Gear Is Up:

This message is generated when the system recognizes that all 3 gear inputs have reached the up conditions (inputs above 2V or disconnected). This consists of the message “Gear Is Up”. It is not preceded by a buzzer. If the gear was retracted after a warning message, the basic message is followed by the message “Thank You”.

Gear Is Down:

This message is generated when the system recognizes that all 3 gear inputs have reached the down conditions (inputs below 2V). This consists of the message “Gear Is Down”. It is not preceded by a buzzer. If the gear was extended after a warning message, the basic message is followed by the message “Thank You”.

4.0 Special Conditions & Warnings

There are certain conditions in which the system may not generate a warning as expected. These are described in sections 4.1 and 4.2. The pilot must also be aware of the behavior of this system in the event of the failure or malfunction of one of the system that it depends upon. These are described in sections 4.3 and 4.4.

4.1 If the *Gear Warning Speed* is set too low, it is possible for the pilot to touch down above this speed in certain situations, such as when landing at higher than normal speeds in gusty conditions. In such an event, the system will not generate a Gear Up Landing Warning if the landing gear is not extended.

4.2 The Gear Up Landing Warnings are disabled for 1 minute after reaching the *Gear Lockout Speed*. In the event of an engine problem immediately after takeoff and gear retraction, it is possible for the pilot to land the airplane before this timeout expires. In such an event, the system will not generate a Gear Up Landing Warning if the landing gear is not extended.

4.3 In the event of a power interruption, the relay will return to its "inactive" state, connecting the *normally closed* output to ground. If this output is used to drive a pressurization dump valve, it will result in a loss of pressurization as soon as the landing gear switch is moved to the down position.

4.4 The airspeed is based on the pitot and static lines. In the event of a failure of the pitot/static system, this system may prevent the pilot from retracting the landing gear and/or generate erroneous warning messages. Such failures of the pitot/static system will also be readily apparent in the erratic and/or erroneous behavior of the airspeed indicator and the VSI.

5.0 Connector & Installation Information

The system requires connection to the pitot and the static lines as well as an electrical connection to various signals. Refer to the installation drawing for locations of these connectors and mounting holes.

Mechanical Installation:

The unit is installed using the two 10-32 mounting screws on the face of the unit. In most cases, it would be required to use some kind of a bracket to mount the unit to the aircraft. The mounting screws can be bottomed out without damage to the unit. Care should be taken not to block the alarm output holes. The unit can be mounted in any orientation.

Pitot Input:

The pitot input is required to determine the airspeed for the warning messages. This is a 1/8-27 NPT connection on the face of the unit and is marked with a "P" symbol. It is good practice to use teflon thread sealer tape or some other similar means to ensure a leak-proof connection.

Static Input:

The static input is also required to determine the airspeed for the warning messages. This is a 1/8-27 NPT connection on the face of the unit and is marked with a "S" symbol. It is good practice to use teflon thread sealer tape or some other similar means to ensure a leak-proof connection. In non-pressurized aircraft, it is possible to vent this input to the cabin (leave it disconnected), but this will result in the system perceiving the speed to be slightly higher than actual. **The practice of leaving the static port disconnected is not recommended.**

Electrical Input:

All the electrical connections to the unit are provided through a 9 pin D connector (commonly referred to as "Male DB9") connector located on the face of the unit. The pinout for this connector is as follows:

Pin 1	Normally open relay output
Pin 2	Normally closed relay output
Pin 3	Audio output, connect to audio panel unswitched input
Pin 4	Lamp output, connect to a lamp or LED
Pin 5	Power, +11V to +34V
Pin 6	Gear down switch 1, connect to grounding thru gear indicator switch to indicate gear down
Pin 7	Gear down switch 2 connect to grounding thru gear indicator switch to indicate gear down
Pin 8	Gear down switch 3 connect to grounding thru gear indicator switch to indicate gear down
Pin 9	Ground

While the chassis is internally connected to the ground input (Pin 9), it is good electrical practice to provide a good ground connection through the ground pin on the connector.

The lamp output is a low side transistor switch capable of sinking up to 200mA. This output is not short circuit protected and does not contain an integral flyback diode. Ideally, this output can be used to drive a red LED placed in the pilot's field of view. For driving a LED, this output would be connected to the cathode of a LED, while the anode would be connected to the supply voltage through a resistor (for a 30mA LED 470Ω, 1/2W resistor for 12V systems, 1.2K, 1W resistor for 28V systems). This output can also be used to drive a standard light bulb of an appropriate rating.

The typical landing gear warning lamp installation uses a light bulb with one side connected to the system voltage and the other side connected to a switch on the landing gear. When the gear is down, this switch connects to ground, grounding the other end of the lamp and completing the circuit, allowing the light to come on. In such a setup, the gear inputs can be connected to the same terminal on the switch, in parallel with the light. As a practical matter, it may be possible to save a lot of wiring by making the connection to the negative terminal of the gear status lamp right behind the panel.

6.0 User Adjustments

The unit allows the user to adjust the output volume, the *Gear Warning Speed*. and the airplane model (which affects the speeds). These adjustments are located inside the unit and require the user to remove the backshell. The backshell is removed by removing the two #1 Phillips screws located on the sides of the unit. **Do not remove the screw or the nuts located on the face of the unit.** The user adjustments are located in the lower edge of the PCB and are clearly marked as "Speed", "Volume", "E1", "E2" and "E3". **Do not attempt to adjust the potentiometer R20, which is epoxied in place at the factory setting. Changing this setting will adversely affect the performance of the system.**

The volume adjustment allows the user to adjust the volume of audio output. Use a small flat screw driver to adjust the potentiometer marked as "Volume" Turning clockwise will decrease the volume, while turning counterclockwise will increase the volume. A typical setting is in the middle of the range, but settings at either extreme are perfectly acceptable. The volume should be set so that it is loud enough to be heard over everything else going on in a busy cockpit, but not loud enough to be startling.

The airplane model is selected by the presence/absence of jumpers in positions E1, E2 and E3. Refer to section 8 for jumper settings for different aircraft. After a change to the jumper settings, the system must be powered down and powered up again in order for the change to take effect.

The *Gear Warning Speed* is set by rotary switch marked "Speed" This switch has 16 settings numbered from 0 to 9 and then A thru F. Only the even digits and the letters A,C and E are marked. The dots between pairs of digits indicate the value between the two digits. Lower numbers represent lower speeds while higher numbers indicate higher speeds. The actual airspeeds corresponding to each setting are given in section 8. After a change to the jumper settings, the system must be powered down and powered up again in order for the change to take effect.

7.0 Specifications

Supply Voltage:	11V - 32V DC for normal operation. Protected against voltage spikes and reversed voltage.
Supply Current:	35mA max when not alarming 65mA max when sounding an alarm
Weight:	6 Oz
Size:	1.870" x 2.810" x 1.500" All connectors located on the 1.870" x 2.810" face
Gear Input: (Gear Up)	Max voltage: Same as supply voltage Leakage current: Less than 0.1mA.
Gear Input: (Gear Down)	Max voltage: 2V Input Impedance: 3.3KΩ, pulled up internally to a 4.5V source
Lamp Output: (Active)	Sink up to 200mA, **NOT short circuit protected**
Lamp Output: (Inactive)	Max Voltage: Same as supply voltage Leakage Current: Less than 0.1mA
Buzzer Output:	Integrated buzzer at 100dB audio output
Audio Output:	0-3V intended to drive a 500 ohm load.
Relay Output:	Both the "normally open" and "normally closed" outputs of the relay are brought out. The common side of the relay is connected to ground. Max Voltage/Current: 36VDC/1A or 100VDC/0.5A

8.0 Speeds

This section describes the airspeeds for Lancair IV/IV-P and Lancair 360. Since all the airspeeds for Lancair IV-P are identical to Lancair IV, only Lancair IV is mentioned. All speeds are in Knots Indicated Airspeed (KIAS).

Lancair IV speeds are selected when all jumpers, E1, E2 and E3 are open.

Lancair 360 speeds are selected when jumper E1 is closed while E2 and E3 are open.

Gear Warning Speed & Switch Positions:

Switch Position	Lancair IV	Lancair 360
0	80	50
1	84	54
2	88	58
3	92	62
4	96	66
5	100	70
6	104	74
7	108	78
8	112	82
9	116	86
A	120	90
B	124	94
C	128	98
D	132	102
E	136	106
F	140	110

	Lancair IV	Lancair 360
Early Warning Speed:	Gear Warning Speed + 20	Gear Warning Speed + 10
V_{LE} Warning Speed:	165	122
Gear Lockout Speed:	60	50