



General Electrodynamics Corp.

AIRCRAFT WEIGHING SYSTEM

Operation Manual for the following Scales

LPA400X-00000-1, LPA400X-00000-2

LPA400X Portable Wireless Aircraft Weighing System

REVISION B

Manual Part Number

PM-LPA400X-1



GENERAL ELECTRODYNAMICS CORPORATION

LPA400X PORTABLE WIRELESS AIRCRAFT WEIGHING SYSTEM

This device may contain a Federal
Communications Commission (FCC)
certified RF transceiver module. Refer to:
FCC ID: U90-SM200

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- Increase the separation between the equipment and the receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

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- i.) General Electrodynamics Corporation (GEC), hereinafter referred to as “GEC,” warrants each new weighing platform to be free from defects in material and workmanship when properly used under normal conditions for a period of one (1) year after shipment from the GEC plant.
- ii.) Notice of any claimed defect must be presented to GEC in writing within the warranty period. Upon receipt of the notice from the buyer, the GEC will issue a return authorization to buyer without reasonable delay. By making a warranty claim, the buyer authorizes GEC to repair or replace any defective units at its plant or at the buyer’s site; whichever (in the Seller’s determination) is most expeditious. The buyer shall make NO RETURNS OR ADJUSTMENTS WITHOUT PRIOR AUTHORIZATION. When authorized, shipment must be made, transportation charges prepaid, and in accordance with such shipping and packing instructions as GEC may issue, the buyer is responsible for returns while in transit. When return is authorized and warranty adjustment is allowed, credit will be issued to the buyer for transit insurance and return transportation cost, and if repair or replacement is made, the repaired or replacement unit will be shipped to the buyer at the GEC’s expense; provided however, that transportation costs in excess of an amount equal to the cost of transportation shall be borne by the buyer. The cost of transportation shall be deemed to be by the usual commercial method of shipment between the GEC’s plant and the destination to which the product was originally delivered.
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The following warnings pertain both to the GEC Platform Scales and the GEC communication control unit used as a part of the LPA400X Wireless Weighing System. Changes or modifications to either of these components of the LPA400X Wireless Weighing System not expressly approved by General Electrodynamics Corporation (GEC) will void the warranty and could preclude the owner's right to use the unit (based on regulatory laws).



Electrostatic Discharge (ESD)

Electrostatic discharge (static electricity) can have unpredictable adverse effects on any electronic device. Although the design of this product incorporates extensive ESD-related precautions, ESD can still cause problems. It is good practice to discharge static by pressing a grounded metal object before inserting cards or connecting devices.

La descarga electrostática (electricidad estática) puede tener efectos nocivos imprevisibles en cualquier dispositivo electrónico. Aunque el diseño de este producto incorpora precauciones ESD-relacionadas extensas, la lata de ESD todavía causa problemas. Es buena práctica descargar parásitos atmosféricos tocando un objeto puesto a tierra del metal antes de insertar tarjetas o de conectar los dispositivos.

La décharge électrostatique (l'électricité statique) peut avoir des effets nuisibles imprévisibles sur n'importe quel dispositif électronique. Bien que la conception de ce produit incorpore des précautions ESD-connexes étendues, le bidon d'ESD posent toujours des problèmes. Il est dans de bons habitudes de décharger la charge statique en pressant un objet au sol en métal avant d'insérer des cartes ou relier des dispositifs.

Elektrostatische Entladung (statisch Elektrizität) kann unvorhersehbare schädliche Wirkungen auf jeder elektronischen Vorrichtung haben. Obgleich das Design dieses Produktes umfangreiche ESD-in Verbindung stehende Vorkehrungen enthält, verursachen ESD Dose noch Probleme. Es ist gutes üblich, Static zu entladen, indem es einen geerdeten Metallgegenstand berührt, bevor es Karten einsetzt oder Vorrichtungen anschließt.



Servicing Information

When servicing the unit, the plug (connect power cable) is the disconnect device. Simply unplug the unit before servicing.

Al mantener la unidad, el enchufe (cable de fuerza conectar) es el dispositivo de la desconexión. Desenchufe simplemente la unidad antes de mantener.

En entretenant l'unité, la prise (câble de raccorder puissance) est le dispositif de débranchement. Débranchez simplement l'unité avant l'entretien.

Wenn er die Maßeinheit instandhält, ist der Stecker (die netzkabelverbindung) die Trennung Vorrichtung. Vor der Wartung trennen Sie einfach die Maßeinheit.



Battery Replacement

CAUTION! There is a risk of explosion if you replace the NiMH battery with an incorrect type. Only use the NiMH battery supplied with your unit or a replacement NiMH battery supplied, recommended, or approved by GEC.

PRECAUCIÓN! Hay un riesgo de la explosión si usted substituye la batería de NiMH por un tipo incorrecto. Utilice solamente la batería de NiMH provista de su unidad o una batería de NiMH del reemplazo provista, recomendada, o aprobada por GEC.

ATTENTION! Il y a un risque d'explosion si vous remplacez la batterie de NiMH avec un type incorrect. Utilisez seulement la batterie de NiMH fournie avec votre unité ou une batterie de NiMH de remplacement fournie, recommandée, ou approuvée par GEC.

VORSICHT! Bei Verwendung von NiMH Akkus, die nicht durch GEC geliefert, empfohlen oder genehmigt wurden besteht Explosionsgefahr! Benutzen Sie daher nur solche NiMH Akkus/Batterien, die mit dem Gerät geliefert wurden bzw. Ersatzakkus, die durch GEC geliefert, empfohlen oder genehmigt wurden.



Battery Disposal

Dispose of batteries in a safe manner. The following are general guidelines for the safe use and disposal of NiMH batteries:

- Replace a defective NiMH battery immediately as it could damage the unit.
- Do not throw the NiMH battery in trash that is disposed of in landfills as it contains heavy metals. Recycle or dispose the NiMH battery as required by local ordinances or regulations.
- Do not disassemble, incinerate, short-circuit the NiMH battery or throw it into a fire. It can explode and cause severe personal injury.
- Excessive discharge damages a NiMH battery. Recharge the NiMH battery when your unit indicates low battery power.

Disponga de las baterías de una manera segura. Los siguientes son pautas generales para el uso seguro y la disposición de las baterías de NiMH:

- Substituya una batería defectuosa de NiMH inmediatamente pues podría dañar la unidad.
- No lance la batería de NiMH él en la basura que se dispone en terraplenes mientras que contiene los metales pesados. Recicle o disponga la batería de NiMH de ella según los requisitos de ordenanzas o de regulaciones locales.
- No desmonte, no incinere, no cortocircuitos la batería de NiMH ni láncela en un fuego. Puede estallar y causar daños corporales severos.
- La descarga excesiva daña una batería de NiMH. Recargue la batería de NiMH cuando su unidad indica energía de batería baja.

Débarassez-vous des batteries d'une façon sûre. Ce qui suit sont les orientations à l'utilisation sûre et à la disposition des batteries de NiMH:

- Remplacez une batterie défectueuse de NiMH immédiatement car elle pourrait endommager l'unité.
- Ne jetez pas la batterie de NiMH il dans le détritius qui est débarassé en remblais pendant qu'il contient les métaux lourds. Réutilisez ou disposez la batterie de NiMH d'elle selon les exigences des ordonnances ou des

règlements locaux.

- Ne démontez pas, n'incinerez pas, ne court-circuitez pas la batterie de NiMH ou ne la jetez pas dans un feu. Il peut éclater et causer des blessures graves.
- La décharge excessive endommage une batterie de NiMH. Rechargez la batterie de NiMH quand votre unité indique la basse puissance de batterie.

Entledigen Sie sich Batterien in einer sicheren Weise. Die folgenden ist allgemeine Richtlinien für den sicheren Gebrauch und die Beseitigung der NiMH Batterien:

- Ersetzen Sie eine defekte NiMH Batterie sofort, da sie die Maßeinheit beschädigen könnte.
- Werfen Sie nicht die NiMH Batterie es im Abfall, der in den Aufschüttungen entledigt wird, während es Schwermetalle enthält. Bereiten Sie auf oder schaffen Sie die NiMH Batterie von ihr wie von lokalen Befehlen oder Regelungen gefordert ab.
- Bauen Sie nicht auseinander, äschern Sie ein, schließen Sie die NiMH Batterie kurz oder werfen Sie sie in ein Feuer. Es kann strenge Personenschäden explodieren und verursachen.
- Übermäßige Entladung beschädigt eine NiMH Batterie. Laden Sie die NiMH Batterie neu, wenn Ihre Maßeinheit niedrige Batterieleistung anzeigt.



Calibration & Repair

- All GEC equipment should be returned to the factory for recalibration, service and repair. Only factory trained, authorized personnel utilizing our state-of-art auto calibration test equipment AND knowledge should service your equipment. Any third (3rd) party calibration and or non-authorized service facility is highly discouraged, can void the warranty and is not likely to have proper test equipment causing irreparable damage to the scales. This may even translate to safety concerns with your aircraft. By returning your scales to the factory, you'll experience the maximum life from the equipment, guaranteed reliability and accuracy leading to a quicker and safer weight and balance.
- Todos los equipos GEC debe ser devuelto a la fábrica para su calibración , servicio y reparación . Sólo el personal de fábrica cualificado y autorizado la utilización de nuestro equipo de prueba de calibración automática del estado - de-arte y el conocimiento debe reparar su equipo . Cualquier tercer (3^o) de calibración partido y o centro de servicio no autorizado no es nada recomendable , puede anular la garantía y no es probable que tenga el equipo adecuado de la prueba que causa daños irreparables en las escalas . Esto incluso puede traducirse en problemas de seguridad con su avión . Devolviendo las escalas de la fábrica , usted experimentará la máxima vida útil del equipo , la fiabilidad y precisión garantizada que conduce a un peso más rápido y más seguro y el equilibrio.
- Tout le matériel GEC doit être retourné à l'usine pour le recalibrage , le service et la réparation . Seul le personnel formé en usine , autorisée en utilisant nos équipements de test state-of- art étalonnage automatique et la connaissance doivent entretenir votre équipement . Tous les troisième (3e) étalonnage du parti et ou un service non - autorisé est fortement déconseillée , peut annuler la

garantie et ne sont pas susceptibles d'avoir un équipement de test approprié causant des dommages irréparables à la balance. Cela peut même se traduire par des problèmes de sécurité avec votre avion . En retournant vos balances à l'usine , vous ferez l'expérience de la vie maximale de l'équipement , la fiabilité et la précision garantie conduisant à un poids plus

- Alle GEC Geräte sollten in die Fabrik zur Rekalibrierung , Service und Reparatur zurückgeschickt werden. Nur geschulte , autorisierte Personen unseren state- of-art automatische Kalibrierung Prüfgeräte und Wissen verwendet wird, sollten Sie Ihre Ausrüstung reparieren. Jede dritte (3.) Partei Kalibrierung und oder nicht autorisierte Serviceeinrichtung wird dringend davon abgeraten , kann die Garantie ungültig und wird wahrscheinlich nicht die richtige Testausrüstung zu haben irreparable Schäden an der Waage verursacht. Dies kann sogar zu Sicherheitsbedenken mit Ihrem Flugzeug übersetzen. Durch Ihre Waage in die Fabrik zurückkehren , werden Sie die maximale Lebensdauer der Geräte auftreten, garantiert die Zuverlässigkeit und Genauigkeit eine schnellere und sicherere Gewicht und Balance führt.

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Information and specifications contained in this document are subject to change without prior notice and do not represent a commitment on the part of GEC. However, GEC may provide changed material as separate sheets or addenda included with this manual or separately in the form of a change package, as it deems necessary.

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Section 1 General Description:

This section contains general information, components, configurations, and specifications for the GEC LPA400X Wireless Weighing System

1.1 Purpose and Scope of this Manual

The following paragraphs provide general information about the LPA400X Wireless Aircraft Weighing System, hereafter referred to as “Weighing System.” This manual contains information and instructions for operating the Weighing System. Section 3 of this manual provides information on how to operate the Weighing System scale platforms.

1.2 Use and Application of the System

The Weighing System is a portable platform scale designed to measure the weight of an aircraft. This system is the most accurate, portable aircraft weighing system in the world. By using multiple Weighing Systems, one for each load-bearing wheel (including tandem wheels), simultaneous weighing is possible to obtain the craft or vehicle total weight. Each Weighing System is capable of measuring loads up to its rated capacity.

- Self-contained scale with display at each platform
- Altitude, latitude correction
- Platforms that weigh only 45 lbs each.
- A complete wireless (optional) weighing system that includes:
 - Weighing platforms with antenna (optional)
 - Entry ramps
 - Spacers or bridges for tandem wheels
 - Safety end stops
 - GEC Windows Tablet (optional)
 - Transport/Storage Cart
 - Battery chargers
 - Operational Manual

1.3 Functional Description

The LPA400X Wireless Weighing System is a completely self-contained system including several separate components that work together to provide a repeatable highly accurate portable weighing capability for a wide range of aircraft types and sizes. The System consists of configurable Weighing System platforms with features, functions and display built into the platforms, accessory assemblies (consisting of ramps, bridges, and wheel stops), and a communication unit. The platforms are made of 6061-T6 aircraft grade aluminum hard anodized, for a lightweight and strong weighing surface.



1. Scale
2. Communication Unit
(may Vary)
3. Ramps (Not shown)

=

Figure 1-1 LPA400X Weighing System

1.3.1 Weighing System Configuration

Each platform can operate independently and has a graphic Organic Light Emitting Diode (OLED) display for reading in the dark or broad daylight. The OLED is far more advanced than a LCD (Liquid Crystal Display). Each platform is programmable for altitude and latitude corrections. The weighing system is accurate to $\pm 0.1\%$ or 5 lbs., whichever is greater, of the applied load regardless of the weighing surface. Off level hangars, tarmacs or imperfections in the hangar surface where the platforms are placed do not impact the accuracy or repeatability.

1.3.2 Communication Units

The Platform Scales digitally communicate with GEC Windows Weighing Software Application. These units control multiple LPA400X Platform Scales.



Figure 1-2 Communication Units (GEC Windows Tablet)

The communication unit provides instantaneous display of individual wheel weights, reaction points, total gross weight, center of gravity, and percent Mean Aerodynamic Cord (MAC). Weigh reports can be exported and shared in excel or text formats, and printed. See GEC-Windows-90000-1 software manual for more detailed information.

1.3.3 Platform

The Weighing System Platform is specifically designed to measure the load of an aircraft wheel resting anywhere on the weighing surface. The measured weight is exhibited on the OLED display that is easy to read in bright sunlight or total darkness. The internal micro controller directs all Weighing System functions.



Figure 1-3 Weighing System Platform

The platform assembly contains five load cells, one at each corner and one in the center of the platform so that a load on the platform is distributed equally to each of the load cells. Weight applied creates a pressure proportional to the applied weight. A highly accurate, rugged, piezo-resistive pressure transducer at each load cell converts the pressure into an analog voltage proportional to the weight.

1.3.4 Ramps, Bridges, and Wheel Stops

The ramps and bridges are designed to be configurable for multiple aircraft, and are constructed of high-strength, lightweight aluminum. The basic configuration consists of an approach ramp, platform, roll-off bridge, and wheel stop. A tandem configuration couples two platforms using a bridge.

The entire system is easy to transport from one plane to another, from hangar to hangar, and site to site. It can be transported in the back of a standard truck and assembled by one person.

1.3.5 Display

An OLED display was chosen for LPA400X for its superior readability, graphical representation, wide viewing angles, low power and self-illumination. This display does not require a backlight as the pixels displaying information are self-illuminated. Compared to LCD displays, this display has higher contrast and very wide viewing angles. The weight numbers displayed are about an inch in height and helps in better readability.

All information is displayed on the main screen without having to scroll through menus. The features displayed are Weight, Unit of Measurement, graphic representation and percentage of battery life, Latitude and Altitude information and the scale address.

When the system turns ON it goes through various diagnostics and displays if there is any error in the system. An internal diagnostic check is performed every 10 mins. This is to compensate for fluctuations due to circuit activation and temperature drift.



Figure 1-4 OLED Display

1.3.6 Controls

All operating controls and indicators are located on the panel of the weighing platform readout assembly (see Section 3, Operation). To operate remotely, the platforms have embedded transmitting/receiving antennas to communicate with the wireless controller unit (See GEC-Windows-90000-1 software manual for more detailed information).



Figure 1-5 Platform Controls and Indicators

1.4 Power Requirements

The LPA400X Wireless Weighing System operates internally on a nominal 9.6 VDC rechargeable battery that will operate a minimum of 24 hours between recharges. A universal external charger provided operates on 100-240 VAC 47-63 Hz. The external charger provided has several safety features to protect the internal circuitry. A world adapter kit is provided, with interchangeable adapter plugs with prongs that fit different electrical outlets around the world.

The system uses 100-240 VAC, 47-63 Hz charger for recharging and alternate power. The system can be used to weigh while the battery is being recharged. A low battery

detection circuit provides a signal that displays an alarm on the OLED when the battery voltage has become too low to operate the system.

1.5 System Specifications

Specification Type	Specification
System Capacity	0 to 30,000 lbs. (0 to 13,608pkgs) up to 45,000 lbs. (20,412kgs)
Graduation	1 / 5 / 10 lb (or 1 / 2 / 5 kg) Increments, User Selectable
Accuracy	$\pm 0.1\%$ or ± 5 lbs. whichever is greater (all based on applied load – platform slope 0° to 3°).
Overload Capacity	50% overload in rated lbs. total
Latitude Calibration	Calibrated for 45° North Latitude “0” Altitude (weight corrections factors must be applied for other latitude and altitudes -- refer to Section 3, Operation for details and a list of correction factors on Table 3-2)
Weighing Resolution	Display reads load in 1 lb. Increments from 0 to 50,000 lbs
Operating Power	
Internal	9.6 VDC battery pack(rechargeable NiMH)
External	110 VAC, 50/60 Hz (keep alive and recharge)
Typical Operating Time	
100-240 VAC, 47-63 Hz	Continuous
Internal Battery	24 hours nominal, continuous (fully recharge 4-6 hours)

Operating Environment	
Temperature	14°F (-10°C) to 122°F (50°C)
Relative Humidity	0% to 100% (non-condensing)
Storage Environment	
Temperature	-50°F (-55°C) to 158°F (70°C)
Relative Humidity	0% to 100% (non-condensing)
Physical Dimensions	
Weighing Surface Dimensions	
Width	22.75"
Length	16.25"
Height	1.5"
Weight	45 lbs

1.6 Physical Description

The LPA400X Weighing System consists of the following assemblies:

Table 1-1 Weighing System Components

Part Number	Description
LPA400X-00000-1-1/2/3 OR LPA400X-00000-2-1/2/3	30,000/40,000/45,000 lb. Wireless Wheel Weighing System
LPA400-60000-1	Entry Ramp
80977	Charger with universal adapter
A10002-4	GEC Windows Tablet with Smartstick (Optional)

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Section 2 Preparation for Use

This section contains information and instruction for unpacking, visually inspecting, cleaning, and assembling the system in preparation for use

2.1 System Unpacking, Visual Inspection, and Cleaning

Open the shipping container carefully to avoid damage to its contents. Remove packing material and the weighing system components from the container. Check all components against the shipping list to ensure that all items are present.

The LPA400X Wireless Weighing System is shipped complete with Wheel Weighing System Platform Scales and communication units fully charged. However, this section provides instructions on charging the unit and the communication unit to ensure the system is ready to use.

The System includes the equipment specified for the appropriate configuration based on your requirements. Refer to Section 1, Table 1-1 Weighing System Components .

If you order a special configuration or more equipment based on your specific needs, carefully unpack and check all items including Platforms, GEC Windows Tablet , USB SmartStick , and Ramps.

2.2 Weighing System Platform Preparation

The Platform, Ramps, Bridges, and Wheel Stops are shipped in their storage cart. The Platform battery is shipped pre-charged. Simply remove the Platform and perform unpacking and visual inspection per Paragraph 2.1 then set in place for use in weighing in the designated weighing area. Assemble with ramps, bridges, and wheel stops in accordance with paragraph 2.3 in accordance with the type of configuration needed.

2.3 Setup of Scales for Weighing

Setup the Platform Scales, Ramps, Bridges, Roll-Off Bridges, and Wheel Stops in accordance with the configuration requirements for the aircraft to be weighed. Pay close attention to selection of the weighing area and placement of the equipment.

Whether performing conventional or local weighing or remote weighing, the placement of equipment and preparation is fundamental to obtaining reliable results. Setup the equipment in accordance with the following paragraphs and Section 3 of this manual.

Note: For best results, when choosing a weighing area, choose area that is a long, flat, level, and hard surface with an approach long enough to accommodate any vehicles inducted for weighing.

Caution: *The electronic instruments of this system are not intended for outdoor storage. The instrumentation must be stabilized to ambient operating temperature for at least 15 minutes prior to operation.*

Move the mobile storage cart with Platforms and its Ramp sections, Bridges (as applicable), and Wheel Stops to the designated weighing area.

Designate a weighing area that is protected from wind and weather conditions, that has a smooth level surface, and that is capable of supporting the aircraft weight (such as a hangar) so that weight readings will not be adversely affected.

Move all equipment listed in Section 1, Table 1-1 to the appropriate weighing area.

Weighing System Components ,

2.3.1 Placement of Equipment:

Place, layout, and prepare the equipment for weighing an aircraft tire in accordance with the following procedures:

Note: Center the width of the ramp to the wheel.

1. With the aircraft in the weighing area, place the low end of the entry ramp against the wheel to be weighed.
2. Align the platform at the high end of the ramp.
3. Check alignment and security of entry ramp and the platform to ensure correct placement.
4. Repeat above steps for all the aircraft tires.

Section 3 Operation:

This section contains instructions and information for operating the LPA400X Portable Wireless Weighing System

3.1 Operation Description

The Portable Wireless Weighing System uses one or more LPA400X Weighing Platforms, access equipment, and a communication unit to perform weighing operations. Although the GEC communication unit can control the Weighing Systems remotely, the operator should note that each Weighing System platform is completely self-contained and can be operated from the platform to obtain weight readings.

3.1.1 Operational Modes

The operation procedures provided in this manual are divided into:

- A. Conventional or local operating procedure (without communication)
- B. Remote or wireless operating procedure (with communication).

3.1.2 Platform Scale Addresses

Each Wheel Weighing Platform Scale is a fully self-contained weighing unit and has a unique address for communicating with the wireless GEC communication controller unit. The address is set on the unit and can be from 1 to **29** (see Paragraph 3.4, Operating Controls and Indicators and 3.4.2, ZERO Switch) as long as it matches the platform on the GEC Windows Tablet.

3.1.3 Menu Items and Navigation

The menu list is accessed by pressing both the LB/KG and ZERO keys at the same time. Once you have entered Menu mode, you will see the following options by pressing the ZERO or LB/KG key to scroll through the menu list. Pressing ON/OFF will select the menu item that you have displayed. This method is used throughout the menu mode.

- Test Load Cells
 - Use the ZERO key to cycle through the load cell list, press ON/OFF to select the load cell output for viewing
- Cell Calibration
 - Allows user to initiate calibration of individual load cells. See Calibration procedure for more information.
- Deck Calibration
 - *Allows user to initiate calibration of platform deck.*

CAUTION: Use GEC Authorized Calibration Labs, Equipment, Procedure & Trained Personnel ONLY. Non-compliance can result in inaccurate weighing's and will void manufacturer's warranty.

- Graduations
 - The scale can be set to 1, 5, 10 Lbs increment or 1, 2, 5 Kgs increment.
- Air Temp Display
 - The scale will display the current ambient temperature in Degrees C.
- See Load Balance
 - The scale will display the weight distribution by individual load cells underneath the platform.
- LAT / ALT Entry
 - User can manually configure local Latitude and Altitude settings to compensate for gravitational correction factors. Display will show if compensation is in effect. The ZERO key changes the value, and ON/OFF saves the modified values. See Table 3-2 for correction factors.

CAUTION: Incorrect Latitude / Altitude settings may result in inaccurate weighing's. Check your local Latitude / Altitude co-ordinates for best results.

- Exit Utilities

- Select this item to return to normal operational mode.

3.2 Wheel Weighing Platform Scales Features

Each LPA400X Wheel Weighing Platform Scale is fully self-contained and can be controlled locally or with the remote GEC handheld communication controller unit. Each Platform Scale has all the operating controls and indicators needed for local control on the readout panel positioned on the side of the platform near the handles. Operating messages, including battery condition, are provided on the built-in OLED display on the Platform Scale control panel. The Platform Scales are operated from an internal 9.6 VDC battery pack that will allow up to 24 hours of continuous use. The Weighing System Platforms also can be operated from 100-240 VAC, 47-63 Hz supplied through the battery charging adapter from a conventional facility power source.

3.3 Platform Scales Power Management

The following paragraphs provide information on the battery power supply, battery indications, power management, power saving feature, and battery recharging.

3.3.1 Low Battery Detection

Low Battery Detection: The Weighing System Platform +9.6 VDC power is applied through a low battery detection circuit. If the battery voltage drops to 10% of battery capacity, the processor will display a “LOWBAT” indication on the OLED display continuously. When the “LOWBAT” message appears, the Weighing System Platform can still be used for a short period of time but will power off automatically to protect the battery from being completely discharged. The Platform will need to be recharged.

3.3.2 Power Saving Feature

Each Weighing System Platform (“scale”) has an inactive timeout feature. If the weight on the platform is less than 500 pounds for 30 minutes or more, the Weighing System Platform will automatically power off to conserve the battery charge. The display has a low power mode, in which the fonts are reduced in size on the display. This mode is activated if there is no activity on the scale or if the weight on the scale for 10 minutes is less than 500 pounds. If the weight goes over 500 pounds or if LB/KG or ZERO buttons are pressed the display goes back to its original bigger font size with all the indications displayed. In low power mode the platform is still fully functional, however only the weight information is displayed.

3.3.3 Battery Recharging

Battery Recharging: The external power supply is a +15 VDC wall adapter unit that delivers as much as 1.0 A when the charger is connected. If the battery charge is very low, in an emergency situation, the scale can be operated from the +15 VDC charger. The battery charge time will be prolonged in this case.

3.3.3.1 Battery Charge Indications

Battery Charge Indications: When connected, the following light emitting diode (LED) indications will occur to provide the status of the battery charging in the charger:

RED: The batteries are charging.

LED OFF: The battery has been fully charged.

3.4 Wheel Weighing Platform Scales Operating Controls and Indicators

Operating controls and indicators are located on panel of the Wheel Weighing System Platform Scales readout assembly. **Figure 3-1** illustrates the location and provides the function for each control and indicator. Table 3-1 lists the controls and indicators pointed out in **Figure 3-1**. Various display messages and alarms are listed in Paragraph 3.7 **Error Messages**.



Figure 3-1 Platform Operating Controls and Indicators

Table 3-1 Platform Controls and Indicators

Item No.	Control/Indicator Name or Label	Function
1.	Display	Organic light emitting diode (OLED) graphics display indicates in pounds/kilograms the load on the Weighing System and displays messages pertaining to the operating status of the Weighing System.
2.	ZERO	Pushing in on this switch tares the weight on scale. If zeroed with weight on scale, removing the load will result in a negative weight being displayed.
3.	ON/OFF	Applies or removes power to unit. When powered ON the red LED ring on the ON/OFF button is lit.
4.	LB/KG	Toggles units of measurement between pounds and kilograms.
5.	RECHARGE Jack	Connection for the +15VDC charger.
6.	Embedded Antenna	Transmits and receives communication signals between GEC wireless unit and Platform scale.

3.4.1 Display (Item 1)

Display: Power ON is indicated when the LPA400X Digital Weighing Unit display is activated it shows a message and the ON/OFF button lights up. The Weighing Unit (“Weighing System”) has an OLED graphics display. It has 256x64 pixels to display messages. The displayed characters are blue and are 0.8 inches (20.32) in height.

The display will do a calibration check every 10 minutes once the Weighing System is turned on. This corrects for fluctuations in circuit excitation or temperature drift. The characters are used to display weight, description, and error messages.

An under zero condition is indicated by a minus sign to the left of the weight data in the display. An overload condition is indicated by a special message (over/under range) if the weight of the displayed channel exceeds the load cell capacity.

3.4.2 ZERO Switch (Item 2)

The ZERO switch, ON/OFF, and the LB/KG switch are used to set the unique scale address for wireless communications as well as zeroing tare weights.

3.4.2.1 Scale Addressing

Scale Addressing: Each scale must have a unique communications address for communicating to the wireless communication unit. The address can be from 1 to 29 and must match the scale position and address for the aircraft layout on the wireless communication unit. The ZERO switch is used to set the scale address as follows:

1. When the Bus address is being displayed during the scale power up sequence, the user should press and hold the ZERO key. This will allow user to change the bus address, each press of the ZERO key thereafter will increment the address.
2. After reaching the correct address number using the ZERO switch, press the ON/OFF button to set the address.

3.4.2.2 Zero Calibration (Tare)

The zero calibration (Tare) of this system is digitally executed and is controlled by the zero switch. Under normal conditions, when this switch is pushed, the message "CALIBRATION ZERO" will be displayed for one second after which the display will return to its previous weight message now indicating an applied load of zero pounds.

3.4.3 ON/OFF Switch (Item 3)

Power ON is indicated when the Digital Weighing Unit display is activated and shows a message. The ON/OFF switch applies power to the unit when pressed and removes power when pressed again.

The ON/OFF switch button is used together with the ZERO and LB/KG switch buttons to enter the Menu mode and then navigate through the menu options.

If the weight on the scale is less than 500 pounds for 30 minutes or more, the Weighing System will automatically shut off in order to preserve battery power.

The Weighing System also uses the automatic shut-off feature to conserve the battery condition. The 2000 mA*H battery pack is designed to operate for 24 hours continuously without recharge. As the +9.6 VDC charge is depleted, the voltage drops. Each scale is provided with an external battery charger which has overload protection, short circuit protection and input protection.

3.4.4 LB/KG Switch (Item 4)

The LB/KG switch is used to toggle the unit of weight being displayed between pounds and kilograms. The LB/KG switch button is used together with the ZERO and ON/OFF switch buttons to enter and navigate the menu options.

3.4.5 RECHARGE Jack (Item 5)

The Recharge Jack is used to connect the charger to recharge the battery to operate the Weighing System.

3.4.6 Embedded Antenna (Item 6) --- (Wireless Communication System)

The antenna is used to receive and transmit communications signals to and from the wireless GEC communication unit and to and from the Weighing System to the GEC communication unit. The antenna is embedded in the scale and operates on 2.4 GHz RF frequency.

3.5 Preparation for Operation

Prepare the aircraft and the system for operation in accordance with the following paragraphs.

3.5.1 Prepare the Weighing System

Prepare the Portable Wireless Aircraft Weighing System in accordance with Section 2. of this manual.

3.5.2 Positioning the Aircraft

Position the aircraft for weighing and position the Weighing Systems Platforms in accordance with the following:

Caution: *The electronic instruments of this system are not intended for outdoor storage. The instrumentation must be stabilized to ambient operating temperature for at least 15 minutes prior to operation.*

Move the mobile storage cart with Weighing System platforms and its ramp sections, bridges (as applicable), and wheel stops to the designated weighing area.

Designate a weighing area that is protected from wind and weather conditions, that has a smooth level surface, and that is capable of supporting the aircraft weight (such as a hangar) so that weight readings will not be adversely affected.

1. Move the weighing system components to the designated weighing area and prepare the area for weighing by properly positioning components (refer to Section 2. Preparation for Use, 2.2, Weighing System Platform Preparation and 2.3, Setup of Scales for Weighing).
2. Press the ON/OFF Switch button.
3. Depress the LB/KG Switch button to toggle between pounds and kilograms; select the appropriate measuring unit for the job.

Caution: *Each wheel must be within the designated weighing area on the platform. DO NOT proceed until all wheels are checked for proper placement and are not pressing against the wheel stops, bridges or ramps. Refer to Figure 3-2 for tire placement.*

4. Carefully tow the aircraft up the ramps and onto the wheel weighing platform assemblies.

Caution: *When weighing an aircraft with tandem wheels, place the platforms, ramps, bridge, and stop at the main gear tire. Tow the aircraft onto the platform until the forward main gear tire is in position on the first platform (platform nearest to the ramp). Next place the nose gear platform, ramps, bridge, and wheel stop in position. Continue to tow the aircraft into the weighing position.*

5. Tow the aircraft onto the roll-off bridge, and then push the aircraft back onto the weighing platform for proper positioning.
6. Repeat Step 4 twice (for a total of 3 times) to ensure proper positioning.

Caution: *If using chocks behind the aircraft wheels during weighing, the weight of the chock must be zeroed out at the readout on the platform. This is obtained by placing the chock on the platform then pushing the ZERO Switch button. Remove the chock and the display will read the chock weight as negative.*

7. With the aircraft off the wheel weighing platform assemblies for approximately 3 minutes, push the ZERO Switch button on each Platform Weighing System readout assembly OR on the wireless communication unit.
8. Repeat Step 4.
9. Remove the tow bar from the aircraft.

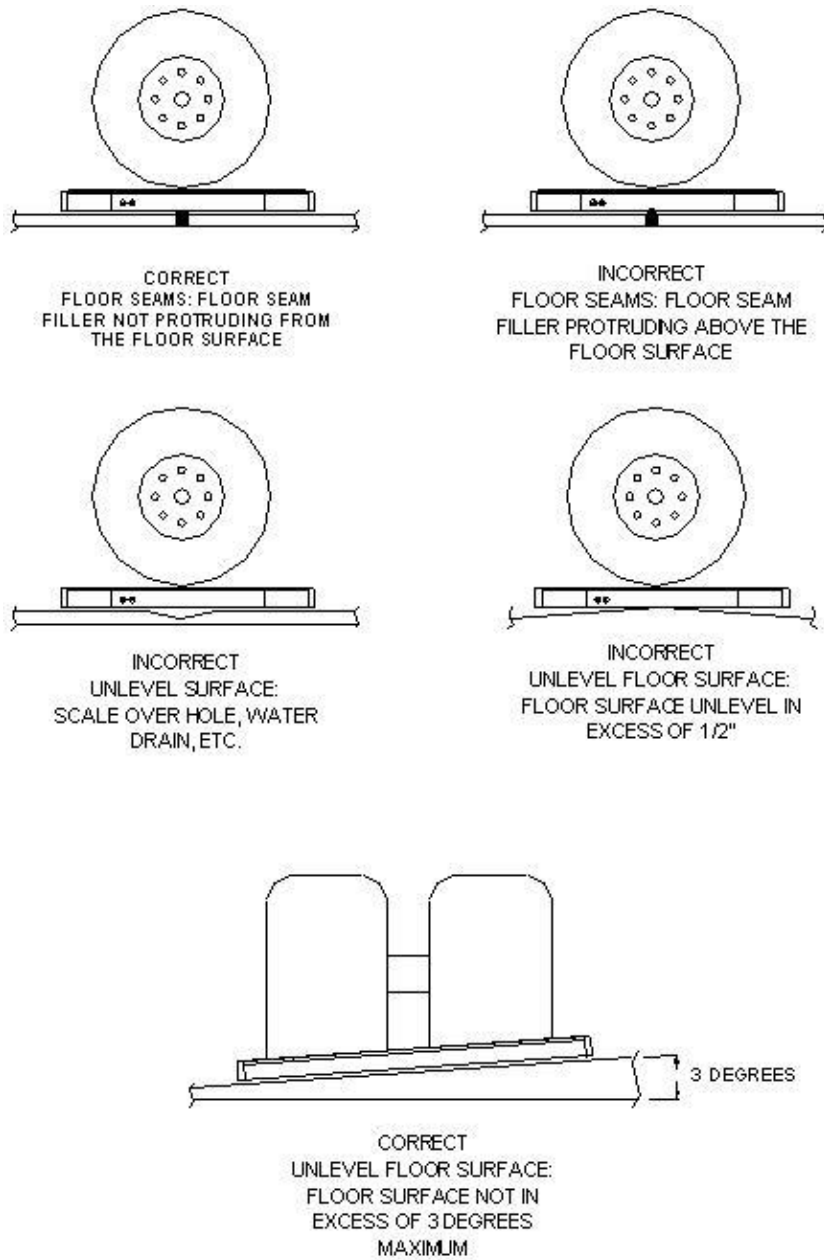


Figure 3-2 Aircraft Wheel Placement with Weighing System

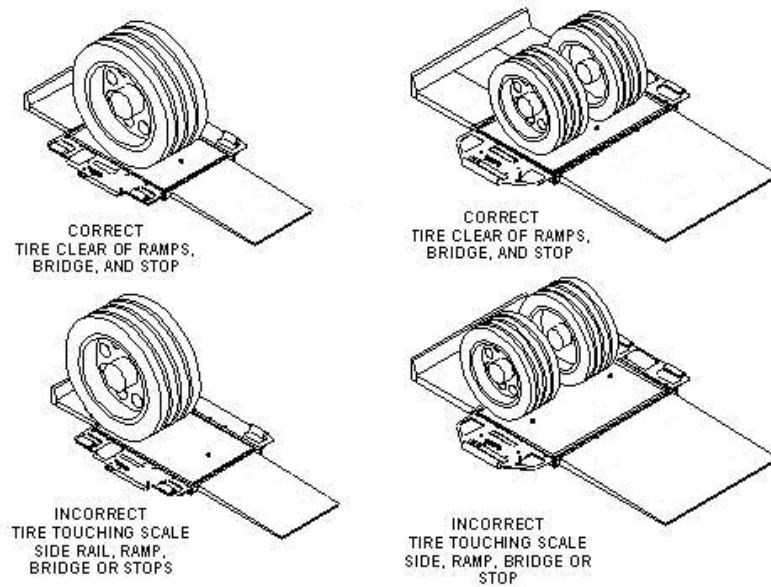


Figure 3-3 Wheel Placement on Weighing System Platforms

**NOTE: The wheel placement on GEC platform is not critical as with other manufacturer's equipment. The entire platform is an "active weighing surface" needing no painted area or sweet spot to ensure guaranteed accuracy and repeatability.*

3.6 System Operation

After system and aircraft preparation (refer to 3.5), accomplish system operation and aircraft weighing in accordance with the following procedures.

3.6.1 Conventional Operation

In conventional operation, the scales are controlled and read individually and locally to obtain the weight readings.

Note: See Platform Scales Operating Controls and Indicators. See Paragraph 3.4, Wheel Weighing Platform Scales Operating Controls and Indicators.

All operating controls and indicators for conventional operation are located on the panel of each weighing platform readout assembly (refer to Paragraph 3.4, Platform Weighing System Operating Controls and Indicators). The following paragraphs provide procedures for using the panel controls and indicators to accomplish weighing operation at the Weighing System Platforms. The GEC windows software manual (GEC-Windows-90000-1)

provides procedures for accomplishing weighing using the system's wireless capability remotely with the software.

3.6.2 Weighing the Aircraft

Weigh the aircraft in accordance with Technical Order (T.O) and the following steps:

1. Level the aircraft in accordance with the aircraft-specific procedures.
2. After leveling the aircraft, read and record the weight indicated on the display at each Platform Weighing System readout assembly.
3. Sum the weight readings to obtain a total.

Note: Obtain information on latitude and altitude for applying the correction factor from the tower. See Table 3-2, Correction Factors

4. Apply latitude and altitude correction factor per the location.
5. Back the aircraft off of the Platform Scales and ramps.

Note: The following 3-minute rest period provides ample time to return to their pre-weighing state.

If zero return is (+) plus, subtract the indicated zero offset from the wheel Platform Scale indicated weight when the aircraft was weighed.

If zero return is (-) minus, add to the wheel Platform Scale indicated weight when the aircraft was weighed.

6. Check the zero return of each wheel Platform Scale.
7. Weighing is now completed; press the ON/OFF Switch button at each Platform Scale readout assembly.
8. Remove the ramps, bridges, wheel stops, and the weighing platforms from the weighing area and stow them in their proper places in the mobile storage container.
9. Return the mobile storage container and its contents back to the designated storage area.

3.6.3 Correction Factors

Each platform is calibrated at 0 foot elevation and 45 degree Latitude. Local Latitude/ Altitude can be set on each platform before weighing to automatically correct for gravitational effects. If using wireless communication, leave the scales at factory default of 0 feet, 45 N and set Latitude/Altitude on Wireless communication unit.

If no corrections applied during weighing, correction factors must be applied for latitude and elevation. Corrections are applicable to altitudes from 0 to 10000 feet Above Sea Level (AGL). *Note: NOT Mean Sea Level (MSL).* The Weighing System is calibrated to standard gravity, which is equal to 980.665 cm/sec (32.174 ft/sec) at sea level. To obtain the actual weight, determine the latitude and elevation where the scale is used then round to the nearest latitude and elevation correction factor show in Table 3-2 Correction Factors for Weighing Locations at Each 5 Degrees Latitudes and Elevations 0 to 10000 Feet AGL

Table 3-2 Correction Factors for Weighing Locations at Each 5 Degrees Latitudes and Elevations 0 to 10000 Feet AGL

°Latitude (5° Steps)	Elevation Above Sea Level In Feet (1000' Increments)										
	0	1000	2000	3000	4000	5000	6000	7000	8000*	9000*	10000*
0	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	1.0034	1.0035	1.0036	1.0037
5	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	1.0034	1.0035	1.0036
10	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033	1.0034	1.0035
15	1.0023	1.0024	1.0025	1.0026	1.0027	1.0028	1.0029	1.0030	1.0031	1.0032	1.0033
20	1.0021	1.0022	1.0023	1.0024	1.0025	1.0026	1.0026	1.0027	1.0028	1.0029	1.0030
25	1.0017	1.0018	1.0019	1.0020	1.0021	1.0022	1.0023	1.0024	1.0025	1.0026	1.0027
30	1.0014	1.0015	1.0016	1.0017	1.0018	1.0019	1.0019	1.0020	1.0021	1.0022	1.0023
35	1.0009	1.0010	1.0011	1.0012	1.0013	1.0014	1.0015	1.0016	1.0017	1.0018	1.0019
40	1.0005	1.0006	1.0007	1.0008	1.0009	1.0010	1.0011	1.0012	1.0013	1.0014	1.0015
45	1.0000	1.0001	1.0002	1.0003	1.0004	1.0005	1.0006	1.0007	1.0008	1.0009	1.0010
50	0.9996	0.9997	0.9996	0.9998	1.0000	1.0001	1.0002	1.0003	1.0004	1.0005	1.0006
55	0.9991	0.9992	0.9993	0.9994	0.9995	0.9996	0.9997	0.9998	0.9999	1.0000	1.0001
60	0.9987	0.9988	0.9989	0.9990	0.9991	0.9992	0.9993	0.9994	0.9995	0.9996	0.9997
65	0.9983	0.9984	0.9985	0.9986	0.9987	0.9988	0.9989	0.9990	0.9991	0.9992	0.9993
70	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985	0.9986	0.9987	0.9988	0.9989	0.9990
75	0.9978	0.9979	0.9980	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985	0.9986	0.9987
80	0.9976	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984	0.9985
85	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984

°Latitude (5° Steps)	Elevation Above Sea Level In Feet (1000' Increments)										
	0	1000	2000	3000	4000	5000	6000	7000	8000*	9000*	10000*
90	0.9974	0.9975	0.9976	0.9977	0.9978	0.9979	0.9980	0.9981	0.9982	0.9983	0.9984

Note: To obtain actual weight, determine latitude and elevation where the scale is being used. Next, round to the nearest latitude and elevation shown on the chart. * Extrapolated values.

3.7 Error Messages

The following paragraphs describe error messages that may appear in the display due to various system or operator actions.

3.7.1 Zero Range Error

Zero Range Error: The following describes the zero range error prompt.

Note: This is a transient message; the previous display will return after one (1) second.

The message “RANGE ERROR K (Ch)” is displayed when the operator attempts to tare out a weight which is outside of the zero capture range.

3.7.2 Weight Motion Error

Weight Motion Error: The following describes the motion error prompt:

Note: This is a transient message; the previous display will return after one (1) second.

The message “MOTION ERROR (Ch)” will be displayed if the operator attempts to read an applied load which is changing at a rate of more than ± 3 pounds in a half-second.

3.7.3 Auto Calibration and Temperature Check

The instrument cycles through a calibration check and a temperature check approximately every 10 minutes.

1. In the auto calibration check mode, the instrument checks the test voltage for any change of the amplifier and other circuitry to verify that it has not changed. If any change is indicated, it makes the necessary adjustments automatically.

2. In the temperature check mode, the instrument circuitry reads a temperature probe and scales the reading as determined by previous temperature affects to the circuitry.

Section 4 Maintenance and Troubleshooting

This section provides information on proper methods for preventive maintenance and troubleshooting of malfunctions.

4.1 Inspection and Preventive Maintenance

Operators of the system should perform regular visual inspection and preventive maintenance of the system. It is recommended that the system be cleaned and inspected on a weekly basis.

4.1.1 Recommended Tools and Equipment

Standard hand tools and electronics test equipment adequate to troubleshoot digital and micro volt-level analog circuitry is required to maintain the system. Special equipment is required for system calibration; refer to paragraph 4.5 for Calibration procedure.

4.1.2 Cleaning and Inspection

Clean and inspect the system periodically to reduce deterioration of the system components and check for visible physical damage.

4.1.2.1 Cleaning

System Cleaning: Clean the system in accordance with the following:

Caution: In the following procedures, DO NOT use solvents or cleaning fluids of any type. Damage to the system components may result from using solvents or cleaning fluids. Instead, use warm water and a clean, dry lint-free cleaning cloth.

Note: Remove electrical components if necessary to prevent them from getting wet.

1. Clean the exterior surfaces with a damp, lint-free cloth, ensuring that the cloth is wrung-out to the extent that no moisture will drip. Remove electrical components if necessary to prevent them from getting wet.
2. Clean interior surfaces in the same manner as that for exterior surfaces.
3. Allow all surfaces to air dry prior to re-assembly.

4.1.2.2 Inspection

Visual Inspection: Visually inspect the system as follows:

Caution: Any cables that have cuts in the outer insulation should be replaced.

1. Inspect all system cables for cuts and nicks.

Caution: Replace all bent or missing pins.

2. Inspect all cable connectors for bent or missing pins, foreign object debris (FOD), and evidence of shell damage.

4.1.2.3 Schedule

Table 4-1 lists preventive maintenance items and the suggested frequency for inspection and maintenance.

Table 4-1 Preventive Maintenance Items and Suggested Schedule

Inspect Items	Inspection Criteria	Frequency	Corrective Action
Cable Connectors, instrument connectors, and platforms	Bent or missing pins, foreign object damage (FOD), and shell damage	Every use or weekly	Clean cable connectors, instrument connectors, and platforms with aerosol electronic contact cleaner. Replace bent or missing pins and connector shells or connectors, as required.
Cables	Cuts, abrasions, nicks	Every use or weekly	Replace any cables that have cuts in the outer insulation
Platform Scales	Signs of fluid loss	Every use	Contact Manufacturer

Inspect Items	Inspection Criteria	Frequency	Corrective Action
		or weekly	
Platform Scales	Accuracy	Annually, or as required	Calibrate the scales using the proper calibration equipment and criteria, if available; otherwise have scales calibrated at an authorized calibration facility or return to GEC for calibration.
Internal instrument and platform components	Form, fit, and functional integrity	Annually, or as required	Replace components, as required; replace instruments or scales, as required.

4.2 Troubleshooting

System Troubleshooting: Troubleshoot the system in accordance with the guidelines provided in Table 4-2 to determine the most likely cause(s) of malfunctions and the recommended corrective actions.

Table 4-2 Operator Troubleshooting Guidelines

Malfunction or Symptom	Probable Cause	Corrective Action
No indication when ON/OFF switch is in the ON position	Battery Discharged or Dead AC power not connected	Connect external power Adapter to a 120 VAC, 60 Hz power source (or if internally configured for it, to 230 VAC, 50/60 Hz)
“LOWBAT” indication	Battery Discharged Damaged components	Connect external power cord to Weighing System and to 110VAC, 50/60 Hz power source. Recharge batteries.
Erroneous weight indications	Internal circuitry malfunction noise induced into system	Return scale to GEC for repair.
Erroneous weight indications	Pinched Wire	Repair Wire.
Communication error	Signal lock	Position POWER SWITCH to the OFF position; wait 30 seconds, then position POWER SWITCH to the ON position.
Erratic display	Lost operating parameter	Reprogram unit
Physical evidence of leaking load cell.	Unit dropped, shock loaded or defective cell	Replace with spare; return scale to GEC for repair.

Malfunction or Symptom	Probable Cause	Corrective Action
Erratic Operation	Defective unit	Replace with spare; return scale to GEC for repair.

Note: Defective load cells or transducers may give no physical evidence of defect. Suspected load cells or transducers must be load-tested at the factory under laboratory conditions to ensure weighing accuracy. Return units with suspect load cells to GEC's factory for repair.

4.3 Platform Scales Battery Replacement

Typically NiMH batteries can be recharged hundreds of times, potentially allowing them to be equivalent to hundreds of alkaline batteries in total service over their life time. However, battery life is limited to 5 years or less and it may become necessary to replace the battery Pack in your platform weighing system.

CAUTION: Use only rechargeable AA NiMH (2000-2400 mAh) batteries. It is recommended to replace all 6 batteries at once and not mix and match used batteries with new. Charging with other type batteries will damage critical components.

If the batteries will no longer charge, replace the battery as follows:

1. Remove 2 captive screws (indicated by 1 and 2), visible on the front side of the cover, by turning them in anticlockwise direction.



Figure 4-1 Platform Scale Battery Access Cover Removal

2. Remove Battery holder cover by gently pulling it out.



Figure 4-2 Platform Scale Battery Removal

3. Remove 6 AA battery pack (3).
4. Replace batteries and push the battery cover inside.
5. Once the battery cover is completely pushed inside tighten the two screws (1, 2) by turning them in clockwise direction.

4.4 Calibration

See TP-LPA400X-001 Field Calibration Procedure, LPA400X Wireless Weighing Platform.

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Appendix B: Terms, Acronyms, and Definitions

Arm (moment arm) - is the horizontal distance in inches from the reference datum line to the center of gravity of the item. The algebraic sign is plus (+) if measured aft of the datum, and minus (-) if measured forward of the datum.

Center of gravity (c.g.) - is the point about which an aircraft would balance if it were possible to suspend it at that point. It is the mass center of the aircraft, or the theoretical point at which the entire weight of the aircraft is assumed to be concentrated. It may be expressed in percent of MAC (mean aerodynamic chord) or in inches from the reference datum.

Center of gravity limits - are the specified forward and aft or lateral points beyond which the c.g. must not be located during takeoff, flight or landing. These limits are indicated on pertinent FAA aircraft type certificate data sheets, specifications, or weight and balance records, and meet the requirements of Federal Aviation Regulations.

Center of gravity range - is the distance between the forward and aft c.g. limits indicated on pertinent aircraft specifications

Datum (reference datum) - is an imaginary vertical plane or line from which all measurements of arm are taken. The datum is established by the manufacturer. Once the datum has been selected, all moment arms and the location of permissible c.g. range must be taken with reference to that point.

Delta - is a Greek letter expressed by the symbol Δ . It is used in weight and balance calculations, as well as in other forms of mathematics, to indicate a change of values. As an example, delta c.g. indicates a change (or movement) of the c.g.

Fuel load - is the expendable part of the load of the aircraft. It includes only usable fuel, not fuel required to fill the lines or that which remains trapped in the tank sumps.

LEMAC - is the leading edge of the mean aerodynamic chord.

Mean aerodynamic chord (MAC) - is the average distance from the leading edge to the trailing edge of the wing. The MAC is specified for the aircraft by determining the average chord of an imaginary wing which has the same aerodynamic characteristics as the actual wing.

Mean Sea Level (MSL) - is the average (mean) height of the sea, with reference to a suitable reference surface. The term above mean sea level (AMSL) refers to the elevation (on the ground) or altitude (in the air) of any object, relative to the average sea level.

Moment - is the product of the weight of an item multiplied by its arm. Moments are expressed in pound-inches (lb-in) or inch-pounds. Total moment is the weight of the aircraft multiplied by the distance between the datum and the c.g.

Moment index (or index) - is a moment divided by a constant such as 100, 1,000, or 10,000. The purpose of using a moment index is to simplify weight and balance computations of large aircraft where heavy items and long arms result in large, unmanageable numbers.

Reduction factor - is the constant which when divided into a moment results in an index. Reduction factors of 100, 1,000, or 10,000 are used to simplify weight and balance calculation processes.

Standard weights - have been established for numerous items involved in weight and balance computations. These weights are not to be used in lieu of available actual weights. Standard passenger weights should not be used in computing the weight and balance of charter flights and other special services involving the carriage of special groups; e.g., athletic groups, etc.

Station - is a location in the aircraft which is identified by a number designating its distance in inches from the datum. The datum is, therefore, identified as station zero. The station and arm are usually identical. An item located at station +50 would have an arm of 50 inches.

Useful load - is the weight of the pilot, copilot, passengers, baggage, usable fuel, and drainable oil. It is the empty weight subtracted from the maximum allowable takeoff weight. This term applies to general aviation aircraft only.

Weight, basic operating - is the weight of the aircraft, including the crew, ready for flight but without payload and fuel. This term is only applicable to transport aircraft.

Weight, empty - consists of the airframe, engines, and all items of operating equipment that have fixed locations and are permanently installed in the aircraft. It includes optional and special equipment, fixed ballast, hydraulic fluid, and undrainable (residual) fuel and oil. When oil is used for propeller feathering, such oil is included as residual oil.

Weight, maximum landing - is the maximum weight at which the aircraft may normally be landed. The maximum landing weight may be limited to a lesser weight when runway length or atmospheric conditions are adverse.

Weight, maximum takeoff - is the maximum allowable weight at the start of the takeoff run. Some aircraft are approved for loading to a greater weight (ramp or taxi) only to allow for fuel burnoff during ground operation. The takeoff weight for a particular flight may be limited to a lesser weight when runway length, atmospheric conditions, or other variables are adverse.

Weight, maximum allowable zero fuel - is the maximum weight authorized for the aircraft not including fuel load. Zero fuel weight for each particular flight is the operating weight plus the payload.

Weight, ramp or taxi - is the maximum takeoff gross weight plus fuel to be burned during taxi and run up.

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