1938

Technical Manual
and
Parts Catalog

INTRODUCTION

This publication is provided solely as a guide for individuals who have received METTLER TOLEDO Technical Training in servicing the METTLER TOLEDO product.

Information regarding METTLER TOLEDO Technical Training may be obtained by writing to:

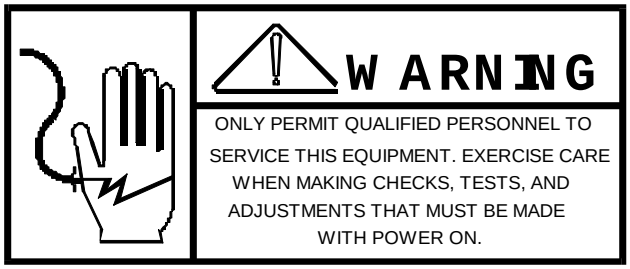
METTLER TOLEDO
Training Center
P.O. Box 1705
Columbus, Ohio 43216
(614) 438-4400

PRECAUTIONS

- **READ** this manual before operating or servicing this equipment.

- **ALWAYS REMOVE POWER** and wait at least 30 seconds **BEFORE** connecting or disconnecting any internal harnesses. Failure to observe these precautions may result in damage to, or destruction of the equipment.

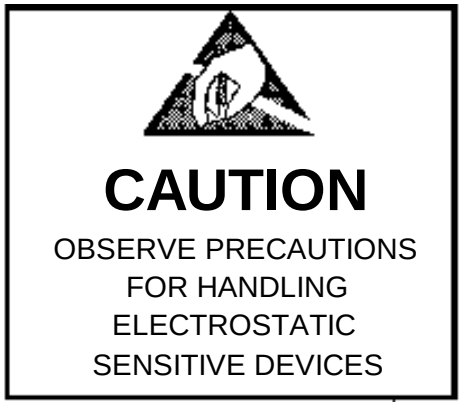
- **ALWAYS** take proper precautions when handling static sensitive devices.



- **DO NOT** connect or disconnect a load cell scale base to the equipment with power connected or damage will result.

- **SAVE** this manual for future reference.

- **DO NOT** allow untrained personnel to operate, clean, inspect, maintain, service, or tamper with this equipment.



- **ALWAYS DISCONNECT** this equipment from the power source before servicing.

- **CALL** METTLER TOLEDO for parts, information, and service.

CONTENTS

1. GENERAL DESCRIPTION

1.1 OVERVIEW

The Toledo Model 1938 is a battery operated high resolution bench scale. It is designed for general purpose industrial or commercial environments, with an emphasis on easy operation and portability. The Model 1938 utilizes heavy duty metal construction for durability, and microprocessor based electronics incorporated in the patented high resolution Toledo DigiTOL™ Load Cell. The high resolution load cell provides maximum sensitivity and accuracy for either parts counting or straight weighing. T he six key membrane keyboard uses graphic symbols to aid the operator.

Optional accessories available for the Model 1938 include an AC Wall Transformer kit, an adjustable height Stand Kit, and Stand Casters.

1.2 FEATURES

- Battery operation allows maximum portability and easy setup.
- Highly visible low power Liquid Crystal Display
- Sleep mode automatically shuts the electronics off and conserves battery power.
- Keyboard setup and calibration minimizes installation time and expense.
- Keyboard selectable sample reference.
- Built-in RS232 data input and output allows connection to printer or host computer.
- Display can be column mounted, base mounted or wall mounted.
- Optional wall transformer can be used in place of batteries when AC power is available.

1.3 STATEMENT OF PERFORMANCE

The performance of any count-by weighing scale is dependent on uniformity of weight per piece, number of pieces in the sample, individual piece weight, and the percent of rated load placed on the scale. In application, count accuracy is also dependent upon the ability of the operator to read and record the count information accurately.

This high resolution counting indicator significantly reduces count errors induced by the operator. In most applications, it provides better practical accuracy than either hand counting or using mechanical techniques. Assuming proper capacity selection, count accuracy of ± one part is attainable in many specific cases. However, the most significant variable is uniform weight of the parts to be counted. This variable is not controllable by the scale system.

1.4 ACCURACY CONSIDERATIONS

Counting accuracy is determined primarily by these factors:

1. Digital resolution of the sample weight.
2. Piece to piece weight variation.

Item 1 is the most frequent cause of parts counting inaccuracy because of the user's desire to count and handle the minimum number of sample pieces. For example, with a sample weight of 0.02% of full scale capacity, sample weight resolution is ± one part in 100, so counting error is ± 1.0% at best. Use of the 0.1% or 0.05% minimum sample weight will significantly improve counting accuracy.

Item 2 is not under control of the parts counter, but is a factor which merits serious attention by the user. The overall count accuracy can be no better than the piece variation, and may be much lower if the sample is not representative of the average piece weight.

2. SYSTEM DESCRIPTION

2.1 INTERNAL FUNCTIONS

The Toledo Model 1938 consists of three major blocks. These are:

2.1.1 DIGITAL LOAD CELL

The digital load cell used in the Model 1938 is the patented high resolution Toledo DigiTOL™ Load Cell. The digital load cell contains all the Analog to Digital circuitry and a microprocessor. The Digital Load Cell processes and transmits weight data, controls scale functions, provides output to a printer, accepts input commands from a host device, and stores softswitch settings.

2.1.2 DISPLAY PCB

The display uses a low power custom liquid crystal display (LCD). Digits are 17.5 mm in height. In addition to displaying data, the Display PCB accepts input data from the keyboard for transmission to the digital load cell, regulates the optional wall transformer input power, and contains the solid state on/off switching circuitry.

2.1.3 POWER SUPPLY

The standard power supply consists of six 1.5 volt alkaline D-cell batteries connected in series to supply 9 VDC. An optional wall transformer is also available which can be used in place of the batteries.

2.2 DISPLAY

The Model 1938 utilizes a low power custom liquid crystal display (LCD), with six seven-segment digits for data display, and special symbols indicating battery power, net/gross weight, zero, etc. A layout of the display and explanation of the symbols are shown in Figure 1.

SYMBOL	DESCRIPTION
Battery Low	Indicates the battery voltage is below a minimum level for sustained scale operation.
Count	When steady, indicates calculated piece count is showing on the display. When blinking, indicates more pieces are required for sample reading.

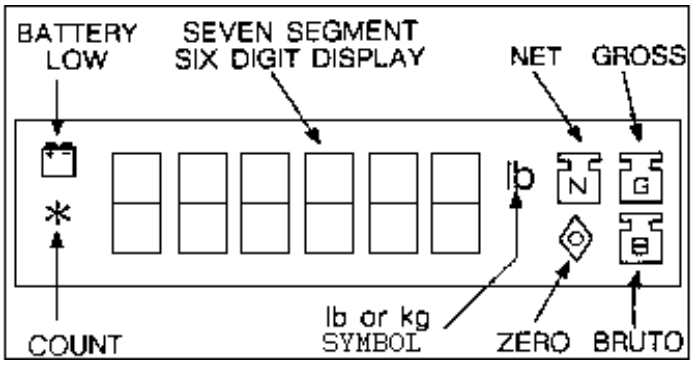


Figure 1

lb or kg	Indicated avoirdupois or metric mode in use.
Zero	The zero legend illuminates when the weight is within ±0.25 increments of zero.
Net	Indicates tare has been taken and the display is showing net weight.
Gross	Indicates the scale is at zero and no tare has been taken.
Bruto	International term for Gross. Used in place of the Gross symbol when Metric Mode (SSW-11), Tare Interlock (SSW-21), and Analog Verify (SSW-23) are enabled.

2.3 KEYBOARD

The keyboard used on the Model 1938 is a six position membrane keyboard utilizing graphic symbols. An illustration of the keyboard is shown in Figure 2. Refer to Section IV-B.4 for descriptions of keys.

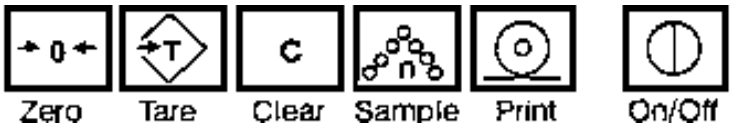


Figure 2

3. SPECIFICATIONS

3.1 ELECTRICAL

The Toledo Model 1938 uses six alkaline 1.5 VDC D-Cell batteries, connected in series to provide a nominal 9 VDC at 33 ma (increases to 48 ma when the Remote Command Input feature is enabled), to power both the Digital Load Cell and the Display PCB. Only the 1.5 VDC alkaline D-Cells are recommended for use in the Model 1938. Rechargeable "in-cad" batteries are not recommended, due to the fact that they are only rated for 1.2 VDC when fully charged. The acceptable voltage range required is between 7.5 VDC to 12.0 VDC. The operation time with fully charged batteries is 200-250 hours. With Sleep Mode enabled, typical battery life should be 3 to 6 months.

When the battery amperage is not sufficient to allow sustained scale operation, a battery-low indicator will be visible in the upper left corner of the display, when Tare Interlock (SSW-21) is disabled. When the battery-low symbol is visible, replace the batteries with six new 1.5 VDC alkaline D-Cell batteries, and discard the old batteries in a proper container.

When Tare Interlock (SSW-21) is enabled (legal-for-trade applications), the display will blank and the battery low indicator will illuminate when the voltage level is not sufficient to allow sustained scale operation. At this point, fresh batteries must be installed.

An optional wall transformer is also available to power the Model 1938 in place of the batteries. The wall transformer converts the AC input voltage to the transformer to a nominal 12 VDC output to the scale. The voltage requirement for use with the wall transformer is 120 VAC, 60hz. The Model 1938 automatically switches to the wall transformer when it is connected. The scale will operate on the transformer with or without batteries installed.

3.2 ELECTRICAL

3.2.1 TEMPERATURE SENSITIVITY

Zero temperature coefficient is ±15 PPM/C
Span temperature coefficient is ±8 PPM/C

3.2.2 OPERATING TEMPERATURE

The Toledo Model 1938 is designed to meet NBS HG-44 5000d and 3000d OIML requirements to operate in a temperature range between:

+14F (-10º C) to 104F (+40º C)
0 to 95% relative humidity, non-condensing.

3.2.3 APPLICATION

The Toledo Model 1938 is designed for general purpose dry indoor industrial or commercial environments.

The Model 1938 is NOT DESIGNED FOR HOSE-DOWN APPLICATIONS. Typical examples of MIS-APPLICATION of the scale include, but are not limited to:

- Immersions
- Hosedown
- Splashing liquids
- Corrosive Chemical Environments

Toledo Scale manufactures other scales that are suitable for “hosedown” applications.

3.2.4 HAZARDOUS AREAS

DO NOT USE the scale in locations classified hazardous by the National Electrical Code (NEC) Article 500.

3.3 PHYSICAL SPECIFICATIONS

3.3.1 DIMENSIONS AND SHIPPING WEIGHT

Dimensions

Platter:	315mm x 350mm (12.37” x 13.87”)
Scale Base Height:	121mm (4.75”)
Foot Adjustment:	+6mm (+0.25”)
Column Height:	483mm (19”)

Shipping Weight

Shipping weight w/column: 13kg (27lb) - approx.

3.3.2 CONSTRUCTION

Platter:	Fabricated Steel
Base and Spider:	Die cast aluminum
Connector Bracket:	Cold roll steel
Column Support / End Caps:	Die cast aluminum
Display Enclosure and Column:	Extruded aluminum

3.3.3 OVERLOADING

Corner Loading:	100% of full scale capacity
Safe Overload:	150% of full scale capacity

3.3.4 RESOLUTION

Displayed Resolution:	3000 (kg mode) or 5000 (avoirdupois mode)
Counting Resolution:	1 part in 200,000 internal for piece weight and total calculations
Maximum Count:	999,999 pieces

3.3.5 ZERO

Power Up Zero -
When power is applied, zero is automatically captured if the weight is within ±2% of scale capacity, and a no-motion condition exists.

Front Panel and Remote Zero -
Pressing the “ZERO” button, or inputting a remote zero command from a host, will re-zero the scale if the weight is within ±2% of scale capacity and the scale is in a no-motion condition with a gross zero indication.

3.4 CONFIGURATION

FACTORY NUMBER	INDICATION	LOAD CELL CAPACITY
1938 - 0001	25 X .005 lb OR 15 x .005 kg	30 kg
1938 - 0002	50 x .01lb OR 30 x .01 kg	60 kg
1938 - 0003	100 x .02 lb OR 60 x .02 kg	140 kg

4. INSTALLATION INSTRUCTIONS

4.1 ASSEMBLY

1). Examine the shipping box for any signs of damage. IF DAMAGE IS FOUND, MAKE A CLAIM WITH THE CARRIER IMMEDIATELY.

2). Open the box and remove the top packing material. Remove the scale base, column and display from the box and place it on a stable flat level surface. Also remove the six 1.5 VDC alkaline D-Cell batteries from the carton and set aside until installation.

**CAUTION! DO NOT LIFT THE SCALE BYT HE PLATTER OR SUB-PLATTER.
LIFT THE SCALE BY GRASPING THE SIDES OF THE BASE ONLY.
DO NOT LIFT THE ASSEMBLED SCALE BY THE INDICATOR OR THE COLUMN.**

3). The display is shipped from the factory mounted to the column and electrically connected to the base. The display column can be mounted in an upright position as shown in Figure 3. The interconnected cable is 2 meters (80”) long, and can be secured in the recess in the rear of the column. The excess length can be inserted into the base cavity as shown in Figure 4.

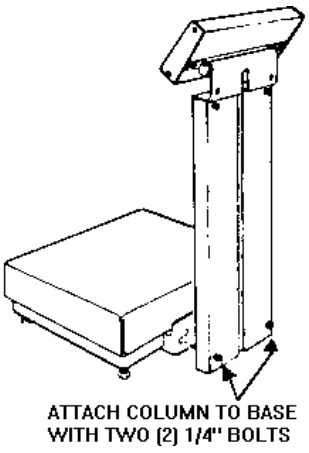


Figure 3

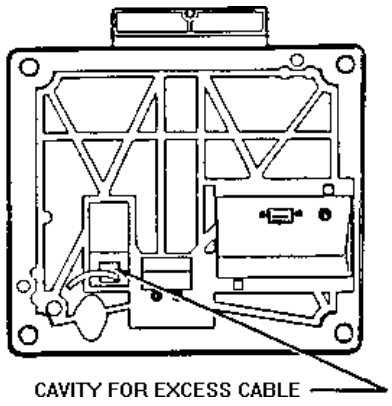


Figure 4

4). Figure 5a and 5b illustrate an alternative method of mounting the display to the base for applications with height restrictions, or where the product being weighed obscures the display, or may touch the column.

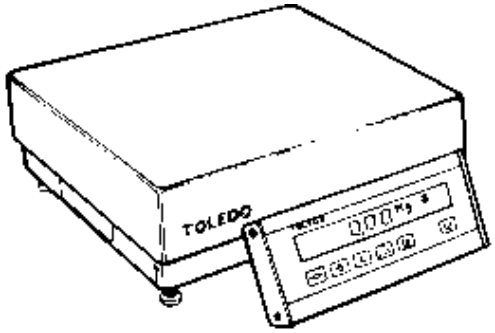


Figure 5a

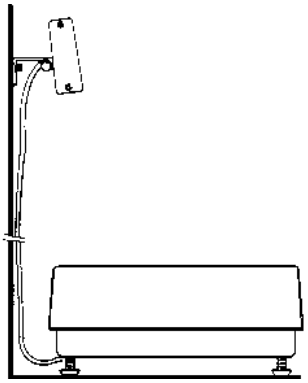


Figure 5b

5). Figure 6 illustrates another method to remotely mount the display to a tabletop or wall.

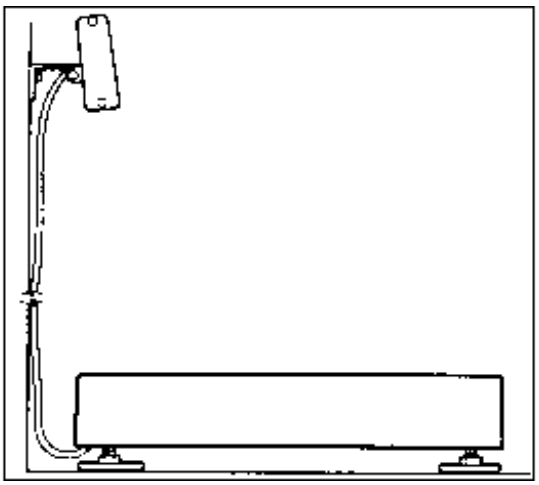


Figure 6

6). Remove the platter and install the six 1.5 VDC alkaline D-Cell batteries in the battery holder, orienting the positive/negative terminals in the direction shown on the battery holder. (Figure 7).

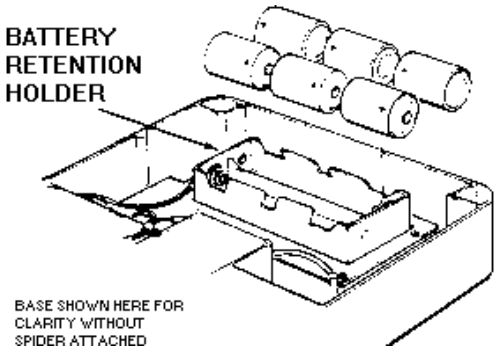


Figure 7

7). Level the scale by turning the adjustable feet on the bottom of the base in or out until a level condition is attained, and the scale does not rock. The scale is in a level condition when the level bubble on the spider assembly is as shown in Figure 8a.

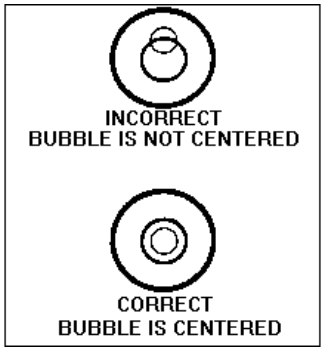


Figure 8a

8). Install the scale platter and press the “ON” button to apply power. If the display does not illuminate, check the batteries for proper installation.

9). If the optional wall transformer assembly is used, it is connected to the jack on the bottom of the base as shown in Figure 8b.

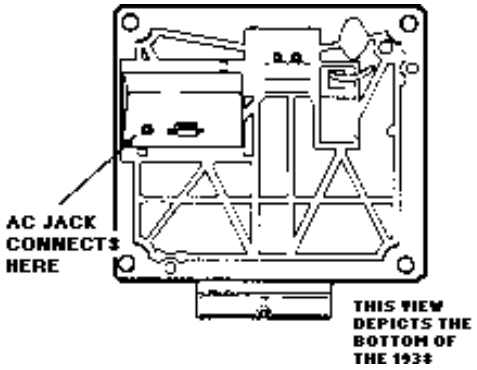


Figure 8b

4.2 ACCESSING SETUP AND CALIBRATION MODE

The Model 1938 is calibrated at the factory per the specification listed on the equipment data plate, and functional programming is completed at the factory, allowing the unit to be operational right out of the box. The unit can be used for normal weighing and counting operations without changing any of the softswitch parameters, or the calibration. However, for commercial purposes (legal for trade), the unit must be calibrated using certified test weights. All operational changes and calibration can be performed using the scale keyboard.

ACCESSING THE SETUP MODE

1). Remove the top screw that secures the end cap on the right side of the display housing, and loosen the lower screw so the end cap can be rotated 180º, allowing access to the inside of the enclosure (Figure 9).

2). Press the white "ON/OFF" key (located on the lower right side of the display assembly to turn the scale power ON. (Refer to Figure 2).

3). After the power-up sequence is completed, press and release the white pushbutton located on the end of the Display PCB (Figure 9). The scale will first display [10 0], indicating the start of the setup mode.

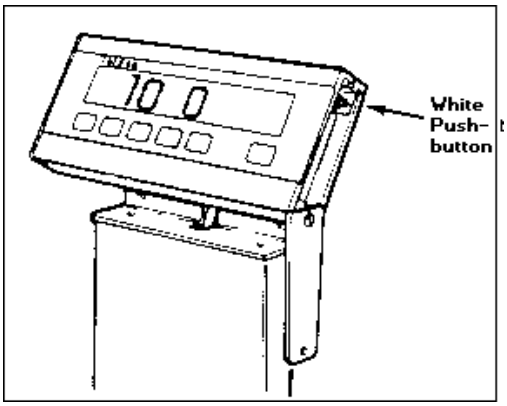


Figure 9

4). In addition to the normal mode functions of the keys, each key performs a different function when the scale is in the setup mode. The functions of the keys are as follows:

KEY	FUNCTION
ZERO	Normal: ZERO - pressing this key will return the scale to a gross zero condition if the weight is within ± 2% of the scale capacity listed on the data plate. Setup: Used as a "cursor" key to back-up to the previous softswitch.
TARE	Normal: TARE - Used to tare the applied weight on the scale platter. Setup: Used to change the status of the softswitch (ON/OFF) or to toggle through a selection of softswitch options. When variable data is required, the Tare key advances the digit in each decade position from 0 to 9.
CLEAR	Normal: CLEAR - clear tare weight or exit from counting mode. Setup: Abort setup and go to the end of setup mode softswitches.
PRINT	Normal: PRINT - Used to initiate printing when a printer is connected to the Model 1938. Setup: Allows entry of the displayed softswitch status and advances to the next softswitch.
SAMPLE	Normal: SAMPLE - Used in the counting mode. Setup: When entering variable data. Sample moves the control (blinking) digit from left to right, one position at a time.
ON/OFF	Normal: ON/OFF - Connects / disconnects power to the scale electronics. Setup: Not used.

5). Following is a brief listing of the softswitches (SSW) for quick reference purposes. The default SSW settings and recommended settings for Legal-for-trade applications are also listed. For complete descriptions of each SSW, refer to Section IV-C.

QUICK REFERENCE CHART
(0=OFF, 1=ON)

SSW	DESCRIPTION	INITIAL DEFAULT SETTING	LEGAL FOR TRADE SETTING
10	**SCALE SETUP SECTION**		
11	Select KG or LB Mode	LB	
12	Capacity Select	Refer to Sec. IV-C	
13	Gravity Adjust	10000	
14	Filter Selection	1 (low)	
15	Sleep Mode	1	0
16	Tare Auto-Clear	0	1
20	**LEGAL-FOR-TRADE SECTION**		
21	Tare Interlock	0	1
22	Display Metric Comma	0	
23	Analog Verify Enable	0	
24	Expanded Weight Display	0	0
25	Calibration Mode	0	
30	**COUNTING SETUP SECTION**		
31	Part Counting Mode Enable	1	
32	Auto Clear APW	1	
33	Minimum Sample Req.	0	
34	Enable Select Fixed / Variable Sample	00 (Variable)	
40	**PRINTER OUTPUT SETUP**		
41	Printer Baud Rate	0 (9600)	
42	Checksum Enable	0	
43	Remote Input Enable	0	
50	**PRINT FORMAT SETUP**		
51	Single Line Print Enable	0	
52	Print Gross Weight	1	
53	Print Tare Weight	1	
54	Print Net Weight	1	
55	Print Double Width Net Wgt.	0	
56	Print APW	1	
57	Print Pieces	1	
58	Print Double Width Pieces	0	
99	**END OF SETUP MODE**		

4.3 SOFTSWITCH FUNCTIONS

When the setup mode is accessed, the first series of softswitches (SSW) will be displayed as [10 0]. The ”10” indicates the first series of switches (11 through 16). Pressing the “TARE” key will change the “0” (OFF), to a “1” (ON). When the “1” is displayed, press the “PRINT” key to accept the displayed setting and advance to the first softswitch selection. If the “10 Series” of softswitches is to be by-passed, leave the display showing [10 0], then just press the “PRINT” key to advance to the “20 Series” of softswitches. Pressing the “PRINT” key without making changes will advance to the next selection, and pressing the “ZERO” key will backup to the next previous selection.

There are five sections or series of softswitches in the setup mode as follows:

10 = SCALE SETUP SOFTSWITCHES
20 = LEGAL FOR TRADE AND CALIBRATION SETUP SOFTSWITCHES
30 = COUNTING SETUP SOFTSWITCHES
40 = PRINTER OUTPUT SETUP SOFTSWITCHES
50 = PRINT FORMAT SETUP SOFTSWITCHES

Following is a list of the softswitch options and description of each softswitch:

SSW DESCRIPTION

10 SCALE SETUP SOFTSWITCHES
0 = Bypass Section 10 SSW 11-16
1 = Access Section 10 SSW 11-16

11 AVOIRDUPOIS OR METRIC MODE
kg = Metric mode in use.
lb = Avoirdupois mode in use.

12 CAPACITY SELECT
Capacity selection - the Model 1938 is calibrated at the factory according to the capacity listed on the data plate and must not be changed. The capacity should be set as follows:
1938-0001 - 25 x .005lb or 15 x .005kg
1938-0002 - 50 x .01lb or 30 x .01kg
1938-0003 - 100 x .02lb or 60 x .02kg

13 GRAVITY ADJUST
0 = Bypass Gravity Adjustment Parameters
1 = Access Gravity Adjustment Parameters.
(Refer to Gravity Adjustment Section IV-E of this manual)

14 FILTER SELECTION
Display Filtering - four selections are available (0,1,2, or 3). By enabling the filter, the scale is less susceptible to the effects of vibration. The scale response time is slowest when the highest filtering parameter (3) is selected. the response time is fastest when filtering is disabled (0). Press the “TARE” key to toggle through the selections, then press “PRINT” to accept the displayed setting.

15 SLEEP MODE
0 = Disable Sleep Mode
1 = Select Sleep Mode Options. When enabled, power to the display and load cell will be disabled after the selected interval from the last time the scale was in use. The “1” setting will result in the longest battery life. Press the “PRINT” key when the “1” is displayed to select the following elapsed time intervals:
0 = Disable Sleep Mode
1 = Enable Sleep Mode after 1 minute
2 = Enable Sleep Mode after 2 minutes
5 = Enable Sleep Mode after 5 minutes

16 TARE AUTO-CLEAR
0 = Disable Tare Auto-Clear - tare must be cleared using the “CLEAR” key.
1 = Enable Tare Auto-Clear - tare will clear when the gross weight is removed.

20 LEGAL FOR TRADE SETUP SOFTSWITCHES
0 = Bypass Section 20 SSW 21-25
1 = Access Section 20 SSW 21-25

21 TARE INTERLOCK

0 = Disable Tare Interlock

1 = Enable Tare Interlock - TARE INTERLOCK MUST BE ENABLED IF THE SCALE IS TO BE USED FOR COMMERCIAL WEIGHING (legal for trade). The Tare Interlock mode requires all tare weight entries to be completed when the scale is in the "gross" zero mode and allows the tare to be manually cleared only when the platter is empty.

22 SELECT METRIC COMMA OR DECIMAL POINT

0 = Display decimal point

1 = Display metric comma in place of decimal point.

23 ANALOG VERIFICATION

0 = Disable Analog Verification

1 = Enable Analog Verification. This softswitch should be normally disabled, unless specified by local authorities.

24 EXPANDED DISPLAY

0 = Normal display

1 = Expanded Display - Displays all minor increments. Used for test mode only. Set to "0" for normal use.

25 CALIBRATION MODE

0 = Bypass Calibration Mode

1 = Access Calibration Mode - Used to calibrate the scale with test weights. (Refer to Calibration Section 4.4 of this manual).

30 COUNTING SETUP SOFTSWITCHES

0 = Bypass Section 30 SSW 31-34

1 = Access Section 30 SSW 31-34

31 PART COUNTING MODE

0 = Disable Counting Mode

1 = Enable Counting Mode

32 AUTO CLEAR AVERAGE PIECE WEIGHT

0 = Disable Auto-Clear Average Piece Weight (APW). When disabled, APW will be retained in memory until manually cleared with the keyboard.

1 = Enable Auto-Clear Average Piece Weight. If enabled, calculated APW will automatically clear from memory when the scale is emptied.

33 MINIMUM SAMPLE REQUIREMENT

0 = No minimum sample weight requirement.

1 = Set minimum sample weight for 0.1% of the scale's rated capacity. When sampling pieces, the scale will prompt the user to add pieces until the 0.1% minimum is applied to the scale.

34 SELECT FIXED OR VARIABLE SAMPLE QUANTITY

Select a variable or fixed sample reference quantity. Press the "TARE" key to toggle the following selections:

00 = Variable Sample Reference - 00 allows the user to set the sample reference quantity for 5, 10, 20, 50 or 100 by pressing the "SAMPLE" key to toggle the selections.

05 = Set Fixed Sample Reference for 5

10 = Set Fixed Sample Reference for 10

20 = Set Fixed Sample Reference for 20

40 PRINTER OUTPUT SETUP SOFTSWITCHES

0 = Bypass Section 40 SSW 41-43

1 = Access Section 40 SSW 41-43

41 PRINTER BAUD RATE

0 = 9600 Baud

1 = 300 Baud

42 CHECKSUM

0 = Do not send checksum

1 = Send checksum

43 REMOTE INPUT

0 = Remote Input is disabled

1 = Remote Input is enabled

50 PRINT FORMAT SETUP SOFTSWITCHES

0 = Bypass Section 50 SSW 51-58

1 = Access Section 50 SSW 51-58

51 SINGLE OR MULTI-LINE PRINTING

0 = Print/send data on multiple lines
1 = Print/send data on single lines

52 PRINT GROSS WEIGHT
0 = Do not print/send Gross Weight data
1 = Print/send Gross Weight data

53 PRINT TARE WEIGHT
0 = Do not print/send Tare Weight data
1 = Print/send Tare Weight data

54 PRINT NET WEIGHT
0 = Do not print/send Net Weight data
1 = Print/send Net Weight data

55 PRINT DOUBLE WIDTH NET WEIGHT
0 = Print Normal Width Net Weights
1 = Print Double Width Net Weights

56 PRINT APW
0 = Do not print/send APW data
1 = Print/send APW data

57 PRINT PIECES
0 = Do not print/send Number of Pieces
1 = Print/send Number of Pieces

58 PRINT DOUBLE WIDTH PIECES
0 = Print Normal Width Number of Pieces
1 = Print Double Width Number of Pieces

99 END OF SETUP MODE
Press the setup pushbutton to return to normal run mode.

4.4 CALIBRATION

If the Model 1938 is used in a commercial (legal-for-trade) application, it must be calibrated to the capacity specified on the equipment data plate using certified test weights. The calibration procedure is as follows:

NOTE: The capacity of the Model 1938 is selectable via softswitch #12 in the setup mode, and must be set according to the Factory Number Configuration and Capacity listed on the equipment data plate, and as listed in Section 3.5 of this manual.

1). Press the setup mode pushbutton at the end of the Displays PCB, as shown in Figure 9. The display will show [10 0]. Press the “PRINT” key to advance to the SSW Section 20 [20 0]. Press the “TARE” key to change the “0” to “1”, then press the "PRINT" key again. The display will show the first SSW in section 20, [21 0]. press "PRINT" to advance to SSW 25, [25 0]. Press the "TARE" key to change the “0” to “1”, then press "PRINT" to enable the calibration mode. The display will show dashes [-----], prompting the user to empty the scale platter. Press the "PRINT" key. The display will count down from 15 to 00 while it waits for the filtered weight to settle.

2). When zero has been established, the display will shown [0000lb] if in the avoirdupois mode, or [0000kg] if in the metric mode. The most significant digit will be blinking, prompting for the entry of the value of the test weight that will be used to calibrate the span. The test weight should be an amount close to the capacity of the scale. The minimum recommended test weight is 2/3 of scale capacity.

The value is entered from left to right. If the first blinking decade position is to be zero, press the “SAMPLE” key to toggle to the next decade. If a value other than zero is to be entered in this position, press the "TARE" key to toggle the selection of digits 1-9. When the required digit is displayed, press the "SAMPLE" key to move to the next decade position. When the complete variable test weight value is on the display, press the "PRINT" key to accept the displayed value (example: [0050lb]).

3). The display will then show [|-|-|-|-|-|-xx], with xx=lb or kg depending on the weighing mode in use. Place the test weight(s) on the platter, then press the "PRINT" key. The display will count down from 15 while the scale waits for the filtered weight to settle.

4). When the span has been determined, the display will again show dashes [-----]. Remove the test weight(s) from the platter and press the "PRINT" key. The display will count down from 15. When calibration has been completed, the display will advance to the next softswitch section [30 0]. Press the "CLEAR" key to advance to the end of the setup mode, or continue in the setup mode in sections 30-50. When [99] is displayed, indicating the end of the setup mode, press the white pushbutton at the end of the Display PCB to return to normal run mode.

4.5 GRAVITY ADJUSTMENT

The Toledo Model 1938 is calibrated at the point of manufacture to the capacity specified on the equipment data plate. If the scale is moved to another location, the factory calibration may require adjustment, due to the effect of gravity factors at the new location. The Gravity Factor is determined by geography (latitude) and distance above sea level (altitude). The probability is high that the gravity factor in your local area is different from the point of manufacture (Spartanburg, SC, U.S.A.). In this case, some calibration adjustment may be required. If required, a gravity adjustment factor can be input into the scale as a calibration correction for your specific location.

NOTE: THIS CORRECTION FACTOR IS NOT REQUIRED IF THE UNIT HAS BEEN CALIBRATED USING TEST WEIGHTS AT THE INSTALLATION SITE OF THE UNIT. ONCE THE UNIT HAS BEEN CALIBRATED WITH TEST WEIGHTS AT A LOCATION OTHER THAN THE FACTORY, THE GRAVITY ADJUSTMENT FACTORS LISTED IN THIS MANUAL ARE NO LONGER VALID.

The gravity adjustment feature is intended for out-of-the-box use where test weights may not be available. The gravity adjustment feature must not be used if the scale has been purchased for commercial use (legal-for-trade). **IF THE SCALE IS INTENDED FOR COMMERCIAL USE, CALIBRATION AT THE INSTALLATION SITE WITH CERTIFIED TEST WEIGHTS WLL BE REQUIRED.**

To use the gravity adjustment feature:

1). Enable softswitch (SSW) 13 by first displaying [10 0]. Press the "TARE" key once to change the “0” (off state) to a “1” (on state), then press the "PRINT" key until SSW-13 is displayed [13 0]. When SSW-13 is displayed, press the "TARE" key to change the “0” to “1”, then press "PRINT", [13 1].

2). Refer to Appendix A, Section Xii, for the Gravity Factors Table to locate the adjustment factor value for your specific location. If your specific location is not listed, use Appendix B or the Alternate Gravity Factors Table to approximate a suitable gravity factor value, based on your location’s longitude and altitude.

3). Input the five digit adjustment factor using the "TARE" key to toggle values for the blinking digit on the display, and the "SAMPLE" key to advance through the four remaining decade positions until the complete gravity adjustment value is displayed.

4). Next, press the "PRINT" key to accept the displayed value. The scale will adjust the preprogrammed calibration parameters accordingly.

5. OPERATING INSTRUCTIONS

5.1 POWER-UP SEQUENCE

When power is first applied to the Model 1938 (by pressing the ON/OFF key on the right side of the keyboard), all of the display segments will be visible momentarily for display verification before displaying weight data. If the weight is less than ± 2% of the capacity, zero is captured. If the weight is outside of ± 2% of zero, and tare interlock (SSW-21) is off, the weight is displayed with the zero cursor blinking. If tare interlock (SSW-21) is on, and the weight display is blanked while the zero cursor is blinking, recalibration may be required.

5.2 OPERATING SEQUENCES

5.2.1 NET WEIGHING

1). Place empty container on the scale platter.
2). Press the "TARE" key - the weight will change to show zero net weight and the net weight indicator will illuminate.
3). Add load to the scale platter. The net weight will be displayed.
4). If the scale is interfaced to a printer or other external device, the weight data can be transmitted from the scale at this time by pressing the "PRINT" key.

5.2.2 PARTS COUNTING

1). Place empty container or carton on the scale platter.
2). Press the "TARE" key - the weight will change to show zero net weight and the net weight indicator will illuminate.
3). Press the "SAMPLE" key to display the reference sample quantity. If the fixed sample mode is selected, the preprogrammed fixed reference sample quantity will be displayed. The display will show a blinking asterisk along with the selected reference sample quantity [* 5]. The flashing asterisk is a prompt to add the required pieces to the scale platter.
If the variable sample mode is selected in the setup procedure, the required sample reference quantity can be changed by pressing the "SAMPLE" key until the desired value is displayed.
The desired sample reference quantity must be selected while the scale is at net or gross zero.

4). Place the required sample on the scale and press the "SAMPLE" key. If the minimum sample requirement has not been met, the display will prompt the operator to add additional pieces. The asterisk will change to a blinking plus symbol (+). When sampling very small pieces, the scale may prompt the operator more than once to add more weight (pieces) in order to accurately calculate the average piece weight of the item being counted.

If you are prompted to add additional pieces for the minimum sample reference, add the pieces to the scale platter, then press the "SAMPLE" key again.

5). When the minimum sample reference requirement has been met, the asterisk (or + symbol) will stop blinking and the count will be displayed shortly after the "SAMPLE" key has been pressed. Add additional pieces as required until the desired count is displayed.

6). If the scale is interfaced to a printer, the count and weight data can be transmitted from the scale at this time by pressing the "PRINT" key.

6. RS232 SERIAL INPUT/OUTPUT

The Model 1938 RS232 Serial Port is a bi-directional port that is capable of receiving certain ASCII characters as well as transmitting scale weight/count data. The EIA specifications for maximum data cable length using RS232 communications is 50 feet.

6.1 DATA OUTPUT

Data output for the Model 1938 is at the TxD RS232 data line on pin 3, and pin 5 (ground), on the 9-pin D-sub connector. The character format is one start bit, seven data bits, one even parity bit, and one stop bit. The data bits are in the ASCII format. The transmission rate is selectable to either 300 or 9600 baud.

Data output occurs when the scale is in a no-motion condition and the "PRINT" key is pressed. During setup mode, the format is selectable as either single or multiple line printing.

The Model 1938 can transmit any or all of its fields on a single line, which can be selected in the setup mode. The data will always be sent in the following order for a single line format:

Gross - Tare - Net - APW - Pieces

When the multiple line format is selected, the data will always be sent in the following order:

Gross
Tare
Net
APW
Pieces

The net weight and piece count can also have the “SO” character added to indicate expanded print.

Using the single line format, the transmitted data will be sent as follows:

SXT	**<GROSS>**	**SP**	**<TARE>**	**SP**	**SO**	**<NET>**

SI	**<APW>**	**SO**	**<COUNT>**	**SI**	**CR**	**CKSM**	**LF**

Using the multiple line format, the transmitted data will be sent as follows:

STX	**<GROSS>**	**CR**	**CKSM**

LF	**<TARE>**	**CR**	**CKSM**

LF	**SO**	**<NET>**	**SI**	**CR**	**CKSM**

LF	**<APW>**	**CR**	**CKSM**

LF	**SO**	**<COUNT>**	**SI**	**CR**	**CKSM**	**LF**

The brackets < > are printed around the data fields when tare interlock, analog verify, and metric mode are enabled. The descriptions for the abbreviations used are as follows:

STX	Start of Text Character
SP	Space Character
<GROSS>	If Gross Weight print is enabled, the six digit (including decimal point) gross weight is printed, followed by “kg” or “lb”.
<TARE>	If tare print is enabled, the six digit (including decimal point) tare weight is printed, followed by “kg” or “lb” and “TR”.

<NET>	If net weight print is enabled, the six digit (including decimal point) net weight is printed, followed by “lb” or “kg” and “NET”.
<APW>	If APW print is enabled, the eight digit (including decimal point) APW is printed, followed by “kg” or “lb” and “APW”.
<COUNT>	If count print is enabled, a one to six digit count is printed, followed by “PCS”.
CR	Carriage Return Character
CKSM	Optional Checksum Character
LF	Line Feed Character
SO	Optional Shift Out Character for expanded print
SI	Optional Shift In Character to end expanded print
SP	Space Character

6.2 DATA INPUT

The Model 1938 is capable of receiving remote commands for Print (p), zero scale (z), Tare (t), and clear scale (c). The commands are input to the scale via the RxD data line on pin 2 of the 9 pin Dsub connector. The only command to which the Model 1938 will return a response to is the “p” print command.

The baud rate of the data input must be the same as what has been selected for the data output in the setup mode, and the Remote Input Enable Softswitch 43 must be set to ON (1). The format of the input data must be one start bit, 7 data bits, one even parity bit, and one stop bit.

The commands that can be remotely input are as follows:

COMMAND	DESCRIPTION
<Z>	Zero the scale if within ± 2% of capacity from zero, when scale is in a no-motion condition and at gross zero.
<T>	Tare the scale to net zero.
<P>	Print command. Sends displayed data back to host.
<C>	Clear the scale. Functions the same as pressing the "CLEAR" key on the scale keyboard.

NOTE: <CR> IS NOT REQUIRED AFTER THE INPUT COMMAND FOR THE MODEL 1938, BUT MAY BE USED IF NEEDED.

6.3 PIN CONNECTIONS FOR RS232 PORT

The pin connections for the 9 pin Dsub female connector used for the RS232 port are as follows:

2 - RxD Receive
3 - TxD Transmit
5 - Signal Ground

7. CARE AND MAINTENANCE

Periodically clean the keyboard and covers with a soft clean cloth that has been dampened with a mild window type cleaner or detergent. DO NOT USE ANY TYPE OF INDUSTRIAL SOLVENT OR CHEMICALS. DO NOT SPRAY CLEANER DIRECTLY ONTO THE UNIT. DO NOT HOSE DOWN

8. TROUBLESHOOTING

CAUTION! BEFORE CONNECTING/DISCONNECTING ANY INTERNAL ELECTRONIC COMPONENTS OR INTERCONNECTING WIRING BETWEEN ELECTRONIC EQUIPMENT ALWAYS REMOVE POWER AND WAIT AT LEAST THIRTY (30) SECONDS BEFORE ANY CONNECTIONS OR DISCONNECTION ARE MADE. FAILURE TO OBSERVE THESE PRECAUTIONS COULD RESULT IN DAMAGE TO, OR DESTRUCTION OF, THE EQUIPMENT

CAUTION
OBSERVE PRECAUTIONS FOR HANDLING ELECTROSTATIC SENSITIVE DEVICES

8.1 PROCEDURES

- If operational difficulties are encountered, first obtain as much information as possible regarding the problem. Failures and malfunctions often may be traced to simple causes such as loose connections, low battery power, improper setup, etc.

- If simple causes cannot be found, additional troubleshooting is best performed by substitution. A printed circuit board (PCB) or Digital Load Cell believed to be defective may be checked by replacing the suspect part with a known good part and then observing whether the problem is corrected.

- To verify that the problem was in the removed part, reinstall the original part and observe whether the problem returns. By doing this simple verification test, you will eliminate the possibility of having replaced a good part because of a loose or poor connection.

- Consult Section 4.3 of this manual for proper programming. Do not automatically program a replacement PCB like the suspected faulty PCB. The original problem may have been caused by a programming error.

8.2 ERROR CODES

ERROR CODE	DESCRIPTION	CORRECTIVE MEASURES
E1	ROM ERROR	1. Remove power/wait 15 sec./retry. 2. Check battery (or wall transformer) voltage/replace batteries/retry operation. 3. Replace Digital Load Cell.
E2	APPLICATION PROGRAM EEPROM ERROR	1. Remove power/wait 15 sec./retry. 2. Check battery (or wall transformer) voltage/replace batteries/retry operation. 3. Replace Digital Load Cell.
E3	DLC NOVROM ERROR	1. Remove power/wait 15 sec./retry. 2. Check battery (or wall transformer) voltage/replace batteries/retry operation. 3. Perform Setup again. 4. Replace Digital Load Cell.
E8	DLC OUT OF RANGE	1. Check battery (or wall transformer) voltage/replace batteries/retry operation. 2. Check voltage to Load Cell. 3. Check for Mechanical Overload. 4. Replace Digital Load Cell.
E13	DLC EEPROM ERROR	1. Remove power/wait 15 sec./retry. 2. Check battery (or wall transformer) voltage/replace batteries/retry operation. 3. Replace Digital Load Cell.
E32	CALIBRATION ERROR or BUILD ERROR	1. Recalibrate/Reconfigure SSW. 2. Replace Digital Load Cell.
E34	BAD ANALOG VERIFY CALCULATION	Replace cell.
AAAAAA	ANALOG VERIFY	Analog verify is on and active.
BLANK	BLANK DISPLAY	1. Check batteries/transformer. 2. If voltages are good, suspect faulty Display PCB.
RETURN		1. Power down. 2. Push Setup button and hold. 3. Power up and verify you are in Toledo Mode and not Mettler Mode. 4. See addendum.

8.3 VOLTAGE CHECKS

8.3.1 BATTERY VOLTAGE

Six 1.5 VDC D-cell alkaline batteries are required in the Model 1938 for proper operation (note: batteries are not required when using the wall transformer option). The six alkaline batteries are connected in series to provide a nominal 9 VDC at 33 ma (48 ma when Remote Command Input is enabled). Standard “flashlight” type batteries or rechargeable “in-cad” batteries are not recommended for use in the Model 1938.

The acceptable voltage range for proper operation is between 7.5 VDC to 12.0 VDC. The “Battery-low” symbol will be visible on the display when the voltage of the batteries drops below the minimum level. When SSW-21 is ON (Tare Interlock), the display will blank and the battery low indicator will illuminate when the voltage is below the minimum requirement for sustained scale operation.

The actual voltage level of the batteries can be checked with a voltmeter between the battery terminals on the end of the battery holder.

8.3.2 WALL TRANSFORMER VOLTAGE

An optional wall transformer is available for the Model 1938 which converts standard 120 VAC/60 hz input voltage to a nominal 12 VDC, at 500 am, output to the scale. The unit will operate using the wall transformer with or without batteries installed in the unit; however discharged batteries should be removed from the scale. An internal switching circuit on the Display PCB automatically switches to the transformer when it is connected to the jack on the bottom of the scale base. this circuit works by switching to the higher voltage input to the scale, which normally will be the wall transformer. (Note: the wall transformer does not charge the batteries.)

Low AC line voltage could cause the transformer voltage output to be lower than the battery voltage output. In this adverse condition, the switching circuit would the switch to battery input, providing batteries are installed and within the acceptable voltage range.

Although the wall transformer output depends directly upon the AC line voltage it is connected to, typical output voltage to the scale will be between +12 VDC to +16 VDC. This voltage can be checked at the transformer jack on the scale base, or on the transformer output plug.

8.3.3 DISPLAY PCB VOLTAGES

Various input and output voltages can be checked at the Display PCB on PJ-1, located at the end of the PCB. Access to PJ-1 is gained by removing the top screw on the side of the display housing. The end cap can then be swiveled down, as shown in Figure 9. A diagram of connector J-1 on the Display PCB is shown in Figure 10.

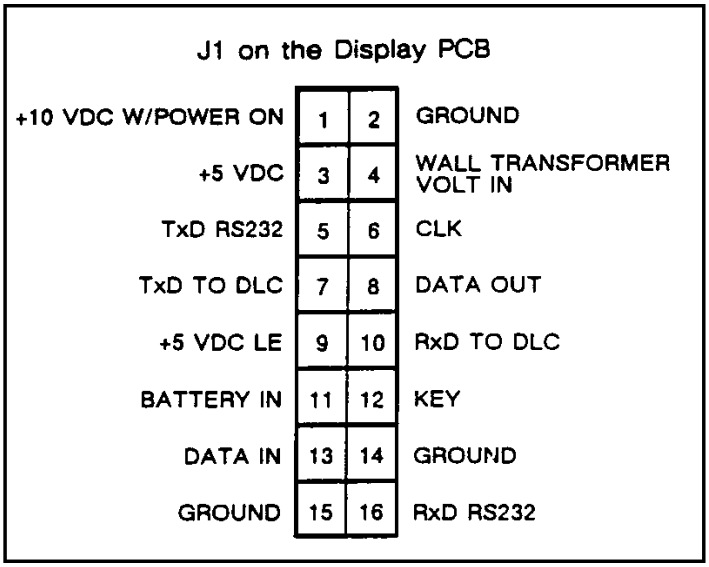


Figure 10

9. PARTS REPLACEMENT AND ADJUSTMENTS

9.1 KEYBOARD REPLACEMENT

The six position switch membrane keyboard is positioned in a slot on the front of the display housing, and is held in place by an adhesive backed overlay. first remove power to the unit by disconnecting the battery connector on the battery holder and/or unplugging the AC wall transformer if used.

To remove the keyboard and overlay, first disconnect the keyboard connector on the Display PCB. Peel the overlay from the display housing. The switch membrane can then be removed. Clean off any remaining adhesive on the housing by rubbing the adhesive into a “ball” with your finger. It can then be pulled off from the housing.

To install the new keyboard components, first position the switch membrane in the slot, and feed the tail through the hole at the end of the slot. Carefully position the overlay on the housing. When positioned correctly, apply pressure on the overlay with your fingers, especially on the edges to secure it to the housing. Do not use excessive pressure on the key positions.

9.2 DISPLAY PCB REPLACEMENT

The Display PCB is retained in slots on the top and bottom of the display housing. To remove the Display PCB, first remove power to the unit by disconnecting the battery connector at the end of the battery holder, and /or unplugging the wall transformer if used.

After power to the unit has been disconnected, remove both end caps from the display housing. Next unplug the Load Cell Harness at J1, the keyboard connector, and the Ground connector on the Display PCB. The Display PCB may now be slid out of the housing to the left (looking at the Display from the front). Reverse the previous steps to install the new Display PCB.

9.3 DIGITAL LOAD CELL REPLACEMENT

CAUTION: BEFORE CONNECTING OR DISCONNECTING THE LOAD CELL HARNESS, REMOVE POWER AND WAIT A MINIMUM OF 30 SECONDS. FAILURE TO OBSERVE THIS PRECAUTION MAY RESULT IN DAMAGE TO THE LOAD CELL.

CAUTION

OBSERVE PRECAUTIONS FOR HANDLING ELECTRO STATIC SENSITIVE DEVICES

To replace the Digital Load Cell Assembly:

1). Remove power to the unit by disconnecting the battery connector on the battery holder, and/or unplugging the AC wall transformer.

2). Remove the two allen-head screws securing the spider to the load cell. Disconnect the load cell harness at the load cell connector.

3). Place the scale on its side, then while supporting the load cell, remove the two allen-head screws securing the load cell to the base. Be sure to retrieve the spacer under the load cell.

4). With the scale on its side, re-insert the two allen-head screws through the base and insert the bottom spacer through the screws

5). Install the new load cell, tightening the allen-head screws to 75-85 inch/pounds for 1938-0001 and 1938-0002, or 185-200 inch/pounds for 1938-0003 scales. Reconnect the load cell harness.

6). Place the scale upright and reinstall the spider assembly.

7). Reconnect the battery harness and/or wall transformer.

8). Programming of the softswitches and calibration of the unit may now be performed. Verify correct operation of the new load cell after setup and calibration has been performed.

9.4 SPIDER REPLACEMENT AND OVERLOAD STOP ADJUSTMENT

The Overload Stop Screws, located in the Spider, are pre-set at the factory, and normally do not require adjustment. However, if the Spider is replaced, the gaps between the screws in the Spider and the overload posts must be checked at the positions shown in Figure 11. To set the gaps, insert the proper size gap gauge between the screw and the post, then turn the allen-had screw in or out until the correct gap is measured. Refer to the appropriate tables following Figure 11 for the correct gap settings by Factory Number.

OVERLOAD STOP POSITIONS

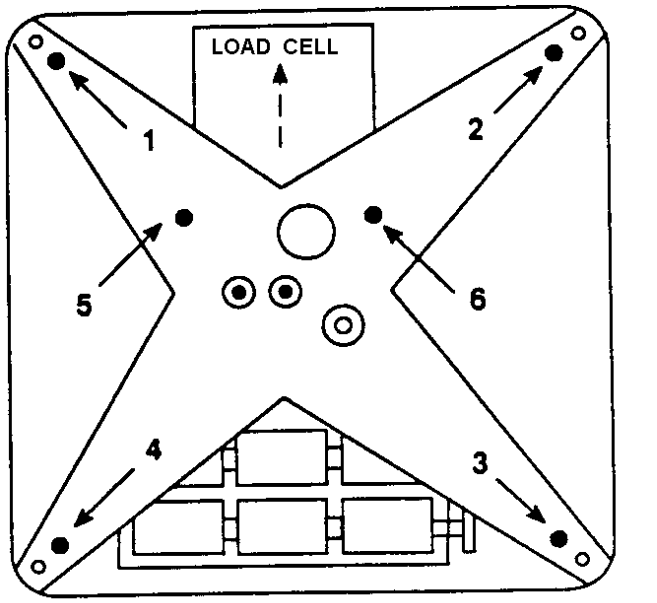


Figure 11

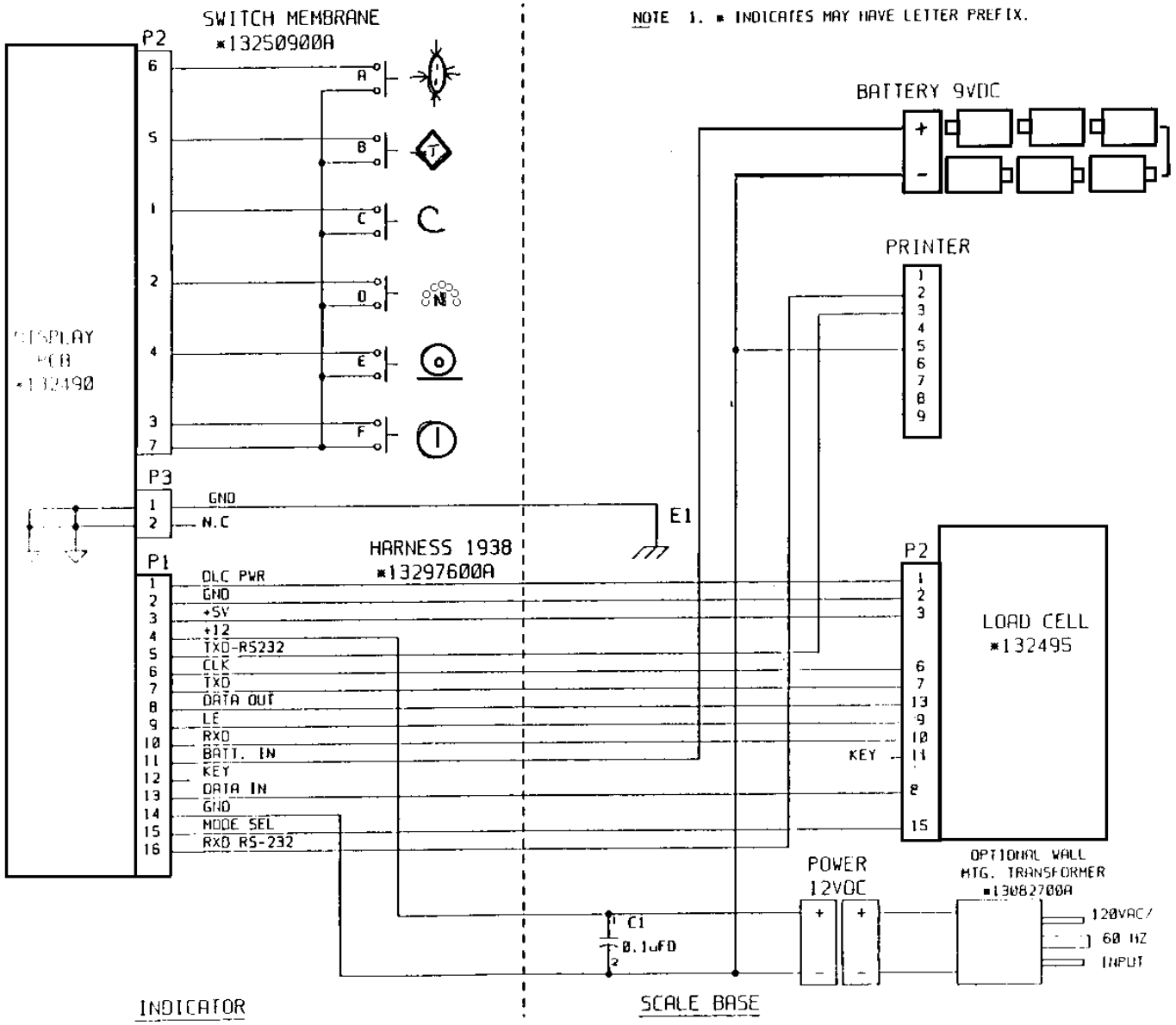
OVERLOAD GAP SETTINGS, TABLES A-C
(Refer to Figure 11)

TABLE A MODEL 1938-0001 25LB/15KG Capacity	
POSITION #	OVERLOAD GAP IN INCHES
1	.044 ± .002
2	.059 ± .002
3	.059 ± .002
4	.080 ± .002
5	.018 ± .001
6	.018 ± .001

TABLE B MODEL 1938-0002 50LB/30KG Capacity	
POSITION #	OVERLOAD GAP IN INCHES
1	.057 ± .002
2	.075 ± .002
3	.119 ± .002
4	.085 ± .002
5	.014 ± .001
6	.019 ± .001

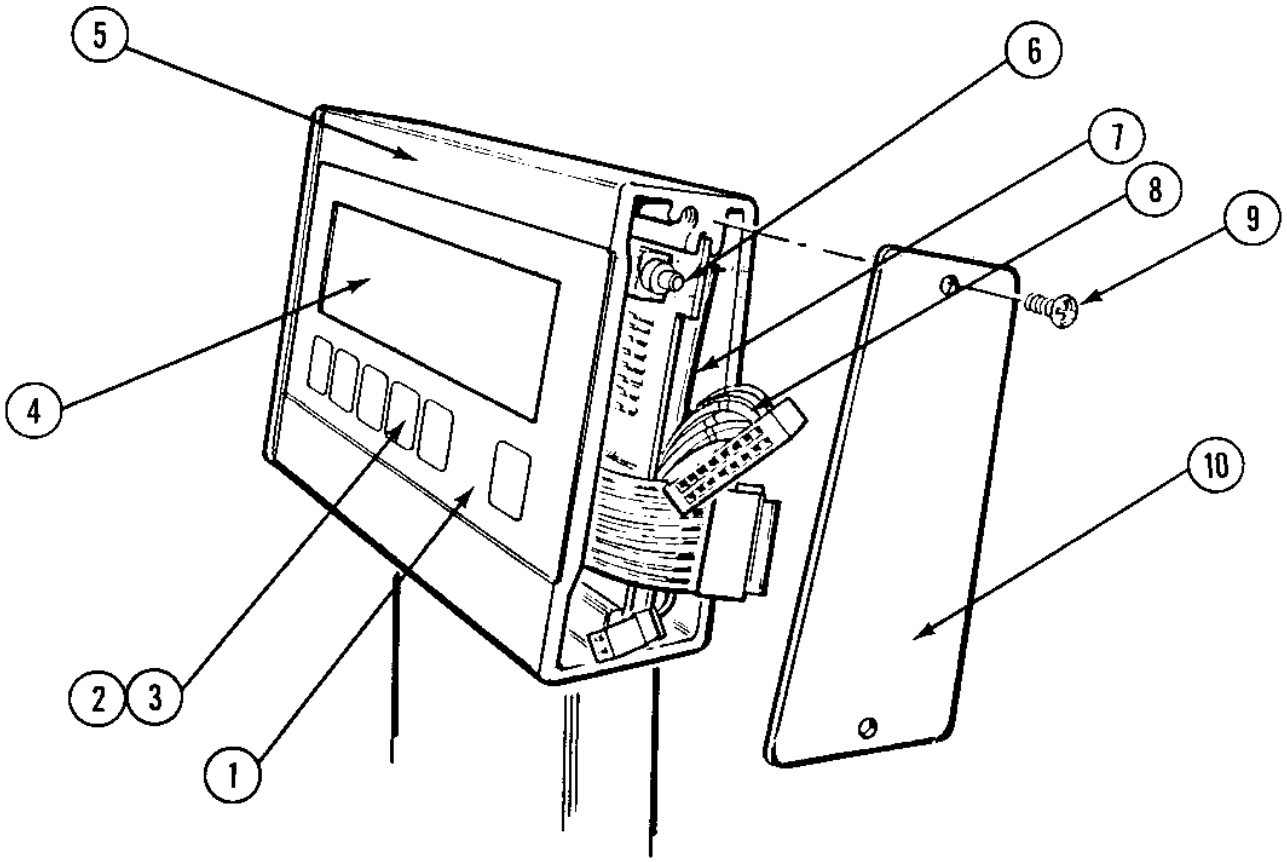
TABLE C MODEL 1938-0003 100 lb/60 kg Capacity	
POSITION #	OVERLOAD GAP IN INCHES
1	.100 ± .002
2	.131 ± .002
3	.219 ± .002
4	.179 ± .002
5	.017 ± .001
6	.028 ± .001

10. SCHEMATIC DIAGRAM



11. REPLACEMENT PARTS

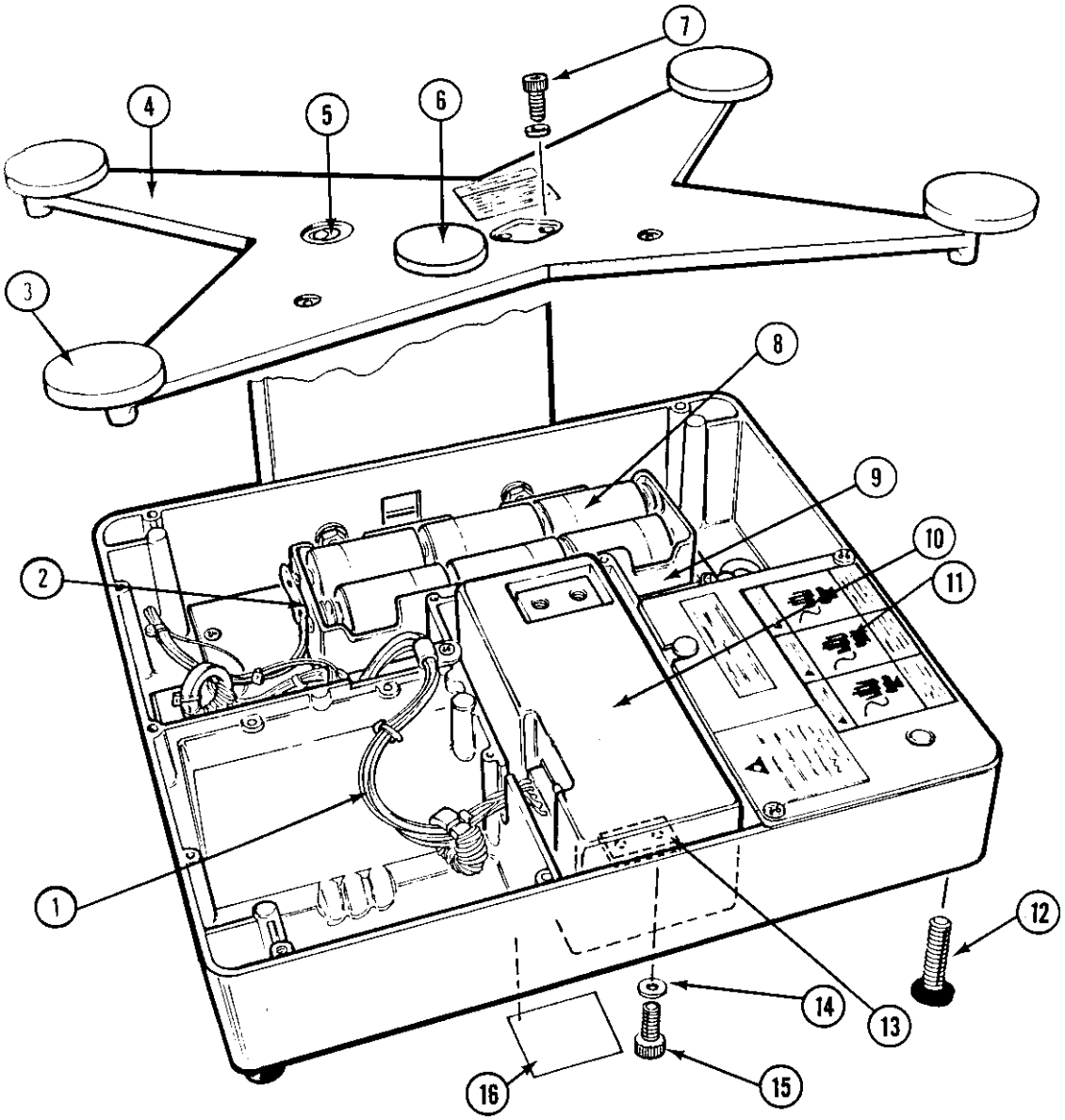
11.1 DISPLAY HOUSING



REF	PART NUMBER	DESCRIPTION	QTY
1	13250800A	KEYBOARD OVERLAY	1
2	A13250900A	KEYBOARD SWITCH MEMBRANE, 1 X 6 (N.S.)	1
3	13298400A	SPACER, SWITCH MEMBRANE LAYER (N.S.)	1
	13488600A	KEYBOARD KIT (INCLUDES ALL THE ABOVE - REF #1,2, &3)	1
4	13250700A	LENS, DISPLAY	1
5	13250000A	HOUSING, DISPLAY	1
6	13249000A	PCB ASSEMBLY, DISPLAY	1
7	13368100A	INSULATOR, PCB	1
8	B13297600A	HARNESS ASSEMBLY, INTERCONNECT	1
9	R0387200A	SCREW, 8-32 X 3/8” TRUSS	4
10	13250400A	END CAP	2

N.S. = NOT SHOWN

11.2 1938 BASE INTERIOR

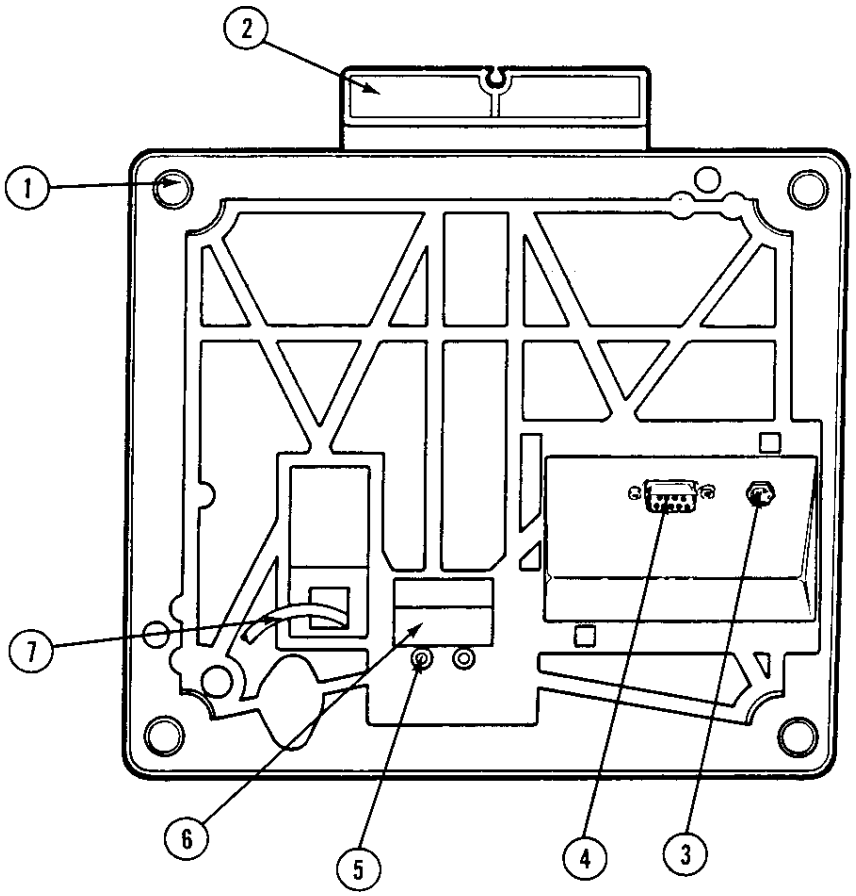


1938 BASE INTERIOR

REF	PART NUMBER	DESCRIPTION	QTY
1	B13297600A	INTERCONNECT HARNESS ASSEMBLY	1
2	A13327500A	CONNECTOR, BATTERY SNAP	1
3	A13253600A	FOOT, PLATTER PAD	4
4	D12051400C	SPIDER, 1938-0001	1
	C12051400D	SPIDER, 1938-0002 & 1938-0003	1
5	10268900A	LEVEL INDICATOR	1
6	13333200A	PAD, CENTER	1
7	R0350800A	SCREW, CAP 1/4-28 X 1” 1938-0001	2
	R0350700A	SCREW, CAP 1/4-28 X 1.5” 1938-0002	2
	R0319700A	SCREW, CAP 1938-0003	2
*8	13293700A	BATTERY, ALKALINE D-CELL 1.5 VDC	6
9	13257500A	HOLDER ASSEMBLY, BATTERY	1
10	13258300A	DIGITAL LOAD CELL, 30 kg 1938-0001	1
	13258500A	DIGITAL LOAD CELL, 60 kg 1938-0002	1
	13258900A	DIGITAL LOAD CELL, 140 kg 1938-0003	1
11	13334800A	LABEL, WARNING	1
12	13315500A	FOOT ASSEMBLY	4
13	A12233900A	SPACER, LOAD CELL LOWER 1938-0001	1
	12259100A	SPACER, LOAD CELL LOWER 1938-0002	1
	13304200A	SPACER, LOAD CELL LOWER 1938-0003	1
14	R0256600A	WASHER, 1/4” FLAT 1928-0002 ONLY	4
15	R0350700A	SCREW, CAP 1/4-28 X 1” -0001/-0002	2
	R0301800A	SCREW, CAP 5/16-18 X 7/8” 1938-0003	2
16	11985900A	LABEL, ASSEMBLY SPEC’S, -0001/-0002	1
	13342800A	LABEL, ASSEMBLY SPEC’S 1938-0003	1

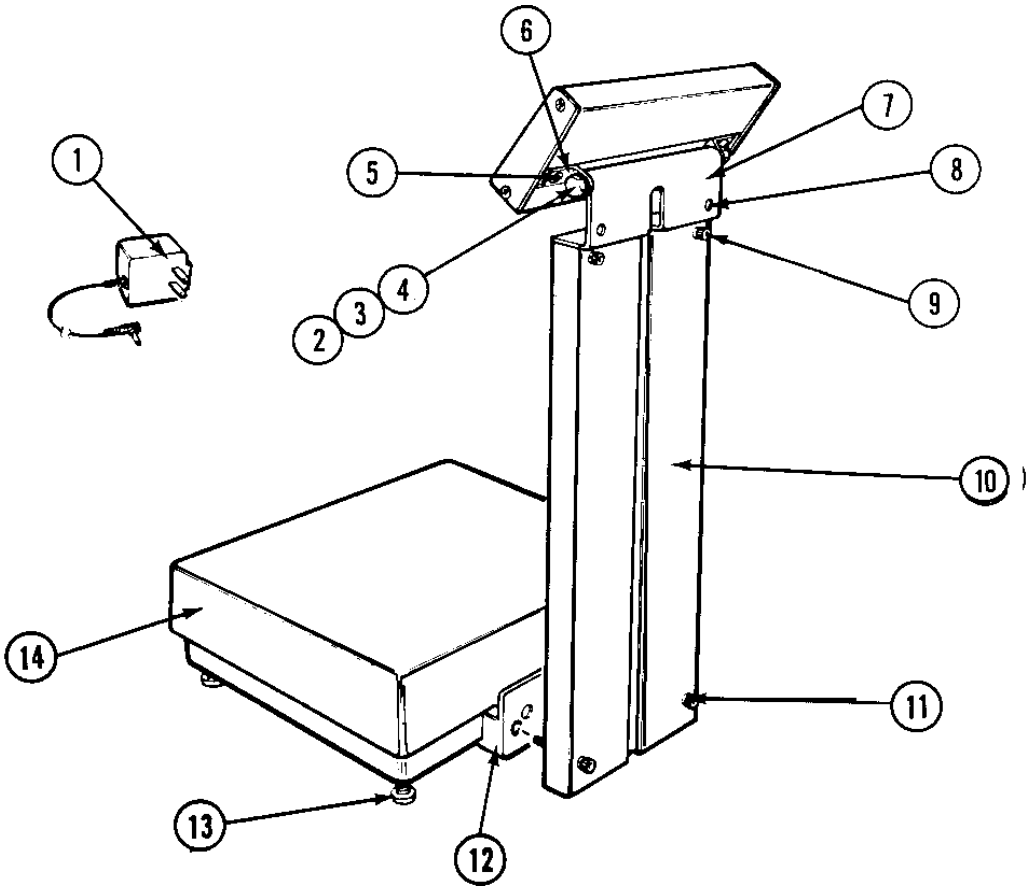
* Expendable item - not covered by standard product warranty.

11.3 1938 BASE EXTERIOR



REF	PART NUMBER	DESCRIPTION	QTY
1	13315500A	FOOT ASSEMBLY	4
2	13250300A	SUPPORT, COLUMN MOUNTING	1
3	13271700A	CONNECTOR JACK, WALL TRANSFORMER	1
4	11867000A	CONNECTOR, 9 POSITION Dsub FEMALE	1
5	R0350700A	SCREW, CAP 1/4-28 X 1” -0001/-0002	1
	R0301800A	SCREW, CAP 5/16-18 X 7/8” 1938-0003	1
6	11985900A	LABEL, ASSEMBLY SPEC’S, -0001/-0002	1
	13342800A	LABEL, ASSEMBLY SPEC’S, 1938-0003	1

11.4 1938 EXTERIOR



REF	PART NUMBER	DESCRIPTION	QTY
1	13082700A	WALL TRANSFORMER, 120VAC/12VDC	1
2	13250500A	SHOULDER SCREW 10-32	2
3	R0387300A	SPRING WASHER, .265 I.D.	2
4	13249900A	PIVOT WASHER, NEOPRENE	2
5	R0387200A	SCREW, 8-32 X 3/8” TRUSS	2
6	13250600A	BRACKET, PIVOT ANGLE	2
7	13250100A	INDICATOR SUPPORT	1
8	R0391100A	HOLE PLUG, BLACK 5/16”	2
9	R0354400A	SCREW, CAP 10-32 X 1”	2
10	13250200A	COLUMN, INDICATOR MOUNTING	1
11	R0272300A	SCREW, CAP 1/4-20 X 1.5”	2
12	13250300A	SUPPORT, COLUMN MOUNTING	1
13	13315500A	FOOT ASSEMBLY	4
14	13254900A	PLATTER	1

11.5 OPTIONAL ACCESSORIES

PART NUMBER	DESCRIPTION	SALES NUMBER
13304500A	ADJUSTABLE HEIGHT STAND	0924-0036
13330400A	CASTERS FOR STAND KOP	0924-0019
13304400A	WALL MOUNT TRANSFORMER KOP	0901-0266

12. APPENDICES

12.1 GRAVITY ADJUSTMENT TABLE FOR SPECIFIC LOCATIONS

The five-digit factors listed below are provided for calibration adjustment on the Model 1938. Refer to Section 4.4 to determine if this feature applies to your situation and/or for details regarding procedure.

WORLD CITIES (Listed alphabetically)

Amsterdam Netherlands	0.9984	Montevideo Uruguay	NR
Athens Greece	0.9997	Moscow USSR	0.9990
Auckland New Zealand	0.9997	Munich West German	0.9989
Bangkok Thailand	1.0013	Naples Italy	0.9994
Beijing PRC	0.9996	Nassau Bahamas	1.0007
Berlin West Germany	0.9984	New Delhi India	1.0006
Bogota Colombia	1.0025	Oslo Norway	0.9977
Bombay India	1.0011	Pago Pago American Samoa	1.0014
Bridgetown Barbados	1.0014	Panama City Panama	1.0015
Brussels Belgium	0.9985	Paris France	0.9987
Bucharest Romania	0.9991	Port of Spain Trinidad	1.0015
Budapest Hungary	0.9989	Prague Czechoslovakia	0.9986
Buenos Aires Argentina	0.9999	Reykjavik Iceland	0.9974
Cairo Egypt	1.0003	Rio De Janeiro Brazil	1.0008
Caracas Venezuela	1.0015	Rome Italy	0.9993
Cologne West Germany	0.9985	Rosario Argentina	NR
Colombo Sri Lanka	1.0016	San Jose Costa Rica	1.0015
Copenhagen Denmark	0.9980	San Juan Puerto Rico	1.0011
Dublin Ireland	0.9982	San Salvador El Salvador	1.0013
Frankfurt West Germany	0.9986	Santiago Chile	1.0002
Gibraltar	0.9998	Santo Domingo DR	1.0011
Guayaquil Ecuador	1.0016	Sao Paulo Brazil	1.0010
Hamburg West Germany	0.9983	Seoul Korea	0.9997
Hamilton Bermuda	NR	Shanghai PRC	NR
Helsinki Finland	0.9977	Singapore	1.0016
Istanbul Turkey	0.9994	Stockholm Sweden	0.9978
Jakarta Indonesia	1.0016	Sydney Australia	NR
Jiddah Saudi Arabia	1.0012	Taipei Taiwan	1.0007
Johannesburg South Africa	1.0012	Tangier Morocco	0.9998
Kingston Jamaica	1.0011	Tegucigalpa Honduras	1.0013
Kuala Lumpur Malaysia	1.0016	Tel Aviv Jaffa Israel	1.0002
London England	0.9985	Tokyo Japan	NR
Lyon France	1.9990	Victoria Hong K Kong	1.0009
Madrid Spain	1.9997	Vienna Austria	0.9988
Managua Nicaragua	1.0014	Warsaw Poland	0.9984
Marseilles France	0.9992	Yokohama Japan	0.9999
Manila Philippines	1.0013	Zurich Switzerland	0.9990
Melbourne Australia	0.9997		
Mexico City Mexico	1.0018	NR - No Adjustment Required	
Milan Italy	0.9990		

U.S.A. (States Listed Alphabetically)

Alabama		1.0002
Alaska		0.9976
Phoenix AZ		NR
Tucson AZ		1.0004
Arkansas		NR
Los Angeles CA		NR
Sacramento CA		0.9996
San Diego CA		NR
San Francisco CA		0.9997
Colorado		NR
Connecticut		0.9994
Delaware		0.9995
Washington DC		0.9996
Miami FL		1.0004
Orlando FL		1.0007
Georgia	1.0002	
Hawaii		1.0010
Idaho		0.9994
Illinois		0.9995
Indiana		0.9994
Iowa		0.9994
Kansas		0.9996
Kentucky		0.9997
Louisiana		1.0003
Maine		0.9991
Maryland		0.9995
Massachusetts		0.9993
Michigan		0.9993
Duluth MN		0.9989
Minneapolis MN	0.9991	
Mississippi		1.0002
Missouri		0.9997
Montana		0.9997
Nebraska		0.9995
Nevada		NR
New Hampshire		0.9992
New Jersey		0.9994
New Mexico		1.0005
New York		0.9992
North Carolina		NR
North Dakota		0.9989
Ohio		0.9995
Oklahoma		NR
Oregon		0.9990
Pennsylvania		0.9995
Rhode Island		0.9993
South Carolina		NR
South Dakota		0.9993
Tennessee		NR
Dallas TX		NR
Houston TX		1.0004
Utah		0.9998
Virginia		0.9998
Vermont		0.9991
West Virginia		0.9995
Washington		0.9988
Wisconsin		0.9992
Wyoming		0.9998

CANADA (Cities Listed Alphabetically)

Calgary	0.9998
Edmonton	0.9984
Halifax	0.9990
Montreal	0.9990
Quebec City	0.9989
Saskatoon	0.9985
Sydney	0.9989
Toronto	0.9992
Vancouver	0.9986
Windsor	0.9993
Winnipeg	0.9986

NR = No Adjustment Required

12.2 ALTERNATE GRAVITY FACTORS TABLE FOR LATITUDE/ALTITUDE

For locations not listed in Appendix 1, use the following table to determine the gravity adjustment factor based on the specific location's longitude and altitude. Refer to Section 4.4 for details on using this adjustment factor.

Gravity Table for Feet/Meters of Altitude and Degrees Latitude
Valid Only for Scales Calibrated at Spartanburg, SC USA

	Altitude above sea level in meters						
	0 to 650	650 to 1300	1300 to 1950	1950 to 2600	2600 to 3250	3250 to 3900	3900 to 4550
	Altitude above sea level in feet						
Degrees Latitude	0 to 2132	2132 to 4264	4264 to 6396	6396 to 8528	8528 to 10660	10660 to 12792	12792 to 14924
0.0 to 12.9	1.0016	1.0018	1.0020	1.0022	1.0024	1.0026	1.0028
12.9 to 18.4	1.0014	1.0016	1.0018	1.0020	1.0022	1.0024	1.0026
18.4 to 22.8	1.0011	1.0013	1.0015	1.0017	1.0019	1.0021	1.0023
22.8 to 26.6	1.0008	1.0010	1.0012	1.0014	1.0016	1.0019	1.0021
26.6 to 30.0	1.0006	1.0008	1.0010	1.0012	1.0014	1.0016	1.0018
30.0 to 33.2	1.0003	1.0005	1.0007	1.0009	1.0011	1.0013	1.0015
33.2 to 36.3	N/A	1.0002	1.0004	1.0006	1.0009	1.0011	1.0013
36.3 to 39.2	0.9998	N/A	1.0002	1.0004	1.0006	1.0008	1.0010
39.2 to 42.1	0.9995	0.9997	N/A	N/A	1.0003	1.0005	1.0007
42.1 to 45.0	0.9992	0.9994	0.9997	N/A	N/A	1.0003	1.0005
45.0 to 47.9	0.9990	0.9992	0.9994	0.9996	0.9998	N/A	1.0002
47.9 to 50.8	0.9987	0.9989	0.9991	0.9993	0.9995	0.9997	N/A
50.8 to 53.7	0.9985	0.9987	0.9989	0.9991	0.9993	0.9995	0.9997
53.7 to 56.8	0.9982	0.9984	0.9986	0.9988	0.9990	0.9992	0.9994
56.8 to 60.0	0.9979	0.9981	0.9983	0.9985	0.9987	0.9989	0.9991
60.0 to 63.4	0.9977	0.9979	0.9981	0.9983	0.9985	0.9987	0.9989
63.4 to 67.2	0.9974	0.9976	0.9978	0.9980	0.9982	0.9984	0.9986
67.2 to 71.6	0.9971	0.9973	0.9975	0.9977	0.9980	0.9982	0.9984
71.6 to 77.1	0.9969	0.9971	0.9973	0.9975	0.9977	0.9979	0.9981
77.1 to 90.0	0.9966	0.9968	0.9970	0.9972	0.9974	0.9976	0.9978

N/R = No Adjustment Required