

OPERATION MANUAL

Masterweigh 2 LIW Integrator

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1. Introduction

1.1 Unit features

The Masterweigh 2 is an advanced precision, microprocessor based electronic integrator.

The Masterweigh 2 is a modular design, comprising a power supply PCB, a main processing PCB, an interconnecting PCB and a display PCB. The modules conveniently plug into each other so that field service replacement is easily accomplished. The printed circuit boards are mounted in a custom chassis, which in turn mounts in an industrial enclosure.

The following are a list of the general hardware features that are standard for the Masterweigh 2 unit:

- A 10 MHz Motorola 68000 CPU.
- A simple, menu driven, user interface.
- All commands, data, etc are entered via a 16 key membrane keypad with audible beeper confirmation.
- All information, user prompts, etc are displayed via a 2 line by 40 character LCD display with backlighting.
- Mass rate and total are displayed on the Masterweigh 2 unit up to 9 digits wide.
- Circuitry to provide the CPU with advance warning of power failure.
- Automatic CPU reset in low voltage conditions.
- CPU "watchdog" monitor circuit, resets Masterweigh 2 unit if abnormal CPU operation is detected.
- Capacity for up to 512 kbytes of program EPROM.
- 16k or 64k of battery backed RAM (BATRAM).
- All CMOS circuitry for low power consumption.
- One RS232 interface.
- One RS485 interface.
- An interface connector for optional future expansion.

The following are a list of the functional features of the Masterweigh 2 unit:

- Easy, automated zero and span calibration.
- Continuous automatic calibration of analog input circuitry.
- Retention of mass total on power-down.
- "Real-time" clock with time and date.
- Accumulation of power-on hours.
- Continuous, automatic, self-diagnostic testing.
- Manual control of PID output for manual process start-up.
- Forward or reverse acting 4-20 mA output.
- mA output can be spanned to 4-20 or 4-25 mA
- Selectable mass rate/total units, tonnes/hour, kgs/hour, tons/hour, lbs/hour, kgs/min or lbs/min.

- Selectable pulse count output pulse width, 10/50/100/300 mS.
- Mains frequency selection (50/60 Hz) for maximum mains interference rejection.

The following are a list of the features of the Masterweigh 2 Loss in weight feeder :

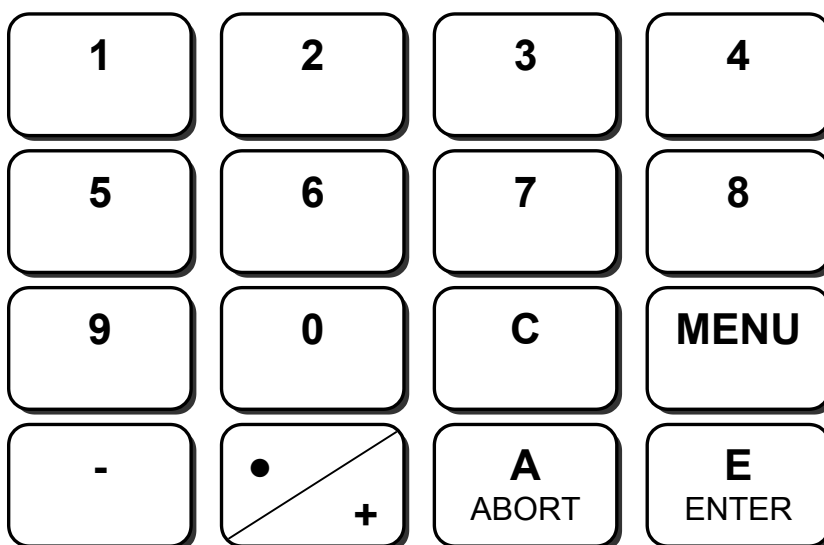
- Plug-on/plug-off field connection terminals.
- Load cell excitation output, variable from 4-12 volts.
- Load cell mV signal input channel.
- Excitation monitoring input for local or remote excitation.
- 4-20 mA remote setpoint input.
- Isolated, 12 bit, 4-20 mA output, for PID control.
- Isolated, 12 bit, 4-20 mA output for remote rate indication.
- Isolated pulse counter output for external totalisation.
- 4-20mA & pulse outputs can be powered from unit or externally.
- Refill mechanism control by a voltage free relay contact output.
- High & low rate alarms with voltage free relay contact outputs.
- High & Low hopper weight alarms with voltage free relay contact.
- Hopper near empty alarm with voltage free relay contact.
- LIW process inhibit (start/stop) optically isolated digital input.
- 2 x >1kHz pulse counter/frequency inputs.
- 2 x optically isolated digital inputs.

1.2 Using the Keypad, LCD Display and Menu System

The user interface for the Masterweigh 2 unit consists of a 16 key membrane keypad for data entry and a 2 line by 40 character LCD unit for information display.

The Masterweigh 2 user interface is based on a menu system consisting of a main mass rate/total menu, and several additional menu "entries" for display and modification of unit configuration. Each menu entry may include several "steps" which display information, allow parameter modification, etc.

The keypad layout is as follows:



All keys will "auto-repeat" at a rate of 10 times per second if held down for more than one second.

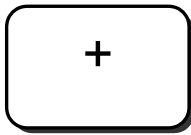
The functions of the keys are as follows:



This key switches between the main mass rate / total menu display and the menu entry mode. From the mass rate/total menu, pressing Menu will display a scrolling list of menu options. From anywhere in the menu entry mode, pressing Menu will prompt the user with the following message:

To update stored parameters, press Enter
else press Abort

Pressing Enter will return to the main mass rate / total menu, saving all parameter modifications made while in the menu entry mode. Pressing Abort will return to the main mass rate/total menu, without saving any modifications made while in the menu entry mode.



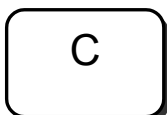
When in menu entry mode, this key is used to go forward one menu entry.



When in menu entry mode, this key is used to go backward one menu entry. It is also used to enter negative parameter values (where permitted).



When in menu entry mode, pressing Abort will return to step zero (top level) of a menu entry.

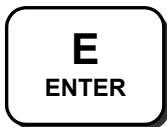


(Clear)

When entering a data value, pressing Clear will cancel the displayed value, allowing a new value to be entered. The Clear key is also used to perform functions in certain menu entries. In these cases, the menu will explain the use of the Clear key.



These are the data entry keys used in menu entry steps that request parameters values.



When in the menu entry mode, pressing Enter will advance to the next menu entry step, at the same time accepting any data entered in the current step, or if no value was entered, the previous value is re-confirmed. When in the main mass rate/total display mode, pressing Enter displays the Masterweigh 2 system status menu.

1.3 The Main Mass Rate/Total Menu

1.3.1 Main Mass Rate/Total Display:

The main rate/total menu displays the following information:

- the instantaneous mass rate,
- the current mass rate units,
- the current mass total,
- the current mass total units, and
- status flags.

The upper right-hand area of the display is used to display an animated system heart-beat to indicate normal Masterweigh 2 operation.

A typical Masterweigh 2 unit main mass rate/total menu display would look like:

Mass rate =	1356.22 kgs/hour	^
Mass total =	45678.01 kgs	L A L h L

1.3.2. System Status Menu:

Pressing Enter from the mass rate / mass total display will show the System status menu. Normally, the system status menu displays the number of times the Masterweigh 2 unit has been reset (powered-up) and the number of times the system parameters have been configured to the default state, ie.:

SYSTEM	Resets =	1	(+ to clear)
NORMAL	Configures =	0	(- to clear)

When the Masterweigh 2 unit detects a system error it will flash the LCD display when the main mass rate/total menu is displayed. The user should then display the system status menu to determine the cause of the system error, this is performed by pressing Enter when the main mass rate/total menu is displayed, ie.:

SYSTEM ERROR !! (Press Clear to reset)
Novram checksum error

The detected error condition can be acknowledged/reset by pressing Clear, but if the source/cause of the error condition remains, the error will be detected and displayed again.

1.3.3. EPROM Header Information Menu:

Information about the Masterweigh 2 EPROM software version currently installed can be displayed. This menu is accessed by pressing Enter from the system status display (Enter-Enter from the main mass rate/total display).

The format of the display is as follows:

Eprom Header Information: Version - J.0T Date - 15/07/99

If Enter is pressed from this screen, the display will prompt for the option to test the operation of the display, as such :

Press E for LCD test, else press Abort When display test complete, press Enter

Pressing Abort will return to the Mass Rate / Mass Total display. Pressing Enter will fill the screen with black segments, so that you can tell if any segments are not working correctly (every letter segment on the screen should be a matrix of black dots). Press Enter or Abort to return to the Mass Rate / Mass Total display.

2. LOSS IN WEIGHT UNIT OPERATION

2.1 Loss in Weight - Introduction

Loss In Weight is a method of weighing and dispensing bulk materials from a hopper via a screw feeder. The principle is based on weighing the entire mass of the hopper, feed-out mechanism and bulk material.

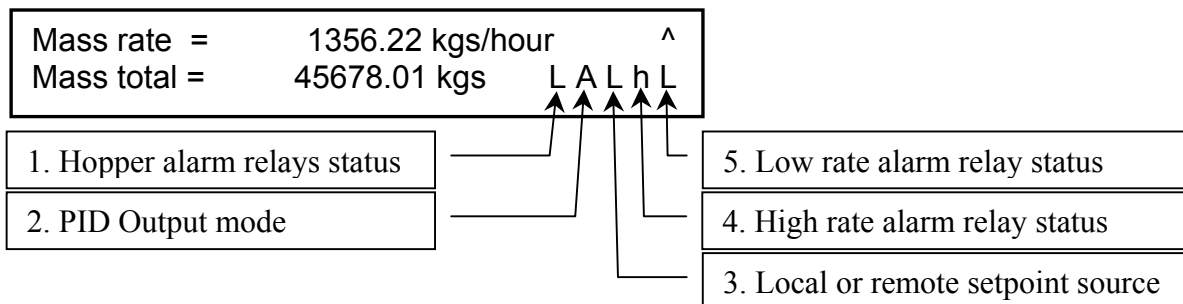
The discharge rate is determined by measuring and computing the loss in weight per unit time of the entire system.

The feed hopper must be re-filled at regular intervals, this is initiated when the weight of the material in the feed hopper falls below a pre-set level. While the feed hopper is re-charging it is not possible to measure the loss in weight of the system.

During hopper re-fill and start-up the system operates in volumetric mode, adjusting the feeder screw speed to the average speed used for the last discharge cycle, taking into account any setpoint change, and integrating mass total on the basis of mass rate x re-fill duration.

2.1.1 Status Display

The lower right-hand area of the main mass rate / total display is used to show a status summary for the Masterweigh 2.



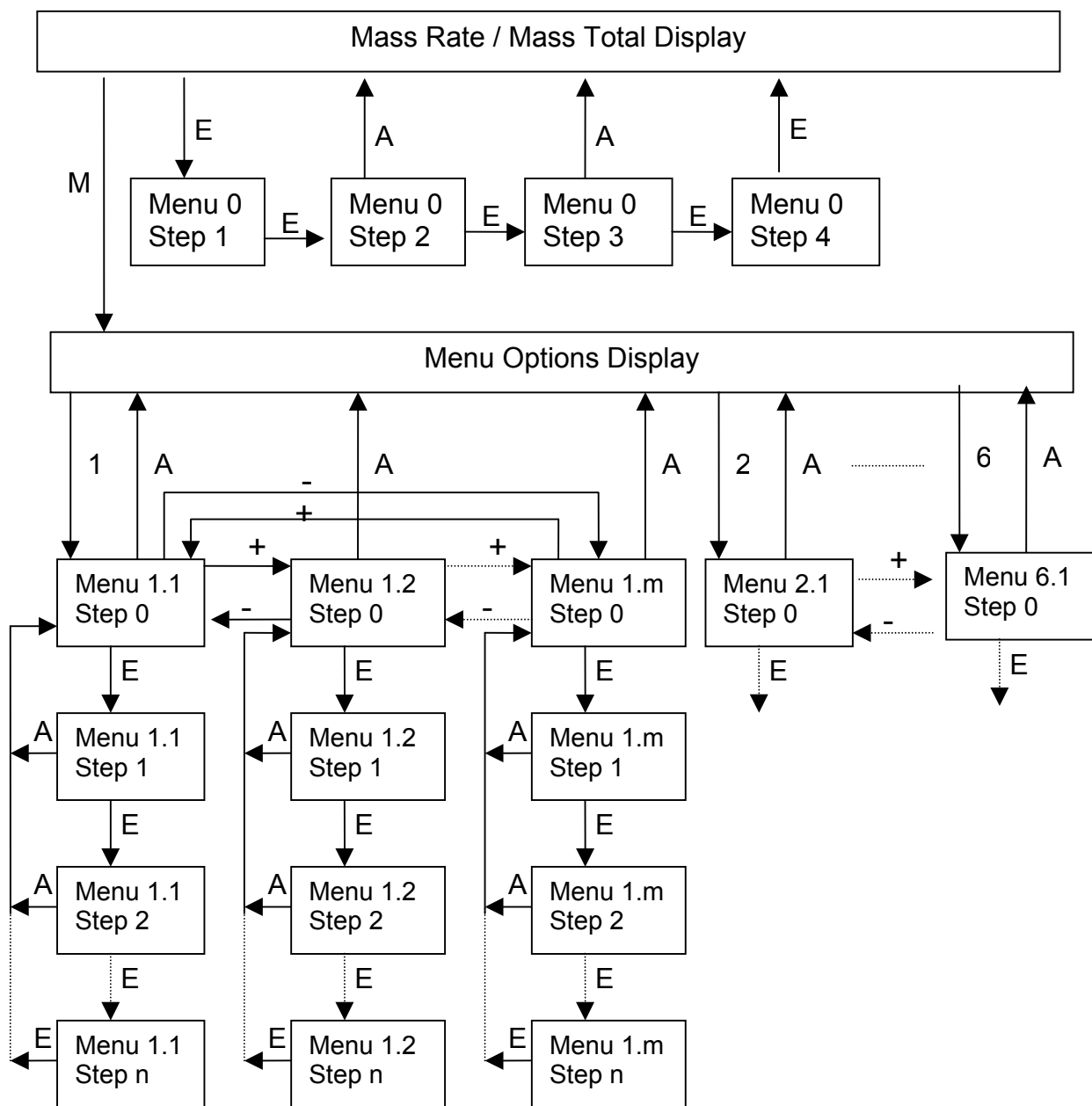
The status display is 9 characters wide and consists of 5 status flags separated by spaces. The displayed status flags and their meanings are as follows:

1. L/H - indicates if a low or high hopper weight alarm relay status.
Blank = OFF,
L = ON (low level alarm),
H = ON (high level alarm).
2. A/V/R/B/r indicates mode of control of the loop 4-20 mA output,
A = Automatic,
V = Volumetric,
R = Rate indicating,
B = Batching mode,
r = refill (volumetric).

3. L/R - indicates local or remote setpoint source
4. H/h - indicates high rate alarm relay status,
H = On,
h = Off.
5. L/l - indicates low rate alarm relay status,
L = On,
l = Off.

2.1.2. Selecting Menus

The Menu Structure of the Masterweigh 2 Loss In Weight is set up as shown :



When the system is reset or turned on, the screen shows the Mass Rate / Mass Total display. From this menu, pressing “E” will bring up the “Menu 0” sub-menu, which is used by technicians for diagnostic purposes. Pressing “E” will move through the options of Menu 0, then return to the Mass Rate / Mass Total display after all of the options of Menu 0 have been viewed. Pressing Abort will return to the Mass Rate / Mass Total display.

Pressing Menu from the Mass rate / Mass Total display will bring up the menu mode, with a scrolling screen showing the options, as detailed below. Selecting a number will enter that menu. From within a menu, using “+” and “-” will scroll through the sub-menus in that menu. The sub-menus are arranged in a circular fashion, so pressing “+” from the last sub-menu will show the first sub-menu, and pressing “-” from the first sub-menu will show the last sub-menu. Pressing Enter will enter the currently displayed sub-menu, showing option 1. The option can be edited, then press Enter to accept the entry, or you may press Enter without entering a new value for the option, and continue to the next option. From within any sub-menu, pressing “Abort” will return to the top level of that sub-menu. Pressing “Abort” again will move up to the “Menu Options Display”.

From anywhere in the menu structure, pressing “Menu” will show the following Confirmation screen :

Confirmation Screen :

Press Enter to update stored parameters
else press Abort

Pressing “Enter” at this point will save all of the parameter changes made since the last entry to the menu structure to permanent memory, and return to the Mass Rate / Mass Total display. Pressing “Abort” will return to the Mass Rate / Mass Total display and restore all of the previous parameter values.

Upon pressing the Menu key whilst in the main Mass Rate / Mass Total display, the screen will progressively scroll through the following three selection screens:

Screen 1:

PRESS 1 FOR SETUP
PRESS 2 FOR CALIBRATION

Screen 2:

PRESS 3 FOR TUNING
PRESS 4 FOR DIAGNOSTICS

Screen 3:

PRESS 5 FOR TIME
PRESS 6 FOR CLEAR MASS TOTAL

Selecting keys 1 through to 6 will enter into the submenu system as listed above.

Example:

Pressing "1" will enter the "SETUP" submenu, whose first submenu is as below

PRESS ENTER FOR SYSTEM CONFIGURATION

Pressing "Enter" will enter the submenu displayed. Pressing "+"/" will progress through other submenus available. Pressing "Abort" whilst within the submenu will take you to the submenu selection screen (Step 0) as shown above. Pressing "Abort" whilst a submenu selection screen is displayed will take you to the main menu progressive display screens.

2.2 Menu Entry 1 - Setup

2.2.1. System Configuration

The system configuration menu is used for the entry of the following load cell input channel configuration parameters:

- entering the mass rate capacity,
- entering the mass total increment,
- entering the pulse counter output pulse duration,
- initiating a print out of all parameters via the serial port.

Step 0 displays the following.

Step 0

PRESS ENTER FOR
SYSTEM CONFIGURATION

Pressing Enter advances to:

Step 1

Current capacity = 2.000 tonnes/hour
Enter new value: 0.000

At this stage, a new value for the nominal full scale capacity may be entered. The 4-20mA Rate output is scaled to this value as 100%.

Pressing Enter advances to:

Step 2

Mass total increment = 0.01 tonnes
Enter new inc. (0.001 - 10): 0.000

At this stage a new value for the displayed mass total increment in the main mass rate/total menu can be entered. This value must be one of the list 0.001, 0.01, 0.1, 1 or 10. Values outside this range are ignored, and values inside the range but not equal to one of the list values are rounded down to the next list member.

The value selected here determines the number of decimal places displayed for both the mass rate and mass total values in the main mass rate/total menu.

Note: That for each time the mass total is increased by the mass total increment value selected, a pulse counter output pulse will be generated.

Note: That by choosing a mass total increment that is small compared to the mass rate, the pulse counter output rate required may be beyond the rate possible and

hence cause the external pulse counter to fall behind the mass total displayed in the main mass rate/total menu.

Pressing Enter advances to:

Step 3

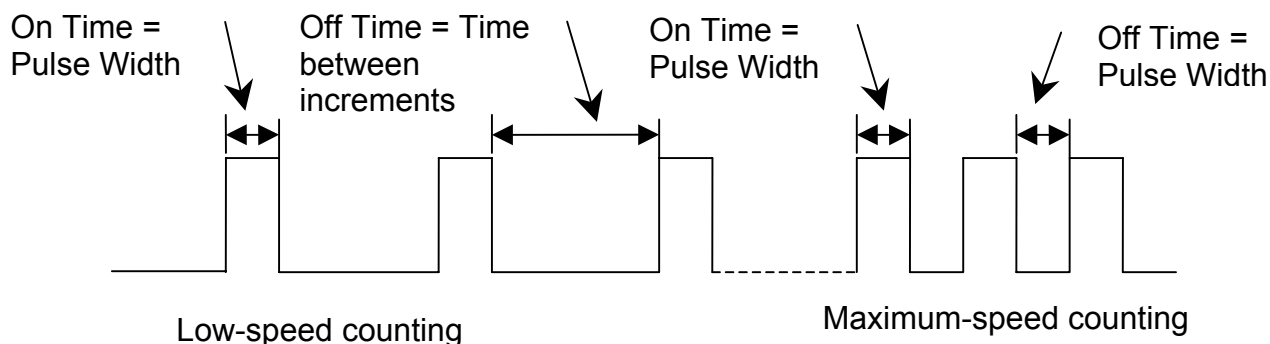
Current pulse width = 100 mS
Press Clear to change, Enter to accept

Pressing Clear will cycle the pulse output duration through the list 10, 50, 100 and 300 mS.

The duration selected is the ON and minimum OFF times for the pulse counter output waveform, hence the minimum pulse counter output pulse width is twice the duration selected. For each of the possible pulse durations the maximum pulse counter output frequency is:

- 10 mS = 50 Hz,
- 50 mS = 10 Hz,
- 100 mS = 5 Hz, and
- 300 mS = 1.67 Hz.

Eg.



Pressing Enter will accept the displayed pulse output duration and advances to:

Step 4

Press Clear to print parameter list
Press Enter to continue

Pressing Clear will initiate a print out of all configuration parameters stored in the Masterweigh 2 unit.

The print out is sent to the device connected to the serial port, ie. printer, terminal, etc.

The serial port is configured as follows:

Baud rate = 19200 baud,
Data bits = 8,
Stop bits = 1, and
Parity = none.

Pressing Enter again will return to menu entry 1, level 0, i.e.

PRESS ENTER FOR SYSTEM CONFIGURATION

From this point, pressing + will advance to the second option in menu entry 1, level 0, which is Displayed Units.

2.2.2. Displayed Units

Step 0

PRESS ENTER FOR
DISPLAYED UNITS

The displayed mass units menu is used to select the desired units to be displayed for the mass rate and the mass total values from the available list of:

- kgs/min and kgs, and
- lbs/min and lbs.
- kgs/hour and kgs,
- lbs/hour and lbs,
- tons/hour and tons,
- tonnes/hour and tonnes,

Step 1 displays the following:

Step 1

Current displayed units are: tonnes/hour
Press Clear to change, Enter to accept

Pressing Clear will cycle the displayed mass units through the available as shown above.

Pressing Enter will accept the displayed mass units and return to Step 0 above. Pressing Abort will reject the changes and return to Step 0 above, restoring the previous units.

2.2.3. LIW Parameters

The Loss In Weight Parameters menu is used to enter an display the following parameters:

- the current "live" feed hopper contents weight,
- the mass level at which to begin hopper refill, and
- the mass level at which to end hopper refill.

Step 0 displays the following:

Step 0

PRESS ENTER FOR
LIW PARAMETERS

Pressing Enter advances to:

Step 1

Current hopper weight = 25.548 tonnes Press Enter to continue

This screen is displayed for information purposes only. Press Enter to advance to the next screen.

Step 2

Hopper refill start = 0.050 tonnes Enter new value: 0.000

At this stage, a new value for the live load mass at which hopper refill is to commence can be entered.

Pressing Enter advances to:

Step 3

Hopper refill stop = 0.350 tonnes Enter new value: 0.000

At this stage, a new value for the live load mass at which hopper refill is to stop can be entered.

As the hopper is discharging, when the hopper weight reaches the “refill start” level, the refill mode will start, and the system will stay in refill mode until the hopper weight reaches the “refill stop” level.

Pressing Enter advances to:

Step 4

Delay after refill = 5 seconds Enter new value: 0

At this stage, the current delay after refill time in seconds is displayed and a new value may be entered. This delay dictates how long the Masterweigh 2 should remain in volumetric mode after refill before recommencing Automatic Control. This allows for the material contents in the hopper to settle. Pressing Enter advances to:

Step 5

Maximum refill time = 120 seconds Enter new Value: 0

At this stage, the maximum refill alarm time in seconds is displayed and a new value may be entered. If the refill time exceeds that shown here, then an Excessive Refill Time alarm is set (refer to Relay Outputs section 3.10). This alarm is reset when the hopper reaches the refill stop point. Pressing Enter advances to:

Step 6

Nominal discharge time = 450.00 sec Press Enter to continue

At this stage, the nominal hopper discharge time (time from end of refill to beginning of next refill) is displayed. This value is calculated based on the live load of the hopper (hopper refill stop mass minus hopper refill start mass) and the desired mass rate setpoint.

It is displayed for information purposes only.

Press Enter to move to step 7, in-flight compensation.

The Material In-flight menu is used to set the mode of operation of material in-flight compensation and enter a value for manual material in-flight compensation.

At the end of the refill procedure, refill is shut off when the measured live load weight reaches the pre-set refill high limit. Without material in-flight compensation the refill high limit weight will be over shot by the amount of material "in-flight" between the refill hopper and the discharge hopper. If this over shoot is a problem then it can be compensated for either manually or automatically. Compensation is achieved by ending the refill prior to achieving the desired level.

Manual compensation is achieved by the user observing the amount of over shoot and entering this value. Automatic calibration is achieved by the Masterweigh 2 system measuring the "gain in weight" that occurs after the end of the refill cycle.

Step 7 displays the current material in-flight compensation factor and the current mode of compensation operation.

Step 7

Material in-flight = 0.005 tonnes Material in-flight mode = Automatic

At this stage, the mode of the material in-flight compensation is indicated. Pressing Enter advances to:

Step 8

Material in-flight = 0.005 tonnes Enter new value: 0.000

At this stage, the current manual material in-flight compensation factor is displayed and a new value may be entered.

Pressing Enter advances to:

Step 9

Material in-flight mode = Automatic
Press Clear to change, Enter to accept

At this stage, the current mode of operation of material in-flight compensation is displayed, Manual or Automatic.

Pressing Clear will toggle between the two options for mode of operation.

Pressing Enter will accept the displayed mode of operation and return to Step 0 above.

From step 0, press + to move to the next option, Hopper high and low level alarms.

2.2.4. Hopper High / Low Level Alarms

The high and low level alarm menu entry is used to enter the hopper mass levels above and below which, and the qualifying periods the hopper must remain above or below, before the high and low level alarm relays will be activated.

I.e. If the hopper weight stays below the “low level alarm level” for as long as the “low level alarm delay”, the low level alarm condition is set. The low level alarm condition is automatically cleared as soon as the hopper level rises above the low level alarm level.

The level alarm status is shown on the Mass Rate / Mass Total display as a letter on the bottom right hand corner of the display, in the far left position of the indicator letters. When a low level alarm is active, an “L” is displayed in this position. When a high level alarm is active, an “H” is displayed, and nothing is displayed when there are no alarms active.

Mass rate =	1356.22 kgs/hour	^
Mass total =	45678.01 kgs	L A L h L

Hopper alarm relays status

Step 0

PRESS ENTER FOR
HOPPER HIGH / LOW LEVEL ALARMS

Press enter from the top level of this menu to edit the levels and delays for the

alarms.

Step 1

High level alarm level =	30.000 tonnes
Enter new value:	0.000

At this entry point the current high level alarm level is displayed, and the user has the option to enter a new level. The level is measured in the currently programmed mass units. Pressing Enter will accept a new level and proceed to the next step. If no new value is entered and Enter is pressed, the old value will be retained.

Step 2

High level alarm delay	60 seconds
Enter new value:	0

Enter the new high level alarm delay time in seconds, if the current displayed delay is unsuitable. Pressing Enter will accept the new value, (or retain the old value if no new value was entered), then proceed to the next step.

Step 3

Low level alarm level =	30.000 tonnes
Enter new value:	0.000

Step 4

Low level alarm delay	60 seconds
Enter new value:	0

Step 3 and 4 behave the same as steps 1 and 2, setting the parameters for the low level alarm.

2.2.5. Hopper High / Low Deviation Alarms

The low deviation alarm menu entry is used to enter the percentage below the mass rate setpoint which the mass rate must deviate by, and the qualifying period it must remain below, before the low rate alarm relay will be activated.

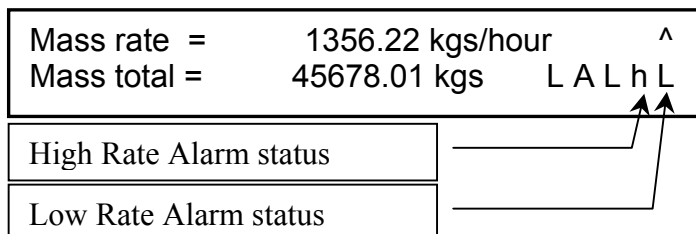
Similarly, the high deviation alarm menu entry is used to enter the percentage above the mass rate setpoint which the mass rate must deviate by, and the qualifying period it must remain above, before the high rate alarm relay will be activated.

The deviations are measured as a % of programmed full scale feeder capacity.

The low rate alarm condition is automatically cleared as soon as the mass rate rises above the low rate alarm level. When a low rate alarm is active an "L" is displayed in the lower right hand corner of the main mass rate/total menu, otherwise an "I" is

displayed.

The high rate alarm condition is automatically cleared as soon as the mass rate falls below the high rate alarm level. When a high rate alarm is active and "H" is displayed in the lower right hand corner of the main mass rate/total menu, otherwise an "h" is displayed.



Step 0

PRESS ENTER FOR HOPPER HIGH/ LOW DEVIATION ALARMS

From step 0 of this menu, press Enter to edit the parameters relevant to the deviation alarms.

Step 1

High dev. alarm = +	5.0 % above s.p.
Enter new value:	0.000

At step 1, enter the percentage of full scale above the current setpoint that the mass rate may deviate before the alarm is triggered. Use the numeric keys to enter a new value, then press Enter to accept the new value, or press Enter without typing a new value to retain the old value.

Step 2

High dev. alarm delay =	60 seconds
Enter new value:	0

At step 2, you may enter the delay time that the rate should be above the setpoint before the alarm is triggered.

Step 3

Low dev. alarm = -	5.0 % below s.p.
Enter new value:	0.000

Step 4

Low dev. alarm delay =	60 seconds
Enter new value:	0

Step 3 and 4 behave the same as steps 1 and 2, setting the parameters for the low rate deviation alarm.

Press Enter again to return to the level 0 of the deviation alarms menu, then press + to progress to the Filters menu.

2.2.6. Filters

Step 0

PRESS ENTER FOR FILTERS

From step 0, press Enter to edit the filter time constants.

The digital filter time constant menu is used to enter time constants for the five digital filters provided by the Masterweigh 2 unit. These filters are:

- displayed mass rate filter,
- 4-20 / 25 mA rate output filter,
- PID input filter,
- PID output filter, and
- 4-20 mA remote setpoint filter.

The digital filters are implemented using a weighted average of the current and previous signal values. The filters will "smooth" rapidly varying signals and introduce a delay equal to the time constant selected.

Step 1 displays the following.

Step 1

Display time constant is	1 sec
Enter new value:	0

At this stage, a new value for the displayed mass rate filter time constant may be entered. This filter affects the mass rate as shown on the Masterweigh 2 display in the Mass Rate / Mass Total mode.

Pressing Enter advances to:

Step 2

Rate output time constant is	1 sec
Enter new value:	0

At this stage, a new value for the 4-20 mA rate output filter time constant may be entered. This filter affects the mass rate as transmitted via the current loop output.

Pressing Enter advances to:

Step 3

PID input time constant is	0 sec
Enter new value:	0

At this stage, a new value for the PID input filter time constant may be entered. The PID input is the error between the current setpoint and the current mass rate, and is the parameter that the PID action is performed on. Changing this value will affect the response of the PID control loop.

Pressing enter advances to:

Step 3

PID output time constant is	0 sec
Enter new value:	0

At this stage, a new value for the 4-20 mA PID control output filter time constant may be entered. This filter smooths the output from the Masterweigh 2's PID algorithm to the controlling device (e.g the inverter).

Pressing Enter advances to:

Step 4

Remote input time constant is	1 sec
Enter new value:	0

At this stage, a new value for the 4-20 mA remote setpoint input filter time constant may be entered. Increasing this filter will smooth the setpoint perceived by the PID algorithm.

Pressing Enter returns to Step 0 above. Pressing + will then proceed to the Batching Parameters menu.

2.2.7. Batching Parameters

The Batching Parameters menu is used to enter and modify the following parameters for controlling batch mode operation:

- batch target setpoint,
- batch "fast" screw speed,
- batch "dribble" screw speed, and
- percentage of batch to dribble.

The user may also control the batch discharge manually from this menu.

Batch mode operation allows preset amounts of material to be accurately dispensed by the loss in weight controller. In batch mode the controller will initially feed at a high constant speed to deliver the bulk of the batch. Then after a preset percentage of the required batch mass has been delivered, the feed rate is slowed to a preset "dribble" level to allow accurate dispensing of the remainder of the required batch.

Step 0

PRESS ENTER FOR
BATCHING PARAMETERS

Step 1

Batch mode = Off
Go to "PID CONTROL MODE" menu to change

Step 1 indicates if batch mode operation has been selected. If you wish to run a batch and the display shows "Batch mode = Off", press Abort to exit this menu, then + to move to the PID Control Mode Menu, where you can set the PID control mode to "Batching". Pressing Enter advances to:

Step 2

Press Clear to start batch
Press Enter to display Batch status

If the Masterweigh 2 unit is in batch mode, then pressing the Clear key will begin the batch and automatically advance to the batch status menu. If a batch has already been started, or if the Masterweigh 2 unit is not in batch mode, pressing C will do nothing.

Step 3

Status: Batch Setpoint = 0.300 tonnes Batch Delivered = 0.000 = 0.000%

At this stage, the status of the current batch operation is displayed for information. Indicated is the desired total batch setpoint, the total amount of the batch delivered to date in terms of mass and the total amount of the batch delivered to date in terms of percent of total requested batch.

If Enter is pressed before the batch is complete, operation advances to step 4 below.

Pressing Enter when no batch operation is active, or when the batch is complete advances to step 5 below.

Step 4

Press Clear to abort current batch Press Enter to continue

At this stage, the operator may abort the current batch by pressing the Clear key.

If the Clear key is pressed operation returns to step 0.

If the active batch is completed while this menu is displayed, operation automatically jumps to step 5.

Step 5

Batch Setpoint = 0.300 tonnes Enter new value: 0.000

At this stage, a new value for the desired total batch mass may be entered.

Pressing Enter advances to:

Step 6

Fast feed speed = 80.0% Enter new value: 0.0

At this stage, a new value for the "fast" batching screw speed (in terms of percentage of 4-20 mA control signal) may be entered.

Pressing enter advances to:

Step 7

Dribble feed speed = 80.0%
Enter new value: 0.0

At this stage, a new value for the "dribble" batching screw speed (in terms of percentage of 4-20 control signal) may be entered.

Pressing enter advances to:

Step 8

% of batch to dribble feed = 12.0%
Enter new value: 0.0

At this stage, a new value for the final portion of the batch (in terms of percentage of the total batch requested) to feed at the slower "dribble" speed may be entered.

Pressing Enter returns to Step 0 above, and pressing + advances to the PID Control Mode menu.

2.2.8. PID Control Mode

Step 0

PRESS ENTER FOR PID CONTROL MODE

Press Enter to edit the PID output mode of operation.

Step 1

PID output mode = Automatic
PID output Action = Forward

Step 1 of this menu displays the current PID output mode and control action direction. Pressing Enter advances to:

Step 2

Rate= 1034.962 S.P.= 1000.0 O/P= 34.1%
+/- controls Vol. O/P, press E when done

Here the current mass rate, PID setpoint and PID control output (as a percentage) are displayed.

If volumetric PID output control mode is selected, the PID output is forced to the value displayed in the upper right of the display and may be manually driven up (with the "+" key) or down (with the "-" key) in 0.5% increments.

Note: That if keys are held down for more than one second, they will auto-repeat at a rate of 10 times per second for fast setting of the manual mode PID output. The range of the PID output is limited to values between 0% (4mA) and 100% (20/25 mA).

This feature is useful for starting up controlled processes with long delays between the point of material feed and weighing. These types of processes can otherwise be subject to PID control output oscillations until a steady mass flow is established at the point of weighing. This mode is also used for testing and diagnostic purposes by Webtech Technicians.

The Masterweigh 2 ensures that the change-over from manual to automatic PID output is "bumpless", by forcing the automatic PID output to track the manual value while manual (Volumetric) control mode is selected.

Pressing Enter advances to:

Step 3

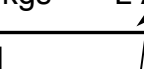
PID output mode is Automatic
Press Clear to change, Enter to accept

Pressing Clear will toggle the PID output mode between automatic, volumetric, mass rate, and batching.

In the mass rate / mass total display, the current PID output mode is indicated by a letter in the lower right hand corner of the display, in the second position from the left.

Mass rate = 1356.22 kgs/hour ^
Mass total = 45678.01 kgs L A L h L

PID Output Mode Status Flag



When operating in Automatic PID output mode, and the system is in it's normal discharge mode, an "A" is displayed as the PID Output Mode Status Flag, and the PID output is determined by the PID algorithm.

When operating in Automatic PID output mode, and the system is in the hopper refill mode, an "r" is displayed as the PID Output Mode Status Flag, and the PID output is frozen at the last output level before refilling.

When operating in Volumetric PID output mode a "V" displayed as the PID Output Mode Status Flag, and the operator may set the PID out using step 1 of this menu entry.

When operating in Mass Rate PID output mode an "R" is displayed as the PID

Output Mode Status Flag, and the PID output will produce a 4-20/25 mA remote mass rate indication signal.

When operating in Batching PID output mode a "B" is displayed as the PID Output Mode Status Flag, and the PID output will produce a Batching Control PID signal.

Pressing Enter will accept the displayed PID output mode and advance to:

Step 4

PID output action is Forward
Press Clear to change, Enter to accept

Pressing Clear will toggle the PID output action direction between forward (0% = 4mA, 100% = 20/25mA) and reverse (0% = 20/25mA, 100% = 4mA).

Pressing Enter will accept the displayed PID output action direction and advance to:

Step 5

PID output range is 4-20 mA
Press Clear to change, Enter to accept

Pressing Clear will toggle the PID output span range between 4-20mA and 4-25mA.

Pressing Enter will return to step zero above. Press + to move to the Setpoint Menu.

2.2.9. Setpoint

Step 0

PRESS ENTER FOR
SETPOINT

The setpoint mode menu is used to select the source, and set the local value of the mass rate setpoint for the PID control loop. The setpoint may be either local or remote. The local setpoint is a fixed value that is entered via the Masterweigh 2 unit keypad. The remote setpoint value is determined by a 4-20 mA signal that may be input via the Masterweigh 2 unit auxiliary input channel.

In the remote setpoint mode it is possible to use two, or more, Masterweigh 2 units in a master/slave (cascade) configuration, the setpoint for the slave(s) being a fixed proportion of the mass rate of the single master unit.

Alternatively, the remote setpoint may come from any device capable of generating the required 4-20mA remote setpoint signal.

Step 1 of this menu displays the current PID setpoint value and the setpoint mode (local or remote).

Step 1

Setpoint source is Local
Setpoint = 0.500 tonnes/hr

This menu is for display purposes only, there is no editing available at this stage. Pressing Enter advances to:

Step 2

Setpoint source is Local
Press Clear to change, Enter to accept

Pressing Clear will toggle the setpoint source between local and remote.

When operating in Local setpoint mode an "L" is displayed in the lower right hand corner of the main mass rate/total menu.

When operating in Remote setpoint mode an "R" is displayed in the lower right hand corner of the main mass rate/total menu.

Mass rate =	1356.22 kgs/hour	^
Mass total =	45678.01 kgs	L A L h L

Setpoint Source Status Flag

Pressing Enter will accept the displayed setpoint source and advance to:

Step 3

Local Setpoint =	800.000 tonnes/hour
Enter new value:	0.000

At this stage, a new local PID target setpoint mass rate may be entered. Enter the new setpoint via the keypad, then press Enter to accept, or press Enter without typing a new setpoint to accept the currently displayed value. This value will only be used for control purposes if the Setpoint Source is set to "Local".

Pressing Enter advances to:

Step 4

Master capacity =	1000.000 tonnes/hour
Enter new value:	0.000

At this stage, a new remote master full scale capacity mass rate value may be

entered. This value is taken to be the master unit mass rate represented by a full scale (20 mA) input signal to the auxiliary/remote setpoint 4-20 mA input channel.

For example:

Master capacity = 1000.000 tonnes/hour, Remote setpoint input = 56% of 4-20 mA, then Current computed master mass rate = 560 tonnes/hour.

Pressing Enter advances to:

Step 5

Slave rate = 66.667 % of Master rate Enter new value: 0.000

At this stage, a new value may be entered for the percentage of the master rate to which the slave unit(s) remote setpoint(s) must be scaled.

For example:

Programmed master mass rate = 1000.000 tonnes/hour,
Slave rate = 33.333 % of master rate, then
Current computed slave mass rate remote setpoint = 333.333 tones/hour.

This ratio can be used to batch an ingredient into a mix at a ratio of a master ingredient easily. E.g. for an ingredient dosed by the Masterweigh 2 is dosed at 1 parts to every 2 parts of the master ingredient, set the Masterweigh 2 capacity, the Master Capacity, and the remote system's capacity to the same values, then set the Slave Rate to 50%. If the ingredient dose changes to 1 in 3, set the slave rate to 33.333%.

Pressing Enter returns to step zero above. Pressing + will scroll around to the first option in submenu 1, System Configuration. You can press Abort to get back to the first menu level, then 2 to enter the calibration menu.

2.3. Menu Entry 2: Calibration

2.3.1. Hopper Zero Calibration

The zero calibration menu is used to perform the calibration required to set the hopper dead weight level.

This value is then subtracted from all mass readings to determine the bulk material live load.

Step 0

PRESS ENTER FOR
HOPPER ZERO CALIBRATION

Step 1

Zero Offset = 9.052 mV
Enter new Value: 0.000

Step 1 displays the currently stored value of zero calibration in mV. A new value can be entered, for example when a board is replaced in emergency. Note that copying the value from an old board to a new board when the board is swapped out does not give an accurate calibration, but does give a rough starting point, for short-term use if a full calibration is not feasible immediately.

Step 2

Current Weight = 0.050 tonnes
Press Enter to zero

This menu displays the current total weight on the scale, using 0mV as a reference. To account for the dead weight of the hopper and the feeder, press Enter. This will move to step 3.

Step 3

Current Weight = 0.050 tonnes
Press Enter to record zero offset

This menu displays the current total weight again. Ensure that the hopper and feeder are empty of product, then press Enter to calibrate the empty weight of the system. If the calculated zero offset is within the valid range of 0.0mV to 20.0mV, the screen will change to step 4. If the calculated zero offset is outside this range, screen 5 will be displayed.

Step 4

New zero offset = 9.052 mV
Press Enter to save, else press Abort

The Masterweigh 2 has just measured the current load cell output, and recorded it as the zero offset. This message will be displayed if the value recorded was valid. If this value was recorded correctly (i.e. the hopper was empty and stable when this menu step was entered), press Enter to save the zero calibration into permanent memory. The display will then change back to Step 0 of this menu. Press + to move to the Hopper Span Calibration Menu.

Step 5

New zero offset of 20.250 mV is invalid
Press Enter to continue

This message is displayed if the zero calibration produces a new zero offset less than 0mV or greater than 20mV. This is an abnormal condition, so the zero calibration will be aborted and the previous zero level used for calculations. You should determine why this condition has arisen, and take measures to correct the situation. This situation may be caused by a damaged load cell, attempting to calibrate when the hopper is full, or if there is too much tare action resulting in no load or negative load on the load cells. Pressing Enter or Abort will return the display to step 0 of the Hopper Zero Calibration menu without recording a new zero offset. You should correct the fault then proceed through this menu again to zero the hopper.

2.3.2 Hopper Span Calibration

The Fixed Weight Span Calibration menu is used to determine a new span calibration factor based on reference calibration weights. For loss in weight applications the reference weight(s) are simply placed in or on the feeding system so that they provide a constant reference mass during the calibration procedure.

Once the initial span calibration for the Masterweigh 2 unit has been set using the Empirical span calibration procedure, it is possible to "calibrate" a reference weight by placing it in or on the feeding system and weighing it. The mass total obtained is then "target mass" that would be expected by repeating the fixed weight calibration procedure.

The fixed weight span calibration procedure is used to check the mass obtained by weighing the reference weights. Given that the zero error calibration has been performed, then any discrepancy between the initial target mass of the calibration reference weights and the total obtained by the fixed weight span calibration procedure is due to changes in the required span factor. The Masterweigh 2 unit will automatically calculate the new span factor required.

Step 0

PRESS ENTER FOR
HOPPER SPAN CALIBRATION

From this level, press Enter to begin the span calibration.

Step 1

Hopper span factor = 155.290
Enter new value: 0.000

The span factor may be manually entered at this point, if it is known. A new value can be entered, for example when a board is replaced in emergency. Note that copying the value from an old board to a new board when the board is swapped out does not give an accurate calibration, but does give a rough starting point, for short-term use if a full calibration is not feasible immediately.

Step 2

Current hopper weight = 0.005 tonnes
Press Enter to continue calibration

This menu level is for display purposes only, and is used by Webtech technicians. It displays the current measured hopper weight using the existing span factor. Press Enter to proceed to the next level.

Step 3

Test Weight total = 0.250 tonnes
Enter new value: 0.000

This menu shows the weight that the Masterweigh 2 will be expecting to see in the hopper when the next stage is complete. If this is not the correct calibration weight (the test weights to be added for calibration only, not including the dead weight of the hopper), type in the correct weight, using the mass units shown, then press Enter. If the weight shown is correct, simply press enter.

Step 4

Apply test weight
Press Enter to continue calibration

The test weights should be secured in place and the system allowed to stabilise, then press Enter to continue.

Step 5

Current hopper weight = 0.245 tonnes Press Enter to record Span calibration

The value shown here is the calculated weight using the old span, and is used to calculate the error existing in the system before the calibration takes place. Press Enter to correct for this error. The Masterweigh 2 will now calculate a new span, based on the hopper weight measured with the old span value and the programmed test weight. If the new span is valid, the display will progress to Step 6. If the new span is too large (greater than 4000), or too small (less than 0.001), the span will be rejected, and Step 7 will be displayed.

Step 6

New span = 158.459 Previous = 155.290 Press Enter to save, else press Abort

This display shows the old span and the new calculated span, after correcting for the error calculated above. If the span calibration was correctly performed (i.e. the correct weights were placed on, there was no other product in the hopper, and the system was stable when the calibration was performed), then press Enter to accept the new span. If there are doubts about the calibration, and you do not wish to correct the span using the calculated data, press abort.

Either way, you will be returned to the top level of the Hopper Span Calibration menu. Press + to move to the Material Span calibration.

Step 7

New span of 5302.450 is invalid Press Enter to continue.

This message is displayed if the new calculated span is too large (greater than 4000), or too small (less than 0.001). This error will occur if a span procedure is attempted without adding the test weights to the hopper, or there is a load cell fault. This error may also occur if a relatively small or large test weight is used compared to the capacity. This condition may be corrected for by changing the mass rate unit from tonnes / hour to kgs / hour, for example. Pressing Enter will return to the top level of the Hopper Span Calibration Menu. Check your calibration procedure then re-calibrate.

2.3.3. Material Span Calibration

The empirical span calibration menu entry is used to adjust the stored value of the load cell mass span factor to compensate for a known error.

This calibration procedure is based on feeding a quantity of material and totalising its weight with both the Masterweigh 2 unit and an independent reference weighing method (ie. a weigh bridge). As both mass totals should be the same, any discrepancy between the two is used as the basis of adjusting the Masterweigh 2 unit's load cell mass span factor.

Step 0

PRESS ENTER FOR MATERIAL SPAN CALIBRATION

Press Enter to start the span correction procedure.

Step 1

Hopper span factor =	68.139
Enter new value:	0.000

The value shown is the span factor currently stored in memory. This can be manually edited by typing the new value in via the numeric keypad, then pressing Enter. To perform a Material Calibration, simply press Enter without typing anything.

Step 2

Enter test scale total:	0.000
Press Enter to Continue	

At this point, enter the mass total as measured by an reliable external source (e.g. the weigh-bridge), then press enter.

Step 3

Enter feeder total:	0.000
Press Enter to continue	

At this point, enter the mass total as measured by the Masterweigh 2, when it has measured the same product that has been measured by the reliable external source, then press enter.

The Masterweigh 2 will now calculate a new span, based on the two values entered. If the new span is valid, the display will progress to Step 4. If the new span is too large (greater than 4000), or too small (less than 0.001), the span will be rejected, and Step 5 will be displayed.

Step 4

New span = 158.459 Previous = 155.290
Press Enter to save, else press Abort

Step 5

New span of 5302.450 is invalid
Press Enter to continue.

Press Enter to return to the top level of the Material Span Calibration, then press + to continue to the RCAL Span Calibration.

2.3.4. RCAL Span Calibration

Note that a standard Masterweigh 2 does not have the additional components required for a RCAL Span Calibration to be performed. If you require this service to be available, please request a modified board from Webtech.

Step 0

PRESS ENTER FOR
RCAL SPAN CALIBRATION

The R-Cal Span Calibration menu is used to determine a new span calibration factor based on a simulated load cell weight. The simulated load cell weight is created by running the hopper empty and then "unbalancing" the load cells resistance bridge circuit by switching in a reference resistance across one arm of the load cell bridge circuit. The reference resistor is a stable component internal to the Masterweigh 2 unit, and is switched into circuit by a low resistance reed relay, thus providing a constant simulated reference load cell mass signal.

Once the initial span calibration for the Masterweigh 2 unit has been set using the Empirical span calibration procedure, it is possible to "calibrate" the reference resistor by "weighing" its effect on the load cell input signal. The mass total obtained is then "target mass" that would be expected by repeating the R-Call span calibration procedure.

The R-Cal span calibration procedure is used to check the mass total obtained by "weighing" the reference resistor load cell mass signal. Given that the zero error calibration has been performed, then any discrepancy between the initial target mass of the calibration reference resistor signal and the total obtained by the R-Cal span calibration procedure is due to changes in the required span factor.

The normal procedure for using the RCAL system would be to perform a zero calibration, then a standard calibration to ensure that the Masterweigh 2 is accurate. After this, perform an RCAL calibration through to step 3, record the weight shown,

then press Abort. This value should then be entered as the "Simulated Test Weight" in step 2, so that an RCAL calibration or calibration test can be performed in the future.

The Masterweigh 2 unit will automatically calculate the new span factor required.

Step 1

```
Hopper span factor = 68.139
Press Enter to continue
```

This screen is for display purposes only. This shows the current span factor stored in memory. Press Enter to continue.

Step 2

```
Simulated test weight = 0.512 tonnes
Enter new value: 0.000
```

This is the weight that is simulated when the resistor is switched into the load cell circuit. Enter the correct weigh then press enter.

Step 3

```
Simulated weight = 0.450 tonnes
Press Enter to start calibration
```

This display shows the weight that has been measured when the calibration resistor has been switched into the circuit. Press Enter to record the error and correct for it.

Step 4

```
Simulated test weight = 0.450 tonnes
Press Enter to record Span calibration
```

The Masterweigh 2 will now calculate a new span, based on the programmed simulated load and the measured simulated load. If the new span is valid, the display will progress to Step 4. If the new span is too large (greater than 4000), or too small (less than 0.001), the span will be rejected, and Step 5 will be displayed.

Step 4

```
New span = 158.459 Previous = 155.290
Press Enter to save, else press Abort
```

Step 5

```
New span of 5302.450 is invalid
Press Enter to continue.
```

Press Enter to return to the top level of the RCAL Span Calibration, then press + to continue to the Analog Loop Calibration.

2.3.5. Analog Loop Calibration

This menu is used for calibrating and testing the analog current loop inputs and outputs.

Step 0

PRESS ENTER FOR
ANALOG LOOP CALIBRATION

Press Enter to begin the analog loop calibration.

Step 1

Two screens are displayed, switching between the following :

WARNING: Analog output calibration
Press Enter to continue

WARNING: Analog output calibration
Press Abort to stop calibration

This warning is displayed to remind the operator that the output loops will activate, and so any equipment attached to the output loops will be controlled to non-zero states. You should ensure that all equipment attached to both the Rate output and the PID loop output has been disabled before proceeding. Press Abort if this is not the case.

Step 2

Rate Analog output. Measure actual output
Enter measured mA: 0.000

The Masterweigh 2 has forced the mass rate output current loop to approximately 24mA. The user should measure the actual output with a reliable instrument, then enter the measured value and press enter. If this calibration is being done as a board replacement where the measurement is not possible, but the previous calibration factor is know, simply press enter.

Step 3

Rate calibration factor = 0.624
Enter new value: 0.000

The rate calibration factor is used to scale the rate output current loop to the correct

value. The value shown is that required to scale the output to the value that was entered in the previous step. If this value is acceptable, simply press Enter. If the calibration factor is known from a previous calibration on this board, and it is not possible to measure the current at this stage, enter the calibration factor then press Enter.

Step 4

PID Analog output. Measure actual output	
Enter measured mA:	0.000

Step 5

PID calibration factor =	0.625
Enter new value:	0.000

Step 4 and 5 are the same as steps 2 and 3 above, except they are calibrating the PID current loop output, and the PID output should be measured.

Step 6

Rate analog output set to 000 Hex
Press C for next data, E to continue

At this stage, the digital data to the Rate output circuit has been set to 000Hex, which should give an output of less than 2mA. Pressing C will cycle the output through a series of values, as shown below. This function is used by Webtech technicians for testing and fault finding purposes. Pressing E will continue to Step 7.

Digital Data	Expected mA
000	<2.0
001	<2.0
002	<2.0
004	<2.0
008	<2.0
010	<2.0
020	<2.0
040	<2.0
080	<2.0
100	2.00
200	4.00
400	7.98
800	15.95
FFF	28.6

Step 7

PID analog output set to Hex Press C for next data, E to continue

Step 7 sets the PID output to preset levels which are selectable with the C key, as above for the Rate output. Press Enter to continue.

Step 8

WARNING: Analog input calibration Press Enter to continue, Abort to stop

Pressing Abort returns to Step 0 Above.

Enter should only be pressed when performing a calibration on the Masterweigh 2 unit 4-20 mA auxiliary input channels, pressing Enter advances to:

Step 9

Setpoint input 1 low = 4.025 mA Enter measured mA : 0.000 mA

At this stage, the setpoint input channel 1 zero calibration is performed. A 4 mA signal should be injected from the setpoint source for calibration. The raw, uncalibrated mA signal as read by setpoint input channel 1 is displayed. The loop calibration current should be "low", ie. less than 8 mA, and the actual measured value of loop current entered. Note that if zero or no value is entered for the zero calibration mA value, then menu display skips to step 11 below.

Pressing enter advances to the setpoint input channel 1 span calibration.

Step 10

Setpoint input 1 high = 19.879 mA Enter measured mA : 0.000 mA

At this stage, the setpoint input channel 1 span calibration is performed. A 20 mA signal should be injected from the setpoint source for calibration. The raw, uncalibrated mA signal as read by setpoint input channel 1 is displayed. The loop calibration current should be "high", ie. more than 16 mA, and the actual measured value of loop current entered.

Step 11

Setpoint input 1 zero factor =	-0.032
Setpoint input 1 span factor =	0.992

At this stage, the setpoint input calibration zero and span factors are displayed for information purposes.

Pressing Enter advances to:

Step 12

Auxiliary input 2 low =	4.067 mA
Enter measured mA:	0.000mA

Step 13

Auxiliary input 2 high =	19.879 mA
Enter measured mA :	0.000 mA

Step 14

Auxiliary input 2 zero factor =	0.032
Auxiliary input 2 span factor =	1.012

Steps 12, 13 and 14 are identical to steps 10, 11 and 12, except they are used for calibrating auxiliary input 2, which is not used in the Loss In Weight system.

Pressing Enter returns to Step 0 of the Setpoint menu entry, then pressing + will advance to the Reference Calibrations menu.

2.3.6. Reference Calibrations

The calibration data menu entry allows the entry of the following hardware calibration data during factory setup:

- zero mV reference,
- span mV reference,
- mains frequency selection,

These values should not normally be adjusted by the user, except if re-entry of all parameters is required after performing a "configure", or, if as part of routine maintenance, the user performs the calibration procedures detailed in the "Hardware Setup" section. The reference values were measured at the factory on a precision bench meter, and have been engraved on the main PCB. In the event that a board is re-configured, the values engraved on the PCB should be re-entered into this menu. The references are engraved on the Main PCB, above the left hand end of

J8, labelled "Ref ZERO:" and "Ref SPAN:".

Step 0

PRESS ENTER FOR
REFERENCE CALIBRATIONS

Press Enter from this display to enter the Reference Calibrations menu.

Step 1

WARNING: Calibration data following,
DO NOT MODIFY ! – Press A to return

If you do wish to check the values, or edit them, press Enter. Otherwise press Abort and you will be returned to the top level of this menu. Note that changing these values will affect the calibration of the system.

Step 2

Reference zero = 4.931 mV
Enter new value: 0.000

Check that this value is the same as the value engraved under "Ref ZERO:" on the main PCB, and edit if necessary, then press Enter to continue.

Step 3

Reference span = 33.930 mV
Enter new value: 0.000

Check that this value is the same as the value engraved under "Ref SPAN:" on the main board, and edit if necessary, then press Enter to continue.

Step 4

Mains Frequency = 50 Hertz
Press Clear to change, Enter to accept

The user can select either 50Hz or 60Hz as the mains frequency. This selection is used to change sampling frequencies so as to best avoid noise from the mains signals. Select the Frequency of the power supply supplied to the Masterweigh 2, then press Enter to continue. You will be returned to the top level of the Reference Calibrations Menu. You can then press + to cycle back to the first option, Hopper Zero Calibration, or press Abort to move up one menu level. From the top menu level, press 3 to enter the Tuning menu.

2.4 MENU ENTRY 3: TUNING

2.4.1. PID Parameters

The PID Parameters menu entry is used to enter / modify parameters for the operation of the Masterweigh 2 PID control algorithm. The Masterweigh 2 provides an enhanced PID controller, incorporating auto / manual control, output offset, feed forward and forward / reverse control action.

Setpoint

The setpoint for the PID can be either the local setpoint as entered into the Setup -> Setpoint menu, or the remote setpoint derived from the 4-20 mA auxiliary input.

The setpoint mode is selected in the Setup -> Setpoint menu.

Error Signal

The error signal, upon which all control action is based, is the difference between the setpoint and the measured mass rate, ie:

$$\begin{aligned} \text{Error} &= \text{Setpoint} - \text{Mass Rate} \\ E &= \text{SP} - \text{MR} \end{aligned}$$

The error signal is normalised to a percentage by dividing by the feeder capacity.

$$\begin{aligned} \text{Normalised Error} &= \frac{\text{Error}}{\text{System Capacity}} \\ E_{\text{NORM}} &= \frac{E}{C} \end{aligned}$$

In the following sections:

M_N = a control term's contribution to the total control output, &

SP = the PID setpoint.

E_{NORM} = The normalised error signal

Proportional Term

The proportional term is calculated as

$$M_P = K_P \times E_{\text{NORM}}$$

The correspondence between the Masterweigh 2 proportional factor, K_P , and PB is:

$$K_P = \frac{100}{\text{PB}}$$

Where PB is the proportional band, this is defined as the percentage change in error required to produce 100% change in the control output and has units of percent.

Integral Term

The integral term is calculated as

$$M_I = \frac{1}{I} \int E_{NORM} dt$$

Where I is the integral time, this is defined as the time taken for a percentage change in the error to cause the same percentage change in the control output, and has units of seconds (per reset).

The inverse of the Integral time is known as the reset rate, RR, and has units of "resets per second".

The correspondence between the Masterweigh 2 integral factor, K_I , and I/RR is :

$$K_I = \frac{2}{I} = 2 \times RR$$

Because the integral term is based the sum of the error with time, it is possible for the sum of the error to accumulate to a large value, this is known as "integral wind-up". To avoid this problem the sum of the error is limited to operator programmable upper and lower integral limits, I_{HI} and I_{LOW} . The Masterweigh 2 PID algorithm also provides the facility for the user to zero the accumulated integral error sum at any time, in case the controller has been subject to integral wind-up.

Derivative Term

The derivative term is calculated as

$$M_D = D \times \frac{d E_{NORM}}{dt}$$

Where D is the derivative time, this is defined as the time by which a 100% rate of change of error causes the derivative term to pre-empt or advance the control output, and has units of seconds.

The correspondence between the Masterweigh 2 derivative factor, K_D , and D is:

$$K_D = D$$

Feed forward Term

The feed forward term is calculated as

$$M_F = \frac{FF \times SP}{100 \times Capacity}$$

Where FF is the feed forward factor, this is defined as the percentage of the setpoint to add on to the control output, and has units of percent.

This is normalised by dividing by feeder capacity. The correspondence between the

Masterweigh 2 feed forward factor, K_{FF} , and FF is :

$$K_{FF} = \frac{FF}{100}$$

Output Offset Term

The output offset term is calculated as

$$M_O = \frac{OO}{100}$$

Where OO is the output offset factor, this is defined as the percentage offset to add onto the control output, and has units of percent.

The correspondence between the Masterweigh 2 output offset factor K_{OO} , and OO is:

$$K_{OO} = \frac{OO}{100}$$

Sum of Controller Terms

The complete PID control algorithm output is the sum of all terms, ie:

$$M_{TOT} = M_P + M_I + M_D + M_{FF} + M_O$$

Because the total control output must be in the form of a percentage, ie. in the range 0.0 to 1.0, the value of M_{TOT} is limited to not less than 0.0 and not more than 1.0. The resulting percentage is used to generate a control signal as a percentage of 4-20 / 25 mA.

Control Action

The following control actions are available:

Forward Acting - M_{TOT} of 0.0 = 4mA and M_{TOT} of 1.0 = 20 / 25 mA.

Reverse Acting - M_{TOT} of 0.0 = 20 / 25 mA and M_{TOT} of 1.0 = 4 mA.

Loss in Weight systems which operate with a low percentage weight loss per unit time will normally calculate mass rate over a period of 5 to 10 seconds in order to obtain a stable indication. This causes a lag in response which necessitates the use of a relatively slow integral term. "Fast Track" and "Override" modes are designed to reduce the effects of this and make the system more responsive.

The Fast track mode essentially speeds up the integral term when the calculated mass rate is away from the setpoint. The Fast Track threshold variable allows the user to define the deviation from the setpoint that is allowed to occur before the Fast Track feature is activated. The threshold parameter is entered as a percentage of the "Current Capacity" value (refer to the "System Configuration" menu, section

2.2.1.). The Fast Track reset multiplier variable allows the user to define how much to speed the integral term up by.

Fast Track reset multiplier	Effect
>1	speed up the integral term
=1	integral terms remains unchanged
<1	slow down the integral term

In the Fast Track mode, Automatic PID control of the process is maintained and it is only the integral term which is adjusted.

The PID Override mode provides a means to totally override the PID calculation process when the calculated mass rate is away from the setpoint for too long, and go into a form of volumetric mode. The Volumetric output used by Masterweigh 2 when the PID Override mode is activated is determined by the Feed Forward gain and Feed Forward offset PID values, even though the PID calculation routine itself is overridden. The Feed Forward component by itself can predict the approximate output required for a given setpoint instantaneously and can thus bring the mass rate into line should it suddenly deviate substantially from the setpoint for a period of time, eg after setpoint change. Masterweigh 2 remains in the PID Override mode for a short period of time to allow the system to settle before resuming Automatic control mode.

In order for the PID override to operate effectively, the Feed Forward parameters should be set up correctly (correctly setup Feed Forward parameters will also improve normal automatic control). To do this, a graph should be established which shows the mass rate, as a percentage of Capacity, obtained for different Volumetric outputs. A line of best fit can then be determined which will give a $y = mx + c$ graph (where $y = \text{mass rate (\%)}$, $x = \text{volumetric output (\%)}$) from which the Feed Forward gain, m , and the Feed Forward offset, c , can be determined.

The PID Override threshold variable allows the user to define the deviation from the setpoint that must be maintained before the PID Override feature is activated. The threshold parameter is entered as a percentage of the "Current Capacity" value (refer to the "System Configuration" menu, section 2.2.1.). The PID Override activation delay variable defines how long the mass rate can be outside the allowable threshold before the PID Override is activated. The PID Override hold delay variable defines how long Masterweigh 2 remains in PID Override, once activated, before resuming in Automatic control mode.

To edit the PID paramters, from the Tuning menu, scroll through to the following screen :

Step 0

PRESS ENTER FOR PID PARAMETERS

Pressing Enter advances to:

Step 1

Proportional band = 100.000 % Enter new value: 0.000

At this stage, a new value for the PID proportional band can be entered.

Pressing Enter advances to:

Step 2

Reset rate = 0.050 resets/second Enter new value: 0.000

At this stage, a new value for the PID reset rate can be entered.

Pressing Enter advances to:

Step 3

Lower integral limit = -50.000 % Enter new value: 0.000

At this stage, a new value for the PID integral sum lower limit can be entered.

Pressing Enter advances to:

Step 4

Upper integral limit = 50.000 % Enter new value: 0.000

At this stage, a new value for the PID integral sum upper limit can be entered.

Pressing Enter advances to :

Step 5

Derivative time = 0.000 seconds
Enter new value: 0.000

At this stage, a new value for the PID derivative time can be entered.

Pressing Enter advances to:

Step 6

Output offset = 20.000 %
Enter new value: 0.000

At this stage, a new value for the PID output offset can be entered.

Pressing Enter advances to:

Step 7

Feed forward = 100.000 % of setpoint
Enter new value: 0.000

At this stage, a new value for the PID feed forward can be entered.

Pressing Enter advances to:

Step 8

Fast Track Reset multiplier = 1.000
Enter new value: 0.000

At this stage, a new value for the Fast Track reset multiplier can be entered. The Fast Track multiplier allows the Masterweigh 2 to effectively use a second integral term when the calculated mass rate is away from the setpoint by a predefined amount (see Step 9). The Masterweigh uses the already defined integral term and applies this multiplication factor to it. Thus systems requiring a high integral time, or low reset rate, which lack responsiveness due to this, may "speed" up the integral time by applying this factor. A reset multiplier of 1.0 effectively turns OFF the Fast Track feature. Pressing Enter advances to:

Step 9

Fast Track Threshold (%FS) = 100.000 % Enter new value: 0.000

At this stage, a new value for the Fast Track threshold can be entered. The Fast Track threshold defines the deviation, in % capacity (full scale), that the calculated mass rate may be away from the setpoint before applying the Fast Track reset multiplier as described above. A threshold of 100% effectively turns OFF the Fast Track feature. Pressing Enter advances to :

Step 10

To zero accumulated Integral press Clear Press Enter to continue

Pressing Clear at this stage will reset the accumulated integral contribution to 0. This is used to manually speed up a system's response after "integral wind up".

Step 11

Override threshold (%FS) = 100.000 % Enter new value: 0.000

At this stage, a new value for the PID override threshold can be entered. The PID override threshold defines the deviation, in % capacity (full scale), that the calculated mass rate may be away from the setpoint, pre-qualified by a time constraint, following, before the PID algorithm is overridden whereby the Masterweigh 2 temporarily intelligently selects a volumetric output (determined by the Feed Forward term), which takes into consideration the current setpoint. The process of selecting the volumetric output involves the usage of the Feed Forward term, above, and the Feed Forward offset value, following. Therefore, care must be taken during setup to correctly determine the Feed Forward parameters in order to use this feature. A threshold of 100% effectively turns OFF the PID override feature.

Pressing Enter Advances to:

Step 12

Override activation delay (s) = 0 Enter new value: 0

At this stage, a new value for the PID override activation delay, in seconds, can be entered. The activation delay is a pre-qualification for the above threshold deviation, in that the mass rate must be away from the setpoint for this amount of time before the PID override feature is actioned.

Pressing Enter advances to :

Step 13

Override hold delay (s) =	0
Enter new value:	0

At this stage, a new value for the PID override hold delay, in seconds, can be entered. The hold delay defines how long the Masterweigh 2 stays in the PID override mode, or volumetric mode, before resuming automatic control. Consideration must be taken in choosing this value as you must allow the process long enough to respond to the PID override, whilst not removing the system from automatic control for too long. Pressing Enter advances to:

Step 14

Feed Forward offset (%) =	0.000 %
Enter new value:	0.000

At this stage, a new value for the Feed Forward offset can be entered. The Feed Forward offset is a constant offset applied to the feed forward PID term when in automatic and PID override modes.

Pressing Enter returns to the top level of the PID PARAMETERS menu.

2.4.2. PID Linearisation

PID Linearisation is necessary in some systems to allow higher PID gains without instability at points of non-linear gain.

PID Linearisation is the application of a piecewise linear "curve" to best match the PID output value calculated by the PID output value calculated by the Masterweigh 2 to that which suits the system feeder characteristics. In other words, whilst PID calculations performed by Masterweigh 2 normally assume a linear response from the feeder, eg. 40% output delivers twice as much material as 20% output, the feeder / system characteristics may prevent this from actually being the case, eg. motor may not even start until a 20% output is applied. With non-linear responsiveness of a feeder / system, it can be difficult, even impossible to achieve satisfactory control of the process.

Thus PID Linearisation provides a means for Masterweigh 2 to internally model the system response and moulds the non-linear output as seen by the system, into one resembling linear, and controllable, characteristics. The Linearisation curve used by Masterweigh 2 should be set up such that it is the inverse of the plant response curve. Thus the product of the Masterweigh 2 Linearisation curve and the plant response curve is a straight line.

The Linearisation curve is described, by up to 10 points, by an input value and output value (similar to (x,y) coordinates on a graph). The point (0,0) is fixed and cannot be modified, however, if linearisation points are entered which don't cover the full 100% PID input range, the PID output value entered for the point with the greatest PID input is maintained, ie. the curve is flattened, to cover the 100% PID input range.

Step 0

PRESS ENTER FOR
PID LINEARISATION

Press Enter to edit the PID Linearisation mode and data points.

Step 1

PID Linearisation Active - No
Press Clear to change, Enter to accept

At this stage, the PID Linearisation can be enabled / disabled by using the Clear key. If there are no linearisation data points entered, the PID Linearisation feature cannot be enabled. Pressing Enter advances to :

Step 2

Point 1	PID Input % =	0.0
Enter new PID Input %,	0.000	

At this stage, a new PID input reference value, *x coordinate*, may be entered for this linearisation point. If value of 0% is entered, this data point is deleted. Pressing Enter advances to:

Step 3

Point 1	PID Output % =	0.0
Enter new PID Output %,	0.000	

At this stage, a new PID output reference value, *y coordinate*, may be entered for this linearisation point. Pressing Enter advances to the next Linearisation point entry.

Steps 2 and 3 are repeated for each of the 10 points on the linearisation curve.

Not all 10 points need be entered, as few as 1 is allowed, to allow the Linearisation feature to be enabled. Upon going back to Step 0, the Masterweigh 2 automatically re-orders the data, removing deleted points, in ascending PID input order.

2.4.3. LIW Process Tuning

Step 0

PRESS ENTER FOR LIW PROCESS TUNING

This menu is for Web Tech use only and parameters contained within should NOT be modified by the end user.

2.5 MENU ENTRY 4 : DIAGNOSTICS

2.5.1. Load Cell Output

Step 0

PRESS ENTER FOR LOAD CELL OUTPUT

Step 1

Load cell = 34.686 mV	Excit. = 10 V
A/D count = 972627	

This menu displays the load cell input as read by the Masterweigh 2, along with the measured Excitation voltage and the Analog to Digital Converter output value when the load cell input channel is being read. Note that the source of the measured Excitation Voltage is determined by link W5, and can be local (Measured at the Excitation Terminals) or remote (Measured at the Rem. Sense Terminals). See Secion 4.4 for setting of this link. The A/D count value is used by Webtech technicians for diagnostic purposes.

2.5.2 Analog Loop Inputs

Step 0

PRESS ENTER FOR ANALOG LOOP INPUTS

Press Enter to view the current Analog Loop input values.

Step 1

Setpoint input =	7.979 mA
Setpoint input =	24.871 % of 4-20 mA

This menu displays the current setpoint input value, expressed in terms of mA and as a percentage of the input range. This menu is for display purposes only. Press Enter to continue to the next step.

Step 2

Aux. input 2 =	11.072 mA
Aux. input 2 =	44.200 % of 4-20 mA

As the Loss In Weight System does not use the Auxiliary Input Channel, the information displayed here is of no relevance to the operation of the system. It is used by Webtech technicians for diagnostic purposes.

2.5.3. Screw Speed

Step 0

PRESS ENTER FOR
SCREW SPEED

The Screw Speed menu is used to display the current feeder screw speed if an external tachometer is connected, and to enter the number of tachometer pulse per screw revolution calibration.

Step 1

Screw Speed = 10.123 rpm
Press Enter to continue

Step 1 displays the current screw speed in Revolutions Per Minute (RPM).

Pressing Enter advances to :

Step 2

Pulses per screw rev. cal. = 1000
Enter new value: 0

At this stage, a new value for the number of tachometer pulses per screw revolution may be entered. The calculated screw speed is based on this value and the measured tachometer input frequency.

Pressing enter returns to step zero above.

2.5.4. Calculator

Step 0

PRESS ENTER FOR
CALCULATOR

Press Enter to use the Calculator function of the Masterweigh 2.

Step 1

Enter Data - Clear to Zero, Abort to End
Result = 0.000 Data = 0.000

At this stage, the data entry menu for the Masterweigh 2 system calculator is displayed. The Masterweigh 2 unit provides a simple four function (*, /, + and-) calculator that operates using "reverse polish" input. The "Result" field displays the current calculation result, and is initially zero and is the first parameter for any calculation. Data shows the currently entered second parameter for any calculation.

Pressing Enter when result is equal to zero will cause the Data value to be transferred to Result.

Pressing Abort will return to step 0 above. Pressing Clear will zero both the Result and Data fields.

Pressing Enter when both the Result and Data fields contains a non-zero value will advance to the function selection menu below.

Step 2

Select function: 1 = *, 2 = /, + or -
Result = 12.000 Data = 2.000

At this stage, the desired mathematical function is selected.

Pressing "1" will calculate: Result * Data.

Pressing "2" will calculate: Result / Data.

Pressing "+" will calculate: Result + Data.

Pressing "-" will calculate: Result - Data.

When a function is selected, the calculation result will displayed in Result and the Data field will be set to zero.

Pressing Abort returns to step 0 above. Pressing Enter returns to step 1 above, the result of the current calculation is retained in Result so that multi-function calculations can be performed.

2.5.5. Digital Input / Output Tests

Step 0

PRESS ENTER FOR
DIGITAL INPUT / OUTPUT TESTS

Step 1

Digital Input test - 0 = Off 1 = On
Digital Inputs 1,2,3 & 4 = 0 0 0 0

At this stage, the status' of all Masterweigh 2 digital inputs are displayed.

A "1" indicates a logic high level input, a "0" indicates an inactive input.

Pressing Enter advances to:

Step 2

Digital Output Test - Press to activate
1=Rel1 2=Rel2 3=Rel 3 4=Rel4 5=GO1 6=GO2

At this stage, all of the Masterweigh 2 digital output channels are disabled and may be tested. Upon entry to this screen, all outputs will be set to "off", regardless of the status of the system. They will only be turned on if a user presses a key, as such :

Pressing "1" will activate relay output 1.

Pressing "2" will activate relay output 2.

Pressing "3" will activate relay output 3.

Pressing "4" will activate relay output 4.

Pressing "5" will activate general purpose output 1.

Pressing "6" will activate general purpose output 2.

The selected output will remain on while the identifying key is held down, on release of the key the output under the test will be set OFF.

Note: While this digital output test menu is displayed, the normal operation of the digital outputs available for test will be suspended.

Pressing Enter will return to Step 0 above.

2.6 Menu Entry 5 - Time

2.6.1. Time Functions

Step 0

PRESS ENTER FOR
TIME FUNCTION

The Real Time Clock menu is used to access the time clock facilities of the Masterweigh 2 unit.

Masterweigh 2 maintains a "real-time" clock/calendar that is accurate as long as the unit remains ON, ie. the time and date must be reset after the unit is powered down.

The time is displayed in 24 hour mode, ie. 3pm is displayed as 15:00:00 hours.

The date is displayed in DD/MM/YY format, automatically taking into account the different number of days in each month and leap years.

Masterweigh 2 provides an "elapsed time" clock that may be clear/reset at any time.

Masterweigh 2 also provides a "power-on" hours count, this count is incremented every hour the unit is powered up and this count is retained on power-down.

Masterweigh 2 provides the facility for the user to enter a clock correction factor, in seconds per 24 hours, to compensate for any tolerance in the Masterweigh 2 master 10 Mhz clock circuit. This tolerance will be no more than 5 seconds in a 24 hour period.

Step 1 displays the current time and date.

Step 1

Time = 15:03:34 (24 hr) Date = 09/04/90
Press Enter to continue

This level of the menu displays the current recorded Time and Date. Pressing Enter advances to:

Step 2

Elapsed time - Press Clear to reset
23 days, 15:03:34 hours

At this stage, the elapsed time since the unit was powered-up, or the elapsed time count was last reset, is displayed.

Pressing Clear will reset the elapsed time count to zero.

Pressing Enter advances to:

Step 3

Time = 15:03:34 (24 hour mode) Enter new time (HHMM):

At this stage a new time can be entered in HHMM (hour-hour-minute-minute) form. E.g. to Enter 9:35 am, type "0935".

Note: Seconds count is automatically set to zero when a new time is entered.

Pressing Enter advances to:

Step 4

Date = 09/04/90 Enter new date (DDMMYY):

At this stage a new date can be entered in DDMMYY (day-day-month-month-year-year) form. E.g. to Enter the 10th of May 2001, type "100501".

Pressing Enter advances to:

Step 5

Clock compensation factor = 0 Enter timing error (sec/24hrs): 0

Here the current clock compensation factor is displayed, and a new value may be entered. The compensation factor has units of seconds per 24 hours.

For example, the Masterweigh 2 elapsed timer and a reference timer, such as an accurate stop-watch, were started at the same time and run for 24 hours exactly as measured by the reference timer.

If after 24 hours on the reference timer the Masterweigh 2 elapsed timer indicated 24:00:03 hours, then the Masterweigh 2 internal clock is 3 seconds per 24 hours too fast. In this case a clock correction factor of -3 sec/24hrs should be entered.

If after 24 hours on the reference timer the Masterweigh 2 elapsed timer indicated 23:59:58 hours, then the Masterweigh 2 internal clock is 2 seconds per 24 hours too slow. In this case a clock correction factor of 2 sec/24hrs should be entered.

Pressing Enter advances to:

Step 6

Masterweigh 2 power-on hours = 456 Press Enter to continue

Here the number of whole hours since the Masterweigh 2 unit was last initialised is displayed. This count is retained on power-down and incremented every 60 minutes of power-on time. It is provided primarily for information and scheduling of routine maintenance.

Pressing enter returns to step 0 above.

2.7 Menu Entry 6 - Clear Mass Total

2.7.1. Clear Mass Total

This menu is used to clear the accumulated mass total. It only has one step, displaying the following:

Step 0

PRESS 'C' FOR CLEAR MASS TOTAL

At this stage, pressing Clear will zero the accumulated mass total.

Pressing Enter will have no effect. Press Abort to return to the upper level menu.

2.8 SYSTEM ERRORS

The Masterweigh 2 is constantly testing it's circuits and testing for errors. If an apparent error occurs, the Mass Rate / Mass Total Display will be flashing, and pressing Enter from this screen will display the latest error to occur. If any errors are flagged, the circumstances should be recorded and your Masterweigh 2 supplier should be contacted for assistance.

3 UNIT HARDWARE

3.1 Introduction

The Masterweigh 2 is a precision microprocessor based industrial instrument for the accurate integration of mass totals and the control of mass rates in belt scale, weigh feeder and loss in weight applications.

The 24 bit address bus of the 68000 allow up to 512 kbytes of EPROM space for Masterweigh 2 system program software.

The 16 bit data bus of the 68000 combined with a CPU operating speed of 10 MHz means that the computing "horsepower" of the Masterweigh 2 ensures maximum system accuracy.

The Masterweigh 2 unit incorporates an all CMOS design for its electronics, giving low power consumption and low heat dissipation.

The following sections detail the hardware components of the Masterweigh 2 system.

3.2 Load Cell Excitation.

The Masterweigh 2 unit provides an integral load cell excitation voltage source.

This source can provide excitation for up to eight 350 ohm load cells connected in parallel.

The excitation voltage is continuously adjustable over the range +4 to +12 volts to enable the maximum performance to be obtained from a variety of load cells, and to compensate for voltage drops caused by IS barriers etc.

The Masterweigh 2 unit excitation voltage is factory set to a value of +10 volts. The excitation voltage is not precisely controlled, but is maintained within one percent of the set value.

The Masterweigh 2 continuously monitors the excitation voltage and automatically compensates the load cell readings for any excitation variations that may occur.

Following adjustment of the excitation, a minimum of one minute should be allowed before proceeding with calibration functions, alternatively, the Masterweigh 2 unit can be powered down and re- powered up. This is to allow the Masterweigh 2 to update its internal excitation reading.

The approximate value of the load cell excitation voltage sensed by the Masterweigh 2 is displayed in menu 3. This should match the voltage measured between terminals 20 and 21 of field connector J7, and should be checked when configuring the Masterweigh 2 (allow one minute for update of excitation voltage display after adjusting the excitation voltage.).

The excitation voltage regulators are overload and short circuit protected, however, short circuiting the excitation output will interfere with the normal operation of the analog input circuitry and the RS232 interface.

Application of an external voltage source to the load cell excitation terminals may cause damage to the Masterweigh 2.

The Masterweigh 2 unit provides for both local and remote sensing of the load cell excitation voltage (see section on User Configuration for details).

When the load cell is positioned a long distance from the Masterweigh 2 unit, the voltage drop across the wires supplying the excitation may be significant.

The installation of another pair of wires to monitor the actual excitation voltage supplied to the remote load cell and connecting them to the remote excitation sense terminals of the Masterweigh 2 unit will improve the measurement accuracy of remote load cell installations.

3.3 Load Cell Inputs.

The Masterweigh 2 is designed to accept up to two load cell millivolt signals in the range 0 to 32 millivolts, providing a measurement resolution of approximately 4 microvolts.

The load cell inputs will accept a differential millivolt signal over a common mode range of -8 to +8 volts and all load cell input terminals are overload protected to +/- 15 volts.

The transient overload capacity is much higher than the continuous overload rating, and depends on the magnitude and duration of the overload.

Masterweigh 2 incorporates an "R-Cal" facility. This is a method of span factor calibration based on simulating a load cell mass signal by unbalancing the load cell resistance bridge circuit.

The principle is based on connecting a precision resistor between the load cell+(positive) and excitation+(positive) terminals. This is achieved by using a reed relay for minimum switch-in resistance.

In the belt weighing and weigh feeder systems the analog to digital conversion is performed using a voltage to frequency converter, thereby providing excellent rejection of signal noise over a wide frequency range. The Loss In Weight system uses a "Sigma-Delta" analog to digital converter, providing tighter resolution.

With the exception of short periods allocated to self-calibration and the reading of auxiliary input channels, the Masterweigh 2 is continuously monitoring/integrating the load cell input. This results in a more accurate measurement of the rapidly fluctuating input signal from the load cell than conventional discrete, "sample and hold" analog to digital conversion techniques.

No calibration or adjustment of the Masterweigh 2 analog inputs is required. Zero and gain are automatically determined, the automatic calibration sequence being repeated every minute, whenever the Masterweigh 2 unit is energised.

3.4 Auxiliary Inputs.

The Masterweigh 2 unit provides one auxiliary input channel for each of the two load cell input channels.

These auxiliary input channels are configured as 4-20 mA inputs and may be used to provide the Masterweigh 2 with a remote setpoint for cascade control and blending functions.

The inputs include a one ohm burden on the current loop, and hence drop 20 millivolts for a loop current of 20 mA.

The inputs are NOT isolated, and hence require the current loop to include an appropriate ground reference.

The inputs will operate over a common mode range of -8 to +8 volts, measured at any loop input terminal with respect to analog ground.

The input loops would normally be earthed at the transmitter end, and MUST only be earthed at one point only. The inputs provide excellent common mode rejection of AC noise, however, the peak AC noise voltage must NOT exceed 8 volts.

The maximum allowable input overload current is 500 mA.

The maximum allowable continuous voltage on any auxiliary input terminal is +/- 15 volts.

If the Masterweigh 2 unit is not earth referenced, then one side of each auxiliary input loop in use must be connected to the adjacent analog ground terminal to provide a loop voltage reference point (see section on Unit Earthing).

The auxiliary inputs may be converted to millivolt inputs by removing the loop current shunt resistors R66 (for load cell channel 1) and R65 (for load cell channel 2). The auxiliary input will then have the same characteristics as the load cell inputs.

3.5 Tacho Supply.

The Masterweigh 2 unit provides an integral regulated +5 volt supply for energising an external digital tacho pulse generator. This supply is rated at 200 mA maximum and is overload and short circuit protected with internal current limiting. In the event of a short circuit on this supply it may be necessary to briefly remove all loads in order to reset the protection circuitry.

Short circuiting the tacho +5 volt supply will not effect the operation of any other section of the Masterweigh 2 unit electronics.

Application of an external voltage source to the tacho supply terminals may cause damage to the Masterweigh 2 unit.

3.6 Tacho Input.

The Masterweigh 2 tacho input is designed to accept a voltage input of 2.5 to 50 volts peak, and will accept either a square wave or sinusoidal voltage input.

The input threshold voltage is +1.2 volts at the positive terminal with respect to the negative terminal. The tacho inputs will accept pulse frequencies up to 1000 Hz.

The negative tacho input terminals are directly connected to the Masterweigh 2 system ground. Avoid earthing these inputs in the field as it will create ground current loops.

3.7 Digital Inputs

3.7.1. Digital Input 1

Loss In Weight Inhibit (Start / Stop) : Apply 15 - 40 V_{DC} to enable the unit. Typically this signal is a start / stop from the Masterweigh 2 front panel or supervisory PLC.

3.7.2. Digital Input 2

Feeder operating feedback, for systems without tacho feedback. Active input of 15 - 40V_{DC} to confirm that the feeder is running. Link to digital input 1 if no feedback signal is available.

3.7.3. Digital Input 3

Not used.

3.7.4. Digital Input 4

Not used.

The Masterweigh 2 unit provides up to 4 optically isolated digital input channels. One of each pair of inputs can generate an interrupt to the CPU, allowing for instantaneous response to process signals. For belt weighing, the interrupt digital inputs are used to re-synchronise the belt zero mapping facility, if used, to the actual position of the revolving belt.

The input threshold voltage is approximately 15 volts DC and the maximum continuous input voltage is 50 volts DC.

Reverse voltages of up to 100 volts DC will not damage the digital inputs.

The input voltage reference terminal for each pair of digital inputs assigned to a load cell input channel is fully floating and independent of the other pair, with the two inputs comprising each pair sharing a common voltage reference terminal.

3.8 Digital Outputs

3.8.1. Digital Output 1

Automatic rate control mode active. This output is active only when in Automatic control mode AND current PID control has not been overridden due to start up / refill / or external disturbance.

3.8.2. Digital Output 2

Not Used.

The Masterweigh 2 unit provides up to 2 optically isolated digital output channels. These outputs provide the Masterweigh 2 unit with two fully floating, voltage free contacts for control process equipment. These outputs are NOT current limited, and can supply loads of up to 250 mA with any supply voltage up to 45 volts DC.

Loads with higher current requirements will require an external interposing switching device, ie. relay or solid state relay. Inductive loads, such as relays and contactors, should be fitted with a reverse voltage transient absorbing diode.

These outputs may be used to switch on both the positive and negative sides of an external load. These outputs are polarised and correct voltage supply orientation must be observed, though reverse voltages of up to 100 volts DC will not damage the outputs.

The two digital outputs are completely independent of each other.

3.9 Pulse Counter Outputs

The Masterweigh 2 unit provides up to 2 pulse outputs for the external accumulation of mass totals.

One 100 millisecond pulse is output each time the least significant mass total digit displayed for each channel is incremented by 1 count. A minimum of 100 milliseconds is guaranteed between successive pulses, hence providing a maximum pulse output rate of 5 pulses per second (100 mS ON, plus 100 mS OFF).

The outputs are current limited transistor drivers which can drive loads of up to 500 mA and is short circuit protected.

The driver operates with any supply voltage up to 45 volts DC and can use either the internal supply provided by the Masterweigh 2 unit, or an external supply.

The pulse outputs are optically isolated from, and floats independent of, the Masterweigh 2 unit ground. The internal supply is an unregulated DC supply of nominally 28 volts. It is connected to the pulse output circuits by appropriate configuration of the pulse output option links on the Masterweigh 2 PCB (see section on User Configuration). This internal supply is rated to a maximum continuous current of 400 mA and may vary over the range 25-35 volts DC, depending on mains voltage fluctuations and the external load. This supply is overload and short circuit protected. The 28 volt DC supply provided integral to the Masterweigh 2 unit is isolated from digital ground to allow the configuration of a fully isolated pulse output.

An external supply may be used by appropriate configuration of the pulse output option links on the Masterweigh 2 PCB (see section on User Configuration), and connecting the external supply to the field connector terminal labelled "V+".

3.10 Relay Outputs

3.10.1. Relay 1

Signal to Refill Mechanism. The relay is energised when the Masterweigh 2 is requesting the refill hopper to refill the discharge hopper.

3.10.2. Relay 2

Low / High Deviation Alarm. This relay is energised when either of the deviation alarms programmed in the Setup Menu is active.

3.10.3. Relay 3

Hopper Empty Alarm. This relay is energised when the hopper weight drops below the level programmed into the Hopper Low Alarm menu, and stays below that level for the delay programmed.

3.10.4. Relay 4

Excessive Refill Time Alarm. This Relay is energised when the system stays in refill mode for longer than the "Maximum Refill Time" period programmed in the LIW Parameters menu.

The Masterweigh 2 unit provides up to 4 relay outputs, use of which is detailed above. These relays are located on the power supply PCB and connection to their contacts is via the power supply PCB field terminal strip.

The relays provide change-over (normally open and normally closed) contacts rated to 250 volts AC at 2.4 amps.

3.11 Analog Outputs

The Masterweigh 2 unit provides up to two fully isolated analog output channels. The outputs operate over a 4-25 mA range and provide a resolution of better than 0.025% (12 bits). The user interface allows the outputs to be set up as either 4-20 mA or 4–25 mA outputs. They operate as a loop-powered configuration and hence derive their operating power from the 4 mA residual loop current.

A minimum of approximately 15 volts is required to operate the loop with zero ohms external loop load, the loop power supply requirement rising by 1 volt for every 50 ohms of additional loop load, ie. a 25 volt supply is required for a 500 ohm loop load. The outputs can operate with a supply voltage of up to approximately 70 volts with zero ohms loop load, and provide excellent rejection of power supply ripple and noise. The loop power supply thus need not be heavily filtered or regulated. For the LIW system, Loop 1 is PID output, and Loop 2 is Rate output.

The Masterweigh provides an unregulated DC supply 2 unit that can be used for energisation of the analog output loops.

The internal supply is an unregulated DC supply of nominally 28 volts. This internal supply is rated to a maximum continuous current of 400 mA and may vary over the range 25-35 volts DC, depending on mains voltage fluctuations and the external load. The 28 volt DC supply provided integral to the Masterweigh 2 unit is isolated from digital ground to allow the configuration of a fully isolated analog output. It is however the same power supply that is used for the pulse and digital outputs, so if more than one output is internally powered, they are using the same floating ground.

Links are provided on the Masterweigh 2 PCB to enable this internal supply or an external supply to energise either or both of the analog output loops (see section on User Configuration). Note that if a common supply (internal or external supply) is used for both outputs, they are no longer independently floating and cannot be referenced to separate earthing points. There is no need or provision for zero adjustment of the analog output loops.

Span adjustment is achieved automatically by software compensation.

3.12 LCD Display

The Masterweigh 2 unit provides a 2 line by 40 character LCD module for the display of information to the operator. This display module provides electro-luminescent (EL) or LED backlighting for improved readability under adverse viewing conditions.

The viewing angle of the LCD module may be adjusted to best suit a particular installation, this adjustment is performed using a potentiometer on the Masterweigh 2 PCB (see section on User Adjustment).

EL backlighting is driven by an "inverter" unit which produces the 70 V AC at 400 Hz required by the EL backlighting. LED backlighting is supplied with +5 V DC.

3.13 RS232 Interface

The Masterweigh 2 unit provides a general-purpose RS232 serial interface port. This port enables connection to a serial terminal / VDU, printer or computer, for remote information display or print out of system configuration parameters.

The interface is normally configured for operation at 19.2 kbaud, with 8 data bits, 1 stop bit and no parity. The maximum recommended transmission distance is 100 metres using shielded cable, however, this depends on the electrical environment in which the cable is being run.

The primary use of the RS232 port to a Masterweigh 2 user is to enable the print out of all system set-up parameters, such a print out may be done to a display terminal or a hard copy unit. If a "receive only" device (ie. no keyboard), such as a printer, is being used, then the parameter print may be initiated from the Masterweigh 2 unit keypad via menu entry 8.

The RS232 serial interface also provides facilities for interrogating and debugging the Masterweigh 2 system via a series of commands. These commands vary according to the software version. Sending a "?<return>" command to the Masterweigh 2 will show a list of the current available commands.

3.14 RS485 Network Interface

The Masterweigh 2 unit provides an integral network interface. The Masterweigh 2 provides a line interface to an RS 485 multi-drop network as standard. The RS 485 port is a three wire (line + / line - / screen) differential interface with over-voltage line surge protection. This interface will allow the Masterweigh 2 unit to directly connect to a high-speed, multi-drop, industrial communications network without the requirement for any special interface equipment.

3.15 Network Expansion Interface

The Masterweigh 2 unit provides a "network expansion interface" connector. This interface provides access to communications data and control signals so that with the addition of an adaptor interface, the Masterweigh 2 unit can be connected to other (and future) industrial communications networks such as optical fibre, ethernet, etc.

3.16 EPROM Memory

The Masterweigh 2 unit uses two EPROMs for the storage of the CPU machine code program. Two EPROMs are required because they provide byte-wise (8 bit) data storage, whereas the 68000 CPU has a 16 bit wide data bus and hence requires 16 bits of program code at a time. The standard Masterweigh 2 unit will use two 27C256 EPROM devices giving a CPU program instruction capacity of 64k bytes (1k bytes = 1024 bytes). The Masterweigh 2 can accept two 27C512 EPROMs (128k bytes capacity), two 27C010 EPROMs (256k bytes capacity) or two 27C020 EPROMs (512k bytes capacity), see section on User Configuration.

Note: (EPROMs must be 250 nS devices, or faster).

The Masterweigh 2 program includes a checksum of the contents of the EPROM instructions, this checksum is continually verified during normal operation to ensure the integrity of the Masterweigh 2 CPU control program. A failure of the EPROM checksum test is flagged as a system error, see section on System Errors.

The UV erasing windows of the two EPROMs should be covered after programming to prevent accidental erasure or program degradation. Always ensure that EPROMs are inserted with the correct orientation, reverse orientation may damage the EPROM. EPROMs are static sensitive devices, always follow static safe procedures when handling EPROM devices.

3.17 BATRAM Memory

The Masterweigh 2 unit provides 16k bytes (or optionally 64k) of battery backed CMOS static RAM (BATRAM). This RAM serves as both CPU program RAM and for the permanent storage of system configuration parameters. The BATRAM devices will provide a minimum of 10 years retention of data without power applied to the Masterweigh 2 unit.

The section of the BATRAMs used for the storage of configuration parameters is protected by write security circuitry which ensures that the CPU must perform a specific sequence of operations to gain access to the secure BATRAM area. The security scheme involves an Arm-Write sequence that must be re-armed before every access. This scheme ensures that spurious CPU operation cannot corrupt the configuration parameters stored in the BATRAM. The BATRAM devices have integral protection circuitry to disable write access during power up and power down.

A checksum is maintained on the system parameters, it is updated when a parameter is modified. The checksum is continually verified during normal operation to ensure the integrity of the Masterweigh 2 CPU control program. A failure of the BATRAM checksum test is flagged as a system error, see section on System Errors.

3.18 Supply Voltage Monitors

The Masterweigh 2 unit incorporates two levels of under-voltage detection, implemented by a dedicated power supply monitoring device.

The +5 volt CPU regulator requires approximately +7 volts input to maintain a +5 volt output. The unregulated DC supply which powers the +5 volt regulator for the CPU circuitry is monitored, if it falls below approximately 8 volts the supply monitor will interrupt the CPU as an advance warning that +5 volt CPU supply may fail. The CPU can then take measures to secure all important data before the onset of power failure.

The +5 volt CPU circuit supply must be maintained close to +5 volts for reliable operation of the components connected to it. The +5 volt CPU supply is monitored, if it falls below 4.75 volts the supply monitor will initiate a reset of the CPU. The reset will remain asserted until the +5 volt supply returns to its normal level.

This system warns the CPU in advance of a power failure, and then resets it when the +5 volt supply falls below tolerance to avoid spurious CPU operation. Note no user setup or adjustment of the supply voltage monitor is required.

3.19 CPU Watchdog Circuit

The Masterweigh 2 unit incorporates a "watchdog" circuit to ensure that a CPU reset will occur should normal CPU execution be upset by some extraordinary event. The watchdog must be regularly serviced by the CPU, an event that interrupts normal CPU operation will cause the watchdog to time out and initiate a CPU reset. The watchdog time out period is approximately one second.

3.20 Hardware Diagnostics

The Masterweigh 2 unit performs a number of internal hardware self checks to ensure system integrity. Should any fault be detected a system error will be flagged (see section on System Errors). The following are the hardware self-diagnostics performed by the Masterweigh 2 system:

1. EPROM checksum - each Eprom is programmed with a checksum equal to the numerical sum of program code. The checksum is continuously re-computed and compared to the pre-programmed value to ensure program software integrity.
2. RAM check - at power up the read/write integrity of the system RAM is checked.
3. The analog to digital converter is continuously checked to detected over-range input voltages that would produce invalid mass rate and total data.

3.21 Field Terminal Connections

The Masterweigh 2 unit has several field I/O connectors. The Process I/O terminal connections are as follows:

J6 - DIGITAL INPUT/OUTPUT CONNECTOR:		
1	DIG I/P 1+	Digital input signal - channel 1
2	DIG I/P COM	Digital input common for input channels 1 & 2
3	DIG I/P 2+	Digital input signal - channel 2
4	DIG I/P 3+	Digital input signal - channel 3
5	DIG I/P COM	Digital input common for input channels 3 & 4
6	DIG I/P 4+	Digital input signal - channel 4
7	DIG O/P 1+	Digital output channel 1 - positive connection
8	DIG O/P 1-	Digital output channel 1 - negative connection
9	DIG O/P 2+	Digital output channel 2 - positive connection
10	DIG O/P 2-	Digital output channel 2 - negative connection
11	PLS O/P 1 COM	Ground for external supply and pulse output
12	PLS O/P 1 OP	Pulse counter output - channel 1
13	PLS O/P 1 V+	External pulse counter input supply
14	PLS O/P 2 COM	Ground for external supply and pulse output
15	PLS O/P 2 OP	Pulse counter output - channel 2
16	PLS O/P 2 V+	External pulse counter input supply

J7 - LOAD CELL 1 INPUT/OUTPUT CONNECTOR:		
17	TACH 1 IN	Tacho pulse signal input
18	TACH 1 +5V	Tacho +5 volt external supply output
19	TACH 1 GND	Tacho ground for signal and external supply
20	LOAD CELL 1 E+	Positive load cell excitation output
21	LOAD CELL 1 E-	Negative load cell excitation output
22	LOAD CELL 1 SC	Ground screen for excitation/load cell
23	LOAD CELL 1 L+	Load cell positive input
24	LOAD CELL 1 L-	Load cell negative input
25	REM. SENSE 1 SC	Excitation remote sensing screen
26	REM. SENSE 1 R+	Excitation remote sensing positive input
27	REM. SENSE 1 R-	Excitation remote sensing negative input
28	AUX IN 1 +	4-20 mA auxiliary input - current in
29	AUX IN 1 -	4-20 mA auxiliary input - current out
30	AUX IN 1 SC	4-20 mA auxiliary input screen
31	LOOP IN 1	4-20 mA output - current in
32	LOOP OUT 1	4-20 mA output - current out

J8 - LOAD CELL 2 INPUT/OUTPUT CONNECTOR:		
33	TACH 2 IN	Tacho pulse signal input
34	TACH 2 +5V	Tacho +5 volt external supply output
35	TACH 2 GND	Tacho ground for signal and external supply
36	LOAD CELL 2 E+	Positive load cell excitation output
37	LOAD CELL 2 E-	Negative load cell excitation output
38	LOAD CELL 2 SC	Ground screen for excitation/load cell
39	LOAD CELL 2 L+	Load cell positive input
40	LOAD CELL 2 L-	Load cell negative input
41	REM. SENSE 2 SC	Excitation remote sensing screen
42	REM. SENSE 2 R+	Excitation remote sensing positive input
43	REM. SENSE 2 R-	Excitation remote sensing negative input
44	AUX IN 2 +	4-20 mA auxiliary input - current in
45	AUX IN 2 -	4-20 mA auxiliary input - current out
46	AUX IN 2 SC	4-20 mA auxiliary input screen
47	LOOP IN 2	4-20 mA output - current in
48	LOOP OUT 2	4-20 mA output - current out

The RS 485 network line interface requires only three connections, for convenience the Masterweigh 2 unit provides duplicate field connectors (electrically connected via the PCB) for easy line-in/line-out connection. Either block of three connectors may be used as line-in or line-out. The connections for the RS 485 network line interface terminals are as follows:

J5 - RS 485 NETWORK INTERFACE PORT CONNECTOR:	
SC	Line screen
L-	Line -
L+	Line +

Provision has been made to access the internal 28 volt unregulated DC supply via J10. This supply could be used to power external switches / proximity switches connected to the digital inputs, devices connected to the general purpose digital outputs, etc.

The connections for J10 are as follows:

J10 - 28V AUXILIARY POWER:	
1	+28V
2	COM/28V GND
3	+28V

3.22 PCB Loading Options

This section details the options available for loading of Masterweigh 2 PCBs.

A. POWER SUPPLY PCB

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1. Fuse 1, 2, 3 and 4.

These current limiting components can be either a PCB mount fuse or Poly-silicon switch of the appropriate current rating.

2. VR1 and VR2.

These transient absorbing components are optional, when loaded they must be the appropriate voltage rating for the mains supply voltage in use.

B. CPU PCB

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1. EPROM Size

Masterweigh 2 allows for the installation of 2 x 32k, 64k, 128k or 256k Eproms. Current software requirements need only 2 x 64k (27512) devices. Plated links for 2 x 64k Eproms have been provided on the artwork. If at a future date higher capacity Eproms are required, one or more of the pre-connected links may be cut and jumper links installed as appropriate.

Note: That only a 28 pin Eprom socket is required to be installed when using 2 x 64k (27512) Eproms.

2. BATRAM Size

Masterweigh 2 allows for the installation of 2 x 8k or 32k BatRams. The 2 x 32k devices are required for the zero map and transit time delay compensations features of the Weigh feeding software option. A jumper link is provided to configure the Masterweigh 2 for either BatRam size.

3. Instrumentation Amplifier Gain

To allow for both V to F and Dual Slope A to D converters, instrumentation amplifier gains of both 100 and 50, respectively, are required. A jumper link is provided to configure Masterweigh 2 for the required gain. R62 (1k00) must be installed for Dual Slope applications, (ie. Loss In Weight), it may be optionally deleted for V to F applications (ie. Belt Weighing and Weigh Feeding).

4. A to D Converter

Masterweigh 2 provides for up to three A to D converter options to be loaded. The AD650 V to F converter for Belt Weighing and Weigh Feeding applications, the AD7703 20 bit converter for Loss In Weight applications, and the ADC1001 Successive Approximation converter for future applications. Only the converter and associated discrete components for the required application need be loaded, though installing more than one converter is allowed.

The following list the discrete components associated with each converter, they must be installed with each converter and/or may be optionally deleted if that converter is not to be loaded.

AD650 V to F Converter: R60, R61, C47, C77 and C78.

AD7703 20 bit Converter: R54 to R59, C66 to C70, D28 and Z8.

ADC1001 Successive Approximation Converter: R90, R120.

5. Load Cell Excitation Sensing

Masterweigh 2 provides for both local and remote load cell excitation sensing. A jumper link is provided for each of the two load cell channels. Plated links have been provided for local sensing. To configure a load cell channel for remote excitation sensing, simply cut the pre-connected link. To return to local sensing after the pre-connected link has been cut, simply install jumper links and link as appropriate.

6. Serial Interface

Masterweigh 2 provides two serial interfaces. The first serial port is an RS232 terminal interface to access the background interpreter system. The second serial port can optionally be a second RS232 port, an RS485 port, or future interface via expansion connector. If serial communications of any type are not required, all of the components shown on the schematic labelled T343-03 may be deleted.

7. RS485 Interface

Masterweigh 2 provides for an optional on-board RS485 port. When the RS485 port is implemented, the following transient suppression/protection components are optional, R27, R28, C56, C57, V1 and V2. If the RS485 port is not used, then the above and the additional following components may be deleted: U62, R26, R121 and J5.

8. LCD Module Backlighting

Masterweigh 2 provides a DC to AC converter (inverter) for generating the necessary voltage required to drive LCD electro-luminescent backlighting. If LED backlighting is to be used, then the inverter (U63) should be deleted and a wire link placed between the inverter input and output pads, to supply +5V DC to the LED backlighting.

9. R-Cal

Masterweigh 2 provides the facility for R-Cal span calibration. If this feature is not required the following components may be deleted: R87 to R89, D41, Q14 and RRL1.

10. Millivolt Reference

Masterweigh 2 provides two loading options for the LM399 (U67) voltage reference. The four pin TO72 option is labelled U67A, and the three pin TO92 option is labelled U67B.

NOTE: only one reference must be loaded.

4 USER CONFIGURATION

4.1 W1/W2 - EPROM size select

The Masterweigh 2 unit can use 27C256, 27C512, 27C010 or 27C020 EPROM devices for storage of the CPU control program instructions. Because the 68000 CPU has a 16 bit data bus, two 8 bit EPROM devices must be used. The following are the link positions required for W1 and W2 to set the size the installed EPROMs:

EPROM Size	W1 Pos	W2 Pos
27C256	<2MB	256KB
27C512	<2MB	>256KB
27C010	<2MB	>256KB
27C020	2MB	>256KB

Note that the link settings for 27C512 and 27C010 EPROMs are the same. Normally, two 27C512EPROMs would be used, and appropriate plated links are provided on the PCB. If EPROMs size 27C010 is required, it will be necessary to cut the plated link on W2 and install link posts. If EPROMs size 27C020 is required, it will be necessary to cut the plated links on W1 and W2, and install link posts. The EPROM size configuration would normally be factory set.

4.2 W3 - BATRAM size select

The Masterweigh 2 unit can use 2 x 8k or 2 x 32k BATRAM devices for CPU RAM and storage of configuration parameters. Because the 68000 CPU has a 16 bit data bus, two 8 bit BATRAM devices must be used. The following are the link positions required for W3 to set the size the installed BATRAMs:

BATRAM Size	W3 Pos
2 x 8k	16k
2 x 32k	64k

Normally, 2 x 32k BATRAMs would only be installed for the weighfeeding option.

Note: This link MUST be installed.

4.3 W4 - Analog amplifier gain selection

The Masterweigh 2 hardware is designed to perform both belt weighing and loss in weight, these two application require two different A to D converters, which have different full scale input voltages. To maintain maximum analog resolution it is necessary to adjust the gain of the AD524 instrumentation amplifier to provide each A to D converter with a maximum input voltage for a full scale mV input load cell signal.

When configured for belt weighing, an AD650 V to F converter is used, this requires an analog gain of 100. When configured for loss in weight, an AD7703 20 bit converter is used, this requires an analog gain of 50. The following are the W4 link settings required for analog gains of 50 and 100:

Analog Gain	W4 Link Position	Masterweigh 2 Application
50	1 - 2	Loss In Weight
100	2 - 3	Belt Weighing / Weigh Feeding

Note: That when a gain of 50 is selected, R62 (1k00) must be installed. When a gain of 100 is selected, R62 must be removed.

4.4 W5 - Excitation sensing channel 1

The Masterweigh 2 unit provides for both local and remote sensing of the load cell excitation voltage. For installations where the load cell is close to the Masterweigh 2 unit local sensing is adequate. Where the load cell is remote from the Masterweigh 2 unit, remote excitation sensing will yield improved accuracy. The following are the W5 link position required for local and remote excitation sensing:

Sensing	Link Positions
Local	1-3 and 2-4
Remote	Open (no links)

Note: When remote excitation sensing is selected, the remote load cell excitation voltage must be returned to the Masterweigh 2 unit process I/O field terminal strip and connected to the "REM SENSE" terminals. Normally, local excitation sensing is used and appropriate plated links are provided on the PCB. If remote excitation sensing is required, simply cut the plated links on W5.

4.5 W6 - Excitation sensing channel 2

The configuration for local or remote load cell excitation sensing for load cell channel 2 is identical to that of W5 for load cell channel 1.

4.6 W7/W8 - Pulse Output 1 voltage supply

The Masterweigh 2 unit provides for powering the pulse output counters with either the internal 28 volt DC supply or an external DC supply. Links W7 and W8 select the pulse output power source for channel 1, link W7 selects the output common source and link W8 selects the output positive supply source. The following are the W7/W8 link positions required for using internal or external pulse counter power supplies:

Supply	W7 Link Positions	W8 Link Positions
Internal	1 - 2	1 - 2
External	not installed	not installed

Note: when an external supply is used, the supply common must be connected to the pulse output field I/O "PLS O/P COM" terminal and the supply positive must be connected to the pulse output field I/O "PLS O/P V+" terminal.

4.7 W9/W10 - Pulse Output 2 voltage supply

The configuration for pulse counter output voltage supply source for pulse output channel 2 is identical to that of W7/W8 for pulse output channel 1.

4.8 W11/W12 - Analog Output 1 voltage supply

The Masterweigh 2 unit provides for powering of the analog output channels from either the internal 28 volt DC supply, or an external DC supply. Links W11 and W12 are used to select the analog output power source for channel 1. The following are the W11/W12 link positions required for internal or external loop power supplies:

Supply	Link positions	
	W11	W12
Internal	1-2	1-2
External	2 - 1	

Note: When an external supply is used, the positive side of the loop must be connected to LOOP OUT and the negative side of the loop to LOOP IN.

4.9 W13/W14 - Analog Output 2 voltage supply

The configuration for analog output channel 2 loop power supply source is identical to that of W11 and W12 for analog output channel 1 loop power supply source.

4.10 LK1 - Unit Earthing

The Masterweigh 2 unit power supply provides transformer isolation from the mains input and hence can be operated in a fully floating mode if required. For safety reasons it is recommended to operate the Masterweigh 2 unit referenced to earth. Link LK1, labelled "GND - EARTH LINK" on the Masterweigh 2 power supply PCB is used to select earth referenced or floating operation, as detailed below:

Operation	LK1 (Power Supply PCB)
Earth Ref	Installed
Floating	Open (not installed)

Normally the Masterweigh 2 unit is operated in the ground referenced mode an appropriate plated link is provided at LK1. If it is desired to "float" the Masterweigh 2 unit, simply cut the plated link at LK1.

5 USER ADJUSTMENT

5.1 RV1 - LCD Display Viewing Angle

This potentiometer is provided for adjusting the optimum display viewing angle for a particular unit installation. The viewing angle adjustment is achieved by varying a bias voltage to the LCD display module. RV1 provides a bias voltage range of approximately +0.8 volts to -4.2 volts.

Note : That some darkening of the display may occur with large increases in ambient temperature. Normal contrast will return as the temperature returns to normal.

5.2 RV2 - Load Cell Excitation

This potentiometer provides adjustment of the load cell excitation voltage produced by the Masterweigh 2 unit. The excitation range is variable over the range approximately 4 to 12 volts, the actual excitation voltage may be measured at the load cell E+ and E- field connector terminals. Note that this excitation voltage is common, and supplied, to both load cell channels.

6 HARDWARE SETUP

6.1 Precision Reference Voltage Calibration

The Masterweigh 2 employs sophisticated auto-calibration technique to establish and maintain high accuracy analog input circuitry.

An extremely stable voltage source provides zero and span mV reference inputs. The Masterweigh 2 uses these to establish the analog zero offset and gain of the input circuit, and can hence automatically compensate for component drift due to temperature and aging. It also means that the initial gain and zero offset of the pre-amplifier and A to D converter circuitry is not critical, and thus component tolerances can be relaxed.

Note that the reference inputs are processed by the same input circuitry as the load cell input, hence the auto-calibration procedure includes the effect of all components which affect the accuracy of the load cell input.

The output of the reference circuit provided, although very stable with temperature and time, cannot be predicted accurately. It is therefore necessary at an early stage in the setup of the unit, to measure the actual reference voltages and to enter them into the system for storage in BATRAM memory. These values should be checked, and updated if required, whenever maintenance of the Masterweigh 2 unit is undertaken.

For this initial calibration the meter used to check the reference voltages should be accurate to better than 0.1% of a reading at a measured voltage of 25 millivolts. The reference calibration procedure is as follows:

- Obtain a very accurate, high resolution digital voltmeter suitable for measurements at 5 and 25 millivolts with a minimum accuracy and resolution of +/- 5 microvolts for both measurements.
- Using pointed probes, connect the meter negative to the left side of R80 and the meter positive to the right side of R80, this is the "zero reference" value and should be approximately 5 millivolts. The measured value should be scribed, to 3 decimal places, onto the CPU PCB in the copper area provided labelled "Ref ZERO:".
- Keeping the meter negative on the left side of R80, move the meter positive to the left side of R68, this is the "span reference" value and should be approximately 32 millivolts. The measured value and should be scribed, to 3 decimal places, onto the CPU PCB in the copper area provided labelled "Ref SPAN:".
- Using the unit keypad, access the calibration menu entry and input the zero and span reference values, and press Enter to save the new values when returning to the main menu. Allow one minute for the auto-calibration routines to re-calibrate based on the newly entered reference values.

7 HARDWARE TROUBLE SHOOTING

7.1 Analog Input Circuitry

The ability to use up to eight analog inputs (2 x load cells, 2 x excitation sense, 2 x auxiliary input, and 2 x mV reference) is provided by two 4 channel analog multiplexers. The multiplexers are four channel, differential devices with a substantial input over-voltage rating, low leakage currents, low channel ON resistance, and matched channel ON resistances.

The AD524 instrumentation amplifier is chosen because of its excellent gain and zero offset stability, common mode rejection, and low input bias and offset currents. Whilst the exact AD524 zero offset is not critical, it is important to have a "live" zero to ensure satisfactory operation of the A to D converter when a zero volt signal is applied to the load cell input. For belt weighing and weigh feeding applications an AD524 gain of 100 is used. For loss in weight applications gain of 50 is used.

The AD524 zero is established by R63 and R64 and can be checked as follows:

- Configure the Masterweigh 2 unit to operate with only the first load cell channel active
- Apply a short circuit to the load cell input of channel one, and if no load cell is connected to provide a ground path, make a connection between the load cell input and the analog ground terminal to ensure that the input does not float outside the common mode range (± 8 volts) of the input circuitry.
- With the Masterweigh 2 operating normally, measure the voltage at pin 9 (with respect to pin 6) of the AD524.
- Since the multiplexer selects the load cell input virtually all the time (even if with remote setpoint mode active), the voltage displayed by a sampling voltmeter is typically quite stable, and will be the signal due to the load cell input (ignore occasional deviant reading due to the multiplexer sampling the auxiliary or mV reference inputs).
- The signal level due to the shorted input should be approximately 1% of full scale, or at Pin 9 if the AD524, approximately 30 mV, and not less than 20 mV.

7.2 Analog To Digital Converter

In the belt weigher Masterweigh 2 option, the A to D converter will be an AD650 voltage to frequency converter. The V to F converter operates over the frequency range 0 - 200kHz, for an AD524 output voltage range of 0 - 3.2 volts (this corresponds to a load cell input voltage of 32 mV).

Note: That the V to F converter will accept inputs of up to 10 volts as configured, with a corresponding output frequency of approximately 600 kHz.

Note: That some loss of converter linearity will occur above 200 kHz. The resolution of the V to F converter is equivalent to 13 bits.

In the loss in weight Masterweigh 2 option, the A to D converter will be an AD7703 20 bit converter. The 20 bit converter provides a count output in the range 0 - 1,000,000 counts for an input voltage in the range 0 - 2.0 volts (this corresponds to a load cell input voltage of 40 mV). The resolution of the Dual Slope converter is equivalent to 20 bits.