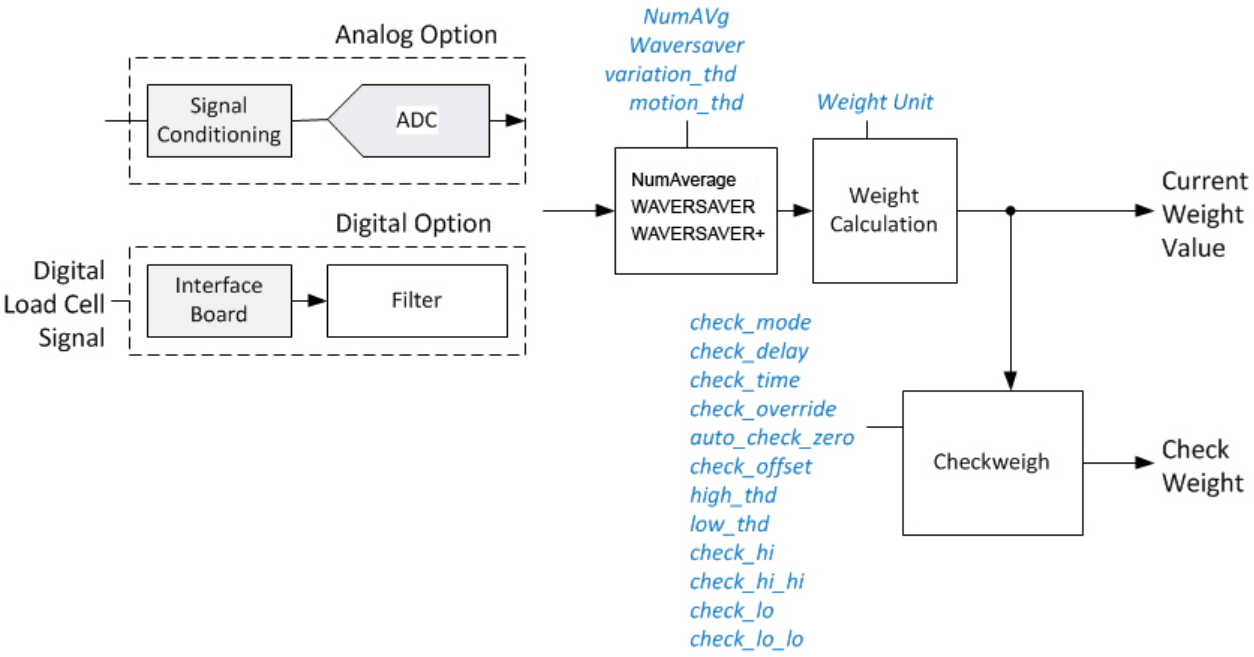
HI 4050-CW
Check Weighing Option

User Guide Addendum

Document Number: 0596-0325-01 Revision E

OVERVIEW

The HI 4050-CW can be used with either analog strain gage load cells or a Hardy Digital Sensor Point.



Functional block diagram of the HI 4050-CW

The output from the analog or digital weigh scale input card can be averaged over a programmable number of samples using NumAverage, and further processed by WAVERSAVER+ to provide a stable calculation of the current weight on the scale.

Two check weighing methods can be used to determine the weight of the object when it is on the scale. The first automatically detects an object as it transitions on and off the scale; the second method uses one or two external triggers to determine when the check weigh value should be calculated.

In all modes, the output from WAVERSAVER, NumAverages and WAVERSAVER+ are collected and processed across the programmed “check time” period to provide the check weight value. The number of samples collected is determined by the check time divided by the sample period.

The “check hold” parameter enables the calculated “Check Weight” value to be held in the HI4050-CW for the programmed time period or until another object moves onto the scale.

If only the contents of a container are of interest to the user, a programmable check_offset value (a function similar to TARE VALUE) can be automatically subtracted from the final check weight value.

WAVERSAVER®

Mechanical noise (from other machinery in a plant environment) can be present in forces larger than the weight forces being measured. The HI 4050-CW is fitted with WAVERSAVER technology that eliminates the effects of vibratory forces present in all dynamic and static industrial weight control and measurement applications. By factoring out almost all of the ambient vibratory forces, the check weigher can separate out the actual weight data from background noise caused by vibration.

WAVERSAVER can be configured from the front panel or via the web browser to ignore noise with frequencies as low as 0.25 Hz. One of four higher additional cut off frequencies can be selected to provide a faster instrument response time.

The default factory setting is 7.5 Hz vibration frequency immunity.

NumAverages

The value you enter for Number of Averages sets the number of weight readings used to compute a sliding average of displayed weight. This setting is to aid in ignoring the effects of material impact and/or vibration. Applications requiring very quick weight readings should reduce this setting to its minimum. If the weight is unstable, increase the averages.

The default factory setting is 10.

WAVERSAVER®+

WAVERSAVER+ uses two parameters, variation_thd and motion_thd to configure an adaptive filtering algorithm which significantly improves the accuracy of the weight reading when the weight is static on the scale.

To configure WAVERSAVER+, set the WAVERSAVER and Numaverages parameters to establish the speed of weighing and the required accuracy for dynamic weighing. Measure the peak to peak variation of the weight value, then set the variation threshold to be 1.5 times larger and the motion threshold to 1/3 of the measured peak to peak weight variation.

For example, if the observed weight change is 6, set the variation_thd should be set to 9 (1.5X) and the set the motion_thd parameter set to 2 (1/3X). Note the weight changes will settle to a 2 increment level.

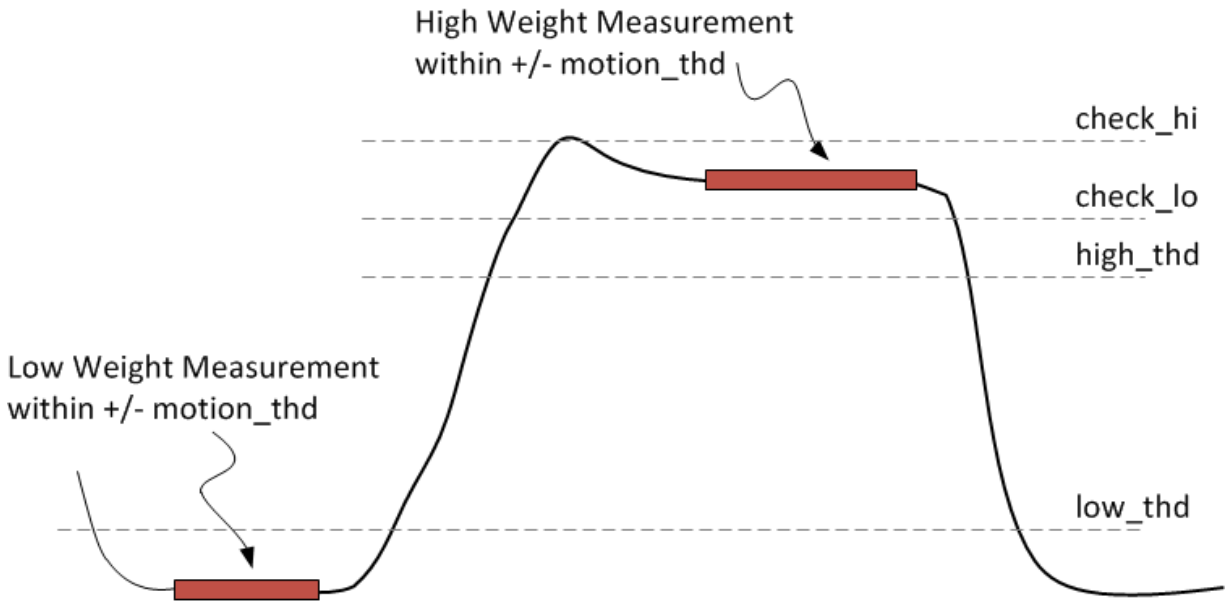
Weight changes smaller than 1:40,000 typically require consideration of environmental protection from air movement forces and additional WAVERSAVER and NumAverages settings.

The default factory setting is 0.0; which turns WAVERSAVER+ off.

Operation

Internal Check Weight Mode (default)

When the check_mode is set to internal, two weight values are used to determine the "Check Weight" value – a value before an object is placed onto the scale and a value while an object is on the scale. The difference between these two values is used to calculate the "Check Weight" value.

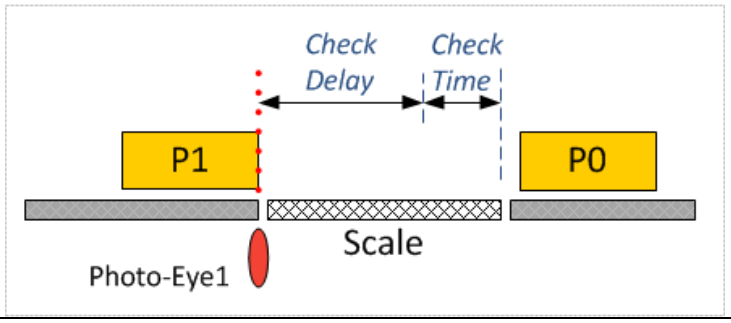
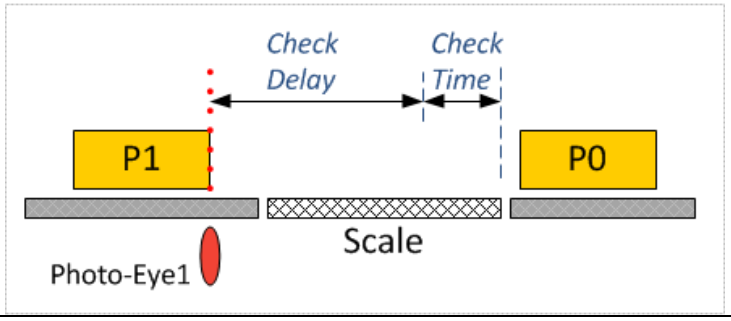
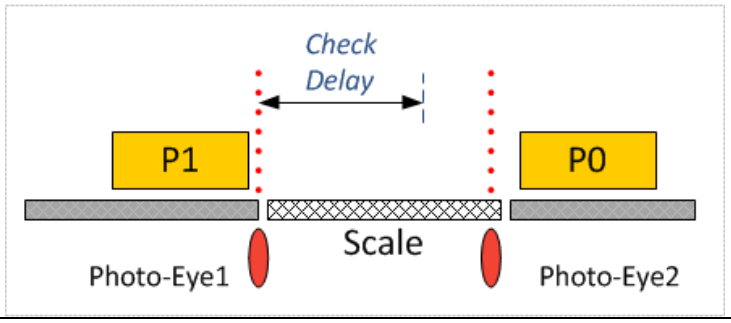
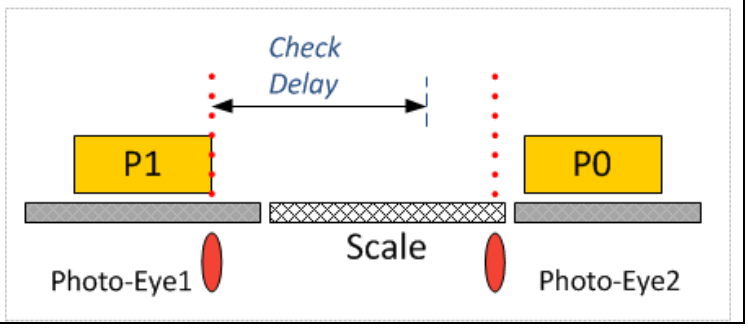


Internal Check Mode: Detecting when an object is ON and OFF the scale

The "Check Weight 1" (high_thd) value sets the upper limit, above which weight values can be assumed to be from objects on the scale and the "Check Weight 2" (low_thd) value sets the lower limit below which weigh values can be assumed to be from the scale when nothing is present. This is illustrated in the diagram above.

External Check Weight Mode

There are four external modes depending on the number of external triggers and the spacing of the trigger points relative to the scale. The 1T1W and 2T1W modes can be configured to run at faster rates but may go extended periods without resetting the dead load value; while the 1T2W and 2T2W modes use additional time before the object moves onto the scale to measure and reset the dead load just before the weight of an object is measured. These four modes are shown in the following table for comparison and more detailed explanations are provided in later sections.

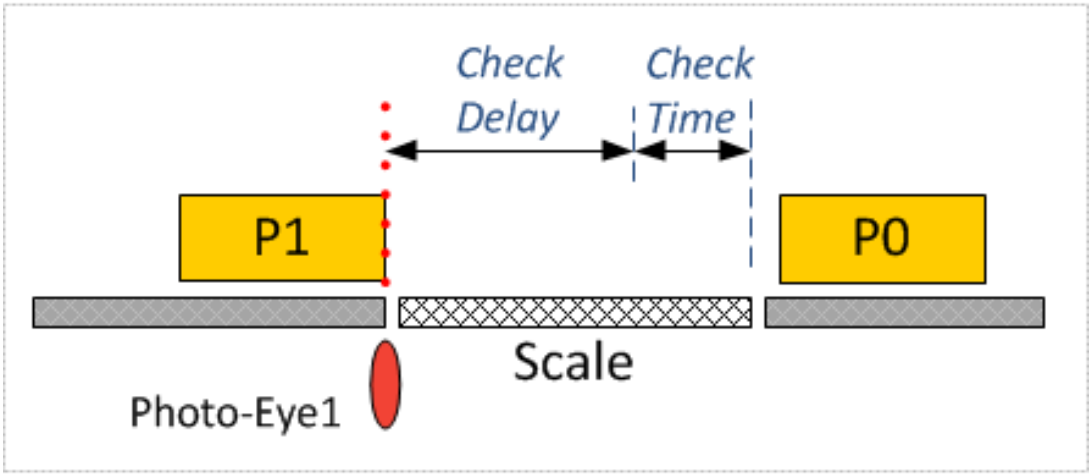
1T1W mode One Trigger One Weight reading *Detects object moving onto the scale, but does not know when the object moves off the scale.*	
1T2W mode One Trigger Two Weight readings *Detects object moving onto the scale, but does not know when the object moves off the scale.*	
2T1W mode Two Triggers One Weight reading *Detects object moving onto and off the scale.*	
2T2W mode Two Triggers Two Weight readings *Detects object moving onto and off the scale.*	

The accuracy of the check weigh result can be affected by drift in a sensor, to help indicate when drift could be a problem a “check alarm” status bit in HS17 bit[0] is set HIGH whenever a programmable number of check weigh cycles have passed without the check zero value (dead load of the scale) being recalculated.

Check Mode: 1T1W

This mode provides the fastest packs per minute, but suffers from an unpredictable dead load measurement and cannot detect when multiple packs are on the scale.

In the following simplified example packages labeled P0 and P1 are transitioning onto and across the scale.



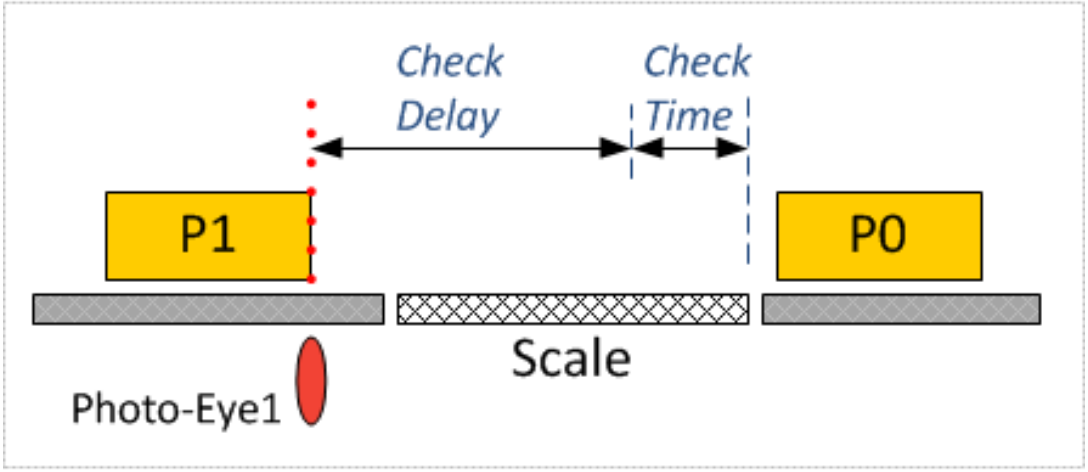
The object weight on the scale is calculated during the “check time” period after the “check delay” period has expired. The dead load is calculated and the “check alarm” count reset to zero, if weight falls below the low threshold and remains stable for the “check time” period; however if the dead load value is not calculated before the next object moves onto the scale the “check alarm” count is incremented.

Check Mode: 1T2W

The increased distance between the photo-eye and the start of the scale reduces the packs per minute rate, but provides a predictable window to measure the dead load weight, but without a second photo-eye cannot detect when multiple packs are on the scale. Although the “check override” status bit can be used to indicate if more than a programmable percentage above the high threshold is detected.

In the following simplified example, packages labeled P0 and P1 are transitioning onto and across the scale.

In this mode, the dead load is calculated if the photo eye detects the P1 and the current weight is stable and below the low threshold, which indicates the P0 has transitioned off the scale. The dead load value continues to be calculated until the object causes the weight to transition above the low threshold or the weight value becomes unstable. If enough samples were collected to provide a new dead load value the "check alarm" count is reset to zero, otherwise the "check alarm" count is incremented.

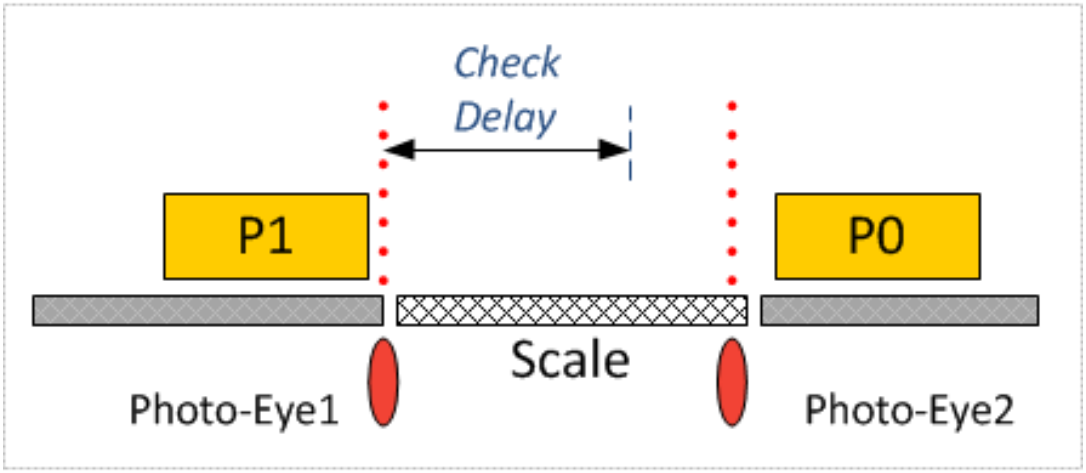


Once the "check delay' period expires the object weight is calculated for the "check time" period.

Check Mode: 2T1W

The 2T1W mode provides the fastest packs per minute and allows objects are varying size to be weighed, but suffers from an unpredictable dead load measurement; however the second photo-eye provides a reliable detection of when multiple packs are on the scale.

In the following simplified example packages labeled P0 and P1 are transitioning onto and across the scale.

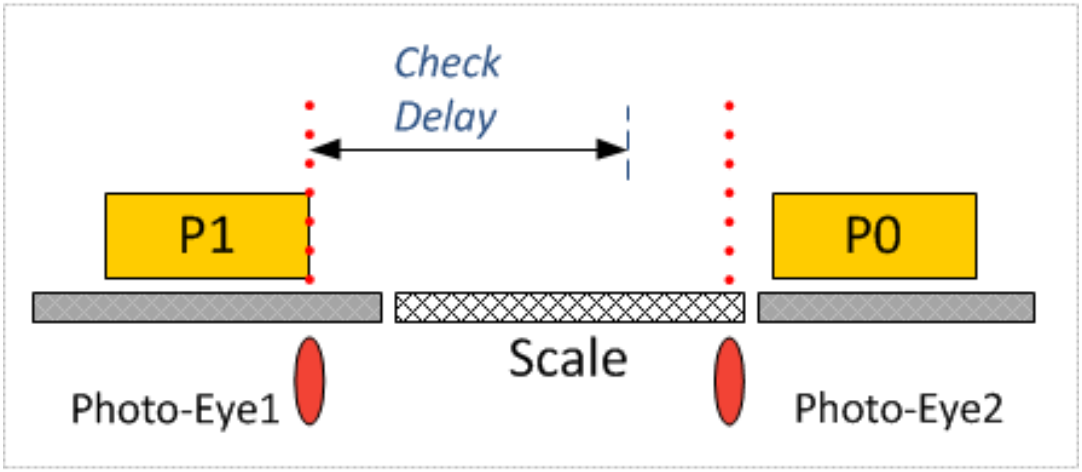


The “check delay” time is started once the object P1 is detected by the photo-eye1. When the “check delay” time expires, or object P1 breaks the beam of photo-eye2, the object weight is calculated. Once the signal from photo-eye2 indicates the object has passed the dead load value can be calculated while the weight is stable and below the low threshold; and is automatically stopped once photo-eye1 detects a new object. If enough samples were collected to provide a new dead load value the “check alarm” count is reset to zero, otherwise the “check alarm” count is incremented.

Check Mode: 2T2W

The increased distance between the photo-eye and the start of the scale reduces the packs per minute rate, but provides a predictable window to measure the dead load weight, and the second photo-eye enables the detection of multiple packs are on the scale.

In the following simplified example packages labeled P0 and P1 are transitioning onto and across the scale.



The “check delay” time is started once the object P1 is detected by the photo-eye1. When the “check delay” time expires, or object P1 breaks the beam of photo-eye2, the object weight is calculated.

If photo-eye2 detects the last object has transitioned off the scale and photo-eye1 has not detected a new object moving onto the scale, dead load can be recalculated until photo-eye1 detects a new object. If enough samples were collected to provide a new dead load value the “check alarm” count is reset to zero, otherwise the “check alarm” count is incremented.

Status of the Check Weigh Measurement

The functionality of these status bits are common to both check weigh modes of operation.

If required the "Check Weight" value can be compared to the "check hi" and "check lo" parameter values to determine if the object on the scale is within a programmable tolerance.

The four possible results are listed in the table below and can be read directly from the HI4050-CW. A "Check Status" signal could be mapped through digital outputs on the HI4050-CW to indicate to an operator if the object weight is outside the desired tolerance.

Check Detect	Description
0	Indicates that the current value of "Check Weight" is not valid or below the "Low Threshold" value.
1	FAIL LOW: indicates when the "Check Weight" value is less than or equal to "Check LO"
2	PASS: indicates when the "Check Weight" value is between "Check HI" & "Check LO"
4	FAIL HIGH: indicates when the "Check Weight" value is greater than or equal to "Check HI"

Two additional parameters can be set to determine is objects are statistically close to the upper and lower weight check weight tolerance values. The check hi_hi value provides the upper weight level and the check lo_lo value sets the lower weight value.

The two possible results are listed in the table below and can be read directly from the HI4050-CW. A "Check Limit" signal could be mapped through digital outputs on the HI4050-CW to indicate to an operator if the object weight is outside the desired tolerance.

Check Limit	**Description**
0	Status bit goes HIGH when the "check weight" value greater than check_lo_lo but is less than or equal to "check_ lo"
1	Status bit goes HIGH when the "check weight" value is less than check_hi_hi but is greater than or equal to check_hi

The period the "Check Detect" and "Check Limit" values are active is set by the "Check Hold" time. Once this time expires or the "Check Weight" value goes to zero the "Check Detect" and "Check Limit" values are forced to zero.

Check Quality

To determine if enough time is being allowed to measure the weight of the object on the scale, the number of samples used to generate the "Check Weight" is used to determine the quality of the check weigh cycle.

A non-zero "Check Quality" value is only generated if a complete weigh cycle has been completed, and reflects the number of samples detected within the "motion_thd" tolerance, while the weight is above the "high threshold". If a check weigh cycle fails to complete an entire weigh cycle, then the check quality value 0 is set.

The following table lists the five possible check quality parameter values; which can be used to help determine if the check-weigher is running at the optimum speed for the required accuracy.

Check Quality	Description
0	Incomplete weigh cycle detected
1	BAD quality
2	LOW quality
3	MED-LOW quality
4	MED-HIGH quality
5	HIGH quality
6	EXCELLENT quality

The "check quality" value is displayed on the HI4050-CW panel display next to the check weight value, or can be extracted from the "Check Weight Status Word" (HSI16) through mapping.

Check Weigh Tamper Detection

Once the check zero value is set, the stable "low weight measurement" is compared to the check zero value. If for more than 32 weigh cycles out of the last 128 weigh cycles the measured "low weight measurement" value is more than the "tamper threshold" value away from the calibrated check zero value the tamper bit, status word bit [11], is set HIGH. The tamper bit is reset LOW automatically if the "low weight measurement" value stays within the "tamper threshold" tolerance of the check zero value for 128 weigh cycles, or can be cleared through mapping, or via the front panel depending on the HI4050-CW configuration.

Common Parameters

Parameter	Default	Description
Variation Thd	*	Sets the peak to peak deviation in weight value expected on the scale. Deviations beyond this threshold are expected to be caused by excessive motion while the object is on the scale.
Motion Thd	**	Sets the peak to peak deviation in weight value used to detect motion on the scale.
Tamper Thd	***	Sets the peak to peak deviation in weight value used to detect that the check zero value has changed since it was calibrated.
High Thd	15% of FS	Weight values above this value are recorded as “On Check” if no motion is detected. Value with respect to “check zero”
Low Thd	1% of FS	Weight values below this value are recorded as “Off Check” if no motion is detected. Value with respect to “check zero”
Check Hi	20% of FS	Sets the upper limit for a valid object weight. Value with respect to “check zero”
Check Lo	10% of FS	Sets the lower limit for a valid object weight. Value with respect to “check zero”
Check HiHi	20% of FS	Sets a statistical upper limit for valid objet weights and is used to trigger a status bit
Check LoLo	10% of FS	Sets a statistical lower limit for valid objet weights and is used to trigger a status bit
Check Override	OFF or 100%	Active range 150% to 999%, use OFF or 100% to disable. Threshold set as a percentage of the check_hi value. If the check weigh value is equal to or more than this value a status bits is set to indicate more than one object on the scale.

Parameter	Default	Description
Check Hold	0.15	Set the time, in seconds, that the check weight value is held after the weight drops below the "high threshold" value. default = 150ms
Check Zero	0	When this bit is set HIGH, the dead load of the checkweigher is calculated and the result stored in the "check zero" value. This parameter is automatically cleared after data collection is completed.
Check Zero Mode	OFF	When this bit is set to ON, whenever the gross weight is "zeroed" the check zero and the check low values are also "zeroed". *Note: In this mode the check low is not calculated.*
Check Mode	internal	When set to internal the check weigh algorithm uses the automatic detection of the check weigh value based on the high and low thresholds. If set to external a signal through the DIO card is mapped to trigger the start of check weigh calculation.
Check Delay	0	Units in milliseconds. Sets the expected time after the object moves onto the scale that the weight value may be unstable. Time starts when the external trigger transitions LOW. This is only used in the external mode, and is set to 0 for the internal mode.
Check Time	40	Units in milliseconds. Sets the time duration the object is expected to be on the scale. The time starts after the end of the programmed check_delay time.
Check Offset (Tare Value)	0.0	A value used to offset the check weigh value is the weight of the container on the check weigh is known.

- * Default value set to 1/2,500 of maximum capacity of the load cell.
- ** Default value set to 1/10,000 of maximum capacity of the load cell
- *** Default value set to 1/5,000 of maximum capacity of the load cell

* See Overview section on WAVERSAVER+ for an example on setting these levels.

Digital Load Cell Parameters

<table>
<tr><th>Parameter</th><th>Default</th><th>Description</th></tr>
<tr><td>Check Period</td><td>1</td><td>Selects the check weigher update period (default is 4ms).
<table>
<tr><th>check_ period</th><th>Update Period (ms)</th><th>Update Rate (Hz)</th></tr>
<tr><td>1</td><td>4 (default)</td><td>250 (default)</td></tr>
<tr><td>2</td><td>6</td><td>167</td></tr>
<tr><td>3</td><td>8</td><td>125</td></tr>
<tr><td>4</td><td>10</td><td>100</td></tr>
<tr><td>5</td><td>12</td><td>83</td></tr>
</table></td></tr>
<tr><td>Filter Sel</td><td>6</td><td>Selects filter (0 – 15)

A zero value disables the filters. The filter selection values starting at 1 and ending at 15 linearly decrease the bandwidth of the data while proportionally increasing the delay.

A filter selection value of 1 sets the rejected frequencies to ~1/5th of the sample rate while a filter selection value of 15 sets the rejected frequencies to ~ 1/50th of the sample rate. However, the higher the number the slower the response of the check weigher.

The filter selection should be used in conjunction with “Check Quality” to provide the highest level of filtering for the best “Check Quality” value.</td></tr>
</table>

Check Weigh Values (in addition to Net & Gross weight)

Output Value	Description
On Check	This value represents the last value captured while the object was on the scale and the count deviations were below the motion_thd threshold level. Value with respect to “check zero”
Off Check	This value represents the last value captured while the object was off the scale and the count deviations were below the motion_thd threshold level. Value with respect to “check zero”
Check Weight (Check Weight ON - OFF)	This value represents the actual object weight (counts) captured while the object was on the scale and the count deviations were below the motion_thd threshold level.
Check Zero	Check Zero Mode = OFF The calculated gross weight of the dead load on the scale. Check Zero Mode = ON Set equal to the gross zero value when the scale is “zeroed”

Check Weigh Status Values

The check weigh status is provided by two status registers, HSI16 and HSI17.

Status bits common to both the internal and external check weigh modes
The check quality bits in status word HSI16 bits [10:8] provide a measurement of the quality of the check weigh value, the higher the value the more accurate the check weigh value. These bits can be used for both the internal and external check weigh modes.

To determine where the product is during a check weigh cycle, the current weight value is compared to the low threshold and high threshold values. These status bits are shown as HSI16 bits [7:4] in the status word HSI16 table. These bits are not related to the stability of the weight measurement just the relative magnitude of the weight with respect to the low threshold and high threshold values.

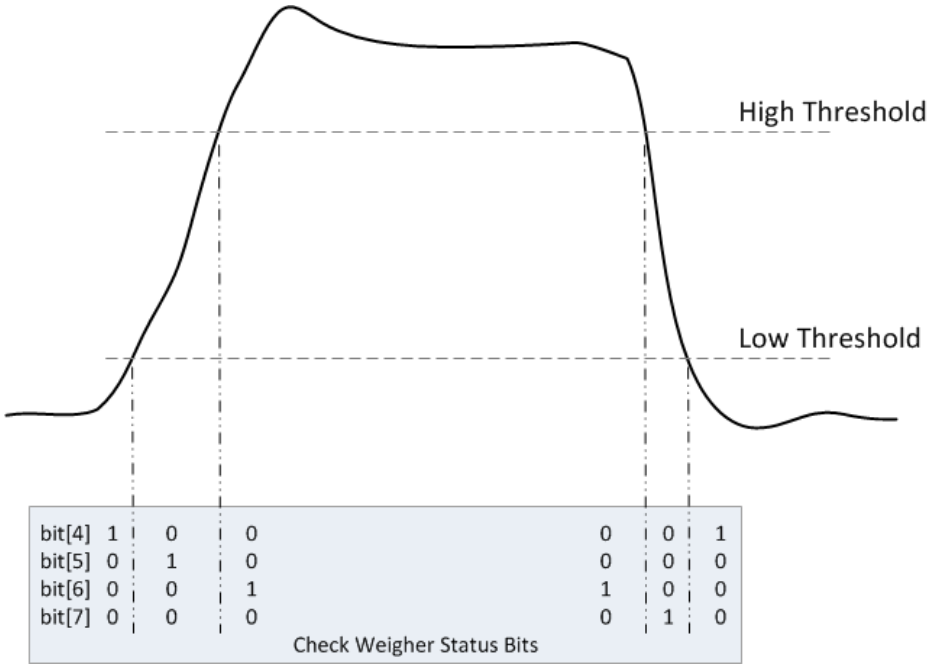
HSI16 status word bits [14] and [13] should be used to determine when an accurate measurement of the product weight can be taken. Status bit[14] is high when the weight is less than or equal to the low threshold and a stable weight reading is available, and bit[13] is high when the weight is greater than or equal to the high threshold and a stable weight reading is available. The difference between these two weight values provides the check weight value.

Additional status bits in HSI17 bits [1:0] can be used to provide statistical information by monitoring how many times a product is over the check_hi but below the check_hi_hi parameter or below the check_lo but above the check_lo_lo parameter.

Status bits used for the external check weigh mode

When using the external check mode, HSI16 bits [4] through [7] provide information about which step in the check weigh process the instrument is operating in after the external trigger starts the process.

HSI16 bits [4] through 7 provide status bits monitoring the package's transition ON and OFF the scale by weight.



Detecting Product Transition during a Check Weigh Cycle

Output Value	Description
Check Detect	Value indicating if the current object weight “check weight” value is between the “Check HI” and “Check LO” parameters.

Check Detect	Description
0	Indicates that the current value of “check weight” is not valid or below the “low threshold” value.
1	FAIL LOW goes HIGH when the “check weight” value is less than or equal to “Check LO”
2	PASS goes HIGH when the “check weight” value is between “Check HI” & “Check LO”
4	FAIL HIGH goes HIGH when the “check weight” value is greater than or equal to “Check HI”

<table>
<tr><th>Output Value</th><th>Description</th></tr>
<tr><td>Check Limit</td><td>2-bit value indicating if the current object weight “check weight” value is between the check_hi_hi and check_hi parameters, or between the check_lo_lo and check_lo parameters
<table>
<tr><th>Check Limit</th><th>Description</th></tr>
<tr><td>0</td><td>Status bit goes HIGH when the “check weight” value greater than check_lo_lo but is less than or equal to “check_ lo”</td></tr>
<tr><td>1</td><td>Status bit goes HIGH when the “check weight” value is less than check_hi_hi but is greater than or equal to check_hi</td></tr>
</table></td></tr>
<tr><td>Check Quality</td><td>Checks the number of samples used to measure the objects weight on and off the check weigher scale The higher the sample count the more accurate the object weight can be calculated.
<table>
<tr><th>Value</th><th>Description</th></tr>
<tr><td>0</td><td>Incomplete weigh cycle detected</td></tr>
<tr><td>1</td><td>BAD quality – less than 8 counts</td></tr>
<tr><td>2</td><td>LOW quality – 8 to 15 counts</td></tr>
<tr><td>3</td><td>MED-LOW quality – 16 to 31 counts</td></tr>
<tr><td>4</td><td>MED-HIGH quality – 32 to 63 counts</td></tr>
<tr><td>5</td><td>HIGH quality – 64 to 127 counts</td></tr>
<tr><td>6</td><td>EXCELLENT quality – 128+ counts</td></tr>
</table></td></tr>
</table>

Check Weighting Option Status Words (HSI16 & HSI17)

The check weighting option status word can be mapped to enable the following information to be extracted. The following table provides a description for each of the status bits.

Status Word bit	Description
[2:0]	Check Detect value
3	Check weight greater or equal to check_override parameter
4	Weight less than or equal to the low threshold value
5	Weight in transition from the low to the high threshold values
6	Weight greater than or equal to the high threshold value
7	Weight in transition from the high to the low threshold values
[10:8]	Check Quality value
11	Check weigh tamper detection
12	Indicates when the check zero value is being calculated
13	Indicates when object is on the scale and the weight is stable[1]
14	Indicates when object is off the scale and the weight is stable[1]
15	Check Mode (internal or external)

Status Word HSI16

Status Word bit	Description
[1:0]	Check Limit value
2	Current state of the external trigger 1 signal
3	Current state of the external trigger 2 signal
4	Indicates when the external trigger 1 is detected. Stays high until the check delay time is reached
5	Indicates when the check_delay time has been reached Stays high until the check_time is reached
6	Indicates when check_time time has been reached Stays high until the check_hold time is reached
7	Indicates if a stable[1] check weight value was calculated Status bit locked until the check_hold time is reached
8	Indicates when a “Off Check” error occurs in external modes 2T1W and 2T2W
9	Indicates when a “On Check” error occurs in external modes 2T1W and 2T2W
10	Indicates when the number of check weigh cycles without setting the dead load value exceeds the “check alarm” value.
11	Reserved
[15:12]	Reserved

Status Word HSI17

1. *For a stable weight to be indicated the peak to peak weight variations during a check weigh cycle must remain within the motion_thd value. This is true for when an object is on or off the scale, and if the internal or external check_mode is used.*

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