Application Note 001e

FIT®

Digital load cell
in checkweigher applications

I1697-1.1 en

Content

1 Use

A fast sampling rate, fast settling filters and an inbuilt trigger function make the FIT® digital load cell particularly suitable for dynamic weighing. The aim of dynamic weighing is a high throughput rate (weighing operations / minute) without loss of accuracy (low standard deviation).

Figure 1 shows a typical checkweigher configuration. The conveyor belt for supplying the packed material to be weighed is on the left. The scale is in the middle and the weighed pack is delivered by the conveyor belt on the right. Weighing takes place in motion. All three conveyor sections work at the same, constant conveying speed.

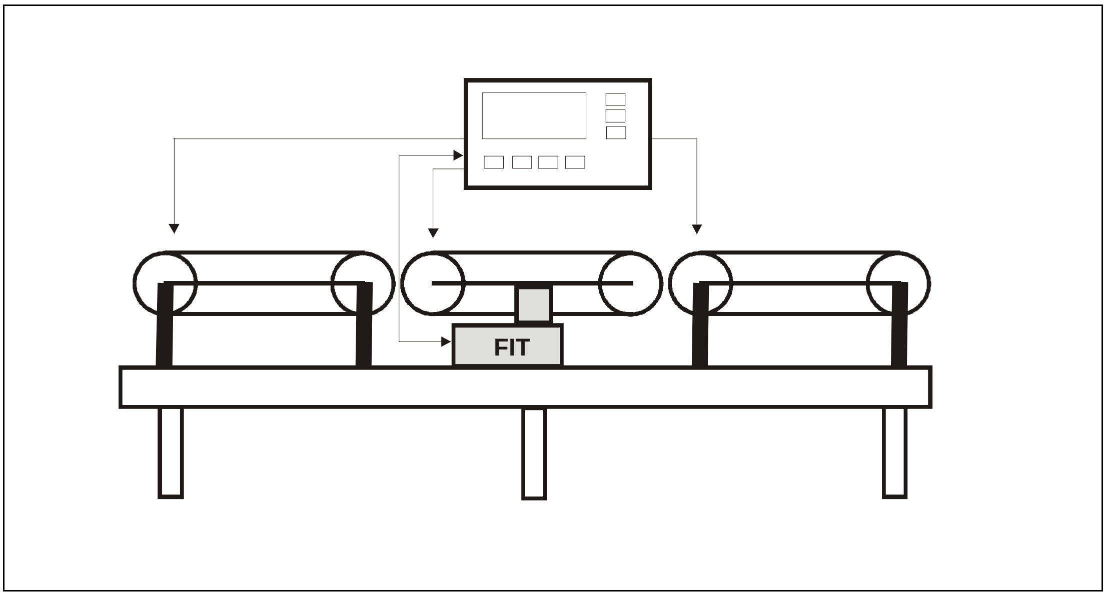

Fig. 1: Basic checkweigher configuration

The throughput rate is dependent on the weight to be weighed, the dead load of the scale, the length of the scale platform, the speed of the conveyor belt, the vibration performance of the scale structure and the required accuracy.

The total weight acting on the load cell during weighing (material to be weighed and dead load of the weigher) is crucial in deciding the scale settling time.

This application document provides information for the FIT® settings in a checkweigher using the *HBM panel program*. The *PC program AED_Panel32* contains all the requisite functions for static and dynamic adjustment of a checkweigher and allows disturbances to be analyzed dynamically.

The AED can perform the same functions in conjunction with an analog load cell.

2 Installing the FIT®

The scale must be regarded as an oscillating spring-mass system. The material to be weighed and the dead load act as the mass. In the first approximation, the spring element is the load cell. The frame on which the FIT® is mounted and the weigher platform (conveyor belt) are additional spring elements. The axial rigidity and the torsional rigidity of both these structural elements thus also determine the dynamic properties of the scale.

Operating the checkweigher excites vibrations at resonance frequency, which can lead to measurement errors. High rigidity produces a high resonance frequency in the spring-mass system. A high dead load reduces the resonance frequency.

A scale can have several resonance frequencies.

So the mechanical construction should take the following information into account:

- The dead load of the scale should be as small as possible (a high resonance frequency allows short transient states for the scale).
- The connection between the motor of the weighing platform and the controller should be extremely flexible and compliant (this force shunt can influence the scale zero point).
- Design the weigher platform to be as short and rigid as possible to reduce the torsional vibrations (symmetrical construction to FIT®).
- Low-vibration conveyor belt drive.
- Smooth, controlled conveyor belt running (if possible little side-to-side motion, these are usually very low-frequency).
- The vibrations caused by the two supply and delivery conveyor belts should only have a limited effect on the base point of the FIT® (segmenting the construction and providing vibration damping for the FIT® base point).
- Reducing the transmission of floor vibrations by using flexible materials to provide vibration damping for the FIT® base point.

An adjustable connection should be available for connecting the FIT® to the checkweigher controller or the PC program, when wanted.

It is also advisable for the controller to be able to activate and deactivate the conveyor belts individually, so that mechanical disturbances/vibrations can be investigated.

3 Static adjustment of the scale

The FIT® is adjusted to the max. capacity characteristic curve at the factory (**SZA**/**SFA** characteristic curve).

The FIT® is now fully fitted into the checkweigher. All cables and connections are available.

To run the scale adjustment with characteristic curve **LDW**/**LWT**, take the following steps:

1. Connect the FIT® to the serial interface of the PC
2. Activate the supply voltage
3. Start the panel program
4. Set the baud rate,..., set up the connection
5. Set the filter for steady measurement display (**ASF**) in the "MEASURE" menu
6. Set the required resolution in the "MEASURE" menu
7. Change to the "ADJUSTMENT" menu
8. The scale is unloaded and at a standstill → press ***"LDW"***
9. Load the scale with the max. capacity, wait for standstill → press ***"LWT"***
10. Set the desired maximum capacity as the **NOV** value,
11. Set the unit of measurement (**ENU**), the increment (**RSN**) and decimal point (**DPT**), if required
12. Check the scale setting between 0...max. capacity at different weights

It is also possible to adjust the partial load using the **CWT** command (enter before the **LDW**/**LWT** adjustment).

For an analysis, it is advisable to set the resolution (**NOV**) to nominal value ∗ 10.

4 Selecting optimum filtering for dynamic weighing

The scale is adjusted statically (see Static adjustment of the scale). The conveyor belts are activated by the controller.

First deactivate the FIT® filters (**ICR**0, **ASF**0, **FMD**0). The parameters are set in the "PARAMETERS" menu and loaded into the FIT® (*"Write"* button).

The measurements are now taken in the "GRAPHICS" menu of the panel program. Choose the maximum recording length (4096 values) and start the measurement run. During the measurement run, allow one or more weights that are already known to pass over the checkweigher.

You will see, for example, the following display (Figure 2, *AED_Panel32 V1.xx*):

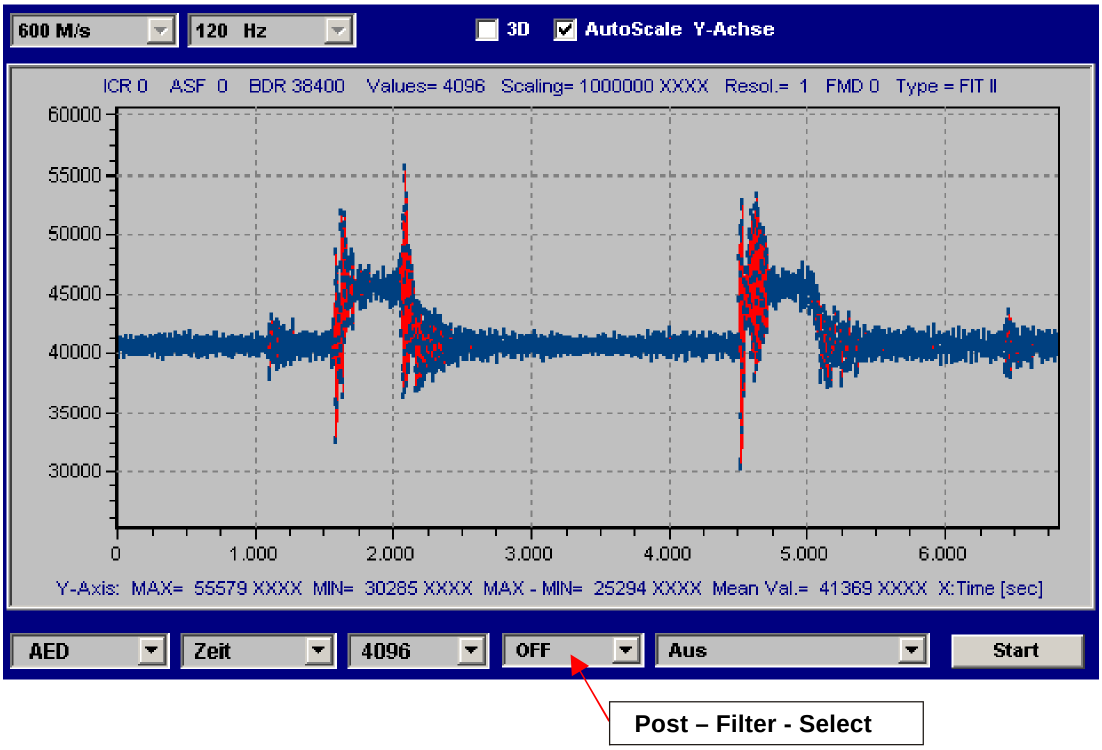

Fig. 2: Recording of a dynamic measurement run at max. FIT® bandwidth (ASF0, ICR0, FMD0)

Figure 2 shows two dynamic measurement runs at a resolution of 1000000 d unfiltered. The vibrations that occurred when the weight arrived on the scale and when it left the scale can clearly be seen.

The panel program contains digital filters (= ‚post' filters), that can be activated after a measurement recording has been made. The panel post-filters are identical to the digital filters incorporated in the FIT®. Even the filter mode (**FMD**) is taken into consideration.

The best filter effect at the shortest settling time is now selected (without re-measuring) with the panel post filter **ASF**1...9,**FMD**(0)/1. The original signal (unfiltered, gray) and the filtered signal (blue/red) are displayed simultaneously (Figure 3).

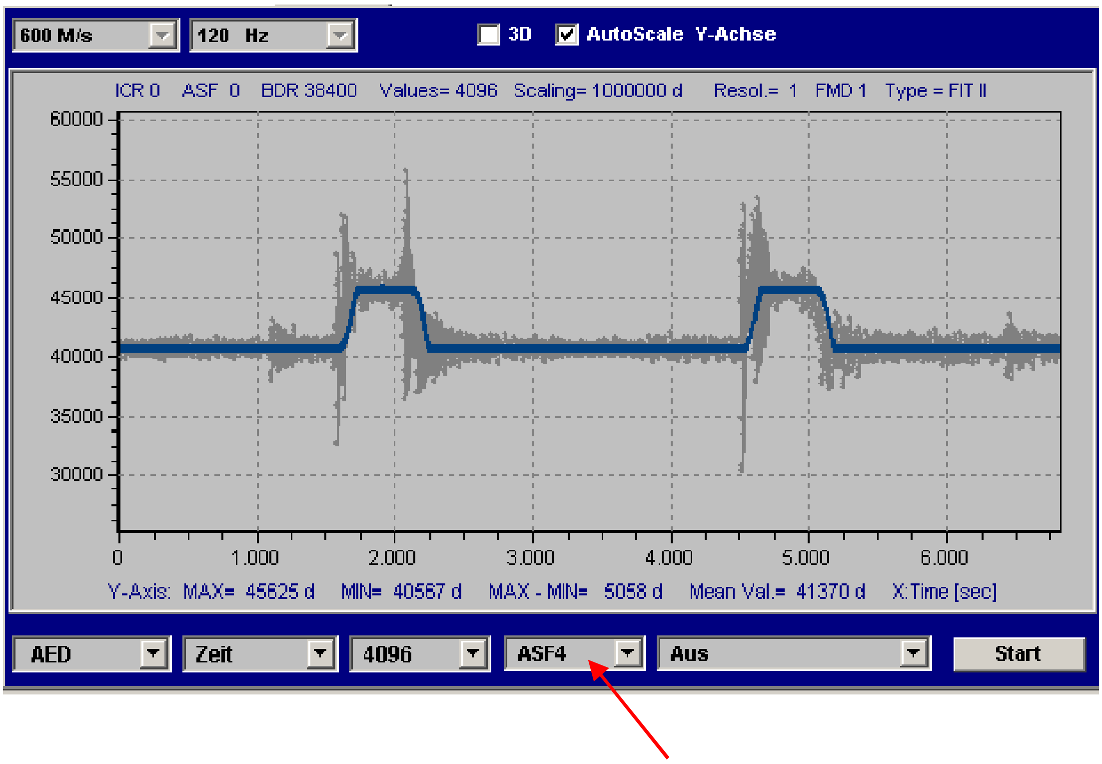

Fig. 3: Measurement run from Figure 2, but with post filter (ASF4, FMD1)

Filter mode **FMD** can be set in the “PARAMETERS” menu (do not forget to press *“Write”*), without having to re-measure.

To assess non-operation in the settled state, you can now use the zoom function to examine this area (autoscaling OFF, drag the rectangular area with the mouse pointer, keeping the right-hand mouse button pressed). The MAX-MIN display will always show the range of fluctuation of all the measured values within the graphic display area (Figure 4).

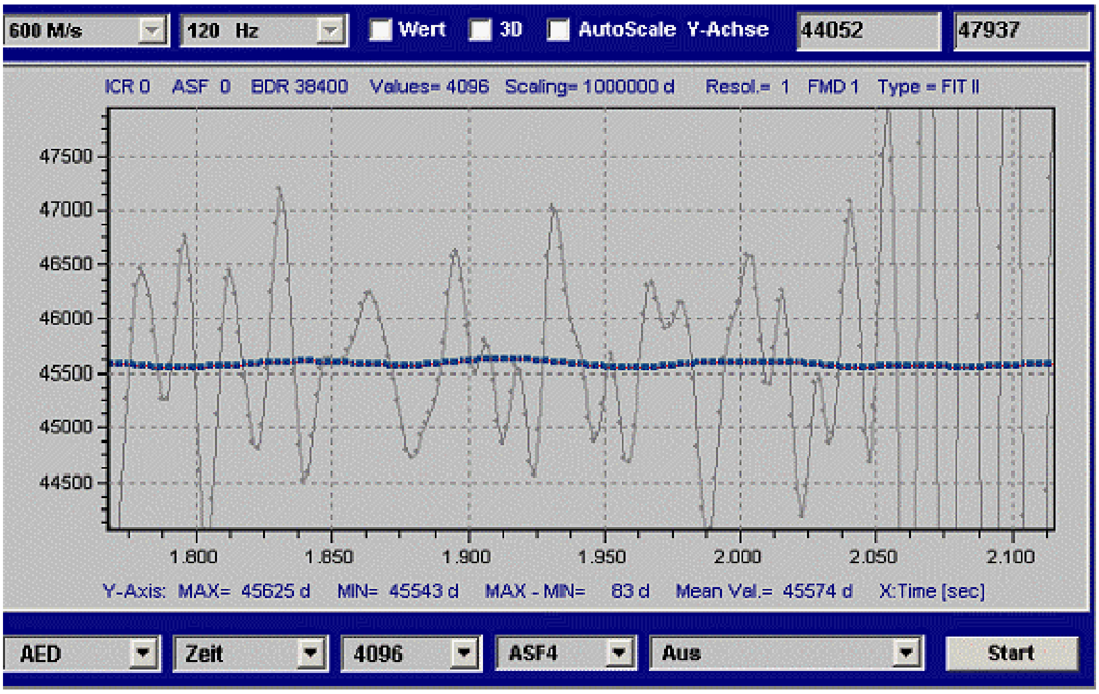

Fig. 4: Measurement run from Fig. 3, with zooming into the first measurement run after settling

The gray data points are again the unfiltered signal. With this MAX-MIN value of 83 d, the range of fluctuation is less than 100 ppm (<10^{-4}).

For a scale with 3000 d, the range of fluctuation must be <<300 ppm (=1/3000).

Where there is a small range of fluctuation (MAX-MIN), the aim is to have a long time domain to determine the weight, if possible (flat top to the square wave function, see Figure 3 and Figure 5).

Figure 5 shows a less suitable filter (settling time too long).

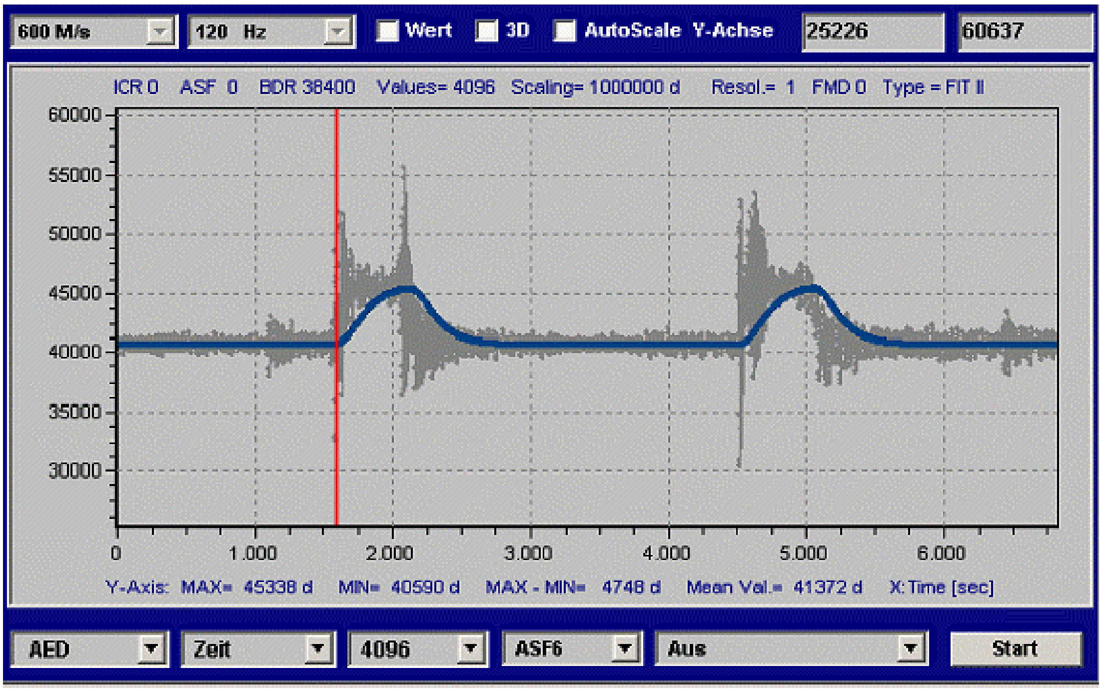

Fig. 5: Measurement run from Fig. 3, with too long a settling time (FMD0, ASF6)

The parameters determined in this way with the post filter (**ICR**0, **ASF**x and **FMD**1) are written to the FIT® in the “PARAMETERS” menu. The measurement run can now be repeated, to confirm the improved filtering of the FIT®.

As soon as **ASF** > 0 and **ICR** > 0 is set in the FIT®, the panel post filters can no longer be used, as this does not match the filters in the FIT® (FIT® and panel filters active simultaneously); there are two aspects to consider in the panel post filters display:

- At the start of the graphics display, a post filter transient state can be seen, which can always be ignored
- There is a delay between the unfiltered and filtered measured values (in accordance with ASF for **FMD**1). This is the filter runtime (= length). This runtime also occurs with filtering in the FIT®. This runtime only needs to be considered when using an external trigger.

The runtime of a filter in the FIT® (**FMD**1) is the same as the settling time of the filter (see help file AED_help_e, “Description of the basic commands” AD103C / FIT® **ASF)**

5 Overview of the trigger function

In dynamic weighing, the trigger function has the task of automatically deciding the weight value and storing it in an output memory (**MAV**? command).

This allows the controller to greatly reduce the query speed.

With repetitive weighing, as is the case with a checkweigher, the trigger function can be used to optimize both the throughput rate and the accuracy. The aim of the trigger function is to output just one weight value to the controller as the result of dynamic measurement. This makes it no longer necessary to transfer all the measured values (up to 1200 meas. values/s) over the serial interface during weighing.

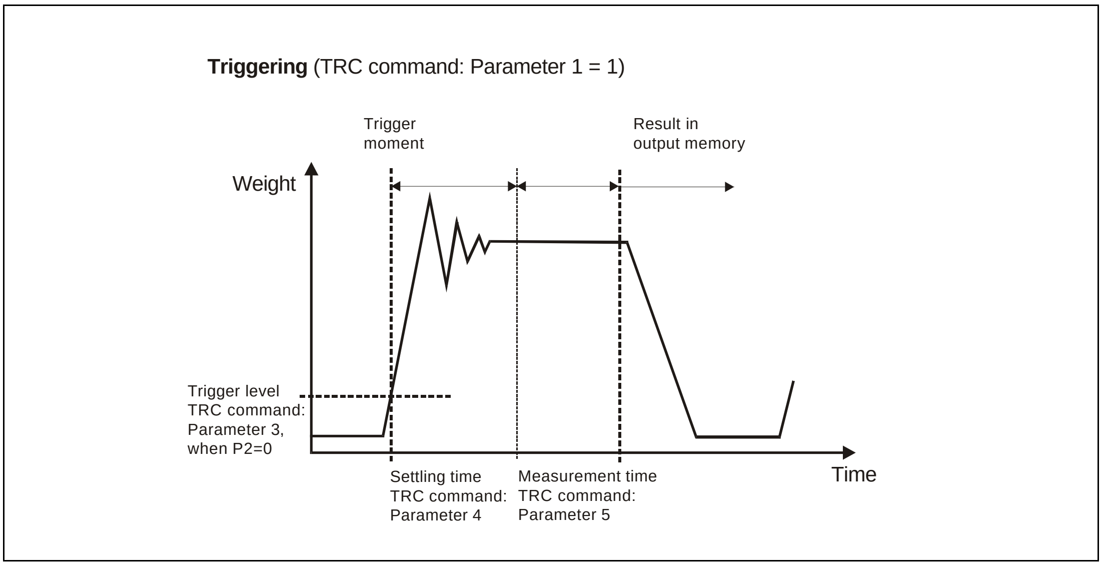

Fig. 6: The trigger function principle

The AED / FIT® has four trigger functions to support the functions in packing machines and checkweighers:

- Level pre-triggering via an adjustable level
- External pre-triggering via the digital trigger input (IN1)
- Level post-triggering via the adjustable level
- External post-triggering via the digital trigger input (IN1)

The first two functions are compatible with the second generation of AED / FIT®.

Basically, level triggering or an external trigger signal can be used as a trigger event (**TRC**, par2).

This special mode of measurement is activated via the **TRC** command. The measured value that is established is read out using the **MAV**? command. The AED / FIT® also calculates the mean value (**TRM**), the standard deviation (**TRS**) and the number (**TRN**) of valid trigger results. The peak value function (**PVS**, **PVA**) can also monitor the trigger results (**MAV**).

The trigger function is integrated into FIT® signal conditioning as follows:

- ADU at 600/1200 meas. values/s (selectable via **HSM**)
- Filter level (driven by **FMD** and **ASF**)
- Characteristic curve calculations (**SZA**/**SFA**)
- Characteristic curve calculations (**LDW/LWT**) with/without zero tracking → gross value
- Tare function (if activated) → G/N value
- Trigger function
- Extreme value function
- Limit value function

Checkweighers should always work at **ICR**0 (fastest data transfer rate). This makes short settling times possible. During the measurement time (after the settling time), the trigger function calculates a mean value, so that trigger measurement also helps to stabilize the measured values, along with the digital filters.

Level pre-triggering

This mode of measurement is suitable for weighing processes when the scale is unloaded between weighing operations.

The scale is not loaded. The product to be weighed is placed on the scale. This exceeds the trigger level and lockout time measurement begins. After the settling time, the actual weighing takes place. After this measurement time, the weight value is stored in the memory. The weighing process can only start again once the weight value is below the trigger level (unload the scale). In this mode of measurement, weighing must not be monitored by a fast external computer. The output memory will contain an invalid value until a new measured value has been calculated. The trigger result is stored in output memory until a new value has been calculated or the memory is read out. Once the measured value memory has been read out using the **MAV**? command, this memory is reset to invalid.

The times for the lockout time and the measurement time depend on the filter selected in **ASF**, **FMD** and the sampling rate (**HSM**, **ICR**). These are documented in the help file AED_help_e, AD103C / FIT®; “Description of the basic commands”.

The times and the trigger level can be adjusted as required using the **TRC** command. The trigger level is on the user-defined characteristic curve (**NOV**).

The current measured value must be less than the trigger level (scale is unloaded) to restart the process.

In the measurement status (**MSV**?), the activation of the trigger algorithm is indicated (Bit6 = 1 for **IMD**1 and **CSM**0). When **CSM** = 2 (enhanced status), the measurement status also has information that there is a new trigger result (Bit2 = 1). This status bit 2 is reset when the trigger result is read out.

External pre-trigger

The trigger sensor is installed at the start of the platform and thus detects that a new product to be weighed is being conveyed onto the platform.

The trigger edge starts lockout time measurement. After this settling time, the actual weighing takes place over the measurement time and the weight value determined is stored in the memory. The output memory will contain an invalid value until a new measured value has been calculated. The trigger result is stored in output memory until a new value has been calculated or the memory is read out. Once the measured value memory has been read out using the **MAV**? command, this memory is reset to invalid.

The times (lockout time and measurement time) can be adjusted as required using the **TRC** command. The times depend on the sampling rate (**HSM**, **ICR**) and the filter settings (**ASF** and **FMD**).

HSM, **FMD**, **ASF** and **ICR** thus determine the sampling rate at which the trigger function receives measured values. Which means that the two parameters Settling Time (**TRC**, par4) and Measurement Time (**TRC**, par5) are dependent on these settings. This is also taken into consideration in the panel program (see the *yellow input window Help texts* in the "IO_Trigger" menu).

Example (HSM = 0):

- FMD = 0, ICR = 0, ASFx → measurement data rate for the trigger function is 600 [M/s]
- FMD = 0, ICR = 1, ASFx → measurement data rate for the trigger function is 300 [M/s]
- FMD = 0, ICR = 2, ASFx → measurement data rate for the trigger function is 150 [M/s]
- FMD = 1, ICR = 0, ASF1 → measurement data rate for the trigger function is 600 [M/s]
- FMD = 1, ICR = 0, ASF2 → measurement data rate for the trigger function is 300 [M/s]
- FMD = 1, ICR = 0, ASF3 → measurement data rate for the trigger function is 200 [M/s]
- FMD = 1, ICR = 0, ASF4 → measurement data rate for the trigger function is 150 [M/s]
- (see help file AED_help_e, FIT® / AD103C; “Description of the hardware of the amplifier” or “Description of the basic commands”: **ASF**, **TRC**)

A new trigger edge starts a new measurement process. It is not necessary to unload the scale here.

During a measurement run (waiting time plus measurement time) a trigger signal will be ineffective (no retriggering).

The moment of triggering can be read via the measurement status (**MSV**?).

In the measurement status (**MSV**?), the activation of the trigger algorithm is indicated (Bit6 = 1 for **IMD**1 and **CSM**0). When **CSM** = 2 (enhanced status), the measurement status also has information that there is a new trigger result (Bit2 = 1). This status bit 2 is reset when the trigger result is read out.

The AD103C / FIT® has additional modes of operation for the trigger function and the trigger results.

It is no longer necessary to set the time parameters (par4,par5) here. These have a different significance in the new functions.

The measurement status for the **MSV** and **MAV** commands has also been enhanced (for **CSM** = 2). Here Bit2 = 1 holds the information that there is a new trigger result.

Level post-trigger

This mode of measurement is suitable for weighing processes when the scale is unloaded between weighing operations.

The scale is not loaded. The product to be weighed is placed on the scale. When the trigger level is exceeded, the current measured values are read into a ring buffer (99 values). If the current measured value is again below the level (product to be weighed leaves the platform), this process is stopped. Which means that the last 99 values are in the ring buffer. An algorithm then determines in reverse order all the measured values that fall within the set tolerance. A mean value is then calculated from these values and stored in the output memory.

The tolerance for this algorithm is set via trigger parameter 4 (**TRC**). This parameter relates to the measurement resolution set via **NOV** and **RSN**:

Example (RSN=1):

Trigger parameter 4 = 5 → +/- 5 d tolerance

The trigger result (**MAV**) has an invalid value until a new mean value has been formed. The trigger result is stored in output memory until a new value has been calculated or the memory is read out. Once the measured value memory has been read out using the **MAV**? command, this memory is reset to invalid.

The number of measured values used to form the mean value is entered in trigger parameter 5 (measurement time). If no valid trigger result has been determined, this parameter 5 = 0 and the MAV value is set to Overflow.

The current measured value must be less than the trigger level (scale is unloaded) to restart the process.

In the measurement status (**MSV**?), the activation of the trigger algorithm is indicated (Bit6 = 1 for **IMD**1 and **CSM**0). When **CSM** = 2 (enhanced status), the measurement status also has information that there is a new trigger result (Bit2 = 1). This status bit 2 is reset when the trigger result is read out.

External post-trigger

This mode of measurement is suitable for weighing processes when the scale is unloaded between weighing operations.

The external trigger sensor is attached at the end of the platform and is activated by the product to be weighed, just before it leaves the platform.

The current measured values are constantly read into a ring buffer (99 values). The trigger edge of external trigger input IN1 stops this process. Which means that the last 99 values are in the ring buffer. An algorithm then determines in reverse order all the measured values that fall within the set tolerance. A mean value is then calculated from these values and stored in the output memory.

The tolerance for this algorithm is set via trigger parameter 4 (**TRC**). This parameter relates to the measurement resolution set via **NOV** and **RSN**:

Example:

Trigger parameter 4 = 5 → +/- 5 d tolerance

The output memory will contain an invalid value until a new mean value has been formed. The trigger result is stored in output memory until a new value has been calculated or the memory is read out. Once the measured value memory has been read out using the **MAV**? command, this memory is reset to invalid.

The number of measured values used to form the mean value is entered in trigger parameter 5 (measurement time).

Trigger parameter 3 (level value) is used as the target value. The target value is the weight that the product to be weighed should be. If the trigger result determined is within the range

(trigger parameter 3 – trigger parameter 4) < trigger result
trigger result < (trigger parameter 3 + trigger parameter 4),

the trigger result is declared to be valid, otherwise it is invalid. This additional comparison with the set target value is not performed if trigger parameter 3 (level value) is set to zero.

If no valid trigger result has been determined, this parameter 5 = 0 and the **MAV** value is set to Overflow.

Status bit 6, which is available in the measurement status (**MSV**?) cannot be evaluated, as the ring buffer is constantly reading in measured values. When **CSM** = 2 (enhanced status), the measurement status also has information that there is a new trigger result (Bit2 = 1). This status bit 2 is reset when the trigger result is read out.

6 Setting trigger parameters (pre-trigger)

This chapter is only valid for pre-trigger functions (not for post-trigger functions). Level triggering has an additional parameter (**TRC**, par2), to be set on the 0...**NOV** characteristic curve. What all trigger functions have in common is that the trigger function cannot be retriggered. This means that once a trigger function has started, it has to be completed before triggering is once again enabled to start.

The following are crucial to the success of these measurement runs:

- An adequate amount of measurement time must be available after the settling time (several values) with a small range of fluctuation. If this is not the case, it may be necessary to reduce the conveyor speed, or even the standard of accuracy to be achieved (<3000 d)
- It must be possible to repeat the measurement runs

Checkweighers should always work at **ICR**0 (fastest data transfer rate). This makes short settling times possible. During the measurement time (after the settling time), the trigger function calculates a mean value, so that this trigger measurement also helps to stabilize the measured values).

Thus **HSM**, **FMD**, **ASF** and **ICR** determine the sampling rate at which the trigger function receives measured values. So it follows that the two parameters Settling time (**TRC**, par4) and Measurement time (**TRC**, par5) are dependent on these settings. This is also taken into account in the panel program (see the *yellow input window Help texts for par4/5*).

Example:

- FMD =0, ICR=1, ASFx → measurement data rate for the trigger function is 300 [M/s]
- FMD=1, ICR=0, ASF1 → measurement data rate for the trigger function is 600 [M/s]
- FMD=1, ICR=0, ASF4 → measurement data rate for the trigger function is 150 [M/s]

  (see help file AED_help_e, AD103C; “Description of the basic commands”, **ASF**, **TRC**)

Now we are going to use the measurement runs from Figure 3 to define trigger parameters par4, 5.

The static settings have been made (Point 2). The filter settings in the FIT® have been made with the aid of Point 3 (**FMD**1, **ICR**0 and **ASF**4).

The zoom function of the panel graphic has been used to define the settling time and the measurement time (first measurement run). This gives us Figure 7, below.

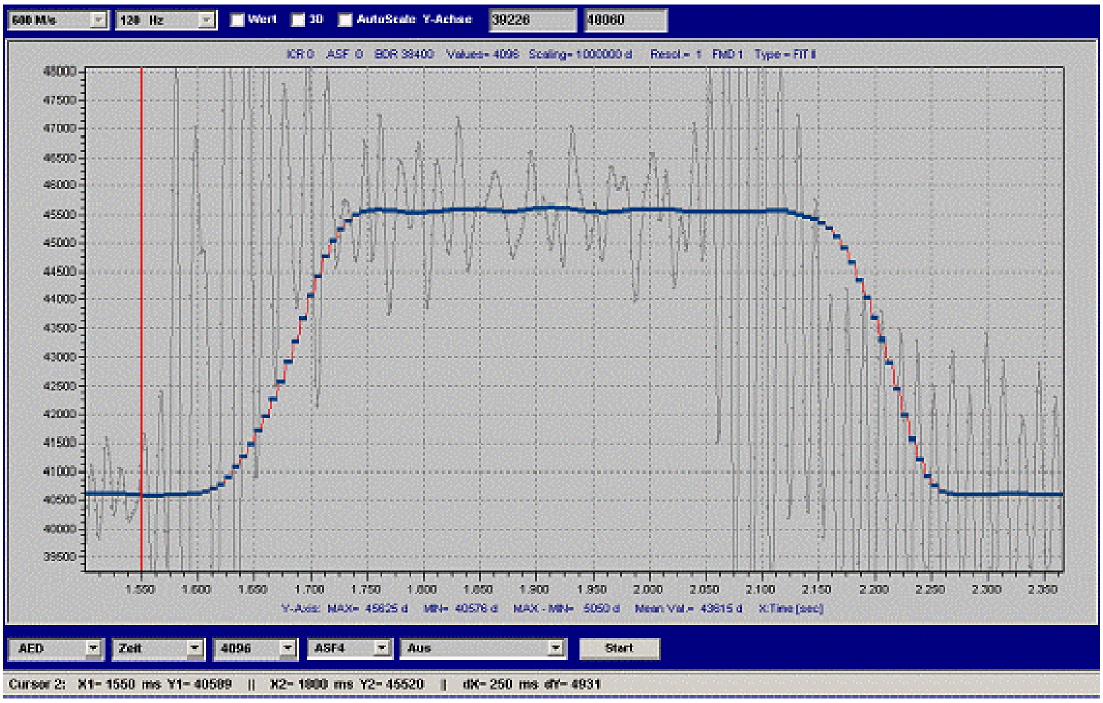

Fig. 7: Measurement run from Fig. 3, with zooming into the first measurement run

The red bar is the moment of triggering for time axis = 1550 ms (external trigger, weight is conveyed onto the scale). The transient state has safely died down at about 1800 ms. This gives a settling time of dx = 1800-1550 = 250 ms.

As from time = 2050 ms, the product to be weighed is taken away again (pronounced vibrations start in the unfiltered signal).
This means that the maximum measurement time is 2000-1800=200 ms.

So parameters par4,5 of trigger function **TRC** can be calculated as follows:

FMD = 1, **ICR** = 0, **ASF**4 → measurement data rate for the trigger function is 150 [M/s]

This means 1/150 = 6.6 ms per measured value.

Settling time: Par4 = 250 ms/6.6 ms = 37

Measurement time: Par4 = 250 ms/6.6 ms = 37

Par5 = 30 means that 30 measured values are determined to calculate the trigger output value.

At 250 ms, the chosen settling time was very long (the settling time of filter **FMD**1, **ASF**4 alone is 150 ms). A back-up time of a further 100 ms gives a good amount of settling time. The measurement time of 200 ms is also very long and should be reduced to tolerate the different pack sizes or arrangements of packs on the conveyor belt. The measurement time can therefore be reduced to 100 ms (par5 = 15 measured values).

The better the settling time dies down, the more accurate the individual weighing.

So it is preferable to choose a slightly longer settling time.

The trigger parameters are set in the "IO_TRIGGER" menu and written to the FIT®.

The trigger function can now be checked with the aid of additional graphic measurement runs.

Using the panel program together with the FIT® also gives you the opportunity to use the special graphics function to display the moment of triggering, the settling time and the end of the trigger function (save the value in the output memory for **MAV**?). For **IMD**1, set additional information to *"Trigger, settling time"*. The start and end of triggering is transferred by the FIT® in real time in the measurement status (**COF**8, bit 6). The settling time is calculated by the panel and displayed.

7 Using the panel program to examine checkweigher function

There are two levels for examining the checkweigher in dynamic mode:

- Dynamic response of a single weighing (see Setting trigger parameters)
- the accuracy over a number of weighings

Dynamic response of a single weighing:

Using the panel program together with the FIT® also gives you the opportunity to use the special graphics display to show the moment of triggering, the settling time and the end of the trigger function (for **IMD**1, set additional information to *"Trigger, settling time"*, Figure 8). The start and end of triggering is transferred by the FIT® in real time in the measurement status (**COF**8, bit 6). The panel program also displays the set settling time.

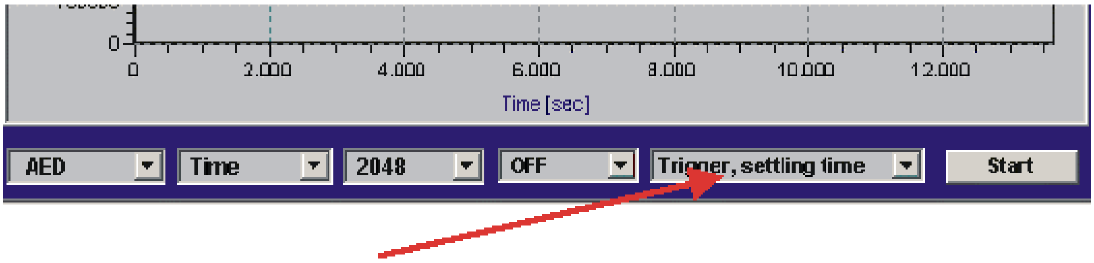

Fig. 8: Activation of the special display of the start of triggering, the settling time and the end of triggering

Measuring the standard deviation of several individual weighings:

The panel program also supports measurement runs over a maximum of 100 weighings. 'Trigger' graphics mode is enabled when the trigger function is activated and is selected in the graphic menu (bottom bar, see Figure 8).

In this function, the panel program uses the **MAV**? command to constantly query the trigger result. Each valid trigger output value is displayed by a data point and at the same time, the mean value and the standard deviation are calculated over all the recorded values.

8 Reading out the trigger results with the MAV? command

Figure 9 shows the period of time in which the trigger result is valid and ready in the output memory and can be read out with the **MAV**? command. It is obvious from this that the result does not have to be read out immediately after the measurement time.

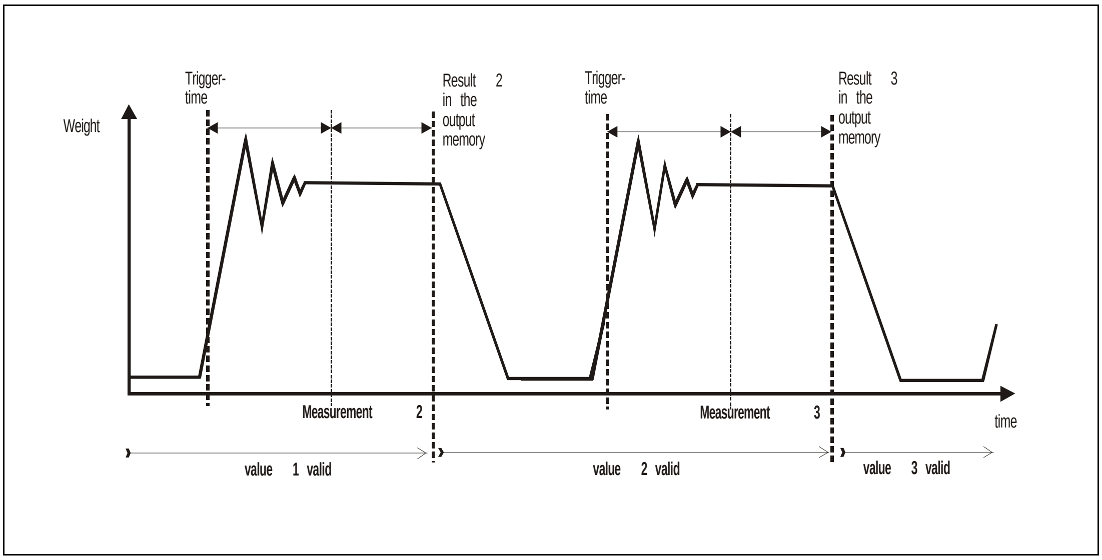

Fig. 9: Validity period of the trigger output memory

More detailed descriptions can be found in the application documents.

- APPN011 (Reading out trigger results).

9 Analysis of mechanical vibrations / disturbance around the scale

There are a number of factors that can influence the way in which the checkweigher behaves and which can have a negative effect on accuracy and performance:

- Vibrating floors (possible caused by adjacent machinery)
- Vibrations caused by the conveyor drives
- The motion of the material to be weighed on the conveyor belt
- Jerking when there are gaps between the conveyor belts
- In the case of small max. capacities, surges in air pressure when doors and windows in the room in which the scale is set up are opened or closed
- The natural vibrations of the scale at resonance frequency,

The HBM panel program gives you the option of analyses in the time range and in the frequency range (using **F**ast **F**ourier **T**ransform). Displaying the FFT's logarithmic amplitude spectrum allows the interference frequencies in the recorded measurement signal to be found. With this information, sources of mechanical disruption can be specifically reduced (see chapter 2, "Installing the FIT®").

Figure 10 shows the disturbances measured by the FIT® in the time range (just with the conveyor belt activated, no material to be weighed). Figure 11 shows the amplitude spectrum for this measurement run.

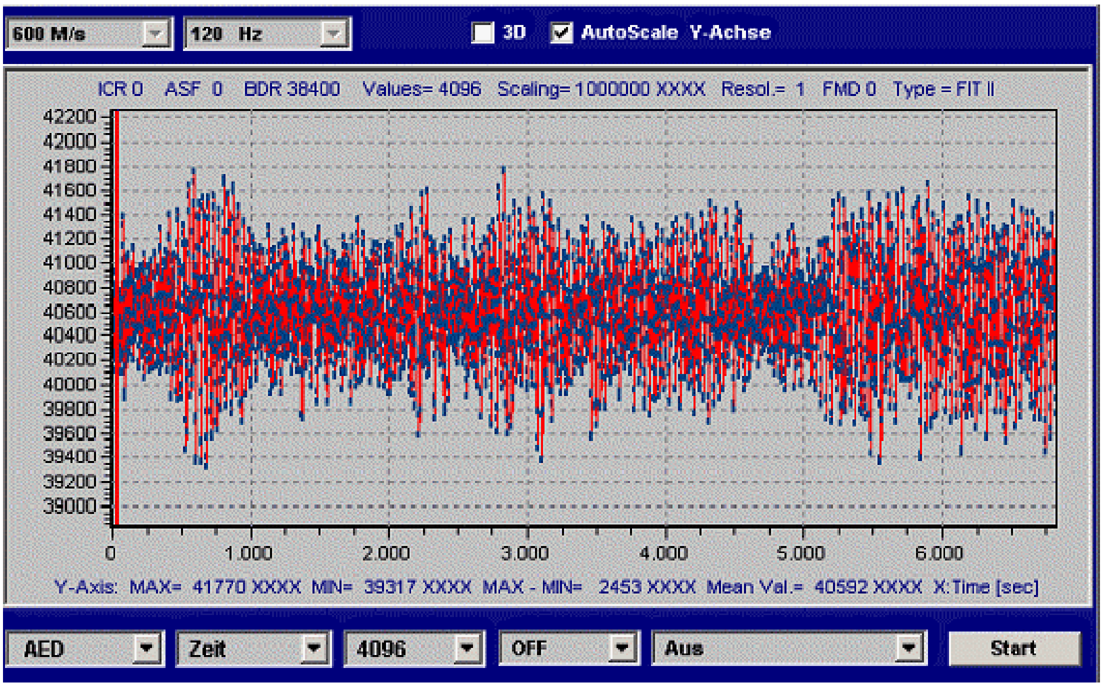

Fig. 10: Measurement run in the time domain, conveyor belts on, no material to be weighed (unfiltered)

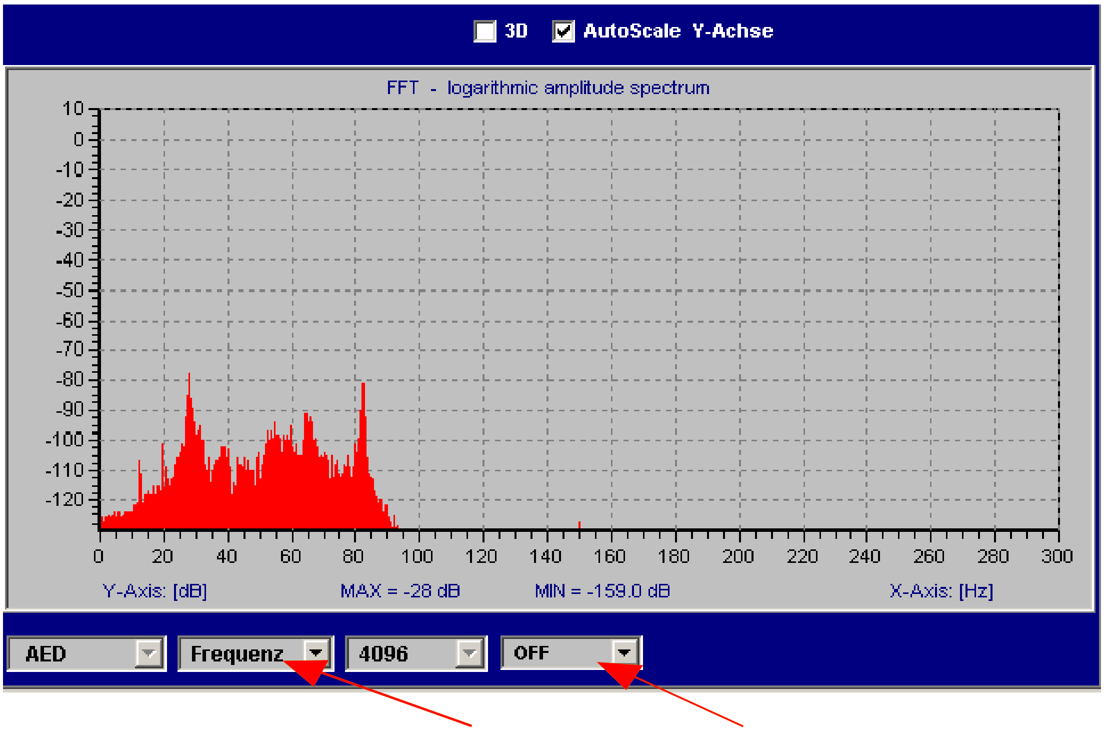

Fig. 11: Measurement run from Fig. 7 in the frequency range, conveyor belts on, no material to be weighed (unfiltered)

The unfiltered frequency spectrum shows two significant incidental amplitudes at 28 Hz and at 84 Hz. The 84 Hz frequency is the third harmonic of 28 Hz.

Figure 12 shows the effect of the FIT® filter (**FMD**1, **ICR**0, **ASF**4), as well as the values without filtering (in gray). Please note that in Figure 12, the frequency axis really is only displayed up to 75 Hz (filter **ASF**4, **FMD**1 reduces the output rate to 150 meas.values/s).

Frequency peaks after 10 Hz are clearly suppressed.

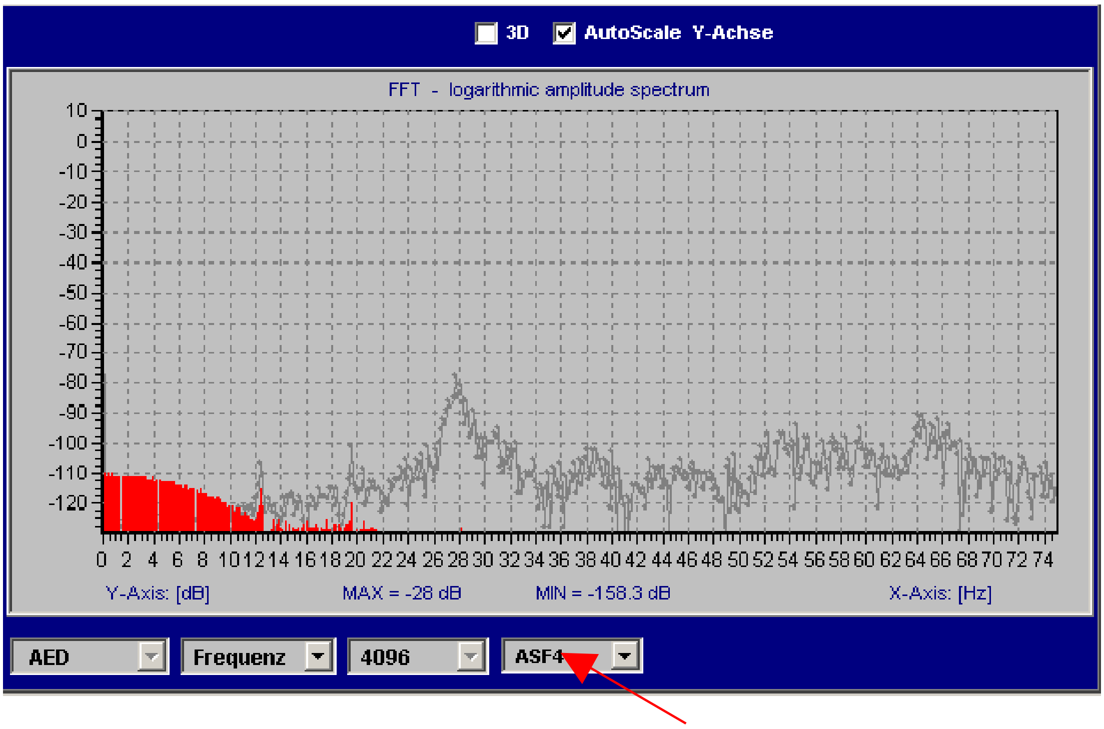

Fig. 12: Measurement run from Fig. 10 in the frequency range, conveyor belts on, no material to be weighed (filtered)

In the example shown here (measurement runs on a real checkweigher) applying the filters implemented in the FIT® has produced very good results.

In this application they were working with a conveyor speed for the material to be weighed of 60 m/min. The time taken to transport the material to be weighed over the weigher was 500 ms. This enables up to 120 packs per minute to be measured. The standard deviation was <1.0 g (<0.04 oz) at 1kg pack (2.20 lb pack).

It is important for the drive frequencies of the conveyor belts to be as high as possible in the frequency band (in our example, 28 Hz), so that these can be well suppressed by the FIT® filters.

10 Reducing zero drift on the scale

When assessing zero point stability, the distinction must be made between the two different modes of operation of a scale that weighs dynamically

- non-automatic (static) mode
- automatic mode (dynamic weighing)

In non-automatic mode, the zero point can be kept stable over a longer period of time by means of the zero tracking function (**ZTR**). But this function can only correct slow and slight drifts, as max. ±0.5 d/s are corrected (d = increment in accordance with the number of weighing divisions, in accordance with OIML). It is also necessary to consider that with this correction, there must be a standstill (for the standstill condition, see the **MTD** command). The maximum correction is limited to ± 2 % of a set weighing range.

In automatic mode with dynamic weighing, the short time interval between the packs to be weighed (usually < 1 sec) prevents the inbuilt zero tracking function from working (no standstill).

There are basically 3 solutions that can be incorporated into the checkweigher controller software:

- Using the tare command (**TAR**) or the tare input IN2 (**IMD**1) when the scale is not loaded
- Measuring the zero point with **MSV**? when the scale is not loaded and subtracting the zero value in the controller software
- Using the dynamic zero tracking function (**DZT**)

It is a condition of zeroing that there is a time between the packs to be weighed when the scale is not loaded (otherwise zeroing or taring is not possible, see Figure 13).

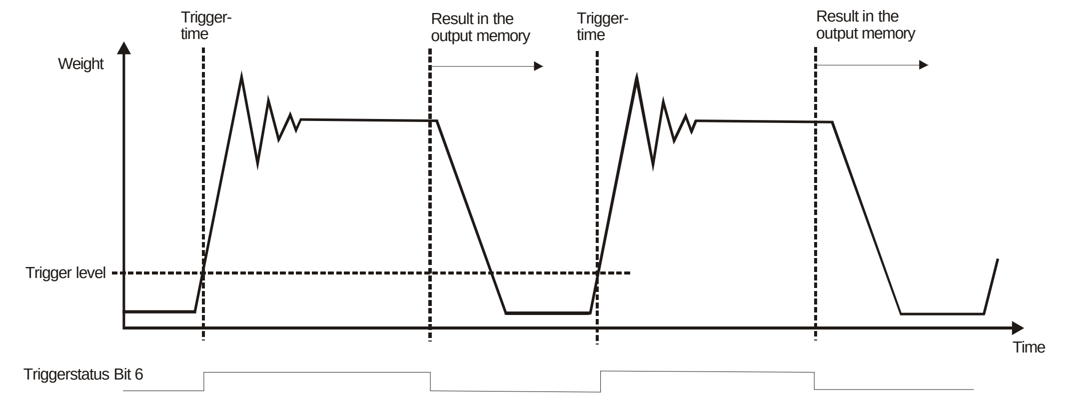

Fig. 13: Measurement in a checkweigher over time

1. Using taring with the TAR command

The current measured value is constantly queried by means of the **MSV**? command. If the current measured value is in a preselected zeroing range, the **TAR** command is sent. This command is executed directly by the FIT® (current internal gross value → tare memory) and changed over to net output for **MSV**? or **MAV**?. (the processing time (= new valid tare value) depends on **FMD**, **ICR** and **ASF** and is, for example, at <10 ms in the FIT®
for **ICR** = 0, **FMD** = 1, **ASF**4 = 1/150 meas. values/sec).

If the trigger function is activated, **MAV**? and **MSV**? can be queried alternately, with **MAV**? being used to read out the trigger result and **MSV**? for monitoring the current net measured values.

The response times of both commands are different:

MAV? - Response arrives immediately (<3.3 ms, weight value from the trigger function or the overflow value, if there is no result yet)

MSV? - Current measured value is output after the measurement time (measurement time depends on **FMD**, **ICR** and **ASF**, for the shortest response times, always use **ICR**0).

Note
for AD103, FIT®: In **COF**8 output format (4-byte binary with status) with an activated trigger function and **IMD**1, the measurement status of **MSV**? can monitor whether the trigger function is actually active (status bit 6 = 1, see Figure 13). If this bit is set, taring will not be performed.

2. Taring using the tare control input IN2 (when IMD = 1)

Tare input IN2 is activated when it is certain that the scale is not loaded. This can be recorded, for example by a light barrier (new pack not yet on the scale, weighed pack has just left the scale). This control input IN2 acts like a tare command.

The advantage of this method is that the **MSV**? command does not have to be constantly sent out and the controller can concentrate on the actual function of reading out the triggered value via the **MAV**? command.

3. Subtracting the zero value in the controller

The zeroing value is determined by the current measured value **MSV**? (**TAS**1=gross output).

The current gross value is constantly queried by means of the **MSV**? command. If this current measured value is within a preselected narrow tolerance band, it is stored in a mean value memory. Measured values outside this tolerance band are discarded. Averaging over a large number reduces the effects of vibration still further. The zero value determined in this way is now deducted from each measured value.

If the trigger function is activated, **MAV**? and **MSV**? can be queried alternately, with **MAV**? being used to read out the trigger result and **MSV**? for monitoring the current gross values (**TAS**1 = gross output)..

The result of measurement query **MSV**? is assessed over a narrow tolerance band around zero (gross value). If this current measured value is within the tolerance band, it is stored in a mean value memory. Measured values outside this tolerance band are not used for this zero calculation. Averaging over a large number reduces the effects of vibration still further. The zero value determined in this way is now deducted from each valid trigger result (**MAV**?).

4. Dynamic zero tracking function (DZT)

See help file AED_help_e, AD103C; “Description of the commands for signal processing”, **DZT**.

5. Automatic zeroing after trigger event and delay time (CDT)

See help file AED_help_e, AD103C; “Description of the commands for signal processing”, **CDT**.

11 Summary

The FIT® digital load cell, in conjunction with the HBM panel program, gives you the opportunity to analyze and set checkweigher functions in real operation.

This system optimization can run in parallel with generating the controller software.

When conditions are changeable (for example, conveyor speed, vast differences in the material to be weighed, etc.), the controller software can supply predefined and different parameter sets for the FIT® and write them to the FIT® as required.

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I1697-1.1 en

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