Application Note 006e

AED / FIT®

Dosing and filling
with AED / FIT

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HBM

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2 Introduction

The basic functions of filling and dosing control are implemented in the FIT® digital load cell and in the AD103 measuring amplifier.

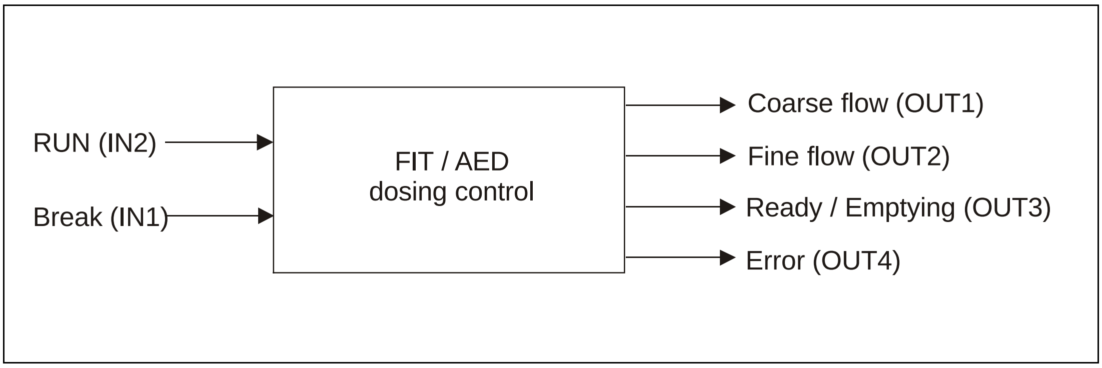


Fig. 1: Control inputs/outputs of the AED / FIT

The aim is to use the FIT or AED to control all the requisite fast processes (data capture, coarse and fine flow control, monitoring tasks) of a dosing control, to determine the dosing result and to automatically adapt to changing conditions (optimization). The strategy behind optimization is to achieve the shortest possible dosing time at a given accuracy (dosing tolerance).

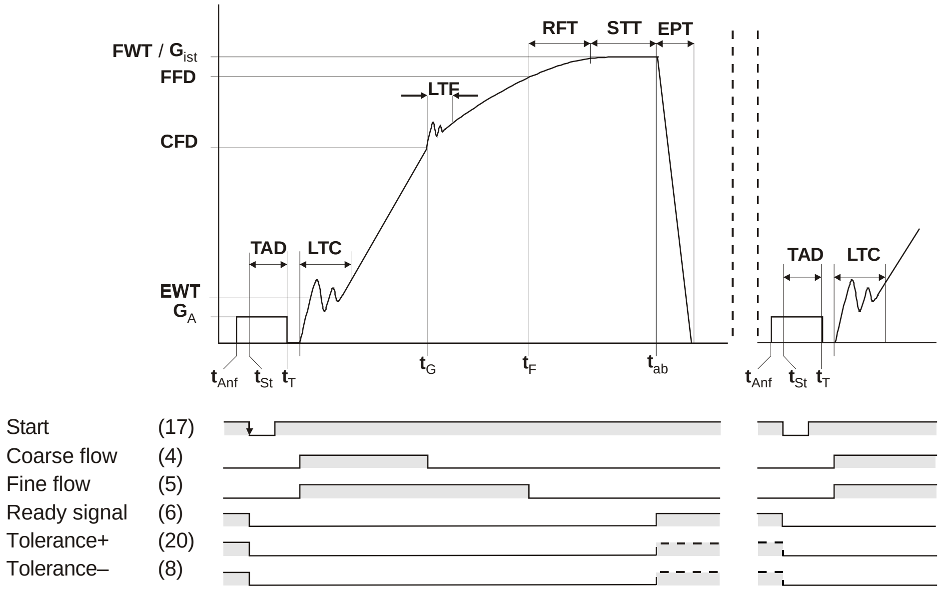
Pre-processing the data in this way allows the external controller to concentrate on control tasks for every aspect of the dosing and filling process (distributed intelligence).

This application document describes the dosing process, as well as the panel program *AED_Panel32*, for parameterization support and analysis of the process time response.

For a detailed description of the dosing control commands, see the help file AED_help_e.

3 Overview of dosing and filling process control

Figure 2 shows the dosing sequence and gives the correlation to the parameters (commands) implemented in AED / FIT, as well as the control signals.



Moments in time		**Time periods**		**Weights**	
t_{Anf}	Initial weight	TAD	Taring delay after starting	G_A	Initial weihgt (empty sack)
t_{St}	Start pulse	LTC	Lockout time for coarse flow assessment	EWT	Empty weight
t_T	Taring	LTF	Lockout time for fine flow assessment	CFD	Coarse flow cut-off weight
t_G	Coarse flow off	RFT	Material in flight duration	FFD	Fine flow cut-off weight
t_F	Fine flow off	STT	Stabilization time for final measurement	FWT	Preset filling weight
t_{ab}	Sack release	EPT	Emptying time	G_{Ist}	Actual filling weight

Fig. 2: Dosing sequence

The phases of the dosing process are:

- Select of a dosing parameter set 0…31 (**RDP**)
- Start dosing (**RUN** command or activating control input IN2)
- Automatic taring (**TMD**, **TAD**, can be deactivated)
- Coarse flow control (**CFD**) with lockout time (**LTC**) and dosage monitoring (**CBK**)
- Fine flow control (**FFD**) with lockout time (**LTF**) and dosage monitoring (**FBK**)
- Residual flow time (**RFT**)
- Settling time (**STT**, minimized by timely standstill)
- Actual value determination (**FRS**?) with tolerance checking (**UTL**, **LTL**)
- Summation function (**SUM**?), dosing counter (**NDS**?), dosing status (**SDO**?)
- Calculation mean value (**SDM**?) and standard deviation (**SDS**?)
- Optimization (**OSN**, works on **CFD** and **FFD**)
- Ready signal (OUT3) or time-driven emptying (**EPT**)

The dosing operation can be interrupted (**BRK** or control input IN1). It is also possible to continue (RUN or activating control input IN2).

There are two monitoring functions available for monitoring the filling process.

- Monitoring during the coarse flow phase (**CBK**)
- Monitoring during the fine flow phase (**CBK**)
- Monitoring of the start weight and error conditions (**SDF**, **MDT**)

The commands **LTC** and **LTF** are available for deactivating coarse and fine flow control monitoring. These prevent premature deactivation when coarse flow starts and when changing over to fine flow.

The strategy behind optimization of the cut-off points is aimed at achieving the shortest possible dosing time (max. coarse flow component) at a given accuracy (dosing tolerance), taking a minimum fine flow component (**FFM**) into account. The optimization calculation always attempts to set the cut-off points in such a way that the filling process consists of a coarse flow phase and a fine flow phase. The optimization severity (**OSN**) defines how strongly optimization corrects a filling error.

The ready signal output can also be used for emptying.

All the time that emptying time **EPT** = 0, the output (6) only works as a ready signal. It is active after checkweighing and remains active until a new start occurs. If the emptying time is set >0, the ready signal output (6) is activated after checkweighing and it remains active throughout the set emptying time.

SYD, the "systematic difference" parameter can be used to adjust differences that arise after checkweighing and which are therefore not covered by optimization.

The command **VCT** defines the behavior of the coarse and fine flow outputs.

The actual value of a fill, the dosing status (tolerance monitoring), a dosing counter and the cumulative value valuen mean value and standard deviation of all the actual values are available as the dosing result.

With the command **RDS** a redosing can be activated if the dosing result is below the lower tolerance limit.

4 Basic settings

The static adjustment of the FIT or the AD103 is described in APPN004 and this should be performed. The settings are given briefly again here in the order in which it makes sense to implement them. The individual steps are explained by means of examples.

Example:

- The following assumptions are made:

- You have incorporated a load cell with a max. capacity of 200 kg into your system.

- The scale should be set up for a max. capacity of 100 kg (display value 10000).
  The display resolution should be 50 g (number of divisions = 200 d).

- The previous scale load was 40 kg.

- in the case of network operation or if any baud rate other than 9600 Bd is to be used, the address (ADR) and the baud rate (BDR) must be set
- Enable the parameters for setting the characteristic curve (e.g.: SPW"AED";)
- If adjustment is carried out with a 100 kg weight, you can omit this point.

- But the only weight you have to carry out the adjustment is 50 kg, that is to say a partial load calibration is performed, at 50 % of the later max. capacity.
- Use the CWT command to enter the partial load percentage value the balancing weight is of the max. capacity, that is to say CWT 500 000; (1000000 d ∗ 50 % / 100 %).

The measured values for the unloaded scale are now not around 0 and the measured values for 100 kg are not at 10000 d. The pair of commands LDW/LWT are used to set a user characteristic curve.

- Measure the zero point for the unloaded scale (LDW;)

  The measured values for the unloaded scale are thus around 200000 d (40 kg), which corresponds to 20 % load cell utilization by the mechanically determined previous load.

  The command LDW; measures the data value for the unloaded scale, but only offset together with the data value for the balancing weight.
- Load the scale with the 50 kg balancing weight, wait for a steady display and use the LWT; command to apply the measured value

  The AED measured values after adjustment are around 500000 d with the 50 kg weight (around 1000000 d with a 100 kg weight) and if you take away the balancing weight, at 0 d.
- Set the numerically correct nominal value (NOV)

  In the example, the measured value should be exactly 10000 d when loaded with 100 kg.

  This is set with the command NOV10000;

  The weigher in the example now returns measured values of 0 d without load and 10000 d when loaded with 100 kg, with a measurement interval of 1 d (=10 g).
- Set the resolution (RSN)

  To make the scale return a measurement interval of 50 g, RSN3; is used to set an increment of 5 for the last digit position. The measured values then change at the following interval: 0, 5, 10, 15,..., 9990, 9995, 10000.

The user characteristic curve is set up; with the scale unloaded, the AED returns a measured value of around 0 and with the scale loaded at max. capacity, a measured value around the nominal value of 10000 set with "NOV", in increments of 5.

The filter setting (ASF, FMD) can be used to influence non-operation.

A filter setting of ASF6 (1 Hz) and FMD0 has proved reasonable for initial trials and in many applications
The data rate ICR should be 600 measured values/s, that is to say, ICR0;

- IMD2;

  This command activates automatic dosing control and the control inputs and outputs.
- The command TDD1; stores the settings.

5 Setting the dosing parameters

The parameters are described here by means of an example, in the time sequence in which they are executed during a filling process (see also Figure 2).
The AED / FIT contains 32 dosing parameter sets which can be activated before start with the command **RDP**. With the command **WDP** the parameters and results can be stored non-volatile.

Example:

Canisters are to be filled with 50 kg and the filling process is to take about 5 s.

5.1 Setting the weight and timing parameters

- First use the "**FWT**" command to enter the target weight. In the **example**, the target weight entered can be a value between 0 and 10000 d (verifiable between 200 and 10000 d). **FWT** 5000; enters the target value as 50 kg.

  When the target weight is entered, the following parameters are set automatically:

the cut-off point for coarse flow (**CFD**) to 50 % of the target weight	=	25.00 kg
the cut-off point for fine flow (**FFD**) to 95 % of the target weight	=	47.50 kg
the lower tolerance limit (**LTL**) to the target weight –0.2 %	=	49.90 kg
the upper tolerance limit (**UTL**) to the target weight +0.2 %	=	50.10 kg
the minimum fine flow amount (**FFM**) to 1% of the target weight	=	0.50 kg

  Coarse flow bag breakage monitoring (**CBK**), fine flow (y) and, systematic difference (**SYD**) are deactivated.

In the **example** we assume that it is to be a net dosing, so the container or bag is tared beforehand. To achieve this, the tare function is activated at the start and a tare delay time is entered.

- **TMD**1; activates tare mode,
- **TAD**40; sets the tare delay to 400 ms (0.4 s)

  this means that after a successful Start (**RUN**; or activating input IN2) and the expiry of the tare delay of 0.4 s, taring takes place.

  The tare delay should be long enough for disturbances in the measurement signal caused by putting on the container or attaching the bag to have died down, so that the weigher is at rest.

  Coarse flow and fine flow are now enabled simultaneously. The valves are opened, the first fill material is hitting the load cell and causing, depending on the size of the pellets and the height from which they are dropped, signal peaks that at the start of the coarse flow phase must not be part of a check to see if the cut-off point has been reached. This prevents the lockout time for coarse flow assessment **LTC**.
- **LTC**50; The lockout time for coarse flow assessment is set to 0.5 s; with a total filling time of 5 s, this is 10 %.

  For the **example** with a 50 kg target weight and a 5 s dosing time, this is a typical value. The lockout time for the coarse flow assessment should be long enough to allow the initial fill material to reach the canister within this time.

  The filling weight is then monitored in a 1. ms timeslot (600 meas. values/s) to see if the coarse flow cut-off point has been reached.

  The next critical point is the coarse flow cut-off at time t_G .

  At this time, the minimum fine flow component parameter (**FFM**) acts and the lockout time for fine flow assessment (**LTF**) begins.

  In our **example**, values are set for
- **FFM** Minimum fine flow component at 2.5 kg (**FFM**250;)

- **LTF** Lockout time for fine flow assessment at 0.2 s (**LTF**20;)

  Although coarse flow is deactivated, it takes a while for the valve to close and there is still material in flight (height of fall) or in the feed elements that is not yet in the bag or container, that is to say, has not yet been weighed.

  This amount of material should be less than the minimum fine flow component (**FFM**), in other words, less than 5.51 lb. The minimum fine flow component (**FFM**) prevents the run-on after coarse flow has been cut off from exceeding the fine flow cut-off point or even the target weights. The minimum fine flow component is also the minimum interval between the coarse flow cut-off point (**CFD**) and the fine flow cut-off point (**FFD**).

  In the **example**, optimization will never bring the coarse flow cut-off point closer to the fine flow cut-off point than 5.51 lb. Even using commands, it is not possible to enter a value for the coarse flow cut-off point that is greater than the difference: (fine-flow cut-off point – minimum fine flow).

  The lockout time for fine flow assessment (**LTF**) prevents disturbances as a result of cutting of the coarse flow from leading to premature fine flow cut-off.

  In the **example**, 0.2 s are adequate for this.

  Once the lockout time for fine flow assessment has expired, bag breakage monitoring starts.

  Fine flow (**FBK**). This is described in detail in the using dosage monitoring during coarse flow and fine flow section.

  The filling weight is then monitored in a 1.6 ms timeslot (600 meas. values/s) to see if the fine flow cut-off point has been reached.

  The fine flow is cut off at time t_F .

- **RFT** Residual flow time 0.2 s (**RFT**20;)

  The residual flow time is a fixed waiting time during which the material that is still in flight or in the feed elements, runs into the bag.

- **STT** Stabilization time 0.5 s (**STT**50;)

  During stabilization time, the AED monitors the measurement signal for standstill. Once the standstill criteria are met, this time is over. Stabilization time ends in any case once the set time has expired (here 0.5 s), even if the standstill criteria have still not been met.

After the stabilization time, checkweighing takes place.

The following functions are executed during checkweighing:

1. The dosing result is determined (queried with the **FRS**? command)
2. The cut-off points are optimized if optimization (**OSN**) is activated.
3. The tolerance outputs TOL+/TOL– are set; the tolerance result is entered in the measured value status and in the dosing status.
4. The cumulative weight is calculated (queried with the **SUM**? command), the piece counter is incremented (queried with the **NDS**? command).
5. The ready signal OUT3 is set and entered in the measured value status and dosing status.

- **EPT** Emptying time 1.5 s (**EPT**150;)

  This time is only required when filling containers.
  Once the emptying time has expired the ready signal (OUT3) is reset. Output OUT3 can also be used for emptying.
  If the emptying time is deactivated (**EPT**0;) the ready signal is reset the next time there is a start.

In order to retain the parameter settings, they must be saved by using the **TDD**1; command.

5.2 Using dosage monitoring dosing during coarse and fine flow

There are two monitoring functions available for monitoring the filling process:

- Monitoring during the coarse flow phase
- Monitoring during the fine flow phase
- Monitoring start weight an error conditions (**SDO**, **MDT**)

All these functions can be activated or deactivated totally independently.

- Monitoring during the coarse flow phase

  The limit value to be monitored is entered with the command **CBK**.
  If the limit value is entered with 0 (**CBK**0;), the function is deactivated.
  CBK is the limit value that must be exceeded by the filling weight 1 s after the coarse flow lockout time (**LTC**) has expired.
  Monitoring starts at time t_{G0} once the coarse flow lockout time (LTC) has expired and ends at time t_G with coarse flow OFF (**CFD**).
  The first comparison occurs 100 ms after **LTC** at 10 % **CBK**
  The next comparison occurs 200 ms after **LTC** at 20 % **CBK** etc.
  Each time there is another comparison, the limit value increases by 10 %**CBK**.
  Active coarse flow monitoring can detect three error conditions:

  1. A start occurs without a container being available.
     Consequently there is no increase in weight. The first limit value 100 ms after **LTC** is not exceeded and coarse and fine flow are cut off
  2. A bag is being filled, but tears during the coarse flow filling phase or bursts; it then takes max. 100 ms until this error is detected and coarse flow and fine flow are cut off.
  3. A container is being filled and the flow of material stops, that is to say the weight value stops increasing, but limit value **CBK** continues to be increased every 100 ms. If the limit value exceeds the weight of the bag, coarse and fine flow are cut off.

  In all three of these error conditions, alarm output (OUT4) is active and BIT 7 is set in the measurement status and the dosing status.

- Monitoring during the fine flow phase

  Monitoring during fine flow begins once the fine flow lockout time (**LTF**) has expired and ends with fine flow OFF.

  Use the command **FBK** to enter a weight value to define the interval at which a monitoring curve follows the actual filling curve. All the weight increases in the filling curve also increase the monitoring curve, whereas when the weight decreases, the monitoring curve does not follow. If the weight drops during the fine flow phase and falls below the monitoring curve that is accompanying it, this is a sign of bag breakage.

  When there is a bag breakage, the alarm output is active and BIT 7 is set in the measurement status and the dosing status.

  If the limit value is entered with 0 (**FBK**0;), the function is deactivated.

Example:

A bag is to be filled with 50 kg. The fine flow starts at 46 kg and is cut off at 49.5 kg. FBK is entered with 500 g for fine flow monitoring. Once the fine flow lockout time (LTF) has expired, the bag weight is 46 kg and the monitoring characteristic curve starts at 45.5 kg.

Filling process without errors			**Filling process when there is bag breakage**		
Bag weight kg	**ΔFBKn kg**	**Monitoring curve kg**	**Bag weight kg**	**ΔFBKn kg**	**Monitoring curve kg**
46.00	0.5	45.50	46.00	0.5	45.50
46.40 ⇑	0.5	45.90	46.40 ⇑	0.5	45.90
46.80 ⇑	0.5	46.30	46.80 ⇑	0.5	46.30
46.60 ⇓	0.3	46.30	46.60 ⇓	0.3	46.30
47.60 ⇑	0.5	47.10	46.40 ⇓	0.1	46.30
48.00 ⇑	0.5	47.50	46.20 ⇓	-0.1	46.30 --> Bag breakage filling curve falls below the monitoring curve Fine flow off Alarm on

⇑ weight rise, ⇓ weight loss

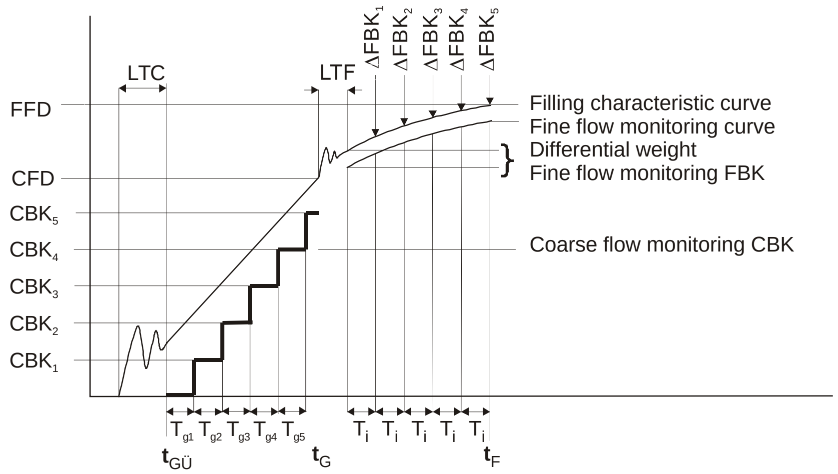


Fig. 3: Bag breakage monitoring

5.3 Optimization

The strategy behind optimization is aimed at achieving the shortest possible dosing time (max. coarse flow component) at a given accuracy (dosing tolerance), taking a minimum fine flow component (**FFM**) into account.

The optimization calculation always attempts to set the cut-off points in such a way that the filling process consists of a coarse flow phase and a fine flow phase.

The optimization severity (**OSN**1...3) defines how strongly optimization corrects a filling error.

What can optimization do – and what can it not do

- Optimization can be used to fully stabilize slow changes in the flow properties, consistency or material changes, by means of temperature. Optimization will only achieve satisfactory results if, when optimization is deactivated and cut-off points are fixed, the same dosing results are achieved, that is to say the filling machine returns reproducible results.
- If, when optimization is deactivated and the cut-off points are fixed the filling machine returns highly variable dosing results, for example 50.50 – 49.00 – 49.90 – 51.00, optimization cannot stabilize this. If optimization is activated, it could even make the situation worse.

The basis of optimization is checkweighing. After checkweighing, the target weight (e.g. 50 kg) is compared to the actual value (e.g. 49.5 kg).

This comparison is used as the basis for establishing whether too much or too little material has been drawn.

- Too much material has been drawn

  The optimization calculation resets the fine flow cut-off point (**FFD**) subject to the optimization severity.

  If it is possible to increase the coarse flow cut-off point (**CFD**) because of the fine flow component, the coarse flow cut-off point (**CFD**) will be increased

  A check is made to establish whether the coarse flow cut-off point (**CFD**) < the fine flow cut-off point (**FFD**) – the minimum fine flow component (**FFM**) and if this is not the case, the coarse flow cut-off point (**CFD**) is reset to the fine flow cut-off point (**FFD**) – the minimum fine flow component (**FFM**).

- Too little material has been drawn

  The optimization calculation increases the fine flow cut-off point (**FFD**) subject to the optimization severity (**OSN**).

  If it is possible to increase the coarse flow cut-off point (**CFD**) because of the fine flow component, the coarse flow cut-off point (**CFD**) will be increased

  A check is made to establish whether the coarse flow cut-off point (**CFD**) < the fine flow cut-off point (**FFD**) – the minimum fine flow component (**FFM**) and if this is not the case, the coarse flow cut-off point (**CFD**) is reset to the fine flow cut-off point (**FFD**) – the minimum fine flow component (**FFM**).

- Special case: The dosing result has been achieved without filling at fine flow

  The fine flow cut-off point (**FFD**) remains unchanged.

  The coarse flow cut-off point (**CFD**) is reset by the minimum fine flow component (**FFM**). The aim is to involve the fine flow in the dosing process.

- If the minimum fine flow component (**FFM**) is too low, in a filling operation where the fine flow cut-off point (**FFD**) is exceeded without involving the fine flow, the coarse flow cut-off point (**CFD**) is reset until fine flow is involved in the dosing process. Then optimization will increase the coarse flow cut-off point (**CFD**) to the fine flow cut-off point (**FFD**) – the minimum fine flow (**FFM**).

  If the coarse flow cut-off point (**CFD**) is brought back up to the minimum interval to the fine flow cut-off point (**FFD**), you will again get a dosing operation where the fine flow cut-off point (**FFD**) is exceeded without fine flow involvement.

  Behavior of this type can lead to inaccurate dosing results. The remedy is to increase the minimum fine flow component (**FFM**), so that each dosing ends with fine flow.

Optimization is activated by the **OSN** command.

OSN0;	Optimization is deactivated.		
OSN1;	means	most severe	optimization level
OSN2;	means	average	optimization level
OSN3;	means	least severe	optimization level

Before activating optimization, you must check how good the reproducibility of the filling machine is with fixed cut-off points.

Setting for the degree of optimization (OSN)	**Difference of actual weight to target weight as %**		
1	<0.2	0.2...0.4	>0.4
2	<0.6	0.6...1.2	>1.2
3	<2	2...4	>4
Correction factor	0.25	0.5	1

Example: for the degree of optimization table:

Setting OSN3; Target weight: 50.00 kg; Filled weight 49.50 kg

Filling was 1 % (500 g) too little.

For the setting

- OSN1, a difference of 1 % produces a correction factor of 1
  the fine flow cut-off point is increased by 0.5 kg ∗ 1 = 500 g
- OSN2, a difference of 1 % produces a correction factor of 0.5
  the fine flow cut-off point is increased by 0.5 kg ∗ 0.5 = 250 g
- OSN3, a difference of 1 % produces a correction factor of 0.25
  the fine flow cut-off point is increased by 0.5 kg ∗ 0.25 = 125 g

Example of when the optimization calculation does not work:

50kg are to be drawn, but in fact 51 kg are drawn.

Optimization level OSN3;

1. The difference is 1 kg or 2 %, the correction factor is 0.5, the fine flow cut-off point is reduced by 1 kg ∗ 0.5 = 0.5 kg.
2. The next dosing result is expected to be 50.5 kg, but in fact, only 49.5 kg were drawn. The difference is 0.5 kg or 1 %, the correction factor is 0.25

   The fine flow cut-off point is increased by 0.5 kg ∗ 0.25 = 0.125 kg.
3. The third filling should be 49,625 kg, but is actually 50.8 kg.

   The difference is 0.8 kg or 1.6 %, the correction factor is 0.25

   The fine flow cut-off point is reduced by 0.8 kg ∗ 0.25 = 0.2 kg.

In this case, optimization will always track, but never lead to satisfactory results. With this scale example, changing the optimization severity to OSN2; or OSN1; would lead to even worse results, because the differences to the target value would have a greater effect on the fine flow cut-off point.

5.4 Emptying function

The ready signal output OUT3 can also be used for emptying.

All the time that emptying time **EPT** = 0, output OUT3 only works as a ready signal. It is active after checkweighing and remains active until a new start occurs.

If an emptying time >0 is set, for example **EPT**50; the ready signal output will be active after checkweighing but will only stay active for the set emptying time, in the **example** 500 ms (0.5 s); for these 500 ms, the output also has the ready signal meaning.

The command **EMD** defines the emptying monitoring controlled by time or weight.

Using the systematic difference parameter

SYD, the "systematic difference" parameter can be used to adjust differences that arise after checkweighing and which are therefore not covered by optimization.

Filling bags is an **example** of this. The filled bag is released after checkweighing. During release, the bag clamp takes about 300 g of material from the filled bag, so that the released bag only weighs 49.7 kg instead of 50 kg.

To correct this systematic error, enter **SYD**30;. The AED now works as if the target value set were 50.30 kg, so that a bag filled with 50.30 kg will still have 50.00 kg after its release.

The **SYD** command can be used to correct differences of ±5 % of the target value.

In the **example** with 50 kg, that is ±2.5 kg.

5.5 Setting filtering

The commands **FMD** and **ASF** set the filters for the electronics.

With **FMD** = 0,2,3,4 the internal data transfer rate (= output rate of the measured values = monitoring rate of the dosing functions) can only be set using the **ICR** command (**ICR** = 0 → 600 meas. values/s).

With **FMD** = 1 the internal data transfer rate (= output rate of the measured values = monitoring rate of the dosing functions) is additionally reduced by the **ASF** command (see command description).

The choice of filter should be such that in static mode (no dosing process) the measurement display is steady (standstill). It may be necessary to take adjacent equipment into consideration that could transfer mechanical vibrations to the scale (for example, through floor vibrations).

The chosen filter acts during both coarse and fine flow control, as well as during checkweighing.

If filtering is too strong (long settling time) or too weak (unsteady measured values) this will naturally have a great effect on the dosing accuracy, the spread of the dosing results and the mass throughput per time unit.

6 Working with the panel program

The *AED_Panel32* panel program automatically adjusts to the particular type of electronics when communication is initialized. With AD103 and FIT, the menu for the dosing parameters is also enabled. In the “IO_Trigger” menu, the **IMD** parameter must be set to ’Dosing’ (IMD2).

The figures are from the *AED_Panel32* version 1.1.x

6.1 Parameter settings

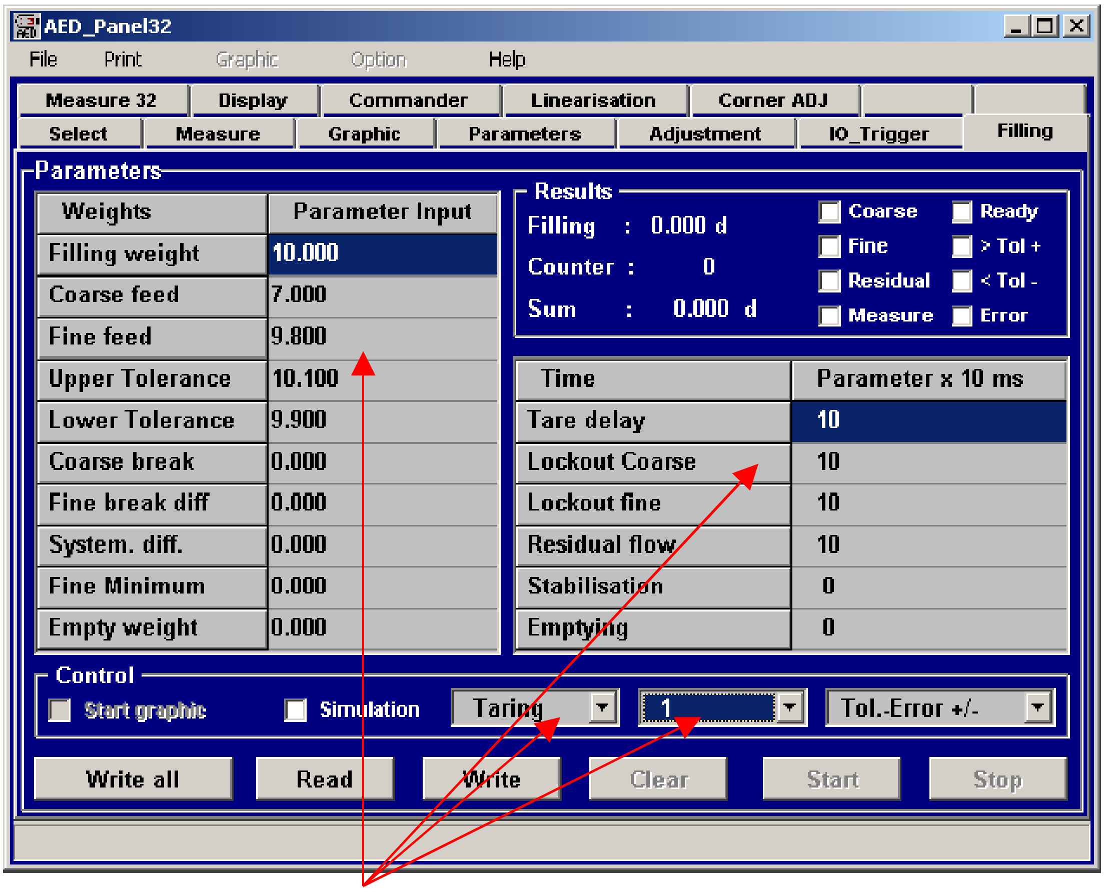


Fig. 4: Dosing parameter settings

In this menu, the current measured value is displayed in the bottom status line (**MSV**?).

As soon as a new dosing result is available (measurement status byte evaluation), the dosing results are queried and displayed (Figure 5).

The modified cut-off points are also displayed, if optimization is activated.

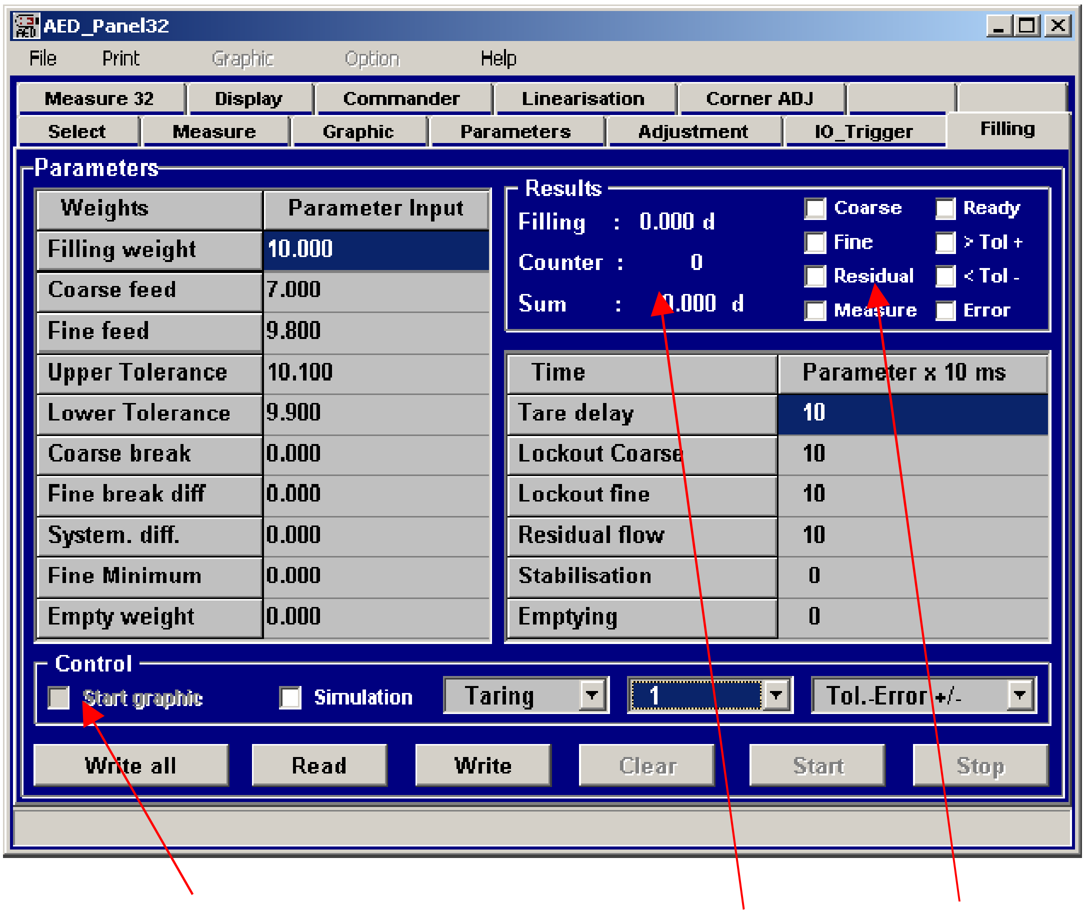


Fig. 5: Activating graphic measurement with RUN and displaying dosing results and dosing status

The *"Start"* and *"Stop"* buttons control the dosing process with the **RUN** and **BRK** commands.

The ***"CLR"*** button clears the sum and the dosing counter.

The Simulation function is only accessible, if the electronics are not connected (for demonstrations only)

6.2 Analysis of a dosing process over time

The course of the dosing process over time can be measured and displayed in the graphic menu. If the Start of the dosing process is started using the **RUN**; command; the 'Start graphic' option must be activated. Then move to the "Graphic" menu.
The analysis over time can now take place in block mode (measurement recording 128...4096 values).

At the start of graphic measurement, first the **RUN**; command is output and then measurement recording starts (**MSV**?xxxx;).

Once the measurement run is over, the measured values are displayed (blue line). The time axis is automatically set to the output rate of the measured values. The timing analysis can now take place using the cursor. The implemented zoom function makes this very easy.

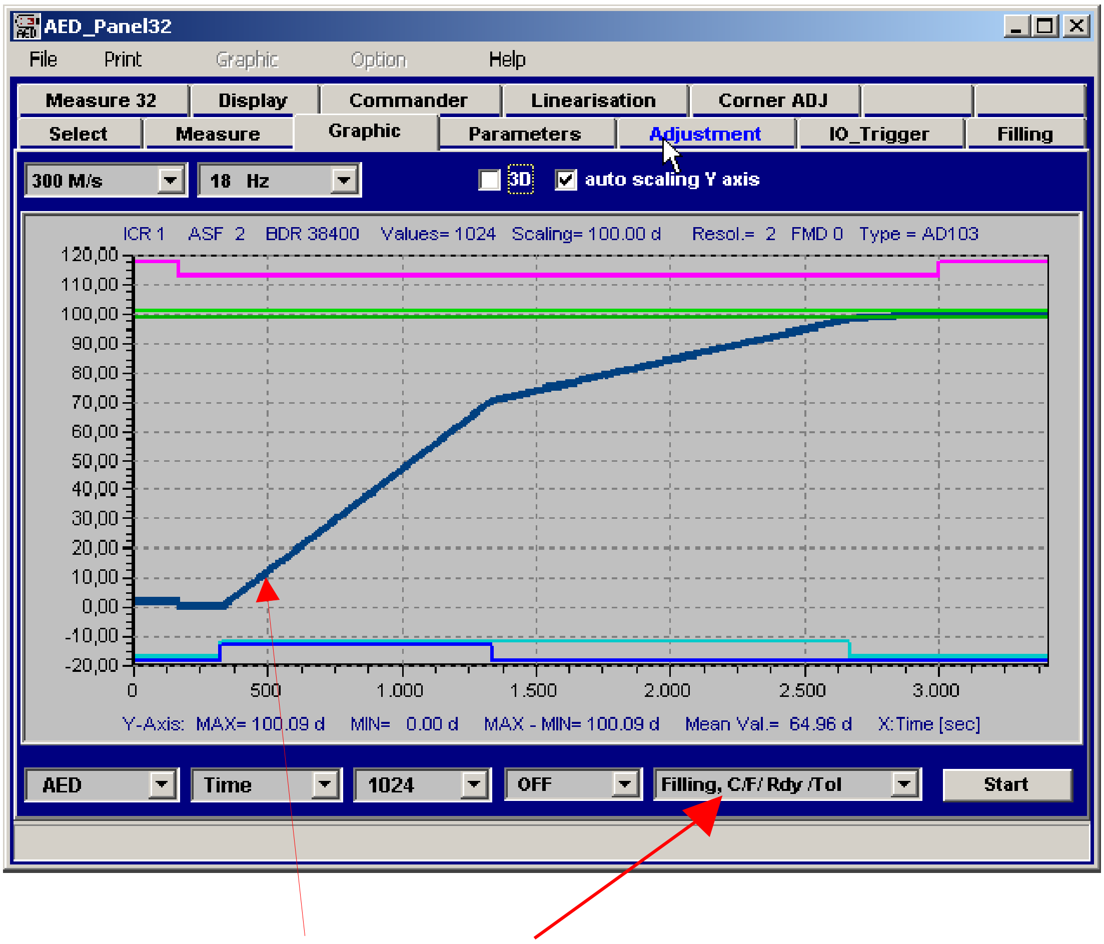


Fig. 6: Displaying a dosing curve (with special additions)

Activating the special additions produces the following display (Figure 6).

The dark blue line indicates the measured values. The upper, cyan curve indicates the beginning and end of dosing. The green lines are the set dosing tolerance range. The blue lines on the bottom edge indicate the active coarse flow and active fine flow times. This additional information is taken from the measurement status of each of the recorded measured values.

6.3 Setting the lookout times for coarse flow and fine flow

In the graphic displayed, there is no settling at the start of coarse flow (see the lower, dark blue line) or at the changeover to fine flow, so in the example (Figure 6), the lockout times are extremely short.

7 Communication over the serial interface

The FIT/AD103 has 32 parameter set for dosing with one component.

For dosing several components, the parameter set of the new component must be selected with **RDP** in the breaks in dosing.

The command short forms used and their meaning can be found in the dosing operating manual.

Requirement: Set **IMD**2 and **OMD** in accordance with the function of output 4

The multi-component dosing sequence can look like this:

1. Select parameter set (**RDP**) for component 1
2. Tare using the **TAR** command
3. Start dosing the first component (e.g. with **RUN**)
4. Wait for the end of first component dosing (possibly read out dosing status or monitor ready output OUT4)
5. Read in first component dosing result
6. Select parameter set for component 2 with **RDP**
7. Tare using the TAR command
8. Start dosing the second component (e.g. with **RUN**)
9. Wait for the end of second component dosing
10. Read in the second component dosing result
11. etc.

The following commands adjust the AED / FIT to a component:

- **Select parameter set RDP (0…31)**
- **Control system**

1.	**TMD0**	Taring deactivated
2.	**OSN**	Optimization
3.	**OMD**	Mode output
4.	**RDS**	Redosing
5.	**DMD**	Dosing mode
6.	**EMD**	Emptying mode
7.	**SDF**	Special functions
8.	**VCT**	Valve control

- **Time value (∗ 10ms)**

1.	TAD	//Tare delay
2.	LTC	//Blanking time coarse flow monitoring
3.	LTF	//Blanking time fine flow monitoring
4.	RFT	//Residual flow time
5.	STT	//Standstill time
6.	EPT	//Emptying time
7.	CBT	Time distance coarse break monitoring
8.	FBT	Time distance fine break monitoring
9.	MDT	Maximum dosing time (∗ 100 ms)

- **Weight values**

1.	**FWT**	**//**Filling weight (enter first, then **CFD**, **FFD**,..)
2.	**CFD**	//Coarse flow cut-off value
3.	**FFD**	//Fine flow cut-off value
4.	**UTL**	//Upper tolerance
5.	**LTL**	//Lower tolerance
6.	CBK	//Coarse flow bag breakage
7.	FBK	//Fine flow bag breakage
8.	SYD	//Systematic difference
9.	**FFM**	//Minimum fine flow component
10.	EWT	//Empty weight tolerance

- **Save parameter set WDP (0…31)**

The parameters shown in bold are mandatory. The other parameters are optional and may possibly only have to be entered for the first component, if the other components can be dosed at the same setting.
It is important to enter the filling weight before the other weight values, as entering the filling weight sets default values for parameters **CFD**, **FFD**, **UTL**, **LTL** and **FFM**.

With multi-component dosing, the automatic taring function **TMD** must be deactivated (**TMD**0;), and taring must be performed using the tare command **TAR** (<15 ms execution time) before each start. The reason for this is a query in automatic tare mode:

current gross / net measured value > emptying threshold (EWT)

If "yes", automatic taring is not performed. This function allows uninterrupted dosing to be continued with a restart (RUN), without having to tare the existing material to be weighed. This cannot be used for multi-component dosing.

The following values are read out as the dosing result.

- **FNB?;** // Actual parameter set number (0…31)
- **FRS?;** // Actual value of the last dosing
- **SDO?;** // Dosing status with tolerance result,...
- **CFD?;** // Coarse flow cut-off point, only when optimization is on (**OSN**>0)
- **FFD?;** // Fine flow cut-off point, only when optimization is on (**OSN**>0)
- SUM?; // Cumulative value, optional
- NDS?; // Dosing counter, optional
- SDM? // mean value, optional
- SDS? // standard deviation, optional
- DST? // dosing time, optional
- CFT? // coarse flow time, optional
- FFT? // fine flow time, optional
- WDP // save parameter set and results nonvolatile, optional

Commands shown in bold are mandatory. The other commands are optional.

Time estimation: The following times are needed to enter a complete parameter set (transmission time to the AED / FIT and processing time):

Baud rate	Input time
9600 bd	approx. 1.4 s
38400 bd	approx. 0.6 s

The same times are produced again when the full parameter set is queried.

Dosing status monitoring

After dosing has started, the status can be queried with the command **SDO**?;.
The second monitoring option comprises the measurement query **MSV**?; with the status byte (e.g. **COF**8: 3-byte measured value binary, 1 byte status, see command description for **MSV**?).

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