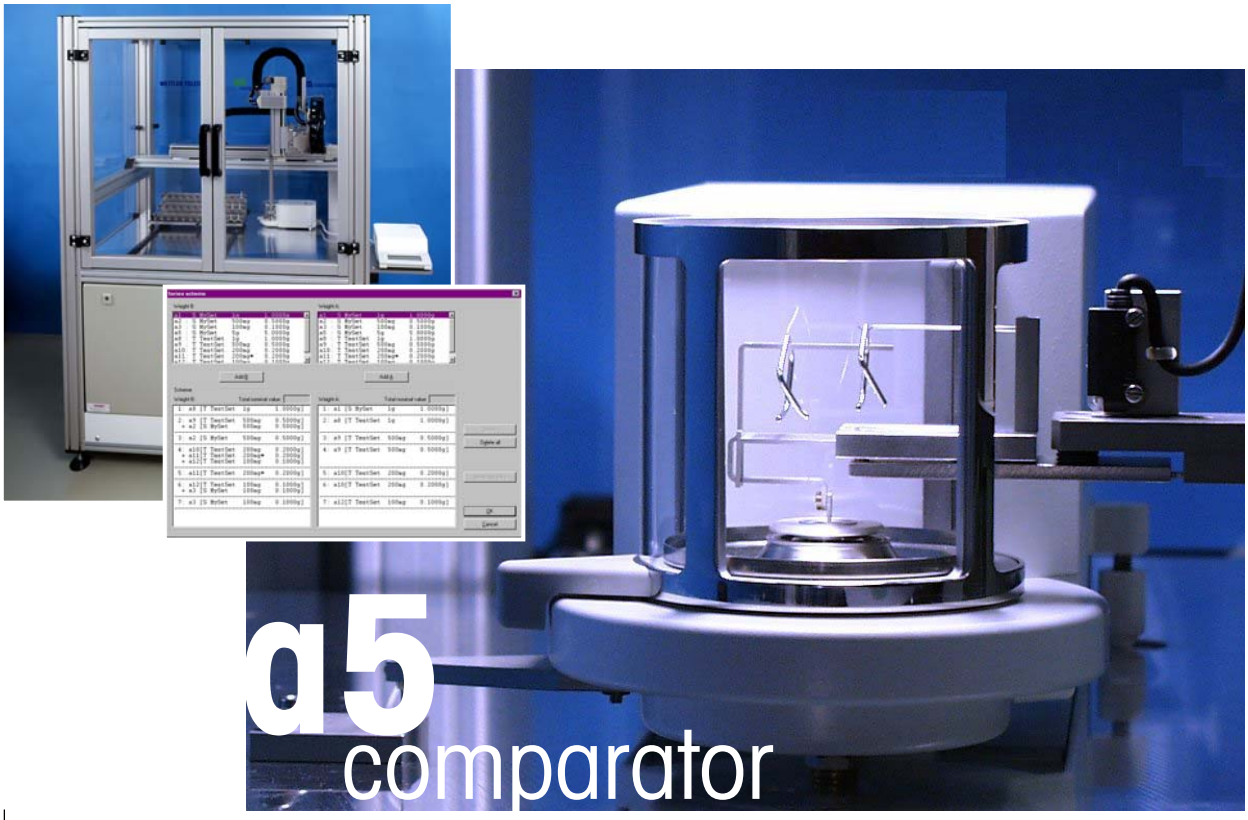
METTLER TOLEDO

Product Outline



a talented micro-weighing machine !

METTLER TOLEDO

metrotec

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1 Introduction

Thank you for showing a keen interest in our **a5**comparator - a talented micro-weighing machine! Combining METTLER TOLEDO's world-class weighing sensor technology with metrotec's specific, optimized system design, '**a5**comparator' - **a**utomated **5** g mass comparator - gives a new dimension to micro-weighing.

Manually handling milligram weights and precisely weighing them on a micro-balance has been a challenge to metrologists. Performance and reliability on the one hand, productivity on the other are concerns which we have addressed: **a5**comparator does offer new ways with respect not only to direct comparison, but to down-/upward calibration as well. **a5**comparator and its smart **a5**control software will become in no time indispensable to any mass standards laboratory. (**a5**control is an original product designed jointly by metrotec engineering and Raillard engineering.)

Among **a5**comparator's numerous remarkable features, let us highlight the essentials:

- "Turn-key" solution for automated micro-weighing processes
- Enhanced measurement quality (in terms of repeatability and reproducibility) and productivity
- Wide scope of application through unique weight carrier design (adequate for all regular weight shapes), large weight magazine (36 places) and advanced software capabilities
- Direct comparison and comparison between combinations of up to three weights
- Rugged design and hassle-free maintenance

We trust this 'Product Outline' will let you realise the tremendous potential which the **a5**comparator represents to your mass standard laboratory. Should you request greater detail, please do contact us.

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2 System components

The **a5**comparator comprises (see Figure 1):

- The micro-balance, METTLER TOLEDO UMT5 Comparator (balance, control unit and AC adapter)
- The 3-axis robot system with its associated control unit, located in the electrical rack
- The 3-row weight magazine, with 12, 24 or 36 weights carriers
- The controller with installed Microsoft® Windows® based **a5**control software

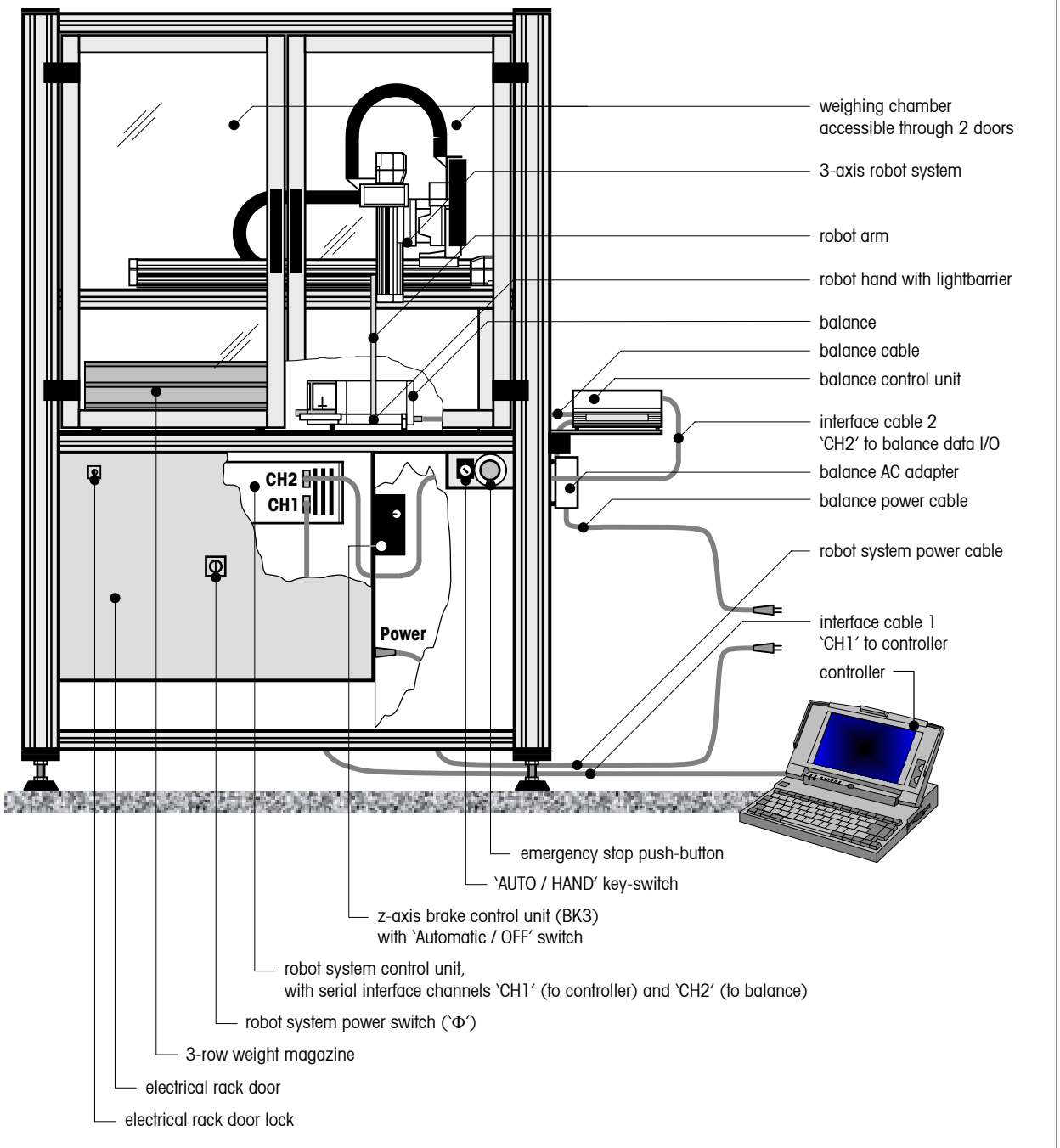


Figure 1 System components and connections

3 36-place weight magazine

The **a5**comparator is delivered with a 36-place weight magazine, equipped with 12, 24 or 36 weight carriers. Each test weight / standard used during the weighing process needs to be placed onto one weight carrier (see Figure 2).

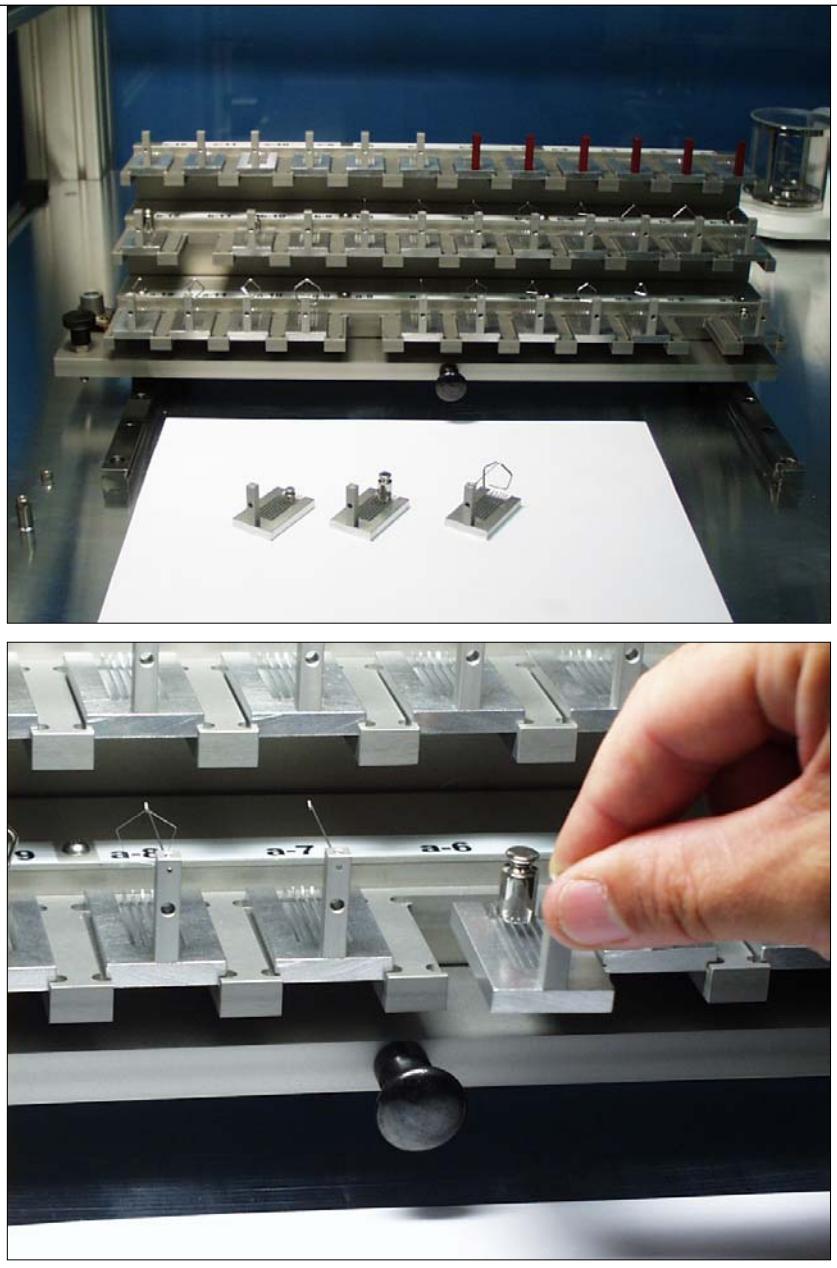


Figure 2 Loading the weights onto the weight carriers, and the weight carriers onto the weight magazine

The selection of the adequate weight carrier type (design 1, 2 or 3 – see Figure 3) is determined by the weight geometry. Strict rules must be followed when it comes to choose, for each weight, the right carrier type, in order to ensure a trouble-free operation of the **a5**comparator. Figure 4 presents the carrier selection criteria for knob and wire weights, Figure 5 for knob and sheet weights.

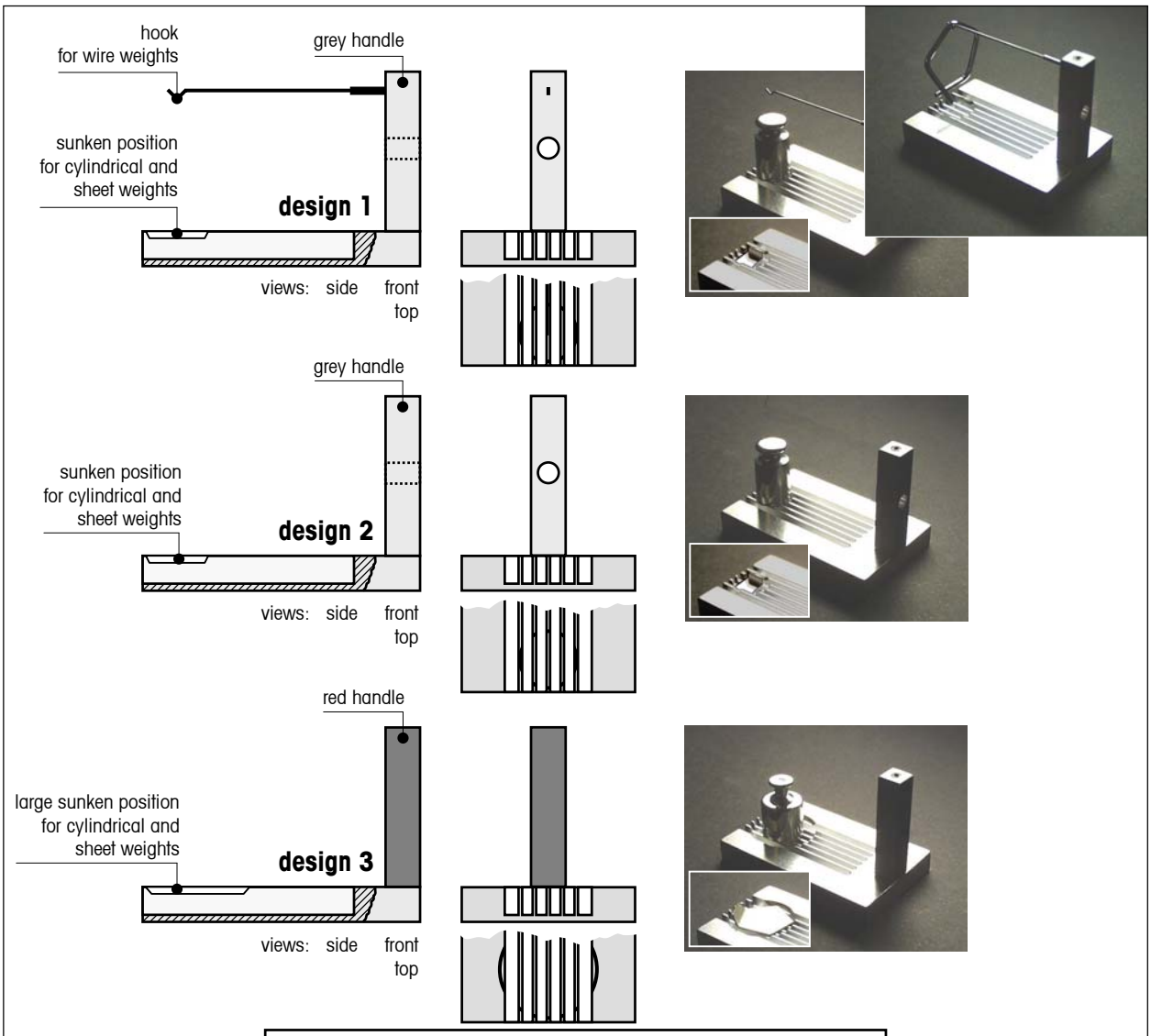
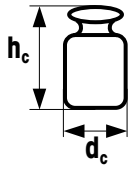
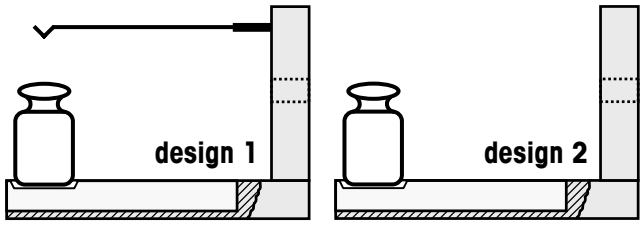
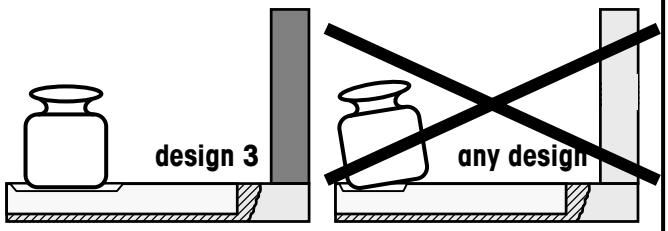
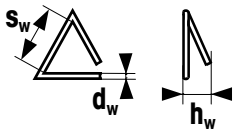
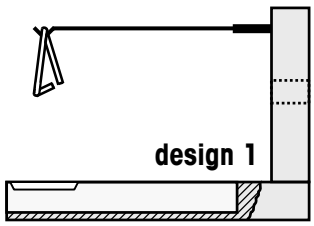
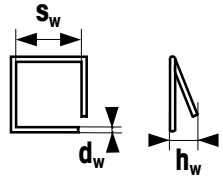
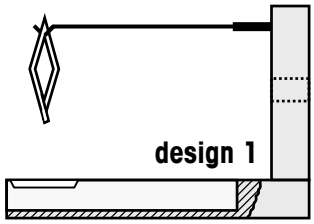
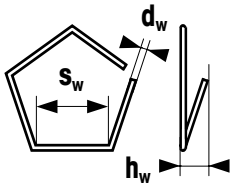
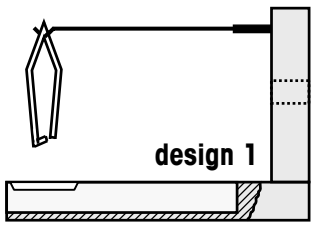


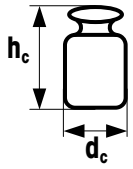
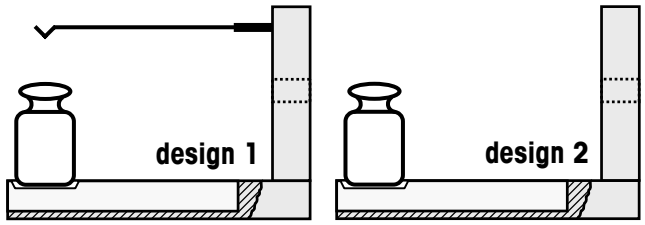
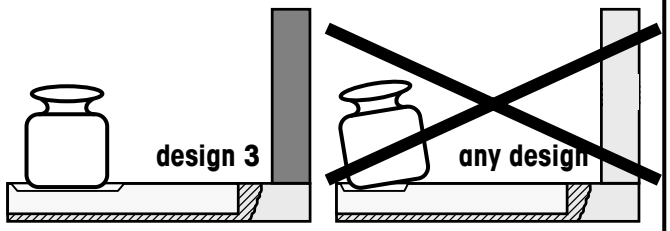
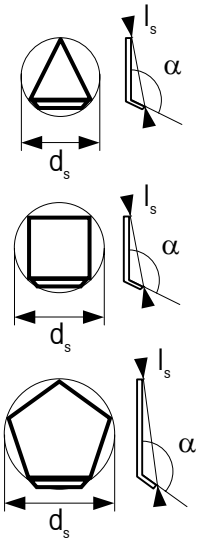
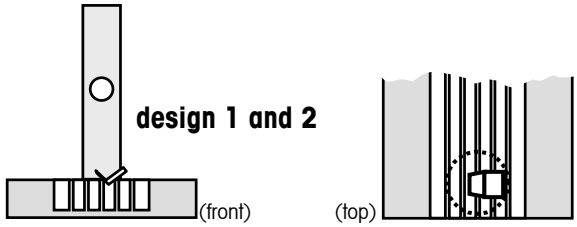
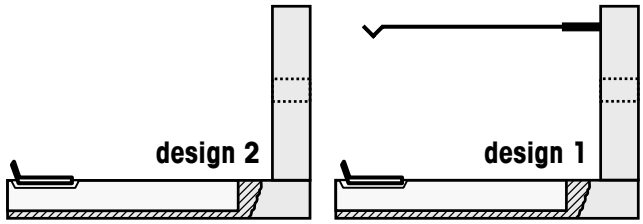
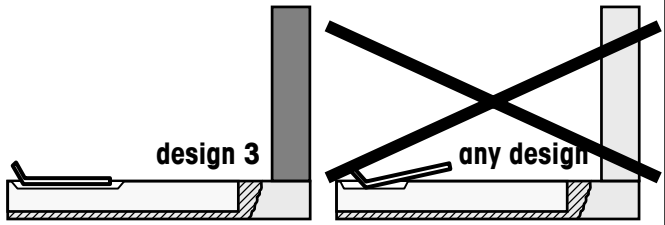
Figure 3 Standard weight carrier designs 1, 2 and 3

Weight shape	Weight dimensions	Weight carrier selection and weight positioning
Cylindrical with knob 	diameter: **$4 \le d_c \le 8.2$ mm** height: **$h_c \le 16$ mm**	
	diameter: **$8.2 \le d_c \le 14$ mm** height: **$h_c \le 16$ mm**	
Wire, triangular 	triangle inner side: **$5.5 \le s_w \le 18$ mm** wire diameter: **$0.1 \le d_w \le 1.5$ mm** height: **$h_w \le 6$ mm**	
Wire, square 	square inner side: **$5.5 \le s_w \le 12$ mm** wire diameter: **$0.1 \le d_w \le 1.5$ mm** height: **$h_w \le 6$ mm**	
Wire, pentagonal 	pentagon inner side: **$5.5 \le s_w \le 12$ mm** wire diameter: **$0.1 \le d_w \le 1.5$ mm** height: **$h_w \le 6$ mm**	

Warning: weights which do not fit in the above categories shall not be loaded on standard carriers. Special carriers can be designed on request - do contact your supplier.

Combinations of up to three weights, placed each on its own carrier of design either 1 or 2, can be weighed in the 'down-/upward calibration' mode. If a weight placed on a carrier of design 3 is involved in the combination, this is limited to two weights only (3-weight combination forbidden!).

Figure 4 Knob and wire weights - Carrier selection guide and weight positioning

Weight shape	Weight dimensions	Weight carrier selection and weight positioning
Cylindrical with knob 	diameter: **$4 \le d_c \le 8.2$ mm** height: **$h_c \le 16$ mm**	
	diameter: **$8.2 \le d_c \le 14$ mm** height: **$h_c \le 16$ mm**	
Sheet, polygonal 	diameter of circumscribed circle (triangle, square, pentagon): **$d_s \le 4$ mm** distance l_s: **$l_s \ge 3$ mm** angle sheet-handle: **$\alpha \ge 90°$**	
	diameter of circumscribed circle (triangle, square, pentagon): **$4 \le d_s \le 8.2$ mm**	
	diameter of circumscribed circle (triangle, square, pentagon): **$8.2 \le d_s \le 14$ mm**	

Warning: weights which do not fit in the above categories shall not be loaded on any standard carrier. Special carriers can be designed on request - do contact your supplier.

Combinations of up to three weights, placed each on its own carrier of design either 1 or 2, can be weighed in the 'down-/upward calibration' mode. If a weight placed on a carrier of design 3 is involved in the combination, this is limited to two weights only (3-weight combination forbidden!).

Figure 5 Knob and sheet weights - Carrier selection guide and weight positioning

4 Performing a weighing process – a5control makes it easy

A double mouse-click on the **a5**control icon

a5control

starts the program and opens a new, blank process settings file whose main window is shown in Figure 6.

Figure 6 **a5**control - main window

4.1 Entering and editing the weights data

The 'Weights' menu (see Figure 7) gives access to the weights database which contains all relevant data on your standards and test weights. While the data on your test weights are, like other settings,

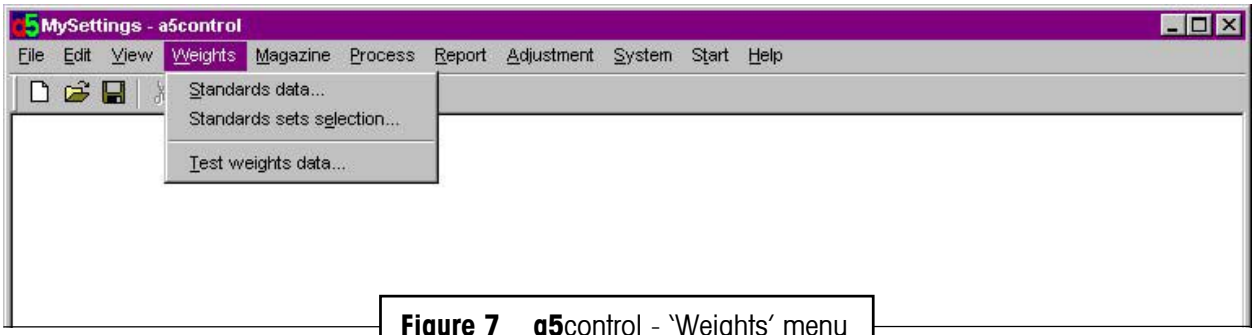


Figure 7 **a5**control - 'Weights' menu

specific to the process and, thus, to the current settings file, the data on your standards are kept in a separate database: these data are specific to your mass standards laboratory, not to the weighing process, and, thus, need to be accessible from any settings file.

After selecting 'Standards data…' in the 'Weights' menu, the window shown in Figure 8 appears. A list box gives all records - all standards - which have been entered. The access to the standards data is password-protected. Once the password is accepted, you may proceed with modifications, i.e.:

- Adding new standards into the database
- Modifying existing standards
- Deleting one (all) existing standard(s)

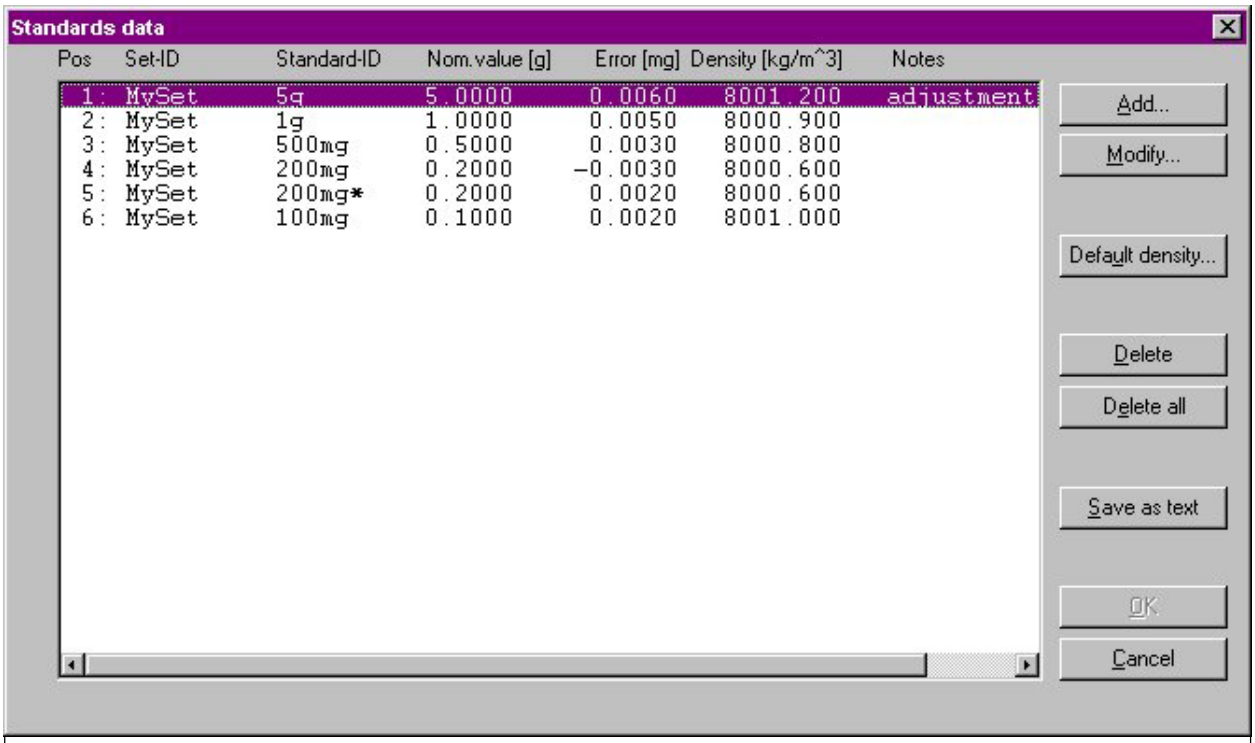


Figure 8 Entering / editing standards data

A window similar to Figure 8 gives access to the test weights database.

4.2 Allocating the weight magazine places

Once standards and test weights are defined in their respective database, their assigned position on the weight magazine needs to be identified and registered in **a5**control. This is done in the 'Allocation of weight magazine places' window shown in Figure 9. The upper list box contains all defined, and, thus, available weights; the lower one shows all available magazine places, identified by their number, from a1 (right) to a12 (left) for the front, lower magazine row, from b1 (right) to b12 (left) for the middle magazine row, and from c1 (right) to c12 (left) for the back, upper magazine row.

To allocate one magazine place to one particular weight, simply:

- Select the weight by clicking on the proper record in the upper list box
- Select the magazine place you want to be allocated to the weight you just selected
- Press the 'Place' button

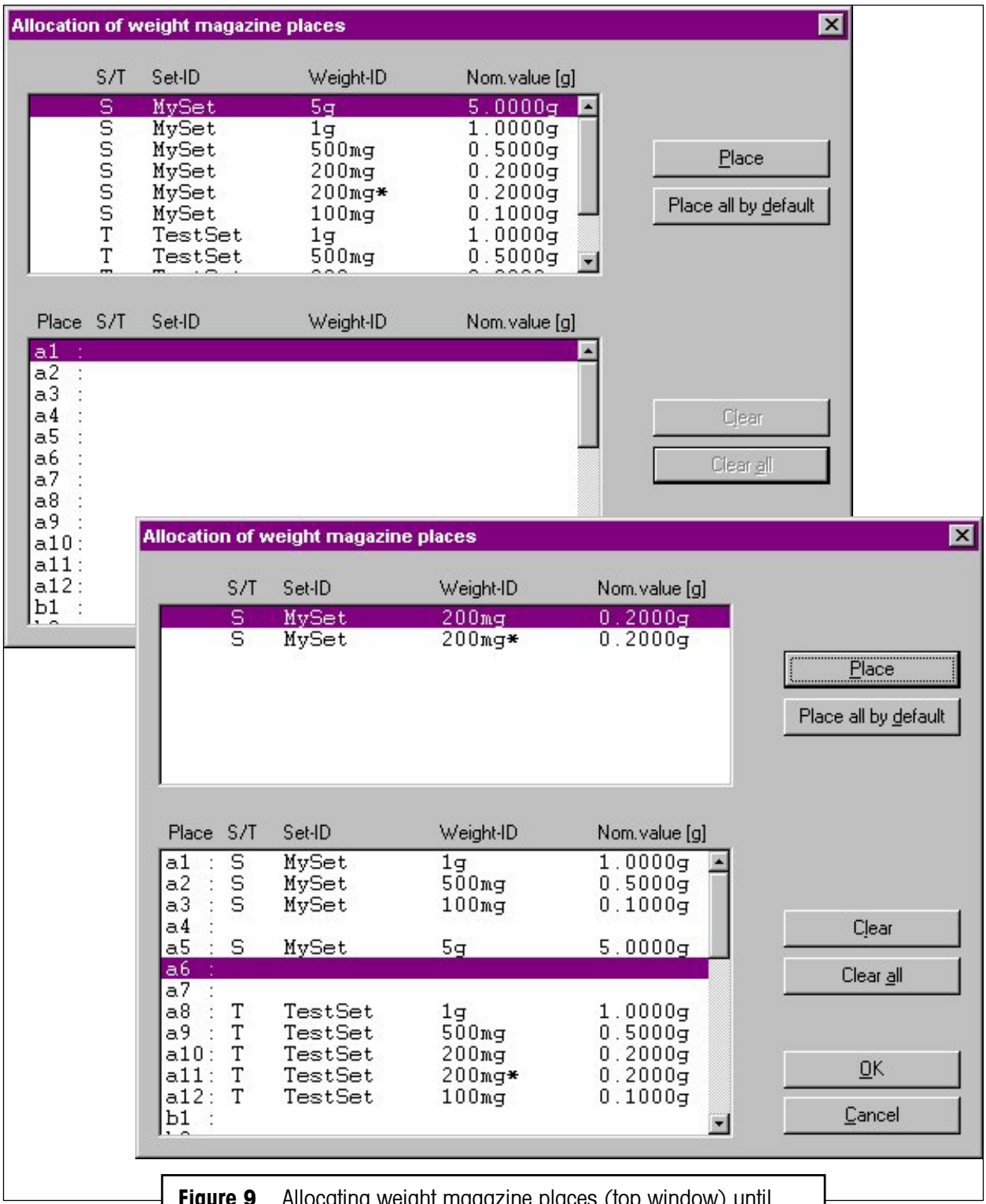


Figure 9 Allocating weight magazine places (top window) until all weights used during the process have got a magazine position assigned to them (bottom window)

4.3 Determining the weighing process settings and series scheme

After defining standards and test weights and determining on which magazine place each of these weights is located, the comparisons, of which the weighing process shall consist, as well as their precise timing and sequence are to be set. As shown in Figure 10, various parameters serve to determine the process, such as, in particular:

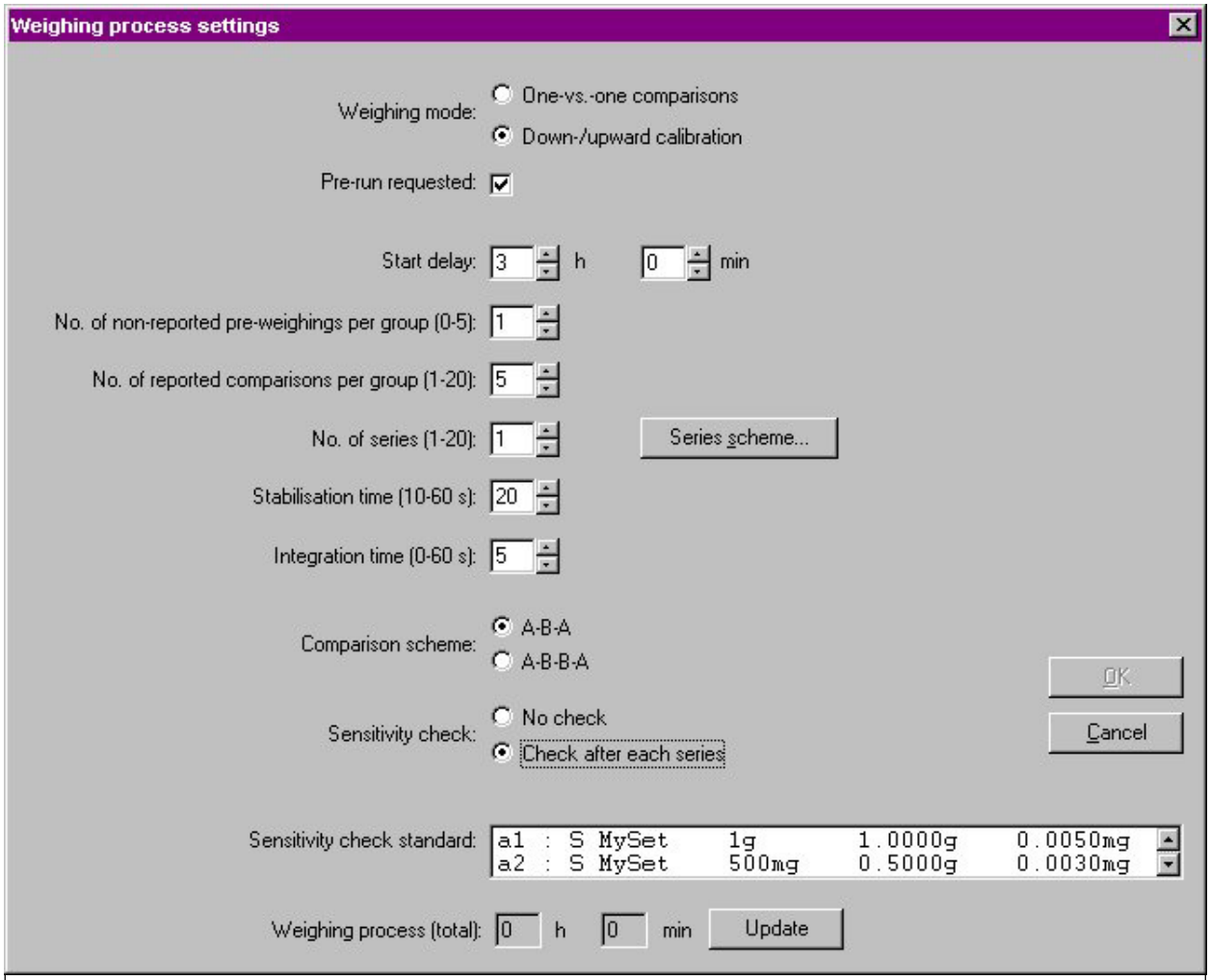


Figure 10 Setting the process parameters

- '**Weighing mode**': 'One-vs.-one comparisons' - direct comparisons, between a single weight B and a single weight A - or 'Down-/upward calibration' - comparison between two combinations of up to three weights each - (professional software edition; optional); the 'standard' software allows 'One-vs.-one comparisons' only
- '**Comparison scheme**': you may choose either the 'A-B-A' or 'A-B-B-A' scheme
- '**Sensitivity check**': should you wish to monitor the balance "sensitivity" during the weighing process, you may select 'Check after each series'; the sensitivity check - determination of the value of the check standard (to be selected) - will be performed before the first series starts and at the end of each series.

After setting these parameters, it remains to determine the series scheme (design), i.e. which comparisons shall be performed and in which sequence. A separate window ('Series scheme', see Figure 11) makes it as easy as it can possibly be. The upper list boxes 'Weight B:' and 'Weight A:' both contain all available weights, i.e. all test weights and all standards to which one magazine place is allocated. The series scheme, displayed in the lower list boxes ('Scheme - Weight B:' and 'Scheme - Weight A:'), consists of a list of comparisons between two combinations of up to three weights each. Each comparison is entered as follows:

- Select first the weight B by clicking on the proper record in the upper 'Weight B:' list box
- Press the 'Add B' button: the selected weight B is entered in the 'Scheme - Weight B:' list box
- If you wish to enter a combination of more than one weight, repeat the previous two steps (the symbol '+' in the 'Scheme' list boxes indicates that a combination is entered - see Figure 11 - and the total nominal value of the combination is displayed on the top of the 'Scheme' list boxes)
- Once the (combination of) weight(s) B is entered, select the weight A by clicking on the proper record in the upper 'Weight A:' list box
- Press the 'Add A' button: the selected weight A is entered in the 'Scheme - Weight A:' list box
- If you wish to enter a combination of more than one weight A, repeat the previous two steps

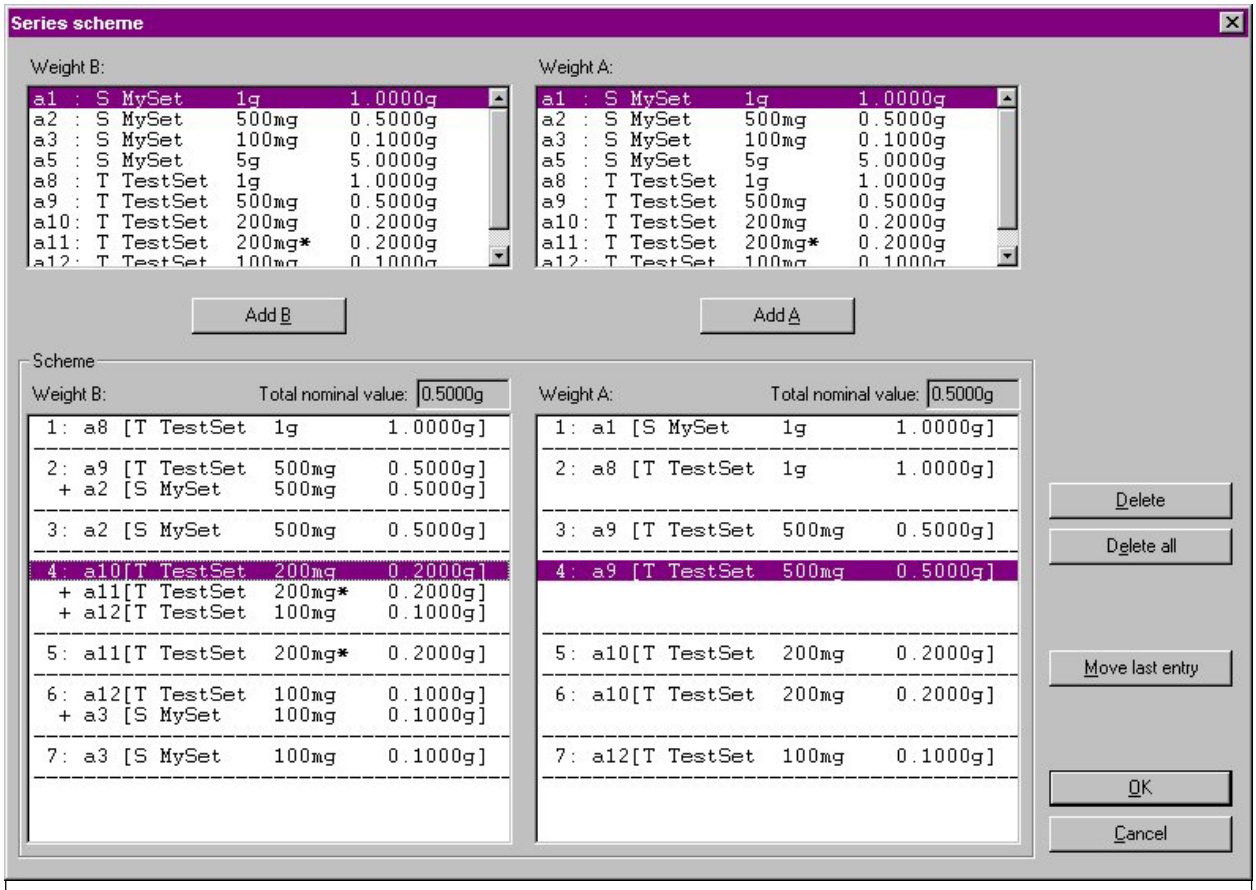


Figure 11 Complete series scheme in mode 'Down-/upward calibration'

4.4 Choosing the report contents

The weighing process is now defined: **a5**control has registered which standards and test weights are involved in this process, where on the magazine these weights are located, it has registered the timing which has to be followed throughout the process and the scheme which defines all comparisons and their sequence. All parameters are set.

Before starting the weighing process, the contents of the report file can be defined, by selecting the information blocks you want to get reported:

- Weighing process settings
- Magazine places allocation
- Series scheme
- Balance settings
- Measurement data
- Summary of results

4.5 Starting and monitoring the weighing process

The start command is given by selecting 'Start measurement' in the 'Start' menu. **a5**control then displays some information on the process timing (see Figure 12). Once the "go" command is given, the weighing process monitor (see Figure 13) allows you to follow the process on-line, step by step. The two upper boxes 'Weight B:' and 'Weight A:' show which comparison weighing is currently being carried out. The large text box first reminds you of the defined process settings; it records every single process step and displays the detailed measurement data, in a format which is similar to the report format. Furthermore, it provides in the 'status field' useful information on the current action, as well as valuable advice with respect to troubleshooting, should an error be detected.

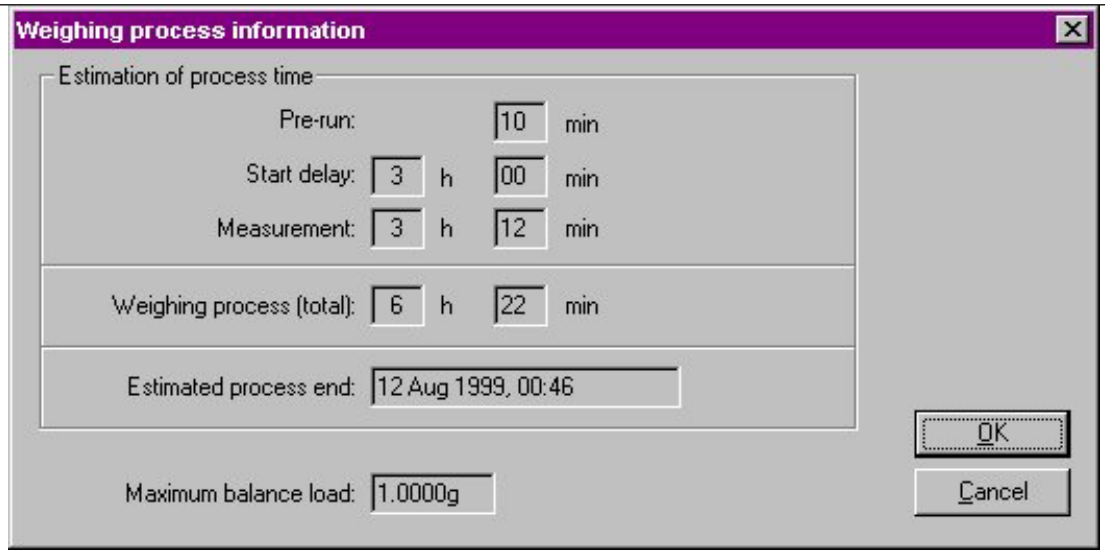


Figure 12 Weighing process information – Timing and maximum balance load

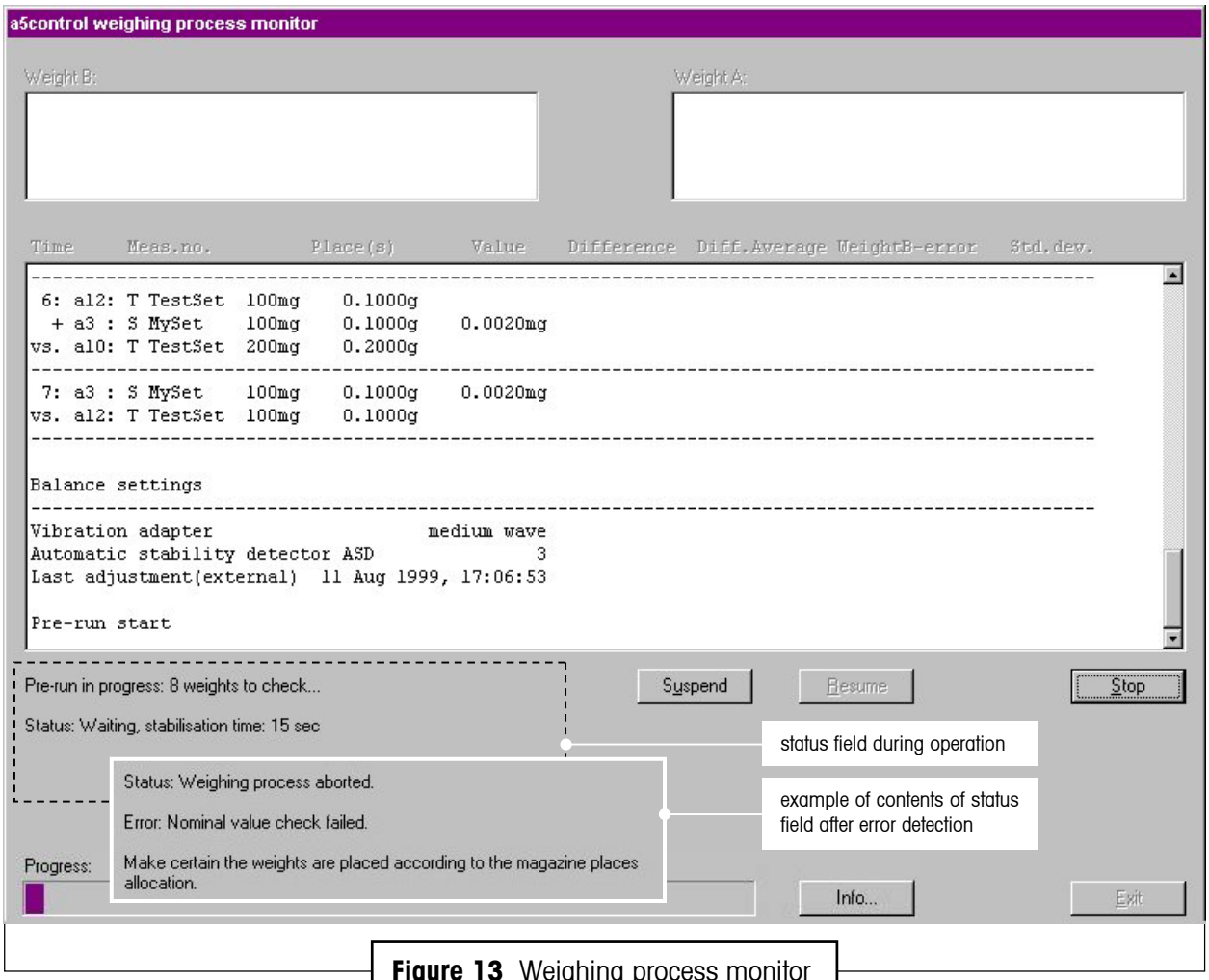


Figure 13 Weighing process monitor

4.6 Measurement report

The Figures 14, 15 and 16 show a report generated by **a5**control after running a weighing process consisting of one series of 7 groups of 5 A-B-A comparison weighings. The selected weighing mode is 'Down-/upward calibration'. Figure 14 presents the report heading, Figure 15 the measurement data and Figure 16 the results summary table from which you get, at a glance, the essentials in a compact, but explicit format. Should the process consist of more than one series, the summary table indicates, in addition, the average of the difference averages.

```
a5control v4.5 - measurement report

File: D:\metrotec\a5comparator\a5control\a5control reports\TestReport.doc

a5comparator settings defined in: D:\metrotec\a5comparator\a5control\1g-100mg.005

Start date                          11 Aug 1999      User                 metrotec engineering ag
Start time                             18:24:05      Notes     determination of TestSet 1g - 100mg
Weighing process time [h:min]             06:22

Weighing process
-------------------------------------------------------------------------------------------------
Pre-run done                                Yes
Start delay [h:min]                       03:00
No. of non-reported pre-weighings per group    1
No. of reported comparisons per group          5
No. of series                                  1
Comparison scheme                          A-B-A
Stabilisation time [s]                        20
Integration time [s]                           5
Sensitivity check done                       Yes       a1 : S Myset    1g       1.0000g    0.0050mg  8000.900kg/m^3

Magazine places allocation
-------------------------------------------------------------------------------------------------------------------------
    a1 : S MySet    1g       1.0000g    0.0050mg  8000.900kg/m^3
    a2 : S MySet    500mg    0.5000g    0.0030mg  8000.800kg/m^3
    a3 : S MySet    100mg    0.1000g   -0.0030mg  8001.000kg/m^3
    a8 : T TestSet  1g       1.0000g              8001.200kg/m^3
    a9 : T TestSet  500mg    0.5000g              8000.000kg/m^3
    a10: T TestSet  200mg    0.2000g              8000.000kg/m^3
    a11: T TestSet  200mg*   0.2000g              8000.000kg/m^3
    a12: T TestSet  100mg    0.1000g              8000.000kg/m^3

Series scheme (B vs. A)
-------------------------------------------------------------------------------------------------------------------------
 1: a8 : T TestSet  1g       1.0000g              8000.000kg/m^3
vs. a1 : S MySet    1g       1.0000g    0.0050mg  8000.900kg/m^3
-------------------------------------------------------------------------------------------------------------------------
 2: a9 : T TestSet  500mg    0.5000g              8000.000kg/m^3
  + a2 : S MySet    500mg    0.5000g    0.0030mg  8000.800kg/m^3
vs. a8 : T TestSet  1g       1.0000g
-------------------------------------------------------------------------------------------------------------------------
 3: a2 : S MySet    500mg    0.5000g    0.0030mg  8000.800kg/m^3
vs. a9 : T TestSet  500mg    0.5000g              8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------------
 4: a10: T TestSet  200mg    0.2000g              8000.000kg/m^3
  + a11: T TestSet  200mg*   0.2000g              8000.000kg/m^3
  + a12: T TestSet  100mg    0.1000g              8000.000kg/m^3
vs. a9 : T TestSet  500mg    0.5000g              8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------------
 5: a11: T TestSet  200mg*   0.2000g              8000.000kg/m^3
vs. a10: T TestSet  200mg    0.2000g              8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------------
 6: a12: T TestSet  100mg    0.1000g              8000.000kg/m^3
  + a3 : S MySet    100mg    0.1000g   -0.0030mg  8001.000kg/m^3
vs. a10: T TestSet  200mg    0.2000g              8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------------
 7: a3 : S MySet    100mg    0.1000g   -0.0030mg  8001.000kg/m^3
vs. a12: T TestSet  100mg    0.1000g              8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------------

Balance settings
-------------------------------------------------------------------------------------------------------------------------
Mass comparator ID                          UMX5
Environment                           very stable
Value release                           very fast
Last adjustment (internal) 31 Jan 2003, 15:05:05

Climate data
-------------------------------------------------------------------------------------------------------------------------
Climate data input                          online
Climate measuring instrument          Klimet A30
```

Figure 14 Report - Part 1: heading and process settings

Measurement data (all values in mg)

Day/Time	Meas.no.	Place(s)	Value	Diff.(B-A)	Diff.average	WeightB-error	Std.dev.	Press.[hPa]	rel.Hum.[%]	T1[degr.C]	T2[degr.C]	T3[degr.C]	T4[degr.C]
01/22:02:19	00 sc	0	-0.00100					972.213	37.94	22.658	22.315	22.691	22.710
01/22:03:11	00 sc	a1	1000.00245					972.213	37.94	22.658	22.315	22.691	22.710
01/22:03:58	00 sc	0	-0.00150	1000.00370	1000.00370			972.177	37.64	22.668	22.336	22.695	22.714
01/22:08:30	010101A	a1	1000.00624					972.213	37.94	22.658	22.315	22.691	22.710
01/22:09:43	010101B	a8	999.99120					972.213	37.94	22.658	22.315	22.691	22.710
01/22:10:55	010101A	a1	1000.00590	-0.01487				972.177	37.64	22.668	22.336	22.695	22.714
01/22:12:07	010102B	a8	999.99128					972.177	37.64	22.668	22.336	22.695	22.714
01/22:13:20	010102A	a1	1000.00576					972.203	37.46	22.677	22.348	22.697	22.714
01/22:14:33	010102B	a8	999.99088	-0.01468				972.203	37.46	22.677	22.348	22.697	22.714
01/22:15:47	010103A	a1	1000.00526					972.207	37.31	22.679	22.353	22.685	22.704
01/22:16:59	010103B	a8	999.99060					972.146	37.16	22.683	22.356	22.678	22.699
01/22:18:13	010103A	a1	1000.00520	-0.01463				972.146	37.16	22.683	22.356	22.678	22.699
01/22:19:26	010104B	a8	999.99085					972.138	37.11	22.687	22.363	22.677	22.700
01/22:20:39	010104A	a1	1000.00507					972.138	37.11	22.687	22.363	22.677	22.700
01/22:21:52	010104B	a8	999.99075	-0.01427				972.104	36.97	22.691	22.371	22.680	22.702
01/22:23:05	010105A	a1	1000.00513					972.036	36.90	22.706	22.402	22.712	22.731
01/22:24:18	010105B	a8	999.99080					972.036	36.90	22.706	22.402	22.712	22.731
01/22:25:30	010105A	a1	1000.00530	-0.01441	-0.01457	-0.00957	0.00023	972.038	36.73	22.716	22.417	22.717	22.739
01/22:32:08	010201A	a8	999.98566					972.213	37.94	22.658	22.315	22.691	22.710
01/22:33:56	010201B	a2 + a9	1000.00550					972.213	37.94	22.658	22.315	22.691	22.710
01/22:35:45	010201A	a8	999.98556	0.01989				972.177	37.64	22.668	22.336	22.695	22.714
01/22:37:33	010202B	a2 + a9	1000.00550					972.177	37.64	22.668	22.336	22.695	22.714
01/22:39:22	010202A	a8	999.98545					972.203	37.46	22.677	22.348	22.697	22.714
01/22:41:11	010202B	a2 + a9	1000.00540	0.02000				972.203	37.46	22.677	22.348	22.697	22.714
01/22:42:59	010203A	a8	999.98533					972.207	37.31	22.679	22.353	22.685	22.704
01/22:44:47	010203B	a2 + a9	1000.00550					972.146	37.16	22.683	22.356	22.678	22.699
01/22:46:35	010203A	a8	999.98540	0.02013				972.146	37.16	22.683	22.356	22.678	22.699
01/22:48:24	010204B	a2 + a9	1000.00495					972.138	37.11	22.687	22.363	22.677	22.700
01/22:50:12	010204A	a8	999.98495					972.138	37.11	22.687	22.363	22.677	22.700
01/22:51:59	010204B	a2 + a9	1000.00514	0.02009				972.104	36.97	22.691	22.371	22.680	22.702
01/22:53:47	010205A	a8	999.98474					972.036	36.90	22.706	22.402	22.712	22.731
01/22:55:35	010205B	a2 + a9	1000.00508					972.036	36.90	22.706	22.402	22.712	22.731
01/22:57:23	010205A	a8	999.98460	0.02041	0.02010		0.00019	972.038	36.73	22.716	22.417	22.717	22.739
01/23:02:53	010301A	a9	499.98922					972.213	37.94	22.658	22.315	22.691	22.710
01/23:04:07	010301B	a2	499.98195					972.213	37.94	22.658	22.315	22.691	22.710
01/23:05:21	010301A	a9	499.98886	-0.00709				972.177	37.64	22.668	22.336	22.695	22.714
01/23:06:34	010302B	a2	499.98180					972.177	37.64	22.668	22.336	22.695	22.714
01/23:07:47	010302A	a9	499.98872					972.203	37.46	22.677	22.348	22.697	22.714
01/23:09:01	010302B	a2	499.98196	-0.00684				972.203	37.46	22.677	22.348	22.697	22.714
01/23:10:14	010303A	a9	499.98870					972.207	37.31	22.679	22.353	22.685	22.704
01/23:11:27	010303B	a2	499.98180					972.146	37.16	22.683	22.356	22.678	22.699
01/23:12:42	010303A	a9	499.98860	-0.00685				972.146	37.16	22.683	22.356	22.678	22.699
01/23:13:56	010304B	a2	499.98184					972.138	37.11	22.687	22.363	22.677	22.700
01/23:15:09	010304A	a9	499.98848					972.138	37.11	22.687	22.363	22.677	22.700
01/23:16:22	010304B	a2	499.98180	-0.00666				972.104	36.97	22.691	22.371	22.680	22.702
01/23:17:37	010305A	a9	499.98858					972.036	36.90	22.706	22.402	22.712	22.731
01/23:18:51	010305B	a2	499.98162					972.036	36.90	22.706	22.402	22.712	22.731
01/23:20:04	010305A	a9	499.98815	-0.00675	-0.00684		0.00016	972.038	36.73	22.716	22.417	22.717	22.739
01/23:28:34	010401A	a9	499.99560					972.213	37.94	22.658	22.315	22.691	22.710
01/23:30:59	010401B	a11 + a12 + a10	499.98150					972.213	37.94	22.658	22.315	22.691	22.710
01/23:33:25	010401A	a9	499.99548	-0.01404				972.177	37.64	22.668	22.336	22.695	22.714
01/23:35:49	010402B	a11 + a12 + a10	499.98150					972.177	37.64	22.668	22.336	22.695	22.714
01/23:38:15	010402A	a9	499.99510					972.203	37.46	22.677	22.348	22.697	22.714
01/23:40:38	010402B	a11 + a12 + a10	499.98110	-0.01380				972.203	37.46	22.677	22.348	22.697	22.714
01/23:43:02	010403A	a9	499.99500					972.207	37.31	22.679	22.353	22.685	22.704
01/23:45:27	010403B	a11 + a12 + a10	499.98104					972.146	37.16	22.683	22.356	22.678	22.699
01/23:47:53	010403A	a9	499.99516	-0.01404				972.146	37.16	22.683	22.356	22.678	22.699
01/23:50:17	010404B	a11 + a12 + a10	499.98100					972.138	37.11	22.687	22.363	22.677	22.700
01/23:52:42	010404A	a9	499.99495					972.138	37.11	22.687	22.363	22.677	22.700
01/23:55:05	010404B	a11 + a12 + a10	499.98095	-0.01398				972.104	36.97	22.691	22.371	22.680	22.702
01/23:57:30	010405A	a9	499.99460					972.036	36.90	22.706	22.402	22.712	22.731
01/23:59:55	010405B	a11 + a12 + a10	499.98064					972.036	36.90	22.706	22.402	22.712	22.731
02/00:02:22	010405A	a9	499.99440	-0.01386	-0.01394		0.00011	972.038	36.73	22.716	22.417	22.717	22.739

Figure 15 Report - Part 2: measurement data

```
Series scheme (B vs. A) and summary of results (in mg)                    Diff.average WeightB-error   Std.dev.
-------------------------------------------------------------------------------------------------------------------
 1: a8 : T TestSet  1g       1.0000g             8000.000kg/m^3  Series 1:      -0.01457      -0.00957    0.00023
vs. a1 : S MySet    1g       1.0000g    0.0050mg 8000.900kg/m^3
-------------------------------------------------------------------------------------------------------------------
 2: a9 : T TestSet  500mg    0.5000g             8000.000kg/m^3  Series 1:       0.02010                  0.00019
  + a2 : S MySet    500mg    0.5000g    0.0030mg 8000.800kg/m^3
vs. a8 : T TestSet  1g       1.0000g             8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
 3: a2 : S MySet    500mg    0.5000g    0.0030mg 8000.800kg/m^3  Series 1:      -0.00684                  0.00016
vs. a9 : T TestSet  500mg    0.5000g             8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
 4: a10: T TestSet  200mg    0.2000g             8000.000kg/m^3  Series 1:      -0.01394                  0.00011
  + a11: T TestSet  200mg*   0.2000g             8000.000kg/m^3
  + a12: T TestSet  100mg    0.1000g             8000.000kg/m^3
vs. a9 : T TestSet  500mg    0.5000g             8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
 5: a11: T TestSet  200mg*   0.2000g             8000.000kg/m^3  Series 1:       0.09904                  0.00016
vs. a10: T TestSet  200mg    0.2000g             8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
 6: a12: T TestSet  100mg    0.1000g             8000.000kg/m^3  Series 1:       0.07617                  0.00008
  + a3 : S MySet    100mg    0.1000g   -0.0030mg 8000.000kg/m^3
vs. a10: T TestSet  200mg    0.2000g             8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
 7: a3 : S MySet    100mg    0.1000g   -0.0030mg 8000.000kg/m^3  Series 1:      -0.01139                  0.00005
vs. a12: T TestSet  100mg    0.1000g           8000.000kg/m^3
-------------------------------------------------------------------------------------------------------------------
sc: a1 : S MySet    1g       1.0000g    0.0050mg 8000.900kg/m^3     Start:    1000.00370
                                                                   Series 1:    1000.00485
```

Figure 16 Report - Part 3: summary of results

Indication of corner load error

a5control automatically handles the comparison of two weight combinations in such a way (placing sequence) that the remaining corner load error is minimized. In the case of a comparison '2 g + 2 g + 1 g' vs. '5 g', the combination entered as '2 g + 2 g + 1 g' will be placed onto the balance pan in the sequence '2 g + 1 g + 2 g': the center of gravity of the weights combination is located on the same vertical axis as the 5 g weight and, consequently, the remaining corner load error equals zero. However, in certain cases, in particular when non OIML weights are involved in a combination (e.g. '3 g + 2 g' vs. '5 g'), a certain error due to corner load remains. Knowing the measured corner load error, **a5**control calculates for each comparison the remaining error due to corner load and, if not zero, indicates it under 'CrLd-err' in the results summary table of the measurement report (see Figure 17).

```
Series scheme (B vs. A) and summary of results (in mg)          Diff.average WeightB-error   Std.dev.
-------------------------------------------------------------------------------------------------------
 1: b11: T TestSet  3g       3.0000g              Series 1:       0.07617       0.07017    0.00008
  + b12: T TestSet  2g       2.0000g              Series 2:       0.07580       0.06980    0.00011
vs. b1 : S MySet    5g       5.0000g   -0.0060mg  Average :       0.07598       0.06998
                                                 CrLd-err:      -0.00013
-------------------------------------------------------------------------------------------------------
```

Figure 17 Indication of corner load error

4.7 "Remote-controlling" the a5comparator

The weighing process settings may need to be generated by a central laboratory information management system, such as for instance the 'Automated Mass Measurement System' (AMMS) supplied by Measurement Technology Laboratories (Minneapolis, USA), and imported from this system into **a5**control. Furthermore certain commands may need to be sent to **a5**control from this central system, in order to let this system "remote-control" the **a5**comparator. **a5**control offers such an interface which fully meets these requirements.

4.7.1 Generating a file importable into a5control as settings file

As above mentioned, the ability of **a5**control to import a settings file generated by a central information management system is indispensable to certain laboratories. To achieve this, a text file needs to be produced by this central system according to well-defined format rules, so that it becomes convertible into a regular, **a5**control-compatible settings file (see Figure 19 and following table). Figure 18 presents an example of such a text file, named 'ImportDemo.imp' and containing all necessary settings.

```
JOB: ImportDemo
a5control 3
HEADER:
<This is an optional 3-line text block which appears in a message box
when the new settings file (imported and converted into a5control)
is loaded>
END HEADER
PROCESS:
1 1 3 0 1 5 1 A-B-A 20 5 a3
END PROCESS
MAGAZINE:
a1 S MySet 1g 1 0.005 8000.9
a2 S MySet 500mg 0.5 0.003 8000.8
a3 S MySet 100mg 0.1 -0.003 8001.0
a8 T TestSet 1g 1
a9 T TestSet 500mg 0.5
a10 T TestSet 200mg 0.2
a11 T TestSet 200mg* 0.2
a12 T TestSet 100mg 0.1
END MAGAZINE
SCHEME:
a8 VS. a1
a9+a2 VS. a8
a2 VS. a9
a10+a11+a12 VS. a9
a11 VS. a10
a12+a3 VS. a10
a3 VS. a12
END SCHEME
REPORT:
metrotec engineering ag
C:\Programs\a5control\DemoOutput
END REPORT
END JOB ImportDemo
```

Figure 18 Example of a text file convertible into a settings file by **a5**control

```
JOB: strJobID<CR LF>
strAppName intDocVersion<CR LF>
[HEADER:<CR LF>
strHeaderLine<CR LF>
[strHeaderLine<CR LF>
[strHeaderLine<CR LF>]]

PROCESS:<CR LF>
blnWeighingMode blnPreRun intStartDelayHours intStartDelayMinutes
intNonReportedPreweighings intReportedComparisons intSeries
strComparisonScheme intStabilisationTime intIntegrationTime
strSensitiv

MAGAZINE:<CR LF>
strPosID strWeightType strSetID strWeightID decNominal[ decError]<CR LF>
[…]
END MAGAZINE<CR LF>
SCHEME:<CR LF>
strCombination VS. strCombination<CR LF>
[…]
END SCHEME<CR LF>
REPORT:<CR LF>
strUserName<CR LF>
strFileName<CR LF>
END REPORT<CR LF>
END JOB strJobID<CR LF>
```

Figure 19 Format of a text file convertible into an **a5**control settings file (<CR LF> means 'carriage return linefeed' and [ ] optional)

Parameter designation	Value (range)	Description
strJobID	<no limitation>	string of characters used as job identification
strAppName	'a5control'	designation of control software used
intDocVersion	3	document version used as internal reference to the settings definition and its history
strHeaderLine	<no limitation>	text appearing in a message box when loading the imported and converted settings file
blnWeighingMode	0 | 1	'0' = 1 vs. 1 comparisons, '1' = down-/upward calibration
blnPrerun	0 | 1	'0' = pre-run not requested, '1' = pre-run requested
intStartDelayHours	0 – 99	integer, number of hours in time requested as start delay
intStartDelayMinutes	0 – 59	integer, number of minutes in time requested as start delay

Parameter designation	**Value (range)**	**Description** (cont'd)
intNonReportedPreweighings	0 – 5	integer, number of non-reported pre-weighings per group
intReportedComparisons	1 – 20	integer, number of reported comparisons per group
intSeries	1 – 20	integer, number of series
strComparisonScheme	'A-B-A' | 'A-B-B-A'	comparison scheme
intStabilisationTime	10 – 60	integer, stabilisation time in seconds
intIntegrationTime	0 – 60	integer, integration time in seconds
strSensitivityCheck	strPosID | 'NO'	mag. place of sens. check standard if check done, 'NO' if not
strPosID	'a' | 'b' | 'c' & '1' | '2' | ...| '12'	magazine position number: a1 to a12, b1 to b12, c1 to c12
strWeightType	'S' | 'T'	'S' = standard, 'T' = test weight
strSetID	<maximum 8 characters>	string of maximum 8 characters, weight set identification
strWeightID	<maximum 8 characters>	string of maximum 8 characters, weight identification
decNominal	0 – 6.1	number (with decimal), weight nominal value in g
decError	<no limitation, in principle>	number (with decimal), error in mg given for standards only (i.e. strWeightType = 'S')
strCombination	strPosID[+strPosID [+strPosID]]	string consisting of up to 3 different magazine positions, separated by the '+' sign
strUserName	<maximum 54 characters>	string of maximum 54 characters (including spaces), user identification
strFileName	<file location path and name>	name of report file, without extension, and its location on disk

Meaning of the symbols used in the above table

'< >' delimits a comment on the value of a parameter, '–' means 'up to', ' \| ' stands for 'or', '[ ]' delimits an optional block and '&' indicates the concatenation of two strings of characters.

The file generated according to the above rules (extension '.imp') can now be imported into **a5**control and converted into a settings file. Before doing so, you need to choose the data import mode between importing from file (accessible locally on disk or via local area network) and importing via a serial communication port. Should the latter be selected, a second serial communication port has to be available - in addition to the port used for communication to the **a5**comparator weighing machine.

4.7.2 Communicating via the serial port

As mentioned earlier on, the `.imp' text file generated by the laboratory information management system (LIMS) can be imported into **a5**control via a serial communication port.

The communication protocol is fixed: 2400 baud, 7 data bits, 1 stop bit, parity even; besides, a fixed time out of 3 seconds is defined during which the reply to a request for data must be sent. To ensure a smooth exchange of information between the LIMS and **a5**control, the following set of commands is available:

Task, description	**Command a5**control ➔ **LIMS**	**Command LIMS ➔ a5**control
Requesting list of pending jobs, pressing 'Get job list' button	JOB ?<CR LF>	
Sending list of pending jobs (empty list if none available)		JOB[strJobID[strJobID[…]]]<CR LF>
Requesting one particular job, pressing `Load job' command button	JOB strJobID<CR LF>	
Sending one particular job		<text file as described in Section 4.7.1>
Accepting job (file syntax and consistency o.k.), saving job as settings file	JOB strJobID OK<CR LF>	
Rejecting job (file syntax and consistency not o.k.)	JOB strJobID DENIED<CR LF>	
Advising of job start and estimated duration, before pre-run/centering starts	JOB strJobID STARTS DURATION: intHours:intMinutes<CR LF>	
Advising of job end, after job successfully completed	JOB strJobID SUCCESSFULLY ENDED<CR LF>	
Advising of job end due to program failure, after program aborted	JOB strJobID ABORTED<CR LF>	
Advising of job end due to 'Abort' command given by user	JOB strJobID ABORTED BY USER<CR LF>	

The output data, i.e. the measurement results, can be sent out via the serial communication port and processed on line by the LIMS. While the weighing process is running, **a5**control sends out the measurement data - without heading -, contained in the first four columns ('Time', `Measurement number', 'Place(s)' and 'Value') of the measurement data block of the report presented in Figure 15, for example:

```
22:02:19  00   sc              0     -0.00100<CR LF>
22:03:11  00   sc             a1   1000.00245<CR LF>
22:03:58  00   sc              0     -0.00150<CR LF>
22:08:30  010101A              a1   1000.00624<CR LF>
22:09:43  010101B              a8    999.99120<CR LF>
22:10:55  010101A              a1   1000.00590<CR LF>
...
01:22:10  01   sc              0     -0.00600<CR LF>
01:23:24  01   sc             a1    999.99820<CR LF>
01:24:38  01   sc              0     -0.00730<CR LF>
```

After the weighing process is successfully completed, **a5**control sends out via the serial port a final data block containing the corner load error, in mg, calculated for each measurement group. The block format is as follows:

```
CORNERLOAD decCrLd_err1[ decCrLd_err2[ decCrLd_err3[ …]]]<CR LF>
```

where 'decCrLd_err1' is the corner load error calculated for the first measurement group, 'decCrLd_err2' the corner load error calculated for the second measurement group etc. Should the error calculated for a particular group equal zero or not have been measured, the value indicated for the error is 'NO' or 'UNKNOWN' respectively. An example of a complete block is given below, advising of the following corner load errors: 0 for the first group, 0.00014 mg for the second group, -0.00013 mg for the third group and 'unknown' because not measured for the fourth and last group.

```
CORNERLOAD NO 0.00014 -0.00013 UNKNOWN<CR LF>
```

4.7.3 Upgrading **a5**control

To upgrade (see Figure 20) the **a5**control to the 'professional' one (optional; Down/-upward calibration), or to enable online climate data input (optional; Temperature, Relative humidity, Pressure), you need to purchase the software options separately.

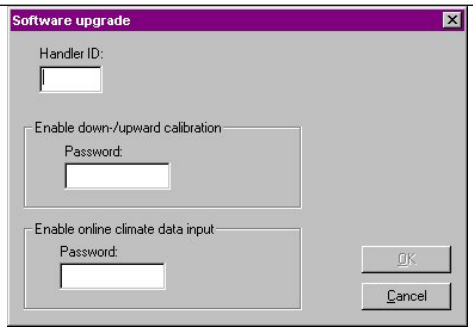


Figure 20 Upgrading the **a5**control software

5 Installation site

The **a5**comparator comprises the robot system and the micro-balance, which are both to be attached separately to the floor. For this purpose, the balance is installed on a separate bench, attached to the floor by 2 screws; the robot system itself needs, to be properly attached, 2 screws as well. Figure 19 shows the footprint of the **a5**comparator and defines the position of the holes which need to be drilled in the floor.

Besides, you need to ensure that at least 30 cm free space is available on both sides and at the back of the **a5**comparator; in the front the two doors which give access to the weighing chamber need at least 60 cm free space to open.

The weighing room should ideally

- be as insensitive as possible to shocks and vibrations
- have only one door (drafts)
- be as free from drafts as possible (important with air conditioning systems)
- be in the basement
- be well insulated
- contain as few heat sources as possible (it is better to locate all computers and other peripherals in an anteroom).

The room temperature should be between 17 and 27°C. Temperature fluctuations within minutes should be kept as small as possible. The air temperature should not change by more than +/- 0.5°C over one hour. Relatively large, long-term fluctuations (summer/winter) are entirely permissible.

The relative humidity should be between 40 and 70%. The relative humidity should not change by more than +/- 5% over one hour. Relatively large, long-term fluctuations (summer/winter) are entirely permissible.

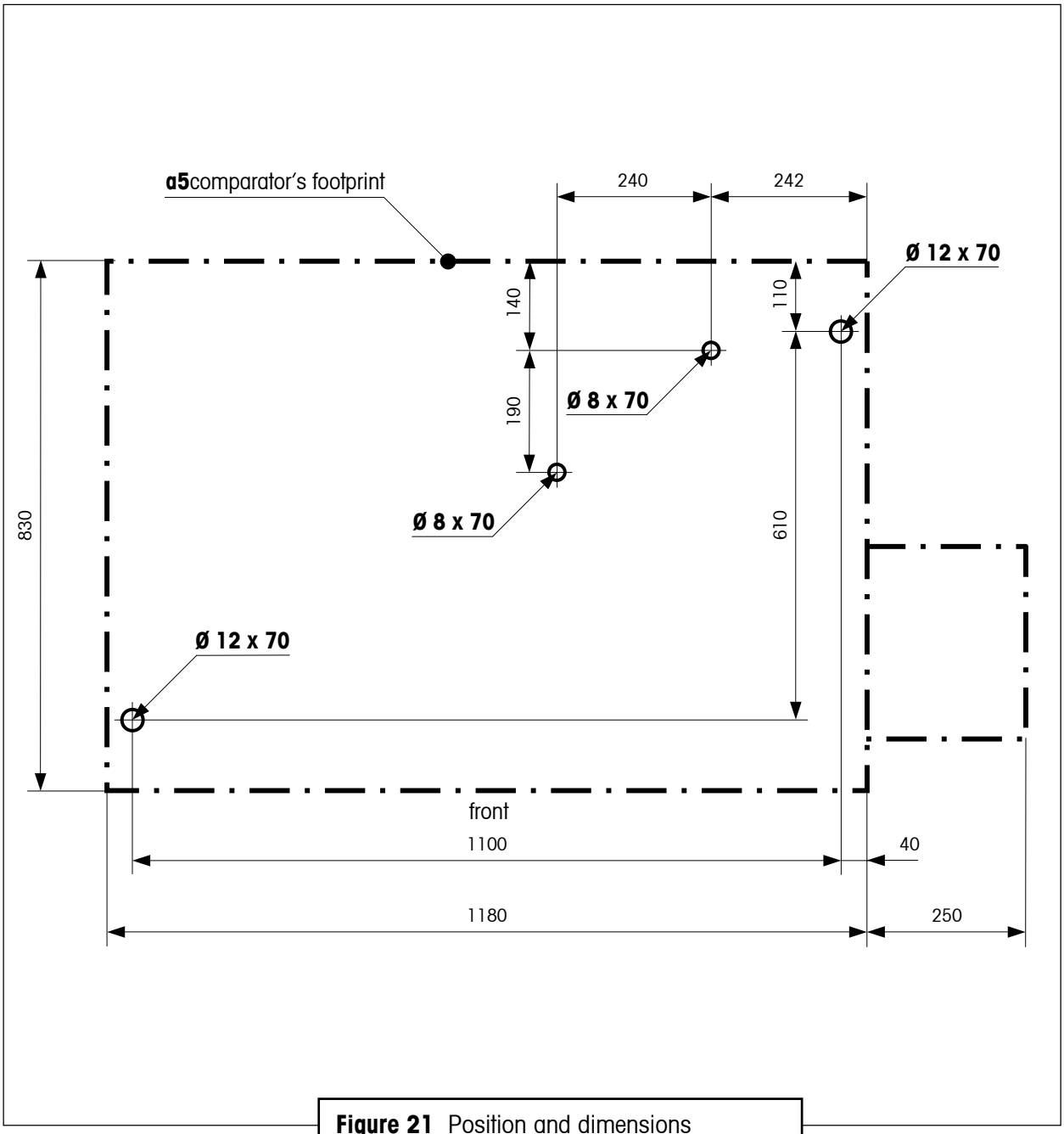


Figure 21 Position and dimensions of the holes for floor attachment

6 Technical data

Balance - METTLER TOLEDO UMX5 Comparator

Readability	0.1 µg
Maximum capacity	5.1 g
Electrical weighing range	5.1 g
Repeatability	Determined as standard deviation of 10 'one-vs.-one' comparative weighings, after drift elimination: @ 0-1 g: $s \leq 0.15$ µg @ 1-2 g: $s \leq 0.25$ µg @ 2-5 g: $s \leq 0.40$ µg
Linearity	± 4 µg, within 500 mg: ± 2 µg
Stabilisation time	10..20 s
Adjustment	Motorized adjustment of the electrical range at a keystroke (built-in 2 x 2.5 g adjustment weights) or adjustment by means of an external 5 g adjustment weight

Automated weight handler

Weight handler	For automatic determination of test weights, by direct comparison of one test weight with one standard, or, as an option, by down- / upward calibration - comparison between combinations of up to three weights, as described in '36-place weight magazine', Section 3
Measuring time (typical)	15 min. for a series of 5 'one-vs.-one' A-B-A comparative weighings, 30 min. for a series of 5 'three-vs.-one' A-B-A comparative weighings
Test weights / standards	Knob-, wire-, sheet-shaped weights (common shapes) with a nominal value of 1 mg - 5 g and geometry as described in '36-place weight magazine', Section 3
Weight magazine	36 places
Control software	Microsoft® Windows® -based **a5**control, compatible with Windows®95, Windows®98, WindowsNT® and WindowsXP®
Data interface	RS232C to controller

Technical data (cont'd)

Admissible ambient conditions

Temperature	17 - 27 °C (± 0.5 °C / hour)
Relative humidity	40 - 70 % (± 5 %)
Vibrations	A set-up in a "vibration-free" room is recommended
Overvoltage category	Class II
Degree of pollution	2

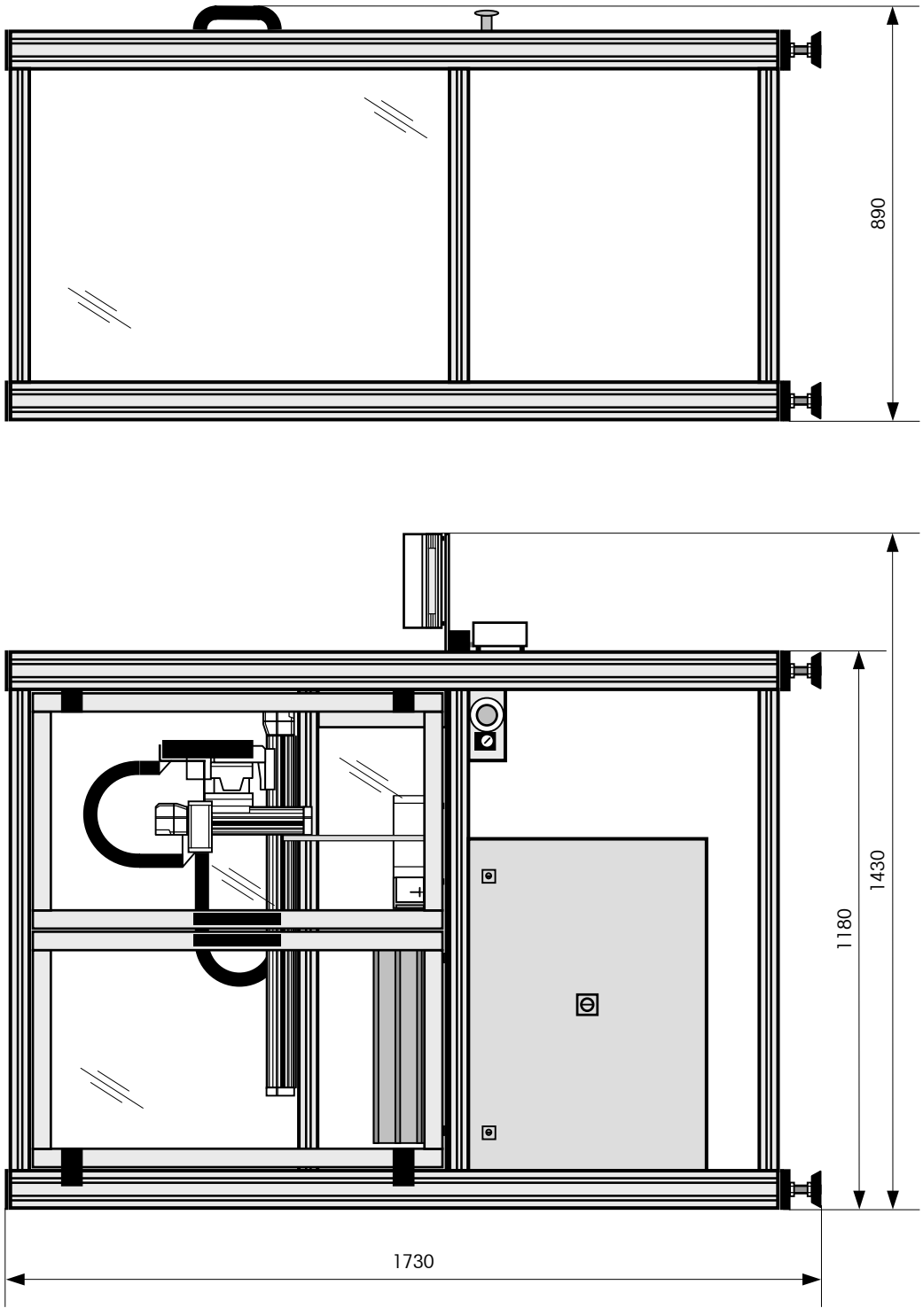
AC adapter

Voltage	
- Balance control unit	100-240V (-15%/+10 %), 0.7A
- Robot system control unit	115 V or 230 V (-20% - +15 %)
Frequency	
- Balance control unit	50 Hz / 60 Hz
- Robot system control unit	50 Hz / 60 Hz
Power consumption	
- Handler	150 VA max.

Dimensions (w x d x h) / net weight

Handler and balance	1430 x 890 x 1730 mm / 290 kg

7 Dimension drawing



This document (version 3.4, July 2003) is subject to technical changes.

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