Vacuscope Comfort 2.1
Milking Machine Test Device
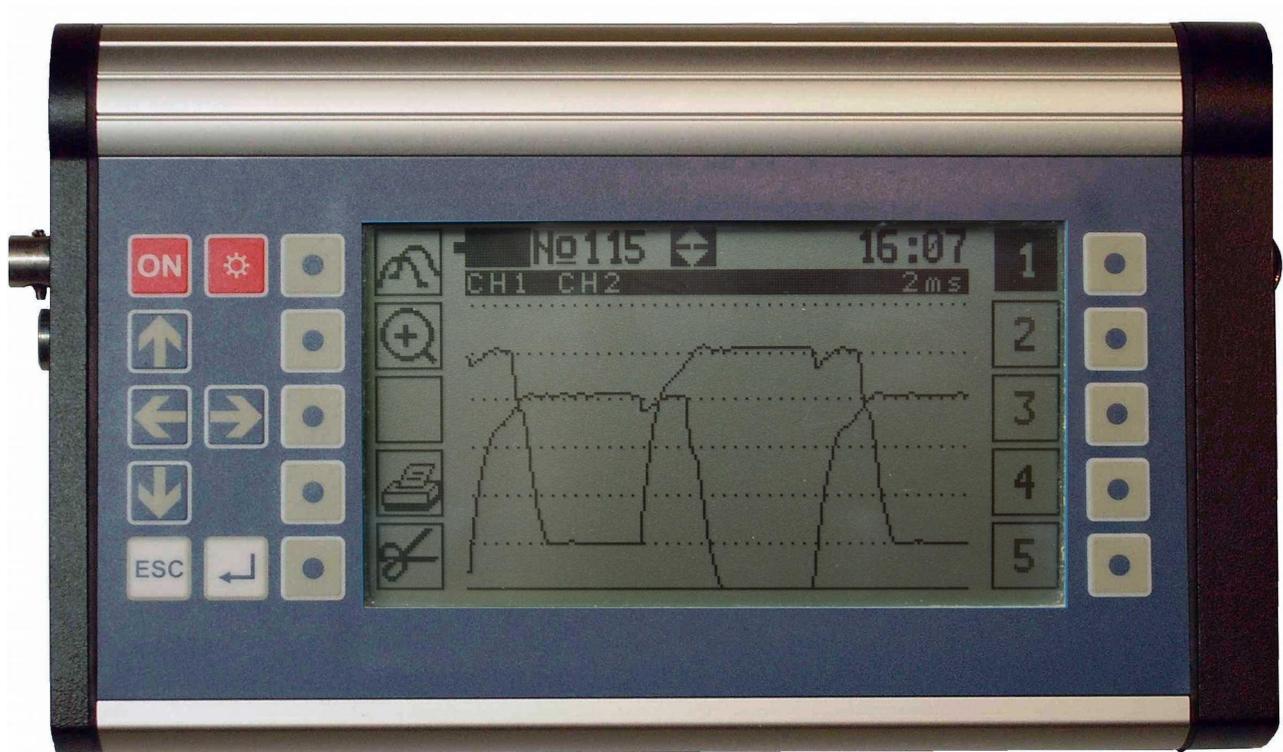
Manual
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Kraft & Butzke GmbH

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Foreword

Thank you for choosing our milking machine test device! You purchased an extraordinary powerful measuring instrument. Due to its two internal high-quality vacuum sensors, its two interfaces for external sensors and another interface for an optional air-flow meter the test device is suitable even for complex measuring tasks, as far as complete milking machine installation tests. Further outstanding features are the metal case which protects the electronics against dust entry and water jet, the big illuminated graphic screen, and the modern keyboard with ten variable function keys (soft keys). Theses features allow for an intuitive and quick operation.

Despite the easy use and the auxiliary information shown on-screen in many programs it is indispensable that you are familiar with the design of milking machine installations as well as with carrying out vacuum and air flow measurements. This applies in particular for the complex mechanical test of milking machine installations according to standards, such as ISO 6690.

We strongly recommend to **read this manual carefully before operating the device**, since only that way you can use its multifarious functions and avoid operating errors. Please note especially all common operating instructions (chapter 1), as the following chapters of this manual are based on these instructions.

Although this manual has been written with the utmost care we can **not guarantee** that all instructions given are completely accurate. Specifically in cases where the user is instructed to make physical adjustments to a milking machine installation itself.

Content

Figures

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1 Common Operating Instructions

The following chapter describes the design of the test device and explains those operations being uniform for all programs. Please read this chapter carefully, since the following chapters do only contain program specific operation instructions.

1.1 Operating Elements

In order to ensure an easy and quick operation the device is equipped with a big graphical screen, an intuitive to use navigation keyboard, and ten variable function keys. These control elements are shown in Figure 1 and explained in the following chapters. Please note that the battery compartment and the measuring ports located on the right side of the device can not be seen in this figure.

	1 Strap connection point
	2 Serial interface
	3 Navigation keys
	4 Function keys F1-F5
	5 Screen
	6 Function keys F6-F10
	7 Battery compartment
	8 Port 1 (internal)
	9 Port 2 (internal)
	10 Port 3 (external)
	11 Port 4 (external)
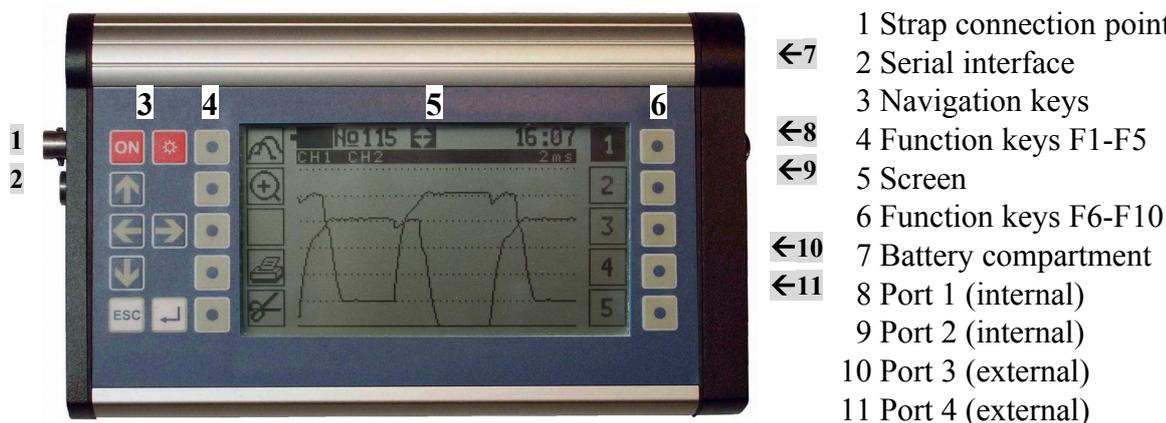
Figure 1:   Operating Elements

1.2 Initial Operation and Changing Batteries

Before using the device the first time or in case of insufficient power supply, insert either four new 1.5 Volt batteries (AAA) or four rechargeable batteries (NiMH) into the battery compartment as follows:

- Remove the battery compartment cap (see Figure 1) by twisting it anti-clockwise with a coin or screw driver.
- Hold one hand beneath the open battery compartment and turn the device to the right so that possibly contained batteries may slide into your hand.
- Turn the device to the left.
- Insert the new batteries gently into the battery compartment with their **positive poles ahead**.
- Close the battery compartment by twisting the cap clockwise and tightening it with a coin.

⚠	Insufficient tightening of the battery compartment cap causes power supply failures and therefore possibly data loss and device damages.

1.3 Switching On the Device and Screen Illumination

Carry out the following steps to switch on the device:

- Disconnect all possibly connected auxiliary devices, such as external probes, air-flow meter, printer or data cable.
- Disconnect possibly connected measuring hoses from the nozzles.

> ⚠ Switching on the device when connected to a pressure or vacuum source causes measurement failures.

- Push the **ON** key.
- Wait until the main menu is being displayed. During this waiting time the device adjusts its measuring system to the ambient atmospheric pressure.

In order to save battery power the screen light can be switched off and on again by repeatedly pushing the ☼ key.

> ⚠ A sufficient battery voltage is needed to illuminate the screen. If the voltage drops under a certain level, you may continue using the device without screen light.

1.4 Screen Design

The screen design is basically the same in all programs. As shown in Figure 2, five frames are displayed at each side of the screen. These frames symbolize the function keys located beside the screen (see Figure 1). Depending on the active program the frames show different symbols to indicate the current function of the keys beside. Further information is given in chapter 1.5.

S1	A	S6
S2		S7
S3	B	S8
S4		S9
S5		S10
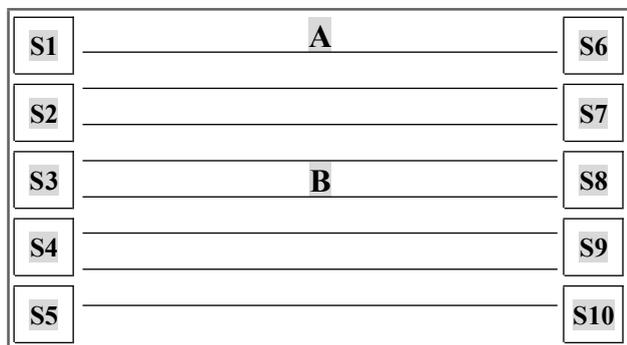
A Head line
B Data area
S Function key symbols (1-10)

Figure 2:   Principal Screen Design

The main part in the middle of the screen consists of one head line and eight data lines. The head line is used to show common information, such as remaining battery power and the current date. The data area beneath, on the other hand, is used to show menus and program data.

1.5 Use of the Function Keys

The current functions of the ten function keys **F1** to **F10** (see Figure 1) depend on the active pro-
gram. They are indicated by symbols shown at the two sides of the screen (see Figure 2). An empty
frame means that the corresponding key has currently no function. To carry out a function you just
have to push the key beside the corresponding symbol. For instance, during most measurements you
can save the current readings by pushing the function key beside the disk symbol. A complete over-
view of all function key symbols being used is given in Table 1.

Table 1:   Function Key Symbols

Symbol	Functions
�క	Change settings (in a separate window)
▶	Start measurement manually
■	Interrupt or terminate measurement
§	Open a window which shows limits or allows for entering limits
✓	Confirm or continue an action (e.g. data deletion)
✕	Abort an action
✎	Edit text, e.g. head-line
⋔	Change display-mode[1]
⊕	Change the scale of a graph by pushing the key repeatedly
🖶	Print current or saved readings
🖫	Save current readings
✂	Delete saved data
❄	Freeze the display and interrupt measurement
⬚	Display saved readings
PC	Transfer saved data to a PC
i	Show additional information

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[1]   Please find further information with the instructions for the relevant sub-programs.

1.6 Navigation in Menus and Program Windows

The different programs can be selected from different menus. In these menus as well as in program windows a dark cursor marks the currently selected menu item, data field respectively (see Figure 3). Push the key ⬆ or ⬇ until the cursor reaches the desired line to select a menu item or data field. If a menu has more than nine lines the screen content can be scrolled by using the arrow keys, so that hidden lines become visible. In this case arrows are shown in the relevant screen's headline.
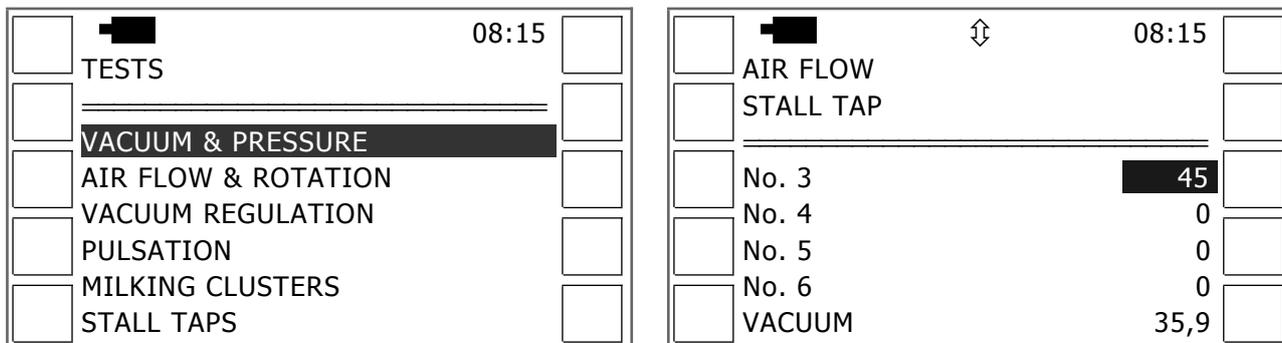
Figure 3:   Design of Menus and Program Windows

By pushing the ⏎ key a selected submenu will be opened or a program will be started. It can be stopped with saving the measured or entered data by using the function key beside the disk symbol. Pushing **ESC** does, however, stop a program without saving or leads back to a previous menu.

1.7 Data Entry via Keyboard

In some sub programs data has to be entered via keyboard. The relevant procedure is the same for all programs and being described in the following, using the entry of user data as an example. This entry is carried out in a window as shown in Figure 4, which is opened by pushing **F8** in the main menu and then selecting the relevant menu item.
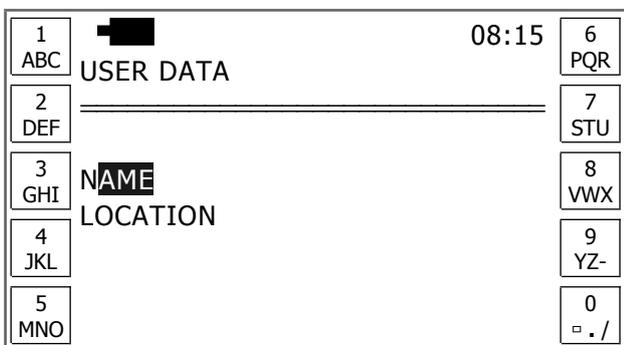
Figure 4:   Window to Enter Data

In the window shown above you have to activate the desired line first, by using the keys ⬆, ⬇ and ↵. Hereupon, the cursor starts blinking at that point where the first character has to be entered. Furthermore, the function keys provide an alphanumeric keyboard. The actual data entry has to be carried out as follows:

- Push one of the function keys as often until the desired character appears.
- Wait until the cursor moves to the right automatically.
- Alternatively you can move the cursor via the key ⬅ or ➡ to the previous or next entry field.
- Repeat the steps described above until you entered the desired text completely.
- Push ↵ to complete the entry or push **ESC** to abort without saving.
- Select the next line or close the window by pushing **ESC**.

1.8 Changing the Basic Settings

The basic settings can be altered **from within the main menu only**. Push the key beside the tool symbol (**F8**) to do so. Hereupon, a submenu is opened, from which the items shown in Table 2 can be selected. All settings and data entries are carried out in separate windows.

Table 2: Basic Settings

Menu item	Functions
Region / Регион	• Choose the dialogue language
Date and time	• Set date and time • Clock calibration (in a separate window via **F8**)
User data	• Enter user data in two lines, e.g. company and operator's name
Power management	• Set the interval after which the device switches off automatically if no key is being hit • Choose the battery type (by repeatedly pushing ')
Measuring units	• SI (international standard) or US (North American standard)
Data transfer	• Set the data-transfer-rate in 10 steps (the higher the figure the faster the data-transfer): Set a low rate if you have problems when transferring data [see also page 36]
Printer	• Choose the printer in use
Initialisation	• Access for trained staff only via PIN[2]

Unlike all other windows the window which is used to set date and time shows a tool symbol at the right edge. This indicates that you can open a separate window via **F8** which allows for calibrating the clock. Should the clock of your test device be slow push **F3** (+) within this calibration window. If your clock should run fast reduce its speed via **F8** (-). Pushing **F5** saves the current settings and closes the calibration window.

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[2] Close this submenu, using **ESC** if you opened it accidentally.

1.9 Printing, Data transfer, Deletion

All readings and additional information can be printed, transferred to a PC, or deleted. To do so, push the key beside the corresponding symbol (see Table 1). In some programs you also have to **specify the set of records** before you can carry out the desired function. For this purpose a window as shown in Figure 5 will be opened automatically.

Figure 5:   Window to Specify a Set of Records

In this window, first select the line beneath the head line and then push ⏎. Hereupon the first digit of the relevant entry field starts blinking (see Figure 5, right). Do now enter the first record number of the desired set of records by using the function keys and the keys ← and →. Complete the entry by pushing ⏎. Then enter the last record number of the desired set of records into the next line in the same way. Finally push **F2** to carry out the desired action (print-out, data transfer, deletion). Alternatively, you may abort the action by pushing **F5** (see Figure 5, left).

Please note that the last two lines of the above figure are shown for printing within the program *Short-term measurements* only. They allow for determining whether graphs and limits shall be printed (✓) or not (✗) by repeatedly pushing ⏎. Please observe also the following general rules for **printing**:

- Connect the printer to the serial interface of the test device (see Figure 1).

 Never use an interface cable other than that which has been delivered with the printer to avoid malfunctions and damages of printer and test device.

- Switch on the printer and set it ON LINE, if necessary (see printer manual).
- Push the key beside the printer symbol (usually **F4**) and specify the desired set of records where required, as described before.

1.10 Wet Measurements

With the test device described here you can carry out vacuum measurements in milking units or pipelines during milking ("Milking Time Tests") or the cleaning of the milking machine. Such wet measurements require the utmost care. In particular, the following instructions have to be observed:

> ⚠ **Prevent liquids** (especially milk) **from entering the test device or its external sensors** by appropriate measures. Clean all sensors used for any wet measurements immediately after completing such a measurement (see page 41).

1.11 Measuring with External Instruments

An air-flow meter is available as auxiliary equipment as well as external probes for measuring vacuum, pressure, revolutions, temperature, and voltage. Please observe the following instructions for all of these external instruments.

> ⚠ Always connect external instruments to the test device described here first and then to the relevant measuring point.

> ⚠ Connect external instruments to the designated interfaces of the test device only. Detailed instructions can be found in the following chapters.

> ⚠ When connecting external instruments, ensure that the data cable plug is connected tightly to the socket of the test device. Otherwise, data transfer failures and hardware damages may occur.

> ⚠ Disconnect all external instruments from the test device immediately after completing the measurement. Otherwise, battery power will be consumed, even after switching off the test device!

When using the optional revolution counter, please observe the following instructions and make all persons close to the revolution counter aware of these instructions.

> ⚠ Laser class 2 - Do not look into the laser beam. - Observe all applicable standards, safety regulations and the enclosed laser warning labels!

Specific instructions for the use of external instruments are to be found in the following chapters together with the explanation of the relevant measuring program.

1.12 Air Flow Measurements with Auxiliary Meters

According to the milking machine standard, high air flow rates should be distributed equally over the installation when testing big milking machines. For that purpose auxiliary air-flow meters shall be connected to different connection points within the installation. If you want to carry out air-flow measurements using such auxiliary meters, **you have to make the test device aware of the air flow rate admitted through auxiliary meters before starting the measurement**. To allow for that, in the relevant programs you can open a sub window via **F3** (*Air +*). There you have to enter the total air admittance through all auxiliary meters according to their scales.

⚠	Use auxiliary meters whose scales relate to a measuring vacuum of 50 kPa (14.75 iHg) only, since the test device described here automatically corrects all air-flow readings for vacuum.

1.13 Switching off the Device

Disconnect the test device from all auxiliary equipment, such as external instruments, air-flow meter, or micro printer, before switching it off.

⚠	If auxiliary equipment remains connected, the batteries may be drawn although the test device has been switched off.

The test device can be switched off from within the main menu only. Push **F3** (OFF) to do so.

2 Short-Term Measurements

The menu *Short-term measurement* contains five programs for analysing and graphical rendering of vacuum conditions in milking units. The readings of all of these programs may be saved in a common memory (200 records with four ports each) and may be displayed later by pushing **F1** (see chapter 2.6). After choosing a program one of the windows shown in Figure 6 will pop up.
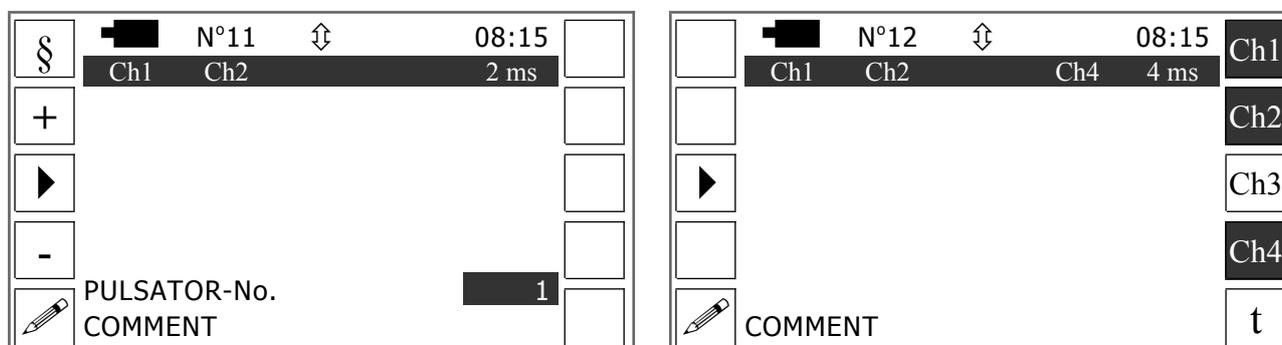
Figure 6:   Preferences-Window for Pulsator Tests or Other Short-Term Measurements

In such a window you can alter the number shown in the screen's headline by using the keys ⬆ and ⬇. That way you set the record-number for saving the following measurement.

> ⚠ Hold the arrow-keys for 5 seconds to open a field in line 1 which allows for entering the desired record number (see chapter 1.7).

In the program *Pulsation* **F1** (§) allows for opening a window in which you can enter limits (see page 12). Furthermore you can set the device-number of the tested pulsator (see Figure 6, left, second to last line) by pushing **F2** (+) and **F4** (-). This number does <u>not</u> necessarily have to be the same as the record-number shown in the headline. The test-device will automatically preset this number to the device-number saved the last time +1. The comment shown in the bottom line can be edited by pushing **F5** (✎).

This applies also to the other programs of the section *Short-Term Measurement*. For these you can also set which sensors will be used for the following measurement by pushing **F6** to **F9** (see Figure 6, right). Push the relevant key repeatedly to switch a port on or off. In this process the activation of a port is indicated immediately by the inversion of the colour of the symbol shown beside the key. Later all activated ports will also be listed at the upper screen edge.

> ⚠ In some programs the settings can be changed for certain measuring ports only. In none of the programs you can deactivate all ports at the same time.

Finally (apart from the program *Pulsation*) you can set the measuring or analysis interval by pushing **F10**. The possible intervals for the different programs can be found in Table 3.

Table 3:   Possible Intervals for Short-Term Measurements

Program	Possible Interval
Pulsation	2 Milliseconds (fix)
Fluctuation	2 - 50 Milliseconds
Range	40 - 400 Measurements per minute[3]
Cluster Vacuum	4 - 5 Milliseconds
Milking Analysis	8 - 10 Milliseconds

The lower the value set here the higher will be the resolution of the graphs. At the same time the period being displayed per page will be shorter. This period is 5.6 to 7 seconds for the programs *Cluster Vacuum* and *Milking Analysis*. The values for the other programs can be found in the appendix of this manual (see page 39). After all settings have been chosen the measurement can be started by pushing F3.

2.1 Pulsation

This program carries out pulsator tests according to the milking machine standard ISO 6690 by measuring and analysing the cyclic vacuum fluctuations in the teat cups caused by the pulsator. According to ISO 5707 a pulsation cycle comprises the phases shown in Table 4.

Table 4:   Pulsation Phases

Symbol	Phase	Teat cup vacuum
A	Evacuation phase	4 kPa to (Maximum teat cup vacuum – 4 kPa)[4]
B	Vacuum phase	above (Maximum teat cup vacuum – 4 kPa)
C	Aeration phase	(Maximum teat cup vacuum – 4 kPa) to 4 kPa
D	Compression phase	below 4 kPa

2.1.1 Test Procedure

Carry out the following steps to test pulsators:

- Plug the teat cups of all milking units.
- Put the milking machine with all milking units into operation.
- Connect measuring port 1 and 2 (see Figure 1) via T-pieces and measuring hoses to different short pulsator tubes of the milking unit being tested.
- Choose the program *Pulsation*.
- Set record-number and measurement parameters, if necessary (see Figure 6)
- Push **F3**.

After the completion of these steps, the device will measure the vacuum conditions in the teat cups and automatically deduce the pulsation rate and phase ratios. Should there be no proper pulsation this will be shown on the screen after a few seconds. Confirm the relevant message by pushing **F2**.

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[3]   This is the interval for the analyses. The basic measurements are carried out in far shorter intervals.

[4]   4 kPa ~ 1.18 iHg

Hereupon the device proceeds with displaying the readings as described in the following, but this without deducing pulsator phases.

2.1.2 Display of Test Results

Following the pulsator test the 1ˢᵗ page of readings (see Figure 7, left) is displayed automatically. This page shows the measuring settings (ports, interval) and below that the related chart. Its second X-axis can be moved by pushing **F1** repeatedly. That way it is either on the same level as the 1ˢᵗ X-axis (screen bottom) or 10 respectively 30 kPa (2,95 respectively 8,85 iHg) above. The meaning of the other function keys can be found in Table 1 (page 3).
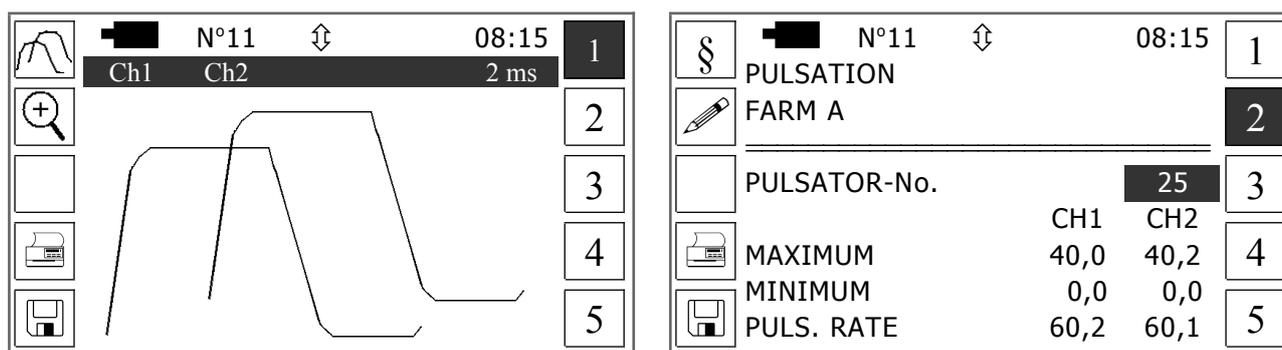
Figure 7: Display of Test Results in the Program Pulsation, Page1 & 2

Use the keys **F6** to **F10** to scroll between the chart and its tables. The first of these tables is shown on page 2. (see Figure 7, right). On this page you can open via **F1** a submenu which allows for editing the limits (see chapter 2.1.3). The key **F2** enables you to edit the text shown in line 2, and thus to use a clients name as headline, for instance. The serial-number of the tested pulsator shown in the line below can be changed by pushing ⏎ and then entering the desired number (see page 9). However, the displayed readings can neither be edited immediately after a pulsator test nor when displaying saved readings. This applies also for the pages 3 to 5, which are not shown in this manual. The only exception to this rule is the Comment-line on page 5.

2.1.3 Limits

Following a pulsator test and when displaying saved records the test results are compared to limits. These have to be defined either before testing or when displaying the test results. In order to do that, push **F1** (§) in the window as shown in Figure 6 or on page 2 to 4 when displaying test results. Following this a window as shown in Figure 8 will open. Here you can enter the desired limits.

```
            I              II           III
  1  ┌──┐ ┌──────────────────────────────┐ ┌──┐
     │  │ │  ▄▄▄▄        ⇕        08:15  │ │  │
  2  ├──┤ │ LIMITS                       │ ├──┤
     │  │ │ ═══════════════════════════  │ │  │
  3  │ i│ │                              │ │  │
  4  ├──┤ │ MAXIMUM            ≥    40,0 │ ├──┤
  5  │  │ │ MINIMUM            ≤     0,0 │ │  │
  6  ├──┤ │ P.-RATE      060   ±      3  │ ├──┤
  7  │  │ │ LIMPING %          ≤     5,0 │ │  │
  8  ├──┤ │ A+B [%]      65,0  ±     5,0 │ ├──┤
  9  │  │ │ A [%]     ≤  15,0  (150 ms)  │ │  │
 10        B [%]     ≥  50,0  (500 ms)
 11        C [%]     ≤  25,0  (250 ms)
 12        D [%]     ≥  10,0  (100 ms)
```

Figure 8:   Window to Enter Limits in the Program Pulsation

Note the following when entering limits:

- Enter the desired maximum and minimum vacuum into column III of line 4 and 5.
- Line 6 is designed to enter the desired pulsation rate (column II) as well as the allowed aberrance (column III).
- Use line 7 to enter the allowed limping (difference between the two pulsation ratios, expressed as percentage).
- Alike line 6, line 8 is used to enter the desired pulsation ratio (column II) and the allowed aberrance (column III).
- Finally, the limits for the B-phase and the D-phase have to be entered into column II of line 10 and 12.
- No entries have to be made in line 9 and 11 (A- and C-Phase), since the device deduces the values shown here from the values entered before (pulsation rate, B- and D-phase).
- Push **F2** to show the measuring-units
- Push **ESC** to complete the entry and to save all limits automatically.

2.2 Fluctuation

This program is designed for testing the fast changing vacuum conditions which are usually found in a milking unit's pulsation chambers during a pre-stimulation phase or the main milking phase, for example. Before the measurement can be started the chosen measuring ports have to be connected to the vacuum source(s) under test. Please note in this context that the graphical rendering of readings is arranged according to to the vacuum conditions on port 1. For this reason **always connect port 1 to the pulsation chamber when recording the vacuum conditions during milking or stimulation.** With start of the measurement a window as shown in Figure 9 will be opened. In this the current measuring values of all activated ports are displayed immediately. As soon as the graphs have reached the right edge of the screen, the pulsation rate for port 1 will be shown and below that the maximum, average and minimum for all active ports. Following this, a new measurement will be started automatically and the display will be updated, beginning from the left.
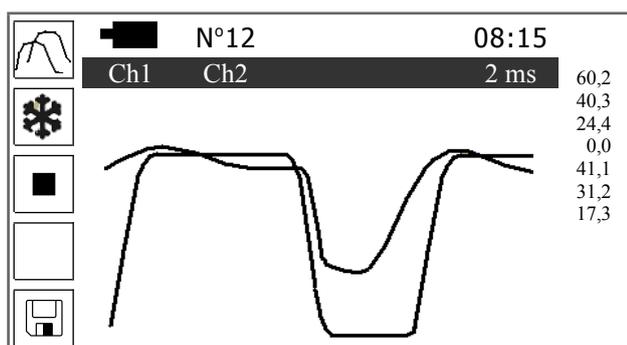
Figure 9:   Window for Fluctuation Measurements

Push **F1** repeatedly to choose one of the following viewing modes:
- All graphs share a common base line
- X-axis for port 2 is 10 kPa (2.95 iHg) above the base line
- Graph for port 2 being displayed in the upper screen-half, graph for port 1 as well as 3 & 4 (if in use) shown in the bottom half.

By pushing **F2** during a measurement you can stop the continuous curve update ("Freezing the display"). To restart measurement and curve drawing, push **F2** again. A measurement may be terminated by pushing either **F3** or **ESC**. Push **F5** to save current readings.

2.3 Range

Though the program described here does carry out continuous vacuum measurements with one port of the user's choice, it takes only the maximum and minimum values of the single measurement intervals as lasting readings. The extent of these intervals depends on the measurement frequency which has to be set by the user before the start of measurement. The applied method of measurement enables you to analyse the vacuum conditions in a liner's head for an entire milking process, for example. Following the program start, a measuring window will be opened. Its design and use is almost the same as for the program *Fluctuation* (see Figure 9). However, the measurement will be terminated automatically once the curves have reached the right screen edge. It may also be interrupted by pushing **F3** (■) or aborted by pushing **F5** (with saving) or **ESC** (without saving).

2.4 Cluster Vacuum

This program allows for carrying out so-called wet measurements (milking time tests) according to the guidelines of the international milking machine standard ISO 6690:2007. Here you can take continuous vacuum measurements during milking on up to 4 ports for as long as you want. The program *Cluster Vacuum,* unlike the program *Long-Term Measurements*, does not automatically save all values of a continuous measurement. Instead, you can record single phases of a milking process. The number of such "snapshots" is limited by the data transfer rate of the tester and its memory capacity only. Theoretically, you can save up to 200 phases of a milking process. However, according

to scientific findings it is sufficient to save just a few typical phases (e.g. beginning milk flow, peak flow, declining flow and minimum milk flow).

Saved readings may be shown on the display of the test device, printed out, or transferred to a PC. In all three cases, not only graphs will be shown but also the automatically calculated maximum-, mean-, and minimum values for the B-phase, D-phase and the entire pulsation cycles.

> ⚠ Please note that the **maximum- and minimum values** are not absolute values but **damped values** according to the milking machine standard ISO 6690.

The practical implementation of such measurements requires great care, such as the use of appropriate equipment and the correct connection to the measuring points. The required knowledge is available in relevant literature. It is not provided in this manual but assumed as existing. The measuring ports have to be used in the program *Cluster Vacuum* always as follows:

- Port 1: Pulsation chamber, using a T-piece according to ISO 6690
- Port 2: Short milk tube (standard) or claw
- Port 3: Claw or long milk tube or inactive
- Port 4: Milk line or inactive

In this program the measured values are displayed during a measurement on the screen of the tester as curves. Once these curves have reached the right edge of the screen, the display will be updated automatically, beginning from the left. Push **F5** to save the currently displayed readings. In this case the measurement will be continued until the curves have reached the right edge of the screen. Then the entire screen content will be saved and the measurement will be resumed. In order to terminate the measurement, press either **F3** or **ESC**.

2.5 Milking Analysis

This program allows for testing pulsation on two ports while simultaneously measuring vacuum on two other ports. It corresponds largely to the program *Cluster Vacuum*. In particular, in this program the shown **maximum and minimum values are** also not absolute values, but **damped values** according to the milking machine standard ISO 6690. Different are, however, the possible measurement intervals (see Table 3) and the use of the measuring ports. This is always as follows:

- Port 1& 2: Pulsation chamber, using a T-piece according to ISO 6690
- Port 3: Claw piece or milk tube
- Port 4: Milk tube or milk line or inactive

2.6 Display of Saved Readings

Saved readings can be displayed on the test device's screen by pushing **F1** in the program menu. Hereupon the last record saved will be displayed as shown in Figure 10.
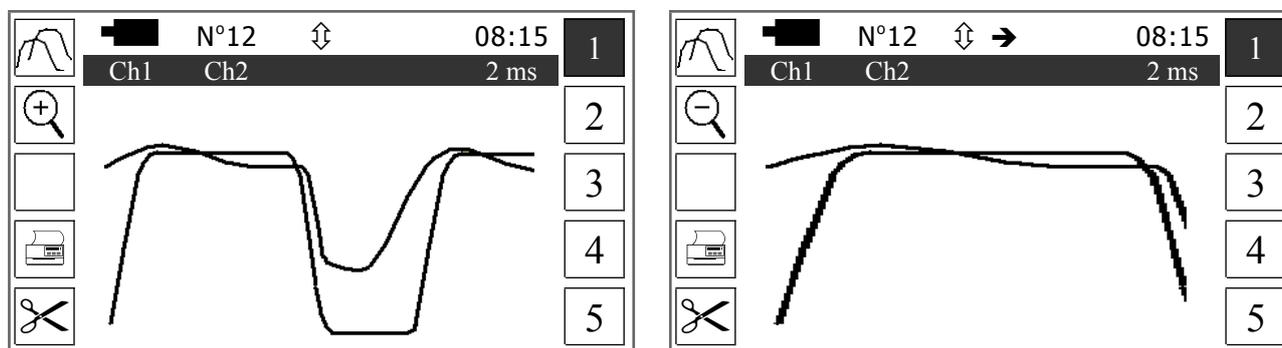
Figure 10:   Display of Saved Short-Term Measurements

The screen design is largely the same as for the relevant measuring windows. However, the **function keys** are used in a different way. For example, you can change the graphical resolution when displaying saved readings only, but not during a measurement. To do so, push **F2** and the shown chart will be split into two parallel sections (see Figure 10). You can move between these sections using the keys ⬅ and ➡. The device indicates the hidden graphic section by an arrow shown in line 1 (see Figure 10, right window). The records can be edited largely the same way as in the relevant measuring windows (see chapter 2.1 - 2.5). For instance, the comments can be changed for all saved records and it is also possible to change the pulsator number when viewing saved results. This, however, not by using the keys **F3** and **F8** but by pushing ↵ and then using the virtual keyboard.

3 Long-Term Measurements

The program described here has been designed to test pressure and temperature conditions in pipelines. With the possibility of a simultaneous 4-port measurement it is particularly suitable for checking the cleaning parameters of milking machines. Following the program start an <u>index</u> as shown in Figure 11 (left) is opened. This shows for saved measurements their first record number, date, and time. If there is memory-capacity for further measurements left, at the end of the index *NEXT* will be shown and beside this the number of the first free record.
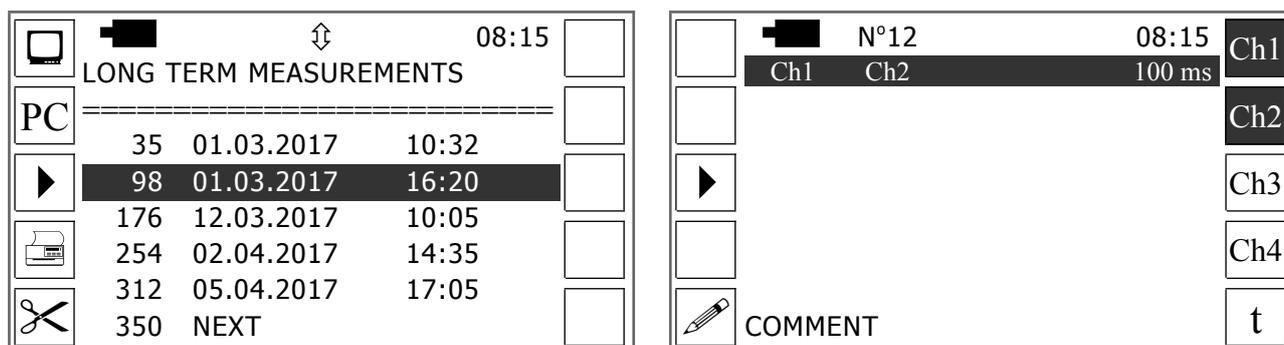
Figure 11:   Index & Preferences-Window for Long-Term Measurements

The results of previous measurements contained in the memory can be either displayed, transferred to a PC, printed, or deleted by using the keys **F1**, **F2**, **F4**, **F5** respectively. Choose the desired set of records before pushing the desired function key.

When <u>displaying saved readings</u>, please also keep in mind that not only you can scroll between the pages manually by pushing the keys ← and → but also automatically by pushing **F1** (◀◀) or **F6** (▶▶) once. Furthermore you can show the first or last page of a saved measurement by pushing **F2** or **F7**. Finally, on the last page of each set of records **F7** (2) allows for showing date, time, and the units of the corresponding measurement as well as editing the comment-line.

In order to start a <u>new measurement</u> push **F3** in the index-window. If you do so while the cursor is in the bottom line (*NEXT*) the new readings will be added behind the already saved ones. In all other cases the previously saved readings will be overwritten from that record-number on, which is highlighted by the cursor.

> ⚠ When overwriting the results of a measurement, the results of following measurements can be deleted without prior notification!

After activating the measurement mode, a window will be opened in which the measuring ports (1 to 4) and the desired measuring interval (25 to 500 milliseconds) can be set (see Figure 11, right). Furthermore this window allows for editing the comment by pushing **F5**.

If all settings have been made push **F3** again to actually start the measurement. Hereupon, a measuring window will appear which displays the current readings graphically as well as numerically. Analogously to the *Short-Term Measurements* a current measurement may be frozen and resumed by pushing **F2** and terminated by pushing **F3**. However, the option for saving manually via function-keys is missing since the readings are saved automatically in the program *Long-Term Measurement*.

4 Single Measurements

Though the eight sub-programs described in this chapter carry out continuous measurements, except for the last subprogram (*Vacuum regulation*) there will be no saved rows of consecutive readings but only single values. You can save 20 independent readings for each of the first seven sub-programs. This allows for recording snapshots, like a milking machine's system vacuum after fixing its regulator.

4.1 Design of the Measuring Windows

Despite the different measuring purposes of the single programs the design of their measuring windows is largely the same. Figure 12 shows the details. As can be seen, each record is displayed individually. In doing so, the measured value is shown in the middle of the screen using big digits. The corresponding record number is shown in the headline. It can be set by pushing ⬆ or ⬇.
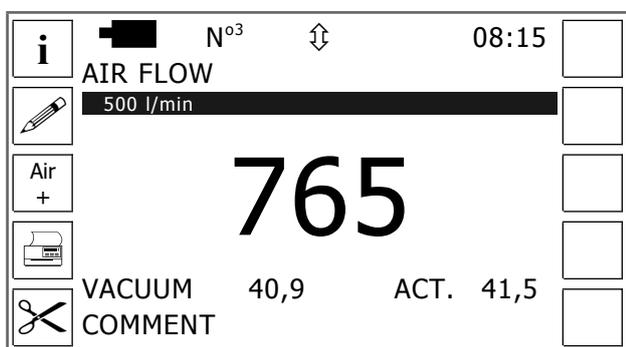
Figure 12: Windows for Single Measurements

The key **F2** allows for editing the text, shown in the bottom line (*Comment*). The second to last line is used in the programs *Air admission*, *Air flow* and *Revolutions* only. It serves to show the vacuum difference between the beginning and end of the measurement (*Air admission*), the current and most recently saved vacuum respectively (*Air flow & Revolutions*).

4.2 Test Procedure

To take a Single Measurement carry out the steps described in chapters 4.2.1 - 4.2.6 first. Then set the record number and push ⏎. Hereupon, the current reading will be displayed instead of the latest saved one. The current reading may be saved by pushing **F5** which also completes the measurement automatically. Alternatively, the measurement can be ended without saving by using **ESC**.

4.2.1 Vacuum & Pressure

The main purpose of these programs is to carry out independent vacuum or pressure measurements in the pipelines of milking machine installations to record the conditions after maintenance work, for example. Carry out such measurements as follows:

- Put the milking machine into operation.
- Connect measuring port 1 (see Figure 1) to the desired measuring point.
- Open the measuring window and select the desired record number.
- Start the measurement.
- Wait for consistent reading and save it.

4.2.2 Air Admission

Before measuring, set the following parameters by pushing **F8** to **F10**:

- Altitude (0-2200 m or 0-7200 feet)
- Ambient atmospheric pressure[5] (953-1053 hPa or 28.12-31.05 iHg)
- Volume of the measuring vessel (10-30 l or 2.60-7.90 gallons)[6]

The further steps of the measurement have to be carried out as described in the appendix of this manual (see page 39).

4.2.3 Air Flow

Air flow measurements can be carried out in connection with a separately available air-flow meter only. Design and operation of this meter are described in its manual. Take air flow measurements as follows:

- Connect the air-flow meter to the serial interface of the test device.
- Connect measuring port 1 and the air-flow meter to the milking machine's connection point.
- Open the measuring window.
- If relevant, push **F3** and enter the air admission through possibly connected auxiliary meters (see page 8).
- Select the desired record number.
- Start the measurement.
- Open the air-flow meter's air vent until the current vacuum (see Figure 12, line 8) equals the rated vacuum and save the reading.

---

[5] The ambient atmospheric pressure may be taken from a barometer, newspaper or the internet.
[6] You can't enter lower or higher values, since according to ISO 6690 the measurement shall be carried out with a vessel having of a volume of about 20 litres (5.28 gallons). A significantly different volume would cause failures.

4.2.4 Revolutions

The program introduced here serves mainly to measure the revolutions at vacuum pump engines. For this purpose, an external infrared sensor has to be used, which is available as ancillary equipment. Special reflectors will be delivered together with this probe. The measurement procedure is as follows:

- Switch off the vacuum pump.
- Attach a reflector of 20 mm minimum width to the pump engine's rotor disc.
- Connect the revolution sensor to the serial interface.
- Connect port 1 to the vacuum measuring point of the vacuum pump.
- Switch on the vacuum pump.

⚠	Body parts (e.g. hair), clothes, and other items must not touch the rotating shaft! RISK OF INJURY!

- Open the measuring window and select the desired record number.
- Start the measurement.
- Point the infrared ray from a distance of ca. 20-30 cm (~ 8-12 inches) towards the rotating reflector. Observe the laser warning instructions (see chapter 1.11)!
- Wait for consistent reading and save it.

4.2.5 Temperature

You can carry out temperature measurements with this test device in connection with a separately available temperature probe. Carry out the measurements as follows:

- Connect the temperature probe to port 4.
- Attach the head of the probe to the measuring medium.

⚠	Never touch extremely hot or cold surfaces or liquids! RISK OF INJURY!

- Open the measuring window and select the desired record number.
- Start the measurement.
- Wait for consistent reading and save it.

4.2.6 Voltage

A probe to measure direct current voltage of 30 Volts at the most is available as ancillary equipment. That way you can check the function of electrical pulsator valves, for example. Take such measurements as follows:

- Connect the volt meter to port 4.
- Connect the red volt meter cable to the positive pole of the measuring object.

⚠	In order to avoid injuries or damages to the test equipment, the volt meter must be connected to direct current voltage sources of 30 Volts at the most only!

- Connect the black volt meter cable to the negative pole of the measuring object.
- Open the measuring window and select the desired record number.
- Start the measurement.
- Wait for consistent reading and save it.

4.2.7 Vacuum Regulation

This sub-program allows for testing the vacuum regulation of a milking machine according to the international milking machine standard ISO 6690:2007 outside the program *Installation Test*. The way of testing is the same for both programs and described from page 26 on.

5 Installation Test

The program described in the following allows for carrying out mechanical tests on milking machine installations according to ISO 6690 or based upon the guidelines of the US-American „National Mastitis Council" (NMC). Despite the clearly arranged measuring windows, the optional display of instructions, and the automatic calculation of all rated vacuum levels needed during testing, it is indispensable that you are familiar with the technical basics of milking machine tests, e.g. the location of the meter connection points. Please keep also in mind that although the following four chapters primarily relate to milking machine tests according to ISO 6690, they do in principle apply to other standards as well. Therefore, please read this common information completely before studying the specific instructions for tests outside ISO 6690. These are to be found from page 32 on.

5.1 Index & Program Menu

Upon start of the program an index-menu appears which offers the records of 10 milking machines for selection. Each label can be changed via **F2** (✎) to assign a meaningful name for each milking machine. The program menu shown in Figure 13 will appear after activation of a record.
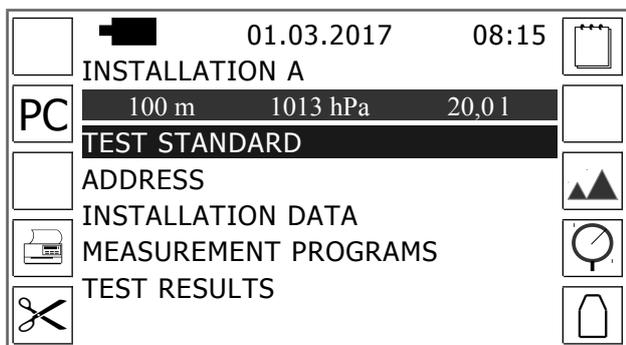
Figure 13:   Program Menu for Installation Tests

The menu shown above allows for making several settings on which the following measurements and the test report are based, namely as follows:

- **F6** = Date of the test: The date is shown in the headline of the menu, printed onto the report, and transferred to any PC.
- **F8** = Altitude above see level: Depending on the chosen units of measurement (see page 5) you can enter values up to 2200 meter or 7200 foot.
- **F9** = Atmospheric pressure at the time of the test: In accordance with the measuring units you can enter values between 953 and 1.053 *Hectopascal* (hPa) or 28.12 and 31.05 *Inches of mercury*.
- **F10** = Volume of the test can which is used for measuring the air admission into clusters (see page 27 & 39). Depending on the measuring units you can enter values between 10 and 30 litres or 2.60 and 7.90 gallons.

After all settings have been made you have to choose the desired test-standard. For this purpose select the first entry from the above menu. Hereupon, a window will open in which you can make

your choice. However, the 2. menu item opens a window in which you can enter any address. This will be printed onto the test report, and transferred to any PC.

5.2 Installation Data

The 3. menu item leads you to a submenu from which you can open windows that allow for entering the following test-relevant installation data:

- **Identification number** for the farm and report, if desired[7]
- **Type** of installation[7] (*Parlour*, *Pipeline*[8], *Bucket* or *Can*)
- Number of **Devices**: <u>Vacuum pumps</u> (1-3), <u>Milk systems</u>[7] (1-3), <u>Milking units</u> (1-100)
- Nominal capacity of the **Vacuum pump(s)**: <u>Air flow</u> at 50 kPa or 14.75 iHg (0 bis 8500 l/min or 0 bis 299.99 cfm), <u>Revolutions</u> of engine[7], <u>Back pressure</u> in the exhaust[7]
- Location of **Connection point *A2*** [7, 9] (*Vacuum regulator* or *Vacuum pump*)
- Air flow in the **Stall tap**[7, 10]
- Nominal capacity of the **Milking units**: <u>Pulsation rate</u> (50-180 Cycles/min), <u>Pulsation ratio</u> (50-75 %), <u>Air flow</u>[7, 11], <u>Air consumption</u>[7, 12], <u>Shut-off valve</u>[7] (*YES* or *NO*)
- **Air admission** of several components as stated by the manufacturer[13]
- Air consumption of **Ancillary equipment**[14]

5.3 Measuring Programs

The order of the measuring programs depends on the parameters and components to be tested. Please carry out the tests in the same order. Elsewise the device can't correctly show the rated vacuum levels needed during testing.

5.3.1 Vacuum & Pressure

The windows for vacuum and pressure measurements according to ISO 6690 are shown in Figure 14. In each window, the name of the measurement is shown below the headline as it is also used in the test report. The following lines show the connection points to be used, and the measured values. These lines usually show the latest saved value. Only during a measurement, the current reading will be shown. In addition to that the bottom line of window 4 shows the vacuum level that has to be obtained by adjusting the air-flow meter's air vent.

---

[7]   This field is provided for tests according to ISO 6690 only.

[8]   This choice has to be made for stanchion barns only.

[9]   This is the air-flow meter connection point in the main air line (see ISO 5707).

[10]   = Air flow capacity of stall taps as stated by the manufacturer

[11]   = Air flow capacity of the long milk tube as stated by the manufacturer

[12]   = Air admittance through a fallen off milking unit as stated by the manufacturer

[13]   This field is provided for tests according to NMC-Guidelines only.

[14]   Enter the air demand for vacuum powered devices being usually operated during milking but not during testing. When creating the test report, the device will subtract the sum of the entries made here from the measured reserve air capacity to calculate the effective reserve.

```
┌─────────────────────────────┬───┐
│  ▬▬          08:15          │ 1 │
│  SYSTEM VACUUM              ├───┤
│ i ════════════════════════ │ 2 │
│  ON VACUUM GAUGE      40,0  ├───┤
│  NEAR VACUUM GAUGE    40,3  │ 3 │
│  MILK SYSTEM (Vm)     39,8  ├───┤
│                            │ 4 │
│                            ├───┤
│                            │   │
└─────────────────────────────┴───┘
```

```
┌─────────────────────────────┬───┐
│  ▬▬          08:15          │ 1 │
│  WORKING VACUUM             ├───┤
│  ════════════════════════  │ 2 │
│  MILK SYSTEM (Vm)     39,7  ├───┤
│  REGULATOR            40,0  │ 3 │
│  VACUUM PUMP          40,2  ├───┤
│                            │ 4 │
│                            ├───┤
│  💾                        │   │
└─────────────────────────────┴───┘
```

```
┌─────────────────────────────┬───┐
│  ▬▬          08:15          │ 1 │
│  BACK PRESSURE              ├───┤
│ i ════════════════════════ │ 2 │
│  VACUUM PUMP 1         0,5  ├───┤
│  VACUUM PUMP 2         1,2  │ 3 │
│  VACUUM PUMP 3         2,4  ├───┤
│                            │ 4 │
│                            ├───┤
│                            │   │
└─────────────────────────────┴───┘
```

```
┌─────────────────────────────┬───┐
│  ▬▬          08:15          │ 1 │
│  VACUUM AT AIR FLOW         ├───┤
│ i ════════════════════════ │ 2 │
│  MILK SYSTEM 1        37,7  ├───┤
│  MILK SYSTEM 2        37,8  │ 3 │
│  MILK SYSTEM 3        37,9  ├───┤
│  REGULATOR (Vr)       38,4  │ 4 │
│  VACUUM PUMP (Vp)     39,1  ├───┤
│  DESIRED VACUUM       37,7  │   │
└─────────────────────────────┴───┘
```

Figure 14: Window for Vacuum- and Pressure Measurements according to ISO 6690

The procedure for vacuum and pressure measurements is basically the same for all shown sections, namely as follows:

- Open the desired measuring window and select the desired line.
- Adjust the milking machine according to test standard (e.g. put milking units into operation)[15]
- Connect port 1 to the installation's connection point.
- Start the measurement[16].
- When measuring the vacuum with air flow in milking system No. 1: Open the air-flow meter's air vent until the actual vacuum equals the desired vacuum.
- Save the reading via **F5** or abort the measurement via **ESC**.

---

[15] Further information can be obtained via **F1**.
[16] When checking the plant vacuum gauge, a vacuum measurement won't be activated but rather a procedure to enter numbers via keyboard. Read the gauge's display and enter the value via keyboard.

5.3.2 Air Flow

Air flow measurements according to ISO 6690 are carried out in two windows. The design of these windows is shown in Figure 15 for both, an ongoing measurement (left) and the idle mode (right). In both air flow measuring windows the headlines show where to connect the air-flow meter (connection point *A1* or *A2* or vacuum pump). How much air is admitted through auxiliary air flow meters in addition to the actual air flow meter is shown below the headlines. You must make the milking machine test device aware of such an additional air admittance <u>before</u> starting the measurement. In order to do this, push **F3** and then enter the total air admittance of all connected auxiliary air flow meters (related to 50 kPa / 14.75 iHg, see page 8).

```
┌──────────────────────────────┐   ┌──────────────────────────────┐  ┌───┐
│        ▬▬▬    ⇕      08:15    │   │        ▬▬▬    ⇕      08:15    │  │ 1 │
│   AIR FLOW A1                 │   │   AIR FLOW A2/VP              │  └───┘
│   ▐ 0 l/min               ▌   │ i │   ▐ 2000 l/min           ▌    │  ┌───┐
│   RESERVE CAPACITY     2448   │   │   WITH MILK. UNITS     2390   │  │ 2 │
│   WITH REGULATOR       2470   │AIR│   WITHOUT M. UNITS    ▐3448▌  │  └───┘
│   WITHOUT REGULATOR    2475   │ + │   WO. MILK SYSTEM      3490   │  ┌───┐
│   MANUAL RESERVE       2460   │   │   PUMP 1         1586  2001   │  │ 3 │
│   ALL UNITS PLUGGED    1720   │   │   PUMP 2          991  1250   │  └───┘
│ 🖫 1 UNIT OPEN           640   │   │   PUMP 3          595   750   │
│   ------- VACUUM AT Vm ------ │   │   -------- VACUUM AT Vr ----- │
│     LIMIT: 37,7   ACT: 37,8   │   │     LIMIT: 40,0   ACT: 0,0    │
└──────────────────────────────┘   └──────────────────────────────┘
```
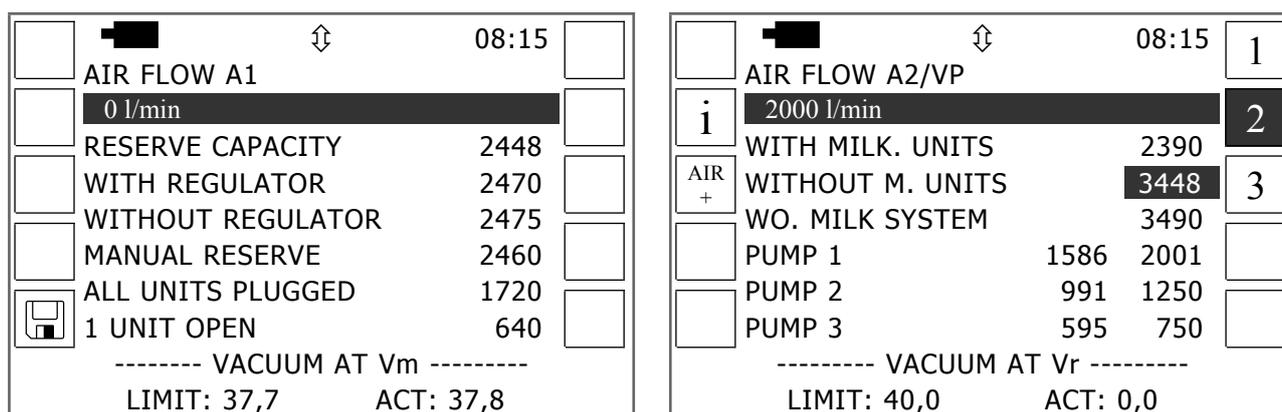
Figure 15:   Window for Air Flow Measurements according to ISO 6690

The lines following the info-line contain the measuring fields. These usually show the latest saved readings. Only during measurements, the current air flow rate will be shown instead. Below the measuring lines you can see where to measure the vacuum during the air flow measurement (*Vm, Vr* or *Vp*). The bottom line displays both the vacuum level to be obtained by adjusting the air vent (LIMIT) as well as the actual vacuum currently measured on port 1 (ACT).

When using the test device described here, air flow measurements according to ISO 6690 have to be carried out as follows:

- Open the desired measuring window.
- Select the desired line, and for measurement on the vacuum pump also the desired field (see window 2)
- Connect the air-flow meter to the measuring point (see headline of the relevant window) and to the serial interface of the test device.
- Connect measuring port 1 to the vacuum measuring point (see line second to last).
- Put the milking machine into operation as shown in the desired measuring line (e.g. switch on the vacuum pump and connect the regulator), further information can be obtained via **F1**.
- Start the measurement
- Adjust the air-flow meter's air vent until the two vacuum readings shown in the bottom line equal each other.

- Save the reading via **F5** or abort the measurement via **ESC**.

5.3.3 Revolutions

The measurement of revolutions according to ISO 6690 has to be carried out as follows:

- If not done yet: Attach a reflector of 20 mm minimum width to the rotor disc of the pump. In this context the vacuum pump has to be switched off.

> ⚠️ Body parts (e.g. hair), clothes, and other items must not touch the rotating shaft!
> RISK OF INJURY!

- Connect the revolution probe to the serial interface.
- Connect port 1 to the vacuum measuring point of the vacuum pump.
- If not done yet: Connect the air flow meter with far opened air vents to the vacuum pump
- Open window 3 of the section *Air flow & Rotation* and (if testing on installations with several vacuum pumps) select the desired line
- Start the vacuum pump and the measurement
- Set the vacuum to 50.0 kPa or 14.75 iHg (see bottom line of the measuring window) by adjusting the air-flow meter's air vents.
- Point the infrared ray from a distance of ca. 20-30 cm (~ 8-12 inch) towards the rotating reflector. Follow the laser warning instructions (see chapter 1.11)!
- Wait for consistent reading and save it (**F5**).

5.3.4 Vacuum Regulation

The vacuum regulation test according to ISO 6690:2007 comprises two parts of five measurements each. For each of these measurements the test device provides a separate window as shown in Figure 16.
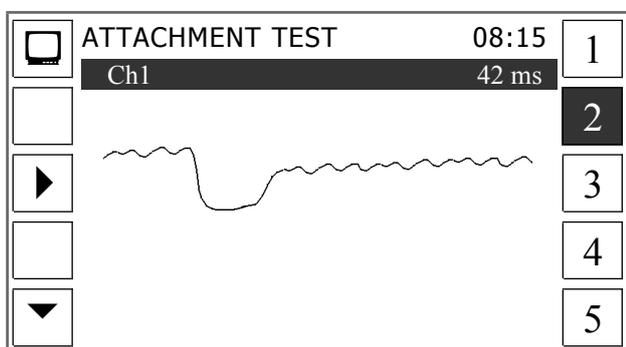
Figure 16:   Window for Testing the Vacuum Regulation according to ISO 6690

To carry out the vacuum regulation test you have to select the item *Vacuum regulation* from the menu *Measurement programs*. Following this: Push **F5** in the above shown window to select the desired test, which is either *Attachment test* (▲) or *Fall off test* (▼)[17]. For both tests its measurements can be repeated as many times as wanted. For this purpose select the desired measuring window (1-

---

[17]   Both differ only by the fact that for the attachment test, only one teat cup per test-cluster is abruptly opened and again closed later just as quickly, while this is done for all teat cups of each test-cluster for the fall-off test.

5) via one of the keys **F6** to **F10**. Following that, start the measurement by pushing **F3**. A complete vacuum regulation test has to be taken as follows:

- Plug all teat cups.
- Put the milking machine with all milking units into operation.
- Connect measuring port 1 to the vacuum measuring point Vm[18].
- <u>Phase 1, 3 & 5</u>: Wait for the working vacuum to be stable (see plant gauge) - Start the measurement - Wait for measurement completion.
- <u>Phase 2</u>: Start the measurement - Unplug the number of teat cups requested in ISO 6690:2007[19] immediately and simultaneously (**!**) - Wait for measurement completion.
- <u>Phase 4</u>: Start the measurement - Plug all unplugged teat cups immediately (**!**) and at the same time (**!**) - Wait for measurement completion.

The completion of a measurement can be seen by the graph reaching the right edge of the screen and the function key symbols appearing again.

5.3.5 Pulsation

The way of testing pulsators and displaying the relevant readings is almost the same as described in chapter 2.1. Compared to chapter 2.1 there is just the slight difference that the milking machine standard does not allow individual limits depending on the pulsator type but gives uniform limits for all types of pulsators. Furthermore, when testing according to ISO 6690 the test will be not only for limping within the single pulsators but also between all pulsators of one installation. The relevant values can be shown by pushing **F2** when displaying the pulsator test report (Page 2-4). In this context, the vacuum drop between the working vacuum and the poorest performing pulsator will also be displayed.

5.3.6 Milking Units

5.3.6.1 Air Admission into Clusters

This test comprises the measurement of the total air admission into a cluster as well as the leakage through the shut-off valve and through the claw. Following the program start, a submenu appears in which the record number (number of a cluster) can be set by using the keys ⬆ and ⬇[20]. After this, push **F3** to open the measuring window shown in Figure 17.

---

[18] This is usually the milking systems receiver
[19] <u>Attachment test</u> = 1 teat cup of each 32. milking unit - <u>Fall-off test</u>: all teat cups of each 32. milking unit
[20] Please note that for this test you can save the results of 50 clusters per installation at the most.

```
┌──────────────────────────────────────────┐
│  ▄▄▄     N° 2              08:15           │
│  AIR ADMISSION                            │
│  ▐ 100 m      1013 hPa      20,0 1 ▌      │
│  VALVE                     2,5            │
│  TOTAL                   ▐ 16,1 ▌         │
│  LEAKAGE                   4,4            │
│  AIR VENT                 11,7            │
│  ------------------------------------     │
│  VACUUM DIFF.              0,0            │
└──────────────────────────────────────────┘
```

Figure 17:   Window for Measuring the Air Admission into Clusters according to ISO 6690

In this window the measurement-relevant data (Altitude, Ambient atmospheric pressure, Volume of the test-can) is shown in the line just beneath the headline. These data must be entered before beginning the installation test (see page 22). The three following lines show the latest measured values. However, the line second to the last shows the calculated air admission through the air vent (Total air inlet - Claw-piece leakage). This line can not be entered.

To carry out a measurement, select one of the three measuring lines first and continue then as described in the appendix of this manual (see page 39).

5.3.6.2 Air Flow at the End of Long Milk Tubes

When carrying out the measurement described here an air-flow meter is connected to the long milk tube instead of the cluster. Following this, the air flow rate that causes a vacuum drop of 5 kPa (1.48 iHg) compared to the working vacuum has to be measured. The design of the measuring window is shown in Figure 18. In this window the number of records basically equals the number of milking units according to installation data, but with a maximum of 50.

```
┌──────────────────────────────────────────┐
│  ▄▄▄          ⇕          08:15            │
│  AIR FLOW AT THE END OF                   │
│  THE LONG MILK TUBE                       │
│  _____         │
│  No. 3                     45            │
│  No. 4                      0            │
│  No. 5                      0            │
│  No. 6                      0            │
│  💾 VACUUM                36,2            │
└──────────────────────────────────────────┘
```

Figure 18:   Window for Measurements on Milk Tubes according to ISO 6690

The measurement of the air flow at the end of the long milk tube is done in the following steps:

- Disconnect the cluster from the milk tube under test.
- Connect the air-flow meter and measuring port 1 to the long milk tube.
- Open the measuring window, select the desired line and start the measurement.
- Open the air-flow meter's air vent until the vacuum drops by 5 kPa (1.48 iHg).
- Save the reading via **F5** or abort the measurement via **ESC**.

5.3.7 Stall Taps

The measurement described in the following is scheduled for testing parlour and stanchion-barn installations according to ISO 6690:2007 only. The test checks how much air can flow through a stall tap until the working vacuum at the measuring point drops by 5kPa (1.48 iHg). The measuring window design is largely the same as for the window shown in Figure 18. Carry out the test on stall taps as follows:

- Connect measuring port 1 and the air-flow meter to the stall tap under test instead of the pulsator.
- Put the milking machine into operation.
- Open the measuring window, select the desired line and start the measurement.
- Open the air-flow meter's air vent until the vacuum drops by 5 kPa (1.48 iHg).
- Save the reading via **F5** or abort the measurement via **ESC**.

5.3.8 Vacuum Taps

A test at vacuum taps is carried out in bucket and direct-to-can milking machines only. In this context, the vacuum drop in a vacuum tap is measured at an air flow of 150 l/min (5.30 cfm). The measuring window is basically the same as for the test on milk tubes (see Figure 18). The measurement has to be carried out as follows:

- Connect the air-flow meter and measuring port 1 to the vacuum tap under test.
- Connect measuring port 2 to the nearby vacuum tap.
- Open the measuring window.
- Select the desired line and start the measurement.
- Adjust the air-flow meter's air vent in such a way that the actual air flow equals the rated one (150 l/min or 5.30 cfm)[21].
- Save the reading via **F5** or abort the measurement via **ESC**.

5.4 Test Report

The test device automatically creates a comprehensive test report, based upon the entered site data, installation data, and measured values. In doing so it automatically calculates all limits and air flow corrections. The test report displays all measured and calculated values. Measured values and results not matching the limits or being not plausible will be marked. On the screen this is done by a dark cursor, whereas a question mark is used for that purpose when printing.

From the program menu (see Figure 13) test reports can be transferred to a PC by pushing **F2** and printed via **F4**. However, to show a test report on the screen of the test device, choose the last item from the program menu. If this is chosen a submenu will open from which the desired section of the report can be selected.

---

[21]   The actual air flow is being displayed permanently in line 9 of the measuring window.

5.4.1 Installation Vacuum

The vacuum values measured in the pipelines are displayed together with the relevant limits and the derived test results in four windows. Using **F6** to **F9** you can browse in-between these windows. In each of these windows the headline shows what has been tested for. This rule applies also for the printed version. Figure 19 shows such a printed report and explains the technical terms and abbreviations being used.

VACUUM GAUGE	
DISPLAYED VALUE	Value displayed on the plant vacuum gauge during the test
MEASURED VALUE	Measured value near plant vacuum gauge
ACCURACY	Difference between the values shown above = Gauge accuracy
LIMIT[22]	Limit according to ISO 5707
REGULATION SENSITIVITY	
SYSTEM VACUUM	Installation vacuum with inactive milking units
WORKING VACUUM	Installation vacuum with active milking units
DIFFERENCE	Difference between the values shown above = Regulation sensitivity
VACUUM DROP TO Vr	
MILK SYSTEM 1	Vacuum drop between the connection point Vm of each milk system and the the regulator sensing point (connection point Vr)
MILK SYSTEM 2[23]	
MILK SYSTEM 3[23]	
VACUUM DROP TO Vp	
MILK SYSTEM 1	Vacuum drop between the connection point Vm of each milk system and the beginning of the main air line (connection point Vp)
MILK SYSTEM 2[23]	
MILK SYSTEM 3[23]	

Figure 19:   Test Report on Installation Vacuum according to ISO 6690

The readings on which the vacuum drop between milk system and the connection points Vr respectively Vp are based, may be shown by pushing **F2** (i), when displaying the report on the screen. However, when printing a test report these values are printed out automatically at the end of each block.

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[22]   This line is displayed on the screen or printed for each section.

[23]   The actual number of lines shown or printed in this section of the report equals the number of milk systems according to installation data (see page 23).

5.4.2 Air Flow Rates

The report for the air flow tests contains for the two connection points *A1* and *A2* three windows each. On the screen of the test device you can switch between the two connection points by pushing **F5**. The selection of the windows is done via the keys **F6** to **F8**. As in the vacuum test report, the headlines show which parameter has been tested for. The technical terms and abbreviations being used in this report can be taken from Figure 20.

RESERVE CAPACITY A1	
MEASURED VALUE	Reading at connected regulator and at vacuum measurement at Vm
NORMAL VALUE	Reading corrected for weather conditions[24]
ANCILLARY CONSUM.	Air demand for ancillary equipment according to installation data (see page 23)
EFFECTIVE VALUE	Difference between the two previous values[25]
REGULATION LOSS A1	
MANUAL RESERVE	Reading at disconnected regulator and at vacuum measurement at Vm
RESERVE CAPACITY	Reading at connected regulator and at vacuum measurement at Vm (see above)
REGULATION LOSS	Difference between the two previous values[26]
REGULATOR A1	
AIR FLOW WITHOUT	Reading at disconnected regulator and at vacuum measurement at Vr
AIR FLOW WITH	Reading at connected regulator and at vacuum measurement at Vr
LEAKAGE	Difference between the two previous values
MILKING UNITS A2	
AIR FLOW WITHOUT	Reading at inactive milking units
AIR FLOW WITH	Reading at active milking units
TOTAL INLET	Air admission through all milking units = Difference between the readings
INLET PER MU	Air admission per milking unit
MILK SYSTEM A2	
AIR FLOW WITHOUT	Reading at disconnected milk system
AIR FLOW WITH	Reading at inactive milking units (see above)
LEAKAGE	Air admission into the milk system = Difference between the two previous lines
VACUUM SYSTEM A2	
AIR FLOW WITHOUT	Reading at disconnected vacuum system
AIR FLOW WITH	Reading at disconnected milk system (see above)
LEAKAGE	Air admission into the vacuum system = Difference between the two previous lines

Figure 20:   Test Report on Air Flow Rates according to ISO 6690

All readings on which the above shown results are based, are printed automatically, as are all related limits and the vacuum levels at the time of the air flow measurements. However, to show all these values on the screen of the test device you have to push **F2** (i).

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[24] The normal value shows what the reading would have been at an atmospheric pressure of 1013 hPa. This value allows for comparing readings to each other which have been taken at different weather conditions.

[25] Air flow rate that causes a vacuum drop of 2 kPa or 0.59 iHg (compared to the working vacuum) in the milking system (*A1*, *Vm*)

[26] = Air admittance through nominally closed regulator[s]. This occurs if there are big vacuum drops between regulator and milking system, e.g. due to long or too narrow air lines.

5.4.3 Vacuum Pump Performance

The vacuum pump test report has one window per pump. Their contents can be seen in Figure 21. In these windows all related limits can be shown via **F1** (§). However, **F2** (i) allows for showing the desired and the actual vacuum levels at the time of the air flow measurements.

PUMP PERFORMANCE	
AIR FLOW	Reading at the vacuum pump air inlet at a vacuum of 50 kPa (14.75 iHg)
NORMAL VALUE	Reading corrected for weather conditions[27]
NOMINAL VALUE	Reading corrected for altitude and weather conditions[28]
REVOLUTION	Measured revolutions of the pump rotation shaft
BACK PRESSURE	Pressure measured in the pump exhaust line

Figure 21:   Test Report on Vacuum Pump(s) according to ISO 6690

5.4.4 Vacuum Regulation & Component Tests

The display of the results of the Vacuum regulation test, Pulsator tests, Cluster tests (Air admission, Air flow in the milk tube) as well as of the tests on the Stall taps and Vacuum taps looks almost the same as the measuring windows. Therefore it will not be explained here.

5.5 Tests according to NMC-Guidelines

The use of the test device described here for milking machine installation tests according to NMC-Guidelines is basically identical to installation tests according to ISO 6690. However, differences exist regarding the installation data to be entered (see page 23) as well as for the following areas.

5.5.1 Measuring Windows

The windows described in context with ISO 6690 which allow for measuring the back pressure in vacuum pump exhaust lines as well as tests on milking clusters (Air admission & Air flow at the end of the long milk tube), Stall taps, and Vacuum taps are not provided for installation tests according to the guidelines of the NMC, since such measurements are not intended in these guidelines. Another difference to the installation tests according to ISO 6690 is that the vacuum and air flow measurements are grouped as one menu item. This item gives access to five measuring windows between which you can switch as you like via the keys **F6** to **F10**.

The left half of Figure 22 shows the principally common design of these windows. Their measuring lines display current readings only during an ongoing measurement, but otherwise the latest saved readings, alike when testing according to ISO 6690. However, a fundamental difference is that for tests according to NMC-Guidelines, a so-called historic reading is displayed at the right edge of the

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[27]   The normal value shows what the reading would have been at an atmospheric pressure of 1013 hPa (29.88 iHg). This value allows for comparing readings to each other which have been taken at different weather conditions.

[28]   The nominal value shows what the reading would have been at an <u>actual</u> atmospheric pressure of 100 kPa (29.50 iHg), at a barometer reading of 1013 hPa (29.88 iHg) and an altitude of ca. 100 m (328 feet) respectively. It allows for comparing the pump performance to the nominal capacity as specified by the manufacturer.

second line of each window. This is the penultimate value of the currently selected measuring line. It is overwritten by the latest reading of the selected line if a new reading is saved in this line. That way you can document both: a milking machine's condition as you found it, as well as its condition after a possible repair of faulty components.

```
┌──────────────────────────────┐ ┌───┐    ┌──────────────────────────────┐
│ ┌──┐  �█▌           08:15  │ │ 1 │    │ ┌──┐  ▐█▌           08:15  │
│ └──┘                         │ └───┘    │ └──┘                         │
│       RESERVE CAPACITY       │ ┌───┐    │       TEST VACUUM            │
│ ┌──┐ ▐70.60 cfm       99.71▌ │ │ 2 │    │ ┌──┐                  12.33 │
│ │VAC│                        │ └───┘    │ └──┘                        │
│ └──┘  AUTOMATIC        98.84 │ ┌───┐    │       REGULATOR SENSOR 12.04│
│ ┌──┐  MANUAL         ▐99.87▌ │ │ 3 │    │ ┌──┐                        │
│ │AIR│                        │ └───┘    │ └──┘                        │
│ │ + │                        │ ┌───┐    │ ┌──┐                        │
│ └──┘                         │ │ 4 │    │ └──┘                        │
│ ┌──┐  ------- VACUUM ------- │ └───┘    │ ┌──┐                        │
│ └──┘   LIMIT: 11.95 ACT:12.30│ ┌───┐    │ │💾│                        │
│                              │ │ 5 │    │ └──┘                        │
└──────────────────────────────┘ └───┘    └──────────────────────────────┘
```

Figure 22:   Measuring Windows for Installation Tests according to NMC-Guidelines

Beside the above instructions, please observe the following for vacuum and air flow tests according to NMC-Guidelines, if these tests are carried out with the tester described here:

In window 1, the **Working vacuum**[29] has to be measured at 4 different points of the milking machine, namely: at the *Receiver*, in the *Pulsator airline* furthest away from the vacuum pump, at the *Regulator sensor*[30], and at the inlet of the *Vacuum pump*. Furthermore you have to enter the value displayed on the *Vacuum gauge* into the last line of this window.

Window 2 is used to measure the **Reserve capacity** at the receiver[31] at active vacuum regulator and at deactivated vacuum regulator (see Figure 22, left). If during such a measurement air is admitted not only through the actual air flow meter but also through auxiliary meters, their total air admittance has to be specified in a separate window before starting the air flow measurements (see page 8 & 25)[32]. This window has to be opened via **F3**. Continue as follows after returning to measuring window 2:

- Measure the *Automatic Reserve* at active vacuum regulator first.
- Push then **F2**, to open a sub-window (see Figure 22, right) for measuring the *Test vacuum at the regulator sensor*.
- Deactivate the vacuum regulator of the milking machine after returning to the measuring window shown above (left). Measure then the *Manual Reserve*.

Use window 3 to measure the **Air flow** at the receiver[31] **at different conditions**, namely: at *Normal operation*, at *4 Teat cups unplugged* (one cluster unplugged), at *1 Teat cup unplugged*, and after

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[29]   This is the vacuum with all milking units in operation.

[30]   Point where the sensor of the vacuum regulator is connected to the main air line of the milking machine

[31]   This is identical to the connection point *A1* according to ISO 6690. Here you have to connect port 1 of the tester for the related vacuum measurements also (matches connection point *Vm* according to ISO 6690).

[32]   This rule applies also for the following measuring windows.

consecutive deactivation of the following components: *Pulsators, Milking clusters, Vacuum regulator, Accessory*. After completing all above named air flow measurements, open a subwindow via **F2** and measure the *Test vacuum at the inlet of the vacuum pump.*

Based upon these values the **Air flow of the vacuum pump(s) at test vacuum** is measured in <u>window 4</u>. To do so, select the right field in each of the up to 3 measuring lines. Then use the left field of each line to measure the **Air flow of the vacuum pump(s) at nominal vacuum** (50 kPa or 14.75 iHg).

After carrying out the above explained measurements, put the milking machine back to normal conditions. Then carry out a **Recheck** in <u>window 5</u>. In this context you have to measure the *Working vacuum* and the *Reserve capacity* at the receiver a second time. The further tests according to NMC-Guidelines relate to the vacuum regulation and pulsation. Both are identical to ISO 6690 and hence not being explained again here.

5.5.2 Test Report

As when testing according to ISO 6690, from the last line of the program menu you can open a submenu which allows for displaying the different sections of the test report. Three of the in total 6 sections are identical to the test reports according to ISO (*Vacuum pumps, Vacuum regulation, Pulsation*), so that an explanation is omitted here. The same applies for the last section (*Recheck*) that only shows the readings. However, the first two sections will be explained based upon their printouts.

The first section relates to the **Installation vacuum**. It comprises the two parts shown in Figure 23. The readings on which the first part of the test report section shown below is based are printed or transferred to a PC automatically. The same applies for the related limits. At the screen of the test device these values can be displayed via the keys **F2** and **F1**.

VACUUM DIFFERENCE TO Vm	
PULS. AIRLINE	
REGULATOR SENSOR	Vacuum difference between the receiver (connection point *Vm*) and the connection
VACUUM PUMP	points named in the test report (see left)
VACUUM GAUGE	

VACUUM AT SENSOR (Vr)	
NORMAL OPERATION	Vacuum at the regulator sensor at normal operation
AT RESERVE AIR	Vacuum at the regulator sensor at reserve air flow at the receiver
DIFFERENCE	Difference between the two previous readings
LIMIT <=	Allowed maximum (1.3 kPa or 0.38 iHg)

Figure 23:   Test Report on Installation Vacuum according to NMC-Guidelines

The report on **Air flow tests** according to NMC-Guidelines consists of three parts. The first of these (*Reserve capacity*) is identical to the test report according to ISO 6690 (see page 31, 20 respectively). The two other sections of the air flow test report are shown in Figure 24.

VACUUM REGULATION	
MANUAL RESERVE	Air flow at inactivated vacuum regulator[33]
RESERVE CAPACITY	Air flow at active vacuum regulator[33]
EFFICIENCY [%]	= Reserve capacity / Manual Reserve * 100
LIMIT [%] >=	Required minimum according to NMC-Guidelines (90,0 %)
AIR ADMISSION	
4 TEAT CUPS	Maximum air admitted by one milking cluster[34]
1 TEAT CUP	Maximum air admission of one teat cup[34]
PULSATORS	Regular air admission of all pulsators
MILKING CLUSTERS	Regular air admission of all milking clusters
REGULATOR	Air admission through the vacuum regulator
ACCESSORY	Regular air admission of ancillary equipment
SYSTEM	Leakage of the basic system (Vacuum and milk lines)

Figure 24:   Test Report on Air Flow Rates according to NMC-Guidelines

For displaying, printing, and transferring the readings, limits and vacuum levels related to the above shown results apply the same rules as for the report on vacuum tests.

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[33]   measured at the receiver at a vacuum of 2 kPa (0,59 iHg) below working vacuum
[34]   = Air admission through unplugged teat cups

6 PC-Software

All essential data may be transferred to a PC and saved, printed, and processed there. The required PC-program is based upon the popular spreadsheet program *Microsoft Excel*®[35].

6.1 System Requirements

In order to use the PC-program described here, the minimum system requirements shown in Table 5 must be fulfilled.

Table 5:   System Requirements for the Use of the PC-Software

Computer	Personal Computer with serial interface or with USB 2.0 and appropriate adapter, e.g. *LogiLink USB 2.0 Serial Adapter*
Processor	x86 Family, 600 MHz
Real memory	512 MB
Virtual memory	2 GB
Operating system	Microsoft Windows 2000 Professional (SP4), XP Professional (SP3) ®
Office-Suite	Microsoft Excel 2000 (SP3), 2003, XP, 2007 ®

6.2 Installation

Carry out the following steps to install the program onto your PC:

- Log in as an administrator or ask your system administrator to carry out the installation.
- Ensure that you have **permanently unlimited writing permission for that drive on which the program will be installed** (see *Windows* ® manual, user account).
- Insert the installation software CD into your computer's CD-compartment.
- Open the folder *PC_Software and a*ctivate the file *install.bat* via double mouse-click
- Hereupon you will be asked if you want to install the *Visual Basic* ® runtime files. Click the left button (Yes).
- Now an input box will be opened. Here you have to type in the desired hard disk path to place the program folder, e.g. *C:*. After doing so, click the button Extract to continue.
- Finally, link the program *Transfer.exe*, which can be found in the folder *Transfer* just being copied onto the hard-disk, to the *Windows* ® Start-menu and/or to the PC-desktop (see *Windows* ® manual).

6.3 Data Transfer

Carry out the following steps to transfer data to a PC:

- Set the transfer-rate before transferring data the first time or in case of failed transfer. To do so: Push **F8** in the main menu, open the submenu *Data Transfer* and continue as described in chapter 1.8.

⚠	Set a low rate (as far down as level 1) to improve the transfer

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[35]   registered trademark of the Microsoft Corporation

- Connect the serial interfaces of PC and test device (see Figure 1) to each other.

> ⚠ Use only the interface cable delivered with the PC-program in order to avoid malfunctions and damages of PC and test device.

- Close all applications possibly still running!
- Start the PC-program (double-click the desktop symbol).
- Select the used serial port (COM 1 - COM 9) from the menu now opening (click the triangular symbol beside the label „COM", highlight the desired COM-port in the window then opening and click the left mouse button).
- Click the symbol ▶ on the PC-screen.
- Push the test device's function key beside the symbol PC (usually **F2**).
- Usually, the data transfer will start immediately. Only when transferring data from one oft the programs *Short-Term* or *Long-Term*, you have to enter the record numbers (e.g. *3 to 28*) first (see page 6).
- Wait until the data transfer is completed.

Please note also the following pieces of advice:

> ⚠ When transferring *Short-Term Measurement* data it is strongly recommended to transfer records not being related to each other (e.g. readings taken at different installations) separately, so that they are saved in different workbooks (files).

> ⚠ *Microsoft Excel* ® can handle only a limited number of objects and is also limited in the maximum file size. For this reason, a maximum of 50 *Short-Term Measurement* records can be transferred at one time.

> ⚠ Since the graphical rendering of *Long-Term Measurement* readings (scale of time-axis, shown ports) is arranged according to the first record transferred, the data of different measurements must be transferred separately!

6.4 Processing Raw Data

Transferred **raw files are usually saved in the installation path subfolder** *Data*, e.g. *C:\ Programs\ Transfer\ Data*). When using **Windows Vista ® with activated user account control**, please note that raw files will be saved in the folder *Desktop\ User\ AppData\ Local\ Virtual Store\ Transfer \ Data*, where *User* represents the user's name. The files are given automatically the same name as the program which has been used to carry out the relevant measurements (e.g. *Short-Term Measurement*) followed by the current date and time. Act as follows to convert the raw files into final files:

- Stop all applications possibly still running and close especially all open Excel-files!

> ⚠ Applications still running consume system resources.
> This can cause unpredictable fatal errors, as far as a program crash.
> This applies particularly when processing big files!

- Open the desired raw file, by either using the Excel-menu *File / Open* or using the *Windows Explorer* ® (double-click the transferred file).

> ⚠ *Raw files can be processed only if Microsoft Excel ® allows the use of macros.*
> Set the safety level (Menu: *Extras*/*Macro/Safety*) for this reason to medium or low.

Following the opening of the raw file the PC-program will check whether the transferred file is complete. It is also tested if the versions of test device software and PC-program match each other. If these conditions are fulfilled the final sheets (tables and charts) will be created and the changed file (workbook) will be saved automatically.

To avoid unintentional deletion of sheets all workbooks are protected. Within the sub-programs *Short-Term Measurements* and *Long-Term Measurements* you can **unprotect workbooks** at any time by using the appropriate *Excel* menu (see *Excel* handbook). That way you are able to copy or delete single sheets. Beside the workbook itself, all of its tables and graphs are protected. You can edit the cells shown in Table 6 only.

Table 6: Editable Cells in PC-Worksheets

Program	Editable cells
Short-Term Measurements	• Title above the charts (1. line on each sheet) • All cells with yellow background colour • Dotted lines below the readings
Long-Term Measurements	• You can insert as many text fields as you like into each chart (see *Excel* ®-manual)
Single Measurements	• Comment fields (right beside the relevant reading)
Installation Test	• All cells with yellow background colour (sheet 1) • You can insert as many text fields as you like into each chart.

Furthermore you can export the table on which the charts are based into a new workbook to process it there any way you like. To do so, push on your PC-keyboard the keys **Strg** and **E** (**Ctrl** and **E**) simultaneously. Hereupon, the program opens automatically a new workbook and inserts a table named „Graph" into this. At the same time the workbook from which the data has been exported is closed automatically without any loss of data. However, the new workbook must be saved manually (*Excel* ® menu *File*) to keep the exported data.

7 Appendix

7.1 Measurement Period depending on the Measuring Interval

Fluctuation		Range		Long Term	
Interval [ms]	Period [s]	Measurem./ min	Period [min]	Interval [ms]	Period [min]
2	1,4	40	17,6	25	25,7
4	2,8	55	12,8	40	41,1
6	4,2	70	10,1	60	61,6
8	5,6	85	8,3	80	82,1
10	7,0	100	7,0	100	102,7
12	8,4	115	6,1	120	123,2
14	9,9	130	5,4	140	143,7
16	11,3	145	4,9	160	164,3
18	12,7	160	4,4	180	184,8
20	14,1	175	4,0	200	205,3
22	15,5	190	3,7	220	225,9
24	16,9	205	3,4	240	246,4
26	18,3	220	3,2	260	266,9
28	19,7	235	3,0	280	287,5
30	21,1	250	2,8	300	308,0
32	22,5	265	2,7	320	328,5
34	23,9	280	2,5	340	349,1
36	25,3	295	2,4	360	369,6
38	26,8	310	2,3	380	390,1
40	28,2	325	2,2	400	410,7
42	29,6	340	2,1	420	431,2
44	31,0	355	2,0	440	451,7
46	32,4	370	1,9	460	472,3
48	33,8	385	1,8	480	492,8
50	35,2	400	1,8	500	513,3

7.2 Air Admission Measurements

The test device described here uses an indirect method to measure the air flow admitted through a milking cluster into a milking machine installation. This method is based on measuring the vacuum drop caused by the admitted air in an airtight vessel of ca. 20 l (5.28 gallons) volume during a period of 10 seconds. In this context, the ambient atmospheric pressure and the altitude are taken into account. For this reason, the results may differ from the table values of the international milking machine standard, which are all based upon an atmospheric pressure of 100 kPa (29.50 iHg). Depending on the program (*Single Measurements* or *Installation Test*), either the total air admission only will be measured, or additionally the air admission through leaky shut-off valves and clawpieces as well. The test procedure is basically the same for all three purposes. Differences exist only in how the milking clusters have to be adjusted. Carry out the test as follows:

- Connect the long milk tube and measuring port 1 to an airtight vessel of ca. 20 l or 5.28 gallons (e.g. milking can).
- Connect the airtight vessel via a tube to the vacuum line's tap.
- Shut the vacuum tap, switch on the vacuum pump and pulsators.
- Adjust the milking cluster according to the measuring purpose (see Table 7).
- Open the vacuum tap.
- Wait until the vacuum level in the can equals the system vacuum (ca. 30 seconds).
- Open the desired measuring window and select the desired record, measuring line respectively (see page 18, 28 respectively).
- Start the measurement via ' and wait until the result is being displayed.

Table 7: Required Cluster Adjustments for Measuring the Air Admission into a Cluster

Test	Required cluster adjustments		
	Shut-off valve	**Teat cup**	**Air vent**
Leakage through shut-off valve	close	unplug	open
Total air admission	open	plug	open
Leakage through claw-piece	open	plug	close

7.3 Technical Data

Processor:	16 bit, 25 MHz
Screen:	240 x 128 dots, illuminated
Keys:	18, 10 of these having variable Functions
Memory capacity:	4 MB
Measuring range:	+40 to -60 kPa (ca. +11.80 to -17.70 iHg)
Measuring accuracy:	< 0,6 kPa (ca. 0.18 iHg), typically ≤ 0.3 kPa (ca. 0.09 iHg)
Measuring solution:	0,1 kPa (ca. 0.03 iHg)
Power supply:	4x AA, NiCd or NiMH
Interfaces:	RS 232, 0-5V Sensor (2)
Degree of protection:	IP65
Physical dimensions:	220 x 130 x 30 mm
Operation temperature:	5 to 40°C (ca. 41 to 104°F)
Storage temperature:	-20 to 60°C (ca. -4 to 140°F)
Weight:	1000 g (without batteries)
Tests:	EN 61000-6-3, EN 61000-6-1

External Probes	Pressure	Temperature	Voltage	Revolutions
Measuring range:	+40 to -50 kPa 11.8 to -14.75 iHg	-20 to + 140°C -4 to +284°F	0 to 30 V	0 to 9999
Measuring accuracy:	< 0.6 kPa (0.18 iHg)	± 1.5 %	± 1 %	± 1 % + 1 digit
Measuring solution:	0.1 kPa (0.03 iHg)	0.5 K	0.1 V	1 Rpm

7.4 Maintenance

The test device needs nearly no maintenance. Use a damp cloth to clean the case. Both, the internal and external pressure sensors are inured to water and mild alkaline solutions. In case of need they may be cleaned by injecting a mild alkaline solution. This solution has to be removed after 5 minutes, by hanging the device or external sensors in such a way that the hose nozzles point to the ground.

> ⚠ If the device is not used for weeks or even a longer time, remove the batteries or rechargeable batteries in order to avoid battery leakages.