l e a k a g e   t e s t i n g   ·   f l o w   t e s t i n g   ·   f u n c t i o n a l   t e s t i n g

Leakage Testing System

INTEGRA

RD, RD1, RD4, RD6, RD10, RDV,
DD, DD1, DD6, DD10, DDV,
DF, DF1M, DF2M, DF1

Instruction Manual

Version 1.45e

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Contents

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

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Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

1 Foreword

1.1 Contents of this manual

This operating manual contains the necessary instructions for the proper operation of the described device.

It explains the procedure for using the device and can be used to train operating personnel. Nevertheless, operating mistakes or improper use can endanger the operator and the device.

Every person concerned with setting up, operating or servicing this device must therefore read this manual before starting to work with the device.

Your safety is at stake!

The manual must be available at the device.

1.2 Safety measures in this manual

In this manual the following symbol is used to indicate descriptions of danger.

Danger!
Signals an immediate danger. If not avoided, the result can be death or serious injuries.

1.3 Intended use

The device must only be used in technically perfect condition.

The operations and maintenance instructions given in this manual must be followed.

For safety reasons, unauthorized alterations and conversions of the device are prohibited.

If the device is integrated into a machine, operation of the device is prohibited until it has been confirmed that the machine conforms to the applicable EU regulations.

Spare parts must conform to the technical requirements defined by the manufacturer. This can only be guaranteed for original spare parts.

The operator must take care that the working order of the device is checked in appropriate intervals using suitable tools.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

2 Safety

2.1 Sources of danger

The following hazards can be connected with operating the device.
Because of these hazards, caution must be exercised when operating the device.

Bursting parts can cause serious injuries!
When filling hollow bodies with compressed air, all valid regulations must be observed.

The device operates on 230 V AC supply voltage.
Before opening the device, disconnect the power and compressed air supply.

The device may only be opened by appropriate and trained personnel.

2.2 Admissible persons

Responsibilities for operation and service must be clearly defined. Unclear responsibilities could endanger the safety of the operating personnel.
Operating personnel must have a contact person or institution in case of problems with the device.

The operating personnel must be trained in using the device by the operator and must have read and understood the operating instructions.
Operating personnel must be of legal minimum age.

Service personnel must consist of **qualified people**.
Only a trained specialist for electrical installations may be allowed to work on electric parts of the device.

2.3 Safety measures at the place of installation

Make sure that the device and the surroundings are clean and orderly.

Check the device at least once per shift for visible damages and defects.
Report defects immediately to the appropriate contact.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

3 General notes

The Leakage Testing System INTEGRA is a multi-functional testing system. Its main applications are tests with fluidic media especially leakage and flow tests using compressed air or other gases or vacuum. Because of the free programmability of the control software, electrical or mechanical tests can be carried out as well. Furthermore, not only the inspection process can be controlled but also entire testing devices or test stands.

4 Device types

The Leakage Testing System INTEGRA can be equipped with almost any common test process. This depends basically on the built-in sensor and valve equipment. Apart from custom-made models, the following standard devices are available:

INTEGRA *RDV*	Relative-pressure method, test pressure and measuring range -1…0 bar
INTEGRA *RD1*	Relative-pressure method, test pressure and measuring range 0…1 bar
INTEGRA *RD4*	Relative-pressure method, test pressure and measuring range 0…4 bar
INTEGRA *RD6*	Relative-pressure method, test pressure and measuring range 0…6 bar
INTEGRA *RD10*	Relative-pressure method, test pressure and measuring range 0…10 bar
INTEGRA *DDV*	Differential-pressure method, test pressure range -1…0 bar, measuring range ±20 mbar
INTEGRA *DD1*	Differential-pressure method, test pressure range 0…1 bar, measuring range ±20 mbar
INTEGRA *DD6*	Differential-pressure method, test pressure range 0…6 bar, measuring range ±20 mbar
INTEGRA *DD10*	Differential-pressure method, test pressure range 0…10 bar, measuring range ±20 mbar
INTEGRA *DF1M*	Flow test method (mass flow), measuring range 0.1...10 ml/min test pressure range 0...1 bar, 0...6 bar or 0...10 bar
INTEGRA *DF2M*	Flow test method (mass flow), measuring range 2...200 ml/min test pressure range 0...1 bar, 0...6 bar or 0...10 bar
INTEGRA *DF1*	Flow test method (volume flow), test pressure range 0...1 bar, manual regulation measuring ranges from 0.3...3 l/min, 1.5...15 l/min, 5…50 l/min or 12.5…125 l/min separate housing 19"/3U high

4.1 Recommended accessories

Besides the leakage test system, we recommend using a **test leak** as accessory.
A test leak is helpful for setting up and checking the system. Test leaks basically consist of a glass capillary permitting a defined volume flow per unit of time. If such a test leak is inserted into the fast coupling in the front panel of the leakage test system, a leak is simulated. Test leaks can be adjusted to almost any leakage rate common in the industry. If an additional test piece – known to be tight – is connected to the system, the drop or rise in pressure caused by the test leak can be used to determine the limiting value for the test evaluation. Also the optional integrated automatic test process optimization *autoTune* (see also *chapter 7*) is possible with a test leak. A quick check of the system is also possible with a test leak. If the test leak is adjusted to the permitted limit value, NOK must be returned after inserting the test leak.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

5 Test methods

5.1 Relative-pressure method

With the relative-pressure method, the test piece is filled with compressed air or vacuum during an adjustable filling time. The filling process is followed by a damping period. During this time the temperature between test piece and test medium equalizes. Before the subsequent test period, the measurement display must be tared. If the test piece is leaking, the pressure will be different at the beginning and end of the test period, which can be measured and evaluated. Since this method measures the absolute change of pressure, measuring accuracy is directly dependent on the test pressure. By connecting to a test leak, an equivalent volume flow can be assigned to the resulting pressure difference.

5.2 Differential-pressure method

With the differential-pressure method, the test piece and a comparison volume are filled with compressed air or vacuum during the filling time. The filling process is followed by a damping period. During this time the temperature between test piece and test medium equalizes. At the end of the damping period, test and comparison volume are sealed from each other. Before the subsequent test period, the measurement display must be tared. If the test piece is leaking, there will be a difference in pressure between it and the comparison volume that can be measured and evaluated. Thus the measuring accuracy is independent of the absolute test pressure since only the difference between reference volume and test piece is measured. By connecting to a test leak, an equivalent volume flow can be assigned to the resulting pressure difference.

5.3 Pressure rise method

The pressure rise method is a variation of the relative pressure or differential pressure method. Not the change of the test pressure is used as the relevant value but the change of the pressure in an enclosure, bell jar or chamber surrounding the test piece. The advantage of this method lies in the fact that the changes in pressure of the test medium have only very little influence on the measuring result. Often, however, very high expenditure is required for the test appliance. In addition, the surrounding volume must constantly be tested for leaks since a leak could be the cause of false OK parts.

5.4 Test of hermetically sealed components

When testing hermetically sealed components for leaks the difficulty lies in the fact that the interior of the test piece cannot be impinged with pressure. In this case, too, a volume surrounding the test piece is used which is subjected to pressure or vacuum. If the test piece has a leak, the air will escape into the piece or from the test piece into the surrounding vacuum. This will lead to a pressure rise or decay in the surrounding enclosure that can be measured. Most of the time, however, it is necessary to take the test pressure or vacuum from a pre-volume to check for big leaks. A big leak would cause the test piece to be emptied or filled so quickly that no decay/rise in pressure would take place during the actual testing period and the test piece would – falsely – be rated OK.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

5.5 Flow test method

5.5.1 Mass flow measurement

For this method the test piece is filled via a bypass pipe with a large cross-section. At the end of the filling process, the bypass valve is closed. The air escaping from the test piece is led to a mass flow sensor. In a heated measuring canal the temperature difference between input and output is measured and used as a proportional measuring value for the flow. Measuring the mass flow is largely independent of the temperature and the medium’s pressure; however, negative effects to the leakage test because of changes in temperature during the test period or because of flexible deformation of the test piece cannot be avoided with this method either.

5.5.2 Volume flow measurement

For this method the test piece is also filled via a bypass pipe with a large cross-section. At the end of the filling process, the bypass valve is closed. The air escaping from the test piece is led to a laminar flow element. The pressure difference generated in laminar flows is directly proportional to the volume flow and can therefore be used as a measured value.
The method is especially suitable for testing parts with a large volume and medium to larger permissible leakage rate, and for checking a target flow. The method is only a little temperature-sensitive with comparably short test cycles.

5.6 Volume measurement (option)

Besides leakage and flow testing, the leakage testing system INTEGRA can also measure and evaluate volume (optional). Measuring the volume is a modification of the relative pressure testing method and can be divided principally into two different methods.

5.6.1 Volume testing with Test Leak

For this testing method the test piece – as with the relative pressure test method - is impinged with test pressure and the pressure decay resulting when a test leak is connected is measured. From the drop in pressure and the known volume flow of the test leak, the connected test piece volume can be calculated.

5.6.2 Volume testing with reference volume

For this method a reference volume is first impinged with test pressure and subsequently the test piece is connected. The final pressure reached after connecting the reference volume is proportional to the test volume. This method is especially suited for obtaining more accurate measuring results for small test volumes; because of the need for a reference volume and an additional separating valve, this method is somewhat more expensive.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 | Fax +49 (0)7151 973636 | info@drwiesner.de | www.drwiesner.de

6 Differential method

For tests using the relative or differential-pressure method, the Leakage Testing System INTEGRA allows evaluation according to the differential method as an alternative to the usual delta-p evaluation.

Evaluation according to the differential method has the following advantages:

- less variance of measuring values,
- shorter test periods since no increased safety factors are necessary,
- simplified set up procedure of a leakage test job,
- display of measured value as change in pressure per time unit (e.g. mbar/s) or volume flow (e.g. ml/min) as desired.

The differential method is based on the continuous mathematical analysis of the pressure or vacuum flow during the test. Due to the sliding differential representation of the first order, an almost constant display value is reached after a short time during the test period that is free of random influences from different behavior of the test subjects.
This constant display value can be easily recognized by the operator and indicates a sufficient length of all time-controlled processes.

At the beginning of the test period, the steady signal is adversely affected by disturbances.
When using the evaluation according to the delta-p process, a relatively long test period is necessary due to the resulting variance to achieve a sufficient distance between “good” and “poor”.
When evaluating with the differential method, a valid and stable result with significantly less variance is achieved much earlier.

Because of the constant display value, it is much simpler for a less experienced operator to determine a sufficient test period.
Extensive measuring series to determine the necessary process time are no longer necessary.

Setting the filling and damping period is also much less critical.
If these times are set too short, more noise is generated at the beginning of the test period. Because of the mathematical analysis of the measuring values in the differential method, noise at the beginning of the test period is automatically suppressed.
Measurement series have shown that if filling or damping time is too short, the necessary test time extends so that the overall duration of the test process is almost unchanged.

7 *autoTune* method (option)

The *autoTune* method is the extension of the differential method. With the *autoTune* method, the procedures and evaluation made possible by the differential evaluation are carried out automatically.
The operator only has to enter the so-called optimization degree specifying the strictness for which the test parameters are to be set. The system then automatically carries out a process optimization with a connected test volume and a test leak, i.e., it sets the necessary process times for each test step. The higher the optimization degree the longer the process times will usually be (see also *chapter 11.3.7*).

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

8 Conditions for optimal leak testing

When testing for leakage or flow using air, some basic prerequisites must be met to achieve the desired test significance. This will be demonstrated using the components involved in the test process.

8.1 Test piece

First of all, the test piece should be dry and as free of contaminants (on the inside, too) as possible before it is inserted into the test device. In addition, it should have reached room temperature. If the test piece was heated, e.g. by a prior production process, an intermediate storage must be available for the pieces to cool. The areas where the test piece is sealed with the adaptation of the test device must not have any damages.

8.2 Test appliance

The test appliance should be set up in a place with little temperature variation. Avoid places that can be exposed to direct sunlight or close to machines radiating strong heat. Drafty spots next to doors or floor conveyor passages should be avoided as well. If necessary, shields must be installed.
A pipe conduct is the optimal connection of test device and test appliance. If this is not possible, a hose of sufficient stability should be used. This avoids bursting under test pressure and flexible distortions of the test volume, which would affect the test results. The pipe should be as short as possible to minimize the test volume. The pipe should be laid in such a way that it cannot be damaged or bent. In the case of vacuum testing a filter with mesh size <50µm should be mounted in this pipe to prevent the absorption of dust into the inside of the test device.
The test appliance should be constructed in such a way that the test piece cannot be damaged during insertion or adaptation. Furthermore, the sealing materials must conform to the conditions at the sealing spots of the test piece. It must be ensured that the adaptation does not exert forces onto the test piece which may seal possible leakage. The forces should be adapted to the given test pressure.

8.3 Test medium

The test medium to be used testing for leakage with the Leakage Testing System INTEGRA is mainly compressed air, vacuum, or, less frequently, nitrogen.
When using compressed air it should conform to quality class 4 acc. DIN ISO 8573-1. Pipe pressure should be at least 1 bar higher than the desired test pressure. If the pipe pressure varies strongly, a pressure regulator should be built in. If the pipe pressure is too low, a pressure intensifier or an additional compressor must be used. The nominal width of the pressure pipe should be adjusted to the supposed consumption. (This is especially important for large test pieces or high pressures.)
Since the temperature of the compressed air has a decisive influence on the leakage test, the air flowing into the test piece should have room temperature. Avoid using too cold or too warm fresh air to generate the compressed air.
If using vacuum for leakage testing, a vacuum pump suitable for the desired vacuum must be used. Usually, maintenance-free membrane vacuum pumps are used; to achieve a better vacuum, oil-sealed slide vane rotary vacuum pumps must be used. Please note that the direction of pressure for vacuum is reverse to that of the excess pressure testing. Thus, the strain on the test piece during admission is also reverse. When testing with a vacuum, the nominal width of the supply pipe must be sufficient.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

8.4 Test device

The test device, like the test appliance, should be set up in a suitable place where neither heat nor mechanical shocks can influence the test results.
The test device should be as close to the test appliance as possible to keep the test volume as small as possible. For multiple-circuit systems, where each test circuit has its own casing, it is also advisable to keep the pressure pipes of the test circuits as short as possible. The operating panel of the test device should be visible and accessible at any time. Also ensure accessibility for maintenance purposes. The test device should never be built into a closed cupboard without heat exchange or air-conditioning.
Before the beginning of test cycles there should be await a warm-up time of about 10 minutes after switching on the device. Through this it will be avoided a minor drift of the measuring results caused by temperature.

8.5 Test leak

A test leak is suitable for adjust the limits and for quick check of the system. If it's connected with the rapid action coupling on the front panel, a leakage is simulated. If the test leak is adapted to the allowed limit and a seal test specimen is connected to the system, the pressure rise or decay generated by the test leak determines the limit for the evaluation in the relevant test methods. It's recommended to adjust the limit so that the evaluation of a test with coupled test leak is NOK. Test leaks are basically consisting of a glass capillary which allows a defined volume flow per time unit. The test leaks should be stored that way to protect them from shocks and dirt. The best way is to store them in a optional available case. If the Leakage Testing System INTEGRA is equipped with the option *switchable test leak*, the test leak can remain permanent in the rapid action coupling.

9 Setup

The Leakage Testing System INTEGRA comes in a desktop casing that can be used as a desk casing or a 19" slot in combination with optionally available angle fixtures. The casing dimensions are 450 x 180 x 380 mm (width x height x depth).
The front panel contains all controls and a fully graphical color display. In addition, there is a rapid action coupling for connecting a test leak on the front panel.
On the back panel of the device are all pneumatic, electrical and electronic connections and interfaces (cf. Chapter 10).
The Leakage Testing System INTEGRA can be equipped for asynchronous multiple-circuit tests. Up to 3 test circuits can be connected altogether, with one test circuit usually in the base device, but it is also possible to house up to 3 test circuits in separate casings. The external test circuits are supplied with test pressure by the base device; optionally they can be equipped with their own manual pressure regulators.

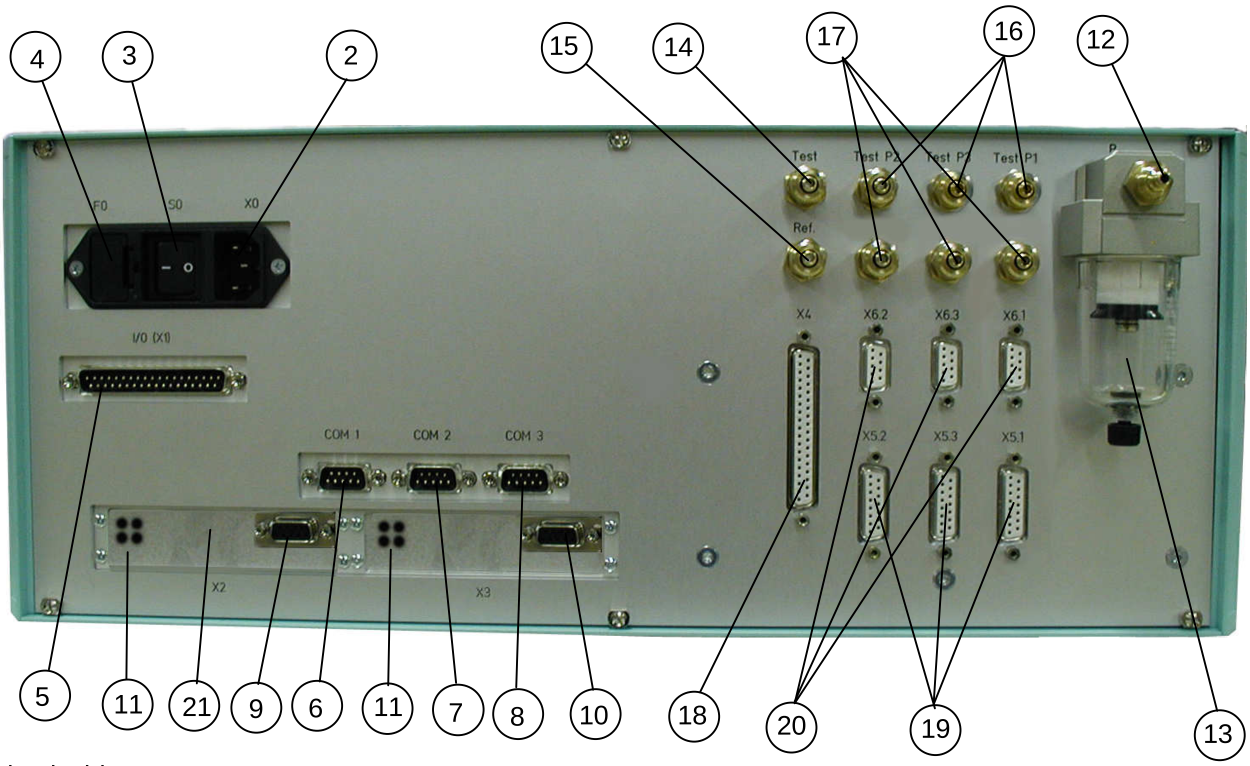
Depending on the test method and configuration, each test circuit contains
- an input filter,
- test pressure regulation using a proportional pressure valve or manual precision pressure regulator (optional for external test circuits),
- a piezoresistive relative-pressure absorber
- a capacitive differential-pressure transmitter (for differential-pressure method and volume flow measurements)
- a mass flow sensor (for mass flow measurements),
- a Laminar Flow Element (for volume flow measurement) and
- various test valves.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4 D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636 | info@drwiesner.de www.drwiesner.de

10 Interfaces

All electrical and pneumatic outputs and interfaces are on the back panel. Only the rapid action coupling for connecting a test leak is on the front panel. The device will be switched on by the mains switch S0 (3) at the back side.

front



back side

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

No.	Designation	Meaning
1		Test leak connection
2	X0	Power supply connector
3	S0	Mains switch
4	F0	Main fuse
5	I/O (X1)	Digital I/O interface (e.g. for connecting to a superior control system); *37-pin Sub-D* (assignment cf. appendix) Allocated for multiple-circuit systems!
6	COM 1	serial interface RS232 (e.g. for PC) (settings cf. appendix)
7	COM 2	serial interface RS232 (e.g. for printer) (settings cf. appendix)
8	COM 3	serial interface RS232 (e.g. for bar code scanner) (settings cf. appendix)
9	X2	Bus interface with built-in coupling module e.g. for Profibus, Interbus (optional)
10	X3	Bus interface with built-in coupling module e.g. for Profibus, Interbus (
11		Status LED
12	P	Connection for pressure supply (vacuum connection on vacuum devices); *4/6 hose*
13		Filter
14	Test	Connector to test piece; *4/6 hose*
15	Ref.	Connector to reference volume (usually blocked); *4/6 hose*
16	Test P1 Test P2 Test P3	Test pressure connectors for up to 3 external test circuits; *4/6 hose*; (optionally)
17		Spare connectors for custom-built devices (e.g. control pressure for external test circuits); *4/6 hose*
18	X4	Digital I/O interface for connection to X1 when using external test circuits; *37-pin Sub-D*; (optional)
19	X5.1 X5.2 X5.3	Digital I/O interface for up to 3 external test circuits; *15-pin Sub-D*; (optional)
20	X6.1 X6.2 X6.3	Analog interface for up to 3 external test circuits; *9-pin Sub-D*; (optional)
21		cover for addressing switch

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

10.1 Serial interfaces

The three built-in serial interfaces COM1, COM2 and COM3 are set to the following data format:

115200	bps
1	start bit
8	data bits (ASCII characters)
1	stop bit
	no parity check

The settings of COM1 and COM2 cannot be changed. COM3 can be configured.

For a detailed description of the interface refer to the appendix *Serial Interface*.

10.2 Digital I/O interface

The leakage testing system **INTEGRA** is equipped with a digital I/O interface featuring a 37-pin D-Sub connector.
According to DIN EN 61000-6-2 / table 3, cable length is limited to 10 m.
The single-/total-capacity of the outputs is 500 mA
When using multiple circuit systems, the interface is used to control the additional test circuits. Therefore, as a standard, the base device for multiple circuit systems contains a PROFIBUS slave interface.

For the allocation of input and outputs refer to the *Digital I/O Interface* appendix.

10.3 PROFIBUS interface (option)

The leakage testing system **INTEGRA** can optionally be equipped with a PROFIBUS coupling module, thus allowing for the operation in an automated manufacturing facility. The installation of the slave-module in slot X2 and the master-module in slot X3 is standard.
<u>Caution:</u> Special applications could necessitate a differing assignment of the slots.
Addressing switches can be found underneath the panel (left units, right tens).
Inputs and outputs are freely configurable.
The assignment is described in the *I/O bit number assignment table* appendix.
The status LEDs (11) indicates as follows:

1 (top left): not used
2 (top right/green): module is online
3 (down right/red): module is offline
4 (down left/red flash): error

10.4 INTERBUS interface (option)

The leakage testing system **INTEGRA** can optionally be equipped with a INTERBUS coupling module, thus allowing for the operation in an automated manufacturing facility too. The installation of the module in slot X2 is standard.
<u>Caution:</u> Special applications could necessitate a differing assignment of the slots.
The baudrate is selected by jumper (500 kbit/s or 2 Mbit/s).
In the **INTEGRA** 8 bytes process data and further 20 bytes PCP-data are provided. In the PCP-array e.g. the numerical measuring result could pass (see also *chapter 18*). The correlation between the Interbus-data and the internal **INTEGRA** dataports is indicated in the list of *chapter 18.4*.
From Interbus side the PCP-output data could be read via PCP-data index 0x6040 (20 bytes).
The status LEDs (11) indicates as follows:

1 (top left/green): cable connection is good and the Interbus master is not in reset mode
2 (top right/green): bus active
3 (down left/yellow): remote bus disabled
4 (down right/green): PCP-communication is active

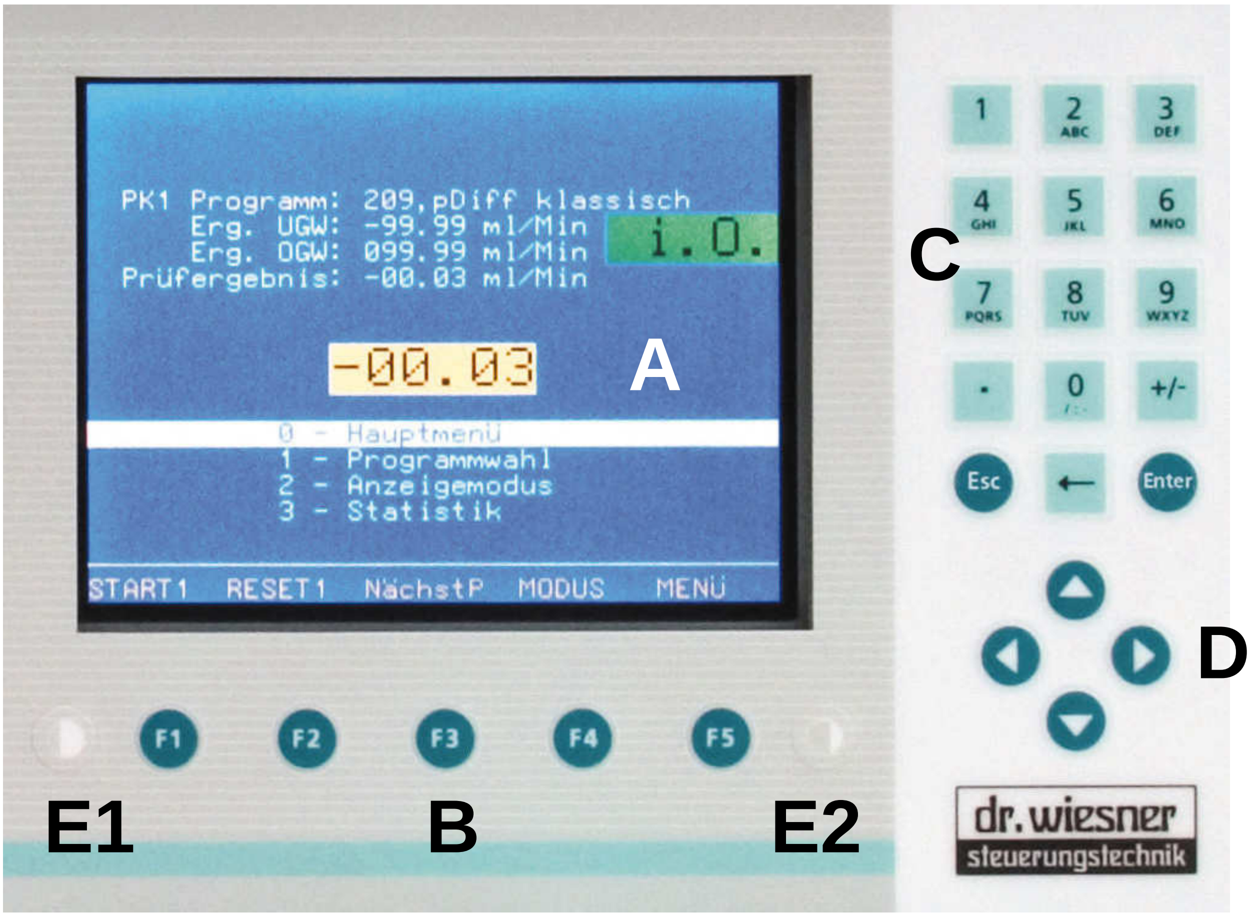
Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

11 Operation

11.1 Control and display elements

The Leakage Testing System INTEGRA is equipped with the following control and display elements:

A Fully graphical LCD display
B Soft keys [F1...F5]
C Keypad with alphanumerical keys
D Cursor keys
E Contrast control of display (E1 darker, E2 lighter)



Note:
Use the keypad only manually. Never use spiky or hard things for pressing the keys! Don't use the keypad with dirty fingers, especially in contact with solvent based substances, oils or fats.

Dr. Wiesner
Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

11.2 Basic screen (standard)

After switching on the device using the mains switch S0, the basic screen is displayed (see also *chapter 11.3.2*).

The program that was active when switching off the device, and the upper and lower limiting values are displayed.
In the middle, the release number of the integrated software is displayed.

By pressing the cursor keys (D) and then confirming with the [Enter] key, or by using the alphanumerical keypad (C), the main menu [0], the program selection [1], display mode [2] or statistics [3] can be selected

Use the [F5] key to enter the main menu.
Use the [F1] key to start a test directly.
Use the [F2] key to stop a test and, by pressing it again, to abort the test.
Use the [F3] key to switch between different test circuits (for multiple-circuit systems).

```
  PK1 Program: 034,pDif. Differential
Result LoLimit: -99.99 ml/min
Result HiLimit: 099.99 ml/min

   INTEGRA Leak Test System
        Version 01.06


        0 – Main Menu
        1 – Select Program
        2 – Change Display Mode
        3 – Statistics

START1   STOP1   NextPro   MODE   MENU
```

Use the [F4] key to switch between different display modes.

During the test run, the current relative pressure, the remaining time for the test step and the current differential pressure respectively the calculated leakage rate are displayed.
The current test step and the current measurement value are clearly displayed in two yellow text boxes.
At the end of the test, the test result is displayed instead of the current value.
In addition, the test result is displayed as OK/NOK on a green respectively red field, and numerically as measurement value in a yellow field.
If in the base data set the option *Acknowledge NOK* (see also chapter 12) is activated, an NOK test result must be acknowledged by pressing [F2] before a new test can be started.

```
  PK1 Program: 034,pDif. Differential
Result LoLimit: -99.99 ml/min      o.k.
Result HiLimit: 099.99 ml/min
Result of Test: 000.00 ml/min

            000.00

        0 – Main Menu
        1 – Select Program
        2 – Change Display Mode
        3 – Statistics

START1   STOP1   NextPro   MODE   MENU
```

11.3 Main Menu

The main menu displays all submenus.
By pressing the cursor keys (D) and confirming with the [Enter] key, or by using the alphanumerical keypad (C), program selection [1], display mode [2], statistics [3], program parameter [5], base data [6], self optimization *autoTune* (optional) [7], data administration [8], diagnostics and setup [9], or the system configuration [0] can be selected.
Press the [F5] key to return to the basic screen. If the protection of protected parameters (e.g. program parameters, cf. *chapter 11.3.5*) is switched off by entering a password, the protection can be turned on again by pressing the [F4] key.

```
--------------------Main Menu--------------------

1 – Select Program
2 – Change Display Mode
3 – Statistics

5 – Edit Program Parameters
6 – Edit Base Data
7 – Self-Optimization (autoTune)

8 – Data Administration
9 – Diagnostics & Setup
0 – System-Configuration

                              01-01-06,13:09:15
          Trace             LogOut    BACK
```


Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4 D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636 | info@drwiesner.de www.drwiesner.de

Press the [F2] key to return to the Trace function. Use this function to output selected data gathered by a running test automatically via one of the serial interface.
The pressures, I/O signals etc. depend on the running test. The output is done in table fashion facilitating further processing of the data (e.g. using Excel).
Note: When restarting the device, all Trace options are reset to the default values. This is a safety measure to prevent a generating a high volume of data traffic without explicit operator action.

```
Trace Options

      Mode: no output
    Format: CSV
  Circuits: all

      Port: Com2

                                   BACK
```

The Trace options could be adjusted as follows:

Mode:

no output:	No output of trace data (default)
each cycle:	Data is output after every measuring cycle (for standard devices approx. 10 times/sec). No output of time information
only when changed:	Data output only when data has changed. The output contains a time stamp displaying the elapsed time since the program was started in [ms].

Format:

tabulated:	The data columns are separated by a TAB (ASCII 8)
CSV:	The data columns are separated by a comma (default)

Circuits: You can select any combination of test circuits. Default: *all*.

Port: You can select one of the interfaces *Com1* to *Com3*. Default: *Com1*
It is possible (and often necessary) to name an interface that is already (also) used by other communication tasks such as a protocol of the test results. It is up to the communication partner to direct the data stream properly.

11.3.1 Program selection

Use this submenu to select the desired test program for each test circuit.
For single-circuit systems the various test circuits can be used to allocate different programs. With multiple circuit systems each test circuit is allocated an actual physical test circuit.
By moving the cursor to the corresponding program line and pressing the [Enter] key, the desired program number can be entered and confirmed by pressing the [Enter] key again. If the program hasn't been saved, it is not accepted.

```
Window 1     PK1 Program:  209,pDif. Classic
                 Program:  209

Window 2     PK2 Program:  210,pDif. Classic
                 Program:  210

Window 3     PK3 Program:  211,pDif. Classic
                 Program:  211

Prg.Dir   SAVE              NextPro   BACK
```

Use the [F1] key to call up the program directory where all programs are listed (see also *chapter 11.3.8.3*). Besides the program number, the corresponding base data set (BDS), the program name, and

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

the type of program are given. By moving the cursor to the desired program, the program can be edited ([Enter] key), the program parameters (see also *chapter 11.3.5*) ([F3] key), or the corresponding base data set ([F4] key) can be called up.

If you press the [F2] key to leave the submenu, selections are saved permanently. If you leave the submenu by pressing the [F5] key, the selections are retained only until the device is switched off.

Note!
Initially, the basic screen displays the program that was active so far, the corresponding limit values and the last test result. The newly selected program number is only displayed in the header separated by a slash from the old one. (In the example to the right, program no. 209 has been active so far, the newly selected program is no. 123.) As soon as the new program is started by pressing the [F1] key or by pressing the [F2] key once or twice, the display of the old program is cleared and the newly activated program with its corresponding parameters is displayed.

```
      PK1 Program: 123/209,pDif. Differential
   Result LoLimit: -99.99 ml/min   o.k.
   Result HiLimit: 099.99 ml/min
   Result of Test: 000.00 ml/min

              000.00

           0 – Main Menu
           1 – Select Program
           2 – Change Display Mode
           3 – Statistics

START1  STOP1  NextPro  MODE  MENU
```

11.3.2 Display Mode

Choose this submenu to select the display of the basic screen.
The standard display [0] has already been described in *chapter 11.2*.

```
              Display Mode

0 – Default (Short Menu + Prg.Window 1)

1 – Program Window 1 as Full Screen

2 – 2 Program Windows stacked

3 – 3 Program Windows stacked

4 – Curve: Most Recent Test

                                   BACK
```

In display mode [2] only the limit values set for evaluation and the test result are displayed. Two program windows are visible.

In full screen mode [1] not only the limit values set for evaluation and the test result but also the pressure values after each test step and the resulting pressure value profile are displayed.
Use the cursor keys to display all program parameters (see *chapter 11.3.5*) and base data (see *chapter 11.3.6*) and to browse up or down.

Use the [F1] key to start a test and the [F2] key to stop it. By pressing Pause, the process is interrupted at the end of the step currently carried out. The time display continues but with a negative sign. Furthermore, a blinking white bar displays the text *Stopped*. Use the [F1] key to restart a test and the [F2] key to abort it.

```
      PK1 Program: 209,pDif. Classic
   Result LoLimit: -99.99 ml/min   o.k.
   Result HiLimit: 099.99 ml/min
   Result of Test: 000.00 ml/min

     pRel at Filling: +500.00 mbar
         pRel Stable: +499.00 mbar
 pDif at Separation: -0.032 mbar
           pRel Tara: +498.00 mbar
           pDif Tara: -0.031 mbar
           dpRel/dt: +0007.750 mbar/min
              dp/dt: -0001.750 mbar/min

START1  STOP1  NextPro  MODE  MENU
```


Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

Use the [F3] key to switch between different test circuits (for multiple-circuit systems).
Use the [F4] key to switch between different display modes.

In display mode [2] only the limit values set for evaluation and the test result are displayed. Two program windows are visible.

In display mode [3] only the limit values set for evaluation and the test result are displayed. However, three program windows are visible.
Use the cursor keys to browse up or down through the parameters.
Use the [F1…F3] keys to start each test circuit.
Use the [F4] key to switch between different display modes.
In display mode [4] the march of the various pressures for the prior test is displayed as a curve.
Especially the march of the test pressure and that of the differential pressure (differential pressure method only).
Refer to *chapter 15* on how to operate the graphics display.

```
          PK1 Program: 209,pDiff Classic
        Result LoLimit: -99.99 ml/min    o.k.
        Result HiLimit: 099.99 ml/min
        Result of Test: 000.00 ml/min

          PK1 Program: 209,pDiff Classic
        Result LoLimit: -99.99 ml/min    o.k.
        Result HiLimit: 099.99 ml/min
        Result of Test: 000.00 ml/min

          PK1 Program: 209,pDiff Classic
        Result LoLimit: -99.99 ml/min    o.k.
        Result HiLimit: 099.99 ml/min
        Result of Test: 000.00 ml/min

START1    START2    START3    MODE    MENU
```

11.3.3 Statistics

Here, the statistical evaluation of the test results is displayed.
The second to fourth line displays the number of all started tests totaled and spared in pass and fail including the tests that did not yield any results (e.g. because they were aborted).
In the lower part of the display the tests related to the test circuit or attribute are indicated.
Count Total displays the tests that yielded an OK or NOK result.
The minimum, maximum and mean values refer only to tests that resulted in OK.
Press the [F1] key to display the statistics for the active test circuit, the [F2] key for the statistics of all test circuits.
Use the [F4] key to display statistics graphically (cf. *chapter 15*).

```
      Program: 209,pDif. Classic
        Tests:    0
  Tests Pass :    0
  Tests Fail :    0

 Test Circuit: 1
    Attribute: pDif Delta

  Count Total:      0
  Count Pass :      0
  Count Fail :      0
         Min.: 000.00 mbar
         Max.: 000.00 mbar
         Mean: 000.00 mbar

One TC    All TC    FUNC    GRAPH    BACK
```

Use the [F3] key to switch the functions of the [F1] and [F2] keys as follows:

In this mode, press the [F1] key to print the statistics. Use the [F2] key to print all data from the cyclic buffer. To print, select the appropriate interface (COM1 … COM3) from the selection dialog using the [F1] … [F3] keys.

```
      Program: 209,pDif. Classic
        Tests:    0
  Tests Pass :    0
  Tests Fail :    0

 Test Circuit: 1
    Attribute: pDif Delta

  Count Total:      0
  Count Pass :      0
  Count Fail :      0
         Min.: 000.00 mbar
         Max.: 000.00 mbar
         Mean: 000.00 mbar

PrnStat   PrnMem    FUNC    GRAPH    BACK
```


Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 | Fax +49 (0)7151 973636 | info@drwiesner.de | www.drwiesner.de

```
        Program: 209,pDif. Classic
          Tests:    0
    Tests Pass :    0
    Tests Fail :    0


   Test Circuit: 1
      Attribute: pDif Delta

    Count Total:      0
    Count Pass :      0
    Count Fail :      0
           Min.: 000.00 mbar
           Max.: 000.00 mbar
           Mean: 000.00 mbar

Del.All   Del.Pg    FUNC      GRAPH     BACK
```

In this mode, press the [F1] key to delete all data from the cyclic buffer (thus all statistical data is deleted also). Press the [F2] key to delete only the data referring to the selected program.
To delete the data, you must enter a password. After entering the password, a second confirmation is necessary before deletion takes place.

11.3.5 Program Parameters

```
                Program: 209,pDif. Classic
      Pressure Setpoint:  0.000 bar
              Fill Time:     5.0 s
         Stabiliz. Time:     5.0 s
           Testing Time:     5.0 s
         Result LoLimit: +0.000 l
         Result HiLimit: +0.000 l
---------------------------------------------------
              Deflating: Time-Controlled
           Deflate Time:     2.0 s
                Marking: No Marking
           Marking Time:     0.0 s
---------------------------------------------------
Local Conversion
       Reference Volume: +0.000 l
            Dead Volume: +0.000 l
        Leak Volume/min: +0.000 l

PRINT                Bas.Dat   Ext.Par   BACK
```

Here you can enter or change the most important program parameters. The meaning of each parameter is explained in *chapter 14.1*.
For input, the cursor must be moved to the selected parameter. After pressing the [Enter] key, enter the password and press the [Enter] key again. Then you can enter the parameter value. If the password has already been activated, data can be entered directly. For input use the alphanumerical keypad or press the cursor key for given selections. Confirm by pressing the [Enter] key again.
Parameters are saved automatically when exiting the menu using the [F5] or [Esc] key.

Use the [F3] key to select the corresponding base data set (see *chapter 11.3.6*).
Start entering input after pressing the [Enter] key. If the specified base data set does not exist, input is not accepted.
Use the [F4] key to set or change extended parameters (see *chapter 14.1*).
Use the [F1] key to print the program parameters. To print, select the appropriate interface (COM1 … COM3) from the selection dialog using the [F1] … [F3] keys.

11.3.6 Base Data

```
      Base Data Set :  001
   Fail Ack required: No
  Volume Data Format: %f61 ml (Format)
    Reference Volume: 25.6 ml
         Dead Volume: 11.4 ml
     Leak Volume/min:  2.0 ml
   Prg.Active Output: 000
     Physical Dim. 1: Rel.Pressure (Dim)
              Format: %f73 bar (Format)
              Offset:   0.00000bar
           Nominator:   0.001 bar
         Denominator:   0.00100bar
       Analog Output: Voltage (Dim)
              Format: %f63 V (Format)
              Offset:   0.000 bar
           Nominator:   0.001 V
         Denominator:   0.001 bar

PRINT                                   BACK
```

Here you can enter or change various program-independent basic settings, formatting and scaling. The meaning of base data is explained in *chapter 14.3*.
Each test program accesses a base data set. A base data set can be used for an unlimited number of test programs. The assignment is defined when a program is created. (see also *chapters 13.4.8.1* and *12.*)
Use the [F1] key to print the base data. To print, select the appropriate interface (COM1 … COM3) from the selection dialog using the [F1] … [F3] keys.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

11.3.7 Self-Optimization *autoTune* (optional)

```
------------------autoTune-------------------------
         PK1 Program: 209,pDif. Classic


         Tuning Factor:     85 %

     Pressure Setpoint:  0.500 bar

             Deflating: Time-Controlled
          Deflate Time:     2.0 s







Start                                        Cancel
```

Here you can optimize the program parameters of the selected program automatically.

The following parameters must be entered first:

Tuning Factor: Enter the degree of test process optimization quality with regard to gauge capability in [%] between 1…99.

Pressure Setpoint: Enter here the target value of the filling pressure.
The default equals the filling pressure entry in the program parameter set. If the filling pressure is changed here, it will be transferred to the program parameters after optimization is done.

Deflating: Selection or deactivation of deflating of test piece.
Here you can select whether deflating of the test piece is time-controlled, controlled by a pressure limit value, or deactivated.

Deflate Time: Time period between beginning and end of the deflating procedure.

The default parameters (except *degree of optimization*) equal the entries in the program parameter set. If these are changed, the changes are transferred to the program parameters after running *autoTune*.

After connecting the test piece and a test leak, *autoTune* can be started by pressing the [F1] key. Since the test process is optimized to the inserted test leak, the test leak should be such that its leakage rate equals the minimum leakage to be detected.
The system then calculates the optimal process time periods automatically. After completing the optimization cycle, the display switches automatically to the program parameter set to show the newly generated parameters or, if necessary, to correct them manually. To confirm the parameters, leave the menu window by pressing the [F5] or [Esc] key.

The individual time periods and the overall process time created (plus emptying) are shown in display mode [2] on the display.

```
          PK1 Program: 209,pDif. Classic
       Result LoLimit: -0099.0
       Result HiLimit: +0099.0
       Result of Test: -0032.347 mbar/min



                  Sum:    16.7 s


            Fill Time:     1.2 s
       Stabiliz. Time:     2.8 s
         Testing Time:     1.1 s
      Filter Interval:     0.3 s
    Differential Pace:     0.8 s
                dp/dt: -0001.750 mbar/min
               E.Rate:     0.4%/s

START1    STOP1     NextPro    MODE      MENU
```


Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

11.3.8 Data Administration

Here you can create, copy, delete or edit new programs and base data sets.
In addition, the various passwords can be changed.
Use the [F1] key to edit all display texts and the [F3] key to edit all format texts.

```
                Data Administration

1 – Create New Program
2 – Duplicate Existing Program
3 – Delete Existing Program
4 – Program Directory

5 – Create New Data Base Set
6 – Duplicate Existing Base Data Set
7 – Delete Existing Base Data Set

8 – Special functions
9 – Edit passwords

F1 – Edit display-texts
F3 – Edit formatting-texts

Texts                Formats              BACK
```

11.3.8.1 Create new program

At first, the desired testing method must be selected using the numerical keyboard or the cursor and the [Enter] key.
If the device does not have the option *Volume measurement*, the key [7] is without function.
In the next display, the program number and the desired corresponding base data set must be chosen. By pressing the [F1] key, the new program is created. If the desired program is already allocated, input is refused. You either have to select a different program number or delete the existing program.
(See also *chapter 12,* parameter setting)

```
          Select Progr.Type / Test Method

1 – pDif. Classic
2 – pDif. Differential
3 –
4 – pRel. Classic
5 – pRel. Differential
6 –
7 – Volume
8 – Flow
9 -


0 – Custom tests

                                          BACK
```

11.3.8.2 Duplicate/delete existing program

When duplicating a program, the program number (source) to be copied must be entered first, then the new program number (target). If the desired program is already allocated, input is refused. You either have to select a different program number or delete the existing program. Pressing the [F1] key executes each action.

11.3.8.4 Program directory

Press the [4] key to call the program directory. If the cursor is moved to the appropriate program line, the program name can be created or changed by pressing [Enter]. A text box appears in which a name can be entered using the alphanumerical keyboard. Press [Esc] to exit the text box.
If you press [F1] while in the program directory, the name of the program selected is deleted.
Use the [F3] key to call the program parameters and the [F4] key for the corresponding base data set.

11.3.8.5 Management of base data sets

Managing base data sets is done in analogy to program management.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

11.3.8.8 Special functions

11.3.8.8.1 Fix datablock sizes

This function enables you to change the size of existing sets of program data generated with firmware versions <1.3 to the new size. After execution, the number of blocks updated and the possible occurrence of problems is shown on the display. Save the changes by pressing the [F1] key, delete them by pressing the [F5] key (reset without save).

11.3.8.9 Password management

Three password hierarchies are provided:
Password 1 is the lowest hierarchical level, e.g. for head of shift.
Password 2 is, for example, for set-up personnel, and password 3 for system administrators.
To create or change a password, the new password has to be entered and repeated in the following line as confirmation.

11.3.9 Diagnostics & Setup

Use sub-menu 1 to change date and time. Enter in this order: year, month, day, hour, minutes, and seconds. By pressing [F1] the newly entered date and time are accepted.
Besides deleting the fixed value memory and data buffer memory, all interfaces can be tested in this menu.
Enter sub-menu 0 to set a calibrating time stamp showing the date of the last calibration.
The Program Debug mode is intended for checking special programs and mostly used by manufacturer's service personnel.

```
1 – Set Date/Time

2 – Erase Permanent Memory

4 – Erase Data Buffer Memory

5 – Check COM-Interfaces
6 – Check AnyBus Module #1
7 – Check AnyBus Module #2

8 – Analog I/O
9 – Digital I/O
0 – Set Calibration Timestamp
    Last Calibrat.:05-01-28, 15:29:20

± - Program Debug View

          SAVE      Boot      BootRom    BACK
```

Use the [F2] key to save system data manually, and [F3] to reboot the entire system. [F4] is reserved for the manufacturer's service personnel.

11.3.10 System Configuration

Use this menu to set the basic settings of the system.
By moving the cursor to the appropriate row and pressing [Enter], it is possible to enter text using the alphanumerical keyboard or by selecting text using the cursor keys.

The following entries can be edited:
- Set language
- Format of the system date
  (e.g. YY-MM-DD) Y = year, M = month, D = day
- Set display mode when system is switched on
- Activate automatic reset of analog output (test pressure) for resetting the built-in pressure proportional regulating valve to zero after each test

```
          System Configuration
             Language: English
                 Date: YY-MM-DD
         Display Mode: Default
Auto-Reset An.Output: Yes
           Device-Id.: 000
       Ser.Port2 Mode: Table
       Ser.Port3 Mode: Text
         TC Interlock: No
           Serial No.:    5.1234
Circuit 1----------------------------------------
       Main Program:  209
    iof PrgSelect 1:  000
    iof PrgSelect 2:  000
    iof PrgSelect 3:  000
    iof PrgSelect 4:  000
    iof PrgSelect 5:  000
    iof PrgSelect 6:  000

PRINT                                     BACK
```


Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

- Setting a device identification number; when using several leakage test systems, a device assignation can be achieved, e.g. when printing statistical data.
- Setting the output format of the serial interface COM2 and COM3
- Activating mutual locking of individual test circuits prevents simultaneous starts of test circuits when they can affect each other.
- Serial no.; here you can find the manufacturer's serial number.

The other settings are used mostly by the manufacturer's service personnel.

Use the [F1] key to print the system configuration. To print, select the appropriate interface (COM1 … COM3) from the selection dialog using the [F1] … [F3] keys.

12 Parameter setting

After switching on the leakage testing system, the basic screen (*chapter 11.2*) is displayed.
Press the [1] key to activate program selection and to select a program as described in *chapter 11.3.1*.
When setting system parameters for a new test task, it is recommended to create a new program.
Proceed as follows:

As described in *chapter 11.3.8.1*, the depicted display can be reached via data management.

First select the test method or program type (classic or differential).
In the next display, the program number desired and the corresponding base data set must be entered; confirm by pressing [F1].
For all test methods or program types, the function *Acknowledge NOK* can be activated or de-activated in the base data set.

The following test methods or program types can be created:

```
Select Progr.Type / Test Method

1 – pDif. Classic
2 – pDif. Differential
3 – pDif. autoTune
4 – pRel. Classic
5 – pRel. Differential
6 – pRel. autoTune
7 – Volume
8 – Flow
9 -

0 – Custom tests

                                    BACK
```

12.1 Differential pressure test method classic (pDiff classic)

With the classic differential pressure method, parameter setting is done using manual setup of program parameters according to *chapter 11.3.5*. The meaning of the parameters is explained in *chapter 14*. When setting the various process time periods (e.g. filling, damping, testing, deflating) manually, the conditions for an optimal leakage test according to *chapter 7* must be observed. The best way to visualize the pressure value profiles is to use the graphical display according to *chapter 15*. To simplify setting the time-periods, use the optional self-optimization *auto-Tune* (see *chapter 11.3.7*).
Usually, the test result is displayed in [mbar] pressure rise or decay. To set the limit values of the test results, a test leak should be inserted into the fast coupling of the front panel after setting the parameters and a known tight test piece connected. If possible, the test leak should be adjusted to a leakage rate close to the permissible limit value. The pressure rise or decay thus caused can then be taken as the limit value.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

12.2 Differential pressure test method with differential evaluation (pDiff differential)

The difference between the differential pressure method with differential evaluation and the classic differential pressure method is the evaluation (see *chapter 6*). As with the classic differential pressure method, parameter setting is done using manual setup of program parameters according to *chapter 11.3.5*. The meaning of the parameters is explained in *chapter 14*. When setting the various process time periods (e.g. filling, damping, testing, deflating), the *conditions for an optimal leakage test* according to *chapter 7* must be observed. The best way to visualize the pressure value profiles is to use the graphical display according to *chapter 15*. To simplify setting the time periods, use the optional self-optimization *auto-Tune* (see *chapter 11.3.7*).

Usually, the test result is displayed in [ml/min] leakage rate or [mbar/min] pressure rise or decay. To set the limit values, a test leak should be inserted into the fast coupling of the front panel after setting the parameters and a known tight test piece connected. If possible, the test leak should be adjusted to a leakage rate close to the permissible limit value. The first test will display a fictitious leakage rate. To display the correct leakage rate, the parameters must be changed in the base data set or, program-specific, under *local conversion*. Proceed as follows (example set of base data):

Press the [F5] key to enter the main menu.
Press the [6] key to access the base data set.
In the base data set the following parameters must be set (select using the cursor keys):
Physical Dim.Leakrate: set to *Leak rate*
Format: set to ml/min (format)
Offset: +0000.000 mbar/min
Nominator: Enter the nominal leakage rate of the test leak in [ml/min]
Denominator: Enter the displayed pressure decay/rise rate in [mbar/min]

```
         Base Data Set :  001
     Fail Ack required: No
     Prg.Active Output: 000
   Physical Dim. dp/dt: dp/dt (Dim)
                Format: %f72 mbar/min (Format)
                Offset: +000.000 mbar/min
             Nominator:    0.01 mbar/min
           Denominator: +000.001 mbar/min
Physical Dim.Leakrate: Leak Rate (Dim)
                Format: %f72 ml/min (Format)
                Offset:    0.00 mbar/min
             Nominator:    0.6 ml/min
           Denominator: -0030.000 mbar/min
       Physical Dim. 1: Rel.Pressure (Dim)
                Format: %F73 bar (Format)
                Offset:   0.00000bar
             Nominator:   0.001 bar
           Denominator:   0.00100bar

PRINT                                  BACK
```

12.4 Relative pressure test method classic (pRel. classic)

Setting parameters for the classic relative pressure test method is done in analogy to the differential pressure method described in *chapter 12.1*. The parameters for the differential pressure method are not displayed.

12.5 Relative pressure test method with differential evaluation (pRel. differential)

Setting parameters for the relative pressure test method with differential evaluation is done in analogy to the differential pressure method described in *chapter 12.2*. The parameters for the differential pressure method are not displayed.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

12.7 Volume measurement (option)

Volume measurement is a modification of the relative pressure test method; parameter setting differs only in a few points.

12.7.1 Volume testing with Test Leak

When doing volume measurements with test leaks, you must enter the nominal value of the test leak for the parameter *Leak volume/min* in the base data set or, program-specific, in *local conversion*. Using this value and the measured pressure decay, the volume is calculated.
Note! For the parameters *Reference volume* and *dead volume* **0** must be entered, lest volume measurement with reference volume (see *chapter 12.7.2*) is activated. If no reference volume is connected, activating the volume measurement with reference volume leads to wrong calculations.

12.7.2 Volume testing with reference volume

When doing volume measurements with reference volume, you must enter the following parameter in the base data set:

Volume Data Format:	The desired volume unit (usually [ml])
Reference Volume:	The volume of the reference volume.
Dead Volume:	The device-specific test circuit volume (cf. appendix *Technical data*) plus the connected tube volume or the volume of the fastening and sealing device. If you enter 0, these volumes are included for volume calculation.

12.8 Flow test method (mass flow or volume flow)

Setting parameters for the mass flow test method is done similarly to the differential pressure method described in *chapter 12.1*.
With flow test methods, it is possible to select a pressure correction in the base data set under *Special Options*. If *pressure correction* is active, the actual pressure is compared to the target pressure during the test. In case of a deviation, the result is corrected linearly.

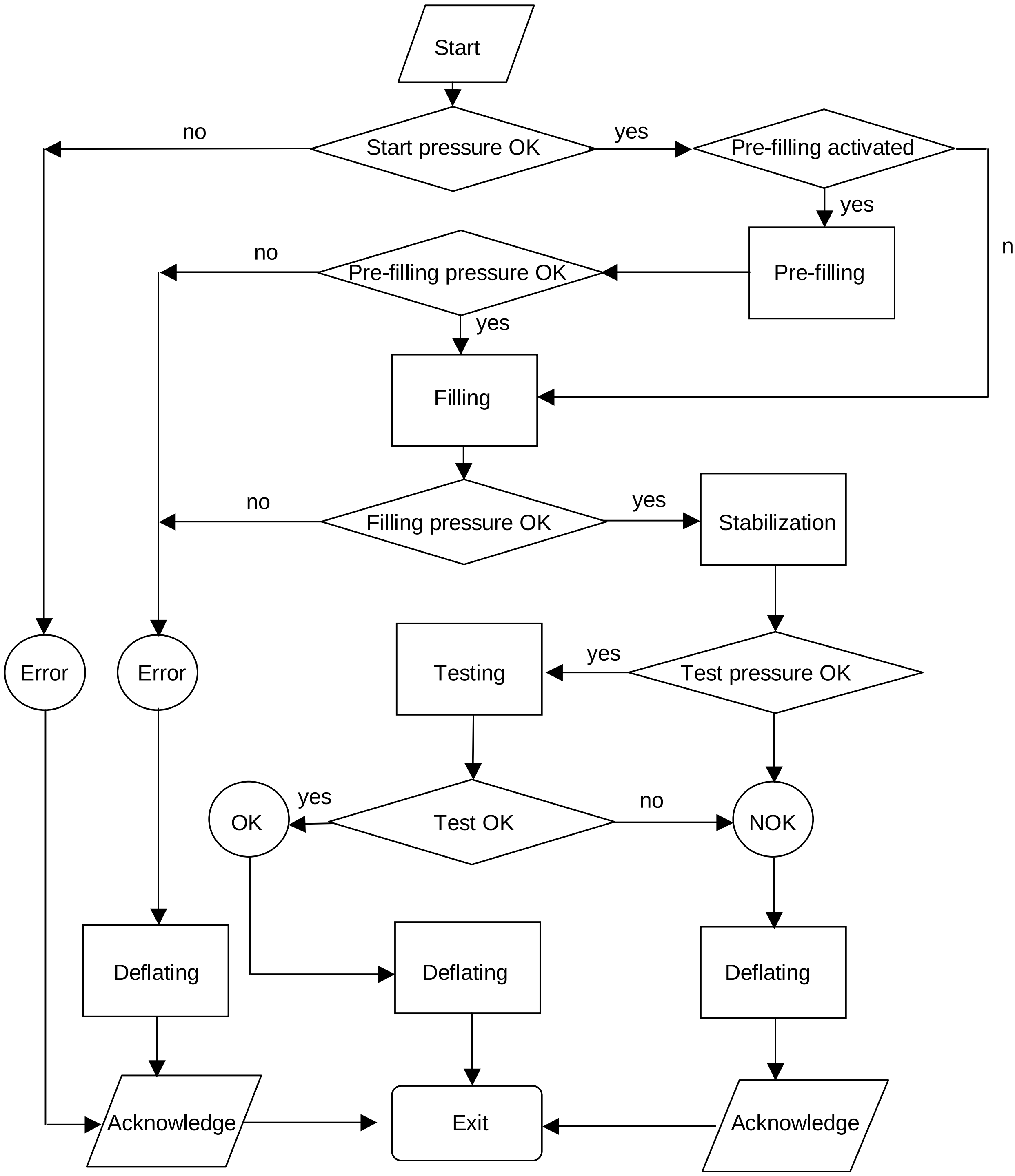
12.9 Automatic adding of test leak connection (option)

For devices equipped with the option to add test leaks automatically, the sub-program 318 (add test leak) or 319 (switch off test leak) must be included via the parameter *Call at Beg.+End* for the creation of the relevant check program in the extended parameters area (see *chapter 14*).

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

13 Test procedure

The following flowchart shows the standard test procedure for a leakage test:



Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

14 Parameters

14.1 Program Parameters

The following parameters can be entered in the Program Parameters submenu (cf. chapter 11.3.5):

Pressure Setpoint: Enter here the target value of the filling pressure.

Fill Time: Time period between beginning and end of the filling procedure.

Stabiliz. Time: Time period between beginning and end of the stabilization period.
The stabilization period serves to equalize the temperature between test medium and test piece.

Testing Time: Time period between beginning and end of the test.
To evaluate the test, the change of pressure (in case of pressure tests) or the measured flow (in case of flow tests) is used.

Result LoLimit: Lower limit value for the evaluation of the test.

Result HiLimit: Upper limit value for the evaluation of the test.
If the test result is outside the range of limit values, the test is evaluated as "NOK".

Deflating: Selection or deactivation of deflating of test piece.
Here you can select whether deflating of the test piece is time-controlled, controlled by a pressure limit value, or deactivated.

Deflate Time: Time period between beginning and end of the deflating procedure.

Marking: Selection or deactivation of marking device control.
Here you can select whether marking should take place before, during or after deflating or not at all.

Marking Time: Time period between beginning and end of the marking command control signal.

Local Conversion: The following parameters are for scaling the testing results for each program (local) ignoring the settings in the base data set. It depends to the program type what data will be changed:
- leak test programs: conversion from pressure drop to leakage rate
- flow test programs: evaluation of the flow
- volume test programs: parameter for volume evaluation

Only the enter of numbers is possible. The format (decimal places, units) is determined by the base data set.
If <u>all</u> values are zeroised, the values will be determined by the base data set too.

The evaluation is carried out by the formula:

$$Y = (X - \text{Offset}) \times \frac{\text{Nominator}}{\text{Denominator}}$$

X = Actual value; Y = Target value

Offset: The value entered here is subtracted mathematically from the measuring result. This might be necessary, if, for example, during a leakage test, thermal effects or plastic deformation of the test piece cause a pressure change that is not due to a leak. Take care to enter the correct algebraic sign!

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4, D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Nominator:.	This is one component used to generate a scaling factor. When converting the pressure drop into a leakage rate, the nominal value of the test leak used must be entered here (see *chapter 12.2*).
Denominator:	In the example of converting the pressure drop into a leakage rate, the measured drop/rise in pressure with the test leak must be entered here (see *chapter 12.2*).
Reference volume:	Volume of the reference volume for volume testing with reference volume (see *chapter 12.7*).
Dead volume:	Device-specific test circuit volume (see appendix *Technical data*) plus the connected tube volume or the volume of the fastening and sealing device for volume testing with reference volume. If you enter 0 here, these volumes are included for volume calculation (see *chapter 12.7*).
Leak volume//min:	For volume measurements with a test leak, the nominal value of the test leak must be entered. Using this value and the measured pressure decay, the volume is calculated (see *chapter 12.7*).

14.2 Extended Parameters

Use the [F4] key to access additional parameters.
If there is entered 0 in certain parameters the value will be evaluated dynamically or changed into pre-configured standard values. In the following these parameters are marked with *. The texts in {} are indicate the automatic generated values if enter 0.

Chain if PASS:	Enter here the three-digit number of one of the 256 possible programs to be run after an OK test (e.g. flow test after a leakage test).
Chain if FAIL:	Enter here the program to be run after an NOK test.
Chain if ERROR:	Enter here the program to be run after an error.
Call at Beg.+End:	Enter here the four-digit number of a subroutine that is run before and after the actual test cycle. This can be e.g. a program for controlling movements or a program for reading a bar-code.
Call when Testing:	Enter here a subroutine for operations to be run at the beginning of a test sequence.
Call synchronized:	Enter here a subroutine to be run for synchronous operations.
Startup delay:	Time period between start signal and beginning of the test procedure.
Signaling delay:	Time period between availability of evaluation result (OK/NOK) and end of test run.
**Initial pRel LoLimit:*	Lower limit value for start pressure monitoring (relative-pressure). Start pressure monitoring ensures that a certain pressure is available at the beginning of a test (usually atmospheric pressure -> 0 bar). {±10% of measuring range}
**Initial pRel HiLimit:*	Upper limit value for start pressure monitoring (relative-pressure). {±10% of measuring range}
**Initial pDif LoLimit:*	Lower limit value for start pressure monitoring (differential-pressure). {±10% of measuring range}

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

**Initial pDif HiLimit:*	Upper limit value for start pressure monitoring (differential-pressure). {±10% of measuring range}
Prefilling:	Selection or deactivation of the pre-filling function. Here you can select whether pre-filling is time-controlled, controlled by a pressure limit value, or deactivated. Pre-filling with a – usually – higher pressure than the test pressure is used to let sealings in the test piece settle.
Prefill Time:	Time period between beginning and end of the pre-filling procedure.
PrePressure Setpoint:	Enter here the target value of the pre-filling pressure.
**PrePressure LoLimit:*	Lower limit value for pre-filling pressure monitoring. {±3% of target value, but min. ±0.33% of measuring range}
**PrePressure HiLimit:*	Upper limit value for pre-filling pressure monitoring. {±3% of target value, but min. ±0.33% of measuring range}
Prefill Hold Time:	Time period between end of pre-filling procedure and beginning of filling procedure.
Filling:	Selection or deactivation of filling function. Here you can select whether filling of the test piece with test pressure (or evacuating it for the vacuum model) is time-controlled, controlled by a pressure limit value, or deactivated.
**Pressure LoLimit:*	Lower limit value for filling pressure monitoring. {±3% of target value, but min. ±0.33% of measuring range}
**Pressure HiLimit:*	Upper limit value for filling pressure monitoring. {±3% of target value, but min. ±0.33% of measuring range}
Fill Hold Time:	Time period between end of filling procedure and beginning of stabilization period.
**Test Pressure LoLimit:*	Lower limit value for test pressure monitoring. {±6.7% of target pressure value, but min. ±0.33% of measuring range}
**Test Pressure HiLimit:*	Upper limit value for test pressure monitoring. If, during the stabilization period, the test pressure goes below the lower limit value or if the test vacuum exceeds the upper limit value, the test is aborted with the result “NOK, pRel Stable”. {±6.7% of target pressure value, but min. ±0.33% of measuring range}
SeparValve Time:	Time period between end of stabilization period and test period. This time period serves to tare a pressure jolt caused by the closing of the separation valve between test and reference circuit (only for differential-pressure test).
**Filter Interval:*	Flexible time window, in which the measured values are averaged. {0.6 sec}
**Differential Pace:*	Time window for differential calculation (differential method only). {1.2 sec}
Result as:	Selection of the display mode of the test result. (e.g. flow, leakage rate, dp/dt, delta p, etc.)
Deflate SetPoint:	Enter here the target pressure after deflating.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4 D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636
info@drwiesner.de www.drwiesner.de

14.3 Base Data

The following parameters can be entered in the Base Data submenu (see *chapter 11.3.6*):

Fail Ack required: Here you can activate or deactivate the function “Acknowledge after NOK evaluation”.

Volume data format: Here you can enter the desired volume unit (usually [ml]) (volume testing).

Reference volume: Volume of the reference volume for volume testing with reference volume (see *chapter 12.7*). These parameters are only accessed when all 3 volume parameters of the program parameters are set to 0 (see *chapter 14.1*).

Dead volume: Device-specific test circuit volume (see appendix *Technical data*) plus the connected tube volume or the volume of the fastening and sealing device for volume testing with reference volume. If you enter 0 here, these volumes are included for volume calculation (see *chapter 12.7*). These parameters are only accessed when all 3 volume parameters of the program parameters are set to 0 (see *chapter 14.1*).

Leak volume//min: For volume measurements with a test leak, the nominal value of the test leak must be entered. Using this value and the measured pressure decay, the volume is calculated (see *chapter 12.7*). These parameters are only accessed when all 3 volume parameters of the program parameters are set to 0 (see *chapter 14.1*).

Prg.Active Output: Here you can enter an I/O bit that will be set during program execution. This is useful when adding an external valve or a lamp etc.

Physical Dim. dp/dt: For leakage tests the value is usually *dp/dt*.
You can also enter a different text.

Physical Dim. Leakrate: For leakage tests the value entered is usually the *leakage rate*.
You can also enter a different text.

Physical Dim. 1: In most cases the relative pressure (*rel. pressure*) is entered here.
You can also enter a different text.

Physical Dim. 2: In most cases the differential pressure (*Diff. pressure*) is entered here.
You can also enter a different text.

Physical Dim. 3: For flow tests the value entered is usually the *flow rate*.
You can also enter a different text.

Format: Here you can enter the format of each physical value.
Example: *%F73 mbar/min*

- mbar/min: Unit of the physical value
- 3: Number of decimal places for the value displayed
- 7: Number of digits incl. decimal point
- F: F = incl. leading zero / f = excl. leading zero
- %: marks the beginning of the format specification

Offset: The value entered here is subtracted mathematically from the measuring result. This might be necessary, if, for example, during a leakage test, thermal effects or plastic deformation of the test piece cause a pressure change that is not due to a leak. Take care to enter the correct algebraic sign!
Note! For *physical value leakage rate* and *physical value 3* this parameter is

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 | Fax +49 (0)7151 973636 | info@drwiesner.de | www.drwiesner.de

only accessed when *offset*, *nominator* and *denominator* of the program parameters are set to 0 (see *chapter 14.1*).

Nominator:. This is one component used to generate a scaling factor. When converting the pressure drop into a leakage rate, the nominal value of the test leak used must be entered here (see *chapter 12.2*).
Note! For *physical value leakage rate* and *physical value 3* this parameter is only accessed when *offset*, *nominator* and *denominator* of the program parameters are set to 0 (see *chapter 14.1*).

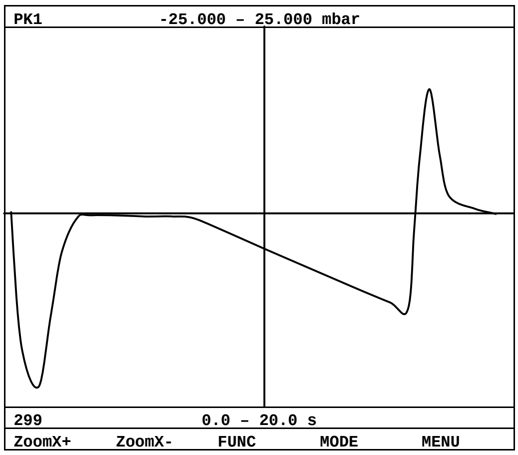
Denominator: In the example of converting the pressure drop into a leakage rate, the measured drop/rise in pressure with the test leak must be entered here (see *chapter 12.2*). Note! For *physical value leakage rate* and *physical value 3* this parameter is only accessed when *offset*, *nominator* and *denominator* of the program parameters are set to 0 (see *chapter 14.1*).

Special options: Here you can activate special options for various test methods.
For flow and differential methods:
Pressure correction: The actual pressure is compared to the target pressure during the test. In case of a deviation, the result is corrected linearly.

Analog output: Here you can scale the proportional pressure control valve.

15 Graphical display

15.1 Display of the march of pressure



In the basic display, press the [F4] key to browse the various display modes. Press this key several times for the graphical display of the march of pressure of the last test.

The graphical display shows the march of the relative pressure [1] or the differential pressure [2] during the entire test run. Press [3] to display the first differentiation of the relative pressure, [4] for that of the differential pressure. Press [5] to display the second differentiation of the relative pressure, [6] for that of the differential pressure.

The upper row shows the display range of the Y-axis in [mbar], the line under the graphics shows the display range of the X-axis in [sec].

Use the [F1] and [F2] keys to enlarge or shrink the display range. Thus it is possible to analyze parts of the pressure curve more easily and using a higher resolution.

Use the [F3] key to switch the zoom function between the X- and Y-axis. Furthermore, you can switch to the Start or Stop function thus enabling an online view of the pressure.

Using the cursor keys, the curve can be moved up/down or to the left/right by 1/10 of the display range.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

15.2 Statistics display

Use the sub-menu (3) of the main menu to access statistical evaluation (see also *chapter 11.3.3*).
Use the [F4] key to display test results graphically.

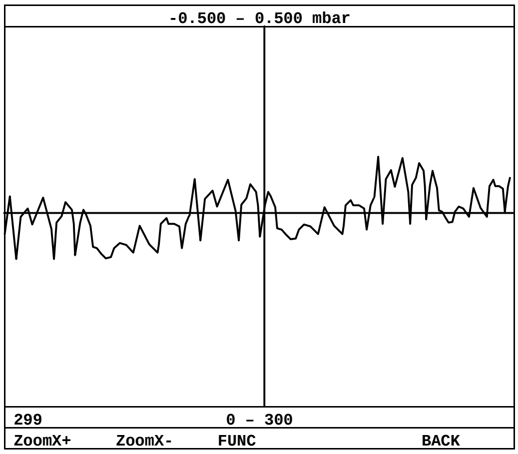
```
        Program: 209,pDif. Clasic
          Tests:    0

   Test Circuit: 1
      Attribute: pDif Delta

    Count Total:      0
    Count Pass :      0
    Count Fail :      0
           Min.: 000.00 mbar
           Max.: 000.00 mbar
           Mean: 000.00 mbar

One TC    All TC    FUNC      GRAPH     BACK
```

The upper row shows the display range of the Y-axis in [mbar] (test results), the line under the graphics shows the display range of the X-axis (number of tests).

Use the [F1] and [F2] keys to enlarge or shrink the display range. This provides maximum clarity.

Use the [F3] key to switch the zoom function between the X- and Y-axis.

Using the cursor keys, the curve can be moved up/down or to the left/right by 1/10 of the display range.



Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

16 Error messages

The test device automatically runs a system test before every test procedure, in which the state of the measuring signals is checked. If one of the entered limit values is exceeded or not reached, the test piece is evaluated as “NOK” and the error cause is displayed.
The most common errors and their causes are listed in the following:

Initial pRel: < LoLimit or ***Initial pRel: < HiLimit***
At start the measured value of the relative-pressure sensor for test pressure monitoring was outside the range of limit values for start pressure monitoring.
Possible causes:

- limit values set wrong (recommended values: -0.1/0.1 bar)
- negative or excess pressure at the test piece connection
- calibration or scaling error
- relative-pressure sensor defective
- measuring electronic defective

Initial pDif: < LoLimit or ***Initial pDif: < HiLimit***
At start the measurement value of the differential-pressure sensor was outside the range of limit values for start pressure monitoring for the differential-pressure (differential-pressure test only).
Possible causes:

- limit values set wrong (recommended values: -0.5/0.5 mbar)
- negative or excess pressure at the test piece connection
- calibration or scaling error
- relative-pressure sensor defective
- measuring electronic defective

pRel at Prefill: < LoLimit or ***pRel at Prefill: > HiLimit***
At the end of the pre-filling period the measurement value of the relative-pressure sensor for test pressure monitoring was outside the range of limit values of pre-filling pressure monitoring.
Possible causes:

- pre-filling pressure set wrong
- limit values set wrong (recommended values: 90/110% of the desired pre-filling pressure)
- a very large leakage or no test piece connected
- negative or excess pressure at the test piece connection
- calibration or scaling error
- relative-pressure sensor defective
- measuring electronic defective

pRel at Filling: < LoLimit or ***pRel at Filling: > HiLimit***
At the end of the filling period the measurement value of the relative-pressure sensor for test pressure monitoring was outside the range of limit values of the filling pressure monitoring.
Possible causes:

- filling pressure set wrong
- limit values set wrong (recommended values: 90/110% of the desired filling pressure)
- a very large leakage or no test piece attached
- negative or excess pressure at the test piece connection
- calibration or scaling error
- relative-pressure sensor defective
- measuring electronic defective

To acknowledge an error, press the [F2] key.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

17 Signal exchange for sequence control

17.1 Introduction

The execution of test programs in the INTEGRA can be controlled using the built-in keyboard or digital I/O signals.
Appropriate setting of the system configuration determines which signals are assigned to which control function.
The following description is valid for all standard programs in the INTEGRA. Application-specific programs may deviate from this.

Two independent instances are involved in sequence control in the INTEGRA:
a) A superior monitoring entity, the *Supervisor*. This entity is responsible for starting (loading and executing) the test programs and for unscheduled abortions.
b) The running test program. As long as a test program (started by the *Supervisor*) is active, it controls further signal exchange autonomously.

For the sake of simplicity, the following description will use a PLC as the partner in the signal exchange throughout. Even if in the actual application a different control device or just manually controlled I/O interfaces instead of a PLC are used: the basic procedure for the signal exchange is always the same.

17.2 Signals and I/O channels

The unusual flexibility of the INTEGRA is made possible last but not least because of a strict separation between the logical (functional) level and the physical level.
The assignment between logical signals and physical I/O channels or flags is determined by the system configuration, separately for each test circuit.
In the following description we will generally refer to the logical level and speak of “signals”, no matter if a physical I/O channel is assigned to a signal or which one.
The terms “input” and “output” are always used from the point of view of INTEGRA, i.e., “output“ always refers to an output of INTEGRA (from the point of view of a superior control this would be an input).

The following list gives an overview of the signals used for sequence control and their functions.

Input signals:
- PROGRAM BIT 1 to 8: Program pre-selection
- START: load and execute the selected program
- PAUSE: execution of the program is stopped after the current step
- STOP (abortion): aborts the running program or resets the completed program
- ACKNOWLEDGE: acknowledge a message (NOK result, disruption etc.)

Output signals:
- READY: system ready for START
- TEST RUNNING: a test program is active
- PAUSING (paused): the current test program was paused
- OK: the test result is “OK”
- NOK: the test result is “NOK”
- DONE (test is completed): the test has been completed
- ERROR: an error or a system failure occurred during the test
  Report defects immediately to the appropriate contact.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 | Fax +49 (0)7151 973636 | info@drwiesner.de | www.drwiesner.de

17.3 Configuration of control signals

Every test circuit has its own set of logical (virtual) control signals. In the system configuration the assignment between the virtual control signals and the physical I/O channels (or device-internal flag bits) is determined. To every logical signal of each test circuit (e.. “Start test circuit 1”), the desired physical I/O bit must be assigned in the system configuration.

The physical I/O bits (including the internal flag bits) are identified by a unique number (1...255). A table of the digital I/O bits can be found in the manual’s appendix. (For example, the pin „IN 1“ of the X1 connector has the bit number 16).
If bit number 0 is given for a signal, the function of the corresponding signal is deactivated.

It is possible to assign the same physical bit number to various logical signals. Therefore, it is possible to set the same digital input channel as start signal for all 3 test circuits.

Appropriate assignment of the signals also determines whether control of the device is possible via keyboard and/or digital I/O signals or not. Configuration can determine, for example, that Start can only be initiated via input channel IN 9 while Stop can be activated using the keyboard or input channel IN 11. For this, the following assignments must be made:
iof Start: 24 (bit no. for connection IN 9)
iof Stop: 26 (bit no. for connection IN 11)
Kb Start: 0 (0 = no Start via keyboard)
Kb Stop: 7 (bit no. of the flag for „Press Stop button for test circuit 1”)

Which test program is loaded and executed at the next Start is also determined by appropriate signal assignment.
To select the desired program manually, the least significant program selection bit must be set to 0. If this signal is assigned a bit number not equal to 0, the manually set program number is ignored and the program is selected according to the given I/O signals.

8 program selection bits are available, but not all need to be assigned. It can happen that the available physical inputs are needed for other purposes and only a few are used as program selection bits. In such cases the signals with the lower values must be assigned while those with higher values are set to 0.
The assigned program bits, beginning with program bit 1 as the least significant bit, up to the last assigned program bit as the most significant one, give the program number as a binary number.

17.4 Exchange of signals in normal test operation

17.4.1 Switch on mode

After switching on the device or after a reset, all output signals are cleared.
As soon as INTEGRA is ready to start the test program, the output is set to READY.
If there is a system malfunction, the ERROR signal is set and READY is cleared.
The signals START, STOP, ACKNOWLEDGE and PAUSE must be cleared by the PLC.

17.4.2 Program pre-selection and Start request by PLC

If READY is set and TEST RUNNING is cleared, the PLC can prepare the program start.
The PLC sets the inputs PROGRAM BIT 1 to 8 as needed.
Note: If these signals come from a different source than the START signal, the PLC has to wait for a sufficiently long time to avoid problems due to different signal delays. For directly connected digital I/O circuits a delay time of 1 ms is sufficient. If, however, signals are connected to different busses, the minimum delay time is equal to the sum of the bus cycle time and a latency of 10 ms.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

Then the PLC sets the START signal.

17.4.3 INTEGRA starts the test program

As soon as INTEGRA has recognized the rising edge on START, the following actions are taken:
- The outputs READY, TEST RUNNING, PAUSING, OK, NOK and ERROR are cleared.
- The output DONE is set.
- The inputs PROGRAM BIT 1 to 8 are read and the number of the program to be started is determined according to the configuration settings.
- The selected test program is loaded and executed. If the program cannot be started (e.g. because the selected program is not available), the ERROR output is set.
- After being started successfully, the test program takes over control of the signal exchange. The DONE signal is cleared and the TEST RUNNING signal is set.

17.4.4 The PLC monitors the starting procedure

Usually, a successful start is checked using the set TEST RUNNING signal.
On rare occasions it can happen that this signal is set for a very brief period of time (e.g. if the program is aborted because of a disruption). This can cause the PLC not to recognize whether the signal has not yet been set or whether it has already been cleared again (after the end of the check routine).
There are two ways to avoid this situation:
a) the PLC uses an internal clock that initiates an appropriate error treatment after the monitoring time has passed. Adequate monitoring time for standard routines is 200 ms, for application-specific extensions longer duration may be necessary.
b) prior to the start, the signals OK, NOK and ERROR are checked for and, if necessary, cleared by a reset call. After the start all 4 signals can be evaluated.

As soon as the PLC recognizes that the test program has been started (or has already been terminated), it can clear the START signal.

17.4.5 Executing the test

During the test procedure itself there is normally no further signal exchange. It is, however, possible to pause the running test at certain points for a while or to request early termination of the test program. For more information turn to section “Special cases”.

17.4.6 Report of the test result

As soon as the test result has been evaluated and all pertaining actions (logging, marking if necessary etc.) have been executed, the test result is reported to the PLC using the signals OK, NOK or ERROR.
Note on the difference between NOK and ERROR:
NOK is reported when the test procedure has been carried out properly but the result is outside the range between the limiting values. The ERROR signal is set when the test procedure could not be carried out properly. The cause can be a disruption but also a defective test piece etc.; therefore, it is not possible to determine whether the test is OK or NOK and ERROR can thus occur by themselves or together.
The appropriate reaction of the PLC to NOK or ERROR depends on the application.

17.4.7 Acknowledge

NOK must only be acknowledged if this has been set in the basic data set of the test program executed.
ERROR must always be acknowledged.
To acknowledge, the PLC has to set the ACKNOWLEDGE signal. Subsequently, INTEGRA clears the ERROR or NOK signal (if both were set, ERROR takes precedence).
Now the ACKNOWLEDGE signal must be cleared.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

17.4.8 End of program

At first INTEGRA sets the READY signal and waits for the signaling time specified in the test program parameters. Subsequently, TEST RUNNING is cleared.
At this point, at the latest, the PLC must clear the START signal. As soon as it has been cleared, the test program is terminated and the supervisor takes over control of the signal exchange.
By setting READY, the PLC is told that INTEGRA is ready for the next start.

17.5 Special cases

17.5.1 Stop test program

For set up and test purposes, it is possible to stop the test procedure of the standard programs at pre-defined points between test steps for a while by setting the input signal PAUSE.
As soon as the test procedure reaches such a break point and PAUSE has been set, as a response to the PLC the output PAUSING (stopped) is set. The test program then waits for the PAUSE signal to be cleared or for the program to be terminated by a stop or reset request.
Note: if PAUSE is cleared before the next break point has been reached, there will be no response.

17.5.2 Abort test procedure prematurely

By setting STOP, the test procedure can be aborted prematurely. As far as possible, the test program tries to shut down the process in a defined way by, for example, venting the test piece. Further signal exchange takes place as described in section “End of program”.

17.5.3 Forced termination of test program (Kill)

In some situations it may be desirable or necessary to force a running test program to be terminated at a certain point, e.g. to create a certain state after an emergency shutdown.
For this, STOP and ACKNOWLEDGE must both be cleared previously, and then set simultaneously for more than 1 second. During this delay time, the running test program can abort the test procedure in analogy to STOP.
If, after this time, the test program does not terminate by itself, the supervisor enforces an immediate program abortion. In this case please note that the test circuit may remain in an undefined state, making a reset of the test circuit (see further down) recommendable.
After killing the process, ERROR is set and OK is cleared. If or as soon as INTEGRA is ready to take a new start request, READY is set.

17.5.4 Acknowledge and clear message

When no test program is active, setting ACKNOWLEDGE or STOP clears all set status signals (OK, NOK, ERROR, TEST RUNNING, PAUSING) and sets the DONE signal.

17.5.5 Reset test circuit

After all messages have been acknowledged (see previous section), setting ACKNOWLEDGE or STOP again causes a reset of the test circuit. At first, all signals pertaining to the test circuit are cleared and all (display) data of the assigned test program are re-initialized.
If or as soon as INTEGRA is ready to take a new start request, READY is set.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

18 Test result output in digital I/O area

18.1 General description

The test results of each test circuit can be made available for other bus participants in the digital I/O area (e.g. in the PROFIBUS output data area).
Upon reset and when confirming the START request, the results and the OK/NOK signals are set to 0.
At the end of the test, before setting OK or NOK, the test result is updated in the data area.
Please note that in case of NOK the numeric test result may be undetermined (e.g. sensor overflow, big leak, premature test abortion etc.) making the test result unsuitable for controlling the data exchange between the bus participants.

18.2 Data format

The test result is stored as a signed 32-bit binary value starting with the most significant byte. The numeric value is equal to the test result shown on the screen (without the decimal point).

18.3 Configuration

In System configuration (Main menu, option 0) you can specify for each test circuit separately, for which virtual 32-bit port the output is intended (set “Result output port” for every test circuit).
You can see from the port table below, which available port is assigned to which physical I/O areas.

Basically any port can be used for data output.
However, it is usually not advisable to use input ports for output, or to assign ports that are already used for other applications (such as Port 1 where the internal digital outputs are that are used for controlling the test valves).

18.4 List of available ports

Port no.	*Direction*	*Description / normal function*	*Comments*
0	Inputs	internal flags and digital inputs IN1...IN16	*1; 2*
1	Outputs	internal flags, valves and digital outputs OUT1...OUT16	*1; 2*
2	Inputs	`AnyBus#1(X3), Bytes 00..03`	*1; 2*
3	Outputs	`AnyBus#1(X3), Bytes 00..03`	*2*
4	Inputs	`AnyBus#2(X2), Bytes 00..03`	*1; 2*
5	Outputs	`AnyBus#2(X2), Bytes 00..03`	*2*
6	Inputs	`AnyBus#2(X2), Bytes 04..07`	*1; 2*
7	Outputs	`AnyBus#2(X2), Bytes 04..07`	*2*
8	Inputs	`AnyBus#2(X2), Bytes 08..11`	*1*
9	Outputs	`AnyBus#2(X2), Bytes 08..11`	*3*
10	Inputs	`AnyBus#2(X2), Bytes 12..15`	*1*
11	Outputs	`AnyBus#2(X2), Bytes 12..15`	*3*
12	Inputs	`AnyBus#2(X2), Bytes 16..19`	*1*
13	Outputs	`AnyBus#2(X2), Bytes 16..19`	*3*
14	Inputs	`AnyBus#2(X2), Bytes 20..23`	*1*
15	Outputs	`AnyBus#2(X2), Bytes 20..23`	*3*
16	Inputs	`AnyBus#2(X2), Bytes 24..27`	*1*
17	Outputs	`AnyBus#2(X2), Bytes 24..27`	*3*

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

Port no.	Direction	Description / normal function	Comments
18	Inputs	AnyBus#2(X2), Bytes 28..31	*1*
19	Outputs	AnyBus#2(X2), Bytes 28..31	
20	Inputs	AnyBus#1(X3), Bytes 04..07	*1*
21	Outputs	AnyBus#1(X3), Bytes 04..07	
22	Inputs	AnyBus#1(X3), Bytes 08..11	*1*
23	Outputs	AnyBus#1(X3), Bytes 08..11	*3*
24	Inputs	AnyBus#1(X3), Bytes 12..15	*1*
25	Outputs	AnyBus#1(X3), Bytes 12..15	*3*
26	Inputs	AnyBus#1(X3), Bytes 16..19	*1*
27	Outputs	AnyBus#1(X3), Bytes 16..19	*3*
28	Inputs	AnyBus#1(X3), Bytes 20..23	*1*
29	Outputs	AnyBus#1(X3), Bytes 20..23	*3*
30	Inputs	AnyBus#1(X3), Bytes 24..27	*1*
31	Outputs	AnyBus#1(X3), Bytes 24..27	*3*
32	Inputs	AnyBus#1(X3), Bytes 28..31	*1*
33	Outputs	AnyBus#1(X3), Bytes 28..31	

Explanations for the comments:

1) *These ports are usually unsuitable for test result output*

2) *These ports contain the I/O signals that are usually used to control the test procedures and that can be assigned to each test circuit / function in the system configuration.*

3) *These ports are accessible via PCP-array in the case of using a Interbus module*

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

19 Maintenance and cleaning

The test device is largely maintenance-free.

If there is a risk that during venting of the test piece **contamination can escape from the test piece** into the test device, a **filter** must be built into the test piece pipe.

The seals of the test valves should be checked in regular intervals approximately twice a year for wear and, if necessary, be replaced. Since the test quality and test accuracy of the device depends on the diligence of execution, the valves must be opened by qualified maintenance personnel only.

To ensure the test quality, it is absolutely necessary to check the test results of the device regularly in short intervals (ideally on a daily basis) using a test leak (see accessories).

Furthermore, the measurement display should be **calibrated** and adjusted once or twice a year. Since the test quality and test accuracy of the device depend on the diligence when calibrating and adjusting, this must be done by qualified maintenance personnel only.

The system is suitable for remote maintenance. This requires connecting a modem or a PC with appropriate data transfer software to the serial interface COM1. This makes it possible to change parameters, upload software updates or get help with problems from the manufacturer's plant.

For cleaning the keypad only use a soft and clean cloth with clear water or mild cleaning agent.
Never use solvent based or aggressive cleanser!

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Leakage Testing System

INTEGRA

Appendixes

Dr. Wiesner
Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Contents

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

1 Data traffic via serial interface

The following types of communication tasks can be carried out via the serial interface:

a) Automatic output of test results at the end of a test:
For this the COM2 and COM3 interfaces can be configured (see “System configuration” menu item). The output can be multiline plain text or a table (CSV format; simplifying reading/editing of data in spreadsheet programs and databases).
Data traffic is text oriented and unidirectional.

b.) Output of data (parameters, statistics etc.) upon manual request from the user interface:
For this all 3 COM interfaces can be used. The selected interface is requested from the user interface on a case by case basis. Data traffic is text oriented and unidirectional.

c) Command-controlled data exchange:
In this case communication is controlled via an external computer. The external computer sends commands and, possibly, parameters or data over the interface. **INTEGRA** processes the received data and replies or sends requested data via the same interface.
For this all 3 COM interfaces can be used.
Data traffic is bi-directional and usually text-oriented; only pure blocks of data (e.g. parameter data) are sent binary.

d) Application-specific special functions:
For tasks that cannot be accomplished with the standard functions, **INTEGRA** can be equipped with customer-specific extensions. For this COM3 is normally used, but in some cases using COM1 or COM2 may be necessary.

With regard to the variety of application possibilities, we recommend the following default assignment of the interfaces:

COM1: For management and diagnostic tasks, especially firmware updates, remote maintenance and debug functions
COM2: To connect external computers for requesting and recording test results and for sending and receiving parameter data. If necessary, this interface may be used for firmware updates and diagnostic functions also.
COM3: To connect report devices (printer, computer with simple data logging function etc.), or for application-specific special functions.

Basically, it is possible to use a combination of operation modes (e.g. automatic data exchange and command-controlled data exchange using the same interface). However, the user or application software of the control computer must ensure that a collision of different data streams does not occur.

2 Interface assignments and data formats

The interfaces use only the data connections TxD and RxD and ground. Handshake connections are not supported. To connect a standard PC, use a so-called null-modem cable (send and receive lines crossed).

The transfer format is generally 115,200 bps, 8 data bits, 1 stop bit, no parity.

For text data the ANSI character set is used, as it is in Windows. External devices that only support the ASCII character set can be used; however, special characters may not be represented correctly.

To send binary data (firmware, parameter files), all available 8-bit characters are used. The soft- and hardware used must support this operation mode and must not, for example, suppress null characters.

For text-oriented command and data lines, CR (carriage return, ANSI code 13) marks the end of a line. For text output, lines are terminated with CR+LF (LF = line feed, ANSI code 10).

Data sets that are output automatically as plain text or, upon request from the user interface, are structured according to the following description.
(The data format for command-controlled data exchange is described in chapter 3.)

2.1 Automatically output test results in plain text

Example:

```
Id. = 02,   Prg= 023,  05-04-21,19:45:30
R077=              Test pressure:  1.525 bar       ok
R098=           Test result:   8.25 ml/min    ok
#
```

General structure:
- a header with device ID, program number, date and time of the test
  Id. = device number according to system configuration (for the time being, this is only a comment).
  The date and time format can be selected in system configuration.
- one or more lines containing test data. Within the line there are the following elements:
  - “R077=” : register number of the value . This register number facilitates automatic data filtering and processing.
  - “Test pressure:” : The plain text denomination of the value concerned
  - “1.525 bar” : Format and physical unit of a value correspond to the display on the screen. Most data formats can be freely configured in the set of basic data.
  - “ok” : evaluation of the value concerned. “ok” means OK, “!F” means NOK or ERROR.
- The “#” character marks the end of a record.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

2.2 Automatically output test results in a table

Example:
`05-04-21,19:45:30,02,023,ok,077,000000001525,ok,098,-00000000825,ok`

General structure:
- All data is contained in one line; fields within the line are separated by commas.
- The first fields contain date, time, device ID and program number, in analogy to the corresponding data of the plain text output.
- The next field shows the overall result of the test, “ok“ or “IF“. A test is considered “ok“ only when all part and intermediate results have been OK.
- Subsequently the values of the measurements are given in the same number and order as in the plain text output. Each measured value consists of the fields register number, value and evaluation.

2.3 Format of data output upon request from the user interface

Example:

```
********************* LOG 2006-02-01,17:09:39 *********************
========================================
Data Block    PRG005   01.02.06,17:11:00
========================================
           Program Type: pRel. Different
          Base Data Set: 001
      Pressure Setpoint: 15000.0 Pa
              Fill Time:     1.0 s
         Stabiliz. Time:   120.0 s
           Testing Time:   120.0 s
         Result LoLimit:    0.00 mbar/mi
         Result HiLimit:    0.00 mbar/mi
----------------------------------------
              Deflating: No Deflating
           Deflate Time:     0.0 s
                Marking: No Marking
           Marking Time:     0.0 s
----------------------------------------
Local Conversion
                 Offset:    0.00 mbar/mi
              Nominator:    0.00 ml/min
            Denominator:    0.00 mbar/mi
Extended Parameter --------------------
          Chain if PASS: 000
          Chain if FAIL: 000
         Chain if ERROR: 000
       Call at Beg.+End: 0000
      Call when Testing: 0000
      Call synchronized: 0000
          Startup delay:     0.1 s
        Signaling delay:     0.0 s
----------------------------------------
   Initial pRel LoLimit: -9999.0 Pa
   Initial pRel HiLimit: 99999.0 Pa
   Initial pDif LoLimit:     0.0 Pa
   Initial pDif HiLimit:     0.0 Pa
```


Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 | Fax +49 (0)7151 973636 | info@drwiesner.de | www.drwiesner.de

```
----------------------------------------
             Prefilling: No PreFilling
           Prefill Time:     0.0 s
   PrePressure Setpoint:     0.0 Pa
    PrePressure LoLimit:     0.0 Pa
    PrePressure HiLimit:     0.0 Pa
      Prefill Hold Time:     0.0 s
----------------------------------------
                Filling: Time-Controlled
       Pressure LoLimit: -9999.0 Pa
       Pressure HiLimit: 99999.0 Pa
         Fill Hold Time:     0.0 s
      TestPress.LoLimit: -9999.0 Pa
     TestPress. HiLimit: 99999.0 Pa
----------------------------------------
        SeparValve Time:     0.0 s
        Filter Interval:     0.3 s
      Differential Pace:     1.2 s
              Result as: dpRel/dt
----------------------------------------
       Deflate SetPoint:     0.0 Pa
# End of Data Block
```

General structure:
Each record starts with two header lines. The middle one contains information about the data block, date and time.
Then the data itself follows, corresponding to the representation in the user interface.
The end of the record is marked by "# End Data block".

3 Command-controlled data exchange

3.1 Basic procedure

The controlling computer sends a command as plain text. The end of the command character string is marked by CR or an asterisk "*". The "*"-type is available only for compatibility reasons with the former model; it is strongly recommended to use CR as the terminator as far as possible. **INTEGRA** starts interpreting and processing the commands only after receiving the terminator.
Depending on the type of command, a block containing binary data can follow. The preceding command specifies the number (and, if applicable, the type) of characters that are then stored transparently (i.e., without further interpretation of control characters etc.) in the data buffer.

If the command received is valid, it will be executed. Execution is usually acknowledged by repeating the command or by sending the requested data (for details see each command). If **INTEGRA** is unable to recognize or execute a command, acknowledgement consists of the received line with a question mark.

The protocol is usually case-insensitive. Exceptions are noted with the corresponding command.
Please note that acknowledgements and other responses may differ in form from the command character string (upper/lower case letters, normalization of address and other numerical data).

Before the commands given by the controlling computer are accepted by **INTEGRA**, a special command to establish communication must be used. Only after this command has been received and acknowledged can further commands be executed. This prevents character strings sent inadvertently

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

over the data line by software (e.g. automatic modem recognition with Plug&Play operating systems) or hardware (impulses at switching on and off) of being misinterpreted by **INTEGRA**.
A number of commands is compatible to the predecessor series (LTS-670). Because of the considerably extended functional range of **INTEGRA**, there are several commands that are no longer supported, require more/other parameters, or that are wholly new in **INTEGRA**.

3.2 Symbols and abbreviations in commands

hh or hhhh: means two or four-digit hexadecimal number

n or nn or nnnn etc.: means a one, two, four etc. –digit decimal number with a fixed number of digits

<any_value> : Expressions in angle brackets define the type of data to be entered in this spot. If the data format doesn't ensue from the date type, the format is arbitrary; i.e., numerical values can usually be entered including or excluding leading blanks or zeros.

3.3 Commands for general device and communication control and status query

WA:=G)WFZB)(/DF : Establishing connection
This cryptic string activates processing of further commands.
INTEGRA responds with "HELLO".
Tip: As mentioned above, for various reasons, characters can be received prior to your application program giving this command so that the command is not accepted. In this case, repeat the command.

"" (empty string, line end character only): Synchronization
Response: empty string (**INTEGRA** answers with terminator)
This command can be used for synchronization purposes if the connection is disturbed or disrupted. It is also possible to check whether **INTEGRA** is online and ready to receive data.

RZ: read BootId
No function, only for compatibility with predecessor series.
Response: RZ:B

WG: reboot
Effect: System restart (hardware reset)

WH: soft reboot (Bootrom)
Effect: System restart (software reset) If supported by the installed boot ROM, a diagnostic menu is started instead of the firmware.

RV: read version-id
Effect: Output of firmware version ID
Response: RV:hhhh
the individual digits in hhhh are to be interpreted as follows:
1. Digit: major version number
2. Digit: minor version number
3. Digit: release number
4. Digit: release status

For example "121F" is version 1.2.1(final) and should be interpreted as follows:
If is firmware with version number 1.2, first release.
It is a final version (release status F).

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

<u>Note:</u>
The **INTEGRA** series is continuously developed further and new or improved features are added. When new functions are added or the user interface is visibly changed, the firmware version number is changed to be identical to the one of the user manual.
For minor internal optimizations, the release number is increased.
Usually, every new release is distributed with the status F, i.e., the release is in the final, approved state. In exceptional cases it may be necessary or desirable to make a release available before final approval. In this case, the last digit contains a number giving the intermediate version number of this release. Early updating to the final version is recommended.

RU: read RTC date/time
<u>Effect:</u> gives date and time read from the internal real-time clock. (The actual readout takes place in cycles in the background, approximately every 2 seconds).
Response: RU:ddmmyyHHMMSS
the letters represent day, month, year, hours, minutes, and seconds.

WU: read RTC date/time
Format: WU:ddmmyyHHMMSS
the letters represent day, month, year, hours, minutes, and seconds.
<u>Effect:</u> sets the real-time clock to the given values. The settings are **NOT** checked for validity or plausibility. Subsequently the real-time clock is read out.
Response: WU:ddmmyyHHMMSS
date and time data is *not* read out from the parameters of the command line but the result after the readout of the real-time clock.

?DATETIME: query formatted date and time
<u>Effect:</u> output of date and time in plain text.
Response: ?DATETIME:<date and time>
The output format equals the one in the user interface (in contrast to the RU command).

WV: set bitrate
Format: WV:115200
<u>Effect:</u> only for compatibility with predecessor series. With **INTEGRA** the data transfer rate is always set to 115200.
Response: WV:115200

WX. show connection msg
No function, only for compatibility with predecessor series.
Response: WX

??: query command list
<u>Effect:</u> Query for command list.
Output: command list The list is in English and serves as mnemonic.

?DIAG: query diagnostic buffer
This command helps to support technical service and enables the query of diagnostic messages.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

3.4 Commands for transferring binary data

Application programs, firmware, memory contents etc. are usually transferred in binary form. Data transfer takes place via a data transfer buffer. The size of this buffer is limited to 16 kByte; thus, larger amounts of data must be sliced into smaller units and transferred in sequence. Data transfer takes place as follows:

Transferring data from **INTEGRA** to control computer:
The computer sends a command requesting transfer of binary data and specifying the memory range and amount of data needed. **INTEGRA** then prepares the transfer and acknowledges the command.
Now the computer requests the actual data transfer. **INTEGRA** acknowledges the request and transfers the prepared data to the computer.
Finally, the computer requests the checksum of the transferred data, compares it with the calculated data and, if necessary, initiates the repetition of the transfer.

Transferring data from the computer to **INTEGRA**:
The computer sends a command to announce the transfer of binary data. **INTEGRA** then prepares the reception and acknowledges the command.
Now the computer transfers the binary data. **INTEGRA** stores the data in the transfer buffer without interpreting them.
Then the computer requests the checksum of the transferred data, compares it with the calculated data and, if necessary, initiates the repetition of the transfer.
Finally, the computer sends a command specifying the storage place for the data and requesting storage execution. **INTEGRA** executes the command and acknowledges.

These are the commands used for binary transfer:

RP: read flash memory
Format: RP:hhhhhhhh,hhhh
the first hexadecimal number defines the flash memory address, the second the number of bytes.
Effect: Preparation of storage area transfer. The actual transfer must be started with the following RD command.
Response: RP:hhhhhhhh,hhhh
Note: The firmware (the “operating system”) is stored in the flash memory of the device.

RE: read eeprom memory
Format, effect and response in analogy to RP command.
Note: The EEprom memory contains calibrating data, user programs and settings.

RR: read RAM memory
Format, effect and response in analogy to RP command.
Note: The battery-buffered RAM contains test results and statistics.

RB read the transfer buffer
Format: RB:hhhh
the hexadecimal number specifies the number of bytes to be transferred.
Effect: Output of data from the transfer buffer.
Response: RB:hhhh
After the terminator, the binary data is transferred.

RD: read number of transferred data bytes
Effect: The number of bytes to be transferred is read (according to a prior transfer command)
Response: RD:hhhh
with hhhh representing the number in hexadecimal format.
Note: This command is redundant. It is recommended not to use this command.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4 D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636 | info@drwiesner.de www.drwiesner.de

RC: read checksum of last transfer
Effect: Read checksum of the last transfer.
Response: RC:hhhh
the hexadecimal number represents a checksum that is made up as follows:
the higher-value byte is the 8 bit checksum of the binary data; the lower value byte is its XOR operation.

RS: calculate checksum
Format: RS:hhhhhhhh,hhhhhhhh
the two hexadecimal numbers specify the beginning and end address of the desired memory area. The addresses are inclusive.
Effect: From the memory area defined the 32-bit checksum is calculated.
Output: RS:hhhhhhhh,hhhhhhhh,hhhhhhhh
The three hexadecimal numbers are start address, end address and the 32-bit checksum of the memory area.
Notes:
This command enables you to check the consistency of larger memory areas without having to read out and transfer the entire memory area. The relevant memory areas are:
from F0000000, 2MB size: flash memory (firmware)
from F1000000, 128KB size: battery-buffered RAM (measuring value memory)
from F2000000, 128KB size: EEprom (calibrating and setting data)

WD: write transfer buffer
Format: WD:hhhh
the hexadecimal number specifies the number of bytes to be transferred.
Effect: After acknowledging the command, **INTEGRA** waits for the specified amount of data to be transferred. The data is stored in the transfer buffer.
Response: WD:hhhh

WN: erase flash memory
Effect: Erase flash memory and prepare for firmware update.
Response: WN,0
If the flash memory cannot be erased, a number > 0 is returned instead of the last zero.

NOTE: Extreme caution must be exercised when using this command!
After erasing, a new firmware must be installed immediately. For example, if the firmware is incomplete or damaged because of a reset, power loss etc., the device does not function anymore. **INTEGRA** can then only be revived with a special original software.
Prior to erasing the flash memory, **INTEGRA** is switched into a state where all non-vital functions (execution of programs, updating of user interface etc.) are deactivated or treated with low priority. This state can only be left with a reset.
WP: write flash memory
Format: WP:hhhhhhhh
Effect: Data in the transfer buffer are burned into the specified address of the flash memory.
Response: WP:hhhhhhhh,0
If an error occurs during burning, a number > 0 is returned instead of the last zero.

NOTE: Extreme caution must be exercised when using this command!
See also explanation for the WN command.
After successfully burning the entire firmware, **INTEGRA** must be reset.

WE: write EEprom memory
Format: WE:hhhhhhhh
Effect: Data in the transfer buffer are burned into the EEprom memory starting at the specified address.
Response: WE:hhhhhhhh,0
If an error occurs during burning, a number > 0 is returned instead of the last zero.

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

Notes:
Erasing the EEprom memory prior to burning is not necessary (unlike the flash memory). If necessary, EEprom pages are erased automatically prior to burning.
After burning the data, a reset is recommended since some settings take only effect after a restart.
The content of the memory should always be transferred completely. Otherwise there is a danger of various areas containing inconsistent data.

NOTE: Special caution must be exercised when using this command!
The EEprom memory contains calibrating data, all user programs and settings. If memory content is incomplete or faulty, this can lead to error messages and usually malfunctions. In this case the memory content must be transferred and burned again.

WR: write RAM
Format: WR:hhhhhhhh
Effect: Data in the transfer buffer are transferred into the battery-buffered RAM starting at the specified address.
Response: WR:hhhhhhhh,0
If an error occurs during writing, a number > 0 is returned instead of the last zero.
Notes:
After writing to the memory, a reset is necessary since some files take only effect after a restart.
The content of the memory should always be transferred completely. Otherwise there is a danger of various areas containing inconsistent data.

3.5 Commands for managing logical data blocks (parameter data + application programs)

Within the EEprom memory the data is organized in logical binary data blocks, comparable to files on the hard disk of a PC. This form of organization makes it possible to read out or write individual parameter sets without changing other data sets (e.g. calibrating data).

For transferring and managing the data blocks the following commands are available.
For the effective transport of pure binary data, the same commands and mechanisms are used that were described in the previous section (see also RB, WD and RC commands).
Please note that creating, changing and erasing data blocks is at first only done in the RAM. Only by using the COMMIT command is the EEprom memory updated. NOTE: COMMIT can also be initiated by the user interface, see also COMMIT command further down.

?EEDIR: read directory of EEprom
Effect: Output of a list of occupied data blocks (block registry).
Response: List of entries as described, followed by "?EEDIR".
Each entry is listed like this:

```
ENTRY: <BlockType> <BlockNumber> <Size_in_Bytes>=<address>
       <BlockType> <BlockNumber> <Size_in_Bytes>=<first_word>
```

The first line contains details about the **INTEGRA** RAM. The entry <address> gives the storage address in RAM for diagnostic purposes.
The second line is for control and diagnosis and contains the data read out from the memory address specified.
Block type and block number are in hexadecimal form. The following block types are possible:
A1: application-specific texts
A2: application-specific format texts
A3: system configuration data
A5: calibration data
A6: sets of basic data
A7: program-specific parameter descriptors

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4 D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636 | info@drwiesner.de www.drwiesner.de

A8: normal test programs with numbers 0 to 255 that can be created, edited and called up in the **INTEGRA** interface.
A9: special programs
AA: empty block at the end of the memory
AB: user-specific program name
FF: empty (erased) data block

Note: Data blocks that haven't been written back to the EEprom are marked by the missing most significant bit in the block type.

!BLDEL: block delete
Format: !BLDEL <BlockType>,<BlockNumber>
Both numbers are decimal.
Effect: The specified data block will be marked as erased in the block list and the RAM.
Response: !BLDEL <BlockType>,<BlockNumber>
If the command is not accepted (e.g. syntax error, block not existing etc.), the command is returned with an added question mark.

.BLPUT: block put
Effect: A data block that was transferred using the WD command and which is now in the data transfer buffer, is written as data block to the RAM. (Type and number of the data block are contained within the data block.) If such a block does already exist, it will be overwritten by the new version; otherwise, the block is created. Then the internal block list is generated again.
Response: .BLPUT <BlockType>,<BlockNumber>,<Size_in_Bytes>
If the command cannot be executed (e.g. syntax error, no data, memory full etc.), the original command is returned with an added question mark.

.BLGET: block get
Format: .BLGET <BlockType>,<BlockNumber>
Effect: The specified data block is prepared for a subsequent transfer (via RB command).
Response: .BLGET <BlockType>,<BlockNumber>
If the command cannot be executed (e.g. block missing), the original command is returned with an added question mark.

!BLINIT: init blocks (erase EEprom and load default blocks)
Effect: Except for calibration data, all data blocks are erased; subsequently a system configuration data block and a block for basic data set 1 is generated according to the default given by the firmware.
Response: !BLINIT
NOTE: By this command (and subsequent COMMIT) all user programs and settings are erased for good; also all special programs and extension options!

!COMMIT:
Effect: this command commits (i.e., burns to the EEprom) all changes made to the EEprom data.
Response: !COMMIT
NOTE: COMMIT can also be initiated by the user interface (e.g. when an editing mask is called or exited)!

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4, D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0, Fax +49 (0)7151 973636 | info@drwiesner.de, www.drwiesner.de

3.6 Commands for control of keyboard, screen and system I/O

Use the following commands to remote control – with some exceptions- **INTEGRA** – via serial interface.

.KBC: send keyboard character
Format: .KBC <key_code> [<key_code>]...
<u>Effect:</u> This command enables you to write any character to the keyboard buffer of **INTEGRA**. These characters have the same effect as pressing the corresponding device button.
A command can contain up to 4 keys; please note that the characters are stored in the keyboard buffer in reverse order.
The keyboard codes must be given in decimal and correspond to the ANSI codes (see down).
Response: ".KBC" followed by a list of keyboard codes in the order written into the keyboard buffer.
The following codes are used for additional characters/special keys:
"<-" (BACKSPACE) : 8
ENTER (START): 13
ESCAPE (STOP): 27
Arrow up: 69 ("E")
Arrow left: 83 ("S")
Arrow right: 68 ("D")
Arrow down: 88 ("X")
+/-: 177
F1: 102 ("f")
F2: 103 ("g")
F3: 104 ("h")
F4: 105 ("i")
F5: 106 ("j")

.KBS: send keyboard string
Format: .KBS <string>
There must be a separator string between the ".KBS" command and <string>. This can consist of a blank, but can also consist of an arbitrary sequence of blanks and commas. (It follows, of course, that the character string must not begin with a blank or comma.)
<u>Effect:</u> The given string that begins after the separator string and runs to the end of the command line is stored in the keyboard buffer character for character. It must be noted that this is a string, a number of actual characters (letters, numbers etc.) and **NOT** their numerical ANSI code (as with the .KBC command).
The desired string can contain the substitute characters for additional characters given above; however, not the functional characters CR (13), LF (10), or NUL.(0).
Response: ".KBS", followed by the string in the keyboard buffer.

?DSY: get display buffer
<u>Effect:</u> Query and transfer of screen buffer. Text characters on the screen are sent line by line. Attributes (colors, flashing etc.) are not sent, neither are graphics.

.BIT: read/write i/o-bit
Format: .BIT <BitNumber> [<NewValue>]
<u>Effect:</u> This command enables reading or writing a bit in the memory for physical inputs and outputs.
If the optional parameter <NewValue> is missing, the queried input/output bit is only read out. If <NewValue> is given, the bit is set to the new value before readout. One value 0 represents "Bit erased", one value <> 0 "Bit set").
Output: .bit <BitNo_decimal> <BitNo_hex> <Value_0_or_1>

Dr. Wiesner Steuerungstechnik GmbH | Weststrasse 4 D-73630 Remshalden, Germany | Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636 | info@drwiesner.de www.drwiesner.de

Important:

With appropriate entries in the system configuration and use of the .BIT command, the set up test programs can be controlled in the same way via digital I/O signals (start, stop, pause, acknowledge etc.).

When giving a bit number, please note the following:
1. The bit number is usually a hexadecimal number. Alternatively, it can be given in decimal form by a preceding “#”. The “.BIT #512“ and “.BIT 200“ commands are therefore identical (in the second case, without the “#”, it is in hexadecimal form!).
2. The user I/O bits 0..255 available for test programs (see also appendix or Excel sheet) start at bit number #512; i.e., 512 (decimal) must be added to all numerical values given in the table.
3. Accessing smaller bit numbers is intended for service and diagnostic purposes; the end user should generally avoid using them. Uncontrolled writing of the bits under #512 can lead to unpredictable system behavior and disruptions.

Here are three examples for the intended use of the .BIT command:

“.bit #513,1” : setting “Start button of test circuit1“ bit. If, in the system configuration of test circuit 1, the entry “Kb Start” contains the value “001”, the program of test circuit 1 is started as if the “START1” button had been pushed on the keyboard.

“.bit #544.1” : set the first digital output (“OUT1“, Bit no. 32 according to I/O table). By setting the bit, further actions can be initiated (depending on the setting of the system configuration or a running test program).

“.bit #528” : query of the state of the first digital input (IN1, Bit no. 16 according to I/O table).

Notes:
It is usually meaningless to write I/O bits that are intended as input signals according to the table. This can cause conflicts between the actual input and the serial control command, and can therefore cause unexpected or random reactions of the device.
I/O bits that are assigned to (optional) bus modules can be used just like normal digital signals or flag bits.

3.7 Other commands

INTEGRA has a number of further commands that are necessary or helpful for the development and test of application programs. To understand this group of commands, extensive programming and system knowledge is necessary. Because of the extent and the limited number of users, this knowledge and the corresponding commands are taught in special training courses.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4 D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636
info@drwiesner.de www.drwiesner.de

Digital I/O interface

The device is equipped with a digital I/O interface featuring a 37-pin male D-Sub connector.
According to DIN EN 61000-6-2 / table 3, cable length is limited to 10 m.
The single-/total-capacity of the outputs is 500 mA
The following inputs and outputs are allocated by default (allocations for custom-built models can vary according to the Appendix *technical data*):

Inputs

Pin	Name	Meaning
X1/11	0V	Reference potential for the test device in- and outputs
		External program pre-selection: The desired program number must be entered before starting.
X1/30	IN 1	Program bit 1 (system - input)
X1/12	IN 2	Program bit 2 (system - input)
X1/31	IN 3	Program bit 3 (system - input)
X1/13	IN 4	Program bit 4 (system - input)
X1/32	IN 5	Program bit 5 (system - input)
X1/14	IN 6	Program bit 6 (system - input)
X1/33	IN 7	Program bit 7 (system - input)
X1/15	IN 8	Program bit 8 (system - input)
X1/34	IN 9	Start (system - input) The input must be set until the device responds with “Test running” (X1/20).
X1/16	IN 10	Stop (system – input) Setting this input stops the test process. The test process continues when the input is reset.
X1/35	IN 11	Abort (system - input) Setting this input aborts the test process.
X1/17	IN 12	Acknowledge bad part (pre-set input) This input must be set for NOK test results.
X1/36	IN 13	Reserve (free input) This input can be used e.g. for controlling the device appliance.
X1/18	IN 14	Reserve (free input) This input can be used e.g. for controlling the device appliance.
X1/37	IN 15	Reserve (free input) This input can be used e.g. for controlling the device appliance.
X1/19	IN 16	Reserve (free input) This input can be used e.g. for controlling the device appliance.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

Outputs

Pin	Name	Meaning
X1/9	+24V	24V DC voltage supply for outputs.
X1/10	+24V	24V DC voltage supply for outputs.
X1/1	OUT 1	Ready (system - output) The test device is switched on and ready for testing.
X1/20	OUT 2	Test is running (pre-set output) This output is set from receiving the start signal until the very end of the test run including periods of interruption after “Stop”, during the waiting period for “Acknowledge bad part” and during the marking and signal period.
X1/2	OUT 3	Pause (system - output) The test run is interrupted by pressing the “Pause” button once or by setting the “Stop“ input.
X1/21	OUT 4	OK (pre-set output) The measured values of all steps of the test were within the set ranges, the test piece is OK.
X1/3	OUT 5	NOK (pre-set output) The measured values of at least one step of the test were outside the set ranges, the test piece is NOK.
X1/22	OUT 6	Test done (pre-set output) This signal is set at the end of the test run and stays active until the next start or until the test results are cleared by Stop.
X1/4	OUT 7	Error (system – output) The test device encountered an error caused by a violation of limiting values at the start or end of the filling process or because of an electronic error.
X1/23	OUT 8	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/5	OUT 9	Mark good part (pre-set output) This output can be programmed using the “Marking” time of the measuring electronic. It is only set when the test result is OK and a marking period > 0 s is programmed. It can be used for controlling a marking device.
X1/24	OUT 10	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/6	OUT 11	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/25	OUT 12	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/7	OUT 13	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/26	OUT 14	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/8	OUT 15	Reserve (free output) This output can be used e.g. for controlling the device appliance.
X1/27	OUT 16	Reserve (free output) This output can be used e.g. for controlling the device appliance.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4 D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636
info@drwiesner.de www.drwiesner.de

This table shows the assignment between external E/A and internal bit numbers.

I/O bit no.	Port/bit	Meaning
0	reserved	
1	flag Bit 01	KbSTART1
2	flag Bit 02	KbSTART2
3	flag Bit 03	KbSTART3
4	flag Bit 04	KbPAUSE1
5	flag Bit 05	KbPAUSE2
6	flag Bit 06	KbPAUSE3
7	flag Bit 07	KbSTOP1
8	flag Bit 08	KbSTOP2
9	flag Bit 09	KbSTOP3
10	flag Bit 10	KbQUIT1
11	flag Bit 11	KbQUIT2
12	flag Bit 12	KbQUIT3
13	flag Bit 13	reserved (Trigger1)
14	flag Bit 14	Trigger2
15	flag Bit 15	Trigger3
16	X1 IN 1	(PrgBit1)
17	X1 IN 2	(PrgBit2)
18	X1 IN 3	(PrgBit3)
19	X1 IN 4	(PrgBit4)
20	X1 IN 5	(PrgBit5)
21	X1 IN 6	(PrgBit6)
22	X1 IN 7	(PrgBit7)
23	X1 IN 8	(PrgBit8)
24	X1 IN 9	(START)
25	X1 IN 10	(PAUSE)
26	X1 IN 11	(STOP)
27	X1 IN 12	(QUIT)
28	X1 IN 13	
29	X1 IN 14	
30	X1 IN 15	
31	X1 IN 16	
32	X1 OUT 1	(ready)
33	X1 OUT 2	(run)
34	X1 OUT 3	(break)
35	X1 OUT 4	(OK)
36	X1 OUT 5	(NOK)
37	X1 OUT 6	(finish)
38	X1 OUT 7	(error)
39	X1 OUT 8	
40	X1 OUT 9	(marking)
41	X1 OUT 10	
42	X1 OUT 11	
43	X1 OUT 12	
44	X1 OUT 13	
45	X1 OUT 14	
46	X1 OUT 15	
47	X1 OUT 16	
48	int. valve 00	(fill)
49	int. valve 01	(emptying)
50	int. valve 02	(separate valve on)
51	int. valve 03	(separate valve off)
52	int. valve 04	(N.C.)

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

I/O bit no.	Port/bit	Meaning
53	int. valve 05	(N.C.)
54	int. valve 06	(N.C.)
55	int. valve 07	(N.C.)
56	flag Bit 56	
57	flag Bit 57	
58	flag Bit 58	
59	flag Bit 59	
60	flag Bit 60	
61	flag Bit 61	
62	flag Bit 62	
63	flag Bit 63	
64	X3 IN 3.00	
65	X3 IN 3.01	
66	X3 IN 3.02	
67	X3 IN 3.03	
68	X3 IN 3.04	
69	X3 IN 3.05	
70	X3 IN 3.06	
71	X3 IN 3.07	
72	X3 IN 2.00	
73	X3 IN 2.01	
74	X3 IN 2.02	
75	X3 IN 2.03	
76	X3 IN 2.04	
77	X3 IN 2.05	
78	X3 IN 2.06	
79	X3 IN 2.07	
80	X3 IN 1.00	
81	X3 IN 1.01	
82	X3 IN 1.02	
83	X3 IN 1.03	
84	X3 IN 1.04	
85	X3 IN 1.05	
86	X3 IN 1.06	
87	X3 IN 1.07	
88	X3 IN 0.00	
89	X3 IN 0.01	
90	X3 IN 0.02	
91	X3 IN 0.03	
92	X3 IN 0.04	
93	X3 IN 0.05	
94	X3 IN 0.06	
95	X3 IN 0.07	
96	X3 OUT 3.00	
97	X3 OUT 3.01	
98	X3 OUT 3.02	
99	X3 OUT 3.03	
100	X3 OUT 3.04	
101	X3 OUT 3.05	
102	X3 OUT 3.06	
103	X3 OUT 3.07	
104	X3 OUT 2.00	
105	X3 OUT 2.01	
106	X3 OUT 2.02	
107	X3 OUT 2.03	
108	X3 OUT 2.04	

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

I/O bit no.	Port/bit	Meaning
109	X3 OUT 2.05	
110	X3 OUT 2.06	
111	X3 OUT 2.07	
112	X3 OUT 1.00	
113	X3 OUT 1.01	
114	X3 OUT 1.02	
115	X3 OUT 1.03	
116	X3 OUT 1.04	
117	X3 OUT 1.05	
118	X3 OUT 1.06	
119	X3 OUT 1.07	
120	X3 OUT 0.00	
121	X3 OUT 0.01	
122	X3 OUT 0.02	
123	X3 OUT 0.03	
124	X3 OUT 0.04	
125	X3 OUT 0.05	
126	X3 OUT 0.06	
127	X3 OUT 0.07	
128	X2 IN 3.00	Test circuit 2 program bit 1
129	X2 IN 3.01	Test circuit 2 program bit 2
130	X2 IN 3.02	Test circuit 2 program bit 3
131	X2 IN 3.03	Test circuit 2 program bit 4
132	X2 IN 3.04	Test circuit 2 program bit 5
133	X2 IN 3.05	Test circuit 2 program bit 6
134	X2 IN 3.06	Test circuit 2 program bit 7
135	X2 IN 3.07	Test circuit 2 program bit 8
136	X2 IN 2.00	Test circuit 2 Start Setting this input starts the test procedure
137	X2 IN 2.01	Test circuit 2 Pause Setting this input stops the test procedure.
138	X2 IN 2.02	Test circuit 2 Abort Setting this input aborts the test procedure.
139	X2 IN 2.03	Test circuit 2 Acknowledge bad part This input must be set for NOK test results.
140	X2 IN 2.04	Reserve (free input) This input can be used freely, e.g. for controlling devices.
141	X2 IN 2.05	Reserve (free input) This input can be used freely, e.g. for controlling devices.
142	X2 IN 2.06	Reserve (free input) This input can be used freely, e.g. for controlling devices.
143	X2 IN 2.07	Reserve (free input) This input can be used freely, e.g. for controlling devices.
144	X2 IN 1.00	Test circuit 1 program bit 1
145	X2 IN 1.01	Test circuit 1 program bit 2
146	X2 IN 1.02	Test circuit 1 program bit 3
147	X2 IN 1.03	Test circuit 1 program bit 4
148	X2 IN 1.04	Test circuit 1 program bit 5
149	X2 IN 1.05	Test circuit 1 program bit 6
150	X2 IN 1.06	Test circuit 1 program bit 7
151	X2 IN 1.07	Test circuit 1 program bit 8
152	X2 IN 0.00	Test circuit 1 Start Setting this input starts the test procedure
153	X2 IN 0.01	Test circuit 1 Pause Setting this input stops the test procedure.
154	X2 IN 0.02	Test circuit 1 Abort Setting this input aborts the test procedure.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4 D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0 Fax +49 (0)7151 973636
info@drwiesner.de www.drwiesner.de

I/O bit no.	Port/bit	Meaning
155	X2 IN 0.03	Test circuit 1 Acknowledge bad part This input must be set for NOK test results.
156	X2 IN 0.04	Reserve (free input) This input can be used freely, e.g. for controlling devices.
157	X2 IN 0.05	Reserve (free input) This input can be used freely, e.g. for controlling devices.
158	X2 IN 0.06	Reserve (free input) This input can be used freely, e.g. for controlling devices.
159	X2 IN 0.07	Reserve (free input) This input can be used freely, e.g. for controlling devices.
160	X2 OUT 3.00	Reserve (free output) This output can be used freely, e.g. for controlling devices.
161	X2 OUT 3.01	Reserve (free output) This output can be used freely, e.g. for controlling devices.
162	X2 OUT 3.02	Reserve (free output) This output can be used freely, e.g. for controlling devices.
163	X2 OUT 3.03	Reserve (free output) This output can be used freely, e.g. for controlling devices.
164	X2 OUT 3.04	Reserve (free output) This output can be used freely, e.g. for controlling devices.
165	X2 OUT 3.05	Reserve (free output) This output can be used freely, e.g. for controlling devices.
166	X2 OUT 3.06	Reserve (free output) This output can be used freely, e.g. for controlling devices.
167	X2 OUT 3.07	Reserve (free output) This output can be used freely, e.g. for controlling devices.
168	X2 OUT 2.00	Test circuit 3 Ready The test device is switched on and the test circuit is ready for testing.
169	X2 OUT 2.01	Test circuit 3 Test is running This output is set from receiving the start signal until the very end of the test run including periods of interruption after “Stop”, during the waiting period for “Acknowledge bad part” and during the marking and signaling period.
170	X2 OUT 2.02	Test circuit 3 paused The test procedure was paused
171	X2 OUT 2.03	Test circuit 3 OK The measured values of all steps of the test were within the set ranges, the test piece is OK.
172	X2 OUT 2.04	Test circuit 3 NOK The measured values of at least one step of the test were outside the set ranges, the test piece is NOK.
173	X2 OUT 2.05	Test circuit 3 Test done This signal is set at the end of the test run and stays active until the next start or until the test results are cleared by Stop.
174	X2 OUT 2.06	Test circuit 3 Error The test device recognized an error caused by a violation of limit values at the start or end of the filling process or an internal electronic error has been detected.
175	X2 OUT 2.07	Test circuit 3 Mark good part This output can be programmed using the “Marking” time of the measuring electronic. It is only set when the test result is OK and a marking period > 0 s is programmed. It can be used for controlling a marking device.
176	X2 OUT 1.00	Test circuit 2 Ready The test device is switched on and the test circuit is ready for testing.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

I/O bit no.	Port/bit	Meaning
177	X2 OUT 1.01	Test circuit 2 Test is running This output is set from receiving the start signal until the very end of the test run including periods of interruption after “Stop”, during the waiting period for “Acknowledge bad part” and during the marking and signaling period.
178	X2 OUT 1.02	Test circuit 2 Pause The test procedure was paused
179	X2 OUT 1.03	Test circuit 2 OK The measured values of all steps of the test were within the set ranges, the test piece is OK.
180	X2 OUT 1.04	Test circuit 2 NOK The measured values of at least one step of the test were outside the set ranges, the test piece is NOK.
181	X2 OUT 1.05	Test circuit 2 Test done This signal is set at the end of the test run and stays active until the next start or until the test results are cleared by Stop.
182	X2 OUT 1.06	Test circuit 2 Error The test device recognized an error caused by a violation of limit values at the start or end of the filling process or an internal electronic error has been detected.
183	X2 OUT 1.07	Test circuit 2 Mark good part This output can be programmed using the “Marking” time of the measuring electronic. It is only set when the test result is OK and a marking period > 0 s is programmed. It can be used for controlling a marking device.
184	X2 OUT 0.00	Test circuit 1 Ready The test device is switched on and the test circuit is ready for testing.
185	X2 OUT 0.01	Test circuit 1 Test is running This output is set from receiving the start signal until the very end of the test run including periods of interruption after “Stop”, during the waiting period for “Acknowledge bad part” and during the marking and signaling period.
186	X2 OUT 0.02	Test circuit 1 Pause The test procedure was paused
187	X2 OUT 0.03	Test circuit 1 OK The measured values of all steps of the test were within the set ranges, the test piece is OK.
188	X2 OUT 0.04	Test circuit 1 NOK The measured values of at least one step of the test were outside the set ranges, the test piece is NOK.
189	X2 OUT 0.05	Test circuit 1 Test done This signal is set at the end of the test run and stays active until the next start or until the test results are cleared by Stop.
190	X2 OUT 0.06	Test circuit 1 Error The test device recognized an error caused by a violation of limit values at the start or end of the filling process or an internal electronic error has been detected.
191	X2 OUT 0.07	Test circuit 1 Mark good part This output can be programmed using the “Marking” time of the measuring electronic. It is only set when the test result is OK and a marking period > 0 s is programmed. It can be used for controlling a marking device
192	X2 IN 7.00	Test circuit 3 program bit 1
193	X2 IN 7.01	Test circuit 3 program bit 2
194	X2 IN 7.02	Test circuit 3 program bit 3
195	X2 IN 7.03	Test circuit 3 program bit 4
196	X2 IN 7.04	Test circuit 3 program bit 5
197	X2 IN 7.05	Test circuit 3 program bit 6
198	X2 IN 7.06	Test circuit 3 program bit 7

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

I/O bit no.	Port/bit	Meaning
199	X2 IN 7.07	Test circuit 3 program bit 8
200	X2 IN 6.00	Test circuit 3 Start Setting this input starts the test procedure
201	X2 IN 6.01	Test circuit 3 Pause Setting this input stops the test procedure.
202	X2 IN 6.02	Test circuit 3 Abort Setting this input aborts the test procedure.
203	X2 IN 6.03	Test circuit 3 Acknowledge bad part This input must be set for NOK test results.
204	X2 IN 6.04	Reserve (free input) This input can be used freely, e.g. for controlling devices.
205	X2 IN 6.05	Reserve (free input) This input can be used freely, e.g. for controlling devices.
206	X2 IN 6.06	Reserve (free input) This input can be used freely, e.g. for controlling devices.
207	X2 IN 6.07	Reserve (free input) This input can be used freely, e.g. for controlling devices.
208	X2 IN 5.00	Reserve (free input) This input can be used freely, e.g. for controlling devices.
209	X2 IN 5.01	Reserve (free input) This input can be used freely, e.g. for controlling devices.
210	X2 IN 5.02	Reserve (free input) This input can be used freely, e.g. for controlling devices.
211	X2 IN 5.03	Reserve (free input) This input can be used freely, e.g. for controlling devices.
212	X2 IN 5.04	Reserve (free input) This input can be used freely, e.g. for controlling devices.
213	X2 IN 5.05	Reserve (free input) This input can be used freely, e.g. for controlling devices.
214	X2 IN 5.06	Reserve (free input) This input can be used freely, e.g. for controlling devices.
215	X2 IN 5.07	Reserve (free input) This input can be used freely, e.g. for controlling devices.
216	X2 IN 4.00	Reserve (free input) This input can be used freely, e.g. for controlling devices.
217	X2 IN 4.01	Reserve (free input) This input can be used freely, e.g. for controlling devices.
218	X2 IN 4.02	Reserve (free input) This input can be used freely, e.g. for controlling devices.
219	X2 IN 4.03	Reserve (free input) This input can be used freely, e.g. for controlling devices.
220	X2 IN 4.04	Reserve (free input) This input can be used freely, e.g. for controlling devices.
221	X2 IN 4.05	Reserve (free input) This input can be used freely, e.g. for controlling devices.
222	X2 IN 4.06	Reserve (free input) This input can be used freely, e.g. for controlling devices.
223	X2 IN 4.07	Reserve (free input) This input can be used freely, e.g. for controlling devices.
224	X2 OUT 7.00	Reserve (free output) This output can be used freely, e.g. for controlling devices.
225	X2 OUT 7.01	Reserve (free output) This output can be used freely, e.g. for controlling devices.
226	X2 OUT 7.02	Reserve (free output) This output can be used freely, e.g. for controlling devices.
227	X2 OUT 7.03	Reserve (free output) This output can be used freely, e.g. for controlling devices.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

I/O bit no.	Port/bit	Meaning
228	X2 OUT 7.04	Reserve (free output) This output can be used freely, e.g. for controlling devices.
229	X2 OUT 7.05	Reserve (free output) This output can be used freely, e.g. for controlling devices.
230	X2 OUT 7.06	Reserve (free output) This output can be used freely, e.g. for controlling devices.
231	X2 OUT 7.07	Reserve (free output) This output can be used freely, e.g. for controlling devices.
232	X2 OUT 6.00	Reserve (free output) This output can be used freely, e.g. for controlling devices.
233	X2 OUT 6.01	Reserve (free output) This output can be used freely, e.g. for controlling devices.
234	X2 OUT 6.02	Reserve (free output) This output can be used freely, e.g. for controlling devices.
235	X2 OUT 6.03	Reserve (free output) This output can be used freely, e.g. for controlling devices.
236	X2 OUT 6.04	Reserve (free output) This output can be used freely, e.g. for controlling devices.
237	X2 OUT 6.05	Reserve (free output) This output can be used freely, e.g. for controlling devices.
238	X2 OUT 6.06	Reserve (free output) This output can be used freely, e.g. for controlling devices.
239	X2 OUT 6.07	Reserve (free output) This output can be used freely, e.g. for controlling devices.
240	X2 OUT 5.00	Reserve (free output) This output can be used freely, e.g. for controlling devices.
241	X2 OUT 5.01	Reserve (free output) This output can be used freely, e.g. for controlling devices.
242	X2 OUT 5.02	Reserve (free output) This output can be used freely, e.g. for controlling devices.
243	X2 OUT 5.03	Reserve (free output) This output can be used freely, e.g. for controlling devices.
244	X2 OUT 5.04	Reserve (free output) This output can be used freely, e.g. for controlling devices.
245	X2 OUT 5.05	Reserve (free output) This output can be used freely, e.g. for controlling devices.
246	X2 OUT 5.06	Reserve (free output) This output can be used freely, e.g. for controlling devices.
247	X2 OUT 5.07	Reserve (free output) This output can be used freely, e.g. for controlling devices.
248	X2 OUT 4.00	Reserve (free output) This output can be used freely, e.g. for controlling devices.
249	X2 OUT 4.01	Reserve (free output) This output can be used freely, e.g. for controlling devices.
250	X2 OUT 4.02	Reserve (free output) This output can be used freely, e.g. for controlling devices.
251	X2 OUT 4.03	Reserve (free output) This output can be used freely, e.g. for controlling devices.
252	X2 OUT 4.04	Reserve (free output) This output can be used freely, e.g. for controlling devices.
253	X2 OUT 4.05	Reserve (free output) This output can be used freely, e.g. for controlling devices.
254	X2 OUT 4.06	Reserve (free output) This output can be used freely, e.g. for controlling devices.
255	X2 OUT 4.07	Reserve (free output) This output can be used freely, e.g. for controlling devices.

Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49 (0)7151 9736 0
Fax +49 (0)7151 973636
info@drwiesner.de
www.drwiesner.de

EC Declaration of Conformity

dr. wiesner
steuerungstechnik

as defined by EC Directive

2004/108/EEC
2006/95/EEC
93/68/EEC

We confirm that the products defined below meet the EC directives above by design, type and the version which are put into circulation by us.
In case of any product changes or use which does not comply with the instructions made without our approval, this declaration will be avoid.

Designation of the product:

Leakage Testing System INTEGRA

type
RD, RD1, RD4, RD6, RD10, RDV,
DD, DD1, DD6, DD10, DDV,
DF, DF1M, DF2M, DF1
and their versions

Manufacturer: Dr. Wiesner Steuerungstechnik GmbH
Weststrasse 4
D-73630 Remshalden, Germany
Phone +49-7151-9736-0
Fax +49-7151-9736-36

The following EN standards were applied at the time of testing:

DIN EN 60204-1, Electrical Equipment for Industrial Machinery
DIN EN 61000-6-2, Generic Standard Disturbance Immunity, Industrial Sector
DIN EN 61000-6-4, Generic Standard Disturbance Transmission, Industrial Sector

Remshalden, January 01, 2010

Dipl.-Ing. Frank Wiesner
General Manager

Pay attention to the safety instructions in the delivered documentation.